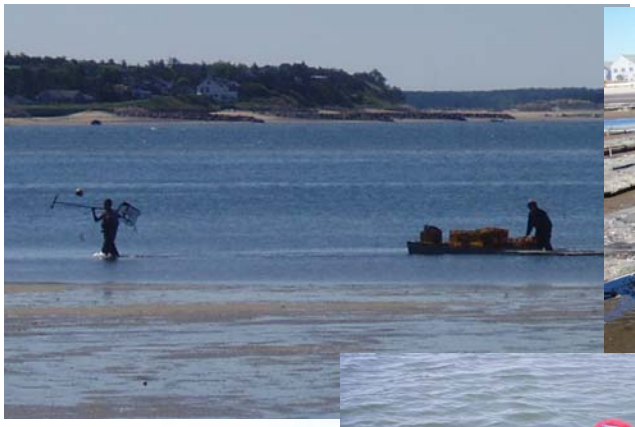
Best Management Practices for the East Coast Shellfish Aquaculture Industry









United States Department of Agriculture

National Institute of Food and Agriculture

Northeastern Regional Aquaculture Center

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Introduction to Codes and Best Management Practices

Introduction

Shellfish aquaculture is a $100 million industry on the East Coast of the United States. Oysters, clams, mussels and scallops are raised on nearly 1,000 farms. Most farms are small enterprises with fewer than ten employees. As of 2010, only about ten farms were larger than this. There are shellfish farms in all of the fourteen East Coast states except Delaware.

The industry is quite diverse because the techniques for growing the various species are different, and because the wide range of climates from Maine to Florida produce very different biological conditions. However, there is also remarkable similarity among East Coast farms that all deal with a multitude of common challenges.

The diversity of the industry and the ability of even small farms to successfully market their products result in substantial competition. This diversity and competition stimulates a lot of industry innovation, but because most farming operations are out in the open and easily observed, good ideas are rapidly copied and become the new industry standard.

Unlike land-based farming where the land is owned, shellfish aquaculture is primarily practiced in public trust areas leased from the state or local government. There are rare exceptions where the grounds are owned, but the vast majority of farmers operate under a lease system. Because shellfish farmers are using public areas for a private business purpose they are under more scrutiny than other users of the public coastal zone.

The regulations that apply to leasing and to some aspects of shellfish production vary widely. Most regulatory oversight comes from the individual

states, but in some states additional leasing authority is given to local jurisdictions as well. There is also an overlay of federal regulation for shellfish farms administered by the U.S. Army Corps of Engineers. The Army Corps authority rests primarily in a number of Corps districts; there are eight Corps districts for the East Coast and they act quite independently, so the Army Corps permits required for shellfish farming may be different from district to district. The Army Corps permits are also reviewed by the U.S. Fish and Wildlife Service and by the National Marine Fisheries Service, and these services can impose additional requirements on a shellfish farmer through the Army Corps permit process and leases with threatened or endangered species, essential fish habitat and migratory birds may have special restrictions based on federal laws pertaining to these conditions.

The regulatory framework that deals with the human health aspects of farmed shellfish is established by an industry-state-federal partnership body, the Interstate Shellfish Sanitation Conference (ISSC) that administers the National Shellfish Sanitation Program (NSSP). This system establishes regulation at a national level for shellfish in interstate commerce, but individual states can establish rules that accomplish the national goals in different ways, resulting in different requirements for the shellfish farmer.

The diversity in both the farm operation and the regulatory framework means that it is impossible to have a uniform, comprehensive set of operational guidelines for the entire East Coast industry that farmers could follow to ensure that they are operating in an environmentally sound, socially acceptable and cost-effective manner. One approach to this dilemma is the development of farm-level Better Management Practices (BMPs) that define specific farm management and operational practices that address environmental concerns and stress a good-citizen, good-neighbor business strategy while still preserving the ability of the farmer to innovate and devise outcome-oriented approaches to achieve management goals.

The shellfish industry is also aware of a growing trend by seafood buyers, distributors and retailers to establish policies to source only products that meet certain environmental standards or have environmental certification. As a result of these developments in the seafood industry, creating a Code of Practice and set of Best Management Practices became a priority for USDA’s National Institute of Food and Agriculture’s (NIFA) Northeast

Regional Aquaculture Center (NRAC) and the National Oceanographic and Atmospheric Administration (NOAA) Office of Aquaculture. With funding from both agencies, this project enabled the development of this BMP manual under the auspices of the East Coast Shellfish Growers Association (ECSGA).

Shellfish aquaculture is among the most environmentally positive uses of the coastal zone. In most states, unproductive acreage is leased for farming and there must be a demonstration of minimal adverse impact to public fisheries and other public resources. Typically, the farmer takes an area devoid of shellfish, purchases and plants juvenile shellfish seed on the leased area, and harvests the crop once market size is reached. The shellfish filter the water as they feed on phytoplankton, removing nitrogen and other often problematic nutrients, as they grow. Further, the in-the-water gear provides habitat for a myriad of organisms that would not otherwise utilize the area. The “ecosystem services” provided by shellfish play a critical role in the health of our coastal water bodies. In the estuaries most impacted, such as the Chesapeake Bay, the environmental community has placed emphasis on increasing shellfish populations, including encouraging private aquaculture.

Shellfish aquaculture done right will make a positive contribution to the environment, and to the local community. Adapting a Costa-Pierce (2003) framework for “ecological aquaculture” we find that shellfish aquaculture:

- Preserves the form and function of natural ecosystems,
- Is one of the world’s most efficient protein producers,
- Improves water quality by removing nutrients and does not use chemicals or antibiotics that could be harmful to human or ecosystem health,
- Uses native species and strains and does not contribute to “biological” pollution,

- Can be integrated with communities to maximize job creation and add to local economies and is a good community citizen.

In addition, shellfish for human consumption must come from clean water that meets very high public health criteria. Anything that degrades the water quality, whether actions by the farmer or external to the farmer, will have the same result – loss of crop, loss of livelihood and loss of cash flow to the local economy. In order to protect his or her business, the typical shellfish farmer is a watchdog against pollution and a passionate advocate for clean water.

These positive aspects of growing shellfish are intuitively understood by the shellfish farmer, but he (or she) often needs to convince regulators and the public that continuing or expanding this business is a net-positive for the environment and for the community. A more formal way for the shellfish farmer to make the case for his business is to be able to demonstrate, in a tangible way, how his farm management and operations address environmental and social concerns and contribute to the community. BMPs can help achieve this goal.

In other terms, stakeholder-driven Codes of Conduct and BMPs can lead to greater industry environmental accountability, reduce multi-user conflicts, improve production efficiency, instill consumer confidence in products, and result in a higher degree of self-regulation which can yield economic benefits to the industry and a better product. They can also be the basis for independent third-party certification which is becoming increasingly important in the marketplace and already required by some retailers.

The BMP Landscape

The need to have a BMP system in place for the East Coast shellfish aquaculture industry has never been clearer or more urgent. In workshops to define important industry issues, shellfish aquaculture companies have consistently placed the highest priority on BMP development and their role in improving public perception of the industry's environmental stewardship. Recently, the Army Corps of Engineers indicated that they are revising their permitting authority under both the Rivers and Harbors Act and the Clean Water Act, and that Regional General Permits for the industry may be

issued based on having a BMP system in place. And nearly every day, new policies are announced by seafood retailers to source only products that meet environmental standards or have environmental certification.

Codes and BMPs have already been developed for the West Coast shellfish industry and by several states, individually. Codes and BMPs have not been similarly developed for the East Coast shellfish industry. The framework of the East Coast Shellfish Growers Association (ECSGA) with NRAC and NOAA funding offers the opportunity to do so now.

Shellfish aquaculture BMP manuals have been written and are in use in several states. The Pacific Coast Shellfish Growers Association produced a Code of Conduct and BMP manual that was entirely industry driven. Maine has a shellfish and finfish aquaculture industry and wrote a document to cover both sectors that also includes a Code of Conduct and more specific BMPs. Massachusetts took a slightly different approach inviting other stakeholders to the table to develop BMPs, but did not include a separate Code of Conduct. Florida has a document that is regulatory, using a “top down” approach. Most recently, Virginia produced a document that is basically a list of BMPs, and Maryland produced a manual that was mandated by the state legislature and developed with industry input. It is presently a voluntary system, potentially moving toward regulation. Both of the last two combine certain elements of those documents already in existence. The remaining East Coast states have nothing in place with respect to BMPs. They all have permitting and regulatory procedures, but no industry guidelines.

What is missing from all the BMP systems is how a farm-specific BMP can be created that accurately and succinctly demonstrates that the farmer is operating his farm in a responsible manner. An individual farm environmental management plan can be used as part of a business plan for financing, or part of a marketing plan to increase visibility and potential market share.

The ECSGA Code/BMP Project

This project relied on extensive communication with people involved with shellfish aquaculture including growers, regulators, academia, non-

government agencies (NGOs) and other stakeholders. We believed that such a document must have a strong industry backing, but that the diversity of coastal zone users must also be invited to participate.

We held twenty workshops in eleven states with a total participation of 370 people. The discussions were broken down into four main topic areas:

- Gear/Operation and maintenance
- User conflicts
- Permitting/Siting
- Environmental concerns

After an initial orientation presentation, participants were divided into small groups to thoroughly discuss each of the main topics. This information was recorded for assimilation and comparison.

The workshops were well attended both by number of participants and by the breadth of representation of the various stakeholder user groups. The result is a document that, as much as possible, represents the current methods, acknowledgment of issues and a sincere desire to mitigate problems and accentuate the many positive aspects of shellfish aquaculture.

How to Use This BMP Manual

This manual was created to provide the information and a framework that will enable a shellfish farmer to write a comprehensive Best Management Practices document for his or her farm. The entire manual can be found on the ECSGA website (http://www.ecsga.org/.) The Code of Practice and specific BMPs are on that website in a form that can be downloaded to a home computer and then used and modified by a shellfish farmer to produce an individualized farm BMP document.

The manual, after a general description of shellfish culture methods, includes three major sections:

1. A Code of Conduct,
2. The BMP section with a discussion of issues and suggested BMP statements for specific farm operations,
3. A shellfish farm template with suggestions for farm-level BMP elements and a sample farm management plan that demonstrates how this template can be used to put together a farm-specific BMP.

The Code of Conduct for Molluscan Shellfish Culture in the Eastern United States is a generic, statement of the overall strategy that a farm agrees to use in dealing with operational and environmental issues. We believe that this should be incorporated into all farm-specific BMP documents.

Each BMP section has a discussion of an issue important for shellfish farmers to address and offers with suggested BMP statements that an individual farm may wish to adopt as is or modify for incorporation into their farm BMP. This is the nuts and bolts part of the manual. Not all issues and not all suggested BMP statements will apply to all farms and there may be some missing as well, that are important to certain individual operations.

The shellfish farm template is designed to make it easy for a farm to produce a complete BMP document. The template contains all of the issues from the discussion section in the same order. Under each issue are suggested BMP statements that can be incorporated as written into a farm-specific BMP, or they can be modified or new ones added. This template can be found on the ECSGA website (http://www.ecsga.org) in Excel format. To produce a farm-specific BMP you choose each element you want to have in your BMP, modify those necessary to better describe your operation, and then print the document.

The model farm BMP was created using this template. We put some farm information into the sections at the top of the template, accepted the Code of Conduct as written, checked off the elements we wanted in our document and then produced the BMP shown.

A farm-specific BMP should be looked at as a “living document”. That is, it should be modified whenever a significant change in management or operations is made in order to address a particular problem or regulation, or to improve farm efficiency.

Description of Shellfish Culture Methods

This section describes some of the methods used typically to grow shellfish in coastal areas of the eastern United States. It will probably be most useful to people just starting off in shellfish aquaculture, and to those who just want to learn more about it. But it should be worth a read for those already engaged in the shellfish aquaculture industry, since it is based on a lot of information from growers from Maine to Florida who have learned to tackle problems with a variety of methods.

In this section and in the manual itself, we have concentrated on clam and oyster culture. These are far and away the most common species in culture on the East Coast. However, although no scallop or mussel culturists attended the workshops, it should be noted that the culture of these species on the East Coast is beginning to expand and that the principles and BMPs contained in this document are directly applicable or can be readily adapted to mussel and scallop culture.

Shellfish aquaculture is essentially a farming process that starts with small seed and attempts to grow them to a much larger, marketable size. This form of husbandry includes ensuring a good flow of phytoplankton rich estuarine water (food) through the various layers of fouling organisms that attach themselves to the gear holding the shellfish and simultaneously battling against a wide array of predators competing with the grower for the crop!

These formidable challenges have shaped the way shellfish are currently grown on the East Coast. Some of these methods are briefly described below.

