AQUACULTURE IN SHARED WATERS

Sea Scallop Farming

Maine Aquaculture Innovation Center

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ACKNOWLEDGEMENTS

The Aquaculture in Shared Waters program prepares fishermen, and other working waterfront users, to start an aquaculture venture. The project builds on some very successful and innovative earlier programming by the Maine Aquaculture Association and the Maine Aquaculture Training Institute.

Program partners include the Maine Aquaculture Association, Maine Aquaculture Innovation Center, Coastal Enterprises, Inc, Maine Sea Grant and University of Maine Cooperative Extension.

This iBook project has been supported with funding from the Maine Aquaculture Innovation Center, USDA Rural Development, and National Science Foundation award #11A-1355457 to Maine EPSCoR at the University of Maine.

Chapter 1

Biology & Ecology of Atlantic Sea Scallops

Hugh Cowperthwaite, Coastal Enterprises Inc

Dana Morse, Maine Sea Grant

Chris Davis, Maine Aquaculture Innovation Center

This chapter covers the biology, ecology, and life cycle of Atlantic Sea Scallops *Placopecten magellanicus*.

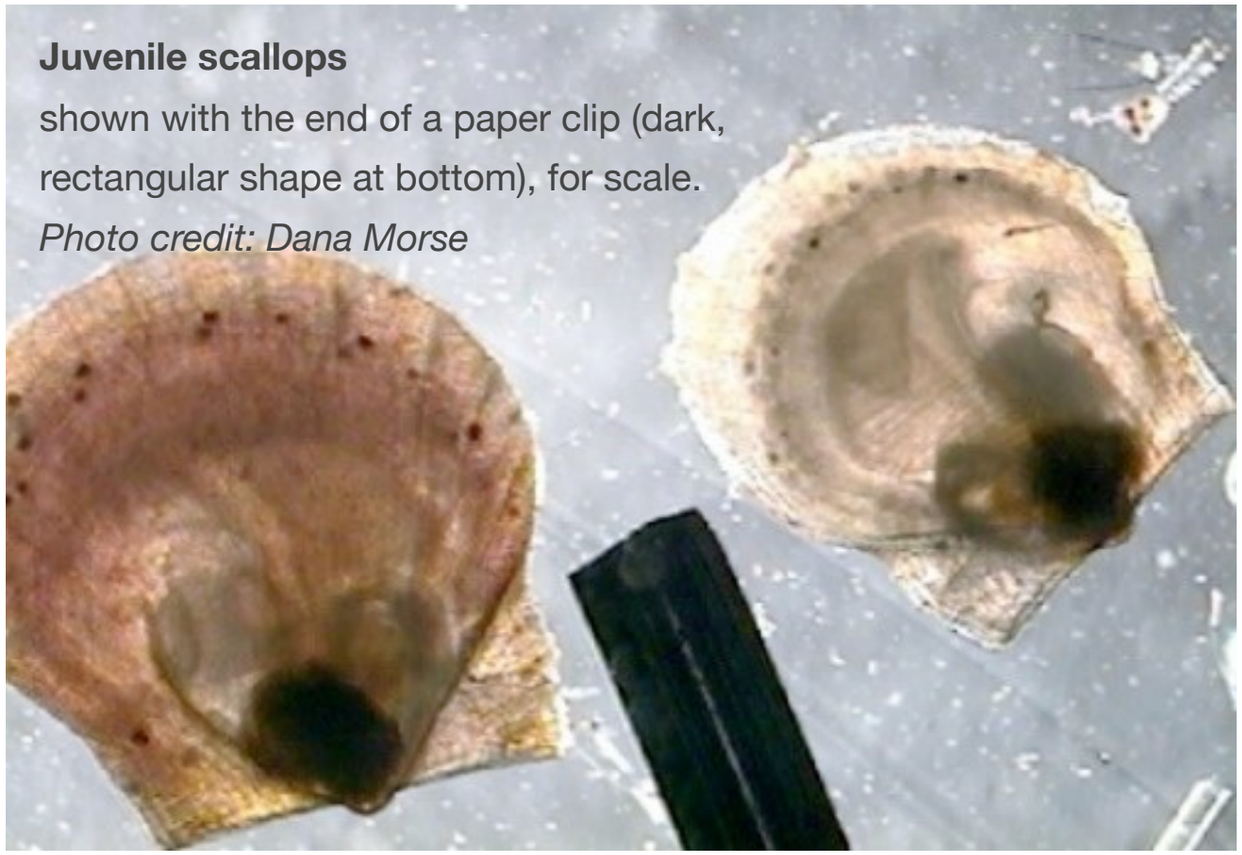
Biology

Biology

Sea scallops (*Placopecten magellanicus*) - also known as the Atlantic Sea Scallop or the Giant Sea Scallop - are filter-feeding bivalves. They occur in coastal and offshore waters from Labrador to North Carolina, along the US and Canadian coasts. Best estimates conclude that scallops can live over 20 years and grow to be over 9" in diameter. Sexes are separate (not hermaphroditic), and individuals reach sexual maturity at age 2, although egg and sperm production is fairly low until age 4.

Spawning

In Maine waters, spawning generally occurs in July and August, but there may be wintertime spawning as well, since ripe male and female gonads have been observed in January, February and March. Fertilization happens externally, and larvae develop in the water column. The larval period is generally 40-45 days depending principally on temperature. Competent larvae - those that are ready to settle - have limited ability to determine their settlement site, and to delay metamorphosis for a short time, if conditions are not ideal. On the coast of Maine, settlement



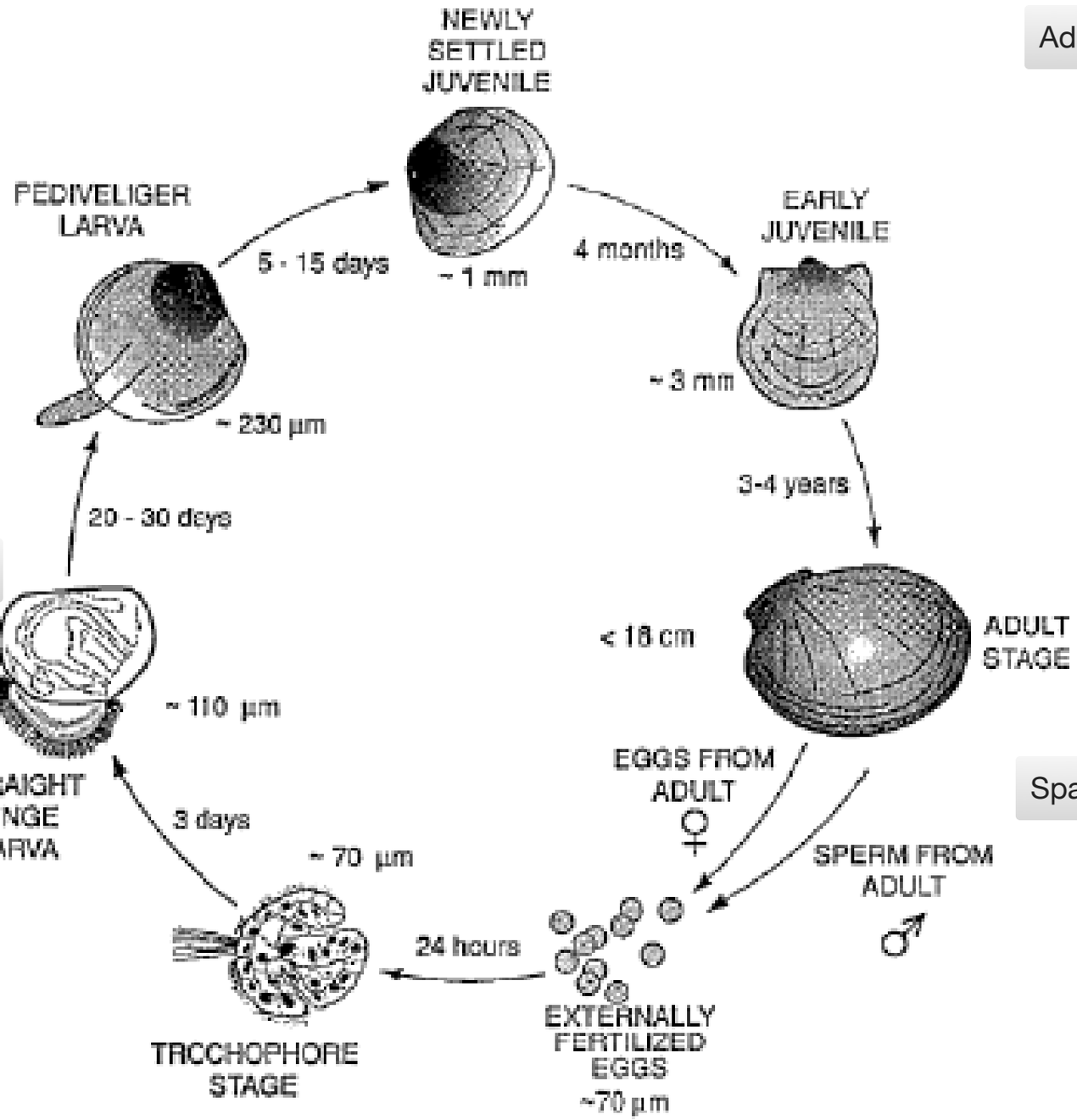
Juvenile scallops
shown with the end of a paper clip (dark, rectangular shape at bottom), for scale.
Photo credit: Dana Morse

generally peaks during the last two weeks of September and the first week of October. Post-set juveniles will attach to the substrate with a byssal thread and can retain that ability until they are over 1" in diameter. A settling sea scallop larva is about 450 microns, or about a half-millimeter in size. They become 5-10 mm typically by the following March-May.

Interactive 1.1 The life cycle of the sea scallop

Settlement

Adults



Larval period

Spawning

Figure 2. Generalized life cycle of the sea scallop, from Stewart and Arnold (1994).

Food and Agriculture Organization of the United Nations
for a world without hunger

Fisheries and
Aquaculture Department

Species Fact Sheets

Placopecten magellanicus (Gmelin, 1791)

Placopecten magellanicus: (click for more)

Synonyms

- *Pecten grandis* Solander, 1797

FAO Names

En - American sea scallop, Fr - Pecten d'Amérique, Sp - Vieira americana.
3Alpha Code: SCA Taxonomic Code: 3160801404

Diagnostic Features

The shell is large, subcircular, and compressed. The two valves are subequal, hinged dorsally, and meet along the ventral margin, except for a small gap between them near the dorsal hinge line. The right valve rests on the bottom. Radial ribs are present along with concentric lamellae or growth lines. This sculpturing is more prominent on the left valve. The wings on the left valve are nearly equal: the wings on the right valve differ in that the anterior wing contains a byssal notch. The inner surface is lustrous and smooth with distinct adductor muscle and pallial scars (roughened areas may be present due to secretions laid down to repair damage from boring organisms). The adductor muscle scar is located slightly posterior and dorsal to the center of the valves and is slightly larger on the left valve.

The left valve is usually reddish-brown in color but may be lavender or yellow; the rigght valve is pale cream or white.

Geographical Distribution

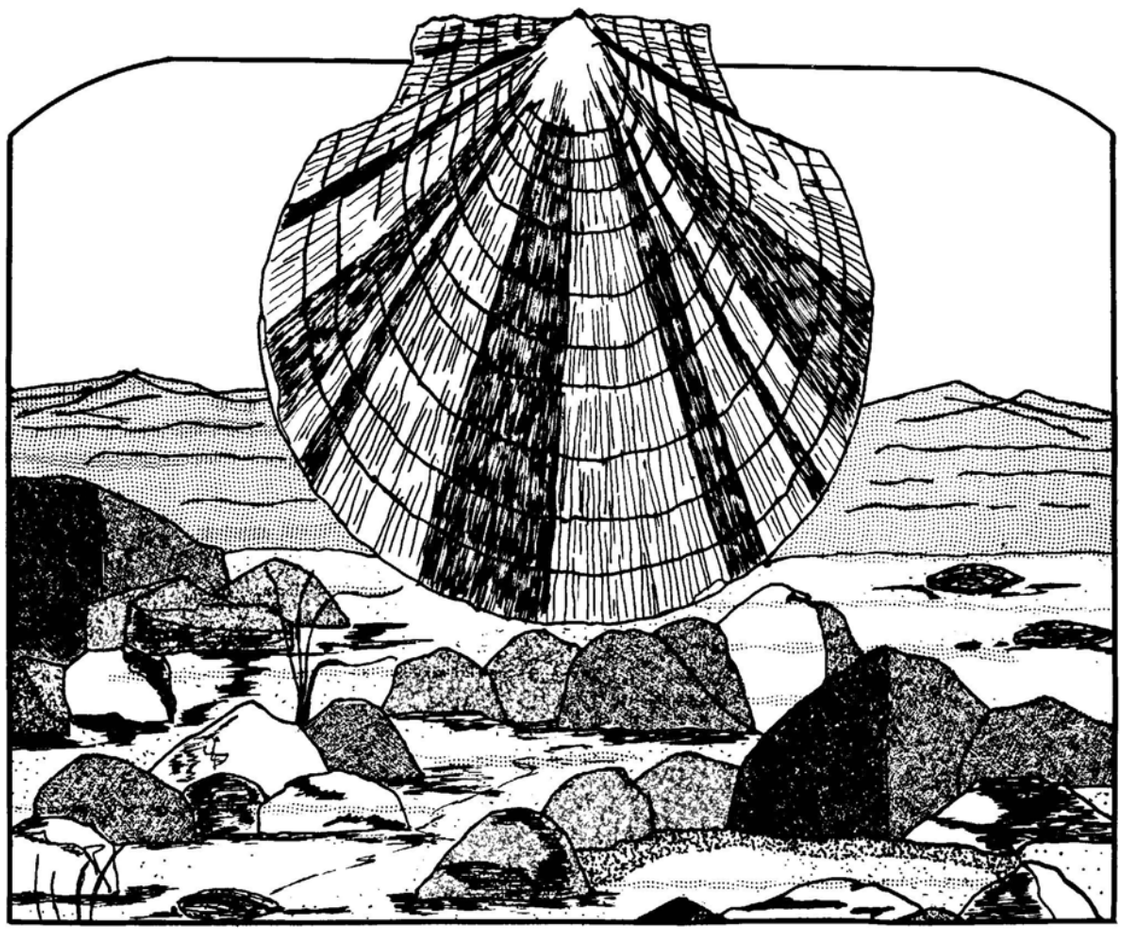
U.S. Fish and Wildlife Service
National Wetlands Research Center
700 Cajun Dome Boulevard
Lafayette, Louisiana 70506

Biological Report 82 (11.67)
August 1986

TR EL-82-4

Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (North Atlantic)

SEA SCALLOP



Fish and Wildlife Service
U.S. Department of the Interior

Coastal Ecology Group
Waterways Experiment Station
U.S. Army Corps of Engineers

Movie 1.1 Swimming scallops

Video Credit: East Coast Divers

Available on YouTube at https://www.youtube.com/watch?v=kw6wGwKEdT8

MORE INFORMATION

NOAA FISHERIES

Species profile, management overview, surveys, research

https://www.fisheries.noaa.gov/species/atlantic-sea-scallop

FAO GLOBEFISH

World trade analysis

http://www.fao.org/in-action/globefish/market-reports/resource-detail/en/c/337242/

NOAA FISHERIES

Seasonal distribution, historical landing data, current wild assessment

https://www.nefsc.noaa.gov/benchmark-assessments/sea-scallop/

NEW ENGLAND FISHERY MANAGEMENT COUNCIL

Wild fishery management plans, quota data

Interactive 1.2 Anatomy of the sea scallop

Section 2

Ecology

Habitat

Sea scallops prefer areas with relatively high flow and will most commonly be found on hard-bottom areas, with sand, gravel or cobble as the preferred substrates; rarely will they be found on mud, which is typical of low-flow, depositional conditions. They will prefer temperature ranges more aligned with European oysters and blue mussels, rather than those typical of Eastern oysters and hard clams: the upper range for reliable scallop survival is between 65 and 70 deg F. Scallops also require higher-salinity areas, rather than estuarine conditions.

Pests & Predators

Scallops are subject to several pests and predators in the natural environment, particularly smaller size scallops. Lobsters and several crab species will readily prey on scallops, with starfish as perhaps the most devastating species, though much of this predation can be reduced in culture and with proper attention to husbandry. A scallops' shell will thicken as it grows, providing some defense, although the main defense is the scallops' well-developed ability to swim. This ability diminishes as the scallop grows however, and studies indicate that scallops above roughly 3.5" in shell height are unlikely to swim any great distance. On the other hand, even large scallops can swim some distance, to evade predators or to seek better conditions for feeding.

