Delaware Bay Oyster Culture – Past, Present and Potential Future

Early History

Delaware Bay has been a prolific source of the eastern oyster, *Crassostrea virginica*, since long before its discovery by European settlers. Large heaps of bivalve shells on the lands adjacent to the Bay attested to the utilization of the abundant supply of oysters and clams. In addition to their immediate use of bivalves as food, the indigenous people of southern New Jersey made items of trade from the bivalves, and these found their way considerable distances inland.

The first European settlers were quick to discover the oysters of the Bay and harvested these in increasing numbers, at first from the shallower intertidal areas and eventually from the deeper waters using tongs from small boats and dredges drawn by larger vessels. The settlers of both English and Dutch origin had a long tradition of using oysters as a high-value food item. Though the oyster of our waters was not quite the same as the common "flat" oyster (*Ostrea edulis*) with which they were familiar in Europe, these settlers were not disappointed with the species that they found to be quite abundant in Delaware Bay.

Indeed, the Delaware Bay oyster had some characteristics that made it even more acceptable as a food item. It could be consumed at any time of the year, while the flat oyster was quite unpalatable during the reproductive phase, since it retained the larvae in the gill chamber. The eastern oyster, often referred to as the "cupped" oyster, also had a much longer shelf life, provided it was properly handled and stored, making it suitable for distribution to areas more distant from the isolated shores of the Bay.

The oyster industry grew rapidly and the towns along the Delaware Bay grew with it. Oysters were the food of the common man. Oyster sellers hawked their wares on the streets of Philadelphia, Trenton and New York. They were, indeed, the hot dog vendors of their day.

Shellfish Biology

To better understand the oyster culture industry, a bit of basic bivalve biology is helpful. Oysters, and many other bivalve mollusks, are filter-feeding animals that use their gills to process large volumes of the water in which they reside, "pumping" into their mantle cavity hundreds of liters per day, extracting from it fine particles to be used as food. This transfer of large volumes of water with the outside environment also serves for the uptake of oxygen and release of metabolites. The oyster is ideally suited to life in the highly turbid waters of Delaware Bay, since it has highly developed mechanisms for sorting of the useful particles and rejecting the non-nutritive elements.

The reproductive capacity of oysters is another element that must be factored into the culture equation. Oysters have separate sexes, though even to the trained eye this is not easily discerned. Stimulated by rising water temperatures in the early summer, the

gonads mature to produce viable gametes, eggs and sperm. The larval oyster formed by the union of egg and sperm drifts through the water nourishing itself on the plankton-rich waters of the Bay. When it is about the size of a small speck of pepper, it settles to the bottom and searches for a clean, hard surface (cultch) to which it will cement itself. This attachment process is called setting, and the newly set oyster is called a spat.

Development of the Industry

The early harvesters of the wild oyster stocks in the lower portion of the Bay discovered by the early-1800s that the natural populations could be quickly depleted, thanks to the employment of larger vessels and perfected harvesting methods. These enterprising farmers of the estuary had a solution to this quickly depleted supply of marketable wild oysters. Many individuals were quite familiar with the practice of oyster culture that had a long history in Europe, and that had been applied effectively in the more northern estuaries on the East Coast.

Those first oyster farmers were aware of the large populations of small oysters that could be found in the less salty portions of the Bay and the adjacent rivers and marsh creeks. These oysters had negligible market value due to poor quality meats, and they took much longer to reach an acceptable size if left in these low salinity areas. These upper bay areas did offer an advantage to the oysters, since their survival was greatly enhanced due to reduced predation, less fouling and less competition for attachment surfaces, as well as lower losses due to parasites.

The early oyster farmers knew that these oysters - commonly referred to as seed stock – could be moved downbay to the better "growing grounds." The oyster culturist often improved these plots of downbay bottom by depositing shell or other hard materials, and marked their boundaries with clusters of small trees embedded in the bottom. Here, the small seed oysters could reach market size and develop acceptable meat quality within a year or two after transplanting.

