Chesapeake Bay Program | Indicator Analysis and Methods Document
Oyster Restoration Indicator| Updated May 2022

Indicator Title: Oyster Restoration

Relevant Outcome(s): Oyster Restoration

Relevant Goal(s): Sustainable Fisheries

Location within Framework (i.e., Influencing Factor, Output or Performance): Output

A. Data Set and Source

(1) Describe the data set. What parameters are measured? What parameters are obtained by calculation? For what purpose(s) are the data used?

Data are collected on the following eleven tributaries: Harris Creek, Little Choptank, Tred Avon, upper St. Mary's and Manokin rivers in Maryland; Piankatank, Lafayette, Lynnhaven, Great Wicomico, lower York, and the Eastern Branch of the Elizabeth rivers in Virginia. Oyster restoration partners track the implementation progress of oyster restoration in each tributary, including the number of acres of oyster reefs that have: 1) undergone restoration treatment (reef construction and/or seeding) to meet the outcomes established under the Executive Order 13508 and the Chesapeake Bay Watershed Agreement; 2) undergone restoration previous to the aforementioned agreements; or 3) otherwise naturally occurring reefs that already meet the oyster density criteria. These numbers are added and reported as the "completed acreage" for each tributary.

All relevant data on the progress of each tributary effort, including in-water restoration costs where available, is tracked for each step of the overall oyster restoration process and documented in annual reports approved by the Maryland and Virginia Oyster Restoration Interagency Teams. The overall process for oyster restoration broadly follows three steps as developing a tributary restoration plan, implementing reef construction & seeding, and monitoring and evaluation.

(2) List the source(s) of the data set, the custodian of the source data, and the relevant contact at the Chesapeake Bay Program.
- Source: Maryland and Virginia Oyster Restoration Interagency Teams (member organizations listed in the oyster restoration management strategy)
- Custodian: Stephanie Westby (NOAA), stephanie.westby@noaa.gov, (240) 628-5394
- Chesapeake Bay Program Contact (name, email address, phone number): Bruce Vogt, bruce.vogt@noaa.gov, (240) 628-4812

(3) Please provide a link to the location of the data set. Are metadata, data-dictionaries and embedded definitions included?

The compiled summary dataset is available for download at https://www.chesapeakeprogress.com/abundant-life/oysters. The Maryland and Virginia Oyster Restoration Interagency Workgroups typically provide an update on oyster restoration progress each year at the winter Sustainable Fisheries Goal Team meetings. All meeting materials can be found on the Sustainable Fisheries Goal Team's webpage. Maryland and Virginia partners publish an annual update on oyster restoration progress, which can be found on the Maryland and Virginia Oyster Restoration Interagency Teams webpage. The 2021 Chesapeake Bay Oyster Restoration Update is available. Tributary plans for each of the 10 tributaries targeted for large-scale oyster restoration are available on the web page for the Maryland and Virginia Oyster Restoration Workgroups. Geospatial data and other detailed data are maintained by the NOAA Chesapeake Bay Office.

B. Temporal Considerations

(4) Data collection date(s): Annual – total completed acreage is initially tallied in late fall each year and documented in annual reports from the Maryland and Virginia Oyster Restoration Interagency Workgroups (by spring of the following year).

(5) Planned update frequency (e.g., annual, biannual, etc.):
- Source Data: annual
- Indicator: annual

(6) Date (month and year) next data set is expected to be available for reporting:

February 2023

C. Spatial Considerations

(7) What is the ideal level of spatial aggregation (e.g., watershed-wide, river basin, state, county, hydrologic unit code)? Tributary-wide

(8) Is there geographic (GIS) data associated with this data set? If so, indicate its format (e.g., point, line polygon).

Yes, oyster reef locations and bottom habitat maps for each tributary are available as GIS data (polygon). Also included is restoration treatment and monitoring information on each reef. These data are collected and maintained by the NOAA Chesapeake Bay Office.

(9) Are there geographic areas that are missing data? If so, list the areas.

Geospatial data exist for all selected tributaries for restoration.

(10) Please submit any appropriate examples of how this information has been mapped or otherwise portrayed geographically in the past.

