

Appendix A

Characterization of Individual Sanctuaries

Oyster Management Review:
2021-2025

A Report Prepared by
Maryland Department of Natural Resources

Final Report
2026

Table of Contents

Introduction	4
Data Sources	4
Replenishment and Restoration Efforts	4
Annual Fall Oyster Dredge Survey	6
Patent Tong Surveys	9
Water Quality	10
Baywide Streamflow	13
Stock Assessment	14
Oyster Density Reference Points	14
2021-2025 Sanctuary Assessment	14
Section A.01: Big Annemessex Sanctuary	20
Section A.02: Breton Bay Sanctuary	23
Section A.03: Calvert Shore Sanctuary	32
Section A.04: Cedar Point Sanctuary	40
Section A.05: Chester River ORA Zone A Sanctuary	44
Section A.06: Choptank River ORA Zone A Sanctuary	51
Section A.07: Cook Point Sanctuary	58
Section A.08: Cox Creek Sanctuary	70
Section A.09: Eastern Bay Sanctuary	73
Section A.10: Fort Carroll Sanctuary	76
Section A.11: Harris Creek Sanctuary	78
Section A.12: Herring Bay Sanctuary	88
Section A.13: Hooper Strait Sanctuary	99
Section A.14: Howell Point Sanctuary	105
Section A.15: Kitts Creek Sanctuary	112
Section A.16: La Trappe Sanctuary	115
Section A.17: Little Choptank River Sanctuary	117
Section A.18: Lower Chester River Sanctuary	127
Section A.19: Lower Choptank River Sanctuary	135
Section A.20: Lower Main Stem Bay Sanctuary	142
Section A.21: Lower Patuxent River Sanctuary	153
Section A.22: Magothy River Sanctuary	157

Section A.23: Manokin River Sanctuary	161
Section A.24: Man O War Sanctuary.....	170
Section A.25: Miles River Sanctuary	174
Section A.26: Mill Hill Sanctuary	183
Section A.27: Nanticoke River Sanctuary.....	189
Section A.28: Neal Addition Sanctuary.....	200
Section A.29: Oxford Lab Sanctuary	207
Section A.30: Piney Point Sanctuary.....	209
Section A.31: Plum Point Sanctuary.....	211
Section A.32: Point Lookout Sanctuary	213
Section A.33: Poplar Island Sanctuary	222
Section A.34: Prospect Bay Sanctuary.....	225
Section A.35: Prospect Bay Cabin Creek Sanctuary	228
Section A.36: Ringgold Sanctuary.....	230
Section A.37: Nanticoke River-Roaring Point Sanctuary	232
Section A.38: Sandy Hill Sanctuary.....	235
Section A.39: Severn River Sanctuary	245
Section A.40: Solomons Creeks Sanctuary.....	257
Section A.41: Somerset Sanctuary.....	259
Section A.42: South River Sanctuary	269
Section A.43: St. Marys River Sanctuary.....	273
Section A.44: Tilghman Island Sanctuary.....	283
Section A.45: Tred Avon River Sanctuary	287
Section A.46: Upper Chester River Sanctuary.....	297
Section A.47: Upper Choptank River Sanctuary.....	308
Section A.48: Upper Patuxent River Sanctuary	318
Section A.49: Webster Sanctuary	329
Section A.50: Wicomico River Sanctuary	331
Section A.51: Wye River Sanctuary	334

Introduction

This appendix presents available data on oyster populations within the 51 individual sanctuaries as a means to examine the general characteristics, background information, and trends over time for each unique area. Recognizing that trends for any given area may shift as future environmental conditions change, an examination of oyster populations before and after 2011 (the first full year after the 2010 regulations) will facilitate informed discussion of the effectiveness of the management areas. This appendix presents detailed data on each sanctuary.

Not all types of data are available for all sanctuaries, and the scientific value of the different types of data may vary. This report leverages data from partners and other Department programs which have particular data on specific sanctuaries. These studies often have limitations related to short study duration, initiation after the creation of sanctuaries in 2010 (no pre-sanctuary data), or a study design that was designed for purposes other than the type of assessment presented in this report (e.g. bottom sonar surveys targeting derelict gear, but which could be used to characterize bottom substrate).

Data used in this assessment includes the following: replenishment and restoration activities, oyster population characteristics (density, recruitment, size structure, and mortality), and water quality.

The various data sources used in the assessment of each sanctuary are described below. For each data source, the objective and term of the sampling program are presented, the specific data sets derived from the program are described, and the value and limitations of each of the data sets for assessment purposes are identified.

Data Sources

Many of the data presented in this appendix 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).

Replenishment and Restoration Efforts

Almost every oyster bar in Maryland has been manipulated over time through replenishment and restoration efforts to improve oyster bar productivity. Replenishment efforts were intended to enhance the public fishery for economic benefit and occurred prior to the establishment of the sanctuaries. Restoration efforts were those activities occurring after the establishment of the sanctuary with the objective to restore oyster populations for ecosystem and ecological benefits. The types of enhancements employed in both replenishment and restoration include planting fresh and dredged

shell, transplanting natural wild seed, and planting hatchery-reared spat in hopes of increasing oyster populations. Records of these activities date back to 1960, but only shell and seed plantings since 2021 will be presented in this appendix.

The amount of replenishment and restoration activities differs widely among the 51 sanctuaries. Some sanctuaries have received numerous plantings of both shell and seed over time, while others received very few or none of either. The annual planting information provides a general sense of how each sanctuary was manipulated over time. An analysis to determine if replenishment or restoration activities contributed to an increase in oyster population is beyond the scope of this report. Furthermore, not all replenishment or restoration plantings have been monitored by the Department. Monitoring projects by other organizations on replenishment and restoration plantings may be referenced when applicable.

Longevity of plantings should also be considered when examining replenishment activities. On average, it is thought that, in the absence of disease, oysters can live up to 20 years¹. Even without disease related mortality, seed plantings in the Chesapeake Bay for harvest purposes are not likely to last more than three to five years due to harvest pressure. Longevity of shell can vary due to type of shell, pH and alkalinity, sediment burial, and attack from shell-boring organisms. The shell dissolution rate for fresh shell has been found to be much faster than for dredged shell. The half-lives of shell were computed by Waldbusser et al (2011)² and the results ranged from roughly one year for fresh shell under mid and low pH to nearly 40 years. This rate however does not account for loss of shell due to burial, transport, and attack from sponges and other shell-boring organisms, all important sources of shell loss in Chesapeake Bay. A further understanding of the fate of historic plantings is important but beyond the scope of this report.

Another source of smaller-scale restoration planting data comes from the Marylanders Grow Oyster Program (MGO). MGO is an outreach and educational program designed to engage the public in oyster restoration by having them grow oysters at their piers in cages and then plant the oysters in local sanctuaries to enhance the oyster population. Growers (individuals in the program) receive spat in cages around September each year. The cages are tended to by growers over the winter and spring. Around June, the approximately nine-month-old oysters are planted in sites within a sanctuary. The shell height of these oysters is approximately one to two inches.

The program began in 2008 in the Tred Avon River and has grown considerably since then. The MGO Program is large in terms of geographic scope (currently in 32 tributaries of the bay), the degree of public involvement (over 1,250 oyster growers and over 500 school students), and the effort invested to grow oysters (5,000 cages are

¹ Buroker NE. 1983. Population genetics of the American oyster *Crassostrea virginica* along the Atlantic coast and Gulf of Mexico. *Marine Biology* 75:99-112.

² Waldbusser, G.G., R. A. Steenson, and M. A. Green. 2011. Oyster Shell Dissolution Rates in Estuarine Waters: Effects of pH and Shell Legacy. *Journal of Shellfish Research*, Vol. 30, No. 3, 659–669

being utilized). It is likely the largest community-based oyster growing program in the country, but it is a small-scale program in terms of the acreage of sanctuary bottom restored and the number of oysters planted. Approximately two million oysters are planted on a few acres of oyster bottom annually. In comparison, large-scale restoration can plant two million oysters in a day (i.e. Harris Creek Sanctuary). However, in tributaries where large-scale restoration is absent, MGO may be the only source of restoration activity.

Annual Fall Oyster Dredge Survey

The purpose of the Department's Annual Fall Oyster Dredge Survey (Fall Oyster Survey), conducted since 1939, is to assess the overall health of Maryland's oyster population. The Fall Oyster Survey represents the longest continuous and most geographically comprehensive oyster population survey in the world.

The Fall Oyster Survey design includes the sampling of spatfall and relative oyster abundance. This report utilizes Fall Oyster Survey data since 2006 - a 20-year time period with standardized survey methodologies. In the fall each year, approximately 300 to 400 samples are collected. Some sanctuaries may have samples taken on multiple bars annually, some sanctuaries have only one oyster bar sampled annually, and some sanctuaries have not been sampled at all by the Fall Oyster Survey. For each sample, one or (in the case of the fixed spat index and disease/biomass bars) two half-bushel subsamples of material are collected by an oyster dredge. Detailed methods for the Fall Oyster Survey may be found in Tarnowski (2020³).

For each sample collected by the Fall Oyster Survey, the number of live oysters per one bushel of material collected is counted. Oysters are classified as spat, small-sized oysters, or market-sized oysters. Spat are less than one year old. Small-sized (sublegal) oysters are usually between one and three years old, and generally greater than 40 mm and always less than 76 mm. Market-sized (legal) oysters are equal to or greater than 76 mm and are generally three years and older. The long time series of the Fall Oyster Survey allows tracking changes in oyster abundance and age/size structure. Relative density of live oysters can be estimated by standardizing the count of live oysters by the total volume of the sample, tow distance, width of the dredge, and a gear efficiency coefficient.

Samples taken on approximately 30% of all the oyster bars sampled, including a fixed subset of spat index and disease index bars, provide more detailed information on oyster sizes annually. Oyster shell height in millimeters is recorded for all oysters collected. Oyster size structure can be assessed by calculating the frequency distribution of oysters in each five mm size class. A healthy oyster population would

³ Tarnowski, 2020. Maryland Oyster Population Status Report, 2019 Fall Survey.
<https://dnr.maryland.gov/fisheries/Documents/19TextFinRevColFigs.pdf>

have a size distribution with oysters in all, or at least most, size classes from five mm to greater than 120 mm. This would indicate multiple age classes in the population.

Biomass is a relative measure of how the oyster population is doing over time. It accounts for recruitment, individual growth, natural mortality, and harvesting in a single metric. In assessing the size of the population, biomass integrates both the abundance of oysters and their collective body weight. Biomass is estimated from field-collected oyster shell heights using laboratory-derived height-weight relationships. Weight is calculated in grams of dry tissue weight. Increases in biomass reflect increases in the number of oysters and/or oyster growth. A biomass index for the entire oyster population is derived from the 43 disease index bars.

Total Observed Mortality is an index of annual mortality rates of small and market sized oysters derived from the 43 disease index bars. Observed mortality, based on the presence of boxes (dead oysters with articulated shells), can occur from disease or other natural factors such as freshets. Mortality is based on post-spat stage oysters and is estimated by dividing the number of dead oysters by the total of live and dead oysters. Spat are not included in observed mortality estimates because their fragile shells are easily disarticulated during sampling or by natural processes.

Cultch (oyster habitat) is crucial for providing hard substrate for oyster setting as well as habitat for the myriad other organisms associated with the oyster community. For the purpose of the Fall Oyster Survey, cultch is defined as primarily both oysters (live and dead) and shell. The collection of quantitative cultch data was initiated during the 2005 Fall Oyster Survey. During a sampling tow, the distance covered by the dredge while sampling on the bottom is measured using a handheld geographic positioning system (GPS) unit with an odometer function. After the dredge is retrieved, the total volume of oysters and shell is measured in bushel units. Since tow distances vary, the volume is standardized to a 100 ft tow by dividing 100 by the actual tow distance and multiplying the result by the total cultch volume. If the dredge is full that sample is dropped from the analysis or the tow is repeated. A value of 1.4 bushels of cultch per 100-foot tow distance is consistent with the top 25% of all sites sampled bay-wide. 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 for cultch. A cultch index for the entire population is derived from the 53 "Key" spat index bars.

Information on oyster diseases is collected from a fixed subset of 43 bars from which the biomass and mortality indexes are also calculated. Dermo (*Perkinsus marinus*) and MSX (*Haplosporidium nelsoni*) infection prevalence (the percentage of oysters infected) and intensity (the severity of infection) are measured from 30 oysters collected at each site. Disease prevalence and intensity both relate to mortality. For example, all of the oysters in a sample may be infected with a disease, but at such low intensity levels that few oysters are in danger of dying in the near future. Intensity is based on a 0 to 7 scale. Individual oysters with intensity greater than 5 may indicate lethal levels. Population-wide MSX and dermo disease indexes are derived from these 43 bars.

The Fall Oyster Survey data were used to explore general characteristics of the oyster populations within those sanctuaries that were sampled. Data presented examines changes over time, based on the average number of oysters per a bushel of material, oyster shell height, live oyster biomass, recruitment, observed mortality, cultch, and disease on oyster bottom within each sanctuary. Data are summarized into four five-year time periods:

- 2006-2010: The population remained low during this period following the four-year disease epizootic (1999-2002), before the 2010 baywide management area regulation changes and through a rebuilding period that began with a strong spatset in 2010.
- 2011-2015: The first full year after the 2010 baywide management area regulation changes and a period of increasing abundance due to two relatively good spatsets in 2010 and 2012
- 2016-2020: A combination of poor recruitment and elevated disease-related mortalities led to a three-year period of declining abundance and harvests before rebounding, including a relatively good spat set in 2020.
- 2021-2025: Building on the upward population trajectory of the previous decade, this five-year period averaged the highest recruitment, biomass, and cultch indexes while disease and mortality indexes were the lowest or second lowest of any five-year period in the entire 36- and 41-year time series.

Although this report covers the last 20 years, oyster populations have varied over time.

- 1990-1994: This five-year period had three years of high streamflow (1990, 1993, 1994) and two years of below average streamflow (1991, 1992). The year 1991 was a high spatfall intensity year, being over four times the long-term average spatfall. The years 1991-1993 had a high mean prevalence of dermo and MSX disease. Elevated mortalities were correlated to the MSX frequency, with observed mortalities on individual bars as high as 88% in 1992.
- 1995-1999: Streamflows swung widely between successive years, impacting disease and resulting mortalities. The year 1995 was a period of low annual streamflow, followed by above-normal annual streamflow in 1996-1998, and 1999 was the first year of a four-year drought. These streamflow shifts were reflected in disease outcomes: 1995 was a year of increased dermo disease; 1996-1998 had low disease levels and observed mortalities; 1999 began a four-year disease epizootic and increase in observed mortality. A high spatset occurred in 1997, with over five times the long-term average spatfall, but this was not extensive spatially, being largely confined to the Eastern Bay region.
- 2000-2005: This period began with a drought that lasted until 2002. With the exception of 2002, the years 2000-2005 saw low recruitment with a spatfall intensity index below the long-term median. Because of the continued drought, 2000-2002 experienced a disease epizootic and the highest observed mortality index on record with nearly 60% of the oysters having died by 2002. This was

followed by two years of record high streamflow in 2003 and 2004, leading to a period of lower disease prevalence and reduced observed mortality (2003-2005).

There are some limitations with using dredges to sample oyster bars. Dredges may not sample well on some alternate material sites. Due to the variability of the oyster bottom, it may have limited spatial discrimination due to the integrated sampling over the tow distance.

Patent Tong Surveys

Patent tong sanctuary surveys have been conducted by the Department since their establishment in 2010. However, only surveys occurring after 2020 will be presented for each sanctuary in this appendix. These surveys use hydraulic patent tongs to obtain spatially explicit estimates of oyster density, as well as information on oyster size and the volume of cultch present. Patent tong surveys conducted by the Department used a stratified random sampling design, with strata based on substrate type. The number of sampling points for each survey on each sanctuary ranged from 50 to 300, depending on the area of potential oyster habitat present in each sanctuary. Most sanctuaries have been surveyed at least once (43 out of 51), and two sanctuaries have had two surveys conducted prior to sanctuary establishment.

The fixed area of the patent tongs (one square meter) allows for the calculation of oyster density. An average density of oysters based on all samples collected within a sanctuary can be used to derive the overall density of oyster habitat in the entire sanctuary. The patent tong surveys also measure the volume of surface and buried shell in each sample. Exposed oyster shell is the preferred settlement substrate for oyster larvae; therefore, the greater the volume of exposed surface shell, the greater the potential for spat set.

Comparison of Fall Oyster Survey and patent tong survey results is difficult given the difference in sampling efficiency and area between the two gear types; therefore, in this appendix the results from the two surveys are presented separately.

In this appendix oyster density from the patent tong surveys will be presented, where available, along with the Fall Oyster Survey information. In addition to the patent tong surveys conducted by the Department, additional patent tong surveys were conducted by WRF Group, LLC and the Oyster Recovery Partnership using a systematic sampling design. Results of these surveys may be referenced in this appendix.

There are some limitations with using patent tong gear to survey oyster bars. Patent tongs may not sample well on some alternate material sites. As oyster populations increase and three-dimensional structure increases, patent tong sampling may have a reduced sampling efficiency. Due to the small sampling area of the patent tongs and variability of oyster densities, individual samples may miss, underestimate, or

overestimate the number of oysters, but collectively provide a reasonable estimate of the average population density. Patent tong surveys are labor and time intensive.

Water Quality

Water quality influences patterns in oyster life-history and disease. Oyster survival, growth, reproduction, and disease incidence are related to water quality parameters including salinity, temperature, and dissolved oxygen. Oyster reproduction (spat fall) and disease-caused mortality both decline with decreasing salinity. Therefore, in areas where reproduction is lowest, survival of mature oysters may be highest. In higher salinity areas where survival may be lower, recruitment is usually higher. Monitoring water quality may also detect the effect of sanctuaries and active restoration efforts on the environment, as oysters also impact the quality of water in which they live. For example, some water quality characteristics such as clarity may be related to oyster biomass, as greater biomass results in a greater filtration rate. However, the association between water quality improvements and oyster population size is complex, since a number of other factors, such as land use practices and water treatment facilities, greatly impact water quality.

Oyster bars in Maryland are located in the mesohaline salinity classification (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 ppt⁴ (Figure A.0-1). Data from Maryland Department of Natural Resources, Maryland Department of Environment, and Chesapeake Bay Program were used to create a Maryland-wide salinity dataset. Oyster sanctuaries are classified by salinity zone using average surface salinity from 2006 to 2020. Although bottom salinity would be more appropriate to use to classify salinity zones for oysters, surface salinity datasets had greater spatial and temporal coverage. Salinity zones were developed to be broad, general categories and some sanctuaries may fluctuate between salinity zones given weather patterns.

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 capability⁵. 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 attempt to foster disease resistance and enhance reproduction. Oysters in this zone have been subjected to heavy disease pressures which historically resulted in high

⁴ Maryland Department of Natural Resources. 2019. Oyster Management Plan. 93 pp.
https://dnr.maryland.gov/fisheries/Documents/MD_Oyster_FMP-2019.pdf

⁵ IBID

mortality⁶. In Zone 3, high recruitment rates 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 years⁷. Annual spat settlement can range from low to moderate to high based on salinity. Mortality related to disease can also fluctuate from year to year. In years with low disease-caused mortality, the oyster populations in this area can recover as long as there is also successful recruitment. However, the reverse can also occur.

⁶ IBID

⁷ Maryland Department of Natural Resources. 2019. Oyster Management Plan. 93 pp.
https://dnr.maryland.gov/fisheries/Documents/MD_Oyster_FMP-2019.pdf

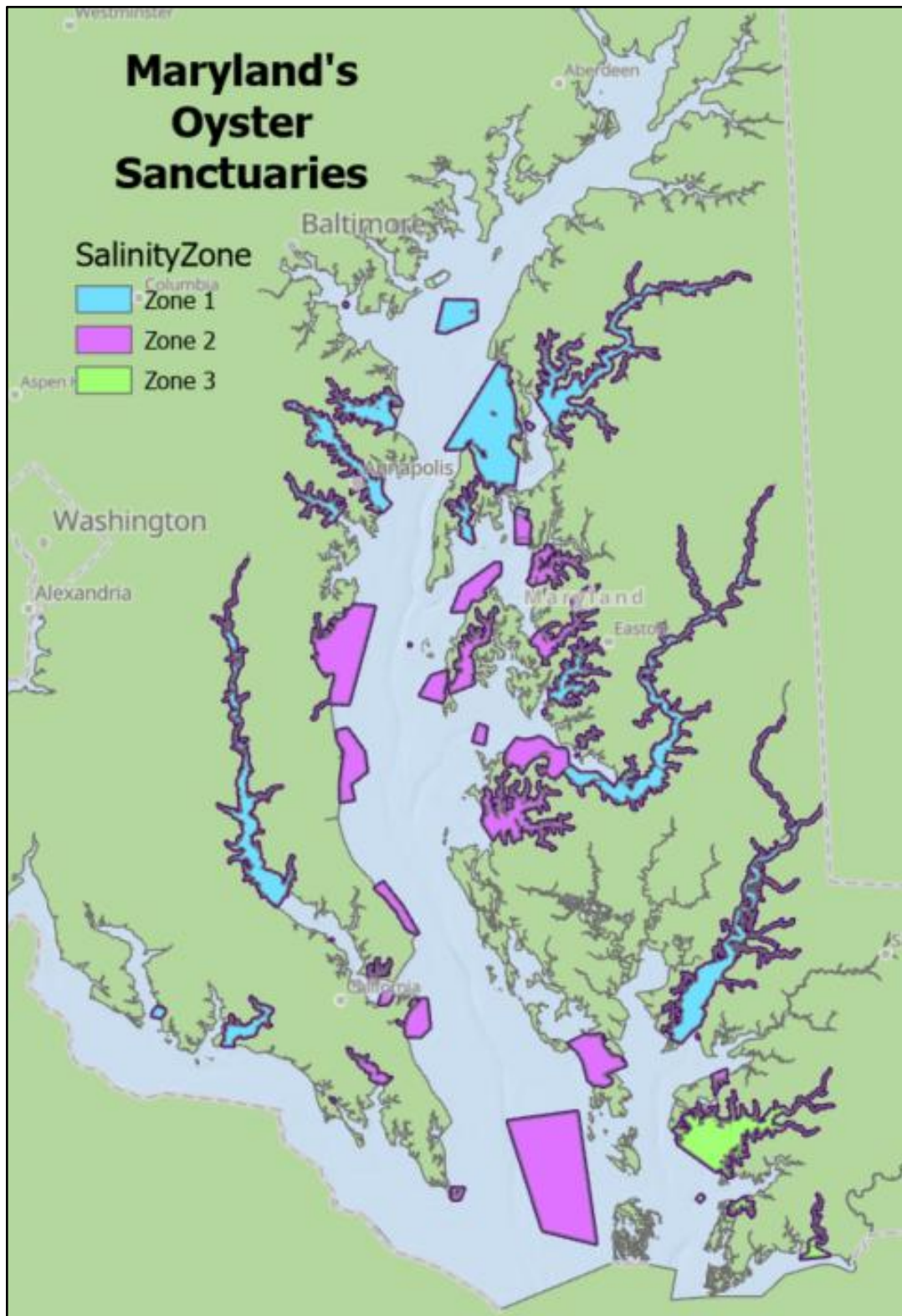


Figure A.0-1 Map of the sanctuaries and the corresponding salinity zone classifications. Zone 1 has an average salinity less than 11 ppt; Zone 2 has an average salinity between 11 and 15 ppt; and Zone 3 has salinities greater than 15 ppt.

Baywide Streamflow

Freshwater inflow into the bay through streams and rainfall can impact water quality, and in particular salinity. The U.S. Geological Survey monitors freshwater streamflow into the bay annually⁸ (Figure A.0-2).

Between 1990 and 1998, freshwater inflows were variable, with years of high flows alternating with low flow years. A prolonged drought began in 1999 and persisted for four years, adversely affecting oyster populations and compounding mortalities associated with oyster disease. The years 2003 and 2004 were high flow years with little adverse effect on oyster mortality. Normal flow conditions persisted from 2005 to 2010 and from 2012 to 2017. High flows in 2011 and 2018 contributed to oyster mortalities in limited areas. In 2011, higher mortalities were confined largely to the upper bay and in 2018 the highest mortalities occurred in the upper bay as well as the Potomac River. Higher flows persisted throughout the first half of 2019 but 2020 resulted in an average flow year. Between 2021 and 2025, four of the five years had normal streamflows, averaged annually, although strong intra-annual variability was evident. The only exception, 2023, experienced below normal flows.

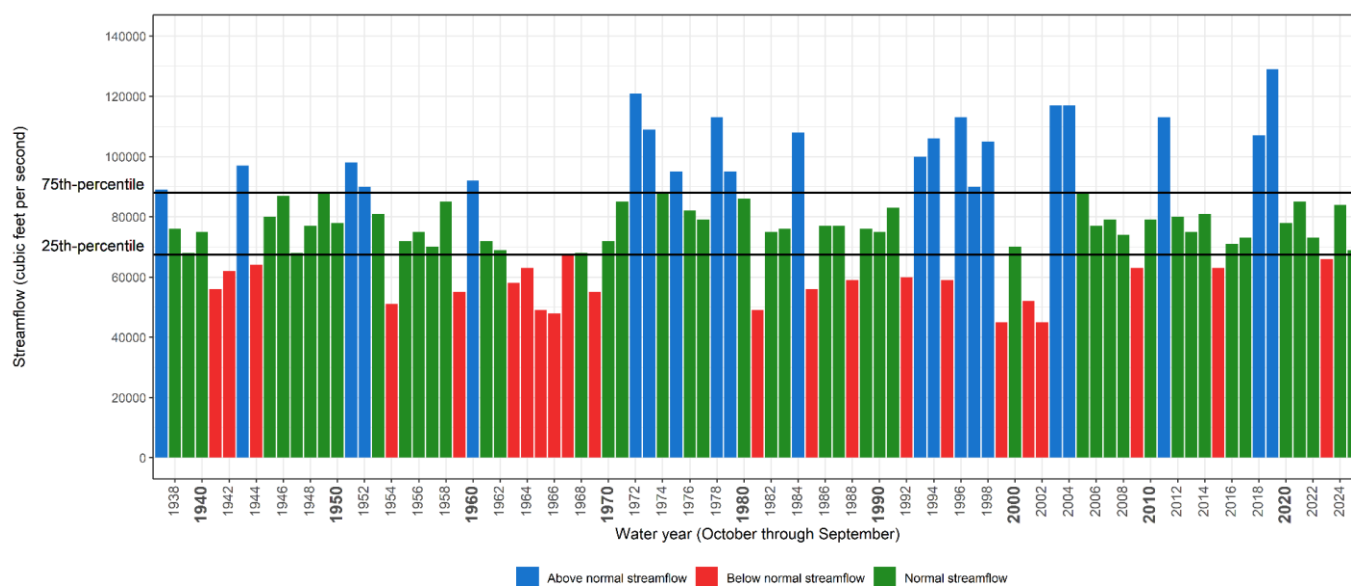


Figure A.0-2. Annual mean monthly freshwater flow into Chesapeake Bay.⁹ Between 2021 and 2025, four of the five years had normal streamflows, with 2023 experiencing below normal flows.

⁸ USGS. 2015. Estimated streamflow entering Chesapeake Bay above selected cross sections. United States Geological Survey Inflow Database. <http://md.water.usgs.gov/waterdata/chesinflow/>

⁹ USGS. 2026. Estimated streamflow entering Chesapeake Bay above selected cross sections. United States Geological Survey Inflow Database. https://www.usgs.gov/centers/cba/science/freshwater-flow-chesapeake-bay?qt-science_center_objects=0#qt-science_center_objects

Stock Assessment

The 2024 Oyster Benchmark Stock Assessment (in review) consists of a stage-structured model that estimates status of the stock relative to biological reference points. Specifically estimated were the time series of abundance, harvest fraction (fishing levels), and natural mortality rates of oysters. 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 (fishing levels), changes to habitat over time, effects of planting substrate and oysters, and the disarticulation of small and market boxes. More information on the 2024 Oyster Benchmark Stock Assessment can be found in the main report.

Oyster Density Reference Points

The 2024 assessment developed a long-term target density (number per square meter) of adult oysters that was common across all NOAA codes to represent a desired level of the oyster population based on density estimates from sanctuaries in Maryland that are known to be achievable from the current population. The 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 lower limit). A long-term target density of 94 oysters per square meter was also set. Long-term densities may take decades to be realized in some areas. When evaluating sanctuaries this long-term density target was used to classify an area as having a high density.

2021-2025 Sanctuary Assessment

When assessing the sanctuaries for the 2021- 2025 timeframe, annual Fall Oyster Survey data was used to help evaluate the trend of the population within the sanctuaries. This assessment is not the same as the ranking of the sanctuaries and NOAA codes into classifications in Section 5.1 of the 2021-2025 Oyster Management Review as this assessment evaluates the performance of each sanctuary separately and does not rank them relative to each other.

In Table A 0-1, the sanctuaries were assessed as restored, positive trend and/or high density, negative trend, restoration received, ongoing or planned, Non-Governmental Organization (NGO) restoration or laboratory use, or no data or poor habitat for restoration (Figure A.0-3).

The five sanctuaries that have received initial restoration towards the 2014 Chesapeake Bay Watershed Agreement oyster goal were designated as restored (Harris Creek, Little Choptank River, Tred Avon River, St. Marys River and Manokin River sanctuaries).

Twelve sanctuaries (Breton Bay, Choptank River ORA, Cook Point, Howell Point, Lower Choptank River, Lower Mainstem, Neal Addition, Point Lookout, Sandy Hill, Severn River, Somerset, and the Upper Choptank River sanctuaries) were classified as having a positive trend and/or a high density from the Fall Oyster Survey 2021- 2025 data as compared to prior five-years of Fall Oyster Survey data. A positive trend was identified when the average total oyster density data from the 2021–2025 Fall Oyster Survey exceeded the results from the 2016–2020 survey. An area was classified as having a high density if its average oyster density during the 2021-2025 Fall Oyster Survey met or exceeded the target reference point of 94 oysters per square meter defined in the recent Oyster Benchmark Stock Assessment.

Sixteen sanctuaries were designated as having restoration received, ongoing or planned. These sanctuaries include the three sanctuaries identified by the Department as the next areas for large-scale restoration (Herring Bay, Hooper Strait and the Nanticoke River sanctuaries), the sanctuaries receiving ongoing plantings as part of the Eastern Bay Region restoration project (Cox Creek, Prospect Bay, Mill Hill, Eastern Bay, Wye River and Miles River sanctuaries) and sanctuaries that have received small-scale restoration plantings or are planned to receive small-scale restoration plantings in 2026 (Magothy River, South River, Poplar Island, Ringgold, Tilghman Island, Upper Patuxent River, and Calvert Shores sanctuaries). Many of these sanctuaries exhibited a positive population trend.

Four sanctuaries were classified as having a negative density trend from the Fall Oyster Survey data, two of which are slated to receive small-scale restoration plantings in 2026. These sanctuaries (Chester River ORA, Upper Chester River, Lower Chester River and Man O War sanctuaries) have been presented to the Oyster Advisory Commission as underperforming in order to receive recommendations for actions to improve their performance.

Five sanctuaries have been classified as Non-Governmental Organization (NGO) or laboratory use sanctuaries (Fort Carroll, Oxford Laboratory, Piney Point, Prospect Bay-Cabin Creek and Nanticoke River-Roaring Point sanctuaries). These sanctuaries were created specifically for the NGO oyster restoration projects or laboratory use and are generally small with little oyster habitat. The Department does not monitor restoration projects by the NGOs.

Nine sanctuaries were designated as data poor for evaluation or habitat poor for restoration (Big Annemessex, Cedar Point, Kitts Creek, LaTrappe Creek, Lower Patuxent River, Plum Point, Solomons Creek, Webster and Wicomico River

sanctuaries). Sanctuaries might be classified as data poor due to the presence of alternate substrates that are incompatible with the Department's sampling gear or because they are not regularly monitored during the Fall Oyster Survey. A status of poor restoration habitat may be attributed to either a lack of appropriate bottom to support recovery initiatives or deep sections that experience low dissolved oxygen (DO) levels.

Table 0-1. 2021-2025 individual sanctuary assessment.

Restored
Positive Fall Oyster Survey trend and/or High Density (>94 oysters per square meter)
Restoration received/planned/ongoing
Negative Fall Oyster Survey trend
NGO restoration efforts or laboratory use
No data or poor habitat for restoration

Sanctuary	Year Established	Acres: Total / Historic Oyster Bottom	2021-2025 Assessment
Big Annemessex	2010	749 / 361	Little to no oyster habitat
Breton Bay	2010	3,212 / 888	Positive trend
Calvert Shore	2010	2,214 / 673	Positive trend, small-scale restoration planned
Cedar Point	2010	3,473 / 2,839	Limited restoration potential due to deep areas subject to low DO
Chester River ORA	1996	6,189 / 184	Negative trend
Choptank River ORA	1996	8,962 / 236	Positive trend and high density
Cook Point	2001/2010	814 / 781	Positive trend
Cox Creek	2010	2,112 / 939	Eastern Bay Project restoration ongoing
Eastern Bay	2010	4,521 / 939	Eastern Bay Project restoration ongoing
Fort Carroll	1995	30 / 0	Created for Living Classrooms Foundation
Harris Creek	2010	4,647 / 1,998	Restored
Herring Bay	2004/2010	16,792 / 7,981	Slated for large-scale restoration

Hooper Straight	2009	7,307 / 5,317	Positive trend and high density- Next area for large-scale restoration
Howell Point	2001	6 / 6	Positive trend and high density
Kitts Creek	2001	1,181 / 95	Lacking data
La Trappe Creek	2002	377 / 13	Little to no oyster habitat
Little Choptank River	2010	9,415 / 1,713	Restored
Lower Chester River	2010	24,147 / 6,930	Negative trend, small-scale restoration planned
Lower Choptank River	2010	7,172 / 4,217	Positive trend
Lower Mainstem	2010	38,290 / 8,234	Positive trend and high density
Lower Patuxent River	2010	335 / 315	Limited restoration potential due to deep areas subject to low DO
Magothy River	2010	5,607 / 230	Received small-scale restoration
Man O War	2010	4,704 / 2,310	Negative trend
Manokin River	2010	16,320 / 11,040	Restored
Miles River	2010	3,449 / 373	Positive trend- Eastern Bay Project restoration ongoing
Mill Hill	2000	295 / 188	Positive trend- Eastern Bay Project restoration ongoing
Nanticoke River	2010	16,699 / 576	Positive trend and high density- Slated for large-scale restoration
Neal Addition	2001	7 / 7	Positive trend and high density
Oxford Lab	1961	36 / 3	No data- Oxford Laboratory research use
Piney Point	1986	13 / 0	No oyster habitat- Piney Point research use
Plum Point	1999	6,209 / 4,405	No data- large MARI site encompassing the sanctuary
Point Lookout	1999	399 / 396	Fall Oyster Survey high density
Poplar Island	2003	7 / 7	Small-scale restoration planned
Prospect Bay	2010	1,478 / 1,061	Eastern Bay Project restoration ongoing
Prospect Bay - Cabin Creek	2010	298 / 128	Created for Chesapeake Bay Environmental Center
Ringgold	2001	120 / 63	Unable to sample due to alternate substrate, small-scale restoration ongoing

Roaring Point	2004	10 / 0	Created for Chesapeake Bay Foundation
Sandy Hill	2009	1,947 / 1,308	Positive trend
Severn River	1998/2010	7,804 / 1,376	Positive trend and high density
Solomons Creeks	2010	617 / 5	Little to no oyster habitat
Somerset	1999	101 / 6	Positive trend and high density
South River	2000	2,327 / 141	Received small-scale restoration and planned small-scale restoration
St Mary's River	2010	1,304 / 89	Restored
Tilghman Island	2010	2,534 / 1,345	Small-scale restoration planned
Tred Avon River	2010	4,149 / 1,152	Restored
Upper Chester River	2010	9,033 / 2,365	Negative trend, small-scale restoration planned
Upper Choptank River	2010	5,898 / 1,675	Positive trend and high density
Upper Patuxent River	2003/2010	14,461 / 2,228	Positive trend and high density, Small-scale restoration planned
Webster	1997	554 / 0	No Data- Oyster bottom is a lease
Wicomico River	2010	450 / 272	Little to no oyster habitat
Wye River	2010	3,510 / 1,100	Positive trend and high density- Eastern Bay Project restoration ongoing

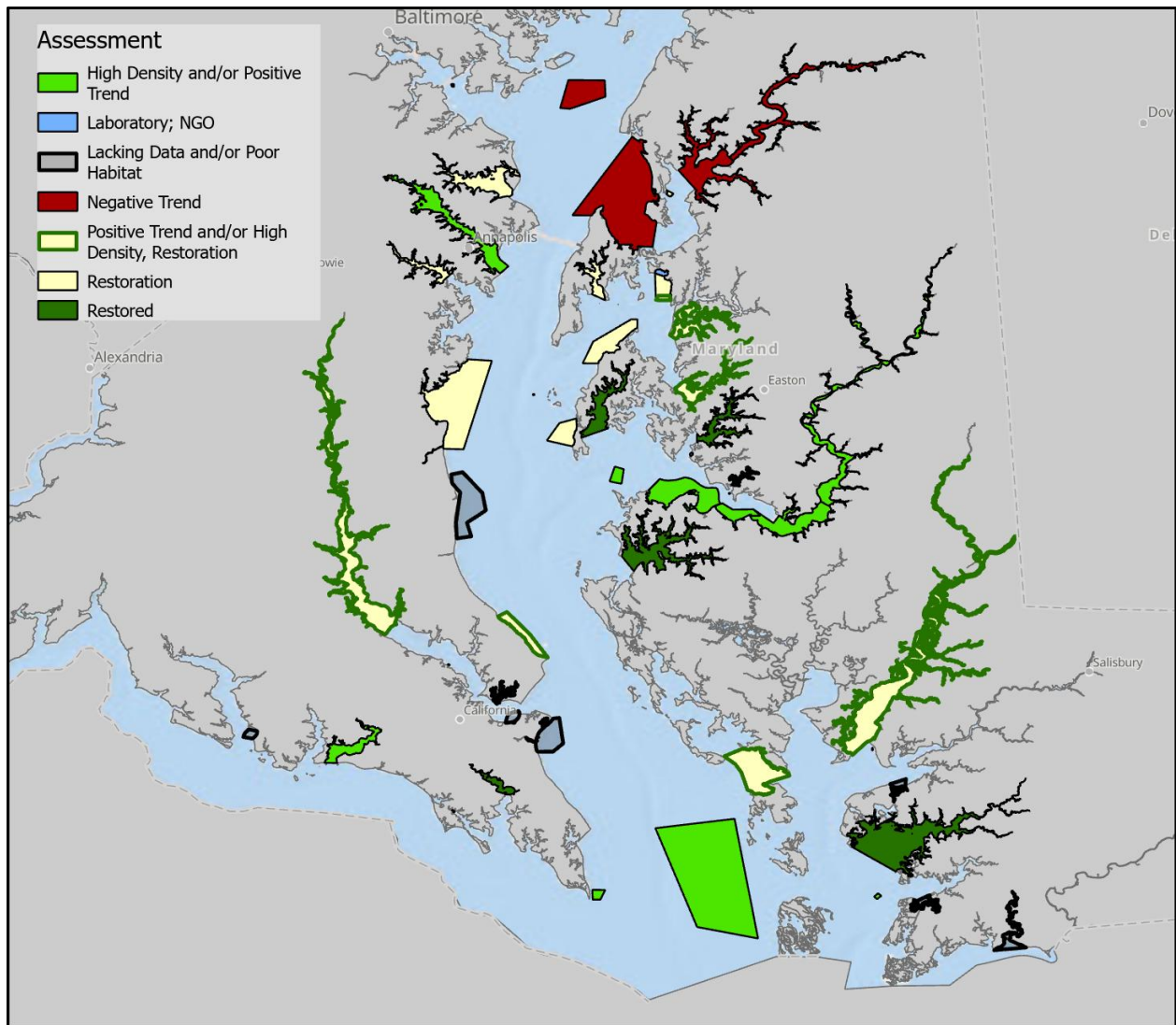


Figure A.0-3. Map showing the sanctuary assessments. Areas are classified as High Density and/or Positive Trend, Laboratory or NGO, Lacking Data and/or Poor Habitat, Negative Trend, Positive Trend and/or High Density receiving Restoration, Restoration planned, and Restored.

Section A.01: Big Annemessex Sanctuary

The Big Annemessex Sanctuary is located in a high salinity (Zone 3) region of Maryland's lower eastern portion of Chesapeake Bay within NOAA Code 005. The sanctuary was created in 2010 and encompasses 749 acres of which 361 acres (48%) are historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments). There are four historic oyster bars within the sanctuary¹⁰, two of which lie almost entirely outside the sanctuary and account for only 0.9% of the total area of the sanctuary and two of which lie almost entirely within the sanctuary boundary.

Information available for this sanctuary includes:

- Sanctuary map (Figure A.01-1)
- Density Survey (Figure A.01-2)

Big Annemessex Sanctuary is located in the Lower Eastern Shore Region of Maryland's Chesapeake Bay. Oysters in the Lower Eastern Shore Region generally grow well but can be impacted by disease. Elevated salinity levels in the region promote increased natural recruitment.

At the time of its designation, this sanctuary contained few to no oysters or suitable habitat, as it was primarily a shallow-water area characterized by loose sand.

The Fall Oyster Survey does not regularly sample this sanctuary.

A patent tong population survey was conducted in 2025 and found no live oysters in Big Annemessex and no surface shell volume. Many of the planned samples could not be obtained due to shallow water. The previous patent tong survey conducted in 2017 also found no oysters or surface shell.

Due to its poor bottom habitat, this area is not considered a candidate for restoration initiatives and has received no active replenishment or restoration efforts since 2006.

The sanctuary was one of the sanctuaries identified by the Department as unlikely to receive a large investment by the Department for restoration and is under evaluation by the Oyster Advisory Commission for potential efforts to improve its performance.

In the 2021-2025 sanctuary assessment, this sanctuary was determined to be lacking due to poor habitat.

¹⁰ See chart 45 for bar names and locations in the State of Maryland Shellfish Closure Areas Book <http://dnr.maryland.gov/fisheries/Pages/oysters/index.aspx>

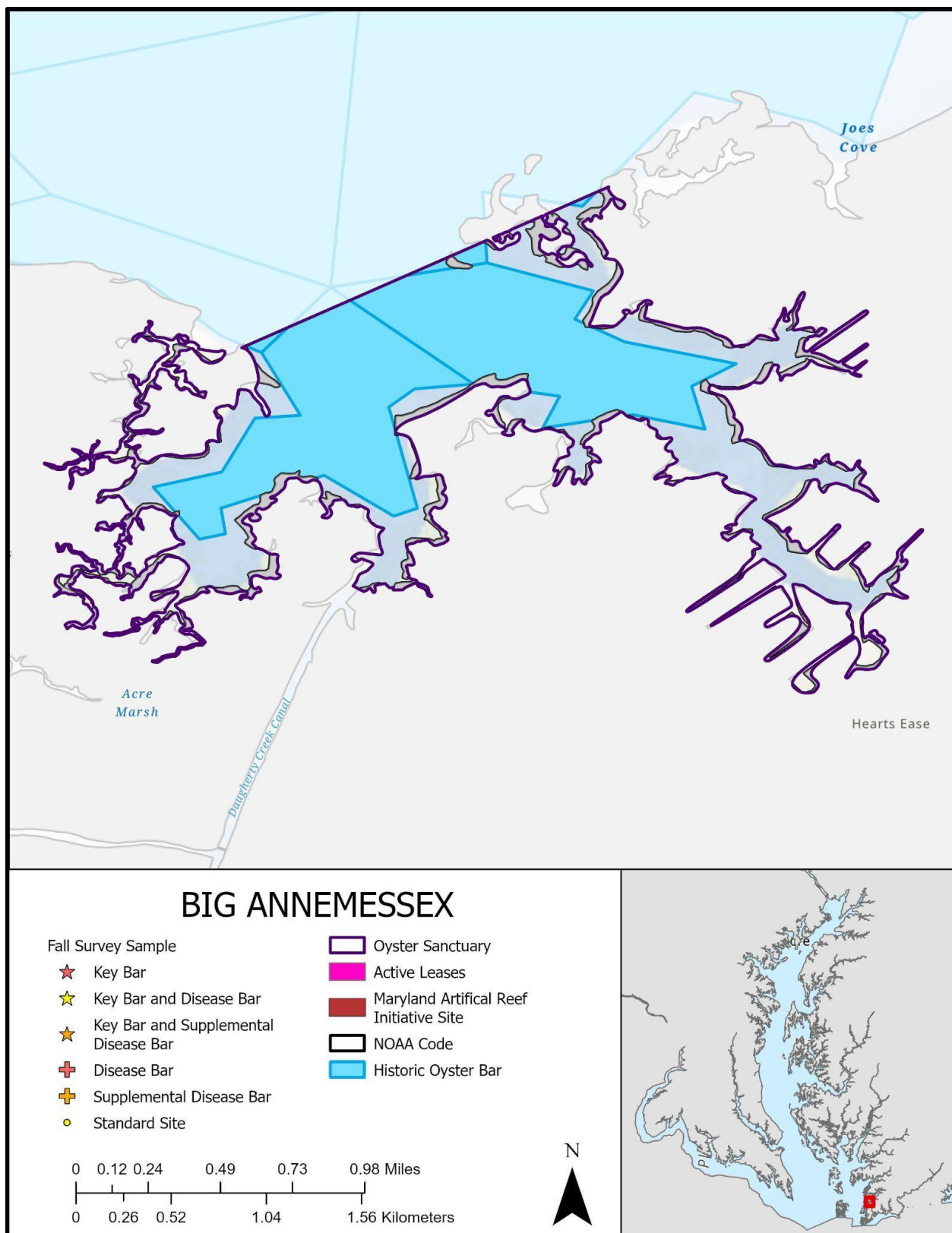


Figure A.01-1. Big Annemessex Sanctuary.

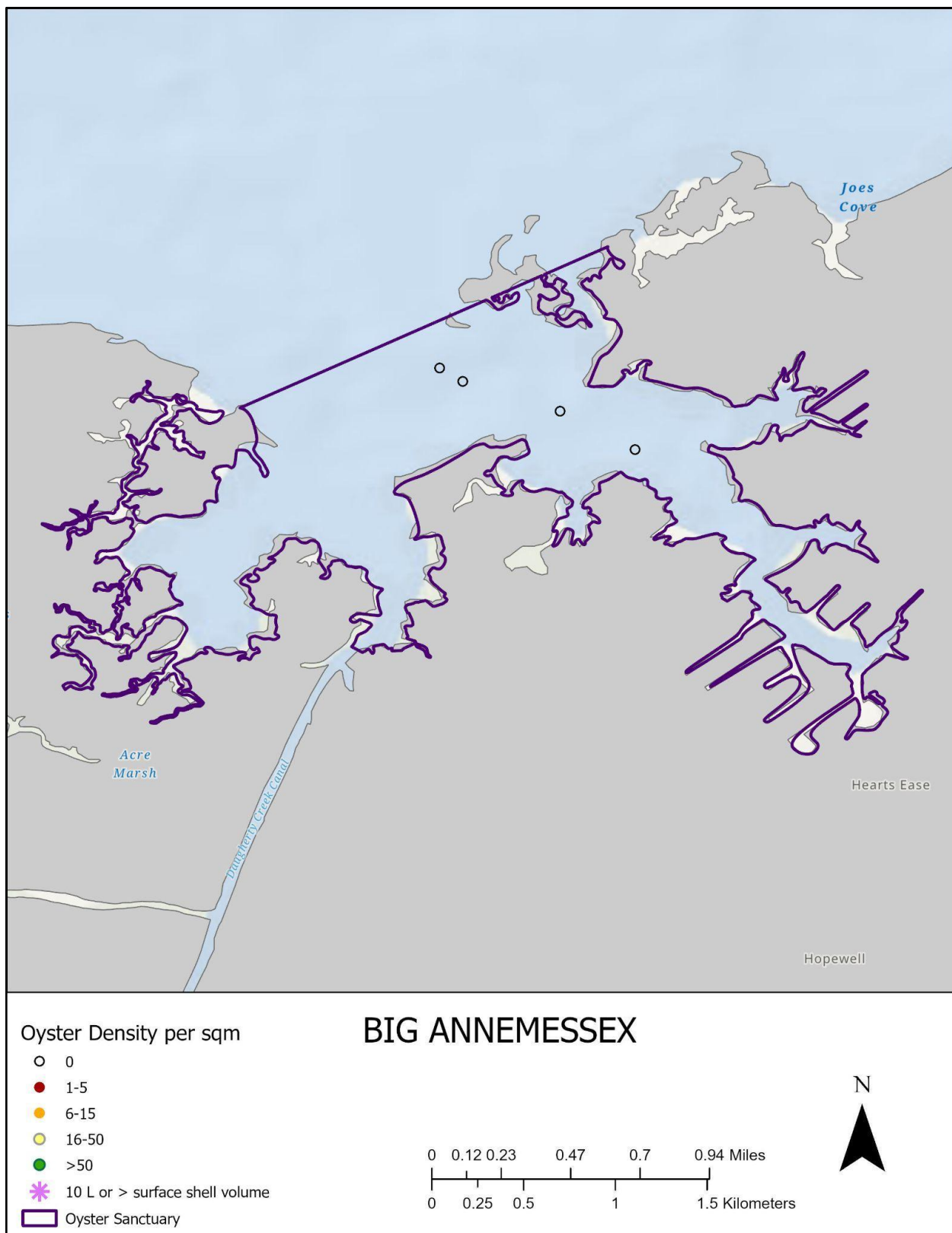


Figure A.01-2. Map of 2025 oyster density in the Big Annemessex Sanctuary. Data from Maryland Department of Natural Resources Patent Tong Population Survey.

Section A.02: Breton Bay Sanctuary

The Breton Bay Sanctuary is located within Breton Bay on the north shore of the Potomac River, a low salinity (Zone 1) region, within NOAA Code 174. The sanctuary was created in 2010 and encompasses 3,212 acres, of which 888 acres (28%) are historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments). There are 10 historic oyster bars within the sanctuary¹¹.

Information available for this sanctuary includes:

- Sanctuary map (Figure A.02-1)
- Density Survey (Figure A.02-2)
- Summary statistics (Table A.02-1)
- Density per year (Figure A.02-3)
- Shell height frequencies (Figure A.02-4)
- Biomass per year (Figure A.02-5)
- Observed mortality (Figure A.02-6)
- Cultch per year (Figure A.02-7)

Breton Bay Sanctuary is located in the Lower Western Shore Region of Maryland's Chesapeake Bay. Oysters in the Lower Western Shore Region generally grow well but may be impacted by disease or freshet events. Natural recruitment occurs regularly in this region.

The Fall Oyster Survey samples one sentinel key bar site in the Breton Bay Sanctuary. While the Lower Western Shore Region generally gets natural recruitment, Breton Bay Sanctuary has little natural recruitment. Table A.02-1 shows an increase in the average number of oysters and biomass from 2021-2025 data compared to the previous 5-year increments. This increase in the average number of oysters is likely due to the historic generational spatset in the Potomac region in 2023. The oyster density and cultch remain low.

A population patent tong survey was conducted by the Department in 2025 and found one live oyster in Breton Bay. There was a total of 17.35 liters of surface shell from the 121 samples taken. This is similar to the 2018 patent tong results that found no live oysters and a total of 11.15 liters of surface shell from the 237 samples taken.

Marylanders Grow Oysters plantings have occurred annually since 2019. The Friends of Saint Clements Bay and the St. Mary's River Watershed Association have planted over 4.5 million spat in addition to the efforts of the Marylanders Grow Oyster program on a 1.5-acre area near Lovers Point. In 2025 they monitored the restoration area and found a healthy reef with three-dimensional structure and multiple year classes present.

In the 2021-2025 sanctuary assessment, this sanctuary was determined to be trending positively.

¹¹ See chart 34 for bar names and locations in the State of Maryland Shellfish Closure Areas Book <http://dnr.maryland.gov/fisheries/Pages/oysters/index.aspx>

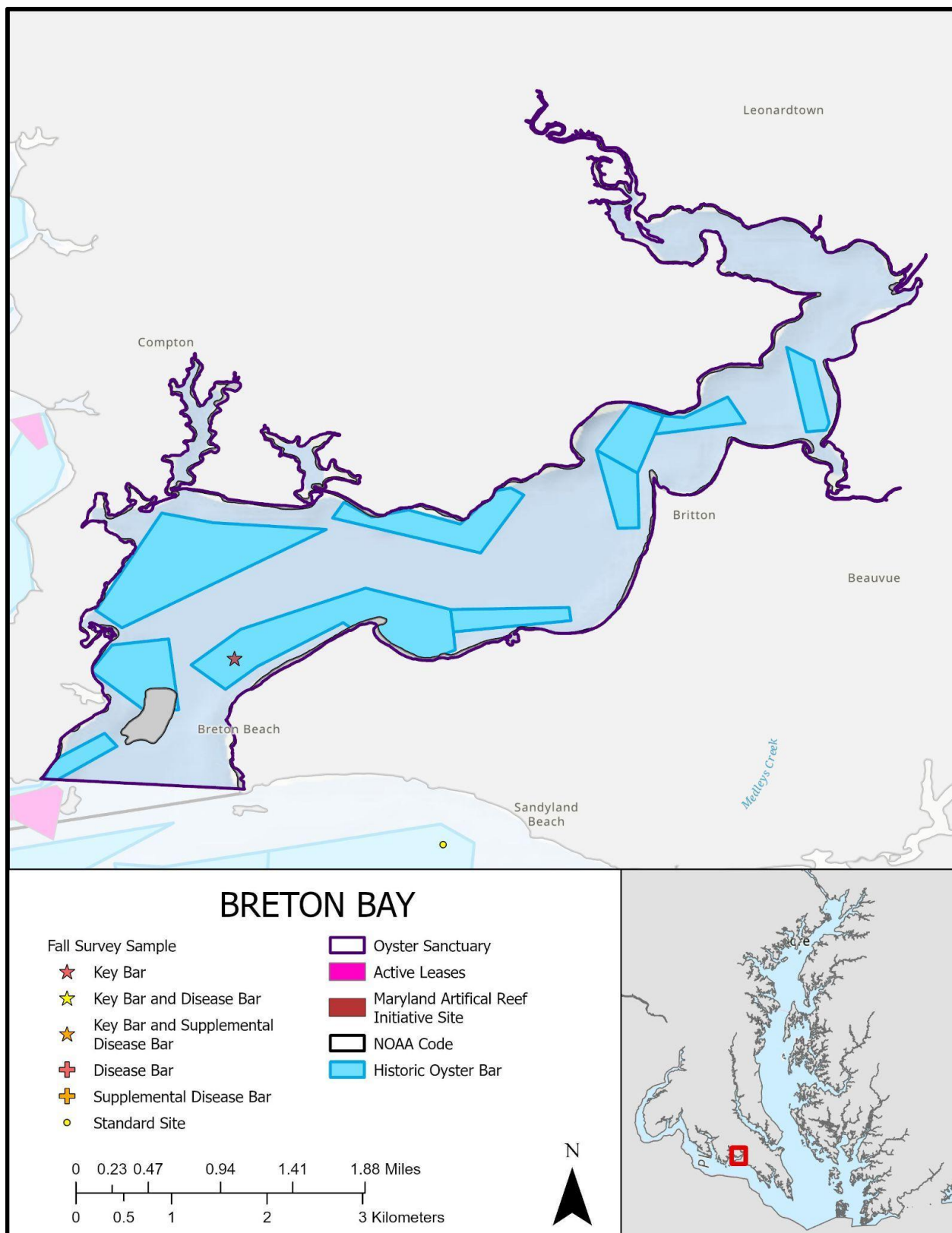


Figure A.02-1. Breton Bay Sanctuary.

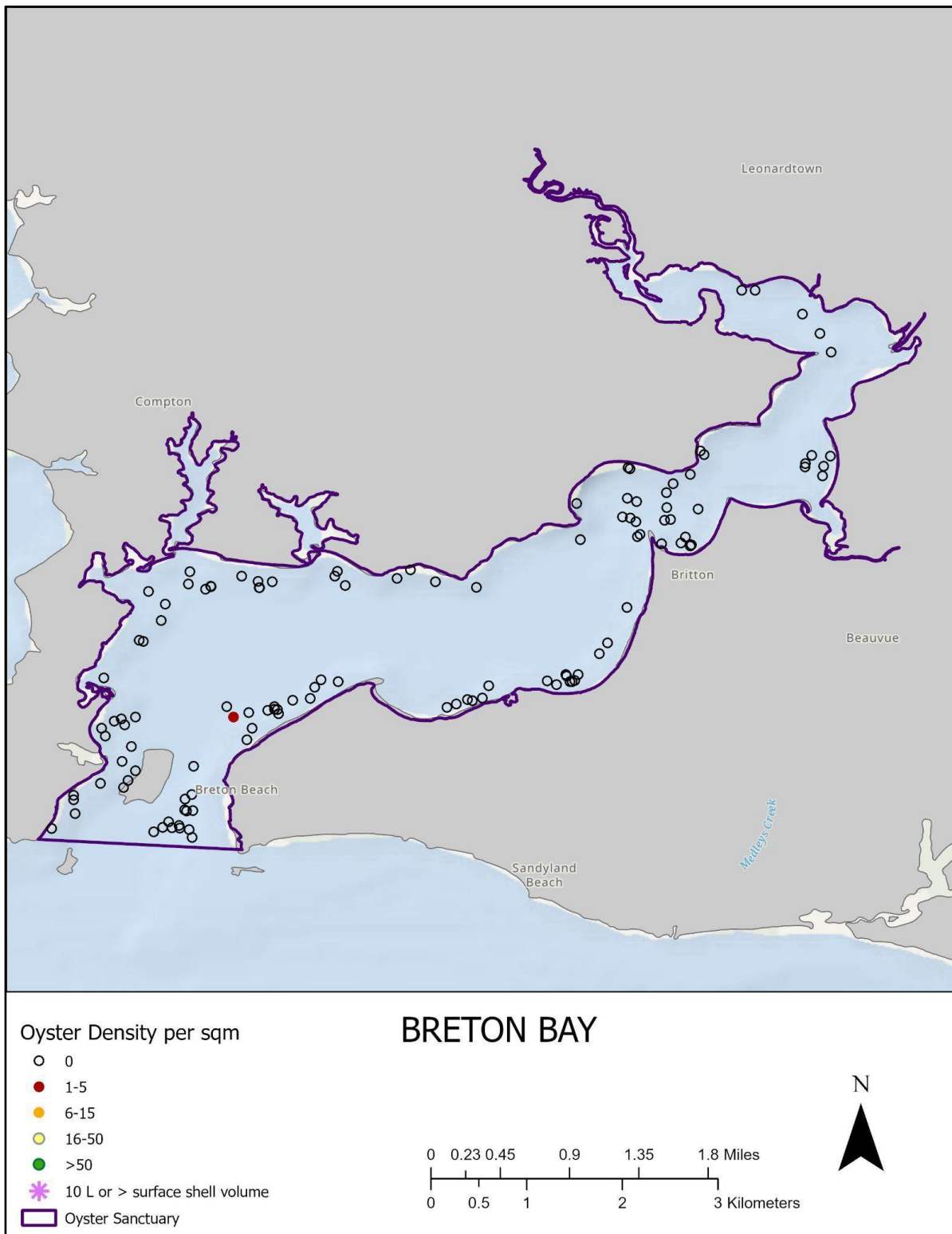


Figure A.02-2. Map of 2025 oyster density in the Breton Bay Sanctuary. Data from Maryland Department of Natural Resources Patent Tong Population Survey.

Table A.02-1. Oyster population characteristics based on the Fall Oyster Survey in the Breton Bay Sanctuary. ND=No Data. Values given are annual mean $\pm$ standard error.

Oyster Characteristic	2006-2010	2011-2015	2016-2020	2021-2025
Number of years sampled/number of samples	5/5	5/5	5/5	5/5
Number of Live Spat Oysters per square meter	0.05 $\pm$ 0.05	0	0.01 $\pm$ 0.01	0.7 $\pm$ 0.6
Number of Live Small Oysters per square meter	0.08 $\pm$ 0.05	0.07 $\pm$ 0.01	0.07 $\pm$ 0.02	9.5 $\pm$ 5.8
Number of Live Market Oysters per square meter	0.84 $\pm$ 0.22	0.88 $\pm$ 0.18	0.35 $\pm$ 0.01	2.8 $\pm$ 2.1
Number of Live Oysters per square meter	1 $\pm$ 0.2	1 $\pm$ 0.17	0.43 $\pm$ 0.1	13 $\pm$ 7
Live Biomass (g Dry Weight per Bushel)	ND	50 $\pm$ 21	38 $\pm$ 12	83 $\pm$ 33
Observed Mortality (%)	15 $\pm$ 10	17 $\pm$ 4.8	16.4 $\pm$ 4.6	0
Cultch (Bushels per 100 feet towed)	0.65 $\pm$ 0.13	0.18 $\pm$ 0.02	0.07 $\pm$ 0.02	0.37 $\pm$ 0.08

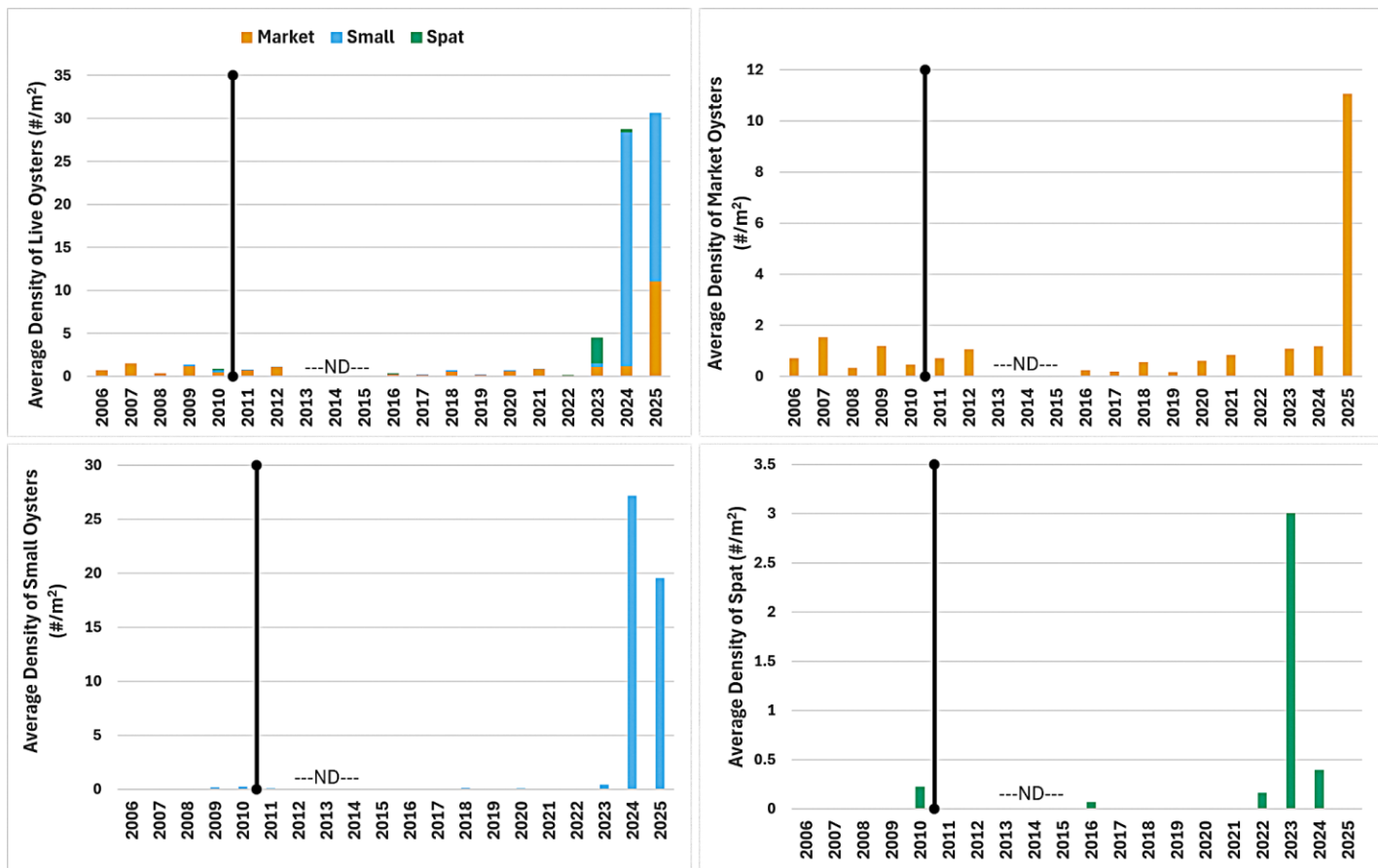


Figure A.02-3. Average number of live oysters per square meter by size class in the Breton Bay Sanctuary. Black line indicates the date the sanctuary was established. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales. ND = No Data.

BRETON BAY (2010)

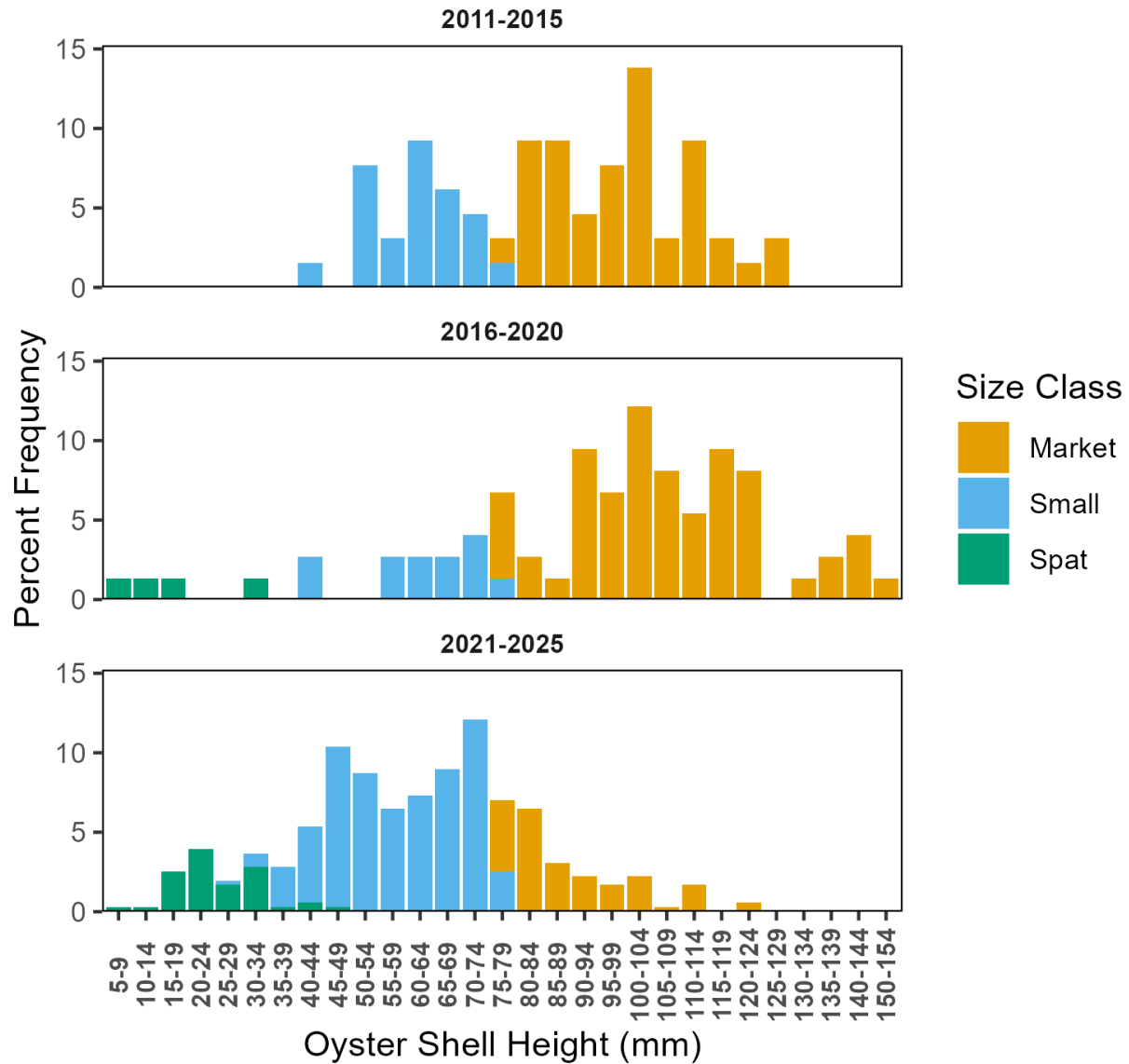


Figure A.02-4. Shell height frequencies of live oysters in the Breton Bay Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey on Black Walnut bar. Data was not collected from 2006 to 2010 or in 2015.

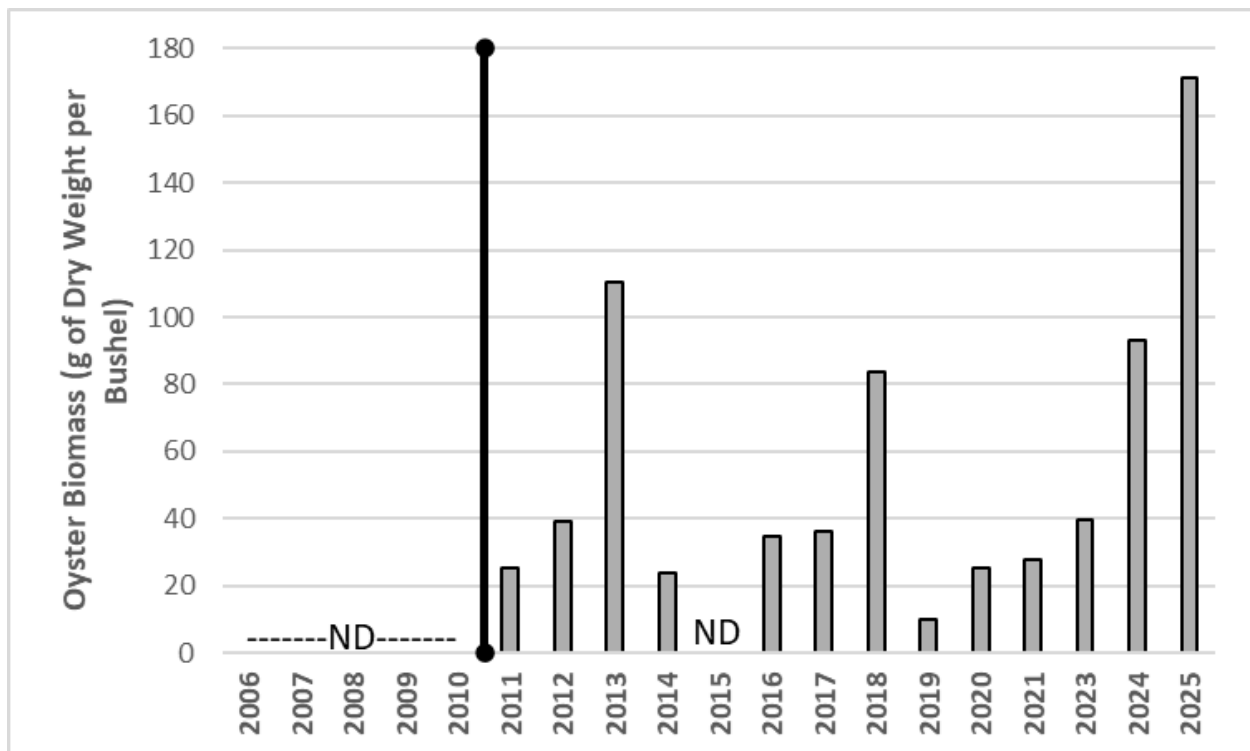


Figure A.02-5. Oyster biomass (grams of dry weight per bushel of material) in the Breton Bay Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey on Black Walnut bar. Black line indicates the date the sanctuary was established. ND = No Data.

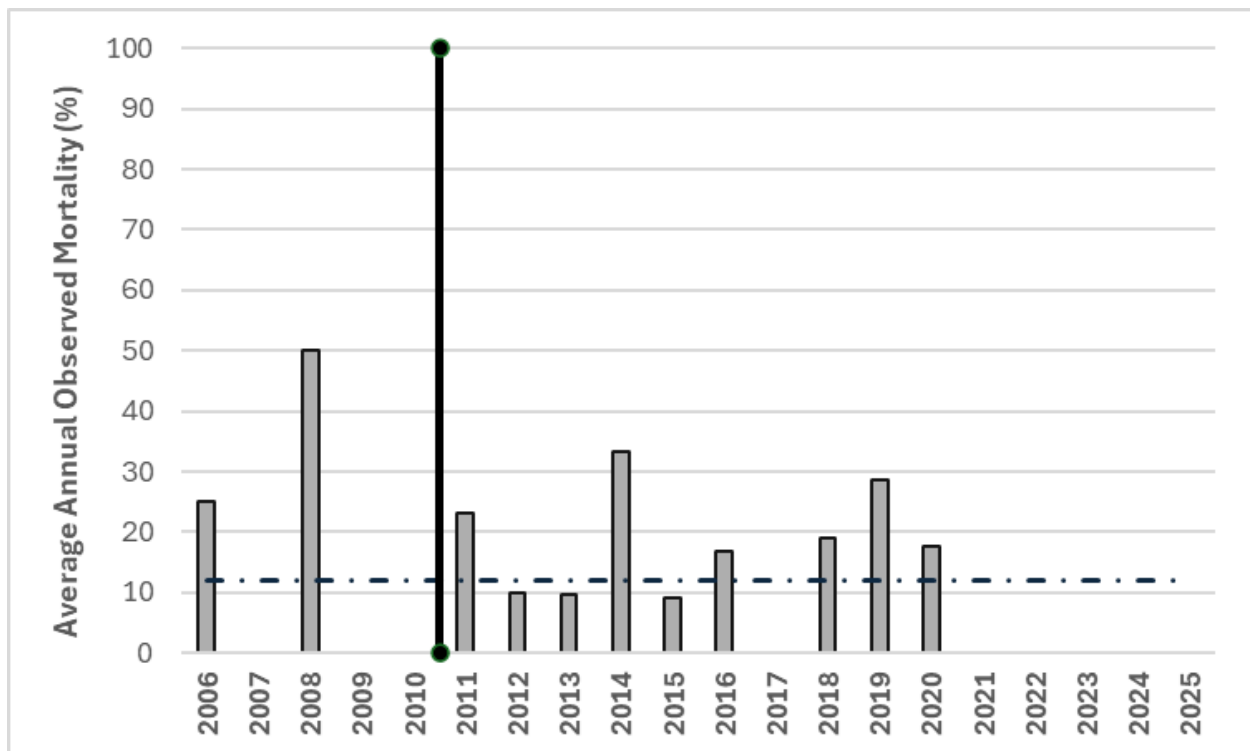


Figure A.02-6. Average annual observed mortality of market-sized and small-sized oysters in Breton Bay Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Black line denotes the date the sanctuary was established, and the dashed line represents the 2006-2025 baywide average observed mortality.

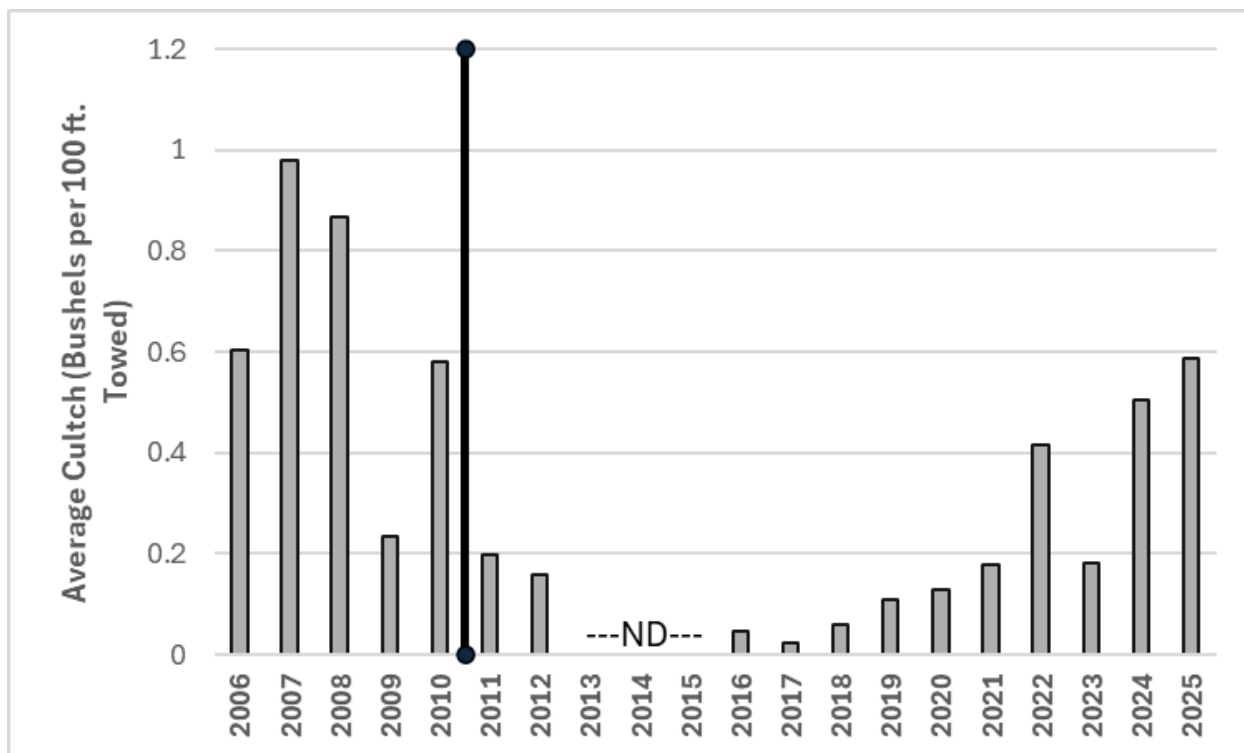


Figure A.02-7. Average cultch (live and dead oysters and loose shell) in the Breton Bay Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Black line denotes the date the sanctuary was established. ND = No Data.

Section A.03: Calvert Shore Sanctuary

The Calvert Shore Sanctuary is located in the medium salinity (Zone 2) region of Maryland's lower western portion of Chesapeake Bay within NOAA Code 027. The sanctuary was created in 2010 and encompasses 2,214 acres of which 673 (30.4%) is historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments). There is one historic oyster bar within the sanctuary, Flag Pond.

Information available for this sanctuary includes:

- Sanctuary map (Figure A.03-1)
- Density Survey (Figure A.03-2)
- Summary statistics (Table A.03-1)
- Density per year (Figure A.03-3)
- Shell height frequencies (Figure A.03-4)
- Biomass per year (Figure A.03-5)
- Observed mortality (Figure A.03-6)
- Dermo and MSX per year (Figure A.03-7)
- Cultch per year (Figure A.03-8)

Calvert Shore Sanctuary is located in the Lower Western Shore Region of Maryland's Chesapeake Bay. Oysters in the Lower Western Shore Region generally grow well but may be impacted by disease or freshet events. Natural recruitment occurs regularly in this region.

The Fall Oyster Survey samples one sentinel key and disease bar site in the Calvert Shore Sanctuary. While the Lower Western Shore Region generally gets natural recruitment, Calvert Shore Sanctuary has little natural recruitment. Table A.03-1 shows an increase in the average number of oysters as well as an increase in mortality from 2021-2025 data compared to the previous 5-year increments. While Calvert Shore Sanctuary has seen some improvement, oyster density and cultch remain low. The increase in observed mortality throughout this time coincides with an increase in lethal prevalence of dermo disease and MSX in 2023 (Figure A.03-7).

A population patent tong survey was conducted by the Department in 2023 and found an average of 0.7 oysters per sq m with a total of 69.3 liters of surface shell from the 150 samples taken. This is higher than the 2015 patent tong results that found 0.2 oysters per sq m and a total of 29.7 liters of surface shell from 136 samples.

In the 2021-2025 sanctuary assessment, this sanctuary was determined to be trending positively with planned restoration. This sanctuary is slated to receive a small-scale restoration planting in 2026.

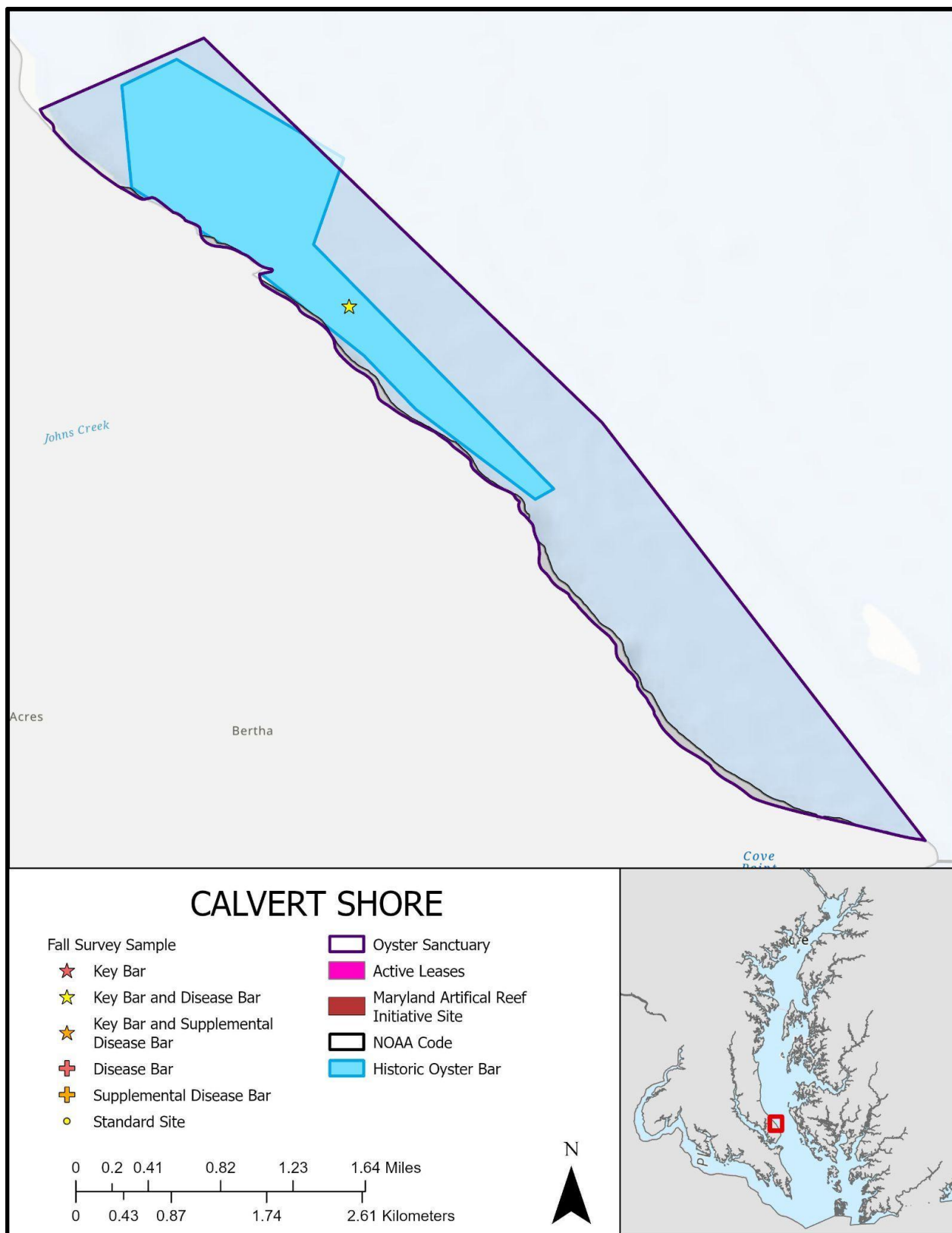


Figure A.03-1. Calvert Shore Sanctuary.

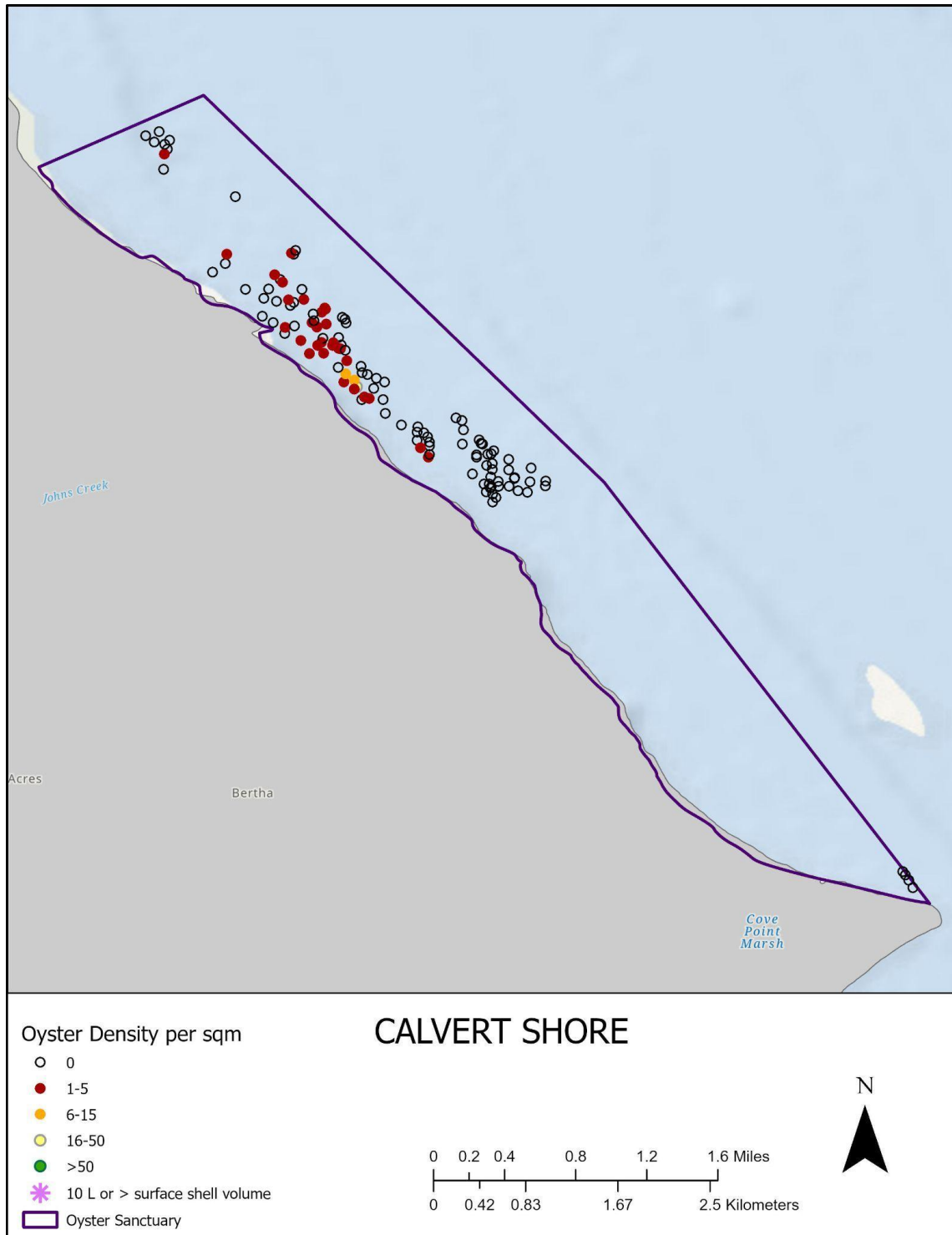


Figure A.03-2. Map of 2023 oyster density in the Calvert Shore Sanctuary. Data from Maryland Department of Natural Resources Patent Tong Population Survey.

Table A.03-1. Oyster population characteristics based on the Fall Oyster Survey in the Calvert Shore Sanctuary. ND=No Data. Values given are annual mean $\pm$ standard error.

Oyster Characteristic	2006-2010	2011-2015	2016-2020	2021-2025
Number of years sampled/number of samples	5/5	5/5	5/5	5/5
Number of Live Spat Oysters per square meter	1.4 ± 1.4	ND	0.17 ± 0.15	1.4 ± 1
Number of Live Small Oysters per square meter	0.54 ± 0.35	ND	1.9 ± 1.1	2.3 ± 0.42
Number of Live Market Oysters per square meter	1.3 ± 0.74	ND	7.8 ± 6.2	14 ± 2.9
Number of Live Oysters per square meter	3.3 ± 0.33	ND	10 ± 7.1	18 ± 2.7
Live Biomass (g Dry Weight per Bushel)	43 ± 19	98 ± 33.1	278 ± 75.5	256 ± 27.3
Observed Mortality (%)	13 ± 4.9	8.82 ± 2.7	13.4 ± 9.2	21.3 ± 4.7
Cultch (Bushels per 100 feet towed)	0.37 ± 0.11	ND	0.11 ± 0.1	0.37 ± 0.1

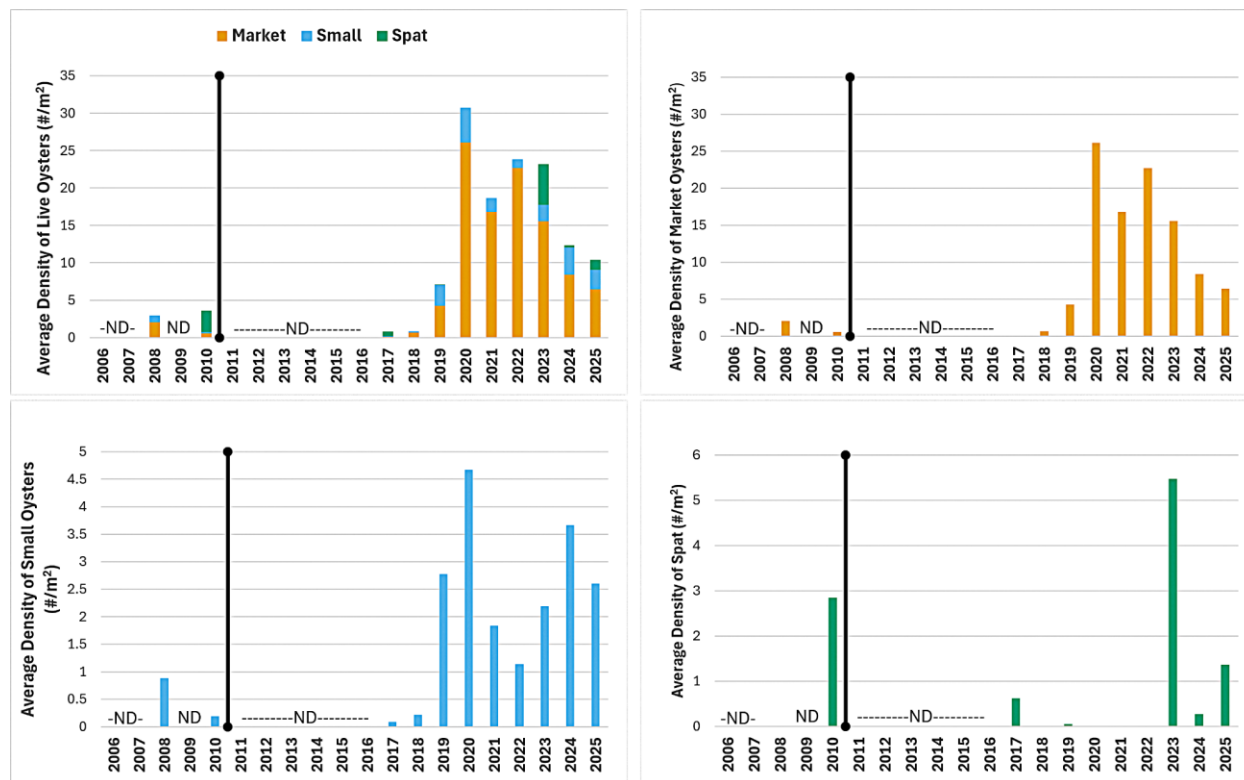


Figure A.03-3. Average number of live oysters per square meter by size class in the Calvert

Shore Sanctuary. Black line indicates the date the sanctuary was established. Data from Maryland’s Annual Fall Oyster Dredge Survey. Note differing Y-axis scales. ND = No Data.

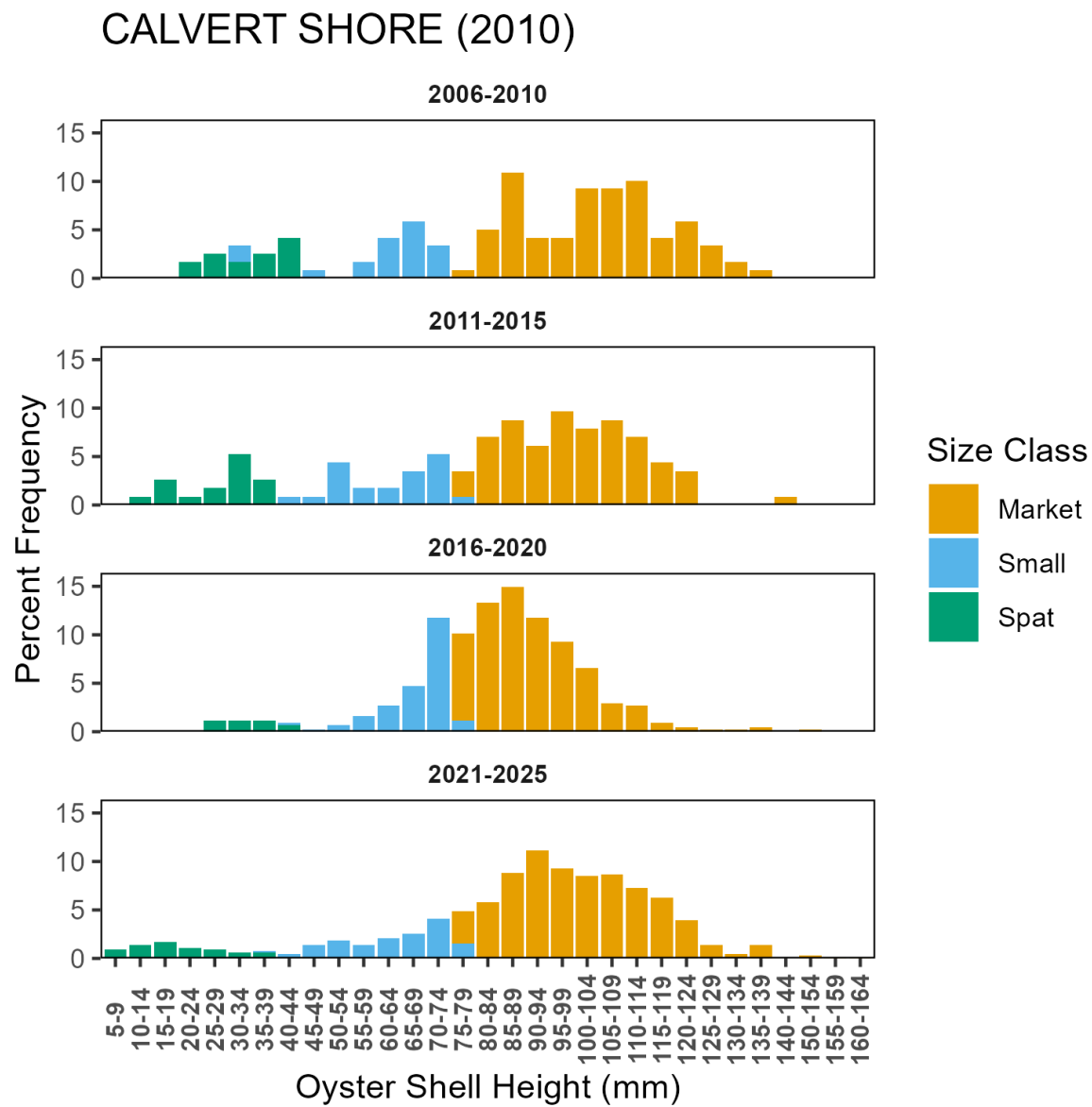


Figure A.03-4. Shell height frequencies of live oysters in the Calvert Shore Sanctuary. Data from Maryland’s Annual Fall Oyster Dredge Survey on Flag Pond bar.

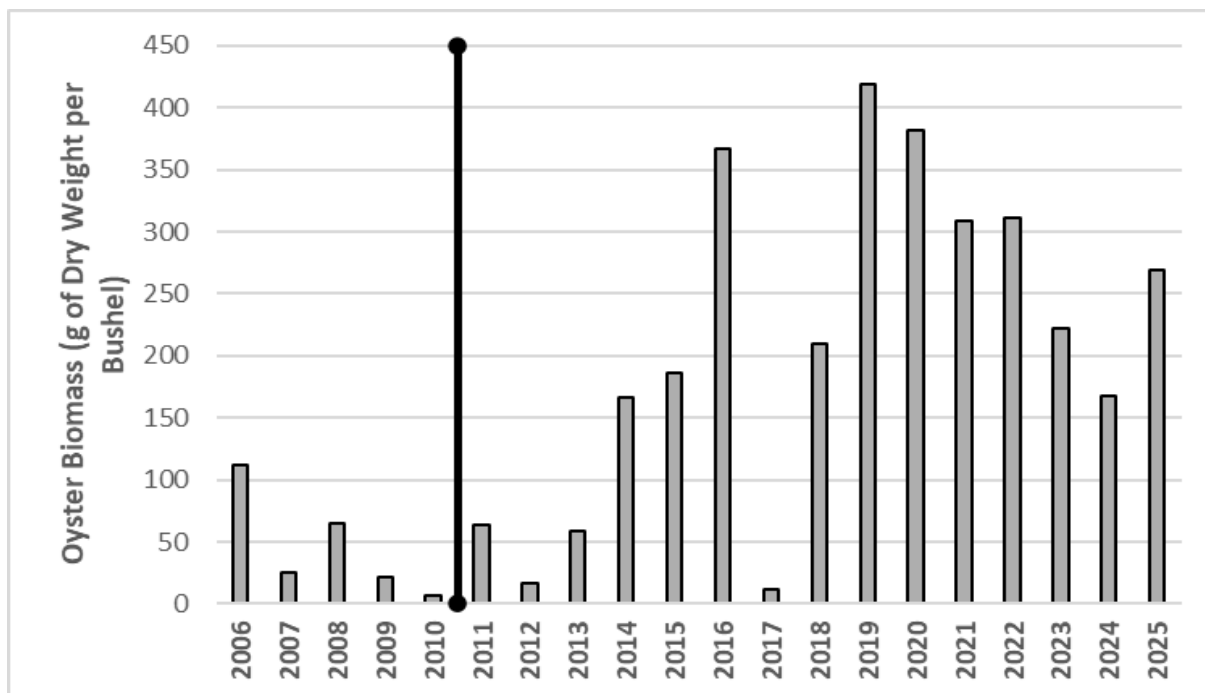


Figure A.03-5. Oyster biomass (grams of dry weight per bushel of material) in the Calvert Shore Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey on Flag Pond bar. Black line indicates the date the sanctuary was established.

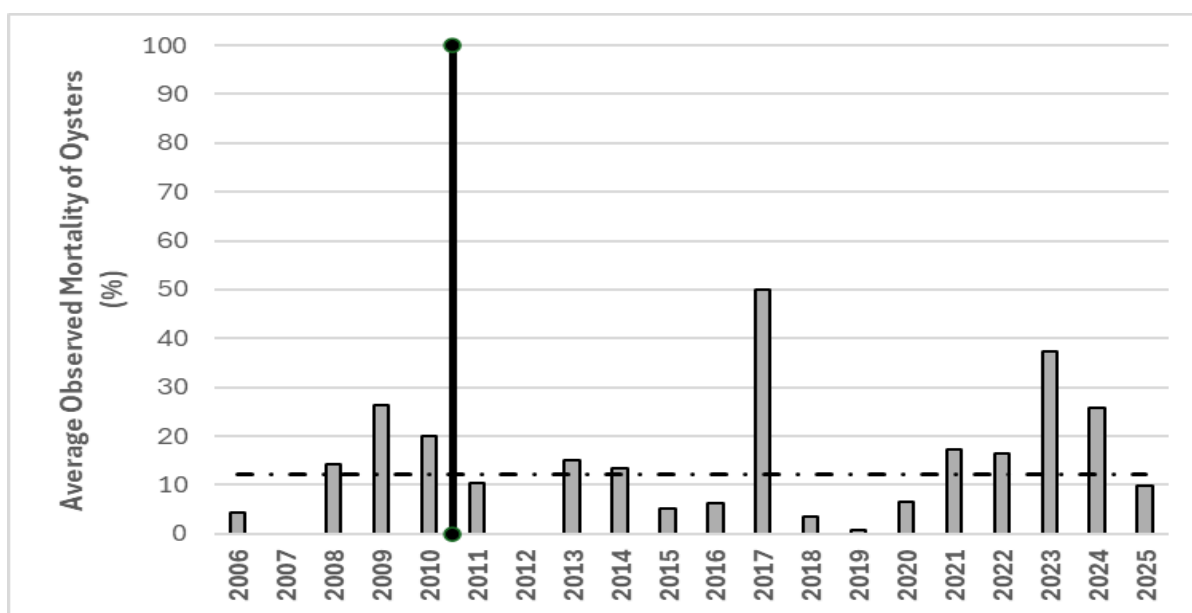


Figure A.03-6. Average annual observed mortality of market-sized and small-sized oysters in Calvert Shore Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Black line denotes the date the sanctuary was established, and the dashed line represents the 2006-2025 baywide average observed mortality.

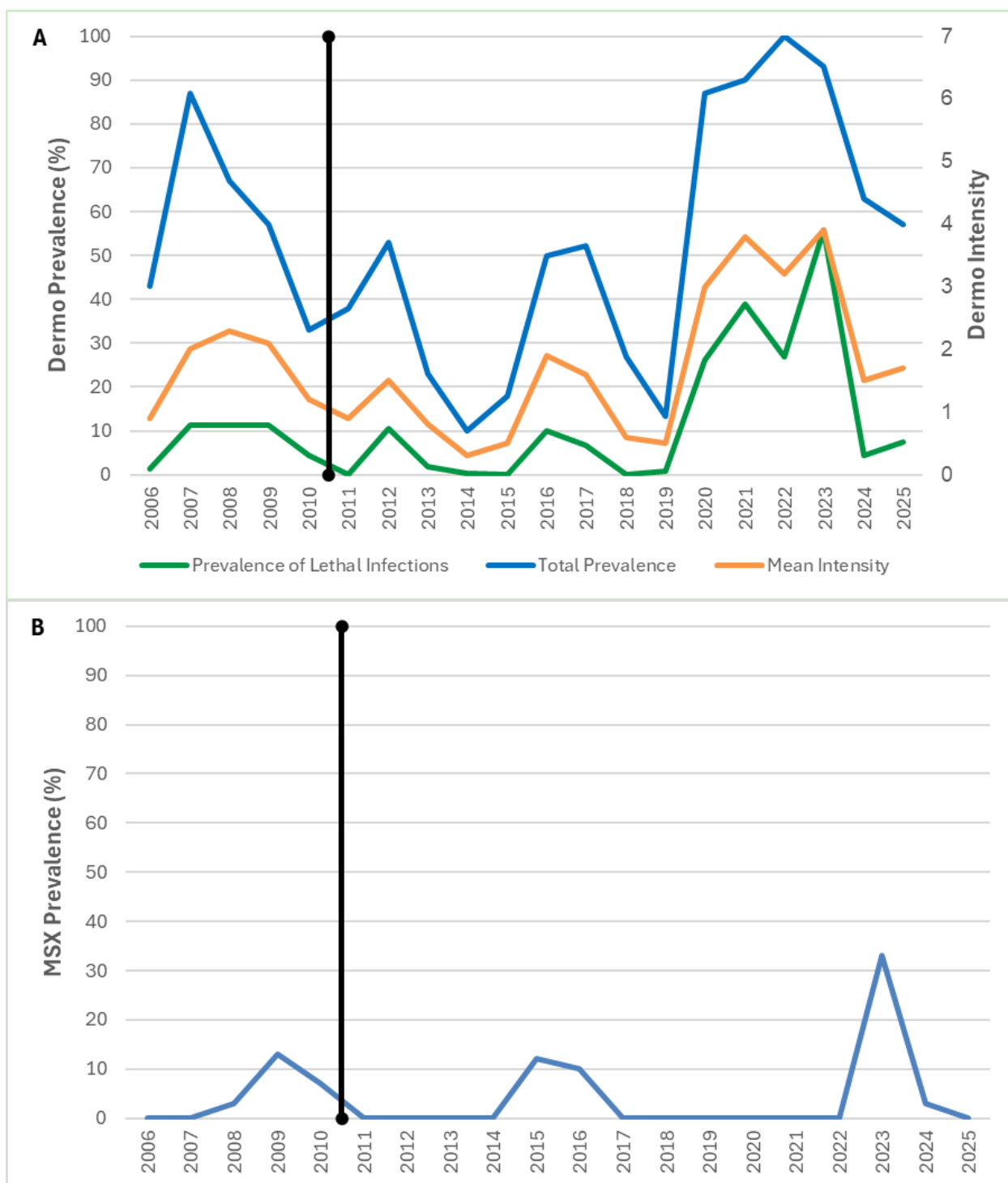


Figure A.03-7. Oyster disease prevalence and intensity in the Calvert Shore Sanctuary. (A) Dermo prevalence and mean intensity (B) MSX prevalence (intensity is not examined). Data from Maryland's Annual Fall Oyster Dredge Survey on Flag Pond bar. Black line denotes the date the sanctuary was established.

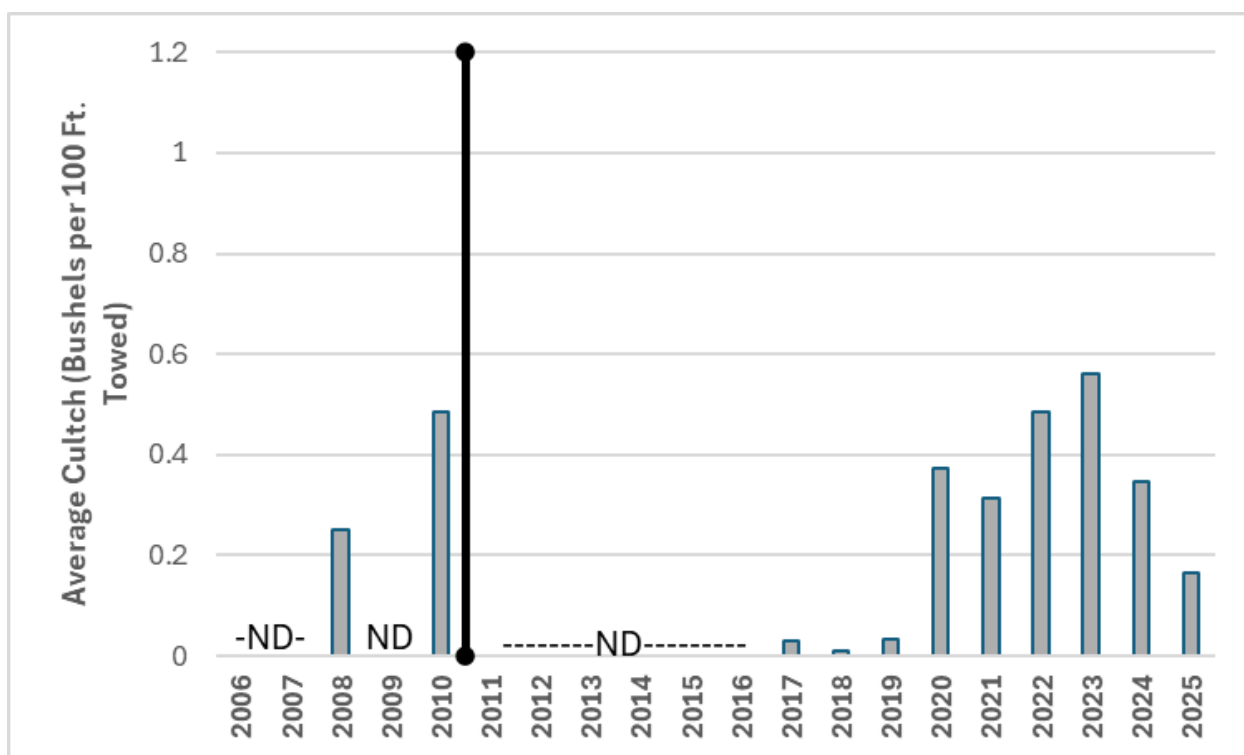


Figure A.03-8. Average cultch (live and dead oysters and loose shell) in the Calvert Shore Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Black line denotes the date the sanctuary was established. ND = No Data.

Section A.04: Cedar Point Sanctuary

The Cedar Point Sanctuary is located on the upper St. Mary's County Shore, a medium salinity (Zone 2) region, within NOAA Code 229. The sanctuary was created in 2010 and encompasses 3,473 acres of which 2,839 (82%) is historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments). There are two historic oyster bars within the sanctuary¹²; however, one of the bars only has 40% of its area within the sanctuary.

Information available for this sanctuary includes:

- Sanctuary map (Figure A.04-1)
- Density Survey (Figure A.04-2)
- Summary Statistics (Table A.04-1)

Cedar Point Sanctuary is located in the Lower Western Shore Region of Maryland's Chesapeake Bay. Oysters in the Lower Western Shore Region generally grow well but may be impacted by disease or freshet events. Natural recruitment occurs regularly in this region.

In 2022 the Department added a standard Fall Oyster Survey site in Cedar Point Sanctuary. A population patent tong survey was conducted by the Department in 2022 and found 5 oysters with a total of 3 liters of surface shell from the 150 samples taken. This is similar to the results from the 2013 patent tong survey.

A majority of this sanctuary is in deep water and may have issues with periods of low dissolved oxygen at these depths, limiting its restoration potential.

This sanctuary was one of the sanctuaries identified by the Department as unlikely to receive a large investment by the Department for restoration and is under evaluation by the Oyster Advisory Commission for potential efforts to improve its performance.

In the 2021-2025 sanctuary assessment, this sanctuary was determined to have poor habitat due to the potential for low dissolved oxygen.

¹² See chart 35 for bar names and locations in the State of Maryland Shellfish Closure Areas Book
<http://dnr.maryland.gov/fisheries/Pages/oysters/index.aspx>

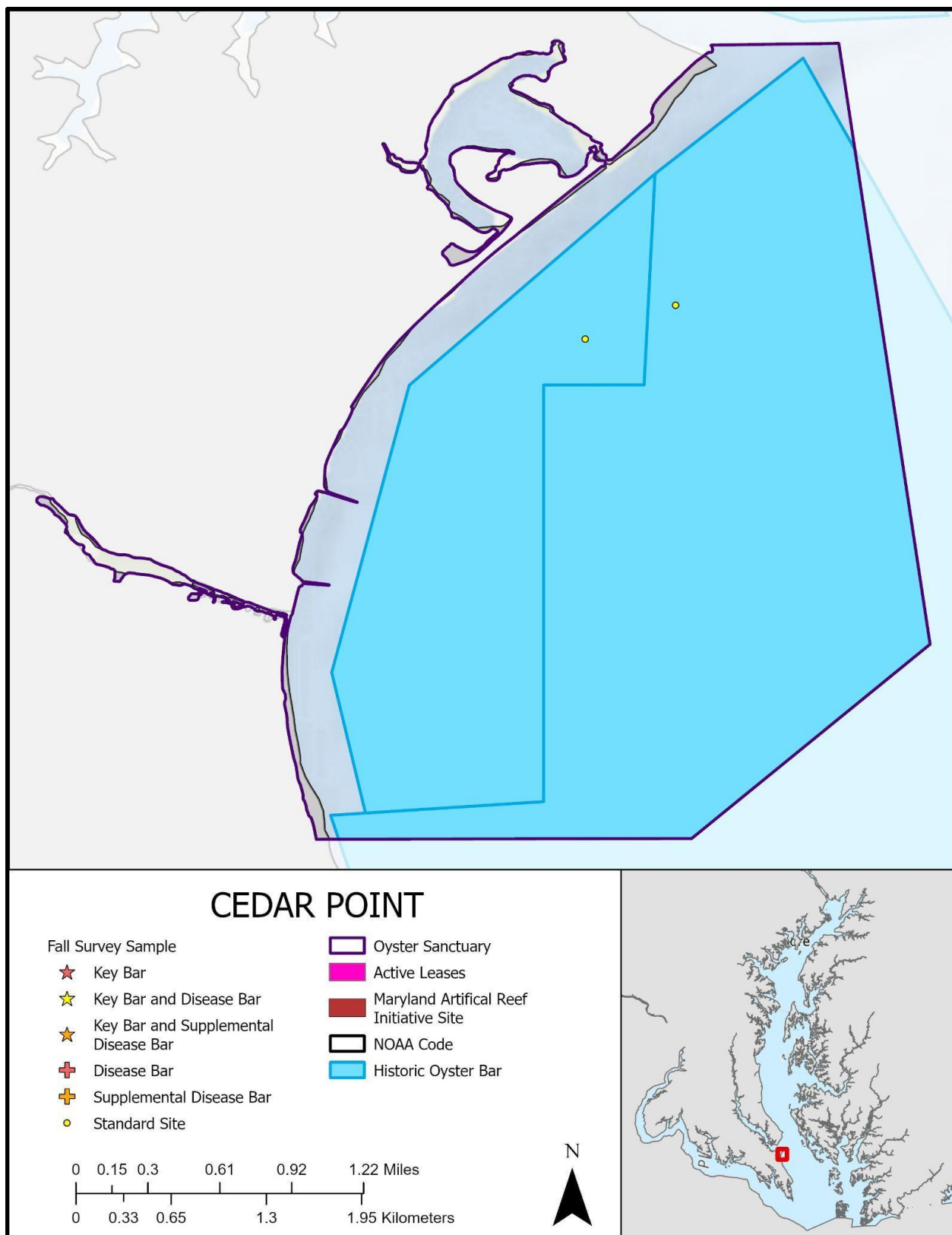


Figure A.04-1. Cedar Point Sanctuary. Fall Oyster Survey sites may not be sampled every year.

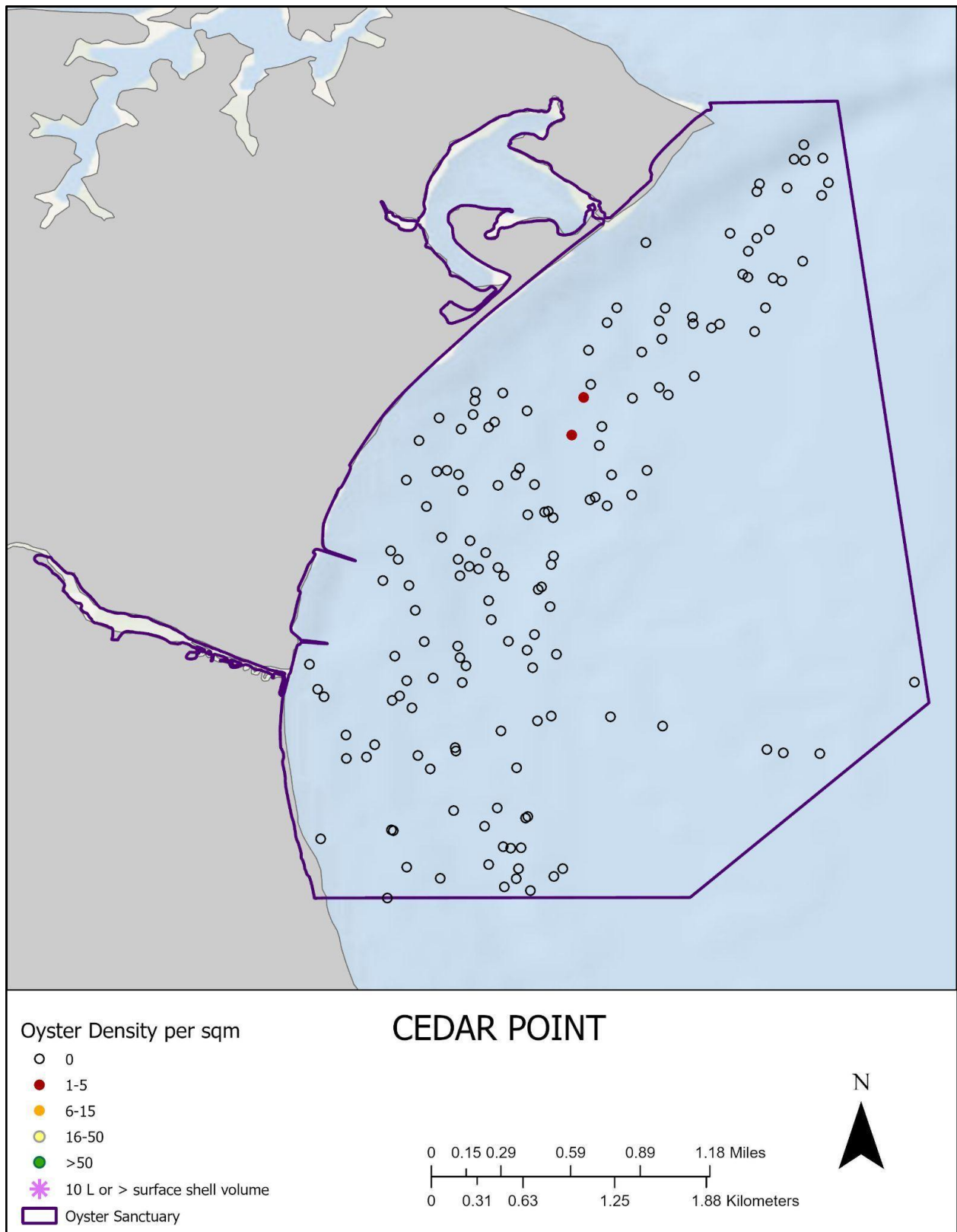


Figure A.04-2. Map of 2022 oyster density in the Cedar Point Sanctuary. Data from Maryland Department of Natural Resources Patent Tong Population Survey.

Table A.04-1. Oyster population characteristics based on the Fall Oyster Survey in the Cedar Point Sanctuary. ND=No Data. Values given are annual mean $\pm$ standard error.

Oyster Characteristic	2006-2010	2011-2015	2016-2020	2021-2025
Number of years sampled/number of samples	ND	ND	ND	4/5
Number of Live Spat Oysters per square meter	ND	ND	ND	4.8 $\pm$ 3.6
Number of Live Small Oysters per square meter	ND	ND	ND	5 $\pm$ 2
Number of Live Market Oysters per square meter	ND	ND	ND	1.5 $\pm$ 0.6
Number of Live Oysters per square meter	ND	ND	ND	11.4 $\pm$ 3.2
Live Biomass (g Dry Weight per Bushel)	ND	ND	ND	ND
Observed Mortality (%)	ND	ND	ND	30 $\pm$ 10
Cultch (Bushels per 100 feet towed)	ND	ND	ND	0.6 $\pm$ 0.1

Section A.05: Chester River ORA Zone A Sanctuary

The Chester Oyster Restoration Area (ORA) Zone A Sanctuary is located in the upper Chester River, a low salinity (Zone 1) region of Maryland within NOAA Code 331. The sanctuary was created in 1996 to evaluate methods for oyster restoration, culture, and production as recommended by the Maryland Oyster Roundtable in 1993. The sanctuary encompasses 6,189 acres of which 184 (3%) is historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments). There are nine historic oyster bars within the sanctuary¹³.

Information available for this sanctuary includes:

- Sanctuary map (Figure A.05-1)
- Density Survey (Figure A.05-2)
- Summary statistics (Table A.05-1)
- Density per year (Figure A.05-3)
- Observed mortality (Figure A.05-4)
- Cultch per year (Figure A.05-5)

Chester River ORA Sanctuary is located in the Upper Bay Region of Maryland's Chesapeake Bay. Oysters in the Upper Bay Region generally grow well and survive but can be impacted by freshet events. Low salinity conditions contribute to a lower rate of natural recruitment in the region.

The Fall Oyster Survey has a standard site within the Chester River ORA Sanctuary. Table A.05-1 shows a decrease in the average number of oysters and cultch from 2021-2025 data compared to the previous 5-year increments.

A population patent tong survey was conducted by the Department in 2023 and found no live oysters with a total of 49.8 liters of surface shell from the 46 samples taken. This is a decrease from the results from the 2012 patent tong survey which found three live oysters and 43.4 liters of surface shell.

This sanctuary is subject to low salinity and recruitment. It was identified by the Department as underperforming and is under evaluation by the Oyster Advisory Commission for potential efforts to improve its performance.

In the 2021-2025 assessment, this sanctuary was determined to be trending negatively.

¹³ See chart 8 for bar names and locations in the State of Maryland Shellfish Closure Areas Book
<http://dnr.maryland.gov/fisheries/Pages/oysters/index.aspx>

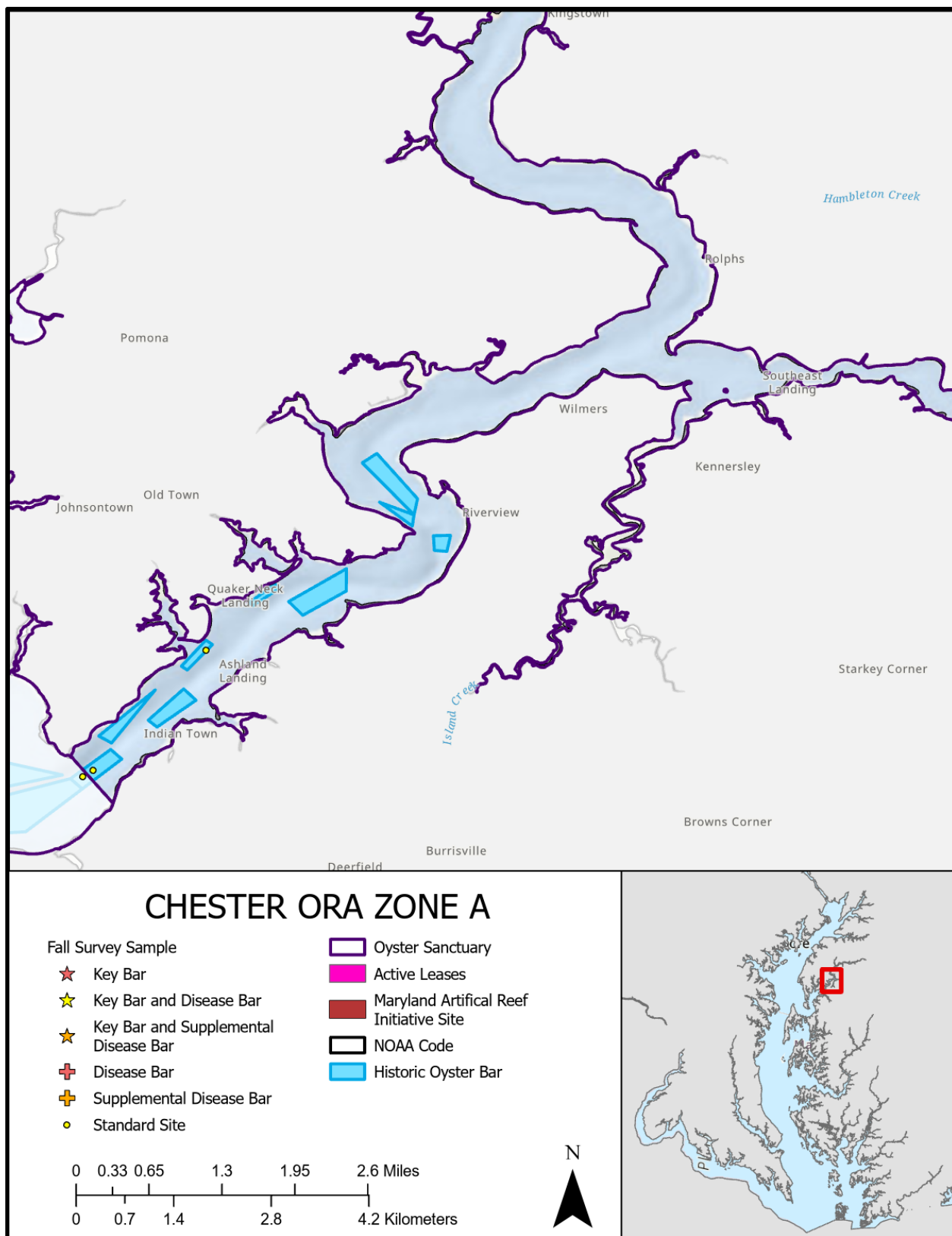


Figure A.05-1. Chester River ORA Sanctuary. Fall Oyster Survey sites may not be sampled every year.

