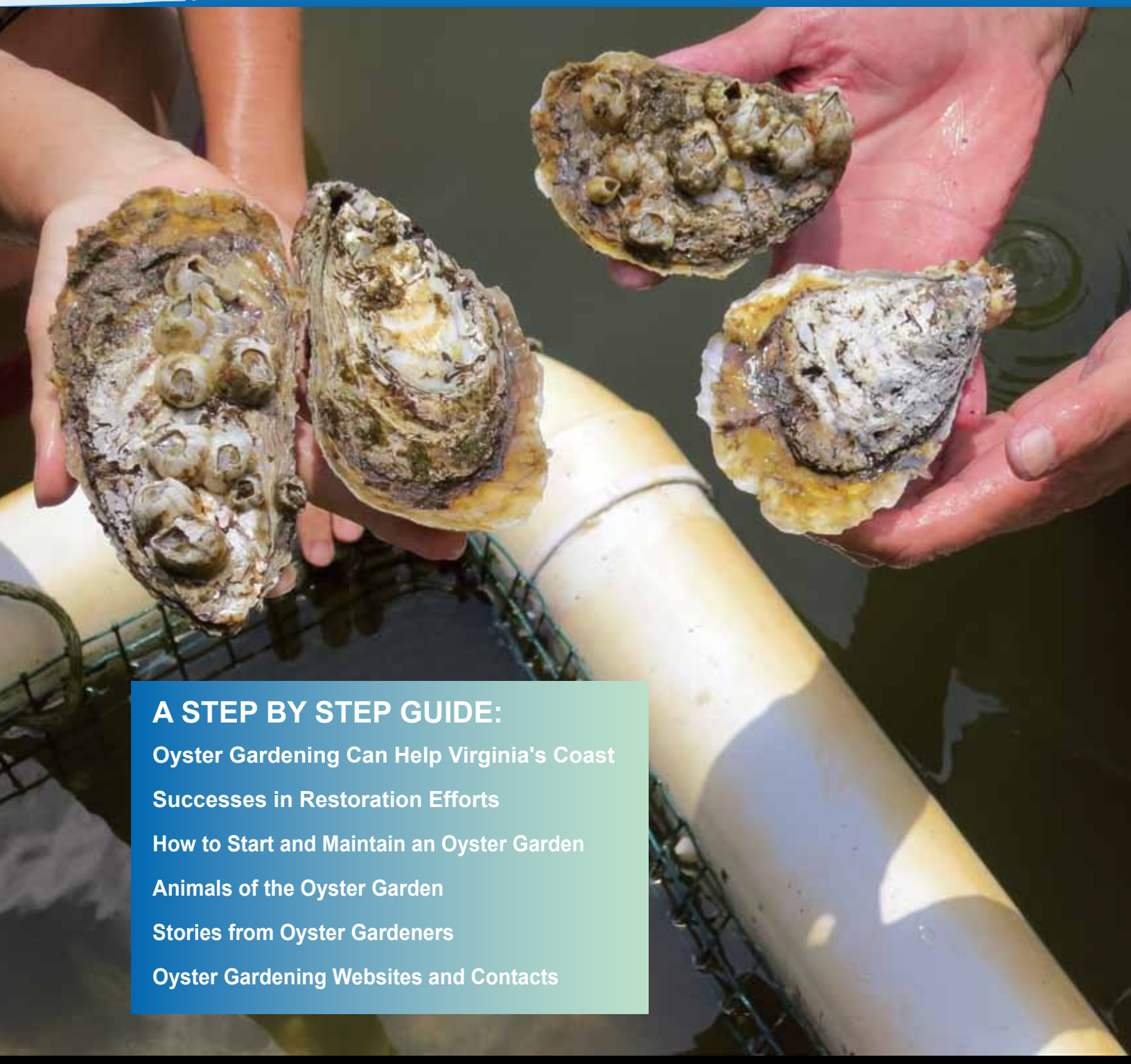
Virginia Oyster Gardening

2013



A STEP BY STEP GUIDE:

Oyster Gardening Can Help Virginia's Coast

Successes in Restoration Efforts

How to Start and Maintain an Oyster Garden

Animals of the Oyster Garden

Stories from Oyster Gardeners

Oyster Gardening Websites and Contacts

Start growing your oysters today for a healthier tomorrow!

This 2nd edition of the Virginia Oyster Gardening Guide was produced by the Virginia Coastal Zone Management (CZM) Program in partnership with the Virginia Marine Resources Commission, Virginia Institute of Marine Science, Tidewater Oyster Gardeners Association, Oyster Reef Keepers, Chesapeake Bay Foundation and Virginia Department of Health.

Funding to print this edition was provided by the Tidewater Oyster Gardeners Association, Chesapeake Bay Foundation and the Virginia Coastal Zone Management Program through a grant from the National Oceanic and Atmospheric Administration under the federal Coastal Zone Management Act.

The first edition of the guide was released in 2006 by the Virginia CZM Program, with support from the Virginia Oyster Reef Heritage Foundation and the NOAA Chesapeake Bay Office, and based largely on a document written in 1999 by Mark Luckenbach, Francis O'Beirn and Jake Taylor of the Virginia Institute of Marine Science: "An Introduction to Culturing Oysters in Virginia."

The guide is available on the Virginia CZM Program Web site at http://www.deq.virginia.gov/Programs/CoastalZoneManagement/CZMIssuesInitiatives/Oysters/Gardening.aspx.

Cover photo by Laura McKay. Photo above courtesy of TOGA. Photo upper right courtesy of TOGA. Photos bottom right top to bottom - oyster seed and oyster float, courtesy of TOGA; mud crab by K. Hill, Smithsonian Marine Station at Fort Pierce, FL; oysters on the half shell, courtesy of CBF. Back cover photo by Tom Zolper/CBF.

Welcome to Oyster Gardening!

Thank you for starting your own oyster garden!

We hope this oyster gardening guide will help you learn how to grow oysters in the most efficient way possible while gaining an understanding of the value oyster gardening brings to improving habitat, water quality and the overall vitality of our coastal waters.

The information is as up to date as possible, but as new information becomes available, please check the Web sites listed at the end of the guide for the most current information.

We hope that through oyster gardening you will become a proponent for restoration efforts to help increase oyster populations and improve Virginia's coastal waters. We also hope that you will encourage others to take up this hobby. Remember even if you don't own waterfront property, your friends, neighbors, employers, schools, local parks and businesses might - and you could be the one to get them hooked on oyster gardening.

Have Fun!

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Oyster Gardening Can Help Virginia's Coast!

Whether you are planning to grow oysters for your own consumption, for donation to sanctuary oyster reefs or for some other reason, your efforts can help improve water quality and biodiversity along Virginia's coast.

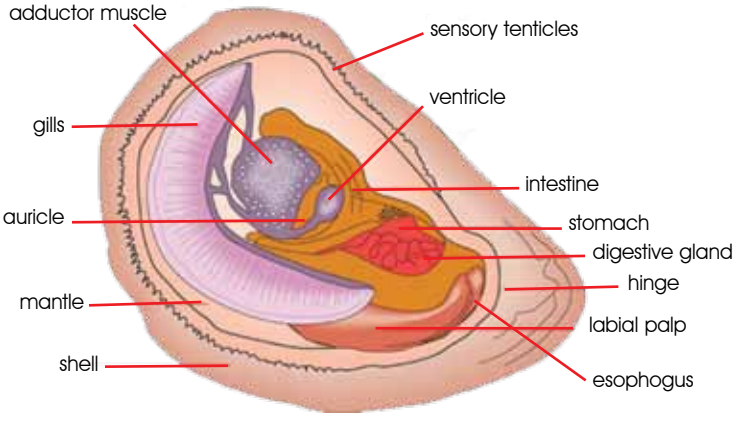
Virginia's coastal population has increased 41% from 3 million in 1986 to 5 million in 2010. We are the 8th fastest growing state in the country. As Virginia's population continues to increase, it becomes more and more difficult to reduce the increasing amounts of fertilizer (from lawns and farms), stormwater runoff and other pollutants associated with human activities that contribute huge quantities of nitrogen to coastal waters. Too much nitrogen causes algae blooms, turning the water a greenish hue and preventing sunlight from reaching underwater grass (SAV *or Submerged Aquatic Vegetation)* beds that provide critical habitat for finfish and other shellfish.

When the algae die, decomposing microorganisms proliferate. Decomposers consume dissolved oxygen and their sudden increase in numbers remove large amounts of oxygen from the water, creating a condition known as anoxia, or absence of oxygen. Anoxia can kill shellfish and finfish - especially species that cannot swim away from the anoxic area. The end result of excessive nutrients like nitrogen and phosphorus in coastal waters is dead finfish and shellfish and many other animals, as well as the loss of a critical part of the Bay and coastal ecosystem. Many nutrient reduction efforts focus on land-based solutions. Growing oysters can potentially contribute to nutrient reduction.

Clear water is needed in order for sunlight to reach underwater grasses rooted to the bottom. SAV beds are essential habitat for other finfish and shellfish. Eelgrass is ideal nursery habitat for the bay scallop, which as juveniles attach themselves to eelgrass blades to stay out of reach of predators. Photo courtesy of VIMS.

In addition to helping to clear the water by filtering out algae and sediment, natural oyster reefs provide habitat to a tremendous number and variety of other finfish and shellfish. See the Oyster Toadfish hiding among the oysters? Photo courtesy of CBF.

Virginia's native oyster, *Crassostrea virginica*, can help to improve water quality because it feeds on algae. An adult oyster can filter up to 50 gallons of water per day when water temperatures are above 50 degrees Fahrenheit. Oysters are one of nature's water filters. They remove particulate algae and sediment from the water by beating the cilia on their gills and drawing water in at a rate of 2-3 gallons per hour. The food particles, caught in mucous strings on their gills, are passed around the gills to the palps where some of the food is ingested. The remainder is released as "pseudofeces", which effectively packages and removes sediment from the water column and places it on the bottom.



Virginia's native oyster, Crassostrea virginica. Drawing and information sources - www.infovisual.info and Maryland Sea Grant.

Oyster Biology, Lifecycle and Interesting Facts

Oysters are scientifically classified as molluscs, a word from the Latin meaning soft.