Maps of restored and proposed oyster reef locations are an important part of the tributary planning process. All tributary plans include these maps. The restoration workgroups utilize geodatabases with spatial data for each tributary. Mapping is underway in additional tributaries. The annual updates document progress in each state using GIS data to track progress.

D. Communicating the Data

(11) What is the target or threshold measured by this indicator? How was it established?

The 2014 Watershed Agreement established the outcome to restore native oyster habitat and populations in 10 tributaries by 2025. More specifically, by 2025 the goal is to have selected 10 tributaries, developed a tributary plan for each, completed reef construction and seeding according to each tributary's acreage target, and begun the monitoring process. The monitoring and evaluation process will not be complete by 2025, as it requires six years of post-construction/seeding monitoring before a tributary can be deemed as "restored."

As defined in the Oyster Metrics Report, each tributary's acreage target is developed using the criteria of "a minimum of 50% of currently restorable area that constitutes at least 8% of historic oyster habitat within a given tributary."

(12) What is the current status in relation to the target established in the outcome? Why? Would you define our outlook[1] toward achieving the outcome as on course, off course, uncertain, or completed? Upon what basis are you forecasting the outlook?

Work toward the target established in this outcome is on course. Ten tributaries have been selected for oyster restoration toward this goal. Tributary restoration plans are finalized for all ten tributaries: the Harris Creek, Little Choptank River, Tred Avon River, upper St. Mary's River, Manokin River, Lafayette River, Lynnhaven River, lower York River, Piankatank River, and Great Wicomico River. (Virginia selected an additional tributary, the Eastern Branch of the Elizabeth River, so data are collected for 11 tributaries.) In-water restoration treatment (reef construction/seeding) is complete in Harris Creek, the Little Choptank River, and the Tred Avon River in Maryland, and in the Lafayette, Piankatank, and lower York Rivers in Virginia. Restoration is in progress in the remaining tributaries. Monitoring and evaluation are under way in all tributaries. Maryland and Virginia restoration partners publish annual updates on restoration. The 2021 Chesapeake Bay Oyster Restoration Update is available here.

(13) Has a new target, threshold or outcome been established since the last reporting period? Why?

No, the goal remains to restore oyster populations in 10 tributaries by 2025, per the 2014 Chesapeake Bay Watershed Agreement. An eleventh tributary (the sixth in Virginia) was selected for restoration, going beyond the outcome.

Background: In 2010, the Executive Order 13508 Strategy for Protecting and Restoring the Chesapeake Bay Watershed established a goal of restoring oyster populations in 20 tributaries of the Chesapeake Bay by 2025. Based on experience with current restoration implementation and resource availability, restoration partners determined that an outcome of restoring native oyster habitat and populations in 10 tributaries by 2025 is an appropriate target for the next 10 years and for the 2014 Chesapeake Bay Watershed Agreement.

(14) Has the methodology of data collection or analysis changed since the last reporting period? How? Why? No.

(15) What is the long-term data trend (since the start of data collection)? N/A.
Completed acreage has generally increased each year at a rate dependent on the resources available to construct and/or seed reefs.

(16) What change(s) does the most recent data show compared to the last reporting period? To what do you attribute the change? Would you characterize that change in the recent progress[2] as an increase, decrease, no change, or completed for this outcome?
The data show an increase from the last reporting period. Restoration progressed in both Maryland and Virginia. In calendar year 2021, restoration work occurred in the Tred Avon, , St. Mary's, Manokin, Lynnhaven, Great Wicomico, Lower York, and Piankatank rivers. The Tred Avon, Piankatank, and Great Wicomico rivers were completed.Restoration work began in the St. Mary's and Manokin, the final two tributaries in Maryland under this goal.

(17) What is the key story told by this indicator?

Chesapeake Bay partners are making progress on large-scale tributary oyster restoration. The ten tributaries have been selected (five in Maryland and five in Virginia). An additional eleventh "bonus" tributary was selected in Virginia. Each state or tributary has a specific workgroup dedicated to planning, implementing and monitoring restoration. Tributary restoration plans have been completed for all ten primary tributaries. In-water restoration (reef construction/seeding) has been completed in six of the original ten planned tributaries, plus one "bonus" tributary, and monitoring is under way for the restored reefs. In-water restoration is in progress in the other tributaries. Partners are currently working to continue implementation (reef construction/seeding).

