CASCO BAY REGIONAL SHELLFISH WORKING GROUP

A Guidance Document for Municipalities in Maine


Photo courtesy of Sam Dorval.

Quahog Management, Restoration, and Aquaculture: A review of case studies in Maine

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Background and Introduction

Northern Quahog (*Mercenaria mercenaria*) landings in Maine increased greatly during the ten-year period from 2009 to 2019[1], while the trend in soft-shell clam landings has been declining over the same period.[2] With their higher value to harvesters and increasing abundance in southern Maine, quahogs are of a significant economic importance to some municipalities. Therefore, over the last 3-5 years, towns have been focusing on volunteer efforts and financial resources to manage their quahog resource. Many municipalities require shellfish harvesters to conduct a certain amount of volunteer hours to earn conservation points to renew their licenses or obtain reduced license fees; thus, they have a volunteer workforce to assist with these activities. This document provides a summary of several conservation activities and research projects focused on quahog conservation. The impetus for this document came from members of the Casco Bay Regional Shellfish Working Group (CBRSWG)[3], who were requesting information on effective conservation activities to conduct in their towns.

Four case studies from Maine are highlighted throughout this document, and one example from Massachusetts is included in the Methodology Section:

A. Growing out quahog seed in nursery bags and floating oyster grow bags on an aquaculture lease for municipal reseeding (Town of Brunswick and Mere Point Oyster Company).
B. Transplanting adult quahogs to diversify shellfish resources (Town of Georgetown and Manomet).
C. Growing out quahog seed in nursery bags, floating oyster bags, and bottom planting bags on a commercial aquaculture lease (Winnegance Oyster Farm).
D. Municipal upweller to grow quahogs for reseeding town flats (Town of Chatham, Massachusetts).
E. Growing out quahog seed in floating aquaculture trays (Downeast Institute)

The primary audiences for this document include members of municipal shellfish committees, harvesters, and researchers.

Case Study Methodologies

This section provides the methodology for each case study, providing specific information on gear, timing, monitoring, and other considerations when planning each activity.

A. **Town of Brunswick and Mere Point Oyster Company**
In 2019, Dan Devereaux, Coastal Resource Manager in Brunswick, and co-owner of Mere Point Oyster, conducted a project to assess the growth rate of quahog seed from June through October. Subsequently, they assessed survival of transplanting the quahogs with and without predator protection. The methods for this project are as follows:

   » **Size:** The seed size averaged 1.0-1.5 mm. It was conditioned for two weeks in floating nursery bags at the tip of Mere Point in Brunswick, Maine, starting on June 19, 2019. The nursery bags were then transferred to Mere Point Bay, where they remained until mid-October (Figure 1).

1 https://www.maine.gov/dmr/commercial-fishing/landings/documents/HardClam.graph.pdf

2 https://www.maine.gov/dmr/commercial-fishing/landings/documents/softshellclam.graph.pdf

3 https://www.tidalbayconsulting.com/cbrswg

» **Gear:** The gear used was a mesh shellfish nursery bag, connected by hog rings to a 1-in flat wire mesh (18-in X 20-in lobster trap wire mesh) and placed inside a 14 mm mesh ADPI floating oyster grow bag. This allowed the nursery bag to maintain a flat contour during wave action.

» **Monitoring:** The gear and quahog seed were inspected once a week from July – October, 2019. Growth rate was monitored on August 27, and increased on average from 1.5 mm to 6 mm (Figure 2).

» **Transplanting:** The quahogs were planted in nearby subtidal mudflats (Smiths Cove in Brunswick) on October 22, 2019. The size range was 5-10 mm. One-hundred animals were planted per 12-in plant pot (without any screening or additional predator protection). Approximately 800 were broadcast throughout the mudflats without plant pots. There was no evidence of an existing quahog population in Smiths Cove prior to this project.

