# 2015 Maryland FMP Report (September 2016)
# Section 14. Eastern Oyster (*Crassostrea virginica*)

Oyster biomass in the Maryland portion of Chesapeake Bay has declined slightly since last year, a result of recent declines in recruitment and an increase in harvest. The biomass index for 2015 was the third highest in the 26 year time series, reflecting strong survivorship of the 2010 and 2012 year classes. Both MSX and dermo disease levels increased since last year, but both diseases remain below long-term average levels. The 2015 baywide spatfall index, a measure of reproductive success and an index of potential population increase, was 34.2 spat/bushel: 50% higher than the 31-year median value and three times as high as last year's value.

Maryland remains committed to restoring five oyster tributaries. Oyster restoration reached a milestone in 2015 with the completion of initial reef construction and seeding in Harris Creek. The Harris Creek effort is the largest oyster restoration project ever attempted in the U.S. Work continues in the Little Choptank River and the Tred Avon River, Maryland's other active tributaries. Of note in the Tred Avon River, was the construction of 16 acres of seeded habitat in 2016. Eight acres of oyster reef under the U.S. Army Corps of Engineers (USACE) was placed on hold at the request of the Maryland Department of Natural Resources (MDNR) pending the release of a 5 year review report of the sanctuary program.[1] Based upon favorable results in the report and a supportive recommendation by the Maryland Oyster Advisory Commission (OAC), the MDNR Secretary asked the USACE to resume the project. Two remaining restoration tributaries are slated for selection in 2017. The selections will be based on recommendations by the OAC and public input.

**Chesapeake Bay Oyster Management**

The Chesapeake Bay Oyster Management Plan was adopted in 1989 and revised in 1994 and 2004. The 2004 management plan provides both a general framework and specific guidance for implementing a strategic, coordinated, multi-partner management effort for oysters in the Bay.[2] The management plan defines several strategies for rebuilding and managing native oyster populations: evaluating the use of sanctuaries and harvest reserves to obtain optimum ecological and economic benefits; rebuilding habitat; managing harvest; increasing hatchery production; evaluating the impediments to aquaculture; improving coordination among the oyster partners; and developing a bay-wide database to track restoration projects. The 2004 management plan was reviewed and amended in 2010. Amendment 1 to the management plan allows aquaculture and clamming within sanctuaries, the use of new enforcement measures to protect sanctuary areas, and the implementation of sanitation guidelines.[3] The Plan Review Team concluded that the framework for managing oysters was still appropriate but that the strategies and actions had changed considerably because of the Maryland 10-point Oyster Restoration and Aquaculture Development Plan. The 10-point plan increased the network of oyster sanctuaries from 9% of available habitat to 24%, identified areas for oyster aquaculture with a streamlined permitting process, and recommended a more targeted, scientifically managed, sustainable public fishery. The sanctuary expansion leaves 176,035 acres of natural oyster bar available for the public oyster fishery. Based on these initiatives, the Plan Review Team recommended a complete revision of the management plan. Revision of the plan is on hold, however, until the Maryland OAC has a chance to review the department's July 2016. The report assessed sanctuaries, public shellfish fishery areas, and aquaculture program.[1] The OAC is in the process reviewing the report and is expected to make recommendations to the MDNR on adjustments to sanctuary and public fishery areas. The Maryland OAC was established in 2007 and new commissioners were appointed in 2016 The Secretary of MDNR assigned the OAC three tasks: to recommend whether or not to proceed with oyster restoration in the Tred Avon River, to recommend two additional tributaries for large-scale oyster restoration, and to suggest adjustments to oyster sanctuary and public fishery areas if warranted.

An oyster workgroup established by the Sustainable Fisheries Goal Implementation Team of the Chesapeake Bay Program in 2010, developed quantitative oyster restoration metrics, defined sampling protocols, and provided assessment techniques for sanctuary reefs. The group completed a consensus document (December 2011) describing a minimum suite of goals and metrics.[4] A restored oyster reef should have a minimum of 15 oysters and 15 grams of biomass per square meter covering at least 30% of the reef with at least two year classes of oysters on each reef.[2]

In 2014, the Chesapeake Bay Program adopted the Chesapeake Watershed Agreement.[5] Since then, a management strategy and a biennial work plan (2016-17) were completed that detail necessary actions to reach the oyster outcome: the restoration of oyster reefs in 10 tributaries by 2025.[6] To date, six tributaries have been selected for oyster restoration, Harris Creek, the Little Choptank River and Tred Avon River in Maryland and the Lynnhaven, Lafayette and Piankatank Rivers in Virginia. The restoration projects are a joint effort among the state agencies (MDNR and VMRC)*, federal agencies (NOAA, USACE)*, non-profit organizations (ORP, NFWF, TNC, and CBF)*, and consulting scientists (University of Maryland, VIMS, SERC, and Morgan State University)*. Both Maryland and Virginia are in the process of determining the next tributaries for restoration. The Maryland OAC will be providing input on the two next tributaries for restoration in Maryland during 2017.

**Stock Status**

Based on harvest reports and the DNR dredge survey data, the oyster population has improved over the past few years. The 2015 Maryland oyster biomass index (a measure of relative oyster abundance and weight) dipped slightly from the two previous year's record highs, which had more than doubled the 2010 Index (Figure 1). Nonetheless, the 2015 biomass index value of 1.77 was the third highest of the 26-year time series, reflecting the high oyster survivorship over the past few years,

particularly the strong 2010 and 2012 year classes. The slight decline was the result of mediocre spat sets over the past three years and an increase in harvesting activity. The 2015 spatfall index, a measure of reproductive success and an index of potential population increase, was 34.2 spat/bushel, 50% higher than the 31-year median value and three times as high as last year's value.[7] Most of this gain occurred in southern Maryland where the north shore of the lower Potomac River experienced the best spat set in nearly a third of a century. However, spatfall generally was average to poor up-bay from Solomons, with large expanses of the upper and middle Bay and the upper Potomac River receiving no spat whatsoever (Figure 2). By comparison, the lower Potomac River received its highest spat set in 33 years. The Potomac River Fisheries Commission (PRFC) closed this area to harvest to protect the spat. To mitigate the loss of harvest opportunity, several hand-tong areas in the upper Potomac were opened to hand-scraping. The protected areas will reopen for the 2016-2017 season and the upper Potomac areas will revert to hand-tong only. Production of oyster larvae and spat by the hatchery at the University of Maryland's Center for Environmental Science (UMCES), Horn Point, remained high with 945 million spat and 3.6 billion larvae produced in 2015.

