

Oyster Management Review: 2021-2025

A Report Prepared by
Maryland Department of Natural Resources
Final Report
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Section 1: Executive Summary

Oyster Management Review

2021-2025

Maryland Department of Natural Resources

The purpose of this report is to fulfill the Maryland Department of Natural Resources' commitment, originally established by 2010 regulations¹, to review three areas of oyster management every five years. The three management areas for oysters in Maryland are defined as:

Sanctuaries - areas where commercial and recreational oyster harvest is prohibited.

Public Shellfish Fishery Areas (PSFA) - areas reserved for public fishery oyster harvest and cannot be leased for aquaculture. A PSFA may be declassified in accordance with [COMAR 08.02.04.17](#) if there is a petition to declassify and a biological survey indicates that the area does not have enough oysters to support commercial harvest by the public fishery.

Aquaculture - areas where the bottom or water column is leased by the State to individuals or businesses for private rearing of oysters.

Specifically, this report serves as the third five-year review (covering the years 2021–2025). The report provides an evaluation of the effectiveness of management areas against the objectives laid out in the 2019 Oyster Management Plan (OMP)², provides information on the current status of oyster sanctuaries, PSFAs, and Maryland's aquaculture industry, and provides recommendations for meeting the overall goal of the OMP.

Objective Status and Area Classification

The three management areas were evaluated to determine the status of each objective stated in the OMP as being met, meeting, or ongoing. Since each management area type serves a different purpose, their objectives are different. Sanctuaries are permanently closed to public fishery harvest to provide long-term ecosystem services, habitat, and oyster broodstock. Many receive restoration investments in addition to the conservation action of prohibiting harvest. Some fishery areas receive replenishment plantings (substrate and oyster plantings) specifically designed to sustain harvest. Aquaculture areas are leased areas by individuals or businesses for privately rearing oysters for commercial purposes.

¹ Maryland Register, Vol 37, Issue 14, p. 943. Friday July 2, 2010
<http://dnr.maryland.gov/fisheries/Documents/Oyster%20Packages%20September%202010.pdf>

² 2019 Oyster Management Plan. https://dnrweb.dnr.state.md.us/archive/fisheries/MD_Oyster_FMP-2019.pdf

In addition to OMP objective evaluation, individual sanctuaries and non-sanctuary NOAA Code areas were evaluated by ranking them relative to one another, within each management type, based on population metrics (spat, small, and market density, mortality, and cultch - which is defined as loose shell, live oysters and dead oysters), as detailed in Section 5 of this report. These rankings were then assigned to distinct levels corresponding to percentiles: > 80th, >50–80th, >20–50th, and ≤ 20th, which reflect the relative oyster productivity of the areas. Some individual sanctuary and non-sanctuary NOAA Code areas had insufficient data to conduct the analysis.

Sanctuaries are ranked strictly relative to other sanctuaries, and non-sanctuary NOAA Code areas are ranked strictly relative to other non-sanctuary NOAA Code areas. A sanctuary in the ">80th percentile" means it performed in the top tier of all sanctuaries; it does not mean it has the same conditions or densities as a non-sanctuary NOAA Code areas in the ">80th percentile".

Overview of Sanctuary Objectives and Status

There are five objectives related to sanctuary areas:

- Objective #1 (ongoing): Increase oyster populations to levels that improve important ecological functions and yield adequate broodstock to sustain regional populations.
- Objective #2 (ongoing): Improve oyster habitat and increase oyster biomass by utilizing appropriate techniques considering the influence of environmental conditions.
- Objective #3 (meeting): Conserve and protect oyster habitat and biomass through maintenance of sanctuaries so that a minimum of 20-30% of oyster habitat and 50% of the 'best bars' are within sanctuaries.
- Objective #4 (met): Conduct and complete large-scale restoration in five tributaries by 2025.
- Objective #5 (ongoing): Support, enhance, and increase ecological restoration activities in other tributaries throughout the Chesapeake Bay.

Currently, two objectives are met and three objectives are ongoing evaluation. Objective #3 is being met with 24% of productive oyster habitats and 50% of the 'best bars' residing within the sanctuary boundaries. Objective #4, which involved large-scale restoration in five tributaries, was successfully achieved by its 2025 target.

Objectives #1 and #2 focus on increasing oyster populations, broodstock and biomass, as well as enhancing overall habitat quality and ecological benefits from oysters. Most sanctuary areas had a positive trend in increasing oyster density thus increasing broodstock. Biomass also has steadily increased due to effective restoration techniques such as substrate and spat-on-shell plantings.

Efforts on Objective #5, aimed at supporting restoration in additional tributaries, are ongoing, featuring small-scale restoration activities and community-based restoration projects.

Sanctuary Classification and Rankings

The primary objective of the sanctuary classification is to examine the general characteristics and long-term trends of oyster populations within sanctuary areas. Relative Productivity Rankings (provided in Section 5.1 & 5.2) evaluate sanctuaries strictly relative to one another based on 2021–2025 survey metrics (market, small, and spat densities, cultch volume, and mortality rate):

- **>80th Percentile (7 sanctuaries):** Exceptional productivity, high live densities, abundant cultch, and low mortality (*St. Marys River, Little Choptank River, Nanticoke River, Harris Creek, Upper Choptank River, Hooper Strait, Tred Avon River*).
- **>50–80th Percentile (11 sanctuaries):** High adult oyster densities, though recruitment and mortality are more variable (*Upper Patuxent River, Neal Addition, Choptank ORA, Manokin River, Howell Point, Somerset, Lower Mainstem Bay, Point Lookout, Wye River, Severn River, Sandy Hill*).
- **>20–50th Percentile (10 sanctuaries):** Below-average adult densities and variable cultch levels (*Eastern Bay, Magothy River, Mill Hill, Cox Creek, Lower Choptank River, Miles River, Cook Point, Breton Bay, Chester ORA, Lower Patuxent River*).
- **≤20th Percentile (7 sanctuaries):** Low densities, low cultch, or low-salinity impacts to recruitment potential (*Man O War, Upper Chester River, Herring Bay, Calvert Shore, Lower Chester River, Cedar Point, South River*).
- **Insufficient Data (16 sanctuaries):** Omitted from relative rankings due to having fewer than 4 representative samples.

Appendix A provides an individual evaluation of each sanctuary, which is separate from their relative ranking classification. The 51 sanctuaries were categorized based on their performance and restoration status as of 2025:

- **Restored (5 sanctuaries):** Large-scale restoration completed under the 2014 Chesapeake Bay Watershed Agreement.
- **Positive Trend and/or High Density (12 sanctuaries):** Demonstrating positive population growth or densities exceeding 94.2 oysters per square meter.
- **Restoration Received, Ongoing, or Planned (16 sanctuaries):** Receiving large-scale target restoration, regional project plantings, or small-scale plantings.
- **Negative Trend (4 sanctuaries):** Underperforming areas under evaluation for corrective action.
- **Non-Governmental Organization (NGO) / Laboratory Use (5 sanctuaries):** Dedicated to educational, non-profit, or laboratory research
- **Lacking Data / Poor Habitat (9 sanctuaries):** Impaired by deep-water hypoxia, artificial substrates incompatible with the Department's sampling gear, or minimal historical habitat.

Overview of Public Shellfish Fishery Area Objectives and Status

The three OMP objectives related to PSFA are:

- Objective #1 (ongoing): Achieve a sustainable public oyster fishery.
- Objective #2 (meeting): Manage the oyster fishery according to science-based biological reference points through harvest rates that are based on oyster stock assessments.
- Objective #3 (ongoing): Manage the oyster fishery using a combination of input (effort) and output (harvest) controls, habitat modification, and stock enhancement to meet targets and avoid thresholds.

The objectives related to fishery management reveal positive progress. Objective #1 is ongoing with sustainability being highly certain in many regions due to current increasing oyster density and biomass, favorable recruitment rates and low mortality. Objective #2 is being met as regular stock assessments with biological reference points and ongoing annual population monitoring are conducted. Maintaining harvest limits and conducting substrate and oyster replenishment plantings are ongoing actions aimed to manage the fishery as well as closing some areas to harvest due to low oyster density (Objective #3).

Non-Sanctuary NOAA Code Area Classification and Rankings

Relative Productivity Rankings analysis (provided in Section 5.2.1) was conducted on non-sanctuary NOAA Code areas. These areas were ranked strictly relative to one another using 2021–2025 Fall Oyster Survey metrics (market, small, and spat densities, cultch volume, and total observed mortality) with most samples taken within the boundaries of the PSFAs:

- **>80th Percentile (6 Areas):** Exceptional productivity and high densities, abundant cultch, and low mortality (*Broad Creek, Tred Avon River, Upper Patuxent River, Smith Creek, Middle Choptank River, Wicomico River East*).
- **>50–80th Percentile (9 Areas):** Above-average productivity and high densities, but with more variable spat recruitment or higher mortality and harvest pressure (*St. Marys River, Fishing Bay, Honga River, Wicomico River West, Lower Patuxent River, Miles River, Middle Patuxent River, Tangier Sound North, Tangier Sound South*).
- **>20–50th Percentile (9 Areas):** Moderate productivity and oyster densities, but lower spat densities, variable cultch, and higher mortality (*Eastern Bay, Lower Choptank River, Harris Creek, Pocomoke Sound, Manokin River, Little Choptank River, Nanticoke River, South River, Big Annemessex*).
- **≤20th Percentile (7 Areas):** Lowest performing areas with sparse cultch and limited suitable bottom, situated mostly in low-salinity area impacting natural recruitment potential (*Middle Chester River, Upper Chesapeake Bay, Lower West Chesapeake Bay, Upper Middle Chesapeake Bay, Lower Middle Chesapeake Bay, St. Clements and Breton Bay, Lower Chester River*).
- **Insufficient Data (8 Areas):** Omitted from relative rankings due to having insufficient non-sanctuary NOAA Code acreage or lack of survey sampling.

During the 2021–2025 review period, a majority of non-sanctuary NOAA Code areas experienced significant increases in total live oyster density, market-sized oysters, and live biomass compared to earlier five-year periods. Observed mortality generally remained below long-term baywide averages across the 5-year period, but several medium- and high-salinity areas experienced temporary mortality peaks in 2023 corresponding to spikes in dermo intensity and MSX prevalence.

Broad Creek (537), Tangier Sound North (292), and Tangier Sound South (192) most consistently ranked as the top three commercial public fishery harvest areas in Maryland waters. Low-salinity areas continued to experience low natural recruitment and declining harvest. This resulted in management actions that closed much of the Upper Bay and Chester River to harvest, only opening small sites that had been previously planted with oysters for the purpose of commercial harvest.

Overview of Aquaculture Objectives and Status

There are two objectives in the OMP relative to aquaculture areas:

- Objective #1 (ongoing): Support policies and partnerships that increase private investment in oyster aquaculture.
- Objective #2 (ongoing): Expand oyster aquaculture production in areas of suitable habitat.

Under Objective #1, Maryland Agricultural and Resource-Based Industry Development Corporation (MARBIDCO) administers a shellfish aquaculture loan program allowing leaseholders to purchase capital equipment, shell, and seed. Aquaculture training and education programs were developed in partnership with extension services through the University of Maryland and Maryland Sea Grant. The permitting process for oyster aquaculture continues to be evaluated and improved in collaboration with state, federal, and industry partners through the Aquaculture Coordinating Council and Aquaculture Review Board. The Aquaculture Coordinating Council recently recommended implementing the demonstration lease program. These leases would be run by public schools, colleges or universities, 4-H clubs, and nonstock, nonprofit corporations organized under the laws of the State and would educate many user groups on the ecological and economic benefits of oyster aquaculture. The Department has begun developing the framework to implement this program.

Under Objective #2, an online mapping tool, the Aquaculture Siting Tool, was created to help prospective commercial shellfish lease applicants locate and self-screen areas of interest.

Conclusions and Recommendations

The oyster management plan aims to restore oyster ecosystems and enhance the commercial fishery for economic and cultural reasons. The 2021-2025 timeframe represents a significant upward trajectory for Maryland's oyster populations. This period averaged the highest recruitment, biomass, and cultch indexes in the 36-to-41-year time series, respectively. Concurrently, disease and mortality indexes were among the lowest on record. Overall, these indices support that the objectives of the OMP are ongoing or being met.

The report outlines several strategic recommendations to maintain the current population trajectory and meet the OMP goals and objectives:

- **Continue Funding the Eastern Bay Regional Project:** Maintain long-term financial appropriation and support for the 25-year Eastern Bay Regional Project, with effectiveness reviews every 5 years.
- **Maintain Sanctuary Restoration Funding:** Continue funding sanctuary restoration to meet 2019 OMP objectives and achieve updated Chesapeake Bay Watershed Agreement goals including restoring or conserving 1,100 additional acres of oyster reef habitat in Maryland by 2040.
- **Support Law Enforcement:** Support Natural Resources Police enforcement capabilities to ensure compliance and uphold the management strategies outlined in the OMP.
- **Improve Fishery Reporting Rates:** Increase harvester reporting compliance (currently at about 60%) through targeted outreach and encouraging harvesters and seafood dealers to use electronic reporting systems.
- **Invest in Ecological Research:** Support ongoing scientific research to measure and evaluate the long-term ecological benefits and ecosystem services provided by restored oyster reefs.
- **Update the Oyster Management Plan (OMP):** Formally update the OMP to incorporate biological reference points and population data from the 2024 Oyster Benchmark Stock Assessment, along with nitrogen and phosphorus removal Best Management Practices (BMPs) for restoration and the public fishery.
- **Continue Bay Bottom Habitat Surveys:** Persist with updated bottom mapping across Maryland's portion of the Bay to determine true viable oyster habitat and improve stock assessment accuracy.
- **Establish Aquaculture Demonstration Leases:** Implement the Aquaculture Coordinating Council's proposal to create demonstration leases (non-commercial) reserved for educational, conservation, or ecological use by public schools, universities, and non-profits.

Section 2: Purpose of Report

In 2010, the Maryland Department of Natural Resources overhauled its regulations for the management of oysters in the Maryland portion of Chesapeake Bay. The new regulations expanded oyster sanctuaries, created new opportunities for oyster aquaculture, and designated areas to be maintained for the public fishery. The preamble of the 2010 oyster regulation states: *“The Department has committed to reviewing the effectiveness of the locations of sanctuaries, Public Shellfish Fishery Areas, and aquaculture areas every five years and to propose changes where needed.”*³ The three types of management areas identified in the preamble are defined as follows:

- Sanctuaries – Areas permanently closed to commercial public fishery or recreational oyster harvest. Some sanctuaries have been targeted for extensive oyster restoration projects to potentially accelerate the recovery of oyster populations within the sanctuary, increase their environmental benefits, and contribute to enhancement of populations outside the sanctuary.
- Public Shellfish Fishery Areas – Areas where shellfish are harvested for commercial purposes and oyster aquaculture leases are not allowed in these areas. However, if a biological survey indicates that the area does not have enough oysters to support commercial harvest by the public fishery, a petition to declassify the area may be approved ⁴.
- Aquaculture – Areas where aquaculture leases are issued by the State to individuals or businesses for private rearing of oysters.

This report is the third five-year oyster review covering the 2021 through 2025 time period. The first report, published in 2016, reviewed 2010 through 2015 information and the second report, published in 2021, reviewed the 2016 through 2020 information.⁵ This report uses available information to describe the current status of oyster sanctuaries, Public Shellfish Fishery Areas, and Maryland’s aquaculture industry fifteen years after the management plan was adopted in 2010. In 2019, the Department updated the oyster management plan. This plan laid out new objectives for the three management sectors: sanctuaries, public fishery, and aquaculture. The 2021-2025 report will evaluate the objectives from the 2019 Oyster Management Plan, not the 2010 regulation objectives, and therefore, will be different from the last two reports.

Defining ‘Effectiveness’

The effectiveness of the management areas are measured against the ten objectives of the 2019 Oyster Management Plan with the overall goal:

“to conserve, protect and where possible, rebuild oyster populations to fulfill their important ecological role and to support the culturally

³ Maryland Register, Vol 37, Issue 14, p. 943. Friday July 2, 2010
<http://dnr.maryland.gov/fisheries/Documents/Oyster%20Packages%20September%202010.pdf>

⁴ (COMAR 08.02.23.03) <http://www.dsd.state.md.us/COMAR/ComarHome.html>

⁵ Maryland Department of Natural Resources. 2016. Oyster Management Review: 2010-2015. <https://dnr.maryland.gov/fisheries/Pages/oysters/5-Year-Oyster-Review-Report.aspx>

significant oyster fishery and industry throughout the Maryland portion of Chesapeake Bay.”

This report provides information on oyster populations within the 51 individual sanctuaries and 176 PSFAs before and after their creation. The status of the aquaculture industry is also examined. Even though future trends may change, a comparison of oyster populations before and after 2010 is a useful first indicator of the effectiveness of the locations of sanctuaries and PSFAs. In particular, ecological services, such as water filtration and creation of habitat for other species, can be linked to oyster survival, abundance, biomass, and size structure^{6,7}.

Any assessment of effectiveness must be considered in the context of the fifteen years since the new oyster management regulations were implemented. However, the variable nature of the estuarine environment greatly impacts the population. For example, wet years and dry years have significant impacts on oyster reproduction, growth, disease pressure, and mortality, and historically, the climate shifts multiple times between these two conditions over periods of several years^{8,9}.

This report does not directly compare sanctuary, PSFA and aquaculture to each other as an indicator of effectiveness of the OMP objectives. The three management areas differ in several ways including in the objective of the area, management actions and varying levels of biological surveys, thus making direct comparisons problematic. Therefore, this report evaluates effectiveness separately for the three management areas.

The report provides a relative ranking classification analysis whereas areas with higher ranks have higher densities of oysters, good habitat, and high survival. However, the analysis cannot be used to compare the performance of individual sanctuaries and individual non-sanctuaries to each other (grouping the 176 PSFA into 39 non-sanctuary NOAA Code areas). The analysis only ranks individual sanctuaries relative to all sanctuaries and only ranks individual non-sanctuary NOAA Code areas relative to all the non-sanctuary NOAA Code areas.

Many of the data presented in this report are complex. If you have any accessibility issues or questions on what is depicted in the graphs, tables, and figures, please reach out to the Department for assistance at customerservice.dnr@maryland.gov, 877-620-8367 (in-state) or 410-260-8367 (out-of-state).

⁶ Grabowski, J.H., Peterson, C.H. 2007. Restoring Oyster Reefs to Recover Ecosystem Services in Ecosystem Engineers: Plants to Protists. Academic Press.

⁷ Luckenbach, M.W., Coen, L.D., Ross, P.G. Jr., Stephan, J.A. 2005. Oyster reef Habitat Restoration: Relationships Between Oyster Abundance and Community Development based on Two Studies in Virginia and South Carolina. Journal of Coastal Research. SI. 40:64-78.

⁸ Tarnowski, 2010. Maryland Oyster Population Status Report, 2009 Fall Survey. <http://dnr.maryland.gov/fisheries/Documents/2009FSreport.pdf>

⁹ Tarnowski, 2012. Maryland Oyster Population Status Report, 2011 Fall Survey. <http://dnr.maryland.gov/fisheries/Documents/2011FSreport.pdf>

Section 3: Description of the Three Types of Management Areas

In 2010, three types of oyster management areas were created in Maryland's portion of Chesapeake Bay (Figure 3-1). These are sanctuaries, Public Shellfish Fishery Areas, and aquaculture areas.

Sanctuary acres have remained the same since the last five-year report at 253,007 acres. PSFA acres have decreased by 15.3 acres since the last five-year report. A total of 219 acres have been declassified from the original 179,943 PSFA acres established in 2010 (0.12%). These acres are now leased acres for use in aquaculture due to not having enough oyster biomass to support the commercial fishery.

Aquaculture areas are permitted across state waters and are subject to specific location and operational requirements. Sites must be situated in waters designated by the Maryland Department of the Environment as approved, conditionally approved, or restricted for harvesting shellfish, and any corporate entity applying for a lease must be majority-owned by Maryland residents, holding over 50% of ownership stock. Regarding setback requirements, activities must maintain a minimum distance of 50 feet from piers or shorelines, unless explicit written consent is granted by the riparian owner, and 150 feet from PSFAs, registered pound net sites, oyster reserves, Yates Bars within oyster sanctuaries, and federal navigation channels. Furthermore, aquaculture is strictly prohibited within submerged aquatic vegetation protection zones and the Assateague Island National Seashore. The total number of active leases stands at 471, spanning 7,622 acres.

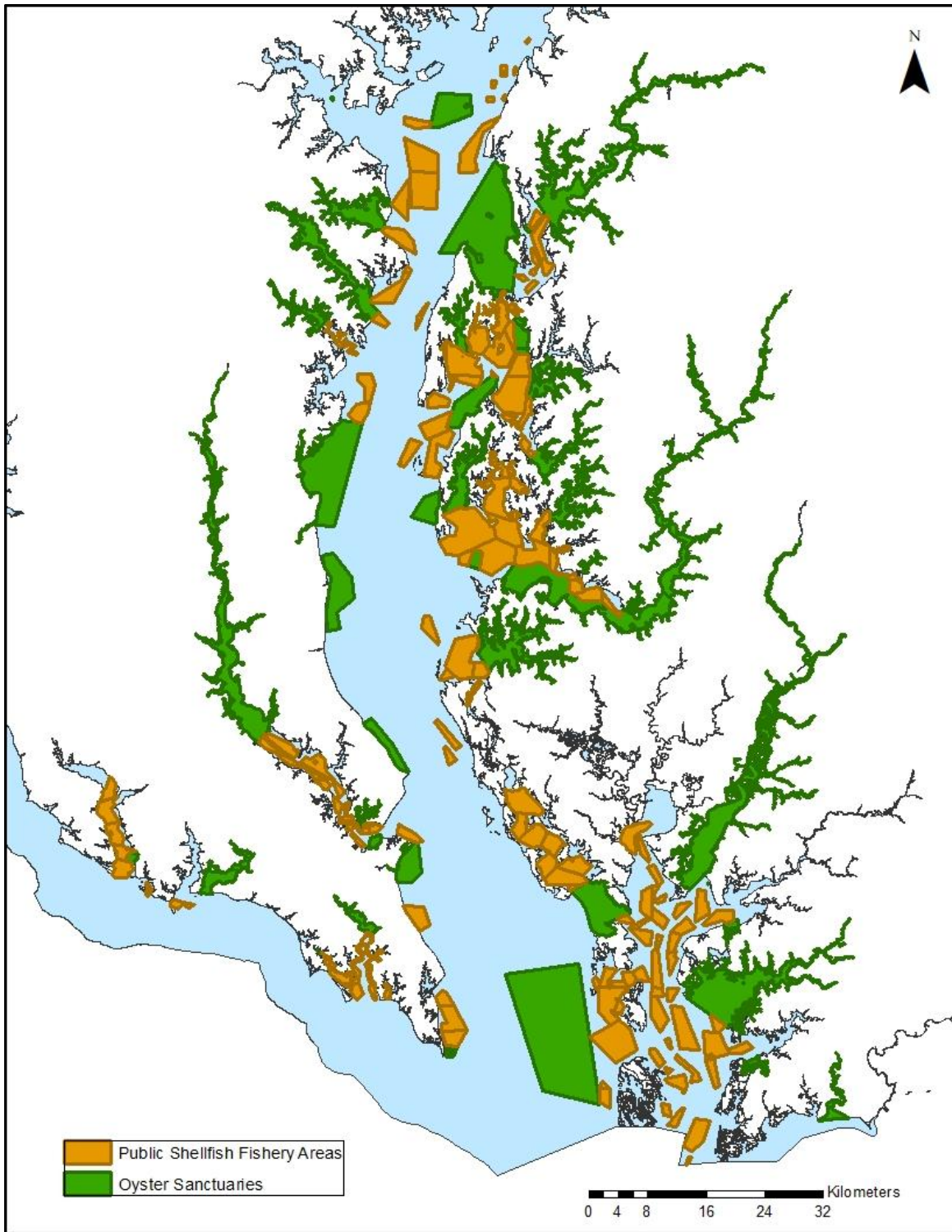


Figure 3-1. Management areas for oysters created in 2010 in Maryland's portion of Chesapeake Bay.

Section 3.1: Sanctuaries

Maryland established 29 oyster sanctuaries between 1961 and 2009. The majority of these sanctuaries were small (less than 500 acres), on the scale of individual oyster bars or within parts of bars, and located in eleven tributaries and the Bay's mainstem. In 2010, 30 new sanctuaries were created. These sanctuaries were created on a much broader scale, incorporating multiple oyster bars and the non-oyster areas between them into single, large sanctuaries. Eight of the original sanctuaries were incorporated into larger 2010 sanctuaries, while 21 remained as established prior to 2010. This resulted in a total of 51 oyster sanctuaries. The sanctuaries are distributed throughout the range of oyster habitat in Maryland's portion of Chesapeake Bay. The current sanctuaries (established in 2010) are located across 16 tributaries and the mainstem of the Bay, encompassing 253,007 surface acres (Figure 3-1). Detailed descriptions of each of the sanctuaries are presented in Appendix A.

Post-2020 Changes to Sanctuaries

Since the 2016 through 2020 Oyster Management Review¹⁰, there have been no changes to the existing sanctuary boundaries.

In the 2016 through 2020 Oyster Management Review, there were five large-scale restoration sanctuaries identified as part of Maryland's commitment to the 2014 Chesapeake Bay Watershed Agreement¹¹: Harris Creek¹², Little Choptank River¹³, Tred Avon River¹⁴, St. Marys River¹⁵ and Manokin River¹⁶ oyster sanctuaries. Initial restoration of 348 acres in Harris Creek was completed in 2015; 358 acres in the Little Choptank River was completed in 2020; 130 acres in the Tred Avon River was completed in 2021; 60 acres in the St. Marys River was completed in 2022; and 455 acres in the Manokin River was completed in 2025. Appendix A of this report provides more detail on the restoration activities in the Harris Creek, Little Choptank River, Tred Avon River, St. Marys River, and Manokin River oyster sanctuaries.

In 2024, DNR announced the Department's Four Point Oyster Sanctuary Plan to guide future oyster sanctuary management and restoration. It consists of monitoring, restoration, evaluation, and connectivity. The goal of monitoring is to continue to evaluate the first five large-scale restoration sanctuaries and to continue to understand the long-term ecological effects. The goal of restoration is to continue and expand

¹⁰ Maryland Department of Natural Resources. 2016. Oyster Management Review: 2010-2015.

<https://dnr.maryland.gov/fisheries/Documents/FiveYearOysterReport.pdf>

¹¹ https://www.chesapeakebay.net/documents/FINAL_Ches_Bay_Watershed_Agreement.withsignatures-HIres.pdf

¹² Maryland Interagency Oyster Restoration Workgroup of the Sustainable Fisheries Goal Implementation Team. 2013. Harris Creek Oyster Restoration Tributary Plan. https://dnr.maryland.gov/fisheries/Documents/Harris_Creek_tributary_plan_011513.pdf

¹³ Maryland Interagency Oyster Restoration Workgroup of the Sustainable Fisheries Goal Implementation Team. 2015. Little Choptank River Oyster Restoration Tributary Plan. https://dnr.maryland.gov/fisheries/documents/2015_Little_Choptank_Blueprint.pdf

¹⁴ Maryland Interagency Oyster Restoration Workgroup of the Sustainable Fisheries Goal Implementation Team. 2015. Tred Avon River Oyster Restoration Tributary Plan. https://dnr.maryland.gov/fisheries/documents/2015_Tred_Avon_Blueprint.pdf

¹⁵ Maryland Interagency Oyster Restoration Workgroup of the Sustainable Fisheries Goal Implementation Team. 2020. Upper St. Marys River Oyster Restoration Tributary Plan. https://dnr.maryland.gov/fisheries/Documents/Reg_Changes/St.%20Mary%27s%20Blueprint%20final.pdf

¹⁶ Maryland Interagency Oyster Restoration Workgroup of the Sustainable Fisheries Goal Implementation Team. 2020. Manokin River Oyster Restoration Tributary Plan. https://dnr.maryland.gov/fisheries/Documents/ManokinRiver_Oyster_Restoration_Tributary_Plan.pdf

oyster restoration within sanctuaries, including small- and large-scale efforts, the Eastern Bay regional projects, and the facilitation of private and non-profit projects. Evaluation includes evaluating alternative management actions and strategies for underperforming sanctuaries. The goal of connectivity is to connect oyster restoration to watershed restoration. An example of oyster connectivity is the use of oysters as a Best Management Practice for the removal of nitrogen and phosphorus, or the use of oysters as living shorelines and breakwaters. This Four Point Oyster Sanctuary Plan allowed the Department to continue to look forward to future oyster restoration. In 2024, the Department announced the next three sanctuaries for large-scale restoration efforts: Herring Bay, Hooper Strait, and Nanticoke River.

In December 2025, a revised Chesapeake Bay Watershed Agreement was signed with a revised oyster goal. The revised oyster goal committed the State to restoring 1,100 acres of additional oyster reef habitat by 2040 to provide ecosystem service benefits, maintain a sustainable oyster abundance through oyster fisheries and aquaculture practices, and to maintain reefs that were established under the 2014 Chesapeake Bay Watershed Agreement to restoration success metrics.

Section 3.2: Public Shellfish Fishery Management Areas

The “Public Shellfish Fishery Areas of the Chesapeake Bay and Its Tidal Tributaries (September 2010)”¹⁷ document contains coordinates for all PSFAs in Chesapeake Bay and its tidal tributaries. Detailed descriptions of the PSFAs, which are combined into larger geographical regions called non-sanctuary NOAA Code areas (Figure 3-2), are presented in Appendix B.

Post-2020 Changes to PSFAs

Since PSFAs were established in 2010, a total of 219 acres have been declassified which equates to 0.12% of the original PSFA acreage (179,943 acres). Since 2020, 15.3 acres have been declassified as a PSFA at the request of lease applicants where a DNR oyster population survey found less than one oyster per square meter.

¹⁷ Maryland Department of Natural Resources. 2012. Public Shellfish Fishery Areas of the Chesapeake Bay and Its Tidal Tributaries. https://dnr.maryland.gov/fisheries/Documents/Public_Shellfish_Fishery_Areas_of_the_Cheseapeake_Bay_and_Its_Tidal_Tributaries.pdf

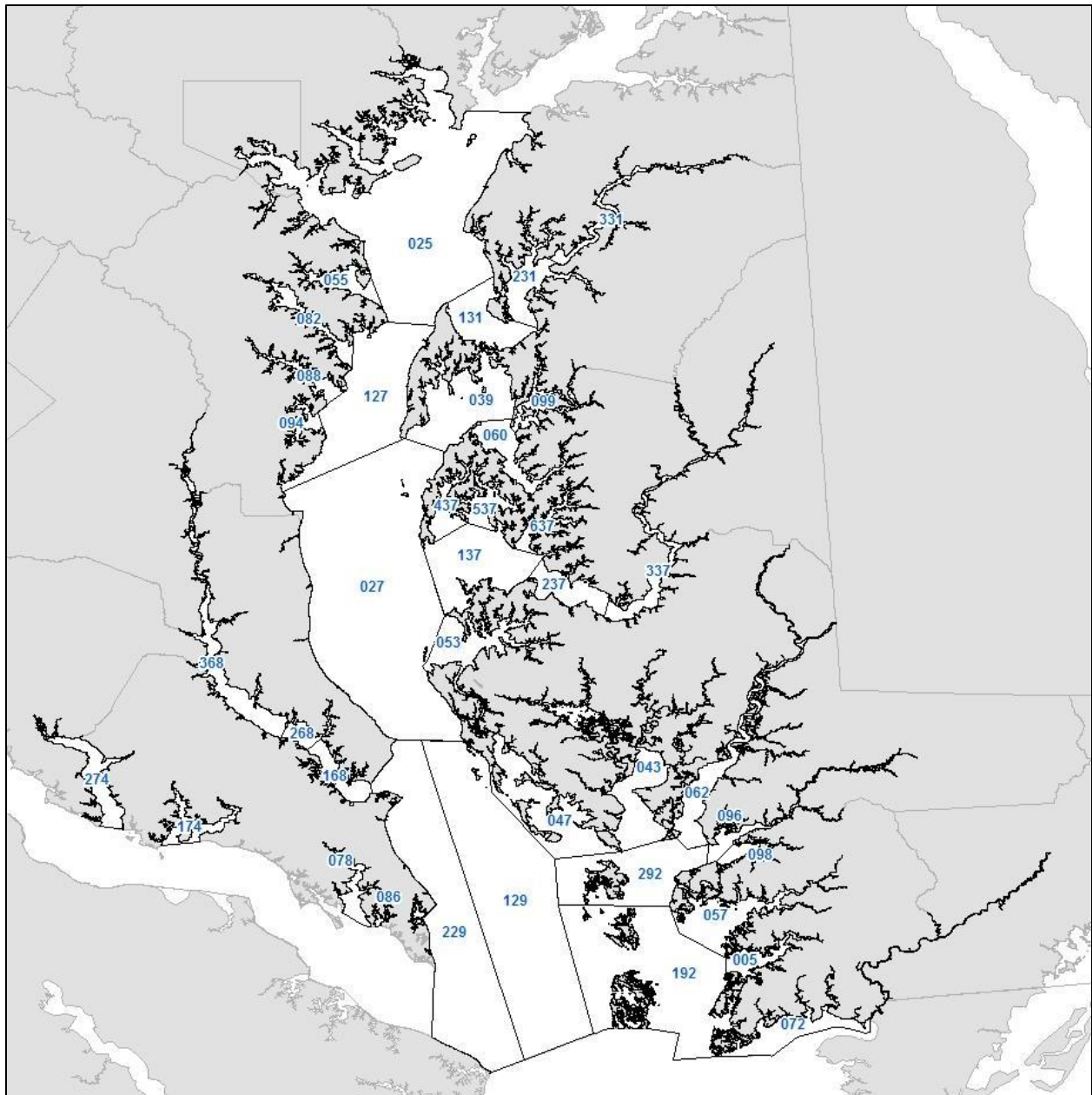


Figure 3-2. Map of the NOAA Code areas within the Chesapeake Bay.

Section 3.3: Aquaculture Areas

Inconsistent record keeping prevents any discussion on trend assessment of aquaculture areas prior to 2009. Between 1974 and 2009, the number of acres of leased aquaculture land in Maryland ranged from 7,519 to 9,470 acres. Through the period 1990 to 2009, very few of these shellfish leases were actively being worked.

Post-2020 Changes to Aquaculture

A new shellfish leasing program was launched in September 2010, implementing a strict active use provision in the lease law that requires leaseholders to actively cultivate their leases or return them to the State. This provision resulted in numerous long-held, inactive leases being returned to the State, making these areas available again to prospective oyster growers. Since the inception of the modern leasing program in 2010 through the end of 2025, Maryland has received 649 shellfish lease applications, with 582 submitted since August 1, 2011, when water column leasing applications began. Over this timeframe, the State executed 390 new commercial shellfish leases totaling approximately 7,531 acres. The total number of active leases stands at 471, spanning 7,622 acres, which comprises 384 submerged land leases (7,084 acres) and 87 water column leases (538 acres).

Under Natural Resources Article § 4-11A-09(c), the active use requirement dictates that a leaseholder must annually plant at least one-fourth of the leased area at a minimum density of 1,000,000 shellfish seed per acre. However, the Department revised the leasing standards in 2016 to assist leaseholders, requiring them to plant at least one-fifth of the leased area at a minimum density of 200,000 shellfish seed per acre. Failure to meet these requirements triggers a warning process, and continued non-compliance can result in lease termination.

