Remote Setting Systems: Producing Spat on Shell Oyster Seed for Aquaculture

Hatcheries are increasingly used in oyster aquaculture to provide consistent annual production of seed. The production process conditions broodstock to develop their eggs and sperm. When mature, the animals are induced to spawn and expel their gametes into the water. The eggs are fertilized with sperm to become free-swimming larvae that are held in tanks while they grow. Larvae are motile at this stage and consume phytoplankton while growing until they develop to a point at which they attach to a substrate and go through metamorphosis to become spat.

Larvae ready for that life change are drained from the tank, kept cool and moist and become dormant. They can survive in this condition for several days. This allows them to be shipped or transported to a grower in a location "remote," or away from, the hatchery. The grower places the larvae into a tank containing a substrate, usually aged and cleaned oyster shell, for several days while the larvae go through their critical life change and attach to the shells to become spat.

Remote setting allows hatcheries to concentrate on the technical process of conditioning, spawning and larval rearing while providing growers with flexibility in determining setting system design, choice of cultch, density of the set and nursery operations. University of Maryland Extension provides annual educational programs in remote setting to train growers to use this important technique to plant their leases and develop continuous crops (Figure 1).

Remote setting was developed in Washington state in the early 1980s. The oyster industry in that region relies on hatcheries and remote setting as a primary method of producing seed. The process was brought to the East Coast and has been adopted for producing seed oysters for both commercial aquaculture and large-scale restoration projects in Chesapeake Bay.

Figure 1. Extension workshops teach growers to produce spat on shell for planting leases.

Oyster Growers in the Chesapeake Bay Area have Successfully Employed Remote Setting since the mid-1980s

Lack of consistent seed supply is a primary cause of declining oyster production in Maryland. Oyster diseases including MSX (Haplosporidium nelsoni) and Dermo (Perkinsus marinus) severely affected oyster populations in the 1980s and led to lower natural reproduction. Meanwhile, research to improve genetic stocks for aquaculture has created selectively bred lines of oysters that are disease resistant.

Remote setting is an important way to produce seed as part of a successful oyster operation. This manual provides information on designing and managing setting systems for those interested in designing a new system, upgrading an existing one or learning to operate a unit successfully.

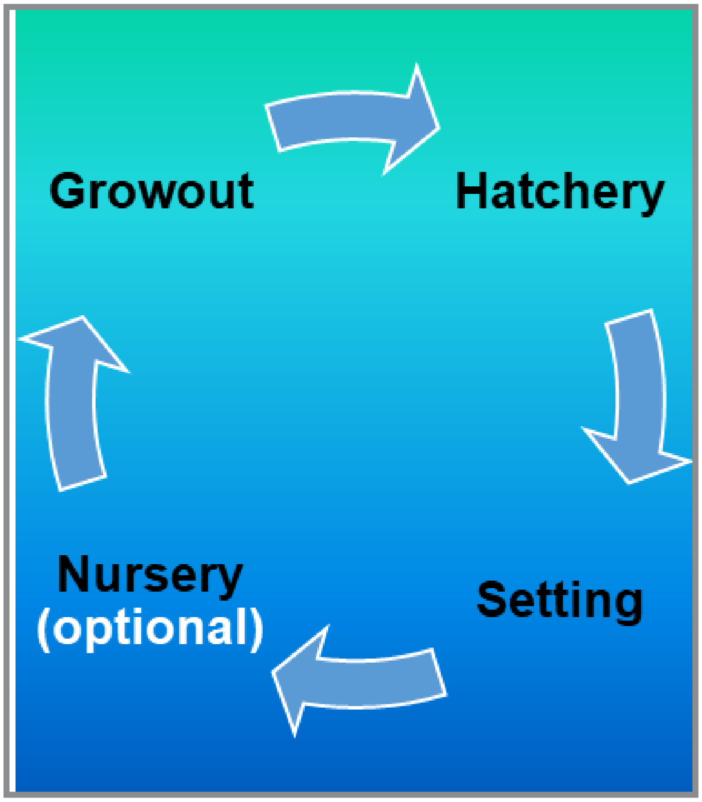

Figure 2. Oyster production components

Hatchery-based Oyster Production Consists of Several Components

In the hatchery, broodstock oysters are conditioned for spawning (Figure 2) using animals from natural populations or selective breeding programs. Technicians condition the animals by slowly increasing the water temperature in holding tanks over a period of weeks, which causes the oysters to build their gonadal products of eggs and sperm. When it is determined that the oysters are ready to spawn, they are placed on shallow tables and the water temperature is built up rapidly. Gametes taken from some of the oysters are placed in the circulating water. The biofiltering oysters sense these and it signals them to spawn. Eggs and sperm that they expel are placed in separate containers and mixed to induce fertilization and become larvae.

