Oyster Restoration Outcome

Management Strategy

Photo credit: Michael Eversmier. Concrete reef ball set by the Chesapeake Bay Foundation on the Choptank River.

Introduction

The eastern oyster (*Crassostrea virginica*) was once abundant throughout the Chesapeake Bay and its tributaries, and was a critical component of the ecological character of the Bay by contributing to maintaining water quality and aquatic habitat in the Bay ecosystem. Oysters support a valuable commercial fishery today; however, harvests over the last three decades are greatly reduced from historic levels. The decline of the Chesapeake Bay's native oyster population can be attributed to several factors, including historic over-harvesting, disease and habitat loss. There is public recognition that the oyster decline has threatened a way of life for both watermen and the Bay itself.

The Executive Order 13508 Strategy for Protecting and Restoring the Chesapeake Bay Watershed established a goal of restoring oyster populations in 20 tributaries of Chesapeake Bay by 2025. Per this goal, a team of academics and state and federal agency staff developed Bay-wide oyster restoration success criteria. Based on experience with current restoration implementation and resource availability, restoration partners determined that an outcome of restoring native oyster habitat and populations in 10 tributaries by 2025 is an appropriate target for the next 10 years and for the 2014 Chesapeake Bay Watershed Agreement.

I. Goal, Outcome and Baseline

This management strategy identifies approaches for achieving the following goal and outcome:

Sustainable Fisheries Goal: Protect, restore and enhance finfish, shellfish and other living resources, their habitats and ecological relationships to sustain all fisheries and provide for a balanced ecosystem in the watershed and Bay.

Oyster Outcome: Continually increase finfish and shellfish habitat and water quality benefits from restored oyster populations. Restore native oyster habitat and populations in 10 tributaries by 2025 and ensure their protection.

Baseline and Current Condition

As of 2014, six tributaries have been selected for oyster restoration: Harris Creek, the Little Choptank and Tred Avon Rivers in Maryland, and the Lynnhaven, Lafayette and Piankatank Rivers in Virginia.

In 2010, the Sustainable Fisheries Goal Implementation Team (Fisheries GIT) established the Oyster Metrics Workgroup comprised of representatives from the National Oceanic and Atmospheric Administration (NOAA), the U.S. Army Corps of Engineers (USACE), Maryland Department of Natural Resources (MD DNR), the Virginia Marine Resources Commission (VMRC) and academic scientists from the University of Maryland-Center for Environmental Science (UMCES) and the Virginia Institute of Marine Science (VIMS). The specific charge to the group was to develop common Baywide restoration goals, success metrics and monitoring and assessment protocols for sanctuary reefs including progress towards achieving a sustainable oyster population and ultimately increasing levels of ecosystem services. The workgroup's 2011 final report specifies that the goal of oyster restoration at the tributary-level is to dramatically increase oyster populations and recover a substantial portion of the ecosystem functions provided by oyster reefs within the tributary.

This management strategy provides the context and guidance for achieving the specific outcome of tributary-level oyster restoration in 10 tributaries as articulated by above Oyster Outcome.

II. Participating Partners

The following partners have participated in the development of this strategy. A workplan to accompany this management strategy will be completed six months after this document is finalized. It will identify specific partner commitments for implementing the strategy.

Chesapeake Bay Watershed Agreement Signatories

- State of Maryland
- Commonwealth of Virginia
- Federal Agencies (National Oceanic and Atmospheric Administration; U.S. Army Corps of Engineers)
- Chesapeake Bay Commission

Key Participants

The Maryland and Virginia Oyster Restoration Interagency Workgroups of the Bay Program's Sustainable Fisheries Goal Implementation Team (Fisheries GIT) are responsible for identifying tributaries for restoration and developing Oyster Restoration Tributary Plans for each waterway, in consultation with partners and scientists. Workgroup members include representatives from federal and state agencies as well as from regional non-governmental organizations, academic institutions and local organizations. Other stakeholders and user groups are engaged on an ad hoc basis. The Maryland workgroup has one team overseeing restoration in all selected tributaries. Virginia has established a specific team for each selected tributary.