Two oyster parasites, *Perkinsus marinus* (dermo) and *Haplosporidium nelsoni* (MSX) impact oyster survival and population growth. The distribution and abundance of both diseases are influenced by environmental factors, especially temperature and salinity, and can vary from year to year. During 2015, the prevalence (percentage of oysters with the disease) of dermo disease was 61% (lower than the 31-year average) with a mean infection intensity of 2.1(a value close to average). MSX continued at low levels (2015 prevalence 7%), mainly as a result of lower salinities unfavorable to the disease. As a result, total natural oyster mortality (including disease-related mortality) during 2015 was relatively low at 14%.[7]

Stock assessment methodology studies were conducted in 2009-2010.[8] The studies included a spatial analysis to determine the appropriate scale for oyster population processes and the development of two oyster stock assessment models. The models were fitted to harvest data from the fishery and relative density data from the fall dredge survey. The models estimated mortality rates and abundance. Both approaches found a substantial decrease in oyster abundance during the study periods. Recommendations were made to improve data collection from the fishery and the fall survey. MDNR has addressed some of the recommendations by requiring more accurate harvest data (catch & effort). For the fall survey, the number of bars where all oysters in a sample were measured was expanded to approximately 30% of the sample locations.

In 2016, the Maryland General Assembly passed the Sustainable Oyster Population and Fishery Act, requiring the MDNR, in conjunction with the UMCES, to conduct a stock assessment and develop biological reference points for management of the oyster fishery. Maryland DNR has begun coordination with the UMCES in this endeavor.

**Current Management Measures**

There are three concurrent approaches to managing oysters in the Chesapeake Bay: ecological restoration; a sustainable public fishery; and aquaculture. Ecological restoration will meet the goal of the Chesapeake Bay Program's Watershed Agreement (2014) to restore oysters to 10 tributaries by 2025 (5 each in Maryland and Virginia). Harris Creek was selected as Maryland's first restoration area. Initial restoration efforts (reef construction and seeding or seeding only on suitable bottom) in Harris Creek were completed in 2015 with 350.9 acres planted with oyster seed or substrate with oyster seed. Three years after planting, the first 12 reefs to be restored within the creek all meet the minimum restoration density of 15 oysters/$m^2$ over 30% of the reef area**.**[9] The Little Choptank River was selected as Maryland's second priority area for targeted oyster restoration with a goal of440 acres. As of 2015, 127.5 acres of reef have been constructed in the Little Choptank River and initial restoration is complete on 45.8 acres. The Tred Avon has been selected as Maryland's third area for oyster restoration with a goal of 147 acres. As of 2015, USACE has constructed 16 acres of reef and initial restoration efforts (substrate and seed) are complete on 2.6 acres. After a delay in restoration efforts to await the results of the oyster review (July 2016), the USACE will resume the construction of oyster reefs in the Tred Avon in 2016.

Maryland's oyster harvest has been approximately 100,000 bushels annually since 2002. Historically, the annual harvest averaged 2.5 million bushels (1920-1969) and 1.3 million bushels (1970-2002) (Figure 3**).** The preliminary harvest estimate for the 2015-2016 season is 383,090 bushels, similar to last season's harvest. The relatively higher harvest is due to strong recruitment in 2010 and 2012. Harvest season, workday and workweek lengths, regional gear restrictions, a 3" cull size, and daily catch limits by gear type are enforced for the public fishery. MDNR began implementing a procedure for tagging each container (bushel) of oysters during the 2011-2012 oyster season. Tagging procedures follow the requirements of the National Shellfish Sanitation Program to protect human health by allowing any contaminated shellfish to be traced to a specific harvest area.

Oyster legislation passed in 2011 included the expansion of lease areas, authority for MDNR to revoke commercial licenses for poaching violations, transfer of the Seafood Marketing and Aquaculture Program from the Department of Agriculture to the DNR, and a requirement for the Department of Environment to use the most reliable data to determine whether shellfish production areas pose risks to consumer health. A $2.2 million financial assistance program was established to aid watermen in aquaculture endeavors. An aquaculture training and education program is also underway. The program includes a series of training publications and the sponsorship of two statewide aquaculture conferences. Through a partnership with ORP, MDNR provides field support for in-the-water activities of oyster aquaculture production. MDNR has implemented an electronic notification system for

leaseholders. Beginning in 2013, leaseholders were required to submit monthly harvest reports. Oyster aquaculture continues to expand in Maryland. In 2015, 62 lease applications were received and 56 leases were issued. As of July 31, 2016, there were 386 leases totaling 6,062 acres in use for growing shellfish. The preliminary harvest estimate from leases in 2015 was 50,637 bushels. The preliminary harvest estimate from leases from January 1 through July 31, 2016 is 41,292 bushels.

In February 2016, Virginia began moving toward a limited-entry fishery by freezing the number of Oyster All Gear User Fee holders. If an oyster harvester does not renew the Oyster Resource User Fee in a particular year, it will be lost. Transfers are allowed between direct family members as well as any oyster harvester that has 40 days of harvest the previous calendar year. Once the number of fee holders drops to 600, there will be a lottery for any open spots in the fishery.

The PRFC has instituted a cooperative aquaculture program where those who pay a fee may harvest oysters planted on a managed reserve. In 2015, the program planted 3,960 bushels of triploid spat on 11 acres. Watermen harvested 1,641 bushels of market-sized triploid oysters from a 5 acre reserve planted earlier.

**Citizen Involvement**

The Marylanders Grow Oysters (http://www.oysters.maryland.gov) program engages waterfront property owners in growing young oysters in cages suspended from private piers. The young oysters are protected during their first year and then planted on local sanctuaries. The program has planted about 8 million oysters in sanctuaries since it began in 2008, and has grown from about 850 cages the first year to over 7,500 cages in 2015. The program includes approximately 3,000 growers on 31 tributaries. Additionally, over 2,000 school students through educational programs are involved in oyster gardening as part of their curriculum.

