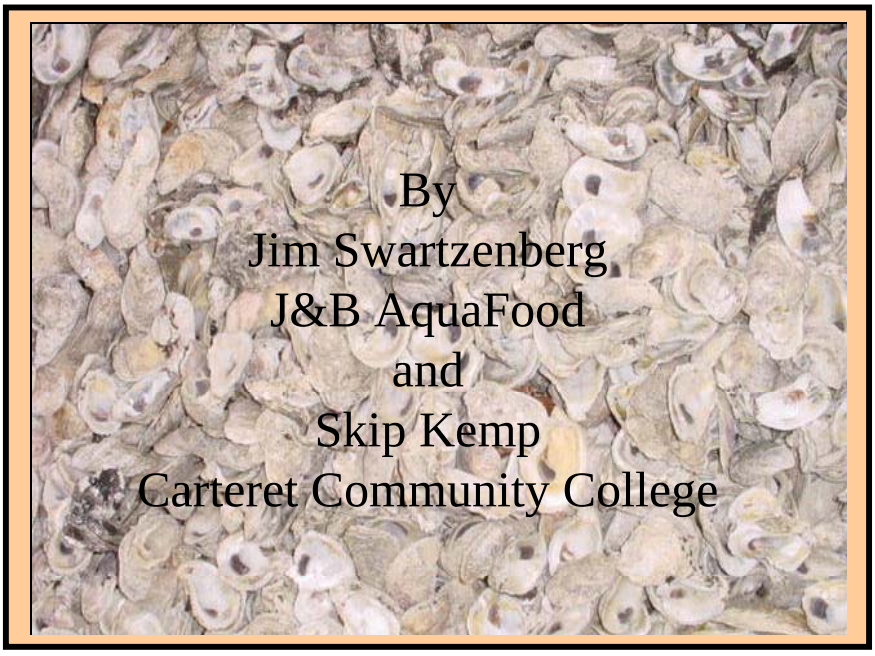

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-CULTURING OYSTERS-

In North Carolina

Sea Grant
North Carolina

What to do and how to do it

Where to go for help

The rewards and the pitfalls

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Introduction

I

Years of Research

This manual is the result of several years of research and development by many people with varying backgrounds. It draws heavily on the experience of others. So in that respect, few of the ideas are really new. After all, culturing oysters can be traced back to the early Romans who found that broken roof tiles that had fallen in the water made good spat collectors. Since then, various cultures have modified those techniques, so that very little is new in this business — just a lot of adaptation and redesigning from the old ways.

For purposes of this manual, oyster culture is distinguished from oyster restoration and rehabilitation. Oyster culture is a sustainable enterprise, requiring a shellfish lease from the state, and is a private, for-profit commercial enterprise. Oyster restoration and rehabilitation can be a private or state effort on public bottom, with no claim of ownership and no intent of economic feasibility. If oyster reefs are harvested, they are not sustainable without additional planting; whereas, oyster culture involves yearly planting and harvesting to maintain a sustained harvest.

For North Carolina, you might say, it all started in the early 1990s when Alfred "Al" Evans, a product design specialist from Tipper Tie, Inc. in Apex, NC, telephoned Philip "Skip" Kemp, then an extension specialist from North Carolina Sea Grant Advisory Service, at that time based at the N.C. Aquarium on Atlantic Beach.

Members of the Oyster Corps carried home the ladders to a total of 30 sites.

Tipper Tie produces and leases the machines that put aluminum clips on the mesh food bags, called chubs, that hold food products such as sausages and turkeys.

Evans had the idea that Tipper Tie's food packaging materials could be used in the aquaculture industry for growing oysters. Although somewhat copied from the mariculture techniques of Washington State and France, he thought his products might be compatible with some sort of new technique and design for growing East Coast oysters.

They labored many months with the idea that they could come up with a system that would somehow resemble agricultural techniques used on a farm. This meant they had to design a mechanized plant-to-harvest system that would be user-friendly and adaptable to fairly large numbers. After all, the French, Japanese, and even Americans on the West Coast had been doing this sort of "oyster farming" for many years. So it just seemed natural, that it could be done on the East Coast, USA.

After about a year, they formed an "Oyster Corps" of volunteer leaseholders who attended several workshops and helped assemble "chub ladders," which were the final product from the Evans/Kemp research project.

Members of the Oyster Corps carried home the ladders to a total of 30 sites. With the blessing of the Division of Marine Fisheries, each participant was granted a 540 square foot research water column sanctuary in which to float their oyster chub ladders.

It was a good year for the test. There was ample rainfall and no hurricanes to tear up the chubs. As we'll see later in this manual, these two factors are vital to the success of a good crop.

The oysters were measured at two, five and fourteen-month intervals. At the best sites, up to 68, 76, and 100 percent of the oysters sampled were of market size at the end of the test.

Oyster growth varied considerably among the sites. The best sites appeared to be in the mid- to high-salinity ranges. However, the best guess at the time was that the growth was probably more closely related to a combination of the energy level and flow of the water, along with the food supply, than it was to the salinity. That debate still goes on.

In any case, the project appeared to be a success, helping to speed up the growth rate of the oysters and to keep them healthy during peak disease seasons. Both Kemp and Evans, along with other marine scientists at Sea Grant, hoped this new method would circumvent the effects of diseases such as dermo that kill oysters in their second year of growth. Ongoing oyster culture research and development projects continue to add to the knowledge base for growing oysters.

Now, more than a decade later, after many different configurations, starts and stops, successes and failures, this manual is being compiled to explain the systems, evaluate their strengths and weaknesses, and outline how to implement them successfully.

If there is one key lesson to learn as you follow the process from start to finish, it is that farming oysters is not an exact science. It simply does not work the same way at all sites, at all times, under all conditions. Farming oysters is a very fluid and flexible process that one must master at a specific place and time. Oyster farmers have to be ready to change midstream and adapt to varying factors. They have to expect that the same end product will not always be the final result and that there will be good years with bumper crops and bad years when the crop is a total loss.

Farming oysters is not an exact science. It is a very fluid and flexible process.

The methods described in this manual are not the end-all and be-all of oyster farming but perhaps a beginning. There has been enough research to provide a long list of lessons learned, of what to do and of what not to do, but even with the best of methods, the uncontrollable forces of Mother Nature tend to prevail. Stretches of drought that result in unusually high salinity for prolonged periods of time, for example, can wreak havoc on any system of confinement that oysters are subjected to. During these times, the sea mosses and sea squirts tend to clog up the containers, slow down the growth of the

oysters, and invite such devastating predators and diseases as mud blisters (*polydora*) and dermo (*Perkinsus marinus*). The same forces that allow for a fast-growing oyster most likely have the same effect on the pathogens that spark the disease. When diseases attack in mass, a crop can be lost very quickly.

Development of a fast-growing, disease resistant strain of oysters is primary for the advancement of the industry. Even then, the new strain would be effective only in an aquaculture situation — and then only as long as the strain can be maintained.

Researchers in Virginia toyed with the idea of a new disease-resistant strain to repopulate unproductive and lost public areas in the Chesapeake Bay, but their attempts so far have ended in failure. They found that their "designer" oyster can augment and enhance the wild population, but then through spawning with wild stocks, it simply reverts to the dominant genetic stock and soon dies out.

Aquaculture is not intended to supplant the wild fishery or other techniques such as relay, tonging, and dredging, but rather to provide a sustainable source of seafood for discriminating consumers. With enough people involved in the cultured oyster industry, the benefits should soon spill over to the waters that surround the leases.

Figure 1: These triploid oyster seed, about two months old, will reach maturity and be ready for market in about eighteen months.

This manual is a follow-on to one that describes raising the seed titled, "Farm Raising of Oyster Seed." Whether you raise your own seed or buy it ready to plant, it might be a good idea to look at both manuals before starting a project. There is an accompanying video to "Farm Raising of Oyster Seed" that provides a brief overview of how some systems work.

This manual examines several off-bottom techniques for raising oysters, including the rack and cage, oyster chub, long-line bag, and bottom/stackable cages. Though it uses the term "off-bottom," some methods that place the oysters on or very near the bottom, but in confined and controlled environments, adapt well to farming techniques.

In addition, this manual presents the tools, techniques, economics, and other business aspects that go into a successful and profitable crop of oysters.

This interactive manual, written in digital format, is intended to be user friendly. It may be printed from a personal computer with a CD-ROM drive and printer. The text comes with helpful tools, which expand the scope and add links to many details unavailable in a printed text. Though it may be printed out and maintained in a binder for ease of use, to experience the full potential, it needs to be accessed on a computer with an Internet hookup.

The reader will find several features helpful. Underlined links are embedded in the text, which can help the reader in several ways. There are a multitude of additional resources and information about oyster culture on the Internet. Many URL links are included for additional information from the Internet such as ➢Kemp's Internet WebSpace. Bookmark links, such as this link to the ➢Introduction are included for ease of navigation through the manual and for cross-referencing. After you jump to a bookmark, you can return to page you just left by left clicking on the back arrow on the tool bar.

As with any digital text, you may use the word search feature if you are interested in some particular aspect of oyster culture. For example, if you want to learn more about economic feasibility, use the word search feature to look up these references in the text. Click on "Edit" in the Toolbar; then click on the binocular icon for "Find"; insert either "economic" or "feasibility" or both words in the dialog box, click, and find the references.

To access ❖ Ask The Experts, you'll need Microsoft Windows Media Player, which you may download at http://www.microsoft.com/windows/windowsmedia/players.aspx. Then you simply need to click on the icon, and a brief video will play on the machine. For example, click on ❖ [Buying Seed], and you'll get a brief video overview of what to look for when buying oyster seed.

We hope you'll find this manual refreshing, different, and fun to follow. And we hope it will bring you to a new level of understanding about oyster culture in North Carolina. Perhaps this new understanding will lead you to get involved in this exciting, new, and profitable business.

Icon Key

- ➢ Links to other sources
- ➢ Links to URL
- ❖ Ask The Experts

II

What are cultured oysters?

Farm-raised: Lite, Pure, and Fresh

The oyster industry is rife with labels. From New York's "Bluepoints" to Florida's "Apalachacolas," it seems that oyster lovers from far and wide have a great urge to set their oysters apart from the others.

Most oysters could lay claim to the term "farm-raised" simply because they came from someone's lease. There is no legal standard. The terms identifying one oyster from another are much abused and as subjective as "lite" in lite beer, "pure" in pure bottled water, and "fresh" in farm fresh eggs.

Such is true for "cultured" oysters. Any particular oyster, such as the Bluepoints, Apalachacolas, Stump Sounds, and others, may claim to be "cultured" along with their regional label, but that doesn't necessarily mean they are cultured unless they are grown on a farm from hatchery raised seed.

The terms identifying one oyster from another are as subjective as "lite" in lite beer, "pure" in pure bottled water, and "fresh" in farm fresh eggs.

The name "Farm-raised Cultured Oysters" means the oysters were spawned in a hatchery and raised from seed in a controlled environment. Though it is subject to abuse, the label "cultured" should add value to an oyster because it will be a cut above what comes from the wild. The cut above means that it will be grown and marketed by responsible growers and will be cleaner, fatter, more select, and adaptable for the half-shell market.

Cultured oysters are better. The technique alone allows for a more selective crop. Unlike their "bottom-raised" counterparts, the selection process begins in the hatchery and continues throughout the life of the oysters, culminating at harvest. Good hatcheries "high grade" their stock from the larval stage on and discard the slow growers. Good farmers continue the grading process by picking out the doubles, the smalls and the deformed. They end up with the top of the crop — all singles, uniform in size and easily cleaned oysters.

A cultured oyster grows faster than a bottom-raised oyster because it can take advantage of the greater food and oxygen supply in the upper levels of the water. That extra nutrition allows it to reach maturity before many harmful diseases and organisms can affect or destroy it. In North Carolina that translates to a harvestable market size

oyster in 18 to 24 months depending on several growth factors such as food supply and annual rainfall. What is harvested is a healthier and better looking oyster.

Dermo, for example, attacks and kills the oysters in about 24 months. Though some dermo may be present in cultured oysters at the time of harvest, most oysters will have been harvested before their second summer, and therefore will have averted the attack.

Cultured oysters are always grown on leases in "open" or "conditionally open" waters with strict monitoring by N. C. Shellfish Sanitation. Because of their faster growth, cultured oysters have thinner shells and therefore, greater meat yield per oyster. In most cases, "cultured" translates to "better handling." Oyster farmers often move their product from the water to the cooler and on to the consumer either directly or in a rapid pre-arranged marketing system. This means quicker turn-around time between harvest and consumption.

Figure 2: Cultured oysters of various sizes, one year old.

Cultured oysters use modern farming techniques that are adaptable to both large- and small-scale operations. This allows for a more regulated end crop, and though these techniques may at times add labor to the overall process, the reward is a crop that commands a higher selling price at market.

❖ *[Ask Matt Parker]*

III

Business Requirements

Leasing, Location, Facilities and Labor

The obvious first step is to have a shellfish lease. In the case of cultured oysters, most likely that will translate to a bottom lease with a water column lease amendment. The exception could be a bottom lease without the amendment if only bottom cages are to be used and if they remain within six inches of the bottom.

The advantage of leasing the water column is that it provides area off-bottom to establish a nursery for seed, making handling a bit easier and saving money in the process. When small mesh nursery cages are placed on or near the bottom, they tend to foul up quickly and require more maintenance to stay clean lest the seed will be stunted or lost. Getting the oysters up into the water column will avert many problems. Fortunately, new proposed legislation promises to reduced the cost of a water column lease amendment to an affordable price.

A water column lease amendment allows the lessee to use the water from the top to bottom. So, a "water column" gives a person control of both the bottom and the column of water above it, but the lessee still may not exclude or hinder normal navigation. By that same rule, a boat may not interfere with the normal operations of the water column holder.

A water column is preferable for raising cultured oysters. Although it does not offer unlimited control of the area, it does allow unlimited (legal) usage of the water from top to bottom. If someone wants to put a crab pot, net or other device in a water column lease, for example, they could do so as long as it does not interfere with the shellfish operation. Normally people leave such marked areas alone.

A water column is preferable for raising cultured oysters.

A water column amendment goes along with a bottom lease, and a bottom lease may be purchased from a current leaseholder, sub-leased or taken up anew.

Leases are treated as real property. They are surveyed, mapped and recorded at the Division of Marine Fisheries. They can be bought, sold, traded, willed or sub-leased. A person who is looking for a lease must ask, "Should I buy, sub-lease, or establish a new lease?"

Buying an existing lease has its advantages. Many of the old leases were established in prime areas, which would no longer be acceptable for a new lease. An

existing lease does not require a new survey, and usually posts and signs are in place so that the new owner would just have to repaint the old signs or add a few new ones. Old leases have production records that can be verified by the Division of Marine Fisheries, and the transfer process is quite simple.

On the other hand, many of the old leases are more than ten acres, and if you're just starting out, that may be a bit too much. In addition, many of the old leases contain areas that are unsuitable for cultivation, such as thoroughfares. However, most of those drawbacks would be evident upon inspection of the area. It is essential to check the production record that comes with a prospective lease purchase. The new owner inherits that production, good or bad, and it may not be sufficient to renew the lease in the near term. In addition, the lease may be located in a marginal area prone to excessive closures because of pollution. If so, the sanitation problems would most likely get worse over time rather than better.

Sub-leasing has much the same advantages and disadvantages of buying an existing lease with a few exceptions. For someone just getting his or her feet wet in the shellfish business and wanting to see what it's like, perhaps a sub-lease agreement is an easy way to "check things out." Each sub-lease agreement is different. It would pay to know the owner of the lease, as well as the motivation behind sub-leasing the area rather than working or selling it. The biggest drawback is that situations change, and without an iron-clad agreement, the owner may decide to pull out at any time for a variety of reasons, leaving the sub-lease investment in jeopardy. A sub-lease agreement of less than five years isn't worth much, unless it carries a good renewal clause.

An important next step is to call or visit the Division of Marine Fisheries, Resource Enhancement Section.

The good thing about a new lease is that it might be able to be located in front of a person's property or at some other site more convenient than anything available for purchase. It can be whatever size and shape desired, that is up to 10 acres for oyster culture or 5 acres for clam culture.

It takes three to six months, and sometimes even longer, to obtain a new lease, so it is wise to begin the process early and ensure that all the details are taken care of as they come up

In North Carolina, the Marine Fisheries Commission — the regulatory body of the Division of Marine Fisheries — grants leases and makes regulations regarding leased bottomland. According to regulations the Commission has enacted, new leases must meet the following standards: [See Appendix D, Marine Fisheries Rules and Regulations]

(A) They cannot contain a natural shellfish bed, which is defined as 10 bushels or more per acre. Marine Fisheries representatives can usually determine this upon initial inspection.

(B) The lease area must not be closer than 100 feet from a developed shoreline, unless it is your own. (A lease may be excluded from this rule if a notarized consent is obtained from the riparian landowners. Beware, though, that a riparian landowner may rescind the consent at will.)

(C) The leaseholder must plant a minimum of 25 bushels of seed or 50 bushels of cultch (or a combination of the two) per bottom lease acre or 100 bushels of seed per water column lease acre every year.

(D) The leaseholder must plant a minimum of 25 bushels of seed or 50 bushels of cultch (or a combination of the two) per bottom lease acre or 100 bushels of seed per water column lease acre every year.

(E) The leaseholder must produce and market at least 10 bushels per acre from a bottom lease or 40 bushels per acre from a water column lease per year.

Having reviewed the rules and regulations and chosen an area for the lease, an important next step is to call or visit the N.C. Division of Marine Fisheries Resource Enhancement Section, obtain an application form, and ask for a free inspection. The Division will send a representative to look at and evaluate the area and perhaps discuss with you the possibilities of obtaining a lease. This "free" evaluation is a good idea because the next step is to submit an application form along with a non-refundable $100 deposit. ❖ [Ask Craig Hardy, N.C. Marine Fisheries]

By the time a deposit is placed, a prospective leaseholder should be fairly sure that he or she is going to get what they want. Otherwise, if the request for a lease is denied, they will lose the $100 deposit. It is essential to talk to other leaseholders, and have a good business plan in hand. The N.C. Shellfish Growers Association may be able to provide the names of nearby members. Consult with an expert who can provide good, technical advice. ❖ [Ask Skip Kemp, Carteret Community College] Some areas are more "lease friendly" than others. If you get into a turf war with someone who doesn't like leases, you could be in for some expensive litigation, and you could lose your $100 application fee, so it's good to know what lies ahead before moving on.

A business plan is a roadmap to making money. There are plenty of references available at libraries and online, and community colleges usually have a small business center that will provide you with both technical and hands-on assistance. You could use some of the projections in this manual as a starting point for your own cost and profit analysis. Again, it pays to talk to others who have been through the same experience. ❖ [Ask Matt Parker, Aquaculture Business Specialist] [View Sample Small Business Plan]

A business plan is a road map to making money.

The prospective leaseholder should do a preliminary survey to evaluate the endemic shellfish population. A single clam, oyster, or scallop, regardless of size per square yard, indicates borderline leaseable area. More than one shellfish per square yard, on average, will likely indicate a natural shellfish bed and will make the area unavailable for leasing.

The application must be accompanied by a map or diagram that shows the location of the lease with detail sufficient to permit on-site identification and location, and the prospective lease must be marked with posts at each corner. Two-inch PVC pipe is ideal for marking leases.

A "management plan" that explains to the Division of Marine Fisheries just how you plan to manage your lease must be drawn up and submitted with the application. They don't care whether you make money or not, but they do care how you are going to operate in the public trust waters, and they insist that you plant and produce the required

amount. So the management plan should be fairly comprehensive and should outline your methods and anticipated results. Details of the management plan are included in the Marine Fisheries rulebook, and a sample management plan is located in Appendix E, Sample Lease Management Plan.

The completed application form, map, and management plan along with a $100 application fee must be submitted to the Resource Enhancement Section, Division of Marine Fisheries, P.O. Box 769, Morehead City, NC 28557-0769. If the application is accepted, you will be asked to post signs provided by the Division on your corner stakes to let the public know of your intentions. In addition the Division will post a notice in the legal section of the local paper. They will then hold a public hearing to see if there is any opposition to the proposed lease. If any opposition is suspected, it may be a good idea to bring supporters who can speak on behalf of the proposed lease.

If the lease is approved, it will need to be surveyed at the leaseholder's own expense. One might expect to pay $400 to $800 for a survey depending on the complexity of the site.

Good habitat and the right location can make a difference. It's important to know that one place is better than another, so a prospective leaseholder must answer the question, "Where is the best place to grow oysters?" A simple answer would be "almost anywhere," because the techniques presented in this manual usually can be adapted to the surroundings. But that's not always the case, and a better answer is to locate the lease in an area that offers the best habitat and practical location for the situation. There are several factors that need to be taken into account: ❖ [Ask Patricia Fowler]

- **Accessibility.** It goes without saying that a site should be accessible, because if a person can't get there, it doesn't show much promise for leasing. Being able to drive to the lease area is an advantage, but many good areas can be accessed only by boat.
- **Security.** Poaching, vandalism and damage to the site can be minimized by adequate surveillance. If the site can be watched from the shore, especially from a home, surveillance becomes much easier.
- **Salinity.** Oysters can live at salinities as low as five or six parts per thousand for a few days, but they thrive at salinities above 20 parts per thousand. The salinity is usually greater and more consistent in areas with active tidal flushing and a relatively small watershed. Areas that produce extreme fluctuations in salinity should be avoided. Creeks or rivers draining large watersheds are more likely to produce damaging freshwater influxes. Rainfall runoff leaves large watersheds more slowly, and prolongs the exposure of shellfish to low salinities and runoff pollution.
- **Tides.** Ideally the tidal range should be above 12 to 15 inches. Adequate tidal flushing ensures a mixing of the water, delivers food, removes wastes and stabilizes the salinity.
- **Pollution.** Avoid polluted waters and shy away from others frequently closed because of pollution. A check with N.C. Shellfish Sanitation can quickly tell

a prospective leaseholder about the status of the potential lease area. ([Ask Patricia Fowler]

- **Substrate.** Most bottom types can be adapted to oyster culture, but the ideal is a firm bottom that will allow a person to walk freely around the area.
- **Depth of water.** It would be difficult, although not impossible, to operate in water that is deeper than a person's chest. Ideally, the water should be about waist high. A water column lease should have enough water at low tide to provide for flow at the bottom of the cages without being silted or sanded in.
- **Dissolved oxygen.** Oysters can stand relatively low dissolved oxygen levels in water, but their growth will be poor, and they will become ever more susceptible to disease. At low oxygen levels, the animals expend more energy pumping water through their bodies to get the necessary oxygen. Therefore less energy is available for growth. Usually water will contain adequate dissolved oxygen if it is in the upper portions of a water column or if it is subject to mixing by the tides, current, or winds.
- **Flow.** There must be sufficient water exchange to carry wastes away and to bring in food. Too much flow may wash away cages or chubs; too little flow may cause excessive silting. The ideal lease would provide plenty of water flow to transport food, for example near a creek or marsh that ebbs and flows with the tides.
- **Turbulence.** Areas open to long distances where waves can build up and wash across the lease and wash away cages and such are suspect and probably should be avoided unless a solid plan of dealing with the situation is in place.
- **Food sources.** The ideal lease would provide a good source of food for the crop and plenty of water flow to transport that food, for example near a creek or marsh that would ebb and flow over the lease with the tidal exchange.

As in any venture of this sort, there has to be a place to conduct business, and in the case of maricultured oysters, there needs to be a facility on shore to handle product. The place to conduct business can be as simple as a home office, but the facility ashore may need to be a bit more elaborate depending on the extent to which a business wants to get involved.

Figure 3: A shore-side facility can allow for ease of handling the product from harvest to market.

At a minimum, the shore area should include a place to dock or launch a boat and unload product. It should have electricity, three phase, if possible, and ideally space for a walk-in cooler and a work area to uncage, wash, sort, and pack oysters. Without these accessories, a farmer would be doomed to selling the product as it comes out of the

water and probably to a middleman at a lesser price. That's not necessarily a bad idea, and many a start-up operation may be wise to work that way. The bottom line, though, is the better equipped the operation, the more options become available for handling product.

With a shore-side facility such as what has just been described, a farmer could install raceways and upwellers. That would allow the business to purchase small seed and grow them out to a size suitable for an in-water nursery. (More about this in Chapter IV.)

At a minimum, the shore area should include a place to dock or launch a boat and unload product. It should have electricity . . . and ideally space for a walk-in cooler and a work area . . .

