



CHESAPEAKE BAY FOUNDATION
Saving a National Treasure

REPORTS

Adding up the cumulative annual losses over the last three decades shows that the decline of oysters has meant a loss of more than \$4 billion for the economies of Maryland and Virginia. —NOAA



On the Brink: Chesapeake's Native Oysters

What it Will Take to Bring Them Back

July 2010

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ABOUT THIS REPORT:

Chesapeake Bay Foundation Senior Writer Tom Pelton and Fisheries Director Bill Goldsborough wrote this report, which is based on interviews with more than a dozen leading oyster scientists, scientific journal articles, data from Maryland and Virginia, and state and federal reports. The same data was not always available from both states.

COVER PHOTO: Dave Harp

On the Brink: Chesapeake's Native Oysters

What it Will Take to Bring Them Back

EXECUTIVE SUMMARY

For centuries, a vast network of oyster reefs fed the Chesapeake Bay's people, cleaned its waters, and protected its fish and crabs. The name "Chesapeake" means "great shellfish bay" in the language of the Algonquin Indians. But by the 1920s, dredging for oysters had removed three-quarters of the Bay's life-giving reefs. The surviving oysters were nearly eradicated in the second half of the 20th century by disease, pollution, and continued overharvesting.

Some have suggested it is now too late for the Eastern oyster, *Crassostrea virginica*. The introduction of an exotic oyster species from Asia was even proposed, but a five-year study by the federal government, Maryland, and Virginia concluded that was too risky and recommended, instead, a renewed focus on native oyster restoration.

There are important new reasons for hope for this keystone species. A bold new sanctuary program is being proposed in Maryland that provides the essential next step to oyster recovery. Recent research shows that oysters are developing resistance to once-devastating diseases, MSX and Dermo, especially in the southern Bay, where the diseases are more common. Oyster aquaculture is booming, providing a new way to bring shellfish back and stimulate the Bay region's economy. And, finally, the federal government has set an ambitious goal of restoring self-sustaining oyster populations in 20 Chesapeake tributaries by 2025.

Oysters are of paramount importance because they are a vital organ necessary for the Bay's ecological health, with each oyster filtering and cleaning up to 50 gallons of water per day. They are also critical for the region's economic health. The Chesapeake is one of the very few remaining places in the world where an industry still exists based on harvesting oysters from the wild. Over the last three decades, Maryland and Virginia have suffered more than \$4 billion in cumulative annual losses because of the decline of industries related to oyster harvesting. Harvests have fallen to less than one percent of historic levels. Rebuilding oyster populations would stimulate economic growth.

To research this report, the Chesapeake Bay Foundation interviewed more than a dozen leading oyster scientists, reviewed numerous scientific journal articles and reports, and examined data on oysters from Maryland and Virginia. Below are some of our key findings about the state of oysters in the Chesapeake.

- **DISEASE RESISTANCE:** Research suggests the increased prevalence of oyster diseases in recent decades is driving a natural selection process that is breeding tougher oysters, especially in the southern Bay. In Virginia's York River, fewer than five percent of oysters are dying from MSX today, while more than half were dying of the disease a decade ago. In Maryland, recently released state data show more oysters surviving diseases, suggesting more resistance. The average annual oyster mortality rate from disease in the state fell to 17 percent in the years 2005 through 2009, compared to an average of 29 percent for the years 1985 to 2004. Some of this increased survival also could be due to favorable weather conditions.

- **SANCTUARIES:** No-harvest zones are critically important for oyster restoration efforts. These zones protect three-dimensional reef structures that act as shelters and breeding grounds for fish, crabs, and scores of other life forms. Sanctuaries also allow maximum reproduction of oysters, which helps them adapt to disease and other environmental challenges. The expansion of sanctuaries will accelerate the development of greater disease resistance. Researchers have estimated that oyster reefs in sanctuaries provide 34 percent more economic value over a 50-year period than reefs from which oysters are traditionally harvested and sold. This is in part because protected reefs enhance the reproduction of fish, which can also be caught and sold. Maryland is taking a dramatic step in the right direction by proposing a more than doubling of its oyster sanctuaries to protect 9,000 acres, or about 25 percent of the state’s remaining reefs. Virginia has over 100 sanctuaries, but most are less than two acres, and a panel of experts has recommended a major expansion.
- **POACHING:** A problem that crippled smaller and more scattered sanctuaries created earlier in Maryland was “rampant theft of oysters in all areas of the state’s waters,” according to a state report. Nearly all of the state’s existing 34 sanctuaries have been victimized by poachers, a problem worsened by a more than 40 percent cut in natural resource police over the last decade. Law-breaking on the water is so common that 43 percent of the active watermen in Maryland were charged with violating the state’s commercial oystering and fishing laws in 2008, according to the Maryland Department of Natural Resources. Illegal harvesting is now seen as one of the biggest obstacles to restoring oysters in the Chesapeake Bay, the Maryland Oyster Advisory Commission concluded. To protect its new sanctuaries, Maryland plans to increase electronic surveillance and pursue heavier penalties. The Blue Ribbon Oyster Panel, a committee of oyster fishery experts in Virginia, also recommends stronger enforcement.
- **HABITAT RECONSTRUCTION:** A major obstacle to the return of oysters—even if they evade disease and dredge—is a lack of hard Bay bottom. Young oysters need to grow atop older oysters or other hard surfaces (which have largely been stripped away by harvesting or buried by siltation). Building elevated reefs with old shells and other materials appears to be succeeding in pilot programs. In Virginia’s Great Wicomico River, for example, more than 180 million oysters are reported to be growing and thriving on reconstructed reefs. Key lessons learned from this project include the necessity of elevating oysters out of the silt, and creating enough reef acreage to make reefs self-sustaining through reproduction. Planting oysters on construction rubble or concrete reef balls also works. Efforts to rebuild reefs cost money. All told, rebuilding the Bay’s oyster habitat and populations could cost \$500 million or more. This cost, however, may be smaller than the economic benefits of cleaner water and restored aquatic life.
- **WATER POLLUTION:** Yet another hurdle for oysters is pollution. Silt and sediment can bury oyster beds, and nitrogen and phosphorus pollution can cause low-oxygen “dead zones” from which oysters cannot flee. Even moderately low oxygen levels that do not kill oysters outright appear to increase their susceptibility to the disease Dermo. And preliminary experiments suggest that intermittently low oxygen levels common in shallow waters could also weaken oyster immune systems, compounding the disease problem. For this reason, efforts to control nitrogen and phosphorus pollution are important for the recovery of oysters.

- **AQUACULTURE:** In Virginia, aquaculture is growing fast, with the number of oysters produced multiplying more than 10 fold over three years. The growth of oyster farming in Virginia is likely to mirror the growth of the state's clam-farming industry, which is now the largest in the country, providing a total boost to the state's economy of about \$70 million a year. To encourage underwater farms, Maryland recently rewrote its laws and will now allow leasing on 95,524 acres of oyster bars. Aquaculture has the potential to grow in Maryland from nine farms employing a handful of people to 150 businesses over the next decade, creating \$25 million annually in total economic impact and 225 jobs.

Oysters can be restored to the Bay. To bring back a healthy network of reefs, the Bay states and federal government must take certain steps.

- Maryland and Virginia should create sanctuaries protecting approximately 40 percent of the Bay's historical oyster reefs, depending on how much is needed for reef sustainability in given areas.
- Maryland and Virginia should work with the federal government to invest sufficient funds to rebuild former reefs with enough shells, concrete, or other appropriate materials to establish successful reef communities.
- Virginia and Maryland should transition from a wild-harvest oyster fishery to an aquaculture industry by continuing to encourage oyster farming through training programs, fee waivers, expedited permit approvals, and start-up grants.
- Both states should boost law enforcement to keep poachers away from no-harvest areas and oyster farms.
- Most importantly, to reduce water pollution, Congress must pass the Chesapeake Clean Water and Ecosystem Restoration Act, which will impose legally enforceable limits on nitrogen, phosphorus, and sediment pollution, and threaten penalties to states that fail to meet these limits.

The "great shellfish bay" needs these actions. Without these steps to save oysters, the entire Chesapeake region risks the permanent loss of not only the Bay's shellfish, but also its health, identity, economy, and greatness.

HISTORY

Oyster reefs were once such a dominant feature in the Chesapeake Bay that visitors described them as both a wonder and a physical hazard. During a 1608 voyage of exploration, Captain John Smith wrote that the oysters “lay as thick as stones” in the Bay.¹ “The abundance of oysters is incredible,” wrote the Swiss nobleman Francis Louis Michel in 1701. “There are whole banks of them, so that the ships must avoid them. A sloop, which was to land us at Kings Creek, struck an oyster bed, where we had to wait about two hours for the tide. They surpass those in England by far in size, indeed they are four times as large.”²

After the Civil War, the invention of canning machines allowed oysters to be transported long distances by railroad without spoiling. This triggered explosive growth of the Chesapeake’s oyster-harvesting industry, which became the largest in the world by the late 19th century.³ Whole towns, such as Crisfield on Maryland’s Eastern Shore, grew from oystering,⁴ and were built upon the mountains of shells produced by shucking houses. But technology cut both ways for the Chesapeake Bay. The introduction of dredges—steel basket-like devices dragged across the bottom—and other destructive harvesting techniques⁵ ripped out about three-quarters of the Bay’s oyster reefs between 1860 and 1920.⁶ The peak of the shellfish harvest came in the 1880s, when about 50,000 oystermen⁷ were working the Bay, pulling out about 120 million pounds of oyster meat a year (or about 17 million bushels).⁸ Maryland’s oyster commissioner at the time, Dr. William K. Brooks, foresaw the precipitous decline that was to follow, and raised alarms about overharvesting. “Everywhere, in France, in Germany, in England, in Canada, and in all northern coast states [of the U.S.] history tells the same story. In all waters where oysters are found at all they are usually found in abundance, and in all of these places the residents supposed that their natural beds were inexhaustible until they suddenly found that they were exhausted,” Dr. Brooks wrote in 1891. “Our present system can have only one result—extermination.”⁹ The calls by Dr. Brooks and other scientists for oyster sanctuaries, limits on catches, and a shift to oyster farming were ignored, as legislators repeatedly bowed to an influential vocal minority of watermen who fought regulation, according to a history of oyster management.¹⁰



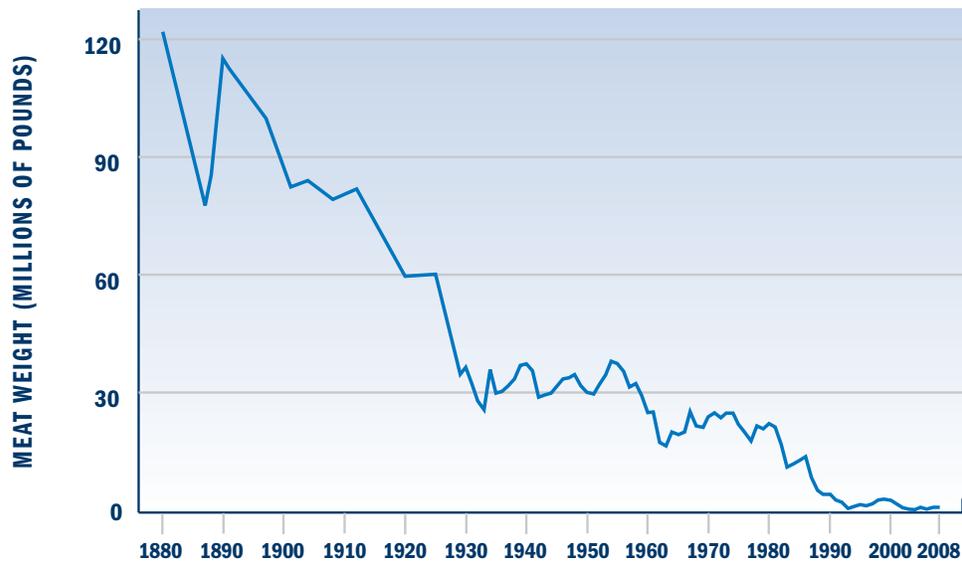
Three-quarters of the Bay’s oyster reefs were removed between the Civil War and the 1920s, leaving huge mounds of shells like this.



