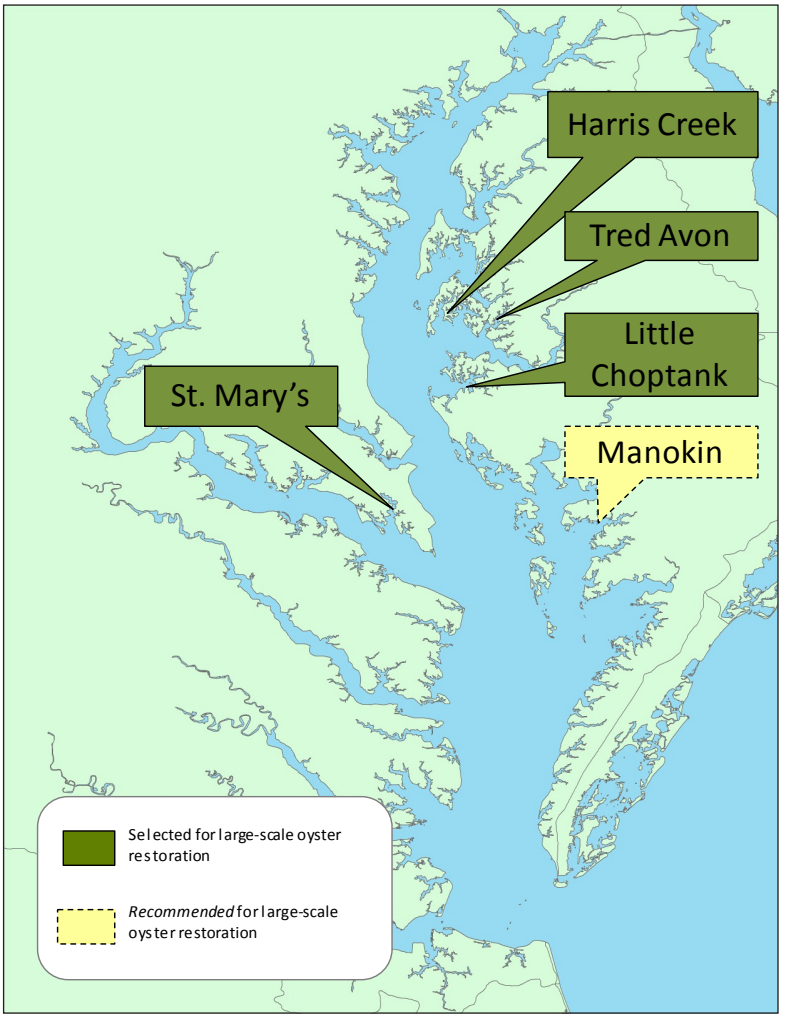
2018 Maryland Oyster Restoration Update

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

June 2019

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 (hereafter, Workgroup) under the auspices of the Sustainable Fisheries Goal Implementation Team (GIT) 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 "oyster restoration tributary plans" that describe how three Maryland tributaries will be restored and monitored, consistent with standards described in the Chesapeake Bay Oyster Metrics report[1].

This update describes progress on implementing oyster restoration tributary plans for Harris Creek[2], the Little Choptank River[3], and the Tred Avon River[4]. The Upper St. Mary's River was selected by the Sustainable Fisheries GIT in December 2018; the Manokin River was recommended by DNR as the fifth Maryland tributary in September 2018.

Overviews of Bay-wide progress[5] and Virginia-specific progress[6] toward the Chesapeake Bay Watershed Agreement oyster outcome are available online.

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.

Summary of Restoration Progress in the Choptank Complex
(Harris Creek, Little Choptank River, and Tred Avon River combined)

Since 2011, initial restoration work has been completed on more than 773 acres of sanctuary (nonharvest) oyster reefs in the Choptank Complex (350.92 acres in Harris Creek, 338.83 acres in the Little Choptank River, and 83.83 acres in the Tred Avon River). These reefs were constructed using one of two methods: either by constructing a substrate base followed by planting with hatchery-produced seed (referred to as 'substrate + seed' reefs), or by placing only seed onto remnant reefs (called 'seed only' reefs). Harris Creek alone is the largest sanctuary oyster restoration project in the United States, and the Choptank Complex has become an internationally recognized example of large-scale restoration success. Scientists and resource managers from throughout the United States as well as China, South Korea, New Zealand, Australia, Germany, Denmark, the Netherlands, and the United Kingdom have visited Maryland to learn about oyster restoration success in the Choptank Complex.

