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Solutions in your community

Remote Setting Systems

**"Economy,
Employment,
Environment"**

Don Webster, Don Meritt and
Stephanie Tobash Alexander
University of Maryland Extension

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"Building Our Industry Together"

Remote Setting System Design and Operation

Don Webster, Don Meritt & Stephanie Tobash Alexander
University of Maryland Extension

Remote setting is a technique used to produce spat on shell oyster seed. It was developed in the Pacific Northwest in the late 1970s and introduced to Maryland in 1982. The large commercial oyster industry in that area depends on hatcheries and remote setting as the primary method of producing oyster seed, while other areas of the nation still largely rely on natural seed. Innovations in technology, along with technical advances in breeding and selection, hatchery operations and growout methods make it logical that the industry of the future will rely more heavily on active management than has been the case in the past.

Figure 1 Remote Setting Training Program workshop teaches production techniques to oyster growers

Remote setting has been successfully used in Chesapeake Bay since the mid-1980s. Maryland and Virginia extension specialists have worked with growers and community groups for many years to teach them how to use remote setting to produce seed for commercial and restoration purposes.

Unlike the Pacific Northwest, lack of seed was not the main reason for declining oyster production. The Mid Atlantic suffers from diseases that can decimate oysters during growout and these have expanded to other states throughout the region. Growers have been reluctant to embrace remote setting to produce oysters that might die before reaching maturity and community groups using seed for restoration become frustrated when oysters die and their efforts to create sustainable populations fail.

Recent improvements in oyster stocks have led to selectively bred lines of native oysters that allow crops to be produced in areas where disease has been a problem in the past. This makes remote setting important to produce seed as part of a successful oyster operation. This manual discusses the components and management of remote setting systems and should be used by those designing new systems, upgrading existing ones and operating a unit for the first time.

PRODUCTION ELEMENTS

Hatchery-based oyster production consists of several components. First is the hatchery phase where oyster broodstock is conditioned for spawning. Oysters from natural populations or from selective breeding programs may be used to produce larval oysters for use in setting systems. Hatchery technicians condition the animals by slowly increasing water temperature in the holding tanks over a period of weeks, which causes them to build their gonadal products of eggs and sperm. When the oysters are judged to be ripe and ready to spawn, they are placed on spawning tables where the water temperature is built up rapidly and gametes taken from some of the oysters are introduced to the circulating water to stimulate spawning. After spawning, the larvae are cared for until they reach *pediveleger* or "eyed" stage. Hatcheries include an *algology* unit for producing phytoplankton, which forms the diet that larvae are fed.

When larvae are ready to attach to substrate, they enter the *setting* phase. This usually takes two to three weeks. Ready-to-set larvae are introduced to containerized *cultch* in a tank with low intensity air that provides water circulation to assure proper mixing. Cultch material can be whole oyster shell, in the production of spat-on-shell, or it can be small chips made from ground shells if cultchless seed is desired for the production of single oysters. Once the animals are set, which is a process that generally takes two days, ambient water is turned on so young spat can obtain phytoplankton from the local water.

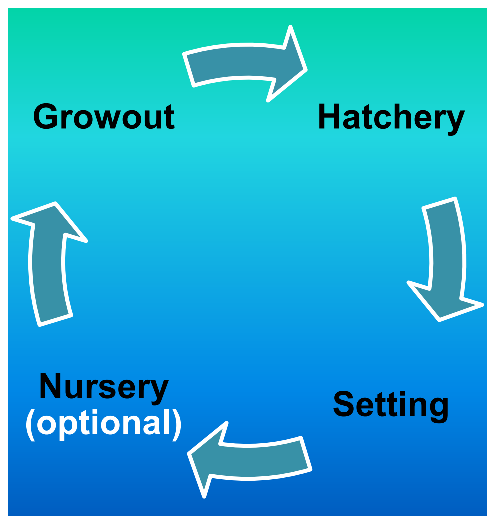

Figure 2 Oyster production components

Spat may undergo a nursery phase where they are kept in containers and placed overboard in a shallow area for additional growth prior to planting. Seed oysters can also be placed in devices known as "upwellers" or "downwellers" for additional protection while they grow. Another option is to immediately plant them after removing them from the tank. Decisions on which nursery technique to use are based on the size of the operation, type of oyster being produced, availability of nursery grounds, equipment and labor needed to handle the oysters at this point, and the projected return for the cost incurred for additional handing.