Source: Harper’s Weekly

Oyster dredging in 1884 on the Chesapeake Bay

**FIGURE 1
OYSTER HARVESTS IN THE CHESAPEAKE BAY, 1880 TO PRESENT**

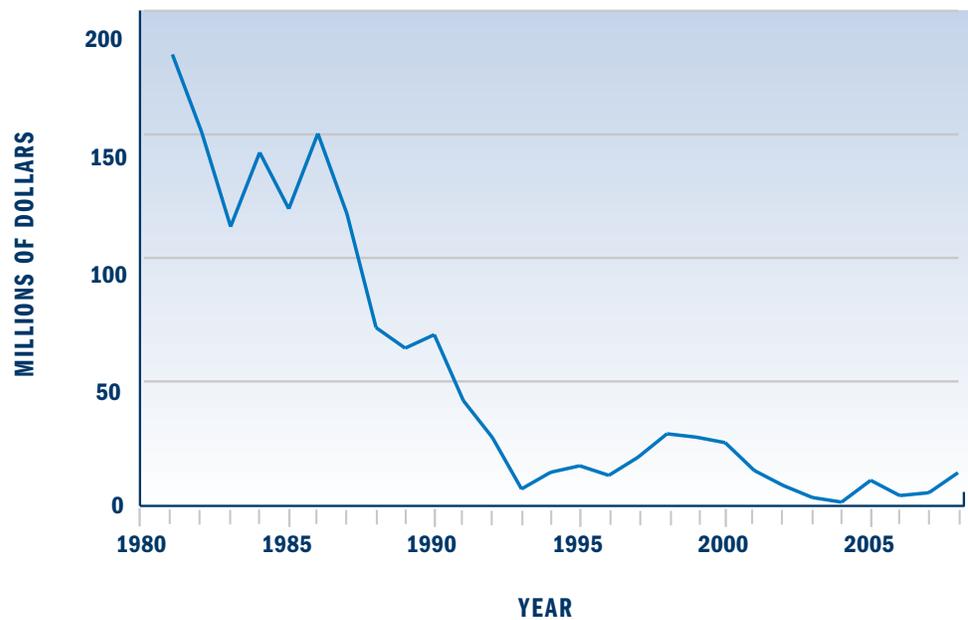


Source: NOAA Chesapeake Bay Office

Oyster harvests tumbled by two-thirds between the 1890s and 1930, but then remained relatively stable at a lower level until the 1950s.¹¹ Then a pair of diseases hit. MSX and Dermo are both caused by parasites that attack and frequently kill oysters, although they are harmless to people.¹² Compounded by continued overharvesting and pollution, these diseases devastated oyster populations in the Chesapeake. The losses to disease were especially severe in the 1980s, and have tended to be worse in Virginia than in Maryland because both parasites thrive in the saltier waters of the Southern Bay. But Maryland has also suffered, with oyster reefs in this state's portion of the Bay declining by about 80 percent in the last 25 years alone. During this time period, oyster harvests have fallen by 90 percent and the number of oystermen has plummeted by 75 percent.¹³ Harvests across the Bay today have fallen to less than one percent of their historic highs in the late 19th century.¹⁴

In 2009, there are only about 1,000 people¹⁵ in Maryland and Virginia with oyster harvesting licenses—roughly two percent the number of oystermen in the late 19th century. And many of those who have oyster licenses today are no longer active.¹⁶

**FIGURE 2
TOTAL ECONOMIC VALUE OF THE CHESAPEAKE BAY OYSTER INDUSTRY
IN MARYLAND AND VIRGINIA, 1981 TO PRESENT**



SOURCES: National Oceanic and Atmospheric Administration; U.S. Bureau of Labor Statistics; Dr. Douglas Lipton of the University of Maryland, College Park. Notes: All figures are in 2010 dollars, adjusted for inflation. “Total economic impact” figures include not only the dockside sales value of oysters, but also the value for restaurants, shucking houses, seafood dealers, equipment manufacturers, and others in oyster-related industries. Figures are only for Chesapeake Bay oysters, and do not reflect the sale of oysters from the Gulf of Mexico or elsewhere.

ECONOMIC DECLINE

As recently as the 1970s, oysters were a key part of the region’s economy, contributing an average of \$207 million a year in total business impact to Maryland and Virginia during that decade.¹⁷ This revenue helped not only watermen, but also restaurants, seafood processors, equipment manufacturers, boat builders, and others. By 2008, however, that economic impact figure had plummeted to about \$13 million for the two states. Adding up the cumulative annual losses over the last three decades shows that the decline of oysters has meant a loss of more than \$4 billion for the economies of Maryland and Virginia.¹⁸

One concrete example of devastation to the business community can be seen in the disappearance of oyster shucking houses, once common around the Chesapeake Bay. In 1974, 136 shucking houses were providing jobs in Maryland and Virginia. By 1990, that number had fallen to 48. Today, only about a half-dozen remain.¹⁹

The Chesapeake Bay is one of only two places left on earth—with the Gulf of Mexico—where an industry still exists based on harvesting oysters from the wild (and the Gulf has now been devastated by the BP oil spill).²⁰ Nearly everywhere else, oysters are produced in aquaculture farms.²¹ In France, England, the U.S. West Coast, Japan, Australia, and elsewhere, oyster reefs have been almost completely eliminated by overharvesting, pollution, and disease, with these diseases often the result of the introduction of exotic oyster species.²²

DISEASE RESISTANCE

MSX

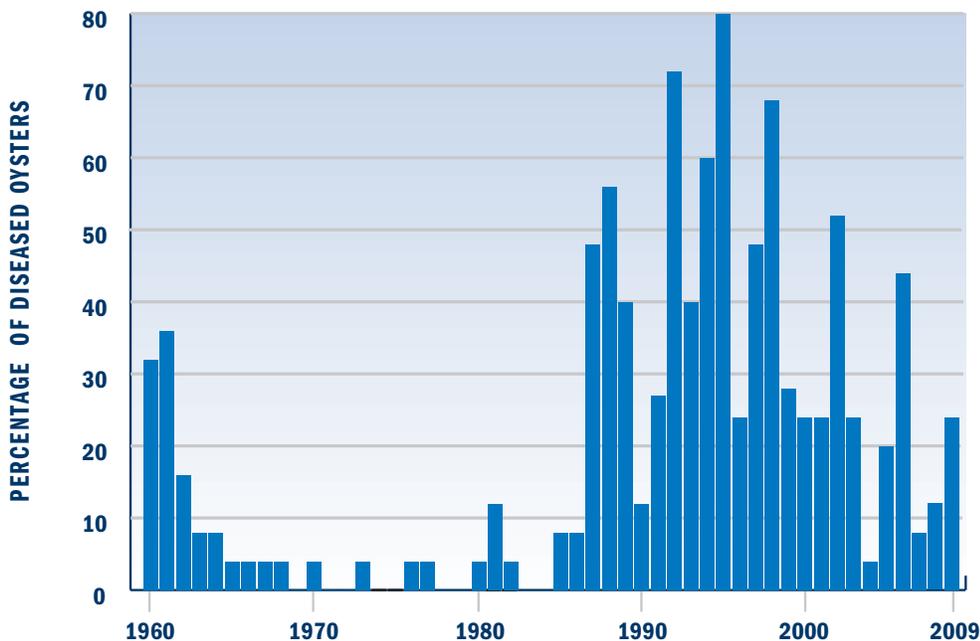
The protozoan parasite that causes the disease MSX, *Haplosporidium nelsoni*, is a species alien to the Chesapeake Bay. It was discovered in the Bay in 1959, killing oysters in Mobjack Bay, Virginia. The outbreak stirred much speculation about its origins.²³ Studies later suggested the disease was caused by an invasive species that hitch-hiked to the Chesapeake Bay on oysters from Asia. An analysis of the parasites revealed that they were nearly identical to those common in Pacific oysters of the species *Crassostrea gigas*.²⁴ In the middle of the 20th century, several oyster farmers attempted illegal plantings of these Pacific oysters in the Chesapeake and Delaware bays.²⁵ While the Pacific oysters failed to survive here, their parasites escaped and thrived, some scientists believe.²⁶ MSX attacks an oyster's gills first and can kill the mollusk quickly. As with the impact of any invasive species, local forms of life which had never encountered the parasites before had little defense against the new aggressors. Over several generations, the small percentage of oysters that survived tended to be those most able to tolerate MSX.²⁷ Disease resistance is genetically inherited, and the process of natural selection is producing increasing numbers of oysters that now can survive MSX, according to research by Dr. Ryan Carnegie, Research Assistant Professor at the Virginia Institute of Marine Science. "It's a form of natural selection, basically, which is a component of evolution," said Dr. Carnegie. "We are seeing selection for the resistant animals over the susceptible animals."