Since 2020, several changes have been made to Maryland's shellfish aquaculture leasing and permitting processes to increase processing speed and efficiency. To minimize unnecessary evaluation steps, the Department streamlined its review criteria to focus on requirements defined in law and regulation. Additionally, much of the lease review process has been automated using GIS technology to evaluate applications more quickly. The Aquaculture Review Board was reconvened to facilitate parallel state and federal reviews for joint permits, allowing application and permit processing to continue during high-demand annual reporting and permitting periods. Capacity was further supported by temporary staff increases through Maryland Environmental Service interns to help clear a backlog of shellfish aquaculture lease applications. Electronic reporting development began in 2023 through a partnership with the Oyster Recovery Partnership (ORP). ORP, working with a third-party software developer, produced a mobile application for tracking lease activities like planting and harvesting and generating standardized mandatory reports from that data which can be submitted directly to DNR.

Legislative changes since 2020 have also helped remove administrative hurdles and modernize tools. Aquaculture leases and shellfish nurseries have been exempted from requiring a separate Tidal Wetlands License. A mandatory mobile application was developed to continually map changing coordinates and supply real-time boundary data to end users, a system now operating as the Maryland Aquaculture Siting Tool. Operational adjustments were also introduced, such as extending summer harvest hours to 30 minutes before sunrise to allow extra time before curfews take effect for *Vibrio* spp. control.

Section 4: Effectiveness of Management Areas

This chapter examines a synthesis of data presented in Appendix A (sanctuaries) and Appendix B (Public Shellfish Fishery Areas) to determine the status of the management objectives of the 2019 Maryland Chesapeake Bay Oyster Management Plan. Data used to make determinations about aquaculture management objectives are presented directly in this chapter.

2019 OMP Objectives for Sanctuaries:

1. Increase oyster populations to levels that improve important ecological functions and yield adequate broodstock to sustain regional populations.
2. Improve oyster habitat and increase oyster biomass by utilizing appropriate techniques considering the influence of environmental conditions.
3. Conserve and protect oyster habitat and biomass through maintenance of sanctuaries so that a minimum of 20-30% of oyster habitat and 50% of the 'best bars' are within sanctuaries.
4. Conduct and complete large-scale restoration in five tributaries by 2025.
5. Support, enhance, and increase ecological restoration activities in other tributaries throughout Chesapeake Bay.

2019 OMP Objectives for Public Shellfish Fishery Areas:

1. Achieve a sustainable public oyster fishery.
2. Manage the oyster fishery according to science-based biological reference points through harvest rates that are based on oyster stock assessments.
3. Manage the oyster fishery using a combination of input (effort) and output (harvest) controls, habitat modification, and stock enhancement to meet targets and avoid thresholds.

2019 OMP Objectives for Aquaculture:

1. Support policies and partnerships that increase private investment in oyster aquaculture.
2. Expand oyster aquaculture production in areas of suitable habitat.

Location is a critical factor when considering oyster management areas due to the wide range of environmental and habitat conditions found at larger, regional scales down to smaller scales including individual oyster bars. Each management area (sanctuary, PSFA, or aquaculture area) has its own combination of history and future potential based in part on the attributes of its location. The prevailing salinity of a location is a primary environmental determinant of oyster population dynamics, given its influence on reproduction, growth, and mortality. Oyster habitat is another key element, providing

necessary substrate to which the young oysters can attach. In Maryland, habitat can be extremely patchy, changing greatly within a small distance even on an individual bar. The management areas may have productive oyster bars that are interspersed with patches of sand, mud, or other substrate that is unsuitable for oysters. Degradation of oyster habitat is a problem throughout Maryland's portion of Chesapeake Bay, with some remnant bars having little, if any, remaining substrate on which young oysters can settle¹⁸.

Other factors can be important in accounting for differences in oyster populations among locations but are less well-understood or documented for specific management areas, and so are not included in this evaluation. For example, water currents can carry oyster larvae away from a spawning area ("source area") or can concentrate them in a distant area ("sink area"). Land use may impact management areas in a variety of ways, ranging from sedimentation and nutrient enrichment to pesticide use and presence of endocrine disruptors. Likely there are other localized factors affecting oyster populations that are presently unknown.

Section 4.1: Sanctuaries

There are currently 51 oyster sanctuaries with a range of available data to assess their effectiveness. Twenty-eight of these sanctuaries have been regularly monitored by the annual Fall Oyster Survey since at least 1990 so trends in oyster populations can be examined before and after sanctuary creation. Some sanctuaries have had patent tong surveys conducted since 2010, which provide additional information about oyster density, size structure, and habitat condition. Since the last Oyster Management Report, some sanctuaries have had an annual Fall Oyster Survey site added. Appendix A provides detailed information on each sanctuary.

Overall, in sanctuary areas, observed oyster mortality has remained stable and below the long-term (1990 through 2025) baywide average since 2010, when most sanctuaries were established (Figure 4-1). Mortality has remained low in more recent years (2021 through 2025).

¹⁸ Smith, G.F., D. G. Bruce, E. B. Roach, A. Hansen, R. I. E. Newell & A. M. McManus. 2005. Assessment of Recent Habitat Conditions of Eastern Oyster *Crassostrea virginica* Bars in Mesohaline Chesapeake Bay. North American Journal of Fisheries Management. Volume 25, Issue 4: 1569-1590.

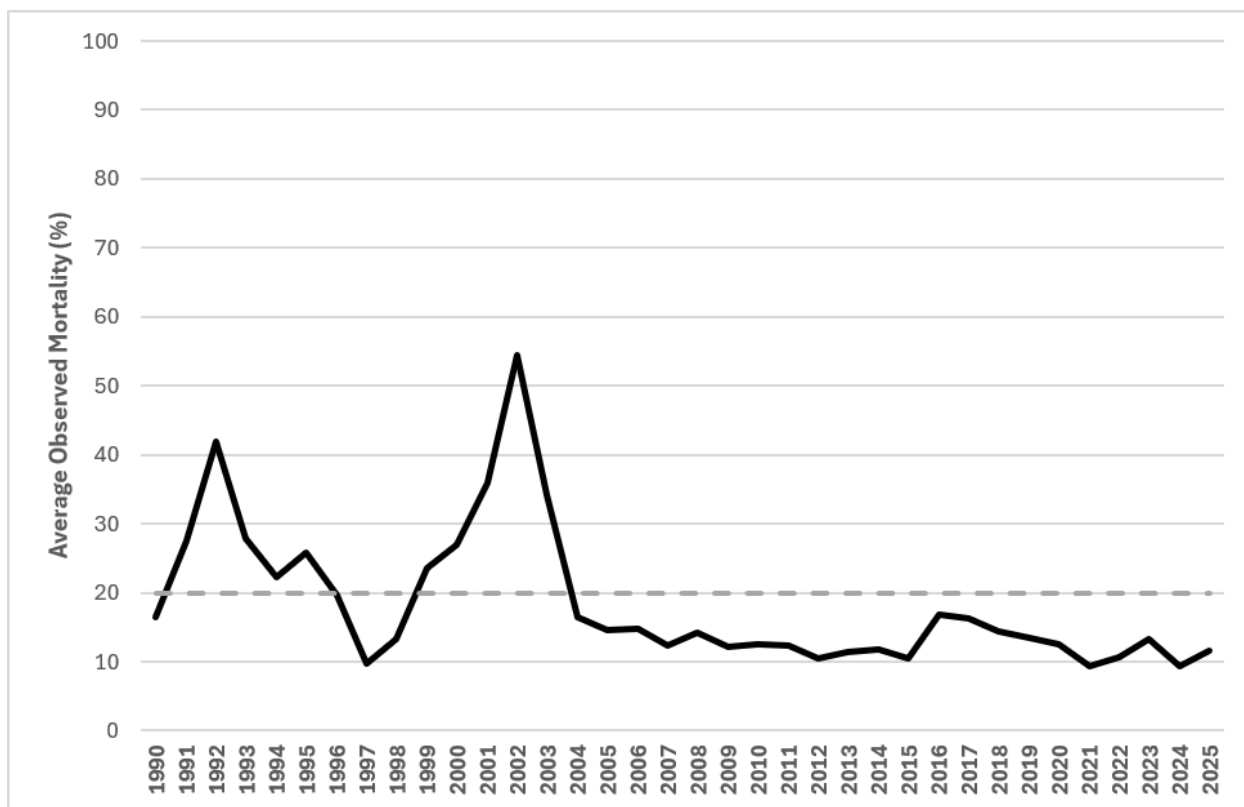


Figure 4-1. Average observed mortality on oyster bars sampled in Maryland sanctuaries during the annual Fall Oyster Survey, 1990 through 2025. The dotted line represents the long-term baywide average. From 2021 through 2025 observed mortalities within sanctuaries remained below the long-term baywide average.

Oyster biomass estimates, a measure of oyster abundance and size distribution, are available for 13 bars located in sanctuaries since 1990. These bars include: Cason in the Little Choptank River, Double Mills in the Tred Avon River, Oyster Shell Point in the Choptank River, Sandy Hill in the Choptank River, Wilson Shoals in the Nanticoke River, Old Field in the Chester River, Bruffs Island in the Wye River, Holland Point in the middle western shore of the Bay mainstem, Long Point in the Miles River, Cook Point in the Choptank River, Flag Pond in the lower western shore of the Bay mainstem, Pagan in the St Marys River, and Georges in the Manokin River.

Average biomass on these sanctuary bars began increasing after 2009, peaking in 2025 (Figure 4-2). Since 2011, the average biomass on sanctuary bars has remained above the long-term baywide average (all oyster bars measured consistently for biomass from 1990 through 2025).

Oyster biomass within sanctuaries varies annually across different salinity zones (Figure 4-3). Since 2006, 22 sanctuaries have been sampled during the annual Fall Oyster Survey for biomass, with all sanctuary zones exhibiting an increase in biomass since

2010¹⁹. Two sanctuaries are sampled in the high-salinity zones and have exhibited the greatest variability in biomass. This variability may be from the small sample size but may also be attributed to high disease-related mortality in this zone. Eleven sanctuaries are sampled in the medium-salinity zone and have generally performed better than the average of all sanctuaries. Nine sanctuaries are sampled in the low-salinity zone and have shown a continual positive trend since 2010. Although the sanctuaries in the low-salinity zone include those trending negatively and are considered underperforming (Lower Chester River and Upper Chester River) it also includes sanctuaries that continue to improve since 2010, including the Sandy Hill, Upper Patuxent River, Nanticoke River, and Tred Avon River sanctuaries.

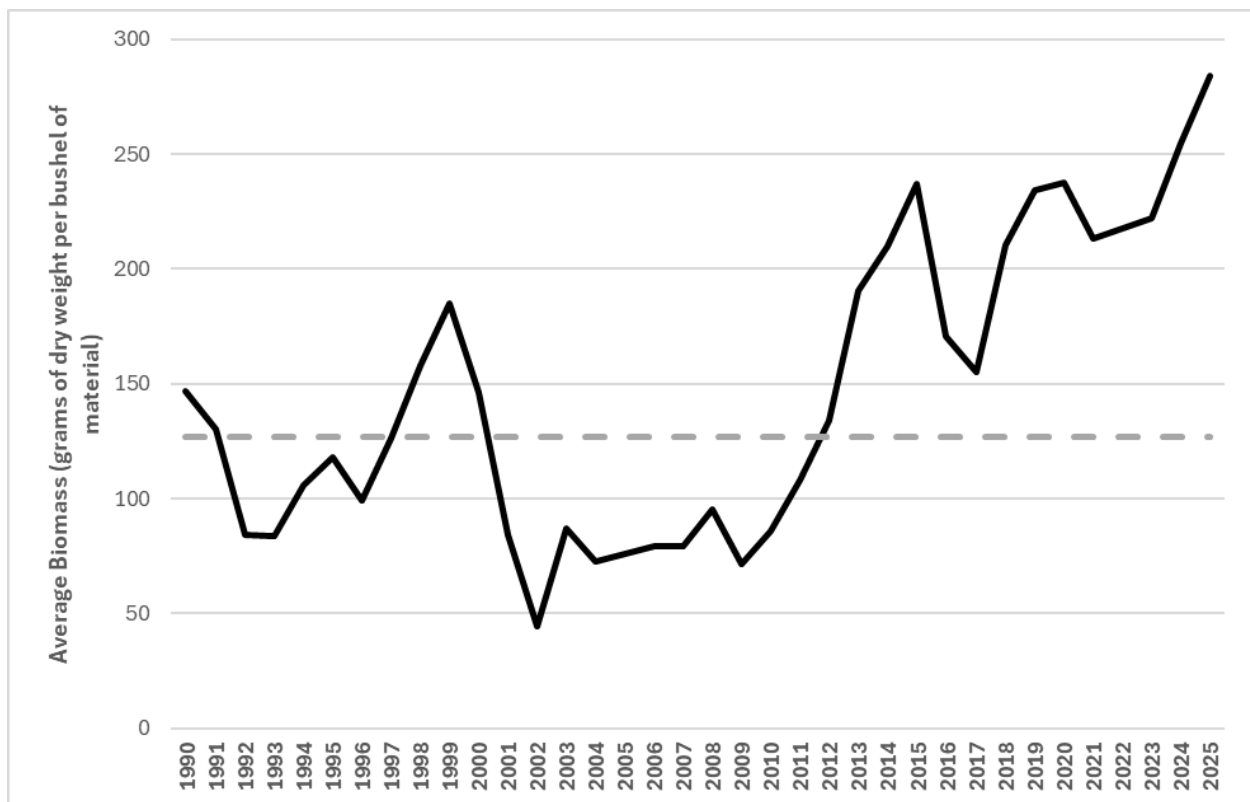


Figure 4-2. Estimated average biomass index from 13 consistently sampled oyster bars within Maryland sanctuary areas, 1990 through 2025. The dotted line denotes the long-term baywide average. From 2021 through 2025, the average biomass in these areas increased with 2025 being the highest biomass of the entire time series.

¹⁹ High salinity sanctuaries: Manokin River and Somerset, Medium salinity sanctuaries: Calvert Shores, Cook Point, Harris Creek, Little Choptank River, Lower Main Stem, Lower Patuxent River, Miles River, Neal Addition, Point Lookout, St. Marys River, and Wye River, Low salinity sanctuaries: Breton Bay, Lower Chester River, Upper Chester River, Sandy Hill, Upper Choptank River, Nanticoke River, Upper Patuxent River, Severn River and the Tred Avon River

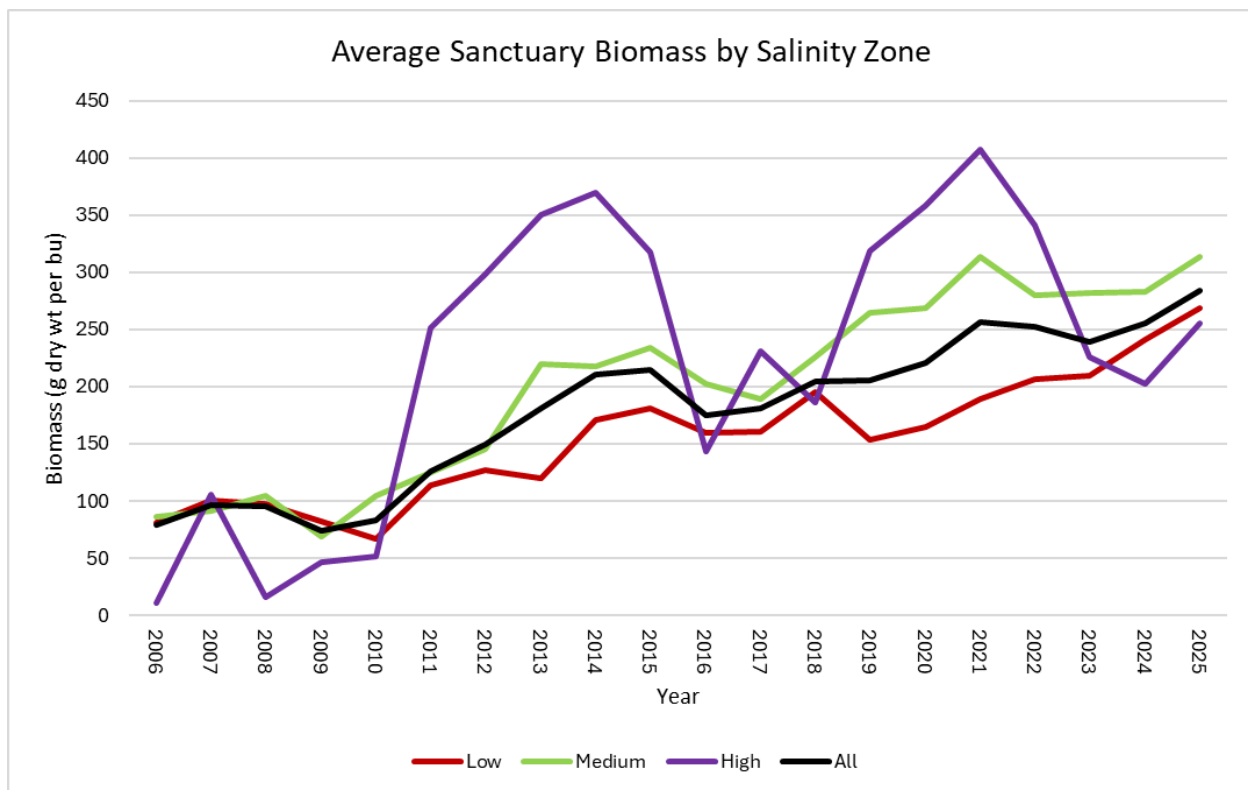


Figure 4-3. Average biomass for each salinity zone from the annual Fall Oyster Survey for oyster bars sampled within current sanctuary areas in Maryland’s portion of Chesapeake Bay, 2006 through 2025. Low-, medium-, and high-salinity zones are defined as: low salinity <11 ppt, medium salinity 11 to 15 ppt, and high salinity >15 ppt. From 2021 through 2025, the high salinity sanctuaries exhibited a decrease from a peak in 2021 through 2025, while medium salinity sanctuaries remained about the same biomass from 2021 through 2025 and low salinity sanctuaries exhibited a continual increase.

Although time series of oyster biomass and mortality are presented for each sanctuary in Appendix A, drawing firm conclusions about the consequences of sanctuary establishment is difficult in the absence of control areas or reference sites. When examining differences between sanctuary and harvest areas, true control sites would be harvest bars that are identical to the sanctuary bars in every way except for the experimental change (prohibition of harvest). Since it is not possible to match any individual sanctuary to an identical PSFA, it is difficult to account for effects of salinity, hydrodynamics (water flow), bathymetric (water depth) characteristics, and water quality characteristics that could confound comparisons. In complex, time-variant systems where no two study areas are alike, long-term time series become a critical tool for separating signals from noise within the system and show the impacts of management changes such as harvest prohibition and/or restoration²⁰.

²⁰ D.M Karl. 2010. Oceanic Ecosystems Time-Series Programs, Ten Lessons Learned. Oceanography Vol. 23, No. 3.

Section 4.1.1: Sanctuary Objective #1

Increase oyster populations to levels that improve important ecological functions and yield adequate broodstock to sustain regional populations.

Sanctuary Objective #1 Status: *This objective is ongoing. The sanctuary areas continue to provide essential ecological functions. Available broodstock continues to increase in most regions of the Bay, with most regions exhibiting a positive trend in oyster density and natural recruitment.*

Reproductive capacity is examined by calculating an index of the potential number of eggs that may be produced by the oysters present in the area over time. This method also accounts for the fact that oysters transition from male to female as they age. According to Galtsoff²¹, the oyster gonad is bisexual – during the first breeding season, the majority of the young oysters are males with some females. By the second season, there may still be more males but generally the ratio is equal. In subsequent years, the ratio tends to favor females. As oysters grow larger and heavier, their annual fecundity (number of eggs produced) increases (Figure 4-4)²². Oyster fecundity also increases with shell height so that even a small increase in the number of older, larger oysters will cause a large increase in reproductive potential. In general, the biomass and reproductive potential of a population will exhibit similar trends.

An index of reproductive potential can be calculated for the 43 “disease sentinel bars” sampled in the annual Fall Oyster Survey, the same areas for which indices of biomass are calculated, because these samples have size information (shell height (mm)) for each oyster collected²³. Following the Mann and Evans model for calculating egg production²⁴, the number of eggs produced were estimated for each oyster using shell height and a factor that decreases oyster egg viability in lower salinity zones. There is some evidence that oysters that are habituated to low salinity do not experience diminished egg viability²⁵. However, including this factor provides a lower-end estimate of egg production. Using the assumption that the sex ratio of oysters is 50% male, 50% female²⁶, the estimated number of eggs was divided in half to simulate only half of the oysters being female and having eggs. Estimates of reproductive potential are available for 13 of the 51 sanctuaries.

²¹ Galtsoff, P.S. 1964. The American Oyster *Crassostrea virginica* Gmelin. Fishery Bulletin of the Fish and Wildlife Service, Volume 64. Washington, D.C. 480 pp.

²² Mann, R., Evans, D.A. 1998. Estimation of oyster, *Crassostrea virginica*, standing stock, larval production and advective loss in relation to observed recruitment in the James River, Virginia. Journal of Shellfish Research, Vol. 17. No.1, 239-253.

²³ Tarnowski, M. (ed.) 2020. Maryland Oyster Population Status Report: 2019 Fall Survey. Maryland Department of Natural Resources, Annapolis, MD, # 17-050420-232, 71 pp. <https://dnr.maryland.gov/fisheries/pages/shellfish-monitoring/reports.aspx>

²⁴ Mann, R., Evans, D.A. 1998. Estimation of oyster, *Crassostrea virginica*, standing stock, larval production and advective loss in relation to observed recruitment in the James River, Virginia. Journal of Shellfish Research, Vol. 17. No.1, 239-253.

²⁵ Davis, H.C. 1958. Survival and growth of clam and oyster larvae at different salinities. Biological Bulletin. 114:296-301.

²⁶ Galtsoff, P.S. 1964. The American Oyster *Crassostrea virginica* Gmelin. Fishery Bulletin of the Fish and Wildlife Service, Volume 64. Washington, D.C. 480 pp.

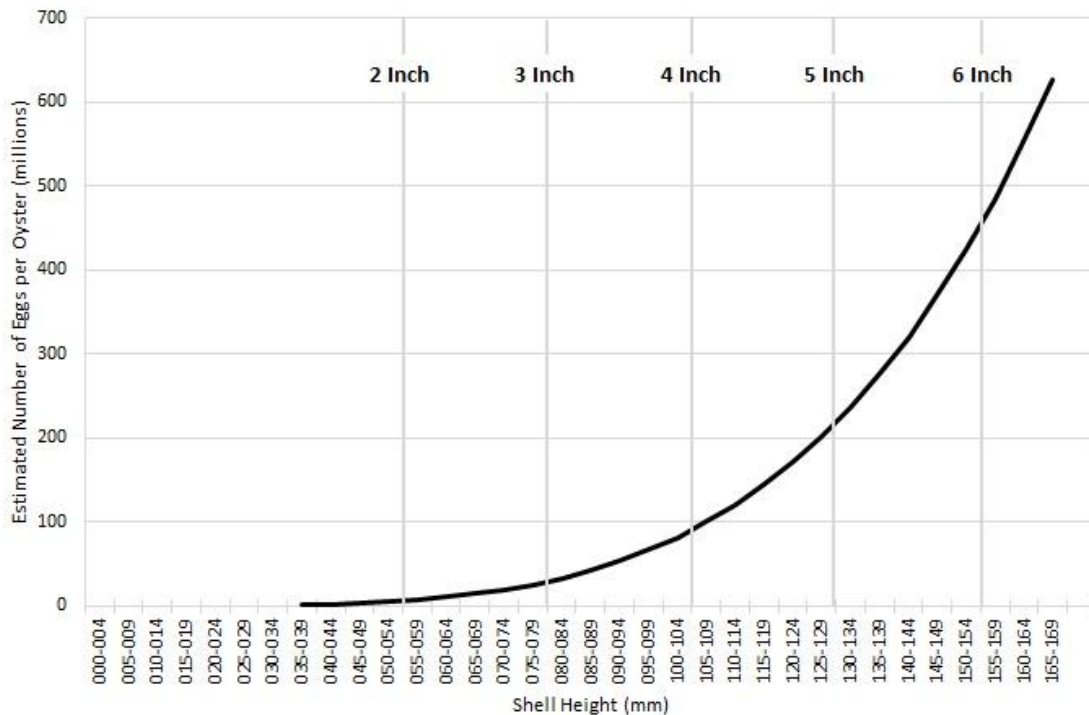


Figure 4-4. The annual estimated number of eggs produced for an individual female oyster of a given shell height²⁷. The number of eggs produced increases very quickly with increasing size. Estimated egg production does not account for effects of salinity on egg viability.

The overall reproductive potential in oyster sanctuaries has increased since 2011, with 2025 being the highest value in the 36-year time series (Figure 4-5). While reproductive potential has increased, this alone is not enough to increase the population over time. Even if fertilization is successful, larval survival is not guaranteed due to a wide and fluctuating range of biological and environmental variables.

Sanctuary location affects reproductive potential largely due to differences in salinity. Salinity directly affects oyster recruitment, which influences population density, biomass, and ultimately, reproductive potential (Figure 4-6). Five sanctuaries with continuous length data from 1990 through 2025 have been identified as being in the low-salinity zone. Reproductive potential increased in the middle and upper Choptank River, low-salinity zones represented by Sandy Hill oyster bar (Sandy Hill Sanctuary) and Oyster Shell Point oyster bar (Upper Choptank River Sanctuary), since becoming a sanctuary. Old Field, a low-salinity bar in Upper Chester River Sanctuary, showed less promising results, declining in reproductive potential due to low densities of oysters. The

²⁷ Mann, R., Evans, D.A. 1998. Estimation of oyster, *Crassostrea virginica*, standing stock, larval production and advective loss in relation to observed recruitment in the James River, Virginia. *Journal of Shellfish Research*, Vol. 17. No.1, 239-253.

Nanticoke River Sanctuary, a low-salinity region represented by Wilson Shoal oyster bar, has a much greater reproductive potential than the other low-salinity areas, attributed to a greater density and biomass of oysters. Double Mills bar (Tred Avon Sanctuary) is a low-salinity sanctuary that has also exhibited an increase in reproductive potential. This sanctuary is one of the large-scale restoration sanctuaries.

Medium-salinity regions have larger variability in reproductive potential between oyster bars in different areas. Wye River Sanctuary, as represented by Bruff Island oyster bar, has been receiving spat-on-shell plantings since 2022 as part of the Eastern Bay Regional Project and has seen an increase in oyster abundance and reproductive potential since becoming a sanctuary. The other medium-salinity sanctuaries (Holland Point in Herring Bay Sanctuary and Long Point in Miles River Sanctuary) showed less promising results. These areas are now showing a decline in reproductive potential due to low densities of oysters. The Miles River Sanctuary has also been receiving spat-on-shell plantings since 2022 as part of the Eastern Bay Regional Project and has seen an increase in the oyster density in the last five years and however, many of these oysters are small and have not yet impacted the biomass of the sanctuary and associated egg potential from large oysters. Reproductive potential in Cook Point Sanctuary in the lower Choptank River initially increased after becoming a sanctuary but declined in 2016. Since then, the oyster densities have started to recover. Relatively high natural mortalities were observed in Cook Point Sanctuary in 2016, 2017, and 2023 (56.5%) which led to a decline in market-sized oysters. However, with the relatively high spat set in 2023, 2024, and 2025, the reproductive potential seems to be increasing. Calvert Shore sanctuary, as represented by Flag Pond bar, has continued to increase its reproductive potential since becoming a sanctuary. Mill Point bar (Harris Creek Sanctuary), Cason bar (Little Choptank Sanctuary), and Pagan bar (St. Marys Sanctuary) are sanctuaries that received large-scale restoration. They have all exhibited an increase in reproductive potential since 2010.

Manokin River Sanctuary, as represented by Georges bar, is the only sanctuary in a high-salinity zone in this data set. It has received large-scale restoration and has exhibited an increase in reproductive potential since 2010.

Five sanctuaries (Harris Creek, Little Choptank River, Tred Avon River, St. Marys River, and Manokin River) have been receiving ongoing large-scale restoration efforts and are located in all three salinity regions. On average, these sanctuaries have increased in reproductive potential since 2010 (Figure 4-6). From 2011 through 2025, average annual estimated reproductive potential was higher in the large-scale restoration sanctuaries than the other low- and medium-salinity zone sanctuaries, likely due to the restoration investments made.

The estimated average reproductive potential of the public fishery areas (27 sites) was also examined (Figure 4-7). The three sites within NOAA Codes 177, 277, and 377 were not included, as these are managed by the Potomac River Fishery Commission. Since the expansion of the sanctuary program in 2010, the reproductive potential in both management areas (sanctuary and non-sanctuary NOAA Code areas) has increased.

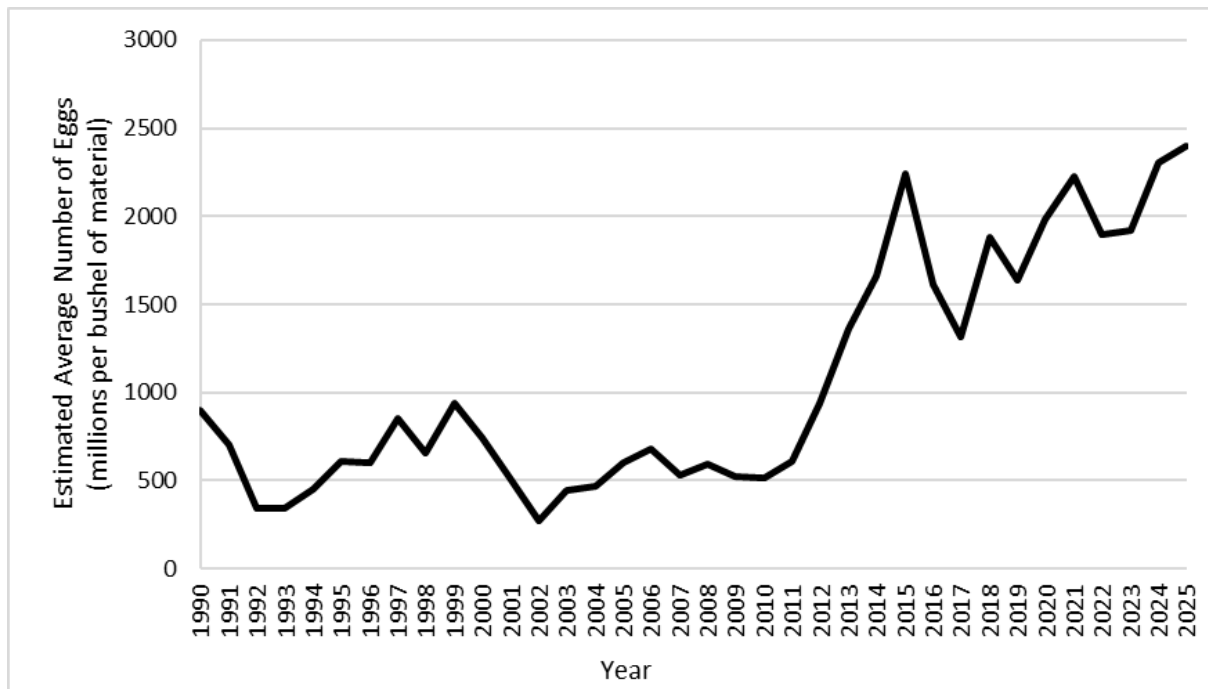


Figure 4-5. The estimated annual number of eggs that could be produced per bushel of material averaged over the 13 sanctuary oyster bars sampled in the Maryland annual Fall Oyster Survey. From 2021 through 2025, estimated egg numbers decreased in 2022 and peaked for the entire time series in 2025.

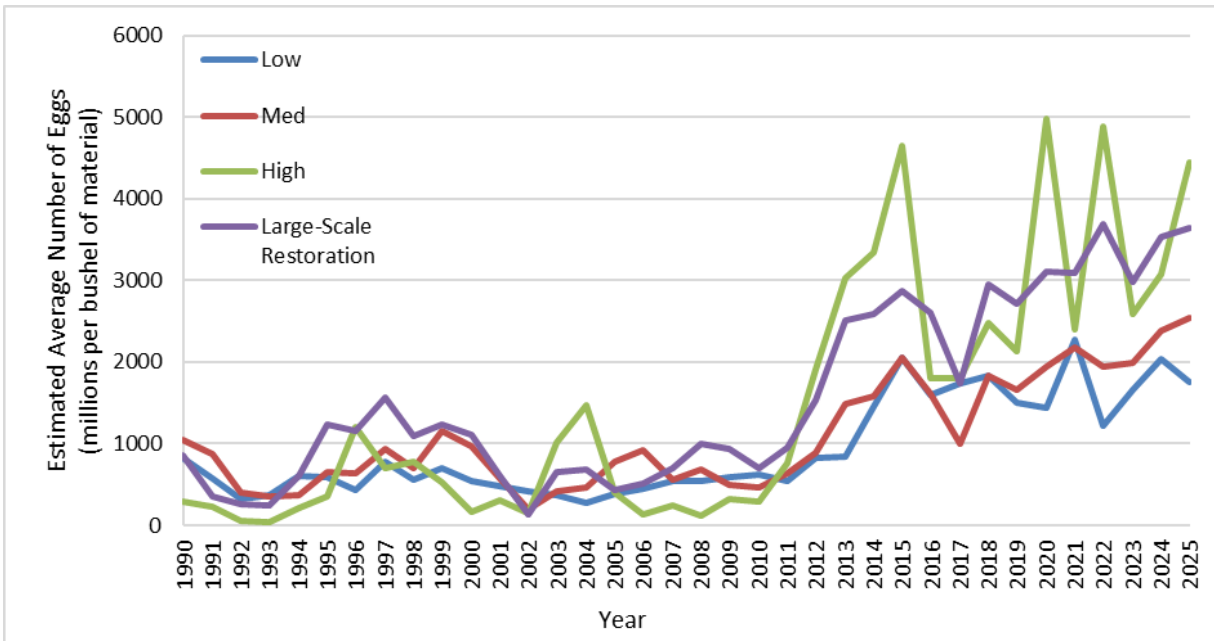


Figure 4-6. Estimated annual average number of eggs that could be produced per bushel of material on 13 sanctuary oyster bars of various salinities sampled in the Maryland annual Fall Oyster Survey, 1990 through 2025. Low- and medium-salinity zones are defined as: low salinity <11 ppt, medium salinity 11 to 15 ppt, and high salinity >15 ppt. The average of the large-scale restoration sanctuaries, as defined as those with ongoing restoration (five bars in Harris Creek, Little Choptank, Tred Avon, St. Marys River, and Manokin River), are located in low-, medium- and high-salinity zones.

