

# Mussel Seed Collection Strategies for Maine Mussel Raft Culture



Prepared for the Maine Aquaculture Innovation Center  
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Aguin Seeding Machine using biodegradable cotton

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Final Project Report : By Carter Newell, Ph.D, March 3, 2008

**Introduction**

The Maine mussel raft industry began with investigations in the late 1990's of the possibility of growing mussels on floating rafts, protected from eider ducks by nets, in relatively ice-free locations in sheltered or semi-exposed regions of the Maine coast. Wood rafts, 20 x 20 feet in size, were deployed as prototypes for larger, commercial-scale rafts. They were initially constructed (with support from Great Eastern Mussel Farms, Inc., Pemaquid Oyster Co. and the Island Institute) in regions of Penobscot and Blue Hill bays, and the mussel seed, obtained from Tight Rope Seafarm in the Blue Hill Bay salt pond, grew well and had excellent meat yields.

Studies funded by MAIC investigated seed collection (types of rope, time of year, and location in Maine) and the use of Spanish machinery for grading and socking mussel seed. It was found that several areas along the Maine coast had good spatfalls (i.e. 2,000 to 50,000 seed per meter of rope), and the seed could be attached to ropes with biodegradable cotton using the Aguin machine (picture on cover page). Further improvements to seeding technology were to use the newer Aguin machine with 2 wheels which moves the ropes better.. No special ropes (i.e. New Zealand or Spanish ropes) were needed for the seed collection, the critical aspect being the density on the ropes and the absence of predators or other fouling organisms (starfish, tunicates). The rafts were replaced with larger, 40 x 40 rafts as the industry began to grow. The collection of mussel seed soon became a culture bottleneck for the industry, and this project was designed to investigate commercial-scale strategies for seed collection at the mussel grow-out sites on smaller seed rafts, on predator nets, and on ropes hanging from the rafts. An initial goal of the project, to develop a longline system for mussel seed collection, was abandoned due to the extra cost and specialized machinery needed for longline mussel culture, and the fact that the longlines are not protected from predation by diving ducks. The project took place between 2005 and 2007, and involved commercial scale experiments at 5 mussel raft lease sites in Lincoln, Knox, and Hancock Counties. Maine and 4 LPA test sites in nearby areas.

**Seed Collection Strategies**

1. **Purchase from the Blue Hill salt pond.** This involves availability of seed (none available in 2006 or 2007), high costs (\$20 per fish tray), labor to harvest the seed, and transportation from the salt pond to the lease site. While this source of seed (Figure 1) was important in the early development of the Maine mussel raft industry, high costs of seed purchase and transportation to sites (by road and by sea) made seeding costs (over \$25 per line) prohibitive.



Figure 1. Mussel seed harvested into a dory from a mussel longline with 8' droppers. This seed was the original source for the mussel rafts, but required harvesting labor, seed cost, and transportation to the farms and became a financial bottleneck to most growers.

2. **Retube undersize seed from harvests.** This results in variable amounts of seed, with as much as one line seeded for every line harvested to negligible amounts. Generally, the retubed seed from market lines yields less mussels (i.e. only 2 bushels per 12 m rope vs over 3 bushels with smaller seed) but since the undersized seed is locally generated and available, it is still cost-effective to use it. If mussels catch a set (Figure 2), retubing the seed is necessary to maintain proper densities on the ropes.



Figure 2. Mussel spat (right) collected on ropes with larger seed mussels. This often occurs if ropes are not seeded uniformly or seeded in July, the spat settles on bare spots of the ropes or on the cotton.

- 3. Collect seed on the rafts by placing empty dropper lines in the water in early July.** This works in some sites (Stonington, Mt. Desert Narrows, Blue Hill Bay), but can be prone to excessive fouling (Figure 3, Belfast Bay) and starfish predation (Figure 4, Blue Hill Bay). However, an effective method of reducing starfish predation is to coil the ropes and hang them about 2m below the surface, since the starfish seem to set below 4-5 m depth at most sites (Figure 5, Blue Hill Bay). We have successfully used coiled ropes for spat collection in Blue Hill Bay, Mt. Desert Narrows and Stonington. In 2007, 40 lines were coiled and hung at 2m below the surface, while 40 lines were hung uncoiled on July 10. By August 25, the lines were examined. All the lines hung uncoiled had a large set of starfish, eating the new spat, but the coiled lines had no starfish set and were covered with spat. These lines were uncoiled (by cutting a small piece of twine) and will be available as seed lines in June of 2008.

