

How to Install a Soft-shell Clam Farm



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This guidebook is the result of the vision of Chris Warner, licensed clam harvester in Georgetown, Maine. Chris had the idea that an individual harvester, with fire in the belly, skin in the game, and a sense of delayed reward, could beat the green crab problem and create a new way for clam harvesters to think about their fishing livelihoods. Chris's vision was made possible by the enthusiastic support of the shoreland owner, Dr. John ("Jay") Holt, who enthusiastically assisted in the installation of the Heal Eddy clam farm and promoted the work in this Guidebook. Thanks to Chris and Jay, Maine has come a long way in understanding the potential for soft-shell clam farming. The work in this guidebook was also inspired by Dr. Brian Beal, who has worked tirelessly for decades to help secure the soft-shell clam fishery through his pioneering studies. We thank Dr. Beal for his valuable work over the years, and for providing helpful feedback on this guidebook.

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Cover

Aerial photo of soft-shell clam farm in Heal Eddy Clam Farm, Georgetown, Maine, established in 2014.

Table of Contents

I.	What is a soft-shell clam farm?	1
II.	Why farm soft-shell clams?	2
III	A stepwise guide for starting your own farm	3
.	Step 1: Finding a suitable location	3
	Step 2: Deciding who will own and operate the farm	4
	Step 3: Getting permission and protection for the site and farm	4
	Step 4: Planning the installation of the farm	8
	Step 5: Installing the farm	10
	Step 6: Monitoring your farm	11
	Step 7: Harvesting your farm	11
	Step 8: Reseeding your farm	12
IV	Is it worth it?	13
.	The financials of clam farming	
V.	Appendices	15
	1. Technical assistance	
	2. State aquaculture leasing program	
	3. Army Corp of Engineers application	
	4. Hatchery clams	
	5. Sources for netting and equipment	
	6. Net monitoring protocol	

I. What is a soft-shell clam farm?

A soft-shell clam (*Mya arenaria*) farm involves seeding sub-productive intertidal flats with hatchery-raised clams and then covering the seeded area with plastic netting to protect the clams from one of its main predators, the European green crab (*Carcinus maenas*).

This “seeding and netting” method has been used in Maine and elsewhere to protect shellfish beds from predators for over thirty years. Some towns use the “seeding and netting” method for enhancement of their public soft-shell clam resource. As predation of wild clam flats intensifies with warming seawater temperatures, there is growing interest in clam farming as a means of adapting to changing conditions. With farming, we hope the soft-shell clam fishery can be maintained, or even increased in Maine.

This guidebook is an introduction to soft-shell clam farming using the seeding-and-netting method. It is a practical, stepwise guide to starting and maintaining a farm. It covers intertidal rights, options for legal protection, tips for building and securing nets, and observations on whether clam farming makes financial sense. As a result of installing Maine’s first commercial-scale soft-shell clam farm in Georgetown, Maine in 2014, and five other farms since then, we have encountered many of the challenges already. This guidebook shares what we have learned.



Figure 1. Installation of a commercial-scaled softshell clam farm in Georgetown, Maine. For sites with “hard mud,” the edges of the nets must be buried in trenches, as shown here. In “soft mud,” the edges can be “walked in.”



Figure 2. The invasive, European green crab (*Carcinus maenas*). The green crab came to the U.S. accidentally in the ballast of ships in the early 1800s in New York and Boston. Populations are increasing with warming seawater temperatures.

II. Why farm soft-shell clams?

The soft-shell clam fishery is the third most valuable fishery in Maine, valued at about \$16 million in 2016 and \$12 million in 2017. Unfortunately, soft-shell clam landings in many coastal communities in Maine have declined in recent years.

Increased predation by the invasive European green crab is believed to be the principal cause for the decline in some towns. Green crab populations have increased in recent years partly because of warming waters in the Gulf of Maine.

Seeding and netting soft-shell clams is effective against green crab predation.

Green crabs prey on soft-shell clams, especially young clams that have thinner shells and live nearer to the mud surface (Figure 2). Locally, green crabs can eliminate young clams that are the harvest of the future, effectively wiping out future stocks of entire clam flats. Clam farming is a way to protect growing clams from green crabs.

However, this seeding-and-netting method does not work to protect soft-shell clams from milky ribbon worms (*Cererebratulus lacteus*), yet another soft-shell clam predator that seems to be expanding its numbers in Maine. At this time, no cost-effective netting method can prevent the milky-ribbon worm problem. **Do not use this method in areas with milky-ribbon worms.**

Table 1. Size of area needed vs. number of 14' x 20' nets installed. The netted area of a single net is 12'x18' because a foot of net on each edge is buried into the mud. The total area of the farm site includes a six-foot space between nets to provide an area to comfortably work.

Nets	Actual netted area (square feet)	Total Acres with buffer around net
1	216	0.01
10	2,160	0.12
25	5,400	0.30
50	10,800	0.60
100	21,600	1.19
150	32,400	1.79
200	43,200	2.39

Licensed soft-shell clam harvesters in Maine might consider clam farming as a means of ensuring a future fishery. Clam farms could provide harvesters a supplement to wild harvesting. Farming has several advantages. It:

- (1) virtually eliminates predation by large green crabs;
- (2) allows clams to be grown to market size on subproductive flats; and,
- (3) creates a "bank" of clams that can be harvested when market price is high.