Dr. Ryan Carnegie
Research Assistant Professor
at the Virginia Institute of
Marine Science

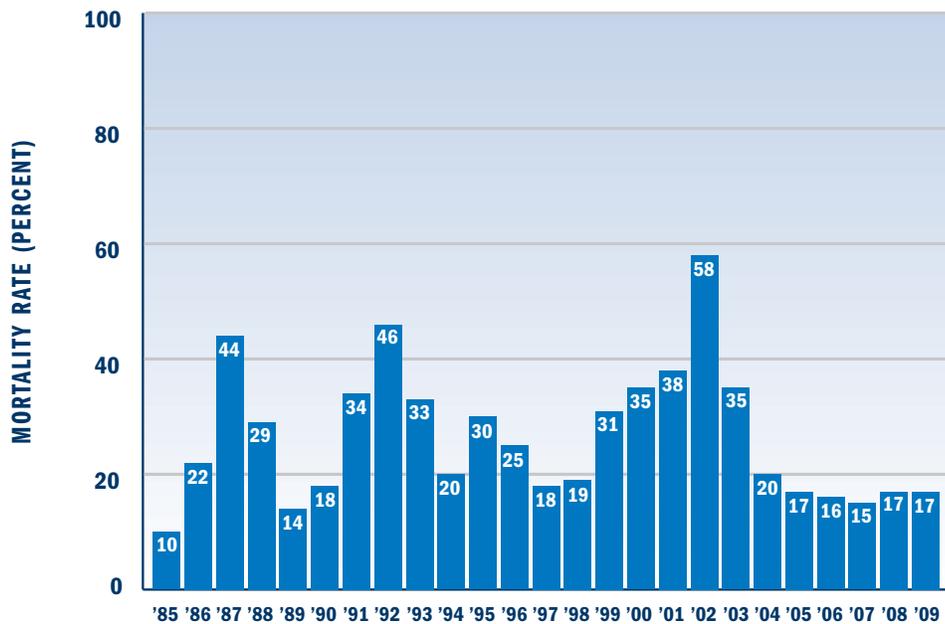
"It's a form of natural selection, basically, which is a component of evolution. We are seeing selection for the resistant animals over the susceptible animals."

FIGURE 3
MSX DISEASE PREVALENCE IN OYSTERS IN THE LOWER JAMES RIVER, 1960 TO 2009



Oysters sampled at Wreck Shoal in the James River. Source: Dr. Ryan Carnegie, Virginia Institute of Marine Science.
Note: Salinity changes as a result of rainfall can lead to large changes in disease prevalence from year to year.

**FIGURE 4
ANNUAL DISEASE-RELATED OYSTER MORTALITY IN MARYLAND**



Source: Maryland Department of Natural Resources. Note: Virginia does not calculate oyster mortality the same way.

In Virginia’s York River, for example, fewer than five percent of oysters monitored today are dying from MSX, compared to more than 50 percent a decade ago.²⁸ In the lower James River in Virginia, 80 percent of oysters were infected with MSX in 1995, but only about 24 percent in 2009.²⁹

DERMO

Dermo is a different kind of disease, both because its origins remain more mysterious and because it acts more slowly. Its parasite, *Perkinsus marinus*, was first discovered in the Chesapeake region in 1949 in the James and Rappahannock rivers.³⁰ It gradually weakens the oyster, and has been usually fatal over two or three years. Scientists first documented the parasite in the 1920s in the Gulf of Mexico, leading some to conclude that it also is an invasive species that was spread with the movement of oysters from the Gulf to the Bay for aquaculture. However, other researchers believe Dermo has always been in the Chesapeake Bay, but that the damage caused by the disease was worsened in the 20th century by harvesting pressure,³¹ pollution,³² and weather conditions.³³ Like MSX, Dermo thrives in saltier waters, meaning that the disease tends to spread more in drought years (when there is less rain and fresh water in the Chesapeake Bay)³⁴ and in the southern parts of the Bay, where the water has naturally higher salinity because of the proximity to the Atlantic Ocean. Dr. Kennedy Paynter, Director of the Marine and Estuarine Science Graduate Program at the University of Maryland, College Park, said that while Dermo caused large die-offs of oysters in the 1980s, over the last decade the oysters he has studied seem to be tolerating their infections with the disease, and no longer are dying of their infections with the parasite.³⁵ He studies parts of the northern Bay, where young oysters have been planted as part of restoration projects. “We haven’t seen significant disease-related mortality from Dermo in most restored populations in the upper Chesapeake Bay in 8 or 10 years. MSX mortality has also declined to a certain extent. The diseases have reduced their impact,” said Dr. Paynter. “They are still out there,



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In Maryland, newly released data from the Department of Natural Resources show that disease-related oyster mortality fell to an average of 17 percent annually in the years 2005 through 2009, down from an average of 29 percent in the years 1985 through 2004.³⁶ Some of the increased survival could be due to favorable weather and salinity conditions in the Bay.³⁷

Dermo remains a problem in Virginia. But in the Lynnhaven and Great Wicomico rivers in Virginia, the proportion of older, larger oysters with more serious Dermo infections has stabilized or decreased, suggesting that some level of disease resistance may have developed.³⁸ In other words, many oysters have the parasites, but are not dying from them.

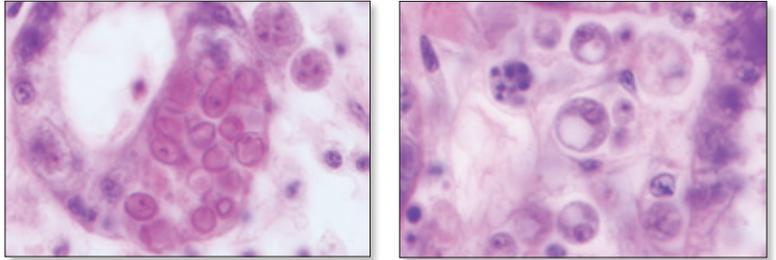
Paradoxically, the increased survival of oysters is not because the parasites are going away, but because the parasites are becoming more common.³⁹ More disease drives the natural selection process, creating more disease-resistant oysters. For example, researchers found record-high levels of the Dermo parasite in 2008 in the Upper James River, when prevalence reached 100 percent, according to a report by scientists at the Virginia Institute of Marine Science (VIMS).⁴⁰ “Increasingly intense parasite activity should favor the development of resistance, as susceptible oysters have fewer opportunities to reproduce,” reads the VIMS study. The report concludes that the growing disease resistance “is a basis for optimism” about the future of Chesapeake Bay oysters.⁴¹

SANCTUARIES

HARVEST IMPEDES NATURAL SELECTION

Harvesting oysters can undermine this natural process of building disease resistance. Older oysters—the ones that reach legal harvest size of three inches—are often the ones that have already survived the parasites MSX and Dermo, according to Dr. Sean P. Powers, Assistant Professor of Marine Sciences at the University of South Alabama.⁴² Survivors can produce millions of eggs, allowing them to pass on their disease resistance to the next generation. “The oysters that are left are not only surviving, but also putting out their small juveniles into the system,” Dr. Powers said. Allowing big oysters to be harvested when they reach the legal size limit preferentially removes the shellfish with the best genes. Among oysters not removed from the Bay, disease resistance has been growing.⁴³ And some scientists believe that this resistance would grow faster if the Bay-area states created large sanctuaries because these no-harvest zones would protect more of the resistant oysters and allow them to reproduce.⁴⁴ This enhanced disease resistance would probably occur more in the saltier southern Bay, because this is where the parasites are more common.⁴⁵ However, protecting the strongest oysters is also important in low-disease areas so the population can adapt to environmental conditions, such as change in salinity levels.

Dr. Mark Luckenbach, Director of the Eastern Shore Laboratory at the Virginia Institute of Marine Science, said “there is absolutely no question” that oysters continue to be over-



Source: Dr. Ryan Carnegie of Virginia Institute of Marine Science (VIMS).

Pictured above are oyster killing parasites Haplosporidium nelsoni, left, which causes MSX disease; and Perkinsus marinus, right, which causes Dermo.



Dr. Sean P. Powers
Assistant Professor of
Marine Science at the
University of South Alabama

“The oysters that are left are not only surviving, but also putting out their small juveniles into the system.”



Dave Harp



Before and after photos of oysters filtering water in a tank. Each adult oyster can filter up to 50 gallons of water a day.



Dr. Mark Luckenbach

Director of the Eastern Shore Laboratory at the Virginia Institute of Marine Science

“Every time an oyster raised its hand and said, ‘I’m resistant,’ we fished it, because it was one of the bigger ones. So that’s what the sanctuary provides—it hopefully eliminates fishing pressure, and therefore it reduces the harvest of those individuals in the population that happen to be the most resistant ones.”

harvested in the Chesapeake Bay and elsewhere, and that this fishing pressure is hurting their ability to develop resistance to disease. He said this is one reason why creating more sanctuaries is critical.⁴⁶ “Every time an oyster raised its hand and said, ‘I’m resistant,’ we fished it, because it was one of the bigger ones. So that’s what the sanctuary provides—it hopefully eliminates fishing pressure, and therefore it reduces the harvest of those individuals in the population that happen to be the most resistant ones,” said Dr. Luckenbach.

ECOLOGICAL BENEFITS OF SANCTUARY REEFS

Sanctuaries also provide many other ecological benefits. Because protected reefs are not knocked down by dredges and other harvesting equipment, they can continue to grow as three dimensional structures. These jagged conglomerations of shells are critical habitat not only for oysters, but also for fish, crabs, and other species.⁴⁷ And protecting reefs allows a higher density of oysters to persist, which helps the mollusks fertilize each other by being close to each other.⁴⁸ This means oyster reproduction rates rise. Most importantly, protecting whole networks of reefs enhances their resilience, because each reef can help to repopulate nearby reefs.⁴⁹

Oyster reefs are shelters for many forms of life. Reefs can have 50 times the surface area of flat bottom.⁵⁰ And a wide variety of animals—including worms, sponges, snails, sea squirts, small crabs, and baby fishes—live on the oysters or hide in the crevices from predators.⁵¹ Protecting oyster reefs is important for the same reason that it is important to protect forests: not only for the value of individual trees, but also because large groups of trees are the necessary habitat for bears, birds, and many other animals.⁵² Just as trees help clean the air, oyster reefs clean the water around them, with each adult oyster filtering up to 50 gallons of water a day, gobbling up algae, and removing dirt and nitrogen pollution.⁵³ By making the water clearer, oysters help sun light penetrate to the bottom, which allows aquatic vegetation to grow, adding oxygen to the water.⁵⁴ These underwater jungles, in turn, allow baby crabs, fish, and other creatures to survive by helping them to escape from larger predators.