If the business is going to process and hold oysters in a cooler, it needs to be licensed as a shellstock dealer. That carries with it sanitation requirements such as a toilet and hand washing facility. An outdoor sink and toilet would do. For more information, contact N.C. Shellfish Sanitation in Morehead City or Wilmington and ask for an evaluation of the proposed site. ❖ [Ask Patricia Fowler]

There will need to be a place to store tools, equipment, and materials, but that does not have to be located on valuable shoreline property. Items such as oyster boxes and/or bags, cages, mesh, harvest tags, and trip tickets that come with being licensed can quickly load up a storage shed. Most of the needed materials are identified in the sections of this manual that deal with culture methods, because each method requires a different set of materials.

Some basic and inexpensive tools and equipment are essential to a smooth running operation. First and foremost would be waders, nubbing irons to break apart oysters and knock off barnacles, hog rings of various small sizes, and a hog ring crimper. A toolbox with the basics for any repair job is a must, stocked with a set of sockets, pliers, vise grips, hammers, PVC cutter and saw, wire cutter, set of screwdrivers, a set of open-end and box-end wrenches, a crescent wrench, pipe wrench, and strap wrench. As the business grows and finds a need for more tools, they can be purchased. It is essential to have the right tool handy when something needs repair. ❖ [Ask Patricia Fowler]

Last, but hardly least, is the question of labor. Do you know the extent of the labor that will be required to manage the size of crop you are intending to grow? Are you physically up to the job? It often requires moderate to heavy lifting, and it is often handy to have a second set of hands to help with the work. The work comes in spurts, so at times you may need help while at other times paying help would be a waste of money. You may want to consider partnering with someone in your same circumstances who could both share the work and the start-up costs. You could hire help, but then you take on the added dimension of

***Sometimes it's quite handy to engage family members in the* operation. They could work for the good of all.**

payroll and figuring all the taxes and such that come with it. Sometimes it's quite handy to engage family members in the operation. They could work for the good of all, and in the case of children may be able to wait for their pay until after the harvest.

Figure 4: Sometimes chores require the services of many people. Here workers move 300 shell bags from larval remote setting tanks.

For help getting your business together check out the Small Business Center at a community college in your area. ❖ [Ask Ann Shaw]

Notes

IV

Raising and Acquiring Seed

Where to Get It and What to Do

Should an oyster farmer raise his or her own seed or purchase some ready for grow-out? That's a question each farmer will have to answer depending on the available facilities, available labor, capital, and experience. In either case, a good basic understanding of hatchery and nursery practices and the knowledge of differences in what is available is a prescription for success.

Figure 5: An upweller can be used to raise small oyster seed when the necessary facilities are available on shore.

Eastern oysters come with different genetic markers depending upon their area of origin. Research has shown a distinct genetic difference in a northern oyster and southern oyster with the dividing line being roughly at the Virginia-North Carolina border. A third and different genetic marker is found in Gulf Coast oysters. Each of these genotypes brings with it a set of characteristics that define its type and reflect the environment in which it historically developed.

Current research on stock differentiation is narrowing in on the premise that within each genetic group are other more subtle differences and adaptability characteristics, which the oyster has taken on over the millennia through the processes of natural selection and adaptation. In other words, an oyster originating from the Cape Fear River may perform differently than one from Stump Sound, no matter where it is grown out. Studies in growth and adaptation characteristics have just begun to validate differences in oysters taken from different areas relatively close in proximity.

It makes a difference where the brood stock comes from . . .

It makes a difference where brood stock for the seed comes from, although there is little scientific documentation on which works better in one area or another. The idea is to find out by trial and error.

Annual climatic changes such as an el Nino rainy season or a drought that tend to alter the normal salinity and flow of water may cause a certain strain to under-perform for a year or two, but in the long run, once a strain is proven to work well in an area, it would probably be a good idea to stick with it.

Figure 6: These brood oysters are beginning to spawn in a tank that allows regulated water temperatures to begin the process.

What goes on in the hatchery is probably just as important as the strain. If quality control procedures are in place, and an educated approach to spawning and nursing is made, that in itself can make as much if not more of a difference to the quality of seed as the selection of the brood oysters. Although spawning and rearing seed oysters is a rather complex operation, here are a few things to look for:

❖ [Ask Skip Kemp]

Brood Stock Selection —Good brood stock comes either from the best of local waters or from a strain that has been selectively developed in a hatchery. Good stock generally consists of very mature specimens that have obviously weathered the ravages and diseases that come with time or from their hatchery-developed offspring. Desirable characteristics of a brood oyster may include such traits as resistance to disease as determined by the age, rapid growth, shape and deep shell cup. Not all brood oysters will be big and old, because most of those will be female, so it may take a few two- or three-year-olds to find the males. Some hatcheries, especially those with a limited selection of brood oysters will inevitably take whatever they can find, but a good hatchery will go to great lengths to find the best brood oysters available.

Figure 7 Many hours of careful attention to detail are spent in the hatchery to ensure a quality crop of oyster seed.

- Conditioning — Under normal circumstances hatcheries collect spawning stock in January or February, clean them of fouling organisms, and store them in trays placed on sub-tidal bottom or suspended sub-tidally from a pier near the hatchery. The gonads ripen

naturally as ambient water temperature and food levels increase. Oysters can be conditioned out of season by holding them in chilled seawater while feeding them a diet of cultured phytoplankton for six to ten weeks, but this later method is rarely used because of the added expense. Spawning an oyster that has not been conditioned can lead to weak spawn and less than desirable offspring. [See Appendix C, Life Cycle of an Oyster.]

- High Grading — A good and healthy spawn will produce far more larvae than is needed or than can be reared to produce good quality seed. Therefore, the weak and diseased must be culled constantly from the batch. Immediately after spawning, eggs are collected and graded according to size by rinsing them through appropriate–size sieves either before or after fertilization. The larger eggs have higher lipid content and produce more viable larvae. Most hatcheries discard the smaller eggs in favor of retaining only the best of the crop. The succeeding stage larvae are much hardier than the embryonic stages. They are held in large rearing tanks and fed a high lipid and protein diet. The tanks are drained about three times a week and at each change the larvae are sorted and collected through a series of descending size sieves. The larvae are inspected for signs of disease. Good hatcheries discard both diseased and slow-growing larvae, thus leaving a robust, highly-graded larvae. The larger the spawn and higher the grading, the more select will be the resultant seed.

The larger the spawn and higher the grading, the more select will be the resultant seed.

Figure 8: This six-month-old triploid oyster at more than three inches is nearly ready for market. It was spawned in mid-April 2003.

- Ploidity — A chemical process during spawning along with other, more modern procedures can alter the number of chromosomes in an oyster and render it sterile. We call an oyster a triploid when it has three sets of chromosomes and a tetraploid when it has five sets. Both the triploid and tetraploid are sterile, and both are produced from related but different processes. A batch of triploid will not be 100 percent sterile, and they have been known to revert to diploid after a year or so. Tetraploid oysters, on the other hand, are 100 percent sterile.

Although some reversion processes have been recorded in field experiments, none have ever been observed reverting to a viable diploid. Not every hatchery is equipped with the knowledge and certifications needed to produce good triploid or tetraploid oysters. However, as demand increases, more should come on line. The advantage of triploid or tetraploid oysters is that they reserve their energy to grow during periods when diploid oysters are spawning and therefore contain higher concentrations of carbohydrates, expend less energy, grow faster, and retain a better condition than diploid oysters. This is vital to an oyster farmer especially during the second summer just prior to and during the early harvest.

Figure 9: These 2,000,000 eyed larvae are ready for setting.

The options for purchasing seed are rather simple, but an option does not in itself guarantee a good seed:

- A farmer can purchase eyed larvae, set it, and nurse it in an onshore upweller/raceway system. Detailed instructions and guidance can be found in a companion manual to this available at NC Sea Grant. Although eyed larvae is the least expensive seed product, a farmer will need to have adequate on-shore facilities to set and nurse the seed to a size that can be safely placed in an in-water nursery system. Such a system would require at a minimum, water and electrical service, a salt-water pump, setting tank, and upwellers. The cost of raising the seed would include the electricity and labor to run the system.

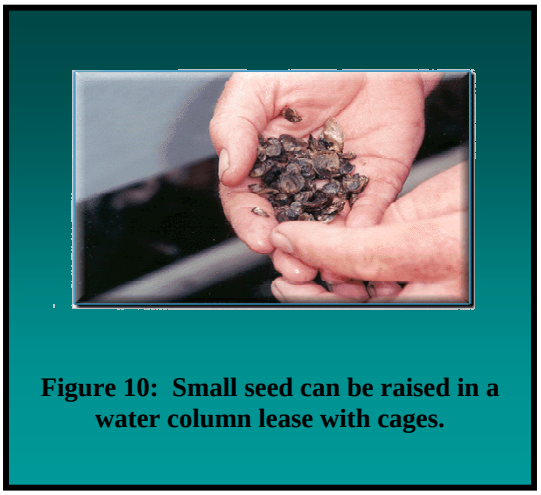


Figure 10: Small seed can be raised in a water column lease with cages.

- A farmer can purchase small, 6-8mm seed and nurse it in floating cages in an in-water nursery system until it is large enough to put into a grow-out system. The only requirements for this option would be the water column lease, floating cages, and labor.

- A farmer can purchase ready-to-plant oyster seed at 30mm or greater and plant it in ½" or larger cages in a water column lease, work it, and put it into its final grow out system.

Whatever the case, young seed will require some sorting to cull out dead oysters and, if necessary, the double and triple clusters. A good salt bath and drying as described in Chapter VII is needed to control predators and some diseases. Thinning the rapidly growing small seed to control crowding and thereby improve growth and lessen mortality is a must. About a liter of seed per cage will allow plenty of room for growth.

Figure 11: Large, ready-to-plant seed is the easiest — and the most expensive.

Finally, if seed is acquired from any out-of-state source, the importer must apply for and obtain an import permit from the Division of Marine Fisheries. ➢ [Check with DMF, Resource Enhancement Section] These permits require that the seed or larvae be tested for disease prior to shipment, so it is important to apply for the permit at least a month before the expected shipment date and to ensure that the out-of-state supplier understands exactly what is required.

Notes

V

Culture Methods

Off-Bottom Techniques that Work

Traditional farming of oysters in North Carolina has its limitations. Most farmers relay intertidal cluster oysters from state shellfish management areas to their leases. Then, depending on the size of the relayed stock, they wait from a few months to two or three years before harvesting with a skiff, a culling board, and a set of tongs. It's a fairly simple process with little investment and time-tested results.

Many farmers supplement plantings with loads of cultch, either oyster (or other) shells or marl spread across their lease. If it is a good year with a high spatfall, the cultch will take on plenty of spat. Then, after a two- to four-year wait, those oysters, less mortality, can be harvested in the same manner as the relayed stock.

Farmers who have access to an on-shore system can "remote set" oyster shell in shell bags and then seed their leases with shell that have spat attached. This method has just recently been tried in North Carolina, and has produced very good results. It is far superior to planting unseeded cultch and hoping Mother Nature will take care of the rest. A completed Fishery Resource Grant report on the subject including how-to instructions are available from ➢NC Sea Grant.

Figure 12: Shells in mesh bags can be "remote set" with oyster larvae to produce thousands of shells seeded with spat and ready to plant on a lease.

In any of these methods, very little attention is given to the crop once it is planted other than maintaining signs and making sure other people don't help themselves.

A few techniques such as aging the oysters to produce a larger and heavier crop and block planting to maintain control of the crop may add some value, but the fact remains that the longer the crop stays in the water, the more mortality and smaller the harvest.

With a bottom crop, experience is the best teacher. The longer a person works at it, the more adept he or she will become at learning the nuances of the site that go into producing a good crop. Sources of technical support and supplies are available in Appendix G, Sources.

A number of systems are available commercially for growing oysters in a controlled manner. While each has its own unique advantages and disadvantages, they generally have a few characteristics in common:

- Off-bottom culture is adaptable to a wide variety of situations and sites. It can be carried out in many areas otherwise unsuitable for bottom culture.
- Off-bottom culture offers ease of handling large numbers of oysters.
- Off-bottom culture promotes a shorter grow-out time. The warming of surface water during the early spring and late fall, along with an increased availability of food in the upper levels, extend the growing season while reducing the growing time.
- Off-bottom culture allows for biofouling control. Many systems integrate a component of air-drying to accelerate decomposing of fouling organisms.
- Off-bottom culture embraces modern farming techniques adaptable to mechanized assembly-line systems.
- Off-bottom culture employs reusable materials.
- Off-bottom culture is relatively easy to use and maintain.
- Off-bottom culture makes optimum use of the available space.

There are a wide variety of materials and techniques used throughout the world in off-bottom culture. Some, such as the bamboo racks and poles used in Japan simply are not practical in the shallow North Carolina estuaries. There are a few systems, however, that together would apply to almost any and all locations. Some of the systems that aren't included in this manual are very similar to, adaptations of, or combinations of those described in the following paragraphs and may be well suited for farmers in North Carolina.

The following four systems — bottom/stackable cages, floating chubs, adjustable longline system, and racks and cages incorporate the basic principles of available technology. Each must be adapted to a particular situation. Some will work where others won't, so prospective culturists must evaluate their situations well before deciding on a particular system. Except where noted, each system requires the use of a water column lease. See Chapter III for an explanation

Figure 23: As many as ten trays could be stacked to take advantage of the entire water column.

of leases and instructions on how to get them. See ➢Appendix H for a side-by-side comparison of the systems.

- Bottom/Stackable Tray Culture. Stackable trays make an excellent option for the shellfish farmer. They have the benefits of mobility, greatly reduced labor in maintenance, adaptability to many growout schemes, and durable construction.

  Both plastic and plastic-coated wire trays are available from a variety of ➢sources.

  These trays can be used for growing oysters subtidally and can be quite effective given the right set of circumstances.

  Usually trays are loaded with oysters and placed on the bottom as singles or stacked in groups of ten or fewer. Depending on the type of tray, they may be interconnected to avoid sliding. Because of their versatility, stacking trays can be deployed in a variety of places: on-bottom, midwater, and on the surface. If off-bottom application is warranted, they do well when hung from rafts or piers. Selecting an area with water flow of less than three knots is ideal. Weighting or anchoring the trays may be necessary in areas of greater water flow.

  The immediate advantage of stackable trays is that the oysters remain in the water 100 percent of the time and therefore tend to grow faster than oysters in a rack and cage system that goes through a daily drying period. It is a very basic system to plant and harvest because it takes only putting the oysters into the trays, putting the trays into the water, and then taking them both out.

Seed Size		Oysters per Tray 4 Liters
Up to 15 mm		Use scrim cloth liner or spat bag to prevent seed falling thru 12 mm tray mesh
40mm - 1.5”		1,200
50mm - 2”		1,030
63mm - 2.5”		900
75mm – 3”	(market size)	800
80mm - 3.5”	(market size)	750
85mm – 4”	(market size)	675

Figure 14: Stocking Density Chart for 48” X 48” X 4” Trays.

The trays are open and can easily be thinned while in the water. Under ideal conditions, the stackable tray should produce a relatively barnacle free

oyster. The only investment other than the seed oysters is in the reusable trays themselves. Some culturing of the seed may be necessary since the trays require a rather large seed that won't fall through the one-inch mesh squares. Smaller seed could be placed in the trays if a removable fine mesh screen were to be placed on the bottom. It is possible that a single tray could be placed on the bottom of a lease without the requirement of a water column amendment.

Each year seems to produce a different set of challenges for the farmer. During rainy years, for example, oysters grow without much effort given to their position in the water or level of care. Other years, especially dry ones, encourage an abundance of fouling tunicates, encrusting bryozoans, tube worms, clogging seaweed and the like and wreak havoc with any subtidal devices. During a drought, what sometimes results is a mass of encrusted, mostly dead oysters. During the "bad times," the Non-Insured Disaster Assistance Program can provide enough disaster relief to save a farmer from going out of business and provide him or her with enough start-up money for a follow-on crop.

Under normal conditions, trays should be inspected at regular intervals, three to four times during the warm season, and at least once during the cold weather for fouling and fast growers. Each time the trays are inspected, the crop should be sorted or separated by sizes and thinned to the proper stocking density. Additional cages should be added as necessary.

Each site must be evaluated independently to see if it is suitable for stackable trays. Shallow areas with good flow and low salinity seem to do better than deep, high salinity areas, however in shallow areas, fewer trays can be stacked. If the trays are to be set on the bottom, they must be in an area of low turbulence or they will silt in. Legs may be attached to the bottom of the cages to raise them off the bottom and offset any silting in (See **Figure 15**).

In deep water, buoys or markers must be in place to keep boat traffic from running over the trays on a low tide.

Planting is a simple matter of placing the appropriate number of seed oysters in a tray, placing the trays on the bottom or on a stack, and spreading the oysters uniformly across the shelf. A periodic check to ensure that the oysters have not washed to the side of the cage may be necessary, especially where boat traffic or other water flow issues may cause movement of the oysters. If the oysters pile up on one side or another of the cage, they will have to be spread back out.

Figure 15: Legs can be added to bottom/ stackable trays for increased circulation and reduced silting.

When the oysters are fully-grown, a cage with 650 oysters including normal biofouling may weigh as much as 200 lb. Harvesting can be handled with two people lifting the trays out of the water. One person with an outrigger winch could handle the cages alone. After the cages are removed from the water, the oysters can be dumped out and culled, with the undersized ones returned for further growth. ❖ [Ask Jim Swartzenberg]

- The Floating Chub. This method has been tested in several different configurations and variations. It has produced consistently deep cupped and fat oysters. Designed with assembly line production in mind, it offers large- and small-scale operations the opportunity to employ modern farming techniques. The system can be managed from a boat, and it includes an element of security because it cannot be pilfered easily.

  The floating chub has on occasion produced a failed crop because it could not be harvested quickly enough. In one test, as the oysters grew and got heavier, the chubs sank to the bottom, and the oysters smothered in silt. This event could have been averted if the operators had not planted more than they could handle and if they would have had a better plan for harvesting the crop. It may also been averted by adding more floats to the chub lines.

  The system has a few limitations that if kept in mind can mean the difference between a successful crop and dismal failure.

Figure 8: Floating chubs.

The floating chub method requires the use of a water column lease, a work area ashore, enough capital to grow the first crop, and a well thought out plan for harvesting and selling the crop.

It would be prudent to try a half-acre or less at first, perhaps purchasing seed oysters large enough to put directly into the chubs. The differences in performance among sites and the lessons learned from the first crop make jumping into this idea with eyes wide open a must. If all goes well on a first try, a farmer will then know how much to expand to build a bigger operation.

Although raising oysters is a very site-specific undertaking, growing them in a floating chub affords a wider range of suitable area. The best spots are in

bays with good food supply. Flow of water is not as important as it is with other methods, except in cases where the flow is too extreme such as near a channel or quickly flowing river. Chub oysters subject to a great deal of wave energy have not proven as well as those in calmer waters. Lease areas where the bottom is soft and heavily silted, and where it cannot support bottom grow-out, are ideal for the floating chub.

No matter where the chubs are located, there will be a degree of fouling, and the oysters in a low-energy area may be more subject to growing into the mesh. The only sure way to get a good area is to try a spot or to look around at what other leaseholders in the area are doing. It may be a good idea to talk to other people who have tried the chub method and perhaps ask them to help evaluate the proposed site.

Figure 17: The clipper machine assembly line can be built with wood and plastic products. Although a clipper machine speeds up the process, the same process can be performed with hog rings.

Regardless of what size the seed oysters are when purchased, the size of the chub mesh dictates the size of seed that can be planted. As a rule of thumb, use a seed size that is about three times the mesh size. Therefore, a 5/8-inch mesh would require a seed of about 2 inches. Smaller seed tend to either slip through or grow into the mesh. As a general rule, the larger the seed the better the crop. Larger

Figure 18: Styrofoam Cutter.

seed tend to reach maturity faster and therefore can avoid some of the problems with barnacles, overspatting, and the like.

Mechanizing the process as much as possible is the goal when dealing with large numbers of oysters. With just a few oysters to put into chubs, hog rings and pliers will work well, but as the numbers increase, a clipper machine and assembly line process will make loading the chubs much easier.

Figure 19: Chub mesh is sleeved onto a piece of 6" sewer pipe.

Supplies required for making chubs include rope, tubular mesh, floats, oysters, and clips. Materials include a work table, several 6" to 8" X 30" tubes, and a rig to support the tubes. The worktable and rig is easily constructed from wood, and the tube can be cut from a piece of plastic sewer pipe (See **Figure 17**).

Floats can be made from 2" X 2' X 8' or 1" X 4' X 8' Styrofoam sheeting used in the construction industry. The Styrofoam can be cut using the homemade hot wire cutter depicted in **Figure 18**. This cutter uses a ni-chrome wire hooked to a low amperage battery charger. The hot wire cuts through the Styrofoam with ease. Styrofoam may also be cut using a circular saw or a large knife such as a machete.

The cutter makes a 2" X 2" X 2'float from the 2" thick sheets which can be broken in half easily to fit a 1' chub. The 1" thick sheets make a 1" X 4" X 1' float that works nearly as well. Other less-effective items for floats, such as

recycled soda bottles, have been tried and work to a degree, although they tend to degrade after too much time in the sun.

- The Process:

Sleeve about 50 feet of mesh over the tube so that it can be pulled off one end. Loading up several tubes at a time helps to speed up the process (**Figure 19**). ❖ [Ask Jim Swartzenberg]

1. Rest one end of the tube on the worktable and the other about eye level hooked to the support rig (**Figure 20**) so that when the oysters and floats are placed into the tube, they will drop to the bottom.
2. Feed a 35-foot piece of 3/16" or smaller rope through the tube and allow it to extend about 8" past the end of the mesh. Clip the mesh to the rope using a clipper machine or hog ring, and clip a long line hook to the end of the rope.
3. Drop a one-foot float and about 10 to 15 seed oysters into the tube. Pull the mesh, rope, float and oysters out from the tube. Allow the mesh to bunch up a bit and create a pouch for the oysters. Clip the mesh with the float and oysters inside to the rope at about a one-foot interval, and then repeat the process until the rope is used up.
4. Clip another long line clip to the trailing end. The result will be a 35' chub link with about 270 oysters (**Figure 21**). Longer or shorter chub links may be made depending on circumstances and preference.

Figure 20: Each chub is loaded with 10 oysters and one float.

Place the chubs in the water by clipping or tying them to long lines that run between anchors. About 15 chub links spaced 30 inches to three feet apart will provide space for adequate water flow and for a person to walk between chubs. Too many chub links per section will cause undue stress on the anchors and ropes and could result in their being pulled out during a storm. ❖ [Ask Jim Swartzenberg]

Note: Planting a fairly large seed oyster (40mm or larger) in late winter allows for a decrease in growing time and subsequent decrease in barnacles and fouling.

The most rewarding part of raising oysters is the harvest. Pulling chub links out of the water with live, well-rounded, fat oysters is reward plenty for anyone on a first try.

Harvesting is a simple process. Pull the chub links out of the water, cut open the mesh, and remove the oysters. Wash and pack. If anything, the challenge comes in automating the process. For just a few chub links, the process can be rather insignificant, but for hundreds of thousands of oysters in thousands of chub links, every hand and arm movement, every tug on a rope, or lifting of a heavy chub link, adds an exaggeration of several multiples.

Figure 21: A 35' chub link will contain about 270 oysters.

If the chubs are near the shore and processing facility, it may be a simple matter of floating them to the shore. If they need to be transported, they can be pulled into a boat and hauled to shore. For larger numbers, a barge designed to float the chubs aboard could be used. In either case, getting them ashore and up on a table can be handled in any number of ways — from simply manhandling the chubs to a more sophisticated power rig that picks them out of the water.

What is common is that the oysters will have to be cleaned of barnacles and overspat, washed, sorted by size, and placed into boxes or bags for delivery to the customer. Another common denominator is that the oysters will have to be refrigerated soon after harvest to comply with HACCP requirements. Therefore, a harvester will either have to have a cooler or deliver them to a licensed dealer within a few hours. A review of the ➢HACCP section in this manual outlines Shellfish Sanitation requirements for harvesting oysters.