Pests include fouling organisms like colonial and solitary tunicates (*Ciona intestinalis*, *Botryllus schlosseri*, *Botrylloides violaceous*, *Molgula manhattanensis*, *Styela clava* and *Ascidiella adspersa*), the hydrozoan *Tubellaria*, and settling shellfish such as blue mussel (*Mytilus edulis*), wrinkled rock-borers (*Hiatella arctica*), and barnacles (*Balanus* spp). Shell-boring polychaetes such as *Polydora websteri*, and boring sponges (*Cliona* spp) can cause damage to the shell and can reduce condition index, when infestations become severe.

Chapter 2

Farmed Scallop Production Cycle

Hugh Cowperthwaite, Coastal Enterprises Inc

Dana Morse, Maine Sea Grant

Chris Davis, Maine Aquaculture Innovation Center

This chapter provides an overview of the farmed production cycle of Atlantic Sea Scallops *Placopecten magellanicus*.

Section 1

Background & Rationale for Farming Sea Scallops

Sea scallops (*Placopecten magellanicus*) represent an intriguing opportunity for aquaculture in the northeast, because of their high value, reasonable growth rate, and the potential for adopting equipment and husbandry methods from established scallop production in Japan and elsewhere.

The US market for scallop adductor muscles, or scallop meats, is large as well: US landings averaged nearly $380M in the years between 2000 and 2016, and in 2016, the US imported another 22,000 tons of scallops worth over $320M (NOAA Fisheries Statistics). Sea scallop landings in Maine, for 2017 totaled 793,544 pounds of meat, valued at $9,300,111.

The strong consumer demand for sea scallops is an opportunity for Maine in particular, where there exists:

(A) A long standing economic and cultural tradition of scallop fishing; and,

(B) The ideal environment for sea scallop culture.

Despite the opportunities in scallop culture, the species has presented challenges over the years, due to its preference for low-density culture, sensitivity to fluctuations in temperature and salinity, relatively short shelf life (for live product) and the careful handling required. The processes and equipment for scallop production in the northeast US continue to evolve, borrowing heavily from experiences in other nations.

Aquaculture of *P. magellanicus* is still in a fairly early stage of development, so there is still a good deal of experimentation under way. Thus far, traditional equipment such as lantern nets, bottom cages and pearl/lantern nets are in use, with some ear hanging as well.

P. magellanicus has a different body type and behavior that other commonly-cultured pectinid species - such as the King Scallop (*Pecten maximus*) and the Yesso, or Japanese Scallop (*Patinopecten yessoensis*) - so it will be a process of investigation, and trial and error to find the best husbandry and equipment for the sea scallop.

Interactive 2.1 The Production Cycle of the Yesso Scallop, *Patinopecten yessoensis,* in Mutsu Bay, Japan

The following video illustrates several steps of scallop farming:

- retrieving spat bags,
- grading spat,
- rinsing Netron,
- stocking lantern nets,
- unpacking equipment from Aomori, Japan,
- installation and operation of wash machine,
- scallop grading machine,
- removing barnacles prior to drilling,
- slow operation of scallop drilling machine,
- fast operation of scallop drilling machine,
- pinning scallops,
- scallop aquaculture cleaning machine,
- cleaning machine power unit on land, and
- use of the washer on the water.

Movie 2.1 Scallop Farming in Maine

Video Credit: Hugh Cowperthwaite

Several steps of high-volume scallop production in Aomori, Japan can be seen in this video.

Movie 2.2 Scallop farming in Japan

Video Credit:

Section 2

Seed

Hatcheries

Hatchery production of sea scallops has proven to be very difficult; many efforts over the years in the US and Canada have all encountered problems, making the process very unpredictable.

With a larval period of 40-45 days, cultures of larvae are very susceptible to losses. Ciliates, bacterial contamination and nutritional aspects all contribute to problems in larval cultures, despite continued investigation in the US and in Canada.

Gallery 2.1 Scallop Research Hatchery

Broodstock sea scallops in conditioning tank

Photo Credit: Anne Langston Noll

Scallop spat collection is a process of deploying a settlement substrate in places where competent larvae (those about to go through metamorphosis) are present in high numbers.

Seed Collection in Japan

In Aomori, Japan they rely on wild spat collection for their seed source. Collection bags are typically set in April-May and are attached to a farm longlines. There is close communication between the Aomori Prefecture Fisheries Research Institute (where they monitor oceanographic conditions to predict scallop spawning and larval release) and the fishing co-ops around Mutsu Bay.

They collectively monitor environmental conditions and this help to best predict when larval settlement will occur and when to set collection bags.

Spat settles in the bags and is protected from predators and allowed to grow in the bags for ~3 months before being transferred into pearl nets.

Gallery 2.2 Spat collection gear (bags, monofilament and Netron) sitting dormant, to be used again in the future

Photo Credit: Hugh Cowperthwaite

Wild Spat Collection in Maine

Collection of wild spat has proven to be very productive in certain areas along the Maine and Massachusetts coasts, with numbers per collector often reaching 2,000-3,000.

Following a trip to Aomori Prefecture, Japan, in 1999, by a delegation of fishermen, scientists and managers from Maine, local fishermen started experimenting with Japanese spat collectors, and rapidly found success in waters just a little offshore, but still within state jurisdiction.

The standard gear was developed in Japan and has two principal parts. The spat bag itself is about 0.6 m long and 0.3m wide, with a drawstring at the top and made of polyethylene mesh, with openings typically 1.5 or 3.0mm in size. Inside the spat bag is the settlement substrate. Many materials have been tried, from monofilament gillnetting material, to fuzzy rope for mussel farming, but polyethylene mesh is the industry standard. Netron is sold commonly by aquaculture suppliers in the Northeast US, although studies indicate that 1/4" agricultural netting (Industrial Nettings OV-7822) works as well or better, and more inexpensively. 20-30 square feet of substrate per collector is common.

Collectors are strung to single, vertical lines, or deployed in an array, and suspended to float in the lower third of the water column. Collectors are usually deployed between the third week of September and the first week of October, and experience in Maine indicates that further offshore sites have better results than collection sites in rivers and in bays. Single lines of collectors are commonly used; bags are tied to the rope with the drawstring of the collector. Avoid setting bags within 2 fathoms of the bottom, to keep the bags from collecting too much sediment or becoming damaged on the bottom, and avoid the top 2-4 fathom of the water, because of the high fouling rates there, especially with

Gallery 2.3 Spat collectors used in Maine

Netron inside a spat bag.

Photo Credit: Dana Morse

mussels. Above the topmost bag, attach a hard-plastic buoy to act as a toggle; this will keep the collectors oriented vertically as much as possible. A surface buoy and an anchor will keep the equipment in place and will allow you and others to mark the location. Scallops will not be readily visible until January or February, and by May of the following year should be in the 3-10 mm range.

Collector retrieval is a process of getting the collector line back aboard the boat, and then removing the settlement substrate and shaking the scallop free.

Movie 2.3 Aomori scallop gear display

Video Credit: Hugh Cowperthwaite

Movie 2.4 Aomori scallop gear display

Video Credit: Hugh Cowperthwaite

These two underwater videos were filmed at the Asamushi Aquarium in Aomori, Japan. It shows various types of scallop culture gear (spat collection bags, pearl nets, lantern nets and ear-hung scallops).

It is often handy to have a large container for this, such as a barrel or an Xactic insulated container, as scallops will scatter as they are shaken off. Once the scallops have been shaken off, they should be transported to clean, circulating water as soon as possible.

Retrieving collectors on very cold or hot days should be avoided where possible, so April-June is a common time-frame in Maine.

Yields on good sites on the Maine coast should be above 1,000 scallop per collector, with collections in excess of 10,000/ collector possible.

Gallery 2.4 Spat Collection Flyer

Wild Scallop Spat Collection

A **spat collector (above)** is a piece of equipment used to capture the larvae of specific types of shellfish. Collectors for sea scallops (*Placopecten magellanicus*, example above) have been used in Maine for nearly 20 years, as fishermen along the coast have used juvenile scallops in re-stocking efforts and more recently to produce seed for aquaculture production. A single collector will often capture 1,500-3,000 scallops.

Netron (above) is a stiff but flexible blue plastic mesh that comes in 300 foot rolls. Other materials such as 1/4" black agricultural netting also work for spat collection, and more cheaply. Each spat bag will need three pieces of Netron cut to 17" x 30", or 20-40 square feet of material. These materials can be re-used for a number of years.

Spat Bags (above) are made of polyethylene mesh, and come in several mesh sizes, although the 1.5mm mesh works best. Bags are the size of a bed pillow and have a drawstring to close. Scallop larvae carried into the bags by currents are about 0.4mm in size but grow rapidly after setting on the Netron, until they are too big to escape the bag. Spat bags generally can't be re-used.

Preparing Bags: Cut approximately three, 3-foot lengths from the roll of Netron (or use pre-cut pieces). One roll will be enough for about 35 bags. For each length, reach down the inside of the tube to the bottom end and pull it through (turning it inside out, like a sock) to just past the middle of the length. Flip it over and do the same for the other end. Open the bag and stuff the pieces of Netron in, the messier the better, to keep the bag 'full'. Tie the drawstring at the end with an overhand knot.

Section 3

Site Selection & Long Line Setup

Site Selection

Site selection for any species is a critical decision, and the factors that influence this decision are complex. However, some of the basics that relate to scallop farming include the following: correct temperature and salinity;

- feed availability;
- ability to access the site;
- proper flow and exposure to extreme conditions;
- depth;
- presence of competing uses such as fishing;
- seabed composition and ability of moorings to remain in place;
- type degree and seasonality of fouling;
- frequency and degree of harmful algal blooms in the area.

Growers may find it helpful to list out the various considerations and take notes about how one site compares to another, to help in decision-making.

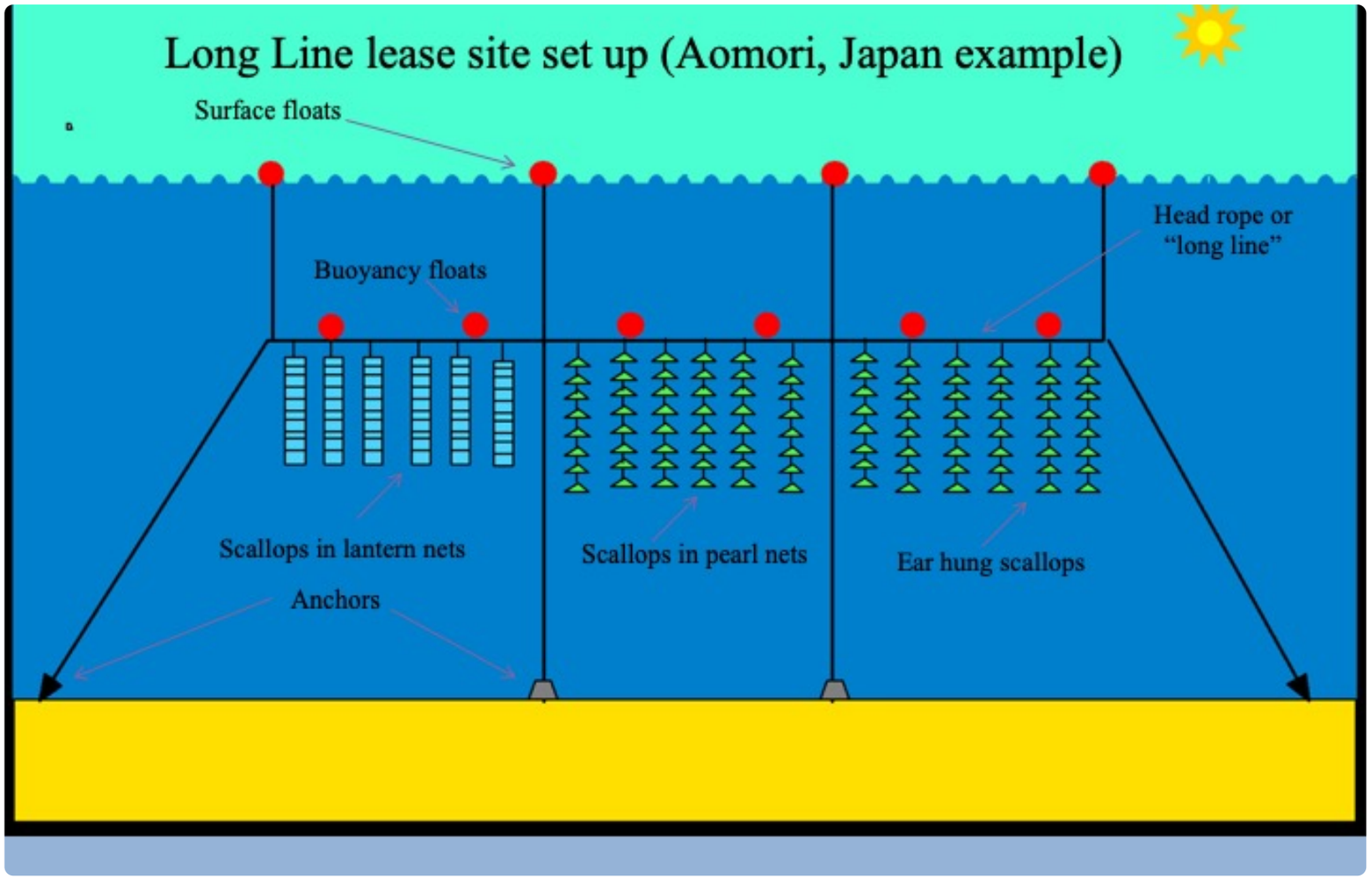
Factor	Notes
Temperature	Cool; below 70 F
Salinity	Salty; above 25 ppt
Stocking density	Low

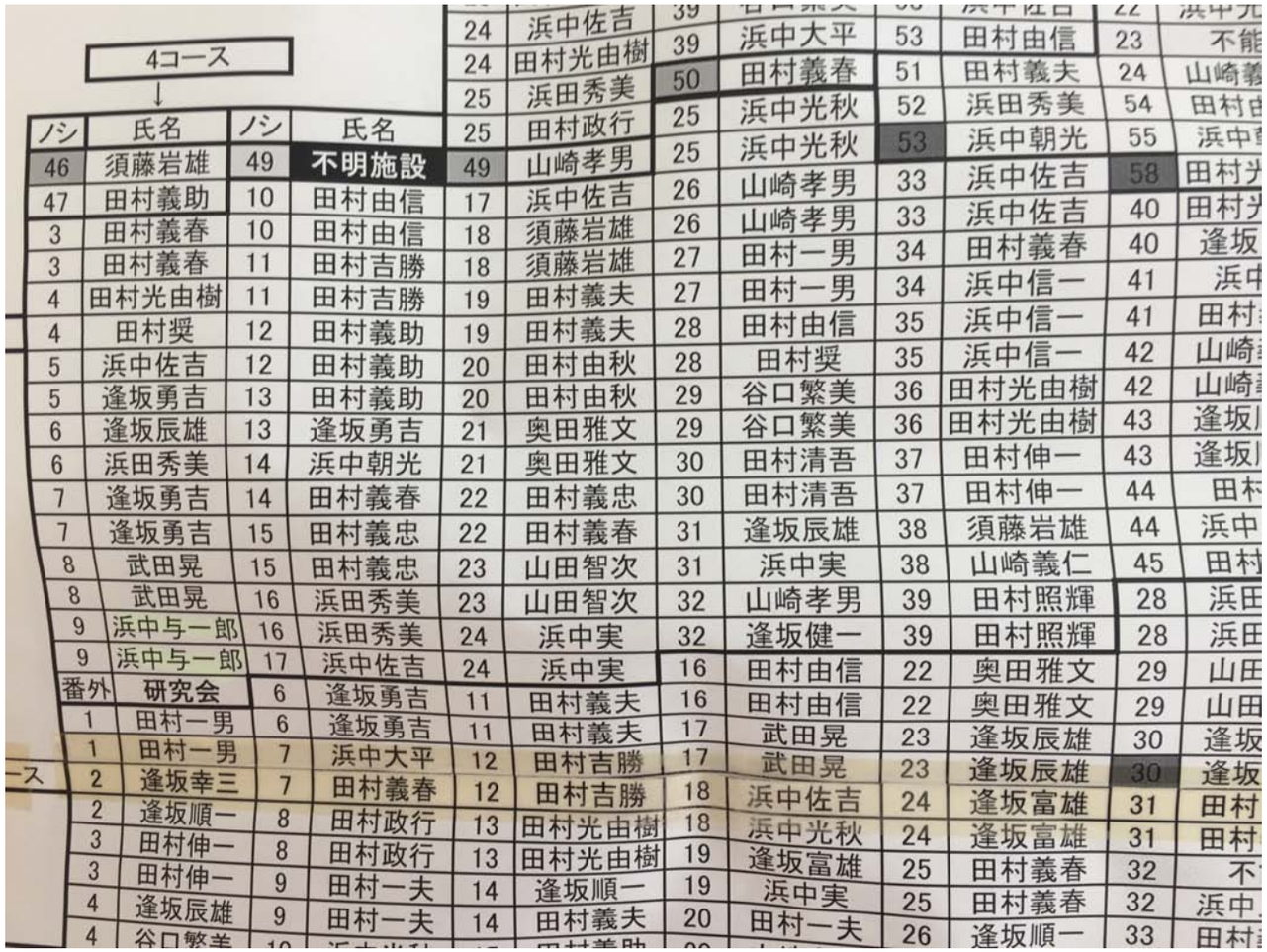
Longlines in Mutsu Bay

The images in Gallery 2.5 show typical long line lease site set ups used in Mutsu Bay, Aomori, Japan. The overall length (footprint) of a 200m long line set up is ~650 feet.