Summary of Restoration Progress in the Choptank Complex

Year	Oyster Seed Planted	Initial Restoration Completed*	Funds Spent on Implementation†
2018	604.96 million	59.47 acres**	$3.78 million
Cumulative (2011-2018)	4.55 billion	773.58 acres	$55.26 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, planned seeding complement; some reefs may require the planned second-year-class seeding, as laid out in the tributary plans.*

***This represents new acreage restored in 2018. Additionally, 7.07 acres in Harris Creek and 53.05 acres in Little Choptank received their planned second-year-class seeding; see definition below.*

†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.

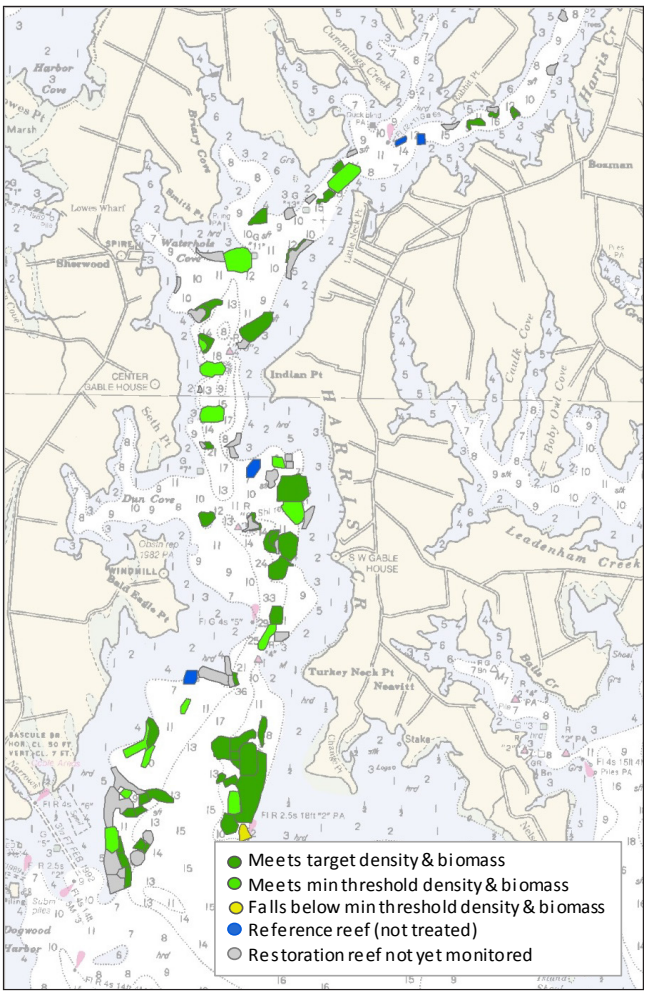
Second-Year-Class Seedings

Per the tributary plans[2,3,4], 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[1] success criterion) and allows for potential savings on the second year class seeding if reefs are faring better than projected. This has resulted in substantial seed savings to date because numerous sites in Harris Creek did not require their planned second-year-class seedings.

Harris Creek

2018 Update

- Since the 2015 completion of initial restoration on 351 acres in Harris Creek, efforts have focused on monitoring and conducting second-year-class seedings.
- Each reef is monitored three years post restoration, and its oyster density and year class structure are evaluated to determine if it requires the scheduled second seeding. If needed, second-year-class seedings are scheduled for four years post restoration, per the Harris Creek Oyster Restoration Tributary Plan. To date in Harris Creek, all seed-only and shell-base (scallop, conch, and clam shell from processing plants) reefs required a second seeding; reefs constructed from stone or Florida fossil shell have not required a second seeding. Harris Creek sonar surveys[8,9] show that the reefs built from Florida shell and stone typically have more structural complexity than those built from mixed shell (scallop, conch, and clam shell). The increased reef complexity may account for some of the higher oyster densities found on stone and Florida shell reefs. Oyster shell was not used as a reef-building substrate in the Choptank Complex, and has not been similarly evaluated. Constructing reefs from different types of shell, or other materials, may produce different results.
- Per monitoring in late 2017, just over seven acres of seed-only and shell-base reefs required a second seeding. A total of 28.66 million seed oysters was planted onto these reefs in 2018. No new acreage was considered restored in 2018, as these acres were accounted for a few years ago 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.