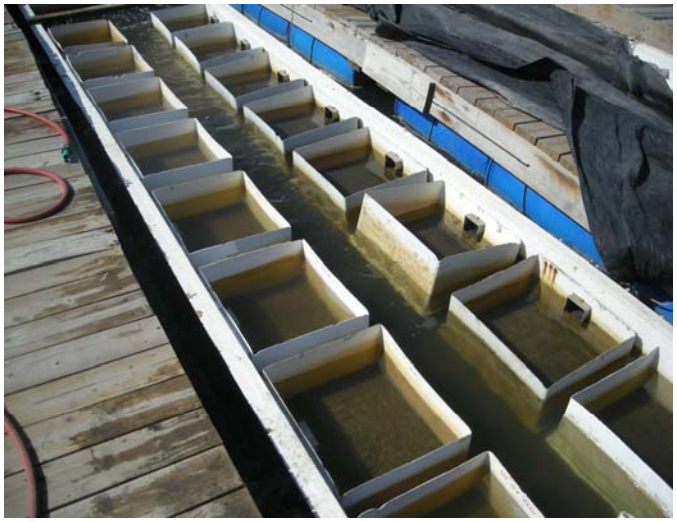
Nursery Culture

Clam and oyster farms generally buy seed from hatcheries to begin the cultivation process. It is more economical to buy small seed as it is less expensive for the hatchery to produce and is more easily and cheaply transported. Buying small seed also introduces the cultured shellfish into an environment near the grow-out site sooner and minimizes the possibility of

introducing disease or other organisms that might occur in the vicinity of the hatchery but not at the grow-out site. Shellfish farmers use both land-based and in-water nurseries to grow hatchery-produced seed to a size suitable for planting. It should be noted that the nursery phase can be challenging and losses of small seed are common, so many growers prefer to start with larger seed especially those just starting out in shellfish aquaculture.

Land-based nurseries consist primarily of upwellers and raceways. Both systems require power to run pumps for these flow-through systems. Similar to floating upweller systems described in the next section, land-based upweller systems are generally constructed with a series of round containers called silos, with netting firmly attached to the bottom, set inside long, rectangular tanks. The silos are held slightly off the bottom to allow for good water flow. A hole large enough for a pipe is drilled near the top of the silo, and another hole is drilled at the same level through a center trough or the tank's side to establish the water level in the silo. The outflow water goes into a trough leading to a drain or through the side of the tank. Thus the water enters the tank, flows through the silo, coming up from the bottom and exits at the top of the silo creating the upwelling current. Plankton, naturally occurring in the water, feeds the seed constantly with the water flow. Some farmers add cultured algae to the system in recirculation mode as supplemental food or as a source of food when the natural plankton is not optimal in species composition or concentration.

Raceways differ from upwellers in that there is one tank with an inflow pipe at one end and a drain on the other end creating a sheet flow of water. With raceways, seed is often moved from one position to another within the tank so that the shellfish nearest the inflow does not always rob the food from the stock at the other end of the tank.



There are a couple of main styles of Floating Upweller Systems (FLUPSYs) and each has its advantages. One design incorporates the nursery system into a floating dock on which people can walk when shellfish husbandry isn't occurring. The deck of the dock opens up and the silos and sluice box of the FLUPSY are hung below the opening and below the surface of the water. The other design is a box (approximately 20' x 6' x 2') that has water pumped into it, the box sinks to a depth determined by floatation, and the water flows up through seed-filled silos and exits the sides of the box. These boxes can sit in a boat slip and take up no more room than a skiff.

Although the FLUPSYs used extensively in the East Coast shellfish industry allow farmers to save money by purchasing very small clam or oyster seed (3-4mm) and raising it to a field planting size, the initial cost of building a floating upweller system is significant. A less expensive process would be the use of Taylor Floats to raise small seed in bags to a field plantable size in the water. Taylor Floats consist of a rectangular basket of vinyl coated wire held afloat by a rectangular ring of 4" PVC pipe. The typical size of the float is about 10' x 2'. Plastic mesh bags of varying sized holes are employed to hold the seed. As the seed grows, the bags are changed allowing larger seed to grow in bags with larger mesh. These Taylor Floats can be either tied to a dock or strung in a line in the water by themselves. They can be susceptible to storms, bags can eject, and shellfish can bunch in the corners reducing growth and possibly impacting survival.

Screen size on the silos in either configuration of FLUPSY can be increased as the seed grows to allow for better water flow. Both types of FLUPSYs require some power source to run the pumps which move the water and access to fresh water for cleaning the seed, silos, and the rest of the equipment is often desirable.

Once seed is large enough, it can be transferred into mesh "nursery" bags and grown either intertidally or subtidally. Nursery seed as small as 3mm can be grown to a size where it can either be planted in the bottom (clam seed at about 8-15mm) or moved into larger mesh bags for off-bottom grow-out (oyster seed at about 20-25mm.) Clam seed will grow to this plantable size either on- or off-bottom. Oyster nursery bags are typically set on raised racks, or floated in some configuration which allows for good water circulation. These bags, like all culture gear, need to have some cleaning done to them periodically to remove fouling organisms, which is discussed in detail in the BMP section.

Up to this point, most of the culture methods described can be used for either clams or oysters. But because larger clam seed requires sediment in

which they can bury and oyster seed does not, different methods are used for grow-out to market size. Some of the methods used for growing clams and oysters are described in the next two sections.

Clam Culture

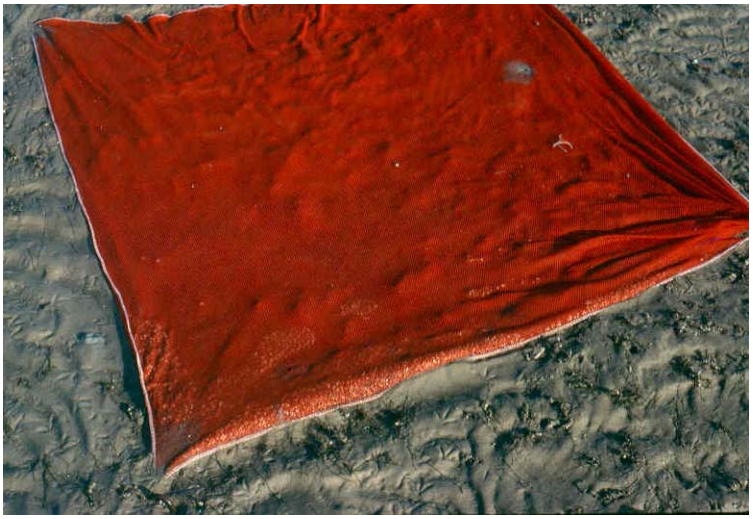
Clams do not perform well in containers without sediment. There are basically two methods for growing hard clams, one being most specific to the far southern states of the eastern seaboard, (clam bags) and the other being utilized from South Carolina to New England (planting under netting). All final grow-out of clams is done in the bottom, although some nursery gear can be used to bring small clams to field planting size in off-bottom gear.

Typically, the process starts with small clam seed in the 8-15mm range purchased from a hatchery. These are planted in the bottom at densities determined over time by local experience, and covered with predator control screen or nets that help to keep the predators from reaching the crop. The density of seed under the screens will vary with the size of the seed planted; larger numbers per area are planted when they are very small and they are thinned, after a time, for subsequent growth to harvest.

The mesh size of the netting can range from 1/8” to 1/2” depending on the size of the clams underneath it. The methods of keeping this material attached to the bottom include use of concrete reinforcing bars (rebar), PVC pipes, stone bags, lead line, J-shaped rebar stakes, or other materials to make a seal around the plot and exclude predators. The most important aspect is to ensure that the edges are securely anchored so that predators cannot get under the nets and to make sure there are no holes anywhere in the net. In areas where winter ice is an issue, farmers often remove the netting prior to ice settling on it but timing is critical – too early and predators will still be actively feeding; too late and ice can destroy the nets.

As the seed grows beyond the size of predator preference, on-bottom unprotected planting may be appropriate. In areas where predators are still a factor, even for larger stock, netting may be required until the clams are harvested. Harvest is typically done with hand rakes.

Bottom screens or nets used in clam culture need repeated removal of macroalgae and various biofouling invertebrates that attach to the plastic material. This is often done either by hand or with long poles with squeegees, stiff brooms or rebar scrapes. Removed biofouling is pushed off the plots to float away, sometimes landing on someone else's area.



In Florida, Georgia, and South Carolina, another method is used where nylon mesh bags of various mesh sizes have seed put into them, and then they are staked to the bottom, singly or connected in lines. In a short time, sediment fills the bags enough so that the clams can dig into the sediment. A nursery bag can be used initially and the clams thinned later into a larger mesh grow-out bag. Some farmers cover the bags with a layer of netting or chicken wire to discourage large predators, such as rays, fish and crabs. To harvest, the entire bag is pulled up from the bottom.

Oyster Culture

Oysters can be grown both on- and off-bottom. The type of lease – intertidal or subtidal – is a major factor in determining the type of gear used. Most often, hatchery reared oyster seed is grown in high-density

polyethylene bags of varying mesh sizes. As the oysters grow, the stocking density is reduced and the mesh size of the bags is increased. The final product is harvested by taking the entire bag and removing marketable oysters, which are then washed and packed for shipping. Sub-marketable oysters are returned to bags for additional growth.

The mesh bags can be set up on racks (often made of rebar) or hung on wooden-staked longlines in the intertidal zone. Or they can be floated in Taylor Floats (4" PVC rectangular collars with vinyl coated wire baskets holding 6 to 12 bags each) or by individual floats attached to the sides of

each bag, or place in cages that will sit on the bay floor, be suspended above the bottom with large floats, or floated at the surface of the water. New floating cage systems, designed in Canada, are also being used. For ice conditions, these cages have an advantage in that the cages are attached to black floats that are hollow and can be filled with water to be sunk below the ice. The systems also allow the cages to be flipped over so that they are above the surface of the water for air drying.

Sometimes, oysters are grown through a prolonged nursery phase in mesh bags and then broadcast on the bay floor for final grow-out. This reduces the amount of gear maintenance required for the final phase of the process, although it requires the grower to dredge, pick or tong the oysters for harvest. The reduced operational costs of bottom culture must be weighed against the increased mortality of product due to predation, siltation, harvesting inefficiencies, etc.

During the grow-out process which can range from 12 to 48 months depending on location, desired market size, or water temperatures, all of

these gear types need to be maintained to remove fouling organisms from the material. If this fouling is not removed, water flow and thus feeding efficiency will be greatly reduced resulting in slower growth, thin meats, susceptibility to disease and, in extreme cases, crop mortality.

Oyster culture maintenance usually requires removing the bags from the culture array and then power washing, air drying, salt dips or changing out the oysters into gear with larger mesh, usually reducing the density and sorting the shellfish by size at the same time.

Code of Conduct for Molluscan Shellfish Culture in the Eastern United States

The concept of a Code of Conduct for Responsible Fisheries originated with the United Nations Food and Agriculture Organization (FAO) suggesting a set of general and generic principles that growers should embrace in order to conduct their business responsibly. They are basically common sense precepts which most growers follow instinctively as good stewards of the waters where they grow shellfish and as good food producers. The Code of Conduct here takes into consideration particular aspects of the East Coast shellfish production industry. We believe that these statements belong at the beginning of a farm BMP.

Shellfish farmers shall:

1. Conduct aquaculture operations in accordance with all applicable laws and regulations, and acquire and maintain all pertinent permits.

2. Make the best effort to produce and handle products of the highest quality and ensure product safety.

3. Make a best effort to communicate early and openly with water-based and land-based neighbors about any facet of their operation which might affect them.

4. Work to benefit the local economy by patronizing local businesses and through employment and contributions to the tax base and infrastructure.

5. Site, plan, develop and manage aquaculture operations in a manner that minimizes negative environmental impacts.

6. Site, plan, develop and manage aquaculture operations in a manner that ensures the economic and social sustainability of the operation.

7. Take all appropriate measures to avoid and contain disease outbreaks and report them quickly to the proper authorities if suspected.

8. Dispose of culturing waste and chemicals in a manner that does not constitute a hazard to human health or to the environment.

9. Consult and collaborate with government and authorities, researchers, other producers and stakeholders for the development and implementation of regulations, technologies and standards to achieve environmentally, economically and socially sustainable shellfish culture when feasible.

10. Encourage other growers to adopt the shellfish code of conduct and better management practices.

BMP Elements

Permits

A substantial number of permits are required in most jurisdictions where shellfish farming occurs. General industry or specific farm permits may be required from state agencies, towns, and/or the U.S. Army Corps of Engineers. Each grower should check with cooperative extension or state shellfisheries departments to learn which permits are necessary, and once these permits have been obtained it is important to keep them current. Most of these contacts are listed in the appendix.

Siting Issues

Site selection is crucial to the success of the shellfish farm over the long term. To be successful, many factors must be considered – biological and physical factors are obvious, but social ones come into play as well.

Most states lease areas for new farms that are currently or historically non-productive for shellfish aquaculture. There is generally a reason an area is non-productive, but the reason is not always obvious and the farmer must be aware of potential biological and physical obstacles for success. As an example, heavy organic mud may be unsuitable bottom type for shellfish bottom-culture but overlying water may be acceptable for bottom cages or floating gear. An area of high current or wave action may be unacceptable for floating gear but the fast-moving water may supply an abundance of food for bottom culture. While most requirements for shellfish survival and growth of the shellfish are known, others are less clear and shellfish aquaculture is still part science, part art and part trial and error. To complicate matters, what works in one situation or area may not work in another making technology transfer difficult.

