# Appendix B

# Characterization of Individual NOAA Codes

**Oyster Management Review:**

**2016-2020**

**A Report Prepared by**

**Maryland Department of Natural Resources**

**Final Report**

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# Introduction

A review of oyster population and harvest characteristics in non-sanctuary areas, including Public Shellfish Fishery Areas, provides a context to discuss their performance over time. The time span covered for this review is 2016-2020. Available data on oyster populations can be used to examine general oyster characteristics, background environmental and fishery information, and oyster population trends over time for each unique area. Recognizing that trends for any given area may shift as future environmental conditions change, nevertheless, an examination of oyster populations before and after the 2010 management regulation changes can facilitate informed discussion of the general characterization of the oyster population in areas available for commercial harvest.

In the late 1980s, small-scale geographical boundaries called NOAA Codes were developed for the reporting of commercial fishery harvest data (Figure B.00-1). Commercial oyster harvest has been reported using these NOAA Code areas since 1988. This appendix uses the NOAA Code boundaries to assess oyster populations and characterize the harvest, which provides a more detailed examination of the oyster population than would a single baywide examination.

The surface acres and NOAA Code boundaries shown in this appendix are slightly different than the last report[1]. The NOAA Codes boundaries were modified slightly to align better with the Maryland shoreline and Virginia state line. The upper boundary of NOAA Code 237 (Middle Choptank River) was aligned with the route 50 bridge, so that all of NOAA Code 337 (Upper Choptank River) falls within the Upper Choptank River Sanctuary. The boundary of 060 (Miles River) towards Wye River was extended by 12 acres so that all of NOAA Code 099 (Wye River) falls within the Wye River Sanctuary.

This appendix includes data from the department for each NOAA Code. Not all types of data are available for all NOAA Codes, and the scientific value of the different types of data may vary. Data used in this assessment include the following: replenishment activities, oyster population characteristics (oyster density, recruitment, size structure, and mortality), and harvest. Data used to characterize the productivity of NOAA Codes were collected in non-sanctuary areas only. In other words, if a NOAA Code encompasses both sanctuary and PSFAs, data for this analysis were collected only from the PSFAs that have remained open to harvest.

The various data sources used in the assessment of each NOAA Code are described below. The objective and term of the sampling program are presented for each data source. 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.

[1] Maryland Department of Natural Resources. 2016. Oyster Management Review: 2010-2015. 112 pp. https://dnr.maryland.gov/fisheries/pages/oysters/5-year-oyster-review-report.aspx

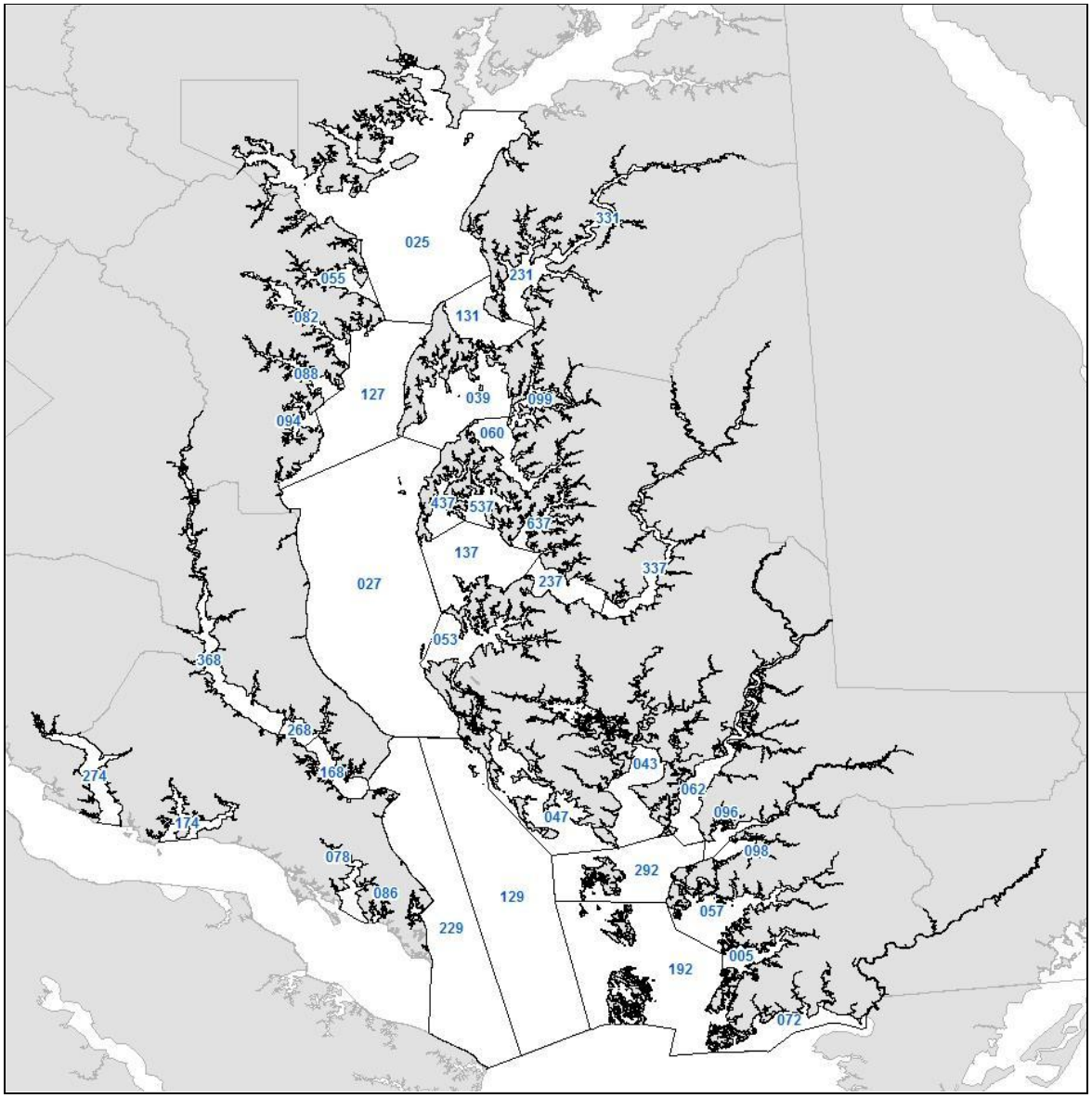


Figure B.00-1. Map of the NOAA Code areas within the Chesapeake Bay.

**Data Sources for General Characterization of the Non-Sanctuary Oyster Populations and Harvest**

*Bay Bottom Surveys*

Bay bottom mapping is important to determine the different substrate types and, if possible, delineate oyster bar boundaries. Two surveys have been completed in the past: the Yates Oyster Survey which conducted oyster bar mapping from 1906 to 1912 and the Maryland Bay Bottom Survey which categorized areas of bay bottom types from 1974 to 1983. There has not been a baywide bottom survey of the area open to the public fishery to determine change in bottom types since 1983. Due to inaccuracies of bottom data that are this old, bottom type information is not included in the sections below.

*Replenishment Efforts*

The majority of oyster bars in Maryland have been manipulated over time. Planting activities occurring in areas open to public shellfish harvest are defined as replenishment activities. Replenishment efforts were conducted to primarily improve oyster bar productivity and increase harvest. Enhancements include planting fresh and dredged shell, transplanting natural wild seed (young oysters), and planting hatchery-reared spat. Records of these activities date back to 1960, but only shell and seed plantings since 2006 are presented in this appendix. Not all plantings are monitored for oyster survival, natural recruitment, and/or economic benefit.

The amount of replenishment activities varies per NOAA Code. Some NOAA Codes have received numerous plantings, while others received very few or none. The annual planting information provides a general sense of how each NOAA Code was manipulated over time. An analysis to determine if replenishment activities contributed to an increase in the oyster population is beyond the scope of this report. This type of project is ongoing for smaller-sized areas and may be referenced when applicable for a particular NOAA Code.

Longevity of plantings should also be considered when examining replenishment activities. On average, in the absence of disease it is thought that oysters can live up to 20 years[2]. 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.

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

The half-lives of shell were computed by Waldbusser et al. (2011)[3] 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.

*Annual Fall Oyster Dredge Survey*

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

The Fall Survey design includes the sampling of spatfall and relative oyster abundance at a subset of Maryland's oyster bars. This report utilizes Fall Survey data since 2006; a 15-year time period with standardized survey methodologies. In the fall each year, approximately 300 to 400 samples are collected. Some NOAA Codes may have samples taken on multiple bars annually, some have only one oyster bar sampled annually, and some have not been sampled at all by the Fall Survey. For each sample, one or two half-bushel (in the case of the 43 fixed disease and biomass bars) subsamples of material are collected by an oyster dredge. Detailed methods for the Fall Survey may be found in Tarnowski (2020)[4].

For each sample collected by the Fall Survey, the number of live oysters per half-bushel of material collected is counted and then expressed as the number per bushel. 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 millimeters and always less than 76 millimeters. Market-sized (legal) oysters are equal to or greater than 76 millimeters and generally three years and older, though ages can vary based on growth rates. Changes in the number of oysters over time can provide a general sense of change 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 a fixed 43-bar subset of all the oyster bars sampled provide detailed information on oyster sizes annually. Oyster shell height in millimeters (mm) is recorded for all oysters collected. Oyster size structure is assessed by calculating the frequency distribution of oysters in each five mm size class. A healthy oyster population would have a size distribution with oysters in all, or at least most, size classes from five millimeters to greater than 120 millimeters. This would indicate multiple age classes in the population.

[3] 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

[4] Tarnowski, 2020. Maryland Oyster Population Status Report, 2019 Fall Survey.
https://dnr.maryland.gov/fisheries/Documents/19TextFinRevColFigs.pdf

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 height using laboratory-derived height-weight relationships. Weight is calculated in grams of dry tissue weight. Increases in biomass may reflect increases in the number of oysters and/or oyster growth.

Total Observed Mortality is an indicator of annual mortality rates of small and market-sized oysters. Mortality can occur from disease, other natural factors such as freshets, or old age. Mortality is estimated based on the total count of small and market-sized live oysters and the total count of small and market-sized boxes (dead oysters with the valves still articulated).

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 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 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.

Information on oyster diseases is collected from the same fixed subset of 43 bars on which shell heights are collected. 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, but at such low intensity that few oysters are in danger of dying in the near future. Intensity is based on a zero to seven scale. Individual oysters with intensities greater than five may indicate lethal infection levels.

The Fall Survey data are used to explore general characteristics of the oyster populations within those NOAA Codes that were sampled. Data presented examined changes over time, based on the average number of oysters per bushel of material, oyster shell height, live oyster biomass, recruitment, mortality, and disease on oyster bottom within each NOAA Code. Data are summarized into three different time periods which can be characterized baywide as:

- 2006-2010: Before the 2010 baywide management area regulation changes and through a rebuilding period after the four-year disease epizootic (1999-2002)
- 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: After the 2010 baywide management area regulation changes and through a major freshet and one relatively good spat set in 2020.

Although this report only covers the last 15 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. Years 1991-1993 had a high mean prevalence of dermo and MSX disease. Mortality correlated to the MSX frequency with an observed mortality >70% in 1992, which is a very high level of mortality.
- 1995-1999: 1995 was a period of low annual streamflow, followed by a high annual streamflow in 1996; 1999 was the first year of a four-year drought; 1995 was a year of increased dermo disease with a prevalence; 1996-1998 had low disease and observed mortality, while 1999 began a four year disease epizootic and increase in observed mortality; 1997 was a high spatset year, with over five times the long term average spatfall.
- 2000-2005: This period of time began with a drought that lasted until 2002. It was followed by two years of record high streamflow in 2003 and 2004. Years 2000-2005 saw low recruitment with a spatfall intensity index below the long term average for all of the years. The years 2000-2002 experienced a disease epizootic and high observed mortality. This was followed by a period of lower disease prevalence and reduced observed mortality (2003-2005).

*Harvest Data*

The department collects harvest data using two methods: seafood dealer reports and oyster harvester reports. The volume of oysters caught each day by each license holder is reported to the department in bushels. One Maryland oyster bushel is approximately 46 liters, notably larger than a standard U.S. bushel (35 liters).

Seafood dealers must report their oyster purchases to the department. These reports are called buy tickets and have been collected since the 1970's. Buy tickets are submitted weekly by licensed dealers who buy oysters directly from harvesters on the day of catch. Information reported on the buy tickets includes the broad location where harvest occurred (the NOAA Code area), quantity of oysters harvested, the gear type, and date of harvest. Both the dealer and the harvester must sign the buy ticket and include their names and license numbers. Harvest data from 2005-06 to 2019-20 seasons are presented in this appendix to be consistent with the period of Fall Survey data presented.

Starting in 2009, the department required oyster harvesters themselves to report their catch. These reports are submitted to the department monthly. Information reported on the harvester

reports include bar-specific harvest location, quantity of oysters harvested, gear used, and the date of harvest. However, due to the longer time series available from the buy ticket record, the monthly harvester reports are not presented in this appendix.

*Stock Assessment*

The first Maryland oyster stock assessment was completed in December 2018 by the Maryland Department of Natural Resources and University of Maryland Center for Environmental Science[5] . The assessment developed a stage-structured oyster population model and biological reference points based on the biological characteristics of the population and other appropriate factors affecting the population. An independent peer review panel concluded that the results from the assessment can serve as an adequate basis for management decisions. An updated stock assessment was completed in June of 2020[6]. This update used the same oyster population model and biological reference points as the 2018 stock assessment, however, it added two more years of data.

The stock assessments' stage-structured model and the reference point estimation models were applied separately to each NOAA Code to estimate 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, natural mortality (including disease-related mortality) of smalls and markets, 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.

Target and threshold harvest reference points were developed in the assessment. The target harvest rate is that which results in a maximum harvest over time, while resulting in a stable or increasing oyster population given current abundances of oysters in Maryland. The threshold harvest rate represents the absolute maximum harvest fraction that would allow sustainable harvest and if this is exceeded over time, it will result in the eventual disappearance of a commercially viable population. Annual estimates of harvest fraction from the assessment model can be compared to the harvest points for each NOAA Code.

A threshold abundance reference point was developed in the assessment. The threshold abundance is the lowest estimated abundance each for NOAA Code for the years 1999-2017. NOAA Codes would be considered "depleted" if abundance falls below the lower limit abundance reference point.

The results of the 2020 stock assessment concluded:

[5] Maryland Department of Natural Resources. 2018. A stock assessment of the Eastern Oyster, *Crassostrea virginica*, in the Maryland waters of Chesapeake Bay. Final Report November 2018. 359 pp https://dnr.maryland.gov/fisheries/Pages/oysters/Oyster_Stock_Assess.aspx

[6] Maryland Department of Natural Resources. 2020. Full Report of the 2020 Update Stock Assessment of the Eastern Oyster, *Crassostrea virginica*, in the Maryland waters of Chesapeake Bay. Final Report July 2020. 79 pp https://dnr.maryland.gov/fisheries/Pages/oysters/Oyster_Stock_Assess.aspx

- Market abundance - 453 million in 2019, the fifth highest in the time series (1999-2019). Highest in the Choptank River and Tangier regions. Market-sized oysters are greater than three inches in size which could be harvested.
- Small abundance - 433 million in 2019, which is slightly below the long-term mean of 480 million. Highest in the Choptank River and Tangier regions. Small-sized oysters are more than one year old and less than three inches in size and are not harvestable.
- Spat abundance - 284 million in 2019, the sixth lowest in the time series (1999-2019). Highest in the Choptank River and Tangier regions. Spat are oysters less than one year old.
- Harvest fraction - 75% of areas decreased the harvest fraction between the terminal year in the last assessment (2017, and 2019).
- Overfishing status - Showing progress from the prior assessment, the number of NOAA Codes above the upper limit reference point declined from 18 in the terminal year in the last assessment (2017) to five (lower Choptank River (137), Broad Creek (537), north and sound Tangier Sound (292 and 192), and Wicomico River east (096)) in 2019, while the number of NOAA Codes at or below the target fishing reference point increased from 15 to 25.
- Depleted status - Three NOAA Codes (Severn, lower Chester, and upper Chester) were below the lower limit abundance reference point (depleted abundance) most likely due to environmental causes and not harvest since these areas include sanctuaries (69%, 98% and 100% of NOAA Codes lower Chester, Severn and upper Chester, respectively, are sanctuary areas) and these codes were not estimated to be experiencing overfishing in the last two years. The department has requested that the commission address management options for these areas in 2021.

*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. Monitoring water quality may also detect the effects of replenishment 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.

Water quality is monitored in Maryland through the department's Eyes on the Bay program. Although water quality data are collected throughout the bay, only 19 stations within the NOAA Code areas have water quality information presented. In areas where more than one station occurred in a NOAA Code, a representative station was chosen to present data. All water quality stations in a NOAA Code that are within a sanctuary boundary can be found in Appendix A and are not presented here. Parameters measured by the Eyes on the Bay program include temperature, salinity, dissolved oxygen concentration, pH, total suspended solids, Secchi depth, chlorophyll a concentration, and nutrient concentrations.

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 ppt[7]. 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 NOAA Codes may fluctuate between salinity zones given weather patterns.

NOAA Codes within Zone 1 are characterized by having lower levels of disease and better survival but low reproductive capability[8]. Oysters are also subject to intermittent freshets that can result in substantial mortality.

NOAA Codes within Zone 3 can be subjected to heavy disease pressures which historically resulted in higher mortality[9]. In Zone 3, there are also high recruitment rates that provide a fairly constant influx of new oysters.

NOAA Codes within Zone 2 may have fluctuating characteristics based on the rainfall variation between wet and dry years[10]. 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.

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

## Overall Harvest and Effort in the Public Fishery

Maryland's oyster harvest has declined significantly since the 1880s (Figure B.00-2). The initial decline lasting into the early part of the 20th century was driven presumably by overharvesting and loss of habitat, both associated with an absence of conservation laws[11]. In the later part of the 20th century, oysters were affected by mortality from diseases, harvesting and habitat loss, including that from sedimentation and in some cases low dissolved oxygen[12].

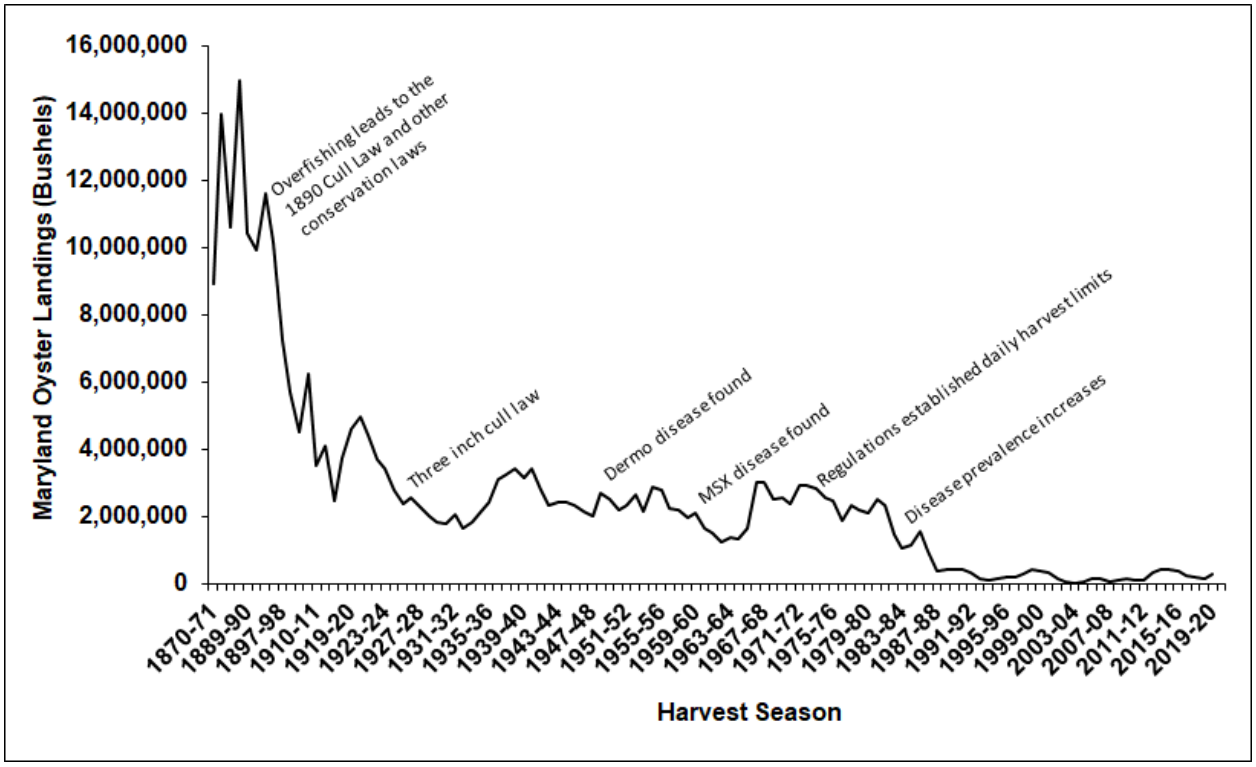


Figure B.00-2. Commercial oyster harvest (Maryland bushels) in Maryland.

Oyster harvest since 1990 has varied widely (Figure B.00-3). There have been numerous disease outbreaks since 1990 with the worst occurring during the drought years of 1999-2002. The lowest harvest on record (26,000 bushels) was recorded just after, during the 2003-2004 season. The highest spatfall since 1990 occurred baywide in 1997, and the increase in harvest that occurred in the years afterwards can be attributed to the 1997 spatfall as well as moving large quantities of seed from this year class to less productive areas. Harvest has increased in 2012-13 to 2016-17 due to good spatfall years (2010 and 2012) and relatively low (less than 15%) annual

[11] Brooks, W.K., 1891. The oyster, re-issued, 1996 Edition with a foreword by K.T. Paynter, Jr. Johns Hopkins University Press, Baltimore, MD, 230 pp.
[12] IBID

disease mortality. In the 2013-2014 season, harvest was the highest since the 1986-87 season. Harvest decreased in 2018-19 most likely due to low spatsets in the years prior and the freshet impacting growth of oysters. Then in 2019-20, harvest increased again.

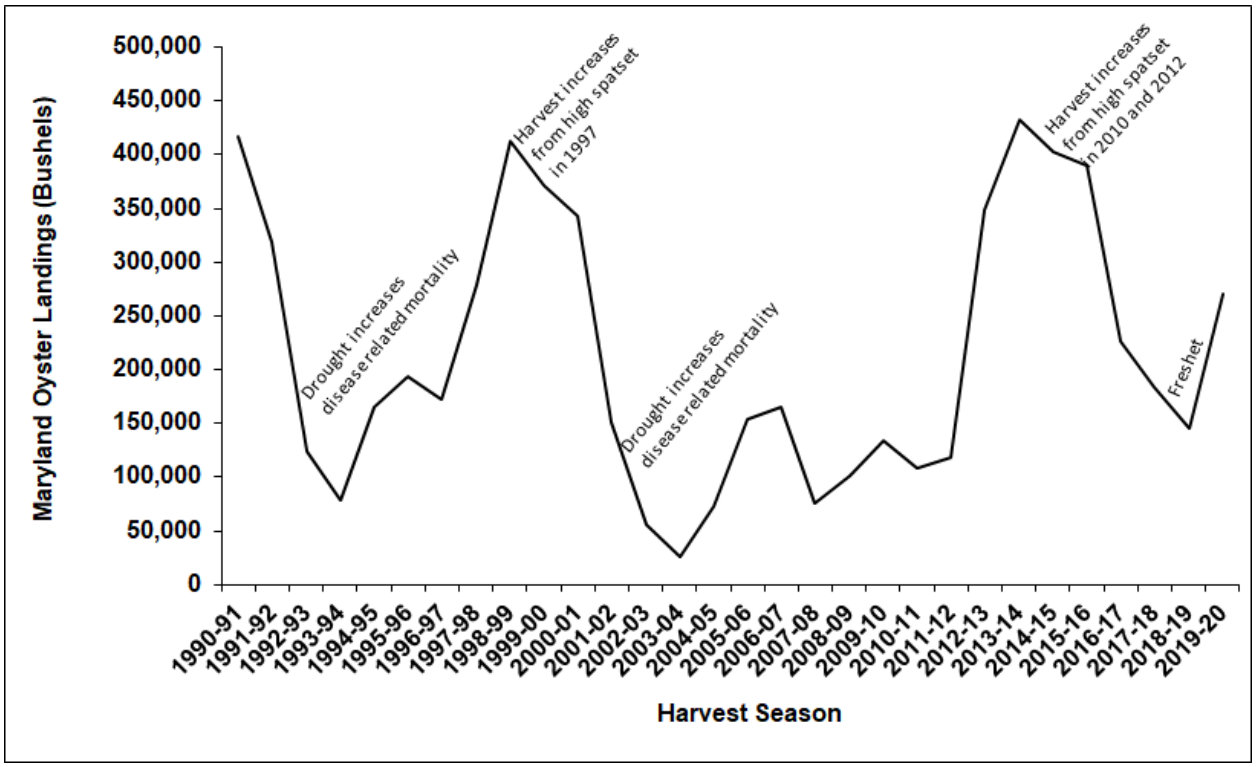


Figure B.00-3. Oyster harvest (Maryland bushels) in Maryland as reported using seafood dealer buy tickets.

Throughout this appendix, harvest information from the 2005-06 to 2019-20 season is presented. This 15-year period is consistent with data presented from the Fall Survey.

Oyster harvest is permitted from October 1st (November 1st for sail and power dredging) to March 31st. The current oyster season has been in effect since 1992 with the exception of the 2014-15 season that was extended to April 15th due to ice impacts in February. Currently, harvest can occur Monday, Tuesday, Thursday, and Friday, however, prior to the 2019-20 season, harvest occurred Monday through Friday. Monthly harvest peaks in November and is the lowest in February and March (as reported on seafood dealer buy tickets) (Figure B.00-4).

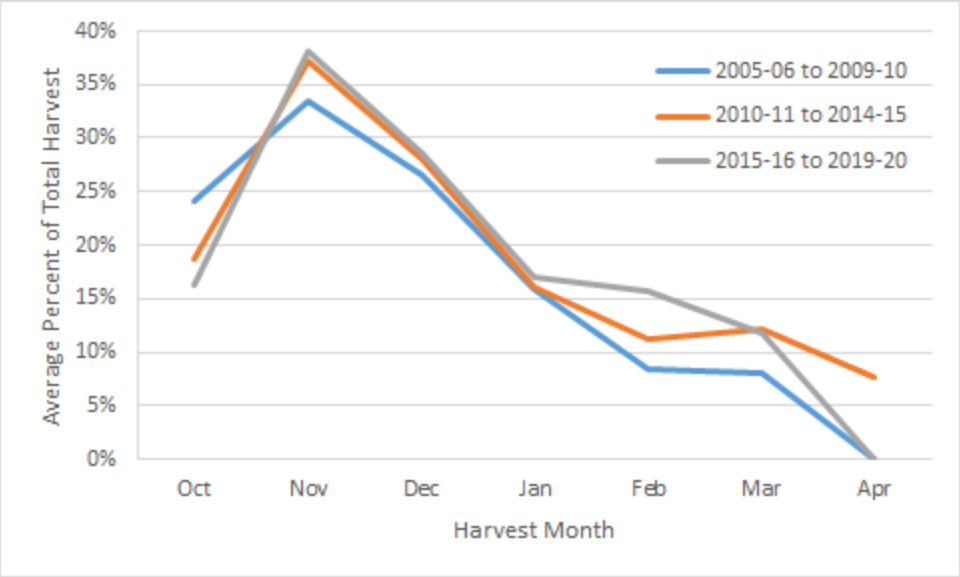


Figure B.00-4. Average monthly percent of total annual harvest as reported using seafood dealer buy tickets for 2005-06 to 2009-10 seasons, 2010-11 to 2014-15 seasons and 2015-16 to 2019-20 seasons. The 2014-2015 season was extended to April 15, 2014.

From 2005-06 to 2018-19 seasons, harvest per license was limited to 15 bushels per day for all gear types except power dredging (12 bushels per day) and sail dredging (150 bushels per day). These daily catch limits had been in place since 1971 for sail dredge, 1983 for power dredging, and 1987 for hand tongs, patent tongs, and diving. For the 2019-20 season, daily harvest per license changed to 12 bushels per day for all gear types except power dredging (10 bushels per day) and sail dredging (100 bushels per day). A maximum of two licenses is permitted on a boat harvest oysters for all gear types except sail dredge.

*Harvest Effort*

Individuals with an Oyster Dredge Boat License, Oyster Harvester License, or an Unlimited Tidal Fish License who have also purchased an oyster surcharge for the current season are permitted to harvest oysters. This equates to a maximum of 2,828 licenses that have the potential to harvest oysters in any year. However, not every license holder purchases an oyster surcharge so the number of actual harvesters is well below the potential maximum. To harvest oysters in any year, a license holder must purchase an oyster surcharge for $300. The surcharge funds are used to plant shell and seed for the public fishery. The department began recording the number of surcharges purchased in 1994 (requirement was enacted in 1991) (Figure B.00-5). Between the 2005-06 to 2014-2015 harvest seasons, the number of surcharges purchased has nearly doubled and is approaching 1,200 participants. After the 2014-2015 season, the number of surcharges started decreasing annually until the 2019-20 season when there was an increase. It should be

noted that not all license holders that pay the surcharge report harvesting oysters. Between 62% and 92% of surcharge holders annually report that they have harvested oysters annually.

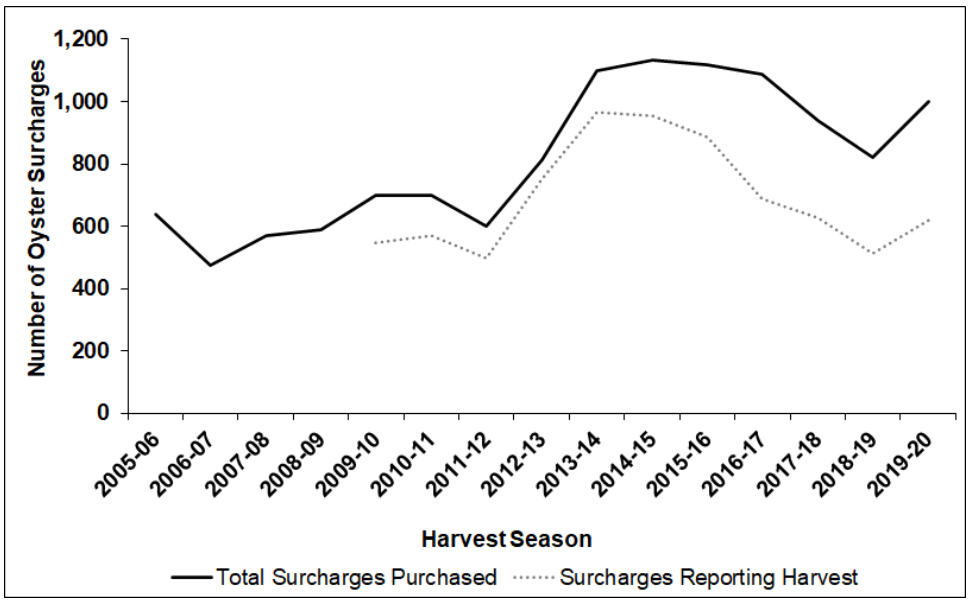


Figure B.00-5. The total number of oyster surcharges purchased in Maryland annually. The number of surcharge holders reporting harvest annually as reported on the monthly oyster harvester reports starting in 2009.

Harvest effort has varied over the 15-year period since the 2005-06 season (Figure B.00-6). Effort, as defined as the total number of days during which oyster harvest occurred for all license holders, has been as low as approximately 9 thousand days in the 2007-08 season and as high as 40.5 thousand days in the 2013-14 season.

Catch per unit effort, as defined as the total harvest divided by the total number of days fished, is a measure of two indices: efficiency of the fishery and oyster abundance. Annual catch per unit effort has been variable over the 15-year period (Figure B.00-6).

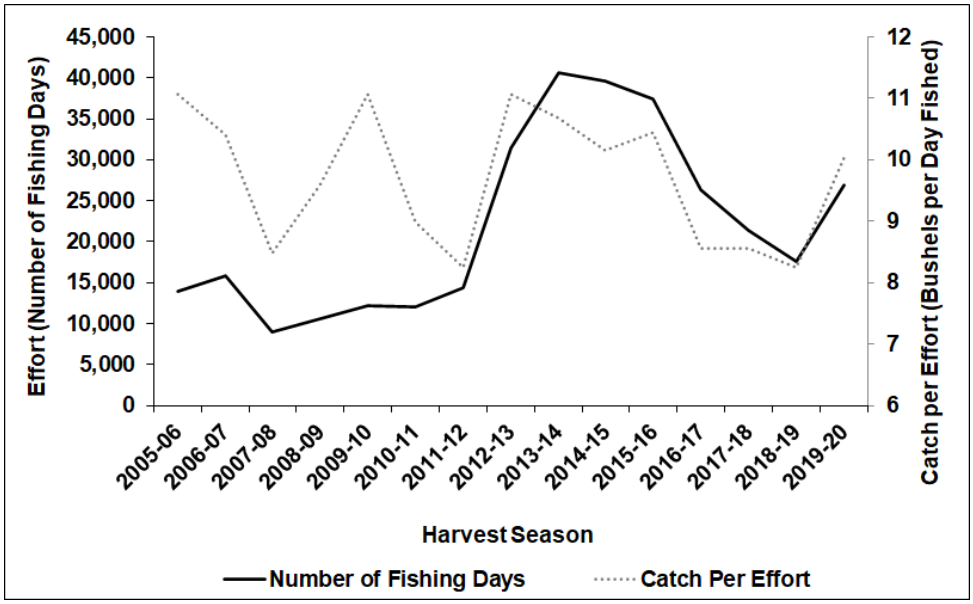


Figure B.00-6. Effort and catch per unit effort (bushels per day) for oyster harvest in Maryland since the 2005-06 season as reported on seafood dealer buy tickets.

*Harvest by Gear Types*

Oysters can be harvested by multiple gear types: hand tongs, diving, patent tongs, power dredge, and sail dredge. Hand tongs are made of two wooden shafts ranging in length from 16' to 30' with rakes attached to each shaft; the shafts are joined together by a pin, mimicking scissors. The harvester stands on the side of the boat, lowering the tongs into the water, and then opens and closes the tongs catching the oysters in the rakes. Some oyster bars are restricted to hand tonging only. However, harvest by hand tonging is permitted on all oyster bars. Areas open to oystering are zoned for specific and sometimes multiple gear types.

Patent tongs employ the same basic technique as hand tongs. However, they are controlled using hydraulics and have a much bigger head (rake) than the traditional hand tong. To harvest oysters, the tongs are lowered into the water and the head is opened and closed using hydraulics. Patent tongs vary by style and weight with lighter or heavier gear being used on different bottoms. Many boats will choose to deploy two patent tongs, one on each side of the vessel, operated by each license-holder. At the request of the industry, patent tongs, thought to be too efficient, are prohibited from certain county waters and most tributaries. They are primarily employed in the Chesapeake Bay mainstem, the lower Patuxent River, and parts of Somerset County.

Oyster diving was legally established as a gear type in 1973. Divers remove oysters from the bottom by hand. Diving is a two-person job; once the person on the bottom fills up a basket, the person on the surface will hoist it up. Diving is allowed on all open bottoms except those

reserved for Hand Tong Only and three of the four small Power Dredge Study Areas but divers typically only work on bars where patent-tonging and dredging are prohibited.

Power dredging for oysters uses a boat with a mast and boom type rig that controls an oyster dredge. A dredge is a toothed scraping bar fitted with a chain or mesh bag that is lowered onto the bar and is then towed by the boat across the bar, collecting oysters in the bag. The dredge is then lifted back onto the boat and the catch is deposited onto the culling station. In 1993, the power dredging gear type was legislatively discontinued but it was reestablished in 1997 and further expanded in 1999, 2003, and 2010, to include much of the lower Bay and significant parts of the middle Bay below the Chesapeake Bay Bridge. Power dredging is allowed in much of the lower Choptank River and the majority of bottoms in southern Maryland including the Bay mainstem and much of Dorchester, Somerset, and St. Mary's Counties.

Sail dredging is an historical harvest method employing the iconic Chesapeake Bay skipjack sailing vessel. The dredge is larger than that used in power dredging and it is lowered and raised by a deck mounted winch not by a mast and boom rig. For at least three of the work days each week the boat must be powered completely under sail. For two days a week, the skipjack can be powered using an auxiliary yawl boat to push the skipjack, effectively making it extremely similar to power dredging. Historically skipjacks operated throughout the mainstem of the Chesapeake Bay as well as some tributaries such as the Choptank, but in recent years, fewer than ten boats are in operation. They are generally found in the Tangier Sound region, possibly due to densities of oysters elsewhere on the regulated skipjack bottom (primarily mainstem Chesapeake Bay) not being sufficient to harvest economically.

The proportion of harvest by each of the gear types has varied over time since the 2005-06 season (Figure B.00-7). Power and sail dredging was used to obtain the majority of harvest (annual average of 50%, ranging from 22% to 68%). Of harvest obtained by dredging, power dredging was the most frequent gear used, with sail dredging obtaining an average of 7% of the total harvest. Patent tongs were used to obtain an annual average of 21% of the harvest (ranging from 14% to 32%). Diving for oysters resulted in 2 to 25% of the harvest (annual average of 10%) and hand tonging produced 4 to 34% of the harvest (annual average of 18%).

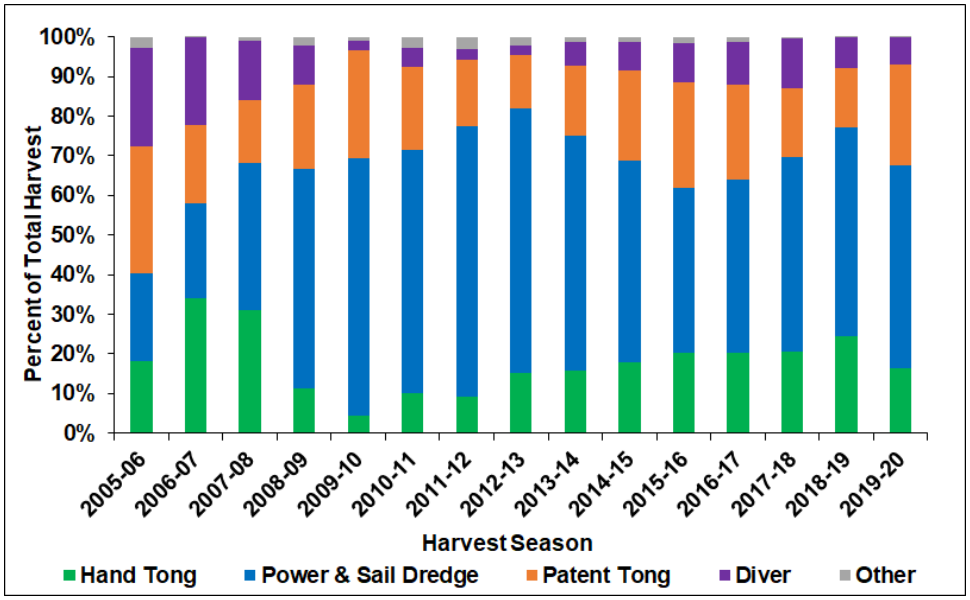


Figure B.00-7. Percent of the total oyster harvest reported in Maryland by each gear type as reported by seafood dealer buy tickets. "Other" gear type harvest occurs when the gear type is not recorded.

*Spatial Extent of Harvest*

Harvest reported by seafood dealer buy tickets are recorded by NOAA Codes (Figure B.00-1). The dominant harvest areas have varied over the years (Table B.00-1). Seventeen of the 39 NOAA Codes ranked in the top five harvested NOAA Codes since the 2005-06 season. Broad Creek (537) and Tangier Sound North (292) most consistently ranked in the top five harvest areas (12 of the 15-year time series). Tangier Sound South (192) and Fishing Bay (043) also ranked in the top five harvest areas the majority of the time series (eight years out of the 15-year time series). The upper bay NOAA Codes (025 and 027) only ranked in the top five the first couple of harvest seasons, when the downbay populations were still recovering from high disease mortalities during 1999 to 2002.

Table B.00-1. Ranking of the five highest harvest areas by Maryland NOAA Code for each harvest season as reported by seafood dealer buy tickets. A ranking of 1 is the highest harvest, 2 the second highest, etc.

| Harvest Season | NOAA Code | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 025 | 027 | 039 | 043 | 047 | 062 | 072 | 078 | 129 | 137 | 168 | 192 | 229 | 268 | 292 | 437 | 537 |
| 05-06 | 2 | 5 | 1 | | | | | | | | | | | 4 | | | 3 |
| 06-07 | 3 | 4 | 2 | | | | | | | | 5 | | | | | | 1 |
| 07-08 | 2 | | 4 | | | | | | | | | 3 | | | 5 | | 1 |
| 08-09 | 5 | | 4 | | 2 | | | | | | | 1 | | | 3 | | |
| 09-10 | | | | 4 | 2 | | | | 5 | | | 1 | | | 3 | | |
| 10-11 | | | | 3 | 4 | | | | | | | 1 | | | 2 | | 5 |
| 11-12 | | | | 3 | 5 | | | | | | | 1 | | | 2 | | 4 |
| 12-13 | | | | 2 | | | 5 | | | | | 4 | | | 3 | | 1 |
| 13-14 | | | | 2 | | | 5 | | | | | 4 | | | 3 | | 1 |
| 14-15 | | | | 4 | | | | | | 5 | 3 | | | | 2 | | 1 |
| 15-16 | | | | | | | | | | 5 | 3 | 4 | | | 2 | | 1 |
| 16-17 | | | 4 | 5 | | | | | | | 3 | | | | 1 | | 2 |
| 17-18 | | | 4 | | | 5 | | 3 | | | | | | | 1 | | 2 |
| 18-19 | | | | | | | | 4 | | 3 | 5 | | | | 2 | | 1 |
| 19-20 | | | 5 | 3 | | 1 | | | | | | | 4 | | | 2 | |

## Section B.01: NOAA Code 005 – Big Annemessex River

NOAA Code 005 encompasses the Big Annemessex River and is located in Maryland's lower eastern portion of Chesapeake Bay. The entire NOAA Code is 7,132 acres and has 15 historic oyster bars[13]. The Big Annemessex River Sanctuary encompasses 10% (749 total acres) of the NOAA Code. This section focuses on information collected within the NOAA Code occurring outside of the current sanctuary area. This equates to 6,383 surface acres. There are 3,935 acres of historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments) located within the NOAA Code and outside a sanctuary. As of 2020, there are 671 acres within the NOAA Code designated as a Public Shellfish Fishery Area (PSFA). Aquaculture leasing is prohibited within PSFA boundaries. This NOAA Code is located within Maryland's high-salinity region (Zone 3).

Information available for this NOAA Code includes:

- NOAA Code map (Figure B.01-1)
- Summary statistics (Table B.01-1)
- Abundance per year (Figure B.01-2)
- Shell height frequencies (Figure B.01-3)
- Biomass per year (Figure B.01-4)
- Observed mortality (Figure B.01-5)
- Cultch per year (Figure B.01-6)
- Harvest (Figure B.01-7)
- Water Quality (Figure B.01-8)

Fall Survey results indicate low market density throughout the time series. Average small-sized oyster density was lower in 2016-2020 and 2011-2015 as compared to 2006-2010, likely due to increased small density in 2007. Spat densities were highest in 2006, 2013, and 2020. There was no change in average spat density among the three time periods. Observed mortality was consistently above the long-term baywide average, with high mortalities in 2006, 2008, 2011, 2014, and 2015. This increase in observed mortality may be due in part to low small and market oyster counts. The average amount of cultch was similar across the time series.

Between 2006 and 2020, no replenishment planting activities occurred to enhance the commercial public fishery in this NOAA Code outside of the current sanctuary area.

Harvest for the NOAA Code has been reported on seafood dealer buy tickets for 13 years out of the 15-year time series. This includes past harvest data from areas in the NOAA Code that are currently in a sanctuary area, but weren't when the harvest occurred prior to the sanctuary being established. Since 2010, 10% of the NOAA Code area has been a sanctuary where harvest is prohibited. Harvest reported ranged from less than 10 bushels in the 2007-08 and 2010-11

[13] 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

seasons to a maximum of approximately four thousand bushels in the 2015-16 season. Power dredging was used to obtain the majority of the harvest.

Continuous water quality monitoring has occurred at station ET9.1 (38.055; -75.8017). During the 2006-2020 timeline, surface salinity ranged from 8.6 ppt to 20.4 ppt, with the lowest salinity being during the freshet of 2018-2019 and during the high rainfall year of 2011.

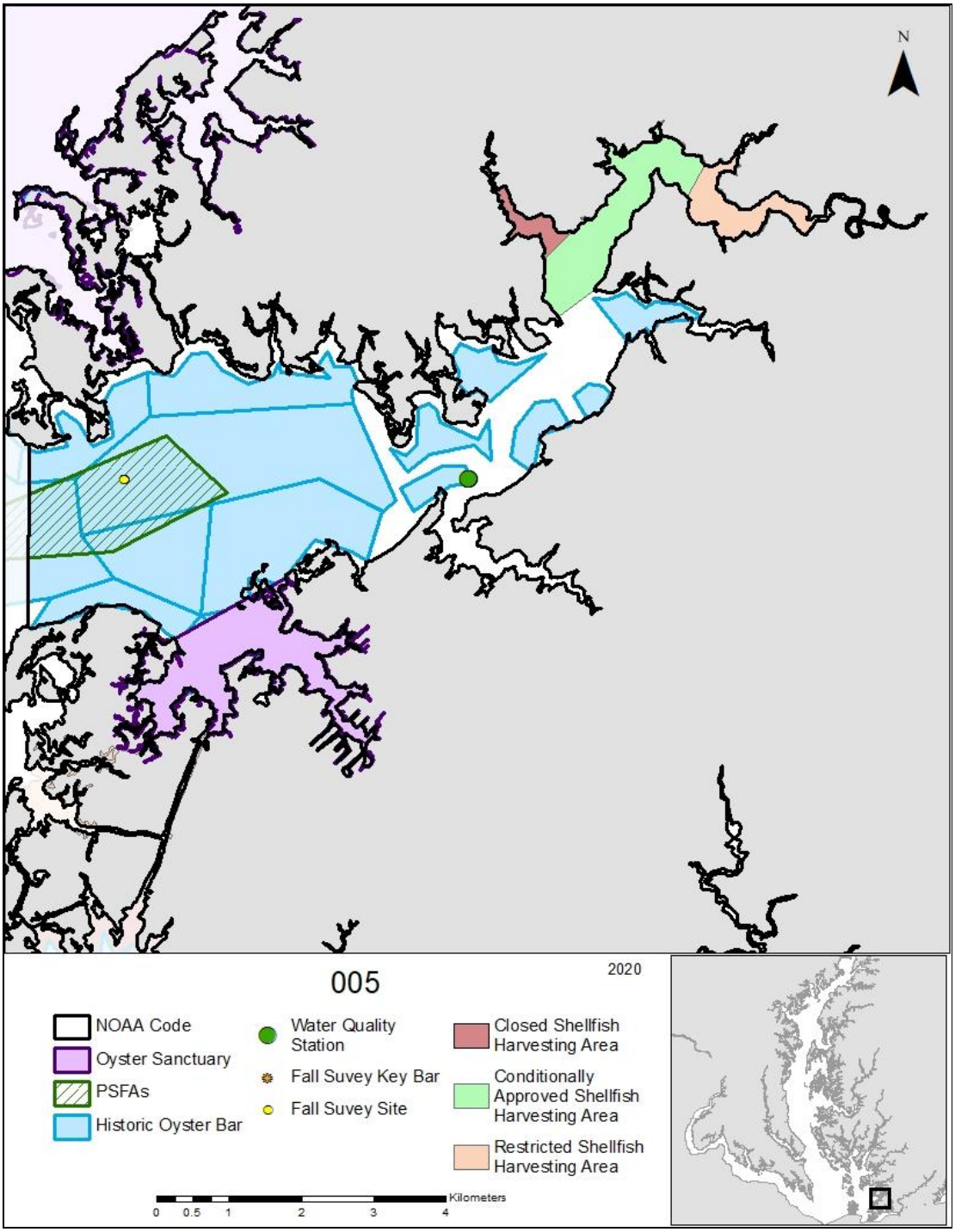


Figure B.01-1. Map of NOAA Code 005 (Big Annemessex River). Fall Survey sites may not be sampled every year.

Table B.01-1. Oyster population characteristics based on the Fall Survey in the NOAA Code 005 (Big Annemessex River) occurring outside of the current sanctuary area. ND = No Data. Values are given as an annual mean ± standard error.

| | 2006-10 | 2011-15 | 2016-20 |
|---|---|---|---|
| Number of Years Sampled / Number of Samples | 5 / 5 | 4 / 4 | 5 / 5 |
| Number of Live Spat Oysters per square meter | 87.7 ± 45.5 | 77.2 ± 35.8 | 51.6 ± 25.5 |
| Number of Live Small-Sized Oysters per square meter | 7.8 ± 5.8 | 2.2 ± 1.3 | 2.9 ± 0.8 |
| Number of Live Market-Sized Oysters per square meter | 0.6 ± 0.6 | 1.3 ± 0.5 | 0.5 ± 0.5 |
| Live Oyster Biomass (g Dry Weight per Bushel) | ND | 5 ± 2 | 3 ± 1 |
| Observed Mortality (%) | 26 ± 14 | 42 ± 21 | 4 ± 4 |
| Cultch (Bushels per 100 ft Towed) | 0.86 ± 0.13 | 0.8 ± 0.21 | 0.75 ± 0.07 |
| Harvest (Bushels) | 37 ± 28 | 326 ± 143 | 947 ± 786 |
| Note: The number of samples is based on the number of samples having a value for observed mortality. There may be fewer samples per year for density, biomass, and cultch. | | | |

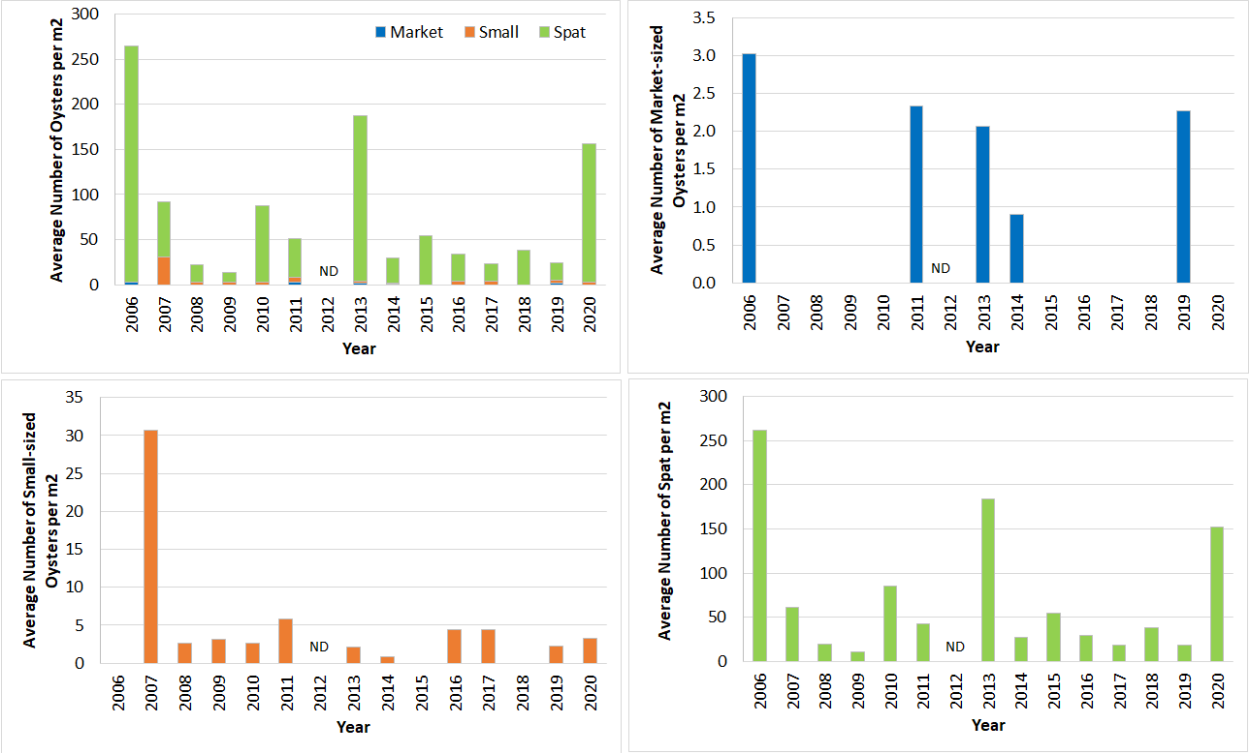


Figure B.01-2. Average number of live oysters per square meter by size class in NOAA Code 005 (Big Annemessex River) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales. ND=No Data.

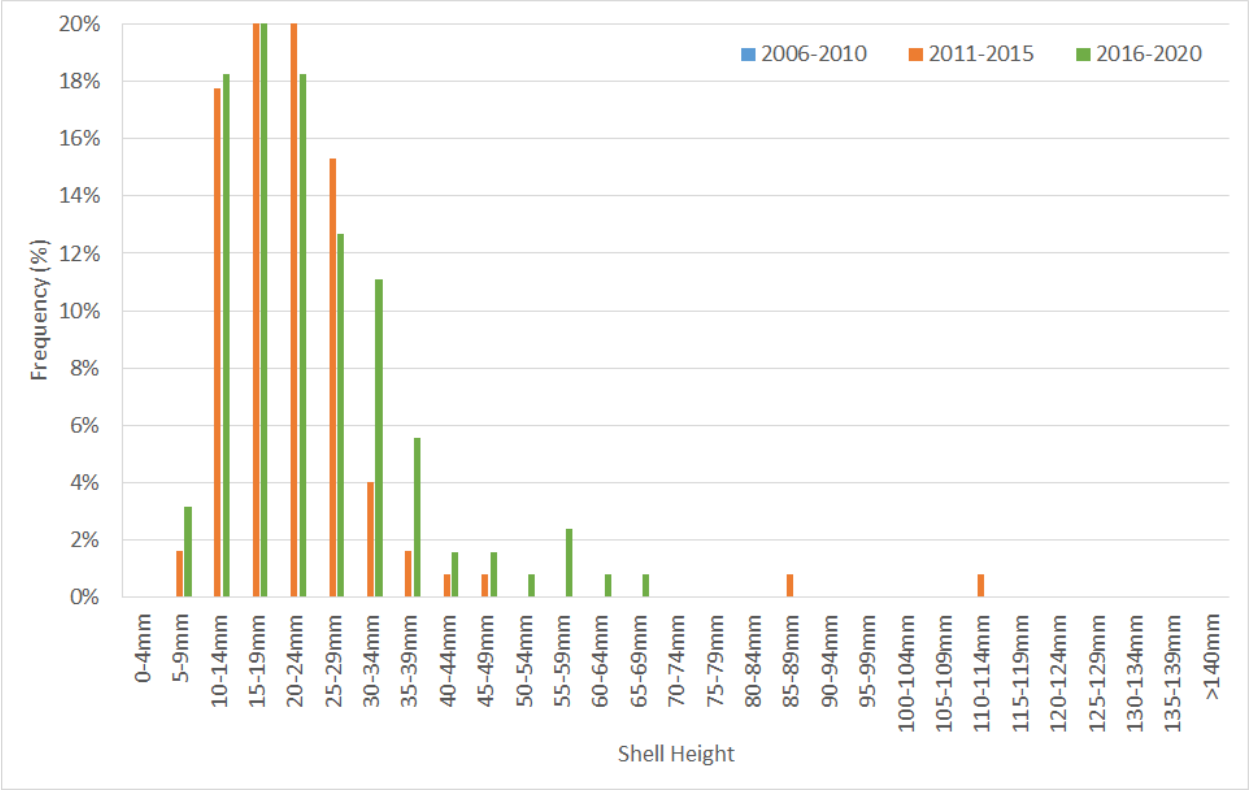


Figure B.01-3. Shell height frequencies of live oysters per bushel of material in NOAA Code 005 (Big Annemessex River) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey on Big Annemessex bar. No data were collected from 2006 to 2012, 2015, and 2019.

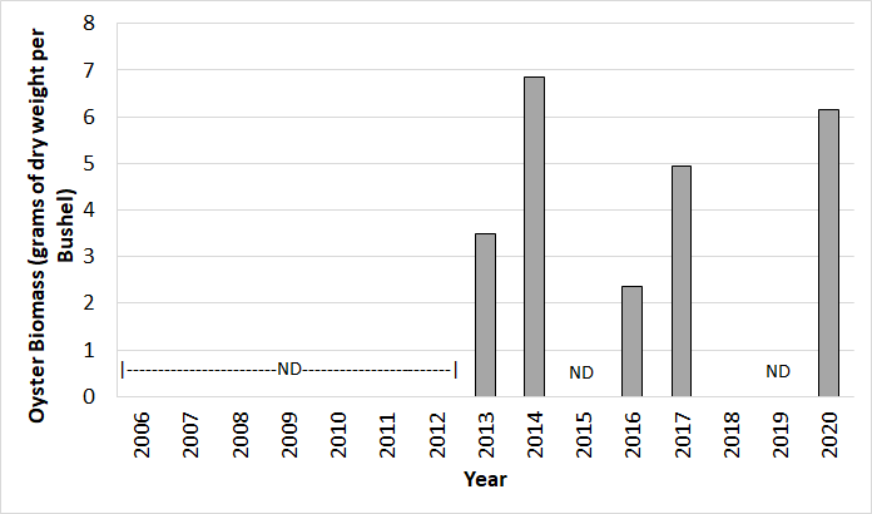


Figure B.01-4. Oyster biomass (grams of dry weight per bushel of material) in NOAA Code 005 (Big Annemessex River) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey on Big Annemessex bar. No data were collected from 2006 to 2012, 2015, and 2019.

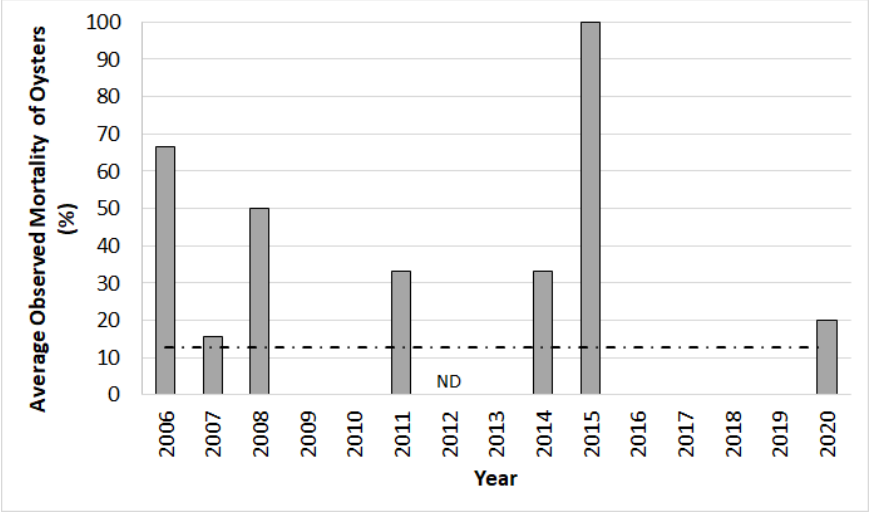


Figure B.01-5. Average annual observed mortality of market-sized and small-sized oysters in NOAA Code 005 (Big Annemessex River) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey. The dashed line represents the 2006-2020 baywide average observed mortality. ND = No Data.

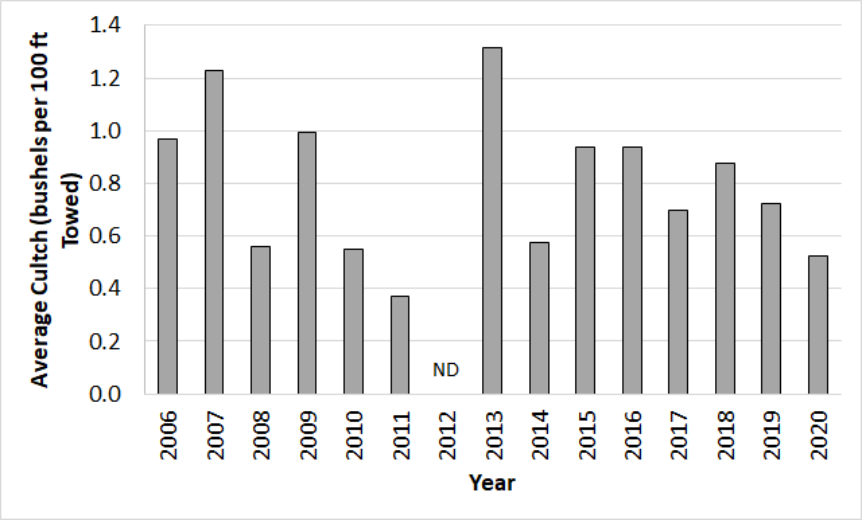


Figure B.01-6. Average cultch (live and dead oysters and loose shell) in NOAA Code 005 (Big Annemessex River) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey. ND = No Data.

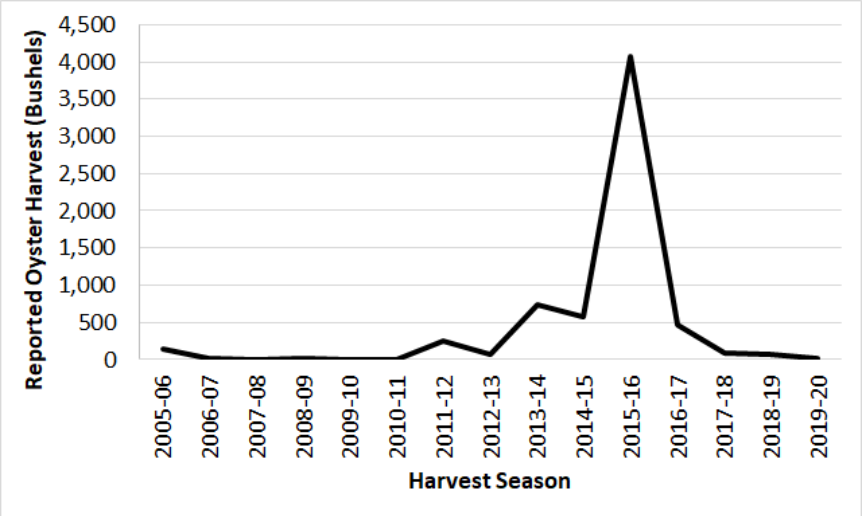


Figure B.01-7. Oyster harvest reported from seafood dealer buy tickets (harvest seasons 2005-06 to 2019-20) in NOAA Code 005 (Big Annemessex River). Since 2010, 10% of the NOAA Code area has been a sanctuary where harvest is prohibited.

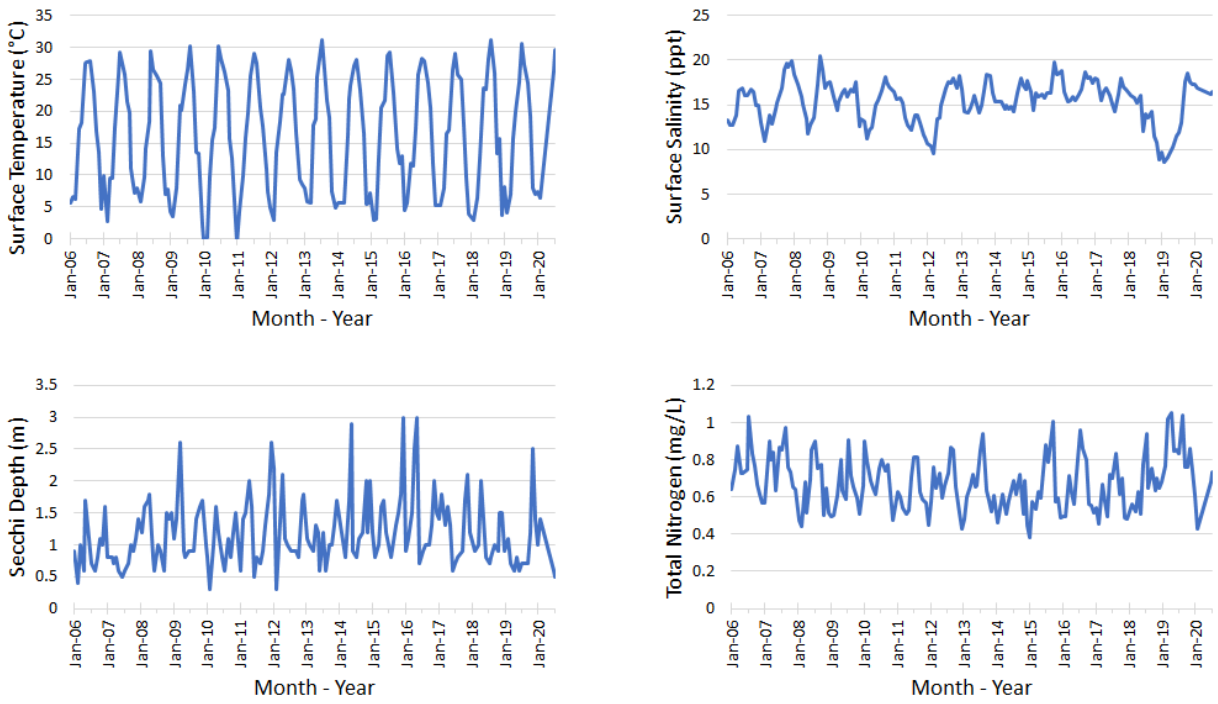


Figure B.01-8. Water quality data collected at Station ET9.1 in NOAA Code 005 (Big Annemessex River). Data from Chesapeake Bay Program Data Hub.

## Section B.02: NOAA Code 025 – Chesapeake Bay Upper

NOAA Code 025 is located in Maryland's upper portion of Chesapeake Bay, north of the Chesapeake Bay Bridge. The entire NOAA Code is 163,540 acres and has 40 historic oyster bars [14]. The Lower Chester River, Man-O-War/Gales Lump, and Fort Carroll sanctuaries encompass 10% (16,730 acres) of the NOAA Code. This section focuses on information collected within the NOAA Code occurring outside of the current sanctuary areas. This equates to 146,810 surface acres. There are 19,300 acres of historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments) located within the NOAA Code and outside a sanctuary. As of 2020, there are 15,465 acres within the NOAA Code designated as a Public Shellfish Fishery Area (PSFA). Aquaculture leasing is prohibited within PSFA boundaries. This NOAA Code is located within Maryland's low-salinity region (Zone 1).

Information available for this NOAA Code includes:

- NOAA Code map (Figure B.02-1)
- Summary statistics (Table B.02-1)
- Abundance per year (Figure B.02-2)
- Shell height frequencies (Figure B.02-3)
- Biomass per year (Figure B.02-4)
- Observed mortality (Figure B.02-5)
- Dermo and MSX per year (Figure B.02-6)
- Cultch per year (Figure B.02-7)
- Harvest (Figure B.02-8)
- Water Quality (Figure B.02-9)

Fall Survey results indicated an increase in average small and market densities in 2016-2020 as compared to 2011-2015. This was likely due to samples taken on wild seed and hatchery spat-on-shell planting in 2010, 2013, and 2020. Average natural spat density was 0.51 in 2006-2010, 0.02 in 2011-2015, and 0 in 2016-2020. Biomass varied during the time series but the average biomass for the three time periods was similar. Mortality was over 50% in 2011 due to spring freshet, a hurricane, and tropical storm. Mortality was also high in 2018 and 2019 due to a prolonged freshet. Average size of oysters was higher (104 mm) before spat-on-shell plantings were initiated.

Between 2006 and 2020, approximately 187 thousand bushels of wild seed and 507 million hatchery spat-on-shell were planted to enhance the commercial public fishery in this NOAA Code outside of the current sanctuary area.

Harvest for the NOAA Code has been reported on seafood dealer buy tickets for all years in the 15-year time series. This includes past harvest data from areas in the NOAA Code that are currently in a sanctuary area, but weren't when the harvest occurred prior to the sanctuaries being established. Since 2010, 10% of the NOAA Code area has been a sanctuary where harvest is prohibited. Harvest reported ranged from less than 10 bushels in the 2011-12 season to a

[14] See charts 4, 5, 6, and 7 for bar names and locations in the State of Maryland Shellfish Closure Areas Book http://dnr.maryland.gov/fisheries/Pages/oysters/index.aspx

maximum of approximately 17 thousand bushels in the 2005-06 season. Patent tongs were used to obtain 60% of the harvest and the remaining harvest was mostly obtained by sail and power dredge. During the 2019-20 season, the department closed the entire NOAA Code to harvest with the exception that specific areas which had been previously planted with oysters could be opened to harvest.

Continuous water quality monitoring has occurred at station CB3.2 (39.16369; -76.3063). During the 2006-2020 timeline, surface salinity ranged from 0 ppt to 14.6 ppt, with the lowest salinity being during the freshet of 2018-2019 and during the high rainfall year of 2011.

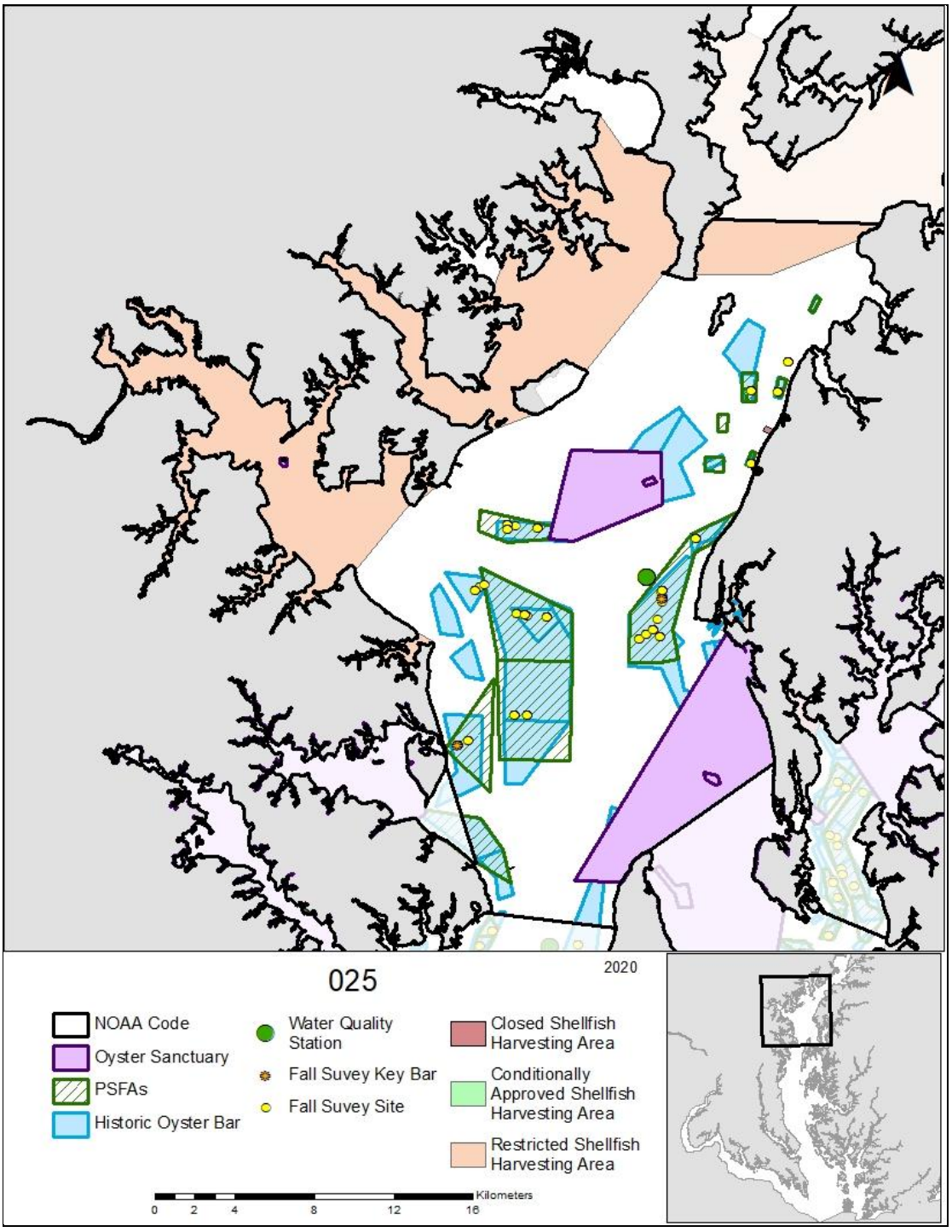


Figure B.02-1. Map of NOAA Code 025 (Chesapeake Bay Upper). Fall Survey sites may not be sampled every year. Fall Survey key bars may consist of a key bar, disease bar or both.

Table B.02-1. Oyster population characteristics based on the Fall Survey in the NOAA Code 025 (Chesapeake Bay Upper) occurring outside of the current sanctuary area. ND = No Data. Values are given as an annual mean ± standard error.

| | 2006-10 | 2011-15 | 2016-20 |
|---|---|---|---|
| Number of Years Sampled / Number of Samples | 5 / 102 | 5 / 83 | 5 / 89 |
| Number of Live Spat Oysters per square meter | 3.1 ± 3.1 | 30.2 ± 30.1 | 3.5 ± 3.5 |
| Number of Live Small-Sized Oysters per square meter | 9 ± 1.9 | 9.7 ± 3.4 | 19.8 ± 9.9 |
| Number of Live Market-Sized Oysters per square meter | 15 ± 2.2 | 4.3 ± 0.7 | 7.4 ± 1.4 |
| Live Oyster Biomass (g Dry Weight per Bushel) | 121 ± 19 | 138 ± 38 | 127 ± 34 |
| Observed Mortality (%) | 6 ± 1 | 22 ± 9 | 18 ± 7 |
| Cultch (Bushels per 100 ft Towed) | 0.62 ± 0.1 | 0.57 ± 0.04 | 0.5 ± 0.03 |
| Harvest (Bushels) | 10,044 ± 2,631 | 1,216 ± 1,053 | 2,346 ± 863 |

Note: The number of samples is based on the number of samples having a value for observed mortality. There may be fewer samples per year for density, biomass, and cultch.

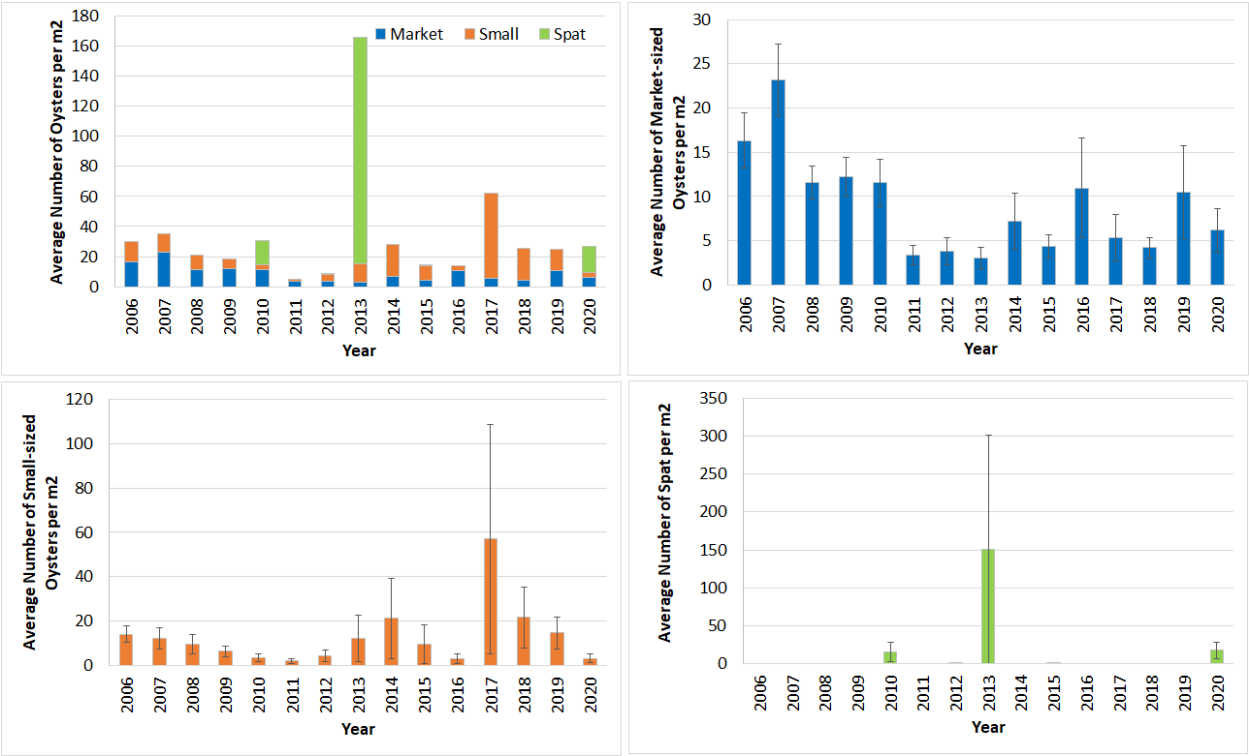


Figure B.02-2A. Average number of live oysters per square meter by size class in NOAA Code 025 (Chesapeake Bay Upper) occurring outside of the current sanctuary area. Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales.

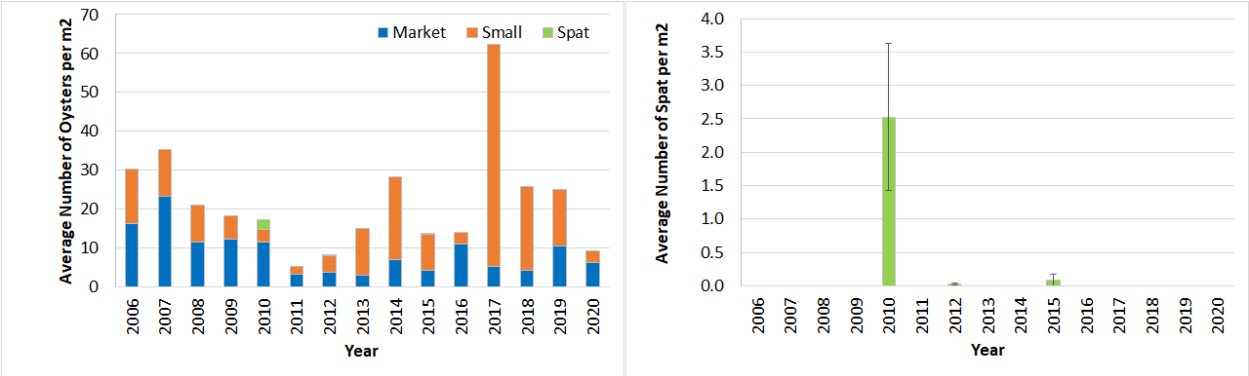


Figure B.02-2B. Average number of live oysters per square meter by size class in NOAA Code 025 (Chesapeake Bay Upper) occurring outside of the current sanctuary area excluding samples taken in the same year as a spat planting. Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales.

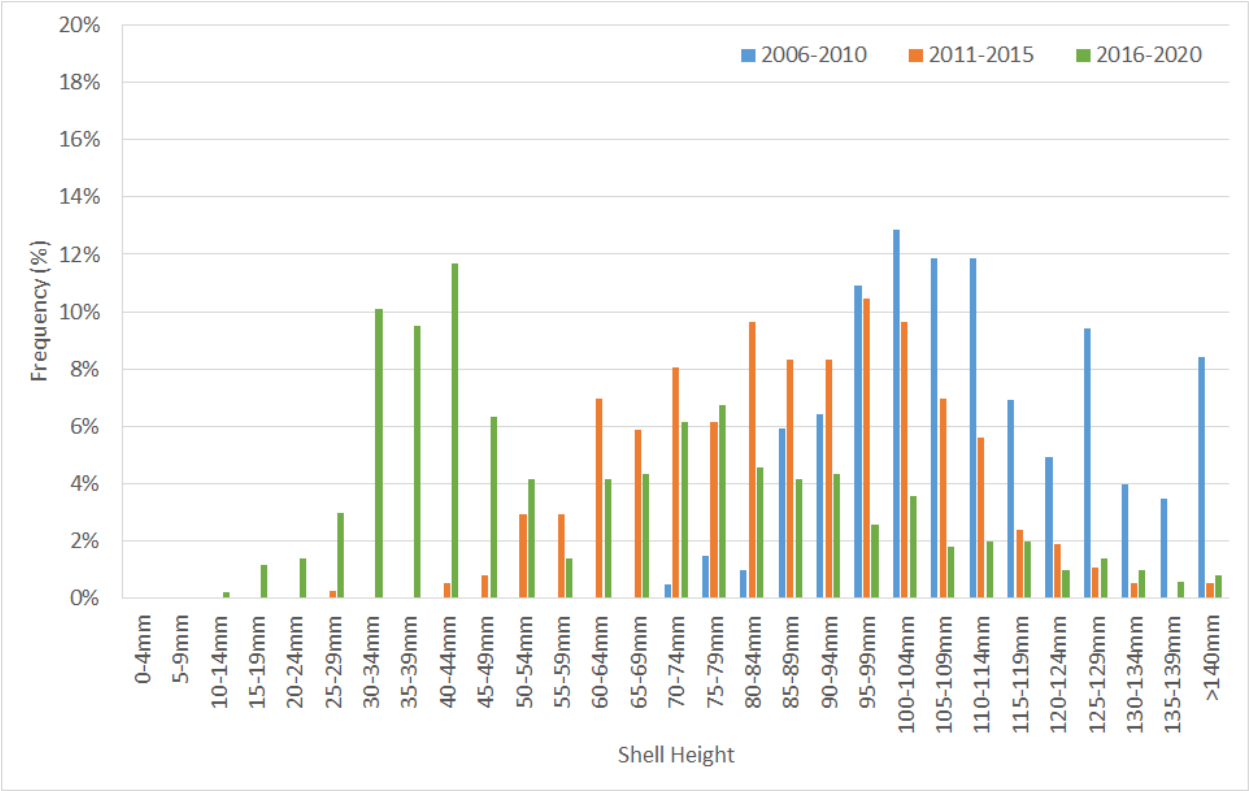


Figure B.02-3. Shell height frequencies of live oysters per bushel of material in NOAA Code 025 (Chesapeake Bay Upper) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey on Swan Point bar.

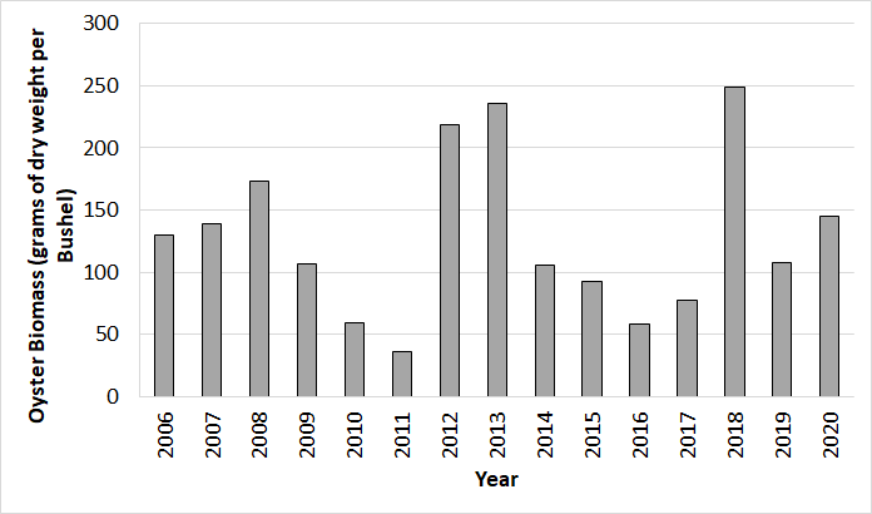


Figure B.02-4. Oyster biomass (grams of dry weight per bushel of material) in NOAA Code 025 (Chesapeake Bay Upper) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey on Swan Point bar.

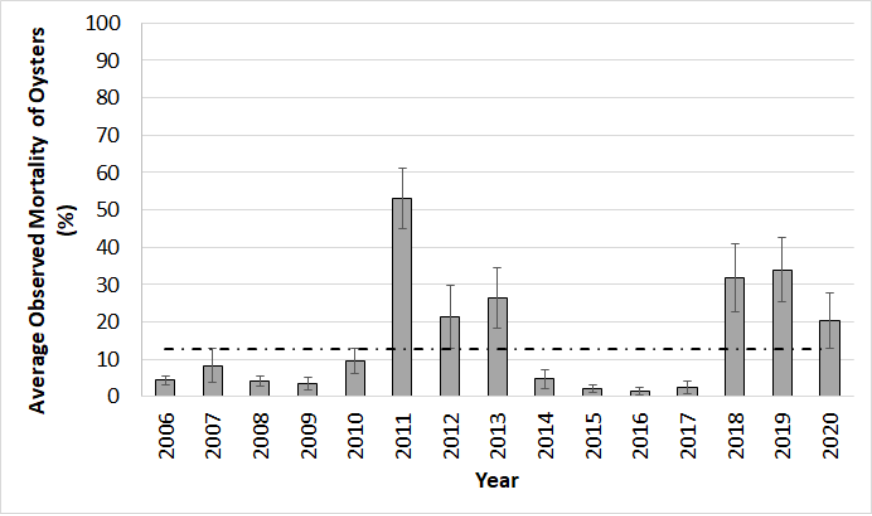


Figure B.02-5. Average annual observed mortality of market-sized and small-sized oysters in NOAA Code 025 (Chesapeake Bay Upper) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey. The dashed line represents the 2006-2020 baywide average observed mortality. Error bars represent ± 1 standard error.

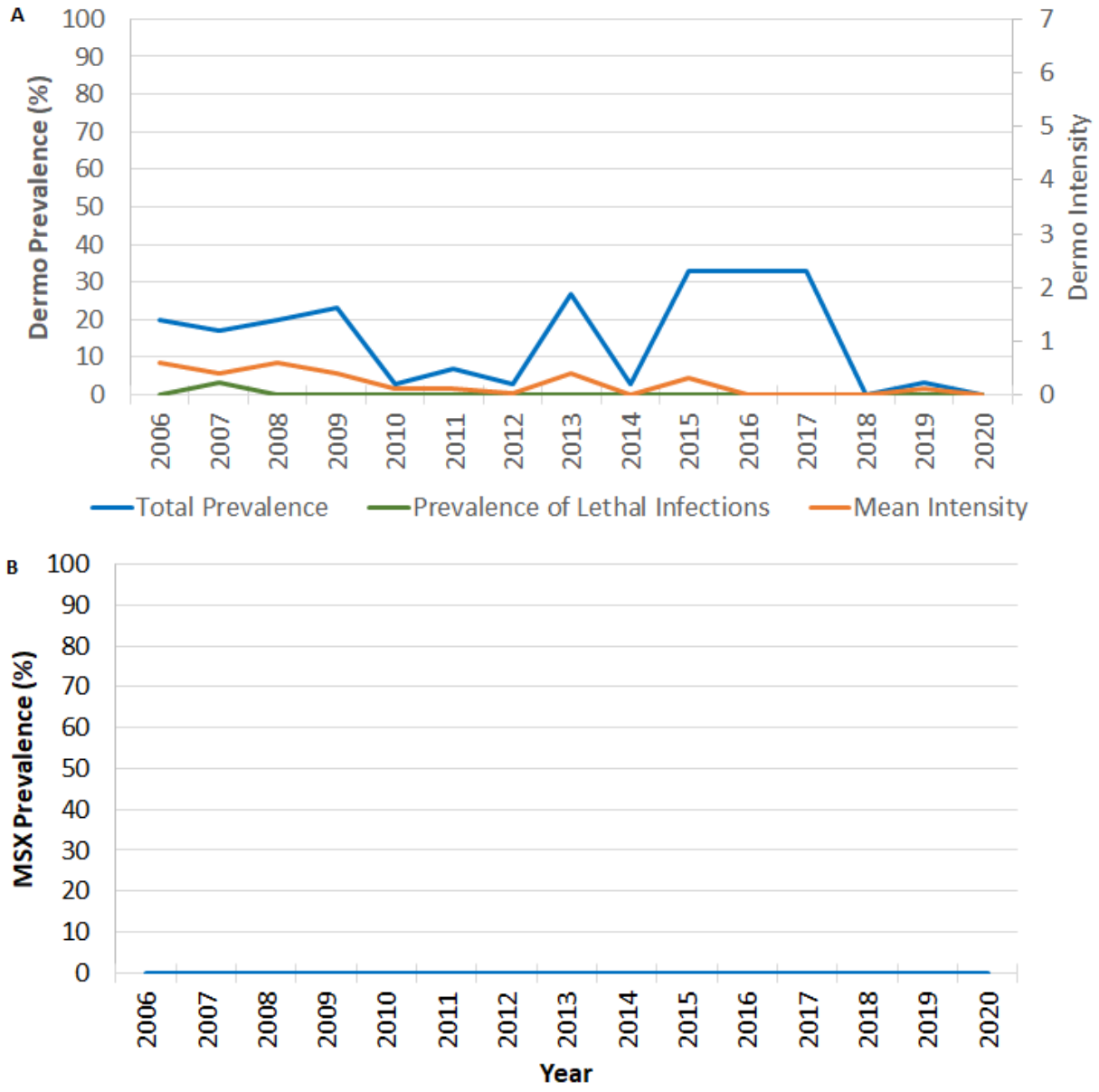


Figure B.02-6. Oyster disease prevalence and intensity in NOAA Code 025 (Chesapeake Bay Upper) occurring outside of the current sanctuary area. (A) Dermo prevalence and mean intensity (B) MSX prevalence (intensity is not examined). Data from Maryland's Annual Fall Oyster Dredge Survey on Swan Point bar.

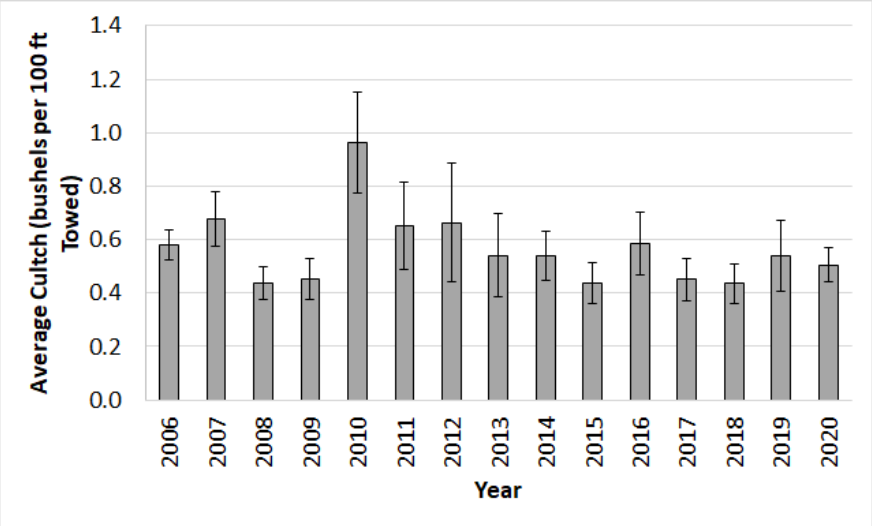


Figure B.02-7. Average cultch (live and dead oysters and loose shell) in NOAA Code 025 (Chesapeake Bay Upper) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey. Error bars represent ± 1 standard error.