ECONOMIC BENEFITS OF SANCTUARY REEFS

Moreover, sanctuaries have economic value. Because healthy shellfish reefs create cleaner water and encourage the multiplication of fish and crabs, they can play an important role in helping tourism, fishing, swimming, and recreation.⁵⁵ In terms of pollution clean up, scientists have estimated that the annual amount of nitrogen pollution removed by oysters in the Choptank River would otherwise cost over \$300,000 a year to remove by waste water treatment systems.⁵⁶

Researchers have calculated that protected oyster reefs are more economically valuable for their production of fish, than for harvested shellfish.⁵⁷ Fishermen can earn 34 percent

more money over a 50-year time span by catching the fish that feed and spawn on a reef than by removing the oysters and selling them.⁵⁸

PROPOSED NEW RESTRICTIONS

From 2004 to 2009, the U.S. Army Corps of Engineers, Maryland, and Virginia, studied several options for oyster restoration, including imposing a total moratorium on oyster harvesting in the Chesapeake Bay and the possibility of introducing an Asian species of oyster. In 2009, the states and the Army Corps rejected the Asian oyster idea, citing the risk that this exotic species could disrupt the Bay by bringing disease or causing other problems. Additionally, while a moratorium on harvesting native oysters would protect the most oysters, the states and the Army Corps decided the gain was not worth the hardship on watermen. Officials chose instead to increase efforts to restore the Chesapeake's native oysters, and rather than a moratorium, adopt a strategy of "more-restrictive oyster-harvesting management."⁵⁹

In December 2009, Maryland announced a major shift in this direction. Governor Martin O'Malley proposed a more than doubling of the state's oyster sanctuaries. Under the governor's plan, the protected areas would expand from covering 3,500 acres (almost 10 percent of the 36,000 acres of remaining living oyster reefs in Maryland) to protecting 9,000 acres (about 25 percent of the remaining reefs).⁶⁰ While this is a very positive step, even more protected living reefs would help the recovery of the Chesapeake's oysters that much more.⁶¹

FAILURE OF PAST EFFORTS

Past oyster restoration efforts have fallen short, in part, because most of the focus has been directed not on restoring the oyster population, but on helping the oyster harvesting industry.⁶² More than two billion oysters have been planted as part of government restoration efforts since 2000.⁶³ But over half have gone into open areas—including "managed reserve" areas—where watermen are allowed to harvest them after the oysters have grown large. These managed reserve areas provide some short-term water filtration benefits, but do not allow the growth of substantial reefs, enough reproduction, or genetic advances in the population. Creating permanent sanctuaries focuses on the long-term ecological value of oysters and less on their short-term economic value. "It does not appear that economic benefits alone can be used to justify the practice of harvesting oysters from reserves," a 2009 report for the Maryland Department of Natural Resources by Philip W. Jones and Brian J. Rothschild concluded.⁶⁴ "Restoration should begin with leaving natural oyster populations alone, creating sanctuaries, and enforcing harvest moratoria to allow populations a chance to naturally expand, and disease resistance to evolve."

MOVING TOWARD SANCTUARIES

Beginning in the early 1990s, Virginia created a system in which thousands of acres of oyster grounds are kept closed until oysters are plentiful enough to allow harvest.⁶⁵ Like Maryland's managed reserves, these areas provide some short-term ecological benefits, but are then often opened to harvesting. Only a few hundred acres of oyster grounds in Virginia are designated as permanent sanctuaries. The May 2007 report of the Blue Ribbon Oyster Panel, a group of oyster fishery experts led by then Virginia Secretary of Natural Resources Secretary L. Preston Bryant Jr., advocated the creation of large new sanctuaries, as well as a rotational harvest system, in which areas are periodically closed off to allow oysters to grow. "Long-term sanctuaries allow for natural selection" and help

the spread of young oysters into adjacent harvest areas, the report states. “Sanctuaries should be further defined, by regulation, as areas preserved in perpetuity, where no commercial or recreational harvest can ever occur.”⁶⁶

Consistent with the Blue Ribbon Panel recommendations, Virginia has established a rotational harvest system in the lower Rappahannock River and, in addition, has placed 10 to 15 percent of the lower river into sanctuary.⁶⁷ However, oyster reproduction has been poor, perhaps explained by research on sanctuary areas, which suggests that at least 20 to 40 percent of natural habitat should be closed to exploitation just to allow reefs to be self-sustaining.⁶⁸

POACHING

THE SCOPE OF THE PROBLEM

Another major problem for oyster restoration is that sanctuaries are often victimized by poaching. The problem was described as “rampant theft of oysters in all areas of the state’s waters” in a 2009 study by the Maryland Oyster Advisory Commission, a panel of experts that reports to the governor and General Assembly.⁶⁹ “Currently there is no single factor more important to the future of ecological restoration and aquaculture than to address and dramatically reduce the ongoing illegal oyster harvesting activities,” the commission concluded. Without a reduction in this kind of theft, the state’s new proposed sanctuaries and oyster farms will likely fail, the panel warned. Judges often don’t take the charges seriously, and fines for poaching today are often so low—when they exist at all—that people who steal from sanctuaries view it as the “cost of doing business,” according to the report.⁷⁰

Law-breaking is so common that 43 percent of Maryland’s 3,940 active commercial watermen were charged with violating the state’s commercial oystering and fishing laws in 2008, according to the Maryland Department of Natural Resources.⁷¹ Many poaching violations are missed or not deterred because the state’s natural resources police force has been cut by nearly half, according to the 2009 oyster commission report. There are 231 officers today, compared to about 450 six years ago, according to the state agency.⁷² Those officers remaining are increasingly “spread very thinly” because they have increased homeland security patrol duties, the commission report says.⁷³ Twenty-five of the police force’s 26 large vessels are more than 15 years old, the maximum recommend age. “The fleet is unreliable and there are increasing safety concerns regarding the operation of the older vessels,” according to a 2008 report to the Governor by Maryland’s Task Force on Fishery Management.⁷⁴

THE HISTORY OF THE PROBLEM

It is a historic fact that Chesapeake watermen have resisted regulation. Oyster dredgers in the late 19th century fought back violently when Maryland tried to restrict the dredges to deeper waters to prevent



Calvert Marine Museum

The Maryland Oyster Navy fought to deter poaching in the 19th and early 20th centuries.



Thomas J. O'Connell

Director of The Fisheries Service
at the Maryland Department of
Natural Resources

“A lot of the biologists who sample our sanctuaries see broad evidence that the majority of our sanctuaries have been poached. It matters because there is significant investment going on in these sanctuaries to learn if we can restore oysters without harvest pressure.”

FIGHTING BACK AGAINST OYSTER POACHERS

It was in the darkness after midnight on January 21, 2010. Watermen in two boats with their navigating lights off were dredging for oysters in Talbot County on Maryland's Eastern Shore. Two of the men were wearing small head lamps, so they could see the shellfish they were taking out of an area in Broad Creek where it is illegal to catch oysters.

Suddenly, a police boat roared up with officers wearing night-vision goggles. When they tried to arrest the poachers, the captain of one of the boats gunned the engine and sped away. The police chased and ultimately arrested four watermen. One of those arrested had a record of more than 30 previous violations.

The arrests in Talbot County were an example of Maryland's crackdown on what a 2009 Maryland Oyster Advisory Commission report described as "rampant theft of oysters in all areas of the state's waters."

The report, by a panel of experts reporting to the Governor and General Assembly, concluded that nothing is more important to the restoration of oysters in the Chesapeake Bay than to halt the widespread and routine violation of oyster sanctuaries and reserve areas.

To fight back, officials at the Maryland Department of Natural Resources (DNR) say they are creating a high-tech network of radar and cameras called the Maritime Law Enforcement Information Network. The system will track boats on the Chesapeake Bay, and alert officers watching computer screens when vessels head into one of the state's 34 sanctuaries.

Thomas J. O'Connell, Director of the Maryland Fisheries Service, said one goal of the stepped-up enforcement is to send a message to potential investors in the aquaculture industry that their oyster farms will not be robbed.

"Poaching has become just a part of doing business for a lot of people," O'Connell said. "And the watermen who are truly trying to follow the rules are being disadvantaged by those who are going out at night and taking the majority of the oysters. That's why we need greater deterrence."

Many oyster poachers are not caught, state officials report. And for those who are arrested, the fines are often minimal, when the courts impose any penalties at all.

To impose a more meaningful penalty in Maryland, the Attorney General's Office has started to immediately suspend the



Maryland Department of Natural Resources

Maryland natural resource police are cracking down on poaching.

licenses of poachers. The Attorney General is using a section of the law that allows suspension on the basis that watermen are endangering "public health, safety and welfare," according to DNR Deputy Secretary Joseph Gill.

Repeat offenders are a problem. For example, one of the four watermen charged with the poaching violations on Broad Creek in January had a record of more than 30 natural resource violations. They included dredging for oysters in a prohibited area in 2007 and possessing undersized oysters that same year, according to a DNR report.

This waterman started off the fall 2009 oyster harvesting season with his license suspended for violations the previous season. And yet, on October 1, 2009, on the first day of the fall season, police caught him catching oysters illegally again and charged him. Six days later, police caught him harvesting oysters illegally again, and charged him for that, according to a DNR report. He failed to appear in court for these charges, and was charged with more oyster violations on January 21.

Some watermen are angry at Governor Martin O'Malley's administration over the crackdown, saying the state is trying to push watermen out of business.

But the President of the Dorchester Seafood Harvesters' Association, Ben Parks, said honest watermen appreciate the state's efforts to crack down on the dishonest ones.

"The guys interested in staying in this business appreciate what DNR is doing to cut this illegal activity off," Parks said. "It gives all watermen a black eye."



Dr. Donald Meritt
Aquaculture Specialist at the
University of Maryland Center for
Environmental Science

"It's a severe problem.... I don't like to use the word 'poaching,' because 'poaching' gives it almost a sportsman's connotation, and it's not. It's theft. If you took those oysters and made them chickens, and then somebody snuck onto a farm and took them out of somebody else's chicken house—that's not poaching, it's theft."

over-harvesting. Author John R. Wennersten described gunfights that killed hundreds of people in his book, *Oyster Wars of the Chesapeake Bay*.⁷⁵ Even though the “wild-west” gunplay out on the Bay is gone, the underlying problem has continued and become increasingly important as oysters have become more scarce.

Maryland created a series of 34 oyster sanctuaries starting in 1986. But since then, the majority of them have been hit by illegal harvesting, according to the Maryland Department of Natural Resources.⁷⁶ The evidence is reported by divers who often see dredge scars on the bottom in sanctuaries, and witnesses on the surface who report boats harvesting oysters in restricted areas.⁷⁷

Dr. Donald Meritt, Aquaculture Specialist at the University of Maryland Center for Environmental Science Horn Point Laboratory, said that “virtually all” of the oyster restoration sites in the Chesapeake Bay have been victimized by poachers.⁷⁸

COMBATING THE PROBLEM

To fight back against this illegal activity and convince potential aquaculture entrepreneurs that their investments won't be stolen, the Maryland Department of Natural Resources is ramping up its enforcement efforts.⁷⁹ Officials plan a high-technology, boat-tracking system; new regulations to suspend the licenses of violators; more aggressive prosecution; and more consolidated sanctuary areas, which are easier to patrol.⁸⁰ Concrete structures called “reef balls” can also help deter poaching by snagging or blocking dredges and other harvesting equipment.

