

## OYSTER AQUACULTURE PRODUCTION

Oysters are produced in many countries of the world. A variety of species are cultured using many innovative methods. Often these represent adaptations to local conditions. In short, when human innovation is utilized, animals can be raised in locations where they may not normally be found and in vastly greater quantities than would be found in nature.

In Dr. William K. Brooks' book, *The Oyster*, which was written in 1891, he described oyster culture developed in the Roman period consisting of bundles of sticks bound together and weighted with a stone. These were placed in areas known for natural reproduction with the stick bundles floating from the bottom where the rock kept the unit anchored. Free floating larvae would attach to the sticks, where they grow until harvested. Brooks made many suggestions for expanding oyster cultivation in the Chesapeake that are still relevant today.

In this section we provide you with a brief overview of culture methods found in other nations and other areas of the United States. We will describe the predominant methods used to raise oysters in the Chesapeake region and will include information about industry development projects that were used in Maryland prior to the epizootics of the 1980s.

In all instances, it should be remembered that "Aquaculture is Agriculture" and the objectives for production are the same for all products:

- Increase survival
- Maximize growth rate
- Develop uniformity
- Protect from predators
- Manage health
- Develop product continuity
- Grow for market demand

## Oyster Aquaculture in Asia

Oyster culture has been practiced since ancient times in Asia. Culture methods have been adapted to many areas in order to produce the animals. Typical of these types of operations, native materials such as bamboo are often used to create structures to support the oysters while they are growing. Raft culture is typical of this type of innovation. Floating culture



Floating raft culture in China  
Photo: S.K. Allen, VIMS

systems are used in many countries and are constructed of many types of material depending upon availability and cost.



Stick culture allows use of mud bottom  
photo: S.K. Allen, VIMS

Another innovation used in Asia is stick culture, which has allowed growers to use muddy bottom that would not otherwise be very productive. Sticks are placed vertically in soft mud bottom, catching spat from the water column. The oysters grow on the sticks, which are eventually picked up. The oysters are then removed from them for consumption. Placing oysters in the

water column is a practice that has been used in many areas for enhancing growth.

## Oyster Aquaculture in Europe

Oysters are raised in many countries of Europe. Producers there have raised several species and, in some instances, had similar problems with disease

destroying the native industry. For example, in France during the 1970s, a disease known as Bonamia largely destroyed the lucrative oyster industry. In that county, the industry supported many small family producers. When faced with impending disaster, the non-native oyster *Crassostrea gigas*, found to be resistant to the disease, was quickly imported and the industry was re-established using this new species. Production data shows that the industry actually tripled its production after that introduction and is today deemed to be a healthy industry that still supports many family businesses.

In some locations, small dike systems have been built that trap water during high tide, keeping it over the oysters during ebb. The water warms in these shallow ponds, which aids phytoplankton blooms that feed the oysters. The animals raised in these areas are known to often bring premium prices.

Off bottom culture techniques are also used in Europe. Some of these utilize racks in which oysters are held off bottom to grow. Being placed in intertidal areas allows them to go dry during low tide. This aids in keeping biofouling down, which is a significant problem with many oyster cultivation techniques. Biofouling cuts down on the amount of food that is available to the oysters since



Rack system in intertidal area Photo: S.K. Allen, VIMS

many of the fouling organisms are competitors for the same food. Cleaning oysters also requires labor, and labor means additional expense to the grower. Methods in which oysters can grow while minimizing labor means more profitable businesses.



Rack and bag system photo: S. Allen, VIMS

Racks for off bottom culture come in a variety of designs. They may be made of wood or metal, depending upon the needs of the grower and the dynamics of the area in which they are placed. In the rack and bag system shown here, the mesh of the bags would be determined according to the seed size. Small mesh bags would be used for juvenile seed so

that it would retain the animals. These would be sorted and transferred to larger mesh bags as they grew. The key in this method is to have the seed in the smallest size that will prevent them from escaping but large enough to provide the maximum water flow for feeding and growth. This is also why it is important to keep the mesh of the bags clean and free from fouling.

