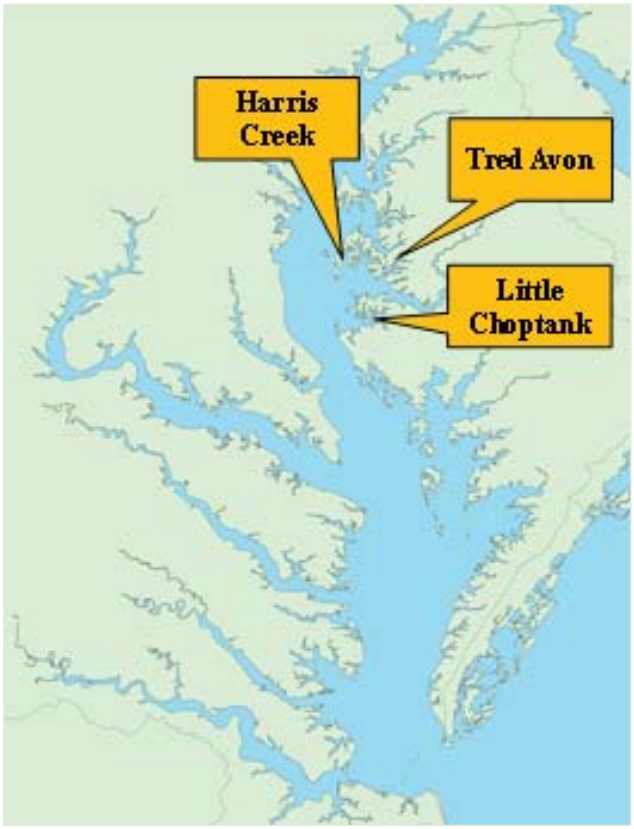
2017 Maryland Oyster Restoration Update

Progress in the Choptank Complex (Harris Creek, Little Choptank River, and Tred Avon River Oyster Sanctuaries)

July 2018

The Chesapeake Bay Watershed Agreement, which guides the work of the Chesapeake Bay Program, commits state and federal partners to "restore native oyster habitat and populations in 10 Bay tributaries by 2025, and ensure their protection." This reinforces the U.S. Army Corps of Engineers' Oyster Restoration Master Plan and Maryland's Oyster Restoration and Aquaculture Development Plan.



To achieve this outcome, the U.S. Army Corps of Engineers' Baltimore District (USACE), the National Oceanic and Atmospheric Administration (NOAA), the Maryland Department of Natural Resources (DNR), and the Oyster Recovery Partnership (ORP) formed the Maryland Oyster Restoration Interagency Workgroup under the auspices of the Sustainable Fisheries Goal Implementation Team of the Chesapeake Bay Program.

The Workgroup, with guidance from consulting scientists and the public, coordinates large-scale oyster restoration in selected Maryland tributaries. To date, the Workgroup has developed "tributary plans" that describe how three Maryland tributaries will be restored and monitored, consistent with standards described in the Chesapeake Bay Oyster Metrics report, www.chesapeakebay.noaa.gov/images/stories/fisheries/keyFishSpecies/oystermetricsreportfinal.pdf.

This update describes progress made in implementing oyster restoration tributary plans for:

- Harris Creek (www.chesapeakebay.noaa.gov/images/stories/habitats/harriscreekblueprint1.13.pdf)
- Little Choptank River (www.chesapeakebay.noaa.gov/images/stories/pdf/oystertribplanlittlechoptank.pdf)
- Tred Avon River (www.chesapeakebay.noaa.gov/images/stories/habitats/april2015tredavontribplan.pdf)

Combined, these three plans call for the restoration of more than 900 acres in the Choptank River complex.

An overview of Bay-wide progress toward the Chesapeake Bay Watershed Agreement oyster outcome is available at www.chesapeakeprogress.com/abundant-life/sustainable-fisheries/oysters.

An overview of Virginia progress toward the Chesapeake Bay Watershed Agreement oyster outcome is available via chesapeakebay.noaa.gov/oysters/oyster-restoration.