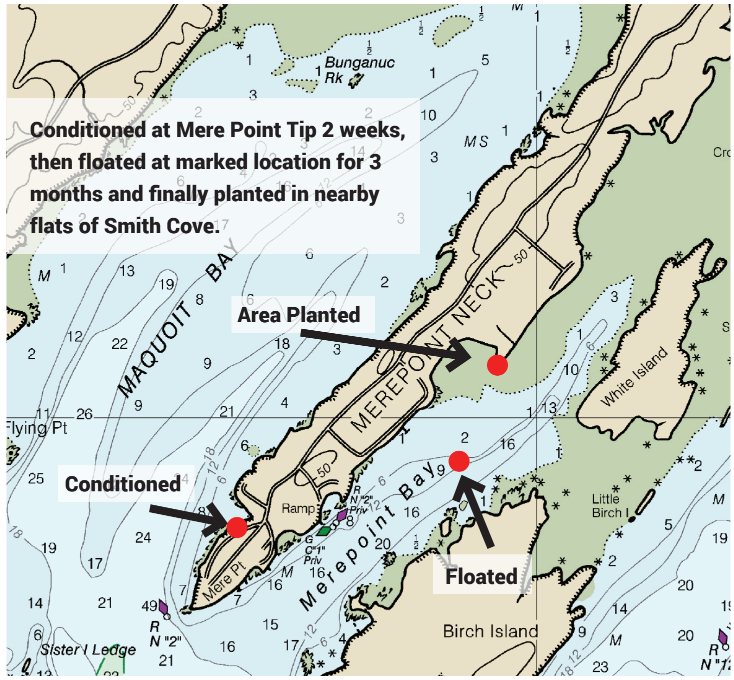

Figure 1. Location of sites used by the town of Brunswick and Mere Point Oyster Company in their study on quahog seed growth rates.

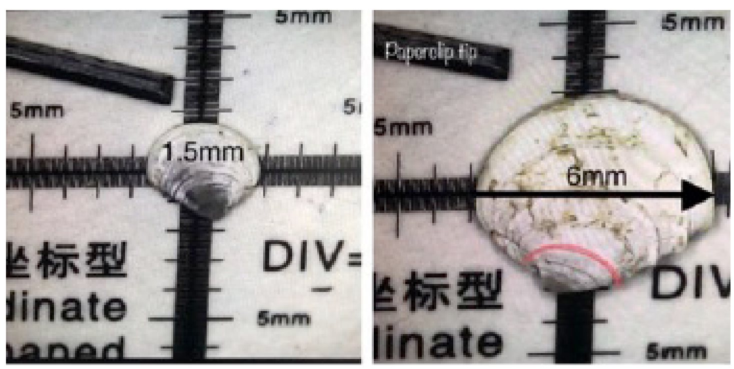

Figure 2. Researchers used this tool to measure the growth rate of quahog seed in the Town of Brunswick study.

B. **Town of Georgetown and Manomet**
From 2018-2019, the Town of Georgetown's Shellfish Committee and Dr. Marissa McMahan of Manomet transplanted adult quahogs into Robinhood Cove in an effort to diversify shellfish resources, which are currently limited to soft-shell clams. They planted 10,000 adult quahogs in April of 2018, and 40,000 adult quahogs from May through September of 2019. The Committee prevented harvesting throughout the town with a conservation closure approved by the Maine Department of Marine Resources (DMR). Other components of the study included hourly temperature recording using temperature loggers and using recruitment boxes to monitor settlement. In addition, they dissected a subsample of quahogs in September of 2018 and 2019 to determine if spawning was occurring. In December of 2019 the recruitment boxes were removed and analyzed along with the quahog recovery data and temperature data.

C. **Winnegance Oyster Farm**

This project aims to test crop diversification on subtidal oyster farms by introducing littleneck clams, or quahogs as a secondary crop species. Since 2017, Winnegance Oyster Farm in West Bath has grown quahog clam seed (1 mm) for sale as a farmed product. While this example is from a private (as opposed to a municipal) aquaculture lease, it is included in this document for several reasons. One being that there could be a public-private partnership between local growers and municipalities such as between Mere Point Oyster Company and the Town of Brunswick, which would allow seed to be grown at a commercial farm for municipal use (i.e., reseeding). This would save time and resources for permitting and equipment. Second, if a municipality has a Limited Purpose Aquaculture (LPA) lease, they may utilize these methods to grow seed for town use.