- The Adjustable Longline System (ALS). Sometimes called the "Seapa" system for the Australian company that invented it, ALS is designed to simplify subtidal and intertidal oyster production. It incorporates rigid posts with clips, a sturdy, adjustable long-line, and the hanging Seapa oyster baskets. It combines the ideas of the chub link and rack-and-cage methods in that it can be set intertidally or sub-tidally, uses a

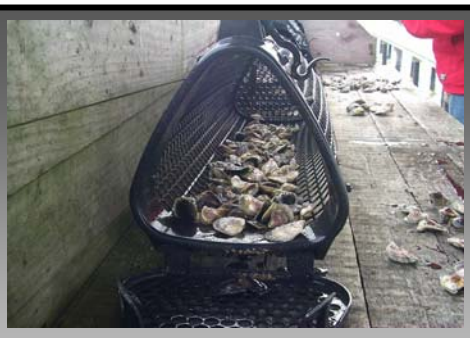


Figure 23: The Seapa bag is made of rigid plastic and holds about 50 oysters. Photo by Kim Hamilton

system of ropes, and incorporates rigid plastic baskets (**Figure 23**). The manufacturers advise that the system requires a minimum of three feet of water.

Adaptable to modern farming techniques, once the posts and long lines are set in place, the planting and harvesting can be managed from a boat The baskets

Figure 24: Seapa bags are suspended intertidally from long lines attached to piers. Photo by Kim Hamilton

Figure 25: The adjustable longline system works best on long piers with at least three feet of water and a hard bottom. Photo by Kim Hamilton

are loaded with about 50 seed oysters each and clipped onto the rigid long line with "duck" clips for grow out (**Figure 24**). The long line may be raised or lowered on the posts by moving it from one clip to another and then re-tightening the line with a mechanical winch.

Moving the lines is a chore, however, that few culturists would want to undertake on a regular basis. The long line would more likely be set at optimum height and remain there for most of the growout. During times of extreme tidal variations, such as extremely low tides and freezing weather, the Seapa bags can be lowered to save the crop. Likewise, during times of extended high tides and extreme fouling, the bags could be raised to dry.

Seapa baskets are ideal for use on long docks hanging from a rope that has been

stretched from one post to another. As such, they are used in less than commercial amounts or as a supplement to a commercial activity. Commercial application of the ALS requires the placement of many sturdy 5" or 6" posts anchored into the bottom and supported with heavier posts on the ends of strings.

ALS is the most expensive to set up of the systems presented, and the longlines tend to wear and fray after a couple of years and require replacement, but that shouldn't deter someone from adopting the system if it works well. It grows very nice oysters.

While moving the lines and baskets from one level to another requires an increased level of work, it affords an opportunity for rapid growth in a submerged environment and, when necessary, the opportunity for the baskets and oysters to air dry or stay submerged.

According to the company that produces the bags, the system is advantageous for hard-bottom, shallow water growout sites. Labor is reduced by clipping the entire line out of water as needed to control fouling on the oysters and cages. The system produces compact, round oysters due to the tumbling action created by the swinging baskets during wave action. The system can best be applied commercially in a series of rows or on a small scale under private piers for personal consumption of oysters.

Figure 26: The adjustable longline system produces compact, round oysters. Photo by Kim Hamilton

Both 12mm and 20mm mesh baskets are available.

- Rack and Cage. Probably the most widespread technique worldwide is the rack and cage method of raising oysters. In Europe, where the tide interval is seven to eight feet, rows of racks and cages are separated by driveways where, on low tide, tractors pull a trailer that is easily loaded with cages of oysters for harvest. Farmers walk around their crop adjusting cages and shaking up the oysters while standing on solid, dry ground. When the tide comes in, the farmers leave.

  In North Carolina, there are only a few places that afford the luxury of a three-foot or more tidal interval for such operations,

Figure 27: One-inch PVC rack with cages.

but nevertheless, the rack and cage system can and has been employed successfully in much slimmer intervals.

Rack and cage is a rather simple and easily managed system. Racks are planted into the estuarine floor, oysters are placed in cages, and cages are secured to the racks using a bungee with hooks. With a little maintenance to the cages to separate clustered oysters and a good growing season, the cages are removed from the racks and transported to shore where the oysters are dumped out, culled, cleaned-up, graded, packaged and sold.

Seed Size		Cage Size	Oysters per Cage
Up to 15 mm		3/16" mesh	2 Liters
40mm - 1.5"		3/8" mesh	600
50mm - 2"		5/8" mesh	500
63mm - 2.5"		5/8" mesh	450
75mm – 3"	(market size)	5/8" mesh	130
80mm - 3.5"	(market size)	5/8" mesh	130
85mm – 4"	(market size)	5/8" mesh	100

Figure 28: Stocking Density for 18"x36"x4" hard cages.

The system offers the advantage of daily air-drying, which keeps fouling to a minimum. The result is an oyster with less overspatting and fewer barnacles than one grown subtidally. The cages are relatively easy to move from one place to another, and a relatively large number of oysters can be handled at a time. Unlike the chub ladder system, it allows for replanting of undersized oysters after harvest.

Figure 29: One-inch PVC rack.

On the other hand, the system can only be employed in areas that have a firm bottom and enough depth to maintain the cages at waist level. Lower or higher water could be used but only to the detriment of the farmer's back.

The farmer must walk in the water when working with the cages, although that is more of a condition than a disadvantage. Sometimes during a high tide,

the farmer has to endure cold water to get to the cages. Working cages on a low tide is usually easier. An area that is extremely muddy, however, may be less than desirable.

Planting a mature seed in early spring can offset a slightly slower growth than that found in a subtidal situation. Periods of low tides as can be experienced during winter can starve the oysters, or worse yet, oysters may freeze if prolonged freezing temperatures accompany that period. Those combined negative conditions occur rarely, so a plan to rescue the dying oysters needs to be in place. Something as simple as moving cages to a lower shelf or temporarily placing them on the bottom might suffice.

Figure 29 provides a design of a rack that can be built from one-inch PVC and that has proven effective in holding cages. This rack includes lower shelves that can hold two cages during the low tide/freezing weather. Similar, and perhaps less expensive racks may be constructed from wood and rebar.

The rack and cage system can support a nursery by holding cages with 3/16" mesh and 5mm-10mm seed oysters. Those oysters can be stepped up to a 3/8" mesh cage and subsequently to a 5/8" grow-out cage. Consult the Planting/Density Chart in **Figure 21**. ❖ [Ask Jim Swartzenberg]

Work processes for all systems are as follows:

Year 1

- (January) Order seed oysters.
- (January-March) Establish one-acre water column lease.
- (March-April) Order materials.
- (January-April) Construct and plant anchor systems for floating nursery.
- (May-June) Build growout system (i.e. mesh, rope cutter, float cutter or racks or other facilities for whichever system is used).
- (July) Plant and work seed in nursery area.

Year 2

- (January-March) Salt bath/plant in final grow-out system (oysters from year 1).
- (January) Order seed oysters.
- (March) Establish processing area.
- (April) Order materials.
- (July) Plant and work seed in nursery area.
- (October) Begin harvest of year 1 crop.

Sustained Operations

- (January-March) Salt bath/plant in final grow-out system (oysters from previous year).
- (January) Continue harvest.
- (January) Order seed.
- (July) Plant and work seed in nursery area.
- (October) Begin harvest of new crop.

Appendix H shows a comparison of the systems side-by-side.

VI

Predators, Pests, Competitors, Diseases, Defense Mechanisms

Introduction

It's like going to war, except here the enemy comes cloaked in many different uniforms and disguises. It employs a variety of weapons including chemical and biological agents. The disguises are the wide variety of predators, pests, competitors, and diseases that can attack or starve oysters of their existence, and the weapons are the many various ways the enemy uses to attack, including chemical, biological, and psychological warfare to claim it's victims.

Barnacles, snails, encrusting bryozoans, various worms, and sponges settle on, overspat, and eventually suffocate oysters. Boring invertebrates weaken shell by destructive tunneling, while starfish, flatworms, crabs and some birds and fish voraciously feed on thin-shelled young oysters.

Sea squirts and fouling mosses clog up cages reducing the flow of food and water to young oysters, further weakening them and making them a ripe target for other predators, pests, competitors, and diseases.

Oysters may harbor other organisms such as pea crabs, certain snails and copepods, worms, nematodes and boring sponges that reduce the marketability and in some cases weaken and destroy the oyster.

From the Pamlico Sound south, the disease "Dermo" attacks and weakens aged oysters and kills them. Generally, but not necessarily, this occurs after the second summer when the water is hottest and saltiest, and perhaps not coincidentally during periods of drought when most other organisms that attack oysters thrive.

While the ➢Noninsured Disaster Assistance Program (NAP) is an option, it can at best help salvage a lost harvest so the farmer can try again the following year. Knowing what to expect and making adjustments to accommodate it, may be the best hope for a bad year.

Worst-case scenario: During an extended drought, there is little a farmer can do other than try to save what few oysters manage to survive the onslaught. The farmer discards dead and dying oysters and wishes he or she had applied for NAP.

Best-case scenario: An El Nino, tropical storm or glancing blow from a hurricane causes a dramatic drop in salinity for a period of time that stems the flow of Dermo and the growth of the organisms that kill oysters. At the same time, the storms are not severe enough to destroy the in-water or on-shore facilities. The oysters grow fast and fat. The farmer makes normal repairs as needed and has a bountiful crop.

Best probable scenario: With a good understanding of predators, pests, competitors, and diseases, along with effective management strategies implemented during the lifespan of the oysters and NAP insurance coverage, an oyster farmer manages the crop with the best degree of predictability possible, minimizes crop loss, and heads off disaster.

Predators include mobile organisms such as crabs, snails, drills, worms and others, which can easily locate oysters, penetrate or invade the shell, and attack and kill an oyster. Pests, on the other hand, are not generally as mobile, although they may come in larger numbers. These include various sponges, worms, and small invertebrates that detract from the health of oysters by competing for food and rendering them unsightly and unmarketable. Competitors, rather than directly injuring oysters, weaken the population by out competing it for space and food. In all cases, oysters that survive will be weakened, susceptible to disease and further predation, and generally less marketable than healthy oysters.

Oyster drills and mud snails number among the most common predators. Characterized by heavy shells and slow movements, their voracious appetites more than make up for other deficiencies. After clinging to an oyster, they secrete a chemical that little by little softens the oyster shell, followed by an abrasive action that erodes the shell, weakens it, and eventually bores a hole through to the oyster. The snail or drill then inserts a proboscis through the hole, feeds on, extracts, and kills the oyster (**Figure 30**).

Figure30: This small oyster does not have long to live. It is being attacked by two mud snails and two oyster drills.

In scientific studies, about 30 percent of the oysters killed by snails showed no signs of mechanical injury to the shell. In those cases, it was thought by some investigators that the snail also may use a paralytic material to gain entry between the valve mechanisms. In either case, drills and snails have proven to be very destructive, and where they proliferate, they usually do so in numbers far greater than the oysters.

Salinity is one of the main forces that determine the distribution of these critters. As a general rule, they are limited to salinities greater than 15 parts per thousand, depending on water temperature, and can tolerate exposure to unfavorable environmental conditions for short periods of time by tightly closing up and insolating themselves from their surroundings. They can tolerate short-term fluctuations in salinity better than long-term exposure to low salinity. At low salinity their activity decreases.

An extreme in temperature limits the activity of drills. Feeding ceases below 10 degrees Celsius (23 degrees Fahrenheit) and decreases above 30 degrees Celsius (112 degrees Fahrenheit). Under flood conditions with a sustained salinity below 15 parts per thousand, the drill and snail population is eliminated. At low salinity and temperature, they tend to bury themselves in the substrate and leave the oysters alone.

Snails and drills may be a serious problem only for oysters cultured on or very near the bottom such as in bottom cages. The snails do not have a mechanism for moving into the water column other than making a very slow and arduous climb up a rack. Oysters in a rack and cage or chub system should be relatively free of drills.

Various methods of controlling drill and snail infestations have been tried with little success. Physically trapping them using small oysters as bait has had a limited effect as has other biological introduction of predators such as moon snails. The problem with such treatments is that then the moon snails have to be dealt with. A salt water brine dip with follow-on drying will rid seed cages of most of the snails and drills, but this method is not practical for mature oysters.

Perhaps the only practical way to control drills that have infested a cage is to bring the cage to the surface, dry it, pick out the drills, and replace it to a different area of bottom or to an off-bottom situation.

Crabs kill oysters, especially spat and juveniles, by crushing the shell and eating out the meat. Blue crabs crush small oysters and chip the lips of larger oysters to extract the meat. Stone crabs crush even large, market size oysters. However, they do so at a much slower rate than when they are crushing small, juvenile oysters. While stone crabs are intolerant of low salinity water, blue crabs tolerate a much greater range of salinity such that there likely will be some type of crab population in predation at any site that supports oyster culture.

Figure 31: Small crabs grow up inside oyster cages and chubs and soon become large enough to destroy small oyster seed.

Crabs are a very mobile species. They can and will enter trays, spat bags, chubs, and cages as juveniles, feed off whatever is available, and grow to substantial size, noshing on small fishes and oysters, especially small seed as they go.

Trapping can reduce the general crab population, but the best control is to check cages, trays, etc. periodically, and physically remove the crabs.

Flatworms, also called oyster leech and *Styloci*, are thin, flat, elliptical, and extremely fecund. In one observation, a flatworm laid 39,000 eggs in a 48-hour period. They grow rapidly, mature sexually in about two months, and live for about a year. They flourish in a salinity greater than 15 parts per thousand but can tolerate salinity as low as six parts.

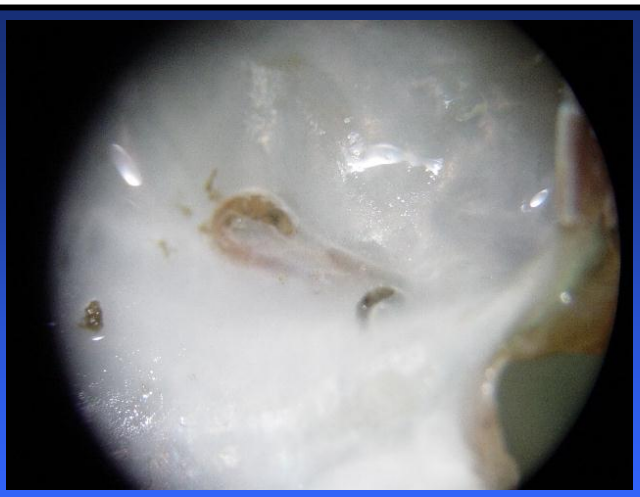


Figure 35: This tiny shell borer can ruin an otherwise valuable cultured oyster crop.

Flatworms enter an oyster through a partially gaping mouth and generally prefer small (less than 6 mm) oysters. Though they do not generally attack large oysters, in one lab experiment, three flatworms killed and ate an adult oyster in a week. They prefer barnacles, but can cause extensive mortality in crowded mariculture conditions.

Control of flatworms is not difficult. Either a fresh water or highly saline water bath will immediately eliminate the flatworms, however, neither will protect against re-infestation when the oysters are returned to their habitat. Cages with large mesh (5/8") will allow small fish to enter the cage and eat the flatworms.

Figure 33: This oyster has a bad case of barnacles (left) and boring sponge (right).

Fish, including cownosed rays, summer flounder, than 8mm. Small toadfish may sometimes find their way into a cage of oysters, but the rays, flounder, sheepshead and drum rarely make it through the mesh. When they do, they rarely are a significant problem. Toadfish, for example, prefer crabs and thus reduce the overall population of predators.

Therefore, care should be exercised in controlling fish populations because they may also exercise a positive influence on the overall culture operation.

Barnacles are a competitor that can become so invasive in a set of cultured oysters that they have to be nubbed off the oyster shell by hand to make the oysters marketable. They tend to reside in the upper portion of the water column and settle on subtidal chub oysters more than intertidal cages. Barnacles can be controlled to a degree by giving the oysters a heavy salt water bath as described in the following section on mud worms.

Sponges are among the most common intertidal pests of oysters. They attack the shell by very slowly boring holes using both a mechanical and chemical etching action. In some older oysters they may bore completely through an oyster and kill it. However, most likely the damage to the oysters will be in the outer shell, producing unsightly holes and reducing the marketability of the oysters. If the oyster shell is penetrated completely, the oyster quickly will lay down another layer to prevent contact between the oyster and sponge. In severe cases, the oyster will not rebuild its shell quickly enough to protect against the sponge, and the sponge can form adhesions to the oyster tissue, weaken it, reduce its ability to reproduce, and eventually kill the oyster.

There are a variety of species that tolerate a wide range of salinity, so it is unlikely a crop of cultured oysters can avoid the habitat.

Sponges seem to favor mature bottom grown oysters. Cultured oysters, however, are not immune from a sponge infestation, but usually grow to maturity before the sponges have the opportunity to significantly deteriorate the shell. Giving mature seed a salt bath and drying before final plant-out will deter most boring sponge.

Figure 34: Polydora (mud blisters) make for an unsightly shell and reduce the marketability of the oyster.

Mud Worms (*polydora*) lay encapsulated eggs that are attached to the inner surface of a tube on the outside shell of the oyster. The eggs develop in four to eight days depending on the temperature, settle on the outer surface of the shell, make their way to the shell lip of the oyster and immediately bore into the shell using a chemical agent.

Mud worms do not directly attack the tissues of the oyster but force it to rebuild the inner shell over and over. As it does so, the oyster produces an unsightly black and yellow blister on the inner shell. The ultimate result is an oyster with a reduced value on the half-shell market. At best, oysters with mud blisters could be mixed with bottom crop oysters and sold by the bushel.

When mud worms attack, the oyster puts its energy into shell maintenance, thereby reducing the energy it puts into growth and reproduction. Poor health and a brittle shell lead to a susceptibility to disease and predator attacks.

An effective control for mud worms is a simple saturation of the juvenile seed in a heavy salt solution of three parts water to one part salt. Usually the seed is given a fresh water rinse followed by 10- to 15-minute saturation in the salt solution and at least 15 minutes of drying. This procedure has proven effective for a variety of problems that tend to devalue the oyster crop and should be a regular part of seed maintenance performed during the late fall, winter, or early spring of the first year. ❖ [Ask Jim Swartzenberg]

Figure 35: These clean oysters will bring top dollar on the half-shell market.

Sea Squirts (*tunicates*) thrive in high salinity waters and can become very destructive during extended periods of drought, especially in waters that are normally high salinity. Sea squirts attach themselves to oysters, oyster chubs, oyster trays and oyster cages, and can become so densely packed that they virtually choke out the oysters and rob them of all available food.

Sea squirts can be controlled by physically removing them from cages and through regular maintenance with a fresh water wash and heavy salt water bath followed by a period of drying. Cages and other intertidal devices that get daily drying should remain relatively free of tunicates.

Figure 36: These young oysters are the victim of bio-fouling by tunicates.

Overspatting occurs when small spat to attach to growing or mature oysters. While the oysters that attach pose a minor problem of competition, their cumulative effect plus the effect of barnacles, sea squirts and other competitors, can lead to stunted growth, a weakened crop, and susceptibility to disease.

Oysters that become heavily overspatted have to be cleaned up by nubbing and washing at harvest time just as those with heavy overgrowths of barnacles.

Some control of overspatting can be obtained with a late fall or early winter salt bath and drying. The heavy salt solution will kill most of the small spat.

Disease, by definition, is a pathological condition of a part, an organ, or a system of an organism resulting from a variety of situations and conditions.

It can be caused by genetic defects as seen in abnormal cellular structure and function, nutritional imbalance that deprives the cells of essential nutrients, physical or chemical agents that injure cells, or infectious agents that damage cells by their actions or physical presence.

A number of diseases infect and kill oysters. Probably the most common and the one blamed for the widest spread mortality in North Carolina is Dermo, but it is by far not the only disease culturists need to prepare for.

MSX (*Haplosporidium nelsoni*) is a disease that has devastated the oyster population in the Chesapeake Bay. It is present in North Carolina waters but at much lesser degrees. Its parasite has been reported as far south as the Florida Keys, but there have been no reported widespread mortalities. Its destructive effect begins at the Virginia border and extends north into Canada.

SSO (*Haplosporidium costale*) was discovered during a search for MSX along the Atlantic coast in Virginia and Maryland. It has caused heavy mortalities in that area but so far has not been a problem in the Carolinas and to the south.

Many other diseases and parasites have been identified that infect the Eastern oyster, but they rarely are associated with high mortality, and information on them is often taken from a single occurrence. As a result, this section will focus on Dermo and Juvenile Oyster Disease.

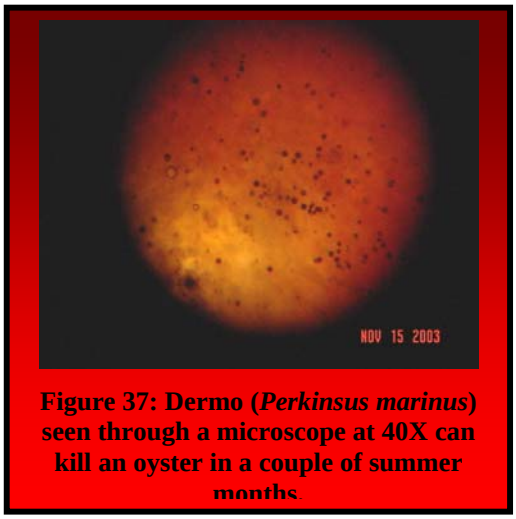


Figure 37: Dermo (*Perkinsus marinus*) seen through a microscope at 40X can kill an oyster in a couple of summer months.

Dermo has been an invasive and destructive disease to oysters in North Carolina and has devastated crops, including those in aquaculture situations. Originally named *Dermocystidicium marinus*, it is commonly referred to as Dermo. It is thought by some investigators to have been introduced into East Coast waters in the 1950s with the limited introduction of C. gigas oysters from the Pacific Coast.

The relationship between Dermo and salinity is well established. In a 1956 study, Makin clearly defined the effects of salinity on Dermo. He demonstrated conclusively that low temperature, low salinity combinations retard the Dermo parasite development and concluded that oysters can exist and grow vigorously in salinities slightly lower that the minimum tolerated by Dermo. The salinity tolerance range of the parasite has been observed at 8 to 50 ppt.

Dermo is a warm temperature disease with outbreaks and mortalities occurring in the summer months. The disease is known to increase dramatically in infected areas that receive heavy plantings of oysters such as in aquaculture situations. Mortalities can reach 100 percent and have been reported to be in the 30-50 percent range during the first year with cumulative mortalities of 75 percent and higher in the second year in oysters introduced to an infected area. The disease does not cause serious mortalities below salinities of 12 to 15 ppt, but can persist in over-wintering oysters in salinities below 5 ppt.

The theoretical practice of raising oysters off bottom to promote faster growth and better health and in turn averting the onset of Dermo has proven itself during years with normal and above average rainfall. It seems to be one of the few management strategies that really works to avert the disease.

The drought and high salinity years of 2001 and 2002, however, rewrote the books on Dermo management. Despite attempts to grow out oysters off bottom in a shorter time period, heavy infestations of sea squirts and barnacles, along with heavy overspatting, infestation of mud worms, flatworms and other unidentified organisms, weakened the crop and set the stage for Dermo to attack. The result was high mortality and a nearly total loss to the crop.

It may be that the higher densities, coupled with higher than normal salinities, negate the beneficial effects of mariculture practices and that the Dermo itself grows and spreads faster than normal under these circumstances. As the oysters contract Dermo, their growth rate is reduced, and by the time they are ready for harvest, emaciation, gaping, and pale digestive glands make the oysters unmarketable.

Few viable methods of managing the disease in an aquaculture situation during periods of high outbreaks have been devised. Moving oysters to a low salinity area at the initial onset of Dermo and then moving them back to "salt them up" just prior to harvest has been tried, but that scenario has drawbacks. It would be difficult and costly to move large amounts of mature oysters to a lower salinity area and back again at the last minute in an attempt to stem the flow of Dermo. Even then, the effectiveness of such a ploy has not been proven. During a rainier than average year, the salinity remains too low for too long of a period, and the young seed oysters succumb. It may, however, be feasible to move large batches of small oysters from one location to another.

It may be possible to sell off a crop at the first sign of Dermo before it has had an opportunity to weaken the oysters beyond what is marketable. However, that is not an easy scenario. One would have to have mechanisms in place to do a quick harvest and the market in gear to accept the product.

The idea is not beyond the realm of possibility, given a less than severe outbreak and an early warning. Dermo testing can be done on the farm using the protocol described in ➢**Appendix A**.

Results of the test can be matched to a formula offered by the ➢University of Texas that can predict the life of the infected oysters, thus giving the farmer valuable information from which a plan of harvesting and marketing could be devised.