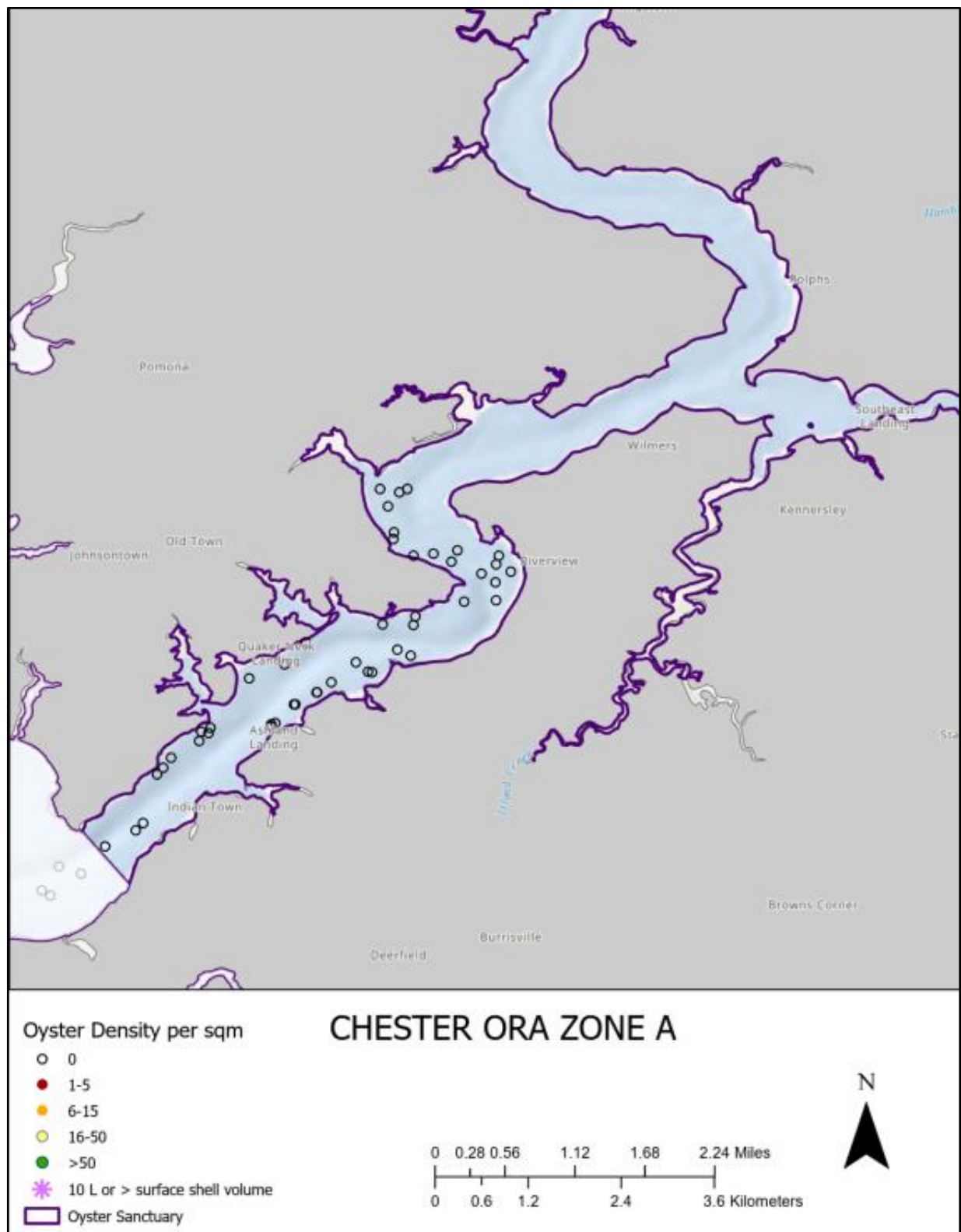


Figure A.05-2. Map of 2023 oyster density in the Chester River ORA Sanctuary. Data from Maryland Department of Natural Resources Patent Tong Population Survey.

Table A.05-1. Oyster population characteristics based on the Fall Oyster Survey in the Chester River ORA Sanctuary. ND=No Data. Values given are annual mean $\pm$ standard error.

Oyster Characteristic	2006-2010	2011-2015	2016-2020	2021-2025
Number of years sampled/number of samples	5/10	5/10	5/10	5/7
Number of Live Spat Oysters per square meter	0 $\pm$ 0	0 $\pm$ 0	0 $\pm$ 0	0 $\pm$ 0
Number of Live Small Oysters per square meter	0 $\pm$ 0	2.3 $\pm$ 0.92	0 $\pm$ 0	0.34 $\pm$ 0.35
Number of Live Market Oysters per square meter	10 $\pm$ 3.6	12.3 $\pm$ 4.9	12 $\pm$ 3.8	2.5 $\pm$ 1.6
Number of Live Oysters per square meter	10 $\pm$ 3.6	14.6 $\pm$ 5	12 $\pm$ 3.8	2.9 $\pm$ 1.6
Live Biomass (g Dry Weight per Bushel)	ND	ND	ND	ND
Observed Mortality (%)	10.7 $\pm$ 4.2	10.5 $\pm$ 5	14.8 $\pm$ 5	8.7 $\pm$ 5.7
Cultch (Bushels per 100 feet towed)	1.1 $\pm$ 0.4	1.5 $\pm$ 0.5	1.1 $\pm$ 0.2	1 $\pm$ 0.2

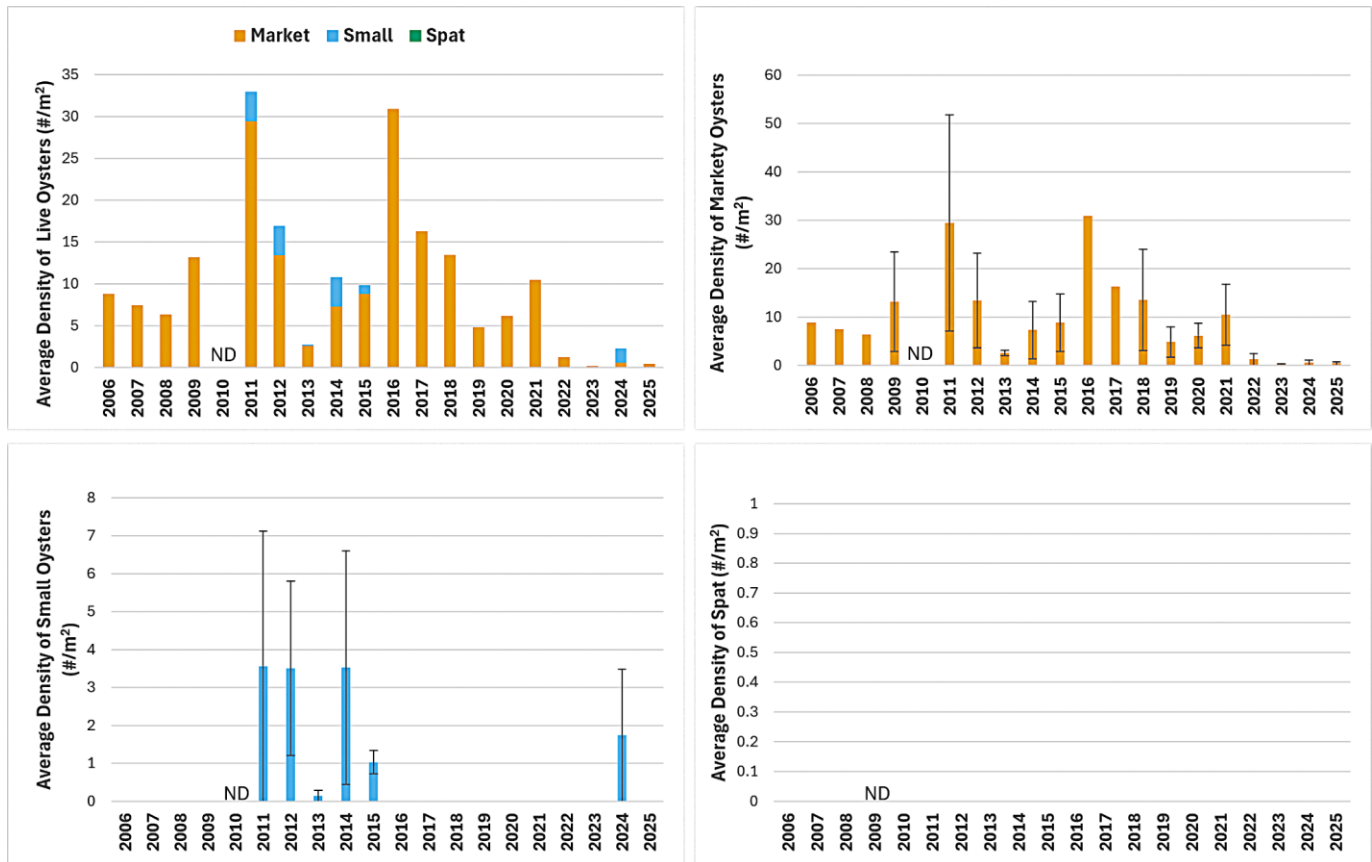


Figure A.05-3. Average number of live oysters per square meter by size class in the Chester River ORA Sanctuary. The sanctuary was established in 1996. Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales. ND = No Data.

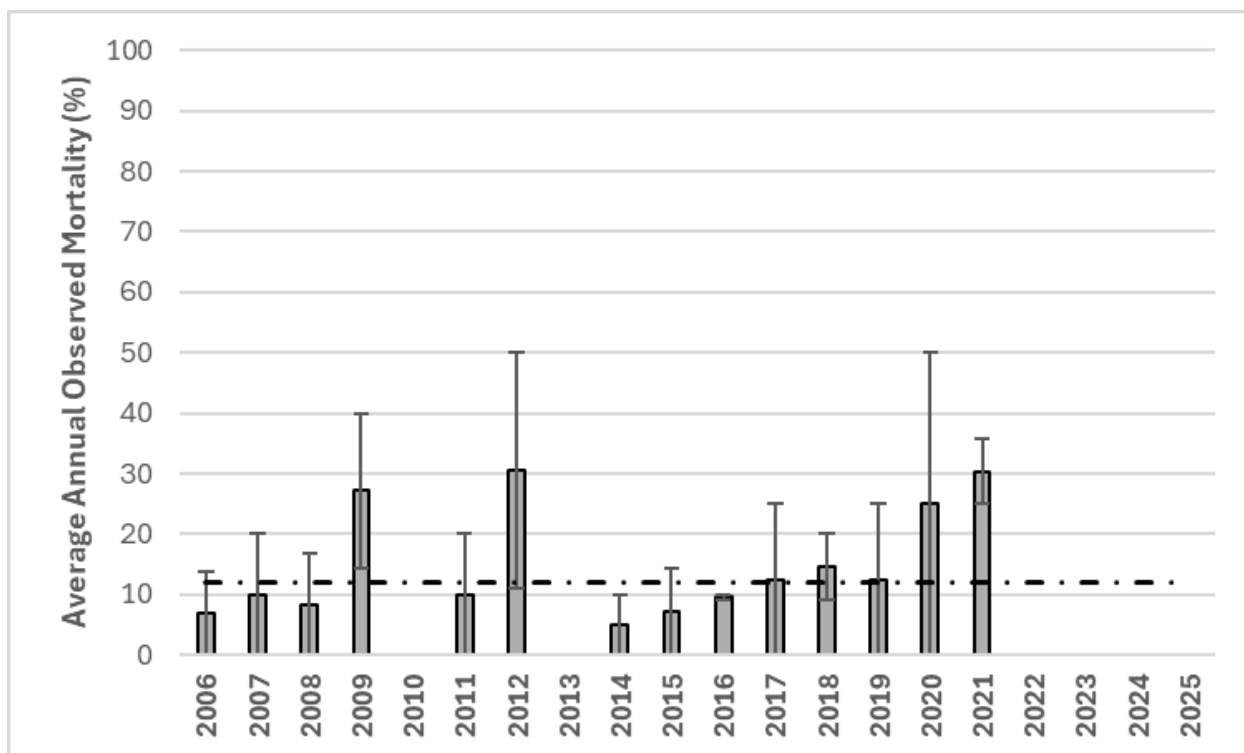


Figure A.05-4. Average annual observed mortality of market-sized and small-sized oysters in Chester River ORA Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. The sanctuary was established in 1996. The dashed line represents the 2006-2025 baywide average observed mortality. Error bars represent ± 1 standard error.

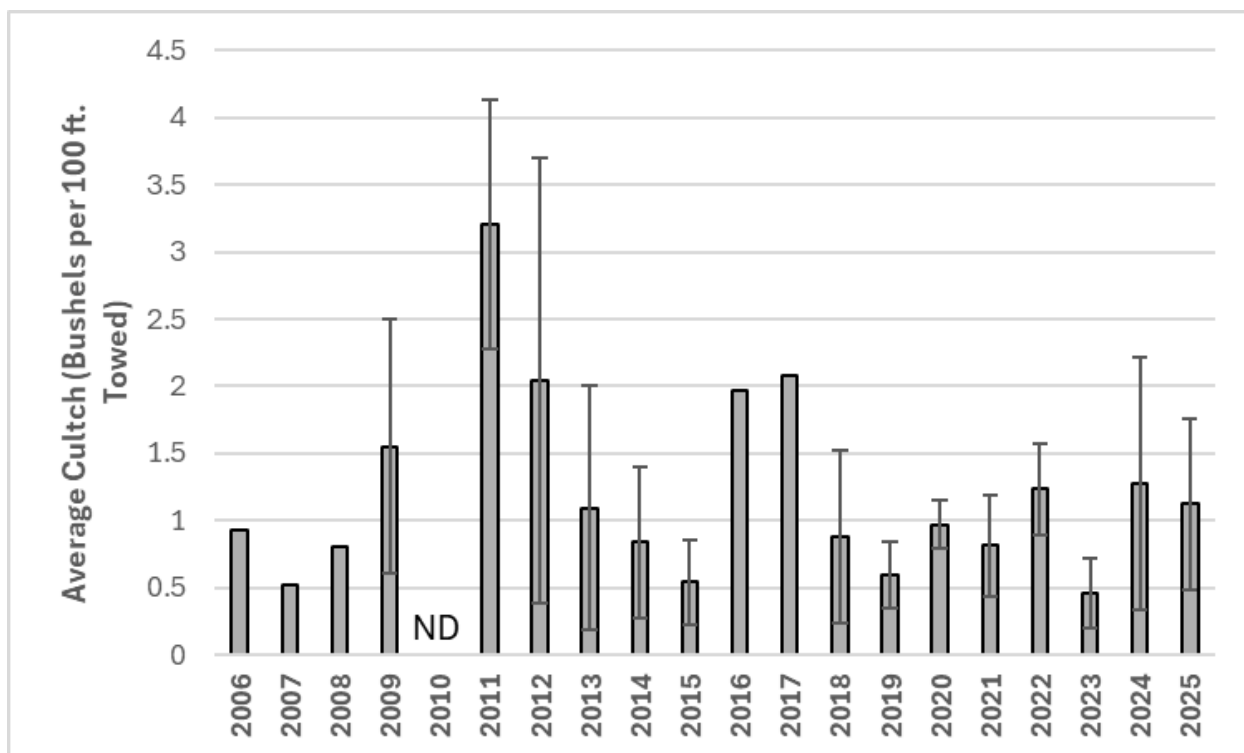


Figure A.05-5. Average cultch (live and dead oysters and loose shell) in the Chester River ORA Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. The sanctuary was established in 1996. Error bars represent ± 1 standard error. ND = No Data.

Section A.06: Choptank River ORA Zone A Sanctuary

The Choptank River ORA Zone A Sanctuary is located in the upper Choptank River, a low salinity (Zone 1) region of Maryland within NOAA Code 337. The sanctuary was created in 1996 to evaluate methods for oyster restoration, culture, and production as recommended by the Maryland Oyster Roundtable in 1993. The sanctuary encompasses 8,962 acres of which 236 (3%) is historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments). There are 6 historic oyster bars within the sanctuary¹⁴.

Information available for this sanctuary includes:

- Sanctuary map (Figure A.06-1)
- Density Survey (Figure A.06-2)
- Summary statistics (Table A.06-1)
- Density per year (Figure A.06-3)
- Observed mortality (Figure A.06-4)
- Cultch per year (Figure A.06-5)

Choptank River ORA Sanctuary is located in the Choptank Region of Maryland's Chesapeake Bay. Oysters in the Choptank Region generally grow well but may be impacted by disease or freshet events. Natural recruitment occurs regularly in this region.

The Fall Oyster Survey has three standard sites within the Choptank River ORA Sanctuary. Table A.06-1 shows an increase in the average number of oysters and cultch from 2021-2025 data compared to the previous 5-year increments, while exhibiting low observed mortality. The average density from 2021-2025 is above the target of 94 oysters per square meter and the average cultch per 100 ft tow indicates sufficient cultch availability.

A population patent tong survey was conducted by the Department in 2023 and found an average of 4.4 oysters per sq m and an average of 4.2 liters per sq m of surface shell from the 28 samples taken. The 2015 patent tong survey had an average of 5.8 oysters per square meter and oysters and 2.8 liters per square meter of surface shell.

While susceptible to low salinity events and likely impacted by the freshet of 2018–2019, the sanctuary has demonstrated some recovery over subsequent years.

In the 2021-2025 sanctuary assessment, this sanctuary was determined to be trending positively with a high oyster density.

¹⁴ See chart 21 for bar names and locations in the State of Maryland Shellfish Closure Areas Book <http://dnr.maryland.gov/fisheries/Pages/oysters/index.aspx>

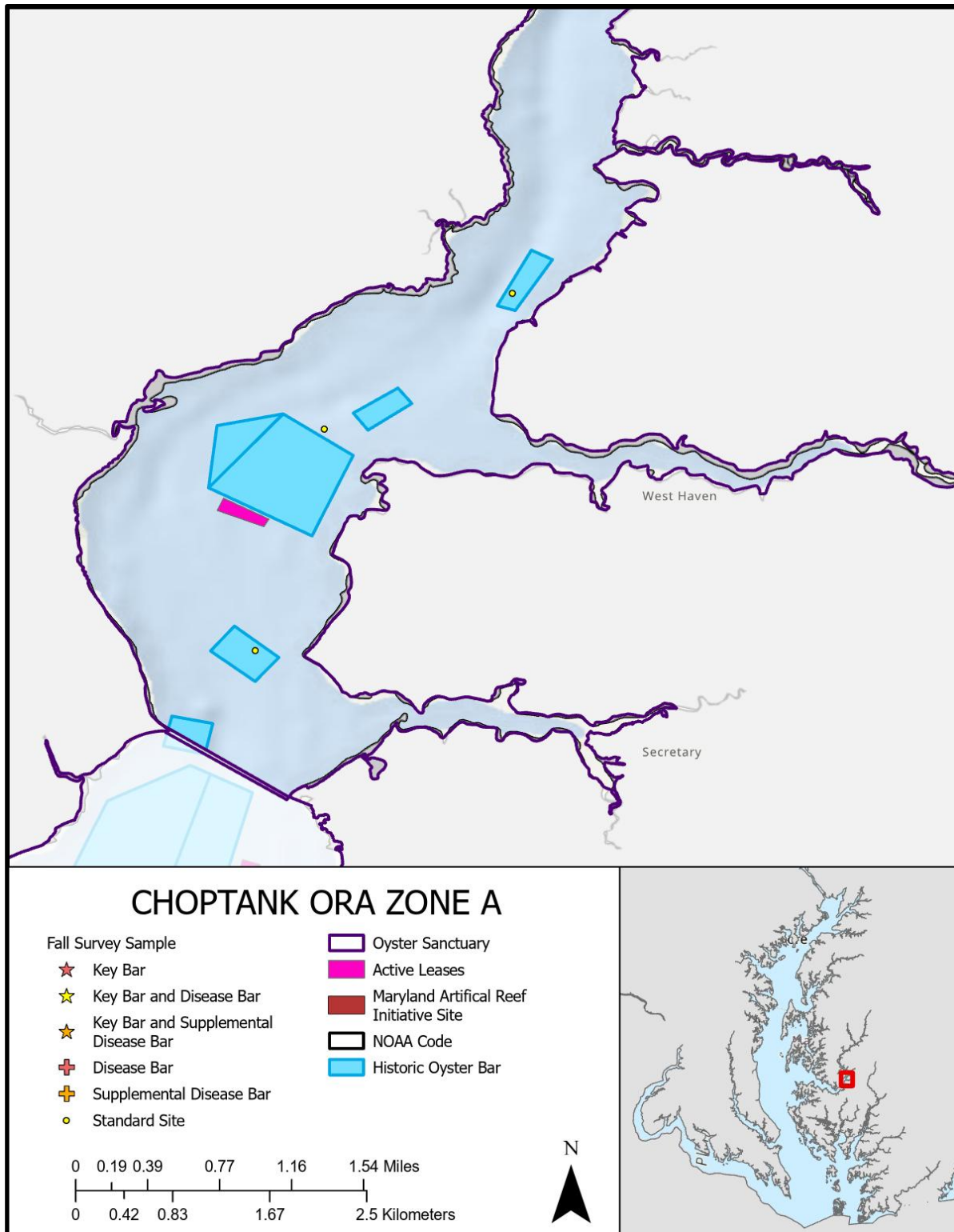


Figure A.06-1. Choptank River ORA Sanctuary. Fall Oyster Survey sites may not be sampled every year.

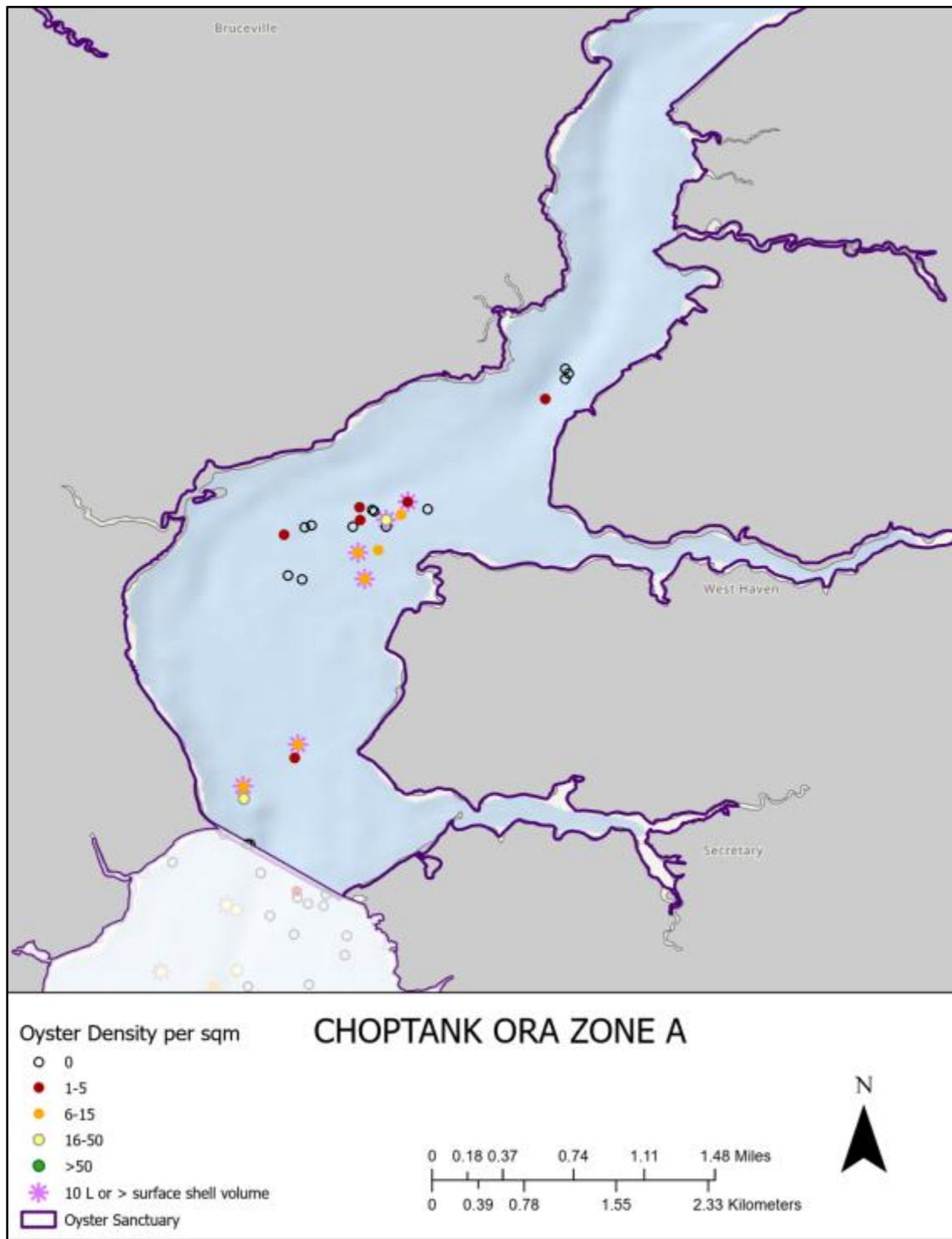


Figure A.06-2. Map of 2023 oyster density in the Choptank River ORA Sanctuary. Data from Maryland Department of Natural Resources Patent Tong Population Survey.

Table A.06-1. Oyster population characteristics based on the Fall Oyster Survey in the Choptank River ORA Sanctuary. ND=No Data. Values given are annual mean $\pm$ standard error.

Oyster Characteristic	2006-2010	2011-2015	2016-2020	2021-2025
Number of years sampled/number of samples	5/17	5/15	5/15	5/15
Number of Live Spat Oysters per square meter	0.76 $\pm$ 0.39	0.59 $\pm$ 0.42	0.23 $\pm$ 0.23	45.5 $\pm$ 16.7
Number of Live Small Oysters per square meter	6.6 $\pm$ 2	42.2 $\pm$ 7.1	13.3 $\pm$ 5.9	136 $\pm$ 40
Number of Live Market Oysters per square meter	5.9 $\pm$ 1.8	25.4 $\pm$ 6.6	38.8 $\pm$ 11	19.3 $\pm$ 5.2
Number of Live Oysters per square meter	13.3 $\pm$ 3	68.2 $\pm$ 12.4	52.4 $\pm$ 16	201 $\pm$ 53.5
Live Biomass (g Dry Weight per Bushel)	ND	ND	ND	ND
Observed Mortality (%)	3.9 $\pm$ 2.3	5 $\pm$ 2.2	14.2 $\pm$ 6.5	3.3 $\pm$ 1.5
Cultch (Bushels per 100 feet towed)	1.3 $\pm$ 0.1	1.9 $\pm$ 0.2	1.5 $\pm$ 0.3	2 $\pm$ 0.3

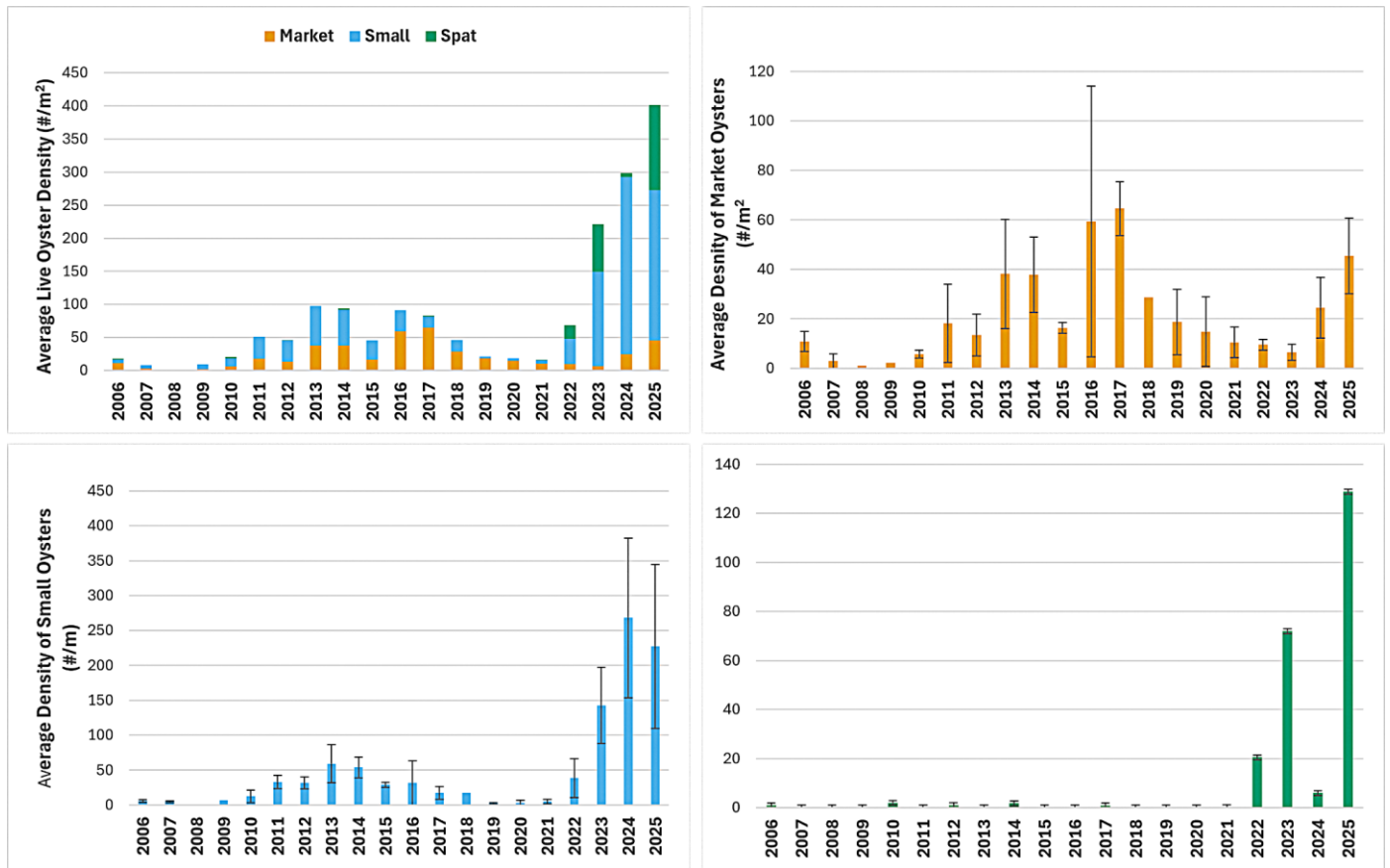


Figure A.06-3. Average number of live oysters per square meter by size class in the Choptank River ORA Sanctuary. The sanctuary was established in 1996. Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales.

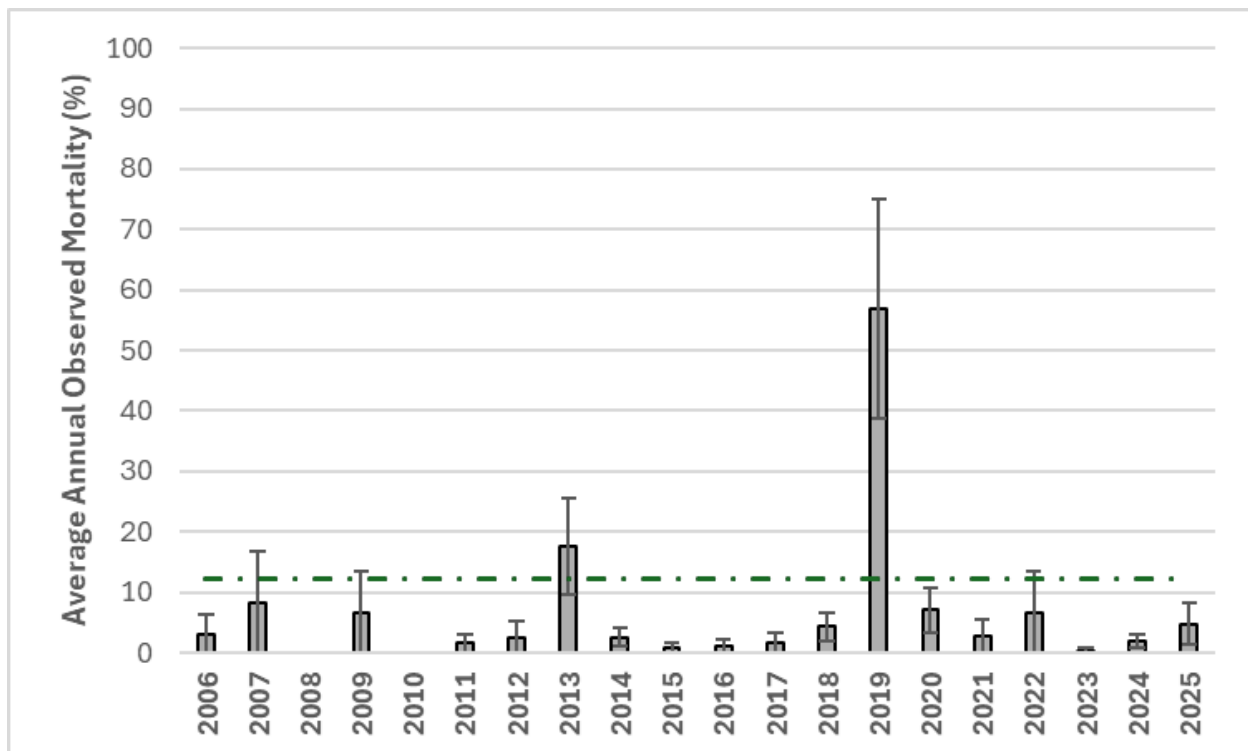


Figure A.06-4. Average annual observed mortality of market-sized and small-sized oysters in Choptank River ORA Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. The sanctuary was established in 1996. The dashed line represents the 2006-2025 baywide average observed mortality. Error bars represent ± 1 standard error.

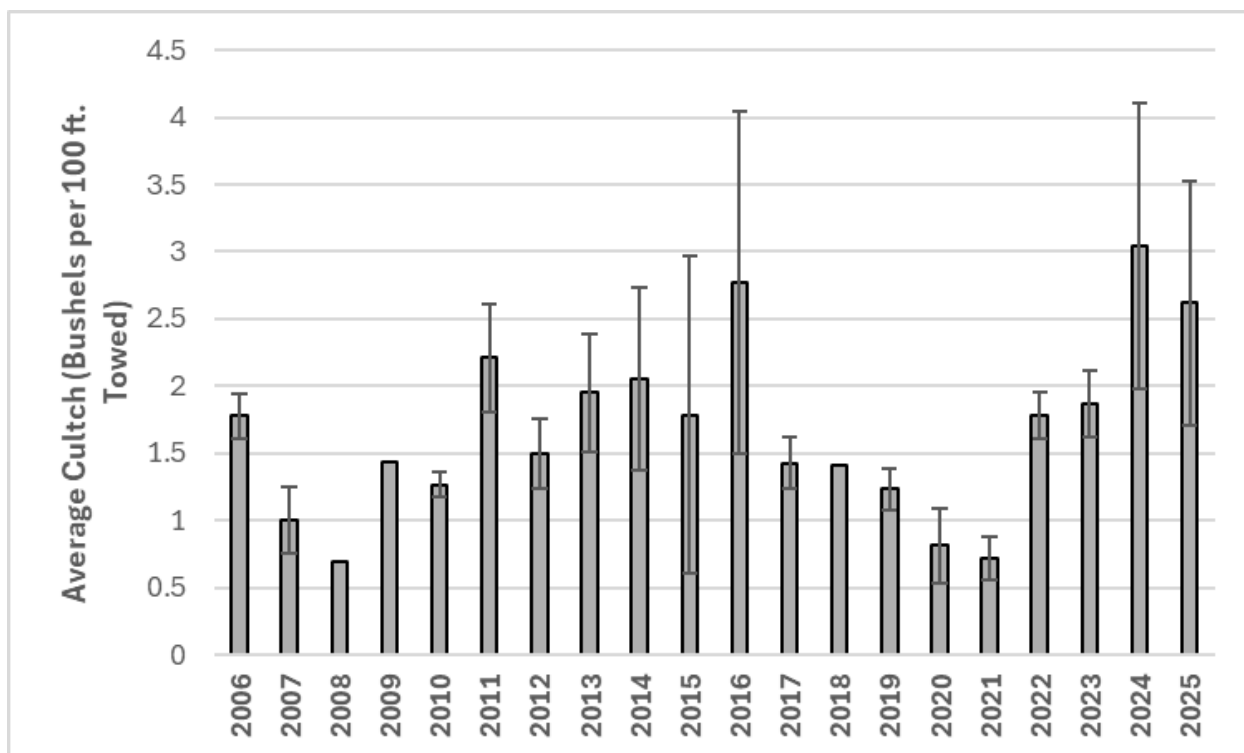


Figure A.06-5. Average cultch (live and dead oysters and loose shell) in the Choptank River ORA Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. The sanctuary was established in 1996. Error bars represent ± 1 standard error.

Section A.07: Cook Point Sanctuary

The Cook Point Sanctuary is located in the lower Choptank River in a medium salinity (Zone 2) region within NOAA Code 137. The sanctuary was originally established in 2001 with an area of 17 acres to accommodate an Environmental Protection Agency project examining three-dimensional oyster habitat. In 2010, the sanctuary was expanded to 814 acres of which 781 acres (96%) are historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments). There are two historic oyster bars within the sanctuary: Cook Point, 78% of which is within the sanctuary, and Todd Point Addition, of which 3% is within the sanctuary.

Information available for this sanctuary includes:

- Sanctuary map (Figure A.07-1)
- Density Survey (Figure A.07-2)
- Summary statistics (Table A.07-1)
- Density per year (Figure A.07-3A)
- Density per year excluding the spat on shell planting (Figure A.07-3B)
- Shell height frequencies (Figure A.07-4)
- Biomass per year (Figure A.07-5)
- Observed mortality (Figure A.07-6)
- Dermo and MSX per year (Figure A.07-7)
- Cultch per year (Figure A.07-8)
- Average Dive Densities (Table A.07-2)
- Dive Survey (Figure A.07-9)

Cook Point Sanctuary is located in the Choptank Region of Maryland's Chesapeake Bay. Oysters in the Choptank Region generally grow well but may be impacted by disease or freshet events. Natural recruitment occurs regularly in this region.

The Fall Oyster Survey has one standard site and one sentinel key bar and disease bar site within the Cook Point Sanctuary. Table A.07-1 shows an increase in the average number of oysters and cultch from 2021-2025 data compared to the previous 5-year increments. The average observed mortality from 2021-2025 and 2016-2020 is above the long-term average. In 2023, the spike in observed mortality coincided with an increase in lethal dermo disease prevalence and MSX disease prevalence and was the highest observed mortality for the Fall Oyster Survey baywide that year (Figure A.07-7). The low average cultch per 100 ft tow indicates insufficient cultch availability. It should be noted that given limitations of traditional gear types, not all restored areas are surveyed by the Department.

A population patent tong survey was conducted by the Department in 2025 and found an average of 8.4 oysters per square meter and an average of 2.4 liters per square meter of surface shell from the 100 samples taken. In 2023 the U.S. Army Corps of Engineers conducted a dive survey on alternate material reefs in the Cook Point Sanctuary. Dive locations can be found in Figure A.07-9 and oyster densities in Table A.07-2.

In the 2021-2025 sanctuary assessment, this sanctuary was determined to be trending positively.

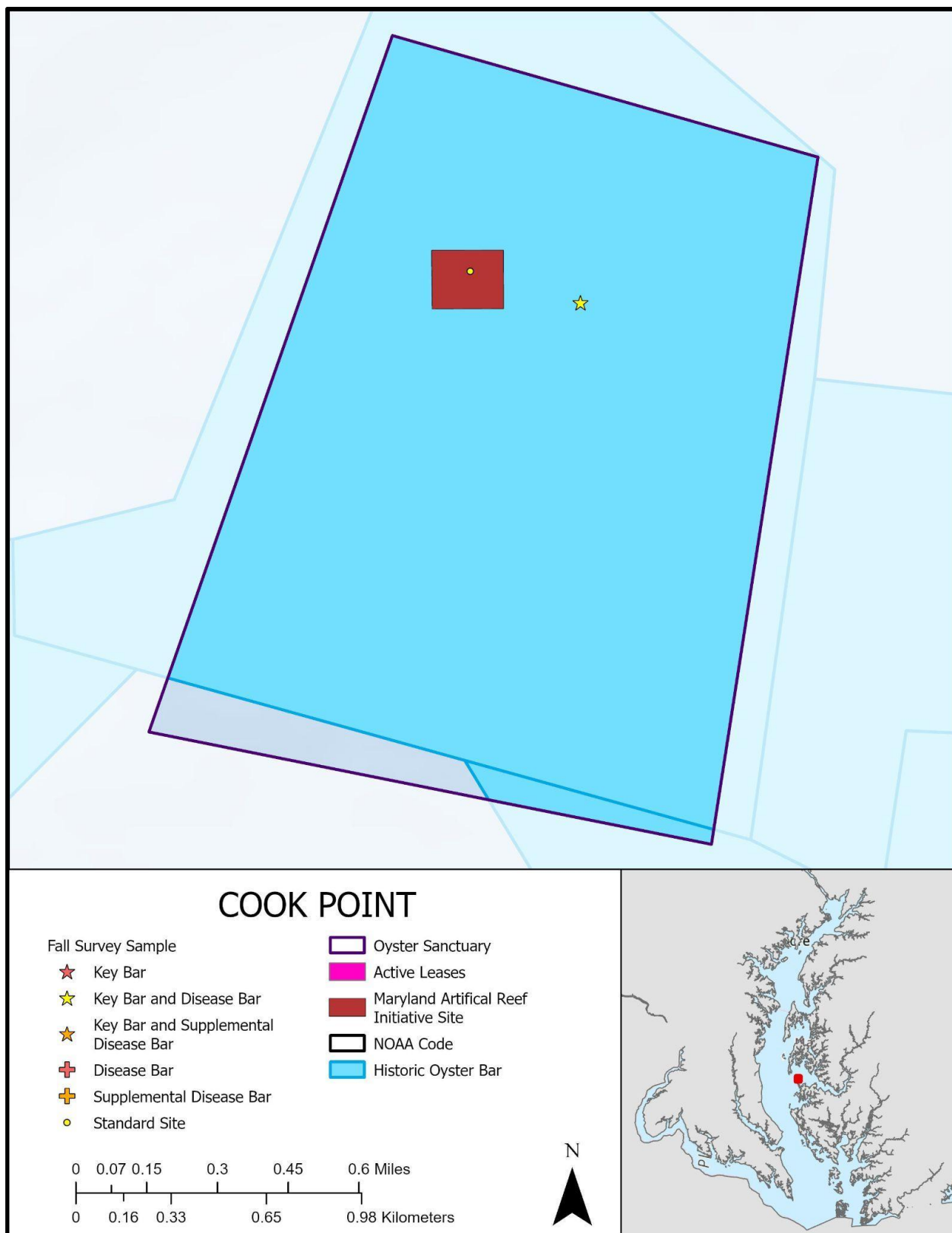


Figure A.07-1. Cook Point Sanctuary. Fall Oyster Survey sites may not be sampled every year.

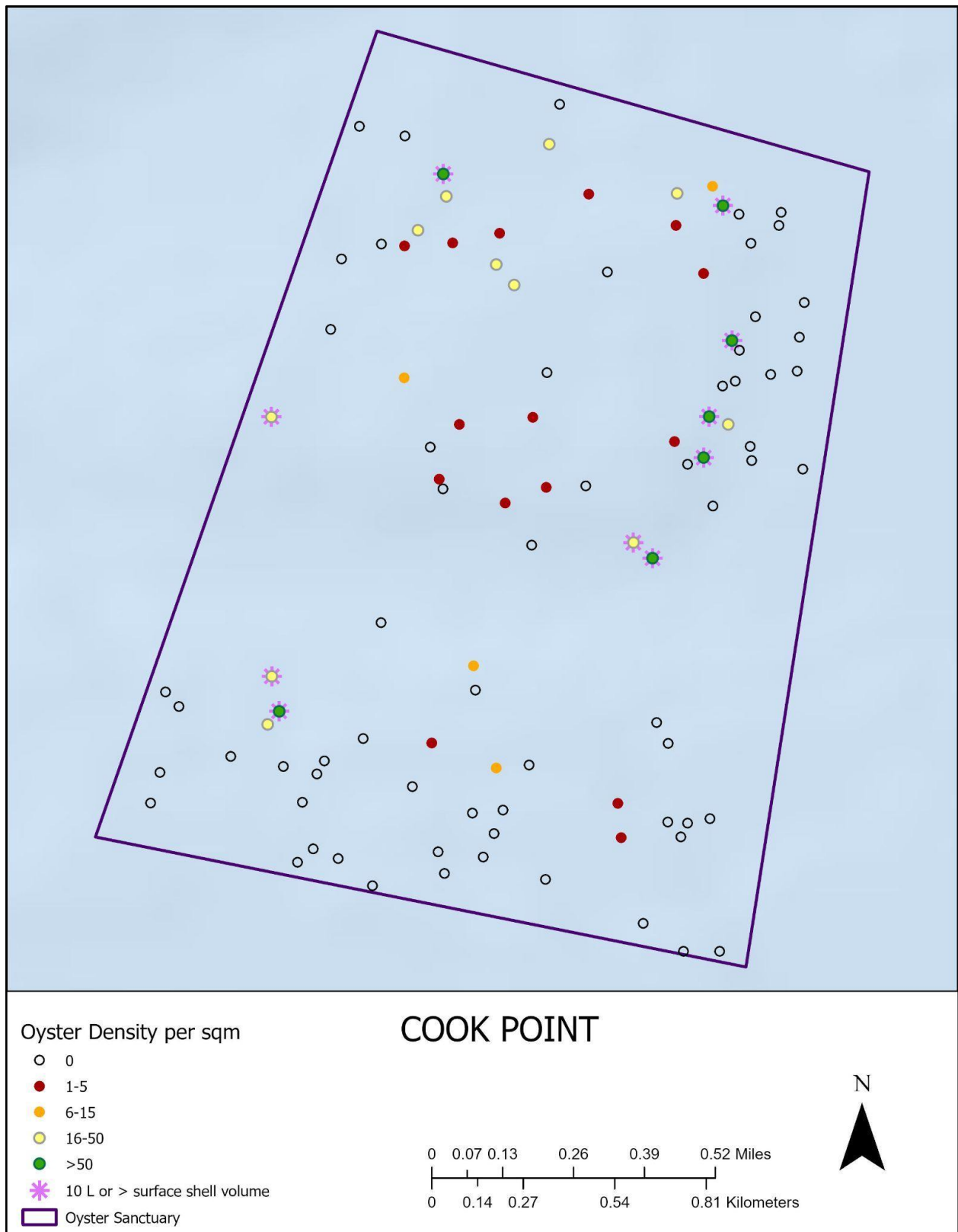


Figure A.07-2. Map of 2023 oyster density in the Cook Point Sanctuary. Data from Maryland Department of Natural Resources Patent Tong Population Survey.

Table A.07-1. Oyster population characteristics based on the Fall Oyster Survey in the Cook Point Sanctuary. ND=No Data. Values given are annual mean $\pm$ standard error.

Oyster Characteristic	2006-2010	2011-2015	2016-2020	2021-2025
Number of years sampled/number of samples	5/10	5/10	5/10	5/10
Number of Live Spat Oysters per square meter	51 $\pm$ 46.4*	4.9 $\pm$ 2.6	4.2 $\pm$ 1.7	32.9 $\pm$ 11.2
Number of Live Small Oysters per square meter	8.9 $\pm$ 5.3	27.4 $\pm$ 9.9	4.0 $\pm$ 1.2	29.1 $\pm$ 15.5
Number of Live Market Oysters per square meter	3.3 $\pm$ 1.1	34.2 $\pm$ 5.5	10.5 $\pm$ 2.5	13.4 $\pm$ 2
Number of Live Oysters per square meter	63.3 $\pm$ 47	67 $\pm$ 11	18.7 $\pm$ 5	75.5 $\pm$ 20.5
Live Biomass (g Dry Weight per Bushel)	40 $\pm$ 16	227 $\pm$ 45	98 $\pm$ 16	157 $\pm$ 16
Observed Mortality (%)	9.3 $\pm$ 3.5	10.6 $\pm$ 1.7	26.8 $\pm$ 5.4	18.2 $\pm$ 5.5
Cultch (Bushels per 100 feet towed)	0.6 $\pm$ 0.1	0.7 $\pm$ 0.1	0.4 $\pm$ 0.05	0.5 $\pm$ 0.1

*Includes 2010 hatchery seed planting.

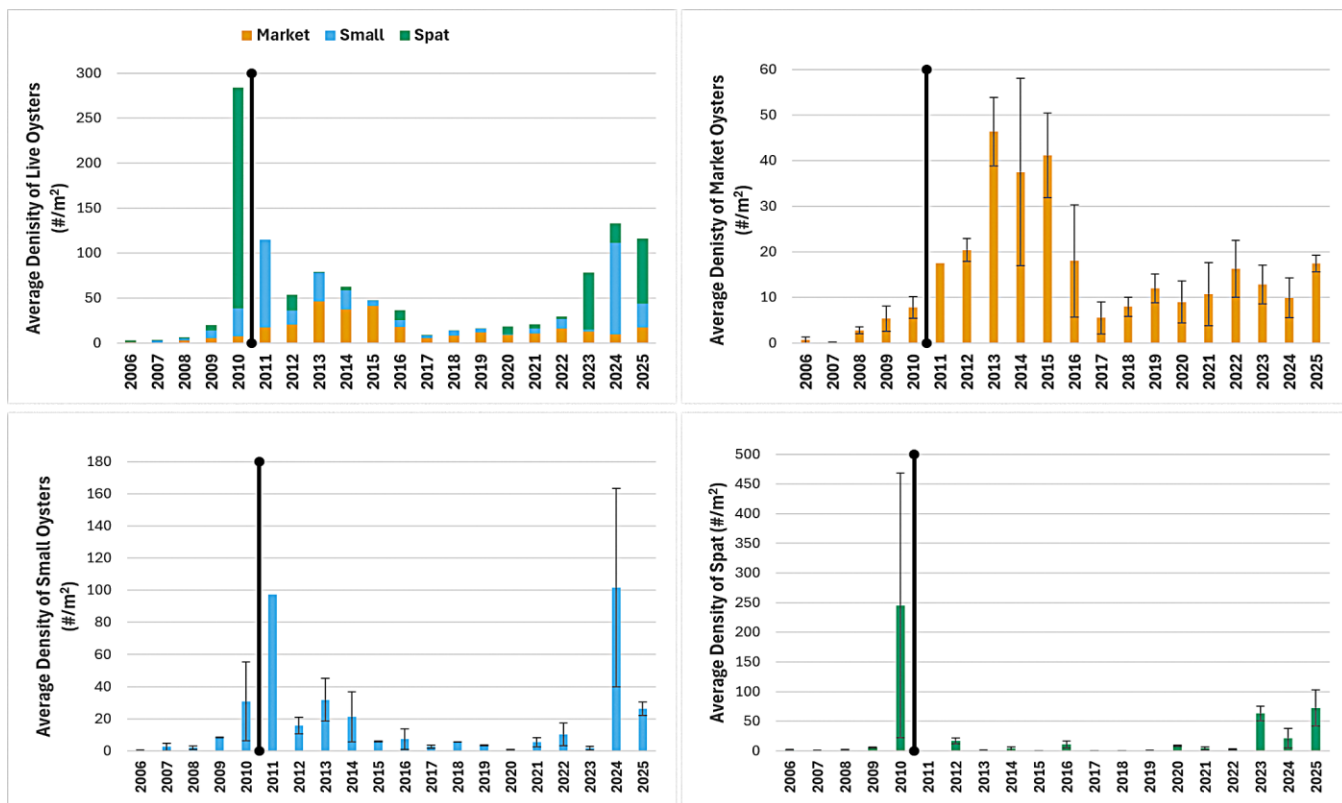


Figure A.07-3A. Average number of live oysters per square meter by size class in the Cook Point Sanctuary including the sample taken on the 2010 hatchery spat-on-shell planting. Black line indicates the date the sanctuary was expanded. Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales.

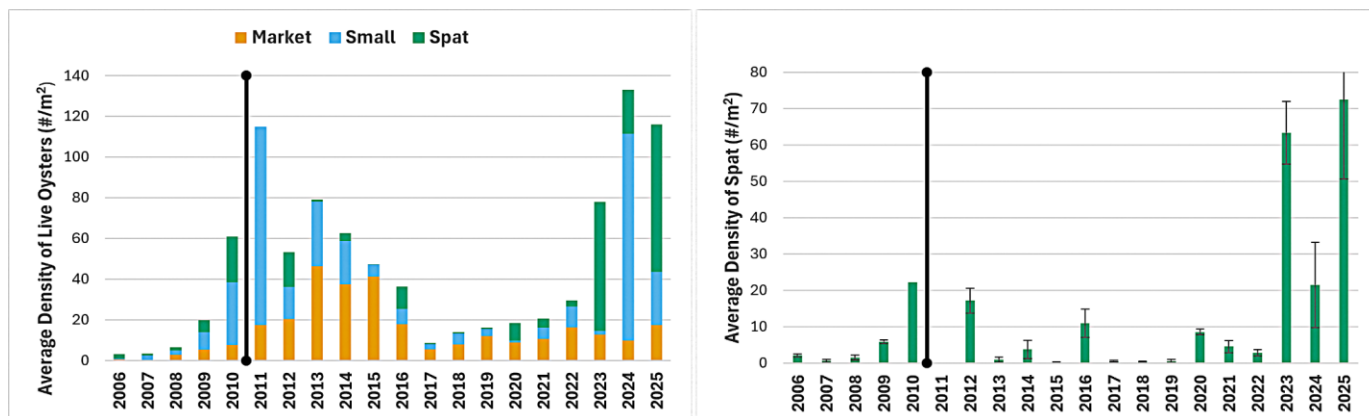


Figure A.07-3B. Average number of live oysters per square meter by size class in the Cook Point Sanctuary excluding the sample taken on the 2010 hatchery spat-on-shell planting. Black line indicates the date the sanctuary was expanded. Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales.

COOK POINT (2001)

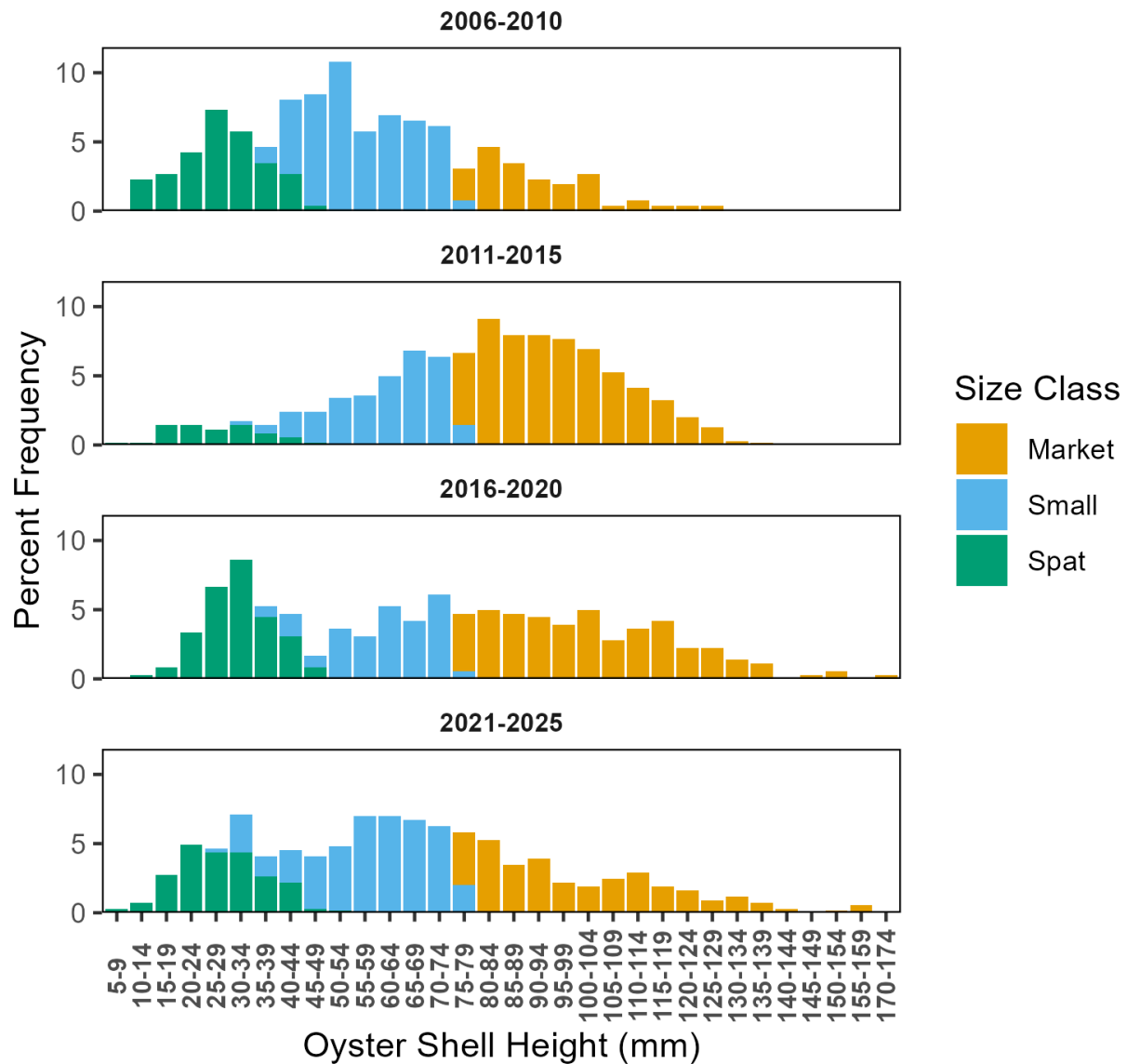


Figure A.07-4. Shell height frequencies of live oysters in the Cook Point Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey on Cook Point bar.

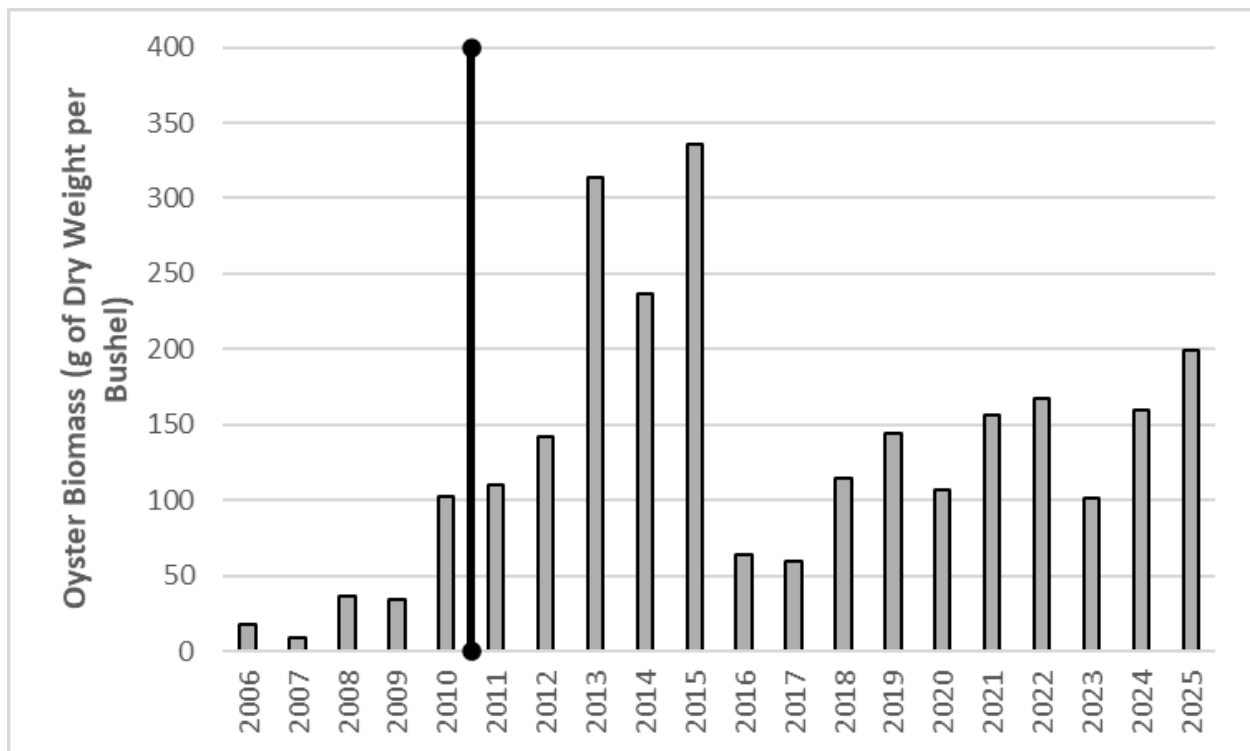


Figure A.07-5. Oyster biomass (grams of dry weight per bushel of material) in the Cook Point Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey on Cook Point bar. Black line indicates the date the sanctuary was expanded.

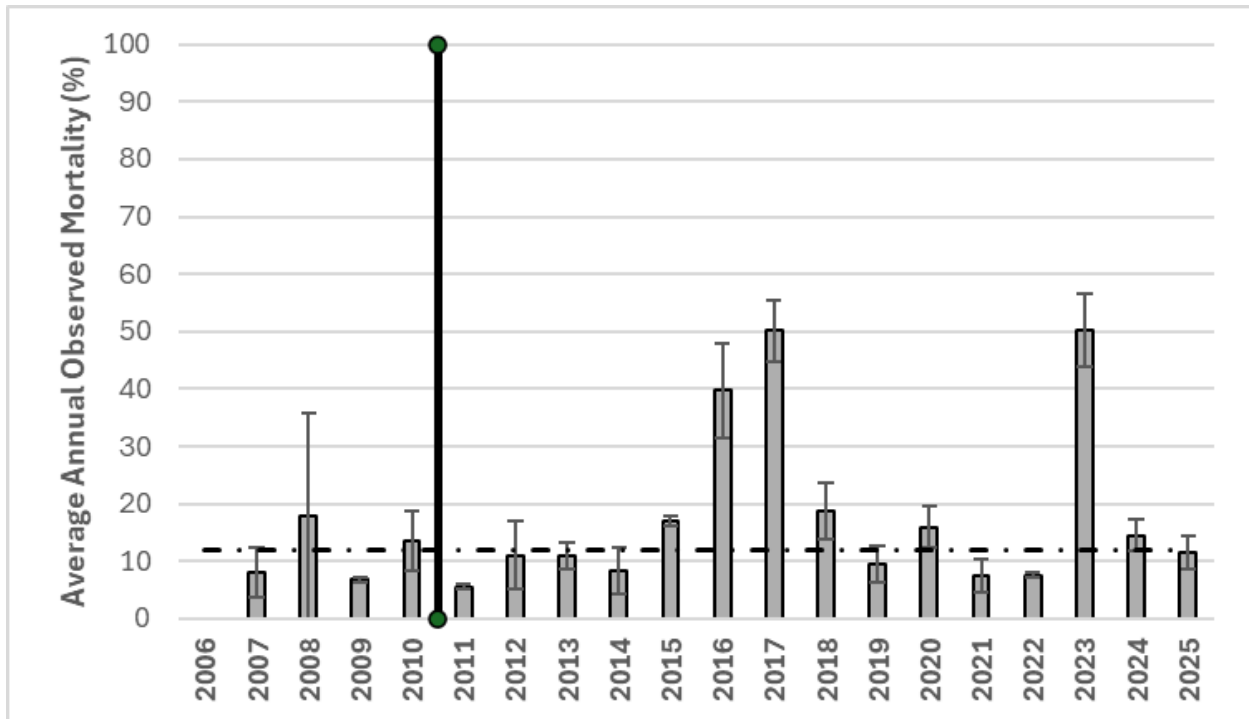


Figure A.07-6. Average annual observed mortality of market-sized and small-sized oysters in Cook Point Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Black line denotes the date the sanctuary was expanded, and the dashed line represents the 2006-2025 baywide average observed mortality. Error bars represent ± 1 standard error.

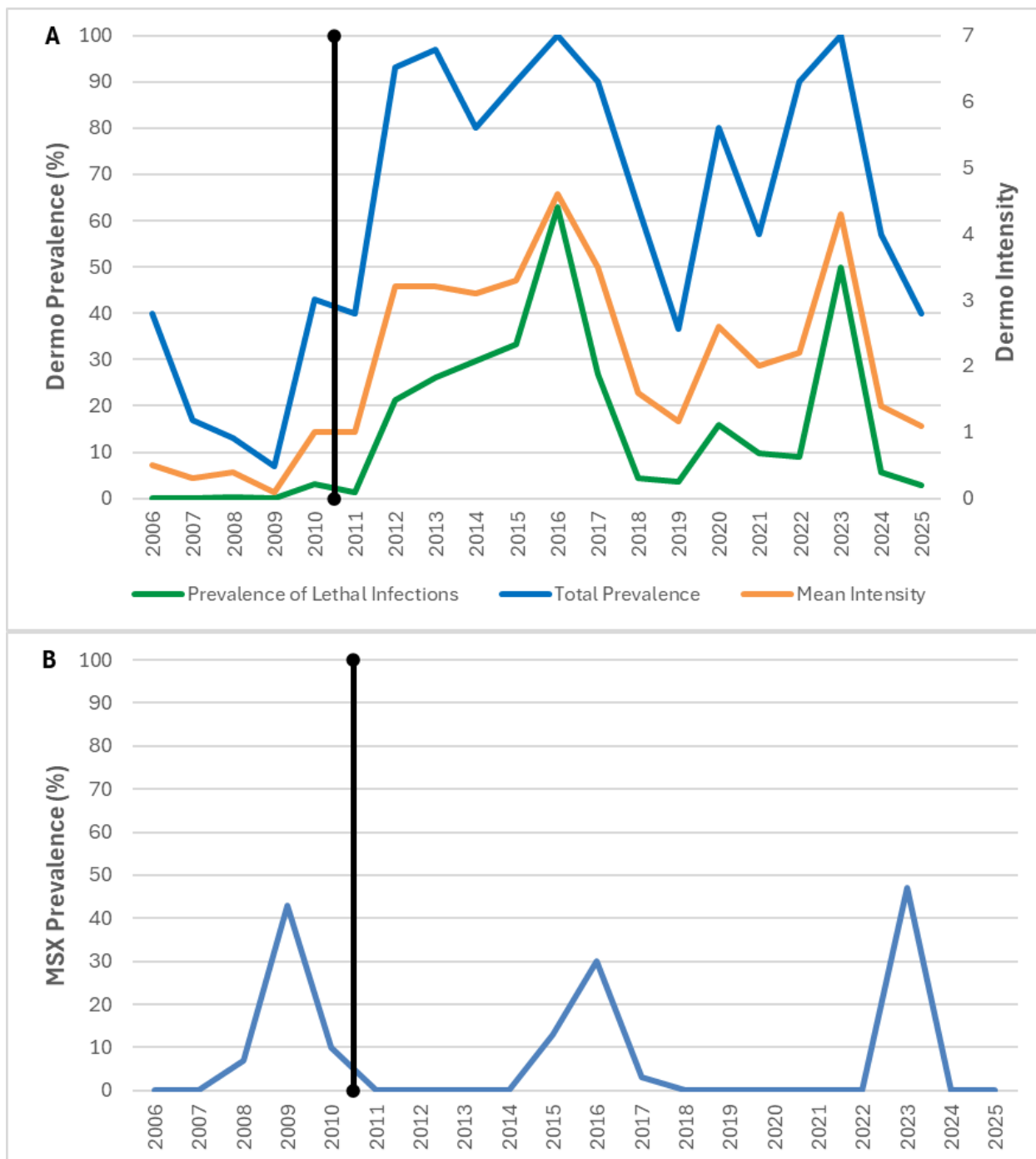


Figure A.07-7. Oyster disease prevalence and intensity in the Cook Point Sanctuary. (A) Dermo prevalence and mean intensity (B) MSX prevalence (intensity is not examined). Data from Maryland's Annual Fall Oyster Dredge Survey on Cook Point bar. Black line denotes the date the sanctuary was expanded.

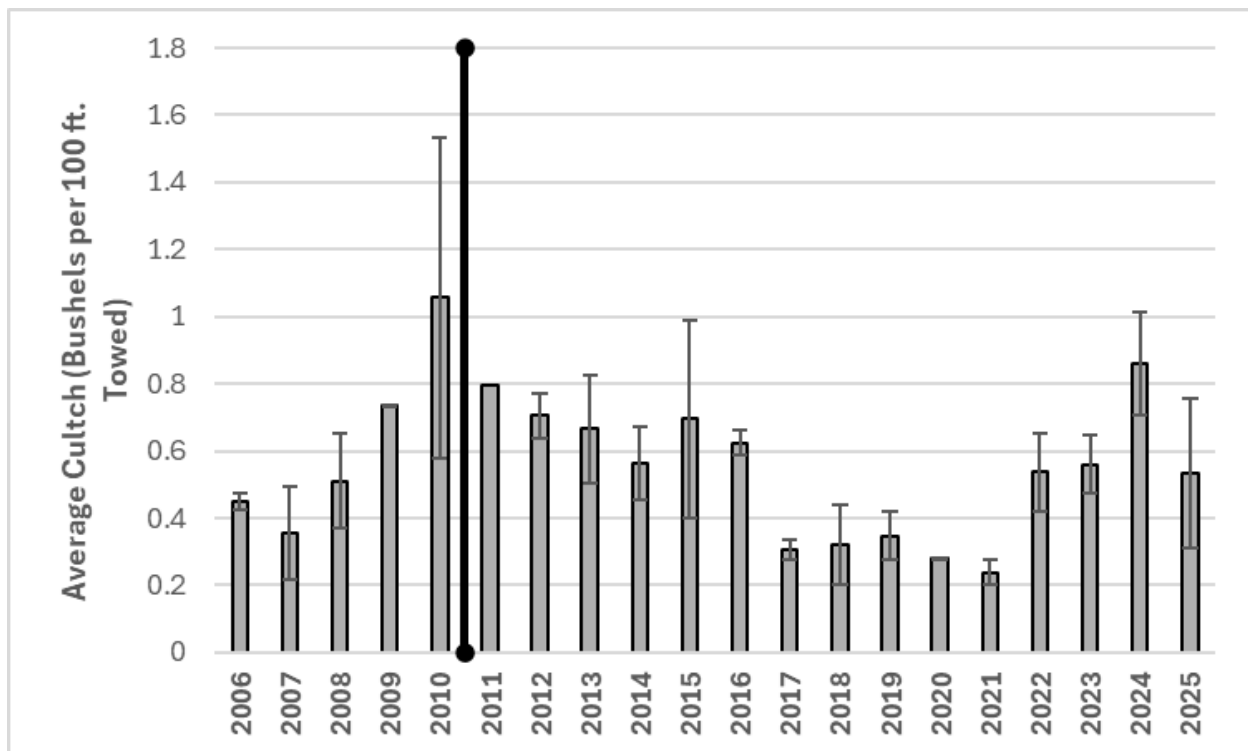


Figure A.07-8. Average cultch (live and dead oysters and loose shell) in the Cook Point Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Black line denotes the date the sanctuary was expanded. Error bars represent ± 1 standard error.

Table A.07-2. Average oyster population densities in 2023 based on the U.S. Army Corps of Engineers dive survey on alternate substrate sites in the Cook Point Sanctuary.

Site	Average Density (number per square meter)	Substrate
A	60.4	granite with shell veneer
B	60.8	granite with shell veneer
C	46.8	granite with shell veneer
D	30.8	granite with shell veneer
E	38.8	granite
F	42.4	granite
G	28.4	granite

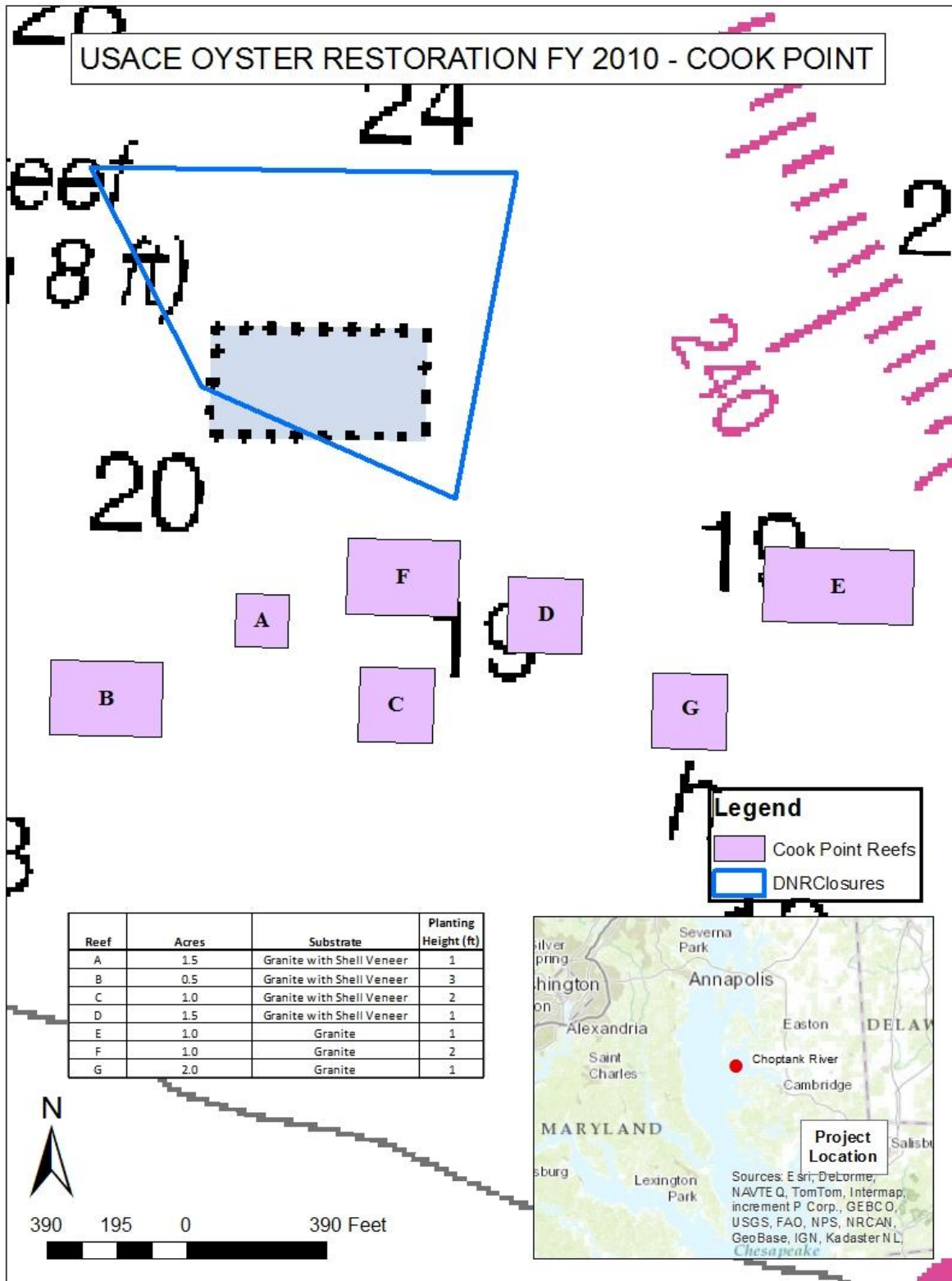


Figure A.07-9. Alternate substrate dive site locations for the U.S. Army Corps of Engineers dive survey on alternate substrate sites in the Cook Point Sanctuary.

Section A.08: Cox Creek Sanctuary

The Cox Creek Sanctuary is located in a tributary of Eastern Bay, a low salinity (Zone 1) region within NOAA Code 039. The sanctuary was created in 2010 and encompasses 2,112 acres of which 939 acres (45%) are historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments). There are nine historic oyster bars within the sanctuary, one of which (Ringgold Middleground) is located only partially within the sanctuary¹⁵.

Information available for this sanctuary includes:

- Sanctuary map (Figure A.08-1)
- Summary statistics (Table A.08-1)

Cox Creek Sanctuary is located in the Eastern Bay Region of Maryland's Chesapeake Bay. Oysters in the Eastern Bay Region typically show favorable growth and survival, generally remaining unaffected by disease or freshets unless subjected to multi-year droughts or significant freshet events. Natural recruitment occurs regularly in this region.

In 2019, the Department added a standard Fall Oyster Survey sampling site to Cox Creek Sanctuary. The last patent tong population survey occurred in 2020.

In the 2021-2025 sanctuary assessment, this sanctuary was classified as receiving restoration. This sanctuary has received spat-on-shell plantings as part of the Eastern Bay Regional Project since 2023.

¹⁵ See chart 11 for bar names and locations in the State of Maryland Shellfish Closure Areas Book <http://dnr.maryland.gov/fisheries/Pages/oysters/index.aspx>

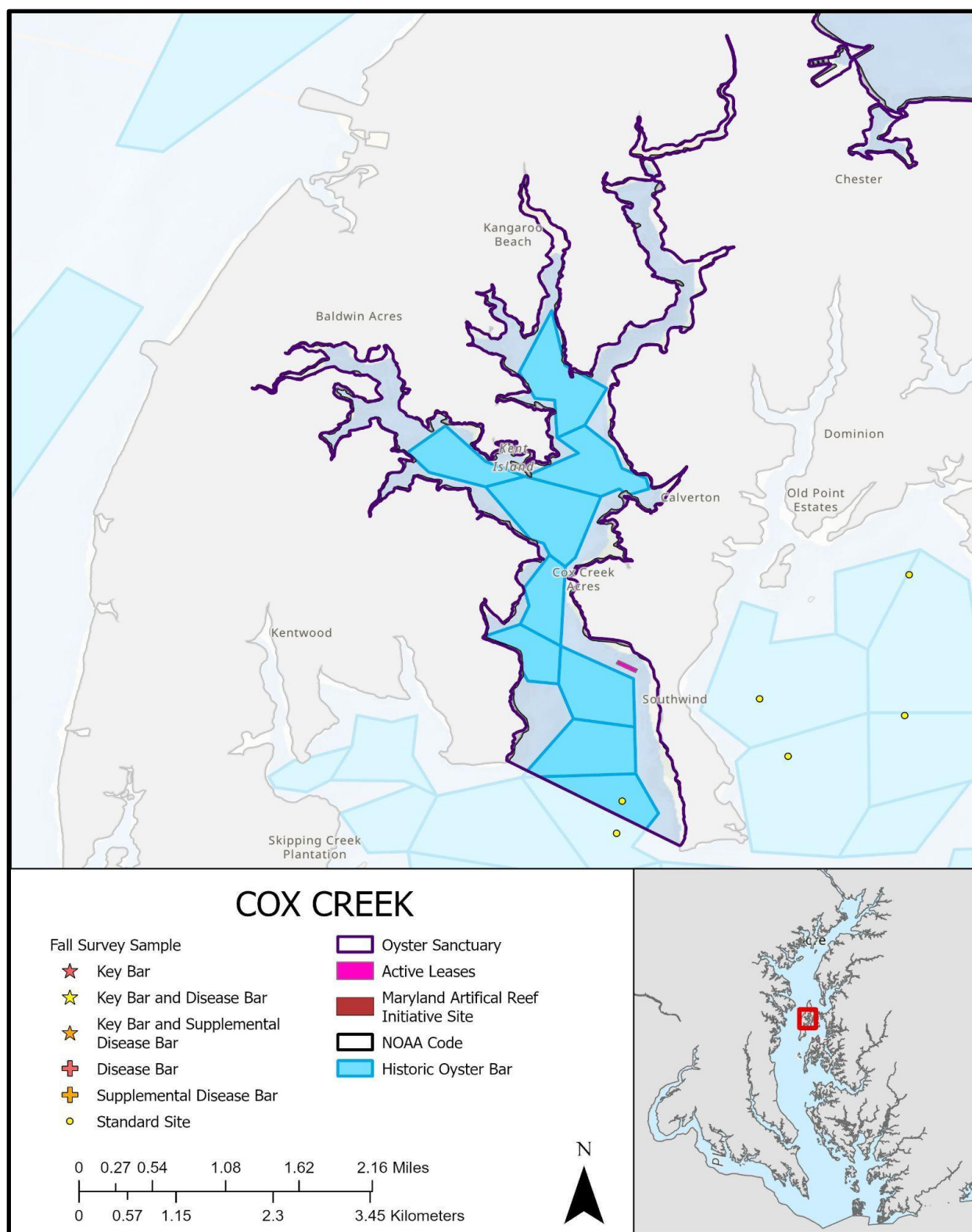


Figure A.08-1. Cox Creek Sanctuary. Fall Oyster Survey sites may not be sampled every year.

Table A.08-1. Oyster population characteristics based on the Fall Oyster Survey in the Cox Creek Sanctuary. ND=No Data. Values given are annual mean $\pm$ standard error.

Oyster Characteristic	2006-2010	2011-2015	2016-2020	2021-2025
Number of years sampled/number of samples	ND	ND	2/2	5/7
Number of Live Spat Oysters per square meter	ND	ND	0	5.3 $\pm$ 2
Number of Live Small Oysters per square meter	ND	ND	0.6	11.8 $\pm$ 6
Number of Live Market Oysters per square meter	ND	ND	5.6	17.7 $\pm$ 7
Number of Live Oysters per square meter	ND	ND	6.2	34.8 $\pm$ 12.4
Live Biomass (g Dry Weight per Bushel)	ND	ND	ND	ND
Observed Mortality (%)	ND	ND	19.1 $\pm$ 0.1	5.1 $\pm$ 2.5
Cultch (Bushels per 100 feet towed)	ND	ND	0.2	1.2 $\pm$ 0.3

Section A.09: Eastern Bay Sanctuary

The Eastern Bay Sanctuary is located along the southern shore of Eastern Bay, a medium salinity (Zone 2) region within NOAA Codes 027 and 039. The sanctuary was created in 2010 and encompasses 4,521 acres of which 939 acres (21%) are historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments). There are 7 historic oyster bars within the sanctuary¹⁶.

Information available for this sanctuary includes:

- Sanctuary map (Figure A.09-1)
- Summary statistics (Table A.09-1)

Eastern Bay Sanctuary is located in the Eastern Bay Region of Maryland's Chesapeake Bay. Oysters in the Eastern Bay Region typically show favorable growth and survival, generally remaining unaffected by disease or freshets unless subjected to multi-year droughts or significant freshet events. Natural recruitment occurs regularly in this region.

The last patent tong population survey occurred in 2020. In 2023, a NOAA diver surveyed a 2022 planting site and found 98.7 oysters per square meter, above the long-term abundance target set in the 2024 Oyster Benchmark Stock Assessment.

In 2022, the Department added a standard Fall Oyster Survey site in the Eastern Bay Sanctuary. In 2025, this sanctuary exhibited the highest mortality in the Fall Oyster Survey. This is likely attributed to low dissolved oxygen.

In the 2021-2025 sanctuary assessment, this sanctuary was classified as receiving restoration. In 2022, this sanctuary received spat-on-shell plantings for small-scale restoration. It has also received plantings as part of The Nature Conservancy's SOAR program and from Build-A-Reef plantings from NGOs. It is one of the sanctuaries that may receive future spat-on-shell plantings as part of the Eastern Bay Regional Project.

¹⁶ See chart 11 for bar names and locations in the State of Maryland Shellfish Closure Areas Book <http://dnr.maryland.gov/fisheries/Pages/oysters/index.aspx>

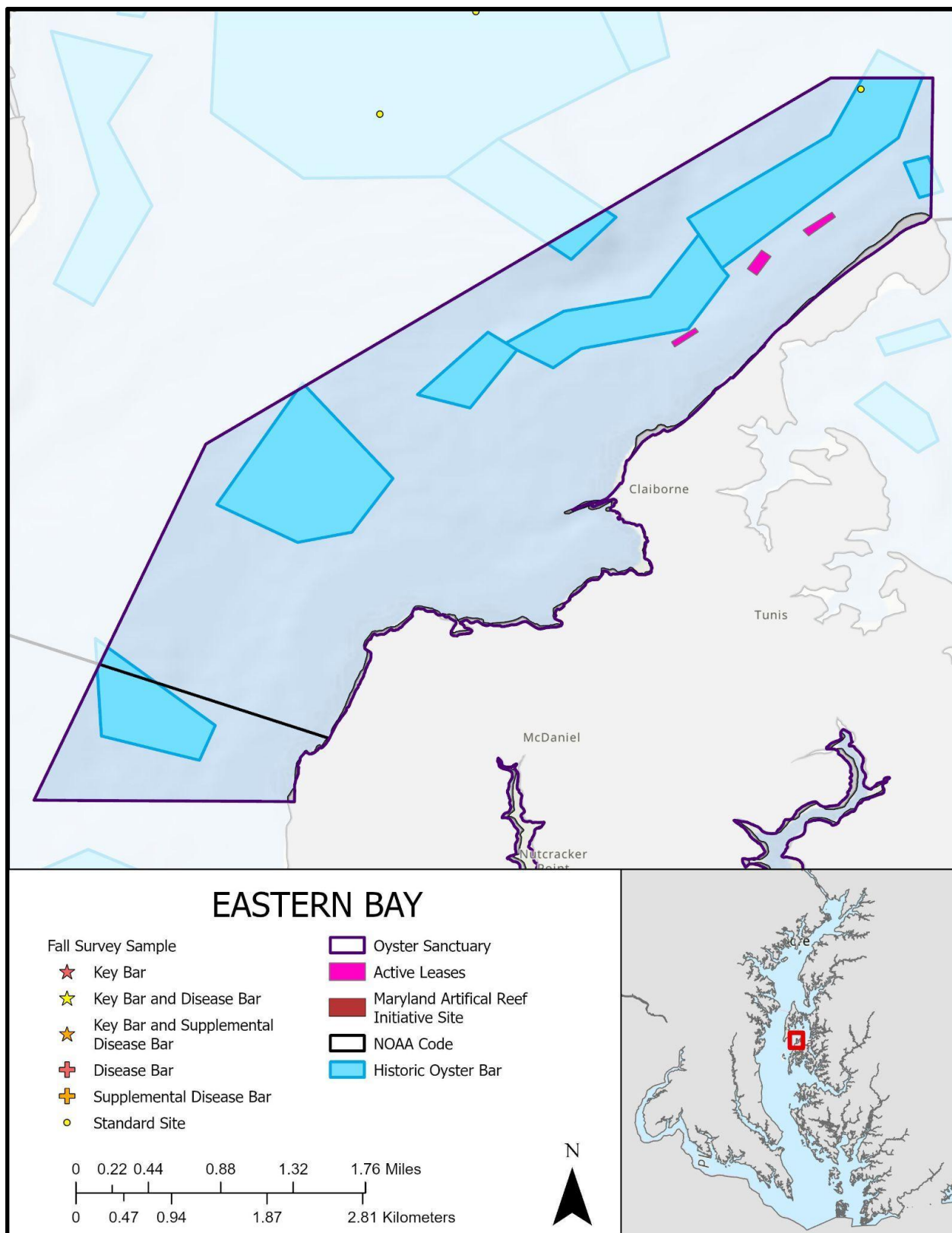


Figure A.09-1. Eastern Bay Sanctuary. Fall Oyster Survey sites may not be sampled every year.

Table A.09-1. Oyster population characteristics based on the Fall Oyster Survey in the Eastern Bay Sanctuary. ND=No Data. Values given are annual mean $\pm$ standard error.

Oyster Characteristic	2006-2010	2011-2015	2016-2020	2021-2025
Number of years sampled/number of samples	ND	ND	ND	4/4
Number of Live Spat Oysters per square meter	ND	ND	ND	7 $\pm$ 3.7
Number of Live Small Oysters per square meter	ND	ND	ND	14 $\pm$ 6.5
Number of Live Market Oysters per square meter	ND	ND	ND	46 $\pm$ 17
Number of Live Oysters per square meter	ND	ND	ND	67 $\pm$ 19
Live Biomass (g Dry Weight per Bushel)	ND	ND	ND	ND
Observed Mortality (%)	ND	ND	ND	24 $\pm$ 20
Cultch (Bushels per 100 feet towed)	ND	ND	ND	0.8 $\pm$ 0.1

Section A.10: Fort Carroll Sanctuary

The Fort Carroll Sanctuary is located in the Patapsco River, a low salinity (Zone 1) region within NOAA Code 025. The sanctuary was created in 1995 and encompasses 30 acres. There is no historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments) in the sanctuary. Fort Carroll Sanctuary was established for educational programs run by the Living Classrooms Foundation.

Information available for this sanctuary includes:

- Sanctuary map (Figure A.10-1)

Fort Carroll Sanctuary is located in the Upper Bay Region of Maryland's Chesapeake Bay. Oysters in the Upper Bay Region generally grow well and survive but can be impacted by freshet events. Reduced salinity levels contribute to a lower rate of natural recruitment.

No patent tong surveys by the Department have occurred since 2006.

In March of 2024, the Francis Scott Key Bridge collapsed, causing concern for the oysters planted within the Fort Carroll Sanctuary. The Chesapeake Bay Foundation performed a diving population survey in the fall of 2024 on the reef that received restoration and found an average of 81 oysters per square meter.

The sanctuary was one of the sanctuaries identified by the Department as unlikely to receive a large investment by the Department for restoration. The Maryland Department of Transportation is considering creating an additional 3-acre reef base area for oyster restoration within this sanctuary as part of the Key Bridge rebuild. This would likely include most of the bottom habitat that is suitable for reef creation.

In the 2021-2025 sanctuary assessment, this sanctuary was classified as being created for NGO purposes.

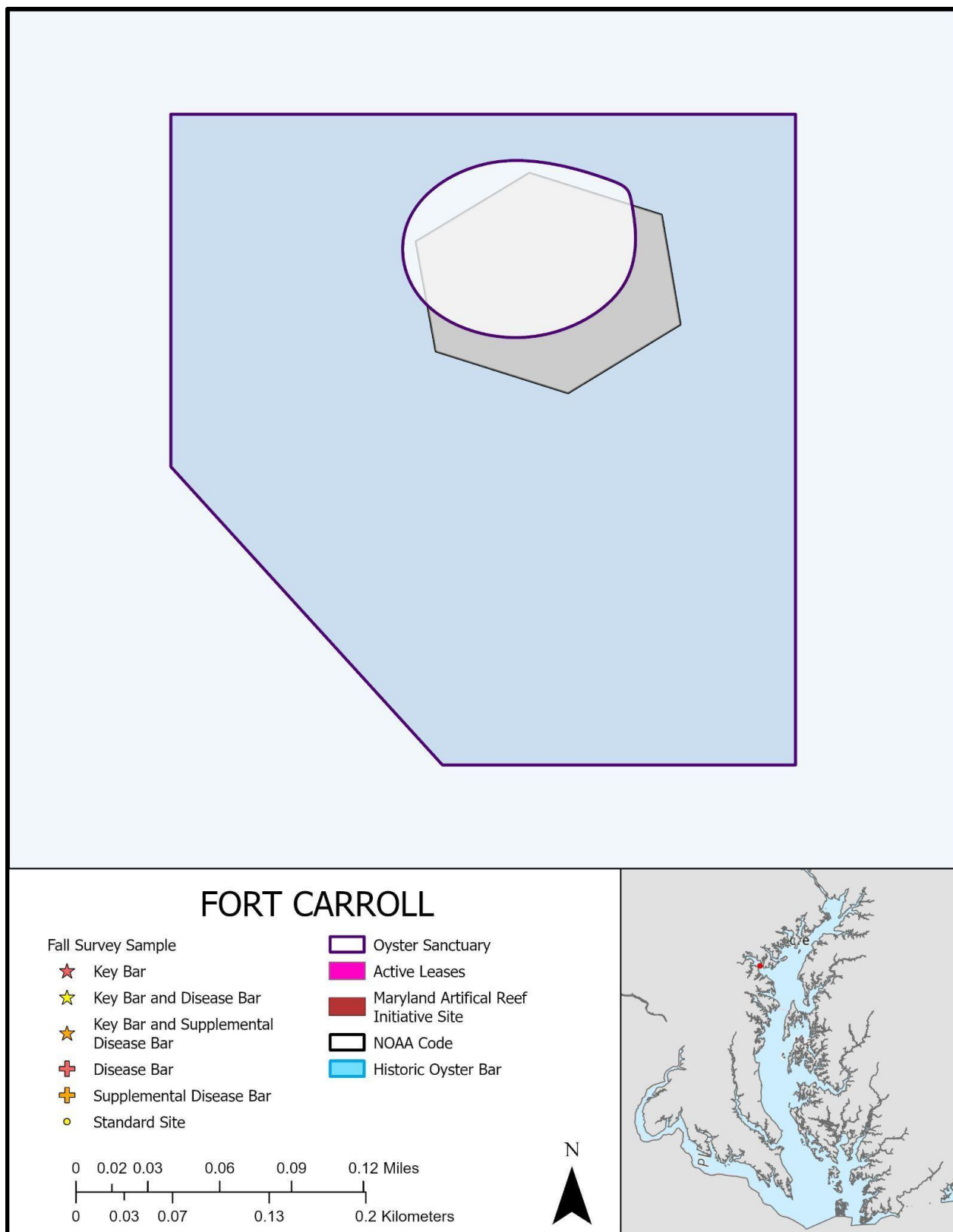


Figure A.10-1. Fort Carroll Sanctuary. The purple circle is the sanctuary boundary around the fort.

Section A.11: Harris Creek Sanctuary

The Harris Creek Sanctuary is located in a medium salinity (Zone 2) tributary of the Choptank River within NOAA Code 437. The sanctuary was created in 2010 and encompasses 4,647 acres of which 1,998 acres (43%) are historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments). There are 15 historic oyster bars within the sanctuary¹⁷. This sanctuary was selected for large-scale oyster restoration under the 2014 Chesapeake Bay Watershed Agreement. Initial restoration of the sanctuary was completed in 2015, and the last hatchery spat-on-shell seeding occurred in 2020.

Information available for this sanctuary includes:

- Sanctuary map (Figure A.11-1)
- Summary statistics (Table A.11-1)
- Density per year (Figure A.11-2)
- Shell height frequencies (Figure A.11-3)
- Biomass per year (Figure A.11-4)
- Observed mortality (Figure A.11-5)
- Dermo and MSX per year (Figure A.11-6)
- Cultch per year (Figure A.11-7)

Harris Creek Sanctuary is located in the Choptank Region of Maryland's Chesapeake Bay. Oysters in the Choptank Region generally grow well but may be impacted by disease or freshet events. Natural recruitment occurs regularly in this region.

The Fall Oyster Survey has six standard sites, one sentinel key and supplemental disease bar, and one supplemental disease site within the Harris Creek Sanctuary. Table A.11-1 shows an increase in the average number of oysters and biomass from 2021-2025 data compared to the previous 5-year increments, while exhibiting low observed mortality. Dermo disease exhibited an increase in lethal prevalence in 2023; however, MSX remained undetected throughout 2021-2025 (Figure A.11-6). The average density from 2021-2025 is above the long-term abundance target of 94 oysters per square meter and the average cultch per 100 ft tow indicates sufficient cultch availability. It should be noted that given limitations of traditional gear types, not all restored areas are surveyed by the Department. The Fall Oyster Survey is unable to sample reefs that have been restored using rock substrate. Past monitoring by U.S. Army Corps of Engineers and National Oceanic and Atmospheric Administration six years after initial restoration has shown densities on these alternate substrate restoration areas ranging from 100 to 374.8 oysters per square meter¹⁸.

In 2025, the Harris Creek Sanctuary had exceptional recruitment (Figure A.11-2).

The Department has not conducted any population patent tong surveys since 2006 in the Harris Creek Sanctuary; however, other organizations have been monitoring the

¹⁷ See chart 15 for bar names and locations in the State of Maryland Shellfish Closure Areas Book <http://dnr.maryland.gov/fisheries/Pages/oysters/index.aspx>

¹⁸ Maryland Oyster Restoration Interagency Workgroup under the Chesapeake Bay Program's Sustainable Fisheries Goal Implementation Team. 2024 Maryland Oyster Reef Monitoring Report: Analysis of Data from the 'Ten Tributaries' Sanctuary Oyster Restoration Initiative in Maryland. 2025.

restoration areas using patent tong and diver surveys. Results from these surveys (2015-2021 monitoring) indicate that, six years post initial restoration, 343 acres of the 348 acres that received restoration (>98%) met or exceeded the minimum threshold success criteria for restoration (15 oysters per square meter over 30% of the reef). This was over the 300-acre minimum required to be considered a successfully restored tributary and was the first successfully restored tributary toward the 2014 Chesapeake Bay Watershed Agreement oyster goal.

In the 2021-2025 sanctuary assessment, this sanctuary was classified as restored.

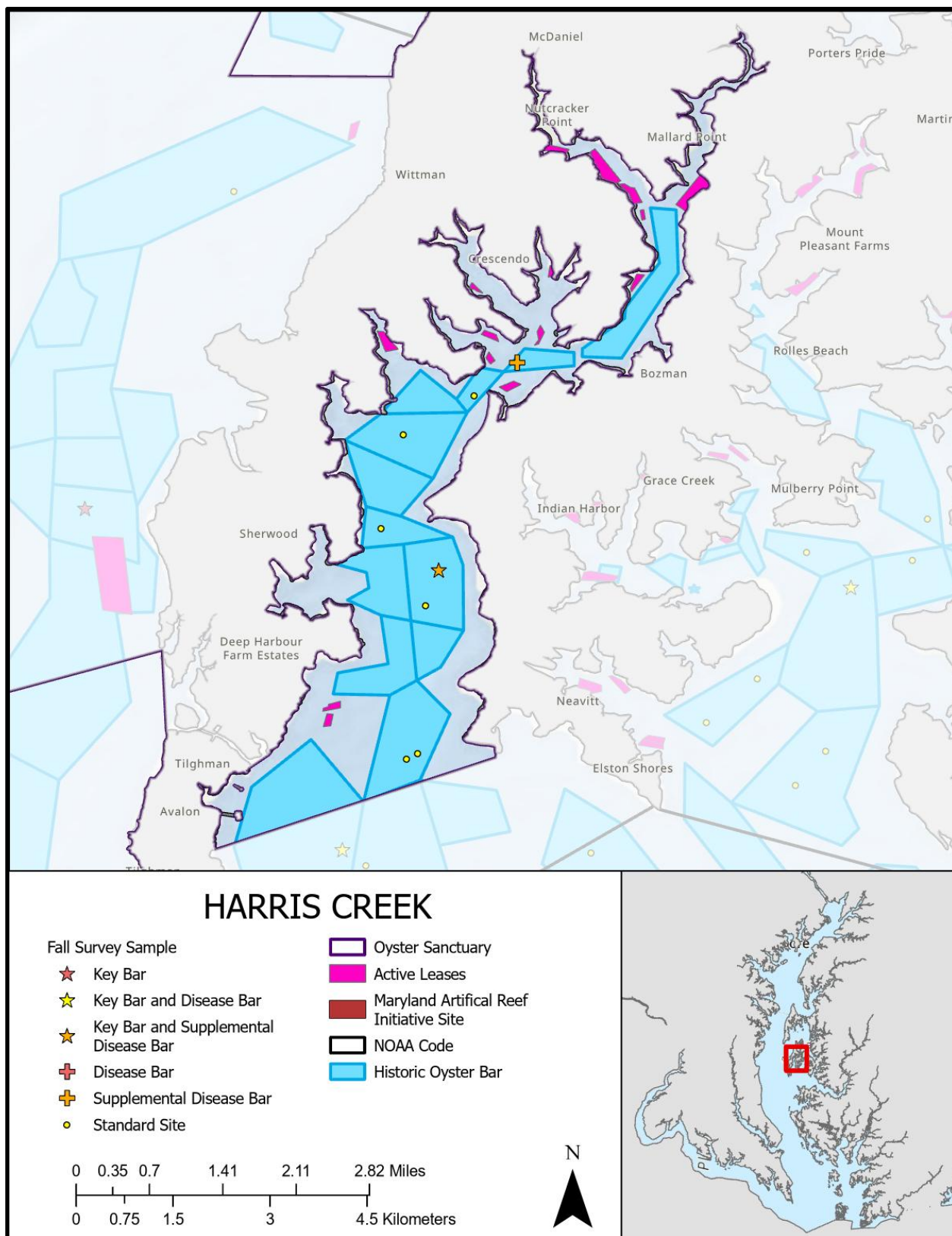


Figure A.11-1. Harris Creek Sanctuary. Fall Oyster Survey sites may not be sampled every year.

Table A.11-1. Oyster population characteristics based on the Fall Oyster Survey in the Harris Creek Sanctuary. ND=No Data. Values given are annual mean $\pm$ standard error.

Oyster Characteristic	2006-2010	2011-2015	2016-2020	2021-2025
Number of years sampled/number of samples	5/26	5/30	5/37	5/40
Number of Live Spat Oysters per square meter	22.7 $\pm$ 10.5	30.7 $\pm$ 14.1	67.7 $\pm$ 12.5	178.7 $\pm$ 74.9
Number of Live Small Oysters per square meter	35.7 $\pm$ 12.1	229 $\pm$ 53.2	149.6 $\pm$ 25.6	123.8 $\pm$ 15
Number of Live Market Oysters per square meter	21.6 $\pm$ 4.2	132.5 $\pm$ 17.8	116.3 $\pm$ 9.9	162.3 $\pm$ 13.3
Number of Live Oysters per square meter	80 $\pm$ 23	392 $\pm$ 59	333 $\pm$ 36	465 $\pm$ 86
Live Biomass (g Dry Weight per Bushel)	50.3	308 $\pm$ 97	357 $\pm$ 24	392 $\pm$ 21
Observed Mortality (%)	7.8 $\pm$ 1.5	4.3 $\pm$ 0.9	7.3 $\pm$ 1.2	6.7 $\pm$ 0.6
Cultch (Bushels per 100 feet towed)	1.5 $\pm$ 0.2	1.8 $\pm$ 0.2	1.4 $\pm$ 0.1	1.7 $\pm$ 0.1

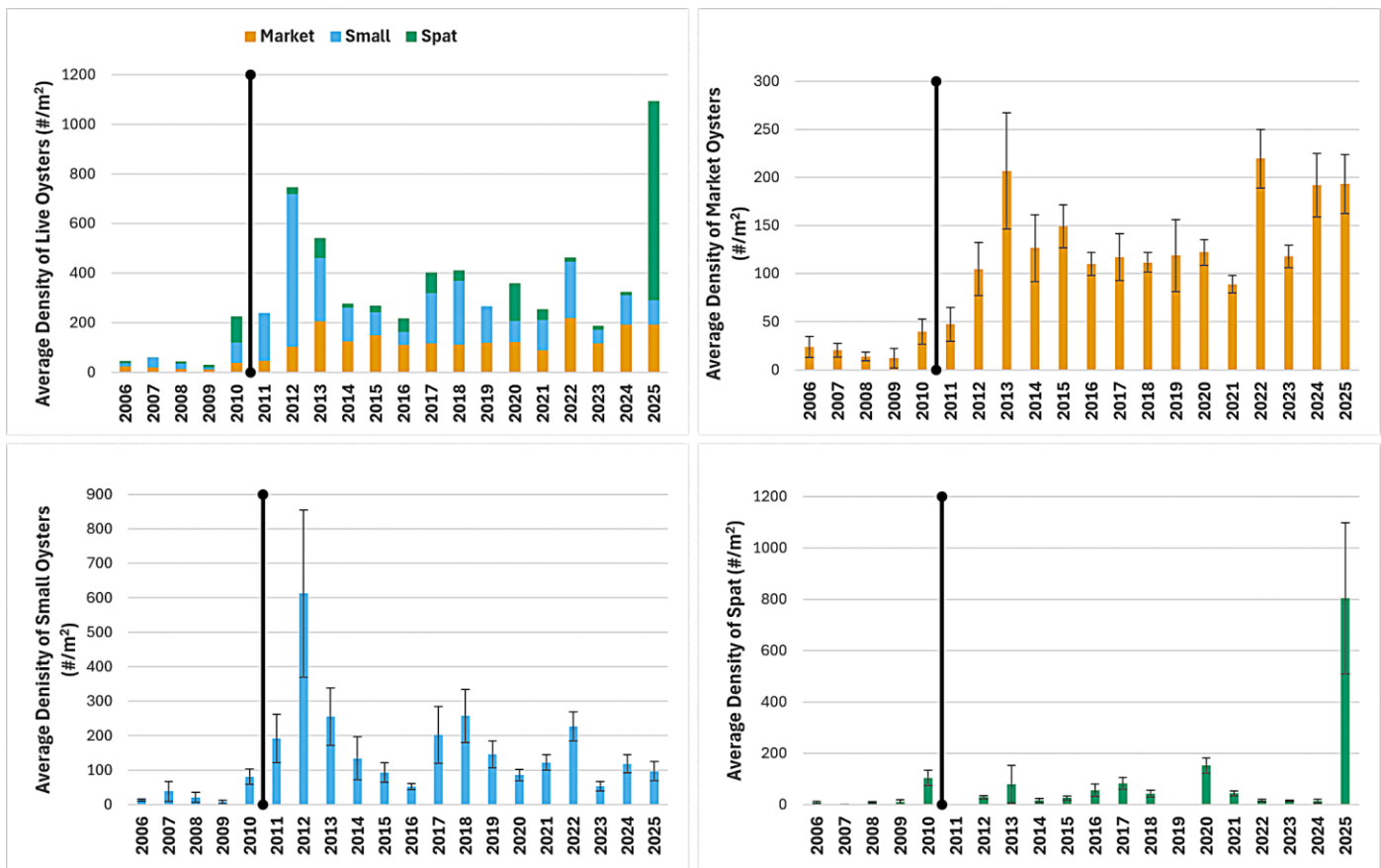


Figure A.11-2. Average number of live oysters per square meter by size class in the Harris Creek Sanctuary. Black line indicates the date the sanctuary was established. Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales.

HARRIS CREEK (2010)

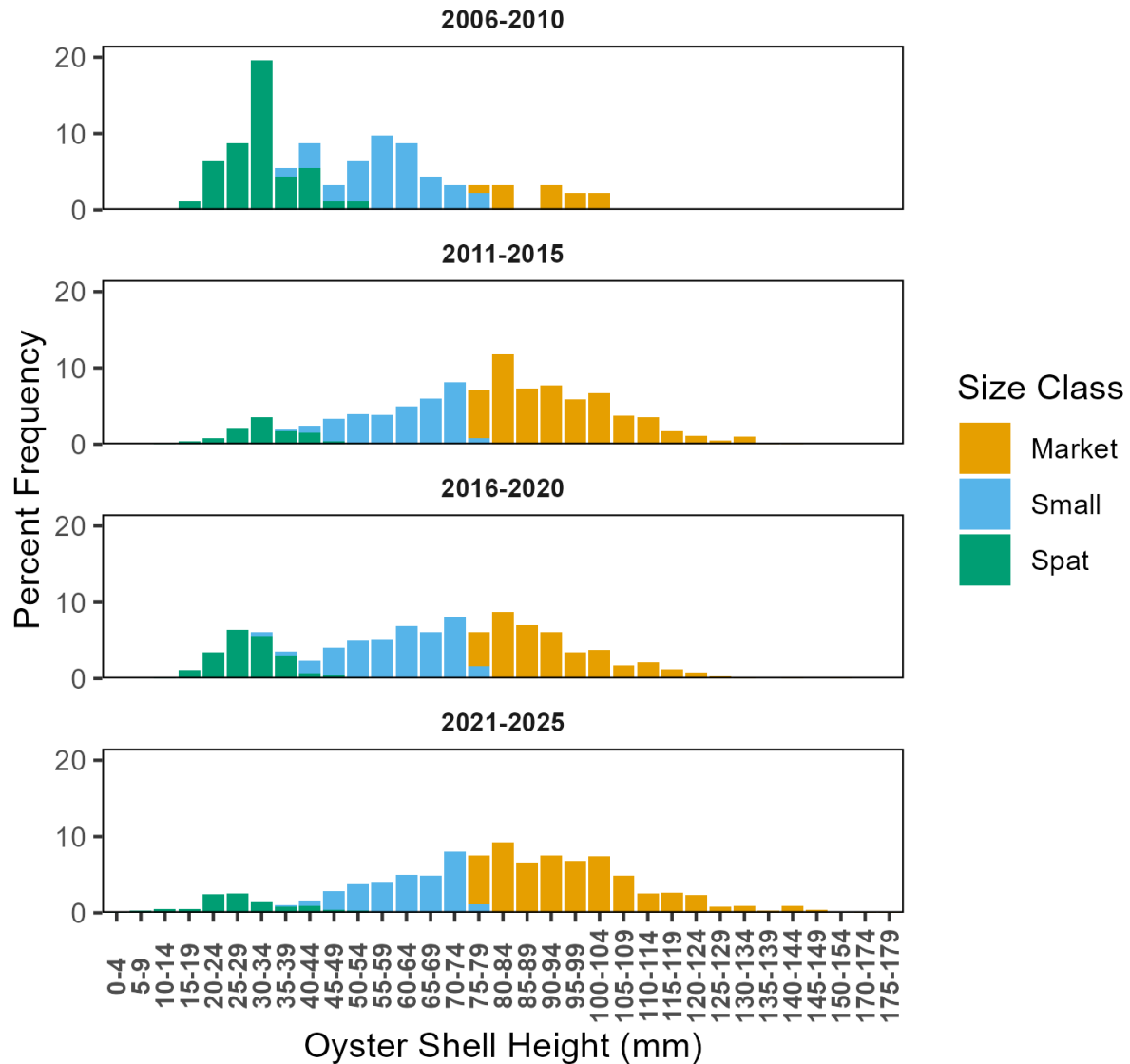


Figure A.11-3. Shell height frequencies of live oysters in the Harris Creek Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Height frequency data was not collected from 2006 to 2009.

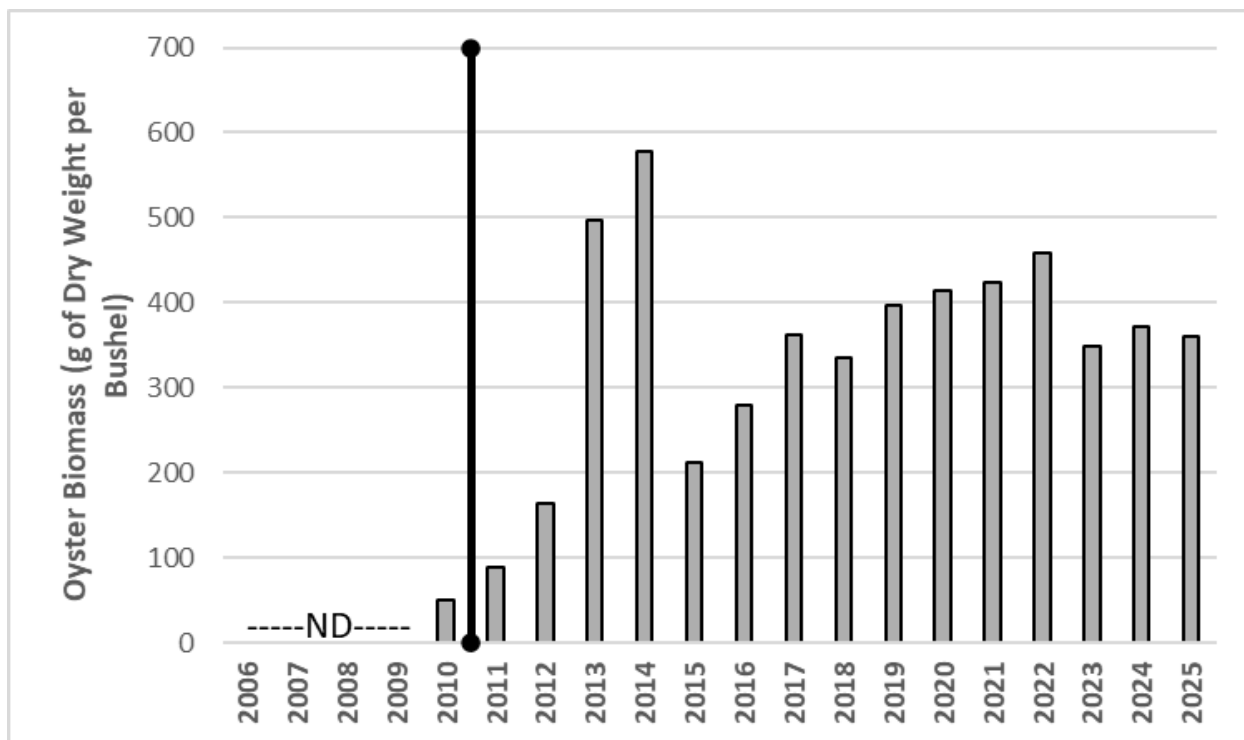


Figure A.11-4. Oyster biomass (grams of dry weight per bushel of material) in the Harris Creek Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey on Mill Point bar. Black line indicates the date the sanctuary was established. ND = No Data.

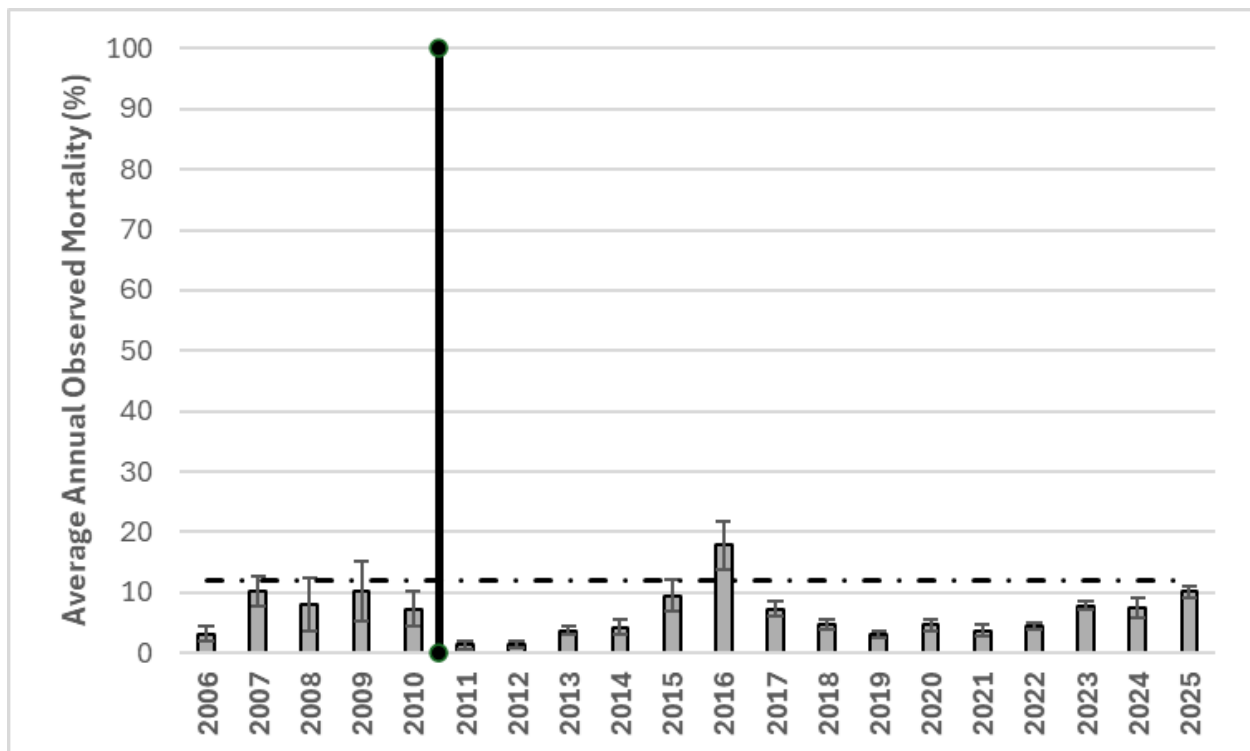


Figure A.11-5. Average annual observed mortality of market-sized and small-sized oysters in Harris Creek Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Black line denotes the date the sanctuary was established, and the dashed line represents the 2006-2025 baywide average observed mortality. Error bars represent ± 1 standard error.

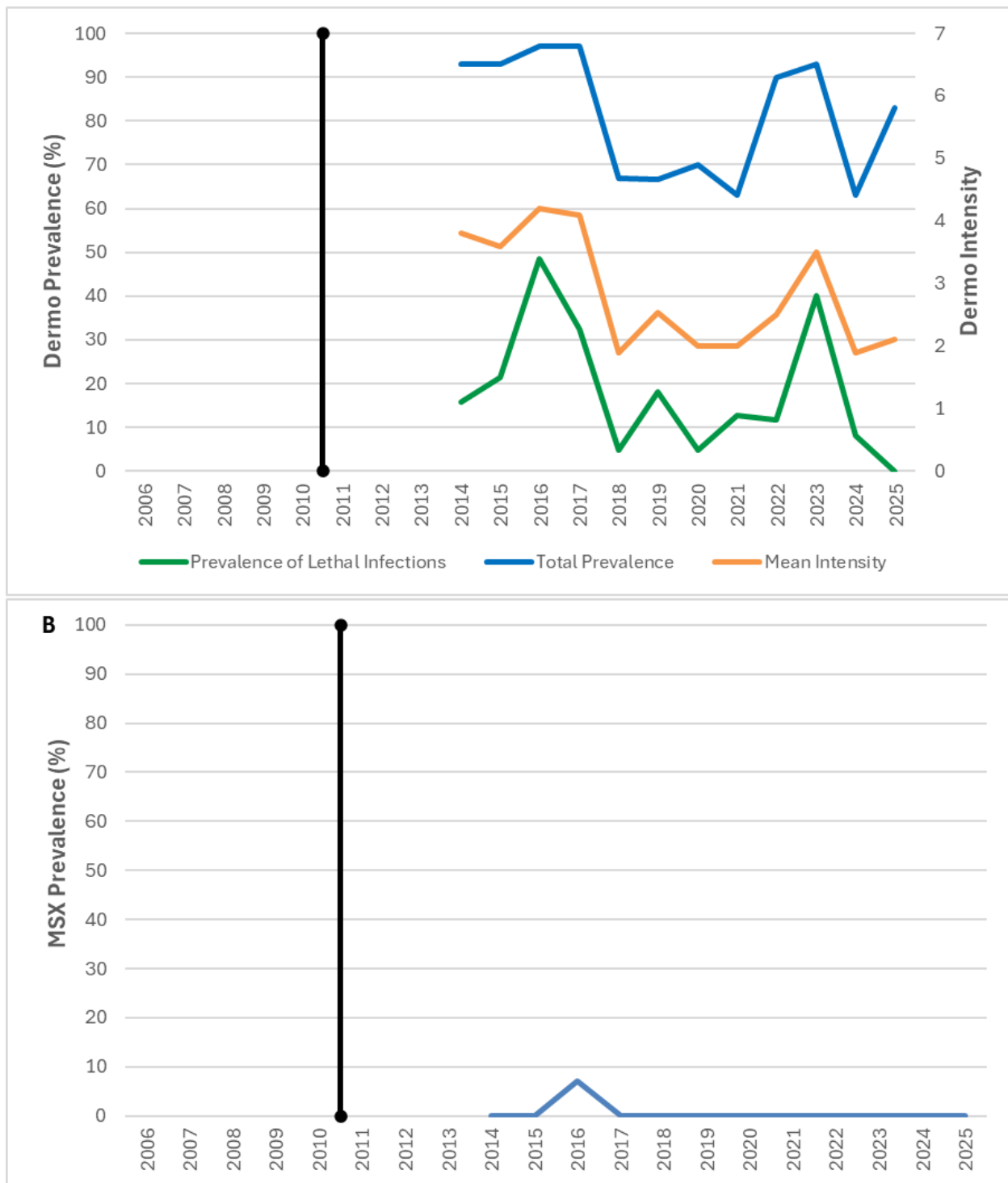


Figure A.11-6. Oyster disease prevalence and intensity in the Harris Creek Sanctuary. (A) Dermo prevalence and mean intensity (B) MSX prevalence (intensity is not examined). Data from Maryland's Annual Fall Oyster Dredge Survey on Mill Point bar. Black line denotes the date the sanctuary was established. Data were not collected in 2006 to 2013.

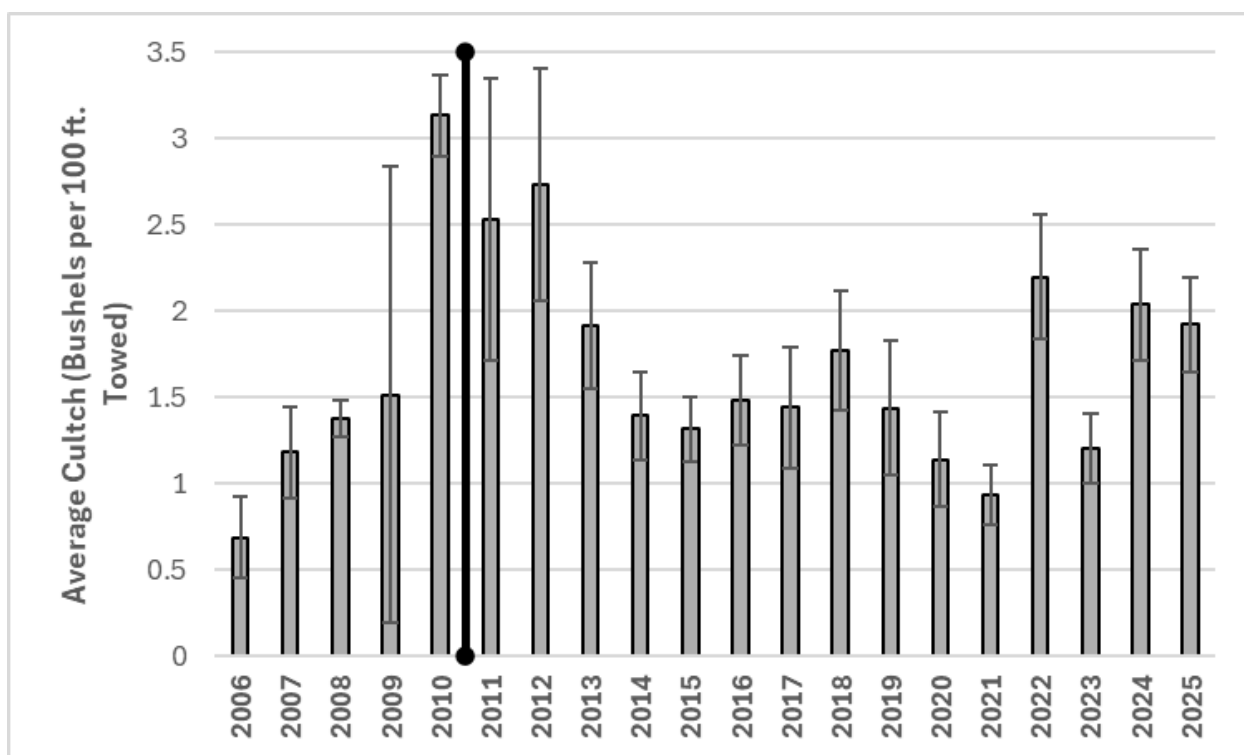


Figure A.11-7. Average cultch (live and dead oysters and loose shell) in the Harris Creek Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Black line denotes the date the sanctuary was established. Error bars represent ± 1 standard error.

Section A.12: Herring Bay Sanctuary

The Herring Bay Sanctuary is located along the shore of lower Anne Arundel County and upper Calvert County within NOAA Codes 027 and 127 which is a medium salinity (Zone 2) region. The sanctuary was created in 2010 and encompasses 16,792 acres of which 7,981 (48%) is historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments). There are 8 historic oyster bars within the sanctuary¹⁹.

Information available for this sanctuary includes:

- Sanctuary map (Figure A.12-1)
- Density Survey (Figure A.12-2)
- Summary statistics (Table A.12-1)
- Density per year (Figure A.12-3)
- Shell height frequencies (Figure A.12-4)
- Biomass per year (Figure A.12-5)
- Observed mortality (Figure A.12-6)
- Dermo and MSX per year (Figure A.12-7)
- Cultch per year (Figure A.12-8)

Herring Bay Sanctuary is located in the Mid Bay Region of Maryland's Chesapeake Bay. Oysters in the Mid Bay Region typically exhibit good growth and survival rates, remaining largely unaffected by disease or freshet events. There are typically low rates of recruitment in this region.

In 2024, the Department announced Herring Bay Sanctuary as one of the next three areas to receive large-scale restoration by the Department. It is slated to receive substrate habitat and spat-on-shell restoration.