### Oyster Aquaculture in the United States

The two largest regions for oysters culture in the United States are the Gulf of Mexico and the Pacific Northwest. Gulf Coast states largely contain extensive leased areas that are farmed using natural spatfall. In Louisiana, leases were formerly planted using shell of the Rangia clam dredged from Lake Ponchartrain, but this has been curtailed. Since the industry raises many oysters and has plants that shuck many of them for cooking products, the shell is available to be replaced on the leases as clean cultch for catching more larval oysters.

### Pacific Coast

The west coast of the United States, especially in upper California, Oregon, and Washington, produce many oysters. The native Olympia oyster, a small animal that requires around 2,000 to make a gallon of meats, was severely reduced in quantity during the early decades of the twentieth century. Growers had to decide whether

to get out of the business or raise another species. They turned to Japan and imported seed of *Crassostrea gigas*. The industry was able to rebuild, using this imported seed for many years. During World War II, however, this was not possible and the industry created new paths afterwards. The use of hatcheries became commonplace and the industry grew several species of oyster for their markets.

Many Pacific coast grounds are intertidal. Tides that range ten (10) feet or more are fairly common. This allows growers to use equipment that would not be available in areas with much smaller tides, like the Chesapeake and coastal bays. It also allows oysters in many areas to be picked by hand, with crews working during the cycle of low tide to harvest animals that are then retrieved by vessels during high tide. It also allows the grower to see the condition of his crop regularly, which aids in planting, harvesting, and overall management of the grounds.



Oyster grounds in Willapa Bay, WA

photo D. Meritt



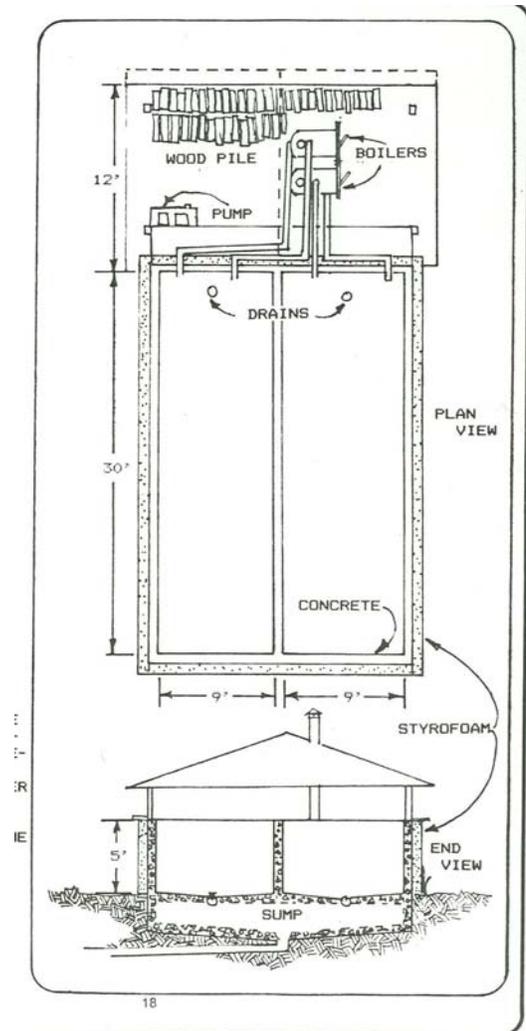
Intertidal grounds, Washington state

Growers use a variety of different methods for growing oysters, depending upon their area, species, and requirements. Some use their grounds for nursery areas, placing shell bags with juvenile oysters in the areas to attain growth while protected prior to final planting. Some raise a variety of species which may include several from Asia, European flat oysters, and even the Eastern oyster.

Some growers use their grounds for the production of Manila clams or the extremely large Geoduck clam, which takes a great deal of work to produce but has a very lucrative return in the marketplace.

