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PRODUCING OYSTER SEED BY REMOTE SETTING

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Maryland Sea Grant Extension Program

INTRODUCTION

Remote setting is a technique for producing oyster seed from larvae. It consists of two phases: (1) setting, in which larvae attach to "cultch," a setting material such as shell; and (2) a nursery period where newly set oysters (called seed) are placed in protected areas until they are ready for planting. Oyster growers often use remote setting when natural seed supplies are not consistently available or must be purchased. By using your own cultch, labor and equipment, you can reduce the cost of seed, a major factor in oyster farming; with practice and planning, you can produce a consistent supply to meet your own needs.

Adult oysters are spawned at a hatchery where they produce millions of tiny larvae. These free swimming larvae are reared for approximately two weeks or until they develop a structure commonly referred to as an "eye-spot." It is at this time that the "eyed larvae" are ready to attach to a surface and undergo metamorphosis into juvenile oysters. In remote setting, hatcheries ship eyed larvae to oyster growers for setting at their sites. Shipping a small package



Free-swimming eyed

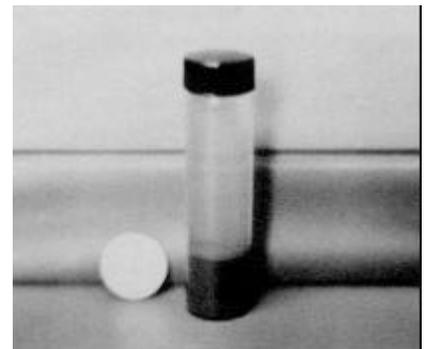
containing millions of larvae is significantly less expensive than moving seed already attached to heavy cultch.

Oyster shells are the most common cultch, but growers use other materials as well. While the remote setting process normally is used to produce seed for bottom culture, you can also produce seed for other growing methods. Setting systems can often be adapted to using different types of suitable cultch.

Growers usually set oysters during the warm summer months, though heaters in the tank can be

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A capsule of one million eyed



used to begin earlier. In the setting phase, containers filled with cultch are placed in a tank of salt water that is equipped with aeration. Cultch is often soaked for 24 hours before the larvae are added. In two to three days, the larvae attach to the cultch in a permanent bond. Growers maintain these new seed, also called spat, in the tank for a few days, and then transfer them to a nursery area. Producing large amounts of seed for bottom planting is simplified when machinery is used to handle the cultch.

In the nursery phase, containers of seed are placed in a protected area, usually shallow water. This practice will allow for easy retrieval when the oysters grow large enough for planting. Protecting tiny oysters against predation and siltation during the nursery period results in significantly better survival rates. While many types of containers can be used, they must permit widespread circulation of water, thus bringing food and oxygen to the growing oysters. Despite being crowded, spat will grow to planting size — usually about 3/4 inch — in a few summer months.

SELECTION OF SETTING AND NURSERY SITES

Proper sites for setting and nursery phases are critical for success in remote setting. Choose locations that will minimize your labor and lead to high survival and rapid growth of young oysters. While the choice of good sites may be limited, an important consideration should be lack of pollutants in the water. Oyster larvae are very sensitive to noxious compounds. Water from poorly flushed harbors, for example, can contain anti-fouling chemicals from boat paints,

bilge cleaners, oil, grease, or other pollutants.

Survey surrounding lands to determine if herbicides and pesticides could enter the water after a rainfall. Runoff containing too much organic matter, for example, leaves, can also be harmfully acidic: decaying leaves produce tannic acid and when viewed from the surface, the water will have the appearance of dark tea. If you are unfamiliar with an area, investigate its history. For example, if oysters are growing in nearby locations, it is an indication that water conditions are favorable. If in doubt about an area, proceed cautiously and be prepared to move to another location if there is a problem with oyster survival rates.

Salinity fluctuations in the setting and nursery areas also can affect survival of seed. Setting success decreases below 10 ppt, although adult oysters can tolerate salinities at or below 5 ppt. Nursery areas should not normally have salinities below 7 ppt. In the setting tank, salinity can be increased by adding salt; however, this option is not always practical and becomes too expensive to use for long periods. You should know the salinity that larvae were raised at in the hatchery: they should not be subjected to extreme salinity changes between the hatchery and the setting location. A change of more than 15 ppt between systems can be harmful. If variation exists between sites, it is safer to go from lower to higher salinity.