Large-scale oyster restoration in Chesapeake Bay has become an internationally recognized success story. Scientists and resource managers from throughout Europe, Asia, and Australia have visited to learn about the effort, and NOAA staff have travelled nationally and internationally to describe the project.

E. Adaptive Management

(18) What factors influence progress toward the goal, target, threshold or expected outcome?

Implementation of oyster reef construction and seeding is dependent on resource availability of spat (oyster seed), shell/substrate and financial and human resources, as well as permitting processes and stakeholder input.

(19) What are the current gaps in existing management efforts?

While all ten tributaries have been selected (plus the eleventh "bonus" tributary), the Maryland and Virginia Interagency Workgroups need to implement restoration treatments in ongoing tributaries to meet the outcome of 10 restored tributaries.

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

(20) What are the current overlaps in existing management efforts? N/A

(21) According to the management strategy written for the outcome associated with this indicator, how will we (a) assess our performance in making progress toward the goal, target, threshold or expected outcome, and (b) ensure the adaptive management of our work?

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

The participating partners and key stakeholders will use the following approaches to ensure adaptive management.

- Specific to tributary-scale oyster restoration, the Oyster Metrics Report (pg. 24) describes adaptive management as "makes use of knowledge gained through data collection to refine both targets and metrics in route to meeting its ultimate goal." Continuing research and data will be used to reevaluate specific tributary acreage targets and the success metrics to reflect the best available knowledge and experience from oyster restoration in the Bay.
- In addition to refining tributary targets and metrics as stated above, restoration partners will consider new knowledge that arises from future experience and research. These factors include new construction techniques, reef design, use of alternative substrate, etc.
- The status of the restored oyster reefs will need to be monitored and assessed in the long term to determine if restoration has achieved the desired ecosystem changes. This ecosystem change will take time, and previous restoration sites may need additional restoration treatment (shell replenishment, additional substrate and/or seeding) in the future to maintain the health of the oyster reefs.

F. Analysis and Interpretation
Please provide appropriate references and location(s) of documentation if hard to find.

(22) What method is used to transform raw data into the information presented in this indicator? Please cite methods and/or modeling programs.

Number of constructed and/or seeded oyster reef acres is tracked by restoration partners and reported to the Chesapeake Bay Program's Sustainable Fisheries Goal Team each year to add to each tributary's total.

(23) Is the method used to transform raw data into the information presented in this indicator accepted as scientifically sound? If not, what are its limitations? Yes.

(24) How well does the indicator represent the environmental condition being assessed?

The indicator shows the qualitative (steps in restoration process) and quantitative (completed acreage) progress for oyster restoration implementation in each tributary.

(25) Are there established reference points, thresholds, ranges or values for this indicator that unambiguously reflect the desired state of the environment?

Each tributary has a target acreage for oyster reef restoration implementation. See the links to tributary plans in question #10 of this document.

(26) How far can the data be extrapolated? Have appropriate statistical methods been used to generalize or portray data beyond the time or spatial locations where measurements were made (e.g., statistical survey inference, no generalization is possible)? N/A

G. Quality

Please provide appropriate references and location(s) of documentation if hard to find.

(27) Were the data collected and processed according to a U.S. Environmental Protection Agency-approved Quality Assurance Project Plan? If so, please provide a link to the QAPP and indicate when the plan was last reviewed and approved. If not, please complete questions 28-30.
No.

(28) *If applicable:* Are the sampling, analytical and data processing procedures accepted as scientifically and technically valid? Yes.

(29) *If applicable:* What documentation describes the sampling and analytical procedures used?

The restoration plan for each tributary describes the process and details of implementation for each tributary (see question #3). The Oyster Restoration Success Metrics report summarizes the Bay-wide criteria for restored oyster reefs and outlines the process for monitoring and assessing reefs after construction/seeding.

(30) *If applicable:* To what extent are procedures for quality assurance and quality control of the data documented and accessible?
The Oyster Metrics described above can be found on the Chesapeake Bay Program website here.