It should also be noted that rafts with duck predator nets generally receive less spatfall than rafts without the nets, since the nets reduce the flow through the rafts. Therefore, a strategy would be to hang ropes (coiled) around July 1, uncoil them after the starfish set (i.e. end of August), and at that time put the nets around. We have observed ducks eating small (1/4 inch or less) spat so growers should be vigilant with respect to duck predation.

The seed collection using empty droppers requires a harvest and thinning phase (Figures 6, 7) in order to obtain correct seeding density on the ropes.



Figure 3. Mussel ropes fouled with colonial tunicates that did not collect a set (Belfast, 2006).



Figure 4. Starfish predators along the bottoms of mussel lines (below about 5 m depth), gradually cleaning the lines to the top (Blue Hill Bay).



Figure 5. Coiled mussel ropes after obtaining a spatfall. Note the absence of starfish.



Figure 6. Harvesting mussel seed ropes in Lamoine in 2006. Each seed line yields 3 lines of mussels at correct stocking density (i.e. 200-400 mussel per linear foot) for market size in 8-12 months. One mussel raft at similar densities yields 1,200 bushels seed (400 lines @ 3 bushels per line) enough to seed in 2 additional mussel rafts (400 lines each) and reseed the collector raft with the 400 lines the seed was harvested from.



Figure 7. Mussel seed at the Lamoine site being stripped from pegged rope collectors. These collectors had to be hand-picked for starfish in October and November. The mussels pictured here were retubed and yielded 3 lines from every collector line.

4. **Collect seed on predator nets** (Figure 8) by scraping or power washing the seed off the nets when they are changed. This can only work when there is an adequate settlement on the nets, no starfish settlement, and the nets are washed before the seed gets too large. We were able to successfully recover seed from predator nets in Lamoine (2005, 2006), Blue Hill Bay (2005), Stonington (2006) and S. Bristol (2006). The nets were hauled, power-washed, and the slurry was shoveled into x-actic totes. The slurry was then seeded using the Aguin socking machine. Within a week, the tiny mussel spat (1 mm – 5 mm) crawled to the outside of the cotton to form seed lines and outcompeted fouling organisms. Similar to seed collecting on empty droppers, the seed lines have to be harvested and thinned (3/1 as above) to final grow-out densities. Timing considerations for seed collection on nets: the seed should be removed soon after spatfall so the nets don't get too heavy and rip and fall off, you can leave side nets on for seed collection if you are changing end nets, and you should beware of thinning seed lines during normal spatfall periods (i.e. July – August) as these lines might also catch a spatfall. We also noted that when there were some starfish mixed in with the mussels, if the seed was small enough they would crawl out of the mussel sock and the tightly wrapped cotton sock would kill the starfish.



Figure 8. A mussel raft in Lamoine, Maine with seed collectors. The 2500 square foot predator nets hanging along the sides of the rafts may be used to collect seed, but they must be hauled and power washed during late summer to prevent tearing of the nets by all the weight. In addition, if droppers are used for seed collectors inside the rafts, it is better to remove the nets during July.

5. **Collect seed on additional rafts or longlines at seed collection areas**, but protect the seed before ice and duck predation seasons. It may be possible to collect seed on longlines, but duck predation could wipe out the harvest. Since ducks at many sites go to nesting islands from late May to early September, seed might survive unprotected, however, we have seen predation as early as Sept. 5 on small seed near coastal islands in Hancock County. In addition, sometimes there is a later spatfall (i.e. August) and seed is not large enough to harvest and thin until the next spring (i.e. May), whereby all the seed would get eaten by ducks. Seed collection on LPA

experimental rafts were only successful at the Mt. Desert Narrows site (see below).