Much of the labor in remote setting involves moving cultch, so choose a site which will minimize handling. Look for simple methods of loading tanks and moving containers to the nursery. Cranes, winches, forklifts, or front-end loaders can be adapted for use.

In addition, a shorter distance between your water source and your tank will lower pumping and equipment costs. Electricity is an important consideration in order to supply aeration, run pumps, and possibly provide heat. Use three-phase power if it is available.

Holding newly set oysters in a nursery area will enhance their survival and growth to planting size. In selecting a nursery site, simplicity in placing and retrieving seeded cultch is also important. Water quality and bottom characteristics are critical: they can affect seed survival in many ways. Many good areas are intertidal with easy access at low tide.

Submerged nurseries are effective but may present problems in seed retrieval and monitoring. In intertidal areas, seed must be placed below mean high water. Higher placement often results in slow growth because oysters are out of the water too long and therefore not feeding. Prolonged exposure to drying winds, particularly in summer, may reduce survival. As a rule, the useful tidal range is below the height at which large barnacles are found.

The nursery area should have a firm bottom so that seed will not sink. Waters which carry large amounts of suspended materials, particularly areas where sand is shifting, can cause problems. The cultch slows the current movement and allows suspended particles to settle. Sediment can then accumulate and smother the tiny oysters.

Make sure that containers of seed do not present a hazard to boating traffic. Marking the edges of the nursery with a hedge of stakes extending above the water can prevent both injuries to



boaters and inadvertent damage to valuable oyster seed. Such markings are required by law. Check local and state regulations before using a nursery site. Finally, theft of oysters is a potential problem and should be a consideration when you are choosing nursery sites.

CULTCH SELECTION AND PREPARATION

The cultch material and type of container you select for remote setting are critical decisions in designing a setting system. Suitable cultch can improve setting success, and should be appropriate for growout later on. Growers prefer containers which are simple to fill and empty, and which minimize handling throughout the remote setting process, because they may directly affect profitability.

Oyster shell is one of the best cultch materials. The irregular shells provide spaces which allow water flow to distribute the setting larvae and to deliver nutrients and oxygen. Other small, brittle, or crushed shells that tend to pack together collapse open spaces and reduce the surface area for larvae to set on. Remote setting is less productive if a large amount of cultch remains unseeded. You may have to modify your setting system if you use cultch other than oyster shell.

The cultch with new oysters must be suitable for use in your growout area. For bottom planting, the cultch must provide enough weight to keep the seed anchored in the currents, yet offer a broad surface area to keep from sinking into the bottom. Whole oyster shells have excellent characteristics that serve these purposes well.

Artificial cultch materials have been examined for suitability in remote setting. For bottom



Baskets of shell cultch stacked in a setting tank.

planting, the requirements above still apply. In addition, artificial cultch must not leach toxic materials while being held in the setting tanks. Even small amounts of toxins can seriously affect setting success and reduce profitability. A trademarked polyvinyl chloride (PVC) product, commonly shaped in pipe form and called "French tubes," has been used successfully. Growers use tubes in suspended or intertidal culture systems. Other materials are being examined, but oyster shells are still often the cultch of choice.

Before shell cultch can be used in the setting tank, it must be conditioned. This means that organic matter such as fouling organisms attached to shells or oyster meats must be allowed to decay. Toxins which may be present in the manufacture of artificial cultch should be allowed to leach out before use. If not, such toxins and harmful bacteria may accumulate during setting and result in poor survival of seed. Therefore, shell cultch must first be aged, or dried out, for a minimum of one year after meats are shucked; artificial cultch may require at least as long. To speed up the process, you can place cultch in water for several months followed by air-drying for a month; however, this process adds to handling costs. Efforts to chlorinate or steam-clean cultch have not

proven economical. As a result, you should estimate the quantities of cultch you will need for the following one or two years and obtain it in advance.

CULTCH CONTAINERS

Important considerations in choosing cultch containers are that they be nontoxic and sturdy and that they allow for good water flow to oyster larvae. The kind of container and its size may influence the type of setting tank you use; most importantly, it will determine your labor and equipment needs in filling, transporting and planting, factors that all affect profitability. A container with cultch weighing 30 pounds will weigh approximately 40 pounds when retrieved from the nursery area; this increased weight is the result of oyster seed, sediments, and fouling. The added weight must be considered in whether you use machinery or hand labor. Handling small containers may



Oyster netting is a common shellbag material.



seem easier, but they require more time and labor. When possible, size your cultch containers to take advantage of available equipment to reduce handling effort.