Last are the field operations. Spat are planted on prepared bottom to keep them from smothering or they may be placed in enclosures for protection from predators. There are many types of enclosures including bottom cages, lantern nets, shell strings, and surface floats. When the animals are of a size and quality for market, they are harvested and sold. Routine monitoring, while not required, is extremely important. Data collected on growth, settlement and survival will help improve profitability.

SYSTEM DESIGN

There is no perfect system that will work best under all conditions. A benefit of remote setting is that there are many correct ways to build and operate a system. Systems are most efficient when incorporated into existing infrastructure at the site where they are located. Location variables should be considered. Factors such as proximity to water, sturdiness of dock structures, and road access are important in system design and location. While many variables can be acceptable, there are some that cannot be compromised.

> *"There is no perfect system that will work best under all conditions"*

BASIC SYSTEM

The basic components of a setting system include a tank that holds cultch (substrate upon which oysters settle), water pump, aerator and containers for holding cultch. Ways of controlling the water temperature are often included in setting tanks. We have not specified the size of tanks, pumps, or blowers, or described the cultch containers that must be used. This is because there is no single right size or configuration for these elements. Growers need to consider seasonal production needs, available sites and other factors when designing a setting system.

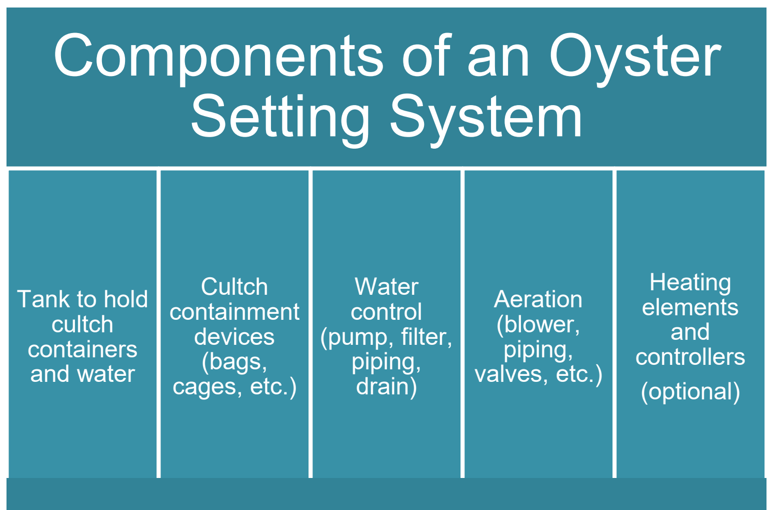

Figure 3 Components of a setting system

SITE SELECTION

One of the most important reasons for failure in any aquaculture business is poor site selection. Setting is no different. As a grower, you are dealing with live animals (oyster larvae) and these have requirements that cannot be seriously compromised if you want them to perform efficiently in your system. Among factors that are important in remote setting are:

SALINITY

Oysters are estuarine animals and capable of surviving a wide range of salinity from full ocean water at around 35 parts per thousand (ppt) to low levels below 5 ppt. However, just because your site might have live oysters living there does not mean that the salinity needed for good, reliable setting. Experience at the University of Maryland Horn Point Hatchery has shown that oysters do not set reliably at salinity below 9 ppt.