III. A stepwise guide to starting your own farm

The technology of a soft-shell clam farm is simple. It involves "seeding" sub-productive intertidal flats with juvenile ($\frac{1}{8}$ – $\frac{1}{2}$ ") clams, and then covering the seeded area with plastic netting to keep out green crabs. The edges of the net must be buried 6-8" to make sure green crabs cannot burrow under the net. A single farm might have 25 to 150 nets (requiring up to 1.5 acres of flats; Table 1). **We recommend two test plots (one or two nets per plot) at your site, and then scaling up if the results are favorable.** Success can be highly variable among sites, sometimes for apparently unknown reasons.

Step 1: Finding a suitable location

Finding a suitable location for your farm is critical. About one-quarter of an acre is needed for a 25-net farm, 0.5 acres for a 50-net farm, and 0.9 acres for a 100-net farm, etc. (see Table 1). A 150-net farm is about all one harvester can manage alone.

Here are some guidelines for finding a suitable site:

- (1) **Avoid conflicts:** Find a site that does not interfere with other interests, such as commercial harvesting of wild clams, recreation (swimming or boating), or other fisheries (such as worming).
- (2) **Find a sub-productive site:** Your farm should not be established in productive soft-shell clam harvest areas, which could upset other commercial harvesters. In addition, it makes no sense to put a clam farm on an already-productive area of mud flat.
- (3) **Get Landowner permission:** In Maine, permission from shoreland landowners is required to place nets in the intertidal zone (Figure 3).
- (4) **Ice:** In areas that "ice up" in the winter, you will have to remove nets in the fall and replace them in the early spring.
- (5) **Access:** Easy access to the farm site makes for easier installation, monitoring, and maintenance.
- (6) **Wormers:** If nets are removed in the winter, wormers may inadvertently dig through your farm. To avoid potential conflicts, the corners of netted plots should be well marked after nets are removed.
- (7) **Milky-ribbon Worms:** Nets protect clams against green crabs but do not protect against milky ribbon worms. If your area has milky ribbon worms, netting will likely not be a viable option. Currently, there is no cost-effective strategy for preventing milky ribbon worm predation.



Figure 3. Intertidal flats are legally owned down to the low water mark by the shoreland owner. Gaining shoreland owner permission is critical for clam farming.

(8) Mud Snails: During late spring and early summer in regions where mud snails (*Tritia* [= *Ilyanassa*] *obsoleta*) occur in high densities (e.g., greater than 50 per square foot), this gastropod can lay a thick mat of eggs on the predator netting. If the snails are not removed, the extra weight on the net can suffocate the clams it was designed to protect. The only remedy either is to replace the fouled net with a new one or plant seed clams after the snails have finished laying eggs.

Step 2: Deciding who will own and operate the farm

You can operate the farm by yourself, or you could partner with another harvester or even a small group. One person can manage a 25 to 150 net farm. It helps to have at least one good professional digger help install the farm. Two experienced diggers can install and seed one net in about 6-10 minutes.

If you prefer to share the work and the profits, find one or more business partners, preferably another licensed harvester in the town. Make sure you are clear how you will share the up-front costs, the labor for installation and maintenance of the farm, and the clam harvest when they reach commercial size. It would be good to have something in writing with your partner(s).

Step 3: Getting permission and protection for the site and farm

Once Steps 1 and 2 are complete, you need to decide how to protect your site from disturbance by commercial and recreational diggers. As with any aquaculture venture, protection of your investment is critical.

There are two ways to do this. One is a **conservation closure and “handshake agreement,”** and the other is an **aquaculture lease** through the Maine Department of Marine Resources (DMR).

Both methods require support from your local Shellfish Committee and Town Council (or Board of Selectmen). You will need to make sure there are no conflicts with other users of your intertidal farm site—including the shoreland owners, wild clam harvesters, wormers, recreationists, and anyone else you can think of who might use (or see) your farm site. It’s good to think about all possible competing uses of your farm site early on.

The **conservation closure and handshake agreement** is the easier of the two methods but requires a high level of trust with the other local shellfish harvesters. On your behalf, the Shellfish Committee in your town can apply for a conservation closure with the state of Maine. This closure will legally prohibit shellfish harvesting within the area of your farm for the specified duration of the closure. Therefore, the conservation closure must expire before you can actually harvest your clams. And, once the closure is lifted, any licensed harvester from the town is legally eligible to harvest your farm. You can have a “handshake agreement” with your fellow harvesters to leave your farm alone, which is a method that has worked in several communities in Maine. Only you can decide whether you have that level of trust.

A conservation closure will protect your farm from clam harvesting, but it will **not** protect your farm from wormers. Wormers have traditionally worked around clam netting, but in some places nets need to be removed in the winter because of ice. In that case, wormers might dig through your farm and destroy your crop. So, it is best if you know that your site does not have bloodworms so that you do not need to worry about competition with wormers or if your site does have worm harvesting be sure to communicate with wormers and clearly label your plots.

A state **aquaculture lease** is the better method to protect your farm, but it is more work. An intertidal lease will give your clams legal protection from other harvesters, wormers, and other potential conflicts (see Table 2, and Appendices, for more details).