These aquaculture practices, really a special branch of agriculture, required some societal recognition of proprietary rights to the oysters that had been collected by culturists and planted on the growing grounds. Once the culturists had developed these practices and policies, they formed producer associations that collected lease fees for the use of growing bottom. Later, the Cumberland County Board of Freeholders managed this type of leasing and controlled the use of the seedbeds to prevent abusive exploitation.

Eventually, following legislation in the late 1800s and early 1900s, the State established Shellfish Boards and later appointed Commissioners to establish policy and to manage industry operations. Fees collected under these various management systems were utilized for surveying the leased areas, to hire watchmen to curtail illicit harvesting, as well as for enhancement of the seed-producing beds. There was increased sophistication of the culture operations, construction of ever-larger vessels to move shells for cultch planting and to expedite harvest from the seed beds and leased grounds, and enhancement of the resource by an efficacious management policy. Annual production volumes often

exceeded one million bushels and occasionally volumes in excess of two million bushels were achieved.

As the market for cultured Bay oysters grew beyond the sustainable capacity of the seed beds, the industry began to import seed from Virginia (James River), where the price was often quite attractive. Paradoxically, rather large volumes of oysters harvested from the New Jersey planted grounds were shipped back to the large processing plants in Southern states - when the price was right and the supply from the Bay was in excess of the requirements of local markets.

The bulk of the production was shipped out of Bivalve to more lucrative markets in the large cities. Originally, shipping was done by water to supply New York and Philadelphia dealers. Soon after the end of the Civil War, the industry solicited the construction of a railroad to connect the port of Bivalve (Port Norris) with the expanding national railway network. This opened the market to places as distant as Chicago, St. Louis and San Francisco. Indeed, the establishment of populations of eastern oysters in West Coast estuaries such as San Francisco and Tamales Bays has been attributed by some to discarded oysters from delayed train shipments originating in Bivalve that were rejected by the West Coast buyer.

A Question of Product Quality

The oysters of the Bay have good shelf life. The process of dredging oysters does, however, introduce some conditions that could compromise their vitality, such as chipped shell edges and entrapment of bottom grit and mud in the shell (mantle) cavity. The industry addressed this problem by resorting to the process of wet storage – colloquially referred to as “floating” –, whereby the harvested oysters were first placed in wooden cages floating in the Maurice River at Bivalve. This process allowed the oysters to purge their mantle cavity and repair shell damage over a period of a few days prior to final culling and packing for shipment. This process enhanced shelf life and had the additional benefit of causing the oyster tissues to become plumper and more attractive due to uptake of water from the lower salinity environment, though this somewhat reduced the saltiness of the product.

This practice came to a sudden stop in 1925. In 1924 there was a widespread epidemic of typhoid fever in North America. Until that time, all cases of shellfish-associated typhoid had been attributed to oysters harvested from a few very polluted estuaries close to urban areas. Oysters are filter-feeders and even some unsavory fine particles, including pathogens such as the bacteria that cause typhoid fever, can be collected from the water and accumulated at very high levels in their tissues, creating an unacceptable risk for the consumer. Delaware Bay was, and still is among the estuaries on the East Coast least impacted by domestic sewage, since it is so far removed from large urban centers. The Maurice River at Bivalve, where oysters were traditionally “floated” prior to shipping, could not make such a claim, since there was a considerable input of untreated domestic sewage in the immediate area of these floating operations. Investigation of the shellfish-

associated typhoid cases resulted in an unequivocal indictment of this industry practice and the U.S. Public Health Service ordered it immediately and permanently discontinued.

Ironically, a beneficial result of this disaster was the development of a national shellfish sanitation policy that brought the entire American industry under a modern program, the National Shellfish Sanitation Program (NSSP), which scientifically addressed the special public health risks associated with the production, harvesting, processing, distribution and consumption of bivalve shellfish. Another change in commercial practice coincident with this disruptive event was a sharp increase in the quantity of oysters that were shucked at the point of landing. When the product was shucked immediately after landing, the packer/shipper was less concerned with compromised vitality due to the harvesting process. Shucked oysters packed in cans, having a smaller volume and weight, also cost considerably less to ship.