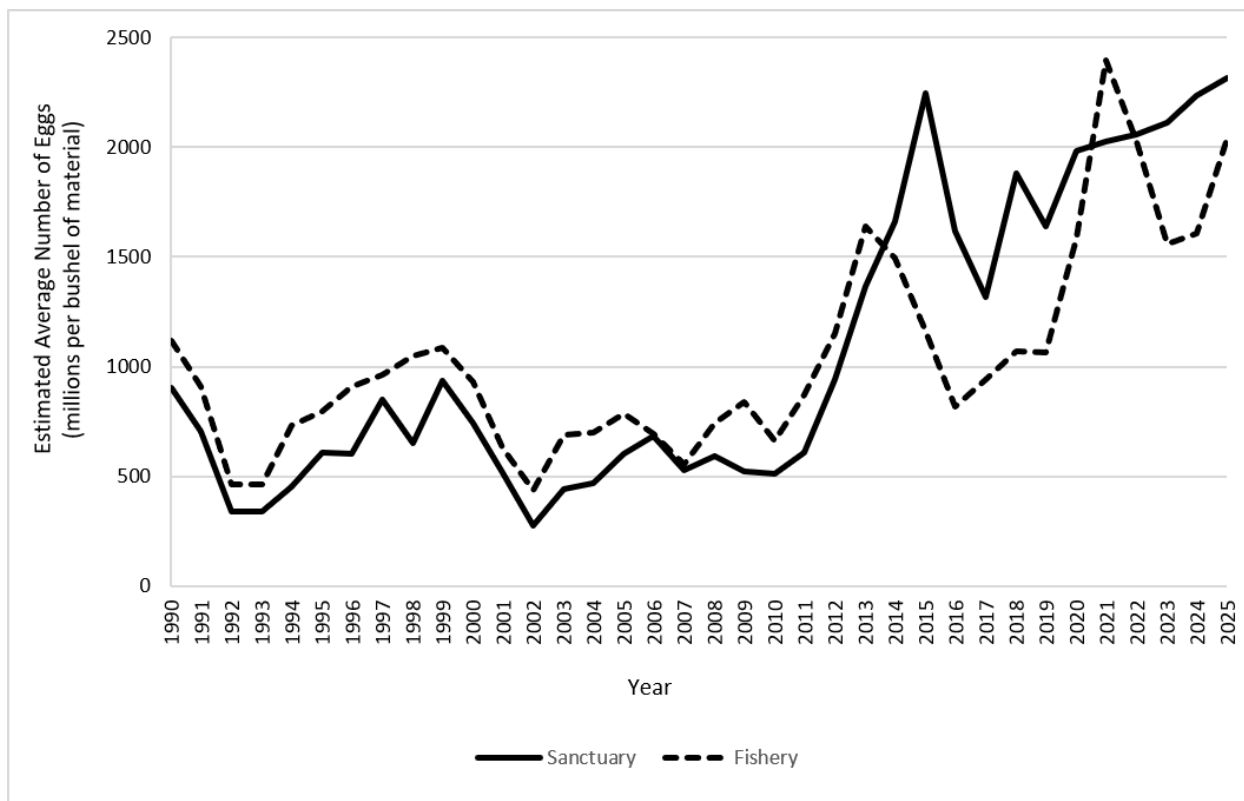


Figure 4-7. The estimated annual average number of eggs that could be produced per bushel of material for 13 sanctuary oyster bars and 27 public fishery bars sampled in the Maryland annual Fall Oyster Survey.

Regional Impacts

To evaluate whether the 2010 expansion of the sanctuary program and the consequential increase in reproductive potential have influenced regional populations, total oyster densities were evaluated by NOAA Code. This evaluation included data from both sanctuary and public fishery areas (Figure 4-8). Since 2019, a general increase in oyster density has been exhibited in many NOAA Codes, with the highest cumulative oyster densities in 2025. There are four NOAA Codes with data used that do not have sanctuaries (043- Fishing Bay, 086- Smith Creek, 096- Wicomico River East, and 537- Broad Creek).

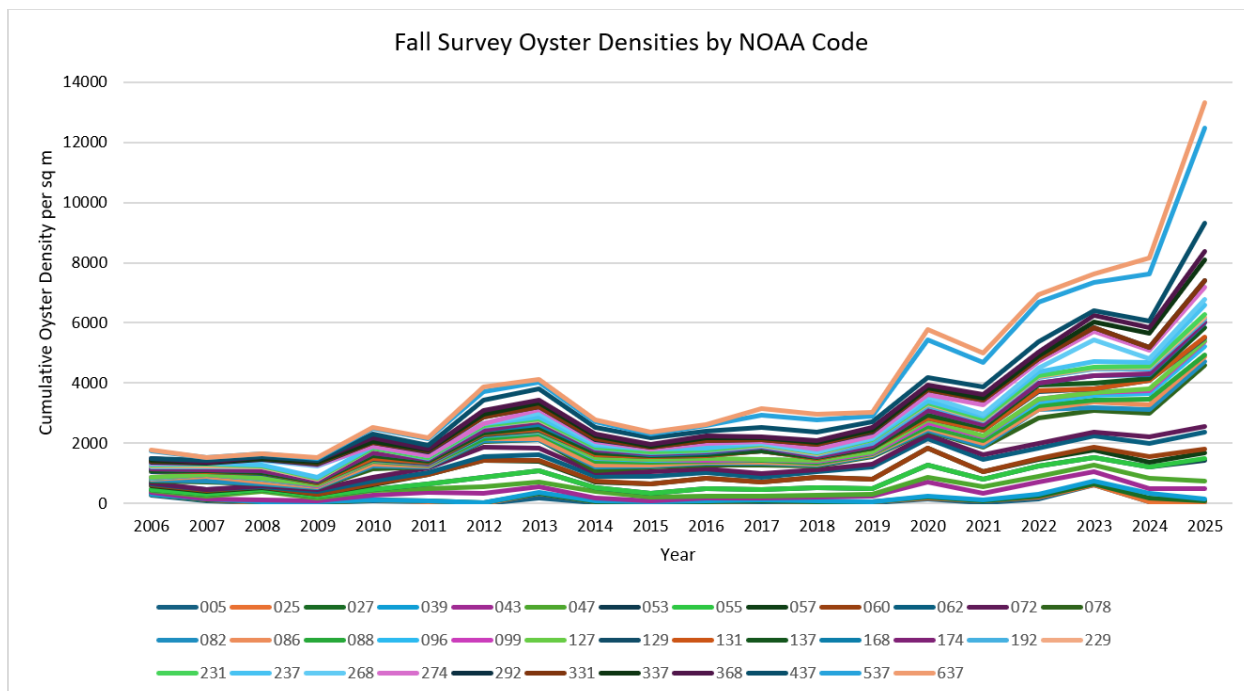


Figure 4-8. Stacked oyster densities by NOAA Code from 2006 through 2025. Data includes both sanctuary and public fishery area densities. From 2021-2025, cumulative oysters densities continued to increase, peaking in 2025 for the entire time series. NOAA Code regions: 005- Big Annemessex River, 025- Chesapeake Bay Upper, 027- Chesapeake Bay Lower Middle, 039- Eastern Bay, 043- Fishing Bay, 047- Honga River, 053- Little Choptank River, 055- Magothy, River, 057- Manokin River, 060- Miles River, 062- Nanticoke River, 072- Pocomoke Sound, 078- St. Marys River, 082- Severn River, 086- Smith Creek, 088- South River, 096- Wicomico River (East), 099- Wye River, 127- Upper Middle Chesapeake Bay, 129- Lower East Chesapeake Bay, 131- Chester River, 137- Choptank River, 168- Patuxent River Lower, 174- St. Clements and Breton Bay, 192- Tangier Sound South, 229- Lower West Chesapeake Bay, 231- Chester River Middle, 237- Choptank River Middle, 268- Patuxent River Middle, 274- Wicomico River (West), 292- Tangier Sound North, 331- Chester River Upper, 337- Choptank River Upper, 368- Patuxent River Upper, 437- Harris Creek, 537- Broad Creek, 637- Tred Avon River

Oyster densities were also evaluated regionally throughout the Bay by aggregating NOAA Codes (Figure 4-9). While not all NOAA Codes within a region show an improvement, when looking at the trendline for the average total oyster densities of the NOAA Codes within the regions, all regions showed a positive trend in density, except the Upper Bay Region (Figures 4-10A through 4-20A). These data include wild seed and spat-on-shell plantings, which can impact overall density, even in areas with low recruitment. The Upper Bay Region is an area with very low recruitment, impacted greatly by low salinity during high stream flow and water release events from the Conowingo Dam. This region exhibited a negative trend overall and has an average density well-below the average across all regions. The greatest increases in oyster density were exhibited in the Choptank and Potomac regions, with the Potomac Region being impacted mostly by the 078- St. Marys River and the Choptank Region impacted

mostly by 537- Broad Creek. The Choptank Region has nine sanctuaries within the area, two of which have received large-scale restoration efforts: Harris Creek Sanctuary, with initial restoration from 2011 through 2015, and Tred Avon Sanctuary, with initial restoration from 2015 through 2021. Since 2010, regional oyster populations have increased due to a combination of sanctuary harvest closures boosting biomass and reproductive potential, active restoration and replenishment efforts, local bathymetry aiding larval retention, and favorable environmental conditions. Additionally, sufficient cultch availability during supportive environmental conditions has contributed to these gains, with Broad Creek (537) likely a regional larval sink area.

To evaluate if the increasing reproductive potential is having an impact regionally, spat density within all management areas (sanctuary and public fishery) was examined by region and NOAA Code (Figure 4-10A through 4-20B). Removing adult oysters negates harvest impact within the assessment and natural recruitment can be used to assess the sustainability of a region. All wild seed and spat-on-shell plantings were removed from spat density data to represent natural recruitment. As with total oyster density, the density of spat was highest in the Choptank and Potomac River regions (Figures 4-10A). While these areas have historically performed well, natural recruitment has continued to increase in the Choptank and Potomac Regions since 2020 and 2022, respectively. The Upper Bay and Upper Mid-Bay regions exhibit little to no natural recruitment and are the only regions that are not trending positively for spat densities.

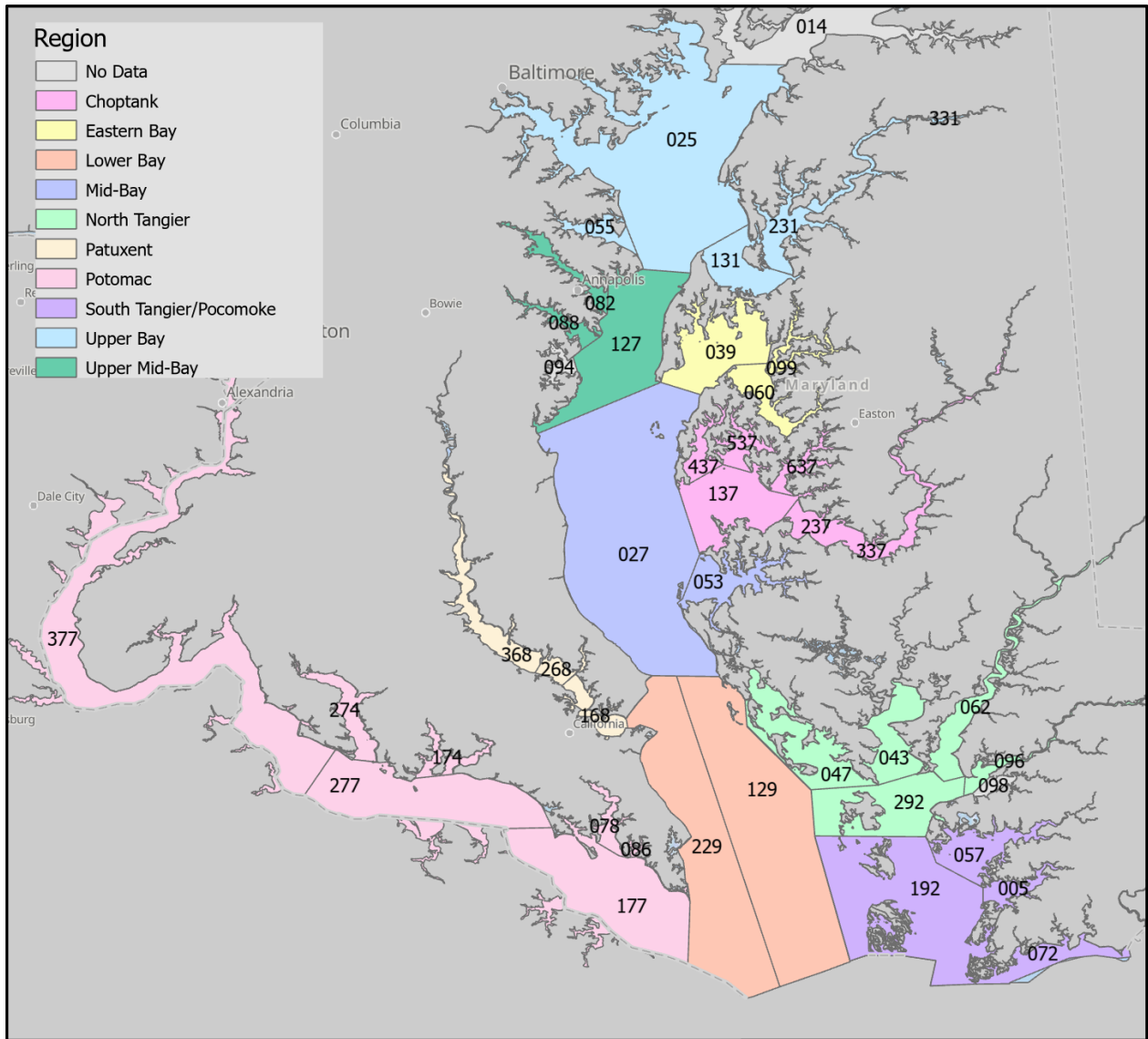
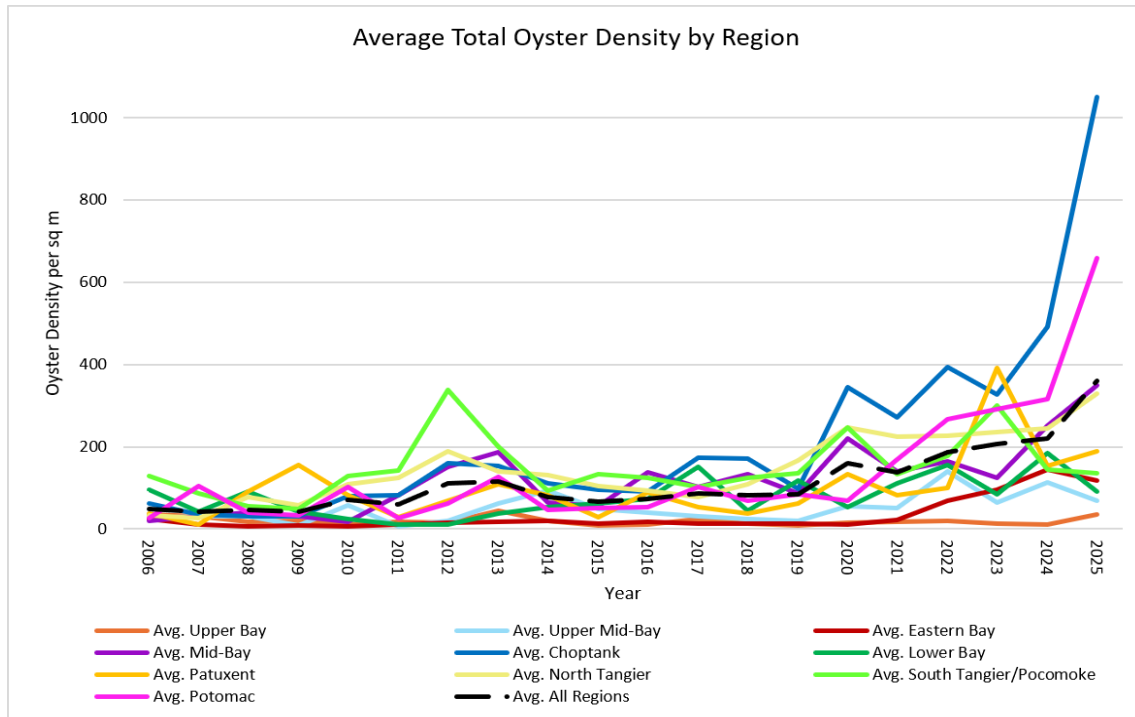


Figure 4-9. NOAA codes identified by regions throughout the Bay. NOAA Codes 177, 277, and 377 are not included as they are managed by the Potomac River Fisheries Commission.

A.



B.

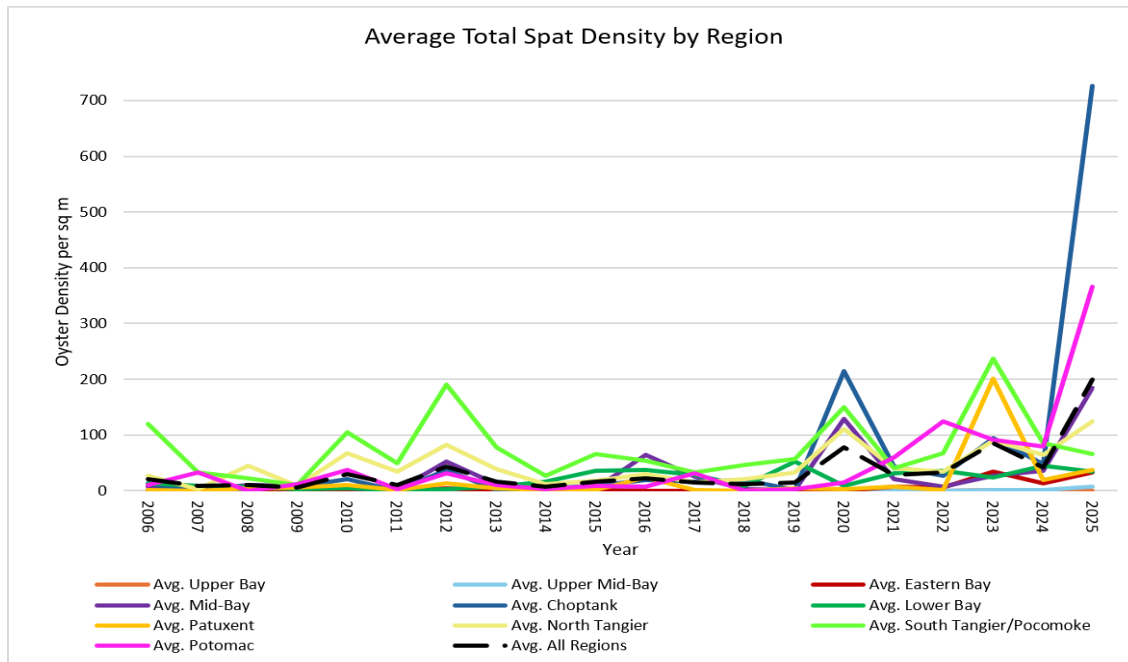
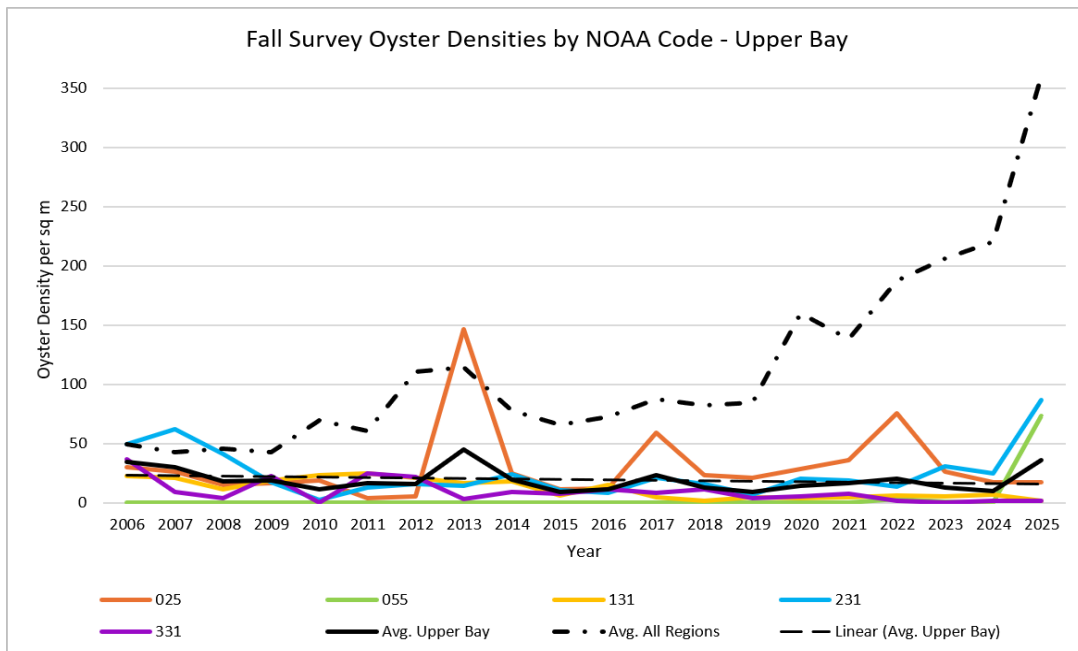


Figure 4-10. Average oyster densities by region from 2006 through 2025. Data includes both sanctuary and public fishery area densities. The average for all regions is also displayed (dashed line). (A) Total average oyster densities within each region include wild seed and spat-on-shell plantings. (B) Total average spat densities in each region, with wild seed and spat-on-shell plantings removed to reflect natural recruitment.

A.



B.

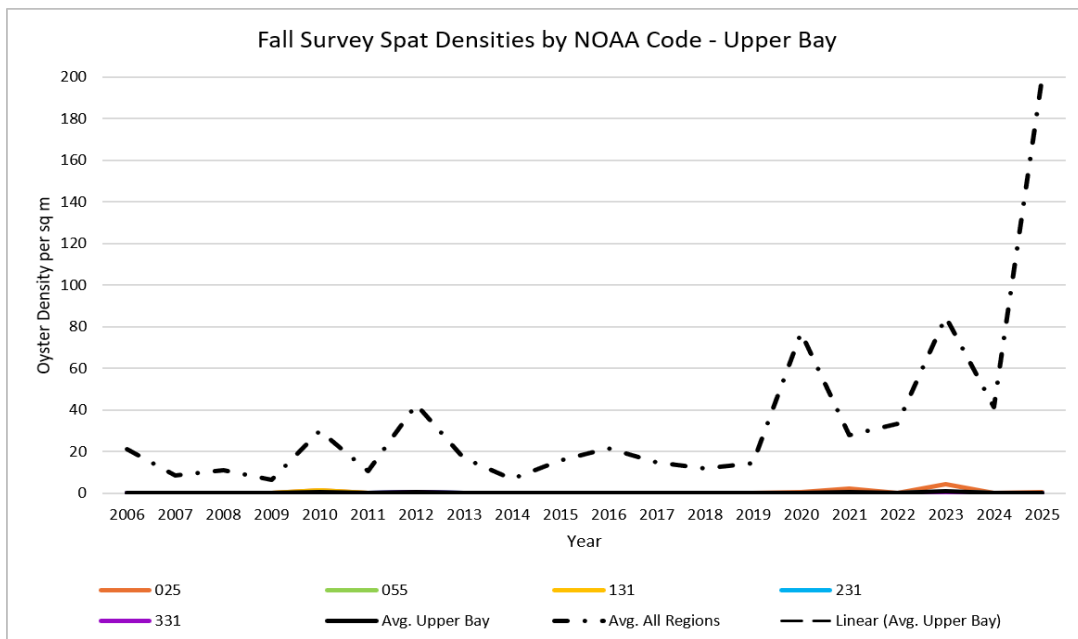
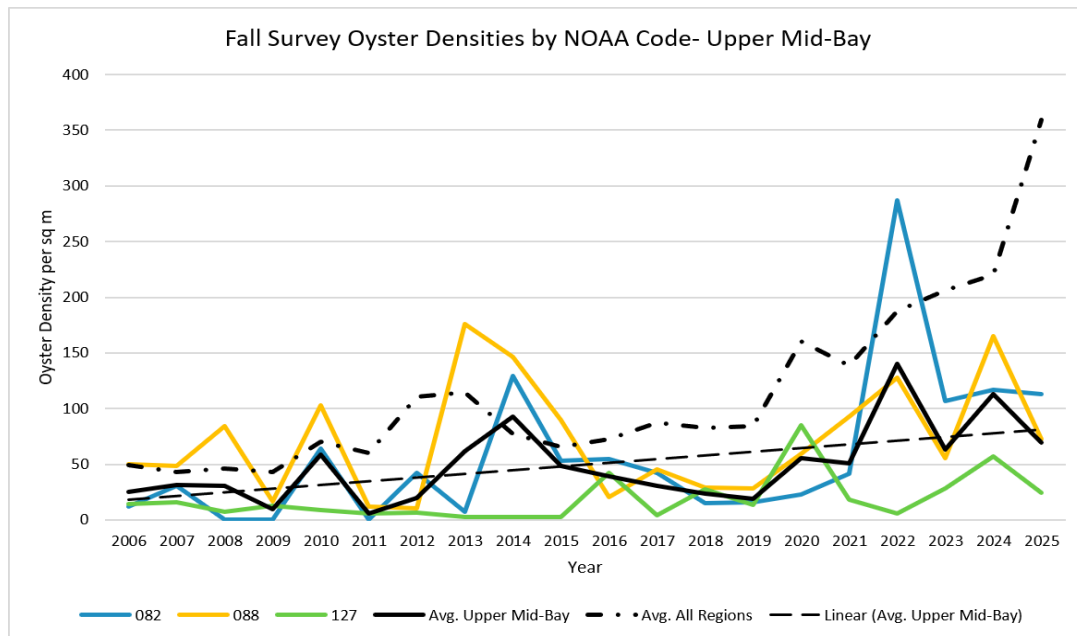


Figure 4-11. Average oyster densities in the Upper Bay by NOAA Code from 2006 through 2025. Data includes both sanctuary and public fishery area densities. (A) Total average oyster densities including wild seed and spat-on-shell plantings. (B) Average spat densities, with wild seed and spat-on-shell plantings removed to reflect natural recruitment. The Upper Bay Region includes NOAA Codes: 025- Chesapeake Bay Upper, 055- Magothy, River, 131- Chester River, 231- Chester River Middle, 331- Chester River Upper. The average densities for this region, the linear trendline for the regional average (dashed line), and for the Maryland portion of the Bay (dot-dash line) are displayed.

A.



B.

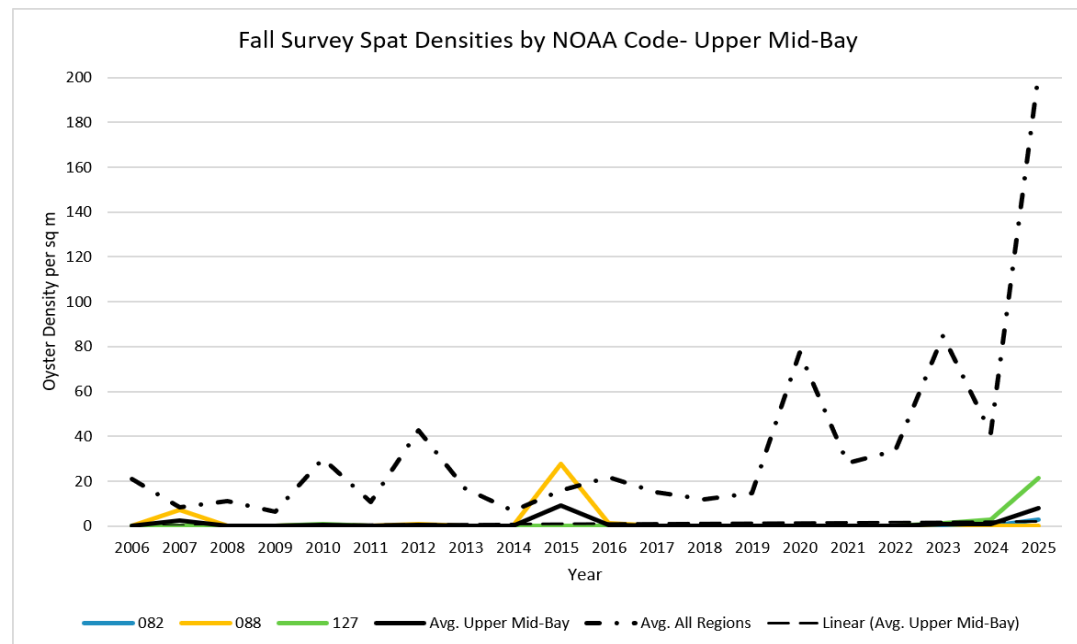
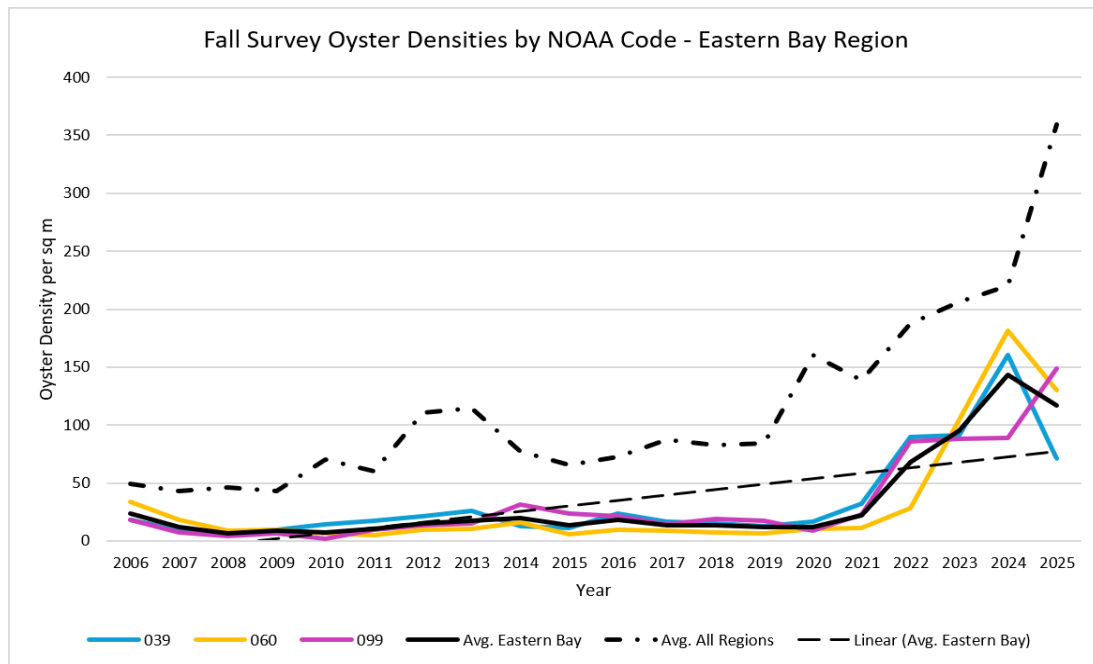


Figure 4-12. Average oyster densities in the Upper Mid-Bay by NOAA Code from 2006 through 2025. Data includes both sanctuary and public fishery area densities. (A) Total average oyster densities, including wild seed and spat-on-shell plantings. (B) Average spat densities, with wild seed and spat-on-shell plantings removed to reflect natural recruitment. The Upper Mid-Bay Region includes NOAA Codes: 082- Severn River, 088- South River, 127- Upper Middle Chesapeake Bay. The average densities for this region, the linear trendline for the regional average (dashed line), and for the Maryland portion of the Bay (dot-dash line) are displayed.

A.



B.

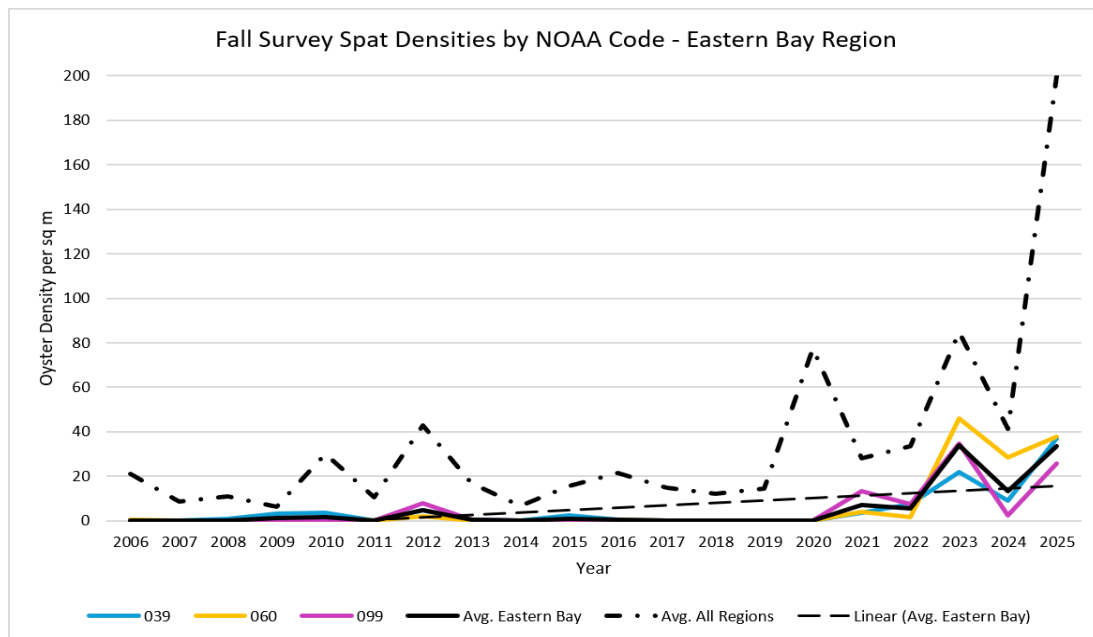
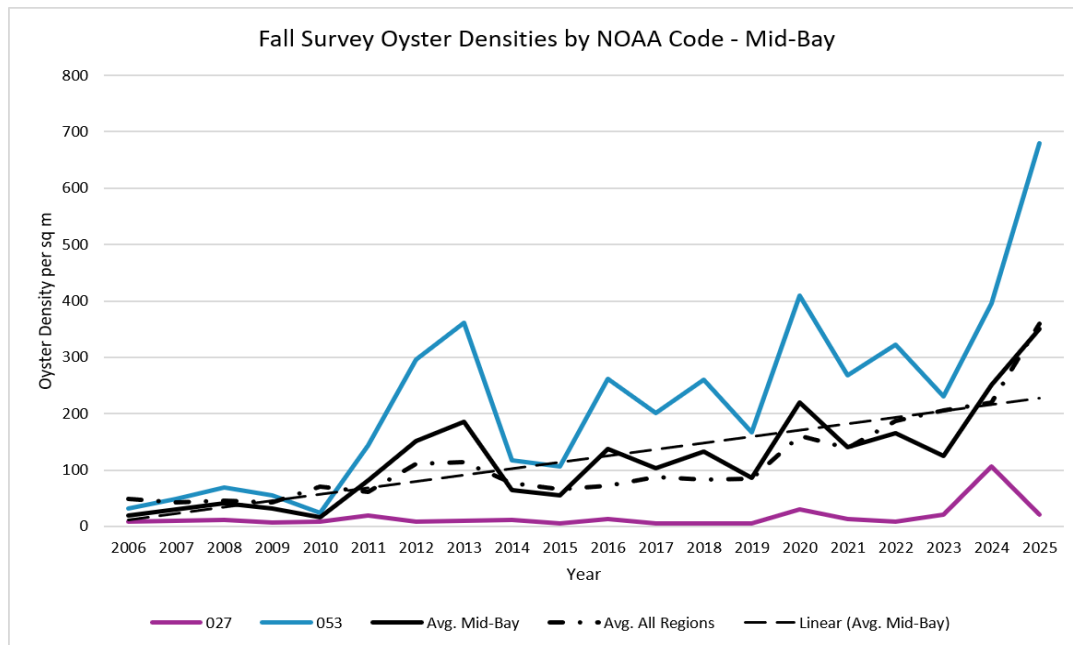


Figure 4-13. Average oyster densities in the Eastern Bay Region by NOAA Code from 2006 through 2025. Data includes both sanctuary and public fishery area densities. (A) Total average oyster densities, including wild seed and spat-on-shell plantings. (B) Average spat densities, with wild seed and spat-on-shell plantings removed to reflect natural recruitment. The Eastern Bay Region includes NOAA Codes: 039- Eastern Bay, 060- Miles River, 099- Wye River. The average densities for this region, the linear trendline for the regional average (dashed line), and for the Maryland portion of the Bay (dot-dash line) are displayed.

A.



B.