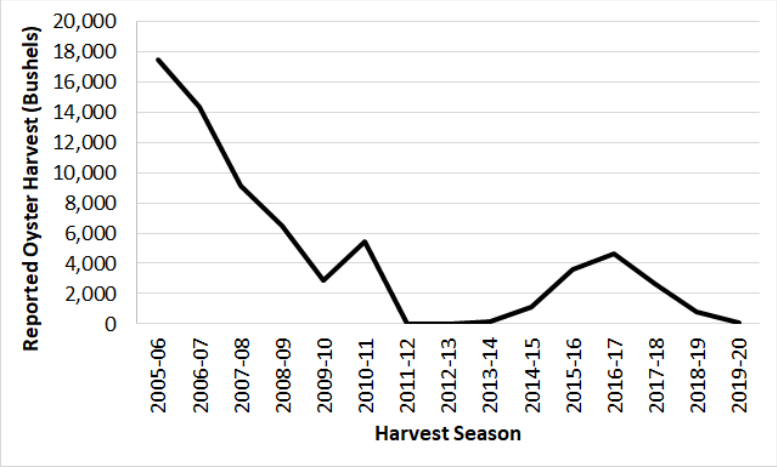


Figure B.02-8. Oyster harvest reported from seafood dealer buy tickets (harvest seasons 2005-2006 to 2019-2020) in NOAA Code 025 (Chesapeake Bay Upper). Since 2010, 10% of the NOAA Code area has been a sanctuary where harvest is prohibited.

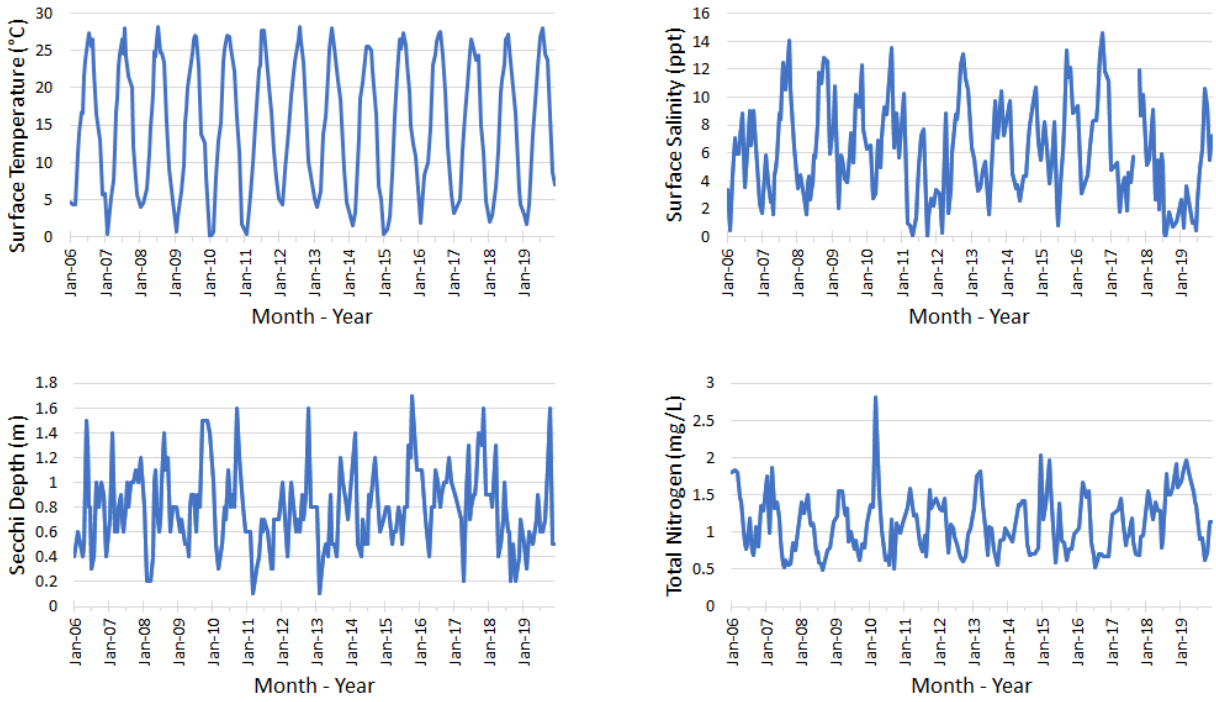


Figure B.02-9. Water quality data collected at Station CB3.2 in NOAA Code 025 (Chesapeake Bay Upper). Data from Chesapeake Bay Program Data Hub.

## Section B.03: NOAA Code 027 – Chesapeake Bay Lower Middle

NOAA Code 027 is located in Maryland's middle portion of Chesapeake Bay, north of Cove Point. The entire NOAA Code is 185,403 acres and has 50 historic oyster bars[15]. Multiple sanctuaries encompass 12% (22,836 total acres) of the NOAA Code (Plum Point, Poplar Island, Tilghman Island, Calvert Shore, and Herring Bay). This section focuses on information collected within the NOAA Code occurring outside of the sanctuary areas. This equates to 162,567 surface acres. There are 21,939 acres of historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments) located within the NOAA Code and outside the sanctuaries. As of 2020, there are 8,421 acres within the NOAA Code designated as a Public Shellfish Fishery Area (PSFA). Aquaculture leasing is prohibited in PSFA boundaries. This NOAA Code is located within Maryland's medium-salinity region (Zone 2).

Information available for this NOAA Code includes:

- NOAA Code map (Figure B.03-1)
- Summary statistics (Table B.03-1)
- Abundance per year (Figure B.03-2)
- Shell height frequencies (Figure B.03-3)
- Biomass per year (Figure B.03-4)
- Observed mortality (Figure B.03-5)
- Dermo and MSX per year (Figure B.03-6)
- Cultch per year (Figure B.03-7)
- Harvest (Figure B.03-8)
- Water Quality (Figure B.03-9)

Fall Survey results indicated that spat density increased in 2020 due to hatchery spat-on-shell plantings. Without the planting, average spat density would be lower in 2016-2020 as compared to the other time periods. Average small and market densities decreased in 2016-2020 as compared to 2010-2015. Mortality was either at or below the long term baywide average throughout the entire time series. There was a decreasing trend in cultch over the time series. While the average size of oysters was similar throughout the time series, the percentage of oysters over 100 mm rose to 14% in 2016-2020, compared to 6% in 2011-2015 and 2% in 2006-2010.

Between 2006 and 2020, approximately 22 thousand bushels of shell, 19 thousand bushels of wild seed and 27 million hatchery spat-on-shell were planted to enhance the commercial public fishery in this NOAA Code outside of the current sanctuary area.

Harvest for the NOAA Code has been reported on seafood dealer buy tickets for all years of the 15-year time series. This includes past harvest data from areas in the NOAA Code that are currently in a sanctuary area, but weren't when the harvest occurred prior to the sanctuaries being established. Since 2010, 12% of the NOAA Code area has been a sanctuary where harvest is prohibited. Harvest reported ranged from approximately 400 bushels in the 2011-12 season to

[15] See chart 13, 14, 17, 23, and 24 for bar names and locations in the State of Maryland Shellfish Closure Areas Book http://dnr.maryland.gov/fisheries/Pages/oysters/index.aspx

a maximum of approximately 13 thousand bushels in the 2015-16 season. Patent tongs were used to obtain about 60% of the harvest and the remaining harvest was mostly obtained by power dredging.

Continuous water quality monitoring has occurred at station CB4.3C (38.05505; -76.4279). During the 2006-2020 timeline, surface salinity ranged from 3.2 ppt to 18.2 ppt, with the lowest salinity being during the freshet of 2018-2019 and during the high rainfall year of 2011.

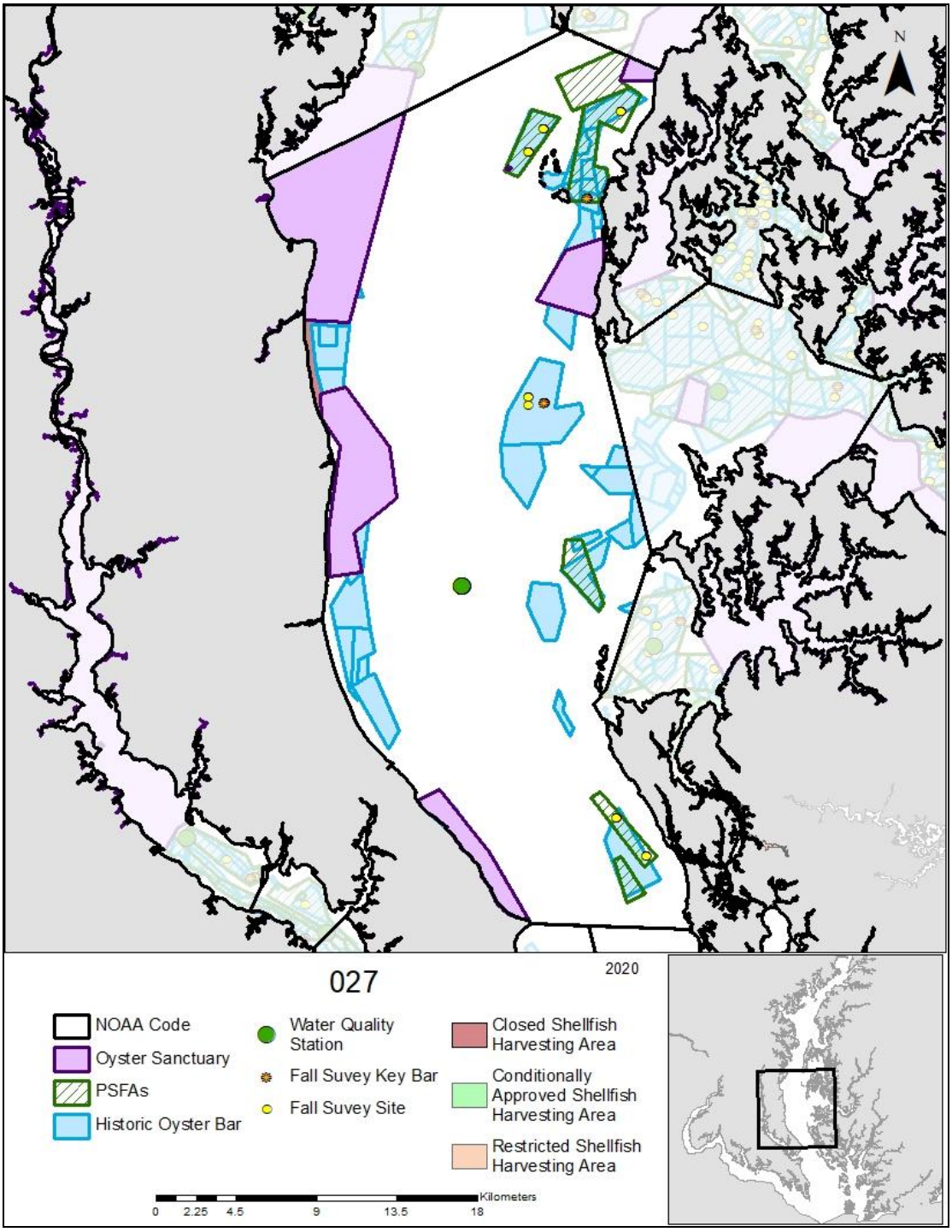


Figure B.03-1. Map of NOAA Code 027 (Chesapeake Bay Lower Middle). Fall Survey sites may not be sampled every year. Fall Survey key bars may consist of a key bar, disease bar or both.

Table B.03-1. Oyster population characteristics based on the Fall Survey in the NOAA Code 027 (Chesapeake Bay Lower Middle) occurring outside of the current sanctuary area. ND = No Data. Values are given as an annual mean ± standard error.

| | 2006-10 | 2011-15 | 2016-20 |
|---|---|---|---|
| Number of Years Sampled / Number of Samples | 5 / 37 | 5 / 30 | 5 / 29 |
| Number of Live Spat Oysters per square meter | 3.4 ± 1.4 | 1.2 ± 0.7 | 8.6 ± 5.9 |
| Number of Live Small-Sized Oysters per square meter | 7 ± 1.5 | 6.6 ± 2.4 | 3 ± 0.5 |
| Number of Live Market-Sized Oysters per square meter | 3.8 ± 1 | 7.3 ± 0.9 | 3.7 ± 0.4 |
| Live Oyster Biomass (g Dry Weight per Bushel) | 76 ± 14 | 208 ± 40 | 187 ± 28 |
| Observed Mortality (%) | 12 ± 2 | 6 ± 2 | 12 ± 2 |
| Cultch (Bushels per 100 ft Towed) | 0.23 ± 0.03 | 0.16 ± 0.03 | 0.13 ± 0.03 |
| Harvest (Bushels) | 5,800 ± 2,071 | 3,747 ± 1,360 | 5,454 ± 2,033 |
| Note: The number of samples is based on the number of samples having a value for observed mortality. There may be fewer samples per year for density, biomass, and cultch. | | | |

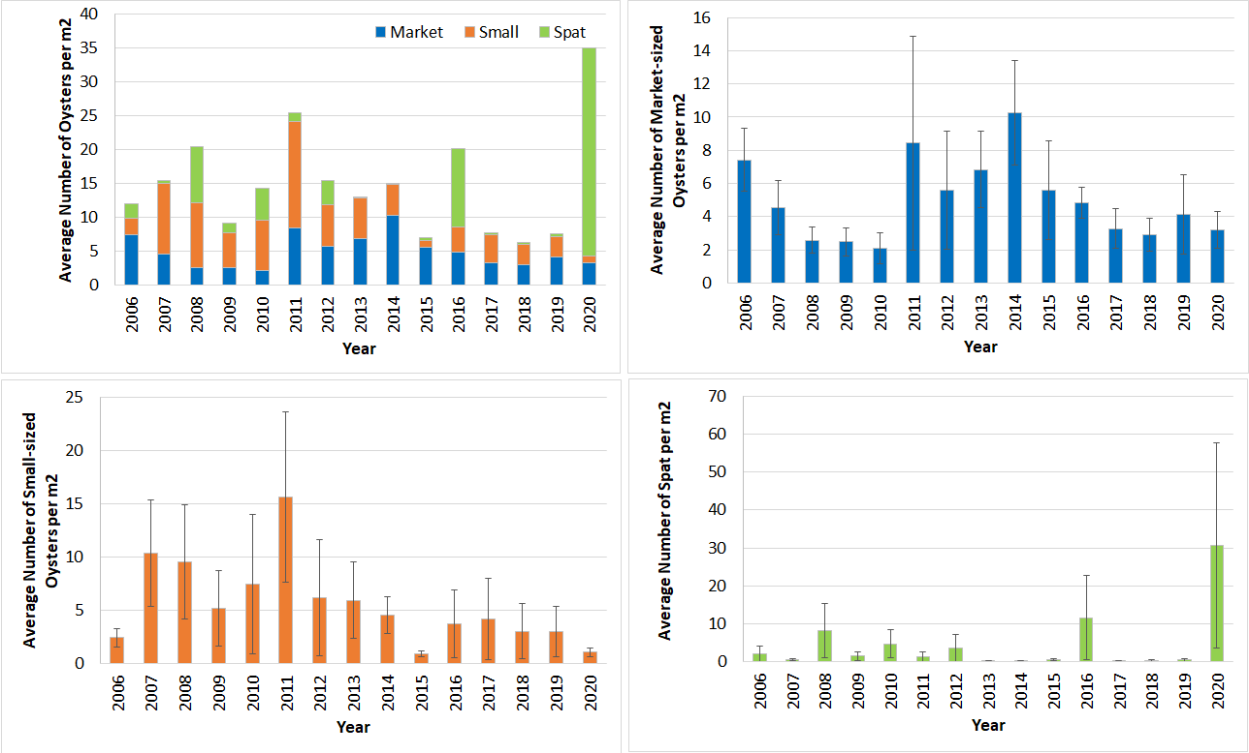


Figure B.03-2. Average number of live oysters per square meter by size class in NOAA Code 027 (Chesapeake Bay Lower Middle) occurring outside of the current sanctuary area. Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales.

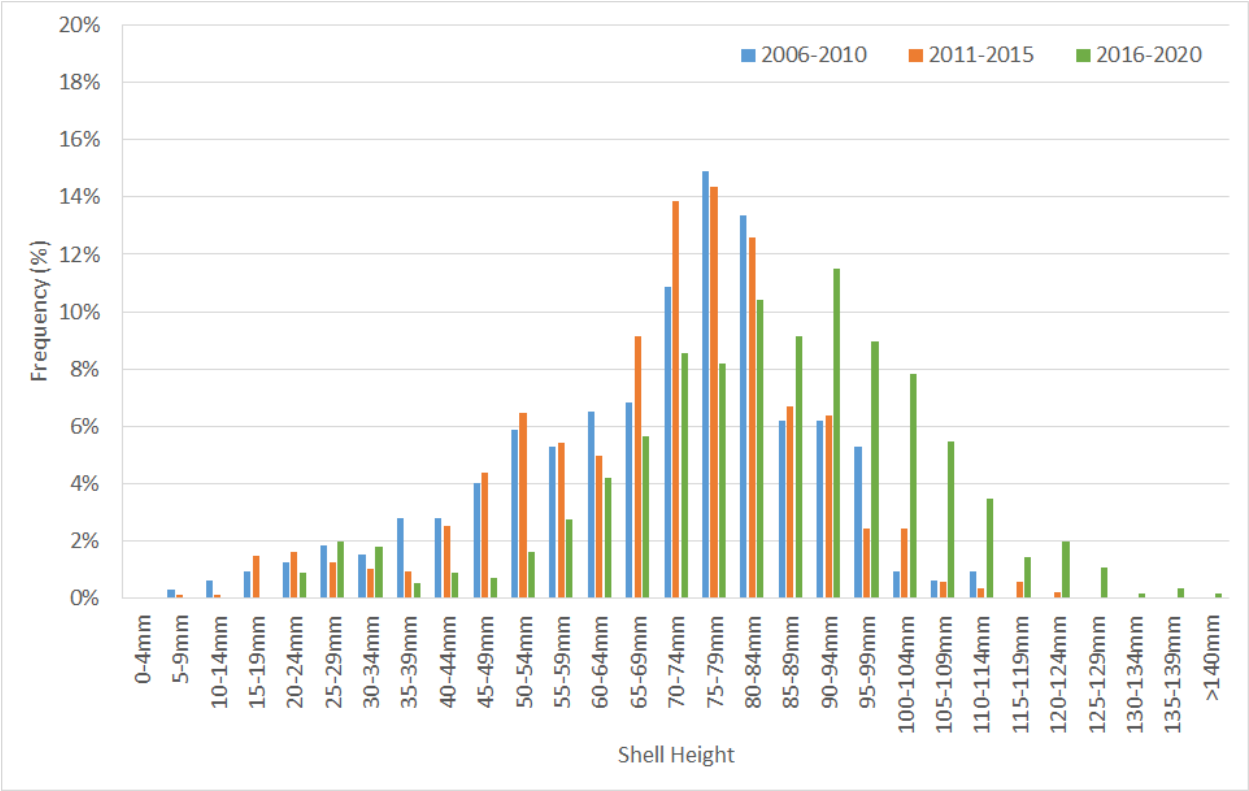


Figure B.03-3. Shell height frequencies of live oysters per bushel of material in NOAA Code 027 (Chesapeake Bay Lower Middle) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey on Stone bar.

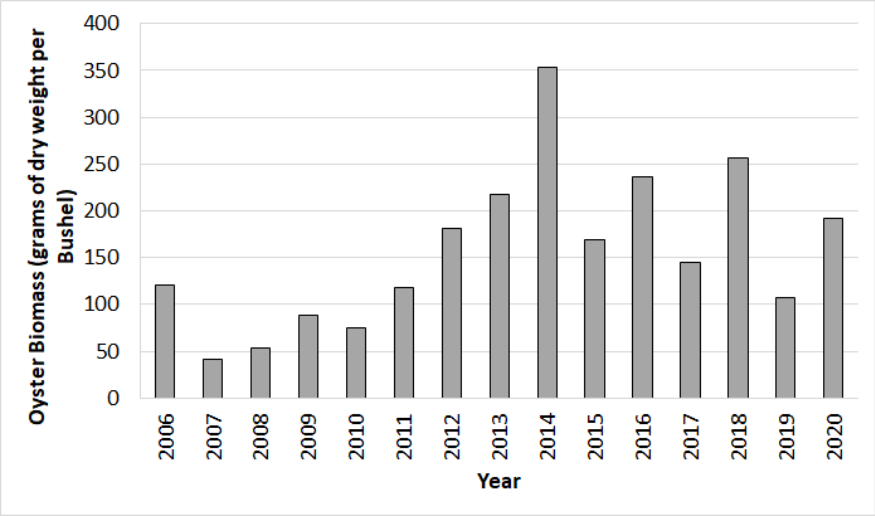


Figure B.03-4. Oyster biomass (grams of dry weight per bushel of material) in NOAA Code 027 (Chesapeake Bay Lower Middle) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey on Stone bar.

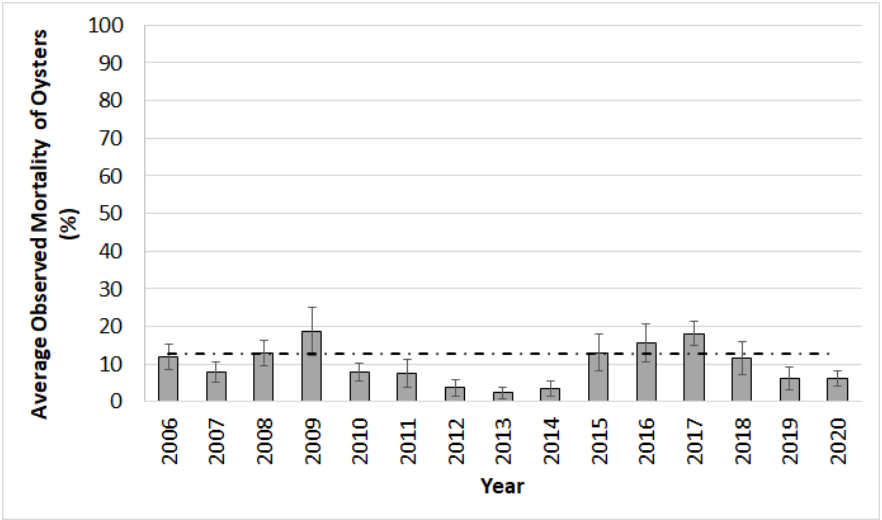


Figure B.03-5. Average annual observed mortality of market-sized and small-sized oysters in NOAA Code 027 (Chesapeake Bay Lower Middle) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey. The dashed line represents the 2006-2020 baywide average observed mortality. Error bars represent ± 1 standard error.

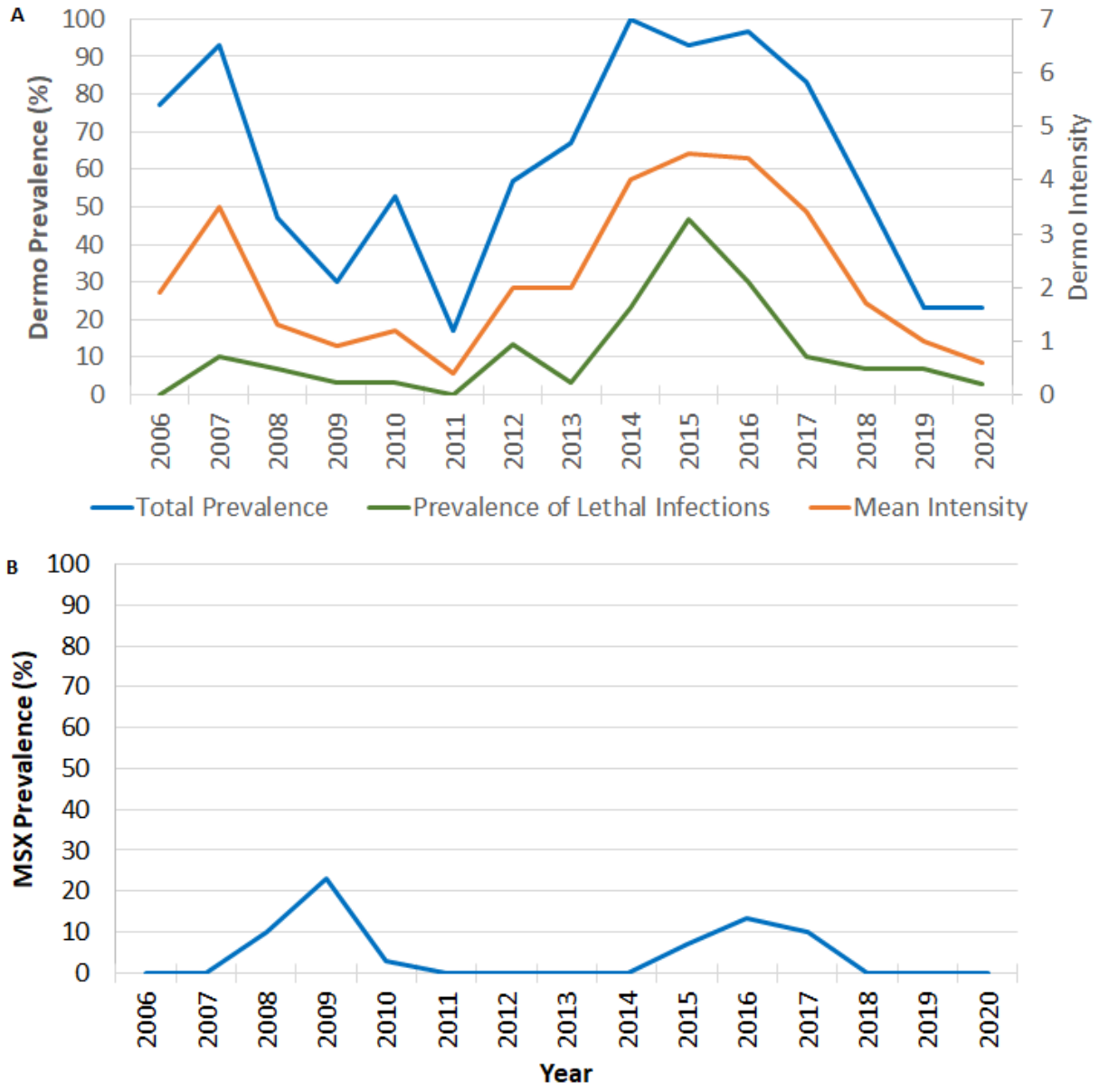


Figure B.03-6. Oyster disease prevalence and intensity in NOAA Code 027 (Chesapeake Bay Lower Middle) occurring outside of the current sanctuary area. (A) Dermo prevalence and mean intensity (B) MSX prevalence (intensity is not examined). Data from Maryland's Annual Fall Oyster Dredge Survey on Stone bar.

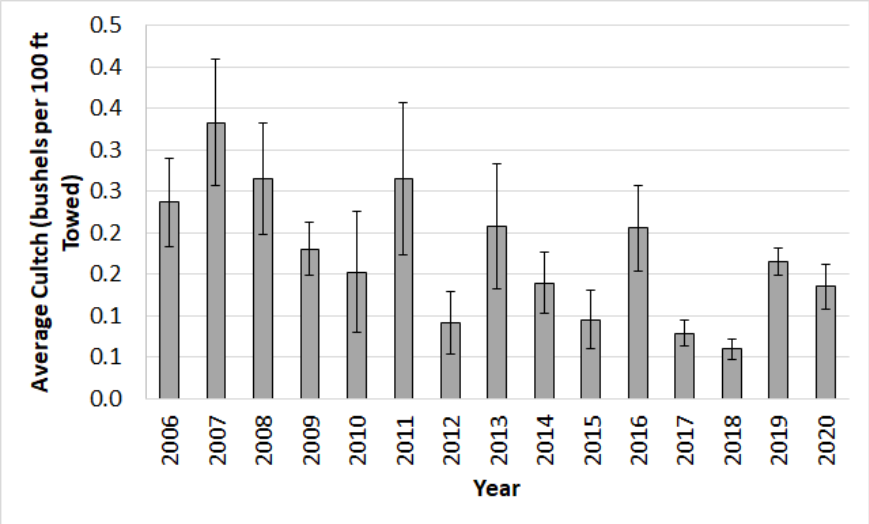


Figure B.03-7. Average cultch (live and dead oysters and loose shell) in NOAA Code 027 (Chesapeake Bay Lower Middle) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey. Error bars represent ± 1 standard error.

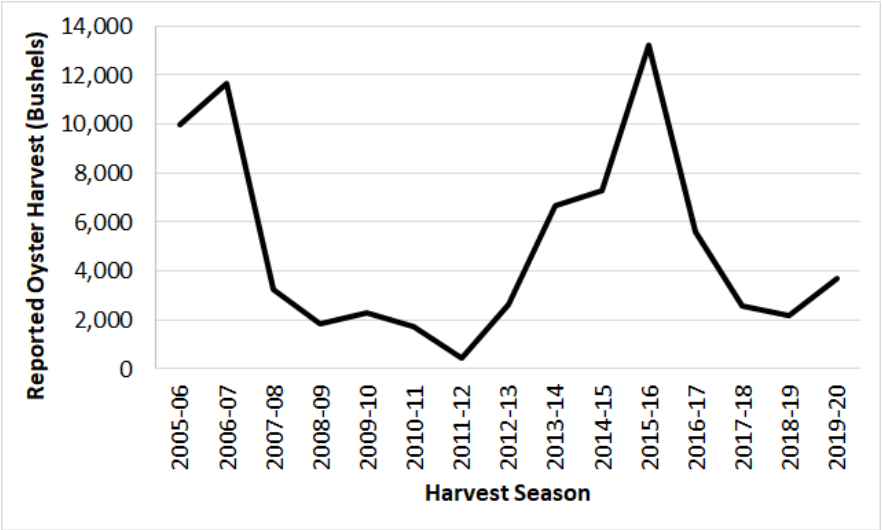


Figure B.03-8. Oyster harvest reported from seafood dealer buy tickets (harvest seasons 2005-2006 to 2019-2020) in NOAA Code 027 (Chesapeake Bay Lower Middle). Since 2010, 12% of the NOAA Code area has been a sanctuary where harvest is prohibited.

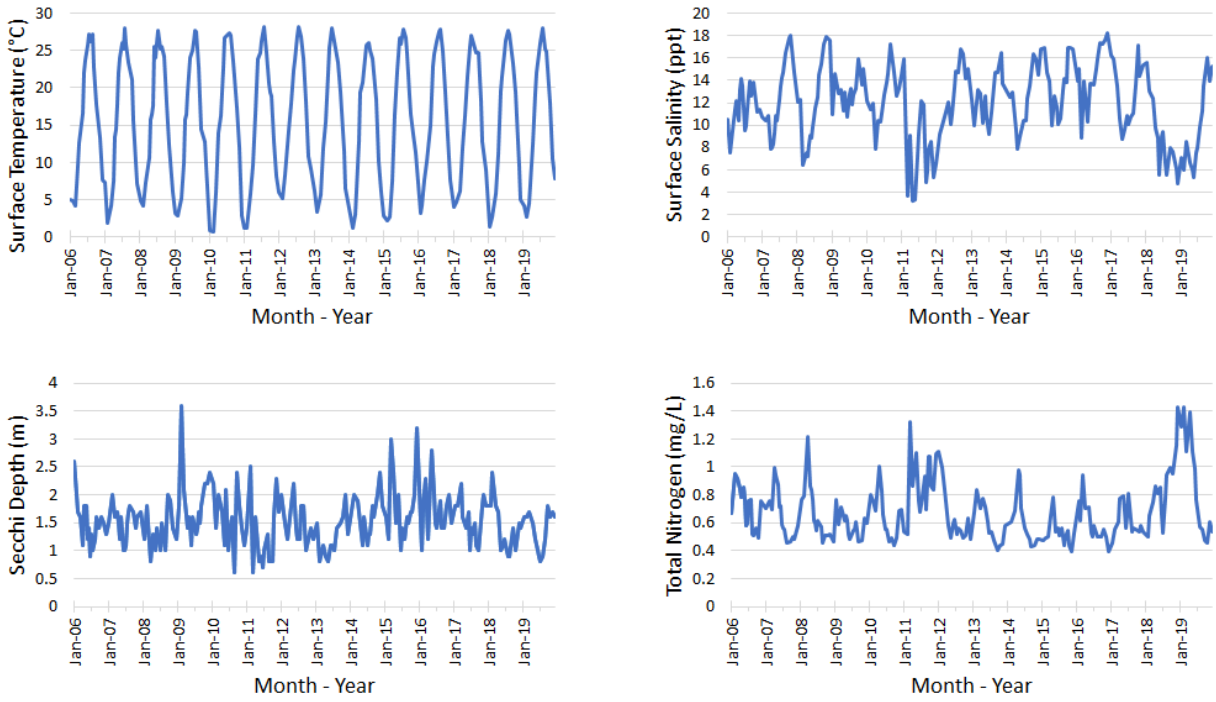


Figure B.03-9. Water quality data collected at Station CB4.3C in NOAA Code 027 (Chesapeake Bay Lower Middle). Data from Chesapeake Bay Program Data Hub.

## Section B.04: NOAA Code 039 – Eastern Bay

NOAA Code 039 encompasses Eastern Bay and is located in Maryland's middle eastern portion of Chesapeake Bay. The entire NOAA Code is 33,019 acres and has 66 historic oyster bars[16]. Five sanctuaries (Cox Creek, Eastern Bay, Prospect Bay, Mill Hill, and Cabin Creek) encompass 25% (8,253 acres) of the NOAA Code. This section focuses on information collected within the NOAA Code occurring outside of the current sanctuary areas. This equates to 24,766 surface acres. There are 12,269 acres of historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments) located within the NOAA Code and not within a sanctuary. As of 2020, there are 17,187 acres within the NOAA Code designated as a Public Shellfish Fishery Area (PSFA). Aquaculture leasing is prohibited in PSFA boundaries. This NOAA Code is located within Maryland's medium-salinity region (Zone 2).

Information available for this NOAA Code includes:

- NOAA Code map (Figure B.04-1)
- Summary statistics (Table B.04-1)
- Abundance per year (Figure B.04-2)
- Shell height frequencies (Figure B.04-3)
- Biomass per year (Figure B.04-4)
- Observed mortality (Figure B.04-5)
- Dermo and MSX per year (Figure B.04-6)
- Cultch per year (Figure B.04-7)
- Harvest (Figure B.04-8)
- Water Quality (Figure B.04-9)

Fall Survey results indicate no change in average small and market densities in 2016-2020 as compared to 2011-2015 but higher than 2006-2010. Average spat density was high in 2020 which corresponds to hatchery spat-on-shell plantings. Mortality was higher in 2006 through 2009 but has been at or below the long term baywide average since then. Cultch has decreased in the 2016-2020 time period. Size distribution of measured oysters was very similar for all three time periods.

Between 2006 and 2020, approximately 29 thousand bushels of shell, 40 thousand bushels of wild seed and 63 million hatchery spat-on-shell were planted to enhance the commercial public fishery in this NOAA Code outside of the current sanctuary area.

Harvest for the NOAA Code has been reported on seafood dealer buy tickets for all years of the 15-year time series. This includes past harvest data from areas in the NOAA Code that are currently in a sanctuary area, but weren't when the harvest occurred prior to the sanctuaries being established. Since 2010, 25% of the NOAA Code area has been a sanctuary where harvest is prohibited. Harvest reported ranged from approximately 150 bushels in the 2011-12 season to

[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

a maximum of approximately 48 thousand bushels in the 2005-06 season. Diving was used to obtain the majority of the harvest.

Continuous water quality monitoring has occurred at station EE1.1 (38.88; -76.2515). During the 2006-2020 timeline, surface salinity ranged from 4.7 ppt to 17.6 ppt, with the lowest salinity being during the freshet of 2018-2019 and during the high rainfall year of 2011.

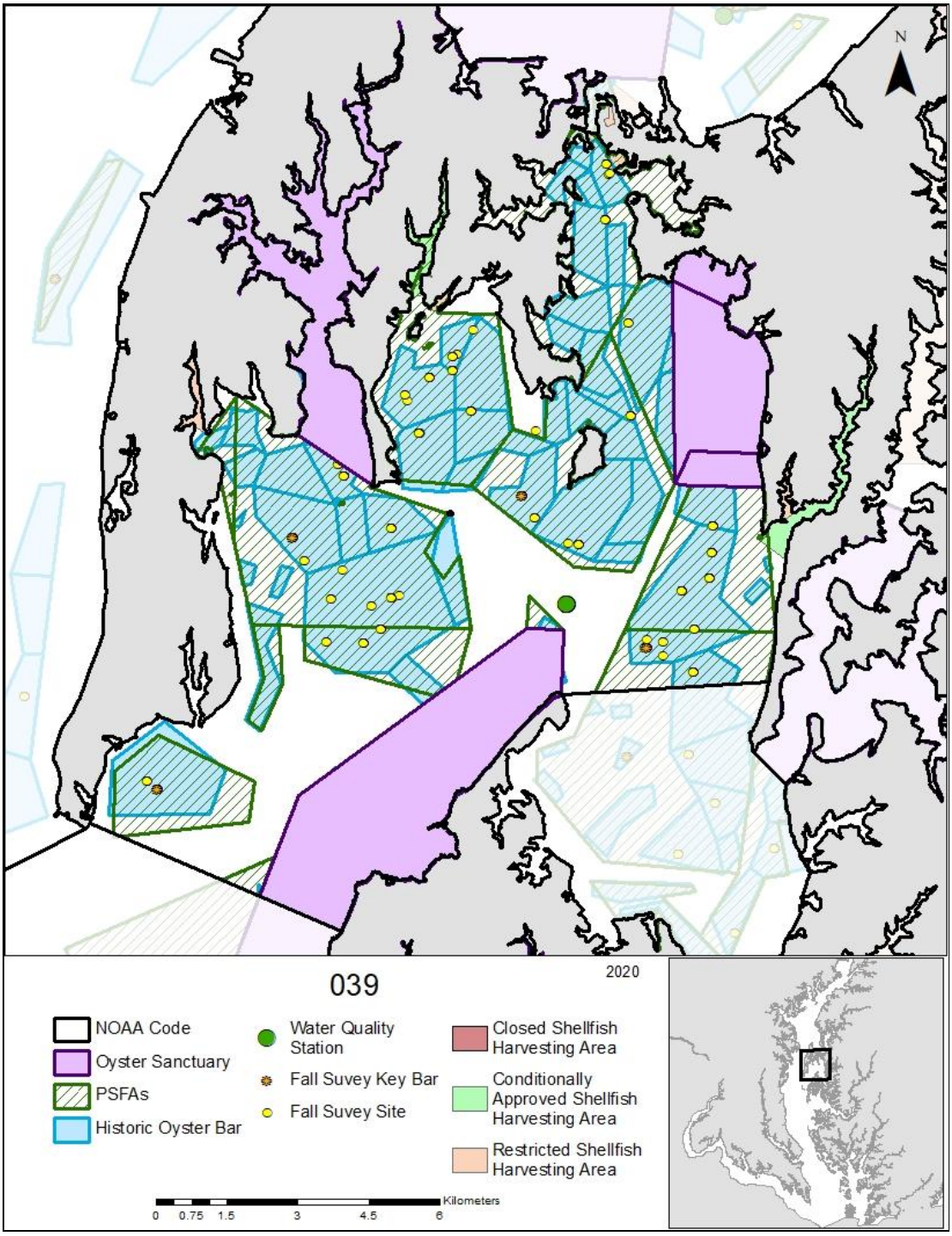


Figure B.04-1. Map of NOAA Code 039 (Eastern Bay). Fall Survey sites may not be sampled every year. Fall Survey key bars may consist of a key bar, disease bar or both.

Table B.04-1. Oyster population characteristics based on the Fall Survey in the NOAA Code 039 (Eastern Bay) occurring outside of the current sanctuary area. ND = No Data. Values are given as an annual mean ± standard error.

| | 2006-10 | 2011-15 | 2016-20 |
|---|---|---|---|
| Number of Years Sampled / Number of Samples | 5 / 135 | 5 / 113 | 5 / 116 |
| Number of Live Spat Oysters per square meter | 1.8 ± 1.1 | 1.8 ± 1 | 2.3 ± 1.9 |
| Number of Live Small-Sized Oysters per square meter | 4.5 ± 1.2 | 8.3 ± 2.3 | 6.9 ± 2 |
| Number of Live Market-Sized Oysters per square meter | 7.8 ± 2.5 | 11.3 ± 3.2 | 9.1 ± 0.6 |
| Live Oyster Biomass (g Dry Weight per Bushel) | 61 ± 14 | 108 ± 17 | 116 ± 5 |
| Observed Mortality (%) | 28 ± 5 | 7 ± 2 | 12 ± 2 |
| Cultch (Bushels per 100 ft Towed) | 0.61 ± 0.05 | 0.56 ± 0.09 | 0.32 ± 0.03 |
| Harvest (Bushels) | 20,628 ± 9,339 | 6,497 ± 2,989 | 11,383 ± 1,312 |
| Note: The number of samples is based on the number of samples having a value for observed mortality. There may be fewer samples per year for density, biomass, and cultch. | | | |

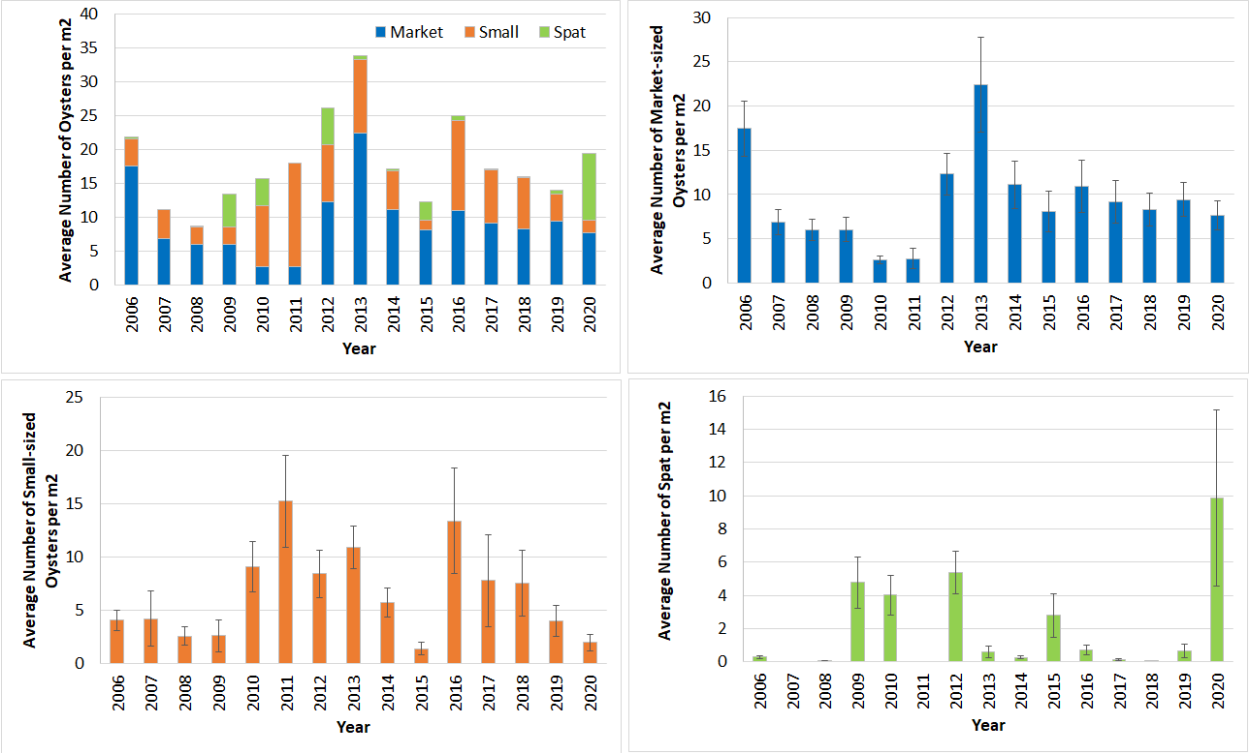


Figure B.04-2. Average number of live oysters per square meter by size class in NOAA Code 039 (Eastern Bay) occurring outside of the current sanctuary area. Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales.

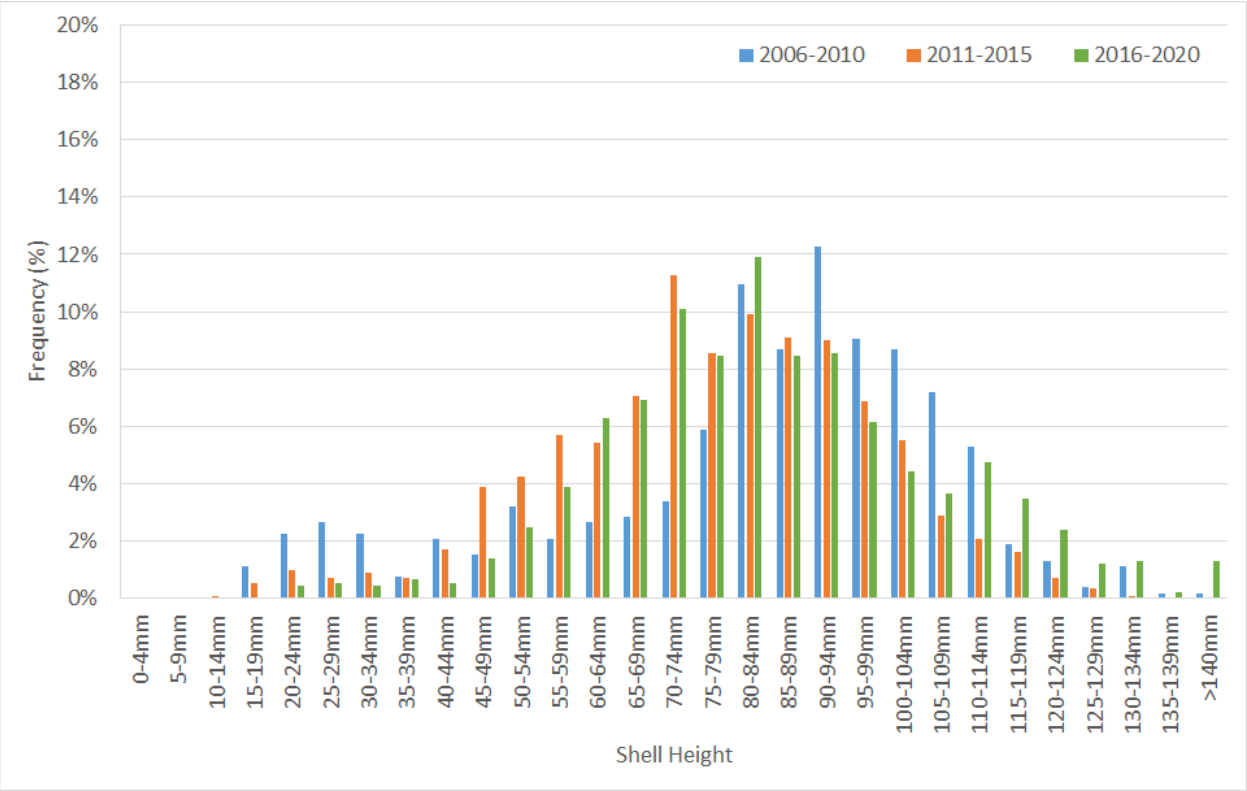


Figure B.04-3. Average shell height frequencies of live oysters per bushel of material in NOAA Code 039 (Eastern Bay) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey on Bugby, Parson Island, and Hollicut Noose bars.

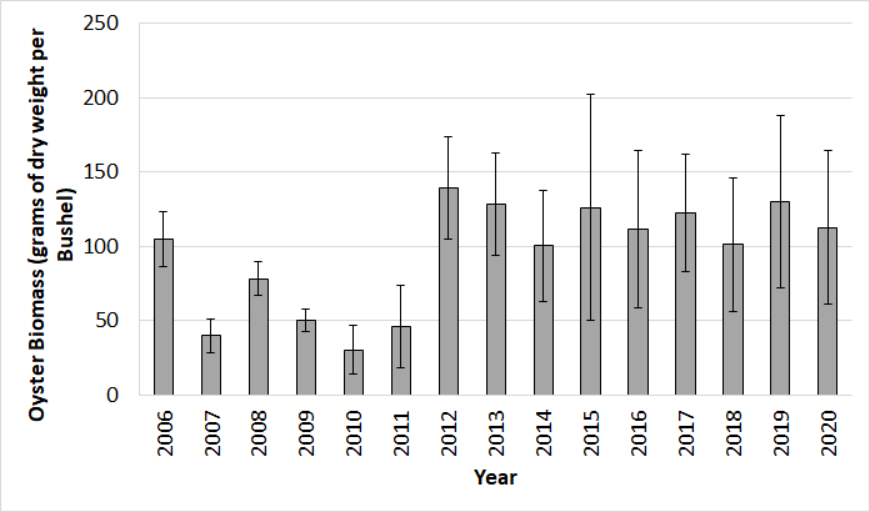


Figure B.04-4. Average oyster biomass (grams of dry weight per bushel of material) in NOAA Code 039 (Eastern Bay) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey on Bugby, Parson Island, and Hollicut Noose bars. Error bars represent ± 1 standard error.

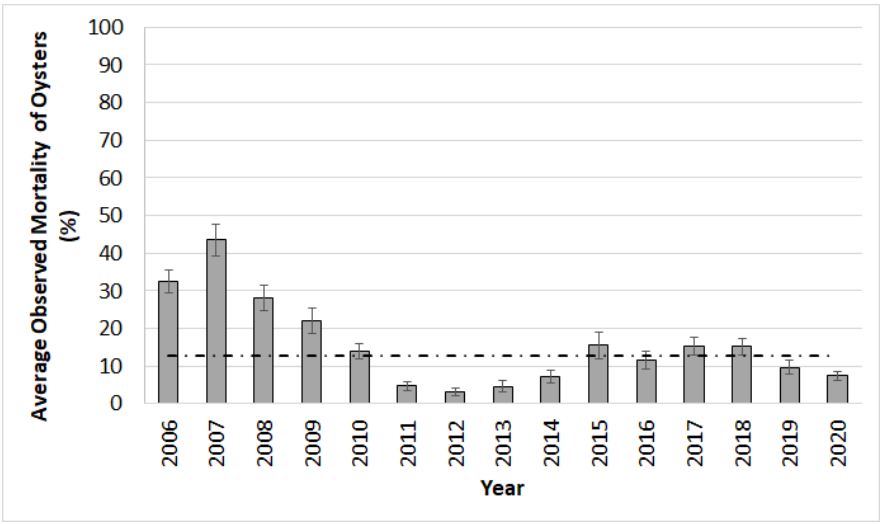


Figure B.04-5. Average annual observed mortality of market-sized and small-sized oysters in NOAA Code 039 (Eastern Bay) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey. The dashed line represents the 2006-2020 baywide average observed mortality. Error bars represent ± 1 standard error.

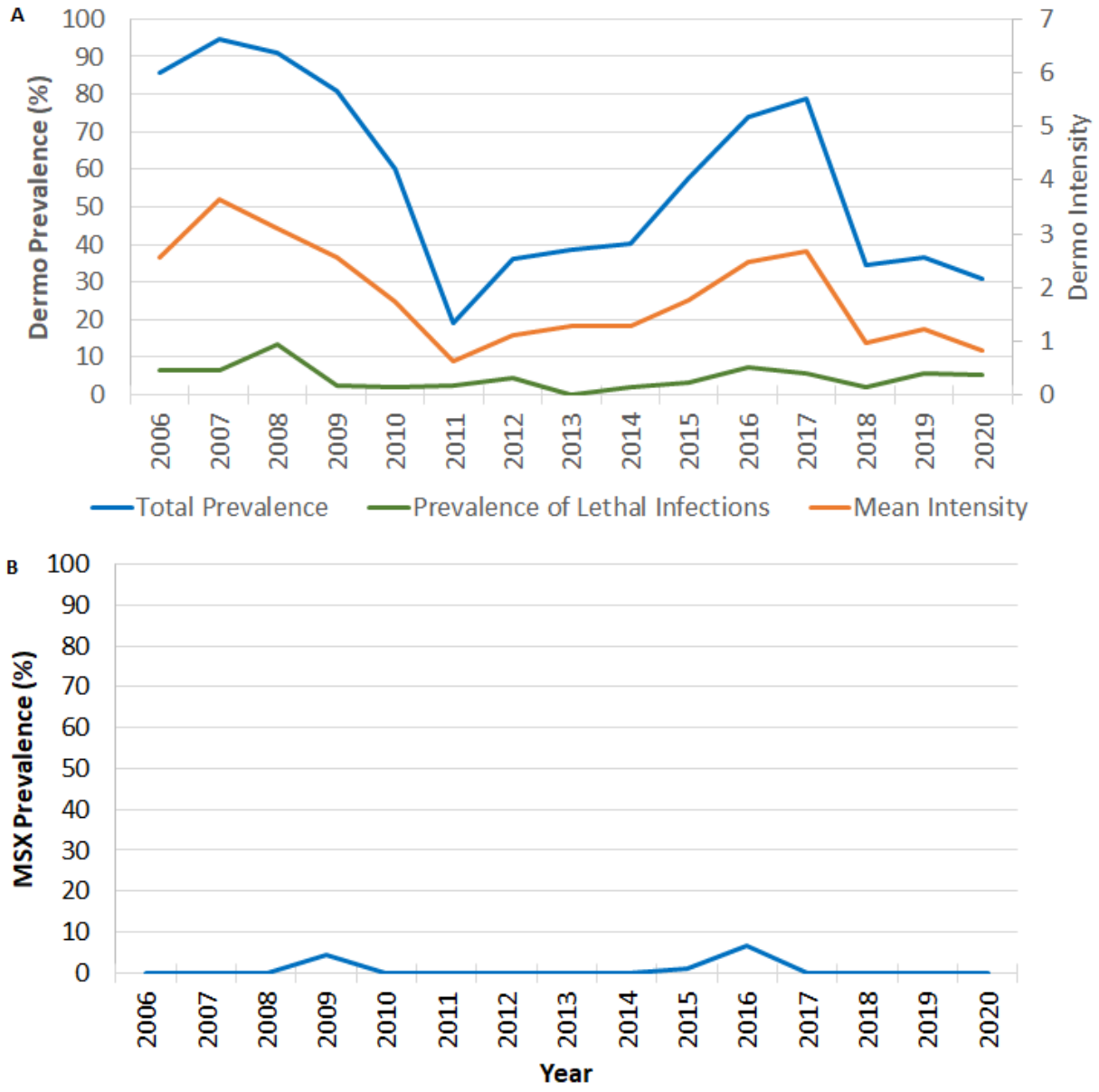


Figure B.04-6. Average oyster disease prevalence and intensity in NOAA Code 039 (Eastern Bay) occurring outside of the current sanctuary area. (A) Dermo prevalence and mean intensity (B) MSX prevalence (intensity is not examined). Data from Maryland's Annual Fall Oyster Dredge Survey on Bugby, Parson Island, and Hollicut Noose bars.

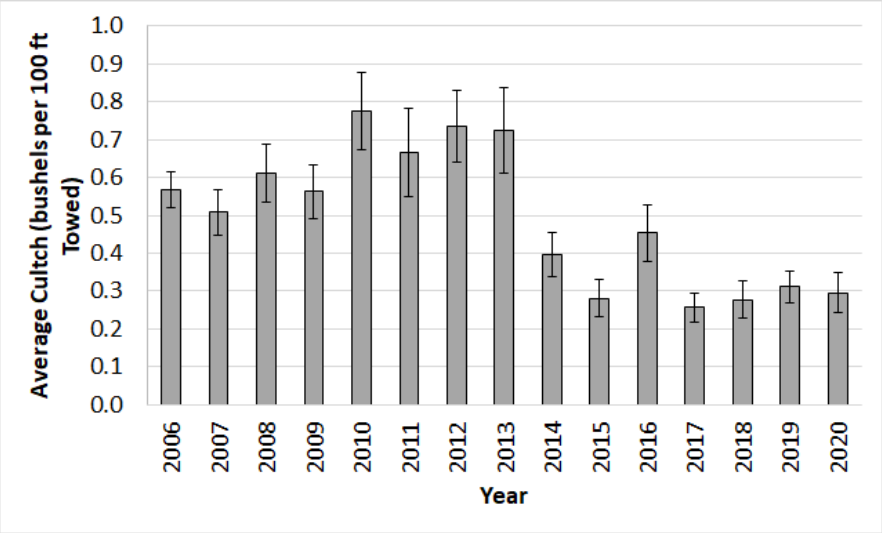


Figure B.04-7. Average cultch (live and dead oysters and loose shell) in NOAA Code 039 (Eastern Bay) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey. Error bars represent ± 1 standard error.

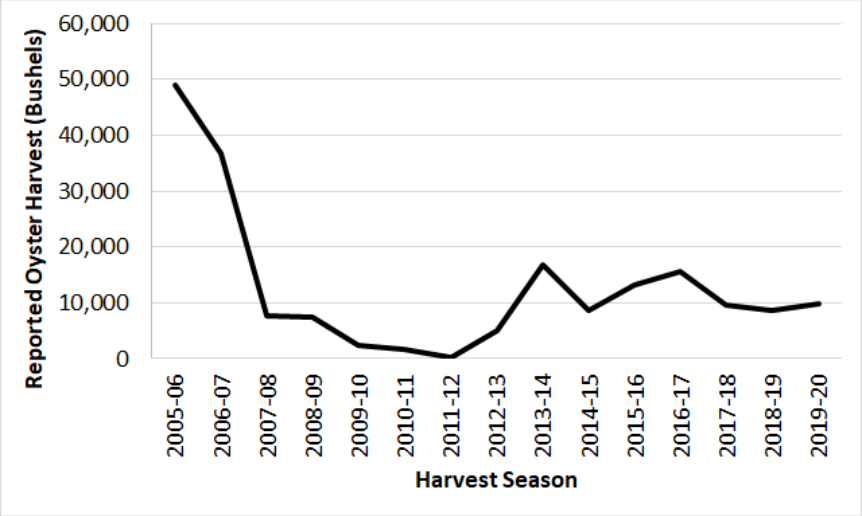


Figure B.04-8. Oyster harvest reported from seafood dealer buy tickets (harvest seasons 2005-2006 to 2019-2020) in NOAA Code 039 (Eastern Bay). Since 2010, 25% of the NOAA Code area is a sanctuary where harvest is prohibited.

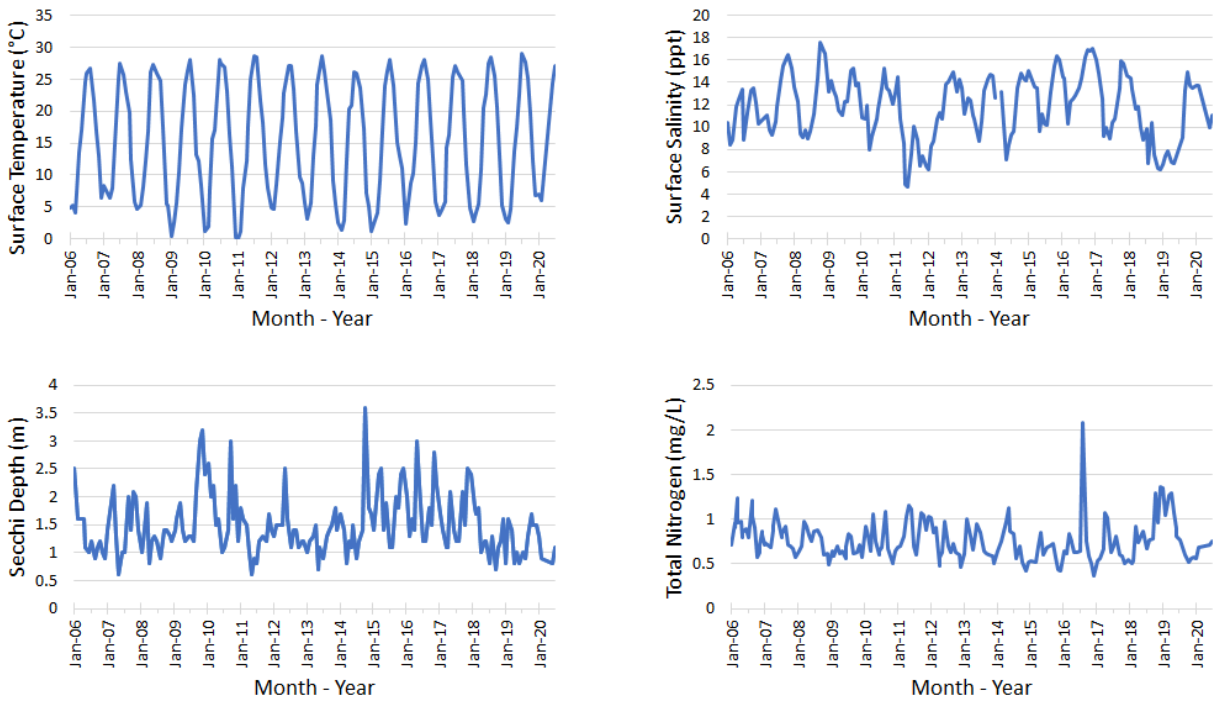


Figure B.04-9. Water quality data collected at Station EE1.1 in NOAA Code 039 (Eastern Bay). Data from Chesapeake Bay Program Data Hub.

## Section B.05: NOAA Code 043 – Fishing Bay

NOAA Code 043 encompasses Fishing Bay and is located in Maryland's lower eastern portion of Chesapeake Bay. The entire NOAA Code is 20,119 acres and 28 historic oyster bars[17]. None of the area within the NOAA Code is within an oyster sanctuary. There are 11,820 acres of historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments) located within the NOAA Code. As of 2020, there are 4,587 acres within the NOAA Code that were designated as a Public Shellfish Fishery Area (PSFA). Aquaculture leasing is prohibited in PSFA boundaries. This NOAA Code is located within Maryland's medium-salinity region (Zone 2).

Information available for this NOAA Code includes:

- NOAA Code map (Figure B.05-1)
- Summary statistics (Table B.05-1)
- Abundance per year (Figure B.05-2)
- Shell height frequencies (Figure B.05-3)
- Biomass per year (Figure B.05-4)
- Observed mortality (Figure B.05-5)
- Dermo and MSX per year (Figure B.05-6)
- Cultch per year (Figure B.05-7)
- Harvest (Figure B.05-8)
- Water Quality (Figure B.05-9)

Fall Survey results indicated increasing densities until the early 2010s. Densities then declined before increasing again in 2018. This is mostly likely due to increased harvest during the 2012-13 through 2014-15 harvest season and slightly higher mortality in 2015 and 2016. Although average densities declined in the 2016-2020 time period as compared to 2011-2015, densities were higher than the 2006-2010 time period. Observed mortality for most years of the time series was below the long term baywide average.

Between 2006 and 2020, approximately 118 thousand bushels of shell, 1.6 thousand bushels of wild seed and 20 million hatchery spat-on-shell were planted to enhance the commercial public fishery in this NOAA Code outside of the current sanctuary area.

Harvest for the NOAA Code has been reported on seafood dealer buy tickets for 14 years out of the 15-year time series. Harvest reported ranged from less than 30 bushels in the 2005-06 season to a maximum of approximately 62 thousand bushels in the 2013-14 season. Power dredging was used to obtain the majority of the harvest.

Continuous water quality monitoring has occurred at station EE3.0 (38.28093; -76.0103). During the 2006-2020 timeline, surface salinity ranged from 4.5 ppt to 17.5 ppt, with the lowest salinity being during the freshet of 2018-2019

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

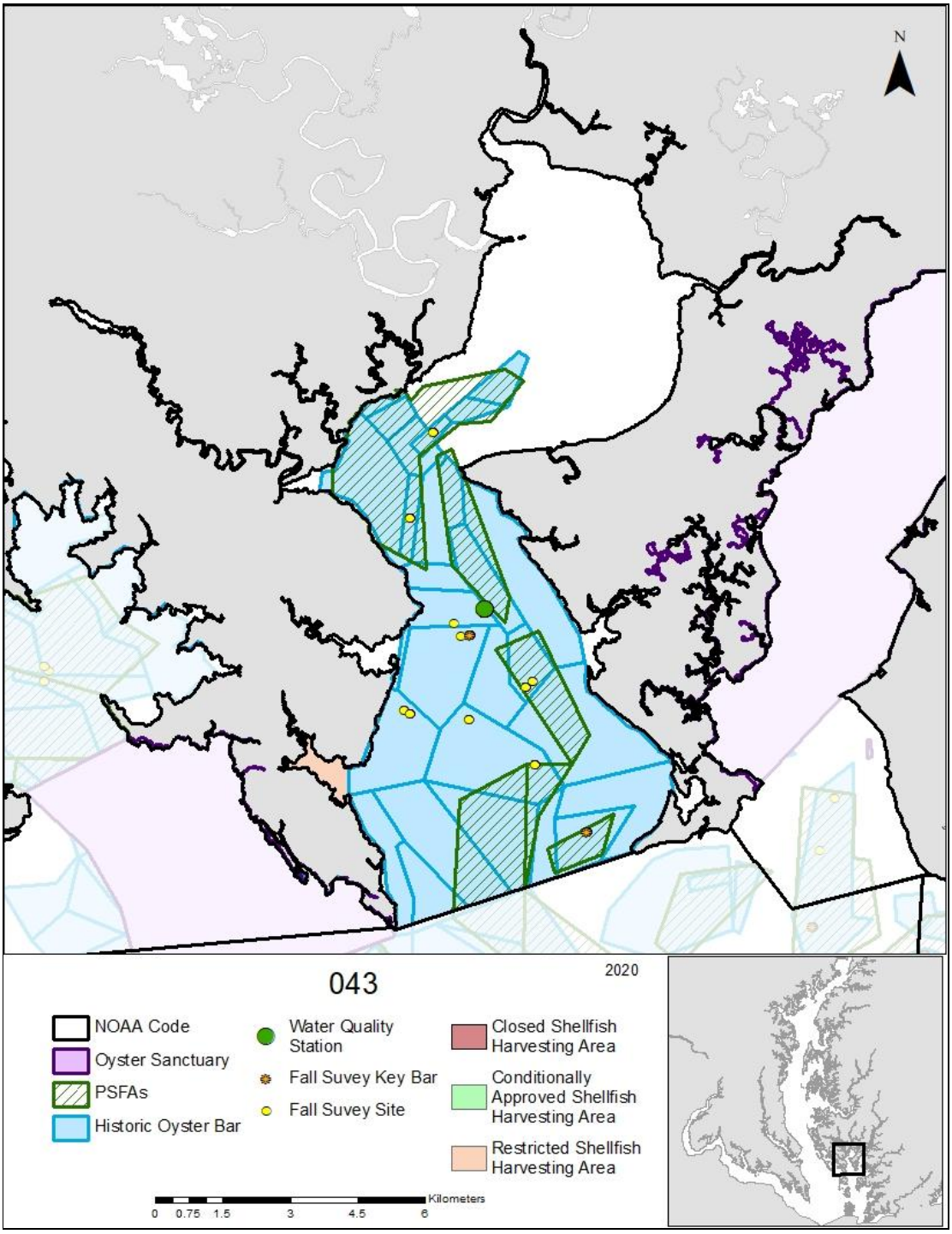


Figure B.05-1. Map of NOAA Code 043 (Fishing Bay). Fall Survey sites may not be sampled every year. Fall Survey key bars may consist of a key bar, disease bar or both.

| Table B.05-1. Oyster population characteristics based on the Fall Survey in the NOAA Code 043 (Fishing Bay). ND = No Data. Values are given as an annual mean ± standard error. | | | |
|---|---|---|---|
| | **2006-10** | **2011-15** | **2016-20** |
| Number of Years Sampled / Number of Samples | 5 / 35 | 5 / 37 | 5 / 40 |
| Number of Live Spat Oysters per square meter | 51.2 ± 25.3 | 78.6 ± 34.9 | 98.6 ± 53.9 |
| Number of Live Small-Sized Oysters per square meter | 24.6 ± 7.5 | 94.7 ± 22.7 | 81.5 ± 18.1 |
| Number of Live Market-Sized Oysters per square meter | 14.4 ± 6.2 | 43 ± 13.8 | 23.5 ± 10.3 |
| Live Oyster Biomass (g Dry Weight per Bushel) | 67 ± 18 | 177 ± 25 | 135 ± 39 |
| Observed Mortality (%) | 6 ± 2 | 13 ± 4 | 10 ± 4 |
| Cultch (Bushels per 100 ft Towed) | 1.3 ± 0.19 | 1.53 ± 0.29 | 1.22 ± 0.1 |
| Harvest (Bushels) | 2,965 ± 2,188 | 36,450 ± 9,552 | 14,046 ± 3,393 |
| Note: The number of samples is based on the number of samples having a value for observed mortality. There may be fewer samples per year for density, biomass, and cultch. | | | |

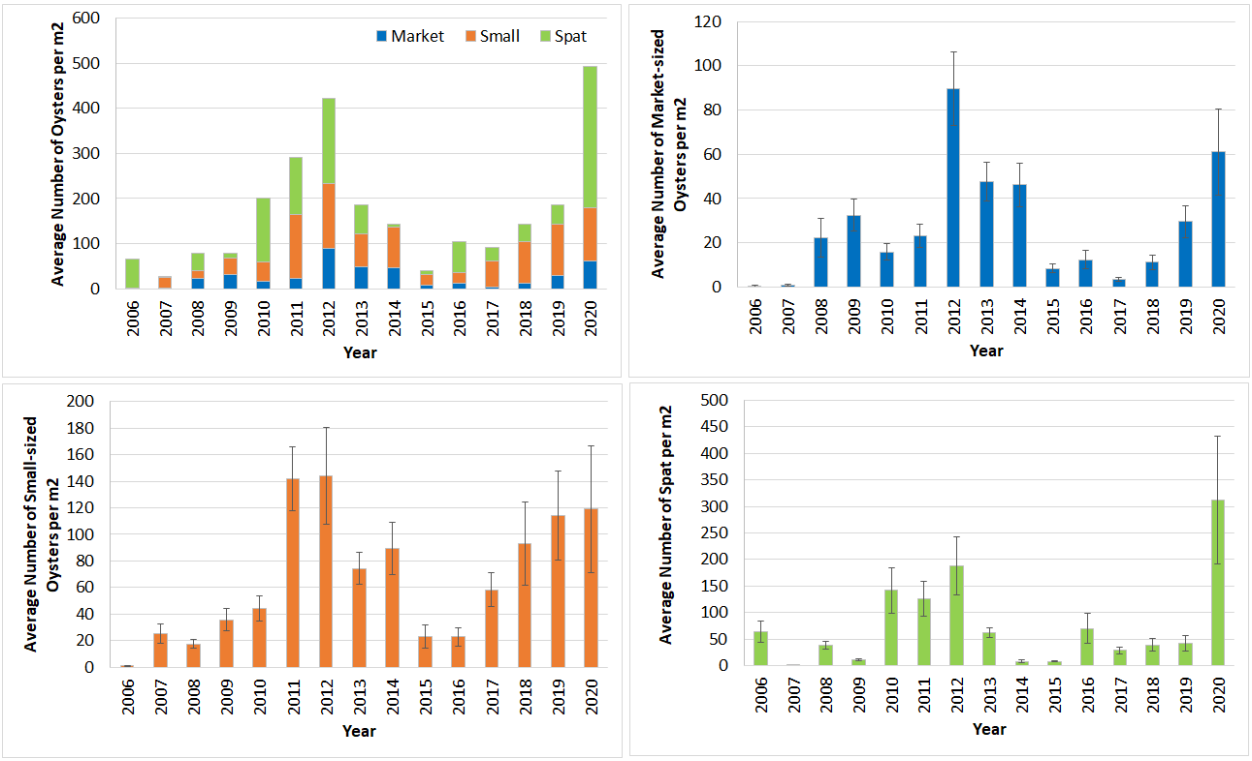


Figure B.05-2. Average number of live oysters per square meter by size class in NOAA Code 043 (Fishing Bay). Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales.

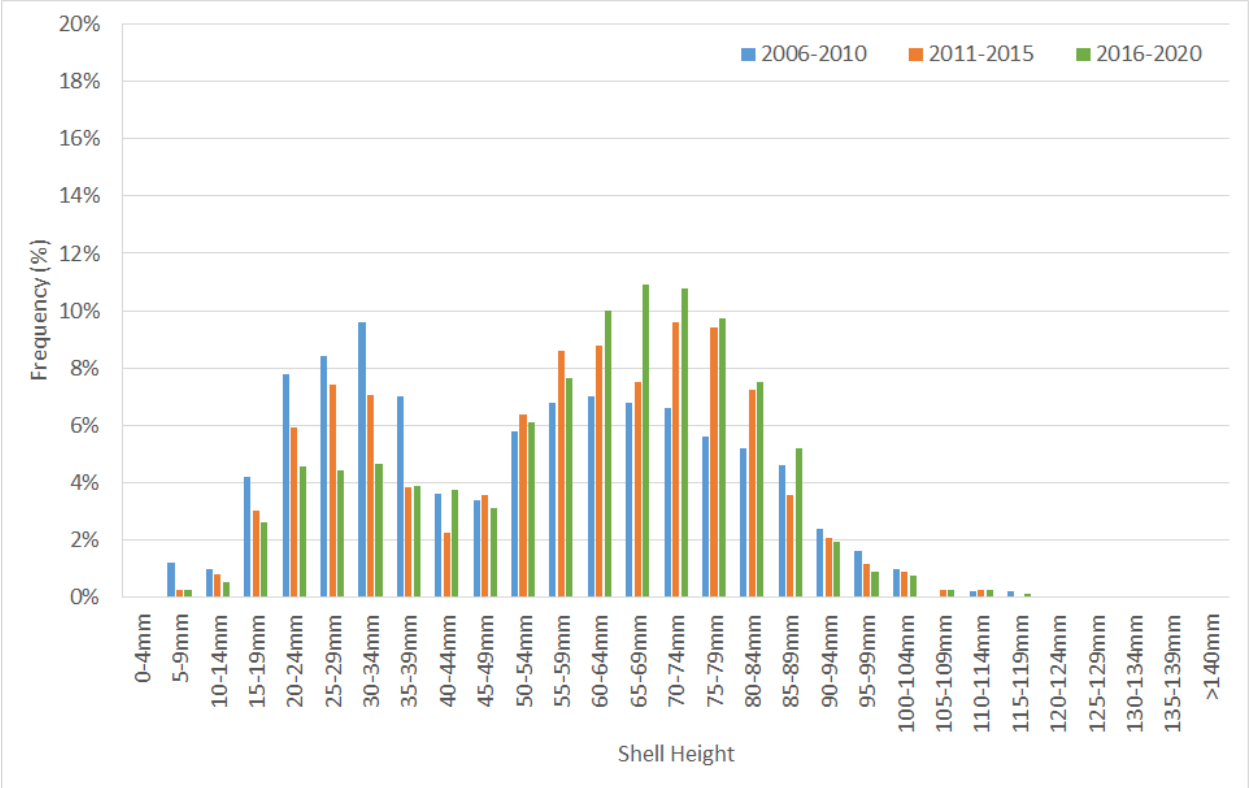


Figure B.05-3. Shell height frequencies of live oysters per bushel of material in NOAA Code 043 (Fishing Bay). Data from Maryland's Annual Fall Oyster Dredge Survey on Goose Creek bar.

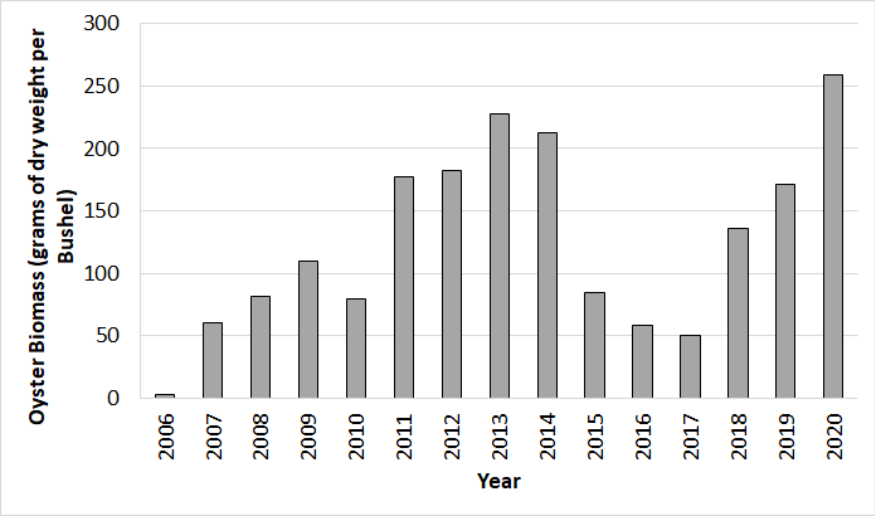


Figure B.05-4. Oyster biomass (grams of dry weight per bushel of material) in NOAA Code 043 (Fishing Bay). Data from Maryland's Annual Fall Oyster Dredge Survey on Goose Creek bar.

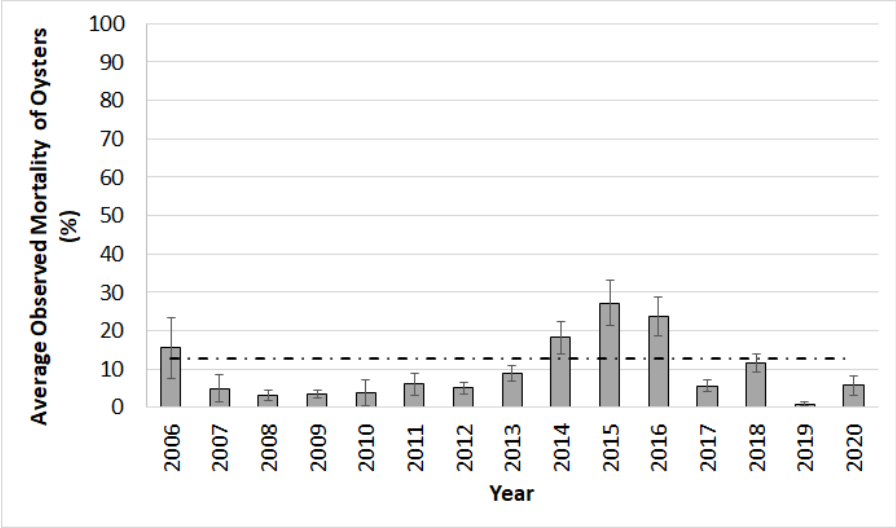


Figure B.05-5. Average annual observed mortality of market-sized and small-sized oysters in NOAA Code 043 (Fishing Bay). Data from Maryland's Annual Fall Oyster Dredge Survey. The dashed line represents the 2006-2020 baywide average observed mortality. Error bars represent ± 1 standard error.

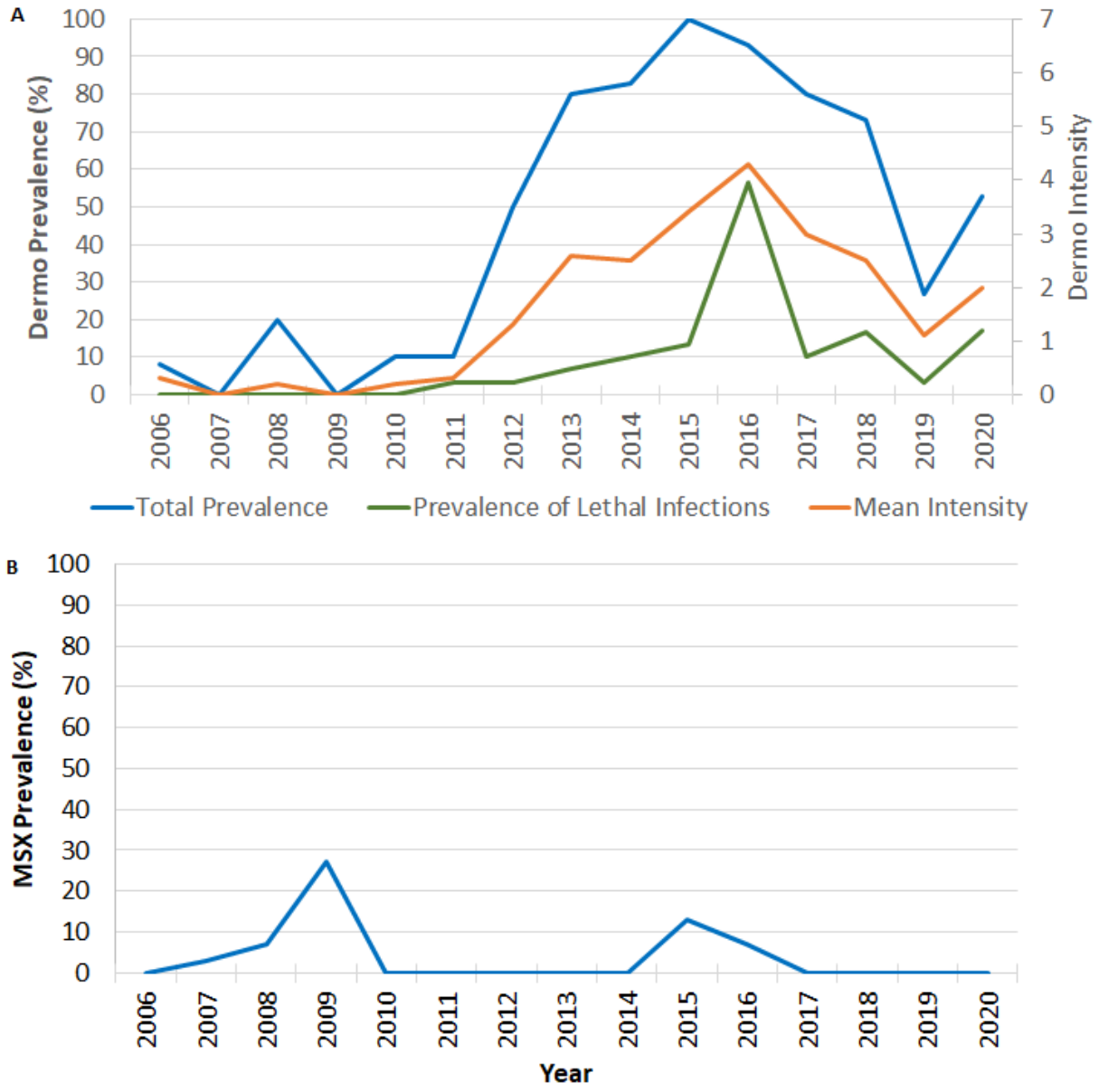


Figure B.05-6. Oyster disease prevalence and intensity in NOAA Code 043 (Fishing Bay). (A) Dermo prevalence and mean intensity (B) MSX prevalence (intensity is not examined). Data from Maryland's Annual Fall Oyster Dredge Survey on Goose Creek bar.

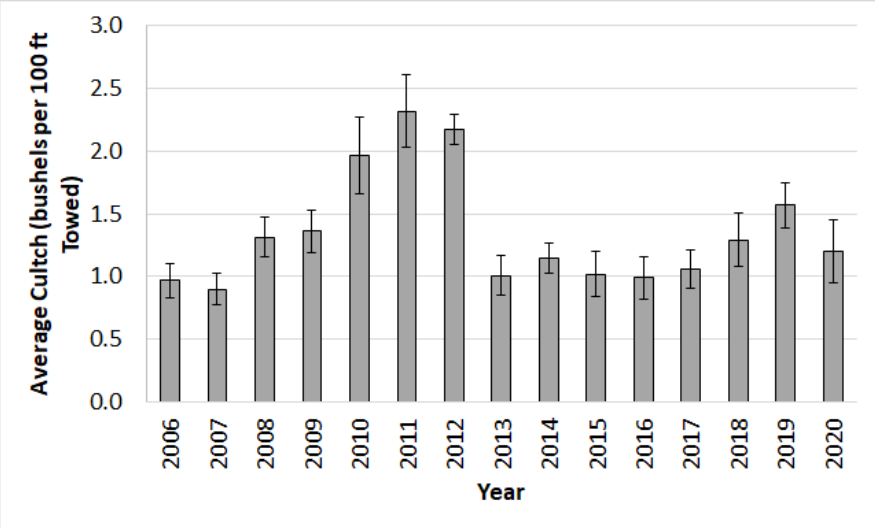


Figure B.05-7. Average cultch (live and dead oysters and loose shell) in NOAA Code 043 (Fishing Bay). Data from Maryland's Annual Fall Oyster Dredge Survey. Error bars represent ± 1 standard error.

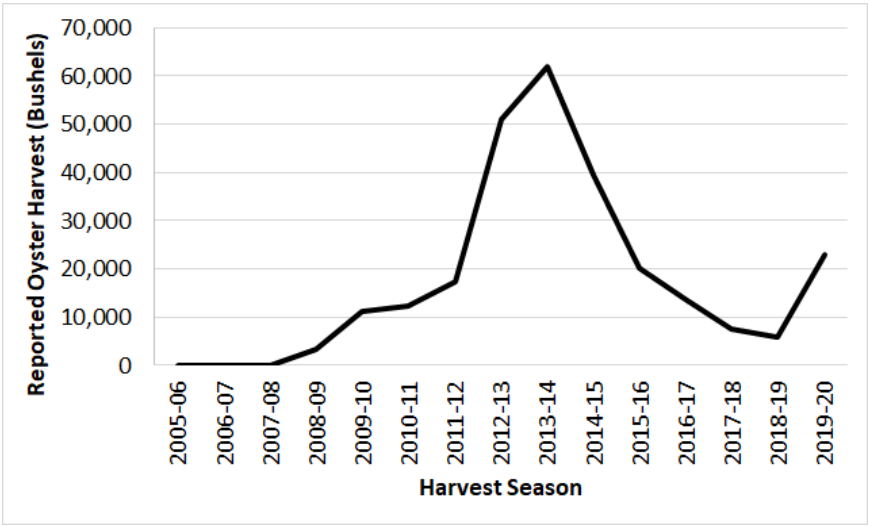


Figure B.05-8. Oyster harvest reported from seafood dealer buy tickets (harvest seasons 2005-2006 to 2019-2020) in NOAA Code 043 (Fishing Bay).

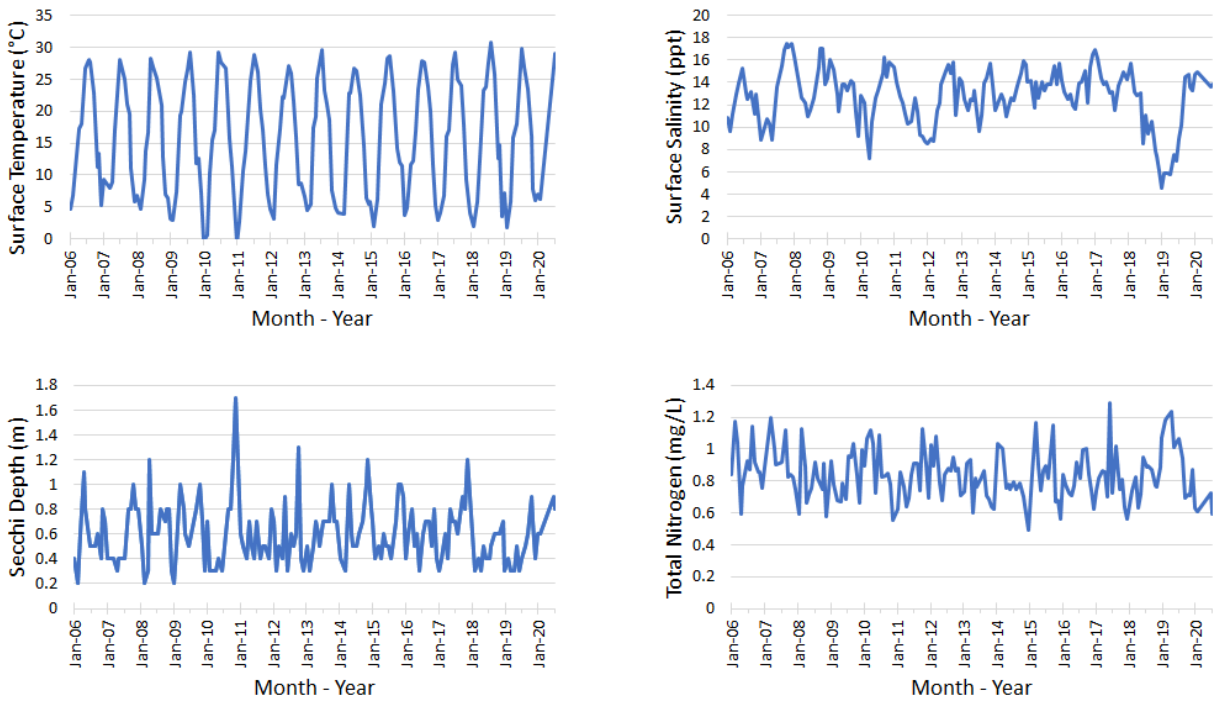


Figure B.05-9. Water quality data collected at Station EE3.0 in NOAA Code 043 (Fishing Bay). Data from Chesapeake Bay Program Data Hub.

## Section B.06: NOAA Code 047 – Honga River

NOAA Code 047 encompasses the Honga River and is located in Maryland's lower eastern portion of Chesapeake Bay. The entire NOAA Code is 31,778 acres and has 55 historic oyster bars[18]. The Hooper Straits Sanctuary encompasses 16% (5,087 acres) of the NOAA Code. This section focuses on information collected within the NOAA Code occurring outside of the current sanctuary area. This equates to 26,691 surface acres. There are 16,317 acres of historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments) located within the NOAA Code and outside a sanctuary. As of 2020, there are 13,346 acres within the NOAA Code designated as a Public Shellfish Fishery Area (PSFA). Aquaculture leasing is prohibited within PSFA boundaries. This NOAA Code is located within Maryland's medium-salinity region (Zone 2).

Information available for this NOAA Code includes:

- NOAA Code map (Figure B.06-1)
- Summary statistics (Table B.06-1)
- Abundance per year (Figure B.06-2)
- Shell height frequencies (Figure B.06-3)
- Biomass per year (Figure B.06-4)
- Observed mortality (Figure B.06-5)
- Dermo and MSX per year (Figure B.06-6)
- Cultch per year (Figure B.06-7)
- Harvest (Figure B.06-8)

Fall Survey results indicate average spat, small, and market densities decreased in 2016-2020 from the previous five-year averages, possibly as a result of increased harvest in the 2012-13 to 2015-16 harvest seasons. Observed mortality also increased beginning in 2015, with a peak in 2018.

Between 2006 and 2020, approximately 146 thousand bushels of shell and 20 million hatchery spat-on-shell were planted to enhance the commercial public fishery in this NOAA Code outside of the current sanctuary area.

Harvest for the NOAA Code has been reported on seafood dealer buy tickets for all years of the 15-year time series. This includes past harvest data from areas in the NOAA Code that are currently in a sanctuary area, but weren't when the harvest occurred prior to the sanctuary being established. Since 2009, 16% of the NOAA Code area has been a sanctuary where harvest is prohibited. Harvest reported ranged from approximately 150 bushels in the 2006-07 season to a maximum of approximately 25 thousand bushels in the 2013-14 season. Power dredging was used to obtain the majority of the harvest.

We are unaware of any continuous water quality monitoring in this area.

