Massachusetts Division of Marine Fisheries
B-120 Buzzards Bay Shellfish Injury and Lost Shellfishing
2018 Progress Report

Prepared for the B-120 Buzzards Bay Trustee Council
Submitted March 2019

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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, Massachusetts, a settlement was secured between the B-120 Buzzards Bay Trustees and the responsible party to restore natural resources and manage natural use injuries across the impacted area. Among the issues addressed were injuries to shellfish resources and the recreational shellfishery in Buzzards Bay, for which the Massachusetts Division of Marine Fisheries (*DMF*) is addressing through three specified restoration strategies. These include 1) a project in which fecal coliform-contaminated quahog broodstock are transferred from donor areas in the Taunton River into designated sites within spill-affected Buzzards Bay communities, 2) out-planting of hatchery quahog seed reared in municipally maintained upwellers, and 3) out-planting of hatchery oyster seed reared in municipally maintained upwellers (Final Restoration Plan and Environmental Assessment). The following report summarizes methods and results of these restoration activities and ongoing monitoring by DMF during 2018.

In October 2015, DMF initiated a quahog relay project to oversee the planned and scheduled relay of quahog broodstock secured from a fecal coliform-contaminated closure area (donor site) in the Taunton River and placement into designated sites within Buzzards Bay municipalities. Surveys of the relay sites were conducted prior to relay activities during each year. The rationale for this project is that broodstock taken from closed waters with high quahog densities will be relocated to municipally-managed sites and strategically opened to harvesting in order to enhance recreational fisheries and contribute to stock enhancement within and in the vicinity of the relay site(s). It is anticipated that this program will result in enhancement of local quahog populations that are then expected to contribute to managed, sustainable, recreational shellfisheries. Quahog relays were successfully conducted in 2015, 2016, and 2018, with all nine Buzzards Bay municipalities (Bourne, Dartmouth, Fairhaven, Gosnold, Marion, Mattapoisett, New Bedford, Wareham, and Westport) receiving quahogs in 2018, as scheduled.

With the advent of commercial and municipal shellfish hatcheries and the development of cost-effective nursery techniques such as upwellers (i.e., moored, floating flow-through systems termed "FLUPSYs"), oyster and quahog reseeding programs have flourished throughout the Northeast. Many municipal and certain non-governmental organizations implement oyster and/or quahog management programs that include reseeding shellfish to enhance local stocks. The B-120 Buzzards Bay recreational shellfishing injury funds are being utilized to purchase seed quahogs and oysters from commercial hatcheries for intermediate grow-out and out-planting to restoration sites. In Massachusetts, many municipalities do not have upweller capacity or staff to tend and manage the nursery grow-out of substantial numbers of oysters. As a result, municipal shellfish managers often purchase larger, field plant sized oysters ($\geq$ 20 mm) for direct seeding in municipal public shellfish beds.

In 2018, B-120 funds were utilized to purchase hatchery-reared oysters from Muscongus Bay Aquaculture in Maine. The Wareham, Marion, and Bourne Shellfish Departments purchased two size classes of oysters for intermediate grow out; smaller oysters ($\geq$ 2 mm) were placed in town-owned upwellers, and the larger oyster seed (9-13 mm) was placed in floating bags and cages located at designated municipal grow-out sites and overseen by DMF and town shellfish staff. All of these oysters were out-planted to restoration sites during fall 2018.

During 2016 and 2017, *DMF* oversaw a program whereby the towns of Wareham, Dartmouth, and Fairhaven purchased upweller kits for growing out small quahog seed for restoration of recreational fishing areas, and then purchased 5-9 mm quahogs for grow-out and eventual out-planting. Due to a poor growth year for quahog seed and time constraints for adequate grow-out, quahog seed was not purchased in 2018. However, B-120 funds set aside for this quahog order will be utilized in 2019 and 2020 to purchase additional quahog seed for nursery grow-out and out-planting at Dartmouth and Fairhaven. Wareham will use their allotted portion of the funds as well as their extensive upweller capacity to purchase additional single oysters instead of quahog seed.

This report summarizes the rationale, methods, and results of these three projects.

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I. *Quahog Relays and Stock Enhancement*

Obtaining Quahog Broodstock

In September-November 2018, *DMF* oversaw the relay of bacterial-contaminated quahogs from closed waters in the Taunton River (donor site) to a total of nine municipal-water sites in Bourne, Dartmouth, Fairhaven, Gosnold, Marion, Mattapoisett, New Bedford, Wareham, and Westport (Refer to Appendix I for relay site locations).

Prior to conducting relays, *DMF* collected quahog samples from the Taunton River donor site for shellfish disease testing at Kennebec River Biosciences in Maine. A full suite of pathology screenings were performed by Kennebec River Biosciences, including examination for any external or internal morphological abnormalities and pests, predators, and parasites. No evidence of shellfish diseases was found in any of the samples. Pathology screening results for the tested donor site quahogs are presented in Appendix II.

DMF established contracts with two qualified dredge boat captains to collect and transport broodstock quahogs from the donor site to each of the relay sites. *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' waters. In 2018, *DMF* estimated that each municipality would receive a minimum of 800 bushels of quahogs based on an estimated price of $18.50 per bushel. Similar to 2015 and 2016, Gosnold requested fewer quahogs due to limited acreage of suitable quahog habitat at the selected site, receiving a total of 50 bushels in 2018 (compared to 70 bushels in 2015 and 2016).

Site Selection Methods

Subsequent to receiving the pathology report, *DMF* worked with the local shellfish departments to determine prospective relay (receiving) sites. Each municipality planted quahogs at one site (Refer to Appendix I). As an important factor driving restoration success, site selection was determined carefully by factors including:

- Suitable quality and quantity of benthic habitat available
- Availability and proximity of the site to public access for public recreational fishing
- A recreational shellfishing-only site designation for each site
- Degree to which the area was previously affected by the B-120 oiling that resulted in harvest closures
- Proper Shellfish Growing Area classification, and
- Lack of a substantial quahog population currently present in the area.

Prior to planting, *DMF* biologists and local Shellfish Constables worked collaboratively to select potential sites and conduct surveys in order to document habitat conditions, level of resident shellfish abundance, and size classes of shellfish at each of the sites. All selected sites were 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 varying hydrographic conditions at each site. At every site, the proposed area was initially assessed for potential suitability of quahog habitat and any sections of the area that were unsuitable (shoreline boulder field, eelgrass beds and 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 resident shellfish population. Transects were run perpendicular to shore to allow for the quantification of resident shellfish resources as well as habitat and substrate variability that is often affected 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). Most surveys were conducted by *DMF* and town shellfish department staff within the subtidal zone during low-tide cycles. Transects were established and sampled in shallow water by survey teams working from shore. One site (Westport) required sampling from a boat; the most suitable planting area corresponded to a depth of 5-8 feet, which was too deep to be surveyed via shoreline wading.

In 2018, transects were consistently 100-150 feet in length and quadrats were again sampled at 10-foot intervals along the transect line. The total number of quadrats that were sampled per survey varied somewhat depending on the number of personnel helping with the survey, weather conditions, and bottom type of the site; however a minimum of 20 quadrats per site was consistent. Total number of quadrats sampled per site is noted in each site summary section below. These quadrats were 1-square foot in area, and were raked using either a mesh-lined basket rake (12-inches across) or bull rake (18 inches across, boat surveys) to a depth of 8-12 inches. All quahogs were counted and measured, and all other shellfish, predators, vegetation type and percent cover, substrate type, and sampling depth were recorded. The minimum threshold density for considering shellfish placement was measured as resident shellfish populations was one quahog per 1-square foot, three soft-shell clams per 1-square foot, and three oysters per 1-square foot; locations with densities above the threshold were deemed productive and were no longer considered as a relay site. GPS coordinates were taken at the start and end of each transect so that the accurate sampling locations could be mapped and to ensure planting occurred in the surveyed areas.

Site Selection Results

Summaries of each pre-planting site survey from 2018 are detailed below, and a summary table of 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 nine B-120 relay sites is provided below (Figure 1), and individual maps of each town's quahog relay sites are provided in Appendix I.

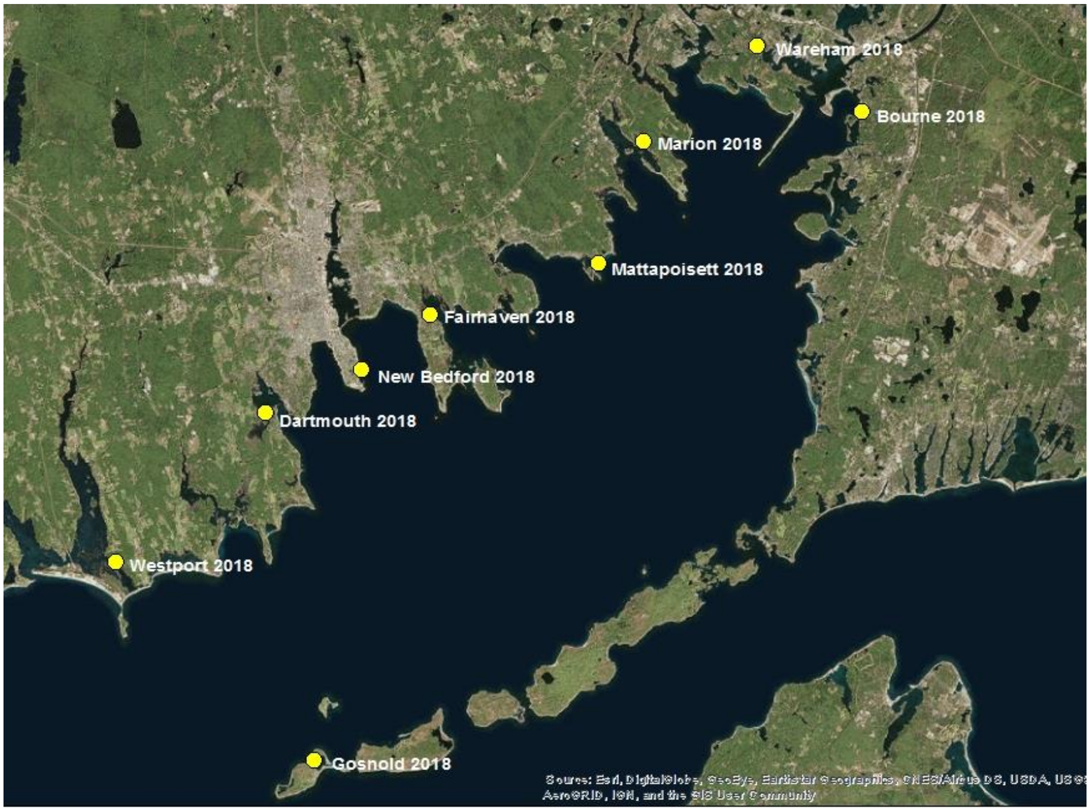

Figure 1. Map of the nine B-120 contaminated quahog relay sites around Buzzards Bay.

Municipality	Site Name	Year Planted	Area Planted (acres)	Depth Range at MLLW (ft.)
Bourne	Little Bay	2018	4.4	0 - 4.8
Dartmouth	Gulf Bridge Road	2018	4.1	1.3 - 4.3
Fairhaven	Seaview Avenue	2018	2.1	0.4 - 2.9
Gosnold	Cuttyhunk Pond - SE Corner	2018	1.7	1.3 - 1.8
Marion	Planting Island Cove, #2	2018	4.6	0.4 - 2.9
Mattapoisett	Nyes Cove	2018	19.1	-0.1 - 2.4
New Bedford	Monkey Pier	2018	6.7	-0.7 - 4
Wareham	Agawam Beach	2018	6.4	1.0 - 2.5
Westport	The Let - NW Quadrant	2018	18.6	0.5 - 2

Table 1. Summary of 2018 B-120 contaminated quahog relay sites. Positive depth values indicate depth below MLLW and negative depth values indicate height above MLLW.

2018 Sites

Bourne – Little Bay

In consultation with *DMF* personnel, the Bourne Shellfish Constable, Tim Mullen, chose a portion of Little Bay off the northeastern side of Toby's Island for the 2018 quahog relay due to the suitability of the substrate and public access for recreational shellfishing. All of Bourne municipal waters including Little Bay, was closed to shellfishing on April 28th, 2003 due to the oil spill and re-opened on May 22nd, 2003. The relay site is in DSGA BB: 46.2, which is classified as "CONDITIONALLY APPROVED" and meets NSSP standards for direct harvest of shellfish during the time period that the area is open. Tim Mullen stated this 4.5-acre area would benefit greatly from a relay because it is favorable habitat for quahogs and has been utilized recreationally in the past. The nearby parking lot at Monument Beach Marina provides public parking and access points.

On July 11th, 2018, a pre-relay site survey was conducted by *DMF* staff members and town shellfish officials. Survey results indicated a firm sand/mud substrate with some gravel, and an absence of any submerged aquatic vegetation (SAV). Water depth in Little Bay ranges between 0.0 to 4.8 feet below MLLW. A total of six transects of 10 quadrats each were sampled within the site (60 quadrats). Forty-six quahogs were harvested for a density of 0.77 quahogs/ft.^{2} (Table 2). Several *Carcinus maenas* (green crab) carapaces were found, but no other predator species were observed. The area will be closed for two years and is expected to reopen to recreational shellfishing in the fall of 2020.

Mean (mm)	39.68
Min (mm)	8.16
Max (mm)	79.37
Total #	46
# Quadrats	60
Density/sq.ft.	0.77

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

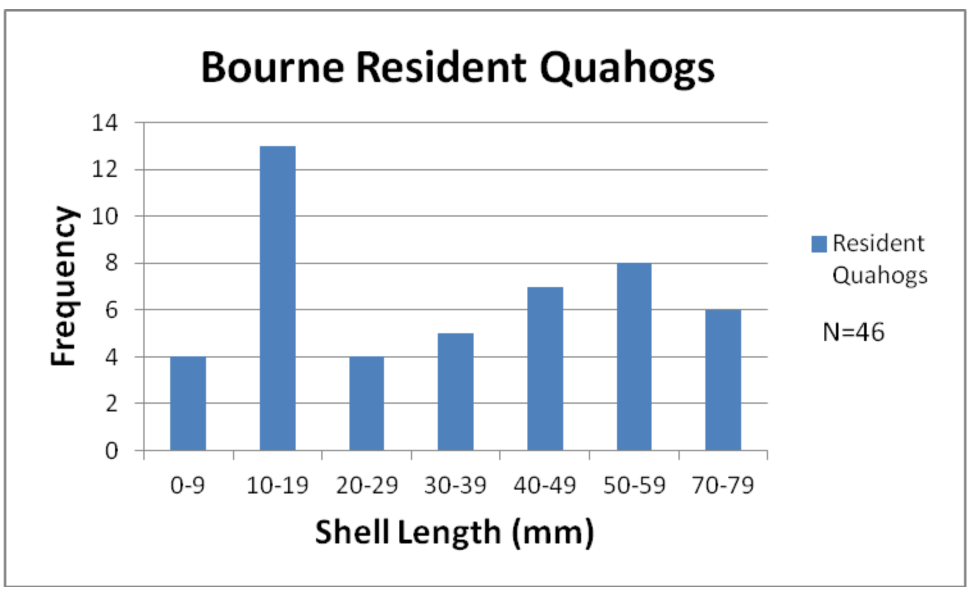

Figure 2. Resident quahog length frequencies at the Bourne B-120 relay site.

Dartmouth – Gulf Road Bridge

In consultation with *DMF* personnel, the Dartmouth Shellfish Constable, Steve Mello, chose the area directly south of the Gulf Road Causeway in Apponagansett Bay for the 2018 quahog relays. All of Dartmouth municipal waters, including Apponagansett Bay, were closed to shellfishing on April 28th, 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 period that the area is open. This 4.1-acre area has favorable habitat for quahogs and does not currently support a recreational shellfishery due to the lack of sufficient quahog resource. In the 1980s and 1990s, however, this area was used as a relay site due to its ease of access and suitable habitat. The large parking lot at Apponagansett Point Recreation Area as well as limited street parking on Smith Neck Road are the access points for the relay area.

On August 9th, 2018, a pre-relay site survey was conducted by *DMF* staff members and the Shellfish Constable. Survey results indicated a sand and mud substrate, with no SAV coverage. Water depth in the area ranges between 1.3 – 4.3 feet below MLLW. A total of 3 transects of 30 quadrats each were sampled within the site (90 quadrats total). Fifty-eight quahogs were found for a density of 0.64 quahogs/ft.^{2} (Table 3). Due to limited recreational shellfishing areas in Dartmouth, the site will be closed for one year, reopening in the fall of 2019.

Mean (mm)	46.87
Min (mm)	12.21
Max (mm)	100.29
Total #	58
# Quadrats	90
Density/sq.ft.	0.64

Table 3. Summary table of the resident quahog population at the Dartmouth B-120 relay site. Size measurements denote shell length.