**Issues/Concerns**

A major issue for oyster recovery is the continued degradation and loss of habitat. It has been estimated, but not definitively confirmed, that approximately 70% of oyster habitat has been lost from 1980 to 2009.[10] A healthy and robust oyster resource in the bay relies on appropriate substrate for the setting of young oysters. The preferred substrate, natural oyster shell, is scarce; there is not enough fresh shell to meet the needs of the public fishery, aquaculture, and restoration. Currently, MDNR directs most fresh shell to the Horn Point hatchery because in most areas of the bay it is more cost effective to put the fresh shell with spat attached on the bottom rather than relying on natural spat set.

The shortage of shells has led to the use of alternative substrates to restore oyster reefs. In 2013 and 2014, MDNR used 90,127 cubic yards of fossil oyster shell from Florida and 133,471 cubic yards of Maryland stone to construct oyster reefs in Harris Creek and the Little Choptank River. To encourage recycling of oyster shells, the ORP has developed the Shell Recycling Alliance, a group of 300 restaurant owners, caterers, seafood distributors and citizens, as a mechanism for collecting shells for habitat and seed. Since the inception of the program in 2010, 90,000 MD bushels of shell have been recycled with an additional 26,005 bushels in 2015. Since July 2013, residents and businesses can receive a tax credit per bushel of recycled oyster shell up to $750 per year. This year MDNR applied for an application to dredge shell from Man O' War Shoal to acquire shell for enhancement of oyster habitat. A decision from USACE is pending.

The increase in sanctuary areas and aquaculture activities require additional law enforcement. Natural Resources Police (NRP) are using the Maritime Law Enforcement Information Network (MLEIN). The network is a system of cameras and radar units that can monitor vessel location and movements. Although this system was primarily intended to provide homeland security and assistance to distressed boaters, it allows NRP to gather and store evidence of illegal activity, especially in sanctuary areas. MLEIN has resulted in more arrests and more convictions of poachers than in previous years. An improved penalty system has resulted in license suspensions and revocations.

**References**

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***Acronyms**

CBF – Chesapeake Bay Foundation
MDNR – Maryland Department of Natural Resources
MLEIN – Maritime Law Enforcement Information Network
NFWF – National Fish and Wildlife Foundation
NOAA – National Oceanic and Atmospheric Administration
NRP – Natural Resources Police
OAC – Oyster Advisory Commission
ORP – Oyster Recovery Partnership
PRFC – Potomac River Fisheries Commission
SERC – Smithsonian Environmental Research Center
TNC – The Nature Conservancy
UMCES – University of Maryland Center for Environmental Science
USACE – U. S. Army Corps of Engineers
VIMS – Virginia Institute of Marine Science
VMRC – Virginia Marine Resources Commission

Figure 1. Maryland oyster biomass index, a measure of relative oyster abundance and weight, 1993 - 2015. Values are relative to 1993 biomass, which was set at a value of 1.[7]

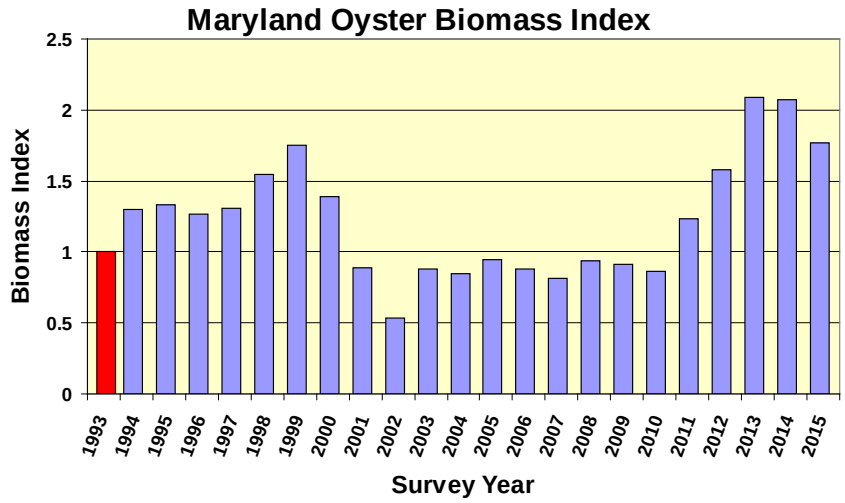


Figure 2. Maryland spatfall intensity index (spat per bushel) from "key bars" including rankings of statistically similar indices, 1985-2015 (MDNR Fall Survey Report, 2015). The statistical tiers provide an indication of the extent and contribution of spat from different geographic areas. To illustrate: although the 1997 spat index was the second highest index on record and an order of magnitude higher than other Tier 3 indices, it was a Tier 3 level because only 5 out of 53 key bars accounted for over 75% of the index.[7]

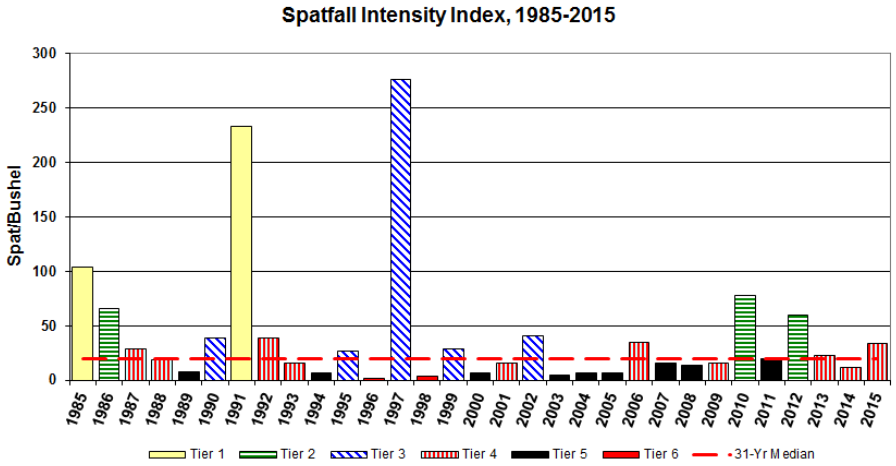
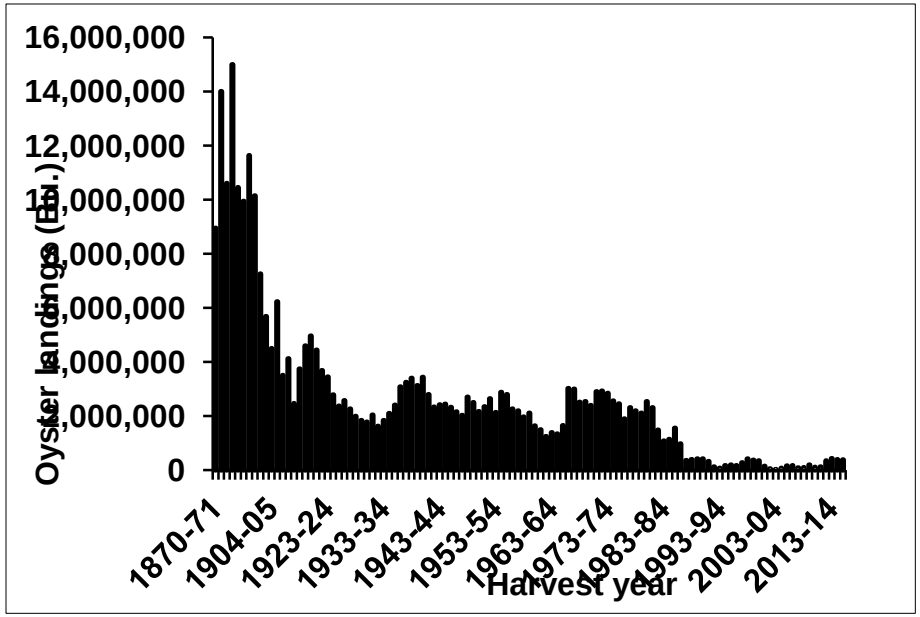