Maryland Interagency Workgroup

- NOAA Chesapeake Bay Office (lead)
- Oyster Recovery Partnership
- USACE Baltimore District
- Maryland Department of Natural Resources

Virginia Interagency Workgroup

Piankatank River

- NOAA Chesapeake Bay Office (lead)
- USACE Norfolk District
- VMRC
- VIMS
- The Nature Conservancy
- Chesapeake Bay Foundation

Lafayette River

- NOAA Chesapeake Bay Office (lead)
- USACE Norfolk District
- VMRC
- VIMS
- Chesapeake Bay Foundation
- Christopher Newport University
- City of Norfolk
- Elizabeth River Partnership

Lynnhaven River

- USACE Norfolk District (lead)
- NOAA Chesapeake Bay Office
- VMRC
- VIMS
- Chesapeake Bay Foundation
- Lynnhaven River NOW
- City of Virginia Beach
- Oyster Reefkeepers

In addition, consulting scientists from academic and research institutions play key roles by conducting research to gain a fuller understanding of oyster biology, developing improved methods and technologies for oyster restoration, and collecting and analyzing data from restoration sites. These consulting scientists provide input and guidance during the restoration planning, implementation, and monitoring efforts.

Local Stakeholder Engagement

In areas open to harvest, watermen in the fishing and aquaculture industries depend directly on the oyster resource and their habitat benefits. It is anticipated that benefits of large-scale restoration such as increased recruitment in areas open to harvest, improvement in water quality, and the potential development of disease resistance within the oyster population would greatly benefit the oyster industry.

Private bottom leaseholders, who are permitted to grow oysters on specific parcels, are an important user group that is considered when selecting restoration sites in Virginia. Local citizens

and land owners directly affect the water quality of these tributaries and their ability to support healthy oyster reefs. Public support is an important key to long-term success of oyster restoration, and public programs such as oyster gardening and volunteer events around oyster restoration activities are examples of public engagement efforts.

Other key stakeholders include local waterfront landowners, recreational anglers, boaters, and the public at large.

III. Factors Influencing

The following are natural and human factors that influence the partnership's ability to attain this outcome. The top priority factors are listed in order, followed by a list of additional factors in no particular order.

1. Low Population

Research and modelling efforts have found that the current oyster population is at less than 1% of historic levels. The main causes for the reduced oyster stocks have been historical overfishing, habitat loss (including poor water quality), and diseases (MSX and Dermo). At their current level of abundance in the Bay, oysters are not creating enough offspring to support full population recovery.

2. Resource Availability

a. Funding

Jurisdictions, federal agencies, and other restoration partners are currently strained due to tight financial budgets and are working hard to secure the required funds to support the necessary shell, alternative substrates, or manpower to accomplish oyster restoration on such large scales. Securing funding and working collaboratively among many restoration partners is essential to accomplish this outcome.

b. Shell/substrate

The amount of natural shell available for restoration is very limited due to high demand among restoration efforts, fishery enhancement, and aquaculture. Alternatives to local shell, including fossil shell, stone, crushed concrete and fabricated reef structures (e.g.: reef balls; oyster castles), have been used with varying degrees of success. These alternatives may offer benefits over shell, such as shoreline stabilization, poaching deterrents and increased persistence over time, but they may also interfere with some legal fishing practices and fishing gear.

c. Hatchery spat supply

Spat (young oysters) on shell produced at hatcheries are an integral part of the restoration implementation process and are planted on restoration sites to augment the oyster populations. The availability of spat is dependent on funding and the capacity of hatcheries. Shortage of spat supply can delay implementation of restoration efforts.

3. **Water Quality**

   Poor water quality (e.g. low dissolved oxygen levels, pollution, sedimentation, eutrophication, sewage contaminants, salinity changes from massive freshwater inputs, etc.) can prevent natural recruitment increase natural mortality among adult oysters. These negative effects can threaten the long-term success of oyster restoration projects if water quality is not improved.