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

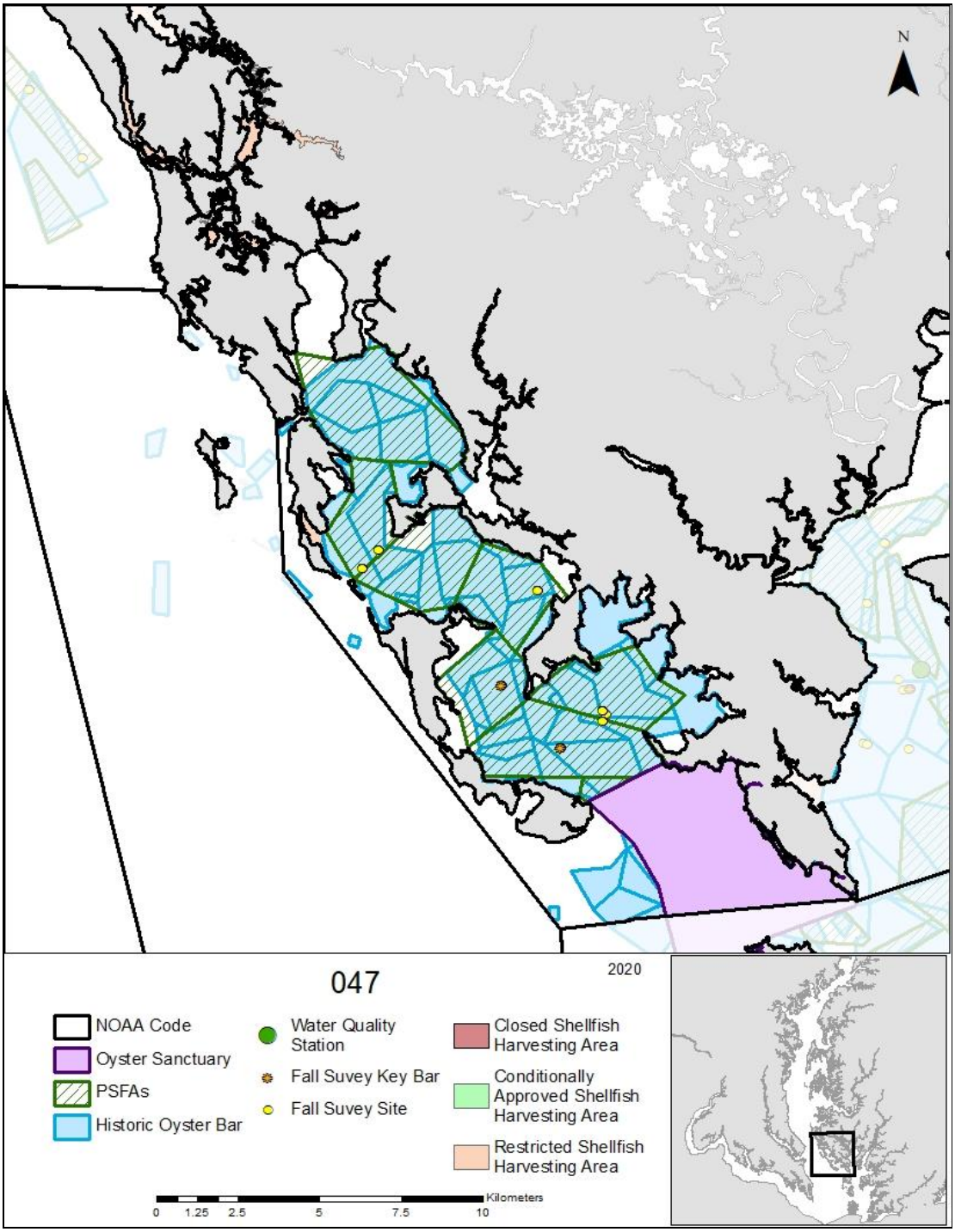


Figure B.06-1. Map of NOAA Code 047 (Honga River). Fall Survey sites may not be sampled every year. Fall Survey key bars may consist of a key bar, disease bar or both.

Table B.06-1. Oyster population characteristics based on the Fall Survey in the NOAA Code 047 (Honga River) occurring outside of the current sanctuary area. ND = No Data. Values are given as an annual mean ± standard error.

| | 2006-10 | 2011-15 | 2016-20 |
|---|---|---|---|
| Number of Years Sampled / Number of Samples | 5 / 25 | 5 / 29 | 5 / 35 |
| Number of Live Spat Oysters per square meter | 98.3 ± 37.6 | 63.4 ± 26.6 | 30.4 ± 14.2 |
| Number of Live Small-Sized Oysters per square meter | 75.5 ± 18.9 | 131.7 ± 24.1 | 31.8 ± 4.2 |
| Number of Live Market-Sized Oysters per square meter | 16.1 ± 6.7 | 30.2 ± 4.5 | 5.9 ± 2.3 |
| Live Oyster Biomass (g Dry Weight per Bushel) | 89 ± 27 | 166 ± 16 | 57 ± 10 |
| Observed Mortality (%) | 9 ± 3 | 11 ± 2 | 16 ± 6 |
| Cultch (Bushels per 100 ft Towed) | 1.2 ± 0.24 | 1.19 ± 0.07 | 0.96 ± 0.04 |
| Harvest (Bushels) | 7,900 ± 4,616 | 16,856 ± 3,634 | 6,063 ± 2,560 |
| Note: The number of samples is based on the number of samples having a value for observed mortality. There may be fewer samples per year for density, biomass, and cultch. | | | |

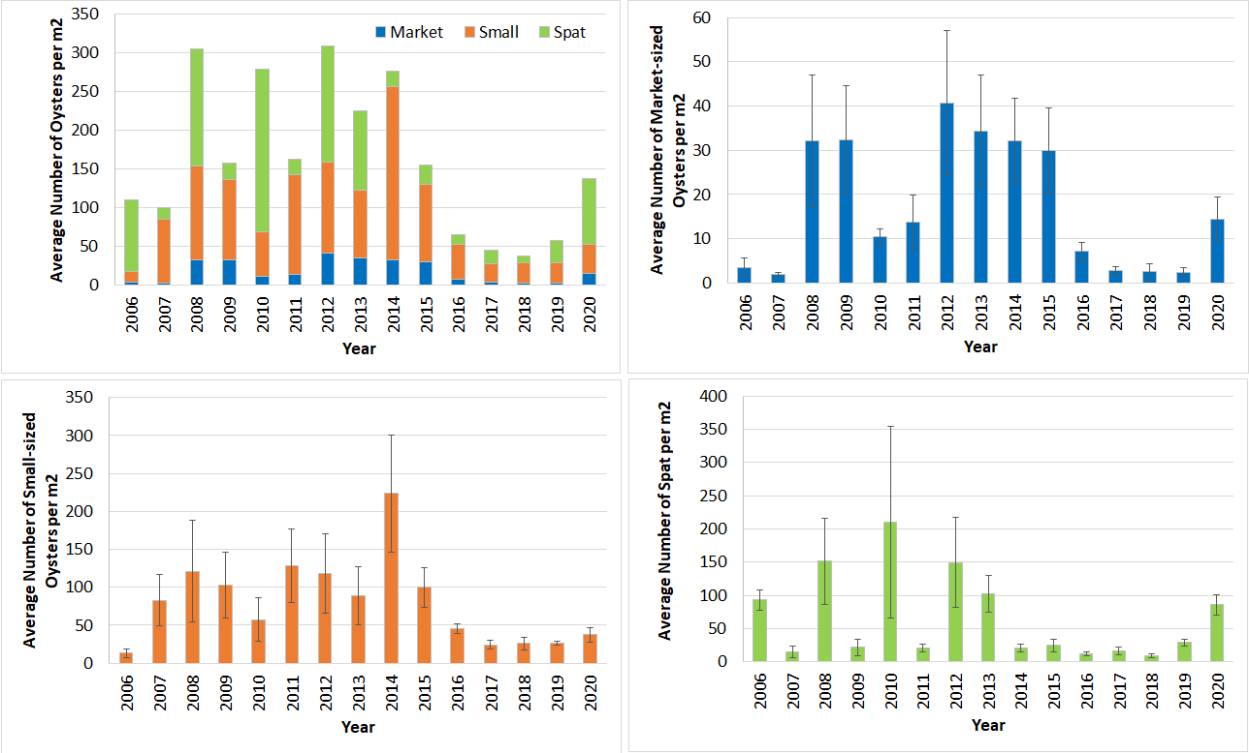


Figure B.06-2. Average number of live oysters per square meter by size class in NOAA Code 047 (Honga River) occurring outside of the current sanctuary area. Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales.

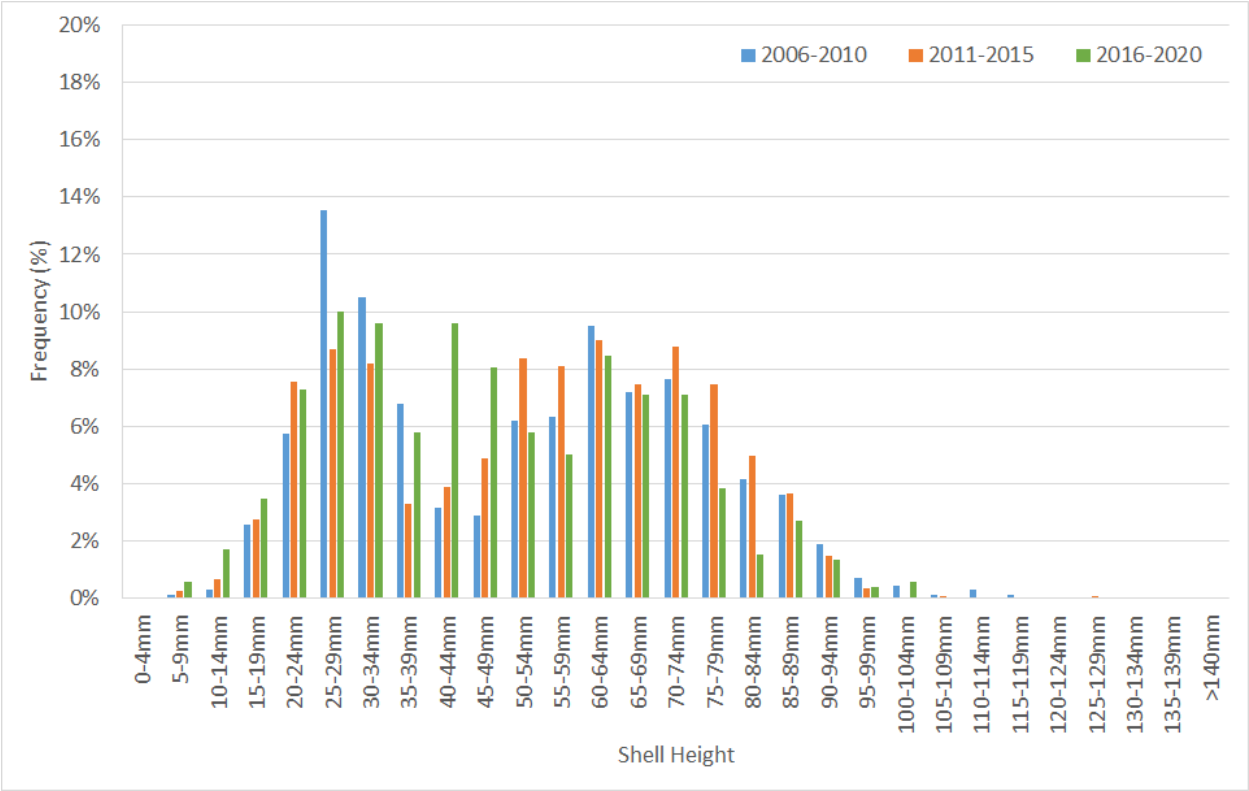


Figure B.06-3. Shell height frequencies of live oysters per bushel of material in NOAA Code 047 (Honga River) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey on Norman Addition 1 bar.

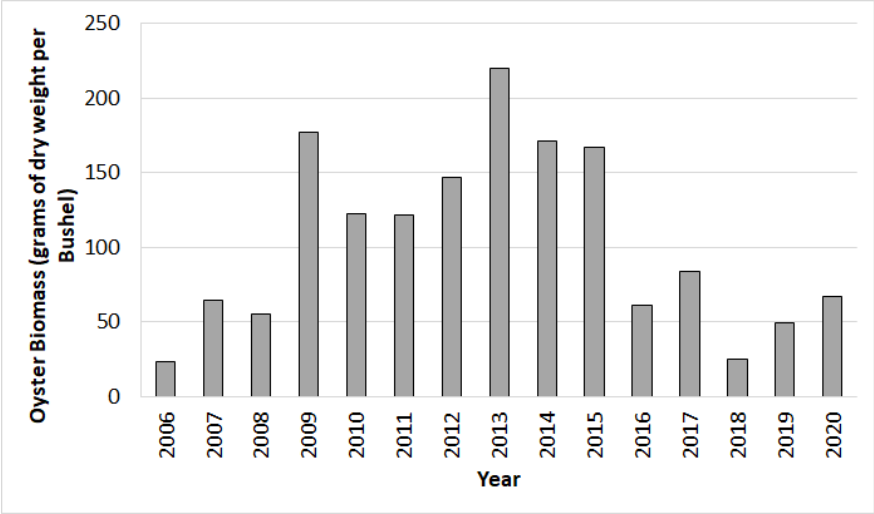


Figure B.06-4. Oyster biomass (grams of dry weight per bushel of material) in NOAA Code 047 (Honga River) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey on Norman Addition 1 bar.

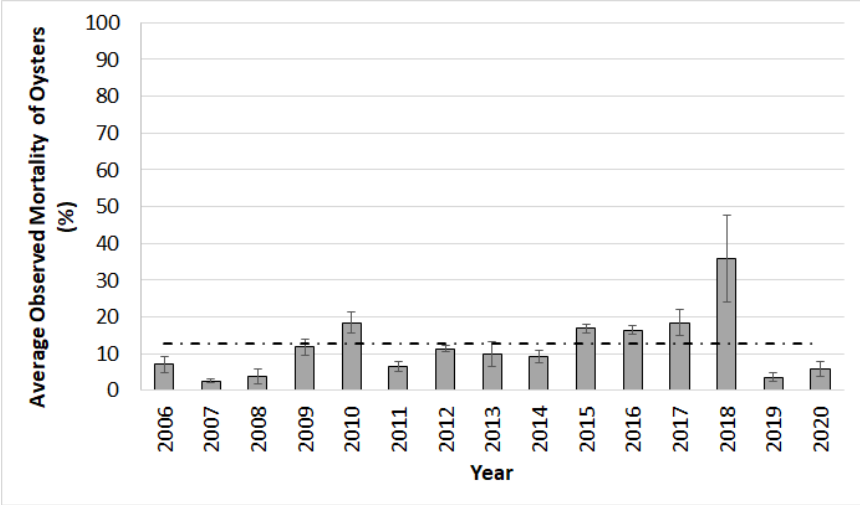


Figure B.06-5. Average annual observed mortality of market-sized and small-sized oysters in NOAA Code 047 (Honga River) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey. The dashed line represents the 2006-2020 baywide average observed mortality. Error bars represent ± 1 standard error.

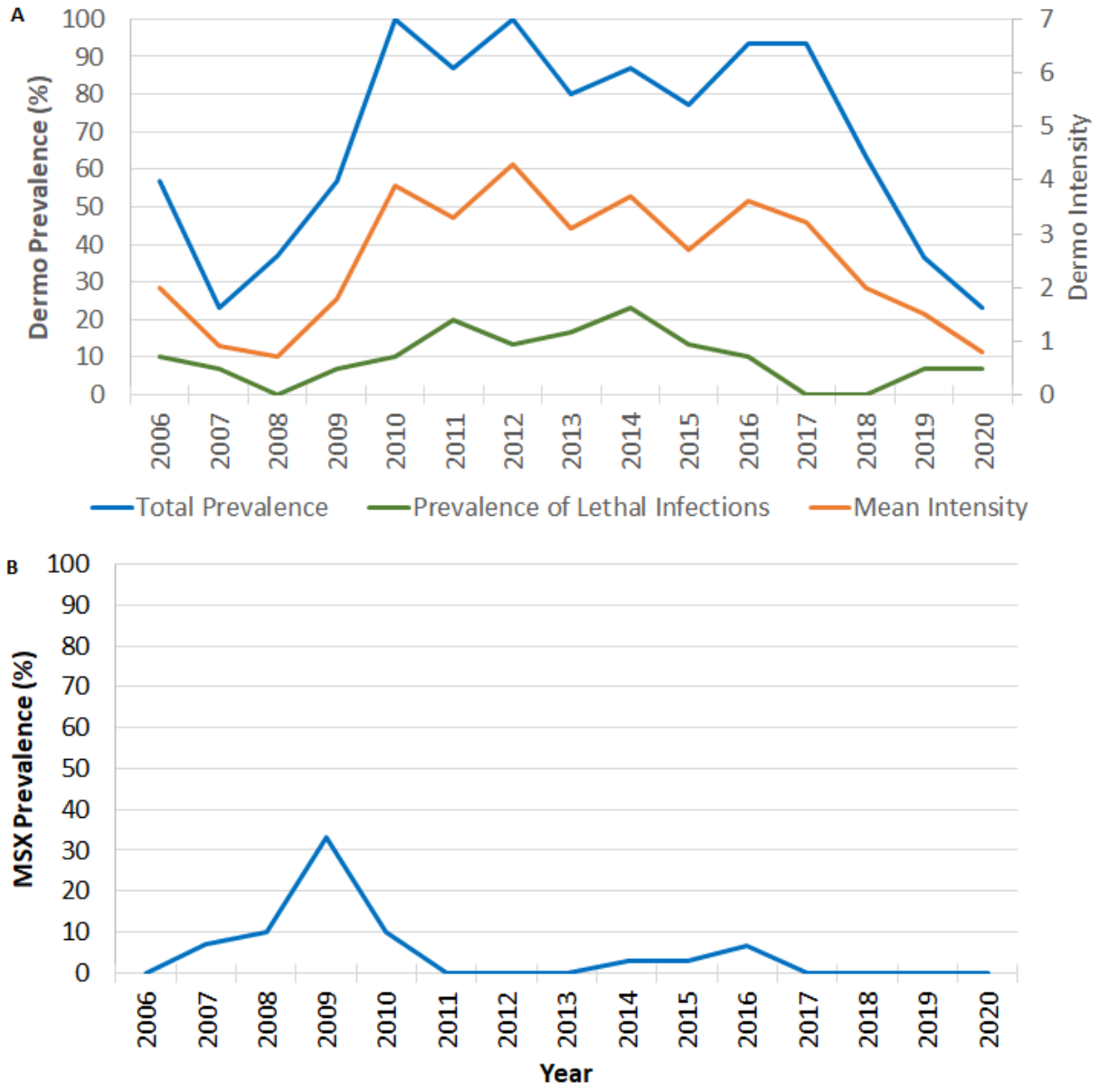


Figure B.06-6. Oyster disease prevalence and intensity in NOAA Code 047 (Honga River) occurring outside of the current sanctuary area. (A) Dermo prevalence and mean intensity (B) MSX prevalence (intensity is not examined). Data from Maryland's Annual Fall Oyster Dredge Survey on Norman Addition 1 bar.

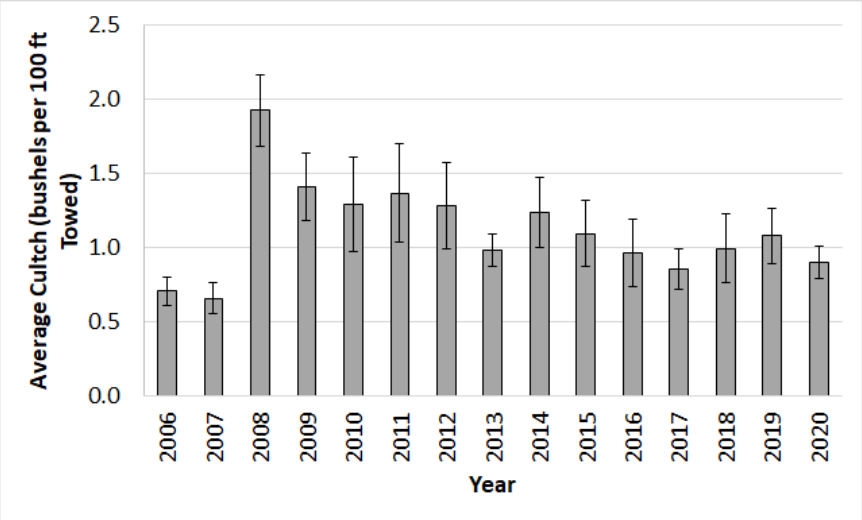


Figure B.06-7. Average cultch (live and dead oysters and loose shell) in NOAA Code 047 (Honga River) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey. Error bars represent ± 1 standard error.

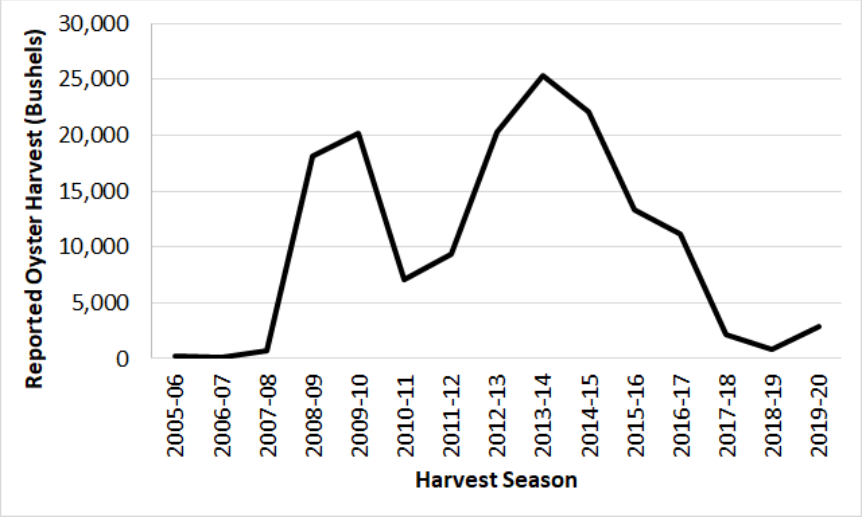


Figure B.06-8. Oyster harvest reported from seafood dealer buy tickets (harvest seasons 2005-2006 to 2019-2020) in NOAA Code 047 (Honga River). Since 2009, 16% of the NOAA Code area is a sanctuary where harvest is prohibited.

## Section B.07: NOAA Code 053 – Little Choptank River

NOAA Code 053 encompasses the Little Choptank River and is located in Maryland's mid-eastern portion of Chesapeake Bay. The entire NOAA Code is 19,447 acres and has 33 historic oyster bars[19]. The Little Choptank River Sanctuary encompasses 48% (9,415 total acres) of the NOAA Code. This section focuses on information collected within the NOAA Code occurring outside of the current sanctuary area. This equates to 10,032 surface acres. There are 2,472 acres of historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments) located within the NOAA Code and outside a sanctuary. As of 2020, there are 6,308 acres within the NOAA Code designated as a Public Shellfish Fishery Area (PSFA). Aquaculture leasing is prohibited within PSFA boundaries. This NOAA Code is located within Maryland's medium-salinity region (Zone 2).

Information available for this NOAA Code includes:

- NOAA Code map (Figure B.07-1)
- Summary statistics (Table B.07-1)
- Abundance per year (Figure B.07-2)
- Shell height frequencies (Figure B.07-3)
- Biomass per year (Figure B.07-4)
- Observed mortality (Figure B.07-5)
- Dermo and MSX per year (Figure B.07-6)
- Cultch per year (Figure B.07-7)
- Harvest (Figure B.07-8)
- Water Quality (Figure B.07-9)

Fall Survey results indicate average spat density increased in 2016-2020 due to high recruitment in 2016 and 2020. Average small and market densities remained consistent from 2011-2015 to 2016-2020. Densities were lower from 2014 to 2017 and then began increasing. Biomass followed the same trend as small and market densities. Mortality was at or below the long term baywide average except in 2016, possibly due to a slight increase in disease.

Between 2006 and 2020, approximately 43 thousand bushels of shell were planted to enhance the commercial public fishery in this NOAA Code outside of the current sanctuary area.

Harvest for the NOAA Code has been reported on seafood dealer buy tickets all years of the 15-year time series. This includes past harvest data from areas in the NOAA Code that are currently in a sanctuary area, but weren't when the harvest occurred prior to the sanctuary being established. Since 2010, 48% of the NOAA Code area has been a sanctuary where harvest is prohibited. Harvest reported ranged from less than 50 bushels in the 2010-2011 season to a maximum of approximately 10 thousand bushels in the 2019-20 season. Hand tonging and diving were used to obtain the majority of the harvest.

[19] 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

Continuous water quality monitoring has occurred at station EE2.2 (38.52609; -76.3041). During the 2006-2020 timeline, surface salinity ranged from 5.2 ppt to 18.7 ppt, with the lowest salinity being during the freshet of 2018-2019 and during the high rainfall year of 2011.

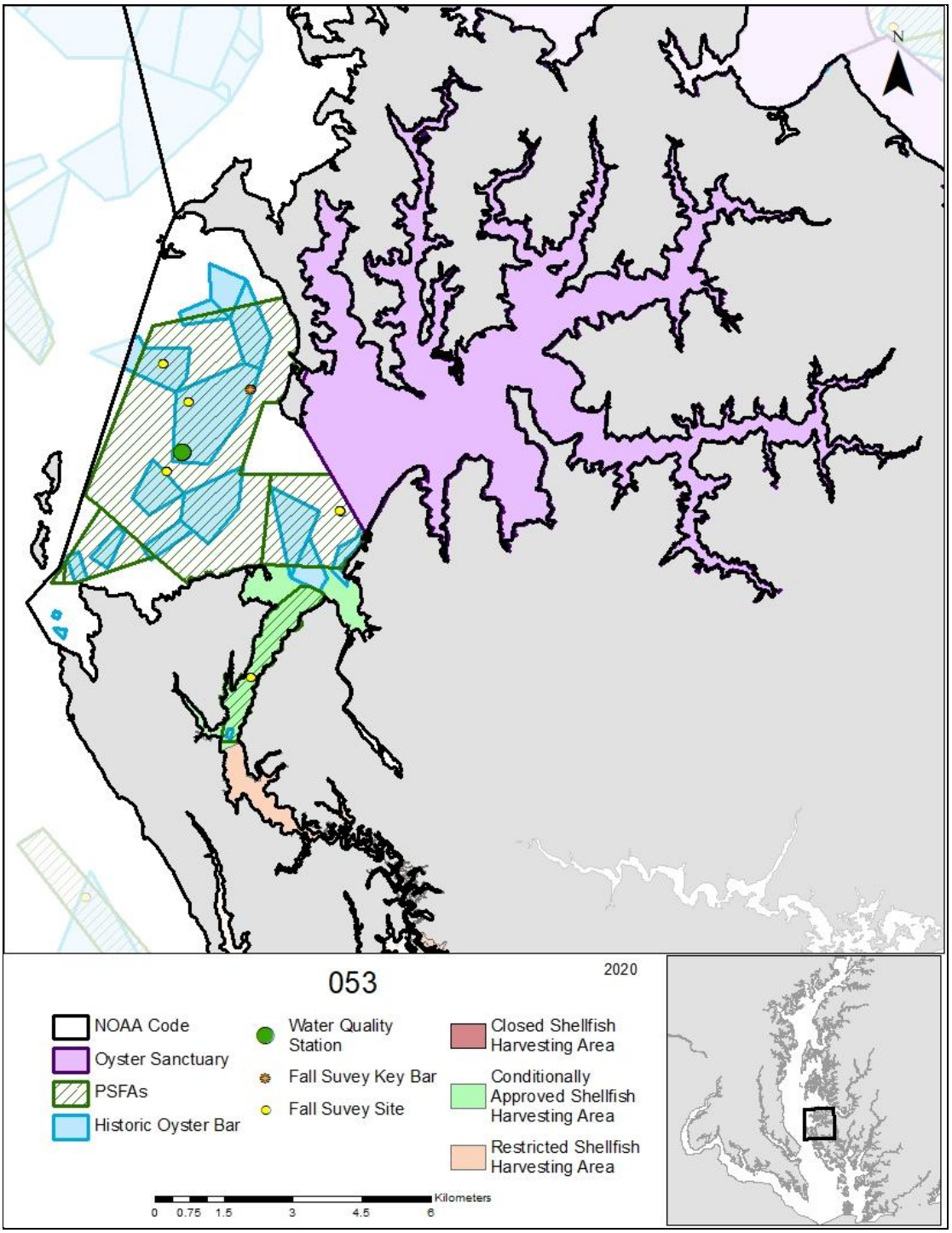


Figure B.07-1. Map of NOAA Code 053 (Little Choptank River). Fall Survey sites may not be sampled every year. Fall Survey key bars may consist of a key bar, disease bar or both.

Table B.07-1. Oyster population characteristics based on the Fall Survey in the NOAA Code 053 (Little Choptank River) occurring outside of the current sanctuary area. ND = No Data. Values are given as an annual mean ± standard error.

| | 2006-10 | 2011-15 | 2016-20 |
|---|---|---|---|
| Number of Years Sampled / Number of Samples | 5 / 25 | 5 / 25 | 5 / 26 |
| Number of Live Spat Oysters per square meter | 6.5 ± 3.3 | 5.4 ± 3.6 | 14.6 ± 7.4 |
| Number of Live Small-Sized Oysters per square meter | 17.7 ± 6.6 | 46.2 ± 14.1 | 44.2 ± 18.9 |
| Number of Live Market-Sized Oysters per square meter | 11.5 ± 3 | 46.6 ± 11 | 36.5 ± 12.7 |
| Live Oyster Biomass (g Dry Weight per Bushel) | 84 ± 5 | 273 ± 35 | 266 ± 51 |
| Observed Mortality (%) | 13 ± 2 | 14 ± 4 | 14 ± 6 |
| Cultch (Bushels per 100 ft Towed) | 0.59 ± 0.12 | 0.87 ± 0.13 | 0.8 ± 0.09 |
| Harvest (Bushels) | 2,170 ± 734 | 1,898 ± 860 | 2,961 ± 1,837 |
| Note: The number of samples is based on the number of samples having a value for observed mortality. There may be fewer samples per year for density, biomass, and cultch. | | | |

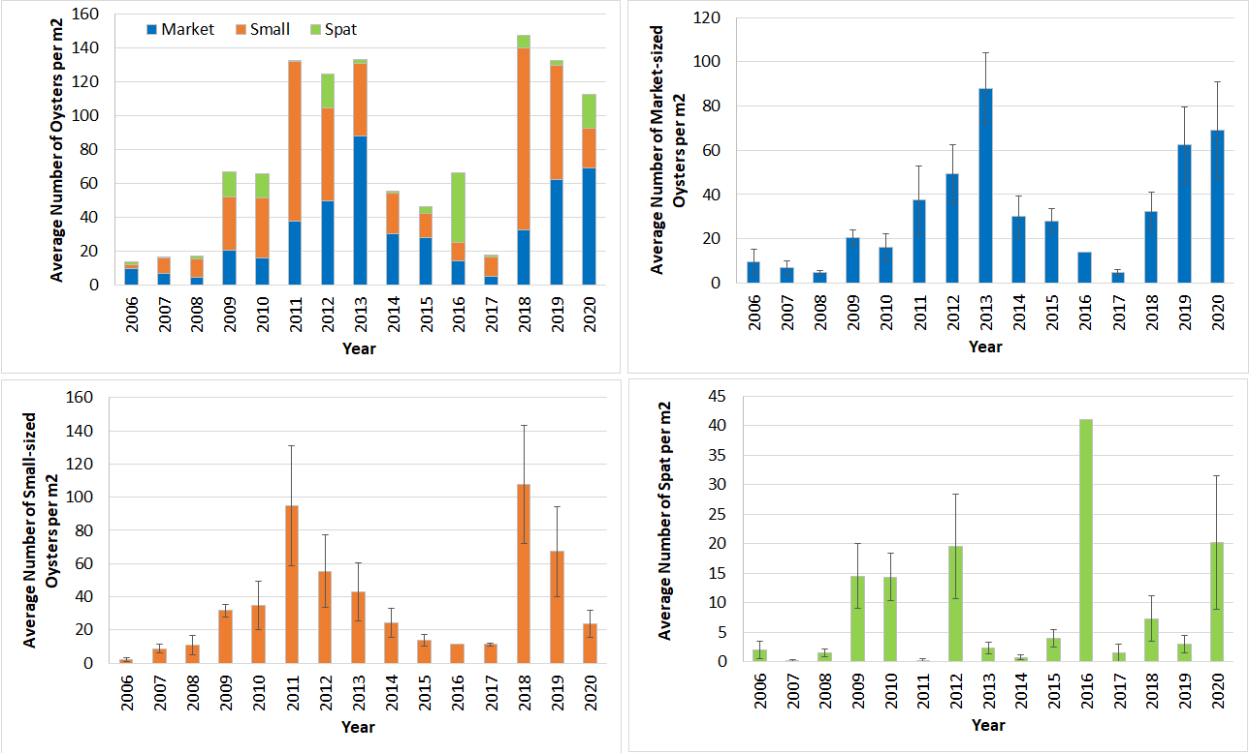


Figure B.07-2. Average number of live oysters per square meter by size class in NOAA Code 053 (Little Choptank River) occurring outside of the current sanctuary area. Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales.

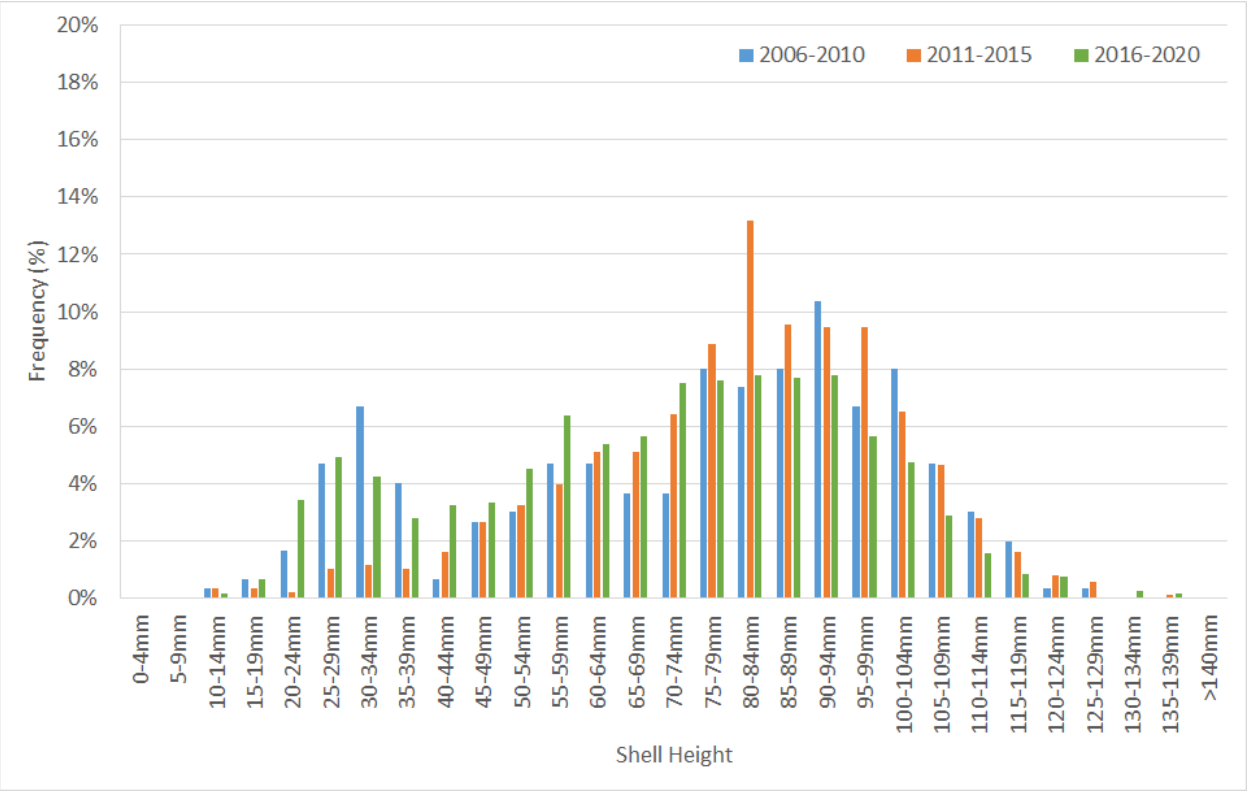


Figure B.07-3. Shell height frequencies of live oysters per bushel of material in NOAA Code 053 (Little Choptank River) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey on Ragged Point bar.

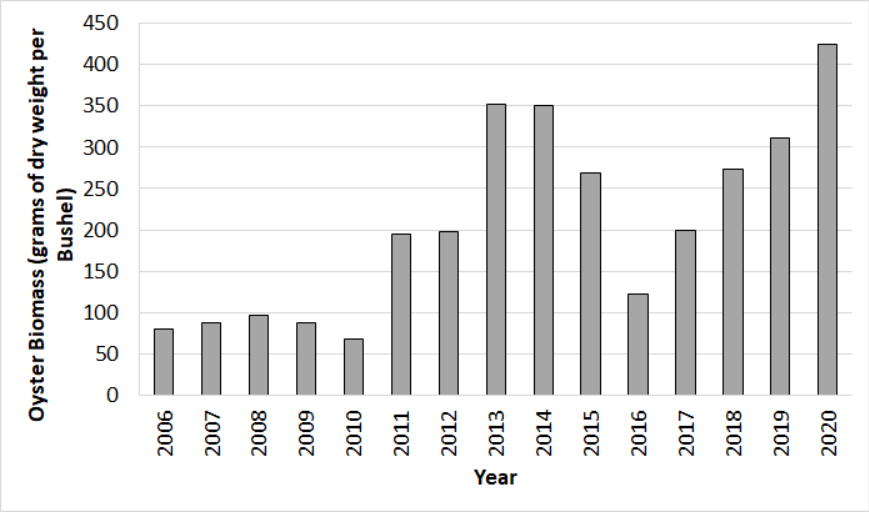


Figure B.07-4. Oyster biomass (grams of dry weight per bushel of material) in NOAA Code 053 (Little Choptank River) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey on Ragged Point bar.

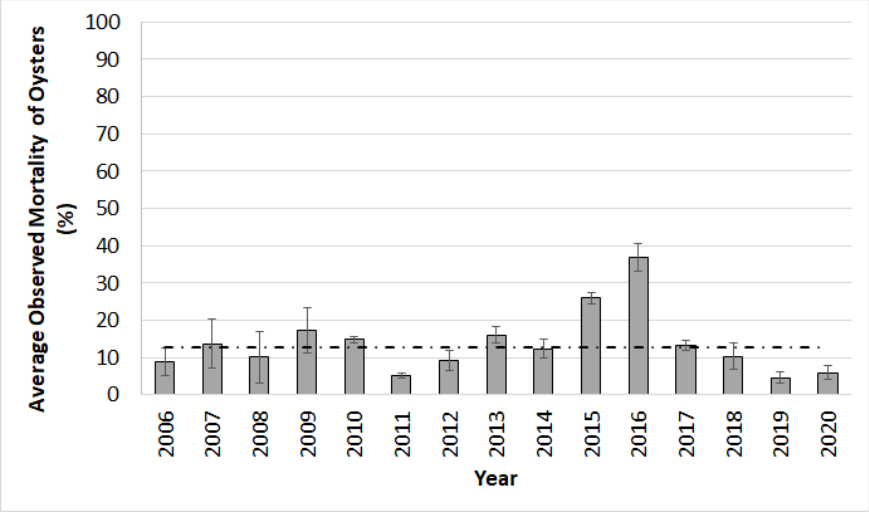


Figure B.07-5. Average annual observed mortality of market-sized and small-sized oysters in NOAA Code 053 (Little Choptank River) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey. The dashed line represents the 2006-2020 baywide average observed mortality. Error bars represent ± 1 standard error.

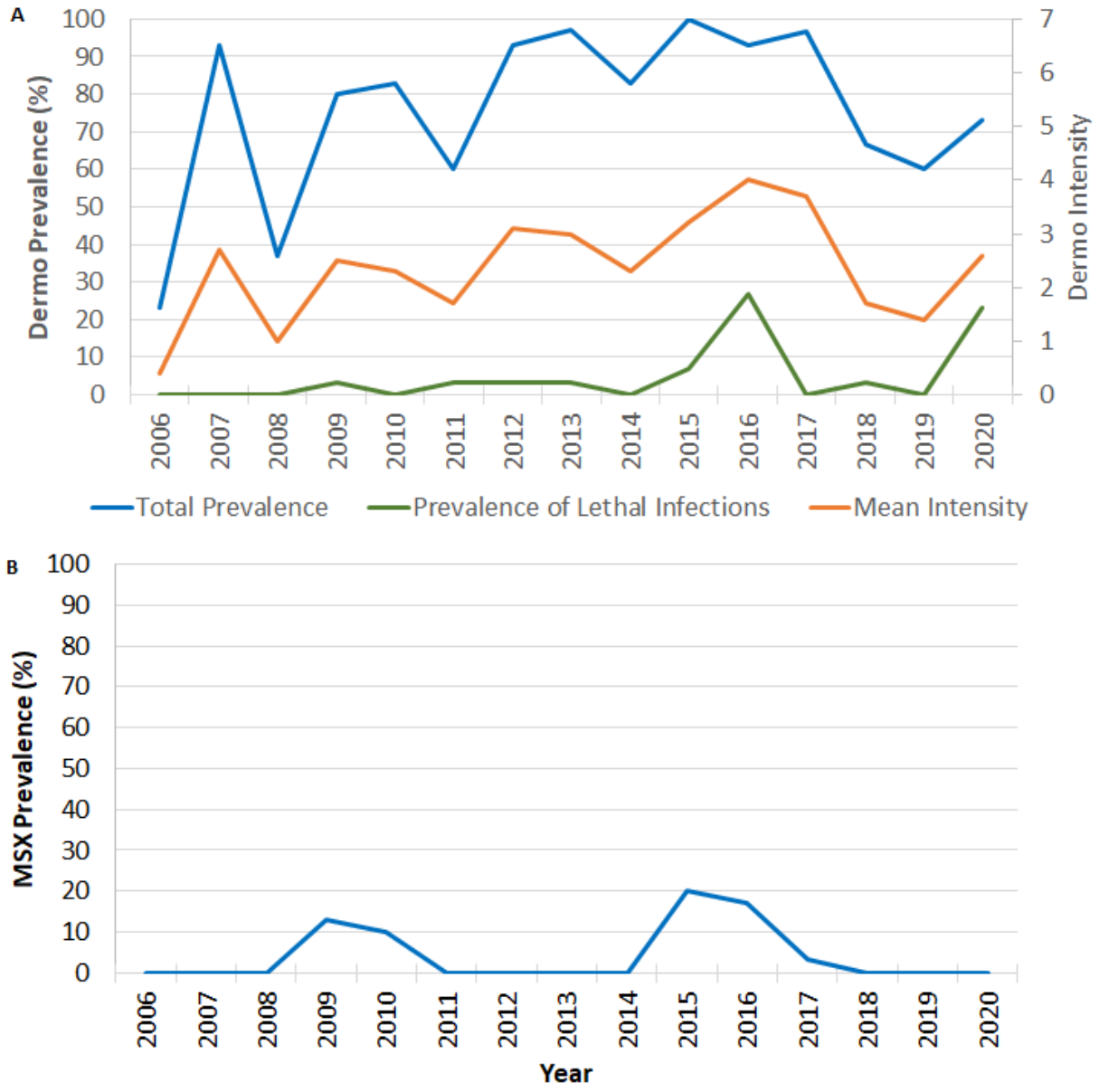


Figure B.07-6. Oyster disease prevalence and intensity in NOAA Code 053 (Little Choptank River) occurring outside of the current sanctuary area. (A) Dermo prevalence and mean intensity (B) MSX prevalence (intensity is not examined). Data from Maryland's Annual Fall Oyster Dredge Survey on Ragged Point bar.

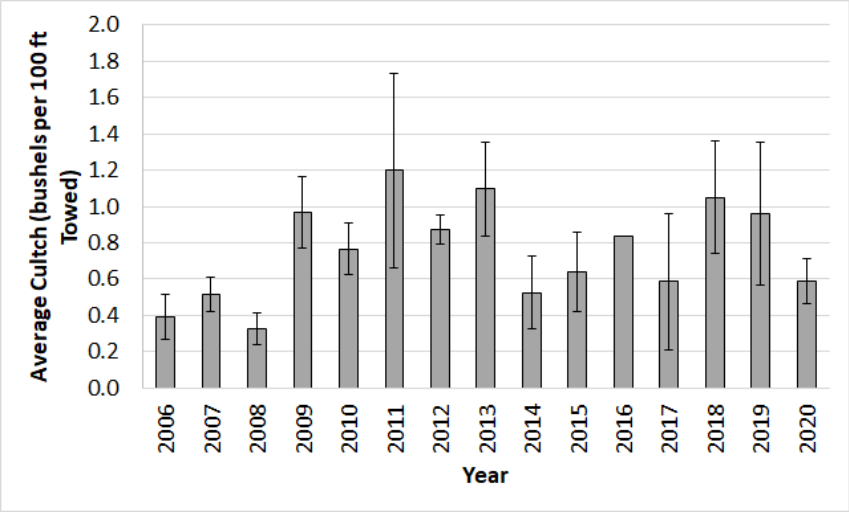


Figure B.07-7. Average cultch (live and dead oysters and loose shell) in NOAA Code 053 (Little Choptank River) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey. Error bars represent ± 1 standard error.

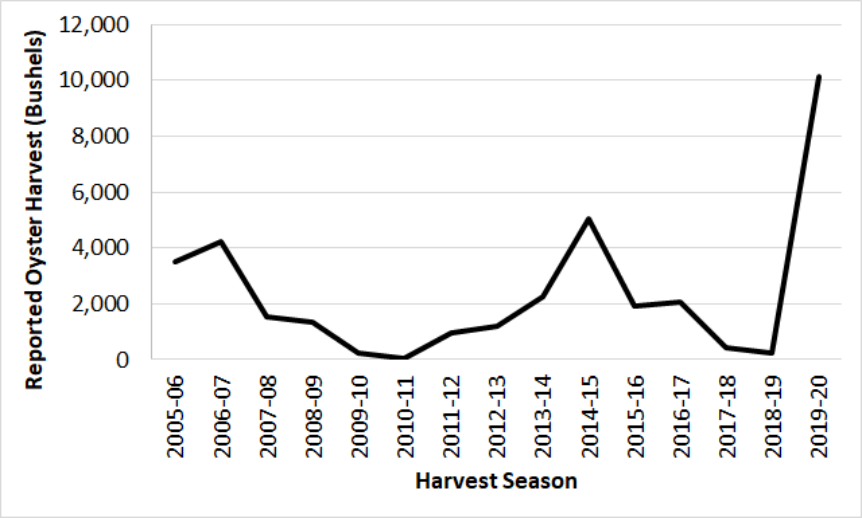


Figure B.07-8. Oyster harvest reported from seafood dealer buy tickets (harvest seasons 2005-2006 to 2019-2020) in NOAA Code 053 (Little Choptank River). Since 2010, 48% of the NOAA Code area has been a sanctuary where harvest is prohibited.

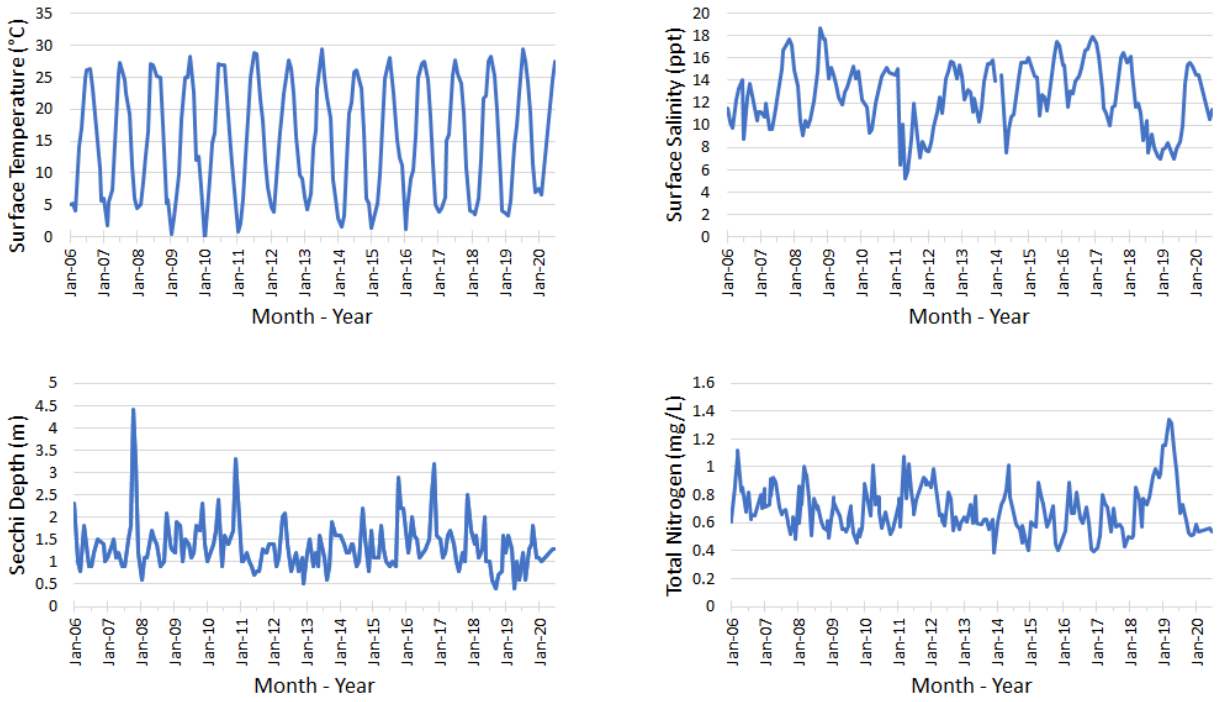


Figure B.07-9. Water quality data collected at Station EE2.2 in NOAA Code 053 (Little Choptank River). Data from Chesapeake Bay Program Data Hub.

## Section B.08: NOAA Code 055 – Magothy River

NOAA Code 055 encompasses the Magothy River and is located in Maryland's upper western portion of Chesapeake Bay. The entire NOAA Code is 6,969 acres and has nine historic oyster bars[20]. The Magothy River Sanctuary encompasses 80% (5,607 total acres) of the NOAA Code. This section focuses on information collected within the NOAA Code occurring outside of the current sanctuary area. This equates to 1,362 acres. There are 717 acres of historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments) located within the NOAA Code and outside the sanctuary. As of 2020, there are 814 acres within the NOAA Code designated as a Public Shellfish Fishery Area (PSFA). Aquaculture leasing is prohibited within PSFA boundaries. This NOAA Code is located within Maryland's low-salinity region (Zone 1).

Information available for this NOAA Code includes:

- NOAA Code map (Figure B.08-1)

The Fall Survey has not collected samples in this NOAA Code since 2006 outside the sanctuary area. Between 2006 and 2020, no replenishment planting activities occurred to enhance the commercial public fishery in this NOAA Code outside of the current sanctuary area.

Harvest for the NOAA Code has been reported on dealer buy tickets for three years out of the 15-year time series for a total of less than 60 bushels. This includes past harvest data from areas in the NOAA Code that are currently in a sanctuary area, but weren't when the harvest occurred prior to the sanctuary being established. Since 2010, 79% of the NOAA Code area has been a sanctuary where harvest is prohibited.

We are unaware of any continuous water quality monitoring in this area.

[20] 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

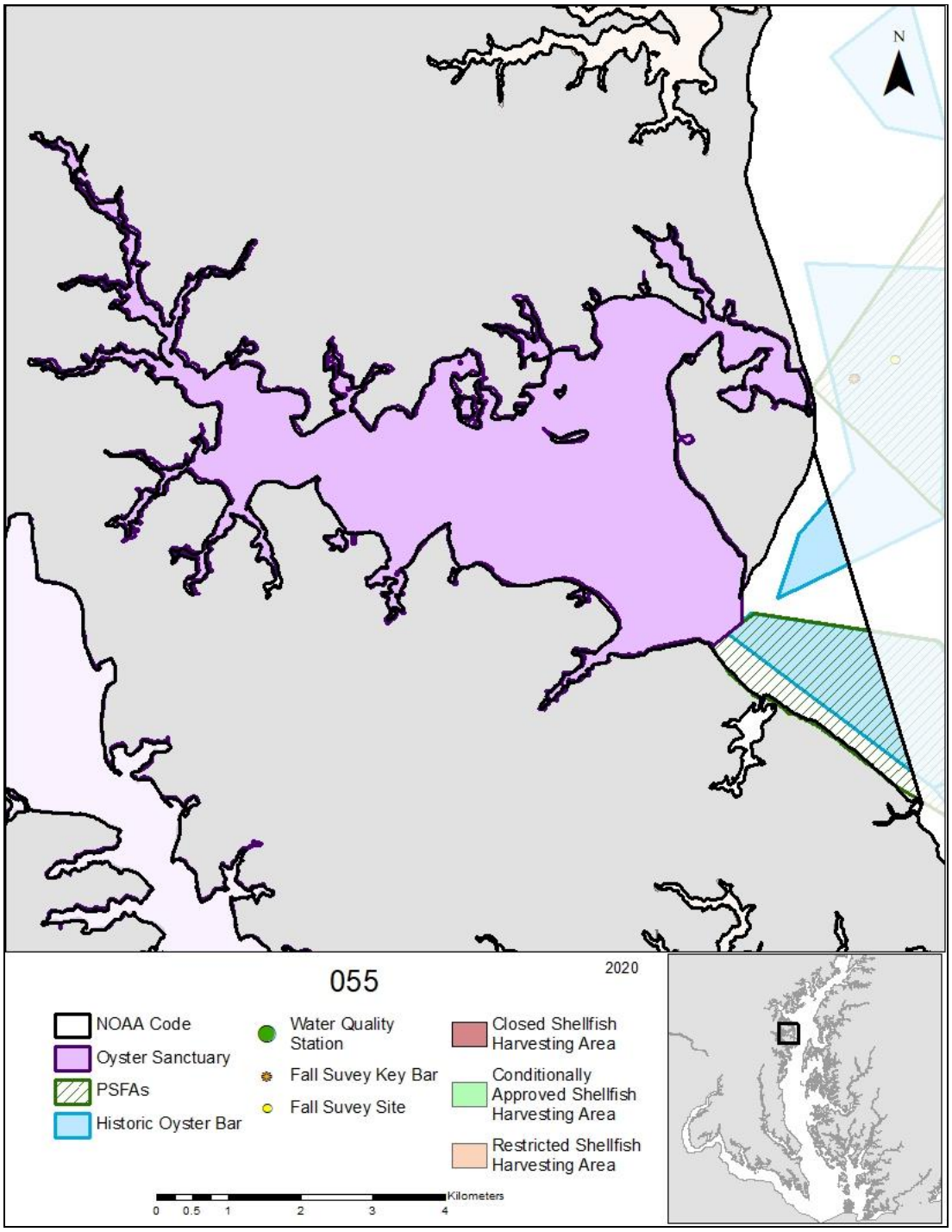


Figure B.08-1. Map of NOAA Code 055 (Magothy River).

## Section B.09: NOAA Code 057 – Manokin River

NOAA Code 057 (Manokin River) is 20,172 surface acres; however, 16,320 acres (80%) of the area is within a current sanctuary boundary (Manokin River Sanctuary, established in 2010). There are 1,825 acres of historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments) located within the NOAA Code and outside a sanctuary[21]. As of 2020, there are 519 acres within the NOAA Code designated as a Public Shellfish Fishery Area (PSFA). Aquaculture leasing is prohibited within PSFA boundaries. This NOAA Code is located within Maryland's high-salinity region (Zone 3).

Information available for this NOAA Code includes:

- NOAA Code map (Figure B.09-1)
- Harvest (Figure B.09-2)

The Fall Survey has not collected any samples since 2006 in this NOAA Code outside the current sanctuary area[22]. Between 2006 and 2020, approximately 10 million hatchery spat-on-shell were planted to enhance the commercial public fishery in this NOAA Code outside of the current sanctuary area.

Harvest for the NOAA Code has been reported on dealer buy tickets all years of the 15-year time series. This includes past harvest data from areas in the NOAA Code that are currently in a sanctuary area, but weren't when the harvest occurred prior to the sanctuary being established. Since 2010, 80% of the NOAA Code area has been a sanctuary where harvest is prohibited. Harvest reported ranged from less than 10 bushels in the 2011-12 season to a maximum of approximately 3 thousand bushels in the 2014-15 season. Power dredging was used to obtain the majority of the harvest.

We are unaware of any continuous water quality monitoring in this area.

[21] 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

[22] See Appendix A, Section A.23 for more information on the oyster population characteristics.

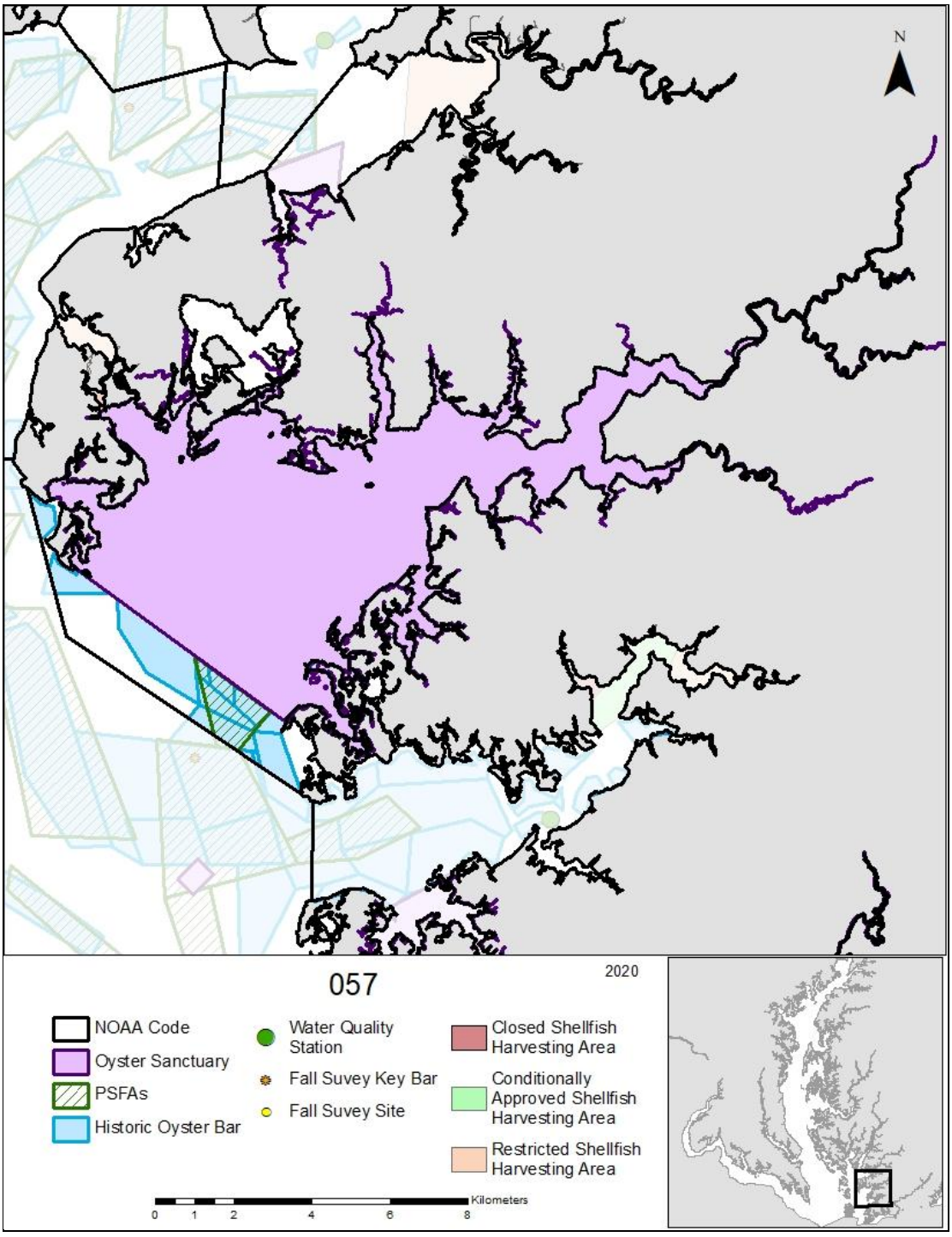


Figure B.09-1. Map of NOAA Code 057 (Manokin River).

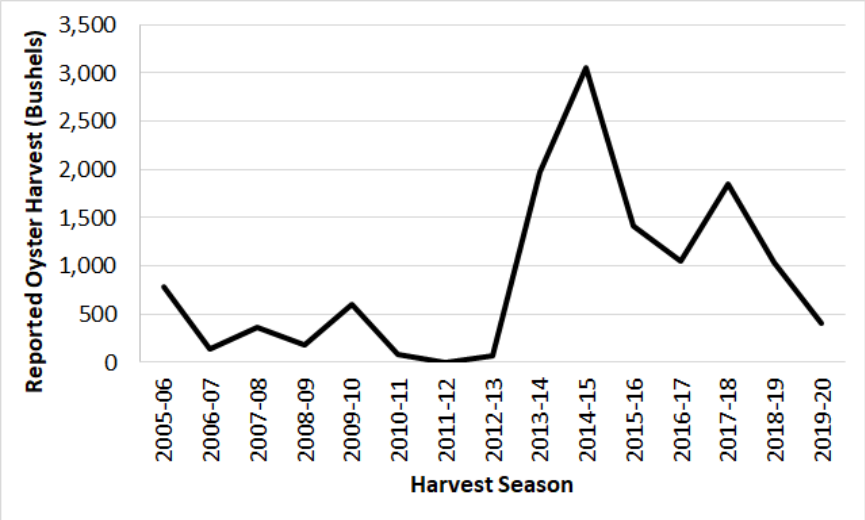


Figure B.09-2. Oyster harvest reported from seafood dealer buy tickets (harvest seasons 2005-2006 to 2019-2020) in NOAA Code 057 (Manokin River). Since 2010, 80% of the NOAA Code area has been a sanctuary where harvest is prohibited.

## Section B.10: NOAA Code 060 – Miles River

NOAA Code 060 encompasses the Miles River and is located in Maryland's upper eastern portion of Chesapeake Bay. The entire NOAA Code is 12,662 acres and has 26 historic oyster bars[23]. The Miles River Sanctuary encompasses 27% (3,449 total acres) of the NOAA Code. This section focuses on information collected within the NOAA Code occurring outside of the current sanctuary area. This equates to 9,213 surface acres. There are 3,089 acres of historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments) located within the NOAA Code and outside a sanctuary. As of 2020, there are 5,458 acres within the NOAA Code designated as a Public Shellfish Fishery Area (PSFA). Aquaculture leasing is prohibited within PSFA boundaries. This NOAA Code is located within Maryland's medium-salinity region (Zone 2).

Information available for this NOAA Code includes:

- NOAA Code map (Figure B.10-1)
- Summary statistics (Table B.10-1)
- Abundance per year (Figure B.10-2)
- Shell height frequencies (Figure B.10-3)
- Biomass per year (Figure B.10-4)
- Observed mortality (Figure B.10-5)
- Dermo and MSX per year (Figure B.10-6)
- Cultch per year (Figure B.10-7)
- Harvest (Figure B.10-8)

Fall survey results indicate a decline in small and spat densities in 2016-2020. Average market density and biomass in 2016-2020 remained similar to 2011-2015 but was lower than 2006-2010. Mortality was highest in the 2006-2010 time period but was at or below the long term baywide average for the rest of the time period. Average cultch has declined throughout the time series.

Between 2006 and 2020, approximately 20 million hatchery spat-on-shell were planted to enhance the commercial public fishery in this NOAA Code outside of the current sanctuary area.

Harvest for the NOAA Code has been reported on seafood dealer buy tickets for 14 years out of the 15-year time series. This includes past harvest data from areas in the NOAA Code that are currently in a sanctuary area, but weren't when the harvest occurred prior to the sanctuary being established. Since 2010, 27% of the NOAA Code area has been a sanctuary where harvest is prohibited. Harvest reported ranged from less than 10 bushels in the 2010-2011 season to a maximum of approximately 3 thousand bushels in the 2005-06 season. Diving and hand tonging was used to obtain the majority of the harvest.

We are unaware of any continuous water quality monitoring in this area.

[23] 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

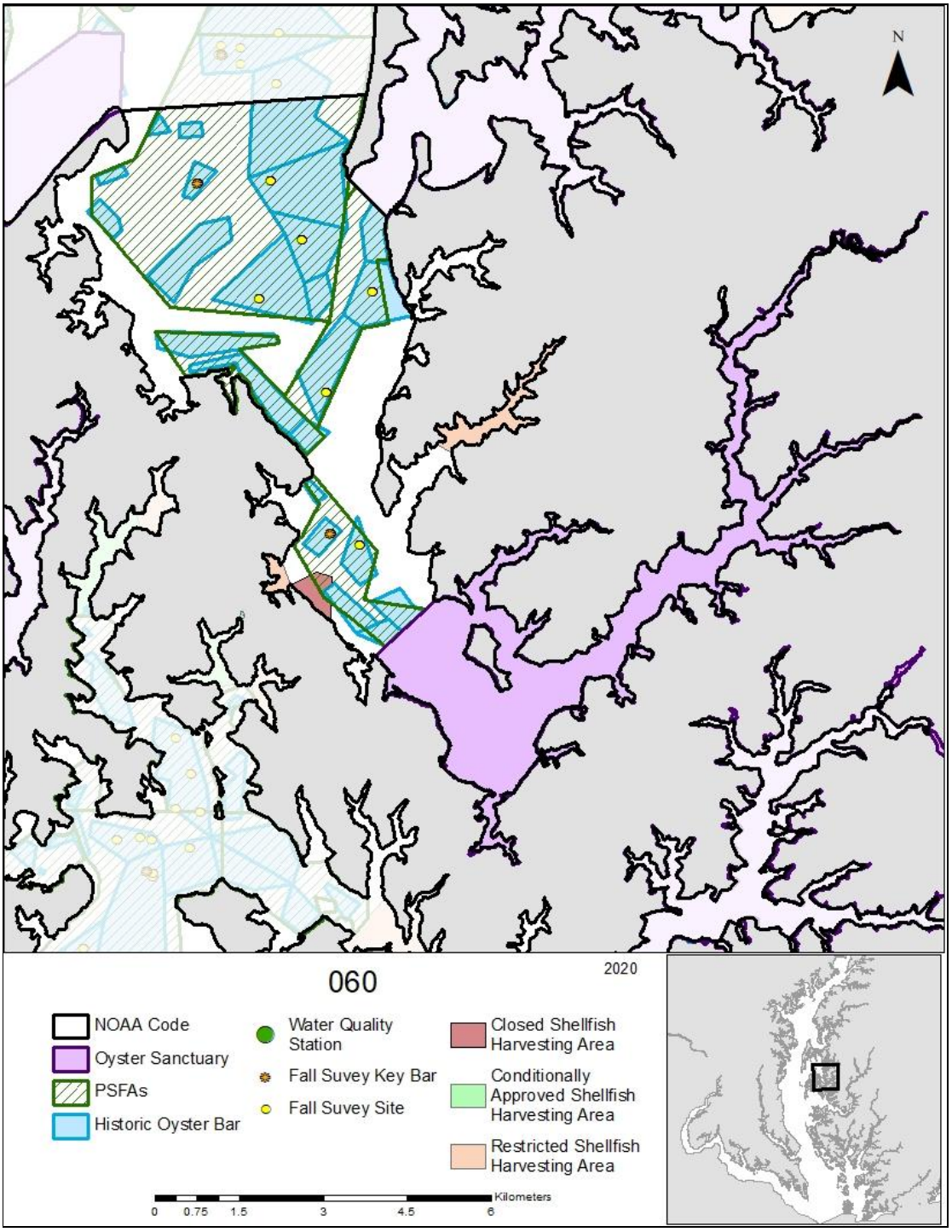


Figure B.10-1. Map of NOAA Code 060 (Miles River). Fall Survey sites may not be sampled every year. Fall Survey key bars may consist of a key bar, disease bar or both.

Table B.10-1. Oyster population characteristics based on the Fall Survey in the NOAA Code 060 (Miles River) occurring outside of the current sanctuary area. ND = No Data. Values are given as an annual mean ± standard error.

| | 2006-10 | 2011-15 | 2016-20 |
|---|---|---|---|
| Number of Years Sampled / Number of Samples | 5 / 40 | 5 / 38 | 5 / 35 |
| Number of Live Spat Oysters per square meter | 0.8 ± 0.4 | 0.6 ± 0.5 | 0.2 ± 0.1 |
| Number of Live Small-Sized Oysters per square meter | 3.1 ± 0.5 | 3.9 ± 1 | 0.8 ± 0.4 |
| Number of Live Market-Sized Oysters per square meter | 15.3 ± 5 | 8.1 ± 2.8 | 8.7 ± 1.1 |
| Live Oyster Biomass (g Dry Weight per Bushel) | 71 ± 8 | 119 ± 53 | 123 ± 17 |
| Observed Mortality (%) | 30 ± 5 | 7 ± 2 | 14 ± 1 |
| Cultch (Bushels per 100 ft Towed) | 0.57 ± 0.07 | 0.33 ± 0.07 | 0.21 ± 0.02 |
| Harvest (Bushels) | 1,148 ± 666 | 541 ± 381 | 1,340 ± 556 |
| Note: The number of samples is based on the number of samples having a value for observed mortality. There may be fewer samples per year for density, biomass, and cultch. | | | |

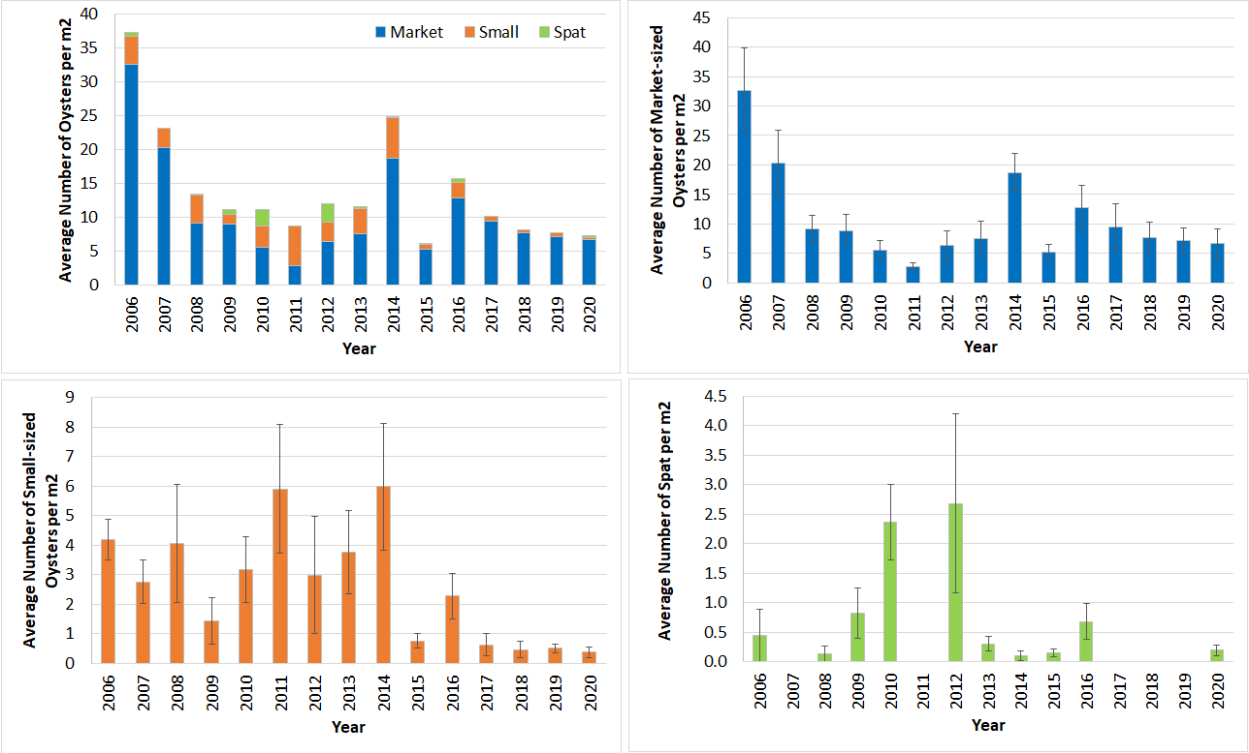


Figure B.10-2. Average number of live oysters per square meter by size class in NOAA Code 060 (Miles River) occurring outside of the current sanctuary area. Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales.

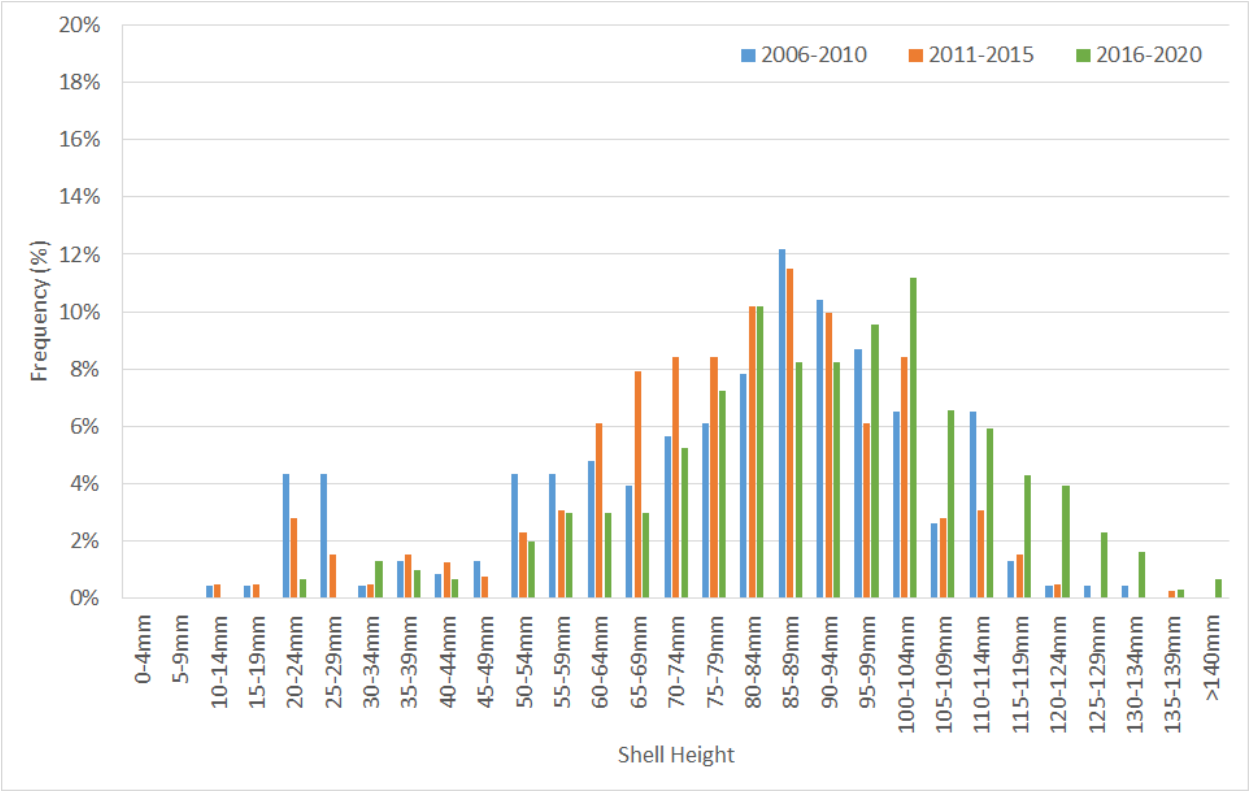


Figure B.10-3. Shell height frequencies of live oysters per bushel of material in NOAA Code 060 (Miles River) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey on Turtleback bar.

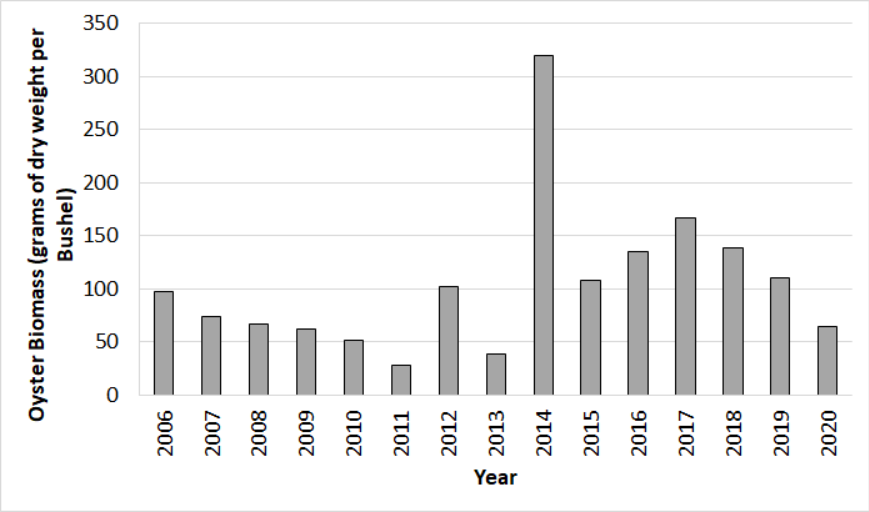


Figure B.10-4. Oyster biomass (grams of dry weight per bushel of material) in NOAA Code 060 (Miles River) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey on Turtleback bar.

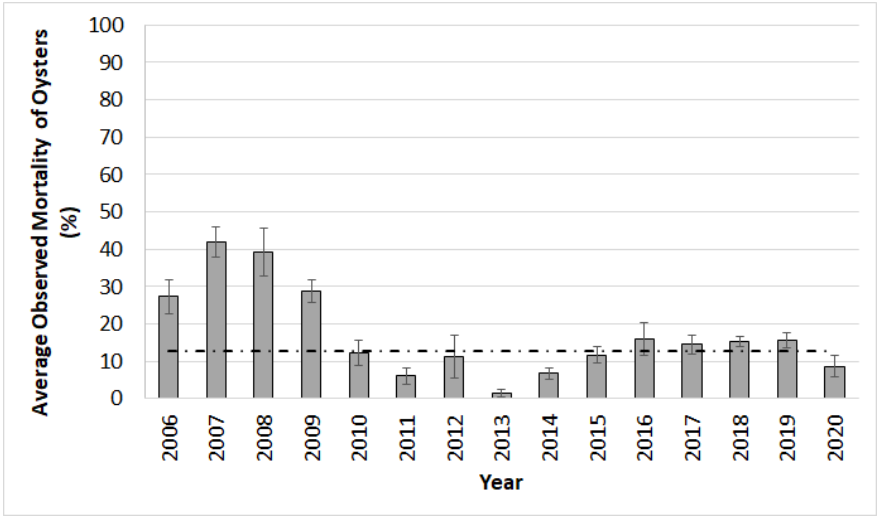


Figure B.10-5. Average annual observed mortality of market-sized and small-sized oysters in NOAA Code 060 (Miles River) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey. The dashed line represents the 2006-2020 baywide average observed mortality. Error bars represent ± 1 standard error.

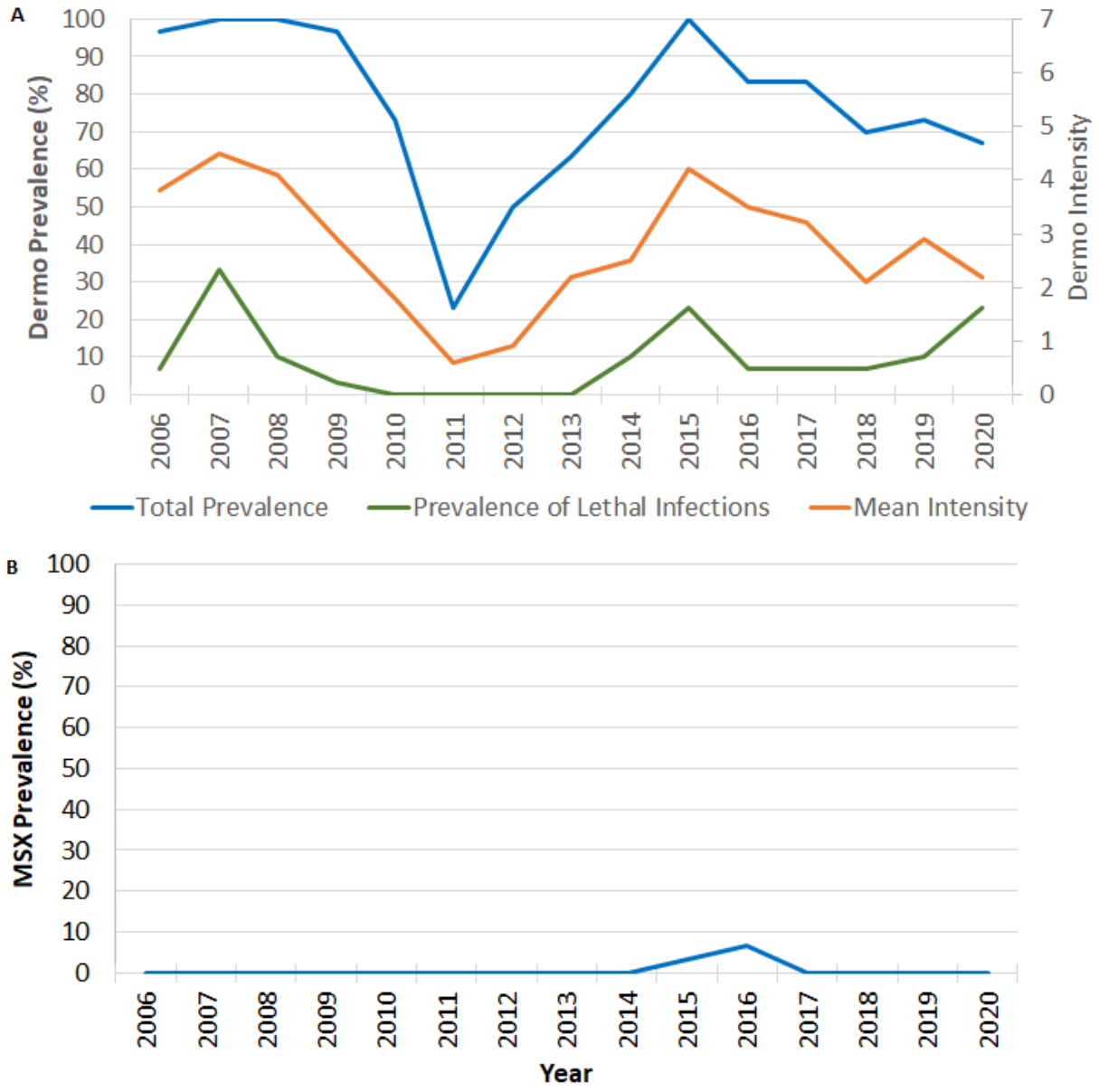


Figure B.10-6. Oyster disease prevalence and intensity in NOAA Code 060 (Miles River) occurring outside of the current sanctuary area. (A) Dermo prevalence and mean intensity (B) MSX prevalence (intensity is not examined). Data from Maryland's Annual Fall Oyster Dredge Survey on Turtleback bar.

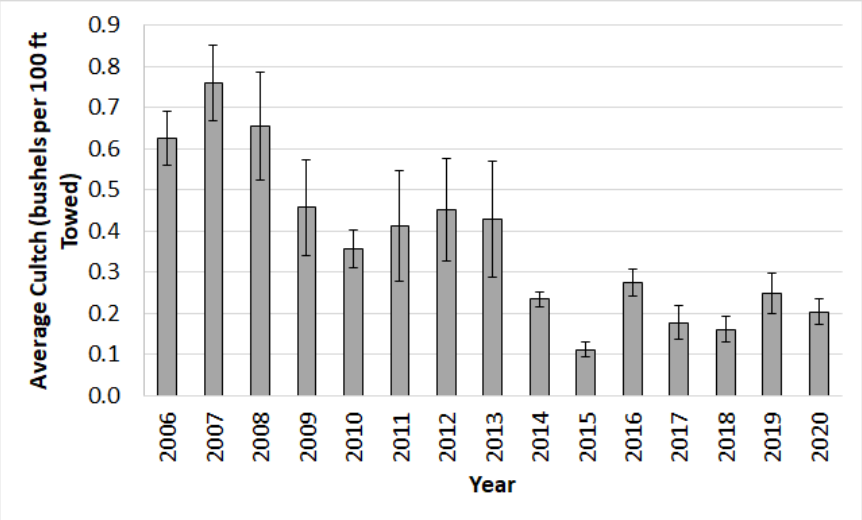


Figure B.10-7. Average cultch (live and dead oysters and loose shell) in NOAA Code 060 (Miles River) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey. Error bars represent ± 1 standard error.

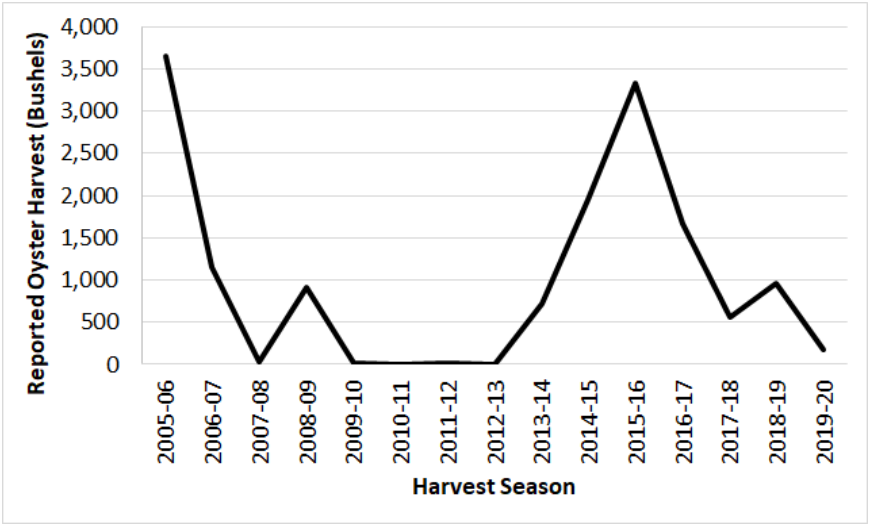


Figure B.10-8. Oyster harvest reported from seafood dealer buy tickets (harvest seasons 2005-2006 to 2019-2020) in NOAA Code 060 (Miles River). Since 2010, 27% of the NOAA Code area has been a sanctuary where harvest is prohibited.

## Section B.11: NOAA Code 062 – Nanticoke River

NOAA Code 062 encompasses the Nanticoke River and is located in Maryland's lower eastern portion of Chesapeake Bay. The entire NOAA Code is 18,971 acres and has 20 historic oyster bars[24]. The Nanticoke River Sanctuary encompasses 88% (16,699 total acres) of the NOAA Code. This section focuses on information collected within the NOAA Code occurring outside of the current sanctuary area. This equates to 2,272 surface acres. There are 680 acres of historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments) located within the NOAA Code and outside a sanctuary. As of 2020, there are 811 acres within the NOAA Code designated as a Public Shellfish Fishery Area (PSFA). Aquaculture leasing is prohibited within PSFA boundaries. The non-sanctuary portion of this NOAA Code is located within Maryland's medium-salinity region (Zone 2).

Information available for this NOAA Code includes:

- NOAA Code map (Figure B.11-1)
- Harvest (Figure B.11-2)

The Fall Survey surveyed one site in this area three times during the time series: 2006, 2007, and 2019. Due to lack of data, no analysis on trends can be determined.

Between 2006 and 2020, approximately 228 thousand bushels of shell, 8 thousand bushels of wild seed and 87 million hatchery spat-on-shell were planted to enhance the commercial public fishery in this NOAA Code outside of the current sanctuary area.

Harvest for the NOAA Code has been reported on seafood dealer buy tickets for the 15-year time series. This includes past harvest data from areas in the NOAA Code that are currently in a sanctuary area, but weren't when the harvest occurred prior to the sanctuary being established. Since 2010, 88% of the NOAA Code area has been a sanctuary where harvest is prohibited. Harvest reported ranged from less than 100 bushels in the 2006-07 season to a maximum of approximately 14 thousand bushels in the 2014-15 season. Power dredging was used to obtain the majority of the harvest.

We are unaware of any continuous water quality monitoring in this area.

[24] 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

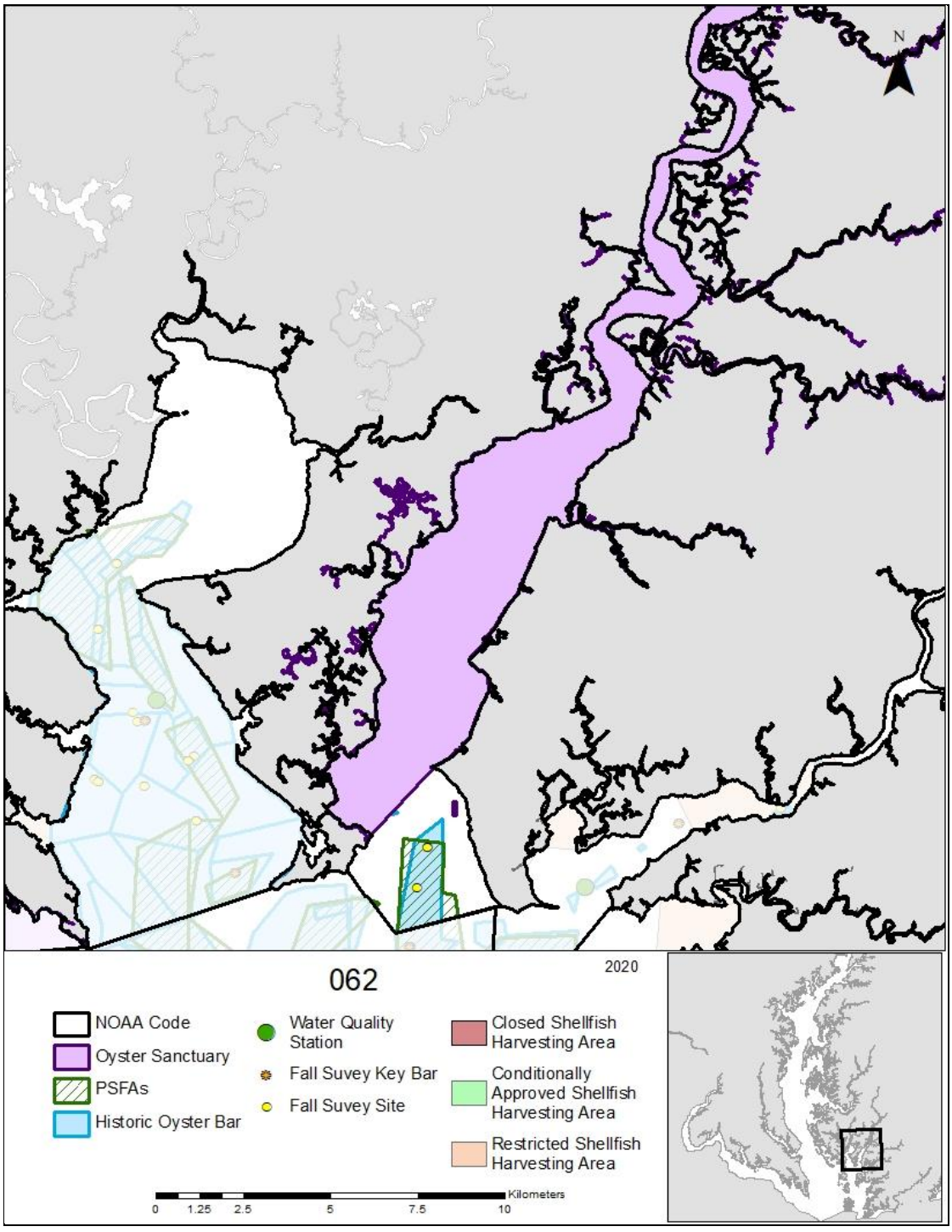


Figure B.11-1. Map of NOAA Code 062 (Nanticoke River). Fall Survey sites may not be sampled every year.