Status of Harris Creek oyster density and biomass based on monitoring results in 2015[7], 2016[8], and 2017[9] combined.

Summary of Harris Creek Restoration Progress

Year	Oyster Seed Planted	Initial Restoration Completed*	Funds Spent on Implementation†
2018	28.66 million	0 acres**	$159,979
Cumulative (2011-2018)	2.49 billion	350.92 acres	$28.56 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, planned seeding complement; some reefs may require the planned second-year-class seeding, as laid out in the tributary plans.*

***This represents new acreage restored in 2018. Additionally, 7.07 acres in Harris Creek received their planned second-year-class seeding; see definition above.*

†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 Oyster Restoration Tributary Plan is for reef construction and seeding only, plus a small amount for monitoring required in excess of ongoing monitoring programs.

- Of the $159,979 spent on implementation in Harris Creek in 2018, NOAA spent $62,982 for seed (funds awarded to DNR/ORP/UMCES), and DNR spent $93,997 for seed.
- Video of typical pre- and postrestoration oyster reefs is available at https://chesapeakebay.noaa.gov/images/stories/habitats/underwater-oyster-video-12816.mp4.

Monitoring and Adaptive Management

The tributary plan for Harris Creek calls for monitoring of reefs three and six years after initial restoration to determine whether they meet the Chesapeake Bay Oyster Metrics[1] success criteria. Reefs planted with seed in 2012[7], 2013[8], and 2014[9] have been monitored to date, with NOAA funding and USACE funding to ORP. Field work was performed by Paynter Labs at the University of Maryland and Versar, Inc.

Of the 56 reefs that received three-year monitoring between 2015 and 2017:

- 98% (55 reefs) met the Oyster Metrics minimum threshold success criteria for oyster density and biomass.
- 75% (42 reefs) met the Oyster Metrics higher target criteria for oyster density and biomass.

In 2017, monitoring was done on reference (unrestored) reefs, seed-only reefs, Florida fossil-shell-base reefs, and stone-base reefs topped with mixed shell (scallop, conch, and clam shell from processing plants). Results (Fig. 1) show that the highest average oyster densities were found on Florida fossil-shell-base reefs and stone-base reefs topped with mixed shell.

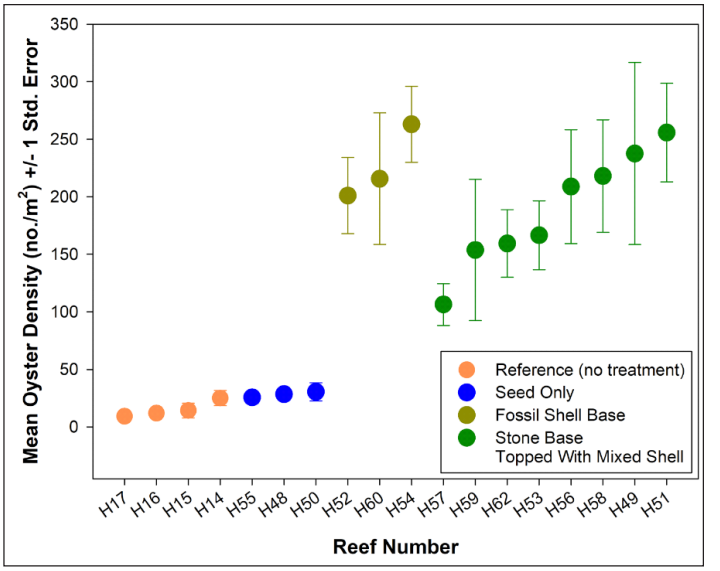


Fig. 1: Mean oyster density, by treatment type, for Harris Creek reefs monitored in 2017. Graph from 2017 Oyster Reef Monitoring Report[9].