Preparation of the lease application paperwork can take between four and twelve hours, not including meeting with landowners and town and state officials. Much of this time is creating maps and getting signatures from shoreland owners and town officials. Intertidal lease applications must be approved by a vote of the town council or board of selectman before being reviewed by the DMR. Once the application is submitted, officials with the DMR will issue a decision on a limited-purpose (“experimental”) lease application within ~60 days, and ~120 days for a standard lease application.

The best way to protect your farm is with an aquaculture lease.

You might use a combination of the two methods. Work with your town to get a three-year **conservation closure** for your farm site. Then, once the farm is installed and deemed successful, apply for a **Limited-Purpose (“Experimental”) Lease**, which will be good for three years from the date of issue. A limited-purpose lease is low cost (\$100 application fee), but it will require some time to fill out the paperwork. If a limited-purpose lease is approved, you can apply for a **Standard Lease** (\$1,500 application fee) before the three-year term of the limited-purpose expires. A Standard Lease may be approved for up to 20 years. This approach will ease you into farming with the least up-front cost. See Table 2 for a list for a comparison of methods for protecting your farm.

Army Corps of Engineers Permit Required

Regardless of the mechanism used to protect your farm, or the number of nets you plan to install, a permit from the **Army Corps of Engineers** (ACOE) will be needed because you will be putting gear or structures (nets) in navigable waters.

If applying for a lease from the state a separate application to the ACOE is not required. The lease application submitted to DMR will be reviewed by the ACOE.

If using a conservation closure to protect your farm, or installing a farm without a lease from DMR, you will need to submit an application to the ACOE. Review of the application takes between two to nine months before approval is issued. After official approval, the ACOE asks to be informed two weeks before nets are installed. **It’s important to file your ACOE application in plenty of time before installing the farm.** A link to the application form is included in the **Appendices** of this Guidebook.

Step 4: Planning installation of the farm

Scheduling installation of the farm is important for things to go smoothly. First, all your paperwork must be in order (described in Step 3 above). Second, once you receive the seed clams from the hatchery, you need to be ready to install the farm on the next low tide.

Table 2. Requirements for different methods of protecting your clam farm.

	Conservation Closure	Limited-Purpose ("Experimental") lease	Standard lease
Duration	Variable	3 years	20 years
Acreage limit	No limit	4 acres	100 acres
Application form?	Yes	Yes	Yes
Application fee	None	\$100 non-refundable	\$1500 non-refundable
Comment Period?	No	Yes	Yes
Public Scoping Session?	No	DMR's discretion	Yes
DMR Site Review?	No	Yes	Yes
Public Notification?	Yes	Yes	Yes
Public Hearing?	No	Discretionary; mandatory if 5 requests	Yes
DMR Decision	Yes, < 20 Business days	~3-6 months	6-12 months
Renewable?	Yes	No (but can covert to standard lease)	Yes
Army Corps Permit	Yes (stand-alone application required)	Yes (review conducted using lease application, no separate application required)	Yes (review conducted using lease application, no separate application required)
Transplant/Relay Permit	Yes	Yes	Yes
Town permission required?	Yes	Yes	Yes
Landowner permission?	Yes	Yes	Yes
Landowner fee?	No	Depends on landowner	Depends on landowner
Annual Report to DMR?	No	Yes	Yes
Escrow account or Performance Bond (if awarded)?	No	\$5,000 (>400 sq. ft.)	\$5,000 (>400 sq. ft.)

Seed Clams

At present, the only source of hatchery soft-shell clams in Maine is the Downeast Institute (DEI) in Beals, Maine. Seed clams cost about \$25 per thousand clams. You will need to **order seed clams at least six months in advance** of installing your farm. If demand is high you may need to order seed clams one year in advance. The seed clams be can shipped overnight to you in a Styrofoam ice chest, or you can pick them up at the hatchery. Seed clams arrive cool in the ice chest (about 43-48 °F) that slows their respiration during transport. It's important to get the clams in the mud as soon as possible, preferably within 24 hours of leaving the hatchery. That's why it's important to have all your gear, paperwork, and helpers lined up before the seed clams arrive. Sources for gear are provided in the Appendices.

Two or three people (if one is an experienced harvester) can install 20-25 nets in one low-tide cycle (~3-4 hrs).

We recommend planting seed clams at a density of **10,000-12,000 clams per net**, or about **46-56 clams per square foot** of net. The number of clams planted depends on your financial goals for each net (see financial section) and the survival rate of the seed clams, which is impossible to predict without one or more test trials. The DEI hatchery will, upon request, divide your order into equal bags of seed clams (one bag for each net). This will help ensure that approximately the same number of clams will be placed under each net without having to divide up the seed clams yourself. Not all clams from the hatchery are alive. Inspection of the netted plots 24 hours after seeding will reveal a few dead, empty shells scattered throughout the plot on the sediment surface. This should not be a concern unless the amount of empty shells is substantial.

NOTE: The hatchery ships clams by weight and estimates actual count. If you wish to know how many seed clams are in a bag (and therefore under your net), you will need to weigh out 100 seed clams so you can estimate the number of seed clams in the bag based on the weight of the whole bag. We typically weigh out ten samples of 100 clams and calculate an average. A postal scale that measures to the nearest gram is handy for this process.