The ancient Romans served large quantities of oysters at their banquets, learned to cultivate them, and even made a monetary unit, the denarius, equal in value to one oyster.

The native eastern oyster, *Crassostrea virginica*, usually lives in water depths of between 3 and 25 feet and naturally forms three-dimensional reefs.

An oyster orients itself with the flared edge of its shell tilted upward. The left valve is cupped, while the right valve is flat. The oyster uses its adductor muscle to open its shell to feed on plankton.

While the power of the adductor muscle varies with the size and condition of the oyster, it takes a pull of over 20 lb to open the shell of a 3 to 4-inch Eastern oyster in good condition.

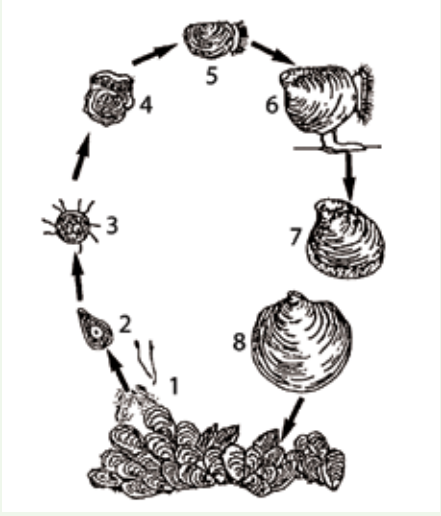
Oysters usually mature in one year. There is no way of telling male oysters from females by simply looking at them. While oysters have separate sexes, they may change sex one or more times during their life span. They are protandric, which means that in the first year they spawn as males, but as they grow larger and develop more energy reserves in the next two to three years, they spawn as females.

An increase in water temperature triggers male oysters to release sperm and females to release eggs into the water. This begins a chain reaction of spawning which clouds the water with millions of eggs and sperm. A single female oyster produces 10 to 100 million eggs annually.

When water temperatures fall over the winter, oysters cease to feed. The oysters stop filtering and seldom open their shells. However, unlike hibernating bears and other animals which live on stored fat, they show very little weight loss after the winter's sleep.

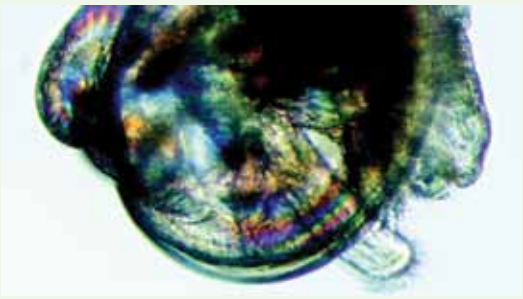
Across the world, almost two billion pounds of oysters are eaten each year. Oysters are high in calcium, iron and protein and contain numerous vitamins including C, D, B_1, B_2 and B_3. Four or five medium size oysters supply the recommended daily allowance of iron, copper, iodine, magnesium, calcium, zinc, manganese and phosphorus.

It is possible for edible oysters from the family *Ostreidae* (such as *Crassostrea virginica)* to produce pearls. However, it is the oysters from the family *Pteriidae* that produce the pearls used in jewelry.



Oyster Life Cycle, Figure: Wallace et al 2008

Sperm fertilize eggs in the water column. Fertilized eggs develop and progress through a series of free-swimming larval stages (Stage 4) over a period of 14 to 20 days, depending on water temperature. These stages are referred to as the trochophore, veliger and pediveliger. The trochophore larvae feed on very small algae as they move through the water column. Trochophore larvae quickly develop into more motile veliger larvae (Stage 5). Toward the end of the larval cycle, pediveligers (Stage 6) develop a foot that helps them find a suitable hard substrate on which to attach (set) and transform into small oysters. This stage is also called an "eyed larvae" because of the development of a pigmented eye spot.



Pediveliger, See Stage 6 - top graphic. Pictomicrograph of eyed larvae with pseudopod extended. Photo by Michael Congrove, VIMS.

Eyed pediveligers settle out of the water column when they are approximately 300 micrometers (µm) and may be stimulated to settle by the presence of adult oysters. Finding a clean, hard substrate (cultch) is essential to their survival. The eyed larvae can move only very small distances, once they settle, in order to find a suitable spot. Once settled, they attach and transform into small oysters called spat. Spat soon begin feeding on algae by filtering water through their gills and a special structure (labial palps) located just in front of the mouth.

Successes in Restoration Efforts

Why are so few wild oysters left?

Based on historical accounts, three-dimensional oyster reefs were once a prominent feature of Virginia's coast. Captain John Smith reported in the early 1600's that a person could practically walk across the James River on the tops of the oyster reefs. During the Civil War, oyster reefs were still so large that they were a danger to navigation in the Chesapeake Bay. In the early 1900's, Diamond Jim Brady was said to have eaten over 100 oysters in one sitting. And in some years past, Virginia used to produce 7-8 million bushels of oysters per year with approximately 20 million bushels harvested Bay-wide. Overharvesting caused a precipitous decline between 1907 and the 1930s.

After a slight recovery in the 1940s and 50s, oyster harvests declined again drastically in the mid-1950's, reaching their lowest points in the 1990's. This decline in oyster populations was due to over-harvesting, habitat loss, poor water quality, and two diseases, MSX and Dermo (see page 6). Due to all of these problems, only a small percentage of the oyster population now exists. Over the last decade, the status of wild oyster populations has improved and the oyster aquaculture industry has grown, however there is still a long way to go.

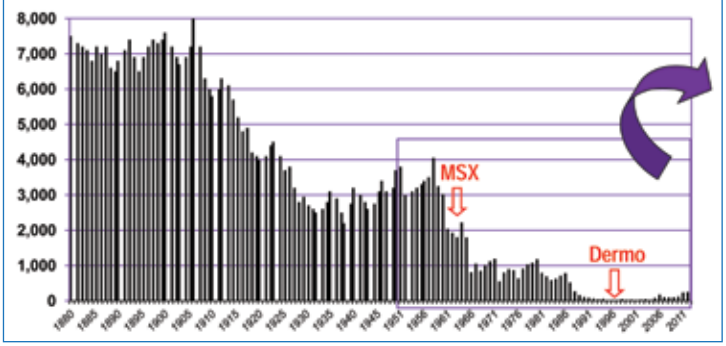
Oyster gardening can help increase native oyster populations if diploid (fertile) animals are grown and allowed to reproduce. The cumulative impact of thousands of people growing fertile oysters could be quite significant.

Increasing our native oyster population.

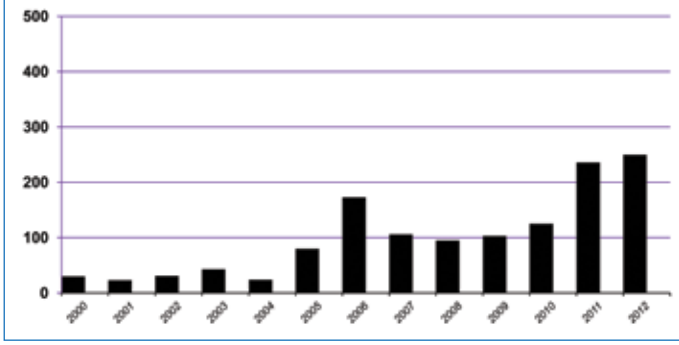
Commercial oyster aquaculture may take some harvesting pressure off the wild population as retailors, resturants and consumers demand consistently sized and shaped oysters. Private oyster gardening also can help increase the native oyster population if gardeners place their reproductive oysters on sanctuary reefs. New techniques to grow oysters both in cages and as spat on shell, improvements in the genetics of the native oyster to impart traits for disease tolerance and faster growth, the availability of sterile, triploid oysters for good year round meat quality, and expanding private hatchery capacity have all spurred rapid growth of oyster aquaculture production in Virginia (see figure on page 5 - private bushels).

There also are improvements in Virginia's wild oyster harvest (see figure below). In 1999 the Virginia CZM Program initiated the Virginia Oyster Heritage Program (VOHP) investing significant coordinative effort and over $1.5 million to increase Virginia's wild oyster population through the restoration of natural 3-dimensional reef habitat. This public-private partnership brought together state, federal, non-governmental, and private oyster industry partners, including the Virginia Marine Resources Commission, Virginia Institute of Marine Science, National Oceanic and Atmospheric Administration, Army Corps of Engineers, and the commercial oyster industry. That year, Virginia's harvest had been the lowest ever recorded. The VOHP partnership leveraged additional funds and led to the construction of more than 80 sanctuary reefs and 1000 acres of harvest area in Virginia's coastal waters. In 2007, as pressure mounted to open oyster sanctuary areas to harvest, the Virginia CZM Program reconvened the VOHP partners. Together the partners created an innovative Oyster Management Plan for the Lower Rappahannock River that combines a 3 year rotational harvest protocol, using six

Virginia Landings 1880 - 2012
(1000s of bushels)