6. **Bottom seed.** Hand harvested bottom seed, if only 1 year old and small in size (i.e.  $\frac{1}{4}$  to 1 inch with no larger mussels or rocks) may be used if you are desperate for mussels. Larger (over 1  $\frac{1}{2}$  inches long) mussel seed, due to their heavier shells, are prone to fall off the ropes and give a smaller yield so should be avoided. Young seed typically has a very black shell and a sharp edge, older seed may have a thicker shell and mussel pearls and should be avoided.

### Seed Collection Experiments

1. **Experimental seed collection rafts.** Project participants (Carter Newell, Joe Larrabee, Ed Hutchinson, Tim Levesque) constructed experimental mussel rafts (figure 9) Bay; Webb Cove, Stonington; and Thomas Island, Mt. Desert Narrows. The rafts were put in place by July 1, 2005 with 30 x 15 foot long rope droppers and moored on each end with mushroom anchors. The rafts were monitored for spatfall from July – Dec.



Figure 9. Experimental mussel raft (4 x 12 feet) in Blue Hill Bay to collect seed with. This was one of 4 rafts deployed for seed collection using LPA permits from the DMR.

**Results.** The smaller 4 x 12 foot rafts at Stockton Springs, Great Cove and Webb Cove all received a light spatfall (under 1000 per foot of collector), but the 15 foot long  $\frac{1}{2}$  polysteel pegged collector ropes tangled up with each other and the mussel seed



eventually fell off. This was due to the vertical motion of the small raft due to waves, the lack of a tensioned mooring system, and inadequate weights on the collector ropes. The raft near Thomas Island was built larger (14 x 20 feet) and ropes were weighted with two weight cases. This raft caught a nice set of mussels, which were over 6000 per foot in September, 2005. The seeded ropes (Figure 10) were transferred to a 40x40 mussel raft in Lamoine, and yielded commercial-scale quantities of seed by June of 2006. This strategy of collecting seed at a shallow, ice prone area, and then moving the seeded ropes to the rafts during the winter, was effective and has resulted in interest by the farmer, Tim Levesque, in deploying two larger rafts at the site for seed collection in 2008.

**2. Empty droppers spat collection.** Empty droppers were deployed in S. Bristol (2005), Lamoine (2005, 2006, 2007), Long Island (2005, 2006, 2007), Stonington (2005, 2006), and Northport (2005, 2006).

**Results.** Collectors in S. Bristol caught a light set of mussels in 2005 but also had a settlement of sea squirts (*Ciona*) which reduced meat yields of the mussels and caused drop-off. Good spatfalls occurred during all three years on the Lamoine lines, but starfish predation resulted in heavy losses. However, coiled ropes in Lamoine were successful. Similar results were found at Long Island. At Stonington, abundant spatfall without starfish occurred each year on coiled or fully extended dropper ropes. In Northport, spatfall was non-existent one year (2005), and moderate in 2006. However, the seeded lines were not thinned early enough in Northport, and there were heavy losses due to drop-off during early fall storms. Recommendations: use coiled lines at Lamoine and Blue Hill, can use uncoiled lines at Stonington. Collection is more risky in Belfast and S. Bristol.



Figure 10. Close-up of mussel seed along a normal ½ inch polysteel dropper rope with 9 inch pegs inserted every foot. Ropes with two dropper weights were also less likely to tangle up than ones with the normal single weight.

3. **Seed collection on predator nets.** We harvested seed from predator nets in August and later in the fall at 5 of the study sites from 2005-2007.

**Results.** Seed collection on predator nets was most successful when the small mussel spat were removed from the nets in August (S. Bristol and Stonington). The S. Bristol spat socked in 2006 resulted in seed lines which provided 25,000 pounds of seed for 300 seeded lines in fall of 2007. When nets were left to the fall, harvest yields of 10,000 pound of seed per net were observed on some nets in Stonington, Lamoine and Long Island in 2005 and 2006, but nets were ripped due to the heavy weight of the seed. Since nets have to be powerwashed regularly, it can be a good strategy to leave some side nets on in July for extra seed if it is needed, as long as you can harvest the net seed by late August.