A major innovation in the Pacific industry was that of "remote setting". This is essentially a logical division of labor between the technical work of the hatchery and the more available labor of the grower. In remote setting, the hatchery concentrates on producing larvae which are shipped to the grower who uses them in the setting operation. The key factor in the success of remote setting was the finding that oyster larvae close to setting could live for several days out of water and that, during that time, they would cease developing. Kept cool and damp, they could then be shipped hundreds of miles from the hatchery. This allowed hatcheries to use their technically trained staff for maximum larval production while the growers used field crews for the bagging, setting, and nursery operations.

A remote setting system is quite simple, yet should be adapted to the needs of the grower based on the area of operations. The system consists of a tank that holds ambient water, a PVC pipe grid in the bottom with holes drilled at regular intervals, and an air pump or blower to provide air to the grid. The system includes a pump to fill the tank with nearby seawater, and often a heater to keep the water temperature at optimum condition for the larvae to set. A cover may be provided to keep heat in, especially at night. Bagged or containerized shells are placed in the



Remote setting system using wood fired boiler for heating water from Jones, 1980

filled tank and larvae are introduced. The air bubbles provide circulation as larvae find and attach themselves to shells in the tank.

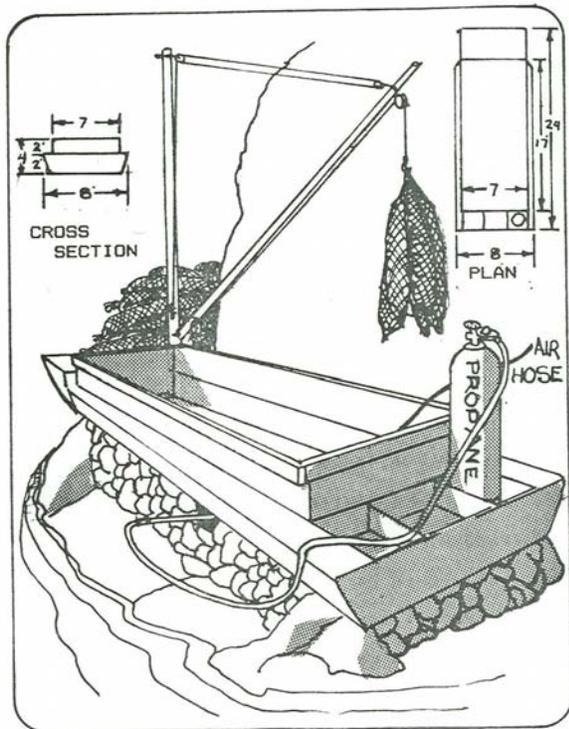


Diagram of old boat converted to remote setting tank, British Columbia from Jones, 1981

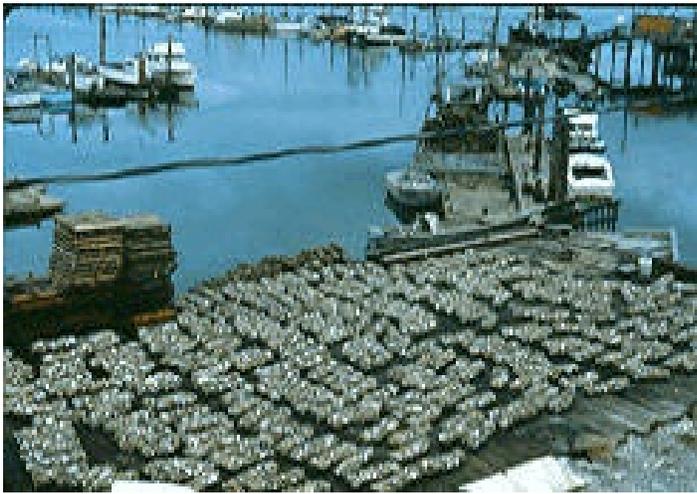
Remote setting systems in the northwest have been made from many innovative items. One described and diagramed in a manual by Bruce and Gordon Jones of British Columbia utilized an old boat. This was fitted with a propane systems for heating the water and included a mast and boom system for moving shell bags into and out of the unit for setting.

