



Delaware Oyster Gardening and Restoration - A Cooperative Effort

A cooperative effort among the Delaware Center for the Inland Bays (CIB), the Delaware Sea Grant Marine Advisory Program, Delaware State University, and citizen volunteers is paying off for the Eastern Oyster, *Crassostrea virginica*. Eastern oyster populations that once flourished along the Eastern Atlantic and Gulf Coasts of the United States have reached dire levels, especially in the Northeast and Mid-Atlantic regions. This drastic decline began in the late 1800's as a result of overharvesting, habitat degradation, reduced water quality, and diseases.

Many regional economies in the United States once dominated by harvesting the Eastern oyster are struggling with the collapsed fishery. Oyster aquaculture is becoming a bigger part of the working waterfront where traditional wild harvest used to thrive. Farm raising oysters will likely be a more sustainable operation than fishing.

Although disease is an issue that may currently be the most limiting in terms of oyster production. The single-celled parasite *Haplosporidium nelsoni*, given the acronym "MSX," caused 90 - 95% mortality of Eastern Oysters in lower Delaware Bay in 1957. MSX resistance soon built up in the surviving members of the oyster population and is no longer considered a major source of mortality in Delaware Bay but may still cause problems in oyster populations elsewhere that have not developed this immunity. *Perkinsus marinus*, which causes the disease known as "Dermo," was first detected north of the Chesapeake Bay in 1990 and continues to cause mortality in Delaware oysters.

Oyster Aquaculture

Oyster aquaculture has benefits beyond supporting human economies and diets. Oysters increase water clarity and quality by filtering sediments and algae, and removing nutrients such as nitrogen and phosphorous. Oyster aquaculture can provide many of the same ecological services as oyster reefs, which are a valuable component of estuaries worldwide, serving as a unique habitat for many ecologically and economically important species. Research focusing on the ecological effects of oysters raised with commercial aquaculture equipment is becoming more prolific as the industry moves away from a wild harvest fishery to a cultivated product such as one conducted by Dr. Gulnihal Ozbay, Delaware State University, and her lab personnel at Delaware Inland Bays.

Measuring biodiversity in and around the equipment is one of the only ways to evaluate the impact of these culture operations on the ecosystem in a holistic way. Unlike some finfish farming, rearing shellfish in high densities in shallow water can have positive effects on the environment and may promote biodiversity. In the Delaware studies conducted around the submerged aquaculture equipment, they found - 2006; 17 species showing significantly greater abundance and richness than in adjacent low-profile oyster shell reefs. 2007; 14 species around the equipment vs. the eutrophied, turbid, soft-bottom lagoon (including 3 species that require oyster shells for spawning substrate). 2008; 49 species of fish and invertebrates along with 8 species of macroalgae greatly contributing to the diversity of the native ecological community.



A crew of volunteers loading shell bags with oyster spat onto a pickup and flat bed. There are typically 2-3 workshops per year for all oyster gardening volunteers where they learn about oysters and their care along with maintenance of the floats.

In Virginia, 45 species of macrofauna were recorded inhabiting one commercial oyster farm that used floating equipment. In a study in Rhode Island, species richness

was significantly greater in submerged aquaculture equipment than in a nearby seagrass bed or an unvegetated sand flat, especially for fishes and invertebrates in their early life stages, demonstrating the equipment may benefit some species more than others. These studies are critical to understanding the complex ecological interactions that occur and will allow farmers, managers, and regulators to fully appreciate the consequences of their actions.

Oyster aquaculture strictly for restoration purposes has been gaining popularity in recent years. Many states have responded to this decline with the development of oyster restoration programs. It has become a common activity among estuary programs to help restore oyster populations for their ecological and commercial contribution to the health and viability of estuaries. Delaware's coastal lagoons, known locally as "Inland Bays," have been experiencing the impacts of sustained nutrient input and sediment erosion resulting from several decades of development within the watershed. The cumulative impact of these anthropogenic effluents has degraded water quality and reduced the diversity and abundance of various species of fishes, invertebrates, and submerged aquatic vegetation. Oyster gardening programs occur in almost every state on the East Coast, many of which, including the one in Delaware, have been modified from a similar program developed in the Chesapeake Bay.