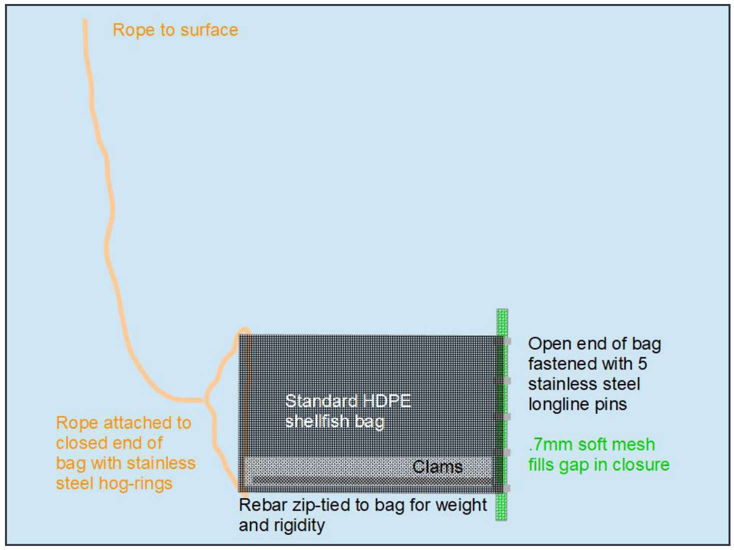

Figure 3. Diagram of the gear configurations for the rigid mesh bottom planted bag treatments used by Winnegance Oyster Farm.

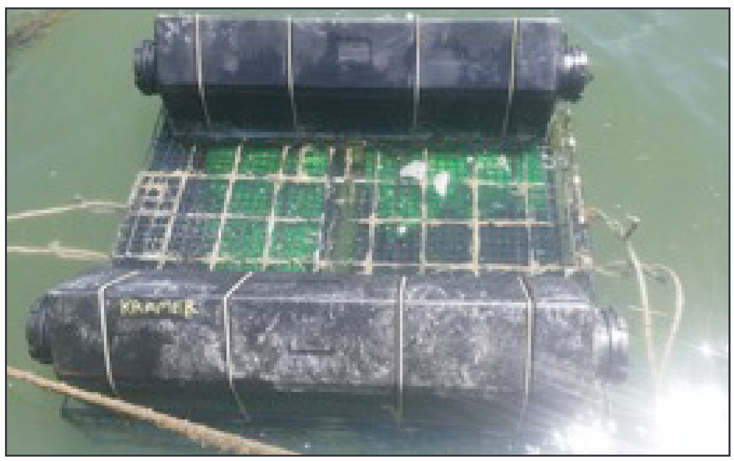

Figure 4. The project conducted by Winnegance Oyster Farm used nursery bags deployed in floating oyster cages for growing out quahog seed.

Seed is initially grown at the surface in soft mesh nursery bags until retained on 4 mm square mesh. At this size, some of the clams were moved to 4 mm rigid mesh oyster bags and lowered to the seafloor below the floating oyster longlines (avg. depth 20’) (Figure 3). The remaining larger clams were retained in surface gear in floating oyster cages (Figure 4). This floating treatment was included to gauge the optimal time to switch from nursery equipment to bottom-planting. The seed from the initial planting in July 2017 began to reach harvestable size at 26 months.

The fastest growth was observed in 2017, with 1 mm seed clams reaching an average length of 11 mm by the end of their first season (5 months after planting), and 22 mm by the end of their second season (17 months). The 2017 tests also had the lowest seed retention (40%) largely due to mechanical losses (clams sifting out of their initial .75 mm mesh, Figure 5).

In 2018 and 2019, seed clams were grown in smaller meshes (0.25 mm [Figure 6] and 0.5 mm respectively). These mesh sizes nearly eliminated sifting losses, but greatly slowed growth. Clams from the 2018 planting only reached 4 mm in their first season and 15 mm in their second season.

The 2019 planting averaged 6 mm at the end of their first growing season.

In 2020 Winnegance is testing four seed-clam sizes for growth, retention, and mortality. Because large seed is currently unavailable in this region, a small-scale downweller will be constructed to produce the large seed tested in this project. A minimum-viable seed size (based on growth) and an optimal seed size (that takes into account growth *and* the price of large seed in other regions) will be determined at the end of the growing season.

Figure 5. Winnegance Oyster Farm grows quahog seed for commercial harvest in floating mesh nursery bags, such as this 0.75mm mesh nursery bag.

D. **Town of Chatham, Massachusetts**

The town of Chatham, MA has conducted quahog propagation work since the 1970s. Since 1998, their primary tool has been an upweller, which produces 2.5-3 million quahogs per year. The upweller sits in an enclosed facility (60 ft x 30 ft) on the shore of a productive water body. There are six tanks in total, 132 silos, and three submersible pumps that run 800 gallons of water through the system every minute.