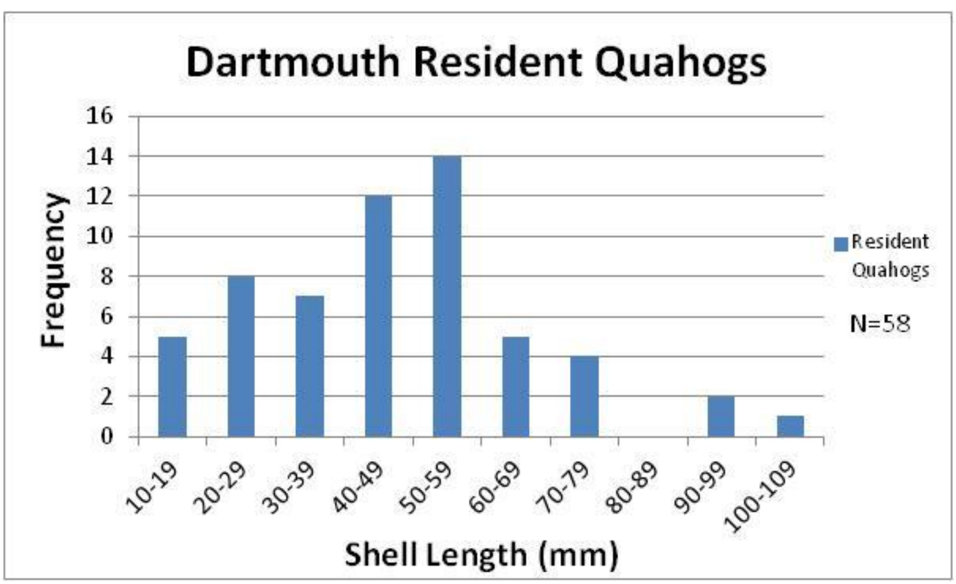

Figure 3. Resident quahog length frequencies at the Dartmouth B-120 relay site.

Fairhaven – Seaview Avenue

In consultation with *DMF* personnel, the Fairhaven Shellfish Constable, Tim Cox, selected waters off the end of Seaview Avenue for 2018 quahog relays. All of Fairhaven waters were closed to shellfishing on April 28th, 2003 due to the oil spill and re-opened on October 13, 2003. The relay site is in DSGA BB: 18.24, which is classified as "APPROVED" and meets NSSP standards for the direct harvest of shellfish throughout the year. The shellfish constable stated that this 2.1-acre area is very favorable habitat for quahogs and has been utilized recreationally in the past. The parking lot at the Seaview Avenue town landing provides parking and access points for this area which the town has designated for recreational shellfishing only.

On July 24th, 2018, a pre-relay site survey was conducted by *DMF* staff and the Shellfish Constable. Survey results indicated a sand substrate, with no SAV coverage. Water depth at the Seaview Avenue site ranges between 0.4 – 2.9 feet below MLLW. A total of six transects of 10 quadrats each were sampled within the site (60 quadrats total). Fifteen quahogs were found for a density of 0.25 quahogs/ft.^{2} (Table 4). The site will be closed for two years and reopened to recreational shellfishing in the fall of 2020.

Mean (mm)	63.67
Min (mm)	23.62
Max (mm)	102.33
Total #	15
# Quadrats	60
Density/sq.ft.	0.25

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

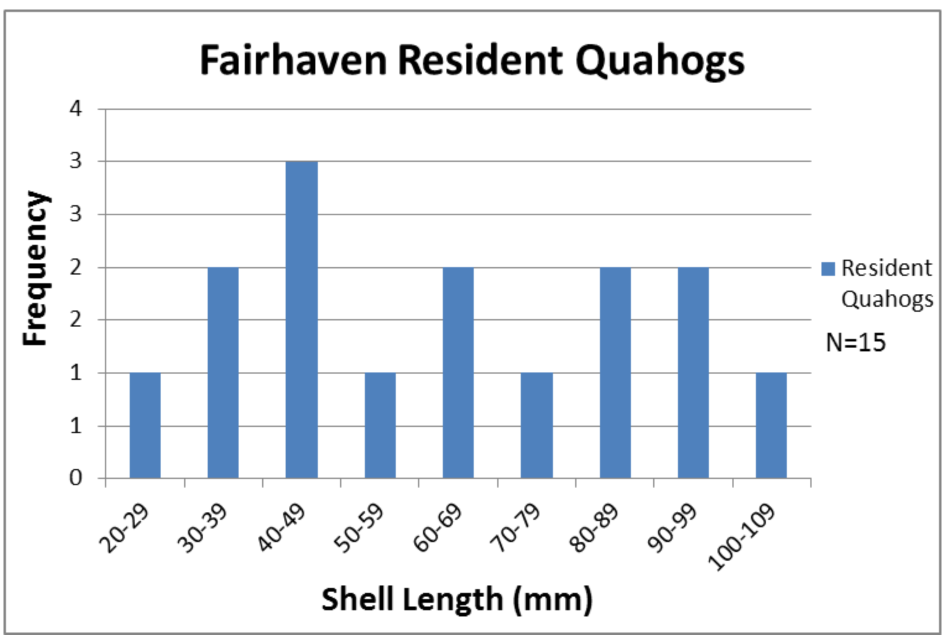

Figure 4. Resident quahog length frequencies at the Fairhaven B-120 relay site.

Gosnold – Cuttyhunk Pond (Southeast Corner)

In consultation with *DMF* personnel, Seth Garfield on behalf of the Gosnold Shellfish Constable, Asa Lombard, chose the southeastern corner of Cuttyhunk Pond as the 2018 relay site. This 1.7-acre location has suitable substrate for quahogs and has not been the focus of previous propagation efforts in the past. All of Gosnold was closed to shellfishing on April 28th, 2003 due to the oil spill and re-opened on May 22nd, 2003. The relay site is in DSGA E: 9.2, which is classified as "CONDITIONALLY APPROVED" and meets NSSP standards for direct shellfish harvest when in the open status. The area is accessible from Gosnold County Road and by vessel.

On July 18th, 2018, a pre-relay site survey was conducted by *DMF* staff members and Seth Garfield. Survey results indicated a firm sand/mud substrate and a lack of SAV coverage. Because of the small size and apparent uniformity of the area, a total of two transects with 10 quadrats each were sampled (20 quadrats total). No quahogs or other shellfish species were observed, despite the suitable substrate. This is most likely due to the relative isolation of the pond from other shellfish recruitment sources. Water depth ranged from 1.3 – 1.8 feet below MLLW. The area will be closed for one year following the contaminated quahog relay and will reopen in October 2019.

Marion – Planting Island Cove, Site #2

In consultation with *DMF* personnel, Marion Shellfish Department staff (Isaac Perry, Harbormaster and Adam Murphy, Shellfish Constable) selected a portion of Planting Island Cove for a quahog relay in 2018. They stated that the 4.6-acre area adjacent to the 2016 quahog relay site is similarly favorable habitat for quahogs. The area has also received quahog relays in the past and the parking lots along the western shore provide parking and access points for this area. All of Marion municipal waters, including Planting Island Cove, were closed to shellfishing on April 28th, 2003 due to the oil spill and re-opened on November 12th, 2003. The relay site is in DSGA BB: 32.0, which is classified as "APPROVED" and meets NSSP standards for direct harvest of shellfish throughout the year. Isaac Perry does not believe the area currently supports a recreational shellfishery due to the limited quahog resource, and the shellfish department has not performed any propagation activity in this area for years.

On August 8th, 2018, a pre-relay site survey was conducted by *DMF* staff members and the Shellfish Constable. Survey results indicated a soft mud/sand substrate, with no SAV coverage. Water depths of the Planting Island Cove site range between 0.4 – 2.9 feet below MLLW. A total of three transects with 13 to 15 quadrats each were sampled within the site (43 quadrats total). Two quahogs were found for a density of 0.05 quahogs/ft.^{2} (Table 5). The site will be closed to shellfishing for one year and reopened to recreational shellfishing in the fall of 2019.

Mean (mm)	108.63
Min (mm)	94.46
Max (mm)	122.80
Total #	2.00
# Quadrats	43.00
Density/sq.ft.	0.05

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

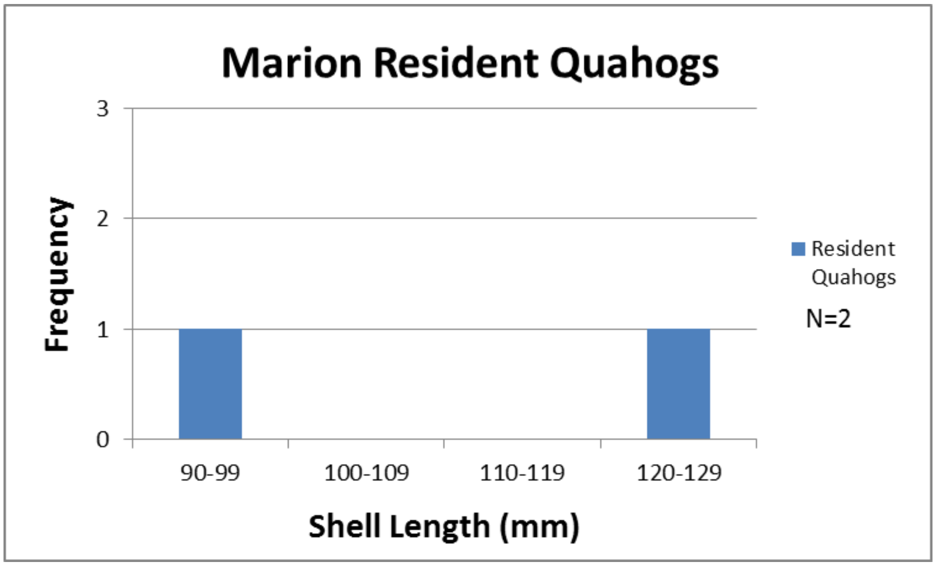

Figure 5. Resident quahog length frequencies at the Marion B-120 relay site.

Mattapoisett – Nyes Cove

In consultation with *DMF* personnel, the Mattapoisett Shellfish Constable, Kathy Massey, chose Nyes Cove off of Point Connett for the quahog relay in 2018. All of Mattapoisett waters were closed to shellfishing on April 28th, 2003 due to the oil spill and re-opened on October 13th, 2003. The 19.1-acre relay site is located within DSGA BB: 29.0, which is classified as "APPROVED", meets NSSP standards for direct harvest throughout the year. Limited street parking on Angelica Avenue and Cedar Street provides access to the site, and the shellfish department has not performed any recent propagation activity in this area.

On July 23rd, 2018, a pre-relay site survey was conducted by *DMF* staff members. Survey results indicated a sandy substrate with some mud and gravel. Water depths of Nyes Cove range between -0.1 – 2.4 feet below MLLW. A total of 4 transects with 10 quadrats each (one transect had 11 quadrats) were sampled within the site (41 quadrats total). Fourteen quahogs were found for a density of 0.34 quahogs/ft.^{2} (Table 6). The site will be closed for one year and will reopen in September 2019.

Mean (mm)	44.18
Min (mm)	11.24
Max (mm)	88.43
Total #	14
# Quadrats	41
Density/sq.ft.	0.34

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

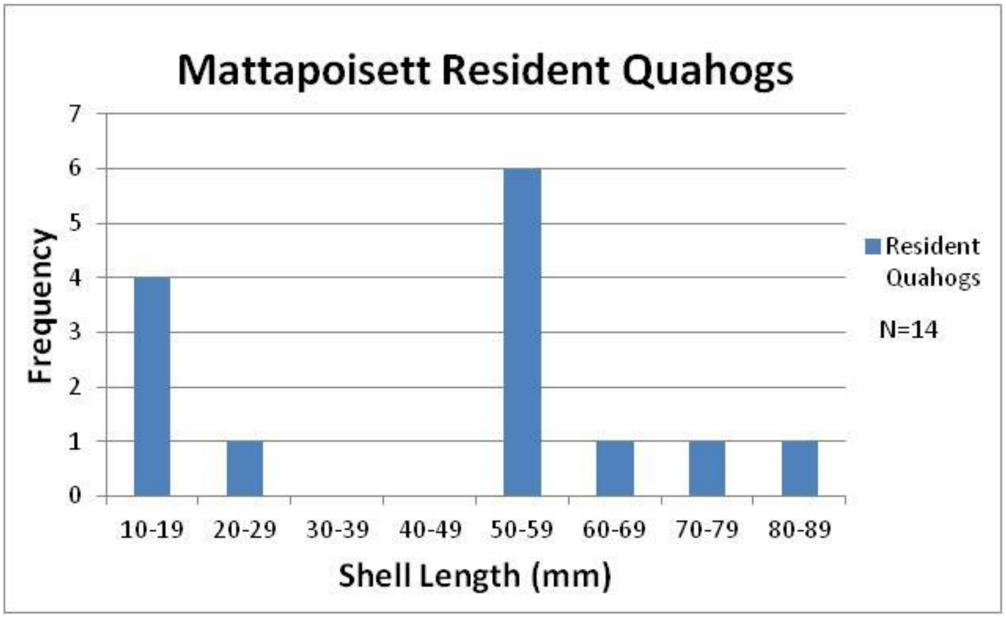

Figure 6. Resident quahog length frequencies at the Mattapoisett B-120 relay site.

New Bedford – Monkey Pier

In consultation with *DMF* personnel, the New Bedford Shellfish Constable, Tom Ringuette, chose a 6.7-acre area along the western shoreline of New Bedford Outer Harbor, extending north of Monkey Pier across from Nina Street, to receive B-120 quahog relays in 2018. All of New Bedford municipal waters, including New Bedford harbor, were closed to shellfishing on April 28th, 2003 due to the oil spill and re-opened on October 13th, 2003. The relay site is in DSGA BB: 15.4, which is classified as "CONDITIONALLY APPROVED" and meets NSSP standards when the area is open to shellfishing. The site supports favorable habitat for quahogs and has been utilized recreationally in the past. However, the site does not currently support a recreational shellfishery due to a limited quahog resource and the lack of city funds for shellfish propagation. The large beach parking lot at the town landing and street parking on Rodney French Boulevard provide ample access points to this area.

On July 26th, 2018, a pre-relay site survey was conducted by *DMF* staff with the assistance of the New Bedford Shellfish Constable. Survey results indicated a bottom substrate consisting of a sand/mud/gravel mixture and some rocks closer to shore with overall conditions that are suitable quahog habitat. Water depth at the site ranged from -0.7 – 4.0 feet below MLLW. A total of 9 transects with 10 quadrats each (one had only 5 quadrats due to a steep depth gradient; 85 quadrats total) were sampled within the site. Forty-three quahogs were found for a density of 0.51 quahogs/$ft.^2$ (Table 7). The site will likely be closed to shellfishing for two years and will reopen in the fall of 2020.

Mean (mm)	55.70
Min (mm)	21.20
Max (mm)	80.60
Total #	43.00
# Quadrats	85.00
Density/sq.ft.	0.51

Table 7. Summary table of the resident quahog population at the New Bedford B-120 relay site. Size measurements denote shell length.

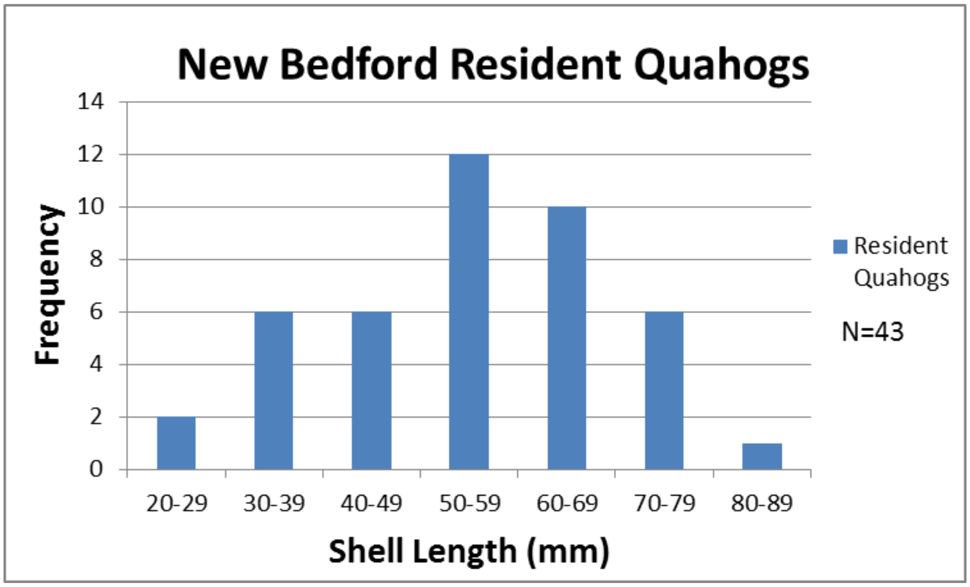

Figure 7. Resident quahog length frequencies at the New Bedford B-120 relay site.

<u>Wareham – Agawam Beach</u>

In consultation with *DMF* personnel, the Wareham Shellfish Constable, Garry Buckminster, selected a portion of Sunset Cove for 2018 quahog relays. The constable states that the 6.4-acre area has favorable habitat for quahogs and has not had any propagation efforts for several years. The Agawam Beach Road right-of-way provides an access point for this area. All of Wareham municipal waters, including Sunset Cove, were closed to shellfishing on April 28th, 2003 due to the oil spill and re-opened on May 22nd, 2003. The relay site is in DSGA BB: 41.2 and is classified as "CONDITIONALLY APPROVED", meeting NSSP standards for direct harvest of shellfish when open to shellfishing.