This report was compiled for the Chesapeake Bay Program's Sustainable Fisheries Goal Implementation Team by the Maryland Oyster Restoration Interagency Workgroup (Stephanie Westby, chair, stephanie.westby@noaa.gov).

Additional partners include the National Fish and Wildlife Foundation, The Nature Conservancy, University of Maryland, and the Chesapeake Bay Foundation.

Restoration Progress in Harris Creek, Little Choptank River, and Tred Avon River

Initial Restoration Complete

Since 2011, initial restoration work has been completed on nearly 670 acres of sanctuary (nonharvest) oyster reefs in the Choptank Complex (350.2 acres in Harris Creek, 238.9 acres in the Little Choptank River, 80.8 acres in the Tred Avon River). These reefs were constructed using one of two methods: either by placing a substrate base followed by seed (referred to as 'substrate and seed' reefs), or by placing only seed onto remnant reefs (called 'seed only' reefs). For reefs monitored in 2015 and 2016, substrate deployed consisted of Maryland stone, and shell (mixture of scallop, conch, and clam from processing plants). Harris Creek alone is the largest sanctuary oyster restoration project in the United States, and together the activities in these three tributaries have become an internationally recognized example of large-scale restoration success. Scientists and resource managers from China, New Zealand, Australia, Germany, Denmark, the Netherlands, and the United Kingdom have visited the Choptank Complex to learn about the oyster restoration progress made there.

Second-Year-Class Seedings

Per the tributary plans, each reef is to receive an 'initial seeding' of 4-5 million seed per acre, followed by a smaller, 'second-year-class seeding' of approximately 1 million seed per acre four years later under certain circumstances. Reefs are monitored three years post restoration. If monitoring shows that reefs are faring *as projected or lower* in terms of oyster density and biomass, they will receive the planned second-year-class seeding. If monitoring shows that reefs are faring *better* than projected, they will not require the planned second-year-class seeding. This planned two-seeding structure ensures reefs will have a second year class of oysters (an Oyster Metrics success criteria) and allows for potential savings on the second year class seeding if reefs are faring better than projected. In Harris Creek, this has resulted in substantial seed savings, as 27.8 acres of reefs in Harris Creek did not require second-year-class seedings. See page 3, second bullet, for more information.

Refined Tributary Restoration Goal-Setting Methodology

In 2017, partners in Maryland and Virginia adopted a refined method for setting oyster restoration goals, to be used in future restoration tributaries. This refined method maintains the original Chesapeake Bay Oyster Metrics language of restoring 50-100% of '*currently restorable oyster habitat*' as the goal for completing oyster restoration within a tributary. It refines the definition of '*currently restorable oyster habitat*' as areas where water quality is sufficient to support oyster survival, and *where there is historic or present-day evidence of oyster populations*. This evidence is typically the presence

Summary of Restoration Progress in the Choptank Complex

Year	Initial Restoration Complete*	Oyster Seed Planted	Funds Spent on Implementation†
2017	106.8 acres	840.7 million	$3.85 million
Cumulative (2011-2017)	670.62 acres	3.94 billion	$51.47 million

**Reef-building substrate has been added, if needed, and reef has been seeded with juvenile oysters. The initial seeding does not represent the full seeding complement; some reefs may require the planned second-year-class seeding, as laid out in the tributary plans.*

†This represents funds expended on reef construction and seeding. Associated costs, such as benthic surveys, oyster population and disease surveys, and water-quality monitoring, are not reflected; nor are staff salaries. Similarly, the cost estimate described in each river's tributary plan is for reef construction and seeding only, plus a small amount for monitoring required in excess of ongoing monitoring programs.

of shell or live oysters, but can also include historic maps or local knowledge. Previously, the definition was not limited to areas with evidence of historic oyster populations, and thus included any river bottom suitable to support a restored oyster reef (e.g., hard sand or hard mud bottom at an appropriate depth with sufficient levels of dissolved oxygen). The refined definition aligns more closely with the original goals of the Chesapeake Bay Oyster Metrics. In Maryland, this refined methodology may apply to the fourth and fifth tributaries.