The Fall Oyster Survey samples one sentinel key and disease bar site within the Herring Bay Sanctuary. Fall Oyster Survey sentinel sites do not receive any restoration or repletion to be able to follow the natural population trends. Although the data for the Fall Oyster Survey sample site shows a poor average number of oysters, biomass and cultch availability (Table A.12-1), there are plantings within the sanctuary that are sampled to obtain a disease sample. A disease sample, obtained from another site within Herring Bay, exhibited an increase in dermo disease intensity and MSX prevalence in 2023 (Figure A.12-7).

In 2025, the Fall Oyster Survey site had the highest spat set in the 1985-to-2025-year times series at 20 spat per bushel of material. This is nearly 20 times the 41-year average of 1.1 spat per bushel of material, and over three times higher than the second highest spat recorded during this time in 1985 at 6 spat per bushel of material.

A population patent tong survey was conducted by the Department in 2023 and found 2 live oysters and an average of 0.4 liters per square meter of surface shell from the 185 samples taken. The prior survey in 2014 found no live oysters and an average of 0.1

¹⁹ See chart 13 and 17 for bar names and locations in the State of Maryland Shellfish Closure Areas Book
<http://dnr.maryland.gov/fisheries/Pages/oysters/index.aspx>

liters per square meter of surface shell. Given the random sampling design of the patent tong survey, only one sampling site was within the planted area in the sanctuary. In 2022, Advocates for Herring Bay conducted a dive survey of the area that they have performed restoration on and found an average of 236 oysters per square meter.

In 2023, the Department planted spat-on-shell on an area within the sanctuary as part of the small-scale restoration effort. In 2024 through 2025, spat-on-shell were planted within the sanctuary as part of the Ever Forward mitigation effort. In 2021, 2023 and 2025 spat-on-shell were planted within the sanctuary as part of a community-based Build-A-Reef efforts supported by Advocates for Herring Bay and Oyster Recovery Partnership. In 2025, the Department placed cages with aged, shucked oyster shell to conduct a spat-set study on 5 historic oyster bars within the Herring Bay Sanctuary (Bay Shore, Fairhaven, Long, Holland Point, and Hog Point bars). One of the sites, Hog Point Bar, exhibited a low level of natural recruitment, the other sites had no recruitment.

In the 2021-2025 sanctuary assessment, this sanctuary was classified as receiving restoration.

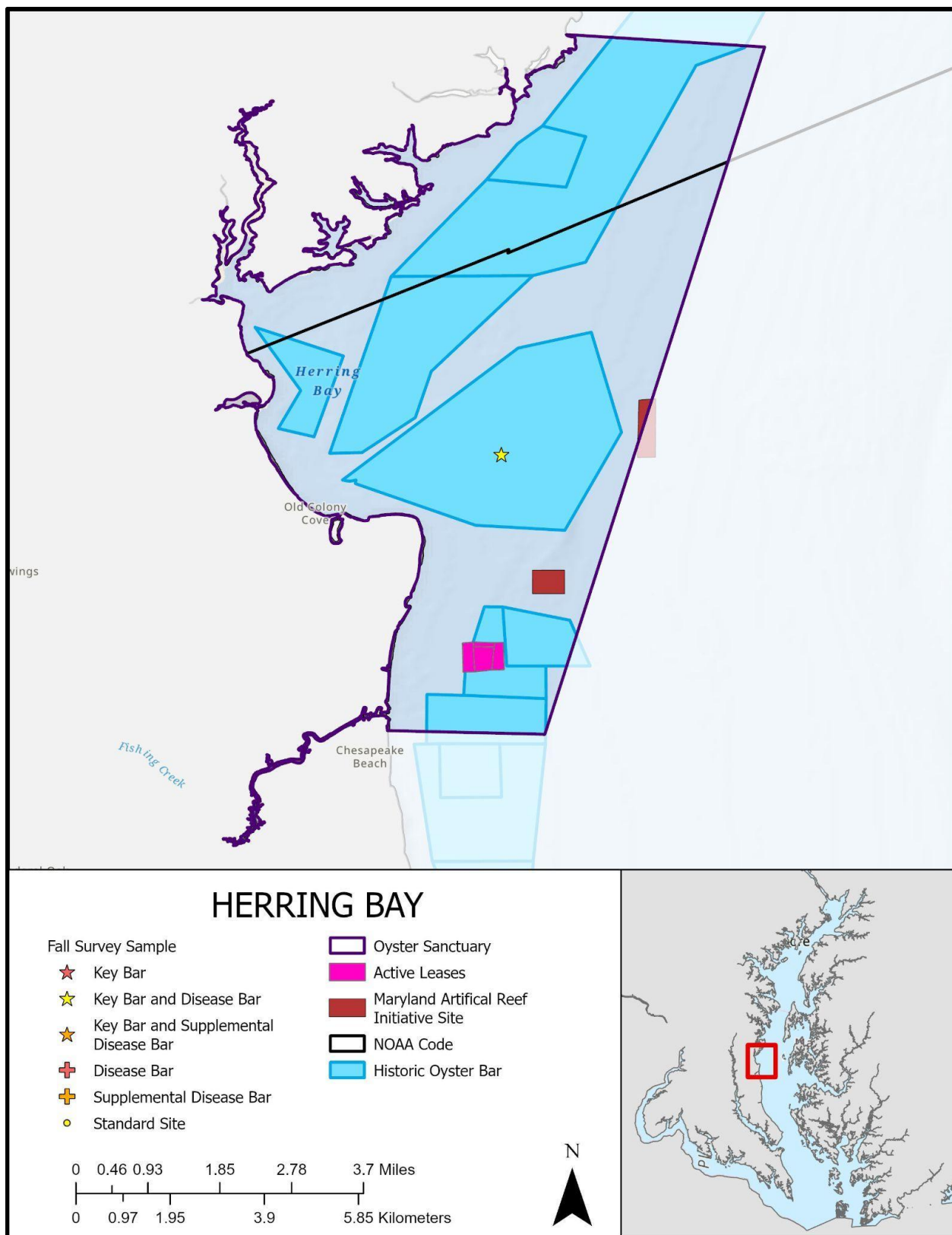


Figure A.12-1. Herring Bay Sanctuary.

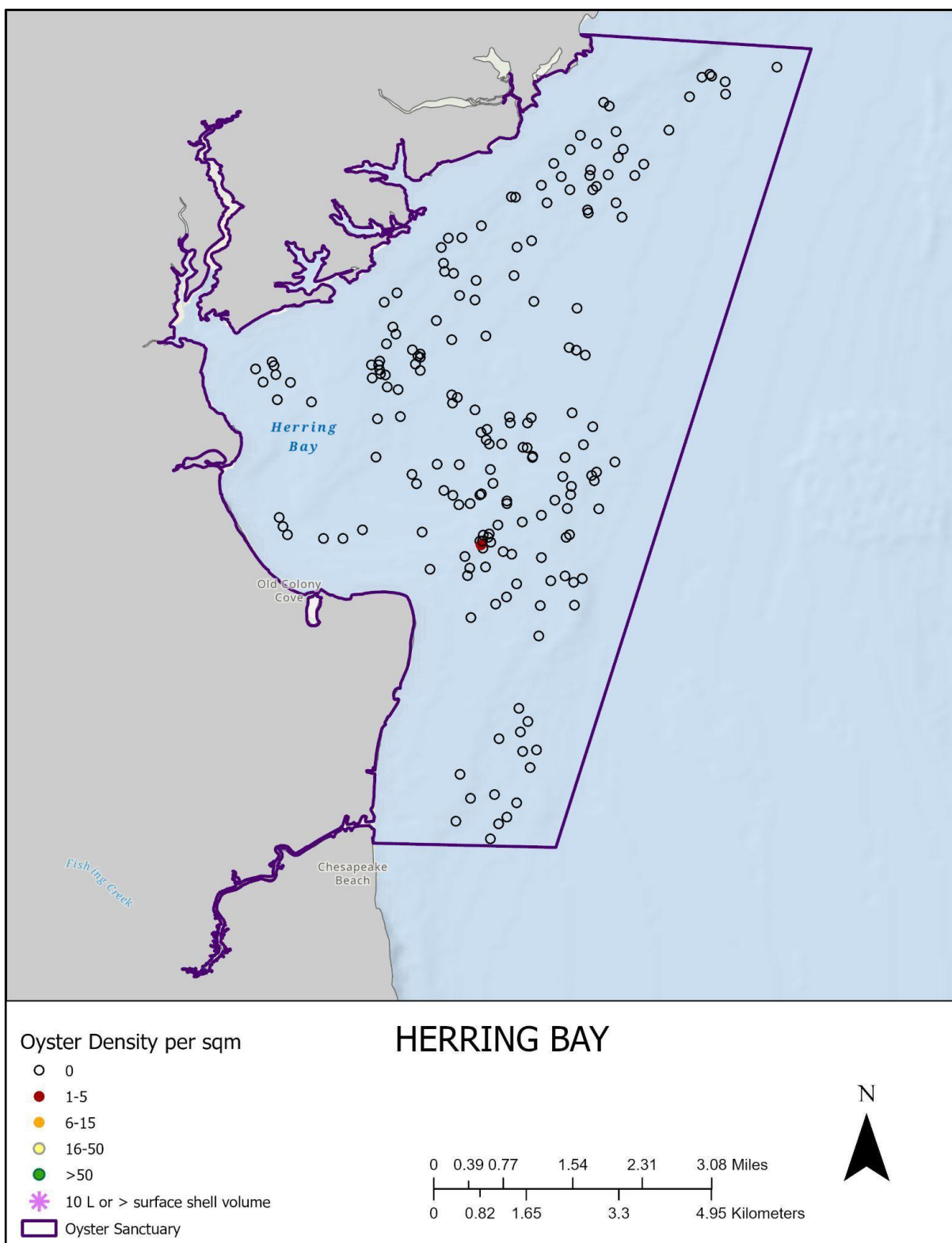


Figure A.12-2. Map of 2023 oyster density in the Herring Bay Sanctuary. Data from Maryland Department of Natural Resources Patent Tong Population Survey.

Table A.12-1. Oyster population characteristics based on the Fall Oyster Survey in the Herring Bay Sanctuary. ND=No Data. Values given are annual mean $\pm$ standard error.

Oyster Characteristic	2006-2010	2011-2015	2016-2020	2021-2025
Number of years sampled/number of samples	5/9	5/5	5/4	5/6
Number of Live Spat Oysters per square meter	0.003 $\pm$ 0.004	0 $\pm$ 0	0.01 $\pm$ 0.005	0.36 $\pm$ 0.29
Number of Live Small Oysters per square meter	0.41 $\pm$ 0.24	0 $\pm$ 0	0.01 $\pm$ 0.01	0.003 $\pm$ 0.003
Number of Live Market Oysters per square meter	1.42 $\pm$ 1.1	0.3 $\pm$ 0.26	0.01 $\pm$ 0.01	0.03 $\pm$ 0.01
Number of Live Oysters per square meter	1.8 $\pm$ 1.2	0.3 $\pm$ 0.26	0.03 $\pm$ 0.01	0.36 $\pm$ 0.3
Live Biomass (g Dry Weight per Bushel)	19.4 $\pm$ 3.1	36.3 $\pm$ 15.2	6 $\pm$ 5	5.6 $\pm$ 2.4
Observed Mortality (%)	2.1 $\pm$ 1.4	25.7 $\pm$ 8	12.5 $\pm$ 12.5	10 $\pm$ 10
Cultch (Bushels per 100 feet towed)	0.2 $\pm$ 0.1	0.03 $\pm$ 0.02	0.1 $\pm$ 0.02	0.1 $\pm$ 0.03

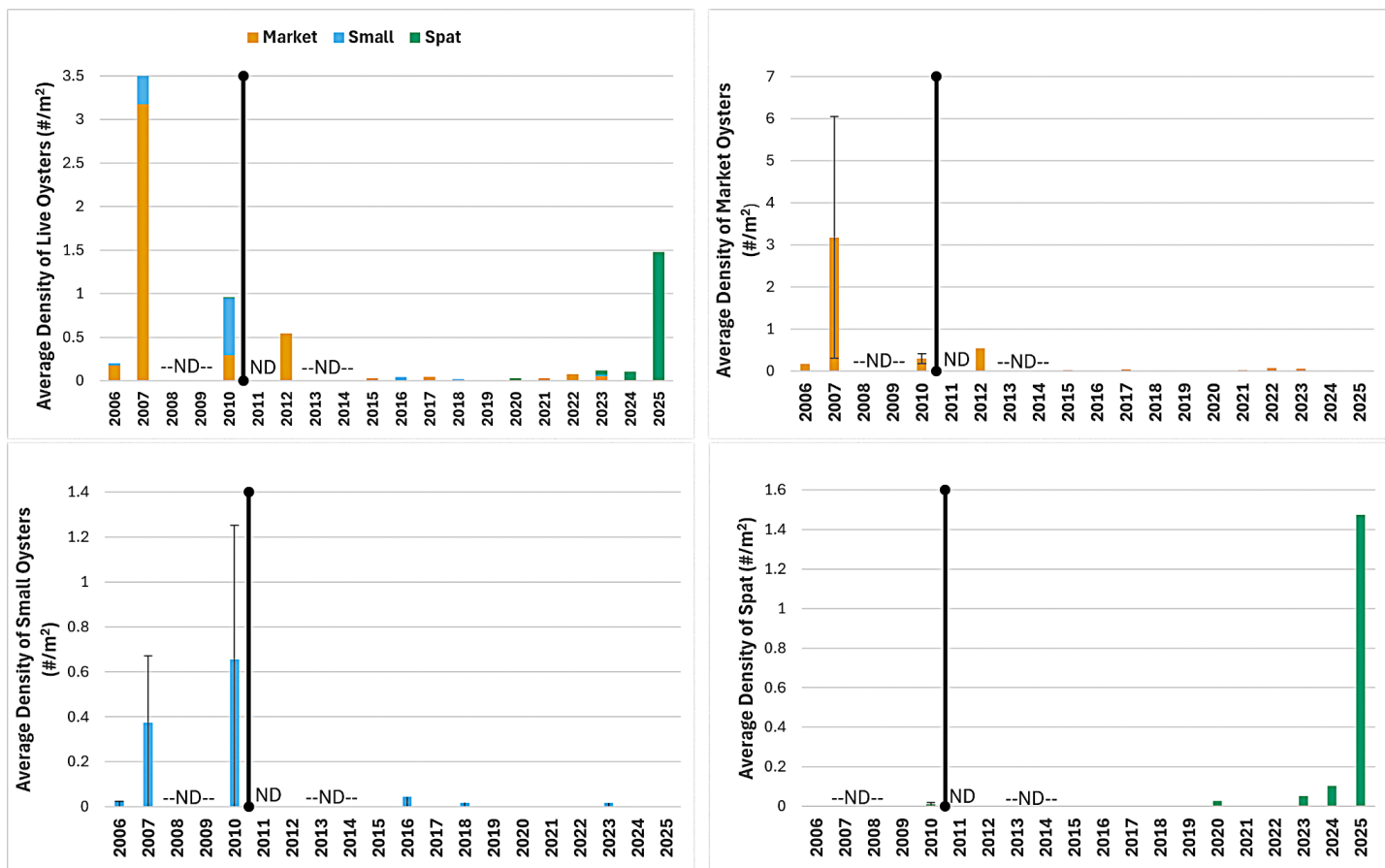


Figure A.12-3. Average number of live oysters per square meter by size class in the Herring Bay Sanctuary. Black line indicates the date the sanctuary was established. Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales. ND = No Data.

HERRING BAY (2010)

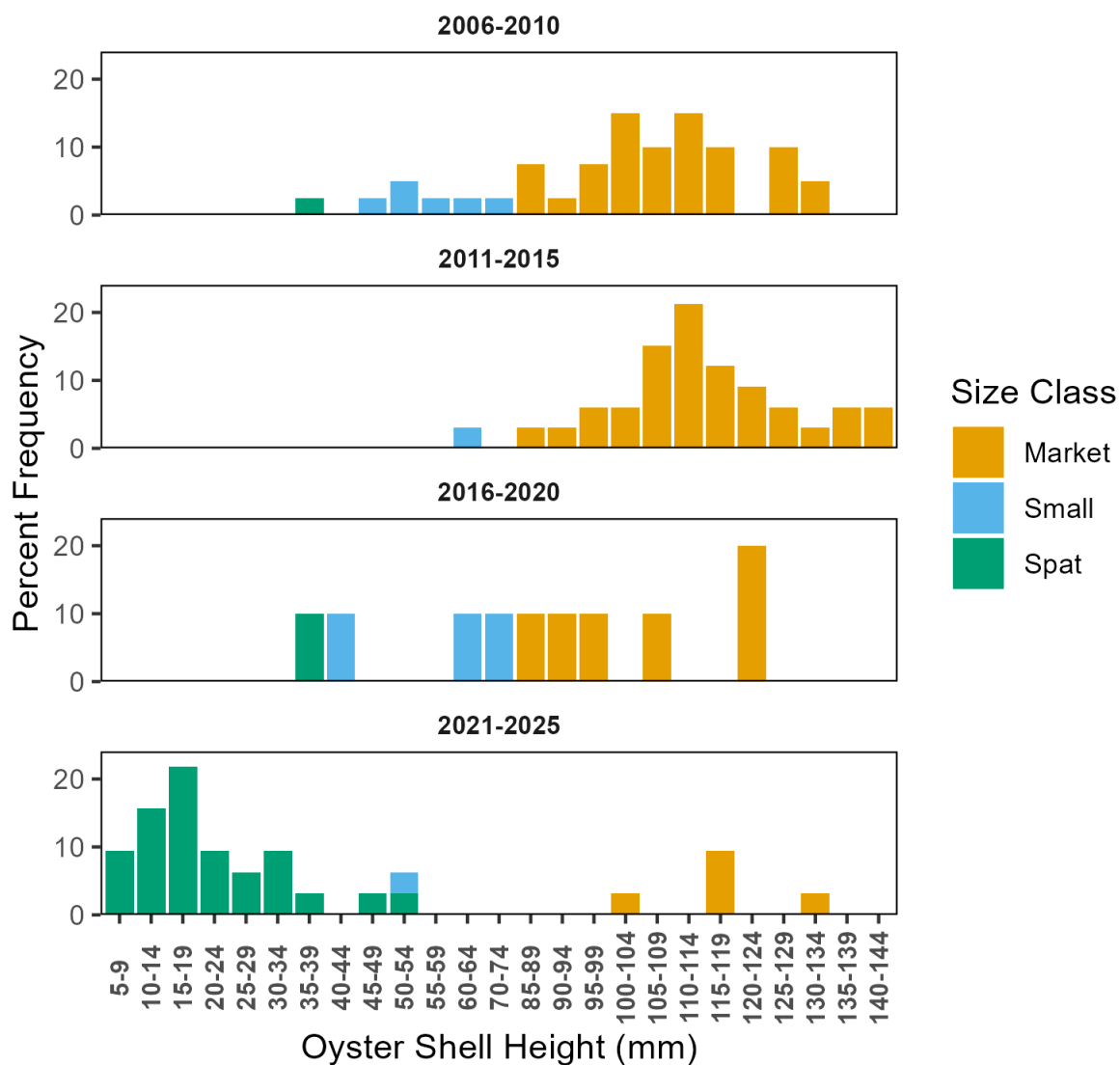


Figure A.12-4. Shell height frequencies of live oysters in the Herring Bay Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey on Holland Point bar.

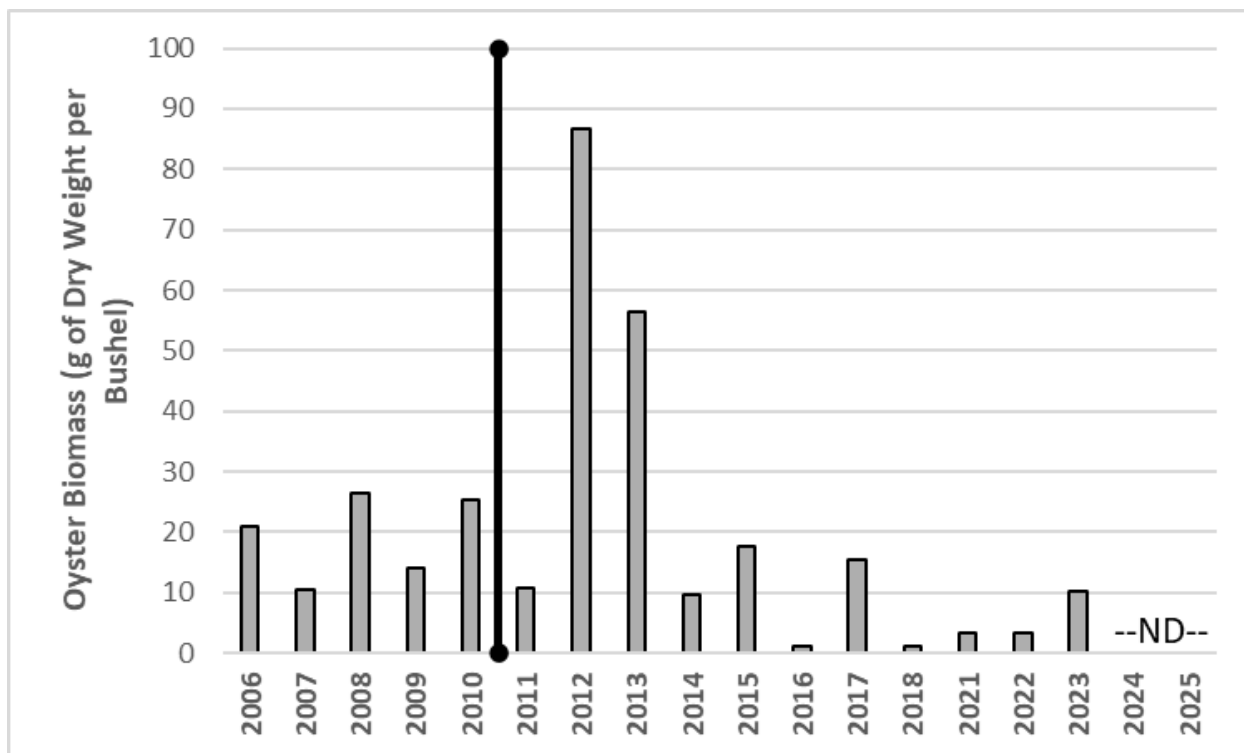


Figure A.12-5. Oyster biomass (grams of dry weight per bushel of material) in the Herring Bay Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey on Holland Point bar. Black line indicates the date the sanctuary was established.

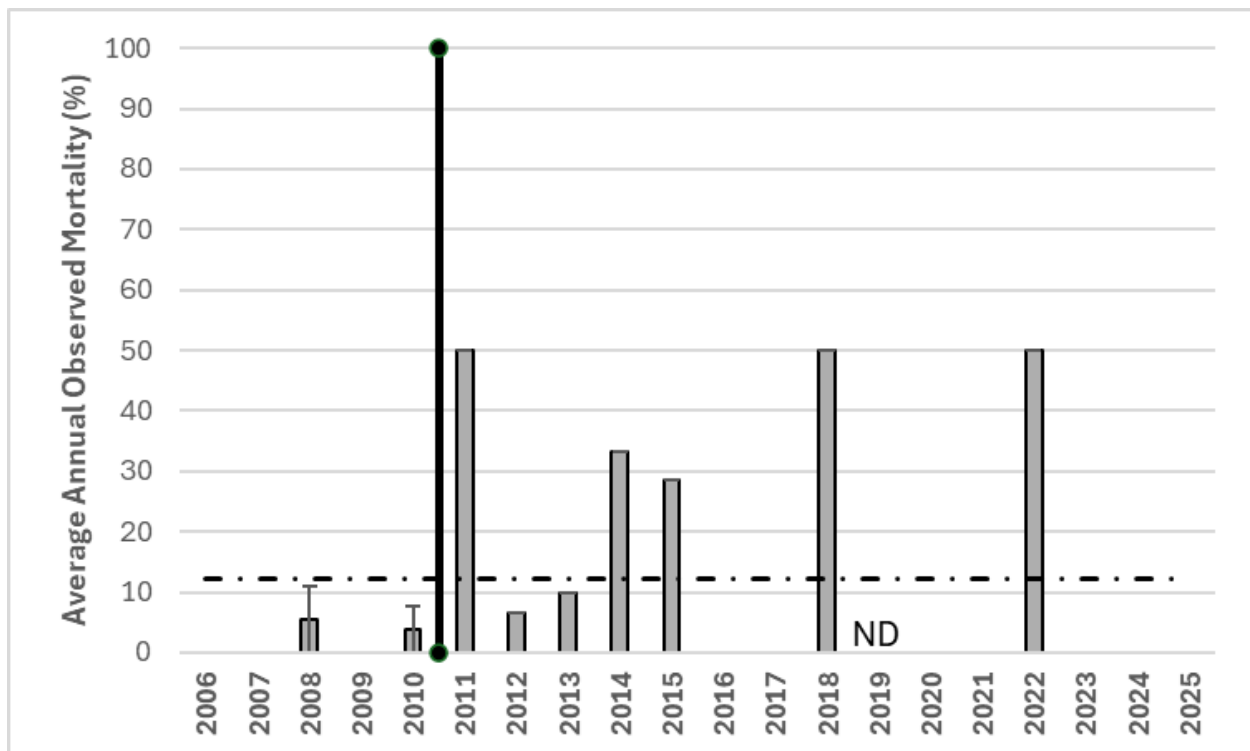


Figure A.12-6. Average annual observed mortality of market-sized and small-sized oysters in Herring Bay Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Black line denotes the date the sanctuary was established, and the dashed line represents the 2006-2025 baywide average observed mortality. Error bars represent ± 1 standard error.

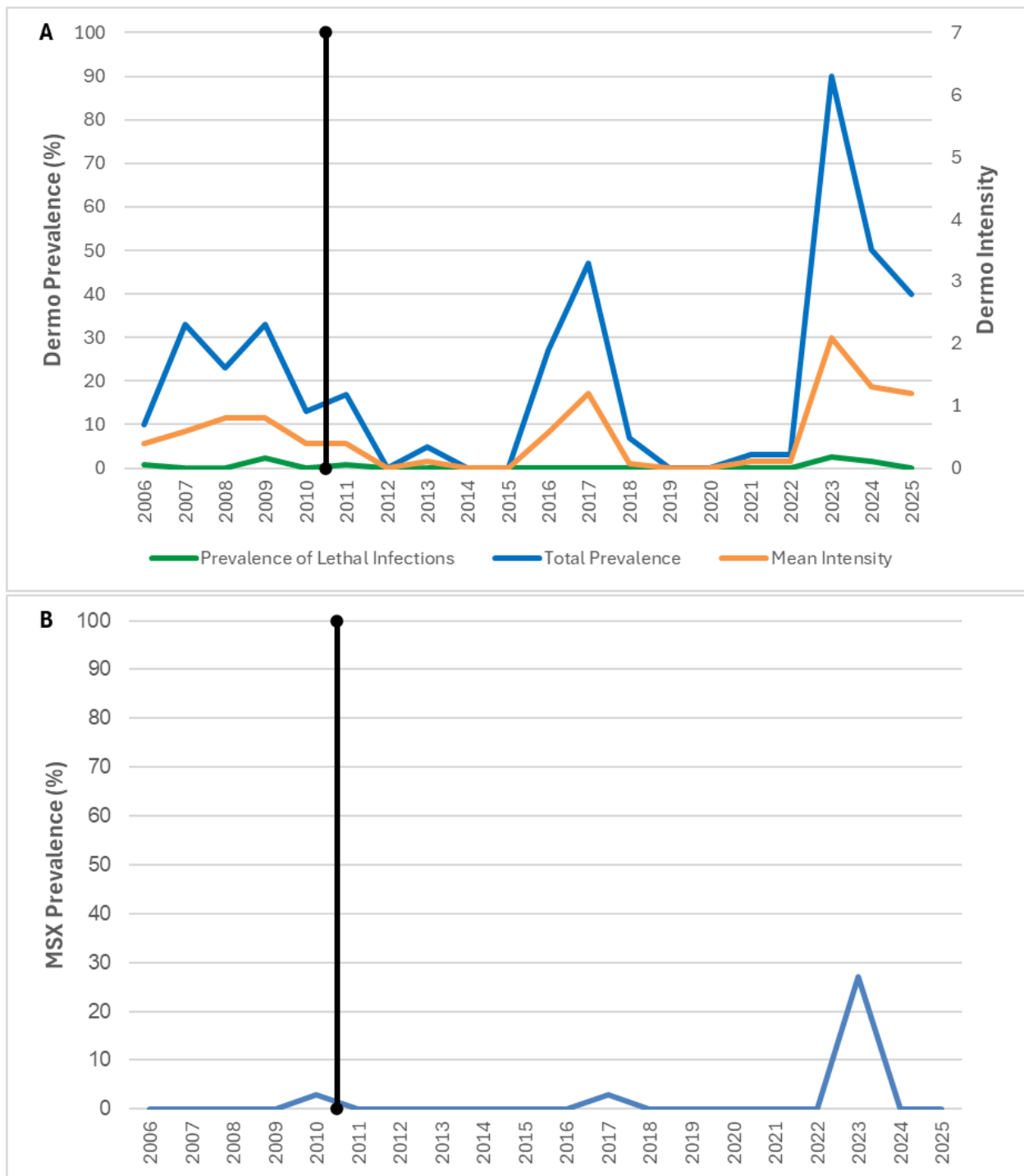


Figure A.12-7. Oyster disease prevalence and intensity in the Herring Bay Sanctuary. (A) Dermo prevalence and mean intensity (B) MSX prevalence (intensity is not examined). Data from Maryland's Annual Fall Oyster Dredge Survey on Holland Point bar. Black line denotes the date the sanctuary was established.

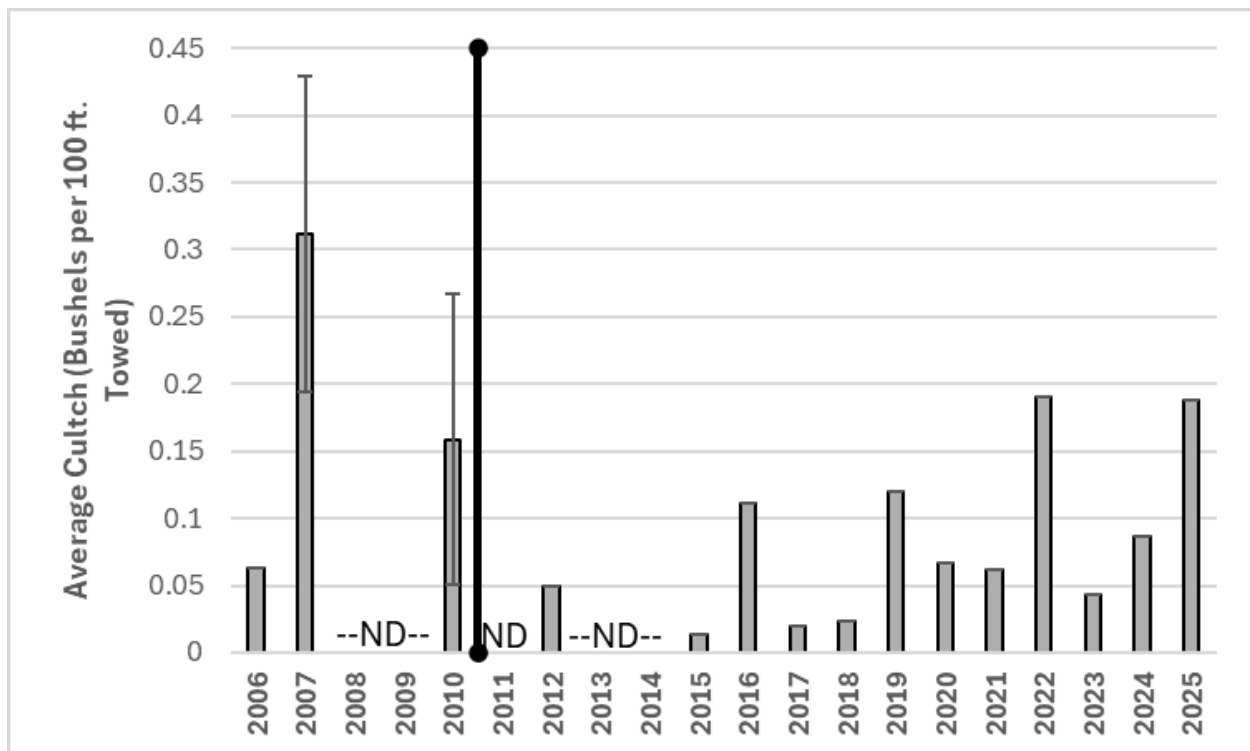


Figure A.12-8. Average cultch (live and dead oysters and loose shell) in the Herring Bay Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Black line denotes the date the sanctuary was established. Error bars represent ± 1 standard error. ND = No Data.

Section A.13: Hooper Strait Sanctuary

The Hooper Strait Sanctuary is located in the lower eastern portion of Maryland's Chesapeake Bay, a medium salinity (Zone 2) region within NOAA Codes 047 and 292. The sanctuary was created in 2009 and encompasses 7,307 acres of which 5,317 (73%) is historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments). There are 15 historic oyster bars within the sanctuary²⁰.

Information available for this sanctuary includes:

- Sanctuary map (Figure A.13-1)
- Summary statistics (Table A.13-1)
- Density per year (Figure A.13-2)
- Observed mortality (Figure A.13-3)
- Cultch per year (Figure A.13-4)

Hooper Strait Sanctuary is located in the Lower Eastern Shore Region of Maryland's Chesapeake Bay. Oysters in the Lower Eastern Shore Region generally grow well but can be impacted by disease. Elevated salinity levels contribute to greater natural recruitment.

The Fall Oyster Survey has two standard sites sampled within the Hooper Strait Sanctuary. Table A.13-1 shows an increase in the average number of oysters from 2021-2025 data compared to the previous 5-year increments' data averages, while exhibiting lower average observed mortality. The average density from 2021-2025 is above the long-term abundance target of 94 oysters per square meter; however, the average cultch per 100 ft tow indicates insufficient cultch availability.

In 2024, the Department announced Hooper Strait Sanctuary as one of the next three areas to receive large-scale restoration by the Department. It is slated to receive substrate habitat restoration only due to the high natural recruitment but insufficient cultch availability. The Department received a \$10 million grant from the National Oceanic and Atmospheric Administration to construct reef habitat within a sanctuary and Hooper Strait Sanctuary was chosen as the location for this effort. Construction is slated to begin in 2026.

The last patent tong population survey occurred in 2020.

In the 2021-2025 sanctuary assessment, this sanctuary was classified as receiving restoration.

²⁰ See chart 36 for bar names and locations in the State of Maryland Shellfish Closure Areas Book
<http://dnr.maryland.gov/fisheries/Pages/oysters/index.aspx>

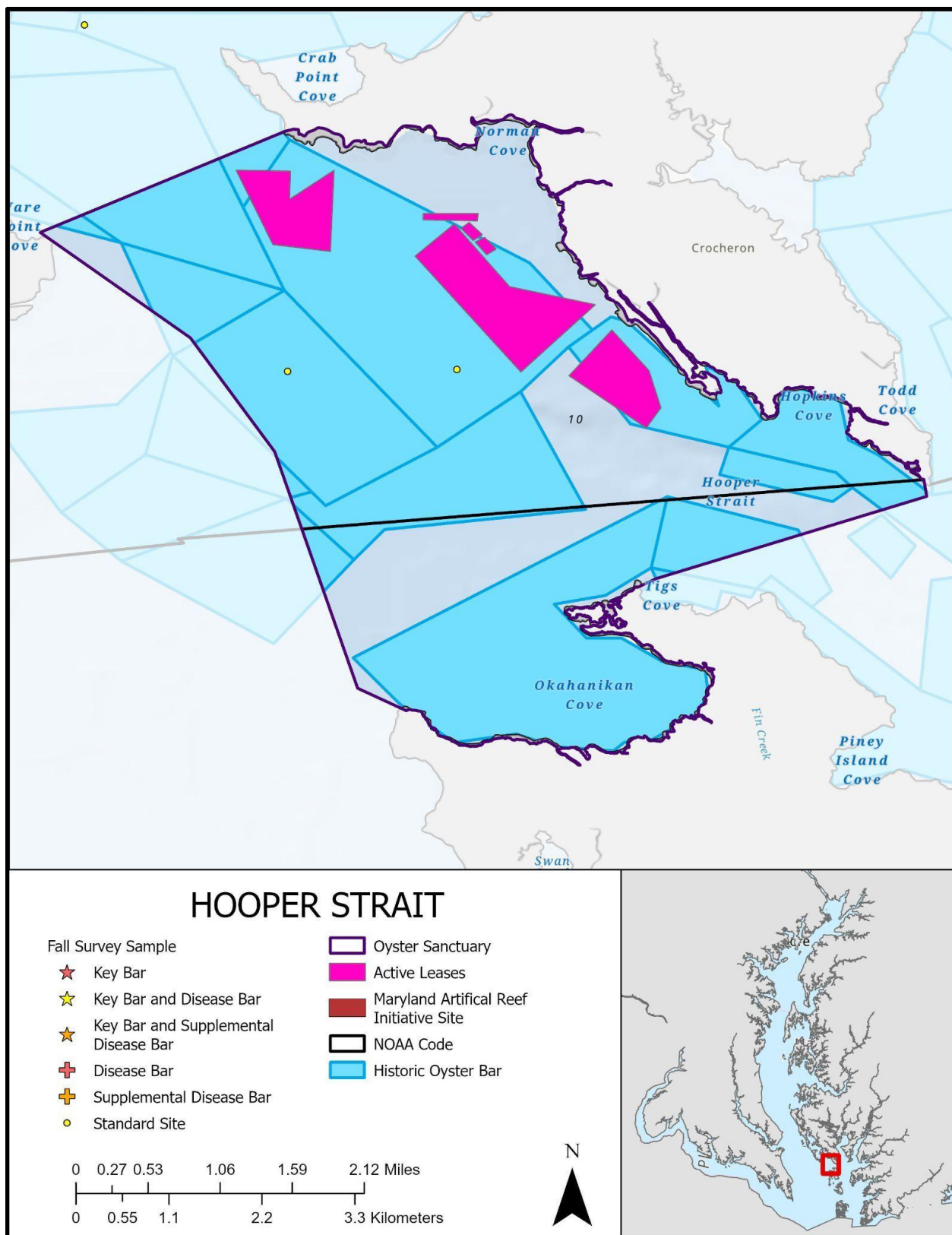


Figure A.13-1. Hooper Strait Sanctuary. Fall Oyster Survey sites may not be sampled every year.

Table A.13-1. Oyster population characteristics based on the Fall Oyster Survey in the Hooper Strait Sanctuary. ND=No Data. Values given are annual mean $\pm$ standard error.

Oyster Characteristic	2006-2010	2011-2015	2016-2020	2021-2025
Number of years sampled/number of samples	5/10	5/10	5/9	5/10
Number of Live Spat Oysters per square meter	91.7 $\pm$ 58.2	60 $\pm$ 15.3	59.7 $\pm$ 19	141 $\pm$ 43.5
Number of Live Small Oysters per square meter	26.7 $\pm$ 7.1	41.8 $\pm$ 12.2	64.7 $\pm$ 31.3	117 $\pm$ 46.7
Number of Live Market Oysters per square meter	5.5 $\pm$ 2.1	15.3 $\pm$ 3.7	24.1 $\pm$ 10.3	67.2 $\pm$ 13.9
Number of Live Oysters per square meter	123.9 $\pm$ 62	117 $\pm$ 26	149 $\pm$ 42	379 $\pm$ 67
Live Biomass (g Dry Weight per Bushel)	ND	ND	ND	ND
Observed Mortality (%)	14.2 $\pm$ 7.2	26.5 $\pm$ 4.6	14.9 $\pm$ 5	13.4 $\pm$ 4.6
Cultch (Bushels per 100 feet towed)	0.4 $\pm$ 0.1	0.5 $\pm$ 0.1	0.7 $\pm$ 0.1	0.9 $\pm$ 0.1

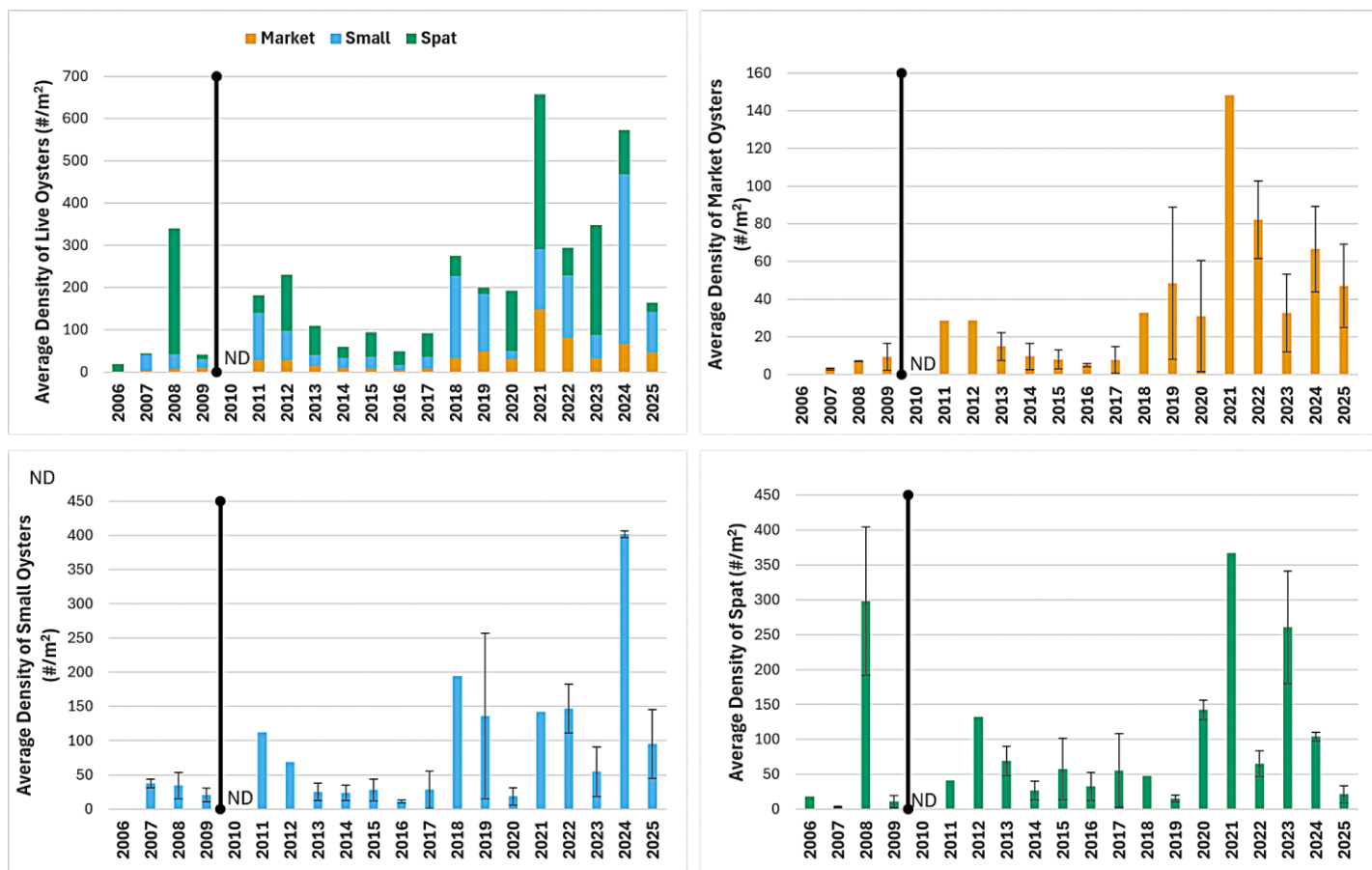


Figure A.13-2. Average number of live oysters per square meter by size class in the Hooper Strait Sanctuary. Black line indicates the date the sanctuary was established. Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales. ND = No Data.

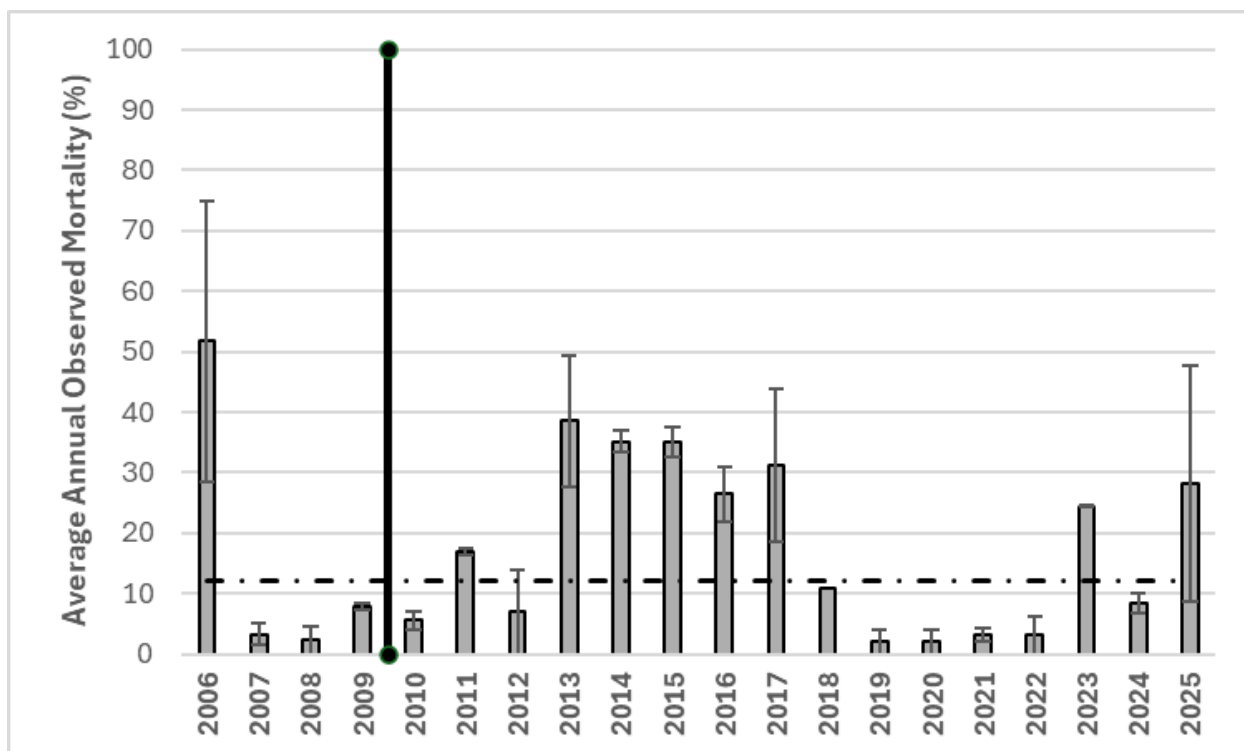


Figure A.13-3. Average annual observed mortality of market-sized and small-sized oysters in Hooper Strait Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Black line denotes the date the sanctuary was established, and the dashed line represents the 2006-2025 baywide average observed mortality. Error bars represent ± 1 standard error.

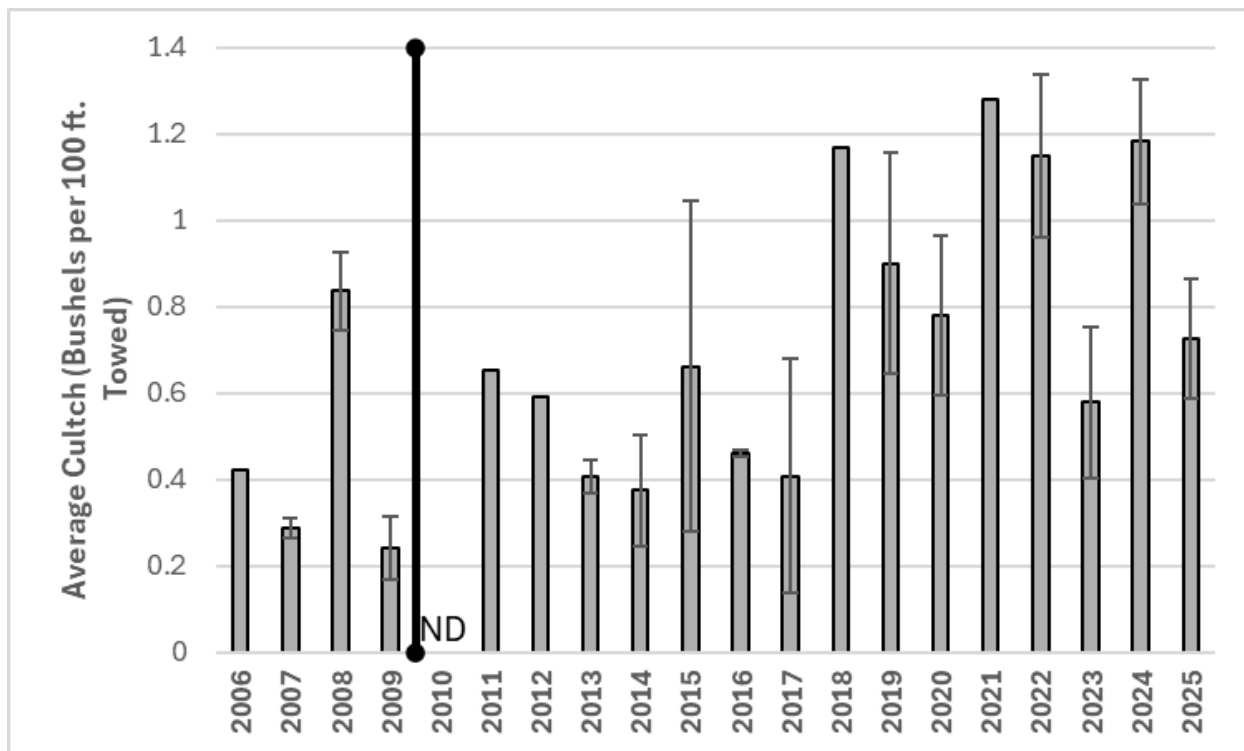


Figure A.13-4. Average cultch (live and dead oysters and loose shell) in the Hooper Strait Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Black line denotes the date the sanctuary was established. Error bars represent ± 1 standard error. ND = No Data.

Section A.14: Howell Point Sanctuary

The Howell Point Sanctuary is located in the middle Choptank River, a low salinity (Zone 1) region within NOAA Code 237. The sanctuary was created in 2001 and encompasses six acres of historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments), all located within the Beacons oyster bar. The Howell Point Sanctuary was established for the U.S. Army Corps of Engineers to study the effectiveness of three-dimensional oyster habitat for use in oyster restoration.

Information available for this sanctuary includes:

- Sanctuary map (Figure A.14-1)
- Density Survey (Figure A.14-2)
- Summary statistics (Table A.14-1)
- Density per year (Figure A.14-3)
- Observed mortality (Figure A.14-4)
- Cultch per year (Figure A.14-5)

Howell Point Sanctuary is located in the Choptank Region of Maryland's Chesapeake Bay. Oysters in the Choptank Region generally grow well but may be impacted by disease or freshet events. Natural recruitment occurs regularly in this region.

The Fall Oyster Survey has one standard site sampled within the Howell Point Sanctuary. Table A.14-1 shows an increase in the average number of oysters from 2021-2025 data compared to the previous 5-year increments' data averages, while exhibiting lower average observed mortality. The average density from 2021-2025 is above the target of 94 oysters per square meter, however, the average cultch per 100 ft² indicates insufficient cultch availability.

A population patent tong survey was conducted by the Department in 2025 and found an average of 12.75 oysters per square meter and an average of 4.99 liters per square meter of surface shell.

In the 2021-2025 sanctuary assessment, this sanctuary was classified as trending positively with a high oyster density.

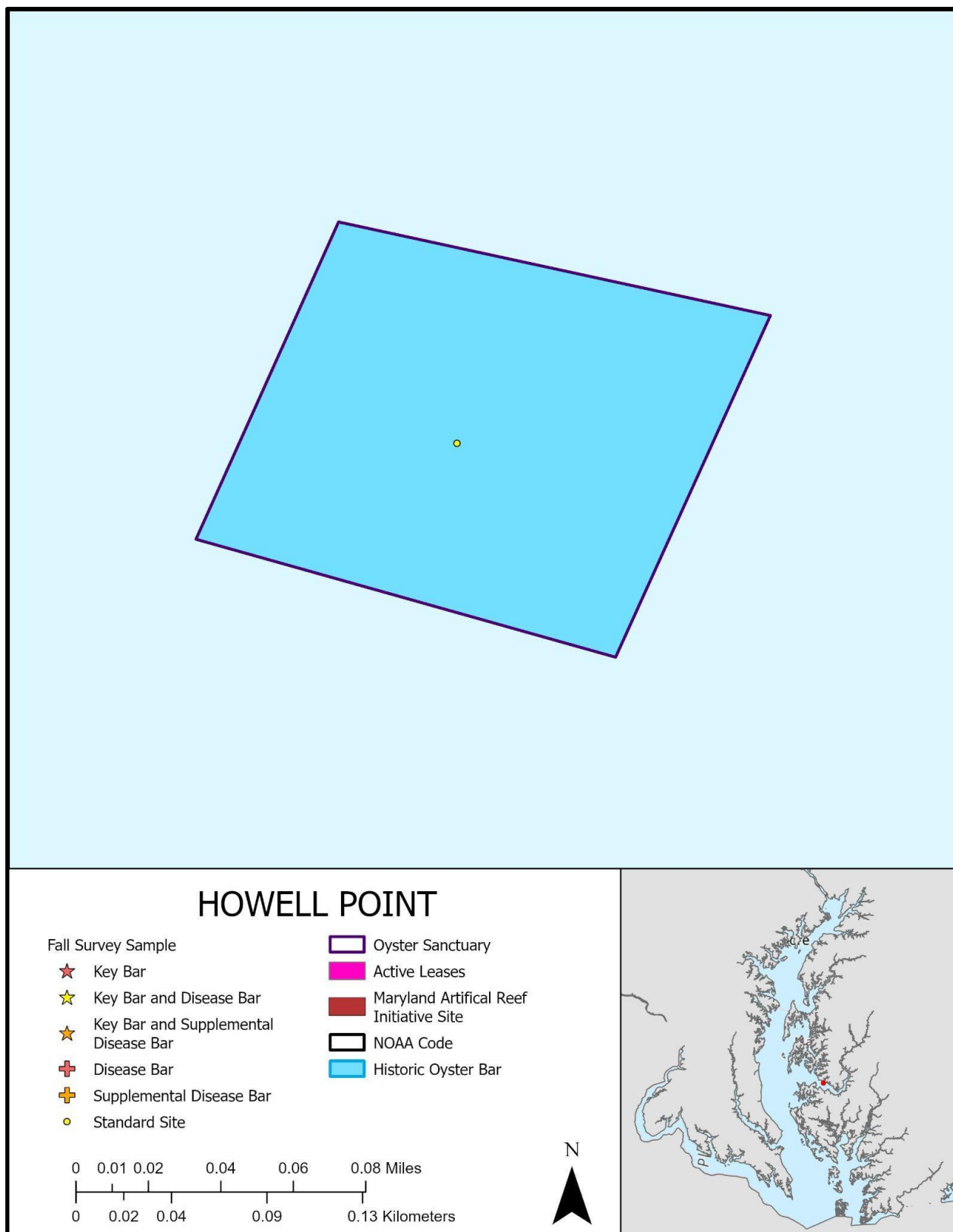


Figure A.14-1. Howell Point Sanctuary. Fall Oyster Survey sites may not be sampled every year.

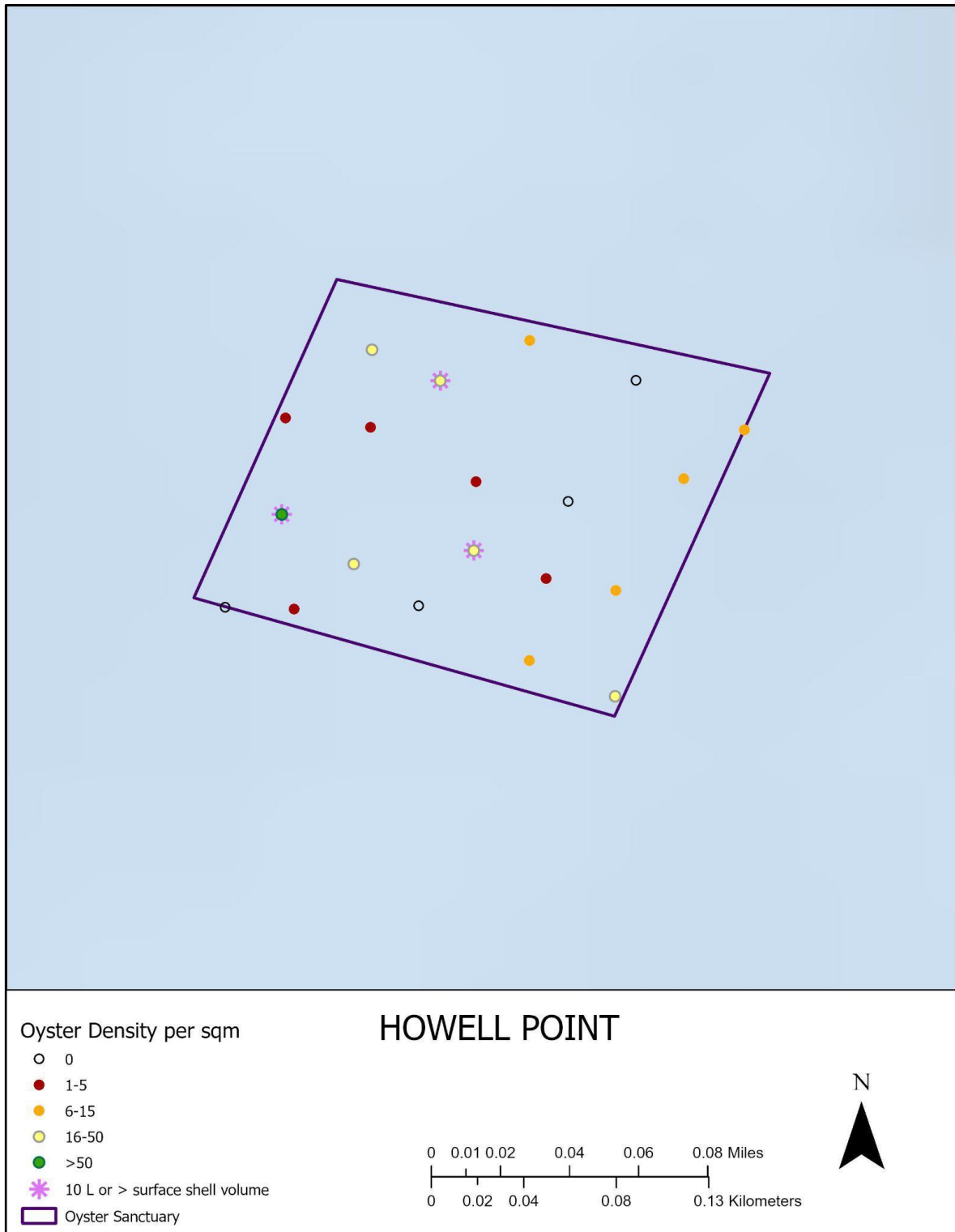


Figure A.14-2. Map of 2025 oyster density in the Howell Point Sanctuary. Data from Maryland Department of Natural Resources Patent Tong Population Survey.

Table A.14.1. Oyster population characteristics based on the Fall Oyster Survey in the Howell Point Sanctuary. ND=No Data. Values given are annual mean $\pm$ standard error.

Oyster Characteristic	2006-2010	2011-2015	2016-2020	2021-2025
Number of years sampled/number of samples	0/0	1/1	5/5	5/5
Number of Live Spat Oysters per square meter	ND	0	2.2 $\pm$ 1.5	48.4 $\pm$ 31.5
Number of Live Small Oysters per square meter	ND	0	5 $\pm$ 2.6	24.4 $\pm$ 3.6
Number of Live Market Oysters per square meter	ND	66	58.4 $\pm$ 12.8	69.3 $\pm$ 17.8
Number of Live Oysters per square meter	ND	66	65.6 $\pm$ 14	142 $\pm$ 49
Live Biomass (g Dry Weight per Bushel)	ND	ND	ND	ND
Observed Mortality (%)	ND	13.9	10.5 $\pm$ 1.9	8.5 $\pm$ 3
Cultch (Bushels per 100 feet towed)	ND	1.1	1.1 $\pm$ 0.3	1.1 $\pm$ 0.2

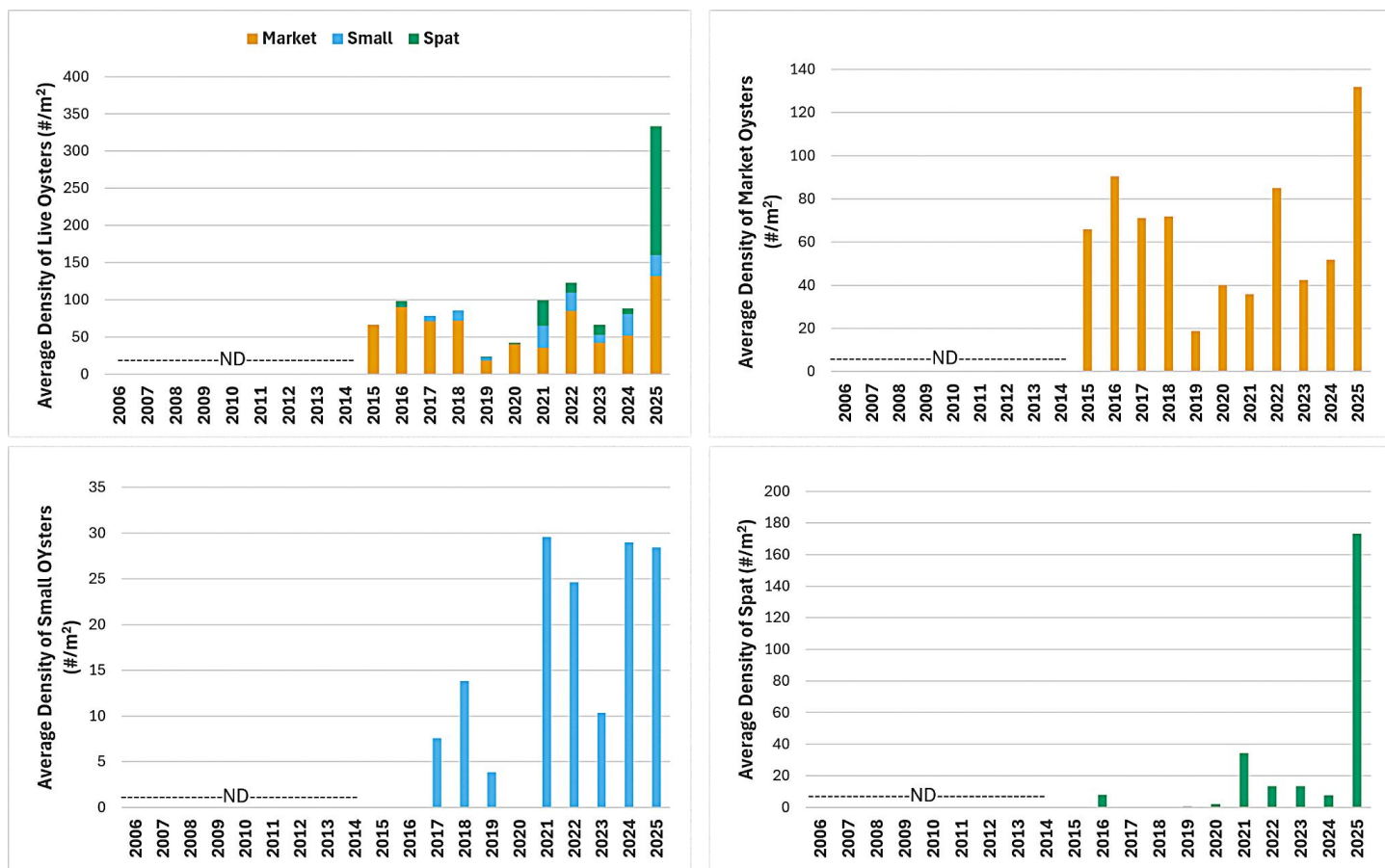


Figure A.14-3. Average number of live oysters per square meter by size class in the Howell Point Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales. ND = No Data.

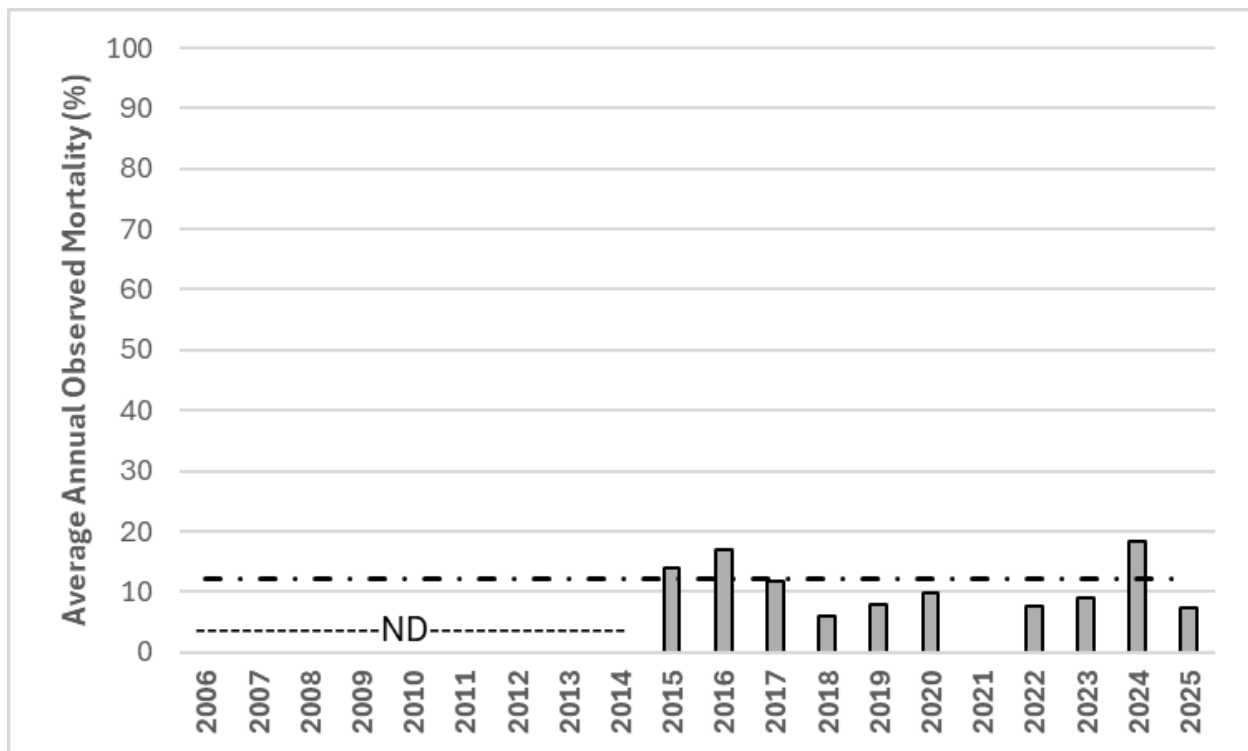


Figure A.14-4. Average annual observed mortality of market-sized and small-sized oysters in Howell Point Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. The dashed line represents the 2006-2025 baywide average observed mortality. ND = No Data.

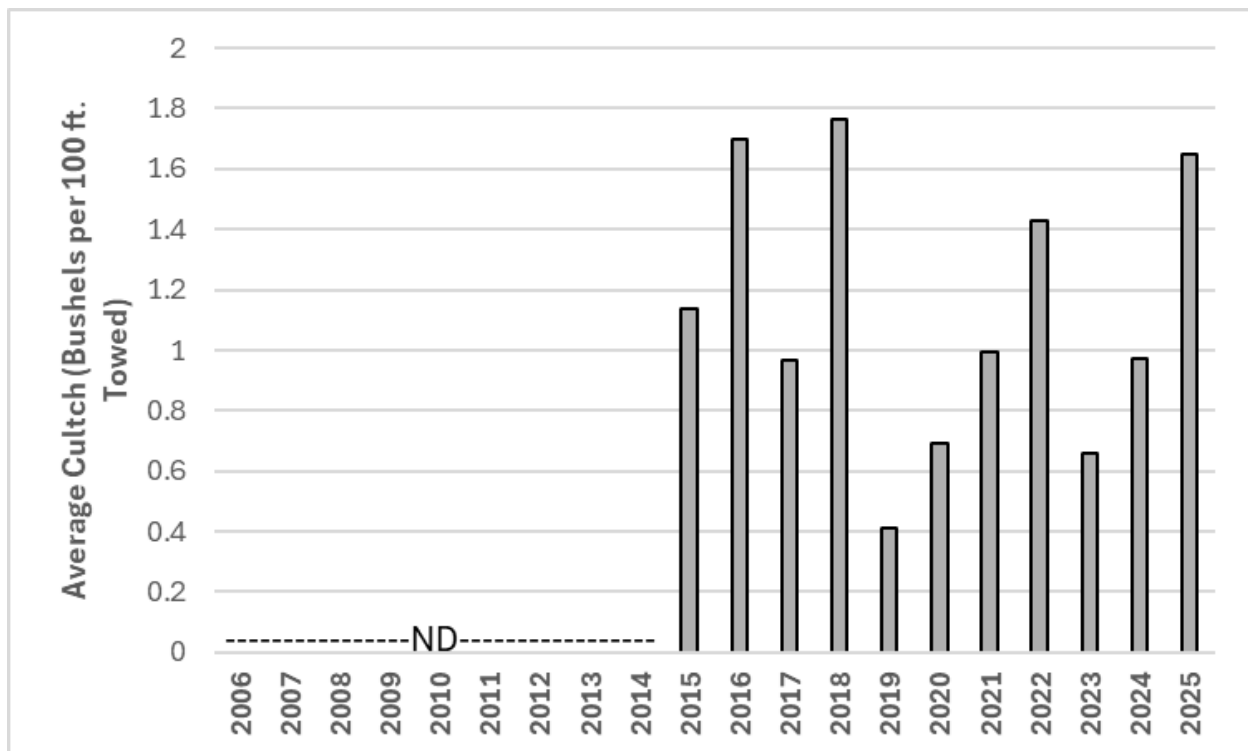


Figure A.14-5. Average cultch (live and dead oysters and loose shell) in the Howell Point Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. ND = No Data.

Section A.15: Kitts Creek Sanctuary

The Kitts Creek Sanctuary is located in the southeastern portion of Maryland's Chesapeake Bay, a high salinity (Zone 3) region within NOAA Code 072. Kitts Creek empties into Pocomoke Sound. The sanctuary was created in 2001 and encompasses 1,181 acres of which 95 acres (8%) are historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments). There are 2 historic oyster bars within the sanctuary²¹. Kitts Creek Sanctuary was established due to local legislators' interest in oyster restoration with the intent of population enhancement through natural spatfall.

Information available for this sanctuary includes:

- Sanctuary map (Figure A.15-1)
- Density Survey (Figure A.15-2)

Kitts Creek Sanctuary is located in the Lower Eastern Shore Region of Maryland's Chesapeake Bay. In the Lower Eastern Shore Region, oysters typically exhibit good growth but remain vulnerable to disease. Elevated salinity levels also contribute to a greater rate of natural recruitment.

There are no Fall Oyster Survey sites sampled regularly in Kitts Creek Sanctuary.

A population patent tong survey was conducted by the Department in 2024 and found an average of 1.5 oysters per square meter and an average of 0.4 liters per square meter of surface shell. This is less than the 2 oysters per square meter and an average of 0.5 liters per square meter of surface shell found in the 2017 survey; however, while conducting the 2024 survey, the hydraulic system for the patent tongs failed and all planned samples were not completed.

In the 2021-2025 sanctuary assessment, this sanctuary was classified as lacking in data.

²¹ See chart 49 for bar names and locations in the State of Maryland Shellfish Closure Areas Book
<http://dnr.maryland.gov/fisheries/Pages/oysters/index.aspx>

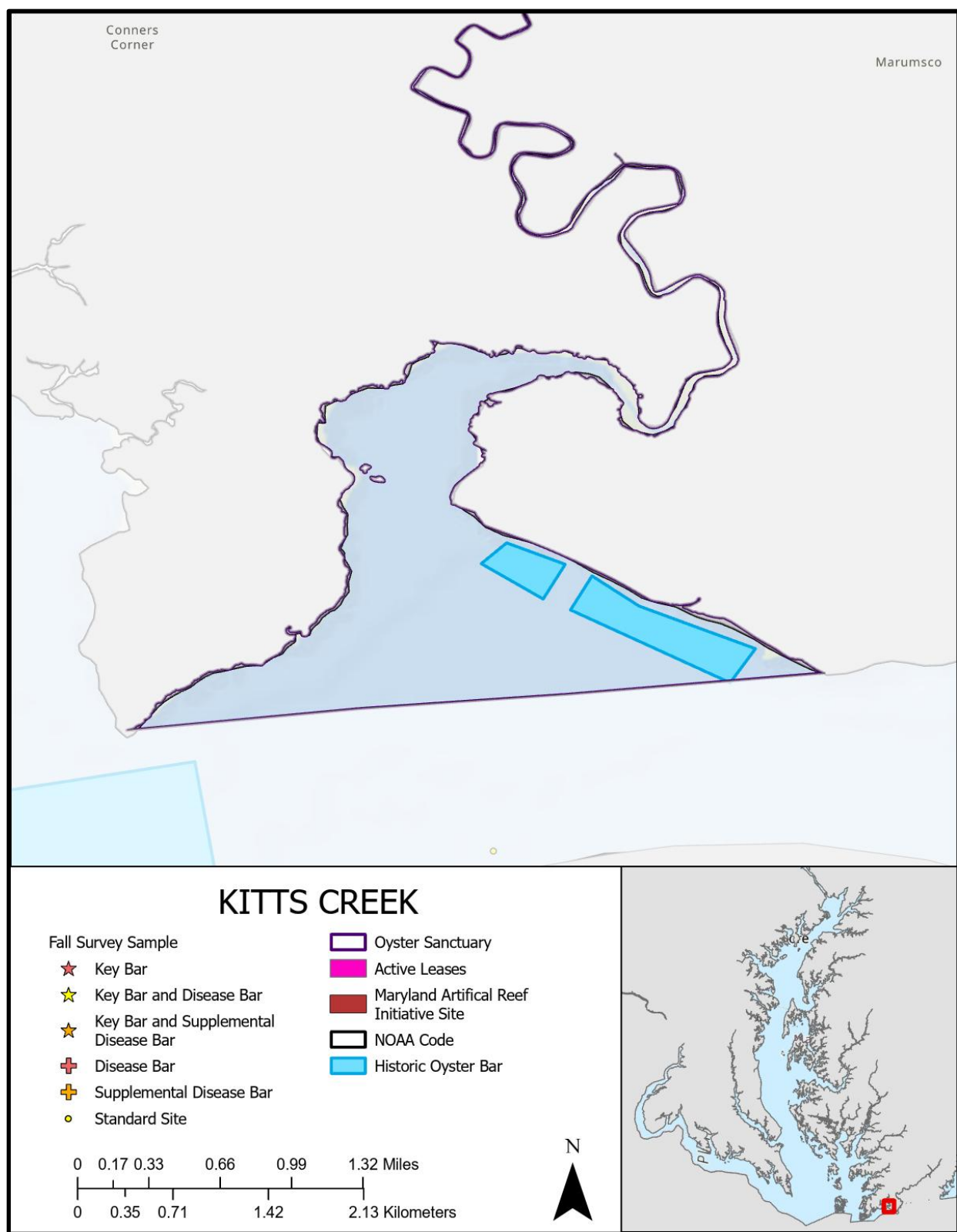


Figure A.15-1. Kitts Creek Sanctuary.

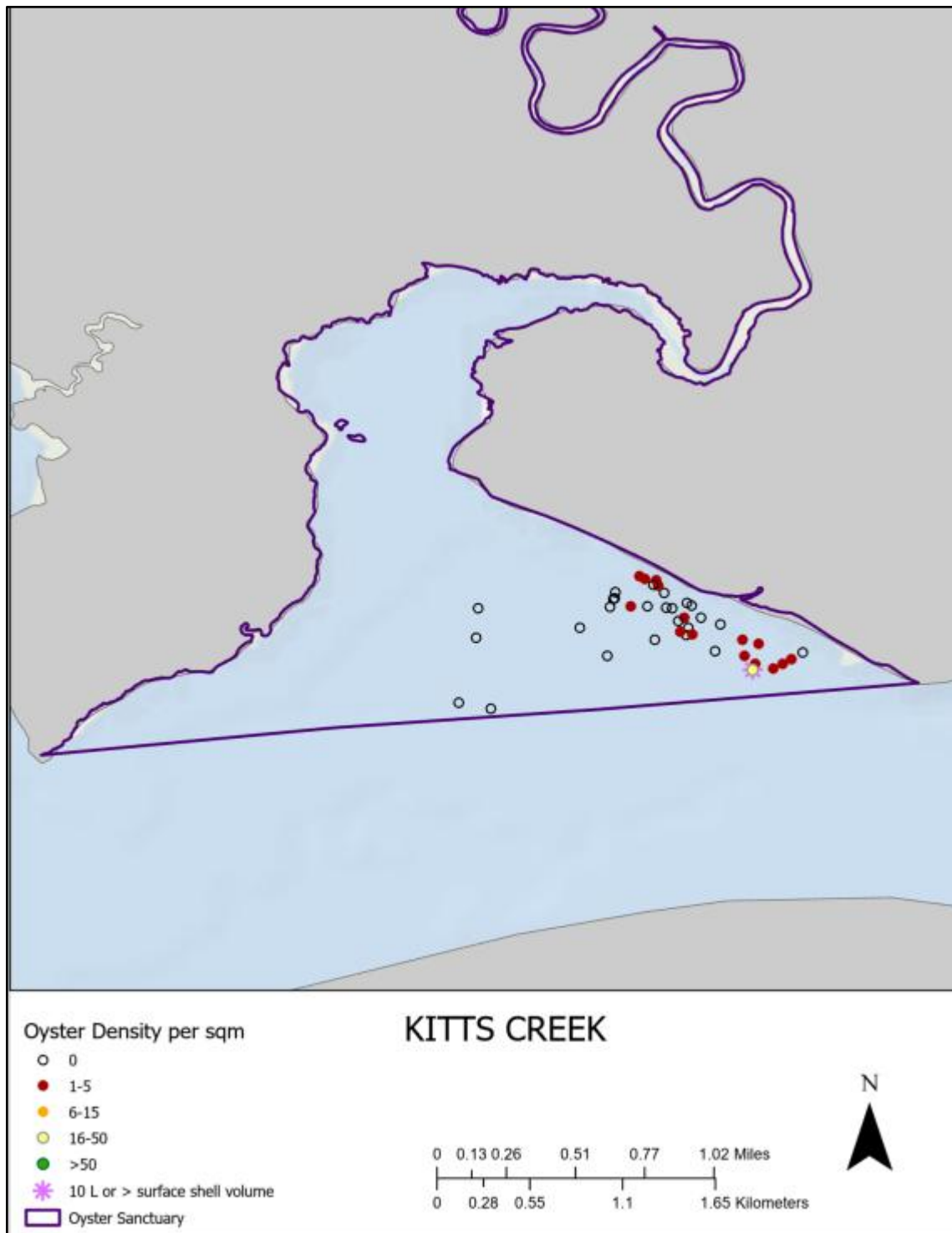


Figure A.15-2. Map of 2024 oyster density in the Kitts Creek Sanctuary. Data from Maryland Department of Natural Resources Patent Tong Population Survey.

Section A.16: La Trappe Sanctuary

The La Trappe Sanctuary is located in La Trappe Creek, a tributary of the Choptank River. The sanctuary is in a low salinity (Zone 1) region within NOAA Code 237. The sanctuary was created in 2002 and encompasses 377 acres of which 13 acres (3.5%) is historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments). There is one historic oyster bar located partially within the sanctuary (La Trappe bar).

Information available for this sanctuary includes:

- Sanctuary map (Figure A.16-1)

La Trappe Sanctuary is located in the Choptank Region of Maryland's Chesapeake Bay. Oysters in the Choptank Region generally grow well but may be impacted by disease or freshet events. Natural recruitment occurs regularly in this region.

There are no regularly sampled Fall Oyster Survey sites in La Trappe Creek Sanctuary.

This sanctuary is in a muddy area with little oyster habitat and few oysters. Marylanders Grow Oysters, a public outreach program, has been present in the creek since 2009. Spat raised by MGO are planted outside the river at the Howells Point Sanctuary due to the poor habitat within this sanctuary.

This area has not received any active restoration or replenishment efforts since 2006 and is not a candidate for restoration efforts due to its poor bottom habitat. The sanctuary was one of the sanctuaries identified by the Department as unlikely to receive a large investment by the Department for restoration and is under evaluation by the Oyster Advisory Commission for potential efforts to improve its performance.

In the 2021-2025 sanctuary assessment, this sanctuary was classified as having poor habitat.

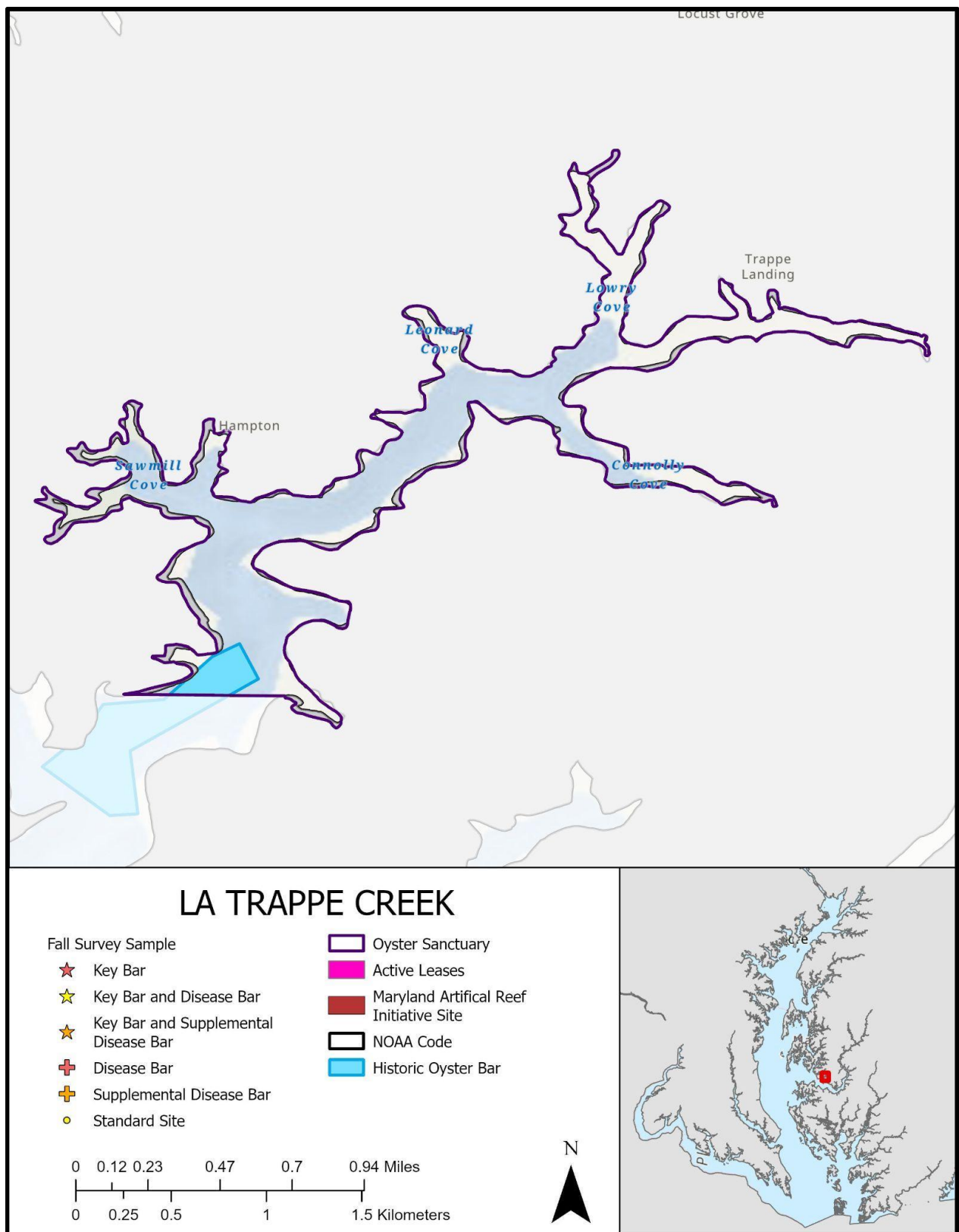


Figure A.16-1. La Trappe Sanctuary.

Section A.17: Little Choptank River Sanctuary

The Little Choptank River Sanctuary is located in the central portion of Maryland's eastern shore of Chesapeake Bay, a medium salinity (Zone 2) region within NOAA Code 053. The sanctuary was created in 2010 and encompasses 9,415 acres of which 1,713 (18%) is historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments). There are 18 historic oyster bars within the sanctuary²². The Little Choptank River Sanctuary was selected for large-scale oyster restoration under the 2014 Chesapeake Bay Watershed Agreement. Initial restoration of the sanctuary was completed in 2020 and planned second hatchery spat-on-shell seedings were completed in 2025. Monitoring is ongoing.

Information available for this sanctuary includes:

- Sanctuary map (Figure A.17-1)
- Summary statistics (Table A.17-1)
- Density per year (Figure A.17-2)
- Shell height frequencies (Figure A.17-3)
- Biomass per year (Figure A.17-4)
- Observed mortality (Figure A.17-5)
- Dermo and MSX per year (Figure A.17-6)
- Cultch per year (Figure A.17-7)

Little Choptank Sanctuary is located in the Mid Bay Region of Maryland's Chesapeake Bay. Oysters in the Mid Bay Region typically exhibit good growth and survival rates, remaining largely unaffected by disease or freshet events. There are typically low rates of recruitment in this region, however, the Little Choptank River generally has greater recruitment than other areas of the Mid Bay Region.

The Fall Oyster Survey has eight standard sites and one sentinel key and disease bar site within the Little Choptank Sanctuary. Table A.17-1 shows an increase in the average number of oysters and biomass from 2021-2025 compared to the previous 5-year increments. Observed mortality remained low, despite MSX prevalence in 2023 (Figure A.17-6). The average density from 2021-2025 is above the long-term abundance target of 94 oysters per square meter and the average cultch per 100 ft tow indicates sufficient cultch availability. It should be noted that given limitations of traditional gear types, not all restored areas are surveyed by the Department. The Fall Oyster Survey is unable to sample reefs that have been restored using rock substrate. Monitoring on some reefs by National Oceanic and Atmospheric Administration six years after initial restoration has shown oyster densities on alternate substrate restoration areas ranging from 208 to 680 oysters per square meter²³. Six-year monitoring is ongoing for reefs that have yet to reach six years post initial construction for restoration.

²² See chart 25 for bar names and locations in the State of Maryland Shellfish Closure Areas Book <http://dnr.maryland.gov/fisheries/Pages/oysters/index.aspx>

²³ Maryland Oyster Restoration Interagency Workgroup under the Chesapeake Bay Program's Sustainable Fisheries Goal Implementation Team. 2024 Maryland Oyster Reef Monitoring Report: Analysis of Data from the 'Ten Tributaries' Sanctuary Oyster Restoration Initiative in Maryland. 2025.

The Department has not conducted any population patent tong surveys since 2014; however, other organizations have been monitoring restoration areas using patent tong and diver surveys. Results from these surveys (2015-2024 monitoring) indicate that, six years post initial restoration, 100% of the reefs surveyed met or exceeded the minimum threshold success criteria for restoration (15 oysters per square meter over 30% of the reef). Final six-year monitoring on all restoration areas will be completed in 2026.

In the 2021-2025 sanctuary assessment, this sanctuary was classified as restored.

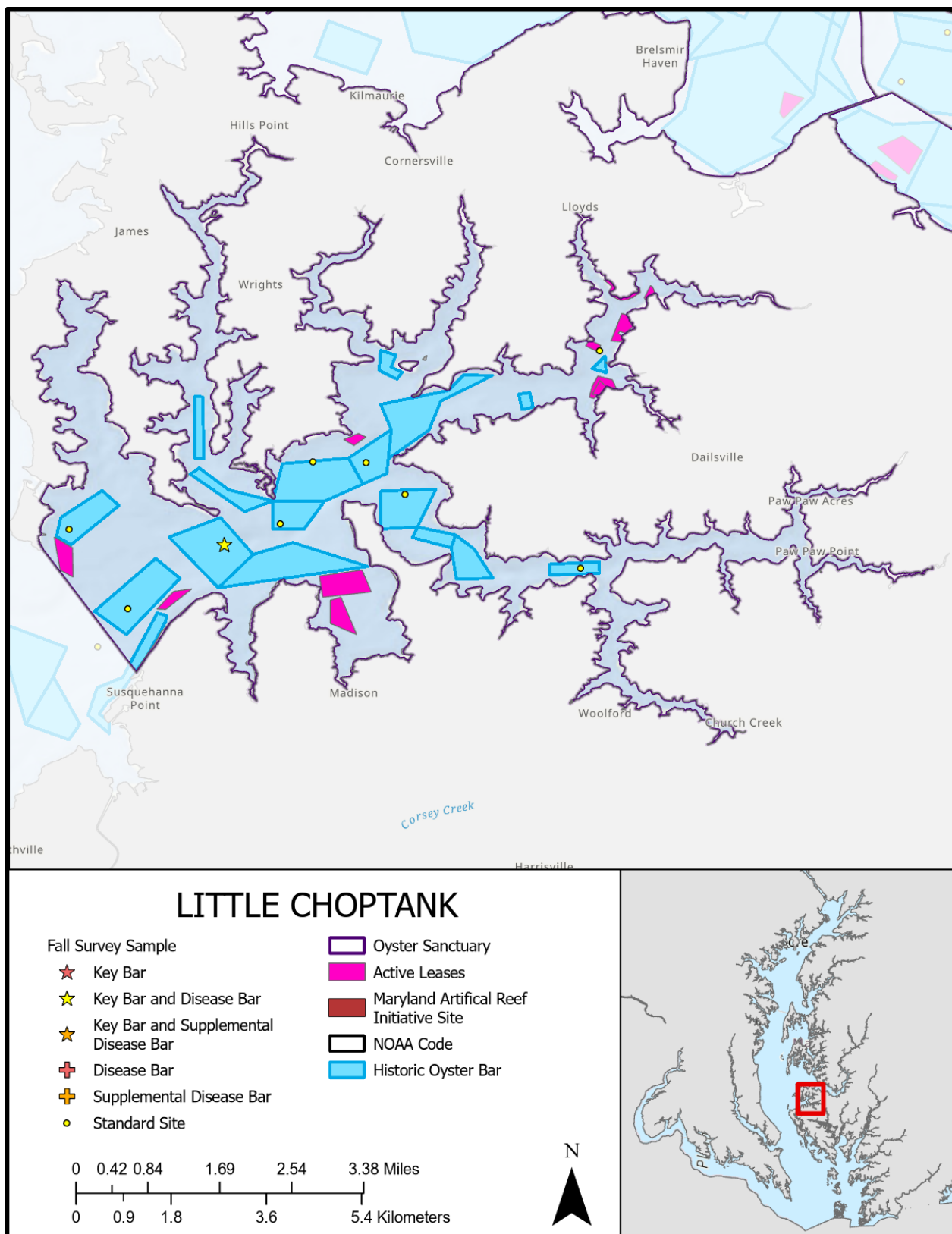


Figure A.17-1. Little Choptank Sanctuary. Fall Oyster Survey sites may not be sampled every year.

Table A.17-1. Oyster population characteristics based on the Fall Oyster Survey in the Little Choptank Sanctuary. ND=No Data. Values given are annual mean $\pm$ standard error.

Oyster Characteristic	2006-2010	2011-2015	2016-2020	2021-2025
Number of years sampled/number of samples	5/42	5/40	5/45	5/45
Number of Live Spat Oysters per square meter	26.5 $\pm$ 6	61.2 $\pm$ 23.5	154 $\pm$ 34	158 $\pm$ 53
Number of Live Small Oysters per square meter	42 $\pm$ 10.9	156 $\pm$ 38.2	155.6 $\pm$ 23.4	224.3 $\pm$ 38.7
Number of Live Market Oysters per square meter	30.2 $\pm$ 4.5	189.2 $\pm$ 29.1	102.6 $\pm$ 11.6	198 $\pm$ 21.1
Number of Live Oysters per square meter	99 $\pm$ 17	407 $\pm$ 77	412 $\pm$ 46	580 $\pm$ 88
Live Biomass (g Dry Weight per Bushel)	153 $\pm$ 20	309 $\pm$ 26	276 $\pm$ 24	479 $\pm$ 22
Observed Mortality (%)	14 $\pm$ 1.4	10.4 $\pm$ 0.7	11.4 $\pm$ 1.3	9.4 $\pm$ 1
Cultch (Bushels per 100 feet towed)	1.1 $\pm$ 0.1	2.2 $\pm$ 0.2	1.7 $\pm$ 0.1	2 $\pm$ 0.2

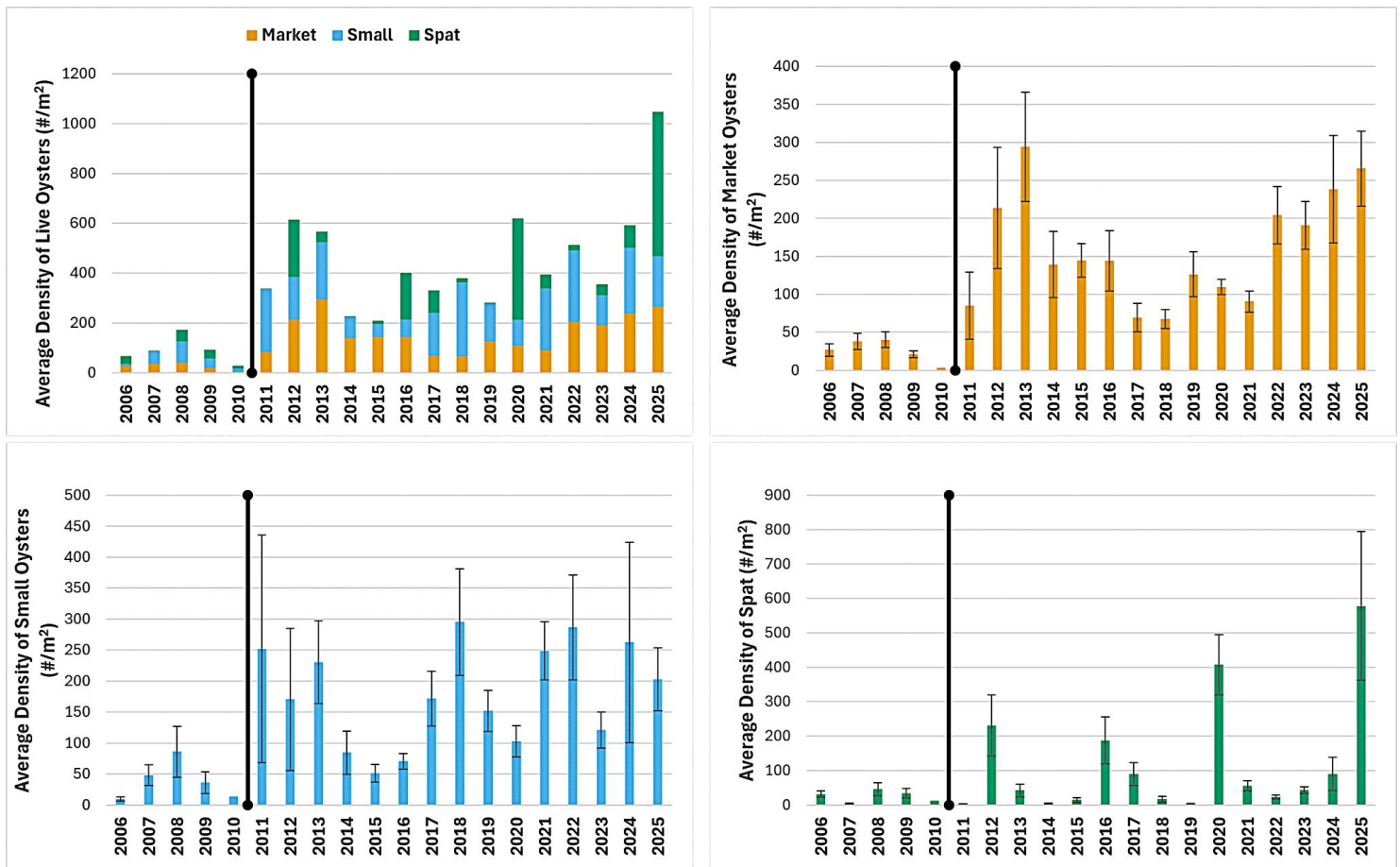


Figure A.17-2. Average number of live oysters per square meter by size class in the Little Choptank Sanctuary. Black line indicates the date the sanctuary was established. Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales.

LITTLE CHOPTANK (2010)

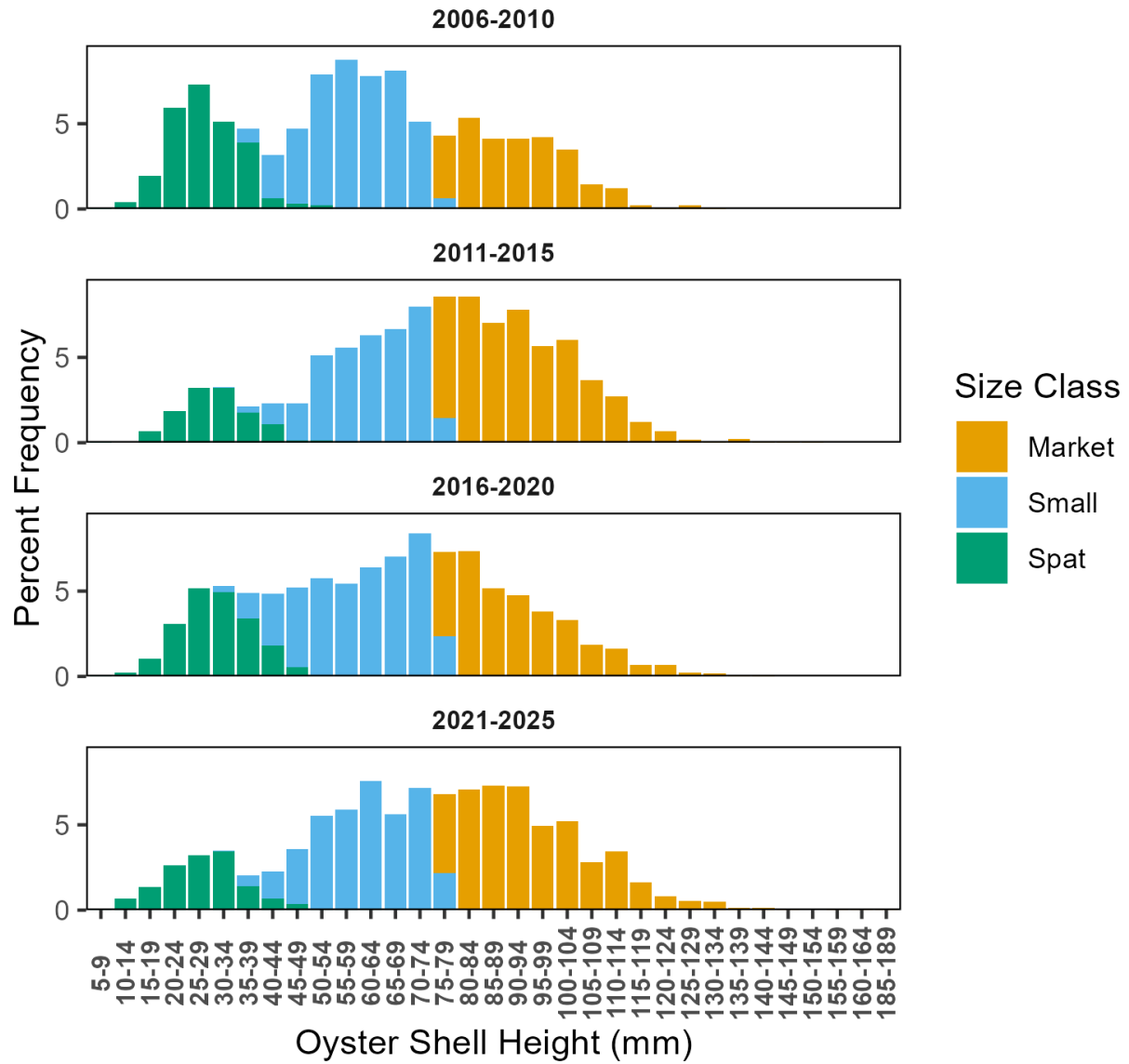


Figure A.17-3. Shell height frequencies of live oysters in the Little Choptank Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey.

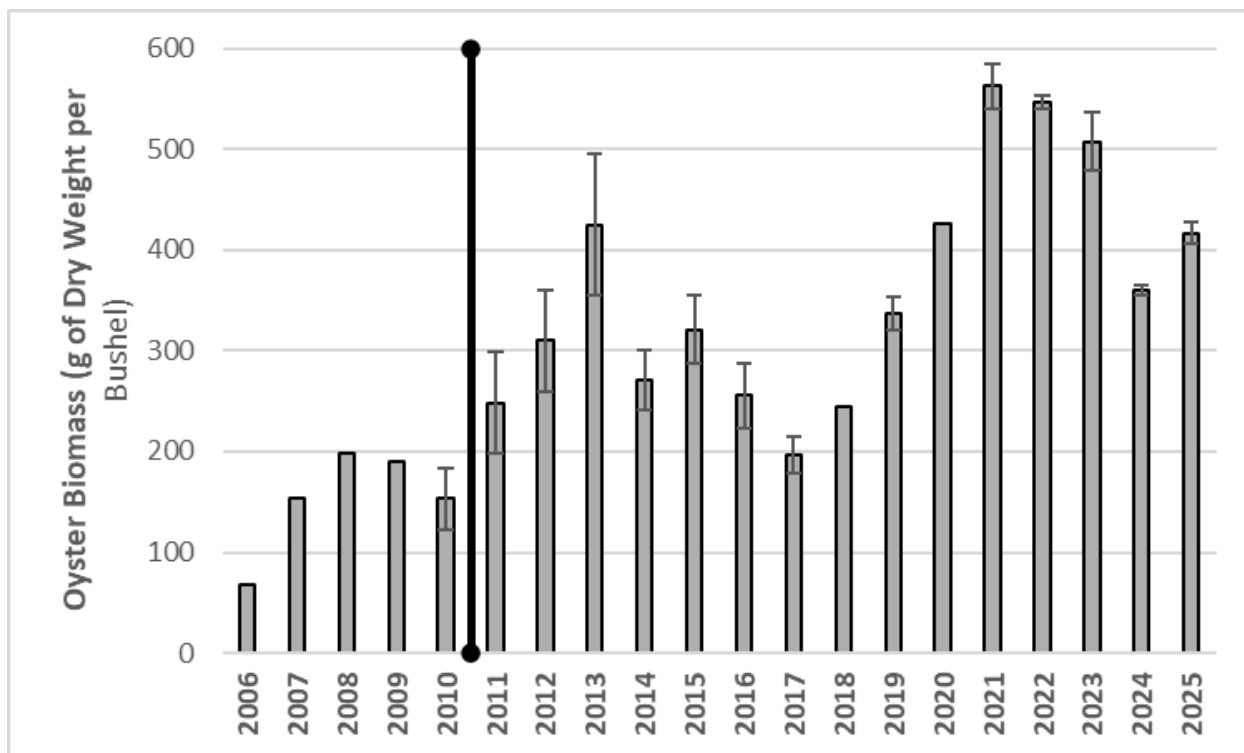


Figure A.17-4. Oyster biomass (grams of dry weight per bushel of material) in the Little Choptank Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Black line indicates the date the sanctuary was established. Error bars represent ± 1 standard error.

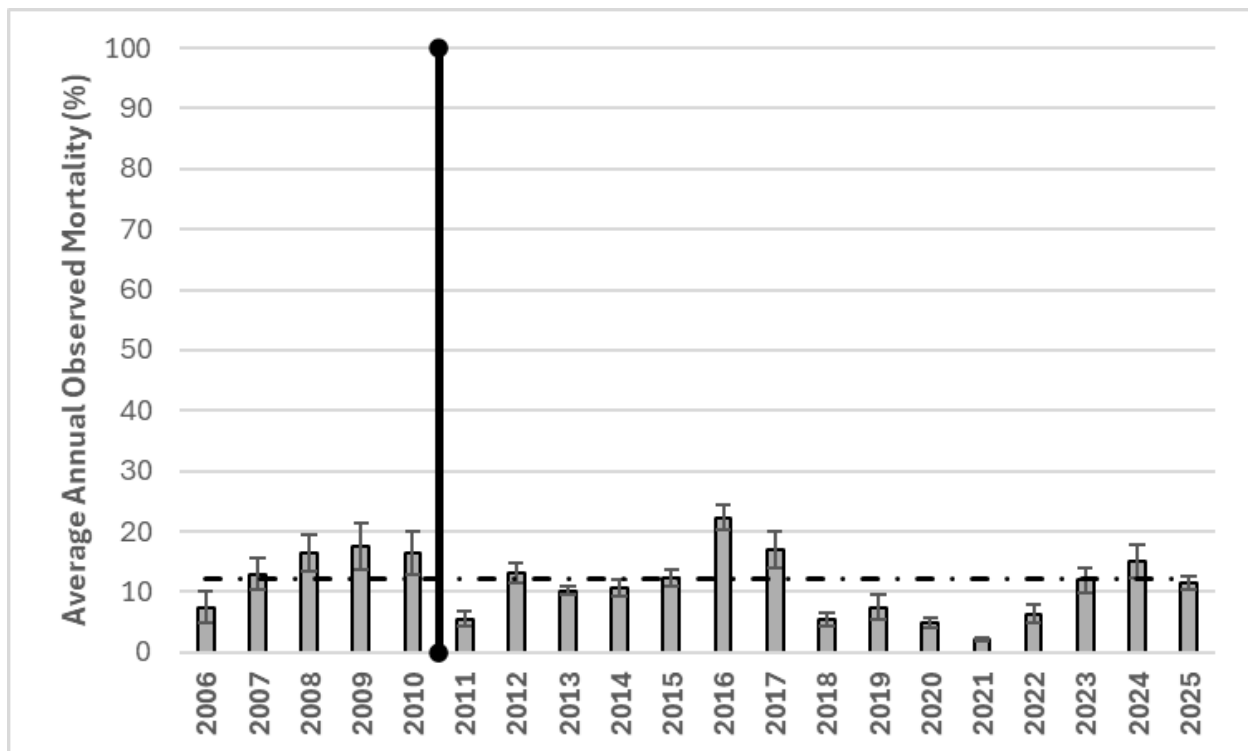


Figure A.17-5. Average annual observed mortality of market-sized and small-sized oysters in Little Choptank Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Black line denotes the date the sanctuary was established, and the dashed line represents the 2006-2025 baywide average observed mortality. Error bars represent ± 1 standard error.

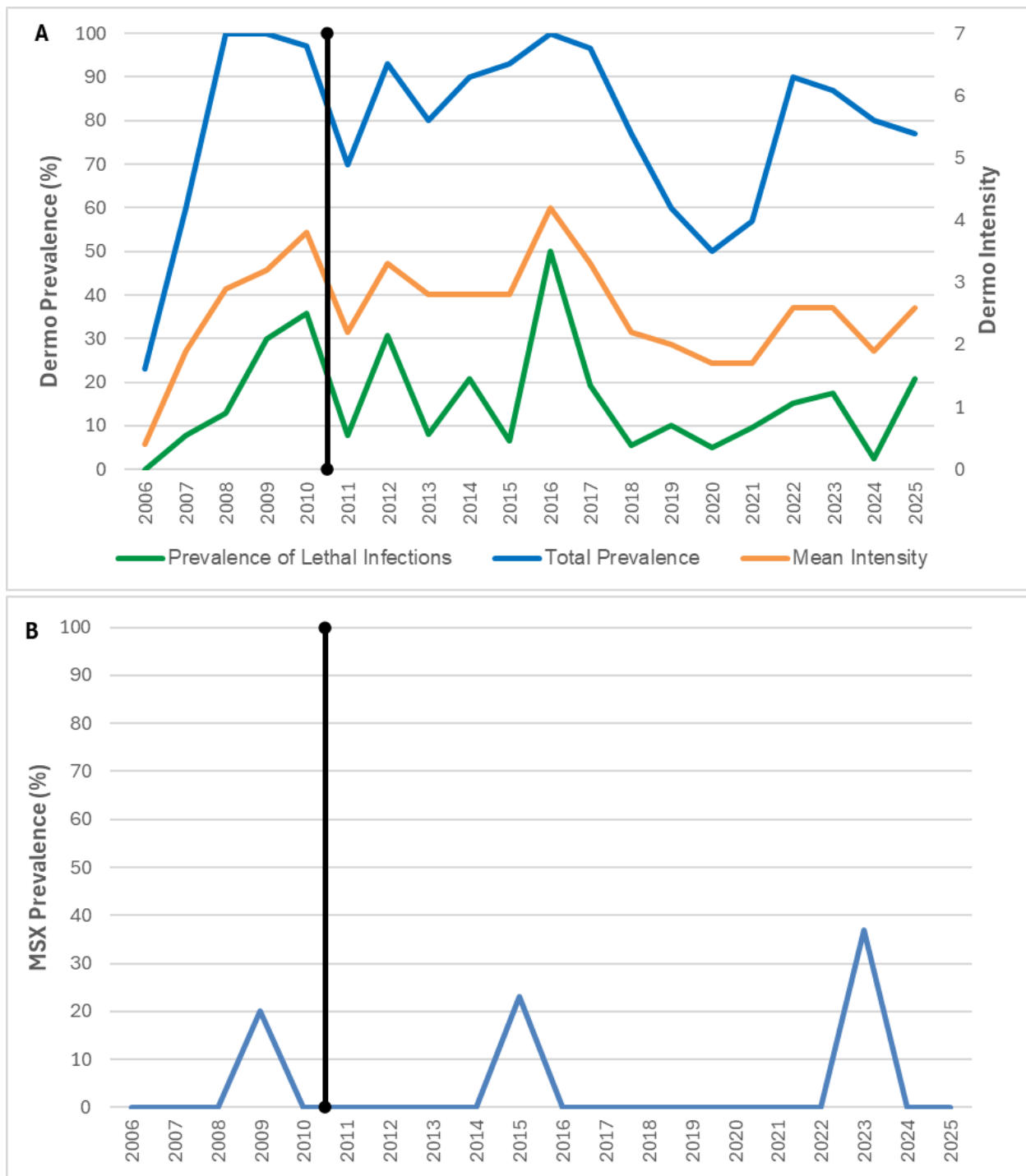


Figure A.17-6. Oyster disease prevalence and intensity in the Little Choptank Sanctuary. (A) Dermo prevalence and mean intensity (B) MSX prevalence (intensity is not examined). Data from Maryland's Annual Fall Oyster Dredge Survey on Cason bar. Black line denotes the date the sanctuary was established.

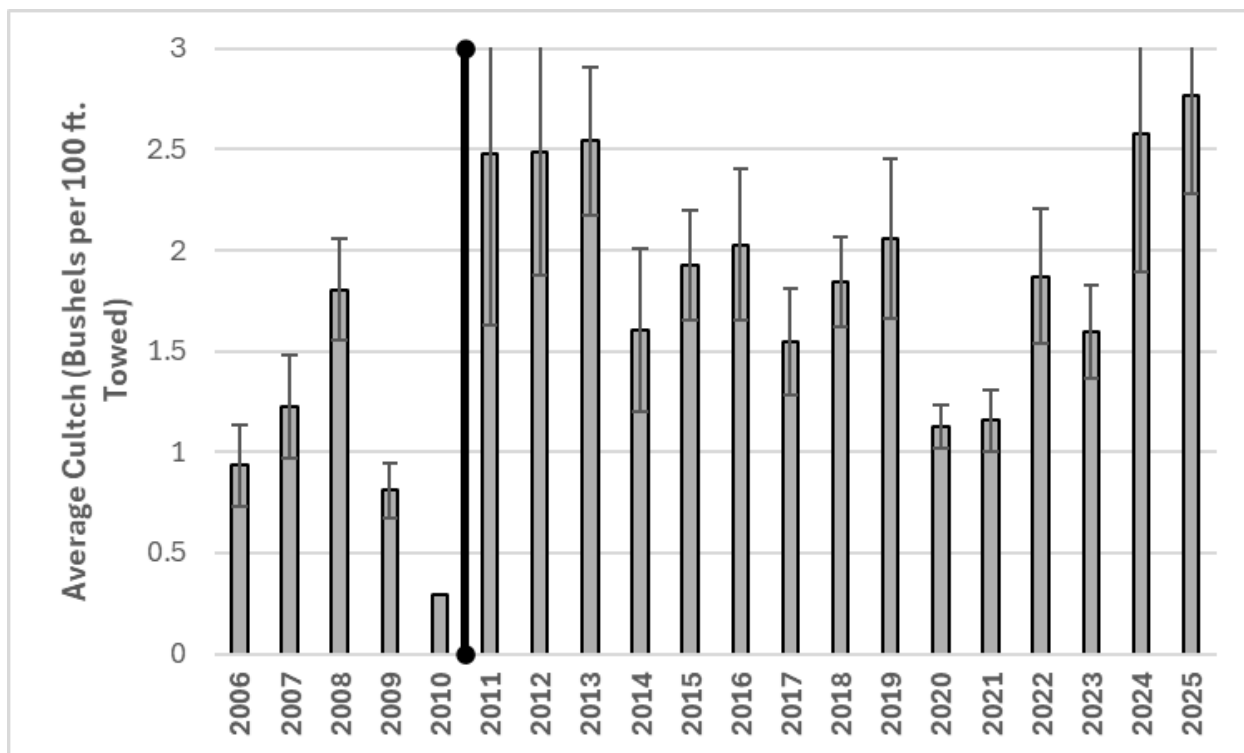


Figure A.17-7. Average cultch (live and dead oysters and loose shell) in the Little Choptank Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Black line denotes the date the sanctuary was established. Error bars represent ± 1 standard error.

Section A.18: Lower Chester River Sanctuary

The Lower Chester Sanctuary is located at the mouth of the Chester River, a low salinity (Zone 1) area within NOAA Codes 025 and 131. The sanctuary was created in 2010 and encompasses 24,147 acres of which 6,930 (29%) is historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments). There are 21 historic oyster bars within the sanctuary²⁴. The Lower Chester includes two previously created sanctuaries: Strong Bay Sanctuary (created in 2003, 320 acres), and East Neck Sanctuary (created in 2007, 78 acres). After the two older sanctuaries were included into this sanctuary, the total surface area is 24,545 acres and the total historic oyster bottom is 7,189 acres.

Information available for this sanctuary includes:

- Sanctuary map (Figure A.18-1)
- Density Survey (Figure A.18-2)
- Summary statistics (Table A.18-1)
- Density per year (Figure A.18-3A)
- Density per year excluding spat-on-shell plantings (Figure A.18-3B)
- Observed mortality (Figure A.18-4)
- Cultch per year (Figure A.18-5)

Lower Chester River Sanctuary is located in the Upper Bay Region of Maryland's Chesapeake Bay. Oysters in the Upper Bay Region generally grow well and survive but can be impacted by freshet events. Low natural recruitment is driven by the reduced salinity levels.

The Fall Oyster Survey has four standard sites within the Lower Chester River Sanctuary. Table A.18-1 shows a decrease in the average number of oysters and biomass from 2021-2025 data compared to the previous 5-year increments, while exhibiting low observed mortality. The average cultch per 100 ft tow from 2021-2025 indicates insufficient cultch availability.

In 2022 the Department conducted a patent tong population survey in the Lower Chester River Sanctuary. It found 8 live oysters from 285 samples. This is less than the 18 live oysters found in the 2014 survey. In 2023, a NOAA diver survey found an average of 5.3 oysters per square meter on the MARI Simpkins Dam Reef alternate substrate site.

In August 2023, a NOAA diver performed a direct oyster larvae release of 24 million oyster larvae onto the MARI Simpkins Reef Dam alternate material site. The Simpkins Reef Dam MARI site is slated to receive a spat-on-shell small-scale restoration planting in 2026.

²⁴ See chart 7 for bar names and locations in the State of Maryland Shellfish Closure Areas Book
<http://dnr.maryland.gov/fisheries/Pages/oysters/index.aspx>

This sanctuary is subject to poor recruitment. It was identified by the Department as underperforming and is under evaluation by the Oyster Advisory Commission for potential efforts to improve its performance.

In the 2021-2025 sanctuary assessment, this sanctuary was classified as trending negatively.

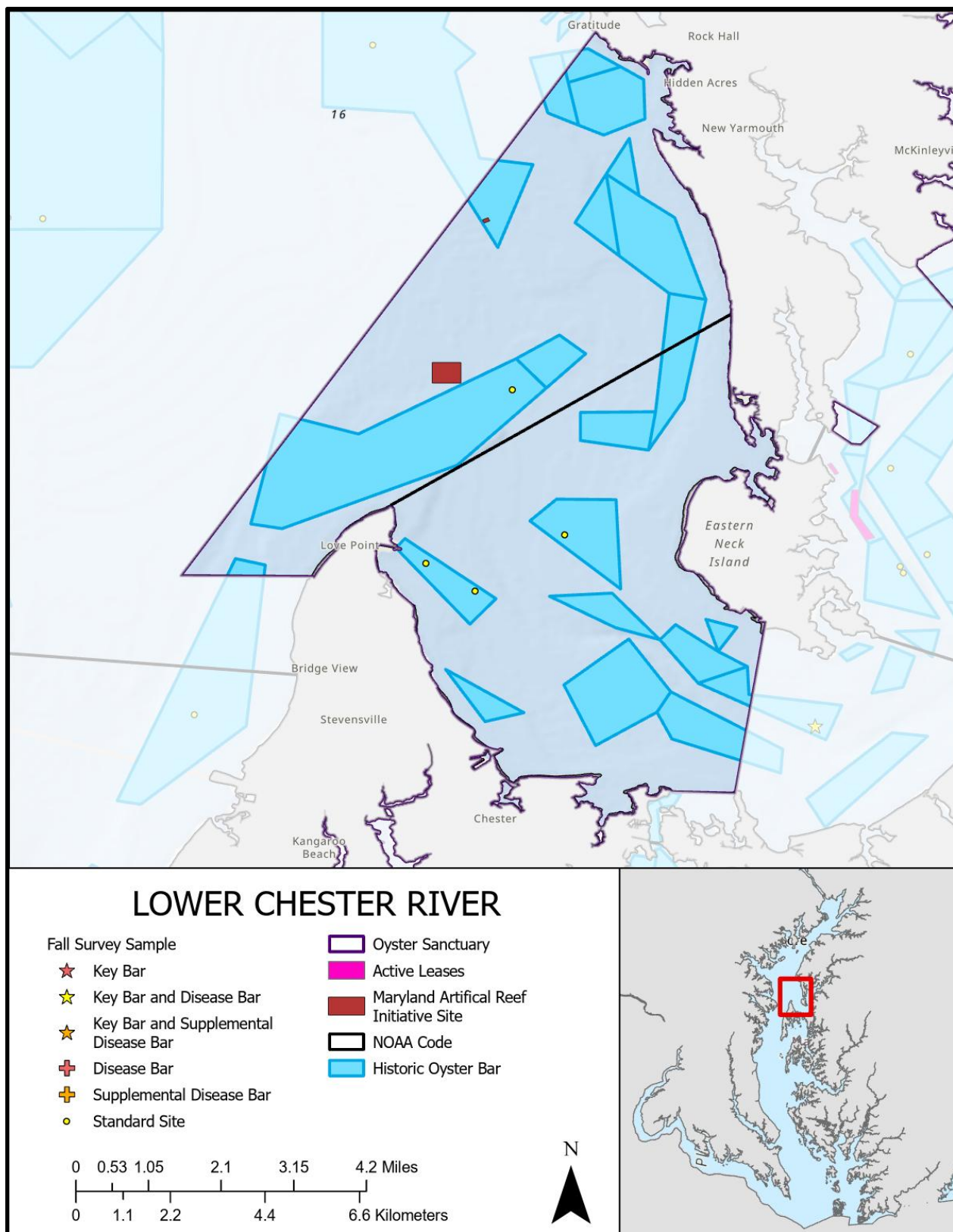


Figure A.18-1. Lower Chester Sanctuary. Fall Oyster Survey sites may not be sampled every year.

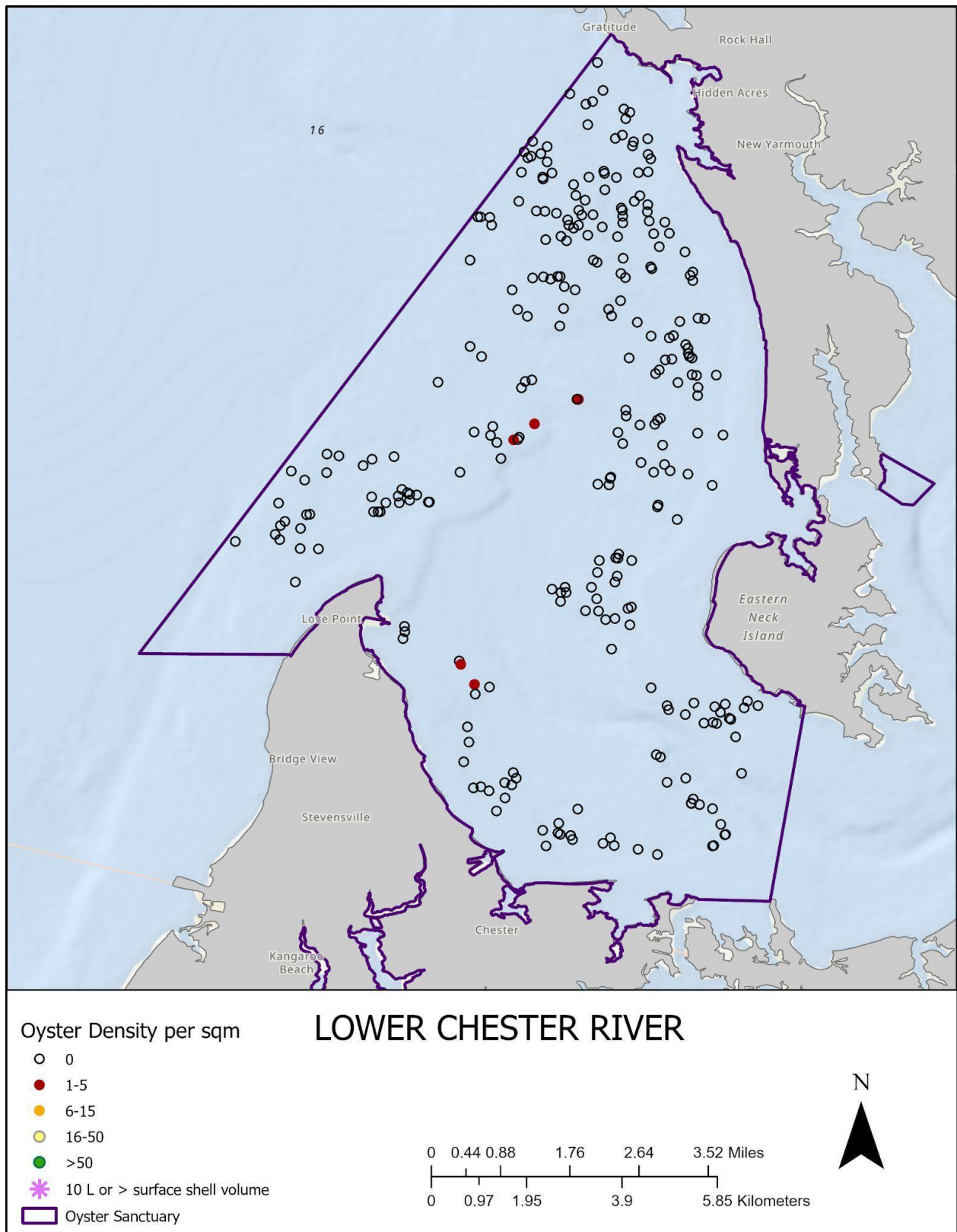


Figure A.18-2. Map of 2022 oyster density in the Lower Chester River Sanctuary. Data from Maryland Department of Natural Resources Patent Tong Population Survey.