Juvenile Oyster Disease (JOD) is a relatively new threat that affects oysters smaller than 25 mm. It arises in hatcheries and nurseries where oysters are placed into high-density situations. Little has been published on this disease, yet the serious nature of the disease warrants consideration of all information currently available.

Early reports indicated that the oysters were emaciated and might be suffering from a nutritional disease. However, there is little evidence that the disease is linked directly with food supply. The most characteristic symptom of JOD is the presence of an organic deposit on the inside of one or both valves.

The onset of JOD is sudden and typically affects oysters that have been growing rapidly. There is only minor evidence of distress before mortalities begin. Survivors resume growth after the mortality episode.

Mortalities may occur from late June through September. First evidence of disease in the form of growth inhibition and mantle lesions can be detected only about one-week before the onset of mortality. The mortality episode itself lasts four to six weeks.

Prevalence of oysters with disease symptoms ranges from 25 to 100 percent with cumulative mortalities of 20 to 90 percent. Mortalities are highly size specific. In a study at Oyster Bay, New York, groups averaging 5 to 20mm shell height when JOD symptoms were first noted suffered total mortalities of 60 to 90 percent. Those averaging 25 to 42 mm had losses of 0 to 30 percent.

Mortalities caused by JOD typically occur at water temperatures between about 21 and 26 degrees C. Salinity ranges from about 25 to 32 ppt. One study noted that the disease process is inhibited at lower salinity.

Several studies have shown that the incidence of JOD and consequent mortality can be reduced by measures that increase the water circulation in containers of juvenile oysters. These include reducing density, increasing mesh size., and increasing flow rate in upwellers. One of the most effective strategies for avoiding JOD, however is to spawn and deploy oysters as early in the season as possible, so that they have passed the critical size threshold of about 25mm before JOD appears.

Notes

VII

Shellfish Sanitation

How to Deliver a Clean Oyster

You have to deliver a quality product to your customer, or you'll be out of business in a hurry, and the whole industry may get a black eye. The way to do this is to follow the plan you make within the guidelines set by North Carolina Shellfish Sanitation, which takes its cue from the National Shellfish Sanitation Program, which gets its marching orders from the U.S. Food and Drug Administration. It's not difficult, but it is the law.

Not too many years ago, a person could harvest a bushel of oysters on a warm October day, throw them in a sack under an oak tree, and leave them until the customer arrived. Not so any more. There simply have been too many people who have gotten sick from eating oysters that were somehow tainted. And because seafood is very much into the global economy, sanitation has far reaching implications, even for the small growers.

It's easy to blame all our problems on the Gulf oysters. After all, they're the ones carrying the *Vibrio vulnificus virus* that has killed a number of people. But the fact remains that North Carolina waters also carry strains of *vibrio,* and people get sick from eating bad oysters for other reasons too such as high levels of fecal coliform. That is to say nothing about the consumer who buys a box of oysters, takes them home, and finds them all dried out and a bit too smelly to eat. That's one customer you won't have to worry about in the future.

Everything has changed from the days of old. Customers, for one, have become more cautious.

There has yet to be a case of sickness from *Vibrio vulnificus* turn up from someone eating raw oysters that came from North Carolina waters — knock on wood. But the general public in many cases doesn't know that, doesn't care, or doesn't trust that piece of data. They want and demand clean, certified oysters for a lot of reasons other than *Vibrio vulnificus*.

Whether the oysters are from North Carolina or the Gulf is irrelevant. There is a general mistrust for raw oysters among many people, so the grower and dealer have to manage the crop, the harvest, and the distribution system around that mistrust. The only way the markets will grow is by presenting top quality products in the stores that consumers just simply fall in love with and gain a respect for.

Everything has changed from the days of old. Customers, for one, have become more cautious. They look at the dates on harvest tags. They get to know their suppliers.

They know cleanliness when they see it, and many look very carefully at the packaging and marking. Some customers are so afraid of tainted oysters that they will buy only from a supplier they know and trust. And the best seafood dealers build their business on offering only top quality products that people trust.

The markets have changed also. Upscale markets gleam with clean stainless steel and crushed ice and cater to discriminating customers who can be either loyal to a sanitary business that serves fresh seafood or ready in a heartbeat to try some other business that better accommodates their preferences. And in these days of tight profit margins and stiff competition, wholesale buyers are ever watchful for a grower who can provide top quality seafood at a decent price.

The competent grower will strive to put out the best product possible, gain and maintain the confidence of the consumer, work to protect the public health, seek to overcome the negative image left by others who are in it just for the profits, and comply with the letter and intent of the laws. ❖ [Ask Patricia Fowler]

Sanitation is not a dirty word. It's a necessity. A grower simply has to maintain a clean area, keep good records, train employees in sanitation practices, monitor all processes ashore, and adopt an approved Hazard Analysis Critical Control Point (HACCP) plan that begins at the harvest and concludes at the point of sale.

In an effort to boost seafood markets worldwide and control the transportation and handling of seafood after it leaves the water, the standardized HACCP system has been adopted internationally. States, in turn, have formulated their rules and regulations to conform to the international standards such that whether you intend to ship and sell your products in another state or foreign country or to just set up a little mom and pop seafood stand out by the road, you will have to abide by the same general set of rules and regulations with very few exceptions.

Figure 38: Keeping up with the paperwork – trip tickets, harvest tags, cooler temps, and warning labels is an important part of sanitation, and it presents a good image to the customer.

The HACCP system of managing, processing and handling food affects virtually everyone involved in the seafood industry. In America the system is monitored by the Food and Drug Administration, which passes on its rules to the states.

HACCP is a two-part process designed to prevent major contaminants from reaching the consumer. The first part is the hazard analysis, and the second the critical control point. The hazard analysis identifies what possible hazards to the food products

may exist, and the critical control point sets a process to deal with those hazards at defined locations in the handling of the food.

Each business is required to establish a team of owners and employees who at first must come up with a plan acceptable to N.C. Shellfish Sanitation and then manage and enforce the processes and procedures within their control.

HACCP training is available at workshops usually sponsored by NC Shellfish Sanitation and is a must for obtaining certification. A sample plan is available in Appendix B, but essentially it involves a systematic review of the processes used to handle fish.

HACCP consists of seven principles:

HACCP is here to stay.

- Conduct a Hazard Analysis. Prepare a list of steps in the process where significant hazards occur and describe the preventive measures.
- Identify Critical Control Point. These are points, steps or procedures at which control can be applied and a food-safety hazard can be prevented, eliminated, or reduced to acceptable levels.
- Establish Critical Limits. Establish critical limits for preventive measures associated with each critical control point.
- Monitor. Establish procedures for using the results of monitoring to adjust the process and maintain control.
- Take Corrective Actions. When a deviation from a critical limit occurs, a predetermined corrective action must be taken.
- Establish Record Keeping Procedures. Establish effective record keeping procedures that document the HACCP system.
- Verify the Procedures. Establish procedures to verify that the HACCP system is working correctly.

For a company that handles only shellstock and does not shuck or otherwise process oysters, this seemingly long involved process can be reduced to a few simple daily activities, such as monitoring the temperature on a cooler, keeping the area relatively clean, posting a few required signs, and keeping up with the paperwork. In addition to harvest tags, businesses that sell directly to the consumer need to tag each container of oysters with an approved FDA warning statement. The statement may be worded in the form of an informational piece, such as: **CONSUMER INFORMATION:** If you suffer from liver disease, diabetes, immune or gastrointestinal disorders, you are at greater risk of serious illness from raw oysters and should eat oysters fully cooked.

N.C. Shellfish Sanitation agents have the authority to permit and suspend or revoke permits for shucker-packers, shellstock shippers, reshippers, and repacking plants. They have the authority to embargo and dispose of product found to be adulterated or mislabeled. They certify each dealer annually and inspect at least quarterly.

Some of the most common deficiencies that may result in punitive action by N.C. Shellfish Sanitation agents include:

- Shellstock not stored under mechanical refrigeration at 45 degrees F or below.
- Shucked shellfish not stored at 40 degrees F or below, or on ice.
- Condensate, dirty ice, or other adulterants contaminating shellfish product.

- Shellstock untagged; tags with insufficient information (no growing area, unreadable, etc.); tags not durable; shucked product improperly labeled.
- Records not being maintained: Cooler temperatures, receiving records, HACCP Plan, Sanitation Standard Operating Procedure.
- Operating without a valid permit.

One might think that such a high-level sanitation program would not affect a little Mom and Pop operation, but it does. HACCP is here to stay and has implications for the very small to the very large operations. ❖ [Ask Barry Nash] or log on to the website.
➢Sea Grant of NC ~ Seafood Science & Technology Outreach Activities

VIII

Markets and Marketing

Promoting Your Product in the Right Places

A good marketing scheme that puts your product in front of the others is worth its weight in gold. Your oysters may be good, but they won't sell themselves, and the buyers, especially the professional ones, will want to get their hands on them as cheaply as possible — cheaper, perhaps than you care to sell them. Retail consumers will buy them only if they know you've got them, and if they know that what they're paying for is worth the money.

You have to market your product. That's what a business does to attract customers. Marketing consists of a wide range of activities from putting advertisements in various media to passing out business cards and pamphlets and packaging oysters in eye-catching containers. Marketing might be a talk about mariculture to a local civic club or a small sack of free samples to some local chefs. One enterprising businessman even took to putting inexpensive flyers under the wiper blades of cars in a mall parking lot to advertise his goods. Marketing is about promoting yourself, your business and your product. So a business that is serious about marketing needs to come up with a serious plan to get the word out to the intended customers.

A marketing plan should address all the issues that will lead to a loyal customer base. It should be designed to get people to appreciate the product and always want more. So getting the most money for your product is probably not as important as making a good profit while building a satisfied customer base. There is a lot more to it than just hawking oysters at the local seafood outlet.

Sell the sizzle, not the steak.

First and foremost, know your audience. Who are your customers? What are their buying habits? What do they read? Where do they get their information? Why do they buy oysters? Is it to put on posh parties with oysters on the half shell or do they like an outdoor oyster roast with cornbread, plastic cups, and plenty of dirty hands? Knowing to whom you are selling and why they are buying can give you valuable clues about how to convince them to buy your product. If your customers are all those people with cars in the mall parking lot, then put flyers under their wiper blades. If not, don't waste your time.

An old advertising adage that works is to "sell the sizzle, not the steak," and that fits perfectly with cultured oysters. Advertising, for example, that touts these oysters as something special, the "best available," and "tastiest ever" will impart the idea the customer needs to hear.

A halfshell oyster, for example, caters to the upscale market and can be sold in small batches — a half bushel, a peck, or a half peck, cleaned and well packaged. Bulk oysters sold in bushel bags are probably better suited for oyster roasts.

So customers who buy cultured oysters need to know that the oysters are meant for the small party or posh get-together. Cultured oysters cost more money, but they're

also more oyster for the money. They're meant for people who want and expect the best and don't mind paying for it. They're a half shell for a raw bar and for oysters Bienville, and oysters Rockefeller recipes. Whether selling directly to the consumer or to a restaurant or seafood dealer, that information is crucial.

By far the easiest marketing available is to sell to a licensed dealer and let that company worry about dealing with the public. Most small operations will want to start out selling through a dealer, but even then the benefits of a cultured oyster can be capitalized on to get the best price. It's a matter of finding the right dealer in the right location.

Figure 39: A well-put-together picture like this one can tell your story and entice a hungry customer better than a thousand words. Photo compliments of NCDA Consumer Marketing.

Not all seafood dealers are interested in selling upscale oysters. Many — in fact most — prefer to stick with the old bushel sack of bottom-raised oysters. Those are a proven product, they're cheap, and the bulk of the oyster market will buy bottom-raised oysters tonged up in the bays, sounds and streams of North Carolina or shipped in from the Gulf Coast by the bushel.

Dealers interested in selling cultured oysters may have to be educated about the quality differences in the product, the packaging and the pricing. This is probably best done in person with a show-and-tell, but it could be supplemented with printed brochures, pictures, recipes, and other such promotional items. It may be necessary to give out free samples and to put oysters in a market on consignment until their worth is established.

A very good source of help can be found at the ➢N.C. Department of Agriculture Marketing office in Plymouth. They attend food shows regularly and talk with restaurant owners and chefs. They have point of sale posters and other generic advertising items that companies can use to promote their own items. And they will make themselves available to discuss marketing on an individual basis to help businesses get started.

The ➢NCDA Aquaculture Division can set up a web page for businesses such as this one for ➢J&B AquaFood. ❖[Ask Matt Parker]

Selling directly to the public and to restaurants is probably in the best interests of the grower. This requires a dealers license from N.C. Marine Fisheries and a health certification of the cooler and work area from N.C. Shellfish Sanitation. It requires tagging each container with a label that warns of the possible dangers of eating raw oysters and posting that same warning in a conspicuous spot in the retail establishment. It also requires manning the store when customers are coming and may require transporting the oysters from the farm to the buyer. The latter generally has to be done under mechanical refrigeration, the exception being when oysters are taken from the water directly to a licensed dealer.

Figure 40: Attractive packaging presents an image important to discriminating customers.

But it also requires getting the word out through advertising. Whether you put an inexpensive classified ad in the local paper or place your business cards or brochures in a real estate rental office, advertising should be targeted to the audience most likely to buy the product. In the case of seafood markets and restaurants, the best approach is usually to visit and talk with the owner or chef, and give them a sample of your product. There are other ways too depending on the circumstances. Perhaps one of your better customers who knows the chef or dealer could intervene by dropping a recommendation ahead of time.

Promotion of cultured oysters should focus on their superb taste, cleanliness, fullness and character. Consumers will be looking for the buzzwords that tend to turn them on. The benefits of the product should be emphasized: grown in approved waters; harvested daily (or to order); farm raised (invokes images of people walking around in white coats); and individually handled (implies quality control). Cultured oysters should be placed in attractive containers, either boxes or bags in such a way that expresses a departure from bottom raised oysters by the sack.

Word-of–mouth is the least expensive and perhaps most effective advertising because it comes with a built-in recommendation. It is also the basis for building a customer base. You build word-of-mouth advertising by building a customer base of satisfied customers.

A customer list can be a handy device, and in these days of home computing, building a mailing list on the business computer is a snap. A list can be used to remind people to get in a holiday order early, to let customers know that the oysters are up and ready for sale after a period of growing, to put on sales during slump times, to send out Christmas cards thanking people for their business throughout the year, and if you're savvy enough, to wish customers a happy birthday.

Inexpensive giveaways are another means of promotion — magnetic business cards, pens, calendars, etc. — but the inexpensive can quickly add up if not used sparingly and targeted to the right customers. It's probably a good idea to pass out something with your phone number that can be handily picked up when a person is thinking of oysters.

You have to have oysters to sell oysters. So what do you do when you don't have enough oysters to build a sustained business? It may be wise for the new or small operator to team up with another new and small operator to pool resources. By dealing in groups, small farmers can often go for markets that are not accessible alone, and they can pool their advertising resources for a wider spread. They also can divvy out a limited size crop a little at a time alternating with another farmer to allow the selling season to go on longer.

IX

Business Investment

The Risks, the Costs and the Returns

You're not in this for your health, although raising oysters may lead to a healthy lifestyle. Most people are in this sort of business to make money. Whether it be a full-time venture or a sideline retirement supplement, there comes a point when you have to put pencil to paper, work the numbers, and calculate whether or not the venture is worth the effort.

Raising oysters is a farming activity. It comes with all the amenities of farming, such as years with a bumper crop and years with a loss. Hopefully, there won't be any total failures, but a prudent farmer should plan on and expect years with losses that exceed the norm as well as years with profits that also exceed the norm. For purposes of good arithmetic and ease of computing, the facts and figures put forth in this chapter will reflect the norm.

It is difficult to put an exact figure on the cost, returns and profits of an oyster operation such as this, because every situation is different. Some of the underlying costs to the infrastructure of a business may vary depending on what a person has to start with and need to continue. A shoreline operation in front of a person's property could save money because it could feasibly be handled without a boat and some of the other necessities of a "travel to" lease area. Each farmer will start at a level that is compatible with the investment of time and money he or she is willing and able to put on the line.

Another variable is the method used to grow out the oysters. This chapter will attempt to make a comparison of the costs of methods. Even though most will be relatively the same, each method has its advantages and disadvantages, and each area and circumstance will dictate the type of grow out that is best.

For purposes of simplicity, this cost analysis will make a few assumptions:

- The crop begins with 100,000 seed oysters, 30mm in length, sufficient to be placed into 3/8" mesh nursery cages. (A prudent first-time investor may want to start with many fewer oysters, but the costs will generally run relatively the same.)
- This is an owner-operated, family-type cottage industry using two people working part time.
- The operators must have a willingness to invest up to three years of time and effort before realizing a profit.
- The operation will meet all federal and state licensing and sanitation requirements.

- Acquisition costs of the necessary infrastructure for an operation are not included (boat and motor, pick-up truck, adequate shellfish lease, suitable area ashore for processing, cooler).

Regardless of the grow out method, the operator will purchase 100,000-30mm seed during the summer, place them in cages, and sort, grade and divide them throughout the next few months to maintain low density and to prepare them for a final grow out. Preparation includes not only getting them to a larger size, but also a salt-water bath and drying just prior to the final grow out stage as described in Chapters IV and V.

In general terms this is what a novice grower could expect:

Investment
First year: $10,600-$25,500
Second Year: $8,200-$10,600
Total Investment: $19,800-$36,000

Risks
Extremely unfavorable weather
Theft
Disease
Market failure

Return
First year: none
Second year: first income from sales (no net profit)
Third year: break even or better
Subsequent years: net $18,000-$20,000

Outcome
Survivability of oysters: 70-90 percent
Anticipated harvest: 80,000 oysters on average
Annual cost of sustained operations: $6,580-$8,409

Income

Since there are currently no established markets or distribution systems in North Carolina, these income estimates will be somewhat conservative. As markets and distribution systems are established, the price will probably rise with consumer demand. In northern city markets, for example oysters have reportedly sold as high as $.65 per piece on the retail market, and $.45 per piece on the wholesale market. The estimates presented here allow for a retail price of $.45, a wholesale price of $.35, and a “seconds” price of $.15. The cost analysis is based on a harvest of 80 percent of the oysters planted (80,000 oysters). ❖ [Ask Matt Parker]

Bottom/Stackable Trays
Cost Analysis

Income	#	Price	Year 1	Year 2	Sustained operations
Retail	16000	$0.45		$7,200	$7,200
Wholesale	48000	$0.35		$16,800	$16,800
Seconds	16000	$0.15		$2,400	$2,400
Total Income				**$26,400**	**$26,400**
Costs					
3/8" Oyster Cage	100	$6.00	$600.00		
600 ft. Roll of 1/2" Rope	1	$15.00	$15.00		
1 acre Water Column Lease	1	$500.00	$500.00	$500.00	$500.00
Shellfish License	2	$25.00	$50.00	$50.00	$50.00
30 mm Seed Oysters	100000	$0.03	$3,000.00	$3,000.00	$3,000.00
Anchor Set-Ups	8	$13.50	$108.00		
Sorting, Washing, Packing Tables		$150.00	$150.00		
Gas/Oil		$300.00	$300.00	$300.00	$300.00
Boat/Truck Maintenance		$500.00	$500.00	$500.00	$500.00
NAP Coverage		$100.00	$100.00	$100.00	$100.00
Boxes	800	$2.00		$1,600.00	$1,600.00
Tags, Advertising Materials		$200.00		$200.00	$200.00
Replacement Cages/Floats etc. for Nursery		$100.00		$100.00	$100.00
4'x4' Stackable Trays	(200,100, 20)	$29.00	$5,800.00	$2,900.00	$580.00
Total Costs			**$10,623.00**	**$9,250.00**	**$6,930.00**
Returns			**($10,623.00)**	**$17,150.00**	**$19,470.00**
Running 3 Year Net Profit			**($10,623.00)**	**$6,527.00**	**$25,997.00**

Floating Chubs
Cost Analysis

Income	#	Price	Year 1	Year 2	Sustained operations
Retail	16000	$0.45		$7,200	$7,200
Wholesale	48000	$0.35		$16,800	$16,800
Seconds	16000	$0.15		$2,400	$2,400
Total Income				**$26,400**	**$26,400**
Costs					
3/8" Oyster Cage	100	$6.00	$600.00		
600 ft. Roll of 1/2" Rope	1	$15.00	$15.00		
1 Acre Water Column Lease	1	$500.00	$500.00	$500.00	$500.00
Shellfish License	2	$25.00	$50.00	$50.00	$50.00
30 mm Seed Oysters	100000	$0.03	$3,000.00	$3,000.00	$3,000.00
Anchor Set-Ups	8	$13.50	$108.00		
Sorting, Washing, Packing Tables		$150.00	$150.00		
Gas/Oil		$300.00	$300.00	$300.00	$300.00
Boat/Truck Maintenance		$500.00	$500.00	$500.00	$500.00
NAP Coverage		$100.00	$100.00	$100.00	$100.00
Boxes	800	$2.00		$1,600.00	$1,600.00
Tags/Advertising Materials		$200.00		$200.00	$200.00
Replacement Cages/Floats etc. for Nursery		$100.00		$100.00	$100.00
OSN Chub Mesh	18, 18, 18	$75.00	$1,350.00	$1,350.00	$1,350.00
Styrofoam 2” X48”X8’	1 pallet (48 pieces), 1 pallet, 10 pieces	$1,200.00	$1,200.00	$1,200.00	$250.00
3/16” Poly Rope, 600’ Spool	21, 21, 21	$9.00	$189.00	$189.00	$189.00
Clips for Chubs (Box of 10,000)	1, 1, 1	$110.00	$110.00	$110.00	$110.00
Clipper Machine (Lease)	1	$3,000.00/ $150.00	$3,000.00	$150.00	$150.00
Air Compressor	1	$250.00	$250.00		
Screw Anchor Set-Ups w/Long-Lines and Buoys	96	$14.00	$1,344.00		
Longline Clips	720, 50, 25	$.40	$288.00	$20.00	$10.00
Total Costs					
			13,054.00	**$9369.00**	**$8,409.00**
Returns			**($13,054.00)**	**$17,031.00**	**$17,991.00**
Running 3 Year Net Profit			**($13,054.00)**	**$3,977.00**	**$21,968.00**

Adjustable Longline System
Cost Analysis

Income	**#**	**Price**	**Year 1**	**Year 2**	**Sustained operations**
Retail	16000	$0.45		$7,200	$7,200
Wholesale	48000	$0.35		$16,800	$16,800
Seconds	16000	$0.15		$2,400	$2,400
Total Income				**$26,400**	**$26,400**
Costs					
3/8" Oyster Cage	100	$6.00	$600.00		
600 ft. Roll of 1/2" Poly Rope	1	$15.00	$15.00		
1 Acre Water Column Lease	1	$500.00	$500.00	$500.00	$500.00
Shellfish License	2	$25.00	$50.00	$50.00	$50.00
30 mm Seed Oysters	100000	$0.03	$3,000.00	$3,000.00	$3,000.00
Anchor Set-Ups	8	$13.50	$108.00		
Sorting, Washing, Packing Tables		$150.00	$150.00		
Gas/Oil		$300.00	$300.00	$300.00	$300.00
Boat/Truck Maintenance		$500.00	$500.00	$500.00	$500.00
NAP Coverage		$100.00	$100.00	$100.00	$100.00
Boxes	800	$1.00		$800.00	$800.00
Tags, Advertising Materials		$200.00		$200.00	$200.00
Replacement cages/floats etc. for nursery		$100.00		$100.00	$100.00
Seapa Bags	1,500, 1,000, 100,	$10.00	$15,000.00	$5,000.00	$1,000.00
600 ft. Roll of 3/8” Poly Rope	6, 0, 3	$10.00	$60.00		$30.00
Riser Clips	400	$.80	$320.00		
8’ x 6” Posts	400	$12.00	$4,800.00		
Total Costs			**$25,503.00**	**$10,550.00**	**$6,580.00**
Returns			**(25,503.00)**	**$15,850.00**	**$19,820.00**
Running Three Year Net Profit			**($25,503.00)**	**($9,653.00)**	**$10,167.00**

Rack and Cage
Cost Analysis

Income	**#**	**Price**	**Year 1**	**Year 2**	**Sustained operations**
Retail	16000	$0.45		$7,200	$7,200
Wholesale	48000	$0.35		$16,800	$16,800
Seconds	16000	$0.15		$2,400	$2,400
Total Income				**$26,400**	**$26,400**
Costs					
3/8" Oyster Cage	100	$6.00	$600.00		
600 ft. Roll of 1/2" Rope	1	$15.00	$15.00		
1 acre Water Column Lease	1	$500.00	$500.00	$500.00	$500.00
Shellfish License	2	$25.00	$50.00	$50.00	$50.00
30 mm Seed Oysters	100000	$0.03	$3,000.00	$3,000.00	$3,000.00
Anchor Set-Ups	8	$13.50	$108.00		
Sorting, Washing, Packing Tables		$150.00	$150.00		
Gas/Oil		$300.00	$300.00	$300.00	$300.00
Boat/Truck Maintenance		$500.00	$500.00	$500.00	$500.00
NAP Coverage		$100.00	$100.00	$100.00	$100.00
Boxes	800	$2.00		$1,600.00	$1,600.00
Tags, Advertising Materials		$200.00		$200.00	$200.00
Replacement Cages/Floats etc. for Nursery		$100.00		$100.00	$100.00
PVC Racks	140, 0, 5	$45.00	$6,300.00		$225.00
5/8” Oyster Grow-Out Cages	1,000, 500, 50	$3.50	$3,500.00	$1,750.00	$175.00
S-Hooks/Bungee	6,000, 3,000, 300	$.02	$120.00	$60.00	$6.00
Hog Rings			$50.00	$25.00	$25.00
Total Costs			**$15,293.00**	**$8,185.00**	**$6,781.00**
Returns			**($15,293.00)**	**$18,215.00**	**$19,619.00**
Running Three Year Net Profit			**($15,293.00)**	**$2,922.00**	**$22,541.00**

Comparative
Cost Analysis
All Systems

		Year 1	Year 2	Sustained Operations
	Total Income (All Systems)	$ -	$26,400	$26,400
Bottom/Stackable Trays	Total Costs	$10,623	$9,250	$6,930
	Returns	($10,623)	$17,150	$19,470
	Running Three Year Net Profit	($10,623)	$6,527	$25,997
Floating Chubs	Total Costs	$13,054	$9,359	$8,409
	Returns	($13,054)	$17,031	$17,991
	Running Three Year Net Profit	($13,054)	$3,977	$21,968
Adjustable Longline System	Total Costs	$25,503	$10,550	$6,580,00
	Returns	($25,503)	$15,850	$19.820.00
	Running Three Year Net Profit	($25,503)	$9,653	$10,167
Rack and Cage	Total Costs	$15,293	$8,185	$6,781
	Returns	($15,293)	$18,215	$19,619
	Running Three Year Net Profit	($15,293)	$2,922	$22,541

Notes

X

Natural Forces

The forces of nature and their effects

Mother Nature often prescribes the difference between a great crop, a good crop, and a failed crop. Unfortunate as it may sound, many times there is little a farmer can do other than stand back and watch a crop dwindle because of some relatively uncontrollable force of nature.