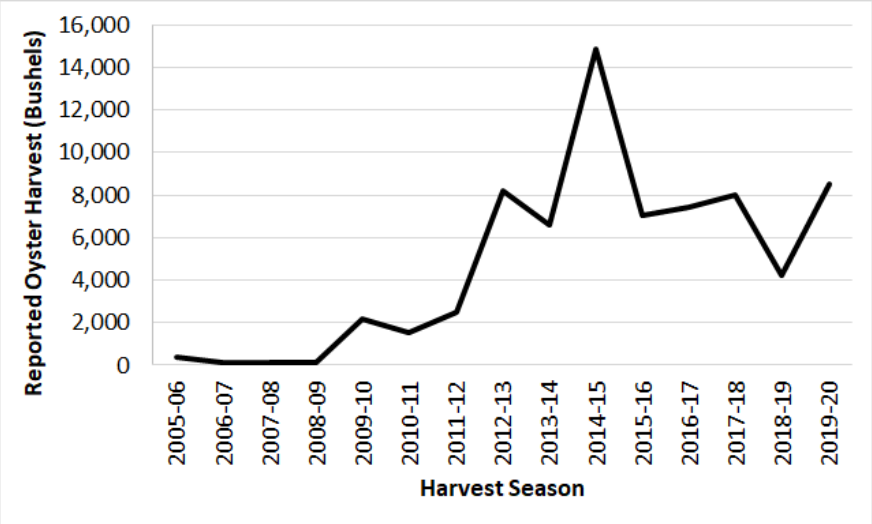


Figure B.11-2. Oyster harvest reported from seafood dealer buy tickets (harvest seasons 2005-2006 to 2019-2020) in NOAA Code 062 (Nanticoke River). Since 2010, 88% of the NOAA Code area has been a sanctuary where harvest is prohibited.

## Section B.12: NOAA Code 072 – Pocomoke Sound

NOAA Code 072 encompasses Pocomoke Sound and is located in Maryland's lower eastern portion of Chesapeake Bay. The entire NOAA Code is 16,273 acres and has 16 historic oyster bars[25]. The Kitts Creek Sanctuary encompasses 7% (1,181 total acres) of the NOAA Code. This section focuses on information collected within the NOAA Code occurring outside of the current sanctuary area. This equates to 15,092 surface acres. There are 4,018 acres of historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments) located within the NOAA Code and outside a sanctuary. None of the area within the NOAA Code was designated as a Public Shellfish Fishery Area. This NOAA Code is located within Maryland's high-salinity region (Zone 3).

Information available for this NOAA Code includes:

- NOAA Code map (Figure B.12-1)
- Summary statistics (Table B.12-1)
- Abundance per year (Figure B.12-2)
- Shell height frequencies (Figure B.12-3)
- Biomass per year (Figure B.12-4)
- Observed mortality (Figure B.12-5)
- Dermo and MSX per year (Figure B.12-6)
- Cultch per year (Figure B.12-7)
- Harvest (Figure B.12-8)
- Water Quality (Figure B.12-9)

Fall Survey results indicated that average spat, small, and market densities decreased in 2016-2020 compared to 2011-2015. This trend is most likely due to increased small and market densities in 2011 through 2013 and correspondingly higher harvests in 2012-13 and 2013-14 harvest seasons. Spat density was highest in 2010 and 2012 which corresponds with high baywide spatsets. Biomass increased in 2011 and then declined until 2019. Mortality was at or below the long term baywide average for the entire time series.

Between 2006 and 2020, approximately 35 thousand bushels of shell were planted to enhance the commercial public fishery in this NOAA Code outside of the current sanctuary area.

Harvest for the NOAA Code has been reported on seafood dealer buy tickets for all of the 15-year time series. Since 2001, 7% of the NOAA Code area has been a sanctuary where harvest is prohibited. Harvest reported ranged from approximately 300 bushels in the 2006-07 season to a maximum of approximately 35 thousand bushels in the 2012-13 season. Power dredging was used to obtain the majority of the harvest.

Continuous water quality monitoring has occurred at station EE3.3 (37.91455; -75.8015). During the 2006-2020 timeline, surface salinity ranged from 9.8 ppt to 21.8 ppt, with the lowest salinity being during the freshet of 2018-2019 and during the high rainfall year of 2011.

[25] See chart 48 for bar names and locations in the State of Maryland Shellfish Closure Areas Book http://dnr.maryland.gov/fisheries/Pages/oysters/index.aspx

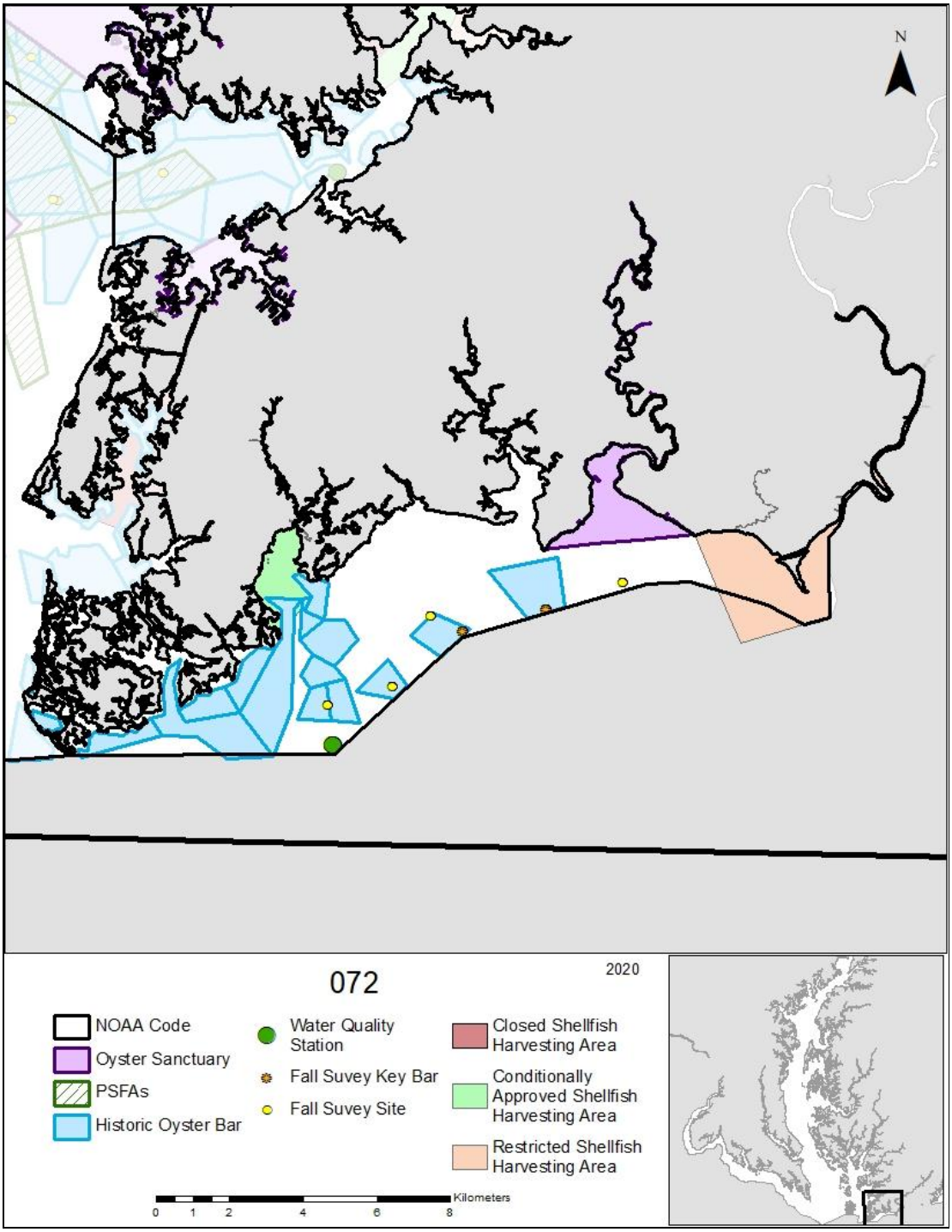


Figure B.12-1. Map of NOAA Code 072 (Pocomoke Sound). Fall Survey sites may not be sampled every year. Fall Survey key bars may consist of a key bar, disease bar or both.

Table B.12-1. Oyster population characteristics based on the Fall Survey in the NOAA Code 072 (Pocomoke Sound) occurring outside of the current sanctuary area. ND = No Data. Values are given as an annual mean ± standard error.

| | 2006-10 | 2011-15 | 2016-20 |
|---|---|---|---|
| Number of Years Sampled / Number of Samples | 5 / 30 | 5 / 30 | 5 / 30 |
| Number of Live Spat Oysters per square meter | 49.5 ± 34.4 | 78.9 ± 29.1 | 34 ± 7.7 |
| Number of Live Small-Sized Oysters per square meter | 24.5 ± 5.6 | 114.2 ± 32.1 | 58.6 ± 10 |
| Number of Live Market-Sized Oysters per square meter | 10.7 ± 3.2 | 38.6 ± 10.9 | 12.9 ± 4.4 |
| Live Oyster Biomass (g Dry Weight per Bushel) | 44 ± 11 | 208 ± 37 | 66 ± 20 |
| Observed Mortality (%) | 13 ± 2 | 10 ± 2 | 9 ± 2 |
| Cultch (Bushels per 100 ft Towed) | 1.01 ± 0.17 | 1.23 ± 0.22 | 0.94 ± 0.09 |
| Harvest (Bushels) | 747 ± 142 | 18,187 ± 7,212 | 5,181 ± 1,508 |
| Note: The number of samples is based on the number of samples having a value for observed mortality. There may be fewer samples per year for density, biomass, and cultch. | | | |

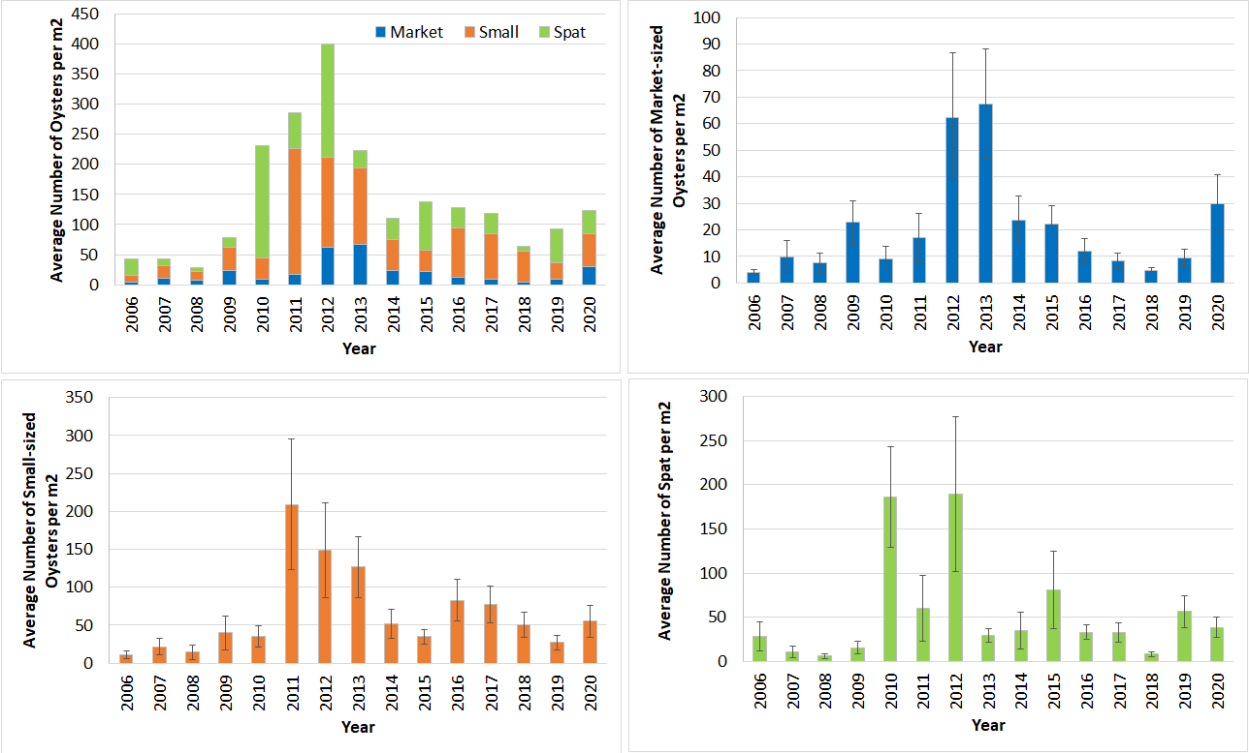


Figure B.12-2. Average number of live oysters per square meter by size class in NOAA Code 072 (Pocomoke Sound) occurring outside of the current sanctuary area. Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales.

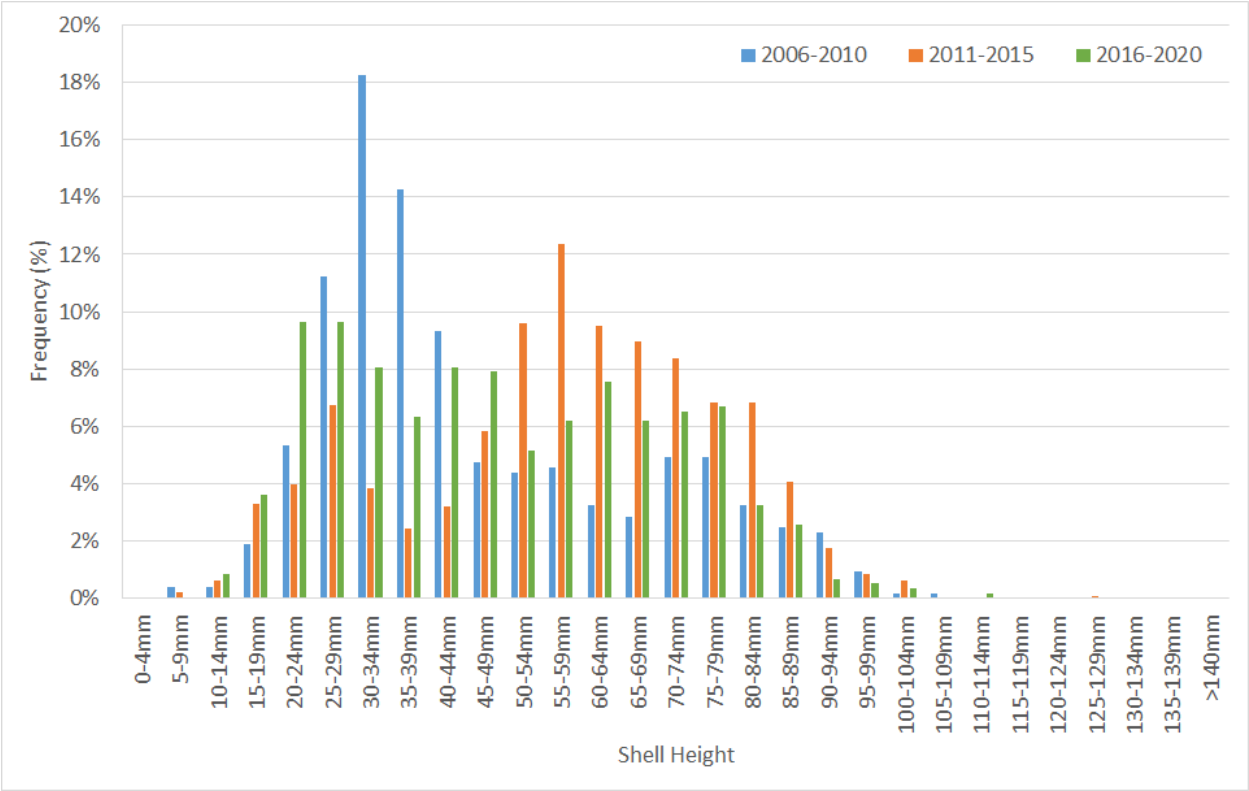


Figure B.12-3. Shell height frequencies of live oysters per bushel of material in NOAA Code 072 (Pocomoke Sound) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey on Marumsco bar.

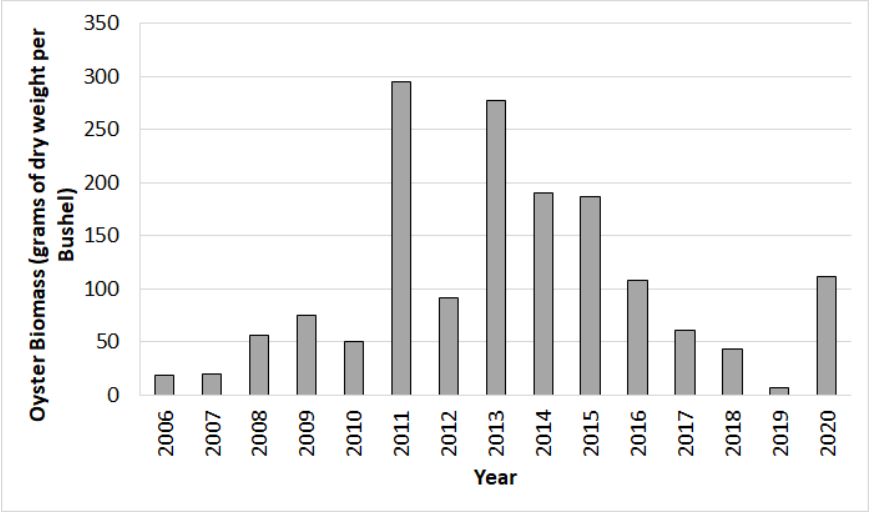


Figure B.12-4. Oyster biomass (grams of dry weight per bushel of material) in NOAA Code 072 (Pocomoke Sound) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey on Marumsco bar.

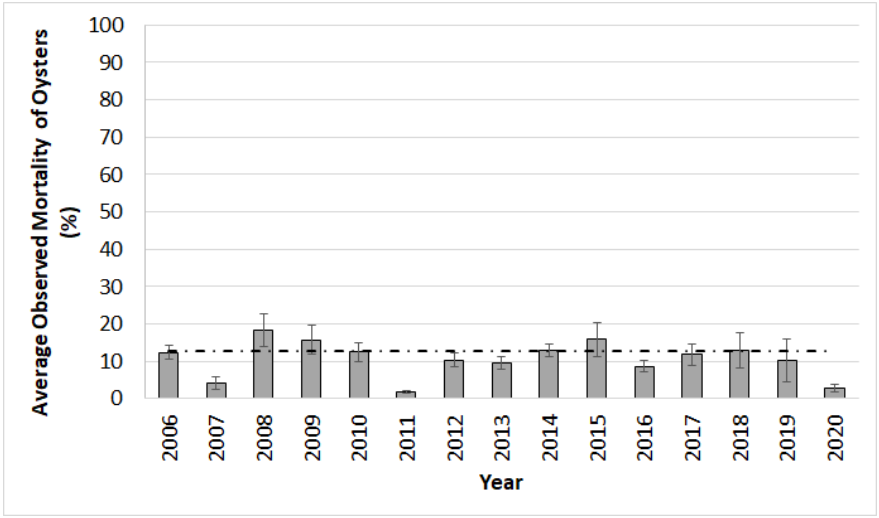


Figure B.12-5. Average annual observed mortality of market-sized and small-sized oysters in NOAA Code 072 (Pocomoke Sound) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey. The dashed line represents the 2006-2020 baywide average observed mortality. Error bars represent ± 1 standard error.

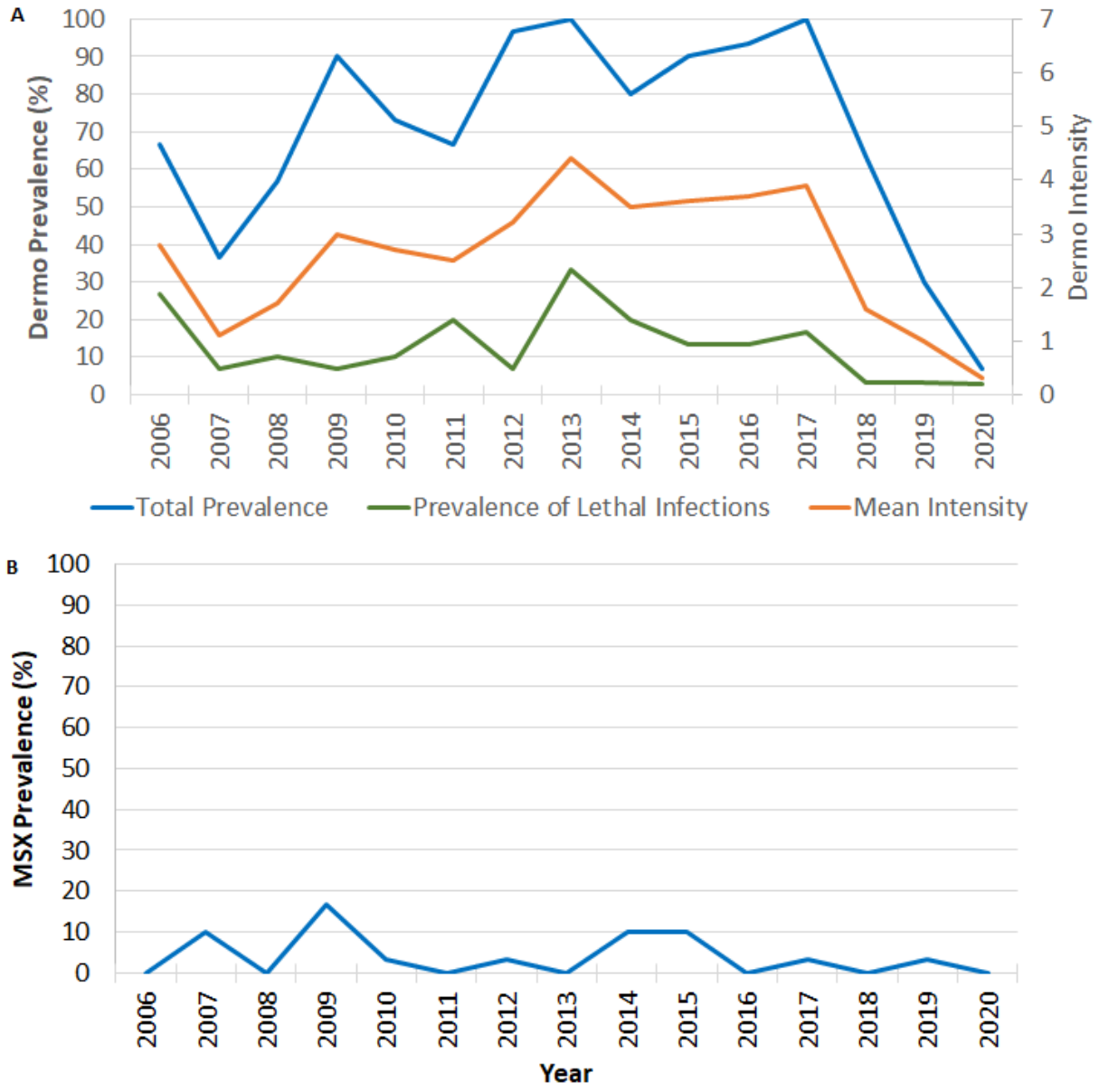


Figure B.12-6. Oyster disease prevalence and intensity in NOAA Code 072 (Pocomoke Sound) occurring outside of the current sanctuary area. (A) Dermo prevalence and mean intensity (B) MSX prevalence (intensity is not examined). Data from Maryland's Annual Fall Oyster Dredge Survey on Marumsco bar.

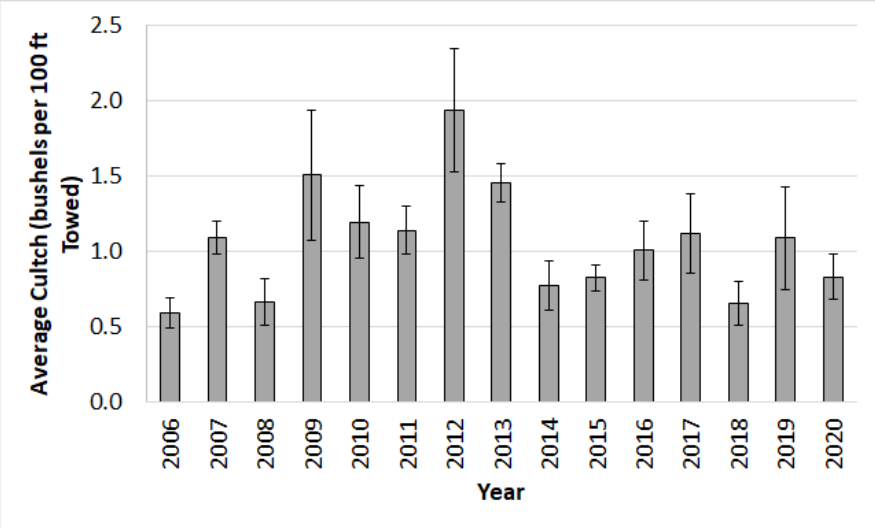


Figure B.12-7. Average cultch (live and dead oysters and loose shell) in NOAA Code 072 (Pocomoke Sound) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey. Error bars represent ± 1 standard error.

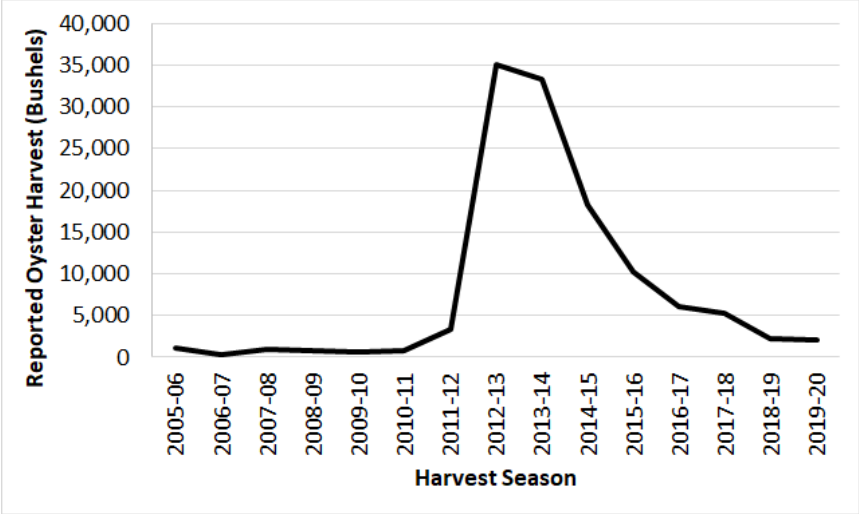


Figure B.12-8. Oyster harvest reported from seafood dealer buy tickets (harvest seasons 2005-2006 to 2019-2020) in NOAA Code 072 (Pocomoke Sound). Since 2001, 7% of the NOAA Code area has been a sanctuary where harvest is prohibited.

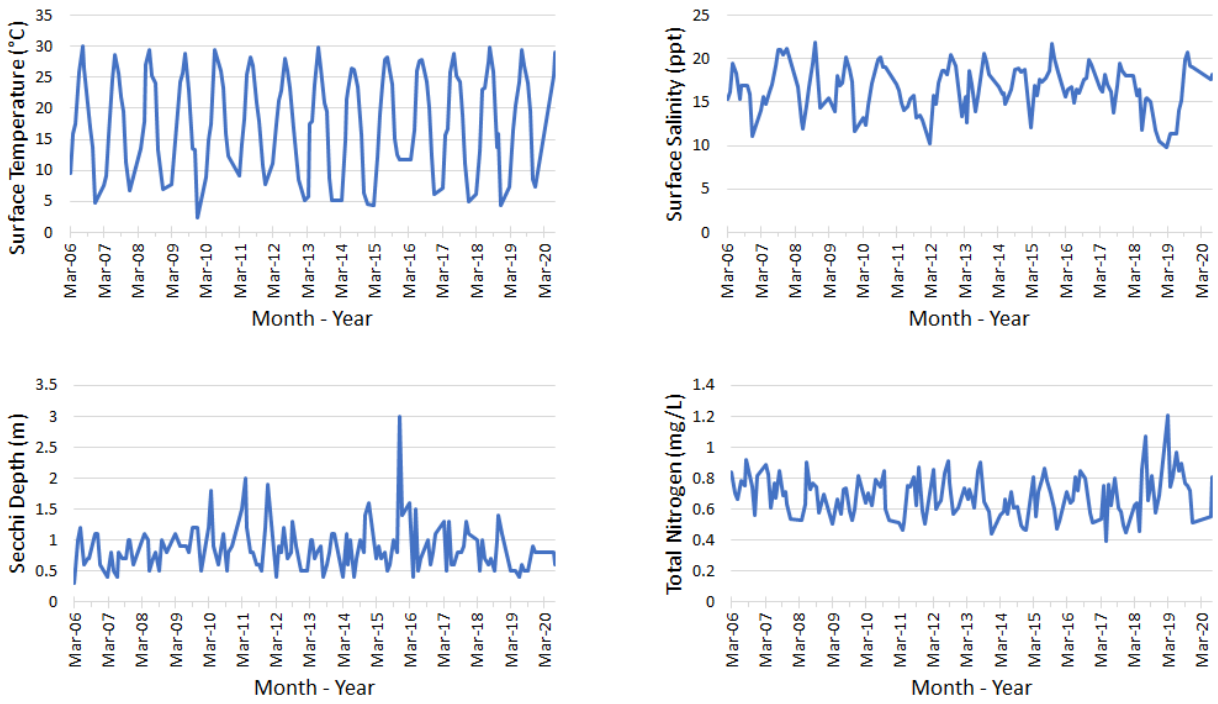


Figure B.12-9. Water quality data collected at Station EE3.3 in NOAA Code 072 (Pocomoke Sound). Data from Chesapeake Bay Program Data Hub.

## Section B.13: NOAA Code 078 – St. Marys River

NOAA Code 078 encompasses the St. Marys River, a tributary of the Potomac River, and is located in Maryland's lower western portion of Chesapeake Bay. The entire NOAA Code is 6,020 acres and has 32 historic oyster bars[26]. The St Marys Sanctuary encompasses 21% (1,304 total acres) of the NOAA Code. This section focuses on information collected within the NOAA Code occurring outside of the current sanctuary area. This equates to 4,716 surface acres. There are 1,096 acres of historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments) located within the NOAA Code and outside a sanctuary. As of 2020, there are 1,981 acres within the NOAA Code designated as a Public Shellfish Fishery Area (PSFA). Aquaculture leasing is prohibited within PSFA boundaries. This NOAA Code is located within Maryland's medium-salinity region (Zone 2).

Information available for this NOAA Code includes:

- NOAA Code map (Figure B.13-1)
- Summary statistics (Table B.13-1)
- Abundance per year (Figure B.13-2)
- Shell height frequencies (Figure B.13-3)
- Biomass per year (Figure B.13-4)
- Observed mortality (Figure B.13-5)
- Dermo and MSX per year (Figure B.13-6)
- Cultch per year (Figure B.13-7)
- Harvest (Figure B.13-8)

Fall Survey results indicated that average small density increased in 2016-2020 and average spat and market densities stayed about the same. Average biomass in 2016-2020 was the same as in 2011-2015 but was about double the 2006-2010 biomass. Mortality remained mostly constant over the three time periods at slightly above the long term baywide average, however, mortality increased in 2009, 2010, and 2016.

Between 2006 and 2020, approximately 43 thousand bushels of shell, 3.3 thousand bushels of wild seed and 23 million hatchery spat-on-shell were planted to enhance the commercial public fishery in this NOAA Code outside of the current sanctuary area.

Harvest for the NOAA Code has been reported on seafood dealer buy tickets for all of the 15-year time series. This includes past harvest data from areas in the NOAA Code that are currently in a sanctuary area, but weren't when the harvest occurred prior to the sanctuary being established. Since 2010, 21% of the NOAA Code area has been a sanctuary where harvest is prohibited. Harvest reported ranged from approximately one thousand bushels in the 2007-08 season to a maximum of approximately 18 thousand bushels in the 2017-18 season. Power dredging was used to obtain about three-quarters of the harvest and hand tonging about a quarter.

[26] 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

We are unaware of any continuous water quality monitoring in this area.

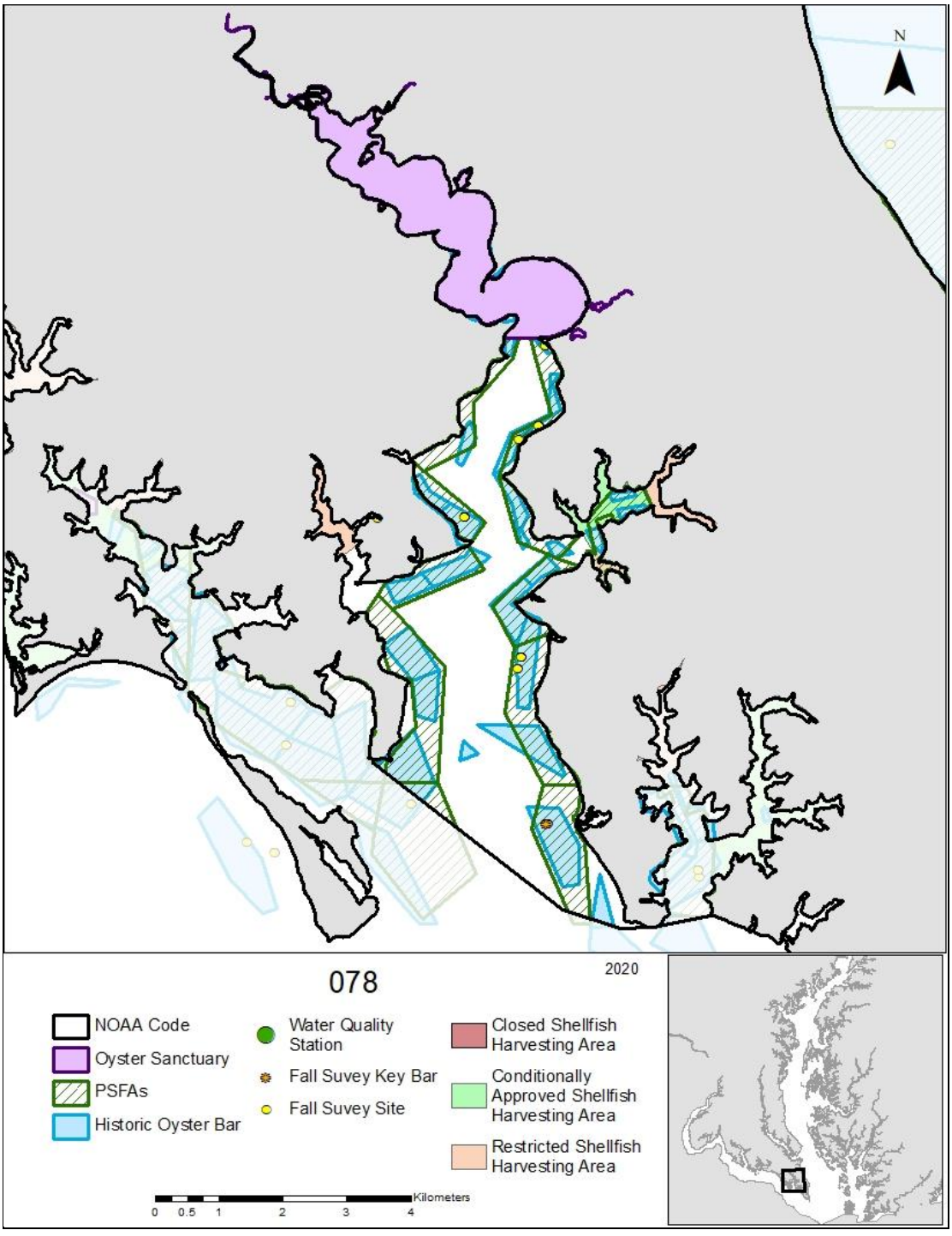


Figure B.13-1. Map of NOAA Code 078 (St. Marys River). Fall Survey sites may not be sampled every year. Fall Survey key bars may consist of a key bar, disease bar or both.

Table B.13-1. Oyster population characteristics based on the Fall Survey in the NOAA Code 078 (St. Marys River) occurring outside of the current sanctuary area. ND = No Data. Values are given as an annual mean ± standard error.

| | 2006-10 | 2011-15 | 2016-20 |
|---|---|---|---|
| Number of Years Sampled / Number of Samples | 5 / 26 | 5 / 25 | 5 / 30 |
| Number of Live Spat Oysters per square meter | 44.5 ± 19.5 | 39.2 ± 23.9 | 51.7 ± 24.9 |
| Number of Live Small-Sized Oysters per square meter | 59 ± 18.9 | 85.2 ± 36.6 | 149.1 ± 56.8 |
| Number of Live Market-Sized Oysters per square meter | 10.3 ± 3.2 | 16.5 ± 4.2 | 21.2 ± 7.3 |
| Live Oyster Biomass (g Dry Weight per Bushel) | 47 ± 10 | 115 ± 34 | 124 ± 20 |
| Observed Mortality (%) | 24 ± 4 | 18 ± 3 | 20 ± 5 |
| Cultch (Bushels per 100 ft Towed) | 0.81 ± 0.15 | 0.78 ± 0.17 | 1.03 ± 0.18 |
| Harvest (Bushels) | 1,890 ± 283 | 6,282 ± 2,086 | 11,411 ± 1,816 |
| Note: The number of samples is based on the number of samples having a value for observed mortality. There may be fewer samples per year for density, biomass, and cultch. | | | |

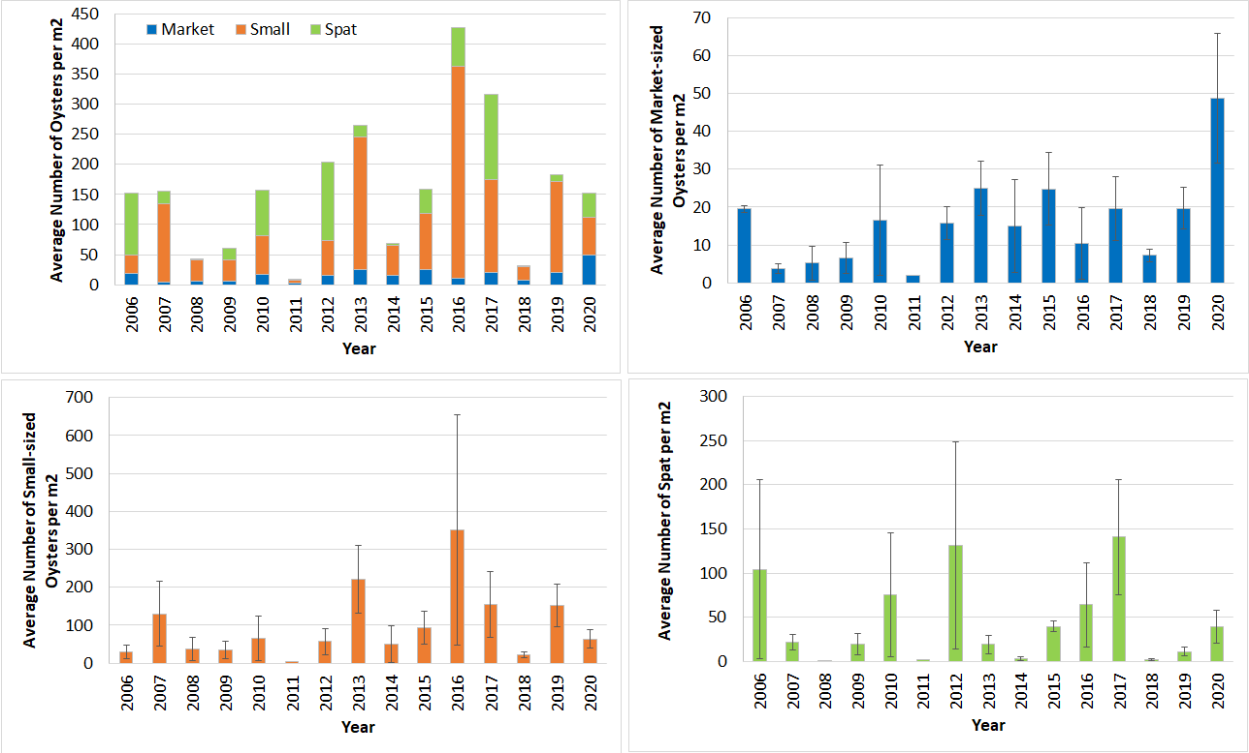


Figure B.13-2. Average number of live oysters per square meter by size class in NOAA Code 078 (St. Marys River) occurring outside of the current sanctuary area. Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales.

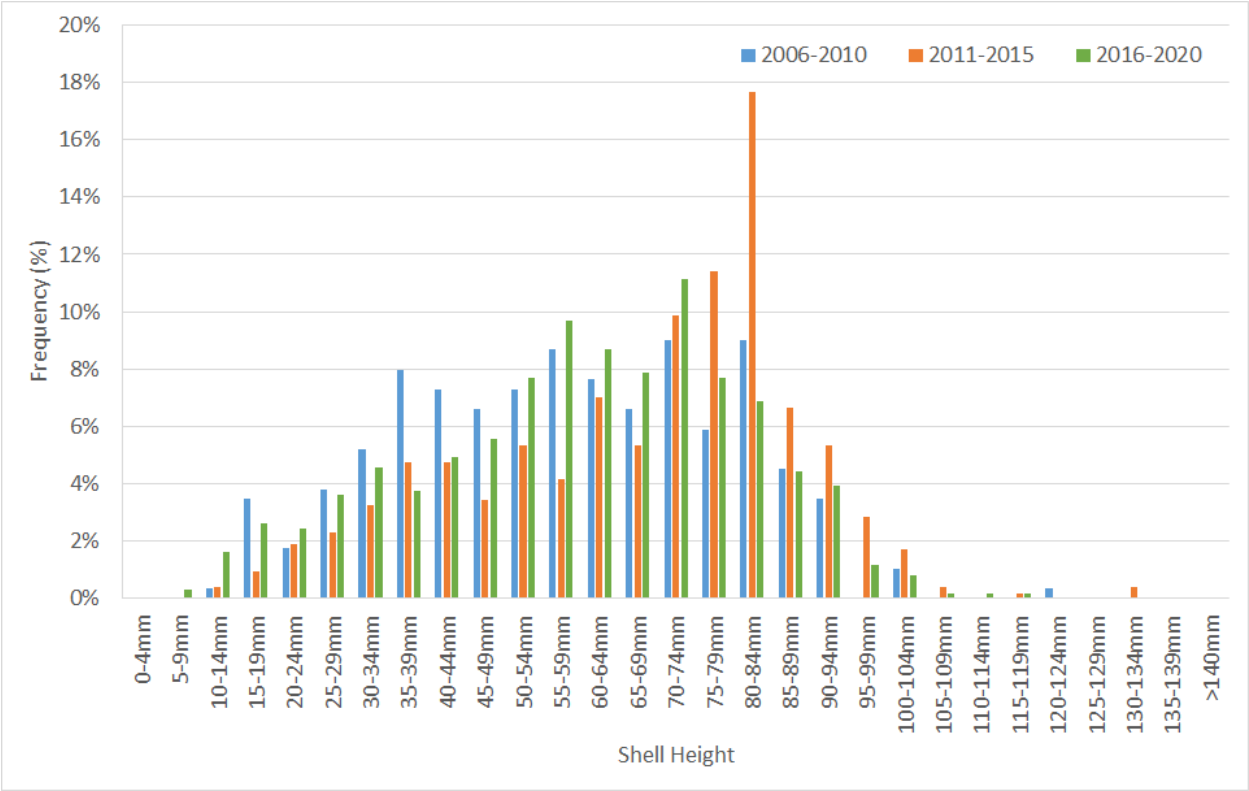


Figure B.13-3. Shell height frequencies of live oysters per bushel of material in NOAA Code 078 (St. Marys River) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey on Chicken Cock bar.

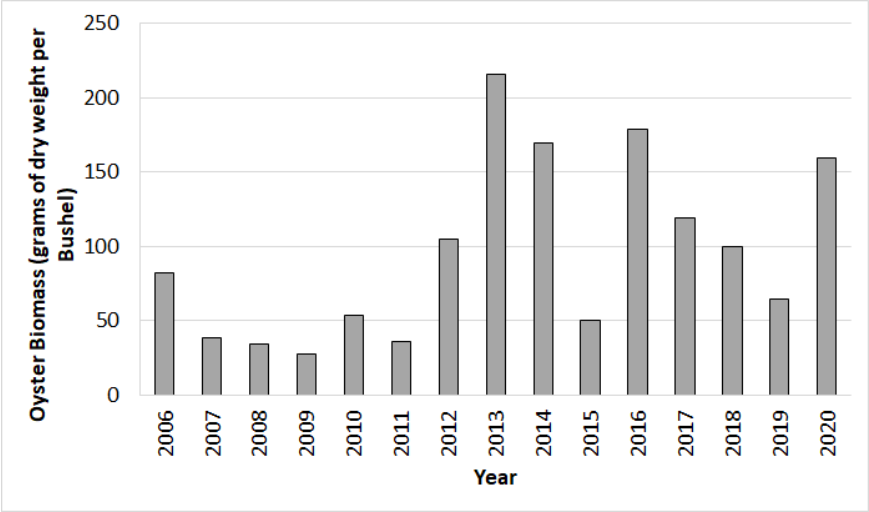


Figure B.13-4. Oyster biomass (grams of dry weight per bushel of material) in NOAA Code 078 (St. Marys River) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey on Chicken Cock bar.

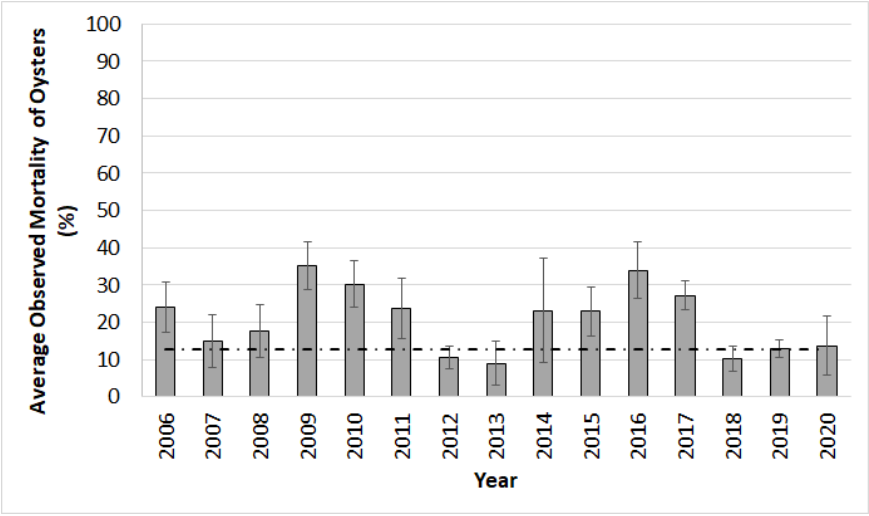


Figure B.13-5. Average annual observed mortality of market-sized and small-sized oysters in NOAA Code 078 (St. Marys River) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey. The dashed line represents the 2006-2020 baywide average observed mortality. Error bars represent ± 1 standard error.

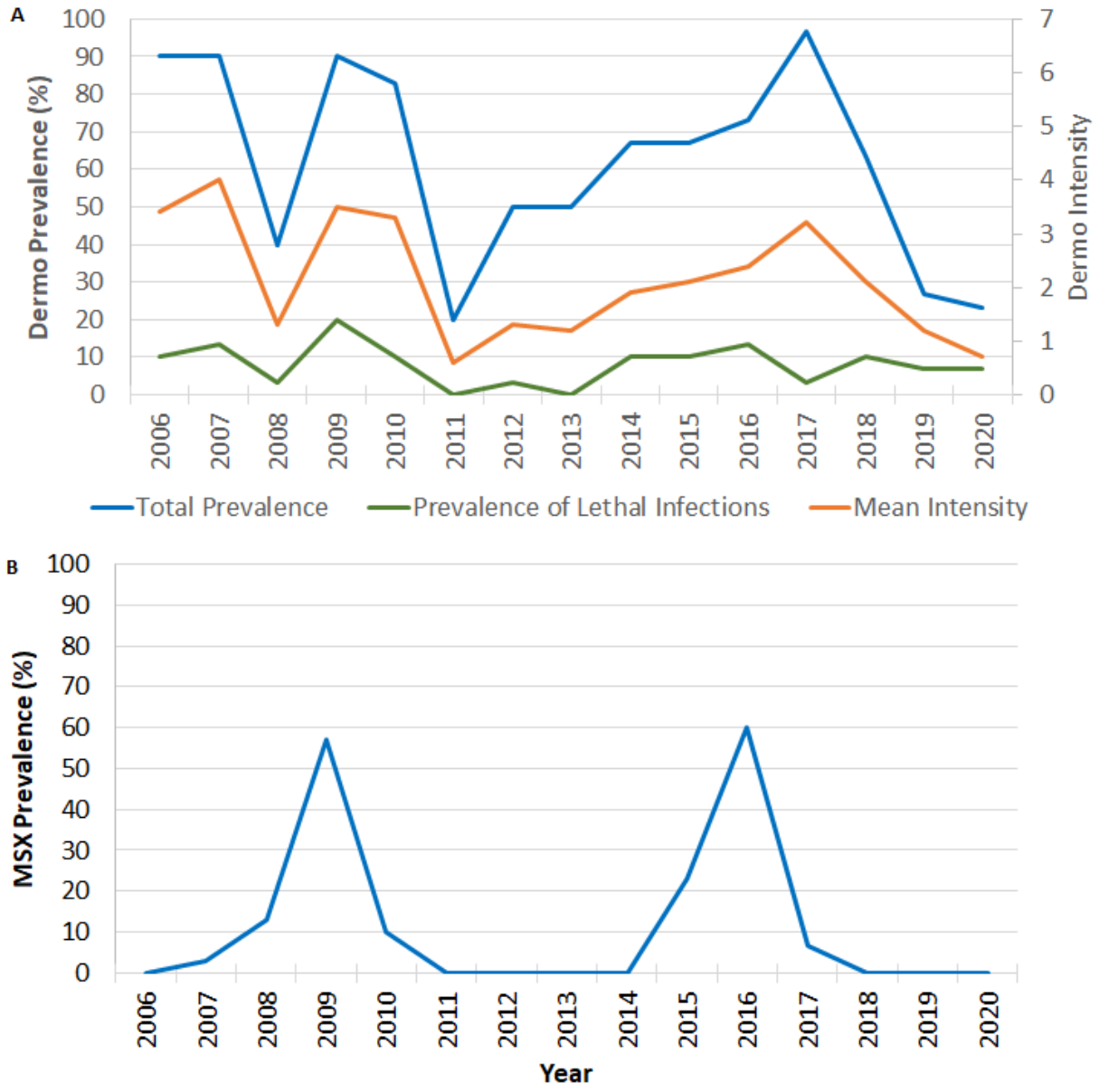


Figure B.13-6. Oyster disease prevalence and intensity in NOAA Code 078 (St. Marys River) occurring outside of the current sanctuary area. (A) Dermo prevalence and mean intensity (B) MSX prevalence (intensity is not examined). Data from Maryland's Annual Fall Oyster Dredge Survey on Chicken Cock bar.

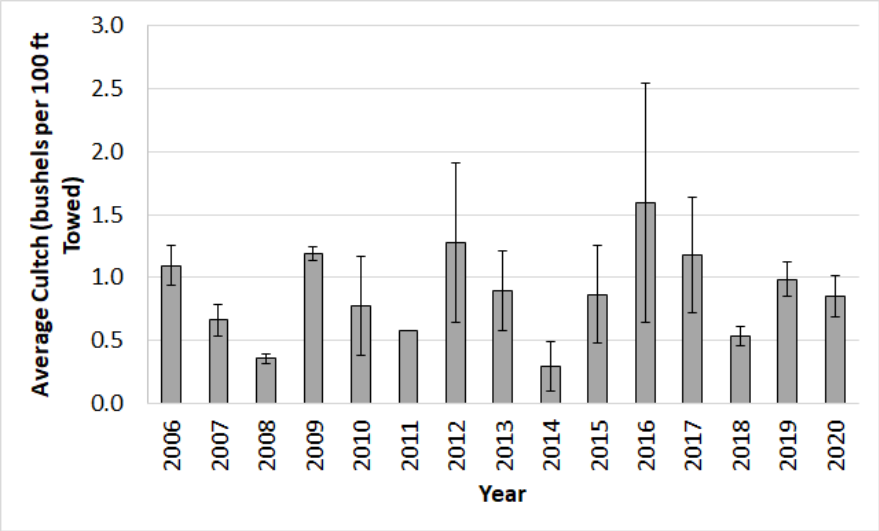


Figure B.13-7. Average cultch (live and dead oysters and loose shell) in NOAA Code 078 (St. Marys River) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey. Error bars represent ± 1 standard error.

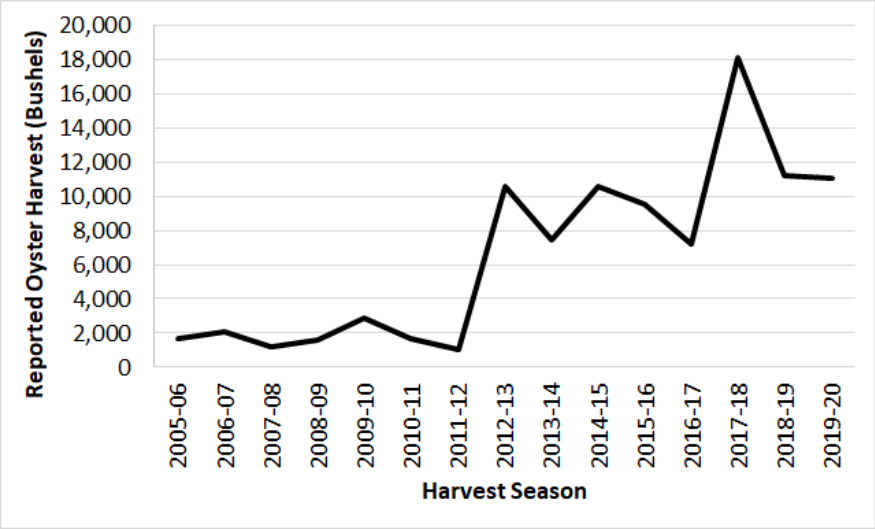


Figure B.13-8. Oyster harvest reported from seafood dealer buy tickets (harvest seasons 2005-2006 to 2019-2020) in NOAA Code 078 (St. Marys River). Since 2010, 21% of the NOAA Code area has been a sanctuary where harvest is prohibited.

## Section B.14: NOAA Code 082 – Severn River

NOAA Code 082 (Severn River) is 7,549 acres; however, only 151 acres is outside a current sanctuary boundary. Severn River Sanctuary was established in 1998 and expanded in 2010. As of 2020, there are 40 acres within the NOAA Code designated as a Public Shellfish Fishery Area (PSFA). Aquaculture leasing is prohibited within PSFA boundaries. This NOAA Code is located within Maryland's low-salinity region (Zone 1).

Information available for this NOAA Code includes:

- NOAA Code map (Figure B.14-1)

The Fall Survey has not collected any samples within this NOAA Code outside the current sanctuary area since 2006. See Appendix A Section A.39 for more information on the oyster population characteristics. Between 2006 and 2020, no replenishment planting activities occurred to enhance the commercial public fishery in this NOAA Code outside of the current sanctuary area.

Harvest for the NOAA Code has been reported on seafood dealer buy tickets for four years out of the 15-year time series for a total of approximately 70 bushels. This includes past harvest data from areas in the NOAA Code that are currently in a sanctuary area, but weren't when the harvest occurred prior to the sanctuary being established. Since 2010, 98% of the NOAA Code area has been a sanctuary where harvest is prohibited.

We are unaware of any continuous water quality monitoring in this area.

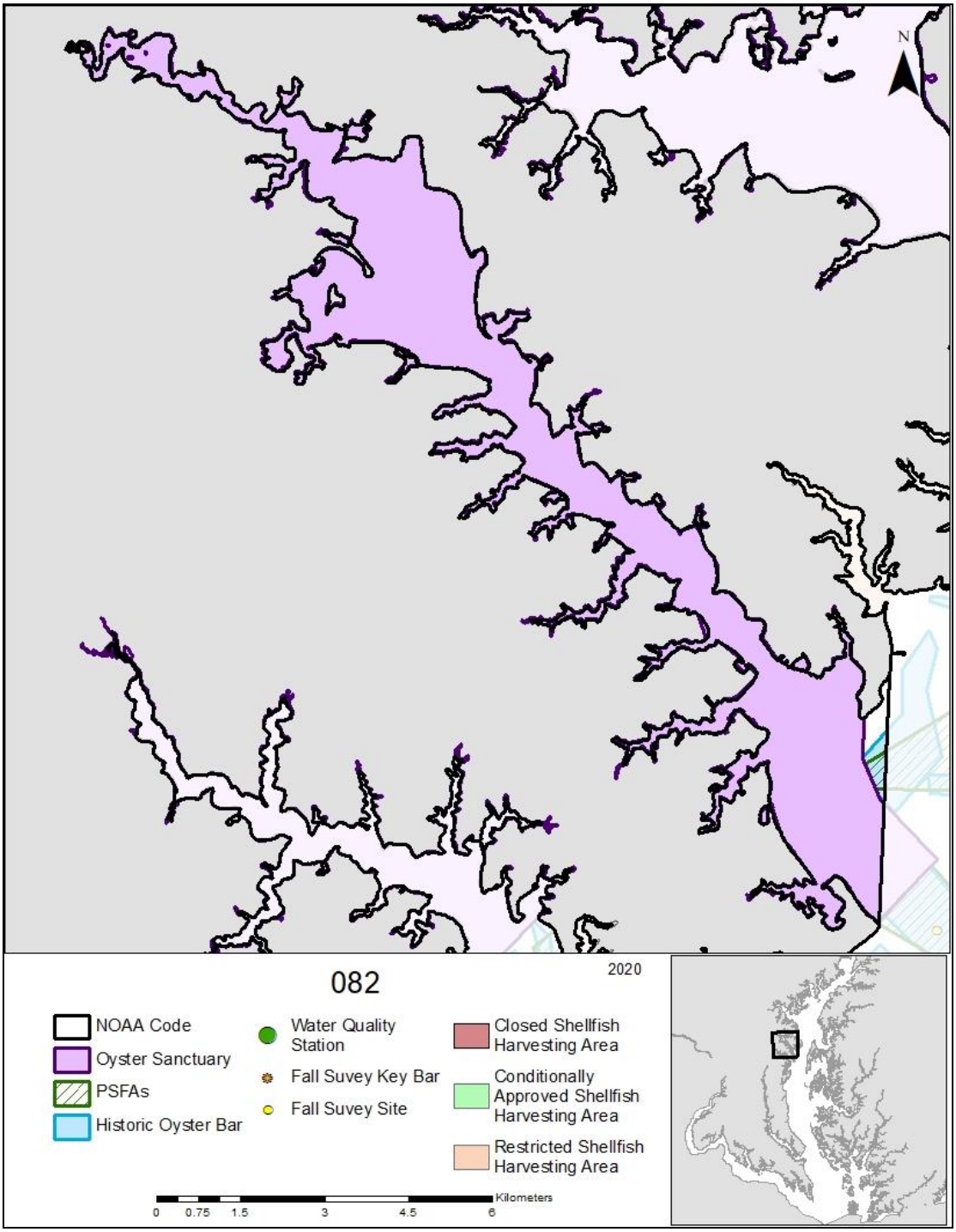


Figure B.14-1. Map of NOAA Code 082 (Severn River). Fall Survey sites may not be sampled every year.

## Section B.15: NOAA Code 086 – Smith Creek

NOAA Code 086 encompasses Smith Creek and is a tributary of the Potomac River located below the St. Marys River. The entire NOAA Code is 845 acres and has six historic oyster bars[27]. None of the area of the NOAA Code is within a sanctuary. There are 246 acres of historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments) located within the NOAA Code. As of 2020, there are 288 acres within the NOAA Code designated as a Public Shellfish Fishery Area (PSFA). Aquaculture leasing is prohibited within PSFA boundaries. This NOAA Code is located within Maryland's medium-salinity region (Zone 2).

Information available for this NOAA Code includes:

- NOAA Code map (Figure B.15-1)
- Summary statistics (Table B.15-1)
- Abundance per year (Figure B.15-2)
- Observed mortality (Figure B.15-3)
- Cultch per year (Figure B.15-4)
- Harvest (Figure B.15-5)

Fall Survey results indicate no trend in spat, small, and market densities during the three time periods. Cultch was the same in 2016-2020 as compared to 2011-2015 but lower than the 2006-2010 time period. Mortality varied over the time series with relatively high mortality in 2009 and 2010 and again in 2016. No disease or water quality information is available for this area to explain the higher mortalities.

Between 2006 and 2020, approximately 2.6 thousand bushels of shell were planted to enhance the commercial public fishery in this NOAA Code outside of the current sanctuary area.

Harvest for the NOAA Code has been reported on seafood dealer buy tickets all years of the 15-year time series. Harvest reported ranged from less than 10 bushels in the 2010-11 season to a maximum of approximately 1.4 thousand bushels in the 2015-15 season. Diving was used to obtain the majority of the harvest.

We are unaware of any continuous water quality monitoring in this area.

[27] 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

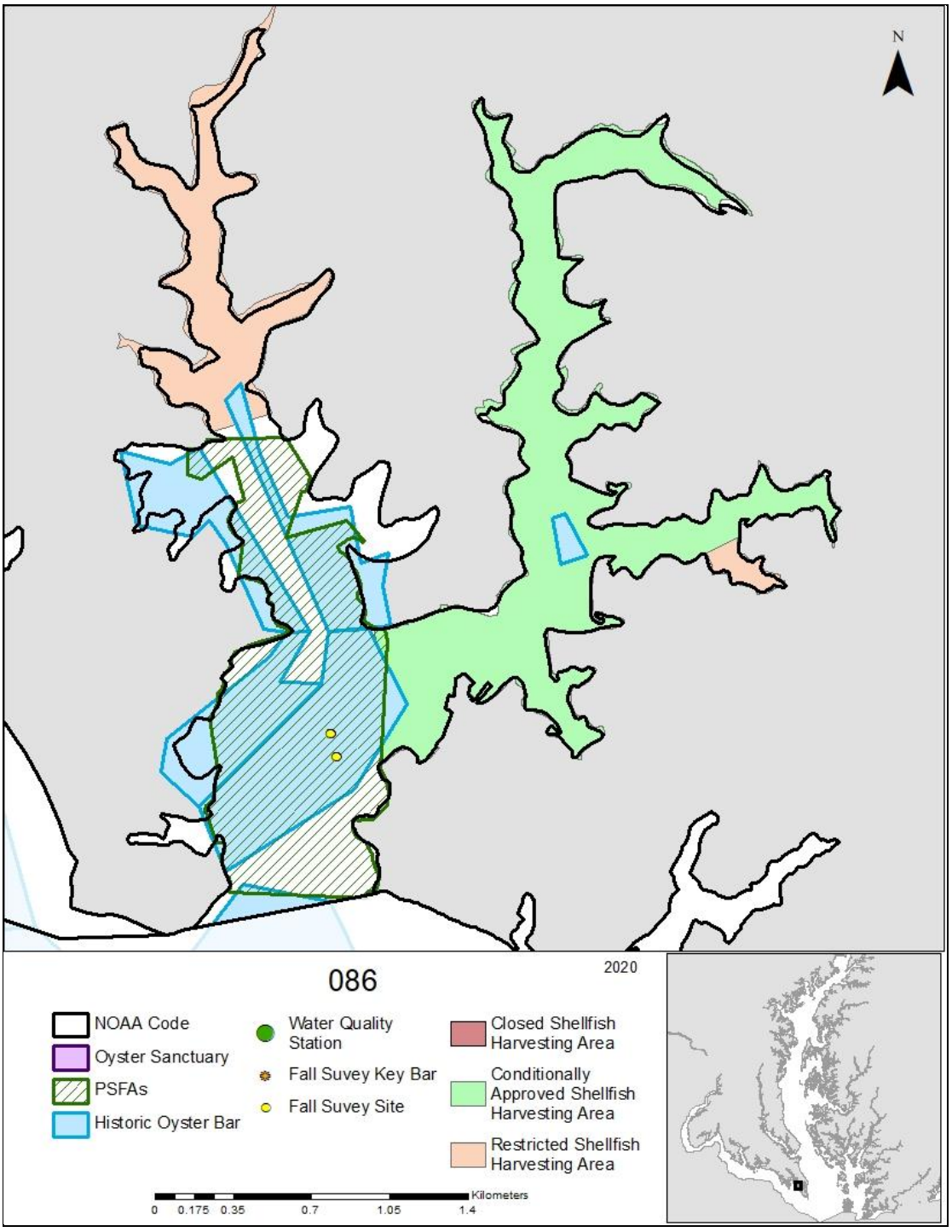


Figure B.15-1. Map of NOAA Code 086 (Smith Creek). Fall Survey sites may not be sampled every year.

| Table B.15-1. Oyster population characteristics based on the Fall Survey in the NOAA Code 086 (Smith Creek). ND = No Data. Values are given as an annual mean ± standard error. | | | |
|---|---|---|---|
| | **2006-10** | **2011-15** | **2016-20** |
| Number of Years Sampled / Number of Samples | 5 / 5 | 5 / 5 | 5 / 5 |
| Number of Live Spat Oysters per square meter | 10.9 ± 6.7 | 7.4 ± 3.7 | 6.3 ± 4.1 |
| Number of Live Small-Sized Oysters per square meter | 39 ± 17 | 14.8 ± 5.3 | 22.2 ± 5.8 |
| Number of Live Market-Sized Oysters per square meter | 23.4 ± 4.3 | 17.3 ± 4.4 | 15.9 ± 3 |
| Live Oyster Biomass (g Dry Weight per Bushel) | ND | ND | ND |
| Observed Mortality (%) | 25 ± 8 | 9 ± 3 | 17 ± 6 |
| Cultch (Bushels per 100 ft Towed) | 1.12 ± 0.23 | 0.53 ± 0.25 | 0.56 ± 0.1 |
| Harvest (Bushels) | 72 ± 33 | 607 ± 274 | 936 ± 117 |
| Note: The number of samples is based on the number of samples having a value for observed mortality. There may be fewer samples per year for density, biomass, and cultch. | | | |

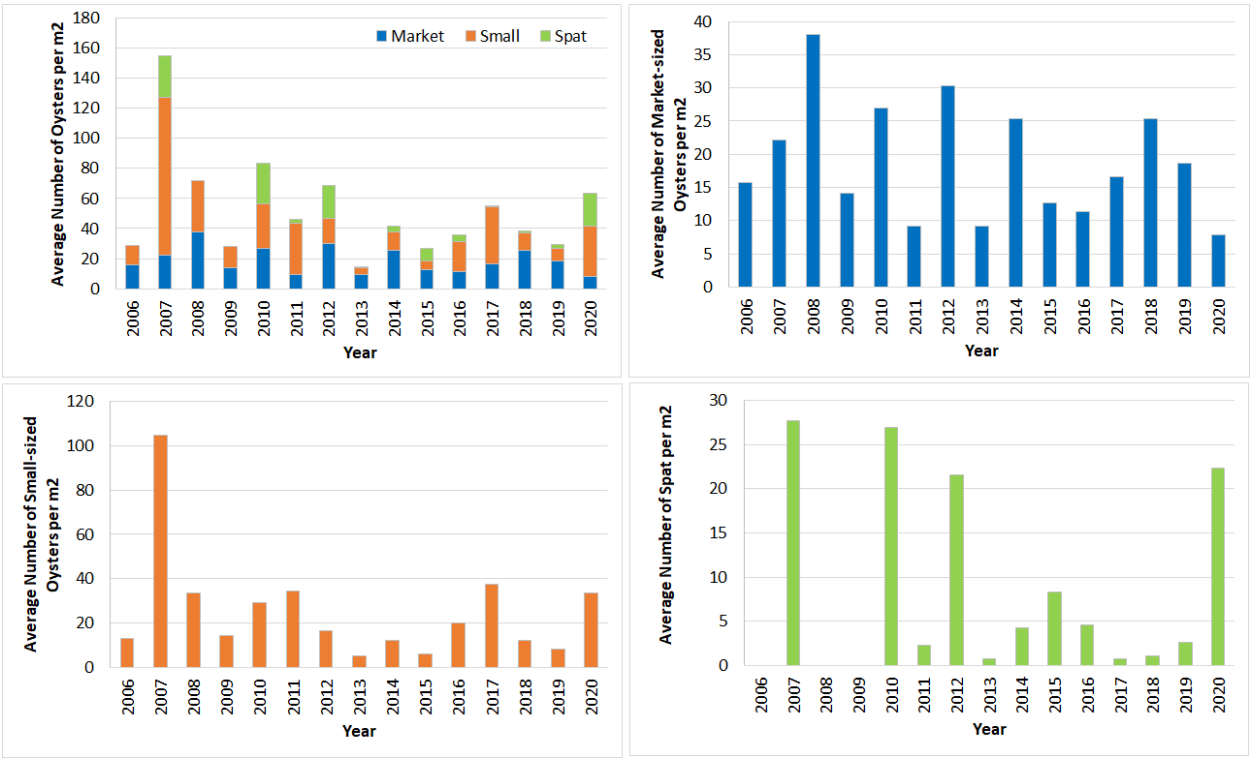


Figure B.15-2. Average number of live oysters per square meter by size class in NOAA Code 086 (Smith Creek). Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales.

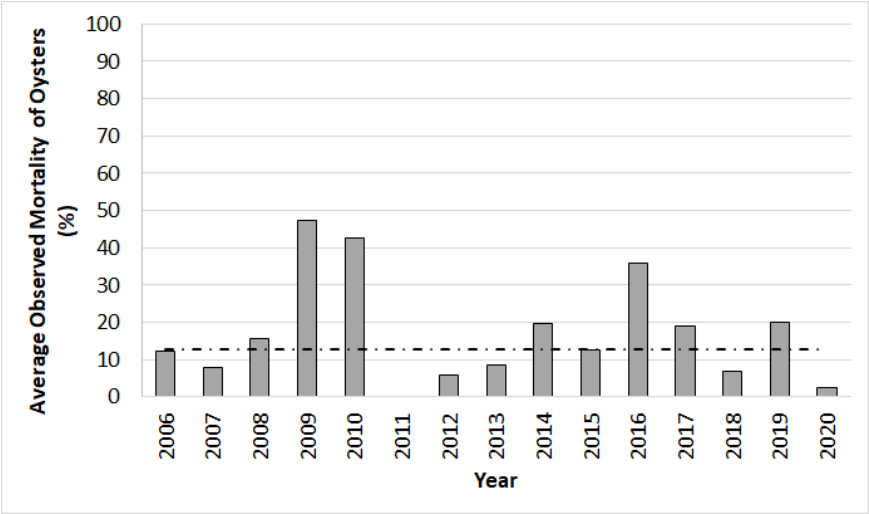


Figure B.15-3. Average annual observed mortality of market-sized and small-sized oysters in NOAA Code 086 (Smith Creek). Data from Maryland's Annual Fall Oyster Dredge Survey. The dashed line represents the 2006-2020 baywide average observed mortality.

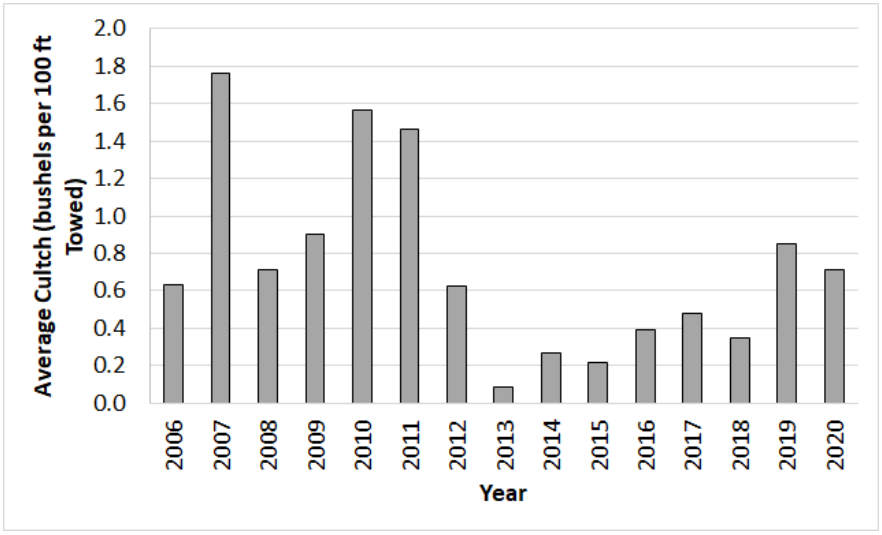


Figure B.15-4. Average cultch (live and dead oysters and loose shell) in NOAA Code 086 (Smith Creek). Data from Maryland's Annual Fall Oyster Dredge Survey.

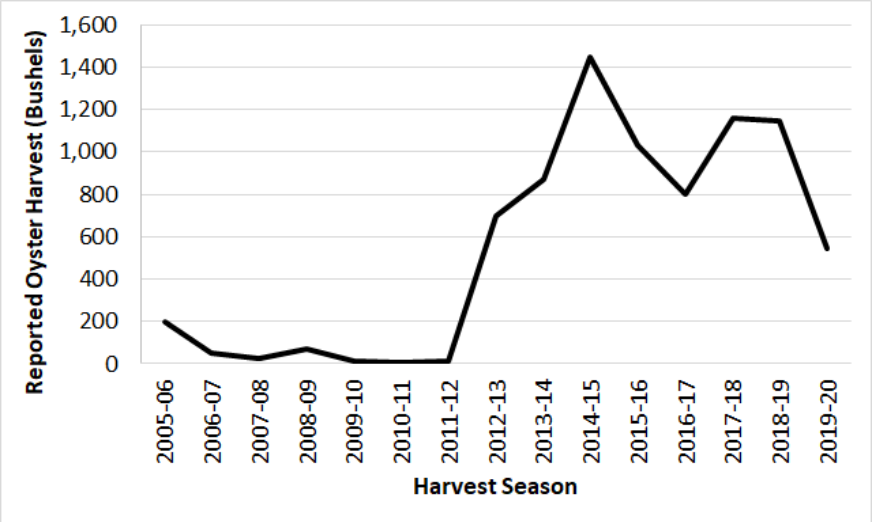


Figure B.15-5. Oyster harvest reported from seafood dealer buy tickets (harvest seasons 2005-2006 to 2019-2020) in NOAA Code 086 (Smith Creek).

## Section B.16: NOAA Code 088 – South River

NOAA Code 088 encompasses the South River and is located in Maryland's upper western portion of Chesapeake Bay. The entire NOAA Code is 5,995 acres and has 20 historic oyster bars [28]. The South River Sanctuary encompasses 38% (2,327 total acres) of the NOAA Code. This section focuses on information collected within the NOAA Code occurring outside of the current sanctuary area. This equates to 3,668 surface acres. There are 1,310 acres of historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments) located within the NOAA Code and outside a sanctuary. As of 2020, there are 617 acres within the NOAA Code designated as a Public Shellfish Fishery Area (PSFA). Aquaculture leasing is prohibited within PSFA boundaries. This NOAA Code is located within Maryland's low-salinity region (Zone 1).

Information available for this NOAA Code includes:

- NOAA Code map (Figure B.16-1)
- Summary statistics (Table B.16-1)
- Abundance per year (Figure B.16-2)
- Shell height frequencies (Figure B.16-3)
- Biomass per year (Figure B.16-4)
- Observed mortality (Figure B.16-5)
- Dermo and MSX per year (Figure B.16-6)
- Cultch per year (Figure B.16-7)
- Harvest (Figure B.16-8)

Fall Survey results indicated that average market density decreased in 2016-2020 but was similar to the 2006-2010 time period. Trends in spat density primarily relate to the amount of wild seed and hatchery spat-on-shell planted; without the plantings, natural spat density was about the same in the three time periods. Mortality remained below the long term baywide average during 2016-2020.

Between 2006 and 2020, approximately 17 thousand bushels of wild seed and 91 million hatchery spat-on-shell were planted to enhance the commercial public fishery in this NOAA Code outside of the current sanctuary area.

Harvest for the NOAA Code has been reported on seafood dealer buy tickets for all years of the 15-year time series. Since 2000, 38% of the NOAA Code area has been a sanctuary where harvest is prohibited. Harvest reported ranged from about 380 bushels in the 2018-19 season to a maximum of approximately 2.6 thousand bushels in the 2013-14 season. Hand tonging was used to obtain the majority of the harvest.

We are unaware of any continuous water quality monitoring in this area.

[28] 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

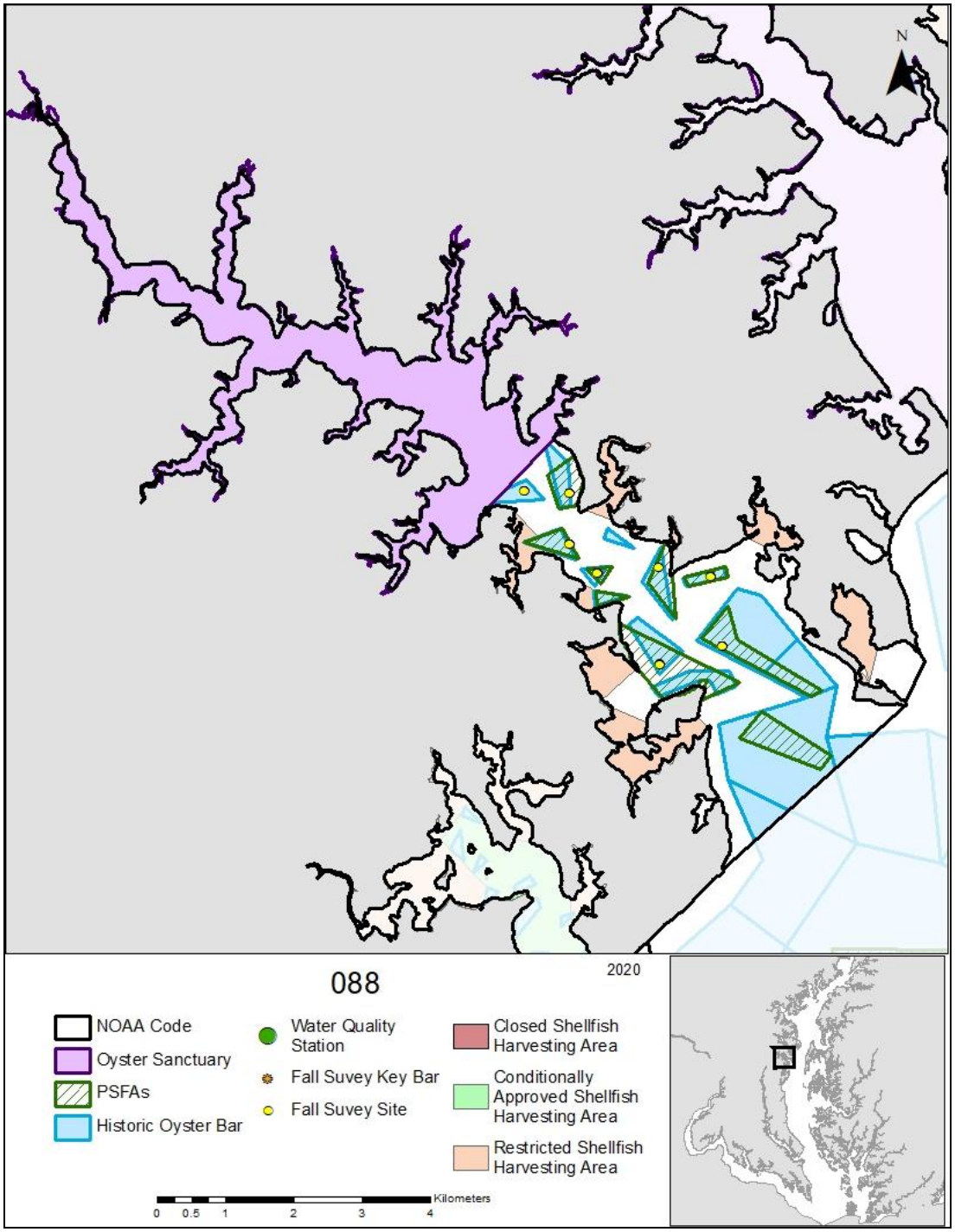


Figure B.16-1. Map of NOAA Code 088 (South River). Fall Survey sites may not be sampled every year.

Table B.16-1. Oyster population characteristics based on the Fall Survey in the NOAA Code 088 (South River) occurring outside of the current sanctuary area. ND = No Data. Values are given as an annual mean ± standard error.

| | 2006-10 | 2011-15 | 2016-20 |
|---|---|---|---|
| Number of Years Sampled / Number of Samples | 5 / 32 | 5 / 31 | 5 / 36 |
| Number of Live Spat Oysters per square meter | 21.4 ± 19.9 | 6.9 ± 6.4 | 6.8 ± 6.5 |
| Number of Live Small-Sized Oysters per square meter | 33.5 ± 14.7 | 43.1 ± 21.5 | 6.6 ± 3.1 |
| Number of Live Market-Sized Oysters per square meter | 22.9 ± 5.4 | 50.1 ± 14.8 | 26.4 ± 2.4 |
| Live Oyster Biomass (g Dry Weight per Bushel) | 115 ± 73 | 215 ± 45 | 136 ± 13 |
| Observed Mortality (%) | 16 ± 3 | 8 ± 3 | 7 ± 0 |
| Cultch (Bushels per 100 ft Towed) | 0.68 ± 0.07 | 1.27 ± 0.09 | 0.72 ± 0.08 |
| Harvest (Bushels) | 690 ± 194 | 1,151 ± 439 | 1,269 ± 389 |

Note: The number of samples is based on the number of samples having a value for observed mortality. There may be fewer samples per year for density, biomass, and cultch.

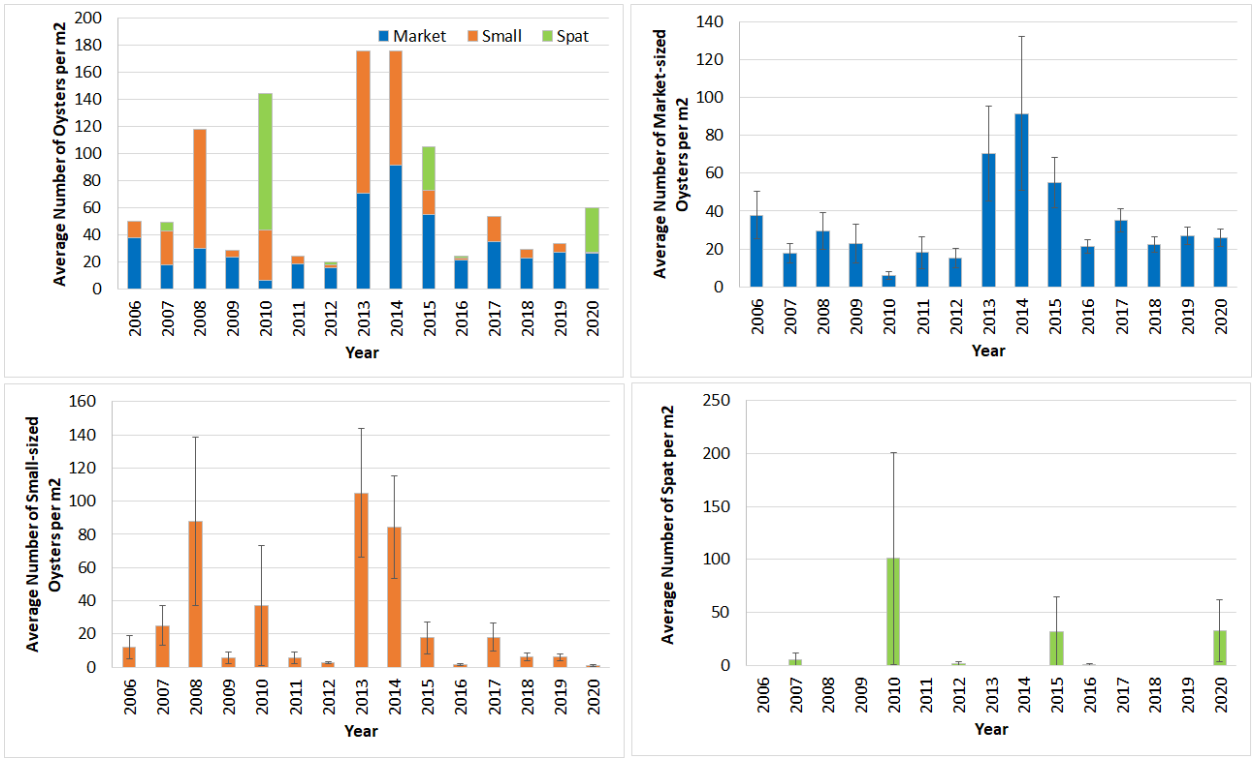


Figure B.16-2A. Average number of live oysters per square meter by size class in NOAA Code 088 (South River) occurring outside of the current sanctuary area. Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales.

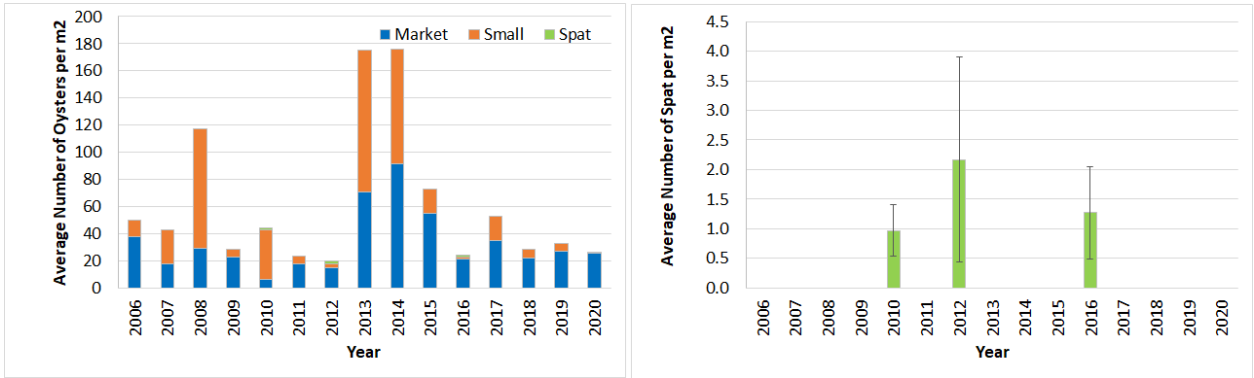


Figure B.16-2B. Average number of live oysters per square meter by size class in NOAA Code 088 (South River) occurring outside of the current sanctuary area excluding samples taken on hatchery spat-on-shell plantings. Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales.

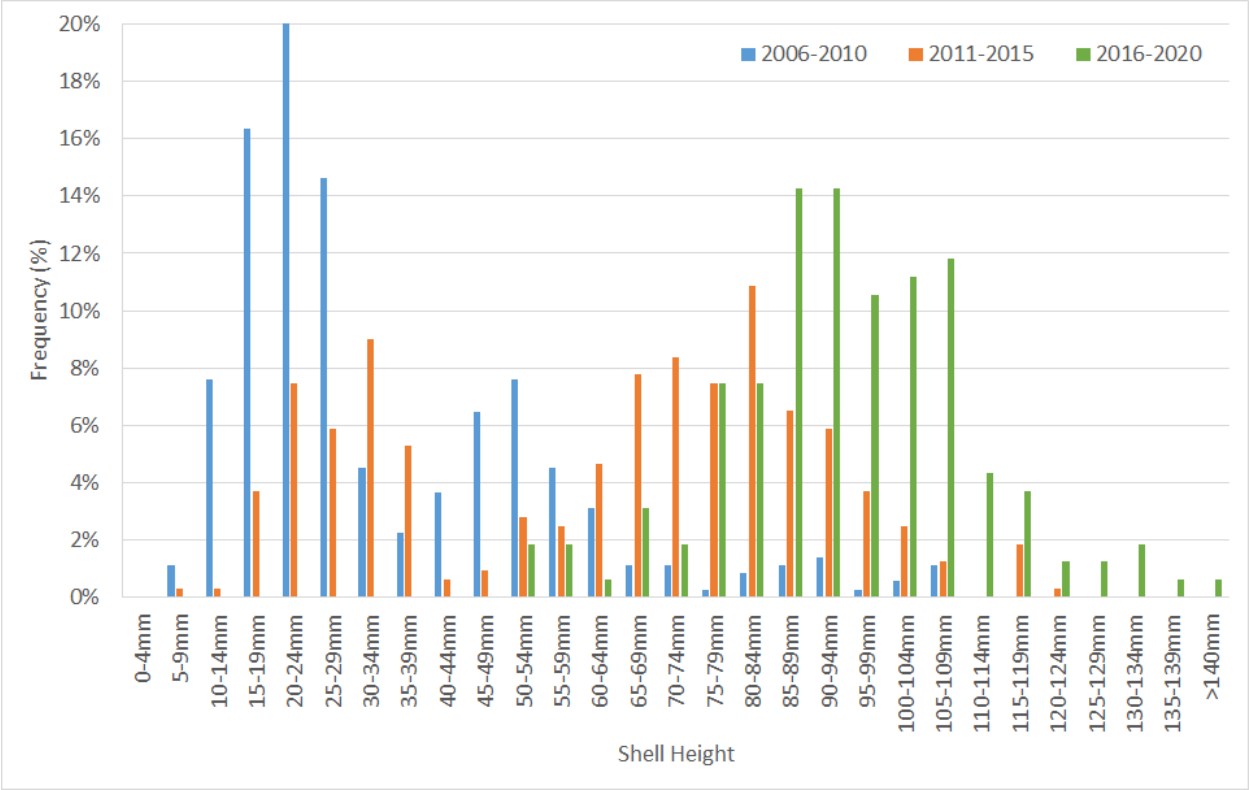


Figure B.16-3. Shell height frequencies of live oysters per bushel of material in NOAA Code 088 (South River) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey on Thunder and Lightning bar. No samples were collected 2006, 2008, 2009, 2001, and 2012.

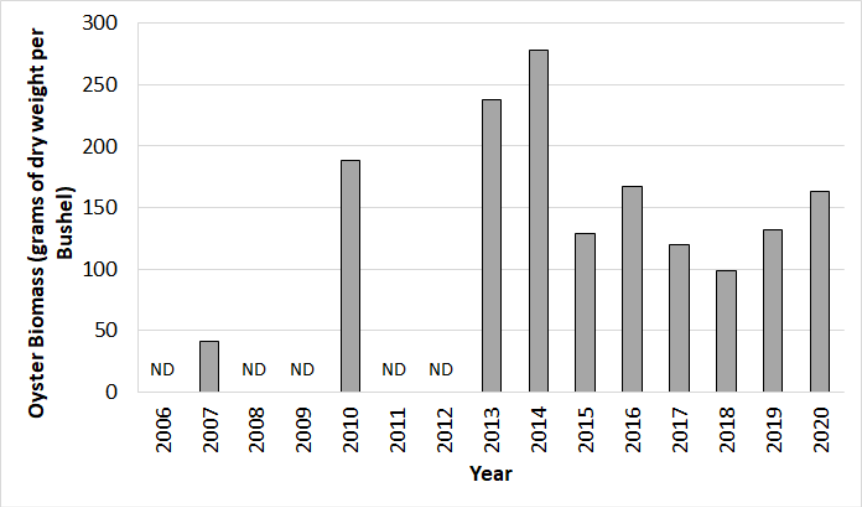


Figure B.16-4. Oyster biomass (grams of dry weight per bushel of material) in NOAA Code 088 (South River) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey on Thunder and Lightning bar. ND = No data.