Each individual farm site (lease area) could have as many as 15 long lines running parallel to each other. Each plot is generally acquired by heredity, although new fishermen can join occasionally as space allows.

Gallery 2.5 Gear Plans for Long Line Systems in Japan





This photo of a spreadsheet shows the different farm sites for each member of the Hiranai Fishermen's Cooperative. The Cooperative has about 500 members of the 1,000 or so fishermen in the region. Each plot is approximately 30 acres in size.

Working the Line

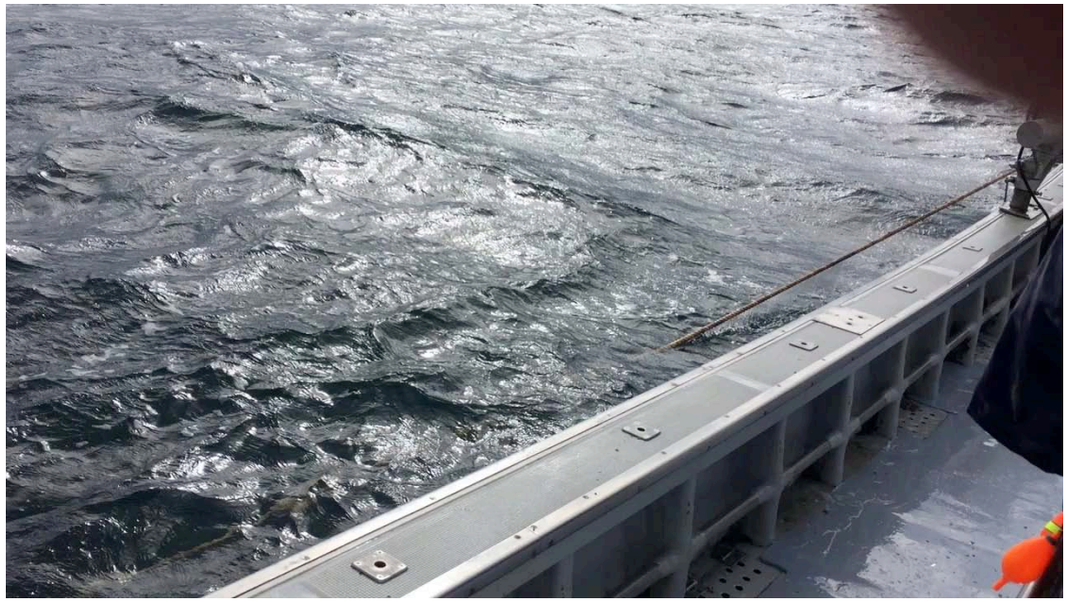
Growers in Japan advised siting farms in water depths of at least 70 feet or greater. The longline is lowered and raised as needed to tend to the gear. Each long line is kept very taught and is suspended ~20 feet below the surface of the water.

Movie 2.5 Scallop farm vessels in Mutsu Bay, Japan

This video shows scallop several vessels working in Mutsu Bay (which gives you a sense of the size and scope of the industry in Japan.

Video Credit: Hugh Cowperthwaite

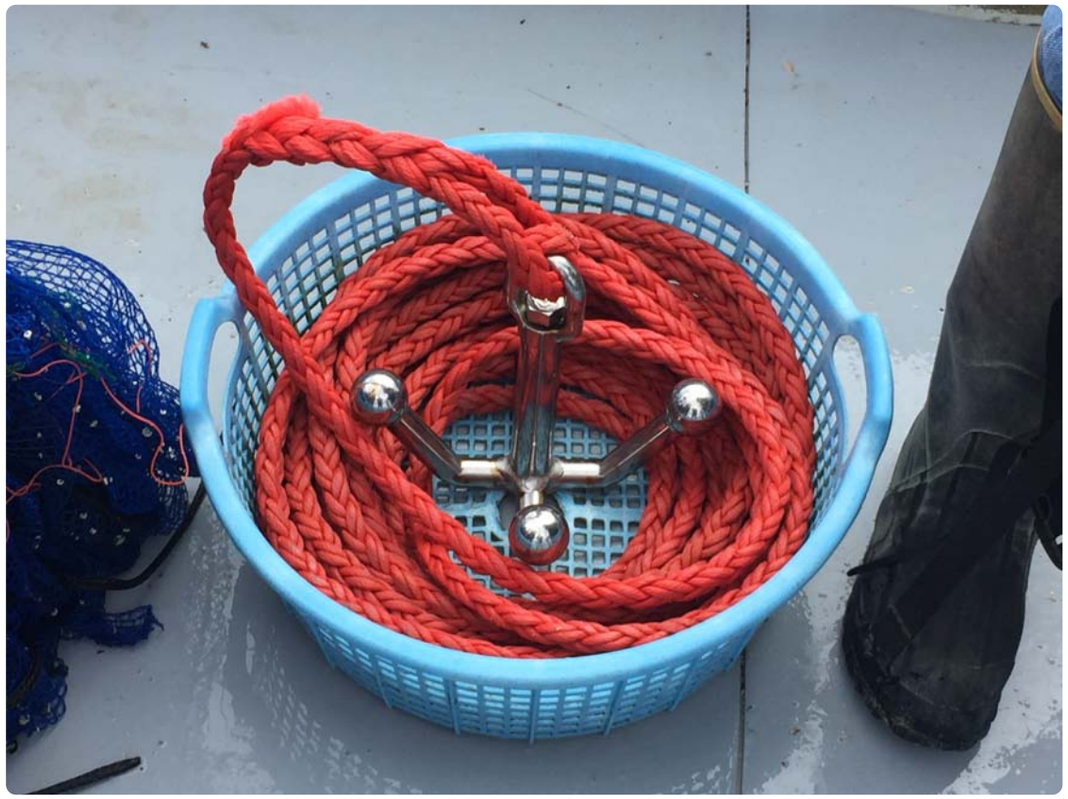
Movie 2.6 Scallop farm vessel in Mutsu Bay, Japan



This video shows the crew on a typical scallop vessel throwing a grappling hook to secure the long line alongside the vessel. Notice the electric powered star wheels on the front and back of the vessel used to help advance the line as the crew conducts their work.

Video Credit: Hugh Cowperthwaite

Gallery 2.6 Gear to collect the long line



Grappling Hook used to secure long line to vessel

Photo Credit: Hugh Cowperthwaite

Movie 2.7 Scallop farm vessel in Mutsu Bay, Japan

This is a video showing a powered star wheel advancing the long line to a new spot for work to be conducted.

Video Credit: Hugh Cowperthwaite

Movie 2.8 Scallop farm vessel in Mutsu Bay, Japan

Shown from a different angle, on a different vessel, this video illustrates the process of securing the long line and positioning it into place alongside the vessel.

Video Credit: Hugh Cowperthwaite

Movie 2.9 Scallop farm vessels in Maine

This video shows Marsden and Bob Brewer from the Pen Bay Scallop Co. in Stonington, Maine as they secure a scallop longline along the side of their lobster boat. Notice they are using a boom hoist to raise the long line up onto the star wheels.

Gallery 2.7 Star Wheels

The hydraulic powered stern star wheel.

Moorings and Mooring Lines

Anchors for longlines include screw-type anchors, deadweights, and modified kedge-type anchors.

Screw/helical anchors are easy to deploy but should only be used where the sediment will definitely support the longline, as failure will lead to lost gear.

Deadweights such as granite blocks may be more expensive but will provide a measure of security if they are properly deployed and matched to the holding power needed.

A modification of kedge anchors is used commonly in Japan and has been tried in Maine with some success, but again must be matched well to holding power needed and sediment, and they will not prevent the longline from moving and tangling if they fail in heavy weather.

Mooring lines are set commonly at 3:1 to 5:1 scope, with appropriate shackles and chain at the anchor end.

Gallery 2.8 Typical anchors used to secure longlines for scallops in Japan

Photo Credit: Hugh Cowperthwaite

Each anchor weighs between 130-220 lbs. and includes a large spade on one end with an eye at the base where a tag-line is fastened (to reposition and tighten slack if needed). The steel anchors are made of 1.5" stock steel and have about a 4-foot shaft. Each long line would have 3 anchors at each end of the line.

In Maine, depending on the water depth and currents a grower may want to use a much larger/heavier granite block to secure each end of a long line.

Gallery 2.9 Mooring in Maine

This mooring weighs 2.5 tons (~5,500 lbs.) and is being used off of Stonington by Pen Bay Scallop Co.

Photo Credit: Dana Morse

Longline (or backline)

Longlines are commonly of 24mm (1") diameter line; nylon is often chosen because of its strength and relatively low stretch and ability to absorb shock. Polypropylene rope is almost as strong as nylon, it retains strength when wet and does not float. Longlines are submerged typically 10-25' below the surface, to

Gallery 2.10 Long line hardware

Long line

Photo Credit: Hugh Cowperthwaite

allow vessel traffic over the line, and to place the culture gear below the light zone where the heaviest fouling will occur.

Tension Buoys

Tension buoys are attached where the mooring line joins the longline ends. Hard plastic, submersible buoys of 75lbs (34 kg) buoyancy are commonly used, sometimes in groups of three or more. Tension buoys function to help maintain the shape of the longline, and can help identify the end of the longline, although they are submerged most of the time.

Marker Buoys

Marker buoys are placed periodically along the longline. Their purpose is somewhat to help maintain a level profile in the longline, but more to act as an indicator of when to add more compensator buoys, as the crop grows and becomes fouled over time. The marker buoys also alert mariners to the presence of the longline and can be used to raise specific portions of the longline when needed.

Compensation Buoys

Compensation buoys are added periodically to the longline, to maintain proper buoyancy along the line, and a generally horizontal profile. There is a balance to be struck; too much flotation will bring the entire longline to the surface where it can present a navigation hazard, and not enough flotation will result in culture gear that might rest on the bottom, where it will abrade and allow predators to climb up the lines. In Gallery 2.10 traditional glass floats are shown alongside more modern plastic versions in use on farms. The floats attract significant fouling organisms and need to lay fallow and be cleaned on occasion to remove unwanted growth. Notice the white spots on the floats where large barnacles had once settled. A scraping tool is used to manually removed fouling from the floats.

Movie 2.10 Scraping biofouling from buoys

Video Credit: Hugh Cowperthwaite

Longline Weights

As a balance to compensation buoys, weighted droplines to the seabed are often used. Weights might be concrete, stone or even bags filled with sand; weight might range from 50 to 200 lbs.

Dropper lines are always kept ~10 feet off the bottom at all tides to avoid predators (star fish, crabs etc). Biofouling on gear and scallops is partially managed by raising and lowering the long line at various times of the year depending on water temperature and fouling that may be occurring at a specific time of the year.

Movie 2.11 Diorama of a scallop long line

Weights on longlines help to dampen the motions from heavy seas and help to maintain a constant height above bottom. Notice the sand weights in this diorama video.

Section 4

Nursery Culture

Once scallops are removed from collectors, they are placed in nursery culture.

The goal of the nursery is to efficiently grow scallops from their small size as juveniles to a size that they can either:

- be sold as a specific product (such as half-shell) or
- move on to the growout site to be grown to final size.

Common nursery gear includes:

- Bottom cages: Bottom cages have the advantage of remaining stable once they are deployed and can be constructed of materials common to aquaculture and the fishing industry, such as oyster bags and wire mesh.
- Lantern nets: Lantern nets and pearl nets have the advantage of being light in weight and collapsible, so many can be transported at one time.
- Pearl nets: Lanterns and pearl nets are the standard gear in scallop-producing countries, and they provide good protection with good water flow, but must be frequently maintained against fouling.
- Suspended cages: Hanging cages such as Dark Sea trays or Aqua-Pacific cages can be used as well, though will likely need a small-mesh liner to accommodate small scallop seed.

Any container having fine mesh will foul quickly, so a proper maintenance program must be planned for. Careful site selection can also help to minimize biofouling. In general, greater depths will help to reduce fouling rates, but benefits from reduced fouling must be balanced against any difficulties in handling, equipment and access caused by operating in a deeper environment.

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Gallery 2.11 Bottom Cages/Suspended Cages

Lorem ipsum dolor sit amet, consectetur adipisicing elit, sed do tempor incididunt ut labore et dolore magna aliqua.

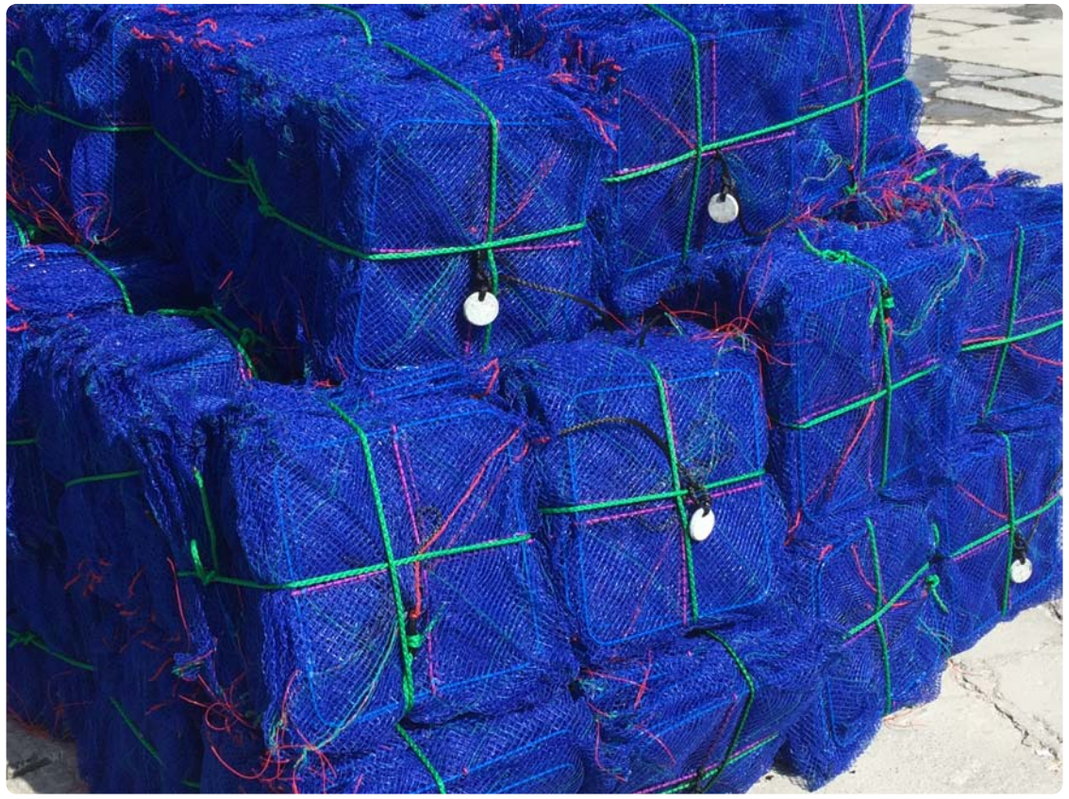
Bottom cages (photos) Dana has some photos of Evan Young's cages, Blair Cooper, large bottom cages and stunted growth scallops (from bottom cages).

Pearl Nets

After spat is collected in July and August, the spat is graded (sorted) by size.

The animals are placed into pearl nets.

Gallery 2.12 Pearl Nets



Pearl nets are stored in bundles and stacked on land in piles when not in use .

Photo Credit: Hugh Cowperthwaite

Movie 2.12 Once stocked to the appropriate density, pearl nets are cast over the side of the vessel and tied to the long line.

Video Credit: Hugh Cowperthwaite

Pearl nets are said to be better “shock absorbers” when compared to the use of larger lantern nets. The nets allow the spat to be protected from predators in an environment that is not crowded and offers a high amount of food availability in the water column.