Farming oysters is like any other farming in that drought, blight, storms and other forces tend to take their toll in their own due time.

Sometimes dealing with nature is just a simple matter of factoring in a certain amount of negative events and living with the hand that nature deals. Other times there is a ray of hope. Just as when a corn farmer salvages what is left after a blight or long drought, so does the oyster farmer use whatever tools are at hand to minimize an otherwise disastrous season.

By that same token, a farmer needs to know when the forces of nature are more favorable than normal so as to take advantage of a good situation. Then if the law of averages runs true, the benign can offset the adverse.

The first lesson for the oyster farmer is to recognize the forces that can affect a crop and then to understand the effects that those forces have. Then the trick is to know what, if anything, can be done to mitigate or take advantage of those forces.

Crop Insurance may be able to salvage an operation that otherwise would go broke. Until quite recently, crop insurance has not been available at a reasonable charge, but now aquacultured clams and oysters have been added to the Noninsured Crop Disaster Assistance Program (NAP), and the charges and rules have come in line with other agricultural crops. This program is administered by the Farm Service Agency, a division of the U.S. Department of Agriculture and can usually be accessed through your county agriculture extension agent. Though NAP will not make up for a bad year, it can provide some relief when a crop is lost because of a natural disaster.

An eligible natural disaster may include damaging weather such as drought, freeze, excessive moisture, excessive wind, and hurricanes. An adverse natural occurrence such as earthquake or flood, or a condition related to damaging weather, or an adverse natural occurrence such as excessive heat, disease, or insect infestation is also covered. The natural disaster must occur before or during harvest and must directly

affect the eligible crop. It must also have occurred despite any preventative measures the farmer could have or may have taken.

A premium of $100 per crop per year not to exceed $300 per producer per county is payable when the insurance is issued.

NAP will pay for losses greater than 50 percent of the expected production. Payment is based on 55 percent of an average market price for the specific commodity established by an FSA state committee.

Most shellfish farmers in North Carolina are eligible producers, and the program covers both aquacultured oysters and aquacultured clams.

While NAP can never make up for a crop lost to disaster, it can go a long way to salvaging an oyster operation that has been devastated by natural disaster.

Drought creates a domino effect on the environment that consequently affects an oyster crop. Drought raises the salinity in estuarine areas to varying degrees depending on the distance from the open ocean, flow, and rate of exchange. A prolonged drought can raise the salinity to a level greater than seawater (35 ppt) and in turn exacerbate the incidence of dermo, sea squirts, barnacles, and other fowling in turn causing a reduction of flow in cages and oyster chubs and an acceleration of disease.

The drought of 2002-2003 caused a reduction of wild and cultured harvest for the entire East Coast with little that could be done to salvage the crop.

Hurricane -- One of the most frequently heard comments from people contemplating a culture operation is, "What about hurricanes? We could invest all our hard earned fortune in an oyster venture only to have it washed away in a few minutes."

The key to hurricane preparedness is simple — have a plan.

The answer to that question is, "you're right!" But with the proper precautions, the damage on shore can be minimized and damage in the water can be virtually eliminated.

Hurricanes Fran and Bertha tore into beach houses, docks, and businesses along the entire North Carolina coast. Among the hardest hit was the mariculture operation at J&B AquaFood in Holly Ridge. With a one-two punch, high wind gusts followed by an extremely high tide and surge of water tore up their buildings, supplies, and equipment on the shore.

During both storms, workers took seed oysters in floating cages out of the water before the storm hit and put them in a cooler on shore. Everything else, including year-old chub links, newly

Figure 42: Hurricane damage on the Carolina coast.

placed chubs, and rack and cage oysters, stayed in the water.

Hurricane Bertha did relatively little damage, although a few young seed oysters left out of the water for two days died. The seed had been crammed into a cooler, which, because of the electric outage, soon became inoperable. The plant and animal material in and on the cages deteriorated quickly as the cooler heated up. By the time workers were able to return the cages to the water, 15 to 20 percent of the seed oysters had died.

Hurricane Fran walloped a heavier punch. The storm surge devastated the work area ashore. Two docks, the cooler, a boat house, pump house, sink, shower, toilet, all the cages and stacked up mesh, ropes, floats, tools, gloves, boots, rain gear, baskets, tables, and a harvesting barge were scattered over several hundred acres. The cooler blew apart sending cages full of seed oysters through the air landing as far away as 300 yards from the site of the cooler. Wires and pipes were torn from the ground. The entire work area ashore needed rebuilding.

The amazing aspect of both storms is that what was left in the water held up relatively well with some minor repairable damage to some of the anchors and ropes holding the chubs. Because of the storm tide, the racks and cages remained so far under water that they simply rode out the storm with ease. The older and heavier chubs held up in much the same manner, while the lighter, newly placed chubs suffered some damage from wind and waves.

Figure 43: This is what is left of a walk-in oyster cooler after Hurricane Fran.

Conditions can change drastically according to the site. The J&B AquaFood chub area is a low energy, well-protected bay behind Topsail Island. Though

this site received heavy winds and very high water, it did not receive the full force of the storm surge that larger bays might have encountered.

To get back on track, J&B AquaFood borrowed a generator and got right to the business of restoring their on shore facilities. They rebuilt the docks, repaired the water and electric infrastructure, and built a stronger, more storm resistant cooler.

Collecting the thousands of floats, cages, tools, and work gear was a major undertaking. They recovered about half of the seed oysters, which was enough for a small but workable crop for the following year. Most of the tables and tools were salvageable; other items were not. Most of the power tools left in the area to ride out the storm were ruined, but many items, such as the boats and compressor had been hauled to a barn before the storm and consequently survived.

A $2,500 clipper machine used in making chubs had been stored in a plastic trunk. It was found in the woods about 500 yards away high and dry and in good shape.

Little by little they pulled things back together. It wasn't cost free. It wasn't covered by insurance, but it also wasn't a complete disaster. They rebuilt the area, and the company survived the storm. More importantly, they developed a hurricane plan that calls for small and light loose items to be kept to a minimum in the work area. Now whenever a storm threatens, they begin early by evacuating items such as floating cages and loose items ashore in a systematic manner as the storm threat increases.

Figure 44: Hurricanes can tear up an otherwise neat operation.

Hurricane predictors are gaining more and more accuracy every year and now give fairy good warning up to five days in advance of a storm. A good plan will outline what actions will be taken during those five days. Although every situation may dictate a different set of actions, the following should be used as a guide:

1. Day five — Call off any long trips away from home. Make an assessment of the work that lies ahead.
2. Day four — Clear off the outside work area as much as possible and stash gear inside a building where it is not likely to be blown or washed away.
3. Day three — Move out harvested stock as much as possible, or return it to the water in bottom cages.

4. Day two — Remove floating cages from the water or sink them. Board up buildings.
5. Day one — Finish cleaning up as much as possible. Take all boats out of the water.

Tides and tidal variations can be quite baffling to the untrained eye. Sometimes it seems that the low tides come when one might expect a high tide and vice versa. Sometimes the tides will be unusually high or low for no apparent reason, and sometimes when the charts are predicting a particularly high, low or normal tide, something quite different occurs. Trying to outguess the system can be difficult, if not impossible.

Unpredicted and abnormal tides may affect an oyster operation. For example, a crop may be in danger when tides run very low for extended periods of time, especially if the weather is very cold or hot. The tide and temperature can be so extreme that a crop may freeze and die. At other times an extended low tide with very high temperatures could take a toll on small oyster seed. In that same vein, the tide can be so unusually high that getting to the oysters becomes a nearly impossible task.

Basic tidal forces set the stage for the ups and downs of the tide. There is no simple way to put together all the mechanics of the tides. Figure 45 depicts the basic forces that affect tides, and in a perfect textbook situation with all other factors normal, it shows how the moon and earth work together to move the ocean's waters. The gravitational force of the moon and the centrifugal force of the rotating earth tend to bulge the ocean waters out on the side of the earth facing the moon and on the opposite side of the facing away, while other areas of the earth experience a simultaneous tidal depression.

Theoretically, the Earth rotating through the tidal bulges and depressions would produce two equal high tides and two equal low tides at any spot each day. But for that to happen, the Earth would have to be free of obstructions, the ocean of uniform depth, and the moon and sun fixed in distance and orientation to the earth. That is far from reality. There are astronomical and physical factors, such as the shape of the shores, which cause the time and the height of the tides to vary from place to place

The tidal day is 24 hours and 50 minutes, the approximate time between recurring tides of the same phase at a given location. The discrepancy between an Earth day and a tidal day is attributed to the fact that the moon is traveling slightly faster in relation to the rotation of the earth. Therefore, a complete tidal cycle requires one "lunar day," or 24 hours and 50 minutes. Successive low and high tides are about 12 hours and 25 minutes apart, and a high tide is separated from a low tide by about 6 hours, 12 1/2 minutes.

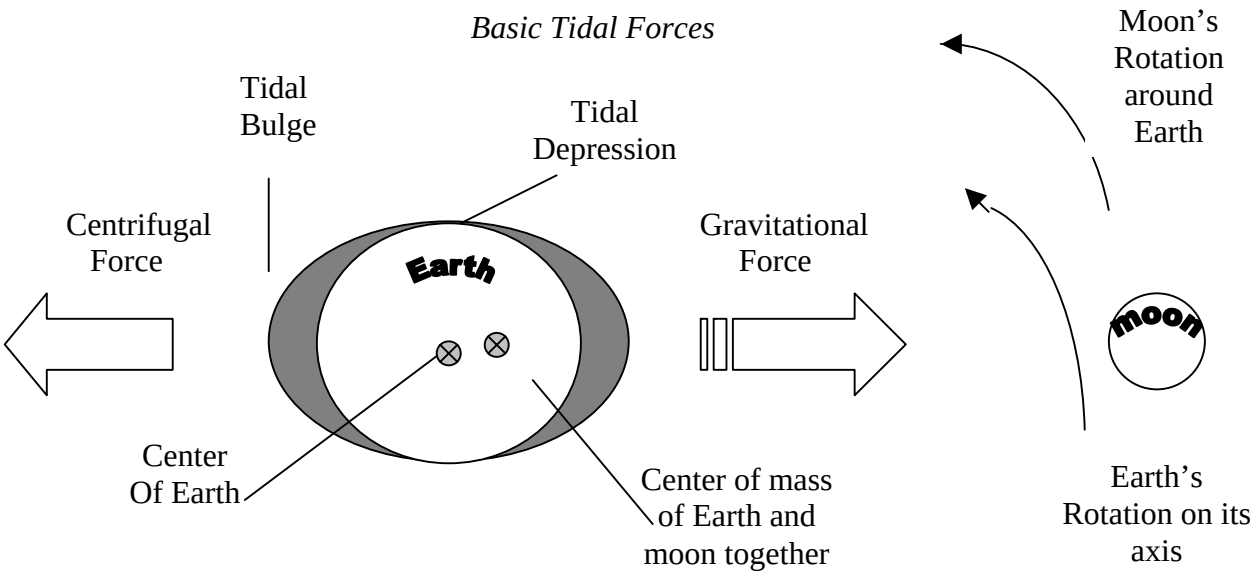


Figure 45

Several other forces combine to alter the level of the tide at any particular place on the globe. In North Carolina, for example, the tidal variance is only a few feet, but in some areas of the world such as the Bay of Fundy in Canada, that variance can be as much as 50 feet from low to high. The lay of the land and sometimes man made alterations in certain harbors can affect the normal ranges of tides, so predicting a tide in a certain area must always begin with the "normal" tidal ranges for that particular area.

Spring Tides. The sun plays an important supporting role though its influence is less than half that of the moon. Twice each month, during the new moon and full moon, the sun and moon are aligned so that their combined pull creates higher high tides and lower low tides. Not to be confused with the season of the year, the term "spring" refers to the leap in tidal range caused by the sun and moon in alignment.

Neap Tides. The opposite effect of a spring tide takes place when during the first and third quarters of the moon, the sun and moon are at right angles to the earth.. During these periods, scant or "neap" tides occur. The gravitational forces of the sun and moon counteract each other producing higher low tides and lower high tides.

Elliptical Orbits. The moon's orbit around the earth is elliptical. Once each month, a mere 216,000 miles separate the earth and moon, which is their closest

encounter. At this close range, they are said to be at "perigee," and their gravitational pull is the greatest. Conversely, once each month the two are at "apogee" — farthest away from each other — and their pull slackens. At "perigee" tides can be expected to be more extreme with higher highs and lower lows, and at "apogee" the tides can be expected to run closer to the median with less of a variation in the high and low.

The earth's orbit around the sun is also elliptical, although its affect is less than that of the moon. The Earth's orbit around the sun has a variance of about three million miles. It takes one year to complete an orbit, so the apogee and perigee occur only once a year.

Declination. The angle of the moon and sun relative to the equator (declination) influences the tides. During its monthly revolution of the earth, the moon moves from a maximum declination of 28.5 degrees north of the equator to a maximum declination of 28.5 degrees south of the equator creating what are called tropic tides. Twice each month, the moon is directly over the equator. At those times, it exerts equal forces on both hemispheres. As a result, the two high tides and two low tides at any location will be about the same.

Local Weather Conditions. Add one more factor to the equation, and with a bit of study, you'll be able to guess the daily tides with a moderate degree of accuracy. In most areas in North Carolina, changes in local weather will affect local tides more than any other single item. Wind can blow water into or out of a particular area depending on the shape of the shoreline, and direction and intensity of the wind. Those areas are well known to local inhabitants. Rain flushing from rivers and streams tend to raise the water levels in estuarine areas. High pressure areas — often associated with cold fronts — generally produce lower tides, while low pressure areas — often associated with impending storms — generally produce higher tides. While there are no hard and fast rules about the degree of affect a particular weather condition may have, an experienced eye, along with a wary ear on the local weather forecast, can help to give an oyster farmer early warning when the unusual is about to occur.

In March 1962 the fierce and famous Ash Wednesday Storm swept the East Coast from the Carolinas to New England. It hit on a spring tide at the "dark of the moon." Coincidentally, the moon reached perigee within a half hour of the astronomical alignment of the moon, sun and Earth. The result was a three-day storm that killed more than 40 people, toppled homes and businesses, and submerged streets.

Mother Nature can exact a toll on an oyster operation. Something unusual happens nearly every season, and the best defense against such an event is to understand it, predict it, prepare for its effects, and insure against it.

Tide predictors can be found on the Web, [➢]http://tbone.biol.sc.edu/tide and [➢]http://www2.shore.net/~mcmorran/tide/tideform.html. With a tide chart, a good local weather forecast, knowledge of the local forces that affect the tides, and some common sense calculating, a person can come close to predicting what to expect in the line of tides.

Notes

A

Appendix A

Dining Room Dermo Testing

Although some hands-on training from someone who had performed the test is helpful, you can learn this on your own and become proficient after just a few tries. You can do it at home or on the farm. All you need are the ingredients listed below and the ability to follow simple directions.

Step 1: Assemble the ingredients.

Item	Amount	Storage	Purchase Amt.	Source
Fluid Theoglycollate Medium (FTM)	3 Tbsp	Dark Shelf	500 grams	Supplier*
Chloramphenicol	¼ tsp	Freezer	25 grams	Supplier*
Nystatin		Freezer	1 Mili-Unit	Supplier*
Lugols Iodine	drops	Dark Shelf	250 Mili-Liter	Supplier*
Non-Iodized Salt	1 Tbsp.	Shelf	Box	Grocery
Oysters	30	Cooler		Your Lease
Sea Water	1 Liter	N/A	1 gallon	Your Lease

Step 2: Setup the equipment.

Cuticle Scissors (curved surgical)	1	1	Variety Store
Tweezers	1	1	Variety Store
Paper Towels	Sheets as Needed	Roll	Grocery
Coffee Filters	2	Pkg.	Grocery
Dental Picks or 2 sharp knives	2	2	Tool Store
Oyster Knife	1	1	Variety Store
20 ML Test Tubes w/ screw Top Lids	20	20	Supplier*
Test Tube Rack	1	1	Supplier*
Dropper/Pipette	1	1	Drug Store
Glass Slides	20	100	Supplier*
Cover slips	20	100	Supplier*
Oyster Gloves	1 Pair	1 Pair	Glove Supplier

Surgical/Household Gloves	1 Pair	1 Pair	Grocery
Shot Glass	1	1	Variety Store
Ethanol Alcohol	1 Pint	1 Pint	Drug Store
Stick lighter (or candle)	1	1	Variety Store
Measuring Cup	2 Quart	2 Quart	Variety Store
Measuring Spoons	Set	Set	Variety Store
Newspapers			
Microscope 40X/100X	1	1	Ebay/Supplier

Figure 46: With a little trial-and-error effort and a few supplies, dermo testing can be done at home on the dining room table.

Step 3: Follow these simple instructions.

1. Filter seawater through coffee filters.
2. Bring water to a boil in the microwave.
3. Mix in Fluid Theoglycollate Medium and non-iodized salt. The mixture will turn pink when mixed.
4. Check salinity, and adjust with salt to the salinity of the oysters.
5. Re-boil the mixture. It should turn yellow when heated to indicate a lack of oxygen.

6. Put FTM mixture into test tubes, filling each tube halfway. Cover loosely.
7. If the mixture turns pink, microwave the filled tubes in 30 second intervals until they turn yellow.
8. Arrange test tubes in a circular or square pattern in a tube rack.

Allow to cool.

Figure 47: The rectum is located at the tip of the tweezers. The intestine is the tube that leads to the rectum. An ideal sample includes the rectum and about ¼" of the intestine.

9. Open all oysters, and place on the table. When opening oysters, it is important to remove the flat top shell of the oyster and leave the oyster in the more rounded bottom shell.
10. Dip dissecting tools into pure ethanol and flame before dissecting each oyster.
11. Cut out the rectum, which is the last ¼" section of the intestine of each oyster. The rectum can be found next to the outer edge of the adductor muscle. Place each specimen in the FTM solution in a test tube.
12. Prepare chloramphenicol solution by mixing ¼ tsp chloramphenicol powder to 10 ML (1/2 test tube) of ethyl alcohol. Note: When working with chloramphenicol,

always wear protective gloves. Chloramphenicol has been linked to some forms of cancer.

13. Open each test tube, put in two drops of chloramphenicol solution, cover and mix lightly. Do not shake.
14. Uncover each test tube. Put in one drop of nystatin solution. Cover. Do not shake. Put test tube in rack.

Step 4: Store covered at room temperature (incubate) for four to seven days.

After the incubation period, remove the oyster tissue from the test tubes with a flamed tweezers, blot on a paper towel, and place on a glass slide.

Add a drop or two of Lugols Iodine to the tissue, and work it in by teasing the tissue with flamed needles or scalpels. Allow 10 minutes to stain the hypnospores. Add a cover slip.

Note: You may need to rinse the excess Lugols before putting on the cover slip to make the slide more readable, especially if the slides appear too darkly stained.

Microscopically examine the tissue at 40x or 100x (depending on intensity of infection) and grade using the Makin Scale in Figure 50. Hypnospores will be black, round spheres of various sizes.

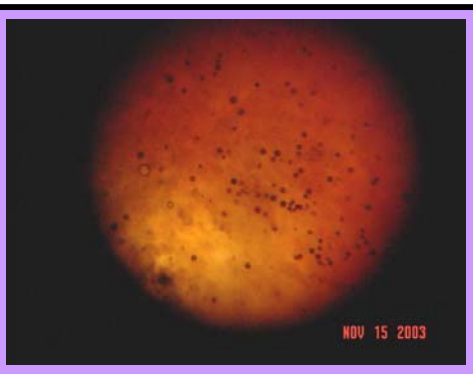


Figure 48: Dermo Hypnospores are round and stain a dark red.

Figure 49: Oyster eggs are not round and do not stain.

Note: 1. A 0 rating should be viewed at 100x for verification.

2. Do not confuse Hypnospores with oyster eggs that may have been associated with the rectal tissue. Eggs are not perfectly round as Hypnospores, do not stain black, and will have nuclei.

Makin Scale

Intensity Description	Code	Number Code	Hypnospore Concentration	Appearance Microscopic
Negative	N	0	None in sample	No hypnospores/tissue orange-brown
Very light	VL	1	1-10/sample	Hypnospores very scattered, usually larger than average/tissue still orange-brown
Light	L	2	11-100/sample	Hypnospores in most fields but sometimes concentrated in specific areas/tissue still orange-brown
Light medium	LM	3	99-1,000/sample (1-30/5 mm field)	Hypnospores common, beginning to make up a significant portion of each field/tissue still brown
Medium	M	4	31-300/5 mm field	Hypnospores numerous everywhere, seem to be occupying a significant volume of the tissue/darkened spots may show in tissue
Medium heavy	MH	5	301-1,000/5 mm field	All fields darkened by the presence of hypnospores, seem to occupy half of tissue volume/tissue o:ften bluish, takes up more than usual stain
Heavy	H	6	1,001 and up/5 mm field	All fields almost black with hypnospores occupying more than half of tissue volume; tissue often difficult to see, almost impossible to get through stain/tissue distinctly blue or black

Figure 49: Use the Makin scale to evaluate the degree of Dermo infection in oysters.

Step 5: Check your results by logging on to the University of Texas Dermo web site ➢University of Texas. With the number code from the Makin scale, salinity, and water temperature, you can predict the life expectancy of the oysters.

Notes

B

Appendix B

Hazard Area Critical Control Point

Every shellfish business that stores and resells shell stock is required to maintain a complete HACCP plan and Standard Operating Procedure. The plan must begin with a description of the company and include a sanitation standing operating procedure and a prescribed HACCP plan.

Sample Company Description:

Company Name

General Information

The Company: *Company Name* is a family run shellfish business owned and operated by Mr. and Mrs. Shellfisher. At times, other family members sell their bottom raised oysters and clams through the company. When necessary the company hires part time help to assist with various tasks.