Figure 4. Building a net. Nets are cut in 14 x 20' rectangles (the bulk roll is 14' wide). We attach 10 gill net floats to each net with zip ties (see Figure 5 for spacing). It takes about 5 minutes to build a net. The floats should be on the BOTTOM SIDE of the net when you install the net in the mud.

Nets

Build nets in advance of installing the farm. When it's time to plant the clams, you need to focus on installing nets, not building nets.

Nets are made of UV resistant plastic with mesh openings between 0.167-.35 inches. Netting material is 14' wide and comes on rolls (between 1900'-3000' long, See Appendices for details) and can be cut into 14' x 20' sections. We recommend nets be 14'x 20' in size because they are easy to handle by one or two people. Plus, these are convenient "units" when it comes time to harvest.

Once all the nets are cut into 20' lengths, attach floats that will lift the net off the bottom, which helps the net clear of silt. We found that gill net floats work best, though others use 4" Styrofoam floats (See Appendices for details). Floats should be roughly evenly spaced and secured with 14" nylon zip ties (see Figure 4 and 5). You will use 10 ties and 10 gill net floats per net. So, 25 nets would require 250 floats and 250 ties (See Table 3).

Clip off the excess zip tie with pliers. The net should be installed on the flats with **float side down**, so the float lifts up under the net when the tide comes in. We have found that folding and packing 4 nets into one 55-gallon contractor bag is the best way for storing and moving nets to the farm site.

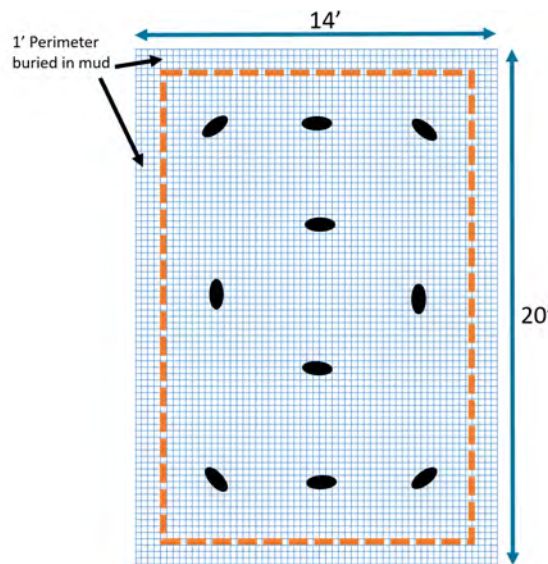


Figure 5. Suggested placement of floats.

Table 3. Amount of netting, floats, and zip ties needed.

Nets	Netting (ft)*	# floats and zip ties
1	20	10
10	200	100
25	500	250
50	1000	500
100	2000	1000
150	3000	1500

* netting comes in roll 14' wide x between 1900'-3000' long

Layout the farm

Before installation day, we lay out the location of every net with pin flags. When seed clams arrive, it's important to concentrate on installing nets and getting the seed clams in the mud, and not laying out the site.

Laying out the farm in an organized way ensures you maximize the number of nets within your farm boundaries and gives you enough space to between your nets for monitoring and maintenance.

We prefer to space nets with 6' between them. Using pin flags to mark where the net corners will go will save time on installation day and help make sure installation is complete before the tide comes in (see Figure 6).

To layout a farm, we extend a 300' long tape (a long rope will do) in a straight line (being careful to stay within the lease or closure boundaries). Using a 25' tape measure we then put pin flags in the mud to mark the eventual corners of the net on the day of installing the farm. Using the shorter edge of the nets as our metric, we place pin flags at 0', 14', (6' spacer), 20', 34', (6' spacer), 40', 54', (6' spacer), 60', etc. (Figure 6). We also mark one corner of the net with a numbered PVC stake, but that can be done after the farm is installed. Each net should have a unique number for tracking its progress (see 'Monitoring your nets' below).