Lease or use requirements for shellfish aquaculture vary widely by state, and in some states, local regulations may also apply. Some states allow shellfish farmers to select their own sites as long as the site meets regulatory requirements. In such cases the responsibility is on the applicant

to ensure the viability of his farm by making sure the area is suitable for growing shellfish using the methodology the grower intends to use, and meets other farm needs. In other states, aquaculture zones have been set aside and the prospective grower must choose a site within these specified areas. The amount of analysis done by the state to ensure whether shellfish will survive and grow in aquaculture zones varies tremendously.

When choosing a site, a prospective farmer should choose a site that avoids submerged aquatic vegetation and navigational channels, both of which are generally regulatory requirements.

Biological/Physical/Social Factors

At a minimum, the most important factors to consider include:

- Salinity and temperature,
- Phytoplankton abundance and types,
- Sediment types,
- Water depth and current velocities,
- Protection from severe storms, winter ice and boat wakes,
- Presence of disease organisms or harmful phytoplankton blooms,
- Water quality acceptable for harvest of product for human consumption,
- Accessibility of riparian owners and other stakeholders of the resource (navigation, fishing activity etc.)

Scale of the operation is also important and if future expansion is contemplated, it must be incorporated in the initial site selection. Most farmers begin with modest aquaculture operations and, when successful, they consider expansion opportunities. However, site selection that allows for expansion, either on the initial lease site or through leasing additional sites, should the need or desire arise, is important. In addition, if other farms are nearby, the total amount of shellfish being cultured must be considered with respect to the carrying capacity of the bay where the shellfish farm is located.

The method of grow-out as well as the method of harvest may have an impact on the siting. Bottom culture is far different from floating gear (see section on user conflicts.) The farmer must be aware of the biological/physical constraints to the gear being contemplated as well as to

the social/political climate for use of a specific area with a specific type of gear. Equally important is the harvest process. A process that does not impact down-drift farmers or the public is far more acceptable than those that may have an adverse impact.

Just as important to the eventual success of the farm is the understanding that there are other people who want to use the coastal waters. User conflicts abound because of multiple users for the same space (see section on user conflicts.) Identifying other users is the first step in a successful farm and includes upland property owners in close proximity, boating/fishing activity, and potential sources of land-based or water-based contamination. Aesthetics, while subjective, is an important consideration in siting and can be minimized if the farmer gives careful thought before the leasing process begins to address any concerns other users may have.

Scoping sessions are increasingly being used by some jurisdictions in the site selection process. In these sessions, prior to a hearing, regulators and stakeholders get together to discuss the applicant's plan, identify issues and examine solutions. The process, which allows for communication among parties who may not otherwise communicate to one another prior to a lease public hearing, has proved to alleviate potential problems among them. While an individual farmer usually doesn't initiate such a process, if it is offered, the applicant would do well to participate in one.

BMPs

- **Choose sites that provide the appropriate biological and physical factors for the species and gear chosen for culture.**
- **Choose sites from which harvest is allowed; factor in future water quality at the site.**
- **Choose sites with no SAV in the general vicinity.**
- **Choose sites away from navigational channels and ones that do not impede public access.**
- **Choose sites where adverse effects from gear or gear maintenance will be minimal.**
- **Attend scoping sessions, if offered, early in the permitting process and educate other stakeholders about your operation.**
- **Be a good neighbor.**

Site Marking

Clearly marking the farm site is usually advantageous to the farmer and is often a permit requirement. A well-marked farm can help with farm operations, prevent damage to the crop or gear from non-farm vessels and reduce crop loss from theft. Marking a site where shellfish are growing does, of course, call attention to the area and might in some cases encourage poaching. Where farm site marking is up to the farmer, he might decide not to do so. The common use of GPS has made this option even more practical.

The most common boundary markers are buoys or stakes. If the farm is large, markers may be required along the perimeter rather than at just the corners. The types of markers, their color and the number and location of markers may be regulated by the state or it may be based on individual preferences. Generally, metal stakes are not advisable because of damage they can cause to passing vessels; alternatives include cedar or bamboo stakes and PVC pipe.

When buoys are used for floating gear and the choice of color is often left up to the farm operator, a number of factors come into play. Generally, when the farm is close to shore or within the view of landowners, dark buoys are preferred as they create less of a visual impact, but in certain weather conditions dark buoys can be so difficult to see that vessels may stray into the lease area. Leases near channels should have markings that are easily distinguishable. Difficulties arise when a lease is both near a channel and near shore properties. If possible, the grower should communicate with the land owners, but it may be the state or federal authority (e.g. Coast Guard) that makes the final decision on the type of markings to be used. For leases out of the public view, and where specific marker colors are not required, it is usually advantageous for the grower to use bright colored buoys.

Replacing missing or broken markers in a timely fashion is important. This is especially true in cases where marking farm sites is a regulatory requirement, and/or where the site marking serves to keep non-farm vessels away from the site to avoid damage to these vessels or to farm gear or to the shellfish.

BMPs

- **Follow regulations regarding marking.**
- **If using stakes, ensure that they are visible and can be seen by other boaters.**
- **Replace broken stakes immediately to ensure that passing boats will not be damaged.**
- **Use appropriate buoy colors for the situation – dark colors near shore and brighter colors that may be appropriate further offshore.**

Site Security

For small growers, site security is not considered to be much of an issue and when it is an issue, there is not much that can be done except to be as vigilant and as visible as possible on the water. Most small farmers do not have the financial ability to pay for security personnel or technology. Farms that can be seen from the land might have an advantage of being able to catch someone disturbing the gear but getting to the farm in time may be problematic. Remote farms are almost impossible to monitor except when the farmer is on the water himself.

For some farms, security measures may include video monitoring and remotely sensed alarms. Poaching is a polite term to describe a crime – theft. For generations, stealing shellfish has been considered a “game” in some quarters, where people stole from the public fishery against regulations aimed at protecting a public resource. With private aquaculture, people who poach are stealing from a private individual who is in business to grow shellfish. While not considered a major obstacle to shellfish aquaculture, poaching, and the culture that allows it, still exists. Sometimes, the theft can be as retaliation in a disagreement. Whatever the cause, the farmer would be wise to try to “keep the peace” as much as possible and to educate people about the purpose of the farm and the hard work required to successfully grow shellfish.

Clearly marking the farm site allows it to be easily identified by law enforcement or citizens and should help to reduce poaching. If illegal

and if in these illegal activities the farm operator should assist in their prosecution. Some states sell official aquaculture signs to growers, indicating the area is patrolled by law enforcement officers.

BMPs

- **Be visible on the water.**
- **Clearly mark boundaries of farm.**
- **Educate people about the nature of the farm as a business.**
- **Prosecute offenders legally if they are caught in the act; do not resort to "street justice."**
- **"Keep the peace."**
- **Maintain vigilance for the security of your crop and your neighbors'. Watch for intruders and either inform them that they are intruding on private property, or call the marine police for assistance.**

Access to Sites

Most farmers access their sites by boat, but there are cases where access is by land or where farmers must drive vehicles over intertidal flats to get to the lease site. It is important to use public highways, waterways, boat ramps, docks and other public spaces in a responsible manner. Access to sites by vehicle may bring the vehicle close to sensitive areas, such as marshes or bird nesting areas where extra care is necessary. Farm boats should avoid routes to farm sites that might damage submerged aquatic vegetation.

BMPs

- **When accessing the farm site by vehicle over land:**
  - Follow all local regulations such as use of public landings,
  - If crossing private property, obtain permission of landowners,
  - Do not cross over a marsh,

- Do not interfere with protected species habitat and obey all vehicular closures.

- **When accessing the farm site by boat:**
  - At low tide, be aware of submerged aquatic vegetation areas so as not to damage the plants,
  - In areas with numerous adjacent shellfish culture leases, avoid crossing neighbor's leases so as not to impact bottom or bottom gear,
  - Set gear with a buffer within lease site to help avoid damage by others.
- **When accessing the farm through a "public way":**
  - Follow all local regulations for use of a "public way".

Potential Changes to Sites and Site Access

One of the biggest threats to shellfish aquaculture is the swift development of the coast for non-water-dependent uses, primarily residential properties. A host of potential problems arise as a result and include but are not limited to:

- Nutrient enrichment of estuaries from wastewater, fertilizer and farming,
- Chemical inputs from stormwater, wastewater, boats and agriculture,
- Decreased access to public facilities such as boat ramps, parking, docks and dockside facilities,
- Decreased availability of waterfront land and lease sites,
- Increase in recreational boating activity and other users on the water,
- "Aesthetics" of aquaculture becoming particularly important in crowded areas.

The cumulative effect of development that is not carefully regulated or controlled can be a decrease in the number of appropriate sites for shellfish farming, and the potential loss of waterfront facilities necessary to carry out farming activities. The loss of farming sites occurs when water quality declines and no longer meets sanitary standards. The loss of public facilities, such as docks and nearby parking, and their replacement with private marinas or other waterfront development can have profound effects on shellfish farmers. This is a very difficult problem, and often out of control

of the individual farmer. But shellfish farmers should be aware of development projects and be involved in community action by making their voice heard, either individually or collectively. Whenever possible, farmers need to take advantage of opportunities to educate stakeholders about the benefits of shellfish aquaculture and keep the shellfish industry represented in the decision-making process. Forming and maintaining good relationships with local politicians can help as well.

Associated with these development issues is the phenomenon called “Not In My Back Yard” or NIMBY. People living or moving into the coastal zone sometimes have no prior experience with or knowledge of traditional uses of the water or shoreline. They frequently do not appreciate or wish to tolerate commercial activities such as wild harvest or shellfish aquaculture within their view. Often, they will seek legal redress to block that activity. In such cases, groups of farmers can often be more effective in defending their actions and businesses than individual ones. A less confrontational and more positive approach is to be a good neighbor, educating neighbors about shellfish culture and perhaps even providing gifts of shellfish. Once there is understanding, it may be possible to convert an opponent into a supporter.

BMPs

- **Be a good neighbor.**
- **Take every opportunity to educate people.**
- **Join or create a local aquaculture association.**
- **Encourage communities to maintain traditional uses of the water.**
- **Accentuate the positive aspects of shellfish farming.**
- **Educate the public on the benefits of shellfish aquaculture.**
- **Get involved in community action programs.**
- **Volunteer for appointment to a decision-making board or committee.**
- **Write letters to elected officials.**
- **Encourage policy makers to make room for shellfish farmers and access to their sites.**
- **Encourage policy makers to devote waterfront land for water-dependent purposes.**

Good Neighbor Policy

Unless a farm is situated in an extremely remote area, it is likely that other people will be using the same general area or even the farm site itself for other purposes – traversing the area by boat and fishing the waters where the farm is located are two common ones. Except in those states that acknowledge Kings Grants, Lords Proprietors, British Crown or Legislative Grants as legitimate deeded ownership, most farms are located in leased public waters and the lease agreement often allows the public to perform certain activities on the lease site.

When lease sites are located near populated areas, or in areas where the public is likely to be present, normal farm maintenance operations may be perceived as a nuisance or detrimental to the enjoyment of the area. U.S. coastal waters are used for many commercial and recreational activities and these uses are often incompatible with farm operations. However, because the farm is sited in leased public waters, it is the farmer's obligation to operate the farm in a manner that respects the legitimate use of the area by the other stakeholders.

Many farms also occupy shore facilities where shellfish are handled, or where gear is sent for maintenance or storage. These shore facilities may be adjacent to public areas or even in the farmer's backyard. Shellfish farmers need to be aware of potential conflicts with the public and with neighbors over the use of such areas.

The following sections describe some of the potential problems and conflicts.

Noise

Machinery – pumps, power washers, tumblers/sorters, engines, "boom boxes" – all produce noise that may be annoying to others. Farmers need to recognize too that sound carries over water better than over land, particularly on calm days. Farm operations on the water often need to start early in the morning or occur into the evening because they are constrained by weather, wind conditions and tides. When a farm is located near a populated area, operating noisy machinery, especially in the early morning

or at night can lead to conflicts with those within earshot. Some consideration of these neighbors is warranted.

BMPs

- **Operate machinery in a manner that is considerate to other people on the water or in nearby homes.**
- **Avoid loud music aboard vessels or on the flats.**

Odors

Most water-related odors are pleasant to most people and one reason people utilize the coastal zone. However, decaying marine life produces foul odors, and if placed where people find it offensive, conflicts arise. Removal of the offensive material as rapidly as possible can go a long way toward alleviating complaints against the farm. The odor problem is more pronounced in warmer months or in warmer climates. Disposal of offending material can be problematic for the farmer because of the large amount of material or great distance to a disposal site that will accept it. However, it is the farmer's responsibility to maintain the operation and keep the noxious odors to a minimum.

BMP

- **Dispose of potentially odor-causing materials quickly and in an approved manner.**

Recreational/Commercial Fishing/Boating Activities

Most states allow other users to access submerged or intertidal areas leased to shellfish growers. Activities such as fishing, either commercial or recreational, or other boating activities are often allowed. Regulations governing those activities differ from state to state and in some cases from

lease to lease. Often a lease-holder has exclusive use of an area for bottom gear. Even in those circumstances, hook and line fishing may be allowed but fixed gear, such as crab or lobster pots, is usually prohibited. Most fishermen do not want to have their tackle hung up where they have to cut it free and will therefore not fish in an area where they know that netting or other gear is likely to snag their lines. Depending on depth, boats passing over a lease site won't generally impact bottom gear but at shallower sites contact between boats and gear can damage both. Growers who clearly mark their lease sites generally have less interference with other users.