Table A.18-1. Oyster population characteristics based on the Fall Oyster Survey in the Lower Chester River Sanctuary. ND=No Data. Values given are annual mean $\pm$ standard error.

Oyster Characteristic	2006-2010	2011-2015	2016-2020	2021-2025
Number of years sampled/number of samples	5/20	5/20	5/20	5/20
Number of Live Spat Oysters per square meter	3.8 $\pm$ 3 *	0.05 $\pm$ 0.05	0	0.07 $\pm$ 0.03
Number of Live Small Oysters per square meter	2.3 $\pm$ 1.5	2.7 $\pm$ 0.8	0.18 $\pm$ 0.08	0.39 $\pm$ 0.12
Number of Live Market Oysters per square meter	14.9 $\pm$ 3.4	10.3 $\pm$ 1.8	6.1 $\pm$ 1	4.9 $\pm$ 1.2
Number of Live Oysters per square meter	21.2 $\pm$ 4.2	13.1 $\pm$ 2	6.3 $\pm$ 1	5.3 $\pm$ 1.3
Live Biomass (g Dry Weight per Bushel)	ND	156 $\pm$ 37	125 $\pm$ 37	63 $\pm$ 15
Observed Mortality (%)	11.1 $\pm$ 2.8	10.9 $\pm$ 1.7	12.8 $\pm$ 2.5	13.4 $\pm$ 3.5
Cultch (Bushels per 100 feet towed)	0.4 $\pm$ 0.04	0.3 $\pm$ 0.04	0.2 $\pm$ 0.03	0.3 $\pm$ 0.1

*Includes 2006 and 2009 hatchery seed plantings.

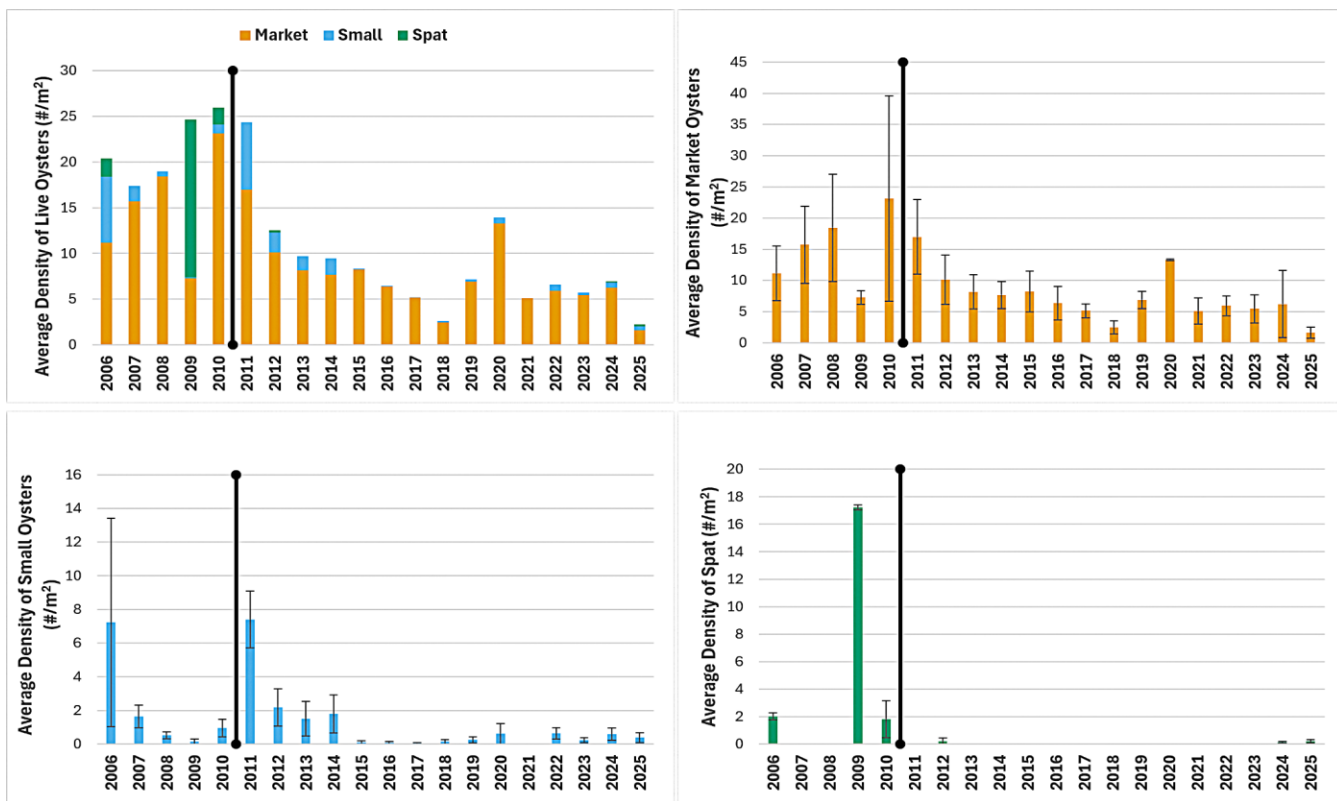


Figure A.18-3A. Average number of live oysters per square meter by size class in the Lower Chester Sanctuary including samples taken on hatchery spat-on-shell plantings. Black line indicates the date the sanctuary was established. Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales.

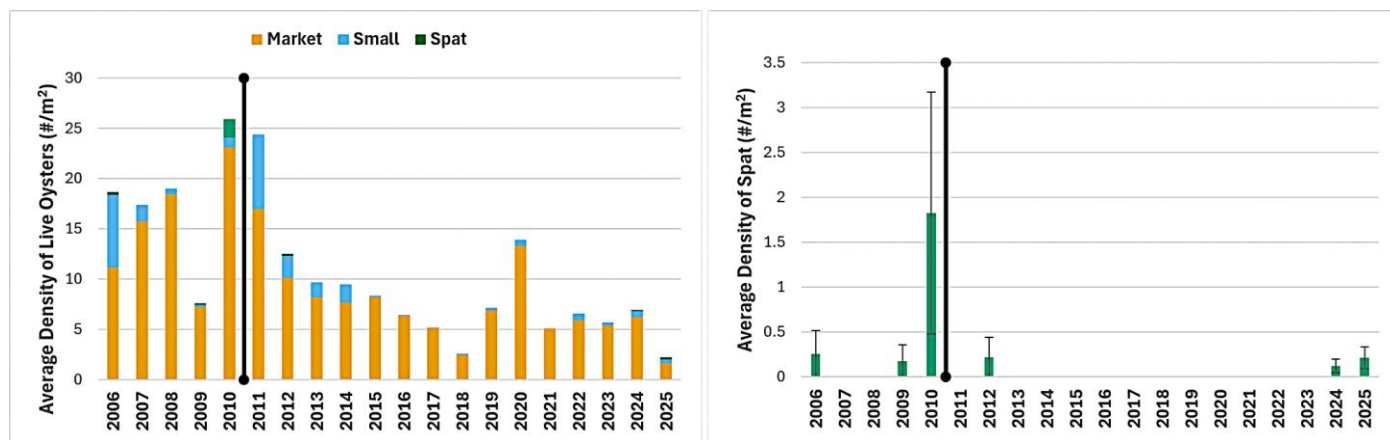


Figure A.18-3B. Average number of live oysters per square meter by size class in the Lower Chester Sanctuary excluding samples taken on hatchery spat-on-shell plantings. Black line indicates the date the sanctuary was established. Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales.

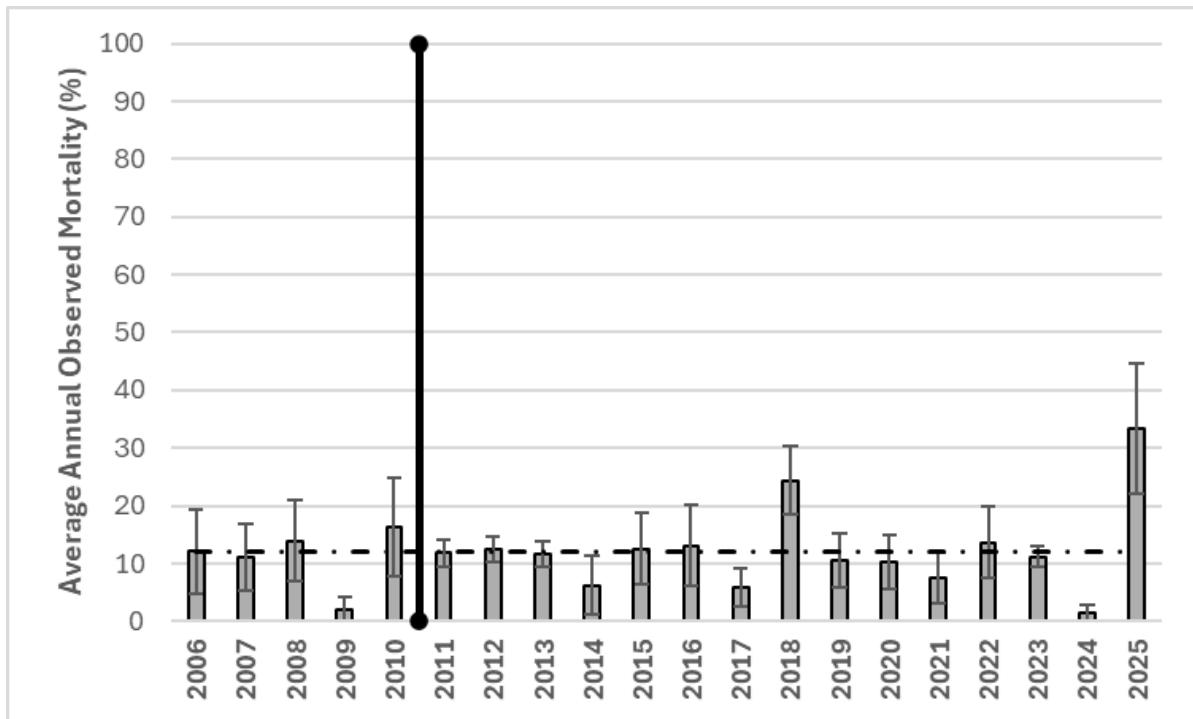


Figure A.18-4. Average annual observed mortality of market-sized and small-sized oysters in Lower Chester Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Black line denotes the date the sanctuary was established, and the dashed line represents the 2006-2025 baywide average observed mortality. Error bars represent ± 1 standard error.

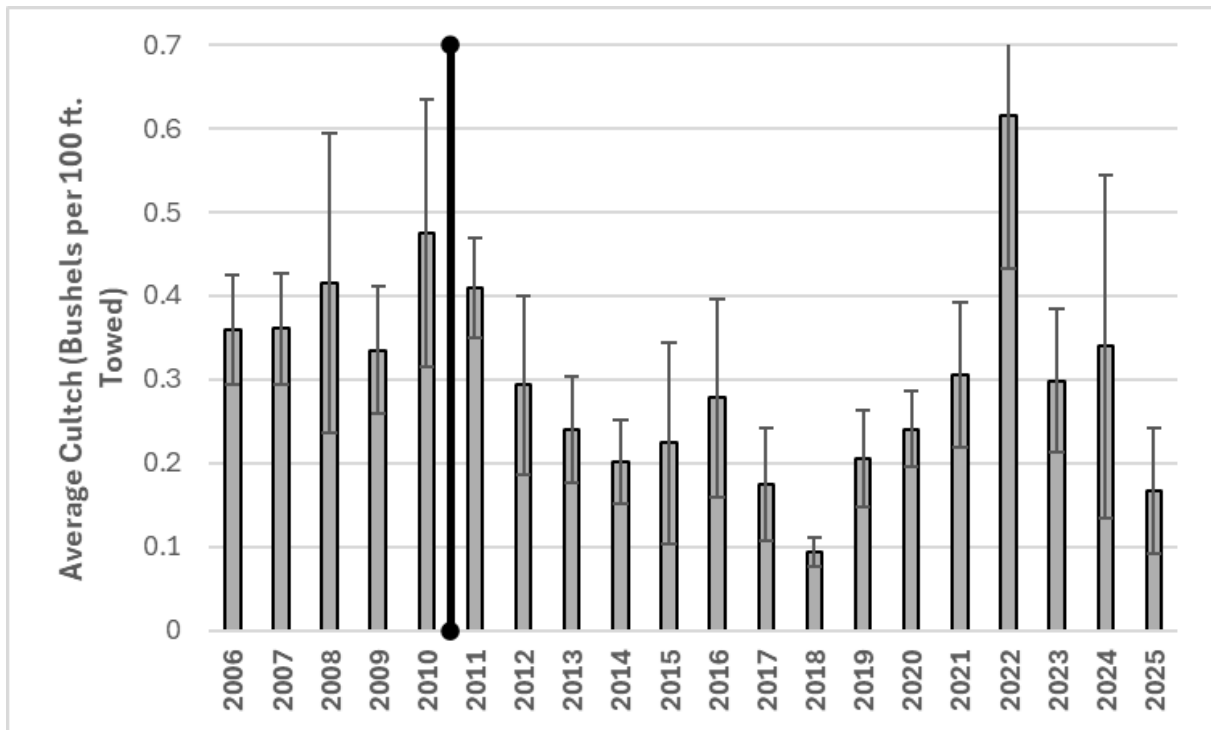


Figure A.18-5. Average cultch (live and dead oysters and loose shell) in the Lower Chester Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Black line denotes the date the sanctuary was established. Error bars represent ± 1 standard error.

Section A.19: Lower Choptank River Sanctuary

The Lower Choptank River Sanctuary is located on the south shore of the Choptank River at its mouth, a medium salinity (Zone 2) area within NOAA Codes 137 and 237. The sanctuary was created in 2010 and encompasses 7,172 acres of which 4,217 (59%) is historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments). There are 14 historic oyster bars within the sanctuary²⁵.

Information available for this sanctuary includes:

- Sanctuary map (Figure A.19-1)
- Density Survey (Figure A.19-2)
- Summary statistics (Table A.19-1)
- Density per year (Figure A.19-3)
- Observed mortality (Figure A.19-4)
- Cultch per year (Figure A.19-5)

Lower Choptank River Sanctuary is located in the Choptank Region of Maryland's Chesapeake Bay. Oysters in the Choptank Region generally grow well but may be impacted by disease or freshet events. Natural recruitment occurs regularly in this region.

The Fall Oyster Survey has one standard site within the Lower Choptank Sanctuary. Table A.19-1 shows an increase in the average number of oysters and cultch from 2021-2025 compared to the previous 5-year increments, while exhibiting high average observed mortality. The average cultch per 100 ft tow indicates insufficient cultch availability.

In 2022, the Department conducted a patent tong survey and found an average of 0.6 oysters per square meter and 0.5 liters of surface shell per square meter. The 2013 survey had an average of 1.6 oysters per square meter and 0.7 liters of surface shell per square meter.

In the 2021-2025 sanctuary assessment, this sanctuary was classified as trending positively.

²⁵ See charts 19 and 20 for bar names and locations in the State of Maryland Shellfish Closure Areas Book
<http://dnr.maryland.gov/fisheries/Pages/oysters/index.aspx>

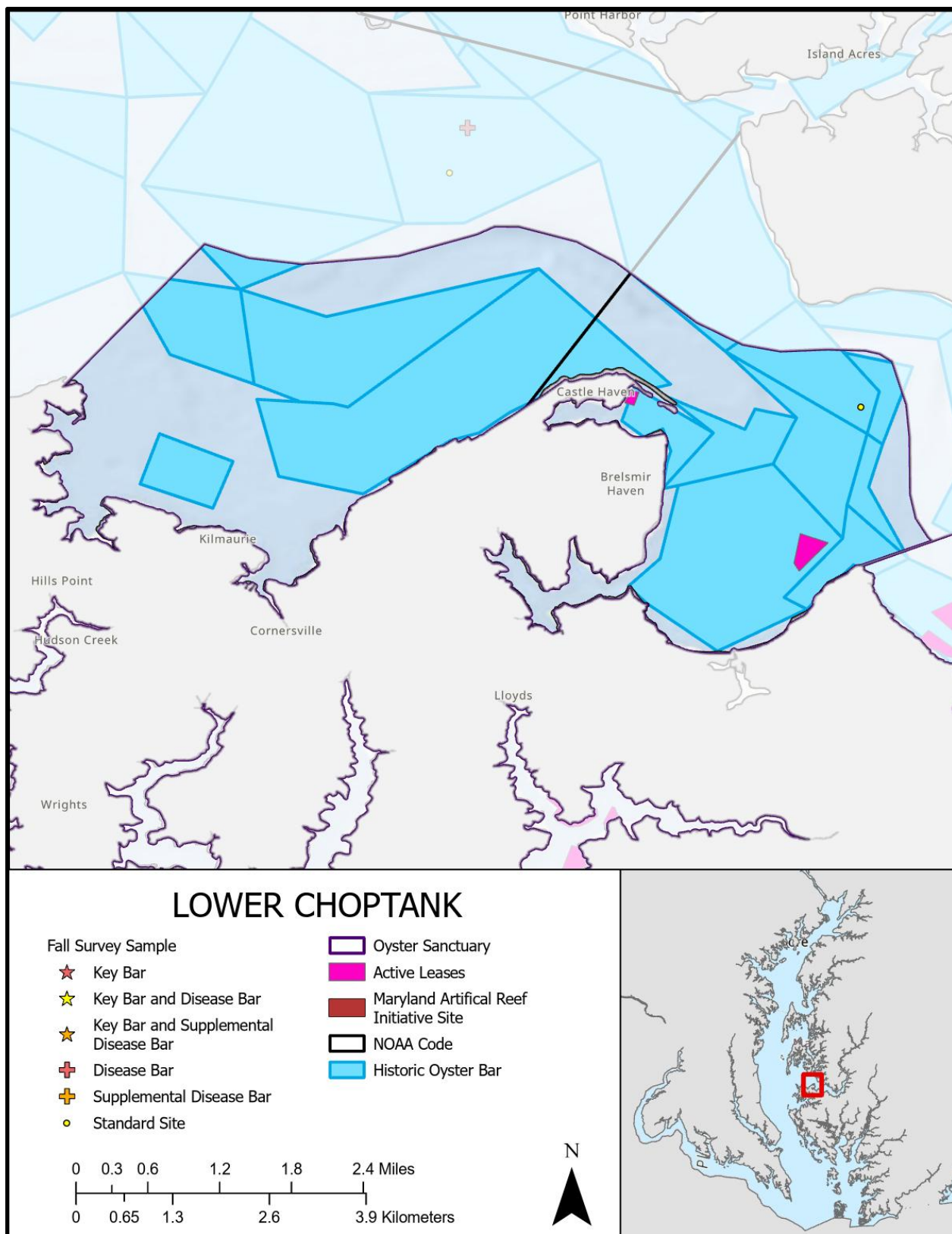


Figure A.19-1. Lower Choptank River Sanctuary. Fall Oyster Survey sites may not be sampled every year.

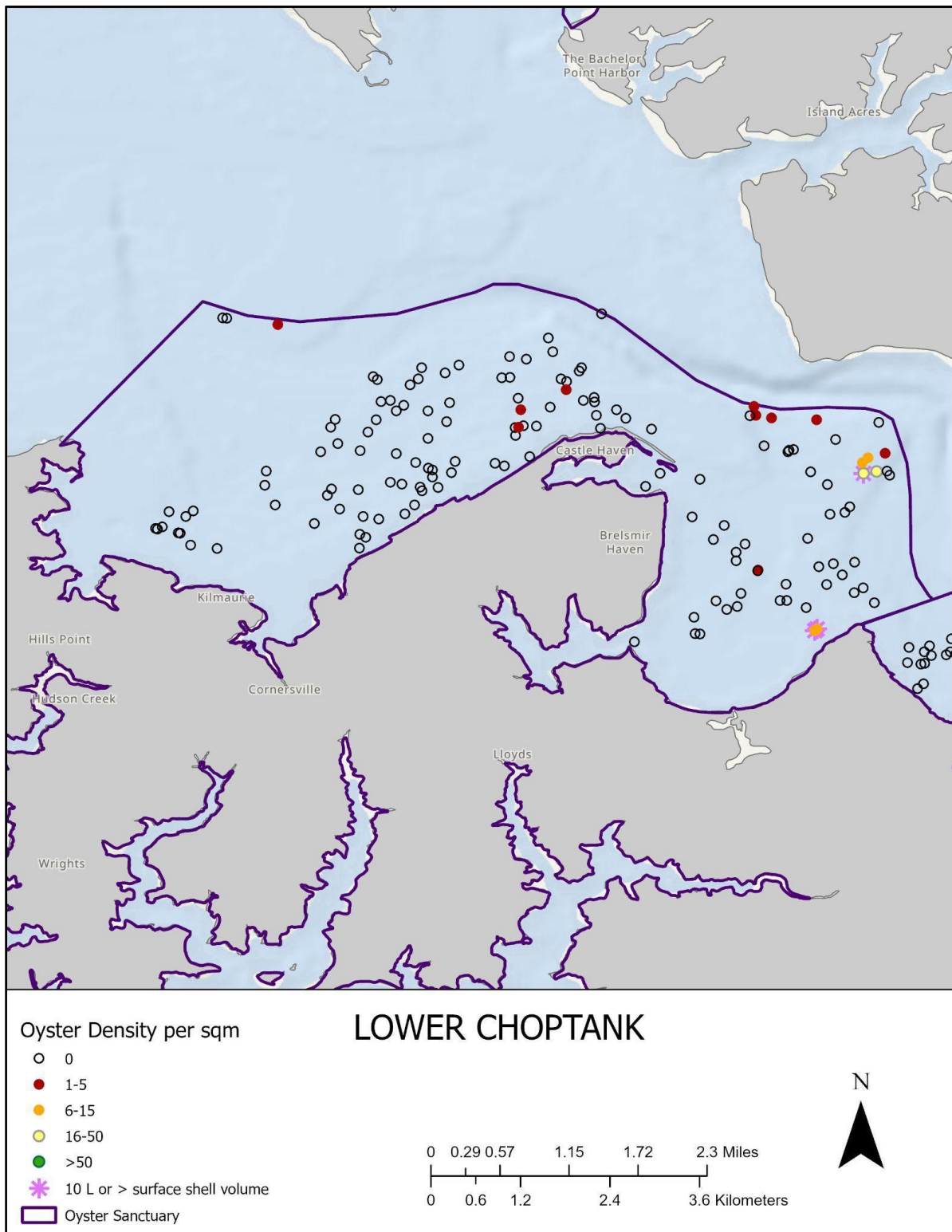


Figure A.19-2. Map of 2022 oyster density in the Lower Choptank River Sanctuary. Data from Maryland Department of Natural Resources Patent Tong Population Survey.

Table A.19-1. Oyster population characteristics based on the Fall Oyster Survey in the Lower Choptank River Sanctuary. ND=No Data. Values given are annual mean $\pm$ standard error.

Oyster Characteristic	2006-2010	2011-2015	2016-2020	2021-2025
Number of years sampled/number of samples	5/5	5/5	5/5	5/9
Number of Live Spat Oysters per square meter	4.4 $\pm$ 2.7	2.9 $\pm$ 2.3	2.4 $\pm$ 2.1	16.4 $\pm$ 5.8
Number of Live Small Oysters per square meter	7.5 $\pm$ 3.4	9.5 $\pm$ 4.5	1.9 $\pm$ 1.2	30.7 $\pm$ 11.2
Number of Live Market Oysters per square meter	6.3 $\pm$ 1.4	18.5 $\pm$ 3.5	23.7 $\pm$ 5.7	33.6 $\pm$ 9.4
Number of Live Oysters per square meter	18.2 $\pm$ 6.6	31 $\pm$ 7	28 $\pm$ 8	80.6 $\pm$ 22
Live Biomass (g Dry Weight per Bushel)	ND	ND	ND	ND
Observed Mortality (%)	2.3 $\pm$ 1.8	6.3 $\pm$ 0.3	17.3 $\pm$ 5	18.9 $\pm$ 3.4
Cultch (Bushels per 100 feet towed)	0.4 $\pm$ 0.05	0.3 $\pm$ 0.1	0.4 $\pm$ 0.1	0.7 $\pm$ 0.1

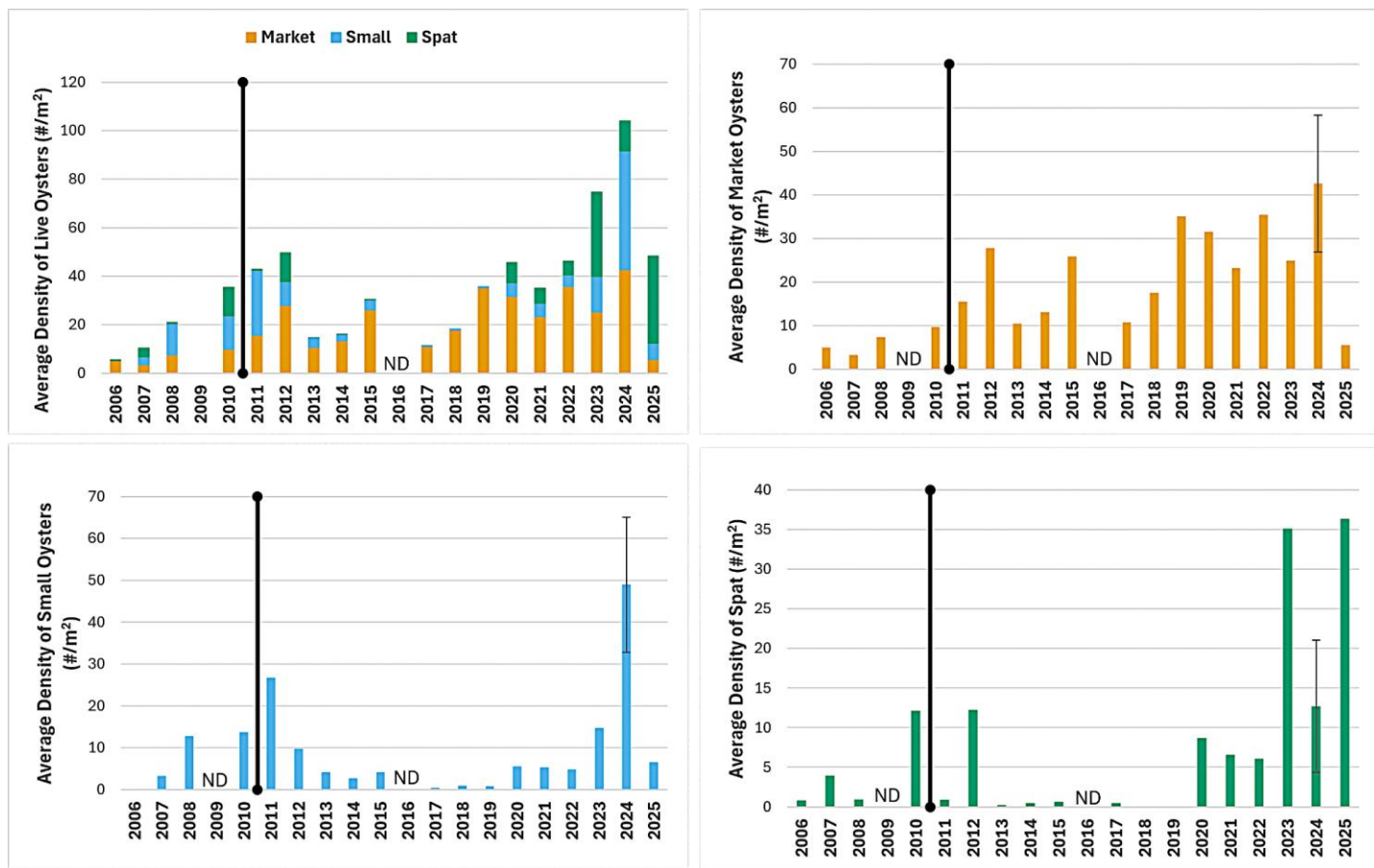


Figure A.19-3. Average number of live oysters per square meter by size class in the Lower Choptank River Sanctuary. Black line indicates the date the sanctuary was established. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales. ND = No data.

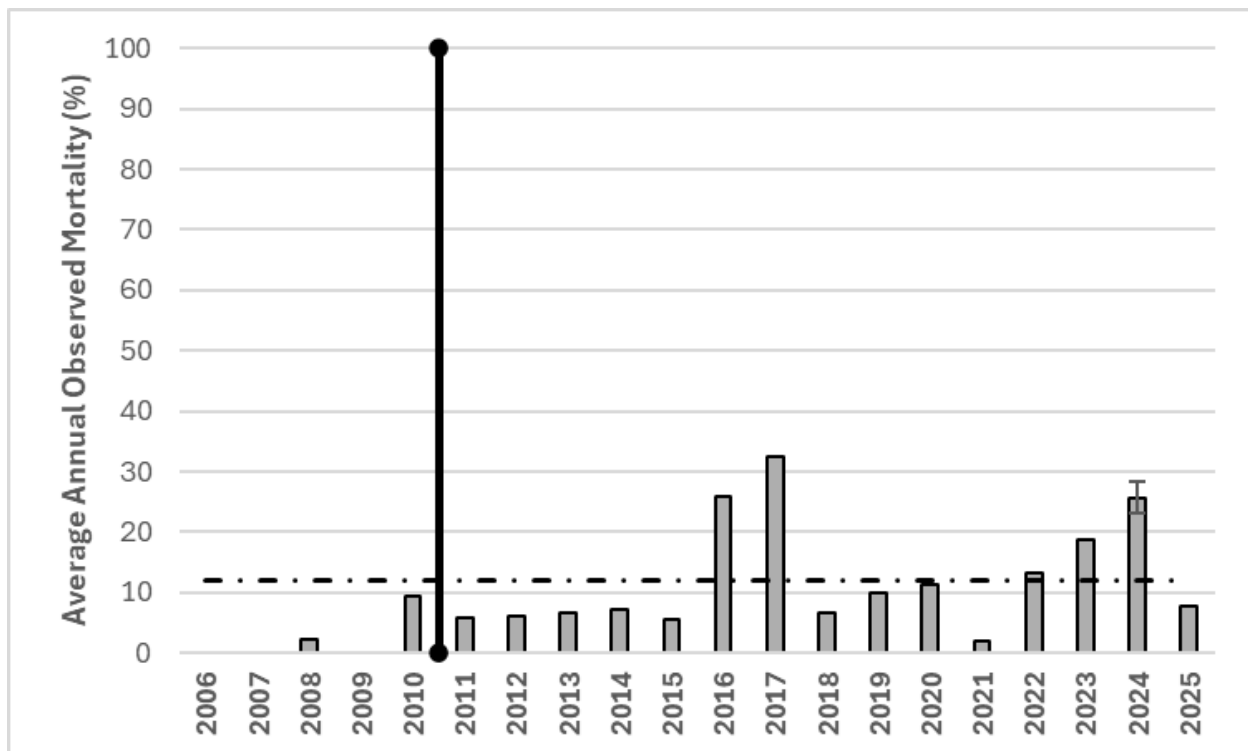


Figure A.19-4. Average annual observed mortality of market-sized and small-sized oysters in Lower Choptank River Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Black line denotes the date the sanctuary was established, and the dashed line represents the 2006-2020 baywide average observed mortality. Error bars represent ± 1 standard error.

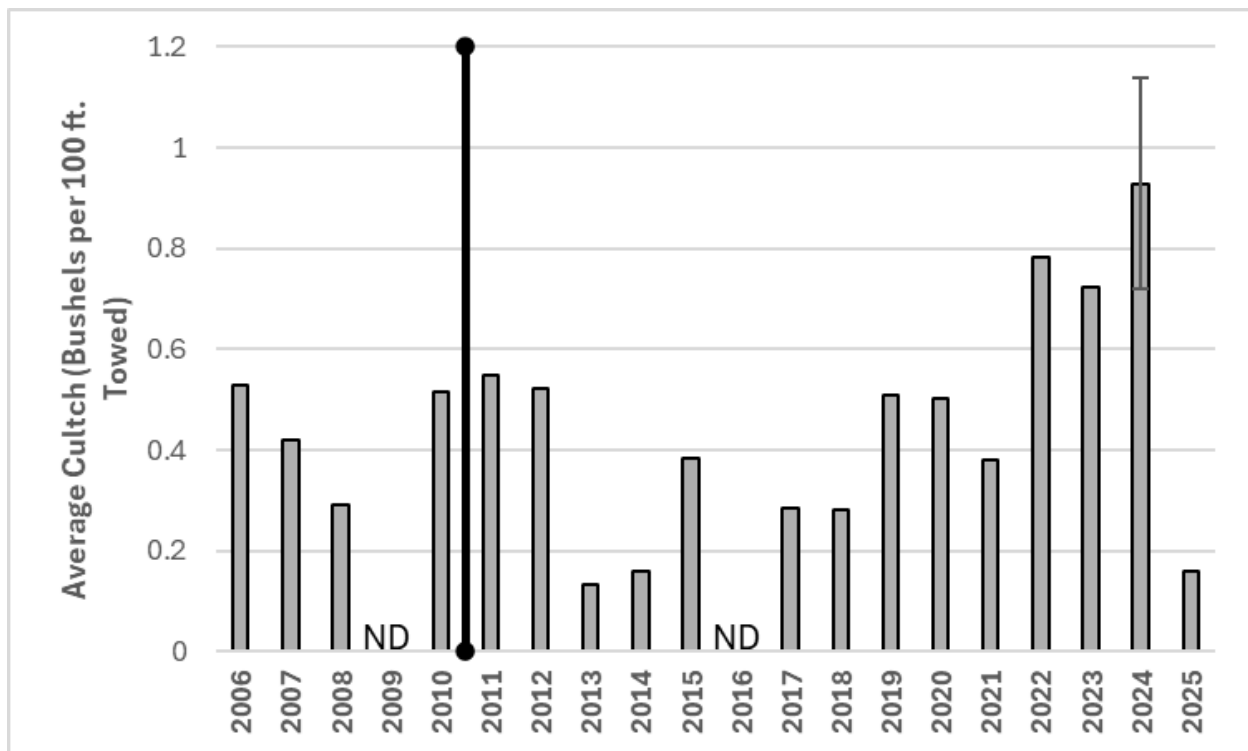


Figure A.19-5. Average cultch (live and dead oysters and loose shell) in the Lower Choptank River Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Black line denotes the date the sanctuary was established. ND = No Data. Error bars represent ± 1 standard error.

Section A.20: Lower Main Stem Bay Sanctuary

The Lower Main Stem Bay Sanctuary is located in the lower eastern portion of Maryland's Chesapeake Bay, a medium salinity (Zone 2) region within NOAA Codes 129, 192, and 292. The sanctuary was created in 2010 and encompasses 38,290 acres of which 8,234 (22%) is historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments). There are 6 historic oyster bars within the sanctuary²⁶.

Information available for this sanctuary includes:

- Sanctuary map (Figure A.20-1)
- Density Survey (Figure A.20-2)
- Summary statistics (Table A.20-1)
- Density per year (Figure A.20-3)
- Shell height frequencies (Figure A.20-4)
- Biomass per year (Figure A.20-5)
- Observed mortality (Figure A.20-6)
- Dermo and MSX per year (Figure A.20-7)
- Cultch per year (Figure A.20-8)

Lower Main Stem Bay Sanctuary is located in the Lower Eastern Shore Region of Maryland's Chesapeake Bay. Oysters in the Lower Eastern Shore Region generally grow well but can be impacted by disease. Elevated salinity levels promote greater natural recruitment.

Located in deep water, this sanctuary is situated in a zone that experiences regular recruitment and consistent disease pressure, though it may face challenges with periods of low DO at these depths. Large boulders present in the area are frequently caught in the sampling gear.

The Fall Oyster Survey has one standard site and one supplemental disease site within the Lower Main Stem Bay Sanctuary. Table A20-1 shows an increase in the average number of oysters and biomass from 2021-2025 compared to the previous 5-year increments, while exhibiting high observed mortality. However, this average observed mortality was lower than the 2006-2010 and 2011-2015 and similar to the 2016-2020 timeframe. In 2023, there was an increase in observed mortality that coincides with an increase in lethal dermo disease prevalence as well as MSX prevalence in 2022 (Figures A.29-6, A.20-7) The average density from 2021-2025 is above the long-term abundance target of 94 oysters per square meter and the average cultch per 100 ft tow from 2021-2025 indicates insufficient cultch availability.

In 2024 the Department conducted a patent tong survey and found an average of 7.2 oysters per square meter and 0.37 liters of surface shell per square meter. This is greater than the 0.2 oysters per square meter and 0.09 liters of surface shell found in 2015.

²⁶ See chart 41 for bar names and locations in the State of Maryland Shellfish Closure Areas Book <http://dnr.maryland.gov/fisheries/Pages/oysters/index.aspx>

In the 2021-2025 sanctuary assessment, this sanctuary was classified as trending positively with a high oyster density.

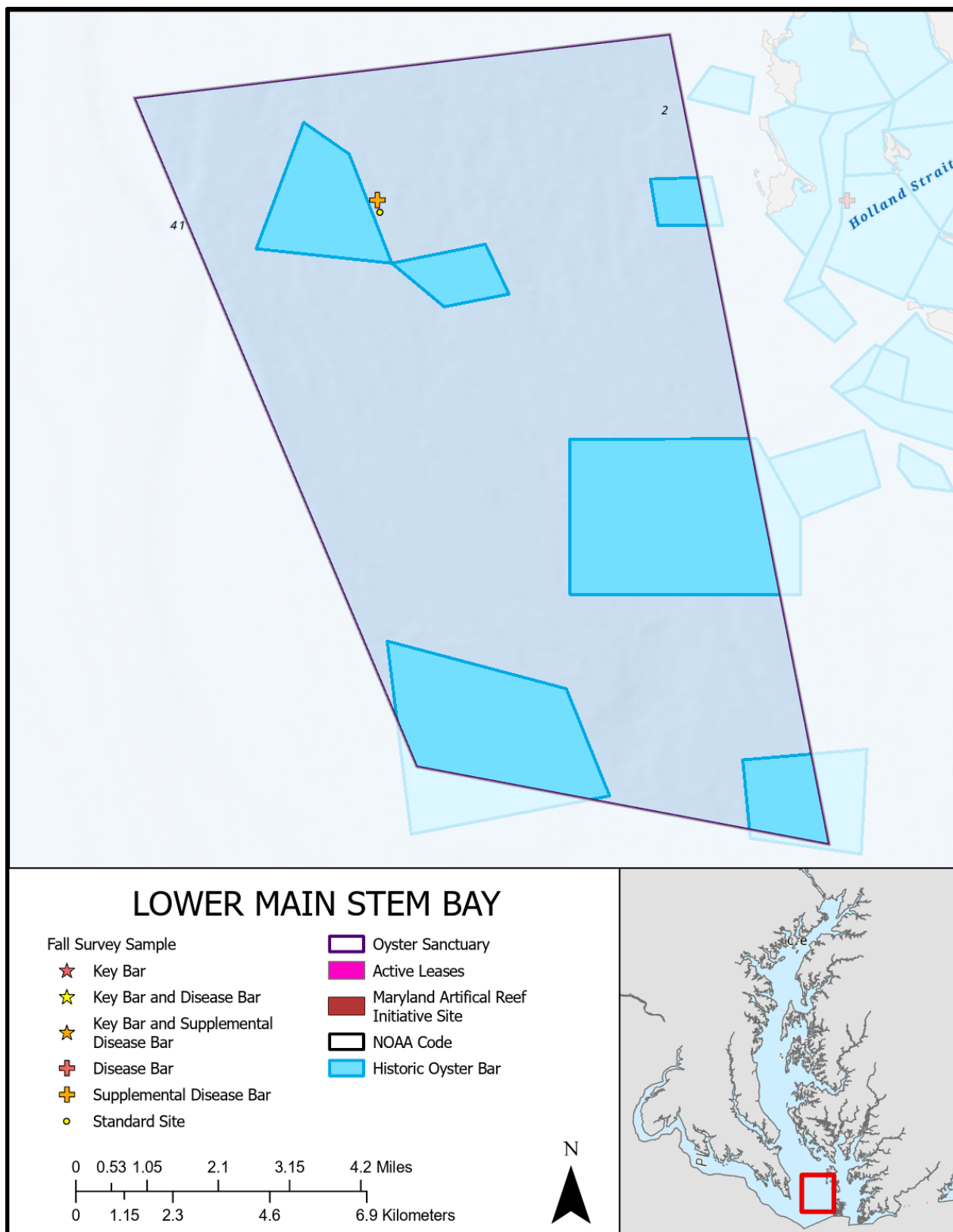


Figure A.20-1. Lower Main Stem Bay Sanctuary. Fall Oyster Survey sites may not be sampled every year.

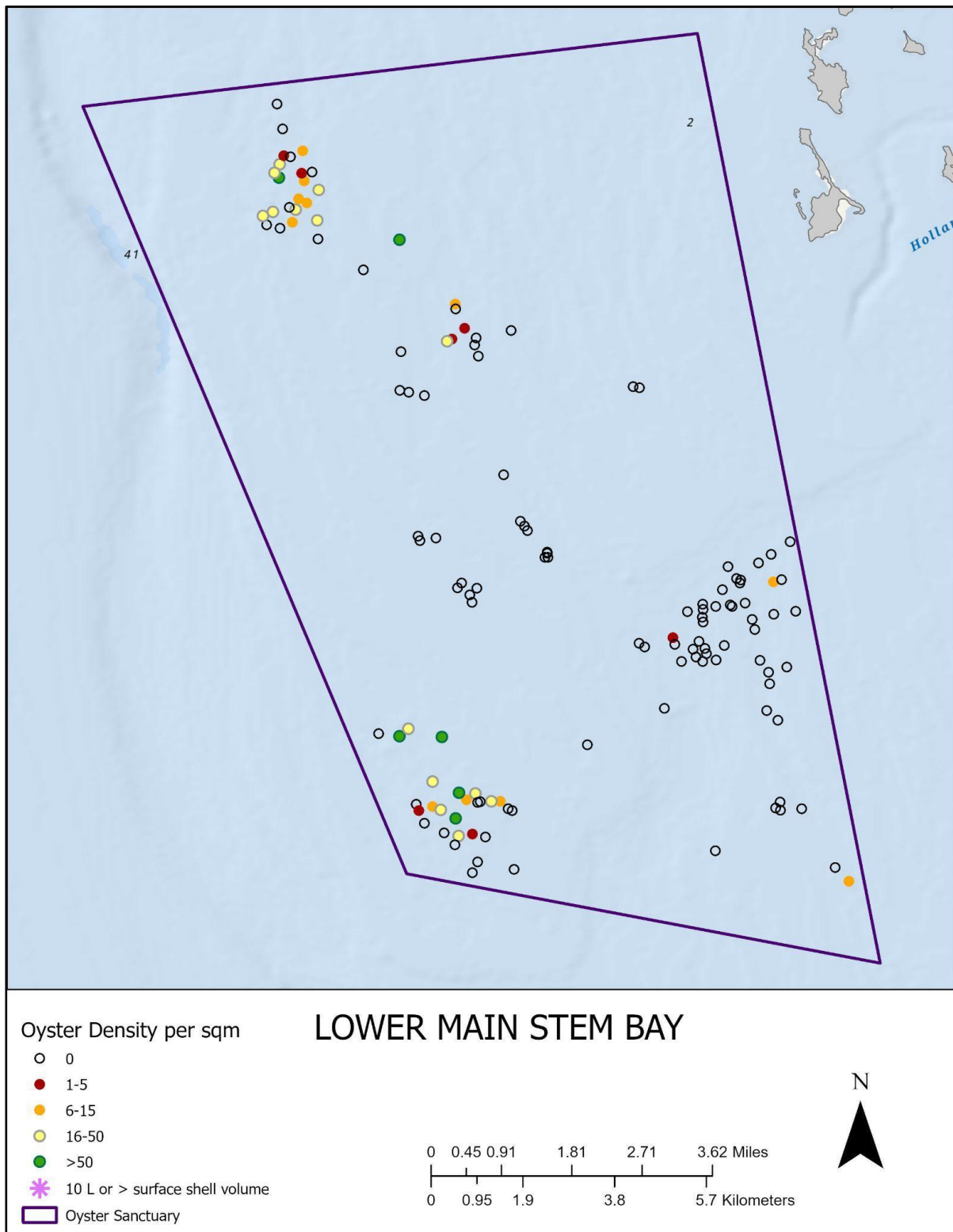


Figure A.20-2. Map of 2024 oyster density in the Lower Main Stem Bay Sanctuary. Data from Maryland Department of Natural Resources Patent Tong Population Survey.

Table A.20-1. Oyster population characteristics based on the Fall Oyster Survey in the Lower Main Stem Bay Sanctuary. ND=No Data. Values given are annual mean $\pm$ standard error.

Oyster Characteristic	2006-2010	2011-2015	2016-2020	2021-2025
Number of years sampled/number of samples	5/10	5/10	5/9	5/10
Number of Live Spat Oysters per square meter	42.6 $\pm$ 29.7	33.3 $\pm$ 10.7	48.1 $\pm$ 14.6	57 $\pm$ 10.1
Number of Live Small Oysters per square meter	64.3 $\pm$ 21.3	35 $\pm$ 14.2	76.4 $\pm$ 27.6	107.6 $\pm$ 20.1
Number of Live Market Oysters per square meter	6.3 $\pm$ 2.4	12.1 $\pm$ 3.4	10.3 $\pm$ 1.9	33 $\pm$ 5.2
Number of Live Oysters per square meter	113.6 $\pm$ 28	80.5 $\pm$ 24.5	135 $\pm$ 36	197.5 $\pm$ 29
Live Biomass (g Dry Weight per Bushel)	ND	125 $\pm$ 28	263 $\pm$ 35	344 $\pm$ 20
Observed Mortality (%)	24.9 $\pm$ 3.7	35.8 $\pm$ 7.7	16.4 $\pm$ 2.6	16.6 $\pm$ 3.5
Cultch (Bushels per 100 feet towed)	0.8 $\pm$ 0.2	0.5 $\pm$ 0.2	0.4 $\pm$ 0.1	0.5 $\pm$ 0.1

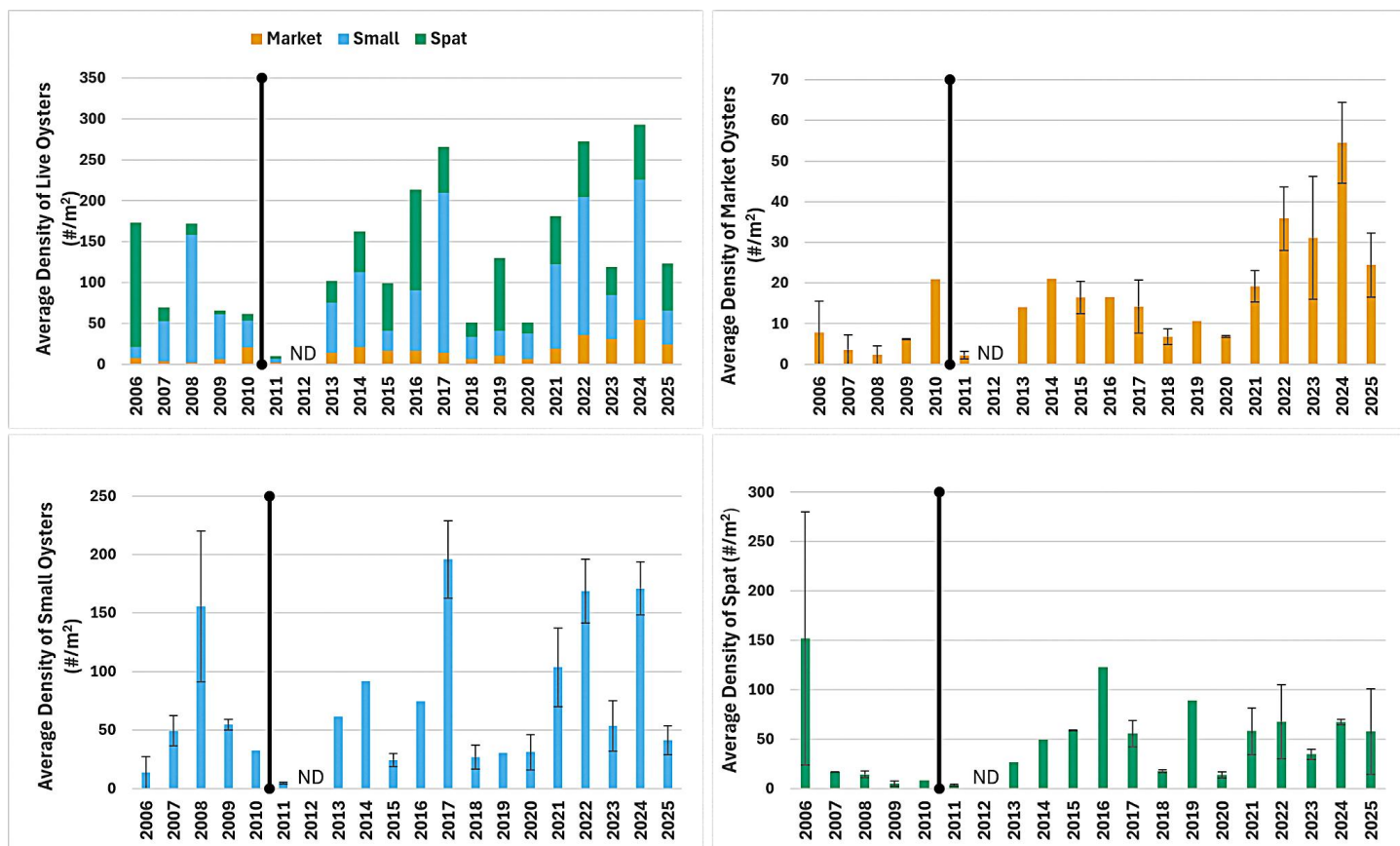


Figure A.20-3. Average number of live oysters per square meter by size class in the Lower Main Stem Bay Sanctuary. Black line indicates the date the sanctuary was established. Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales. ND = No data.

LOWER MAINSTEM BAY (2010)

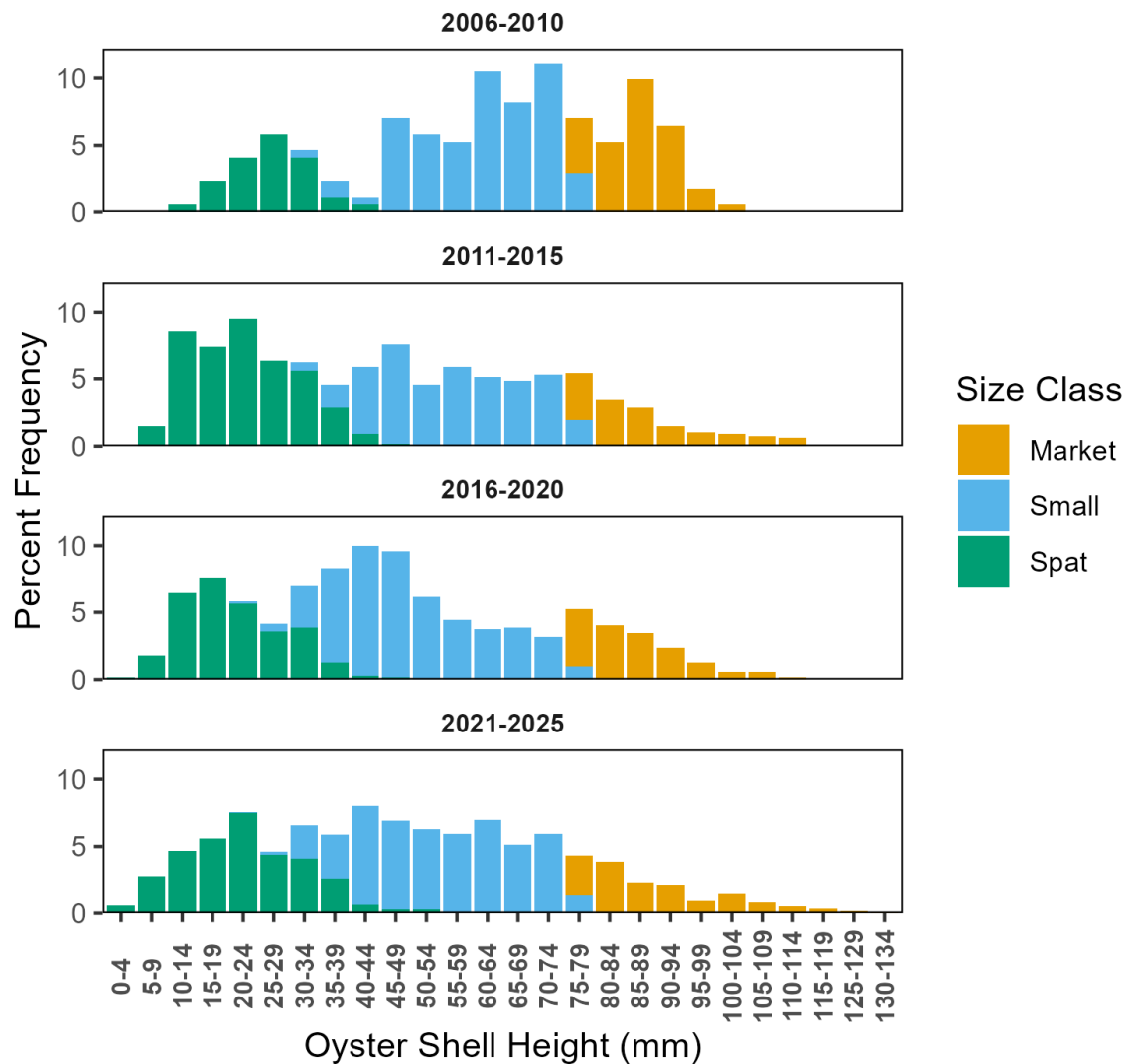


Figure A.20-4. Shell height frequencies of live oysters per bushel of material in the Lower Main Stem Bay Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey on Northwest Middleground bar. No data was collected in 2006 to 2009, 2018 and 2019.

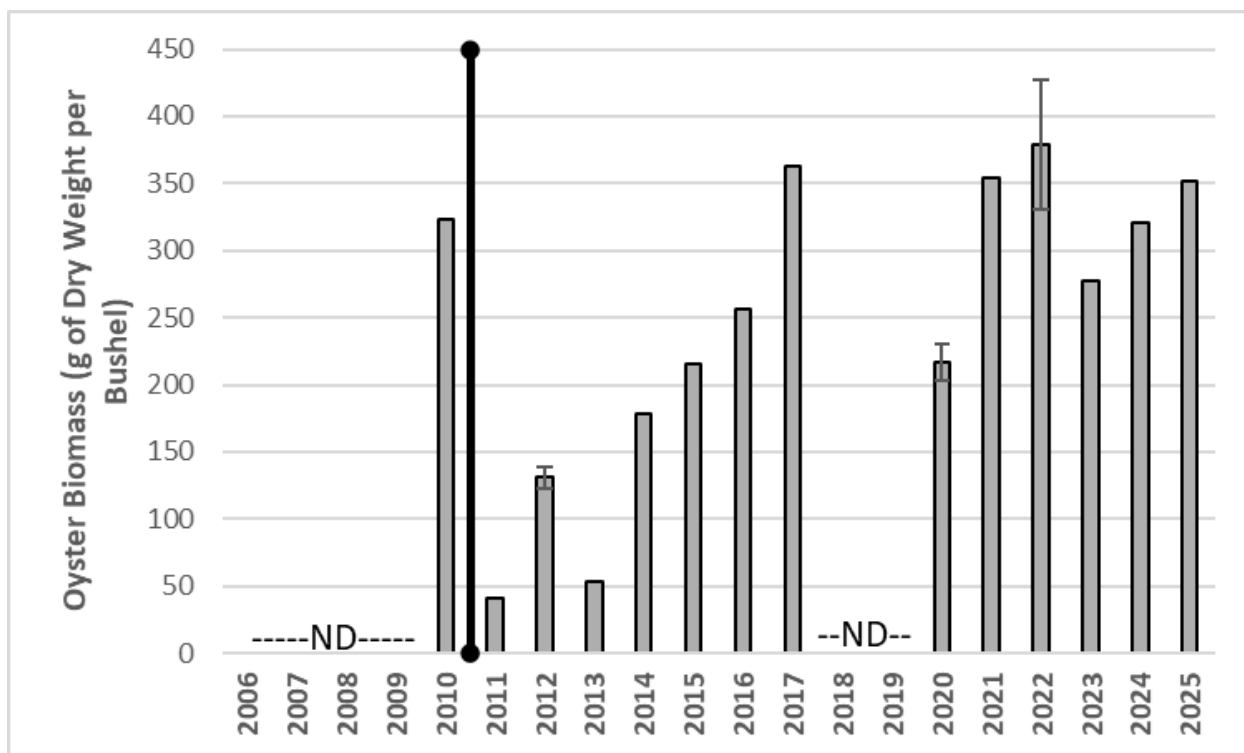


Figure A.20-5. Oyster biomass (grams of dry weight per bushel of material) in the Lower Main Stem Bay Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Black line indicates the date the sanctuary was established. ND = No Data. Error bars represent ± 1 standard error.

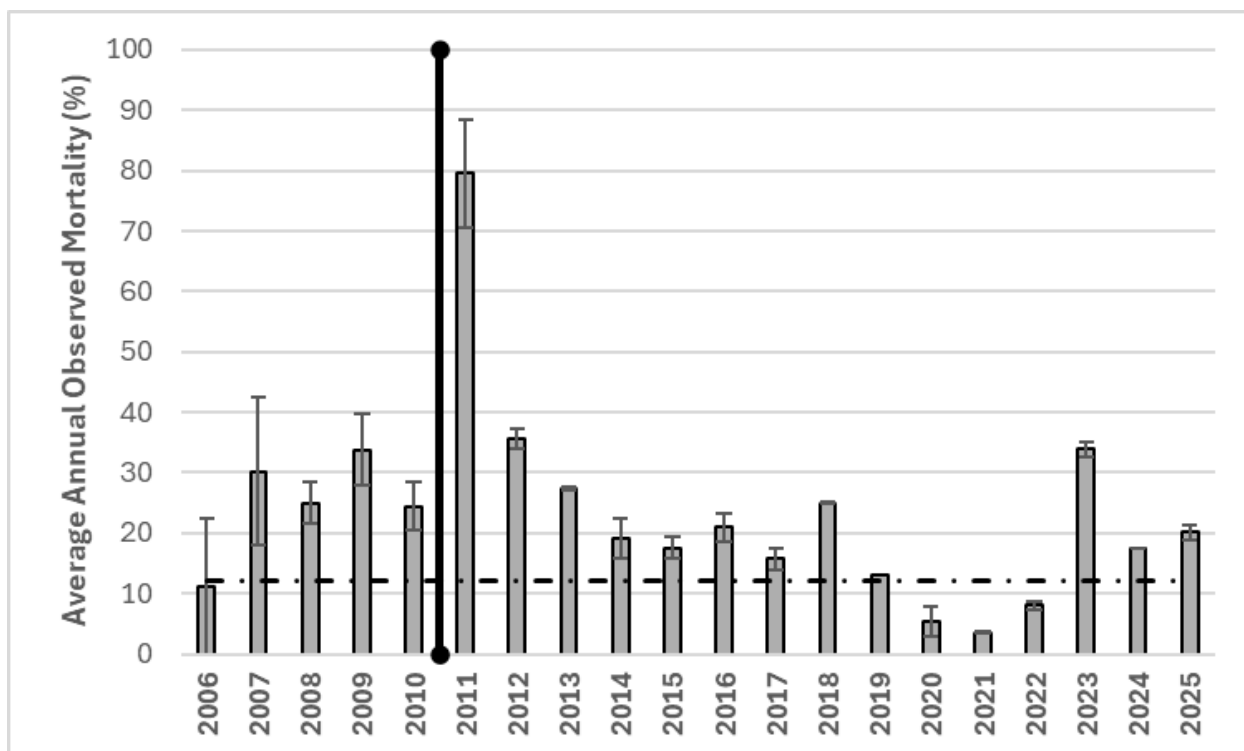


Figure A.20-6. Average annual observed mortality of market-sized and small-sized oysters in Lower Main Stem Bay Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Black line denotes the date the sanctuary was established, and the dashed line represents the 2006-2025 baywide average observed mortality. Error bars represent ± 1 standard error.

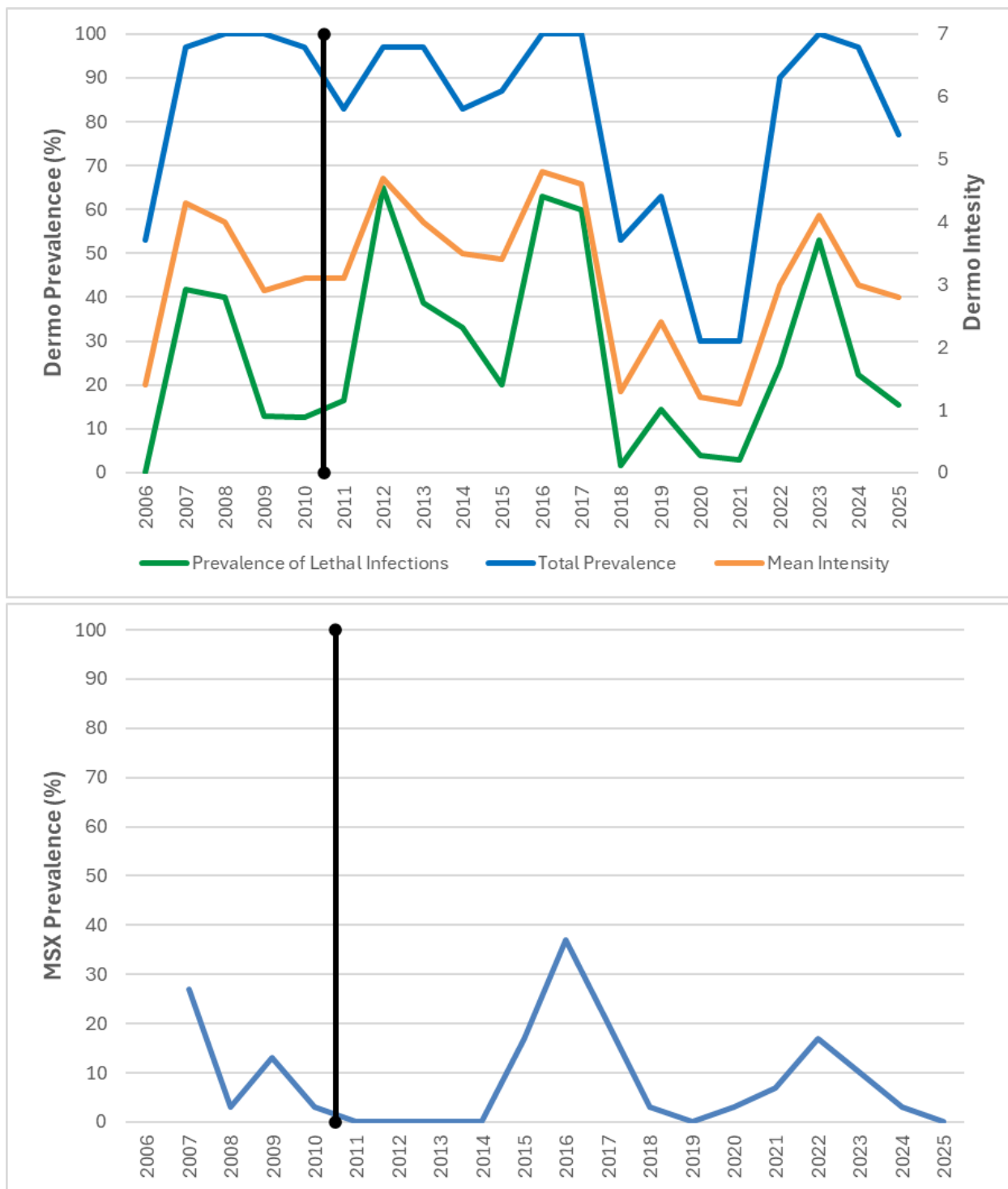


Figure A.20-7 Oyster disease prevalence and intensity in the Lower Main Stem Bay Sanctuary. (A) Dermo prevalence and mean intensity (B) MSX prevalence (intensity is not examined). Data from Maryland's Annual Fall Oyster Dredge Survey on Northwest Middleground bar. Black line denotes the date the sanctuary was established. No MSX data was collected in 2006.

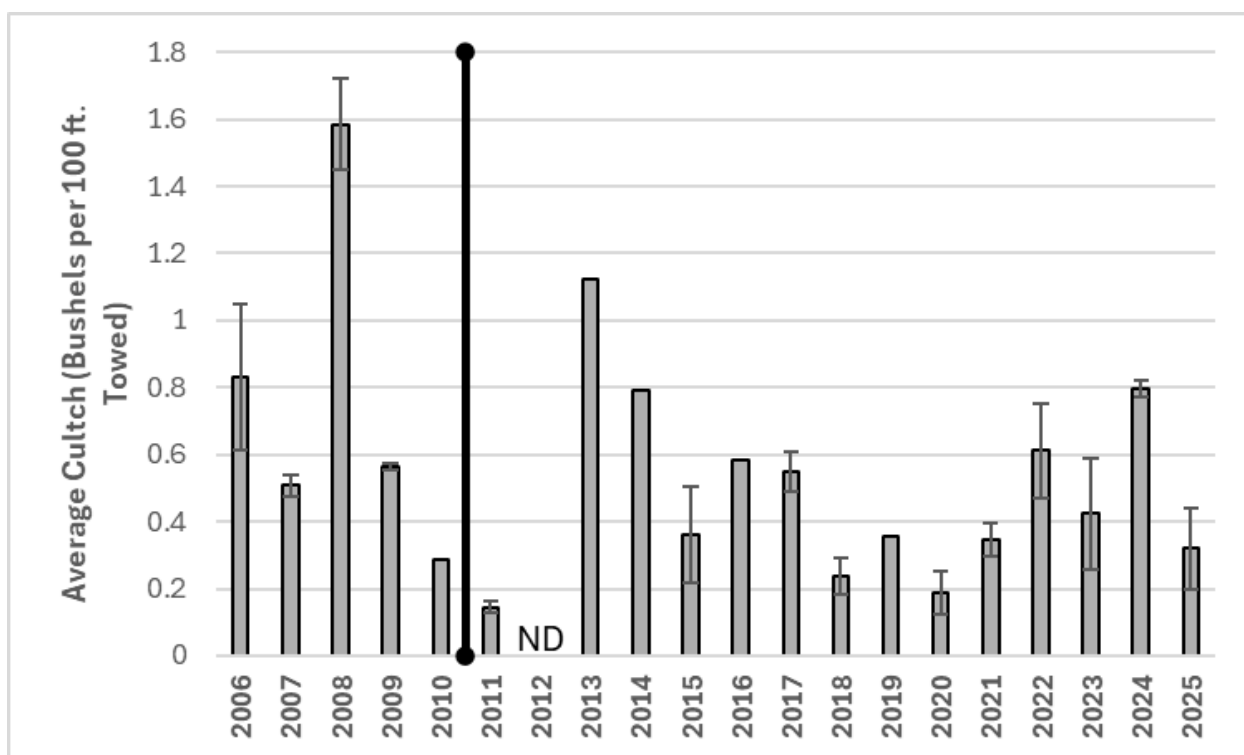


Figure A.20-8. Average cultch (live and dead oysters and loose shell) in the Lower Main Stem Bay Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Black line denotes the date the sanctuary was established. Error bars represent ± 1 standard error. ND = No Data.

Section A.21: Lower Patuxent River Sanctuary

The Lower Patuxent River Sanctuary is located on the southern shore of the Patuxent River near the river's mouth, a medium salinity (Zone 2) region within NOAA Code 168. The sanctuary was created in 2010 and encompasses 335 acres of which 315 (94%) is historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments). There are 2 historic oyster bars within the sanctuary.

Information available for this sanctuary includes:

- Sanctuary map (Figure A.21-1)
- Density Survey (Figure A.21-2)
- Summary statistics (Table A.21-1)

Lower Patuxent River Sanctuary is located in the Lower Western Shore Region of Maryland's Chesapeake Bay. Oysters in the Western Shore Region generally grow well but may be impacted by disease or freshet events. Natural recruitment occurs regularly in this region.

In 2024 the Department conducted a patent tong population survey in this sanctuary. It found an average of 1.8 oysters per square meter and 0.2 liters of surface shell per square meter. This is a higher oyster density than the 1 oyster per square meter and a lower surface shell of 0.4 liters per square meter found in a 2015 survey.

A majority of this sanctuary is in deep water and may have issues with periods of low dissolved oxygen at these depths, limiting its restoration potential.

The sanctuary was one of the sanctuaries identified by the Department as unlikely to receive a large investment by the Department for restoration and is under evaluation by the Oyster Advisory Commission for potential efforts to improve its performance.

In the 2021-2025 sanctuary assessment, this sanctuary was classified as poor habitat due to potential low dissolved oxygen.

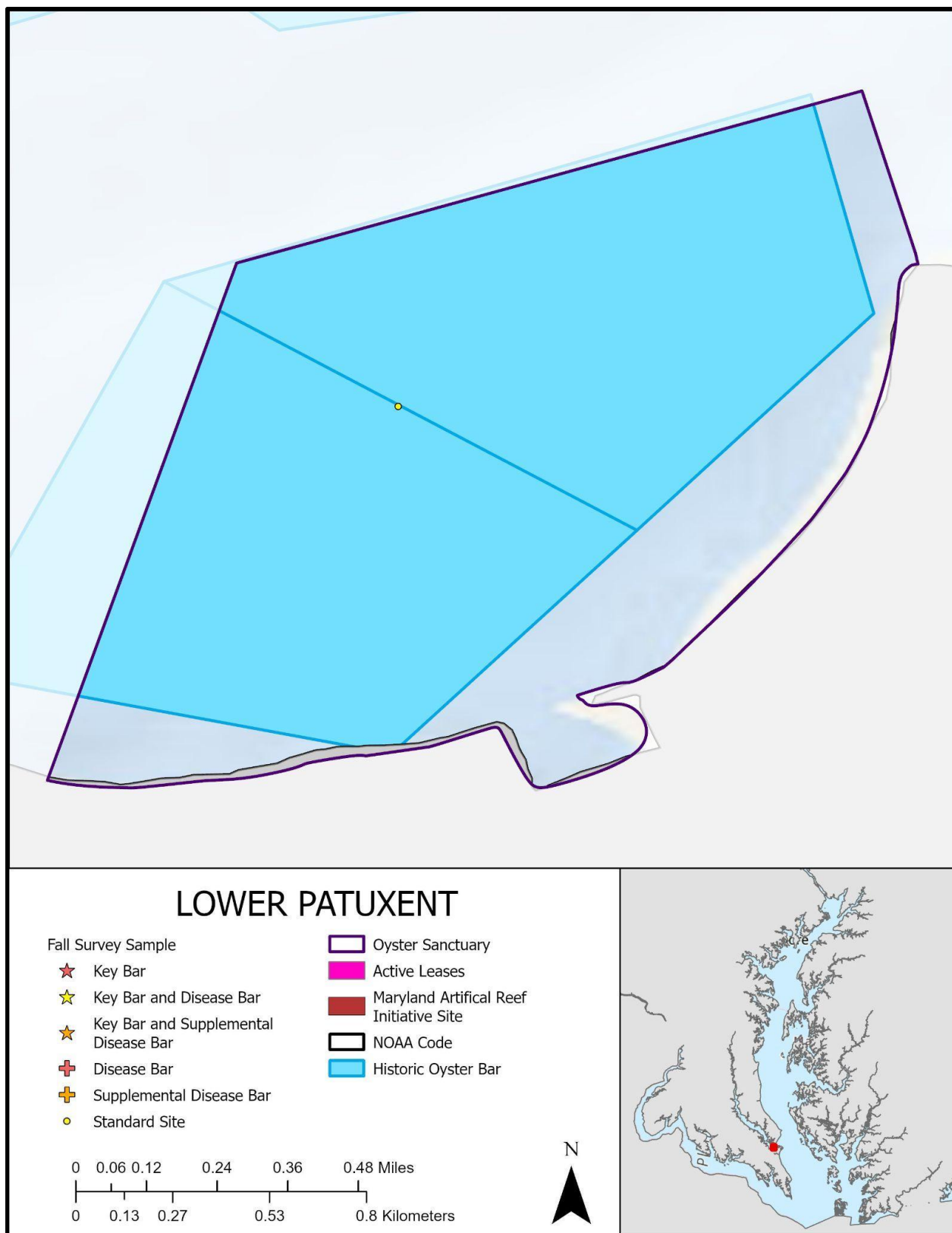


Figure A.21-1. Lower Patuxent River Sanctuary.

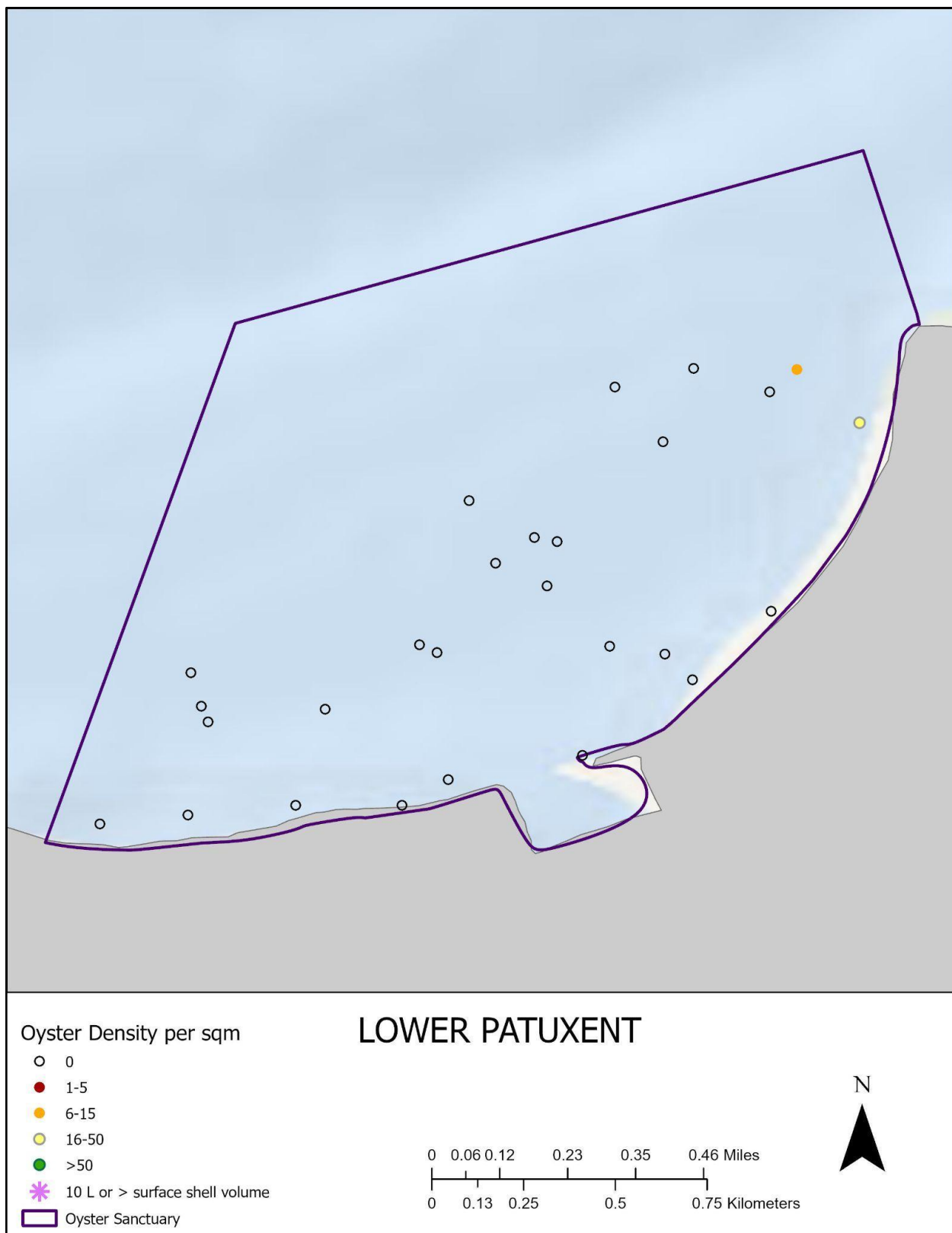


Figure A.21-2. Map of 2024 oyster density in the Lower Patuxent River Sanctuary. Data from Maryland Department of Natural Resources Patent Tong Population Survey.

Table A.21-1. Oyster population characteristics based on the Fall Oyster Survey in the Lower Patuxent River Sanctuary. ND=No Data. Values given are annual mean $\pm$ standard error.

Oyster Characteristic	2006-2010	2011-2015	2016-2020	2021-2025
Number of years sampled/number of samples	ND	ND	ND	4/4
Number of Live Spat Oysters per square meter	ND	ND	ND	10 $\pm$ 8.6
Number of Live Small Oysters per square meter	ND	ND	ND	8 $\pm$ 5
Number of Live Market Oysters per square meter	ND	ND	ND	4 $\pm$ 1.3
Number of Live Oysters per square meter	ND	ND	ND	22 $\pm$ 8.3
Live Biomass (g Dry Weight per Bushel)	ND	ND	ND	ND
Observed Mortality (%)	ND	ND	ND	8.6 $\pm$ 3.5
Cultch (Bushels per 100 feet towed)	ND	ND	ND	0.2 $\pm$ 0.03

Section A.22: Magothy River Sanctuary

The Magothy River Sanctuary is located in the Magothy River, a low salinity (Zone 1) region within NOAA Code 055. The sanctuary was created in 2010 and encompasses 5,607 acres of which 230 (4%) is historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments). There are 8 historic oyster bars within the sanctuary²⁷.

Information available for this sanctuary includes:

- Sanctuary map (Figure A.22-1)
- Density Survey (Figure A.22-2)
- Summary statistics (Table A.22-1)

Magothy River Sanctuary is located in the Upper Bay Region of Maryland's Chesapeake Bay. Oysters in the Upper Bay Region generally grow well and survive but can be impacted by freshet events. Low salinity levels contribute to a lower rate of natural recruitment.

In 2022 the Department added a standard Fall Oyster Survey site in the Magothy River Sanctuary. In 2024, the Department conducted a patent tong population survey in the sanctuary. It had an average density of 10.7 oysters per square meter and 1.8 liters of surface shell per square meter. Most of the oysters found in this survey were in areas that had received restoration. This is higher than the average of 2.9 oysters per square meter and 0.89 liters of surface shell per square meter found in 2018.

In 2023, the sanctuary received a spat-on-shell planting as part of the small-scale restoration effort. In the 2021-2025 sanctuary assessment, this sanctuary was classified as having received restoration.

²⁷ See chart 6 for bar names and locations in the State of Maryland Shellfish Closure Areas Book <http://dnr.maryland.gov/fisheries/Pages/oysters/index.aspx>

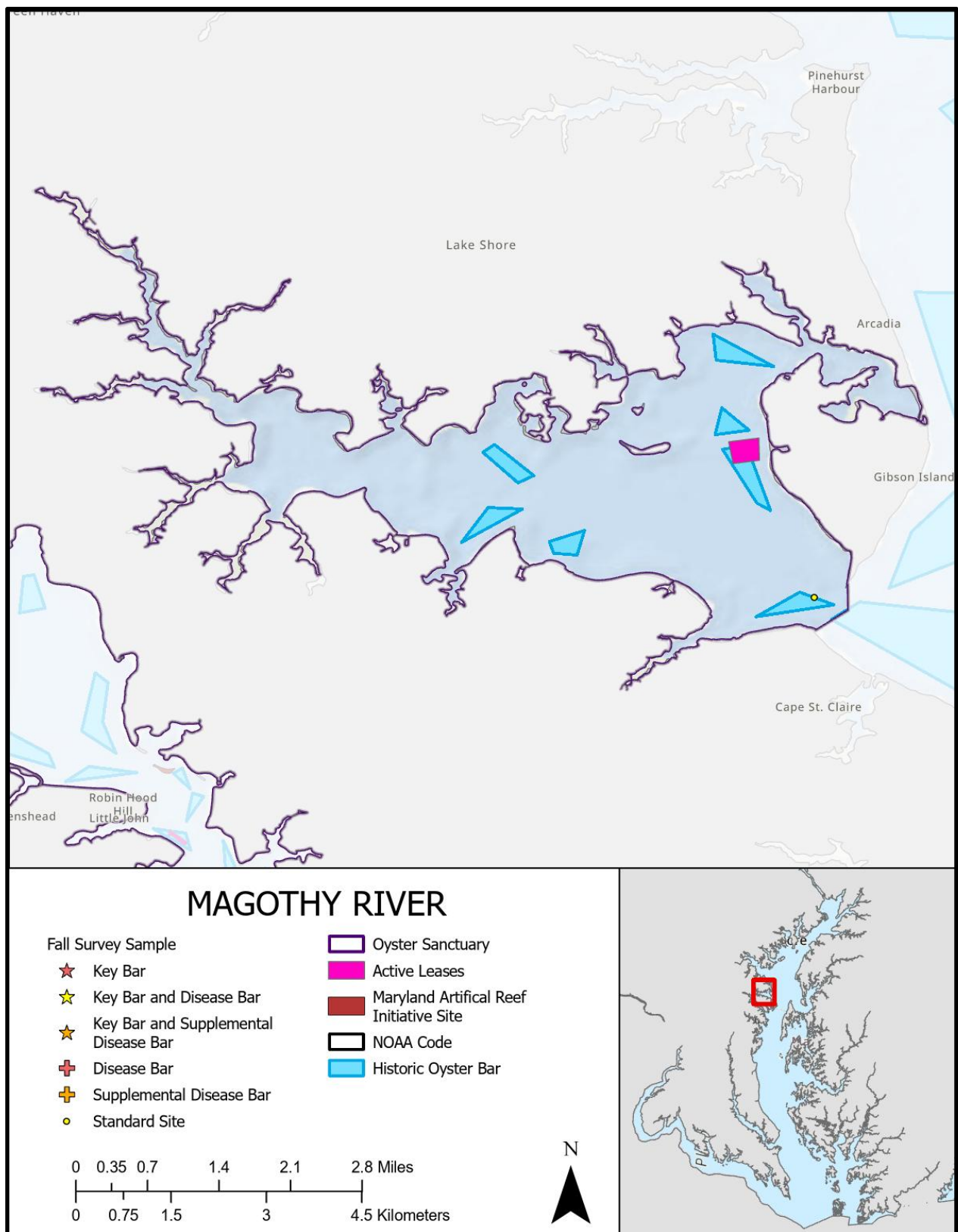


Figure A.22-1. Magothy River Sanctuary. Fall Oyster Survey sites may not be sampled every year.

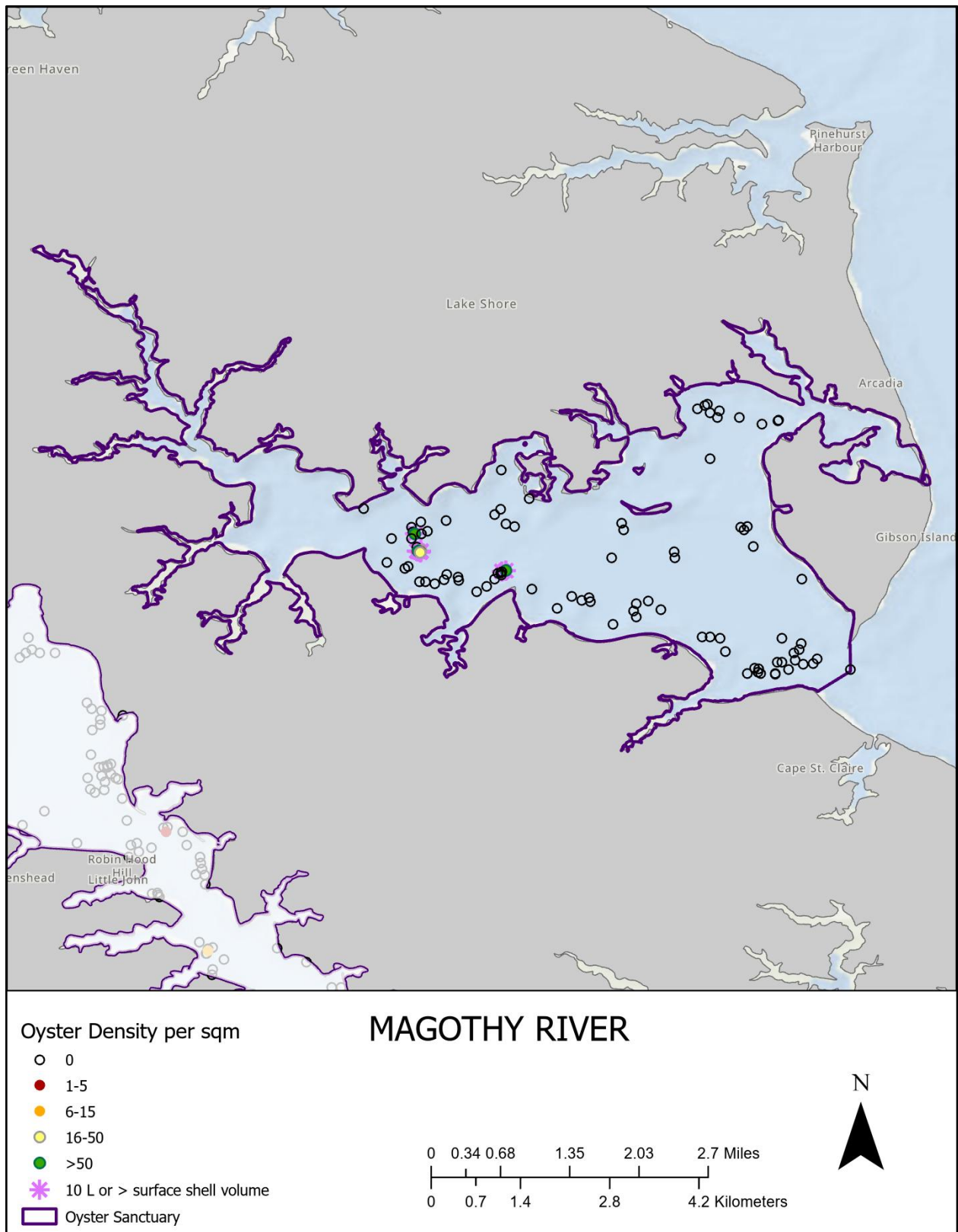


Figure A.22-2. Map of 2024 oyster density in the Magothy River Sanctuary. Data from Maryland Department of Natural Resources Patent Tong Population Survey.

Table A.22-1. Oyster population characteristics based on the Fall Oyster Survey in the Magothy River Sanctuary. ND=No Data. Values given are annual mean $\pm$ standard error.

Oyster Characteristic	2006-2010	2011-2015	2016-2020	2021-2025
Number of years sampled/number of samples	ND	ND	ND	4/4
Number of Live Spat Oysters per square meter	ND	ND	ND	0
Number of Live Small Oysters per square meter	ND	ND	ND	7.8 $\pm$ 7.8
Number of Live Market Oysters per square meter	ND	ND	ND	11.5 $\pm$ 10
Number of Live Oysters per square meter	ND	ND	ND	19.3 $\pm$ 18
Live Biomass (g Dry Weight per Bushel)	ND	ND	ND	ND
Observed Mortality (%)	ND	ND	ND	0
Cultch (Bushels per 100 feet towed)	ND	ND	ND	2.0 $\pm$ 0.8

Section A.23: Manokin River Sanctuary

The Manokin River Sanctuary is located in the lower eastern portion of Maryland's Chesapeake Bay, a high salinity (Zone 3) region within NOAA Code 057. The mouth of the river empties into the Tangier Sound. The sanctuary was created in 2010 and encompasses 16,320 acres of which 11,040 (68%) is historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments). There are 19 historic oyster bars within the sanctuary²⁸. In 2018, this sanctuary was selected to receive large-scale restoration to meet the 2014 Chesapeake Bay Watershed Agreement. Initial restoration of the sanctuary was completed in 2025. Planned second hatchery spat-on-shell seedings and monitoring are ongoing.

Information available for this sanctuary includes:

- Sanctuary map (Figure A.23-1)
- Summary statistics (Table A.23-1)
- Density per year (Figure A.23-2)
- Shell height frequencies (Figure A.23-3)
- Biomass per year (Figure A.23-4)
- Observed mortality (Figure A.23-5)
- Dermo and MSX per year (Figure A.23-6)
- Cultch per year (Figure A.23-7)

Manokin River Sanctuary is located in the Lower Eastern Shore Region of Maryland's Chesapeake Bay. Oysters in the Lower Eastern Shore Region generally grow well but can be impacted by disease. Elevated salinity levels promote a higher rate of natural recruitment.

The Fall Oyster Survey has six standard sites and two sentinel sites, one a key bar and the other a key and disease bar within the Manokin River Sanctuary. Table A.23-1 shows an elevated average observed mortality for the 2021 to 2025 timeframe. This elevated observed mortality coincides with an increase in lethal dermo disease prevalence as well as MSX prevalence in 2023 (Figures A.23-5, A.23-6). The average density from 2021-2025 is above the long-term abundance target of 94 oysters per square meter. It should be noted that given limitations of traditional gear types, not all restored areas are surveyed by the Department.

The last patent tong survey by the Department was in 2018.

In the 2021-2025 sanctuary assessment, this sanctuary was classified as restored.

²⁸ See chart 44 for bar names and locations in the State of Maryland Shellfish Closure Areas Book <http://dnr.maryland.gov/fisheries/Pages/oysters/index.aspx>

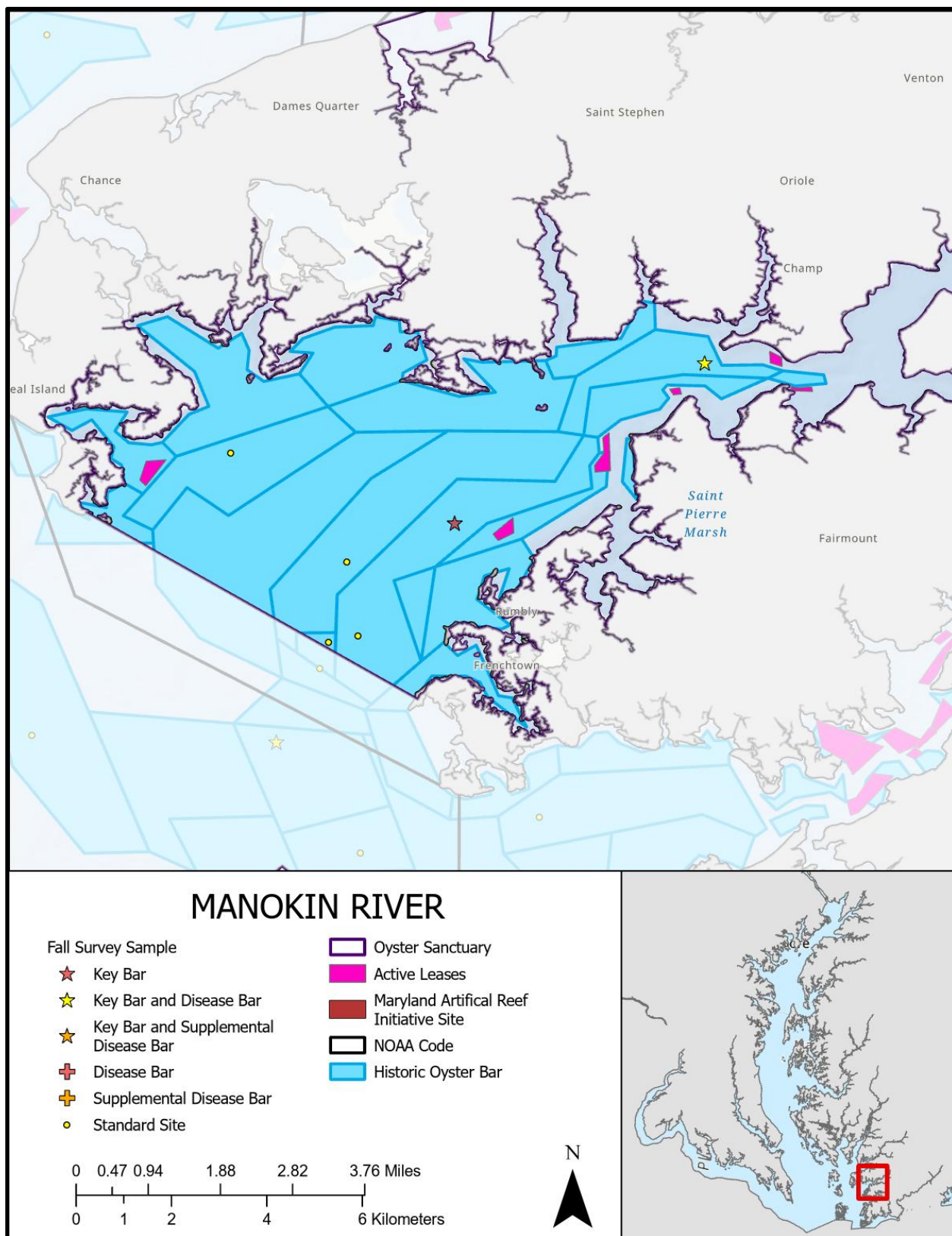


Figure A.23-1. Manokin River Sanctuary. Fall Oyster Survey sites may not be sampled every year.

Table A.23-1. Oyster population characteristics based on the Fall Oyster Survey in the Manokin River Sanctuary. ND=No Data. Values given are annual mean $\pm$ standard error.

Oyster Characteristic	2006-2010	2011-2015	2016-2020	2021-2025
Number of years sampled/number of samples	5/30	5/37	5/30	5/30
Number of Live Spat Oysters per square meter	95 $\pm$ 19	136.7 $\pm$ 34.7	161.6 $\pm$ 30.7	61.9 $\pm$ 10.8
Number of Live Small Oysters per square meter	46.5 $\pm$ 10.6	141.2 $\pm$ 18	165.7 $\pm$ 20	79.6 $\pm$ 8
Number of Live Market Oysters per square meter	12 $\pm$ 42	74 $\pm$ 8.5	87 $\pm$ 10.9	70.5 $\pm$ 6.3
Number of Live Oysters per square meter	153.3 $\pm$ 22	352 $\pm$ 46	414 $\pm$ 43	212 $\pm$ 19
Live Biomass (g Dry Weight per Bushel)	35 $\pm$ 7.4	344 $\pm$ 15	304 $\pm$ 28	264 $\pm$ 20
Observed Mortality (%)	20.3 $\pm$ 3	12 $\pm$ 0.8	10.9 $\pm$ 1.1	17.8 $\pm$ 1.5
Cultch (Bushels per 100 feet towed)	0.9 $\pm$ 0.1	1.6 $\pm$ 0.1	1.7 $\pm$ 0.1	1.3 $\pm$ 0.1

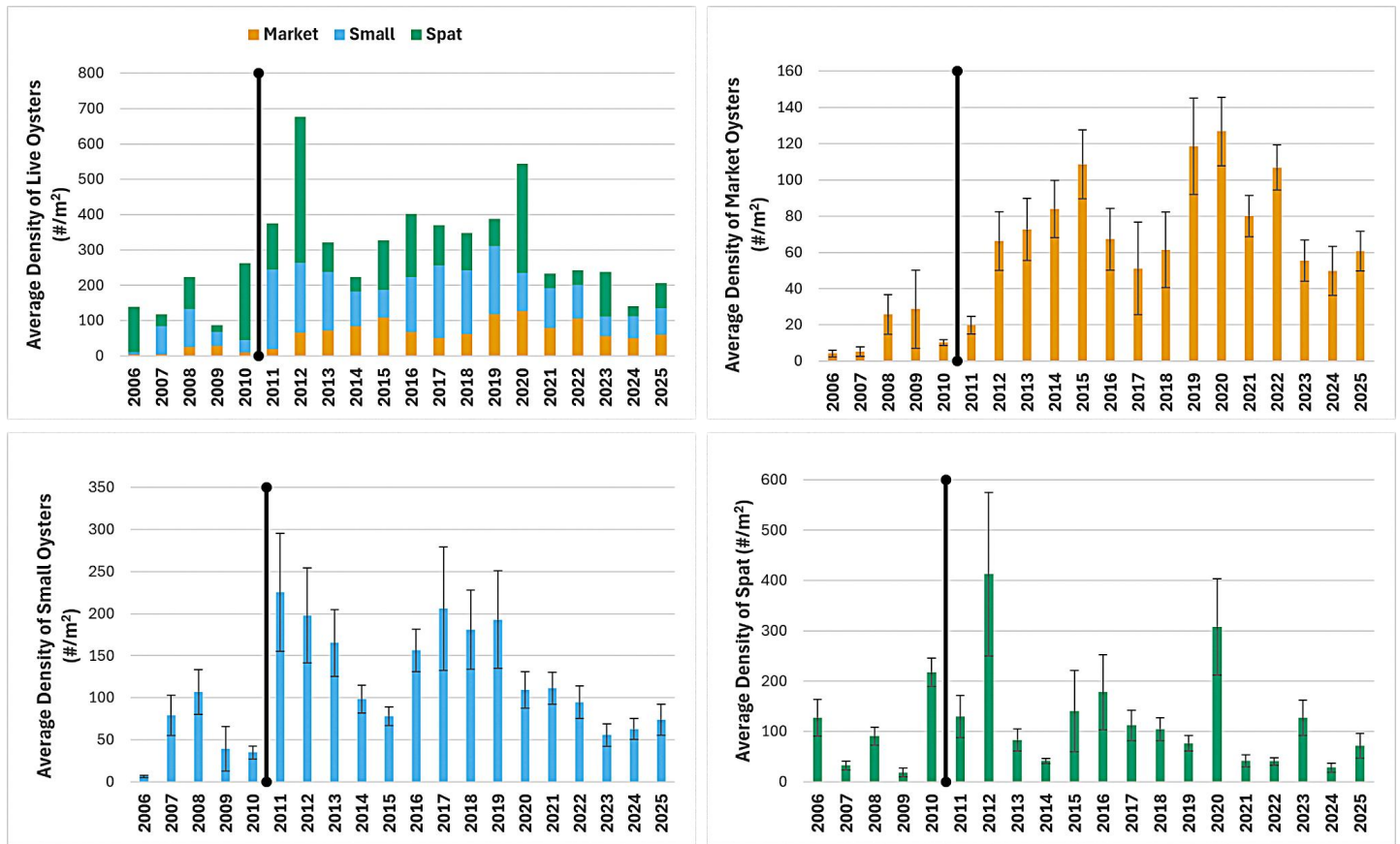


Figure A.23-2. Average number of live oysters per square meter by size class in the Manokin River Sanctuary. Black line indicates the date the sanctuary was established. Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales.

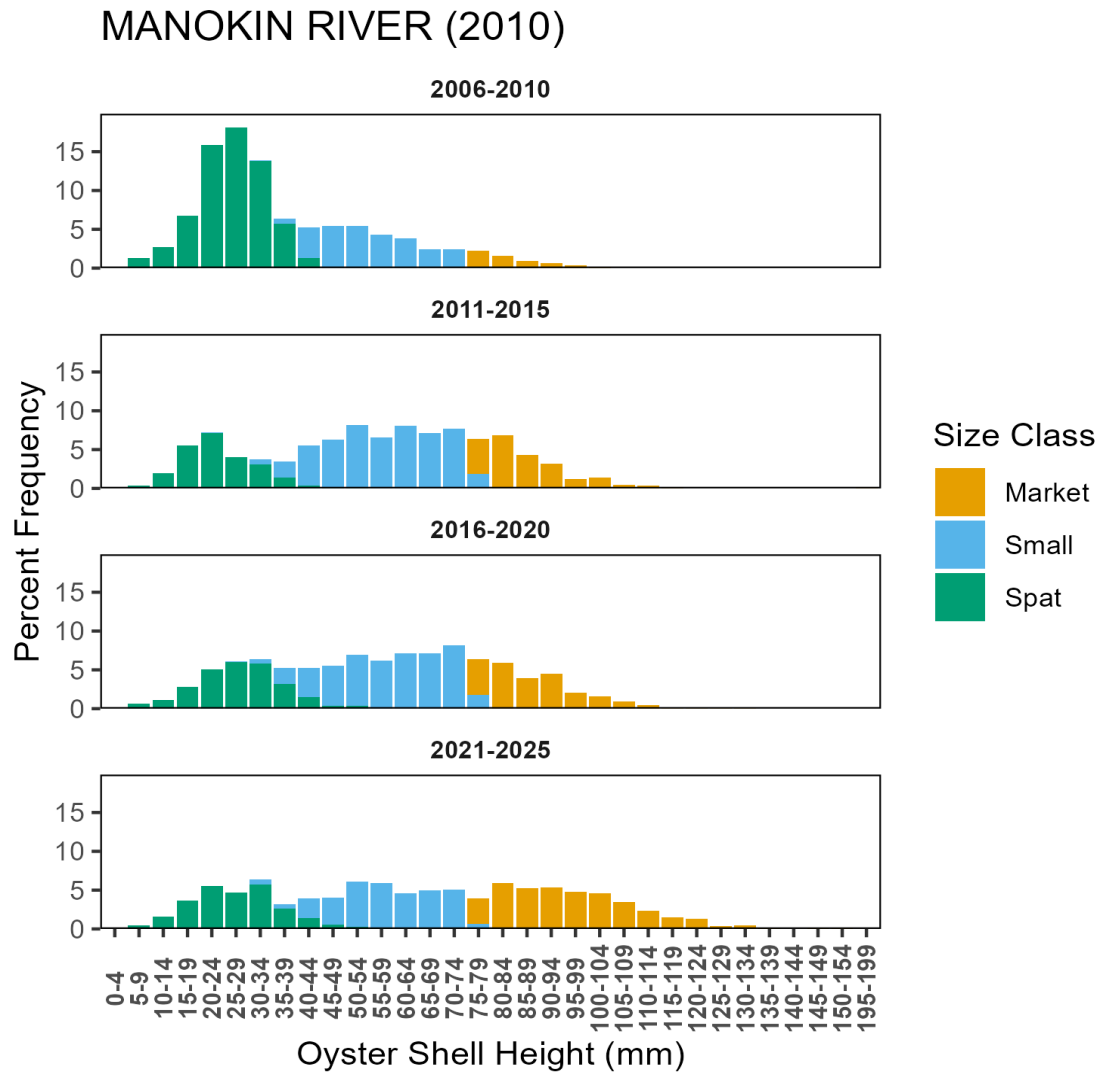


Figure A.23-3. Shell height frequencies of live oysters in the Manokin River Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey.

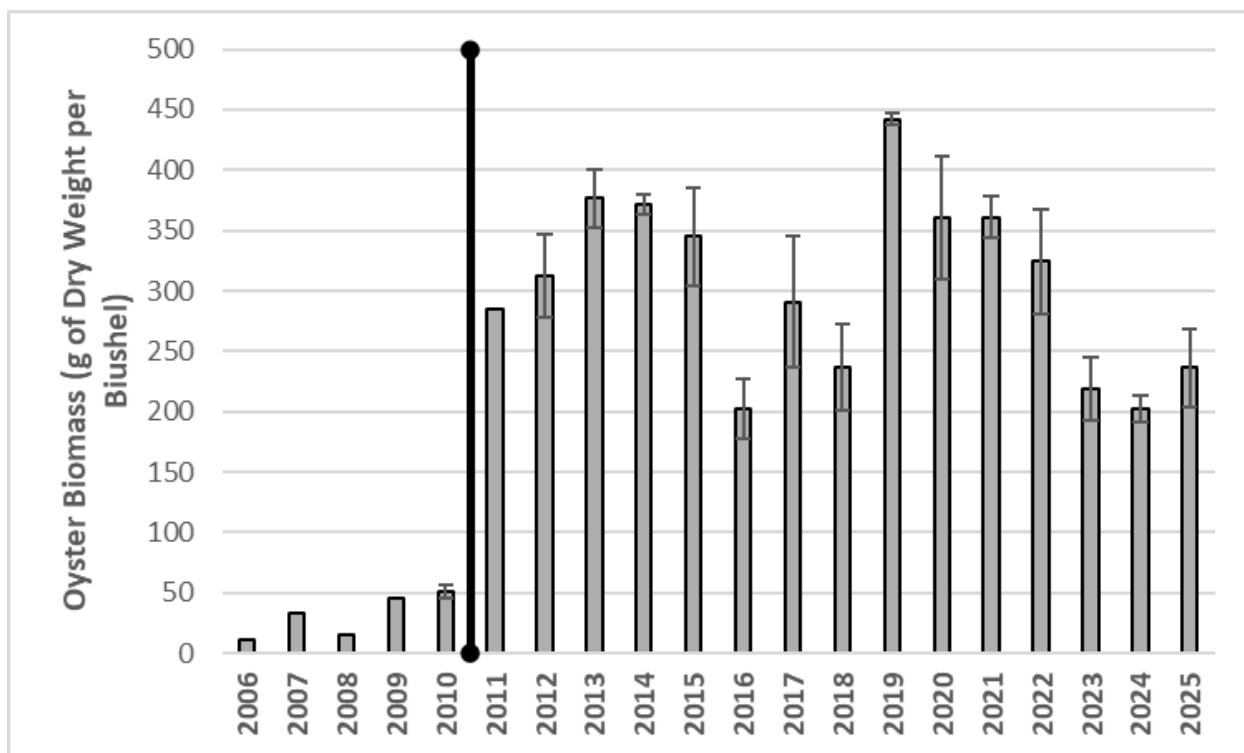


Figure A.23-4. Oyster biomass (grams of dry weight per bushel of material) in the Manokin River Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Black line indicates the date the sanctuary was established. Error bars represent ± 1 standard error.

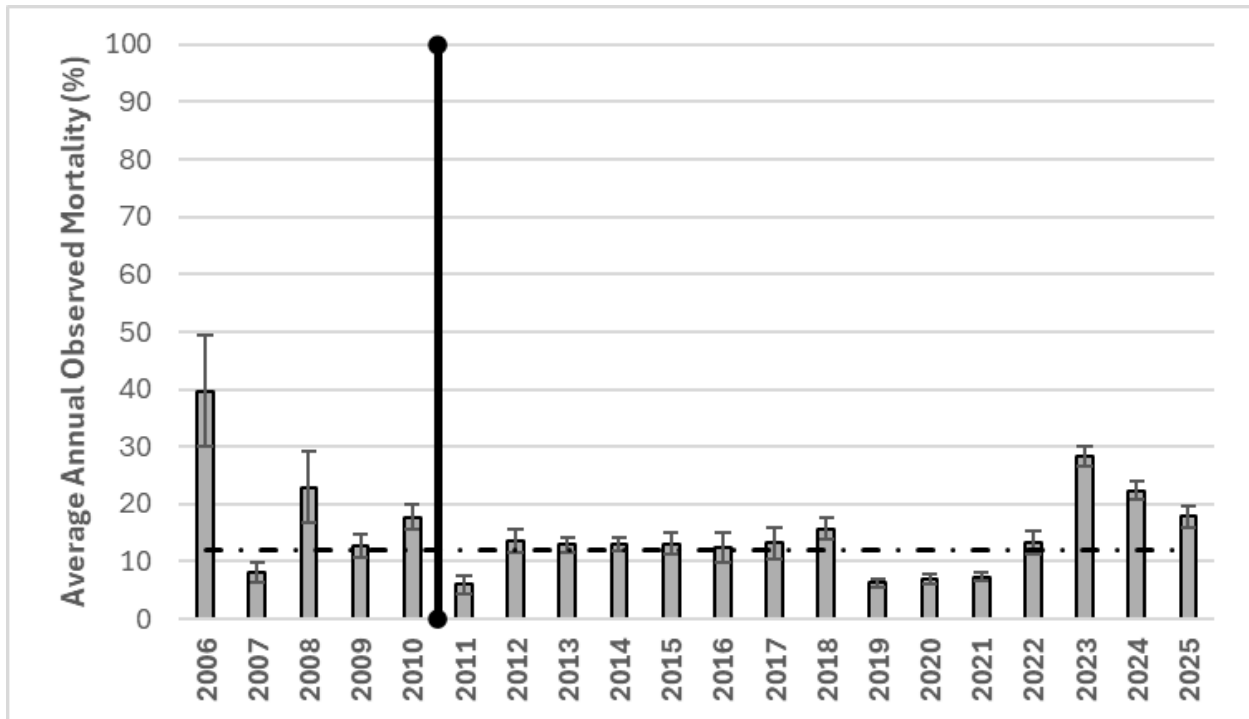


Figure A.23-5. Average annual observed mortality of market-sized and small-sized oysters in Manokin River Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Black line denotes the date the sanctuary was established, and the dashed line represents the 2006-2020 baywide average observed mortality. Error bars represent ± 1 standard error.

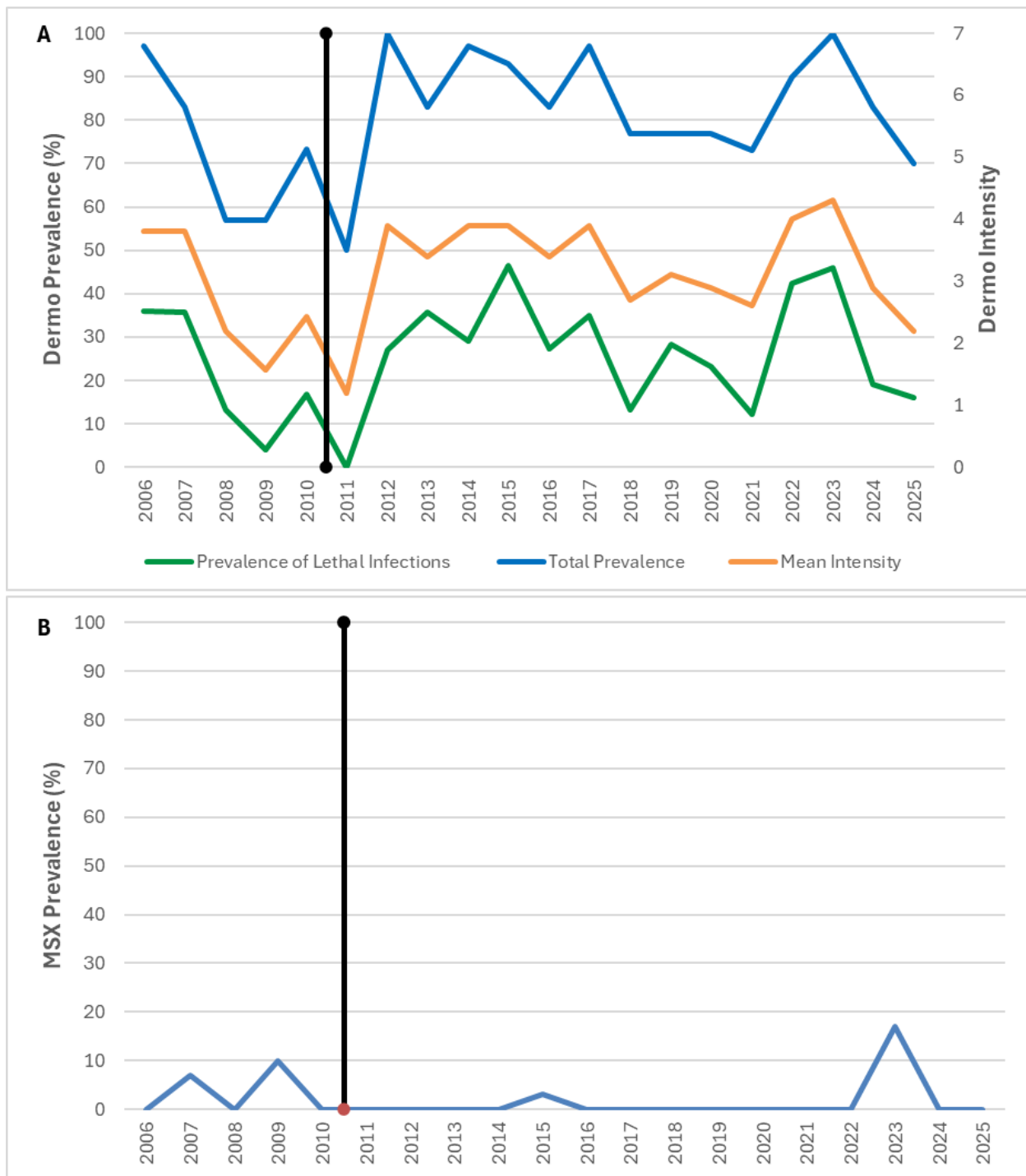


Figure A.23-6. Oyster disease prevalence and intensity in the Manokin River Sanctuary. (A) Dermo prevalence and mean intensity (B) MSX prevalence (intensity is not examined). Data from Maryland's Annual Fall Oyster Dredge Survey on Georges bar. Black line denotes the date the sanctuary was established.

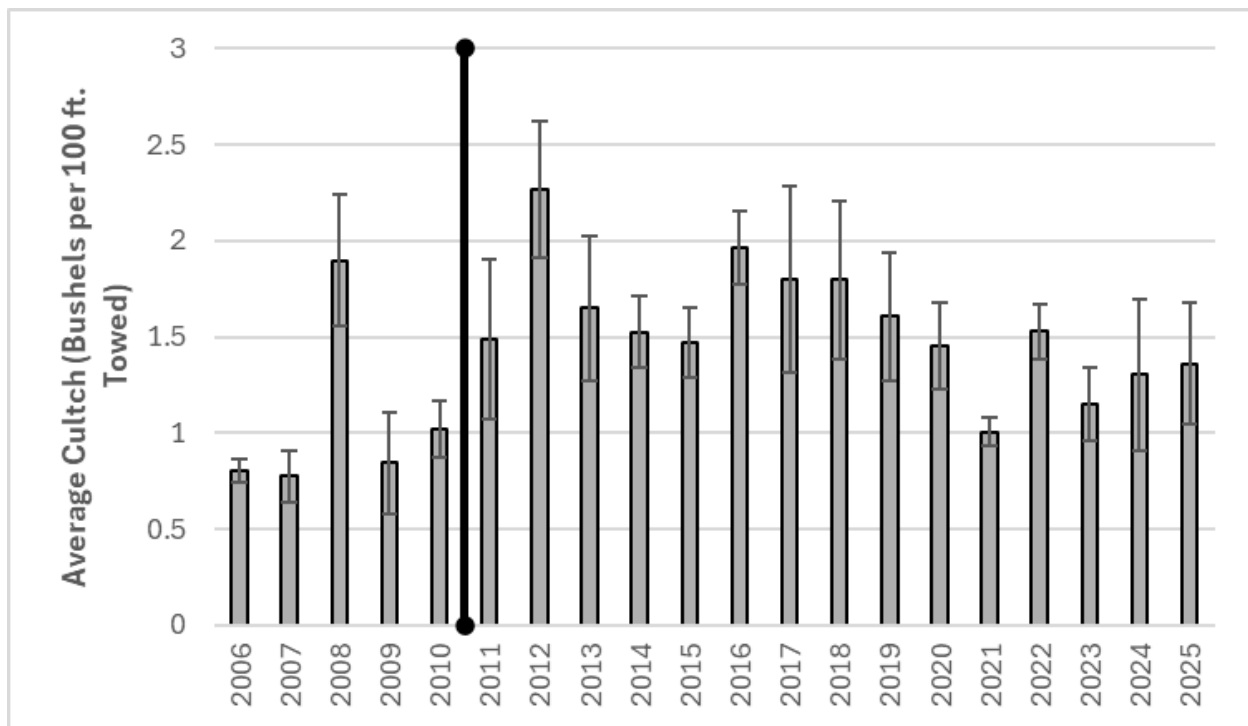


Figure A.23-7. Average cultch (live and dead oysters and loose shell) in the Manokin River Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Black line denotes the date the sanctuary was established. Error bars represent ± 1 standard error.

Section A.24: Man O War Sanctuary

The Man O War Sanctuary is located in upper Chesapeake Bay, a low salinity (Zone 1) region within NOAA Code 025. Gales Lump (43 acres) constituted the original sanctuary area. In 2010, the sanctuary was expanded to 4,704 acres, of which 2,310 (49%) is historic oyster bottom as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments. Thus, the total surface area is 4,747 acres and the total historic oyster bottom is 2,353 acres (49%). There are four historic oyster bars within the sanctuary²⁹.

Information available for this sanctuary includes:

- Sanctuary map (Figure A.24-1)
- Density Survey (Figure A.24-2)
- Summary statistics (Table A.24-1)

Man O War Sanctuary is located in the Upper Bay Region of Maryland's Chesapeake Bay. Oysters in the Upper Bay Region generally grow well and survive but can be impacted by freshet events. Low salinity levels contribute to a lower rate of natural recruitment.

In 2024 the Department conducted a patent tong population survey in the sanctuary. It found no live oysters and an average of 0.28 liters per square meter of surface shell. This is less than the 2 oysters per square meter and average surface shell volume of 2.5 liters per square meter found in 2015.

In 2022 the Department added a standard Fall Oyster Survey site to the Man O War Sanctuary. This sanctuary is in an area that is subject to low salinity and recruitment. It was identified by the Department as an underperforming sanctuary and is under evaluation by the Oyster Advisory Commission for potential efforts to improve its performance.

In the 2021-2025 sanctuary assessment, this sanctuary was classified as trending negatively.

²⁹ See chart 4 for bar names and locations in the State of Maryland Shellfish Closure Areas Book <http://dnr.maryland.gov/fisheries/Pages/oysters/index.aspx>

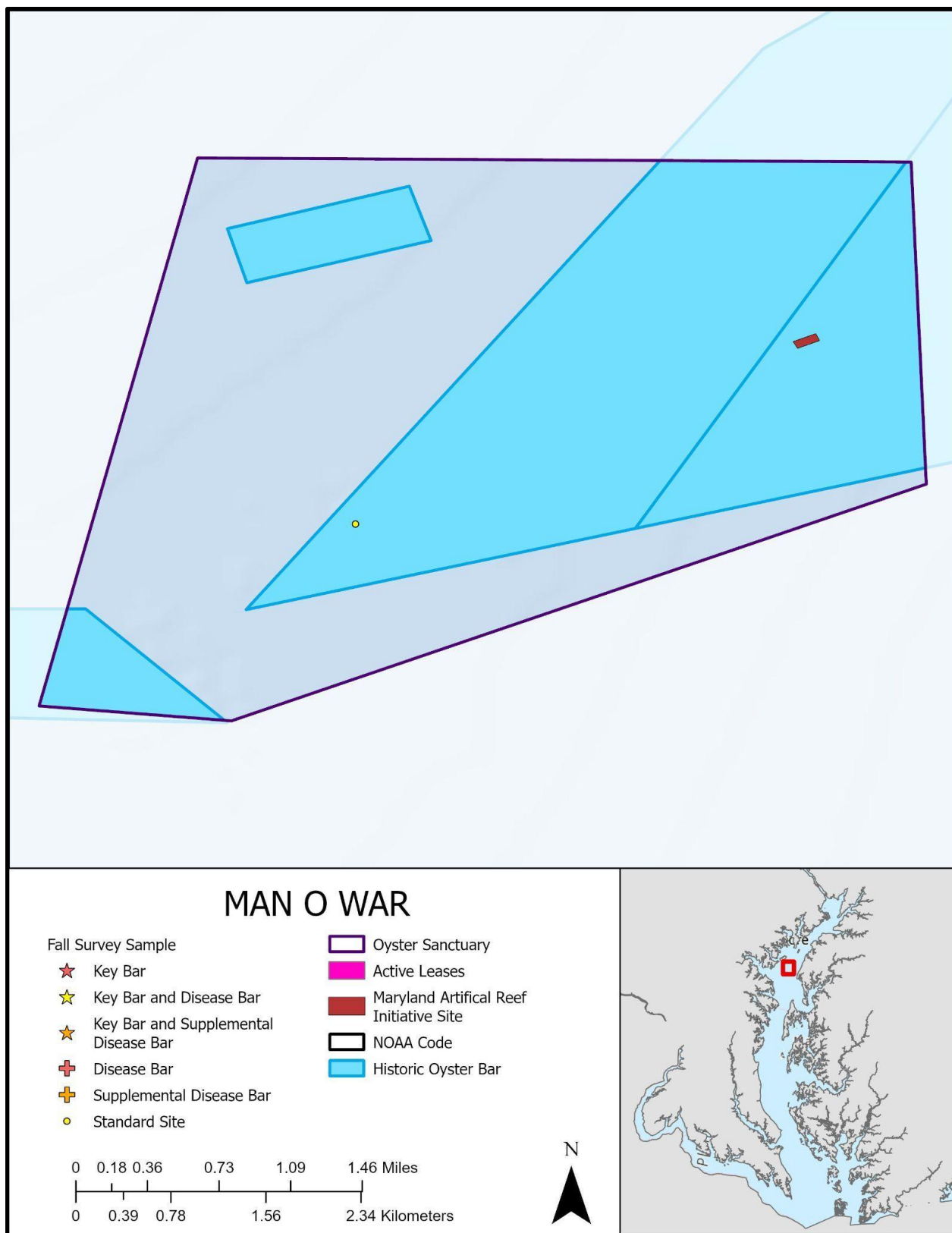


Figure A.24-1. Man O War Sanctuary. Fall Oyster Survey sites may not be sampled every year.

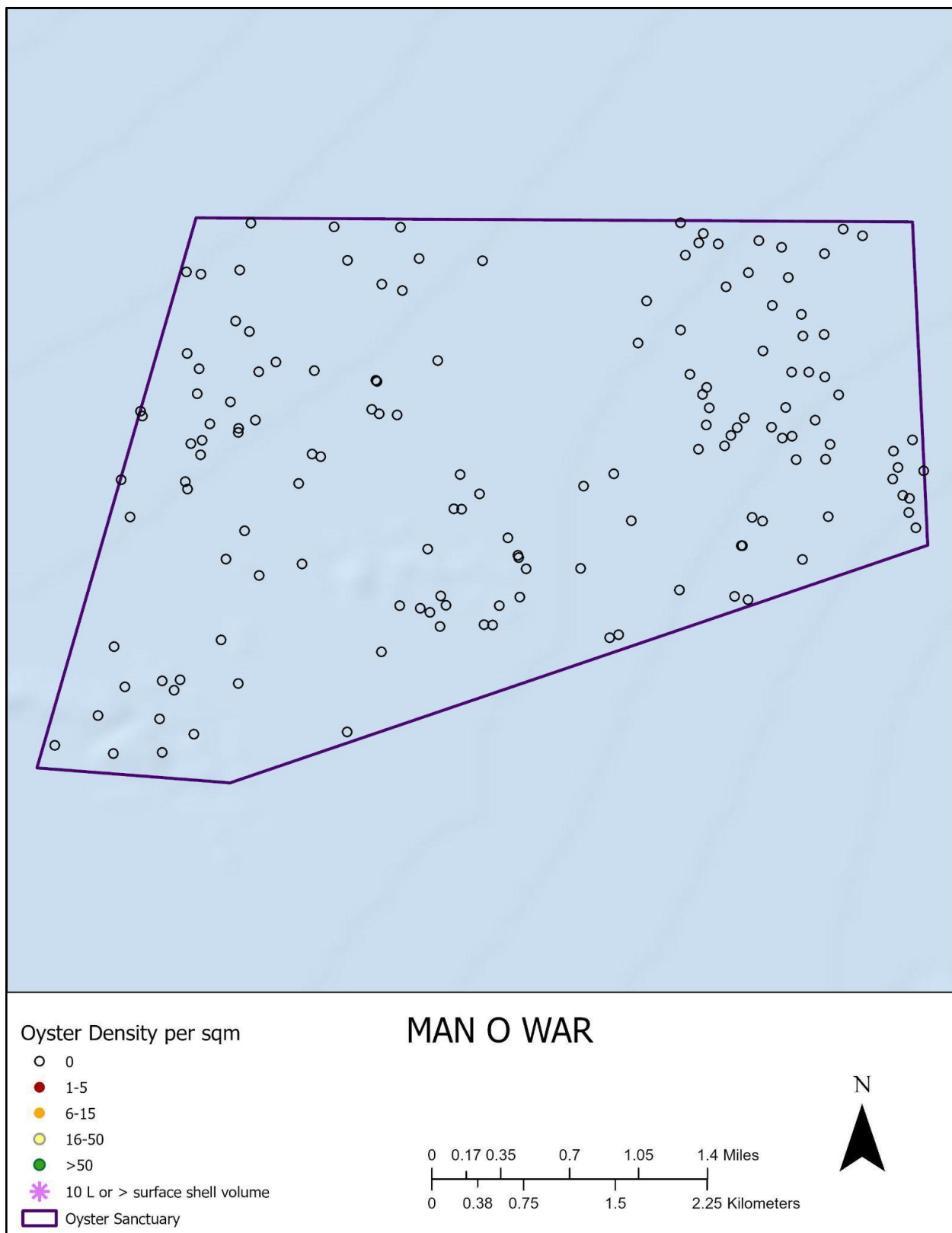


Figure A.24 -2. Map of 2024 oyster density in the Man O War Sanctuary. Data from Maryland Department of Natural Resources Patent Tong Population Survey.