On July 11th, 2018, a pre-relay site survey was conducted by one *DMF* staff member. This survey was a brief "spot check" of the area, since this site had been previously surveyed in 2015 as a potential relay site and then not been used. In 2015, the substrate was designated as very suitable for quahogs with firm sand/mud across the area, and the density of quahogs across 192 quadrats was 0.17 quahogs/ft.^{2} (a total of 32 quahogs found) (Table 8). In 2018, the substrate was the same firm sand/mud with no SAV coverage. Water depth at the Agawam Beach site ranged between 1.0 to 2.5 feet below MLLW. In 2018, a total of twenty quadrats were sampled within the site, and 8 quahogs were found for a density of 0.4

quahogs/ft.^{2} (Table 9). The site will be closed to recreational shellfishing for at least two years and will reopen in the fall of 2020.

Mean (mm)	63.25
Min (mm)	30.00
Max (mm)	112.00
Total #	32.00
# Quadrats	192.00
Density/sq.ft.	0.17

Table 8. Summary table of the resident quahog population in 2015 at Wareham's B-120 relay site. Size measurements denote shell length.

Mean (mm)	64.36
Min (mm)	38.10
Max (mm)	85.46
Total #	8.00
# Quadrats	20.00
Density/sq.ft.	0.40

Table 9. Summary table of the resident quahog population in 2018 at the Wareham B-120 relay site. Size measurements denote shell length.

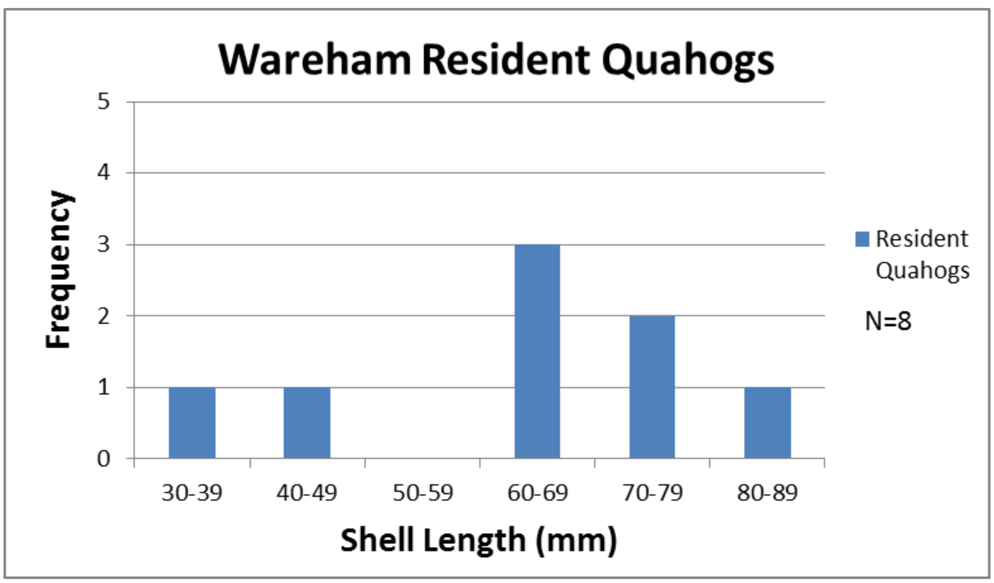

Figure 8. Resident quahog length frequencies at the Wareham B-120 relay site.

<u>Westport – Westport River-The Let, Northwest Quadrant</u>

In consultation with *DMF* personnel, the Westport Shellfish Constable, Chris Leonard, chose an 18.6-acre site in the northwestern portion of the Let in the East Branch of the Westport River (North of "East Beach Road") for a quahog relay in 2018. The constable states that the nearshore area is very favorable habitat for quahogs. All of Westport municipal waters, including The Let, were closed to shellfishing on

April 28th, 2003 due to the oil spill and re-opened on May 22nd, 2003. The relay site is in DSGA BB: 4.0, which is classified as "APPROVED", and meets NSSP standards for direct harvest of shellfish year round. Emma Tripp Landing, located at the southern end of The Let, provides adequate parking. Additional parking and access to this area are provided along Beach Road. Recreational fishermen often access the area by shallow-draft boat.

On July 17th, 2018, a pre-relay site survey was conducted by *DMF* staff members and the Westport Shellfish Constable. The survey was conducted from a boat with the use of a bull rake for the deeper water. The proposed relay area consisted primarily of mud and sand sediment which is favorable habitat for quahogs. Water depth of The Let site ranges between 0.5 to 2 feet below MLLW. A total of 25 randomly distributed quadrats were sampled, and only 2 quahogs and 1 oyster were found. Mean quahog density was 0.08 quahogs/ $ft.^2$ (Table 10). The site will be closed to recreational shellfishing for two years and will reopen in the fall of 2020.

Mean (mm)	85.40
Min (mm)	78.11
Max (mm)	92.69
Total #	2.00
# Quadrats	25.00
Density/sq.ft.	0.08

Table 10. Summary table of the resident quahog population at the Westport B-120 relay site. Size measurements denote shell length.

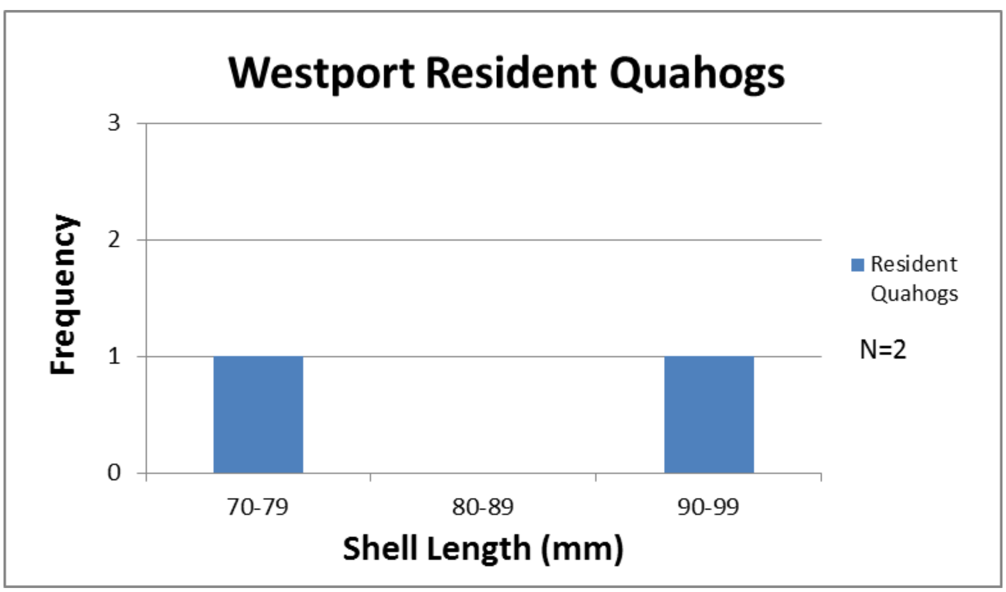

Figure 9. Resident quahog length frequencies at the Westport B-120 relay site.

2018 Quahog Relay Methods

With the assistance of Shellfish Department staff in each municipality, *DMF* biologists sampled quahogs from the Taunton River donor site as they were being loaded into boats for planting at the B-120 sites. Random quahog subsamples of a known volume (1-peck basket) were collected from the 800+ bushels of relayed quahogs prior to planting in each municipality, and all individuals were counted and measured for shell length (mm). Sample size at each site ranged between 3 and 12 pecks on a given day, and varied depending on availability of personnel. These measurements were used to estimate the total number and size frequency of relayed quahogs within each B-120 site. Following sampling, quahogs were planted by boat/barge across the designated area. In 2018, all quahog relay activities were conducted between late August and mid-November.

Figure 10. Photographs depicting the B-120 contaminated quahog planting off a barge in Wareham (top), and the delivery of contaminated quahogs prior to planting in New Bedford (bottom).

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 specify geographic boundaries for each relay area and prohibit shellfishing or attempting to shellfish in the area during the specified closure period. The nine sites in 2018 were marked with posted signs on the shoreline and/or buoys for outer boundary markings prior to and during the closure period (see Figure 11), and regular enforcement patrols are routinely carried out by municipal shellfish department personnel.

In order to maximize quahog spawning and recruitment within and around the B-120 relay sites, *DMF* works with the 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 others close their sites for two or three years. In 2018, the municipalities of Bourne, Fairhaven, New Bedford, Wareham, and Westport will close their relay sites for two years (reopening in the fall of 2020), while Dartmouth, Gosnold, Marion, and Mattapoisett will reopen in the fall of 2019, one year after the relays.

Prior to allowing any harvest from the B-120 quahog relay sites within the municipalities, *DMF* collects shellfish and water samples for bacteriological analysis to determine if health standards are met for direct harvest and human consumption. For sites where results are within acceptable values, DMF will lift the contaminated area closure status and municipal shellfish departments will generate management opening notices that allow recreational shellfishing in those areas. All 2018 contaminated quahog relay sites are currently closed, and the earliest that some of them will re-open will be the fall of 2019 (a one-year closure).

Figure 11. Posted signage for the B-120 contaminated quahog relay sites.

2018 Quahog Relay Results

With the exception of Mattapoisett and Gosnold, all participating Buzzards Bay municipalities relayed a minimum of 800 bushels of quahogs to their respective B-120 restoration sites. Due to logistical issues and personnel shortages, Mattapoisett received only 619 bushels of quahogs. Wareham received most of the quahogs that Mattapoisett was unable to plant. Gosnold requested and received only 50 bushels of quahogs due to the limited availability of suitable habitat within municipality-designated recreational shellfishing areas. A total of 6,375 bushels and an estimated 1,210,323 quahogs were relayed from the Taunton River to the nine Buzzards Bay municipalities over the course of the 2018 season.

A summary of estimated number, size range, and planting density of quahogs at each 2018 B-120 site is presented in Table 11, as well as the total number of bushels and quahogs relayed across all sites in 2018. Length frequencies of relayed quahogs within each B-120 site are provided in Figures 12 through 20.

Municipality	Site Name	# of Bushels Relayed	Estimated # of Quahogs	Size Range (mm)	Mean Size (mm)	Area Planted (acres)	Area Planted (ft.^{2})	Planting Density (# per ft.^{2})
Bourne	Little Bay	803	152,463	43-109	86.1	4.4	191,664	0.80
Dartmouth	Gulf Bridge Road	800	159,872	38-109	83.8	4.1	178,596	0.90
Fairhaven	Seaview Avenue	800	145,304	64-106	86.57	2.1	91,476	1.59
Gosnold	Cuttyhunk Pond - SE	50	8,800	72-109	88.26	1.7	74,052	0.12
Marion	Planting Island Cove, #2	801	152190	51-109	86.1	4.6	200,376	0.76
Mattapoisett	Nyes Cove	619	118,494	54-112	86.3	19.1	831,996	0.14
New Bedford	Monkey Pier	800	161,524	34-117	84.21	6.7	291,852	0.55
Wareham	Agawam Beach	902	167,922	38-111	85.35	6.4	278,784	0.60
Westport	The Let - NW Quadrant	800	143,754	66-107	85.67	18.6	810,216	0.18
	Total	**6375**	**1,210,323**					

Table 11. Summary table of the 2018 B-120 contaminated quahog relay results. Size measurements denote shell length.

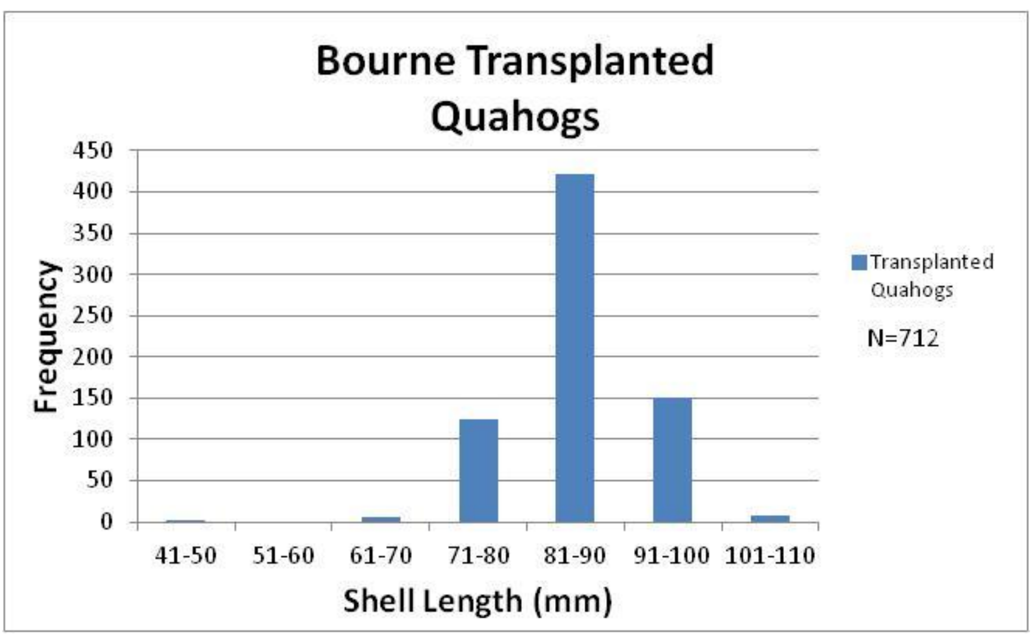

Figure 12. Quahog length frequencies at Bourne B-120 relay site.

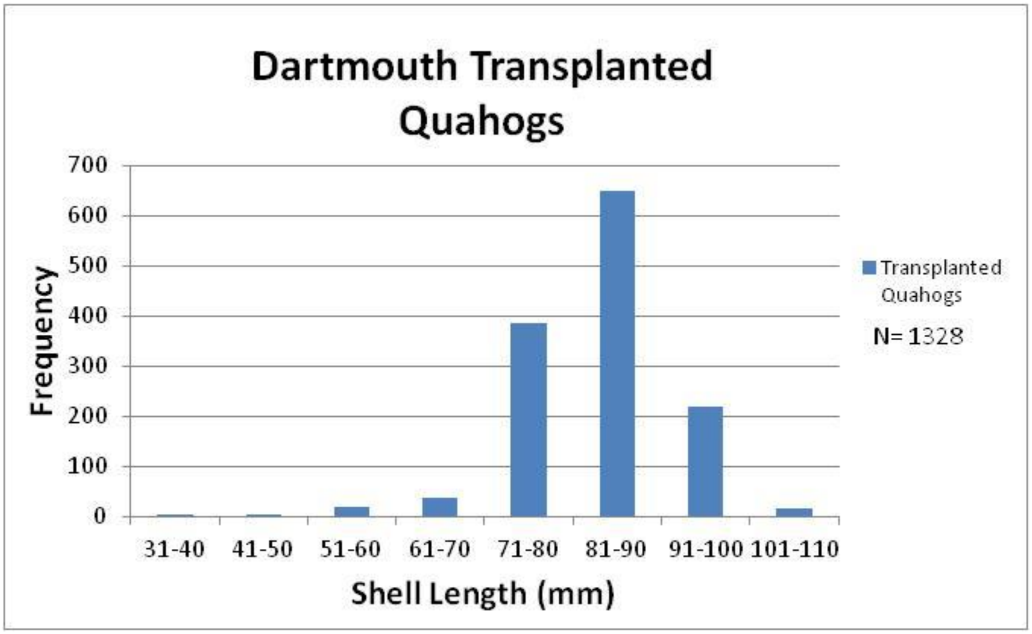

Figure 13. Quahog length frequencies at Dartmouth B-120 relay site.

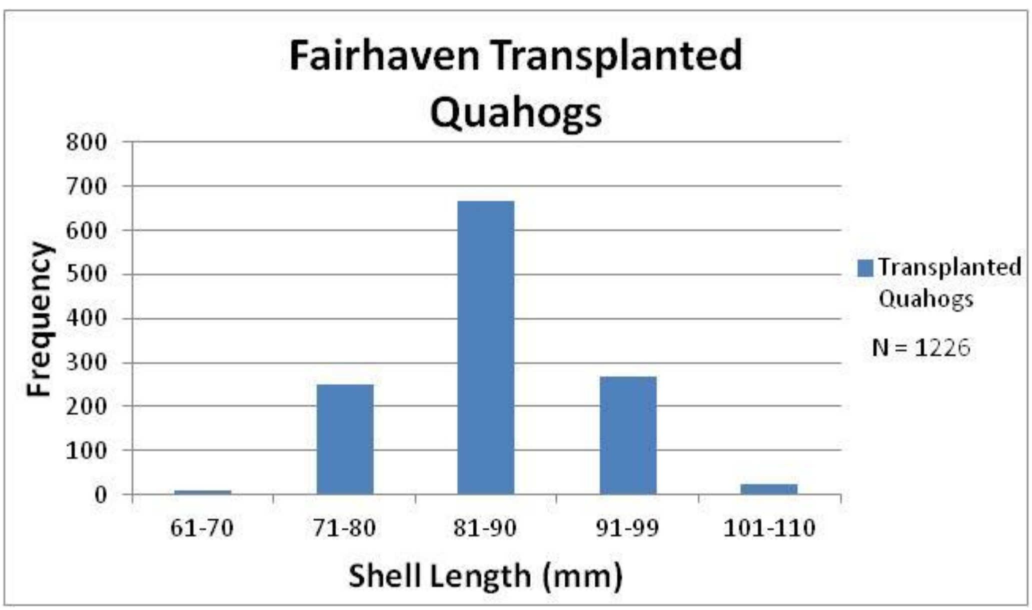

Figure 14. Quahog length frequencies at Fairhaven B-120 relay site.