After spawning, technicians care for the larvae for several weeks until they reach pediveleger or "eyed" stage. Hatcheries generally include a unit that produces phytoplankton for the diet larvae are fed. This is placed in the larval tanks either using computerized controls to maintain the proper density of phytoplankton, or manually according to a feeding schedule.

Setting takes place when the larvae are ready to attach to a substrate, which is usually two to three weeks after spawning. Ready-to-set larvae are introduced into a tank with filled with bay water and cultch that is held in containers. Cultch is usually clean and aged oyster shell. Once filled, the water flow is shut off and low-intensity air from a manifold at the bottom aids water circulation to ensure proper mixing and move the larvae throughout the tank. Once the animals are set, a process that generally takes two to three days, the water pump is turned on so young spat obtain phytoplankton from the local water. They remain in the tank with water being pumped through them for seven to ten days for the larvae to grow before being removed and planted.

Spat on shell may undergo a nursery phase where they are kept in their containers and placed overboard in a shallow area for additional growth before planting. This additional handling requires more labor which increases the cost of the seed. Another factor is that small predatory flatworms known as s*tylocchus* can get into the contained seed and consume many of them before planting occurs. The containers act as barriers to the fish that would otherwise prey on the flatworms to keep their populations down. Growers base decisions on the size of their operation, availability of nursery grounds, equipment and labor needed to handle the oysters and the projected return for the cost incurred for additional handing.

During growout**,** spat are planted on the lease bottom that has been prepared with a shell base to keep the seed from smothering. The crop is checked periodically be sampling to gather data on growth and survival. Often the crop is brought to the surface between one year to one growing season before marketing. Clumps are broken apart and the oysters returned to grow with better shape. When they are of a size and quality for market, they are harvested and sold. Routine monitoring during growout is highly recommended. Data should be collected on growth, size and meat quality to improve profitability.

There is no perfect system that works best under all conditions. A benefit of remote setting is that there are many ways to build and operate a system. Location factors to be considered during system design include proximity to water, quality of local water, sturdiness of dock structures, permits required and access for delivering and preparing cultch and loading the planting vessel with the seed. While some variables can be acceptable, others cannot be compromised.

Setting System Design: Growers Need to Consider Production Requirements and Available Sites for Location

Components of a setting system include a tank that holds cultch (substrate oysters settle on), water distribution system, aeration and containers to hold cultch (Figure 3). If early season setting is desired, heating elements and controllers will be required. The size of tanks, pumps, blowers and cultch containers should be designed based on production plans for the lease. There is no single right size or configuration for a system.

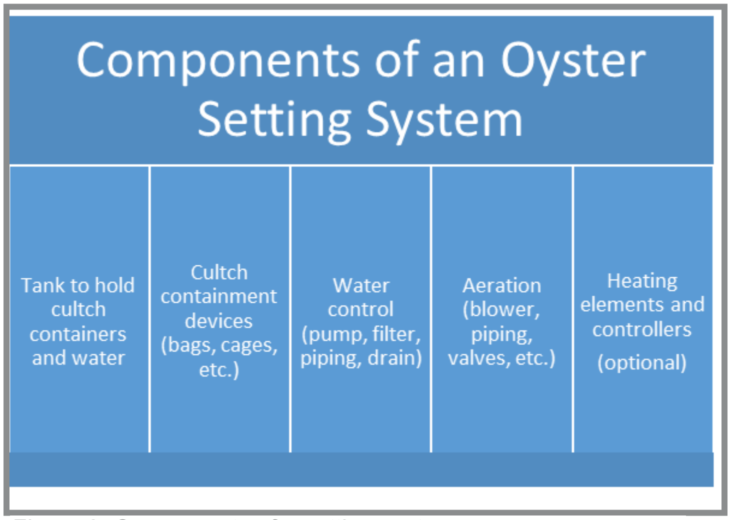

Figure 3. Components of a setting system.