Table A.24-1. Oyster population characteristics based on the Fall Oyster Survey in the Man O War Sanctuary. ND=No Data. Values given are annual mean $\pm$ standard error.

Oyster Characteristic	2006-2010	2011-2015	2016-2020	2021-2025
Number of years sampled/number of samples	ND	ND	ND	4/4
Number of Live Spat Oysters per square meter	ND	ND	ND	0
Number of Live Small Oysters per square meter	ND	ND	ND	0.2 $\pm$ 0.2
Number of Live Market Oysters per square meter	ND	ND	ND	0.2 $\pm$ 0.2
Number of Live Oysters per square meter	ND	ND	ND	0.4 $\pm$ 0.2
Live Biomass (g Dry Weight per Bushel)	ND	ND	ND	ND
Observed Mortality (%)	ND	ND	ND	0
Cultch (Bushels per 100 feet towed)	ND	ND	ND	0.5 $\pm$ 0.13

Section A.25: Miles River Sanctuary

The Miles River Sanctuary is located in the upstream section of the Miles River, a tributary of Eastern Bay within NOAA Code 060. The sanctuary is in a medium salinity (Zone 2) region. The sanctuary was created in 2010 and encompasses 3,449 acres of which 373 (11%) is historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments). There are 5 historic oyster bars within the sanctuary³⁰.

Information available for this sanctuary includes:

- Sanctuary map (Figure A.25-1)
- Summary statistics (Table A.25-1)
- Density per year (Figure A.25-2)
- Shell height frequencies (Figure A.25-3)
- Biomass per year (Figure A.25-4)
- Observed mortality (Figure A.25-5)
- Dermo and MSX per year (Figure A.25-6)
- Cultch per year (Figure A.25-7)

Miles River Sanctuary is located in the Eastern Bay Region of Maryland's Chesapeake Bay. Oysters within the Eastern Bay Region typically grow and survive well, generally remaining unaffected by disease or freshets except in cases of multi-year droughts or major freshet events. Natural recruitment occurs regularly in this region.

The Fall Oyster Survey has one standard site and one sentinel disease bar site within the Miles River Sanctuary. Table A.25-1 shows an increase in the average number of oysters from 2021-2025 compared to the previous 5-year increments, while exhibiting low observed mortality. Lethal dermo disease prevalence remained low during this timeframe and MSX was not detected (Figure A.25-6). The average cultch per 100 ft tow indicates insufficient cultch availability.

The last patent tong population survey occurred in 2020. This sanctuary is a site for MGO plantings. In 2023, a NOAA diver surveyed the MGO site and found no live oysters. The site showed anoxic shells that appeared to be silted over.

In the 2021-2025 sanctuary assessment, this sanctuary was classified as trending positively and receiving restoration. This sanctuary has received spat-on-shell plantings since 2023 as part of the Eastern Bay Regional Project.

³⁰ See chart 12 for bar names and locations in the State of Maryland Shellfish Closure Areas Book <http://dnr.maryland.gov/fisheries/Pages/oysters/index.aspx>

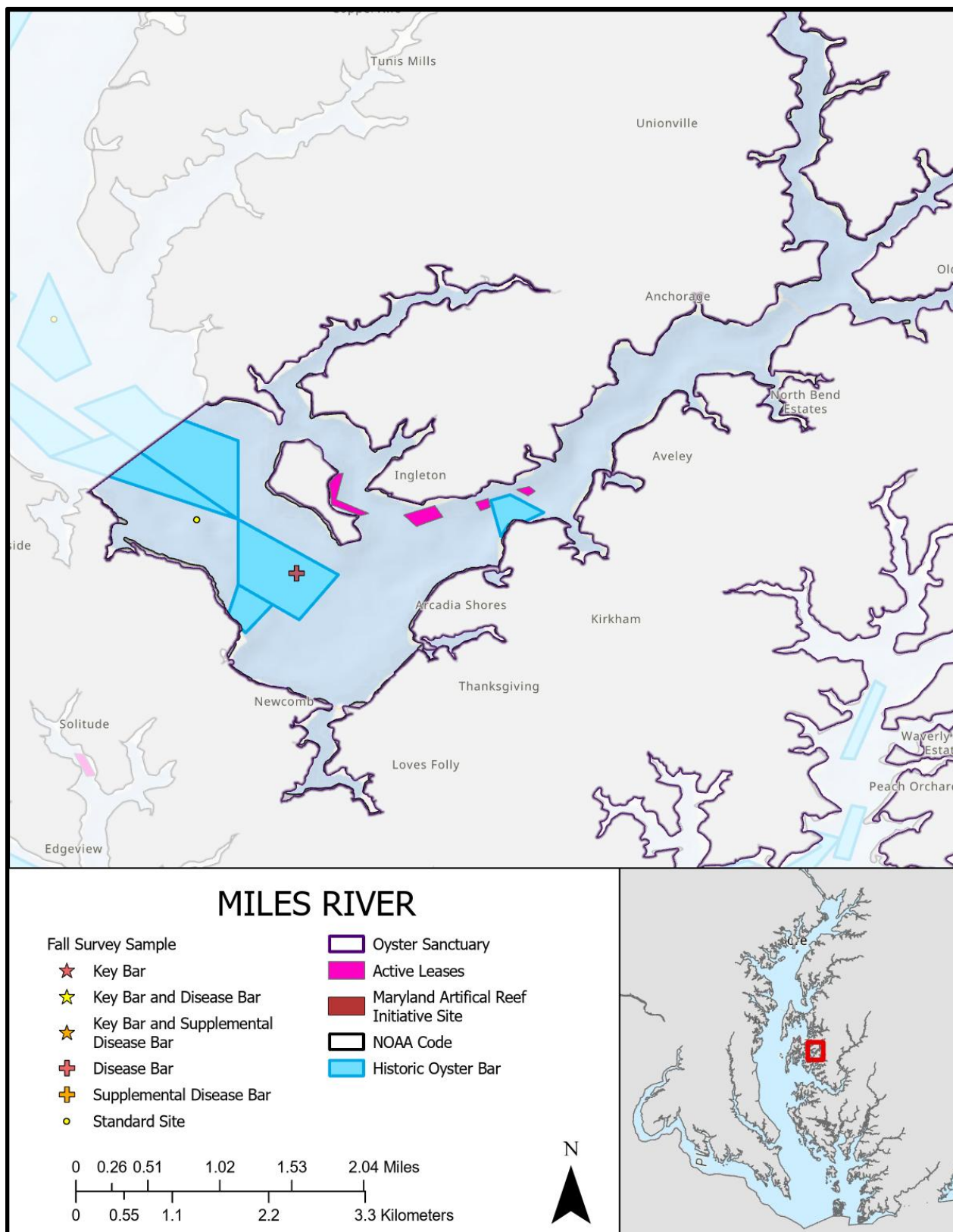


Figure A.25-1. Miles River Sanctuary. Fall Oyster Survey sites may not be sampled every year.

Table A.25-1. Oyster population characteristics based on the Fall Oyster Survey in the Miles River Sanctuary. ND=No Data. Values given are annual mean $\pm$ standard error.

Oyster Characteristic	2006-2010	2011-2015	2016-2020	2021-2025
Number of years sampled/number of samples	5/5	5/5	5/5	5/12
Number of Live Spat Oysters per square meter	0.07 $\pm$ 19	0.20 $\pm$ 34.7	0	5 $\pm$ 3.4
Number of Live Small Oysters per square meter	0	0.42 $\pm$ 0.18	1.2 $\pm$ 1.2	7 $\pm$ 8
Number of Live Market Oysters per square meter	3.5 $\pm$ 2.2	1.5 $\pm$ 0.5	5.8 $\pm$ 6	18.8 $\pm$ 5.8
Number of Live Oysters per square meter	3.6 $\pm$ 2.3	2.2 $\pm$ 0.6	7 $\pm$ 6.8	30.8 $\pm$ 9.1
Live Biomass (g Dry Weight per Bushel)	48 $\pm$ 19	23 $\pm$ 12	13 $\pm$ 3	19 $\pm$ 9
Observed Mortality (%)	30 $\pm$ 6.3	11 $\pm$ 7	19 $\pm$ 10	9.3 $\pm$ 5
Cultch (Bushels per 100 feet towed)	0.4 $\pm$ 0.1	0.8 $\pm$ 0.3	0.4 $\pm$ 0.1	1 $\pm$ 0.1

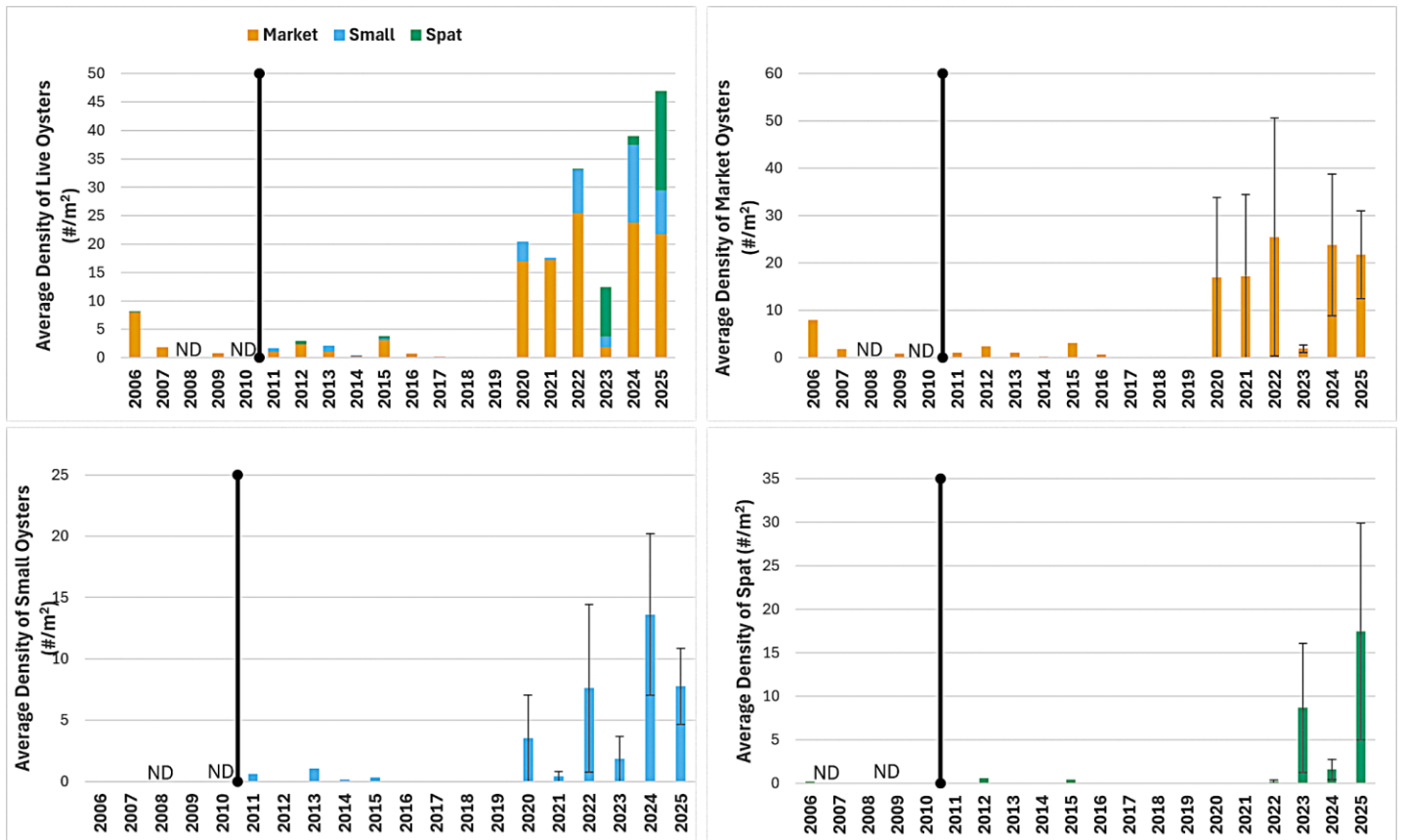


Figure A.25-2. Average number of live oysters per square meter by size class in the Miles River Sanctuary. Black line indicates the date the sanctuary was established. Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales. ND = No Data.

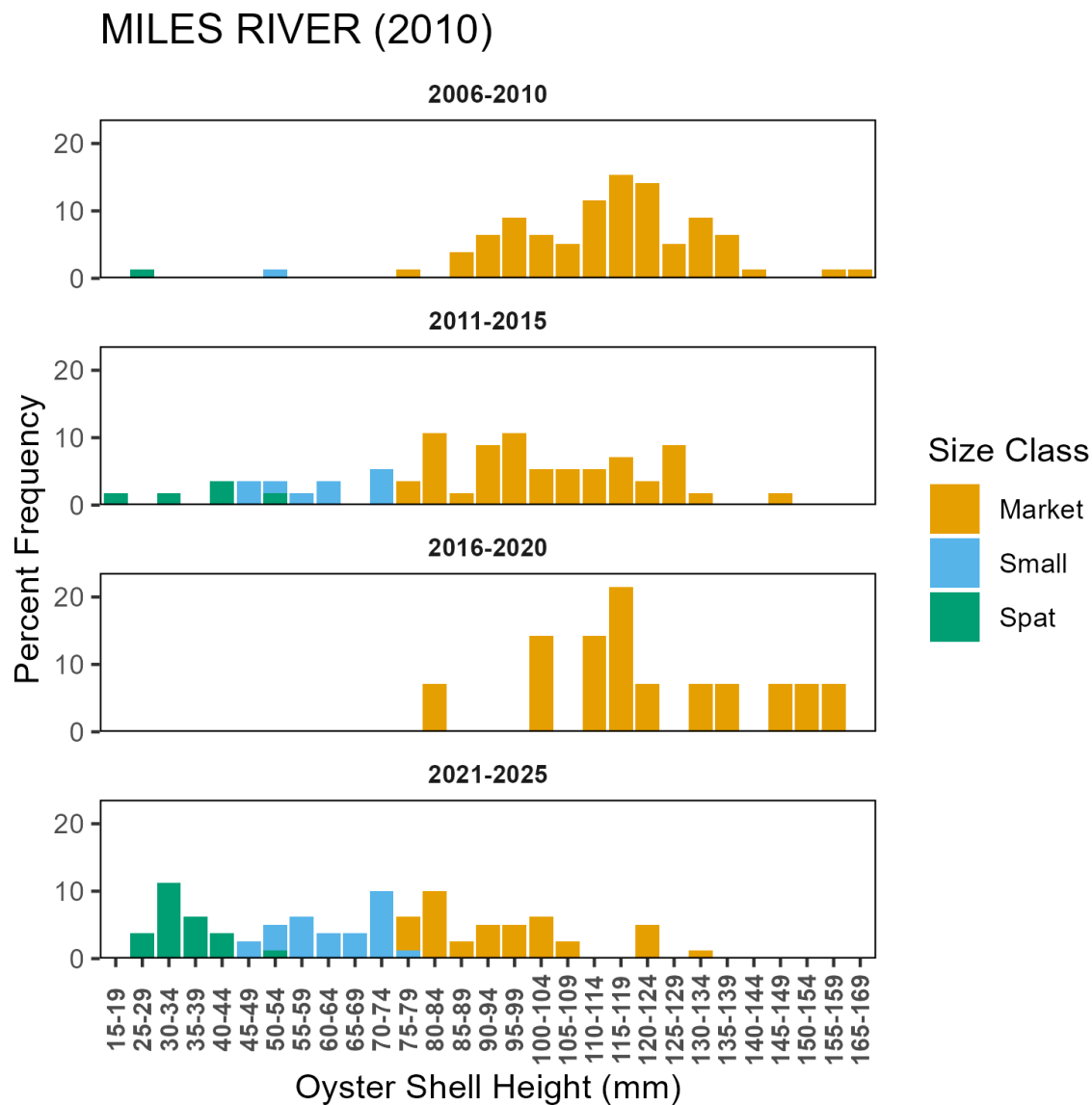


Figure A.25-3. Shell height frequencies of live oysters per bushel of material in the Miles River Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey on Long Point bar.

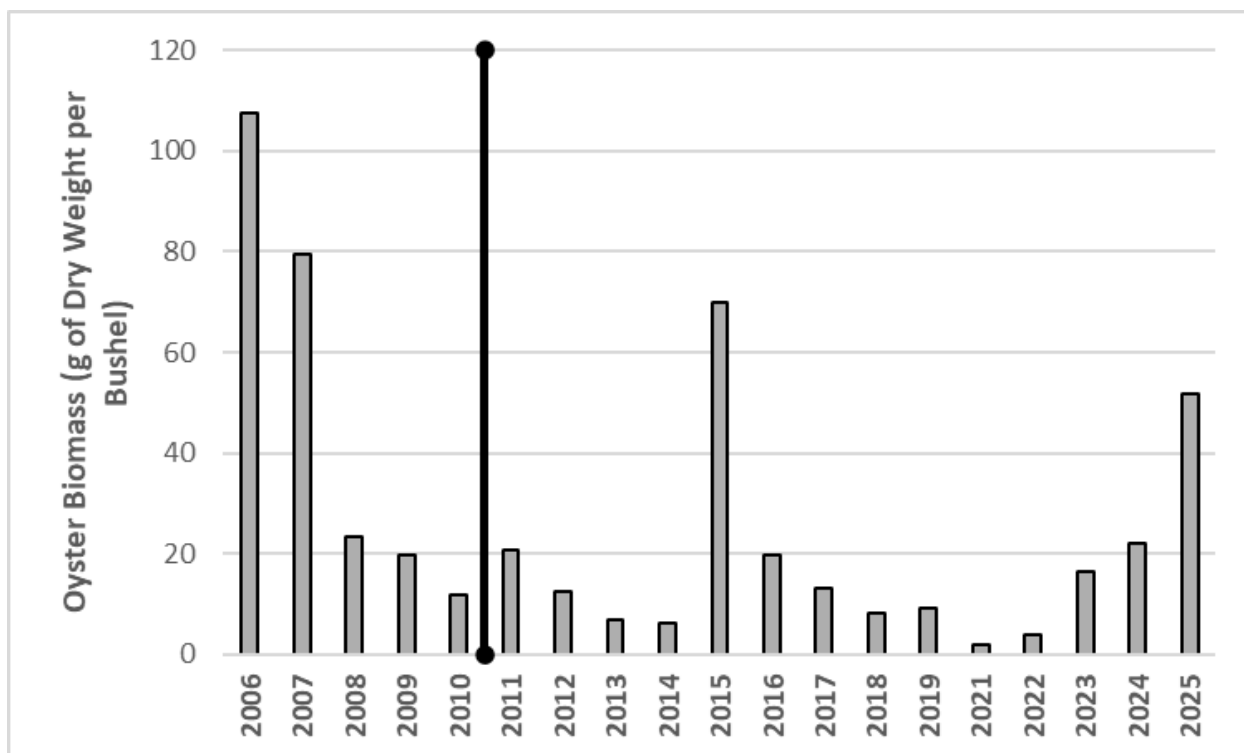


Figure A.25-4. Oyster biomass (grams of dry weight per bushel of material) in the Miles River Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey on Long Point bar. Black line indicates the date the sanctuary was established.

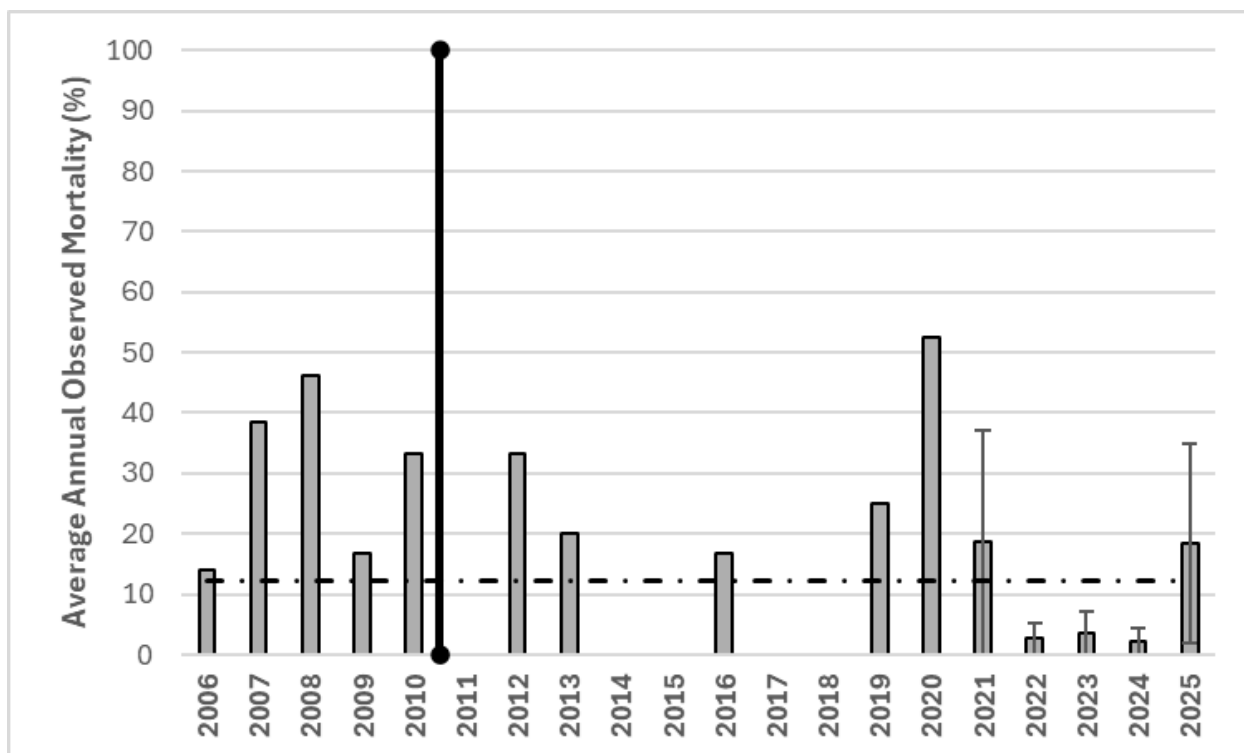


Figure A.25-5. Average annual observed mortality of market-sized and small-sized oysters in Miles River Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Black line denotes the date the sanctuary was established, and the dashed line represents the 2006-2025 baywide average observed mortality. Error bars represent ± 1 standard error.

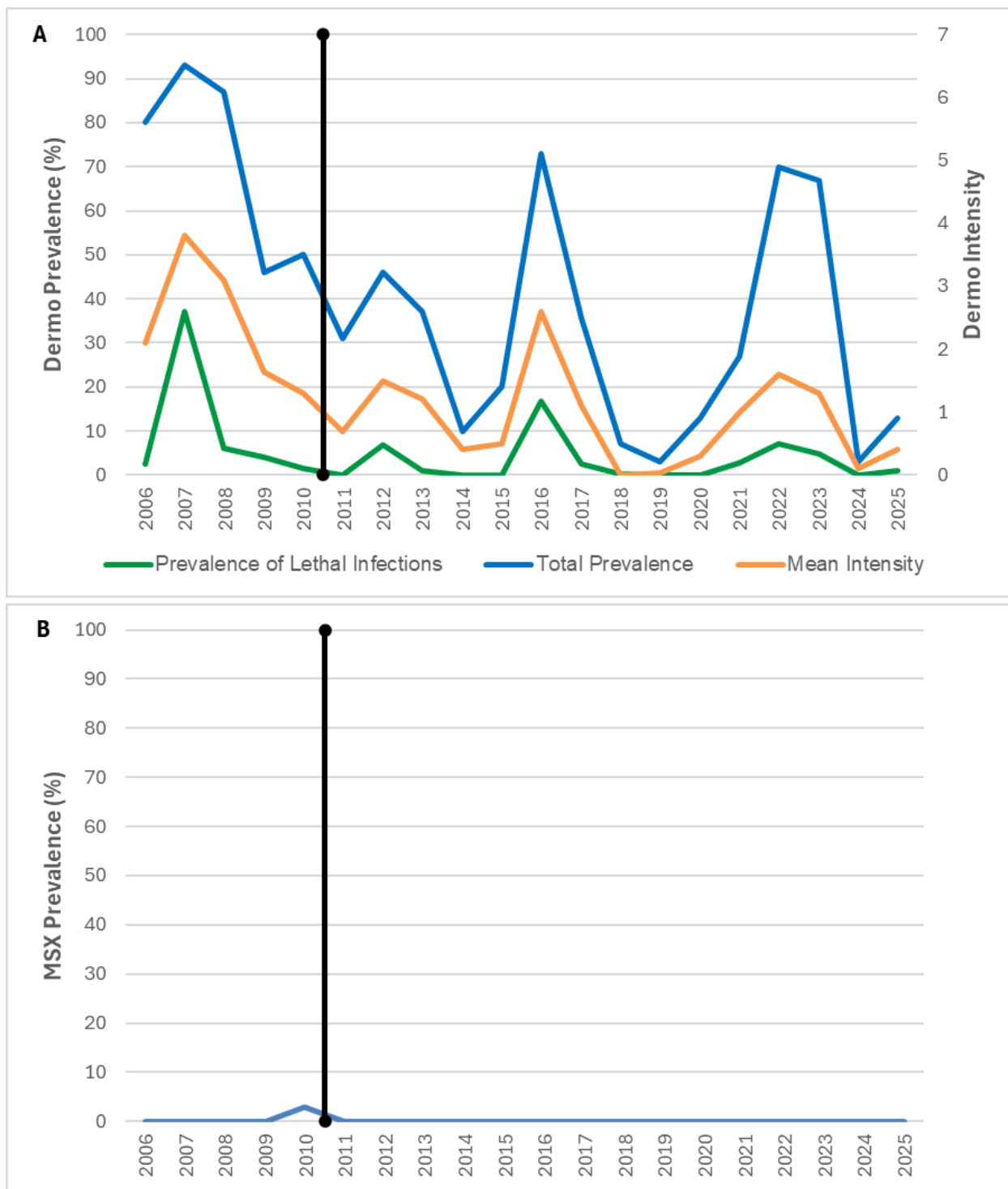


Figure A.25-6. Oyster disease prevalence and intensity in the Miles River Sanctuary. (A) Dermo prevalence and mean intensity (B) MSX prevalence (intensity is not examined). Data from Maryland's Annual Fall Oyster Dredge Survey on Long Point bar. Black line denotes the date the sanctuary was established.

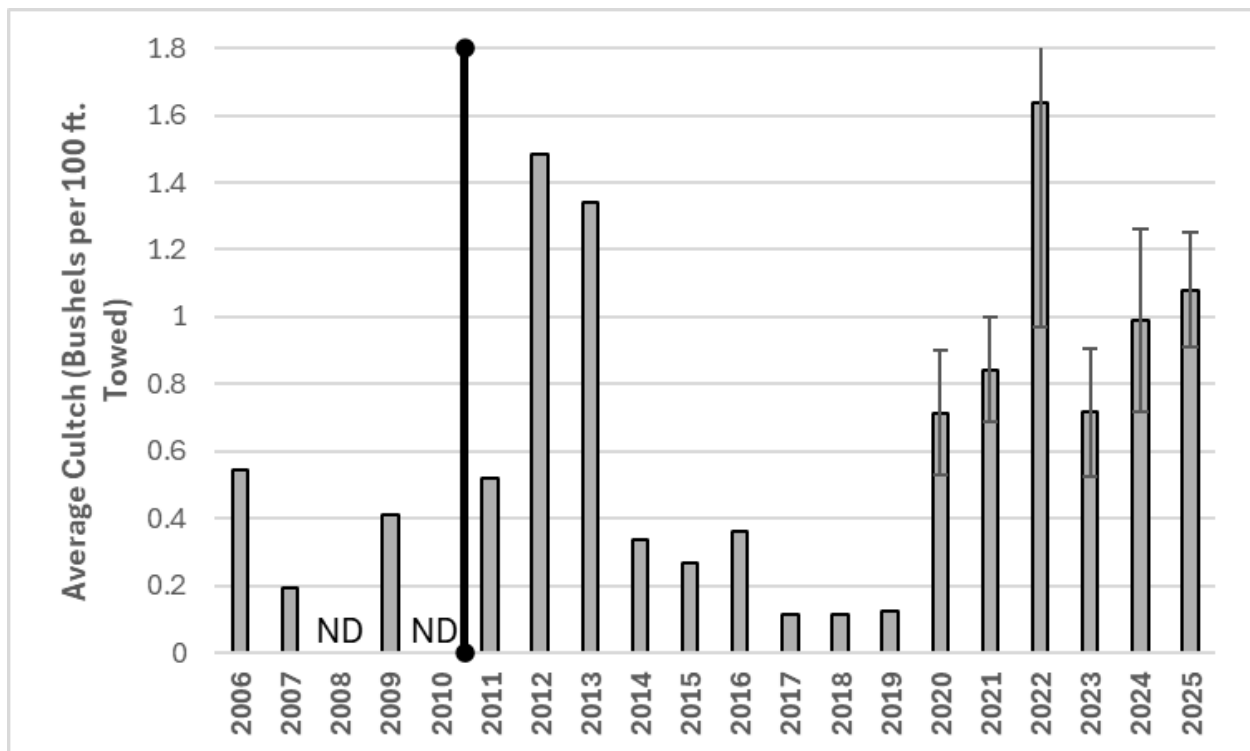


Figure A.25-7. Average cultch (live and dead oysters and loose shell) in the Miles River Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Black line denotes the date the sanctuary was established. Error bars represent ± 1 standard error. ND = No Data.

Section A.26: Mill Hill Sanctuary

The Mill Hill Sanctuary is located in Eastern Bay, a medium salinity (Zone 2) region within NOAA Code 039. The sanctuary was created in 2000 for a U.S. Environmental Protection Agency (EPA) project examining mounded habitat and alternative materials for oysters. The sanctuary encompasses 295 acres of which 188 (64%) is historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments). There are 2 historic oyster bars within the sanctuary although neither bar has the majority of its area within the sanctuary (Mill Hill 31% and Saw Mill Creek 9%).

Information available for this sanctuary includes:

- Sanctuary map (Figure A.26-1)
- Summary statistics (Table A.26-1)
- Density per year (Figure A.26-2)
- Observed mortality (Figure A.26-3)
- Cultch per year (Figure A.26-4)

Mill Hill Sanctuary is located in the Eastern Bay Region of Maryland's Chesapeake Bay. Oysters within the Eastern Bay Region typically grow and survive well, generally remaining unaffected by disease or freshets except in cases of multi-year droughts or major freshet events. Natural recruitment occurs regularly in this region.

The Fall Oyster Survey has one standard site within the Mill Hill Sanctuary. Table A.26-1 shows an increase in the average number of oysters from 2021-2025 compared to the previous 5-year increments, while exhibiting low observed mortality. The average cultch per 100 ft tow indicates insufficient cultch availability. It should be noted that given limitations of traditional gear types, not all restored areas are surveyed by the Department.

The last patent tong population survey occurred in 2020.

In the 2021-2025 sanctuary assessment, this sanctuary was classified as trending positively and receiving restoration. This sanctuary has received spat-on-shell plantings since 2023 as part of the Eastern Bay Regional Project.

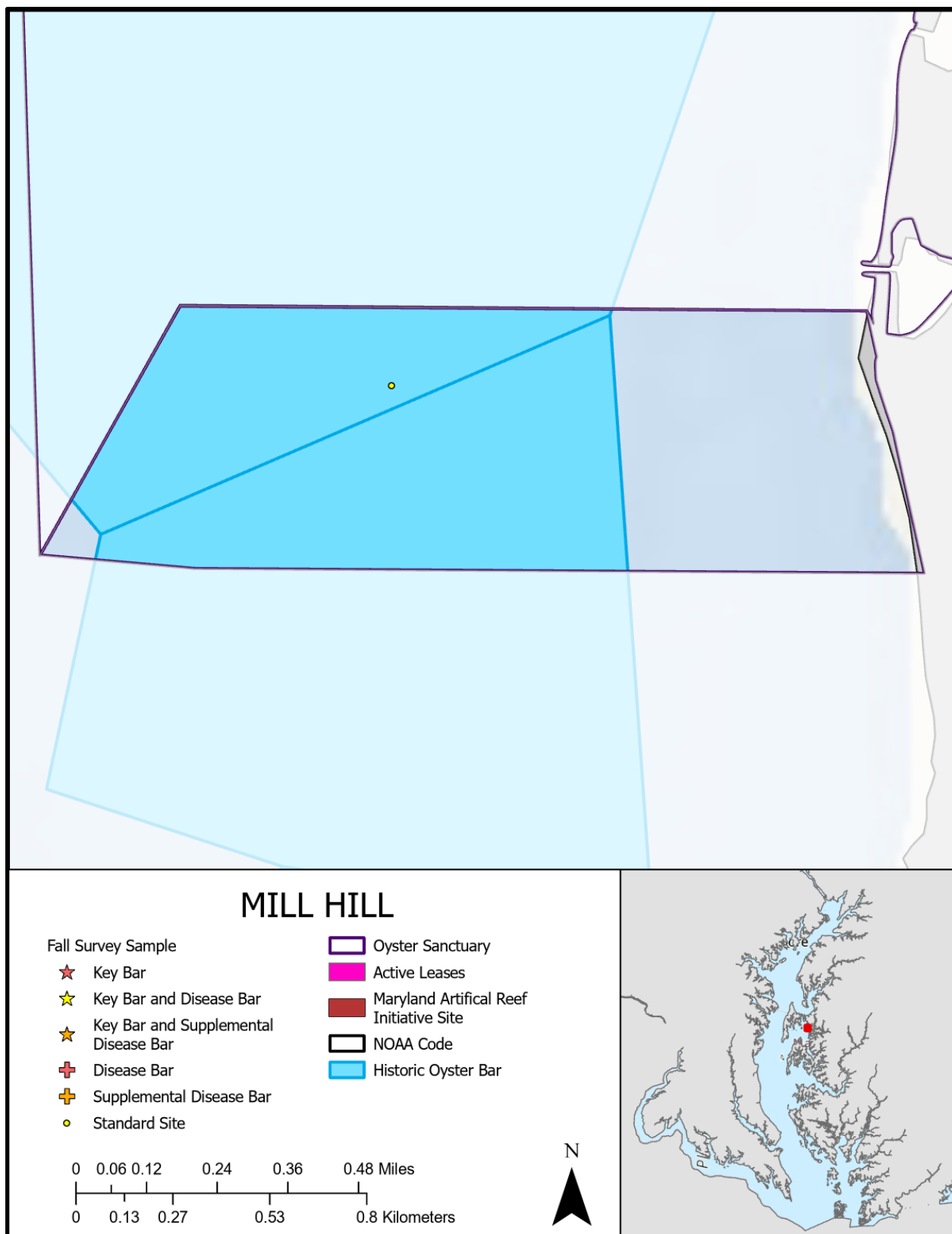


Figure A.26-1. Mill Hill Sanctuary. Fall Oyster Survey sites may not be sampled every year.

Table A.26-1. Oyster population characteristics based on the Fall Oyster Survey in the Mill Hill Sanctuary. ND=No Data. Values given are annual mean $\pm$ standard error.

Oyster Characteristic	2006-2010	2011-2015	2016-2020	2021-2025
Number of years sampled/number of samples	5/5	5/5	5/5	5/6
Number of Live Spat Oysters per square meter	7.7 $\pm$ 4.3	3.4 $\pm$ 2.2	0.15 $\pm$ 0.1	12.7 $\pm$ 9.2
Number of Live Small Oysters per square meter	5.7 $\pm$ 3.6	10.6 $\pm$ 6.8	2.9 $\pm$ 1.4	14.9 $\pm$ 5.2
Number of Live Market Oysters per square meter	4.0 $\pm$ 0.81	16.0 $\pm$ 2.8	10.9 $\pm$ 1.4	32.7 $\pm$ 16.7
Number of Live Oysters per square meter	17.3 $\pm$ 4.2	30 $\pm$ 4.5	14 $\pm$ 2.4	60.3 $\pm$ 25.3
Live Biomass (g Dry Weight per Bushel)	ND	ND	ND	ND
Observed Mortality (%)	19.7 $\pm$ 7	6 $\pm$ 3	11.7 $\pm$ 3.7	6.8 $\pm$ 1.9
Cultch (Bushels per 100 feet towed)	0.4 $\pm$ 0.04	0.6 $\pm$ 0.6	0.2 $\pm$ 0.04	0.4 $\pm$ 0.1

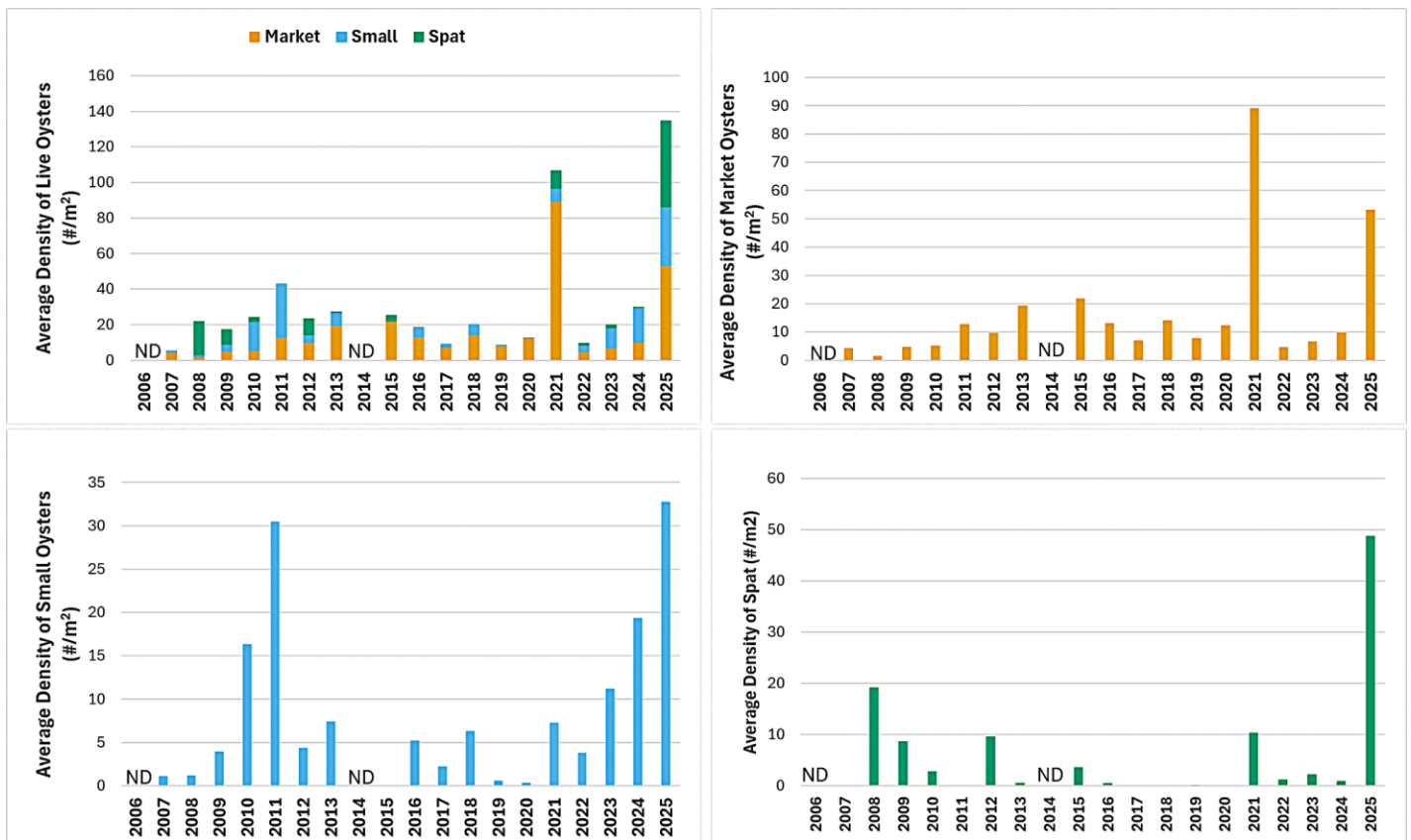


Figure A.26-2. Average number of live oysters per square meter by size class in the Mill Hill Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales. ND = No Data.

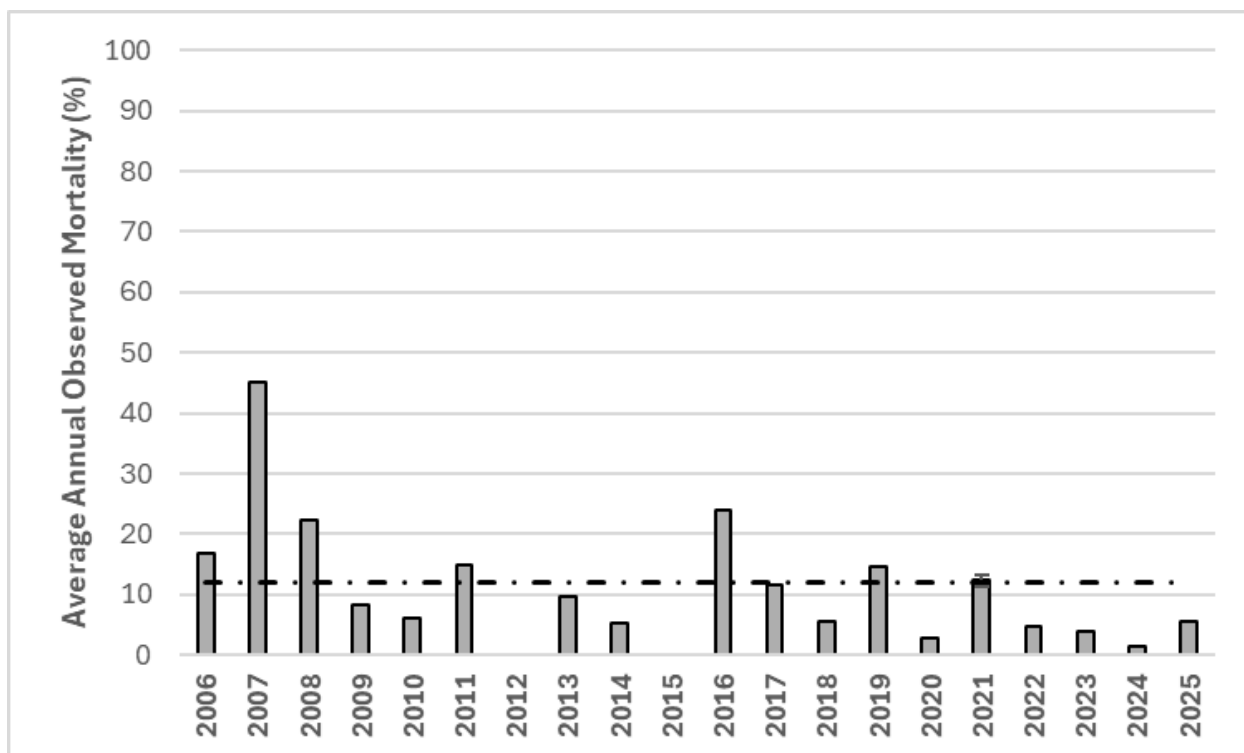


Figure A.26-3. Average annual observed mortality of market-sized and small-sized oysters in Mill Hill Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. The dashed line represents the 2006-2025 baywide average observed mortality.

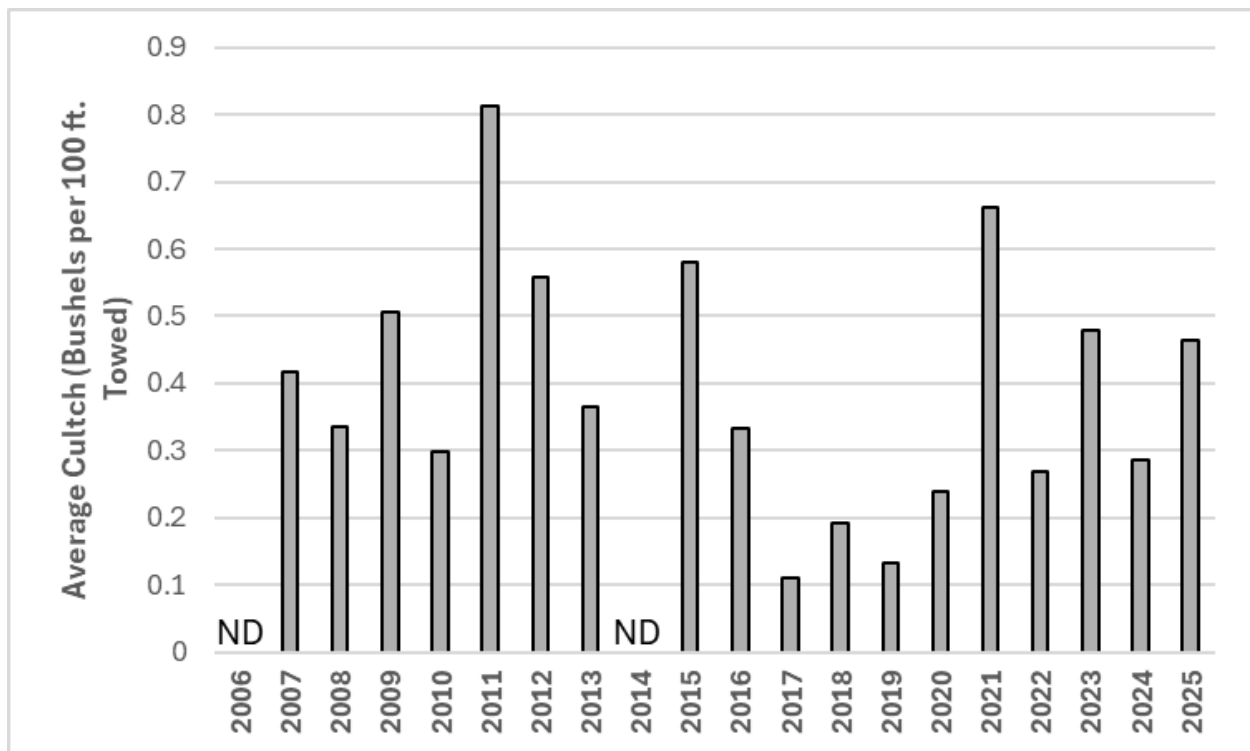


Figure A.26-4. Average cultch (live and dead oysters and loose shell) in the Mill Hill Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey.

Section A.27: Nanticoke River Sanctuary

The Nanticoke River Sanctuary is located in the Nanticoke River, a low salinity (Zone 1) region within NOAA Code 062. The sanctuary was created in 2010 and encompasses 16,699 acres of which 576 (3.4%) is historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments). There are 19 historic oyster bars within the sanctuary³¹.

Information available for this sanctuary includes:

- Sanctuary map (Figure A.27-1)
- Density Survey (Figure A.27-2)
- Summary statistics (Table A.27-1)
- Density per year (Figure A.27-3)
- Shell height frequencies (Figure A.27-4)
- Biomass per year (Figure A.27-5)
- Observed mortality (Figure A.27-6)
- Dermo and MSX per year (Figure A.27-7)
- Cultch per year (Figure A.27-8)

Nanticoke River Sanctuary is located in the Lower Eastern Shore Region of Maryland's Chesapeake Bay. Oysters in the Lower Eastern Shore Region generally grow well but can be impacted by disease. Increased salinity levels promote a greater rate of natural recruitment.

The Fall Oyster Survey has six standard sites and two sentinel sites, one a disease bar and one a key bar, within the Nanticoke River Sanctuary. Table A.27-1 shows an increase in the average number of oysters and biomass from 2021-2025 compared to the previous 5-year increments, while exhibiting low average observed mortality. This low observed mortality occurred despite an increase in lethal dermo disease prevalence and MSX prevalence in 2023 (Figures A.27-6, A.27-7). The average density from 2021-2025 is above the target of 94 oysters per square meter and the average cultch per 100 ft tow indicates sufficient cultch availability.

In 2024 the Department conducted a patent tong population survey. It found an average density of 29.2 oysters per square meter and average of 8.5 liters of surface shell per square meter. This is higher than the 11.1 oysters per square meter and 4.7 liters per square meter of surface shell found in 2018.

In 2022, the Nanticoke River Sanctuary received spat-on-shell plantings for the small-scale restoration project. In 2024, the Department announced Nanticoke River Sanctuary as one of the next three areas to receive large-scale restoration by the Department. It is slated to receive spat-on-shell only restoration in 2026 on areas that exhibit lower oyster densities.

³¹ See chart 31 for bar names and locations in the State of Maryland Shellfish Closure Areas Book
<http://dnr.maryland.gov/fisheries/Pages/oysters/index.aspx>

In the 2021-2025 sanctuary assessment, this sanctuary was classified as trending positively with a high oyster density and receiving restoration.

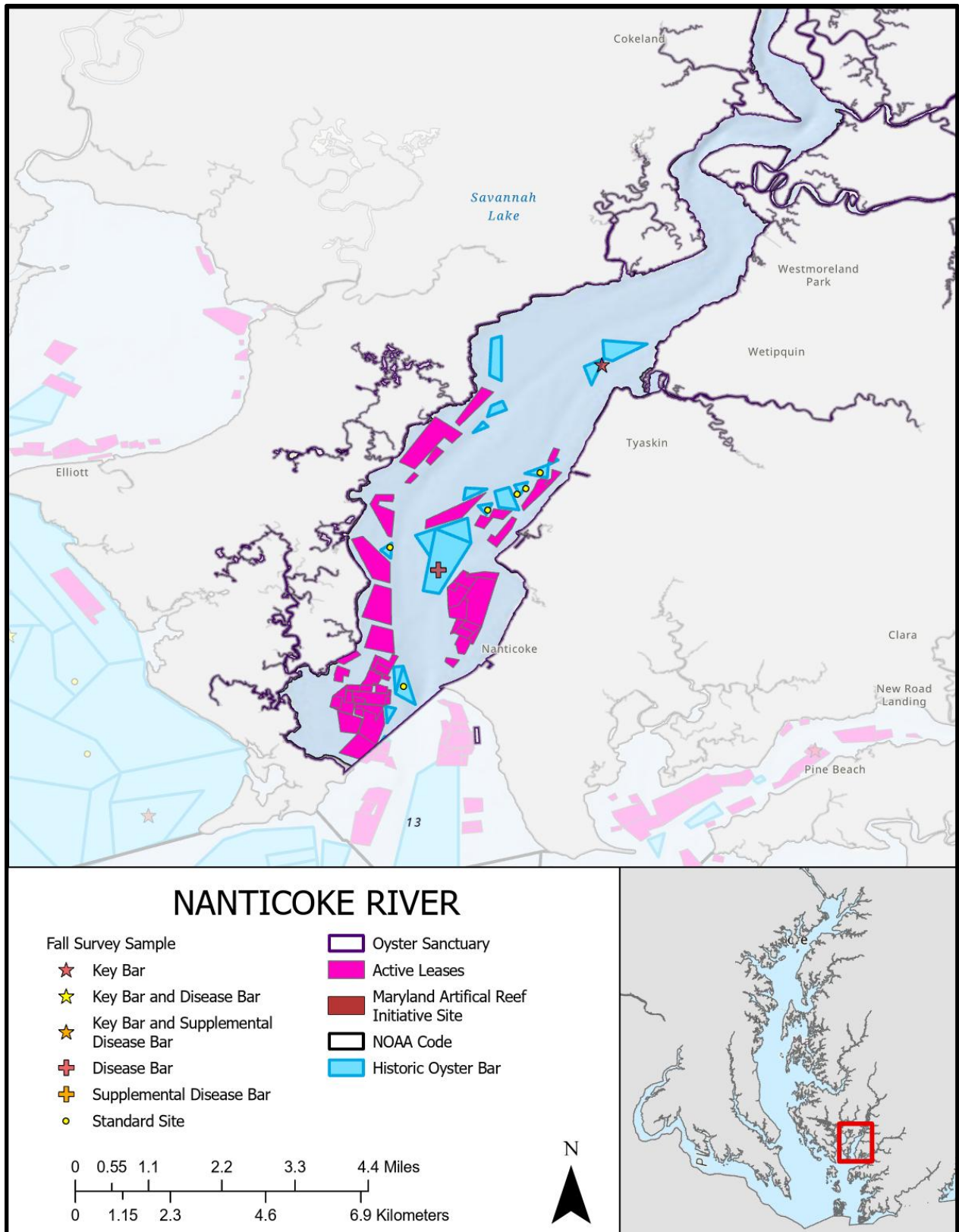


Figure A.27-1. Nanticoke River Sanctuary. Fall Oyster Survey sites may not be sampled every year.

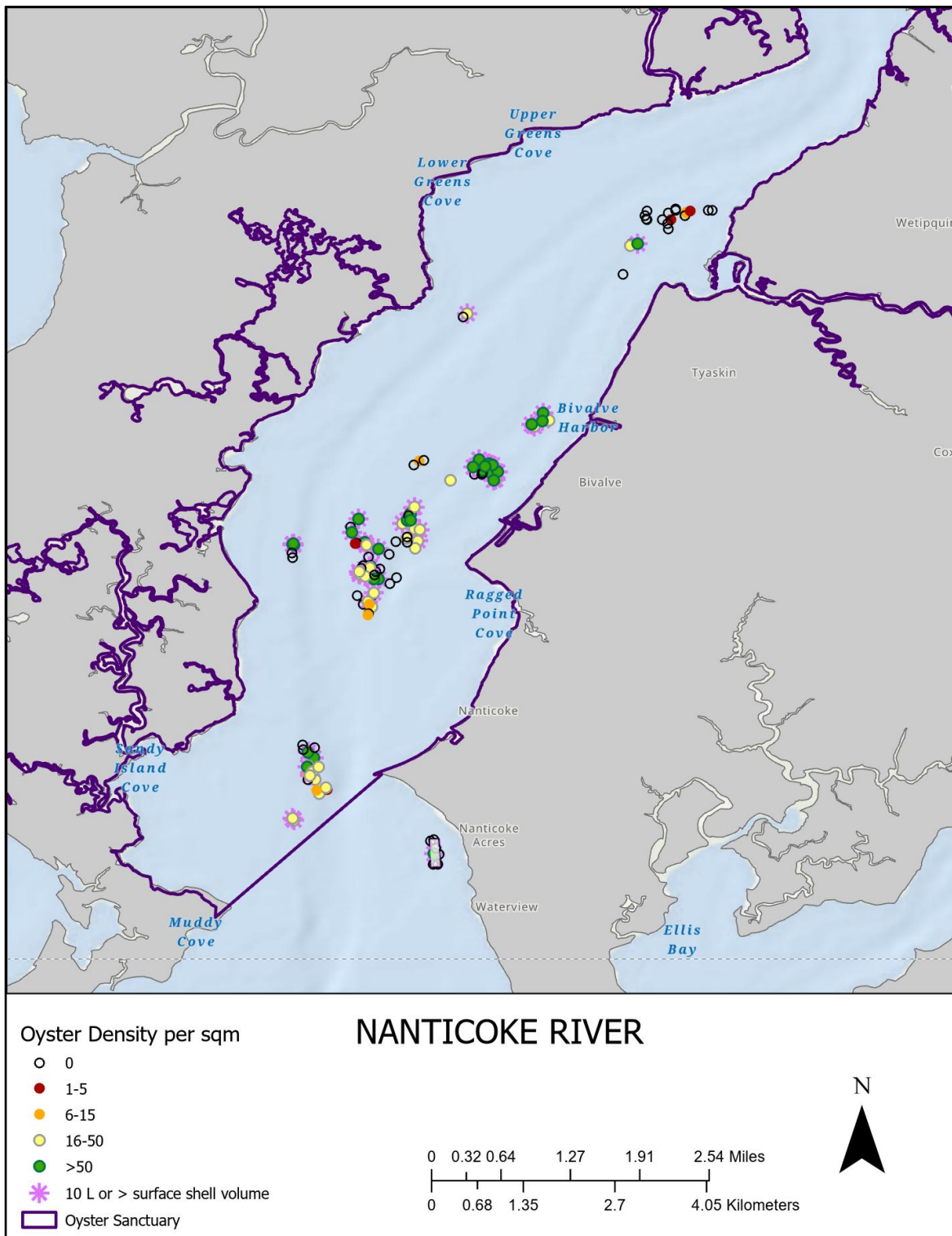


Figure A.27-2. Map of 2024 oyster density in the Nanticoke River Sanctuary. Data from Maryland Department of Natural Resources Patent Tong Population Survey.

Table A.27-1. Oyster population characteristics based on the Fall Oyster Survey in the Nanticoke River Sanctuary. ND=No Data. Values given are annual mean $\pm$ standard error.

Oyster Characteristic	2006-2010	2011-2015	2016-2020	2021-2025
Number of years sampled/number of samples	5/45	5/44	5/40	5/43
Number of Live Spat Oysters per square meter	11.6 $\pm$ 2.6	23 $\pm$ 3.3	44.6 $\pm$ 9.6	71.8 $\pm$ 10.8
Number of Live Small Oysters per square meter	21.4 $\pm$ 4.8	60.9 $\pm$ 6.8	100 $\pm$ 18.3	122.6 $\pm$ 15.3
Number of Live Market Oysters per square meter	34.5 $\pm$ 7.5	109.5 $\pm$ 13.6	162.6 $\pm$ 20.3	233.3 $\pm$ 29
Number of Live Oysters per square meter	67.5 $\pm$ 13	193 $\pm$ 20	307 $\pm$ 43	428 $\pm$ 48
Live Biomass (g Dry Weight per Bushel)	95 $\pm$ 19	129 $\pm$ 33	268 $\pm$ 17	334 $\pm$ 21
Observed Mortality (%)	7.3 $\pm$ 1.2	5.4 $\pm$ 0.8	7.9 $\pm$ 0.9	10.1 $\pm$ 1
Cultch (Bushels per 100 feet towed)	2.0 $\pm$ 0.2	2.8 $\pm$ 0.2	2.5 $\pm$ 0.2	2.7 $\pm$ 0.3

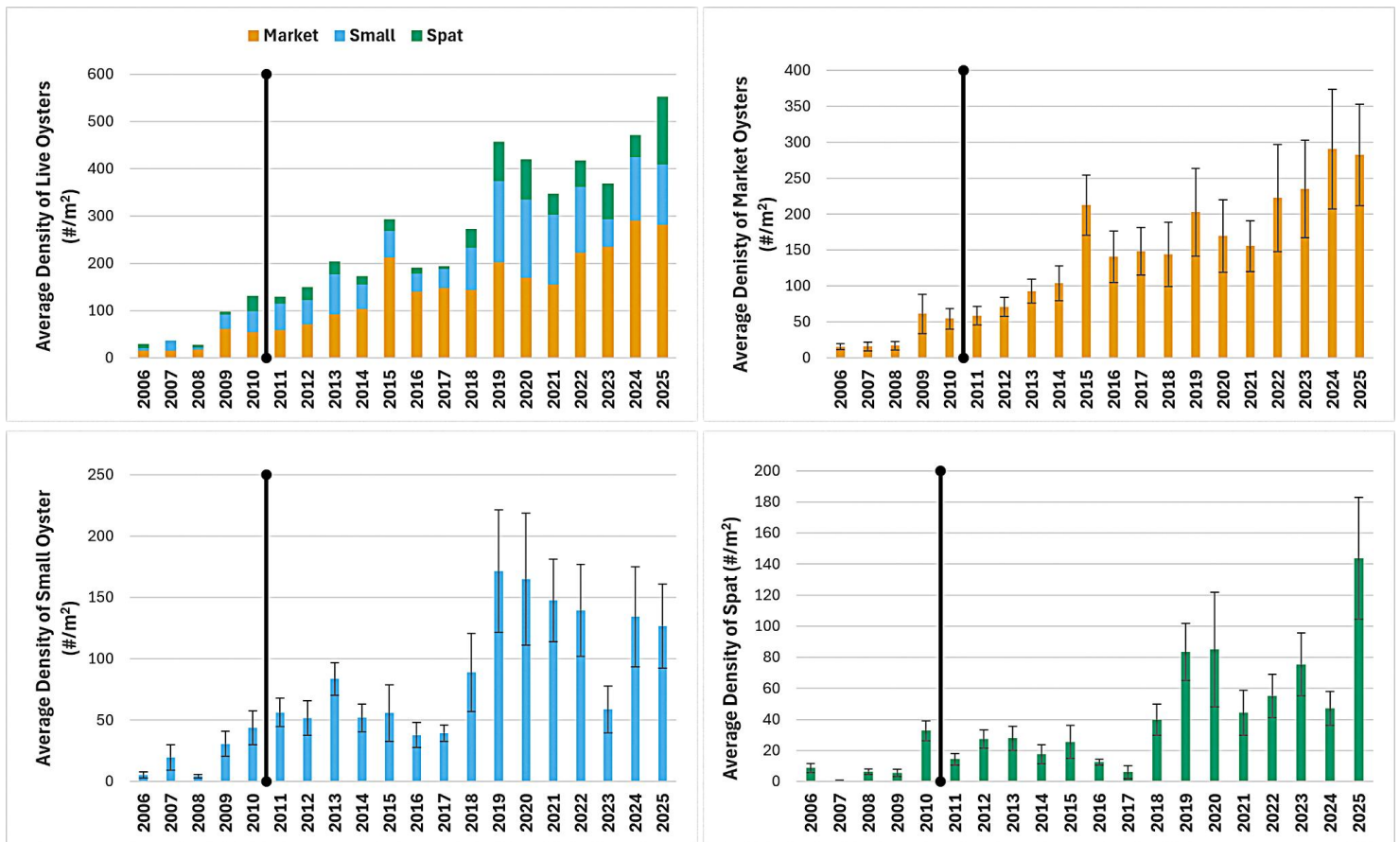


Figure A.27-3. Average number of live oysters per square meter by size class in the Nanticoke River Sanctuary. Black line indicates the date the sanctuary was established. Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales.

NANTICOKE (2010)

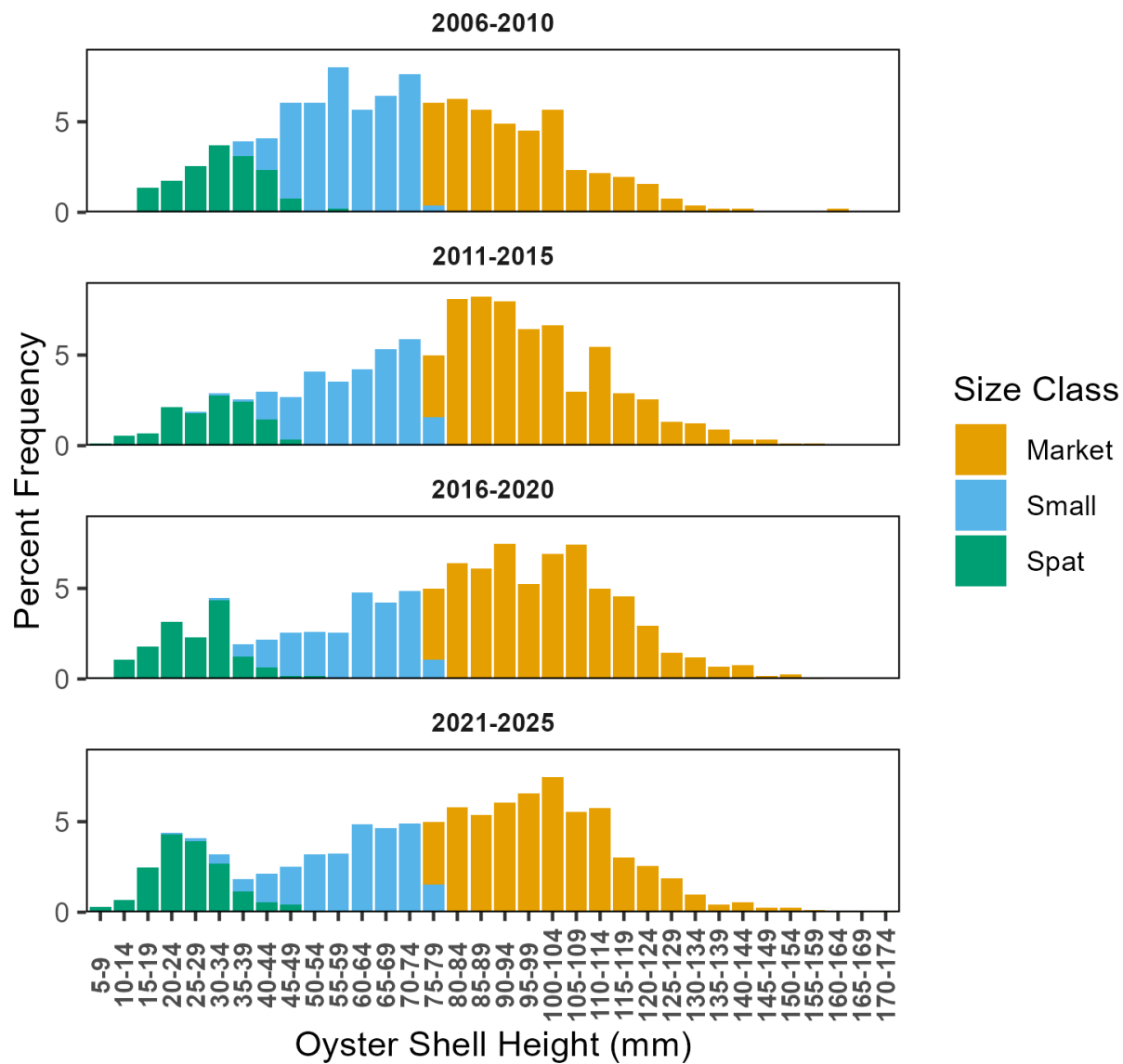


Figure A.27-4. Shell height frequencies of live oysters in the Nanticoke River Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey.

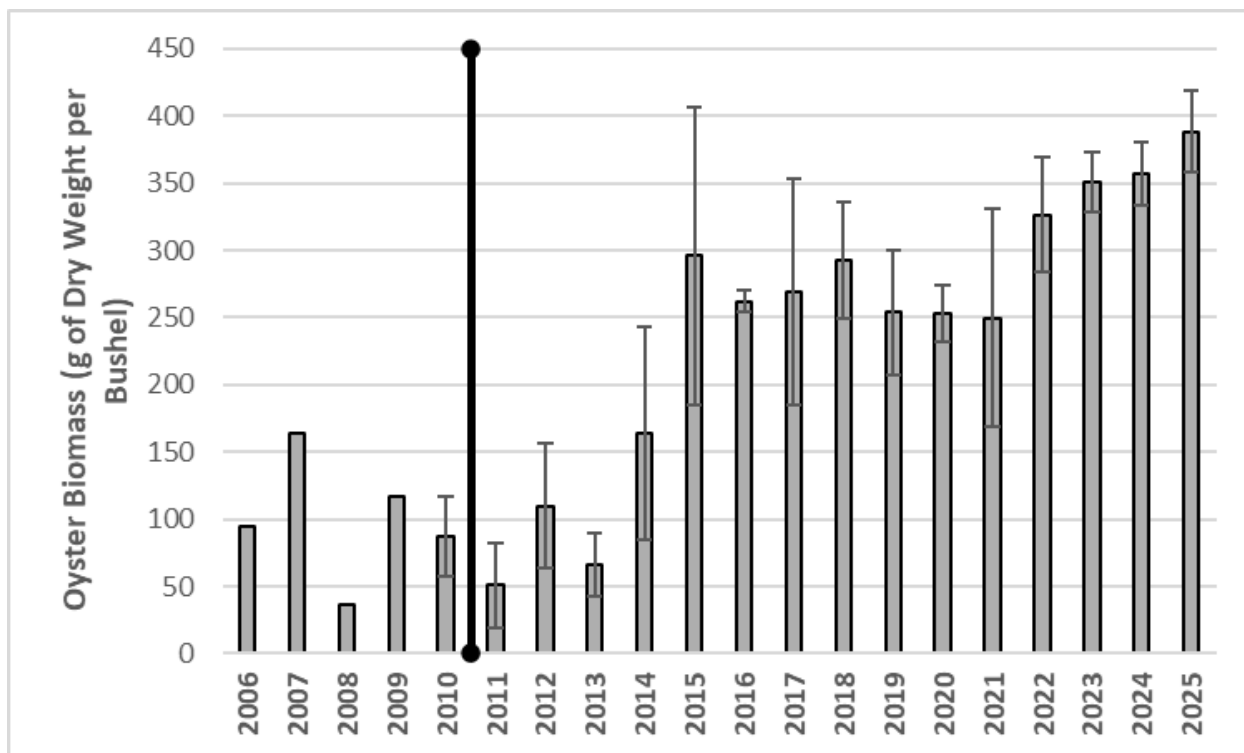


Figure A.27-5. Oyster biomass (grams of dry weight per bushel of material) in the Nanticoke River Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Black line indicates the date the sanctuary was established. Error bars represent ± 1 standard error.

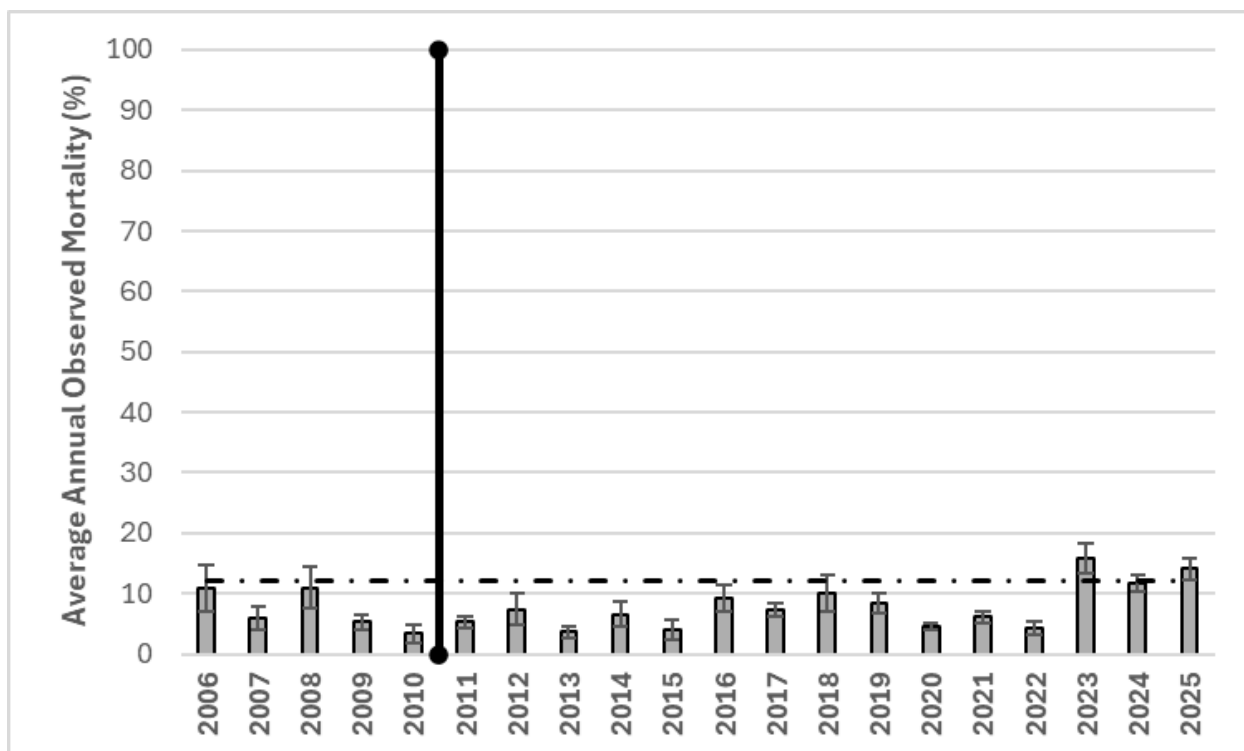


Figure A.27-6. Average annual observed mortality of market-sized and small-sized oysters in Nanticoke River Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Black line denotes the date the sanctuary was established, and the dashed line represents the 2006-2025 baywide average observed mortality. Error bars represent ± 1 standard error.

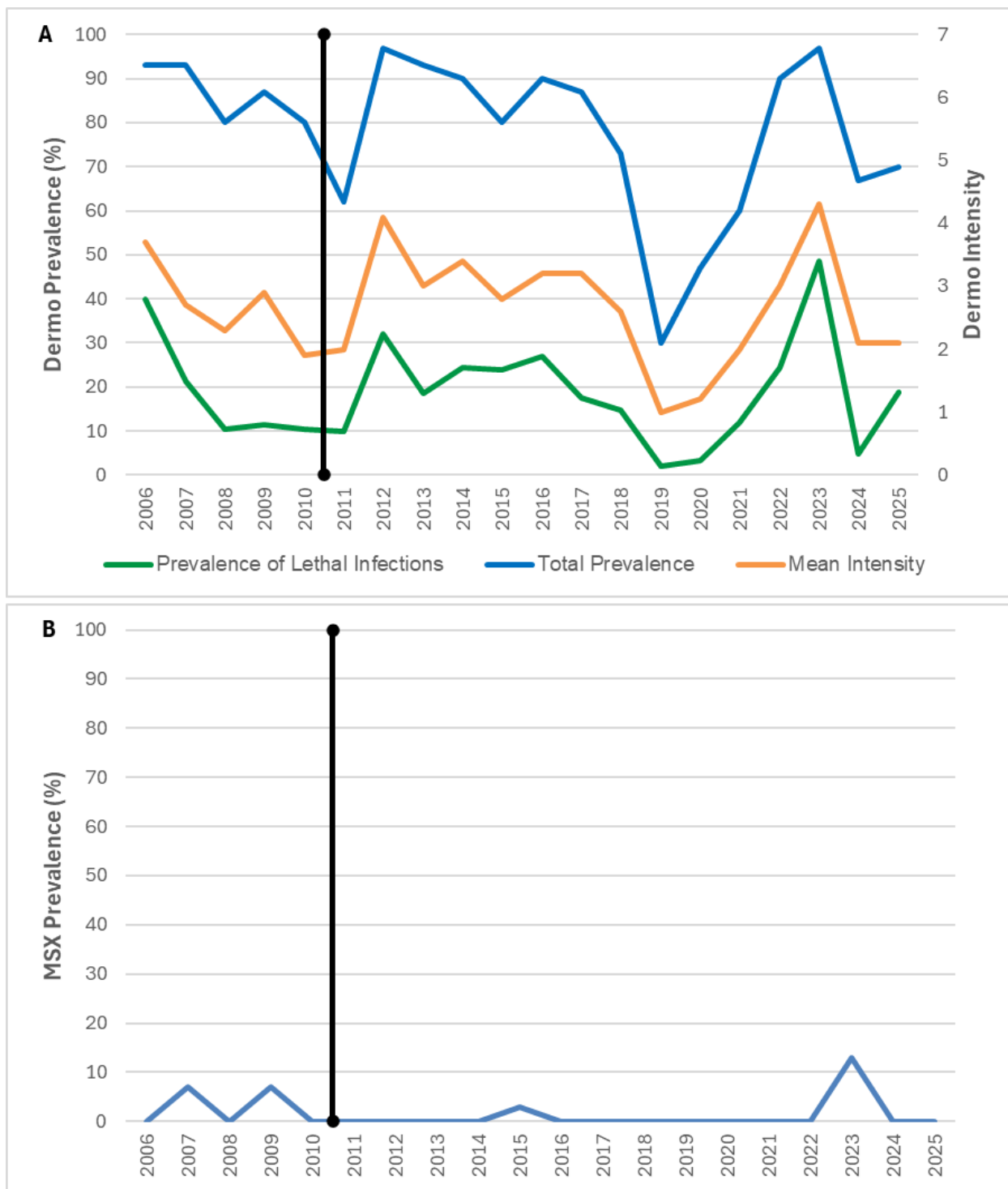


Figure A.27-7. Oyster disease prevalence and intensity in the Nanticoke River Sanctuary. (A) Dermo prevalence and mean intensity (B) MSX prevalence (intensity is not examined). Data from Maryland's Annual Fall Oyster Dredge Survey on Wilson Shoal bar. Black line denotes the date the sanctuary was established.

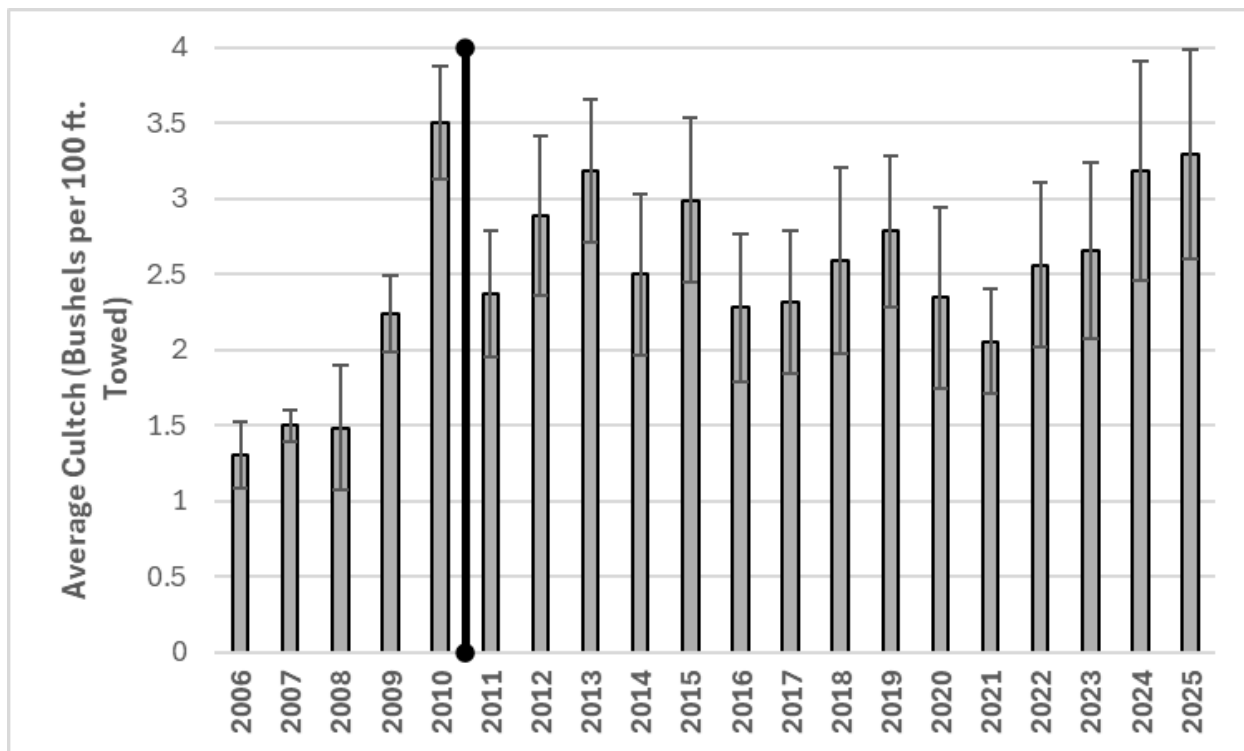


Figure A.27-8. Average cultch (live and dead oysters and loose shell) in the Nanticoke River Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Black line denotes the date the sanctuary was established. Error bars represent ± 1 standard error. ND = No Data.

Section A.28: Neal Addition Sanctuary

The Neal Addition Sanctuary is located in the middle Patuxent River, a medium salinity (Zone 2) region within NOAA Code 268. The sanctuary was created in 2001 as an U.S. Army Corps of Engineers project examining three-dimension habitat. It encompasses seven acres, all of which is one historic oyster bar (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments).

Information available for this sanctuary includes:

- Sanctuary map (Figure A.28-1)
- Density Survey (Figure A.28-2)
- Summary statistics (Table A.28-1)
- Density per year (Figure A.28-3)
- Observed mortality (Figure A.28-4)
- Cultch per year (Figure A.28-5)

Neal Addition Sanctuary is located in the Lower Western Shore Region of Maryland's Chesapeake Bay. Oysters in the Lower Western Shore Region generally grow well but may be impacted by disease or freshet events. Natural recruitment occurs regularly in this region.

The Fall Oyster Survey has one standard site within the Neal Addition Sanctuary. Table A.27-1 shows an increase in the average number of oysters from 2021-2025 compared to the previous 5-year increments, while exhibiting observed mortality close to the long-term average. The average density from 2021-2025 is above the target of 94 oysters per square meter and the average cultch per 100 ft tow indicates sufficient cultch availability, although this was skewed by a high value in 2023.

In 2024 the Department conducted a patent tong population survey and found an average of 23.7 oysters per square meter and average volume of surface shell of 5.4 liters per square meter. This is similar to the results found in the 2018 survey.

In the 2021-2025 sanctuary assessment, this sanctuary was classified as trending positively and having a high oyster density.

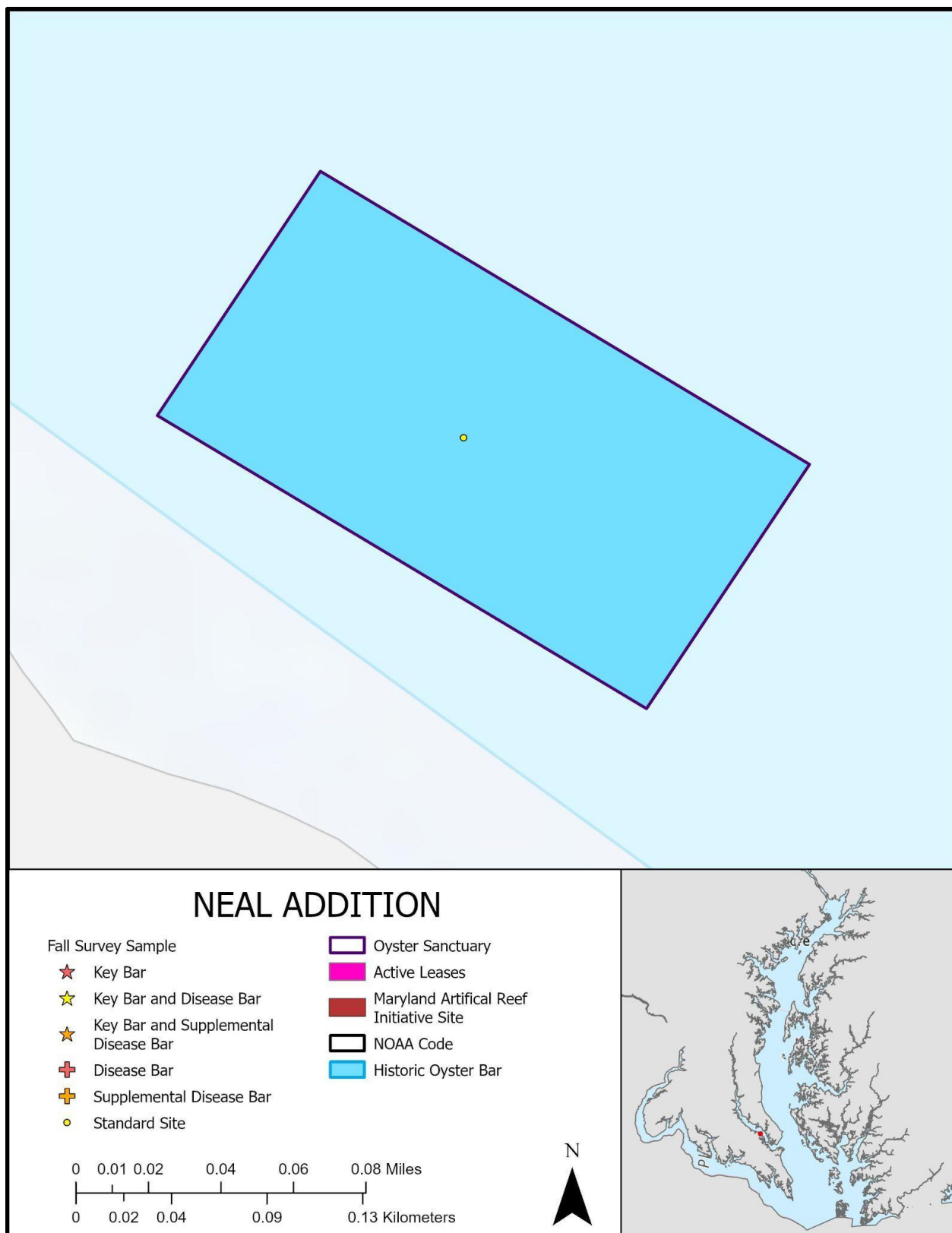


Figure A.28 -1. Neal Addition Sanctuary. Fall Oyster Survey sites may not be sampled every year.

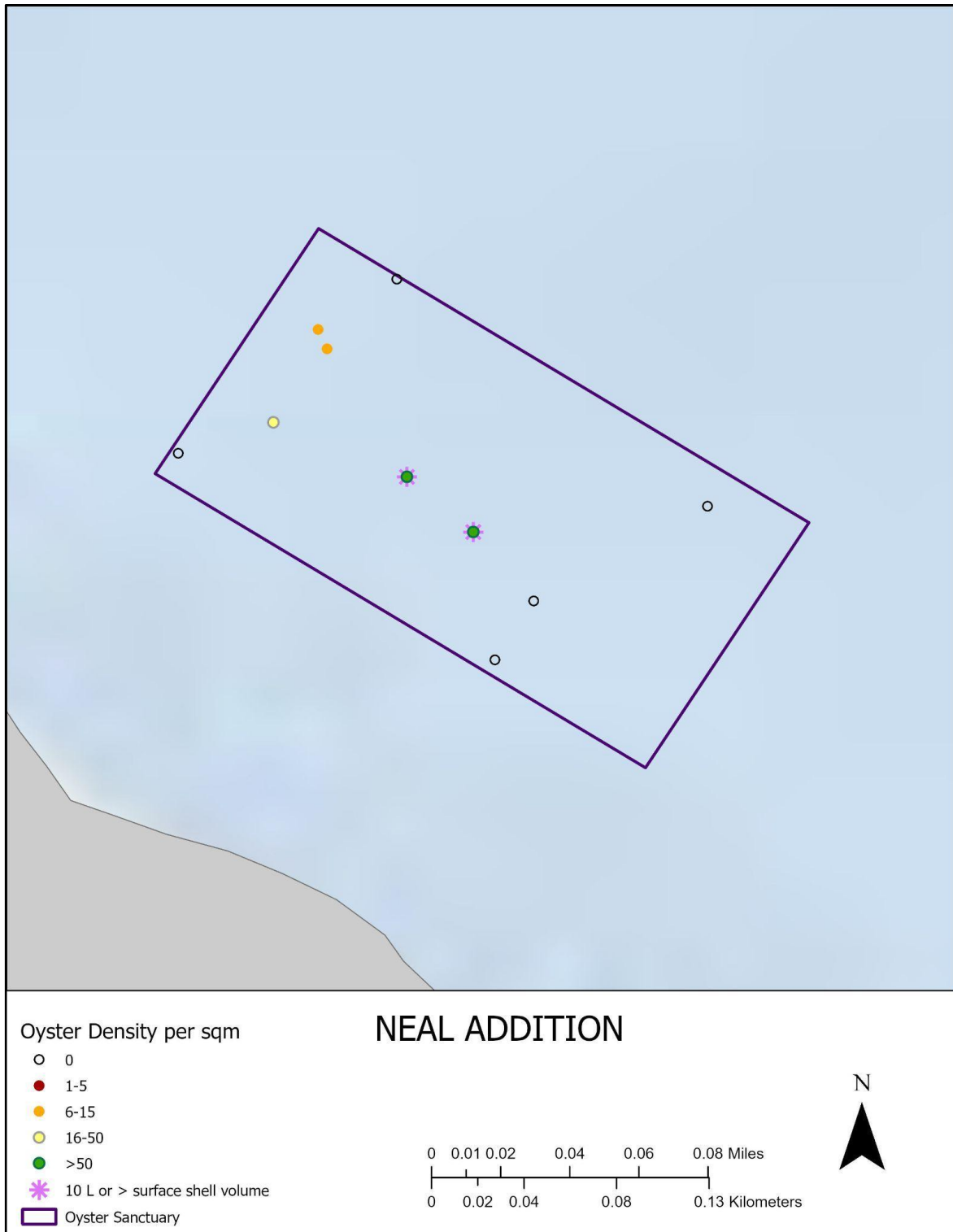


Figure A.28-2. Map of 2024 oyster density in the Neal Addition Sanctuary. Data from Maryland Department of Natural Resources Patent Tong Population Survey.

Table A.28-1. Oyster population characteristics based on the Fall Oyster Survey in the Neal Addition Sanctuary. ND=No Data. Values given are annual mean $\pm$ standard error.

Oyster Characteristic	2006-2010	2011-2015	2016-2020	2021-2025
Number of years sampled/number of samples	5/5	5/5	5/5	5/5
Number of Live Spat Oysters per square meter	6.3 $\pm$ 4.4	4.3 $\pm$ 3.0	16.7 $\pm$ 15.4	96.2 $\pm$ 79.5
Number of Live Small Oysters per square meter	154.2 $\pm$ 92	27.2 $\pm$ 11.5	44.2 $\pm$ 22.2	96.4 $\pm$ 30.7
Number of Live Market Oysters per square meter	26.7 $\pm$ 9.6	69.3 $\pm$ 15.4	58.5 $\pm$ 15.6	144.1 $\pm$ 63.7
Number of Live Oysters per square meter	187 $\pm$ 106	101 $\pm$ 30	119 $\pm$ 30	337 $\pm$ 168
Live Biomass (g Dry Weight per Bushel)	ND	ND	ND	321 $\pm$ 29
Observed Mortality (%)	18.2 $\pm$ 5.4	11.6 $\pm$ 1.4	17.3 $\pm$ 3.1	11.2 $\pm$ 2.1
Cultch (Bushels per 100 feet towed)	2.2 $\pm$ 1.1	1 $\pm$ 0.2	1 $\pm$ 0.1	1.8 $\pm$ 0.7

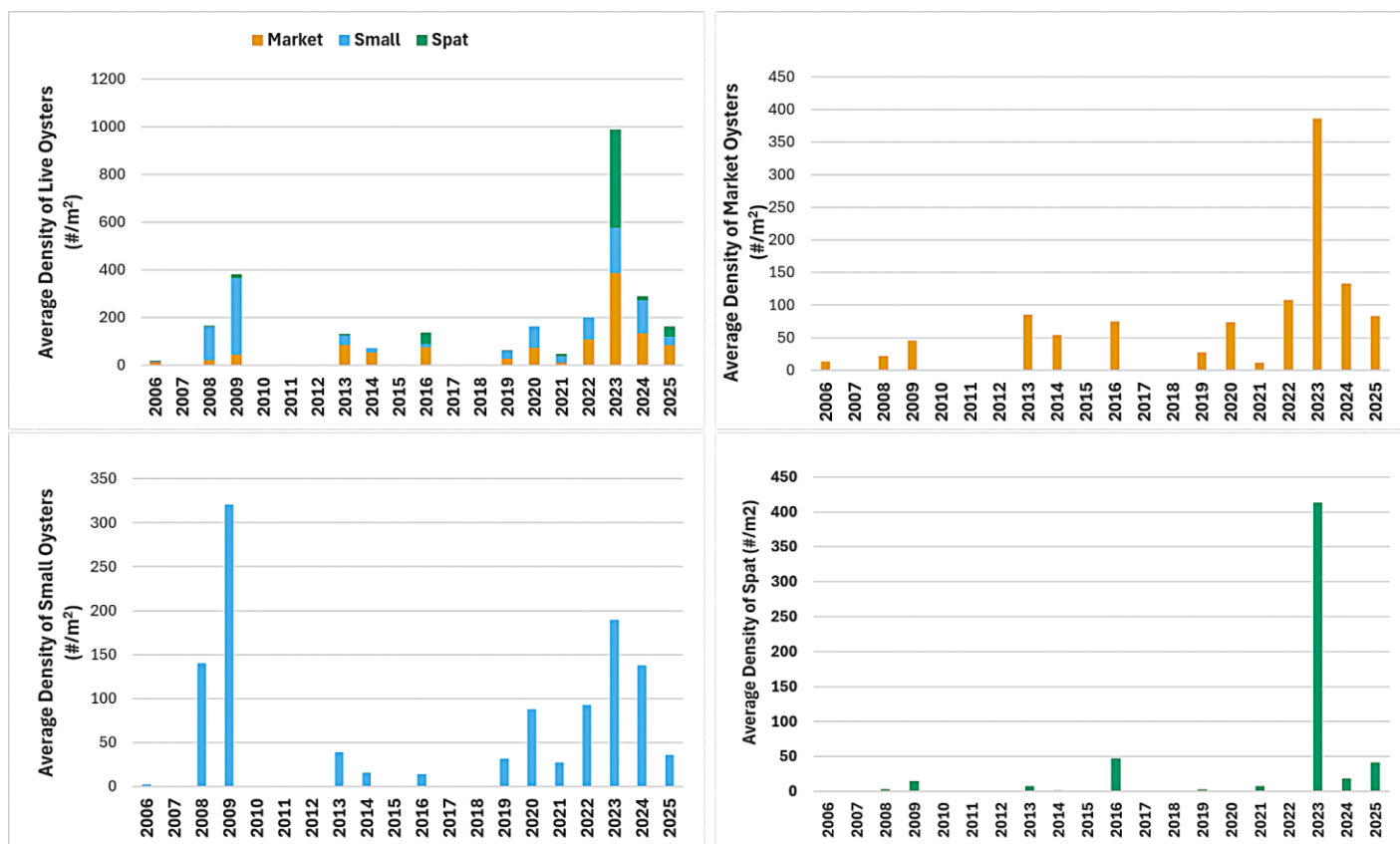


Figure A.28-3. Average number of live oysters per square meter by size class in the Neal Addition Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales. ND = No Data.

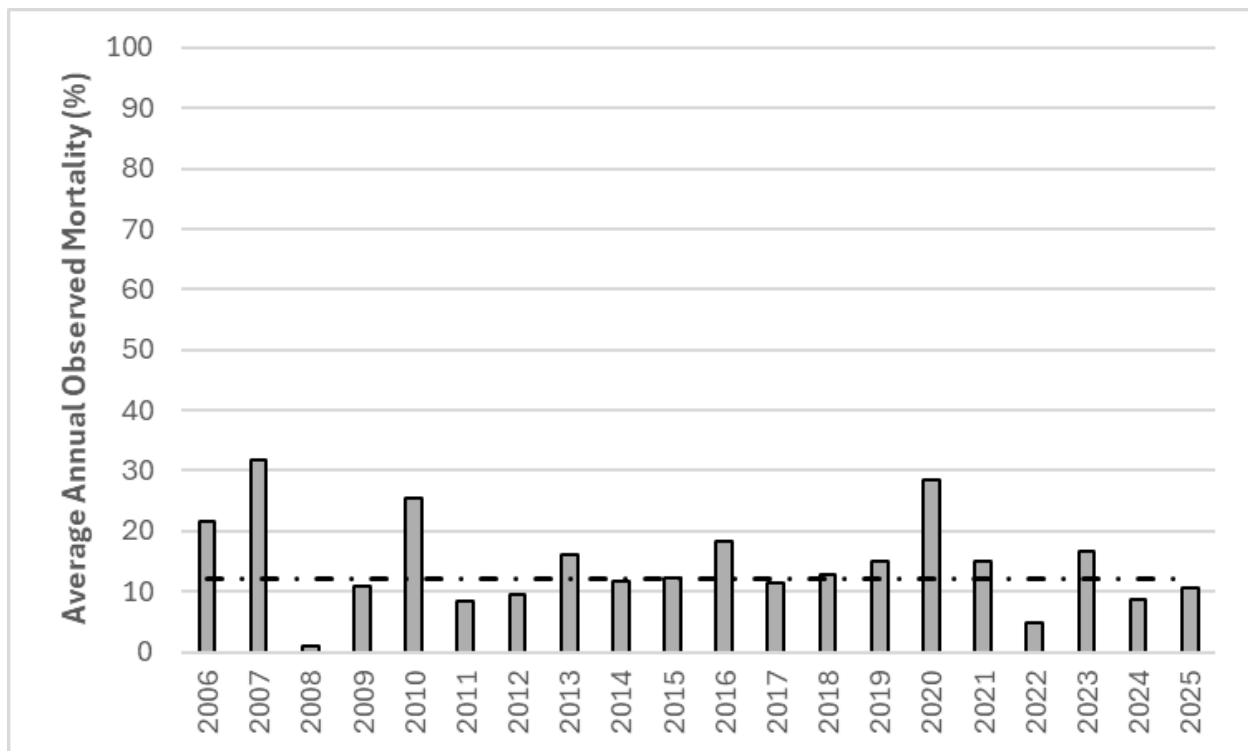


Figure A.28-4. Average annual observed mortality of market-sized and small-sized oysters in Neal Addition Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. The dashed line represents the 2006-2025 baywide average observed mortality.

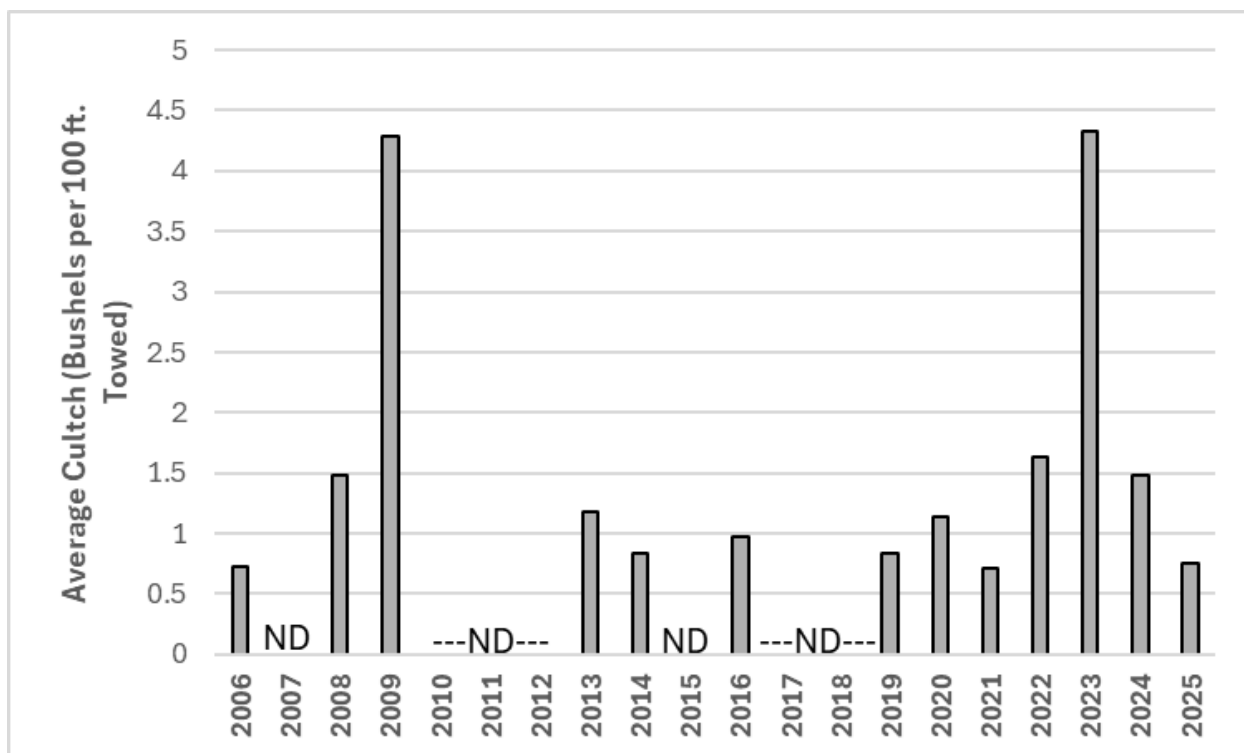


Figure A.28-5. Average cultch (live and dead oysters and loose shell) in the Neal Addition Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. ND = No Data.

Section A.29: Oxford Lab Sanctuary

The Oxford Lab Sanctuary is located in the Tred Avon River, a low salinity (Zone 1) region within NOAA Code 637. The sanctuary was created in 1961 and encompasses 36 acres of which 3 (7%) is historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments). There is one historic oyster bar partially within the sanctuary. This was Maryland's first oyster sanctuary and was created to support the Cooperative Oxford Research Laboratory's oyster research needs.

Information available for this sanctuary includes:

- Sanctuary map (Figure A.29-1)

Oxford Laboratory Sanctuary is located in the Choptank Region of Maryland's Chesapeake Bay. Oysters in the Choptank Region generally grow well but may be impacted by disease or freshet events. Natural recruitment occurs regularly in this region.

There are no Fall Oyster Survey sites in this sanctuary, and a patent tong population assessment has not been conducted by the Department for this sanctuary. This sanctuary was created specifically to support the research needs of the Oxford Laboratory and is a site for MGO plantings. In 2023, a NOAA diver surveyed the MGO site and found an average of 19 oysters per square meter.

The sanctuary was one of the sanctuaries identified by the Department as unlikely to receive a large investment by the Department for restoration and is under evaluation by the Oyster Advisory Commission for potential efforts to improve its performance. The main focus of this sanctuary will be to continue to support research efforts by the Cooperative Oxford Laboratory.

In the 2021-2025 sanctuary assessment, this sanctuary was classified as created for laboratory use.

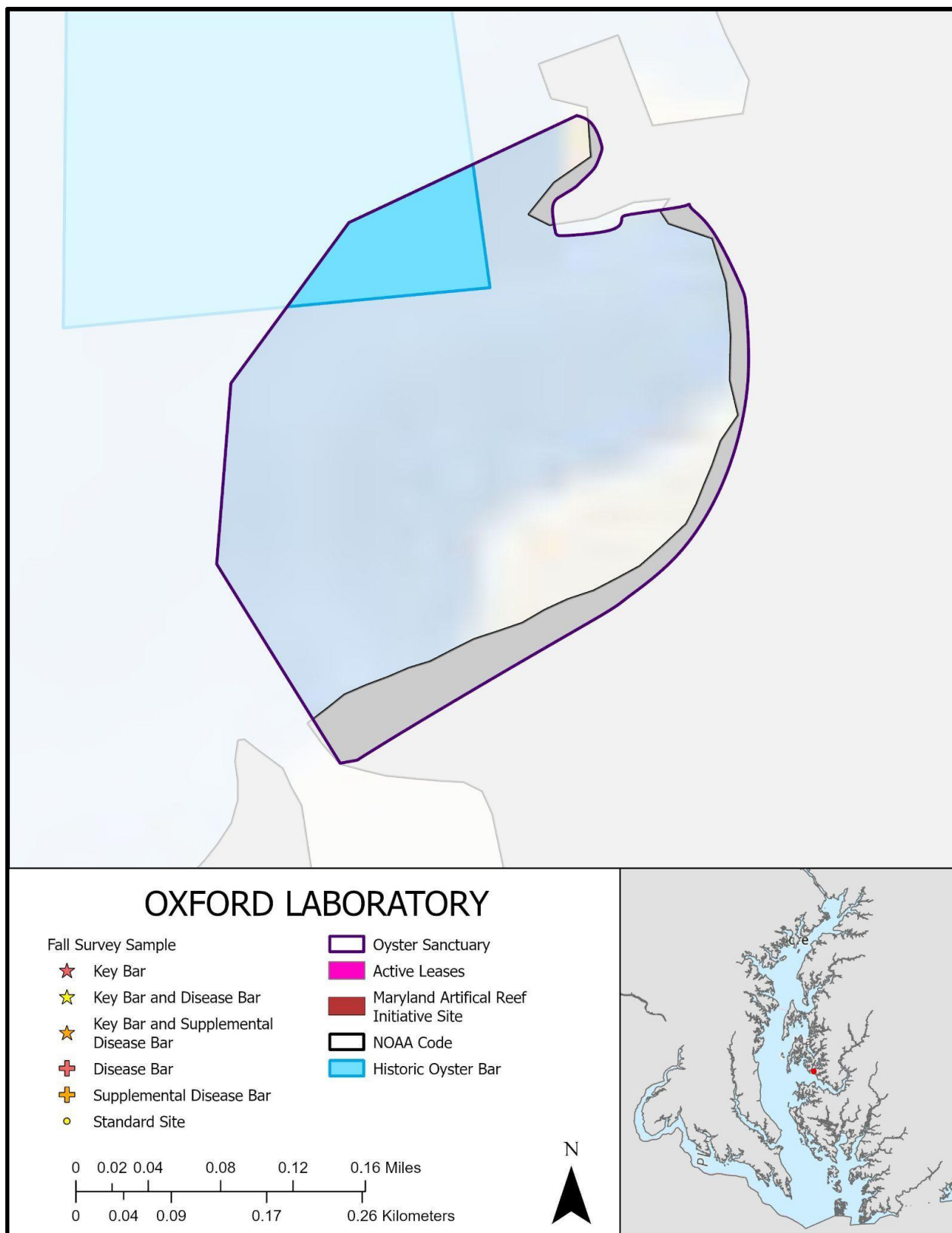


Figure A.29-1. Oxford Lab Sanctuary.

Section A.30: Piney Point Sanctuary

The Piney Point Sanctuary is located in St. George Creek, a low salinity (Zone 1) tributary of the lower Potomac River. The sanctuary was created in 1986 to support the Piney Point Aquaculture Center's logistical, and research needs and encompasses 13 acres in which there is no historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments).

Information available for this sanctuary includes:

- Sanctuary map (Figure A.30-1)

Piney Point Sanctuary is located in the Lower Western Shore Region of Maryland's Chesapeake Bay. Oysters in the Western Shore Region generally grow well but may be impacted by disease or freshet events. Natural recruitment occurs regularly in this region.

This sanctuary was created specifically for the Piney Point Aquaculture Facility's logistical and research needs. It has no historic oyster habitat.

The sanctuary was one of the sanctuaries identified by the Department as unlikely to receive a large investment by the Department for restoration and is under evaluation by the Oyster Advisory Commission for potential efforts to improve its performance.

In the 2021-2025 sanctuary assessment, this sanctuary was classified as created for laboratory use.

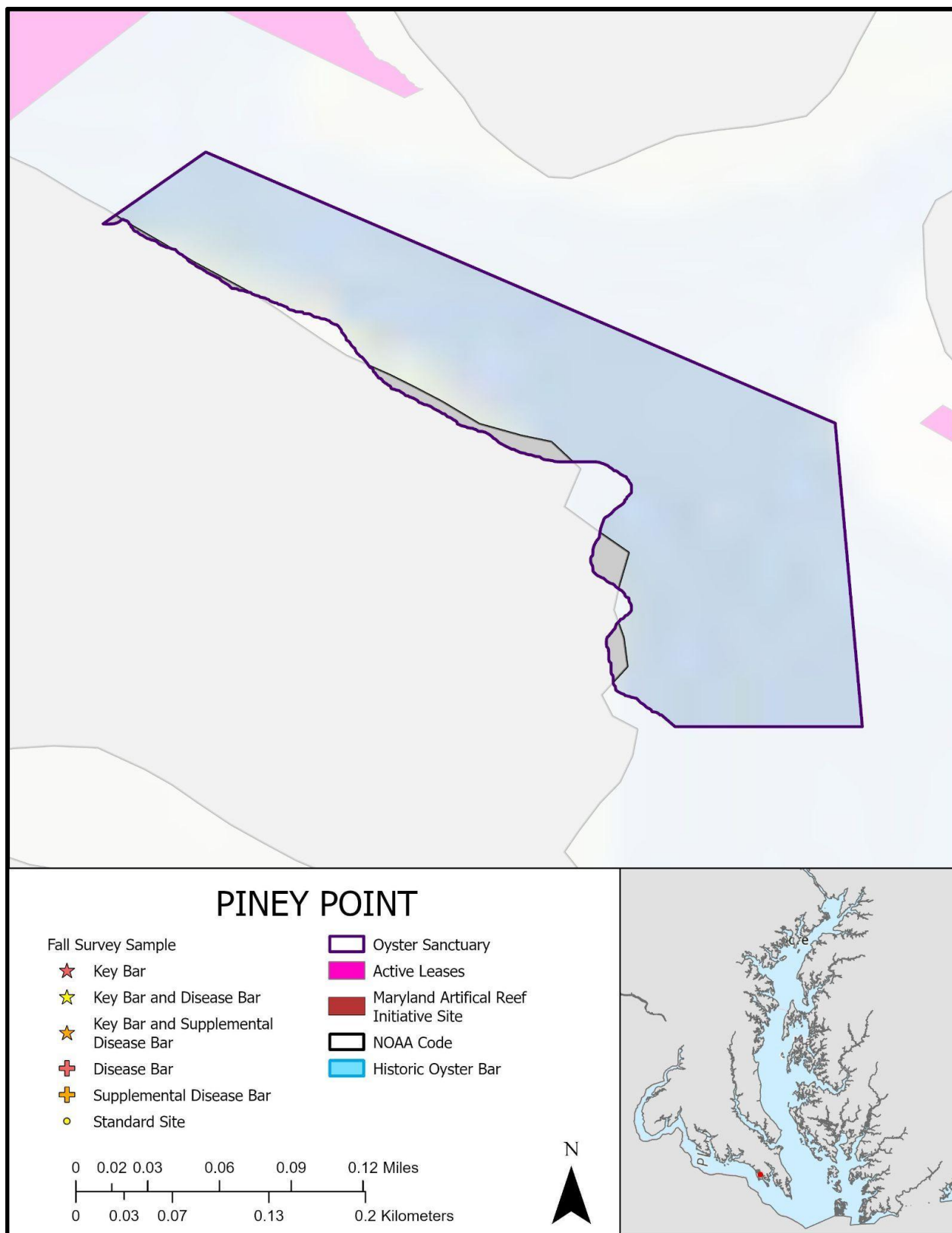


Figure A.30-1. Piney Point Sanctuary.

Section A.31: Plum Point Sanctuary

The Plum Point Sanctuary is located in the middle-western portion of Maryland's Chesapeake Bay along the Calvert County shore in a medium salinity (Zone 2) region within NOAA Code 027. The sanctuary was created in 1999 and encompasses 6,209 acres of which 4,405 acres (71%) is historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments). Six historic oyster bars are within the sanctuary³². This sanctuary was one of four sanctuaries created in 1999 when legislation was passed opening up new areas to power dredging oysters.

Information available for this sanctuary includes:

- Sanctuary map (Figure A.31-1)

Plum Point Sanctuary is located in the Mid Bay Region of Maryland's Chesapeake Bay. Oysters in the Mid Bay Region experience favorable growth and survival rates, generally remaining unaffected by disease or freshet occurrences. There are typically low rates of recruitment in this region.

The Department has not conducted patent tong population surveys within this sanctuary. A large MARI site featuring alternate substrate covers most of this sanctuary, making it impossible to sample using the Department's gear types (dredge or patent tong).

This sanctuary was one of the sanctuaries identified by the Department as unlikely to receive a large investment by the Department for restoration and is under evaluation by the Oyster Advisory Commission for potential efforts to improve its performance.

In the 2021-2025 sanctuary assessment, this sanctuary was classified as lacking in data.

³² See chart 17 for bar names and locations in the State of Maryland Shellfish Closure Areas Book <http://dnr.maryland.gov/fisheries/Pages/oysters/index.aspx>

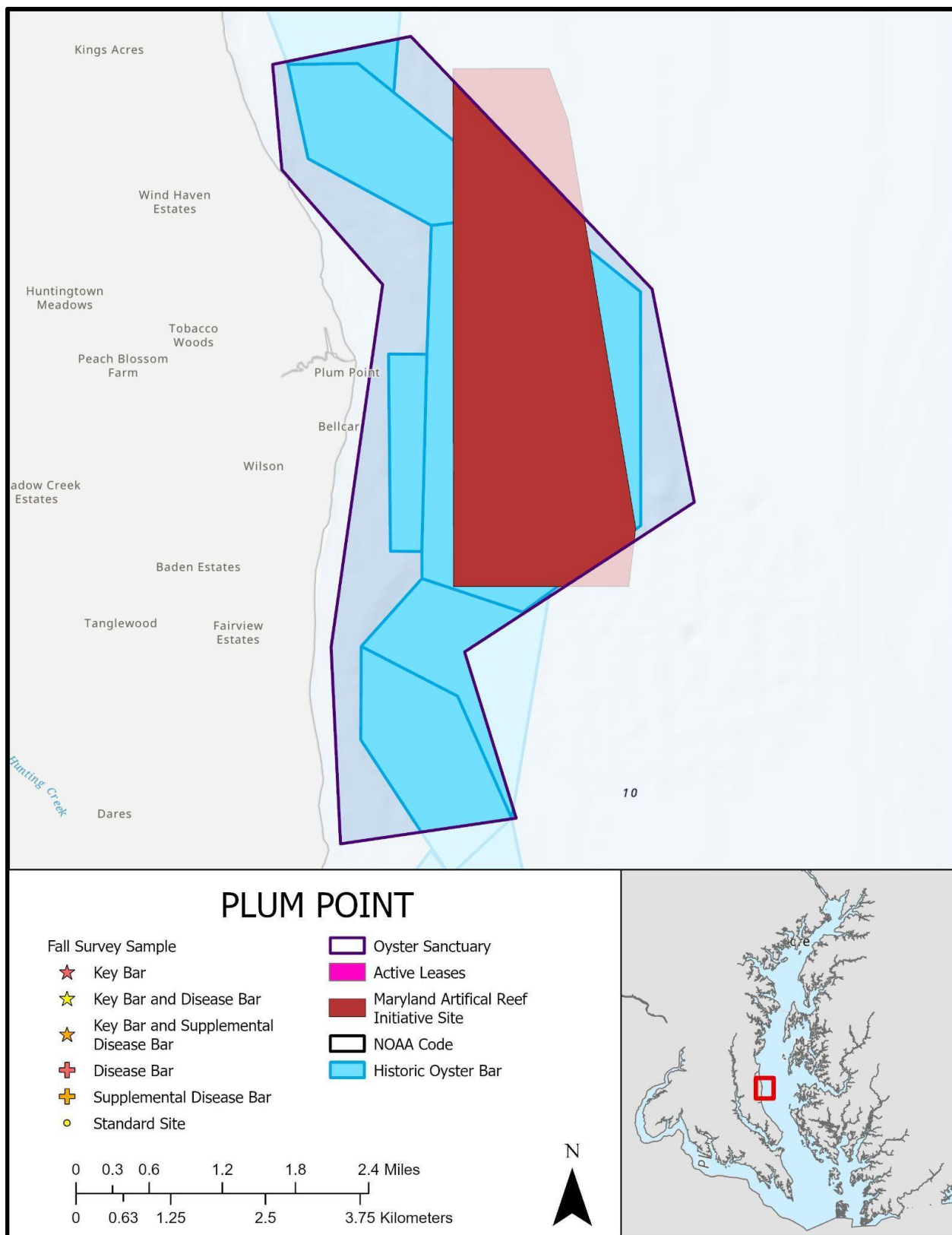


Figure A.31-1. Plum Point Sanctuary.

Section A.32: Point Lookout Sanctuary

The Point Lookout Sanctuary is located in the lower western portion of Maryland's Chesapeake Bay at the mouth of the Potomac River, a medium salinity (Zone 2) region within NOAA Code 229. The original sanctuary was 104 acres but was expanded to 399 acres in 2010, of which 396 acres (99%) is historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments). Thus, the total surface area is 503 acres, and the total historic oyster bottom is 500 acres (99%). There are 2 historic oyster bars within the sanctuary³³. The sanctuary was one of four sanctuaries created in 1999 when legislation was passed opening up new areas to power dredging of oysters.

Information available for this sanctuary includes:

- Sanctuary map (Figure A.32-1)
- Summary statistics (Table A.32-1)
- Density per year (Figure A.32-2)
- Shell height frequencies (Figure A.32-3)
- Biomass per year (Figure A.32-4)
- Observed mortality (Figure A.32-5)
- Dermo and MSX per year (Figure A.32-6)
- Cultch per year (Figure A.32-7)

Point Lookout Sanctuary is located in the Lower Western Shore Region of Maryland's Chesapeake Bay. Oysters in the Lower Western Shore Region generally grow well but may be impacted by disease or freshet events. Natural recruitment occurs regularly in this region.

The Fall Oyster Survey has one supplemental disease bar site in the Point Lookout Sanctuary. Table A.32-1 shows a decrease in the average number of oysters per square meter and an increase in the biomass from 2021-2025 compared to the previous 5-year increments, while exhibiting observed mortality near the long-term average. The observed mortality rate in 2021-2025 was lower than the previous 5-year increments and coincided with a decrease in lethal dermo disease prevalence and a low MSX disease prevalence throughout the timeframe (Figures A.32-5, A32-6). While the average density was lower from 2021-2025 as compared to 2016-2020, it is above the long-term abundance target of 94 oysters per square meter. The average cultch per 100 ft tow indicates insufficient cultch availability.

The last patent tong survey was in 2020.

In the 2021-2025 sanctuary assessment, this sanctuary was classified as having a high oyster density.

³³ See chart 40 for bar names and locations in the State of Maryland Shellfish Closure Areas Book <http://dnr.maryland.gov/fisheries/Pages/oysters/index.aspx>

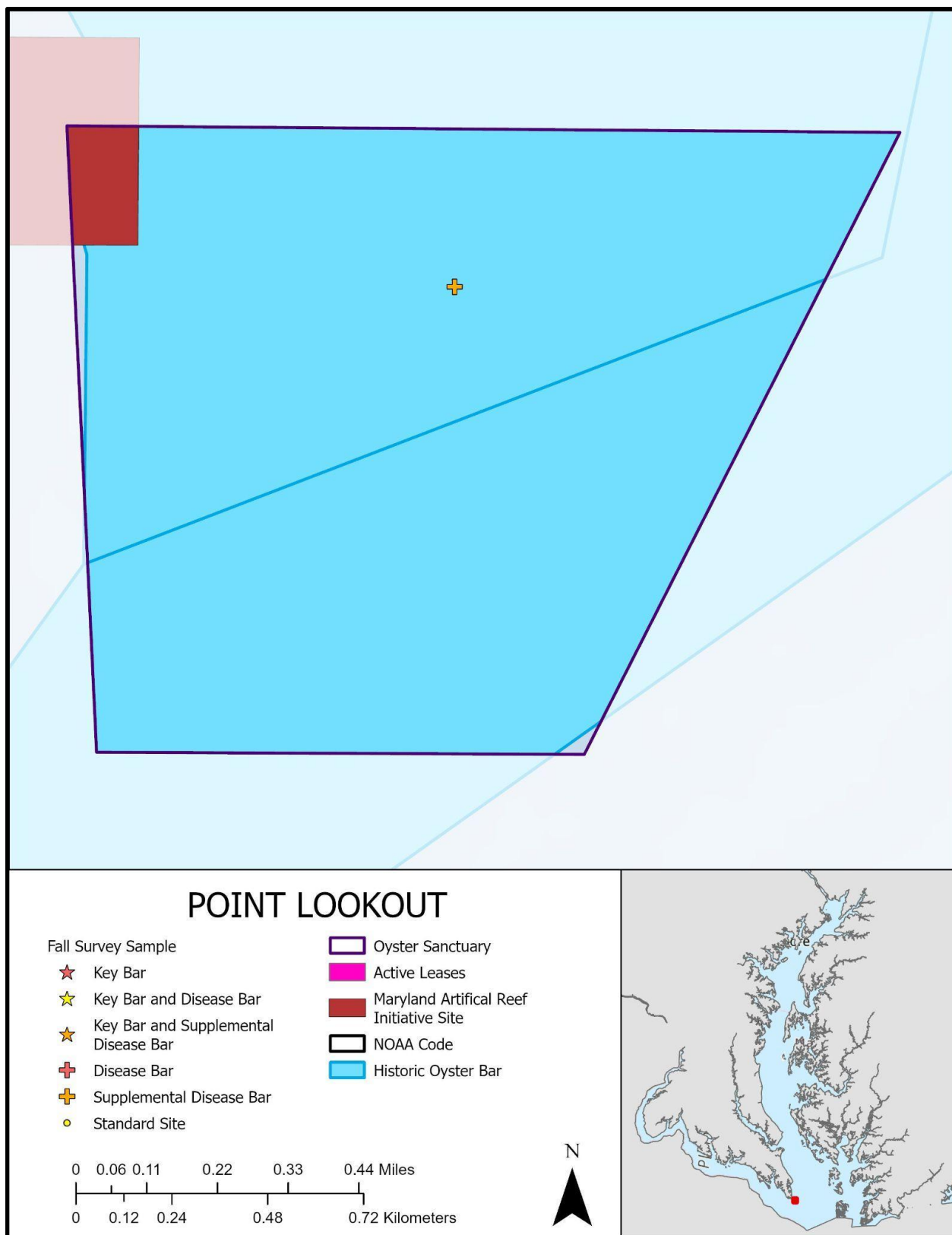


Figure A.32-1. Point Lookout Sanctuary. Fall Oyster Survey sites may not be sampled every year.

Table A.32-1. Oyster population characteristics based on the Fall Oyster Survey in the Point Lookout Sanctuary. ND=No Data. Values given are annual mean $\pm$ standard error.

Oyster Characteristic	2006-2010	2011-2015	2016-2020	2021-2025
Number of years sampled/number of samples	5/10	5/6	5/5	5/5
Number of Live Spat Oysters per square meter	4.9 $\pm$ 2.1	26.5 $\pm$ 13.7	40.6 $\pm$ 19.5	20.8 $\pm$ 4.2
Number of Live Small Oysters per square meter	13.7 $\pm$ 3.4	20.9 $\pm$ 6.0	60.7 $\pm$ 11.9	53.4 $\pm$ 13.7
Number of Live Market Oysters per square meter	16.2 $\pm$ 2.2	36.8 $\pm$ 8.7	61.8 $\pm$ 15.8	61.8 $\pm$ 16.8
Number of Live Oysters per square meter	35 $\pm$ 6	84 $\pm$ 26	163 $\pm$ 29	136 $\pm$ 32.3
Live Biomass (g Dry Weight per Bushel)	NA	215 $\pm$ 35	342 $\pm$ 21	372 $\pm$ 26
Observed Mortality (%)	23.2 $\pm$ 2.7	16.3 $\pm$ 2.1	15.2 $\pm$ 3.3	11 $\pm$ 1.3
Cultch (Bushels per 100 feet towed)	0.5 $\pm$ 0.1	0.7 $\pm$ 0.2	0.7 $\pm$ 0.1	0.6 $\pm$ 0.1

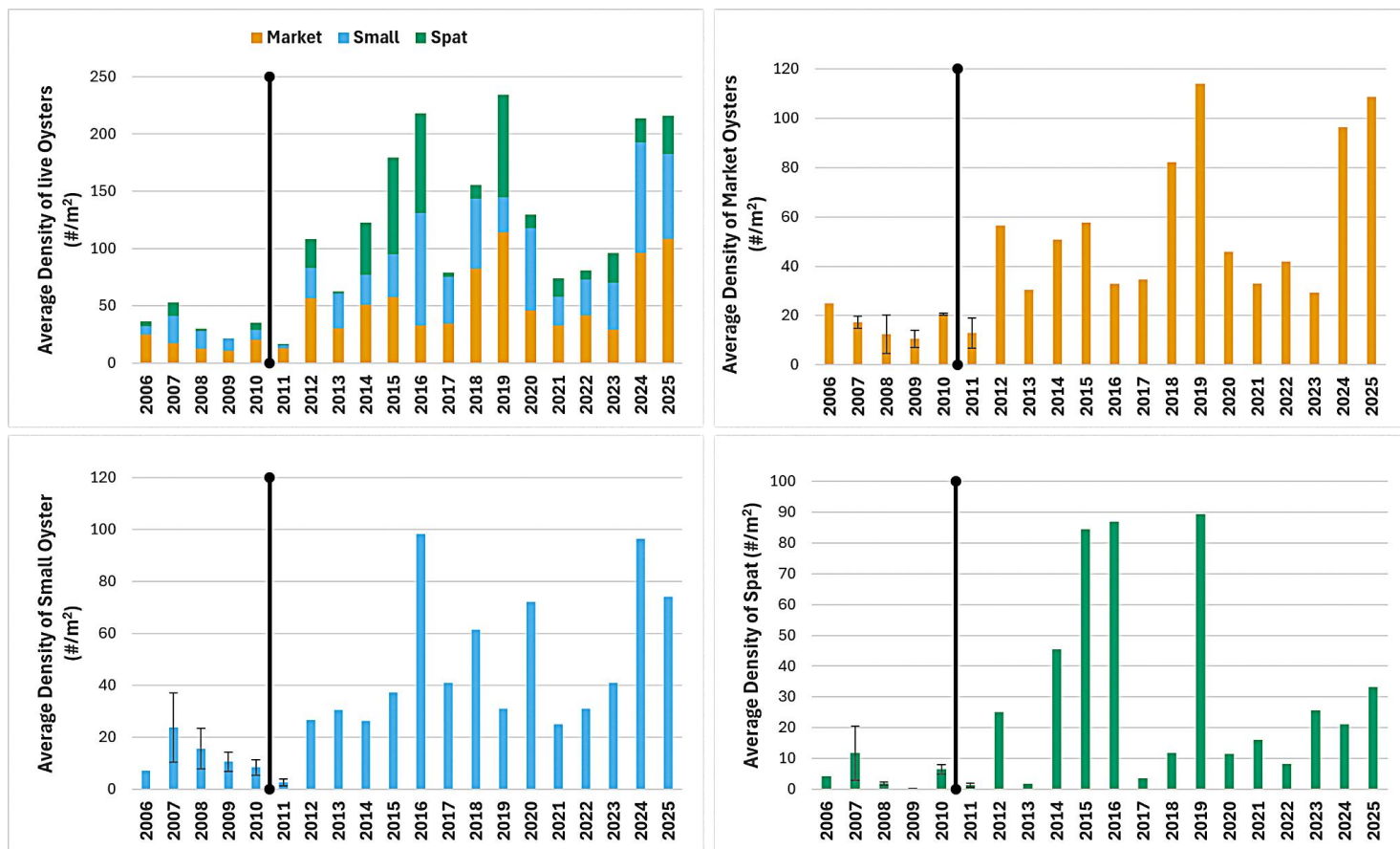


Figure A.32-2. Average number of live oysters per square meter by size class in the Point Lookout Sanctuary. Black line indicates the date the sanctuary was established. Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales.