Harris Creek

2017 Update

- Following the completion of initial seeding on 351 acres in Harris Creek in 2015, efforts have focused on monitoring and conducting second-year-class seedings.
- Per the Harris Creek Tributary Plan, each reef was to receive an initial seeding of approximately 5 million seed per acre, followed by a smaller, second-year-class seeding of approximately 1 million seed per acre four years later. Reefs are monitored three years post restoration. Monitored reefs faring *as projected or lower* in terms of oyster density and biomass receive the planned second-year-class seeding. Monitored reefs faring *better* than projected do not receive the planned second-year-class seeding. This planned two-seeding structure ensures reefs will have a second year class of oysters for reproductive purposes (an Oyster Metrics success criteria), and allows for potential savings on the second year class seeding if reefs are faring better than projected. Harris Creek monitoring data from 2015 and 2016 indicate that all seed-only and shell-base reefs required the planned second-year-class planting. Of the stone-base reefs, two reefs (3.45 acres) required the planned second-year-class planting, while 11 reefs (27.8 acres) did not require the planned second-year-class planting. This has resulted in substantial seed savings.
- Per 2015 and 2016 monitoring, 164 acres of Harris Creek reefs did require the planned second-year-class seeding. A total of 325.92 million seed oysters were planted onto these reefs in 2017. No new acreage is considered restored in 2017, as these acres were accounted for in 2012 and 2013, when they received their initial seeding. Seed oysters were produced by the University of Maryland Center for Environmental Science (UMCES) and ORP with funding from NOAA and DNR.
- Video of typical pre- and postrestoration oyster reefs is available at https://chesapeakebay.noaa.gov/images/stories/habitats/underwater-oyster-video-12816.mp4

Summary of Harris Creek Restoration Progress

Year	Initial Restoration Complete*	All Planned Restoration Complete††	Oyster Seed Planted	Funds Spent in Implementation†
2017	N/A	191.8 acres	325.92 million	$707,850**
Cumulative (2011-2017)	350.92 acres (153. 82 seed only; 197.1 substrate & seed)	191.8 acres	2.46 billion	$28.39 million

**Reef-building substrate has been added, if needed, and reef has been seeded with juvenile oysters. The initial seeding does not represent the full seeding complement; some reefs may require the planned second-year-class seeding, as laid out in the tributary plans.*

***2017 funding breakdown: NOAA: $312,000 (for seed; funds awarded to DNR/ORP/UMCES); DNR: $395,850 (for seed).*

†This represents funds expended on reef construction and seeding. Associated costs such as benthic surveys, oyster population and disease surveys, and water-quality monitoring, are not reflected; nor are staff salaries. Similarly, the cost estimate described in the Harris Creek Tributary Plan is for reef construction and seeding only, plus a small amount for monitoring required in excess of ongoing monitoring programs.

††Areas that have either received their planned second-year-class seeding (164 acres), or that, per three-year post-restoration monitoring, do not require the second-year-class seeding (27.8 acres).

Monitoring and Adaptive Management

The tributary plan for Harris Creek calls for monitoring reefs three and six years after initial restoration to determine whether they meet the Chesapeake Bay Oyster Metrics success criteria. Reefs planted with seed in 2012 and 2013 have been monitored to date (Fig. 1 and below). NOAA funding to the National Fish and Wildlife Foundation (NFWF) and ORP, and USACE funding to ORP, enabled fieldwork and data analysis that was performed by Paynter Labs at the University of Maryland and Versar, Inc.

Of the 191.8 acres of reefs monitored in 2015 and 2016:

- 98% meet the minimum threshold for oyster density (15 oysters per m2) and biomass (15 grams dry weight per m2), and are on a successful trajectory toward being restored as of the three-year post-restoration mark;
- 60% also meet the higher, target level for oyster density (50 oysters per m2) and biomass (50 grams dry weight per m2), and are on a successful trajectory toward being restored as of the three-year post-restoration mark;
- 2% of reefs failed to meet the minimum threshold for oyster density and biomass, and cannot be considered on a path toward being successfully restored as of the three-year post-restoration mark.