BMPs

- **Clearly delineate boundaries of lease site with stakes or buoys.**
- **Check site often for damaged gear due to boating activities.**
- **Use state designated Aquaculture Development Zones, if available.**
- **Become involved in public education programs aimed at public users.**
- **Try to get your location identified on the maps provided with electronic chart plotters.**

Upland Gear Storage Areas

Most shellfish farms require areas for the storage of gear not in use. In areas where ice can be a problem, farmers remove gear from the water in the winter. In addition to producing foul odors that we have already discussed, the gear may also be considered unsightly by some, especially if the gear is stored in a residential area. To prevent problems with neighbors, farms can install fences around their property or plant trees/shrubs as a natural barrier.

BMPs

- **Clean gear in an approved area before storage on residential property to avoid noxious odors as the marine life dies.**

- **If possible, store gear in a commercial location where noxious odors will be less of a problem.**
- **If a residential area is necessary for gear storage, install a fence or living hedge to block visual issues.**
- **Store gear neatly.**
- **Remove trash regularly from the site.**

Seed Sourcing

Seed Selection/Sourcing

All of the shellfish grown on the East Coast are native species. It is highly unlikely that states or the Federal government will ever allow the new introduction of non-native species.

All clam seed for culture and almost all oyster seed comes from a hatchery. A few oyster growers may use collecting devices such as shell (cultch), or spat collectors such as “Chinese hats” to collect wild spat for planting on their farms. Mussel growers, on the other hand, use wild set exclusively.

After numerous attempts at purchasing seed from out of state hatcheries, growers have learned the hard way – through poor performance or severe mortalities – that local seed tends to grow best. There is also some evidence that seed which is brought from northern states to ones further south perform better than those brought from south to north. Many growers have discovered this through trial and error, and some states have codified this concept into regulation.

The most important reason to purchase local seed is to minimize the possibility of the transmission of shellfish diseases from the hatchery waters to the grow-out waters. In many cases, post-hatchery seed raised in upwellers, is sold across state lines, often moving hundreds of miles north or south. In spite of required pathology examinations, transmission of disease is still a possibility and a reason in and of itself to discourage such shipments, especially to growing areas devoid of diseases.

Hatchery production makes it possible to incorporate selected genetic traits into the seed. Shellfish that offer disease resistance, better growth and unique shell markings that enable stock identification are commonly available and used by many shellfish farms.

Most of the genetic improvements in shellfish have come through extensive research at government and university laboratories, and after extensive field trials using multiple generations. Severe mortalities of wild oysters in the 1960s led to an enormous amount of research focused on oyster disease and disease resistance. This genetic work was originally done for enhancement of wild populations, but the results were found applicable to cultured shellfish as well. Hatcheries producing and selling selected strains of shellfish often operate under license from the university where the genetic work was been done, and this may involve paying a premium for the seed to cover royalty fees. Oyster growers will often seek disease resistant seed. Most often, this type of seed has been selected or bred for disease resistance for MSX (*Haplosporidium nelsoni*), Dermo (*Perkinsus marinus*) or Juvenile Oyster Disease (JOD) now called Roseovarius Oyster Disease (ROD).

Less work has been done and transferred to industry with genetically improved clam seed. Some hatcheries in operation for a long time, some as long as 30 years, have continuously selected the best growing clams to use as broodstock. Such seed may offer a growth advantage over non-selected seed.

Clam growers very often choose clam seed that have a *notata* variant bred into it. The red shell markings of *notata* clams can be used to identify farmed clams since in nature, the *notata* markings only occur about 2% of the time. This has proven to be useful in reducing or prosecuting poaching.

Most states require that seed shipped into that state be certified as having been inspected for common parasitic diseases. It is important to be aware of and comply with these regulations to avoid transferring diseases to your farm.

There are numerous hatcheries throughout the East Coast and a list of these is contained on the East Coast Shellfish Growers Association (ECSGA) website at http://ecsga.org/Pages/Resources/hatcheries.htm.

This list is updated annually. All growers are encouraged to obtain seed from hatcheries that operate in a responsible fashion.

BMPs

- **Use only native or naturalized species.**
- **Purchase seed from a reputable hatchery.**
- **Use locally sourced seed where possible.**
- **Purchase hatchery seed that is approved by state officials.**
- **Ensure that disease inspection regulations have been followed.**

Operational/Maintenance Issues

Hatcheries

Hatcheries are complex and unique operations and out of the scope of this BMP manual. Some information is provided in an appendix for those who are interested. All growers are encouraged to obtain seed from reputable hatcheries that operate under BMPs.

On-shore Nurseries

The basic description of on-shore nurseries can be found in the section on culture methods. Basically two types of on-shore nurseries are used on the East Coast – raceways and upwellers. Because on-shore nurseries involve pumping seawater up to the facilities and then discharging it back into receiving waters, these facilities might require a discharge permit. The relatively small volume of shellfish seed in nursery facilities results in only very small changes to the water passing through the nursery and is not usually of any environmental concern. However care must be exercised when the nursery is cleaned to avoid the discharge of harmful substances. For both raceways and upwellers, the tanks, silos and pipes must be cleaned often to control fouling. Cleaning is most often done with scrub brushes, scrapers, and small amounts of soap and water, but dilute concentrations of bleach can be used as well to better remove surface films and attached bacteria. The equipment is then rinsed thoroughly to

eliminate the bleach. Small quantities of chlorine will dissipate quickly with minimal impact. There are some ways to reduce the amount of substances such as bleach and soap from reaching the seawater source. An area set aside for washing nursery gear with a drain to a municipal or approved sewer system is effective. It is also possible to design an entire land-based system with a double drain system that allows cleaning water to flow to a sewer system. Chlorine in bleach can be dechlorinated with sodium thiosulfate which is more acceptable than discharging large quantities of bleach.

Systems located on land have some unique security issues. There is a liability issue with the potential of unauthorized people getting hurt, and accidents can occur that can harm or kill shellfish. Something toxic may end up in the tanks simply by having someone who used even a small amount of insect repellant or other harmful substance dip their hands into the water. Unauthorized access can be problematic requiring additional vigilance and/or security measures such as fencing around the systems.

BMPs

- **Keep adequate security such as fences around upwellers and raceways.**
- **Protect seed that can be easily contaminated with many substances.**
- **Minimize the use of bleach and soap.**
- **Check with State Department of Environmental Protection or equivalent to make sure of compliance with any discharge permits.**

In-water Nurseries*/Floating Upweller Systems (FLUPSYs)*

In-water nurseries can be as simple as putting the shellfish seed into mesh bags and putting the bags on racks in either a subtidal or intertidal environment, or in the case of clams, directly on the bottom. But many shellfish growers use Floating Upweller Systems (FLUPSYs) that have been shown to be very effective in growing seed to a larger size. However a major difference between a simple bag system and a FLUPSY is the high

initial cost of a floating upweller system compared to the low cost of the bag system.

FLUPSYs require access to water – under a dock, or anchored. In either case, there must be enough flow of water to move through the silos just as in the land-based upwellers. In areas where tidal action is strong enough to push water through the silos, pumping is not required, but areas that fit that description while also being out of the way of other boating activities are rare, and pumps are most often necessary, requiring the grower to have access to electricity.

If the grower does not own waterfront property, he must obtain permission to use a dock or to anchor the FLUPSY in the water. If anchored, the FLUPSY must not be placed in a channel or other high-traffic area and the grower must adhere to all local regulations.

FLUPSYs also require maintenance and access to fresh water for cleaning is useful. Heavy cleaning should be done at a land-based site if soap and bleach are used. Occasional air drying of gear and/or fresh water rinse is often more effective than using chemical treatments.

Under-dock FLUPSYs are often located in marinas where there is access to both fresh water and electricity. When sited under a dock, they are virtually invisible to anyone walking on the dock. However, when located in a marina, there could be problems because of fuel, soap or other harmful substances in the water. The grower must emphasize to the owner (and hopefully all marina users) that seed shellfish is being grown and to exercise extreme caution with fuel or other harmful substances.

Taylor Floats

Taylor Floats allow growers who have neither waterfront land-based nursery capabilities nor the funds to construct or purchase a FLUPSY system to use the natural phytoplankton in the water to grow small seed to field planting size. These floats can be tied off to a dock or in a boat slip, placed under a dock, or anchored off. Bags of various sized meshes are placed in the floats and shellfish seed can grow in them. Clams will not grow to market size in them but oysters can. The floats along with the bags will foul throughout the growing season and cleaning, with brushes or a

power-washer is absolutely needed on a regular basis. Sometimes, loose-fitting netting can be strung over the top to prevent loss of bags if the wind and weather impact the floats in a negative way.

Care should be taken to turn the bags over periodically, shake the seed around in the bags if it bunches up in a corner since that could lead to mortalities. Seed should be sieved or separated, and then moved up into larger mesh bags as the crop grows to allow for better water flow and access to food.

BMPs

- **Obtain permission from waterfront landowner for use of electricity and fresh water.**
- **Obtain permission for mooring if necessary.**
- **If a power washer is being used for cleaning, be considerate of the noise generated and the timing of the cleaning operation.**
- **Be conscious of water movement when cleaning so that adjacent boats are not affected by the cleaning process.**
- **Clean gear often to prevent large quantities of fouling material from being dumped overboard possibly impacting neighbors in the marinas.**
- **Access a floating dock FLUPSY in a marina when foot traffic is the least.**
- **Exercise caution with fuel and other hazardous materials and encourage other dock users to also exercise extreme caution.**
- **Moor FLUPSYs in areas not subject to high boat traffic as in a channel.**
- **Locate racks with bags on the lease site and outside of areas with non-farm boat traffic.**

Fouling Control

A farmer uses netting to prevent predation of his stock during the growing process and to keep animals from washing or spilling out of the culture gear, but the netting attracts fouling organisms consisting of both plants

and animals. As the fouling organisms grow, they clog the mesh decreasing the flow of water and consequently the food supply for the shellfish. Cleaning the mesh and removing the fouling becomes one of the principal activities of good farm maintenance and one of the principal challenges to the farmer. Fouling may also become a nuisance on other “hard” parts of the culture gear such as cage frames, and on mooring lines and buoys.

Fouling can be by both hard and soft bodied organisms. On the East Coast, soft bodied tunicates and bryozoans often cause the most problems, but in some of the southeastern states, wild oyster sets on gear are the biggest fouling threats. The fouling control methods discussed below are all used with various levels of success. It is important to point out that killing a large quantity of fouling organisms and leaving them in place may result in increased oxygen demand as the dead fouling material decays, causing an additional problem for the shellfish.

The fouling control methods described below can be done at the farm site, or at a land site. Cleaning gear and shellfish of fouling at a land-based facility with subsequent disposal in an approved land site can prevent any negative effects that can potentially occur if fouling materials are disposed of at the farm site. However, it is usually impractical and cost-prohibitive take gear out of the water for all fouling removal, and most farms combine fouling control with the cleaning of gear on land only when it is ready to be repaired or stored.

Chemical Control

Chemical treatment of gear prior to use to prevent or retard fouling is an option, and a number of products are entering the marketplace. However, the use of potentially toxic chemicals poses a threat not only to the species being cultured but to other marine organisms requiring careful consideration before choosing this option. Non-toxic alternatives to copper bottom paint to discourage fouling organisms from settling on surfaces are entering the market. Experiments are being conducted on coatings for netting but they are inconclusive to date. Farmers should exercise extreme caution when using chemical means of fouling control, and use only those materials that are environmentally friendly.

Air Drying

One of the most effective methods of fouling removal is air drying. Most marine fouling organisms cannot live out of water. Devising methods for shellfish culture that allow the shellfish to be in the water but holding the fouled parts of the gear above water has led to interesting innovations in culture methodology and is constantly evolving. The amount of time for the gear to air dry is site specific and depends on the type of fouling organisms present and the speed of desiccation. Once the fouling material is dry, it can be brushed off the gear or left for crabs and fish to consume.

Brine or Fresh Water Dips

A second effective fouling control method is a dip of brine or fresh water. Acetic acid or vinegar might also be used. High concentrations of salt, low concentrations of acetic acid and fresh water are all environmentally appropriate. The amount of time for soaking in either brine or fresh water is dependent on the types of fouling organisms. If the shellfish themselves are being treated using either method, the farmer must recognize the limitations of soaking shellfish, taking care not to leave them in so long that the treatment may weaken or even kill the clams or oysters being treated. The duration of soaking animals to remove fouling is size, density, temperature and time dependent. Oysters will tolerate brines considerably longer than clams or mussels. Brine or freshwater dips are not appropriate for species such as scallops or soft-shell clams which cannot close tightly.

Power Washing

A third fouling control method is to use a power-washer which combines the use of water and high pressure. The combination of the pressure and fresh water effectively kills and/or removes the fouling organisms from culture gear.

Manual Control

The simplest method of controlling fouling is manual control using brushes or other tools to remove accumulating organisms. Of course this is also the most labor intensive method, and has led to the development of the alternate methods for fouling control discussed above.