Figure 3. Maryland commercial oyster harvest, 1870 – 2015.
Landings data for 2015-2016 are preliminary.



| **2004 Oyster Management Plan (OMP) Implementation Table** (updated 9/2016) | | | |
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| **Section** | **Action** | **Date/ Responsible agencies** | **Comments** |
| Disease Strategy<br>3.1A. Utilize disease management in all aspects of restoration & harvest to minimize spreading disease<br><br>3.1B. Develop & implement disease strategies within each of the 3 designated salinity zones. | 3.1 Conduct an analysis of how disease management might affect overall survival and productivity. Answer the following question: What management strategies will help increase biomass over a large scale and in the long-term? | Continue<br>Univ. of MD, VIMS, MDNR, and VMRC. | Modeling and assessment frameworks were utilized through the PEIS process to evaluate the benefits of disease management strategies. They included developing and testing of disease tolerant strains for aquaculture; implementing geographically distinct, large-scale oyster restoration (VIMS/NOAA funding); and producing disease-free spat on shell (ORP/UMCES). Scientific research results indicate the need for a cautionary approach to using disease resistant strains for restoration (see Action 6.3.1). Maryland has adopted a new approach for managing against oyster disease. Maryland will use a targeted restoration approach to facilitate the evolution of natural disease resistance, while managing against the spread of disease. Sanctuaries located in areas with salinities >14 ppt will encourage the development of disease resistance through natural selection. **However, the supply of larvae from low-salinity disease refuges may slow the development of disease resistance.** |
| | 3.2 Increase hatchery production to supplement natural recruitment and mitigate the prevalence of *P.marinus* (refer to Chapter VI Hatchery Production for additional details) | Continue<br>Univ. of MD, VIMS, MDNR, aquaculture industry | Additional State and Federal funding has resulted in an increase in hatchery production from 38 million spat in 2000 to over 1.2 billion in 2013. Over the years hatchery production has increased: 750 million spat (2009); ~450 million spat (2010); over 600 million spat (2011); over 800 million spat (2012)**,** 1.2 billion spat (2013), and 972 million spat (2014). **The hatchery produced 945 million spat in 2015**. Production is dependent on spawning success in the hatcheries, availability of cultch, and long-term funding to operate the hatcheries at full capacity**.** VIMS started an Oyster Aquaculture Training program to provide skilled technicians in oyster husbandry for both hatchery and field operations. ORP has supported UMCES hatchery infrastructure and capacity (MDNR/NOAA funding). |
| | 3.3 Establish broodstock sanctuaries in heavily infected areas to possibly produce disease resistant seed. (See Chapter IV Sanctuaries for more details). | Open<br>MDNR, VMRC, ORP, VA Corps | Sanctuaries have been established in a variety of areas throughout the Bay to produce self-sustaining populations of oysters. **Sanctuary areas were evaluated in 2016 and the Maryland Oyster Advisory Commission is formulating recommendations on changes to sanctuary areas.** |
| | 3.4 Develop, implement and maintain a seed policy to reduce and minimize disease impacts. | 2004<br>2007<br>Continuing | MDNR developed a new policy with additional restrictions, however**,** beginning in 2007 no seed was available to move and very little was moved in 2008 & 2009 to the present. VIMS has a long standing advisory to the state (VMRC) against moving diseased seed. Both MD & VA have oyster advisory committees to provide advice on seed policy issues as they arise. |