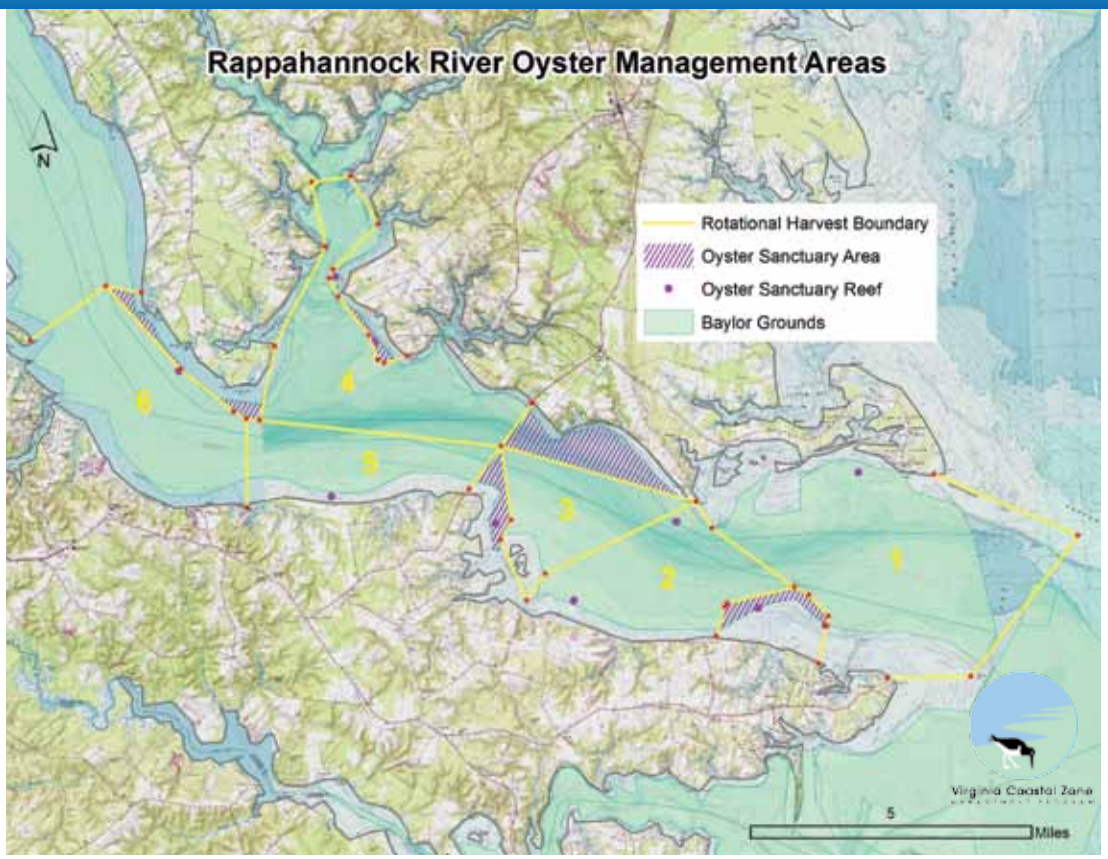
Virginia Landings 2000 - 2012
(100s of bushels)



Graphs courtesy of Virginia Marine Resources Commission and Virginia CZM Program.

geographic areas in the lower section of the river, and a buy-back program for large oysters that helps preserve brood-stock on the sanctuary reefs.

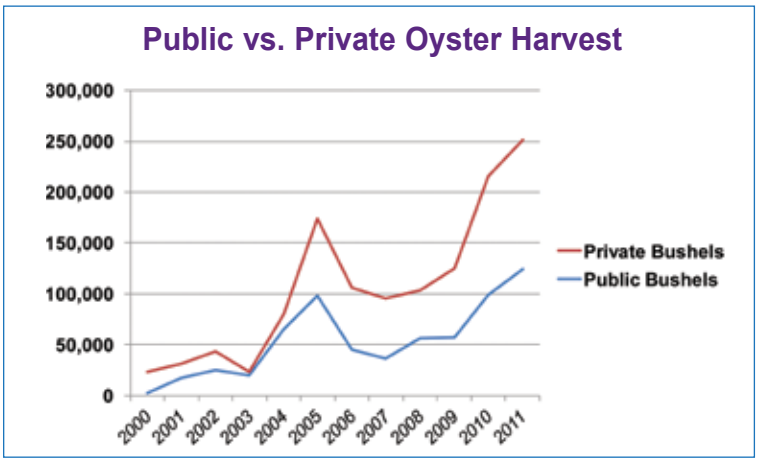
The three-year rotational harvest protocol allows the maximum amount of harvest before oysters succumb to disease, and then allows each area time to "rest", giving oysters time to reproduce and replenish the harvest area. Oyster harvests have increased significantly with this harvest strategy, and the populations of oysters on both sanctuary and harvest areas remain stable. This model has now expanded to the Tangier-Pocomoke Sound Area and the York River.



The payoff for this investment over the past 10 years has been substantial. Oyster harvests have increased 10-fold over the past decade, from an annual harvest of less than 23,000 bushels to a harvest of more than 250,000 bushels and a dockside value now of over $9 million (2012 VMRC data). Planting shells on public harvest areas has provided a positive return on the financial investment.

Over the last 5 years, researchers, commercial fishermen and aquaculturalists on the Seaside of the Virginia's Eastern Shore have all observed very high oyster recruitment on restored reefs and noticeable increases in oyster densities. In 2008, an inventory estimated the number of oysters to be 3.1 million. Today, the number of oysters would be exponentially higher!

In 2013, the Governor and General Assembly appropriated $2 million for oyster restoration, which is the largest state investment that has ever been made in oyster restoration.



Graph courtesy of Virginia Marine Resources Commission and Virginia CZM Program.

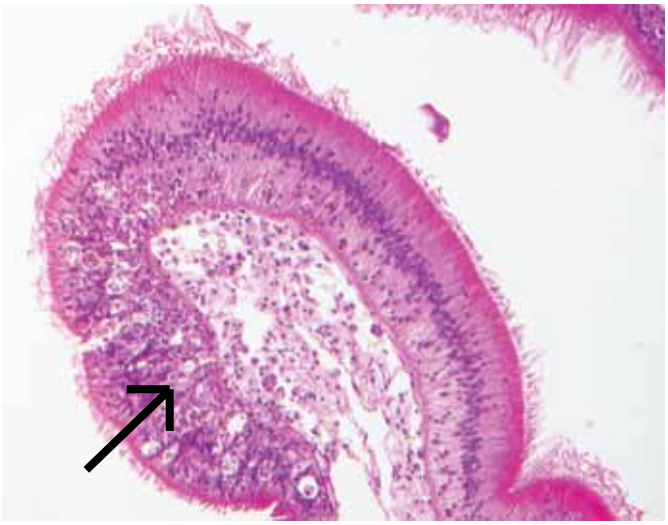
Dealing with Disease

Oyster diseases

MSX and Dermo are not caused by viruses or bacteria, but rather by single-celled protozoans. Neither parasite is harmful to humans. In the Chesapeake Bay, oysters become infected with MSX from mid-May through October. Infections develop rapidly in susceptible oysters and result in mortalities from April through October. Oysters that survive their first season may still harbor the parasite over the winter and succumb to the disease the following spring or early summer. Temperature and salinity regulate MSX. Both parasite and oyster are inactive at temperatures <5°C (41°F). At 5-20°C (41-68°F), the parasite proliferates more rapidly than the oyster can control it. Above 20°C (68°F), resistant oysters can overcome the parasite while susceptible oysters are killed. A salinity below 10 parts per thousand (ppt) results in expulsion of the parasite at temperatures above 20°C. A salinity of 15 ppt is required for infection; 20 ppt is required for rapid and high mortality. Fortunately, wild oysters are increasingly tolerant to MSX and this tolerance is heritable. For several decades hatchery-based breeding programs have made use of this heritability to selectively breed strains of oysters that are highly tolerant to MSX. If you are growing oysters in waters where the salinity regularly exceeds 10 ppt, you should be sure to use one of these lines of oysters. See VIMS' Aquaculture Genetics and Breeding Technology Center (ABC) website, *www.vims.edu/abc.* for more information about lines breeding. A variety of selectively bred lines may be available from commercial seed sellers – just ask!

Dermo infections occur throughout the warm months, May through October, with maximum mortalities observed in September and October. Low numbers of parasites remain over the winter, and these parasites proliferate once temperatures increase in late spring. Infective stages of the parasite are released from infected and dying oysters, so it is imperative to avoid moving infected oysters into an area containing uninfected oysters. Temperature and salinity greatly influence Dermo. The parasite proliferates and infections intensify above a threshold of 20°C (68°F). At temperatures above 25°C (77°F), the parasite rapidly multiplies, spreads, and kills oysters. Infections decline at temperatures below 15°C (59°F). Prevalence and infection intensities of Dermo increase with increasing salinity. High intensity infections and high mortalities often occur in areas with salinities above 12-15 ppt. Infection intensities remain low in areas with salinity consistently below 9 ppt. While selective breeding has yet to produce a strain of oysters that is totally resistant to Dermo, different strains do have varying degrees of tolerance to the parasite. For example, some lines bred at VIMS, using naturally Dermo resistant oysters from the Gulf coast hybridized with Virginia oysters, display improved tolerance to Dermo. Oysters also have been bred for faster growth so that they reach market size before they succumb to Dermo. When growing oysters at sites with salinities above 9 ppt, it is important to use one of the selected strains that have been demonstrated to have some Demo tolerance.

The timing of planting your oyster seed can also affect their exposure to Dermo. Growing oysters rapidly and harvesting prior to a second summer of exposure to the disease can reduce mortality.



Healthy oyster gut epithelium on the right side of the photo and a region damaged by Dermo on the left side of the photo. Photo by Ryan Carnegie, VIMS.

Oyster Aquaculture Links

Aquaculture Genetics & Breeding Technology at VIMS-*www.vims.edu/abc*

VIMS Marine Advisory Services Aquaculture-*www.vims.edu/map/aquaculture*

Aquaculture Program at VA Tech VA Seafood Agricultural Research Center-*www.arec.vaes.vt.edu/virginia-seafood/*

VMRC Shellfish Aquaculture, Farming and Gardening-*www.mrc.virginia.gov/Shellfish_Aquaculture.shtm*

Virginia Aquaculture Oyster Growers-*virginiaoysters.org*

Creating a better oyster for cultivation

Disease resistant oyster lines are now a reality for aquaculture. However, wild stocks of oysters are also showing some effect of natural selection with increased tolerance to MSX and, to a lesser extent, Dermo. Selective breeding for aquaculture has produced lines of oysters that live longer and grow faster. And genetic improvement has led to another beneficial farm characteristic - sterility. Sterile oysters have three sets of chromosomes (triploid) instead of two, like a normal fertile (diploid) oyster. At first, making oysters sterile might seem counterproductive. Triploids, however, are used exclusively on oyster farms to enhance product quality because triploids do not become spent, watery and of poor quality for consumption after spawning, like their normal reproducing cousins. There are other advantages to triploids on commercial farms, including faster growth (even faster than an oyster selectively bred for faster growth) and higher survival in the face of disease (even higher than those selectively bred for survival). Selective breeding is an ongoing process and as one generation of oysters has been distributed to hatcheries, another generation is being developed and tested. Selective breeding programs might someday deliver the “perfect oyster” and diseases could become a distant memory to aquaculturists. Diseases will likely always be an issue in the wild.