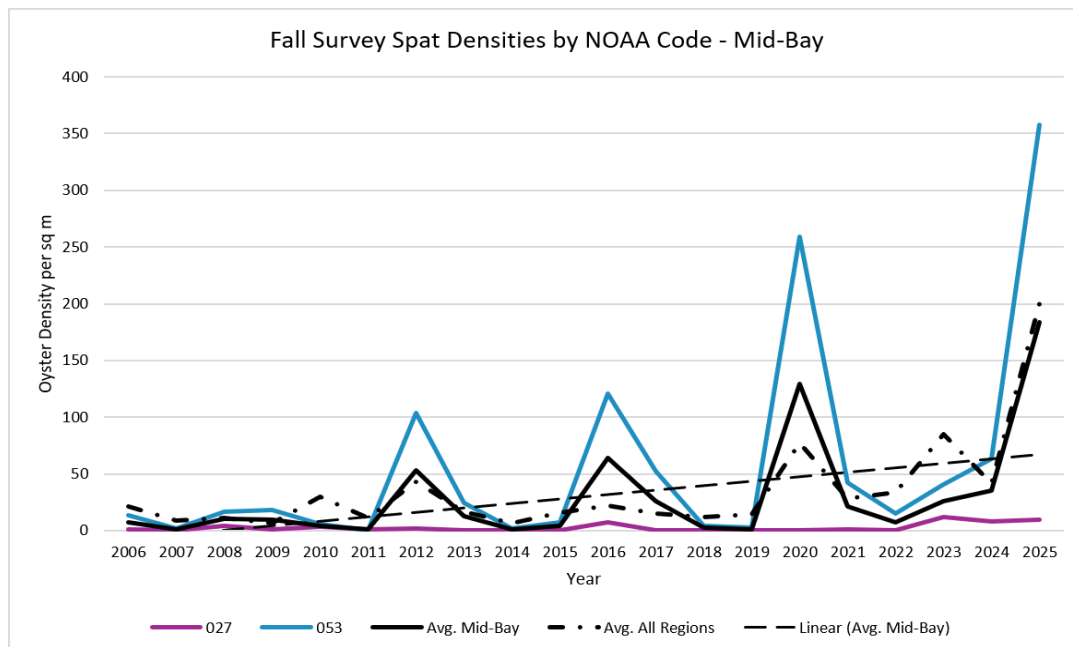
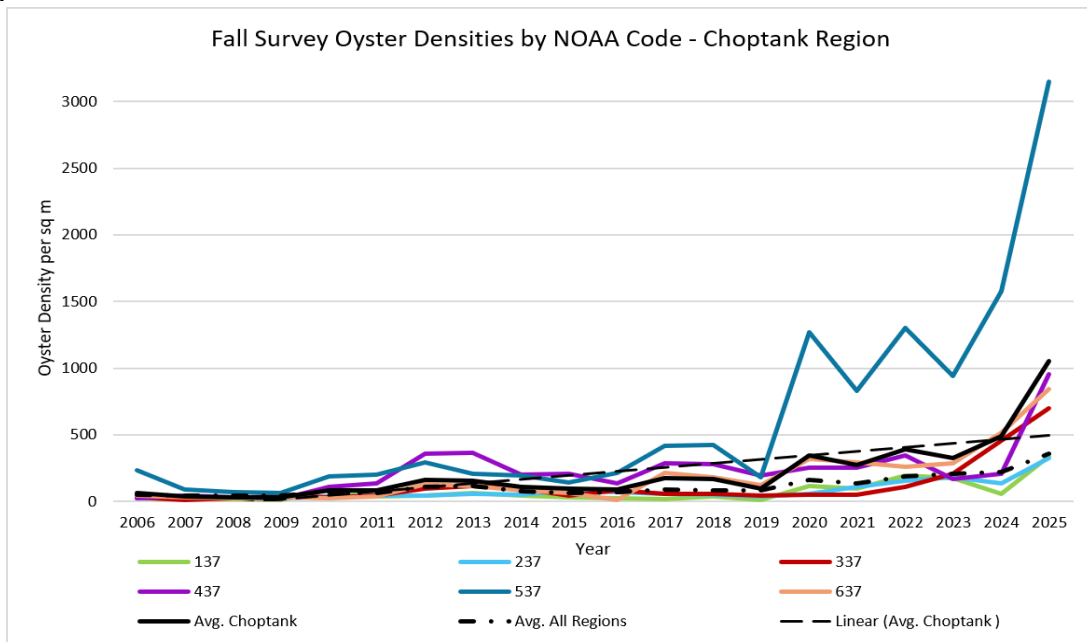


Figure 4-14. Average oyster densities in the Mid-Bay by NOAA Code from 2006 through 2025. Data includes both sanctuary and public fishery area densities. (A) Total average oyster densities, including wild seed and spat-on-shell plantings. (B) Average spat densities, with wild seed and spat-on-shell plantings removed to reflect natural recruitment. The Mid Bay Region includes NOAA Codes: 027- Chesapeake Bay Lower Middle, 053- Little Choptank River. The average densities for this region, the linear trendline for the regional average (dashed line), and for the Maryland portion of the Bay (dot-dash line) are displayed.

A.



B.

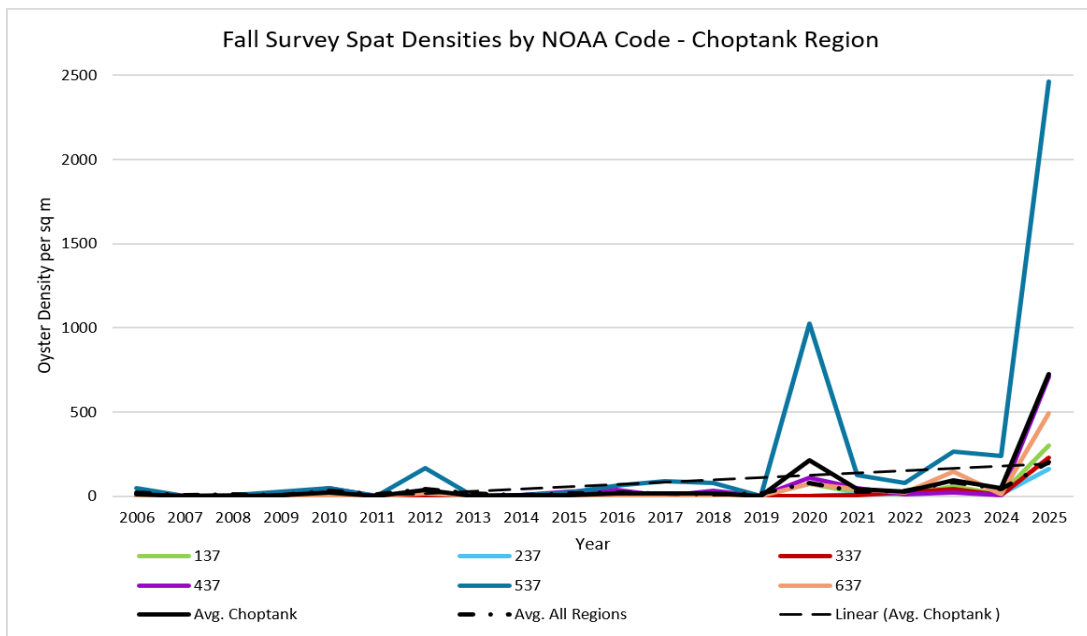
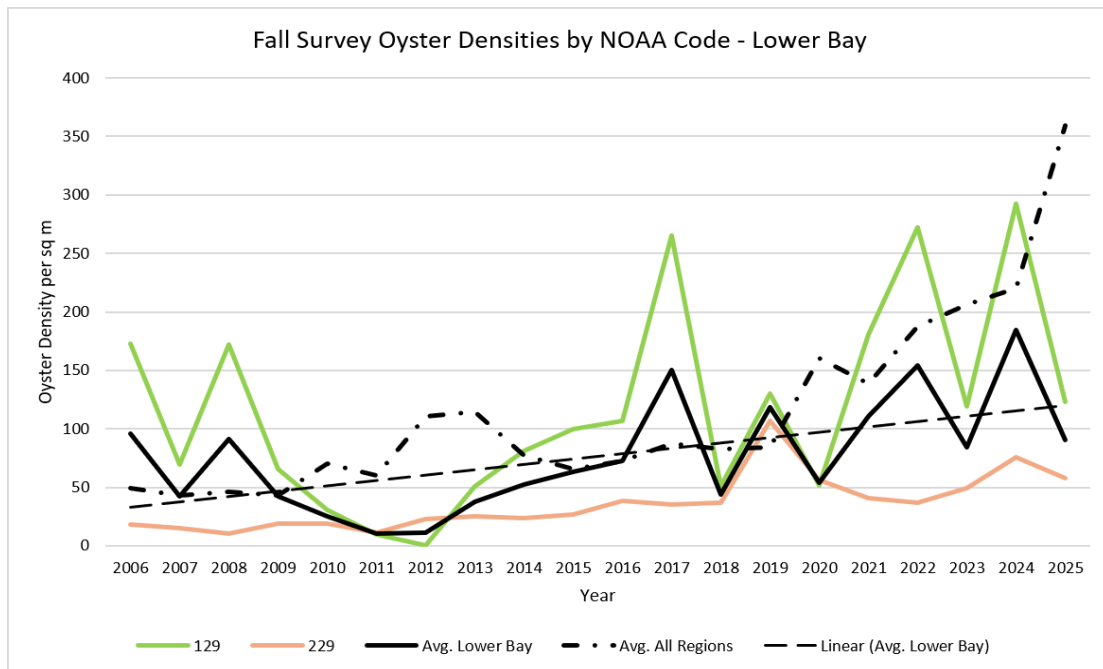


Figure 4-15. Average oyster densities in the Choptank Region by NOAA Code from 2006 through 2025. Data includes both sanctuary and public fishery area densities. (A) Total average oyster densities, including wild seed and spat-on-shell plantings. (B) Average spat densities, with wild seed and spat-on-shell plantings removed to reflect natural recruitment. The Choptank Region includes NOAA Codes: 137- Choptank River, 237- Choptank River Middle, 337- Choptank River Upper, 437- Harris Creek, 537- Broad Creek, 637- Tred Avon River. The average densities for this region, the linear trendline for the regional average (dashed line), and for the Maryland portion of the Bay (dot-dash line) are displayed.

A.



B.

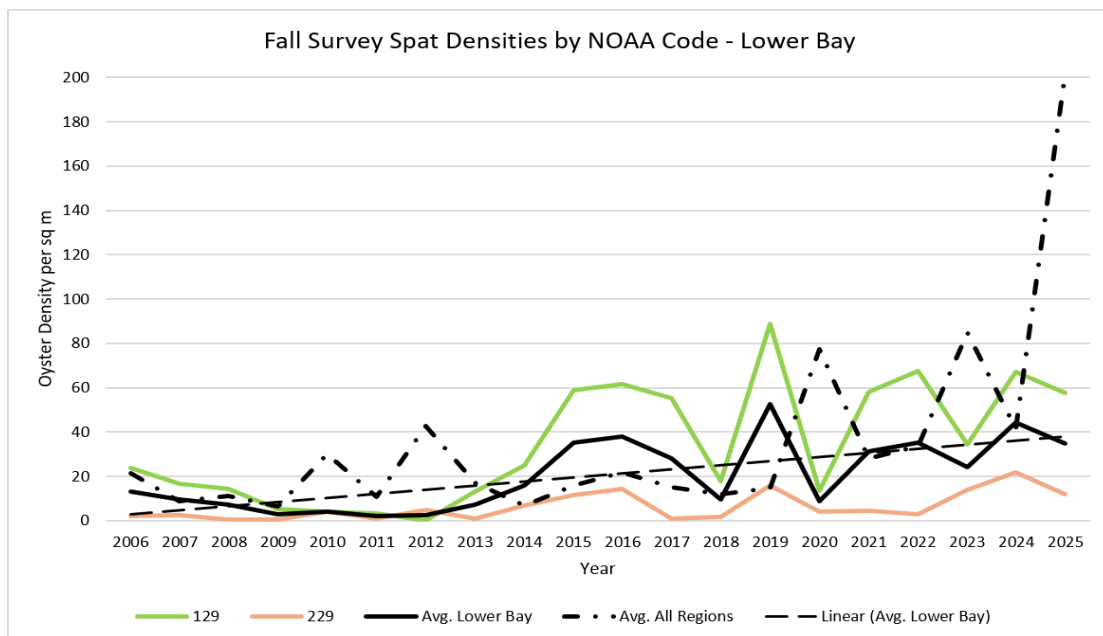
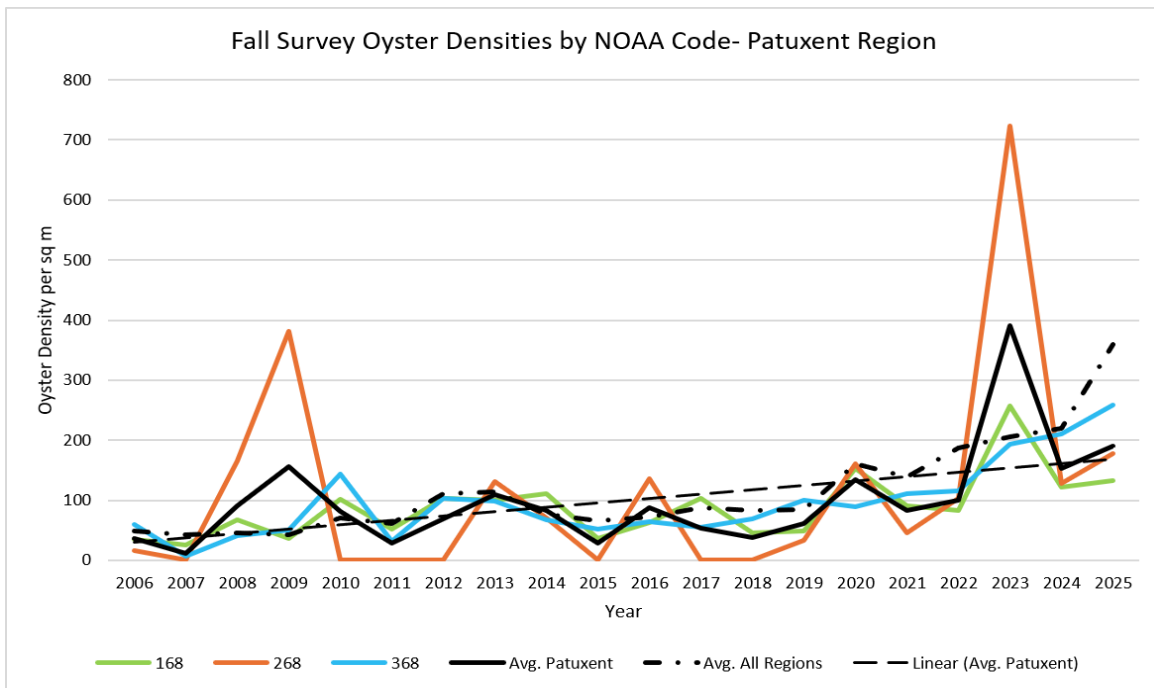


Figure 4-16. Average oyster densities in the Lower Bay by NOAA Code from 2006 through 2025. Data includes both sanctuary and public fishery area densities. (A) Total average oyster densities, including wild seed and spat-on-shell plantings. (B) Average spat densities, with wild seed and spat-on-shell plantings removed to reflect natural recruitment. The Lower Bay Region includes NOAA Codes: 129- Lower East Chesapeake Bay, 229- Lower West Chesapeake Bay. The average densities for this region, the linear trendline for the regional average (dashed line), and for the Maryland portion of the Bay (dot-dash line) are displayed.

A.



B.

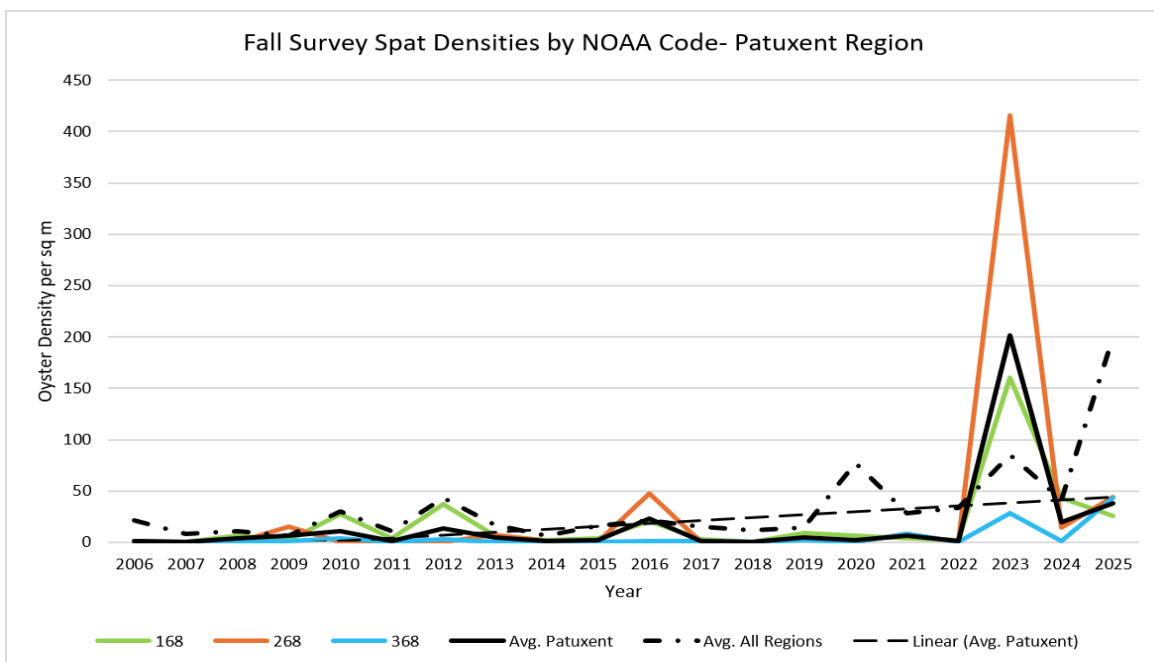
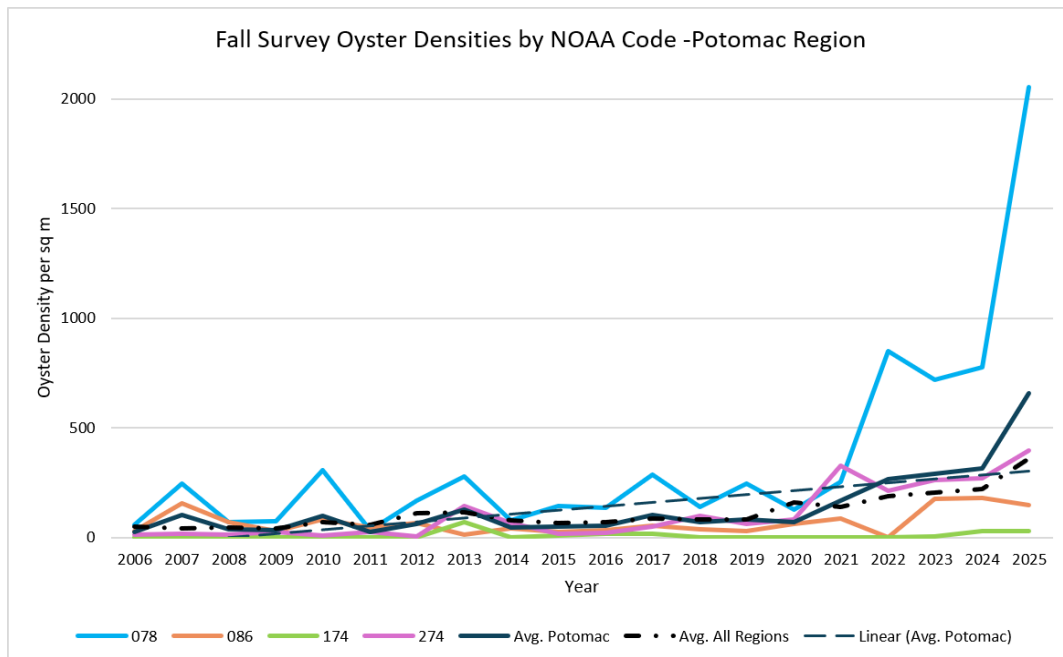


Figure 4-17. Average oyster densities in the Patuxent Region by NOAA Code from 2006 through 2025. Data includes both sanctuary and public fishery area densities. (A) Total average oyster densities, including wild seed and spat-on-shell plantings. (B) Average spat densities, with wild seed and spat-on-shell plantings removed to reflect natural recruitment. The Patuxent Region includes NOAA Codes: 168- Patuxent River Lower, 268- Patuxent River Middle, 368- Patuxent River Upper. The average densities for this region, the linear trendline for the regional average (dashed line), and for the Maryland portion of the Bay (dot-dash line) are displayed.

A.



B.

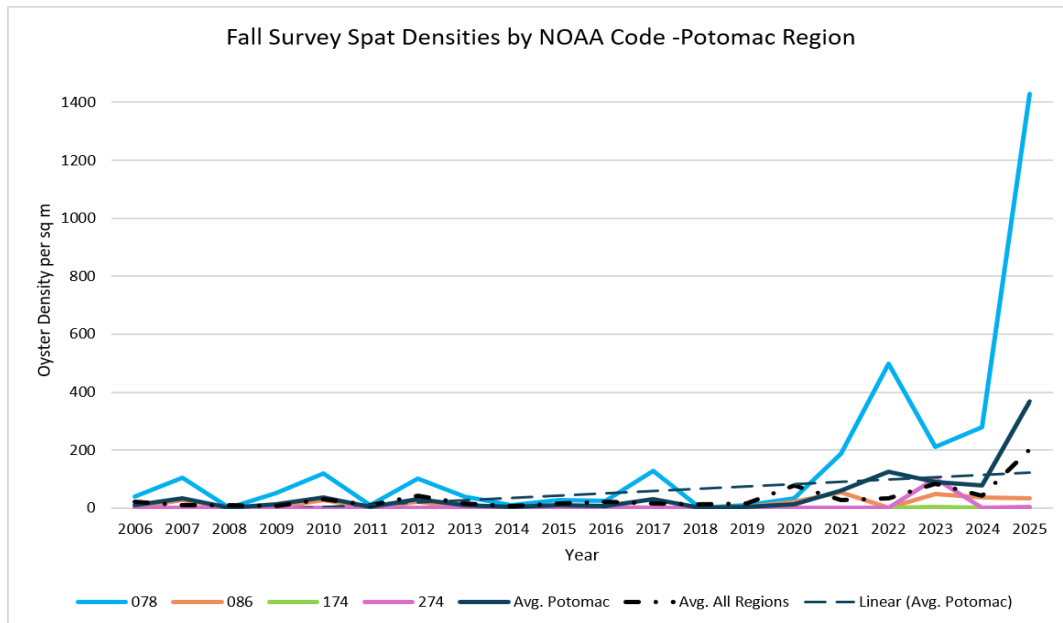
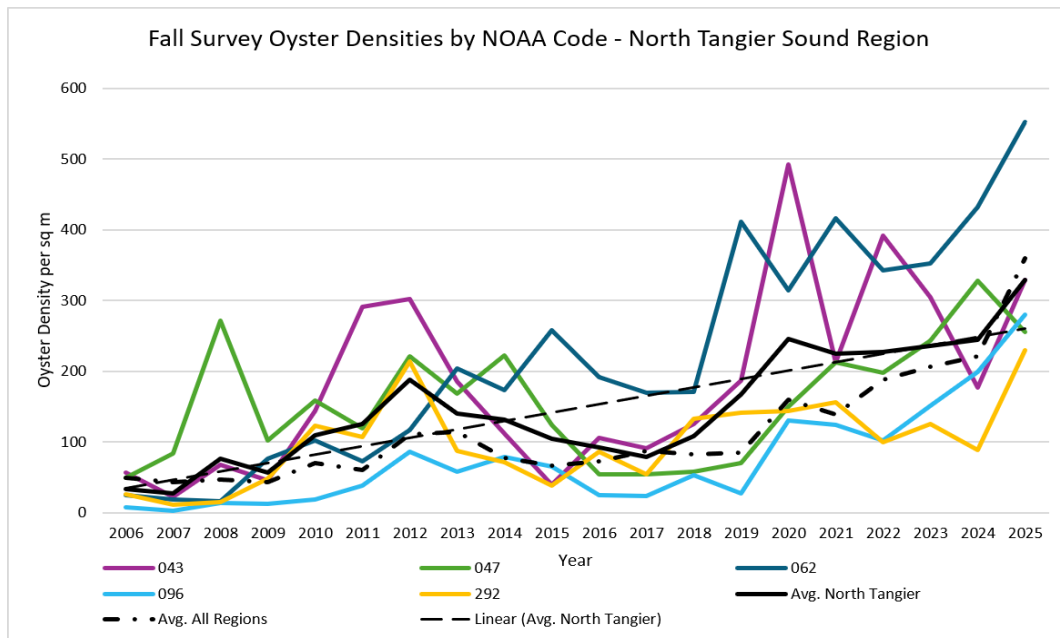


Figure 4-18. Average oyster densities in the Potomac Region by NOAA Code from 2006 through 2025. Data includes both sanctuary and public fishery area densities. (A) Total average oyster densities, including wild seed and spat-on-shell plantings. (B) Average spat densities, with wild seed and spat-on-shell plantings removed to reflect natural recruitment. The Potomac Tributary Region includes NOAA Codes: 078- St. Marys River, 086- Smith Creek, 174- St. Clements and Breton Bay, 274- Wicomico River (West). The average densities for this region, the linear trendline for the regional average (dashed line), and for the Maryland portion of the Bay (dot-dash line) are displayed.

A.



B.

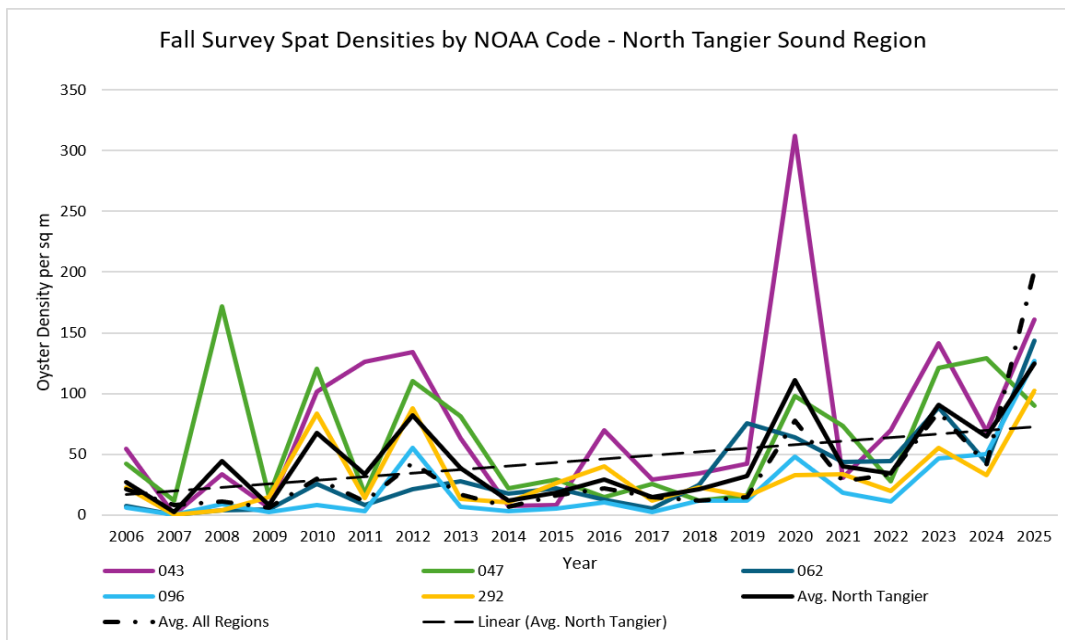
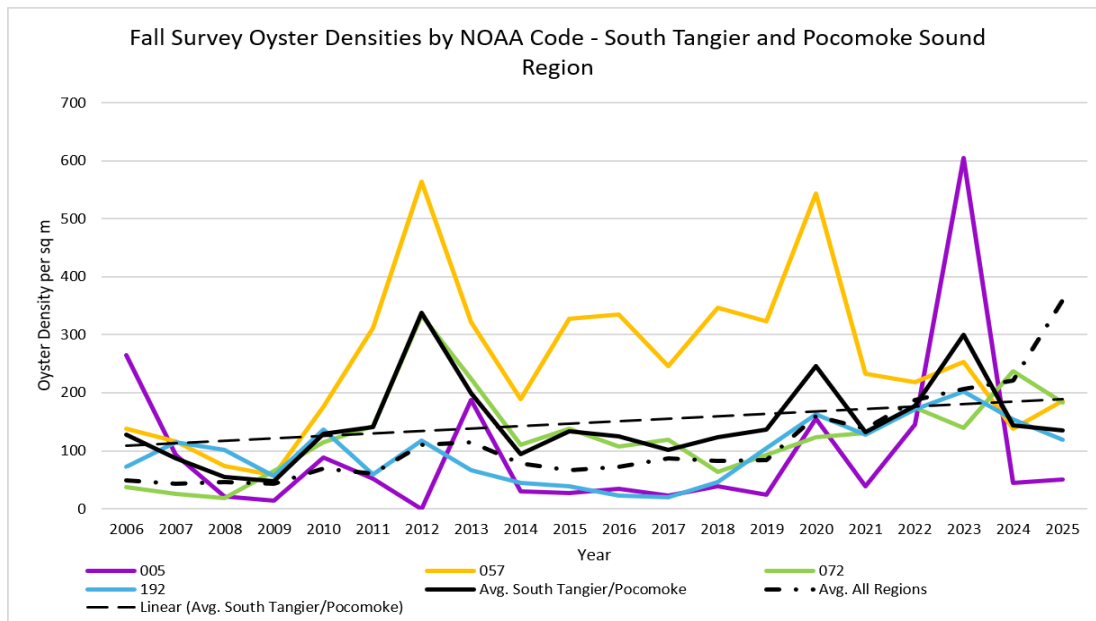


Figure 4-19. Average oyster densities in the North Tangier Sound Region by NOAA Code from 2006 through 2025. Data includes both sanctuary and public fishery area densities. (A) Total average oyster densities, including wild seed and spat-on-shell plantings. (B) Average spat densities, with wild seed and spat-on-shell plantings removed to reflect natural recruitment. The North Tangier Sound Region includes NOAA Codes: 043- Fishing Bay, 047- Honga River, 062- Nanticoke River, 096- Wicomico River (East), 292- Tangier Sound North. The average densities for this region, the linear trendline for the regional average (dashed line), and for the Maryland portion of the Bay (dot-dash line) are displayed.

A.



B.

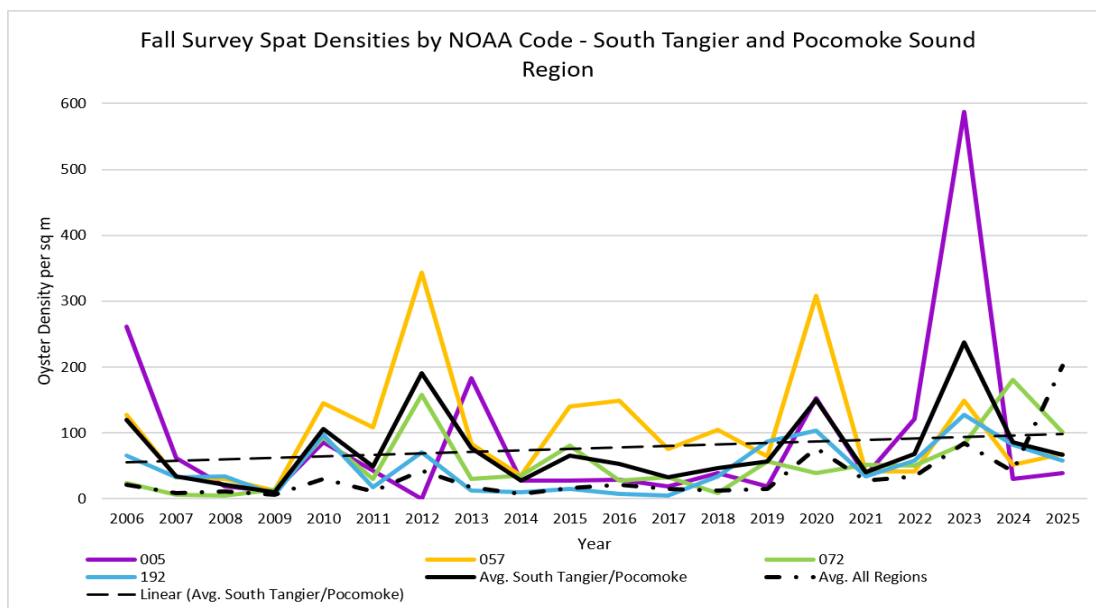


Figure 4-20. Average oyster densities in the South Tangier and Pocomoke Sound Region by NOAA Code from 2006 through 2025. Data includes both sanctuary and public fishery area densities. (A) Total average oyster densities, including wild seed and spat-on-shell plantings. (B) Average spat densities, with wild seed and spat-on-shell plantings removed to reflect natural recruitment. The South Tangier and Pocomoke Sound Region include NOAA Codes: 005- Big Annemessex River, 057- Manokin River, 072- Pocomoke Sound, 192- Tangier Sound South. The average densities for this region, the linear trendline for the regional average (dashed line), and for the Maryland portion of the Bay (dot-dash line) are displayed.

Even if environmental conditions are favorable for reproduction, oyster areas must have adequate cultch availability for larval settlement in order to have an impact on the population. If an area is lacking in cultch, populations will likely not rebound to their full potential. For the purpose of the annual Fall Oyster Survey, cultch is defined as primarily both oysters (live and dead) and shell. A cultch index of 1.4 bushels per 100 feet is consistent with the top 25% of all sites sampled baywide. It is roughly equivalent to 25 L of cultch per square meter, or approximately 1" of cultch over the bottom. This value is what the Department considers an adequate level of cultch. Cultch indices were developed for each region using a 3-year rolling average to help smooth the natural variability of this measurement (Figure 4-21). The Lower Bay had the lowest cultch index. This is an area that has regular natural recruitment and is likely limited by cultch availability. In general, most areas have seen an increase in the cultch index since 2008. The region with the highest average cultch availability is the Choptank Region, which also has the highest average densities and has seen the highest average recruitment.

Overall, reproductive potential, oyster densities, natural recruitment, and cultch availability have exhibited a positive trend from 2021 through 2025.

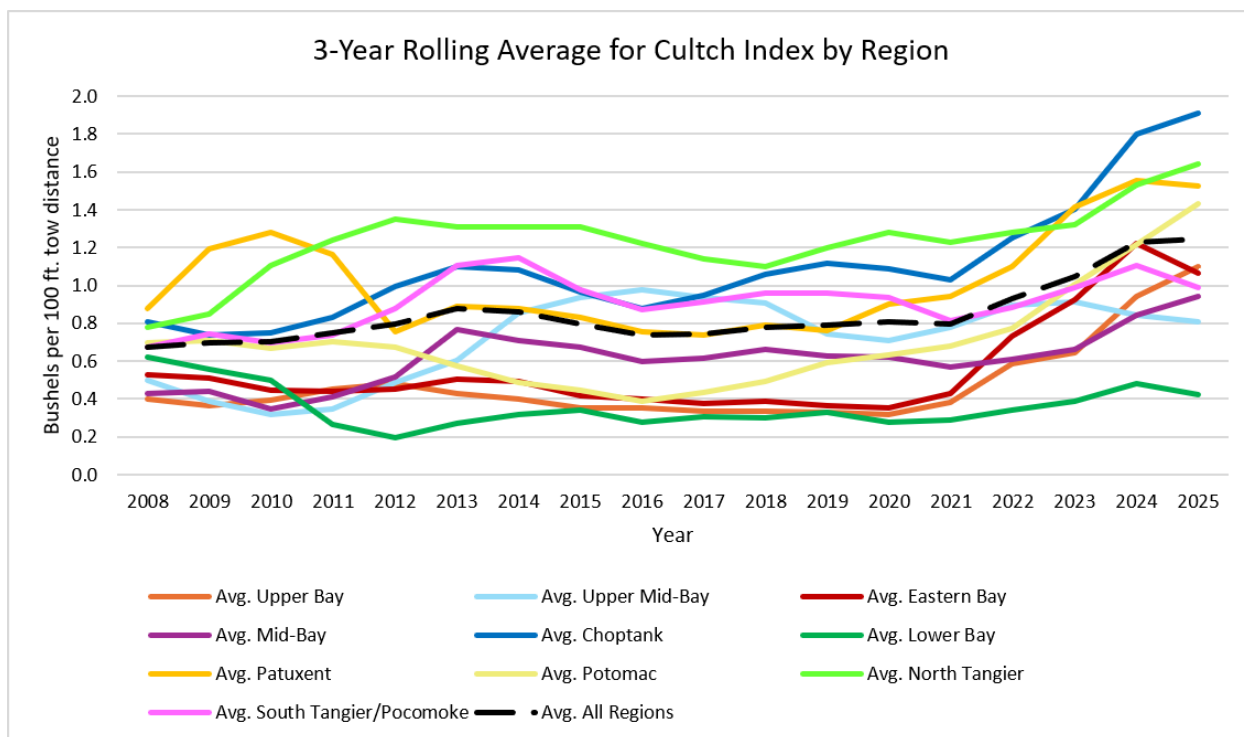


Figure 4-21. Cultch index by region from 2006 through 2025. Data includes both sanctuary and public fishery areas. The average index for all regions is also displayed (dashed line). Data are based on the 3-year rolling average for the region.