Multiple reefs constructed using both a shell base and a stone base were monitored in 2016. Results (Fig. 2) show that reefs constructed using a stone base average more than three times the oyster density found on the shell-base reefs.

The full 2016 monitoring report is at https://chesapeakebay.noaa.gov/images/stories/pdf/2016oysterreefmonitoringreport.pdf.

Reefs constructed in 2014 are being monitored in fall/winter 2017-18, with funding from NOAA and USACE; a full report on this most recent monitoring will be released in 2018.

DNR collected oyster disease data in fall 2017 in Harris Creek as part of its annual Fall Survey; that information will be available when DNR publishes its 2017 Fall Survey Report. DNR's 2016 Fall Survey Report, posted at http://dnr.maryland.gov/fisheries/Pages/shellfish-monitoring/reports.aspx, shows Harris Creek Sanctuary Dermo prevalence ranged from 47% to 100%, lethal Dermo prevalence ranged from 0 to 27%, and MSX ranged from 6.7% to 27%. The spatfall index within the sanctuary ranged from 58 to 68 spat per bushel, which is above the 32-year average Bay-wide spatfall index (41.1 spat per bushel).

With funding from The Nature Conservancy, DNR monitored three water-quality stations in Harris Creek. Data from these stations is available at www.eyesonthebay.dnr.marylandgov. Salinity and dissolved oxygen were suitable for oysters throughout 2017, except for brief periods of hypoxia in late summer.

Some of the reefs built in Harris Creek in 2015 were constructed too high, and as a result did not maintain the required five feet of water depth needed for boats to navigate safely over them. The majority of these areas have been corrected; the remaining areas (less than three