Stocking Density Reduction

Stocking density varies with size of the scallop. At the time of removal from the spat collectors:

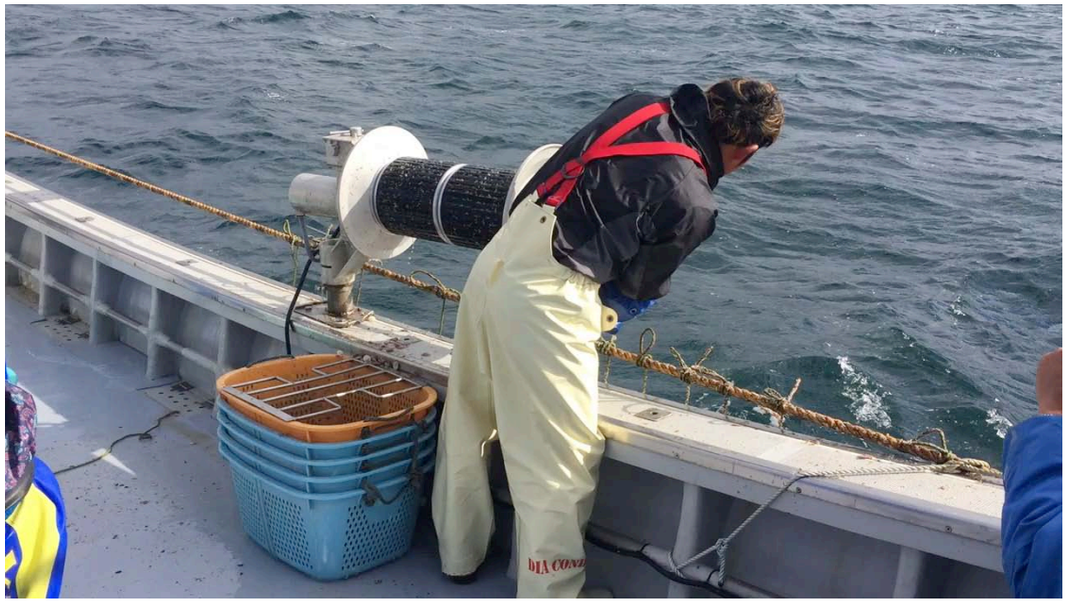
- The larger animals are placed at a stocking density of (80-100 animals).
- At 5mm shell height (length or depth???), stocking density can be slightly higher at 100 scallops per pearl net.

From the initial placement of scallops in pearl nets, they are allowed to grow for ~3 months undisturbed. In October, the lantern nets are hauled up and the scallops are once again graded by size.

At ~20mm size they can be restocked into clean pearl nets with a larger mesh and the stocking density should be reduced to 15-20 animals per Pearl net. This step serves several purposes:

- biofouling on the nets is eliminated,
- the larger mesh allows for more water flow and access to food,
- scallops are less crowded, and
- their size uniformity should carry forward through the rest of the production cycle.

Movie 2.13 Specialized electric haulers are mounted on the side of the vessel to mechanically haul in the pearl nets which can become quite heavy due to fouling. The hauler can easily be removed from the rail of the vessel when not in use.



Video Credit: Hugh Cowperthwaite

Movie 2.14 Scallops are removed from the pearl nets by lightly shaking the net over a plastic tote

Video Credit: Hugh Cowperthwaite

Controlling biofouling

Pests include fouling organisms such as:

- colonial and solitary tunicates (*Ciona intestinalis, Botryllus schlosseri, Botrylloides violaceous, Molgula manhattanensis, Styela clava and Ascidiella adspersa*),
- the hydrozoan *Tubellaria*,
- settling shellfish such as blue mussel (*Mya arenaria*), barnacles (*Balanus* spp), wrinkled rock boring clam (*Hiatella arctica*),
- Shell-boring polychaetes such as *Polydora websteri*, and
- boring sponges (*Cliona* spp)

Polydora and *Cliona* can cause damage to the shell and can reduce condition index when infestations become severe.

Grading provides an opportunity to address biofouling. A cylindrical washer has been developed to remove debris and dead shells prior to grading. Scallops are then graded to a uniform size before restocking in clean pearl nets.

Grading can also be a task that is performed on land as long as there is seawater nearby. The grader runs on electricity and is mounted to the deck of the vessel for stability. A trickle of seawater is let into the top section of the grader to help wash away fouling material and detritus.

Movie 2.15 Cylindrical Washer

Video Credit: Hugh Cowperthwaite

Movie 2.16 Grading Machine

Video Credit: Hugh Cowperthwaite

Movie 2.17 Water in the grading machine

Video Credit: Hugh Cowperthwaite

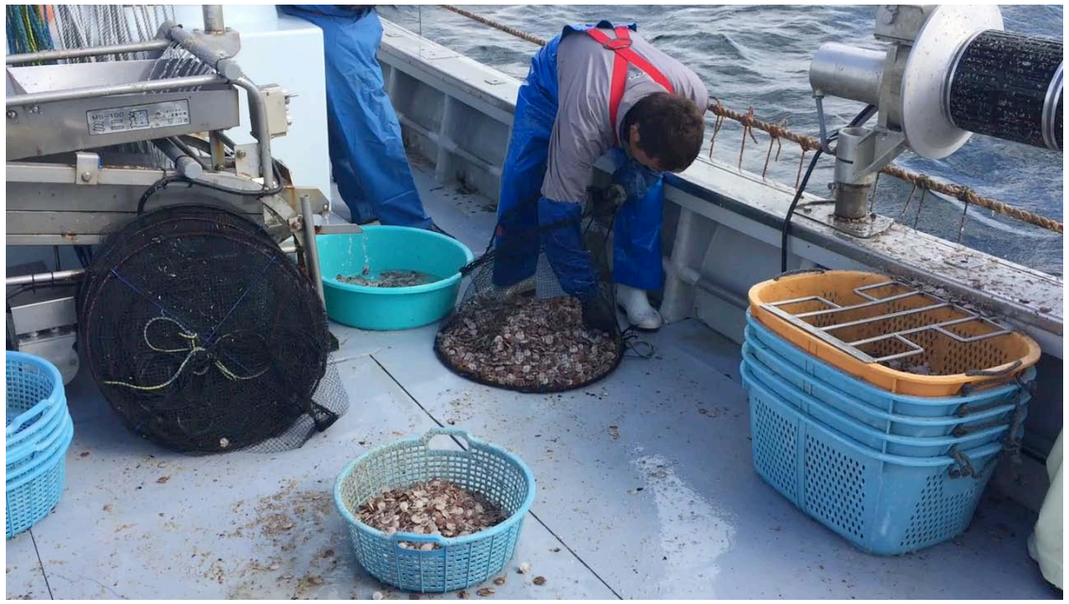
Due to the large volume of juvenile scallops being handled on board the vessel when changing nets, some of the scallops are stored temporarily over the side of the vessel in a larger net. This allows the crew to work at a comfortable pace and keeps the scallops out of the air and sunlight until they are ready to be restocked.

This is also a time when crew might remove runts or debris that was not removed by the grading process.

Movie 2.18 Temporary stowing of scallops

Video Credit: Hugh Cowperthwaite

Movie 2.19 Removing runts and debris by hand



Video Credit: Hugh Cowperthwaite

Scallops are then restocked into clean pearl nets. Several crew will assist with this task to increase efficiency and work in a timely manner.

Crew will stock each individual pearl net section with ~20mm scallops between 15-20 per net. They don't typically count the scallops but will grab a "quick handful" and place them into the net.

Movie 2.20 Filling Pearl Nets

Video Credit: Hugh Cowperthwaite

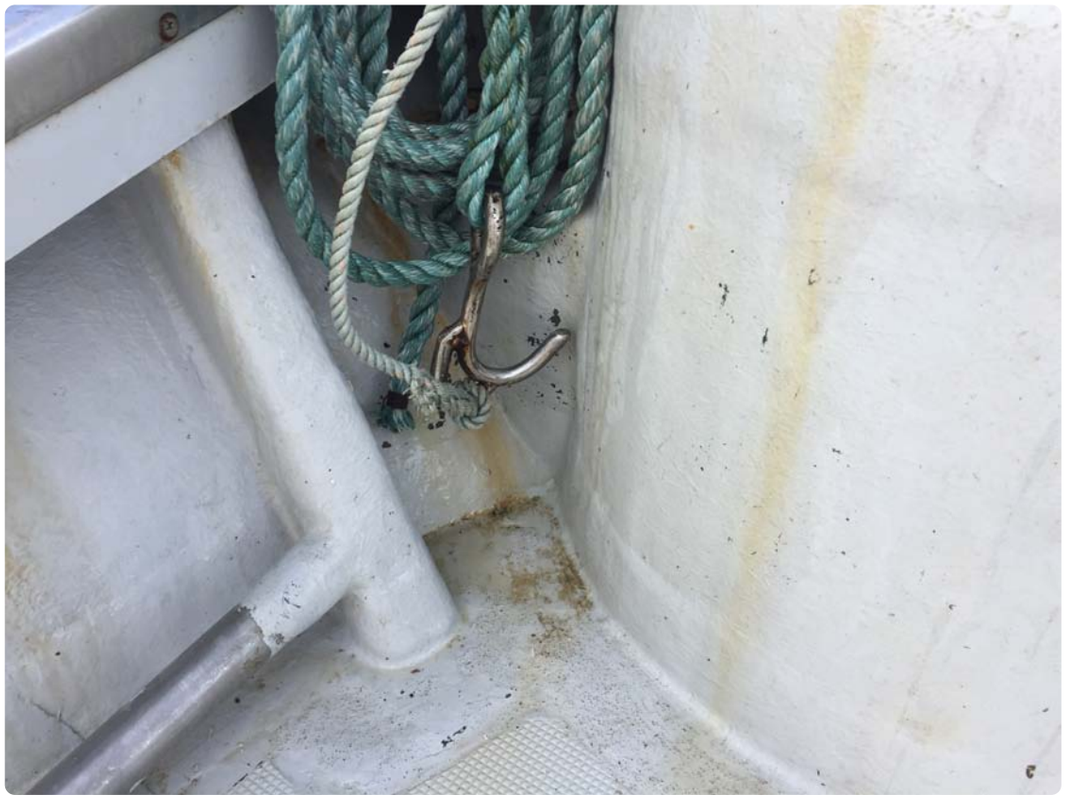
Crew will then return the freshly stocked pearl nets to the water and tie the nets off with a quick knot spacing each net approximately 5 inches apart.

Movie 2.21 Deploying Pearl Nets

Video Credit: Hugh Cowperthwaite

A hook on the end of a line is then used with the assistance of an electric capstan power winch to lift the longline up off the bow and stern star wheels (simultaneously) and slowly lower the head rope back into the water.

Gallery 2.13 Returning the longline to the water



Line with a hook

Photo Credit: Hugh Cowperthwaite

Movie 2.22 Lowering the head rope back into the water

Lorem ipsum dolor sit amet, consectetur adipisicing elit, sed do tempor incididunt ut labore et dolore magna aliqua.

At the end of the nursery phase (first year of production) (February-March) growers will transfer scallops to lantern nets or ear-hanging lines for further growout.

This decision is typically made months in advance based on the growers intended final grow out size and market.

Movie 2.23 Wave goodbye

Video Credit: Hugh Cowperthwaite

Section 5

Grow Out

Depending on how large the seed is to start, and what size scallop your market is looking for, growout can take 1 to 3 years.

Spat bags that spend 12 months in the water can expect to yield scallops in excess of 25mm, although problems may be encountered with fouling, smothering or mortality due to starfish, which will also settle inside the spat bag.

Using pearl nets as an intermediate, nursery phase can reduce these problems.

Scallops are prone to damage each other

As sea scallops grow, they get increasingly prone to damaging one another: one scallop will clasp onto another's shell, causing mantle damage to both - often referred to as 'knifing.' This is usually a response to two linked issues: improper stocking density, and feed/temperature/salinity conditions.

Scallops growing in ideal conditions will probably be able to handle higher stocking densities, whereas animals in sub-optimal conditions will move around in the cage more, seeking a better environment, and resulting in higher knifing rates.

Scallops that bite one another will be misshapen (oblong, rather than rounded), and will suffer lower growth and higher mortality. However, stunting may reduce shell length but increase shell height, and therefore produce 'taller' meats - all considerations that must be evaluated by the grower.

Stocking density is usually measured as a percentage of the bottom that is covered by scallops, and typically, 30% to 60% bottom coverage is appropriate for a given type of gear and location, but each grower will have to determine the proper density for his/her site.

Stocking Densities

Shell height	Number of Scallops	Gear Type
5mm	100	pearl net
5mm	200	lantern net tier
20mm	15-20	pearl net
20mm	15-30	lantern net tier
75mm	5	pearl net
75mm	10-15	lantern net tier

Lantern Nets

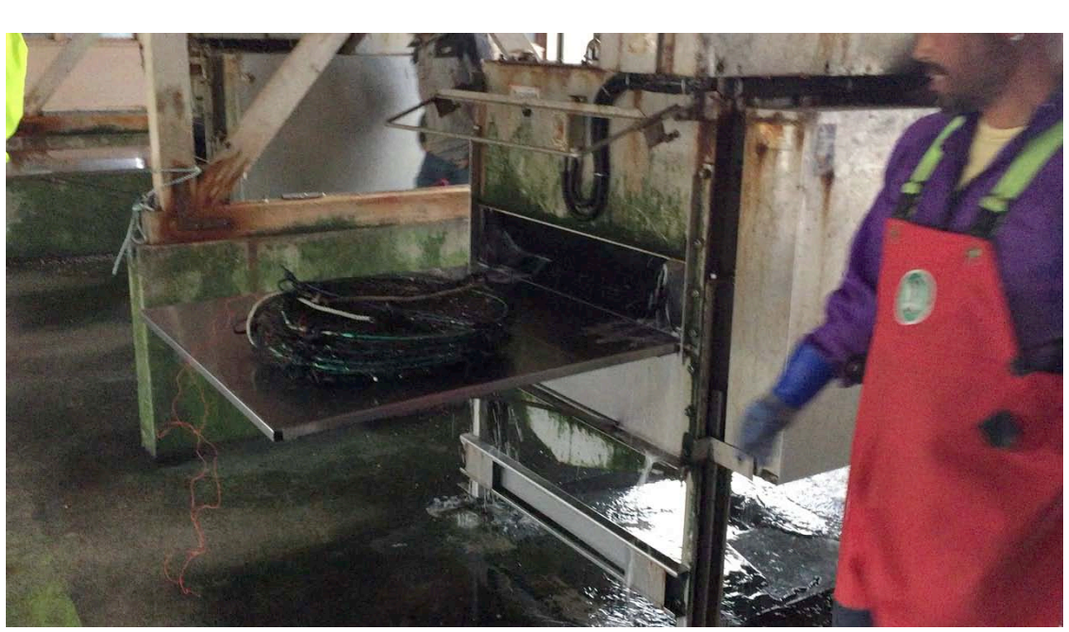
In February, pearl nets are hauled, and scallops are placed into lantern nets at a reduced stocking density or approximately 10 scallops per chamber of the net.

Much like the earlier reducing of stocking density (with pearl nets) this step serves several purposes:

- biofouling on the nets is eliminated,
- the larger mesh size of the lantern nets allows for more water flow and access to food,
- scallops are less crowded, and
- their general size uniformity should carry forward with the rest of the production cycle.

Lantern nets can become heavily fouled with unwanted growth. Land based net washers are commonly used in Japan and are typically part of a fishing co-op's offering to its members.

Movie 2.24 Lantern Net Washer



Video Credit: Hugh Cowperthwaite

Ear Hanging

Ear Hanging is a grow out culture technique that offers ample nutrients, provides minimal crowding and is believed to offer faster growth rates and larger meats.

Movie 2.25 Diorama of ear-hung scallops

Filmed at the Asamushi Aquarium in Aomori, Japan

Video Credit: Hugh Cowperthwaite

A small hole is drilled in the byssal groove of the lower shell and an individual scallop. A plastic pin with a barb on it is then inserted through the hole to attach the scallop to a dropper line and hung vertically in the water column. It has proven to be successful in Japan and trials are underway in Maine to evaluate the technique with Atlantic Sea Scallops.

It does require a fair amount of mechanization to reach scale and there are several pieces of equipment that have been developed to drill scallops and control biofouling.