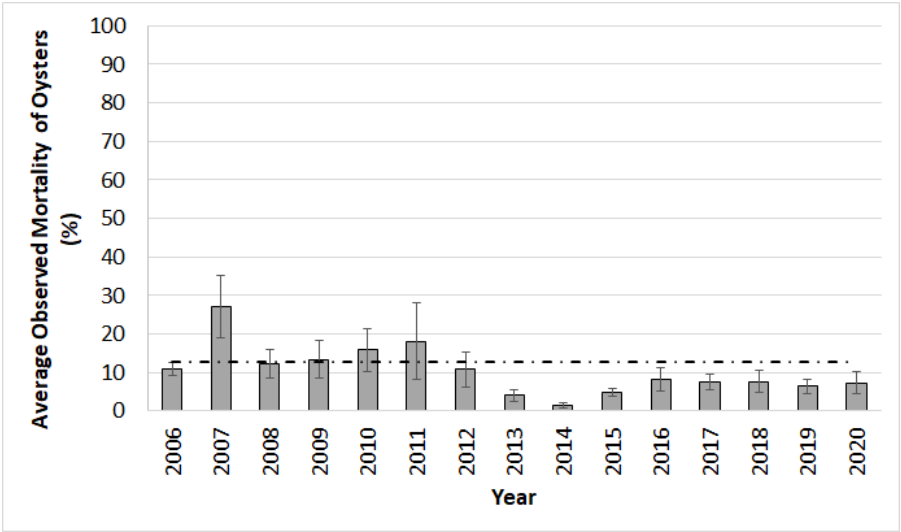


Figure B.16-5. Average annual observed mortality of market-sized and small-sized oysters in NOAA Code 088 (South River) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey. The dashed line represents the 2006-2020 baywide average observed mortality. Error bars represent ± 1 standard error.

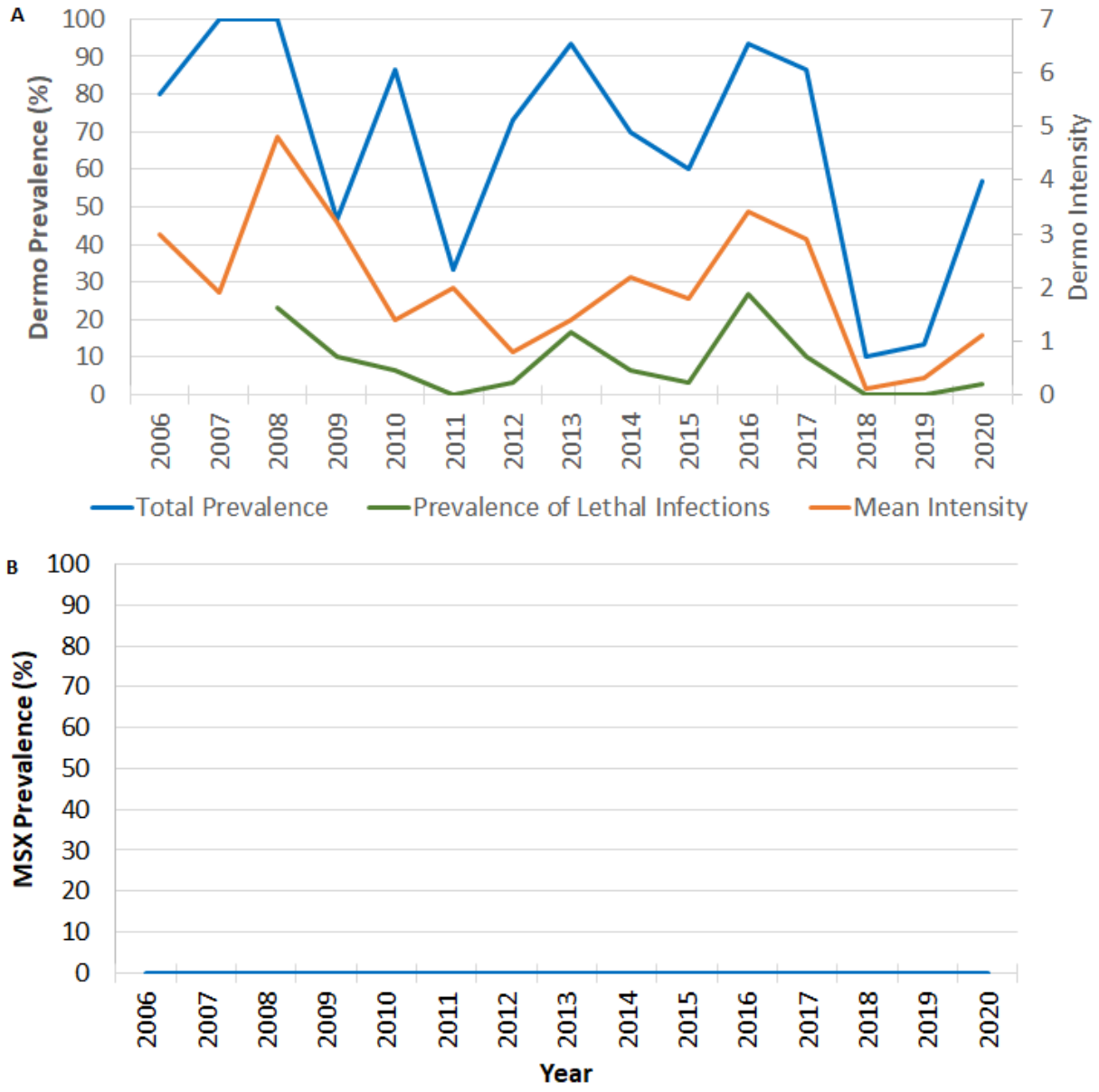


Figure B.16-6. Oyster disease prevalence and intensity in NOAA Code 088 (South River) occurring outside of the current sanctuary area. (A) Dermo prevalence and mean intensity (B) MSX prevalence (intensity is not examined). Data from Maryland's Annual Fall Oyster Dredge Survey on Thunder and Lightning bar.

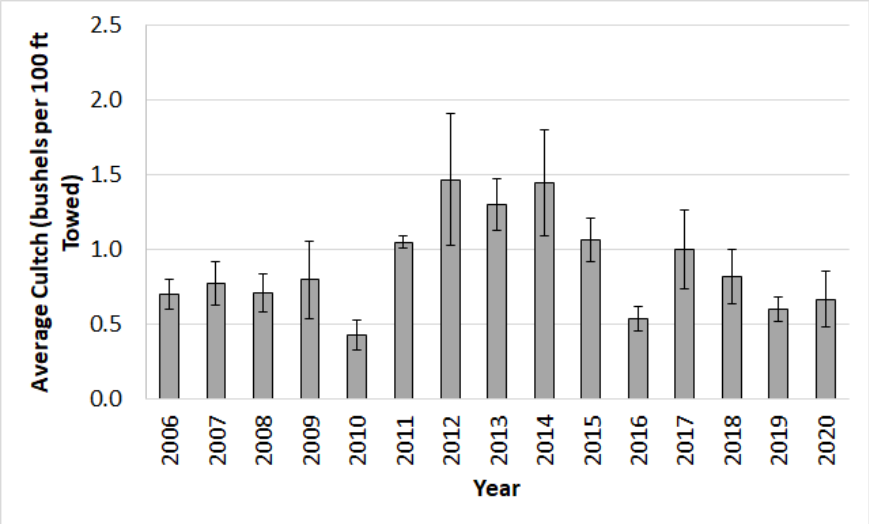


Figure B.16-7. Average cultch (live and dead oysters and loose shell) in NOAA Code 088 (South River) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey. Error bars represent ± 1 standard error.

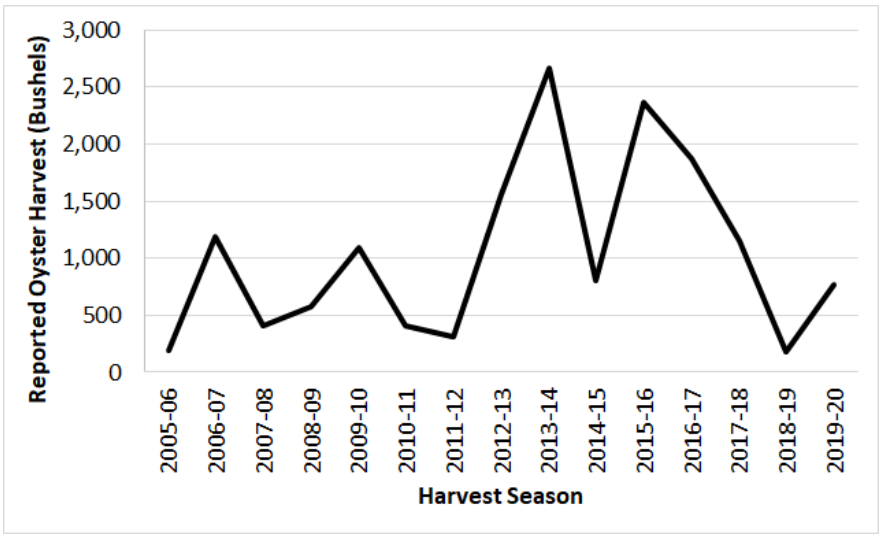


Figure B.16-8. Oyster harvest reported from seafood dealer buy tickets (harvest seasons 2005-2006 to 2019-2020) in NOAA Code 088 (South River). Since 2000, 38% of the NOAA Code area has been a sanctuary where harvest is prohibited.

## Section B.17: NOAA Code 094 – West River and Rhode River

NOAA Code 094 encompasses the Rhode and West rivers and is located in Maryland's mid-western portion of Chesapeake Bay. The NOAA Code is 3,751 acres and has 17 historic oyster bars[29]. None of the NOAA Code is an oyster sanctuary. There are 367 acres of historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments) located within the NOAA Code. There are no acres within the NOAA Code designated as a Public Shellfish Fishery Area. This NOAA Code is located within Maryland's low-salinity region (Zone 1).

Information available for this NOAA Code includes:

- NOAA Code map (Figure B.17-1)
- Water Quality (Figure B.17-2)

The Fall Survey has not sampled in this NOAA Code since 2006, thus there are no oyster population characterization results. Between 2006 and 2020, no replenishment planting activities occurred to enhance the commercial public fishery in this NOAA Code outside of the current sanctuary area. Harvest for the NOAA Code has been reported on seafood dealer buy tickets for two years out of the 15-year time series for a total of 33 bushels harvested.

Continuous water quality monitoring has occurred at station WT8.3 (38.8425; -76.5341). During the 2006-2020 timeline, surface salinity ranged from 2.5 ppt to 16.4 ppt, with the lowest salinity being during the freshet of 2018-2019 and during the high rainfall year of 2011.

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

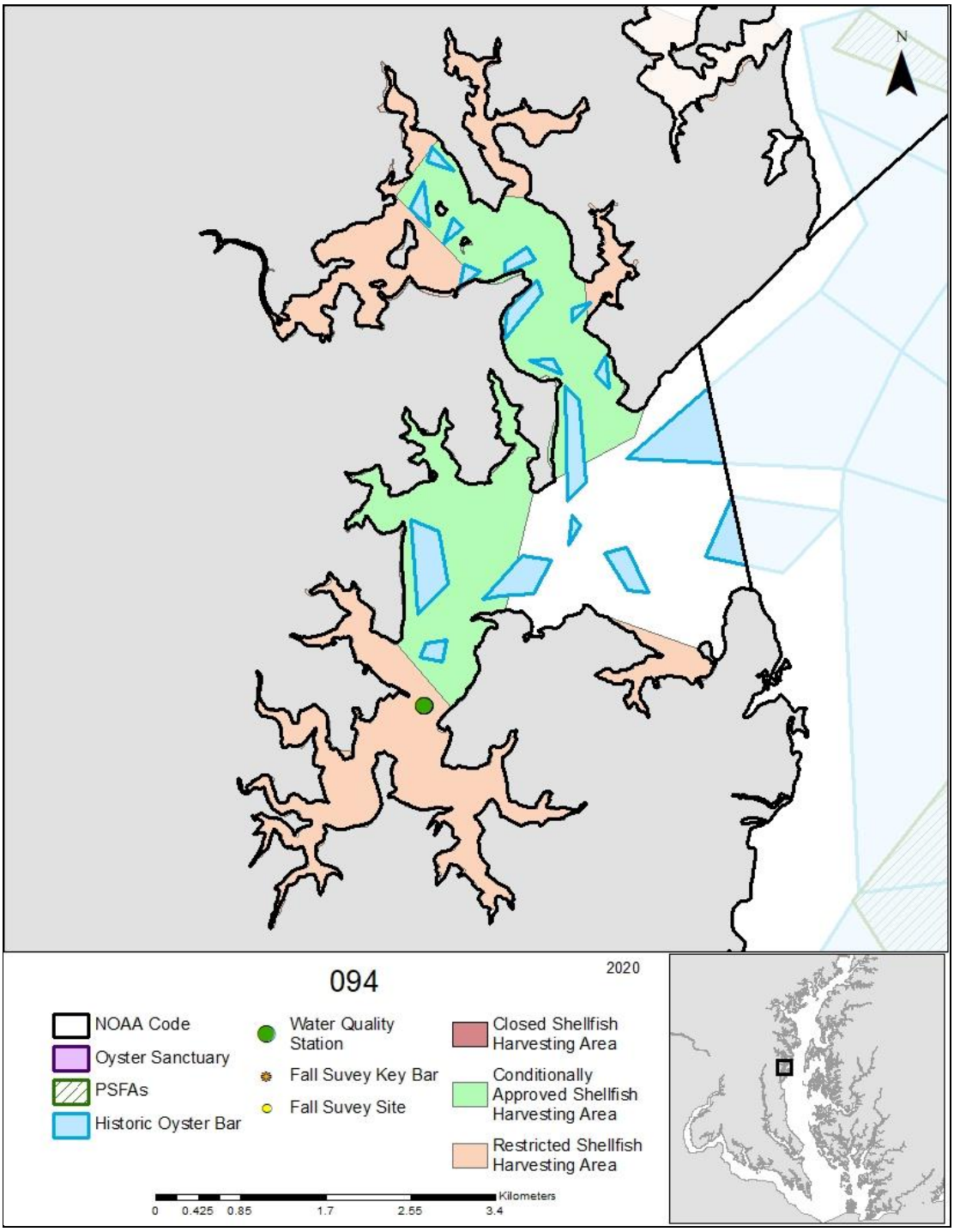


Figure B.17-1. Map of NOAA Code 094 (West River and Rhode River).

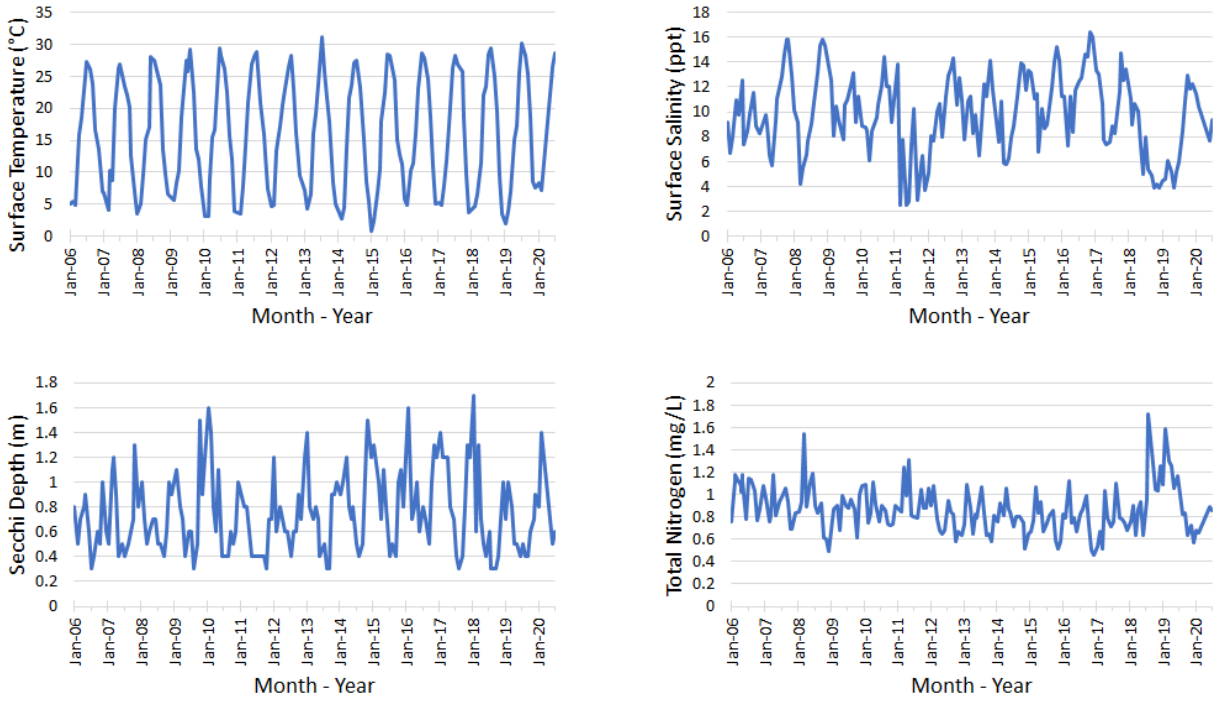


Figure B.17-2. Water quality data collected at Station WT8.3 in NOAA Code 094 (West River and Rhode River). Data from Chesapeake Bay Program Data Hub.

## Section B.18: NOAA Code 096 – Wicomico River (East)

NOAA Code 096 encompasses the Wicomico River (East) and is located in Maryland's lower eastern portion of Chesapeake Bay. The entire NOAA Code is 6,608 acres and has nine historic oyster bars[30]. There are no sanctuaries in the NOAA Code. There are 715 acres of historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments) located within the NOAA Code. As of 2020, there are 766 acres within the NOAA Code designated as a Public Shellfish Fishery Area (PSFA). Aquaculture leasing is prohibited within PSFA boundaries. This NOAA Code is located within Maryland's medium-salinity region (Zone 2).

Information available for this NOAA Code includes:

- NOAA Code map (Figure B.18-1)
- Summary statistics (Table B.18-1)
- Abundance per year (Figure B.18-2)
- Shell height frequencies (Figure B.18-3)
- Biomass per year (Figure B.18-4)
- Observed mortality (Figure B.18-5)
- Cultch per year (Figure B.18-6)
- Harvest (Figure B.18-7)
- Water Quality (Figure B.18-8)

Fall Survey results indicated market density increasing from 2006 to 2015, decreasing from 2016 to 2019, and then increasing in 2020. The decrease was most likely due to increased harvest in the 2014-15 season although natural mortality was also high in 2015 and 2016. Average spat density was similar in 2016-2020 and 2011-2015. Spat density was highest in 2012 and 2020 corresponding to high baywide spatset events. Average small density was lower in 2016-2020 compared to 2011-2015.

Between 2006 and 2020, approximately 20 thousand bushels of shell and 92 million hatchery spat-on-shell were planted to enhance the commercial public fishery in this NOAA Code outside of the current sanctuary area.

Harvest for the NOAA Code has been reported on seafood dealer buy tickets for 14 years out of the 15-year time series. Harvest reported ranged from less than 20 bushels in the 2006-07 season to a maximum of approximately 9 thousand bushels in the 2014-15 season. Power dredging was used to obtain about 60% of the harvest, patent tonging about 30% of the harvest and hand tonging about 10%.

Continuous water quality monitoring has occurred from 2006-2013 and in 2020 at station XCI4078 (38.23379; -75.8696). During the 2006 to 2020 timeline, surface salinity ranged from 4.4 ppt to 17 ppt.

[30] 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

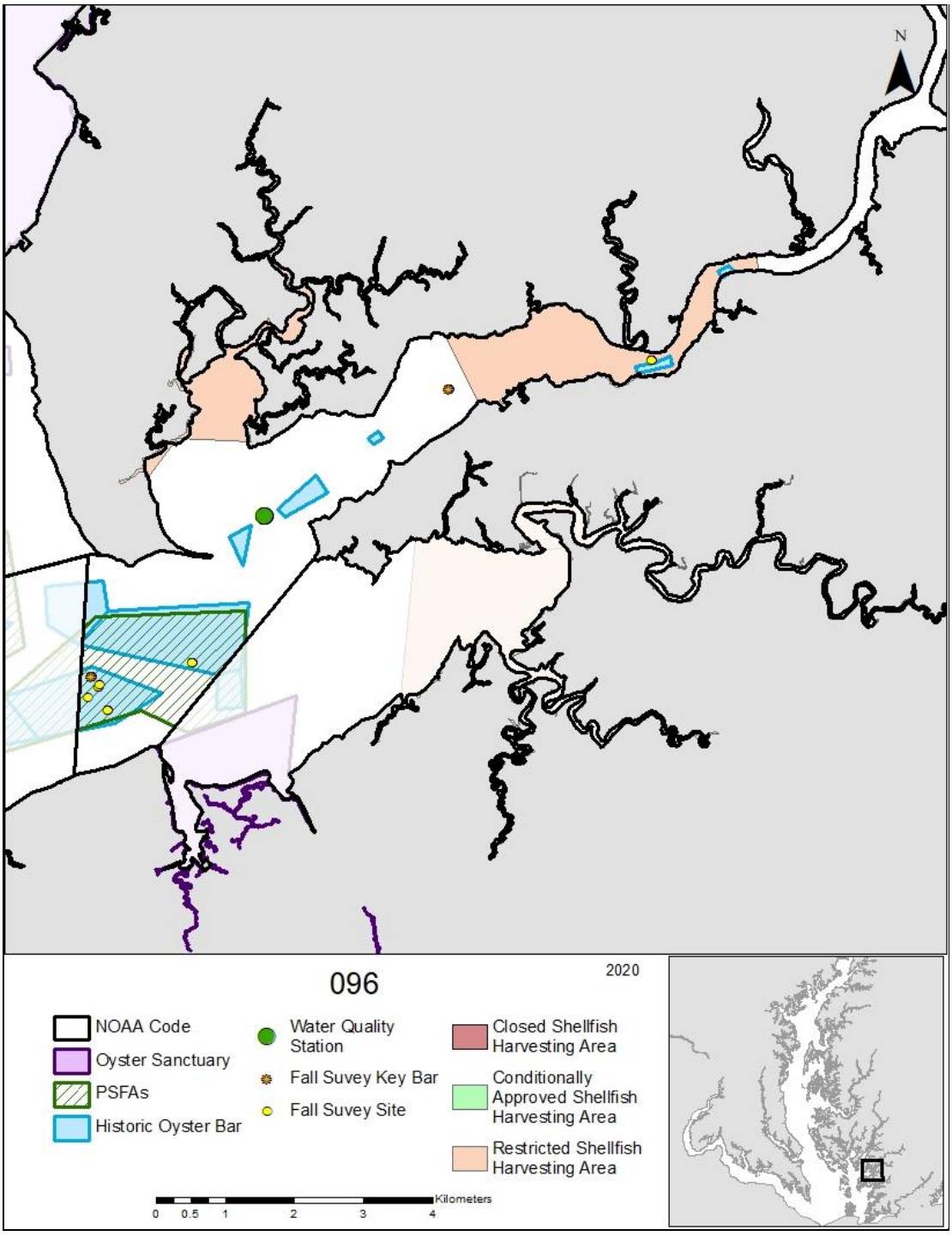


Figure B.18-1. Map of NOAA Code 096 (Wicomico River (East)). Fall Survey sites may not be sampled every year. Fall Survey key bars may consist of a key bar, disease bar or both.

| Table B.18-1. Oyster population characteristics based on the Fall Survey in the NOAA Code 096 (Wicomico River (East)). ND = No Data. Values are given as an annual mean ± standard error. | | | |
|---|---|---|---|
| | **2006-10** | **2011-15** | **2016-20** |
| Number of Years Sampled / Number of Samples | 5 / 20 | 5 / 19 | 5 / 20 |
| Number of Live Spat Oysters per square meter | 6.8 ± 2.8 | 19.4 ± 13.6 | 18.8 ± 8.1 |
| Number of Live Small-Sized Oysters per square meter | 4.3 ± 3.1 | 36.8 ± 12.1 | 21 ± 5.9 |
| Number of Live Market-Sized Oysters per square meter | 4.1 ± 1.2 | 29 ± 5 | 15.2 ± 6.3 |
| Live Oyster Biomass (g Dry Weight per Bushel) | ND | 131 ± 36 | 56 ± 9 |
| Observed Mortality (%) | 10 ± 4 | 9 ± 3 | 13 ± 6 |
| Cultch (Bushels per 100 ft Towed) | 1.08 ± 0.27 | 1.34 ± 0.19 | 1.19 ± 0.24 |
| Harvest (Bushels) | 116 ± 50 | 3,658 ± 1,565 | 1,555 ± 812 |
| Note: The number of samples is based on the number of samples having a value for observed mortality. There may be fewer samples per year for density, biomass, and cultch. | | | |

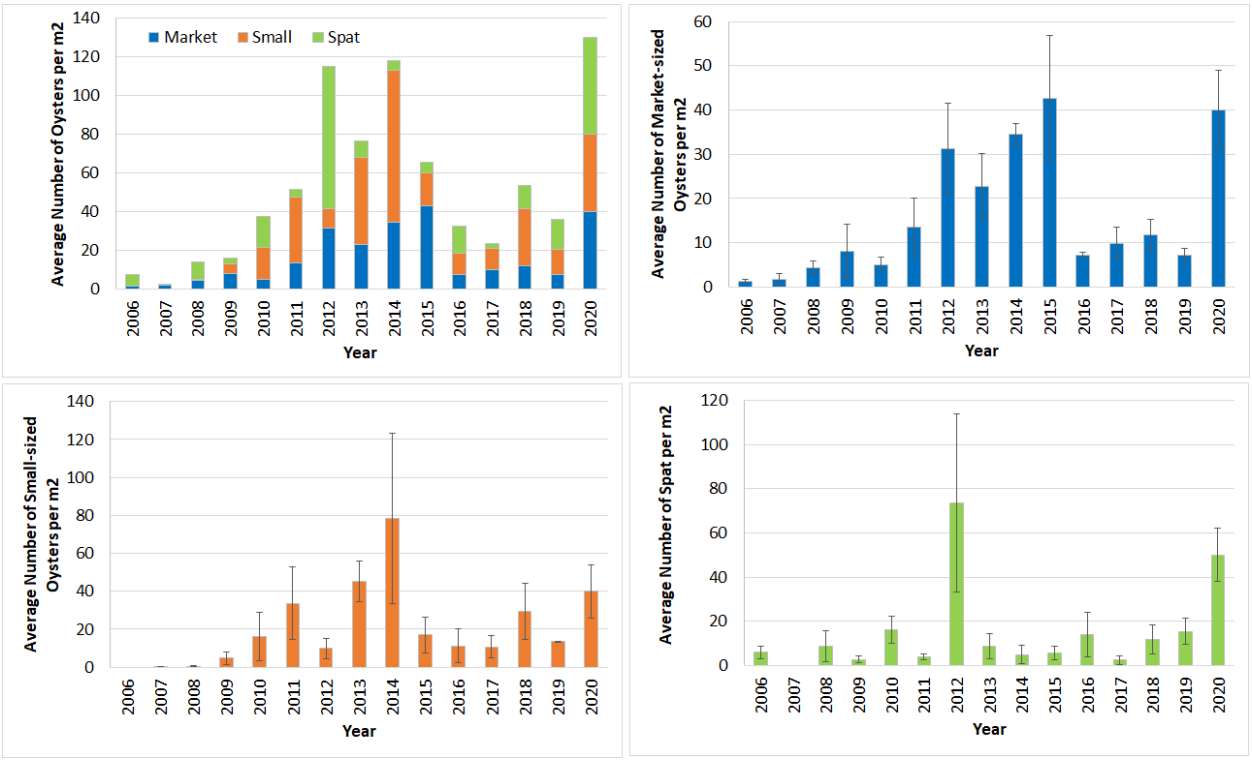


Figure B.18-2. Average number of live oysters per square meter by size class in NOAA Code 096 (Wicomico River (East)). Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales. Samples were not collected from 2006 to 2009.

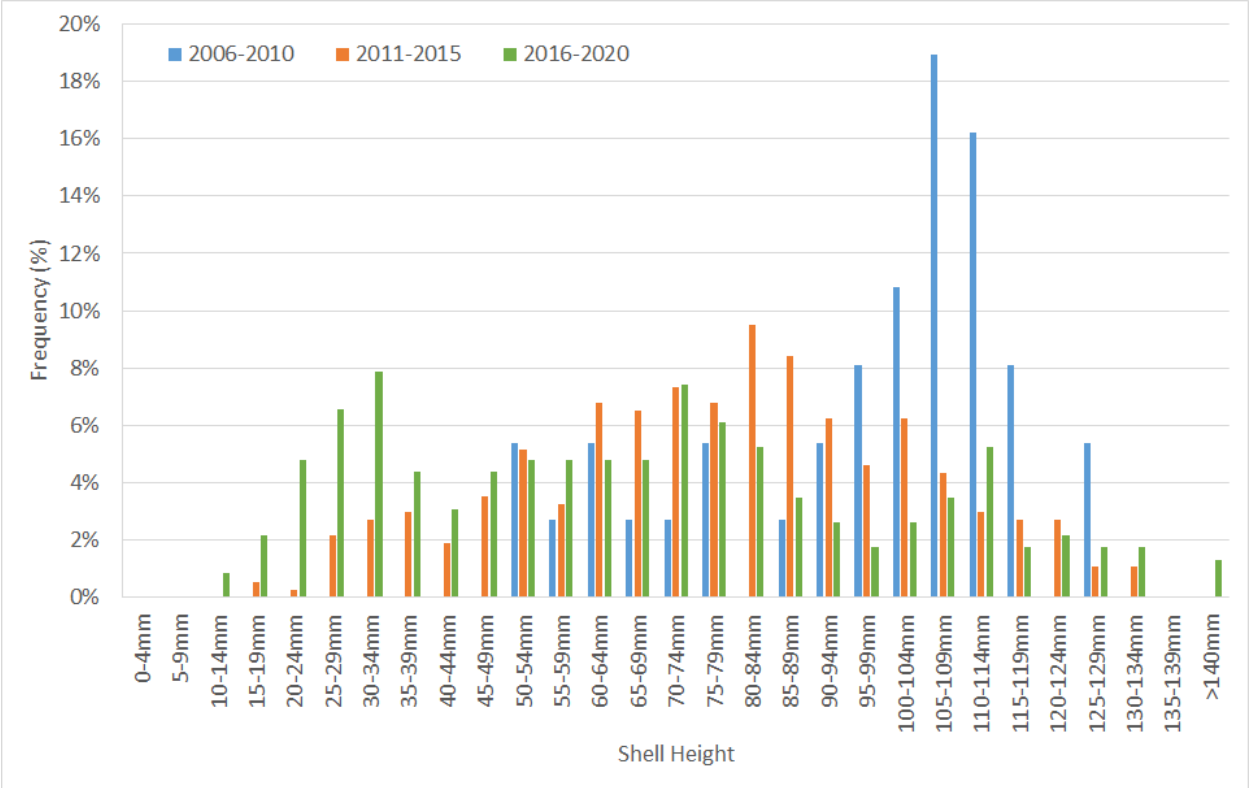


Figure B.18-3. Shell height frequencies of live oysters per bushel of material in NOAA Code 096 (Wicomico River (East)). Data from Maryland's Annual Fall Oyster Dredge Survey on Mt Vernon Wharf bar.

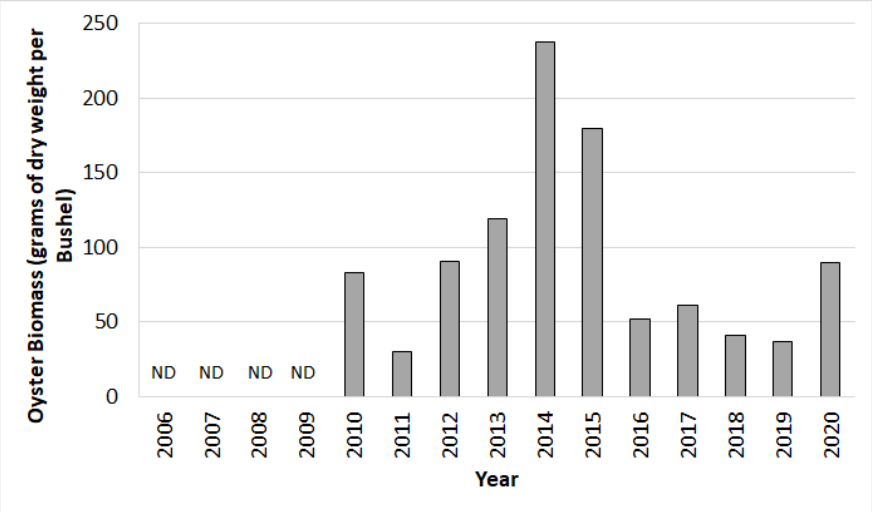


Figure B.18-4. Oyster biomass (grams of dry weight per bushel of material) in NOAA Code 096 (Wicomico River (East)). Data from Maryland's Annual Fall Oyster Dredge Survey on Mt Vernon Wharf bar. ND = No Data.

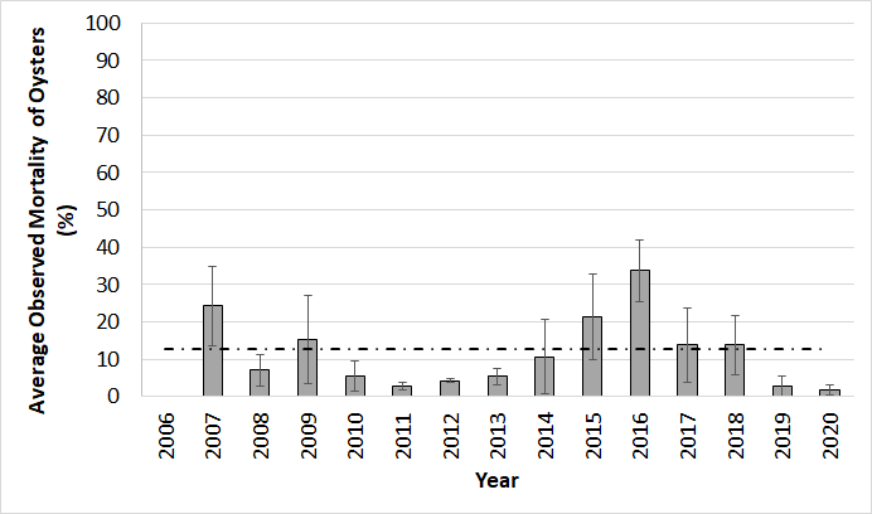


Figure B.18-5. Average annual observed mortality of market-sized and small-sized oysters in NOAA Code 096 (Wicomico River (East)). Data from Maryland's Annual Fall Oyster Dredge Survey. The dashed line represents the 2006-2020 baywide average observed mortality. Error bars represent ± 1 standard error.

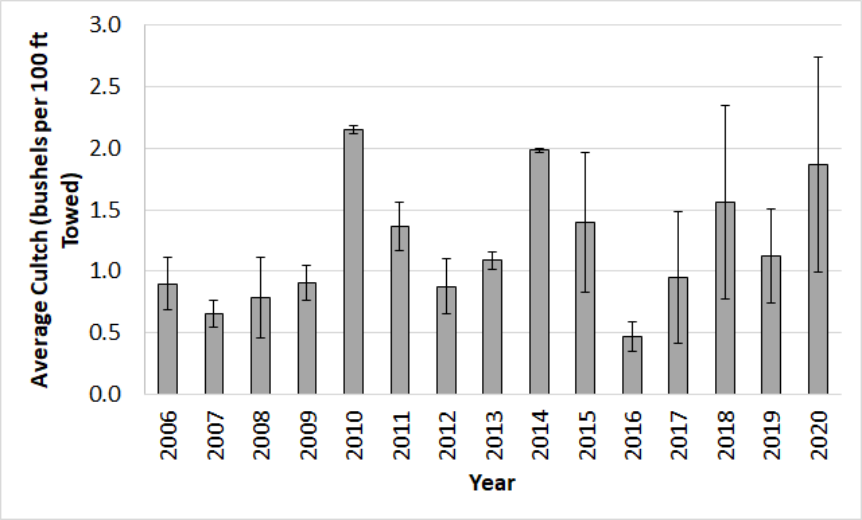


Figure B.18-6. Average cultch (live and dead oysters and loose shell) in NOAA Code 096 (Wicomico River (East)). Data from Maryland's Annual Fall Oyster Dredge Survey. Error bars represent ± 1 standard error.

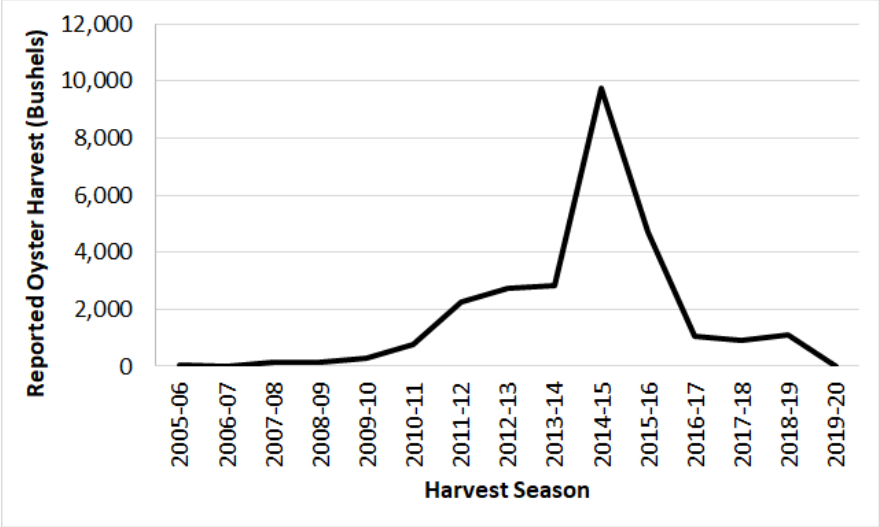


Figure B.18-7. Oyster harvest reported from seafood dealer buy tickets (harvest seasons 2005-2006 to 2019-2020) in NOAA Code 096 (Wicomico River (East)).

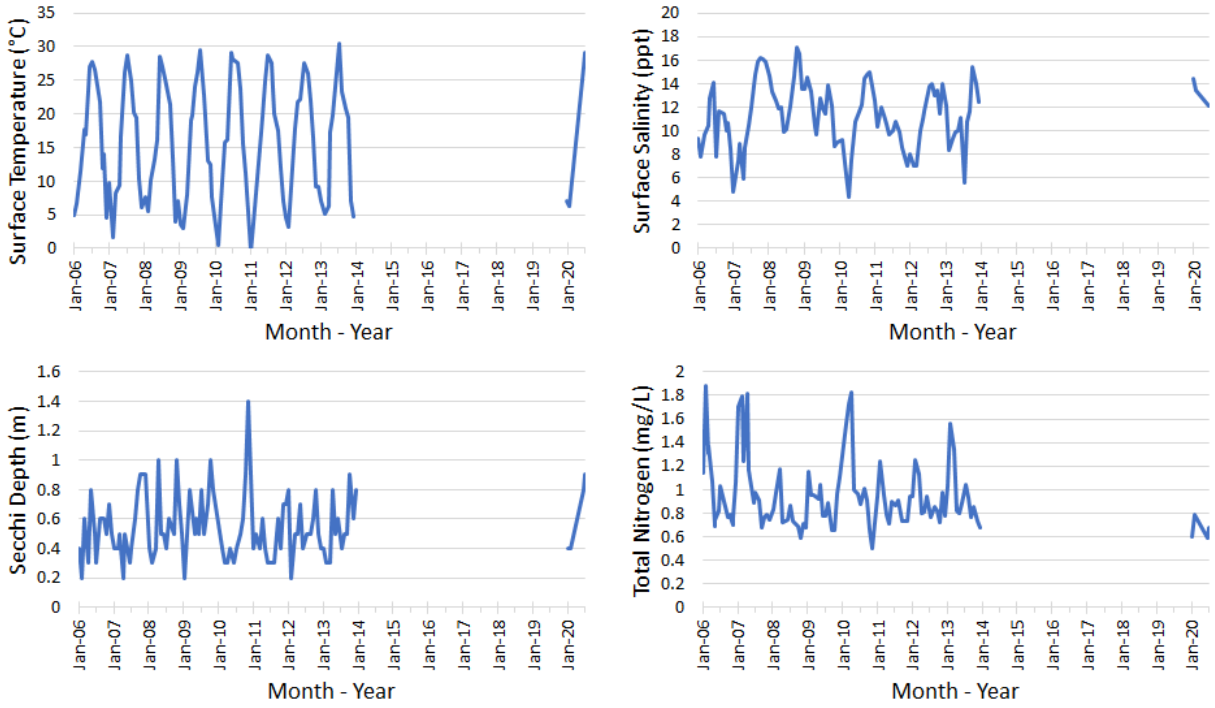


Figure B.18-8. Water quality data collected at Station XCI4078 in NOAA Code 096 (Wicomico River (East)). Data from Chesapeake Bay Program Data Hub. Data was not collected from 2014 to 2019.

## Section B.19: NOAA Code 098 – Monie Bay

NOAA Code 098 encompasses Monie Bay and is located in Maryland's lower eastern portion of Chesapeake Bay. The entire NOAA Code is 3,242 acres and has two historic oyster bars[31]. The Webster Sanctuary encompasses 17% (554 total acres) of the NOAA Code. This equates to 2,688 surface acres. There are 59 acres of historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments) located within the NOAA Code and outside the sanctuary area. As of 2020, there are 148 acres within the NOAA Code designated as a Public Shellfish Fishery Area (PSFA). Aquaculture leasing is prohibited within PSFA boundaries. This NOAA Code is located within Maryland's medium-salinity region (Zone 2).

Information available for this NOAA Code includes:

- NOAA Code map (Figure B.19-1)
- Harvest (Figure B.19-2)

The Fall Survey has not sampled in this NOAA Code outside of the current sanctuary area since 2006, thus there are no oyster population characterization results. Between 2006 and 2020, no replenishment planting activities occurred to enhance the commercial public fishery in this NOAA Code outside of the current sanctuary area.

Harvest for the NOAA Code has been reported on seafood dealer buy tickets for 12 years out of the 15-year time series. Since 1997, 17% of the NOAA Code area has been a sanctuary where harvest is prohibited. Harvest reported ranged from less than ten bushels in the 2018-19 season to a maximum of approximately 3 thousand bushels in the 2012-13 season. Power dredging was used to obtain the majority of the harvest.

We are unaware of any continuous water quality monitoring in this area.

[31] See chart31 for bar names and locations in the State of Maryland Shellfish Closure Areas Book http://dnr.maryland.gov/fisheries/Pages/oysters/index.aspx

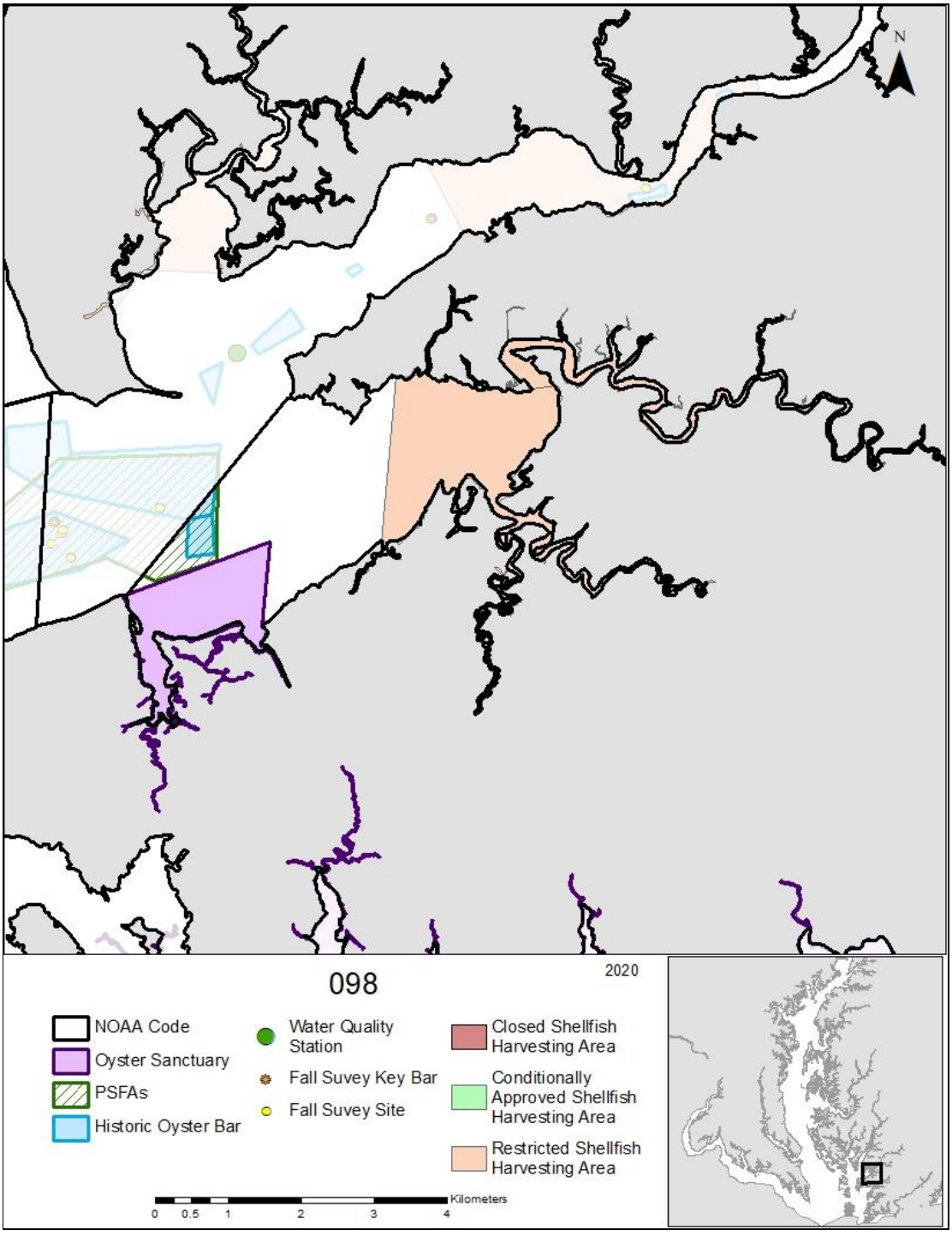


Figure B.19-1. Map of NOAA Code 098 (Monie Bay). Fall Survey sites may not be sampled every year.

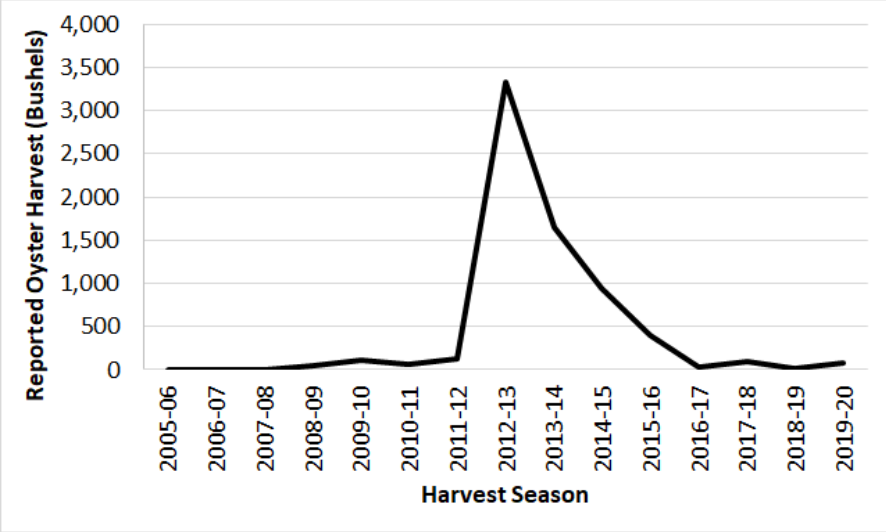


Figure B.19-2. Oyster harvest reported from seafood dealer buy tickets (harvest seasons 2005-2006 to 2019-2020) in NOAA Code 098 (Monie Bay). Since 1997, 17% of the NOAA Code area has been a sanctuary where harvest is prohibited.

## Section B.20: NOAA Code 099 – Wye River

NOAA Code 099 (Wye River) is 6,411 acres; all of the area is within the Wye River Sanctuary boundary (established in 2010). See Appendix A, Section A.51 for more information on the oyster population characteristics.

## Section B.21: NOAA Code 127 – Upper Middle Chesapeake Bay

NOAA Code 127 encompasses Chesapeake Bay mainstem south of the Bay Bridge and north of a line from Kent Point to Fairhaven. The entire NOAA Code is 57,029 acres and has 30 historic oyster bars[32]. The Herring Bay and Severn River sanctuaries encompass 10% (5,623 total acres) of the NOAA Code. This section focuses on information collected within the NOAA Code occurring outside of the current sanctuary areas. This equates to 51,406 surface acres. There are 14,777 acres of historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments) located within the NOAA Code and outside the sanctuary areas. As of 2020, there are 5,709 acres within the NOAA Code designated as a Public Shellfish Fishery Area (PSFA). Aquaculture leasing is prohibited within PSFA boundaries. This NOAA Code is located within Maryland's low-salinity region (Zone 1).

Information available for this NOAA Code includes:

- NOAA Code map (Figure B.21-1)
- Summary statistics (Table B.21-1)
- Abundance per year (Figure B.21-2)
- Shell height frequencies (Figure B.21-3)
- Biomass per year (Figure B.21-4)
- Observed mortality (Figure B.21-5)
- Dermo and MSX per year (Figure B.21-6)
- Cultch per year (Figure B.21-7)
- Harvest (Figure B.21-8)
- Water Quality (Figure B.21-9)

Fall Survey results indicated an increase in average spat, small, and market densities in 2016-2020 from 2011-2015. This is most likely due to the wild seed and hatchery spat-on-shell plantings. Biomass also increased during 2016-2020 compared to 2011-2015. Mortality was below the long term baywide average for the entire time period.

Between 2006 and 2020, approximately 99 thousand bushels of wild seed and 120 million hatchery spat-on-shell were planted to enhance the commercial public fishery in this NOAA Code outside of the current sanctuary area.

Harvest for the NOAA Code has been reported on seafood dealer buy tickets for all years of the 15-year time series. This includes past harvest data from areas in the NOAA Code that are currently in a sanctuary area, but weren't when the harvest occurred prior to the sanctuary being established. Since 2010, 10% of the NOAA Code area has been a sanctuary where harvest is prohibited. Harvest reported ranged from less than 50 bushels in the 2014-15 season to a maximum of approximately 7 thousand bushels in the 2005-06 season. Patent tonging was used to obtain the majority of the harvest.

[32] See charts 9, 10, and 13 for bar names and locations in the State of Maryland Shellfish Closure Areas Book http://dnr.maryland.gov/fisheries/Pages/oysters/index.aspx

Continuous water quality monitoring has occurred at station CB3.3C (38.99596; -76.3597). During the 2006-2020 timeline, surface salinity ranged from 0.2 ppt to 17.9 ppt, with the lowest salinity being during the freshet of 2018-2019 and during the high rainfall year of 2011.

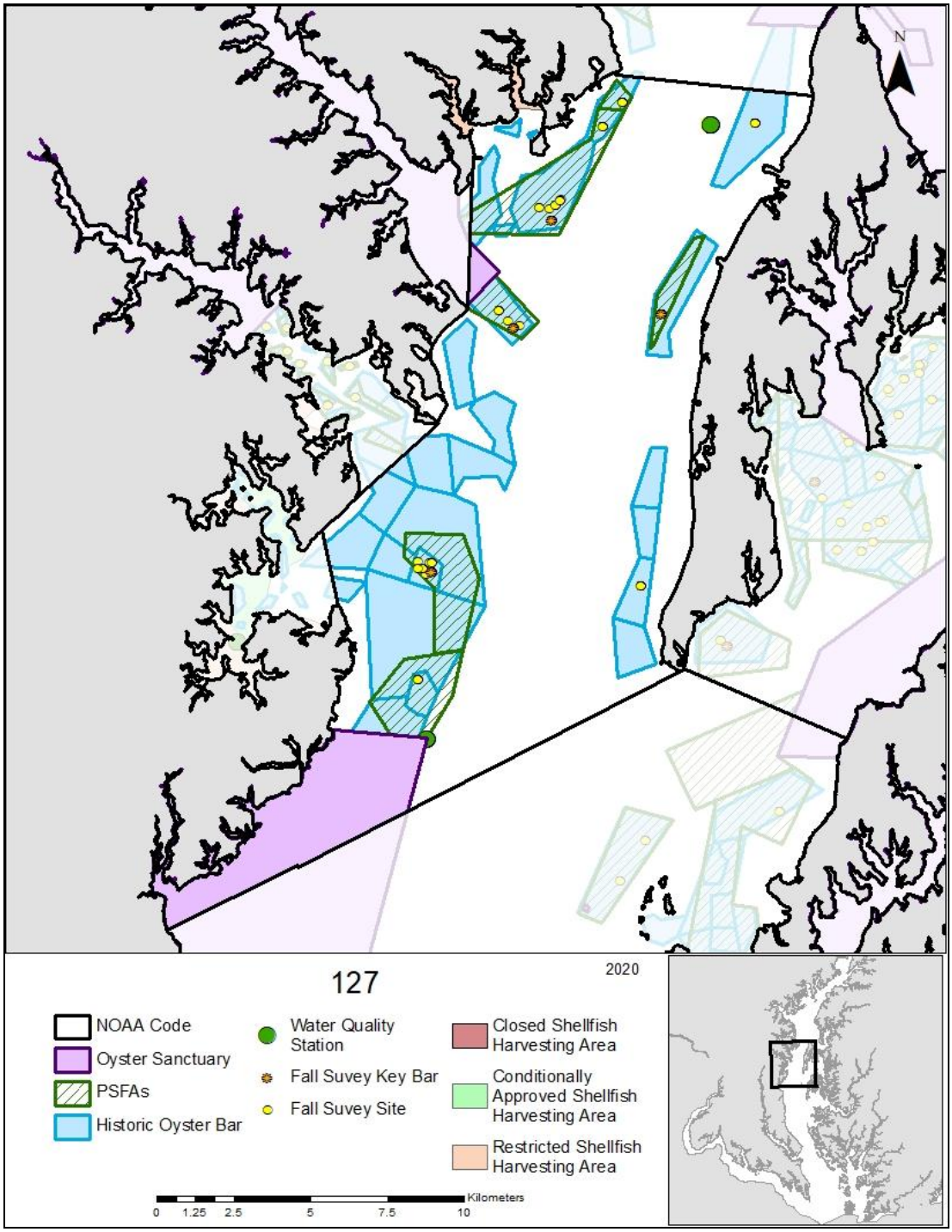


Figure B.20-1. Map of NOAA Code 127 (Upper Middle Chesapeake Bay). Fall Survey sites may not be sampled every year. Fall Survey key bars may consist of a key bar, disease bar or both.

Table B.20-1. Oyster population characteristics based on the Fall Survey in the NOAA Code 127 (Upper Middle Chesapeake Bay) occurring outside of the current sanctuary area. ND = No Data. Values are given as an annual mean ± standard error.

| | 2006-10 | 2011-15 | 2016-20 |
|---|---|---|---|
| Number of Years Sampled / Number of Samples | 5 / 65 | 5 / 53 | 5 / 52 |
| Number of Live Spat Oysters per square meter | 0.2 ± 0.2 | 0.04 ± 0.03 | 22.4 ± 16.7 |
| Number of Live Small-Sized Oysters per square meter | 9.2 ± 3.6 | 1.7 ± 0.8 | 10.9 ± 7.6 |
| Number of Live Market-Sized Oysters per square meter | 8.4 ± 0.6 | 3.3 ± 0.6 | 5 ± 0.4 |
| Live Oyster Biomass (g Dry Weight per Bushel) | 88 ± 23 | 35 ± 6 | 74 ± 7 |
| Observed Mortality (%) | 10 ± 1 | 4 ± 0 | 4 ± 1 |
| Cultch (Bushels per 100 ft Towed) | 0.31 ± 0.01 | 0.27 ± 0.04 | 0.31 ± 0.05 |
| Harvest (Bushels) | 3,128 ± 1,456 | 140 ± 50 | 1,834 ± 537 |

Note: The number of samples is based on the number of samples having a value for observed mortality. There may be fewer samples per year for density, biomass, and cultch.

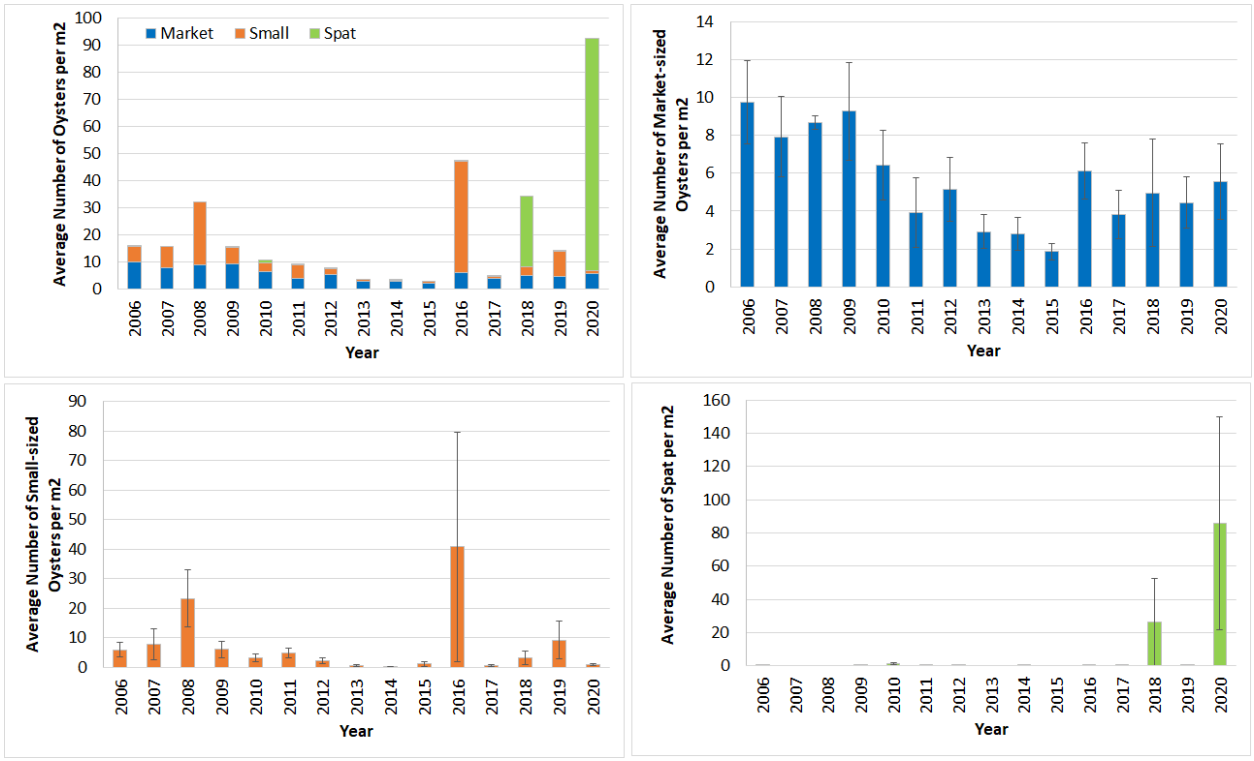


Figure B.20-2A. Average number of live oysters per square meter by size class in NOAA Code 127 (Upper Middle Chesapeake Bay) occurring outside of the current sanctuary area. Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales.

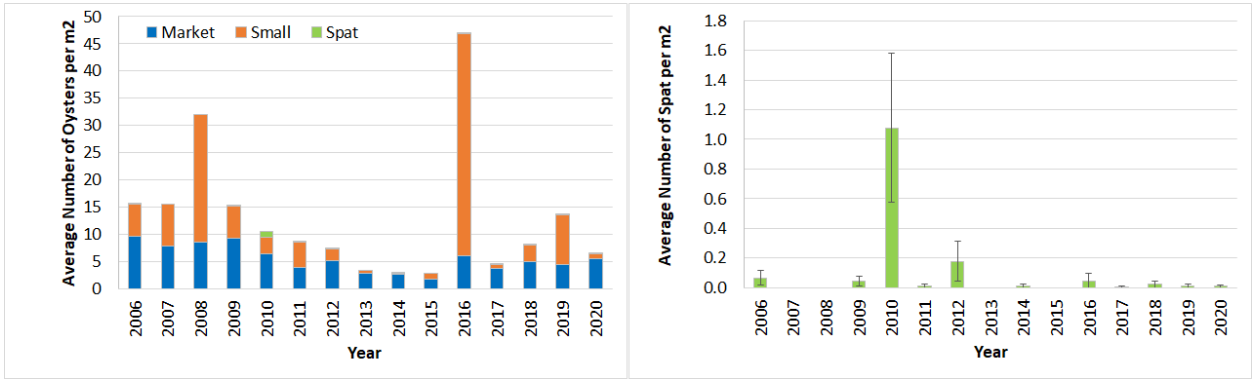


Figure B.20-2B. Average number of live oysters per square meter by size class in NOAA Code 127 (Upper Middle Chesapeake Bay) occurring outside of the current sanctuary area excluding samples taken on hatchery spat-on-shell plantings. Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales.

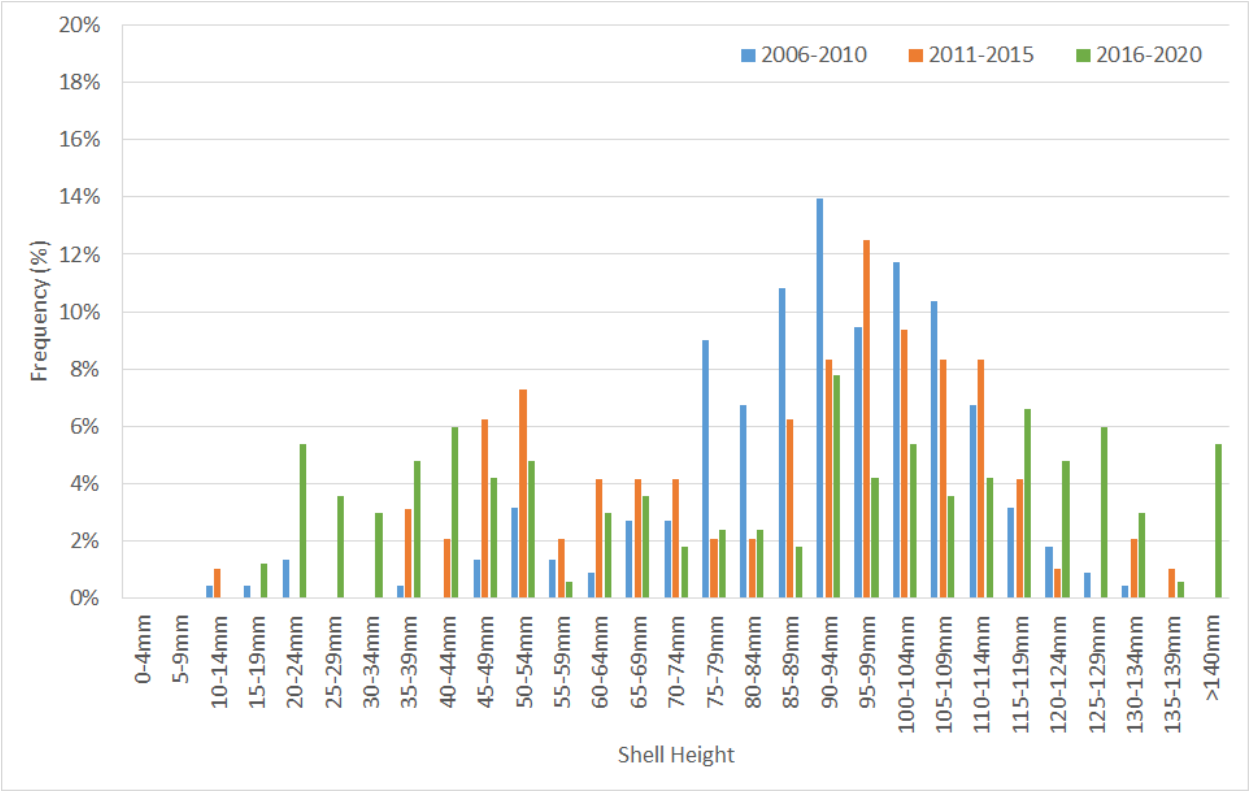


Figure B.20-3. Shell height frequencies of live oysters per bushel of material in NOAA Code 127 (Upper Middle Chesapeake Bay) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey on Hackett Point bar.

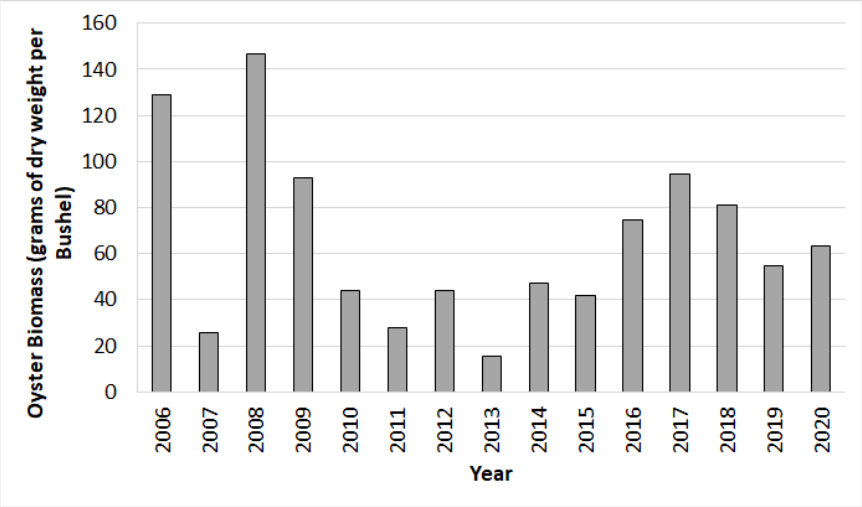


Figure B.20-4. Oyster biomass (grams of dry weight per bushel of material) in NOAA Code 127 (Upper Middle Chesapeake Bay) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey on Hackett Point bar.

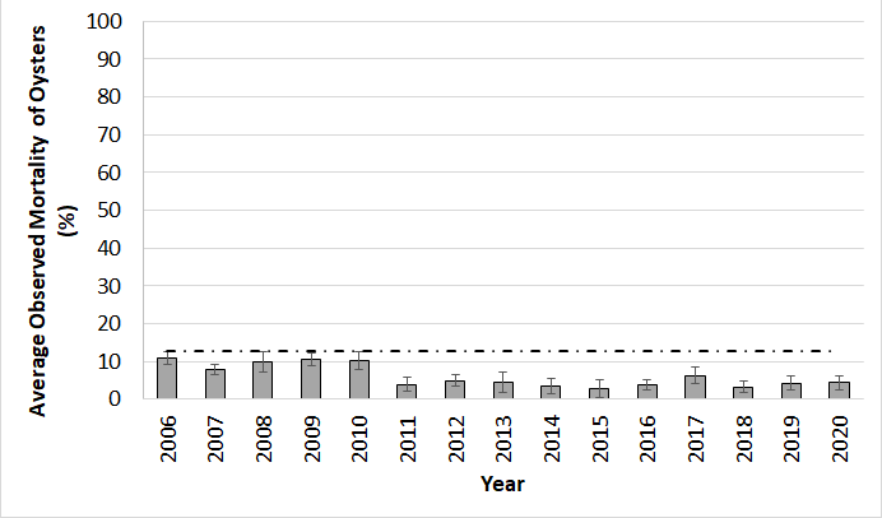


Figure B.20-5. Average annual observed mortality of market-sized and small-sized oysters in NOAA Code 127 (Upper Middle Chesapeake Bay) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey. The dashed line represents the 2006-2020 baywide average observed mortality. Error bars represent ± 1 standard error.

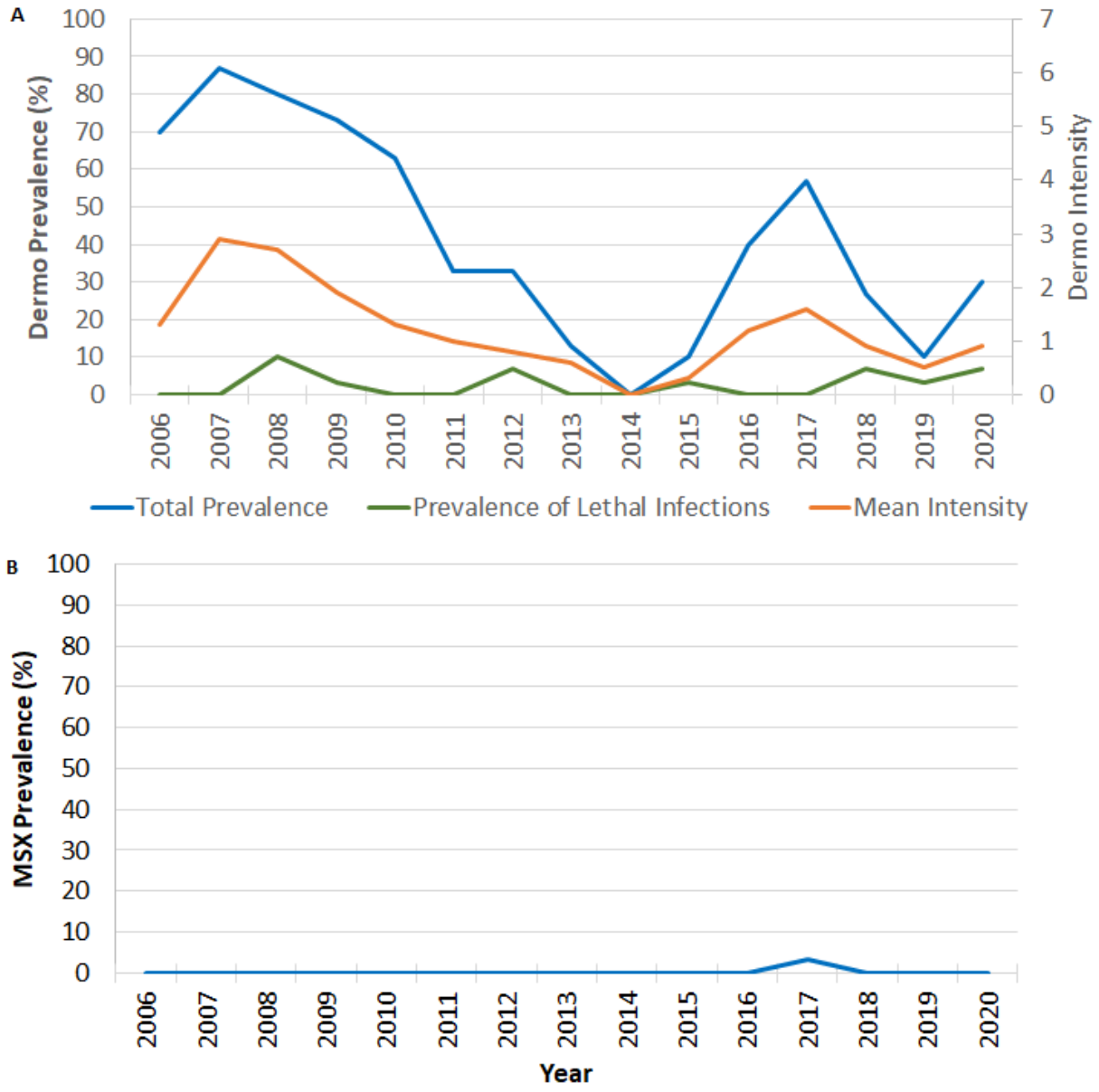


Figure B.20-6. Oyster disease prevalence and intensity in NOAA Code 127 (Upper Middle Chesapeake Bay) occurring outside of the current sanctuary area. (A) Dermo prevalence and mean intensity (B) MSX prevalence (intensity is not examined). Data from Maryland's Annual Fall Oyster Dredge Survey on Hackett Point bar.

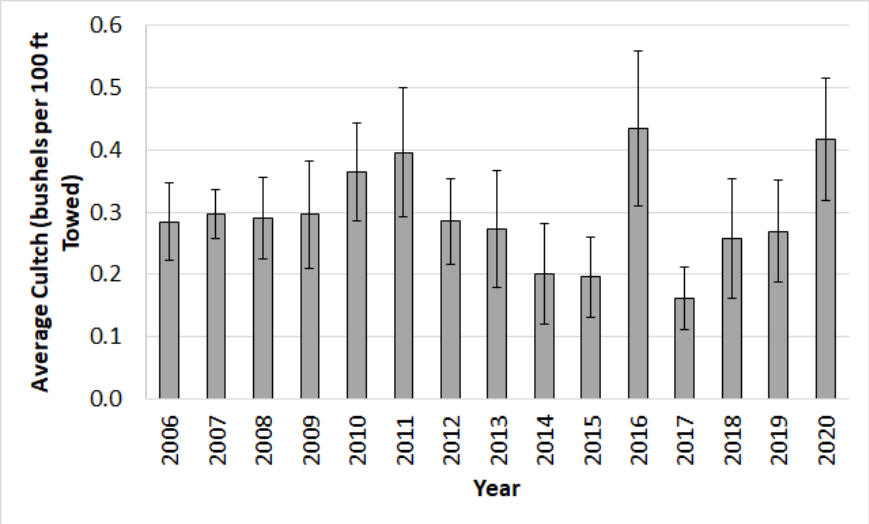


Figure B.20-7. Average cultch (live and dead oysters and loose shell) in NOAA Code 127 (Upper Middle Chesapeake Bay) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey. Error bars represent ± 1 standard error.

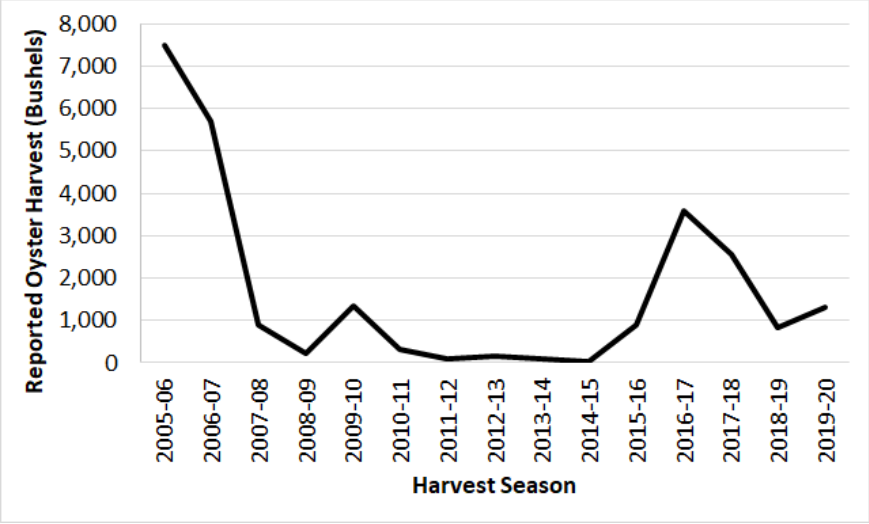


Figure B.20-8. Oyster harvest reported from seafood dealer buy tickets (harvest seasons 2005-2006 to 2019-2020) in NOAA Code 127 (Upper Middle Chesapeake Bay). Since 2010, 10% of the NOAA Code area has been a sanctuary where harvest is prohibited.

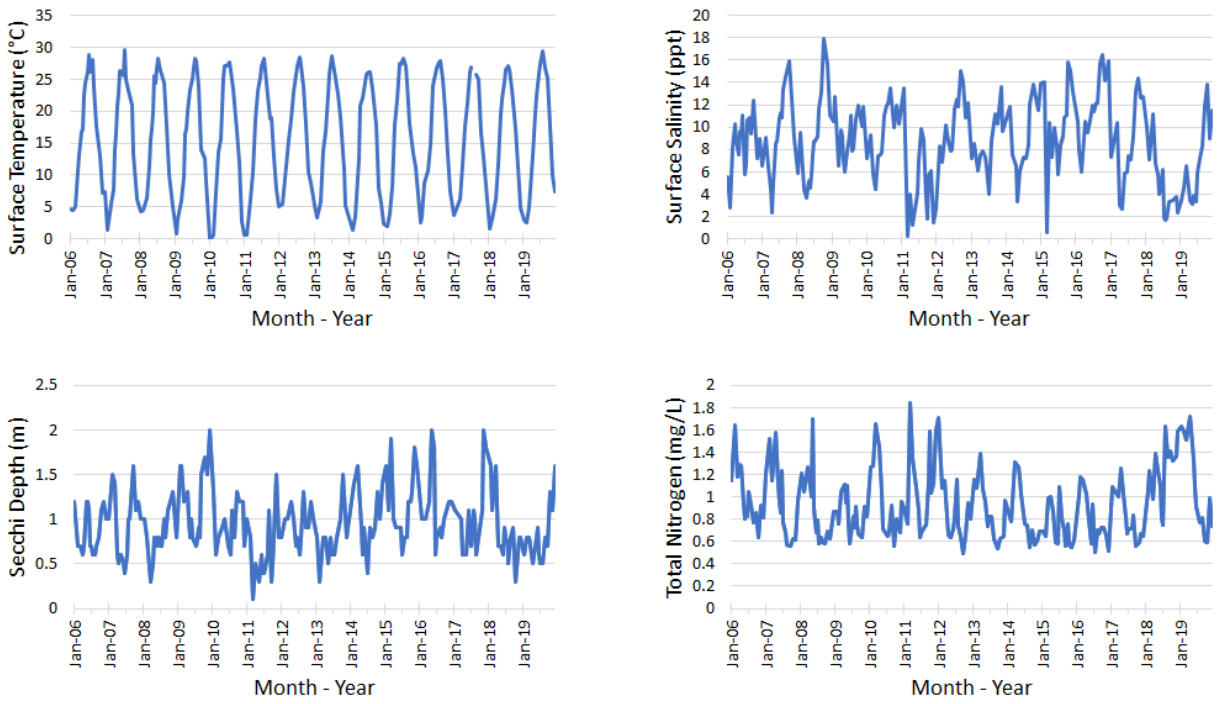


Figure B.20-9. Water quality data collected at Station CB3.3C in NOAA Code 127 (Upper Middle Chesapeake Bay). Data from Chesapeake Bay Program Data Hub.

## Section B.22: NOAA Code 129 – Lower East Chesapeake Bay

NOAA Code 129 encompasses the Chesapeake Bay mainstem south of Cove Point and east of the ship channel and is located in Maryland's lower eastern portion of Chesapeake Bay. The entire NOAA Code is 130,570 acres and has 16 historic oyster bars[33]. The Lower Mainstem Sanctuary encompasses 24% (31,934 total acres) of the NOAA Code. This section focuses on information collected within the NOAA Code occurring outside of the current sanctuary area. This equates to 98,636 surface acres. There are 1,359 acres of historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments) located within the NOAA Code and outside a sanctuary. No acres within the NOAA Code are designated as a Public Shellfish Fishery Area. This NOAA Code is located within Maryland's medium-salinity region (Zone 2).

Information available for this NOAA Code includes:

- NOAA Code map (Figure B.22-1)
- Harvest (Figure B.22-2)
- Water Quality (Figure B.22-3)

The Fall Survey has not sampled in this NOAA Code outside of the current sanctuary area since 2006, thus there are no oyster population characterization results. Between 2006 and 2020, no replenishment planting activities occurred to enhance the commercial public fishery in this NOAA Code outside of the current sanctuary area.

Harvest for the NOAA Code has been reported on seafood dealer buy tickets for all years of the 15-year time series. This includes past harvest data from areas in the NOAA Code that are currently in a sanctuary area, but weren't when the harvest occurred prior to the sanctuary being established. Since 2010, 24% of the NOAA Code area has been a sanctuary where harvest is prohibited. Harvest reported ranged from less than 40 bushels in the 2005-06 season to a maximum of approximately 9 thousand bushels in the 2009-10 and 2013-14 seasons. Power dredging was used to obtain the majority of the harvest.

Continuous water quality monitoring has occurred at station CB5.2 (38.13705; -76.2279). During the 2006-2020 timeline, surface salinity ranged from 0.8 ppt to 19.8 ppt.

[33] See chart 28 and 41 for bar names and locations in the State of Maryland Shellfish Closure Areas Book http://dnr.maryland.gov/fisheries/Pages/oysters/index.aspx

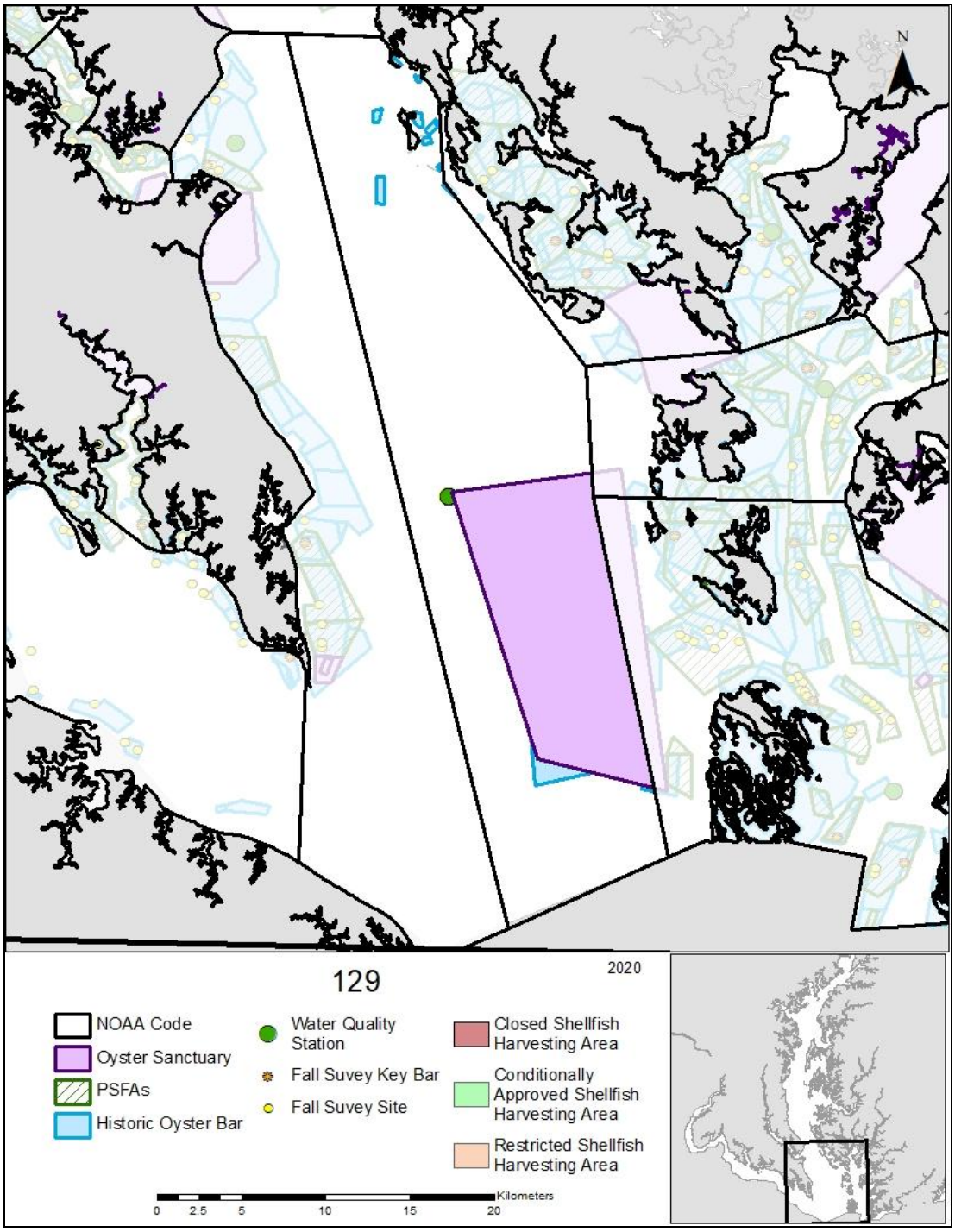


Figure B.20-1. Map of NOAA Code 129 (Lower East Chesapeake Bay). Fall Survey sites may not be sampled every year.

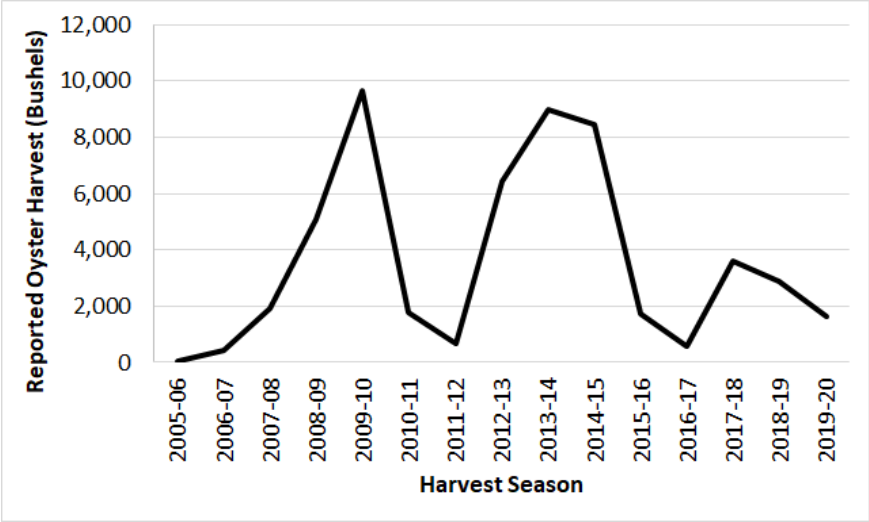


Figure B.20-2. Oyster harvest reported from seafood dealer buy tickets (harvest seasons 2005-2006 to 2019-2020) in NOAA Code 129 (Lower East Chesapeake Bay). Since 2010, 24% of the NOAA Code area has been a sanctuary where harvest is prohibited.

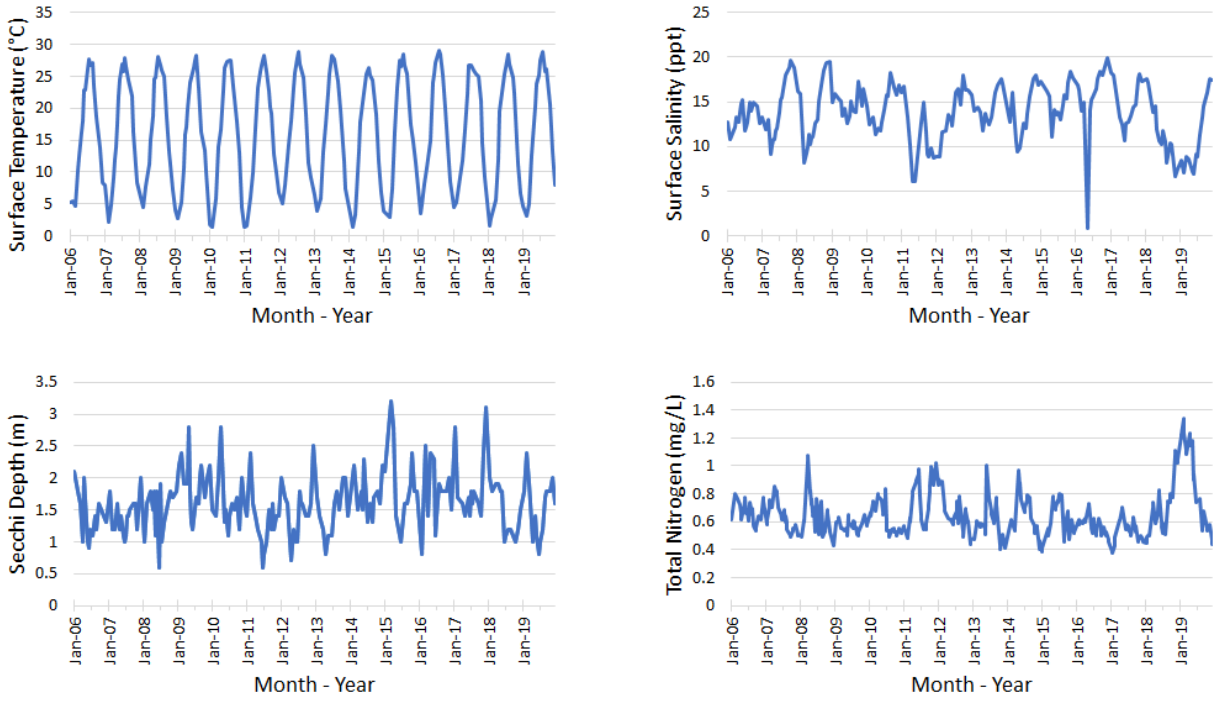


Figure B.20-3. Water quality data collected at Station CB5.2 in NOAA Code 129 (Lower East Chesapeake Bay). Data from Chesapeake Bay Program Data Hub.

## Section B.23: NOAA Code 131 – Chester River Lower

NOAA Code 131 encompasses the lower portion of the Chester River below Queenstown Creek and is located in Maryland's upper eastern portion of Chesapeake Bay. The entire NOAA Code is 18,080 acres and has 18 historic oyster bars[34]. The Lower Chester River Sanctuary encompasses 69% (12,591 acres) of the NOAA Code. This section focuses on information collected within the NOAA Code occurring outside of the current sanctuary area. This equates to 5,489 surface acres. There are 986 acres of historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments) located within the NOAA Code and outside the sanctuary. As of 2020, there are 763 acres within the NOAA Code designated as a Public Shellfish Fishery Area (PSFA). Aquaculture leasing is prohibited within PSFA boundaries. This NOAA Code is located within Maryland's low-salinity region (Zone 1).

Information available for this NOAA Code includes:

- NOAA Code map (Figure B.23-1)
- Summary statistics (Table B.23-1)
- Abundance per year (Figure B.23-2)
- Shell height frequencies (Figure B.23-3)
- Biomass per year (Figure B.23-4)
- Observed mortality (Figure B.23-5)
- Dermo and MSX per year (Figure B.23-6)
- Cultch per year (Figure B.23-7)
- Harvest (Figure B.23-8)
- Water Quality (Figure B.23-9)

Fall Survey results indicated average spat, small, and market densities decreased in 2016-2020 compared to 2011-2015. Mortality increased during 2016-2020, most likely due to the 2018-2019 freshet.

Between 2006 and 2020, approximately 2.6 thousand bushels of wild seed and 227 million hatchery spat-on-shell were planted to enhance the commercial public fishery in this NOAA Code outside of the current sanctuary area.