(31) Are descriptions of the study design clear, complete and sufficient to enable the study to be reproduced? Yes.

(32) Were the sampling, analytical and data processing procedures performed consistently throughout the data record? Yes.

(33) If data sets from two or more sources have been merged, are the sampling designs, methods and results comparable? If not, what are the limitations? N/A

(34) Are levels of uncertainty available for the indicator and/or the underlying data set? If so, do the uncertainty and variability impact the conclusions drawn from the data or the utility of the indicator?
No.

(35) For chemical data reporting: How are data below the MDL reported (i.e., reported as 0, censored, or as < MDL)? If parameter substitutions are made (e.g., using orthophosphate instead of total phosphorus), how are data normalized? How does this impact the indicator? N/A

(36) Are there noteworthy limitations or gaps in the data record? No.

H. Additional Information (*Optional*)

(37) Please provide any further information you believe is necessary to aid in communication and prevent any potential misrepresentation of this indicator.

The Oyster Restoration Management strategy and workplan provide more details about the overall oyster restoration process and specific efforts in each tributary. These documents can be accessed here.

Map: Oyster Restoration in Chesapeake Bay Tributaries (2021)

Data Point	Text
Harris Creek	o Project Name: Lower Choptank River o Tributary: Harris Creek o Completed/Target Acreage: 348/348 o Restoration Status: Between 2011 and 2015, 348 acres of reefs in Harris Creek were built and seeded with spat, marking the completion of the initial restoration phase for this tributary. In 2017 and 2018, several Harris Creek reefs received a planned "second-year-class" seeding of spat. Reef monitoring in 2019 and early 2020 of reefs in Harris Creek that were six years old showed that 97% of the reefs met the minimum oyster density success criterion, and 81% met the higher, ideal target density. 100% of the six-year-old restored reefs met the multiple year class, shell budget, reef height, and reef footprint success criteria. o Partners: National Oceanic and Atmospheric Administration (lead), U.S. Army Corps of Engineers, Maryland Department of Natural Resources, Oyster Recovery Partnership o Learn More

Little Choptank River	o Project Name: Little Choptank River o Tributary: Little Choptank River o Completed/Target Acreage: 358/358 o Restoration Status: The Little Choptank River restoration, comprising 358 acres, was completed in summer 2020. o Partners: National Oceanic and Atmospheric Administration (lead), U.S. Army Corps of Engineers, Maryland Department of Natural Resources, Oyster Recovery Partnership o [Learn More](#)
Tred Avon River	o Project Name: Lower Choptank River o Tributary: Tred Avon River o Completed/Target Acreage: 130/130 o Restoration Status: The Tred Avon River restoration plan initially called for 147 acres of reefs to be present in the sanctuary, but this was eventually reduced to 130 acres. Initial in-water restoration was completed in 2021. o Partners: National Oceanic and Atmospheric Administration (lead), U.S. Army Corps of Engineers, Maryland Department of Natural Resources, Oyster Recovery Partnership o [Learn More](#)
Great Wicomico	o Project Name: Great Wicomico o Tributary: Great Wicomico o Completed/Target Acreage: 124/122 o Restoration: Partners developed a restoration target and restoration plan in 2020. Due to past restoration work, 100 acres of reefs in this tributary already meet our definition of restored. Following the restoration of 24 acres in 2021, the tributary was deemed complete. o Partners: National Oceanic and Atmospheric Administration (lead), U.S. Army Corps of Engineers, Virginia Marine Resources Commission o [Learn More](#)