Many oyster businesses in the northwest are large, integrated operations that include production and processing. But many smaller operations exist to provide a useful model for what could occur in the Chesapeake. Some small producers have

created businesses where they sell directly to the consumer. One such business had coupled a retail outlet with a series of picnic tables and charcoal grills. Customers would purchase wasters by the dozen and they would be placed on trays which had an oyster knife attached to it via cable. The customers would shock the oysters, place them on the barbecue grills, coat them with sauces, and enjoy a meal of oysters right out of the water. The business owner reported having customers calling for reservations of his picnic tables during certain times of the year.

Oyster aquaculture includes multiple phases. In the hatchery phase, oyster brood stock is conditioned and spawned. The larvae are cared for until they become eyed and are ready to set. In the setting phase, oyster larvae or introduced into a tank of cultch where they remain until they attach and metamorphose into spat. They

may then enter a nursery phase where they are grown out in a protective container until they are large enough to be planted. The final phase is grower, where oysters



Shell bags on pier await setting photo: D Meritt

are placed in the area in which they will grow to market size.

Key factors in the process include access to sufficient quantities of high quality oyster larvae at the time needed, access to cultch in sufficient quantity and quality to produce spat, and availability of growing grounds that will allow oysters to get to market. It is not

unusual in larger businesses on the West Coast for setting to require 40,000 to 50,000 shell bags per year.

As production increases, the problems in material handling increase. In the northwest, high tidal amplitude and firm bottom on many grounds makes it possible to use mechanization. In the Chesapeake with low tidal amplitude, increasing shoreline ownership, and often times soft bottom presents an entirely different series of challenges to those who wish to engage in aquaculture.

### New England

In New England, oyster aquaculture is carried out in many states using a variety of culture methods. Hatcheries exist in New York, Massachusetts Rhode Island and Maine. Culture methods range from traditional bottom culture using planted shells to catch natural spat to order column aquaculture using cages and nets. New



Mechanized handling in nursery grounds photo: D Meritt

England production is largely aimed at the high-value halfshell trade market. High salinity waters tend to make these animals highly prized for that use. Some companies have made progress in gaining brand name acceptance in the marketplace. In addition to the Eastern oyster there has been production of the European flat oyster. Shellfish aquaculture in addition to oysters in New England includes the hard clam, surf clam, and mussel.



Midwater oyster cages, Portsmouth RI  
web photo, unknown origin

While many areas in New England are very good for the cultivation of oysters, social and political problems have often faced the industry. Rhode Island, which was one of the first states in the nation to enact aquaculture legislation in the early 1800s, saw much of that early innovation fall apart in later years. Much of this had to do with the social conflict between entrepreneurs and laborers that spilled over from the factory and millwork differences. In recent years, Rhode Island has made significant progress in modernizing its aquaculture laws and regulations, but significant conflict still exists. Today, this largely has to do with shoreside property owners who wish to have only an unobstructed view of the horizon and feel that aquaculture provides visual impacts to that desire.

While in many instances it is necessary to have permission from both the state and federal regulatory authorities, in many New England states such as Massachusetts, it is also necessary to obtain permission from the local jurisdiction. Historical precedents give local townships authority over the bottom in their areas. This has led to many applications for aquaculture leases being turned down. Often this was a result of perceived conflict between local harvesters and those who wanted to engage in aquaculture.

## Chesapeake Bay

Historically, the principal production method for oysters has been bottom culture. Shell would be placed on the bottom and used it to attract free swimming larval oysters which would then attach to this cultch and grow. At the beginning of the 20<sup>th</sup> century in the states of Maryland and Virginia surveyed the natural oyster grounds of their respective states. These were placed on official charts and made off-limits to anyone wanting to lease bottom. At that point the two states diverged, with Virginia actively encouraging private oyster production and Maryland seeking to place obstructions in the way of those who wanted to try it.

The principal seed grounds in the Chesapeake Bay were in the James River. While close by many of the Virginia grounds, it was normally only the largest planters in Maryland who were able to afford the significant cost of importing that seed to their leased grounds.



Floats at St. Thomas Creek Oyster Company, MD restoration program. Citizens place these floats at docks and raise disease-free hatchery oyster seed for a year before turning it over to the foundation for planting on sanctuaries.