Section 4.1.2: Sanctuary Objective #2

Improve oyster habitat and increase oyster biomass by utilizing appropriate techniques considering the influence of environmental conditions.

Sanctuary Objective #2 Status: *This objective is ongoing. Multiple techniques are utilized to improve oyster habitat, including shell plantings, hatchery produced spat-on-shell plantings, and substrate placement for oyster reef base enhancement. Oyster biomass within sanctuaries has continued to increase since the expansion of the sanctuary program in 2010.*

Oyster populations are influenced greatly by environmental conditions, with salinity being one of the driving factors. Oyster bars in Maryland are located in the mesohaline salinity zone (5-18 ppt). Within this mesohaline zone, Maryland oyster bars are further classified into three zones: Zone 1 has an average salinity less than 11 ppt; Zone 2 has an average salinity between 11 and 15 ppt; and Zone 3 has salinities greater than 15 ppt²⁸. Salinity zones were developed to be broad, general categories and some sanctuaries may fluctuate between salinity zones depending on weather patterns.

Using data collected by the Maryland Department of Environment, Shellfish and Fish Monitoring Division, monthly surface salinity data collected at 227 sites (mostly over oyster bars) baywide from 2006 to 2020 were used to classify sanctuaries into the different salinity zones. Although bottom salinity would be more appropriate to use to classify salinity zones for oysters, surface salinity datasets had greater spatial and temporal coverage.

Sanctuaries within Zone 1 (22 sanctuaries and 119,186 surface acres) were chosen to increase oyster biomass through stocking and long-term survival. Oysters within Zone 1 are characterized by having lower levels of disease and better survival but low reproductive capability²⁹. These oysters are also subject to intermittent freshets that can result in substantial mortality.

Sanctuaries within Zone 3 (4 sanctuaries and 18,351 surface acres) were chosen to foster disease resistance and enhance reproduction. Oysters in this zone have been subjected to heavy disease pressures which historically resulted in high mortality³⁰. In Zone 3, there are also high recruitment rates that provide a fairly constant influx of new oysters.

Sanctuaries within Zone 2 (25 sanctuaries and 115,470 surface acres) represent transition areas incorporating the goals of Zones 1 and 3. Oyster located in Zone 2 may have fluctuating characteristics based on the climatic variation between wet and dry years³¹. Annual spat settlement can range from low to moderate to high based on

²⁸ Maryland Department of Natural Resources. 2019. Oyster Management Plan. 93 pp.
https://dnr.maryland.gov/fisheries/Documents/MD_Oyster_FMP-2019.pdf

²⁹ IBID

³⁰ IBID

³¹ IBID

salinity. Mortality related to disease can also fluctuate from year to year influenced by salinity. In years with low disease mortality, the oyster populations in this area can recover as long as there is also successful recruitment. However, the reverse can also occur.

Oyster sanctuaries are distributed across all salinity zones in Maryland's portion of Chesapeake Bay. Based on historic oyster bottom³², approximately 30% of the sanctuary area is in low salinity, 56% in medium salinity, and 15% in high salinity areas (Table 4-1, Figure 4-22).

Oyster population growth and survival are driven primarily by the amount of spat settlement (reproduction) and the mortality rate, which in turn are strongly influenced by the prevailing salinity of the area (Figure 4-23, Figure 4-24). If the rate of spat settlement on a bar is greater than the mortality rate, the population should increase provided that the availability of shell or other hard substrate remains constant. Spat densities within the medium- and high-salinity sanctuaries have generally remained above the baywide average, while the low salinity sanctuaries have seen an increase in spat density in the last five years. Observed mortality rates also fluctuate depending on environmental conditions and generally have an inverse impact on oyster biomass. The average oyster biomass across all sanctuaries has continued to show a positive trend since 2010 (Figure 4-3).

Presence of shell or hard substrate is an important component of oyster habitat for spat settlement (Powell et al. 2006)³³. Along with spatfall and natural mortality, the ability for shell to accumulate on a reef will depend on the interaction of reef height and sedimentation. For reefs to accrete vertically or expand laterally, the addition of shell must exceed shell loss from all sources (e.g. fouling, sedimentation, burial, dissolution, removal through harvesting). Because the addition and loss of shell depend on many of the same factors as population growth (recruitment, individual growth, boring organisms, mortality) as well as abiotic factors (e.g. dissolution), salinity plays a significant role in reef growth as well.

Table 4-1. Sanctuary acres located in each salinity zone.

Salinity Zone (With salinity range in ppt)	Total Surface Acres	% Acres	Total Historic Oyster Bottom Acres*	% Acres
Low (<11 ppt)	119,186	47%	23,372	29.6%
Medium (11-15 ppt)	115,470	46%	44,087	55.8%
High (>15 ppt)	18,351	7%	11,502	14.6%

³² As charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments

³³ Powell, E. N., J. N. Kraeuter & K. A. Ashton-Alcox. 2006. How long does oyster shell last on an oyster reef? *Estuaries and Coastal. Shelf Science* 69:531–542

*Historic oyster bottom as charted in the Yates Oyster Survey of 1906 to 1912 and its amendments.

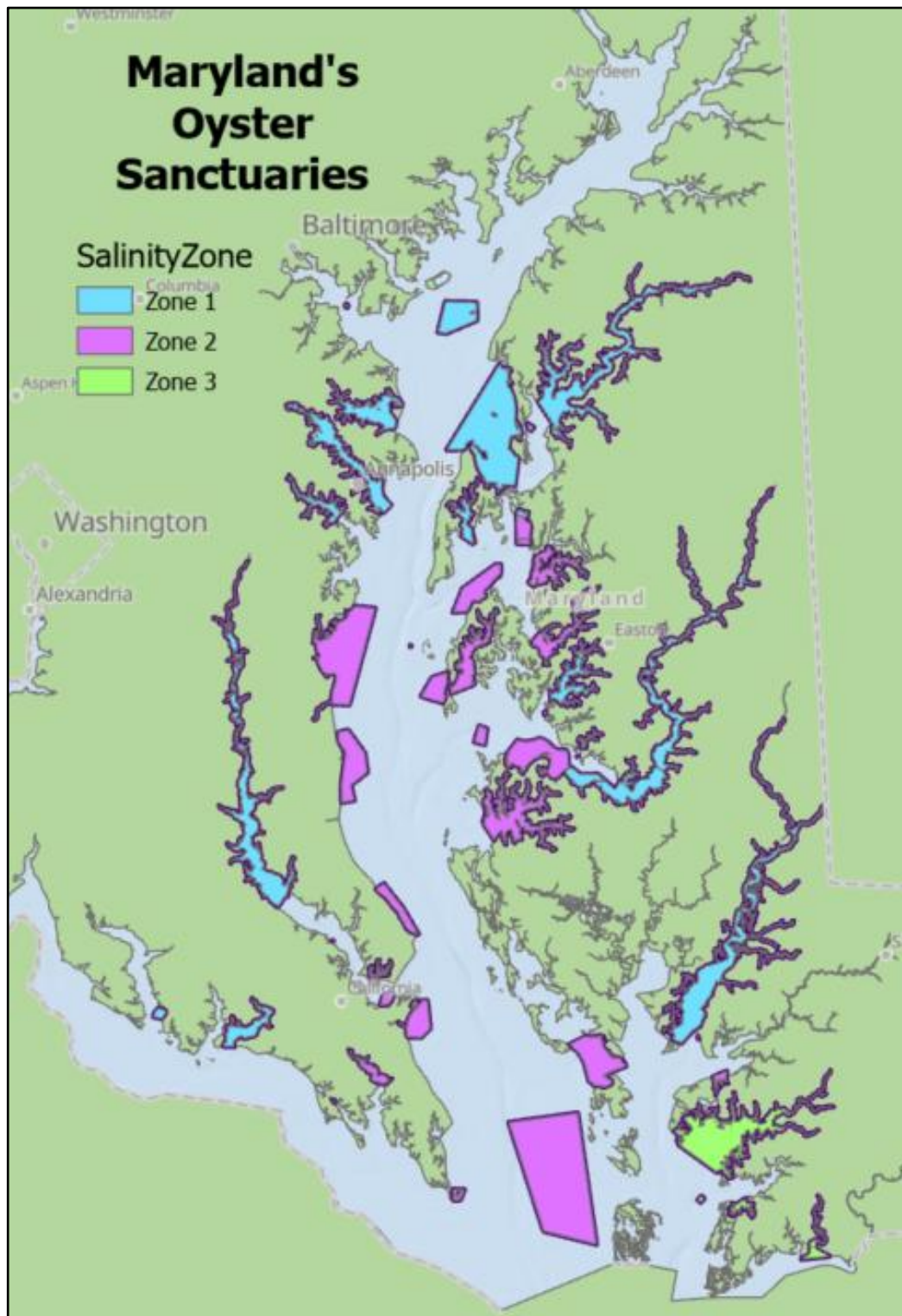


Figure 4-22. Map of the sanctuaries and the corresponding salinity zones. Zone 1 has an average salinity less than 11 ppt; Zone 2 has an average salinity between 11 and 15 ppt; and Zone 3 has salinities greater than 15 ppt.

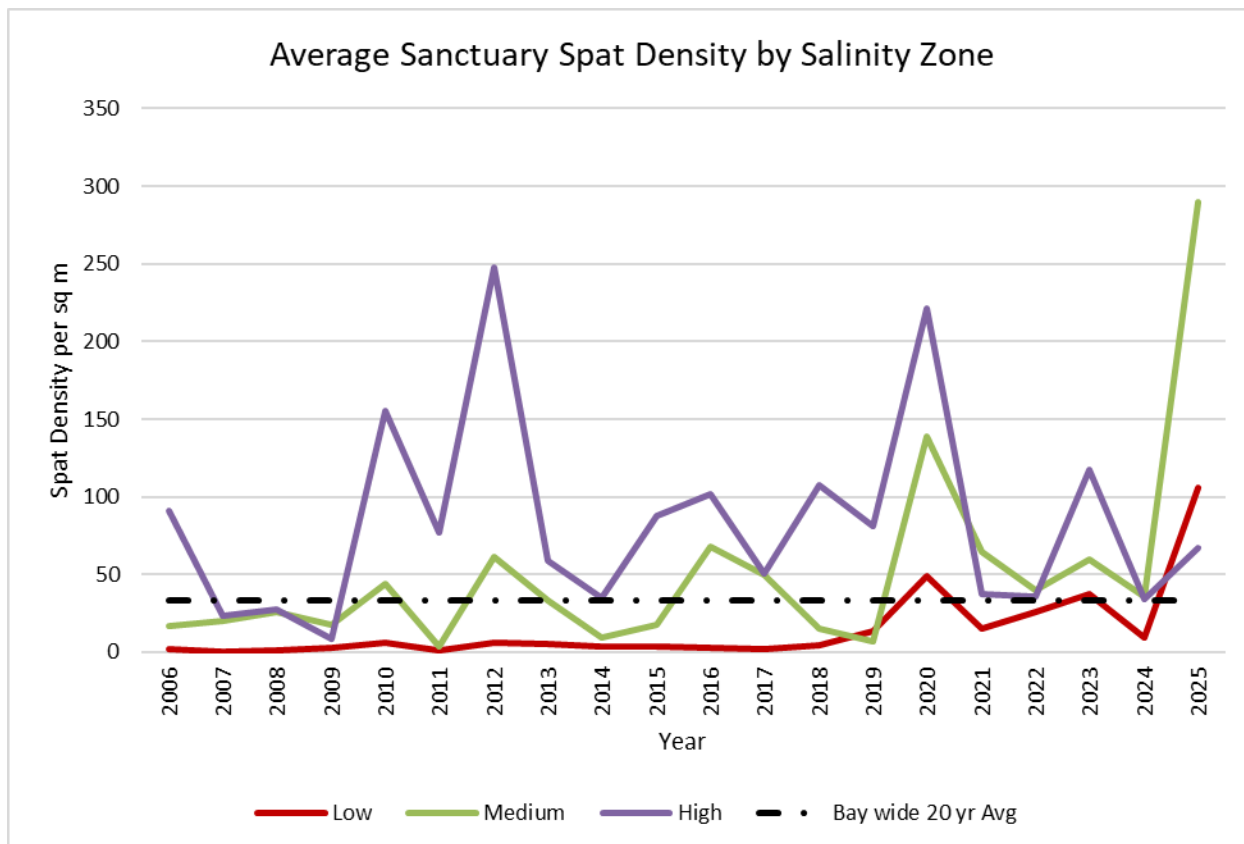


Figure 4-23. Average number of spat per square meter in each salinity zone based on annual Fall Oyster Survey data. Low-salinity zones average <11 ppt; medium-salinity zones average 11 to 15 ppt; and high-salinity zones average >15 ppt. Average spat density baywide is for all annual Fall Oyster Survey sites sampled in the 20-year time series, including non-sanctuary bottom (dot-dash line), with hatchery spat-on-shell plantings removed.

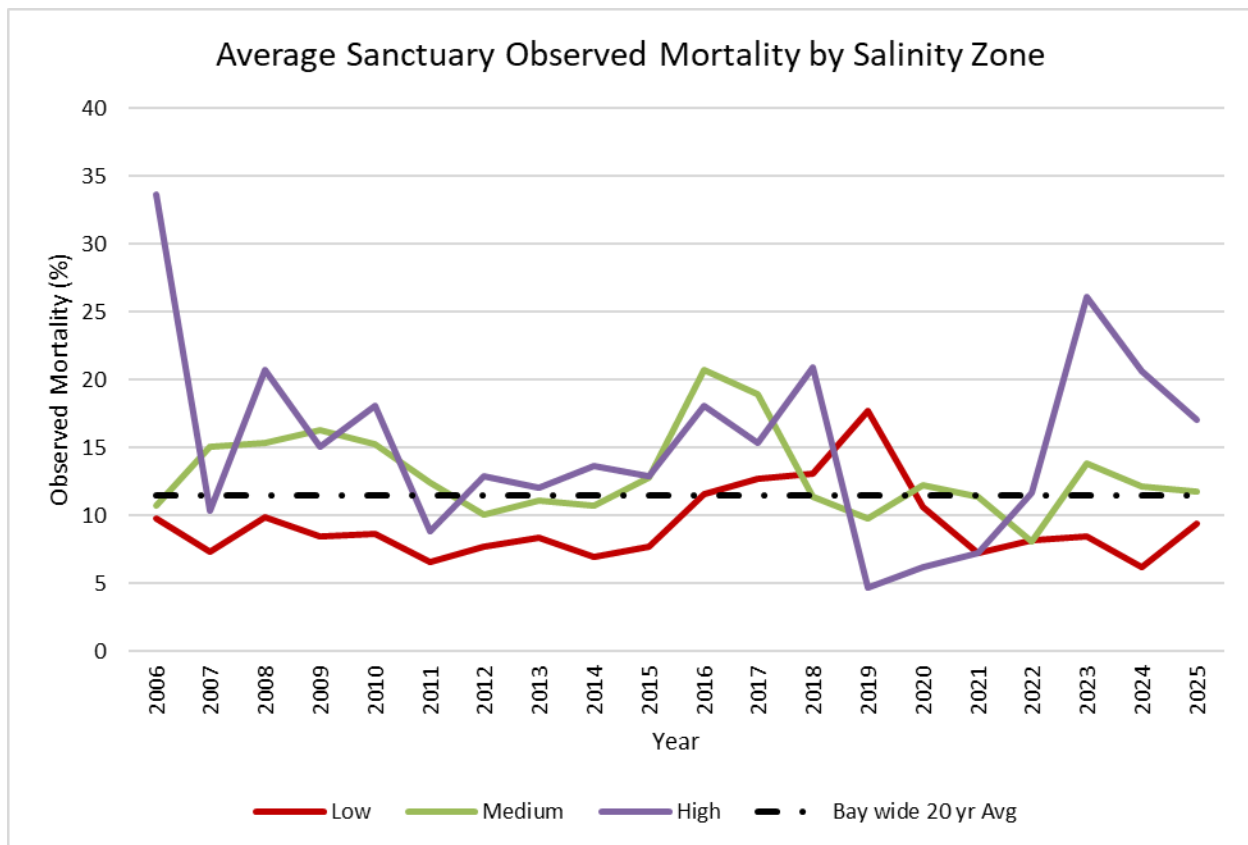


Figure 4-24. Average observed mortality in each salinity zone based on annual Fall Oyster Survey data. Low-salinity zones average <11 ppt; medium-salinity zones average 11 to 15 ppt; and high-salinity zones average >15 ppt. The baywide average is for all annual Fall Oyster Survey sites sampled in the 20-year time series, including non-sanctuary bottom (dot-dash line).

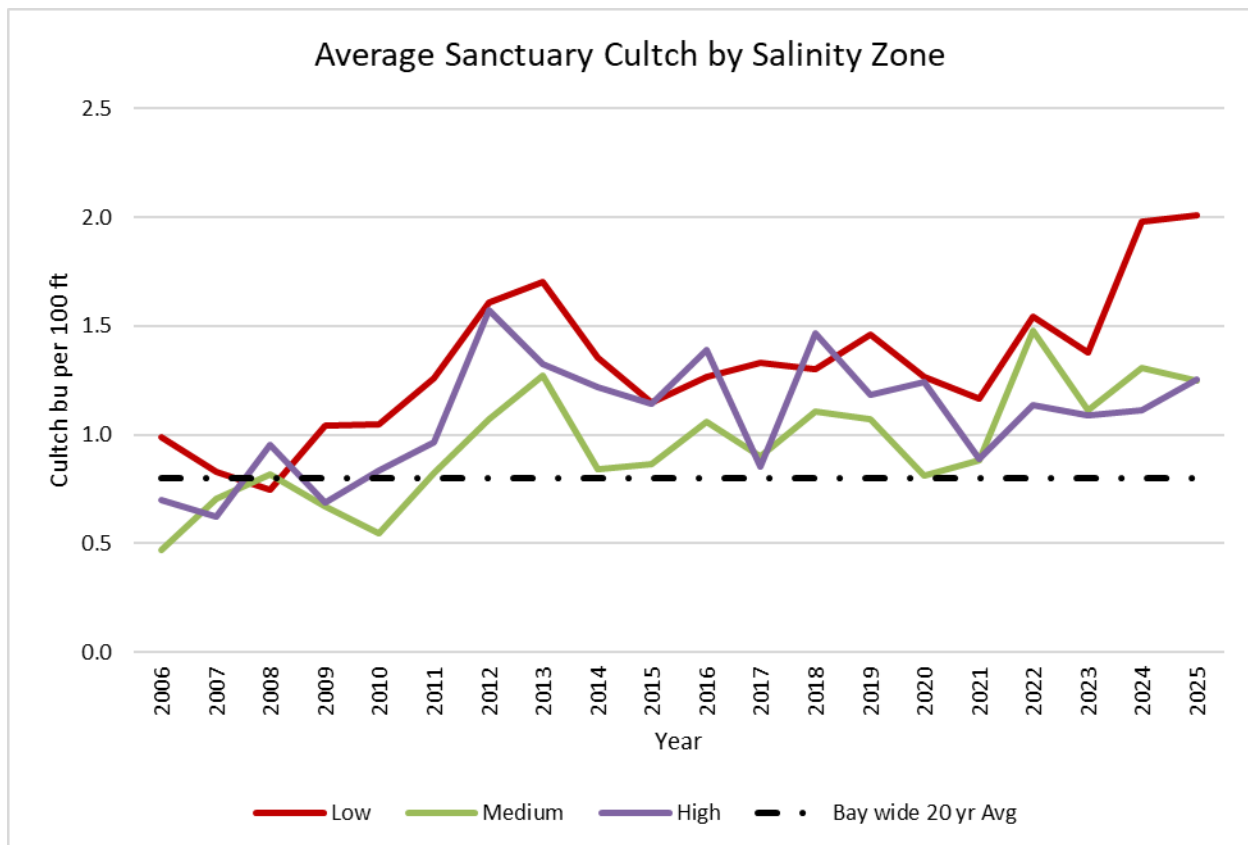


Figure 4-25. Average cultch per 100 feet in each salinity zone based on annual Fall Oyster Survey data. Low-salinity zones average <11 ppt; medium-salinity zones average 11 to 15 ppt; and high-salinity zones average >15 ppt. The baywide average is for all annual Fall Oyster Survey sites sampled in the 20-year time series, including non-sanctuary bottom (dot-dash line).

The oyster sanctuaries are distributed throughout Maryland waters to provide ecological benefits specific to their particular salinity zones, such as accommodating salinity-restricted organisms (e.g. habitat for redbear sponge *Microciona prolifera* in high-salinity Tangier Sound, habitat for dark false mussels *Mytilopsis leucophaeata* in the fresher upper reaches of the Bay and tributaries). Oysters in lower-salinity areas generally have lower mortality rates which enhances their ecological benefit – more oysters remain alive and for a longer period of time. Medium- and high-salinity sanctuaries serve as broodstock reservoirs and disease-resistant populations may naturally develop there.

Locating sanctuaries over the full range of salinity zones may help lessen the effects of catastrophic weather events to the sanctuary network as a whole. For example, should a low-salinity population be devastated by a freshet, the higher salinity areas would still be intact and may aid in the recovery as an ample source of oysters for transplanting or by supplying larvae to eventually repopulate the area. Over time, sanctuaries located in diverse salinity zones will allow us to observe the interplay between changes in salinity and oyster survival and growth.

The Department and other community and non-governmental organizations (NGO) utilize several methods to improve oyster habitat, including shell plantings (fresh or dredged shell), hatchery-produced spat-on-shell plantings, wild seed plantings, substrate placement for reef base, and/or direct larvae release on suitable oyster habitat. Since the expansion of the sanctuary program in 2010, many sanctuaries have received habitat improvement efforts, including Cook Point, Cox Creek, Eastern Bay, Harris Creek, Herring Bay, Howell Point, Little Choptank River, Lower Chester River, Lower Choptank River, Magothy River, Manokin River, Miles River, Nanticoke River, Prospect Bay, Ringgold, Sandy Hill, Severn River, South River, St. Marys River, Tred Avon River, Upper Choptank River, Upper Patuxent River, and Wye River.

Section 4.1.3: Sanctuary Objective #3

Conserve and protect oyster habitat and biomass through maintenance of sanctuaries so that a minimum of 20-30% of oyster habitat and 50% of the 'best bars' are within sanctuaries.

Sanctuary Objective # 3 Status: *This objective is being met. Since sanctuary boundaries have not changed since 2010, 24% of oyster habitat remains within sanctuaries. The 'best bars' analysis was updated in 2020 and found that 50% of productive bars have at least a portion of bottom within a sanctuary.*

Historic oyster bottom refers to oyster bars charted by the Yates Survey (1906 through 1912)³⁴ and its amendments. The Yates Survey identified 779 named bars totaling 214,772 acres. It should be noted, however, that the historic oyster bottom does not necessarily represent current viable oyster reefs with oysters and substrate. As estimated in the Programmatic Environmental Impact Statement (PEIS, 2009), only 36,000 acres of the historic oyster bottom are viable today³⁵. Of these 36,000 acres, approximately 9,000 remain within sanctuaries or 24% of the estimated oyster habitat. Since the analysis in the PEIS remains the same, this objective is continuing to be met.

The 'best bars' objective was assessed based on the 2020 updated analysis to define productive oyster bottom. Based on the analysis of data from 2009 through 2018, 13 of the 26 best bars have all or some portion of historic oyster bottom³⁶ outside of sanctuaries (50%). Conversely, 15 of the 26 best bars have all or some portion of historic oyster bottom within sanctuaries (58%). Because some of these bars have acres in both sanctuaries and PSFAs, some bars can be counted twice. When considering acreage of the updated list of 'best bars' from 2009 through 2018, 4,472 acres (39%) are within sanctuaries.

³⁴ Yates, Charles. 1913. Survey of Oyster Bars of Maryland 1906 to 1912. <http://www.biodiversitylibrary.org/item/96740>

³⁵ U.S. Army Corps of Engineers, Norfolk District. 2009. Programmatic Environmental Impact Statement for Oyster Restoration in Chesapeake Bay Including the Use of a Native and/or Nonnative Oyster. <http://dnr.maryland.gov/fisheries/Pages/eis.aspx>

³⁶ Historic oyster bottom as charted in the Yates Oyster Survey of 1906 to 1912 and its amendments.

Section 4.1.4: Sanctuary Objective #4

Conduct and complete large-scale restoration in five tributaries by 2025.

Sanctuary Objective #4 Status: *This objective has been met. The initial restoration was completed in the final sanctuary, the Manokin River Sanctuary, in the fall of 2025. Planned second seedings and monitoring to gauge success are ongoing. The Department has since identified the next three areas for large-scale restoration.*

Under the 2014 Chesapeake Bay Watershed Agreement, Maryland committed to restoring oyster populations in five target tributaries by 2025: Harris Creek, Little Choptank River, Tred Avon River, St. Marys River, and Manokin River. In 2015, Harris Creek was the first tributary where initial restoration was completed and it has since been officially deemed restored following the completion of its six-year monitoring cycle. Subsequently, initial restoration efforts were completed in the Little Choptank Sanctuary in 2020, the Tred Avon River Sanctuary in 2021, and the St. Marys River Sanctuary in 2022. The final initial restoration milestone was achieved in the Manokin River Sanctuary in 2025. Monitoring continues across these final four sanctuaries to evaluate long-term restoration success.

Section 4.1.5: Sanctuary Objective #5

Support, enhance, and increase ecological restoration activities in other tributaries throughout the Chesapeake Bay.

Sanctuary Objective #5 Status: *This objective is ongoing. Restoration efforts continue within sanctuaries through community-based oyster gardening, and other small-scale, regional and large-scale restoration projects.*

The Department has four oyster restoration programs that support restoration activities within the sanctuaries throughout the Maryland portion of Chesapeake Bay. These programs include a community-based oyster gardening program called Marylanders Grow Oysters (MGO), small-scale restoration projects, the Eastern Bay Regional Project, and large-scale restoration projects.

MGO consists of growing oysters for nine months at private piers and then planting them within a sanctuary for ecological benefits. The program started in 2008 in the Tred Avon River and currently operates in 32 tributaries across Maryland.

In 2017 and 2018, the Maryland Oyster Advisory Commission (OAC) expressed concern that only five of the 51 sanctuaries in Maryland would receive restoration efforts. To address this concern, the State announced its plan to begin investing resources for spat-on-shell restoration within the sanctuaries outside of large-scale

restoration areas. The small-scale restoration projects are used to plant oyster seed in these other sanctuaries.

In 2019, the Department initiated the Eastern Bay Regional Project with the goal to restore and replenish the Eastern Bay region through oyster and habitat planting activities conducted in sanctuaries, public fishery bottom, and aquaculture leases, effectively combining these three sectors of oyster management and oyster partners in one large restoration project. The OAC supported DNR's plan for the Eastern Bay Regional Project and included it in their December 2021 report recommendations to the Department. Their recommendation was:

Over the next 25 years, a combination of replenishment, restoration, and aquaculture activities should be collectively planned and undertaken in Eastern Bay, with an equal amount of funding for spat planting in sanctuaries (\$1M annually adjusted for inflation) and for spat and shell planting on fishery bars (\$1M annually adjusted for inflation) in addition to current replenishment and restoration activities. The effectiveness of this option should be evaluated every 5 years³⁷.

The Maryland General Assembly passed SB830 in 2022 in support of the Eastern Bay Regional Project and included three years of project funding. The Department has been conducting restoration plantings within six of the sanctuaries within the project area: Cox Creek, Miles River, Wye River, Eastern Bay, Prospect Bay, and Mill Hill.

As the oyster goal of restoring five tributaries by 2025 set in the 2014 Chesapeake Bay Watershed Agreement was achieved, in August 2024, the Department adopted the Four Point Sanctuary Plan and has committed to enhancing oyster populations in other sanctuaries beyond the initial five large-scale tributaries. To continue the success of large-scale restoration in additional sanctuaries, the Department worked with the OAC to acquire feedback on choosing the next areas to focus the large-scale restoration efforts. The sanctuaries chosen for large-scale restoration include the Nanticoke River, Herring Bay, and Hooper Strait.

In 2025, an updated Chesapeake Bay Watershed Agreement was signed and includes four new oyster goals:

- By 2040, restore or conserve at least 2,000 additional acres of oyster reef habitat concentrated primarily in restoration focus areas to provide ecosystem service benefits.
- Increase ecosystem benefits from oysters through reef habitat restoration, sustainable harvest, and aquaculture.
- Maintain sustainable oyster abundance through oyster fisheries and aquaculture practices.

³⁷ First evaluation will be in 2028.

- Maintain reefs established under the 2014 Chesapeake Bay Watershed Agreement to achieve restoration success metrics.

Maryland committed to restoring 1,100 additional acres of oyster reef habitat by 2040.

In Appendix A Sanctuary Assessment, sixteen sanctuaries were designated as having restoration received, ongoing, or planned. This includes the three sanctuaries identified by the Department as the next areas for large-scale restoration (Herring Bay, Hooper Strait, and the Nanticoke River), the sanctuaries receiving ongoing plantings as part of the Eastern Bay Regional Project (Cox Creek, Prospect Bay, Mill Hill, Eastern Bay, Wye River and Miles River), and sanctuaries that have previously or are planned to receive small-scale restoration plantings in 2026 (Poplar Island, Ringgold, Tilghman Island, Upper Patuxent River, Calvert Shore, Magothy River, and South River). The Department intends to continue restoration within other sanctuaries as long as funding and support remain.

Section 4.2: Non-sanctuary NOAA Code Areas

To evaluate regional trends, the 176 Public Shellfish Fishery Areas (PSFAs) were aggregated into 39 non-sanctuary NOAA Code areas, 31 of which contain PSFAs that have been consistently monitored by the Fall Oyster Survey since at least 1990. NOAA Code areas serve as the primary spatial units used by DNR and the commercial oyster industry to report harvest. To ensure an accurate characterization of public fishery productivity, the survey data used for these classifications exclude any samples collected within sanctuary boundaries. Detailed profiles for each individual non-sanctuary NOAA Code area are available in Appendix B.

Similar to sanctuaries, oyster mortality in non-sanctuary NOAA Code area has remained stable and below the long-term baywide average since 2010 (Figure 4-26).

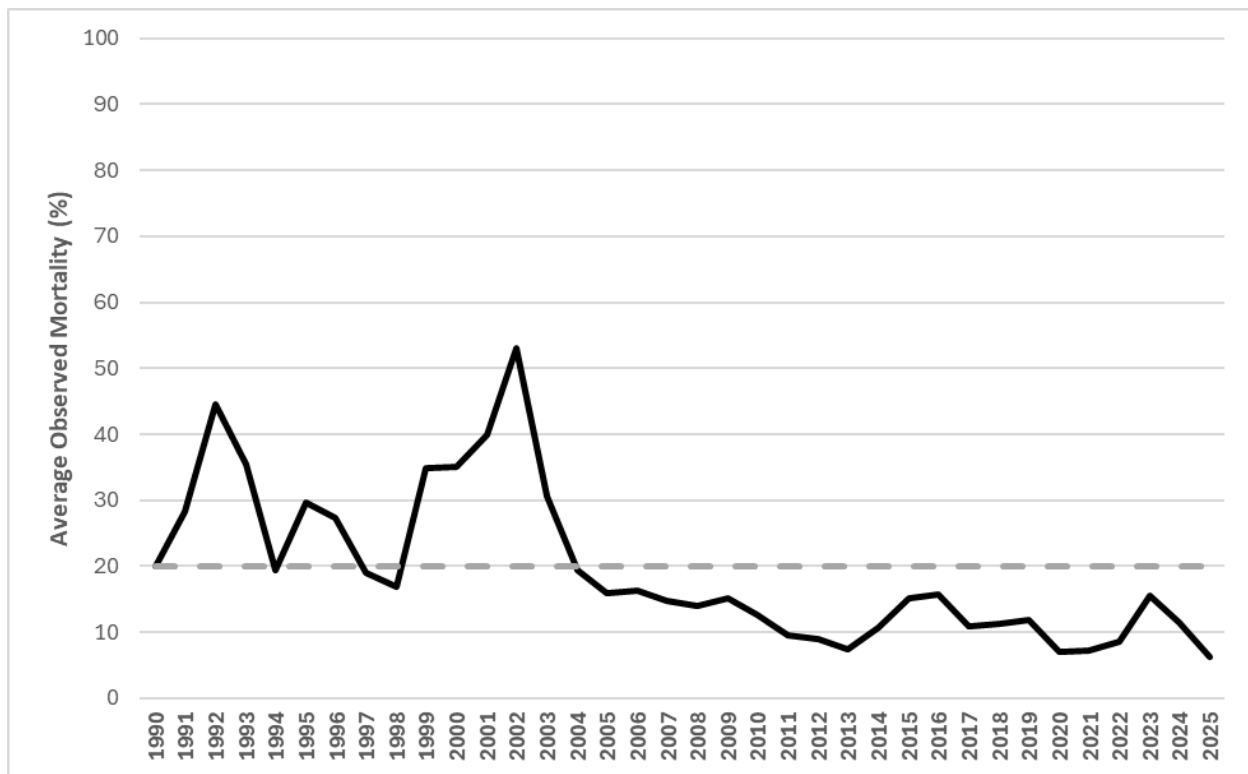


Figure 4-26. Average observed mortality on oyster bars in non-sanctuary areas observed in the Maryland annual Fall Oyster Survey, 1990 through 2025. The dotted line represents the long-term baywide average.

Biomass estimates since 1990 are available for 19 of the 39 non-sanctuary NOAA Code areas for 27 oyster bars. The bars and their NOAA Codes include: Swan Point (025), Stone (027), Bugby (039), Hollicuts Noose (039), Parsons Island (039), Goose Creek (043), Norman Addition 1 (047), Ragged Point (053), Turtleback (060), Marumsco (072), Chicken Cock (078), Hackett Point (127), Buoy Rock (131), Lighthouse (137), Royston (137), Back Cove (192), Hollands Straits East (192), Old Womans Leg (192), Piney Island East (192), Butler (229), Hog Island (229), Lancaster (274), Mills West (274), Sharkfin Shoal (292), Broome Island (368), Tilghman Wharf (437), and Deep Neck (537).

Some non-sanctuary NOAA Code areas have multiple bars that were sampled for biomass. Overall biomass increased from 2010 to 2013, then decreased in 2014 and started increasing again in 2017 (Figure 4-27). From 2012 through 2015 and after 2018, the average biomass has been above the long-term baywide average (all oyster bars measured consistently for biomass from 1990-2025). Biomass trends in non-sanctuary NOAA Code areas are somewhat different than what was observed in sanctuaries (Figure 4-2) where biomass has consistently remained above the long-term average since 2011 but has been trending upward since then. Biomass increases were seen in

all salinity zones, with the greatest apparent increase on the bars in the medium-salinity areas (Figure 4-28).