Commonly used containers include plastic milk carriers, bushel baskets, or tubular plastic webbing, often called "oyster netting," which is used for making shell bags. Bags can be cut from rolls, which are several hundred feet long. A 4-foot length of oyster netting will hold some 30 pounds of shell, or about ½ bushel. Shell bags can be used individually, or stacked, bound, and handled in units as your equipment allows. Growers normally cut bags open for planting seed in growout areas and then properly dispose of them on shore. Larger containers are often custom-made according to the handling equipment available.

Another consideration to keep in mind when using large containers or stacked and bound units is the depth of the nursery area: it needs to be sufficient to prevent overexposure to desiccation of the upper layers of oyster seed by tides. Water flow must be sufficient to deliver nutrients to the seed. Finally, your equipment must be able to raise the weight of the cultch at planting time.

In preparing your containers for the tank, make sure you remove debris and small chips of cultch: they can attract some oyster setting that will be lost during handling. Rinsing cultch or containers with a large volume of water should remove most debris; also effective is dipping the filled containers in a water bath several times before use.

SETTING EQUIPMENT

Tanks

Many sizes and types of remote setting tanks have been used successfully. Large tanks will minimize the number of settings



Large fiberglass cylindrical tank for holding cultch containers — in this example, containers are bags of shell.

you need to produce sizeable quantities of seed. Tanks must permit easy container handling, and are often sized to match the containers. If the cultch provides proper spacing, the containers can be packed tightly in the tank.

Tank materials are often a matter of availability or cost. Wood, concrete, fiberglass and metals have been used successfully, though there are a number of construction factors you'll want to consider. You must make sure that whatever the material, surfaces exposed to water must be non-toxic to oyster larvae.

Wood is frequently used in tank construction, either as marine grade plywood or treated lumber. Joints must be sealed and waterproofed; internal surfaces should be coated with fiberglass. If the tank height exceeds three feet, extra supports may be required at the sides and joints.

Concrete, poured at least four inches thick and reinforced at sides and bottom, has also proved effective and allows a variety of designs. New, pre-cast concrete septic tanks have been used with success, but there are indications

that some concrete mixes can leach harmful compounds into salt water. Coating internal surfaces with epoxy paint may be advisable.

Fiberglass and metals have also been used successfully. Metals may corrode with exposure to salt water; consequently, internal surfaces must be coated with fiberglass or epoxy paint to prevent harmful compounds from leaching into the water. Fiberglass tanks should be filled carefully when using machinery in order to avoid cracking the units.

All new tanks should be filled with sea water and allowed to stand overnight. The water should then be changed several times before initial use; this process allows residues remaining after construction to leach out before coming in contact with oyster larvae.

Because of their weight when full, tanks should be well supported. Be cautious if you consider locating your tank on a dock. In time, settling may occur



and result in the tank warping or cracking. It is safest to set tanks directly on flat, compacted surfaces whenever possible.

Tanks need to be drained easily: slightly tilting the tank (about one inch over its length) toward the drain will allow easier emptying and cleaning after setting. Drains can be plugged from inside or outside the tank, or a removable stand pipe can be cut to the proper water level. A screened drain cover may be necessary to keep objects from lodging in the opening.

Aeration Systems

Good circulation of water within the tank is essential; consequently, setting tanks require aeration, which helps to ensure sufficient flow. Aeration also distributes the free-swimming larvae and then brings nutrients to the settled oysters.

To provide aeration, an air pump is commonly connected to a 3/4 to 1-1/2 inch PVC pipe grid which fits the bottom of the tank. The pipes are spaced 12 to 16 inches apart. A large number of small air outlets are needed to circulate water uniformly, so 1/8- or 1/16-inch holes are drilled at least every 12 to 16 inches along the pipes for air to escape.

An air lift system can also be used to circulate water. It consists of a wide tube placed vertically in the tank, with an air outlet installed 1/3 of the distance from the bottom of the pipe for greatest efficiency. The rising air lifts water and can direct it using an elbow at the top of the tube. Airlifts at the corners and the center of the tank, with cultch packed around them, can provide adequate and inexpensive water circulation for the system.