With funding from The Nature Conservancy, DNR monitored water quality at three stations in the Harris Creek sanctuary. Data from these stations is available at http://eyesonthebay.dnr.maryland.gov. Salinity and dissolved oxygen were suitable for oysters throughout 2018, except for brief periods of hypoxia in the summer.

DNR collected oyster disease data in fall 2018 in Harris Creek as part of its annual Fall Oyster Survey; that information will be available when DNR publishes its 2018 Maryland Oyster Population Status Report. DNR's 2017 Oyster Population Status Report[10] shows Harris Creek oyster sanctuary Dermo disease prevalence was 97%; lethal Dermo prevalence was 33%. MSX disease prevalence was 0%. The spatfall index within the sanctuary was 55 spat per bushel, which is above the 33-year average Bay-wide spatfall index (40.6 spat per bushel). Average natural mortality within the sanctuary (7.3%) was comparable to average natural mortality right outside the sanctuary (6.9%).

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 mandated by the state. Between February and March 2016, USACE corrected high spots within 10 of 57 reefs that it had constructed in Harris Creek. Between May 2017 and July 2018, DNR corrected high spots within four reefs out of nine it had constructed in Harris Creek. NOAA is currently surveying the corrected areas as part of annual structural monitoring.

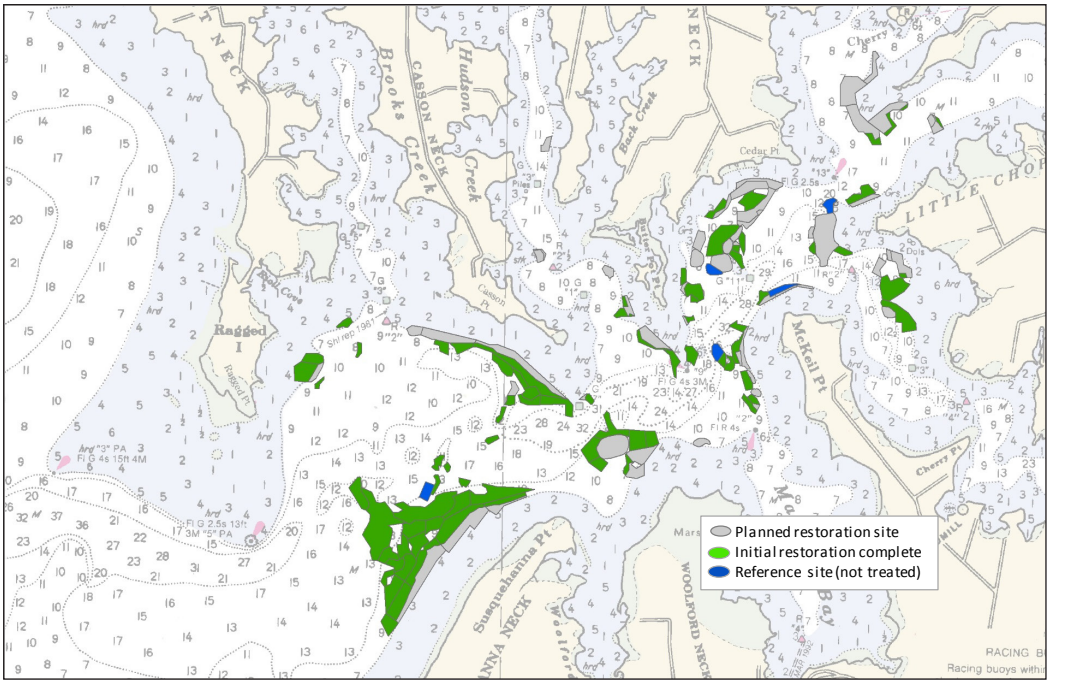
Outlook for 2019

- Initial in-water restoration work is complete in Harris Creek. No additional reef construction is planned.
- Reefs initially planted in 2015 are being monitored in fall/winter 2018-19, with funding from NOAA and USACE. A full report will be released in 2019.
- Fall/winter 2018-19 monitoring results will inform summer 2019 Harris Creek second-year-class seedings.
- Monitoring work is planned through 2021.