Figure 6. 0.25mm nursery bag used by Winnegance Oyster Farm in 2018 to grow quahog seed.

Chatham uses a two-phase growing system. At the beginning of the summer, 1.2-2 mm quahog seed are put into the upweller, where they are afforded complete protection from predation, and constant food as the water runs through the system. Quahogs grow at different rates; therefore, to limit competition for food, the town uses a thinning machine. The silos are periodically emptied into the machine, which sorts them into new silos by size. By mid-August, the facility is packed with quahogs, and the fastest growers are moved into grow out areas in the field.

The town has the capacity to raise approximately 150,000 quahogs at once in multiple grow out areas. The quahogs are kept under nets with light gauge rebar bent over the nets and stapled in. Once the water temperature dips below 50°, the nets are removed so they do not ice over. At such cold temperatures, predators have generally stopped moving around, so removing the nets should not increase predation. Depending on the sediment conditions and the exact location of the growing area, it takes between 2-5 years for quahogs to reach the target size of 25 mm. Once they reach this size, they are dug out and broadcast into water bodies to continue growing to legal harvesting size.

Figure 7. Floating wooden aquaculture trays used by DEI.

E. **Downeast Institute**
The Downeast Institute (DEI) has been growing out quahog seed using aquaculture trays since 2006, with 2021 being the first year that they will be selling seedable (>6 mm) quahogs. The process for growing out the quahog seed begins in January when broodstock is collected from local flats and placed in tanks in DEI's hatchery. Quahogs are fed algae for approximately two months before being induced to spawn. For the first two weeks of life, the larval clams live in circular tanks and grow from 1/600th of an inch to 1/50th of an inch. From there the clams are transferred to trays with fine mesh screening and floated on rectangular tanks where they settle on the surface of the screens. When the quahogs are large enough (2 mm in length), hatchery staff use a graduated cylinder to move 15,000 to 20,000 clams to wooden aquaculture trays. Before moving to an ocean nursery site, each tray receives a handful of periwinkles as they help to keep the screens in the wooden aquaculture trays free of fouling material. The aquaculture trays float on the surface of the water until November (Figure 7) and are then transferred from the trays to mesh bags, which are stacked in modified lobster traps and submerged in circulating seawater from the winter to spring. When the spring comes, the quahogs are then transferred to nearby flats (Hatchery: Soft-Shell Clams).

Key Findings from Case Studies

This section provides results and other findings from each of the case studies where information is available.

A. **Town of Brunswick and Mere Point Oyster Company**
Initial qualitative monitoring of the site in June of 2020 uncovered some dead clam shells at the surface in areas where quahog seed was broadcast in Smiths Cove. Generally speaking, there were less clams alive near the surface than deeper under the sediment. In July 2020, this area was excavated, including sifting through the plant pots, and only two 10-13 mm quahogs were found alive in the plant pots. However, numerous shells around the same size range were found, indicating that the quahogs did grow significantly (around 3-8 mm) since they were planted in

October 2019. Based on the initial results, floating nursery methods can be successful. The mortality rate will vary based on clam size, water temperature, predators, currents, and other variables.

B. **Town of Georgetown and Manomet**

In 2018, there was a range of recovery from 17%-56% of the quahogs. Spawning was 0-40%, aside from the Post Office site, which was 80%. In 2019, recovery ranged from 39%-40%. Spawning ranged from 20-80%, this time with the Post Office site at 20% and a separate site (Phebe Island) at 80%, indicating the annual variability of spawning success. These results are summarized in Table 1, and study sites are shown in Figure 8.

Georgetown continues to deploy recruitment boxes to capture any quahog settlement that might be occurring. They did not observe settlement in 2019, but are hopeful that settlement will occur in 2020. Future studies will include data collection on currents and water flow in Robinhood Cove using bucket drifters to better understand if there is local larval retention. Future studies may also consider collecting core samples around the boxes to gauge natural recruitment.

Figure 8. The study sites (Robinhood Cove) used by Georgetown and Manomet in their case study.