Poor Site Selection is One of Main Reasons Aquaculture Operations Fail; Remote Setting is no Different

As a grower, you are dealing with live animals that have requirements that cannot be ignored if you want good performance from your setting system. Important factors include:

Salinity

Oysters are estuarine animals capable of surviving a wide range of salinity from full ocean water at around 35 parts per thousand (ppt) to levels below 5 ppt. However, because your site may have live oysters nearby does not mean that salinity is optimal for reliable setting.

University of Maryland Horn Point Laboratory (HPL) experience has shown that oysters do not set reliably at salinities below about 9 ppt (Figure 4). A site being considered for establishing a remote setting operation should regularly have salinity above that. Keep in mind that 9 ppt is the minimum and higher is generally better. The tradeoff, however, is that higher salinity locations bring increased threat from oyster diseases such as MSX and Dermo. It is also important that larvae are set at salinities similar to those at the hatchery where they were reared. In salinity varying more or less than 5 ppt, they will need to be acclimated prior to setting for best success.

Figure 4. Setting tanks at the UM Horn Point hatchery.

Salinity varies seasonally in an estuary. It is usually higher moving from fall to winter and generally lowest in spring. It also varies from year to year so determining salinity range at your site when you plan to operate the setting system is necessary. Most setting takes place from April through August and may go into September in the Chesapeake Bay. Salinity may be measured using an electronic meter, refractometer, or chemical test kit to collect data to use for tracking success.

Adding Salt

Salt can be added to a setting tank in locations that sometimes have low salinity occurances, However, the salt required for this is designated as marine grade and is often quite expensive. Some salt contains anti-caking agents which may be ammonia based and would cause toxic water conditions if used for larvae.

Temperature

The eastern oyster (C. virginica) typically spawns in midsummer and the larvae grow in warm water. Oyster larvae are capable of surviving a fairly wide range of temperatures but they prefer between 25C and 30C (77F to 86F). Stable temperatures seem to promote better sets so many setting operations include water temperature controls in the setting tanks.

There are several options to regulate water temperature. The simplest is to add an immersion heating element with a thermostat to each tank (Figure 5). The element should be made of titanium or other non-toxic metal. It is important to have tank heaters during cool temperatures, storms or rainy periods. While rain usually does not cause problems with salinity, the cold water can cause the temperature in a setting tank to fall several degrees. If water temperature falls below 25C (77F), it can result in poor setting. Cooler temperatures can cause total failure of a set, which wastes the expensive larvae and decreases profit in the operation.

Figure 5. Immersion heaters with controller.

Water Quality

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

Tank Filters

If you select a site with good water quality, outfitting setting tanks with filters is usually not required. The oysters you put in your setting system will feed on the phytoplankton present in the water you have pumped into your tanks. While filtering may remove sediment and other unwanted materials, it will also deplete important phytoplankton and lead to deficient early post-settlement growth and poor survival of the seed oysters in the tanks. Oyster spat can survive low levels of sediment in setting tanks. If there are short periods of high levels of sediment in incoming water, it is better to restrict or stop the inflow to the setting tank until the quality improves. Oysters survive under these conditions for a day or so with few problems.

Cultch Preparation

Your setting system will not be successful if you don't pay attention to cultch preparation. Most operations use whole, aged oyster shell and there are requirements that cannot be ignored for success to occur.

The most important is that cultch must be clean. This does not just mean that it is free of dirt and small shell fragments. Clean cultch must be free of any organic material. Since most shell comes from oyster shucking plants, it typically contains unopened small oysters, mussels, barnacles, sponge, and other organisms that will decompose and putrefy in a static tank of warm water. This consumes dissolved oxygen in the water and kill the larvae.

To avoid this problem, only use shell in your setting tanks that has been aged at least one full year, then tumbled and washed to remove unwanted material. About 20 percent of the initial raw shell should be removed as these 'fines.' These can then be placed on a bottom lease to provide a base for planting spat on shell from setting. When the aged and cleaned cultch material is ready, it is then containerized for use in setting.

Setting Tanks are Efficient Producers of Oyster Seed but Require Labor to Operate

Labor-intensive parts of setting are cultch preparation, containerization, and handling operations. Containers used in setting systems vary according to the type of system and equipment available to the operator.