Air pumps should produce large volumes rather than high pressure. Growers should avoid compressors because they can leak oil, which is toxic to larvae. Blowers are sized according to the depth of water in

the tank and the number of outlets. *Consult a knowledgeable source when purchasing a blower.*

Homemade blowers can also be constructed from vacuum blowers, or from automobile pollution control pumps. Normally, about 1/4 to 1/2 hp is required per tank. Use a valve to bleed off excess air since only gentle bubbling is needed. Multiple tanks can share a common blower, but controls for individual tanks are necessary. The blower should be located above water level in the setting tanks to prevent water from siphoning back in case of a power failure.

Heating Systems

Oyster larvae set most successfully between 80° and 90° Fahrenheit. Below 75°F, setting proceeds very slowly, if at all. For this reason, most remote setting systems are used in the summer months, when optimal temperatures are easily maintained. However, if the system is operated during cooler periods, a heating system becomes necessary.

A heating system can also help you produce oyster seed earlier than you would normally be able to; this seed can then benefit from a longer growing season and may result in an earlier harvest. Setting larvae at near-optimal temperatures results in a quicker turnover of tanks and allows the system to be used more efficiently and more often. For these reasons, heating systems are in common use in remote setting operations.

Use energy-efficient heaters — remember that available power and equipment costs are considerations, so consult heating experts before purchasing a system. A heater needs to increase water temperatures in a reasonable amount of time, usually over several hours. Use gentle aeration while heating water to prevent the

formation of hot spots in the tank. A setting tank, once heated, will maintain temperature quite well; thus, heating requirements are sporadic. If heating is used regularly, additional foam insulation will reduce heat lost by the tanks. Covering the tanks will also reduce the greatest loss of heat.

The most common units are electric heating elements placed directly in the tank. However, many metals can leach toxic compounds - make sure that your unit employs only nontoxic materials. Even some grades of stainless steel can adversely affect larvae. So far, titanium or Incoloy™ compounds have proven safe for use.

Electrical power outlets must contain ground fault circuit interrupters (GFCI). In some systems, blowing air heated by propane or wood along tubes running through the tank has also proven feasible. In general, seek the most inexpensive and dependable energy source available.

WATER DELIVERY

Water in the setting tank will need to be replaced regularly. Because oyster seed should not dry out between draining and filling, pumps should be capable of refilling the tank in 15 to 20 minutes. Filter intake water—1/2 inch or greater mesh will prevent small fish or other waterborne materials from being pulled into the pump and damaging the impeller. You may also find it necessary to filter the water to remove small predators, sediment, and organic debris which can coat the cultch and reduce the available setting surfaces. A sand filter with large grains, or reusable polypropylene bag filters of about 25 micron mesh, will remove most of this debris without removing natural algae



or restricting water flow.

Make sure that all materials which come in contact with water are nontoxic. Use pumps with plastic impellers and PVC pipes to carry water to the tanks. Flexible hoses may be used in some applications. The water system itself can be permanently installed or portable.

Not all larvae will settle when first placed in the tank. Some may still be swimming a few days later. Rather than lose these larvae, drain water from the tank through a fine sieve. You can return larvae to the tank after refilling and give them another chance to set. U-shaped siphons can be constructed from

1-½ or 2 inch diameter PVC pipe, readily available in hardware stores. You can make a sieve from fine nylon screening of 165 microns or less. Nylon screening is available from aquaculture supply houses and can be glued to a section of wide plastic pipe. You can also use a clean, five gallon plastic bucket with a locking lid by removing the bottom and cutting a large hole in the lid: stretch the screen across the top and snap the lid back on. The sieve should be supported on blocks or legs to allow water to flow easily and prevent damage to the fine screening.

Monitoring water quality is

essential for managing your system properly. To monitor salt content of the water, it is useful to have a salinity meter, refractometer or test kit. For temperature, a simple thermometer will do. To help keep track of larval activity as well as setting success and growth of the oyster seed, you can use a 40X or greater magnifier.

PREPARING THE SETTING TANK

A successful remote setting system should allow free swimming larval oysters to attach to the cultch, complete their metamorphosis to become spat and recover from this strenuous period before being transported to a nursery area. Each step occurs more quickly and uniformly at 80° to 90°F.