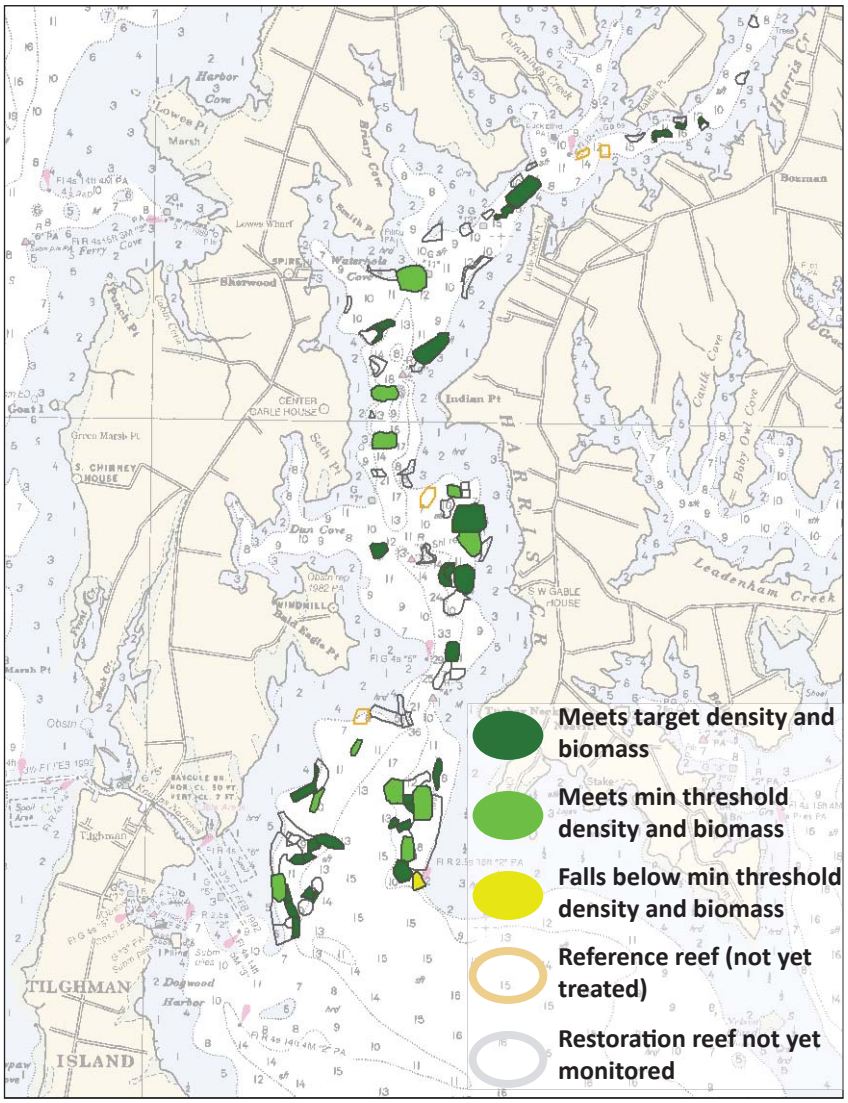


Fig. 1: Map of 2015 and 2016 combined monitoring results on Harris Creek oyster reefs.

acres) have been buoyed to alert boaters. Buoys will remain until the corrective work is completed in 2018. For future reef construction, additional actions will be taken to gauge the accuracy of reef heights, including: completing postconstruction surveys sooner; ensuring contractors use a consistent bucket size for material deployment; and marking the depth on the bucket cable as an additional visual cue. Efforts will continue to notify boaters of changes in bathymetry resulting from the project through the Coast Pilot, Local Notice to Mariners, or other appropriate media.

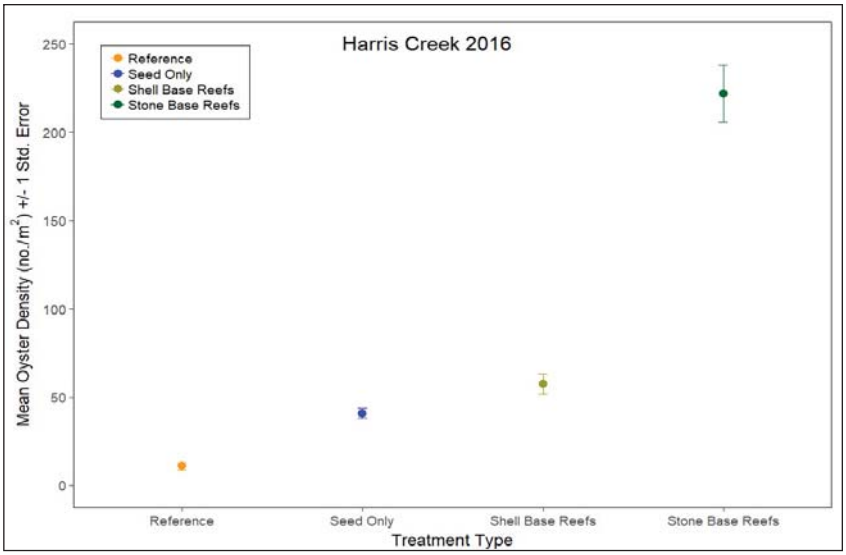


Fig. 2: Mean oyster density, by treatment type, for Harris Creek reefs monitored in 2016. Orange point represents mean density on 4 reference reefs; blue point represents mean density on 7 seed-only reefs; light brown point represents mean density on 10 shell-base reefs; dark green point represents mean density on 13 stone-base reefs. Graph from 2016 monitoring report, https://chesapeakebay.noaa.gov/images/stories/pdf/2016oystermonitoringreport.pdf.

Outlook for 2018

- Initial in-water restoration work is complete in Harris Creek. No additional reef construction is planned.
- Monitoring results from fall/winter 2017-18 will inform second-year-class seedings on Harris Creek reefs in summer 2018. Monitored reefs faring as projected or lower in terms of oyster density and biomass will receive the planned second-year-class seeding. Monitored reefs faring better than projected will not receive the planned second-year-class seeding. (See 'second year class seedings,' page 2, above.)
- Monitoring work, including water-quality monitoring, is planned through 2021. 2018 will be the first year that a cohort of reefs (those planted in 2012) will be old enough to require the planned six-year-post-restoration monitoring. Results from this work will determine whether these reefs meet the Chesapeake Bay Oyster Metrics success criteria. Monitoring will also inform adaptive management.