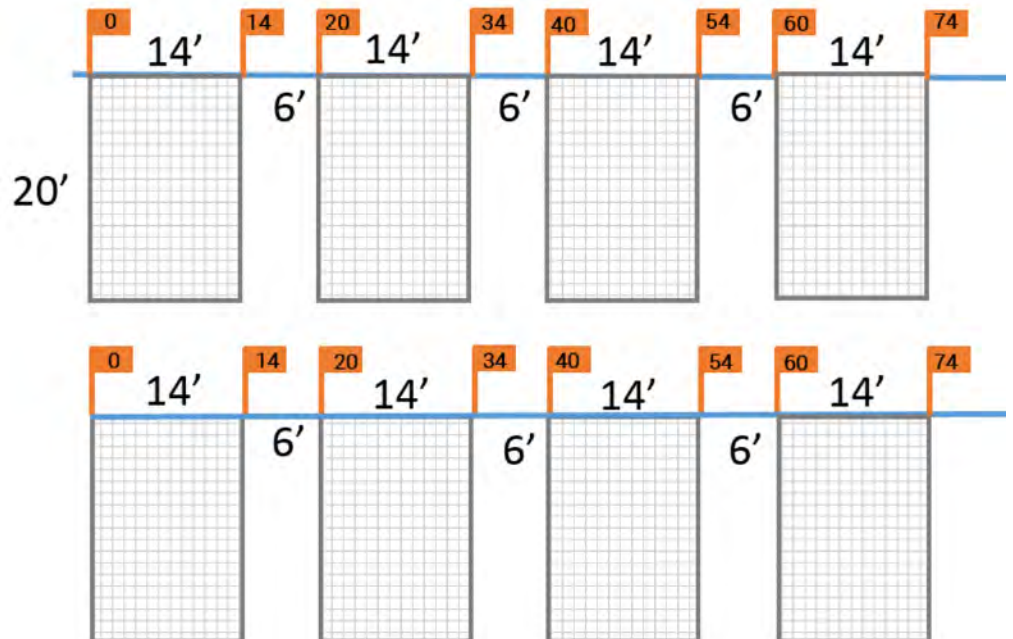


Figure 6. Laying out the nets. We recommend 6' between nets for ease of working and installing nets. Laying out pin flags where the nets will go several days in advance of planting will allow you to concentrate on installing nets on planting day, saving time, and maximizing the installation of the greatest number of nets on a single tide.

Step 4: Planning installation of the farm

The type of sediment will dictate exactly how you install the nets. If working on “hard mud” you will need to dig trenches with a clam hoe for all the edges of the net. If in “soft mud” you can lay out the net and “walk in” the edges by carefully walking on all four edges of the net. “Hard mud” requires more manual labor but is less messy.

Unfold a net and align the short edge with the pin flags (see **Layout the farm** above). If you are working in hard mud and need to dig trenches, follow this procedure:

- 1) Spread out the net, making sure the floats are on the underside of the net. Align the net with the pin flags that you used to layout your farm (Figure 7a).
- 2) Fold all the edges of the net back about 1 foot. Use a handful of mud to hold the fold in place. (Figure 7a).
- 3) Dig a trench all around the perimeter. Dig as deep as you can with each flip of mud (6-10 inches). Be careful not to rip a hole in the edge of the folded net edge with your clam hoe (Figure 7b).
- 4) Once the complete trench is dug, create a “hinge” end by unfolding **one short edge** into the trench and backfilling with mud (Figure 7c).
- 5) Fold the net back off the plot area using the buried edge as the “hinge.” The net should now be folded back off the plot with floats on the top side.
- 6) Spread the seed clams in the plot. Start at one end of the net and work your way to the other end sprinkling the seed clams as evenly as you can throughout the plot. Do not step on the seed clams (Figure 7d).
- 7) Once the seed clams are deposited on the mud, carefully pull the net back over the plot. You will need a helper for this to avoid dragging the net over the seed clams. You do not need to bury the clams. They should begin to dig themselves in after an hour or so (Figure 7e).
- 8) Reposition the net so that the all edges of the net fall into the trenches, and the floats are in contact with the sediment.
- 9) “Walk” the net edges into each trench to make sure it is seated. Then, fill in the remaining three sides (the hinge side is already filled). Walk on the filled mud to press it in place. Make a quick inspection to make sure all the edges are buried.

That’s it for one net. The net is installed. Move on to the next net.

We have found that with three people it takes about 6-10 minutes to install one net (6 nets per hour, or 20-25 nets per low tide, depending on the exact tide that day and the tide elevation of your farm site). The trench digger(s) can begin working on the next net while one person is seeding. Then, the digger can go back and fill in the trenches for the previous net. You will quickly figure out the most efficient system, depending on the number of people helping.

Other tips:

- Keep the seed clams in the cooler until you are ready to plant them on the mud and cover with the netting.
- If you have a choice, don’t work on a hot day. The temperature shock going from the ice chest to the mud surface could kill the seed clams. You should avoid installing a farm in the middle of summer. Cooler spring and fall days are better for installing a clam farm.



Figure 7a. Once you lay the net where you want it, fold back each of the four edges by about 1 foot.



Figure 7b. With the edges folded back, dig a trench about 6-10" deep all around the net. Be careful not to cut the net with your clam hoe.



Figure 7c. "Hinge" one short end of the net (fill in the trench on one end) and peel back the net for seeding the plot.



Figure 7d. Seed the plot with hatchery-raised seed clams. Spread them as evenly as possible. Don't walk on the seeded clams.



Figure 7e. Cover the seeded plot with the net and fill in all the trenches. The plot is complete.

Step 6: Monitoring your farm

Once installed, clam farms are relatively low maintenance. You should monitor your farm at least monthly (See Appendices for monitoring protocol). It only takes 20-30 minutes to walk the farm and look for any net edges that might have come up. Re-bury any exposed net edges. It is rare for edges to come up if buried properly during installation. If your site is exposed to ocean storms, edges might be more likely to come up after a storm. It would be good to check your farm the day after a storm.

In an exposed “hard-mud” site, we have found that sediment can build up over the net especially in the winter when more energy stirs up sediments that can be deposited in the netted plots. The nets slow down the water and sediment drops out of the water and onto the net. If the sediment builds up too much it can cut off a clam’s access to the water column, which it needs for respiration and feeding. The sediment can be scraped off with a common garden hoe. Be careful to not tear the net. We’ve found that it’s easier to clean off the sediment when there is 6-8” of water over the nets, right before the tide clears, or on a flood tide that has just covered your farm. It’s best to keep sediment under control monthly. Sediment does not seem to be a problem in the summer months.