In filling the tanks with the filtered sea water, allow the tank to overflow -this will help remove floating debris. The water should be clear, or have a green tint caused by natural algae. All of the cultch must be submerged. If a heating element is used, apply gentle aeration to distribute the water throughout the tank. This helps avoid hot spots which may damage the tank.

Larvae ready to set may receive a beneficial "cue" from cultch that has a thin surface coating of bacteria: this coating will form naturally on the setting surfaces by filling the tank with the cultch and warm water a day before adding larvae. In early spring, fewer bacteria may be present, so an extra day of soaking could prove helpful. However, good sets do occur without this aging process and if time doesn't permit, it may be possible to skip this process. Experience with your setting system will allow you to determine if this step is necessary for your system.

If the larvae are ready to set when they arrive from the hatchery, they may attach to the cultch within a few hours. Normally, most

Estimating Eyed Larval Needs from the Hatchery

The number of eyed larvae you order from the hatchery will depend on the size of your remote setting tank; the number of cultch containers it will hold, and the count of spat per shell you would like to have for planting.* In addition, your estimate must take into account eyed larvae survival from the hatchery (assume 50%) and survival from eyed larvae to spat in the remote setting tank (assume 10%). These percentages could well differ depending on your operation.

Sample calculation: for cultch containers (e.g., shell bags) that hold 200 shells/containers and a setting tank that holds 100 of these containers, the tank will hold:

$$200 \text{ shells/container} \times 100 \text{ containers} = 20,000 \text{ shells}$$

To achieve a count of 10 spat/shell at planting, you multiply 10 eyed larvae/shell \times 20,000 shells = 200,000 eyed larvae. If, survival from the hatchery is assumed to be 50% and survival, in the setting tank is assumed to be 10%, you will need to multiply spat/shell needs by 2 and 10, respectively:

$$200,000 \text{ eyed larvae} \times 2 \times 10 = 4,000,000 \text{ eyed larvae}$$

Keep track of spat survival from planting through harvest to gain a better understanding of optimal seed counts for each oyster bed.

* counts above 25 spat/shell are often too crowded, and counts much below 5 spat/shell may result in large numbers of blank shells.



Oyster larvae are distributed by spreading them across the surface of the tank.

settlement occurs during the first day. Metamorphosis of settled larvae to spat takes about another day. Most larval energy reserves have been drained during this process. Thus, allowing the young oysters to recover for a few days in the tank will improve their chances of survival during the stress of being moved to a nursery area.

ADDING LARVAE TO THE TANK

Larvae are shipped in containers from the hatchery — they are extremely fragile and should be handled carefully. If aeration in the tank can be adjusted, strong bubbling should be applied to the tank. Place the larvae in a bucket of water that has been taken from your tank. Having been cooled during shipment, larvae will take a few minutes to revive and start swimming. Before this occurs, mix the water in the bucket, then scoop water from the bucket with a small plastic

container and spread across the surface of the setting tank: this action will distribute the larvae before they begin swimming.

Many growers cover setting tanks with tarps, black plastic sheeting or thin plywood to try and improve oyster setting distribution. This is because larvae tend to orient themselves to the light: in an uncovered tank in bright sunlight, larvae might set in the upper layers of cultch. By darkening the tank, larvae are likely to spread more evenly throughout the cultch. After covering the tank, adjust aeration to promote good water flow.

One to two days after the larvae have settled, change the water in the tank. This step is important because toxic waste products from the larvae will accumulate otherwise; in addition, new water also provides food for the small spat. The more often water is ex-

changed, the better your water quality will be.

Water needs to be changed quickly to avoid stressing the young oysters. You may find it easier to change part of the water daily, rather than completely changing it every few days. This new water should also be filtered. As the oysters increase in size, filtering becomes less critical. During setting and metamorphosis, usually during the first 48 hours, maintain optimal temperatures. When water is drained from the tank, siphon it through the screen - knowing how much water you drain, you can estimate the number of larvae still swimming. If a large number are swimming, maintaining temperatures of 80° to 90°F may help speed larval setting. Observing oysters setting on the cultch is difficult, though, with practice, it gives the best indication of setting success.