Scallop Grading Machine (MS-100)

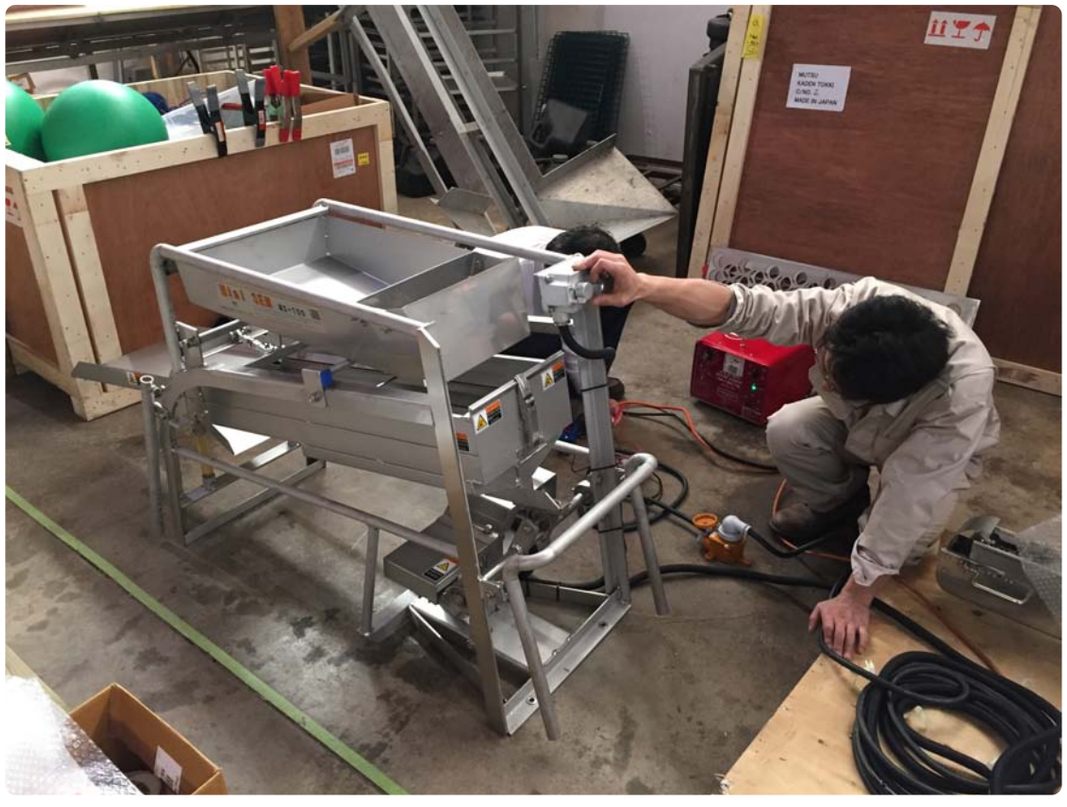
A grader is one of the most important and heavily used machines in scallop farming.

Nine months out of a year a grader is used on board scallop farm vessels in Japan.

In Japan, they remove the “runts” early in the growout process as a way to selectively encourage faster growing scallops to dominate the genepool.

The MS-100 is used to grade scallops between 9mm – 65mm.

Gallery 2.14 MS-100 Grading Machine Set-up



MS-100 grader

Photo Credit: Hugh Cowperthwaite

Movie 2.26 Small scallops being graded for restocking into clean lantern nets.

Video Credit: Hugh Cowperthwaite

Movie 2.27 MS-100 grading scallops into 3 different sizes

Video Credit: Hugh Cowperthwaite

It can be run using AC100V, 50HZ or DC24V, 350W. Electrical conversion is necessary when using on land or a vessel. For land-based use, a grower will want to purchase an industrial type of battery charger to convert from AC120V to DC24V.

The interchangeable screens are made of either plastic or stainless steel. Plastic screens typically wear out faster than stainless steel screens, but they will last for many years.

Some growers prefer plastic screens for the small size scallops (10-15mm) because they believe using stainless steel screens may damage the shells. Using plastic screens on MS-100 will grade small scallops very well due to the increased vibration.

- Plastic screens measure: 285mm X 940mm, and 2.0mm thick
- Stainless steel screens measure: 285mm X 950mm and are 1.0mm thick

Plastic screens are designed to be slightly shorter which helps it vibrate inside of the grader, stainless steel screens fit snug and are not made to move around inside of the grader.

Growers will use a screen size that has 2 to 3 mm smaller holes than the scallops they are grading. Growers carry around 30 screens to change for the size they want to grade. Growers will change the screen every few days, increasing the size of the holes as the scallops grow.

If a grower intends to ear hang their scallops, they will likely use a larger grader size MS-300 when they start ear hanging them due to the larger scallop size and volume handled.

Scallop Drilling Machine (Drill MD-120)

This machine (built by Mutsu Kaden Tokki Co.) is used to drill a 1.5 mm diameter hole at a rate of one scallop per second in the byssal groove of the lower shell. This prevents the plastic Age-pin that will be inserted through the hole from restricting movement of the shell (opening and closing) or damaging the tissue. The pin will eventually be overgrown by the shell. The drill is designed to accommodate juvenile scallops ranging in shell size from 2” up to 4.75”. After scallops are drilled they are pinned to grow out ropes to be hung vertically in the water column. Age-pins are offered in several gauges to accommodate for different drill hole sizes, shell size and velocity of the tidal current. The MD-120 drill was developed to drill scallops ranging in size from 5cm to 12cm. It is meant for drilling through one side of the scallop shell (not both shells as is sometimes done in Japan).

Gallery 2.15 User’s Manual for Scallop Drilling Machine MD-120

MD -120 MANUAL

Mutsu Kaden Tokki
MutsuCity, Japan
Tel: 175-22-3930

This drill was developed for the scallop size of 5cm to 12cm, especially for drilling only one side of the shells. We are proud of the precision of drilling holes. We used stainless steel for the most parts, including a chassis, so we can guarantee the long life of the machine. We hope you have an ease of mind for using MD-120.

Specifications:
Power source: single phase 100V 50 Hz 5A
Drill Motor: 30,000 rpm
Cooling method forced air cooling (new motor)
Drill bits need to be used: diameter 3.175 should be used.
Size of the machine: 601mm (height) X 402mm (width) X 1080mm (length)
Weight of the machine: 85kg
Regular equipment: a cap for preventing from the shell dust
adjustment for the size of the shells
noise filter
inside chassis- stainless steel
operating panel, front and back – stainless steel
operating light
manual handle for adjusting
Additional parts: 1 grounding stick
2 sizes of wrench for replacing a drill bit
1 tool for setting the position of the drill bit
2 kinds of hexagons (2 each)

Installation:
Please use a steady base for the drill.
Please ground the machine.

Warning:
Do not connect a ground on the gas pipe, water pipe, or a lightning rod.

Operation:
1. plug it in and off ---make sure the switch is off.
When you finish work turn the switch off and unplug it.

2. Operation
*When you turn the main switch on the spindle motor starts,
When the spindle motor gets to the regular speed, the caterpillar starts moving.

Based on use of the drill in Maine with Atlantic Sea Scallops, we offer this additional guidance:

- Stable Base: The drill should be set up on a flat, level surface to allow for accurate calibration. It is not recommended that the drill be taken on a vessel on the water. When operating the drill, the operator will typically be seated and place scallops into the drill using both left and right hands. A stable base can be constructed out of 6x6 timbers to provide a good platform. Small tables (to hold scallops) should be constructed out of wood and a fiberglass surface to provide longevity.

- Shell Size: In general, larger scallops are better for drilling. Smaller scallops take more time to handle, the shells are fragile and there's less room on the actual hinge (byssal groove) to allow for an accurate drill hole location. Scallops that do not drill properly must then be returned to a lantern net (to allow the shell to repair and try again in the future) or are damaged to the point where they can't be drilled. Smaller scallops can wear out the white plastic pads on the conveyor, typically after drilling ~500,000 scallops.

- Setting up and Calibrating the Drill: The drill must be set up for an approximate size of the scallops you are drilling. In our initial trials we set the drill for 5cm to accommodate shells that were 4.5cm-6cm (width of the shell). Uniformity in scallop size is key when drilling. Grading scallops is essential to establish a relatively uniform size scallop to be drilled. There is a slight

Gallery 2.16 MD-120 Drill Stand Construction

Gallery 2.17 Drilling

Drill table Constructed for Bangs Island Mussels

Photo Credit: Hugh Cowperthwaite

tolerance the drill allows for when adjusting the drill.

For example, when setting up the drill for 7cm, technically you can drill scallop shells that are 6-8cm. 4.5cm is too small, the drill will penetrate through both sides of the shell and the scallop will not likely live beyond ~6 months. Drilling through both sides of the shell will damage the mantle and growth will stop around the hole. 4.5cm scallops are drilled in Hokkaido but they are harvested at 70cm (half mature). A 3cm shell depth is the maximum capacity the drill can handle, anything deeper than this is too thick to fit in the conveyor.

First adjust the table height of the drill so it sits just to the top of the ear on the scallop. The table height should be measured from the bottom:

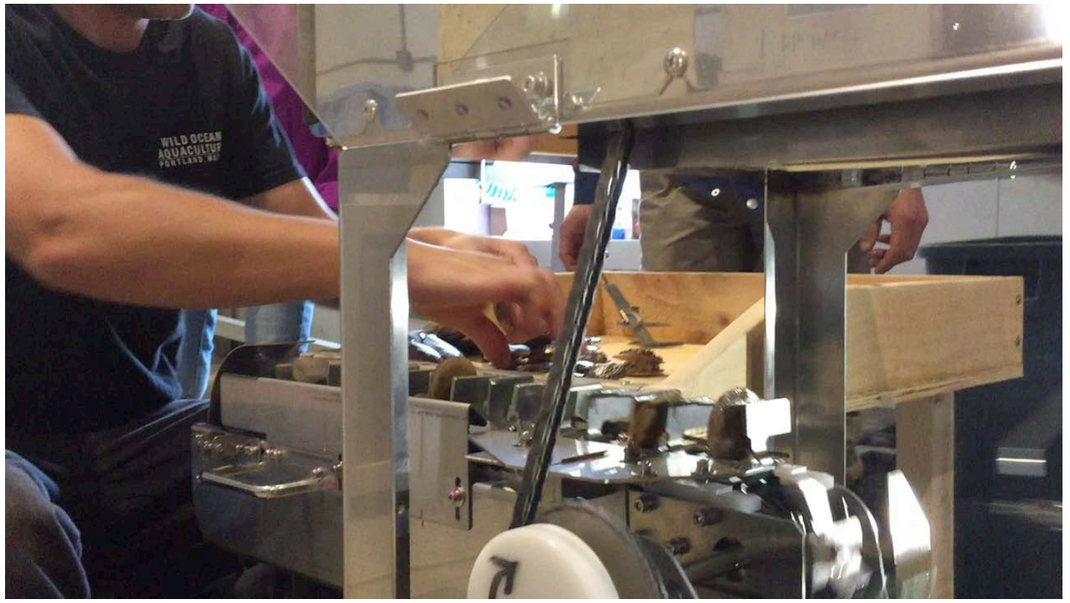
- The height of the table should be set at 10mm when drilling 4.5-5cm (smaller) scallops.
- The height of the table should be set at 15mm when drilling for 6-7cm (larger) scallops.

Place one scallop in the conveyor and advance it forward manually, to see where the drill touches the scallop. This will help determine the exact height the table should be set at. Never advance the hand wheel backwards. It will break the springs unless you hold the two springs back. Don’t let the spring pass beyond the end of the table. It generally takes about 20 minutes to properly adjust the drill.

Movie 2.28 The drill running at a slow speed as the operator properly calibrates the drill to the scallops size

Video Credit: Hugh Cowperthwaite

Movie 2.29 Once the drill is calibrated, the operator can increase the speed as desired



Video Credit: Hugh Cowperthwaite

- Shell Dust: If the operator plans on doing a lot of drilling (several hundred scallops). It's important to run a small PVC pipe off the back of the drill with an elbow positioned towards the floor and into a bucket of water (with the pipe submerged below the water line). This will keep shell dust from becoming airborne. It's also important to always have the fan turned on (located on the back side of the machine) to keep the drill clear of shell dust build-up.

Movie 2.30 Several scallops with hard fouling that needs to be removed prior to drilling

Video Credit: Hugh Cowperthwaite

- Placing Scallops in the Drill: The base of the shell (along the hinge) must be clean, so the shell sits level in the drill, otherwise it will be lopsided and not drill properly. The top side of the shell should be facing the drill bit. Biofouling (barnacles etc) should face the drill bit. Hard fouling just be removed before the scallop can be drilled.

Movie 2.31 Manual removal of hard fouling in preparation for drilling

Video Credit: Hugh Cowperthwaite

- Age-pin sizes:
  - Orange pins use a 1.5mm diameter drill bit, and can support 2.5kg of force while in the water.
  - Green pins use a 1.6mm diameter drill bit, and can support 3kg of force while in the water. These are stronger pins that are used for growing larger scallops.
- Drill bits: Drill bits can and should be sharpened after they are purchased, you want the bits to be more pointed for smaller scallops. The drill bit should be replaced if shells start cracking. A drill bit will drill up to 30K scallops before it needs to be replaced.
- Removing the Drill Cover (if necessary): There is a grease fitting on the bar on top of the drill that will occasionally need to be greased. The black and yellow tubes are connected to an air compressor to cool the motor. There is a brake at the top of the machine. There are two inverters, one running the chain motor and the other running the drill. 30,000 RPM. There is a 10-amp fuse in the back of the machine.
- Clean up: Use a nylon toothbrush to clean shell dust and debris from the drill chuck. A small O-ring keeps dust and water out of the chuck. Do not use water on the drill itself. The outside of the chuck is stainless steel, the inside is steel. Cover the drill mechanism with a plastic bag (IMG_9330.JPG). Spray down the conveyor and table with fresh water to remove shell dust and prevent long term corrosion while advancing the drill by hand (IMG_9329.MOV). A food grade lubricant can be applied to the conveyor. A small amount of WD-40 can be applied to the drive chain.
- Small Adjustments: The timing of the conveyor can sometimes be thrown off if something hits it. Simply loosen the chain to adjust it. The drill will make a banging sound when the chain is too loose. Tightening the chain will make it quieter and smother. The paddles on the conveyor can become bent, but can be fixed with a pair of pliers.

Automatic “Age” Pin Setter (Pin Setter FPS-1000)

This machine (built by Mutsu Kaden Tokki Co.) is used to insert age pins into grow out lines. (IMG_4483.MOV)

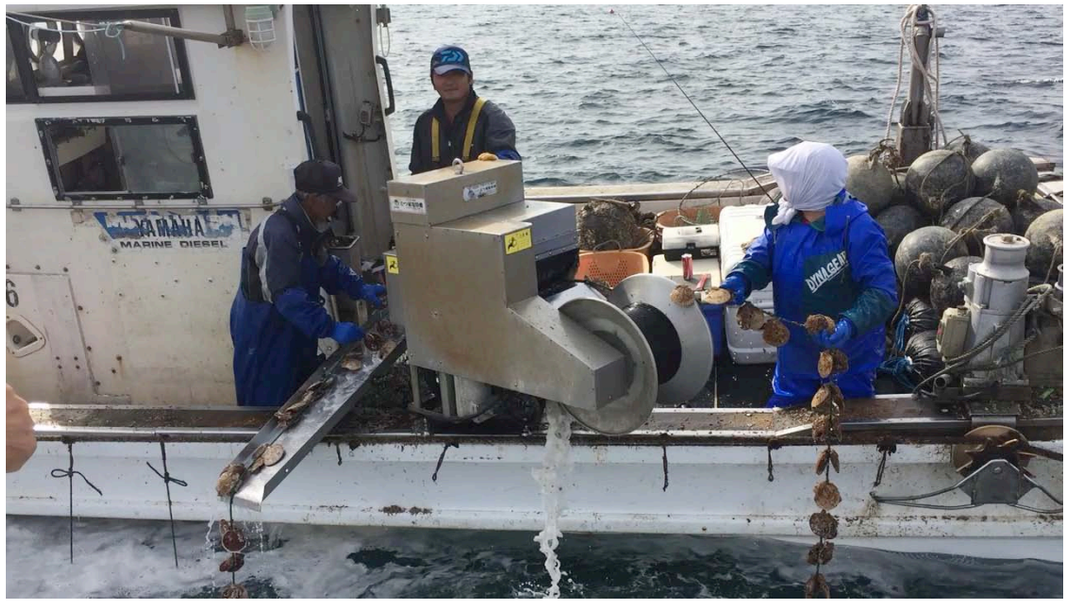
Movie 2.32 Pin Setting machine FPS-1000

Video Credit: Hugh Cowperthwaite

Scallop Aquaculture Cleaning Machine (On Board Cleaner MK357 full set).

This machine (built by Mutsu Kaden Tokki Co.) is used in the field to clean biofouling off of ear-hung scallops that have accumulated growth. Biofouling inhibits the growth of scallops so removing it is an important step in the grow-out process.

Movie 2.33 Scallop washing



Video Credit: Hugh Cowperthwaite

The machine positions scallops to lay flat and forces pressurized seawater onto the top and bottom shell surfaces of the scallops to remove algal growth and tunicates (think car wash). The scallops remain attached the vertical grow out line as it is fed through the cleaning machine and are deployed right back into the water after cleaning. Biofouling will vary by location and the need for repeat cleaning will also depend on local conditions.

The following two documents provide directions on the operation of the washer. Please note that both documents are in DRAFT format and will be updated at a later date.

Gallery 2.18 Scallop Washer Operation

Scallop Washer Operation

Fluids

10W30 engine oil 7.5 liters for engine (~2 gallons)

10W30 engine oil 3 liters for pump (~.80 gallons)

Mix water and coolant 50/50. Fill reservoir with 4 to 5 liters (total).