A potential conflict arises when the amount of material removed from any of the methods described above gets carried downstream and affects either public waters or a neighboring grower's farm. If the fouling organisms are not killed outright, they may reattach to other gear. They can also cause foul odors and create an unsightly mess if the removed material builds up on the shore and decays. Large amounts of fouling material may also accumulate on the sea bottom and cause harm to the benthic animals and plants living there. With all of the above methods, the degree of impact to other users is proportional to the size of the farm – larger farms have the potential for greater overall conflict than smaller ones.

Minimizing the amount of fouling that has to be removed is an obvious solution. The smaller the fouling organism, the easier it is to get rid of it, and the less impact the cleaning operation has on other user groups and the environment. However, cleaning gear is labor intensive and the farmer needs to balance the time and energy devoted to cleaning gear against the reduction in growth of clams or oysters because of the fouling. But he also must balance the potential impact from cleaning larger fouling communities with the better husbandry practice of more frequent cleaning resulting in fewer negative impacts. Reducing the impact to other users by frequent gear cleaning when the fouling is slight rather than waiting until the infestation is difficult to control goes a long way toward keeping adverse public opinion toward shellfish aquaculture to a minimum.

An alternative is to clean gear and shellfish on shore and dispose of the fouling material in an approved manner, such as in a landfill or other public disposal facility. If a land site is used, gear and shellfish should be cleaned in an expeditious manner, in areas where odors or an unsightly operation can cause problems with the public.

BMPs

- **Whenever possible, clean gear on shore and dispose of fouling materials in appropriate manner, removing them from the ecosystem.**
- **If on-shore cleaning is not possible or is highly impractical, use methods that will not adversely affect other farmers.**

- **Clean gear regularly and more often when infestations warrant additional care. Use only environmentally appropriate methods: air drying, brine dip, vinegar dip, or fresh water dip.**
- **Use power washing in appropriate areas and at appropriate times.**
- **Do not use public landings for cleaning gear.**

Predator Control

There are a number of shellfish predators which, in some cases, can occur in significant numbers and cause a lot of damage to the crop. For shellfish in bags, cages or other gear or under netting, the mesh material is usually quite effective in excluding most large predators like crabs, fish and sea stars. However, predators such as these have larval or juvenile stages that are small enough to get into the gear and grow up with the shellfish crop. At the size where they start to prey on the shellfish, they must be removed to limit damage. In the case of clams under nets, some crabs and predatory gastropods can cause damage despite the presence of the netting. Where predators can reach the crop and cause damage it is important to control them. Some of the treatments discussed in the fouling control section can be effective for some predators, especially when they are small. But larger predators usually have to be manually removed from the site or the gear. Keep in mind that some shellfish predators such as some crab species, conchs and fish are of value in other fisheries, and you should use non-lethal removal methods for these. In some areas, protected species such as sea lions and birds may potentially be shellfish predators. Since lethal control is not an option in theses cases, the farmer should work with NOAA and state authorities to decide on a course of action.

BMPs

- **Check the grow-out area and gear for predators, especially in the seasons where they are known to occur.**
- **Remove predators using non-lethal methods as much as possible.**
- **Work with authorities on a control strategy for protected species if they become important predators on your crop.**

Siltation

Siltation is generally more of a problem with subtidal culture than intertidal and can occur either in the normal maintenance of the farm gear or in the harvesting procedures. Hydraulic harvesting equipment produces the greatest amount of sediment disturbance and can cause significant siltation. The question is one of scale and duration. The larger particles settle out quickly back to the sediment; the finer particles remain suspended in the water longer and can be carried over greater distances. Once the fine particles settle out, they may inadvertently cover a neighboring farm or public resource downstream, sometimes relatively far downstream. However, unless the amount of silt is extreme, the effect is seldom deleterious (usually less than what is observed after a strong wind storm). The effect of hydraulic harvesting operations on a small farm is rarely more than would occur in a strong wind event. The East Coast Shellfish Institute is currently studying the effects of hydraulic harvesting and this issue should be revisited once the report is completed.

BMP

- **Avoid or manage activities that generate excessive silt.**

Gear Maintenance, Disposal and Recycling

One of the biggest potential adverse impacts to users of the coastal areas is derelict aquaculture gear. Loose netting, cages or other gear that gets wrapped around propellers, centerboards, rudders or other boat parts is dangerous, a nuisance, and can cause economic hardship to the unsuspecting boating public. Gear that is washed up on shores or in marshes can entangle wildlife, is unsightly, and can negatively impact the public enjoyment of coastal areas.

Although not all gear loss can be prevented, and severe weather may cause the loss of a substantial amount of farm gear, it is important to be as

diligent as possible to minimize gear loss. Use of proper anchoring and mooring systems, using sufficient tie-downs for nets, and immediately removing unused netting from sites are examples of good management. Some growers tag their gear with an identifying marker that enables loose gear to be returned to the farm by people who find it, but more importantly shows the public that the farm takes responsibility for the gear.

For most types of shellfish aquaculture, some loss of gear is inevitable and periodically organizing or participating in a beach clean-up is a great way to demonstrate the farm's environmental stewardship.

Some gear such as rebar, ADPI bags, clam bags and some types of plastic netting for example can be reused after cleaning, while other types of materials can be recycled. Once gear has passed its useful life, proper disposal becomes important and gear must be disposed in an appropriate manner and in accordance with local regulations. Once rebar rots away, dangerous pins in the sediment may remain and should be removed.

BMPs

- **Pick up loose gear as soon as possible.**
- **Partner with recycling companies and other farmers to dispose of gear that can be recycled in larger batches to have an economy of scale.**
- **Recycle or reuse gear whenever possible.**
- **Dispose of used gear appropriately when no longer usable.**
- **Participate in community beach clean-up activities.**
- **Keep gear neat and orderly.**

Fuel Handling and Fuel Spill Contingencies

Fuel, lubricating or hydraulic oils, and other hydrocarbons can have a deleterious environmental impact on coastal waters and cultured shellfish. The sources of these are usually from boat operations, but can come from farm vehicles and other farm equipment. All precautions should be taken to

minimize any spills or leaks of these fluids and waste oils should be disposed of properly.

BMPs

- **Exercise extreme caution when handling fuel, flammable or hazardous materials near or on the water.**
- **Carry absorbent materials for small spill clean-up in vessels, if accessing site by water, or vehicles, if accessing sites by land.**
- **Maintain all mechanical equipment in good condition to avoid fuel and oil leaks.**

Handling and Reporting Disease

Farm Protocols for Addressing Disease

A number of diseases that affect shellfish are known, and there is no effective way to treat diseased animals. These shellfish diseases do not make people ill, but can be devastating to a shellfish farm. For some species in some locations, disease resistant stock can be used, but even these may still be susceptible to disease. Shellfish grown in areas where disease is expected to occur may still be successful if the shellfish can be grown to market size before the disease starts to cause mortality. In all cases where diseases occur, it is very important to practice good shellfish husbandry. This includes culturing the shellfish at a density that allows for rapid growth, and removing weak or dead animals where possible.

Communication about Disease Events

When a disease is suspected on a shellfish farm, it is prudent to communicate the situation as soon as possible to state agencies, other growers, shellfish extension personnel, and the state veterinarian. State or university experts can then identify shellfish diseases using laboratory analyses, and may be able to suggest a farm strategy to minimize losses.

Communicating a disease event to other growers in the area may help them anticipate and deal with a similar situation on their farm. Similarly, such communication should allow you to get useful information from them to help to put the situation into some broader context and possibly reduce infections or mortalities to one's own farm or neighboring leases. Samples of live, dying and dead shellfish can be preserved for disease analysis by putting them into a container with rubbing alcohol. Disease analysis needs to be performed by trained experts and your state extension agents, listed in the appendix, can help you find a laboratory for this.

BMPs

- **Communicate disease events to appropriate authorities and neighboring growers.**
- **When disease is suspected, take samples and send them to a laboratory for analysis.**

Protected Species and Habitats

There are a number of federal laws and state regulations that protect certain species of plants and animals and are relevant to shellfish farmers. At the federal level, the Endangered Species Act (ESA) is the most well known, but the Migratory Bird Treaty Act, the Marine Mammal Protection Act, and the Essential Fish Habitat provisions of the Magnuson Stevens Fisheries Conservation and Management Act can also affect shellfish growers.

The Endangered Species Act of 1973 protects plants and animals that are listed by the federal government as "endangered" or "threatened." In general, most of the species listed as protected are charismatic macrofauna such as certain whales, sea lions and turtles, but Atlantic salmon, some corals, mussels and plants such as Johnson's seagrass in Florida are also listed. The Marine Mammal Protection Act of 1972 made all marine mammals protected species. A complete list of protected species listed by state can be found at this site: http://ecos.fws.gov/tess_public/StateListing.do?state=all

The consequences of a “take” of a protected species can be severe, and a shellfish grower should be aware of which species might occur in the area of the farm and take measures to avoid interactions with these species. According to the Endangered Species Act a “take” is defined as harming a protected species and therefore actions which actually kill or injure protected wildlife are included, but a “take” also extends to actions that cause significant habitat modifications or degradations that lead to killing or injuring wildlife by significantly impacting essential behavioral patterns, including breeding, feeding or sheltering. The penalties for a “take” can be found at this web site:
http://www.gc.noaa.gov/schedules/6-ESA/EnadangeredSpeciesAct.pdf

The Migratory Bird Treaty Act of 1918 forbids anyone to “hunt, take, capture, kill or possess” any bird protected by one of the treaties or to disturb their nesting sites. There are over 800 species of migratory birds, including many common ones like Canada geese, barn swallows, and two kinds of starling. In fact, very few birds are *not* migratory for regulatory purposes. Courts have held that even the accidental killing of a migratory bird can be a criminal act under this law. The Department of Interior and the states can pass regulations to allow activities such as hunting migratory species, as long as they are consistent with the intentions of the treaties.

Submerged aquatic vegetation (SAV) is considered a high quality habitat especially important for the young stages of many fish and invertebrate species. In the New England and northern mid-Atlantic regions, eelgrass (*Zostera marina*) is the dominate species, but other species are important further south. Generally, aquaculture siting is not allowed in areas where SAV is present, and many states have specific regulations to preserve and enhance SAV. Shellfish growers have found that in some cases areas where no SAV was present and where farms were established, that SAV starts to grow. Changes to the substrate, reduced turbidity and increased light penetration where farm activities occur are probably responsible for creating habitat where the SAV can now become established and grow. It is important to pay attention to this possibility to avoid conflicts with those with responsibilities for SAV.

BMPs

- **Know the species that are protected in your area and work to minimize interactions with them and avoid any "take" of protected species.**
- **Document SAV in the area of your farm, and if SAV starts to become established at the farm's site report it to the appropriate authorities.**

Shellfish Sanitation – Protecting Human Health

The U.S. national regulatory authority for public protection and seafood regulation is vested in the Food and Drug Administration (FDA). FDA is required to cooperate with and aid state and local authorities in the enforcement of their health regulations and is authorized to assist states in the prevention and suppression of communicable diseases. Under this authority, FDA participates with state regulatory agencies, some foreign nations, and the molluscan shellfish industry in the National Shellfish Sanitation Program (NSSP). The NSSP is a voluntary, cooperative program to promote the safety of molluscan shellfish by providing for the classification and patrol of shellfish growing waters and for the inspection and certification of shellfish processors. Twenty-three coastal shellfish producing states are part of the program along with nine foreign countries. The rules and regulations for the NSSP come from the Interstate Shellfish Sanitation Conference (ISSC) which meets formally every two years to review and modify the regulations. However the implementation and enforcement of these regulations falls to the state public health agencies and marine law enforcement.

In order to ensure that shellfish are safe to eat, there are three main areas regulated by the NSSP. The first is setting standards for shellfish growing waters that allow harvest from waters that have acceptable numbers of the bacteria that can cause human illness. There are also standards for "red tide" organisms in growing waters. These standards are used by the state authorities to classify the growing areas, accomplished by frequent sampling of the water. Many coastal areas become degraded after rains when pollution from runoff and occasionally from sewage plant failures enters the water. Many "conditional" areas are automatically closed to

shellfish harvest after a certain amount of rainfall, and are opened again only after bacterial sampling shows that they meet the NSSP standard.

The second major part of the NSSP program is a system of product identification which enables trace back to the harvest waters. This is accomplished by putting a tag on every unit of harvested shellfish that contains information about the harvester, date of harvest, and harvest area. This tag must remain with the shellfish at every step in the chain from harvester to final point of sale, and at the point of sale the tag must be retained for 90 days. This allows a rapid and orderly trace back to the harvest area if the shellfish causes illnesses.

The third important part of the NSSP program is a monthly list they publish of all state and foreign shellfish processors and dealers that are certified under the NSSP. This ‘‘Interstate Certified Shellfish Shippers List,’’ allows participating States to identify and keep out shellfish processed by uncertified processors in other States and foreign nations and thereby control the distribution of uncertified and possibly unsafe shellfish in interstate commerce.