In Virginia, poaching is not regarded by state officials as being as significant a problem as in Maryland.⁸¹ There may be less theft of oysters in Virginia, and this could be because this state has more watermen leasing the bottom of the Bay for aquaculture, which encourages a culture of respect for private property.⁸²

But Lt. Col. Warner Rhodes, deputy chief of the Virginia Marine Police,⁸³ said oyster poaching remains a chronic problem in some areas. “It's like anything else—you go down the interstate, and everybody is speeding until somebody sees a trooper,” Rhodes said. “It's the same thing out on the water. If the opportunity is there, people will try to take advantage of it.”

Virginia's Blue Ribbon Oyster Panel has recommended that the state provide “strong enforcement... and substantial patrolling of Virginia's sanctuaries” as “critical elements” to restoring oysters in the Chesapeake Bay.⁸⁴

HABITAT RECONSTRUCTION

THE NEEDS OF A GREGARIOUS ANIMAL

One of the biggest challenges to restoring native oyster populations in the Chesapeake Bay is rebuilding the reef habitat they need to survive.⁸⁵ Scientists describe oysters as gregarious, because they need to live with—and on top of—other oysters.

During spawning, male and female oysters must be near each other to allow mixing of their eggs and sperm, which are released into the water and carried at the mercy of the currents. Fertilized eggs develop into larvae that drift before settling to the bottom and beginning their sedentary lives as oysters. When they settle, larvae must find something



Michael Eversmier © 2010

Oysters and fish are protected in concrete reef balls.

hard to which they can attach, and the shells of other oysters are the primary home for these young “spat.” As oysters grow atop other oysters over many generations, they create a three-dimensional matrix of shell, a reef. Growing this way elevates oysters in the water column, which protects them from being buried in silt.

In effect, oysters build the habitat necessary for their own survival. However, heavy dredging in the 19th

and early 20th centuries destroyed most of the Bay’s original reefs, and siltation buried much of the remaining oyster shell. As a direct result of historic reef destruction, and later disease, the Bay’s oysters had declined to an estimated one percent of their 1870 numbers by 1988, bringing both economic and ecological losses.⁸⁶

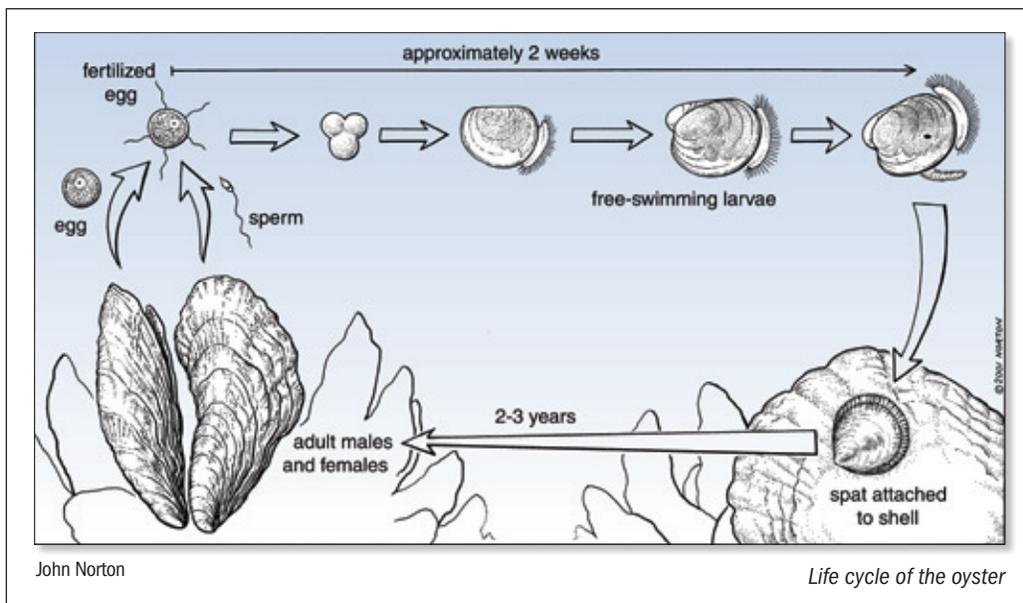
Harvesting by dredge continues even today, despite the known harm it causes by flattening reefs. Some watermen believe that dredging helps oyster reproduction by removing silt, creating a cleaner bottom on which larval oysters can settle. However, the consensus of scientists is that dredged areas silt over again quickly.⁸⁷ A report by the Maryland Department of Natural Resources concluded that dredging does not, in fact, help oyster reproduction.⁸⁸ Dredges also remove more adult oysters than other methods of harvest, reducing reproduction even further.⁸⁹

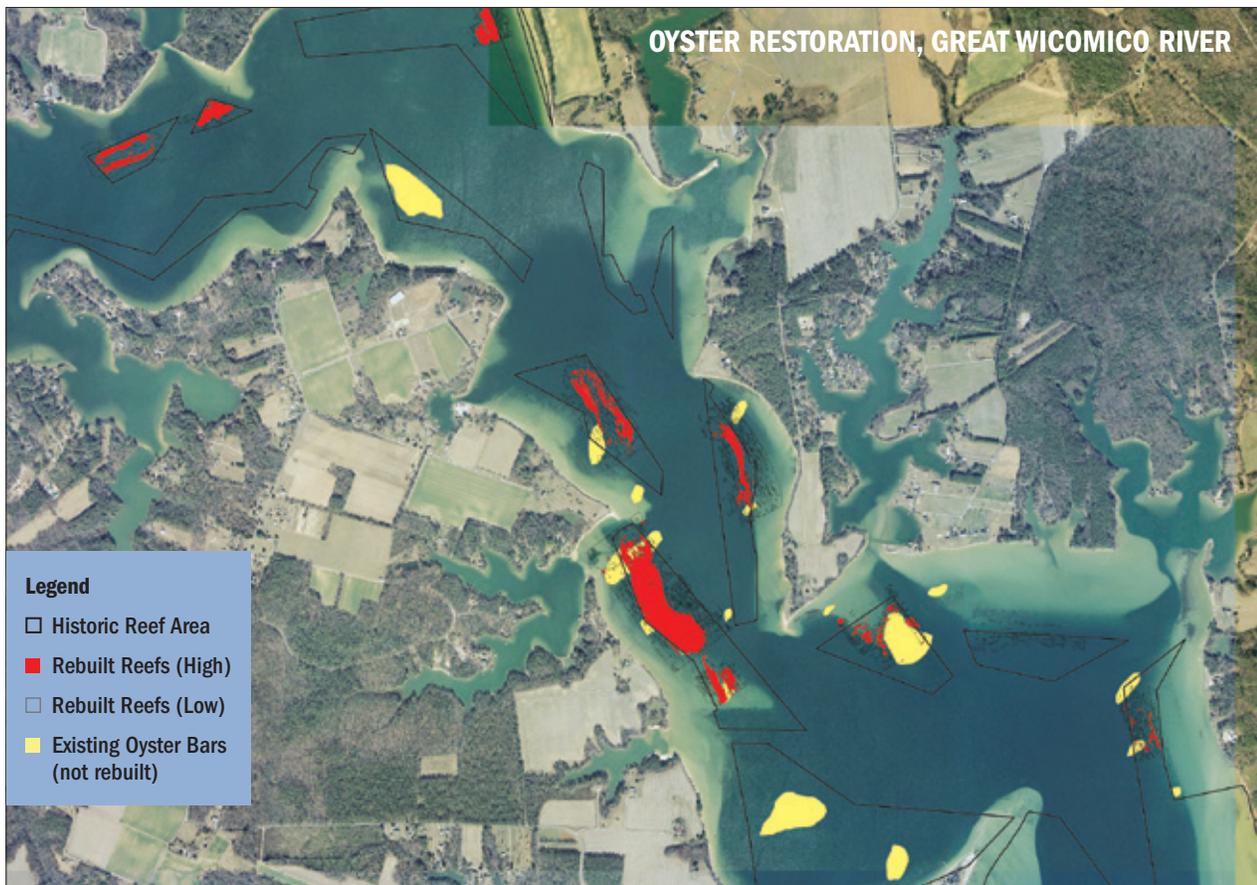
Rebuilding hard bottom habitat has been recognized as a critical need by panels of top oyster experts in both Maryland and Virginia.^{90, 91} And the federal government has recognized



Dr. Roger Newell
Biologist at the University of Maryland Center for Environmental Science

“The oysters that we harvested out from 1850 to 1950, those reefs had built up over the 10,000 years since the last ice age. We’ve taken out in about 100 years what it took 10,000 years to accrete....It’s going to take a long time to rebuild.”





OYSTER RESTORATION, GREAT WICOMICO RIVER

Legend

- Historic Reef Area
- Rebuilt Reefs (High)
- Rebuilt Reefs (Low)
- Existing Oyster Bars (not rebuilt)

Source: Norfolk District Corps of Engineers

The Great Wicomico River in Virginia is the site of an oyster restoration project.



Dr. Romuald Lipcius

Professor at the Virginia Institute of Marine Science

“To restore the whole of the Chesapeake [oyster population], it has been estimated would cost roughly \$500 million...but if you think about it, the benefits in the end will be much more than that. There will be better water quality, more blue crabs and other species, and all of the attendant benefits.”

this, too. A new Chesapeake Bay restoration strategy issued by the Obama Administration in May 2010 calls for the rebuilding of functioning reefs in 20 Bay tributaries by 2025. Much effort has gone into reef restoration in recent years beginning with the pioneering efforts of the Virginia Marine Resources Commission in the early 1990s. While many projects established reefs, most have been too small to thrive.

LESSONS FROM THE GREAT WICOMICO RIVER

There are, however, some important examples of success when a large-scale approach has been employed. In 2004, the U.S. Army Corps of Engineers built a network of reefs of over 85 acres in the Great Wicomico River in Virginia. The project resulted in years of strong reproduction. The rebuilt reefs in the Wicomico now house more than 180 million oysters⁹² according to project designer Romuald Lipcius, a professor at the Virginia Institute of Marine Science. Some researchers have disputed this figure. But Dr. Lipcius and other researchers say a key lesson learned during this project is the necessity of creating enough properly located reef acreage, so the reefs can help sustain each other through spawning and the natural drifting and settling of young oysters. This reproduction and the growth of oysters is needed to overcome the natural breakdown of shells caused in the southern Bay by sponges that drill holes in oysters. Also apparent from the Wicomico project is that building up the bottom with sufficient quantities of old shells or other material elevates oysters out of the silt, which helps them survive.