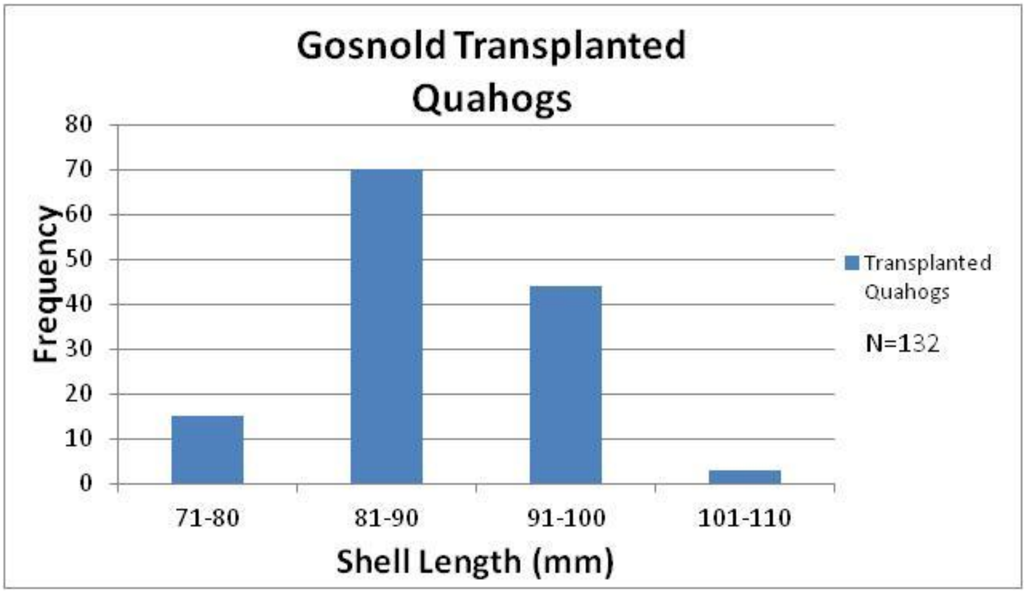

Figure 15. Quahog length frequencies at Gosnold B-120 relay site.

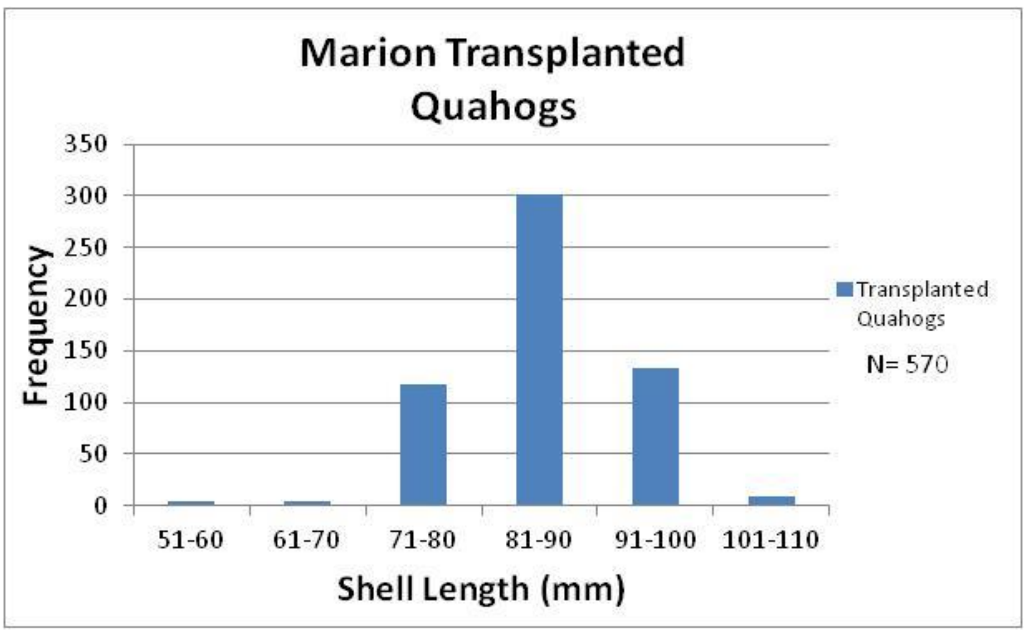

Figure 16. Quahog length frequencies at Marion B-120 relay site.

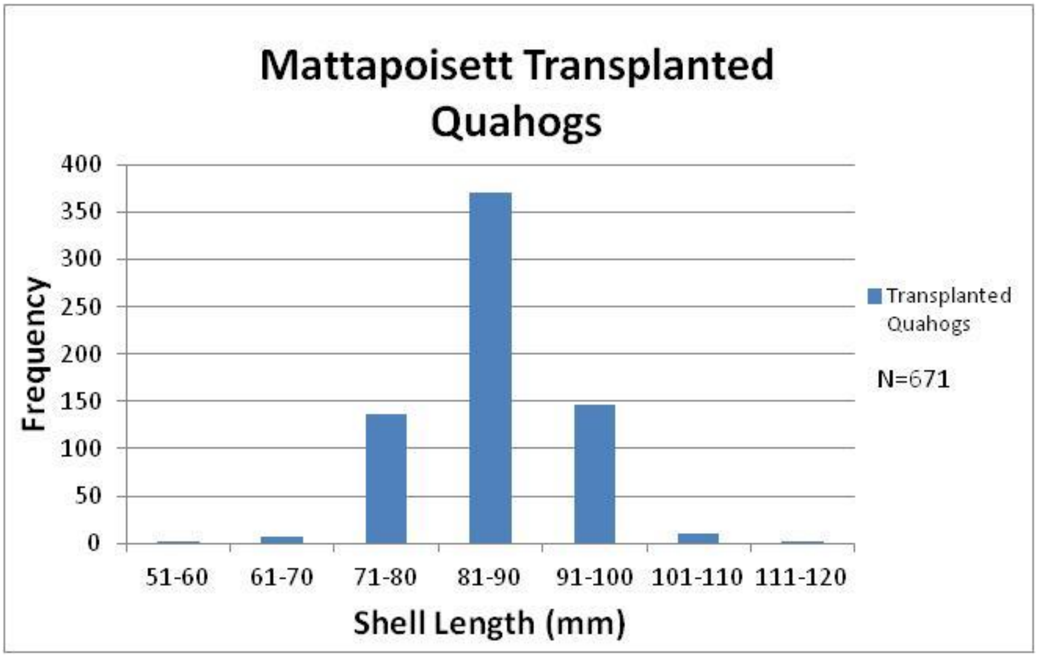

Figure 17. Quahog length frequencies at Mattapoisett B-120 relay site.

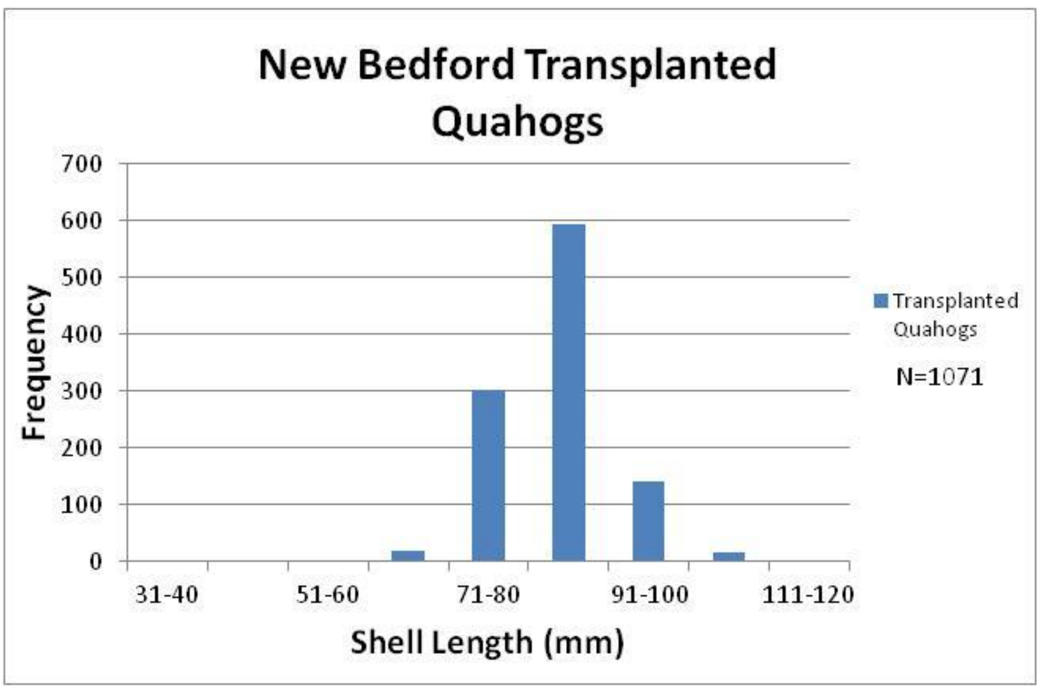

Figure 18. Quahog length frequencies at New Bedford B-120 relay site.

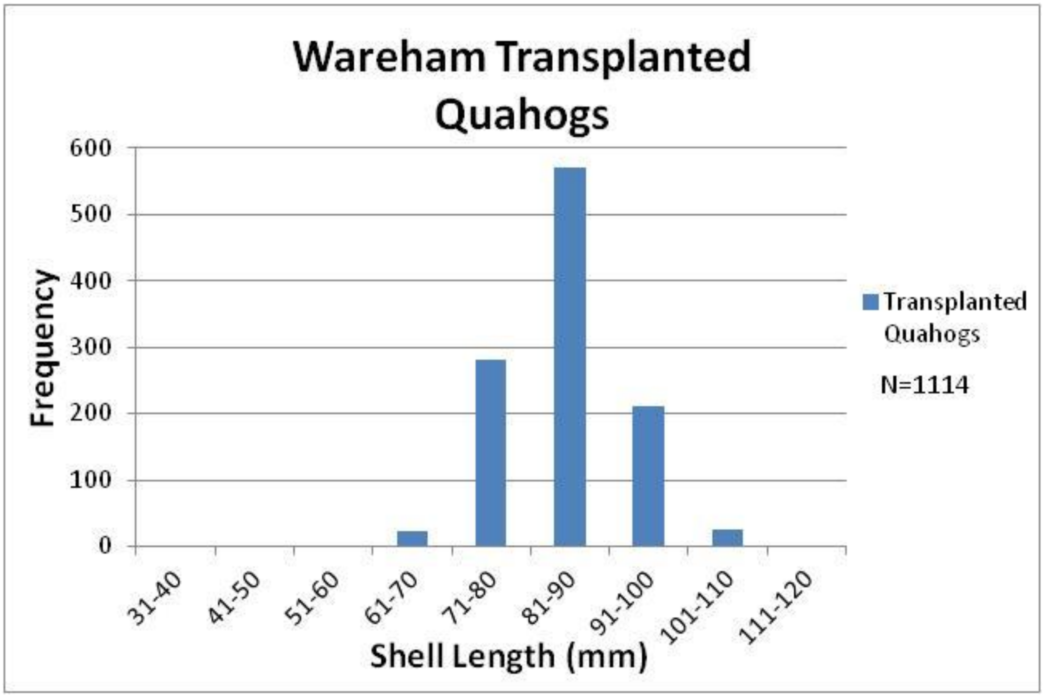

Figure 19. Quahog length frequencies at Wareham B-120 relay site.

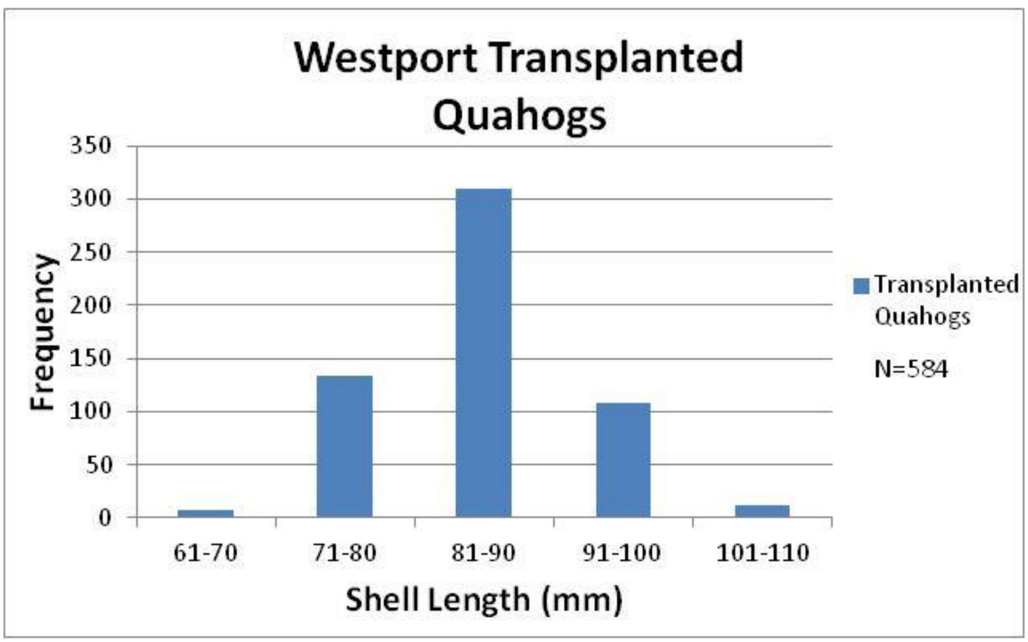

Figure 20. Quahog length frequencies at Westport B-120 relay site.

Condition Index Methods and Results

In 2018, *DMF* collected samples of relayed quahogs from the B-120 study sites in Dartmouth, New Bedford, and Wareham for the determination of Condition Index (CI). These samples were taken at the time of harvest from the Taunton River and will be compared against samples that will be taken one year post-planting in fall 2019. Although CI is not a direct indication of the reproductive potential of quahogs, it is a good indicator of their general condition, gonadal development, and health (Marroquin-Mora and Rice 2008). It is believed that CI in the range of computed values of upper 60s to 70s indicates generally good condition, with documented values for quahogs ranging from below 60 to over 100 (Marroquin-Mora and Rice 2008). Condition index categories in the table below are general grouping based on this documented range, and it is widely accepted that CI values are most useful as a comparative tool across and within seasons and between individuals and populations rather than an independent metric of reproductive health. Twenty quahogs were collected from each site for lab processing and determination of CI. At the *DMF* New Bedford Lab, staff used the procedures and formula of Crosby and Gale (1990) to determine the CI of the collected quahogs:

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

All weights were estimated to the nearest 0.01 g. The CI results from 2018 are presented in Table 12. Due to the loss of a shell length measurement during processing, we could only use 19 of the 20 quahog samples for Dartmouth.

Municipality	Relay Dates	CI Processing Period	# of Samples	CI Range	Mean CI	Standard Deviation	CI Category
Dartmouth	9/4 - 9/14	9/11 - 9/13	19	59.1 - 96.3	74.3	9.62	Good
New Bedford	9/17 - 11/9	9/25 - 9/27	20	42.8 - 71.6	55.2	6.93	Fair
Wareham	10/9 - 10/24	10/9 - 10/11	20	44.4 - 72.7	59.8	7.60	Fair

Table 12. 2018 B-120 condition index summary of relayed quahogs.

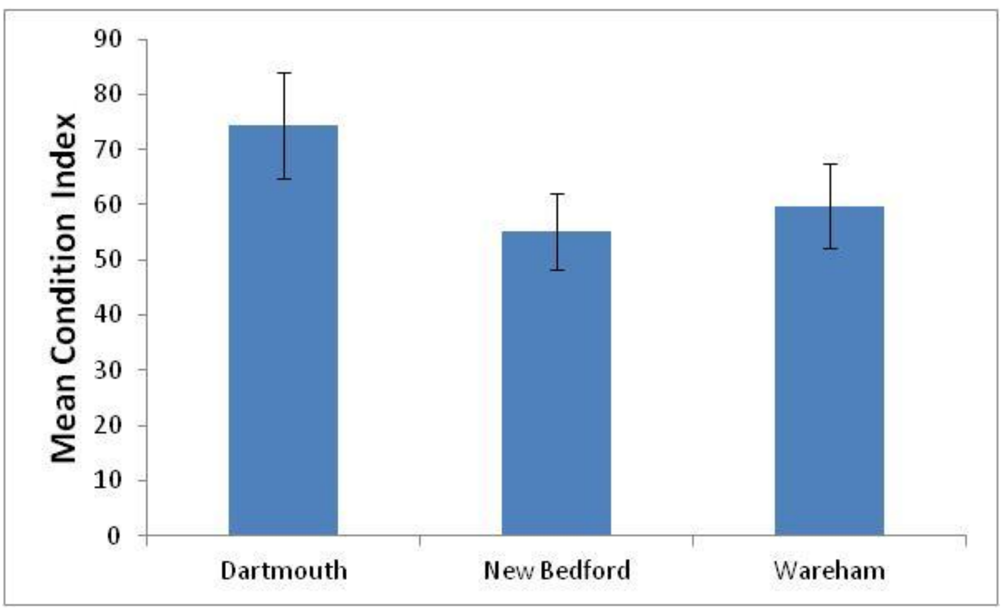

Figure 21. Mean condition index (+/- SD) of relayed contaminated quahogs at the three intensively-sampled sites: Dartmouth, New Bedford, Wareham. Condition index was assessed at the time of planting during fall 2018.