4. **Enforcement**

   Enforcement of sanctuaries and harvest regulations is challenging and illegal harvest of oysters (poaching) has long been problematic in the Chesapeake. Although, enforcement is difficult and poaching may go unnoticed, improvements have been occurring. The Maryland Natural Resources Police and Virginia Marine Police forces have been reduced in size in recent years, and are limited by funding allocation and available manpower to enforce both the protection of oyster reefs and commercial and recreational regulations for all fish species. Illegal removal of oysters poses threatens the success of restoration efforts in sanctuaries.

5. **Spat set variability**

   Spat set varies tremendously interannually and spatially within the Chesapeake Bay, with higher spat levels in higher salinity waters and low to no spat set in lower salinity waters. Although this was likely the case historically, today's extremely low oyster populations produce insufficient spat most years to rebuild stocks in many tributaries. Some areas may require intensive seeding and re-seeding with hatchery-produced oysters to rebuild stocks, particularly in lower-salinity waters.

Additional Factors (in no particular order)

- Oyster Resource Management
  a. Permitting

     In order for reef construction to occur, partners must obtain a variety of permits, both at the federal and state level for various phases of construction. Regulatory agencies require detailed information and applications, as well as time for public comment and hearing. Time for this permit review process must be integrated into the restoration timeline. Unexpected issues during the permitting process can cause delays and/or prevent reef construction and restoration from moving forward on the planned timeline.

  b. Bottom Leasing

     Both Maryland and Virginia allow private leasing of specific parcels of tributary bottom for aquaculture. Leased grounds, or grounds that otherwise could be leased, are presumably unavailable for restoration without reconciliation with the states or individual leaseholders. Particularly in Virginia, this can limit the amount of bottom available for restoration in selected tributaries.

  c. Designation of sanctuary areas

     Sanctuaries are an integral part of restoring and maintaining significant populations of oysters to the Chesapeake Bay. Sanctuaries are areas where oyster harvest is not permitted. The oysters within sanctuaries are protected as sources of larvae to fished reefs, for their ecosystem services and to provide adult oysters that have survived

disease challenges to reproduce. Sanctuaries provide legal protection to restoration sites.

- Shell Loss
  The dynamics of oyster shell habitat are driven by addition processes (mortality that adds to the shell base) that are dependent on the dynamics of the life history of oysters and loss processes (physical degradation, chemical dissolution, biologically mediated disaggregation and removal by harvest) that are independent of life history dynamics. When oyster populations are low, the stable feedback loop of shell addition and loss processes breaks down. When shell loss rates exceed addition rates, a negative feedback loop drives lower shellfish recruitment and habitat production. Restoration is an addition process by constructing habitat or replenishing shell, but in order to ensure long-term success of restoration efforts, increases in recruitment and/or oyster longevity (preferably both) are required to ensure that future oysters can maintain the necessary levels of shell.

- Connectivity
  Oyster larvae are planktonic in early life stages and require appropriate hard substrate for successful settlement. Healthy historic populations likely relied on river-wide networks of areas that produced larvae, 'source reefs', and areas where larvae settled, 'sink reefs', for a sustainable system. Degradation, loss and fragmentation of oyster reefs have broken this connectivity. Reestablishing this dynamic process, through data-driven reef placement and appropriate restoration scale will be a key consideration for success. Past restoration efforts on very small areas within larger tributaries may have been insufficient to reestablish this connectivity.

- Hard Bottom Availability
  Without sufficient hard bottom habitat, much of the oyster's natural recruitment goes to waste because larvae have few suitable locations to settle. After decades of damage to reefs from harvest, increased disease, falling salinity due to the increased runoff that accompanies increased impervious surface, and increased sedimentation from runoff, a significant amount of hard bottom habitat has been lost.

- Public Support
  The eastern oyster is highly valued as a source of food, an economic resource supporting families and businesses, and a contributor to the health of the Chesapeake Bay ecosystem. Harvesting, selling, and eating oysters has historically been and continues to be a central component and driver of social and economic development in the region. Public support for oyster restoration projects, especially from citizens who live near selected tributaries, is essential for the long-term success of restored oyster reefs.