Set Up

Connect the intake hose to the (water intake on the pump), the lower option. Immerse the other end of the intake hose in the water (over the side of the vessel).

Connect the high-pressure water (yellow hose) to the (water flow on the pump) the mid option. Connect the other end to the washer unit (water input).

Attach the excess water hose to the (excess water overflow), the high option and run the hose over the side of the vessel.

To Start

Turn the pressure adjusting valve (silver handle) to the right (clockwise) and then slide the pressure adjusting valve lever (red knob) to the left. This allows water to be diverted and drained by the excess water hose. (If the hose vibrates there may be a problem inside the pump or the hose could be clogged).

Slide both circuits to "on" position. Engine switch is on the left, Generator switch is on the right

Turn the key to start the engine

Run the engine for 3 to 5 minutes at ~700 RPM to warm it up.

Adjust the RPM (with the locking pin) to ~200 RPM

The pressure adjusting valve lever, (red knob) should be all the way to the right (this will begin to direct water to the washer).

Turn pressure adjusting valve (silver handle) counter clockwise (left)

Open the pressure gauge cock (at the base of the gauge).

Once pressure is at 3 MPa, tighten the pressure cock at the base of the pressure value indicator

Turn the silver turn knob on the top of the water intake pump all the way counter-clockwise to increase water pressure

Volts can be adjusted to 28.5 V

Water should now be flowing through the nozzles on the washer (4 on top and 4 on the bottom)

To Stop

Adjust the RPM (with the locking pin) to reduce the RPM

Relive the pressure value at the base of the pressure value indicator

Turn the silver turn knob on the top of the water intake pump all the way clockwise to reduce water pressure

Turn the key off, Slide both circuits to "off", otherwise it will drain the batteries

Credit: Coastal Enterprises Inc

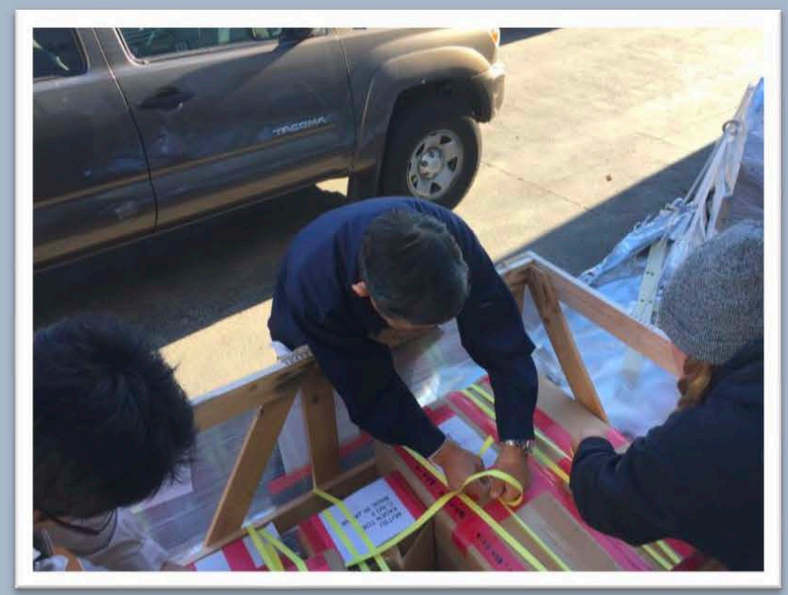
Gallery 2.19 Scallop Washer

DRAFT

Chapter 1 – Scallop Washer

Unpacking the engine

Unpack the engine and accessories from shipping crates



Credit: Coastal Enterprises Inc

Chapter 3

Disease & Animal Health

Hugh Cowperthwaite, Coastal Enterprises Inc

Dana Morse, Maine Sea Grant

Chris Davis, Maine Aquaculture Innovation Center

Disease

For prospective sea scallop producers in Maine, two of the most common problems to keep an eye out for include:

- burrowing polychaete worms (such as *Polydora websteri*), and
- the orange boring sponge (*Cliona* spp.).

While not immediately a danger to the scallop itself, these pests can deform and weaken the shell, causing the scallop to expend energy to make repairs, and lowering the overall condition of the scallop.

Off-color meats can be caused by a variety of factors, but is generally an indication of a weakened state for the individual scallop. The adductor muscle is where much of the scallops' energy is stored, and when much of the energy is used up, the meat can appear gray, or even bluish. The energy loss can be from a post-spawning phase, poor feed or water quality conditions, pollution, or many other reasons.

Orange and reddish meats have been observed from both offshore and inshore scallops periodically as well. Bourne and Bligh reported in 1965 (Journal of the Fisheries Research Board, Canada) that this phenomenon only occurs in female scallops, and that the orange color comes from the carotenoid compound zeaxanthin. Zeaxanthin is apparently responsible for the red coloration of scallop roe, and an excess of this compound in the feed results in deposition into the adductor muscle, and sometimes other tissues such as the mantle.

Chapter 4

Scallops & Public Health

Hugh Cowperthwaite, Coastal Enterprises Inc

Dana Morse, Maine Sea Grant

Chris Davis, Maine Aquaculture Innovation Center

Anne Langston Noll, Maine Aquaculture Innovation Center

This chapter provides an overview of biotoxin testing, and public health considerations for Atlantic Sea Scallops *Placopecten magellanicus*. It was prepared using information available on the Maine Department of Marine Resource website, and presentation materials prepared by Kohl Kanwit.

Harvesting & Public health

While there are many considerations that the potential scallop producer must think about (efficiency, rapid delivery to cool storage, etc), the most critical issue is being sure the product is safe to consume. For all tissues other than the adductor muscle, biotoxin accumulation is an issue that every grower must address. Working with the appropriate agencies at the state level and elsewhere is necessary to ensure public health, and it is currently illegal to land anything other than the adductor muscle in Maine, unless specially permitted by Maine DMR to do so.

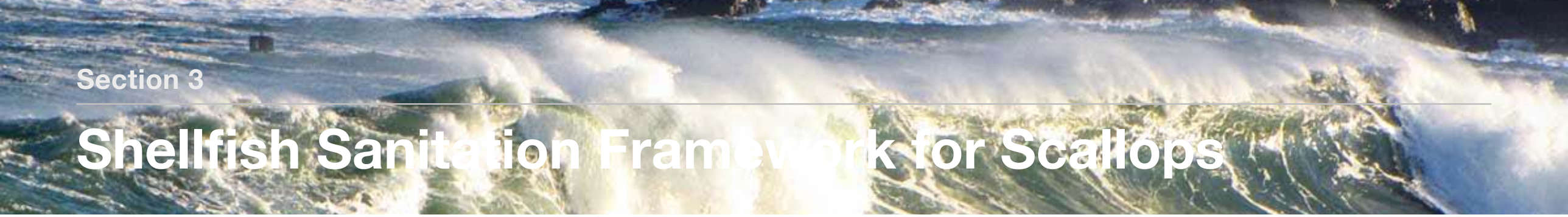
Diversification is already happening in the market for products made from scallops. While a premium will always be paid for top-quality meats, products are appearing that feature half-shell whole scallops with garnishes and sauce, roe-on scallops, and live scallops. Advances in freezing and packaging technology have improved the ability of the producer to get a high-quality product to the consumer in an appealing, flavorful and affordable fashion.

Section 2

Biotoxins

US consumers are generally used to eating only the adductor muscle of the scallop (scallop 'meat'), and this tissue accounts to about 15% of the total weight. Consumers elsewhere are more used to eating both the adductor muscle and the roe, or even the entire scallop. Greater utilization of the scallop helps to diversify products from scallops, and may bring greater return to the farmer. However, there are critical issues with respect to public health and seafood safety that cannot be ignored, when considering these options.

Under no circumstances should scallop tissues other than the muscle be consumed, unless it has been part of an approved testing process overseen by appropriate authorities. Phycotoxins such as saxitoxin and domoic acid can build in scallop tissues to dangerous or deadly levels, and it is impossible to tell without testing if scallop tissues are safe to eat. Moreover, scallops can hold such toxins for weeks or months, and can be toxic even in the absence of a harmful algal bloom.



Section 3

Shellfish Sanitation Framework for Scallops

Closed Area 1000 was promulgated in 1989, and amended most recently in 2010. This emergency regulation limited the scallop fishery to adductor muscle only for the protection of public health due to the risk of high levels of PSP in scallop viscera.

Sea scallops have specific biotoxin risks associated with them because:

- Scallops retain biotoxin for longer periods than other species of shellfish, and have slow detoxification rates
- There are variations in biotoxin between tissues
- There are variations in toxin that occur seasonally and not linked to active phytoplankton blooms. There is a rise in toxicity AFTER phytoplankton blooms have passed
- Biotransformation of toxins

Gallery 4.1 Closed Area 1000 Regulation

NOTICE OF EMERGENCY RULE-MAKING

AGENCY: Department of Marine Resources
STATUTORY AUTHORITY: 12 M.R.S. §§6172, 6192, 6193 & 6194
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BASIS STATEMENT

The Commissioner of the Maine Department of Marine Resources amends the emergency DMR Chapter 96.22 Closed Area No. 1000, Maine Coast, amended on October 19, 1999. This amendment adds all species of scallops to the rule, and removes the exceptions to shuck whole scallops at a shoreside wholesale dealer's facility, or to allow aquaculturists to harvest and distribute whole scallops, due to the increasing severity of PSP events in Maine, and the accompanying threat to public health. All existing pollution and red tide/psp closures remain in effect. As authorized by 12 M.R.S. §§6172, 6192, 6193 & 6194 the Commissioner of Marine Resources adopts emergency amendments to Chapter 96.22.

RULE TITLE AND SUBJECT: DMR Chapter 96.22 Closed Area No. 1000, Maine Coast, amended on October 19, 1999, is amended as follows:

TITLE & TEXT OF RULE: DMR Chapter 96.22 ~~Closed~~ Area No. 1000, Maine Coast

Effective immediately, because of paralytic shellfish poisioning (PSP), it shall be unlawful to land any species of scallops, including but not limited to *Placopecten magellanicus* and *Argopecten irradians*, whole or intact, or scallop viscera, taken from Maine coastal waters and those offshore waters of the exclusive economic zone (EEZ/200 mile limit) between the Maine/New Hampshire border and the Canadian border. Only the adductor muscle may be retained and landed for personal use, wholesale, or retail trade.

~~Effective immediately, because of contamination (paralytic shellfish poisoning), it shall be unlawful to possess any scallops, whole or intact, or scallop viscera taken from Maine coastal waters and those offshore waters of the U.S. Exclusion Economic Zone (200 mile limit) between the following two boundaries:(1) the Maine – New Hampshire border to the limits of the U.S. jurisdiction; and (2) the Canadian – U.S. boundary extending seaward out to the limits of the U.S. jurisdiction. EXCEPTION: (A) it shall be lawful to shuck whole or intact scallops at the time of harvesting or at a shoreside wholesale dealer's facility, but only the adductor muscle shall be retained for personal use, wholesale or retail trade. (B) it shall be lawful for an aquaculturist with an approved aquaculture lease, and a signed Memorandum of Understanding with the Department of Marine Resources to harvest, possess and distribute whole scallops which are grown on their specified lease site as long as the lease site is in the open status.~~

EFFECTIVE DATE: November 9, 2010 EFFECTIVE TIME: 9:00 AM

AGENCY CONTACT PERSON: Amy M. Fitzpatrick, Department of Marine Resources,
194 McKown Point Road, W. Boothbay Harbor, Maine 04575
http://www.maine.gov/dmr/rm/public_health/closures/closedarea.htm
EMAIL: Amy.Fitzpatrick@maine.gov

History of Whole Scallops in Maine

In 1999 draft policy for aquacultured whole or roe-on scallops was drafted by Maine DMR. Despite no history of allowing whole or roe-on scallops from wild harvest, DMR undertook pilot projects with several growers of both sea scallops and bay scallops.

Research has shown that the digestive gland is the most risky part of a scallop with regard to biotoxins: roe is less risky than the whole scallop.

As such, Maine DMR has developed a low risk model for shellfish sanitation of aquacultured scallops for harvest of roe-on shellfish.

This involves a Memorandum of Understanding with Growers. Growers submit pooled samples of 15 animals (no adductor muscle) for testing. There must be two clean tests (PSP and ASP toxins) before roe-on sales are allowed, and confirmation of no active blooms before roe-on sales are allowed

Roe-on sales are not allowed if toxin is present. The grower can choose to wait, or shuck the product (adductor muscle only).

Chapter 5

Markets & Products

Hugh Cowperthwaite, Coastal Enterprises Inc

Dana Morse, Maine Sea Grant

Chris Davis, Maine Aquaculture Innovation Center

This chapter covers the potential markets for Atlantic Sea Scallops *Placopecten magellanicus*.

Section 1

Preparing a Scallop for Market

The principal market for sea scallops in the United States is for the adductor muscle, or meat.

Scallop meats generally range from $7 to $13 dollars per pound, although recently-decreased Japanese production is increasing the prices paid to harvesters in the inshore Maine fishery.

In 2010, landings of scallop meats in Maine waters amounted to approximately 185,000 lb., worth just under $1.5 million USD. By contrast, total scallop landings in the US were 58 million pounds, worth over $380 million USD.

Products and markets for scallop meats are well developed, and 'diver' or 'dayboat' scallops are enjoying particular favor in recent years, by virtue of their top quality, and good associations between fisherman and consumer.

The market for other products - such as roe-on, whole or live scallops - is currently limited, but it appears that this is due to lack of production, given that many buyers, chefs and restaurant owners have indicated a strong interest in obtaining such products.

Unless grown under careful monitoring, landing of whole scallops is disallowed, because of the scallops' ability to accumulate deadly levels of biotoxins. That said, producers in the US have had several tries at growing scallops through aquaculture, and Canadian producers appear to be having a measure of production and economic success.

As a practical matter, generating cash flow at several points in the production process is a standard approach for Japanese and others who are currently producing scallops of other species, eg: *Patinopecten yezzoensis*.

Producers might plan on selling:

- scallop seed,
- selling individuals in the 50-75mm range into the 'Princess Scallop' market,
- larger animals sold as roe-on, whole, or live; and
- the largest might be used to produce adductor muscles into the high-end market for big scallop meats.

Other opportunities exist for other food and non-food markets: scallop seed as garnish in salads and other dishes (small scallops often have distinctive and very attractive shells), small shells and scallop pearls to be used as jewelry, and larger shells for the culinary trade.

Scallop product formats include:

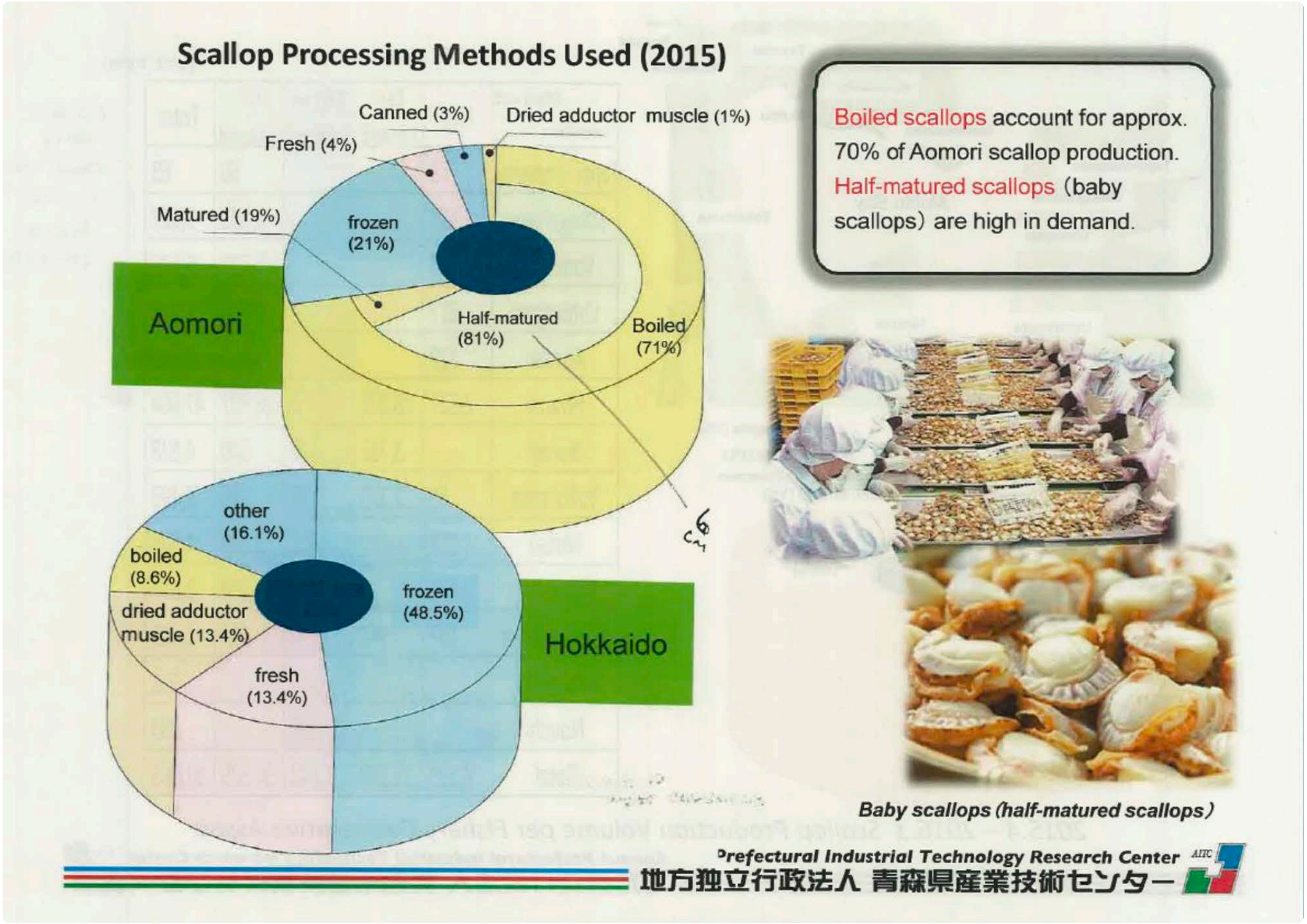
- boiled,
- deep fried,
- raw,
- dried,
- roe on,
- mantle on,
- foil packed,
- scallop flavored ice cream,
- potato chips,
- individual “poppers”, BBQ, etc.