Condition index values of the Dartmouth quahog sample were noticeably higher than those destined for both New Bedford and Wareham (see Figure 21). These differences are most likely due to the strong seasonality and correlation with spawning activity that affects quahog CI. It has been demonstrated that CI values often increase before spawning periods, followed by a decrease post-spawning (Marroquin-Mora and Rice 2008). In early September, when the quahogs for Dartmouth were being harvested, spawning activities could still have been occurring, leading to higher CI values than the quahogs harvested later in the fall when all spawning would likely have been completed. Since all quahogs came from the same general Taunton River site, it is unlikely that these differences would have been due to environmental conditions or site factors; however more targeted mapping of the Taunton River harvest sites will be attempted during the 2019 relay season to obtain more information on the donor populations and site conditions. *DMF* will continue to monitor CI at future B-120 quahog relay sites, and will strive to maintain consistent timing in seasonal sampling in order to accurately compare CI values across years.

II. Single Oyster Purchase, Grow-out, and Out-Planting

Methods Overview

Oyster Seed Purchases

The B-120 oyster project began in 2017 in Bourne, Marion, and Wareham. Each town committed to planting oysters at one site per year over two years (2017 and 2018), amounting to a total of 6 planted sites within municipally-managed waters of Buzzards Bay. Each year, the participating three towns pool their resources to purchase hatchery oyster seed at the best available price. Prior to procuring oyster seed, the participating towns work collaboratively with *DMF* to determine the size and quantity of oyster seed best suited to meet town needs. Municipalities provide *DMF* with information detailing the locations and characteristics of the proposed planting sites, anticipated planting densities, information on the availability of upweller space, and alternative nursery systems (i.e., floating bags). Generally, each municipality purchases small-sized oyster seed to be placed in upwellers as well as larger-sized oysters for placement in nursery grow-out systems. These nursery systems are located at designated areas in each town that are easily accessible for management and maintenance. Generally, they consist of floating rack and bag systems with bags held within large cages, or single bags strung together in lines and secured with buoys and anchors on either end. Based on the availability of oyster seed at commercial hatcheries, the towns receive small seed first and the larger seed later in the season, allowing them to maximize their grow-out resources and distribute the work load.

The participating towns and *DMF* work together closely to ensure these efforts support the B-120 goal to create and maintain sustainable, recreationally-available oyster resources at each of the oyster planting sites. Through monitoring of the oyster seed within the upwellers, and monitoring the growth, survival, and density of out-planted oysters, we intend to continuously refine these efforts and enhance restoration success.

Grow-out Sampling

During June through October, when the oysters were in the upwellers and floating bags and cages for intermediate grow-out, *DMF* personnel worked closely with town personnel to monitor growth and survival of the seed. From late June, when the first order of oysters arrived, to the time of out-planting in the fall, bi-weekly (every two weeks) size measurements of oyster shell height were taken on a subsample of oysters in each town. *DMF* personnel provided participating town shellfish departments with standardized datasheets for these measurements, taken with digital calipers to the nearest 0.01 mm. A minimum of 50 measurements for each size class (and often up to 100-150) were collected during each sampling event, and general maintenance of grow-out units and survival of oysters were noted at the time of sampling. In Bourne and Wareham, which had staff dedicated to this data collection, these data were collected irrespective of *DMF* personnel availability, and results were emailed to *DMF*. Marion lacked the dedicated staff to monitor oyster growth and survival in the upwellers and nursery grow-out systems, so these data were collected by *DMF* personnel during bi-weekly site visits.

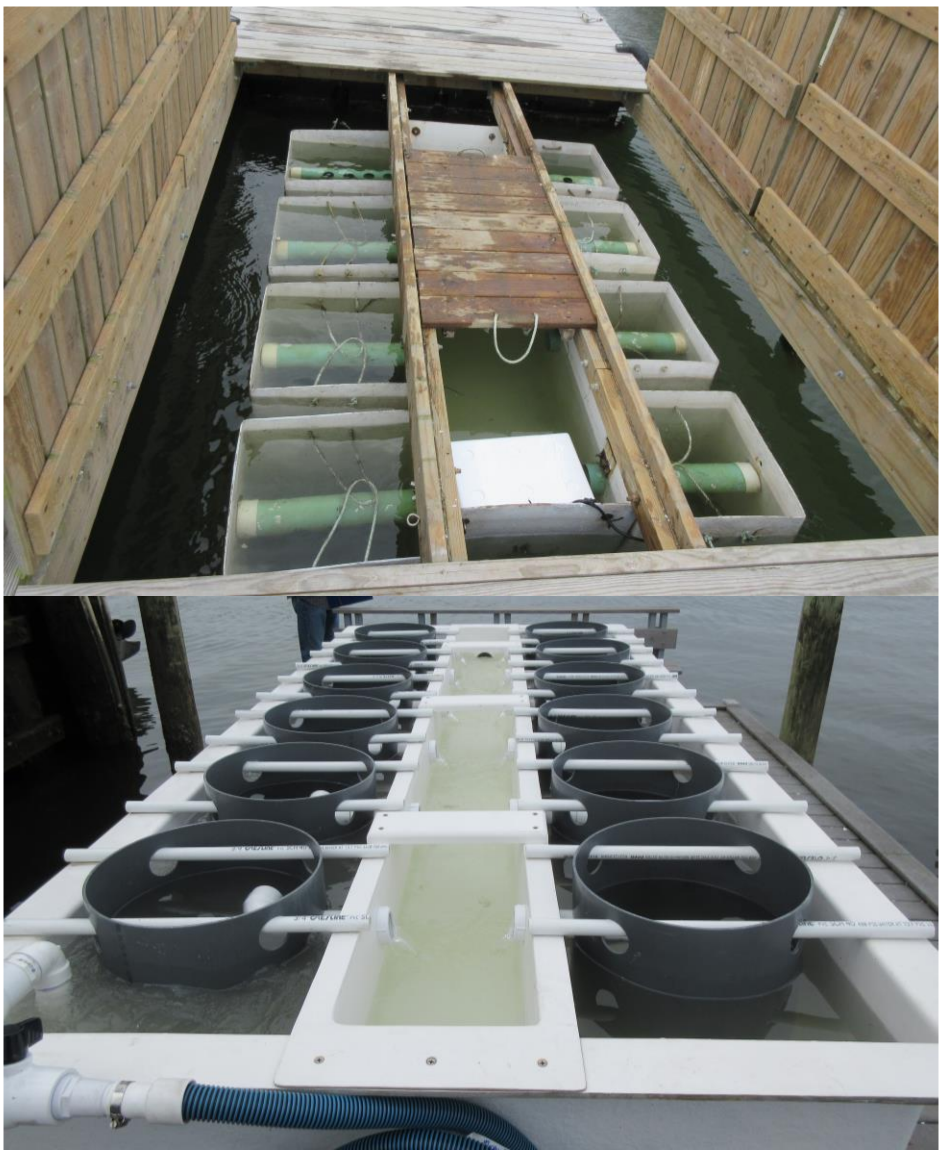

Figure 22. Photograph depicting Bourne's FLUPSY (top) and Marion's upweller system (bottom).

Figure 23. Photograph depicting one of the oyster grow-out sites in Bourne (Winsor Cove).

Prior to out-planting, *DMF* personnel worked with town staff to collect data on oyster survival during this grow-out phase and estimated total number of oysters using volumetric methods. Bourne's shellfish department worked closely with *DMF* to develop these methods, which Bourne employed throughout the entire grow-out season, and these sampling techniques were then used at the other two towns just prior to planting. To estimate survival, a measured volume of oysters (0.5-1 liter container, depending on oyster size) was counted for numbers of living and dead seed. Three replicates of these counts were taken for each size class, and a mean count of living and dead oysters was calculated across replicates. For total survival in each size class, these estimates were scaled up using the total volumes of each bag and the total number of bags per site. Bag volumes were measured by counting the number of volume units (1-2 liter container) of oysters in each bag. The total number of oysters out-planted was calculated using the number of living oysters per unit volume (liter), the total volume of each bag, and the total number of bags out-planted.

Figure 24. Photographs depicting the pre-planting sampling for oyster size, survival, and total volume in Wareham.

Pre-Planting Surveys and Post-Planting Surveys
In 2018, surveys of the proposed oyster restoration sites were conducted prior to out-planting. *DMF* personnel collaborated with town staff to conduct these surveys. Surveys consisted of running multiple transects across each site and using basket rakes to excavate 1-ft.^{2} quadrats at 10-foot intervals along each transect. Quadrats were dug to a depth of 8-12 inches and all oysters were counted and measured, and any other shellfish, predators, vegetation presence, type and percent cover, and substrate type were recorded. The length of individual transects and number of quadrats varied based on site dimensions. Post-planting surveys will be conducted one year following planting to assess survival and growth of planted oysters. These surveys use the same methods as described above for the pre-planting surveys of oyster restoration sites.

Results

Oyster Seed Purchase and Grow-out
In 2018, Bourne, Marion, and Wareham purchased varying numbers and sizes of juvenile oysters with B-120 funds (Table 13). On June 27th 2018, 1.2 million $\geq$2 mm oysters from Muscongus Bay Aquaculture in Maine were shipped to towns, with Wareham receiving 500,000 oysters, Marion receiving 400,000 oysters, and Bourne receiving 300,00 oysters. The oyster seed were placed in town-owned upwellers for grow-out and eventual out-planting within B-120 restoration sites. Between July 19th and July 23rd, 2018, all three towns received the larger-sized seed oysters from Muscongus Bay Aquaculture's Bourne facility; Bourne received 353,000 oysters, Marion received 325,000 oysters, and Wareham received 297,000 oysters. While this order was intended to include only large oysters (9-13mm in shell height), the oysters instead ranged from 6-20mm, resulting in the placement of the small oysters in the upwellers with the first cohort of oysters. While the larger oysters were placed in floating bags and cages as originally intended, the mishap with the second order's varying sizes resulted in the mixing of the two oyster cohorts in the upwellers and inability to monitor the two orders as distinctly separate entities. The upwellers and floating bags and cages were maintained on a regular basis to maximize survival and growth prior to out-planting. All purchased oysters were certified as disease-free by *DMF*-approved shellfish pathology laboratories prior to receipt by the towns (refer to Appendix II).

Municipality	Destination	Size Range	Quantity	Source	Outplanting Site
Bourne	Upweller	$\leq$ 2 mm	300,000	Muscongus Bay	Monument Beach Marina - overwinter
Bourne	Floating bags	6-20 mm	353,000	Muscongus Bay - Rod Taylor	Little Bay; Winsor Cove
Marion	Upweller	$\leq$ 2 mm	400,000	Muscongus Bay	Black Point in Sippican Harbor
Marion	Floating bags	6-20 mm	325,000	Muscongus Bay - Rod Taylor	Black Point in Sippican Harbor
Wareham	Upweller	$\leq$ 2 mm	500,000	Muscongus Bay	Northwest Lydia's Island; Onset Reef
Wareham	Floating cages	6-20 mm	297,000	Muscongus Bay - Rod Taylor	Northwest Lydia's Island; Onset Reef

Table 13. Summary of 2018 B-120 oyster purchases by towns of Bourne, Marion, and Wareham. Size range refers to shell height.

Bourne

Pre-Planting Survey – Little Bay; Winsor Cove in Red Brook Harbor, Bourne

On October 4th, 2018, *DMF* personnel and Town of Bourne personnel conducted a pre-planting survey of the two proposed oyster restoration sites, the first located just south of Monument Beach Marina in Little Bay (0.79 acres) and the second in Winsor Cove within Red Brook Harbor (0.74 acres) (Figure 25). At the Little Bay site, a total of 4 transects were run perpendicular to shore, starting at the water's edge, and 10 1-ft.^{2} quadrats were sampled along each transect (a total of 40 quadrats). A total of 9 oysters and 13 quahogs were found in the 40 quadrats, for a density of 0.23 oysters/ft.^{2} and 0.33 quahogs/ft.^{2}. Resident oysters were mainly adults, with a mean size of 65.7mm, and resident quahogs tended to be juveniles with a mean size of 41.3 mm (Table 14). Substrate was sand and fine gravel, suitable habitat for oysters and other shellfish.

The Winsor Cove oyster planting site was surveyed on the same day, and as this was a flat, uniform area that varied little in depth, only two transects of 15 quadrats each were sampled (a total of 30 quadrats). No shellfish or any other species were observed in the quadrats (Table 15). However, the proposed, marked-off area was uniformly sandy and shallow, ideal substrate for oysters, and some surrounding areas had been used for oyster propagation efforts in the past.

Figure 25. Map of the two B-120 oyster planting areas and acreage in Bourne.

Species	Oysters	Quahogs
Mean (mm)	65.72	41.26
Min (mm)	43.96	13.67
Max (mm)	95.24	69.70
Total #	9	13
# Quadrats	40	40
Density/sq.ft.	0.23	0.33

Table 14. Summary table of pre-planting survey results at Bourne's Little Bay oyster planting site. Size measurements denote shell height (oysters) and shell length (quahogs).

Total #	0
# Quadrats	30
Density/sq.ft	0.00

Table 15. Summary table of pre-planting survey results at Bourne's Winsor Cove oyster planting site.

Grow-out Sampling – Monument Beach Marina, Little Bay, Winsor Cove, Eel Pond

During the grow-out season, Bourne Shellfish Department staff and *DMF* personnel sampled all oyster size classes for growth, survival, and total volume estimates. In 2018, Bourne hired a full-time shellfish technician, which allowed them to intensively sample the oysters every two weeks, and *DMF* personnel assisted whenever schedules allowed in order to be involved in the data collection and provide oversight. Bourne staff were very conscious of maintaining and cleaning grow-out equipment as well as sorting the oysters regularly based on size class, which lead to the partial mixing of cohorts, but likely resulted in the highest growth and survival rates. From early July to mid-October, the early cohort of oysters grew from an average of 4.8 mm to an average of 41.7 mm (1.6 inches) in shell height (Figure 26). Different from other towns, Bourne staff decided to over-winter this cohort to achieve greater growth; these oysters are being overwintered in API bags anchored subtidally at Monument Beach Marina and will be planted in one of the B-120 restoration sites during spring 2019. Data on survival, growth, and planting density will be collected at the time of out-planting. The second cohort of oysters grew from an average of 17.3 mm to an average of 46.9 mm (1.8 inches) from late July to mid-October (Figure 26). The combined survival rate of all size classes based on the total number of oysters purchased was 86.3 % (Table 19).

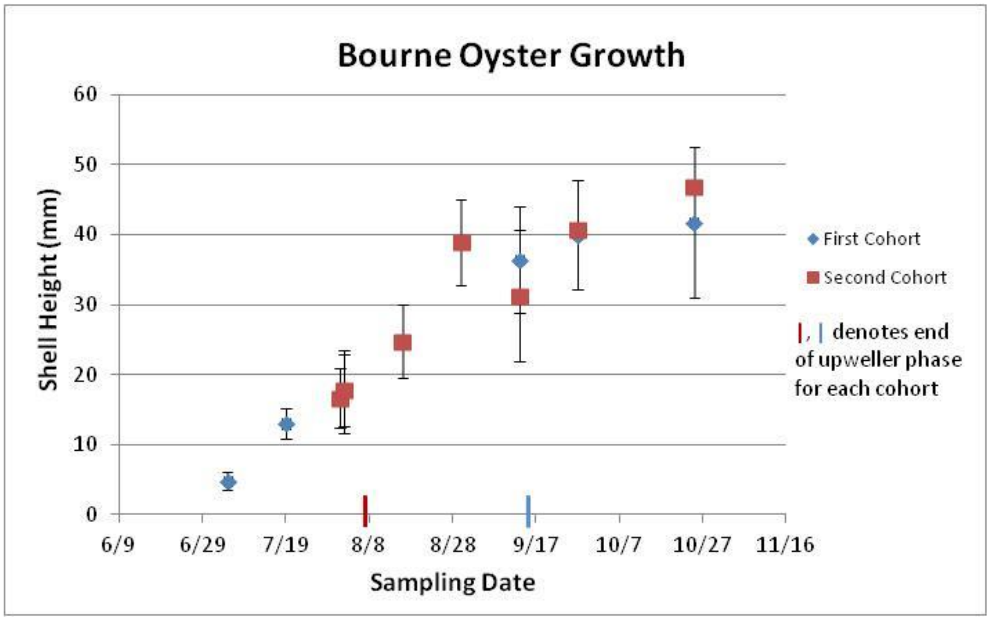

Figure 26. Mean shell height of oysters (+/- SD) across the grow-out season. Blue diamonds denote the early, smaller-sized cohort, and red squares denote the second, larger-sized cohort. Blue and red lines on x-axis denote end of upweller grow-out phase and transfer to floating bags/cages for each cohort.