It’s also a good idea to monitor your nets for clam holes (Figure 7). After seeding, holes are not obvious for six to eight months. But when they do begin showing you will have confidence that your nets are “working.” Keep notes on each net. We developed a net monitoring protocol that is described in the Appendices of this guidebook.

Step 7: Harvesting the farm

Once you know most of your clams have grown to at least 2” (legal size), you can harvest your farm. The number of growing seasons it will take for clams to reach harvestable size will depend on your site, particularly water temperature. The colder the water the longer it will take clams to reach harvestable size. In the Mid-coast Maine region, it takes 4 growing seasons (a little over 3 years if you plant in spring) for clams to reach an average size of 2.75”. Note that 3” clams weigh more than twice that of 2” clams, so if you can wait till the clams are larger (maybe one more growing season) you could double your income.

Beginning in 2017, DMR now requires an **aquaculture license** when selling cultured shellfish from a lease or LPA (See Appendices for details).

Removing the net

Depending on the planting density of the seed clams and their survival rate, one person can harvest only one to three nets per low tide.

Before removing the net, mark the corners of the net with wooden stakes or 12” galvanized “Texas nails.” You will want to keep the plot carefully marked for future reference, because not all the clams can be harvested in one pass. Plus, you might want to re-seed the exact same net plot in the future.



Figure 8. Clam holes showing under a seeded net after 2 years. Note the sediment buildup along the edges of the net. Clams can generally “blow through” a half an inch of sediment, but you do not want sediment to build up on the net over time because the clams will suffocate and starve.

Find an edge of the net and carefully pull up the net. Try to pull the net up toward the middle of the net so the mud falls to the outside of the net. Otherwise, the net becomes filled with mud and cumbersome to move. Move slowly to avoid ripping the net so you can re-use it. Grab the net as close to the mud as you can to avoid ripping. Once removed, it’s best to fold the net carefully, and use a sled to remove the nets from the flat.

Harvesting the clams

Start at one end of the plot and flip the mud systematically, harvesting as you go. Flip every square foot of mud. You will want to weigh the clams **for each net** so you can document your harvest relative to the number of clams that were planted under the net. This is crucial data for estimating percent survival for understanding whether netting and seeding makes financial sense at your location. We know nets keep out green crabs, but we know a lot less about whether the investment in the net and the seed clams is worth it in the end (see “Financials” section later in this report). In part, it depends on the market price of clams at the time of harvest. The only way to know if clam farming is worth the investment is to keep careful track of your harvest on a per net basis.

It is unlikely that you can harvest all the clams under a net in one pass. Some days clams do not “show.” You will want to harvest your nets when clams are showing. Oddly, some nets will “show” clams on one day and others will not. Different nets can show clams on different days (a mystery). It may make sense to harvest the plot again in a few weeks, since you won’t get them all on one pass. Consider the ones you miss as future harvest.

Step 8: Reseeding your farm

Based on your financial success you can decide whether it makes sense to reseed your farm. If you do want to continue farming, then after you have harvested most of the clams from the net plot simply reseed the plot with hatchery clams and cover them with netting.

IV. Is it worth it? The financials of clam farming

Although the basic technique of seeding-and-netting is not new, we know little about the financial returns of this method. The critical question is, for the initial investment of time and money, 'is clam farming worth it?'

This section gives you an idea of the costs and potential revenues of clam farming. We understand the costs (nets, floats, seed clams, labor) but the revenue can be hard to predict for a site. The Heal Eddy clam farm is providing good information on the financial merits of clam farming. The jury is still out, but we can help you do your own financial analysis.

Below we have calculated expenses and revenue for a single 14' x 20' net. How much money you might make from your farm can be estimated by multiplying projected revenue for one net by the number of nets in your farm.

Expenses

The expenses for one net include:

Item	Cost
14' x 20' net	\$10
10 floats	\$20
10 zip ties	\$2
10,000 seed clams @ \$25/1000	\$250
The value of your time *	\$17
Total cost per seeded net	\$298

* We assume it will take about 10 minutes to seed and install one net. We calculated the value of your time at \$100/hr (you could be wild harvesting if not installing this net). We assumed you could harvest one bushel of clams in 1 hour, and we assumed a market price of \$100/bushel. Make adjustments to these estimates as you wish. Relative to the cost of the seed clams, the value of your time (~\$17 for 10 minutes) is a much smaller part of the overall cost of one seeded net (the seed clams are about 83% of the cost). We also assume that you can find one or two helpers to install the net(s) for free. This is usually the case, so we did not include the cost of helpers.

Given that the greatest part of the cost is the seed clams, if you know of a source you may be able to harvest your own seed clams for free. But keep in mind—time is money. You should incorporate the value of your time collecting your own wild seed clams into the estimate of expenses.

Revenue

How much money you can make from a net will depend on:

1. The initial seed clam planting density;
2. The survival rate of the seed clams;
3. The growth rate at your site;
4. Your ability to recover all the surviving clams, and;
5. The market price at the time of harvest.