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| | 3.5 Implement oyster surveys as necessary to obtain the best estimates of oyster population data: a) Increase the frequency & spatial intensity of sampling; b) Seek additional funding. | On-going | MDNR funded a project (UMCES) to develop spatially-explicit assessment tools for the oyster stock in Chesapeake Bay. The project evaluated current data collection, recommended improvements to data collection and evaluated the feasibility of including environmental factors into assessment models. Maryland has addressed some of the recommendations by requiring more accurate harvest data and increasing the number of fall survey samples in which all oysters are measured. DNR/ MGS & NOAA are continuing to coordinate field operations to characterize benthic habitat. DNR is surveying oyster sanctuaries to obtain population estimates. **In 2016 the Maryland General Assembly passed the Sustainable Oyster Population and Fishery Act, requiring MDNR, in conjunction with the UMCES, to conduct a stock assessment develop biological reference points for management of the oyster fishery. MDNR and UMCES have begun coordination on this endeavor.** |
| Sanctuaries<br>Strategy 4.1 A network of clearly marked oyster sanctuaries will be established throughout the Chesapeake Bay and its tributaries<br><br>Strategy 4.2. Utilize the steps outlined in the OMP for establishing oyster sanctuaries throughout the bay. | 4.2.1 Decisions on where to locate sanctuaries will be guided by the Virginia Oyster Restoration Plan developed by VIMS and VMRC and Maryland's Priority Restoration Areas developed by MDNR and the Maryland Oyster Roundtable Steering Committee. The maps will be used as a preliminary tool to focus restoration activities<br>(The MD Oyster Roundtable has been replaced by the Oyster Advisory Commission) | 2004<br>2009<br>On-going | MDNR supported a study to determine the best productive oyster bars within Maryland and used the results to develop a 10 point Oyster Restoration and Aquaculture Development Plan. Based on this study, new sanctuaries were established in 2010. **The Maryland OAC will recommend changes to the Maryland sanctuaries based on a 2016 review of sanctuary performance.** Six tributaries have been selected for oyster restoration, Harris Creek, the Little Choptank River and Tred Avon River in Maryland and the Lynnhaven, Lafayette and Piankatank Rivers in Virginia**. Initial restoration has been completed in Harris Creek and continues in the remaining five tributaries. The Maryland OAC is in the process of recommending two additional tributaries for restoration.** |
| | 4.2.2 Utilize existing protocols & standard operating procedures for recording or charting GPS coordinates for oyster sanctuaries in order to verify locations and track restoration progress. | Beginning in 2005<br>2008/2009<br>On-going | Protocols have been developed to delineate and mark sanctuary areas**.** Bay jurisdictions continue to track restoration progress. **Maryland oyster sanctuaries are marked with buoys; locations are shown on maps provided to watermen. Restoration progress is tracked using a geo-database.** |
| | 4.2.3 Evaluate the use of alternative cultch material because all restoration efforts depend on the availability of suitable habitat and traditional shell dredging cannot support the scale of the current & future sanctuary initiative. | On-going | A study on alternative cultch material in MD was conducted in various salinities & the report is on file with MDNR. VIMS and the USACE released a report on the effectiveness of alternative materials (2006). The function of alternative substrates is to provide a firm base for a constructed oyster bar. Alternate materials to replace natural oyster shell can be expensive. MDNR used Florida fossil shell to construct reefs in Harris Creek and Little Choptank River. The shell performed well both as a substrate for natural settlement and as a platform for spat on shell. **MDNR has applied for a permit to dredge shell from Man o' War Shoal and is awaiting a decision from the USACE.** |

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| | 4.2.4 Develop and implement techniques to locate and recover buried shell or shell with layers of sedimentation using vacuuming, bar cleaning or other innovative methods. | 2005<br>2009<br>On-going | MD obtained a permit for a reclamation program that will provide up to 25 million bushels of shell. The MDNR/MGS and NCBO bottom survey program provided information to prioritize areas and facilitated decisions on shell reclamation techniques. In 2012, 550,850 bushels of previously-planted shells were reclaimed; 370,900 bushels were placed on fishery bars and 179,950 bushels were purchased by leaseholders. ORP started a Shell Recycling Alliance and collected approximately 15,000 bushels of shell in 2012. Beginning in 2013, a tax credit up to $750 is allowed for recycling oyster shell. |
| | 4.2.5 Increase hatchery production to support restoration needs. Current seed levels are too low to effectively stock sanctuaries (see Chapter VI Hatchery and Aquaculture). | 2005 | See comment for Action 3.2. The question of what is an effective quantity of hatchery seed in sanctuaries is unknown. |
| | 4.2.6 Monitor areas to evaluate oyster population status and measure progress towards the commitment to increase oyster biomass by 10-fold. | On-going<br>MDNR, VIMS | **The 2015 estimate of Maryland oyster biomass was down slightly from the previous two years, but still the third highest in the 26 year time series and 77% greater than the 1993 baseline.** Maryland's biomass estimate is based on the annual fall survey data and an estimate of available oyster habitat. Documentation for MD's methodology for calculating biomass estimates is available in the PEIS. There is a need to improve the data, especially the habitat estimates that support the biomass calculations. **MGS and NOAA are using sonar to refine habitat estimates.** Criteria for determining a restored oyster reef were adopted in 2011. Jurisdictions are focusing on restoring targeted tributaries, Harris Creek, Little Choptank River and Tred Avon River (MD) and the Lynnhaven, Lafayette and Piankatank Rivers (VA). **The first reefs constructed and seeded in Harris Creek meet the minimum density goal of 15 oysters/$m^2$ over 30% of the bottom.** |
| Sanctuaries (cont'd)<br>Strategy 4.3 Management actions within sanctuaries are primarily based on salinity zones and focus on three key factors: growth, reproduction and disease. The zonal approach to management provides general guidelines for selecting project objectives and anticipating project results in each area | Strategy 4.3.A: Zone 1 (5ppt to <12ppt) Increase biomass & enhance reef habitat. Enhance reef/ bottom habitat to increase oyster biomass and promote the development of living oyster reefs with broad size/age class structure that supports a diverse reef community<br><br>Action 4.3.A.1 Identify priority areas in Zone 1 that would have the most success at reaching the defined project objectives<br><br>Action 4.3.A.2 Rehabilitate and maintain oyster bottom habitat to provide planting substrate for seed oysters and optimal conditions for larval settlement<br><br>Action 4.3.A.3 Plant hatchery produced SPF seed, if necessary, over several years to establish an oyster population with a diverse age class structure | 2005<br>**On-going** | MD is implementing a 10-Point Oyster Restoration Plan that focuses on targeted restoration strategies, expands the sanctuary program, rehabilitates oyster habitat, manages against disease, increases hatchery production, and enhances law enforcement. **The first three tributaries chosen for large-scale oyster restoration are located in Zone 2 to balance good reproduction with lower disease pressure.** |