Little Choptank River

2017 Update

- The Little Choptank River Tributary Plan calls for restoring 440 acres of reefs. Of the 440 acres, 45 acres already meet the definition of a restored reef, by virtue of the existing natural oyster population there. These reefs will be monitored, but may not require any restoration treatment. The minimum tributary restoration goal described in Chesapeake Bay Oyster Metrics (restoring a minimum of 50% of currently restorable oyster habitat) may be achieved on the Little Choptank River without completing all 440 acres of reefs described in the Little Choptank tributary plan.
- In-water restoration work began on the Little Choptank in 2014.

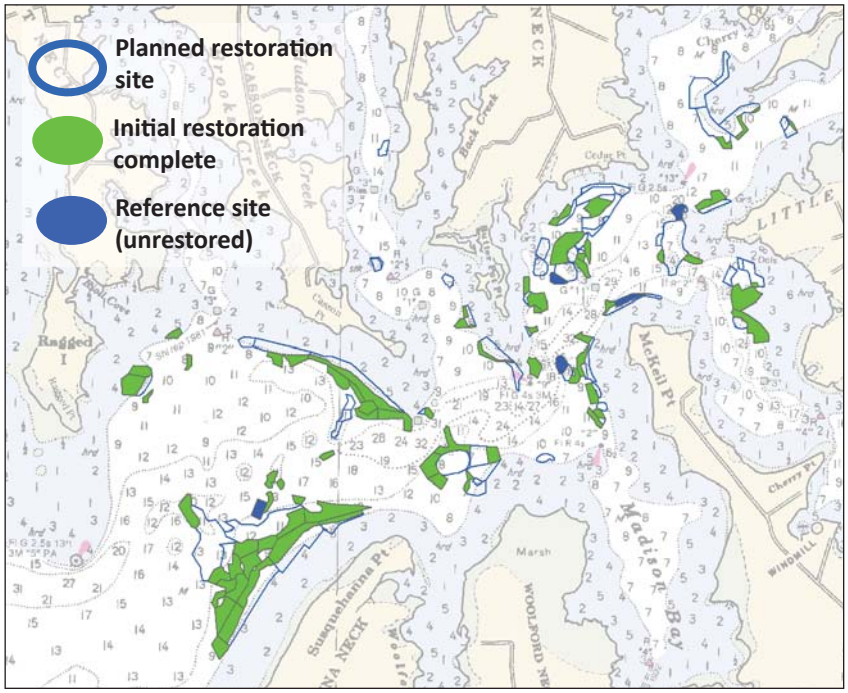


Fig. 3: Restoration progress in the Little Choptank River through the end of calendar 2017.

- No new reef-building substrate was placed into the Little Choptank in 2017.
- A total of 60.9 acres of reefs were seeded with oysters in 2017. These were sites that either did not require reef-building substrate, or had been treated with substrate in 2014 or 2015 and were awaiting seed.
- In 2017, 288.07 million seed oysters were planted in the Little Choptank River. ORP and UMCES produced and planted 280.77 million seed oysters with funding from NOAA, NFWF, and DNR. The Chesapeake Bay Foundation (CBF) produced and planted 7.3 million seed oysters.
- Water quality was monitored at the mouth of the Little Choptank River, outside the sanctuary boundary; data are available at eyesonthebay.dnr.maryland.gov. Salinity and dissolved oxygen were suitable for oysters throughout 2017.
- DNR collected oyster disease data in fall 2017 in Little Choptank as part of its annual Fall Survey; that information will be available when DNR publishes its 2017 Fall Survey Report. DNR's 2016 Fall Survey Report, posted at http://dnr.maryland.gov/fisheries/Pages/shellfish-monitoring/reports.aspx, shows Little Choptank River oyster sanctuary Dermo prevalence was 100%, lethal Dermo prevalence was 10%, and MSX prevalence was 0%. The spatfall index within the sanctuary was 60 spat per bushel, which is above the 32-year average Bay-wide spatfall index (41.1 spat per bushel).