It is generally claimed that oysters on the surface grow at a faster rate than those on the bottom. Surface floats have taken many forms over the years. The current

use of the PVC variety is now most prevalent in the use of plastic has enabled many innovative designs in the aquaculture industry. The design used by the Circle C Oyster Ranchers Association uses a novel design that allows rafts to be flipped over periodically for control of biofouling.

A problem that has arisen in the use of surface floats has been their positioning in areas close to shore. Shellfish growing waters are classified by the Maryland Department of the Environment. Studies have shown that these nearshore waters are more prone to have high bacteria counts. This has led to the need for several producers to move or "relay" they are oysters for final grow out before marketing. This increase in labor adds additional cost to the product. Also, since the relay process must be overseen by state authorities, it has to be done during particular dates. Often this leads to conflict between the schedules desired by the producers and those available by officials.



Oyster cages in VA

Virginia has made substantial advances in oyster cultivation in recent years. Research has led to selected strains that survive better in the face of the diseases that have ravaged the industry. An offshoot of open water trials using non-native oysters has been the development of a cage that is placed on the bottom, rising approximately 1 foot from it. These cages were originally designed so that the non-native oysters could be recovered in their entirety. They were later found useful in controlling predation by the Cow nosed ray, and have since been used for the production of triploid native oysters. When used in the production of cultchless oysters these

cages have been beneficial in controlling losses to these predators.



Floating upweller in MD

The use of floating dwellers or "FLUPSYs" has provided an innovative way to grow seed to planting size. A FLUPSY consists of a unit which floats at the surface of the water. Surrounding water is moved into the unit and up through containers which hold juvenile oysters. The animals feed on the phytoplankton contained in the water and the constant flow moves the waste material out a discharge pipe. Because there is a low head in the movement of the water these devices are efficient and very economical to operate.

While small units have been used in Maryland and other states, a large unit capable of producing over 10 million oysters has recently been built for in use in Virginia. It uses a paddlewheel to move large quantities of water through the unit. The paddlewheel rotates at low RPM (~4-7) but moves vast quantities of water through the upweller units. An overhead hoist can be moved on rails for positioning above the holding cages to lift the units out of the



Large paddlewheel FLUPSY in Va

FLUPSY for cleaning, grading, and transfer. Units of this type are useful for production of large amounts of spat. Aside from the high construction cost, the operational costs are quite low and the units should have a long useful life.



Remote setting tanks at Horn Point Lab

Remote setting has become a fixture in the Chesapeake region as well. From early experiments in the 1980s, this process has evolved to be used for the production of seed in both Maryland and Virginia. At the University of Maryland's Horn Point oyster hatchery located near Cambridge, over a dozen tanks are used. This facility

provides seed for large-scale restoration projects as well as private oyster aquaculture. Plans call for the creation of a pier that would house many more setting tanks for enhanced production in the next several years.

Virginia has established a core group of growers who are participating in the production of spat on shell through remote setting. These growers are using triploid oysters that put most of their energy into growth, thereby reaching marketable size and quality before being affected by disease. Remote setting will be a useful tool in increasing production of oysters through aquaculture in future years. However, there are considerations that need to be taken into account in the siting of these facilities. Differences in salinity between the hatchery and the remote setting site may require tempering of the larvae prior to shipment. Also, location of setting facilities near areas that might contain toxins that could be pumped into the tanks would need to be avoided. Lastly, remote setting facilities need to be located on the shoreline for use of ambient water and ease of transportation to nursery or planting grounds. This could put the grower in a situation where local zoning might not be assumed to apply to such an operation.

Oyster aquaculture can provide significant benefits not only to the environment but also to the establishment of new businesses, economic growth, and enhancing employment opportunities. To be successful, restoration policy should seriously consider the role of private oyster aquaculture in returning the Chesapeake and coastal



Large vessel engaged in spreading oyster seed

bays to a healthy balance. Inviting private investment to aquaculture in Maryland will require a restructuring of laws and regulations, as well as providing protection for property rights. While various methods are currently used in the state, there should be a move towards legalizing and encouraging the same ones throughout the Maryland, Virginia, and Potomac River management areas.

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