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Oysters and Corn: Learning from Agriculture

There has been a precipitous decline in Mid Atlantic oyster production, with various groups attempting to identify causes and assign blame. However, it is instructive to veer away from traditional arguments to compare oysters with traditional agricultural crops for a different view of the problem and to create a vision for potential solution. Comparing production of oysters with other agricultural commodities lets us examine how those have been managed over time to increase production. The United States is considered a world leader in food production. Taking lessons from that development and applying them to oysters could help guide restoration of the industry that once flourished.

For decades, Maryland oysters have been treated as a farmed product. While true of private oyster production on leases, elements of the public resource were manipulated by state management agencies to enhance populations. Maryland's public oyster fishery, therefore, has elements of farming practices although the goal has more often been for social, rather than strictly financial, benefits.

Aquaculture Defined

The Food and Agriculture Organization (FAO) of the United Nations introduced a definition of aquaculture in 1988 to reduce confusion with capture fisheries: "*Aquaculture is the farming of aquatic organisms, including fish, mollusks, crustaceans and aquatic plants. Farming implies some form of intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators, etc. Farming also implies individual or corporate ownership of the stock being cultivated. For statistical purposes, aquatic organisms which are harvested by an individual or corporate body which has owned them throughout their rearing period contribute to aquaculture, while aquatic organisms which are exploitable by the public as a common property resources, with or without appropriate licenses, are the harvest of fisheries.*"[1]

This FAO definition introduces a social criterion, *i.e.,* ownership of the stock throughout the rearing period, to qualify as aquaculture. Stocking wild or hatchery-raised seed is aquaculture if the crop is owned by individuals or corporations until harvest but becomes a capture fishery if open access is provided for the public. Social issues relating to the use of traditionally communal waters for aquaculture have often led to political issues.[2]

Fisheries statistics are often poor but can provide trends for illustration. Maryland's public oyster reefs have been surveyed twice, first in 1912, and again in 1983. The 1912 survey estimated the acreage of natural oyster reefs at 214,772[3], while the 1983 survey estimated increased acreage at 329,977, mostly due to additions to the original oyster bar delineations of the 1912 survey. All areas should not be considered "prime" oyster ground as habitat destruction increased in recent years making it difficult to accurately determine the number of acres of productive oyster bottom. However, changes in production can be used to provide comparisons between oysters and other crops. Examples allow us to identify problems and how applying agricultural production techniques could help to solve our oyster crisis.

Factors Influencing Harvest

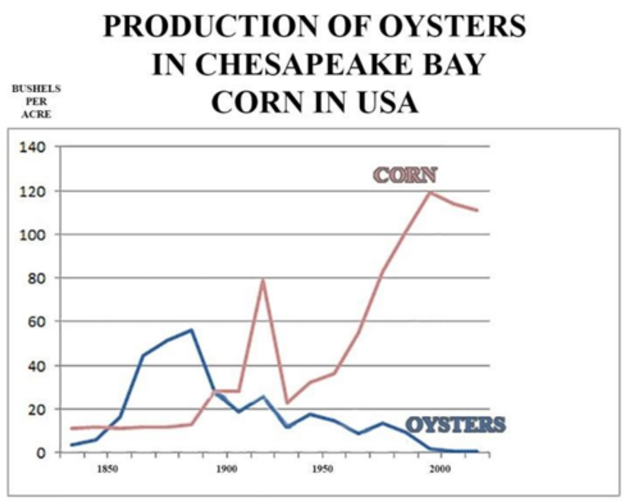
Maryland's oyster fishery has been characterized as "management by legislated inefficiency," by limiting the efficiency of harvest gear, separating gear types by zones, and

Towed oyster dredge   Photo: Don Webster

In 2009, Maryland's Governor supported an initiative to revise the state's century-long leasing program to spur the rental of portions of bay bottom or water column to raise shellfish. The first leasing program in Maryland began in 1830, with revisions in 1865 and 1906 but, during the past century, those opposed to leasing had supported restrictive laws that kept the industry small. The 2009 legislation deleted most constraints and created a program based on "active use" with the goal of attracting private investment to the aquaculture industry. New applications were accepted beginning in September 2010 and the program currently includes over 7,800 acres with 2,500 additional acres in the application phase. During the past eight years, lease numbers and acreage have continued to increase and the harvest has as well, while the public harvest has declined to very low levels.

establishing daily and seasonal harvest limits. However, advancements adopted by harvesters have made them more resourceful. Marine electronic equipment provided technological advancements while declining prices for these units made them available to even small boat fishermen. The approved use of power winders to raise hand tongs from the bottom has made this laborious task easier for harvesters.