Out-Planting – Winsor Cove in Red Brook Harbor; Little Bay, Bourne

On November 6th, 2018, the strings of oyster bags that were kept in Winsor Cove, Red Brook Harbor for grow-out were collected and planted in the nearby Winsor Cove planting site. Each bag was opened and emptied within the site. *DMF* personnel were not present for this planting, but Bourne shellfish staff provided the data indicating that a total of 60 bags were planted. Based on the pre-planting sampling, this amounts to an estimated total of 43,806 oysters planted at this site, and a planting density of 1.37 oysters/ft.^{2} (Table 20). The size range of oysters planted at this site was 23.0-59.0 mm and mean oyster size at the time of planting was 42.2 mm (Table 20).

On November 14th, 2018, the strings of oyster bags kept in Little Bay for grow-out were collected and loaded into the town boat by Bourne personnel. *DMF* personnel were present for this planting event; once again the bags were opened and distributed across the site. A total of 260 bags of two oyster size classes were planted, which was estimated to be 374,974 oysters planted. Planting density at this site was estimated to be 10.95 oysters/ft.^{2} (Table 20). The size range of oysters planted in Little Bay was 32.0-71.0 mm and mean oyster size was 49.3 (Table 20).

Marion

Pre-Planting Survey – Black Point, Sippican Harbor, Marion

On September 19th, 2018, *DMF* and Marion harbormaster personnel conducted a pre-planting survey of the proposed oyster restoration site at Black Point in Sippican Harbor (0.31 acres) (Figure 27). This site is the only town-designated area for recreational oyster harvesting, and the Shellfish Constable feels that the minimum size of 3 inches for recreational harvest of oysters sufficiently protects small oysters planted within the B-120 restoration site following the closure period. These planted oysters reach maturity and spawning age prior to being targeted for harvesting. The area had been propagated in the past and aquaculture operations have been ongoing in the area for years. It is assumed that the existing oyster population is a combination of wild-set oysters and past propagation efforts conducted by Marion. For the site survey, a total of 5 transects were run perpendicular to the shore with 8 1-ft.^{2} quadrats sampled along each transect (only 5 in the last transect because of increased water depth) (a total of 37 quadrats). A total of 36 oysters and 28 quahogs were found in the 37 quadrats, for a density of 0.97 oysters/ft.^{2} and 0.76 quahogs/ft.^{2} (Table 16). It was impossible to distinguish between true resident oysters and those that have been planted in the past, but by collecting these data prior to planting oysters, we may be able to assess the future oyster population trends from B-120 propagation efforts specifically.

Resident oysters were mainly adults, with a mean size of 61.4 mm and resident quahogs tended to be smaller with a mean size of 52.0 mm (Table 16). Substrate consisted of firm sand and gravel extending from the vegetation line (*Spartina alterniflora*) into the water and eventually becoming softer mud. The most suitable oyster habitat was the 30-foot wide band of firmer sediment extending seaward from the *Spartina* line; this was where most B-120 oysters were planted.

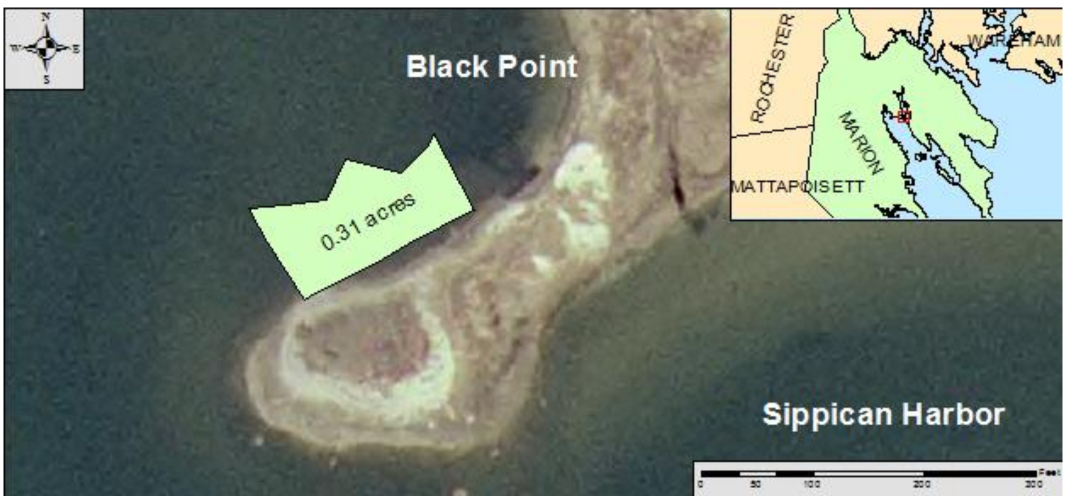

Figure 27. Map of the B-120 oyster planting area and acreage in Marion.

Species	Oysters	Quahogs
Mean (mm)	61.43	51.99
Min (mm)	11.33	19.28
Max (mm)	99.66	75.00
Total #	36	28.00
# Quadrats	37	37.00
Density/sq.ft.	0.97	0.76

Table 16. Summary table of pre-planting survey results at Marion's Black Point oyster planting site. Size measurements denote shell height (oysters) and shell length (quahogs).

Grow-out Sampling – Town Dock, Marion

During the grow-out season, Marion Shellfish Department staff and *DMF* personnel sampled both oyster cohorts for growth, and conducted a final pre-planting sampling for final size, survival, and total volume estimates. Marion lacked personnel dedicated to collecting data on their oyster seed; a summer intern from Tabor Academy working for the Marion Harbormaster assisted with oyster growth sampling over the summer, and *DMF* personnel made bi-weekly site visits to collect data for the remainder of the season. From early June to early October, the early cohort of oysters grew from an average of 4.69 mm to an average of 16.6 mm (0.7 inches) (Figure 28), and survival at the time of planting was estimated to be 54.5 % of the total number of small oysters purchased (Table 19). The second cohort of seed grew from an average of 13.4 mm in August to an average of 28.2 mm (1.1 inches) in early October (Figure 28), and survival of this second cohort was estimated to be 45.5 % (Table 19). The low survivorship in both cases was likely due to overcrowding in the grow-out bags and lack of sufficient sorting of the seed in its final growth stages.

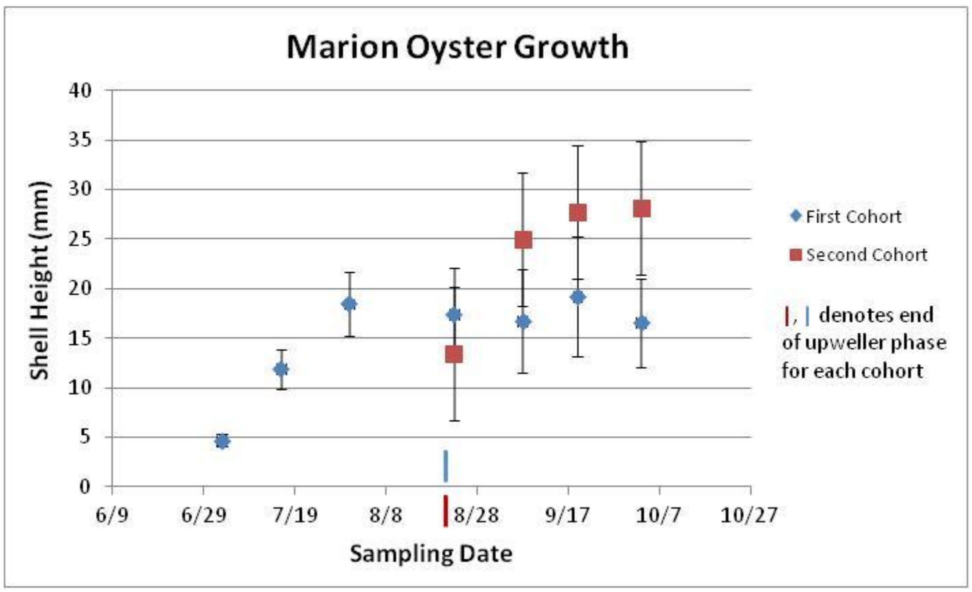

Figure 28. Mean shell height of oysters (+/- SD) across the grow-out season. Blue diamonds denote the early, smaller-sized cohort, and red squares denote the second, larger-sized cohort. Blue and red lines on x-axis denote end of upweller grow-out phase and transfer to floating bags/cages for each cohort.

Out-Planting – Black Point, Sippican Harbor, Marion

On October 4th, 2018, *DMF* personnel met Marion Shellfish Department staff at the town dock, where Marion personnel had loaded up their barge with all the oysters from the bags and cages. That morning, Marion staff had emptied all bags containing the smaller oysters onto the table of their barge, while the bags with the larger oysters were piled on deck. After arriving at Marion's oyster restoration site at Black Point, the smaller oysters were broadcast-planted using a large scoop and distributed around the site, while the larger bags were opened and emptied off the side of the barge, and spread out as much as possible. A combination of Marion staff and *DMF* personnel helped plant while Adam Murphy, the Marion Shellfish Constable, drove the boat slowly throughout the site to aid in seed distribution. A total of 70 bags were planted, 36 of which contained the smaller (first) cohort of oysters, and 40 bags held the larger (second) cohort. Based on the pre-planting sampling in late September, an estimated 260,928 small oysters were planted and 104,760 oysters of the second cohort were planted across the site.

Planting density at the site was estimated to be 27.08 oysters/ft.^{2} (Table 20). At the time of planting, the size range of the oysters (small and large cohorts) was 8.8-62.8 mm, with a mean oyster shell height of 21.84 mm (Table 20).

Figure 29. Photograph depicting the broadcast seeding of oysters at Marion's Black Point site.

<u>Wareham</u>

Pre-Planting Survey – Lydia's Island, Wareham

On October 3rd, 2018, *DMF* personnel and Town of Wareham personnel conducted a pre-planting survey of the two proposed oyster restoration sites in Wareham, the first located on the northwestern shore of Lydia's Island (1.14 acres) and the second at the Onset Reefs in Onset Bay (0.47 acres) (Figure 30). At the Lydia's Island site, a total of 4 transects were run perpendicular to shore and 10 1-ft.^{2} quadrats were sampled along each transect (a total of 40 quadrats). A total of 254 oysters and 4 quahogs were found in the 40 quadrats for a density of 6.35 oysters/ft.^{2} and 0.1 quahogs/ft.^{2} (Table 17). Resident oysters were almost exclusively adults that had been planted through the B-120 oyster restoration project in 2017; The Wareham shellfish constable was able to identify them and the site was deemed extremely successful because of the considerable growth the oysters had achieved. The mean size of oysters was 68.38 mm and the mean size of quahogs was 55.33 mm (Table 17). Substrate throughout this site was firm sand and gravel, becoming solely firm sand at 6-8 inches of water depth. The Deputy Shellfish Constable reported that the area was a productive bay scallop site in years previous to the oyster propagation efforts.

The Onset Reef oyster site was surveyed the same day, and this area was propagated with B-120 oysters in 2017 and with town-driven restoration efforts previously. This site was not delineated by a shoreline but had clearly-identified edges based on the accumulated oysters and built-up shell material, so quadrats were randomly sampled across the area instead of laying out transects. Fifteen 1-ft.^{2} quadrats were sampled and a total of 20 oysters were found for a density of 1.33 oysters/ft.^{2} (Table 18). Mean oyster size was 64.07 mm and no other species were observed. The substrate consisted of a mixture of hard-packed sand and gravel with layers of old scallop shells and oyster cultch on the surface.

Figure 30. Map of the two B-120 oyster planting areas and acreage in Wareham.

Species	Oysters	Quahogs
Mean (mm)	68.38	55.33
Min (mm)	32.10	51.10
Max (mm)	103.50	63.20
Total #	254.00	4.00
# Quadrats	40.00	40.00
Density/sq.ft.	6.35	0.10

Table 17. Summary table of pre-planting survey results at Wareham's Lydia's Island oyster planting site. Size measurements denote shell height (oysters) and shell length (quahogs).

Species	Oysters
Mean (mm)	64.07
Min (mm)	34.60
Max (mm)	98.20
Total #	20.00
# Quadrats	15.00
Density/sq.ft.	1.33

Table 18. Summary table of pre-planting survey results at Wareham's Onset Reefs oyster planting site. Size measurements denote shell height.

Grow-out Sampling – Onset Pier, Wareham

During the grow-out season, Wareham Shellfish Department staff and *DMF* personnel sampled oyster cohorts for growth, and conducted a final pre-planting sampling for final size, survival, and total volume estimates. Wareham has one Aquaculture Technician who conducted the bi-weekly size sampling and routinely emailed the data to *DMF* project personnel. *DMF* staff members would make monthly site visits to help with sampling and provide oversight, and eventually to supervise and conduct the final pre-planting collection of size, survival, and volume data. In early July, the average size of the early cohort was 3.19 mm, and the initial size of the second cohort in late July was 13.31 mm (Figure 31). When the early cohort of oysters was larger enough to be transferred to floating bags and cages, all oysters were mixed together and the combined average size in late October was 49.9 mm (~2.0 inches) (Figure 31). The combined survival rate of both cohorts based on the total number of oysters purchased was 57.34% (Table 19).

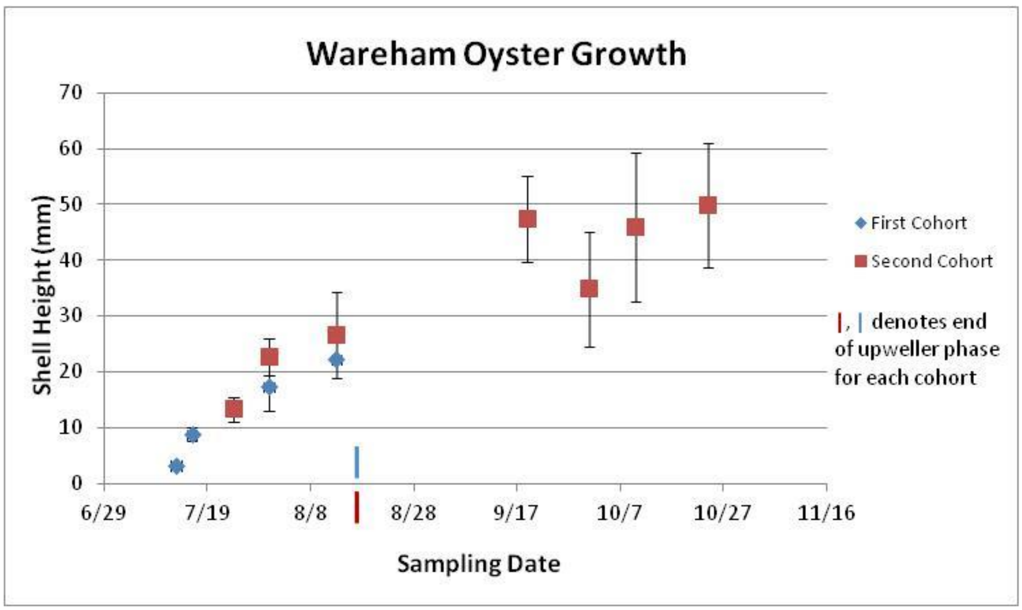

Figure 31. Mean shell height of oysters (+/- SD) across the grow-out season. Blue diamonds denote the early, smaller-sized cohort, and red squares denote the second, larger-sized cohort. Blue and red lines on x-axis denote end of upweller grow-out phase and transfer to floating bags/cages for each cohort.

Out-planting – Onset Reef; Lydia's Island, Wareham

The town of Wareham notified *DMF* in late September that they had planted three of the 8 strings of oyster bags at Onset Reef on September 22nd, September 23rd, and September 29th, 2018. DMF was not given sufficient notice to be present at the time of planting, but Wareham personnel described broadcast-seeding the bags across the site. A total of 180 bags of oysters were planted. Based on the pre-planting sampling, this amounts to an estimated 139,628 oysters planted at the site and a planting density of 6.80 oysters/ft.^{2} (Table 20). The size range of oysters planted at this site was 14.7-80.5 mm and mean oyster size at the time of planting was 49.14 mm (Table 20).

The remaining 5 strings of oyster bags were planted at the Lydia's Island site on October 26th, 2018. *DMF* personnel were not notified in time to be present, but the planting methods described were similar to those used at the Onset Reef. A total of 258 oyster bags were planted at the Lydia's Island site. This amounts to an estimated 317,405 oysters planted and a planting density of 6.42 oysters/ft.^{2} (Table 20). The size range of oysters planted at this site was similar to those planted at the Onset Reef, with a range of 18.4-77.6 mm and a mean size of 49.89 mm (Table 20). The majority of the oysters from the 2018 orders were planted here because of the high survival and significant growth of the B-120 single oysters planted at this site in 2017.

Town Comparison of Single Oyster Project

The B-120 oyster project was successfully completed in 2018 with Bourne, Marion, and Wareham all purchasing single oysters of various sizes that were grown in upwellers and floating bags/cages before being out-planted in the fall. Pre-planting site surveys were completed at all 5 restoration sites (2 in Bourne, 2 in Wareham, and 1 in Marion) and growth and survival data were collected prior to planting. Additionally, Bourne will be planting an additional site with the B-120 oysters which they over-wintered, and *DMF* personnel will conduct a site survey and sampling of these oysters prior to planting in the spring 2019. As seen in Tables 19 and 20, and Figure 32 (below), final oyster size and survival rates differed among towns. Due to diligent monitoring and maintenance of grow-out equipment, Bourne achieved especially high survival rates prior to planting, while Wareham and Marion varied in their pre-planting sizes and survival rates (Table 19). Planting density varied based on the number and size of propagation sites available in each town (Table 20), and post-planting survival rates of planted oysters will be documented during B-120 monitoring surveys in 2019. An estimated total of 1,805,047 oysters were out-planted across the 5 sites in 2018, and an additional estimated 144,767 oysters are being overwintered in Bourne and will be out-planted in spring 2019 (see Table 19).