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| | Strategy 4.3.B: Zone 2 (12-14ppt) Transition Area: The boundaries of Zone 2 shift because of variations in rainfall and resulting salinity. Consequently, Zone 2 will exhibit fluctuations in spat settlement and disease mortality. Projects in this zone must utilize current environmental data during planning.<br><br>Action 4.3.B.1 Critically examine long-term environmental conditions and develop relevant project objectives for sanctuaries in Zone 2.<br><br>Action 4.3.B.2 In the areas that have predominantly Zone 1 characteristics, utilize Zone 1 guidelines and in areas that have predominantly Zone 3 characteristics, utilize Zone 3 guidelines. | | |
| | Strategy 4.3.C (>14ppt) Develop Disease Tolerance:<br>It is not certain that disease resistance can develop via a management approach in Zone 3. The strategy will be to promote the development of disease resistance where disease mortality is high<br><br>Action 4.3.C.1 Reestablish and maintain bottom habitat for oyster spat settlement and growth of disease resistant adults<br><br>Action 4.3.C.2 Monitor Zone 3 sanctuaries to determine the effects of disease mortality<br><br>Action 4.3.C.3 Utilize Zone 3 as an area to test laboratory strains of disease resistant oysters<br><br>Action 4.3.C.4 Limit the use of natural seed to sanctuaries in Zone 3. The use of natural seed in repletion areas is allowed as long as disease protocols are followed. | | |
| Sanctuaries (cont'd)<br><br>Strategy 4.4<br>The jurisdictions will establish oyster sanctuaries to promote maximum ecological value | Action 4.4.1 Identify areas of special interest throughout the Bay, especially areas that may retain larvae (maybe auto-recruiting), and protect them using the sanctuary status | **On-going** | The Great Wicomico, Lynnhaven and Lafayette Rivers have been identified as areas of special interest in VA**.** MD has established sanctuaries based on protecting 25% of the state's most productive areas as identified by an analysis of the annual fall survey data. **UMCES developed a model to predict where oyster larvae will be transported throughout Harris Creek and surroundings. This research will help identify locations for restoration activities that may result in larval retention and supply of larvae to areas outside the sanctuary. The USACE Master Plan for Native Oyster Restoration contains estimates of flushing time for many tributaries, a parameter contributing to larval retention.** |
| Strategy 4.5<br>Implement the actions described in chapter III to address disease problems. | Action 4.5.1 Utilize only SPF hatchery seed in sanctuaries designated for oyster biomass accumulation, Zone 1 and Zone 2. | On-going | Two workshops held in 2007 provided guidance on the role of hatchery-based oysters used for restoration. Using domesticated strains has not improved survival or resulted in higher recruitment. Preserving local wild stocks is preferred since data suggest some level of natural disease |

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| In addition, the jurisdictions will take further action to minimize the spread of disease | Action 4.5.2 Place hatchery seed on newly created sanctuary bottom and not on top of infected oyster populations in order to prevent rapid infection of the disease-free seed<br>Action 4.5.3 Continue to prohibit the movement of infected oysters from higher salinity waters onto newly or previously created sanctuaries in Zone 1 | On-going | resistance is occurring (VIMS). **2015 Maryland dermo disease prevalence was below the long-term average. MSX prevalence increased and the parasite's range expanded up-bay. Although mortality remains low, it is difficult to separate the effects of environmental conditions, especially temperature and salinity, from improved survival due to disease resistance.** |
| Sanctuaries (cont'd)<br>Strategy 4.6 To facilitate the enforcement of closed areas, especially sanctuaries, implement the following actions: | Action 4.6.1 Sanctuaries will be placed in geographically distinct areas with enough space to create a buffer zone between harvest and sanctuary areas to enable enforcement<br>Action 4.6.2 Sanctuaries will be buoyed and marked<br>Action 4.6.3 The public and judiciary will be notified about sanctuary areas through educational initiatives, public announcements and stakeholder meetings<br>Action 4.6.4 New enforcement measures will be identified and implemented. Additional manpower will be recommended if necessary | Began in 2003 and continue | State agencies are responsible for marking sanctuary areas but sanctuaries continue to experience enforcement problems. New enforcement strategies have been developed to address this issue. See strategy 5.4. During 2009, MDNR provided educational materials to the court system and implemented a pilot program in Anne Arundel County to establish a Natural Resource Day in court. This system has proven successful and more than half of Maryland counties attempt to group natural resources cases. MDNR also provided in-service training to NRP officers on all fishery issues especially regarding oysters. The use of MLEIN has led to more arrests and conviction than in previous years. The new penalty system has resulted in license suspensions and revocations. **Sanctuaries are marked with buoys and the locations marked in closure books distributed to all watermen**. |
| Managing Harvest<br>Strategy 5.1 Establish sanctuaries & special management areas thereby reducing F & develop appropriate biological reference pts. | Action 5.1.1 Establish a network of sanctuaries (refer to Section 1.IV for details) and special management areas throughout the Bay to limit harvest and increase oyster production | Continue | In 2008 4% of quality oyster habitat was in sanctuary. This area was increased to 9% in 2009. In 2010, the MD 10-pt Plan increased the total area designated as oyster sanctuaries to 24%. The plan allows approximately 176,035 acres of natural oyster bars for the public oyster fishery. **The Maryland OAC is currently reviewing the sanctuary and fishery areas and may recommend changes.** VA has a combination of 3-dimensional oyster reefs and acreage set aside as sanctuary areas. More than 100 reefs have been constructed throughout VA's portion of the Chesapeake Bay. |
| | Action 5.1.2 Define appropriate biological reference points for the oyster resource based on the results of the bay wide stock assessment | 2007/2008<br>2010 | MD is working on developing BRPs. Wilberg and Miller's (2010) study indicated that exploitation rates have been around 25%. Assessments of oyster populations on specific bars are being conducted. **Harvester tagging regulations have yielded data on bar-specific exploitation rates and serve as a check on dealer reports. These data may be used in the development of BRPs. MDNR will be working with UMCES to develop a stock assessment and biological reference points for management of the oyster population.** |
| | Action 5.1.3 Utilize the disease guidelines and actions presented in Section 1.III in all aspects of special management areas and the fishery | 2005 | Continuing |
| | Action 5.1.4 Control oyster harvest to reach an appropriate F determined by the Oyster Scientific Committee. | 2007/2008 | Oyster harvest is controlled through a number of regulations by MDNR & VMRC. If BRPs are determined, a target and threshold F will be defined. **Virginia has initiated an effort to reduce the number of oyster harvesters by freezing and then lowering the number of Oyster All Gear User Fee holders. PRFC has instituted a cooperative aquaculture program in which people may pay a fee to harvest oysters planted in a managed reserve.** |