Any site considered for establishing a remote setting operation should have salinity above that. Keep in mind that 9 ppt is a minimum and higher salinity is better for setting. The tradeoff, however, is that higher salinity brings increased threat from oyster diseases such as MSX and Dermo. It is also important that oysters are set at salinities similar to those at the hatchery where they were reared. Salinity varying more or less than 5 ppt from that will need acclimation.

Figure 4 Setting tanks at the UM Horn Point hatchery

Salinity varies seasonally in an estuary. Typically, salinity is higher moving from fall into winter and generally lowest in spring. It also varies annually so you will need to determine the salinity range at your site during the period when you plan to operate the setting system. Most setting takes place from April through August in the Mid Atlantic, and into September in Chesapeake Bay. If you plan on using water from your site during these months you need to determine what the salinity will be during that period. Salinity may be measured using an electronic meter, refractometer, or chemical test kit.

ADDING SALT

It is not recommended that salt be added in low salinity areas although this has been used in some situations. Not all salt is equal and those required for use in oyster systems are expensive. Unless you are setting oysters for a hobby or for personal enjoyment, effort should be made to limit the costs of your setting operation.

> ***"Not all salt is equal...that required for setting oysters is expensive"***

TEMPERATURE

Our native oyster spawns in summer and the larvae therefore grow in warm water. Larvae are capable of surviving a fairly wide range of temperatures but they prefer those between 25ºC and 30ºC (77ºF to 86ºF). Stable temperatures seem to promote better sets so most setting operations have a way to control water temperature in the tanks. There are several options for this. The simplest is to add an immersion heating element on a thermostat to each tank. These should be made of titanium or other nontoxic metal. It is important to have tank heaters during cool temperatures, during storms, or rainy periods. While a rain storm usually does not pose problems with salinity, it can cause the temperature of a setting tank water to fall several degrees. Allowing setting water temperature to fall below 25°C can result in poor sets while cooler temperatures can cause total failure of a setting operation, wasting expensive larvae and decreasing profit.

Figure 5 Immersion heaters with controller

WATER QUALITY

Oysters, like most other aquatic organisms, do best when held in good quality water. In setting, quality refers to water that is free from contaminants like sewage, metals, excess sediment, petroleum products, and agricultural chemicals. It is best to select a site for setting that does not have high concentrations of any pollutants. Marinas are often proposed as setting sites because they are located near deep water, have ample electrical power, and are usually easy to access with vehicles and vessels. However, a marina may also have high levels of metals such as copper in the water due to the anti-fouling paint used on boats. Care should be taken when investigating marinas. It is usually better to find a location where uncontaminated water can be used in the setting system than to use a site based on non-oyster benefits. Remember that you are trying to set oysters here that have biological requirements and, as a grower, you must be aware of their needs.

> *"Marinas may have high levels of metals such as copper…"*

TANK FILTERING

If you have done a good job in selecting a site with good water quality, outfitting setting tanks with filters is usually not required. Remember that in most cases the oysters you put in your setting system will be feeding on phytoplankton present in the water pumped into the tanks. Filtering may remove phytoplankton in addition to sediment and other unwanted materials which can lead to poor early post-settlement growth and survival of seed oysters in the tanks. Oyster spat can survive low levels of sediment while in the setting tanks. In the event of short-term high levels of sediment in the incoming water supply, it is better to throttle back or stop the incoming flow to the tank until water quality improves. Oysters can survive under these conditions for a day or so with few problems.

CULTCH PREPARATION

No oyster setting operation will be successful without proper attention being paid to cultch preparation. Most setting operations use oyster shell as cultch in their operations and there are a few requirements that cannot be ignored if one is to have any chance of a successful setting operation. Cultch should be clean! Clean cultch does not just mean that it should be free of dirt and small shell fragments. Clean cultch means that it should be free of any organic material. Since shell for use in setting tanks usually comes from oyster packing houses, it typically contains un-opened oyster spat, mussels, barnacles, sponge, and many other organisms that will decompose and putrefy when placed in a static tank of warm water. This will take the oxygen out of your setting tank and kill everything that you have worked so hard to keep alive, including larval oysters. The easiest way to avoid this problem is to only use aged shell in your setting tanks. Every shell used in the system should be aged at least a full year out in the open where it will be is exposed to weather and other factors that will remove the organic material from the shells. Once this ageing process is completed, it is best if the shells are washed or cleaned to remove as much dirt and small shell fragments from the cultch as possible. When you have clean cultch material it is ready to be containerized for use in your setting system.