Most diseases from shellfish on the East Coast are due to one particular bacteria, *Vibrio parahaemolyticus* (Vp), that typically causes nausea, diarrhea and fever in affected people. Another *vibrio*, *Vibrio vulnificus*, is much more dangerous and although symptoms similar to that for Vp occur in most people, it can cause death in immune-compromised individuals. The *vibrio* bacteria can grow in shellfish, but this growth can be controlled by putting the shellfish into refrigeration. Therefore, the NSSP control plans for these *vibrios* are based on time and temperature regimes. Some states do not allow harvest of shellfish in warm months while in other states, shellfish harvested in the warmer months have to be put into refrigeration shortly after harvest.

Having a disease outbreak caused by your shellfish is about the last thing you want to happen. Therefore, complying with your state’s regulations regarding the harvest and post harvest handling of shellfish is critical to your business and its future.

BMPs

- **Comply with all rules and regulations in your state regarding shellfish sanitation.**
- **Report any sewage leak events to state authorities immediately.**
- **Report possible red tide events to state authorities.**
- **Become a certified shellfish dealer or sell your product to only certified dealers.**
- **Consider participating in the NSSP process by attending ISSC meetings.**

Record Keeping

Monitoring the Environment

Like land farmers, successful shellfish culturists record and maintain detailed records that serve as guides to predict and review fluctuations on the farmed shellfish beds. Accurate record keeping goes beyond writing down observations and data. Culturists must analyze this information periodically and modify their operation appropriately to increase their profitability. Improved management practices translate into increased production and lower operating costs.

Environmental factors, which affect the growth and survival rates of shellfish, can be categorized as weather, water and site. Recorded measurements of these changeable factors are the foundation of accurate record keeping. The more detailed the records, the more beneficial they become, and the greater chance for success.

Rainfall can affect salinity, and rapid air or water temperature fluctuations in a coastal area can have an immediate effect on the availability of phytoplankton in the water, which may directly or indirectly affect the shellfish. Temperature variations can easily be measured with a thermometer. Salinity changes are measured with an optical refractometer or hydrometer. Salinity and temperature can vary with depth, so measurements should be made from the depth where the shellfish are grown and not from surface water. Different species have preferred salinities, and extreme and rapid changes may cause problems.

Increased winds from a specific direction may affect tidal levels. Changes at the site should be monitored closely and recorded. Knowledge of tides and winds which might cause a lease site to become exposed to freezing during cold winter months is important. Records of strong wind variations and directions may prove to be valuable. If a site is shallow and prone to freezing, the effects of ice-cover should be noted. Record its occurrence and effect on the shellfish, gear, predator control devices and the site itself. Home weather station data (i.e. through www.wunderground.com) is available to anyone and could be helpful to growers.

Monitoring the Crop

Environmental records will have limited value unless kept in conjunction with shellfish growth. Growth and environmental data should be set up to allow quick comparisons through time. The goal is to correlate growth data with environmental information so production can be optimized. The condition of the shellfish should be noted and measured periodically. The most obvious biological parameters to note are growth and survival. Other important observations include predation, planting densities, differences in conditions of shellfish groups, and equipment failures or successes.

Observations, measurements, or counts should be recorded in writing as soon as possible. Do not trust your memory! Always keep a note pad, two soft lead (#2) pencils (pens are useless in a wet environment,) and a clipboard covered with a clear sheet of plastic with you. Summarize important information obtained from the field into a computer or ledger later. A two ledger system (one field and one home) has the benefit of providing a back-up version, which will be neater and easier to read in the future. Keep field data sheets and permanent records in separate locations. Precise and accurate facts recorded in timely fashion yield better information for future decisions and action.

A fact sheet titled “Recordkeeping for Shellfish Aquaculture” which expands on these ideas and also provides field data sheets can be found on the Rutgers Cooperative Extension website at http://njaes.rutgers.edu/pubs/subcategory.asp?cat=6&sub=45

Keeping the BMP Document Current

After a grower develops his own set of Best Management Practices, the document should not be viewed as the “final” product. As operational changes are made to the farm, these changes should be incorporated into a new written version of the BMPs. Perhaps a good time to do this would be at the end of the season when there is time to reflect and make changes in the document.

It is important to keep in mind that while new innovations may be good for the farm, there may be unintended consequences to using new techniques. The farmer needs to carefully evaluate new methodologies to avoid actions that might negatively impact other users or the environment. A good source of technological improvements and regulations that affect shellfish farming, are aquaculture associations, such as the one in your particular state and the East Coast Shellfish Growers Association.

Keeping the BMP document on the computer, with user-friendly software that allows easy editing, makes this process less tedious than keeping it all in a hand written form. If there is an issue with computer skills, perhaps the local shellfish extension person could assist in the computer process. The key though is to understand that a BMP document needs to change as the farm grows and other regulations are adopted to which the grower must respond.

BMPs

- **Maintain detailed records of the physical environment.**
- **Make observations, measurements, and counts of the stock frequently and write them down as soon as possible.**
- **Keep up to date on technology and regulatory changes that might affect your farm management plan.**
- **Change the BMP document to reflect changes in farming practices.**

BMP Farm-level format

Blank Farm-level BMP Template

Following is a complete BMP farm template that can be used as a guide to produce a farm-specific BMP. It follows the same order of issues discussed in the previous section. Under each issue are a variety of BMP statements that can be incorporated as written into a farm-specific BMP, or they can be modified or new ones added. This template can be found on the ECSGA website (http://www.ecsga.org) in Excel format. To produce a farm-specific BMP from the electronic version you only have to select each issue and BMP element you want to have in your BMP by putting an X next to that issue or element, modify the specific text where necessary to better describe your operation, and then print the document. Note that the BMP statements cover a wide range of conditions and possibilities, many of which will not apply to your farm. Select only the issues and BMP statements that apply to your farm. If you do things on your farm that are not included, they can be easily added. At the end, your BMP should accurately describe how you manage your farm.

Farm Name:
Farm Address:
Phone Number:
Responsible for BMP:
Date of Latest Revision:
Species Grown:
Location of Farm
Description of Basic Farm Process:
CODE OF CONDUCT: **We endorse the ECSGA Code of Conduct for Molluscan Shellfish**

Shellfish
farmers shall:

• Conduct aquaculture operations in accordance with all applicable laws and regulations, and acquire and maintain all pertinent permits.
• Make the best effort to produce and handle products of the highest quality and ensure product safety.
• Make a best effort to communicate early and openly with water based and land based neighbors about all facets of their operation.
• Work to benefit the local economy by patronizing local businesses and through employment and contributions to the tax base and infrastructure.
• Site, plan, develop and manage aquaculture operations in a manner that minimizes environmental impacts.
• Site, plan, develop and manage aquaculture operations in a manner that ensures the economic and social sustainability of the operation.
• Take all appropriate measures to avoid and contain disease outbreaks and report them quickly to the proper authorities if suspected.
• Dispose of culturing waste and chemicals in a manner that does not constitute a hazard to human health or to the environment.
• Consult and collaborate with government authorities, researchers, other producers and stakeholders for the development and implementation of regulations, technologies and standards to achieve environmentally, economically and socially sustainable shellfish culture when feasible.
• Encourage other growers to adopt the shellfish code of conduct and better management practices.

BMP
ELEMENTS
PERMITS AND TITLES HELD

We have all of the permits required by the state to operate a shellfish farm and to sell our product in-state and out-of-state.

• Our farm site is leased from the state and we pay an annual fee to maintain this lease.
• We have an aquaculture permit issued by the state.
• We are a licensed shellfish dealer that allows us to sell our product in interstate commerce.

THE FARM

SITE

It is important to have a farm site that will support good shellfish survival and growth, and at the same time avoid unnecessary conflicts with navigation, traditional fishing and protected habitats and species. It is a state requirement to mark the farm site, and these markers also serve to keep recreational and commercial boat traffic away from the site to avoid damage to the boats and to the growing shellfish. Site marking also serve to minimize inadvertent or intentional poaching. A good farm site also need to be protected from future changes that could make the farm site unusable or less valuable, especially upland or upstream development that could negatively impact water quality or reduce access to the sites.

FARM SITING

- Our farm site and plan was reviewed in a public scoping session held in 1998.
- Our farm site was chosen for characteristics necessary for good shellfish growth.
- Our farm site is in a state-approved aquaculture zone.
- Our farm site was chosen to avoid sensitive habitats.
- Our farm site chosen to avoid submerged aquatic vegetation.
- Our farm site chosen to avoid interactions with protected species.
- Our farm site was chosen to stay clear of navigation channels and areas traditionally used for fishing or recreational boating.

SITE MARKING

- Farm boundaries are marked according to state regulations.
- Site marking is not required.
- GPS is used to ensure that farm operations occur in the permitted location.
- Damaged or missing boundary markers are replaced as soon as possible.
- Marker buoy colors were chosen to be as unobtrusive as possible.
- Marker buoys are bright colored to be more visible to recreational boaters.

SITE SECURITY

- We participate in programs to educate the public and other fishermen about the farm.
- Farm personnel are instructed to take a firm but friendly approach with those suspected of doing harm.
- Farm personnel notify marine police if illegal activity is suspected
- We will assist in the prosecution of known offenders.

ACCESS TO SITES

- Access to the farm site is by boat.
- Farm personnel are instructed to avoid routes to farm sites that might damage submerged aquatic vegetation.
- Farm personnel are instructed to avoid passing close to bird nesting areas.
- Access to the farm site is by farm vehicle.
- Farm personnel are instructed to use only public rights of way.

POTENTIAL CHANGES TO SITES AND SITE ACCESS

- We monitor and evaluate the potential effects of proposed development projects that might interfere with farm operations.
- We participate in public hearings for projects that will negatively affect farm operations.
- We look for opportunities, and when possible make presentations at public events in order to educate stakeholders about shellfish farming and its benefits.
- We take the time to talk to the owners of homes adjacent to the farm site in order to keep relations friendly.

GOOD NEIGHBOR POLICY

We recognize that even though we took care to properly site our farm that there are still some cases where we need to take extra care to be good neighbors. The following are some of the things we do to be good neighbors.

NOISE

- We operate boats and machinery to minimize noise.
- We seek to minimize noise from the farm when it might bother neighbors.

ODORS

- We are aware of potential odors coming from the gear we remove from the water.
- We clean gear before storage to minimize foul odors.
- We dispose of material we clean off our gear efficiently to minimize offensive odors.
- We store gear at an industrial site to keep potential odors away from populated areas.

RECREATIONAL AND COMMERCIAL BOATING

- Our submerged farm gear has a minimum of 4 feet of water over it so that recreational boats can freely pass over the area.

- Our submerged farm gear is exposed at low tide, and the farm area is clearly marked with buoys to keep recreational boats away from the area.
- Farm gear is regularly inspected for damage caused by boats

UPLAND GEAR STORAGE AREAS

- Our gear storage area chosen to be as unobtrusive as possible.
- Gear is usually cleaned before it is brought to storage area.
- A safety fence has been installed to prevent children from entering and injuring themselves.
- Gear is stored in a neat and orderly fashion.

SEED

SOURCING

One of the most important aspects of good management on the farm is the selection of seed and its source. Good seed will grow faster and stay healthier. And choosing seed from reputable hatcheries lessens the possibility of introducing diseases and unwanted organisms into our environment. For these reasons we:

- We use only native species on the farm.
- We purchase seed from reputable hatcheries.
- We purchase seed from out-of-state hatcheries that are approved by state officials.
- We have all seed from out-of-state hatcheries certified to be disease free by a competent testing laboratory.

OPERATIONAL/MAINTENANCE ISSUES: ON-SHORE NURSERIES

We use an on-shore nursery to grow seed to a planting size.

• We have installed a security fence around our on-shore facilities.
• We have a discharge permit for our on-shore nursery.
• Gear is washed in an area that drains into the municipal sewage system.
• Employees are trained to use minimal amounts of detergent and bleach to avoid contaminating receiving waters.

OPERATIONAL/MAINTENANCE ISSUES: IN-WATER NURSERIES

We operate an in-water nursery to grow seed to a planting size.

• Our floating nursery that is located under a dock which we own.
• Our floating nursery under a dock which we rent.
• Our floating nursery is located on a site which we lease for this purpose.

• Our floating nursery is located under a public dock for which we have permission.
• We take care to service our floating nursery to have minimum impact on other users of the dock.
• We clean our floating nursery frequently to minimize the amount of material entering the water.

OPERATIONAL/MAINTENANCE ISSUES: FOULING CONTROL

One of the most difficult tasks on our farm is keeping the gear and the shellfish free of fouling organisms. The task is similar to that land farmers face with weed control. And as with land farming, if we allow the fouling organisms to get out of control they will choke our crop and reduce yields.

• We clean our in-the-water gear frequently to minimize the amount of material entering the water.
• When fouling is heavy we remove gear from the water and clean it at our on-land facility.
• Fouling material from our on-land facility is brought to the municipal land-fill daily.
• Fouling material from our land-based facility is disposed of properly to avoid odors.
• All of our in-the-water gear cleaning is done by hand or with a power washer.
• When fouling is heavy we use brine (saturated salt) dips to control it.
• When fouling is heavy we use air-drying to control it.
• When fouling is heavy we use fresh water dips to control it.
• We never use chemicals that could harm the environment at our farm site.
• Some of our farm gear is coated with an anti-fouling compound approved for use in the marine environment.