POINT LOOKOUT (2010)

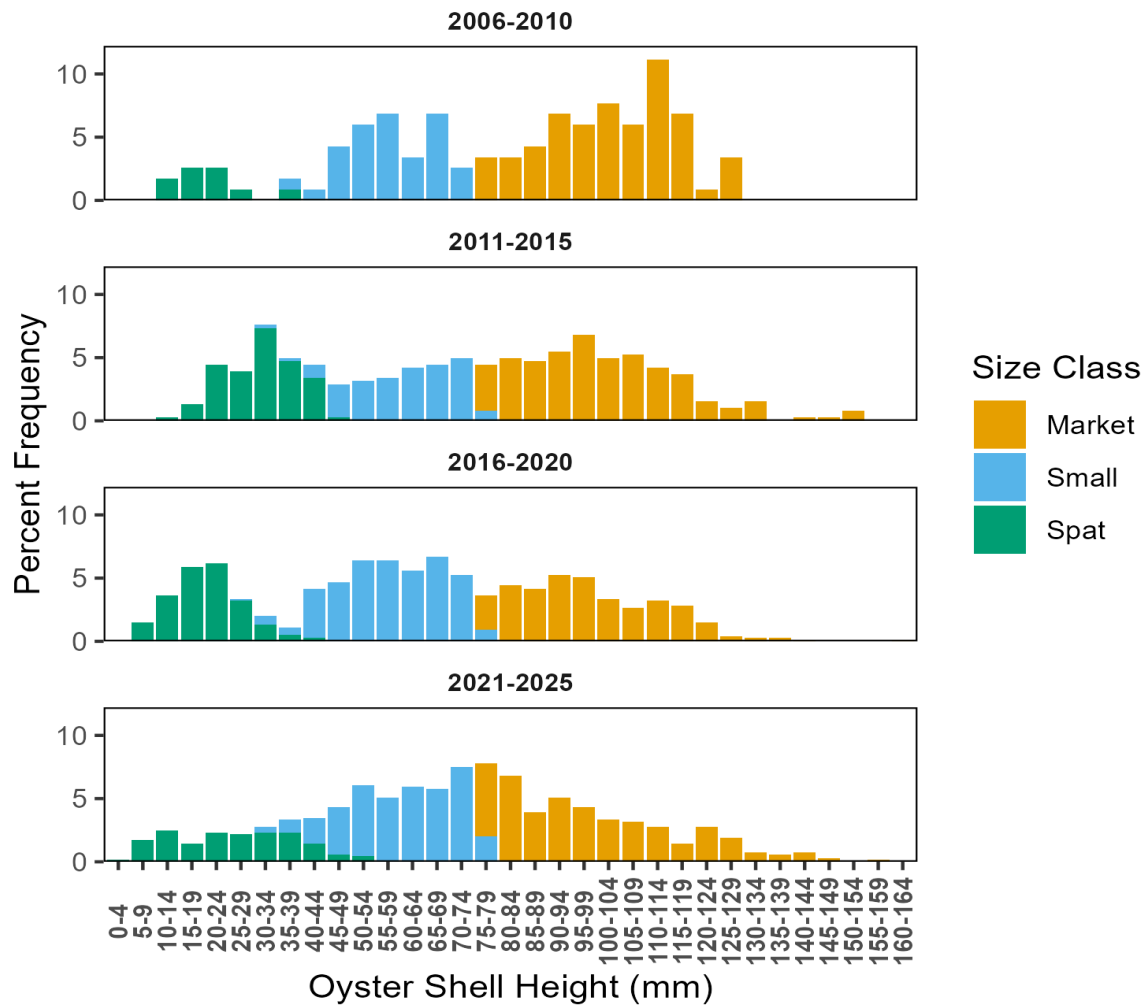


Figure A.32-3. Shell height frequencies of live oysters per bushel of material in the Point Lookout Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey on Point Lookout bar. No data was collected in 2006, 2008, and 2009.

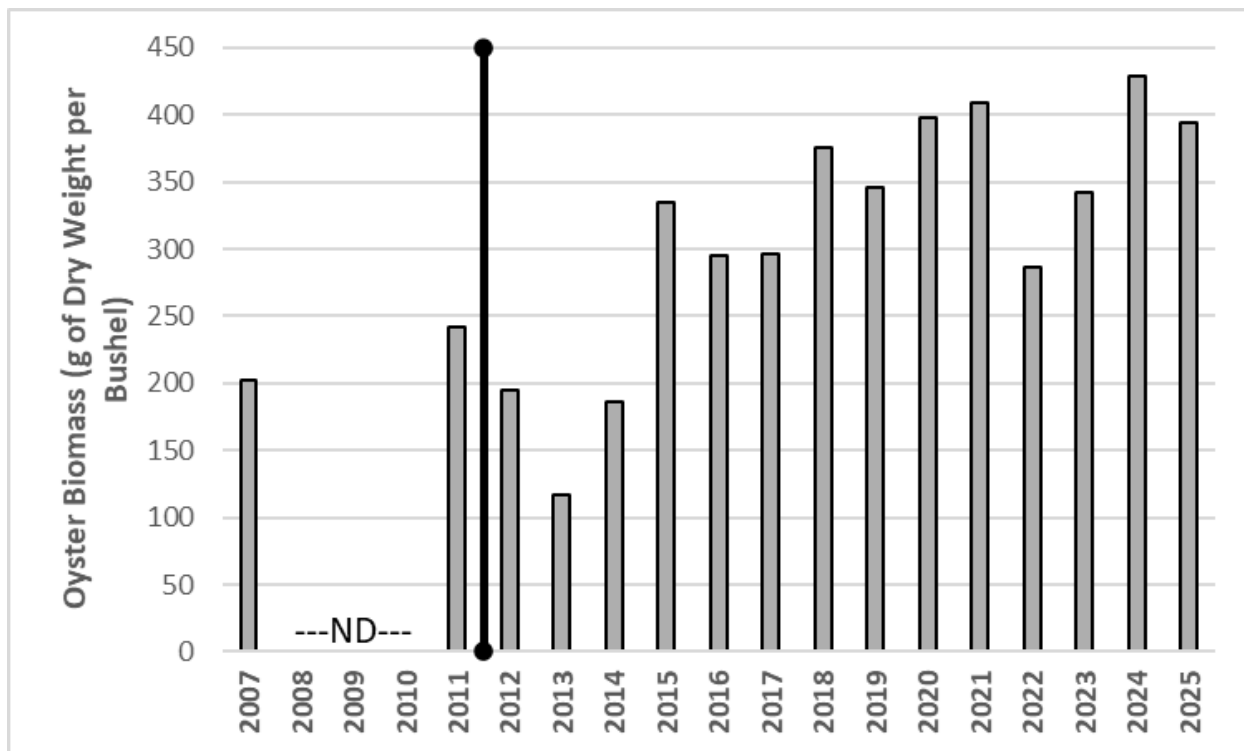


Figure A.32-4. Oyster biomass (grams of dry weight per bushel of material) in the Point Lookout Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey on Point Lookout bar. Black line indicates the date the sanctuary was established. ND = No Data.

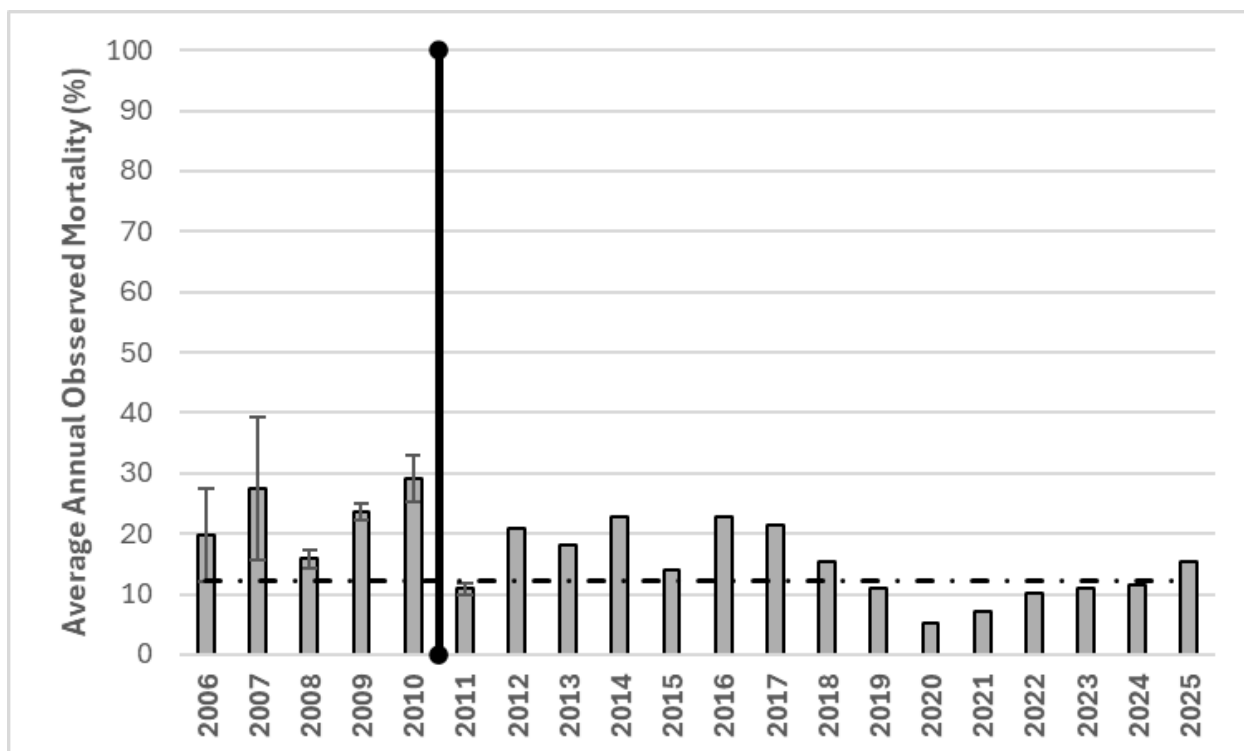


Figure A.32-5. Average annual observed mortality of market-sized and small-sized oysters in Point Lookout Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Black line denotes the date the sanctuary was established, and the dashed line represents the 2006-2025 baywide average observed mortality. Error bars represent ± 1 standard error.

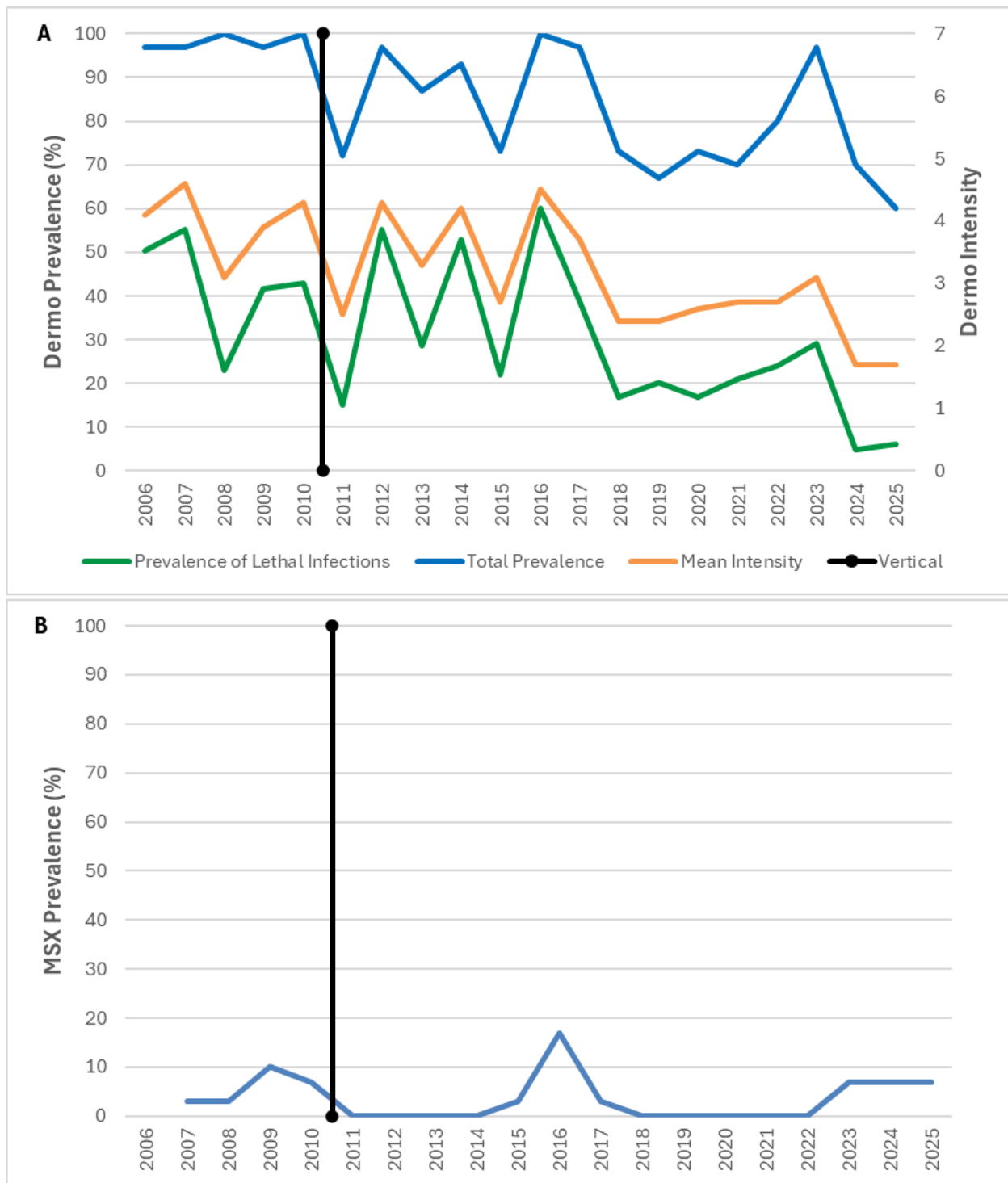


Figure A.32-6. Oyster disease prevalence and intensity in the Point Lookout Sanctuary. (A) Dermo prevalence and mean intensity (B) MSX prevalence (intensity is not examined). Data from Maryland's Annual Fall Oyster Dredge Survey on Point Lookout bar. Black line denotes the date the sanctuary was established.

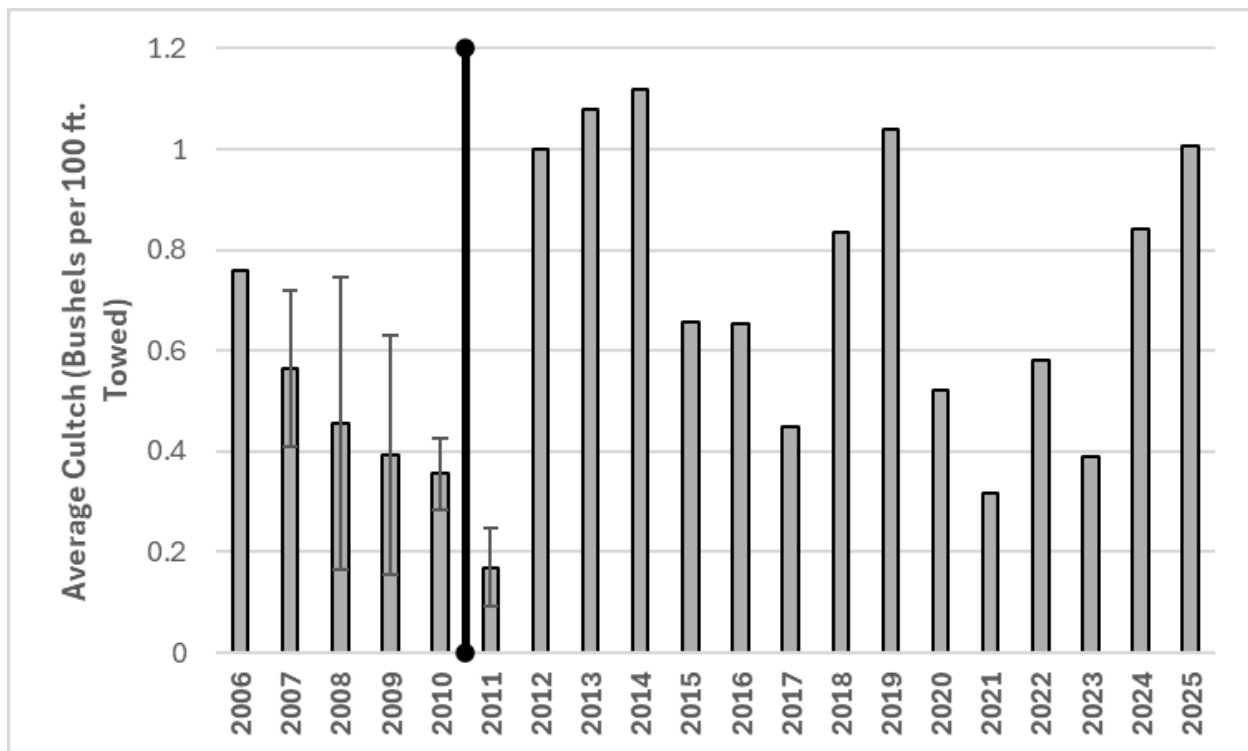


Figure A.32-7. Average cultch (live and dead oysters and loose shell) in the Point Lookout Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Black line denotes the date the sanctuary was established. Error bars represent ± 1 standard error.

Section A.33: Poplar Island Sanctuary

The Poplar Island Sanctuary is located in the central portion of Maryland's Chesapeake Bay, a medium salinity (Zone 2) region within NOAA Code 027. The sanctuary was created in 2003 and encompasses seven acres, all of which is historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments). The sanctuary is located in the southwest corner of the historic Poplar Island bar.

Information available for this sanctuary includes:

- Sanctuary map (Figure A.33-1)
- Density Survey (Figure A.33-2)

Poplar Island Sanctuary is located in the Mid Bay Region of Maryland's Chesapeake Bay. In the Mid Bay Region, oysters typically survive and grow well, remaining largely unaffected by freshets or disease. There are typically low rates of recruitment in this region.

There are no Fall Oyster Survey sites sampled in the Poplar Island Sanctuary.

In 2023 the Department conducted a patent tong population survey and found no live oysters and an average of 0.3 liters of surface shell per square meter.

In the 2021-2025 sanctuary assessment, this sanctuary was classified as receiving restoration. This sanctuary is planned for small-scale restoration in 2026.

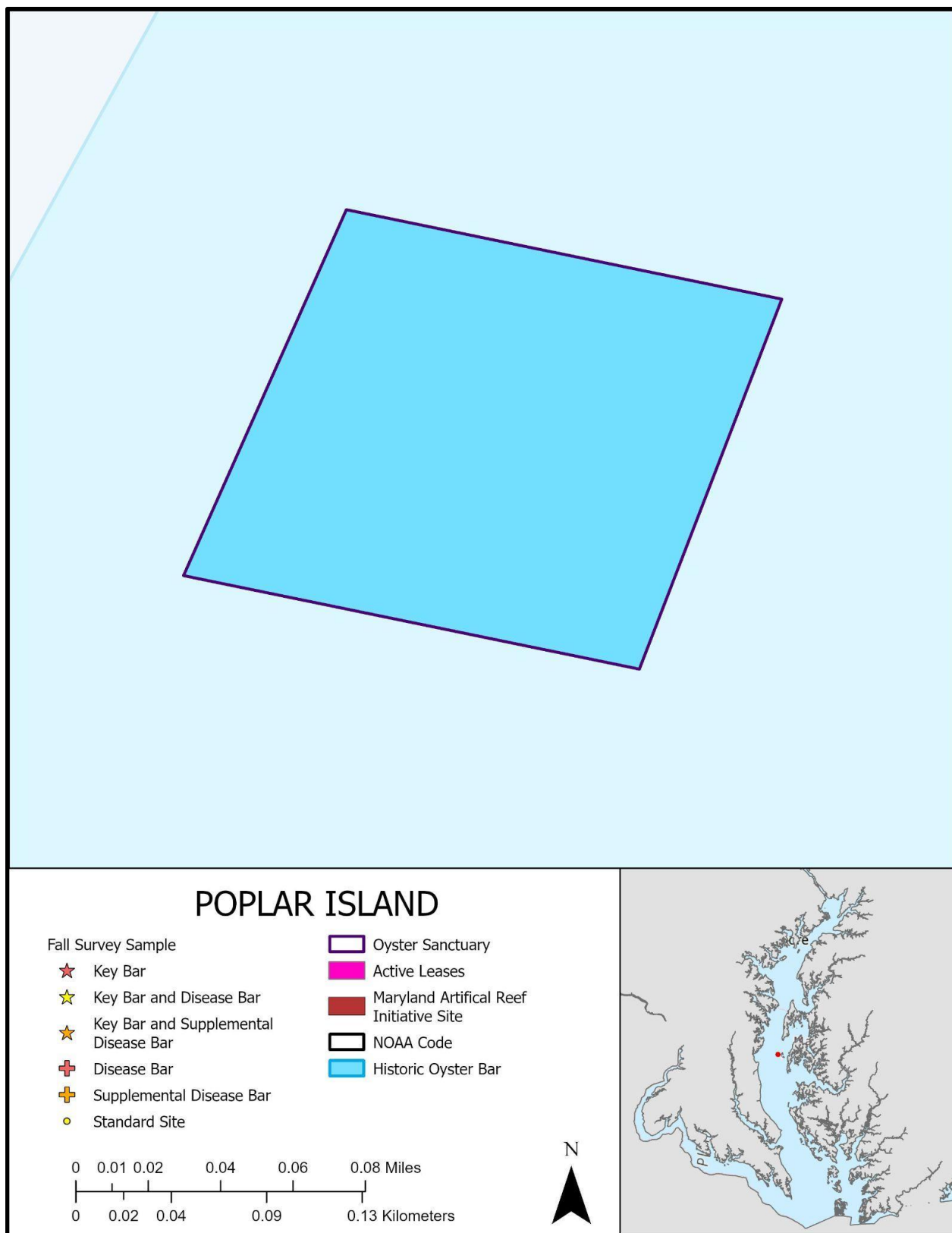


Figure A.33 -1. Poplar Island Sanctuary.

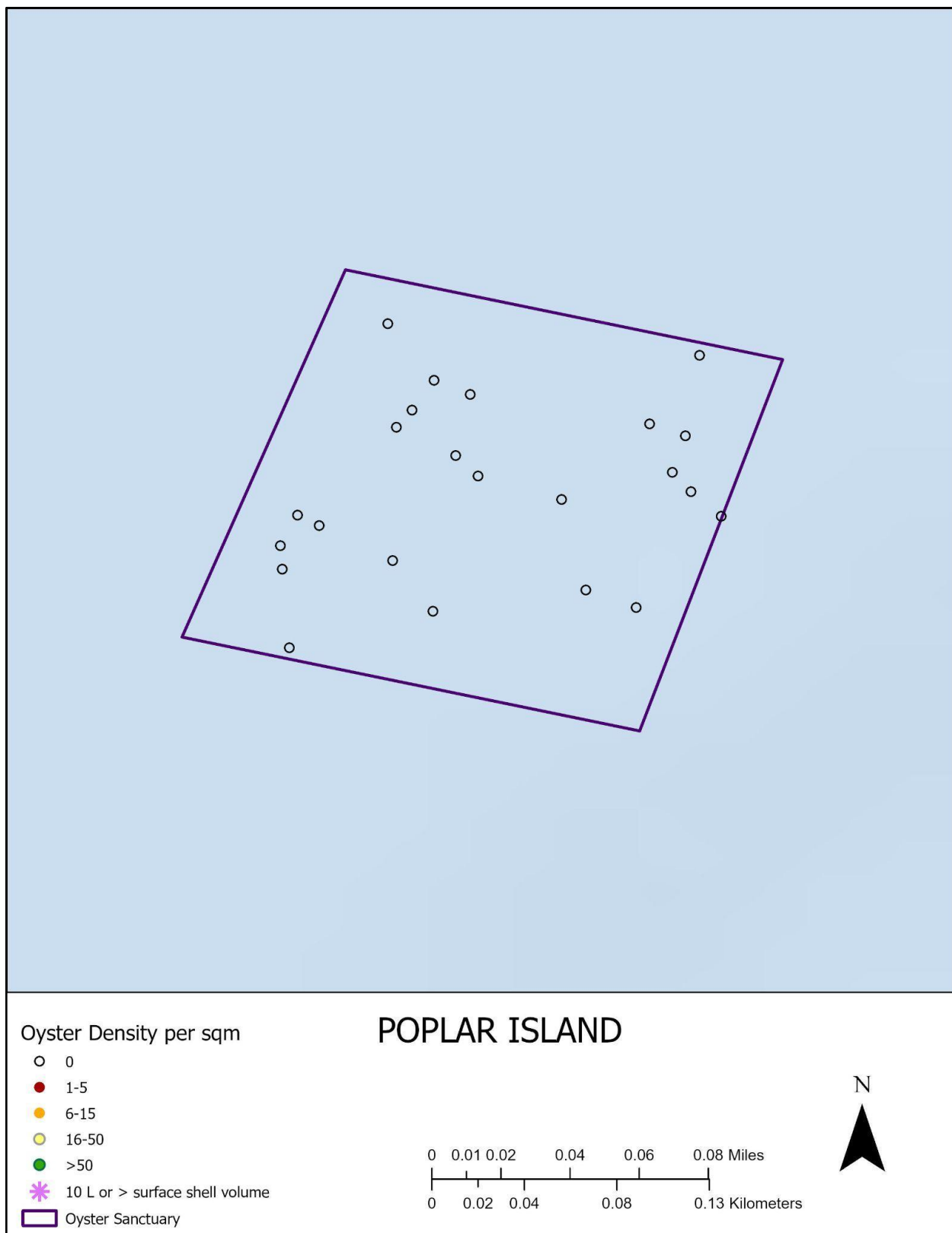


Figure A.33-2. Map of 2023 oyster density in the Poplar Island Sanctuary. Data from Maryland Department of Natural Resources Patent Tong Population Survey.

Section A.34: Prospect Bay Sanctuary

The Prospect Bay Sanctuary is located in Eastern Bay, a medium salinity (Zone 2) region within NOAA Code 039. The sanctuary was created in 2010 and encompasses 1,478 acres of which 1,061 acres (72%) is historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments). There are 3 historic oyster bars within the sanctuary³⁴.

Information available for this sanctuary includes:

- Sanctuary map (Figure A.34-1)
- Summary statistics (Table A.34-1)

Prospect Bay Sanctuary is located in the Eastern Bay Region of Maryland's Chesapeake Bay. Oysters in the Eastern Bay Region generally experience good growth and survival rates. They are typically resilient against disease and freshets, except during multi-year droughts or major freshet events. Natural recruitment occurs regularly in this region.

In 2022 the Department added a standard Fall Oyster Survey site in the Prospect Bay Sanctuary. From 2022-2025, total live density averaged 56 oysters per square meter (market density = 25, small density = 28, spat density = 3), total observed mortality averaged 8.3% and cultch averaged 1.1 bushels per 100 feet towed. Two of the four samples were taken on hatchery spat-on-shell plantings. No densities or mortality were calculated for those samples.

The last patent tong population survey occurred in 2020.

This sanctuary has received spat-on-shell plantings since 2023 as part of the Eastern Bay Regional Project. In the 2021-2025 sanctuary assessment, this sanctuary was classified as receiving restoration.

³⁴ See chart 11 for bar names and locations in the State of Maryland Shellfish Closure Areas Book <http://dnr.maryland.gov/fisheries/Pages/oysters/index.aspx>

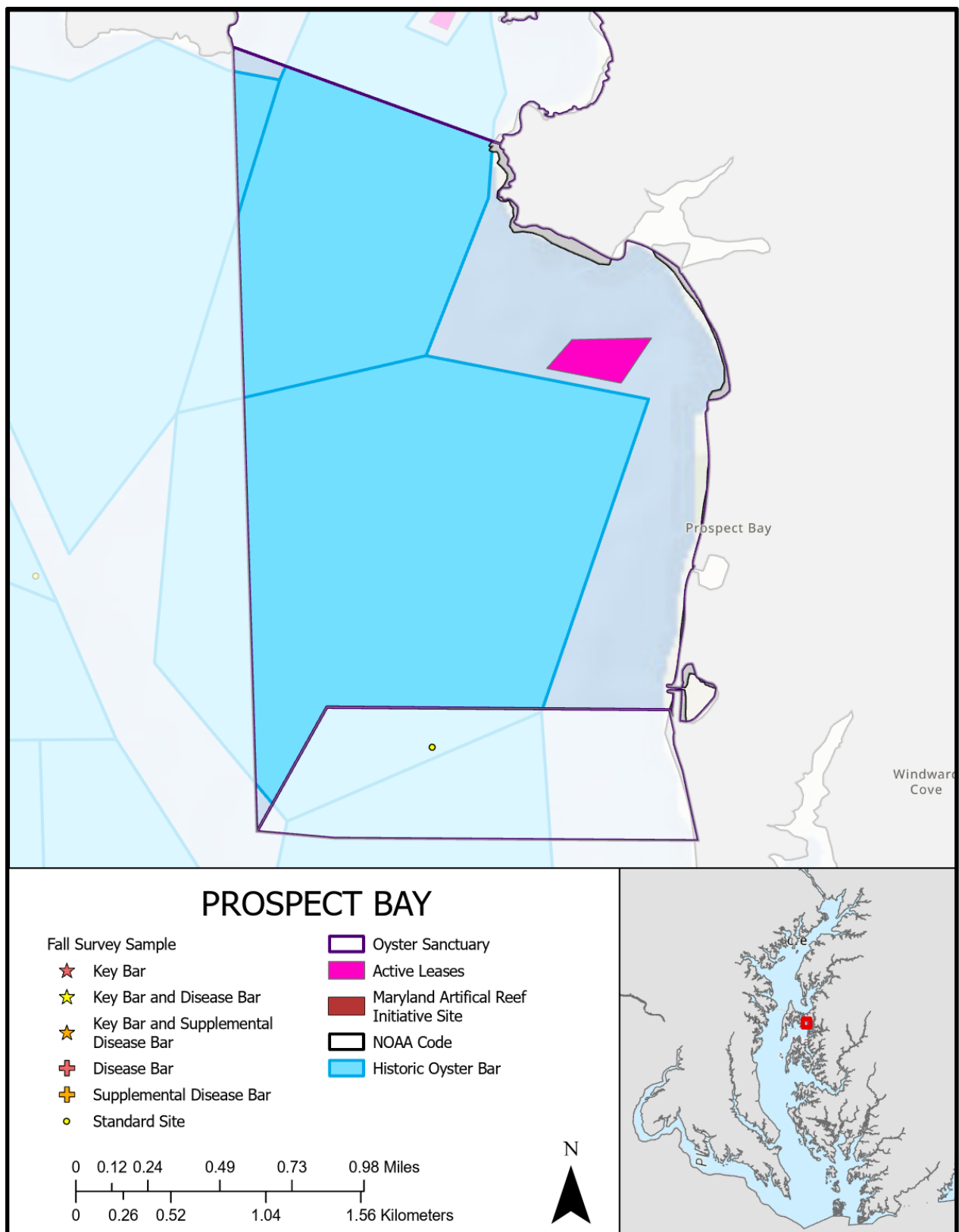


Figure A.34 -1. Prospect Bay Sanctuary.

Table A.34-1. Oyster population characteristics based on the Fall Oyster Survey in the Prospect Bay Sanctuary. ND=No Data. Values given are annual mean $\pm$ standard error.

Oyster Characteristic	2006-2010	2011-2015	2016-2020	2021-2025
Number of years sampled/number of samples	ND	ND	ND	4/4
Number of Live Spat Oysters per square meter	ND	ND	ND	3 $\pm$ 0.03
Number of Live Small Oysters per square meter	ND	ND	ND	28 $\pm$ 2.8
Number of Live Market Oysters per square meter	ND	ND	ND	25 $\pm$ 6.4
Number of Live Oysters per square meter	ND	ND	ND	56 $\pm$ 9.3
Live Biomass (g Dry Weight per Bushel)	ND	ND	ND	ND
Observed Mortality (%)	ND	ND	ND	8.3 $\pm$ 8.3
Cultch (Bushels per 100 feet towed)	ND	ND	ND	1.1 $\pm$ 0.4

Section A.35: Prospect Bay Cabin Creek Sanctuary

The Prospect Bay Cabin Creek Sanctuary is located in Eastern Bay, a low salinity (Zone 1) region within NOAA Code 039. The sanctuary was created in 2005 for restoration work by the Chesapeake Bay Environmental Center, which was designated by the State as a site for testing and developing comprehensive restoration techniques that might have bay-wide application for enhancing oyster stocks. The sanctuary encompasses 298 acres of which 128 (43%) is historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments). There is one historic oyster bar (Cabin Creek bar) within the sanctuary.

Information available for this sanctuary includes:

- Sanctuary map (Figure A.35-1)

Prospect Bay Cabin Creek Sanctuary is located in the Eastern Bay Region of Maryland's Chesapeake Bay. Oysters in the Eastern Bay Region generally experience good growth and survival rates. They are typically resilient against disease and freshets, except during multi-year droughts or major freshet events. Natural recruitment occurs regularly in this region.

There are no Fall Oyster Survey sites within the Prospect Bay Cabin Creek Sanctuary.

This sanctuary was created to evaluate restoration techniques for the Chesapeake Bay Environmental Center. This area is predominantly shallow and lacks oyster habitat. It features oyster castles, making it impossible to survey with the Department's sampling gears (either dredging or patent tongs).

This sanctuary was one of the sanctuaries identified by the Department as unlikely to receive a large investment by the Department for restoration and is under evaluation by the Oyster Advisory Commission for potential efforts to improve its performance.

In the 2021-2025 sanctuary assessment, this sanctuary was classified as created for NGO use.

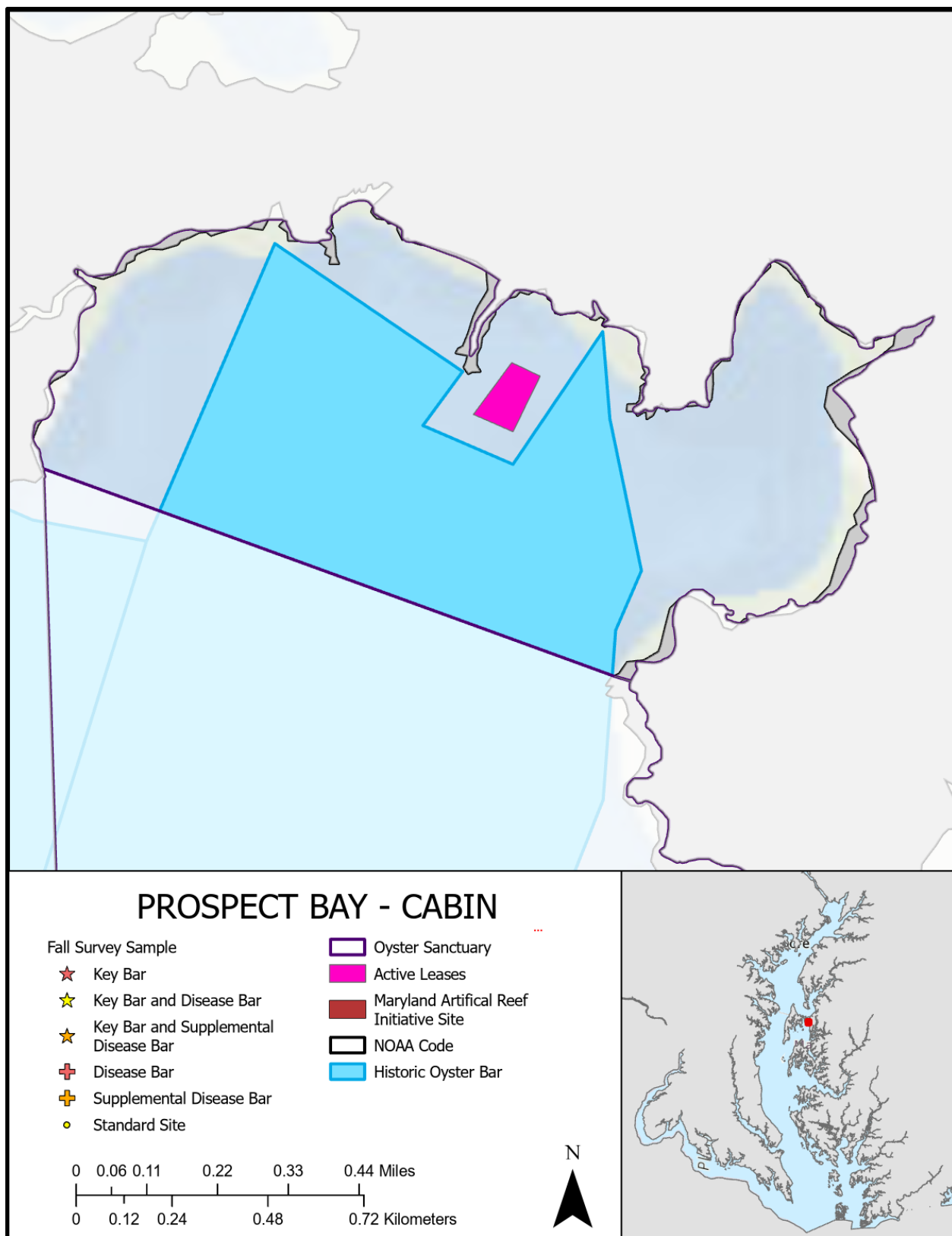


Figure A.35-1. Prospect Bay Cabin Creek Sanctuary.

Section A.36: Ringgold Sanctuary

The Ringgold Sanctuary is located in the upper Chester River, a low salinity (Zone 1) region within NOAA Code 231. The sanctuary was created in 2001 and encompasses 120 acres of which 63 (52%) is historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments). There is one historic oyster bar (Bay Bush Point bar) within the sanctuary. The sanctuary was created for a project by the U.S. Army Corps of Engineers designed to examine differences in oyster growth, mortality and disease prevalence between hatchery spat-on-shell and natural seed and between bars constructed with a minimum of 150 cm relief above the bottom and “flat” bars, with no more than 15 cm relief above the bottom³⁵.

Information available for this sanctuary includes:

- Sanctuary map (Figure A.36-1)

Ringgold Sanctuary is located in the Upper Bay Region of Maryland's Chesapeake Bay. Oysters in the Upper Bay Region generally grow well and survive but can be impacted by freshet events. Low salinity conditions contribute to a lower rate of natural recruitment.

There are no Fall Oyster Survey sites within the Ringgold Sanctuary.

The last patent tong survey in this sanctuary was in 2020. This sanctuary has a large portion of alternate substrate and is not easily sampled with the Department's gear (dredge or patent tong).

This sanctuary is receiving small-scale restoration plantings in 2025-2026. In the 2021-2025 sanctuary assessment, this sanctuary was classified as lacking data and receiving restoration.

³⁵ Paynter, K. T., 2007. A 10-Year Review of Maryland's Hatchery-based Oyster Restoration Program: 1997-2006. A Summary of Monitoring and Research Conducted by the Paynter Laboratory at the University of Maryland.

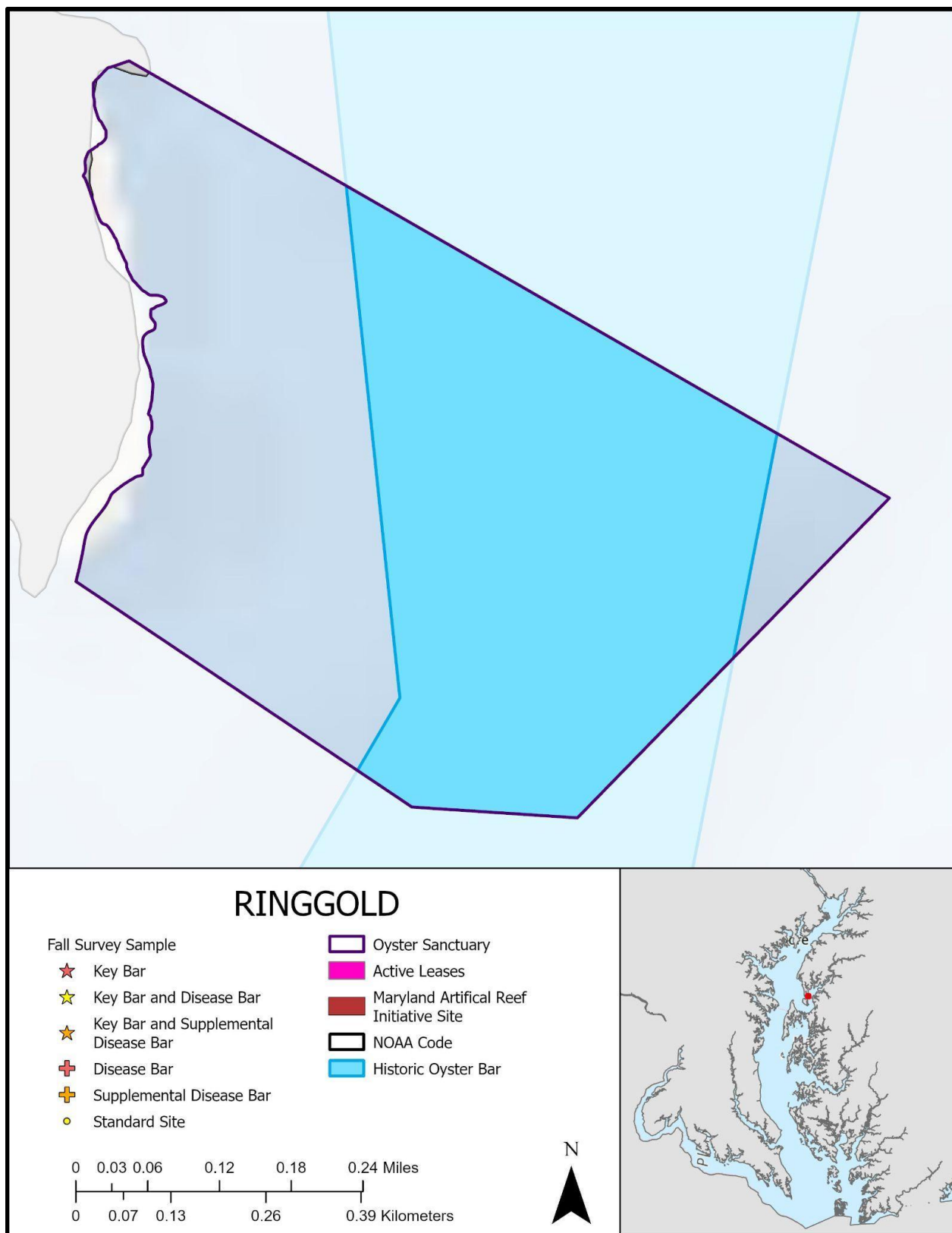


Figure A.36-1. Ringgold Sanctuary.

Section A.37: Nanticoke River-Roaring Point Sanctuary

The Nanticoke River-Roaring Point Sanctuary is located at the mouth of the Nanticoke River, a medium salinity (Zone 2) region within NOAA Code 062. The sanctuary was created in 2004 and encompasses 10 acres of which none is historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments). Nanticoke River-Roaring Point Sanctuary was created from an old oyster lease for oyster restoration by the Chesapeake Bay Foundation.

Information available for this sanctuary includes:

- Sanctuary map (Figure A.37-1)
- Density Survey (Figure A.37-2)

Nanticoke River-Roaring Point Sanctuary is located in the Lower Eastern Shore Region of Maryland's Chesapeake Bay. Oysters in the Lower Eastern Shore Region generally grow well but can be impacted by disease. Higher salinity in the area contributes to higher natural recruitment.

There are no Fall Oyster Survey sites within the Nanticoke River-Roaring Point Sanctuary.

The Department conducted a patent tong population survey in 2025 and found an average of 8.4 oysters per square meter and an average volume of 1.5 liters per square meter of surface shell. All oysters were found in an area that received restoration.

In the 2021-2025 sanctuary assessment, this sanctuary was classified as being created for NGO use.

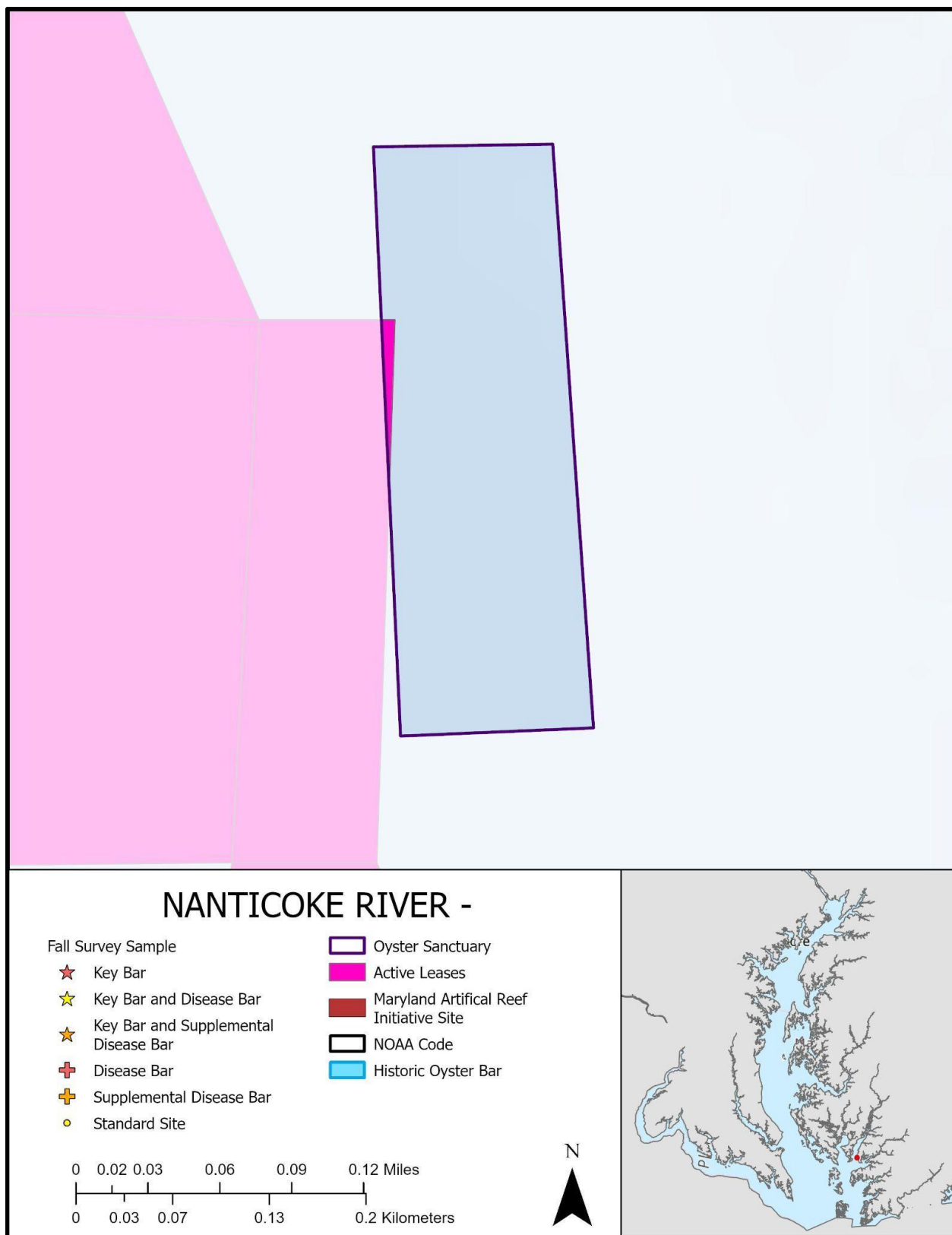


Figure A.37-1. Nanticoke River-Roaring Point Sanctuary.

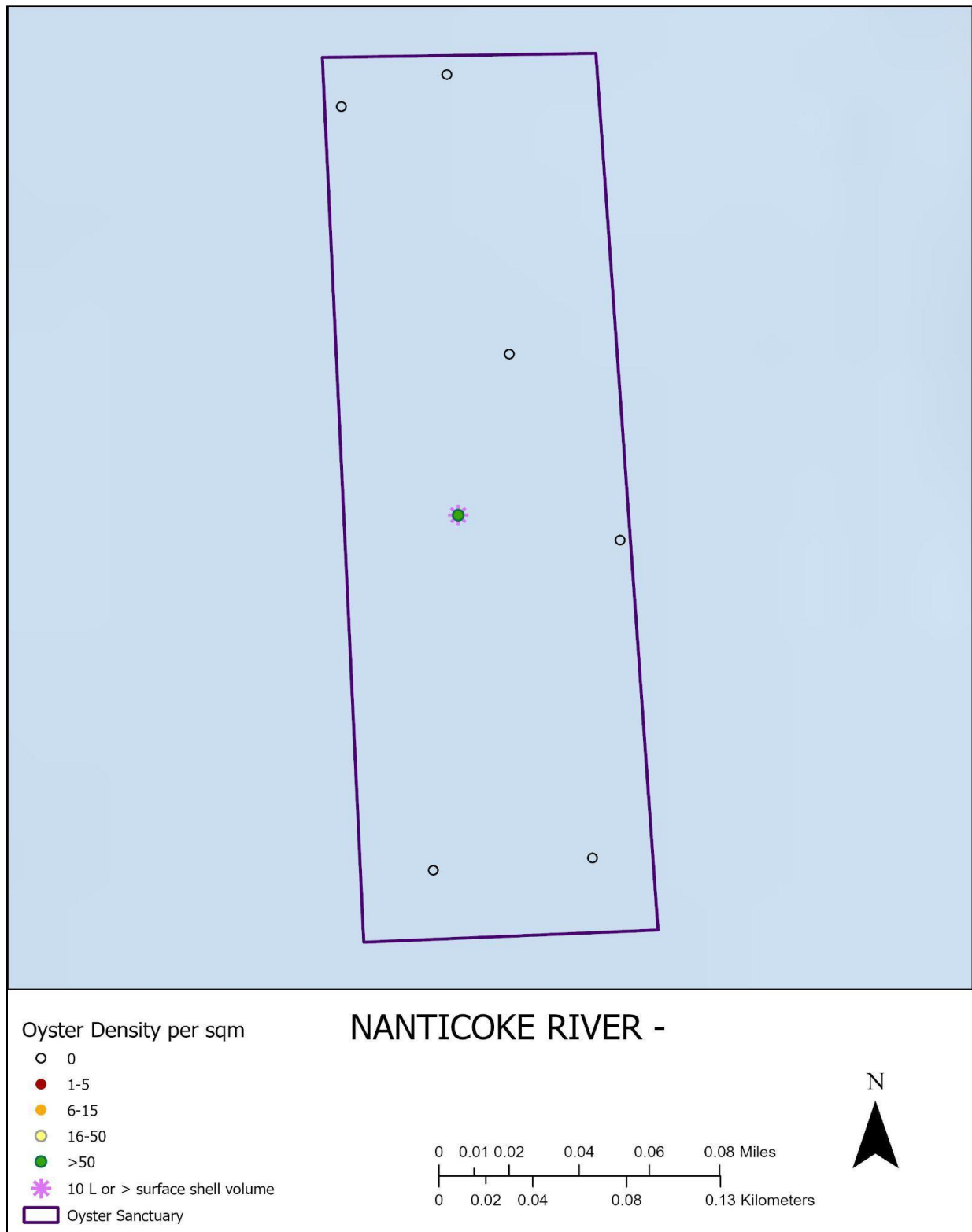


Figure A.37-2. Map of 2025 oyster density in the Nanticoke River-Roaring Point Sanctuary. Data from Maryland Department of Natural Resources Patent Tong Population Survey.

Section A.38: Sandy Hill Sanctuary

The Sandy Hill Sanctuary is located in the middle Choptank River, a low salinity (Zone 1) region of Maryland within NOAA Code 237. This sanctuary connects the Lower and Upper Choptank River sanctuaries on the southern shore of the river, creating a large contiguous sanctuary area. The sanctuary was created in 2009 and encompasses 1,947 acres of which 1,308 (67%) is historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments). Sandy Hill Sanctuary encompasses one older sanctuary, University of Maryland's Horn Point Sanctuary, which has ten surface acres, all of which is historic oyster bottom. Thus, the total surface area is 1,957 acres and the total historic oyster bottom is 1,318 acres (67%). There are 11 historic oyster bars within the sanctuary³⁶. This sanctuary was created based on recommendations from the Oyster Advisory Commission to establish larger oyster sanctuaries in a range of salinities.

Information available for this sanctuary includes:

- Sanctuary map (Figure A.38-1)
- Density Survey (Figure A.38-2)
- Summary statistics (Table A.38-1)
- Density per year (Figure A.38-3)
- Shell height frequencies (Figure A.38-4)
- Biomass per year (Figure A.38-5)
- Observed mortality (Figure A.38-6)
- Dermo and MSX per year (Figure A.38-7)
- Cultch per year (Figure A.38-8)

Sandy Hill Sanctuary is located in the Choptank Region of Maryland's Chesapeake Bay. Oysters in the Choptank Region generally grow well but may be impacted by disease or freshet events. Natural recruitment occurs regularly in this region.

The Fall Oyster Survey has one supplemental key and supplemental disease bar site in the Sandy Hill Sanctuary. Table A.38-1 shows an increase in the average number of oysters, biomass, and cultch from 2021-2025 compared to the previous 5-year increments, while exhibiting low average observed mortality. The observed mortality increased slightly in 2024, following an increase in lethal dermo disease and MSX prevalences in 2023 (Figures A.38-6, A38-7). The average cultch per 100 ft tow indicates insufficient cultch availability.

In 2022 the Department conducted a patent tong population survey and found an average of 1.2 oysters per square meter and an average volume of 1.3 liters per square meter of surface shell. The 2015 survey had an average of 2 oysters per square meter and 1.9 liters per square meter of surface shell.

In the 2021-2025 sanctuary assessment, this sanctuary was classified as trending positively.

³⁶ See chart 20 for bar names and locations in the State of Maryland Shellfish Closure Areas Book
<http://dnr.maryland.gov/fisheries/Pages/oysters/index.aspx>

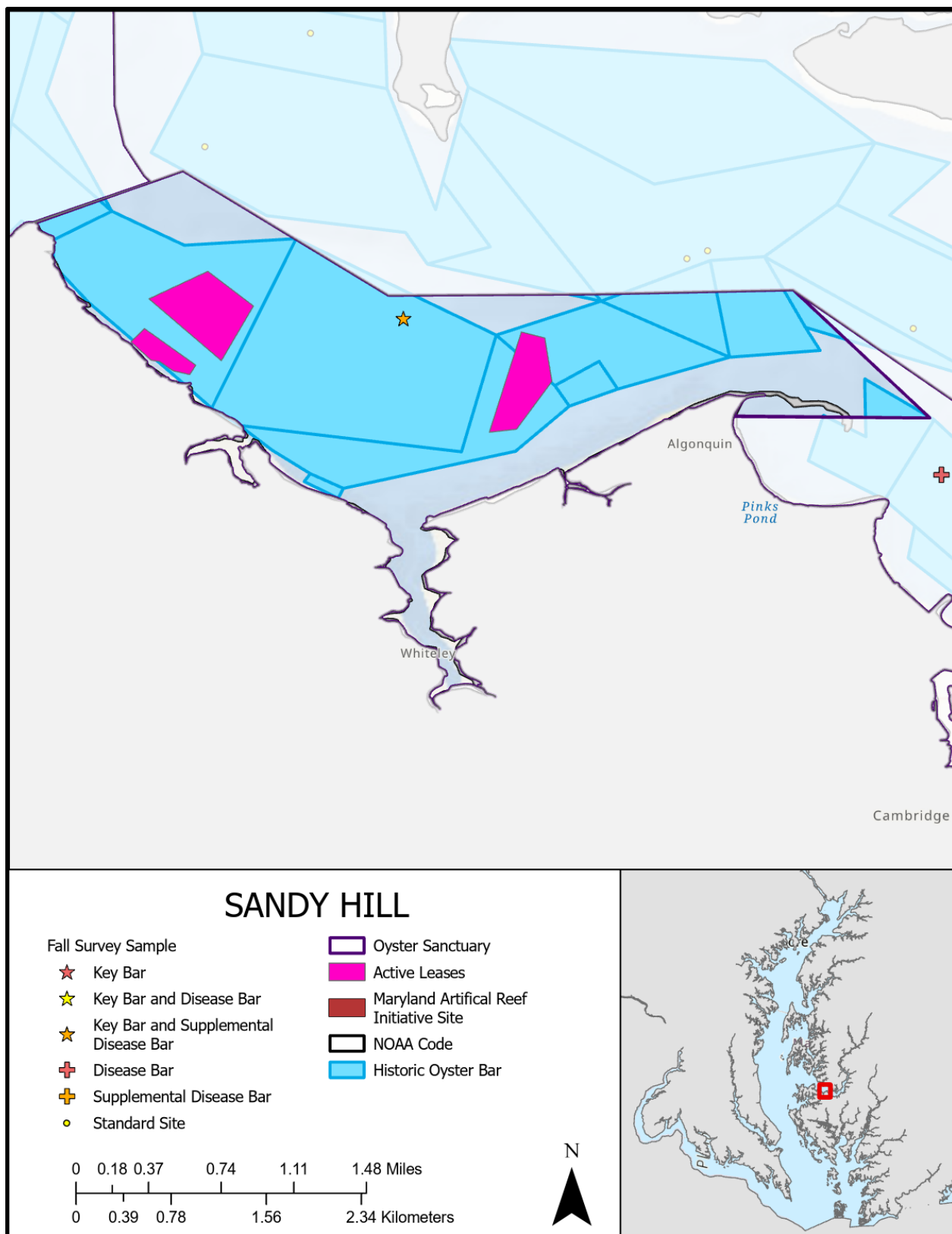


Figure A.38-1. Sandy Hill Sanctuary.

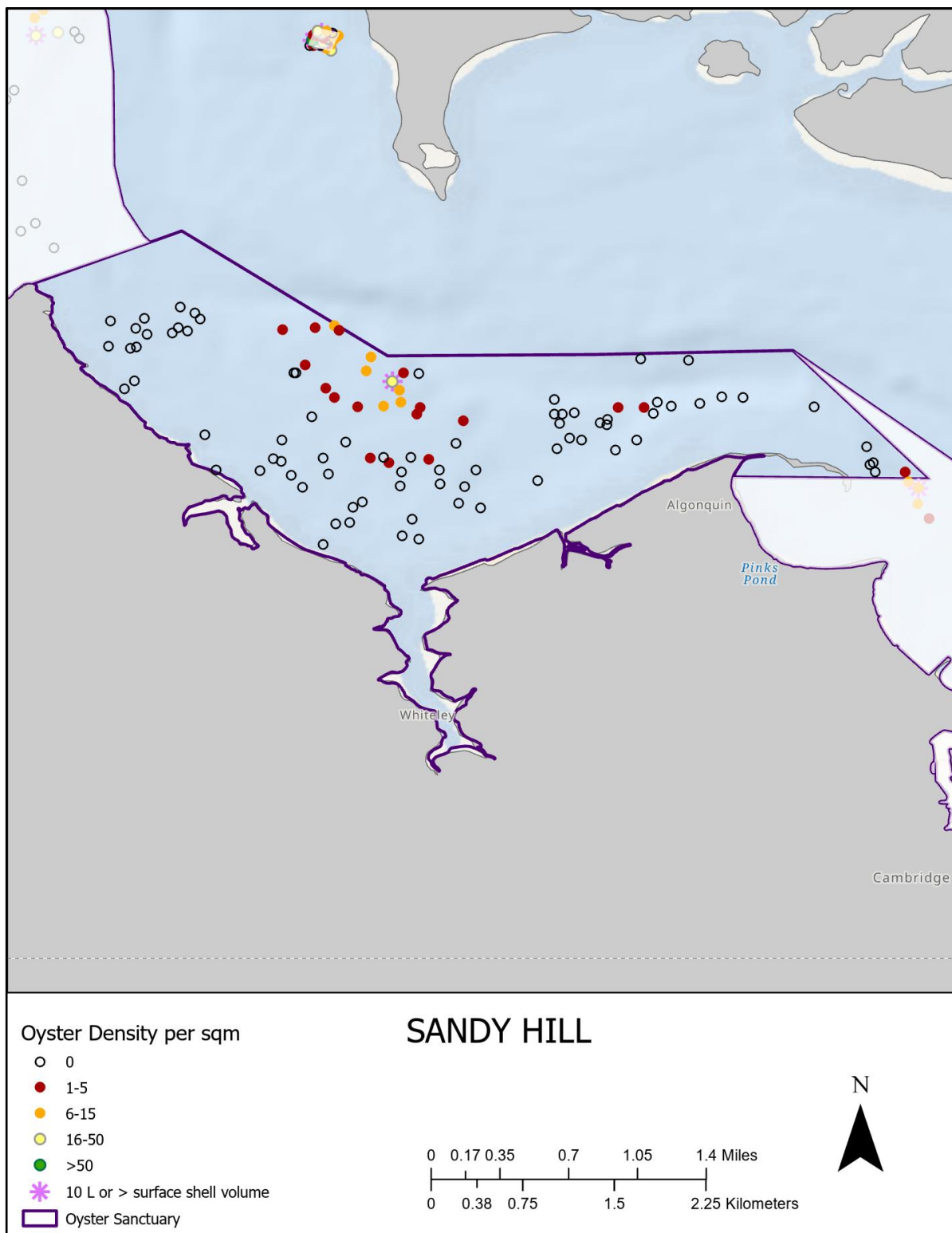


Figure A.38-2. Map of 2025 oyster density in the Sandy Hill Sanctuary. Data from Maryland Department of Natural Resources Patent Tong Population Survey.

Table A.38-1. Oyster population characteristics based on the Fall Oyster Survey in the Sandy Hill Sanctuary. ND=No Data. Values given are annual mean $\pm$ standard error.

Oyster Characteristic	2006-2010	2011-2015	2016-2020	2021-2025
Number of years sampled/number of samples	5/5	5/5	5/5	5/5
Number of Live Spat Oysters per square meter	0.78 $\pm$ 0.28	0.53 $\pm$.42	0.75 $\pm$ 0.35	25.1 $\pm$ 17.9
Number of Live Small Oysters per square meter	0.74 $\pm$ 0.21	3.2 $\pm$ 1.1	2.5 $\pm$ 0.78	14.1 $\pm$ 2.3
Number of Live Market Oysters per square meter	3.5 $\pm$ 0.28	15.1 $\pm$ 2.9	17.1 $\pm$ 2.1	44.7 $\pm$ 8.5
Number of Live Oysters per square meter	5.1 $\pm$ 0.4	19 $\pm$ 2.7	20.4 $\pm$ 3.1	84 $\pm$ 25
Live Biomass (g Dry Weight per Bushel)	60 $\pm$ 10	200 $\pm$ 43	193 $\pm$ 13	276 $\pm$ 27
Observed Mortality (%)	7.5 $\pm$ 4.1	8.3 $\pm$ 1.8	11.2 $\pm$ 2	9.1 $\pm$ 2
Cultch (Bushels per 100 feet towed)	0.5 $\pm$ 0.1	0.6 $\pm$ 0.1	0.7 $\pm$ 0.1	1.1 $\pm$ 0.2

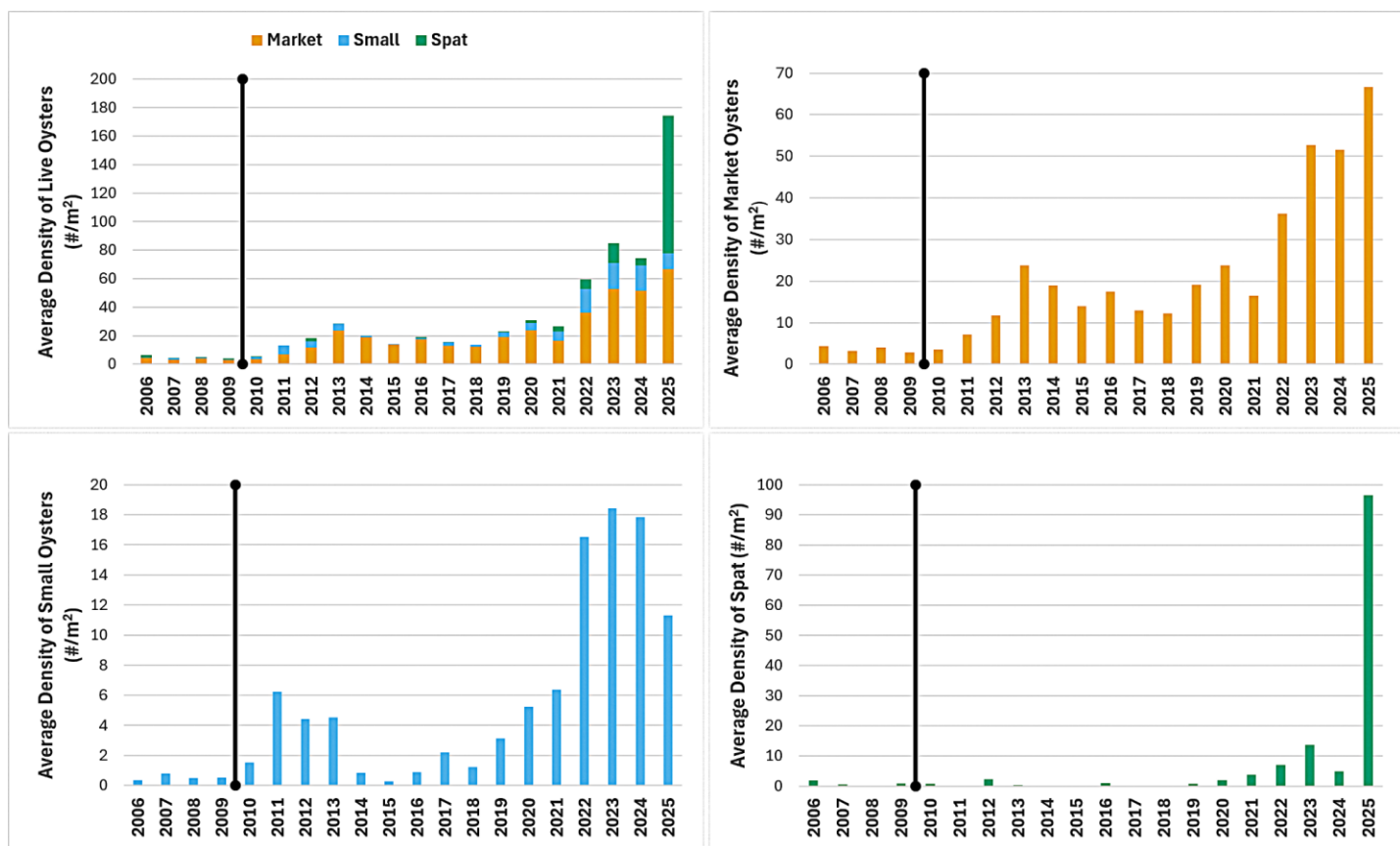


Figure A.38-3. Average number of live oysters per square meter by size class in the Sandy Hill Sanctuary. Black line indicates the date the sanctuary was established. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales.

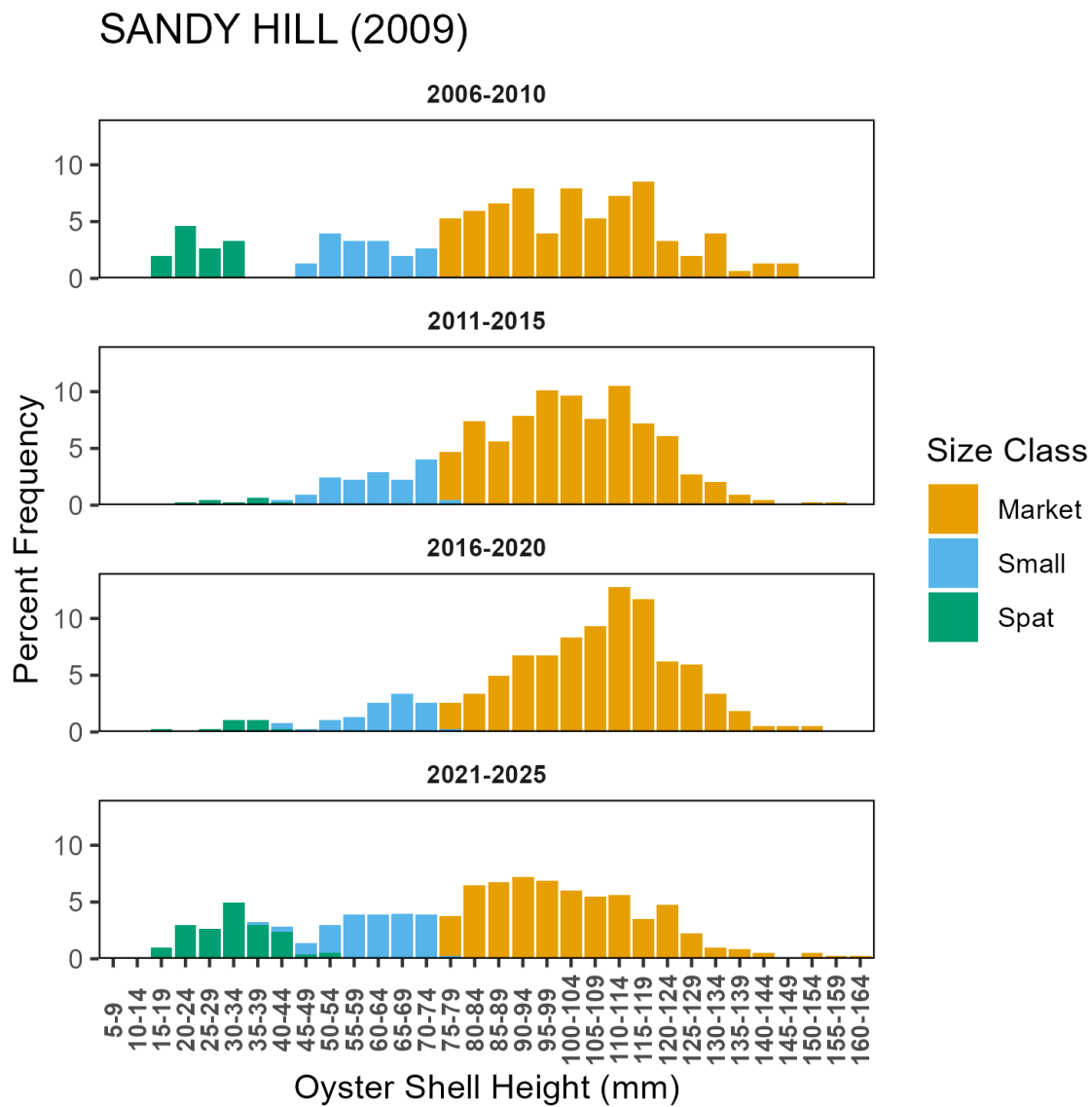


Figure A.38-4. Shell height frequencies of live oysters in the Sandy Hill Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey on Sandy Hill bar.

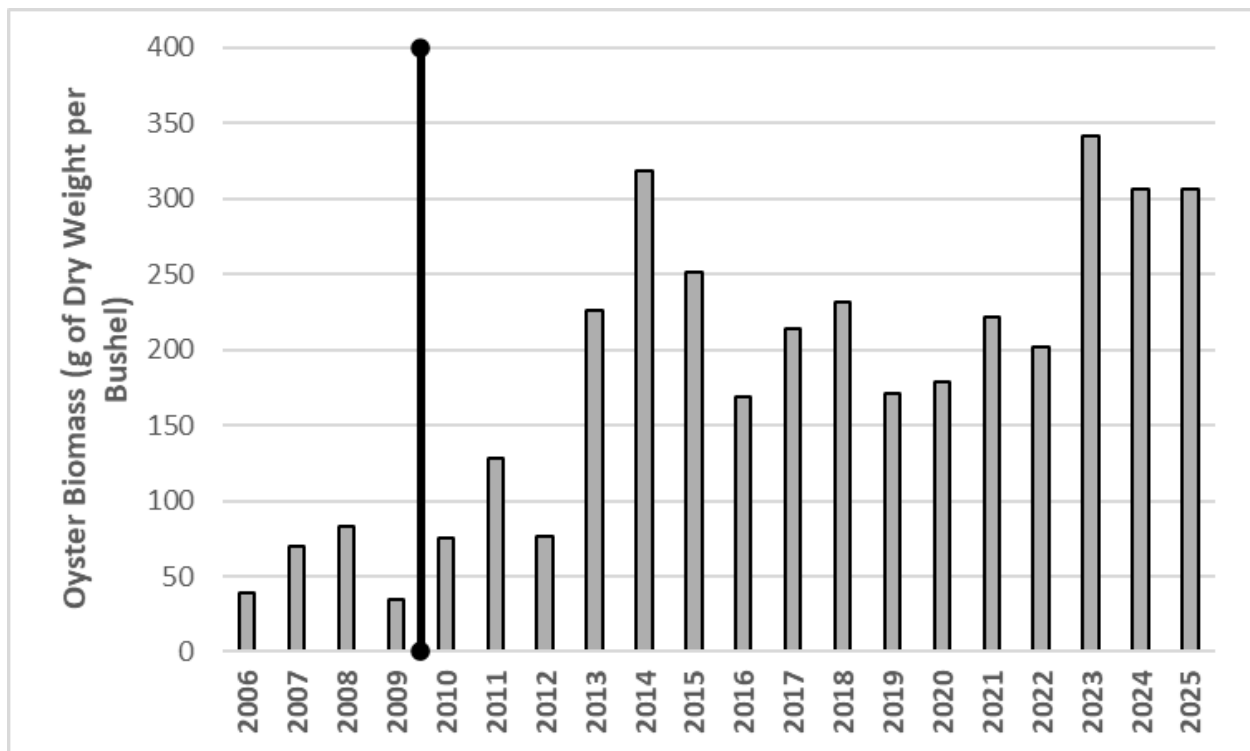


Figure A.38-5. Oyster biomass (grams of dry weight per bushel of material) in the Sandy Hill Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey on Sandy Hill bar. Black line indicates the date the sanctuary was established.

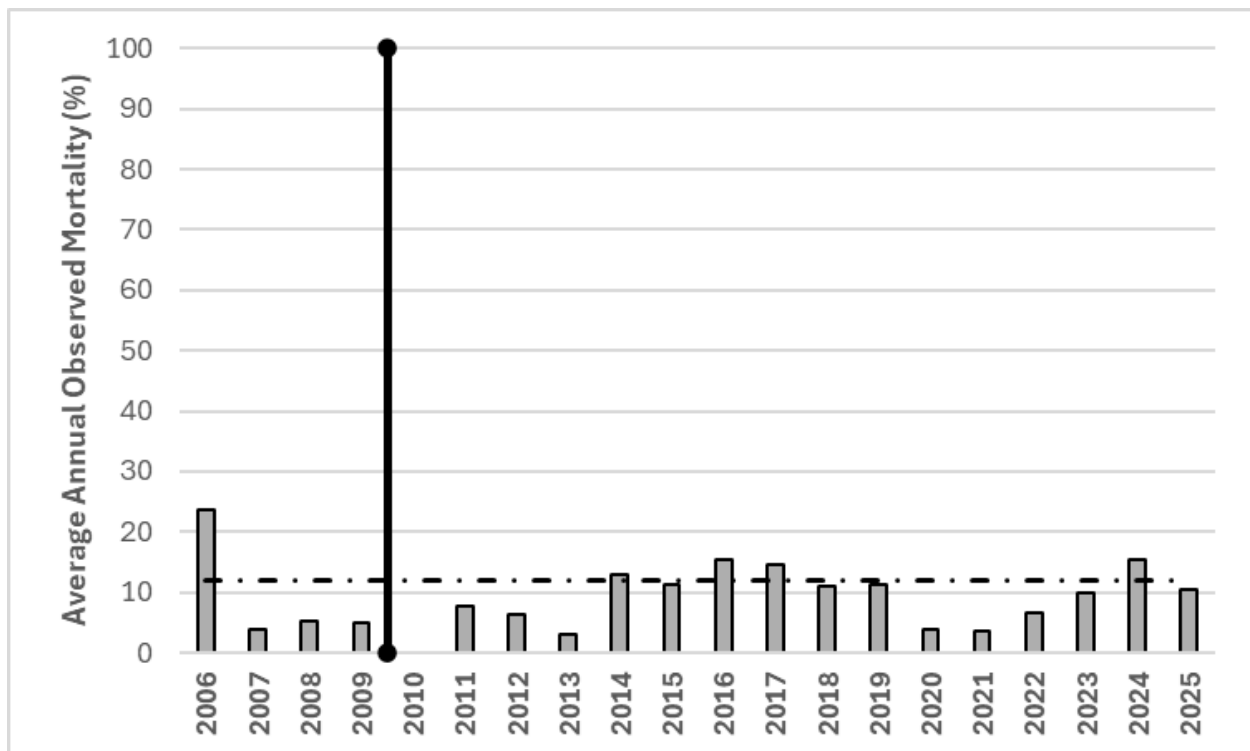


Figure A.38-6. Average annual observed mortality of market-sized and small-sized oysters in Sandy Hill Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Black line denotes the date the sanctuary was established, and the dashed line represents the 2006-2025 baywide average observed mortality.

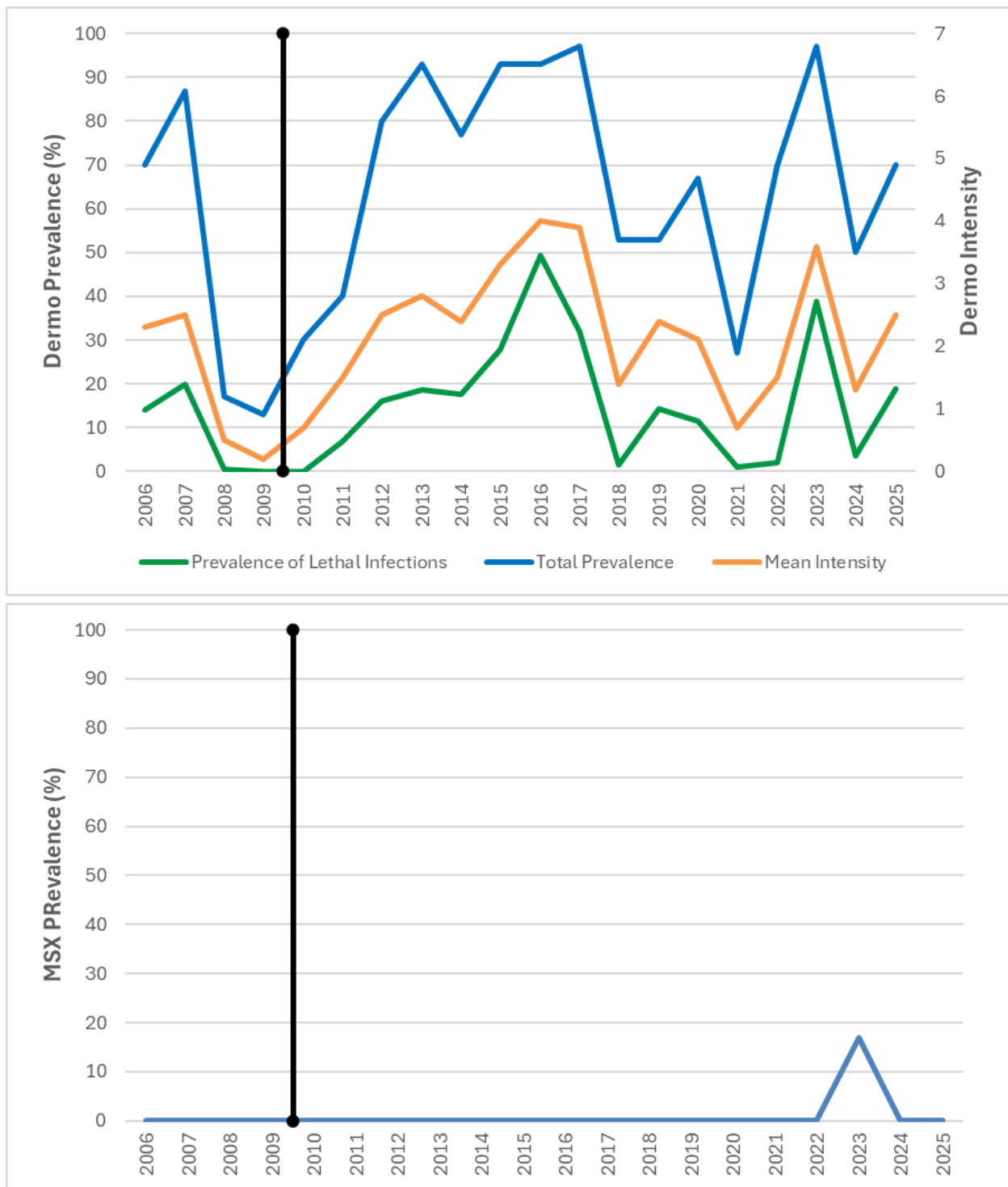


Figure A.38-7. Oyster disease prevalence and intensity in the Sandy Hill Sanctuary. (A) Dermo prevalence and mean intensity (B) MSX prevalence (intensity is not examined). Data from Maryland's Annual Fall Oyster Dredge Survey on Sandy Hill bar. Black line denotes the date the sanctuary was established.

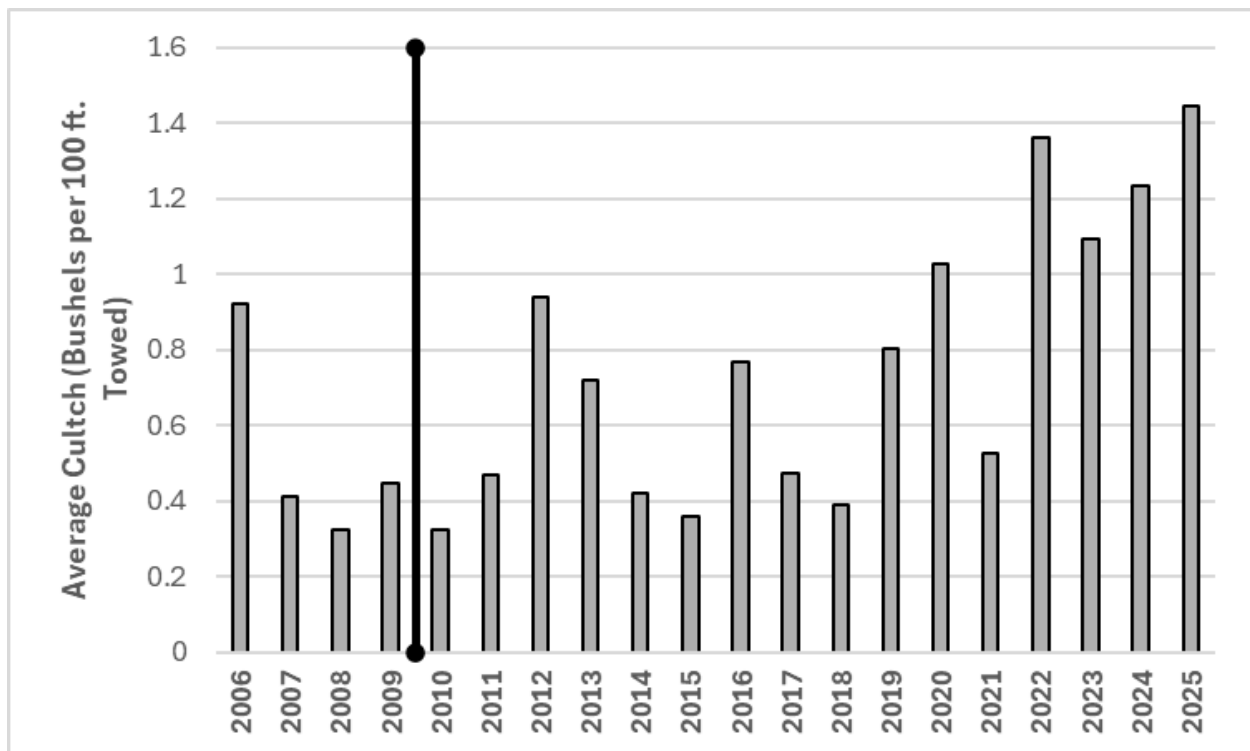


Figure A.38-8. Average cultch (live and dead oysters and loose shell) in the Sandy Hill Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Black line denotes the date the sanctuary was established.

Section A.39: Severn River Sanctuary

The Severn River Sanctuary encompasses the entire Severn River, a tributary of the upper western Chesapeake Bay within NOAA Codes 082 and 127, in a low salinity (Zone 1) region. In 1998, 6,719 acres were designated by Maryland Department of the Environment (MDE) as restricted from harvest due to potential contamination of shellfish by fecal coliform and other bacteria. This restricted area constituted most of the river and essentially made the area a sanctuary since no harvest was allowed. In 2010, 7,804 acres were designated as a sanctuary. Within the sanctuary, 1,376 (18%) acres are historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments). There are 27 historic oyster bars within the sanctuary³⁷.

Information available for this sanctuary includes:

- Sanctuary map (Figure A.39-1)
- Density Survey (Figure A.39-2)
- Summary statistics (Table A.39-1)
- Density per year (Figure A.39-3A)
- Density per year, without plantings (Figure A.39-3B)
- Shell height frequencies (Figure A.39-4)
- Biomass per year (Figure A.39-5)
- Observed mortality (Figure A.39-6)
- Cultch per year (Figure A.39-7)
- Average Dive Densities (Table A.39-2)
- Dive Survey (Figure A.39-8)

Severn River Sanctuary is located in the Upper Bay Region of Maryland's Chesapeake Bay. Oysters in the Upper Bay Region generally grow well and survive but can be impacted by freshet events. Low salinity levels contribute to a lower rate of natural recruitment.

The Fall Oyster Survey has two standard sites in the Severn River Sanctuary. Table A.39-1 shows an increase in the average number of oysters and biomass from 2021-2025 compared to the previous 5-year increments, while exhibiting low average observed mortality. This increase can be attributed to a hatchery spat-on-shell planting in 2022. The average cultch per 100 ft tow indicates sufficient cultch availability. It should be noted that given limitations of traditional gear types, not all restored areas are surveyed by the Department.

In 2022, the Department conducted a patent tong population survey and found an average of 0.5 oysters per square meter and 0.5 liters of surface shell per square meter. In a 2012 survey an average of 2.2 oysters per square meter and 1.3 liters of surface shell was found.

A significant portion of the restored zones in this sanctuary are situated on alternative substrates, rendering them unsuitable for sampling with the Department's standard gear types (dredge and patent tong). In 2022, the U.S. Army Corps of Engineers conducted

³⁷ See chart 9 for bar names and locations in the State of Maryland Shellfish Closure Areas Book
<http://dnr.maryland.gov/fisheries/Pages/oysters/index.aspx>

diving surveys on alternate substrate sites that have received restoration. Locations of their dive sites can be found in Figure A.39-9 and the observed oyster densities in Table A.39-2. In 2022-2023 the sanctuary received spat-on-shell plantings for the small-scale restoration project. It has also received spat-on-shell plantings by NGOs.

In the 2021-2025 sanctuary assessment, this sanctuary was classified as trending positively with a high oyster density.

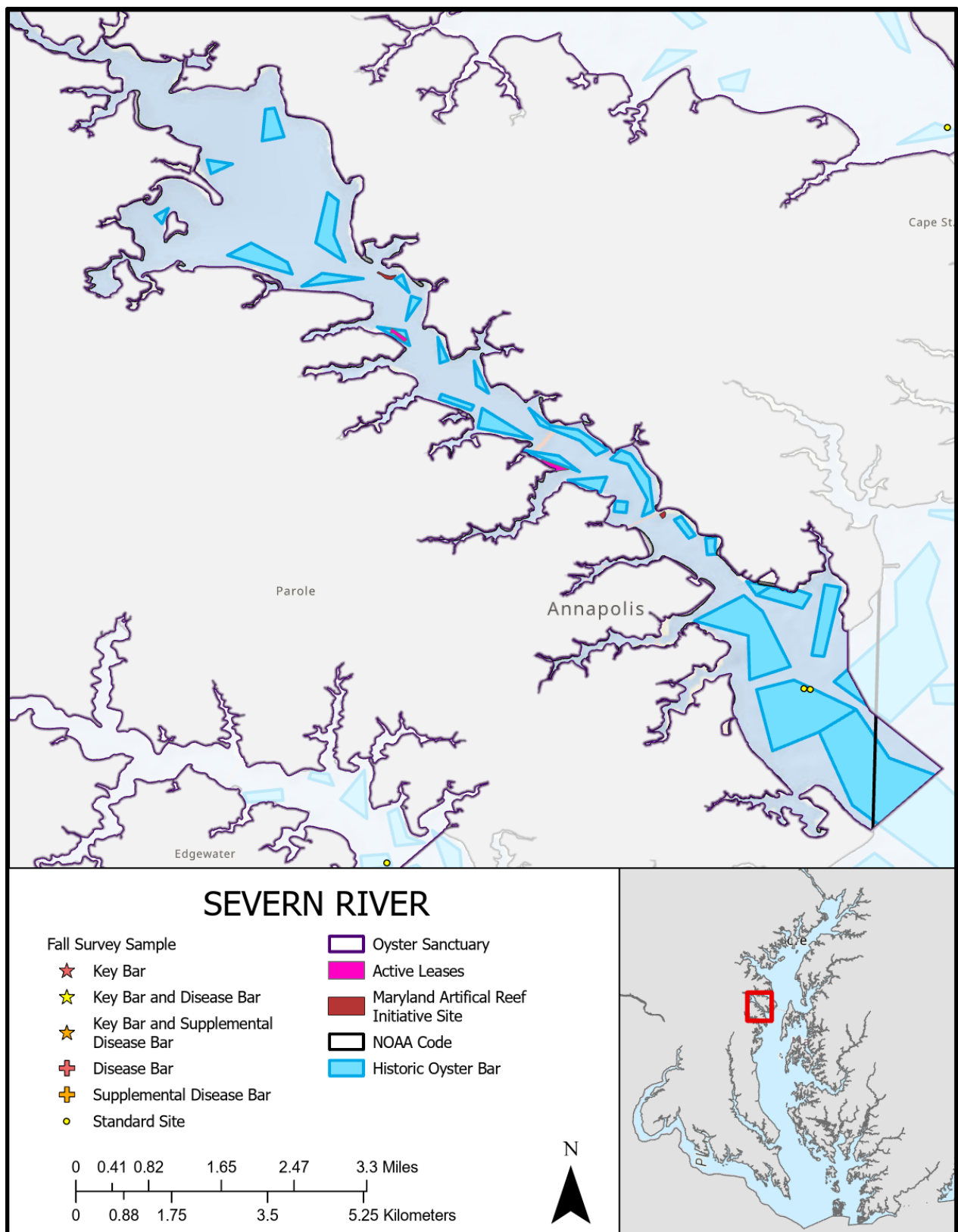


Figure A.39-1. Severn River Sanctuary. Fall Oyster Survey sites may not be sampled every year.

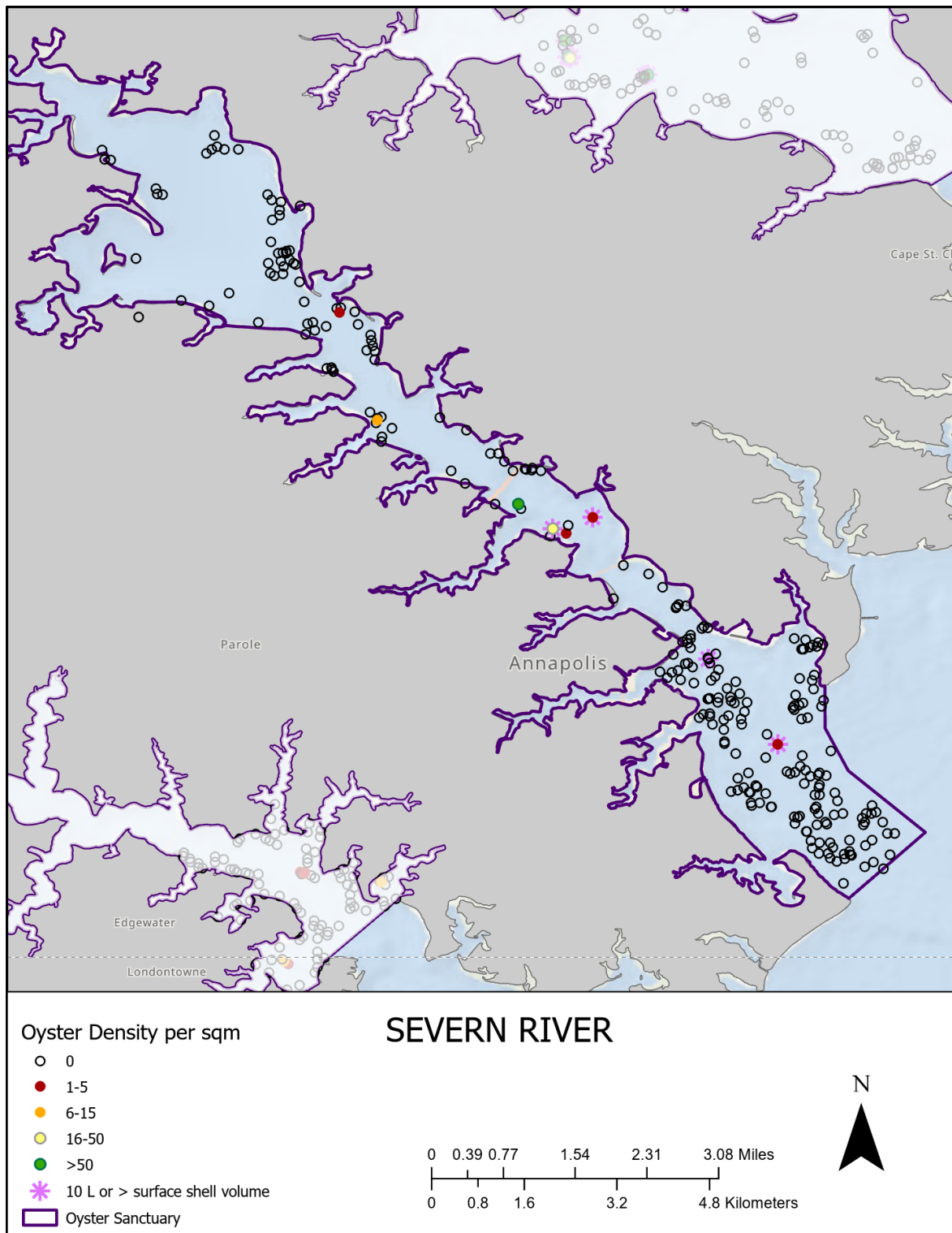


Figure A.39-2. Map of 2022 oyster density in the Severn River Sanctuary. Data from Maryland Department of Natural Resources Patent Tong Population Survey.

Table A.39-1. Oyster population characteristics based on the Fall Oyster Survey in the Severn River Sanctuary. ND=No Data. Values given are annual mean $\pm$ standard error.

Oyster Characteristic	2006-2010	2011-2015	2016-2020	2021-2025
Number of years sampled/number of samples	5/10	5/10	5/10	5/10
Number of Live Spat Oysters per square meter	8.2 $\pm$ 8.2	0	0	55.5 $\pm$ 37.4*
Number of Live Small Oysters per square meter	10.9 $\pm$ 10.6	4.6 $\pm$ 1.3	1 $\pm$ 0.43	13.7 $\pm$ 6.5
Number of Live Market Oysters per square meter	23.8 $\pm$ 13.1	72.8 $\pm$ 21.4	29.1 $\pm$ 6.2	63.9 $\pm$ 15.3
Number of Live Oysters per square meter	43 $\pm$ 23	77.5 $\pm$ 21.6	30.2 $\pm$ 6.2	133.2 $\pm$ 32
Live Biomass (g Dry Weight per Bushel)	ND	88 $\pm$ 30	86 $\pm$ 7	245 $\pm$ 70
Observed Mortality (%)	8 $\pm$ 4.3	5.8 $\pm$ 2.1	18.1 $\pm$ 4.3	6.5 $\pm$ 1.9
Cultch (Bushels per 100 feet towed)	1.2 $\pm$ 0.2	1.8 $\pm$ 0.2	1.5 $\pm$ 0.2	1.4 $\pm$ 0.2

*Includes a 2022 hatchery spat-on-shell planting.

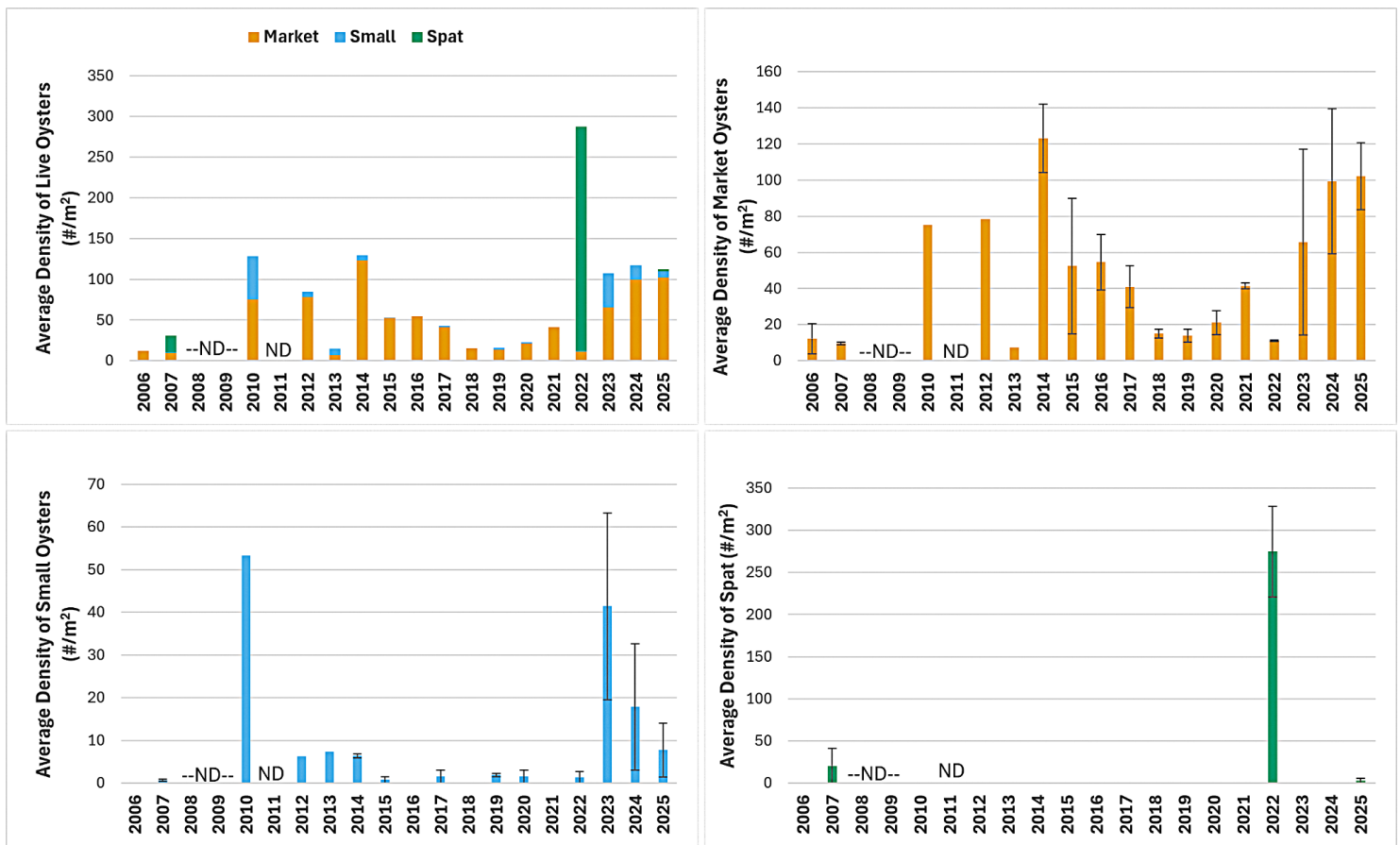


Figure A.39-3A. Average number of live oysters per square meter by size class in the Severn River Sanctuary. Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales. ND= No Data.

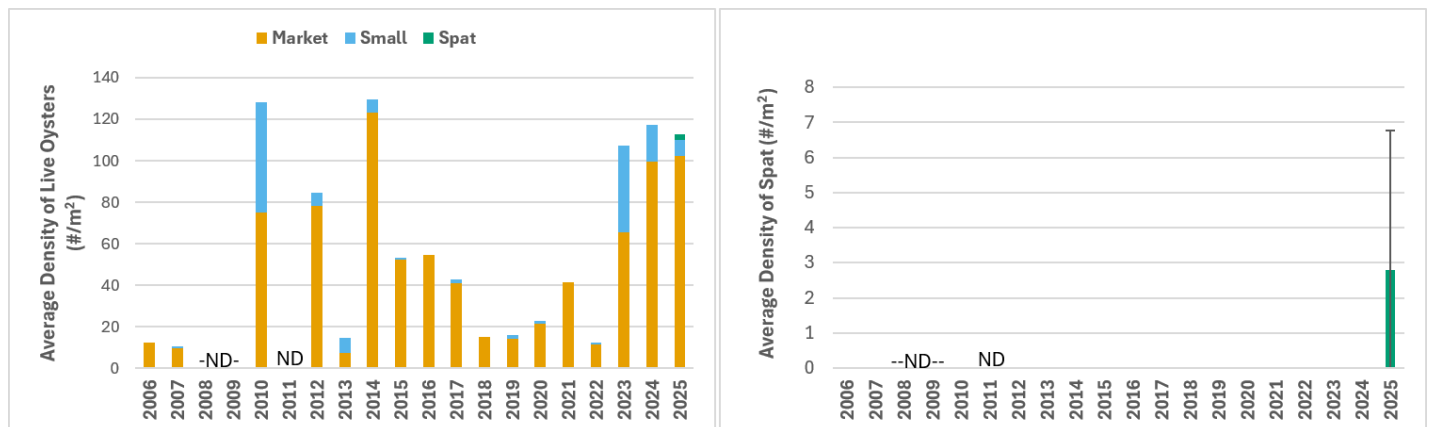


Figure A.39-3B. Average number of live oysters per square meter by size class in the Severn River Sanctuary without plantings in 2007 and 2022. Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales. ND= No Data.

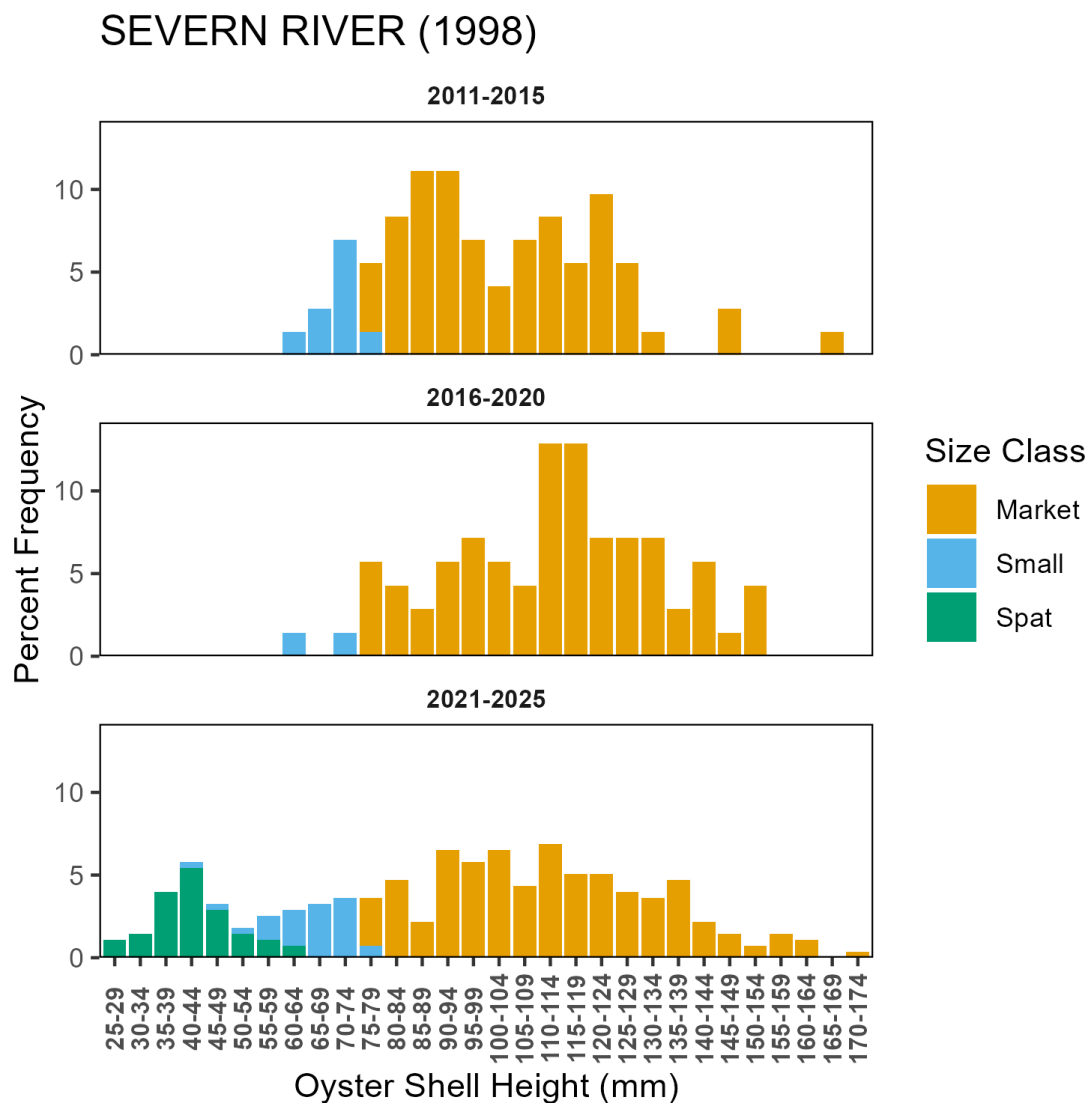


Figure A.39-4. Shell height frequencies of live oysters in the Severn River Sanctuary. Data from Maryland’s Annual Fall Oyster Dredge Survey on Chinks Point bar. No data was collected from 2006 to 2010 and 2014.

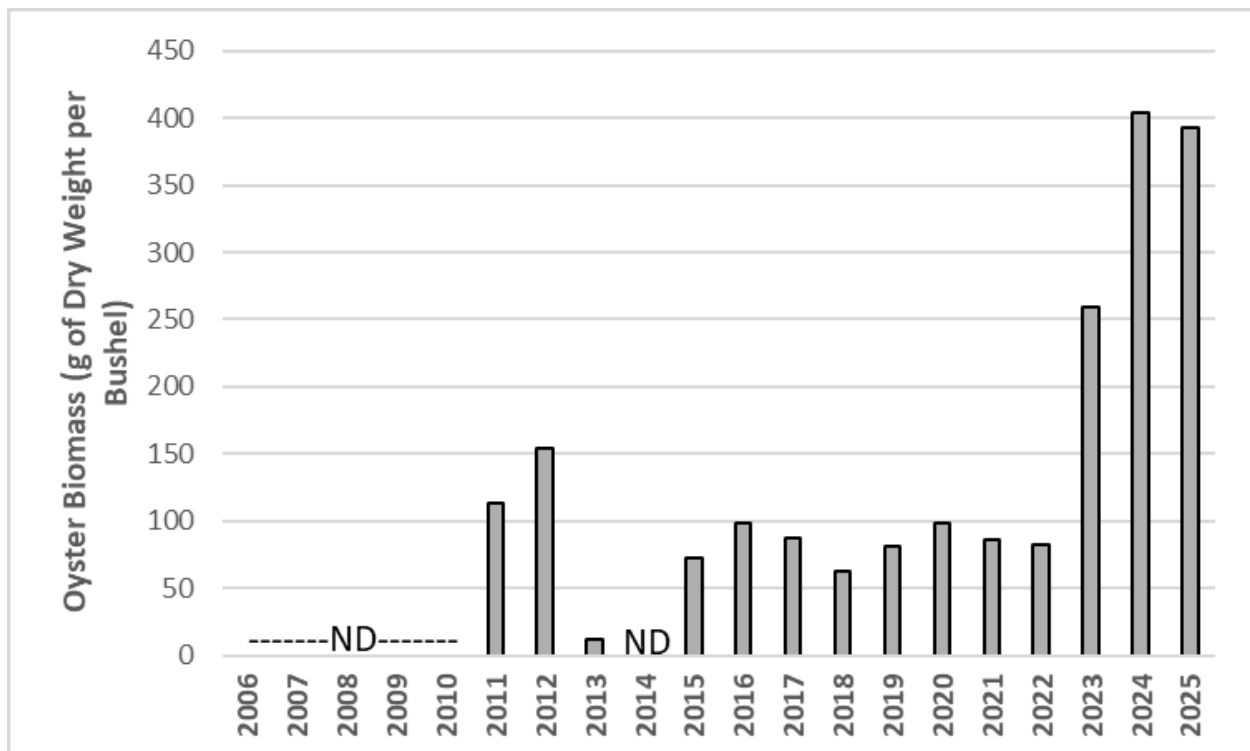


Figure A.39-5. Oyster biomass (grams of dry weight per bushel of material) in the Severn River Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey on Chinks Point bar. No data was collected from 2006 to 2010 and in 2014.

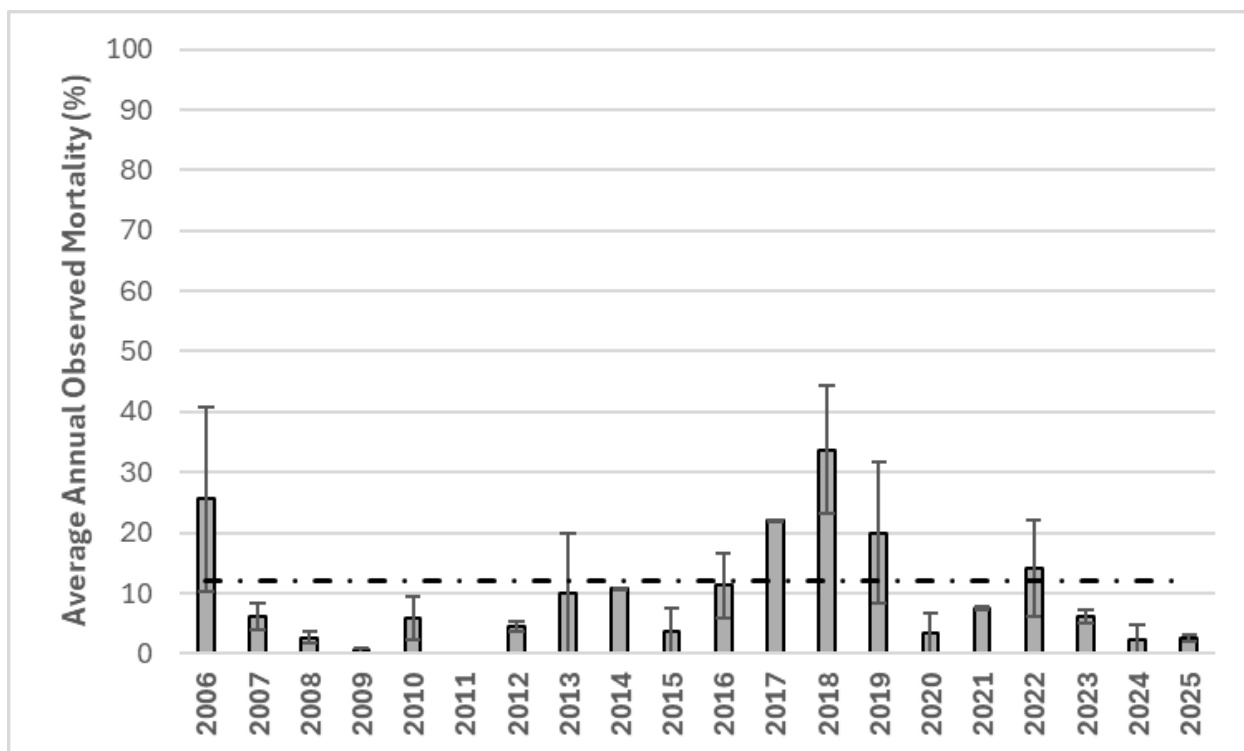


Figure A.39-6. Average annual observed mortality of market-sized and small-sized oysters in Severn River Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. The dashed line represents the 2006-2025 baywide average observed mortality. Error bars represent ± 1 standard error.

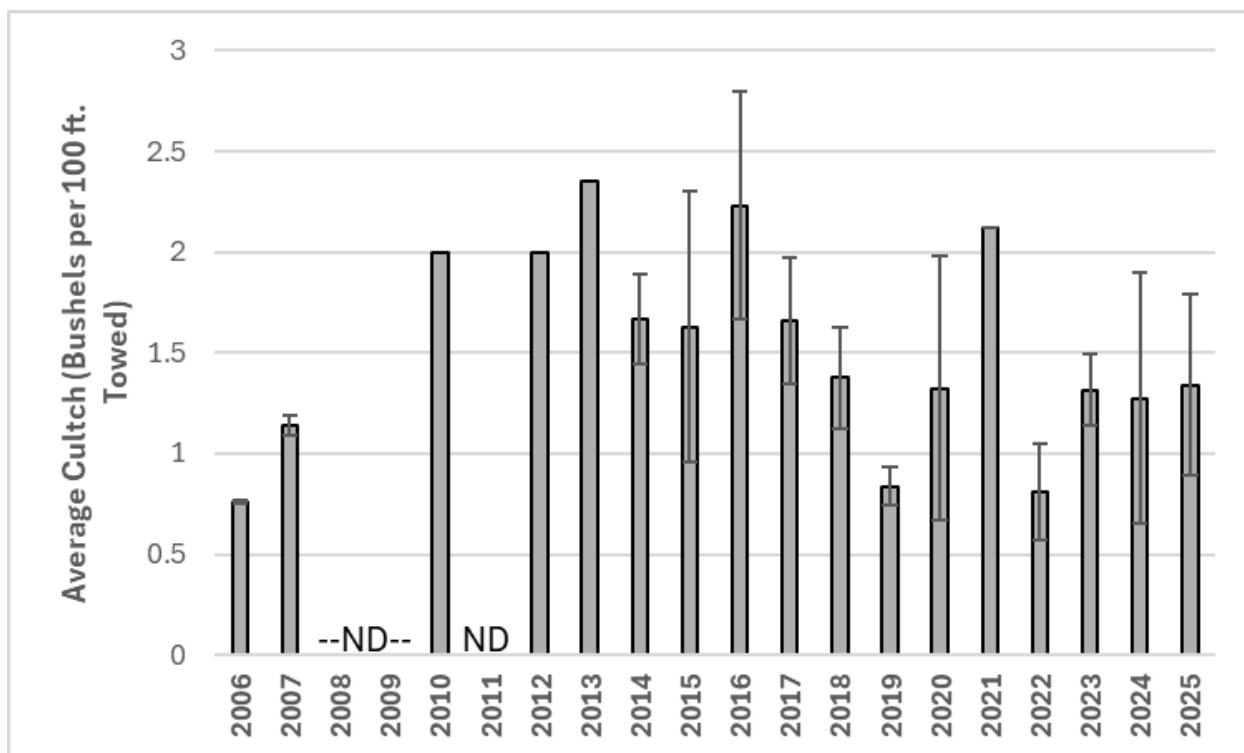


Figure A.39-7. Average cultch (live and dead oysters and loose shell) in the Severn River Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Error bars represent ± 1 standard error. ND = No Data.

Table A.39-2. Average oyster population densities in 2023 based on the U.S. Army Corps of Engineers dive survey on alternate substrate sites in the Severn River Sanctuary.

Site	Average Density (number per square meter)	Substrate
Traces Hollow 1A	31.2	granite
Traces Hollow 1B	182	Concrete and granite
Traces Hollow 2A	36.4	granite
Peach Orchard 1	11.25	granite
Peach Orchard 2	42.8	granite
Peach Orchard 3	12	slag
Wade 1	67.5	concrete
Wade 2	74.2	Concrete, granite and slag
Weems Upper	68.6	granite



Figure A.39-8. Alternate substrate dive site locations for the U.S. Army Corps of Engineers dive survey on alternate substrate sites in the Severn River Sanctuary.

Section A.40: Solomons Creeks Sanctuary

The Solomons Creeks Sanctuary is located in the lower Patuxent River, a medium salinity (Zone 2) region within NOAA Code 168. The sanctuary was created in 2010 to accommodate oysters produced by the Southern Maryland Oyster Cultivation Society, a citizen-sponsored restoration group. It encompasses 617 acres of which only 5 acres (0.8%) is historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments). The sanctuary contains all of the Shell Pile historic oyster bar and a portion of the Cherry Tree bar.

Information available for this sanctuary includes:

- Sanctuary map (Figure A.40-1)

Solomons Creeks Sanctuary is located in the Lower Western Shore Region of Maryland's Chesapeake Bay. Oysters in the Lower Western Shore Region generally grow well but may be impacted by disease or freshet events. Natural recruitment occurs regularly in this region.

This sanctuary has no oyster habitat and has not been surveyed by the Department.

This sanctuary was one of the sanctuaries identified by the Department as unlikely to receive a large investment by the Department for restoration and is under evaluation by the Oyster Advisory Commission for potential efforts to improve its performance.

In the 2021-2025 sanctuary assessment, this sanctuary was classified as having poor habitat.

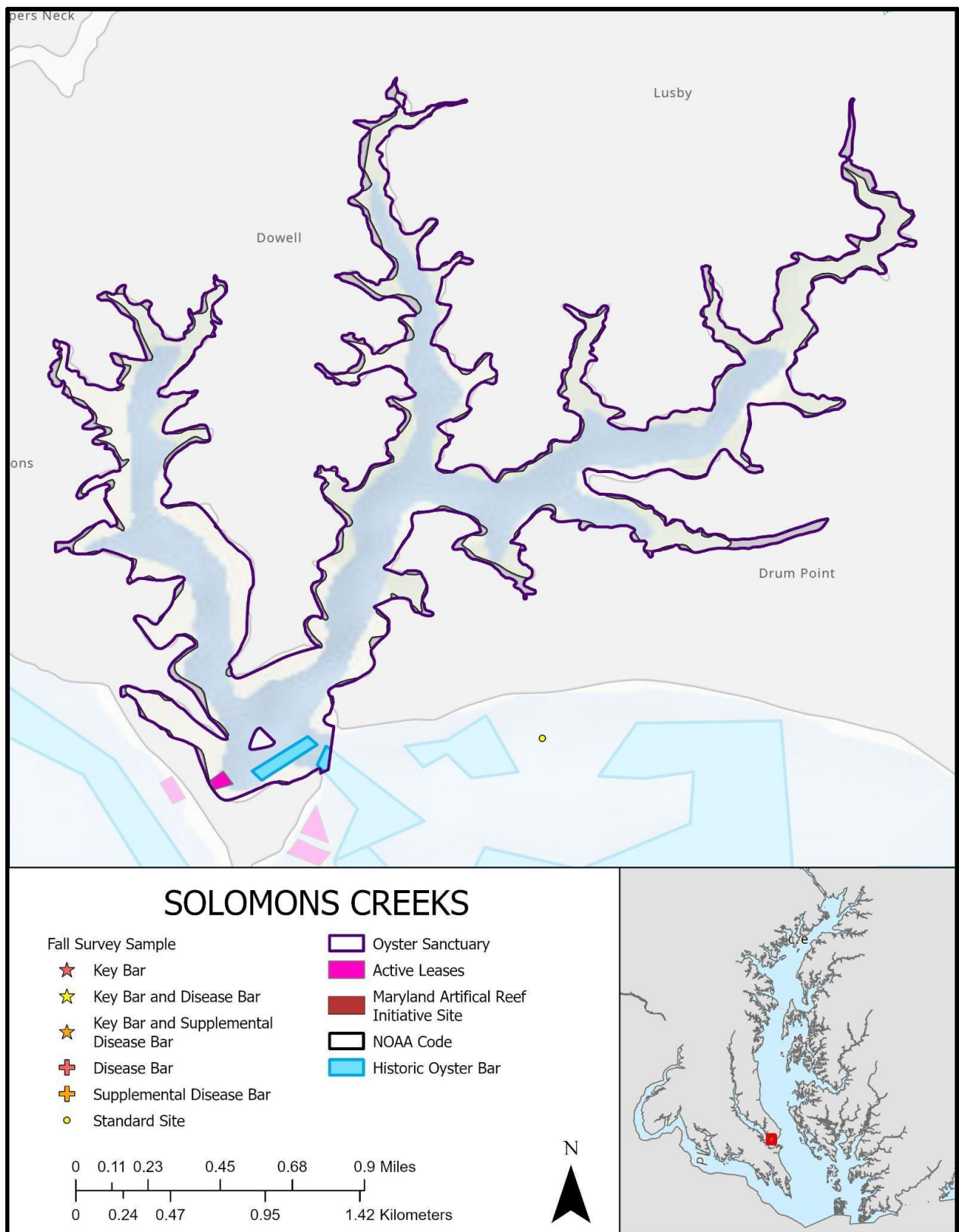


Figure A.40-1. Solomons Creeks Sanctuary.

Section A.41: Somerset Sanctuary

The Somerset Sanctuary is located in Tangier Sound, a high salinity (Zone 3) region within NOAA Code 192. The sanctuary was created in 1999 and encompasses 101 acres of which 6 acres (6%) are historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments). There is one historic oyster bar (Piney Island East Addition) within the sanctuary. The sanctuary was one of four sanctuaries created in 1999 when legislation was passed opening up new areas to power dredging of oysters.

Information available for this sanctuary includes:

- Sanctuary map (Figure A.41-1)
- Summary statistics (Table A.41-1)
- Density per year (Figure A.41-2)
- Shell height frequencies (Figure A.41-3)
- Biomass per year (Figure A.41-4)
- Observed mortality (Figure A.41-5)
- Dermo and MSX per year (Figure A.41-6)
- Cultch per year (Figure A.41-7)

Somerset Sanctuary is located in the Lower Eastern Shore Region of Maryland's Chesapeake Bay. Oysters in the Lower Eastern Shore Region generally grow well but can be impacted by disease. Elevated salinity levels promote increased natural recruitment.

The Fall Oyster Survey has three sampling sites in the Somerset Sanctuary; however, high red beard sponge prevalence has frequently prevented sampling at one site in recent years (Image A.1). The Fall Oyster Survey has one standard site in the Somerset Sanctuary and two other sites sampled. Table A.41-1 shows an increase in the average number of oysters and biomass from 2021-2025 compared to the previous 5-year increments, while exhibiting an average observed mortality. There was an increase in observed mortality in 2023 that coincided with an increase in lethal dermo and MSX disease prevalences (Figures A.41-5, A.41-6). The average density from 2021-2025 is above the long-term abundance target of 94 oysters per square meter while the average cultch per 100 ft tow indicates insufficient cultch availability.