Table 1. Quahog Transplant Results – Robinhood Cove (2018 and 2019)

LOCATION	RIGG'S COVE	THE LANE	MILL POND		PHEBE ISLAND	POST OFFICE	
Year	2018	2018	2018	2019	2019	2018	2019
# Planted	2,500	2,500	2,500	7,500	11,000	2,500	21,500
% Recovery	17%	36%	55%	39%	40%	56%	39%
% Spawning	40%	40%	0%	20%	80%	80%	20%

C. **Winnegance Oyster Farm Nursery**

Information in this section is summarized from two grant reports to the Sustainable Agriculture Research and Education (SARE) program. For more information: https://projects.sare.org/project-reports/fne17-877/ and https://projects.sare.org/project-reports/fne18-901/

Seed Loss/Retention

2017: In the nursery portion of the experiment (8 weeks), 60% of seed were lost due to sifting. This degree of loss was unexpected, and can be attributed to the difficulty of working with 1 mm seed. During the same 8-week period from mid-June to early August, 40% of seed clams that were retained grew six times larger (on average).

2018: Seed retention was much greater in 2018 than in 2017 (87% versus 40%, respectively retained). Greater retention in 2018 can be attributed to improved handling, including during measurements and transfer between bags for de-fouling.

Monitoring and Limiting Fouling

2017: The 0.7 mm mesh nursery bags experienced a small amount of algal fouling, which was easily mitigated by rotating bags into the shade, and switching out fouled bags on a weekly basis. Clams grown on the surface were fouled slightly by blue mussels, but the impact was negligible. The sediment-grown clams were free of fouling entirely.

2018: It was a bad year for fouling due to a large "set" of blue mussels. This fouling particularly affected the smaller mesh and equipment that could not be air dried, such as the 0.75 mm mesh clam nursery bags.

Mesh Size

2017: In the nursery, researchers used 0.7 mm soft mesh scallop bags, held open with sheets of HDPE screen. The nursery bags were deployed in four tier lantern nets built out of 18 mm mesh oyster bags. Clams that were large enough were then transferred to rigid mesh 4 mm bottom-planting bags for grow out.

2018: 1 mm clam seed was acquired in 2018 and deployed in 5-gallon 0.22 mm mesh bags that were placed in floating oyster equipment. The clam seed that remained in the nursery, averaging 4 mm in size, from 2017 was deployed in 0.75 mm mesh bags stretched over PVC frames (Figure 4).

Stocking Density

2017: Because of the high loss of seed in the nursery stage, the researchers could not conduct the density experiments they had originally planned.

2018: In the sediment, the low-density treatment (3000 ml bag) grew much faster, at a rate of 57%, than the high-density treatment (6000 ml bag) which grew at a rate of 17%. Due to a broken closure pin in the low-density treatment, surface treatment densities could not be compared. However, the high-density (6000 ml bag) grew at a rate of 50%.

Growth Rates

2017: On average, the surface-treatment clams reached a length of 11.5 mm by the end of November and sediment-grown clams reached a length of 10.9 mm. In both treatments, individuals were observed measuring as long as 17 mm. The trends seen in this measurement suggest clams grown on the surface grew the fastest until late October, while sediment-grown clams grew faster in November, the final month of the experiment. This could be a seasonal/environmental effect (surface waters cool faster in the fall) or a product of clam age/growth stage (larger clams grow faster in the mud).

2018: Growth rates between the clams at the surface and the clams on the sediment were similar on average. At the surface, the average growth was 2.1times in length while on the sediment the average growth was 2.0 times in length. In May, clams at the surface grew much faster than those on the sediment (77.8% vs. 11.9% respectively). Additionally, the growth rate between southern and northern sediment treatments varied greatly.

D. **Town of Chatham, Massachusetts**
This case study provides an example of how a town successfully uses an upweller to raise quahogs. The fact that Chatham has been using this methodology for several years is testament to the effectiveness of this approach.

E. **Downeast Institute**
In a study between 2006-2010, growing out quahogs using aquaculture trays, researchers found that stocking density influenced the final size of quahogs grown on these trays. Animals grew larger on trays of 2,500 to 5,000 quahogs, than quahogs on trays of higher densities (such as 7,500 quahogs per tray). Additionally, survival on all trays regardless of density was nearly 100% (Farming Quahogs in Trenton).

Best Practices

The following section provides a summary of the best practices used in each case study described above. These are practices that were successful in past projects, and may be applicable to towns looking for guidance on how to replicate such projects.