Table 4 provides an estimate of the projected gross and net revenue from one net, at various recovery rates (the proportion of seeded clams that you recover during harvest). At the Heal Eddy clam farm, we recovered 42% of seeded clams on one harvest pass, for one net after three growing seasons. Recovery rate may be lower or higher, depending on the site. Table 4 assumes a market value of \$100/bushel. In 2015, after the 2014 spurt in the green crab population, the market price spiked to about \$220/bushel in Mid-coast Maine. Obviously, market price will affect net revenue. **NOTE: Harvest your nets when the price is high!** This is one advantage of clam farming. You have an "inventory" of product ready to go when the price spikes.

Table 4. Estimated revenue (gross and net) based on three recovery rates (proportion of planted clams that are ultimately harvested). Market prices is assumed to be \$100/bushel. Obviously, market price will have a lot to do with net revenue. "Net profit" in the table is revenue in excess of the cost of the net and seed clams (~\$298 for a 10,000-seed-clam net).

Recovery rate	after 3 growing seasons ¹			after 4 growing seasons ²		
	bushels	gross profit	net profit	bushels	gross profit	net profit
30%	2.6	\$ 264	\$ -34	6.9	\$ 687	\$ 389
40%	3.5	\$ 352	\$ 54	9.2	\$ 916	\$ 618
50%	4.4	\$ 441	\$ 142	11.5	\$ 1,145	\$ 847

¹ assumes average 2.25" clam at 0.04 lbs/clam

² assumes average 3.00" clam at 0.11 lbs/clam

We suggest that for clam farming to work financially, a net should yield (gross) at least twice the amount invested. That means one net needs to yield about \$600 of revenue, assuming the installation cost was about \$300. Assuming a market price of \$100/bushel, you would need to harvest 6 bushels from one net. So far, we have not been able to get more than about 3 bushels from one net. However, we have not yet harvested nets that we planted at 10,000 and 12,000 seed clams per net. We will know more by the end of 2018.

If the cost of the seed clams is paid for by your town for a group conservation effort, then obviously the financials change completely from the perspective of the individual harvester. However, the costs are still real, whomever bears them. Ultimately, for soft-shell clam farming to become widespread in Maine, the financials will have to work out.

V. Appendices

Getting technical assistance

For some videos and further information related to clam farming, visit our project web site at: <https://www.manomet.org/project/soft-shell-clam-aquaculture>

Maine Sea Grant Aquaculture in Shared Waters: <http://www.seagrant.umaine.edu/aquaculture/aquaculture-in-shared-waters>

General information about how clams are produced and the ecology of juvenile soft-shell clams

For soft-shell clam production, illustrated clam culture manual, and project reports: <http://www.downeastinstitute.org/soft-shell-clams-1.htm>

Downeast Institute has been conducting research on cultured soft-shell clam juveniles, and other aspects of clam farming since 1989. Visit their web site to read peer-reviewed articles relating to various field experiments conducted around the state of Maine: <http://www.downeastinstitute.org/soft-shell-clams-1.htm>

State aquaculture leasing program

Maine's Division of Marine Resources has an overview of the leasing process: "Conducting Aquaculture in Maine". Link: <https://www.maine.gov/dmr/aquaculture/documents/CONDUCTINGAQUACULTUREINMAINErev2-22-17.pdf>

Lease Application Forms:

<https://www.maine.gov/dmr/aquaculture/forms/index.html>

(NOTE: the state requires a "suspended aquaculture lease" for any method that involves gear, even though the clam farm nets are secured to the bottom.)

Conservation Closure Application:

<https://www1.maine.gov/dmr/shellfish-sanitation-management/programs/municipal/forms/documents/ConservationClosureNew03-22-163pages.pdf>

State Aquaculture License Application:

Beginning in 2017, DMR requires an aquaculture license when selling cultured shellfish from a lease or LPA.

<https://www.maine.gov/dmr/commercial-fishing/licenses/documents/2018/shellfish-worm-greencrab-aquaculture.pdf>

Contact Information:

Intertidal leasing requires written permission of the abutting shoreland owner(s) and a vote of town officials. If you have questions about intertidal leasing, contact Jon Lewis, Aquaculture Program Lead at the Maine Division of Marine Resources, 207-633-9594, or email jon.lewis@maine.gov

Army Corp of Engineers Permit

To install nets in the intertidal zone, a permit from the Army Corps of Engineers is required. If you are applying for an aquaculture lease, you do not need to make a separate application to the Corps of Engineers.

Corps of Engineers Permit Information:

<http://www.nae.usace.army.mil/Portals/74/docs/regulatory/Forms/PermitGuide.pdf> (handbook)

Contact Information:

Army Corps of Engineers, Maine Project Office, 207-623-8367

Obtaining hatchery clams

At the time of this publication the only source for hatchery-raised soft-shell clams in Maine is the Downeast Institute in Beals, Maine. Hatchery clams generally need to be ordered 6 to 12 months in advance.

Contact Information:

Downeast Institute, 207-497-5769; or visit their web site: <http://www.downeastinstitute.org/>

Sources for netting and equipment

Netting

Look for UV resistant plastic netting with a mesh size between: 0.167-.35 inches.