You can lower temperatures after setting and metamorphosis: this reduces the need to reheat water. Several days after setting, oyster seed should be ready for moving to the nursery. If water temperature in the nursery area is cooler than tank water, an accepted management practice is to reduce the tank temperature 5°F per day to reach the nursery temperature. This procedure also allows the oysters to gain a slightly larger size before moving them to the nursery area. Near the end of the holding period, unfiltered water can be flushed through the tank as well.

With practice, you will become familiar with these operations and should be able to adjust your management strategies to improve the setting success, spat distribution, and survival.



FEEDING OYSTER LARVAE

While natural water supplies some algae, the young oysters will benefit from supplemental feeding during setting. This is because the number of oysters in the tank exceeds densities in nature. Though newly-settled oysters do not feed during their metamorphosis, they are ravenous feeders once the process is completed. You can observe this feeding after a water change: if setting has been successful, the green tint of algae will be removed within a few hours. At this point, no further nutrition is available for spat. Increasing the frequency of water changes can supply additional algae, but it is simpler to add concentrated algae, available from hatcheries or specialty firms.

Daily feedings of supplemental algae are sufficient for the first few days, but should be increased after that. The changing tint of the water will indicate when more food is necessary. Feeding large amounts of algae at one time, however, should not replace more frequent feedings; in fact, overfeeding may cause feeding to cease. While oysters will consume many types of available algae, they may simply pass much of the food through their systems without digesting it completely. This is a waste of food, and it will increase your production costs. An amount of algae which can be cleared by oysters in four to six hours is usually sufficient. Check with suppliers for effective amounts and methods of feeding.

RECORD KEEPING

It is essential that you record water quality data (i.e., temperature, pH, salinity) and other observations during the setting process and that you keep track of different batches of the seed you produce. There are variations

in setting success and survival between batches - having accurate data can enable you to assess differences in survival and setting efficiencies. Good records are critical to the success and profitability of your operation.

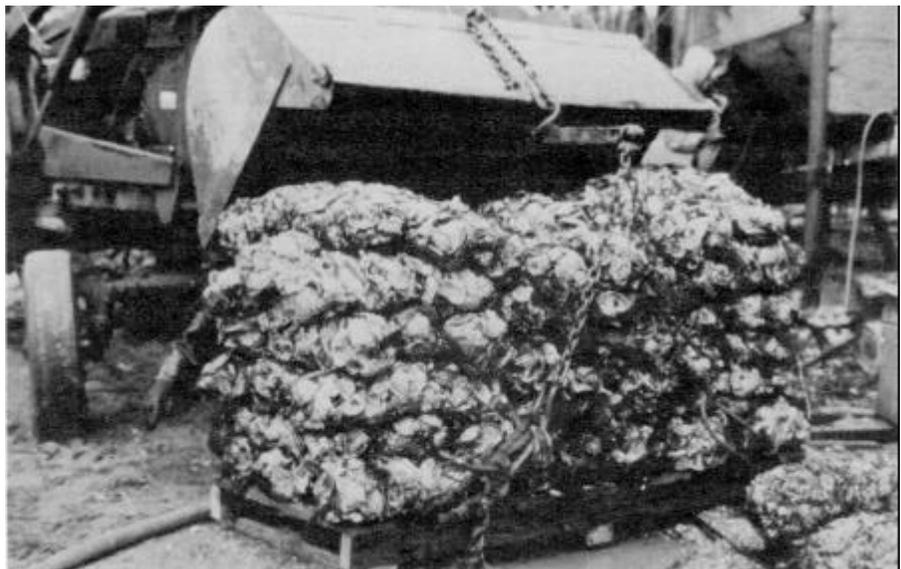
The percentage of oysters that successfully set is difficult to assess accurately until seed has grown for a few weeks; however, oysters on cultch should increase visibly in size in the setting tanks. The larval shells are still somewhat transparent at this stage, and the spat may be difficult to see until they begin feeding. By removing about 25 pieces of cultch from several locations in the tank during unloading and suspending them below the tidal range for a few weeks, you can get an accurate count. Count spat as soon as they are all visible to prevent loss by crowding or predation.

It is important to sample different levels and locations in your tank during the first sets to ensure that setting has been occurring throughout. You may find it necessary, for example, to modify the aeration system to achieve more evenly-distributed

setting and to prevent blank cultch. It is especially important to verify an even distribution of spat early in the use of a setting system.