### **Project Summary and Recommendations**

Mussel seed collection strategies are summarized below based on the results of this project:

#### **A. Seed Collection on site: Droppers**

Put out collectors in early July (no predator nets)

Coil them with some twine at 2 m below surface (especially at Lamoine and Blue Hill Bay). Coiling increases spatfall concentration near the surface waters and discourages starfish settlement.

Monitor for starfish settlement (August/Sept)

Uncoil lines to full length (Sept.)

Protect with predator nets (Sept.)

Harvest and reseed in December or May

#### **B. Seed collection on site: Predator nets**

Leave side nets on through July/August (Lamoine, Blue Hill Bay, Stonington, S. Bristol)

Power wash nets in August, sock up seed

Protect with predator nets (Sept.)

Harvest and reseed in December or May

**C. Bottom seed** (hand harvested or dredged): only if desperate, no rocks allowed, seed must be small in size (1/4 inch to 1 inch long). Seed in May or September/October

**D. Seed collecting rafts or longlines.** May be used but longlines are prone to eider duck predation, harvest as soon as possible to protect inside rafts with predator nets. Raft collectors in sheltered and ice prone areas must be harvested by December and moved. The rafts must be tensioned on the mooring system to reduce vertical motion which causes tangling and drop-off. Spatfall is usually better in moderate (1/2 knot) current areas than in areas with little tidal currents<sup>1</sup>.

**E. Starfish control strategies.** 1. Coil ropes for seed collection. 2. Pick off starfish in the fall by hand. 3. Collect seed in areas with fresh water which starfish avoid. 4. Lines

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<sup>1</sup> Newell, C.R., H. Hidu, G. Podniesinski, B.J. McAlice, L. Kindblom and F. Short. 1991. Recruitment and commercial seed procurement of the blue mussel, *Mytilus edulis*. J. World Aquaculture. Soc. 22: 134-152.

can be stripped and starfish will be killed by immersion overnight in fresh water, also by sprinkling with quicklime.

**F. Notes on seed grading.** Seed harvested from ropes or nets must be declumped using an Aguin declumper or similar. We usually shovel the seed through the declumper into x-actic totes (Figure 11), which store the seed (ice or wet storage), and the seed is shoveled from the totes into the seeding machine when seeding. On several occasions, we were able to harvest, grade and ship 3-4 tons of seed by noon time, transport by sea overnight, and seed in ½ a raft 100 miles away the next day. If there are small (i.e. 1-5 mm) seed mixed in with the larger 20-25 mm seed, it is advantageous to grade out the small seed (Figure 12) such that proper growing densities (i.e. 200-400 mussels per linear foot) can be maintained on the line. In addition, it takes one season for uniform 1 inch seed to grow to market size but another 3-6 months for the tiny seed to make it to 60 mm. Therefore, graded seed gives a higher % yield of market mussels during harvesting and increases raft turnover.



Figure 11. Mussel seed graded through an Aguin declumper either on deck or into x-actic totes. Note the correct angle of the declumper. Seed can also be washed by running a deck hose into the front of the machine.



Figure 12. An Atkinson and Bower seed grader to grade seed into small, medium and large sizes, outfitted to a fish dragger. If seed is graded, keep the different sized seeded lines in different designated areas of the raft because they will be ready at different times of the year.

Match Documentation:

Construction, deployment, monitoring of 4 experimental rafts, obtaining LPA's for the sites, includes boat time, labor :  $4 \text{ sites} \times \$2,000 \text{ per site} = \$8,000$ .

Hauling predator nets and powerwashing for seed: Damariscotta and Stonington sites: 3 days barge Mumbles and crew @ \$1,200 per day = \$3,600.

Monitoring, harvesting and retubing of mussel collectors on rafts: 2 days barge Mumbles and crew: \$2,400.

C. Newell labor match :  $4 \text{ days} @ \$250/\text{day} = \$1,000$

Total Match: \$15,000.