In Japan, there is a seemingly endless opportunity for markets and products for which scallops are used. Small, half-mature, large, jumbo etc are all sizes utilized for consumption.

Movie 5.1 A small batch of large ear-hung scallops with the exterior of the shell being cleaned by hand in preparation for market.

Video Credit: Hugh Cowperthwaite

Gallery 5.1 Scallop Products in Japan



Chapter 6

Aquaculture & Spat Collection Licenses

Anne Langston Noll

This chapter was prepared using information available on the Maine Department of Marine Resource website, and in consultation with Maine Dept. of Marine Resources Staff.

Aquaculture License

Aquaculture License

This is DIFFERENT from an LPA license.

In 2017, a law was passed creating the new Aquaculture license. The new licensing requirements took effect from May 1, 2018.

The Aquaculture license is be required to sell cultured organisms removed from a lease or license site. Prior to this change in law, the only aquaculturists who were required to obtain a license were those growing certain shellfish (e.g. oysters, mussels and clams). Those individuals have historically obtained either the commercial shellfish license, or a mussel harvesting license, depending on what they were growing.

Now, these aquaculturists need to buy an Aquaculture license INSTEAD of a commercial shellfish or mussel license. However, please note that if you are an aquaculturist who also engages in the wild harvest and sale of any marine organism you will also need to purchase the appropriate commercial harvesting license to cover those activities. The Aquaculture license only pertains to organisms that you have cultured on your lease or license site.

Other aquaculturists who are growing and selling species which were previously exempted from having to hold a license (e.g. salmon, seaweed, scallops, etc.) **now need to purchase an Aquaculture license.**

Aquaculturists growing product for personal use only (no sale) are not required to purchase an Aquaculture license.

The fee for the Aquaculture license is $133, of which $74.75 is deposited in the Aquaculture Management Fund.

The licensing year for the Aquaculture license is the same as that for the commercial shellfish license (May 1-April 30) in order to ease this transition. License applications are be available no later than April 17 on the DMR website.

Please follow this link for the law creating the Aquaculture license.http://legislature.maine.gov/legis/statutes/12/title12sec6810-B.html

If you have any questions regarding the Aquaculture license, contact Jon Lewis, Aquaculture Division Director at 633-9594, or send an email to Jon.Lewis@maine.gov.

Aquaculture Licenses can be applied for either:

- by using a paper based form: the paper based form is available at https://www.maine.gov/dmr/commercial-fishing/licenses/documents/2019/2019%20Clam-Worm-Green%20Crab-Aquaculture%20License.docx.pdf

If accessing through the DMR's commercial licensing webpage, you will need the form entitled *Clam, Worm, Green Crab, Aquaculture License Applications*

- through the DMR's online licensing system, LEEDS

See Chapter 6, Section 3 for more information on the LEEDS system.

License May 1, 2019 to April 30, 2020

Shellfish/Marine Worm/Green Crab/Aquaculture

Commercial Harvesting Application

Instructions: This form may be used for new or renewal licenses. Please provide all information requested. Incomplete applications will be returned for correction.

Part A: Applicant Information

Last Name: _____ First Name_____
Social Security #_____ Sex_____ DOB_____
Eye Color_____ Hair Color_____ Height_____
Weight_____ Driver's License_____
If no driver's license - reason_____
If UNDER 18 –parent/guardian license #_____
Mailing Address: _____
City: _____ State: _____ Zip Code: _____
Physical Address: _____
(IF DIFFERENT THAN MAILING)
Email_____
Landline# _____Mobile#_____
Must list at least one phone number
Fax#_____

Part B: Fishery Information

Check all licenses requested and indicate whether it is a renewal or new license. ***License fees are non-refundable.***

	Renew	New	Fees
Commercial Shellfish [A]	☐	☐	$133
Comm. Shellfish under age 18 [A]	☐	☐	$ 67
Comm. Shellfish over age 70 [A]	☐	☐	$ 67

Shellfish license covers: Shellstock clams, quahogs other than mahogany quahogs & oyster shellstock ONLY.

Marine Worm Diggers	☐	☐	$ 50
Green Crab	Resident ☐ $10	Nonresident ☐ $20	
Aquaculture License [B]		☐	$133

Red Tide Hotline 1-800-232-4733

(A) Shellfish Harvester – According to DMR regulation, Chapter 9.06, each shellfish harvester licensed by the Department must, prior to landing, securely affix a tag to each container harvested. For details please check regulations under Chapter 9 at *www.maine.gov/sos/cec/rules/13/chaps13.htm*.
A town license may also be required. For more information check out the link for municipal licenses at *www.maine.gov/dmr/crd/smd/municipal_licensing.htm*.
(B) Aquaculture License -Will be required to sell cultured organisms removed from a lease or license site. Aquaculturists will need to buy this license instead of a shellfish or mussel license.
Note: Aquaculturists who also engage in wild harvest and sale of any marine organism will also need to purchase the appropriate commercial harvesting license to cover those activities. This license only pertains to organisms that you have cultured on your lease or license site. Salmon, Seaweed, Scallops, etc., who are growing and selling these species will now need this license.

Part C: Supplemental Information

Fill out all information completely. False statements or misrepresentations will result in the revocation of the license and prosecution in Court.

Vessels:
Will a boat be used with this license? Yes☐ No☐
Boat Reg #/ Doc #_____Boat Name _____
Length _____Town of Primary Anchorage _____

Did you fish recreationally in tidal waters of the State of Maine last year?
No ☐ Yes ☐ (answering yes will register you for recreational saltwater fishing for 2019)

Note: Shellfish harvest areas may be closed due to pollution or marine biotoxins. It is important to always check the status of growing areas before you harvest to protect public health. All current pollution and biotoxin closures may be found on the DMR website: http://www.maine.gov/dmr/shellfish-sanitation-management/index.html. DO NOT harvest shellfish from closed areas including Prohibited, Restricted, Conditionally Restricted, Conditionally Approved in the closed status, or from any emergency biotoxin or flood closures.

Part D: Certification

I hereby declare, under the penalty of perjury under the laws of the State of Maine and the United States of America that the foregoing information is true and correct and, if applying for a resident license, that I have read and understood the residency requirements listed on the back of this form and meet those requirements. I have also read and understood the Consent to Inspection responsibilities described on the back of this form.

Today's Date _____/_____/_____
Month Day Year
Applicant_____
(Signature of applicant)
Parent or Guardian_____
(Applicants under 18 must have a parent or legal guardian who also meets the residency requirements sign this form.)

Under Title 12, §6306, (1)(2) and (3), a person licensed by the Department of Marine Resources has a duty to submit to inspection, search and seizure by a Marine Patrol Officer. Failure to comply with this duty may result in a license suspension.

Section 2

Spat Collection License

A scallop spat collection license has been available since 2019.

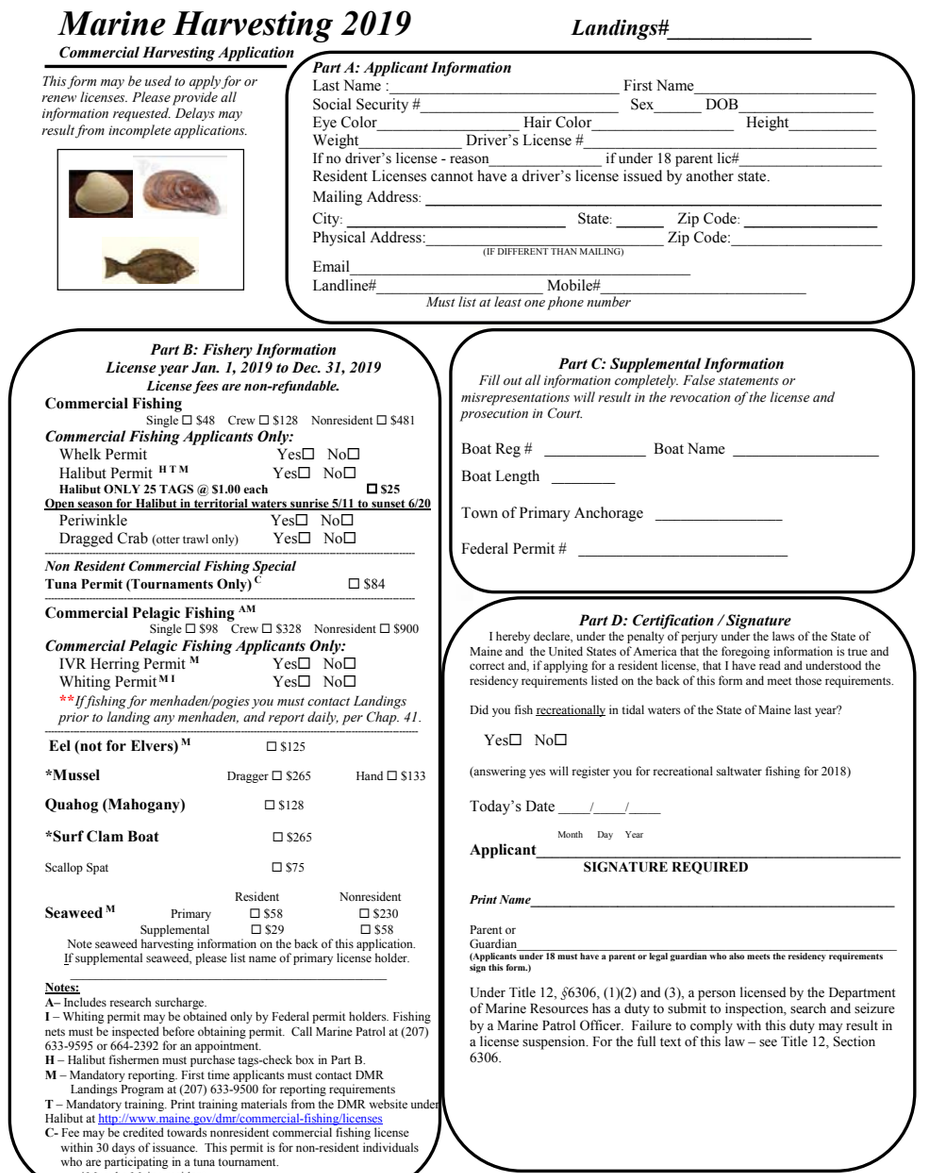
Spat Collection Licenses can be applied for either:

- by using a paper based form: the paper based form is available at https://www.maine.gov/dmr/commercial-fishing/licenses/documents/2019/2019%20Marine%20Harvesting%20License%20Application.pdf

If accessing through the DMR's commercial licensing webpage, you will need the form entitled *Marine Harvesting License*

- through the DMR's online licensing system, LEEDS

See Chapter 6, Section 3 for more information on the LEEDS system.



Marine Harvesting 2019 ***Landings#_____***

Commercial Harvesting Application

This form may be used to apply for or renew licenses. Please provide all information requested. Delays may result from incomplete applications.

Part A: Applicant Information
Last Name :_____ First Name_____
Social Security #_____ Sex_____ DOB_____
Eye Color_____ Hair Color_____ Height_____
Weight_____ Driver's License #_____
If no driver's license - reason_____ if under 18 parent lic#_____
Resident Licenses cannot have a driver's license issued by another state.
Mailing Address: _____
City: _____ State: _____ Zip Code: _____
Physical Address:_____ Zip Code:_____
(IF DIFFERENT THAN MAILING)
Email_____
Landline#_____ Mobile#_____
Must list at least one phone number

Part B: Fishery Information
License year Jan. 1, 2019 to Dec. 31, 2019
License fees are non-refundable.

Commercial Fishing
Single ☐ $48 Crew ☐ $128 Nonresident ☐ $481

Commercial Fishing Applicants Only:
Whelk Permit Yes☐ No☐
Halibut Permit H T M Yes☐ No☐
Halibut ONLY 25 TAGS @ $1.00 each ☐ $25
Open season for Halibut in territorial waters sunrise 5/11 to sunset 6/20
Periwinkle Yes☐ No☐
Dragged Crab (otter trawl only) Yes☐ No☐

Non Resident Commercial Fishing Special
Tuna Permit (Tournaments Only) C ☐ $84

Commercial Pelagic Fishing AM
Single ☐ $98 Crew ☐ $328 Nonresident ☐ $900
Commercial Pelagic Fishing Applicants Only:
IVR Herring Permit M Yes☐ No☐
Whiting Permit M I Yes☐ No☐
** *If fishing for menhaden/pogies you must contact Landings prior to landing any menhaden, and report daily, per Chap. 41.*

Eel (not for Elvers) M ☐ $125

***Mussel** Dragger ☐ $265 Hand ☐ $133

Quahog (Mahogany) ☐ $128

***Surf Clam Boat** ☐ $265

Scallop Spat ☐ $75

Seaweed M	Resident	Nonresident
Primary	☐ $58	☐ $230
Supplemental	☐ $29	☐ $58

Note seaweed harvesting information on the back of this application.
If supplemental seaweed, please list name of primary license holder.
_____

Notes:
A– Includes research surcharge.
I – Whiting permit may be obtained only by Federal permit holders. Fishing nets must be inspected before obtaining permit. Call Marine Patrol at (207) 633-9595 or 664-2392 for an appointment.
H – Halibut fishermen must purchase tags-check box in Part B.
M – Mandatory reporting. First time applicants must contact DMR Landings Program at (207) 633-9500 for reporting requirements
T – Mandatory training. Print training materials from the DMR website under Halibut at http://www.maine.gov/dmr/commercial-fishing/licenses
C- Fee may be credited towards nonresident commercial fishing license within 30 days of issuance. This permit is for non-resident individuals who are participating in a tuna tournament.
*Must be Maine resident.

Part C: Supplemental Information
Fill out all information completely. False statements or misrepresentations will result in the revocation of the license and prosecution in Court.

Boat Reg # _____ Boat Name _____
Boat Length _____
Town of Primary Anchorage _____
Federal Permit # _____

Part D: Certification / Signature
I hereby declare, under the penalty of perjury under the laws of the State of Maine and the United States of America that the foregoing information is true and correct and, if applying for a resident license, that I have read and understood the residency requirements listed on the back of this form and meet those requirements.

Did you fish recreationally in tidal waters of the State of Maine last year?

Yes☐ No☐

(answering yes will register you for recreational saltwater fishing for 2018)

Today's Date ____/____/____
Month Day Year

Applicant_____
SIGNATURE REQUIRED

Print Name_____

Parent or Guardian_____
(Applicants under 18 must have a parent or legal guardian who also meets the residency requirements sign this form.)

Under Title 12, §6306, (1)(2) and (3), a person licensed by the Department of Marine Resources has a duty to submit to inspection, search and seizure by a Marine Patrol Officer. Failure to comply with this duty may result in a license suspension. For the full text of this law – see Title 12, Section 6306.