CLEANING THE TANK

Clean your setting tank after every use. A few oysters will inevitably settle on the tank itself; if the tank is used often, they may be able to survive and grow. These oysters compete with the smaller oysters for food, and produce waste products in the tank. Consequently, it is important to remove them. Scrub the sides and bottom with a stiff brush. Sponging off the aeration system and rinsing the unit thoroughly is all that is necessary—it is easiest to do this after you've emptied the tank and it is still wet. It is also good practice to allow the tank to dry in the sunlight before being used again. Scrubbing with a diluted bleach solution may prevent persistent growth on the tank, but rinse thoroughly and use bleach only in a well ventilated area.



Pallets can provide a foundation for stacking cultch containers on bottom



NURSERY

When the oyster seed is ready, you should move it to the nursery area as quickly as possible. On hot or windy days, sprinkle salt water or fresh water on the oysters during transport. The evaporating liquid will cool the oysters and reduce the stress that results from being out of water. Handle containers with the least possible disturbance since the oysters are fragile and can be easily crushed or scraped off the cultch.

In the nursery, place cultch containers where they are protected and can be easily retrieved. Unless the bottom is very hard the containers will tend to sink into the sediment, smothering lower layers of seed and making retrieval difficult. Wooden poles or inexpensive pallets can be laid down and the containers stacked on top of each other. Supports may be mired in the sediment when the seed is picked up, but will provide a better foundation for the next crop. Hard bottom is important if the pallet and cultch containers are moved and retrieved as a unit.

Containers can be deeply stacked and still provide good oyster growth. Seed is small and requires little water flow for food and oxygen: currents and tides can provide adequate flow, especially if it is less than two or three feet to an outside edge from any point in the stack. Stacking reduces the impact of being on an outside edge, such as heavier fouling or exposure to drying winds, by protecting seed from these effects.

While stacking protects seed from exposure and improves survival, it increases the need to monitor the nursery. Sediments carried by water may settle out among the cultch,



Planting oysters in a protected area.

smothering the small seed. Be on the lookout for smothering, especially after storms.

Seed should be monitored for signs of predators: in many cases, predation is not a concern at first but can result in escalating losses just before planting. Most predators leave obvious signs of their presence by how they opened the spat. Examine empty shells closely since predators leave clean shells behind, while smothering causes shells to blacken. Large predators like starfish are easily observed and removed in intertidal sites.

Nurseries should be free of oyster drills, not only because of their predatory habits but because movement of seed from infested grounds is restricted by many states. Invasive species, including crabs and flatworms, may actually seek shelter or multiply among the cultch containers, resulting in an exploding number of hungry predators. In these cases, planting the seed and exposing the predators to their natural enemies may be the simplest approach.

Predation losses in the nursery must be balanced against extra losses in handling and the risk of siltation affecting the small oysters planted.

Keep track of seed growth and survival. Differences within a nursery from tidal or seasonal effects may mean that you have to adopt other methods to improve survival. Examine inner layers of seed, which represent the bulk of the cultch and often appear different than outside layers.

Seed is ready for planting to grow-out areas or production beds when oysters reach a length of $\frac{1}{2}$ to $\frac{3}{4}$ inch. Often, the seed will begin growing away from cultch, seeking more food. They can be held in the nursery indefinitely although their growth will slow down. But they should not be kept in the nursery until they begin to grow through the holes in their containers: this makes removal of the seed for final planting difficult and will result in higher labor costs and increased seed mortality.



PLANTING IN PRODUCTION BEDS

Growers often plant seed in early fall or spring. Overwintering in a nursery should be avoided if there can be excessive exposure to cold air, ice, or silt.

Handle the seed carefully when planting to avoid damage, although some losses should be expected. Planting rates differ greatly due to a number of factors, but should be based on accurate seed counts. Counting will reveal the survival rate, the ultimate goal for improvement. Take care to obtain samples from several locations within containers. Blank shells suggest poor distribution of larvae in the setting tank or sediments accumulating in the nursery.

SUMMARY

Many factors must be considered in a successful remote setting system. Reducing labor and effort in handling cultch is critical. Pollutants and toxic materials must be avoided, and providing favorable conditions will improve the survival of oysters and profitability of a system. With good records, frequent monitoring and some luck, you can achieve a stable source of oyster seed for planting or sales.

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