A major change in harvest efficiency began in 2003 when the use of towed dredges was legalized, creating more efficient harvesting of remaining scattered populations. Many of those were previously left unworked because efficiency of the gear was low and did not return a profit per unit of effort. Power dredging has been shown to be a destructive harvest practice, but many Maryland harvesters believe it has created more successful natural reproduction. Scientific data does not support this and has documented the destruction of small oysters and the movement of important bottom substrate. However, many harvesters dismiss the science in favor of their opinions.[4]



The number of harvesters fluctuates widely based on perceived and actual harvest. In periods when the resource is stressed, there have been as few as 200 public harvesters. However, when two good spat sets increased the population, over 1,200 individuals were harvesting a few years later. This fluctuating pressure depresses populations and has been shown to destroy many small oysters that would otherwise be in the future harvest, due to the destructive action of towed dredges.

Crop Production Comparisons

Over the past century, agriculture has approached crop production by conducting research and applying technological improvements. Corn and oysters provide instructive comparisons, but with results going in different directions. The Maryland oyster industry can be characterized by distinct eras.

Era One, from 1860 to the 1930s, was a period when introduction of towed dredges combined with canning, early refrigeration and expansion of railroads westward created a harvest that peaked at fifteen million bushels in 1883, then declined steadily to about two million by 1930.

Era Two, from before WWII until 1983, saw fairly stable harvests between 2.3 to 3 million bushels annually. Disease epizootics, aided by poor biosecurity, then devastated the population to its current level, which has fluctuated between 100,000 to just over 300,000 bushels annual harvest. The movement of seed with disease organisms was based on the political effort of the harvest industry to obtain oysters for individual county waters, regardless of where they came from. Since natural reproduction was usually higher in areas with significant disease organisms, these were moved to locations where the diseases had not previously been a factor. Scientists and disease experts who raised concerns about this practice were ignored by resource managers during that period. When several years of drought raised salinity levels, massive mortality of oysters occurred throughout their range in Maryland.

Domestic corn production in the United States had similar eras, although with reverse trends. From 1866 until the late 1930s, it exhibited a flat yield that showed no improvement during that 70-year period. In the early 20th century, university researchers worked on genetic advancements that led to improved yields. This was known as "hybrid vigor" and, as the era of the Great Depression ended, farmers adopted corn varieties that had dramatically higher yields and had improved stress tolerance compared to former open-pollinated varieties. Development of inorganic nitrogen fertilizers, chemical pesticides and mechanization also drove annual yield increases.

Era Three began in the 1950s and has continued through today. It brought biotechnology that led to insect and herbicide resistance, higher-producing plants and computerized agricultural equipment. This move towards "precision agriculture" with intensive soil sampling used to produce spatial application maps led to variable-rate application of field inputs including lime, nutrients and herbicides and provided the move to another "quantum leap" in production.[5]

Commercial test plots for corn varieties

Lessons for Oyster Restoration

If we investigate areas where we can apply lessons from agriculture, we see there are some that are already in development but at early stages. However, there are lessons for using science to restore our public resource while increasing production through commercial aquaculture. These include:

Genetics

Improving oyster lines offers strong potential to develop disease resistance in the animals, as well as traits to produce high quality products, improve meat yields and create other features for specific markets. Lines and families have been produced for the Chesapeake and coastal bays to aid in surviving epizootics of known diseases. These have been accepted and used by many growers with future research planned that will lead to additional lines being developed for specific geographic areas.

Ground Mapping

Soil mapping has greatly aided agricultural productivity. However, it is easier to provide this on land than subaqueous areas. Some current soil scientists have mapped tributaries in Maryland, but the requirements for building oyster reefs are not well known or able to be calculated with significant accuracy.[6] This is important due to the need to stabilize bottom prior to planting seed oysters. These small animals must remain raised in the water column and not allowed to descend into mud so that they will live and grow. Current bottom stabilization is traditionally provided by planting of oyster shell but, with the processing industry in severe decline, available shell is a scarce and expensive commodity.

Planting Density

Better understanding of potential oyster bottom must be coupled with precise data on planting densities for optimum yield. These have traditionally been based on anecdotal information from planters who had made observations regarding their grounds in the past and extrapolated to other areas. The information may or may not have been accurate for all grounds. Planting density and yield studies are required to develop accurate scientific information for ground management.