A. **Town of Brunswick and Mere Point Oyster Company**

The following are best practices for growing quahogs using plant pots:

- **Overwintering and Transplanting:** Based on the results of a fall transplant (October) of quahog seed that ranged from 5-10 mm, the project investigators hypothesize that the quahog seed was susceptible to cold temperatures and other factors that affected their survival. Quahogs are less tolerant to freezing temperatures than soft-shell clams. Therefore, the recommended practice based on this small study is to overwinter the seed and transplant in the spring, when the seed is slightly larger and environmental conditions are more optimal for growth and survival.
- **Protection from Predators:** It did not appear as though the plant pots offered protection from predators. Other studies utilized Pet Screen® on the top and bottom of plant pots seeded with soft-shell clams for additional protection from predators; results were mixed.

B. **Town of Georgetown and Manomet**

The following are best practices for transplanting adult quahogs:

- **Time Consideration:** Work with practical amounts of quahogs (e.g. 5,000 – 10,000) so they can be transported and transplanted in a reasonable amount of time. For example, in one low tide, it took three researchers and three-to-four harvesters about two hours to plant 10,000 quahogs. This timing is affected by proximity of the site to parking access or whether a boat was needed to transfer the quahogs, which added time.
- **Project Partners:** Work with shellfish dealers who can procure recently harvested quahogs in top condition, to minimize natural mortality. It is not recommended to utilize quahogs that have been in cold storage.
    - Ipswich Shellfish was an excellent partner in the Georgetown Case Study.
- **Communication:** Ensure open communication among all project partners, including the municipality, volunteers, committees, and research organizations to allow for efficient and timely

transfer of information and product.

- **Project Location:** As it is not legal to prohibit wormers from digging through the plots (conservation closures are only for town-managed species and marine worms are managed by the state), consider siting your project away from areas where wormers typically dig. Marking the sites may not be enough to prevent worming in your project area.
- **Monitoring:** Continued monitoring beyond the study period is a key component.

C. **Winnegance Oyster Farm**

The following are best practices for growing out quahog seed on an aquaculture site:

- **Seed Loss/Retention:** The majority of seed loss was due to handling and sifting when transferring seed between bags. Limited and careful handling can help to mitigate seed loss, as well as using smaller mesh bags.
- **Monitoring and Limiting Fouling:** To limit fouling, surface bags should be rotated between sun and shade on a weekly basis and fouled bags should be swapped out.
- **Mesh Size:** There are tradeoffs with regards to mesh bag size. Larger mesh bags lead to increased seed loss while small mesh bags limit the amount of seed loss, but slow the growth speed. Beginning with smaller mesh bags in the nursery phase and then transferring the seed to a larger mesh bag once grown is optimal.
- **Stocking Density:** In the sediment, the low-density treatment (3000 ml bag) grew much faster than the high-density treatment (6000 ml bag).
- **Growth Rates:** On average, both the sediment and surface treatment clams grew approximately the same amount. However, surface treatment clams grew at a faster rate until the final month of the experiment, in which the sediment treatment clams grew faster than those at the surface.

D. **Town of Chatham, Massachusetts**

The following are best practices for growing out quahog seed in an upweller:

- **Upweller:** Using an upweller allows the grower to raise quahog seed with complete protection from predation and providing constant food. These conditions create the best chances for survival and optimal growth.
- **Sorting Quahogs by Size:** The Town of Chatham uses a thinning machine to sort quahogs by size as they grow at different rates. This limits competition for food and results in higher survival rates as slower growing quahogs are given the chance to reach full size without being outcompeted for food by larger quahogs.
- **Transfer to Grow-Out Areas:** After 2-3 months in the upweller, the largest quahogs are transferred to grow-out areas. These areas are protected by nets with light gauge rebar stapled in, and provide a safe environment for quahogs to grow until they reach 25 mm.

E. **Downeast Institute**

The following are best practices for growing out quahog seed using aquaculture trays shifting seasonally between indoor tanks and ocean-based nursery sites:

- **Stocking Density:** Growth will be greater when stocking density on aquaculture trays is lower. In other words, the higher the density of quahogs on the tray, the lower the growth will be.