OPERATIONAL/MAINTENANCE ISSUES: PREDATOR CONTROL

There are a number of predators that prey on shellfish and in some cases can occur in significant numbers and cause a lot of damage to the crop. It is important for us to recognize predators that can cause harm, and either keep them away from our crop through exclusion or directly eliminate them by other means.

• The cages we use keep most predators away from our crop.
• When predators are found in the cages we remove and release them.
• When predators are found in the cages we remove them; minor

species are killed and important species are released.
• We use predator netting over our clam crop.
• We use predator netting over our clam crop for the first year when they are vulnerable to predation.
• We frequently inspect our clam plots and remove predators by hand.
• We avoid any harassment of protected species.
• We work with NOAA and state officials to find methods to deter predation by protected species.

OPERATIONAL/MAINTENANCE ISSUES: SILTATION

Silt or mud can build up on our farm site. Although a small amount of silt doesn't require any maintenance on our part, larger amounts have to be removed to prevent the shellfish from suffocating, and our harvest methods can also re-suspend silt.

• We harvest our shellfish at slack tide to minimize silt transport away from the farm site.
• We are aware that some farm activities stir up silt and use methods to minimize the impacts from this.

OPERATIONAL/MAINTENANCE ISSUES: GEAR MAINTENANCE, DISPOSAL AND RECYCLING

The gear we use to grow our shellfish represents a significant investment, and we do everything we can to make sure it stays in place and doesn't become a hazard or nuisance to others. We are also committed to recycling as much material as possible when it is no longer usable.

• We use robust anchoring systems for our gear to avoid loss in severe weather events.
• We instruct employees to pick up loose gear as soon as possible.
• We instruct employees to discard nothing into the bay where our farm is located.
• We recycle much of our plastic material.
• We cooperate with adjacent farms to pool recyclable materials.
• We keep gear at our on-land site in a neat and orderly fashion.
• We participate in community beach clean-up days.
• We organize and lead a community beach clean-up each year.
• We organize and pay the expenses of a boy scout and girl scout annual beach clean-up.
• We participate in local “Earth Day” events.

OPERATIONAL/MAINTENANCE ISSUES: FUEL HANDLING AND FUEL SPILL CONTINGENCIES

We know that considerable environmental damage can come from gasoline or oil spills. In our case some of the equipment we use in the field runs on gasoline. It is important to us and to the environment to take precautions with fuels.

• Farm employees are instructed in proper fuel and oil handling procedures to minimize possible spills.
• Farm equipment is well-maintained to minimize fuel and oil leaks.
• Farm boats and vehicles carry absorbent materials that can be used to clean up small fuel spills.

OPERATIONAL/MAINTENANCE ISSUES: HANDLING AND REPORTING DISEASE

The shellfish we grow are susceptible to a couple of diseases caused by microscopic organisms. These diseases do not affect the quality of our product nor do they pose any problems for people who consume them. Keeping disease to a minimum on our farm is important and it is important for us to communicate farm diseases to other growers and to state authorities so that disease outbreaks can be contained as well as possible. In order to control diseases on the farm:

• We use disease-resistant stocks to minimize disease effects.
• We monitor our crops and if disease is suspected we will take samples and send them to a competent laboratory for analysis.
• We will communicate confirmed disease events to appropriate authorities and neighboring growers.

OPERATIONAL/MAINTENANCE ISSUES: PROTECTED SPECIES AND HABITATS

Protecting vulnerable species and sensitive habitats is important to us and to the community.

• The following species may occur in the area of my farm and I will work to minimize interactions with them and avoid doing harm to them: Species 1; Species 2; Species 3; etc.
• Eel grass is the major SAV in the farm area. I have made a map of the patches of SAV closest to the farm and will update this map on an annual basis.
• If SAV appears on the farm site we report it's occurrence to the appropriate state agency as soon as it is detected.

OPERATIONAL/MAINTENANCE ISSUES: PROTECTING HUMAN HEALTH

Producing and selling a product that is safe to eat is critical to our business. The National Shellfish Sanitation Program, working through our state authorities, sets the food safety standards by which we operate.

• We comply with all state regulations that safeguard consumers who eat our products.
• When we see or suspect sewage leaks we report them to state authorities.
• When we see what may be a red tide, we report it immediately to state authorities.
• Our company is a member of the Interstate Shellfish Sanitation Conference, part of the National Shellfish Sanitation Program.
• We get our shellfish under refrigeration immediately after harvest.

RECORD KEEPING - MONITORING THE CROP AND THE ENVIRONMENT

As in any business, maintaining good records is a key part of good management. Having good records of the environment and good data for our crops allows us to become more efficient.

• We maintain detailed records of the physical environment.
• We monitor our crops through careful observations of their condition, and by taking measurements and counts of the stock.

RECORD KEEPING - KEEPING THIS BMP DOCUMENT CURRENT

This Code and BMP document is a large part of our operations manual for our farm. Keeping it current is important to our business.

• We review and change our Best Management Plan to account for changes in farming practices.
• We are members of the East Coast Shellfish Growers Association and become aware of changes in regulations and farming practices through their communications.

IMPORTANT PHONE NUMBERS AND CONTACTS

Completed Example of a Farm-level BMP

Following is a BMP for a fictitious clam farm in New Jersey that was constructed using the electronic BMP template. We manually filled in the farm data at the top of the document, decided to adopt the ECSGA Code of Conduct, and then selected issues and BMP elements from the template that described the way we envisioned "Mr. Ridgeway" manages his farm. In the electronic version, selecting issues and BMP elements is done by simply putting an X in the "Select" column for each of those relevant to your farm, and then printing the document. Only the selected issues and elements appear in the final document.

Farm Name:	**Ridgeway Clam Farm**
Farm Address:	12 Mercenaria Way, Toms River, NJ 12345
Phone Number:	222-234 5678
Responsible for BMP:	Bob Ridgeway
Date of Latest Revision:	22 April 2010
Species Grown:	Hard clams, *Mercenaria mercenaria*
Location of Farm	5 acres of intertidal grounds in the town of Rising Sun and another 7 acres in Springsteen Cove in Morrisville Township.
Description of Basic Farm Process:	We buy small hatchery seed that we grow to planting size in an on-shore nursery facility. We put planting-size seed on prepared intertidal bottom that we lease from the state at the two farm locations. The seed are covered with a protective mesh for about one year, then the mesh is removed and the clams grown for another year to market size. Harvest is with hand rakes. We market directly to some local restaurants and through licensed distributors.
CODE OF CONDUCT: Shellfish farmers shall:	**We endorse the ECSGA Code of Conduct for Molluscan Shellfish**

• Conduct aquaculture operations in accordance with all applicable laws and regulations, and acquire and maintain all pertinent permits.

• Make the best effort to produce and handle products of the highest quality and ensure product safety.

• Make a best effort to communicate early and openly with water based and land based neighbors about all facets of their operation.

• Work to benefit the local economy by patronizing local businesses and through employment and contributions to the tax base and infrastructure.

• Site, plan, develop and manage aquaculture operations in a manner that minimizes environmental impacts.

• Site, plan, develop and manage aquaculture operations in a manner that ensures the economic and social sustainability of the operation.

• Take all appropriate measures to avoid and contain disease outbreaks and report them quickly to the proper authorities if suspected.

• Dispose of culturing waste and chemicals in a manner that does not constitute a hazard to human health or to the environment.

• Consult and collaborate with government authorities, researchers, other producers and stakeholders for the development and implementation of regulations, technologies and standards to achieve environmentally, economically and socially sustainable shellfish culture when feasible.

• Encourage other growers to adopt the shellfish code of conduct and better management practices.

BMP ELEMENTS

PERMITS AND TITLES HELD

We have all of the permits required by the state to operate a shellfish farm and to sell our product in-state and out-of-state.

• Our farm site is leased from the state and we pay an annual fee to maintain this lease.

• We have an aquaculture permit issued by the state.

THE FARM SITE

It is important to have a farm site that will support good shellfish survival and growth, and at the same time avoid unnecessary conflicts with navigation, traditional fishing and protected habitats and species. It is a state requirement to mark the farm site, and these markers also serve to keep recreational and commercial boat traffic away from the site to avoid damage to the boats and to the growing shellfish. Site marking also serve to minimize inadvertent or intentional poaching. A good farm site also need to be protected from future changes that could make the farm site unusable or less valuable, especially upland or upstream development that could negatively impact water quality or reduce access to the sites.

FARM SITING

- Our farm site was chosen for characteristics necessary for good shellfish growth.

- Our farm site chosen to avoid submerged aquatic vegetation.
- Our farm site was chosen to stay clear of navigation channels and areas traditionally used for fishing or recreational boating.

SITE MARKING

- Farm boundaries are marked according to state regulations.

- Marker buoy colors were chosen to be as unobtrusive as possible.

SITE SECURITY

- We participate in programs to educate the public and other fishermen about the farm.

- Farm personnel notify marine police if illegal activity is suspected

ACCESS TO SITES

- Access to the farm site is by farm vehicle.

- Farm personnel are instructed to use only public rights of way.

POTENTIAL CHANGES TO SITES AND SITE ACCESS

- We monitor and evaluate the potential effects of proposed development projects that might interfere with farm operations.
- We look for opportunities, and when possible make presentations at public events in order to educate stakeholders about shellfish farming and its benefits.
- We take the time to talk to the owners of homes adjacent to the farm site in order to keep relations friendly.

GOOD NEIGHBOR POLICY

We recognize that even though we took care to properly site our farm that there are still some cases where we need to take extra care to be good neighbors. The following are some of the things we do to be good neighbors.

NOISE

- We operate boats and machinery to minimize noise.

ODORS

- We clean gear before storage to minimize foul odors.

RECREATIONAL AND COMMERCIAL BOATING

- Our submerged farm gear is exposed at low tide, and the farm area is clearly marked with buoys to keep recreational boats away from the area.

UPLAND GEAR STORAGE AREAS

- Gear is usually cleaned before it is brought to storage area.

- A safety fence has been installed to prevent children from entering and injuring themselves.

SEED SOURCING

One of the most important aspects of good management on the farm is the selection of seed and its source. Good seed will grow faster and stay healthier. And choosing seed from reputable hatcheries lessens the possibility of introducing diseases and unwanted organisms into our environment. For these reasons we:

- We use only native species on the farm.

- We purchase seed from out-of-state hatcheries that are approved by state officials.
- We have all seed from out-of-state hatcheries certified to be disease free by a competent testing laboratory.

OPERATIONAL/MAINTENANCE ISSUES: ON-SHORE NURSERIES

We use an on-shore nursery to grow seed to a planting size.

• We have installed a security fence around our on-shore facilities.

• We have a discharge permit for our on-shore nursery.

OPERATIONAL/MAINTENANCE ISSUES: FOULING CONTROL

One of the most difficult tasks on our farm is keeping the gear and the shellfish free of fouling organisms. The task is similar to that land farmers face with weed control. And as with land farming, if we allow the fouling organisms to get out of control they will choke our crop and reduce yields.

• We clean our in-the-water gear frequently to minimize the amount of material entering the water.

• We never use chemicals that could harm the environment at our farm site.

There are a number of predators that prey on shellfish and in some cases can occur in significant numbers and cause a lot of damage to the crop. It is important for us to recognize predators that can cause harm, and either keep them away from our crop through exclusion or directly eliminate them by other means.

• We use predator netting over our clam crop for the first year when they are vulnerable to predation.

• We frequently inspect our clam plots and remove predators by hand.

OPERATIONAL/MAINTENANCE ISSUES: GEAR MAINTENANCE, DISPOSAL AND RECYCLING

The gear we use to grow our shellfish represents a significant investment, and we do everything we can to make sure it stays in place and doesn't become a hazard or nuisance to others. We are also committed to recycling as much material as possible when it is no longer usable.

• We instruct employees to pick up loose gear as soon as possible.

• We instruct employees to discard nothing into the bay where our farm is located.

• We organize and lead a community beach clean-up each year.

OPERATIONAL/MAINTENANCE ISSUES: FUEL HANDLING AND FUEL SPILL CONTINGENCIES

We know that considerable environmental damage can come from gasoline or oil spills. In our case some of the equipment we use in the field runs on gasoline. It is important to us and to the environment to take precautions with fuels.

• Farm employees are instructed in proper fuel and oil handling procedures to minimize possible spills.

• Farm equipment is well-maintained to minimize fuel and oil leaks.

OPERATIONAL/MAINTENANCE ISSUES: HANDLING AND REPORTING DISEASE

The shellfish we grow are susceptible to a couple of diseases caused by microscopic organisms. These diseases do not affect the quality of our product nor do they pose any problems for people who consume them. Keeping disease to a minimum on our farm is important and it is important for us to communicate farm diseases to other growers and to state authorities so that disease outbreaks can be contained as well as possible. In order to control diseases on the farm:

• We monitor our crops and if disease is suspected we will take samples and send them to a competent laboratory for analysis.

• We will communicate confirmed disease events to appropriate authorities and neighboring growers.

OPERATIONAL/MAINTENANCE ISSUES: PROTECTED SPECIES AND HABITATS

Protecting vulnerable species and sensitive habitats is important to us and to the community.