For more about these diseases, visit the VIMS MSX and Dermo Fact Sheet at *www.vims.edu/_docs/oysters/oyster-diseases-CB.pdf*.

Dr. Stan Allen, director of the Aquaculture Genetics and Breeding Technology Center (ABC), counts eggs to ensure equal genetic contribution of females to the formation of selectively bred disease resistant-fast growing oyster lines. Photo courtesy of VIMS ABC.

(Above) Selected oyster lines are tested in the field in a variety of locations, here in the Lynnhaven River. Testing sites are also in the York River, Rappahannock River, and two low salinity sites. Most lines are grown on rack-and-bag culture. Photo courtesy of VIMS ABC.

(Below) Dr. Anu Frank-Lawale creates specialized lines of oysters by crossing specific males with specific females. Unlike in the wild, these matings have to be done under controlled conditions so that oyster "A" mates with, and only with, oyster "B." Eggs from a female are removed by dissection and held in the red Solo cups, while sperm dissected from the male is held in the small beaker (with blue tape). Anu is systematically adding sperm to its designated Solo-cup mate, in the dating ritual of oyster breeding. Photo courtesy of VIMS ABC.

Step One: Evaluate Your Site

Will your site support growth?

The first two things you need to know are whether the location you have chosen for your oyster garden will actually support oyster growth, and whether it will be safe to eat the oysters grown at that site. An oyster garden needs to be located where you have 5 basic things:

- **the correct water salinity range**
- **a minimum water depth**
- **adequate amounts of oxygen**
- **adequate amounts of plankton (algae)**
- **absence of sewage and other contamination**

Salinity

The salinity of the water at your site will influence the growth rate of your oysters and whether they may become exposed to oyster-specific diseases. Salinity is measured in grams of salt per liter of water, or parts per thousand (ppt or ‰). Oysters require a salinity of at least 8 ppt to grow and oyster growth increases with increased salinity. Below 10 ppt salinity oyster growth rates are generally reduced; some oysters show intermediate growth rates at salinities between 10–20 ppt and highest growth rates at high salinities >20 ppt. You can test your water salinity using a simple device known as a hydrometer. Hydrometers may be found easily at pet stores that sell saltwater fish or online. The map on the opposite page shows the general areas of salinity in Tidewater Virginia. It is a good idea to keep records of the salinity at different times of the year, under varying environmental conditions (for example, after a rainfall), and at different tidal cycles. Also keep in mind that as sea level rises, high salinity waters will move up the Bay and tributaries.

Water depth

For two reasons your site must have a minimum water depth of one foot, even at the lowest tide:1) oysters can only filter water and grow when they are submerged - so they will grow faster if they are always under water; 2) in the winter, when tides and winds may cause oysters to be exposed, they may freeze. Oysters can be frozen solid in the water and survive, but they can die if exposed to sub-freezing air temperatures.

Dissolved oxygen

Oysters need water with dissolved oxygen levels of at least 3.2 milligrams per liter, but 5.5 mg/l or more is best for survival and growth. Colder water can hold more oxygen than warmer water. That is why “anoxia events” (low oxygen situations) usually occur in the summer. Generally Virginia’s coastal waters have sufficient oxygen to support oysters grown close to the shore and off the bottom. If you are concerned about oxygen levels, you can measure dissolved oxygen using a field kit purchased online.

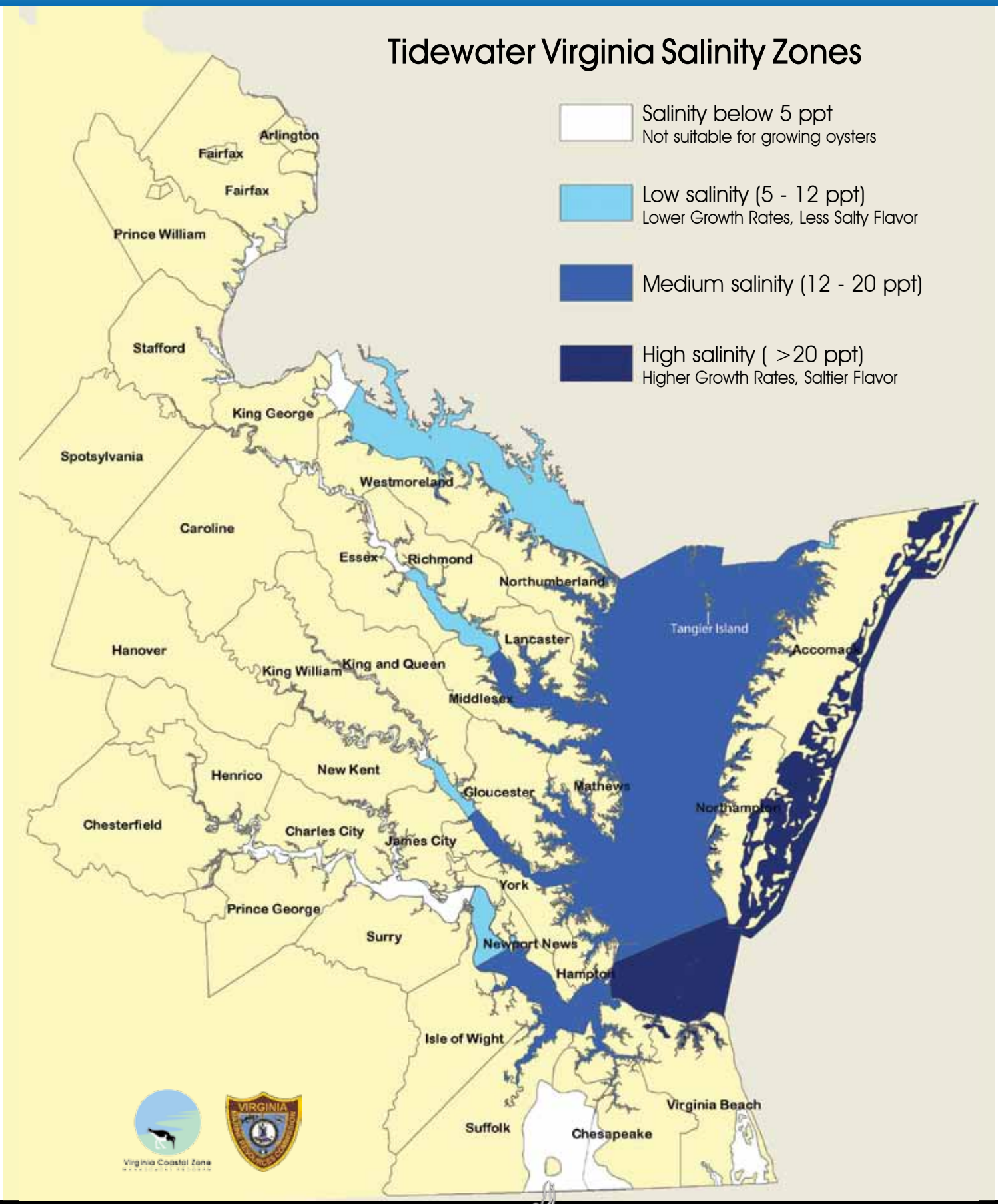
Plankton

The quantity and quality of food available to oysters can vary considerably from location to location. The quantity and quality are a function of the hydrodynamics at a site (how the water is moving through the site) as well as the abundance of phytoplankton in the water. If you have access to more than one site, you may want to experiment with the different areas to see which produce the biggest oysters. If you have only one location, you may have to evaluate different seed stocks and handling strategies in order to maximize oyster growth and survival.

Will it be safe to eat oysters grown at your site?

As oysters pump water through their gills and filter out microscopic food particles, they may also ingest bacteria and viruses. And because oysters, including their intestinal tracts, may be eaten raw, care must be taken to ensure that oysters harvested for consumption are taken from very clean water. Waters approved for harvest of shellfish must be much cleaner than waters approved for swimming and fin-fishing.

Not all gardeners choose to eat their oysters, but if you do, you must determine whether they are safe to eat. As is true with meat, proper cooking kills disease causing micro-organisms. The Virginia Department of Health (VDH), Division of Shellfish Sanitation (DSS), tries to minimize our risk by monitoring and classifying shellfish waters for safe commercial and recreational harvest. VDH/DSS maintains boats at each of its field offices and collects and analyzes fecal coliform samples monthly at designated stations throughout shellfish growing waters in tidal rivers, Chesapeake Bay and the Seaside of Virginia's Eastern Shore. DSS collects and analyzes about 22,000 seawater samples per year. Visit the Virginia Department of Health’s online maps of condemned shellfish areas at *www.vdh.virginia.gov/EnvironmentalHealth/Shellfish/closureSurvey/index.htm*. The maps are updated about 4 times a year but more frequently in areas subject to rapid change.


Tidewater Virginia Salinity Zones
Salinity below 5 ppt
Not suitable for growing oysters
Low salinity (5 - 12 ppt)
Lower Growth Rates, Less Salty Flavor
Medium salinity (12 - 20 ppt)
High salinity (>20 ppt)
Higher Growth Rates, Saltier Flavor
Arlington
Fairfax
Fairfax
Prince William
Stafford
King George
Spotsylvania
Westmoreland
Caroline
Essex
Richmond
Northumberland
Tangier Island
Lancaster
Hanover
King William
King and Queen
Middlesex
Accomack
Henrico
New Kent
Gloucester
Mathews
Northampton
Chesterfield
Charles City
James City
York
Prince George
Surry
Newport News
Hampton
Isle of Wight
Virginia Beach
Suffolk
Chesapeake
Virginia Coastal Zone
VIRGINIA

Step Two: Choose a Containment System

A wide range of options exist for oyster gardening containment systems. Methods include the use of floats, suspended mesh bags and fixed bottom racks or cages. No single method is right for everyone, and no single method guarantees success. Each grower must consider characteristics of the growing site and his or her ability to handle the weight of the containers. Several options are offered here and a number of different modifications of these systems may be commercially available. See pages 15 and 24 for more information and contacts. Oyster gardeners have been quite inventive in devising containers and methods that work for them. You should feel free to experiment with modifications and methods to make gardening easier for you, given your particular site. The important thing to remember is that your system must provide:

1) minimal flow obstruction
2) ease of maintenance and handling
3) adequate predator protection

Taylor float

Taylor floats can be attached to lines so they can be hauled more easily onto a dock or pier for maintenance. Photo by Kathy Hoffman.