- **Overwintering Equipment:** During winter, quahog seed should be placed in window screen bags (45 cm x 45 cm). These bags should then be placed in cages constructed by lobster wire.
- **Planting Overwintered Seed:** Overwintered seed clams must be planted prior to mid-May each year as this is prior to major predator events and allows for maximum growth (Porada, 2010).

Permitting, Regulatory Requirements, and Other Considerations

When planning any of these conservation activities, there are municipal, state, and sometimes federal requirements to adhere to. These include state permits and licenses, approval from a municipal shellfish or marine resource committee, as well as coordination of volunteers. This section provides a description of some of these processes. However, before starting a new activity, it is recommended that municipalities contact their area biologist at DMR to discuss the process. The requirements described below are summarized in Table 2.

DMR CONSERVATION CLOSURE AND TRANSFER/RELAY FORMS

The DMR conservation closure document is a request by a municipality for either the closing or opening of an area to shellfish harvesting. Three steps must be taken to gain the approval from the Commissioner in order for the opening or closing of an area. The steps are as follows: 1) contact the area biologist responsible for your town to gain consensus, 2) fill out the following application: https://www.maine.gov/dmr/shellfish-sanitation-management/programs/municipal/forms/documents/ConservationClosureNew8-29-193pages.pdf, and 3) submit the completed application to the appropriate area biologist at least 20 business days before the requested date.

The DMR transplant/relay permit application is necessary for moving bivalve shellfish from any area, including those closed due to pollution. The following guidelines are required when transferring shellfish: 1) ensuring the transplant occurs during the day, 2) ensuring the transplant occurs on designated dates, 3) ensuring the transplant occurs under the supervision of either the town's shellfish officer or a designee of the Shellfish Committee, and 4) completing and sending a shellfish transplant activity log to the department within 20 days of the transplant. All quahogs must be less than 1" hinge width in order to transplant. Two steps must be taken in order to gain this permit, as follows: 1) submit the completed application 20 days prior to the requested date for seed transplants and 2) notify Maine Marine Patrol of the transplant supervisor, source area and transplant area, and the method and route of transport including the departure and arrival points. More information can be found online: https://www.maine.gov/dmr/shellfish-sanitation-management/programs/municipal/forms/documents/TransplantFormEdited8292019.pdf

DMR LIMITED PURPOSE AQUACULTURE LICENSES

The DMR offers a limited purpose aquaculture license (LPA) in order to streamline the lease application process and allow shellfish growers (including municipalities) to test growing locations more efficiently. The LPA lasts for one year, and allows growers to rear specific species using particular gear types that cover no more than 400 square feet. The short period and specific gear requirements mean the application review process will be much quicker than for a standard lease application, making LPAs the ideal option for new growers. Growers may want to apply for an LPA in order to practice aquaculture on a small scale, before investing in a larger area and longer duration. It costs $50 to apply for an LPA for Maine residents, and $300 for non-residents. Resources to aid in LPA application, as well as the application form itself, can be found online: https://www.maine.gov/dmr/aquaculture/forms/lpa.html.

COORDINATION WITH MUNICIPAL SHELLFISH COMMITTEES

If a municipality and/or partner organization is interested in conducting one or more of these conservation activities, the first step should be to include the topic on the agenda of a shellfish or marine resource committee meeting. This allows for harvester input, a discussion on the costs and benefits, and consensus on whether or not to move forward with an activity.

INVOLVEMENT OF COMMERCIAL HARVESTERS

Many municipalities require harvesters to complete a minimum number of conservation hours each year in order to renew their commercial license. In CBRSWG meetings, harvesters have discussed their wish for additional, meaningful conservation projects to meet their hourly requirements. If towns were to begin a quahog nursery or relay clams, offering conservation hours for harvester participation in those projects could be beneficial.

Table 2. Summary of Permitting and Other Requirements for Conservation Activities

	CONSERVATION CLOSURE	TRANSPLANT/ RELAY PERMIT	LIMITED PURPOSE AQUACULTURE LEASE	APPROVAL FROM MUNICIPAL SHELL-FISH COMMITTEE
Growing/reseeding quahogs (A*)	✓	✓	✓	✓
Transplanting adult quahogs (B)	✓	✓		✓
Quahog nursery techniques (bags/cages-C or trays-E)**			✓	(✓)
Upweller (D)**			✓	✓

NOTE

*Letters correspond to case studies described above.