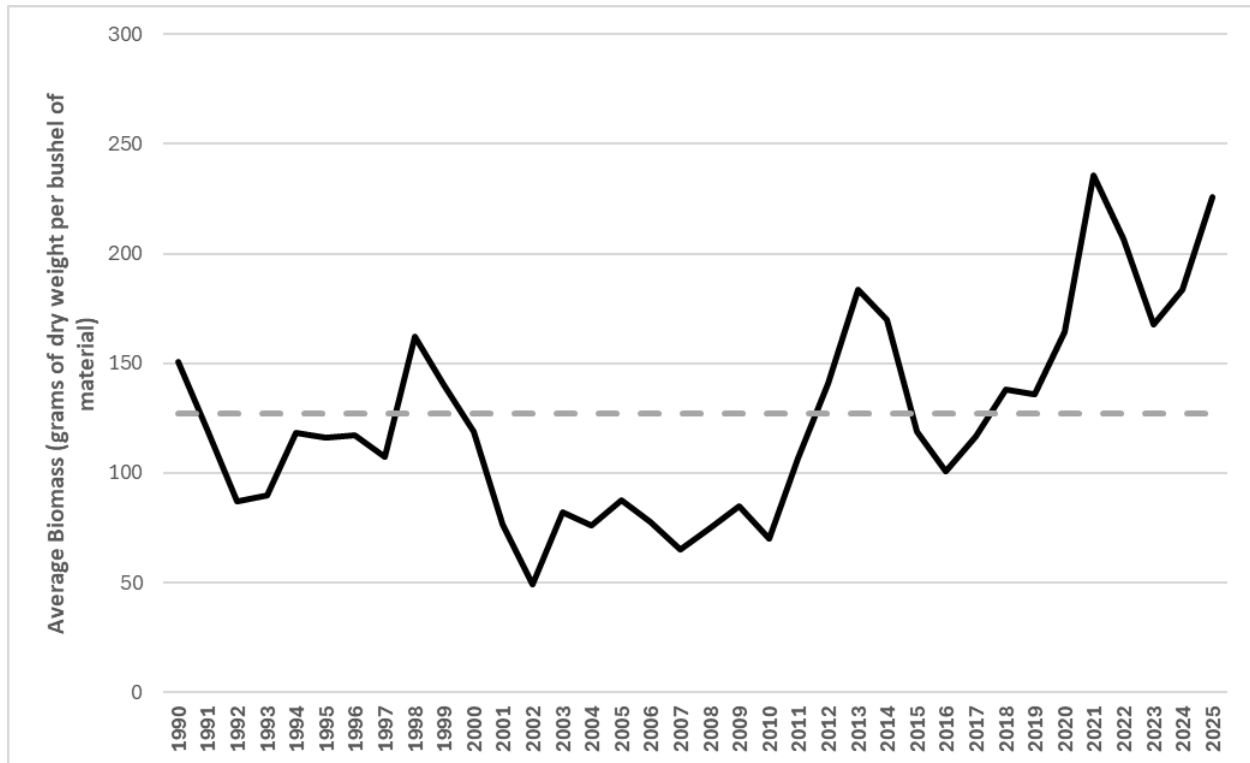


Figure 4-27. Estimated average biomass index from 27 consistently sampled oyster bars currently within 19 non-sanctuary NOAA Code areas, 1990 through 2025 (non-sanctuary bars within the NOAA Codes). The dotted line denotes the long-term baywide average for these bars.

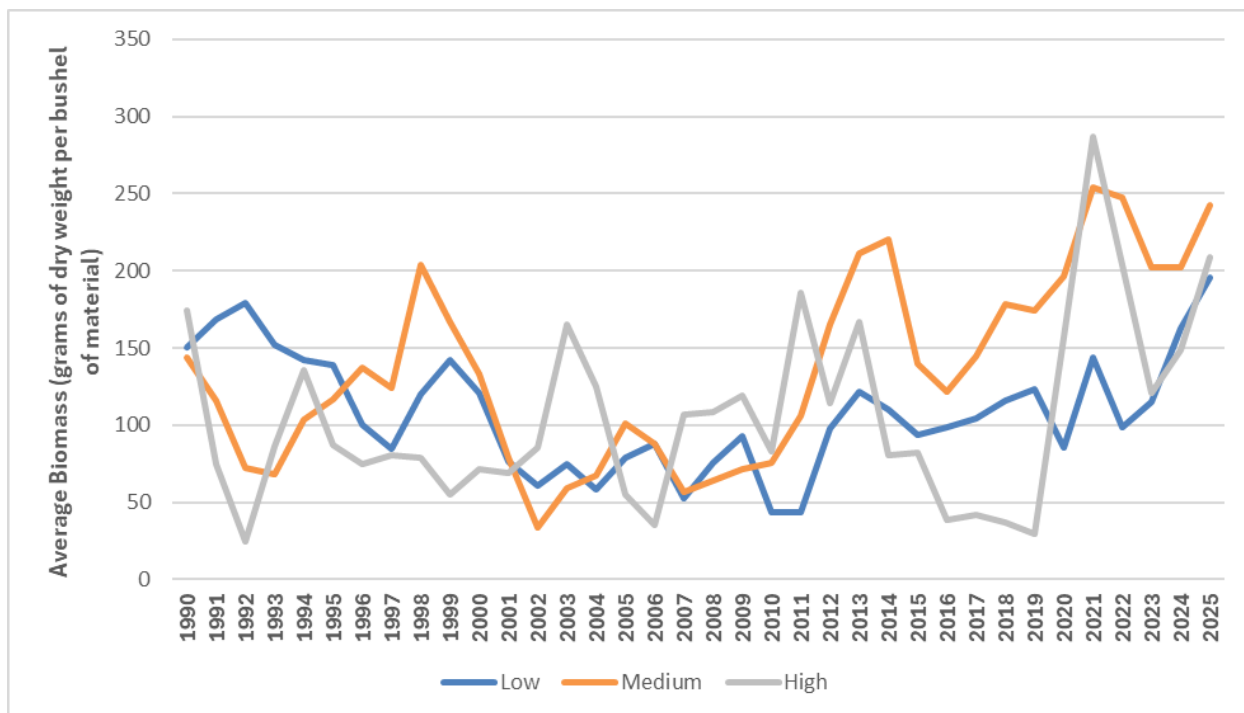


Figure 4-28. Estimated average biomass index for each salinity zone from the annual Fall Oyster Survey for 27 oyster bars currently located within 19 non-sanctuary NOAA Code areas in Maryland's portion of Chesapeake Bay, 1990 through 2025 (non-sanctuary bars within the NOAA Codes). Low, medium and high salinity zones are defined as: low salinity <11 ppt, medium salinity 11 to 15 ppt, and high salinity >15 ppt.

Oyster harvest has varied widely since the current management areas were established in 2010, but overall harvest has been relatively stable or increasing on average. Low disease mortality for the last fifteen years, coupled with good survival and multiple above-average spat sets, has led to increases in harvest in several areas. The reported harvest from the 2022-2023 oyster season³⁸ was the highest in 35 years (Figure 4-29).

³⁸ An oyster season typically runs from October to the following March. The 2022-2023 oyster season is defined as October 1, 2022 to March 30, 2023.

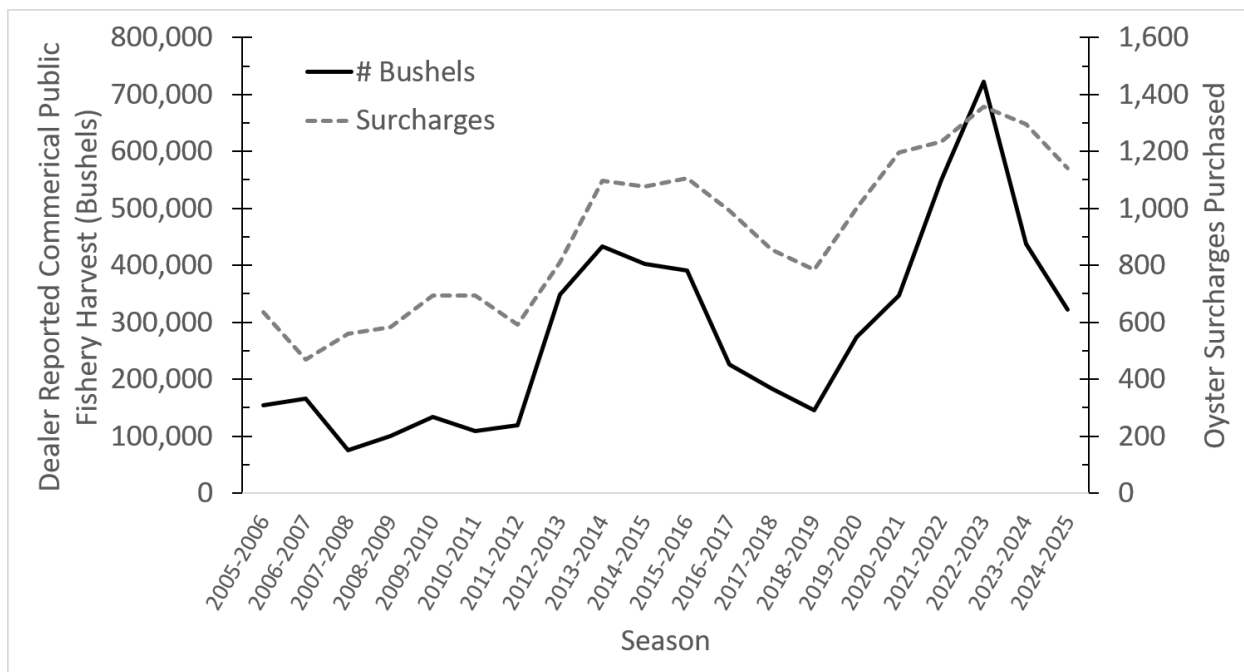


Figure 4-29. Commercial public fishery oyster landings in Maryland from the 2005-2006 season to the 2024-2025 season as reported on seafood dealer buy tickets. Note that the method of surcharge counting changed from the number of licenses utilizing a surcharge (including transfers) to the number purchased (not including transfers) in 2021.

The dominant harvest areas have been consistent over time. Broad Creek (537), Tangier Sound North (292), and Tangier Sound South (192) most consistently rank in the top five harvest areas (Figure 4-30).

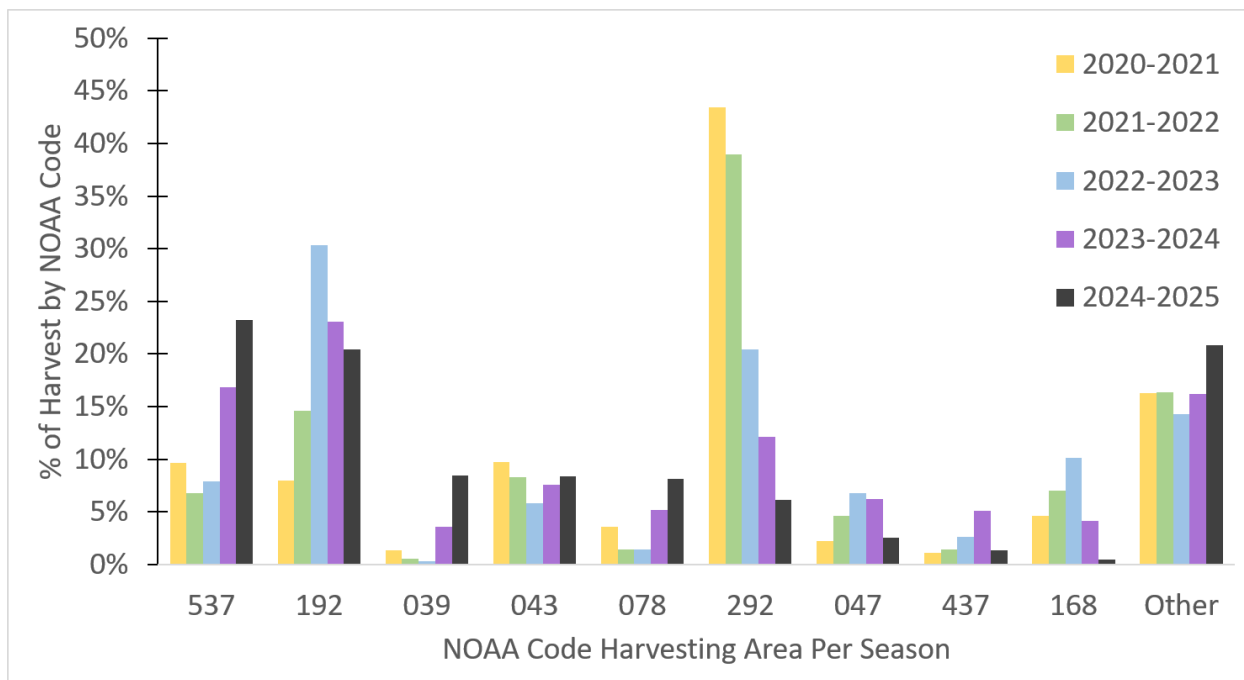


Figure 4-30. Percent of commercial public fishery oyster harvest by NOAA Code in Maryland's portion of Chesapeake Bay (non-sanctuary bars within the NOAA Codes) from the 2020-2021 season to the 2024-2025 season as reported on seafood dealer buy tickets. Categories on x-axis correspond to NOAA Code areas (537- Broad Creek; 192 - lower Tangier Sound; 039 - Eastern Bay; 043 - Fishing Bay; 078 - St. Mary's River; 292 - upper Tangier Sound; 047 - Honga River; 437 - Harris Creek; 168 - lower Patuxent River).

Section 4.2.1: Public Shellfish Fishery Area Objective #1 *Achieve a sustainable public oyster fishery.*

Public Shellfish Fishery Area Objective #1 Status: *This objective is ongoing. Short-term sustainability of the oyster fishery in many areas is highly certain given current increasing oyster density and biomass, low mortality, and above-average recruitment. Current harvest limits were maintained over this timeframe along with continued annual monitoring and regular stock assessments. This provides the best chance of medium- to long-term sustainability in many areas provided continued good recruitment and low natural mortality.*

Due to multi-year increases in the biomass index and estimated oyster density, low mortality, above-average recruitment in many areas, and lower harvest rates in some areas, chances of a sustainable oyster fishery have dramatically improved in recent years.

In the 2024 Oyster Benchmark Stock Assessment,³⁹ the goal was to estimate a long-term target density (number per square meter) of adult oysters that was common across

³⁹ https://dnr.maryland.gov/fisheries/pages/oysters/oyster_stock_assess.aspx

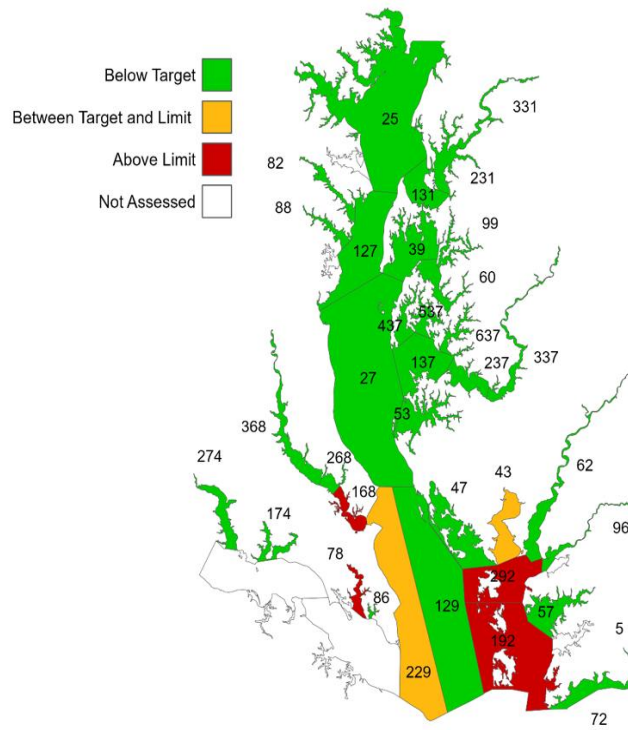
all NOAA codes to represent a desired level of the oyster population. The target biological reference point for oyster density was based on the densities achieved on restored oyster bars in Maryland that was conducted six years after initial restoration. The oyster density threshold reference point is based on minimum success criteria from the large-scale oyster restoration goal of 4.5 adult oysters per square meter (15 oysters per square meter over 30% of an oyster bar). The cautionary level is set at twice the threshold (9.0 adult oysters per square meter) so that management can be alerted to low density before it crosses the threshold.

A limit harvest rate reference point was developed based on the rate that was expected to achieve no net loss of oyster shell habitat over time when there is the removal of oysters for harvest. Because oysters create their own habitat for recruitment, maintaining habitat is essential for population persistence. The harvest rate that achieved no net habitat loss was determined by conducting a linear regression of year-over-year changes in cultch per square meter from the Fall Oyster Survey against estimated harvest rate from the assessment model. The target reference point was selected as 75% of the limit based on standard practice from the literature. This resulted in the harvest rate limit being 12.6% per year and the harvest rate target being 9.4%. A harvest rate higher than 12.6% in a NOAA Code would be considered overfishing.

Although the number of NOAA Codes that experienced overfishing decreased between assessments, some areas continue to exceed the harvest rate limit identified in the 2024 Oyster Benchmark Stock Assessment (Tangier Sound, St. Marys River, and the lower Patuxent River) and should continue to be monitored closely (also see Objective 2) (Figure 4-31A).

NOAA code areas in the Chesapeake Bay mainstem, the Chester River, and St. Clements and Breton Bay remain below the oyster density threshold identified in the 2024 Oyster Benchmark Stock Assessment. These areas have been known for long-term low oyster density, but low harvest rates indicate that overfishing is not occurring. Inadequate substrate, broodstock, and low salinity environmental conditions are likely the primary factors limiting the recovery of oysters in these areas (Figure 4-31B).

A.



B.

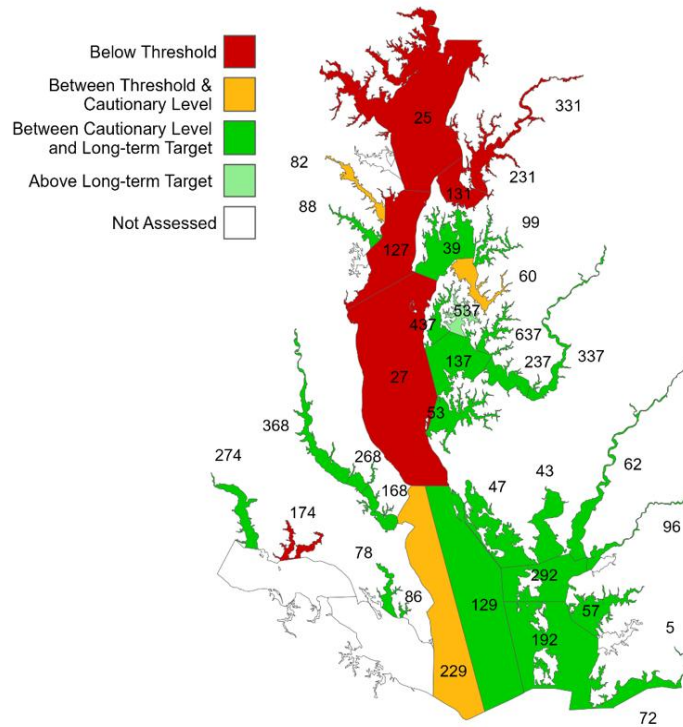


Figure 4-31. Oyster stock status in each NOAA code relative to the (A) harvest rate and

(B) oyster density reference points from the 2024 Oyster Benchmark Stock Assessment. Stock status was determined using data from both sanctuaries and non-sanctuaries.

Section 4.2.2: Public Shellfish Fishery Area Objective #2

Manage the oyster fishery according to science-based biological reference points through harvest rates that are based on oyster stock assessments.

Public Shellfish Fishery Area Objective #2 Status: *This objective is being met. A Maryland oyster stock assessment has been developed that includes harvest rates and oyster densities relative to biological reference points. Annual oyster population monitoring is ongoing. An update assessment is run at least every two years.*

The Sustainable Oyster Population and Fishery Act of 2016 (Statute §4–215) requires DNR, in consultation with University of Maryland Center for Environmental Science (UMCES), to conduct benchmark stock assessments for the Maryland oyster population every six years and update assessments every two years. The first stock assessment was completed in December 2018⁴ and developed a stage-structured oyster population model and biological reference points based on the biological characteristics of the population and other appropriate factors affecting the population. An independent peer review panel concluded that the results from the assessment could serve as an adequate basis for management decisions. Stock assessment updates were completed in 2020, 2021, and 2023 using the same model as in 2018. A new benchmark was completed in 2024⁴⁰. The update assessments used the same oyster population model and biological reference points as the 2018 stock assessment, with two more years of data included. The 2024 model, in contrast, being a benchmark, gave the opportunity to re-evaluate all of the data sources, calculations and gave the assessment team the ability to use a new and improved modeling approach.

Stock Status Evaluation

The 2024 assessment evaluated the population (stock) status by calculating annual estimates of harvest fraction which can be compared to the harvest rate reference points for each NOAA Code. Each NOAA Code's adjusted harvest rate, which accounts for shell and seed plantings, was compared to the harvest rate reference points. The average density and oyster density of the last 3 years were compared to the oyster density reference points. Estimates of stock status generated by the previous

⁴⁰ https://dnr.maryland.gov/fisheries/Pages/oysters/Oyster_Stock_Assess.aspx

assessment model were compared to the new model estimates. Detailed stock assessment results can be found in the 2024 benchmark assessment report.⁴¹

The 2024 Oyster Benchmark Stock Assessment developed a stage-structured population model that estimates the status of the stock relative to biological reference points (oyster density and harvest rate). Time series of oyster density, harvest fraction (harvest rate), and natural mortality rates were developed as a result of the assessment. The modeled processes included recruitment (natural spat set and plantings), growth from small to market sizes, the effect of fishing on small and market oysters, changes to habitat over time, and the disarticulation of small and market boxes.

Assessment model results included the number of spat (<1 year old), small (>1 year old, < 3 inches, <76 mm), and market-sized oysters (≥3 inches, ≥76 mm), natural mortality rates (fraction that die due to causes other than harvest), harvest rates, and several diagnostics including comparisons with observed data and comparisons with results from the previous assessment model.

Both benchmark stock assessments and assessment updates examine oyster populations by NOAA Code including sanctuary and non-sanctuary areas. Therefore, the oyster density estimates and reference points pertain to the entire oyster population in Maryland waters of Chesapeake Bay. The harvest rates are estimated based on the number of oysters removed through harvest relative to the total oyster population within the entire NOAA Code (both sanctuary areas if present and non-sanctuary areas).

For the 2024 Oyster Benchmark Stock Assessment, the status of oysters in the Maryland portion of Chesapeake was evaluated using a similar spatial scale (39 NOAA Codes in 2024 versus 36 in 2018 assessment) but a modified timeframe (2005-06 to 2023-24 harvest season data and 2005 to 2023 Fall Oyster Survey data). The timeframe was changed to align with the start of the Fall Oyster Survey recording tow distance and ended with the most recently completed fishing year prior to the assessment. This time period also captured a period of post-epizootic disease mortality. Model data for both assessments included the annual Fall Oyster Survey (number of oysters per area swept), harvest data from seafood dealer buy tickets (number of bushels reported harvested by NOAA Code before/after annual Fall Oyster Survey), planting data (number of spat-on-shell, wild seed), and habitat area (acreage of shell habitats from 1970-80's Bay Bottom Survey).

Harvest Rate Reference Points

The 2024 Oyster Benchmark Stock Assessment developed a limit harvest rate reference point based on the harvest rate that was expected to achieve no net loss of

⁴¹ https://dnrweb.dnr.state.md.us/archive/fisheries/2024MDOysterAssessment_DraftforPeerReview.pdf

oyster shell habitat over time. The target reference point was selected as 75% of the limit. This resulted in the harvest rate limit being 12.6% per year and the harvest rate target being 9.4%. A harvest rate higher than 12.6% in a NOAA Code would be considered overfishing.

Of the 39 NOAA Codes in the 2024 assessment, 29 had harvest rates at or below the target reference point indicating these areas were not experiencing overfishing (Table 4-3., Figure 4-31A).

Two of the 39 NOAA Codes in the 2024 assessment had harvest rates between the target and limit reference point: 229, 043 (Chesapeake Bay mainstem south west, Fishing Bay; Table 4-3., Figure 4-31A). While these areas are not currently classified as having overfishing occurring, continued monitoring and assessments are critical.

Four of the 39 NOAA Codes in the 2024 assessment had harvest rates above the limit reference point indicating overfishing was occurring: 168, 078, 192, 292 (lower Patuxent River, St. Mary's River, lower Tangier Sound, upper Tangier Sound; Table 4-3., Figure 4-31A). These areas are currently classified as having overfishing occurring.

Overfishing consistently over multiple years could cause the abundance of oysters to decline and affect sustainability of the fishery.

Most NOAA Codes had similar results examining harvest using the 2024 model compared to the 2018 model despite different methodologies. The 2018 assessment results showed 19 NOAA Codes experiencing overfishing when it was first run in 2018. Currently, there are four NOAA Codes experiencing overfishing indicating improvement towards a more sustainable fishery.

Oyster Density Reference Points

The 2024 Oyster Benchmark Stock Assessment developed long-term target and threshold density reference points (number per square meter) for adult oysters that were common across all NOAA codes to represent a desired oyster population. This was based on density estimates from sanctuaries in Maryland that are known to be achievable from the current population. The oyster density threshold was set at 4.5 oysters per square meter with a cautionary oyster density level of 9 oysters per square meter (twice the density of the oyster density threshold). The long-term oyster density target was set at 94 oysters per square meter (half the mean density observed over 6 years on large-scale restoration reefs sampled by divers). Oyster density targets are long-term and may take decades to be realized in some areas, although one NOAA Code (537) in Broad Creek (Choptank region) already exceeded the density target by two-fold according to the 2024 benchmark assessment (Table 4-2).

Of the 39 NOAA Codes evaluated in the 2024 assessment, 23 had oyster densities between the cautionary level and long-term target and one NOAA Code (Broad Creek)

was above the long-term target (Table 4-2., Figure 4-31B). These areas are currently doing well in terms of oyster density.

Three of the 39 NOAA Codes in the 2024 assessment had oyster densities between the threshold and cautionary level oyster density reference points: 060, 082, 229 (Miles River, Severn River, Chesapeake Bay south west mainstem; Table 4-2., Figure 4-31B). While these areas were not below the oyster density threshold, neither are they near the target and continued monitoring and assessments are critical to monitor these populations.

Seven of the 39 NOAA Codes in the 2024 assessment had oyster densities below the threshold oyster density reference point: 025, 027, 127, 131, 174, 231, 331 (upper and middle Chesapeake Bay mainstem, lower Chester River, St. Clements and Breton Bays, middle Chester River, upper Chester River; Table 4-2., Figure 4-31B). These areas have little to none reported harvest so the cause of the low density is most likely due to low salinity impacts on self-sustainability through little to no recruitment (upper bay and Chester River) and decreased habitat (St. Clements and Breton Bays). The results of the assessment indicate that these NOAA Codes are depleted.

Stock status results for most NOAA Codes using the 2024 model were similar to the 2018 model results (e.g. oyster densities above the threshold reference point). Five NOAA Codes had oyster densities below the threshold in the 2023 update (using the 2018 model) compared to seven below the threshold in the 2024 model results. Five of the seven NOAA codes with oyster densities below the threshold reference point were the same in both models with the 2024 model results indicating NOAA Code 025 (Upper Bay above the Bay Bridge) and NOAA Code 027 (Chesapeake Bay mainstem) below the oyster density threshold. However, when the model was first run in 2018 using data through 2017, there were only four NOAA Codes below the oyster density threshold (127, 131, 231, 331; Chesapeake Bay mainstem, lower Chester River, middle Chester River, upper Chester River).

Table 4-2. Mean oyster density (per square meter) in each NOAA Code for the last three years relative to the oyster density reference points. Values shaded green are above the cautionary level reference point; values shaded yellow are between the threshold and cautionary level reference points; and values shaded red are below the threshold reference point.

NOAA Code	Threshold	Cautionary Level	Target	Oyster Density
25	4.5	9.0	94.2	2.3
27	4.5	9.0	94.2	1.0
39	4.5	9.0	94.2	9.1
43	4.5	9.0	94.2	38.7
47	4.5	9.0	94.2	30.3
53	4.5	9.0	94.2	66.9
57	4.5	9.0	94.2	58.8
60	4.5	9.0	94.2	7.3
62	4.5	9.0	94.2	67.0
72	4.5	9.0	94.2	16.4
78	4.5	9.0	94.2	46.1
82	4.5	9.0	94.2	7.8
86	4.5	9.0	94.2	32.1
88	4.5	9.0	94.2	18.3
96	4.5	9.0	94.2	34.4
99	4.5	9.0	94.2	12.2
127	4.5	9.0	94.2	3.8
129	4.5	9.0	94.2	25.5
131	4.5	9.0	94.2	1.2
137	4.5	9.0	94.2	15.0
168	4.5	9.0	94.2	28.8
174	4.5	9.0	94.2	0.4
192	4.5	9.0	94.2	22.7
229	4.5	9.0	94.2	5.3
231	4.5	9.0	94.2	2.4
237	4.5	9.0	94.2	26.8
268	4.5	9.0	94.2	44.1
274	4.5	9.0	94.2	26.1
292	4.5	9.0	94.2	24.6
331	4.5	9.0	94.2	0.7
337	4.5	9.0	94.2	19.2
368	4.5	9.0	94.2	22.7
437	4.5	9.0	94.2	64.6
537	4.5	9.0	94.2	205.2
637	4.5	9.0	94.2	62.4

Table 4-3. Mean adjusted harvest rates in each NOAA Code for the last three years relative to the harvest rate biological reference points. Harvest rates are presented as

proportions of the population harvested. Values shaded green are at or below the target reference point; values shaded yellow are between the target and limit reference points; and values shaded red are above the limit reference point.

NOAA Code	Limit	Target	Harvest Rate
25	0.13	0.09	0.00
27	0.13	0.09	0.00
39	0.13	0.09	0.00
43	0.13	0.09	0.12
47	0.13	0.09	0.09
53	0.13	0.09	0.00
57	0.13	0.09	0.00
60	0.13	0.09	0.00
62	0.13	0.09	0.02
72	0.13	0.09	0.04
78	0.13	0.09	0.19
82	0.13	0.09	0.00
86	0.13	0.09	0.04
88	0.13	0.09	0.00
96	0.13	0.09	0.02
99	0.13	0.09	0.00
127	0.13	0.09	0.00
129	0.13	0.09	0.01
131	0.13	0.09	0.00
137	0.13	0.09	0.02
168	0.13	0.09	0.20
174	0.13	0.09	0.00
192	0.13	0.09	0.16
229	0.13	0.09	0.11
231	0.13	0.09	0.00
237	0.13	0.09	0.00
268	0.13	0.09	0.00
274	0.13	0.09	0.00
292	0.13	0.09	0.25
331	0.13	0.09	0.00
337	0.13	0.09	0.00
368	0.13	0.09	0.00
437	0.13	0.09	0.00
537	0.13	0.09	0.08
637	0.13	0.09	0.00

Section 4.2.3: Public Shellfish Fishery Area Objective #3

Manage the oyster fishery using a combination of input (effort) and output (harvest) controls, habitat modification, and stock enhancement to meet targets and avoid thresholds.

Public Shellfish Fishery Area Objective #3 Status: *This objective is ongoing. Annual stock enhancement through the addition of oyster shell, seed, and spat-on-shell to public fishery areas is ongoing with available funding. Daily harvest limits, reduced in 2019, are being maintained. The Chester River and Upper Bay have been closed to oystering in most years (except planted areas) due to continued low oyster density.*

The Department manages the fishery using various input and output controls. Daily harvest limits by gear type have been maintained since the harvest reductions taken in 2019, and from October 2019 to October 2021, days of harvest were decreased to four days a week instead of five. Some areas that have oyster densities below the threshold reference point (Chester River and Upper Bay) have been closed to harvest in most years (except planted areas). These actions were undertaken to address the level of overfishing and low oyster abundance in the original 2018 Oyster Benchmark Stock Assessment and update assessments thereafter. Input and output controls continued to be reviewed annually in conjunction with results of the 2024 Oyster Benchmark Stock Assessment.

Annual stock enhancement with the addition of oyster shell, seed, and hatchery-reared spat-on-shell to public fishery areas is ongoing in almost all NOAA Codes. Seed, shell, and spat-on-shell replenishment plantings for all NOAA Codes outside the sanctuaries completed between 2021 and 2025 are shown in Table 4-4. Generally, shell plantings occur in the medium to higher salinity areas where natural recruitment occurs regularly. Oyster seed and spat-on-shell plantings usually occur in the lower salinity areas where there is decreased natural recruitment potential.

Because of the natural variability in environmental conditions and relative small scale of the plantings, it is difficult to determine correlations between plantings, oyster populations and harvest. However, often areas receiving substrate plantings like shell do have higher natural recruitment rates. Similarly, in low salinity areas, harvest occurs primarily on the areas that have been previously planted with oyster seed and spat-on-shell.

Public fishery replenishment plantings are funded from revenue from commercial oyster surcharges, revenue from oyster bushel and export tax, and grant funding from the

Maryland Department of Transportation. In 2023, the bushel tax was raised from \$1 to \$2 and the export tax from \$0.30 to \$1.00. As of 2024, a \$10 recreational oyster license is required prior to recreational harvesting and this additional funding is used for replenishment plantings. This increased funding was highly supported by the public fishery to offset increased planting costs and maintain or increase planting amounts.

In addition, some County Oyster Committees have requested additional harvest controls in specific areas, particularly specific area openings and closings, and rotational harvest projects. Somerset County Oyster Committee often requests the Department to close individual oyster bars to harvest for part of each season due to concerns about local overharvesting, especially at certain points in the season. Queen Anne's, Kent and Anne Arundel County Oyster Committees often request the Department to close specific oyster seed and spat-on-shell planted sites to harvest until the majority oysters are of market size. When these sites are requested to be opened, sometimes the counties request lower bushel harvest limits and/or limited time frame or days of week it is opened. The Charles County Oyster Committee has requested the Department conduct a rotational harvest project within the oyster bars in the Charles County portion of Wicomico River. The program consists of planting multiple sites with spat-on-shell or oyster seed and rotationally opening/closing the sites when the oysters are of market size as a long-term project to enhance the oyster population and harvest in the river.

Table 4-4 Plantings in NOAA Codes outside of sanctuaries from 2021 through 2025. Shell plantings include both fresh Eastern oyster shell as well as Pacific oyster shell.

Planting Type	Acres Planted	Volume (Millions of Spat-on-Shell)	Volume (Bushels)
Alternate Materials (Crushed Concrete)	10.8	NA	15,232
Shell Plantings	510	NA	848,388
Hatchery Spat-on-Shell Plantings	556	1,772	NA
Wild Seed Plantings	64	NA	50,686
Grand Totals	1,140.8	1,772	914,306

Section 4.3: Aquaculture Areas

As of the end of 2025, there were a total of 471 oyster leases on 7,622 acres in Maryland. Since the program's implementation in 2010, the Department has received a total of 649 applications (Table 4-5), averaging roughly 38 applications per year. Through January 2026, this has resulted in 390 new commercial shellfish leases executed by the State, totaling approximately 7,622 acres, with an additional 23 applications processed as lease amendments or consolidations (Table 4-6). Application processing times initially averaged one to two years between 2010 and 2018, but surged to over three years due to COVID-19 disruptions across state and federal agencies. However, following key process improvements, including the integration of automated GIS screening tools, the deployment of temporary staff to clear backlogs, parallel reviews by the Aquaculture Review Board, and electronic document execution, the typical turnaround time for an unprotested lease application has been reduced to approximately one year.