The company holds multiple acres of shellfish bottom leases which include water column leases in Shelly Bay in Onslow County. It has extensive experience at growing and marketing oysters, both cultured and bottom raised. In addition it raises clams from natural and seeded beds.

The Product: The company sells only what it produces which includes bottom oysters raised by family members on their individual leases, bottom raised oysters from the *company name* leases, cultured oysters from *company name* water column leases, and clams from both natural and seeded beds.

Distribution and Storage: Bottom raised oysters are placed in dry storage as soon as they are landed and then usually sold wholesale in bushel sacks. Cultured oysters are packaged on shore and then placed in dry storage for subsequent sale to retail and wholesale customers.

Clams usually are sold directly to wholesalers in mesh clam bags when landed, although occasionally they are stored overnight in dry storage before being sold retail or being taken to market.

Company Policy:

a. *Company name* endeavors to sell only healthy and mature products that have been recently taken from the water and will therefore have a relatively long shelf life for both the retailer and consumer.

b. Bottom-grown oysters are three- to four-years-old, free of undersized culls that meet the high quality standards traditional in a select garden oyster.

b. Cultured oysters are 18-24 months old, select, meaty and mostly single oysters with light watery oysters culled out.

c. Clams are market-size (*mercinaria*) hard clams free of disease or adulteration.

Sample SOP:

Sanitation Standard Operating Procedures

Sanitation Concerns:

1. **Goal:** Water that comes into direct contact with oysters is derived from a safe and sanitary source or is treated to make it safe.

   Procedure: Well water used to wash product will be tested annually by an independent lab to ensure safety. A copy of the water quality report will be maintained on file.

2. **Goal:** There are no cross connections between potable water systems and any non-potable system.

   Procedure: A designated quality control person will inspect annually to determine that no cross connections exist between potable water and waste systems. The results of the inspection will be maintained on file.

3. **Goal:** All food contact surfaces of equipment and utensils are designed of such materials and workmanship that they can be easily cleaned and maintained in a relatively clean condition during operations. Such surfaces will be constructed of nontoxic materials

and designed to withstand the environment of their intended use and the action of the food cleaning compounds and agents.

Procedure:

a. Presently all equipment and utensils meet current recommended state and federal standards. Prior to expanding or replacing any major piece of equipment, the family will meet to evaluate the equipment. Where deemed appropriate and necessary, advice will be solicited from state agencies and/or independent biologists and sanitarians. The evaluation will determine whether the new equipment will meet allowable standards and whether it will impact other steps in processing. Specifications of all equipment will be reviewed to ensure it is capable of withstanding the intended use and can be easily cleaned. The same evaluation will be conducted on materials used in the modification of the physical set-up. A report of this evaluation will be maintained on file.

b. Orders of minor equipment, utensils, and tools will be reviewed by a quality control person. The results of these evaluations will be kept on file.

c. A quality control person will inspect and evaluate the condition of equipment, utensils and tools quarterly. The results of these evaluations will be recorded on the quarterly sanitation audit form.

4. **Goal:** All utensils and surfaces of equipment that contact food during processing are cleaned with a germicide preparation at the end of the day's operation.

Procedure: At the end of the production day, the crew will clean the tools, utensils, tables, sinks, and work area with water and a food-grade detergent to ensure that mud and residue from harvested shellfish are washed free of the work area. Observations will be recorded on a daily sanitation audit form.

5. **Goal:** All expended chub materials are cleaned or disposed of in a safe and sanitary manner.

Procedure:

a. As chubs are opened, the floats will be scraped, rinsed, and laid out to air dry. They will be gathered later, bagged, and stored away from the work area.

b. Longline clips will be placed in a bucket for storage away from the work area.

c. Expended mesh and rope will be piled off of the immediate work area concrete slab for subsequent burning at the next available opportunity. Cages and other materials will be air dried and removed from the work area daily.

d. Observations will be recorded on a daily sanitation audit form.

6. **Goal:** Gloves and outer garments used in the production area are made of impermeable material and are kept clean.

Procedure: The Company will use only rubber gloves, pants or aprons, and boots. The gear will be cleaned and placed in a dry location at the end of each workday. A quality control person will check the gear at the beginning of each workday. Observations will be recorded on a daily sanitation audit form.

7. **Goal:** Hand washing facilities are equipped with hand cleaning and effective sanitizing preparations and disposable towels.

Procedures: The hand washing facility will be checked by the quality control person for adequate water, paper towels, and soap daily before operations begin. Deficiencies will be corrected. The results will be recorded on a daily sanitation audit form.

8. **Goal:** Food, food contact surfaces, and food packaging materials shall be protected from adulteration with lubricants, fuel, pesticides, cleaning compounds, sanitizing agents, metal fragments or other physical contaminants.

Procedure:

a. All cleaning compounds, sanitizing agents, lubricants, fuel, and pesticides will be clearly identified and stored away from the process area when not in use.

b. A quality control person will inspect the processing area daily before operations begin for possible contamination sources and to make sure toxic compounds are labeled and stored properly. The results will be recorded on a daily sanitation audit form.

9. **Goal:** Anyone who has or may have, by medical examination or supervisory observation, an illness, infected wound, an open lesion such as a boil or sore, or any other medical problem that might contaminate food, food contact surfaces, or packaging materials shall be excluded from any operations until the condition is healed or corrected.

Procedure:

a. As a part of new employee orientations, employees will be briefed on the need to notify the family immediately of any illness or injury that may lead to contamination of the product. The result of this training will be documented and kept on file.

b. Quality control persons will observe others and each other for their well-being and for signs of medical problems daily before operations begin. At any indication of injury or illness that may contaminate the product or facilities, the injured or ill person will be removed from the area until the matter is corrected.

c. Observations will be recorded on a daily sanitation audit form.

10. **Goal:** Adequate toilet facilities that provide for proper sewage disposal shall be available and maintained in a clean and orderly condition and in good repair.

Procedure: The condition of the toilet will be inspected daily to insure its cleanliness and that it contains adequate bug spray and paper. Observations will be recorded on a daily sanitation audit form.

Sample HACCP Plan

Farm-Raised Oysters Flow Chart

Receiving

↓

Washing/Draining/Sorting/Packaging

↓

Dry Cooler Storage

Hazard Analysis Worksheet

Processing Step	Potential Hazards	Significant -Yes/No	Justification for column 3 decision	Preventive Measures	CCP Yes/No
Receiving	Biological: Pathogen Growth Chemical: Industrial Pollution	Yes No	Shellfish come from approved waters	Licensed Harvesters Tagged Containers	Yes
Washing Draining Sorting Packaging	Biological: Pathogen Growth	No	Controlled by SSOP		No
Dry Cooler Storage	Biological: Pathogen Growth Chemical: Sanitizer Residues	Yes No	Without controlled temperatures bacterial pathogen may increase in numbers Controlled by SSOP	Daily log kept	Yes

HACCP Plan

Critical Control Point (CCP)	Significant Hazards	Critical Limits	Monitor What	Monitor How
Receiving Raw Oysters and Clams	Pathogen Growth Natural Toxins Chemical Contaminants	Must have properly tagged containers. Must come from a licensed harvester	Harvest tag Harvester license	Visual Annually at First purchase
Dry Cooler Storage	Bacterial Pathogen Growth	*Cooler not to exceed 45 degrees F	Cooler Temperature	Visual check of thermometer

*National Shellfish Sanitation Program Manual of Operations, Part II, 1995 Revision, (Appendix F).

Monitor Frequency	Monitor Who	Corrective Actions	Records	Verification
Each bag upon receipt Annually at first purchase after June 30	Quality Control Person	Reject or tag owner product	Cooler log/trip tickets	Review records daily during season
Daily time-temp log	Quality Control Person	Adjust cooler temperature/hold and evaluate based on total time of exposure	Cooler log	Review records daily during season Annual Thermometer Calibration

Corrective Action Plan

1. If the cooler temperature is greater than 45 degrees F and the shell stock temperature is between 45-50 degrees F, the product will be iced and moved to another cooler.

2. If the cooler temperature is greater than 45 degrees F and the shell stock temperature is greater than 50 degrees F, the product will be iced, isolated, and evaluated to insure the product is safe.

Company Name

Daily Sanitation Audit Form

_____ _____
Inspector Date

SSOP Checklist for Shipper/Packer

Everyday Before Startup	**Sun**	**Mon**	**Tues**	**Wed**	**Thurs**	**Fri**	**Sat**
Water supply safe, protected							
Food contact surfaces/equipment clean							
Prevention of cross contamination							
Toilets clean, working, supplied							
Protection from adulterants							
Toxic chemicals labeled/stored							
Employee health OK							
Area free of pests							
Product ok Adequate ice Cooler Temperature	**a.m.** **p.m.**	**a.m.** **p.m.**	**a.m.** **p.m.**	**a.m.** **p.m.**	**a.m.** **p.m.**	**a.m.** **p.m.**	**a.m.** **p.m.**

Record Corrective Actions on Separate Page

Reviewed by: _____Date: _____

Company Name

Quarterly Sanitation Audit Form

Sanitation Condition	Time Pass/ Fail	Comments/ Corrections
No cross connections between potable and wastewater systems		
Processing equipment, utensils, and tools in suitable condition		
Miscellaneous tests and reviews: Well water Review new equipment since last inspection Oysters tested for e-coli		

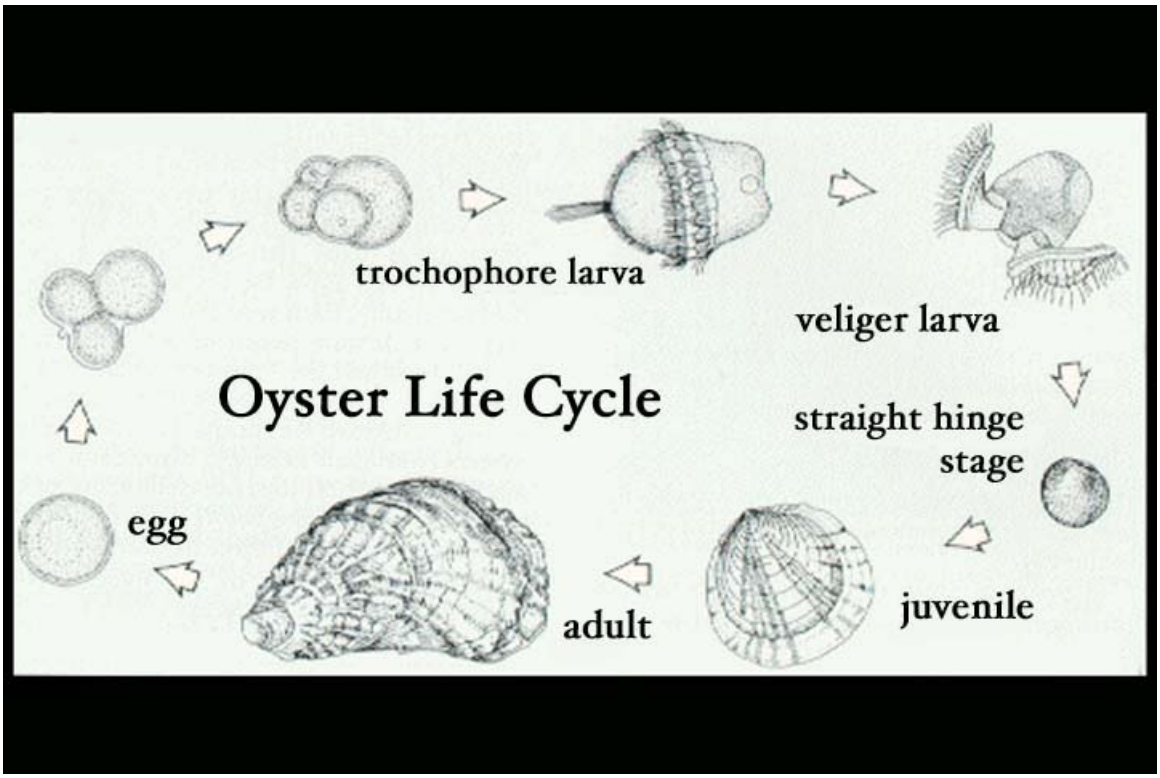
_____ _____

Inspector Date

C

Appendix C

Lifecycle of an Oyster



Notes

D

Appendix D

Marine Fisheries Rules and Regulations

The following rules and regulations are excerpted from *North Carolina Fisheries Rules for Coastal Waters 2003.* These rules were selected because they apply to aquaculture operations. For updates and other rules, consult the latest edition of the rulebook.

NORTH CAROLINA ADMINISTRATIVE CODE
TITLE 15A
DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES

CHAPTER 3
MARINE FISHERIES

3I .0114 RECORDKEEPING REQUIREMENTS

(a) It is unlawful for a fish dealer:

(1) To fail to accurately and legibly complete all mandatory items on the North Carolina trip ticket for each transaction and submit the trip ticket in accordance with G.S. 113-168.2;

(2) To fail to provide to the Division a completed no transaction form by the tenth day of the following month when no transactions occurred for a month;

(3) To fail to keep all trip tickets and all supporting documentation for each transaction including receipts, checks, bills of lading, records and accounts for a period of not less than three years.

(b) It is unlawful for a seller licensed under G.S. 113, Article 14A or donor to fail to provide to the fish dealer, at the time of transaction, the following:

(1) A current and valid license or permit to sell the type of fish being offered and if a vessel is used, the commercial fishing vessel registration; and

(2) Complete and accurate information on harvest methods and area of catch and other information required by the Division.

(c) It is unlawful to transport fish without having ready at hand for inspection a bill of consignment, bill of lading, or other shipping documentation provided by the shipping dealer showing thereon the name of the consignee, name of the shipper, the date of the shipment, and the quantity of each species of fish shipped. In the event the fisherman taking the fish is also a dealer and ships from the point of landing, all shipping

records shall be recorded at the point of landing. Fishermen who transport their fish directly to dealers are exempt from this Paragraph of the Rule.

(d) It is unlawful to export fish landed in the state in a commercial fishing operation without a North Carolina licensed fish dealer completing all the record keeping requirements in GS 113-168.2(i).

(e) It is unlawful to offer for sale fish purchased from a licensed fish dealer without having ready at hand for inspection written documentation of purchase showing thereon the name of the licensed dealer, name of the purchaser, date of the purchase, and the quantity of each species purchased.

(f) It is unlawful for the holder of a Fish Dealer's License to have fish in possession at a licensed location without written documentation from a licensed fish dealer or a completed North Carolina Marine Fisheries Trip Ticket to show the quantity and origin of all fish.

3I .0119 PROHIBITED FISHING ACTIVITY DUE TO PUBLIC HEALTH OR SAFETY

(a) It is unlawful to possess, sell, or take fish by any method or use any fishing equipment in areas of coastal waters that are closed to fishing by the Marine Fisheries Commission because the areas are determined to pose a public health or safety risk by the State Health Director.

(b) After prior consent of the Marine Fisheries Commission the Fisheries Director may, by proclamation, prohibit or restrict the taking of fish by any method and the use of any fishing equipment in areas of coastal waters that are the subject of warnings or advisories by the State Health Director concerned with dangers or risks to public health or safety.

3K .0101 PROHIBITED SHELLFISH AREAS/ACTIVITIES

(a) It is unlawful to possess, sell, or take oysters, clams or mussels from areas which have been designated as prohibited (polluted) by proclamation by the Fisheries Director except as provided in 15A NCAC 03K .0103, .0104, .0107, and .0401. The Fisheries Director shall issue such proclamations upon notice by the Division of Environmental Health that duly adopted criteria for approved shellfish harvest areas have not been met. The fisheries Director may reopen any such closed area upon notification from the Division of Environmental Health that duly adopted criteria for approved shellfish harvest areas have been met. Copies of these proclamations and maps of these areas are available upon request at the Division of Marine Fisheries, 3441 Arendell St., Morehead City, NC 28557; (252) 726-7021.

(b) The Fisheries Director may, by proclamation, close areas to the taking of oysters, clams, scallops and mussels in order to protect the shellfish populations for management purposes or for public health purposes not specified in Paragraph (a) of this Rule.

(c) It is unlawful to possess or sell oysters, clams, or mussels taken from polluted waters outside North Carolina.

(d) It is unlawful to possess or sell oysters, clams, or mussels taken from the waters of North Carolina except as provided in G.S. 113-169.2 (i) without a harvest tag

affixed to each container of oysters, clams or mussels. Harvest tags shall be affixed by the harvester and shall meet the following criteria:

(1) Tags shall be identified as harvest tags. They shall be durable for at least 90 days, water resistant, and a minimum of two and five-eights inches by five and one-fourth inches in size.

(2)Tags shall be securely fastened to the outside of each container in which shellstock is transported. Bulk shipments in one container and from the same source may have one tag with all required information attached. Harvesters who are also certified shellfish dealers may use only their dealers tag if it contains the required information. The required information shall be included on all lots of shellfish subdivided or combined into market grades or market quantities by a harvester or certified shellfish dealer.

(3) Tags shall contain legible information arranged in the specific order as follows:

(a) The harvester's name, address, and shellfish license or standard or retired standard commercial fishing license with shellfish endorsement number.

(b) The date of harvest.

(c) The most precise description of the harvest location as is practicable (e.g. long Bay, Rose Bay) that can be easily located by maps and charts.

(d) Type and quantity of shellfish.

(e) The following statement in bold, capitalized type: "**THIS TAG IS REQUIRED TO BE ATTACHED UNTIL CONTAINER IS EMPTY AND THEREAFTER KEPT ON FILE FOR 90 DAYS**".

3K. 0104 PERMITS FOR PLANTING SHELLFISH FROM PROHIBITED/POLLUTED AREAS

(a) It is unlawful to take oysters or clams from prohibited (polluted) public waters for planting on leases and franchises except as authorized by G.S. 113-203. Lease and franchise holders shall first obtain a permit from the Fisheries Director setting forth the time, area, and method by which such shellfish may be taken. The procedures and requirements for obtaining permits are found in 15A NCAC 03O. 0500.

(b) The season for relaying clams shall be between April 1 and May 15 and the season for relaying oysters shall be for a specified six week period between the date of the statewide closure of oyster season and June 30, as determined by the Fisheries Director based on the status of oyster resources available for harvest from public bottom and market factors affecting sale of oysters from public bottom which will assist in determining the statewide closure date and manpower available to monitor the relaying activity.

(c) For areas designated by the Fisheries Director as sites where shellfish would otherwise be destroyed in maintenance dredging operations, the season as set out in Paragraph (b) of this Rule shall not apply.

(d) The Fisheries Director, acting upon recommendations of the Division of Environmental Health, shall close and reopen by proclamation any private shellfish beds for which the owner has obtained a permit to relay oysters and clams from prohibited (polluted) public waters.

3K .0106 TAKING OR UNLOADING OYSTERS AND CLAMS ON SUNDAY OR AT NIGHT

(a) It is unlawful to take oysters or clams between the hours of sunset and sunrise on any day.

(b) It is unlawful to unload oysters or clams from any vessel or remove any vessel containing oysters or clams from the water on Sunday or between sunset and sunrise on any day except that in New Hanover, Pender, and Brunswick Counties, oysters and clams may be unloaded until two hours after sunset. Oysters and clams taken on Sunday under the provisions of 15A NCAC 03K .0105 are exempt from the Sunday unloading prohibition.

3K .0107 DEPURATION OF SHELLFISH

(a) It is unlawful to take clams or oysters from the public or private prohibited (polluted) waters of the state for the purpose of depuration except when the harvest will utilize shellfish that would otherwise be destroyed in maintenance dredging operations. All harvest and transport activities within the State of North Carolina related to depuration shall be under the direct supervision of the Division of Marine Fisheries or the Division on Environmental Health. For the purpose of this Rule, the term depuration does not include relaying of clams or oysters from shellfish leases or franchises as authorized by 15A NCAC 03K .0104.

(b) The Fisheries Director, may, by proclamation, impose any or all of the following restrictions on the harvest of clams or oysters for depuration:

(1) Specify species,

(2) Specify areas except harvest will not be allowed from designated buffer zones adjacent to sewage outfall facilities,

(3) Specify harvest days,

(4) Specify time period,

(5) Specify quantity or size,

(6) Specify harvest methods,

(7) Specify record keeping requirements.

(c) Depuration permits:

(1) It is unlawful for individuals to harvest clams or oysters from prohibited (polluted) waters for the purpose of depuration unless they have obtained a Depuration Permit or are listed on designees on a Depuration Permit from the Division of Marine Fisheries and Division of Environmental Health setting forth the method of harvest to be employed. Permits shall be issued to licensed North Carolina Clam or Oyster Dealers only. Permittees and designees harvesting under Depuration Permits must have a current Shellfish License or Shellfish Endorsement on a Standard or Retired Commercial Fishing License.

(2) In addition to information required in 15A NCAC 03M .0501, the permit application shall provide the name, address, location and telephone number of the depuration operation where the shellfish will be depurated.

(3) Clam or Oyster Dealers desiring to obtain prohibited (polluted) clams or oysters for depuration shall apply for a depuration permit at least 15 days prior to initiation of operation.

(d) Transport of clams or oysters for depuration:

(1) Clams or oysters harvested from prohibited (polluted) waters for depuration in a depuration operation located within the state of North Carolina shall be transported under the direct supervision of the Division of Marine Fisheries or the Division of Environmental Health.

(2) Clams or oysters harvested from prohibited (polluted) waters for depuration in a depuration operation outside the State of North Carolina shall not be transported within the State of North Carolina except under the direct supervision of the Division of Marine Fisheries or the Division of Environmental Health.

(e) It is unlawful to ship clams or oysters harvested for depuration to depuration facilities located in a state other than North Carolina unless the facility is in compliance with the applicable rules and laws of the shellfish control agency of that state.

(f) The procedures and requirements for obtaining permits are found in 15A NCAC 03O .0500.

SECTION .0200 - OYSTERS

3K .0201 OPEN SEASON AND POSSESSION LIMIT

It is unlawful to take, buy, sell, or possess any oysters from public bottoms except during the open season from October 15 through May 15. During any open season that may be allowed within the time period stated herein, the Fisheries Director may, by proclamation, close and open the season or close and open any of the various waters to the taking of oysters depending on the need to protect small oysters and their habitat, the amount of saleable oysters available for harvest, the number of days harvest is prevented due to unsatisfactory bacteriological samples and weather conditions, and the need to prevent loss of oysters due to parasitic infections and thereby reduce the transmission of parasites to uninfected oysters or other variable conditions and may impose any or all of the following restrictions:

(1) Specify days of the week harvesting will be allowed;

(2) Specify areas;

(3) Specify means and methods which may be employed in the taking;

(4) Specify time period;

(5) Specify the quantity, but shall not exceed possession of more that 50 bushels aboard a vessel; and

(6) Specify the minimum size limit by shell length, but not less than 2 1/2 inches.

3K .0202 SIZE LIMIT AND CULLING TOLERANCE

(a) It is unlawful to possess oysters which have accumulated dead shell, accumulated oyster cultch material, a shell length less than that specified by proclamation, or any combination thereof that exceeds a 10 percent tolerance limit by volume. In determining whether the tolerance limit is exceeded, the Fisheries Director and his agents may grade all, or any portion, or any combination of portions of the entire quantity being graded, and in cases of violations, may seize and return to public bottom or otherwise dispose of the oysters as authorized by law.

(b) All oysters shall be culled by the catcher where harvested and all oysters of less than legal size, accumulated dead shell and cultch material, shall be immediately returned to the bottom from which taken.

(c) This Rule shall not apply to oysters imported from out-of-state solely for shucking and packing plants currently permitted by the Shellfish Sanitation Section of the Division of Environmental Health.

3K .0205 MARKETING OYSTERS TAKEN FROM PRIVATE SHELLFISH BOTTOMS

(a) It is unlawful to take, possess, buy, or sell oysters from shellfish leases or franchises during the open season unless such oysters have been culled in accordance with Rule 15A NCAC 03K .0202.

(b) It is unlawful to sell, purchase or possess oysters during the regular closed season without the lease or franchise holder delivering to the purchaser or other recipient a certification, on a form provided by the Division, that the oysters were taken from a valid shellfish lease or franchise. Certification forms shall be furnished by the Division to lease and franchise holders upon request.

(c) It is unlawful for lease or franchise holders or their designees to take or possess oysters from public bottom while possessing aboard a vessel oysters taken from shellfish leases or franchises.