The Taylor float (named after its designer, Jake Taylor) is a containment system that holds oysters about one foot under the surface of the water. The Taylor Float has a sturdy, relatively open design that provides limited surface area for fouling and permits good water flow. Disadvantages include the cumbersome size (some are as large as 2' x 8') and the possible need for a hoist to retrieve the floats when they are full of oysters. A 2' x 3' Taylor float will hold about 500 adult oysters, about a bushel and a half. Taylor floats can be tied under a dock or pier which keeps them out of the sun and helps slow the accumulation of algae on the float and on the oysters.

Taylor floats are generally constructed with a 2' x 3' frame of four inch PVC pipe and a one inch by one inch mesh marine plastic coated wire basket. Vinyl coated galvanized wire is best for reducing corrosion and extending the life of the float. Mesh bags of various sizes for holding small oysters can be laid in the float and turned over frequently, but oysters should be moved to the largest possible mesh size as soon as possible and the density reduced. Reducing the density of oysters in the float helps maintain good water flow and reduces the competition for food among the oysters.

For extra protection against predators, a mesh liner may be placed within the float and attached to it with cable ties. For a 2' X 3' Taylor float, cut a 3 ft x 4 ft section of mesh and secure it to the inside of the float. The liner should extend six inches up the sides of the float and be secured at the top with cable ties. The liner may protect against predators, but may slow water flow through the float.

Larger oysters can be placed directly into the floats, but the float may need a lid to keep out predators. Lid options for this float include ¼ inch thick plywood lids, wire mesh, and shade cloth. Performance of different lid options varies with location, and opinions about the best type of lid vary among oyster gardeners. Lids can restrict the growth of macro algae in the floats and reduce predation by otters and seagulls. However, barnacle and oyster settlement may be greater on lids, and seagulls roosting on top of the lids may cause elevated fecal coliform bacteria levels.

The Tidewater Oyster Gardeners Association holds workshops each year where gardeners can learn how to build their own floats. Directions for building the floats along with information on devices that TOGA can build for you can be found at *www.oystergardener.org/#!devices-and-designs/c2ir*.

The flip float is just one of the innovative designs oyster gardeners have devised to contain their oysters. Photo courtesy of TOGA.

Photos courtesy of TOGA.

Mesh bags

A less expensive oyster garden, illustrated in the photo above, consists of ADPI marine plastic mesh bags, each containing about 150 oysters. The bags are kept afloat by four, empty, one-liter soda bottles. Multiple bags are lined up with a rope running through the middle of each bag and attached at each end to a piling or stake. Running a rope through the middle of the bags allows them to be flipped end to end every week or so, to help keep them clean. Fouling organisms tend to grow on the bottom side, so when the bags are flipped, that side is exposed to sun and air which will kill off most of the fouling organisms.

Gardeners in locations where the water may freeze in winter may not want to use this method. Be aware that sinking the bags by filling the bottles with water to keep them below the ice will kill any oysters that end up buried in mud. The mesh bags may also be placed on racks constructed of steel reinforcing bar (rebar). This "rack and bag" method involves securing bags with oysters onto racks that extend 1 – 2 feet above the bottom. Bags may be purchased from commercial suppliers or made with 1/8", 3/16", and 5/8" mesh size openings. The bags can be closed with four inch cable ties, using a combination of ½" stainless steel hog rings and cable ties, or sliding a piece of slit PVC pipe over the end and securing it with cable ties.

Gardeners have devised ways of lifting floats up to the dock for cleaning and maintenance. Small cranes, boat lifts, even jet-ski lifts may be adapted for this purpose. Photo courtesy of TOGA.

Cages

Photo by Preston Philyaw.

Bottom racks or cages are useful in places where the bottom is hard and wave action is too great for surface floats. They may also be preferred in shallow waters where aesthetics are a consideration and you don't want the oyster garden to be visible. These cages are commercially available or may be constructed. They sit on feet that are a few inches high and must have a lid to protect oysters from predators. These cages full of adult oysters can be quite heavy, and this should be kept in mind when purchasing or building them. It is also critical that the oysters be kept up in the water and out of the mud if they are to survive and grow.

Photo courtesy of TOGA.

Small baskets (Australian cages), as in the photo above, are also commercially available. These hold around 100-150 mature oysters. They may be fastened to long lines, or suspended in the water by a PVC pipe sealed at both ends and hung from a dock so that they remain horizontal. The sealed pipe will prevent one end from sinking onto the mud even as the weight of the oysters shifts. An advantage of these cages is they are not as heavy to lift out of the water to clean or maintain compared to those described above. However, they don't hold many oysters.

Step Three: Get a Permit

It's important because...

Getting a permit for oyster gardening is a simple process, it's free, and it's for your own protection and benefit. The Virginia Marine Resources Commission issues oyster gardening permits. They have provided the simple application form on page 13 that you can cut out, fill out, and mail in to them.

This permit will authorize you to use state-owned waters near your property for the noncommercial culture of shellfish. In other words, it allows you to grow oysters in public waters for your own personal consumption or use, but it does not allow you to sell those oysters commercially. Selling oysters commercially requires other permits from VMRC and the Virginia Department of Health. VMRC does not currently apply size or season harvest regulations to cultured oysters grown for non-commercial purposes.

When you get a permit, you are on record at the VMRC as an aquaculture site. Recording the locations of oyster gardens makes it possible to get a better estimate of how many cultured oysters are in state waters and what positive effect they may be having on water quality. So be sure your efforts are counted!

Another benefit of being a permit-holding gardener is that you now have an additional, publicly-recognized stake in the quality of the waters adjacent to your property. This could be an important factor for the VMRC when they are asked to consider issuing permits for other activities in your neighborhood which may conflict with your use of the state's waters. It could also allow the Virginia Department of Health to see where concentrations of oyster gardening are occurring and compare that data to areas condemned for shellfish and known sources of fecal coliform contamination so that your health can be better protected. You may receive a letter from the Virginia Department of Health, Division of Shellfish Sanitation, warning you that your waterway is "condemned" and you should not consume oysters from it.

By applying for a permit which the VMRC reviews and approves, you also ensure that your oyster garden does not interfere with the public's right to navigate, nor with the growth and health of submerged aquatic vegetation (SAV). If SAV is present near your shoreline, it could be shaded by floats on the surface or damaged by cages placed on the bottom.

Photo courtesy of TOGA.

Here's how you do it...

Complete one signed, original of the permit application form on the facing page if you plan to deploy up to 160 square feet of aquaculture structures in the tidal waters of Virginia for oyster gardening (a non-commercial purpose). You can use Virginia CZM Program's Coastal Geospatial and Educational Mapping System (GEMS) (*www.coastalgems.org*) to check if oysters grown in your area are safe to consume, locate submerged aquatic vegetation, and even produce your vicinity map and plan view drawing using the application's "mark up" tool.

Be sure to include the required drawings of your containment system and return it to VMRC at the address on the back side of the form. VMRC will forward copies of your application to your Local Wetlands Board and your Local Health Department for their review. The Health Department may contact you if your proposed project is in polluted waters. You should receive notification of your permit approval from VMRC within a few weeks.

If you believe your project will cover more than 160 square feet or may impact navigation or SAV beds, you may need to complete a Joint Permit Application which you can obtain by calling VMRC at (757) 247-2252 or the US Army Corps of Engineers at (757) 201-7652. For more guidance on obtaining shellfish aquaculture permits, ask VMRC for a copy of "Guide to Virginia's Laws, Regulations & Requirements for Marine Shellfish Aquaculture Activities." This guide covers both commercial and non-commercial shellfish farming.

Abbreviated Joint Permit Application For Noncommercial Riparian Shellfish Aquaculture Structures - "Oyster Gardening"

1. Applicant's name and complete mailing address:

_____

_____

_____

Telephone numbers:
Home (____) _____
Work (____) _____

2. Physical address of the project site (if different from above):
Street address:_____
OR
Local Tax Map No.: _____

3. Waterbody at the project site:
a tributary to _____ in _____County/City

4. Please provide accurate directions to the project site from the nearest intersection of two state roads:

5. Description of the aquaculture structures to be employed:

Floats: Size (LxWxH in inches) _____ Number to be used _____
Bottom Cages: Size (LxWxH in inches) _____ Number to be used _____

Other structures: Please provide a description including the size and number to be used.

6. (A) Will the structures be secured to an existing private pier?
(B) If yes, will they extend beyond the end of the pier?
(C) If yes, how far channelward of the pier will they extend and what is the distance to the recognized channel?
_____ feet.
What is the width of the waterway at the project site (mean low water to mean low water)?
_____ feet.

7. If you answered NO to question 6 (A) above, will they be located in the waters immediately opposite your shoreline? Describe how will the structures be secured.

Note: If new pilings are required to secure the structures, a standard permit may be required. Please call VMRC for details at (757) 247-2252.

Cut along the dotted line to submit application.

8. What is the Health Department's current classification of the growing waters at the project site?
Open for direct harvesting, Seasonally closed, Permanently closed, or Uncertain. (Circle one)

9. Please provide the following required drawings:

A. Vicinity Map - Use a map to depict the exact location of the project site. Please indicate the name of the map used. USGS quadrangle maps, street maps, or county maps are preferred.

B. Plan View Drawing - This drawing must depict the proposed structures as if viewed from above. The drawing must include, a north arrow, the waterway name, the location of mean high water and mean low water, the location of any submerged aquatic vegetation at the site, the width of the waterway, the direction of ebb and flood of the tide, your property lines and shoreline, the opposite shoreline if the waterway is less than 500 feet wide, the depth of water at the project site, and the location of the existing navigation channel. A recent plat of the property, if available, provides a good scaled template for the plan view drawing.

C. Cross Sectional Drawing - The cross sectional drawing must show the dimensions of the proposed structures as viewed from the side. It should include the depth of the water and any structures which will be used secure the floats or cages. If the application is for floats which will be secured to your existing pier, a cross sectional drawing will not be required.