CULTCH CONTAINERIZATION

Setting tanks provide an efficient method to produce oyster seed but require labor to operate. One of the most labor intensive parts of the setting operation is cultch preparation, containerization, and handling, to include loading and unloading the tanks. The type of containers used in a setting system vary according to the type of system and the equipment available to the system operator. Remote setting evolved on the West coast using plastic mesh bags as the primary containers. Businesses use a variety of bag sizes depending upon whether they are moved primarily by hand or with mechanization. The size of the operation also has a direct effect on the number of bags required annually and the labor needed to manage them. Recently, some setting operations have used large stainless steel or vinyl coated wire cages for cultch containers because of their high volume need and the availability of equipment to handle them. There is no one correct container but some simple rules should be followed when designing a system for your site. You will need to design a setting system based on the amount of seed you require for your annual lease planting. Decide whether you want to set all at once or throughout a season. Decide on the time period will you be operating your system, including when you want to begin and end. If early, you will have to heat the water to keep larvae actively swimming.

Figure 6 Bags with aged shell ready for setting

Remember what you are doing by containerizing cultch for your operation. Containerization allows the operator to easily handle large amounts of cultch. Mechanization aids efficiency and as most businesses grow, the operators figure out ways to mechanize as much as possible. Obviously, the amount of mechanization that any setter uses depends on the site and the availability of equipment. It is possible to mechanize almost all aspects of the cultch operation from shell storage to final planting depending upon the situation at a particular setting operation. Labor is important in profitability of a business and it is frequently difficult to find enough local workers to reliably do these jobs.

Figure 7 Stainless steel cages for high volume setting operation

The second important component to cultch containerization and handling is the biological component. Setting tanks should be filled with clean cultch in such a way that the larval oysters are able to circulate between the shells and that there are no dead spots anywhere in the tanks. Aeration can help with this but aeration cannot effectively circulate water between tightly packed oyster shells or between shells that are piled too high or deep in all directions. In other words, make sure that at least **one** of the dimensions of your cultch pile is less than 12 to 15 inches. This means that any containerization should create a situation where shells are never stacked deeper than this in all directions.

A rule of thumb is that with clean oyster shells where the small shell fragments have been removed, larvae can penetrate to the center of shells piled about 12 to 15 inches wide or deep. More study may change this number but if these guidelines are followed it is safe to assume that setting can occur throughout the entire allotment of cultch for a setting tank. Remember that even though your containerization system may contain channels to aid water movement, if the cultch you use is prone to compact or is small enough to pack tightly it will limit water circulation and reduce settlement or concentrate settlement on a small part of the total volume in a tank. This is a situation that be avoided.

AERATION

Setting systems need a way to circulate water around and between cultch containers during the setting period, as well as to bringing food to newly settled spat after settlement. The most common approach is to use aeration. Most setting tanks are fairly shallow (6 feet deep or less) and this lends itself to aeration by rotary blower. Rotary blowers are used because they provide high volumes of air at low pressure. They are more efficient than compressors and do not introduce oil into the system.

Blowers should be sized to provide a gentle rolling movement throughout the entire setting tank. When installing aeration, make sure that water from the setting tanks is not allowed by gravity to flow backwards into the blower when the blower is off. The easiest ways to do this are either to install the blower above the highest water level of the setting tanks or to add a section of pipe that extends above the high water mark.