- Climate Change/Ocean Acidification
  Increasing concentrations of carbon dioxide in the atmosphere can contribute to a lower pH and acidification in the Bay. The shells of oysters and other bivalves are sensitive to pH levels and research indicates that lower pH levels reduce the shell production rates and slow calcification processes resulting in less natural available shell in the ecosystem.

- Innovative Restoration Techniques
  Innovative restoration techniques have the potential to increase the likelihood of success of oyster restoration efforts. Evidence suggests that reef design is a critical component of restoration success. Continuing to incorporate concepts of experimental design from the earliest planning stages will allow for rigorous evaluation of restoration outcomes and provide for adaptive innovation in reef design.

- Navigation
  Boaters (commercial, recreational, maritime safety, etc.) are a key user group in the Bay's waterways. Navigation requirements of these vessels must be taken into account when selecting restoration sites with selected tributaries. Restoration projects need to leave sufficient navigational clearance overtop to allow for local vessel traffic, and/ or be marked with appropriate aids to navigation. This substantially reduces the area of potential oyster habitat where restoration can take place.

IV. Current Efforts and Gaps

To date, six tributaries have been selected for tributary-scale oyster restoration by the Maryland and Virginia Oyster Restoration Interagency Workgroups. Each of the selected tributaries, listed below, are at different levels of progress in the general approach for completing restoration, as described in the following "Management Approach" section.

Maryland

Tributary	*Progress through 2014*	*Next Steps*
Harris Creek Final Tributary Plan	377-acre target; 258 acres restored; 27 additional acres constructed (to be seeded in 2015)	Remaining seeding and substrate construction set to be complete by 2015
Little Choptank Final Tributary Plan	440-acre target; 17 acres restored; 95 acres of substrate constructed (to be seeded in 2015)	Seeding in 2015
Tred Avon Draft Tributary Plan	185-acre target	First 24 acres to be constructed in 2015

Virginia

Tributary	*Progress through 2014*	*Future Projections*
Lynnhaven River	63 acres constructed in 2007-08; these reefs meet criteria for a restored reef	Working to develop restoration goal and identify future project sites; at least 30 additional acres required to meet the metrics for a restored tributary; USACE will construct 31 acres in 2018

Lafayette River	10 acres restored; 11 additional acres meet criteria for a restored reef	Working to develop restoration goal and identify future project sites
Piankatank River	20 acres constructed	Working to develop restoration goal and identify future project sites; 20 additional acres planned for 2015

In addition to the current restoration work described above, federal agencies and local organizations have led many smaller-scale oyster restoration efforts over the past few decades in both Maryland and Virginia. Some of these past projects in Virginia are being evaluated to determine if they meet the Oyster Metrics criteria for a restored reef (see the "Assessing Progress") section.

By the end of 2015, the implementation of restoration treatments in Harris Creek is set to be complete and an assessment of the Lafayette River will have evaluated whether successful past restoration projects already meet the criteria for a restored tributary.

Gaps

While six tributaries have already been selected, the Maryland and Virginia Interagency workgroups need to select, plan, and implement restoration treatments in four additional tributaries to work toward the outcome of 10 tributaries. The workgroups will carefully consider a variety of factors, including current bottom uses, regulations, and biological/physical conditions, in order to choose tributaries that have the most potential for restoration success and for maintaining healthy oyster reefs into the future.

The restoration process and monitoring efforts are heavily reliant upon available federal, state, and other partner funds over the long term. Restoration funds are not guaranteed, so partners should continue to work collaboratively to plan for future restoration activities and document the results of current efforts.

V. Management Approaches

The partnership will work together to carry out the following actions and strategies to achieve the oyster outcome. These approaches seek to address the factors affecting our ability to meet the goal and the gaps identified above.