ALL APPLICANTS MUST SIGN

I hereby apply for all necessary permits for the activities described herein. I agree to allow the duly authorized representatives of any regulatory or advisory agency to enter upon the premises of the project site at reasonable times to inspect and photograph site conditions.

I hereby certify that the information submitted in this application is true and accurate to the best of my knowledge.

_____ _____

APPLICANT'S SIGNATURE APPLICANT'S NAME (PRINTED/TYPED)

_____

DATE

IF DIFFERENT FROM APPLICANT:

_____ _____

PROPERTY OWNER'S SIGNATURE PROPERTY OWNER'S NAME (PRINTED/TYPED)

_____

DATE

Please mail your completed "Oyster Gardening" permit application to:

Virginia Marine Resources Commission
Habitat Management Division
2600 Washington Avenue, 3rd Floor
Newport News, Virginia 23607-0756

This Virginia General Permit #3 Application was pulled from the *Virginia Oyster Gardening* guide

Thank You!

When buying seed, it's important for the oyster gardener to be sure that it comes from a hatchery that has the best available brood stocks. You should try to obtain oysters with a proven record of good growth and survival in areas where disease is prevalent. While disease tolerant oyster lines have been developed, it is unlikely that a fully disease resistant oyster will ever be produced.

Vendors for oyster seed and containment systems change frequently but you should be able to locate one close to you, no matter where you are along Virginia's coast. See Reference C on page 24 for Web site addresses for the Tidewater Oyster Gardeners' Association (TOGA) and the Chesapeake Bay Foundation (CBF). The TOGA web site lists many vendors for seed and gear. TOGA's site also provides contact information for Master Oyster Gardeners (MOGs). You may want to contact a MOG near you for advice on the best seed and container sources, as well as for advice on oyster gardening in general. The CBF web site also gives you a list of suppliers organized by geographic region within Virginia and some, out-of-state mail order suppliers.

What will it cost?

You could spend anywhere from $60 to $140 to start your garden. It all depends on the size of seed, the type of containment system you buy and how many oysters you want to grow. For the most up-to-date information and prices, go to the Web sites for CBF and TOGA listed on page 24 under "Oyster Gardening Web Sites."

A bag of 1000 seed oysters can cost from $25 - $60. The larger the seed you buy the more expensive it will be. But the upside is you will not need to use small mesh bags, predation from crabs will be less of a problem, and the oysters will be large enough to eat sooner. Some suppliers will even ship the seed to you.

An assembled oyster cage. Photo courtesy of TOGA.

A bag of 1000 oyster seed of varying sizes. Photo courtesy of TOGA.

Your containment system costs will probably be the more expensive part of your garden. On the high end of costs are prefabricated Taylor floats. They can cost $80 to $115 for 2'x3'x1' or 4'x6'x1' floats. Plus, you will have to buy mesh bags for your small oysters. However, if you can build a float yourself, the Taylor float materials should only cost about $50-$60. But be careful to construct it properly so that it doesn't sink. You will need hand tools such as a pig-ring tool, a wire cutter, a saw for cutting the PVC pipe and a method for bending the wire mesh. TOGA conducts an annual float-building workshop in September where you can learn to build your own floats.

Floats, bottom cages and hanging cages smaller than the Taylor float cost from $30 to $60. In addition you will need to buy about 6 mesh bags at $4-6 each. You will start your oysters in 2 of the bags with the largest mesh that will retain the spat you purchased, and eventually move them into the other 4 bags as they grow. So if you start with 1000 seed oysters, you'll end up with about 250 oysters in each of the four larger bags.

Growing oysters in mesh bags alone may be the least expensive option. You can buy a $40 mesh bag kit with one bag having small mesh size for small seed oysters and five bags with large mesh size for use as your oysters grow. Each 2'x3' bag will hold 200 harvest-size oysters and you supply the 2-liter plastic bottles to use as floats.

It may cost more to produce oysters in your garden the first year compared to buying them in the store, but, don't forget you are adding filter feeders to Virginia's waters and a "nursery" where tiny fish can hide, and you can go out and harvest your oysters whenever you like!

Contact information for hatcheries that provide oyster seed or "spat," can be found at the Tidewater Oyster Gardeners Association (TOGA) "Spat Center" at: *www.oystergardener.org/#!spat-center/c845*

Step Five: Set Up, Maintain and Harvest

Set up

Most people find setting up and maintaining an oyster garden quite easy and enjoyable. By setting up your oysters in containment systems suspended above the bottom, both the quantity and quality of the food available to the oyster is improved and you've generally made life easier for them.

There are no strict guidelines regarding the best position in the water column to place the oysters. Often raising the oysters as little as 6 inches above the bottom is enough to reduce the amount of suspended sediments which they must filter and this improves their growth rates. Most people find it convenient to tie their containment systems to their dock as in the photos on pages 10 - 12. Keep in mind performance is site specific and depends on water depth, food availability, predators and presence of disease.

Placement of oysters in racks or bags in the intertidal zone can have advantages which include easy access to your oysters at low tide, fouling control, and predator protection. However, extended exposure out of the water reduces the feeding time available for oysters and reduces growth rates. If intertidal culture sites are used, oysters should be placed in the lowest depth of the intertidal area as possible to reduce exposure to extremes of heat and cold.

The steps below are for growing oysters in a Taylor float. However, the basic approach can be adapted to mesh bags and cages:

1. Secure floats in the water with lines or other means to keep them in place but allowing for tidal and storm surge flow. Try to place float(s) in a low wave action setting.

2. Place 3/4" (20 mm) seed oysters in bags with the largest mesh to retain them at a density not exceeding 1000 oysters/bag in Taylor float. (Numbers will vary in other floats.)

3. As the oysters grow, move them to the coarsest mesh bags or liners available that will retain them. Densities within a 2 ft. x 3 ft. float should not exceed 1000 small or 500 market size oysters. Some growers prefer to keep oysters in 3/8" - 1/2" mesh bags throughout the growing cycle. If this is done, densities should be reduced to about 200 oysters/bag, but you will experience slow growth rates due to restricted water flow.

Maintain

Maintaining an oyster garden is a little like caring for a vegetable garden, although many find it easier. But like vegetable gardening, it's a good idea to stay on top of things and check on your oysters regularly.

The containment system should be cleaned periodically when fouling reduces water circulation through the mesh or liner. The cleaning schedule will vary according to conditions in your area, but usually every 3-4 weeks in winter and every 2 weeks in summer is sufficient.

Fouling (growth of small organisms) on floats, bags, and oysters can be removed by washing with water (fresh or salt) and scrubbing with a stiff brush. Also, allowing your float or bag to air dry on land for a day can kill many fouling organisms. Clean algae off your float or bag so that the mesh does not get clogged and smother your oysters. In some locations the settlement of barnacles, mussels, and even oysters onto the floats can be a problem, since these are not easily washed off. Please wear gloves and relevant protective clothing while handling your oyster shells or floats in order to prevent waterborne illness, cuts or infections.

Parasites, such as flatworms (see page 23), can kill your oysters. If detected early enough, these animals can be removed using a brine dip. A brine dip should be used only with oysters greater than 10 mm. Smaller oysters will die from the procedure. Leave oysters (>10mm or about 1/2 an inch) out of the water for about one hour before dipping to ensure they are closed. Make a brine solution by dissolving 25 pounds of salt in 10 gallons of estuarine water (plastic trash cans work well). Leave oysters in the bags and dip and agitate each bag for five minutes. Leave the bags out of the water for another hour or two then rinse them thoroughly before placing them back into the water. The amount of time that oysters should be left out of the water will depend upon

This fouled float has filamentous algae, sea grapes and barnacles on it that can be removed with freshwater, a brush and scraper, or by allowing the float to air dry and then brushing/scraping them off. Photo by Brian Wood.

their size and the weather conditions. If cleaning small oysters on a very hot day, the times given above should be reduced.

An alternative to the brine dip is to simply raise the bags above the low water mark so they are exposed to the sun at low tide. This method should also kill the flatworms but not the oysters. Occasionally flipping the bags over in the water can help to control fouling and improve water flow to the oysters. Make sure oysters are spread evenly in the bag, allowing all oysters space to feed and grow.

You may occasionally find dead oysters in your containment system. You should remove the dead oysters. However, clean, empty shells provide "nests" for beneficial small fish such as blennies and gobies so don't throw them out! One of the benefits of your oyster garden is the habitat it provides for other animals, so do what you can to help out the welcome visitors to your garden. See pages 22 and 23 to learn about the animals that will be attracted to your oyster garden.

If a storm is coming, be sure lines are secure and your name and address are on your float. Use a waterproof sharpie marker. During more intense storms – hurricanes, tropical storms and northeasters – it is best to take your floats out of the water and store them in a safe, cool and dry place. The oysters will be fine out of the water for 1-2 days. The larger the oyster, the greater its ability to withstand being out of the water.

To eat or to donate?

With luck and a "Blue Thumb," you should have oysters ready for harvest within about 12-18 months. Of course, like any form of gardening, you should expect some mortality and will probably not be able to grow all of the seed you purchased to the peak, 2 ½ - 3 inch size. Large oysters should be moved to separate containment systems so that any remaining, smaller oysters will have less competition for food.

Below are some considerations to guide you whether you choose to eat your oysters, donate them to a sanctuary reef, or simply release them to public waters. No matter what your choice, you can be proud of your accomplishment in raising your oysters and providing a small "cleaning" service to Virginia's coastal waters and "housing" service to other small marine creatures needing places to feed, hide and "nest."

Eating your oysters

For the gardener, the size at which you eat the oysters is up to you since regulations limiting harvest size for wild stocks

Fried oysters with caper sauce made with oysters from Jeff and Marianne Donahue's oyster garden. Photo by Laura McKay.

do not pertain to cultured oysters in Virginia. Rapidly grown oysters tend to have thin shells and a high meat content, so they should be easy to open and tasty.