About 40 percent of the historical reef sites in the Great Wicomico River have been rebuilt with old shells and protected by sanctuaries. Dr. Lipcius and other researchers believe that this 40 percent threshold was key to the success of the project because it allowed the rebuilt reefs to connect with each other through reproduction. However, the exact amount needed to achieve this reproductive connection may vary from area to area, depending on circulation and other factors.⁹³

To create the Great Wicomico project, the Army Corps used old oyster shell dredged from deposits on the bottom of the Bay at a cost of roughly \$3 million. Dredging for shell for oyster restoration projects continues in Virginia. But in Maryland, the practice was stopped four years ago because of concerns that it was hurting other fisheries. Maryland is now considering restarting a shell dredging program and is planning to recover previously planted shell from sites around the Bay that have become silted over. These approaches cost an estimated \$5,000 to \$8,000 per acre.⁹⁴

Another important source of shell for oyster restoration projects has been shucking houses, especially in Virginia, which are reliant in large part on oysters trucked in from the Gulf of Mexico. The oil spill off Louisiana, however, has shut down much of the Gulf's oyster industry, cutting off this supply of shell. This shortage makes the recycling of oyster shell, from restaurants and seafood markets, more important, and it increases the need to look at other alternatives.

Alternatives to shell that have been used successfully in rebuilding oyster reefs include recycled concrete, marine limestone, and granite. While viable and even preferred in some circumstances, the cost of using these materials is substantially higher than using shell, about \$24,000 per acre.⁹⁵ Concrete "reef balls" (see page 35) can be built and planted for \$22,000 per acre and up.⁹⁶ Obtaining, transporting and placing these materials is the most expensive part of oyster restoration, and the biggest challenge. These costs and the need to undertake large-scale restoration have driven recent estimates for restoring oysters across the Bay to \$500 million or more.⁹⁷ However, the costs would likely be less than the value of the long-term environmental and economic benefits of oyster restoration, including improved water quality and increased populations of oysters, crabs, and fish in the Bay.⁹⁸

WATER POLLUTION

SILT, BACTERIA, AND NUTRIENTS

Poor water quality is yet another hurdle for the return of the Chesapeake Bay's oyster reefs. Silt washed by rain from urban areas and agricultural fields can bury oyster beds particularly those that have been flattened by dredges.⁹⁹ Threats from sewage and bacteria forced Maryland and Virginia to close or restrict oyster harvesting in 223,864 acres of the Bay and its tributaries in 2008, about 8 percent of the total shellfish beds.¹⁰⁰ Nitrogen and phosphorus pollution stimulates the growth of algal blooms, which die and rot, feeding bacteria that suck oxygen out of the water. An adult oyster can survive a low-oxygen "dead zone" for hours or even a few days by closing up. But oysters will suffocate in zero-oxygen conditions for more extended periods.¹⁰¹ Moreover, even moderately low-oxygen levels not normally associated with the death of oysters or fish can stress the immune systems of oysters, making them more susceptible to the Dermo disease, according to research by Dr. Robert S. Anderson, Professor Emeritus at the University of Maryland Chesapeake



Dr. Robert S. Anderson
Professor Emeritus at the
University of Maryland
Chesapeake Biological
Laboratory

"There have been several studies, including mine, that show low levels of pollution that are not lethal apparently stress the organism. And one sign of stress is the lack of an ability to resist diseases like Perkius marinus (Dermo)."



Bob Fisher/Virginia Sea Grant

Cownose rays eat oysters. And ray populations are rising, because one of their main predators, sharks, are overfished.

THE APPETITE OF COWNOSE RAYS

Though native to the Bay, the cownose ray (*Rhinoptera bonasus*), poses an additional threat to the Chesapeake's oysters, just as that beleaguered shellfish stock appears poised for a long-sought rebound.

Cownose rays, with their powerful crushing jaws, prey on oysters. Ray populations have grown significantly since the 1970s. The likely reason is overfishing of their primary predators, large coastal sharks, according to a March 2007 report by Dr. Ransom A. Myers in the journal *Science*. Meanwhile, a crash in the stock of the rays most favored food, soft clams, has caused these opportunistic fish to shift wholesale to oysters.

"Consequences of the region-wide proliferation of rays...have cascaded down through the food web," Myers and colleagues wrote in the article.

Several promising oyster restoration projects have come to naught because of rays, and commercial seafood companies in Virginia have lost large plantings of seed oysters. The resulting loss of millions of public and private dollars has discouraged some people from investing in oyster restoration and aquaculture.

If native oyster restoration and the Chesapeake's oyster industry are to succeed, predation by cownose rays may need to be reduced. In 2008, a coalition of Eastern states in the Atlantic States Marine Fisheries Commission adopted a plan to boost

populations of large coastal sharks by prohibiting fishing for certain species of sharks, setting limits on others, and outlawing catching pregnant females and juveniles. But because sharks are long-lived and have low reproductive rates, scientists believe it will take several years before shark populations recover.

Ray populations could also be kept in check by fishing for them. Demand for ray meat today is low. But there are promising markets for rays in bait (for lobsters in the Northeast), for export (mostly to Korea), in processed food (as a substitute for clam strips and in fish cakes), and in gourmet restaurants (which recognize the culinary potential of ray-wing fillets).

"It's a good product, from ray barbecue, to ray fish cakes and clam-strip substitutes," said Dr. James A. Wesson, Director of the Department of Conservation and Replenishment at the Virginia Marine Resources Commission.

The ecosystem is out of balance. Reducing the ray population strictly by increased fishing could cause problems, however. The cownose takes five to seven years to mature and breed, and then the females give birth to only one pup per year. A sustainable level of harvest would have to be determined scientifically, and then carefully regulated, because it would be easy to overreact to the oyster problem by decimating the rays.

Biological Laboratory.¹⁰² In laboratory tanks, Dr. Anderson exposed oysters infected with Dermo to both normal levels of dissolved oxygen and low levels of oxygen (less than 3 milligrams per liter) and found more died from disease in the reduced oxygen conditions. He also found that deaths from the disease were more common when another pollutant, a boat paint additive called tributyltin, was added to low-oxygen water.¹⁰³

INTERMITTENT LOW OXYGEN

This research has been continued by Dr. Denise Breitburg, Senior Scientist at the Smithsonian Environmental Research Center (SERC) in Edgewater, Maryland. She has been examining an even more common condition in the Bay than continuously low-oxygen levels. Dr. Breitburg has been exposing oysters to brief, intermittently low to moderate oxygen levels that are common at nighttime in the shallow waters where oysters often grow.¹⁰⁴ Although her research continues, preliminary evidence indicates that these flashes of low-oxygen levels also seem to impair the defense systems of oysters, making them more likely to be killed by Dermo.¹⁰⁵ “Dermo may be made worse by exposure to low oxygen....,” said Dr. Breitburg. “There is potentially important feedback between water quality and oyster restoration, where water quality may affect the chances of success of oyster restoration.”

These links between nutrient pollution, low-oxygen levels, and oyster disease and mortality suggest that efforts to reduce nitrogen and phosphorus pollution could be important in the recovery of oysters.¹⁰⁶ Legislation pending in Congress, the Chesapeake Clean Water and Ecosystem Restoration Act, would significantly reduce pollution and improve oyster survival.



Dr. Denise Breitburg
Senior Scientist at the
Smithsonian Environmental
Research Center

“Dermo may be made worse by exposure to low oxygen.... There is potentially important feedback between water quality and oyster restoration, where water quality may affect the chances of success of oyster restoration.”

AQUACULTURE

GROWTH OF OYSTER FARMS IN VIRGINIA

Virginia has long been home to an entrepreneurial, aquaculture-based model for the seafood industry. One-third of Virginia’s oyster grounds are in private leases for farming.¹⁰⁷ The Virginia Marine Resources Commission has worked to retrain watermen and teach them how to create oyster farms.¹⁰⁸ In 2008, Virginia created an expedited permitting



Tom Pelton/CBF Staff

Kevin McClarren, General Manager of the Choptank Oyster Company, shows his 4,500 floating cages holding about nine million oysters in aquaculture in Cambridge, Maryland.

process for oyster farms and more recently established “aquaculture enhancement zones” for waters along the state’s portion of the Eastern Shore. In these areas, the state imposes additional regulations designed to reduce pollution and help shellfish growers.¹⁰⁹ Today in Virginia, oyster farms employ 154 people. And the aquaculture industry is expanding rapidly, with the number of farmed oysters sold rising more than tenfold in just three years, from

OYSTER FARMING IN A RIVER REBORN

On a recent morning, Cameron Chalmers lifted a cage out of the Lynnhaven River in Virginia, popped open the lid, and dumped hundreds of fat oysters onto the deck of his workboat.

Toadfish gaped, eels slithered, blue crabs scurried, and sea squirts spat. There is a riot of life thriving around Chalmers' oyster farm, where he is growing 2 million mollusks atop river bottom leased from the state.

Chalmers, a former landscaping contractor who owns the Lynnhaven Oyster Company, expects to sell about 400,000 oysters in 2010. This is up from 312,000 oysters sold last year, 160,000 in 2008, and about 80,000 in 2007. So business is booming for this young aquaculture entrepreneur, as it is for oyster farmers across Virginia, where the number of farmed oysters multiplied ten-fold from 2005 to 2008.

One reason Chalmers' business is even possible is improved water quality in the Lynnhaven River. This waterway was famous for its oysters early in the 20th century. But it was off-limits for shellfish harvesting from the 1970s until about five years ago because of bacterial pollution. The river flows through dense suburban developments in Virginia Beach, and fecal bacteria seeped from sewage and septic tank leaks, pet waste, and boats.

Bacteria levels in the Lynnhaven have been declining for several reasons. An environmental organization called Lynnhaven River Now used ads and signs to educate homeowners about the need to pick up after pets and avoid feeding ducks and geese, whose waste fouls the water.

Federal, state, and local governments imposed a "no-discharge zone" for boats, meaning they are prohibited from dumping human waste. Virginia Beach reduced the number of homes on septic tanks—which can leak—and increased the number on public sewage treatment systems. The city also cut down on sewage pipe leaks.