• Eel grass is the major SAV in the farm area. We have made a map of the patches of SAV closest to the farm and will update this map on an annual basis.

• If SAV appears on the farm site we report it's occurrence to the appropriate state agency as soon as it is detected.

OPERATIONAL/MAINTENANCE ISSUES: PROTECTING HUMAN HEALTH

Producing and selling a product that is safe to eat is critical to our business. The National Shellfish Sanitation Program, working through our state authorities, sets the food safety standards by which we operate.

• We comply with all state regulations that safeguard consumers who eat our products.
• Our company is a member of the Interstate Shellfish Sanitation Conference, part of the National Shellfish Sanitation Program.

RECORD KEEPING - MONITORING THE CROP AND THE ENVIRONMENT

As in any business, maintaining good records is a key part of good management. Having good records of the environment and good data for our crops allows us to become more efficient.

• We maintain detailed records of the physical environment.
• We monitor our crops through careful observations of their condition, and by taking measurements and counts of the stock.

RECORD KEEPING - KEEPING THIS BMP DOCUMENT CURRENT

This Code and BMP document is a large part of our operations manual for our farm. Keeping it current is important to our business.

• We review and change our Best Management Plan to account for changes in farming practices.
• We are members of the East Coast Shellfish Growers Association and become aware of changes in regulations and farming practices through their communications.

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Appendices

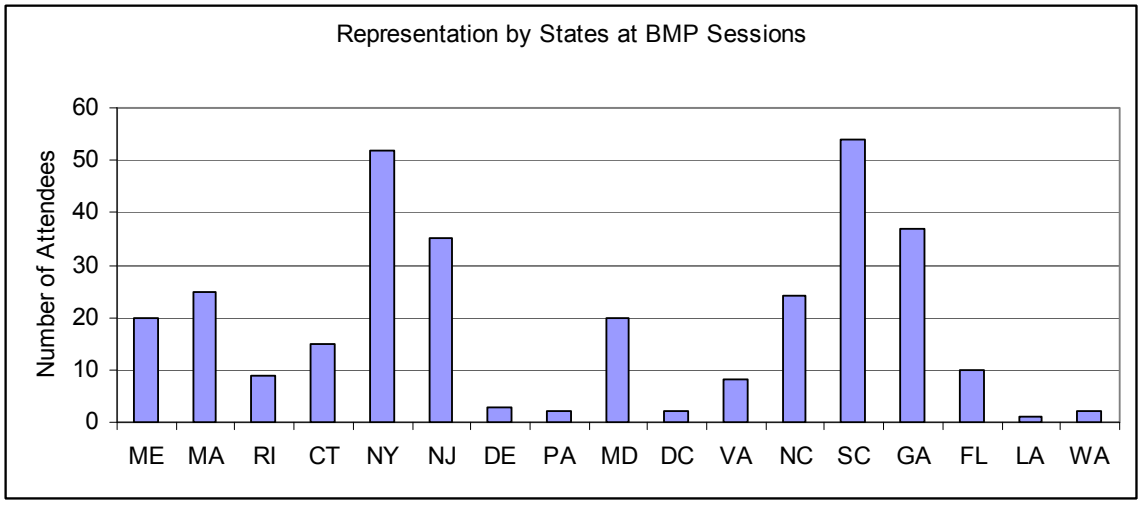
Workshop Dates and Locations

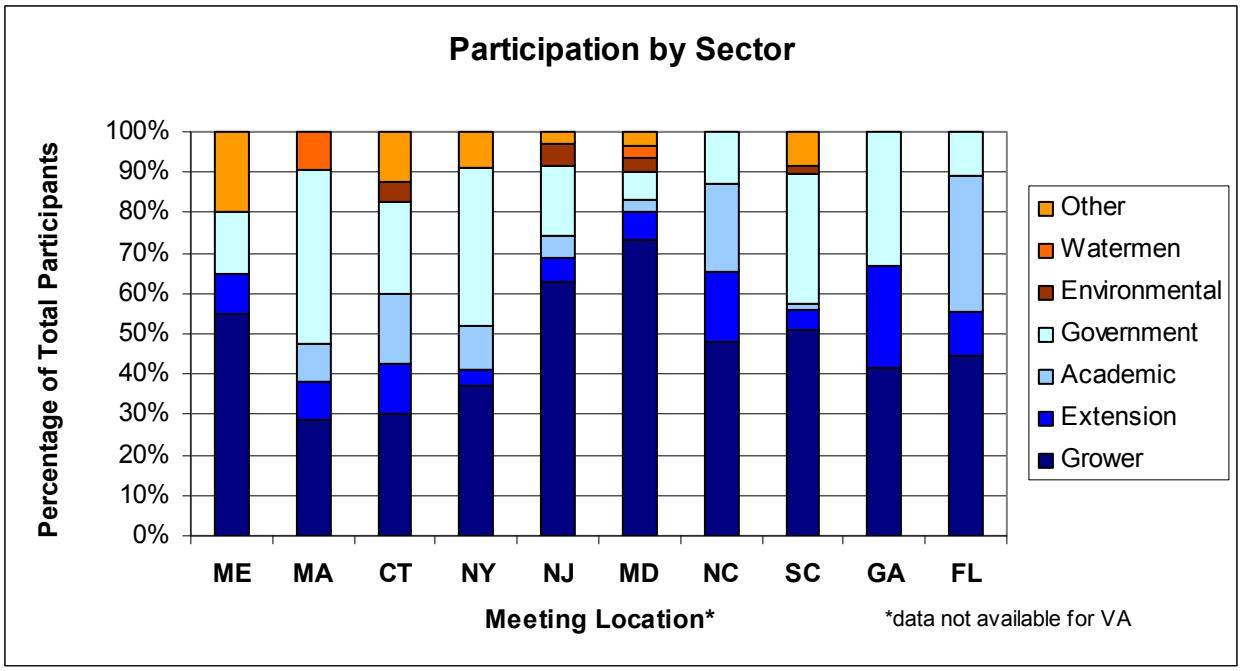
NRAC/ECSGA BMP Stakeholder Meetings

New York	Riverhead, NY	December 13, 2007
Maryland	Ocean City, MD	January 26, 2008
Connecticut & Rhode Island	Meriden, CT	February 25, 2008
Massachusetts	Bourne, MA	March 26, 2008
Maine & New Hampshire	Belfast, ME	March 27, 2008
Maine & New Hampshire	Belfast, ME	September 12, 2008
New Jersey	Tuckerton NJ	December 15, 2008
New York	Riverhead, NY	January 22, 2009
Maryland	Ocean City, MD	January 24, 2009
Connecticut & Rhode Island	Meriden, CT	February 23, 2009
New Jersey	Tuckerton NJ	April 17, 2009
Massachusetts	Buzzards Bay, MA	April 21, 2009

NOAA/ECSGA BMP Stakeholder Meetings

South Carolina	Charleston, SC	November 19, 2008
North Carolina	Atlantic Beach, NC	January 31, 2009
Florida	Cedar Key, FL	March 20, 2009
Georgia	Brunswick, GA	March 27, 2009
Virginia	Williamsburg, VA	November 14, 2009
Georgia	Brunswick, GA	November 16, 2009
South Carolina	Charleston, SC	November 17, 2009
North Carolina	Morehead City, NC	November 18, 2009




Participation by Sector
Percentage of Total Participants
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
ME
MA
CT
NY
NJ
MD
NC
SC
GA
FL
Meeting Location*
*data not available for VA
Other
Watermen
Environmental
Government
Academic
Extension
Grower

Hatcheries

NB. Although the process upon which this work has been predominantly focused, the grow-out of shellfish and aimed at the growers themselves, we thought it appropriate to make some mention of practices that could be incorporated into the shellfish hatcheries which supply seed for the growers.

Facilities Construction

Because of the requirement of having large quantities of seawater, hatcheries must be constructed adjacent to a good source of bay or seawater. This provides all the feed that the shellfish will require through the hatchery and nursery phase. It is not necessary that this water be from the Approved category since these tiny shellfish are not marketed as food, nor consumed. They will all spend at least six months if not much more in the field growing to a marketable size. The only consideration might be a good knowledge of the potential for hydrocarbons and heavy metals reaching the hatchery but this can also be remediated by a charcoal filter to remove the former.

The hatchery facility doesn't have to be anything special and can be as simple or complex as the operator's checkbook can allow. The facility can be as small as the front room of a houseboat to a large edifice. The most important part is that the facility be able to be sanitized to reduce any microbial pathogen contamination which might lead to larval and post-set mortalities.

Hatchery Operations

The term "hatchery" actually describes two or three separate operations. The hatching or spawning of shellfish seed is the most obvious.

To do the spawns, and have food to feed the larvae and post-set, there needs to be an algae production process incorporated into the hatchery itself. This algal production is started before the actual spawning begins so that there is some food to give the broodstock to ripen them for spawning.

In the northern states this algal production can begin in January and may continue for several months. The selected species of algae have been researched for years by the NOAA Fisheries Laboratory in Milford, Connecticut and samples of the unicellular algae are often given to hatcheries for free. Other state or university shellfish facilities may also supply the same.

Algal production requires an area dedicated to this operation. Unless the hatchery is getting live algae from another source, there is typically a separate room used just for algae production. This room will have containers of varying sizes from test tubes to large tanks, in which algae is grown. This can include Erlenmeyer flasks, five gallon water cooler plastic carboys, Kalwall tubes and fiberglass tanks. All containers of glass and plastic are usually illuminated with full spectrum fluorescent light bulbs from behind the shelves on which they sit or overhead, as is the case with large tanks. Most hatcheries use an air bubbler infused with carbon dioxide to improve mixing and algal growth and to adjust pH.

The actual hatching or spawning area may be very simple. Gravid or ripe shellfish are treated to warm seawater interspersed with cooler water to induce spawning. Once they begin to eject gametes (eggs or sperm) individual clams or oysters may be put into individual bowls or dishes to allow for the entire expulsion of the gametes which will then be mixed according the operators preference to maintain genetic diversity.

Following fertilization, the resultant embryos are drained onto very fine mesh screens to remove unfertilized eggs and extra sperm. The embryos then begin a period of being sequestered in larval tanks which are bubbled using air stones to maintain mixing during the time – about two weeks – that the larvae are in the free swimming mode. These larvae are fed daily with large quantities of specific algae. The larval tanks are drained down often to remove dead larvae so they won't contaminate the survivors and to replenish the culture water.

After settlement and metamorphosis, the clam and oyster seed go onto downweller systems which are simply plastic or PVC open top containers with fine mesh on the bottom sitting in a tank of seawater. These are called silos. The water is circulated by spraying into the silos from above as upwelling at this time might suspend the post-set and have them go down the drain. The system is changed to upwelling mode, in which the water

comes from the bottom of the silo, when the seed has increased in size and can stay on the mesh with current passing by them. When water temperatures and sunlight have sufficiently improved, the tiny seed are placed in unfiltered or “raw” seawater. This ends the second part of the hatchery process.

The third part of the hatchery process is the nursery phase where seed from about 300 µ (microns) and larger are placed in silos in upweller tanks where raw seawater is circulated through the tanks in a one pass process to increase the size of the shellfish seed. This process can be continued or the seed, especially clam seed, can be placed on raceways where seawater flows over the seed which feed on the native phytoplankton from the ambient water source until they reach field planting size. This also is a one-pass system.

Hatchery Effluents

There has been little discussion about effluents from shellfish hatcheries. This is mainly because nothing is added to the seawater that flows through the shellfish. There are no drugs used in a hatchery, no pesticides, no herbicides, and the only chemicals would be those nutrients used in algae production and a hypochlorite solution (bleach) often used for disinfection of equipment.

The shellfish can actually sequester bacteria from the surrounding waters and effectively cause the effluents to be cleaner than the water that enters the hatchery or nursery. Several states don't require discharge permits for hatcheries because of these reasons. The only thing that would be flushed out would be feces and pseudo-feces from the growing shellfish which would have little impact if any in the marine environment. The National Pollutant Discharge Elimination System (NPDES) has an exemption for requiring a discharge permit based on pounds of animals cultured – hatcheries and land-based nurseries usually produce much less than this limit – and most states follow this in their SPDES regulations.

Hatchery BMPs

- **Use broodstock that is appropriate for the locale where the shellfish will be grown.**
- **Be aware that seed imported from states where those seed may not be acclimatized to your area.**
- **Use oyster seed that will be disease resistant.**
- **Keep in contact with extension agents or specialists, state agency, or university personnel if unexplained mortalities appear.**
- **Take samples of dead or dying seed for analysis by trained personnel.**
- **Get disease certification for seed imported into your state, if required by state regulation.**
- **Be aware of potential contaminants entering through the hatchery water source and treat it accordingly.**
- **Acquire algal samples for culture from trusted sources.**
- **Keep good records of hatchery/nursery process.**
- **Keep spawns separated from each other during the larval and early post-set process.**
- **Keep water lines as clean as possible, potentially have two water lines that can be alternated to reduce fouling within the system,**
- **Use no unapproved chemicals in the hatchery for the shellfish seed.**
- **If bleach or other disinfectants are used, dispose of them into the municipal sewer system instead of into the marine environment.**
- **Monitor fecal and pseudo-fecal effluents so as not to impact the local waters.**

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