Since oysters filter their food from large volumes of water, they not only concentrate algal food in their gut, but they also concentrate some portion of any bacteria and viruses present in the water. Even if your oysters are located in approved waters, if a heavy rainfall has just occurred it would be wisest to wait 2-3 days after the water clears to harvest them. Delaying harvest will provide the oysters time to pass most bacterial contaminants through their digestive tract.

No one wants to make someone sick, but if you handle oysters in the warm weather months you should be aware of Vibrio bacteria and how to minimize their growth as you handle shellfish during and after harvest. Vibrios are a group of bacteria, some of which cause illness in people who eat raw oysters or undercooked oysters. In some cases, people with certain health conditions are at risk from a particular kind of Vibrio (V. vulnificus), which can cause severe illness or even death. There are several types of Vibrio bacteria that live naturally in Virginia shellfish harvest waters and are not associated with contamination. These bacteria tend to die back during the winter months, but begin to grow as the water warms above 50-55° F (10-13°C) in the spring. Shellfish concentrate these bacteria from the water, and if the shellfish are not placed under refrigeration and cooled quickly after harvest, the bacteria that have accumulated can multiply at alarming rates. Therefore, it is important that shellfish be placed in refrigeration below 50° F (10°C), or iced, as quickly as possible after harvest.

For more information on Vibrio, go to the Center for Disease Control web site at *www.cdc.gov/nczved/divisions/dfbmd/diseases/vibriov/.*

Stories from Oyster Gardeners

Donating Your Oysters

In some areas you can donate your oysters to sanctuary reefs where the oysters cannot be harvested and are left to serve as brood stock and habitat for other marine creatures. The Chesapeake Bay Foundation (CBF) holds "Oyster Round-Ups" at various locations throughout Virginia from mid-July through mid-September where you can donate your oysters. Please pre-register for the Oyster Round-Ups on the CBF website: *www.cbf.org/how-we-save-the-bay/programs-initiative/hampton-roads-virginia/oyster-restoration/oyster-gardening/returning-gardeners-round-up-registration*.

Another option, if you have hard, sandy bottom nearby, is to place your large oysters on the bottom. Eventually you may be able to build an oyster reef. You could put your clean, empty shell on the bottom as well. Huge oyster reefs along many of Virginia's shorelines once provided protection from erosion by breaking the wave energy before it hit the shore. These reefs create a "living shoreline" where plants and animals can thrive. A living shoreline is of far greater ecological benefit than a bulkhead or rip rap and under moderate to low wave energy conditions can provide the same protection from erosion.

Volunteers with the Chesapeake Bay Foundation spread a crop of oysters on a protected reef in Virginia Beach's Lynnhaven River. Photo courtesy of CBF.

Photo by Brian Wood.

***"Children** love oyster gardening! Oysters attract a microcosm of aquatic life and teaching children about the ecology of oysters is one of the most gratifying aspects of oyster gardening."*

- Jackie Partin,
TOGA

George Miller working with oysters from his oyster garden on Nanci Reeves' dock. The Millers work cooperatively with the Reeves on their oyster gardens. Photo by Maryethel Miller.

***"Ten** years ago, my wife and I took the TOGA oyster gardening course at VIMS. We learned all about the process of growing oysters, and built our first Taylor float with the assistance of the TOGA instructors. We then started growing oysters under our dock on Whays Creek off the Great Wicomico River. Since then, we have added seven more Taylor floats, and we now plant 2000 oysters every year. Oyster gardening has been the perfect hobby for us. It has given us the chance to grow oysters both to eat and to plant in our oyster bed that we lease from the state, and it has enabled us to contribute significantly to the health of our creek. We also have enjoyed teaching our friends and colleagues at work about the fascinating process of oyster gardening. Thanks, TOGA!"*

- Ted Ellett

***"After** our son completed his Virginia Tech masters thesis on oysters, we decided it was time to get into the fun! Not only do we feel as if we are helping the environment in a small way but learning about the oyster is fascinating. What a great and rewarding experience it has been, to say nothing of the delicious meals!"*

- Maryethel and George Miller

"My wife and I own a home in Irvington VA and have been oyster gardeners for over ten years. I have learned a lot about our most famous bi-valve,...enjoy sharing them with friends who visit, and being a mini-expert about how to grow them plus their value in purifying the water. I have written two magazine articles on the subject and gotten at least four friends to take up the hobby; not a lot of work or expense, tasty to eat, and something that is fun to share with others".

- Marshall Orr

"I have been oyster farming on the Rappahannock in Urbanna, Virginia for nine years for my personal (and friend's) consumption. I currently have 500 oysters in my seed float and 300 larger oysters in two other floats. I usually average about 500 oysters at any one time and estimate that over the past nine years, my oysters have filtered over 80 million gallons of Rappahannock river water. If everyone that had river front property would raise oysters as I do, the bay would be crystal clear again!"

- Mark Mikuta

"We got our first oyster spat at the TOGA Workshop in Christchurch 7 years ago. Once we realized how fast they grow, we were hooked! We set them out to grow in April and we ate them for New Year's – just 8 months

Jeff Donahue and daughter Ellie Boyd with their Taylor float. Photo by Laura McKay.

Mark Mikuta displaying some of his oysters from his float (on the right). Photo by Sherry Mikuta

later. Roasted Oysters Rockefeller is one of our favorite ways to eat them. We've taken them from our river house in Lancaster County to our friends and family in Richmond, the Outer Banks, New Jersey and Cape Cod – they've become quite famous!

We put all the shell back in the water and now after all these years, we're getting some spatfall on the shell and some of the oysters out there are now 5 years old. The river otters have been enjoying them too – they get the wild ones and then use our Taylor floats as their dining table. We know because they don't clear the "dishes" after they eat!

- The Donahue Family

Oysters from the Donahue family floats. Photo by Laura McKay.

Stories from Oyster Gardeners

*"**After** completing the Master Oyster Gardener Course in 1999, my goal has been to restore a self-sustaining oyster population along the shoreline at Bay Point in Poquoson. This would be my oyster garden. I implemented three strategies:*

- *Deploying oyster shell cultch to restore habitat as oyster reefs and beds.*
- *Recruiting natural seed using net bags and cages containing oyster shell cultch and planting the seed laden shell on restored habitat annually.*
- *Husbandry of disease tolerant brood stock oysters from local waters kept in cages to help populate existing habitat.*

Some of Julian Cox's brood stock naturals (wild oysters) kept in cages hanging from his dock. Photo by Brian Lockwood.

One of the numerous clumps of oysters present on the oyster reef along the shore line of Lyons Creek. The oyster reef supports a diverse and abundant population of marine life. Photo by Brian Lockwood.

Many large oysters, from 4 to 6 inches in length observed growing on the sloped shoreline oyster reef along Lyons Creek indicate a healthy oyster population. This oyster reef was likely populated with progeny from some of Julian Cox's brood stock oysters grown through oyster gardening. Photo by Brian Lockwood.

Primary habitat restoration was accomplished from 2000 – 2008. Since then, selected reefs expanded, recruitment and planting of seed on shell on restored habitat, and the husbandry of best of breed brood stock naturals continues. The abundance of oysters cleansing local waters and providing prime habitat for many other beneficial marine plants and animals has increased dramatically. From 2005 to 2008 my neighbor Brian Lockwood and I restored the oyster habitat and population along the Bay Point shoreline of Lyons Creek. Moreover, the sloped shoreline oyster reef help mitigate shoreline erosion caused by increased boat traffic and costal storms, and protect valuable wetlands. The ecological services provided by the self-sustaining oyster population in our gardens improve water quality for the benefit of all"

- Julian Cox

School Children Growing Oysters

Teachers are showing students that they CAN make a difference in our environment. Each year, Oyster Reef Keepers of Virginia (ORKV) provides schools in coastal Virginia with the opportunity to participate in a student oyster restoration program called "Schools Restoring Oysters to the Chesapeake." This program engages 8,350 students from 167 K-12 grade classes each year in a Bay-wide effort to restore the oyster population. As of 2013, 99,700 students have contributed a remarkable 6.1 million oysters to sanctuary reefs in Virginia. This project takes a hands-on approach to education, allows students to execute authentic science, is based on scientifically sound restoration strategies, and meets multiple Virginia Standards of Learning.

Each September, classes receive 2,000 baby oysters from ORKV and deploy them in Taylor Floats near their school. Each month, students visit their oysters and measure their growth rates and mortality and monitor the water chemistry. They clean and maintain their oysters and containers, and identify natural and human-induced actions that may impact oysters and water quality. At the end of the school year, classes transplant their oysters onto sanctuary reefs where they will spawn and provide offspring to revitalize future oyster generations.

By growing and transplanting oysters, students gain knowledge of ecology, oyster biology, and water quality.

Students transplanting oysters. Photo courtesy of ORKV.

They also get a chance to take part in authentic scientific research and learn field sampling techniques. In addition to academic skills, students gain a connection to our coast and an empowering sense that they have the ability to improve it.

Oyster Reef Keepers of Virginia provides teachers with a training workshop, oysters, water chemistry equipment, a Taylor Float, and classroom curricula and teaching resources, all for $200. Teachers interested in joining the program should contact Laurie Carroll Sorabella at Oyster Reef Keepers of Virginia at oysterreefkeeper@yahoo.com or at 757-460-1200, or visit their upcoming web site *www.orkv.org*.

Stories from Teachers and Students

***"I** love the Schools Restoring Oysters to the Chesapeake project. It's a great way to promote environmentalism, teach science, and have fun with the students."*

- ***Joleen Zackowski***, Granby High School in Norfolk

***"My** class is participating in Oyster Reef Keepers of Virginia's "Schools Restoring Oysters to the Chesapeake" program. By raising oysters, I have discovered that oysters provide great habitat for fish, shrimp, crabs and sponges. In the fall, my class found 23 different species that use our oysters for habitat. It's exciting to touch and hold the critters that we are helping. Next week, our class is going on a boat to transplant the oysters into the Lynnhaven River. I like it that when we raise oysters, we are saving the earth."*

- ***Quinn Carroll,*** 1st grade

***"There** is no better way to teach students how to live sustainably than to get their hands dirty raising oysters. They learn how they can get involved and make a positive impact in the world, in addition to learning science and math... This project is something that will stay with them and hopefully transform who they are and who they will become."*

- ***Melissa Follin,*** Glenwood Elementary School in Virginia Beach

Neighbors...