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| Strategy 5.2. Develop guidelines for managing fishing effort and monitoring oysters in open and closed areas. | Action 5.2.1 a) Determine the criteria for opening and closing areas; b) Monitor population; c) Determine level of acceptable exploitation; d) Regulate harvest and gear type; e) Develop additional monitoring if necessary; f) Close area when harvest criteria are met. | 2005<br>On-going | Criteria for opening/closing harvest reserves have been developed. The managed reserves are opened to harvest only upon approval by the State and when 50% or more of the oysters are 4" in size. The 4" size limit allows the oysters an additional year to provide ecological services **and an extra year to reproduce. Reserves located in sanctuaries were harvested for a final time, with those areas then becoming part of the surrounding sanctuary. All but 2 of the remaining harvest reserves have reverted to the public fishery.** |
| | Action 5.2.2 Utilize the site selection criteria set forth in the OMP to select special management areas (see Section 2 for details). | 2005<br>Continuing | All oyster partners are managing oysters according to the salinity zones specified in section 2. Zone 1 (5-12 ppt) management involves the enhancement of populations by the planting of shell and seed. Zone 3 (>15 ppt) management involves the development of disease-resistant natural populations as well as the maintenance of hard substrate for spat settlement. Zone 2 (12-14 ppt) involves a mixture of these approaches. |
| | Action 5.2.3 a) MDNR will utilize the ORT STAC to review & make recommendations on where to locate harvest reserve areas; b) VA will utilize their current system to review and make recommendations on open & closed areas. | Continue<br>2007 | The ORT STAC is no longer active. In 2007, MD established an Oyster Advisory Commission (OAC) to develop new strategies for rebuilding and managing the oyster resource. The OAC's recommendations resulted in MD's 10 point oyster management plan. The plan includes increasing the area and number of sanctuaries, encouraging aquaculture, and the support of a more targeted, sustainable, scientifically-managed oyster fishery. **The OAC is currently reviewing sanctuary and public fishery areas and may recommend changes.** |
| | Action 5.2.4 Identify and implement regulatory & legislative changes needed for managing open & closed harvest areas. | 2006 | **MDNR opens and closes areas via public notice or the regulatory process, including scoping and public comment. Harvest reserves are opened by public notice.** VMRC utilizes the Commission process. |
| | Action 5.2.5 a) Evaluate how rotating open & closed areas contributes to reproduction, oyster biomass & harvest; b) Based on the harvest reserve biological data, reevaluate the criteria (Action 5.2.1) for opening & closing areas & modify actions as necessary. | 2005<br>On-going | Monitoring is underway and evaluation is on-going. **Models are lending insight into the conditions under which rotational harvest is sustainable. Counties will propose rotational harvest schemes to be reviewed by DNR.** |
| Strategy 5.3 a) Follow project guidance criteria specified in section 2 when developing repletion program work plans; b) Maintain the MDNR work plan review process | Action 5.3.1 Modify the MD repletion program through the established ORT Steering & Scientific Committee**s** to reduce and minimize disease impacts: a) Establish criteria to limit and/or restrict seed movement to certain regions depending on environmental conditions & disease levels; b) Avoid transplanting older year classes that have higher levels of disease than young spat; c) Rotate and/or clean seed areas; d) Allow old seed areas to lie fallow and/or be harvested; e) Utilize the disease results from the Fall survey; f) Transplant wild seed as soon as possible. | 2004<br>On-going | MDNR no longer implements a repletion program. **Instead, spat-on-shell produced by state hatcheries and private growers are placed on public bars for harvest. The program is funded by industry fees.** |
| | Action 5.3.2 MD will evaluate the effects of the repletion program on oyster population dynamics and habitat; and document how it contributes to an increase in oyster biomass & habitat. | 2006 | No repletion effort currently in progress. |
| Strategy 5.4 Strengthen the enforcement of oyster closures in sanctuaries & special management areas. | Action 5.4.1 Evaluate and implement the appropriate enforcement measures. | 2005<br>MNDR, VMRC<br>2010 | The MD Natural Resources Police (NRP) has begun to utilize the radar and camera vessel monitoring technology. The system, Maritime Law Enforcement Information Network (MLEIN), is largely a national security tool that has been adapted to aide enforcement of fishery laws. |

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| | Action 5.4.2 Prohibit the culling of oysters while underway to minimize the movement of infected oysters. | On-going MDNR, VMRC | |
| Hatchery and Aquaculture Considerations Strategy 6.1 Utilize hatchery-produced seed to augment natural reproduction reduce disease effects & increase biomass. | Action 6.1.1 Develop an inter-lab certification program for oyster diseases. Utilize the molecular diagnostic protocols for certifying SPF oyster seed developed by the VIMS Shellfish Pathology Laboratory. | 2005 | Program was completed and currently used by VIMS, UMCES, and MDNR. |
| | Action 6.1.2 MD will increase hatchery production of SPF seed to support the 10-fold increase in oyster biomass: a) Increase & maintain as necessary the operating funds for each MD hatchery facility; b) Evaluate & optimize the efficiency of each facility in order to ensure maximum production of spat. | On- going MDNR, ORP, UMD | **States are focusing on restoring targeted tributaries: Harris Creek, Little Choptank River, and the Tred Avon River (MD) and the Lynnhaven, Lafayette and Piankatank Rivers (VA). MD hatchery production has increased and spat are being placed in the three MD tributaries.** See comments for Action 3.2 |
| | Action 6.1.3 Continue the protocol for certifying and using SPF seed: a) establish standards & refine criteria; b) use only SPF seed in sanctuaries located in Zone 1 (< 12ppt). | Continue VIMS, MDNR, UMD | Implemented and continuing. |
| | Action 6.1.4 The U.S. Army Corps of Engineers (USACE) will conduct an analysis of hatchery project production in relationship to environmental benefits as part of its long-term restoration planning, and determine whether augmenting or building new hatchery (ies) is warranted | 2008 ACOE | The master plan examines and evaluates the problems and opportunities related to oyster restoration and formulates a plan for implementing large-scale bay-wide restoration. This action was expected to be addressed as part of the Native Oyster Master Plan by the USACE. However, the plan establishes guidelines for restoration and not specific actions. |
| Hatchery and Aquaculture Considerations (cont'd) | Action 6.1.5 Virginia will increase hatchery production of disease resistant seed to support the 10-fold increase in oyster production: a) Increase and maintain as necessary, the operating funds for oyster breeding in Virginia; b)Evaluate the feasibility of a public or a public-private hatchery | Ongoing VMRC, VIMS | VIMS/VMRC conducted a pilot project to promote capacity building of private hatchery and grow-out infrastructures in order to provide oyster spat-on-shell for restoration (NOAA funding FY04 continued in FY06). VIMS is currently training oyster technicians for aquaculture work both in the hatchery and in the field. |
| | Action 6.1.6 Virginia will develop strategies for effective seeding of reefs and their effects on recruitment, especially in relation to the spread of disease resistance in the wild population. | 2005 VMRC, VIMS | VIMS is conducting research on these questions through NOAA funding. |
| Strategy 6.2 Continue to track the genetic background of broodstocks used in hatcheries for restoration or replenishment activities | No specific actions recommended at this time. | To be determined MDNR, VMRC | There is some concern about reduced genetic variability of selectively bred oysters compared to wild oysters. In 2007, oyster disease experts recommended to discontinue transplanting infected natural seed; to discontinue bar cleaning for disease; to use hatchery-produced seed for augmenting natural stocks; to create sanctuaries and enforce a harvest moratorium; and consider larval dispersal mechanisms when creating oyster sanctuaries. |