3K .0206 PERMITS TO USE MECHINICAL METHODS FOR OYSTER OR CLAMS ON SHELLFISH LEASES OR FRANCHISES

(a) Permits to Use Mechanical Methods for Oysters or Clams on Shellfish Leases or Franchises shall be issued in compliance with the general rules governing all permits in 15A NCAC 03O .0500. The procedures and requirements for obtaining permits are also found in 15A NCAC 03O .0500.

(b) It is unlawful to harvest oysters by the use of mechanical methods from shellfish leases or franchises without first obtaining a Permit to Use Mechanical Methods for Oysters and Clams on Shellfish Leases or Franchises.

3K .0207 OYSTER SIZE AND HARVEST LIMIT EXEMPTION

Possession and sale of oysters by a hatchery or oyster aquaculture operation and purchase and possession of oysters from a hatchery or oyster aquaculture operation shall be exempt from bag and size limit restrictions set under authority of 15A NCAC 03K

.0201 and 03K .0202. It is unlawful to possess, sell, purchase, or transport such oysters unless they are in compliance with all conditions on the Aquaculture Operations Permit.

SUBCHAPTER 30 – LICENSES, LEASES, AND FRANCHISES

SECTION .0100 – LICENSES

3O .0101 PROCEDURE AND REQUIREMENTS TO OBTAIN LICENSES, ENDORSEMENTS AND COMMERCIAL FISHING VESSEL REGISTRATIONS

(a) To obtain any Marine Fisheries licenses, endorsements, commercial fishing vessel registrations except Recreational Fishing Tournament Licenses to Sell Fish and Land or Sell Licenses, the following information is required for a proper application by the licensee, a responsible party or person holding power of attorney:

(1) Full name, physical address, mailing address, date of birth, and signature of the licensee on the application. If the licensee is not appearing before a license agent or a representative of the Division, the licensee's signature on the application must be notarized;

(2) Current picture identification of licensee or responsible party; acceptable forms of picture identification are driver's license, state identification card, military identification card, resident alien card (green card) or passport or if purchased by mail, a copy thereof ;

(3) Certification that the applicant does not have four or more marine or estuarine resource violations during the previous three years;

(4) Valid documentation papers or current motor boat registration or copy thereof when purchasing a commercial fishing vessel registration. If an application for transfer of documentation is pending, a copy of the pending application and a notarized bill of sale may be submitted;

(5) Current articles of incorporation and a current list of corporate officers when purchasing a license or commercial fishing vessel registration in a corporate name. In the case of incorporation of an individual fishing vessel, the name of the master of that vessel shall also be specified. It is unlawful to fail to notify the Morehead City Office of the Division of Marine Fisheries within five days of change of the master specified for that vessel;

(6) If a partnership is established by a written partnership agreement, a current copy of such agreement shall be provided when purchasing a license, endorsement or commercial fishing vessel registration in a partnership name;

(e) Proof of residency in North Carolina for:

(1) Standard Commercial Fishing License or Retired Standard Commercial Fishing License shall be:

(A) a notarized certification from the applicant that the applicant is a resident of the State of North Carolina as defined by G.S. 113-130 (4); and

(B) a notarized certification from the applicant that a North Carolina State Income Tax Return was filed for the previous calendar or tax year as a North Carolina resident; or

(C) a notarized certification that the applicant was not required to file a North Carolina State Income Tax Return for the previous calendar or tax year; or

(D) military identification, military dependent identification and permanent change of station orders or assignment orders substantiation individual's active duty assignment at a military facility in North Carolina.

(1) All other types of licenses:

(A) North Carolina voter registration card; or

(B) Current North Carolina Driver's License; or

(C) Current North Carolina Certificate of Domicile; or

(D) Current North Carolina Identification Card issued by the North Carolina Division of Motor Vehicles; or

(E) Military Identification, military dependent identification and permanent change of station orders or assignment orders substantiating individual's active duty assignment at a military facility in North Carolina.

(f) Applications submitted without complete and required information will be deemed incomplete and will not be considered further until resubmitted with all required information.

(g) It is unlawful for a license or registration holder to fail to notify the Division of Marine Fisheries within 30 days of a change of address.

(h) Licenses are available at Offices of the Division or by mail from the Morehead City Office, unless otherwise specified. In addition, Recreational Commercial Gear Licenses are available at Wildlife Service Agents who have been designated as agents of the Department.

(i) To renew any Marine Fisheries licenses, endorsements, and commercial fishing vessel registration, except Recreational Commercial Gear Licenses, the following is required for a proper renewal application by the licensee, a responsible party or person holding a power of attorney;

(1) The information required in Subparagraphs (a) (4), (a) (5), and (a) (6) of this Rule are only required if a change has occurred since the last issuance of license, endorsement or commercial fishing vessel registration.

(2) Certification that articles of incorporation and list of corporate officers, if incorporated, written partnership agreement, if written partnership, or documentation papers or motor boat registration previously provided for initial license purchase are still valid and current for renewal.

(3) Current and valid state driver's license or state identification picture identification numbers and expiration dates must be verified on mail license renewal applications or any other electronic license renewal process, otherwise the licensee must provide a photocopy for renewal by mail or visit a Division License Office and present a current and valid picture identification pursuant to Subparagraph (a) (2) of this Rule.

(4) The licensee's or responsible party's signature on the application shall certify all information as true and accurate. Notarization of signature on renewal applications is not required.

(5) The Division of Marine Fisheries may require current copies of documentation for licenses, endorsements, commercial fishing vessels registration on renewal when necessary to verify inconsistent information or the information cannot be verified by independent sources.

(6) If the linear length of the pier has not changed for the Ocean Fishing Pier License renewal, the responsible party will certify that the length is accurate; otherwise, a Marine Patrol Officer's signature is required to certify the linear length before the license can be renewed.

30 .0104 COMMERCIAL UNLOADING OF FISH

It is unlawful to unload fish from a vessel in North Carolina engaged in a commercial fishing operation outside state waters without possessing a valid:

(1) Standard or Retired Standard Commercial Fishing Licenses; or

(2) Menhaden License for Nonresidents Without a Standard Commercial Fishing License; or

(3) Shellfish License for North Carolina Residents without a Standard Commercial Fishing License; or

(4) Land or Sell License.

30 .0106 DISPLAY OF LICENSES AND REGISTRATIONS

(a) It is unlawful:

(1) For any person to use a vessel required to be registered under the provisions of G.S 113-168.6 in a commercial fishing operation without a current commercial fishing vessel registration decal mounted on an exterior surface so as to be plainly visible when viewed from the port side;

(2) To display any commercial fishing vessel registration decal not issued for the vessel displaying it.

(b) It is unlawful to fail to display any fish dealer's licenses required by G.S. 113-169.3 or ocean fishing pier license required by G.S. 113-169.4 in prominent public view in each location subject to licensing.

SECTION .0200 – LEASES AND FRANCHISES

30 .0201 STANDARDS FOR SHELLFISH BOTTOM AND WATER COLUMN LEASES

(a) All areas of the public bottoms underlying coastal fishing waters shall meet the following standards in addition to the standards in G.S. 113-202 in order to be deemed suitable for leasing for shellfish purposes:

(1) The lease area must not contain a natural shellfish bed which is defined as 10 bushels or more of shellfish per acre.

(2) The lease area must not be closer than 100 feet to a developed shoreline. In an area bordered by undeveloped shoreline, minimum setback is required. When the area to be leased borders the applicant's property or borders the property of riparian owners who have consented to a notarized statement, the Secretary may reduce the distance from shore required by this Rule.

(3) Unless the applicant can affirmatively establish a necessity for greater acreage through the management plan that is attached to the application and other evidence submitted to the Secretary, the lease area shall not be less than one-half acre and shall not exceed:

(A) 10 acres for oyster culture;

(B) 5 acres for clam culture;

(C) 5 acres for any other species.

This Subparagraph shall not be applied to reduce any holdings as of July 1, l983.

(b) Franchises recognized pursuant to G.S. 113-206 and shellfish bottom leases shall meet the following standards in addition to the standards in G.S. 113-202. In order to avoid termination, franchises and shellfish bottom leases shall:

(1) Produce and market 10 bushels of shellfish per acre per year; and

(2) Plant 25 bushels of seed shellfish per acre per year or 50 bushels of cultch per acre per year; or a combination of cultch and seed shellfish where the percentage of required cultch planted and the percentage of required seed shellfish planted totals at least 100 percent.

(c) The following standards shall be applied to determine compliance with Subparagraphs (1) and (2) of Paragraph (b) of this Rule:

(1) Only shellfish planted, produced or marketed according to the definitions in 15A NCAC 03I .0101 (26), (27) and (28) shall be submitted on production/utilization forms for shellfish leases and franchises.

(2) If more than one shellfish lease or franchise is used in the production of shellfish, one of the leases or franchises used in the production of the shellfish must be designated as the producing lease or franchise for those shellfish. Each bushel of shellfish may be produced by only one shellfish lease or franchise. Shellfish transplanted between leases or franchises may be credited as planting effort on only one lease or franchise.

(3) Production and marketing information and planting effort information shall be compiled and averaged separately to assess compliance with the standards. The lease or franchise must meet the production requirement and the planting effort requirement within the dates set forth to be judged in compliance with these standards.

(4) In determining production and marketing averages and planting effort averages for information not reported in bushel measurements, the following conversion factory shall be used.

(A) 300 oysters, 400 clams, or 400 scallops equal one bushel;

(B) 40 pounds of scallop shell, 60 pounds of oyster shell, 75 pounds of clam shell and 90 pounds of fossil stone equal one bushel.

(5) In the event that a portion of an existing lease or franchise is obtained by a new owner, the production history for the portion obtained shall be a percentage of the originating lease or franchise production equal to the percentage of the area of lease or franchise site obtained to the area of the origination lease or franchise.

(6) These production and marketing rates shall be averaged over the most recent three-year period after January 1 following the second anniversary of initial bottom leases and recognized franchises and throughout the terms of renewal leases. For water column leases, these production and marketing rates shall be averaged over the first five year period for initial leases and over the most recent three year period thereafter. Three year averages for production and marketing rates shall be computed irrespective of transfer of the shellfish lease or franchise.

(7) All bushel measurements shall be in U.S. Standard Bushels.

(d) Water columns superjacent to leased bottoms shall meet the standards in G.S. 113-202.1 in order to be deemed suitable for leasing for aquaculture purposes.

(e) Water columns superjacent to franchises recognized pursuant to G.S. 113-206 shall meet the standards in G.S. 113-202.2 in order to be deemed suitable for leasing for aquaculture purposes.

(f) Water column leases must produce and market 40 bushels of shellfish per acre per year to meet the minimum commercial production requirement or plant 100 bushels of cultch or seed shellfish per acre per year to meet commercial production by planting effort. The standards for determining production and marketing averages and planting effort averages shall be the same for water column leases as for bottom leases and franchises set forth in Paragraph (c) of this Rule except that either the produce and market requirement or the planting requirement must be met.

30 .0202 SHELLFISH BOTTOM AND WATR COLUMN LEASE APPLICATIONS

(a) Application forms are available from the Division's office headquarters referenced in 15A NCAC 03H .0101 for persons desiring to apply for shellfish bottom and water column leases. Each application must be accompanied by a map or diagram prepared at the applicant's expense and must meet the information requirements contained in the application including an inset vicinity map showing the location of the proposed lease with detail sufficient to permit on-site identification and location.

(b) As part of the application, the applicant must submit a management plan for the area to be leased on a form provided by the Division which meets the following standards:

(1) States the methods through which the applicant will cultivate and produce shellfish consistent with the minimum requirement in 15A NCAC 03O .0201;

(2) States the time intervals during which various phases of the cultivation and production plan will be achieved;

(3) States the materials and techniques that will be utilized in the management of the lease;

(4) Forecasts the results expected to be achieved by the management activities; and

(5) Describes the productivity of any other leases or franchises held by the applicant.

(c) The completed application, map or diagram, and management plan for the requested lease shall not be accepted by the Division unless accompanied by a non-refundable filing fee of one hundred dollars ($100.00). An incomplete application shall be returned and not considered further until re-submitted complete with all required information.

(d) Immediately after an application is deemed to have met all requirements and is accepted by the Division, the applicant must identify the area for which a lease is requested with stakes at each corner in accordance with 15A NCAC 03O .0204 (a) (1) (A). The applicant shall firmly attach to each stake a sign, provided by the Division containing the name of the applicant, the date the application was filed, and the estimated acres.

3O .0203 SHELLFISH LEASE APPLICATION PROCESSING

(a) Upon acceptance of a completed application, the proposed lease area shall be inspected within a reasonable time by agents of the Division. Proposed lease areas inconsistent with applicable standards contained or referenced in 15A NCAC 03O .0201 shall result in the return of applications for amendment to remove the inconsistencies. If the boundaries of the proposed lease area are modified, the stakes identifying such areas shall be relocated accordingly by the applicant. The failure of applicants to amend applications or modify lease area identification, when required, shall result in the denial of such applications.

(b) If the initial or amended lease application is deemed consistent with all applicable requirements, the Secretary or his designee shall notify the applicant and publish notices of intention to lease in accordance with standards in G.S 113-202(f).

(c) The Secretary shall consider the lease application, the Division's proposed lease area analysis, and public comments, and may in his discretion lease or decline to lease the proposed lease area or any part thereof. Special conditions may be imposed so that leases may be issued which would otherwise be denied. Should an applicant decide not to accept any special condition imposed on the lease by the Secretary, the application shall be considered denied.

(d) Upon approval of leases by the Secretary, applicants shall mark the shellfish bottom leases in accordance with 15A NCAC 03O .0204 (a) (1), water column leases in accordance with 15A NCAC 03O .204 (a)(2), and shall within 90 days submit to the Division acceptable surveys of the areas approved for leasing except that a water column lease which entirely covers a shellfish bottom lease or franchise with an accepted survey on file does not require another survey. Such surveys shall be made at the expense of applicants and must meet the following standards:

(1) Surveys and maps shall meet all the requirements of 21 NCAC 56 .1600, Standards of Practice for Land Surveying in North Carolina, which is hereby incorporated by reference including subsequent amendments and editions. This material is available for inspection and copies may be obtained from the Marine Fisheries Division, Marine Fisheries Building, 3441 Arendell St., P.O. Box 769, Morehead City, North Carolina 28557, at no cost.

(2) Maps shall bear the certificate:

"I _____ certify that this map was (drawn by me) (drawn under my supervision) from (an actual survey made by me) (an actual survey made under my supervision); that the error of closure as calculated by latitudes and departures is 1:_____, that the area is _____acres. Witness my hand and seal this _____ day of _____AD_____."

_____

Surveyor or Engineer

(3) The phrase "other appropriate natural monuments or landmarks" in 21 NCAC 56 .1604 (e)(9) shall include bridges, roads, highways, intersections, publicly maintained aids to navigation, houses and other permanent buildings, radio, telephone, TV, and water towers; docks; piers, and bulkheads; but does not include stakes marking the boundaries of adjoining leases, points of marsh, junctions of streams, or other landmarks which are particularly subject to change through natural processes, storms, or the effect of man.

(4) A written description of the survey suitable for official documents shall be provided with the survey.

(e) Proposed shellfish bottom lease areas remain public bottom until a formal lease has been executed by the Secretary.

(f) Proposed water column lease areas superjacent to shellfish bottom leases and recognized perpetual franchises remain public water until a formal lease has been executed by the Secretary.

3O .0204 MARKING SHELLFISH LEASES AND FRANCHISES

(a) All shellfish bottom leases, franchises, and water column leases shall be marked as follows:

(1) Shellfish bottom leases and franchises shall be marked by:

(A) Stakes of wood or plastic material at least three inches in diameter at the water level and extending at least four feet above the high water mark. The stakes shall be firmly jetted or driven into the bottom at each corner.

(B) Signs displaying the number of the lease or franchise and the name of the owner printed in letters at least three inches high must be firmly attached to each corner stake.

(C) Supplementary stakes of wood or plastic material, not farther apart than 50 yards or closer together than 50 feet and extending at least four feet above the high water mark, must be placed along each boundary except when such would interfere with the use of traditional navigation channels.

(2) Water column leases shall be market by anchoring two yellow buys, meeting the material and minimum size requirements specified in 15A NCAC 03J .0103 (b) at each corner of the area or by larger buoys, posts and signs as identified and approved by the Secretary in the Management Plan.

(b) Stakes marking areas of management within shellfish bottom leases or franchises, as approved in the management plan, must conform to Subparagraph (a) (1)(C) of this Rule and may not exceed one for each 1,200 square feet. Marking at concentrations of stakes greater than one for each 1,200 square feet constitutes use of the

water column and a water column lease is required in accordance with G.S. 113-202.1 or G.S 113-202.2.

(c) All areas claimed in filings made pursuant to G.S. 113-205 as deeded bottoms through oyster grants issued by the county clerk of court or as private bottoms through perpetual franchises issued by the Shellfish Commission shall be marked in accordance with Paragraph (a) of this Rule, except the sign shall include the number of the franchise rather that the number of the lease. However, claimed areas not being managed and cultivated shall not be marked.

(d) It is unlawful to fail to remove all stakes, signs, and markers within 30 days of receipt of notice from the Secretary pursuant to Departmental Rule 15A NCAC 0lG .0207 that a G.S. 113-205 claim to a marked area has been denied.

(e) It is unlawful to exclude or attempt to exclude the public from allowable public trust use of navigable waters on shellfish leases and franchises including, but not limited to, fishing, hunting, swimming, wading and navigation.

(f) The Division has no duty to protect any shellfish bottom lease, franchise, or water column lease not marked in accordance with Paragraph (a) of this Rule.

3O .0205 LEASE RENEWAL

(a) Lease renewal applications shall be provided to lessees as follows:

(1) For shellfish bottom leases, renewal applications shall be provided in January of the year of expiration.

(2) For water column leases, renewal applications shall be provided at least 90 days prior to expiration dates.

(b) Lease renewal applications shall be accompanied by management plans meeting the requirements of 15A NCAC 03O .0202(b). A filing fee of fifty dollars ($50.00) shall accompany each renewal application for shellfish bottom leases.

(c) A survey for renewal leases shall be required at the applicant's expense when the Division determines that the area leased to the renewal applicant is inconsistent with the survey on file.

(d) When it is determined, after due notice to the lessee, and after opportunity for the lessee to be heard, that the lessee has not complied with the requirements of this Section or that the lease as issued is inconsistent with this Section, the Secretary may decline to renew, at the end of the current terms, any shellfish bottom or water column lease. The lessee may appeal the Secretary's decision by initiating a contested case as outlined in 15A NCAC 03P .0102.

(e) Pursuant to G.S. 113-202 (a)(6), the Secretary is not authorized to recommend approval of renewal of a shellfish lease in an area closed to shellfishing by reason of pollution. Shellfish leases partially closed due to pollution must be amended to exclude the area closed to shellfishing prior to renewal. For purposes of lease renewal determinations, an area shall be considered closed to shellfish harvest by reason of pollution when the area has been classified by the State Health Director as prohibited or has been closed for more than 50 percent of the days during the final four years prior to renewal except shellfish leases in areas which have been closed for more than 50 percent of the days during the final four years prior to renewal and continue to meet established

production requirements by sale of shellfish through relay periods or other depuration methods shall not be considered closed due to pollution for renewal purposes.

(f) If the Secretary declines to renew a lease that has been determined to be inconsistent with the standards of this Section, the Secretary with the agreement of the lessee, may issue a renewal lease for all or part of the area previously leased to the lessee that contains conditions necessary to conform the renewal lease to the minimum requirements of this Section for new leases.

3O .0206 LEASE PROTEST

(a) Should any person object to the granting of any initial or renewal lease, he has the right to protest its issuance prior to the granting of the lease by the Secretary. The protestant may file a sworn statement of protest with the Division stating the grounds for protest. The Secretary shall notify both the prospective lessee and the protestant upon receipt of a protest, and shall conduct such investigation as he deems necessary, and shall notify both parties of the outcome of his investigation. Protestants or applicants receiving an adverse recommendation on the lease application from the Secretary may appeal this decision as outlined in G.S. 113-202(g).

(b) Any member of the public shall be allowed an opportunity to comment on any lease application during the public hearing at which the lease application is being considered by the Secretary.

3O .0207 PRODUCTION REPORTS

(a) The owners of shellfish leases and franchises shall provide annual production reports to the Division showing the amounts of material planted and harvested in connection with management for commercial production. Reporting forms will be provided to owners of shellfish bottom leases and recognized franchises during the period that annual notices of rent due are provided to owners of shellfish bottom leases in accordance with G.S. 113-202(j). Reporting forms will be provided to owners of water column leases prior to each annual anniversary date.

(b) Failure to furnish the required production report, correct and in detail requested, or filing a report containing false information can constitute grounds for termination.

3O .0208 CANCELLATION

(a) In addition to the grounds established by G.S. 113-202, the Secretary shall begin action to terminate leases and franchises for failure to produce and market shellfish or for failure to maintain a planting effort of cultch or seed shellfish in accordance with 15A NCAC 03O .0201.

(b) Action to terminate a shellfish franchise shall begin when there is reason to believe that the patentee, or those claiming under him, have done or omitted an act in violation of the terms and conditions on which the letters patent were granted, or have by any other means forfeited the interest acquired under the same. The Division shall investigate all such rights issued in perpetuity to determine whether the Secretary should

request that the Attorney General initiate an action pursuant to G.S. 146-63 to vacate or annul the letters patent granted by the state.

(c) Action to terminate a shellfish lease or franchise shall begin when the Fisheries Director has cause to believe the holder of private shellfish rights has encroached or usurped the legal rights of the public to access public trust resources in navigable waters.

(d) In the event action to terminate a lease is begun, the owner shall be notified by registered mail and given a period of 30 days in which to correct the situation. Petitions to review the Secretary's decision must be filed with the Office of Administrative Hearings as outlined in 15A NCAC 03P .0102.

(e) The Secretary's decision to terminate a lease may be appealed by initiating a contested case as outlined in 15A NCAC 03P .0102.

3O .0503 PERMIT CONDITIONS; SPECIFIC

(f) Aquaculture Operations/Collection Permits

(1) It is unlawful to conduct aquaculture operations utilizing marine and estuarine resources without first securing an Aquaculture Operation Permit from the Fisheries Director.

(2) It is unlawful:

(A) To take marine and estuarine resources from coastal waters for aquaculture purposes without first obtaining an Aquaculture Collection Permit from the Fisheries Director.

(B) To sell, or use for any purpose not related to North Carolina aquaculture, marine and estuarine resources taken under an Aquaculture Collection Permit.

(C) To fail to submit to the Fisheries Director an annual report due on December 1 of each year on the form provided by the Division the amount and disposition of marine and estuarine resources collected under authority of this permit.

(3) Lawfully permitted shellfish relaying activities authorized by 15A NCAC 3K .0103 and .0104 are exempt from requirements to have an Aquaculture Operation or Collection Permit issued by the Fisheries Director.

(4) Aquaculture Operations/Collections permits shall be issued or renewed on a calendar year basis.

(5) It is unlawful to fail to provide the Division of Marine Fisheries with a listing of all designees who shall be acting under an Aquaculture Collection Permit at the time of application.

E

Appendix E

Sample Lease Management Plan

UTILIZATION PLAN FOR SHELLFISH WATER COLUMN LEASE

NAME Mari Culture LEASE NUMBER 425 COUNTY Onslow

ADDRESS 5 Leaseway Dr. Shellfish, NC 28555 LEASE SIZE 3.2 Acres WATER BODY Oyster Bay

AREA SIZE OF WATER COLUMN LEASE 1 Acre LOCATION South Sound

TELEPHONE (910) 555-5555 DATE GRANTED/ISSUED _____

PRODUCTION PLANS:

CULTCH/SEED TYPE AND SOURCE Hatchery oyster and clam seed

VOLUME TO BE PLANTED PER ACRE 100,000 PLANNED UTILIZATION DATES Year Round

EXPECTED HARVEST IN BUSHELS 200 MARKET POTENTIAL $26,400

EQUIPMENT TO BE USED Boat, Racks, Plastic Cages, and Chub Links

LABOR AVAILABLE My husband and I , two teenage sons when available

CAPITAL INVESTMENT 1st and 2d year $20,000, thereafter $6,500 per year

ESTIMATED RETURNS 1st year no return, 2d year $6,000, thereafter $20,000 per year

MARKING IDENTIFICATION PLANS Posts and signs on corners, posts on each rack, floating items marked with their floats

DESCRIBE THE METHODS TO BE USED AND PROVIDE REFERENCES THAT DOCUMENT THEIR USE AS COMMERCIALLY FEASIBLE FORMS OF AQUACULTURE. ADDITIONAL SHEETS AS NECESSARY.