Figure 8 High volume low pressure air keeps larvae circulating

There are two methods of using aeration in remote setting systems. One uses continuous, gentle aeration during the settlement process and the other practice relies on intermittent aeration. Both have been shown to be successful. The one you choose should be determined after your system is in operation and testing initiated to see which gives you the better result.

Getting air from the blower to the tanks is usually done through PVC pipes. Pipes should be sized according to the volume of the setting tanks but, with smaller tanks capable of holding 200-300 shell bags, 1.5 to 2 inch inside diameter pipes are sufficient. Larger tanks will require larger diameter aeration lines. Blowers used in remote setting do not create much pressure and therefore the use of larger pipe is required. Pipes should be drilled with 3/8” holes about every 8 to 12 inches along the length of the pipe to provide adequate aeration. Aeration pipes should be spaced apart to allow a gentle flow to be created when the air is on. For example, a 12 foot diameter tank with 3 or 4 pipes spaced at the bottom of the tank provides sufficient aeration for good settlement to occur.

It is important that aeration pipes used inside the tanks NOT be glued together. These pipes will fill with sediment, have oyster larvae settle on them, and other things that require them to be cleaned inside and out. In fact, each time a setting tank is broken down and reloaded with cultch, the air pipes should be taken apart and thoroughly cleaned inside and out. This can be done with a brush on a rope and fresh water, another good reason to use larger diameter piping. Care should be taken to remove ALL newly settled oyster spat from the pipes and any other surface in the setting tank. If the tanks are re-used these spat will continue to grow. These spat are voracious feeders and will compete with the next batch of larval oysters for the food in the tank and as they get bigger will provide substrate for oysters to settle on other than what is in the cultch containers.

> *"…aeration pipes used inside the tanks should NOT be glued together"*

OPERATING THE SETTING SYSTEM

BASICS

Start with a clean system. Your tanks should be clean, your cultch should be clean, all piping inside the tank should be clean, and you should be filling the system with high quality seawater that meets the needs of your oyster larvae. This is one of the most important factors in successful system operation and one that cannot be compromised.


Figure 9 Tanks and cultch must be clean for setting

Once your tanks have the air lines in place and are filled with clean cultch, you can fill them with seawater. When the seawater has reached the desired temperature (25-30°C), you can add the larval oysters that you received from the hatchery. During this phase of the setting process, setting tanks are operated in a closed loop. After filling the tanks with seawater, no additional water is added until after the setting process is completed. Flowing water through the tanks during settlement would only flush your expensive oyster larvae out of the tank drain.

HANDLING LARVAE

Larval oysters are usually delivered damp and packed in coolers from the hatchery. If they are kept damp (but not in standing water) and cool (typical refrigerator temperature) they should last for up to 5 or 6 days. Remember that these larvae may have already been held for a day or two at the hatchery so if they are not going to be used right away it is important for you to know how long they have been held.

When you are ready to begin the setting process, remove the larvae from the cooler or refrigerator and gently rinse them into a bucket that contains water from setting tank. At this point the water should be warmed to the temperature desired for setting. Initially the larvae should all fall to the bottom of the bucket and lie there. At this point they are cold and dormant and should not be active. After a period of 15 to 30 minutes they should start to swim and you should be able to see a good portion of them swimming around in the bucket. It is not necessary to wait for ALL the larvae to begin to swim as this is not likely to happen. Until you gain experience with this stage of the larval handling process it is often helpful for you to take a clear glass and put a small amount (approximately one teaspoon) of larvae into a clear glass container with water from the setting tank. Close examination of the larvae in the glass will allow you to see swimming activity.

Figure 10 Larvae collected and being readied for shipment

Figure 11 Distribute larvae evenly and keep refilling bucket

There is a lot of variation in larval behavior during the warming stage. Very active larvae may form chains hanging down from the surface of the bucket while others may only swim close to the bottom of it. In either case, if you see activity, the larvae are ready to introduce into the setting tanks. It is important to distribute the larvae evenly over the entire surface of the tanks. One method of doing this is to use a glass or cup and keep re-filling the bucket as you go, taking care to pour the larvae all over the tank. Tanks should be aerated during this step to help mix the larvae throughout the entire volume of the tank.