Little Choptank River

2018 Update

- The Little Choptank River Oyster Restoration Tributary Plan calls for restoring 440 acres of reefs. The minimum tributary restoration goal described in Chesapeake Bay Oyster Metrics[1] (restoring a minimum of 50% of currently restorable oyster habitat, which in the Little Choptank River is 343 acres) may be achieved without completing all planned 440 acres of reefs.
- In-water restoration work began in the Little Choptank in 2014.



Restoration progress in the Little Choptank River through the end of calendar 2018.

- No new reef-building substrate was placed into the Little Choptank in 2016, 2017, or 2018.
- In 2018, 56.44 acres of Little Choptank reefs received their initial oyster seeding. In addition, 53.05 acres received their planned second-year-class seeding.
- In 2018, 540.11 million seed oysters were planted in the Little Choptank River. ORP and UMCES produced and planted 517.61 million seed oysters with funding from NOAA and DNR. The Chesapeake Bay Foundation (CBF) produced and planted 22.5 million seed oysters with funding from NOAA.
- Of the $2.97 million spent in 2018 in the Little Choptank River, NOAA spent $1,269,472 for seed, with funds awarded to DNR/ORP/UMCES and CBF, and DNR spent $1,697,631 for seed.
- Water quality was monitored at the mouth of the Little Choptank River, outside the sanctuary boundary; data are available at http://eyesonthebay.dnr.maryland.gov. Salinity was suitable for oysters throughout 2018 while dissolved

Summary of Little Choptank Restoration Progress

Year	Oyster Seed Planted	Initial Restoration Completed*	Funds Spent on Implementation†
2018	540.11 million	56.44 acres**	$2.97 million
Cumulative (2014-2018)	1.64 billion	338.83 acres	$21.44 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, planned seeding complement; some reefs may require the planned second-year-class seeding, as laid out in the tributary plans.*

***This represents new acreage restored in 2018. Additionally, 53.05 acres in the Little Choptank River received their planned second-year-class seeding in 2018; see definition above.*

†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 River Oyster Restoration Tributary Plan is for reef construction and seeding only, plus a small amount for monitoring required in excess of ongoing monitoring programs.

oxygen was suitable to a depth of 5 meters throughout the year, with depths greater than 5 meters exhibiting hypoxic conditions for brief periods in the summer.

- DNR collected oyster disease data in fall 2018 in Little Choptank as part of its annual Fall Oyster Survey; that information will be available when DNR publishes its 2018 Maryland Oyster Population Status Report. DNR's 2017 Oyster Population Status Report[10] shows Little Choptank River oyster sanctuary Dermo disease prevalence was 97%; lethal Dermo prevalence was 20%. MSX disease prevalence was 0%. The spatfall index within the sanctuary was 67 spat per bushel, which is above the 33-year average Bay-wide spatfall index (40.6 spat per bushel). Average natural mortality within the sanctuary (17.0%) was comparable to average natural mortality right outside the sanctuary (13.2%).