As a result of successful clean-up efforts, and perhaps less rainfall, 38 percent of the Lynnhaven—or 1,934 acres—last year met water-quality standards that allow for the consumption of shellfish out of the river, compared to just one percent of the river in 2005. The waterway still has pollution problems, but bacteria levels are dropping.

"Things have really changed on this river, and it's allowed me to have some success," said Chalmers, who started the business in 2004. "It took some time, but this past year my aquaculture businesses got out of the red and now we are really growing our customer base."

On the deck of his boat, Chalmers blasted his oysters with a



Tom Pelton/CBF staff

Oyster farmer Cameron Chalmers works the Lynnhaven River

hose to wash them off. The eels, crabs, and toadfish slid, scrambled, and flapped back into the drink. Then Chalmers worked with his company's one employee, Andre Alexio, to shovel the oysters into plastic baskets.

"I love working out here on the water," Chalmers said, sun flashing on the waves near the wooded shoreline of First Landing State Park. "It's great. Sometimes we see dolphins swimming around our boat out here."

Chalmers rents about 550 acres of the bottom of the Lynnhaven River from Virginia for the rate of \$1.50 an acre per year. He buys millions of baby oysters from hatcheries when they are the size of large grains of sand, and grows them first in bags and then in cages on the bottom of the river.

His 680 cages are constructed from black wire and are about four feet long and three feet wide. They sit in about four feet of water on legs that raise them about a foot off the bottom. Elevating the oysters keeps them out of silt that can smother mollusks. And keeping them behind bars prevents them from being gobbled up by the legions of cownose rays that swarm in the Lynnhaven and elsewhere in the Chesapeake Bay.

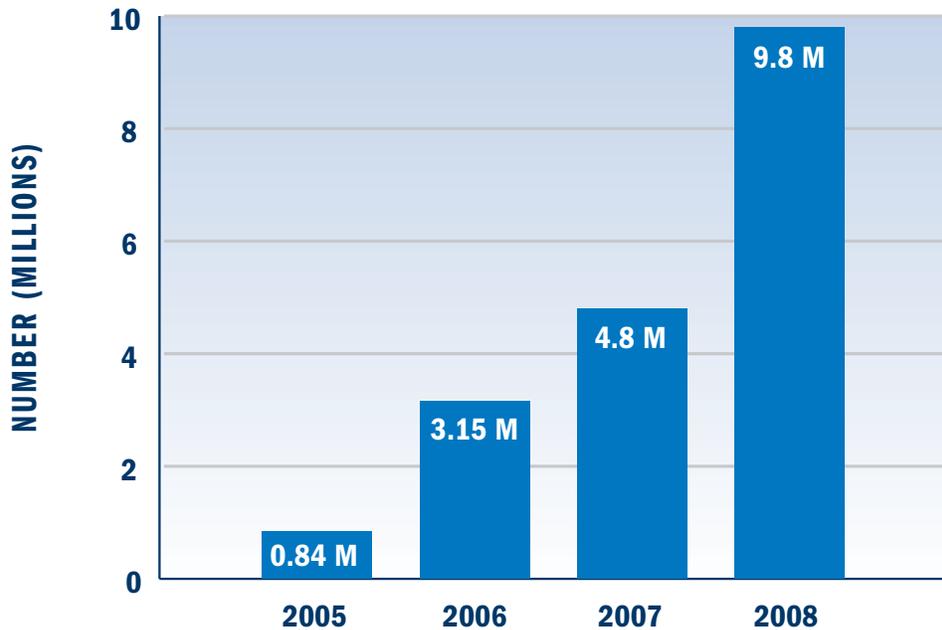
The oysters take a year-and-a-half to two years to grow to market size. And while roughly 40 percent of the baby oysters die for one reason or another, Chalmers said that he can successfully grow and sell most of them before parasites and disease can cause much damage.

His company sells the oysters to a distributor, who ships them to high-end restaurants from Las Vegas to Charlotte.

Karen Forget, Executive Director of Lynnhaven River Now which helped to clean up the waterway, said she sees oyster farms like this popping up all over Virginia and Maryland.

"I think what he is doing is really the future of oystering for the whole Chesapeake Bay," Forget said.

**FIGURE 5
OYSTERS SOLD BY VIRGINIA AQUACULTURE FARMS**



Source: Virginia Sea Grant Marine Extension Program, Virginia Institute of Marine Science

840,000 in 2005 to 9.8 million in 2008, the most recent available figures.¹¹⁰ The direct sales value of those oysters was \$2.8 million that year, but the total impact throughout the whole economy was \$7 million.¹¹¹ The growth of oyster aquaculture in Virginia may mirror the growth of its clam-farming industry, which is now the largest in America, having a total impact on the economy of about \$70 million a year.¹¹²

MARYLAND'S PLAN FOR EXPANSION

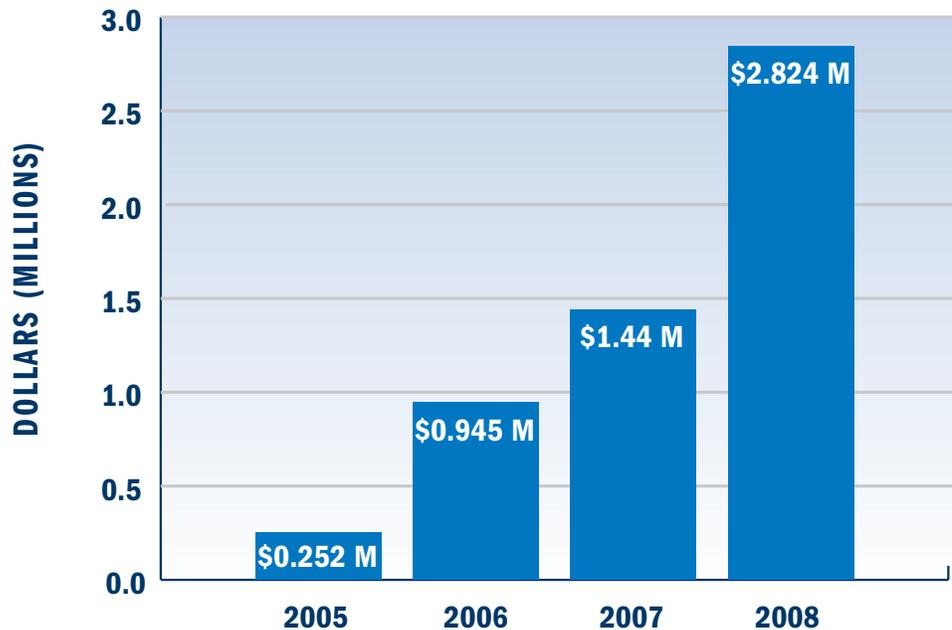
Maryland Governor O'Malley has acknowledged that his state would like to copy—and eventually surpass—its neighbor to the south.¹¹³ To encourage aquaculture, the Maryland General Assembly passed legislation in 2009 allowing significantly more leasing of the Bay bottom for the first time in about a century. Governor O'Malley proposed in May 2010 to allow leasing on 95,524 acres¹¹⁴ of oyster bars that were off-limits on the state's Eastern Shore, where watermen have long resisted aquaculture.¹¹⁵ Today in Maryland, only 6 percent of oyster grounds are in private leases. The state is also creating aquaculture enterprise zones with pre-approved leases on the Patuxent River.¹¹⁶ And the Maryland Department of the Environment is waiving aquaculture permitting fees of \$1,500 or more.¹¹⁷ With diseases no longer as much of a threat (in part because of the breeding of resistant domesticated oysters), growing oysters commercially has the potential for dramatic expansion.¹¹⁸ Dr. Douglas Lipton, Associate Professor of Resource Economics at the University of Maryland, College Park, estimates that oyster farming has the potential to grow in Maryland from nine farms employing a handful of people today to 150 businesses over the next decade.¹¹⁹ These small businesses would generate about \$9.6 million a year in direct sales, and provide a roughly \$25 million annual boost to the state's economy



Dr. James A. Wesson
Director of Conservation and Replenishment Department, Fisheries Management Division, Virginia Marine Resources Commission

"I see for us, a major expansion in the private production of oyster. If oyster grow like our hard clam industry, which is now the largest in the country, we could have significant growth."

**FIGURE 6
MARKET VALUE OF VIRGINIA AQUACULTURE OYSTERS**



Source: Virginia Institute of Marine Science.



Dr. Standish K. Allen, Jr.
Professor at the Virginia
Institute of Marine Science

“I think the potential for growth in aquaculture is vast...Oysters are this historic legacy and this tragic story. But if we can make oyster farming profitable—if people can make a living at it—that has far more upside than any public program in the Bay.”

and 225 full-time equivalent jobs when sales by restaurants and equipment companies and other collateral impacts are added, according to Dr. Lipton’s calculations. The state is trying to gradually shift from a fishing model for harvesting oysters to a farming model, according to Mike Naylor, Assistant Director of the Fisheries Service at the Maryland Department of Natural Resources.¹²⁰

Although some Maryland watermen are fighting the state’s move from a “wild” oyster fishery toward underwater farms, even the “wild” fishery in the state is not really wild.¹²¹ About 80 percent of the oyster harvest from Maryland’s portion of the Bay in recent decades has been taken from areas where the state planted oysters or shell, according to a report by the National Research Council.¹²² So it is a natural next step for Maryland to develop a private aquaculture industry.

THE FUTURE

Dr. Standish K. Allen, Jr., Professor at the Virginia Institute of Marine Science, sees a bright future for aquaculture across the Chesapeake Bay.¹²³ “I think the potential for growth in aquaculture is vast,” said Dr. Allen. “Oysters are this historic legacy and this tragic story. But if we can make oyster farming profitable—if people can make a living at it—that has far more upside than any public program in the Bay.” He predicts a proliferation of shellfish farms, so that they become as dominant in Virginia and Maryland as they are in France and China. He sees new wealth and jobs in the Chesapeake’s working waterfronts. Restaurants and shucking houses in Virginia and Maryland will no longer be forced to import oysters from the Gulf Coast, and the Chesapeake Bay will once again be identified around the world by its rich and succulent oysters.¹²⁴

CONCLUSION AND RECOMMENDATIONS

Oyster populations in Chesapeake Bay today are only a tiny fraction of their historical bounty. In this depleted state, reefs are easily the most endangered of all Bay habitats. Oysters can no longer fulfill their essential role of filtering the estuary at a time when the algae-choked Chesapeake needs all the help it can get. The numbers of oysters harvested, oystermen working, processors in business, and the overall economic value of the fishery, are all down dramatically from as recently as the 1980s. Clearly, the status quo is not working for the Bay or for the people whose livelihoods depend on oysters or clean water.