The majority of the current oyster leases are concentrated within St. Marys, Dorchester, Talbot, and Wicomico counties. Throughout the State, submerged land leases (also called bottom leases) remain the dominant format, accounting for 82% of all leases and 92% of the total leased acreage. These bottom leases are utilized for traditional spat-on-shell culture, relying heavily on hatchery-produced larvae set onto oyster or clam shells, though natural spat sets also contribute in regions where growers maintain appropriate bottom cultch. In contrast, water column leases account for 18% of all leases and 8% of the leased acreage. Water column operations employ intensive surface and suspended gear, such as floats and cages, to cultivate single oysters targeted specifically for sale at restaurants and raw bars. The juvenile seed for water column systems is sourced from permitted in-state and out-of-state nurseries. There is no statutory minimum or maximum lease size, resulting in a wide variation of configurations. Water column leases tend to be smaller, averaging 5.67 acres (ranging from 0.12 to 39.6 acres), whereas submerged land leases are substantially larger, averaging 19.13 acres (ranging from 0.08 to 310.7 acres).

As of 2025, 149 leases encompassing 3,198 acres are located directly within designated oyster sanctuary areas (Table 4-7). Leasing is prohibited on historic oyster bars within these sanctuary areas. This represents 32% of all state shellfish leases and 42% of the cumulative leased acreage yet occupies only 1% of the overall sanctuary surface area.

Table 4-5. Number of new oyster leases issued in Maryland from 2010 through 2025.

Year	All Lease Applications Submitted	New Submerged Land Leases Executed	New Water Column Leases Executed	Applications Processed as Lease Amendments	All New Leases Issued
2010	47	0	0	0	0
2011	67	10	14	0	24
2012	71	8	19	0	27
2013	27	28	12	0	40
2014	64	7	15	0	22
2015	62	13	43	0	56
2016	53	28	10	1	38
2017	74	18	13	2	31
2018	51	21	13	2	34
2019	43	21	18	3	39
2020	16	13	3	5	16
2021	14	0	2	0	2
2022	17	17	1	0	18
2023	16	11	3	0	14
2024	14	14	1	5	15
2025	13	14	0	5	14
Total	649	223	167	23	390

Table 4-6. Number of oyster leases and acreage in each Maryland county as of December 2025.

County	No. Bottom Leases	No. Water Column Leases	Total Leases	Bottom Leases (acres)	Water Column Leases (acres)	Total Acres
Anne Arundel	19	2	21	257.9	7.5	265.4
Calvert	10	6	16	143.6	34.5	178.1

County	No. Bottom Leases	No. Water Column Leases	Total Leases	Bottom Leases (acres)	Water Column Leases (acres)	Total Acres
Charles	5	1	6	79.5	7.9	87.4
Dorchester	96	22	118	2,695.4	209.85	2,905.3
Kent	1	1	2	44.8	4.9	49.7
Queen Anne's	2	3	5	20.4	13.2	33.6
St. Marys	94	28	122	882.91	133.21	1,016.12
Somerset	36	1	37	1,039	5.3	1,044.3
Talbot	71	10	81	752.49	37.2	789.69
Wicomico	48	0	48	1,161.9	0	1,161.9
Worcester	2	13	15	6.1	84.8	90.9
Total	384	87	471	7,084	538.36	7,622.36

Table 4-7. Number of aquaculture leases and acreage located in Maryland oyster sanctuaries from 2010 through 2025.

Year	Number of Leases	Leased Acreage
2010	118	1,409
2011	100	1,213
2012	71	868
2013	62	797
2014	67	836
2015	70	1,016
2016	90	2,271
2017	103	2,595
2018	110	2,654
2019	120	2,737

Year	Number of Leases	Leased Acreage
2020	127	2,851
2021	127	2,895
2022	126	2,863
2023	134	2,969
2024	144	3,014
2025	141	3,198

Section 4.3.1: Aquaculture Objective #1

Support policies and partnerships that increase private investment in oyster aquaculture.

Aquaculture Objective #1 Status: *This objective is ongoing. Maryland Agricultural and Resource-Based Industry Development Corporation (MARBIDCO) administrates a shellfish aquaculture loan program allowing leaseholders to purchase capital equipment, shell, and seed. Aquaculture training and education programs were developed in partnership with extension services through the University of Maryland and Maryland Sea Grant. The permitting process for oyster aquaculture continues to be evaluated and improved in collaboration with state, federal, and industry partners through the Aquaculture Coordinating Council and Aquaculture Review Board.*

Aquaculture loan and grant programs available to growers through the Maryland Agricultural and Resource-Based Industry Development Corporation have played an important role in the continued growth and support of the oyster industry in the Chesapeake Bay. DNR has also helped facilitate purchase of aquaculture oysters used in restoration projects through The Nature Conservancy's Supporting Oyster Oyster Aquaculture and Restoration (SOAR) Program.

Since the creation of the Maryland Shellfish Aquaculture Financing Fund in 2011, MARBIDCO has approved 88 loans to 52 borrowers totaling \$5,606,571 for projects located in 10 tidewater counties. Projects include 31 submerged land leases, 48 water column (cage or float) leases, and nine bottom and water column projects. Seventy-four (74) loans were made to commercial watermen (Tidal Fish License holders) and 85 loans are fully drawn. Borrowers in good standing have an opportunity for forgiveness of 40% (up to a maximum of \$100,000) or 25% (\$100,000 to \$300,000) of the loan principal balance amount.

In 2012, a special finance program was established for commercial watermen to develop remote setting systems for the production of seed oysters. MARBIDCO has approved and funded six loans in this program totaling \$179,984. Growers who have taken advantage of this program have not only used the systems to produce seed oysters for their leased grounds but have sold spat-on-shell to the State for placement on public harvest grounds to keep that important part of the oyster industry viable.

The U.S. Department of Agriculture Natural Resources Conservation Service's Environmental Quality Incentives Program (EQIP) provides financial and technical assistance to agricultural producers to address natural resource concerns and deliver environmental benefits such as improved water and air quality, conserved ground and surface water, increased soil health, reduced soil erosion and sedimentation, improved or new wildlife habitat, and mitigation against drought and increasing weather volatility. In Maryland, this program, in collaboration with DNR, has been applied to shellfish farms providing financial and technical assistance to aquafarmers to implement structural and management practices to optimize the environmental benefits of aquaculture production.

The Maryland Department of Agriculture (MDA) operates the Seafood Marketing unit that creates demand for aquaculture oysters. Through their Maryland's Best marketing arm, and in collaboration with DNR and private industry partners, MDA has launched various aquaculture-specific campaigns including the annual Shuck & Stout campaign that celebrates local oysters and beer, and the Eat Like a Marylander campaign which highlights how to eat locally, encouraging consumers to eat more seasonal food from local growers thereby supporting local jobs and the economy. MDA also partners with the Oyster Recovery Partnership (ORP) for Chesapeake Oyster Week, a weeklong event that encourages consumers to show their appreciation to Bay-friendly businesses by dining at restaurants that participate in ORP's shell recycling program. These marketing efforts are supported by DNR collaborations with industry and the Aquaculture Coordinating Council.

The University of Maryland (UMD) Extension and Maryland Sea Grant have produced a series of digital aquaculture business planning tools and conducted numerous webinars on how to incorporate these tools into an operation. Specialists at UMD have also recently published a site selection tool to aid potential growers in determining the feasibility of a particular aquaculture lease location based on biological and economic data.

Section 4.3.2: Aquaculture Objective #2

Expand oyster aquaculture production in areas of suitable habitat.

Aquaculture Objective #2 Status: *This objective is ongoing. An online mapping tool, the Aquaculture Siting Tool, was created to help prospective commercial shellfish lease applicants locate and self-screen areas of interest.*

Driven by industry feedback through the Aquaculture Coordinating Council, several DNR processes were updated following policy, regulatory, and legislative changes. To accelerate the review and issuance of leases, the Department implemented process improvements that reduced average turnaround times for untested applications to approximately one year after previously surging to over three years due to COVID-19 related disruptions. Key strategies included executing electronic lease agreements, improving internal review coordination with tighter deadlines, and adding automated GIS screening layers. Additionally, parallel state and federal reviews for joint permits were enabled by reconvening the Maryland Aquaculture Review Board, and temporary staff were deployed to clear application backlogs.

Further improvements are being developed in other areas of aquaculture reporting and licensing to free up administrative resources for lease application processing. The Department is investigating electronic submission options for monthly harvest and annual reports. Legislative changes like the Chesapeake Bay Legacy Act of 2025 also helped clarify protest requirements and allowed the Department to send protests to mediation prior to lengthy litigation.

Section 5: Performance Metrics and Rankings

Section 5.1: Defining Productive Areas

Establishing performance metrics for individual areas facilitates a relative comparison across different locations. To evaluate performance, each sanctuary and non-sanctuary NOAA Code area was ranked according to its overall productivity, which is defined by a high density of oysters across multiple size classes, suitable habitat, and high survival rates. An additional assessment was conducted that evaluated individual sanctuaries (see below and Appendix A).

The relative oyster productivity of sanctuaries and non-sanctuary NOAA Code areas were examined based on data from the Department's annual Fall Oyster Survey (Fall Oyster Survey) from 2021 through 2025. This time period was chosen to update the classification from the previous report. Neither NOAA Code nor sanctuary boundaries have changed since the 2010 expansion of oyster sanctuaries.

The 176 PSFAs were grouped into 39 large non-sanctuary NOAA Code areas and evaluated for performance. Each NOAA Code area may contain multiple PSFAs and some PSFAs do not reside entirely within a single NOAA Code area. Sanctuaries and non-sanctuary NOAA Codes were evaluated and classified separately. NOAA Code samples were collected outside the current oyster sanctuaries. Some NOAA Codes have no samples taken outside of sanctuaries (Upper Chester River, Upper Choptank River, Lower West Chesapeake Bay, Magothy River, Severn River, and Wye River). NOAA Codes 094 (West and Rhode rivers), and 098 (Monie Bay) are not sampled by the annual Fall Oyster Survey. Sixteen sanctuaries either have no samples taken in them, or have fewer than four samples, and are not included in this study.

To evaluate the performance of sanctuaries and non-sanctuary NOAA Code areas, criteria were developed for five key metrics: 1) the density of spat, small, and market-sized oysters; 2) the amount of cultch (substrate); and 3) total observed mortality. Biomass was excluded because it is not calculated for each individual sanctuary or non-sanctuary NOAA Code area. Each area was subsequently assigned to a percentile from highest (>80th) to lowest ($\leq$ 20th), with remaining areas having insufficient data (fewer than four samples), based on an average of the scores for each category.

The same methodology was applied to both sanctuaries and non-sanctuary NOAA Code areas, utilizing annual Fall Oyster Survey data from 2021 through 2025. Counts of market oysters, small oysters, and spat were standardized to density (number per square meter). Cultch was defined as the quantity of material collected (in bushels) per 100 meters of tow distance. Estimated total mortality was calculated as the proportion of dead oysters relative to the combined total of live and dead oysters within the sample. Full dredge samples and any samples with missing tow distances, total sample volumes, or dredge volumes were excluded from the analysis.

Converting the data to ranks was an attempt to mitigate the influence of extreme values, such as high spat sets or mortality in a given year or location. The raw metrics (density, mortality, and cultch) were converted into rankings across five separate categories (market density, small density, spat density, cultch, mortality) for each year. For oyster density and cultch, the highest numerical value was assigned a rank of 1, whereas for mortality, the lowest value (typically 0) received a rank of 1. Tied values were allocated the average of the corresponding ranks. These annual rankings were then averaged for each sanctuary or non-sanctuary NOAA Code area, producing a single mean ranking for each category at each location. Finally, category scores were derived using the following formula:

$$\text{Category Score} = ((\text{MaxRankCategory} - \text{MeanRankLocation}) / \text{MaxRankCategory}) * 100$$

The MaxRankCategory was the maximum rank for the entire category (market density, small density, etc). The MeanRankLocation was the mean rank for the non-sanctuary NOAA Code area or sanctuary in that category. The Total Score is the sum of the category Scores and is used in evaluating the relative contributions of each category to the overall score. The Rank Score is the mean of the category scores and is used to determine the overall percentile. Although the same scale is used for both sanctuaries and non-sanctuary NOAA Code areas, there is no direct comparison between the two different management types. Sanctuaries are ranked relative to other sanctuaries and non-sanctuary NOAA Code areas are ranked relative to other harvest areas. The classification was then assigned based on 20th, 50th and 80th percentiles of the Rank Score (Table 5-1), where a percentile is the percentage of scores at or below a certain value.

Table 5-1. Percentiles of the RankScore used in establishing classifications.

Percentile	
>80	Above the 80th percentile
>50-80	Above the 50th percentile and at or below the 80th
>20-50	Above the 20th percentile and at or below the 50th
≤20	20th percentile or below
Insufficient data	

Section 5.2: Relative Productivity Rankings

Non-sanctuary NOAA Code areas and sanctuaries were ranked based on oyster densities across size classes, cultch availability, and observed mortality (Figures 5-2, 5-3, 5-4, and 5-5). Because sanctuaries and non-sanctuary NOAA Code areas operate under fundamentally different management goals (permanent ecological protection versus active commercial harvesting), direct comparisons between them are inappropriate. Furthermore, these classifications do not inherently indicate whether a sanctuary or non-sanctuary NOAA Code area is performing 'well' or 'poorly,' as they are ranked only in comparison to one another, within each management type, during this limited time period. Some areas may naturally maintain low oyster densities with high survival rates, potentially causing them to be ranked lower than areas with consistently high densities that also experience higher mortality.

This analysis is based on a relatively short five-year time frame, which may not be sufficient to support meaningful long-term conclusions. The data may be influenced by extreme values or unusual events, such as the large spat set of 2025 or a high mortality event, particularly when averages are used. Because of the short time frame, the findings may reflect short-term fluctuations rather than underlying trends. Additionally, the large variability in sample sizes between areas may also lead to inconsistent results. The chosen percentiles are arbitrary; they represent break points in the data, but are not significant in and of themselves.

Two non-sanctuary NOAA Code areas (Manokin and Nanticoke rivers) and seven sanctuaries (Cedar Point, Cox Creek, Eastern Bay, Lower Patuxent River, Magothy River, and Man O War Shoals) were added to the report for 2021 through 2025. Because of the differing time frames, as well as the addition of new areas, comparisons should not be made between the classifications in the previous report and the current one.

Section 5.2.1: Non-Sanctuary NOAA Code Areas

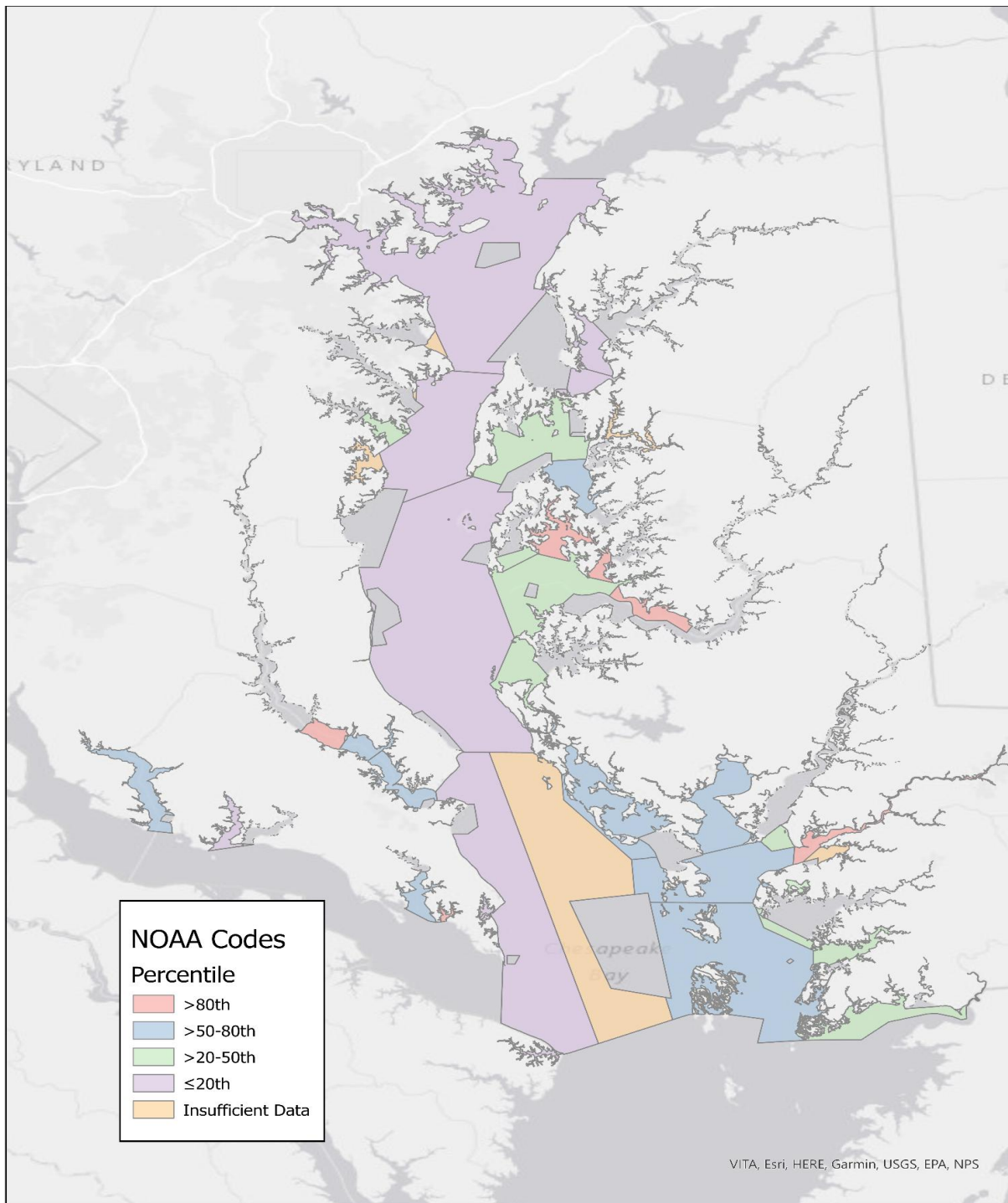


Figure 5-2. Map showing non-sanctuary NOAA Code areas, colored by percentile of their RankScores.

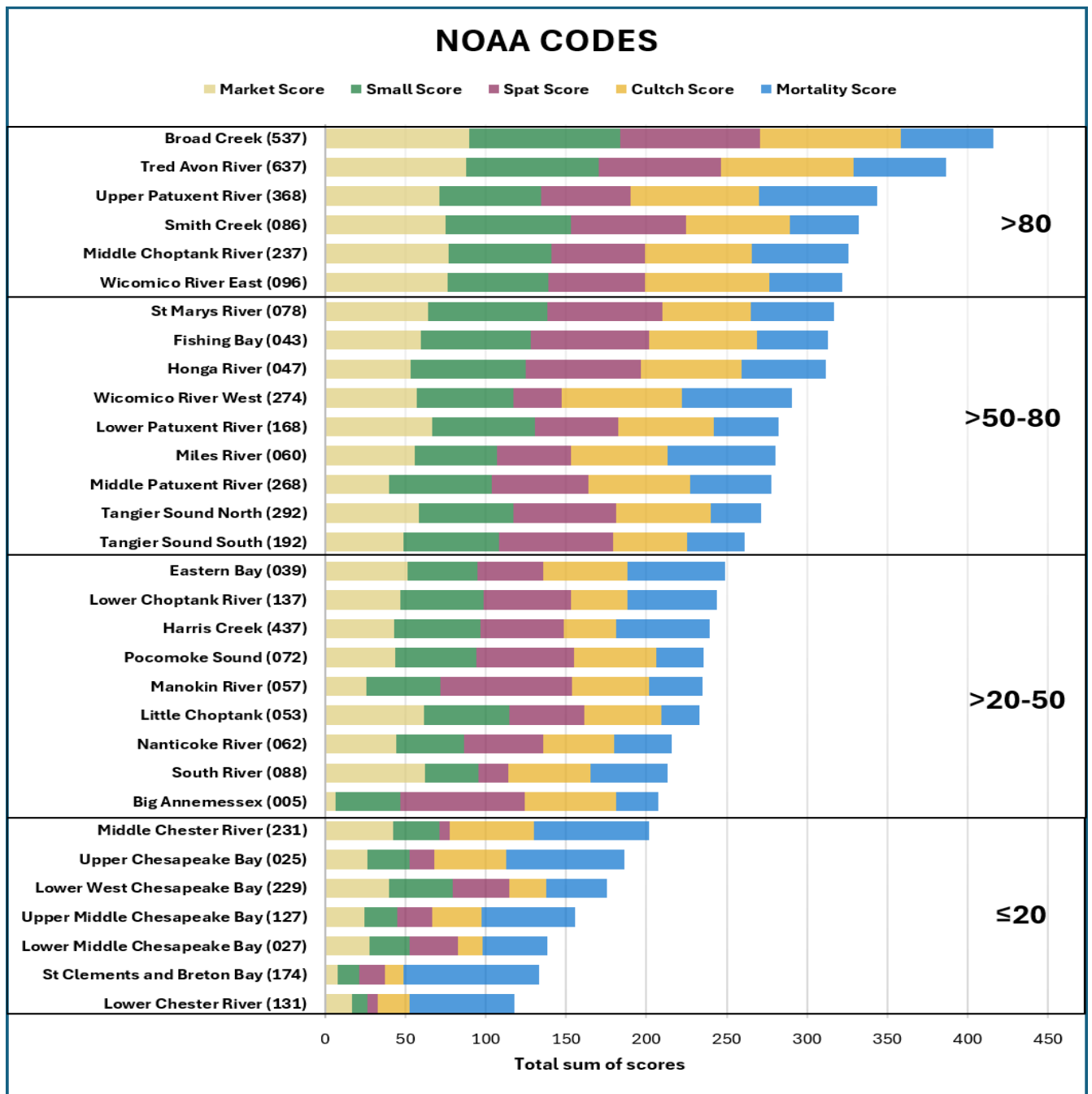


Figure 5-3. Total rank scores for all non-sanctuary NOAA code areas showing the contribution of each category to the total. Higher scores reflect greater densities for all oyster categories and greater accumulation for cultch. For mortality, a lower mortality rate is represented by a wider bar. The number on the right is the percentile, which is calculated from the average of the scores and represents the value below which that percentage of scores fall.

Section 5.2.1.1: Non-Sanctuary NOAA Code Areas (>80th Percentile)

Non-sanctuary NOAA Code areas that scored above the 80th percentile are characterized by exceptional productivity and favorable habitat. They consistently show high combined rankings for market-sized oysters, small oysters, and spat, alongside higher cultch availability and low mortality rates. Many of these locations have also benefited from strategic investments in harvest replenishment by the industry.

Figure 5-3 shows the category scores that contributed to the final ranking. For the areas above the 80th percentile, there were higher scores across all categories than for any of the other areas. These areas tended to be more consistently productive from year to year. Table 5-2 shows live oyster densities, observed mortality, and cultch for these areas, averaged over 2021 through 2025. Although total live density is not one of the metrics used in this method, it is indicative of the overall productivity of these areas. All of these areas had five-year average oyster densities at the sites sampled that exceed the long-term oyster density target reference point from the recent 2024 Oyster Benchmark Stock Assessment (94 oysters per square meter). There is considerable variability in the average density of these areas, but mortality is generally lower and average cultch is higher than it is for the other classifications. With the exception of Smith Creek and the Upper Patuxent areas, all these areas have had some hatchery-spat-on-shell or shell plantings. With the exception of Wicomico East and some of Broad creek, these areas are all hand tong harvest areas and all have estimated harvest rates below the limit.

Table 5-2. Non-sanctuary NOAA Code areas ranked above the 80th percentile relative to all other areas when assessing oyster density, natural mortality, and cultch using data from the annual Fall Oyster Survey from 2021 through 2025.

NOAA Code	Number of years sampled/number of samples	Average Number of Live Oysters per square meter	Average Observed Mortality (%)	Average Cultch (Bushels per 100 feet towed)
Broad Creek (537)	5/54	1,665 ± 245	6 ± 0.6	3 ± 0.3
Tred Avon (637)	5/21	682 ± 135	5.4 ± 0.9	2.4 ± 0.3
Upper Patuxent (368)	5/5	149 ± 34	3.2 ± 1.3	1.8 ± 0.4
Smith Creek (086)	5/10	302 ± 76	10 ± 2.4	1.1 ± 0.2
Middle Choptank (237)	5/32	213 ± 35.5	4.8 ± 0.7	1.3 ± 0.2
Wicomico East (096)	5/19	171 ± 21	10.4 ± 2.5	1.8 ± 0.3

Section 5.2.1.2: Non-Sanctuary NOAA Code Areas (>50-80th Percentile)

Non-sanctuary NOAA Code areas that had a combined ranking above the 50th percentile and at or below the 80th percentile had somewhat higher mortality rates from 2021 through 2025 than those areas above the 80th percentile, but also more variable densities of all categories of live oysters (Figure 5-3).

While many of these locations exhibit high oyster densities, especially spat, they are situated in regions where natural mortality often exceeds the average. For instance, the St. Marys River experienced one of the strongest spat sets in 2025, a trend reflected in the high average live oyster density shown in Table 5-3; however, certain bars within this river also recorded significantly elevated mortality rates during the 2021 through 2025 period. All of these areas had five-year average oyster densities at the sites sampled that exceed the long-term oyster density target reference point from the recent 2024 Oyster Benchmark Stock Assessment (94 oysters per square meter). Some of these areas, particularly St. Marys River (078), Lower Patuxent River (168) and the Tangier Sound (192 and 292) experience high harvest rates, likely reducing densities of market-sized oysters.

All these areas have had seed and shell plantings to enhance the public fishery.

Table 5-3. Non-sanctuary NOAA Code areas above the 50th percentile and at or below the 80th percentile, relative to all other areas when assessing oyster density, natural mortality, and cultch using data from the annual Fall Oyster Survey from 2021 through 2025.

NOAA Code	Number of years sampled/number of samples	Average Number of Live Oysters per square meter	Average Observed Mortality (%)	Average Cultch (Bushels per 100 feet towed)
St. Marys River (078)	5/41	654 ± 172	9 ± 1.4	1.5 ± 0.2
Fishing Bay (043)	5/36	284.5 ± 39	11 ± 1.5	1.3 ± 0.1
Honga River (047)	5/35	233 ± 24	8.6 ± 1.2	1 ± 0.1
Wicomico River West (274)	5/53	303 ± 42	3.7 ± 0.6	1.8 ± 0.2
Lower Patuxent River (168)	5/47	192.3 ± 17.2	11.4 ± 1.3	1.6 ± 0.2
Miles River (060)	5/32	213 ± 35.5	4.8 ± 0.7	1 ± 0.1
Middle Patuxent River (268)	5/5	178 ± 84	38 ± 19	1.8 ± 0.3
Tangier Sound North (292)	5/37	156 ± 28.2	14.5 ± 1.6	0.9 ± 0.1
Tangier Sound South (192)	5/79	204.2 ± 17.6	13 ± 1	0.7 ± 0.05

Section 5.2.1.3 Non-Sanctuary NOAA Code Areas (>20-50th Percentile)

Non-sanctuary NOAA Code areas that have a combined ranking for oyster densities (market-sized oysters, small-sized oysters, and spat), cultch, and mortality above the 20th percentile and at or below the 50th percentile generally exhibit lower oyster densities, less available cultch, and higher mortality rates, despite potentially having more moderate spat sets (Figure 5-3). All these areas had five-year average oyster densities at the sites sampled that exceed the long-term oyster density target reference point from the 2024 Oyster Benchmark Stock Assessment (94 oysters per square meter) (Table 5-4). With the exception of the Big Annemessex, these areas have had seed and shell plantings to enhance the fishery, which contributes to the higher densities.

Table 5-4. Non-sanctuary NOAA Code areas above the 20th percentile and at or below the 50th percentile, relative to all other areas when assessing oyster density, natural mortality, and cultch using data from the annual Fall Oyster Survey from 2021 through 2025.

NOAA Code	Number of years sampled/number of samples	Average Number of Live Oysters per square meter	Average Observed Mortality (%)	Average Cultch (Bushels per 100 feet towed)
Eastern Bay (039)	5/109	113.8 ± 12.5	7.1 ± 0.9	1.1 ± 0.1
Lower Choptank River (137)	5/33	186.4 ± 43	8.3 ± 1.5	0.6 ± 0.1
Harris Creek (437)	5/19	202 ± 67.4	10 ± 4.1	0.6 ± 0.1
Pocomoke Sound (072)	5/31	160.4 ± 31	15 ± 1.7	1 ± 0.1
Manokin River (057)	4/4	151 ± 64	18 ± 3	0.8 ± 0.2
Little Choptank River (053)	5/33	127 ± 15	19.5 ± 2.8	0.8 ± 0.1
Nanticoke River (062)	4/7	394 ± 224	6.7 ± 3.1	0.7 ± 0.1
South River (88)	5/38	117 ± 30.2	10 ± 1.5	0.9 ± 0.1
Big Annemessex (005)	5/5	177 ± 109	17.4 ± 5.6	0.9 ± 0.2

Section 5.2.1.4: Non-Sanctuary NOAA Code Areas (≤20th Percentile)

Non-sanctuary NOAA Code areas that have a combined ranking for oyster densities (market-sized oysters, small-sized oysters, and spat), cultch, and mortality at or below the 20th percentile are characterized by few market-sized oysters, little cultch, and extensive acreage with very limited suitable oyster habitat, despite low mortality rates and favorable survival (Figure 5-3) in these areas. None of these areas had a five-year average oyster density at the sites sampled that exceeded the long-term oyster density target reference point in the 2024 Oyster Benchmark Stock Assessment (94 oysters per square meter) (Table 5-5). These areas are primarily found in the Chesapeake Bay mainstem and the Upper Bay area, where low salinity hinders natural recruitment. The Upper Bay fishery, in particular, was formerly sustained through the Department's seed and shell program where oysters were continually planted annually. Regular seed and shell plantings occur in some of these areas.

Table 5-5. Non-sanctuary NOAA Code areas below the 20th percentile, relative to all other areas when assessing oyster density, natural mortality, and cultch using data from the annual Fall Oyster Survey from 2021 through 2025.

NOAA Code	Number of years sampled/number of samples	Average Number of Live Oysters per square meter	Average Observed Mortality (%)	Average Cultch (Bushels per 100 feet towed)
Middle Chester River (231)	5/36	55.3 ± 24.8	7.2 ± 2.9	0.8 ± 0.1
Upper Chesa. Bay (025)	5/71	40.2 ± 9.6	3.6 ± 0.9	0.8 ± 0.1
Lower West Chesa. Bay (229)	5/39	51 ± 8.3	11.4 ± 1.5	0.3 ± 0.04
Upper Middle Chesa. Bay (127)	5/49	30.2 ± 7.7	6.9 ± 1	0.5 ± 0.05
Lower Middle Chesa. Bay (027)	5/28	61.3 ± 25	11.9 ± 2.1	0.3 ± 0.05
St. Clements and Breton Bay (174)	5/6	62 ± 31	0.6 ± 0.6	0.2 ± 0.04
Lower Chester River (131)	5/5	2.7 ± 0.5	4.5 ± 1.5	0.2 ± 0.05

Section 5.2.1.5: Non-Sanctuary NOAA Code Areas with Insufficient Data

There are eight non-sanctuary NOAA Code areas that had fewer than four samples and were not included in the productivity rankings: Magothy River (055), Severn River (082), West and Rhode Rivers (094), Monie Bay (098), Wye River (099), Lower East Chesapeake Bay region (129), Choptank River Upper (337), and Chester River Upper region (331). Most have little acreage open to the public fishery and three lie entirely within a sanctuary (Wye River (099), Choptank River Upper (337), and Chester River Upper region (337)).

Section 5.2.2: Sanctuaries

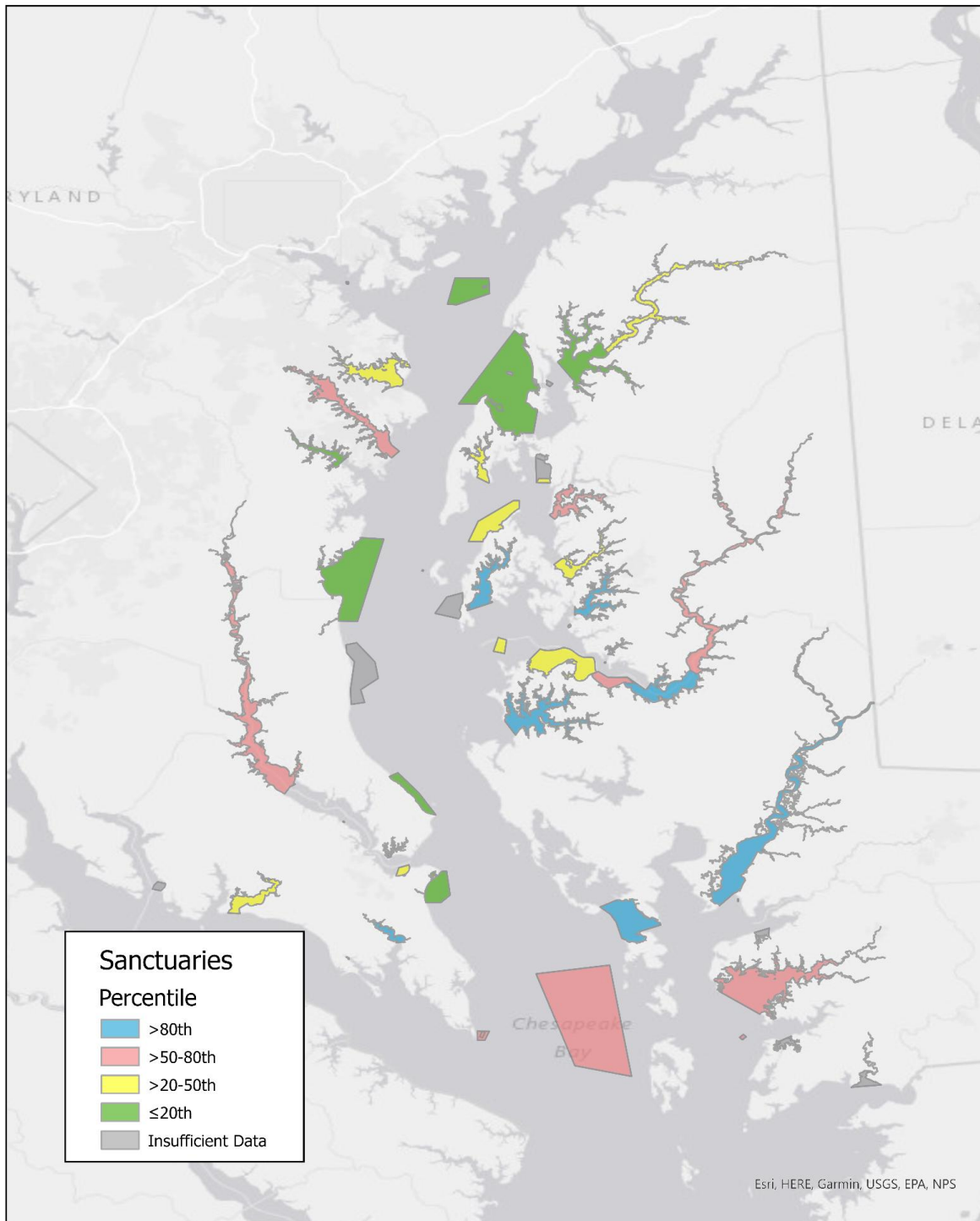


Figure 5-4. Map showing sanctuaries, colored by percentile level of their RankScores.