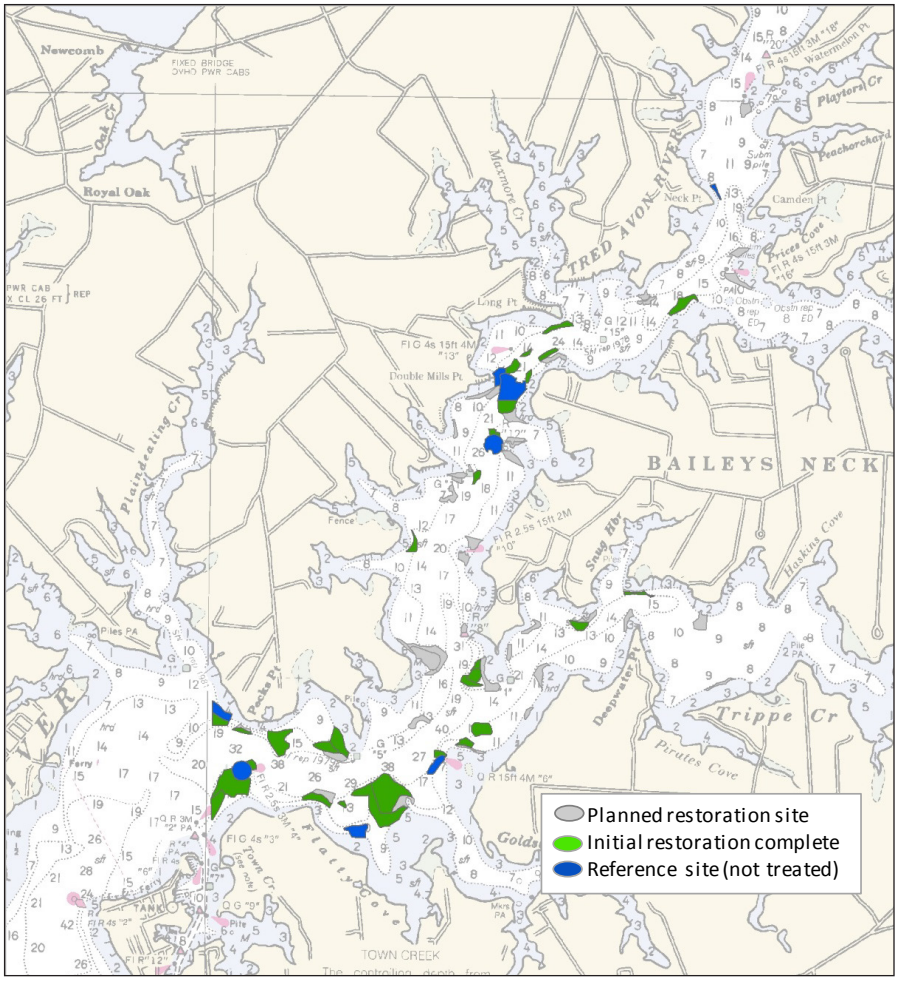
Outlook for 2019

- Approximately five 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 2019, as hatchery production allows.
- The original Little Choptank River Oyster Restoration Tributary Plan calls for constructing just over 100 additional acres of substrate + seed reefs in water depths of 6 to 9 feet. Due to concerns regarding boating from potential high spots and potential conflict with trotline crab harvest, it is DNR's goal to meet the minimum restoration criteria without constructing these originally planned reefs. As defined by Oyster Metrics[1], the minimum restoration criteria is 50% of currently restorable oyster habitat, which in the Little Choptank River is 343 acres.

Tred Avon River

2018 Update

- The original Tred Avon Oyster Restoration Tributary Plan calls for restoring 147 acres of oyster reefs in the Tred Avon oyster sanctuary. Due to concerns about navigational clearance in shallow-water areas, there were some areas where the original targeted reef locations were reduced or removed from consideration for construction. The minimum reef acreage required in the river to meet the Oyster Metrics[1] definition of a successfully restored tributary is 125 acres. The Workgroup projects that it is possible to construct at least this minimum number of acres of reefs in the river, pending funding.
- In-water restoration work on the Tred Avon began in 2015.
- In 2018, USACE contractor Blue Forge, LLC, used mixed shell (scallop, conch, and clam shell from processing plants) to construct 4.25 acres of reefs in the Tred Avon River.
- In 2018, 36.19 million seed oysters were planted in the Tred Avon River. ORP and UMCES produced and planted these oysters with funding from NOAA and DNR.



Restoration progress in the Tred Avon River through the end of calendar 2018.