Remote setting evolved on the West Coast using plastic mesh bags as the primary containers (Figure 6). Growers use a variety of shell bag sizes depending on whether they are moved manually or with mechanization. The size of the operation has a direct effect on the number of bags required annually and the labor needed to manage grounds.

Figure 6. Bags with aged shell ready for setting.

In the East, growers use a variety of containers. The UM Horn Point Hatchery uses stainless steel cages because of their need for high-volume production and the availability of equipment and labor (Figure 7). Other growers have developed vinyl coated wire cages that are sized for their tanks and handling equipment. There is not one correct container but some simple rules should be followed when designing a system for your site.

Containers allow an operator to handle large amounts of cultch. Mechanization aids efficiency and as most businesses grow, operators figure out ways to cut labor input as much as possible. The amount of mechanization you may use depends on the site and availability of equipment. Mechanization can be applied to many aspects of cultch handling, from shell storage to final planting. Labor is an important aspect for business profitability and it is often difficult to find enough local workers to reliably do the required jobs.

Figure 7. Stainless steel cages for high-volume setting operation.

Circulation is important within the tank. Setting tanks should be filled with clean cultch so larvae can circulate between the shells without dead spots in the tanks (Figure 8).

Figure 8. High-volume, low-pressure air circulates larvae.

Aeration

Aeration helps move larvae but it cannot effectively circulate water if the cultch is small and tightly packed. This is why shells dredged from fossil deposits in the Chesapeake Bay have not been usable for setting. The interstitial spaces are minimal and setting success is very poor.

After aging and cleaning, oyster shells are placed in the tank. Larvae are aided by the aeration circulation to penetrate and attach to the shells throughout the tank. An effective operation allows setting to occur evenly since the shells contain channels to aid water movement. However, you should take care to avoid situtations where cultch is tightly packed. This limits circulation and may reduce or concentrate settlement on a small portion of the total tank volume, leaving a lot of cultch with no spat.

Setting systems circulate water within the cultch and bring food to new spat after settlement using aeration. Most tanks are fairly shallow, being six feet deep or less. This is ideal for aeration by rotary blowers, which provide high-volume flows at low pressure. They are more efficient than compressors and do not have the possibility of introducing oil into the system.

Blowers should be sized to provide gentle rolling movement throughout the tank. When installing aeration, make sure that water from the setting tank is not allowed to flow backward by gravity into the blower when it is turned off. Install the blower above the highest water level of the tank or add a section of pipe in a “U” that extends above the high water mark.

There are two proven methods of aerating setting systems. One uses continuous, gentle aeration during the settlement process and the other provides intermittent flow. Choose an aeration method after your system has been operated and tested to see which method gives the best result.

Air from the blower goes through PVC pipes to the tanks. Pipes should be sized according to the volume of the setting tanks. In smaller tanks holding only 200-300 shell bags, 1.5- to 2-inch inside diameter pipes are sufficient. Larger tanks require larger diameter aeration lines. Blowers used in remote setting do not create much pressure and using larger pipe is recommended. Drill 3/8 inch holes about every 8 to 12 inches along the length of the pipe to provide adequate aeration with caps on the ends of all lines. Space aeration pipes far enough apart to allow a gentle air flow. For example, a 12-foot diameter tank with three or four pipes spaced at the bottom provides sufficient aeration for good settlement.

DO NOT GLUE aeration pipes together; just press fit them before placing in the tank. There is little pressure in them during setting so they should not separate. But they will fill with sediment and have oyster larvae or other organisms settle on them that require them to be cleaned inside and out.

Start with a Clean System

Each time a tank finishes a setting cycle, the air manifold pipes should be separated and thoroughly cleaned. A brush can be mounted on a pole or placed on a rope for this, which is another reason to use larger diameter piping. Take care to remove ALL newly settled oyster spat from pipes and the surface in the setting tank. If you fail to properly clean the tank and use it again, the attached spat will continue to grow. They are voracious feeders and will compete with the next batch of larvae for the food in the tank.

With air lines and containerized cultch in the tank (Figure 9), it can be filled with seawater from your setting location using the pump. When the seawater has reached the a temperature of 25-30oC (77o-86oF.), larvae from the hatchery can be added.