Summary of Little Choptank River Restoration Progress

Year	Initial Restoration Complete*	Oyster Seed Planted	Funds Spent on Implementation†
2017	60.9 acres	288.07 million	$646,370**
Cumulative (2011-2017)	238.9 acres (113 seed only; 125.9 substrate & seed)	1.1 billion	$18.47 million

**Reef-building substrate has been added, if needed, and reef has been seeded with juvenile oysters. The initial seeding does not represent the full seeding complement; some reefs may require the planned second-year-class seeding, as laid out in the tributary plans.*

***2017 funding breakdown: NOAA: $272,000(for seed; funds awarded to DNR/ORP/UMCES); DNR: $345,100 (for seed); CBF: $29,270 (for seed)*

†This represents funds expended on reef construction and seeding. Associated costs such as benthic surveys, oyster population and disease surveys, and water-quality monitoring, are not reflected; nor are staff salaries. Similarly, the cost estimate described in the Little Choptank Tributary Plan is for reef construction and seeding only, plus a small amount for monitoring required in excess of ongoing monitoring programs.

Outlook for 2018

- Nearly 60 remaining acres on the Little Choptank River require only the addition of seed oysters (not reef-building substrate). These areas are slated to receive seed oysters in 2018, as hatchery production allows, after final examination by divers to determine the sites' suitability.
- In the tributary plan, 118 acres of shallow-water restoration in water depths of 6 to 9 feet were slated to be constructed using substrate and seed. Due to concerns regarding boating safety from potential high spots and conflict with crab harvest using trotlines, it is DNR's goal to meet the minimum Oyster Metrics restoration criteria without pursuing the construction of these 118 acres.

Tred Avon River

2017 Update

- The Tred Avon Tributary Plan calls for restoring 147 acres of oyster reefs in the Tred Avon oyster sanctuary.
- In-water restoration work on the Tred Avon began in 2015.
- In 2017, 226.73 million seed oysters were planted in the Tred Avon River. ORP and UMCES produced and planted 213.93 million seed oysters with funding from NOAA, NFWF, and DNR. CBF produced and planted 12.8 million seed oysters.

- In 2017, USACE constructed 13.5 acres of reefs in the Tred Avon River, all using mixed shell (scallop, conch, and clam shell from processing plants). All but 1.3 acres of these reefs were also seeded in 2017.
- Water quality was monitored in the Tred Avon oyster sanctuary; data are available at eyesonthebay.dnr.maryland.gov. Salinity and dissolved oxygen were suitable for oysters throughout 2017.
- DNR collected oyster disease data in fall 2017 in Tred Avon reefs as part of its annual Fall Survey; that information will be available when DNR publishes its 2017 Fall Survey Report. DNR's 2016 Fall Survey Report, posted at http://dnr.maryland.gov/fisheries/Pages/shellfish-monitoring/reports.aspx, shows Tred Avon River Dermo disease prevalence was 88% and lethal Dermo prevalence was 3.6%. MSX was not found in Tred Avon River samples. The spatfall index within the sanctuary was 12 spat per bushel, which is below the 32-year average Bay-wide spatfall index (41.1).