- In 2018, $645,224 was spent on Tred Avon River oyster restoration. USACE spent $447,000 for substrate; NOAA spent $79,530 for seed (funds awarded to DNR/ORP/UMCES); DNR spent $118,694 for seed.
- Water quality was monitored by NOAA in the Tred Avon oyster sanctuary. Salinity and dissolved oxygen were suitable for oysters throughout 2018.
- DNR collected oyster disease data in fall 2018 in Tred Avon as part of its annual Fall Oyster Survey; that information will be available when DNR publishes its 2018 Maryland Oyster Population Status Report. DNR's 2017 Oyster Population Status Report[10] shows Tred Avon oyster sanctuary Dermo disease prevalence was 97%; lethal Dermo prevalence was 43%. MSX disease prevalence was 0%. The spatfall index within the sanctuary was 3 spat per bushel, which is below the 33-year average Bay-wide spatfall index (40.6 spat per bushel). Average natural mortality within the sanctuary (16.8%) was comparable to average natural mortality right outside the sanctuary (6.9%).

Summary of Tred Avon Restoration Progress

Year	Oyster Seed Planted	Initial Restoration Completed*	Funds Spent on Implementation†
2018	36.19 million	3.03 acres	$645,224
Cumulative (2015-2018)	416.19 million	83.83 acres	$5.26 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, planned 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 the Tred Avon River Oyster Restoration Tributary Plan is for reef construction and seeding only, plus a small amount for monitoring required in excess of ongoing monitoring programs.

Outlook for 2019

- The three acres of reefs constructed in 2018 will be seeded in 2019.
- USACE plans to continue Tred Avon River reef construction pending available funding. The next potential round of USACE funding will be in fiscal year 2020.
- In 2019, monitoring will be conducted on the first set of substrate reefs constructed in the Tred Avon (16 acres).

Upper St. Mary's River

2018 Update

- The Upper St. Mary's River was selected as a target tributary for large-scale oyster restoration by the Sustainable Fisheries GIT in December 2018.
- Prerestoration sonar surveys and oyster population surveys have been completed in the sanctuary. A tributary plan is being developed for the sanctuary. This will describe restoration goals for the river consistent with Oyster Metrics[1], and will lay out which areas will be slated for restoration.
- Pending finalization of the Upper St. Mary's Oyster Restoration Tributary Plan, oyster seeding will begin in the River in spring/summer 2019.

Manokin River

2018 Update

- Breton Bay was initially recommended in December 2017 to be the fifth large-scale oyster restoration area in Maryland waters. Because subsequent surveys revealed a significant lack of oyster habitat, absence of live or dead oysters, and poor water quality, this river was determined to be unsuitable for large-scale oyster restoration.
- In September 2018, DNR recommended the Manokin River as Maryland's fifth target tributary for large-scale restoration. The Manokin sanctuary was the second-most recommended tributary by the Maryland Oyster Advisory Commission (Breton Bay was first). Existing scientific information suggests the Manokin River supports an oyster population and is suitable for oyster restoration. The Workgroup is currently collecting, reviewing, and analyzing information that will be used to develop a Manokin River Oyster Restoration Tributary Plan. The Sustainable Fisheries GIT will finalize the selection of Maryland's fifth tributary, likely in 2019.

Research Related to Large-Scale Oyster Restoration

Researchers have produced scientific information quantifying the effects of large-scale oyster restoration in Maryland These include:

- A Morgan State University project to quantify the economic impact of oyster restoration in the Choptank Complex. See https://news.morgan.edu/pearl-project-gains/
- A project by researchers at the University of Maryland and the Virginia Institute of Marine Science to quantify the amount of nitrogen removed by Harris Creek oyster restoration. See https://www.chesapeakebay.net/channel_files/30431/kellogg_et_al_-_fisheries_git_presentation_-_2018-12-17.pdf
- NOAA's Oyster Reef Ecosystem Services project (ORES), which seeks to quantify the benefits restored oyster reefs provide to other species and the environment. See https://chesapeakebay.noaa.gov/images/stories/habitats/2018oresresearchupdate.pdf

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Please cite this document as:
Maryland Oyster Restoration Interagency Workgroup of the Chesapeake Bay Program's Sustainable Fisheries Goal Implementation Team. 2019. 2018 Maryland Oyster Restoration Update: Progress toward Achieving the Chesapeake Bay Watershed Agreement Oyster Outcome in Harris Creek Little Choptank River, Tred Avon River, and Upper St. Mary's River. Annapolis, MD.