Restoration Planning and Implementation

The exact process for planning and implementing tributary-scale restoration is likely to vary by state, and even by tributary. This is appropriate, as ecological conditions (e.g., salinity, present-day spat set, water quality, wave energy, river basin morphology), and political factors (e.g., state oyster management policies, user group conflicts) vary between states, rivers, and even to some degree within rivers. However, below is a generalized approach to tributary-scale restoration planning and implementation.

a. Selection process and considerations: Establish workgroup of interested parties, likely to include state and federal agencies, academics, and stakeholders interested in advancing

ecological oyster restoration on a tributary scale. Workgroups are responsible for reporting on progress to the Sustainable Fisheries Goal Implementation Team.

b. Data collection: Compile existing data sets that help describe the current and past state of the river's oyster population, spat set, water quality, land use, benthic habitat conditions, management policy (e.g., wild fishery, leases, sanctuaries). If needed, collect additional data.
c. Set acreage target: Using the Oyster Metrics report as guidance, develop a restoration target for the river that is between 50% and 100% of the currently restorable acreage and is at least 8% of historic oyster bottom. Currently restorable means, at a minimum, areas that have hard benthic habitat and water quality that can sustain oyster populations.
    i. If the workgroup determines that the Oyster Metrics guidance is not appropriate for a particular tributary, the workgroup will develop a suitable alternative goal setting process and success criteria for that tributary, and explain the rationale.
d. Develop plan: The workgroup should develop a plan to achieve the restoration acreage goal. This may generally include locations where reefs are to be built, restoration treatment (reef substrate type needed, if any; seeding needed, if any; appropriate reef height and material), costs, monitoring plans, etc. Additional input from the academic, scientific and management communities, and additional user group and public outreach, may be part of the plan development.
e. Implementation: Workgroups will be responsible for ensuring a coordinated approach to implementation, for tracking implementation progress, and reporting results to the Fisheries GIT.
f. Track progress, monitor, and manage adaptively (see next section)

Securing Support and Resources

State and federal agencies and local restoration partners will continue to work collaboratively on the planning, permitting, and implementation process. Implementation of tributary plans is dependent on resource availability of spat, shell/substrate and financial and human resources, and a streamlined process and collaborative effort will allow partners to align and maximize available resources.

Future Protection

The restoration partners working on each tributary will consider the future protection of the restored oyster reefs in the long term. In Maryland, tributaries selected for restoration have previously been designated as sanctuaries, which provide legal protection against oyster harvest. In Virginia, sanctuary areas are often interspersed within harvest areas in tributaries. In some tributaries, Virginia employs a rotating system in some tributaries where areas are protected from harvest for a few years, then opened. Virginia regulations annually specify the areas open for harvest for all tributaries. All areas not open for harvest and not leased are closed to harvest. Some public areas are not part of the harvest areas and therefore have remained closed to harvest. Working to ensure that restored oyster reefs are protected for the long term is a priority for restoration partners. In addition, enforcement against poaching is crucial to protecting the restoration investment and to allow the oyster population and habitat to increase in those areas.

Approaches Targeted to Local Participation

Communication and outreach to local communities, especially those in close proximity to restoration sites, is essential for the long-term success of large-scale oyster restoration. A restored oyster population has the potential to return filtering functionality to shallow-water habitat in the Bay. However, poor land management and further degradation of water quality will jeopardize any gains. Ultimately, water quality benefits provided by oyster restoration will rely on sustainable land management and development. Efforts being undertaken to support the Chesapeake Bay Restoration and Protection Executive Order and the nutrient reduction goals established in the Chesapeake Bay Total Maximum Daily Loads (TMDL) will help address water quality issues. The Executive Order goals targeting water quality, habitat and fish and wildlife are directly related to achieving the goals presented in the master plan. Opportunities to match oyster restoration efforts, spatially and temporally, with land management projects should be implemented to the greatest extent.

Cross-Outcome Collaboration and Multiple Benefits

More information can be found in the "Factors Influencing" section on pages 4-7.

- Water quality: Improvements to water quality (nutrients, sedimentation, etc.) will help promote the long-term success of oyster reefs in selected tributaries and throughout the Bay.
- Climate change: Increasing levels of carbon dioxide in the water can change acidification rates resulting in less natural shell available to support oyster populations in restored reefs and throughout the Bay.
- Citizen stewardship: Public support and engagement throughout the restoration process are essential for the protection of restored tributaries.