Harvest for the NOAA Code has been reported on seafood dealer buy tickets for all years of the 15-year time series. This includes past harvest data from areas in the NOAA Code that are currently in a sanctuary area, but weren't when the harvest occurred prior to the sanctuary being established. Since 2010, 69% of the NOAA Code area has been a sanctuary where harvest is prohibited. Harvest reported ranged from less than 25 bushels in the 2012-13 season to a maximum of approximately 2.7 thousand bushels in the 2006-07 season. Diving was used to obtain the majority of the harvest.

[34] See chart 7 and 8 for bar names and locations in the State of Maryland Shellfish Closure Areas Book http://dnr.maryland.gov/fisheries/Pages/oysters/index.aspx

Continuous water quality monitoring has occurred at station ET4.2 (38.99233; -76.2151). During the 2006-2020 timeline, surface salinity ranged from 1.1 ppt to 15.1 ppt, with the lowest salinity being during the freshet of 2018-2019 and during the high rainfall year of 2011.

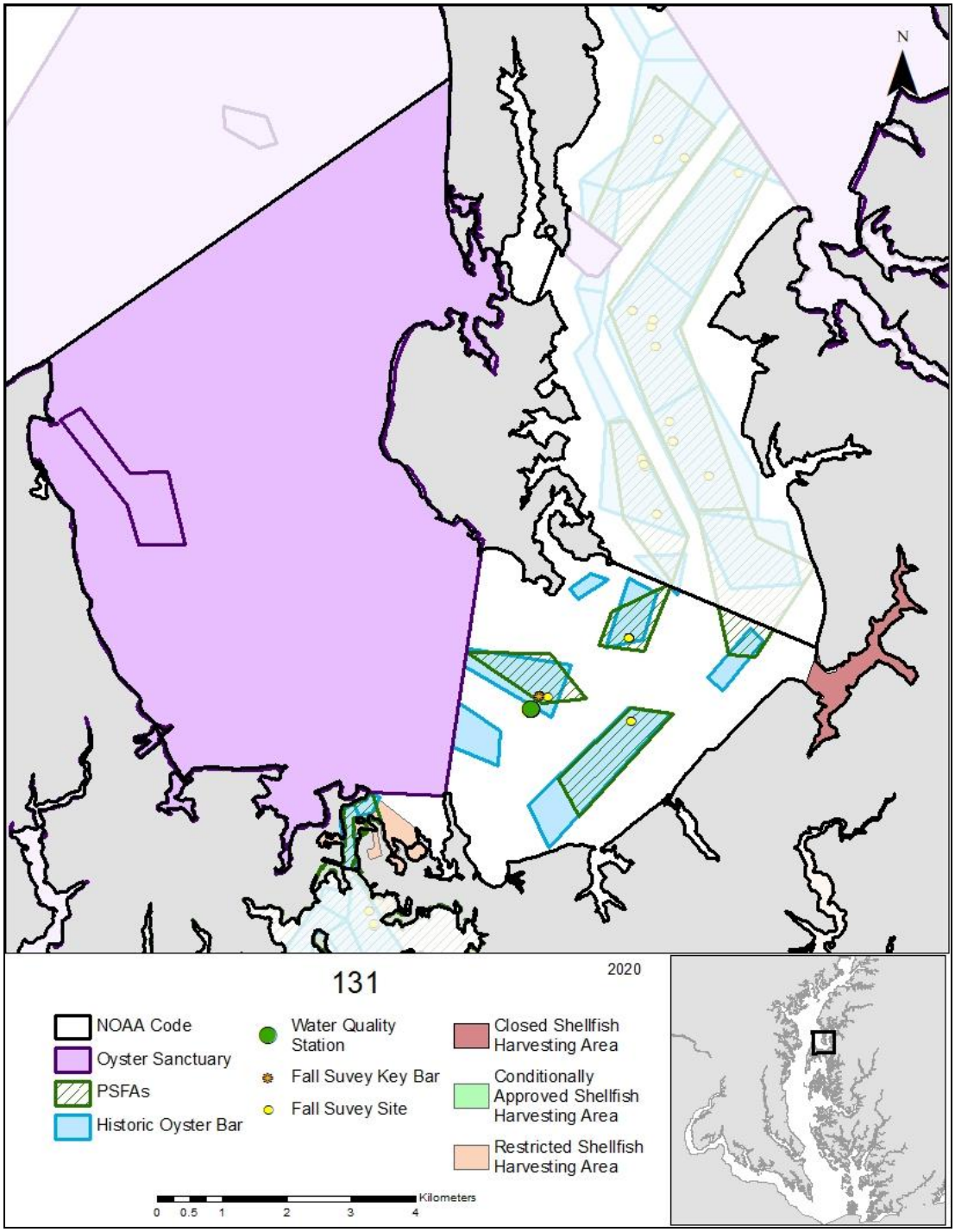


Figure B.23-1. Map of NOAA Code 131 (Chester River Lower). Fall Survey sites may not be sampled every year. Fall Survey key bars may consist of a key bar, disease bar or both.

Table B.23-1. Oyster population characteristics based on the Fall Survey in the NOAA Code 131 (Chester River Lower) occurring outside of the current sanctuary area. ND = No Data. Values are given as an annual mean ± standard error.

| | 2006-10 | 2011-15 | 2016-20 |
|---|---|---|---|
| Number of Years Sampled / Number of Samples | 5 / 10 | 5 / 11 | 5 / 12 |
| Number of Live Spat Oysters per square meter | 2.3 ± 2 | 0.1 ± 0.1 | 0 ± 0 |
| Number of Live Small-Sized Oysters per square meter | 6.8 ± 3.8 | 6.8 ± 2.7 | 2.1 ± 2.1 |
| Number of Live Market-Sized Oysters per square meter | 8.5 ± 4 | 16.7 ± 3.5 | 4.4 ± 1.8 |
| Live Oyster Biomass (g Dry Weight per Bushel) | 63 ± 17 | 83 ± 12 | 89 ± 19 |
| Observed Mortality (%) | 16 ± 6 | 4 ± 1 | 19 ± 5 |
| Cultch (Bushels per 100 ft Towed) | 0.36 ± 0.04 | 0.43 ± 0.07 | 0.3 ± 0.03 |
| Harvest (Bushels) | 1,797 ± 506 | 664 ± 350 | 819 ± 447 |

Note: The number of samples is based on the number of samples having a value for observed mortality. There may be fewer samples per year for density, biomass, and cultch.

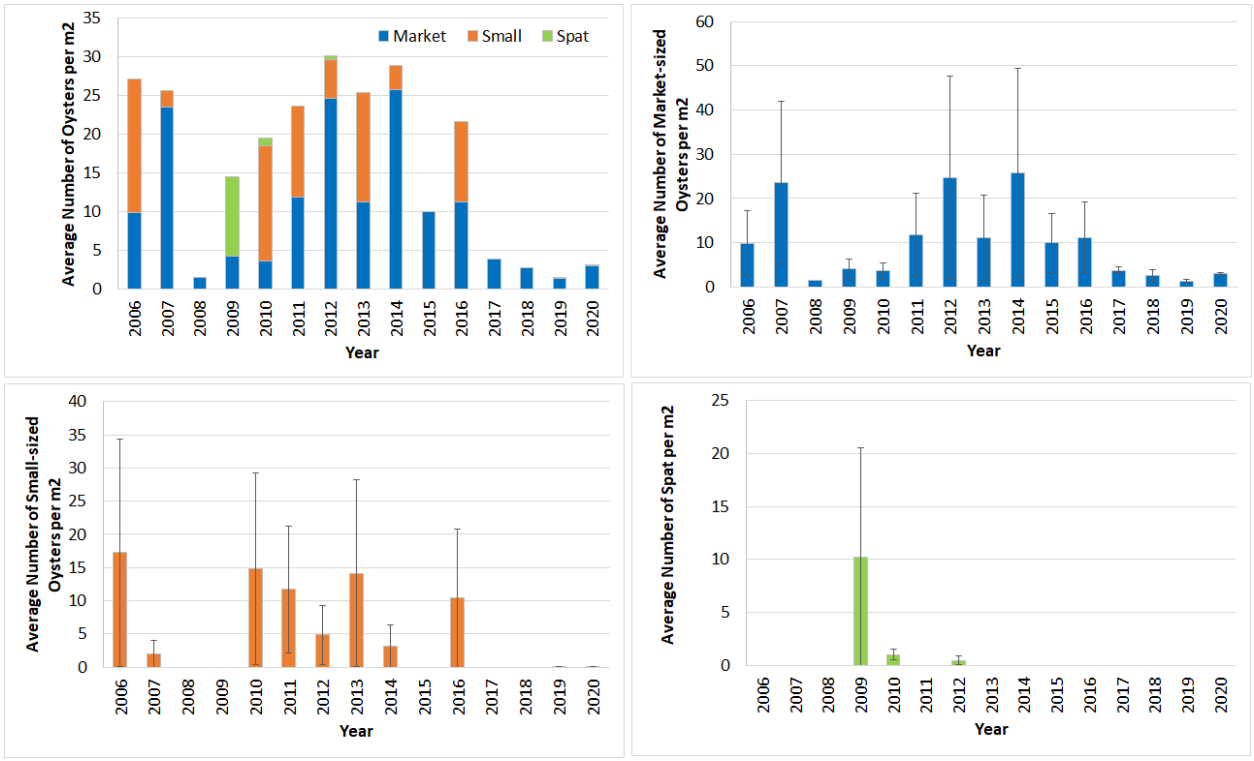


Figure B.23-2A. Average number of live oysters per square meter by size class in NOAA Code 131 (Chester River Lower) occurring outside of the current sanctuary area. Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales.

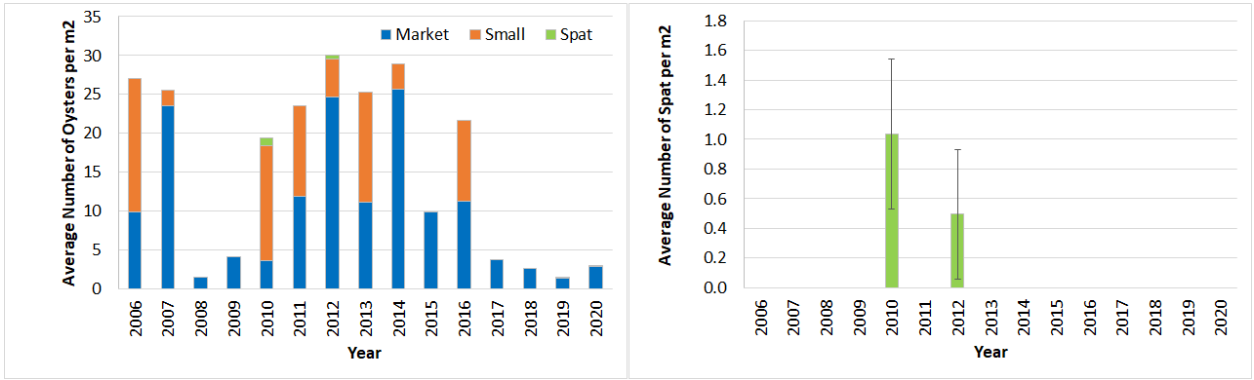


Figure B.23-2B. Average number of live oysters per square meter by size class in NOAA Code 131 (Chester River Lower) occurring outside of the current sanctuary area excluding samples taken on hatchery spat-on-shell plantings. Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales.

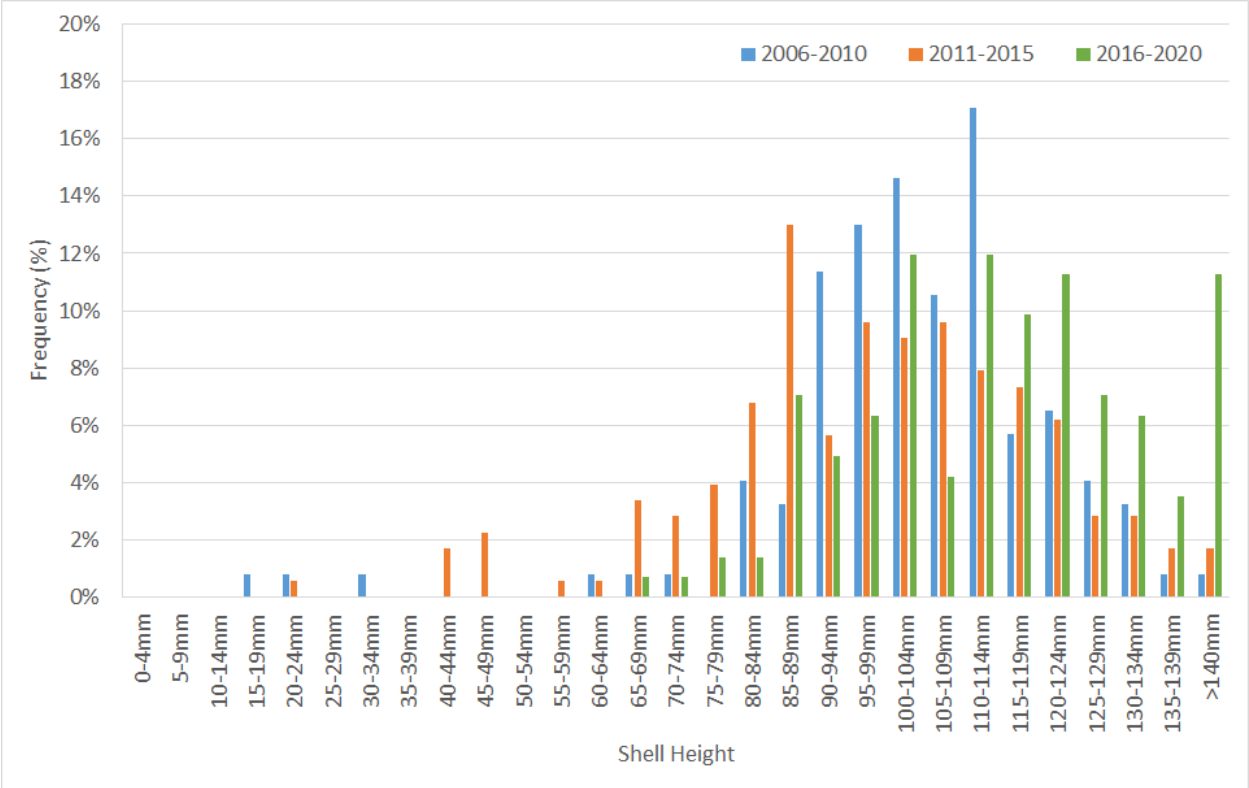


Figure B.23-3. Shell height frequencies of live oysters per bushel of material in NOAA Code131 (Chester River Lower) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey on Buoy Rock bar.

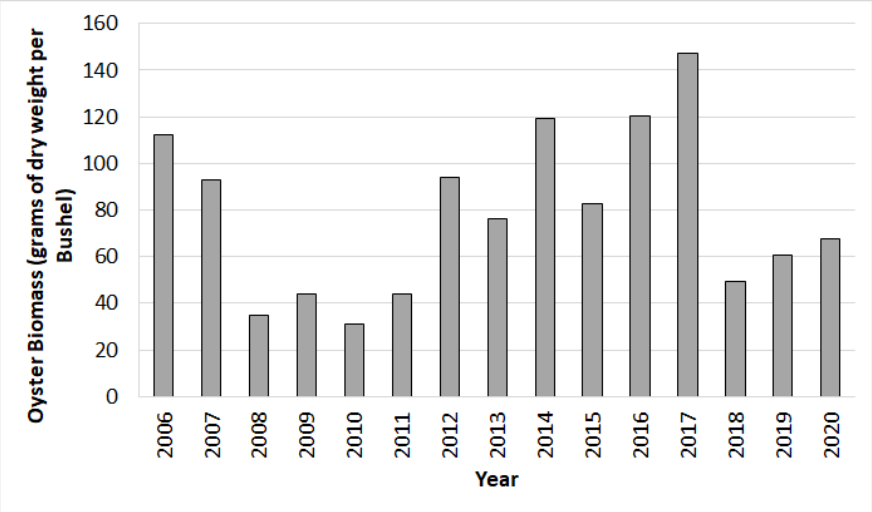


Figure B.23-4. Oyster biomass (grams of dry weight per bushel of material) in NOAA Code 131 (Chester River Lower) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey on Buoy Rock bar.

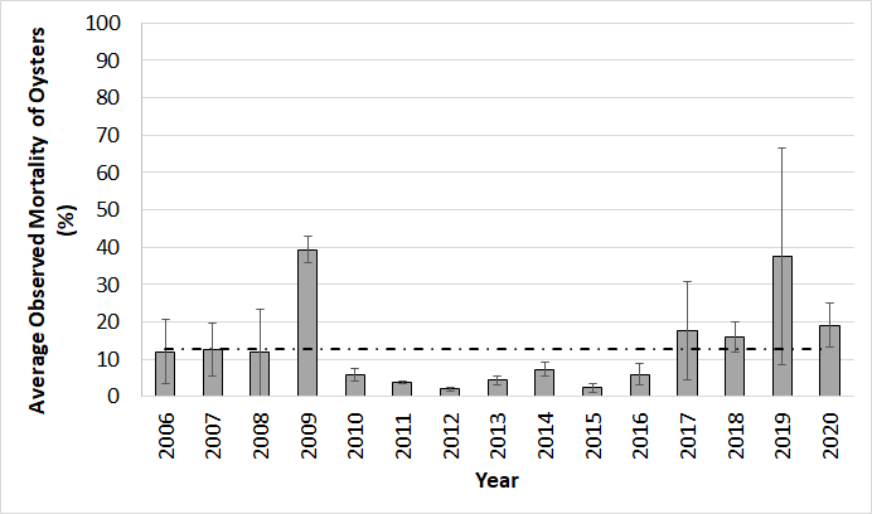


Figure B.23-5. Average annual observed mortality of market-sized and small-sized oysters in NOAA Code 131 (Chester River Lower) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey. The dashed line represents the 2006-2020 baywide average observed mortality. Error bars represent ± 1 standard error.

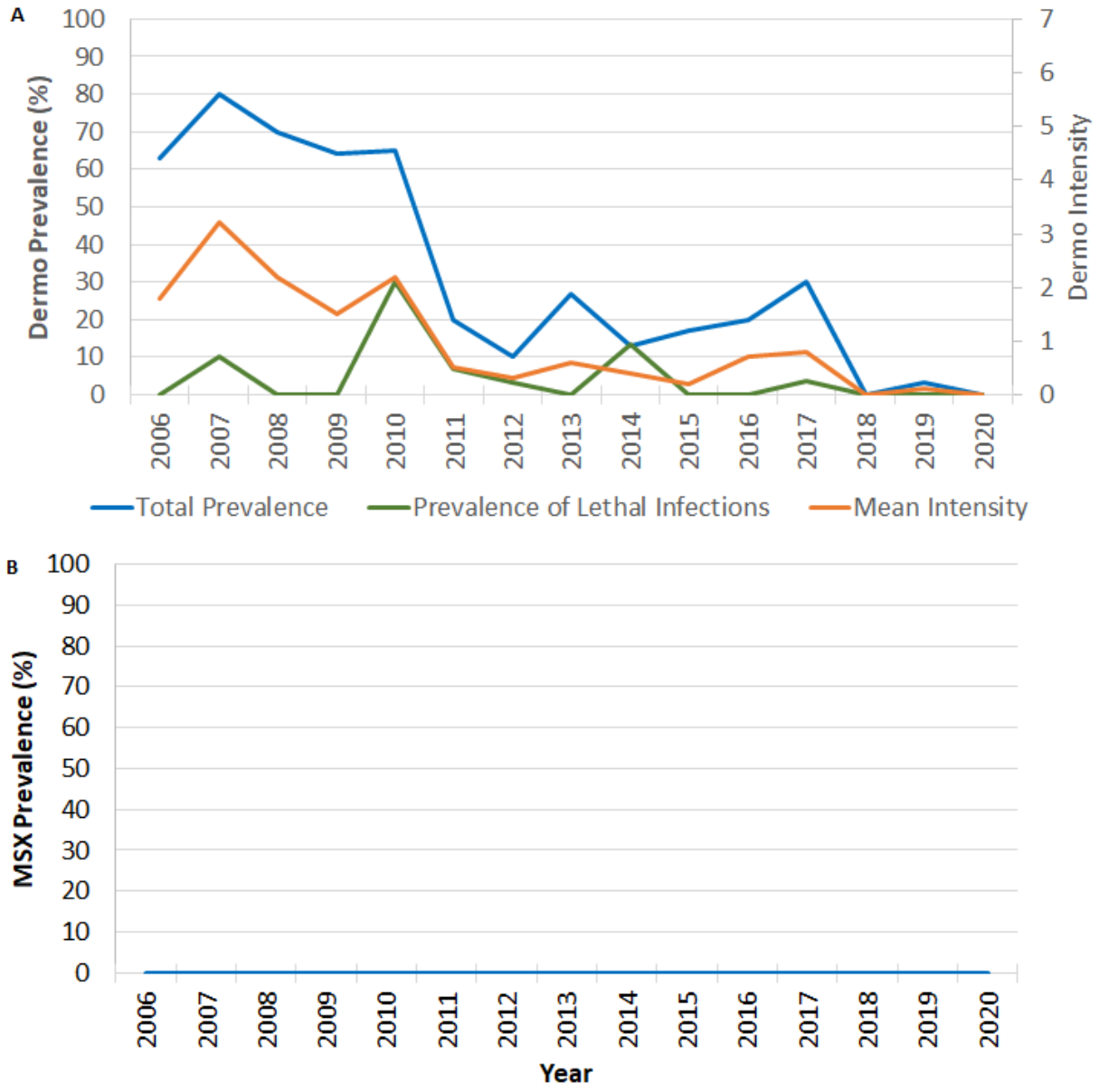


Figure B.23-6. Oyster disease prevalence and intensity in NOAA Code 131 (Chester River Lower) occurring outside of the current sanctuary area. (A) Dermo prevalence and mean intensity (B) MSX prevalence (intensity is not examined). Data from Maryland's Annual Fall Oyster Dredge Survey on Buoy Rock bar.

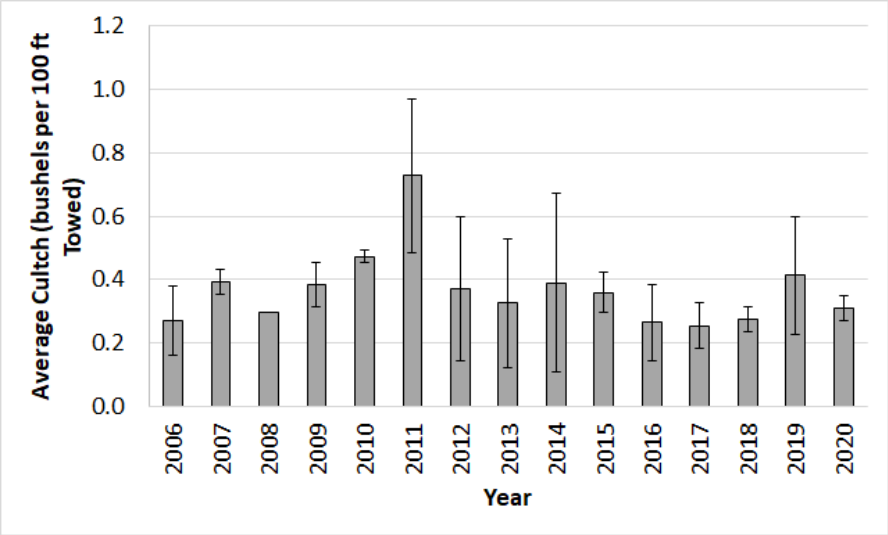


Figure B.23-7. Average cultch (live and dead oysters and loose shell) in NOAA Code 131 (Chester River Lower) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey. Error bars represent ± 1 standard error.

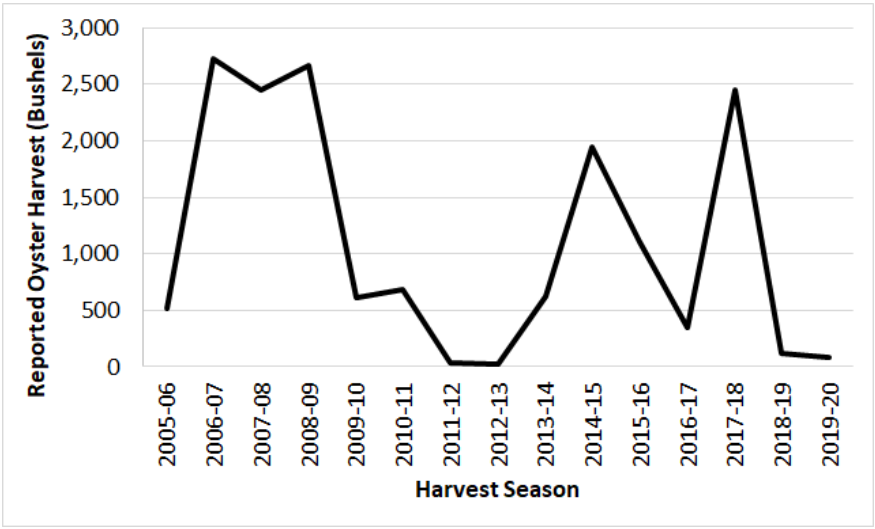


Figure B.23-8. Oyster harvest reported from seafood dealer buy tickets (harvest seasons 2005-2006 to 2019-2020) in NOAA Code 131 (Chester River Lower). Since 2010, 69% of the NOAA Code area has been a sanctuary where harvest is prohibited.

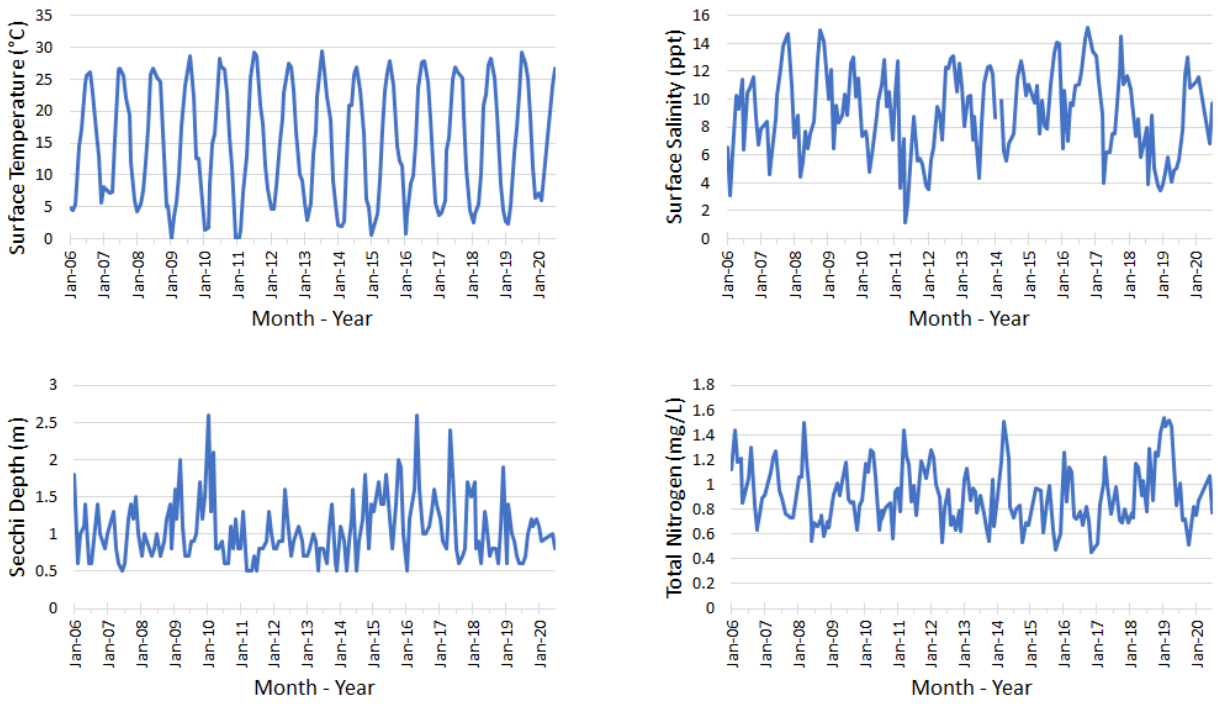


Figure B.23-9. Water quality data collected at Station ET4.2 in NOAA Code 131 (Chester River Lower). Data from Chesapeake Bay Program Data Hub.

## Section B.24: NOAA Code 137 – Choptank River Lower

NOAA Code 137 encompasses the lower portion of the Choptank River west of Castle Haven and is located in Maryland's mid-eastern portion of Chesapeake Bay. The entire NOAA Code is 34,721 acres and has 48 historic oyster bars[35]. Two sanctuaries (Lower Choptank and Cook Point) encompass 14% (4,996 total acres) of the NOAA Code. This section focuses on information collected within the NOAA Code but occurring outside of the current sanctuary area. This equates to 29,725 surface acres. There are 17,314 acres of historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments) located within the NOAA Code and outside a sanctuary. As of 2020, there are 17,603 acres within the NOAA Code designated as a Public Shellfish Fishery Area (PSFA). Aquaculture leasing is prohibited within PSFA boundaries. This NOAA Code is located within Maryland's medium-salinity region (Zone 2).

Information available for this NOAA Code includes:

- NOAA Code map (Figure B.24-1)
- Summary statistics (Table B.24-1)
- Abundance per year (Figure B.24-2)
- Shell height frequencies (Figure B.24-3)
- Biomass per year (Figure B.24-4)
- Observed mortality (Figure B.24-5)
- Dermo and MSX per year (Figure B.24-6)
- Cultch per year (Figure B.24-7)
- Harvest (Figure B.24-8)
- Water Quality (Figure B.24-9)

Fall Survey results indicated average spat density was higher in 2016-2020 than the other time periods, likely driven by the relatively high spatset in 2020. Average small-sized density remained constant over the three time periods. Average biomass and market density were lower in 2016-2020 than 2011-2015 but higher than 2006-2010. This is most likely due to the higher harvest during the 2014-15 and 2015-16 harvest season. Mortality was below the long term baywide average in most years.

Between 2006 and 2020, approximately 69 thousand bushels of shell were planted to enhance the commercial public fishery in this NOAA Code outside of the current sanctuary area.

Harvest for the NOAA Code has been reported on seafood dealer buy tickets for all years of the 15-year time series. This includes past harvest data from areas in the NOAA Code that are currently in a sanctuary area, but weren't when the harvest occurred prior to the sanctuaries being established. Since 2010, 14% of the NOAA Code area has been a sanctuary where harvest is prohibited. Harvest reported ranged from about one thousand bushels in the 2005-06 season to

[35] See chart 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

a maximum of approximately 28 thousand bushels in the 2014-15 season. Power and sail dredging were used to obtain the majority of the harvest.

Continuous water quality monitoring has occurred at station EE2.1 (38.6549; -76.2643). During the 2006-2020 timeline, surface salinity ranged from 5.5 ppt to 17.9 ppt, with the lowest salinity being during the freshet of 2018-2019 and during the high rainfall year of 2011.

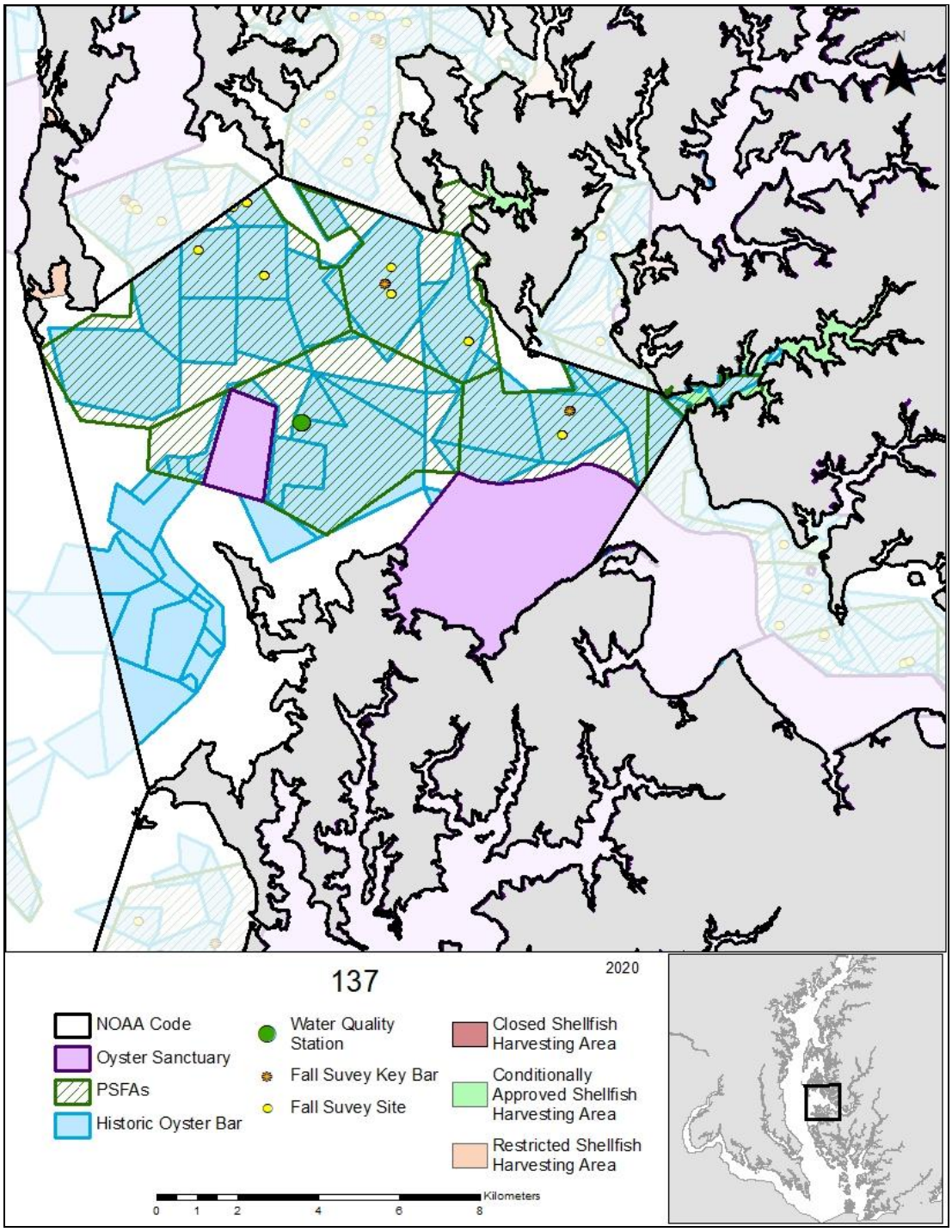


Figure B.24-1. Map of NOAA Code 137 (Choptank River Lower). Fall Survey sites may not be sampled every year. Fall Survey key bars may consist of a key bar, disease bar or both.

Table B.24-1. Oyster population characteristics based on the Fall Survey in the NOAA Code 137 (Choptank River Lower) occurring outside of the current sanctuary area. ND = No Data. Values are given as an annual mean ± standard error.

| | 2006-10 | 2011-15 | 2016-20 |
|---|---|---|---|
| Number of Years Sampled / Number of Samples | 5 / 40 | 5 / 35 | 5 / 39 |
| Number of Live Spat Oysters per square meter | 6.5 ± 2.8 | 6.9 ± 3.9 | 21 ± 17.9 |
| Number of Live Small-Sized Oysters per square meter | 13.1 ± 3.9 | 19.3 ± 4.1 | 16.3 ± 4 |
| Number of Live Market-Sized Oysters per square meter | 7.1 ± 2.4 | 18.7 ± 3.5 | 11.6 ± 3 |
| Live Oyster Biomass (g Dry Weight per Bushel) | 44 ± 5 | 173 ± 31 | 118 ± 25 |
| Observed Mortality (%) | 3 ± 1 | 4 ± 1 | 7 ± 2 |
| Cultch (Bushels per 100 ft Towed) | 0.56 ± 0.05 | 0.37 ± 0.03 | 0.32 ± 0.03 |
| Harvest (Bushels) | 2,096 ± 323 | 11,836 ± 4,859 | 13,433 ± 3,014 |
| Note: The number of samples is based on the number of samples having a value for observed mortality. There may be fewer samples per year for density, biomass, and cultch. | | | |

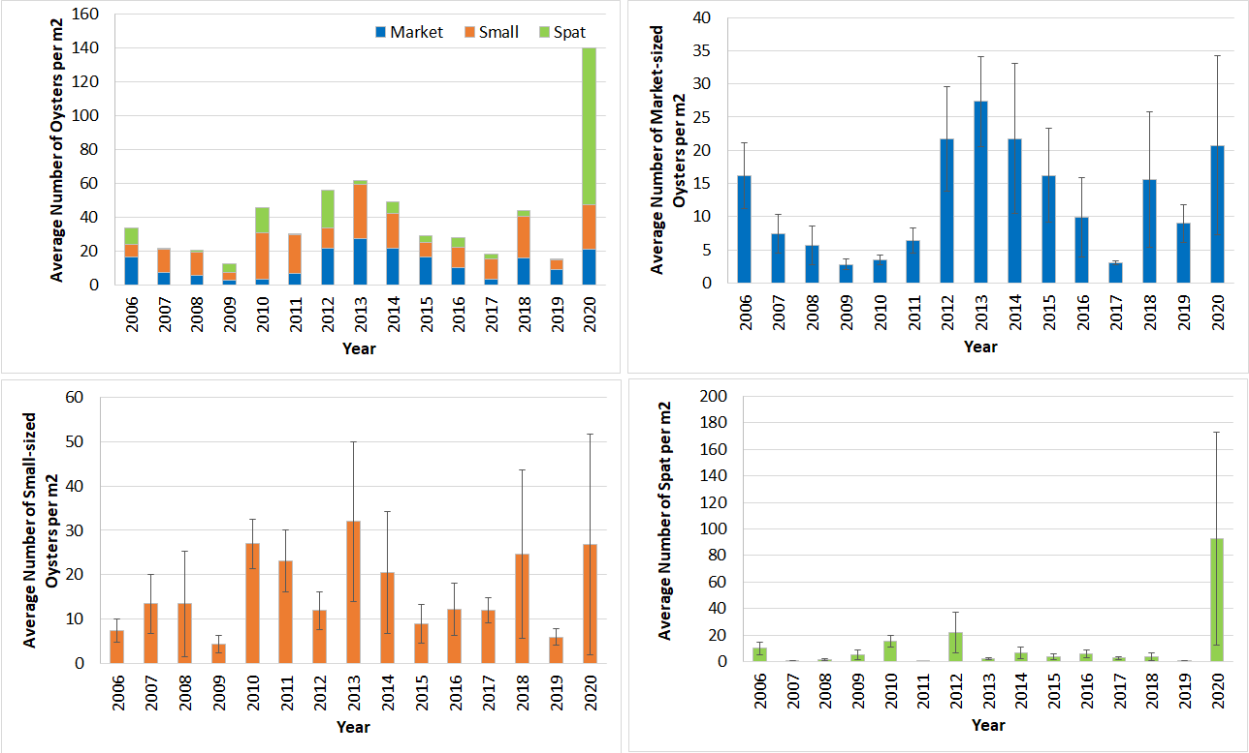


Figure B.24-2. Average number of live oysters per square meter by size class in NOAA Code 137 (Choptank River Lower) occurring outside of the current sanctuary area. Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales.

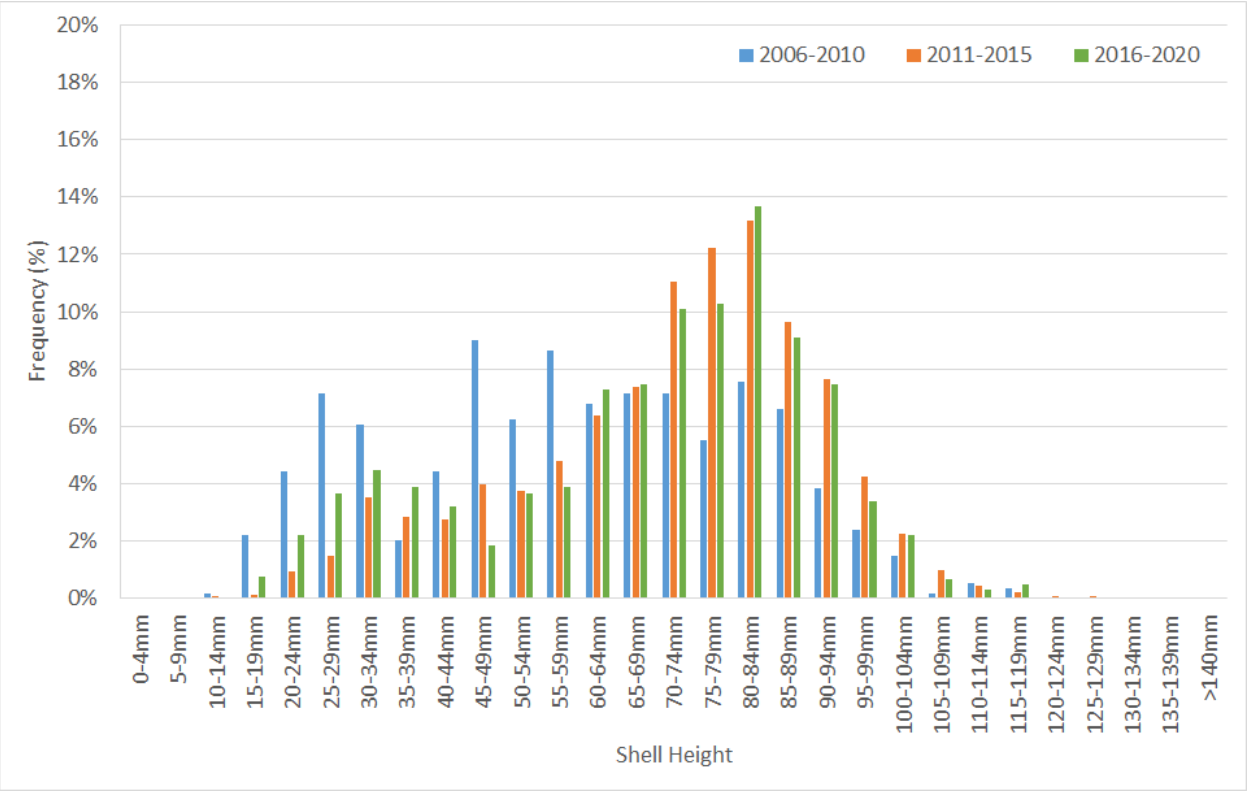


Figure B.24-3. Shell height frequencies of live oysters per bushel of material in NOAA Code 137 (Choptank River Lower) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey based on an average of Royston and Lighthouse bars.

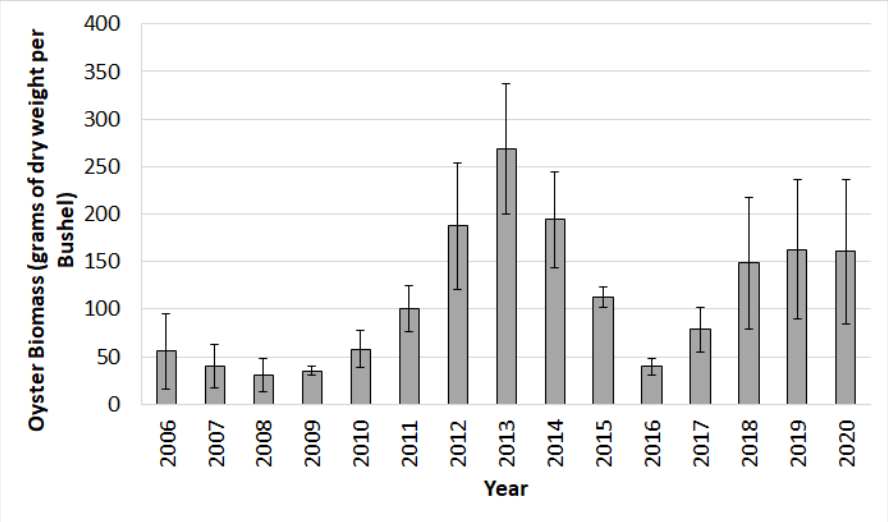


Figure B.24-4. Oyster biomass (grams of dry weight per bushel of material) in NOAA Code 137 (Choptank River Lower) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey based on an average of Royston and Lighthouse bars. Error bars represent ± 1 standard error.

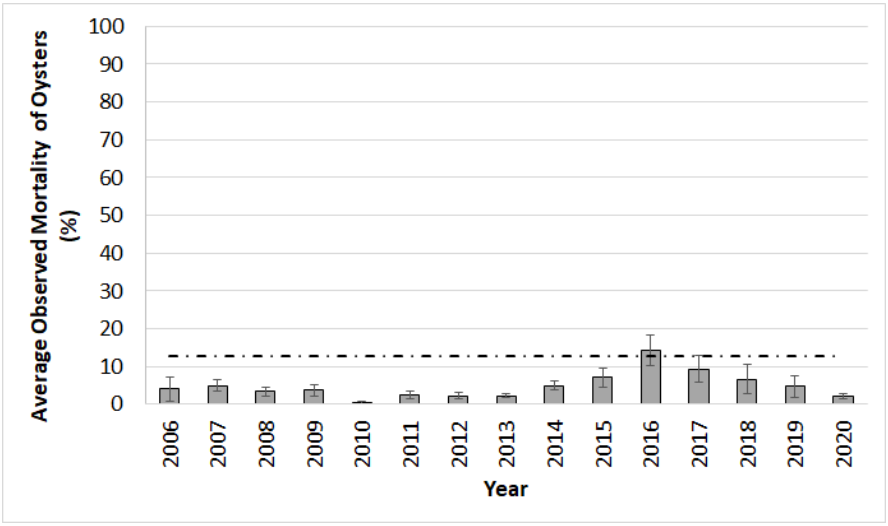


Figure B.24-5. Average annual observed mortality of market-sized and small-sized oysters in NOAA Code 137 (Choptank River Lower) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey. The dashed line represents the 2006-2020 baywide average observed mortality. Error bars represent ± 1 standard error.

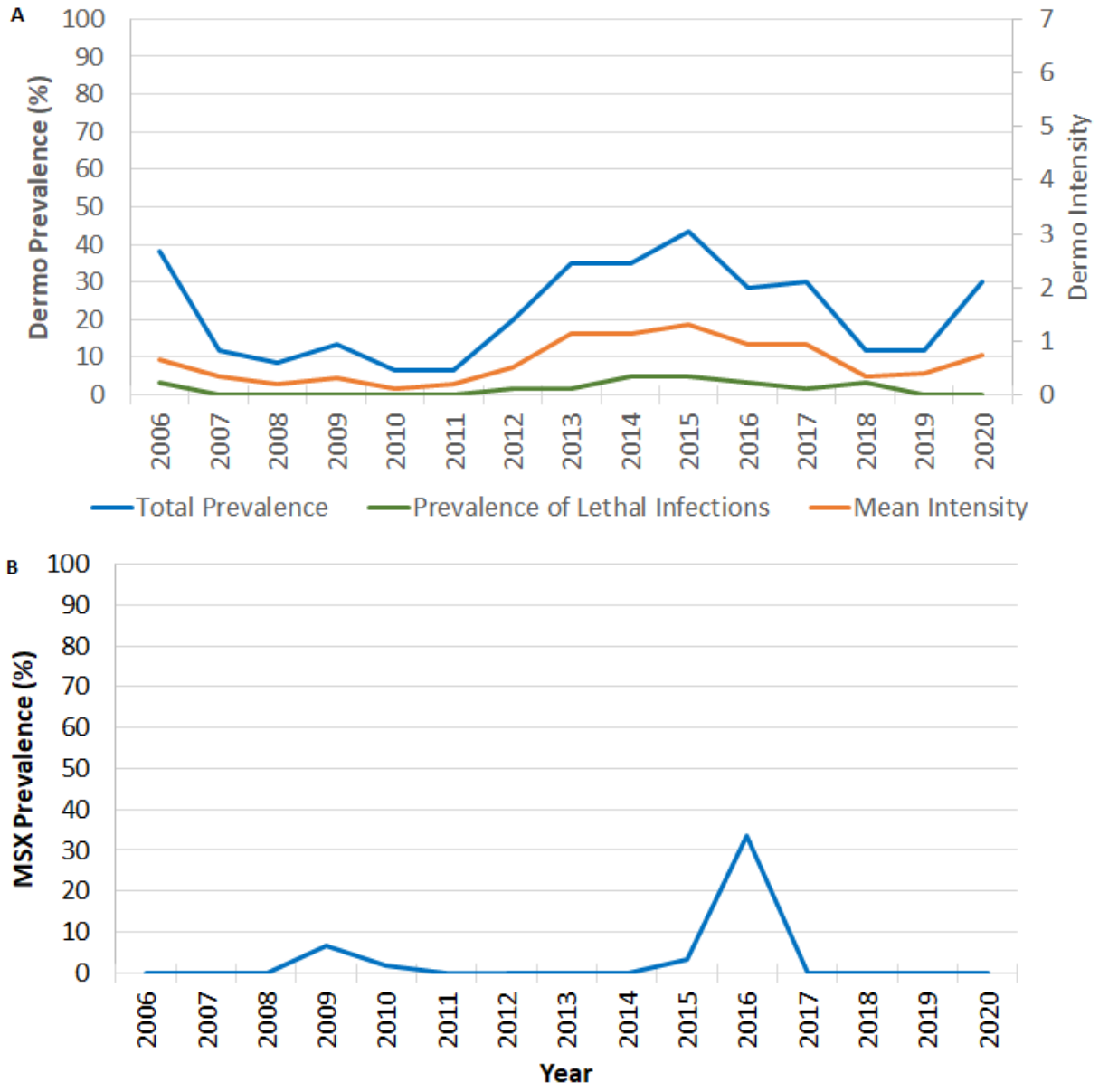


Figure B.24-6. Oyster disease prevalence and intensity in NOAA Code 137 (Choptank River Lower) occurring outside of the current sanctuary area. (A) Dermo prevalence and mean intensity (B) MSX prevalence (intensity is not examined). Data from Maryland's Annual Fall Oyster Dredge Survey based on an average of Royston and Lighthouse bars.

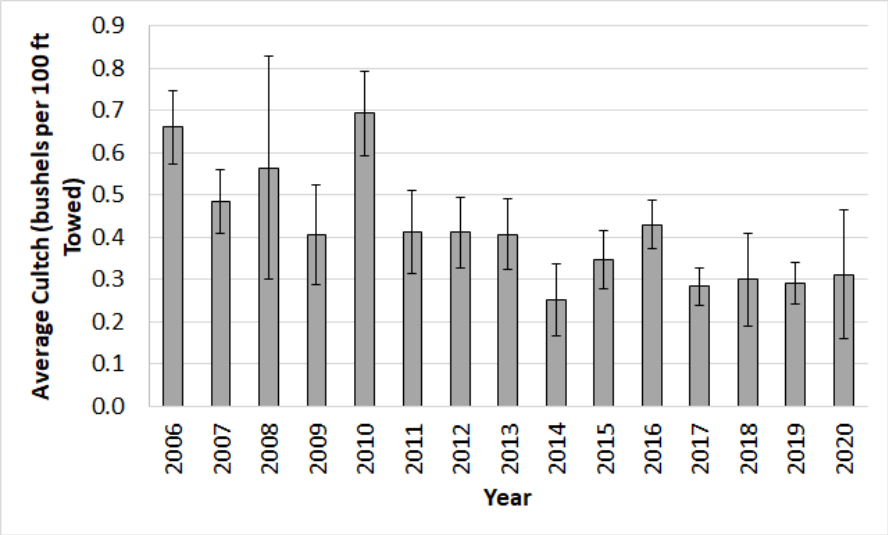


Figure B.24-7. Average cultch (live and dead oysters and loose shell) in NOAA Code 137 (Choptank River Lower) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey. Error bars represent ± 1 standard error.

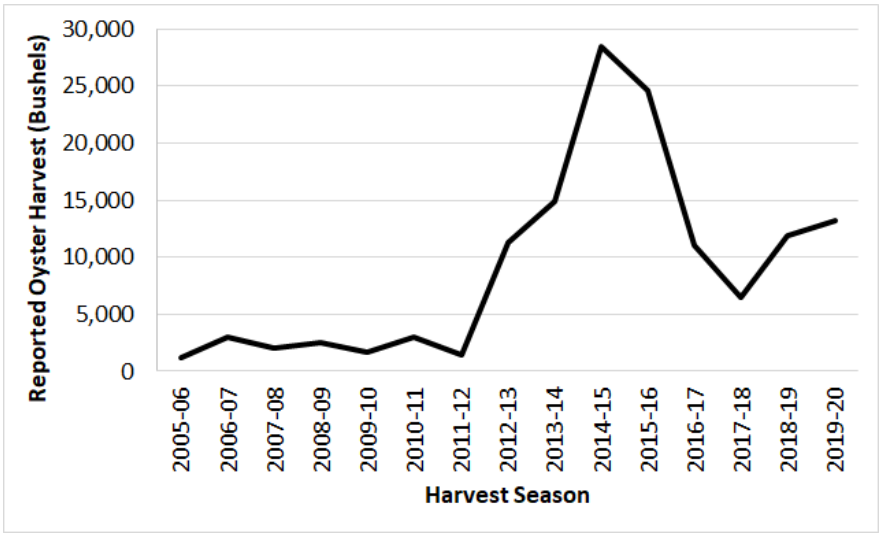


Figure B.24-8. Oyster harvest reported from seafood dealer buy tickets (harvest seasons 2005-2006 to 2019-2020) in NOAA Code 137 (Choptank River Lower). Since 2010, 14% of the NOAA Code area has been a sanctuary where harvest is prohibited.

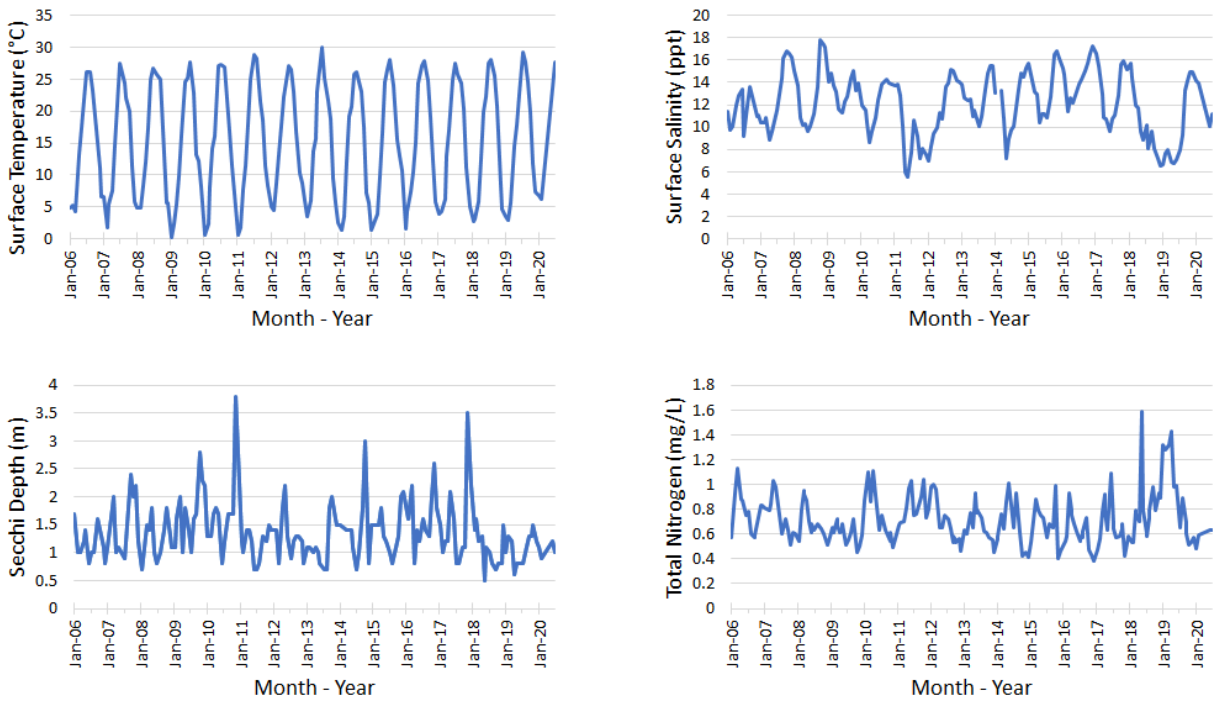


Figure B.24-9. Water quality data collected at Station EE2.1 in NOAA Code 137 (Choptank River Lower). Data from Chesapeake Bay Program Data Hub.

## Section B.25: NOAA Code 168 – Patuxent River Lower

NOAA Code 168 encompasses the lower portion of the Patuxent River south of St. Leonard Creek and is located in Maryland's lower eastern portion of Chesapeake Bay. The entire NOAA Code is 8,799 acres and has 22 historic oyster bars[36]. Two sanctuaries (Solomons Creek and Lower Patuxent) established in 2010 are within the NOAA Code and encompasses 11% (951 acres) of the NOAA Code. This section focuses on information collected within the NOAA Code occurring outside of the current sanctuary areas. This equates to 7,848 surface acres. There are 2,231 acres of historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments) located within the NOAA Code and not within a sanctuary. As of 2020, there are 2,994 acres within the NOAA Code designated as a Public Shellfish Fishery Area (PSFA). Aquaculture leasing is prohibited within PSFA boundaries. This NOAA Code is located within Maryland's medium-salinity region (Zone 2).

Information available for this NOAA Code includes:

- NOAA Code map (Figure B.25-1)
- Summary statistics (Table B.25-1)
- Abundance per year (Figure B.25-2)
- Shell height frequencies (Figure B.25-3)
- Biomass per year (Figure B.25-4)
- Observed mortality (Figure B.25-5)
- Cultch per year (Figure B.25-6)
- Harvest (Figure B.25-7)
- Water Quality (Figure B.25-8)

Fall Survey results indicated average market density was similar over the three time periods. Market density increased from 2007 to 2012, decreased until 2018, and then increased starting in 2019. These trends follow harvest, where the highest harvest occurred in the 2014-15 and 2015-16 harvest seasons. Average small-sized oyster density remained similar from 2011-2015 to 2016-2020, however this was higher than 2006-2010. Spat density was highest in 2011-2015 time period but this trend is mostly driven by the relatively high spatset in 2012. Average mortality for 2010-2015 and 2016-2020 time periods remained at the long term baywide average and lower than the 2006-2010 average mortality.

Between 2006 and 2020, approximately 81 thousand bushels of shell, 34 thousand bushels of wild seed and 75 million hatchery spat-on-shell were planted to enhance the commercial public fishery in this NOAA Code outside of the current sanctuary area.

Harvest for the NOAA Code has been reported on seafood dealer buy tickets for all years of the 15-year time series. This includes past harvest data from areas in the NOAA Code that are currently in a sanctuary area, but weren't when the harvest occurred prior to the sanctuaries being established. Since 2010, 11% of the NOAA Code area has been a sanctuary where harvest

[36] See chart 26 and 27 for bar names and locations in the State of Maryland Shellfish Closure Areas Book http://dnr.maryland.gov/fisheries/Pages/oysters/index.aspx

is prohibited. Harvest reported ranged from less than 300 bushels in the 2007-08 season to a maximum of approximately 40 thousand bushels in the 2015-16 season. Patent tonging was used to obtain the majority of the harvest.

Continuous water quality monitoring has occurred at station LE1.3 (38.3398; -76.4849). During the 2006-2020 timeline, surface salinity ranged from 4.6 ppt to 18 ppt, with the lowest salinity being during the freshet of 2018-2019 and during the high rainfall year of 2011.

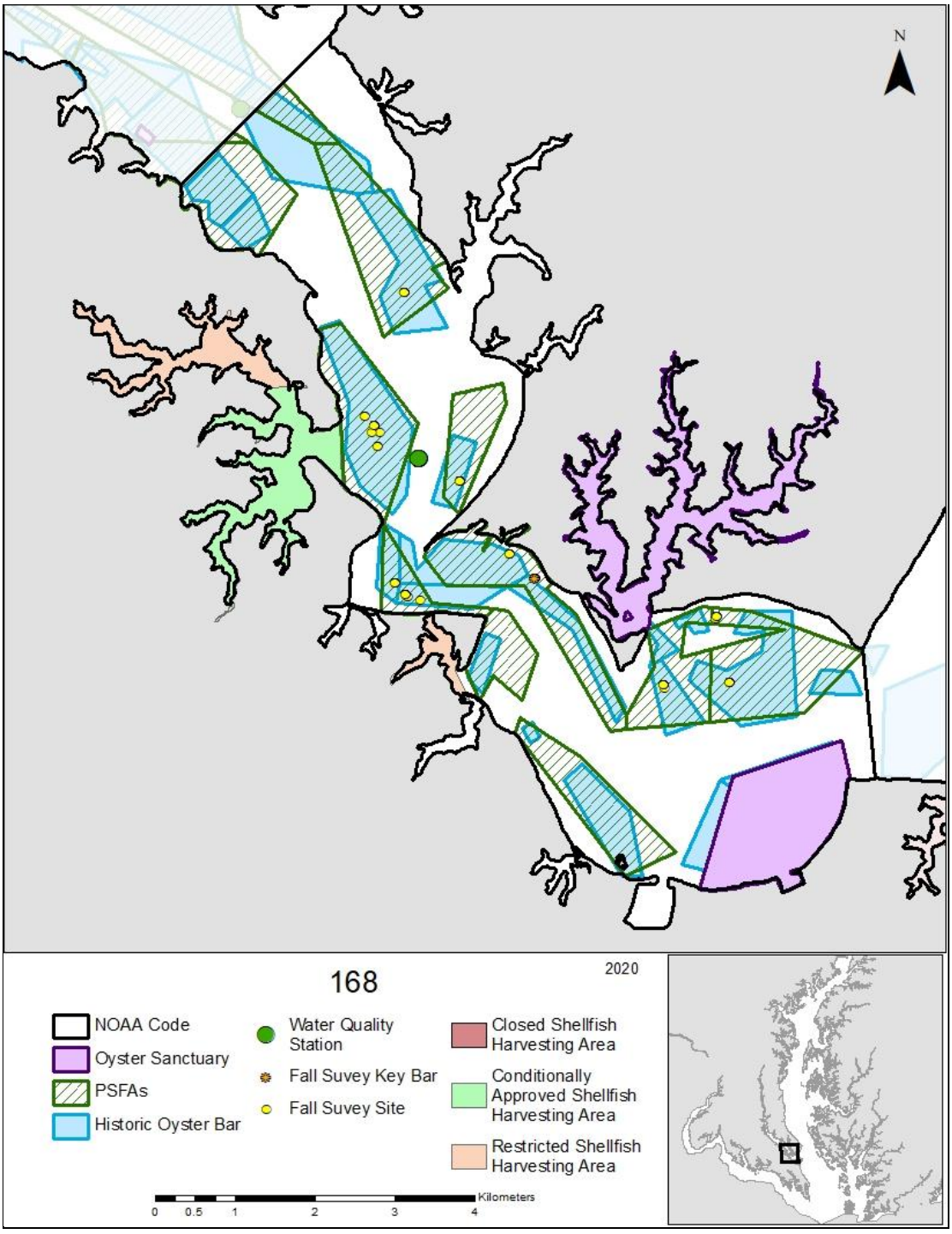


Figure B.25-1. Map of NOAA Code 168 (Patuxent River Lower). Fall Survey sites may not be sampled every year. Fall Survey key bars may consist of a key bar, disease bar or both.

Table B.25-1. Oyster population characteristics based on the Fall Survey in the NOAA Code 168 (Patuxent River Lower) occurring outside of the current sanctuary area. ND = No Data. Values are given as an annual mean ± standard error.

| | 2006-10 | 2011-15 | 2016-20 |
|---|---|---|---|
| Number of Years Sampled / Number of Samples | 5 / 49 | 5 / 46 | 5 / 53 |
| Number of Live Spat Oysters per square meter | 8.7 ± 5.8 | 17.3 ± 10 | 9.9 ± 4.3 |
| Number of Live Small-Sized Oysters per square meter | 32 ± 9.3 | 55.6 ± 12.5 | 65.5 ± 17.2 |
| Number of Live Market-Sized Oysters per square meter | 21.7 ± 4.7 | 24.6 ± 2 | 22.7 ± 4.7 |
| Live Oyster Biomass (g Dry Weight per Bushel) | ND | 170 ± 25 | 150 ± 23 |
| Observed Mortality (%) | 23 ± 4 | 13 ± 2 | 12 ± 5 |
| Cultch (Bushels per 100 ft Towed) | 1.05 ± 0.14 | 0.88 ± 0.15 | 0.95 ± 0.09 |
| Harvest (Bushels) | 3,033 ± 1,374 | 15,897 ± 6,468 | 19,317 ± 5,963 |
| Note: The number of samples is based on the number of samples having a value for observed mortality. There may be fewer samples per year for density, biomass, and cultch. | | | |

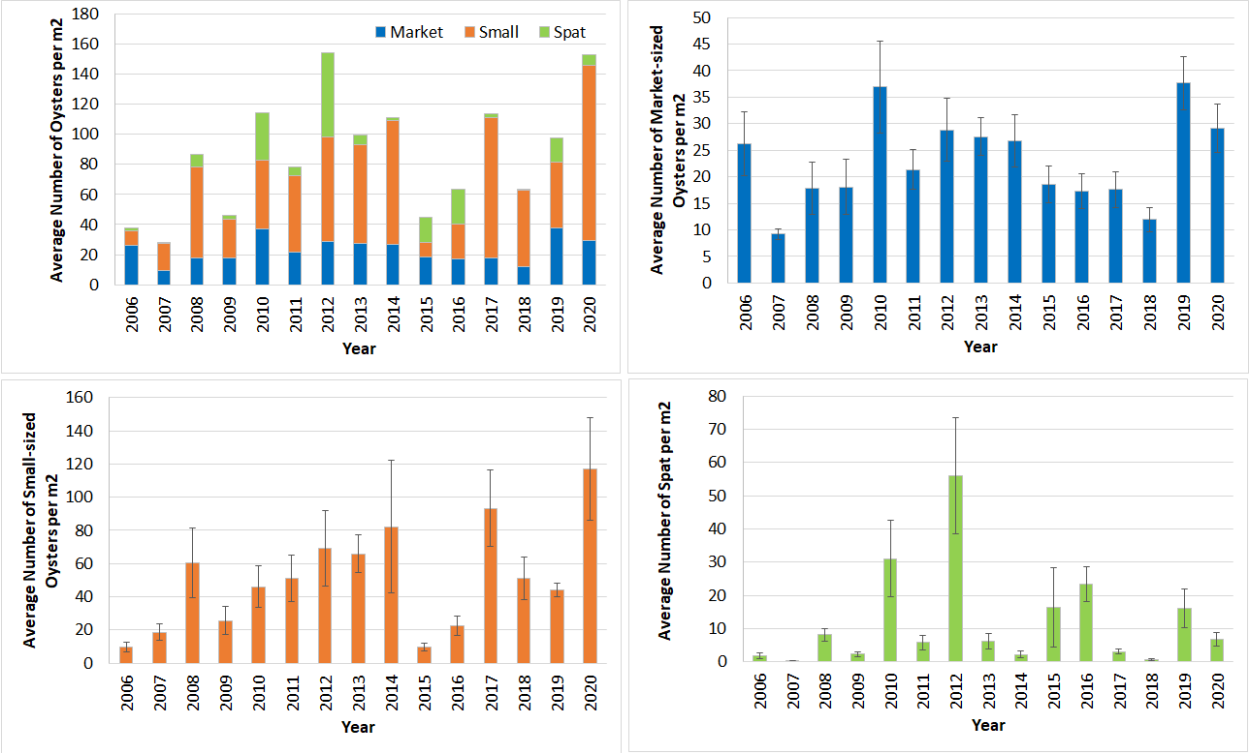


Figure B.25-2. Average number of live oysters per square meter by size class in NOAA Code 168 (Patuxent River Lower) occurring outside of the current sanctuary area. Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales.

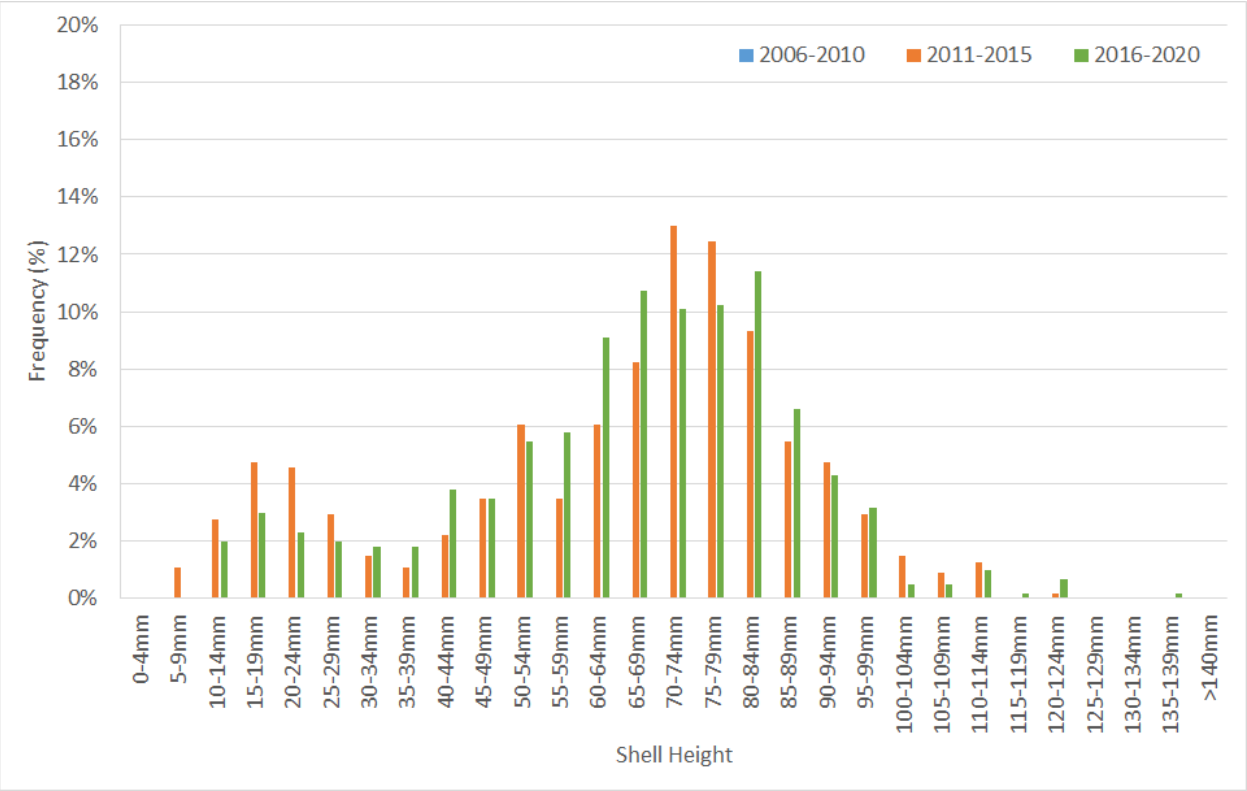


Figure B.25-3. Shell height frequencies of live oysters per bushel of material in NOAA Code 168 (Patuxent River Lower) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey on Back of the Island bar. Data was not collected from 2006 to 2010.

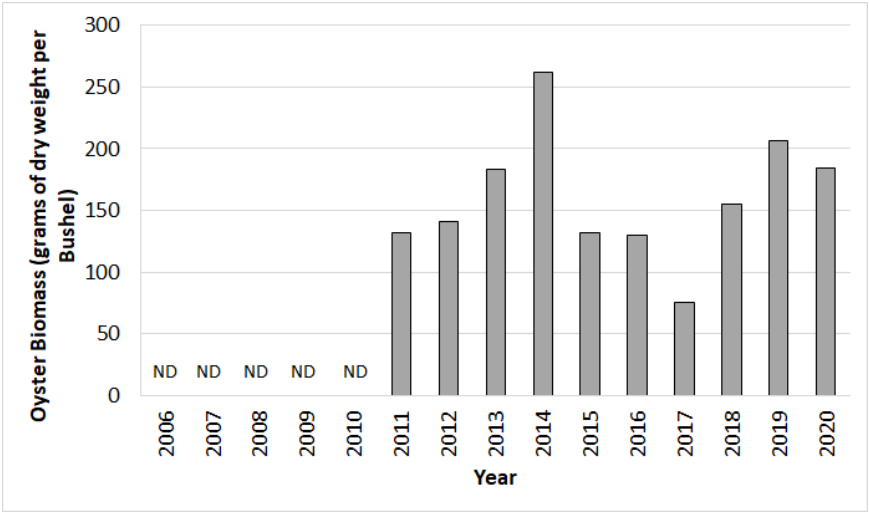


Figure B.25-4. Oyster biomass (grams of dry weight per bushel of material) in NOAA Code 168 (Patuxent River Lower) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey on Back of the Island bar.

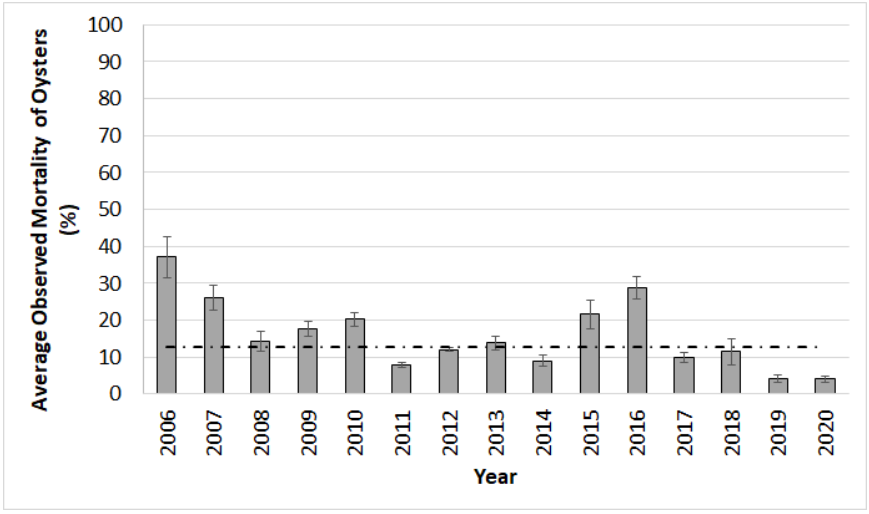


Figure B.25-5. Average annual observed mortality of market-sized and small-sized oysters in NOAA Code 168 (Patuxent River Lower) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey. The dashed line represents the 2006-2020 baywide average observed mortality. Error bars represent ± 1 standard error.

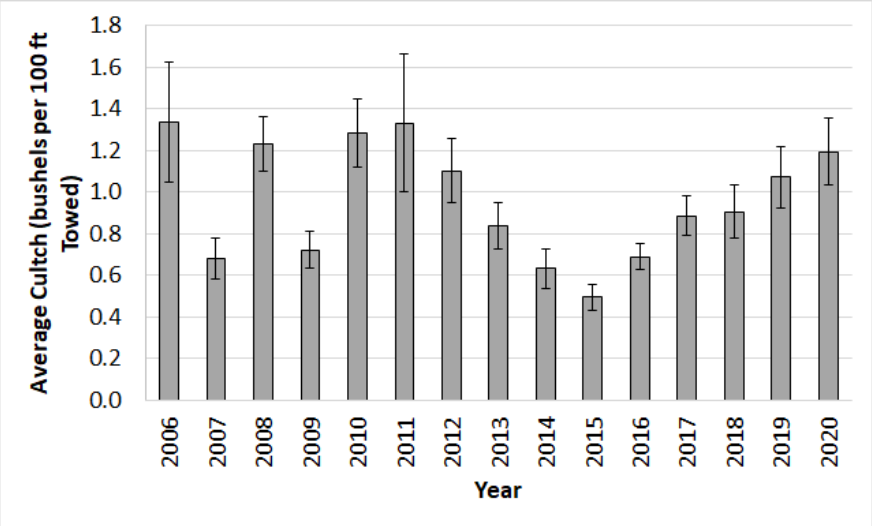


Figure B.25-6. Average cultch (live and dead oysters and loose shell) in NOAA Code 168 (Patuxent River Lower) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey. Error bars represent ± 1 standard error.

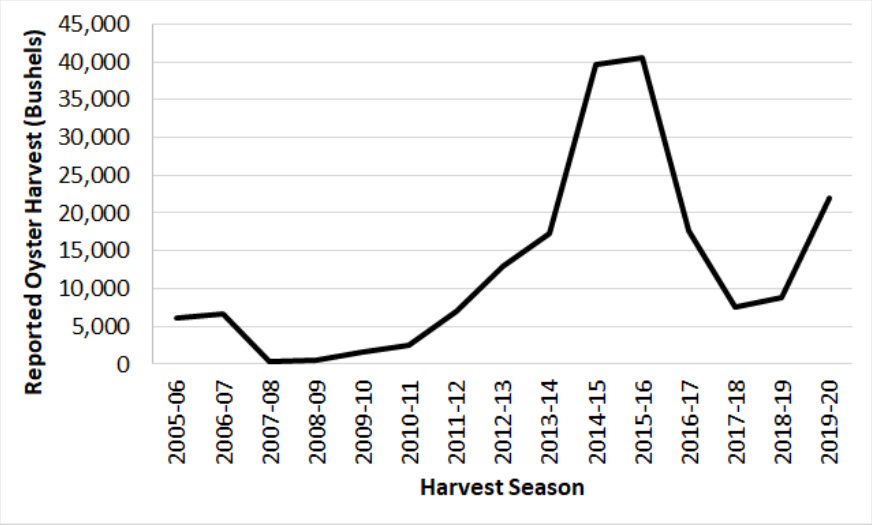


Figure B.25-7. Oyster harvest reported from seafood dealer buy tickets (harvest seasons 2005-2006 to 2019-2020) in NOAA Code 168 (Patuxent River Lower). Since 2010, 11% of the NOAA Code area has been a sanctuary where harvest is prohibited.

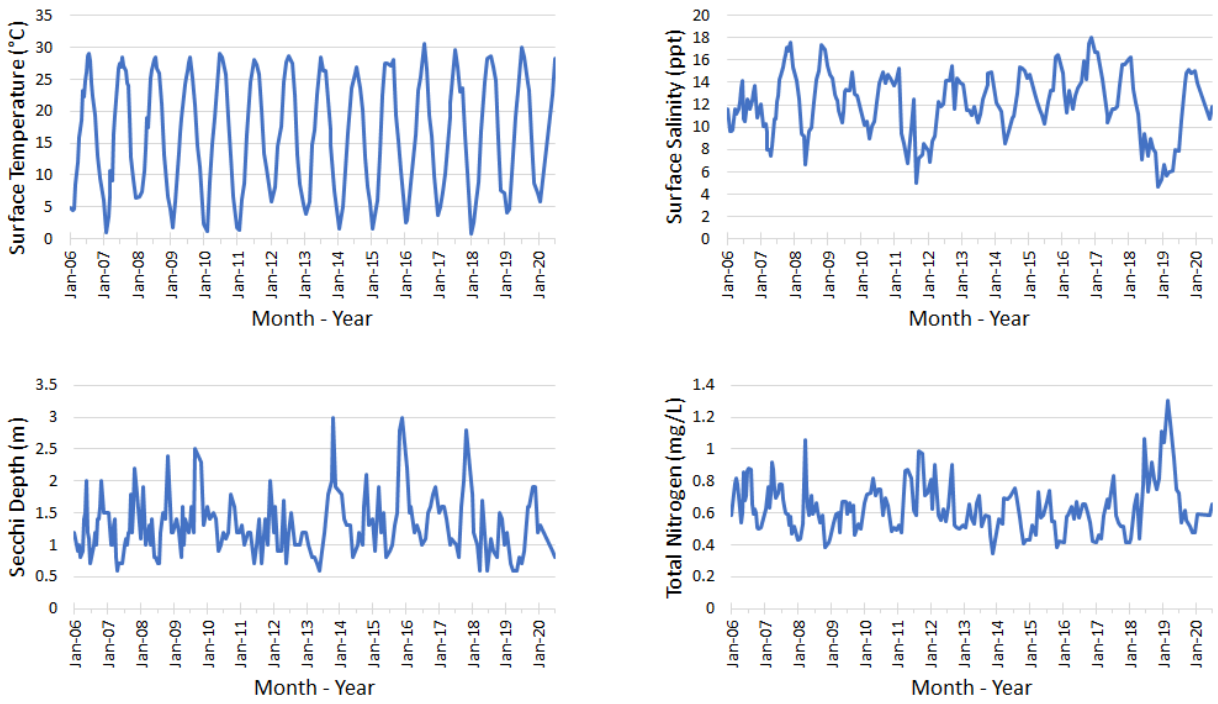


Figure B.25-8. Water quality data collected at Station LE1.3 in NOAA Code 168 (Patuxent River Lower). Data from Chesapeake Bay Program Data Hub.

## Section B.26: NOAA Code 174 – St. Clements and Breton Bay

NOAA Code 174 encompasses St. Clements and Breton Bays, tributaries of the Potomac River, located in Maryland's lower western portion of Chesapeake Bay. The entire NOAA Code is 7,061 acres and has 23 historic oyster bars[37]. The Breton Bay Sanctuary encompasses 46% (3,212 acres) of the NOAA Code. This section focuses on information collected within the NOAA Code occurring outside of the current sanctuary area. This equates to 3,849 surface acres. There are 1,496 acres of historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments) located within the NOAA Code and outside the sanctuary. As of 2020, there are 8 acres within the NOAA Code designated as a Public Shellfish Fishery Area (PSFA). Aquaculture leasing is prohibited within PSFA boundaries. This NOAA Code is located within Maryland's low-salinity region (Zone 1).

Information available for this NOAA Code includes:

- NOAA Code map (Figure B.26-1)
- Summary statistics (Table B.26-1)
- Abundance per year (Figure B.26-2)
- Observed mortality (Figure B.26-3)
- Cultch per year (Figure B.26-4)
- Harvest (Figure B.26-5)

The Fall Survey samples one bar at the mouth of St. Clements and Breton Bay. This area has a low density of oysters with a declining abundance trend over time. Observed mortality has remained low over the entire time series. Cultch has also declined over time.

Between 2006 and 2020, no replenishment planting activities occurred to enhance the commercial public fishery in this NOAA Code outside of the current sanctuary area.

Harvest for the NOAA Code has been reported on seafood dealer buy tickets for 8 years out of the 15-year time series. This includes past harvest data from areas in the NOAA Code that are currently in a sanctuary area, but weren't when the harvest occurred prior to the sanctuary being established. Since 2010, 46% of the NOAA Code area has been a sanctuary where harvest is prohibited. A total of 650 bushels of harvest has been reported.

We are unaware of any continuous water quality monitoring in this area.

[37] 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

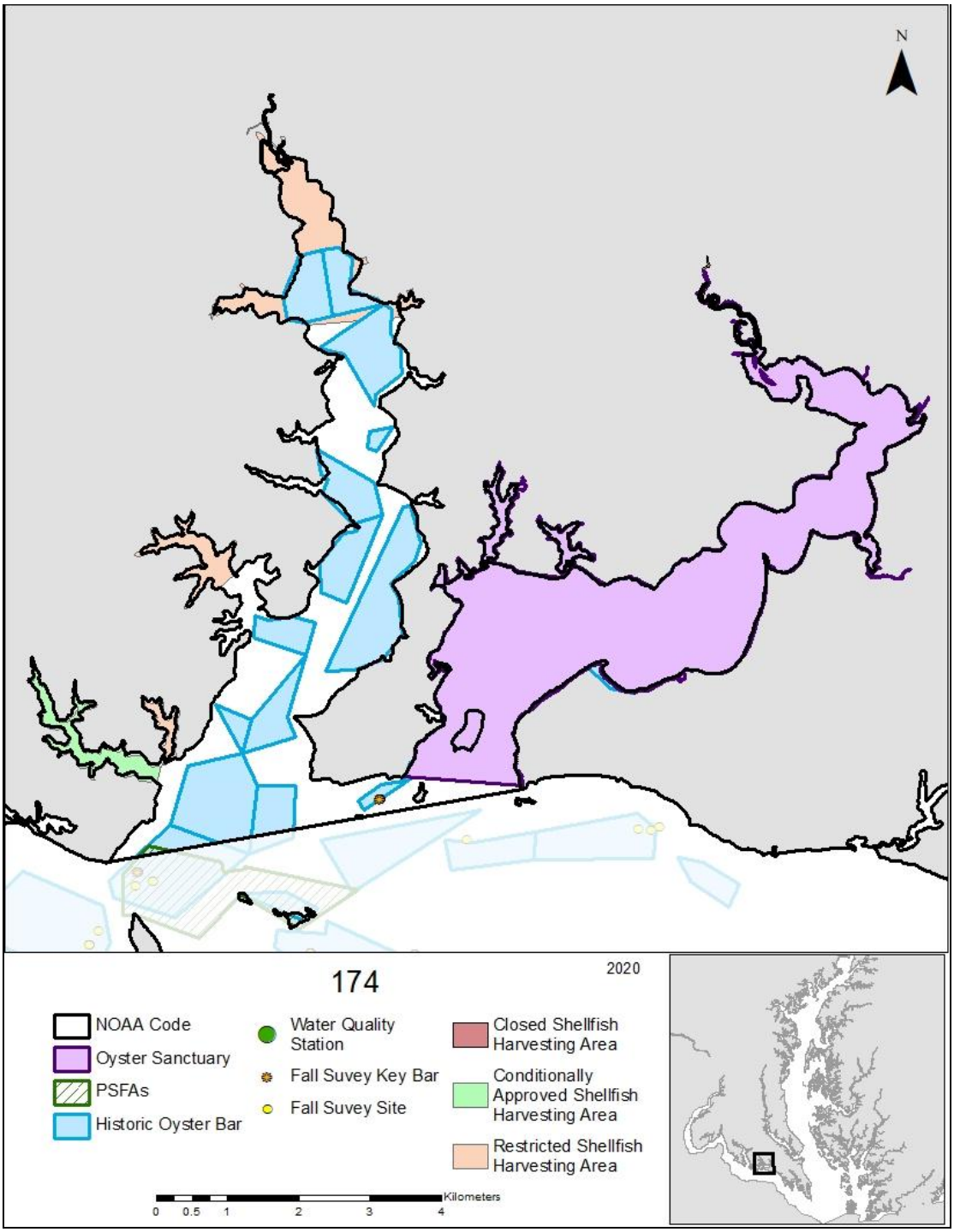


Figure B.26-1. Map of NOAA Code 174 (St. Clements and Breton Bays). Fall Survey sites may not be sampled every year. Fall Survey key bars may consist of a key bar, disease bar or both.

Table B.26-1. Oyster population characteristics based on the Fall Survey in the NOAA Code 174 (St. Clements and Breton Bays) occurring outside of the current sanctuary area. ND = No Data. Values are given as an annual mean ± standard error.

| | 2006-10 | 2011-15 | 2016-20 |
|---|---|---|---|
| Number of Years Sampled / Number of Samples | 5 / 5 | 2 / 2 | 2 / 2 |
| Number of Live Spat Oysters per square meter | 0.08 ± 0.08 | 0 ± 0 | 0.01 ± 0.01 |
| Number of Live Small-Sized Oysters per square meter | 0.37 ± 0.14 | 0.1 ± 0.1 | 0 ± 0 |
| Number of Live Market-Sized Oysters per square meter | 1.53 ± 0.31 | 0.86 ± 0.86 | 0.01 ± 0.01 |
| Live Oyster Biomass (g Dry Weight per Bushel) | ND | ND | ND |
| Observed Mortality (%) | 2 ± 2 | 8 ± 8 | 0 ± 0 |
| Cultch (Bushels per 100 ft Towed) | 0.55 ± 0.13 | 0.6 ± 0.11 | 0.04 ± 0.01 |
| Harvest (Bushels) | 34 ± 21 | 80 ± 47 | 17 ± 11 |
| Note: The number of samples is based on the number of samples having a value for observed mortality. There may be fewer samples per year for density, biomass, and cultch. | | | |

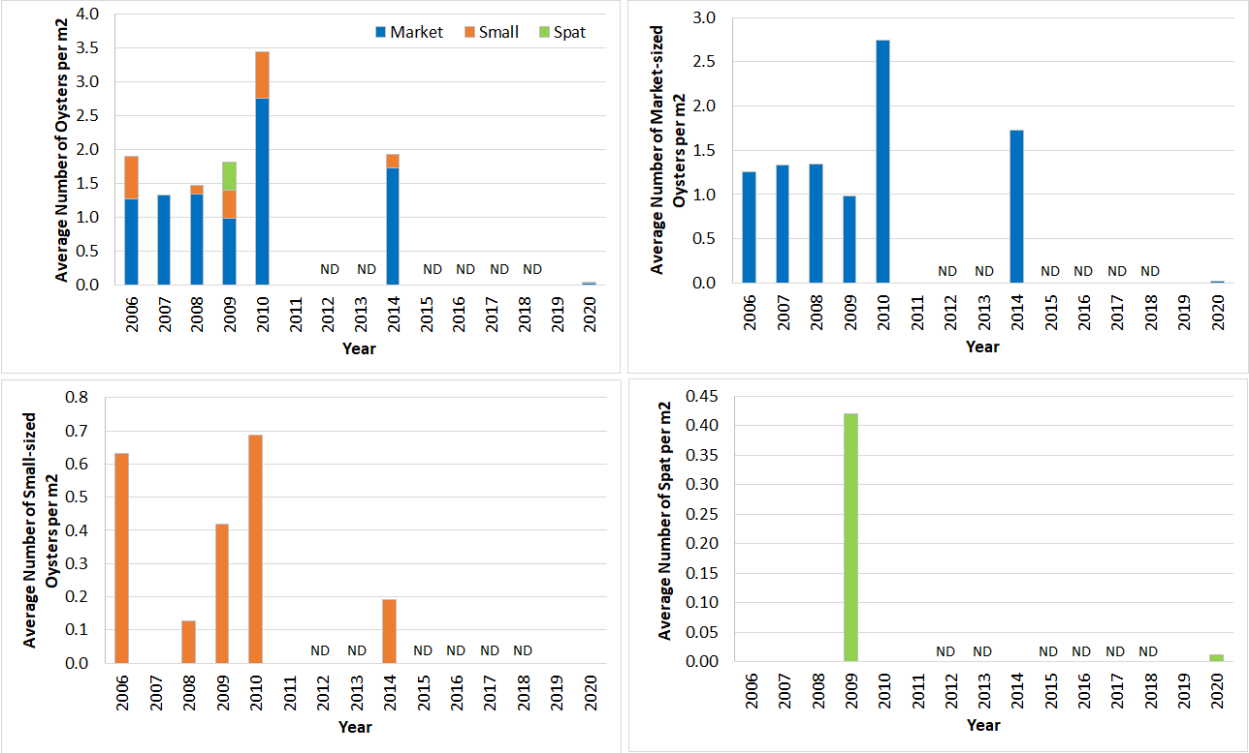


Figure B.26-2. Average number of live oysters per square meter by size class in NOAA Code 174 (St. Clements and Breton Bays) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales.