Nets at Heal Eddy were made from Tenax R-9 netting (<http://tenaxfencing.com/clam-netting.html>). Others prefer Industrial Netting OV7100 (<http://www.industrialnetting.com/ov7100.html>).

Nets come on rolls 14' wide and between 1900-3000' long. A 1900' x 14' roll will make 95 14' x 20' nets and costs approximately \$1300 plus shipping.

Floats

Gill net floats can be obtained at your local marine supply store for about \$2.00/ea. You will use 10 ties and 10 gill net floats per net. So, 25 nets would require 250 floats and 250 ties.

14" zip ties can be obtained from most hardware stores. However, it can be cheaper to buy zip ties in bulk through the internet.

Net Monitoring Protocol

The purpose of monitoring the nets is to make sure the nets remain in place and are functioning properly. The monitoring also provides an index to the success of the farm in terms of clam density.

INSTRUCTIONS: At least once a month, fill out the NET MONITORING DATASHEET.

FIELD PROCEDURE: Walk slowly down the center of each row of nets and record (1) net edges that are exposed, (2) sediment buildup over the net, and (3) the presence of any clam holes showing under the net.

It doesn't matter at which end of the farm you start, so long as you match your scoring to the correct net number. Each net should be numbered with a wooden stake that is easily read from 10 or 20 feet away.

Assess the following:

I. NET INTEGRITY

For each net, note on the datasheet any edges of the net that have come out of the sediment. It is rare for a net to come up, but it can happen with extremely rough conditions.

Score net integrity as:

"OK" if all edges are buried and look good.

or...

If a net edge has come up, list each edge that has come up by compass direction. e.g., N, S, E, or W; or NE, SE, SW, or NW, depending on the orientation of your farm.

If you have a clam hoe, re-bury the net. If you don't have a clam hoe, then come back as soon as you can to re-bury the net.

If there is anything unusual about the net edge (e.g., a piece of driftwood is sitting on it; a tear has occurred for whatever reason), describe in the comments for the net.

II. SEDIMENTATION

Note whether there is any sediment build up over the net. Sediment tends to build up in winter months (more energy in the water). If the sediment gets too thick over top of the net, the clams can't filter water and they can suffocate and starve. We score the sediment build up as 0, 1, 2, or 3, as follows:

- 0 No significant sediment buildup over the net
- 1 Some minor sediment buildup along edges (a foot or less from the edge)

- 2 Moderate sediment buildup, extending more than a foot in from the edge; but not critical.
- 3 Major sediment buildup; scrape off the sediment soon.

If the net scores a '3' you should scrape the sediment off the net as soon as you can. If it scores a '2,' you might decide to clean it off, or watch it carefully. If there is 1" or more of sediment over a net, it should definitely be cleaned off.

To clean a net, use a regular garden hoe to scrape off the sediment. CAREFULLY. It is easy to rip a hole in a net. A plastic snow shovel can work too, if there is more sediment. It is easier to clean the sediment off a net when covered by about 6-8" of incoming or outgoing tide. The water makes the sediment come off easily and float away. Work in way that the floating sediment doesn't obscure your view.

III. CLAMS HOLES

Score the presence of any clams "showing" (the siphon holes). For some unknown reason, "nets" will "show" one day and not another. Two adjacent nets may show very differently on any given day. One is showing, the other not. The next day they might switch.

Don't count individual holes. Just take a quick scan of the net and score it according to the chart below. Once you are practiced at this it should take 3-5 seconds to score a net for clam holes.

- 0 No clam holes are obvious.
- 1 >0 but fewer than 20 holes showing
- 2 >20 but <200 holes showing.
- 3 >200 holes showing.
- 3+ Probably >1000 holes showing.

Generally, it is easiest to score "net integrity" and "sediment" before you walk up onto the net. Then, step into the middle of the net, take a quick look around, and score for clam holes. Move to the next net in the row.

This protocol should take about 20 minutes for 25 nets. It will get faster as you get comfortable with the scoring system.

Keep a copy of the datasheet in a file or log book.

A sample data sheet is included on the next page.

Clam Farm Net Monitoring Data Sheet

Date: (m,d,y)	/	/	Time start:		Time end:	
Observer:		~Air Temp? (F)		Weather?		

General comments:

(see bottom of data sheet for scoring codes)

Net#	Net Integrity	Sediment?	Clams?	Comments
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				
25				

Scoring Codes:

NET INTEGRITY	SEDIMENT	CLAM HOLES SHOWING
<p>"OK" if all edges look good</p> <p>otherwise...</p> <p>If a net edge has come up, list all the edges that have come up by compass direction (e.g., N, S, E, or W).</p>	<p>0 No significant sediment buildup over the net</p> <p>1 Some minor sediment build up along edges (a foot or less from the edge)</p> <p>2 Moderate sediment buildup, extending more than a foot in from the edge; but not critical.</p> <p>3 Major sediment buildup; take action soon to scrape off the sediment.</p>	<p>0 no clams holes showing</p> <p>1 >0 but fewer than 20 holes showing</p> <p>2 >20 but <200 holes showing.</p> <p>3 >200 holes showing.</p> <p>3+ Probably >1000 holes showing.</p>

[illegible]