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Oyster Gardening

Oyster gardening is the nursery culture of small, hatchery-produced oysters, called “seed” or “spat” to a larger “juvenile” size. This larger size is preferred for stocking artificial oyster reefs and for other shellfish restoration projects. Citizen volunteers involved in oyster gardening programs are growing oysters noncommercially in their backyards, or at least in the estuaries, rivers, and canals of the Delaware Inland Bays. The Oyster Gardening Program allows volunteers to grow oysters near the surface of the water. This affords them excellent exposure to oxygen and phytoplankton as their food source, and helps produce big, healthy mature oysters for restoration in Delaware. The structure of the garden also affords some protection from predators that can feed on young oysters. After two seasons in this environment, oysters are planted in off-bottom sites such as rip rap.

The Oyster Gardening Program, initiated during the summer of 2003, is a cooperative effort along the waterfront of Delaware’s three Inland Bays: Rehoboth, Indian River and the Little Assawoman. Volunteer gardeners support the program by caring for small 0.25 inch spat attached to old oyster shell by holding them in baskets placed in Taylor floats tied to their docks. Oysters held off bottom in floating cage systems experience better conditions for growth than oysters grown on the bottom, presumably due to increased water flow and greater access to particulate foods so they reach a planting size of 1-2 inches much more rapidly than oysters on the bottom. Losses to predators are greatly reduced resulting in larger and hardier oysters for field planting and for other restoration work. During the 2006 summer season, volunteer oyster gardeners were growing oysters at 45 locations around the Inland Bays. During the 2007 season more than 150 volunteer oyster gardeners helped to grow oysters at over 95 locations around the three Inland Bays. In 2008, there were Taylor floats at 105 private docks in the Inland Bays.

Oysters used in the gardening program are hatchery produced using broodstock lines bred for resistance to MSX and Dermo disease. During early to mid-summer, the bags of oyster shells with fingernail sized spat are then distributed throughout the Inland Bays to the gardeners for grow-out in their Taylor floats until the end of the season in late October and November. From deploying oysters at locations all around the Inland Bays, it is apparent that oysters grow well throughout the estuary and that seasonal growth ranges from good to excellent depending on location. This includes the Little Assawoman Bay where native oyster populations no longer exist. Juvenile oysters produced by the gardening program are kept in the floats for two seasons to give them a chance to mature and spawn before transplantation to an oyster reef established at the James Farm or to other Inland Bay locations. “Prior to getting gardeners involved, the YSI 556 handheld multiparameter instrument is used to select sites that will sustain oyster growth. Using the YSI 556 instrument, we also obtain water quality conditions at the oyster gardening sites throughout the gardening season, from May thru November”, says Dr. Ozbay.

Besides their value to commercial and recreational fisheries, oysters, hard clams and other bivalve shellfish feed by filtering bay water to remove phytoplankton and other suspended particles. By serving as natural biological filters they perform an important ecological service



A Taylor oyster float attached to a pier in shallow waters.

to maintain water clarity and quality and to recycle nitrogen and phosphorous, two nutrients responsible for over enrichment of the Inland Bays. Oysters and the shell clusters they form provide habitat that attracts communities of small bottom dwelling organisms like grass shrimp and worms which in turn support populations of crabs, larger fish and other predators. Developing annually spawning adult oyster populations improves the potential for natural recruitment. Increased filtration of plankton by healthy shellfish populations can also help to keep Harmful Algal Blooms (HAB) from occurring.

Oysters, like all bivalves, by filtering phytoplankton and other particles from the water may increase photosynthetically active radiation penetration to the point where submerged aquatic vegetation can become reestablished and may help to remove excess nutrients in anthropogenically eutrophied estuaries and bays. Oysters and the fauna of their associated communities will continue to be an essential area of study as restoration efforts continue all along the East coast of the United States and will be important indicators of environmental quality as humans continue to develop, modify, and manipulate coastal environments. According to Dr. Ozbay, continuous nutrient and other water quality monitoring efforts along with expansion of oyster gardening programs must continue to restore condition once existing in Delaware ecosystems.

For additional information including specifications on YSI instruments, please visit: www.ysi.com/aquaculture

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