Municipality	Cohort	Pre-Plant Sampling Date	# Oysters Planted (or OW)	# Oysters Purchased	Survival Rate (%)
Bourne	June (1)	10/25/18	144,767 (OW)	300,000	n/a
Bourne	July (2)	10/25/18	418,780	353,000	n/a
Bourne	Combined	10/25/18	563,547	653,000	86.30
Marion	June (1)	10/3/18	217,728	400,000	54.43
Marion	July (2)	10/3/18	147,960	325,000	45.53
Wareham	Combined	10/24/18	457,032	797,000	57.34

Table 19. Summary table of pre-planting survival rates of B-120 oysters. 'OW' denotes the oysters that are currently being over-wintered until spring 2019 at Monument Beach Marina in Bourne.

Municipality	Planting Site	Planting Area (acres)	Planting Area (sq.ft.)	Total # Oysters Planted	Mean Size (mm)	Size Range (mm)	Planting Density (#/sq.ft.)
Bourne	Little Bay	0.79	34,231	374,794	49.30	32.0-71.0	10.95
Bourne	Winsor Cove	0.74	32,048	43,806	42.17	23.0-59.0	1.37
Marion	Black Point	0.31	13,504	365,688	21.84	8.8 - 62.8	27.08
Wareham	Onset Reefs	0.47	20,524	139,628	49.14	14.7 - 80.5	6.80
Wareham	Lydia's Island	1.14	49,455	317,405	49.89	18.4 - 77.6	6.42

Table 20. Summary table of planting data from the three B-120 oyster restoration towns. Size measurements denote shell height.

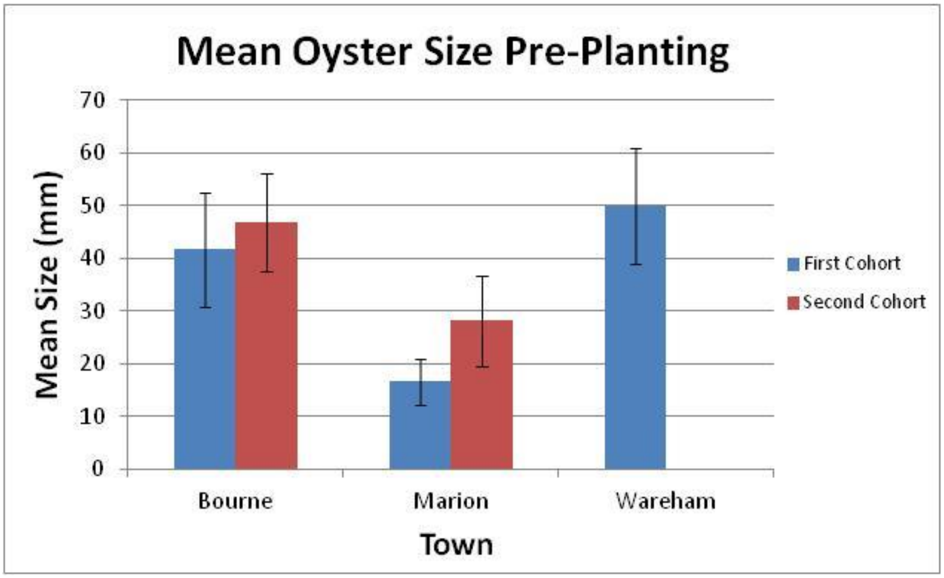

Figure 32. Mean oyster size (+/- SD) at each B-120 oyster restoration town prior to planting. Blue denotes the early cohort and red denotes the later cohort of oysters. (In Wareham, all oysters were combined for the later stage of seed grow-out.)

Monitoring of Single Oysters Planted in 2017

As part of the B-120 oyster restoration project in 2018, *DMF* personnel completed monitoring of the 2017 oyster restoration sites in both Marion and Wareham. Unfortunately, Bourne's 2017 oyster planting site in Cohasset Narrows could not be surveyed because Bourne town staff broadcast-seeded their oysters in an area that was not clearly marked and no current staff were present to clarify the planted location. Additionally, these oysters were apparently planted in slightly deeper waters than the area surveyed, so a typical survey from shore would have been difficult to conduct. In both Marion and Wareham, the 2018 pre-planting oyster site surveys served as post-planting monitoring surveys of the 2017 oysters because both towns used the same propagation sites to plant B-120 oysters during 2017 and 2018 in order to restore oyster populations in their respective towns.

As described in the above site survey section and summarized in Table 21 (below), in Marion we found a total of 36 oysters in the 37 sampled quadrats, for a density of 0.97 oysters/$ft.^2$. The mean size of these oysters was 65.7 mm, and these were assumed to be primarily planted oysters due to a lack of a resident population prior to the start of propagation efforts. The one-year post-planting survival rate of Marion's 2017 oysters is estimated at 25.06% based on 2017 planting densities and 2018 survey densities (Table 21). In Wareham's Lydia's Island site, 254 oysters were found within the 40 sampled quadrats for a density of 6.35 oysters/$ft.^2$. Mean oyster size at this site was 68.38 mm, and were also identified as exclusively B-120 oysters planted in 2017. Unfortunately, this site's planting density was not documented in 2017 so a 1-year post-planting survival rate cannot be calculated. At the Onset Reef in Wareham, 20 oysters were found within the 15 sampled quadrats for a density of 1.33 oysters/$ft.^2$. Mean oyster size was 64.07 mm, and the 1-year post-planting survival rate of these oysters is estimated at only 3.19% (Table 21). There may have been some harvesting of the larger oysters in the area, which could partially explain the low survival rate. While all surveyed propagation sites appeared to support a significant oyster population, Wareham's Lydia's Island site stands out as a highly successful area in terms of planted oyster growth and survival.

Municipality	Site	2017 Planting/Survey Date	2017 Mean Size (mm)	2017 Planting Density (#/ft.^{2})	2018 Survey Date	2018 Mean Size (mm)	2018 Density (#/ft.^{2})	One-year Survival Rate (%)
Bourne	Cohasset Narrows	6/23/2017	54.90	3.87	n/a	n/a	n/a	n/a
Marion	Black Point	12/19/2017	34.50	3.87	9/19/2018	61.43	0.97	25.06
Wareham	Lydia's Island	12/13/2017	36.36	n/a	10/3/2018	68.38	6.35	n/a
Wareham	Onset Reef	9/29/2017	41.74	4.30	10/3/2018	64.07	1.33	3.19

Table 21. Summary table comparing B-120 oyster restoration planting data (2017) and monitoring data (2018). Size measurements denote shell height.

Considerations for Baseline and Performance Monitoring in 2019

The primary objectives of the B-120 oyster project were met in 2018 with the acquirement of both small and large oyster seed for all three towns and the subsequent out-planting of these oysters to suitable sites in Buzzards Bay. Additionally, several improvements to performance monitoring and record-keeping were made that allowed for an increase in quantity and quality of data collected. Bourne and Wareham personnel frequently cleaned and maintained their grow-out systems, as well as conducted frequent thinning and sorting of oysters as they grew. At *DMF*'s request, their shellfish staff dedicated time to collecting bi-weekly size measurements at the minimum, and Bourne's Shellfish Technician, Mike Corson, collected additional bi-weekly survival and volumetric data. *DMF* provided datasheets and digital calipers (if needed) to each town to streamline and standardize data collection as much as possible. Marion's shellfish department staff encouraged their summer intern to collect the bi-weekly size data during her tenure, but data collection was primarily driven by *DMF* personnel during their site visits. Regardless, the frequency of sampling and quality of data was an improvement on the 2017 season.

In addition to an improvement in town initiative, increased communication and collaboration between town Shellfish Departments and *DMF* personnel allowed for successful data collection before and during the oyster out-planting process. In 2018, all site surveys were completed and a final pre-planting sampling event was coordinated and conducted by a combination of *DMF* and town personnel that resulted in successful collection of final grow-out size, survival, and oyster density data. Additionally, most towns followed instructions about notifying *DMF* personnel prior to out-planting their seed so that *DMF* personnel could partake in the planting and collect any final data that was needed. All oysters were planted at the targeted, pre-surveyed sites in each town, and the increased involvement of *DMF* personnel will allow for improved methods when conducting post-planting surveys in 2019.

Going forward, improved communication and cooperation between towns and DMF personnel will continue to be a focus in order to successfully complete all project data collection and monitoring of oyster restoration efforts in 2019.

III. *Quahog Seed Monitoring*

Post-Planting Survey Methods and Results

While no additonal quahog seed was ordered in 2018 for a variety of reasons, *DMF* personnel and town Shellfish Department staff conducted post-planting surveys of all 2017 sites planted with upweller-reared quahogs in Dartmouth, Fairhaven, and Wareham. The objective of these surveys was to assess growth and survival of planted quahogs from 2017 (Table 22) as well as to evaluate planting techniques for the continuation of the B-120 quahog seed project in 2019 and 2020. Survey methods were similar to those described for the contaminated quahog relays and the single oyster project.

Municipality	2017 Planting Site	2017 Planting Date	2017 Mean Size (mm)	2017 Planting Density (#/ft.^{2})	2018 Survey Date	2018 Mean Size (mm)	2018 Density (#/ft.^{2})	Seed Survival Rate (%)
Dartmouth	Bush Point	11/9/2017	8.40	0.63	10/23/2018*	40.67*	1.12*	n/a
Fairhaven	Round Cove	11/14/2017	9.92	50.00	6/13/2018	10.30	7.03	14.06
Wareham	Lydia's Island	11/6/2017	13.00	50.00	5/29/2018	12.95	4.80	9.60

Table 22. Summary table comparing B-120 quahog seed planting data (2017) and monitoring data (2018). *Denotes a mean shell length and density of combined resident and planted quahogs in Dartmouth.

Fairhaven

On June 13th, 2018, *DMF* personnel and the Fairhaven Shellfish Constable conducted a post-planting survey of the quahog out-planting site in Round Cove, Fairhaven (Figure 33). Quahog seed was planted under seven anchored predator nets (30 x 14 ft.) in late fall 2017, but five of the nets at the planting sites had been damaged or lost due to ice and winter storms. The two predator-exclusion nets that were still present at Round Cove were removed at the time of the survey, and the other previously-netted planting locations were located using GPS coordinates. Four transects were sampled across the previously netted area with ten 1-ft.^{2} quadrats excavated at 10-foot intervals along each transect using a mesh-lined basket rake (a total of 40 quadrats). GPS coordinates were taken at the start and end of each transect for subsequent mapping. A total of 281 planted, juvenile quahogs were found across the 40 quadrats for a density of 7.03 quahogs/ft.^{2} (Table 23). Compared to the 2017 planting density of 50 quahogs/ft.^{2} under the nets, the survival rate of the seed quahogs was estimated to be 14.06 % (Table 22). Twenty additional, adult quahogs were also observed and recorded.

Figure 33. Map of the B-120 quahog seed planting area and acreage in Fairhaven.

Mean (mm)	10.3
Min (mm)	7.1
Max (mm)	16.3
Total #	281
# Quadrats	40
Density/sq.ft.	7.03

Table 23. Summary table of the 2017 planted quahog seed monitoring results at the Fairhaven B-120 site. Size measurements denote shell length.

Wareham

On May 29th, 2018, *DMF* personnel and two Wareham Shellfish Department staff conducted a survey of the quahog seed planting site in Sunset Cove, Wareham (Figure 34). Of the five predator-exclusion nets that were originally installed in 2017, three nets were still present at the site but they were bunched up and tangled due to heavy storms. These nets were removed and the original netted planting areas were located by the landmarks that the Deputy Shellfish Constable used at the time of planting. A total of 24 1-ft^2 quadrats were sampled witin the prevously netted areas and 115 planted quahogs were found for a density of 4.80 quahogs/$ft.^2$ (Table 24). Compared to the 2017 planting density of 50 quahogs/$ft.^2$ under the installed nets, the survival rate of the seed quahogs was estimated to be 9.06 % (Table 22).

Figure 34. Map of the B-120 quahog seed planting area and acreage in Wareham.

Mean (mm)	12.95
Min (mm)	9.60
Max (mm)	17.70
Total #	115.00
# Quadrats	24.00
Density/sq.ft	4.80

Table 24. Summary table of the 2017 planted quahog seed monitoring results at the Wareham B-120 site. Size measurements denote shell length.


Figure 35. Photograph depicting one of the remaining predator-exclusion nets at Wareham's 2017 quahog seed out-planting site.

Figure 36. Photograph of DMF and town of Wareham Shellfish Department staff raking quadrats during the 2018 post-planting survey of out-planted seed quahogs.

Dartmouth

On October 23rd, 2018, *DMF* personnel and the Dartmouth Shellfish Constable conducted a post-planting survey of the B-120 site planted with seed quahogs in Apponagansett Bay in 2017 (Figure 37). This site differed from Fairhaven and Wareham because the site was broadcast-seeded with quahogs instead of planting them under predator-exclusion nets. During the survey, the boundaries of the area were estimated using pre-recorded GPS coordinates and quadrats were randomly distributed throughout the site to try and target the planting area as much as possible. A total of 25 quadrats were sampled and 28 quahogs, both juvenile and adult, were observed for a density of 1.12 quahogs/ft.^{2} (Table 25). Unfortunately, because there was no defined netting area that was raked clear of other species before planting, it was impossible to distinguish the 2017 planted juveniles from the resident juvenile quahogs. Thus, we have reported the total quahog density for the site, and will ensure improved planting methods in 2019.

Figure 37. Map of the B-120 quahog seed planting area and acreage in Dartmouth.

Mean (mm)	40.67
Min (mm)	10.85
Max (mm)	72.17
Total #	28.00
# Quadrats	25.00
Density/sq.ft.	1.12

Table 25. Summary table of the planted quahog seed monitoring results at the Dartmouth B-120 site. Total #, density, and mean size represent total number of quahogs found, both planted and resident. Size measurements denote shell length.

Figure 38. Photograph depicting resident and planted quahogs found during the post-planting survey of out-planted seed quahogs in Dartmouth.

Considerations for Baseline and Performance Monitoring in 2019

As the first year of monitoring the B-120 out-planted quahog seed, several topics came up that will be addressed in the 2019 and 2020 seasons. First, there was varied success with the predator-exclusion netting techniques and effectiveness. In 2019, *DMF* plans to use similar net material but will improve anchoring techniques to keep nets in place throughout the fall. *DMF* personnel will spend time recruiting an appropriate number of town and volunteer personnel to successfully install the nets at planting time. Nets will be installed by late October/early November and will then be retrieved before January in order to reduce the number of lost and damaged nets due to heavy ice and winter storms. We are assessing the feasibility of re-installing the nets during the spring to protect the seed quahogs from predators until they achieve greater growth. This is a technique employed by many municipalities, and while it is labor-intensive, may be an improvement to the B-120 2017 netting methods and may ultimately increase quahog seed survival rates.

DMF personnel have been working with both towns slated to receive B-120 seed quahogs, Dartmouth and Fairhaven, in 2019 to ensure upweller units will be fully prepared and of a suitable capacity for the 2019 seed order. The Fairhaven Shellfish Department may install a second set of silos to increase volume for separating the seed, but will have an adequate set-up whether they use the additional system, or not. The Dartmouth Shellfish Constable is collaborating with the Dartmouth Community Boating Center (CBC) and a local aquaculturist from Roger Williams University, Dale Leavitt, to construct and maintain upwellers at CBC's dock in Clark's Cove. CBC students will help with routine upweller maintenance and seed monitoring as a way to gain experience, as well as help with the data collection for the project. With this new collaboration and additional personnel, the Dartmouth Shellfish Department should have a greater ability and adequate resources to manage the project.

In 2019 and 2020, there will once again be a focus on proper shellfish husbandry practices that include routine cleaning of the upwellers to control biofouling and the buildup of pseudofeces, as well as culling the seed as the quahogs grow. Fast-growing, larger quahogs need to be routinely sorted and separated from smaller individuals in order to lessen competition and achieve uniformly high growth rates across size classes. In addition to routine maintenance, town shellfish managers have committed to becoming more involved in monitoring the seed and taking size and survival measurements throughout the growing season. To address these needs, *DMF* will coordinate with both towns that will be receiving quahog seed to ensure they have appropriate staff and resources to manage the project. *DMF* staff will also ensure the municipalities use a standard set of methods to follow when independently collecting data for the project by training town personnel and providing standardized datasheets for biweekly length measurements. Additionally, *DMF* personnel will still strive to be present at sampling events to the extent possible, particularly early in the season.

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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.