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| Strategy 6.3 Develop recommendations for using disease resistant strains of native oysters for restoration. Selectively bred oyster strains should be used for restoration only in areas where native oysters are locally depleted. | Action 6.3.1 Assess and evaluate the use of disease resistant stocks as a tool for increasing disease resistance in the native oyster population in the Bay. | 2007 | The participants at the 2007 OMP Workshop concluded that the development of alternative strains for use in restoration should not be pursued thereby preserving the natural ability of oysters to develop disease resistance. There was also consensus that domesticated disease-resistant strains were acceptable for aquaculture endeavors. |
| | Action 6.3.2 Monitor restoration activities to clarify the interaction between selectively bred strains and wild stocks of oysters. | 2005<br>UMCES, ORP, VMRC | Carlsson et al (2008) evaluated the contribution of a selectively bred, domesticated oyster strain to recruitment in the Great Wicomico, Lynnhaven, York, and Elizabeth Rivers from 2002 to 2006. They were unable to detect a significant contribution of the domestic strain to wild-produced spat. |
| Strategy 6.4 The members of the OMP drafting team will review the MD task force report & recommend changes to the OMP as appropriate regarding aquaculture strategies & actions | Action 6.4.1 Amend the OMP as necessary to incorporate new strategies and actions regarding aquaculture. | 2009<br>2010<br>Currently on hold | The vision of the new Maryland 10-Point Oyster Plan is "to establish a private aquaculture industry that emerges as a major economic contributor to the State of Maryland while maintaining a more targeted and scientifically managed wild oyster fishery that is sustainable." Chapter 173 of the Legislative Acts of 2009 passed new aquaculture leasing statutes that completely changes how Maryland regulates, administers, and manages aquaculture and leasing of shellfish. Grants have been secured to help people with start-up and operational costs for new oyster farms. **The federal and state permitting processes have been streamlined.** The first Aquaculture Enterprise Zone (AEZ) was established by regulation in October 2009 in the Patuxent River near Broomes Island. **The AEZ has not yet been permitted by USACE, so leases there are not yet available.** Amendment 1 to the OMP was adopted in 2010. The amendment allows aquaculture and clamming activities within the larger, expanded sanctuary (areas closed to shellfish harvest and focused restoration activities) program; the use of new enforcement measures to protect sanctuary areas; and the implementation of sanitation guidelines. During 2010, the OMP was reviewed. The PRT recommended that the plan be revised. **Results from Maryland's 2016 evaluation of sanctuaries, harvest areas, and aquaculture areas will be used to develop any new management strategies and actions.** |
| Monitoring and Information Management Strategy 7.1 A) Utilize the results of the oyster stock assessment as an estimate of oyster abundance in the Bay; B) Use the 1994 biomass value as a baseline to track progress towards the 10-fold objective. | Action 7.1.1 Conduct monitoring programs that are consistent in terms of sampling procedure, timing of sampling, types of data collected, and analysis and provide the results to a central database or databases. | Continue | Monitoring programs have been reviewed. UMCES has provided recommendations on how to improve existing fishery-independent and fishery-dependent data collection methodology. MDNR Shellfish Program has taken the recommendations under consideration. **The 1993 biomass value is now being used as the baseline for assessment of population change. Bar-specific harvester tagging in conjunction with dealer reporting is leading to improved estimates of exploitation rates. Monitoring protocols for assessing sanctuary restoration success are being developed. In support of a bay-wide stock assessment, a gear calibration study was conducted to compare Virginia's patent tong sampling to Maryland's dredge sampling.** |

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| | Action 7.1.2 Establish a Technical Committee to develop data management guidelines for handling oyster data. | 2005 | Original committee meeting did not result in specific guidelines. |
| | Action 7.1.3 Develop and maintain a database to track oyster restoration projects and provide web-based access. | open<br>MDNR, VMRC, NOAA | NOAA compiled an inventory of all oyster restoration project implemented in recent years in both states (2007). NOAA also established a full database of implementation and monitoring data for all oyster restoration projects completed with federal funding, beginning in FY07 and ongoing. |
| | Action 7.1.4 The Chesapeake Bay Program will conduct an annual oyster symposium | | An Oyster Workshop was convened in December 2007. Oyster restoration is a regular agenda topic for the CBP's Sustainable Fisheries Goal Implementation Team. An Oyster Summit is scheduled for February 2016 to provide a forum to discuss oyster issues in the Chesapeake Bay. |
| | Action 7.1.5 Promote the research recommendations listed in Section 2. | 2005<br>2009 | All oyster partners. Research recommendations will be developed during the OMP revision process. |

Acronyms:

BRPs = Biological Reference Points
CBP = Chesapeake Bay Program
MGS = Maryland Geological Survey
MDNR = Maryland Department of Natural Resources
MLEIN = Maritime Law Enforcement Information Network
NCBO = NOAA Chesapeake Bay Office
NOAA = National Oceanographic and Atmospheric Administration
NRP = Natural Resources Police
OAC = Oyster Advisory Commission
OMP = Oyster Management Plan
ORP = Oyster Recovery Partnership
PEIS = Programmatic Environmental Impact Statement
PRT= Plan Review Team
SPF = Specific Pathogen Free
STAC = Scientific and Technical Advisory Committee
UMCEES = University of Maryland Center for Environmental & Estuarine Studies
UMCES = University of Maryland Center for Environmental Studies
USACE = U.S. Army Corps of Engineers
VIMS = Virginia Institute of Marine Science
VMRC = Virginia Marine Resources Commission