The last patent tong survey was in 2020.

In the 2021-2025 sanctuary assessment, this sanctuary was classified as trending positively and having a high oyster density.



Image A.1. Red beard sponge prevalence, limiting oyster sampling ability.

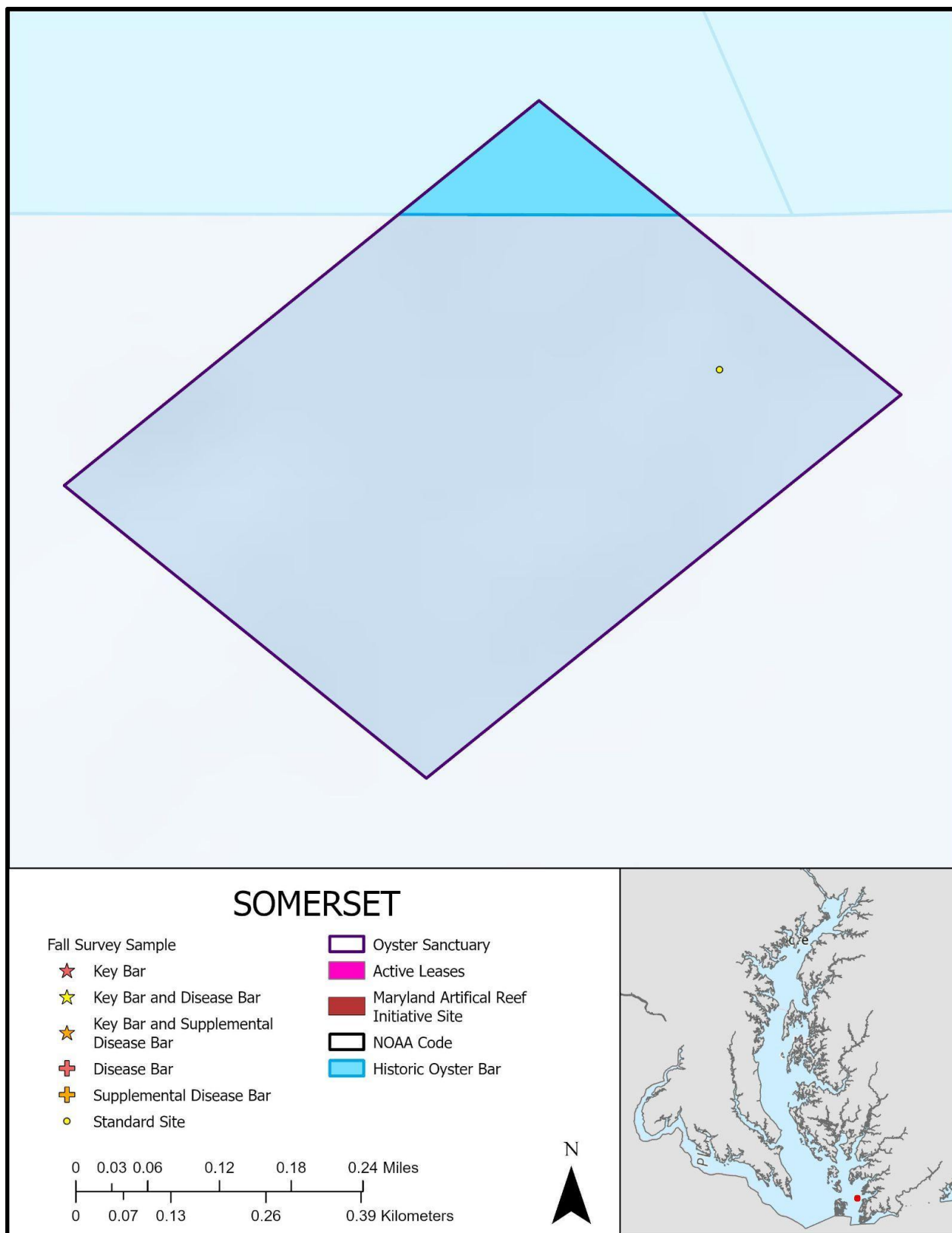


Figure A.41-1. Somerset Sanctuary. Fall Oyster Survey sites may not be sampled every year.

Table A.41-1. Oyster population characteristics based on the Fall Oyster Survey in the Somerset Sanctuary. ND=No Data. Values given are annual mean $\pm$ standard error.

Oyster Characteristic	2006-2010	2011-2015	2016-2020	2021-2025
Number of years sampled/number of samples	5/15	5/15	5/15	5/11
Number of Live Spat Oysters per square meter	63.3 $\pm$ 28	31.9 $\pm$ 9.1	78.8 $\pm$ 25.7	44.2 $\pm$ 8.1
Number of Live Small Oysters per square meter	53.5 $\pm$ 23	43.2 $\pm$ 13.7	33.7 $\pm$ 13.8	56.5 $\pm$ 9.9
Number of Live Market Oysters per square meter	14.1 $\pm$ 3.6	31.5 $\pm$ 5.2	10.4 $\pm$ 2.1	33.4 $\pm$ 4.6
Number of Live Oysters per square meter	131 $\pm$ 49	107 $\pm$ 22.5	123 $\pm$ 32.6	134 $\pm$ 16.4
Live Biomass (g Dry Weight per Bushel)	ND	283 $\pm$ 24	106 $\pm$ 61	369 $\pm$ 64
Observed Mortality (%)	19 $\pm$ 1.7	14 $\pm$ 2	17.4 $\pm$ 4.1	11.8 $\pm$ 2
Cultch (Bushels per 100 feet towed)	1.1 $\pm$ 0.2	1 $\pm$ 0.1	1 $\pm$ 0.1	0.6 $\pm$ 0.1

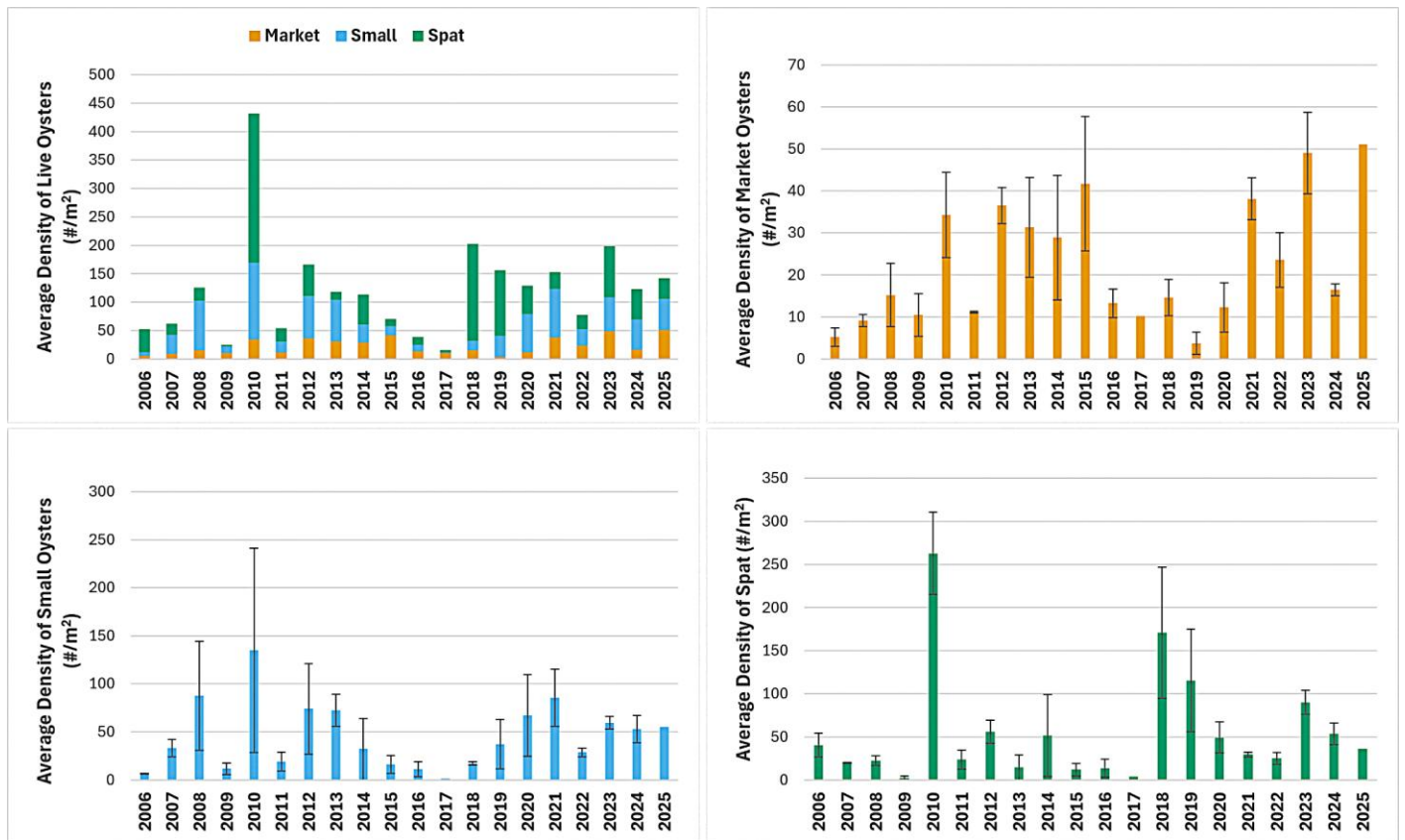


Figure A.41-2. Average number of live oysters per square meter by size class in the Somerset Sanctuary. Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales.

SOMERSET (1999)

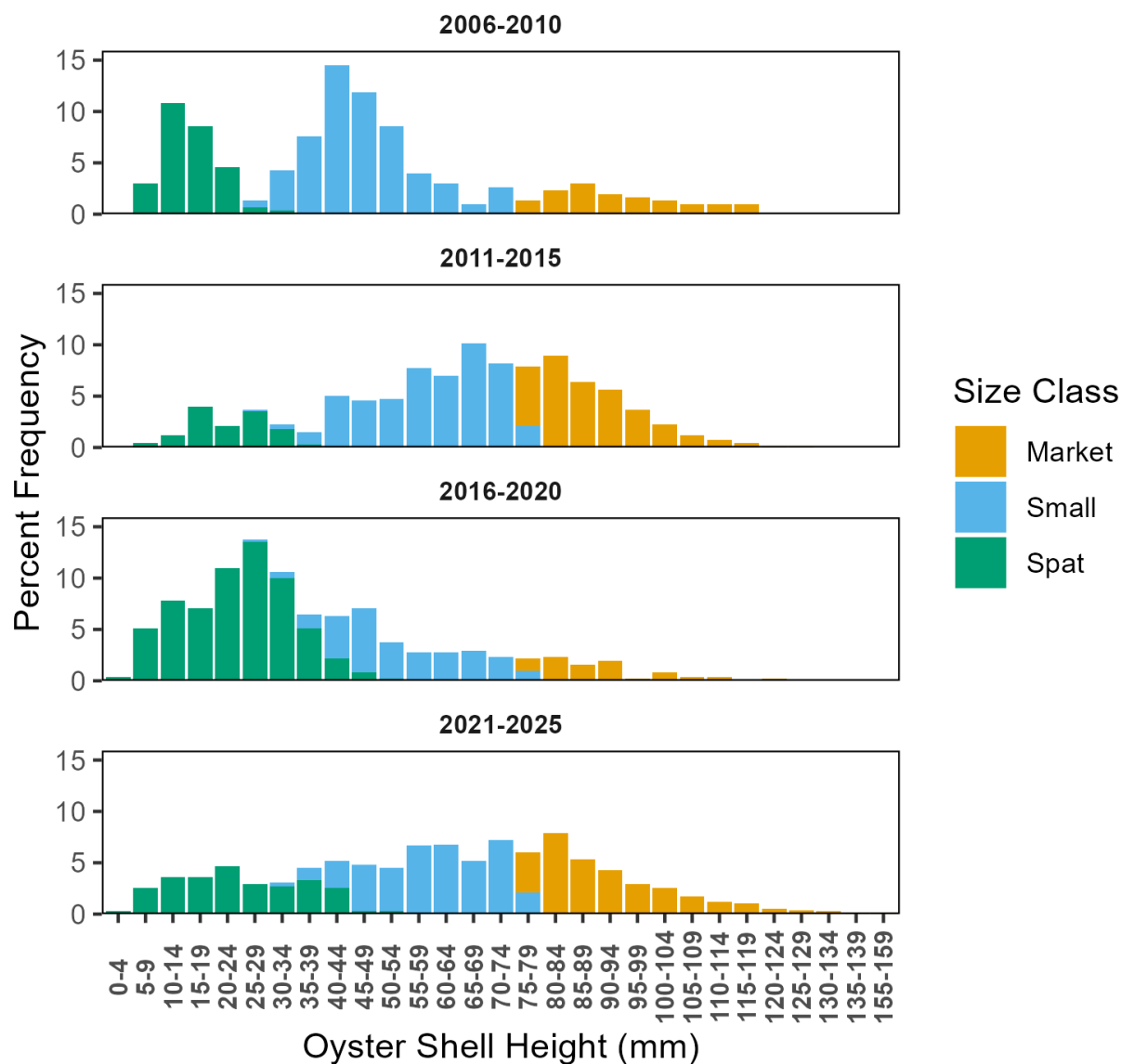


Figure A.41-3. Shell height frequencies of live oysters in the Somerset Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey on Piney Island East Addition 1 bar. Data was not collected in 2006 and 2008 to 2010.

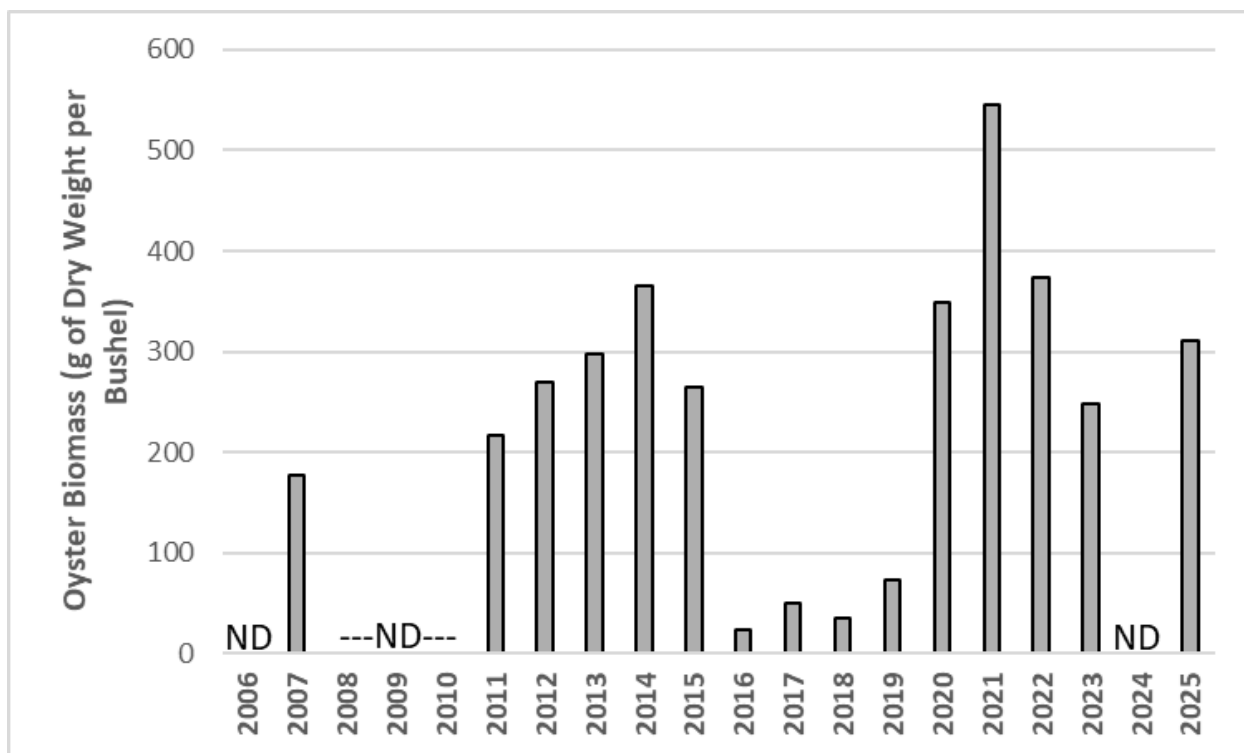


Figure A.41-4. Oyster biomass (grams of dry weight per bushel of material) in the Somerset Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey on Piney Island East Addition 1 bar. ND = No Data.

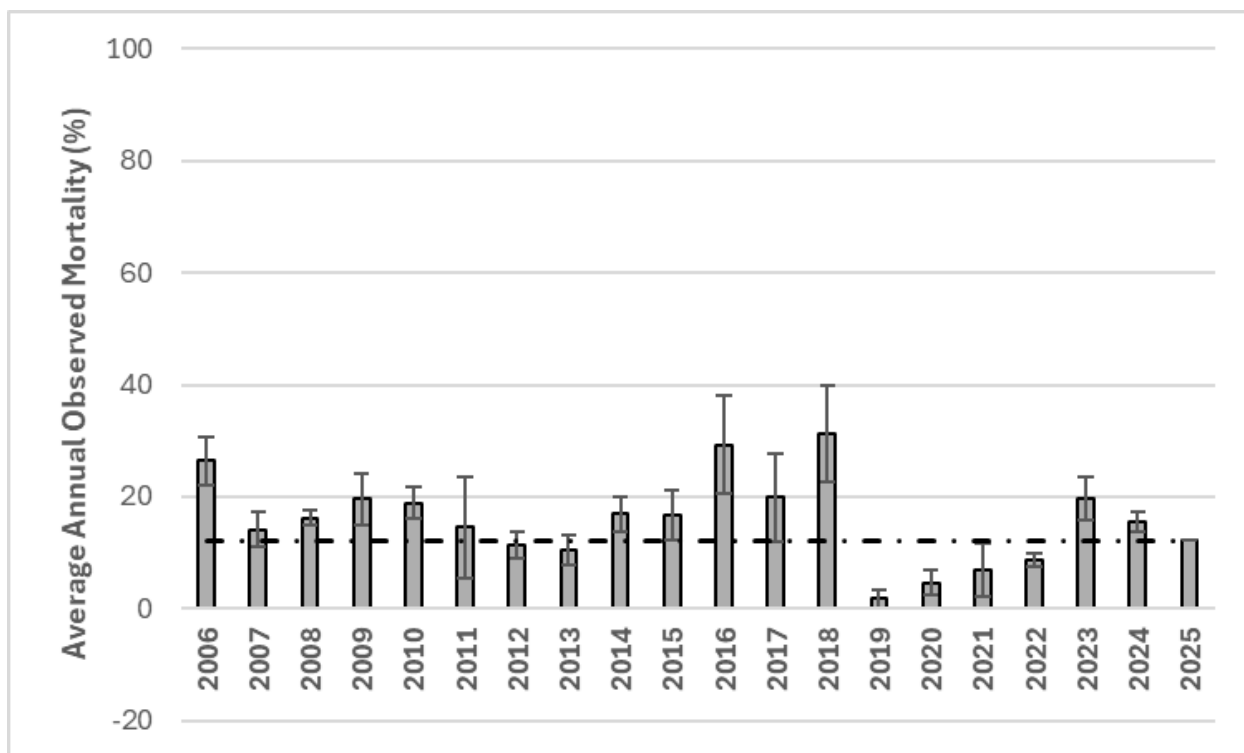


Figure A.41-5. Average annual observed mortality of market-sized and small-sized oysters in Somerset Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. The dashed line represents the 2006-2025 baywide average observed mortality. Error bars represent ± 1 standard error.

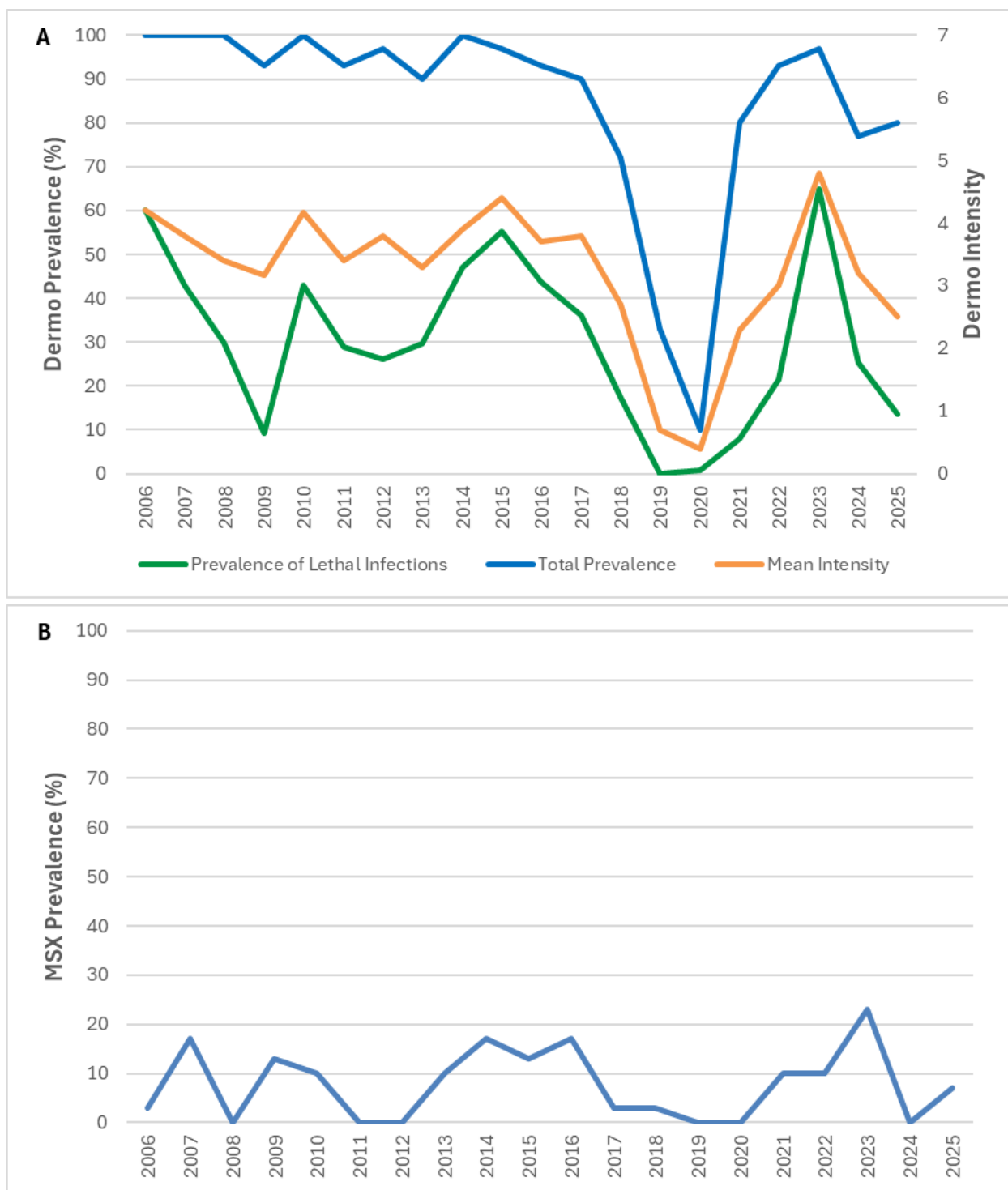


Figure A.41-6. Oyster disease prevalence and intensity in the Somerset Sanctuary. (A) Dermo prevalence and mean intensity (B) MSX prevalence (intensity is not examined). Data from Maryland's Annual Fall Oyster Dredge Survey on Piney Island East Addition 1 bar.

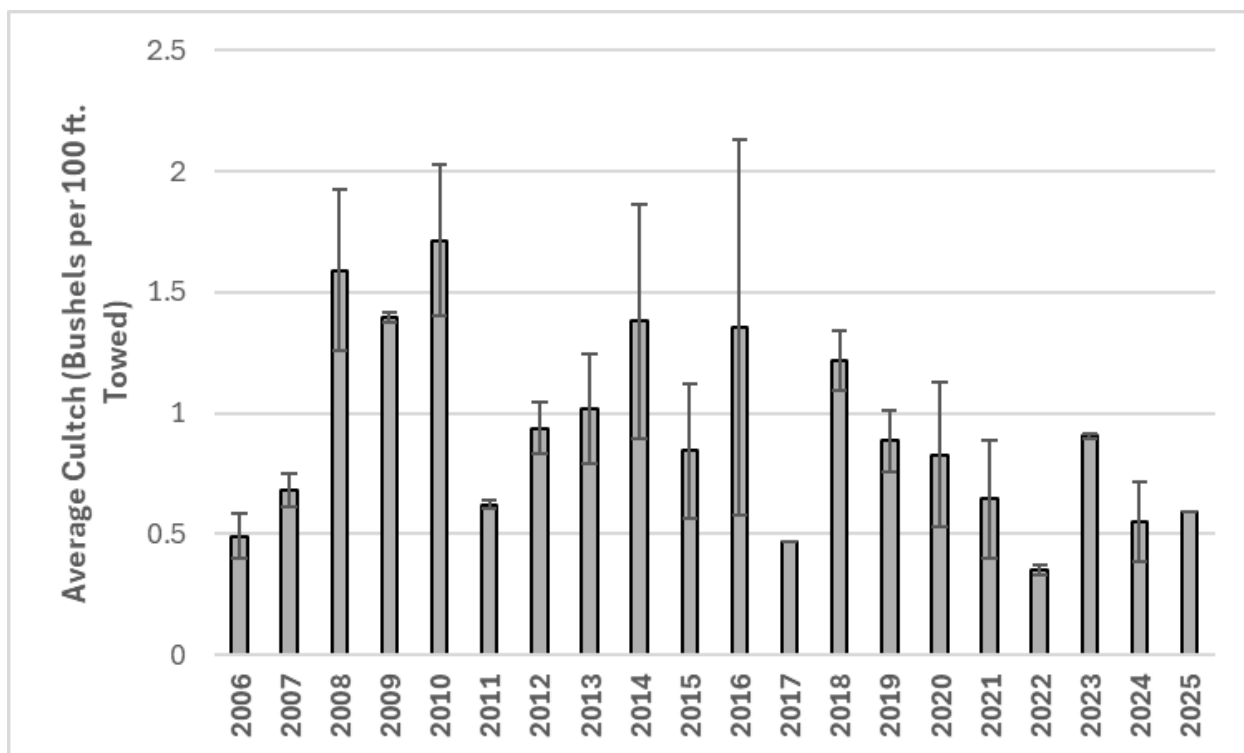


Figure A.41-7. Average cultch (live and dead oysters and loose shell) in the Somerset Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Error bars represent ± 1 standard error. ND = No Data.

Section A.42: South River Sanctuary

The South River Sanctuary is located in the upstream part of the South River, a tributary of the upper western shore of Chesapeake Bay within NOAA Code 088. The sanctuary is in a low salinity (Zone 1) region. The South River Sanctuary was created in 2000 and encompasses 2,327 acres of which 141 (6%) is historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments). There are 7 historic oyster bars within the sanctuary³⁸.

Information available for this sanctuary includes:

- Sanctuary map (Figure A.42-1)
- Density Survey (Figure A.42-2)
- Summary statistics (Table A.42-1)

South River Sanctuary is located in the Upper Bay Region of Maryland's Chesapeake Bay. Oysters in the Upper Bay Region generally grow well and survive but can be impacted by freshet events. Reduced salinity levels contribute to a lower rate of natural recruitment.

In 2025, the Department conducted a patent tong population survey and found an average density of 0.4 oysters per square meter and an average volume of 0.4 liters per square meter of surface shell. The 2014 survey had an average of 0.6 oysters per square meter and 1.4 liters per square meter. In 2022 the Department added a standard Fall Oyster Survey site to the South River.

In 2021 the Chesapeake Bay Foundation had a systematic patent tong survey conducted in the South River Sanctuary to evaluate the restoration potential of reefs. This survey identified reef areas that would be used for a Before-After-Control-Impact (BACI) study for restoration. In 2023, the Department conducted spat-on-shell plantings as part of small-scale restoration efforts on three areas identified during this study. The BACI study is anticipated to be completed in 2026.

In the 2021-2025 sanctuary assessment, this sanctuary was classified as receiving restoration.

³⁸ See chart 9 for bar names and locations in the State of Maryland Shellfish Closure Areas Book <http://dnr.maryland.gov/fisheries/Pages/oysters/index.aspx>

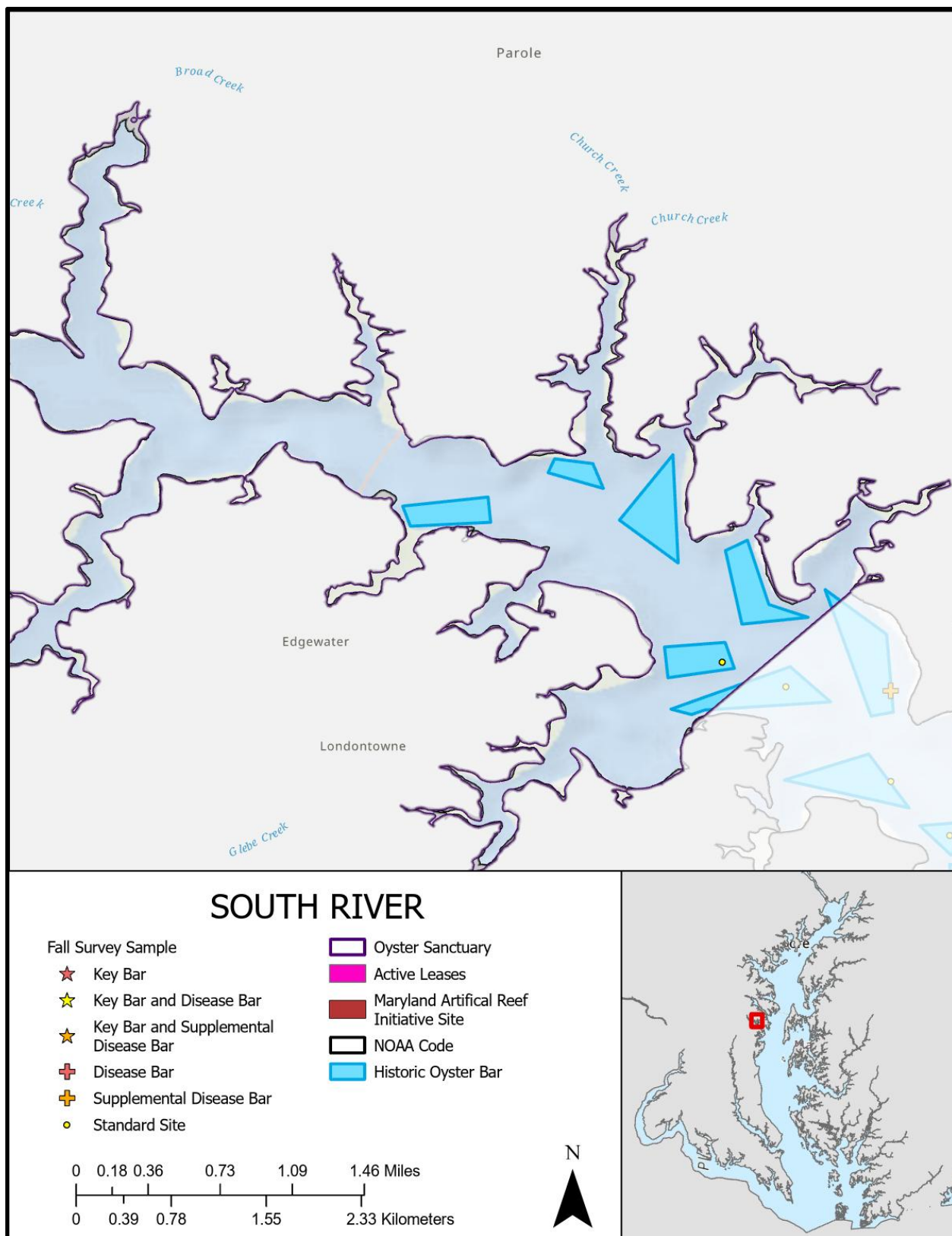


Figure A.42-1. South River Sanctuary. Fall Oyster Survey sites may not be sampled every year.

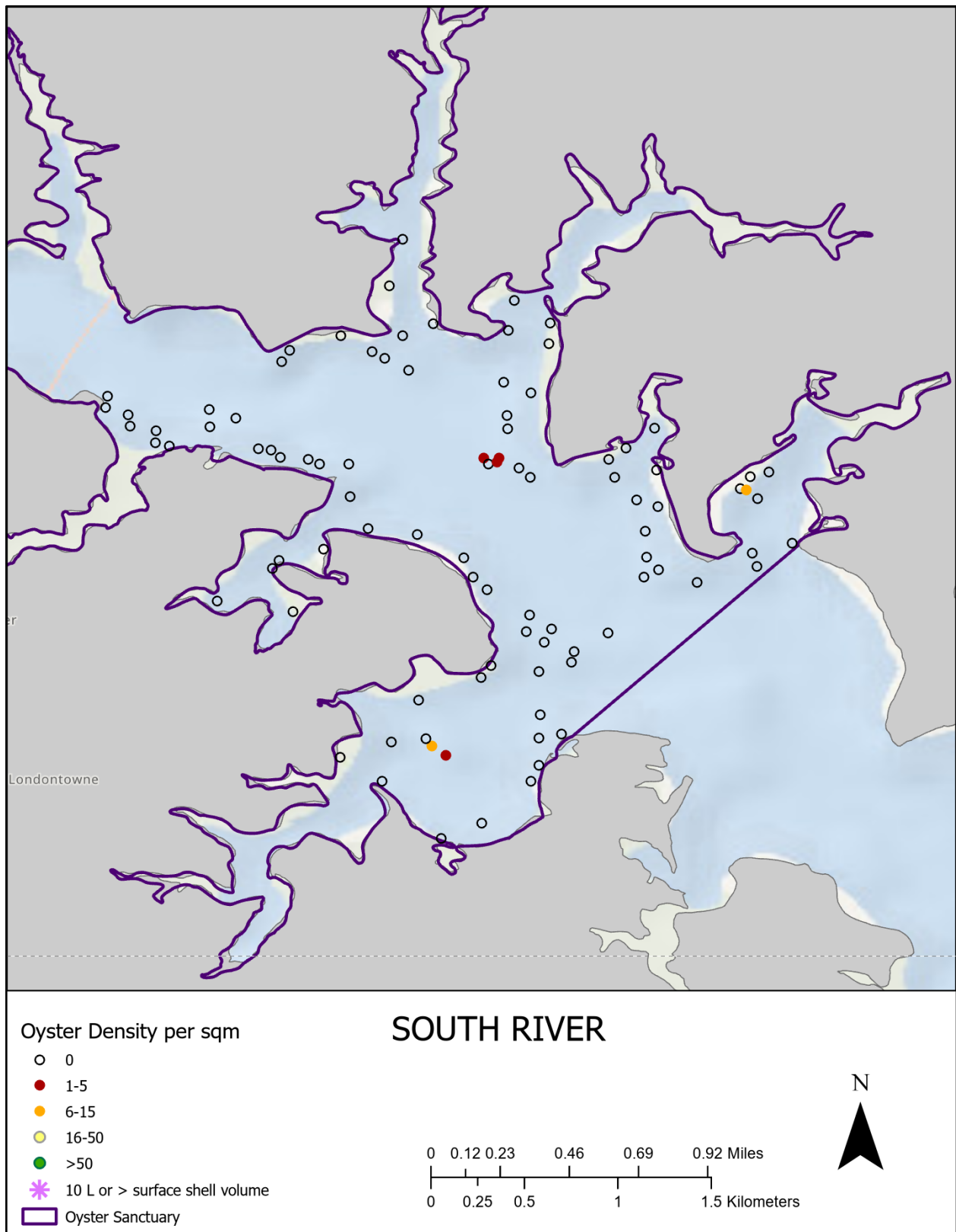


Figure A.42-2. Map of 2025 oyster density in the South River Sanctuary. Data from Maryland Department of Natural Resources Patent Tong Population Survey.

Table A.42-1. Oyster population characteristics based on the Fall Oyster Survey in the South River Sanctuary. ND=No Data. Values given are annual mean $\pm$ standard error.

Oyster Characteristic	2006-2010	2011-2015	2016-2020	2021-2025
Number of years sampled/number of samples	ND	ND	ND	4/4
Number of Live Spat Oysters per square meter	ND	ND	ND	0.1 $\pm$ 0.1
Number of Live Small Oysters per square meter	ND	ND	ND	0.3 $\pm$ 0.2
Number of Live Market Oysters per square meter	ND	ND	ND	2 $\pm$ 0.3
Number of Live Oysters per square meter	ND	ND	ND	2.4 $\pm$ 0.5
Live Biomass (g Dry Weight per Bushel)	ND	ND	ND	ND
Observed Mortality (%)	ND	ND	ND	24 $\pm$ 14
Cultch (Bushels per 100 feet towed)	ND	ND	ND	0.2 $\pm$ 0.07

Section A.43: St. Marys River Sanctuary

The St. Marys River Sanctuary is located in the upstream portion of the St. Marys River, a medium salinity (Zone 2) region within NOAA Code 078. The mouth of the river empties into the Potomac River. The sanctuary was created in 2010 and encompasses 1,304 acres of which 89 (9%) is historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments). There are nine historic oyster bars within the sanctuary³⁹. In 2018, the St. Marys River Sanctuary was selected to be the fourth large-scale restoration area in Maryland towards meeting the 2014 Chesapeake Bay Watershed Agreement⁴⁰. Initial restoration was completed in 2022. Planned second hatchery spat-on-shell seedings and monitoring are ongoing.

Information available for this sanctuary includes:

- Sanctuary map (Figure A.43-1)
- Summary statistics (Table A.43-1)
- Density per year (Figure A.43-2)
- Shell height frequencies (Figure A.43-3)
- Biomass per year (Figure A.43-4)
- Observed mortality (Figure A.43-5)
- Dermo and MSX per year (Figure A.43-6)
- Cultch per year (Figure A.43-7)

St. Marys River Sanctuary is located in the Lower Western Shore Region of Maryland's Chesapeake Bay. Oysters in the Lower Western Shore Region generally grow well but may be impacted by disease or freshet events. Natural recruitment occurs regularly in this region.

The Fall Oyster Survey has one standard site and one key and disease bar sentinel site in the St. Marys River Sanctuary. Table A.43-1 shows an increase in the average number of oysters and cultch bushels per 100 feet tow distance from 2021-2025 compared to the previous 5-year increments, while exhibiting an above average observed mortality. In 2021, there was a large observed mortality rate, while mortality in 2022-2025 remained low. This increase in observed mortality was not coincident with high lethal disease prevalences but was likely due to low dissolved oxygen (Figures A.43-5, A.43-6). The average density from 2021-2025 is above the long-term abundance target of 94 oysters per square meter while the average cultch per 100 ft tow indicates sufficient cultch availability. It should be noted that given limitations of traditional gear types (dredge and patent tong), not all restored areas are surveyed by the Department.

In 2025, St. Marys River Sanctuary had exceptional recruitment, which may account for some of the marked increase in densities.

³⁹ See chart 38 for bar names and locations in the State of Maryland Shellfish Closure Areas Book <http://dnr.maryland.gov/fisheries/Pages/oysters/index.aspx>

⁴⁰ Maryland Interagency Oyster Restoration Workgroup of the Sustainable Fisheries Goal Implementation Team. 2020. Upper St. Mary's River Oyster Restoration Tributary Plan. https://dnr.maryland.gov/fisheries/Documents/Reg_Changes/St.%20Mary%27s%20Blueprint%20final.pdf

The Department has not conducted a patent tong population survey since 2015; however, restoration partners have conducted monitoring. As of 2024, of the restoration reefs that are three years old, 92% meet the minimum restoration metrics (15 oyster per square meter over 30% of the reef).

In the 2021-2025 sanctuary assessment, this sanctuary was classified as restored.

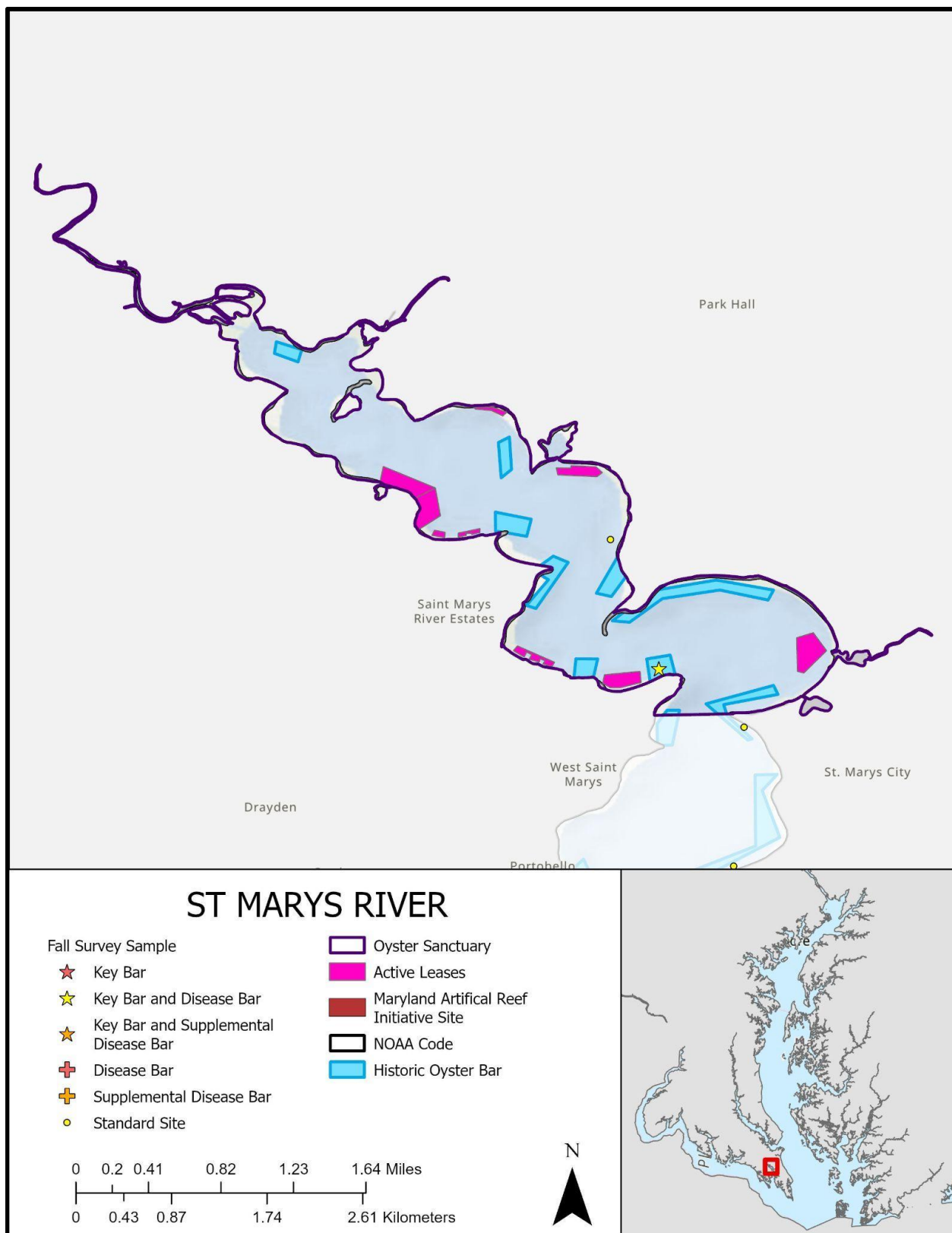


Figure A.43-1. St Marys River Sanctuary. Fall Oyster Survey sites may not be sampled every year.

Table A.43-1. Oyster population characteristics based on the Fall Oyster Survey in the St. Marys River Sanctuary. ND=No Data. Values given are annual mean $\pm$ standard error.

Oyster Characteristic	2006-2010	2011-2015	2016-2020	2021-2025
Number of years sampled/number of samples	5/10	5/10	5/10	5/11
Number of Live Spat Oysters per square meter	332 $\pm$ 140	128 $\pm$ 56	36 $\pm$ 20.4	558 $\pm$ 228
Number of Live Small Oysters per square meter	391 $\pm$ 185	234 $\pm$ 36	232 $\pm$ 72	376 $\pm$ 93
Number of Live Market Oysters per square meter	29.5 $\pm$ 12.5	79.3 $\pm$ 20	99.3 $\pm$ 24	69.6 $\pm$ 19
Number of Live Oysters per square meter	753 $\pm$ 304	441 $\pm$ 69	367 $\pm$ 89	1004 $\pm$ 239
Live Biomass (g Dry Weight per Bushel)	206 $\pm$ 45	347 $\pm$ 52.5	399 $\pm$ 56	378 $\pm$ 30
Observed Mortality (%)	11.8 $\pm$ 2.2	11 $\pm$ 2.1	22.4 $\pm$ 9.3	19.8 $\pm$ 10
Cultch (Bushels per 100 feet towed)	2.4 $\pm$ 0.4	2 $\pm$ 0.2	2.1 $\pm$ 0.2	2.5 $\pm$ 0.2

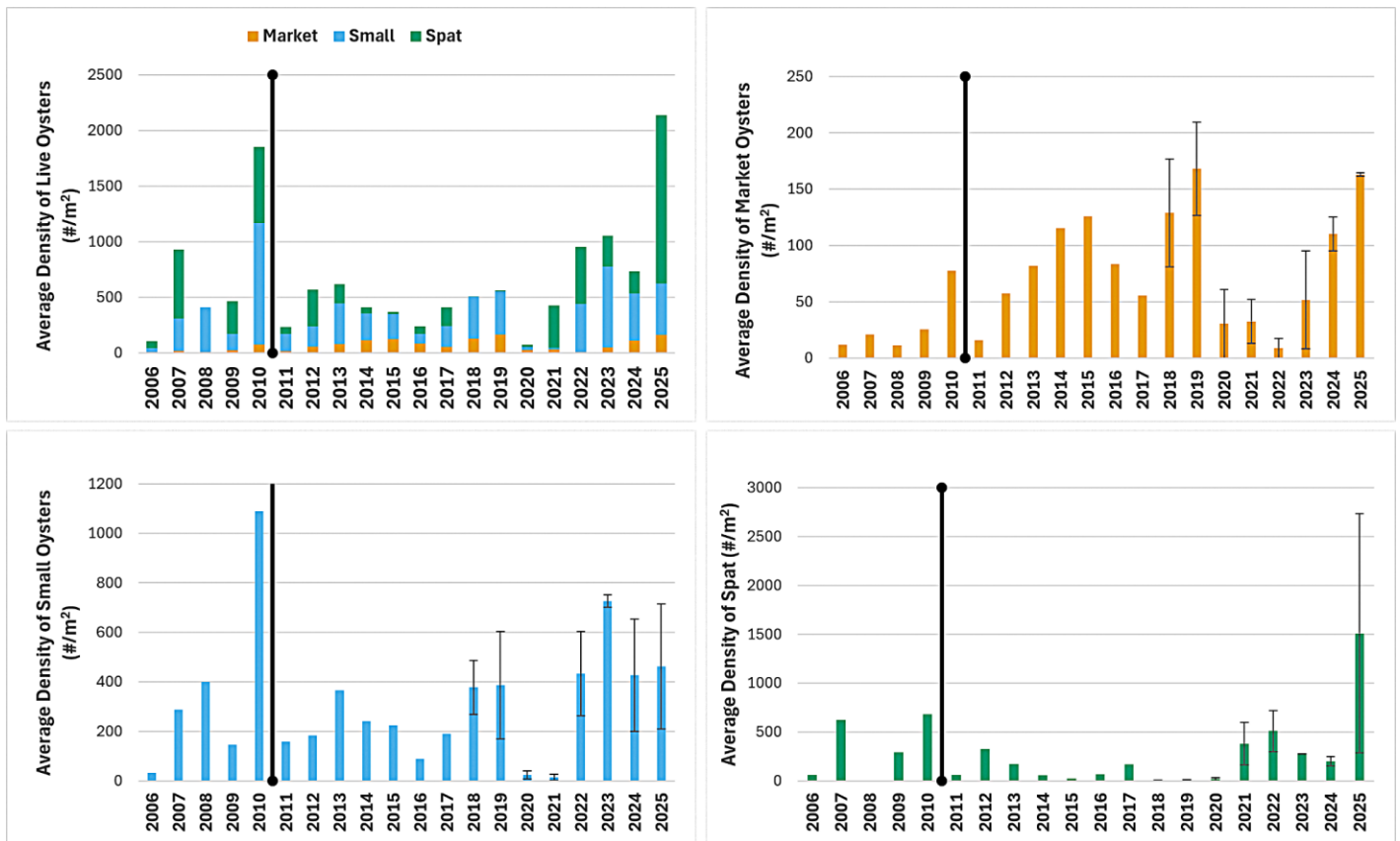


Figure A.43-2. Average number of live oysters per square meter by size class in the St. Marys River Sanctuary. The black line denotes the year the sanctuary was established. Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales.

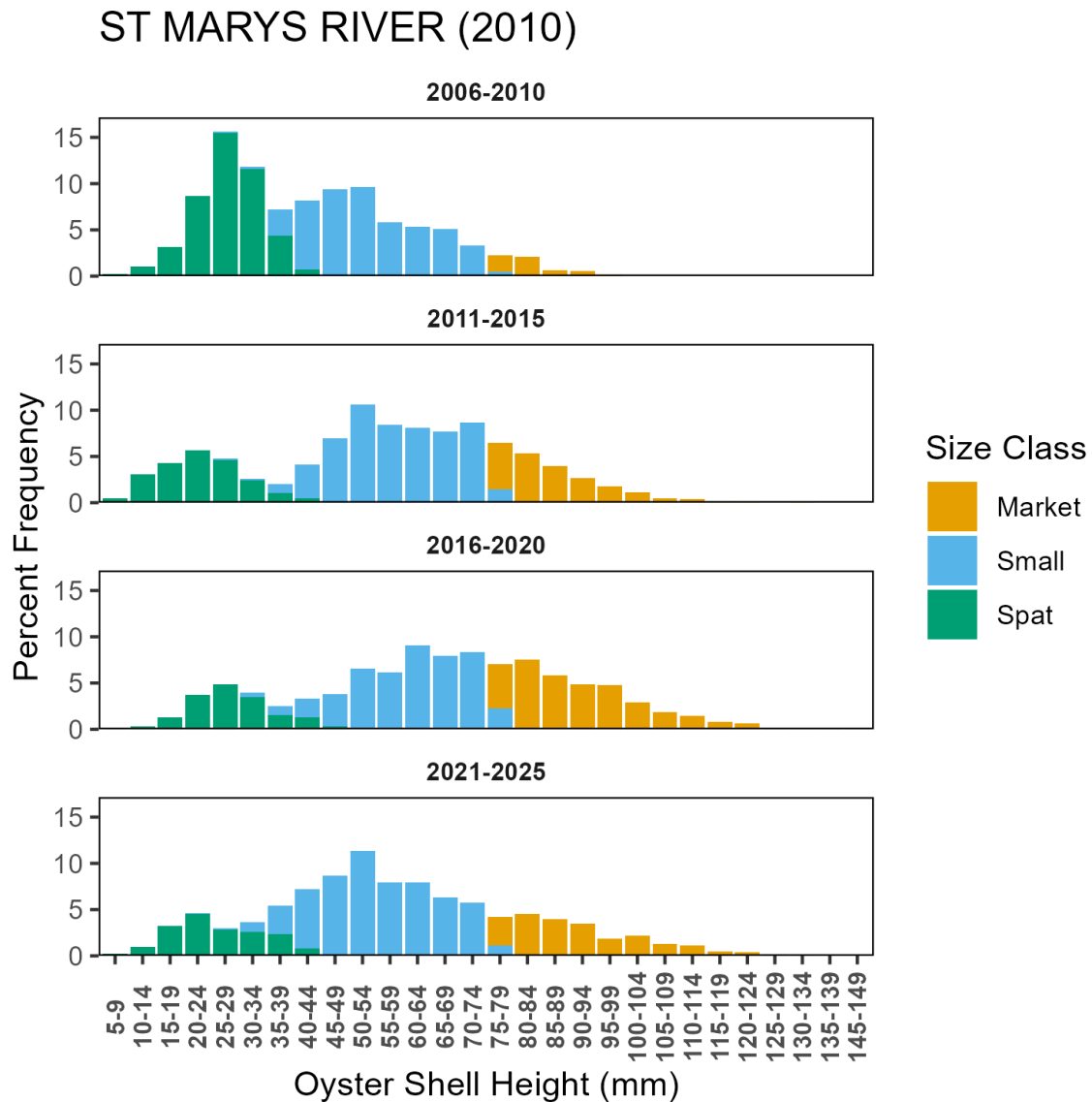


Figure A.43-3. Shell height frequencies of live oysters in the St. Marys River Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey on Pagan bar.

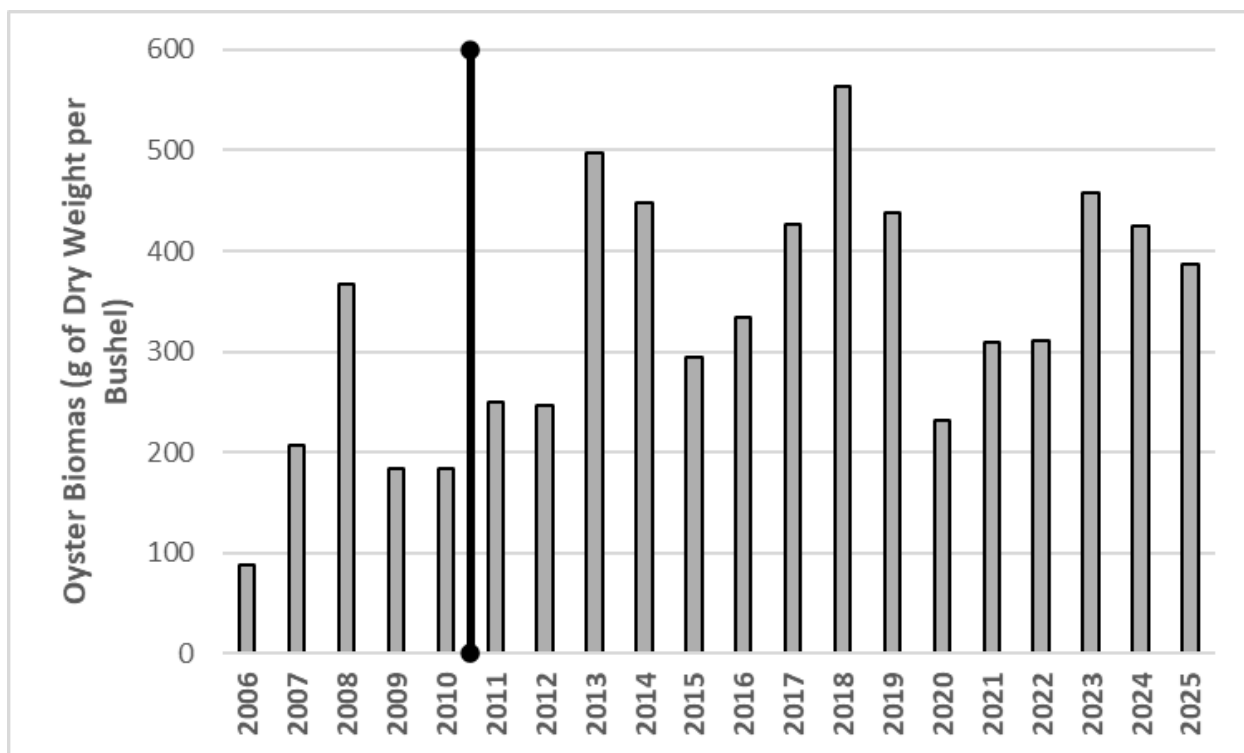


Figure A.43-4. Oyster biomass (grams of dry weight per bushel of material) in the St. Marys River Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey on Pagan bar. Black line indicates the date the sanctuary was established.

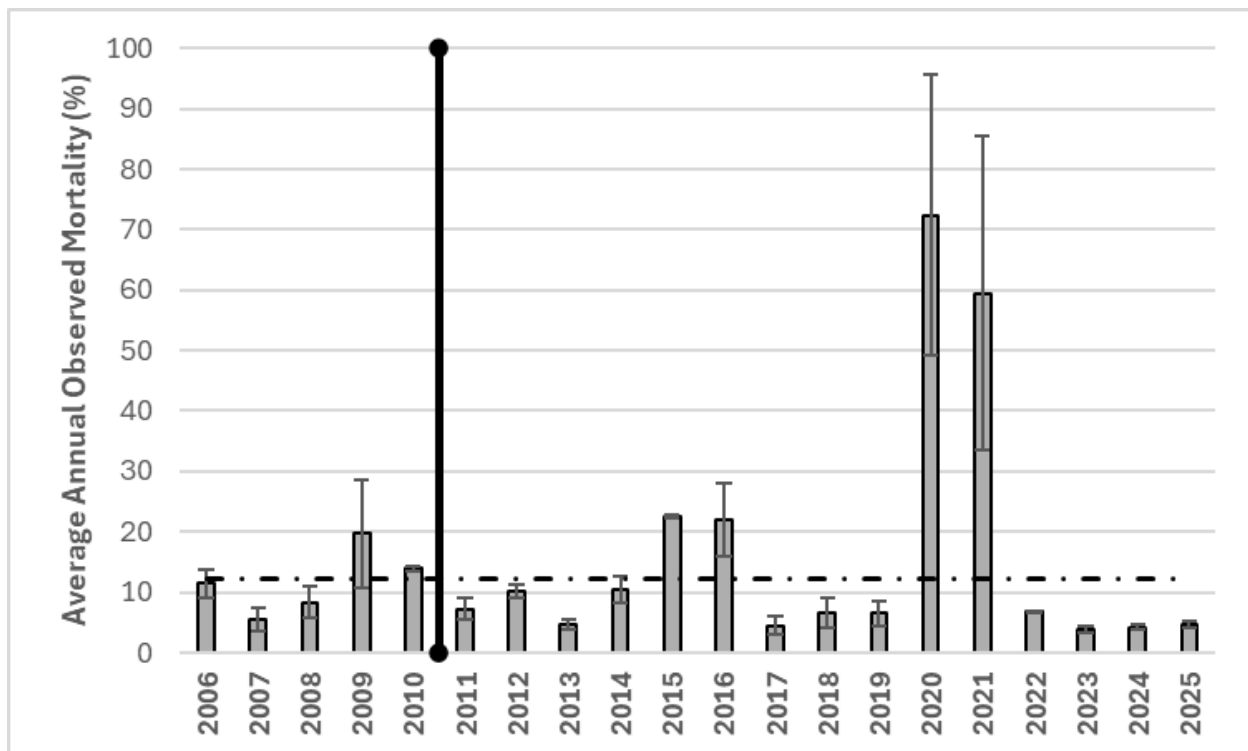


Figure A.43-5. Average observed mortality of market-sized and small-sized oysters in St. Marys River Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Black line denotes the date the sanctuary was established, and the dashed line represents the 2006 to 2025 baywide average observed mortality. Error bars represent ± 1 standard error.

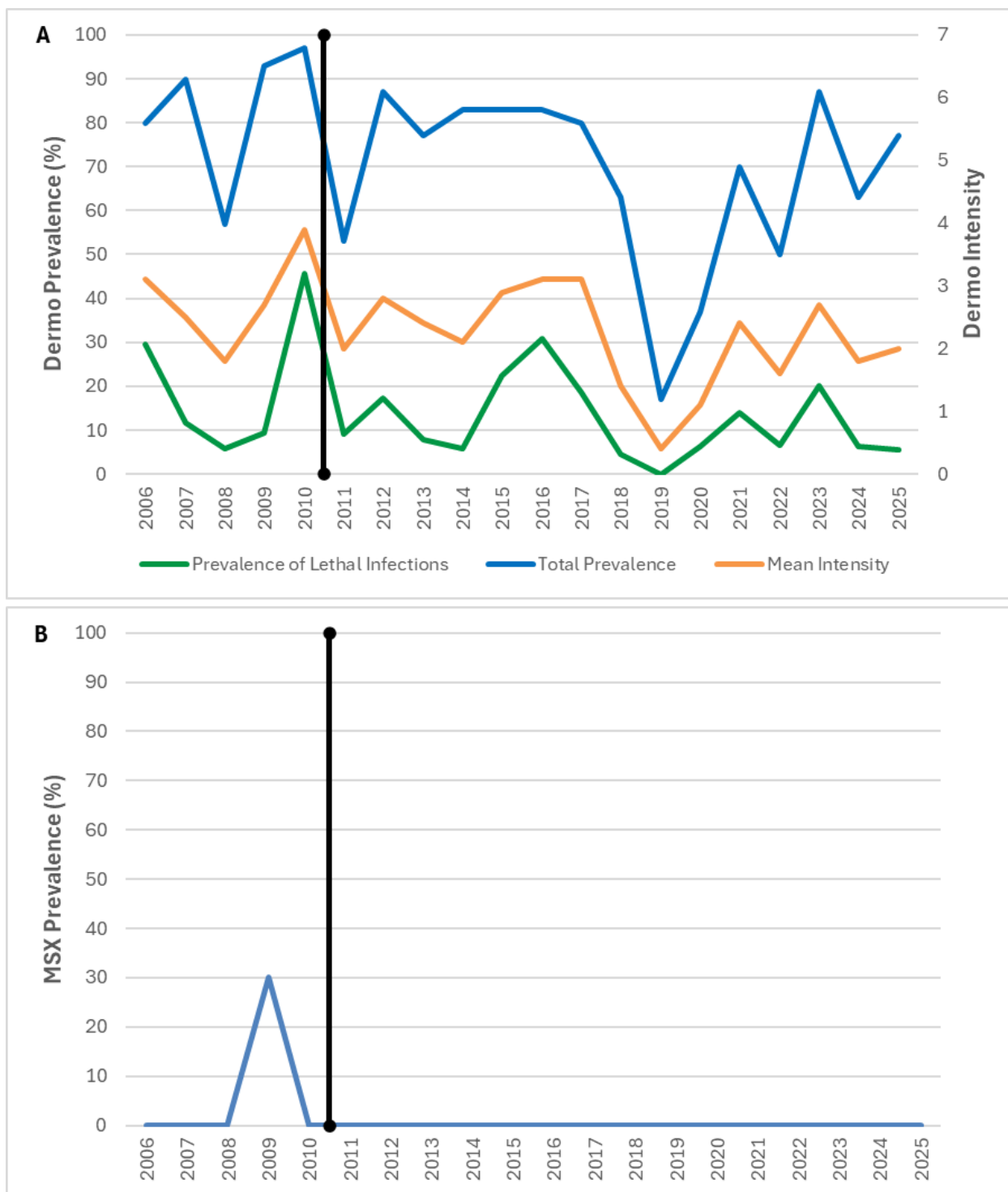


Figure A.43-6. Oyster disease prevalence and intensity in the St. Marys River Sanctuary. (A) Dermo prevalence and mean intensity (B) MSX prevalence (intensity is not examined). Data from Maryland's Annual Fall Oyster Dredge Survey on Pagan bar. Black line denotes the date the sanctuary was established.

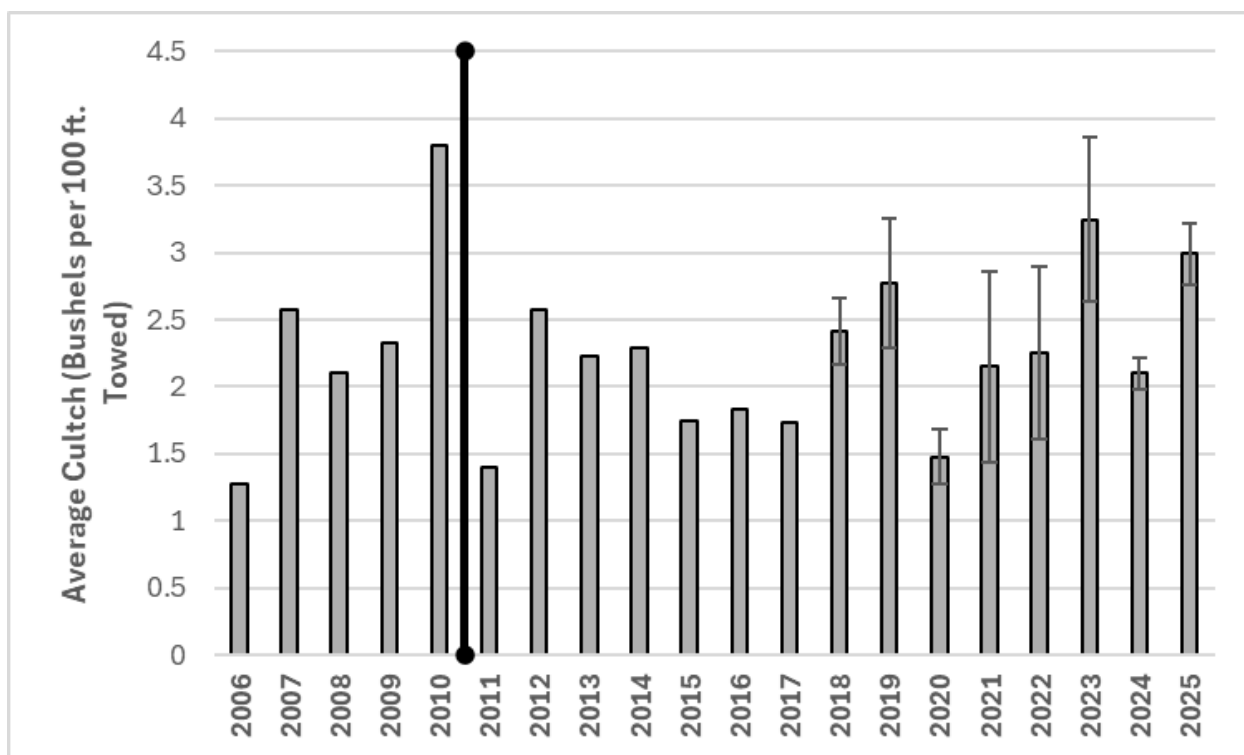


Figure A.43-7. Average cultch (live and dead oysters and loose shell) in the St. Marys River Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Black line denotes the date the sanctuary was established. Error bars represent ± 1 standard error. ND = No Data.

Section A.44: Tilghman Island Sanctuary

The Tilghman Island Sanctuary is located in the middle eastern portion of Maryland's Chesapeake Bay, a medium salinity (Zone 2) region within NOAA Code 027. The sanctuary was created in 2010 and encompasses 2,534 acres of which 1,345 acres (53%) are historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments). There are 2 historic oyster bars (Bay Hundred and Pone bars) within the sanctuary.

Information available for this sanctuary includes:

- Sanctuary map (Figure A.44-1)
- Density Survey (Figure A.44-2)
- Summary statistics (Table A.44-1)

Tilghman Island Sanctuary is located in the Mid Bay Region of Maryland's Chesapeake Bay. Oysters in the Mid Bay Region typically exhibit good growth and survival rates, remaining largely unaffected by disease or freshet events. There are typically low rates of recruitment in this region.

In 2023 the Department conducted a patent tong population survey and found two live oysters out of 160 samples. While there was an average volume of 0.06 liters per square meter of surface shell, there were significant areas of hard bottom. This makes Tilghman Island Sanctuary a good candidate for restoration.

In 2023, the Department added a standard Fall Oyster Survey site in the Tilghman Island Sanctuary.

This sanctuary is slated to receive small-scale restoration in 2026. In the 2021-2025 sanctuary assessment, this sanctuary was classified as receiving restoration.

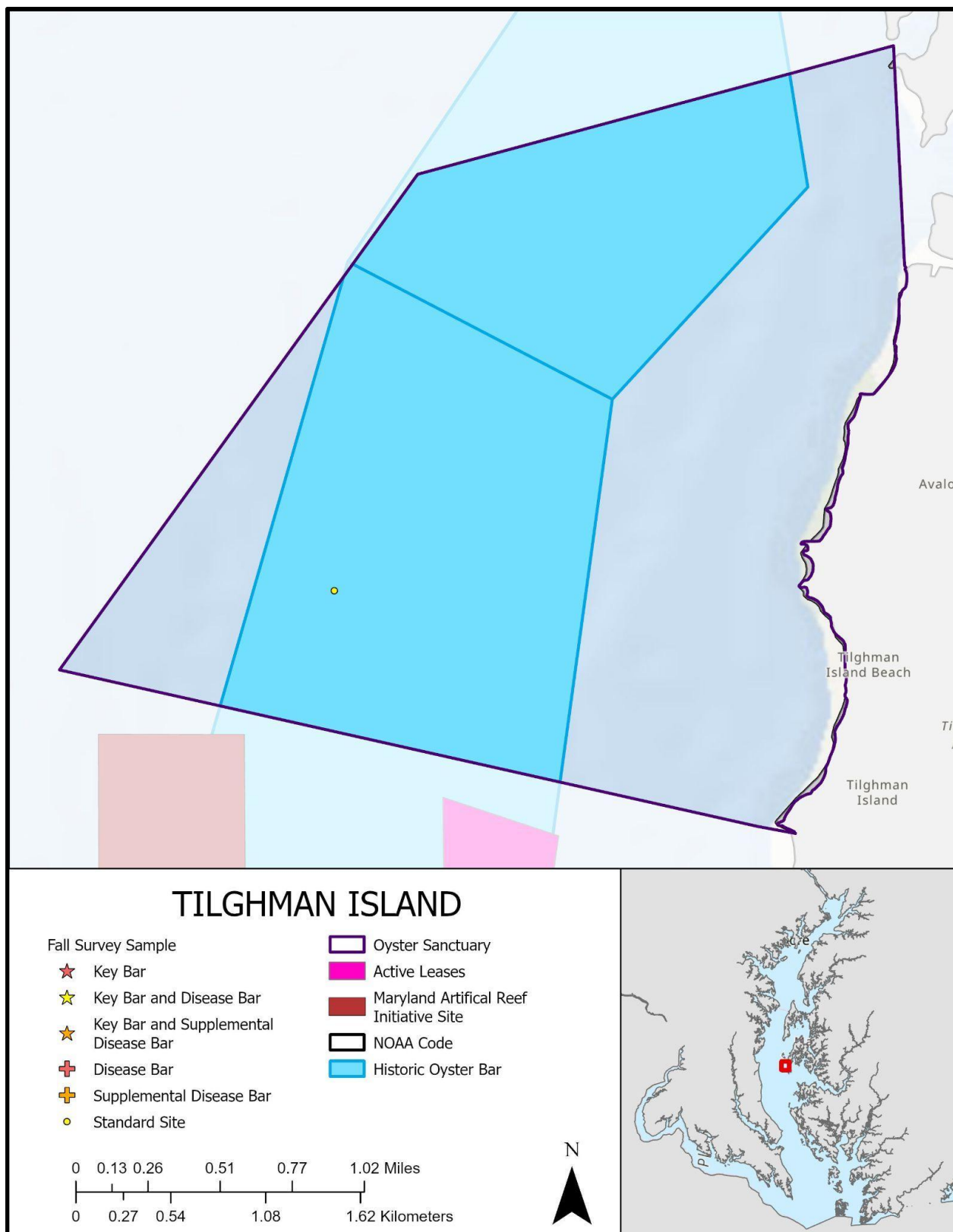


Figure A.44-1. Tilghman Island Sanctuary. Fall Oyster Survey sites may not be sampled every year.

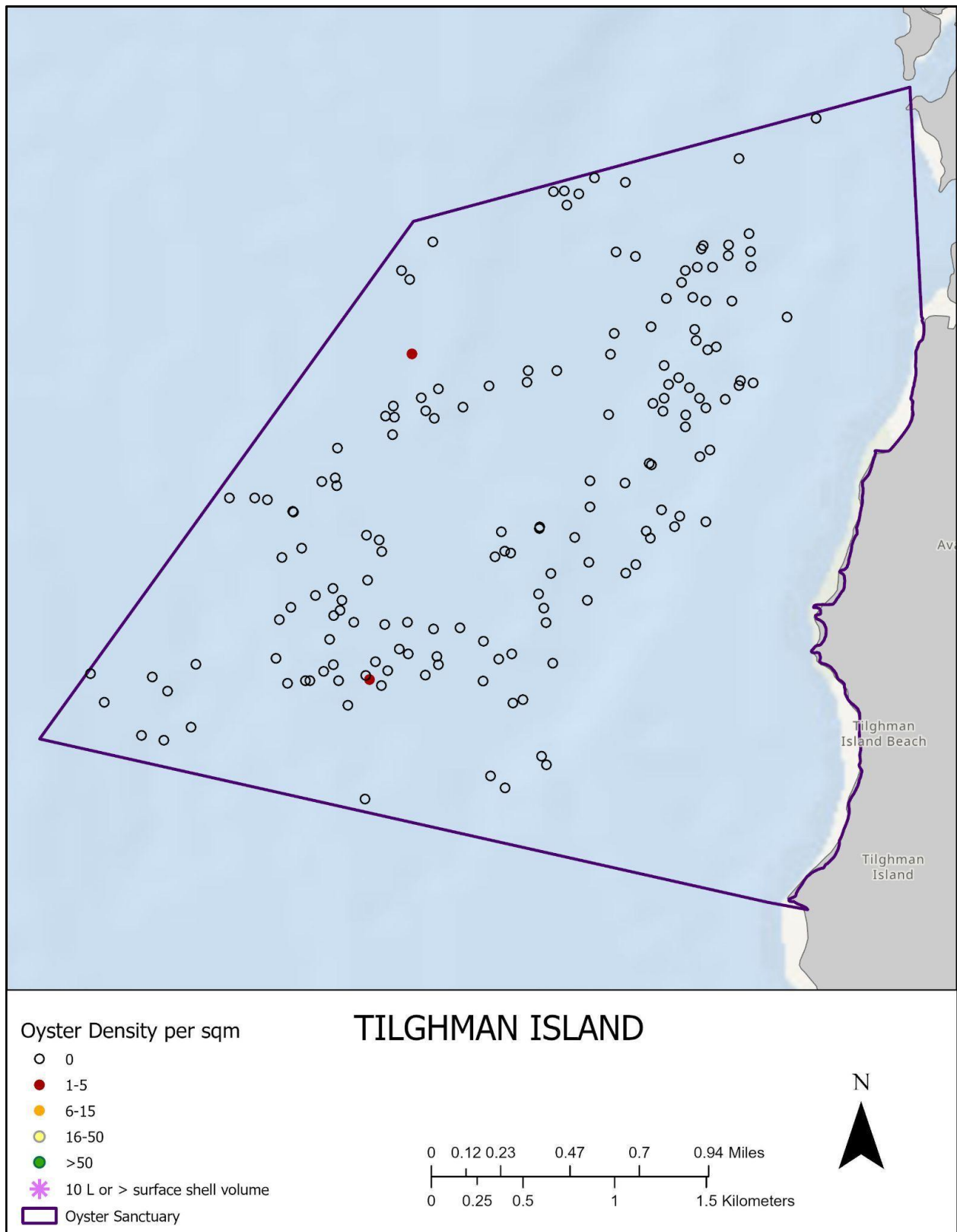


Figure A.44-2. Map of 2023 oyster density in the Tilghman Island Sanctuary. Data from Maryland Department of Natural Resources Patent Tong Population Survey.

Table A.44-1. Oyster population characteristics based on the Fall Oyster Survey in the Tilghman Island Sanctuary. ND=No Data. Values given are annual mean $\pm$ standard error.

Oyster Characteristic	2006-2010	2011-2015	2016-2020	2021-2025
Number of years sampled/number of samples	ND	ND	ND	3/3
Number of Live Spat Oysters per square meter	ND	ND	ND	11.4 $\pm$ 4.3
Number of Live Small Oysters per square meter	ND	ND	ND	3.3 $\pm$ 1.1
Number of Live Market Oysters per square meter	ND	ND	ND	2.8 $\pm$ 0.7
Number of Live Oysters per square meter	ND	ND	ND	17.5 $\pm$ 4.7
Live Biomass (g Dry Weight per Bushel)	ND	ND	ND	ND
Observed Mortality (%)	ND	ND	ND	21 $\pm$ 5.3
Cultch (Bushels per 100 feet towed)	ND	ND	ND	0.2 $\pm$ 0.02

Section A.45: Tred Avon River Sanctuary

The Tred Avon River Sanctuary, created in 2010, is located in the upper reaches of the Tred Avon River, a tributary of the Choptank River within NOAA Code 637. The sanctuary is in a low salinity (Zone 1) region and encompasses 4,149 acres of which 1,152 (28%) is historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments). There are 27 historic oyster bars within the sanctuary⁴¹. The Tred Avon River Sanctuary was one of the sanctuaries chosen for large-scale oyster restoration under the 2014 Chesapeake Watershed Agreement. Initial restoration was completed in 2021. Planned second hatchery spat-on-shell seedings and monitoring are ongoing.

Information available for this sanctuary includes:

- Sanctuary map (Figure A.45-1)
- Summary statistics (Table A.45-1)
- Density per year (Figure A.45-2)
- Shell height frequencies (Figure A.45-3)
- Biomass per year (Figure A.45-4)
- Observed mortality (Figure A.45-5)
- Dermo and MSX per year (Figure A.45-6)
- Cultch per year (Figure A.45-7)

Tred Avon River Sanctuary is located in the Choptank Region of Maryland's Chesapeake Bay. Oysters in the Choptank Region generally grow well but may be impacted by disease or freshet events. Natural recruitment occurs regularly in this region.

The Fall Oyster Survey has five standard sites and one key and disease bar sentinel site in the Tred Avon River Sanctuary. Table A.45-1 shows an increase in the average number of oysters and biomass from 2021-2025 compared to the previous 5-year increments, while exhibiting low average observed mortality. Lethal dermo disease prevalence remained low, with no MSX prevalence reported (Figure A.45-6). The average density from 2021-2025 is above the long-term abundance target of 94 oysters per square meter. It should be noted that given limitations of traditional gear types (dredge and patent tong), not all restored areas are surveyed by the Department. The Fall Oyster Survey is unable to sample reefs that have been restored using rock substrate. Past monitoring by the U.S. Army Corps of Engineers six years after initial restoration has shown densities on alternate substrate restoration areas ranging from 29.6 to 494.6 oysters per square meter⁴². Six-year monitoring is ongoing for reefs that have yet to reach six years post initial construction for restoration.

⁴¹ See chart 16 for bar names and locations in the State of Maryland Shellfish Closure Areas Book <http://dnr.maryland.gov/fisheries/Pages/oysters/index.aspx>

⁴² Maryland Oyster Restoration Interagency Workgroup under the Chesapeake Bay Program's Sustainable Fisheries Goal Implementation Team. 2024 Maryland Oyster Reef Monitoring Report: Analysis of Data from the 'Ten Tributaries' Sanctuary Oyster Restoration Initiative in Maryland. 2025.

The Department has not done a patent tong survey since 2012; however, restoration partners have conducted restoration monitoring. As of 2024, 96% of the restoration reefs monitored at six years post restoration have met minimum restoration criteria (15 oysters per square meter over 30% of the reef). Final six-year monitoring on all restoration areas will be completed in 2027.

In the 2021-2025 sanctuary assessment, this sanctuary was classified as restored.

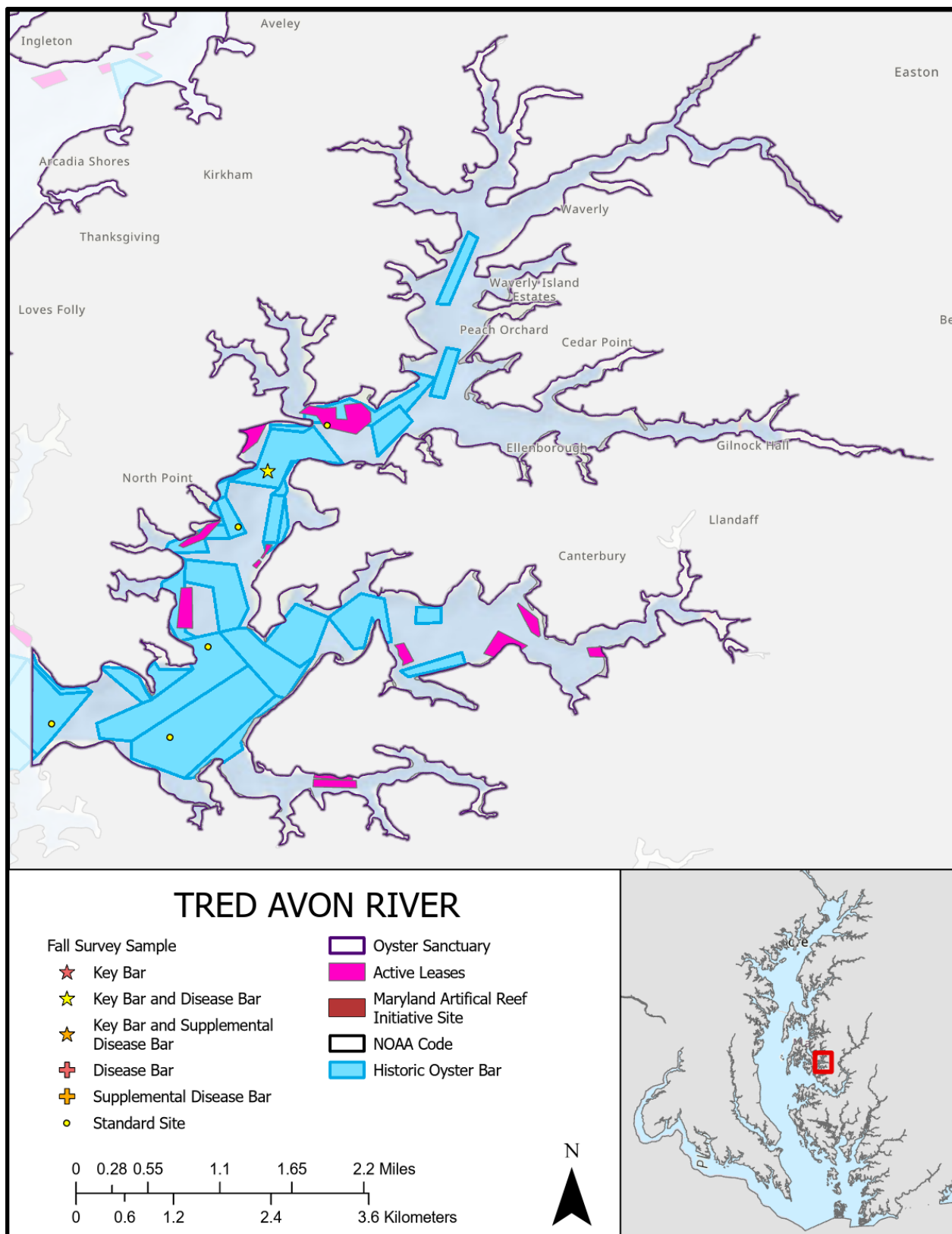


Figure A.45-1. Tred Avon River Sanctuary. Fall Oyster Survey sites may not be sampled every year.

Table A.45-1. Oyster population characteristics based on the Fall Oyster Survey in the Tred Avon River Sanctuary. ND=No Data. Values given are annual mean $\pm$ standard error.

Oyster Characteristic	2006-2010	2011-2015	2016-2020	2021-2025
Number of years sampled/number of samples	5/30	5/30	5/30	5/30
Number of Live Spat Oysters per square meter	5.5 $\pm$ 1.2	11.7 $\pm$ 2.8	76 $\pm$ 56*	88 $\pm$ 28
Number of Live Small Oysters per square meter	14.6 $\pm$ 4.3	19 $\pm$ 4.9	55 $\pm$ 17.6	100 $\pm$ 19
Number of Live Market Oysters per square meter	29.6 $\pm$ 3.9	116 $\pm$ 21	124 $\pm$ 14	103 $\pm$ 12.4
Number of Live Oysters per square meter	49 $\pm$ 6.6	139 $\pm$ 25	255 $\pm$ 56	291 $\pm$ 40
Live Biomass (g Dry Weight per Bushel)	103 $\pm$ 13	165 $\pm$ 15	244 $\pm$ 23	349 $\pm$ 25
Observed Mortality (%)	7.8 $\pm$ 1.2	8.4 $\pm$ 0.97	11.5 $\pm$ 1.8	7.6 $\pm$ 0.93
Cultch (Bushels per 100 feet towed)	1.5 $\pm$ 0.11	2.4 $\pm$ 0.3	1.9 $\pm$ 0.14	1.3 $\pm$ 0.11

*Includes sample taken on 2020 hatchery seed planting

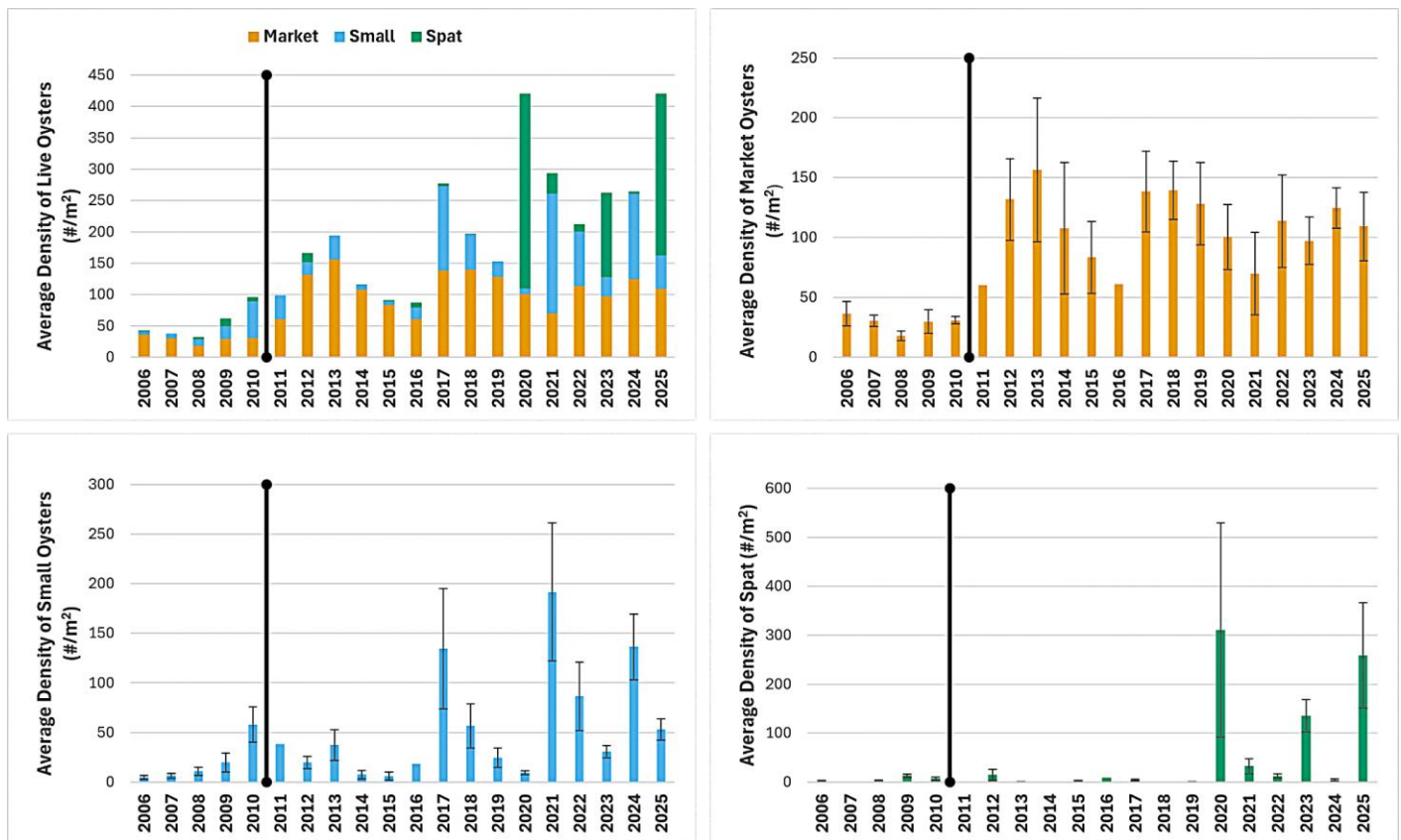


Figure A.45-2. Average number of live oysters per square meter by size class in the Tred Avon River Sanctuary. Black line indicates the date the sanctuary was established. Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales.

TRED AVON (2010)

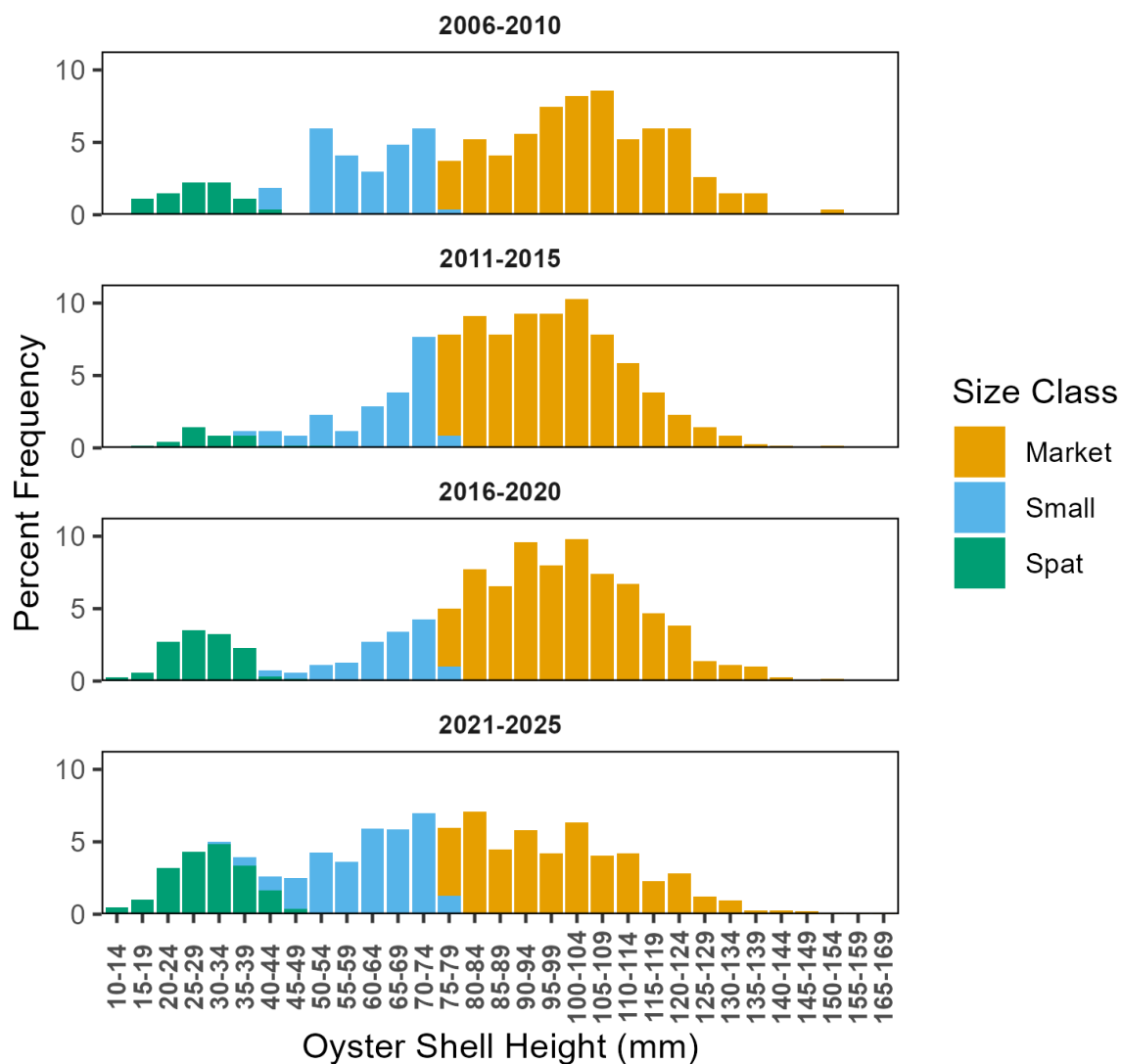


Figure A.45-3. Shell height frequencies of live oysters in the Tred Avon River Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey.

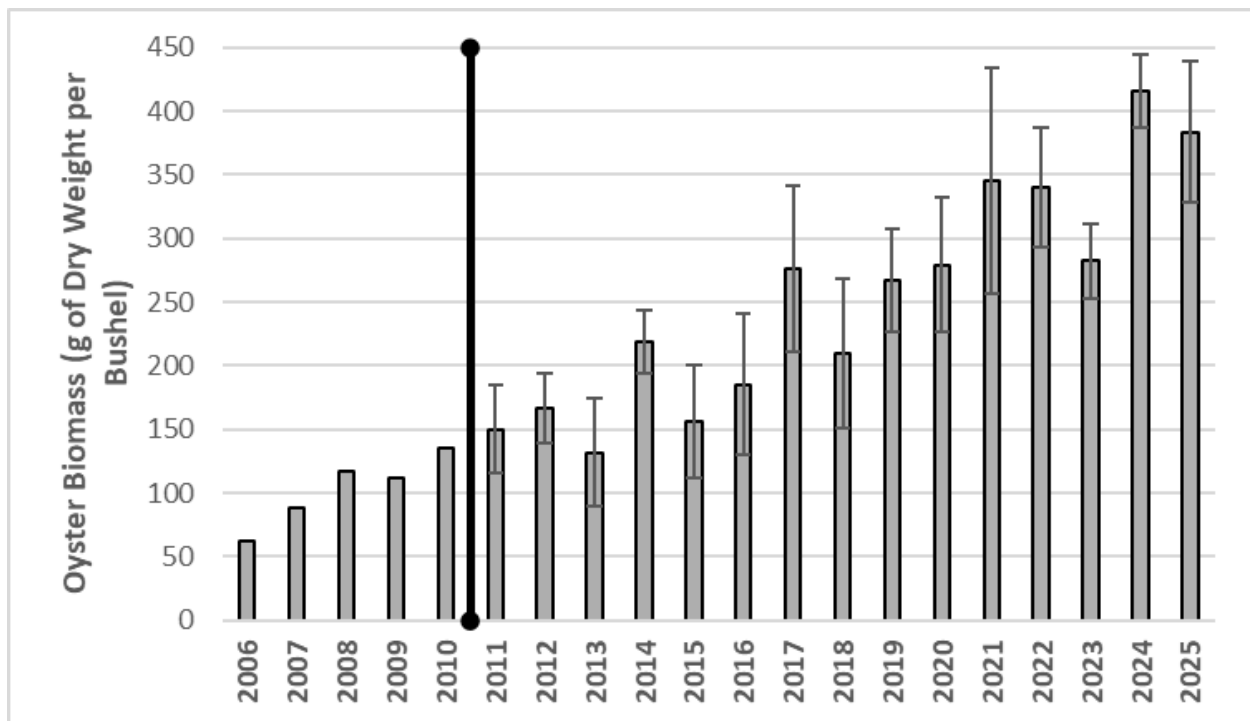


Figure A.45-4. Oyster biomass (grams of dry weight per bushel of material) in the Tred Avon River Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Black line indicates the date the sanctuary was established. Error bars represent ± 1 standard error.

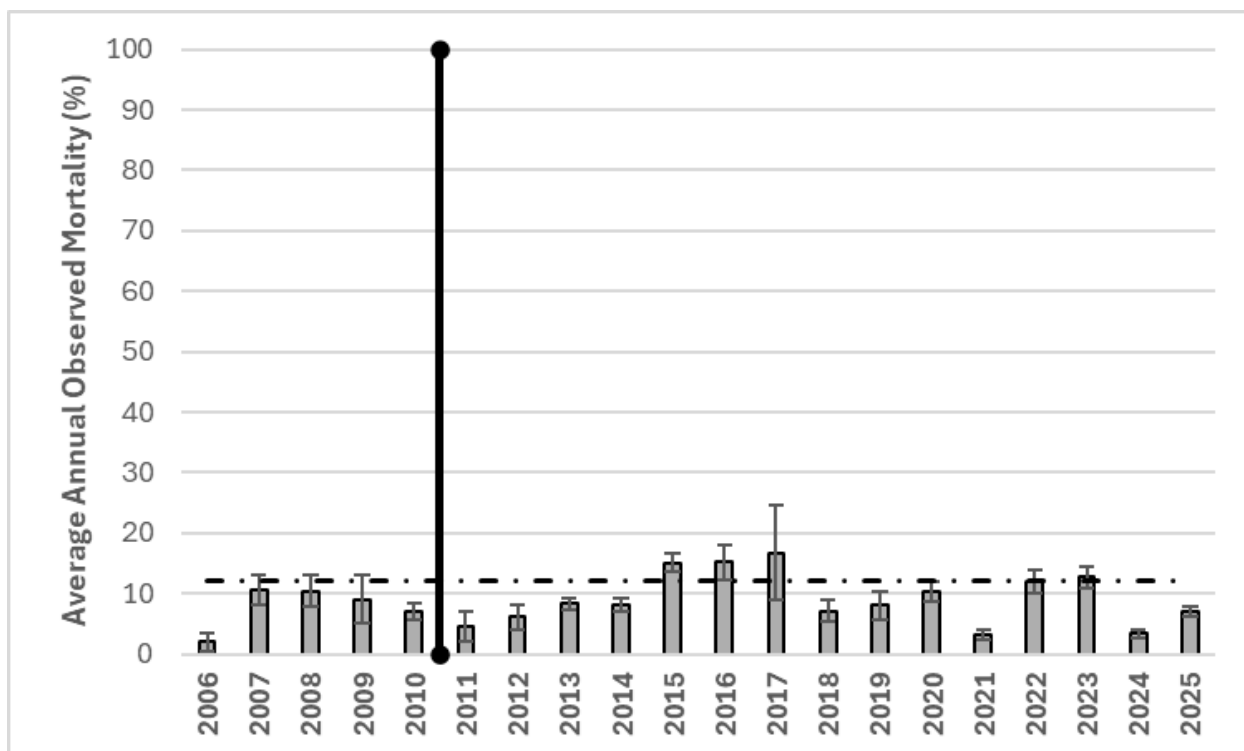


Figure A.45-5. Average annual observed mortality of market-sized and small-sized oysters in Tred Avon River Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Black line denotes the date the sanctuary was established, and the dashed line represents the 2006-2025 baywide average observed mortality. Error bars represent ± 1 standard error.

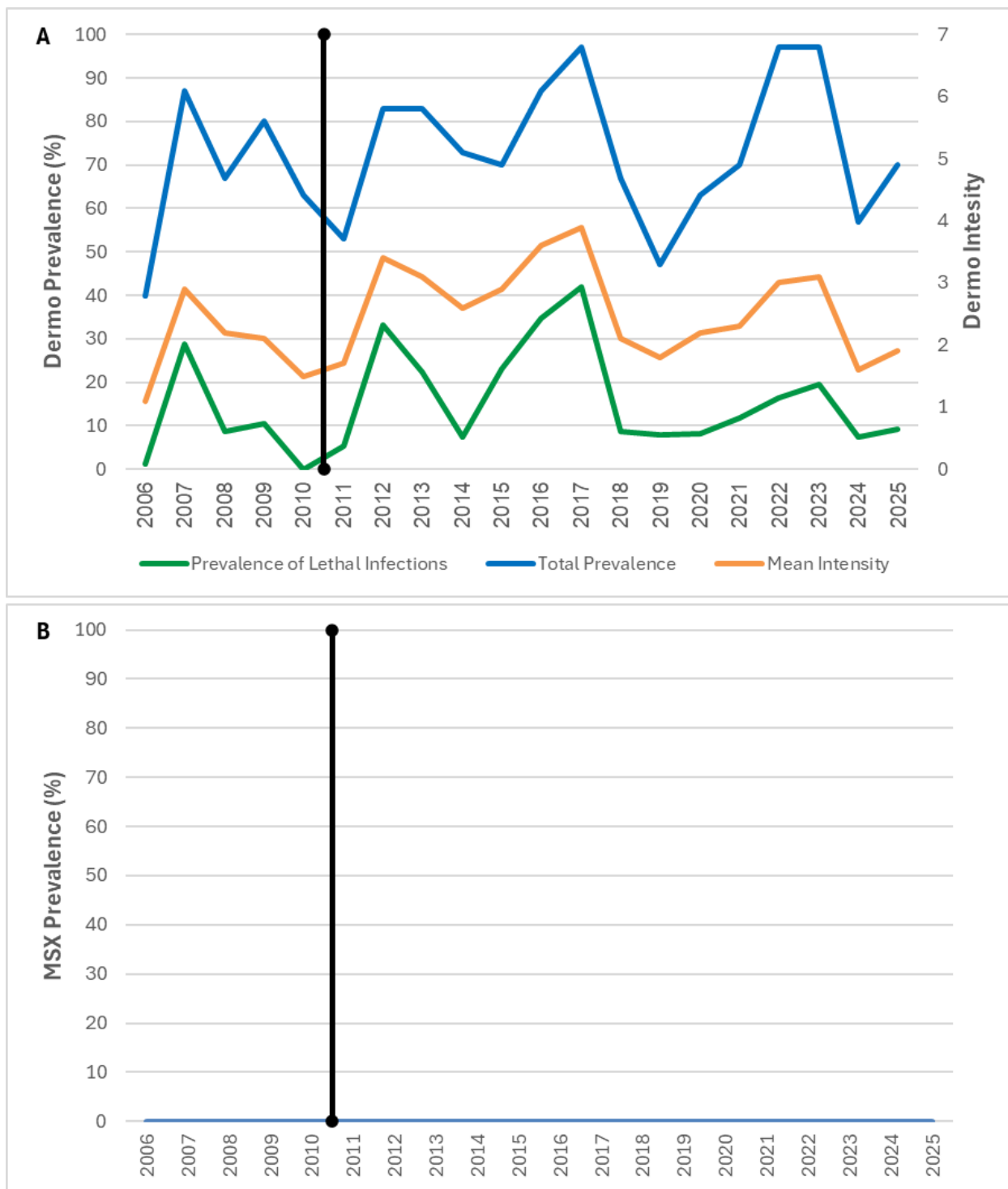


Figure A.45-6. Oyster disease prevalence and intensity in the Tred Avon River Sanctuary. (A) Dermo prevalence and mean intensity (B) MSX prevalence (intensity is not examined). Data from Maryland's Annual Fall Oyster Dredge Survey on Double Mills bar. Black line denotes the date the sanctuary was established.

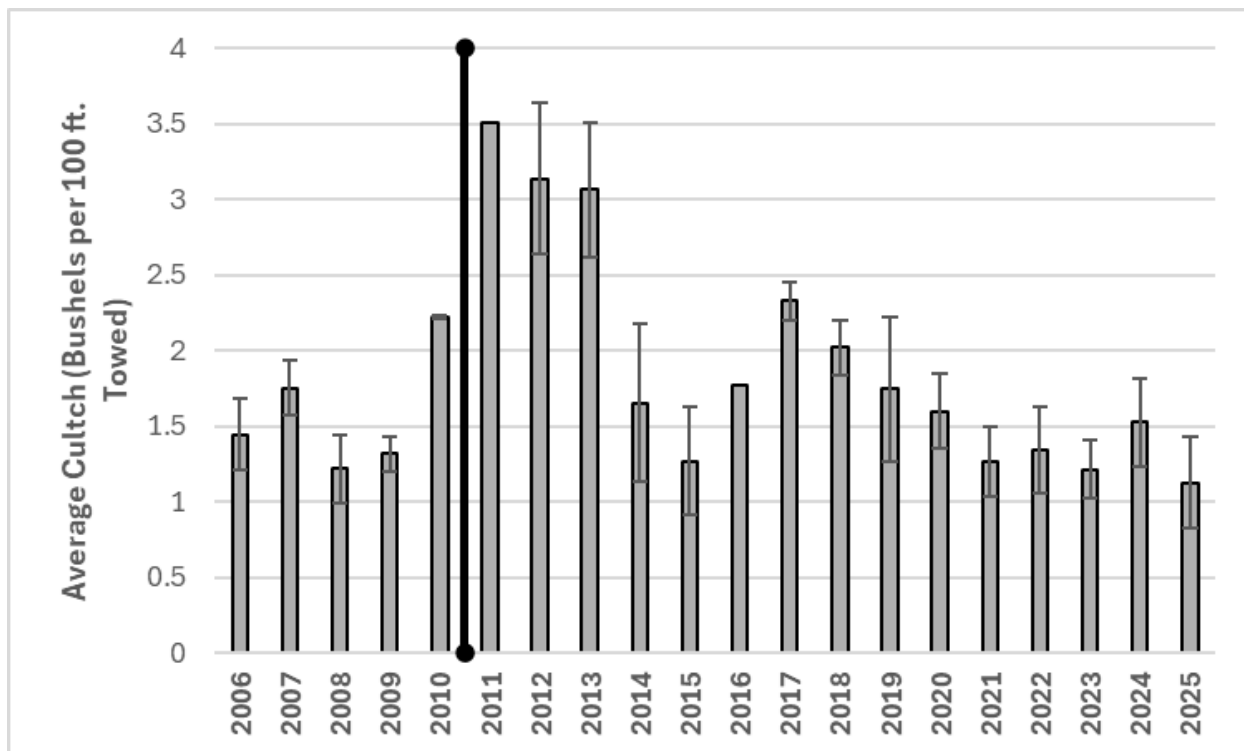


Figure A.45-7. Average cultch (live and dead oysters and loose shell) in the Tred Avon River Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Black line denotes the date the sanctuary was established. Error bars represent ± 1 standard error.

Section A.46: Upper Chester River Sanctuary

The Upper Chester River Sanctuary is located in the Chester River adjacent to the Chester ORA Sanctuary, creating a large contiguous protected area. The sanctuary is located in a low salinity (Zone 1) region within NOAA Codes 231 and 331. The sanctuary was created in 2010 and has an area of 9,033 acres of which 2,365 (26%) are historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments). Two smaller sanctuaries created in 2007 are encompassed in this sanctuary: Emory Wharf (65 acres) and Possum Point (11 acres). Thus, the total surface area is 9,109 acres and the total historic oyster bottom is 2,389 acres (26%). There are 31 historic bars within the sanctuary⁴³.

Information available for this sanctuary includes:

- Sanctuary map (Figure A.46-1)
- Density Survey (Figure A.46-2)
- Summary statistics (Table A.46-1)
- Density per year (Figure A.46-3)
- Shell height frequencies (Figure A.46-4)
- Biomass per year (Figure A.46-5)
- Observed mortality (Figure A.46-6)
- Dermo and MSX per year (Figure A.46-7)
- Cultch per year (Figure A.46-8)

Upper Chester River Sanctuary is located in the Upper Bay Region of Maryland's Chesapeake Bay. Oysters in the Upper Bay Region generally grow well and survive but can be impacted by freshet events. Low salinity conditions contribute to a lower rate of natural recruitment.

The Fall Oyster Survey has six standard sites and one disease bar sentinel site in the Upper Chester River Sanctuary. Table A.46-1 shows a decrease in the average number of oysters, biomass and cultch from 2021-2025 compared to the previous 5-year increments. Lethal dermo disease prevalence remained low, with no MSX prevalence reported (Figure A.46-7).

In 2022 the Department conducted a patent tong population survey and found an average of 0.03 oysters per square meter and an average volume of surface shell of 0.9 liters per square meter. This is less than 0.4 oysters per square meter and 1 liter per square meter found in 2012.

This sanctuary is subject to low salinity and poor recruitment. It was identified by the Department as underperforming and is under evaluation by the Oyster Advisory Commission for potential efforts to improve its performance.

This sanctuary is slated for a small-scale restoration spat-on-shell planting in 2026 to assist the Fall Oyster Survey in being able to sample enough oysters for disease

⁴³ See chart 8 for bar names and locations in the State of Maryland Shellfish Closure Areas Book
<http://dnr.maryland.gov/fisheries/Pages/oysters/index.aspx>

testing. In the 2021-2025 sanctuary assessment, this sanctuary was classified as trending negatively.

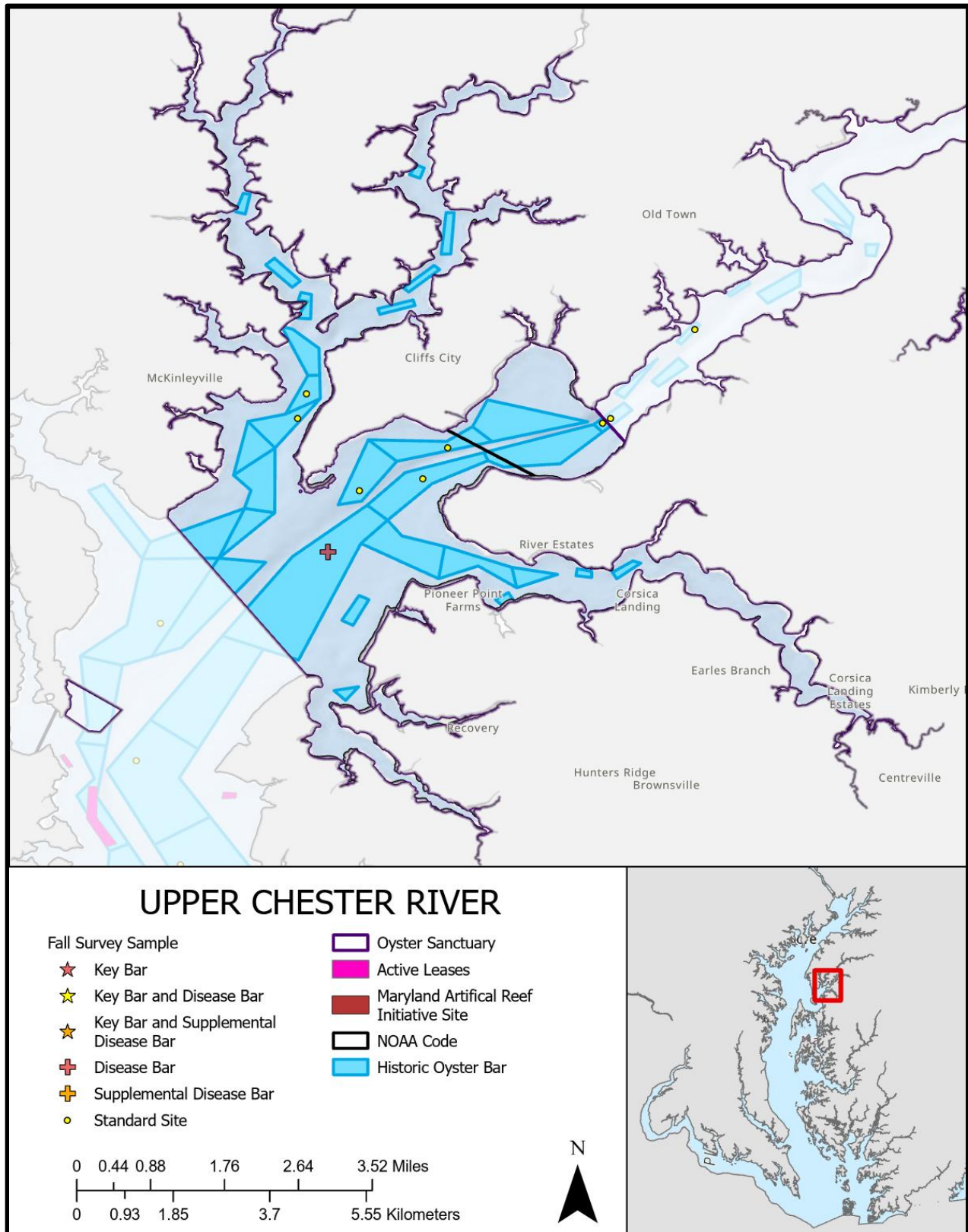


Figure A.46-1. Upper Chester River Sanctuary. Fall Oyster Survey sites may not be sampled every year.

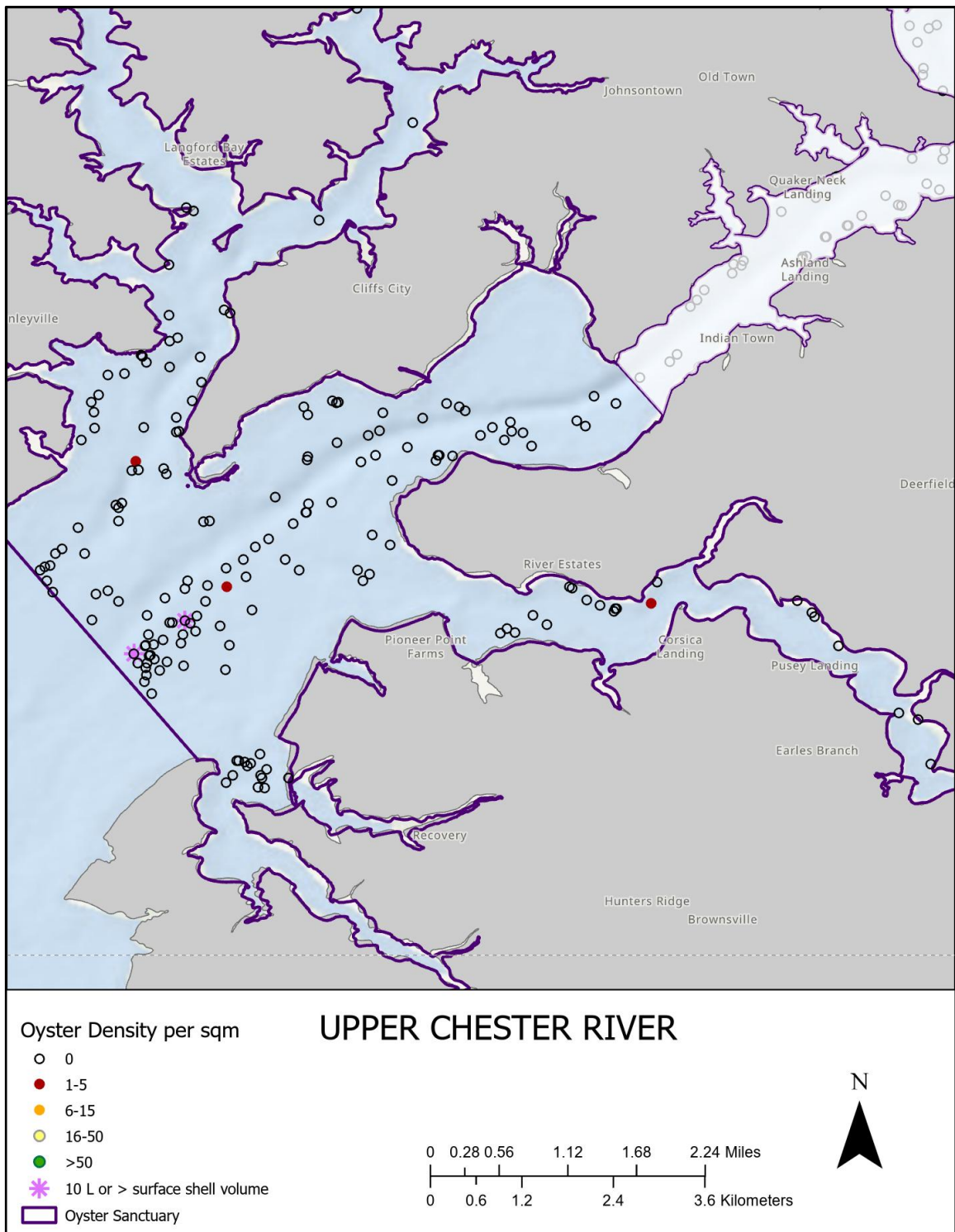


Figure A.46-2. Map of 2022 oyster density in the Upper Chester River Sanctuary. Data from Maryland Department of Natural Resources Patent Tong Population Survey.

Table A.46-1. Oyster population characteristics based on the Fall Oyster Survey in the Upper Chester River Sanctuary. ND=No Data. Values given are annual mean $\pm$ standard error.

Oyster Characteristic	2006-2010	2011-2015	2016-2020	2021-2025
Number of years sampled/number of samples	5/37	5/35	5/33	5/34
Number of Live Spat Oysters per square meter	0.1 $\pm$ 1.2	0.23 $\pm$ 2.8	0	0
Number of Live Small Oysters per square meter	5 $\pm$ 2.2	6.1 $\pm$ 4.4	0.04 $\pm$ 0.04	0.05 $\pm$ 0.03
Number of Live Market Oysters per square meter	19 $\pm$ 3.6	14.3 $\pm$ 2.3	10.6 $\pm$ 2.7	6.7 $\pm$ 1.7
Number of Live Oysters per square meter	24.2 $\pm$ 4.4	20.6 $\pm$ 5	10.6 $\pm$ 2.7	6.7 $\pm$ 1.7
Live Biomass (g Dry Weight per Bushel)	78 $\pm$ 23	82 $\pm$ 15	81 $\pm$ 25	58 $\pm$ 15
Observed Mortality (%)	13.5 $\pm$ 3	7.2 $\pm$ 1.5	19.2 $\pm$ 3.2	12.6 $\pm$ 2.5
Cultch (Bushels per 100 feet towed)	1.1 $\pm$ 0.08	1 $\pm$ 0.1	0.97 $\pm$ 0.1	0.9 $\pm$ 0.1

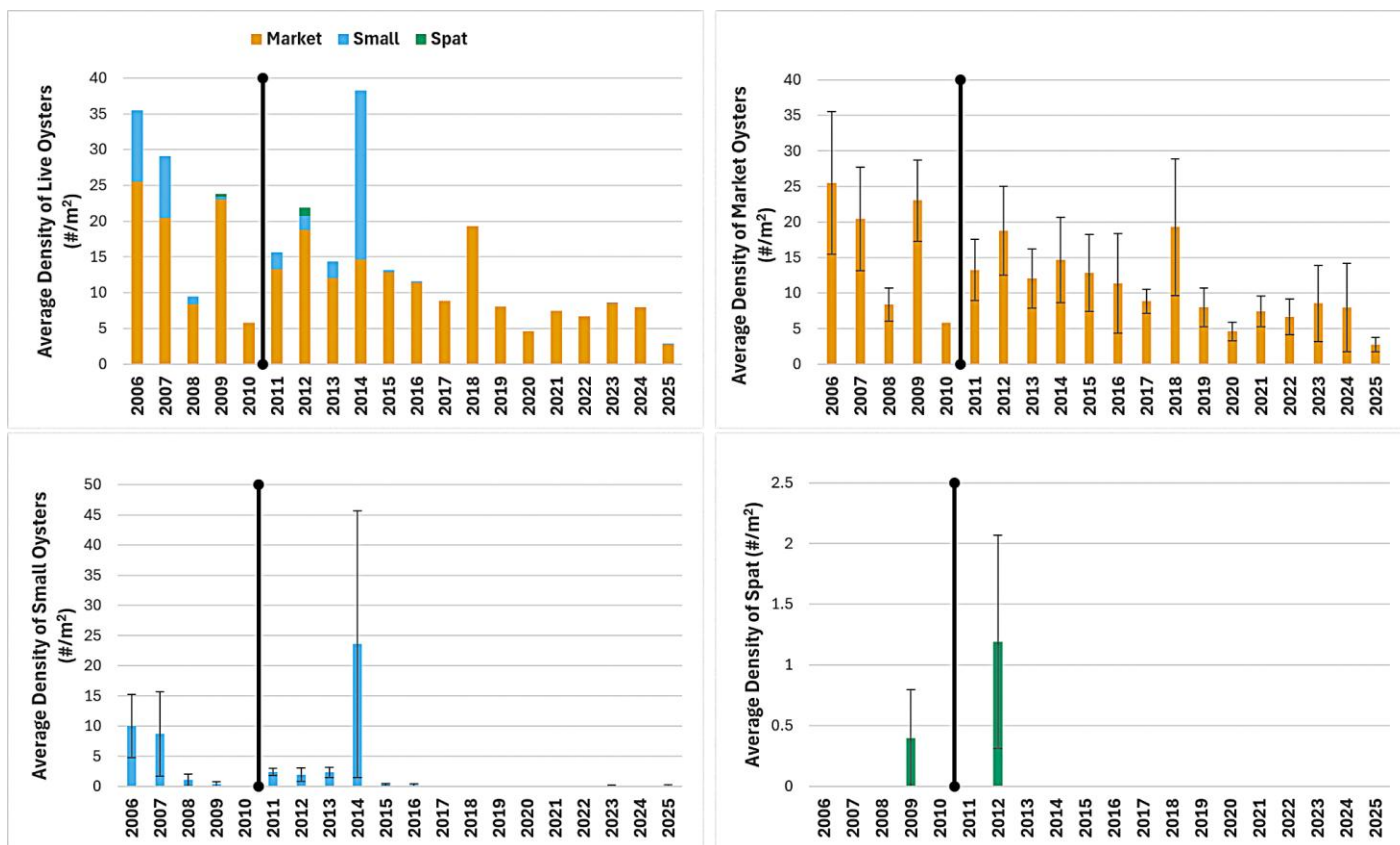


Figure A.46-3. Average number of live oysters per square meter by size class in the Upper Chester River Sanctuary. Black line indicates the date the sanctuary was established. Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales.

UPPER CHESTER (2010)

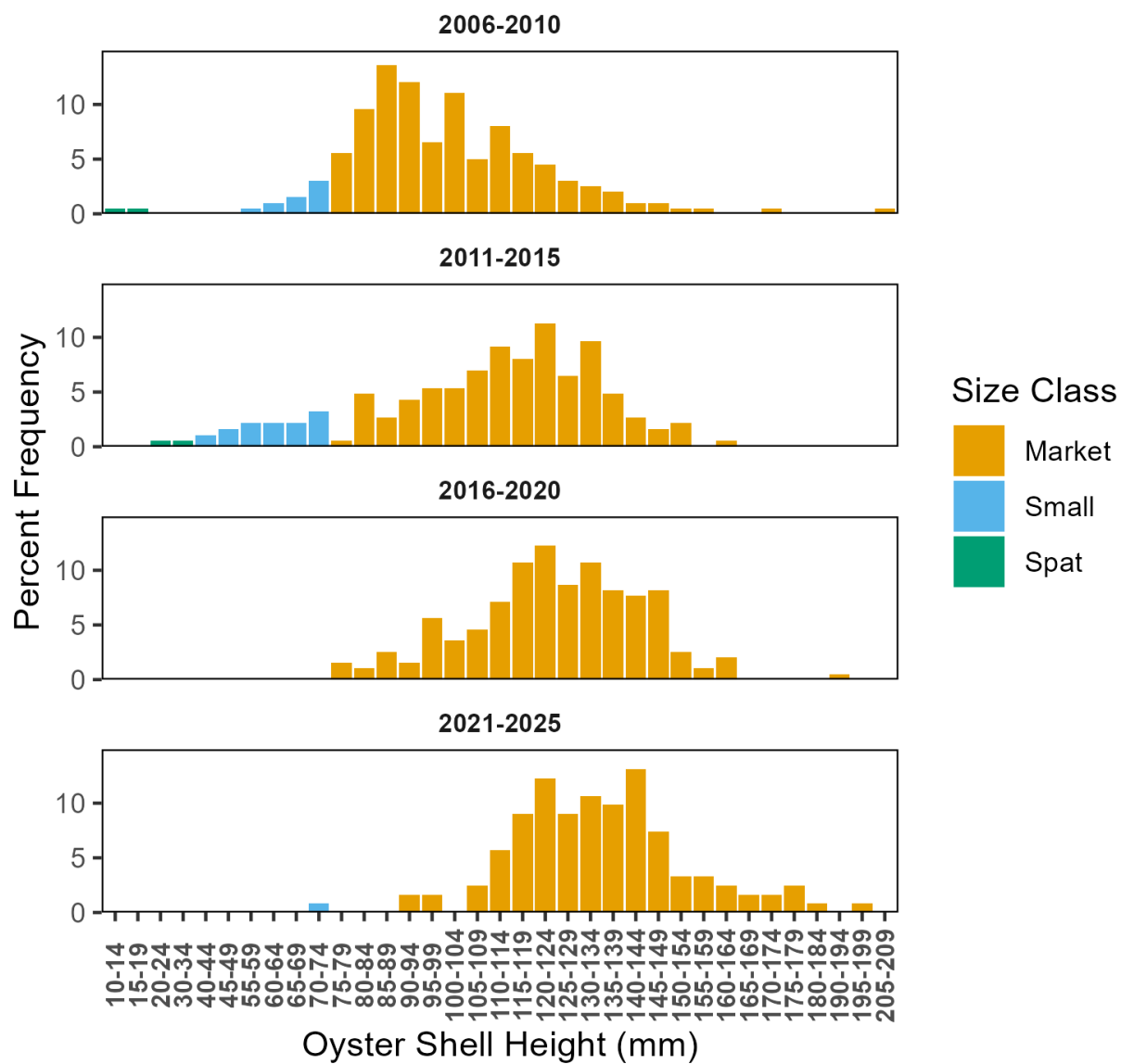


Figure A.46-4. Shell height frequencies of live oysters in the Upper Chester River Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey.