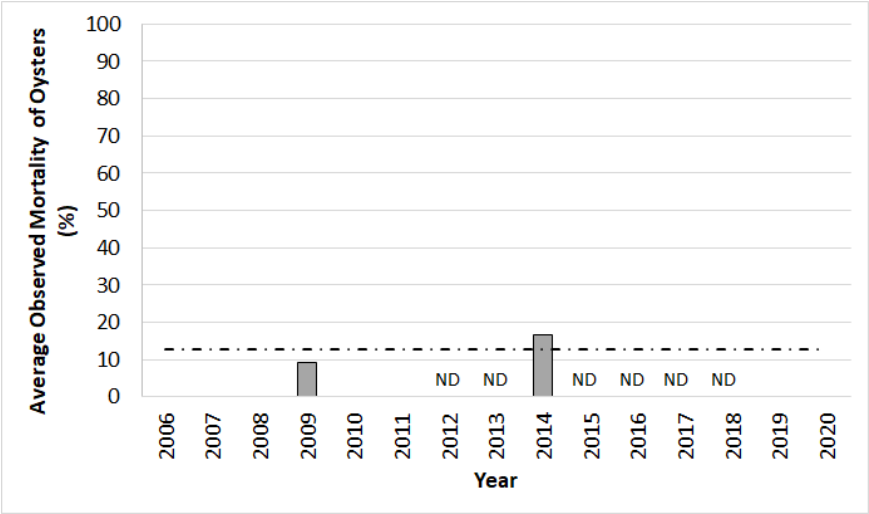


Figure B.26-5. Average annual observed mortality of market-sized and small-sized oysters in NOAA Code 174 (St. Clements and Breton Bays) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey. The dashed line represents the 2006-2020 baywide average observed mortality.

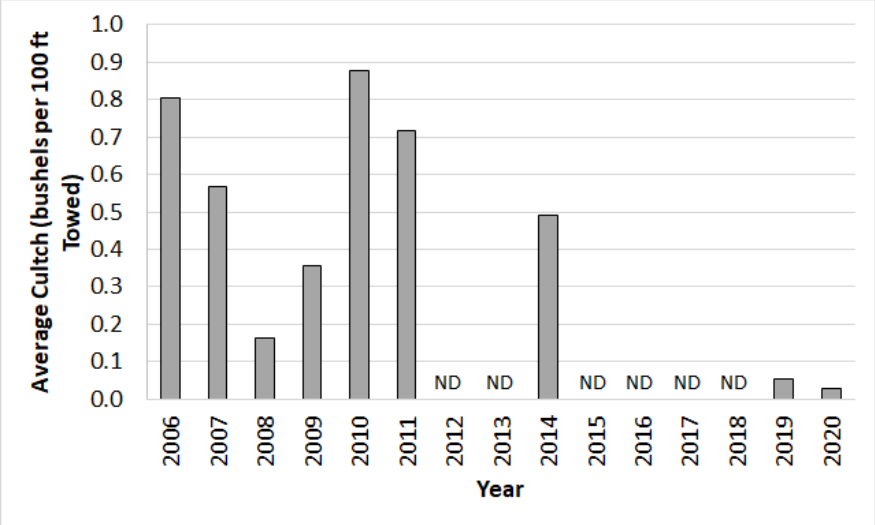


Figure B.26-6. Average cultch (live and dead oysters and loose shell) in NOAA Code 174 (St. Clements and Breton Bays) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey. ND = No Data.

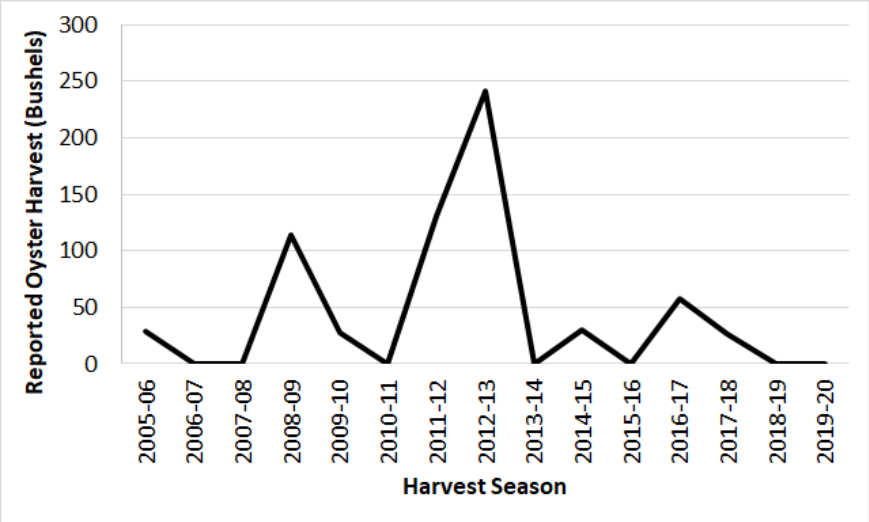


Figure B.26-7. Oyster harvest reported from seafood dealer buy tickets (harvest seasons 2005-2006 to 2019-2020) in NOAA Code 174 (St. Clements and Breton Bays). Since 2010, 46% of the NOAA Code area has been a sanctuary where harvest is prohibited.

## Section B.27: NOAA Code 192 – Tangier Sound South

NOAA Code 192 encompasses the southern portion of Tangier Sound and is located in Maryland's lower eastern portion of Chesapeake Bay. The entire NOAA Code is 89,457 acres and has 75 historic oyster bars[38]. There are two sanctuaries within the NOAA Code and they encompass 6% (5,755 acres) of the NOAA Code (Lower Mainstem and Somerset Sanctuaries). With the exception of harvest information, this section will focus on information collected within the NOAA Code occurring outside of the current sanctuary areas. This equates to 83,702 surface acres. There are 37,269 acres of historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments) located within the NOAA Code and not within a sanctuary. As of 2020, there are 26,478 acres within the NOAA Code designated as a Public Shellfish Fishery Area (PSFA). Aquaculture leasing is prohibited within PSFA boundaries. This NOAA Code is located within Maryland's high-salinity region (Zone 3).

Information available for this NOAA Code includes:

- NOAA Code map (Figure B.27-1)
- Summary statistics (Table B.27-1)
- Abundance per year (Figure B.27-2)
- Shell height frequencies (Figure B.27-3)
- Biomass per year (Figure B.27-4)
- Observed mortality (Figure B.27-5)
- Dermo and MSX per year (Figure B.27-6)
- Cultch per year (Figure B.27-7)
- Harvest (Figure B.27-8)
- Water Quality (Figure B.27-9)

Fall Survey results indicated small and market densities have declined over the entire time period. Spat density increased in 2016-2020 due to relatively high spatsets in 2019 and 2020, however, the average spat density was higher in 2006-2010. Biomass decreased in the 2016-2020 time period, however, there was an increase in 2020. Mortality was slight above the long term baywide average for most years.

Between 2006 and 2020, approximately 270 thousand bushels of shell, 59 thousand bushels of wild seed and 45 million hatchery spat-on-shell were planted to enhance the commercial public fishery in this NOAA Code outside of the current sanctuary area.

Harvest for the NOAA Code has been reported on seafood dealer buy tickets for all years of the 15-year time series. This includes past harvest data from areas in the NOAA Code that are currently in a sanctuary area, but weren't when the harvest occurred prior to the sanctuaries being established. Since 2010, 6% of the NOAA Code area has been a sanctuary where harvest is prohibited. Harvest reported ranged from approximately 3 thousand bushels in the 2018-19 season to a maximum of approximately 45 thousand bushels in the 2009-10 and 2013-14

[38] See charts 36, 42, 43, 46, and 47 for bar names and locations in the State of Maryland Shellfish Closure Areas Book http://dnr.maryland.gov/fisheries/Pages/oysters/index.aspx

seasons. Power dredging was used to obtain about three-quarters of the harvest and patent tonging about a quarter of harvest.

Continuous water quality monitoring has occurred at station EE3.2 (37.98139; -75.9242). During the 2006-2020 timeline, surface salinity ranged from 9.9 ppt to 21 ppt, with the lowest salinity being during the freshet of 2018-2019 and during the high rainfall year of 2011.

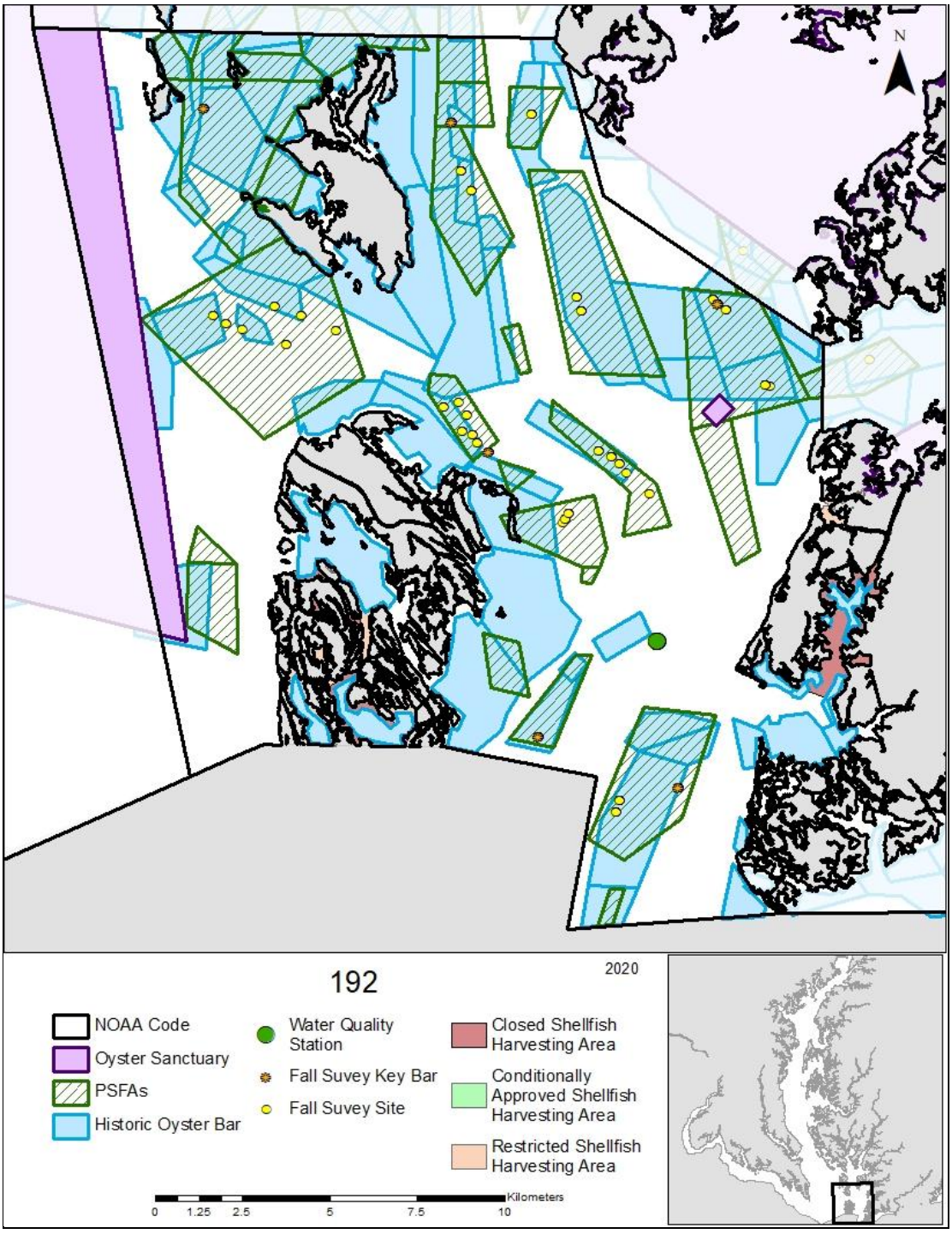


Figure B.27-1. Map of NOAA Code 192 (Tangier Sound South). Fall Survey sites may not be sampled every year. Fall Survey key bars may consist of a key bar, disease bar or both.

Table B.27-1. Oyster population characteristics based on the Fall Survey in the NOAA Code 192 (Tangier Sound South) occurring outside of the current sanctuary area. ND = No Data. Values are given as an annual mean ± standard error.

| | 2006-10 | 2011-15 | 2016-20 |
|---|---|---|---|
| Number of Years Sampled / Number of Samples | 5 / 161 | 5 / 95 | 5 / 77 |
| Number of Live Spat Oysters per square meter | 71.4 ± 24.8 | 28.5 ± 13.2 | 46.4 ± 21.8 |
| Number of Live Small-Sized Oysters per square meter | 53.2 ± 17 | 30.5 ± 6.2 | 19.5 ± 6.9 |
| Number of Live Market-Sized Oysters per square meter | 13.7 ± 4.4 | 12.9 ± 0.5 | 4.1 ± 1.3 |
| Live Oyster Biomass (g Dry Weight per Bushel) | 102 ± 17 | 105 ± 22 | 59 ± 27 |
| Observed Mortality (%) | 19 ± 4 | 18 ± 1 | 15 ± 4 |
| Cultch (Bushels per 100 ft Towed) | 0.8 ± 0.07 | 0.73 ± 0.06 | 0.65 ± 0.04 |
| Harvest (Bushels) | 16,787 ± 7,622 | 32,203 ± 4,360 | 11,027 ± 4,447 |
| Note: The number of samples is based on the number of samples having a value for observed mortality. There may be fewer samples per year for density, biomass, and cultch. | | | |

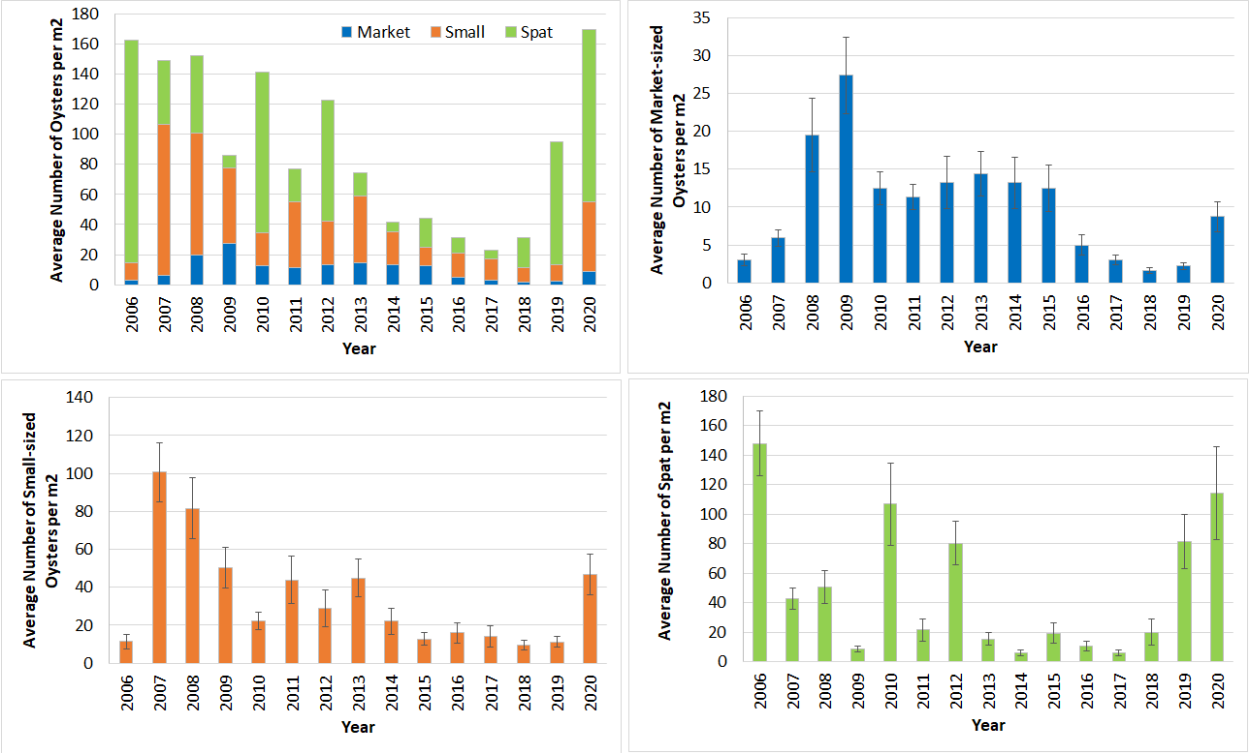


Figure B.27-2. Average number of live oysters per square meter by size class in NOAA Code 192 (Tangier Sound South) occurring outside of the current sanctuary area. Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales.

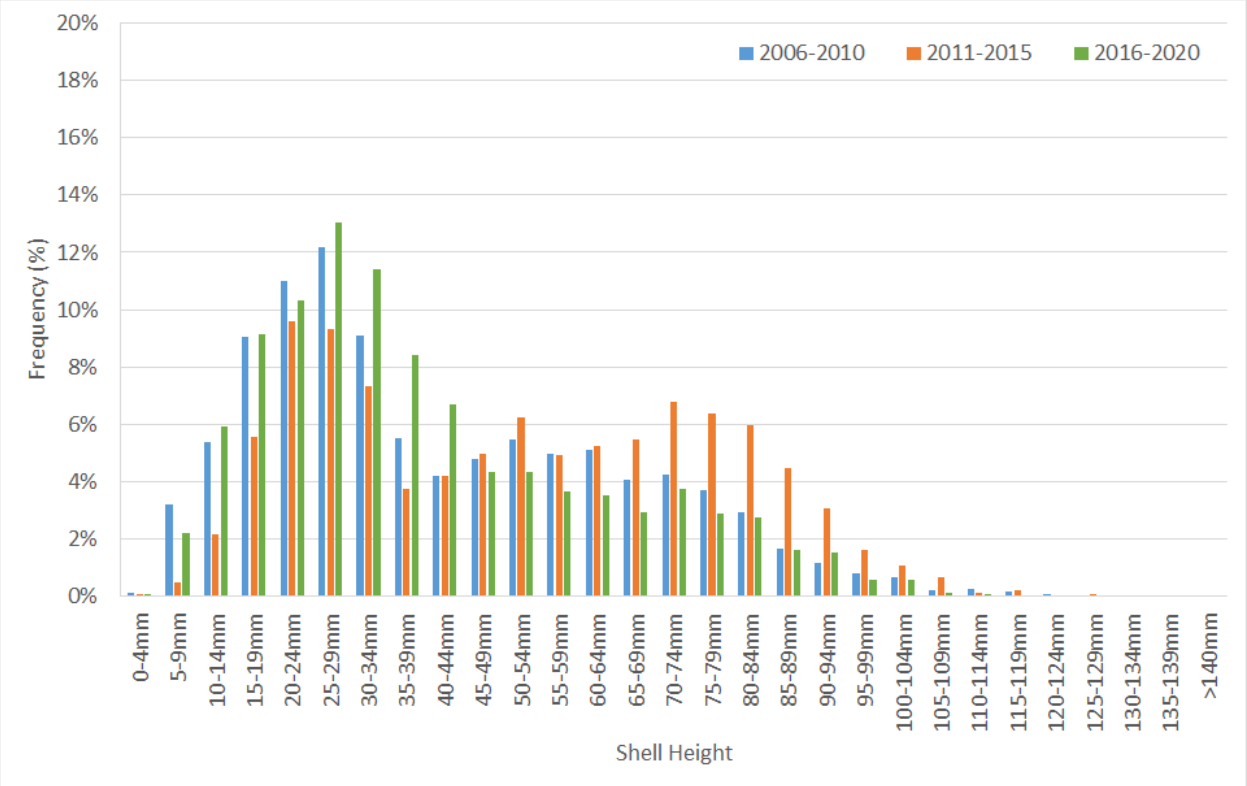


Figure B.27-3. Shell height frequencies of live oysters per bushel of material in NOAA Code 192 (Tangier Sound South) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey based on an average of Holland Straits, Old Womans Leg, Back Cove, and Piney Island East bars.

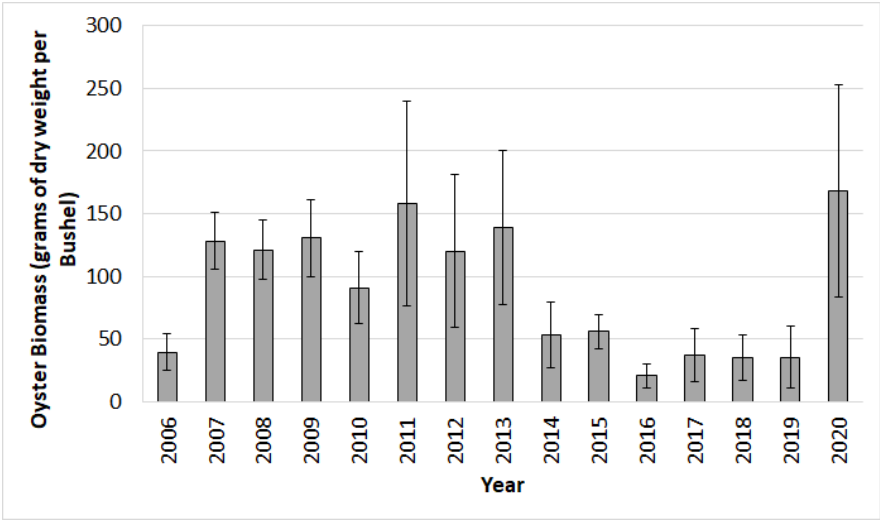


Figure B.27-4. Oyster biomass (grams of dry weight per bushel of material) in NOAA Code 192 (Tangier Sound South) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey based on an average of Holland Straits, Old Womans Leg, Back Cove, and Piney Island East bars. Error bars represent ± 1 standard error.

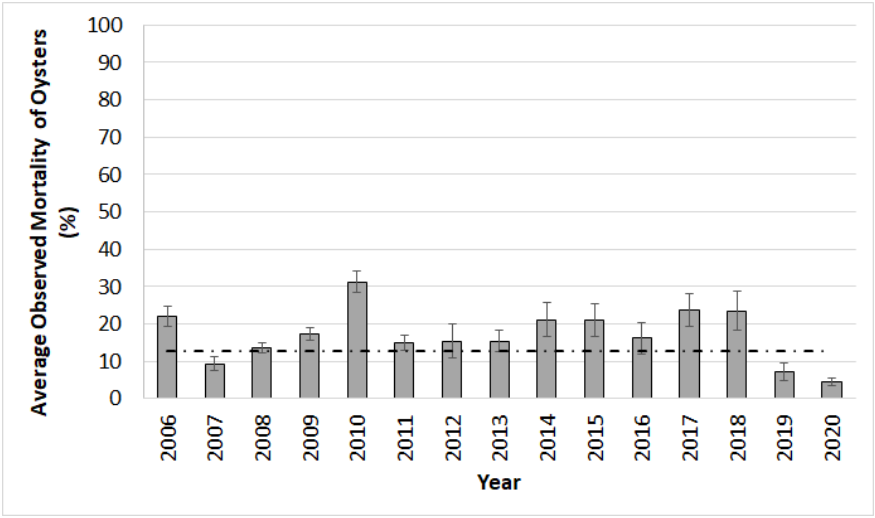


Figure B.27-5. Average annual observed mortality of market-sized and small-sized oysters in NOAA Code 192 (Tangier Sound South) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey. The dashed line represents the 2006-2020 baywide average observed mortality. Error bars represent ± 1 standard error.

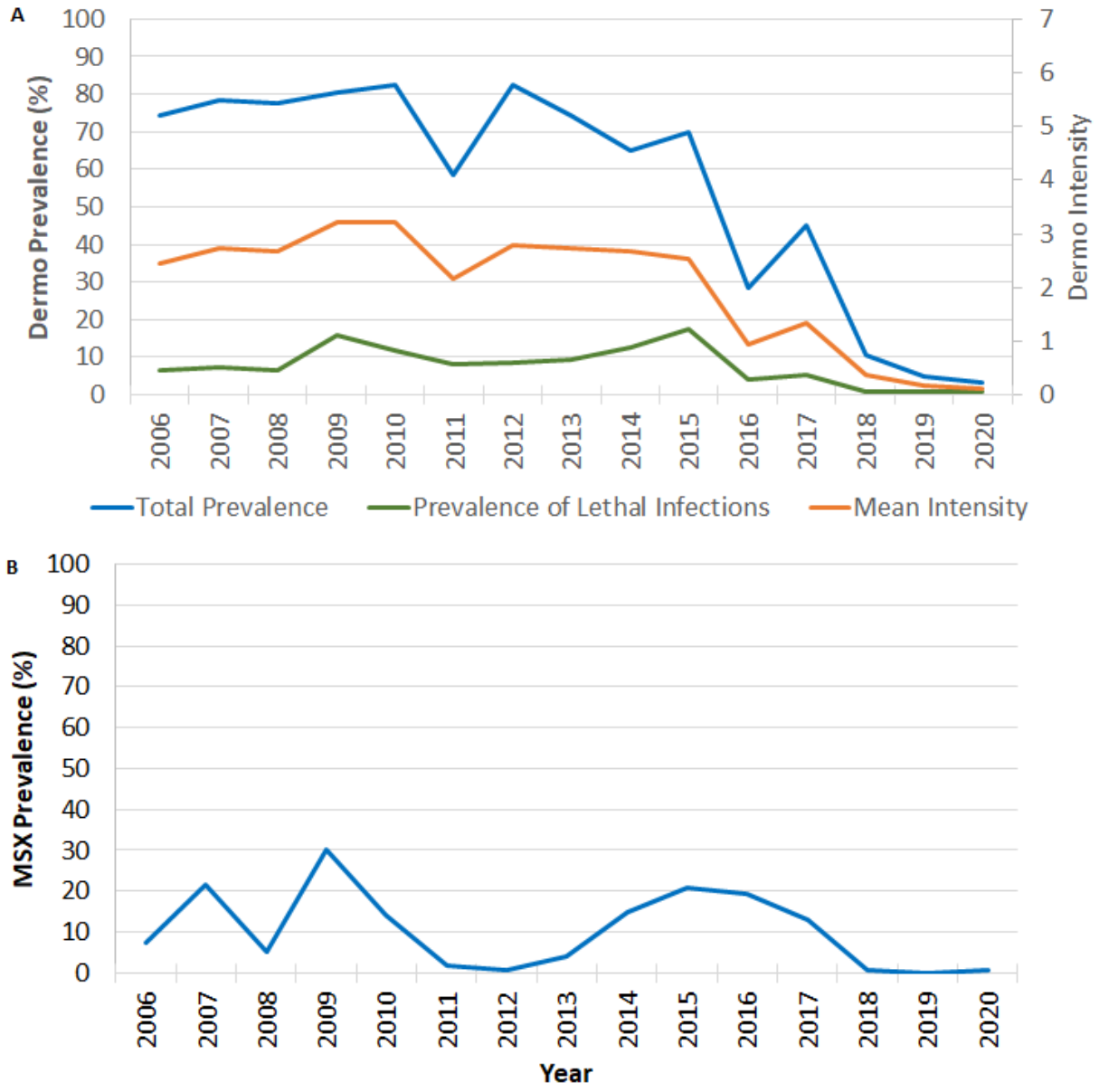


Figure B.27-6. Oyster disease prevalence and intensity in NOAA Code 192 (Tangier Sound South) occurring outside of the current sanctuary area. (A) Dermo prevalence and mean intensity (B) MSX prevalence (intensity is not examined). Data from Maryland's Annual Fall Oyster Dredge Survey based on an average of Holland Straits, Old Womans Leg, Back Cove, and Piney Island East bars.

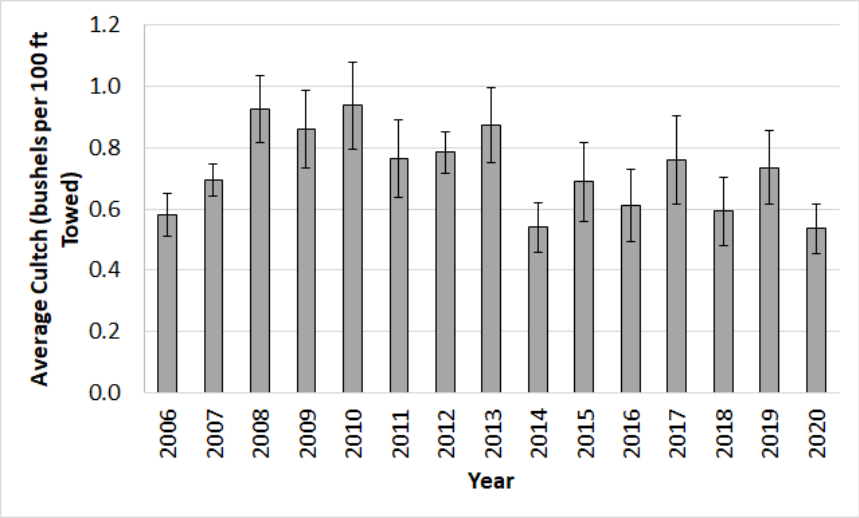


Figure B.27-7. Average cultch (live and dead oysters and loose shell) in NOAA Code 192 (Tangier Sound South) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey. Error bars represent ± 1 standard error.

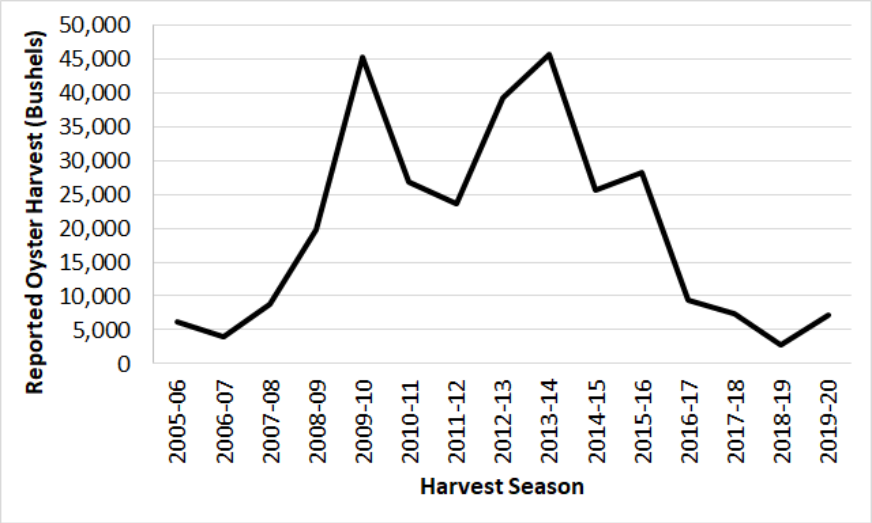


Figure B.27-8. Oyster harvest reported from seafood dealer buy tickets (harvest seasons 2005-2006 to 2019-2020) in NOAA Code 192 (Tangier Sound South). Since 2010, 6% of the NOAA Code area has been a sanctuary where harvest is prohibited.

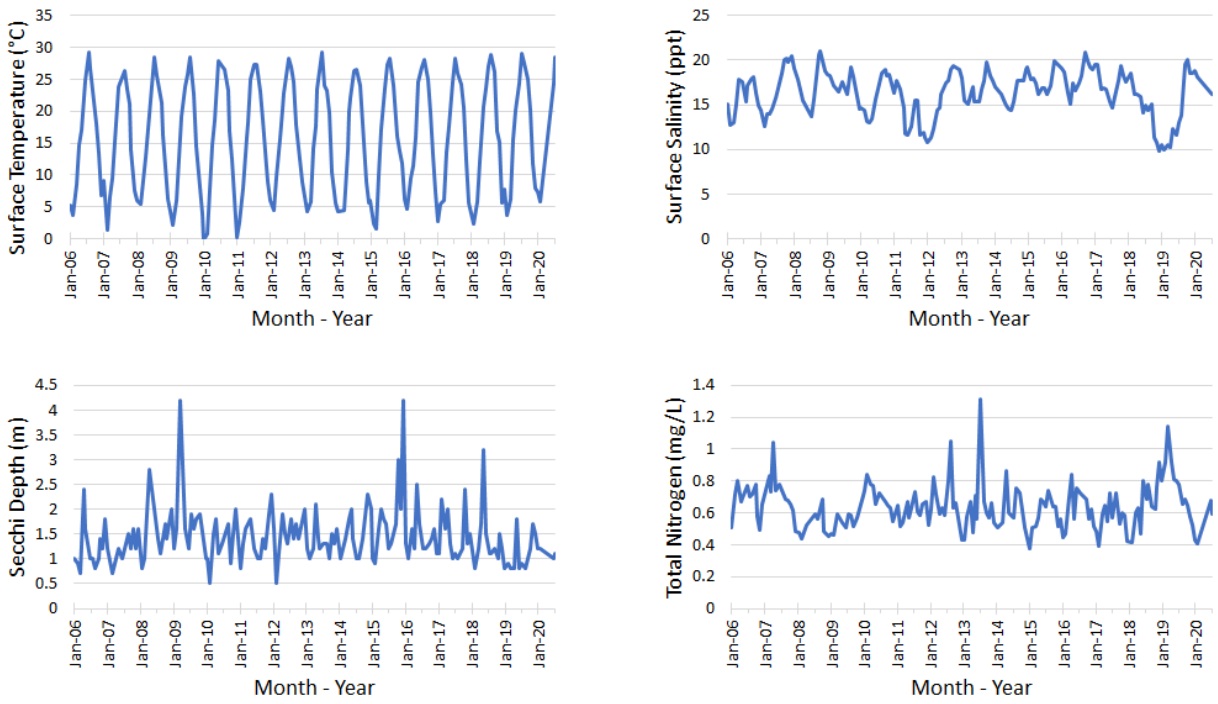


Figure B.27-9. Water quality data collected at Station EE3.2 in NOAA Code 192 (Tangier Sound South). Data from Chesapeake Bay Program Data Hub.

## Section B.28: NOAA Code 229 – Lower West Chesapeake Bay

NOAA Code 229 is located in Maryland's lower western portion of the Chesapeake Bay mainstem, south of Cove Point and west of the ship channel. The entire NOAA Code is 107,484 acres and has 28 historic oyster bars[39]. Two sanctuaries, both established in 2010, encompass 4% (3,976 total acres) of the NOAA Code (Point Lookout Sanctuary and Cedar Point Sanctuary). This section focuses on information collected within the NOAA Code occurring outside of the current sanctuary areas. This equates to 103,508 surface acres. There are 20,262 acres of historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments) located within the NOAA Code and outside a sanctuary. As of 2020, there are 6,790 acres within the NOAA Code designated as a Public Shellfish Fishery Area (PSFA). Aquaculture leasing is prohibited within PSFA boundaries. This NOAA Code is located within Maryland's medium-salinity region (Zone 2).

Information available for this NOAA Code includes:

- NOAA Code map (Figure B.28-1)
- Summary statistics (Table B.28-1)
- Abundance per year (Figure B.28-2)
- Shell height frequencies (Figure B.28-3)
- Biomass per year (Figure B.28-4)
- Observed mortality (Figure B.28-5)
- Dermo and MSX per year (Figure B.28-6)
- Cultch per year (Figure B.28-7)
- Harvest (Figure B.28-8)
- Water Quality (Figure B.28-9)

Fall Survey results indicated an increase in spat and small densities in 2016-2020 compared to the previous time periods. These trends were mostly due to a hatchery spat-on-shell and fresh shell planting in 2019 resulting in more small-sized oysters in 2020, although there was a relatively high natural spatset on Point Lookout bar in 2019. Average market density was similar between the time periods. Biomass has increased steadily over the entire time period. Mortality has remained at or below the long term baywide average.

Between 2006 and 2020, approximately 135 thousand bushels of shell, 17 thousand bushels of wild seed and 4 million hatchery spat-on-shell were planted to enhance the commercial public fishery in this NOAA Code outside of the current sanctuary area.

Harvest for the NOAA Code has been reported on seafood dealer buy tickets for all years of the 15-year time series. This includes past harvest data from areas in the NOAA Code that are currently in a sanctuary area, but weren't when the harvest occurred prior to the sanctuaries being established. Since 2010, 4% of the NOAA Code area has been a sanctuary where harvest is prohibited. Harvest reported ranged from about 60 bushels in the 2007-08 season to a maximum

[39] See chart 35 and 40 for bar names and locations in the State of Maryland Shellfish Closure Areas Book http://dnr.maryland.gov/fisheries/Pages/oysters/index.aspx

of approximately 11 thousand bushels in the 2019-20 season. Power dredging was used to obtain the majority of the harvest.

Continuous water quality monitoring has occurred at station CB5.1W (38.32522; -76.3757). During the 2006-2020 timeline, surface salinity ranged from 4 ppt to 19 ppt, with the lowest salinity being during the freshet of 2018-2019 and during the high rainfall year of 2011.

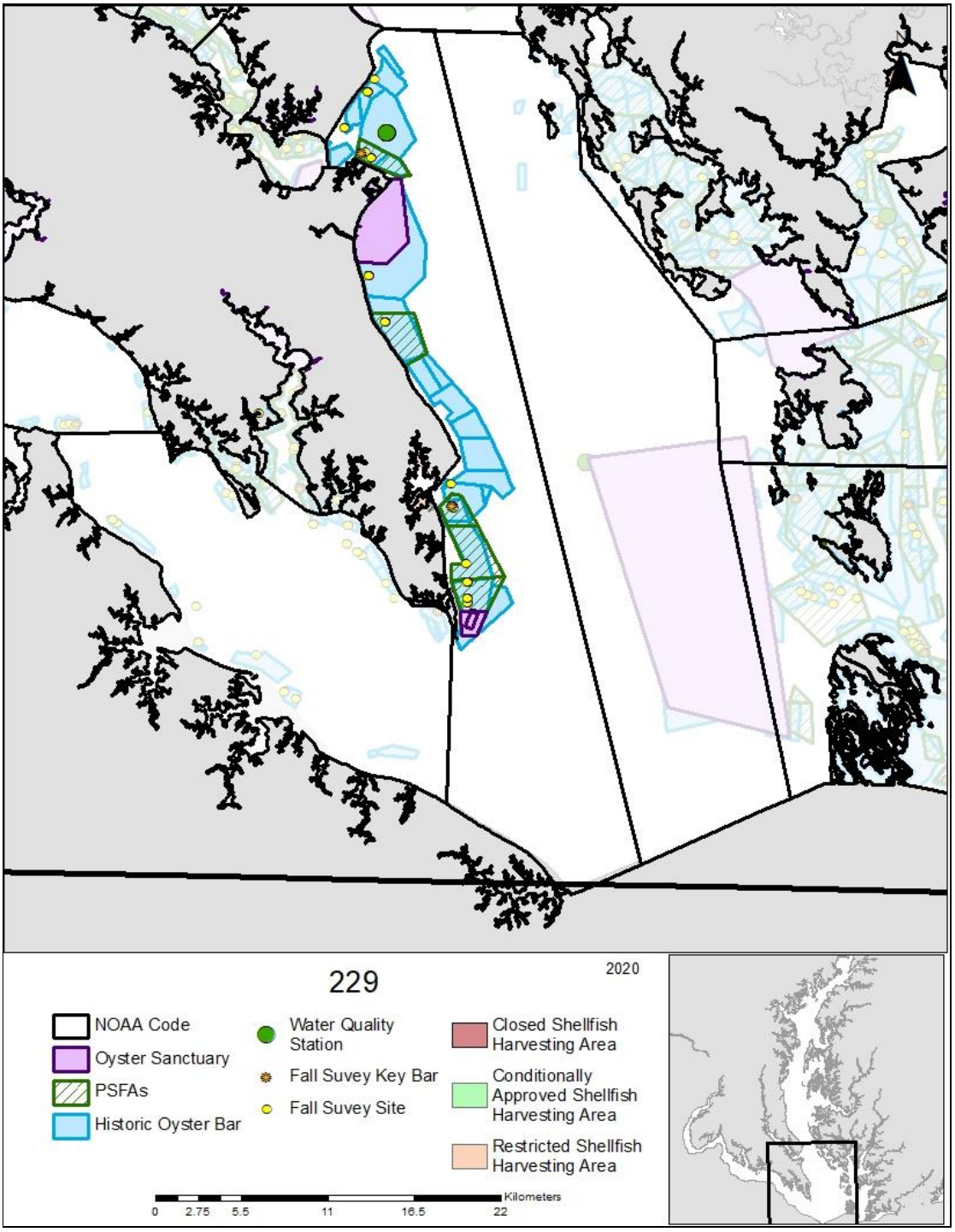


Figure B.28-1. Map of NOAA Code 229 (Lower West Chesapeake Bay). Fall Survey sites may not be sampled every year. Fall Survey key bars may consist of a key bar, disease bar or both.

Table B.28-1. Oyster population characteristics based on the Fall Survey in the NOAA Code 229 (Lower West Chesapeake Bay) occurring outside of the current sanctuary area. ND = No Data. Values are given as an annual mean ± standard error.

| | 2006-10 | 2011-15 | 2016-20 |
|---|---|---|---|
| Number of Years Sampled / Number of Samples | 5 / 46 | 5 / 34 | 5 / 37 |
| Number of Live Spat Oysters per square meter | 1.7 ± 0.7 | 1.7 ± 0.5 | 22.6 ± 19.7 |
| Number of Live Small-Sized Oysters per square meter | 7.4 ± 1.1 | 5.5 ± 1.7 | 17.4 ± 4.6 |
| Number of Live Market-Sized Oysters per square meter | 8.6 ± 1.2 | 6.2 ± 0.9 | 7.7 ± 1.1 |
| Live Oyster Biomass (g Dry Weight per Bushel) | 55 ± 11 | 106 ± 22 | 194 ± 26 |
| Observed Mortality (%) | 16 ± 2 | 8 ± 2 | 10 ± 3 |
| Cultch (Bushels per 100 ft Towed) | 0.32 ± 0.04 | 0.25 ± 0.07 | 0.23 ± 0.02 |
| Harvest (Bushels) | 597 ± 347 | 2,683 ± 714 | 6,366 ± 1,651 |
| Note: The number of samples is based on the number of samples having a value for observed mortality. There may be fewer samples per year for density, biomass, and cultch. | | | |

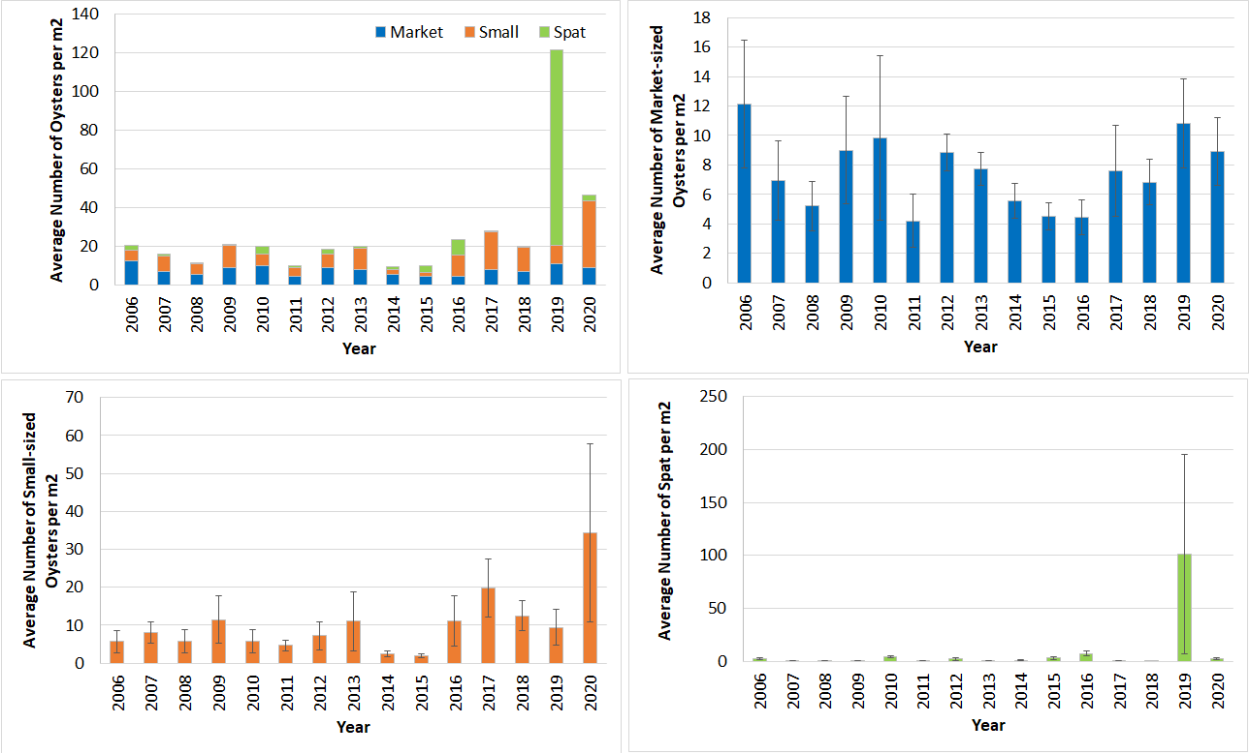


Figure B.28-2. Average number of live oysters per square meter by size class in NOAA Code 229 (Lower West Chesapeake Bay) occurring outside of the current sanctuary area. Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales.

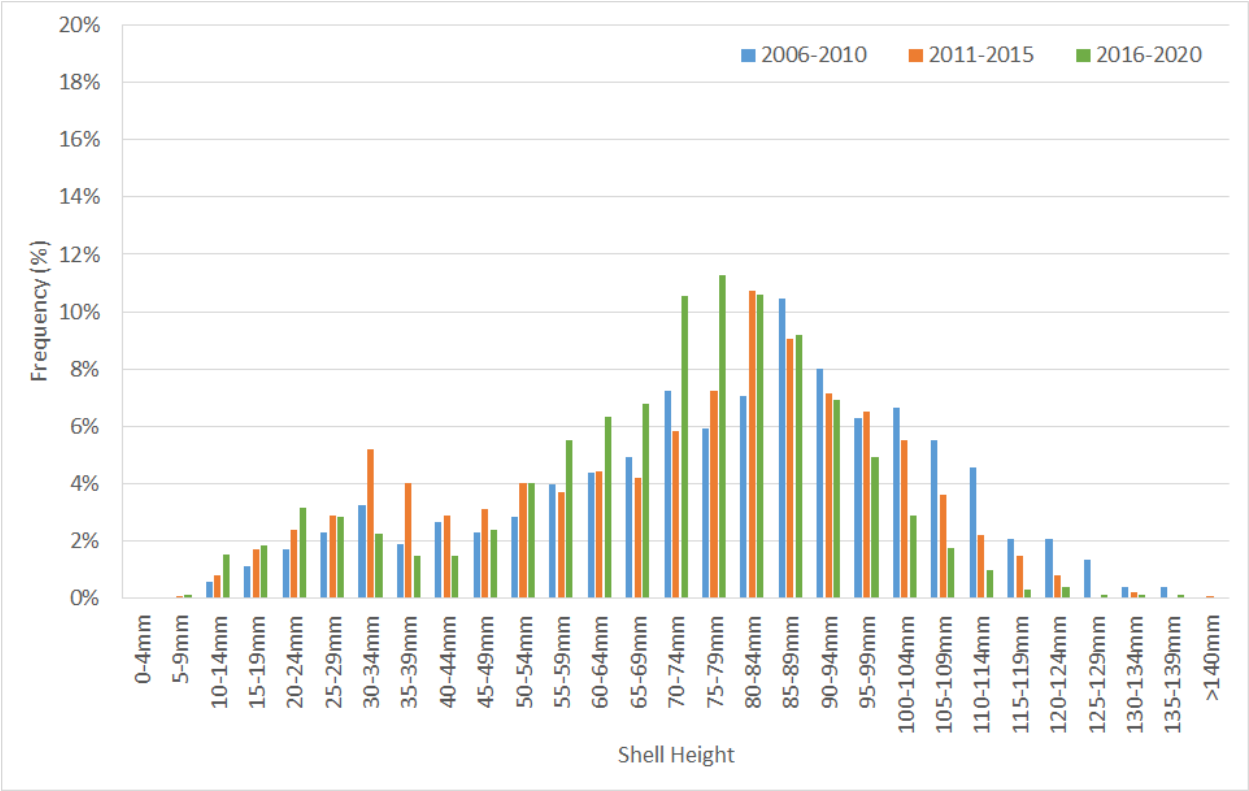


Figure B.28-3. Shell height frequencies of live oysters per bushel of material in NOAA Code 229 (Lower West Chesapeake Bay) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey based on an average of Flag Pond, Butler, and Hog Island bars.

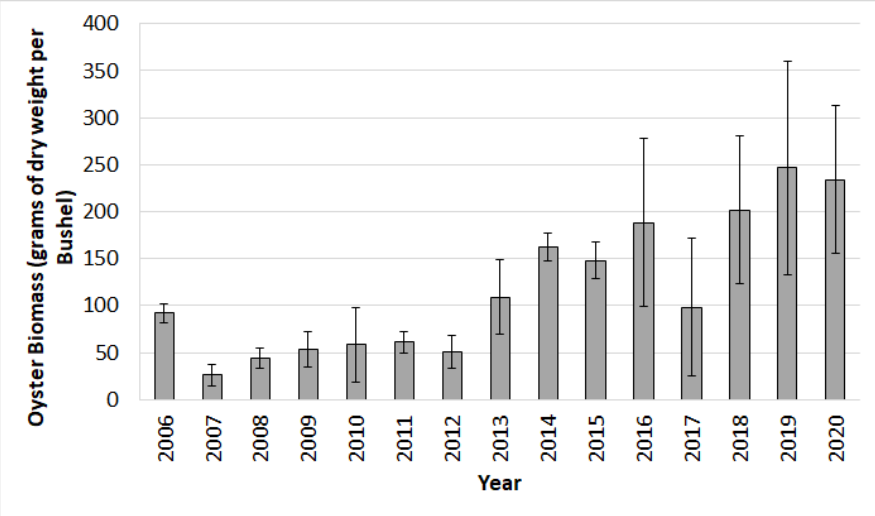


Figure B.28-4. Oyster biomass (grams of dry weight per bushel of material) in NOAA Code 229 (Lower West Chesapeake Bay) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey based on an average of Flag Pond, Butler, and Hog Island bars. Error bars represent ± 1 standard error.

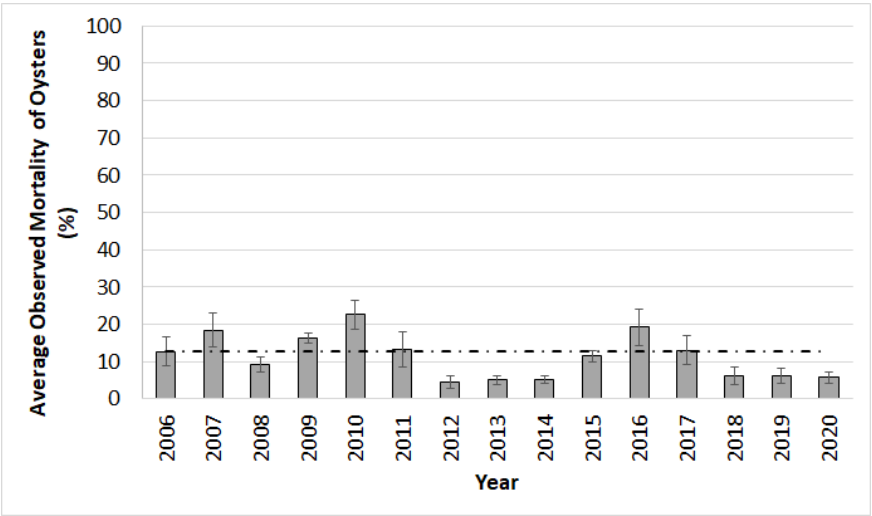


Figure B.28-5. Average annual observed mortality of market-sized and small-sized oysters in NOAA Code 229 (Lower West Chesapeake Bay) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey. The dashed line represents the 2006-2020 baywide average observed mortality. Error bars represent ± 1 standard error.

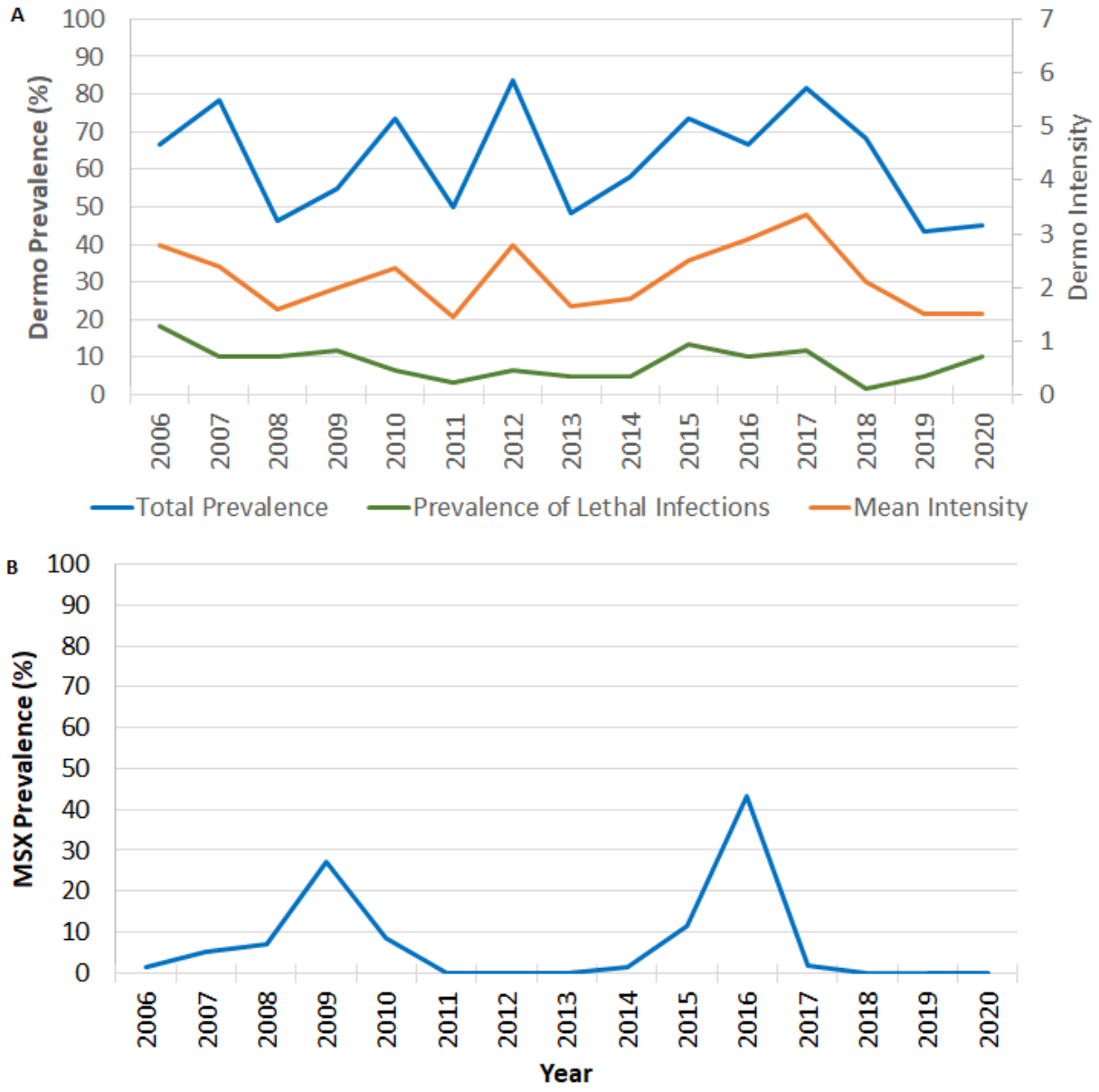


Figure B.28-6. Oyster disease prevalence and intensity in NOAA Code 229 (Lower West Chesapeake Bay) occurring outside of the current sanctuary area. (A) Dermo prevalence and mean intensity (B) MSX prevalence (intensity is not examined). Data from Maryland's Annual Fall Oyster Dredge Survey based on an average of Butler and Hog Island bars.

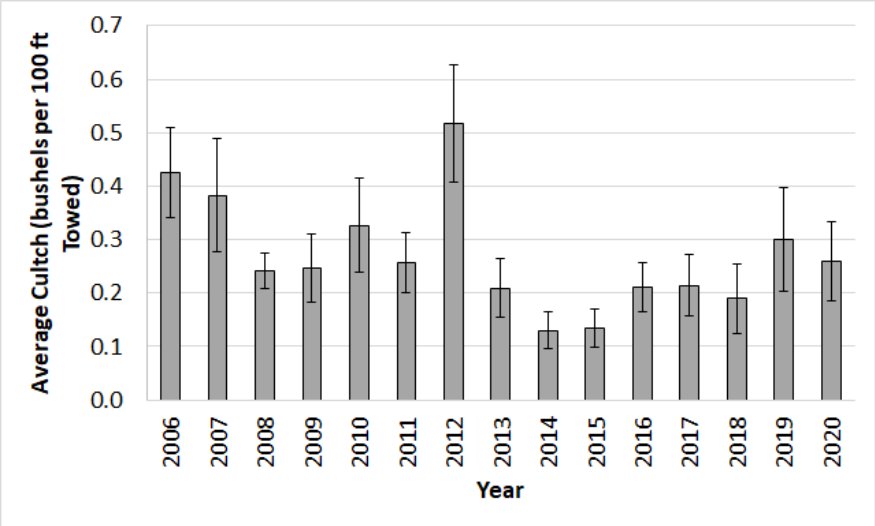


Figure B.28-7. Average cultch (live and dead oysters and loose shell) in NOAA Code 229 (Lower West Chesapeake Bay) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey. Error bars represent ± 1 standard error.

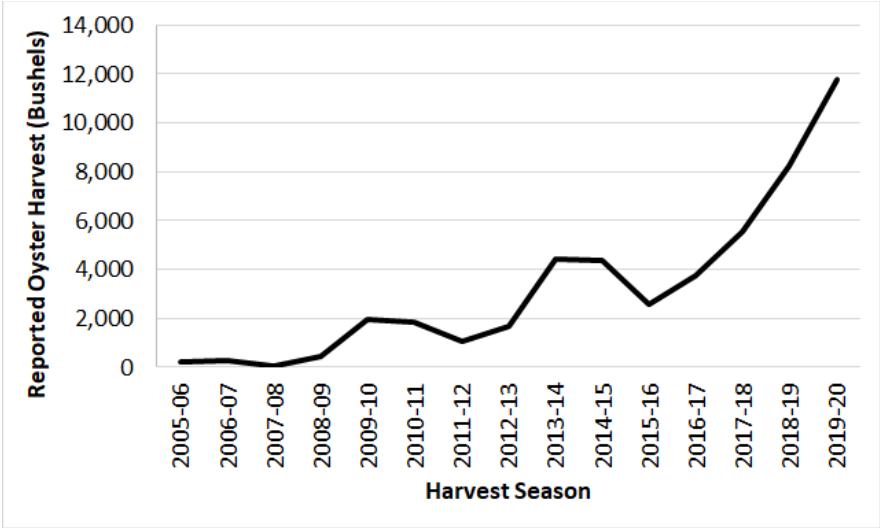


Figure B.28-8. Oyster harvest reported from seafood dealer buy tickets (harvest seasons 2005-2006 to 2019-2020) in NOAA Code 229 (Lower West Chesapeake Bay). Since 2010, 4% of the NOAA Code area has been a sanctuary where harvest is prohibited.

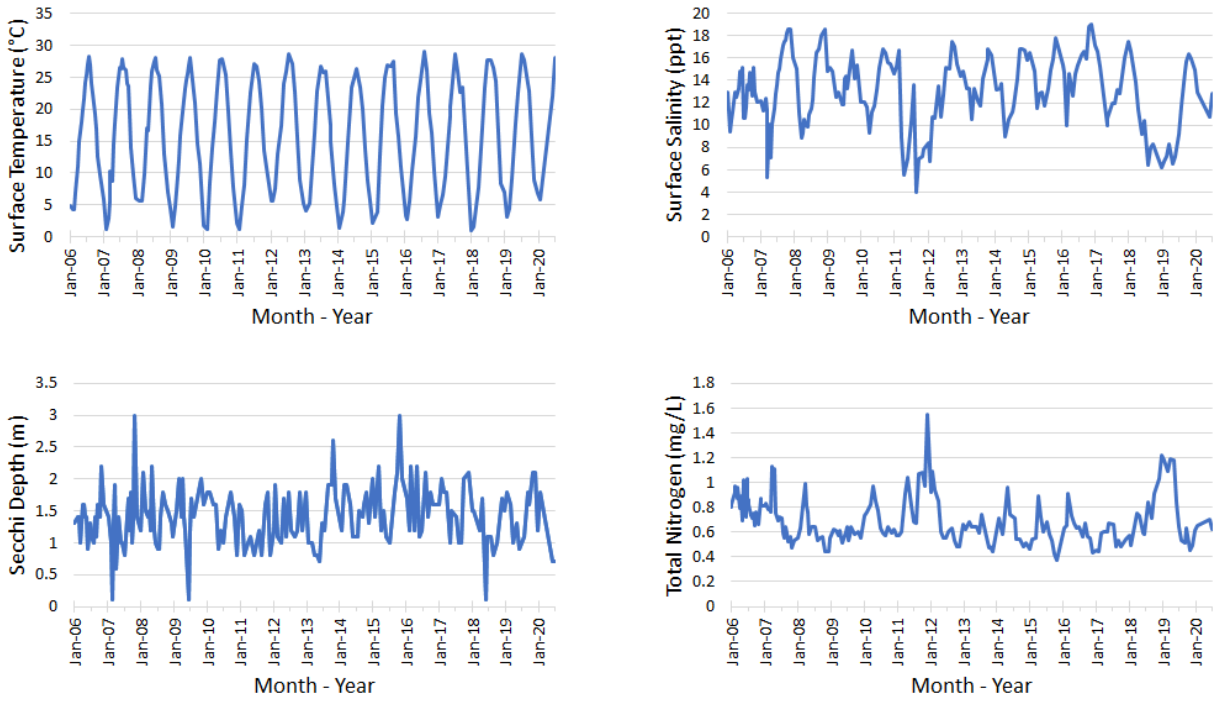


Figure B.28-9. Water quality data collected at Station CB5.1W in NOAA Code 229 (Lower West Chesapeake Bay). Data from Chesapeake Bay Program Data Hub.

## Section B.29: NOAA Code 231 – Chester River Middle

NOAA Code 231 encompasses the middle section of the Chester River, from Spaniard Point to Queenstown Creek, and is located in Maryland's upper eastern portion of Chesapeake Bay. The entire NOAA Code is 15,280 acres and has 38 historic oyster bars[40]. There are two sanctuaries in this NOAA Code (Ringgold and Upper Chester River Sanctuaries), encompassing 53% (8,211 acres) of the NOAA Code. This section focuses on information collected within the NOAA Code occurring outside of the current sanctuary areas. This equates to 7,069 surface acres. There are 3,220 acres of historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments) located within the NOAA Code and outside the sanctuaries. As of 2020, there are 2,780 acres within the NOAA Code designated as a Public Shellfish Fishery Area (PSFA). Aquaculture leasing is prohibited within PSFA boundaries. This NOAA Code is located within Maryland's low-salinity region (Zone 1).

Information available for this NOAA Code includes:

- NOAA Code map (Figure B.29-1)
- Summary statistics (Table B.29-1)
- Abundance per year (Figure B.29-2)
- Observed mortality (Figure B.29-3)
- Cultch per year (Figure B.29-4)
- Harvest (Figure B.29-5)

Fall survey results indicated spat density was highest in 2006-2010. This is due to the hatchery spat-on-shell plantings. Natural spatset was only seen by the Fall Survey in 2010. Small-sized oyster density increased in 2016-2020 compared to 2011-2015 but was still lower than 2006-2010. Average market density increased in 2016-2020, due to higher counts in 2017 and 2020. In 2017, this is most likely the result of the closure of planted areas at the request of the county oyster committees until most of the oysters reached market size.

Between 2006 and 2020, approximately 1.5 thousand bushels of wild seed and 276 million hatchery spat-on-shell were planted to enhance the commercial public fishery in this NOAA Code outside of the current sanctuary area.

Harvest for the NOAA Code has been reported on seafood dealer buy tickets for all years out of the 15-year time series. This includes past harvest data from areas in the NOAA Code that are currently in a sanctuary area, but weren't when the harvest occurred prior to the sanctuaries being established. Since 2010, 53% of the NOAA Code area has been a sanctuary where harvest is prohibited. During the 2019-20 season, this NOAA Code was closed to harvest with the exception of areas that had been previously planted with oysters. Harvest reported ranged from less than 30 bushels in the 2013-14 season to a maximum of approximately 4 thousand bushels in

[40] See chart 7 and 8 for bar names and locations in the State of Maryland Shellfish Closure Areas Book http://dnr.maryland.gov/fisheries/Pages/oysters/index.aspx

the 2006-07 season. Diving was used to obtain about half of the harvest and hand tonging to obtain the other half.

We are unaware of any continuous water quality monitoring in this area.

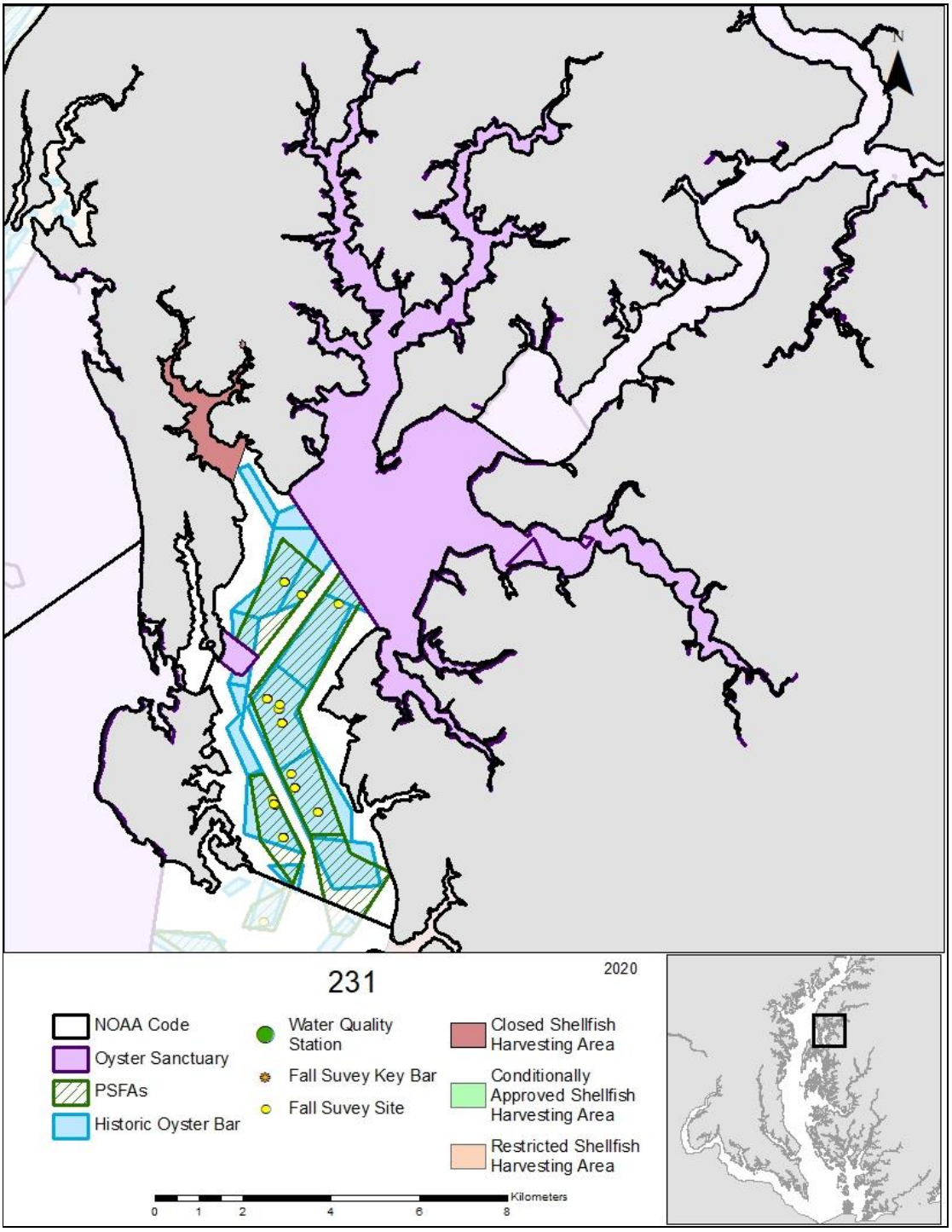


Figure B.29-1. Map of NOAA Code 231 (Chester River Middle). Fall Survey sites may not be sampled every year.

Table B.29-1. Oyster population characteristics based on the Fall Survey in the NOAA Code 231 (Chester River Middle) occurring outside of the current sanctuary area. ND = No Data. Values are given as an annual mean ± standard error.

| | 2006-10 | 2011-15 | 2016-20 |
|---|---|---|---|
| Number of Years Sampled / Number of Samples | 5 / 34 | 5 / 30 | 5 / 38 |
| Number of Live Spat Oysters per square meter | 38.1 ± 24.3 | 0 ± 0 | 2.1 ± 1.4 |
| Number of Live Small-Sized Oysters per square meter | 19.4 ± 15.9 | 1.4 ± 0.6 | 4.3 ± 1.7 |
| Number of Live Market-Sized Oysters per square meter | 11 ± 1.5 | 7.8 ± 1.2 | 13.3 ± 4.3 |
| Live Oyster Biomass (g Dry Weight per Bushel) | ND | ND | ND |
| Observed Mortality (%) | 15 ± 4 | 9 ± 3 | 11 ± 3 |
| Cultch (Bushels per 100 ft Towed) | 0.65 ± 0.08 | 0.68 ± 0.12 | 0.7 ± 0.07 |
| Harvest (Bushels) | 2,912 ± 555 | 895 ± 558 | 798 ± 442 |

Note: The number of samples is based on the number of samples having a value for observed mortality. There may be fewer samples per year for density, biomass, and cultch.

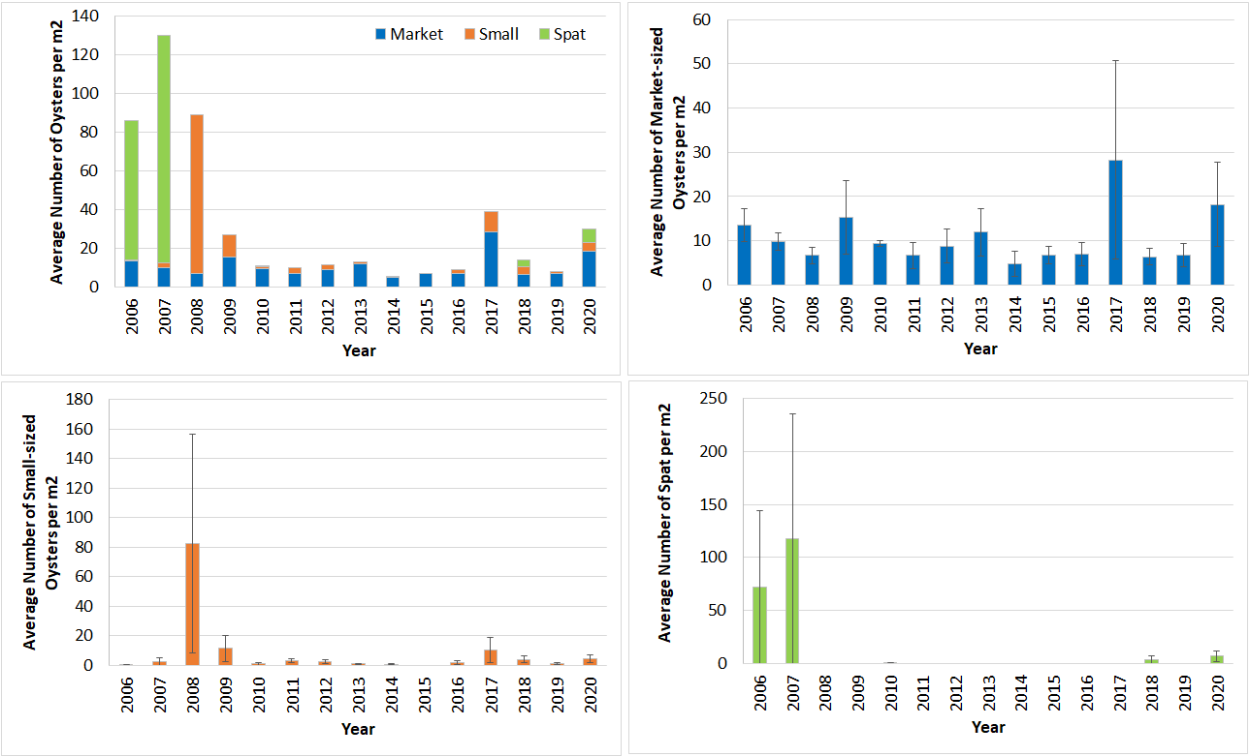


Figure B.29-2A. Average number of live oysters per square meter by size class in NOAA Code 231 (Chester River Middle) occurring outside of the current sanctuary area. Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales.

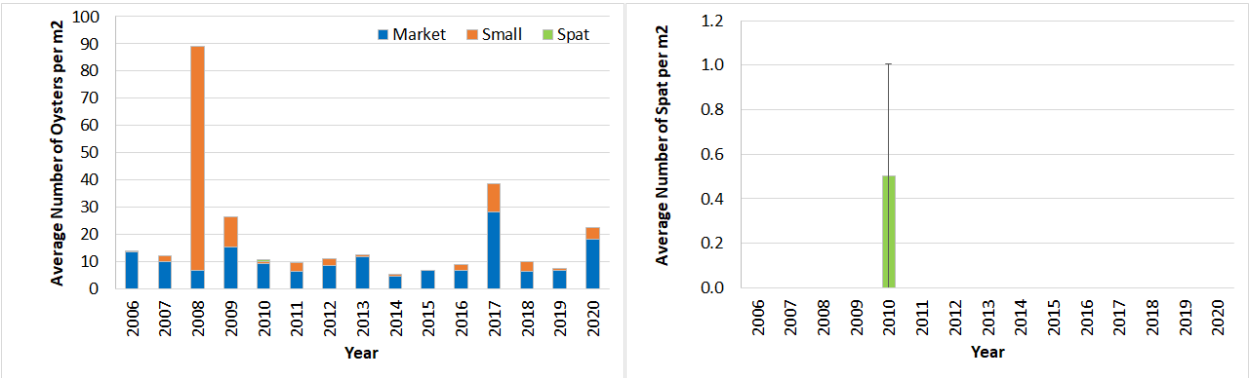


Figure B.29-2B. Average number of live oysters per square meter by size class in NOAA Code 231 (Chester River Middle) occurring outside of the current sanctuary area excluding samples collected on hatchery spat-on-shell plantings. Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales.

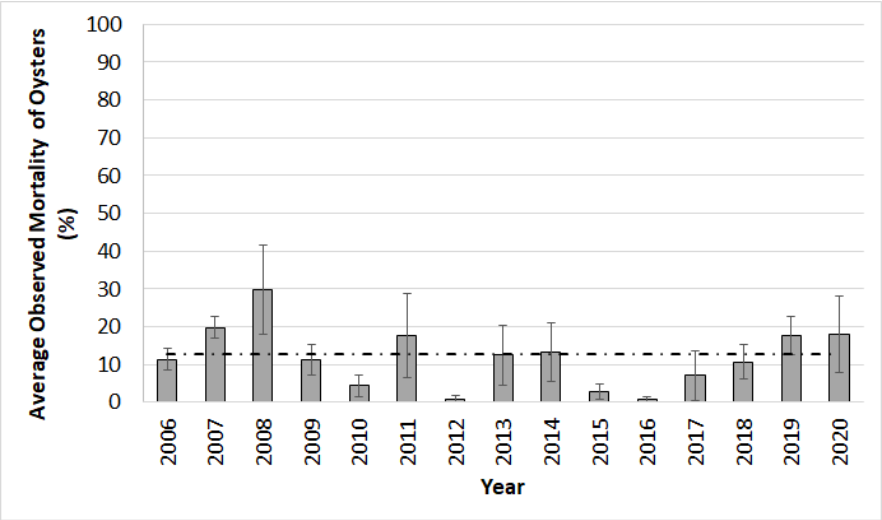


Figure B.29-3. Average annual observed mortality of market-sized and small-sized oysters in NOAA Code 231 (Chester River Middle) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey. The dashed line represents the 2006-2020 baywide average observed mortality. Error bars represent ± 1 standard error.

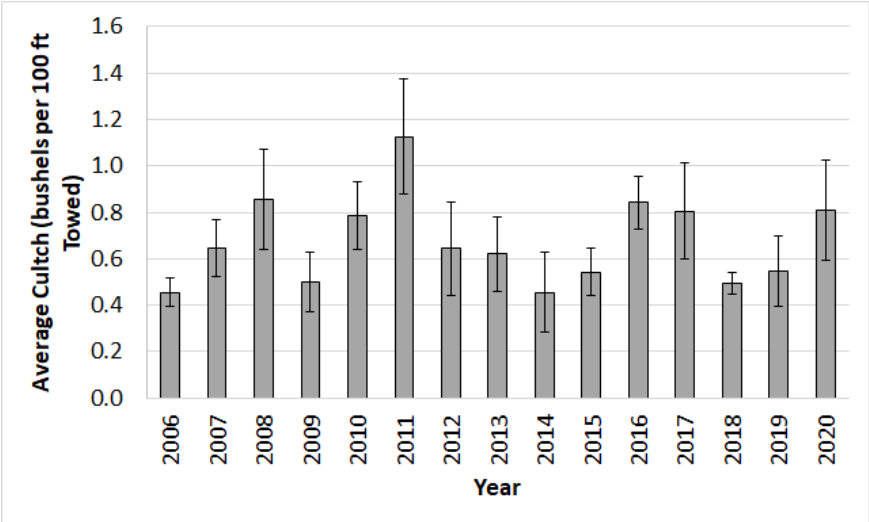


Figure B.29-4. Average cultch (live and dead oysters and loose shell) in NOAA Code 231 (Chester River Middle) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey. Error bars represent ± 1 standard error.

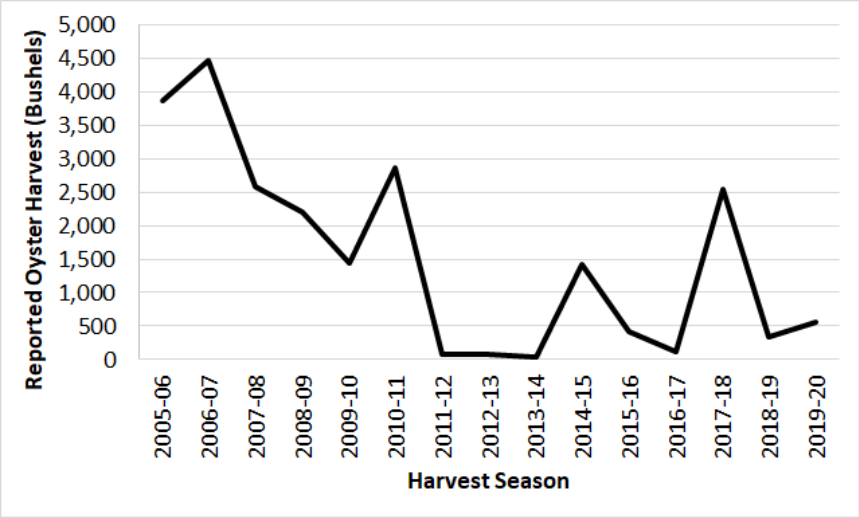


Figure B.29-5. Oyster harvest reported from seafood dealer buy tickets (harvest seasons 2005-2006 to 2019-2020) in NOAA Code 231 (Chester River Middle). Since 2010, 53% of the NOAA Code area has been a sanctuary where harvest is prohibited.

## Section B.30: NOAA Code 237 – Choptank River Middle

NOAA Code 237 encompasses the middle portion of the Choptank River and is located in Maryland's mid-eastern portion of Chesapeake Bay. The entire NOAA Code is 11,946 acres and has 37 historic oyster bars[41]. There are five sanctuaries partially or completely within the NOAA Code: Sandy Hill, La Trappe Creek, Howell Point – Beacon, Upper Choptank River, and Lower Choptank River (total of 6,221 sanctuary acres, 52% of the NOAA Code). This section focuses on information collected within the NOAA Code occurring outside of the current sanctuary areas. This equates to 5,725 surface acres. There are 3,605 acres of historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments) located within the NOAA Code and outside of a sanctuary. As of 2020, there are 3,457 acres within the NOAA Code designated as a Public Shellfish Fishery Area (PSFA). Aquaculture leasing is prohibited within PSFA boundaries. This NOAA Code is located within Maryland's low-salinity region (Zone 1).

Information available for this NOAA Code includes:

- NOAA Code map (Figure B.30-1)
- Summary statistics (Table B.30-1)
- Abundance per year (Figure B.30-2)
- Shell height frequencies (Figure B.30-3)
- Biomass per year (Figure B.30-4)
- Observed mortality (Figure B.30-5)
- Cultch per year (Figure B.30-6)
- Harvest (Figure B.30-7)

Fall survey results indicated an increase in spat density in 2016-2020 as a result of hatchery spat-on-shell plantings. Natural spat density did not change from 2011-2015 to 2016-2020 but was still lower than 2006-2010. Small density increased after 2014. Market density increased steadily from 2006 to 2013, declined in 2014 through 2017, most likely corresponding to the harvest, and increased in 2018 to 2020. Mortality remained at or below the long term baywide average for the entire time period.

Between 2006 and 2020, approximately 2.3 thousand bushels of wild seed and 112 million hatchery spat-on-shell were planted to enhance the commercial public fishery in this NOAA Code outside of the current sanctuary area.

Harvest for the NOAA Code has been reported on seafood dealer buy tickets for all years of the 15-year time series. This includes past harvest data from areas in the NOAA Code that are currently in a sanctuary area, but weren't when the harvest occurred prior to the sanctuaries being established. Since 2010, 52% of the NOAA Code area has been a sanctuary where harvest is prohibited. Harvest reported ranged from approximately 500 bushels in the 2007-08 season to a maximum of approximately 9 thousand bushels in the 2015-16 season. Hand tonging was used

[41] See chart 20 and 21 for bar names and locations in the State of Maryland Shellfish Closure Areas Book http://dnr.maryland.gov/fisheries/Pages/oysters/index.aspx

to obtain about half of the harvest, diving to obtain about a quarter, and dredging (both power and sail) the other quarter.

We are unaware of any continuous water quality monitoring in this area.

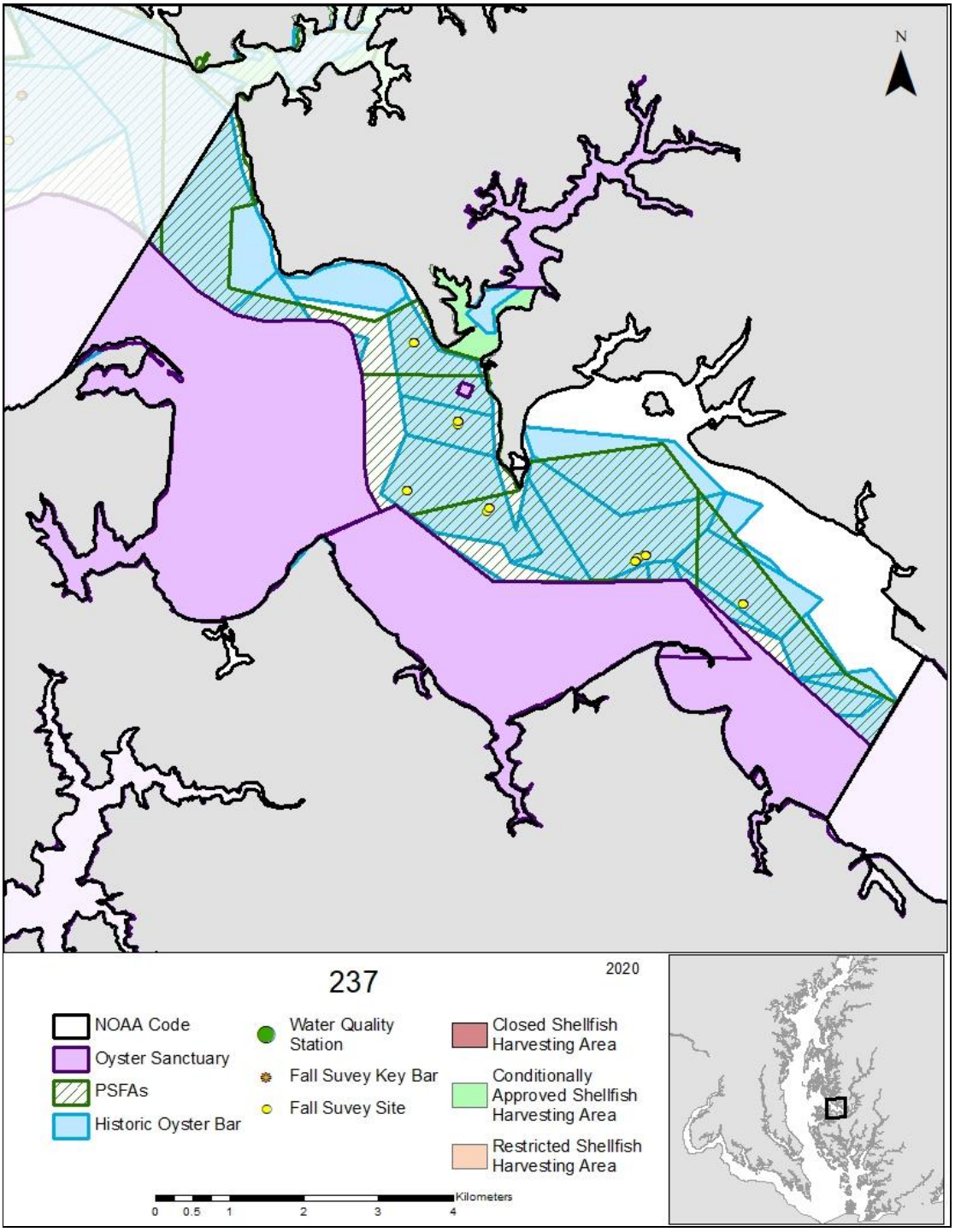


Figure B.30-1. Map of NOAA Code 237 (Choptank River Middle). Fall Survey sites may not be sampled every year.

Table B.30-1. Oyster population characteristics based on the Fall Survey in the NOAA Code 237 (Choptank River Middle) occurring outside of the current sanctuary area. ND = No Data. Values are given as an annual mean ± standard error.

| | 2006-10 | 2011-15 | 2016-20 |
|---|---|---|---|
| Number of Years Sampled / Number of Samples | 5 / 34 | 5 / 30 | 5 / 33 |
| Number of Live Spat Oysters per square meter | 5.7 ± 2.4 | 4.9 ± 2.1 | 27 ± 16.9 |
| Number of Live Small-Sized Oysters per square meter | 11.6 ± 3.7 | 26.4 ± 12.6 | 30.9 ± 8.7 |
| Number of Live Market-Sized Oysters per square meter | 21.6 ± 4.8 | 42.8 ± 3.9 | 29.7 ± 4.5 |
| Live Oyster Biomass (g Dry Weight per Bushel) | ND | 207 ± 49 | 182 ± 29 |
| Observed Mortality (%) | 7 ± 1 | 7 ± 1 | 7 ± 3 |
| Cultch (Bushels per 100 ft Towed) | 0.74 ± 0.06 | 0.83 ± 0.07 | 0.73 ± 0.09 |
| Harvest (Bushels) | 1,048 ± 377 | 2,774 ± 1,087 | 6,079 ± 1,037 |

Note: The number of samples is based on the number of samples having a value for observed mortality. There may be fewer samples per year for density, biomass, and cultch.

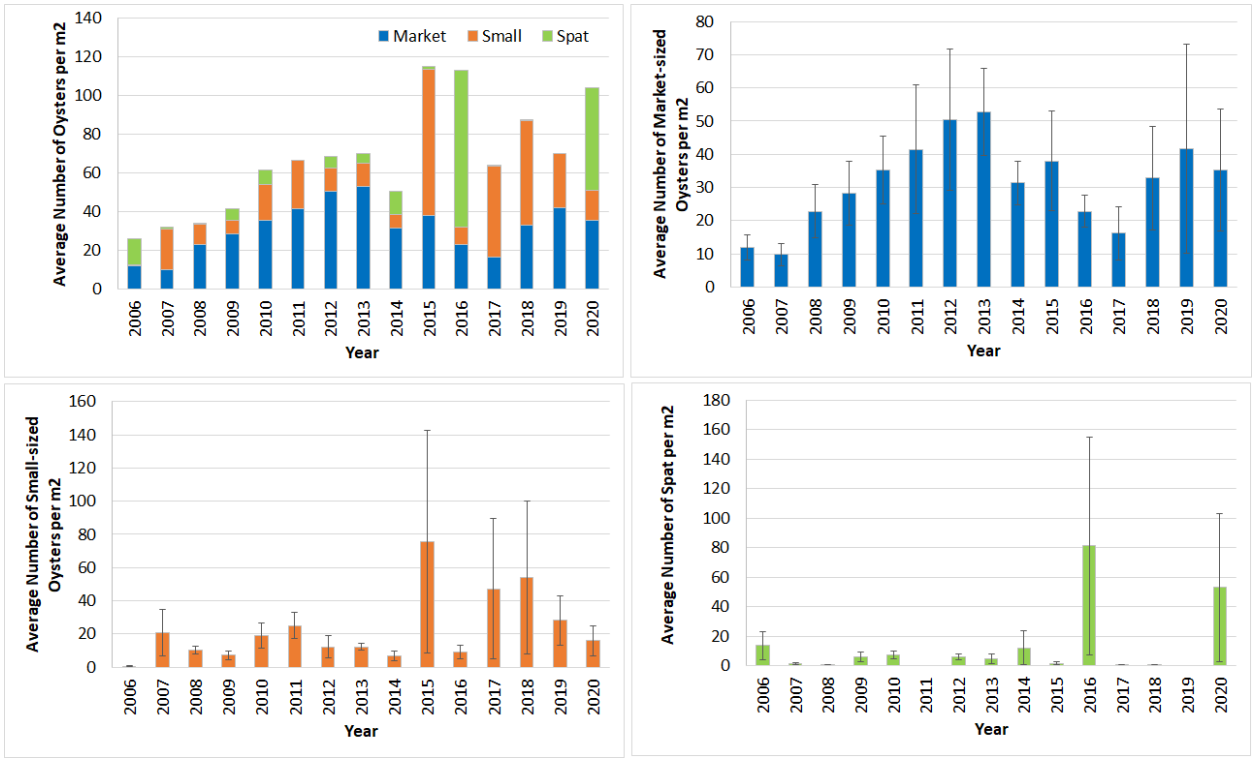


Figure B.30-2A. Average number of live oysters per square meter by size class in NOAA Code 237 (Choptank River Middle) occurring outside of the current sanctuary area. Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales.

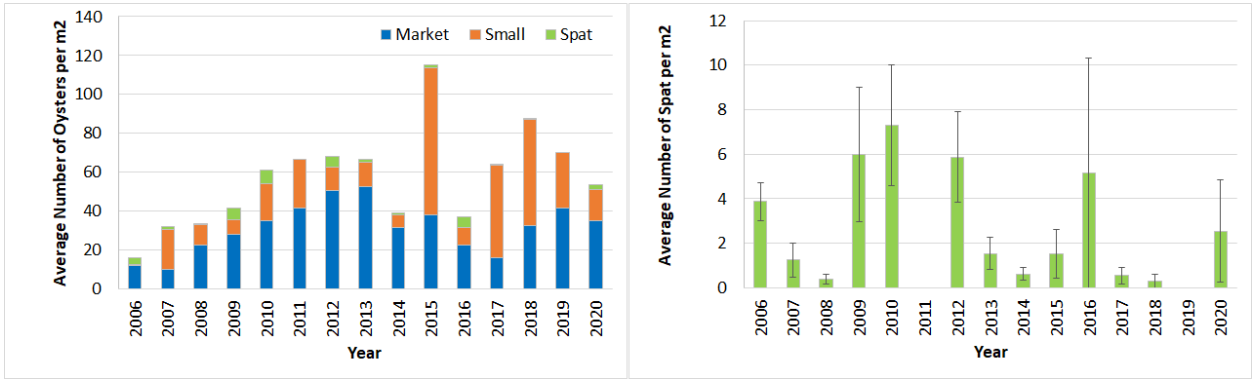


Figure B.30-2B. Average number of live oysters per square meter by size class in NOAA Code 237 (Choptank River Middle) occurring outside of the current sanctuary area excluding samples taken on hatchery spat-on-shell plantings. Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales.