VI. Monitoring Progress

Monitoring for the oyster restoration outcome is a complex process that will measure progress at three major levels:

1. Baywide Level:
   The Chesapeake Bay Program and the Maryland and Virginia Oyster Restoration Interagency Workgroup partners will measure progress at a broad scale by tracking progress toward the outcome of 10 restored tributaries by 2025. The status of each selected tributary will be tracked as it is selected, plans and targets are developed, implementation takes place, and monitoring begins. Partners will also note how many tributaries still need to be selected to reach a total of 10.

2. Tributary Level Implementation:
   Partners will track progress toward achieving the specific restoration acreage targets for each tributary. This includes tracking acres of reefs built and restoration treatment (putting down reef substrate and seeding).

3. Reef and Tributary Level Post-Implementation:
   Monitoring of tributaries will take place for six years after implementation is complete to gather data that will be used to determine if the tributary has been successfully restored (see "Assessing Progress" section). The Oyster Metrics Report (pg. 13-21) outlines a

monitoring protocol to measure progress toward the established targets and thresholds. The report calls for required monitoring of specific parameters including the structure of the restored reef, population density and total reef population/biomass estimate.

Successful completion of the monitoring protocols is contingent upon adequate funding and human resources available each year. Participation and support is necessary from all restoration partners, including federal and state agencies, nonprofits and research institutions. A tributary cannot be declared "restored" until this long-term monitoring protocol is complete and the success metrics have been met.

VII. Assessing Progress

Success in oyster restoration efforts will need to be evaluated on several levels over varying spatial and temporal scales. Targets and metrics of operational success are required to guide restoration activity, such as what percentage of a historical bar or other area should be planted with shell or spat-on-shell. Monitoring of individual reefs following initial restoration activity will be required to determine success at various stages by evaluating recruitment success, early post-settlement or post-planting survival, natural mortality, disease status, growth, reproduction and shell accumulation. Ecosystem services benefits will also be evaluated using controlled experiments and modelling studies to quantify the benefits of oyster restoration in specific tributaries. The Oyster Metrics Report (pp. 21-23) summarizes the goals, assessment protocols, assessment frequency, and success measures established by the Oyster Metrics workgroups.

VIII. Adaptively Manage

The Partnership will use the following approaches to ensure adaptive management.

- Specific to tributary-scale oyster restoration, the Oyster Metrics Report (pg. 24) describes adaptive management to "makes use of knowledge gained through data collection to refine both targets and metrics in route to meeting its ultimate goal." New research and data will be used to reevaluate specific tributary acreage targets and the success metrics to reflect the best available knowledge and experience from oyster restoration in the Bay.

- In addition to refining tributary targets and metrics as stated above, restoration partners will consider new knowledge that arises from future experience and research. These factors include new construction techniques, reef design, use of alternative substrate, etc.

- The status of the restored oyster reefs will need to be monitored and assessed in the long term to determine if restoration has achieved the desired ecosystem changes. This ecosystem change will take time, and previous restoration sites may need additional restoration treatment (shell replenishment, additional substrate and/or seeding) in the future to maintain the health of the oyster reefs.

IX. Biennial Workplan

Biennial workplans for each management strategy will be developed by December 2015. They will include the following information:

- Each key action

- Timeline for the action
- Expected outcome
- Partners responsible for each action
- Estimated resources

References

Fishery Management Planning & Coordination Workgroup. 2004 Chesapeake Bay Oyster Management Plan. Chesapeake Bay Program Living Resources Subcommittee. U.S. Environmental Protection Agency.

Oyster Metrics Workgroup. Restoration Goals. 2011. Quantitative Metrics and Assessment Protocols for Evaluating Success on Restored Oyster Reef Sanctuaries. Report to the Chesapeake Bay Program Sustainable Fisheries Goal Implementation Team. Link

U.S. Army Corps of Engineers Baltimore and Norfolk Districts. 2012. Chesapeake Bay Oyster Recovery: Native Oyster Restoration Master Plan – Maryland and Virginia. Link