Figure 9. Tanks and cultch must be clean for setting.

Keep Larval Oysters Damp

Larval oysters are delivered damp and packed in coolers from the hatchery (Figure 10) with chill packs. If they are kept damp in this manner, they should last for five or six days. Remember that the larvae may have already been held for a day or two at the hatchery. If you are not going to use them immediately, it is important that you find out how long they were held.

When you are ready to begin setting, remove the larvae from the cooler or refrigerator and gently rinse them in a bucket containing water from the setting tank. The tank water should be warmed to the temperature desired for setting. Since they are still chilled and dormant, the larvae should sink to the bottom of the bucket and should not be active.

Figure 10. Larvae being made ready for shipment.

Figure 11. Distribute larvae across the setting tank and keep refilling bucket to wash all larvae out.

They should begin to move within 15 to 30 minutes. Within that time, you should see a portion of the larvae moving in the bucket. However, it is unlikely that all of the larvae will begin to swim.

Until you gain experience with handling larvae, it is often helpful to put a teaspoon full of larvae into a clear glass container with water from the setting tank. Closely examining the larvae in the glass will let you to see their swimming activity to confirm reanimation.

A lot of variation occurs in larval behavior during the warming stage. Active larvae may form swarms at the surface of the bucket while others only swim close to the bottom. In either case, if you see activity, the larvae are ready to introduce into the setting tank. Distribute the larvae evenly over the entire surface of the tank. Use a glass or cup and keep refilling the bucket to ensure that all larvae are washed off the inside surfaces, taking care to pour the larvae all around in the tank (Figure 11). Aeration should be on during this step to help mix the larvae throughout the volume of the tank.

Good Quality, Competent Oyster Larvae Should Complete Metamorphosis within 48 Hours of being Introduced into the Setting Tank

Metamorphosis often occurs much faster than 48 hours. For very ”hot“ batches, it can occur within a few hours. Once introduced into the tank, it is not feasible to recover larvae.

You must examine the cultch to determine their setting stage and success rate (Figure 12).

One method is to choose some test shells, place them around inside the tank, and examine them to determine if settlement has occurred. Test shells should be selected for 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 noted attached to the test shells, settlement has occurred and you should turn on the water pump and flow ambient water through the setting tank.

Once water is flowing through the tanks, turn off the heater but keep aeration flowing. Aeration will help mix new seawater with existing water in the tanks and allow a more uniform growth rate for newly settled oyster spat. Operate the tank this

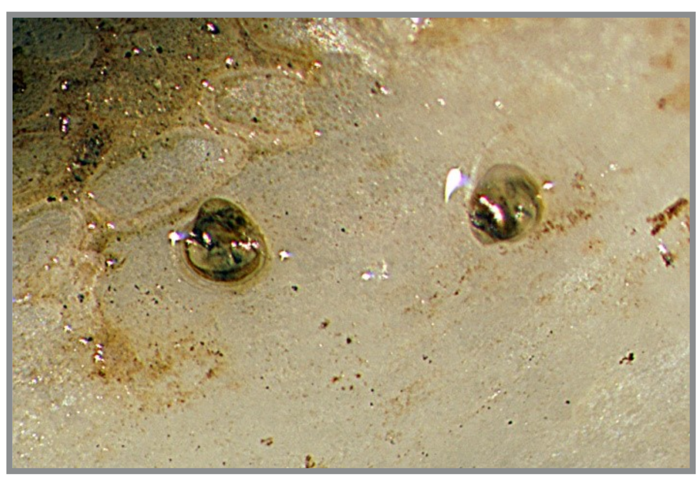

Figure 12. Spat attached to oyster shell after setting (under magnification).

way until the oyster spat on the shells are ready for deployment to a growout site.

After Setting,There are Several Ways to Deploy Spat

An option after setting is use a nursery stage where the containers with spat on shell are placed in a shallow water site for hardening and initial growout.

Nursery sites are usually near setting locations and provide a place where small spat can grow larger before planting. You can remove spat from the setting tank any time from a couple of days after they have set to weeks later. However, the longer they are left in the setting tank, the more sediment will collect on them which will cause mortality by smothering. In most cases, spat grow faster and survive better when they are moved out of the setting tank (Figure 13).