The Beginning of the Decline in Production

In recognition of the need to protect the seed bed resources from excessive exploitation, harvesting of oysters from those areas initially was limited in both scope and intensity by a requirement to use only use sail vessels for dredging or tongs in shallower waters. Following WW II this requirement was eliminated, allowing the use of engine propelled vessels on the seedbeds. This had some immediate, but very short-term benefits for oyster producers. The efficacy of the power dredge vessels and the reduced crew requirements made oyster culture even more cost effective. However, the ability to collect more seed, as well as utilize areas heretofore inaccessible to sailing vessels, led to a rapid deterioration of the seed beds. A compounding factor in the demand for seed resulted from the changes in regulations in Virginia, which restricted export of oysters from the seedbeds of the Chesapeake. This increased pressure on the resource caused a rapid decline in the annual output.

In 1953, Drs. T. C. Nelson and Harold H. Haskin of the Department of Oyster Culture, N. J. Agricultural Experiment Station, were asked to examine the problems confronting the industry. They initiated a long-term evaluation of the factors involved in the recruitment, maintenance and utilization of seed oysters and the beds. This led to the development of more rational policies to protect and enhance the seedbeds.

Slow gains in production, approaching one million bushels per year, were achieved through 1957. Then an unexpected disaster struck. Sporadic mortalities, often unexplained, had been noted in the past and tolerated by the industry.

Landings dropped to less than 10 percent of the previous 10-year average. This mortality was caused by a newly recognized parasite, first noted in dying oysters by Dr. L. A. Stauber of Rutgers University, and dubbed "MSX" (*"multinucleated sphere X")*. The scientific name of this parasite is *Haplosporidium nelsoni.*

It appears that some bay oysters have developed a considerable degree of tolerance to MSX as a result of many years of natural selection. Dr. Haskin embarked on a project to accelerate the genetic selection process by controlled breeding of survivors of the mortalities that occurred in the late-1950s. The progeny of these survivors exhibited significantly lower mortalities than the unselected native stocks, and each successive generation had measurable gains over their parents.

This project led to the development of an internationally recognized program of shellfish breeding that is currently a major component of the activities of the Haskin Shellfish Research Laboratory. This facility has worked closely with the producer community for over a century in collaborative research and development initiatives, and plays a key advisory role by conducting monitoring and stock assessment of oyster populations, using the data collected to assist in formulating management strategies, as mandated by State statute (Title 4:16-10).

An Unwelcome Surprise

In 1990, the industry planted about 160,000 bushels of seed and, due to excellent growing and fattening conditions, realized a very good return on this effort. In late summer of that year, a newly emergent parasite, "*Dermo*", or more precisely *Perkinsus marinus,* was found to be infecting and killing oysters in the Maurice River and the adjacent portion of the Bay. This parasite had long been recognized as the causative agent of high mortalities in southern oyster populations. Though it had in the past been noted in Delaware Bay, often associated with imported seed from the south, it had never resulted in excessive losses in the commercial oyster populations. Neither of these oyster parasites, MSX and Dermo, poses a risk to humans

A Change in Operational Strategy

Following the unhappy experiences of 1991 and 1995, management policies were revised to permit the direct marketing of limited quantities of larger seed oysters harvested from the seedbeds. As is also true for MSX, the Dermo parasite exhibits reduced virulence in the lower salinities of the upper Bay, resulting in considerably lower mortality on the seedbeds. This permits the oysters in those areas to grow to near market size with lower losses than would occur in the downbay leased grounds.

A policy of collecting a fee per bushel of oysters harvested from the seedbeds was established when the direct market program was initiated, and each harvest vessel was assigned an equal allotment of the calculated quota of market-size oysters available for harvest from the seedbeds, based on the results of an annual survey of the beds. The fees generated by the direct market program are dedicated to a fund used for enhancing seed bed production capacity. These monies are used to plant cultch (oyster and clam shell) on certain bottoms to favor recruitment of spat. They are also used to pay for the transfer of

seed from the beds in the extreme upper portions of the Bay to intermediate seedbeds where better growth conditions will permit achievement of market-size

Production Impediments and Potential Solutions

In response to the problems afflicting oyster production in Delaware Bay, the New Jersey Legislature passed a Joint Resolution in 1996, establishing a Task Force to examine all aspects of oyster production and make recommendations to address the key impediments. After 18 months of intensive examination of the available information, aided by input from the technical community, state administrators and the industry, the Task Force issued a detailed report, published by the New Jersey Department of Agriculture in 1999.