Lafayette River	o Project Name: Lafayette River o Tributary: Lafayette River o Completed/Target Acreage: 82/80 o Restoration Status: In the Lafayette River, partners set a goal to restore 80 acres of reefs. Of this total, 70 acres already met our definition of a restored reef, due to past restoration work and a decades-long harvest closure that has allowed some reefs to self-restore. In 2017, the Chesapeake Bay Foundation and Elizabeth River Project built four and a half acres of reefs, bringing the total acreage of restored reefs in the tributary to 75. The two nonprofit organizations built the remaining five acres of reefs in 2018, making it the first tributary in Virginia where initial in-water restoration was completed. o Partners: National Oceanic and Atmospheric Administration (lead), U.S. Army Corps of Engineers, City of Norfolk, Christopher Newport University, Virginia Institute of Marine Science, Virginia Marine Resources Commission, Chesapeake Bay Foundation, Elizabeth River Partnership o [Learn More](#)
Lower York River	o Project Name: Lower York River o Tributary: Lower York River o Completed/Target Acreage: 55/200 o Restoration Status: In 2021, VMRC constructed 10 acres of shell reefs in the river. VMRC intends to continue work here in 2022. o Partners: National Oceanic and Atmospheric Administration (lead), U.S. Army Corps of Engineers, Virginia Marine Resources Commission o [Learn More](#)

Lynnhaven River	o Project Name: Lynnhaven River o Tributary: Lynnhaven River o Completed/Target Acreage: 114/152 o Restoration Status: Due to past restoration work, 89 acres of reefs in this tributary already met our definition of restored. The Chesapeake Bay Foundation and Lynnhaven River now plan to construct 26 acres of reef in 2022. o Partners: U.S. Army Corps of Engineers (lead), National Oceanic and Atmospheric Administration, City of Virginia Beach, Virginia Institute of Marine Science, Virginia Marine Resources Commission, Chesapeake Bay Foundation, Lynnhaven River NOW, Oyster Reefkeepers o [Learn More](#)
Piankatank River	o Project Name: Piankatank River o Tributary: Piankatank River o Completed/Target Acreage: 444/438 o Restoration Status: In the Piankatank River, partners set a goal to restore 438 acres of reefs, which they exceeded in 2021, when the river was considered completed at 444 acres. Work toward the goal got a boost thanks to the presence of existing reefs (203 acres) in the river. o Partners: National Oceanic and Atmospheric Administration (lead), U.S. Army Corps of Engineers, Virginia Institute of Marine Science, Virginia Marine Resources Commission, Chesapeake Bay Foundation, Nature Conservancy o [Learn More](#)

St Mary's River	o Project Name: St Mary's River o Tributary: St Mary's River o Completed/Target Acreage: 49/60 o Restoration Status: A restoration plan has been developed for the upper St. Mary's River, and work begin with the seeding of 14 acres of reef in 2021. There were 35 acres of preexisting oyster reefs present. Partners: National Oceanic and Atmospheric Administration (lead), U.S. Army Corps of Engineers, Maryland Department of Natural Resources, Oyster Recovery Partnership o [Learn More](#)
Manokin River	o Project Name: Manokin River o Tributary: Manokin River o Completed/Target Acreage: 35/441 o Restoration Status: Partners have developed a restoration target (441 acres) and a restoration plan for the river. There are an estimated 20 acres of healthy reef in the river. Restoration began in 2021 with the seeding of 15 acres of reef. o Partners: National Oceanic and Atmospheric Administration (lead), U.S. Army Corps of Engineers, Maryland Department of Natural Resources, Oyster Recovery Partnership o [Learn More](#)
Eastern Branch of the Elizabeth River	o Project Name: Elizabeth River Eastern Branch o Tributary: Elizabeth River – Eastern Branch o Completed/Target Acreage: 24/20 o Restoration Status: In 2020, the Virginia Marine Resources Commission constructed 21 acres of reef. Due to past restoration work 2.7 acres of reef in this tributary already met the definition of restored. o Partners: Virginia Marine Resources Commission, Elizabeth River Project, National Oceanic and Atmospheric Administration

[1]*Outlook:* Outlook is the forecasted trajectory for whether the Chesapeake Bay Program is on course to achieving the outcome. An outcome's outlook may be on course, off course, uncertain, or completed. This information will be incorporated into the outcome's progress page. An outcome's course outlook is reviewed and updated during the outcome's Strategy Review System (SRS) Quarterly Progress Meeting in addition to when recent progress is assessed.

[2]*Recent Progress:* Recent Progress describes the change in the indicator based on the most recent data collected since the last reporting period. The recent progress icon will reflect this change as an increase, decrease, no change, or completed, depending upon this progress. This information will be discussed at the outcome's Strategy Review System (SRS) Quarterly Progress Meeting.