SETTLEMENT

Good quality, competent oyster larvae should complete metamorphosis within 48 hours of being introduced into the setting tank. Often this occurs much faster and on very Ahot@ batches this can occur within a few hours. Once introduced into the tank, it is all but impossible to recover the larvae and you are forced to examine the cultch to determine what stage the setting is in. One method for this is to choose some test shells, place them around the tank, and examine them to judge whether settlement has occurred. The test shells should be selected for their smooth, white inner surfaces. It is much easier to find newly settled oyster spat on the inner surface of oyster shells than on the rough irregular outer surface. If spat are attached to the test shells it is safe to assume that settlement has occurred and that it is time to turn on the water to the setting tank.

Figure 12 Spat attached to oyster shell after setting (under magnification)

Figure 13 Loading newly set spat for planting

Once water is flowing through the tanks, turn off heaters but keep aeration going. Aeration helps mix new seawater with the existing water in the tanks and should allow a more uniform growth rate for newly settled oyster. Operate the tanks until they are ready to be broken down for deployment to the nursery or growout site.

POST SETTING OPTIONS

After setting has occurred, deploying spat from the tanks can be carried out in several ways. Frequently, a nursery stage is used where containerized shell containing the newly settled oyster spat is removed from the tank and re-located to a shallow water site for a hardening period. Nursery sites are usually nearby the location of the setting tanks and provide a place where small spat can be grown to a larger size before planting. Spat can be removed from the setting tanks as early as a couple of days after they have set to several months later. However, the longer they are left in the setting tanks, the more sediment will collect on them which will cause mortality by smothering. In most cases spat will grow faster and survive better when they are moved out of the setting tank.

While the spat are kept in their containers on the nursery grounds, they may also fall prey to other animals. One of the principal predators is the flatworm *Stylochus elipticus*. This small animal will enter small spat and consume the young oyster before going on to others. Because the oysters are in containers such as bags, predators that would eat the flatworms are excluded, providing an ideal situation for *Stylochus*. Growers should constantly monitor the spat in their nursery grounds. If there is an infestation of *Stylochus* the grower should be ready to immediately move the oysters to the planting grounds. Once they are out of the bags and spread on the grounds, the flatworms will become food for fish and hopefully depleted before they kill too many spat.

Figure 14 Predatory flatworm *Stylochus* consumes spat

It is also possible to plant immediately from the setting tank. In this case, it may be necessary to leave the newly set spat in the tanks with ambient water flowing for a few more days to ensure that they get some growth prior to planting. There is usually a tradeoff in lower ultimate survival of directly planted spat but there savings in labor from removing additional handling steps, as well as the problem of not having readily available nursery grounds.

DATA COLLECTION

Newly set oyster spat should be monitored both in the setting tanks and the nursery, if that step is used. Every grower should collect data on the performance of larvae used in their setting tanks. This will provide valuable information on hatcheries, oyster lines, and weather conditions that may affect setting and lead to better management decisions that aid profitability.

As soon as possible after setting, it is important to determine success of the process. Each site, setting tank, and batch of larvae will show different setting success rates. Taking time to collect good data will lead you to develop a better understanding of the factors that affect success in aquaculture.

The term for settlement success in setting tanks is “setting efficiency”. Setting efficiency is one of the most important numbers you will need when making decisions about how to operate your setting tanks. It is an important number when you discuss setting success with the hatchery operator who supplied your larvae. Setting efficiency is simply a measure of the percentage of eyed-larvae that were introduced into your setting tank that resulted in spat that went to your nursery or planting grounds. Obviously, operations that do not utilize a nursery will use setting efficiency to determine the number of spat deployed to a growout site.