Post-planting Mortality

Some data has been generated regarding yield after deployment on poor versus good grounds, but it is minimal and has required the use of diver-conducted surveys, which are expensive and time consuming for the data produced. Mortality on poor, *i.e.*, mud or sand, grounds can reach high levels in a short period. Developing methods to map large-scale areas quickly and cost effectively would greatly enhance profitability for growers.

Managing Disease

Lack of effective biosecurity led to disease epizootics of the 1980s and ultimate collapse of the resource. Disease management remains a principal challenge to creating strong natural populations and productive aquaculture grounds. Enhancing disease toleration of oyster lines, developing quick and affordable methods to identify disease levels and creating equipment to clear planting grounds of all animals at harvest, could aid in holding diseases in check and increasing yields.

Innovative Cultch

The substrate most used to restore reefs or develop leases has traditionally been oyster shell. This was formerly in abundance, being the product left after meats were removed during processing. Also, large tracts of fossil shell in the upper Bay were dredged and translocated to areas where natural repopulation might occur. In recent years, these upper Bay shell deposits have resulted in political battles over whether further dredging should be allowed due to the environmental damage that it may cause. In some instances, oceanic clam shell and stone have been used but these can be expensive due to transportation costs. New or innovative ideas for developing cultch are needed for restoration and aquaculture. This includes material for stabilizing bottom for planting as well as for use in setting tanks to produce hatchery seed. Another prospective investigation would be to search other areas of the Bay in which historic shell deposits are present and use those closest to the needed locations, to minimize transportation expense.

Production Equipment

Clearly, a beneficial factor for agriculture advancement was developing machinery for cost-effective ground preparation, planting, management and harvest. Currently, the state of technological improvement for aquaculture is poor. Vessels simply wash shell and seed overboard with no measurable planting density while harvests are done using towed dredges that are inefficient at removing all animals from the grounds and damage small oysters when used. While GPS equipment can be adapted to vessels, there is a need for more efficient equipment to prepare, plant and harvest oyster grounds.

Vessel washing seed overboard to plant grounds

New Management Structure

State resource management is usually conducted on either a Bay-wide or county basis, largely driven by opinions of local harvesters. Based on the current state of the resource, this has failed. Lease applicants are required to include a production plan that provides guidance on how they intend to manage their grounds. They must annually report what they have done and provide monthly harvest reports. This same practice should be required for any person, group or agency working on oyster development. The State should be mandated to produce a plan for each reef it seeks to manage as a public resource, as should county oyster committees attempting to manage reefs in their locations. If they are not able to do so or do not have funds committed to ensure continuing productivity, private individuals or companies should have the right to lease the area and place it in production using the same criteria that currently exists for leases.

Enforcement

Theft of farm products has not been a major problem in agriculture; however, it is a serious factor that has long plagued Maryland's oyster industries. Illegal harvest on public and private grounds will continue as long as the cost is too low to dissuade law breakers. While many laws and regulations have been passed to attempt control, problems still exist from harvesters who find that rewards exceed the potential penalties. During the 1960s and 70s, vessels and equipment of those illegally dredging were impounded and forfeited upon conviction. This placed a high economic cost on the lawbreaker and, as a result, it was not as great a problem as currently, when the resource is low and prices are high. Technology, in the form of electronic vessel identification systems, could be required to be on board any vessel using a towed dredge and mandated to be operational at any time it was in transit.

Processing and Marketing

Increasing annual oyster production will take a great deal of effort and require development of methods and equipment through science. Once the crop increases, the problem will shift to market penetration and development of processing technology. Oysters are currently sold in the shell for raw consumption or shucked with meats placed in containers and sold for cooking. There is room for both markets but processing will require ways to remove meats more easily than is now done manually. Mechanization has been tried but has been elusive. However, integrated research has been successful with agricultural crops and it can be used to develop machine processing in conjunction with breeding and selection and ground management research that would lead to more similar size and shape for the animals. With large crop expansion, food technology research could develop pre-packaged products or industrial-scale fast food items to increase demand for high quality oyster merchandise.

Summary

Parallels between corn and oyster production provide insight into areas requiring research and the benefits of pursuing these directions aggressively. During the past decade, the Maryland aquaculture industry has steadily grown while the public resource and its resultant harvests have declined. The fact that we have been unable to effect long-term, continuing increases in the public resource while private growers have been expanding their grounds, production and markets should point to the most beneficial means for returning oysters to a point of expanding commercial viability. Science can provide answers to many of the questions concerning oyster restoration. Increasing the growth of this industry would have long-term, positive benefits for economic and employment growth while significantly aiding the environment through enhanced biofiltration and nutrient cycling.

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Donald Webster

dwebster@umd.edu

Donald Merritt

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