APPENDIX I

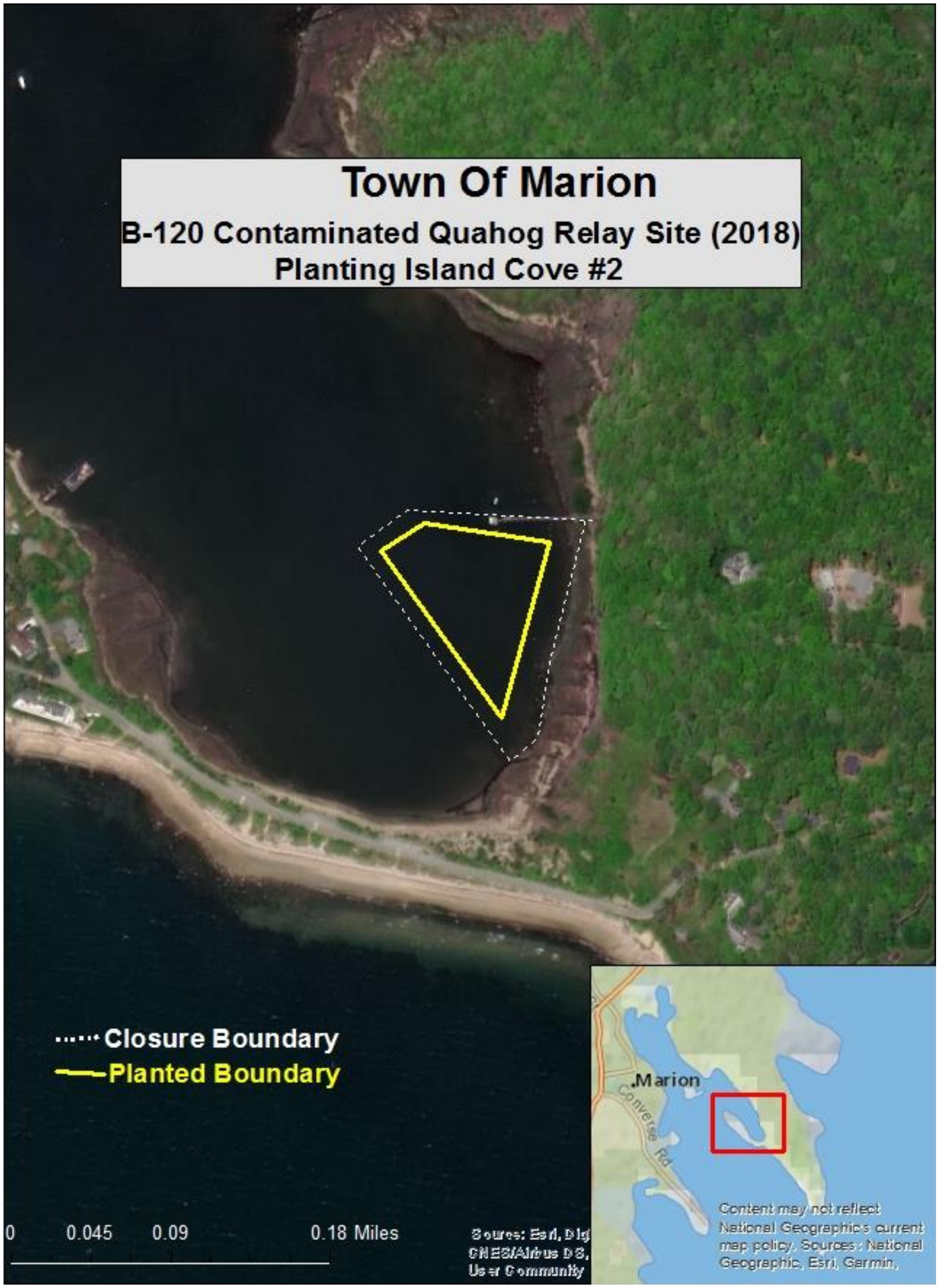
2018 Contaminated Quahog Relay Site Maps


Town of Bourne
B-120 Contaminated Quahog Relay Site (2018)
Little Bay - Emmons Road
Closure Boundary
Planted Boundary
0 185 370 740 Feet
Monument Beach
Mac Arthur Blvd
Pocasset
Content may not reflect National Geographic's current map policy. Sources: National Geographic, Esri, Garmin,

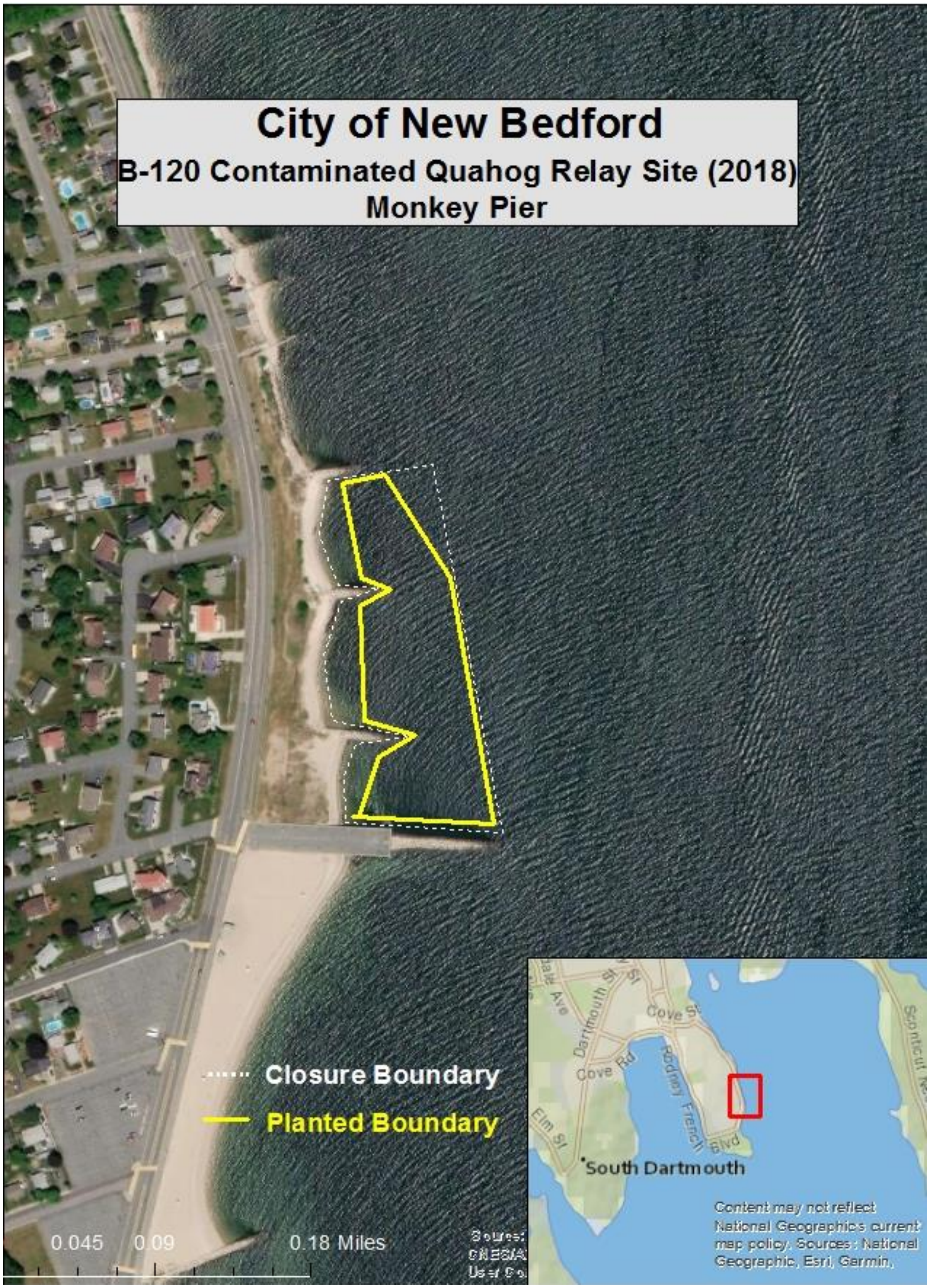

Town of Dartmouth
B-120 Contaminated Quahog Relay Site (2018)
Gulf Road Bridge
Closure Boundary
Planted Boundary
0
1.75
3.5
7 Miles
Allen St
Tucker Rd
Cove St
Cove Rd
Elm St
South Dartmouth
Russells Mills Rd
Content may not reflect
National Geographic's current
map policy. Sources: National
Geographic, Esri, Garmin,


Town of Fairhaven
B-120 Contaminated Quahog Relay Site (2018)
Seaview Avenue
Closure Boundary
Planted Boundary
0 0.0275 0.055 0.11 Miles
Nasketucket Bay
Content may not reflect National Geographic's current map policy. Sources: National Geographic, Esri, Garmin,

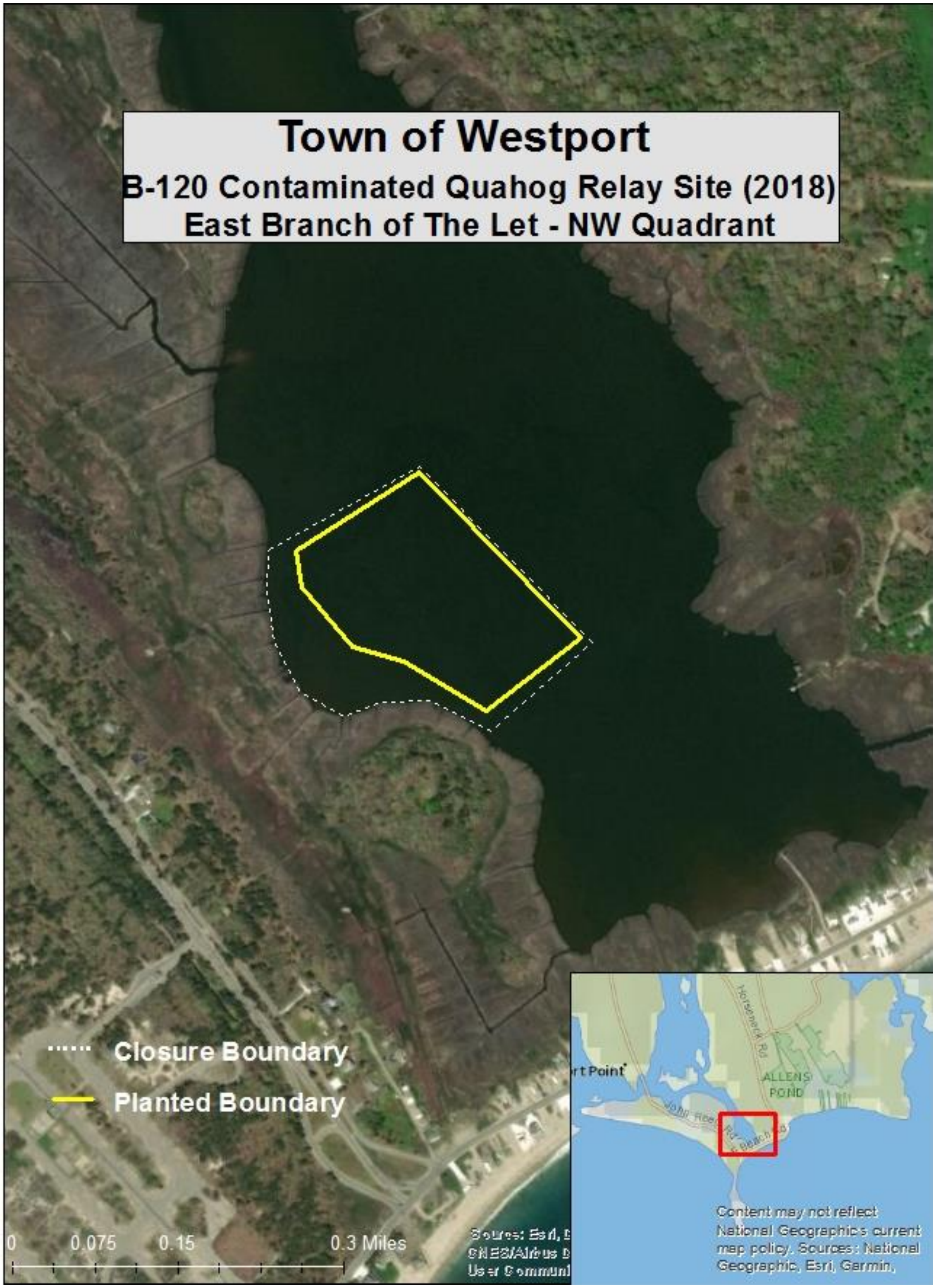

Town of Gosnold
B-120 Contaminated Quahog Relay Site (2018)
Cuttyhunk Pond (SE corner)
Closure Boundary
Planted Boundary
0 1 2 4 Miles
Cuttyhunk
Content may not reflect National Geographic's current map policy. Sources: National Geographic, Esri, Garmin,


Town Of Marion
B-120 Contaminated Quahog Relay Site (2018)
Planting Island Cove #2
Closure Boundary
Planted Boundary
0 0.045 0.09 0.18 Miles
Marion
Converse Rd
Content may not reflect National Geographic's current map policy. Sources: National Geographic, Esri, Garmin,

Town of Mattapoisett
B-120 Contaminated Quahog Relay Site (2018)
Nyes Cove, Point Connett
Closure Boundary
Planted Boundary
0 0.05 0.1 0.2 Miles
195
Marion
Mattapoisett
Content may not reflect National Geographic's current map policy. Sources: National Geographic, Esri, Garmin,


City of New Bedford
B-120 Contaminated Quahog Relay Site (2018)
Monkey Pier
Closure Boundary
Planted Boundary
0.045
0.09
0.18 Miles
Cove St
Dartmouth St
Cove Rd
Rodney French Blvd
Elm St
South Dartmouth
Content may not reflect National Geographic's current map policy. Sources: National Geographic, Esri, Garmin,


Town of Wareham
B-120 Contaminated Quahog Relay Site (2018)
Agawam Beach
Closure Boundary
Planted Boundary
0
0.035
0.07
0.14 Miles
Onset
Arlington Rd
Content may not reflect National Geographic's current map policy. Sources: National Geographic, Esri, Garmin,


Town of Westport
B-120 Contaminated Quahog Relay Site (2018)
East Branch of The Let - NW Quadrant
Closure Boundary
Planted Boundary
0 0.075 0.15 0.3 Miles
Horseneck Rd
ALLENS POND
Content may not reflect National Geographic's current map policy. Sources: National Geographic, Esri, Garmin,

APPENDIX II

Pathology Screening Results for Quahogs from the 2018 Taunton River Donor Site

KENNEBEC RIVER BIOSCIENCES

Shellfish Health Inspection

Company:	Massachusetts Division of Marine Fisheries	**Report Date:**	18-Jul-18
Address:	706 South Rodney French Blvd.	**Receipt Date:**	28-Jun-18
	New Bedford, MA 02740	**Accession:**	M18062808
Site:	N. side of Braga Bridge, Somerset, MA		
Species:	*Mercenaria mercenaria*	**Collected By:**	Greg Sawyer
Age:		**Date Collected:**	27-Jun-18
Size:	Avg. 96 mm	**Witnessed by:**	

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 USFWS & AFS-FHS (2016) and OIE (2017) 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 using a combination of RFTM, histology and PCR.

Comments:

External and internal examination did not indicate 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

Shellfish Health Inspection

KENNEBEC RIVER BIOSCIENCES

Company:	Massachusetts Division of Marine Fisheries	**Report Date:**	18-Jul-18
Address:	706 South Rodney French Blvd.	**Receipt Date:**	28-Jun-18
	New Bedford, MA 02744	**Accession:**	M18062809
Site:	S.Side of Braga Bridge, Somerset, MA		
Species:	*Mercenaria mercenaria*	**Collected By:**	Greg Sawyer
Age:		**Date Collected:**	27-Jun-18
Size:	Avg. 103 mm	**Witnessed by:**	

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 USFWS & AFS-FHS (2016) and OIE (2017) 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 using a combination of RFTM, histology and PCR.

Comments:

External and internal examination did not indicate 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

Pathology Screening Results for 2018 Single Oysters from Muscongus Bay Aquaculture

KENNEBEC RIVER BIOSCIENCES

Shellfish Health Inspection

Company: Muscongus Bay Aquaculture, Inc.
Address: PO Box 204
Bremen, ME 04551

Report Date: 01-Jun-18
Receipt Date: 25-May-18
Accession: M18052504

Site: New Meadows River, ME
Species: *Crassostrea virginica*
Age: 3 months
Size: Avg. 5 mm

Collected By: Jean MacKenzie
Date Collected: 25-May-18
Witnessed by: Tonie Simmons

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

n/a = not applicable or not requested

Methods:

Shellfish were inspected at an assumed pathogen prevalence level of 2% (over 175 individuals tested), according to USFWS & AFS-FHS (2016) and OIE (2017) protocols. Shellfish were examined for any external or internal morphological abnormalities and fouling organisms. Whole animals were screened for targeted etiologic agents using a combination of RFTM, histology and PCR.

Comments:

External and internal examination did not indicate 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:	Muscongus Bay Aquaculture, Inc.	**Report Date:**	13-Jul-18
Address:	PO Box 204	**Receipt Date:**	10-Jul-18
	Bremen, ME 04551-0158	**Accession:**	M18071001
Site:	Kingman Yacht Ctr (MBA Nursery), Bourne, MA		
Species:	*Crassostrea virginica*	**Collected By:**	Rod Taylor
Age:	3 months	**Date Collected:**	09-Jul-18
Size:	Avg. 20 mm	**Witnessed by:**	Gabe Lundgren

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

n/a = not applicable or not requested

Methods:

Shellfish were inspected at an assumed pathogen prevalence level of 5% (60 individuals tested), according to USFWS & AFS-FHS (2016) and OIE (2017) 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 using a combination of RFTM, histology and PCR.

Comments:

External and internal examination did not indicate 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