Setting efficiency is calculated by dividing the total number of oyster larvae introduced into the setting tank by the total number of spat produced in the tank. The total number of spat produced by a setting tank can be determined by randomly selecting shells from throughout the setting tank. Care should be taken to select shells from all segments of the cultch pile. The more shells that are examined the better the estimate of total spat becomes. A minimum of 30 shells should be examined for each tank.

$$\frac{\text{Spat produced}}{\text{Larvae in tank}} = \text{Setting Efficiency}$$

Newly settled oyster spat are extremely small and very difficult to see without magnification, especially on the outside of shells. Attempting to determine setting efficiency when spat are too small to see easily with the naked eye are time consuming and difficult. Most observers, especially new ones, find the job of locating all spat on shell at this stage impossible and a large amount of them are missed. If this is the only time when spat from a setting tank are to be counted, it is highly recommended that a subsample of the shells used to determine setting efficiency be saved. These should be held in a protective mesh bag or container and allowed to grow until they are able to be seen without aid. Once they reach this size, they should be re-counted and the numbers compared with earlier counts. A ratio can be established between these two numbers and used to determine a more accurate settlement count. For instance, if later counts are 1.5 times the earlier ones and they have not been held where natural spat sets might have occurred then your original counts should be multiplied by 1.5 to determine the actual setting number. This conversion number will vary with each setting tank so the more times you make the calculation the more accurate it becomes.

When you have counted the randomly collected shells, add all the spat counted and divide them by the total number of shells you have examined. This gives you an average number of spat per shell. Once you have determined this number, multiply it number by the total number of shells in the setting tank to determine the number of spat produced by for that set. Use this number (or later ones obtained when spat are larger) to determine your setting efficiency.

$$\frac{\text{Total spat counted}}{\text{Total number shells}} = \text{Average spat per shell}$$

Setting efficiency is an important number. It lets you determine the amount of larvae that needs to be introduced into the setting tank to produce a desired number of spat. For instance, if the setting tanks contain 50,000 shells and you want to average 10 spat per shell you can use your setting efficiency to make an easy calculation. If your setting efficiency averages about 10% you would need to add 5 million oyster larvae to the tank.

Example: 50,000 shells x 10 spat/shell = 500,000 spat

5,000,000 oyster larvae with a setting efficiency of 10% will yield 500,000 spat

Through experience you become comfortable with these calculations. With time and practice they will allow you to better understand and determine which conditions or changes in operation result in better or poorer sets. The following tables (1a & b) have been provided to help you in calculating larvae requirements for setting. Assume that a target setting rate of 10 spat per shell is desired so the number of shells would be the total number of spat divided by 10. The tables will aid you in determining how many millions of larvae would be required at different setting percentages in order to reach a desired goal of a number of spat.

Average spat per shell X Number shells = Tank Production

GETTING INTO PRODUCTION

Remote setting provides a cost-effective way for growers to produce oyster spat for commercial or restoration aquaculture. It allows the hatchery to concentrate on the technical process of conditioning, spawning and larval rearing while providing the grower flexibility in determining the choice of cultch, density of set, nursery operations, and culture systems.

Oyster aquaculture has never been an easy business to engage in. However, it has been shown to be profitable in many areas. Recent research indicates that there is market demand for product that is not currently being met. This offers the potential for growers to enter the business and have the opportunity to produce and market quality shellfish that can aid in creating economic growth and expanding employment opportunities while aiding the environment.