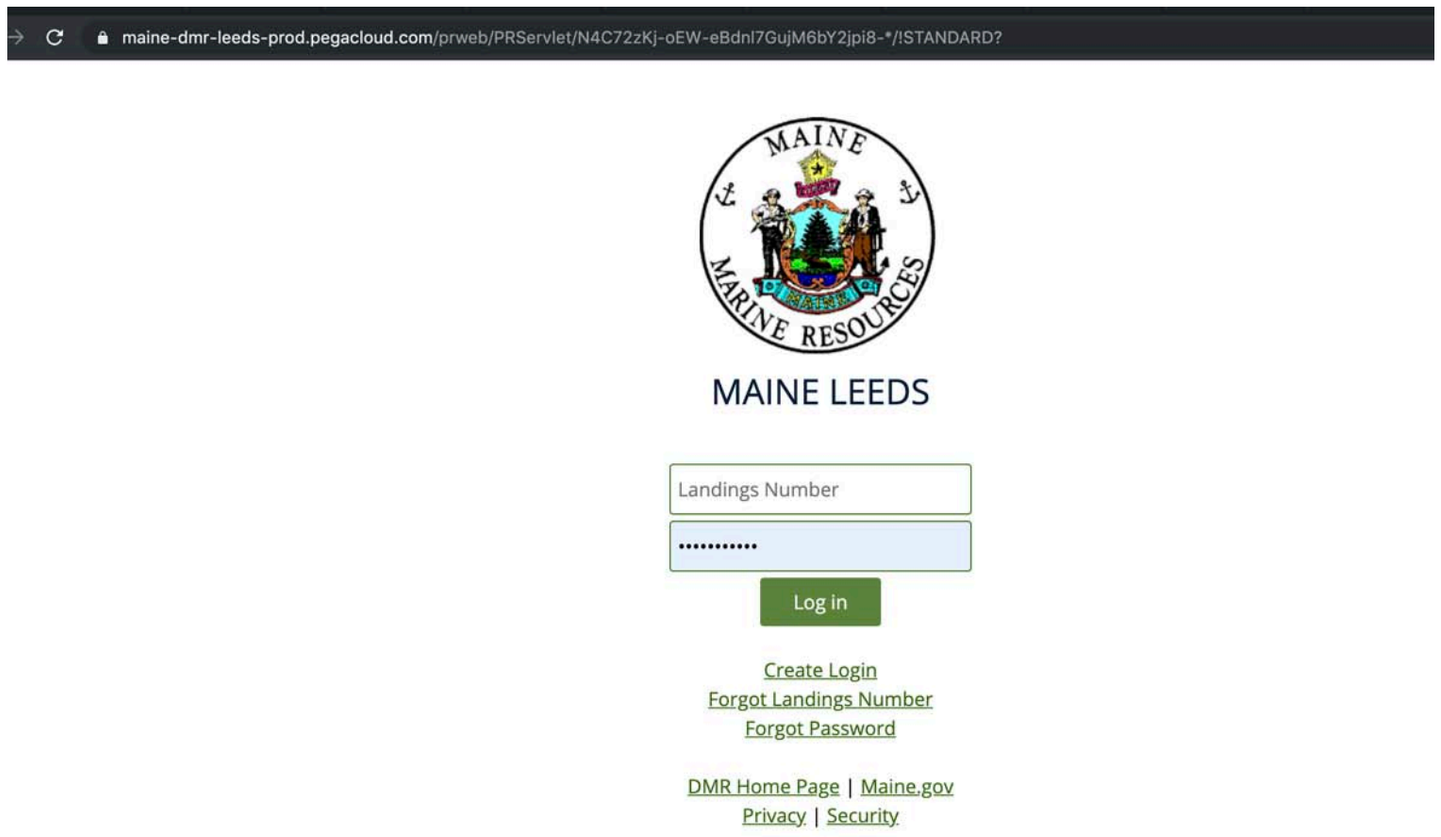
Section 3

Maine LEEDS

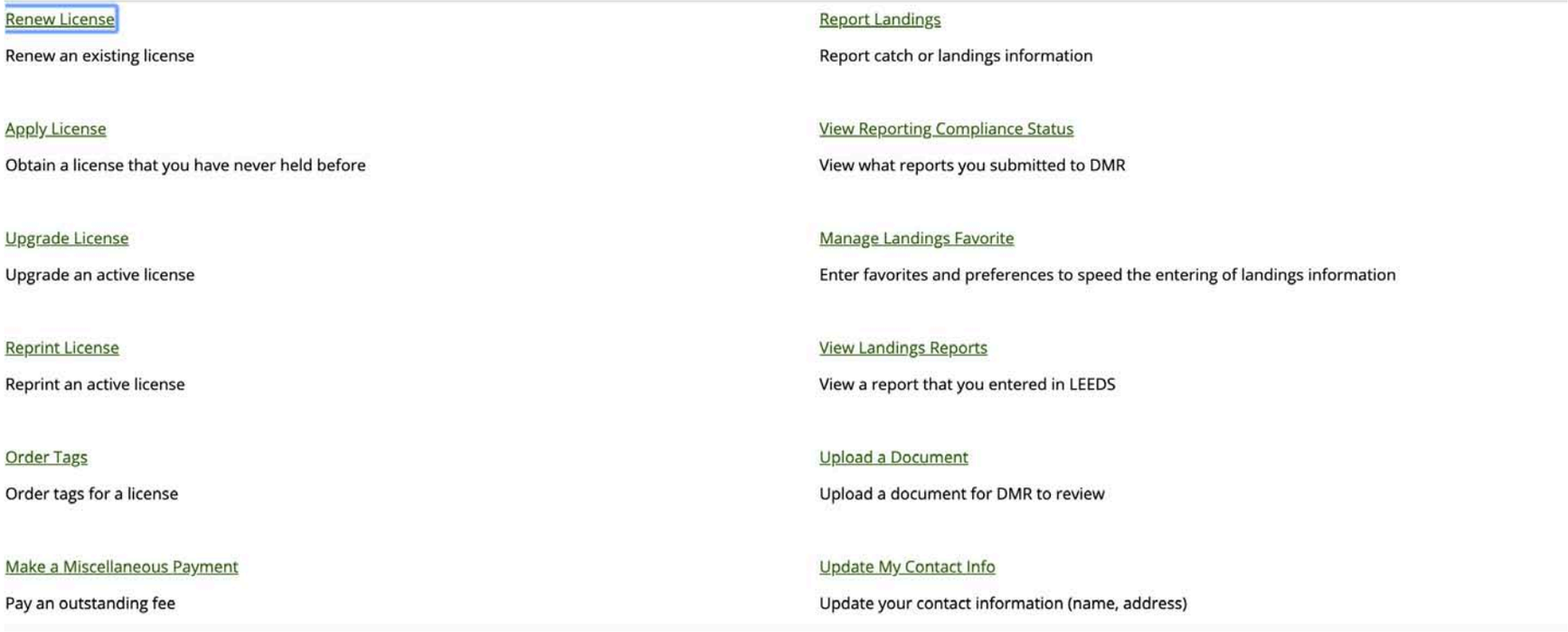
The Maine Department of Marine Resources' (DMR) has an online licensing and landings system, called LEEDS (Licensing Enforcement and Environmental Data System).

In order to apply for a new license or renew a license with the system, you first need to create a login for LEEDS.

Instructions on how to create a LEEDS login can be found at https://www.maine.gov/dmr/commercial-fishing/licenses/index.html



Once you are registered for Maine LEEDS and have logged in choose “Renew License” or “Apply License”.



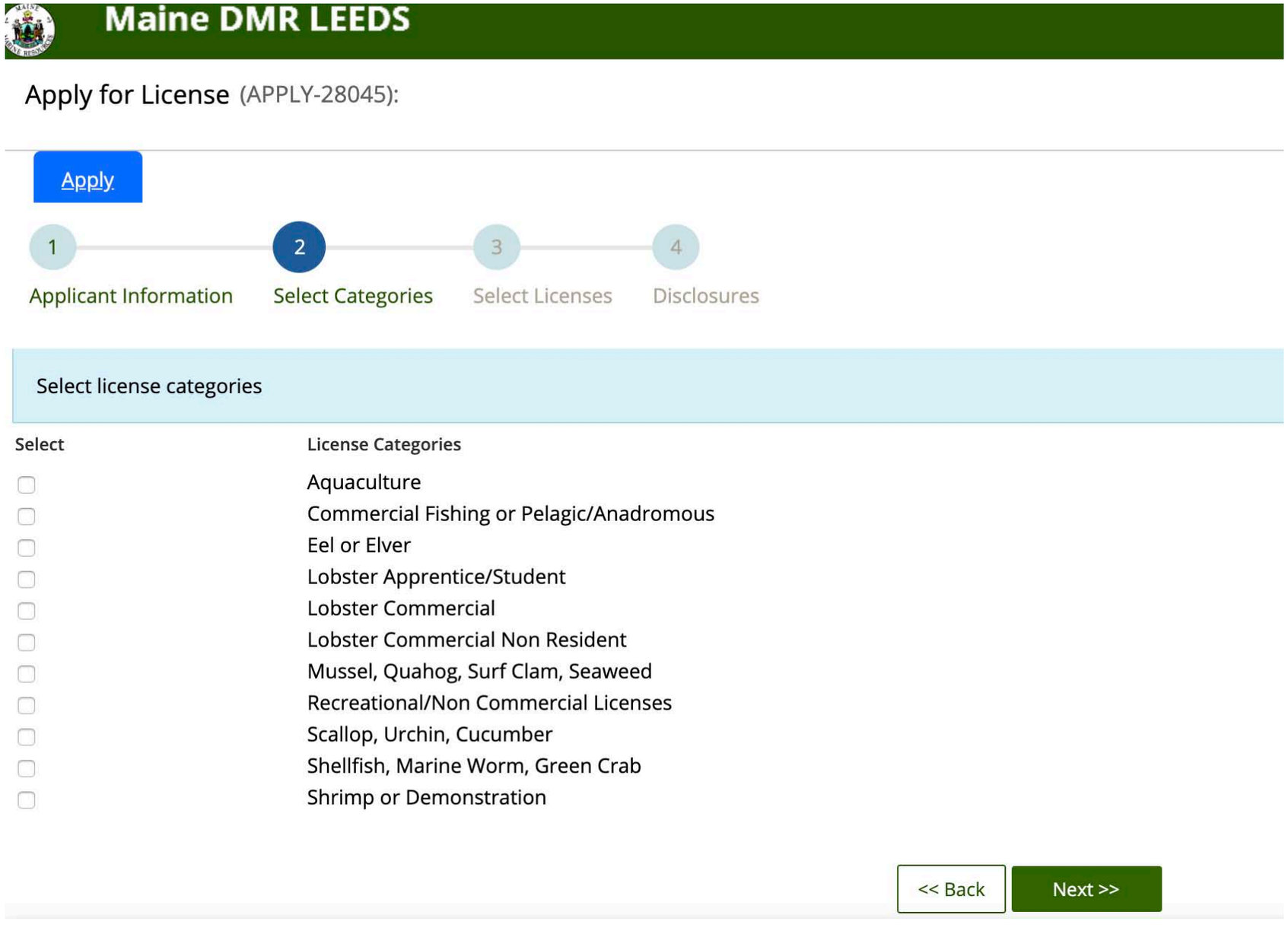
The application process has 4 steps:

STEP 1: Applicant Information

In this section you will enter personal details, contact details, and make a residency declaration.

STEP 2: Select Categories

Select “Aquaculture”.



STEP 3: Select Licenses

You will then be asked to select license type.

- For the AQUACULTURE LICENSE select *Aquaculture (AL).*
- For the SCALLOP SPAT COLLECTION LICENSE select *Spat (SPT)*

License Category	License Name	License Type
Aquaculture	Aquaculture (AL)	AL
Aquaculture	Spat (SPT)	SPT

STEP 4: Disclosures

This requires acknowledgement of a series of statements, and disclosures.

Finally:

- Once this application process is complete you will be taken to a payment page.
- Licenses can be downloaded and/or printed.

MAINE MARINE LICENSE – 2019

Maine Department of Marine Resources License - 2019

LANDINGS #****** Type: Spat (SPT) #*****

Issue Date: Jul 10, 2019 Expiration Date: Dec 31, 2019

NAME	DOB: */*/19**	Sex: Female
ADDRESS	Hair: GREY	Eyes: BLUE
	Weight: 135	Height: 60

----There is no Vessel assigned to this License Type. ----

License must be in possession when engaged in activities covered by this license. By knowing and cooperating with your local Marine Patrol Officer, you can help us protect your industry. Failure to submit to an inspection, or a conviction or adjudication of a violation of a licensed activity may result in loss of license.
Making any false statements on the application of this license is punishable under Title 17-A, MRS, Section 453.

MAINE DEPARTMENT OF MARINE RESOURCES
21 State House Station
Augusta, ME 04333
Phone: 207-624-6550
www.maine.gov/dmr

Maine Operation Game Thief: Anonymous Reporting Hotline
1-800-ALERT-US (1-800-253-7887)
"Protecting all of Maine's natural resources"

Chapter 7

Insurance

Hugh Cowperthwaite, Coastal Enterprises Inc

Dana Morse, Maine Sea Grant

Chris Davis, Maine Aquaculture Innovation Center

Section 1

Crop Damage Insurance

Farm Service Agency reports that farm-raised scallops (on lines) are now eligible for coverage under the Non-Insured Crop Disaster Assistance Program (NAP).

Caged/lantern net scallops are covered, since they are in a 'controlled environment' which is a requirement of the NAP.

Chapter 8

Assessment

Anne Langston Noll

Please go to this link and complete the assessment:

https://www.surveymonkey.com/r/AQSWscallops

Amnesic shellfish poisoning (ASP)

ASP is caused by the diatom Pseudo-nitzschia that can produce the toxin, domoic acid.

Related Glossary Terms

Drag related terms here

Index Find Term

Aquaculture

The rearing of aquatic animals or the cultivation of aquatic plants.

Related Glossary Terms

Drag related terms here

Index Find Term

Aquaculture in Shared Waters

The Aquaculture in Shared Waters program prepares fishermen, and other working waterfront users, to start an aquaculture venture. The project builds on some very successful and innovative earlier programming by the Maine Aquaculture Association and the Maine Aquaculture Training Institute.

Program partners include the Maine Aquaculture Association, Maine Aquaculture Innovation Center, Coastal Enterprises, Inc, Maine Sea Grant and University of Maine Cooperative Extension.

Related Glossary Terms

Drag related terms here

Index Find Term

Aquaculture License

All holders of aquaculture leases and LPA licenses are required to hold the Aquaculture License in order to harvest and sell **ANY** product from their aquaculture sites, regardless of the species they grow: this includes sea vegetables and finfish.

Related Glossary Terms

Drag related terms here

Index Find Term

Biosecurity

Processes and procedures intended to protect humans or animals against disease or harmful biological agents.

Related Glossary Terms

Drag related terms here

Index Find Term

Bivalve

An aquatic mollusc (invertebrate) with 2 hinged shells, such as oysters, clams, mussels, and scallops.

Related Glossary Terms

Drag related terms here

Index Find Term

Diarrhetic shellfish poisoning (DSP)

DSP is caused by the dinoflagellate Dinophysis that can produce the toxins okadaic acid and dinophysistoxins.

Related Glossary Terms

Drag related terms here

Index Find Term

Diploid

Two sets of chromosomes.

Related Glossary Terms

Triploid

Index Find Term

Downweller

A container that holds small oysters in a way that feed-rich water can be made to flow past the crop.

Water can be made to flow upward past this bed of oysters (an upweller), or it can be made to flow downward past them (a downweller).

Related Glossary Terms

Upweller

Index Find Term

Grading

Sorting oysters by size. Grading results in similarly-sized oysters being placed together, where their feeding rates will be similar.

Related Glossary Terms

Drag related terms here

Index Find Term

National Shellfish Sanitation Program (NSSP)

The National Shellfish Sanitation Program (NSSP) is a program recognized by the U. S. Food and Drug Administration (FDA) and the Interstate Shellfish Sanitation Conference (ISSC) for the sanitary control of shellfish produced and sold for human consumption.

NSSP is a cooperation between federal (FDA, EPA, NOAA) and state agencies. It aims to promote and improve the sanitation of shellfish (oysters, clams, mussels and scallops) through cooperation and uniformity of State shellfish programs.

Related Glossary Terms

Drag related terms here

Index Find Term

Paralytic Shellfish Poisoning (PSP)

PSP is caused by the dinoflagellate *Alexandrium* that can produce the toxin, saxitoxin.

Related Glossary Terms

Drag related terms here

Index Find Term

Polyspermy

More than one sperm fertilizes one egg.

Related Glossary Terms

Drag related terms here

Index Find Term

Shellfish Growing Classification Area

Each commercially harvested growing area is assigned a "classification" according to the results of its evaluation.

Related Glossary Terms

Drag related terms here

Index Find Term

Triploid

Three sets of chromosomes.

Related Glossary Terms

Diploid

Index Find Term

Upweller

A container that holds small oysters in a way that feed-rich water can be made to flow past the crop.

Water can be made to flow upward past this bed of oysters (an upweller), or it can be made to flow downward past them (a downweller).

Related Glossary Terms

Downweller

Index Find Term

Vibrio

Vibrios are naturally occurring bacteria typically found in marine waters.

Related Glossary Terms

Drag related terms here

Index Find Term