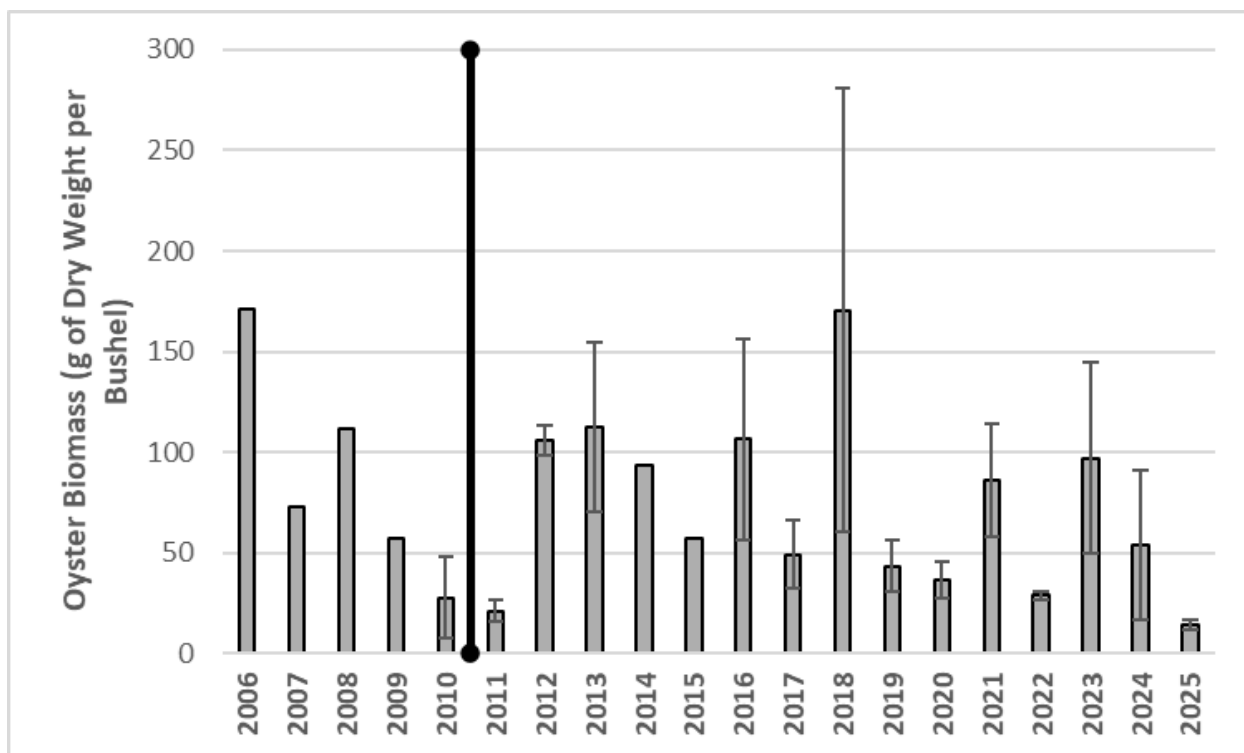


Figure A.46-5. Oyster biomass (grams of dry weight per bushel of material) in the Upper Chester River Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Black line indicates the date the sanctuary was established. Error bars represent ± 1 standard error.

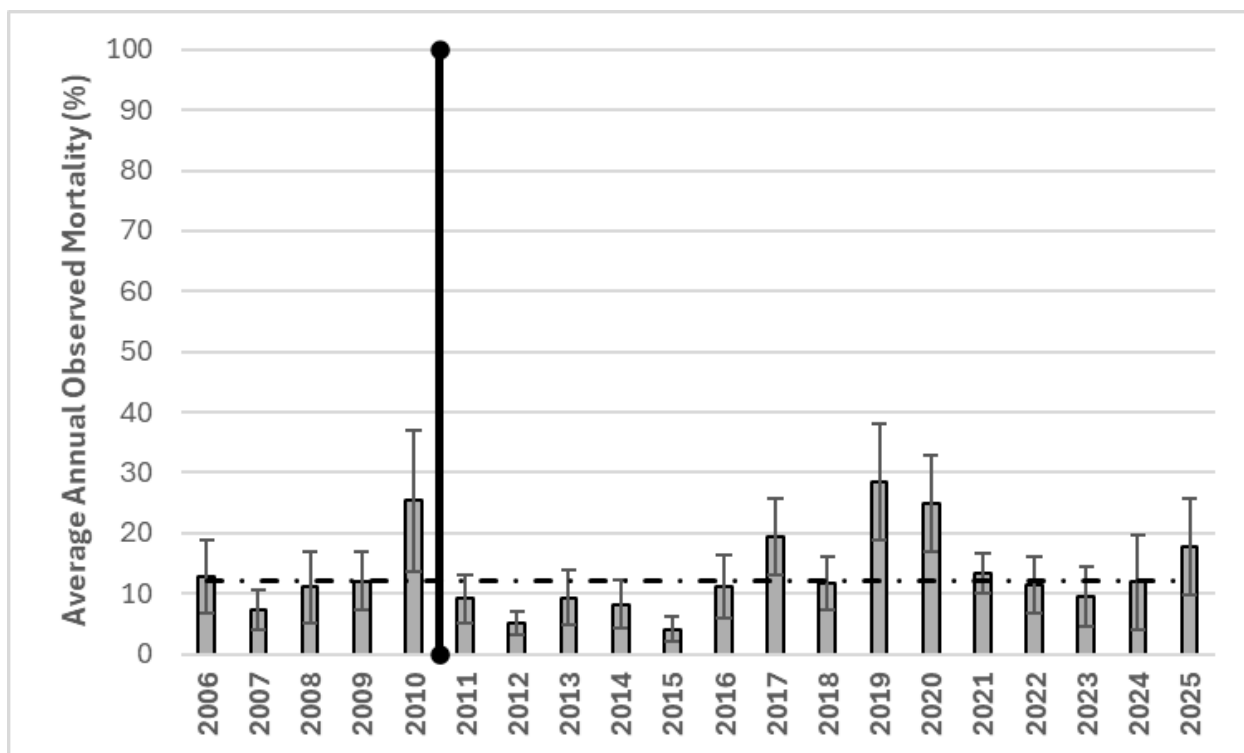


Figure A.46-6 Average annual observed mortality of market-sized and small-sized oysters in Upper Chester River Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Black line denotes the date the sanctuary was established, and the dashed line represents the 2006-2025 baywide average observed mortality. Error bars represent ± 1 standard error.

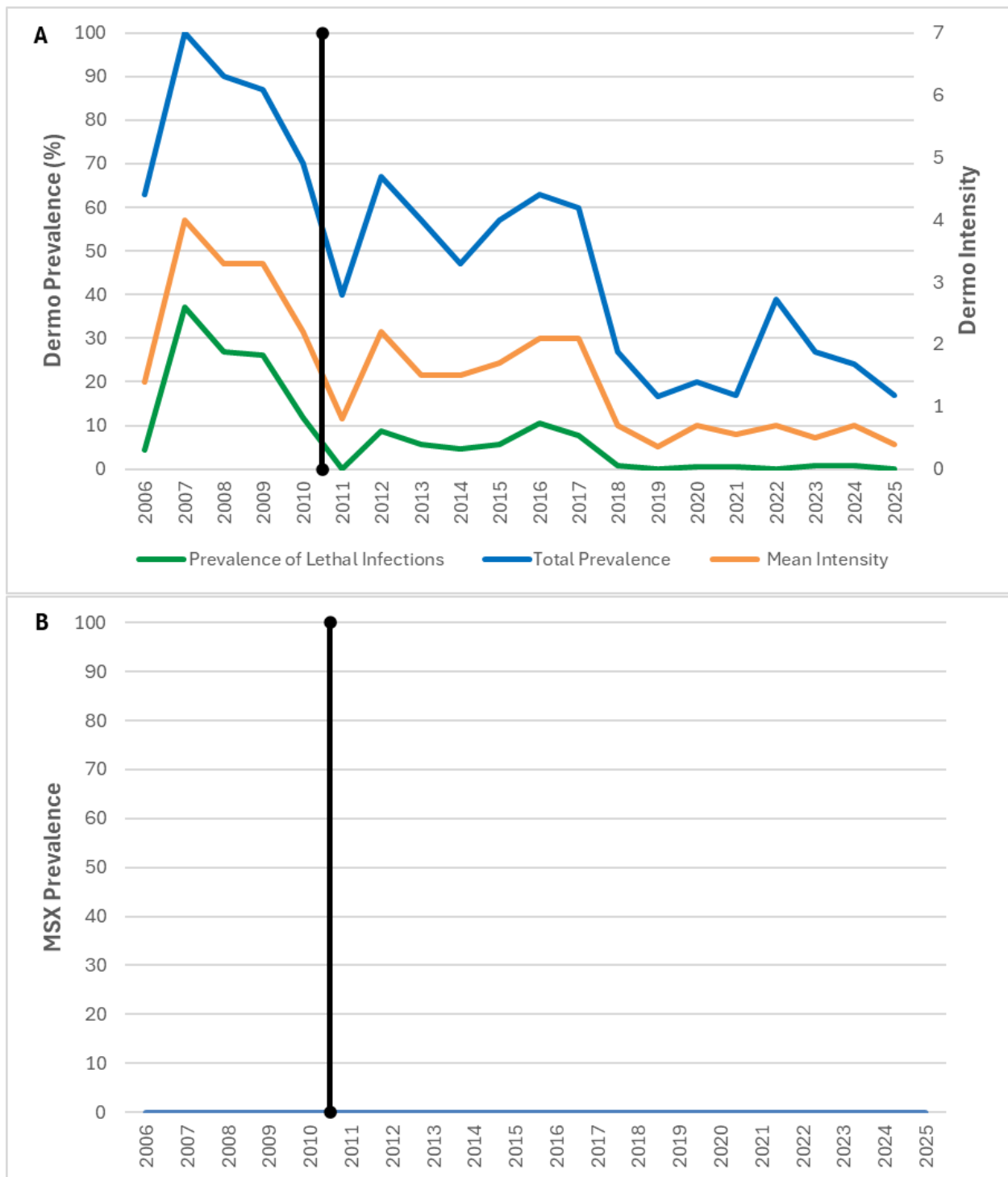


Figure A.46-7. Oyster disease prevalence and intensity in the Upper Chester River Sanctuary. (A) Dermo prevalence and mean intensity (B) MSX prevalence (intensity is not examined). Data from Maryland's Annual Fall Oyster Dredge Survey on Old Field bar. Black line denotes the date the sanctuary was established.

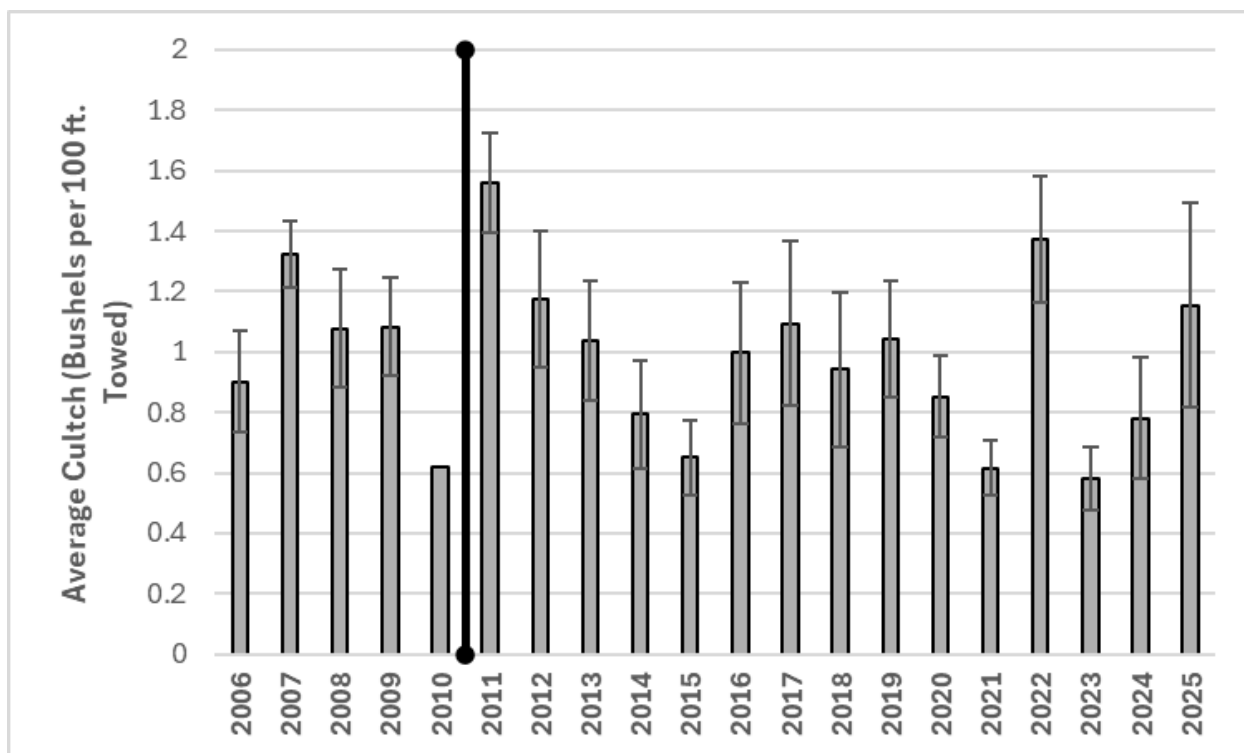


Figure A.46-8. Average cultch (live and dead oysters and loose shell) in the Upper Chester River Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Black line denotes the date the sanctuary was established. Error bars represent ± 1 standard error.

Section A.47: Upper Choptank River Sanctuary

The Upper Choptank River Sanctuary is located along the southern shore of the Choptank River, a low salinity (Zone 1) region within NOAA Codes 237 and 337. The sanctuary was created in 2010 and has 5,898 acres of which 1,675 (28%) is historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments). States Bank Sanctuary (82 acres), established in 2005, is now encompassed by the Upper Choptank River Sanctuary. Thus, the total surface area is 5,980 and the total historic oyster bottom is 1,687 acres (28%). There are 9 historic oyster bars within the sanctuary⁴⁴.

Information available for this sanctuary includes:

- Sanctuary map (Figure A.47-1)
- Density Survey (Figure A.47-2)
- Summary statistics (Table A.47-1)
- Density per year (Figure A.47-3)
- Shell height frequencies (Figure A.47-4)
- Biomass per year (Figure A.47-5)
- Observed mortality (Figure A.47-6)
- Dermo and MSX per year (Figure A.47-7)
- Cultch per year (Figure A.47-8)

Upper Choptank River Sanctuary is located in the Choptank Region of Maryland's Chesapeake Bay. Oysters in the Choptank Region generally grow well but may be impacted by disease or freshet events. Natural recruitment occurs regularly in this region.

The Fall Oyster Survey has six standard sites and two disease bar sentinel sites in the Upper Choptank River Sanctuary. Table A.47-1 shows an increase in the average number of oysters, biomass and cultch from 2021-2025 compared to the previous 5-year increments, while exhibiting low average observed mortality. Lethal dermo disease prevalence remained low, with no MSX prevalence reported (Figure A.47-7). The average density from 2021-2025 is above the long-term abundance target of 94 oysters per square meter while the average cultch per 100 ft tow indicates sufficient cultch availability.

In 2023, the Department conducted a patent tong population survey and found an average oyster density of 4.9 oysters per square meter and 3.2 liters per square meter of surface shell. This is more than the 4 oysters per square meter and 2.9 liters per square meter of surface shell found in 2015.

In the 2021-2025 sanctuary assessment, this sanctuary was classified as trending positively and having a high oyster density.

⁴⁴ See chart 21 for bar names and locations in the State of Maryland Shellfish Closure Areas Book <http://dnr.maryland.gov/fisheries/Pages/oysters/index.aspx>

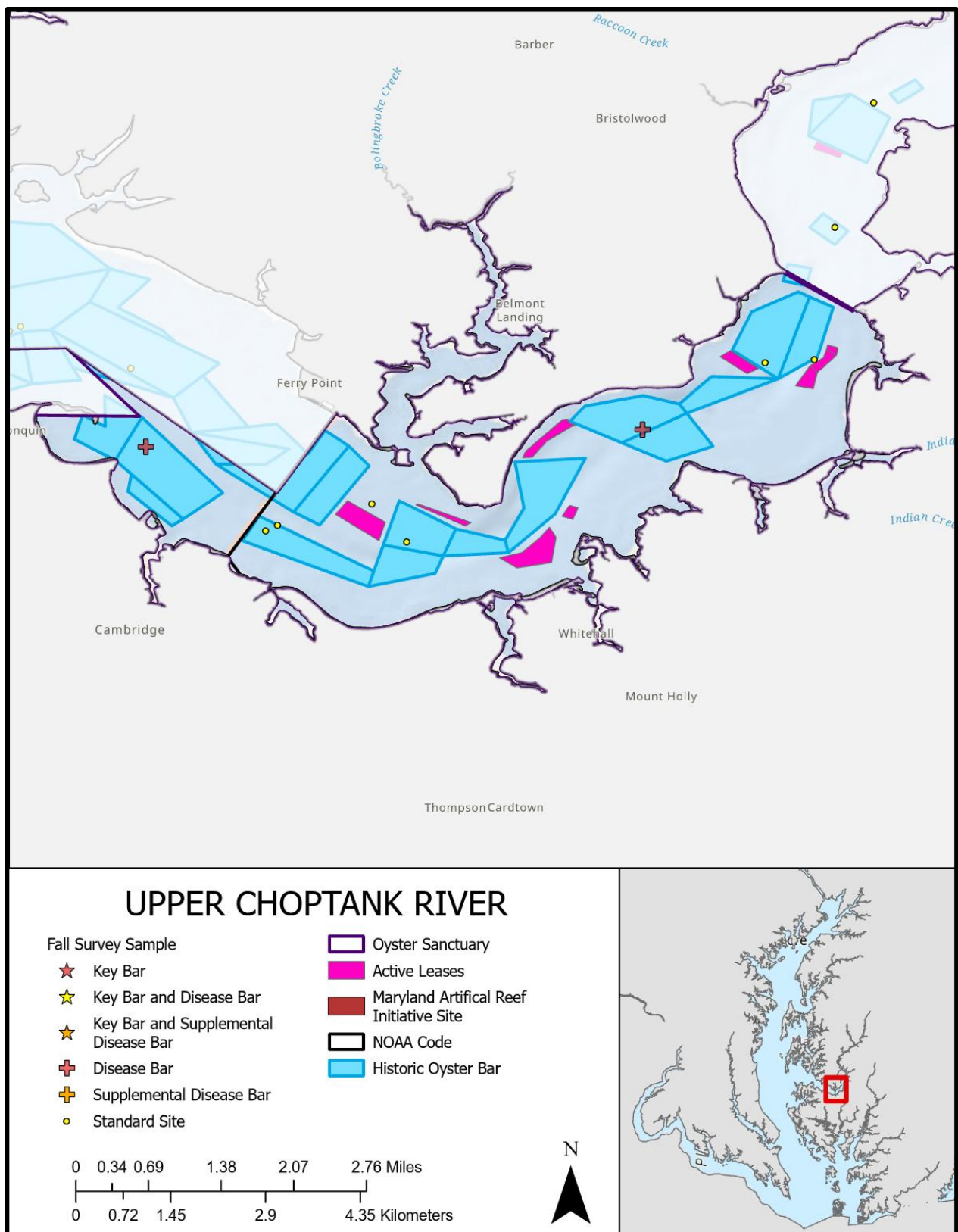


Figure A.47-1. Upper Choptank River Sanctuary. Fall Oyster Survey sites may not be sampled every year.

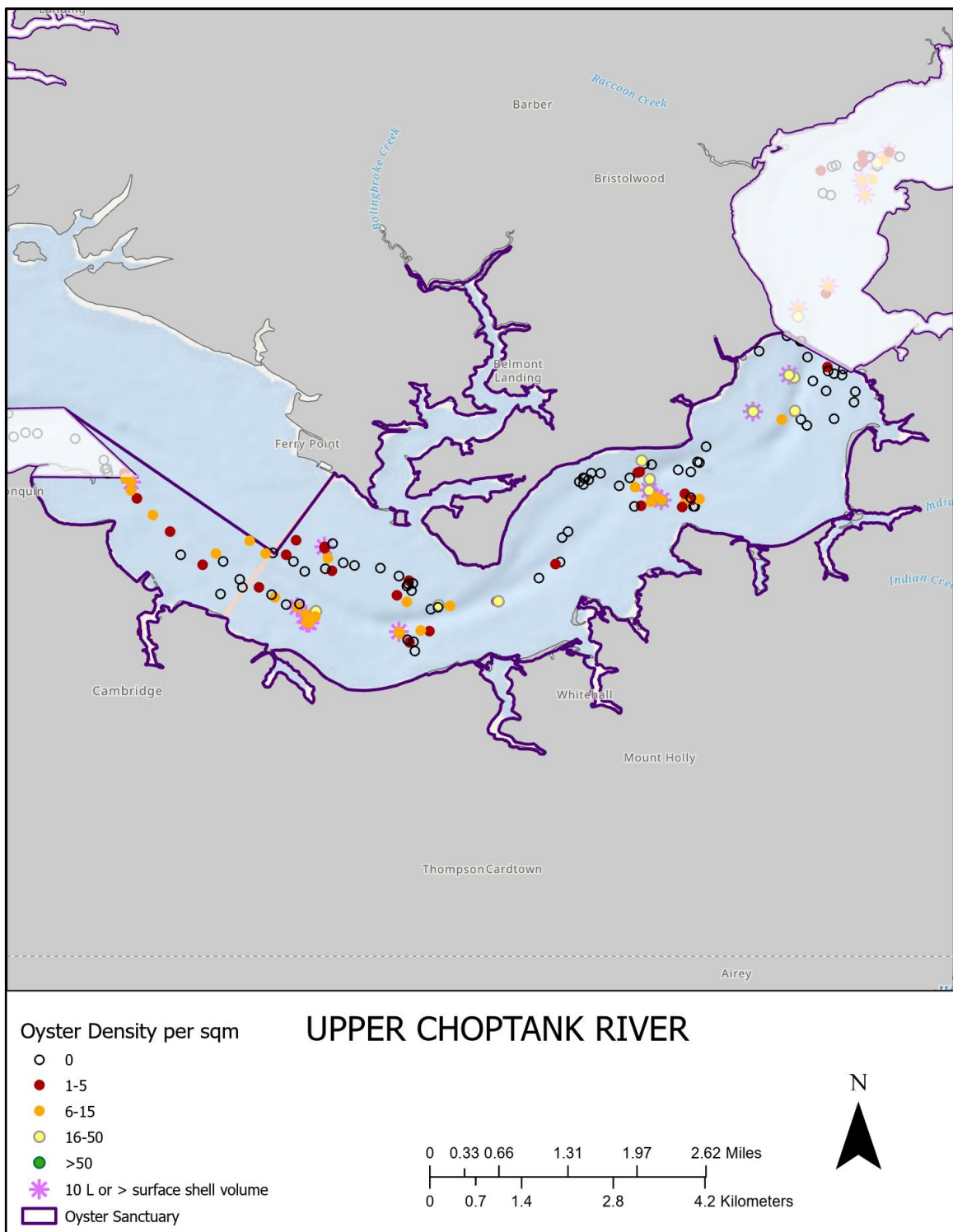


Figure A.47-2. Map of 2023 oyster density in the Upper Choptank River Sanctuary. Data from Maryland Department of Natural Resources Patent Tong Population Survey.

Table A.47-1. Oyster population characteristics based on the Fall Oyster Survey in the Upper Choptank River Sanctuary. ND=No Data. Values given are annual mean $\pm$ standard error.

Oyster Characteristic	2006-2010	2011-2015	2016-2020	2021-2025
Number of years sampled/number of samples	5/50	5/42	5/40	5/40
Number of Live Spat Oysters per square meter	3.6 $\pm$ 1.5	1.2 $\pm$ 0.4	0.27 $\pm$ 0.2	69.9 $\pm$ 18.9
Number of Live Small Oysters per square meter	15.7 $\pm$ 5.6	24.5 $\pm$ 5.2	7.2 $\pm$ 1.3	137.3 $\pm$ 39.5
Number of Live Market Oysters per square meter	18.9 $\pm$ 2.4	79.8 $\pm$ 12.1	68.1 $\pm$ 7.4	136.7 $\pm$ 27
Number of Live Oysters per square meter	39 $\pm$ 6.8	105.5 $\pm$ 15.6	75.6 $\pm$ 7.8	344 $\pm$ 74
Live Biomass (g Dry Weight per Bushel)	96 $\pm$ 16	170 $\pm$ 10	166 $\pm$ 19	213 $\pm$ 22
Observed Mortality (%)	5.8 $\pm$ 1.4	6.5 $\pm$ 1.0	16.4 $\pm$ 1.8	6.1 $\pm$ 0.8
Cultch (Bushels per 100 feet towed)	1.2 $\pm$ 0.1	1.9 $\pm$ 0.2	2.1 $\pm$ 0.1	2.6 $\pm$ 0.3

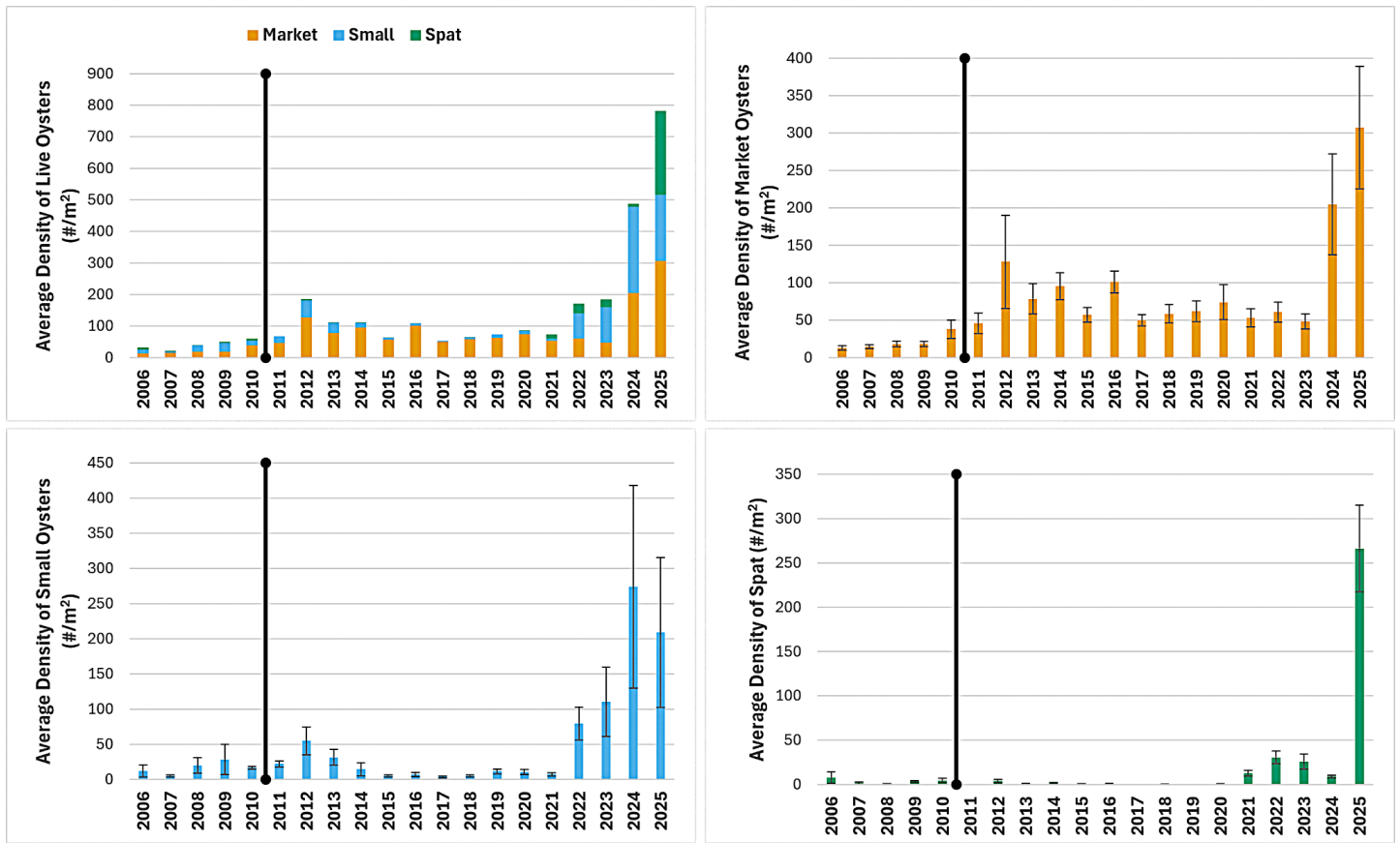


Figure A.47-3. Average number of live oysters per square meter by size class in the Upper Choptank River Sanctuary. Black line indicates the date the sanctuary was established. Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales.

UPPER CHOPTANK (2010)

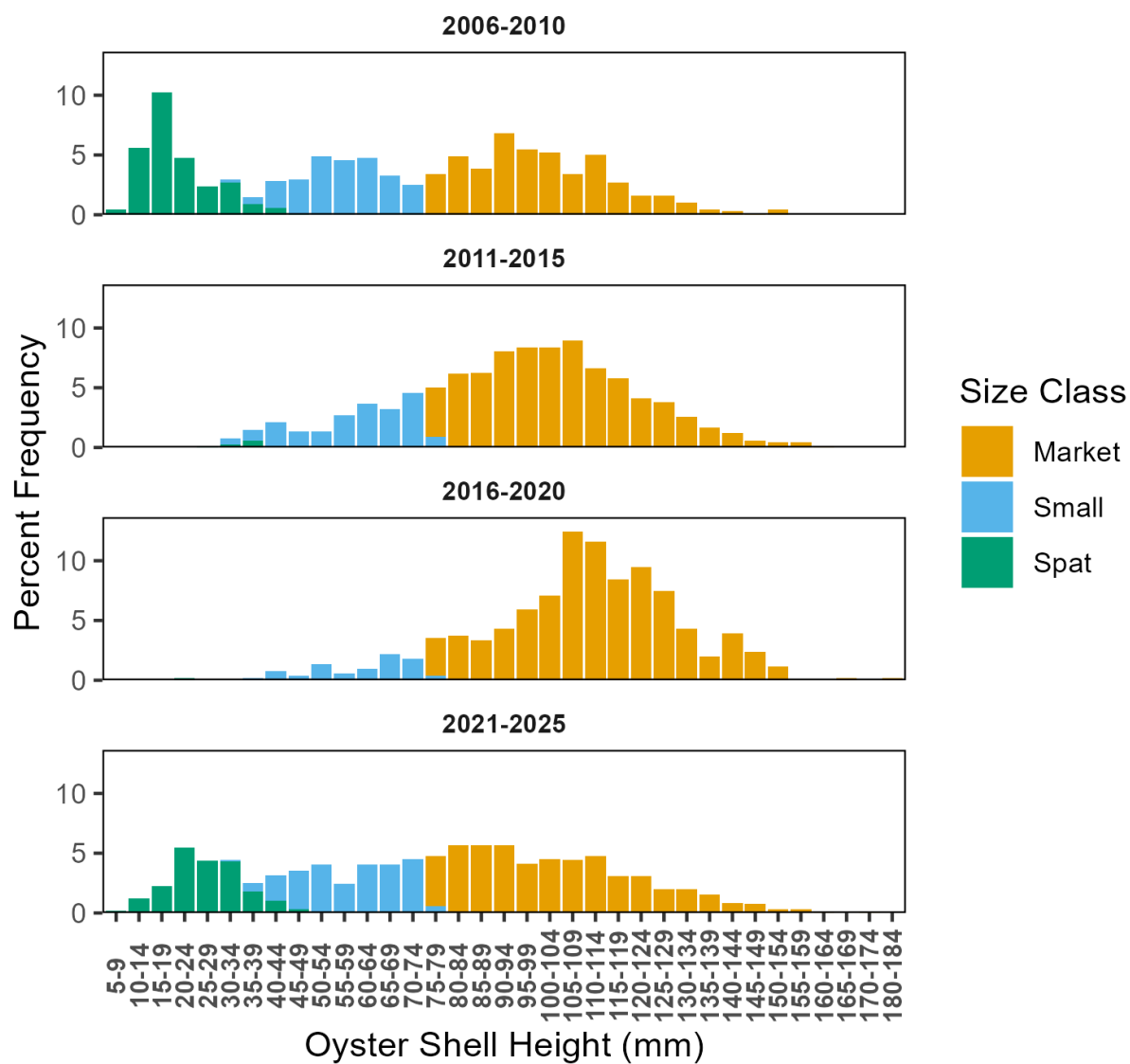


Figure A.47-4. Shell height frequencies of live oysters in the Upper Choptank River. Data from Maryland's Annual Fall Oyster Dredge Survey

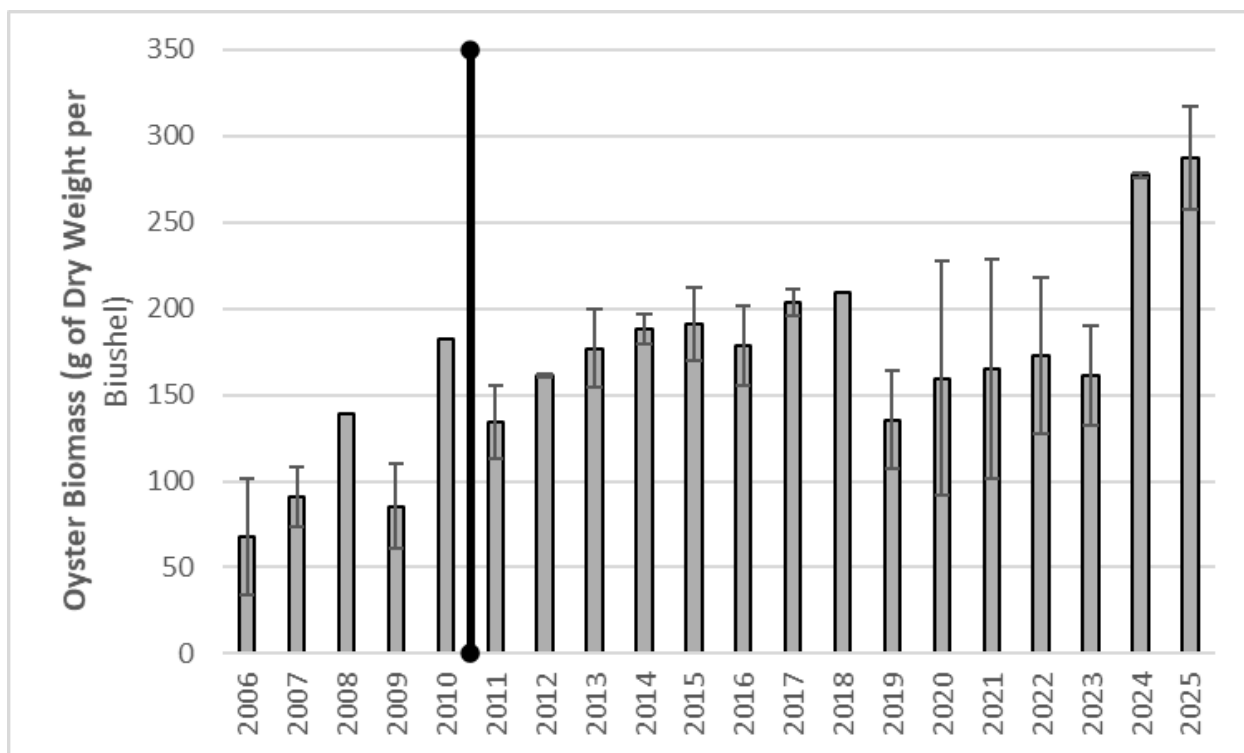


Figure A.47-5. Oyster biomass (grams of dry weight per bushel of material) in the Upper Choptank River Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Black line indicates the date the sanctuary was established. Error bars represent ± 1 standard error.

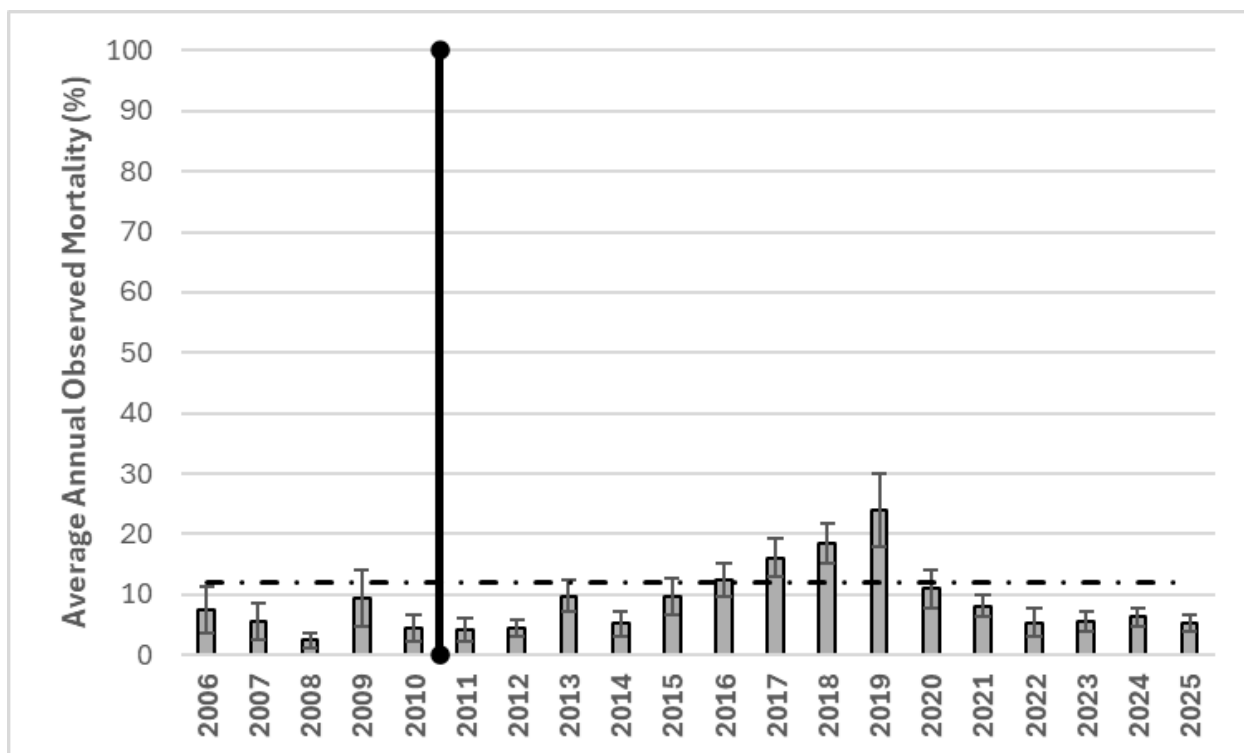


Figure A.47-6. Average annual observed mortality of market-sized and small-sized oysters in Upper Choptank River Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Black line denotes the date the sanctuary was established, and the dashed line represents the 2006-2025 baywide average observed mortality. Error bars represent ± 1 standard error.

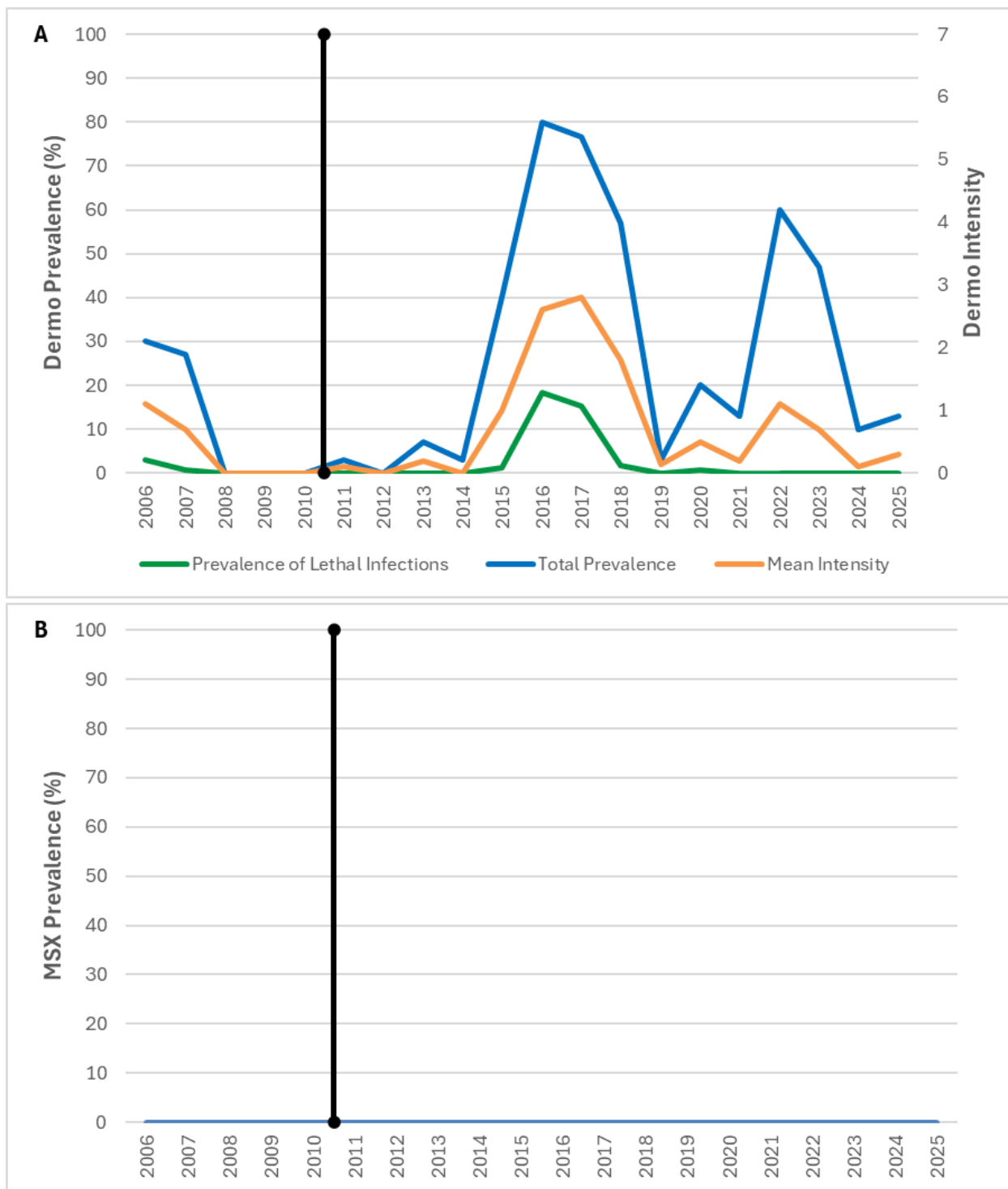


Figure A.47-7. Oyster disease prevalence and intensity in the Upper Choptank River Sanctuary. (A) Dermo prevalence and mean intensity (B) MSX prevalence (intensity is not examined). Data from Maryland's Annual Fall Oyster Dredge Survey on Oyster Shell Point bar. Black line denotes the date the sanctuary was established.

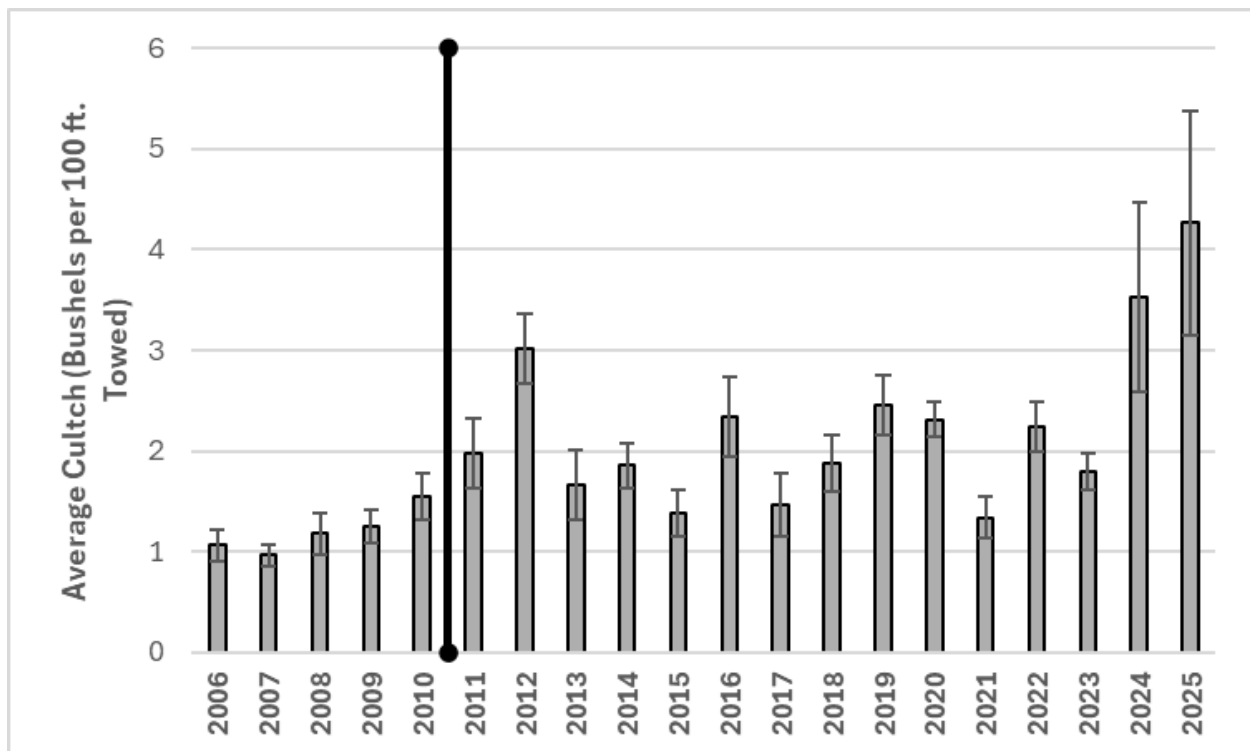


Figure A.47-8. Average cultch (live and dead oysters and loose shell) in the Upper Choptank River Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Black line denotes the date the sanctuary was established. Error bars represent ± 1 standard error.

Section A.48: Upper Patuxent River Sanctuary

The Upper Patuxent River Sanctuary is located in the Patuxent River, a low salinity (Zone 1) region within NOAA Code 368. The sanctuary was created in 2010 and has 14,461 acres of which 2,228 (15%) is historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments). Originally there was a small sanctuary in the area (Trent Hall, 9 acres, created 2003). Thus, the total surface acres are 14,470 acres and the total historic bottom is 2,229 acres (15%). There are 29 historic oyster bars within the sanctuary⁴⁵. After the sanctuary was established, harvest was allowed in two areas within the sanctuary during the 2010-2011 oyster harvest season. These were the Broad Neck (224 acres, established 2001) and Holland Point (33 acres, established 2008) harvest reserves (areas that are closed to commercial oyster harvest until biological criteria are met). After the 2010-2011 harvest season, these two reserves were eliminated and re-classified as part of the sanctuary.

Information available for this sanctuary includes:

- Sanctuary map (Figure A.48-1)
- Density Survey (Figure A.48-2)
- Summary statistics (Table A.48-1)
- Density per year (Figure A.48-3A)
- Density per year excluding spat on shell planting (Figure A.48-3B)
- Shell height frequencies (Figure A.48-4)
- Biomass per year (Figure A.48-5)
- Observed mortality (Figure A.48-6)
- Dermo and MSX per year (Figure A.48-7)
- Cultch per year (Figure A.48-8)

Upper Patuxent River Sanctuary is located in the Lower Western Shore Region of Maryland's Chesapeake Bay. Oysters in the Lower Western Shore Region generally grow well but may be impacted by disease or freshet events. Natural recruitment occurs regularly in this region.

The Fall Oyster Survey has four standard sites and one supplemental disease bar site in the Upper Patuxent River Sanctuary. Table A.48-1 shows an increase in the average number of oysters, biomass and cultch from 2021-2025 compared to the previous 5-year increments, while exhibiting low average observed mortality. Lethal dermo disease prevalence remained low, with no MSX prevalence reported (Figure A.48-7). The average live oyster density from 2021-2025 is above the long-term abundance target of 94 oysters per square meter while the average cultch per 100 ft tow indicates sufficient cultch availability.

The Department conducted a patent tong population survey in 2022 and found an average density of 0.7 oysters per square meter and average surface shell volume of

⁴⁵ See chart 22 for bar names and locations in the State of Maryland Shellfish Closure Areas Book
<http://dnr.maryland.gov/fisheries/Pages/oysters/index.aspx>

0.5 liters per square meter. The 2012 survey had an average of 0.9 oysters per square meter and 1.4 liters per square meter.

This sanctuary is slated to receive small-scale restoration in 2026.

In the 2021-2025 sanctuary assessment, this sanctuary was classified as trending positively with a high oyster density and receiving restoration.

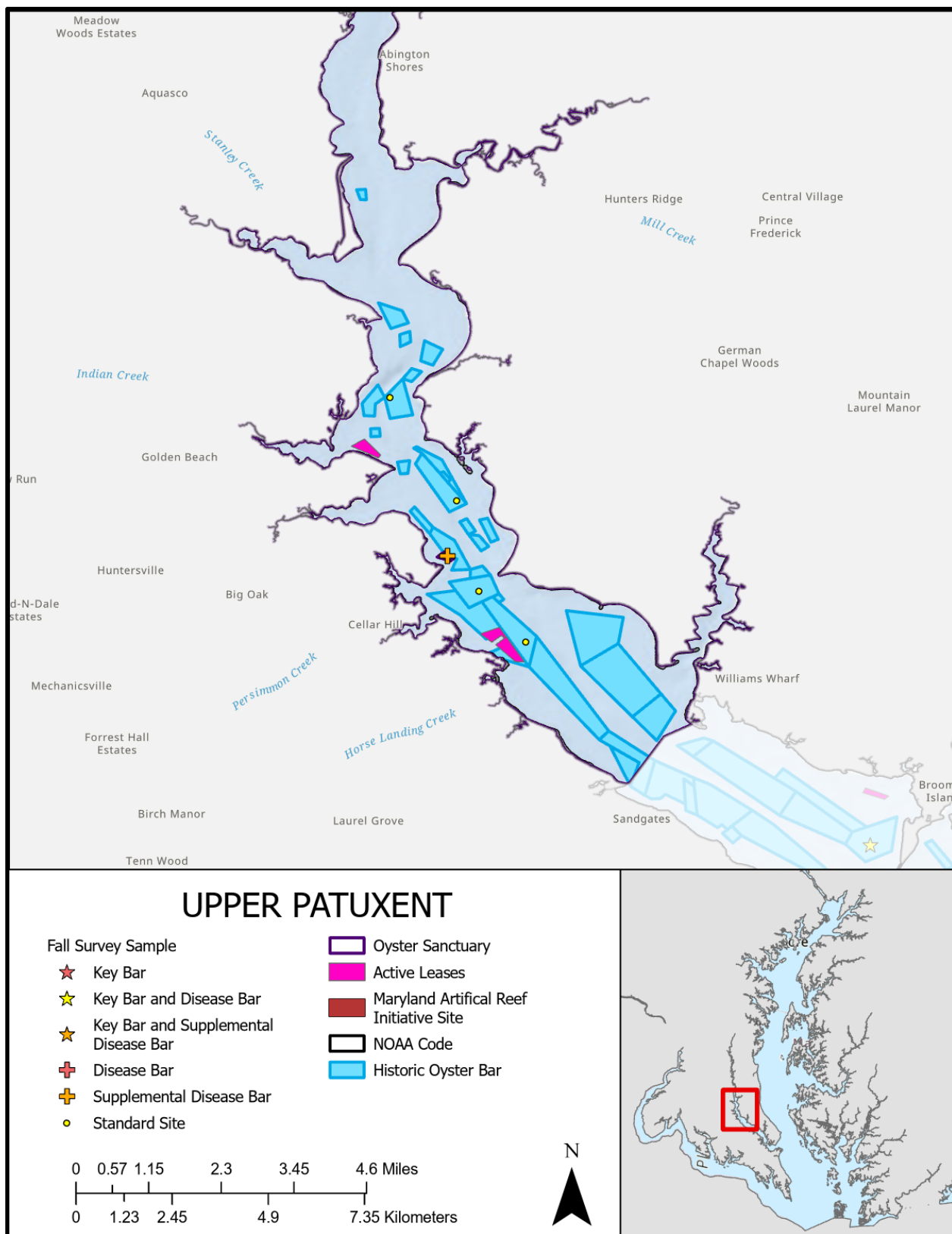


Figure A.48-1. Upper Patuxent River Sanctuary. Fall Oyster Survey sites may not be sampled every year.

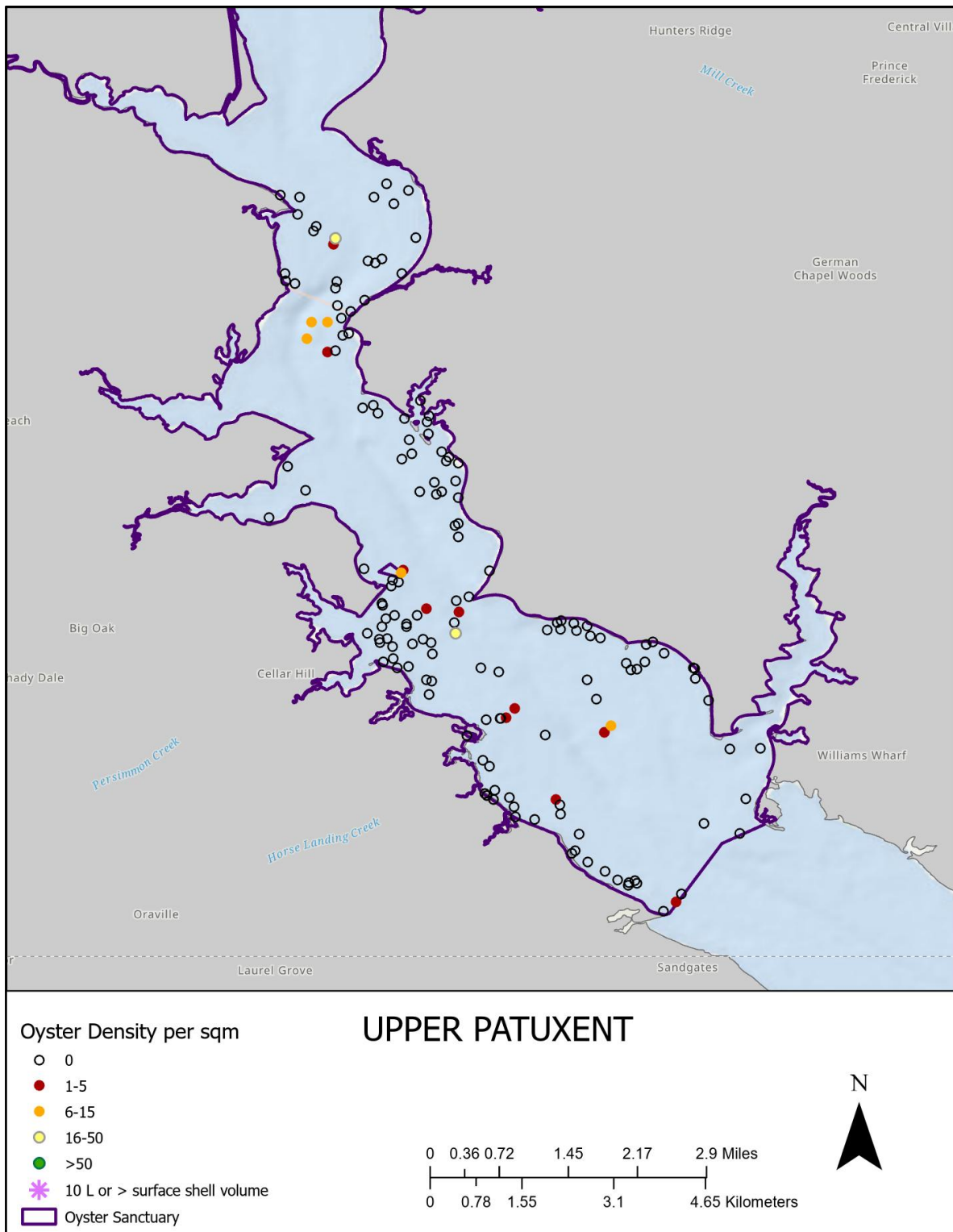


Figure A.48-2. Map of 2023 oyster density in the Upper Patuxent River Sanctuary. Data from Maryland Department of Natural Resources Patent Tong Population Survey.

Table A.48-1. Oyster population characteristics based on the Fall Oyster Survey in the Upper Patuxent River Sanctuary. ND=No Data. Values given are annual mean $\pm$ standard error.

Oyster Characteristic	2006-2010	2011-2015	2016-2020	2021-2025
Number of years sampled/number of samples	5/27	5/25	5/25	5/25
Number of Live Spat Oysters per square meter	16 $\pm$ 14.7	0.7 $\pm$ 0.5	0.9 $\pm$ 0.4	12.3 $\pm$ 3.8
Number of Live Small Oysters per square meter	68.3 $\pm$ 45.6	27.5 $\pm$ 6.5	34.2 $\pm$ 8.1	48.2 $\pm$ 8.4
Number of Live Market Oysters per square meter	20.7 $\pm$ 4.6	58.7 $\pm$ 15.4	66.7 $\pm$ 10.8	122.7 $\pm$ 20.2
Number of Live Oysters per square meter	105 $\pm$ 50	87 $\pm$ 20	102 $\pm$ 17	183 $\pm$ 29
Live Biomass (g Dry Weight per Bushel)	73 $\pm$ 52	160 $\pm$ 35	178 $\pm$ 21	227 $\pm$ 32
Observed Mortality (%)	10.7 $\pm$ 2.7	8.1 $\pm$ 1.6	8.5 $\pm$ 1.4	3 $\pm$ 0.7
Cultch (Bushels per 100 feet towed)	1.5 $\pm$ 0.2	1.6 $\pm$ 0.2	1.7 $\pm$ 0.1	1.9 $\pm$ 0.1

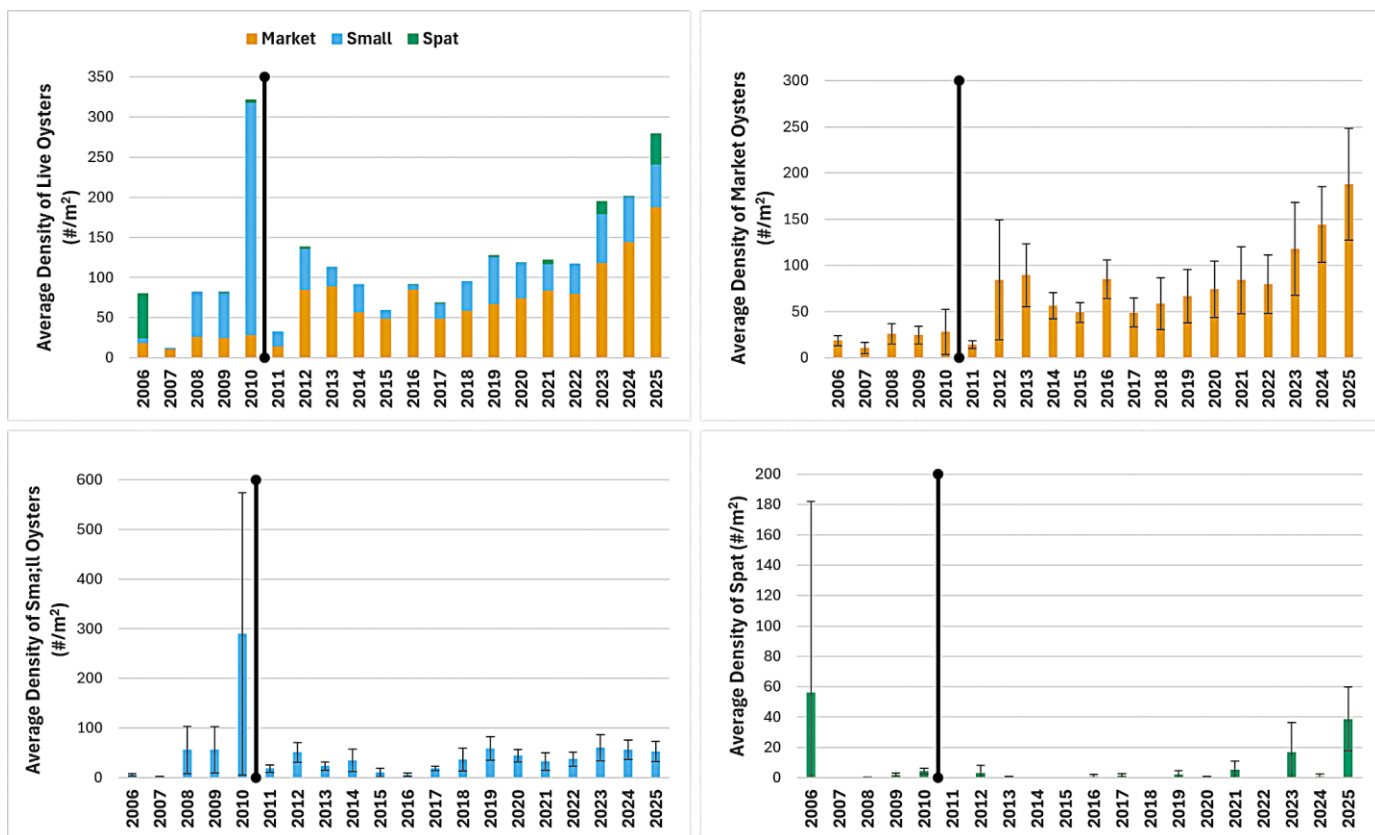


Figure A.48-3A. Average number of live oysters per square meter by size class in the Upper Patuxent River Sanctuary. Black line indicates the date the sanctuary was established. Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales.

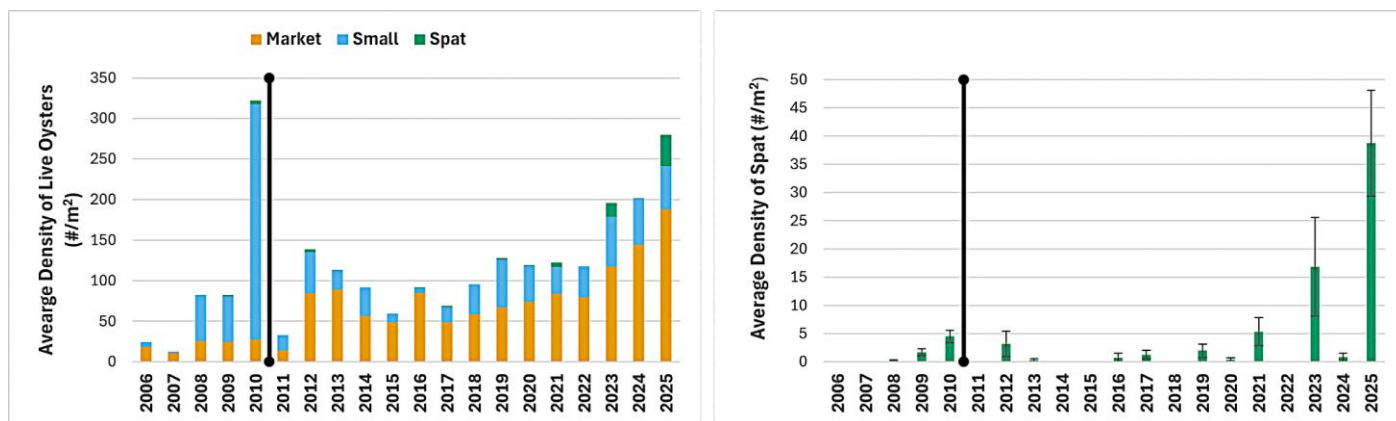


Figure A.48-3B. Average number of live oysters per square meter by size class in the Upper Patuxent River Sanctuary excluding the sample taken in 2006 on the hatchery spat-on-shell planting. Black line indicates the date the sanctuary was established. Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales.

UPPER PATUXENT (2010)

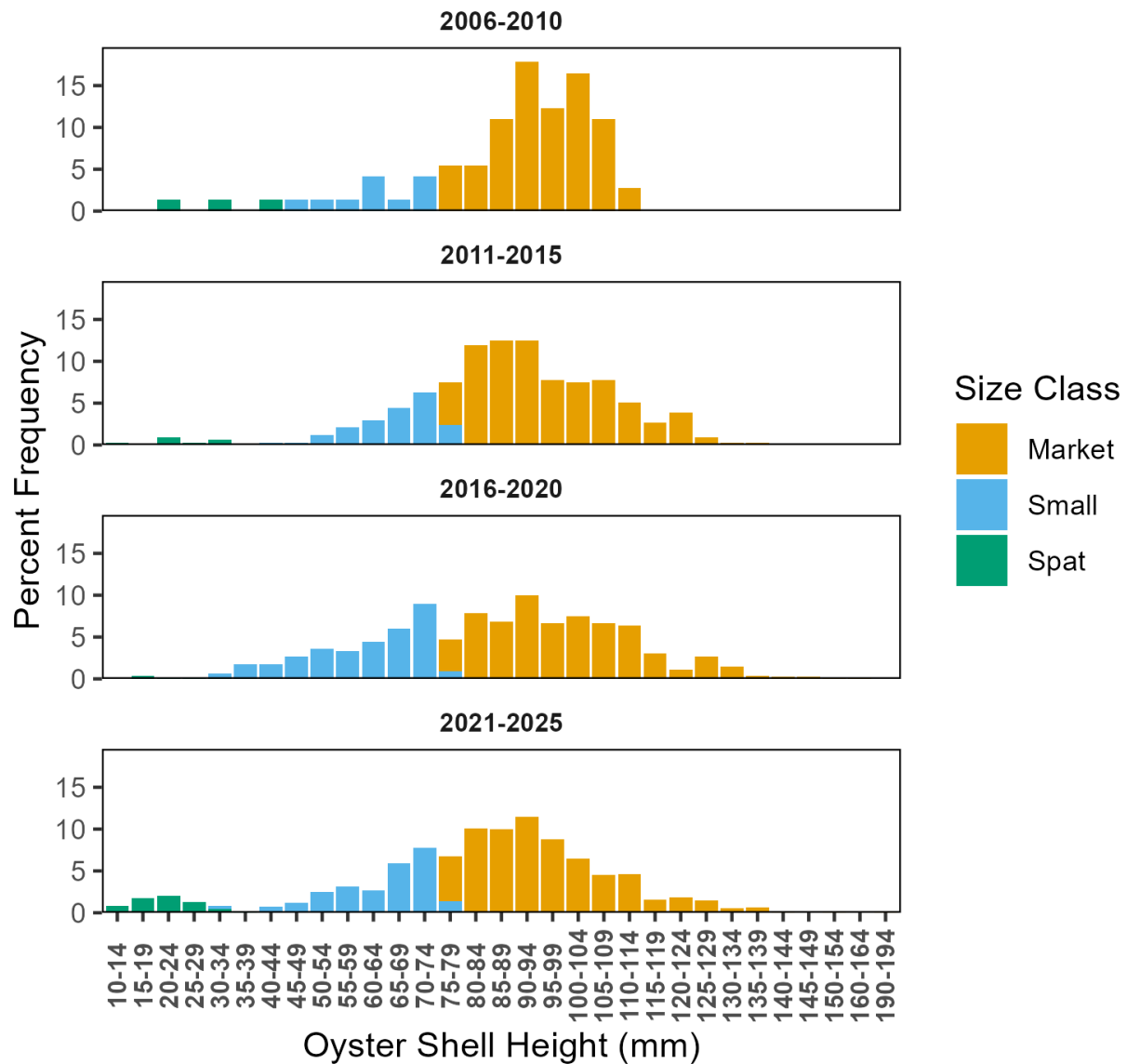


Figure A.48-4. Shell height frequencies of live oysters in the Upper Patuxent River Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. No data was collected in 2006 and 2008 to 2010.

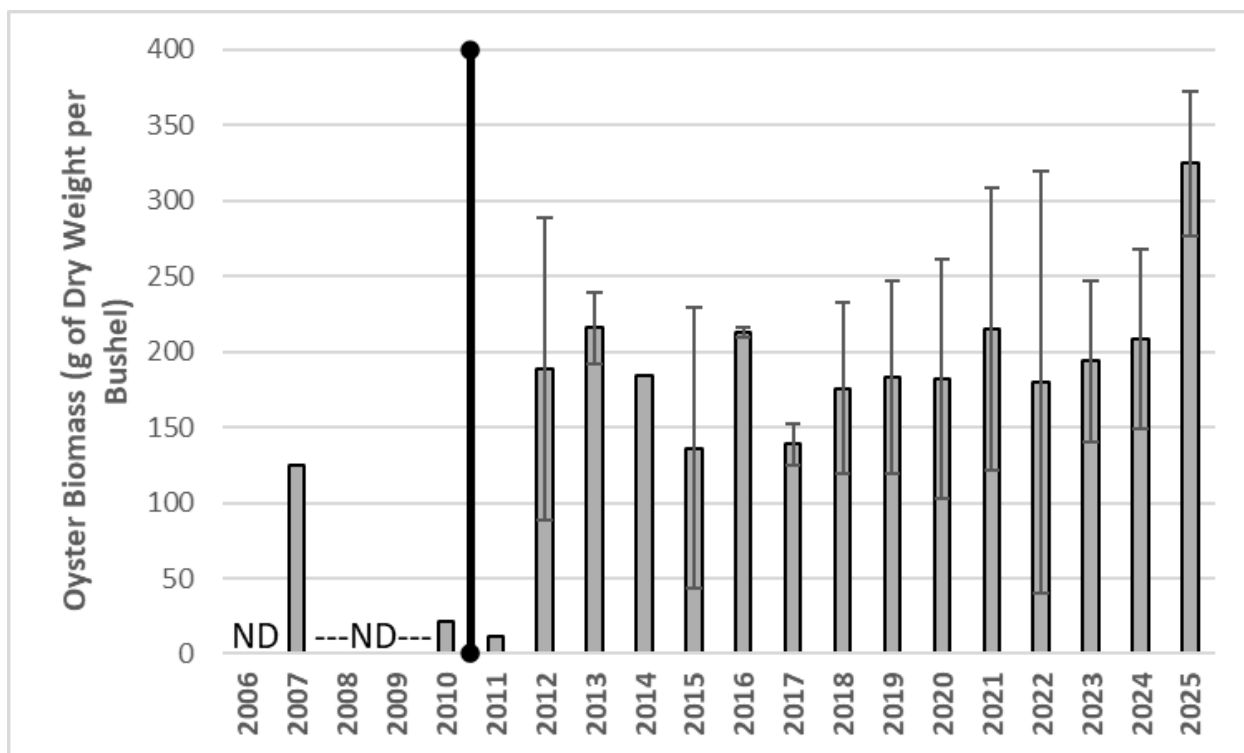


Figure A.48-5. Oyster biomass (grams of dry weight per bushel of material) in the Upper Patuxent River Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Black line indicates the date the sanctuary was established. ND = No data. Error bars represent ± 1 standard error

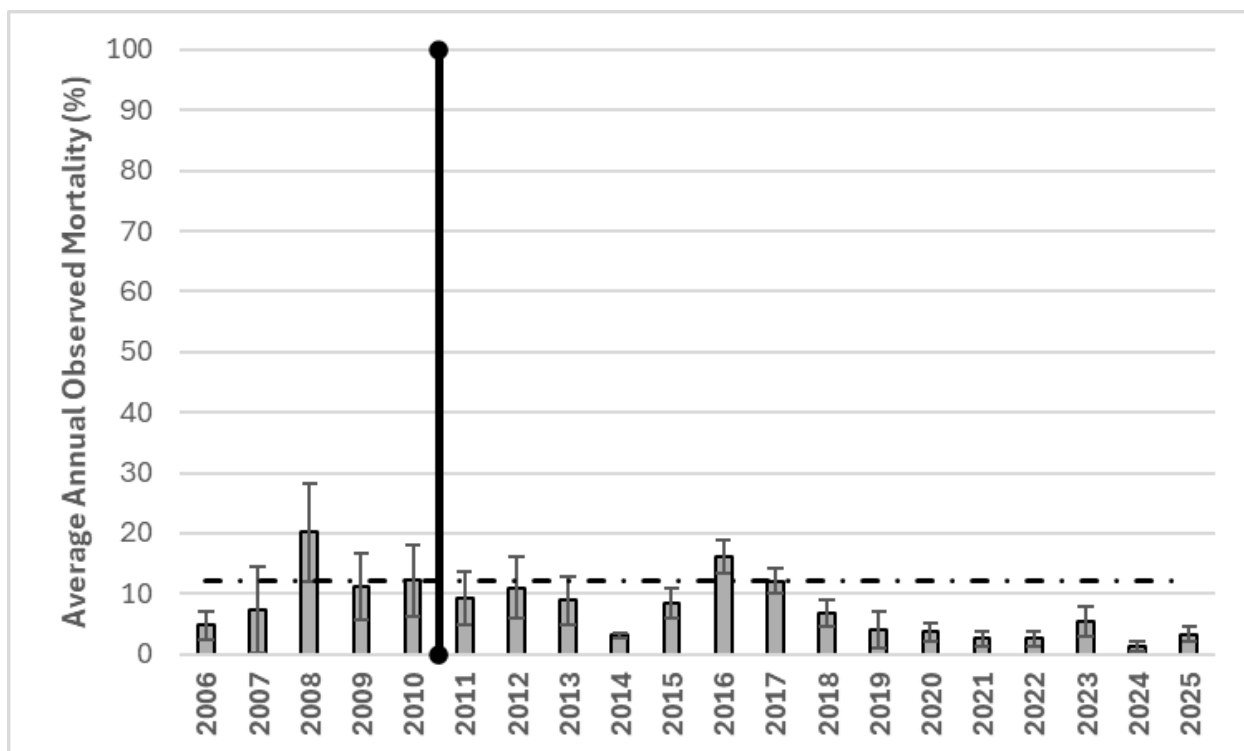


Figure A.48-6. Average annual observed mortality of market-sized and small-sized oysters in Upper Patuxent River Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Black line denotes the date the sanctuary was established, and the dashed line represents the 2006-2025 baywide average observed mortality. Error bars represent ± 1 standard error.

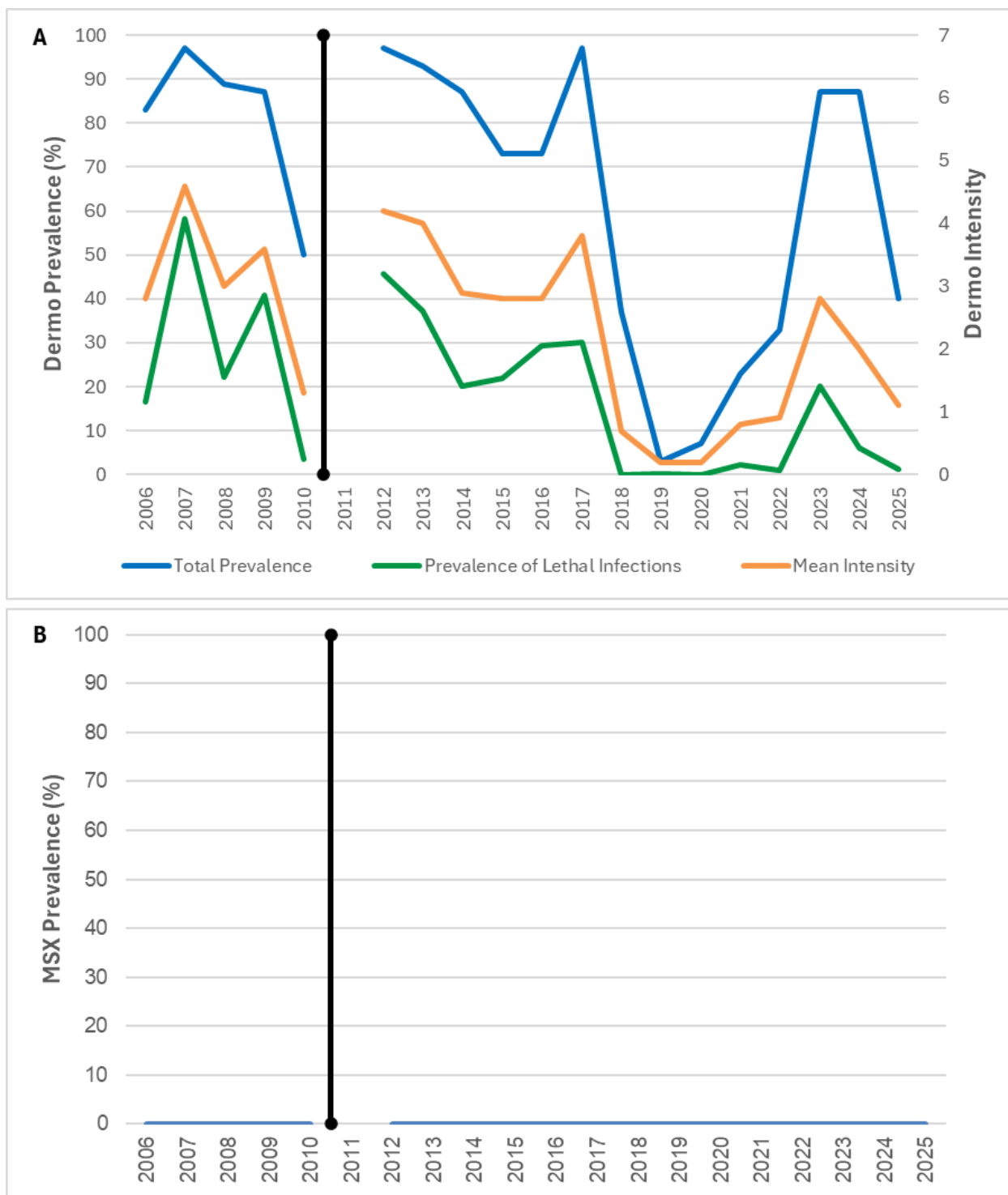


Figure A.48-7. Oyster disease prevalence and intensity in the Upper Patuxent River Sanctuary. (A) Dermo prevalence and mean intensity (B) MSX prevalence (intensity is not examined). Data from Maryland's Annual Fall Oyster Dredge Survey on Trent Hall bar. Black line denotes the date the sanctuary was established. No data was collected in 2011.

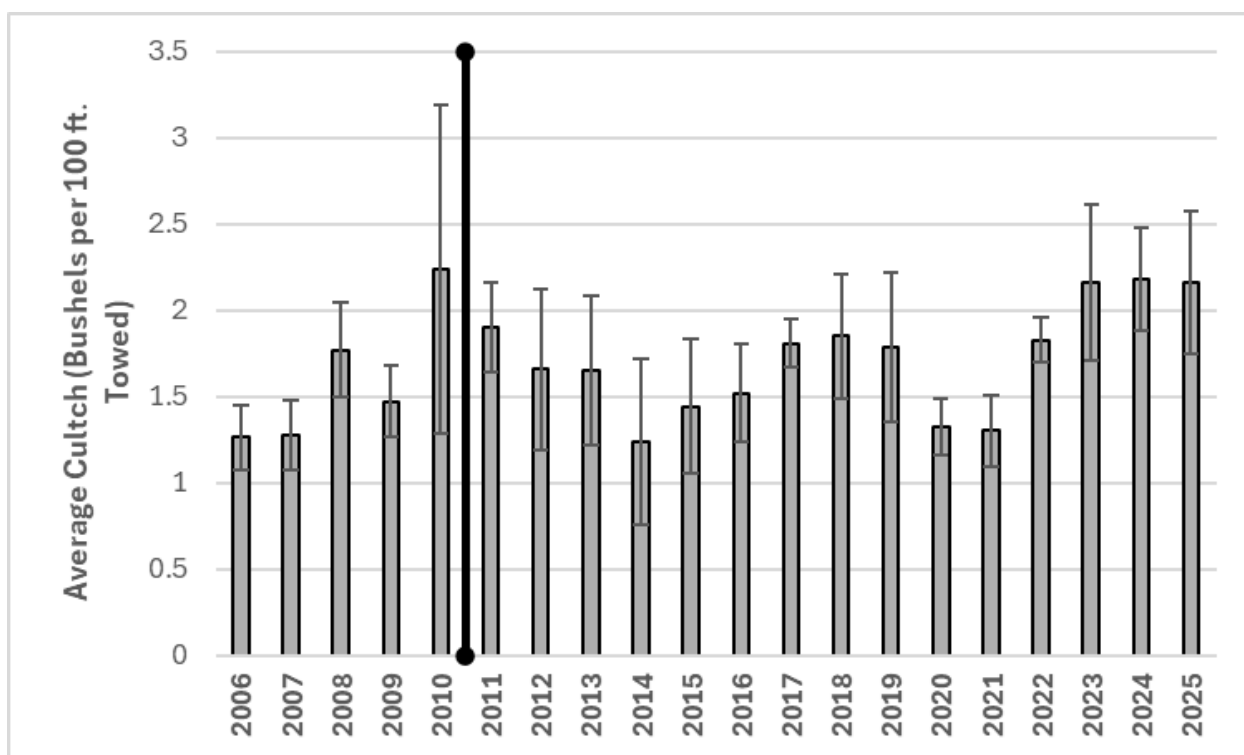


Figure A.48-8. Average cultch (live and dead oysters and loose shell) in the Upper Patuxent River Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Black line denotes the date the sanctuary was established. Error bars represent ± 1 standard error.

Section A.49: Webster Sanctuary

The Webster Sanctuary is located in the lower eastern portion of Maryland's Chesapeake Bay, a medium salinity (Zone 2) region within NOAA Code 098. The sanctuary is located at the mouth of the Wicomico River. It was created in 1997 and encompasses 554 acres, none of which is historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments). The sanctuary was an old aquaculture lease that is located adjacent to the Monie Bay National Estuarine Research Reserve and the Deal Island Facility Wildlife Management Area.

Information available for this sanctuary includes:

- Sanctuary map (Figure A.49-1)

Webster Sanctuary is located in the Lower Eastern Shore Region of Maryland's Chesapeake Bay. Oysters in the Lower Eastern Shore Region generally grow well but can be impacted by disease. In this region, elevated salinity levels contribute to a greater rate of natural recruitment.

This sanctuary was created with no historic oyster bottom. Most of the potential oyster bottom within the sanctuary is covered by an aquaculture lease, rendering the area impossible to survey.

This sanctuary was one of the sanctuaries identified by the Department as unlikely to receive a large investment by the Department for restoration and is under evaluation by the Oyster Advisory Commission for potential efforts to improve its performance.

In the 2021-2025 sanctuary assessment, this sanctuary was classified as lacking in data.

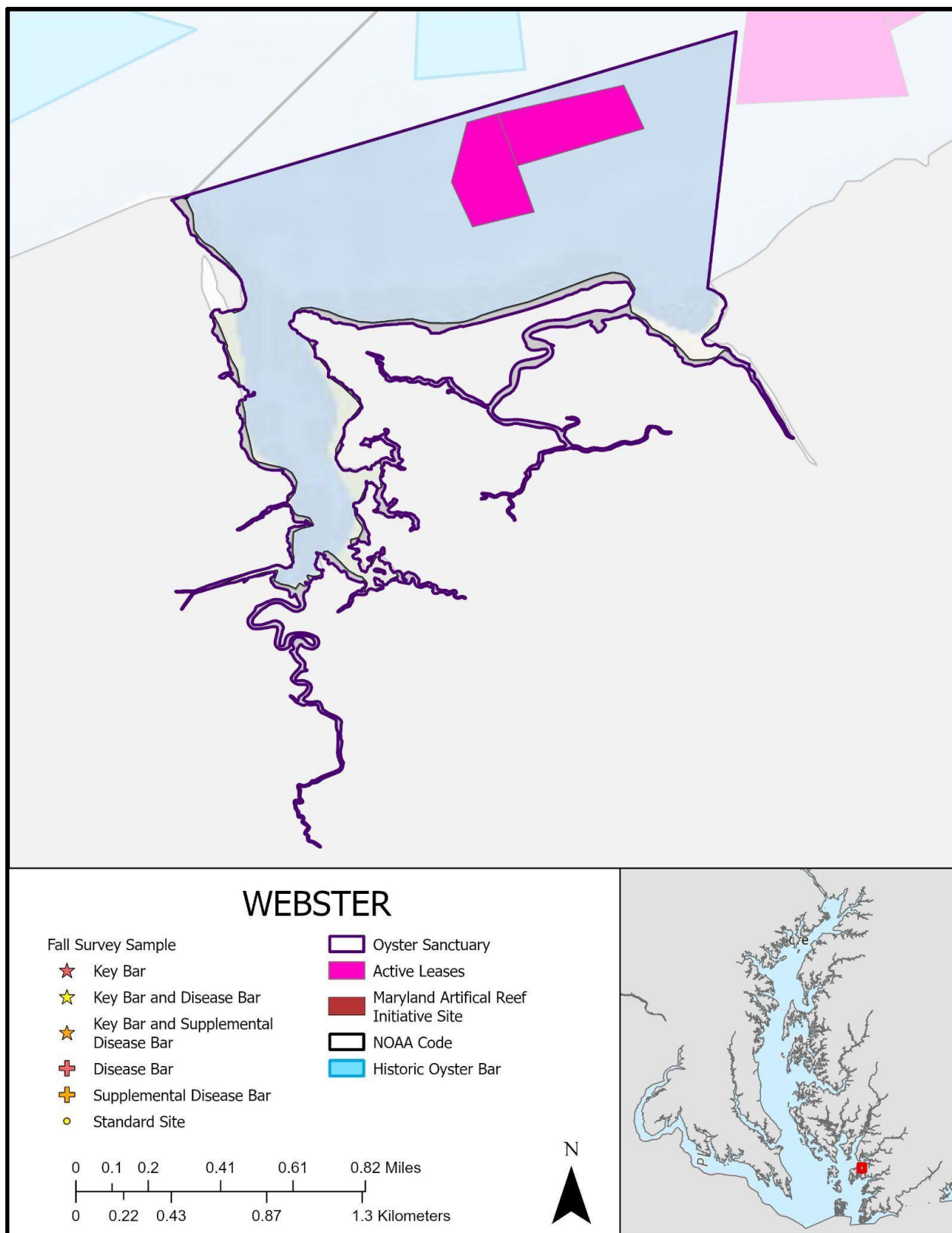


Figure A.49-1. Webster Sanctuary.

Section A.50: Wicomico River Sanctuary

The Wicomico River Sanctuary is located on Maryland's western shore, a low salinity (Zone 1) region, and near the Potomac River within NOAA Code 274. The sanctuary was created in 2010 and encompasses 450 acres of which 272 (61%) is historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments). There are portions of three historic oyster bars within the sanctuary. Blackstone bar is located almost entirely within the sanctuary (96%), but two others are only partially within the sanctuary (Bluff Point, 35%; White Point, 7%).

Information available for this sanctuary includes:

- Sanctuary map (Figure A.50-1)
- Density Survey (Figure A.50-2)

Wicomico River Sanctuary is located in the Lower Western Shore Region of Maryland's Chesapeake Bay. Oysters in the Lower Western Shore Region generally grow well but may be impacted by disease or freshet events. Natural recruitment occurs regularly in this region.

There are no Fall Oyster Survey sites in the Wicomico River Sanctuary.

In 2023 the Department conducted a patent tong population survey and found an average of 0.02 oysters per square meter and an average surface shell volume of 0.07 liters per square meter. The majority of the area sampled was mud bottom, making the sanctuary an unlikely candidate for restoration.

This sanctuary was one of the sanctuaries identified by the Department as unlikely to receive a large investment by the Department for restoration and is under evaluation by the Oyster Advisory Commission for potential efforts to improve its performance.

In the 2021-2025 sanctuary assessment, this sanctuary was classified as poor habitat.

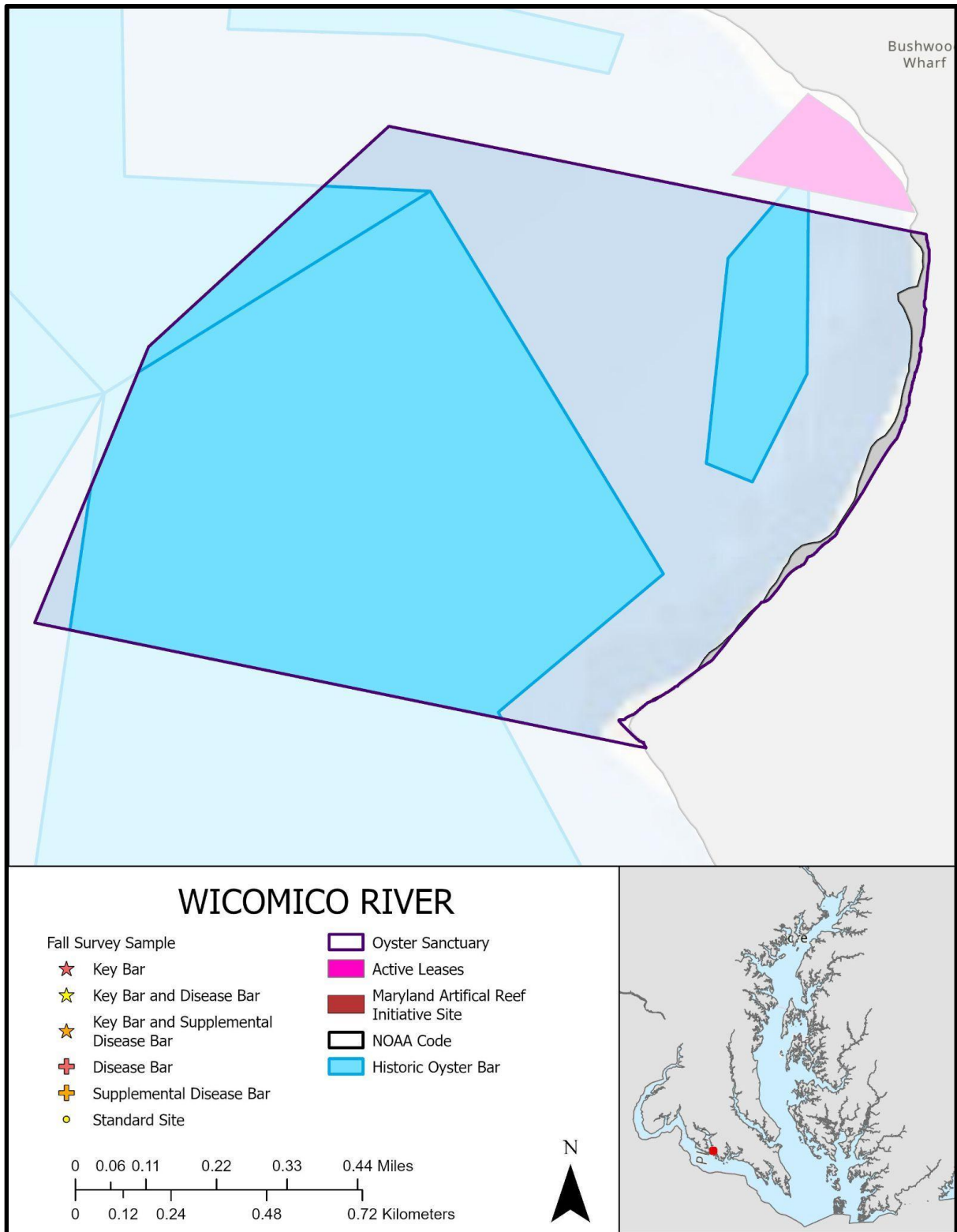


Figure A.50-1. Wicomico River.

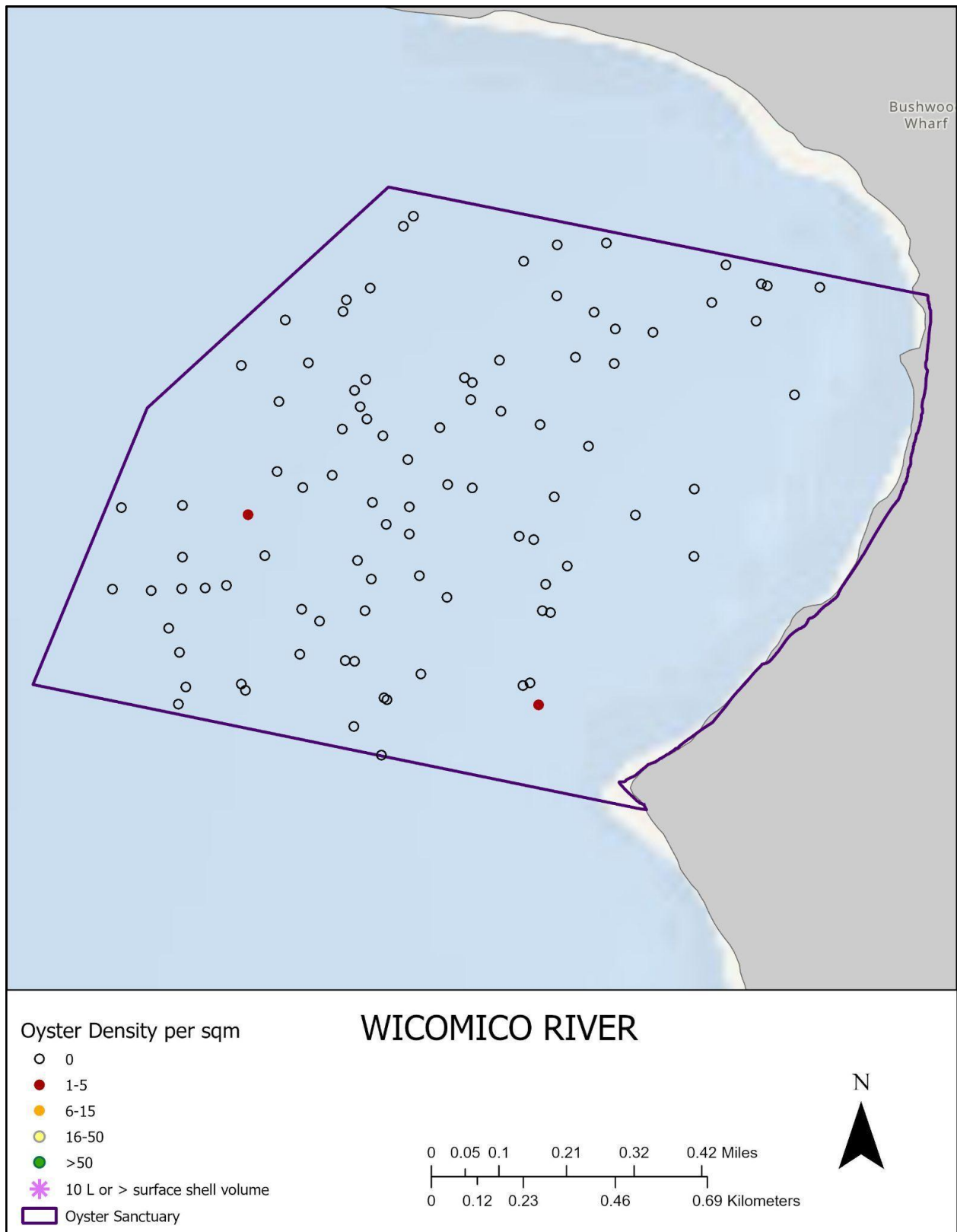


Figure A.50-2. Map of 2023 oyster density in the Wicomico River Sanctuary. Data from Maryland Department of Natural Resources Patent Tong Population Survey.

Section A.51: Wye River Sanctuary

The Wye River Sanctuary is located in Eastern Bay, a medium salinity (Zone 2) region within NOAA Code 099. The sanctuary was created in 2010 and encompasses 3,510 acres of which 1,100 (31%) is historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments). There are 23 historic oyster bars within the sanctuary⁴⁶.

Information available for this sanctuary includes:

- Sanctuary map (Figure A.51-1)
- Summary statistics (Table A.51-1)
- Density per year (Figure A.51-2)
- Shell height frequencies (Figure A.51-3)
- Biomass per year (Figure A.51-4)
- Observed mortality (Figure A.51-5)
- Dermo and MSX per year (Figure A.51-6)
- Cultch per year (Figure A.51-7)

Wye River Sanctuary is located in the Eastern Bay Region of Maryland's Chesapeake Bay. Oysters in the Eastern Bay Region typically exhibit good growth and survival, generally remaining unaffected by disease or freshets except during multi-year droughts or major freshet events. Natural recruitment occurs regularly in this region.

The Fall Oyster Survey has five standard sites and one sentinel key and disease bar site in the Wye River Sanctuary. Table A.51-1 shows an increase in the average number of oysters, biomass and cultch from 2021-2025 compared to the previous 5-year increments, while exhibiting low average observed mortality. Lethal dermo disease prevalence remained low, with an increase in 2025, with no MSX prevalence reported (Figure A.51-6). The average oyster density from 2021-2025 is above the long-term abundance target of 94 oysters per square meter while the average cultch per 100 ft tow indicates insufficient cultch availability.

The last patent tong population survey occurred in 2020. This sanctuary is a site for MGO plantings. In 2023, a NOAA diver surveyed the MGO site and found an average of 51.7 oysters per square meter.

In the 2021-2025 sanctuary assessment, this sanctuary was classified as trending positively with high oyster density and receiving restoration. Since 2023, this sanctuary has received spat-on-shell plantings as part of the Eastern Bay Regional Project.

⁴⁶ See chart 12 for bar names and locations in the State of Maryland Shellfish Closure Areas Book <http://dnr.maryland.gov/fisheries/Pages/oysters/index.aspx>

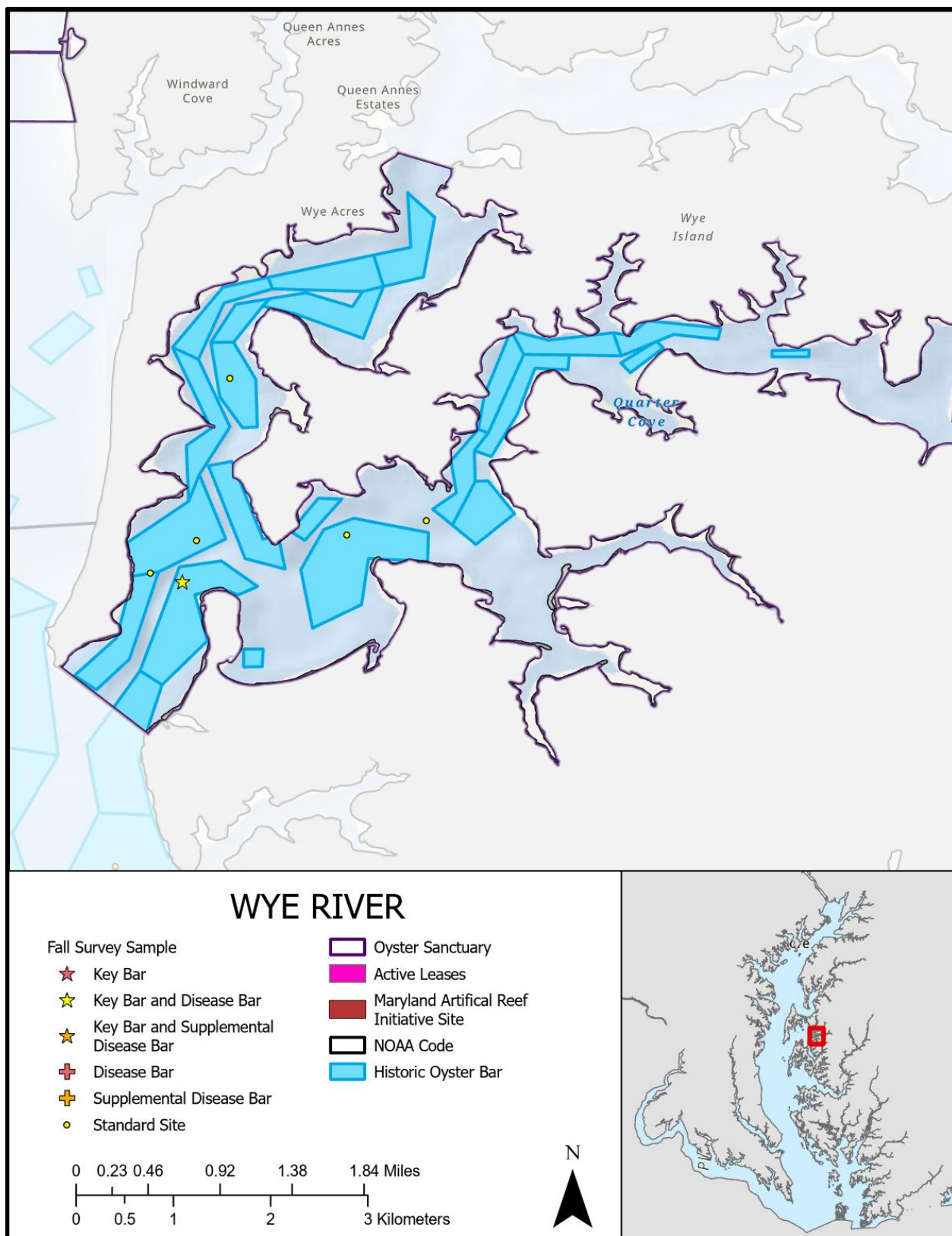


Figure A.51-1. Wye River Sanctuary. Fall Oyster Survey sites may not be sampled every year.

Table A.51-1. Oyster population characteristics based on the Fall Oyster Survey in the Wye River Sanctuary. ND=No Data. Values given are annual mean $\pm$ standard error.

Oyster Characteristic	2006-2010	2011-2015	2016-2020	2021-2025
Number of years sampled/number of samples	5/25	5/25	5/25	5/28
Number of Live Spat Oysters per square meter	0.3 $\pm$ 0.2	2.6 $\pm$ 2	0.1 $\pm$ 0.1	17.1 $\pm$ 3.9
Number of Live Small Oysters per square meter	1.4 $\pm$ 0.4	7.7 $\pm$ 2.3	0.4 $\pm$ 0.1	25.2 $\pm$ 5.1
Number of Live Market Oysters per square meter	11.8 $\pm$ 2.2	19 $\pm$ 3.9	18.6 $\pm$ 3.1	64.6 $\pm$ 16.4
Number of Live Oysters per square meter	13.5 $\pm$ 2.2	29.3 $\pm$ 5.2	19 $\pm$ 3.1	107 $\pm$ 20
Live Biomass (g Dry Weight per Bushel)	70 $\pm$ 27	141 $\pm$ 40	142 $\pm$ 16	195 $\pm$ 35
Observed Mortality (%)	20.5 $\pm$ 2.8	5.1 $\pm$ 1.3	22.8 $\pm$ 2.2	8.9 $\pm$ 1.4
Cultch (Bushels per 100 feet towed)	0.9 $\pm$ 0.1	0.9 $\pm$ 0.1	0.7 $\pm$ 0.1	1.2 $\pm$ 0.1

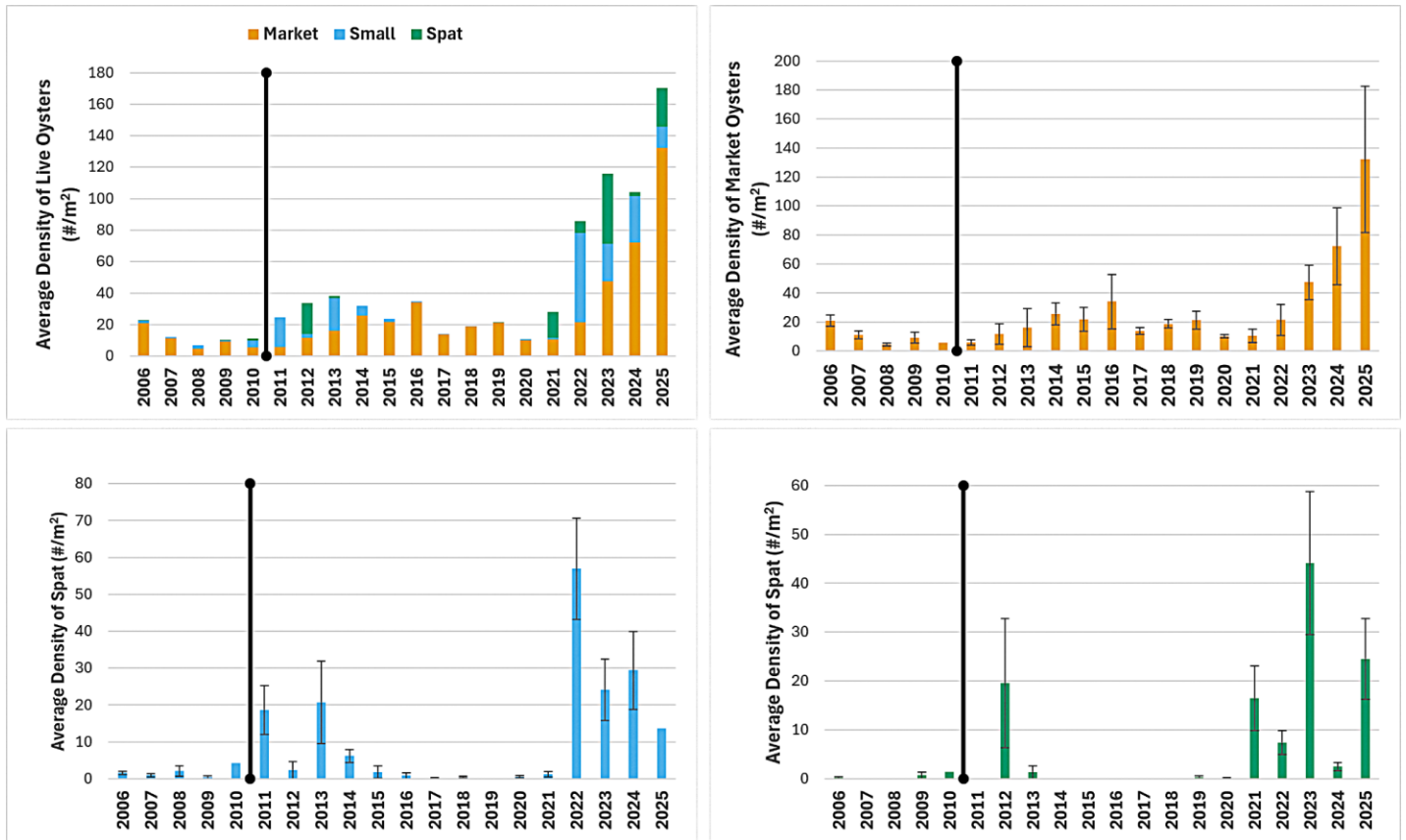


Figure A.51-2. Average number of live oysters per square meter by size class in the Wye River Sanctuary. Black line indicates the date the sanctuary was established. Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales.

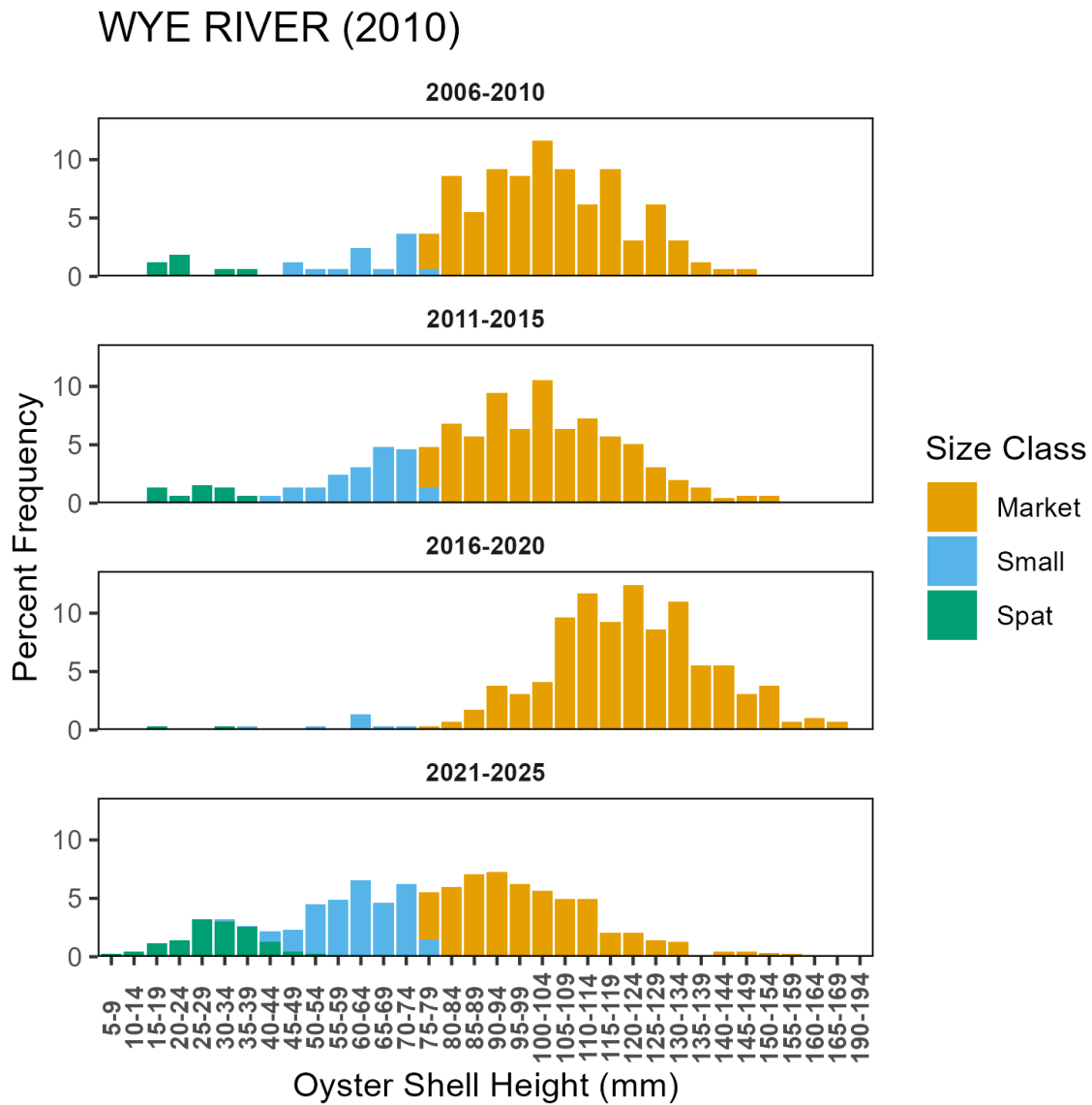


Figure A.51-3. Shell height frequencies of live oysters in the Wye River Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey.

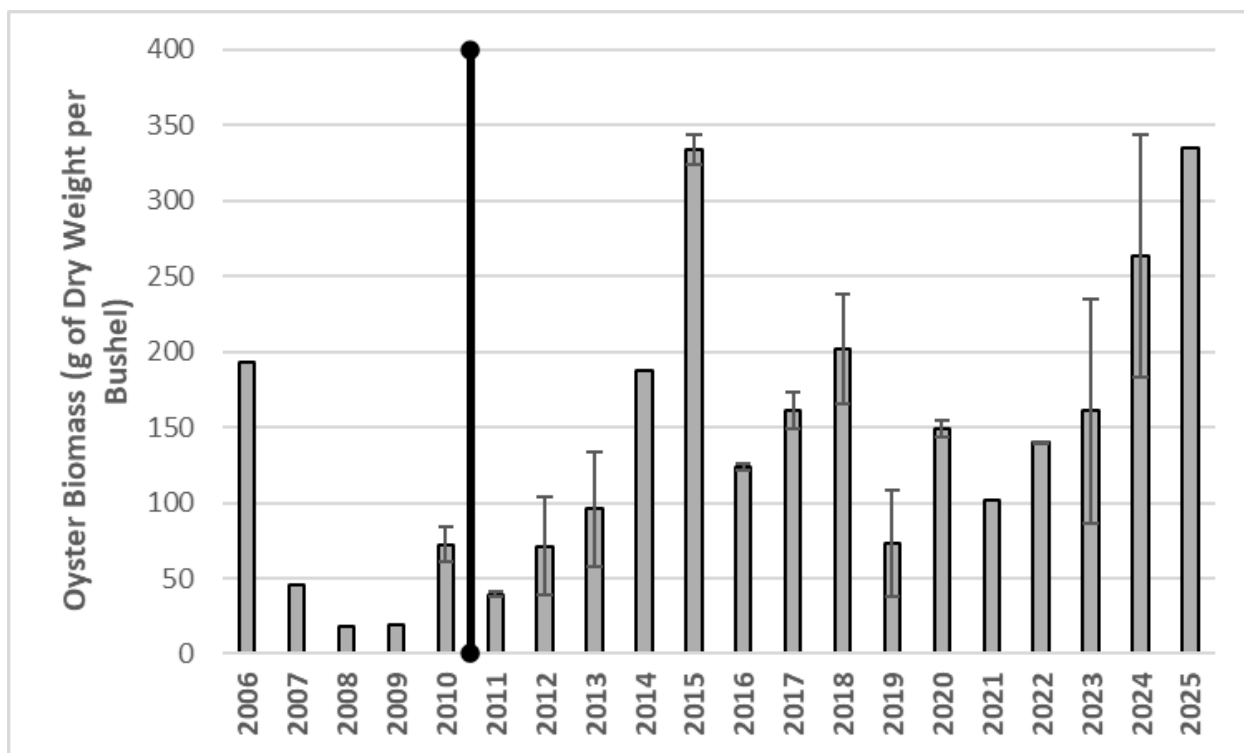


Figure A.51-4. Oyster biomass (grams of dry weight per bushel of material) in the Wye River Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Black line indicates the date the sanctuary was established. Error bars represent ± 1 standard error.

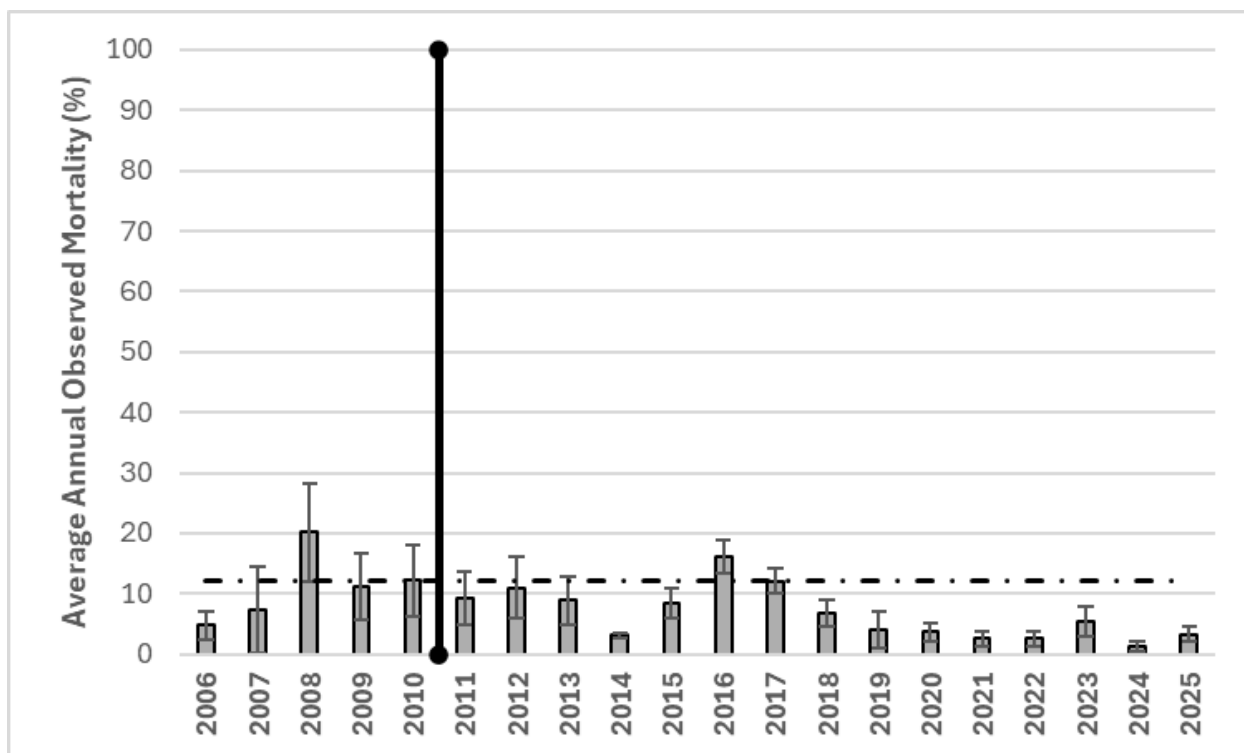


Figure A.51-5. Average annual observed mortality of market-sized and small-sized oysters in the Wye River Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Black line denotes the date the sanctuary was established, and the dashed line represents the 2006-2025 baywide average observed mortality. Error bars represent ± 1 standard error.

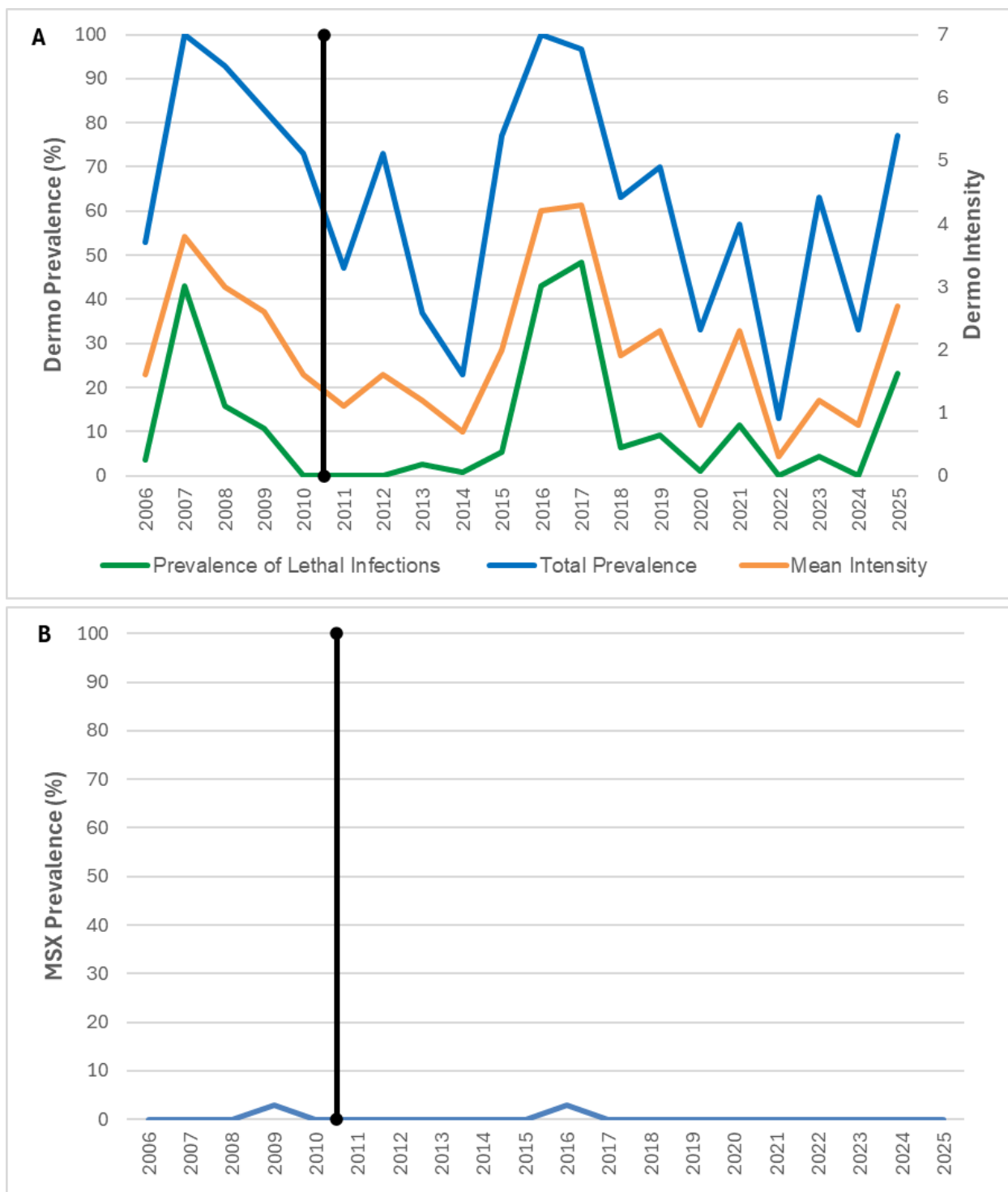


Figure A.51-6. Oyster disease prevalence and intensity in the Wye River Sanctuary. (A) Dermo prevalence and mean intensity (B) MSX prevalence (intensity is not examined). Data from Maryland's Annual Fall Oyster Dredge Survey on Bruff Island bar. Black line denotes the date the sanctuary was established.

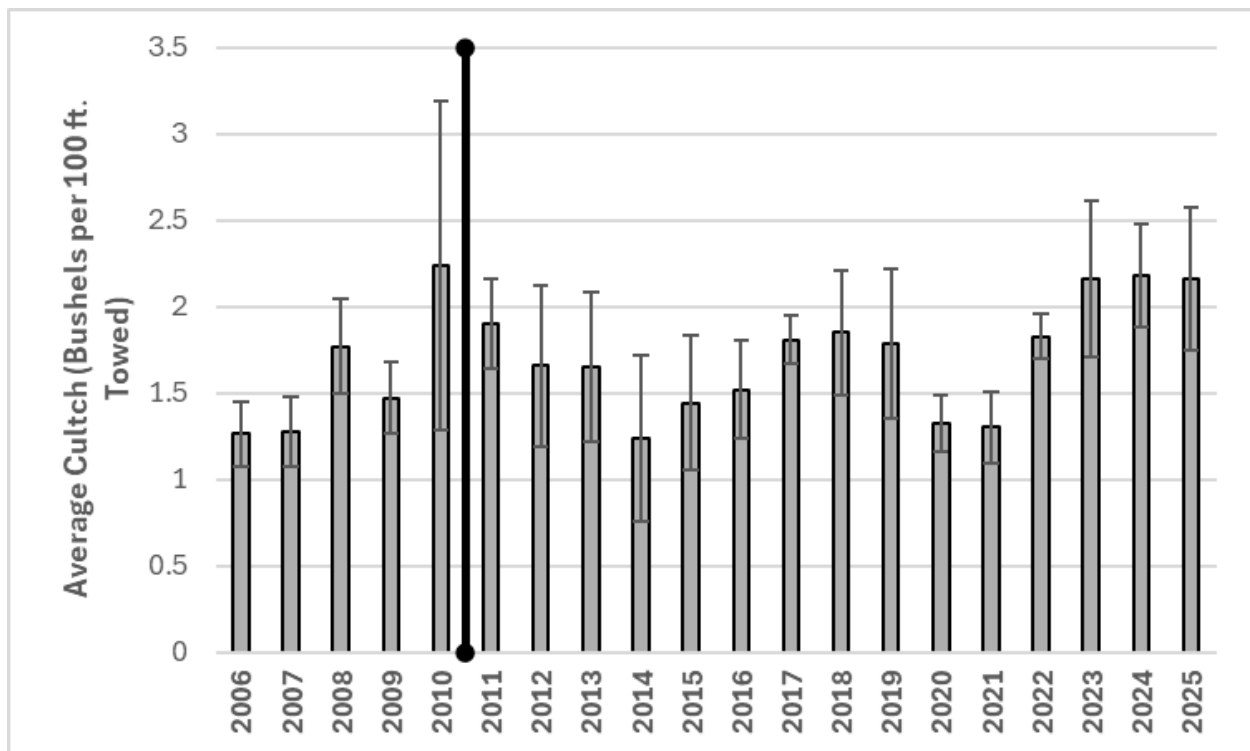


Figure A.51-7. Average cultch (live and dead oysters and loose shell) in the Wye River Sanctuary. Data from Maryland's Annual Fall Oyster Dredge Survey. Black line denotes the date the sanctuary was established. Error bars represent ± 1 standard error.