Spat kept in their containers on nursery grounds can also become prey to other animals. A principal predator is the flatworm Stylochus elipticus, which enters small spat and consume the young oyster before moving to others (Figure 14). Putting oysters in containers such as bags, blocks predators that eat flatworms and provides an ideal condition for Stylochus. Growers should constantly monitor spat in nursery grounds. If there is an infestation of Stylochus, the oysters should immediately be moved to planting grounds. Once out of the bags and spread on the ground, fish will eat the flatworms, hopefully depleting them before they kill too many spat.

Figure 13. Loading newly set spat for planting

Spat can also be immediately planted from the setting tank. This has become the standard method to cut labor and ensure the most profitable production. In direct planting, it is suggested that newly set spat remain in the setting tank with ambient water flowing for seven to ten days to ensure spat growth before planting. This eliminates the need for nursery grounds and the expense for additional transfer of the oyster spat.

Figure 14. Predatory flatworm Stylochus consumes spat.

Data Collection is Key to Success

Every grower should collect data on the performance of larvae used in their setting tanks. This provides valuable information on hatcheries, oyster lines and weather conditions that may affect setting, and lead to better management decisions that can aid business profitability.

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

Settlement success is referred to as "setting efficiency". It is the percent of eyed-larvae introduced into your setting tank that successfully resulted in spat for planting. Setting efficiency is among the most important data you will need when making decisions about setting operations. It is important when making decisions about purchasing larvae from a variety of hatcheries or to determine the best genetic lines for success. It is critical for determining the number of spat deployed for growout.

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

Setting efficiency is determined by randomly selecting shells from throughout the setting tank. Carefully select shells from all portions of the cultch pile. The more shells you examine, the better the estimate of total spat will be. You should examine a minimum of 30 shells from each tank. These are examined using a magnifying glass or a dissecting scope, if one is available. Count the number of spat per shell viewing both sides of it.

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

Newly settled oyster spat are extremely small and difficult to see without magnification and experience. Most observers, especially new ones, find locating newly set spat on the shells at this stage challenging and many may be missed. However, continued practice will develop the skill needed to identify new spat.

Another method to help calculate setting efficiency is to save a sample of the shells taken from the tank. They are placed in a mesh bag or container and hung from a nearby pier or piling and allowed to grow until the spat can be seen without aid. When they reach this size, they should be counted again and compared with your initial tank count. You can use the ratio between these two numbers to gain a more accurate settlement count. For instance, if later counts are 1.5 times the earlier ones (and the shells have not been held where natural spat sets may have occurred), multiply your original count by 1.5 to determine the actual setting number. This conversion will vary with each setting so the more times you make the calculation, the more accurate it will be.

$$\text{Average spat per shell} \times \text{Number of shells} = \text{Tank production}$$

Add all the spat counted and divide by the total number of randomly collected shells you examined. The result is the average number of spat per shell in your sample. Multiply the spat per shell estimate by the total number of shells in the setting tank to determine the number of spat produced by that set. Use this result (or later ones obtained when spat are larger) to determine your setting efficiency.

In calculating the number of shells in a tank, there are several methods. If you are using shell bags, the number of shells per bag can be counted. A 36-inch long bag usually holds about 220 shells, Do this for several bags to determine an average. For larger containers, use a measure like a bushel and count the number of shells held in it. Then record the number of bushels in a single container. The number of containers in the setting tank will then allow you to determine the number of shells.

Setting efficiency estimates are important. They let you determine the amount of larvae needed for a setting tank to produce a desired number of spat for production. For instance, if a tank contains 50,000 shells and you want to average 10 spat per shell, you can use your setting efficiency to make the calculation. If setting efficiency averages 10%, you need 5 million oyster larvae in the tank.

You will become more comfortable with the calculations as you gain experience. With time and practice, you can understand and determine conditions or changes in the operation that result in better or poorer sets. Tables 1a and 1b will help you determine how many millions of larvae are required at different setting percentages that result in a desired number of spat.

Number of	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	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

Tables 1a & b. Systems with higher setting efficiency require fewer larvae to produce a given number of spat (millions of larvae required at percent set for number of spat)

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 you would require only 5 million larvae 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 – A 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 oysters selectively feed on.

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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Donald Webster

dwebster@umd.edu

Donald Meritt

MuttMeritt@outlook.com

Stephanie Alexander

tobash@umces.edu

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