The biological potential of Delaware Bay to produce a prime quality oyster is well established, and that potential remains quite viable even in the face of some adverse natural conditions. It would not be overly optimistic to project a consistent annual production well in excess of 250,000 to 300,000 bushels; others have predicted even higher values. But to achieve this objective, it is clear that changes in both technology and the management strategy must be instituted.

The Critical Questions

This leaves the questions as to what can be done and what currently is being done to change the obvious downward trend in Delaware Bay oyster production. Poor recruitment on the seedbeds has encumbered the industry for many years. This can be addressed by taking actions to enhance recruitment by judicious supplementation and redistribution of cultch in key areas.

An alternative that has for too long been ignored by the industry is the utilization of the very high setting potential and consistent recruitment of spat in the intertidal areas of the Cape May shore of the Bay. It has long been recognized that this portion of the Bay typically harbors large broods of competent mature oyster larvae that set in phenomenal densities on any clean, hard surface in or adjacent to the intertidal flats. However, due to high predation, the overwhelming fouling that smothers the small spat, and the mechanical damage due to winter ice, most of these oysters never survive to market size.

In the past there have been a few oyster culturists that took advantage of this abundant recruitment by deploying various types of spat collecting systems on the flats or just off its edge. The operational protocol involved placing the cultch on the bottom immediately prior to the calculated setting period, and then moving the heavily spatted cultch prior to the onset of winter. Due to the current shortage of seed oysters, there has been a renewed interest in commercial development of this spectacular seed source

Another use for the intertidal areas of the Cape Shore is the intensive culture of a super-quality oyster for the high-end half-shell trade. In the early part of the 1900s, there were

Cape May oyster culturists who would purchase submarket-size seed oyster for "layout" on the Cape Shore tidal flats. This layout was done on prepared (screened or shelled) bottom to prevent the oysters from sinking too deeply into the shifting sediments.

In the 1940s, one enterprising operator acquired heavy wire trays and used these for seasonal growout and fattening operations. This location on the tidal flats has ideal water conditions for both growth and conditioning of the oysters, and by late fall a superb product is available. This tradition has in the last eight years been reactivated by a handful of culturists using more modern materials.

These operations have been producing a small quantity of the highly prized "cocktail" oysters that demand an exceptional price in the restaurant trade. The restricting factors for this type of culture are the severe winter conditions prevailing at this location, the periodic heavy fouling of the bags by mud accumulating worms, the high labor costs for maintenance of the culture system, and a limit on the use of such culture gear under current New Jersey land use regulations. However, most of these difficulties have been at least partially resolved by this small group of intrepid aquaculturists.

The Future

The most vexing question remains: What is the prognosis for redevelopment of oyster culture in the Delaware Bay? As clearly defined in the Task Force report of 1999, technical interventions to address most of the natural encumbrances are available, though some funding would be required to permit the application of some of these at an effective level.

The industry itself has already shown its willingness to share some of the financial burden by virtue of the fees collected for the oysters harvested from the seedbeds, which are dedicated to rehabilitation efforts. Considering the currently small net yields of most producers, this source of revenue is clearly limited for the foreseeable future.

Hopefully, future observers of the story of oyster culture in Delaware Bay will not be commenting on how disappointing it is that those who were in a position to revitalize the productivity of this outstanding natural potential had failed to heed the admonition of Horace, "*…carpe diem…,*" and had not grasped the opportunity to institute those measures needed to remedy a highly fragile situation when that opportunity was still available.

W. J. Canzonier, N J Aquaculture Association, 3/10/04; rev. 4/10/04