**If seed is intended to be broadcast on the flats following grow-out to a size where they are less susceptible to predation, the municipality would need to obtain a transplant/relay permit and institute a conservation closure until they reach a legal size.

Cost Estimates

This section provides ballpark cost estimates for a selection of the methods described above or for individual components to consider, e.g., labor, equipment, seed, etc.

Table 3 provides information on growing out quahog seed using aquaculture trays based on information provided by the Downeast Institute case study.

Table 4 provides information on transplanting adult quahogs. We did not provide costs for the upweller utilized by the Town of Chatham as the scale is much larger than would be utilized by a municipality in Maine. Instead, we provided cost estimates of an upweller built by the Town of Harpswell, which would be more applicable to other municipalities in Maine (Table 5). The Harpswell Marine Resource Committee purchased 1 mm quahog seed in the spring of 2020 with the plan to grow them in the upweller to a sustainable size by October. Then the quahogs will be transplanted to the mud flats.

Costs were not provided for the growing of quahogs on a commercial aquaculture lease (Winnegance Oyster Farm) as those costs to grow out product to a harvestable size on an existing lease are not comparable to the costs a town would incur with an LPA specific to growing out seed to restock their flats.

Table 3. Cost for Growing Out Quahog Seed Using 4-ft by 3-ft Aquaculture Trays

CATEGORY	UNIT COST	NUMBER	TOTAL COST
1 mm Quahog seed	$9/1000 (1.5 mm seed)	10,000	$90
Equipment (Pet Screen®, window screen, styrofoam, 6 mm black screening, spruce strapping)	N/A	N/A	$75 for all equipment to make one tray
Yearly Maintenance	N/A	N/A	$10
Total			**$175/one tray**

NOTE: This table is based on the aquaculture trays created by DEI. For more information, contact Kyle Pepperman at kyle.pepperman@downeastinstitute.org or visit https://downeastinstitute.org/wp-content/uploads/2018/08/pictorial-hatchery-manual-b.pdf

Table 4. Cost of Transplanting Quahogs (from Georgetown Case Study)

CATEGORY	UNIT COST	NUMBER	TOTAL COST
Littleneck quahogs	$0.30*	29,967**	$8,990
Mileage			$25
Other equipment			$60
Labor			$4,400
Total			**$13,474**

NOTES: *This price is ~$0.05 higher than market price due to extra handling.

**An additional 10,000 seed quahogs were purchased and transplanted in 2018 and 2019 that are not included in this budget.

Table 5. Cost of Building an Upweller

CATEGORY	TOTAL COST
Lumber/Hardware	$1800
Fiberglass Silos	$2400
Quahog Seed	$2625 (500,000 1mm seed)
Mooring Gear	$1200
Float	$500
Towing/Transport	$900
Total	**$9425/upweller**

NOTE: At the time this table was created, some items were not completed yet and thus these figures indicate anticipated costs (Paul Plummer, personal email message, July 5, 2020).

Contact Information and Additional Resources

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References Cited

Farming Quahogs in Trenton - 2006-2010. (2020, June 12). Retrieved July 10, 2020, from https://downeastinstitute.org/research/quahogs/farming-quahogs/

Gagne, Renee. (2020, June 11). *Town of Chatham Upweller/ Interviewer: N. Moon.*

Hatchery: Soft-Shell Clam. (2020, June 23). Retrieved July 10, 2020, from https://downeastinstitute.org/hatchery/soft-shell-clams/

Krammer, J. (2019). Littleneck Clam and American Oyster Polyculture: Economic Viability and Nursery Technique. *Sustainable Agriculture Research & Education*. Retrieved June 24, 2020, from https://projects.sare.org/project-reports/fne18-901/

Krammer, J. (2018). Integrated oyster and littleneck clam aquaculture to increase seafarm yield. *Sustainable Agriculture Research & Education*. Retrieved June 24, 2020, from https://projects.sare.org/project-reports/fne17-877/

Pepperman, Kyle. (2020, June 17). *Downeast Institute Reseeding/ Interviewer: J. Carter.*

Porada, J. L. (2010). Hard clam farming in eastern Maine: Field experiments to evaluate biological and economic efficacy of field-based nursery and growout. U.S. Department of Agriculture. Retrieved July 10, 2020, from https://downeastinstitute.org/wp-content/uploads/2018/08/5_27-final-report-usda-sbir-phase-ii-porada.pdf