Clam Worm

This harmless polychaete worm (*Nereis succinea*) is often seen crawling on top of cultured oysters. It is 1 - 3 cm (1/2 - 1 inch) in length and looks similar to a centipede.

Grass Shrimp

This shrimp (*Paleomonetes pugio* and *P. vulgaris*) is the most common organism associated with oyster floats and does not pose a threat to oysters. They are primarily detritivores and feed on decaying animal or plant material.

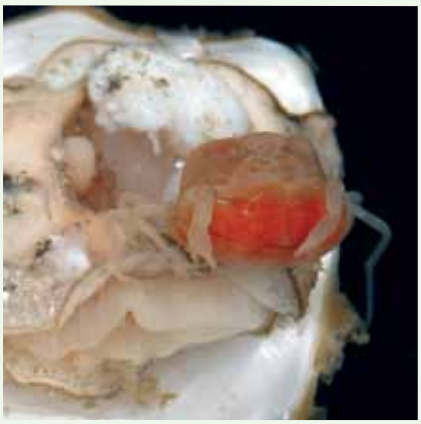
Periwinkle Snails

This snail (*Littorina littorea*) climbs up and down salt marsh grasses, where it feeds on small fouling organisms. Adding a dozen or so periwinkles to your oyster garden will help keep it clean.

Blennies, Gobies and Skillet Fish

Small fish, like blennies, gobies and skilletfish, love to visit oyster gardens where they can hide from their predators. Blennies nest in empty oyster shell.

Pea Crabs



These tiny crabs (*Zaops ostreum*) live inside the oyster, feeding on algae and often bits of the oyster gill, but they generally cause little harm to the oyster.

Hermit Crabs

Small, 1-2 cm (about 1/2 - 1 inch), hermit crabs (genus *Pagurus*) are no threat to oysters and can help keep your garden clean of fouling organisms that obstruct water flow. Larger hermit crabs are capable of eating smaller oysters.

Mud Crab

Several species of mud crabs (*Panopeous* and related genera) are very common to the oyster garden. This small crab may feed on your small oysters but is also in search of other prey such as Hermit crabs and Periwinkle snails.

Photo credits: Clam Worm & Pea Crab courtesy of Southeastern Regional Taxonomic Center/South Carolina Department of Natural Resources; Grass Shrimp courtesy of NOAA; Hermit Crabs, Striped Blennie, Barnacles & Mussels by Tim George, Virginia Aquarium and Marine Science Center; Sea Squirt courtesy of Melissa Frey, Royal BC Museum, Canada; Periwinkle Snail by Virginia Witmer; Mud Crab by K. Hill, Smithsonian Marine Station at Fort Pierce, FL; Blue Crab courtesy of Virginia Tidewater Oyster Gardeners Association; Boring Sponge, Mud Blister Worm and Flatworm courtesy of Virginia Institute of Marine Science.

Competitors...

Barnacles

These hard-shelled crustaceans that attach in large numbers can compete with oysters for space and food. Barnacles can be eliminated by air exposure if identified early enough, but large individuals must be physically removed with a scraper. Careful! Barnacles are very sharp.

Mussels

Mussels (blue mussel, *Mytilus edulis;* ribbed mussel, *Guekensia demissa*; scorched mussel, *Brachiodontes spp.*) may settle in your garden. Blue mussels are the most common. They do not pose a threat unless abundant and then they compete with oysters for food. Remove them when small by scraping.

Sea Squirts

Sea Squirts or Grapes (*Molgula manhattensis*) are commonly found in higher salinity waters and may be controlled by scraping or aerial exposure for 1-2 hours.

Predators...

Blue Crab

(*Callinectes sapidus*) a voracious oyster predator, may settle in your garden mid to late summer, growing rapidly to a size capable of consuming your oysters. Regularly inspect floats and bags and remove any crabs.

Flatworms

(*Stylocus ellipticus*) prey on small oysters in late spring or early summer. No larger than 25 mm, this worm is green, yellowish brown, or salmon colored. Flatworms can be devastating to a young oyster garden. The preferred treatment for flatworm is a brine dip. See page 16 for details.

Boring Sponge

(*Cliona celata*) filter feeders that burrow into and weaken shell (watch for series of holes with light yellow sponge tissue visible), usually affects 3-4 yr. old oysters in high (18+ppt) salinity. The sponge can generally be ignored, but severe infestation can make oysters unsightly and (rarely) cause mortality. A brine dip can control the sponge.

Mud Blister Worm

(*Polydora webstri*) blisters shell (look for yellowish sores in adductor muscle). Infection rarely causes death and oysters are edible, but blisters may interfere with shucking. Outbreaks may be reduced through a brine dip. See page 16 for details.

Oyster Gardening Websites and Contacts

Oyster Gardening

Virginia Marine Resources Commission- Shellfish Farming and Gardening - *www.mrc.state.va.us/Shellfish_Aquaculture.shtm*
Chesapeake Bay Foundation - *www.cbf.org/virginiaoysters*
Tidewater Oyster Gardens Association (TOGA) - *www.oystergardener.org/*

Oyster Restoration

Virginia Coastal Zone Management Program - *www.deq.virginia.gov/Programs/CoastalZoneManagement/CZMIssuesInitiatives/Oysters.aspx*
Virginia Institute of Marine Science (VIMS) Molluscan Ecology - *web.vims.edu/mollusc/index.htm*
The Virginia Oyster Reef Restoration Map Atlas - *web.vims.edu/mollusc/oyrestatlas/*
VIMS Oyster Monitoring Program - *www.vims.edu/molluscan_ecology/monitoring*
NOAA Chesapeake Bay Office - *chesapeakebay.noaa.gov/oysters/oyster-restoration*
Chesapeake Bay Program - *www.chesapeakebay.net/issues/issue/oysters*

Oyster Reef Ecosystems

Oyster Reef Communities in the Chesapeake Bay - CD-Rom - *web.vims.edu/mollusc/education/orccb.html*
Smithsonian Marine Station at Fort Pierce - *www.sms.si.edu/irlspec/Oyster_reef.htm*
Chesapeake Bay Program - *www.chesapeakebay.net/fieldguide/critter/eastern_oyster*

Teacher Resources

Virginia Institute of Marine Science –Advisory Services - *www.vims.edu/map/education*
Oyster Anatomy Laboratory - *www.mdsg.umd.edu/issues/chesapeake/oysters/education/anatlab/*
Bivalve Anatomy - *www.assateague.com/nt-bival.html*
TOGA School Resource - *www.oystergardener.org/#!education/c1l7*

Oyster Disease Information and Research

VIMS Oyster Disease Monitoring- *www.vims.edu/shellfish_pathology/monitoring*
Disease Resistant Oyster Research - VIMS Aquaculture Genetics and Breeding Technology Center - *www.vims.edu/abc*

Virginia Aquaculture

Virginia Aquaculture Association - *www.virginiaaquaculture.org*
East Coast Shellfish Growers - *www.ecsga.org*

Eating Oysters

Virginia Marine Products Board - *www.virginiaseafood.org/the_trade/foodservice/recipe.htm* (Great Recipes!)
How to prepare and open oysters - a quick web search - "opening oysters" - yields videos and by-step instructions

Permits

Virginia Marine Resources Commission (VMRC)
Shellfish Farming & Gardening:
www.mrc.state.va.us/Shellfish_Aquaculture.shtm

Habitat Management Division
Chip Neikirk
(757) 247-2254
chip.neikirk@mrc.virginia.gov

Conservation and Replenishment
James Wesson
(757) 247-2121
jim.wesson@mrc.virginia.gov

Water Quality

Virginia Department of Health
Division of Shellfish Sanitation:
www.vdh.virginia.gov/EnvironmentalHealth/Shellfish/
Robert Croonenberghs
(804) 864-7480
bob.croonenberghs@vdh.virginia.gov

Accomac Field Office:
Paul Widgen (757) 787-5864 x221,
paul.widgen@vdh.virginia.gov

Norfolk Field Office:
Jonathan Dickerson (757) 683-8461,
jon.dickerson@vdh.virginia.gov

Whitestone Field Office:
David Geeson (804) 435-1095
david.geeson@vdh.virginia.gov

Virginia Department of Environmental Quality
Water Quality Monitoring Data
Roger Stewart (804) 698-4449,
Roger.Stewart@deq.virginia.gov

Aquaculture Information

Virginia Department of Agriculture and Consumer Services (VDACS)
Aquaculture
T. Robins Buck (804) 371-6094,
robins.buck@vdacs.virginia.gov

Virginia Marine Resource Commission (VMRC):
Saltwater Aquaculture
Kathy Leonard (757) 247-2120
kathy.leonard@mrc.virginia.gov

Shellfish Growers of Virginia Association:
Mike Oesterling (804) 815-1316
mikeo@vashellfish.org
http://vashellfish.org

Extension Support

Virginia Institute of Marine Science (VIMS)
Sea Grant Advisory Services
Karen Hudson, (804) 684-7742, khudson@vims.edu

Oyster Gardening Organizations

Chesapeake Bay Foundation in Virginia
Virginia CBF Oyster Gardening Program
Tanner Council, (757) 622-1964, tcouncil@cbf.org

Tidewater Oyster Gardeners Association
awood45858@aol.com, www.oystergardener.org

Lynnhaven Now
Laurie Sorabella, (757) 962-5398, Laurie@LRNow.org
www.lynnhavenrivernow.org

School Oyster Gardening

Oyster Reef Keepers of Virginia
Laurie Carroll Sorabella, (757) 460-1200,
oysterreefkeeper@yahoo.com
www.orkv.org

Mailing Addresses

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P.O. Box 1346
Rt. 1208 Great Road
Gloucester Point, Virginia 23062

Virginia Marine Resources Commission
Habitat Management Division
2600 Washington Avenue, 3rd Floor
Newport News, VA 23607
(804) 247- 2200

U.S. Army Corps of Engineers
Norfolk District
803 Front Street
Norfolk, Virginia 23510
(757)-201-7500

www.deq.virginia.gov/Programs/CoastalZoneManagement/CZMIssuesInitiatives/Oysters/Gardening.aspx