The once-famous Chesapeake oyster is now at a turning point. Maryland, Virginia, and their federal partners are faced with a historic opportunity. An exhaustive five-year study concluded that importing a foreign oyster is the wrong approach and that restoration of the native oyster should be scaled up and focused. President Barack Obama issued an Executive Order for the Chesapeake Bay in 2009, and in response the federal government set a goal of rebuilding functioning networks of oyster reefs in 20 tributaries by 2025. This kind of large-scale commitment is necessary. But restoration of the Bay's oysters will only be achievable with forward-thinking oyster management policies, pollution reduction, strict enforcement, sufficient investment, and a true spirit of collaboration among all parties.

Much is known about oyster biology and life history, and much more needs to be learned. As the science evolves, restoration programs must continue to incorporate new information and adjust course. Today, a new paradigm is emerging that views oyster reefs not as independent entities that can be created in isolation, but as networks of reefs that depend on each other to persist over time. The drift of oyster larvae helps one reef populate another. Understanding this interconnection between reefs is key to successful restoration. Reefs will only persist over time if they are repopulated by their neighbors so they can overcome losses from disease, predation, and shell degradation.

The one reef restoration project in the Chesapeake system that appears to have achieved this interconnectedness is in Virginia's Great Wicomico River, where 40 percent of historical reef acreage has been restored. This is consistent with scientific estimates of the amount of protected areas necessary to restore other types of marine systems. Exactly how much reef acreage is necessary for a given part of the Bay will depend on circulation patterns, salinity, and other factors. To achieve acreage targets, the states should first protect a portion of existing, productive reefs that have shown by their persistence to be ecologically important. Maryland's new plan for restoring oysters embraces this approach. The protection of these existing reefs should be supplemented by the rebuilding of historical but now dead reefs to achieve enough acreage for a healthy system. Work in Virginia has substantially advanced our understanding of how to restore oysters, and the 2007 Blue Ribbon Oyster Panel incorporated much of this knowledge in its recommendations. With the final decision to reject foreign oysters and even more scientific progress since then, the time is right for updating and expanding upon that work.

Beyond total acreage, the location and design of reefs are also critical. Using historical charts and electronic bottom-survey methods, restored reefs should be located where they grew originally. Circulation models should be used to pinpoint sites where reefs should be protected and rebuilt. Finally, the Bay's original reefs were three-dimensional.

Restoration works best when reefs are built up into the water column, where exposure to currents brings food and oxygen to oysters and reduces siltation.

In addition to the design and construction of reefs, there are several problems that stand in the way of successful restoration and must be addressed. Establishing sanctuaries that protect “survivor” oysters is the best long-term strategy for helping shellfish develop resistance to disease. Better deterrence of poaching through increased patrols and penalties will help reduce illegal harvesting, as will concrete reef structures that block harvesting equipment. Establishing a sustainable fishery for rays and limiting the catch of coastal sharks, which eat rays, will help control these predators of oysters.

Rebuilding the oyster industry and restoring its cultural and economic benefits are important parallel objectives to ecological restoration. Oyster harvest have spiraled downward over many decades because watermen compete for fewer and fewer oysters while political pressures prevent change. Private aquaculture is a proven alternative. Growers are motivated to cultivate, protect, and replant oysters. There is tremendous potential for reviving the oyster economy and culture through aquaculture. A public fishery can continue; indeed, time for watermen to transition from it to aquaculture is necessary. But any continued fishery in public areas must be managed with sound science.

Finally, the most fundamental problem facing the Bay and its oysters is water quality. The Chesapeake is overloaded with nitrogen and other pollutants that cause algal blooms and low-oxygen “dead zones.” Oysters suffer from disease more readily if exposed to reduced oxygen concentrations. A comprehensive solution to the decline of oysters and the Bay must include action to stem pollution.

The Chesapeake Bay Foundation recommends six specific steps be taken to revive both the oyster and the oyster industry.

- 1.** Maryland and Virginia should create sanctuaries protecting approximately 40 percent of the Bay’s historical oyster reefs, depending on how much is needed for reef sustainability in given areas. Virginia should reconvene the Blue Ribbon Oyster Panel to develop a strategy for achieving this goal.
- 2.** Maryland and Virginia should work with the federal government to invest sufficient funds for rebuilding former reefs with enough shells, concrete, or other appropriate materials to establish successful reef communities. Only with full federal support will adequate resources be available to significantly rebuild this natural reef infrastructure.
- 3.** Virginia and Maryland should work to transition from a wild harvest oyster fishery to an aquaculture industry. To help encourage oyster farming, the states should offer expedited permit approvals, fee waivers, training programs, and start-up grants.
- 4.** Both states should boost law enforcement to keep poachers away from no-harvest areas and oyster farms. The states should work to make the judiciary a full partner in effective oyster management.
- 5.** To control predation on oysters, the states should do more to encourage commercial and sport fishing for predatory cownose rays. But first, a sustainable harvest should be determined scientifically, and then it should be carefully regulated.

6. To fight water pollution in the Chesapeake Bay, Congress must pass new federal clean-water legislation. The Chesapeake Clean Water and Ecosystem Restoration Act will impose legally enforceable science based limits on nitrogen, phosphorus, and sediment pollution, and threaten penalties to states that fail to meet these limits.

These investments of political capital and taxpayer money are likely to bring a strong return for the environment and economy in the long run. Young oysters and fish will multiply in restored reefs and proliferate across the Bay. Aquatic vegetation will thrive, water quality will improve, and tourist industries will prosper. Encouraging aquaculture will both keep watermen on the water and have a ripple-effect through local economies.

It will take time and political will to bring oysters back from the brink in the Chesapeake Bay. But with cleaner water, protected reefs, and a flourishing economy built on long-term health rather than exploitation, the Chesapeake will once again be worthy of the title “great shellfish bay.”

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CBF Staff

CBF restoration vessel Patricia Campbell planting young oysters.

THE CHESAPEAKE BAY FOUNDATION AND OYSTERS

The Chesapeake Bay Foundation (CBF) has been deeply engaged in oyster restoration and management since the 1980s when it was becoming clear that oysters were important well beyond their traditional value as harvested seafood. The term “keystone species” was used to describe oysters’ critical role as filterers and reef-builders. When in 1988 scientists estimated the Bay’s oysters had declined to a mere one percent of their former bounty, CBF took on the role of advocate for oysters to protect this critical ecological function.

In 1991, CBF proposed a temporary moratorium on oyster harvesting. The proposal received little support, and until recent efforts to ramp up restoration significantly, oyster populations languished at their low. On the other hand, the proposed moratorium raised the profile of the issue and stimulate dialogue in forums like the Maryland Oyster Roundtable and Virginia Blue Ribbon Oyster Panel. Over the decades, CBF has continued to be the leading advocate for oyster conservation and restoration in advisory panels, at regulatory hearings, in the legislatures of Virginia and Maryland, and in the halls of Congress. Most recently, we worked with partners to defeat the proposed introduction of the Asian oyster into the Bay.

CBF became directly involved in efforts to restore oyster reefs in 1997 when we started our citizen oyster-gardening program in which we train and equip citizens to grow oysters in floats or cages alongside their docks. Gardeners’ oysters are planted on sanctuary reefs that CBF has built or collaborated on with state and federal agencies, universities and citizen groups. To date, nearly 4,000 households have participated in the program and produced over eight million adult oysters for restoration.

Complementing the oyster gardening program are CBF's Maryland and Virginia oyster restoration centers. In 2000, CBF began operation of a demonstration oyster farm in Virginia for promoting oyster aquaculture as a viable option for the oyster industry and growing oysters for restoration. The farm uses advanced culture techniques that raise oysters to market size within 18 months, (half the time of wild oysters). Countless decision-maker, media, and industry visits to the farm helped spread the word, and several successful aquaculture businesses have subsequently sprung up in tidewater Virginia.

CBF's Maryland oyster restoration center began operations in 2002 with the launch of the custom-built oyster restoration vessel, *Patricia Campbell*, designed to efficiently plant up to one thousand bushels of oysters at a time. Working closely with partners, CBF began producing seed oysters for planting directly on sanctuary reefs. CBF's Virginia center expanded its scope to produce seed oysters beginning in 2006, and between the two centers our production through 2009 totaled about eighty-five million. In support of the centers' work, CBF's Save Oyster Shell program has promoted the recycling of shell, a critical commodity for restoration, since 2007.

Currently CBF is expanding its oyster reef restoration work by focusing more on the production of concrete reef modules called "reef balls." Reef balls provide three-dimensional reef habitat for oysters and other organisms, and they protect sanctuary reefs from poaching. Working with partners, CBF has placed over 1,500 reef balls in the Bay and its tributaries since 2003. With support from NOAA, our production will reach nearly five hundred in 2010 alone.

Most importantly, CBF's oyster work is designed to involve citizens and depends heavily on volunteer help. From oyster gardening to reef ball production, volunteers are integral to the program. In 2009 alone volunteers contributed 19,668 hours of time to CBF's oyster restoration work. Building this constituency—our "Oyster Corps"—is critical to maintaining public support for oyster restoration.

CBF's oyster protection and restoration work has been supported in part by the Butch Butt Memorial Foundation, The Cabell Foundation, Chesapeake Bay Trust, the Fair Play Foundation, The Keith Campbell Foundation for the Environment, the National Oceanic and Atmospheric Administration, The Nature Conservancy, National Fish and Wildlife Foundation, the Pew Charitable Trusts, Restore America's Estuaries, and the Virginia Wellington Cabot Foundation.



Michael Eversmier © 2010 *A black sea bass and oysters thrive on and around a reef ball built by CBF and deposited in the Choptank River.*



CBF Staff *Volunteers bag shells at Virginia's Oyster Restoration Center.*



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Saving a National Treasure

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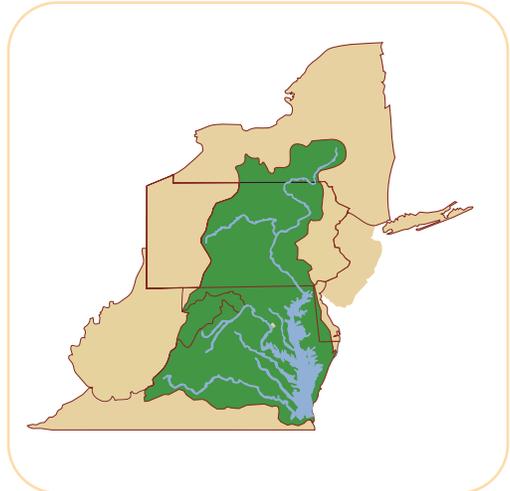
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CHESAPEAKE BAY WATERSHED



The Chesapeake Bay's 64,000-square-mile watershed covers parts of six states and is home to more than 17 million people.



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