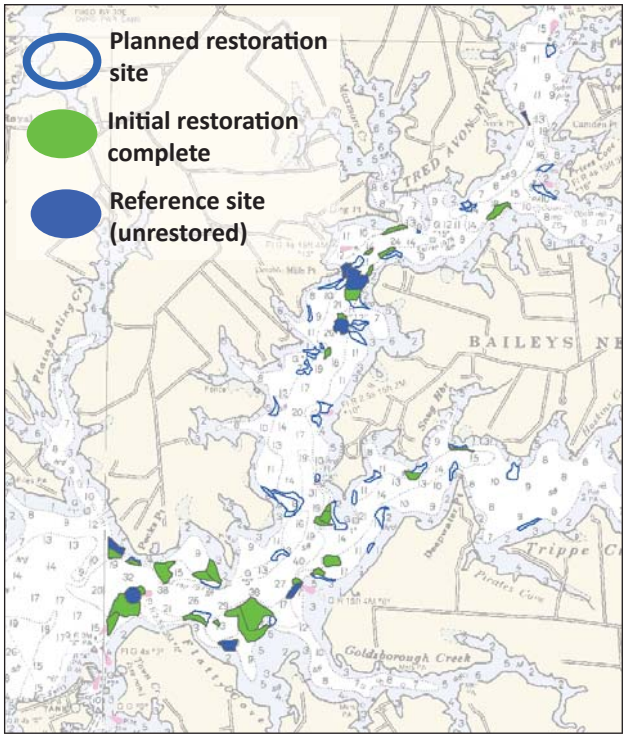


Fig. 3: Restoration progress in the Tred Avon River through the end of calendar 2017.

Outlook for 2018

- There are approximately five acres remaining in the Tred Avon River that only require seed for restoration. In addition, there are 1.3 acres where substrate was placed in 2017, but have not yet received seed. These 6.3 acres of reefs combined are scheduled to receive seed oysters in 2018, as hatchery production allows, after final examination by divers to determine each site's suitability.
- In winter 2017-18, USACE will construct four acres of alternate substrate reefs originally planned for spring 2017, using mixed shell (scallop, conch, and clam shell from processing plants). These acres are not included in the reefs constructed in calendar 2017. These areas are scheduled to receive seed in 2018, as hatchery production allows.
- Consistent with the Tred Avon Tributary Plan, USACE is planning to construct an additional approximately 42 acres using reef-building substrate. These reefs will be constructed as funding and resources allow.

Summary of Tred Avon River Restoration Progress

Year	Initial Restoration Complete*	Initial Restoration Partly Complete (reefs constructed and awaiting seed)	Oyster Seed Planted	Funds Spent†
2017	45.9 acres	1.3 acres	226.73 million	$2.5 million**
Cumulative (2015-2017)	80.8 acres (52.6 seed only; 28.2 substrate & seed)	1.3 acres	380 million	$4.61 million

**Reef-building substrate has been added, if needed, and reef has been seeded with juvenile oysters. The initial seeding does not represent the full seeding complement; some reefs may require planned second-year-class seeding, as laid out in the tributary plans.*

***2017 funding breakdown: NOAA: $216,000 (for seed; funds awarded to DNR/ORP/UMCES); USACE $1,825,564; DNR, $274,050 (for seed); CBF: $51,200 (for seed); NFWF: $129,850 (for seed; funds awarded to ORP).*

†This represents funds expended on reef construction and seeding. Associated costs such as benthic surveys, oyster population and disease surveys, and water-quality monitoring, are not reflected; nor are staff salaries. Similarly, the cost estimate described in the Tred Avon Tributary Plan was for reef construction and seeding only, plus a small amount for monitoring required in excess of ongoing monitoring programs.

Restoration Reefs as a Research Platform

The large-scale oyster restoration projects in the Choptank Complex serve as important platforms for scientific research, including:

- NOAA's Oyster Reef Ecosystem Services project (ORES) seeks to quantify the benefits restored oyster reefs provide to other species and the environment. See chesapeakebay.noaa.gov/images/stories/habitats/2016oresresearchupdate.pdf.
- Work by scientists from Virginia Institute of Marine Science, funded by NFWF and ORP, resulted in an online calculator to help estimate the ecosystem service value of various Harris Creek oyster restoration scenarios. (See netsim.vims.edu/netsims/brush/harris_creek_model/index.html.) Additional funding has been secured to update the model with data from the ORES projects in Harris Creek as they become available.
- In fall 2014, USACE contracted Paynter Labs at the University of Maryland to monitor restored reefs at Cook Point, an oyster sanctuary in the Choptank River. This study reaffirmed the importance of hard substrate for oyster planting. (See life.umd.edu/biology/paynterlab/labpub/2014%20USACE%20Report%20Final%2020150902.pdf.)

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