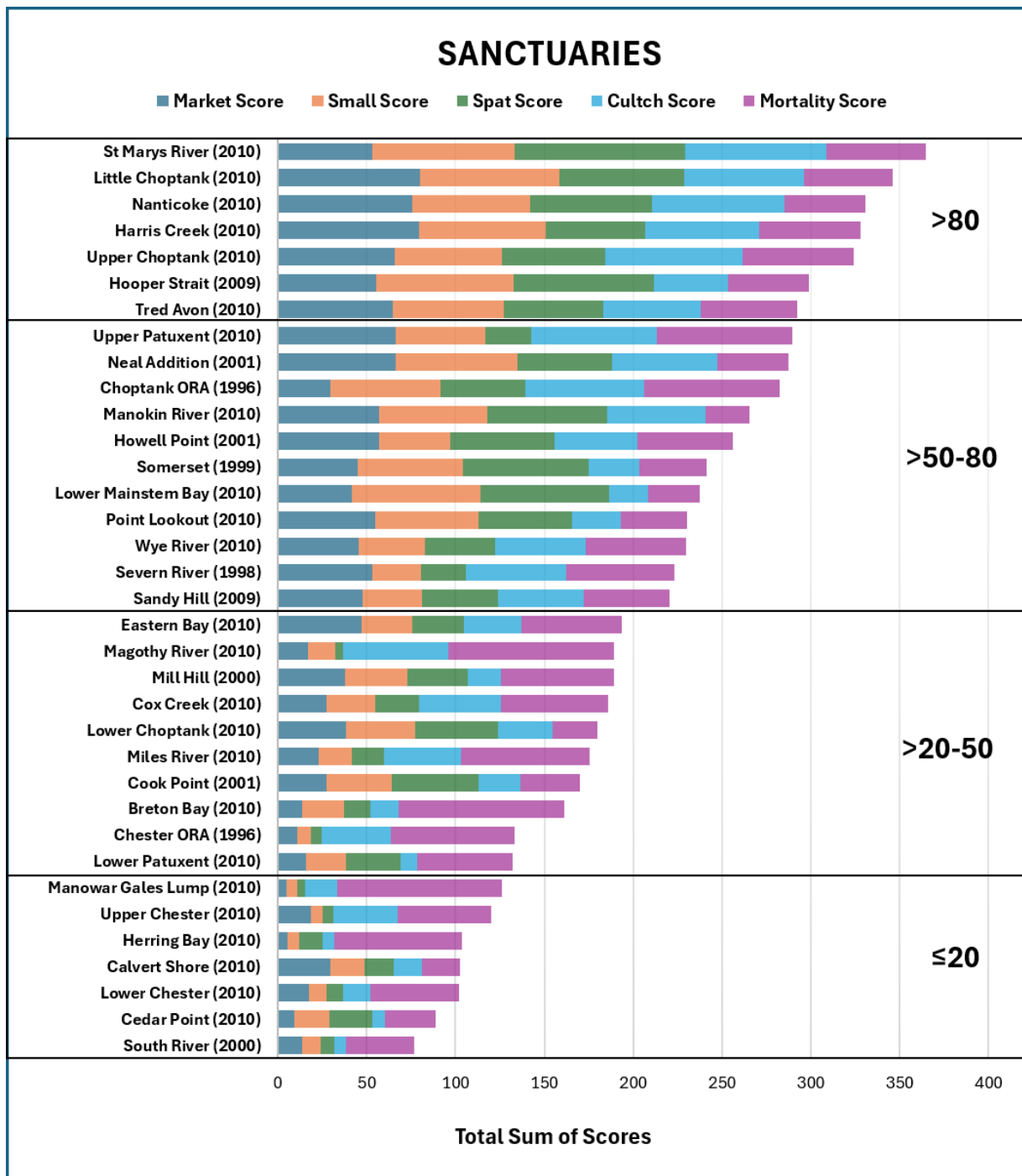


Figure 5-5. Total scores for all sanctuaries showing the contribution of each category to the total. Higher scores reflect greater densities for all oyster categories and greater accumulation for cultch. For mortality, a lower mortality rate is represented by a wider bar. The number on the right is the percentile, which is calculated from the average of the scores and represents the value below which that percentage of scores fall.

Section 5.2.2.1: Sanctuaries (>80th Percentile)

Oyster sanctuaries that scored above the 80th percentile are characterized by exceptional productivity and favorable habitat. They consistently show high combined rankings for market-sized oysters, small oysters, and spat, alongside higher cultch availability and low mortality rates (Figure 5-4, Figure 5-5). Many of these areas have received investment towards production in the form of hatchery seed plantings, shell plantings, or substrate addition. Some have undergone large-scale restoration efforts and others are planned for the future.

These sanctuaries, when compared to all the other sanctuaries, have high oyster densities with the five-year average ranging between 291 to 1,004 oysters per square meter at the sites sampled, which is well above the long-term oyster density target reference point (94 oysters per square meter) (Table 5-6). Since the 2010 sanctuary program went into effect, all these sanctuaries have been positively trending upward with increasing oyster density over time.

Table 5-6. List of sanctuaries ranked above the 80th percentile relative to all other sanctuaries when assessing oyster density, natural mortality, and cultch using data from the annual Fall Oyster Survey from 2021 through 2025.

Sanctuary	Number of years sampled/number of samples	Average Number of Live Oysters per square meter	Average Observed Mortality (%)	Average Cultch (Bushels per 100 feet towed)
St Marys	5/11	1,004 ± 239	19.8 ± 10	2.5 ± 0.2
Little Choptank	5/45	580 ± 88	9.4 ± 1	2 ± 0.2
Nanticoke	5/43	428 ± 48	10.1 ± 1	2.7 ± 0.3
Harris Creek	5/40	465 ± 86	6.7 ± 0.6	1.7 ± 0.1
Upper Choptank	5/40	344 ± 74	6.1 ± 0.8	2.6 ± 0.3
Hooper Strait	5/10	379 ± 67	13.4 ± 4.6	0.9 ± 0.1
Tred Avon	5/30	291 ± 40	7.6 ± 0.93	1.3 ± 0.11

Section 5.2.2.2: Sanctuaries (>50-80th Percentile)

Sanctuaries that have a combined ranking for oyster densities of market-sized oysters, small-sized oysters, and spat, as well as amount of cultch, and mortality above the 50th

and at or below the 80th percentile tend to maintain high densities of adult oysters, but generally exhibit more variable spat densities, slightly higher mortality, and less cultch compared to the areas above the 80th percentile. Many of these areas have received investment in the form of wild seed plantings, hatchery seed plantings, or shell plantings.

These sanctuaries exhibited total live oyster densities ranging from 84 to 337 per square meter (Table 5-7). Excluding the Sandy Hill Sanctuary, their average five-year densities on sites sampled exceeded the 94 oysters per square meter long term oyster density target defined in the recent Oyster Benchmark Stock Assessment.

Some of these sanctuaries have planned or ongoing restoration such as the Upper Patuxent River and Wye River sanctuaries. No restoration planting is currently planned for the other sanctuaries in this category though they may occur in the future. Otherwise, the absence of harvest can be considered a conservation measure in order to contribute to the ecological benefits and reproduction potential in the region.

Table 5-7. List of sanctuaries ranked above the 50th percentile and at or below the 80th percentile relative to all other sanctuaries when assessing oyster density, natural mortality, and cultch using data from the annual Fall Oyster Survey from 2021 through 2025.

Sanctuary	Number of years sampled/number of samples	Average Number of Live Oysters per square meter	Average Observed Mortality (%)	Average Cultch (Bushels per 100 feet towed)
Upper Patuxent	5/25	183 ± 29	3 ± 0.7	1.9 ± 0.1
Neal Addition	5/5	337 ± 168	11.2 ± 2.1	1.8 ± 0.7
Choptank ORA	5/15	201 ± 53.5	3.3 ± 1.5	2 ± 0.3
Manokin River	5/30	212 ± 19	17.8 ± 1.5	1.3 ± 0.1
Howell Point	5/5	142 ± 49	8.5 ± 3	1.1 ± 0.2
Somerset	5/11	134 ± 16.4	11.8 ± 2	0.6 ± 0.1
Lower Mainstem Bay	5/10	197.5 ± 29	16.6 ± 3.5	0.5 ± 0.1
Point Lookout	5/5	136 ± 32.3	11 ± 1.3	0.6 ± 0.1
Wye River	5/28	107 ± 20	8.9 ± 1.4	1.2 ± 0.1
Severn River	5/10	133.2 ± 32	6.5 ± 1.9	1.4 ± 0.2
Sandy Hill	5/5	84 ± 25	9.1 ± 2	1.1 ± 0.2

Section 5.2.2.3: Sanctuaries (>20-50th Percentile)

Sanctuaries that have a combined ranking for oyster densities of market-sized oysters, small-sized oysters, and spat, as well as amount of cultch, and mortality above the 20th and at or below the 50th percentile have lower spat densities, variable cultch, and lower adult oyster densities than sanctuaries above the 50th percentile. None of these sanctuaries reach the five-year average long term oyster density target of 94 oysters per square meter on sampled sites, as defined in the recent Oyster Benchmark Stock Assessment. Total live densities ranged from 2.9 to 80 per square meter (Table 5-8).

These regions may have received investment towards production in the form of hatchery seed plantings or shell plantings, and four of these sanctuaries are currently part of the Eastern Bay Regional Project (Eastern Bay, Cox Creek, Miles River, and Mill Hill). Ongoing restoration work is also occurring in the Severn River and Magothy River sanctuaries in the form of small-scale plantings. Lower Chester and Lower Patuxent River sanctuaries are under consideration by the Oyster Advisory Committee for which management activities may benefit these areas. Oyster density has declined in the Lower Chester River Sanctuary, and the Lower Patuxent River Sanctuary has limited restoration potential due to lack of suitable bottom and deep water, which may lead to low oxygen levels. Samples were added in four sanctuaries (Cox Creek, Eastern Bay, Lower Patuxent and Magothy River) to enable classification in this report.

Table 5-8. List of sanctuaries ranked above the 20th percentile and at or below the 50th percentile relative to all other sanctuaries when assessing oyster density, natural mortality, and cultch using data from the annual Fall Oyster Survey from 2021 through 2025.

Sanctuary	Number of years sampled/number of samples	Average Number of Live Oysters per square meter	Average Observed Mortality (%)	Average Cultch (Bushels per 100 feet towed)
Eastern Bay	4/4	67 ± 19	24 ± 20	0.8 ± 0.1
Magothy River	4/4	19.3 ± 18	0	2.0 ± 0.8
Mill Hill	5/6	60.3 ± 25.3	6.8 ± 1.9	0.4 ± 0.1
Cox Creek	5/7	34.8 ± 12.4	5.1 ± 2.5	1.2 ± 0.3
Lower Choptank	5/9	80.6 ± 22	18.9 ± 3.4	0.7 ± 0.1
Miles River	5/12	30.8 ± 9.1	9.3 ± 5	1 ± 0.1
Cook Point	5/10	75.5 ± 20.5	18.2 ± 5.5	0.5 ± 0.1
Breton Bay	5/5	13 ± 7	0	0.37 ± 0.08
Chester ORA	5/7	2.9 ± 1.6	8.7 ± 5.7	1 ± 0.2
Lower Patuxent	4/4	22 ± 8.3	8.6 ± 3.5	0.2 ± 0.03

Section 5.2.2.4: Sanctuaries (≤20th Percentile)

Sanctuaries that have a combined ranking for oyster densities of market-sized oysters, small-sized oysters, and spat, as well as amount of cultch, and mortality at or below the 20th percentile have not reached the five-year average long-term oyster density target of 94 oysters per square meter at sites sampled, as defined in the recent Oyster Benchmark Stock Assessment. Total live densities ranged from 0.4 to 18 per square meter (Table 5-9).

These sanctuaries had low cultch values when compared to the other sanctuaries. Mortality was variable, ranging from 0 to over 30%, possibly due to disease during some of those years. Most of the other sanctuaries are in the Upper Bay, where low salinity limits natural recruitment and occasional freshets result in high mortality

Small-scale restoration efforts are ongoing in South River Sanctuary and will likely occur in the Calvert Shore sanctuary. Under the new Chesapeake Bay Watershed Agreement, Herring Bay sanctuary is one of three slated for large-scale restoration. The Cedar Point

sanctuary has limited oyster bottom and deeper water, which can result in low oxygen levels. Three sanctuaries (Cedar Point, Man O War, and South River) were classified as Level E in the last report due to a lack of data but samples were added in those sanctuaries, enabling classification in this report.

Table 5-9. List of sanctuaries ranked at or below the 20th percentile relative to all other sanctuaries when assessing oyster density, natural mortality, and cultch using data from the annual Fall Oyster Survey from 2021 through 2025.

Sanctuary	Number of years sampled/number of samples	Average Number of Live Oysters per square meter	Average Observed Mortality (%)	Average Cultch (Bushels per 100 feet towed)
Man O War	4/4	0.4 ± 0.2	0	0.5 ± 0.13
Upper Chester	5/34	6.7 ± 1.7	12.6 ± 2.5	0.9 ± 0.1
Herring Bay	5/6	0.36 ± 0.3	10 ± 10	0.1 ± 0.03
Calvert Shore	5/5	18 ± 2.7	21.3 ± 4.7	0.37 ± 0.1
Lower Chester	5/20	5.3 ± 1.3	13.4 ± 3.5	0.3 ± 0.1
Cedar Point	4/5	11.4 ± 3.2	30 ± 10	0.6 ± 0.1
South River	4/4	2.4 ± 0.5	24 ± 14	0.2 ± 0.07

Section 5.2.2.5: Insufficient Data Areas

Sixteen sanctuaries have insufficient data (fewer than four total samples) for classification: Big Annemessex, Fort Carroll, Kitts Creek, La Trappe, Oxford Laboratory, Piney Point, Plum Point, Poplar Island, Prospect Bay, Prospect Bay-Cabin Creek, Ringgold, Nanticoke River- Roaring Point, Solomons Creek, Tilghman Island, Webster, and Wicomico River.

Since 2010, four of these sanctuaries (Fort Carroll, Oxford Laboratory, Prospect Bay, and Wicomico River) have received restoration efforts. Some of these areas are small, contain very little historic oyster bottom, and are therefore omitted from the annual Fall Oyster Survey. Others, such as Plum Point and Ringgold, feature artificial substrates that prevent standard dredge sampling. Crucially, this classification does not mean an area is unproductive; the Fort Carroll and Nanticoke River- Roaring Point sanctuaries have undergone active restoration and may be productive, but they currently lack the consistent data required to establish a comparative rank. Several other sanctuaries,

including Big Annemessex, Kitts Creek, La Trappe Creek, Solomons Creek, Webster, and Wicomico River, have possessed minimal oyster habitat since before the 2010 program's inception. Consequently, these areas are excluded from the annual Fall Oyster Survey due to a lack of sufficient oyster bottom for representative sampling. The Oxford Laboratory and Piney Point sanctuaries, established prior to 2010, are used for oyster research.

Section 5.3: Individual Sanctuary Assessment

Appendix A provides an individual evaluation of each sanctuary, which is separate from their relative classification. Sanctuaries were assessed based on several categories: restored; positive trend and/or high density; negative trend; restoration received, ongoing, or planned; NGO restoration or laboratory use; or no data or poor habitat for restoration. The map below displays the sanctuaries along with their individual assessments (Figure 5-6). For further details, refer to Appendix A.

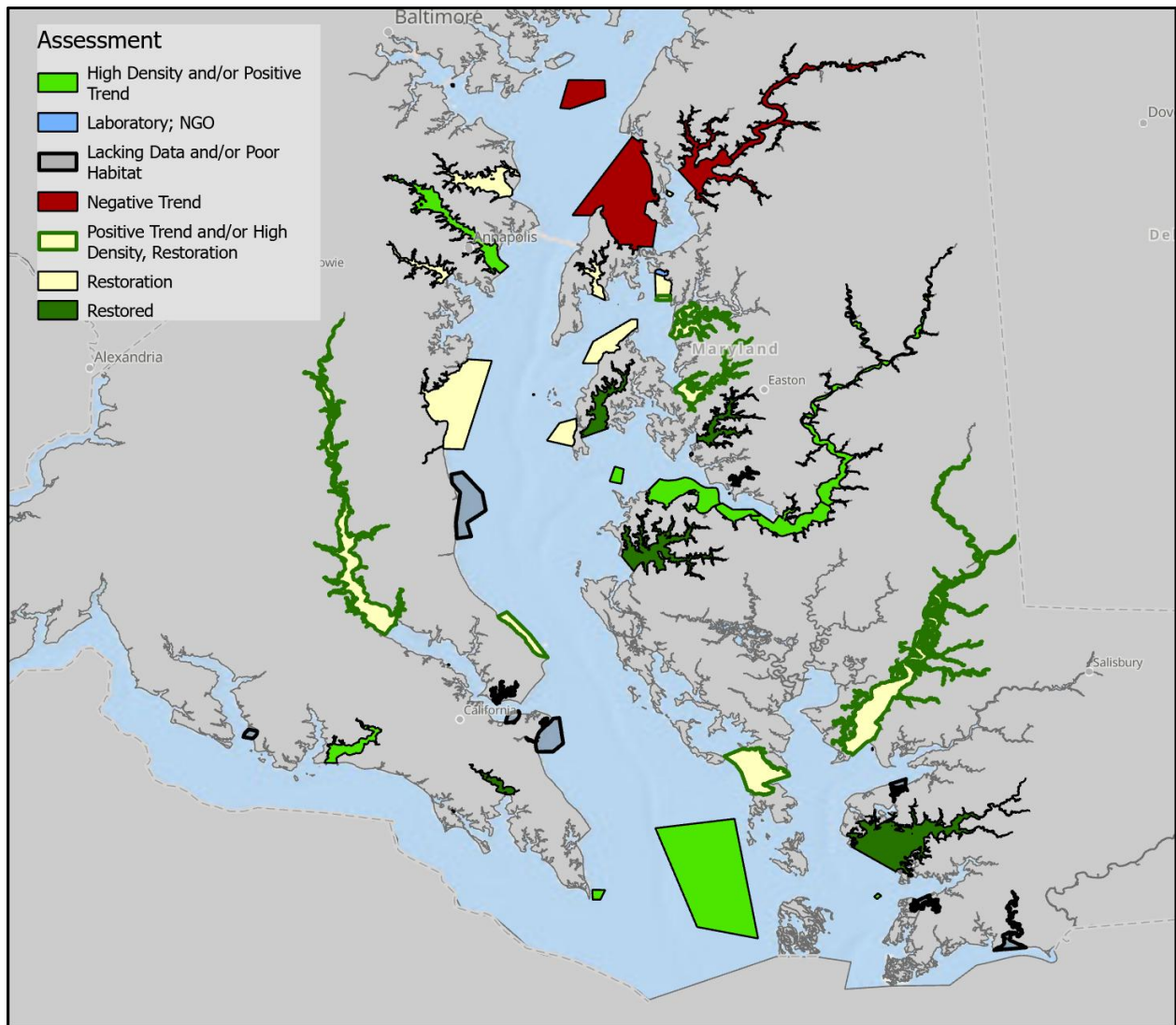


Figure 5-6. Map showing the sanctuary assessments. Areas are classified as High Density and/or Positive Trend, Laboratory or NGO, Lacking Data and/or Poor Habitat, Negative Trend, Positive Trend and/or High Density, Restoration (receiving or planned), and Restored.

Section 6: Summary and Recommendations

Section 6.1 Summary

Maryland's oyster populations have recently benefited from low disease mortality and strong reproductive success. Notably, the 2025 spatfall was the second highest on record, trailing only 1997. While the 2018 through 2019 freshet hindered reproduction in some areas and caused higher localized mortality, the robust spat sets observed in 2020 and 2023 through 2025 offer significant potential for enhancing both fishery and sanctuary areas, provided the spat survive to maturity. Overall, Maryland has experienced a general increase in oyster biomass over the last decade (Figure 6-1). According to estimates from the 2024 Oyster Benchmark Stock Assessment, oyster abundance in Maryland has more than tripled since 2005.

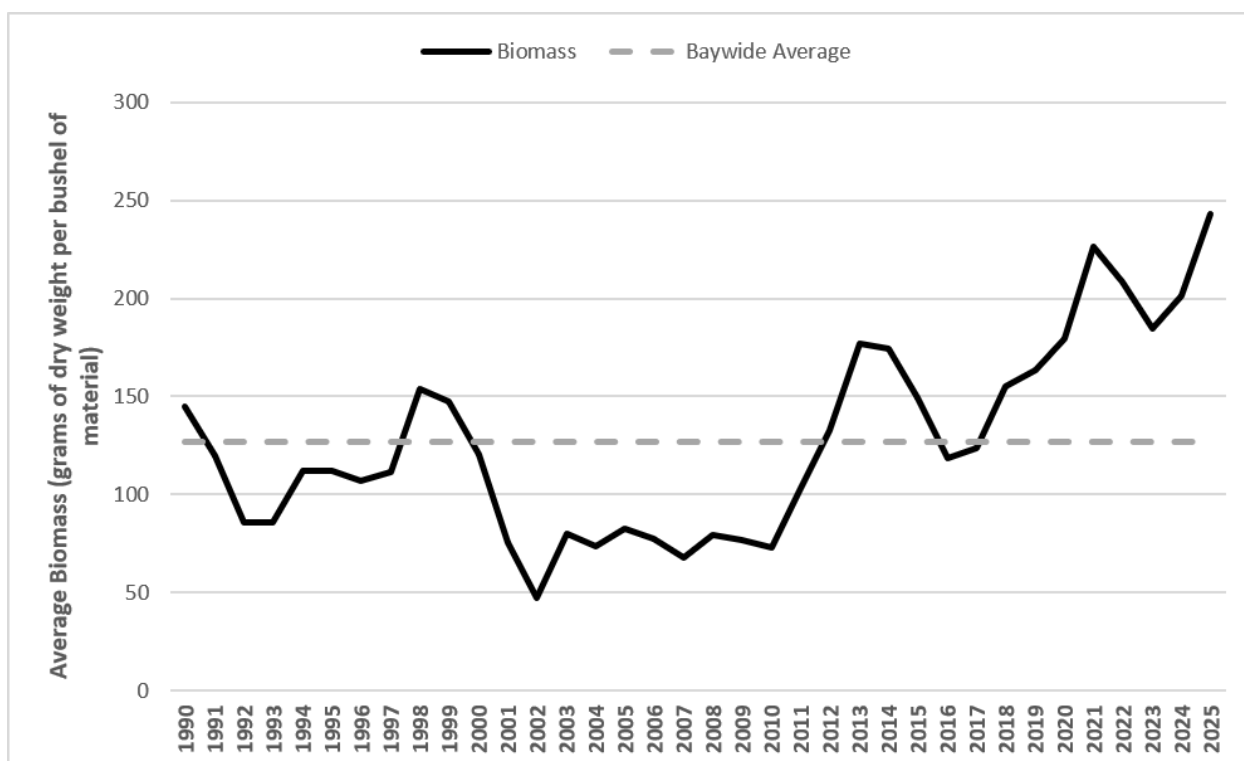


Figure 6-1. Average oyster biomass for all oyster bars sampled for biomass in Maryland's portion of Chesapeake Bay, both inside and outside of sanctuary areas. The dotted line is the long term baywide average oyster biomass for all oyster bars from 1990 through 2025.

The overarching objectives of oyster management in Maryland are to restore the ecological function of oysters and to enhance the commercial fishery for its economic and cultural benefits. To achieve ecological restoration, the scale of oyster sanctuaries remains important. The 2010 regulation placed an estimated 24% of Maryland's

remaining productive oyster bottom in sanctuaries, with the additional objective of including half of the productive 'best bars' within the sanctuaries. This is consistent with the 2019 Oyster Management Plan sanctuary objective to "Conserve and protect oyster habitat and biomass through maintenance of sanctuaries so that a minimum of 20-30% of oyster habitat and 50% of the 'best bars' are within sanctuaries"⁴².

There are sanctuaries and non-sanctuary NOAA Code areas that are known to have poor oyster habitat and/or very low densities of oysters. These underperforming areas may not be restored either for ecological or fishery purposes without substantial financial investment either by government or by private entities. To date, no such investment has come forth. In some areas, even with investment, low salinity impacts the ability for the area to be self-sustaining due to little to no natural recruitment. If the ultimate goal is to have more oysters in the water, then employing new management techniques to different areas should be considered. In the near future, the Oyster Advisory Commission will be making recommendations on management actions to increase oyster density in these poor productivity and habitat areas.

Determining how each sanctuary and non-sanctuary NOAA Code area is performing will provide the Oyster Advisory Commission additional information to consider when making management recommendations. Sanctuaries and non-sanctuary NOAA Code areas were classified into different levels of productivity as a measure of performance. A productive area is defined as having 1) high density of spat, small-sized oysters, and market-sized oysters; 2) good habitat; and 3) high survival. This includes areas planted with shell and oysters. Classifying areas by productivity enables comparisons within their respective categories: sanctuaries are compared with other sanctuaries, and non-sanctuary NOAA Code areas with other non-sanctuary NOAA Code areas. While the same evaluation method is applied to both, no direct comparison is made between these two distinct management types; they may vary in density (particularly for market-sized oysters), cultch availability, or mortality rates.

Section 6.2 Recommendations

The current management review identifies several specific sectors for which management recommendations may be warranted. Recommendations include:

The most recent 2024 Oyster Benchmark Stock Assessment and the recent Fall Oyster Survey results have shown improvements in the Eastern Bay Region. The Department recommends continued funding for the Eastern Bay Regional Project, aligning with the Oyster Advisory Commission's consensus recommendation and supported by SB 830 / HB 1228 (2022) as follows:

⁴² Maryland Department of Natural Resources. 2019. Maryland Chesapeake Bay Oyster Management Plan. 93 pp. https://dnr.maryland.gov/fisheries/Documents/MD_Oyster_FMP-2019.pdf

Over the next 25 years, a combination of replenishment, restoration, and aquaculture activities should be collectively planned and undertaken in Eastern Bay, with an equal amount of funding for spat planting in sanctuaries (\$1M annually adjusted for inflation) and for spat and shell planting on fishery bars (\$1M annually adjusted for inflation) in addition to current replenishment and restoration activities. The effectiveness of this option should be evaluated every 5 years⁴³.

The legislation provided for an annual appropriation of \$2,000,000 to help reach the Eastern Bay goals for fiscal years 2024 through 2026 only. Continuing to fund sanctuary restoration to meet the updated Chesapeake Bay Watershed Agreement goals and meet the updated Chesapeake Bay Watershed Agreement oyster outcome and support the 2019 OMP sanctuary objectives:

- Increase oyster populations to levels that improve important ecological functions and yield adequate broodstock to sustain regional populations;
- Improve oyster habitat and increase oyster biomass by utilizing appropriate techniques considering the influence of environmental conditions;
- Support, enhance, and increase ecological restoration activities in other tributaries throughout the Chesapeake Bay.

The management actions outlined in the OMP will only provide meaningful outcomes when supported by robust and effective law enforcement. The success of these management strategies relies on the capacity to uphold them through diligent enforcement practices. Supporting law enforcement is recommended to strengthen the efficacy of the OMP.

Current harvester reporting rates are approximately 60%. The Department needs fishery-dependent data to effectively manage the oyster population. Therefore, it is recommended to improve fishery reporting rates and improve outreach to ensure reports are being filled out completely. The Department encourages electronic harvester and dealer reporting to meet these recommendations.

Support continued research to evaluate the ecological benefits of restored oyster reefs.

Update the Oyster Management Plan to include the results of the 2024 Oyster Benchmark Stock Assessment and Best Management Practices for restoration and the public fishery.

Continue conducting the updated bottom survey of Maryland's portion of the Bay to determine the extent of oyster bottom and update the boundaries of oyster bars as reported in Maryland regulations for management of oysters and other natural resources. Understanding the current oyster habitat will allow the Department to

⁴³ First evaluation in 2028.

improve the oyster management and provide more accurate population abundance estimates in the stock assessment.

Implement the Aquaculture Coordinating Council's recommendation to establish demonstration leases. Demonstration leases are designed to be used exclusively for educational, conservation, or ecological purposes by public schools, colleges or universities, 4-H clubs, and nonstock, nonprofit corporations organized under the laws of the State. These leases can aid in the expansion of aquaculture and serve to increase use of spaces otherwise absent of oyster resources.

Section 7: Glossary

Aquaculture - the rearing of fish, shellfish, or aquatic plants for commercial purposes. For this report aquaculture pertains to growing shellfish in areas where the bottom or water column is leased by the State to individuals or businesses for commercial purposes.

Biomass - the dry-meat weight of the oyster population for a given area or volume of its habitat. In assessing the size of the oyster population, biomass integrates both oyster abundance and collective body tissue weight (another way of looking at how large they are).

Box Oyster - pairs of empty shells joined together by their hinge ligaments. These remain articulated for months after the death of an oyster, providing a durable estimator of recent oyster mortality.

Bushel - unit of volume used to measure oyster catches. The official Maryland bushel is equal to 2,800.9 cu. in., or 1.0194 times the U.S. standard bushel (heaped) and 1.3025 times the U.S. standard bushel (level).

Conditional Shellfish Harvest Area – an area designated by Maryland Department of the Environment that may be conditionally closed to shellfish harvest based on rainfall and impacts of bacteria and fecal coliform in shellfish that may be potentially harmful for human consumption. The area will be closed to shellfish harvest for three days after a rainfall event of one inch or greater over 24 hours.

Cultch - material that larval oysters can use as substrate for settlement. The Cultch Index, a measure of cultch volume from a standardized dredge tow distance, is derived from a subset of 53 Key bars.

Density - a measure of abundance over a known area

Dermo Disease - the oyster disease caused by the protozoan pathogen, *Perkinsus marinus*.

Dredging - a method of collecting oysters by dragging a toothed scraping bar fitted with a chain/mesh bag (the dredge) over an oyster bar.

Dredged Shell - oyster shell dredged from buried shell deposits.

Ecology - the scientific study of the distribution and abundance of life and the interactions between organisms and their environment.

Ecosystem - a functional system that includes the organisms of a natural community together with their environment.

Fresh Shell - shells from shucked oysters, usually stored on land for less than a few years before planting as oyster habitat or used in a hatchery as substrate for setting oyster larvae.

Freshet - a deluge of freshwater flooding into Chesapeake Bay, causing salinity to decrease suddenly.

Hatchery - a facility that spawns and fertilizes oysters to produce oyster larvae and spat.

Hatchery Spat-on-Shell – spat settled on shell within a hatchery laboratory using larvae spawned by a hatchery operation.

Haplosporidium nelsoni - The protozoan oyster parasite that causes MSX disease.

Harvest Reserve – area that is closed to commercial oyster harvest until biological criteria are met and the area is opened to harvest.

Harvest Rate - Fishery exploitation rate as defined by the 2024 Oyster Benchmark Stock Assessment. This is an estimate of the proportion of oysters removed by harvest per season.

Historic Oyster Bottom – an oyster bar as charted by the Yates Oyster Survey of 1906 to 1912 and its amendments.

Intensity (of disease) - a measure of the concentration of disease-causing parasites within an oyster; high disease intensity generally results in mortality.

Key Bar (Spat) – a subset of 53 fixed sampling locations in the Annual Fall Oyster Survey. The annual Spat Index is derived from average spat counts from these Key Bar.

Larvae (plural form of larva) - a free-swimming (planktonic) and sometimes feeding stage in the early development of certain animals. Oysters have several larval stages including: trochophore, veliger, and pediveliger. Their larvae remain in the water column for two to three weeks before attaching to hard substrate when they become spat.

Market Oysters – oysters that are 76 mm (3 in.) or greater and can be harvested legally.

Mesohaline - moderately brackish, estuarine water with salinity ranging from 5 to 18 ppt.

Non-sanctuary Areas - all areas covered in this report that are not within the boundaries of oyster sanctuaries.

Oyster Benchmark Stock Assessment - This assessment is a comprehensive, science-based evaluation of the oyster population and fishery status in the Maryland portion of the Chesapeake Bay. Mandated by the Sustainable Oyster Population and Fishery Act of 2016 (Statute §4–215), an update assessment is reviewed every two years and a

benchmark assessment is conducted every six years. The latest Oyster Benchmark Stock Assessment was conducted in 2024.

Oyster Reef Habitat – in reference to bay bottom type mapping surveys, bottom types suitable for larvae settlement.

Patent Tong – a mechanical method of collecting oysters by using two hinged rake heads that are opened and closed by a hydraulic piston and tethered by a cable.

Prevalence (of disease) - a measure of the frequency of occurrence of infection (i.e., the percent of examined oysters that contain at least one disease causing parasite).

Public Shellfish Fishery Area (PSFA) - areas reserved for public fishery oyster harvest. A PSFA is reserved for commercial harvest of wild oysters and cannot be leased for aquaculture. A PSFA may be declassified in accordance with [COMAR 08.02.04.17](#).

Recruitment - additions to a population, either through birth or immigration. When oyster larvae settle and attach in the vicinity of other oysters, they are 'recruits' into that population.

Reef Ball – a rounded, hollow, and vented form made of concrete placed on the bottom of the bay with the purpose of oyster restoration and ecological benefits. Reef balls can be seeded with hatchery-produced spat prior to planting or may attract a natural oyster set afterwards, depending on its location.

Replenishment (of habitat) - any of a range of approaches for attempting to increase the amount of suitable habitat for oyster settlement to benefit the public oyster fishery; “standard” habitat method involves placing relatively thin layers of clean shell on existing hard bottom.

Replenishment (of population) - any of a range of approaches for attempting to increase the amount of oyster for harvest by the public oyster fishery; “standard” method involves placing hatchery oyster spat or transferring wild, natural oyster spat.

Restoration (of population) - any of a range of approaches for attempting to increase the population of oysters in Chesapeake Bay to a level at which it provides desired ecosystem services (e.g., habitat rehabilitation, planting seed oysters).

Restricted Shellfish Harvest Area - an area designated by Maryland Department of the Environment that is permanently closed to shellfish harvest based on rainfall and problems of fecal coliform and other bacteria in shellfish that may be potentially harmful for human consumption.

[Sanctuary](#)- areas where the wild harvest, commercial or recreational, of oysters is prohibited. In sanctuaries established prior to September 2010, harvest of both oysters and clams is prohibited.

Sentinel Bars (Disease and Biomass) - a subset of 43 fixed sampling locations in the Annual Fall Oyster Survey. Oyster disease information is collected from these sentinel bars (also known as Disease Bars). The annual Biomass Index is also derived from average counts and size distributions from these sentinel bars.

Setting; Settlement - the metamorphosis from the planktonic (free-swimming) larval form to the benthic adult form. When oysters set or settle, they permanently attach to a hard substrate.

Shell Height – the distance from the hinge to the ventral margin of an oyster shell; usually the longest dimension.

Small (sublegal) Oysters – oysters normally ranging between about 40 to 75 mm and are at least one year old and generally up to two to three years old. These oysters are not harvested legally.

Spat (seed) – early juvenile oysters that have settled by attaching to a hard substrate. These oysters are less than one year old and usually smaller than 40 mm.

Spawning - producing and releasing gametes (eggs or sperm). Gametes are released into the water column where fertilization occurs. Oysters normally spawn from May to September. Males often spawn first and the presence of sperm in the water is a stimulant to the females.

Spatfall - the settling and attachment of larvae to substrate.

Substrate - hard surface to which a fixed organism is attached. Oysters can attach to a wide variety of hard substrates but prefer oyster shell.

Surface Acres- a measure of the horizontal surface area of a body of water.

Wild Seed – oysters collected from a natural recruitment area within the bay and transported to an oyster bar in another usually low-recruitment area of the bay. These oysters tend to be spat and small-sized oysters.

Yates Bar Survey – a survey conducted from 1906 to 1912 to designate the boundaries of all oyster bars within Maryland's portion of Chesapeake Bay.