Tables 1a & b. SETTING EFFICIENCY CHART (*Millions of Larvae* required at *Percent Set* for *Number of Spat*)

Number of Spat	2%	4%	6%	8%	10%	12%	14%	16%	18%	20%
100,000	5.0	2.5	1.7	1.3	1.0	0.8	0.7	0.6	0.6	0.5
200,000	10.0	5.0	3.3	2.5	2.0	1.7	1.4	1.3	1.1	1.0
300,000	15.0	7.5	5.0	10.0	3.0	2.5	2.1	1.9	1.7	1.5
400,000	20.0	10	6.7	5.0	4.0	3.4	2.9	2.5	2.2	2.0
500,000	25.0	12.5	8.3	6.3	5.0	4.2	3.6	3.1	2.8	2.5
600,000	30.0	15.0	10.0	7.5	6.0	5.0	4.3	3.8	3.3	3.0
700,000	35.0	17.5	11.7	8.8	7.0	5.8	5.0	4.4	3.9	3.5
800,000	40.0	20.0	13.3	10.0	8.0	6.7	5.7	5.0	4.4	4.0
900,000	45.0	22.5	15.0	11.3	9.0	7.5	6.4	5.6	5.0	4.5
1 million	50.0	25.0	16.7	12.5	10.0	8.3	7.1	6.2	5.5	5.0
Number of Spat	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%
100,000	.40	.33	.29	.25	.22	.20	.18	.17	.15	.14
200,000	.80	.67	.57	.50	.44	.40	.36	.33	.31	.29
300,000	1.2	1.0	.86	.75	.67	.60	.55	.50	.46	.43
400,000	1.6	1.3	1.1	1.0	.89	.80	.73	.67	.62	.57
500,000	2.0	1.7	1.4	1.3	1.1	1.0	.91	.83	.77	.71
600,000	2.4	2.0	1.7	1.5	1.3	1.2	1.1	1.0	.92	.86
700,000	2.8	2.3	2.0	1.8	1.6	1.4	1.3	1.2	1.1	1.0
800,000	3.2	2.7	2.3	2.0	1.8	1.6	1.5	1.3	1.2	1.1
900,000	3.6	3.0	2.6	2.3	2.0	1.8	1.6	1.5	1.4	1.3
1 million	4.0	3.3	2.9	2.5	2.2	2.0	1.8	1.7	1.5	1.4

HOW THE TABLE WORKS: To produce one million spat at a setting efficiency of 2% you would need to put 50 million larvae in the setting tank. If your setting efficiency is 20% then only 5 million larvae would be required to produce the same million spat. Oyster larvae are a major expense in remote setting. This chart shows how improving setting efficiency or working with a hatchery that has consistently high setting efficiencies is important to economic success in an aquaculture business.

GLOSSARY

Broodstock – male and female oysters used as parents for spawning.

Cultch – material that oyster larvae attach to in changing from free-swimming larvae to spat; usually contains significant amounts of calcium, such as oyster shell.

Dermo – an oyster disease that can cause high mortality and is most active in waters with salinity above 10 ppt; now classified as *Perkinsus marinus*.

Downweller – device for juvenile oysters that flows water down while on a screen allowing them to feed and grow while being protected and having waste products flushed away.

Gonad – organ in an animal that makes the gametes, or sexual products that form for the purpose of reproduction.

Larvae – young or juvenile form of an animal, in this case oysters; at this stage oyster larvae are free-swimming and can move in response to stimuli; oysters generally are in this stage for one to two weeks after spawning occurs.

Metamorphosis – a biological process in which an animal progresses through distinct stages; in oysters this occurs when free-swimming larvae attach to cultch and become sedentary spat.

MSX – oyster disease that created significant epizootics in the Mid Atlantic from 1957 through the 1980s; formerly known as Multinucleated Sphere Unknown ("MSX"); now classified as *Haplospridium nelsoni.*

Phytoplankton – small, single-celled algae that are selectively fed upon by oysters.

Remote setting – the process where oyster larvae are set on cultch at a location away from, or "remote", from the hatchery; usually takes place at a grower's site.

Salinity – salt in seawater; measured in parts per thousand with seawater generally being around 35 parts per thousand.

Spat – a small oyster after it has changed from a larva and attached to cultch.

Stylochus elipticus – a predatory flatworm that can have devastating effects upon containerized oysters.

Upweller – device for juvenile oysters that flows water up while on a screen allowing them to feed and grow while being protected and having waste products flushed away.

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