We will use methods currently in use as developed by NC Sea Grant, presented in their publication "Culturing Oysters in North Carolina," and taught in workshops sponsored by Carteret and Coastal Carolina Community Colleges.

Location Map
Ms. Mari Culture
Lease 425/WC-7
February 27, 2004

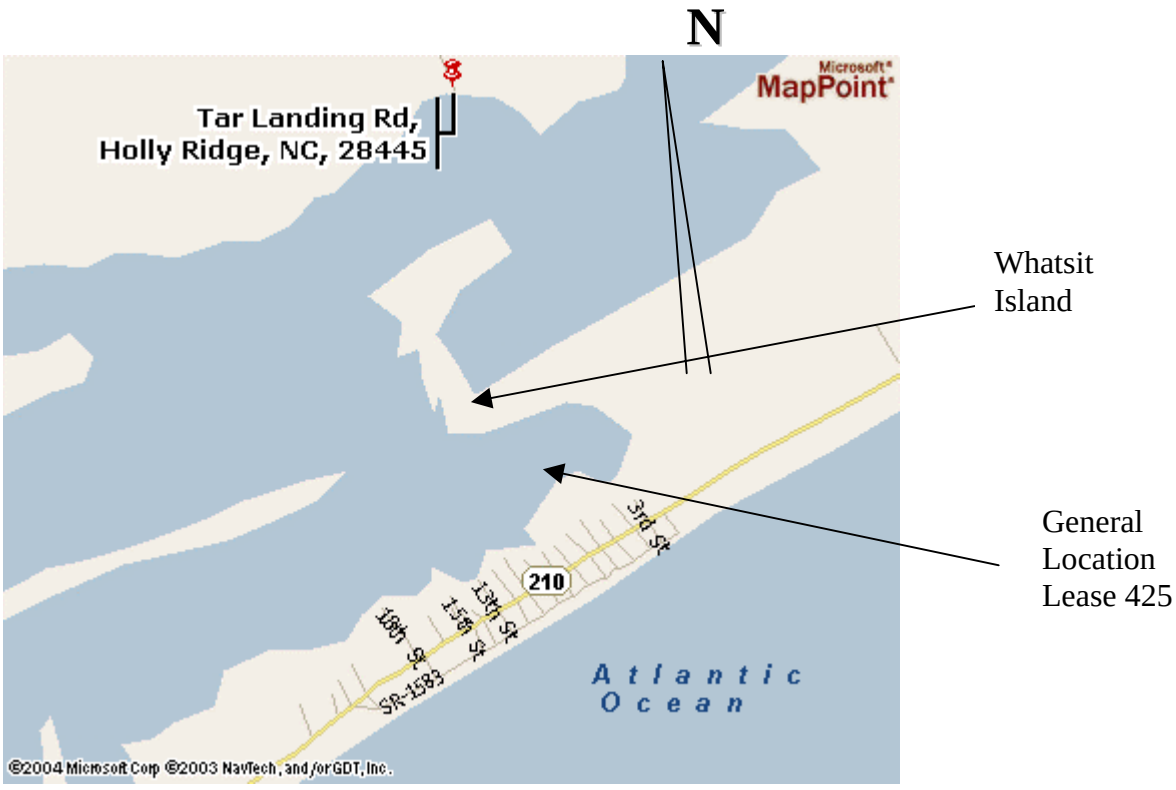
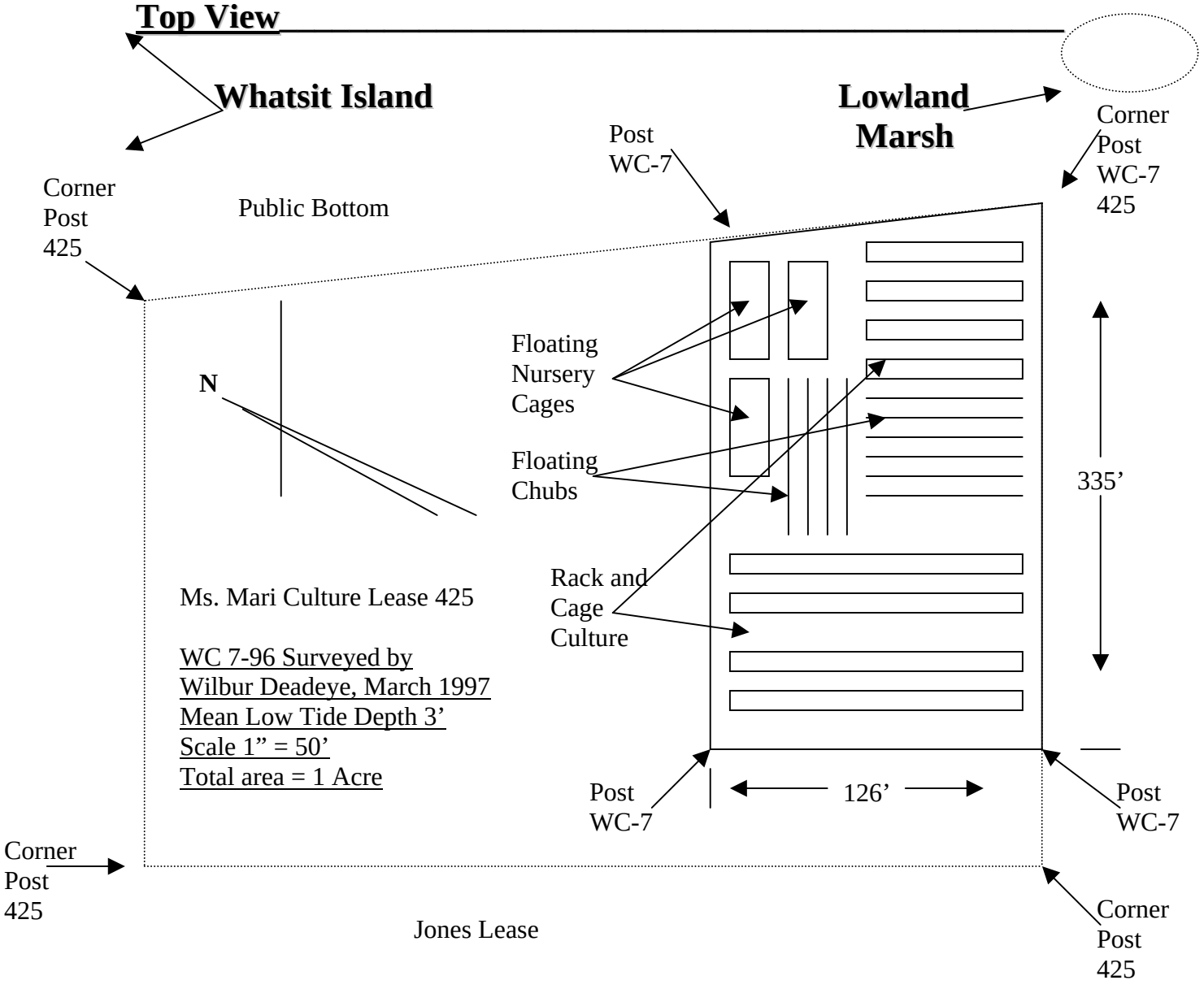
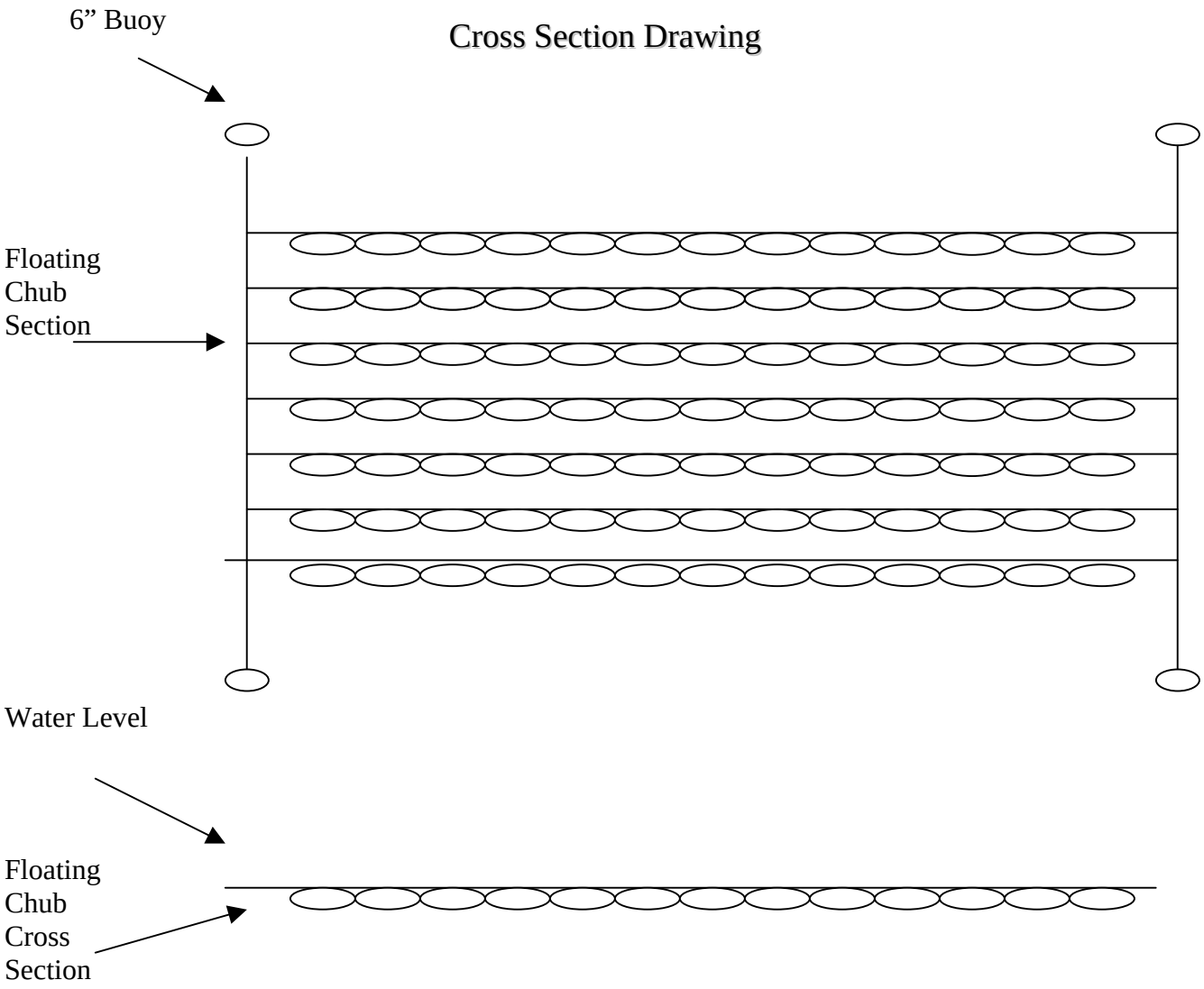
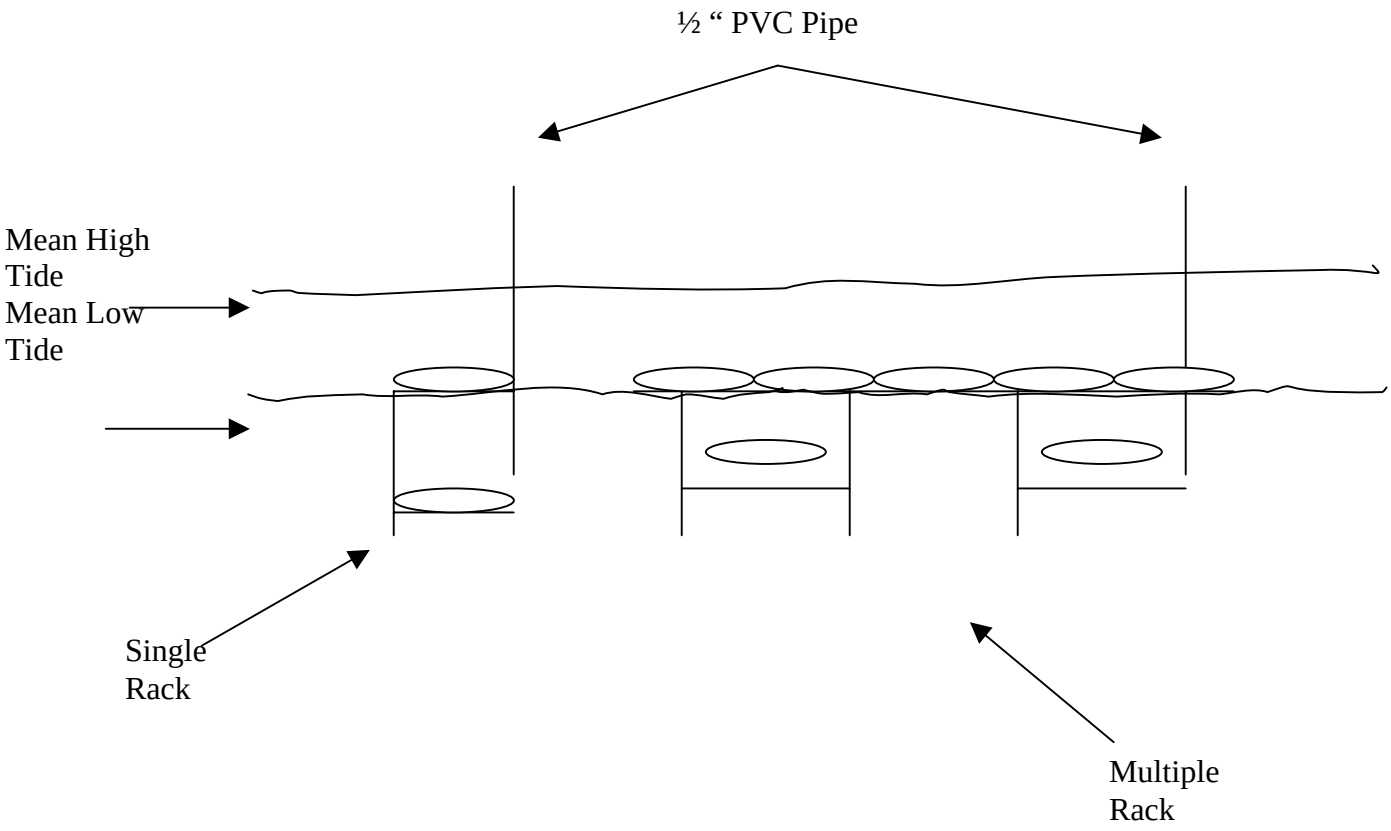


Figure 9

Ms. Mari Culture
February 27, 2004
Water Column Use Area
Water Column Number WC 7-96
Shellfish Lease 425




6” Buoy
Cross Section Drawing
Floating
Chub
Section
Water Level
Floating
Chub
Cross
Section


½ “ PVC Pipe
Mean High Tide
Mean Low Tide
Single Rack
Multiple Rack

Notes

F

Appendix F

Small Business Plan

❖ [Ask Ann Shaw]

❖ [Ask Matt Parker]

An executive summary outlining goals and objectives. The executive summary introduces your business strategy and probably is the most important section for lending institutions, but beyond that, it is your opportunity to clearly, logically, and concisely put your business idea into words. If it doesn't make sense here, it probably isn't a good idea.

The executive summary should include highlights from the following topics:

A. The goals and objectives of the business
B. Physical description and location
C. Legal form of organization
D. Owners and investors
E. Products and services produced
F. Financial relationships

A brief account of how the company began. Clearly explain the origins behind the company's creation and how you or your business associate came up with the idea to start your business.

The service or product you plan to offer. A key aspect of this section will be a discussion of how your product or service differs from everything else on the market.

The market potential for your service or product. If yours is a locally based business, you need to assess the demand for your offering within an xx-mile radius, based on what you determine is a reasonable distance from your business. If it's a Web-based business or a business that relies on both the Internet and local traffic for revenues, you'll need to evaluate demand on a local and/or a national basis.

This section should address the general conditions of the market for your product and the specific broad or niche market areas you intend to use. It should also include the risks inherent in your business in general and what you intend to do to protect from them.

A marketing strategy. What is your target market and how do you intend to reach it? How do you plan to tell the world you're open for business? How will you market and advertise your business, and how much you plan to spend on marketing? Who is your competition and how do you plan on meeting that competition? Build a customer profile. Draw up a plan for handling customers.

A three- to five-year financial projection. This section should include a summary of your financial forecasts with spreadsheets showing the formula you used to reach your projections. You'll need balance sheets, income statements and cash-flow projections for the entire forecast period. The summary in this section is also where you would tell prospective lenders how much money you'd like to borrow to cover your startup costs.

Operations and management plan. Who will run the company? Who will make operational/financial/personnel decisions? Will you hire employees? If so what will be their duties, pay and benefits? Will you need to train employees, and if so, how will you do that?

Legal form of the business. Describe the legal structure of the business (sole proprietorship, partnership, limited liability company, S-corporation) that you intend to form and how you intend to do that.

Taxes, licenses and insurance. Show that you understand the hidden costs and risks of business and how you will meet them.

Key business associates. List the professionals that will help you form and run your business including an attorney, accountant, business consultant, insurance broker, primary vendors, etc.

Accounting and record keeping. Describe how you intend to keep track of your money.

Annexes

Start-Up Expenses
Personal Financial Statement
Balance Sheet
Income Statement
Loan Amortization Schedule
Cash Flow Projections
Profit and Loss Projection

Appendix G

Sources

Shellfish Farming Technical Assistance

Philip S. (Skip) Kemp Jr.
Curriculum Area Coordinator
Aquaculture Technology Program
Carteret Community College
3505 Arendell Street
Morehead City, NC 28557
252-222-6114
252-222-6227 fax
kemps@carteret.edu
http://main2.carteret.edu/~kemps

Leasing, Licensing, Permitting

Craig Hardy
Chief, Resource Enhancement Section
N. C. Division of Marine Fisheries
P.O. Box 769
Morehead City, NC 28557-0769
(800) 682-2632
Craig.Hardy@ncmail.net
http://www.ncdmf.net/

Shellfish Sanitation

Wayne Mobley
N.C. Shellfish Sanitation
Fisheries Building,
P.O. Box 769
Morehead City, NC 28557
(252) 762-6827
Wayne.Mobley@ncmail.net

Business Practices

Matthew Parker
Aquaculture Business Specialist
North Carolina Cooperative Extension Service
Craven County Center
300 Industrial Drive
New Bern, NC 28562
(252) 633-1477
(252) 633-2120 (fax)
Matthew.Parker@ncmail.net
www.ncagr.com/aquacult/

Ann Shaw
Director, Small Business Center
Coastal Carolina Community College
(910) 938-6322
shawa@coastal.cc.nc.us

Coastal Business Specialist
North Carolina Sea Grant
Center for Marine Sciences and Technology
303 College Circle, Room 111
Morehead City, NC 28557
(252) 222-6314

HACCP Training

Barry Nash
North Carolina Sea Grant
Seafood Lab
NC State Center for Marine Sciences and Technology
303 College Circle, Room 213
Morehead City, NC 28557
(252) 222-6337
Fax: (252) 222-6308
barry.nash@ncsu.edu

North Carolina Shellfish Growers Association

Jim Swartzenberg, President
P.O. Box 269
Smyrna, NC 28579
(910) 347-7240
oyster@coastalnet.com

Oyster Larvae and Seed

Gef Flimlin
Marine Extension Agent
Rutgers Cooperative Extension of Ocean County
1623 Whitesville Road
Toms River, NJ 08755
(732) 349-1152
Flimlin@aesop.rutgers.edu
(Ask for the East Coast Shellfish Hatchery and Nursery List)

Clipper Machine for Making Chubs

Tipper Tie, Inc.
P.O. Box 866
Apex, NC 27502
(919) 362-8811

Chemicals

Fisher Scientific Company, L.L.C.
2000 Park Lane
Pittsburgh, PA 15275
(412) 490-3333 x 1260
(412) 490-1202 (fax)

Carolina Biological Supply Co.
P.O. Box 6010
Burlington, NC 27216-6010
(336) 584-0381
(336) 584-7686 (fax)

Aquaculture Supplies and Materials

Atlantic Aquaculture Supply, Inc.
86 Tupelo St.
Bristol, RI 02809
(401) 253-0240
(800) 442-8727
(401) 253-3334 (fax)
Atlantic@atlanticAquaculture.com
www.alanticaquaculture.com

Aquatic Eco-Systems, Inc.
1716 Benbow Court
Apopka, Fl 32703
(877) 347-4788
(407) 886-6787 (fax)
aes@aquaticeco.com
www.aquaticeco.com

Aquaculture Supply
33418 Old Saint Joe Road
Dade City, FL, 33525
(352) 567-8540
(352) 567-3742 (fax)
Info@Aquaculture-Supply.com

Coastal Aquacultural Supply
100 Glen Road
P.O. Box 8066
Cranston, RI 02920
(401) 467-9370
(401) 461-9520
coastal@coastalaquacultural.com
www.coastalaquacultural.com

Peter and Diane Perina
Distributors for ADPI and Coastal Aquacultural Supply
(804) 725-3948
eastfields@rivnet.net

Boxes and Packaging

Packaging Products, Inc.
198 Herman Melville Blvd.
P.O. Box 6002
New Bedford, MA 02742-6002
(800) 545-225-0484
(508) 993-9807 (fax)

Victory Packaging
1413 Transport Drive
Raleigh, NC 276036250 Brookhollow Parkway
Norcross, GA 30071
(770)209-1291 Voice
(770)209-1295 Fax
csat@victorypackaging.com
Click here for Map

Cady Industries, Inc.
P.O. Box 68
Pearson, GA 31642
U.S.A.
1-800-243-2451
ga_sales@cadyind.com
Sales: 1-800-511-0160

Plastic Products

ADPI, Inc.
3621 B Street
Philadelphia, PA 19134
(800) 521-2598
ADPI Enterprises Inc

Internet, Inc.
2730 Nevada Ave
North Minneapolis, MN 55427
(800) 328-8456

Tenax, Inc.
8291 Patuxent Range Road
Jessup, MD 20794
(800) 356-8495

Appendix H

The Systems at a Glance

System	Description	Advantages	Disadvantages	Process	Cost/100,000 oysters **1-year one** **2-year two** **Sys-sustained operations**
Bottom/ Stackable Trays	4'X4' wire or plastic trays w/650 oysters placed on-bottom or stacked	**E**asy access **A**daptable to a variety of areas **F**ast growing **R**eusable materials	**P**rone to bio-fouling **R**equires large seed **H**eavy cages	**P**lant-650/cage **M**aintenance-Sort and rotate **H**arvest-Many oysters/limited effort	**1**-$11,123 **2**- 8,450 **Sus**-6,130
Floating Chub Links	35' long links of 1' mesh bags with 10 oysters per bag (chub)	**P**roduces deep-cup oysters **F**ast growing **L**ow maintenance **U**ses assembly-line techniques **C**an be managed from a boat	**L**imited reusable materials **O**ysters not accessible **O**ysters attract barnacles **S**usceptible to storm damage	**P**lant-Mechanized loading system **M**aintenance-Very little **H**arvest-Pull in chub links, tear apart chubs, save floats	**1**-$12,554 **2**- 8,687 **Sus**-7,469
Adjustable Longline	Rigid plastic "Seapa" bags with 50 oysters each suspend from ropes stretched from post to post	**P**roduces compact, round oysters **F**ast growing **I**dea for docks **C**an be managed from a boat **R**eusable Materials	**M**ost expensive start-up **M**oving ropes a chore **C**ommercial crop requires extensive system of ropes and poles	**P**lant-Place 50 oysters in cage, hang cages **M**aintenance-Move ropes, air dry, return to water **H**arvest-Unclip bags, dump out oysters	**1**-$25,503 **2**- 10,550 **Sus**-6,580
Rack and Cage	Plastic cages w/30 oysters strapped at low tide level to fixed racks	**A**llows daily drying/biofouling control **E**ase of handling **R**eusable materials	**P**roduces long-flat oyster **S**lower growth **O**ysters tend to gather in ends of cages	**P**lant-130 oysters/cage, strap on cages **M**aintenance-Shake cages to separate oysters **H**arvest-Bring in cages, dump oysters	**1**-$15,393 **2**- 7,385 **Sus**-5,756

Notes