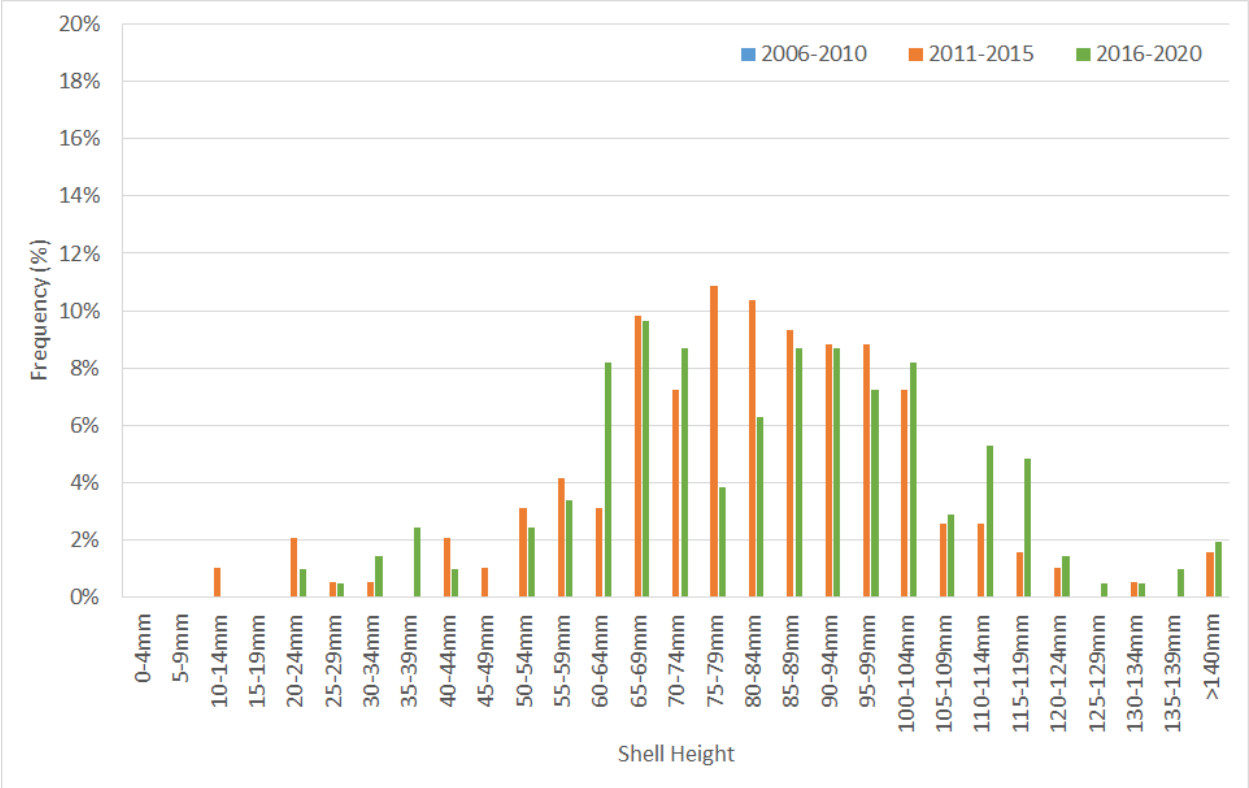


Figure B.30-3. Shell height frequencies of live oysters per bushel of material in NOAA Code 237 (Choptank River Middle) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey on Hambrooks bar. No data were collected from 2006 to 2010 and 2014 to 2015.

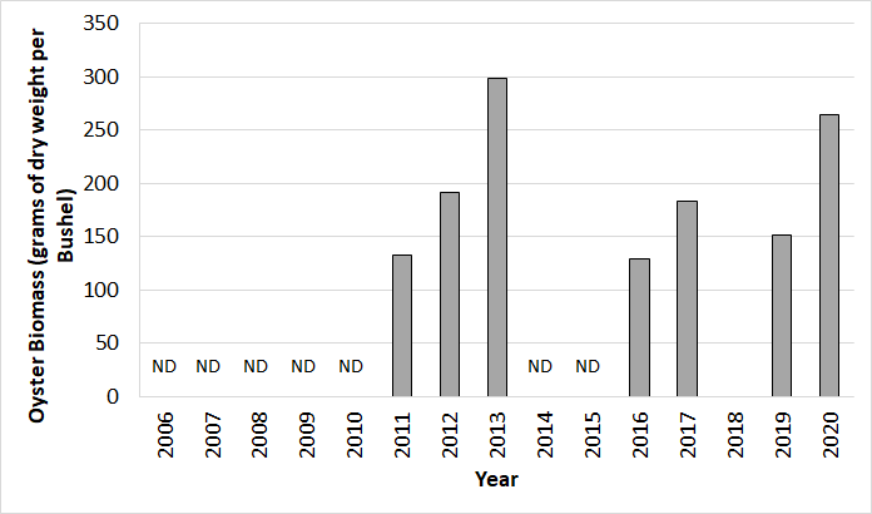


Figure B.30-4. Oyster biomass (grams of dry weight per bushel of material) in NOAA Code 237 (Choptank River Middle) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey on Hambrooks bar. ND = No Data.

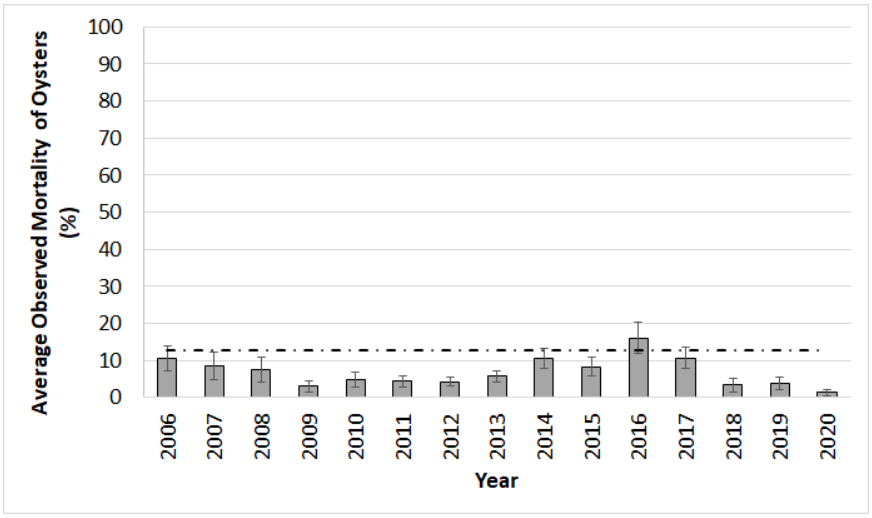


Figure B.30-5. Average annual observed mortality of market-sized and small-sized oysters in NOAA Code 237 (Choptank River Middle) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey. The dashed line represents the 2006-2020 baywide average observed mortality. Error bars represent ± 1 standard error.

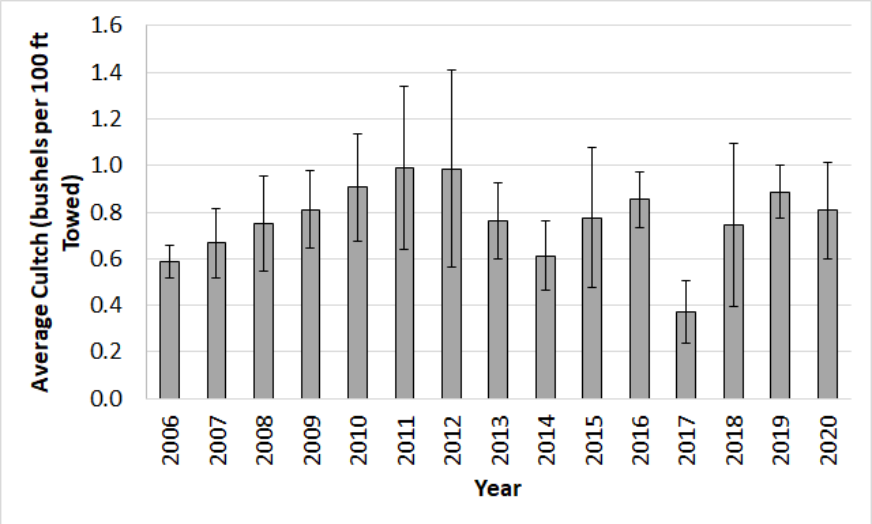


Figure B.30-6. Average cultch (live and dead oysters and loose shell) in NOAA Code 237 (Choptank River Middle) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey. Error bars represent ± 1 standard error.

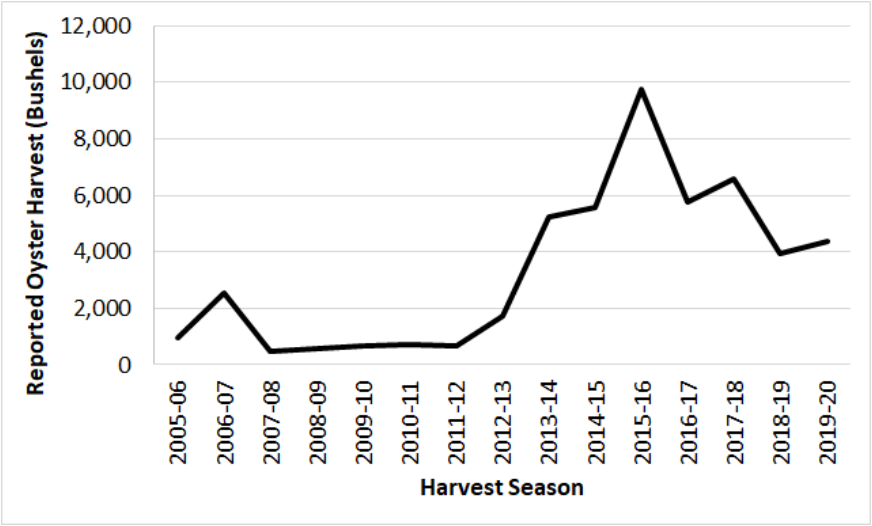


Figure B.30-7. Oyster harvest reported from seafood dealer buy tickets (harvest seasons 2005-2006 to 2019-2020) in NOAA Code 237 (Choptank River Middle). Since 2010, 52% of the NOAA Code area has been a sanctuary where harvest is prohibited.

## Section B.31: NOAA Code 268 – Patuxent River Middle

NOAA Code 268 encompasses the middle portion of the Patuxent River between Broomes Island and St. Leonard Creek and is located in Maryland's lower western portion of Chesapeake Bay. The entire NOAA Code is 4,432 acres and has seven historic oyster bars[42]. The Neal Addition Sanctuary was established in 2001 and encompasses less than 1% (6.7 acres) of the NOAA Code. This section focuses on information collected within the NOAA Code occurring outside of the current sanctuary area. This equates to 4,425 surface acres. There are 1,223 acres of historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments) located within the NOAA Code and outside a sanctuary. As of 2020, there are 1,878 acres within the NOAA Code designated as a Public Shellfish Fishery Area (PSFA). Aquaculture leasing is prohibited within PSFA boundaries. This NOAA Code is located within Maryland's medium-salinity region (Zone 2).

Information available for this NOAA Code includes:

- NOAA Code map (Figure B.31-1)
- Harvest (Figure B.31-2)
- Water Quality (Figure B.31-3)

The Fall Survey has only sampled this area once in 2019, a single sample with 93% total observed mortality and thus not enough information to state trends in oyster populations.

Between 2006 and 2020, approximately 7 thousand bushels of shell, 1.3 thousand bushels of wild seed and 0.04 million hatchery spat-on-shell were planted to enhance the commercial public fishery in this NOAA Code outside of the current sanctuary area.

Harvest for the NOAA Code has been reported on seafood dealer buy tickets for all years of the 15-year time series. Since 2001, less than 1% of the NOAA Code area has been a sanctuary where harvest is prohibited. Harvest reported ranged from 162 bushels in the 2007-08 season to a maximum of approximately 11 thousand bushels in the 2005-06 season. Patent tonging was used to obtain about half of the harvest and diving to obtain the other half.

Continuous water quality monitoring has occurred at station LE1.2 (38.37887; -76.5113). During the 2006-2020 timeline, surface salinity ranged from 3.8 ppt to 17.5 ppt, with the lowest salinity being during the freshet of 2018-2019 and during the high rainfall year of 2011.

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

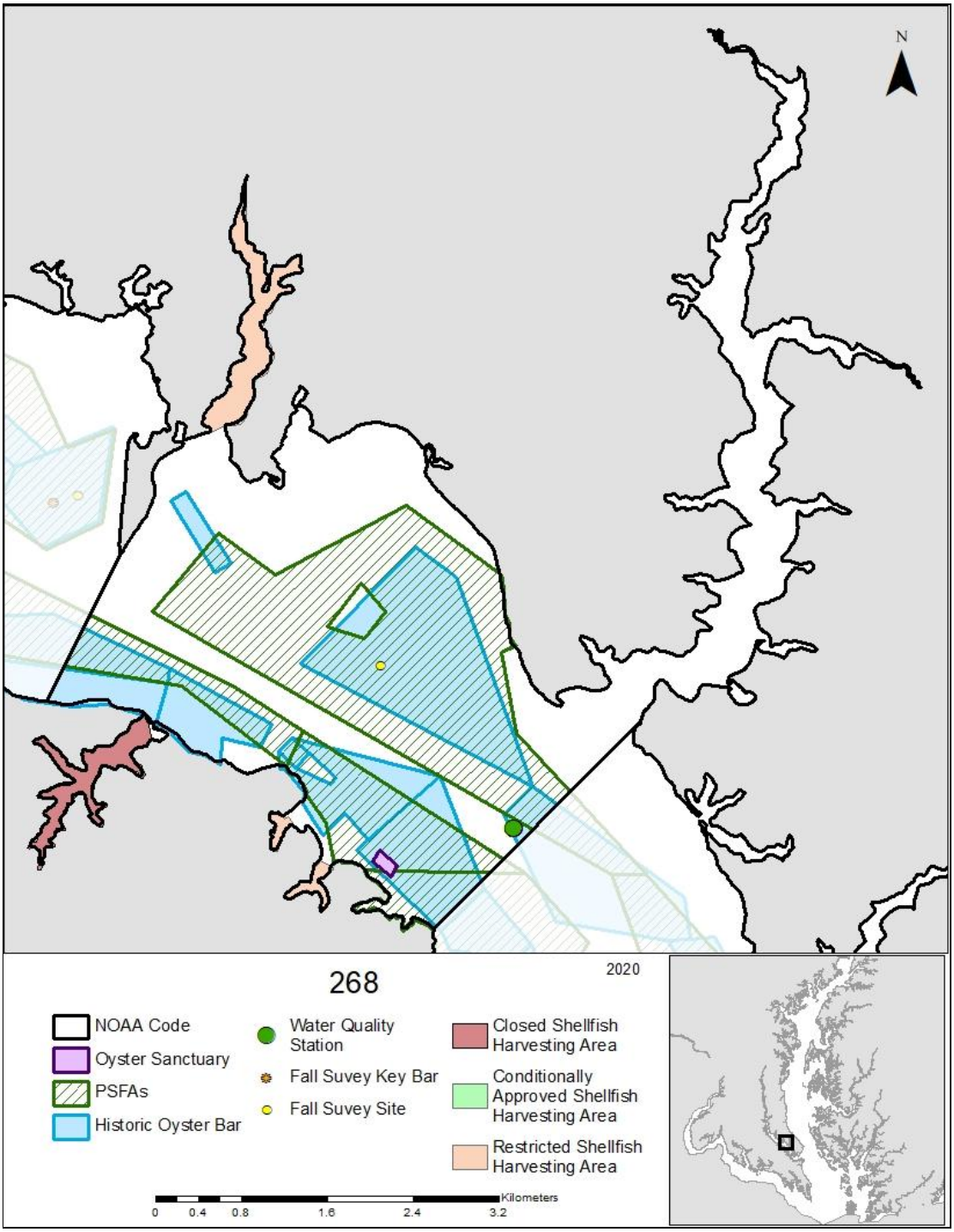


Figure B.31-1. Map of NOAA Code 268 (Patuxent River Middle). Fall Survey sites may not be sampled every year.

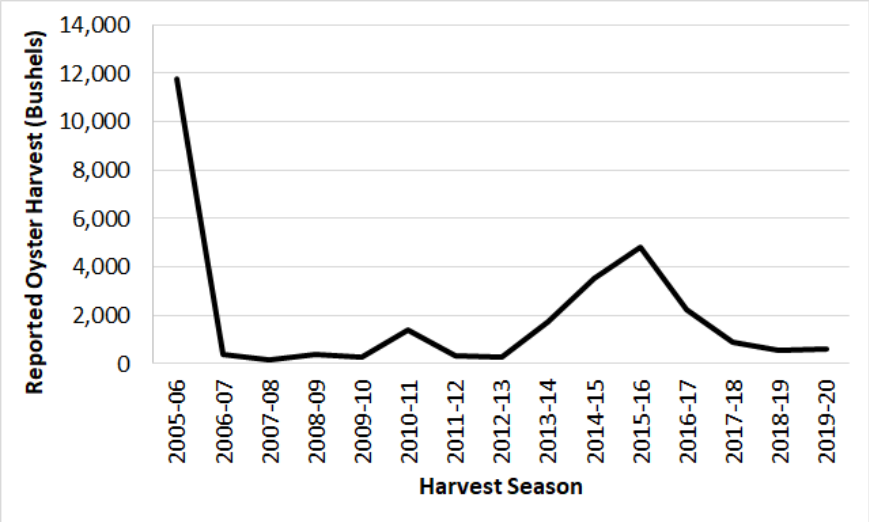


Figure B.31-2. Oyster harvest reported from seafood dealer buy tickets (harvest seasons 2005-2006 to 2019-2020) in NOAA Code 268 (Patuxent River Middle). Since 2001, less than 1% of the NOAA Code area has been a sanctuary where harvest is prohibited.

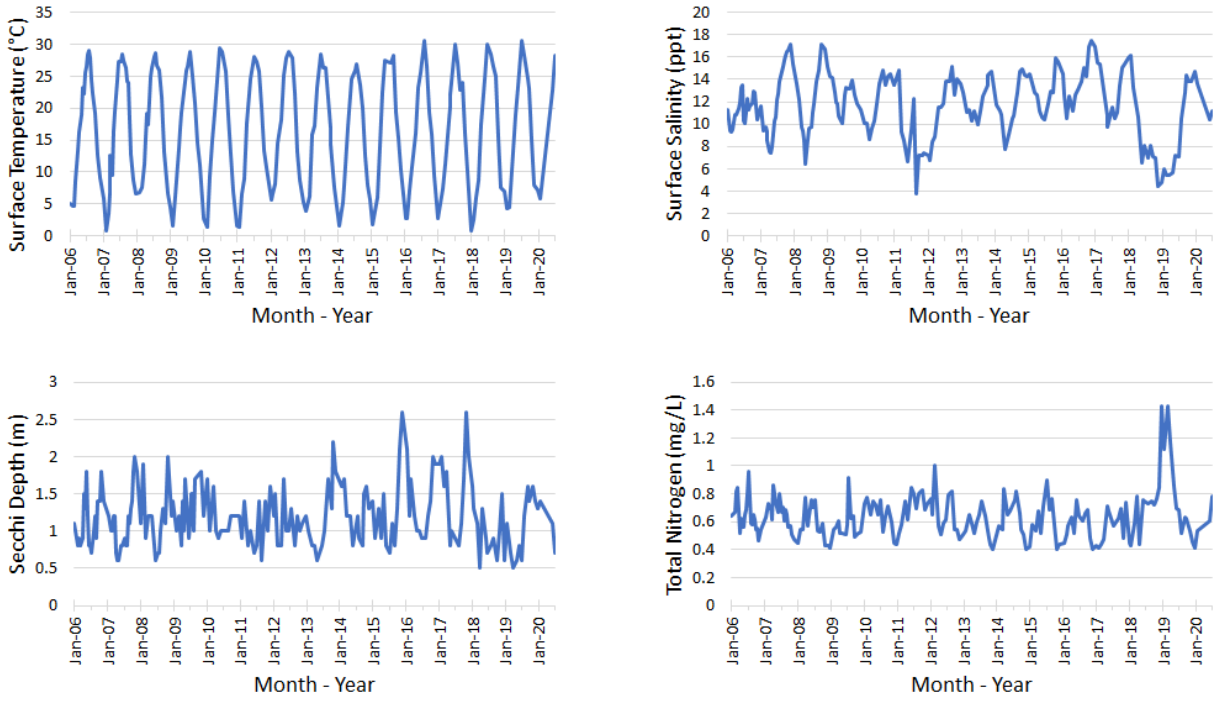


Figure B.31-3. Water quality data collected at Station LE1.2 in NOAA Code 268 (Patuxent River Middle). Data from Chesapeake Bay Program Data Hub.

## Section B.32: NOAA Code 274 – Wicomico River West

NOAA Code 274 encompasses the Wicomico River (West), a tributary of the Potomac River and is located in Maryland's lower western portion of Chesapeake Bay. The entire NOAA Code is 11,774 acres and has 24 historic oyster bars[43]. The Wicomico River Sanctuary was established in 2010 and encompasses 4% (450 total acres) of the NOAA Code. This section focuses on information collected within the NOAA Code occurring outside of the current sanctuary area. This equates to 11,324 surface acres. There are 4,128 acres of historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments) located within the NOAA Code and not in a sanctuary. As of 2020, there are 5,950 acres within the NOAA Code designated as a Public Shellfish Fishery Area (PSFA). Aquaculture leasing is prohibited within PSFA boundaries. This NOAA Code is located within Maryland's low-salinity region (Zone 1).

Information available for this NOAA Code includes:

- NOAA Code map (Figure B.32-1)
- Summary statistics (Table B.32-1)
- Abundance per year (Figure B.32-2)
- Shell height frequencies (Figure B.32-3)
- Biomass per year (Figure B.32-4)
- Observed mortality (Figure B.32-5)
- Dermo and MSX per year (Figure B.32-6)
- Cultch per year (Figure B.32-7)
- Harvest (Figure B.32-8)

Fall Survey results indicated increases in biomass, small density, and market density in the 2016-2020 time period. Spat density was primarily due to the hatchery spat-on-shell plantings; however, there was some natural spat during the time period with 2010 and 2020 having the highest density. Mortality remained at or below the long term baywide average.

Between 2006 and 2020, approximately 2.4 thousand bushels of shell, 23 thousand bushels of wild seed and 244 million hatchery spat-on-shell were planted to enhance the commercial public fishery in this NOAA Code outside of the current sanctuary area.

Harvest for the NOAA Code has been reported on seafood dealer buy tickets for all years of the 15-year time series. This includes past harvest data from areas in the NOAA Code that are currently in a sanctuary area, but weren't when the harvest occurred prior to the sanctuary being established. Since 2010, 4% of the NOAA Code area has been a sanctuary where harvest is prohibited. Harvest reported ranged from 80 bushels in the 2006-07 season to a maximum of approximately 6 thousand bushels in the 2013-14 season. Hand tonging was used to obtain the majority of the harvest.

We are unaware of any continuous water quality monitoring in this area.

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

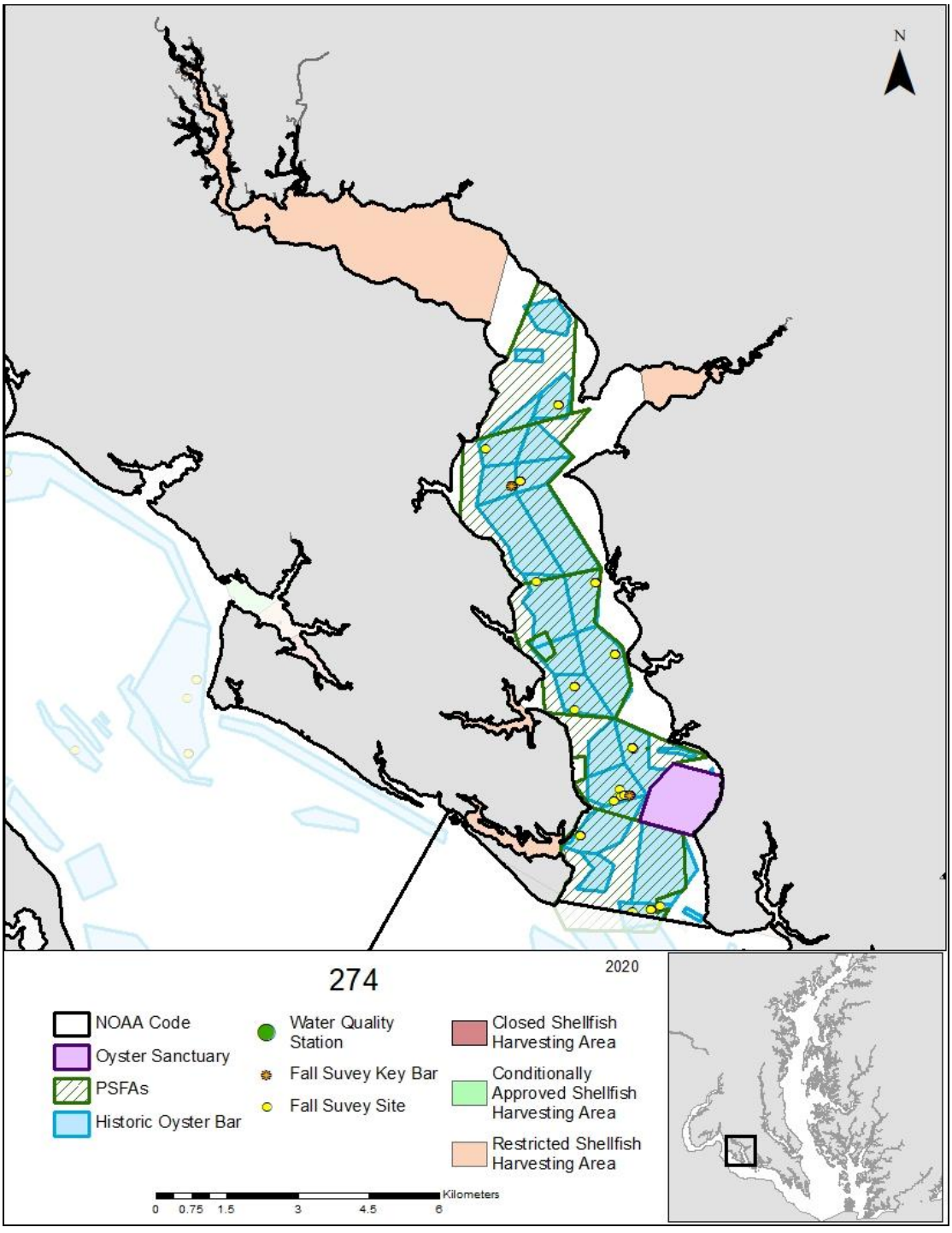


Figure B.32-1. Map of NOAA Code 274 (Wicomico River (West)). Fall Survey sites may not be sampled every year. Fall Survey key bars may consist of a key bar, disease bar or both.

Table B.32-1. Oyster population characteristics based on the Fall Survey in the NOAA Code 274 (Wicomico River (West)) occurring outside of the current sanctuary area. ND = No Data. Values are given as an annual mean ± standard error.

| | 2006-10 | 2011-15 | 2016-20 |
|---|---|---|---|
| Number of Years Sampled / Number of Samples | 5 / 55 | 5 / 49 | 5 / 56 |
| Number of Live Spat Oysters per square meter | 0.3 ± 0.3 | 38 ± 38 | 23.4 ± 14.1 |
| Number of Live Small-Sized Oysters per square meter | 8.5 ± 2.2 | 23.7 ± 12.6 | 36.6 ± 13.4 |
| Number of Live Market-Sized Oysters per square meter | 15.7 ± 1.5 | 13.3 ± 1.1 | 25.3 ± 6.1 |
| Live Oyster Biomass (g Dry Weight per Bushel) | 40 ± 8 | 64 ± 9 | 115 ± 16 |
| Observed Mortality (%) | 14 ± 3 | 6 ± 1 | 9 ± 2 |
| Cultch (Bushels per 100 ft Towed) | 0.77 ± 0.05 | 0.8 ± 0.08 | 0.77 ± 0.16 |
| Harvest (Bushels) | 707 ± 209 | 3,253 ± 1,083 | 2,278 ± 981 |

Note: The number of samples is based on the number of samples having a value for observed mortality. There may be fewer samples per year for density, biomass, and cultch.

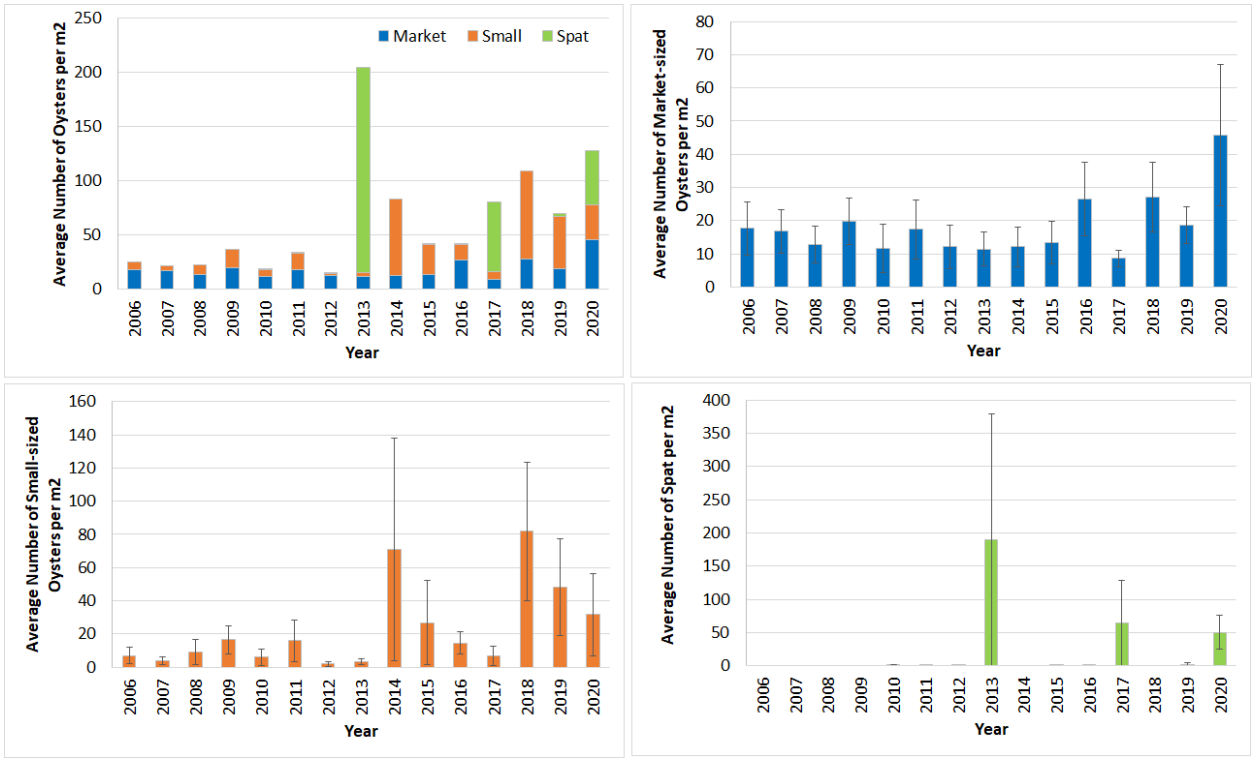


Figure B.32-2A. Average number of live oysters per square meter by size class in NOAA Code 274 (Wicomico River (West)) occurring outside of the current sanctuary area. Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales.

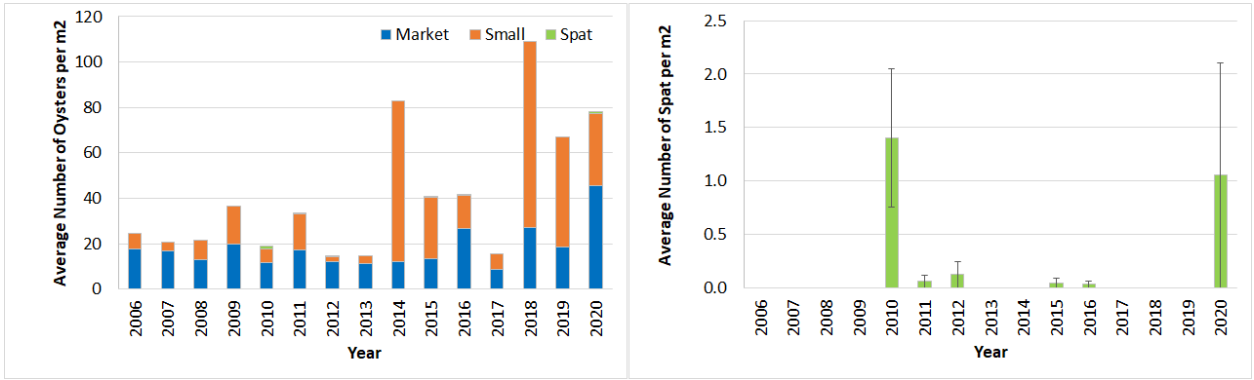


Figure B.32-2B. Average number of live oysters per square meter by size class in NOAA Code 274 (Wicomico River (West)) occurring outside of the current sanctuary area excluding samples taken on hatchery spat-on-shell plantings. Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales.

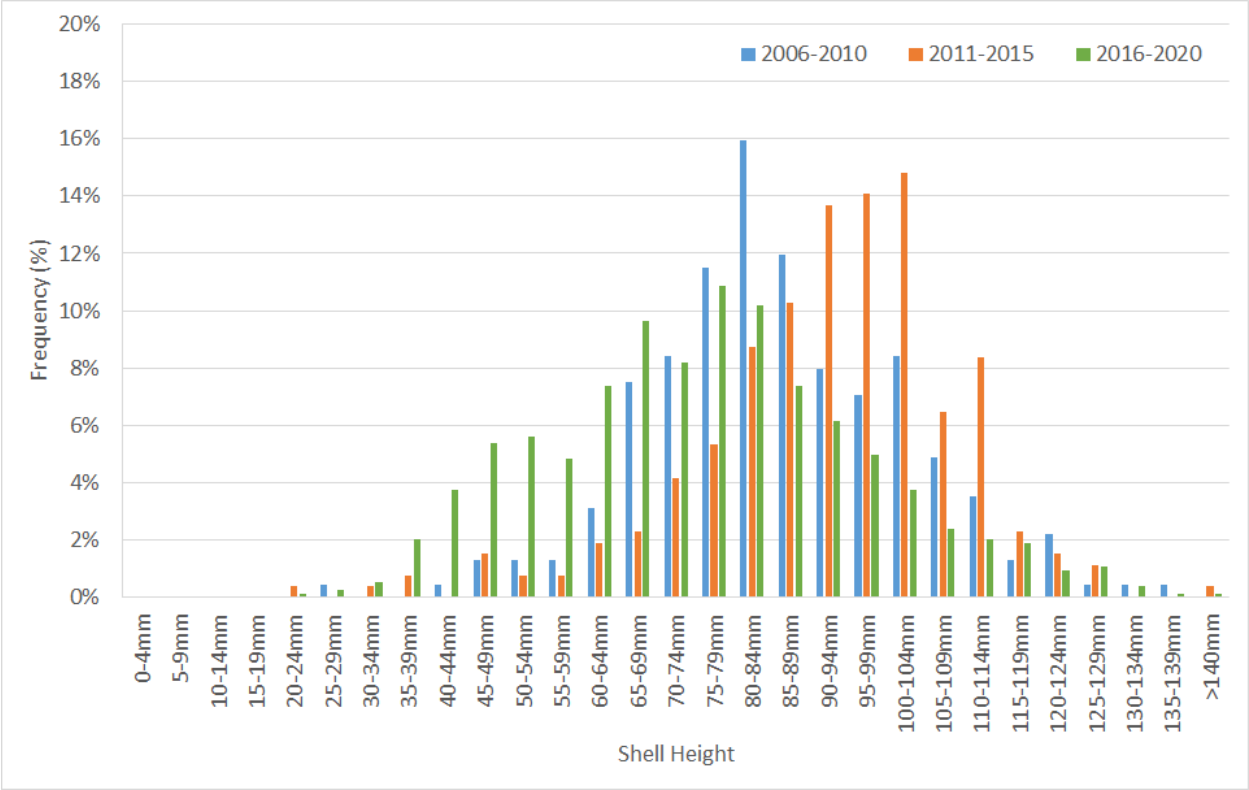


Figure B.32-3. Shell height frequencies of live oysters per bushel of material in NOAA Code 274 (Wicomico River (West)) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey based on an average from Lancaster and Mills West bars.

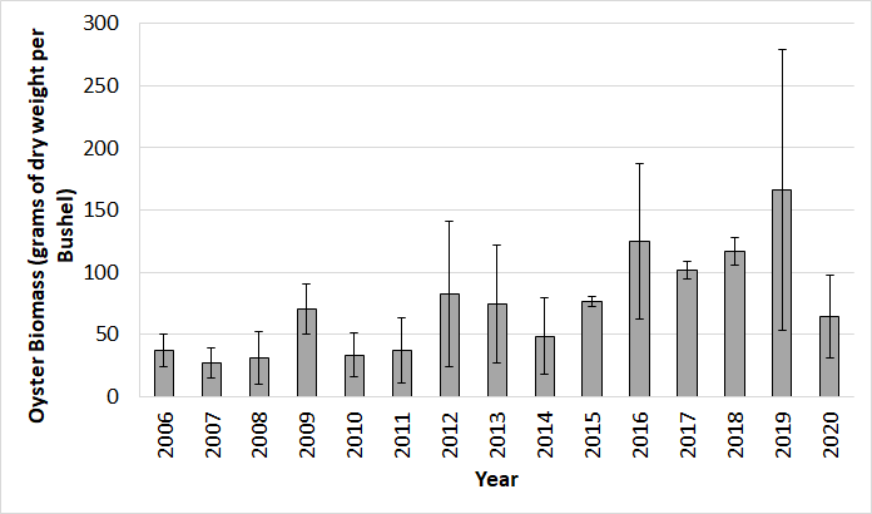


Figure B.32-4. Oyster biomass (grams of dry weight per bushel of material) in NOAA Code 274 (Wicomico River (West)) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey based on an average from Lancaster and Mills West bars. Error bars represent ± 1 standard error.

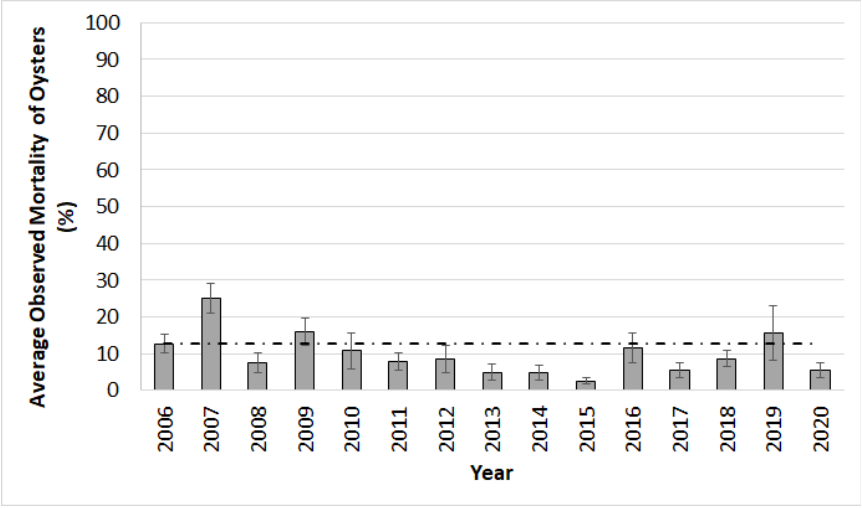


Figure B.32-5. Average annual observed mortality of market-sized and small-sized oysters in NOAA Code 274 (Wicomico River (West)) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey. The dashed line represents the 2006-2020 baywide average observed mortality. Error bars represent ± 1 standard error.

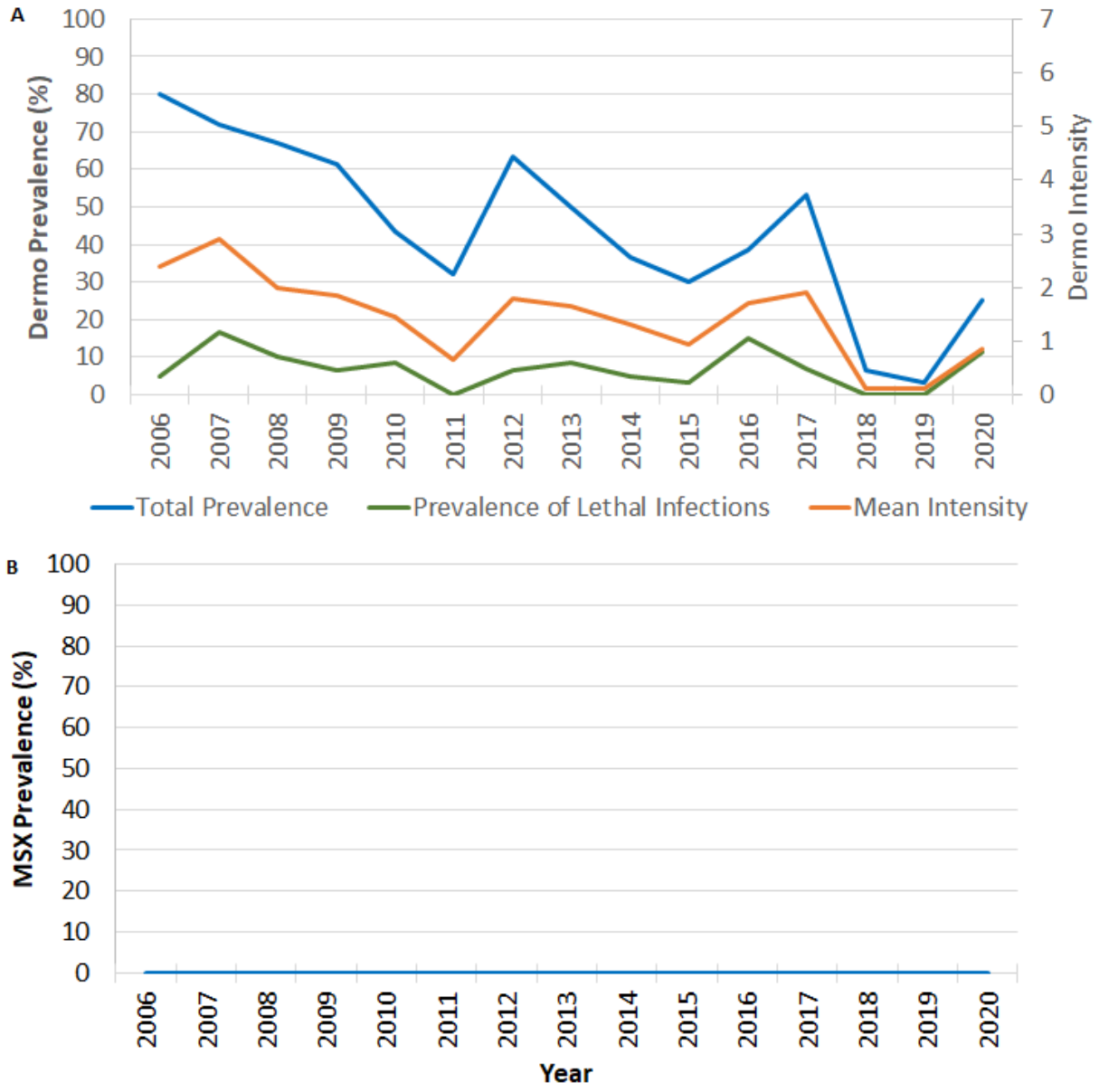


Figure B.32-6. Oyster disease prevalence and intensity in NOAA Code 274 (Wicomico River (West)) occurring outside of the current sanctuary area. (A) Dermo prevalence and mean intensity (B) MSX prevalence (intensity is not examined). Data from Maryland's Annual Fall Oyster Dredge Survey based on an average from Lancaster and Mills West bars.

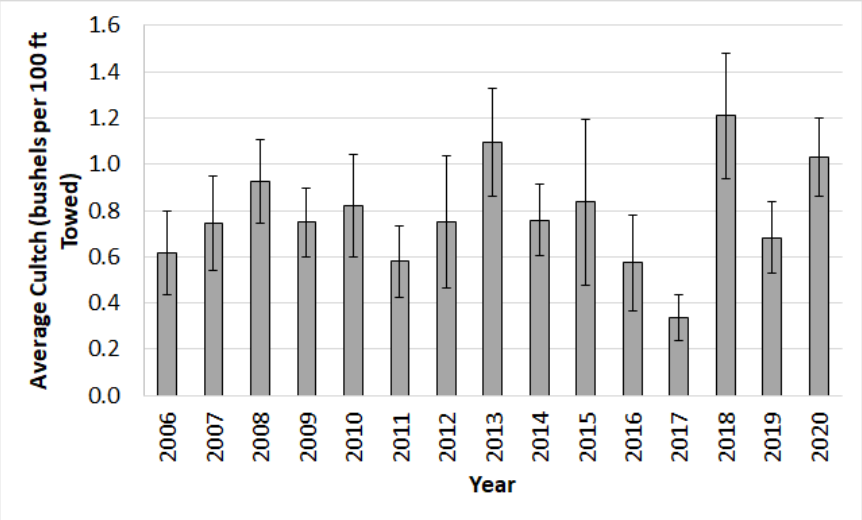


Figure B.32-7. Average cultch (live and dead oysters and loose shell) in NOAA Code 274 (Wicomico River (West)) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey. Error bars represent ± 1 standard error.

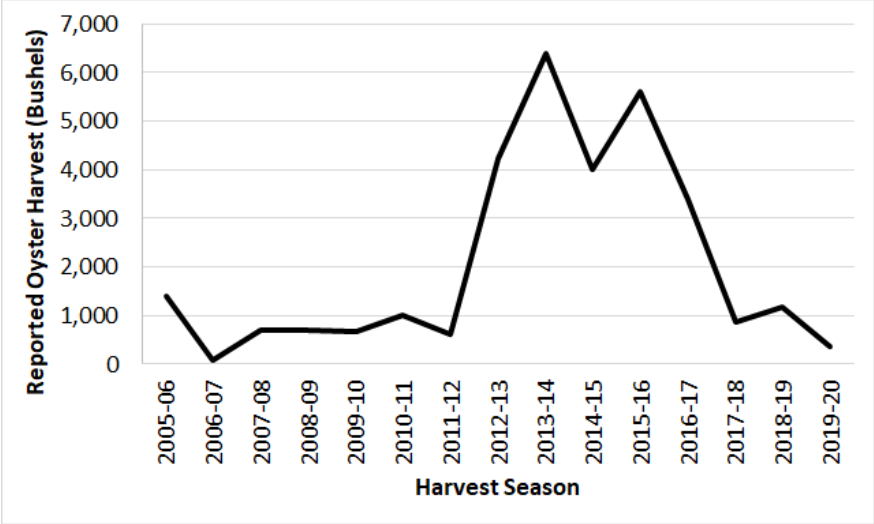


Figure B.32-8. Oyster harvest reported from seafood dealer buy tickets (harvest seasons 2005-2006 to 2019-2020) in NOAA Code 274 (Wicomico River (West)). Since 2010, 4% of the NOAA Code area has been a sanctuary where harvest is prohibited.

## Section B.33: NOAA Code 292 – Tangier Sound North

NOAA Code 292 encompasses the northern portion of Tangier Sound and is located in Maryland's lower eastern portion of Chesapeake Bay. The entire NOAA Code is 35,607 acres and has 53 historic oyster bars[44]. Two sanctuaries (Lower Mainstem and Hooper Straits) are partially located within the NOAA Code and contain 8% (2,924 total acres) of the NOAA Code. This section focuses on information collected within the NOAA Code occurring outside of the current sanctuary areas. This equates to 32,683 surface acres. There are 17,401 acres of historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments) located within the NOAA Code and outside a sanctuary. As of 2020, there are 9,663 acres within the NOAA Code designated as a Public Shellfish Fishery Area (PSFA). Aquaculture leasing is prohibited within PSFA boundaries. This NOAA Code is located within Maryland's medium-salinity region (Zone 2).

Information available for this NOAA Code includes:

- NOAA Code map (Figure B.33-1)
- Summary statistics (Table B.33-1)
- Abundance per year (Figure B.33-2)
- Shell height frequencies (Figure B.33-3)
- Biomass per year (Figure B.33-4)
- Observed mortality (Figure B.33-5)
- Dermo and MSX per year (Figure B.33-6)
- Cultch per year (Figure B.33-7)
- Harvest (Figure B.33-8)
- Water Quality (Figure B.33-9)

Fall Survey results indicated no change in average market density from the 2011-2015 to 2016-2020 time periods; however, market density declined in 2015 through 2017 then increased from 2018 to 2020. Average spat density was similar over the three time periods; however, 2010 and 2012 had relatively high spat sets. Small density declined from 2012 to 2015, increased in 2016 and 2017, and then started declining again; however, average small density was highest in the 2016-2020 time period. Average biomass was similar between the 2011-2015 and 2016-2020 time periods, however, there was a decline with low biomass in 2014 through 2016. Mortality was either around or below the long term baywide average.

Between 2006 and 2020, approximately 217 thousand bushels of shell, 26 thousand bushels of wild seed and 91 million hatchery spat-on-shell were planted to enhance the commercial public fishery in this NOAA Code outside of the current sanctuary area.

Harvest for the NOAA Code has been reported on seafood dealer buy tickets for all years of the 15-year time series. This includes past harvest data from areas in the NOAA Code that are currently in a sanctuary area, but weren't when the harvest occurred prior to the sanctuaries being established. Since 2010, 8% of the NOAA Code area has been a sanctuary where harvest is prohibited. Harvest reported ranged from 2 thousand bushels in the 2006-07 season to a

[44] See chart 30, 31, and 37 for bar names and locations in the State of Maryland Shellfish Closure Areas Book http://dnr.maryland.gov/fisheries/Pages/oysters/index.aspx

maximum of approximately 82 thousand bushels in the 2019-20 season. Power (28%) and sail dredging (23%) were used to obtain half of the harvest and patent tonging used to obtain the other half.

Continuous water quality monitoring has occurred at station EE3.1 (38.19685; -75.9732). During the 2006-2020 timeline, surface salinity ranged from 7 ppt to 19.1 ppt, with the lowest salinity being during the freshet of 2018-2019.

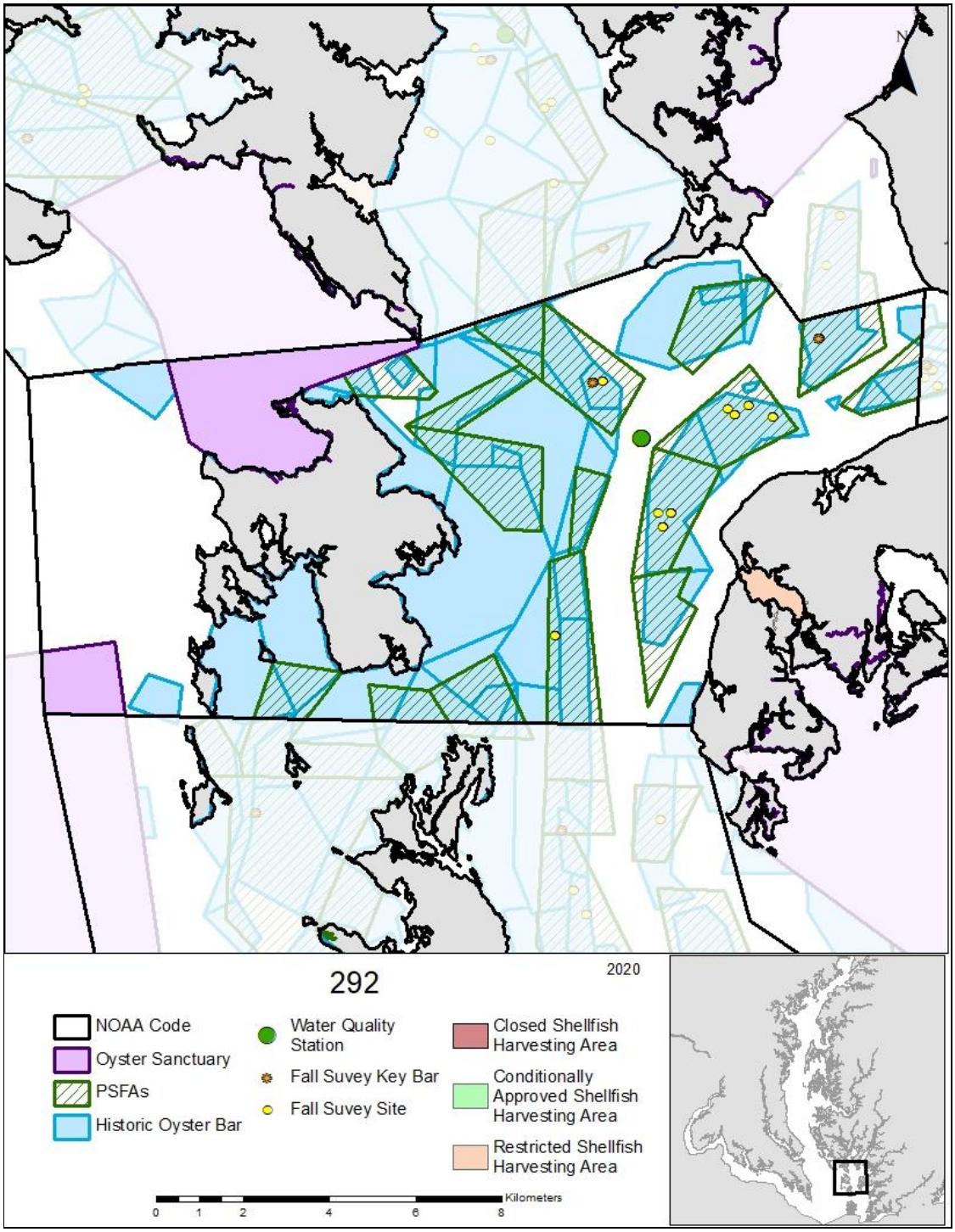


Figure B.33-1. Map of NOAA Code 292 (Tangier Sound North). Fall Survey sites may not be sampled every year. Fall Survey key bars may consist of a key bar, disease bar or both.

Table B.33-1. Oyster population characteristics based on the Fall Survey in the NOAA Code 292 (Tangier Sound North) occurring outside of the current sanctuary area. ND = No Data. Values are given as an annual mean ± standard error.

| | 2006-10 | 2011-15 | 2016-20 |
|---|---|---|---|
| Number of Years Sampled / Number of Samples | 5 / 41 | 5 / 36 | 5 / 30 |
| Number of Live Spat Oysters per square meter | 32.8 ± 20 | 32.7 ± 14.2 | 30.8 ± 5.7 |
| Number of Live Small-Sized Oysters per square meter | 17.6 ± 6.5 | 53.8 ± 13.8 | 75.2 ± 11.5 |
| Number of Live Market-Sized Oysters per square meter | 10.6 ± 4.2 | 29.9 ± 9.1 | 30.8 ± 12.6 |
| Live Oyster Biomass (g Dry Weight per Bushel) | 57 ± 14 | 155 ± 41 | 174 ± 35 |
| Observed Mortality (%) | 18 ± 4 | 15 ± 2 | 9 ± 3 |
| Cultch (Bushels per 100 ft Towed) | 1 ± 0.17 | 1.05 ± 0.08 | 1.06 ± 0.07 |
| Harvest (Bushels) | 8,098 ± 3,193 | 38,687 ± 8,588 | 47,612 ± 11,162 |
| Note: The number of samples is based on the number of samples having a value for observed mortality. There may be fewer samples per year for density, biomass, and cultch. | | | |

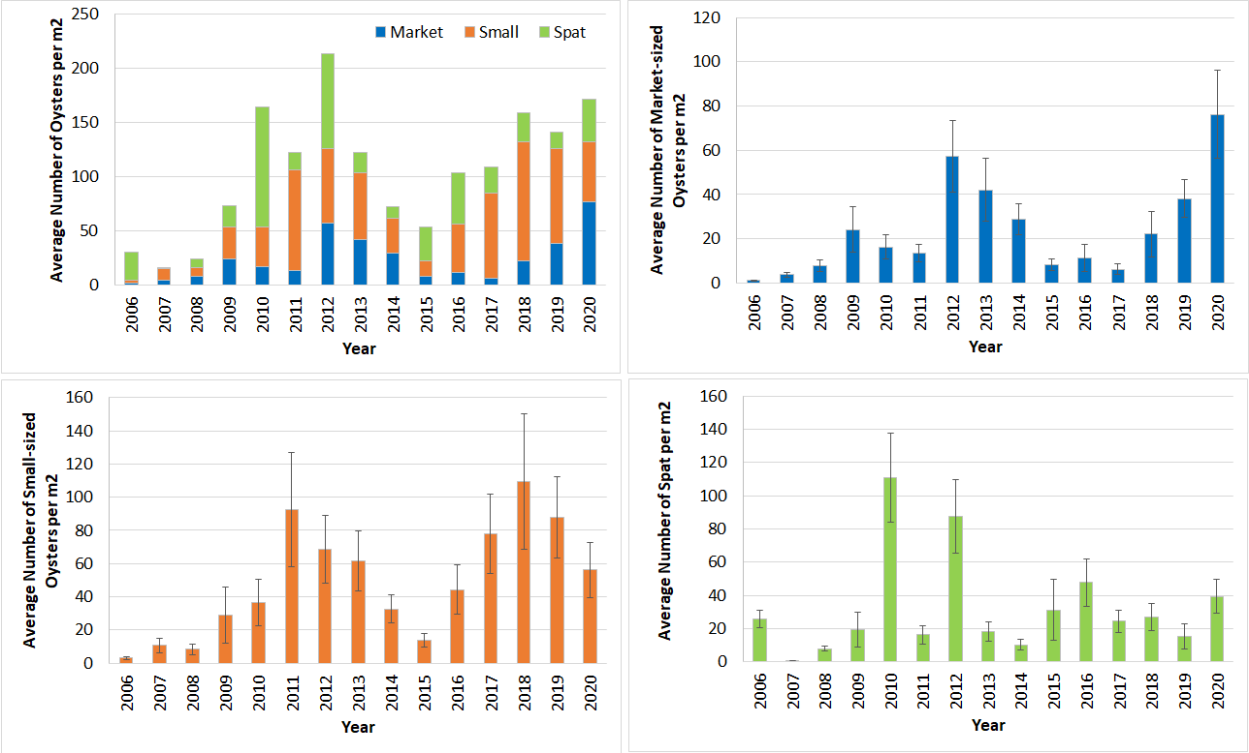


Figure B.33-2. Average number of live oysters per square meter by size class in NOAA Code 292 (Tangier Sound North) occurring outside of the current sanctuary area. Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales.

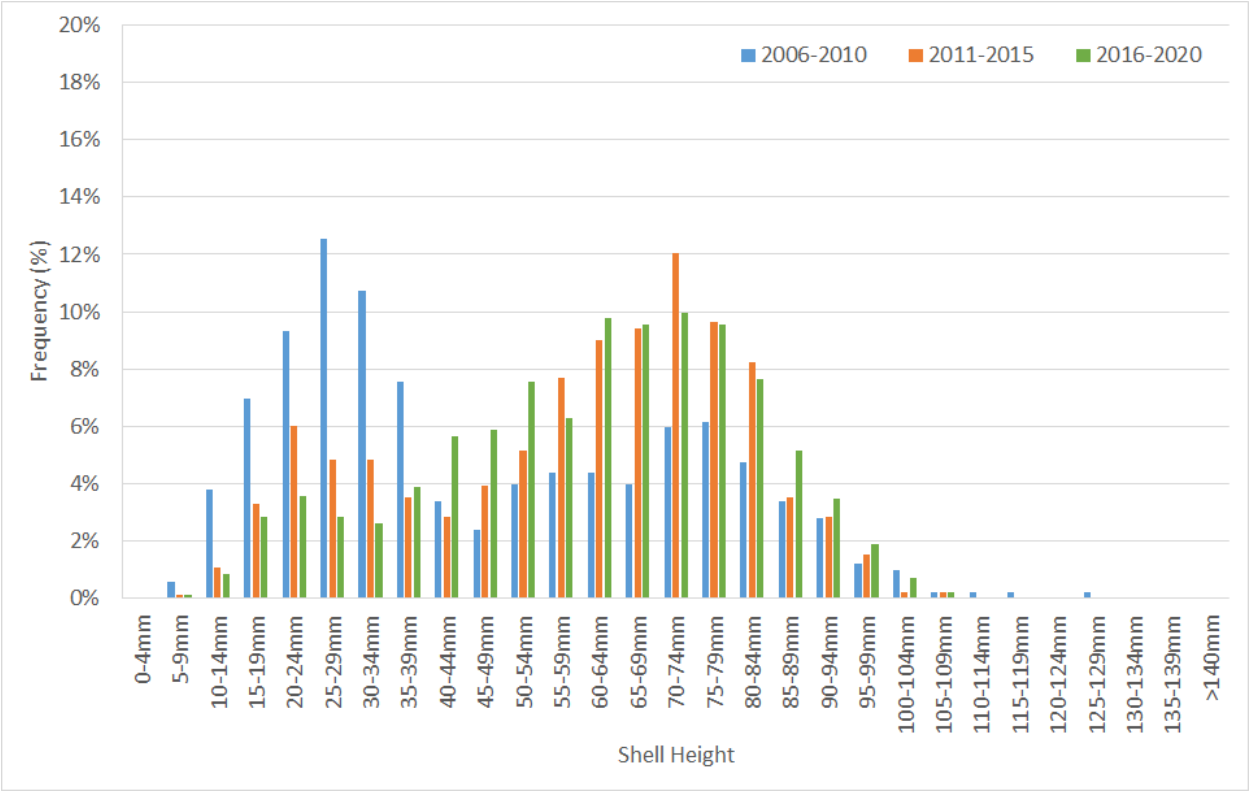


Figure B.33-3. Shell height frequencies of live oysters per bushel of material in NOAA Code292 (Tangier Sound North) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey on Sharkfin Shoal bar.

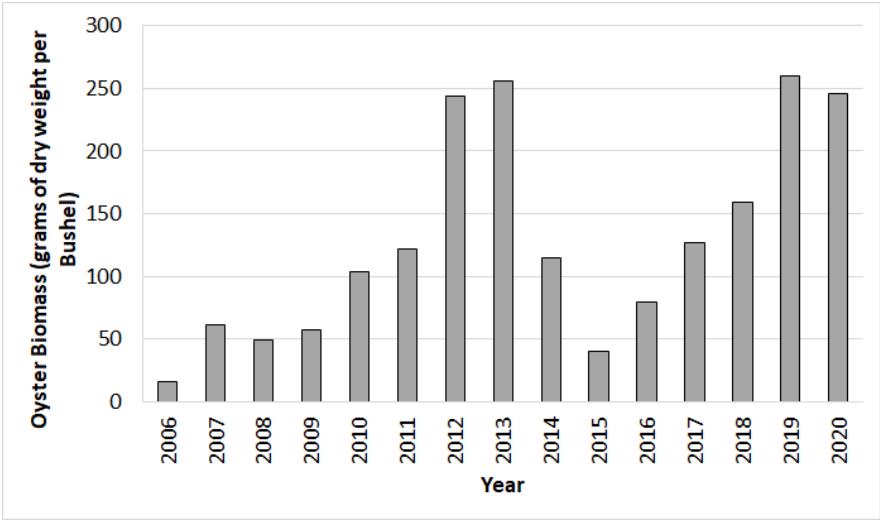


Figure B.33-4. Oyster biomass (grams of dry weight per bushel of material) in NOAA Code 292 (Tangier Sound North) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey on Sharkfin Shoal bar.

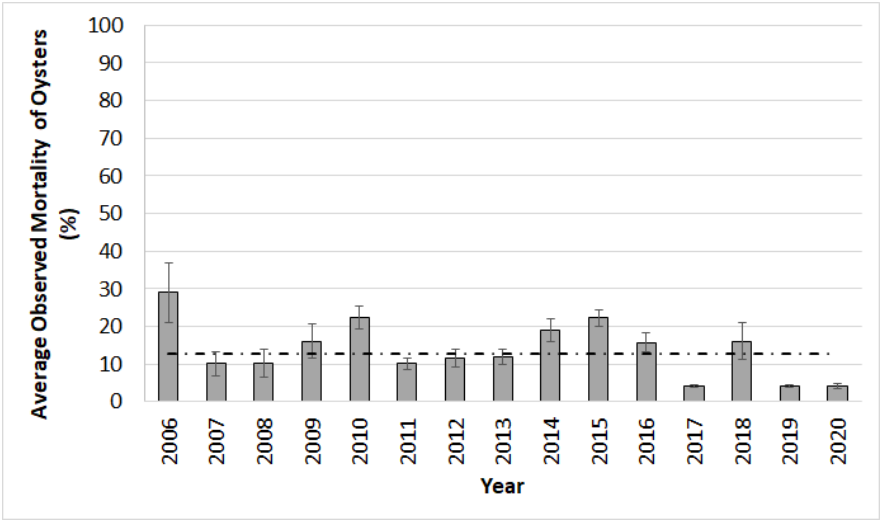


Figure B.33-5. Average annual observed mortality of market-sized and small-sized oysters in NOAA Code 292 (Tangier Sound North) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey. The dashed line represents the 2006-2020 baywide average observed mortality. Error bars represent ± 1 standard error.

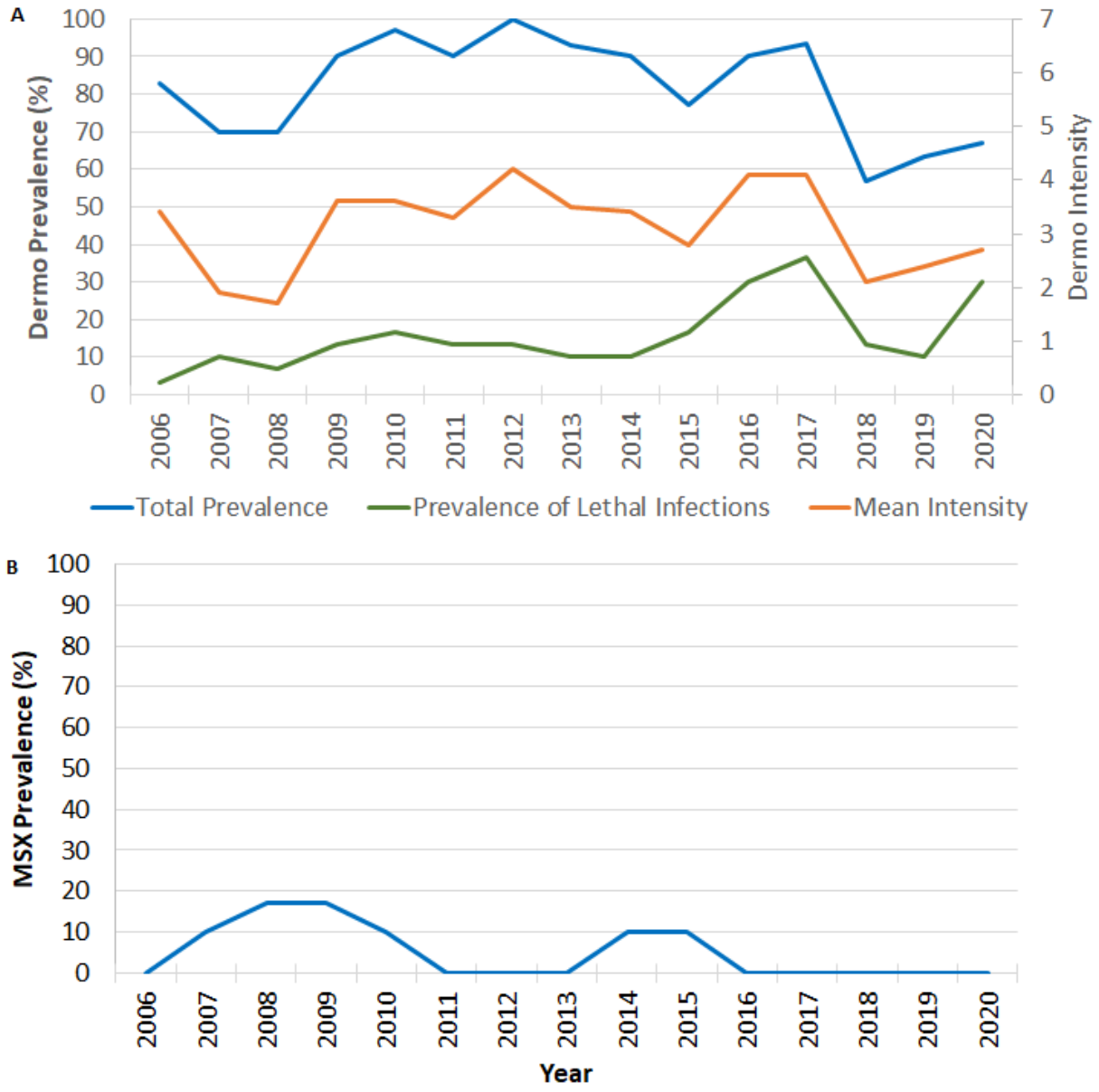


Figure B.33-6. Oyster disease prevalence and intensity in NOAA Code 292 (Tangier Sound North) occurring outside of the current sanctuary area. (A) Dermo prevalence and mean intensity (B) MSX prevalence (intensity is not examined). Data from Maryland's Annual Fall Oyster Dredge Survey on Sharkfin Shoal bar.

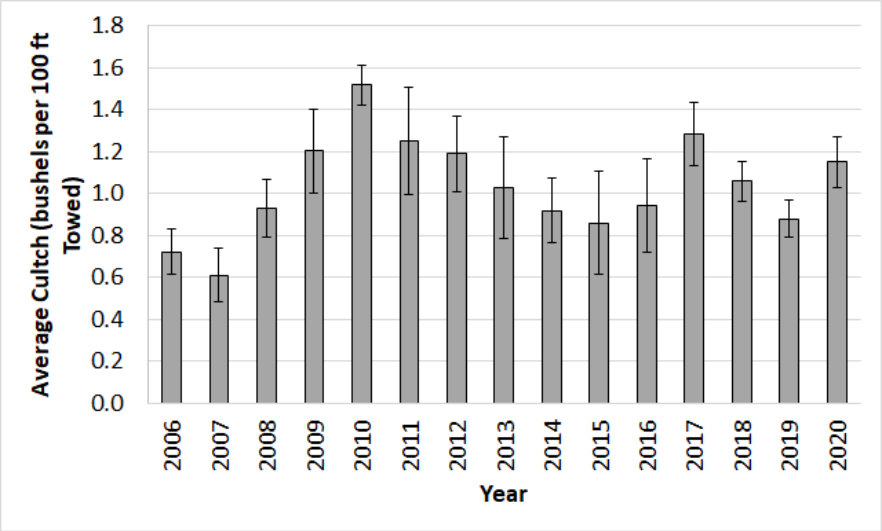


Figure B.33-7. Average cultch (live and dead oysters and loose shell) in NOAA Code 292 (Tangier Sound North) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey. Error bars represent ± 1 standard error.

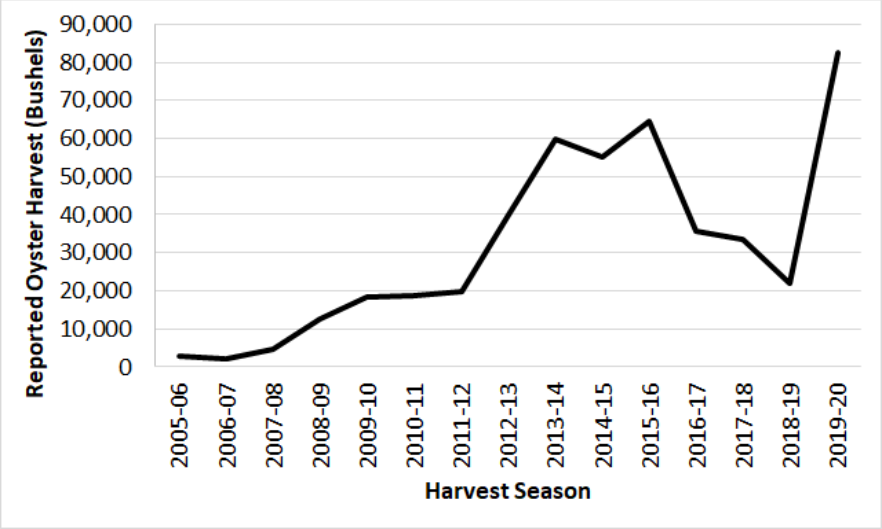


Figure B.33-8. Oyster harvest reported from seafood dealer buy tickets (harvest seasons 2005-2006 to 2019-2020) in NOAA Code 292 (Tangier Sound North). Since 2010, 8% of the NOAA Code area has been a sanctuary where harvest is prohibited.

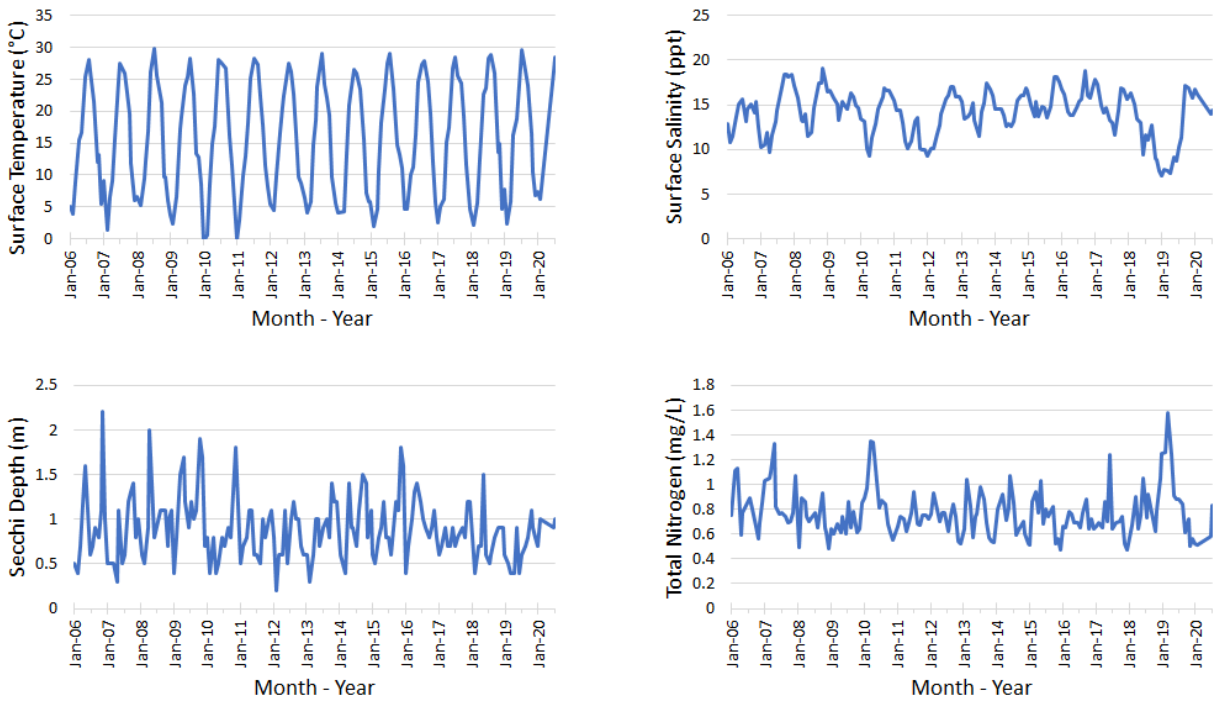


Figure B.33-9. Water quality data collected at Station EE3.1 in NOAA Code 292 (Tangier Sound North). Data from Chesapeake Bay Program Data Hub.

## Section B.34: NOAA Code 331 - Chester River Upper

NOAA Code 331 (Chester River Upper) is 7,204 acres; all of the area is within a current sanctuary boundary. The two sanctuaries are Chester River ORA Zone A (established in 1996) and Upper Chester River (established in 2010). See Appendix A Section A.05 and A.46 for more information on the oyster population characteristics.

## Section B.35: NOAA Code 337 - Choptank River Upper

NOAA Code 337 (Choptank River Upper) is 13,306 acres; all of the area is within a current sanctuary boundary. The two sanctuaries are Choptank River ORA Zone A (established in 1996) and Upper Choptank River (established in 2010). See Appendix A Section A.06 and A.47 for more information on the oyster population characteristics.

## Section B.36: NOAA Code 368 – Patuxent River Upper

NOAA Code 368 consists of the Patuxent River north of Broomes Island and is located in Maryland's mid-western portion of Chesapeake Bay. The entire NOAA Code is 18,153 acres and has 41 historic oyster bars[45]. The Upper Patuxent River Sanctuary encompasses 79% (14,461 total acres) of the NOAA Code. This section focuses on information collected within the NOAA Code occurring outside of the current sanctuary area. This equates to 3,692 surface acres. There are 1,769 acres of historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments) located within the NOAA Code and not within a sanctuary. As of 2020, there are 2,130 acres within the NOAA Code designated as a Public Shellfish Fishery Area (PSFA). Aquaculture leasing is prohibited within PSFA boundaries. This NOAA Code is located within Maryland's low-salinity region (Zone 1).

Information available for this NOAA Code includes:

- NOAA Code map (Figure B.36-1)
- Summary statistics (Table B.36-1)
- Abundance per year (Figure B.36-2)
- Shell height frequencies (Figure B.36-3)
- Biomass per year (Figure B.36-4)
- Observed mortality (Figure B.36-5)
- Dermo and MSX per year (Figure B.36-6)
- Cultch per year (Figure B.36-7)
- Harvest (Figure B.36-8)
- Water Quality (Figure B.36-9)

The Fall Survey has collected one or two samples annually and results indicated no change in market density throughout the time period. Small density increased during the 2016-2020 time period. Spat density increased slightly in 2016-2020 as compared to 2011-2015 but was lower than 2006-2010. Biomass decreased in 2016-2020. Mortality remained around or below the long term baywide average in 2016-2020. Cultch increased in 2016-2020 as compared to the other time periods.

Between 2006 and 2020, approximately 12 thousand bushels of shell and 3 thousand bushels of wild seed were planted to enhance the commercial public fishery in this NOAA Code outside of the current sanctuary area.

Harvest for the NOAA Code has been reported on seafood dealer buy tickets for all years of the 15-year time series. This includes past harvest data from areas in the NOAA Code that are currently in a sanctuary area, but weren't when the harvest occurred prior to the sanctuary being established. Since 2010, 79% of the NOAA Code area has been a sanctuary where harvest is prohibited. Harvest reported ranged from less than 40 bushels in the 2009-10 season to a

[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

maximum of approximately 5 thousand bushels in the 2015-16 season. Diving was used to obtain the majority of the harvest.

Continuous water quality monitoring has occurred at station LE1.1 (38.42535; -76.6018). During the 2006-2020 timeline, surface salinity ranged from 3.4 ppt to 16.6 ppt, with the lowest salinity being during the freshet of 2018-2019 and during the high rainfall year of 2011.

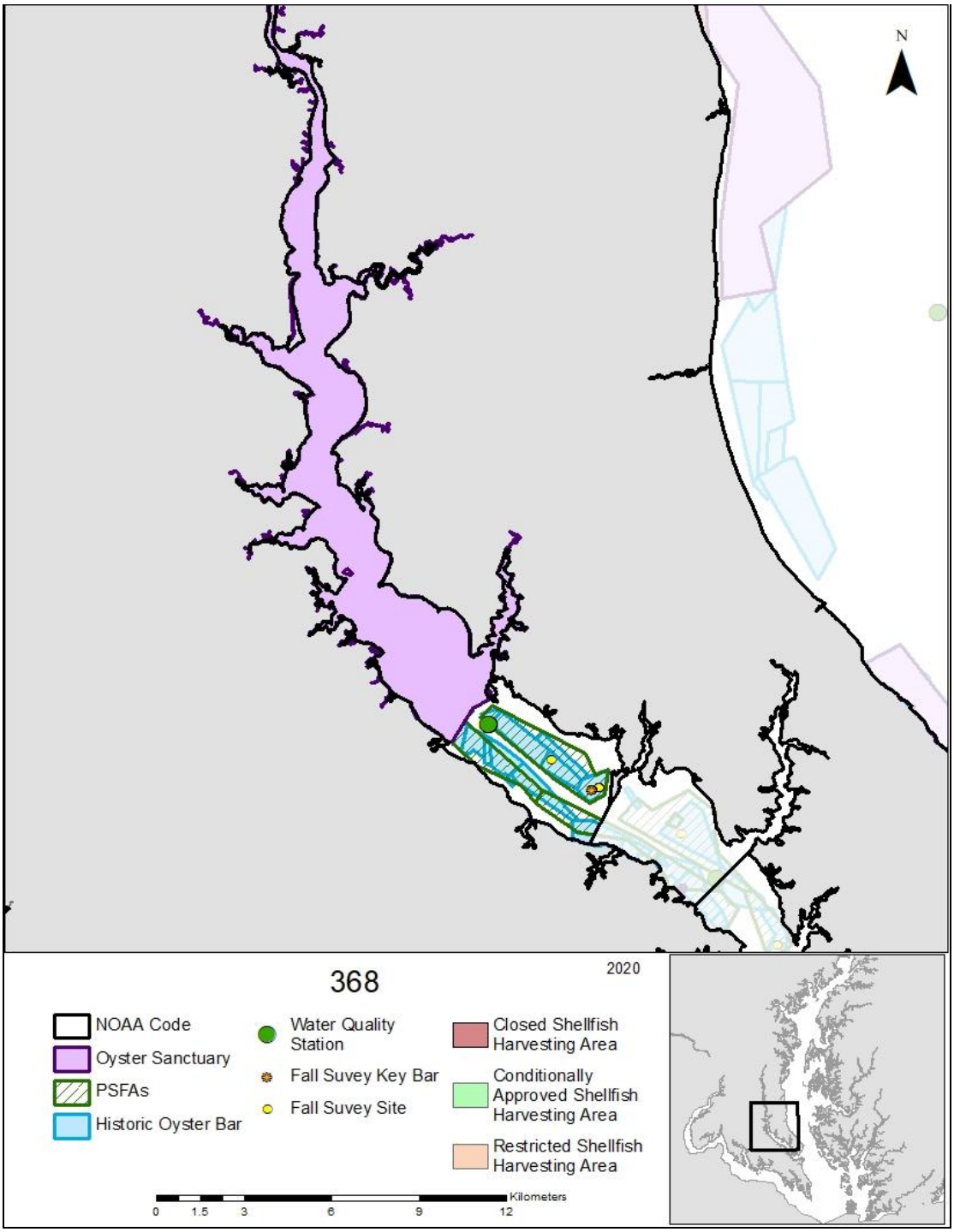


Figure B.36-1. Map of NOAA Code 368 (Patuxent River Upper). Fall Survey sites may not be sampled every year. Fall Survey key bars may consist of a key bar, disease bar or both.

Table B.36-1. Oyster population characteristics based on the Fall Survey in the NOAA Code 368 (Patuxent River Upper) occurring outside of the current sanctuary area. ND = No Data. Values are given as an annual mean ± standard error.

| | 2006-10 | 2011-15 | 2016-20 |
|---|---|---|---|
| Number of Years Sampled / Number of Samples | 5 / 10 | 5 / 7 | 5 / 6 |
| Number of Live Spat Oysters per square meter | 4.6 ± 3.4 | 1.1 ± 0.4 | 2.5 ± 0.9 |
| Number of Live Small-Sized Oysters per square meter | 7.5 ± 1.4 | 9.2 ± 2.6 | 24.9 ± 6.6 |
| Number of Live Market-Sized Oysters per square meter | 12.7 ± 4.7 | 12.9 ± 2.8 | 12.3 ± 3 |
| Live Oyster Biomass (g Dry Weight per Bushel) | 70 ± 29 | 177 ± 46 | 114 ± 19 |
| Observed Mortality (%) | 20 ± 6 | 8 ± 2 | 8 ± 4 |
| Cultch (Bushels per 100 ft Towed) | 0.83 ± 0.09 | 0.51 ± 0.1 | 1.03 ± 0.18 |
| Harvest (Bushels) | 281 ± 62 | 1,385 ± 789 | 2,275 ± 1,066 |
| Note: The number of samples is based on the number of samples having a value for observed mortality. There may be fewer samples per year for density, biomass, and cultch. | | | |

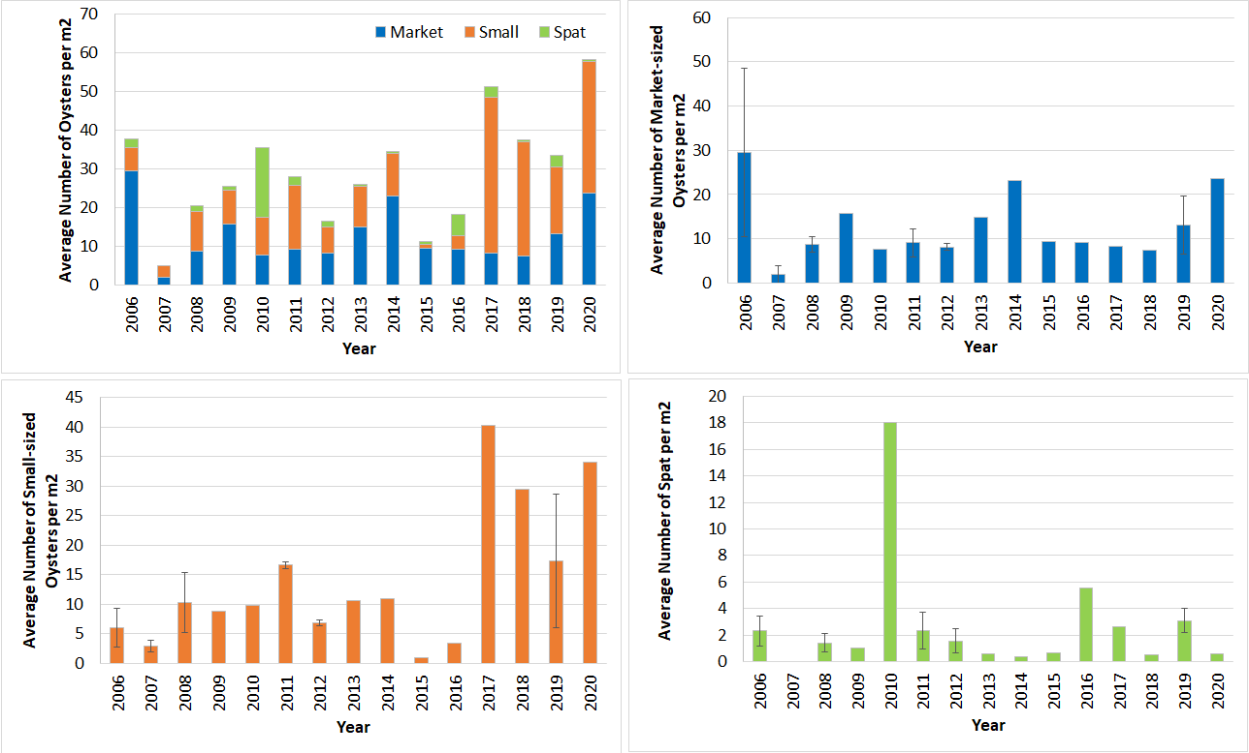


Figure B.36-2. Average number of live oysters per square meter by size class in NOAA Code 368 (Patuxent River Upper) occurring outside of the current sanctuary area. Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales.

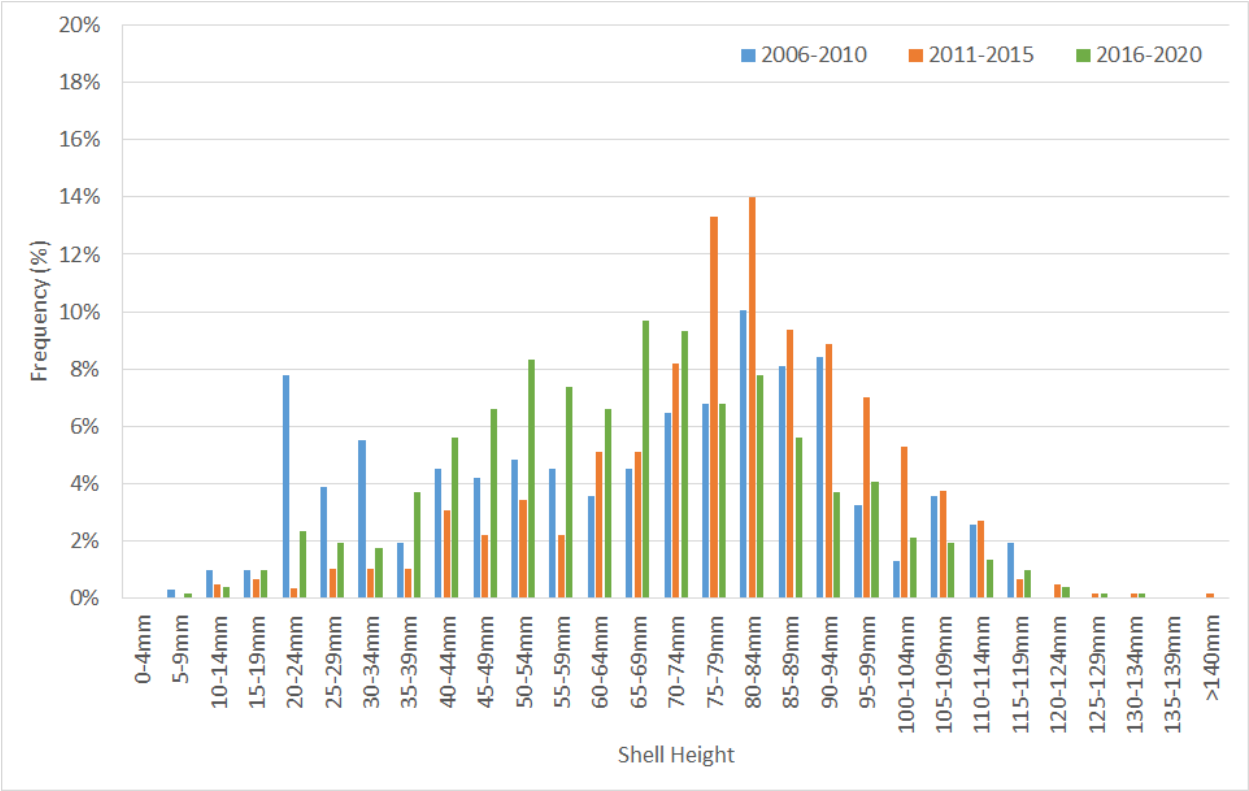


Figure B.36-3. Shell height frequencies of live oysters per bushel of material in NOAA Code 368 (Patuxent River Upper) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey on Broome Island bar.

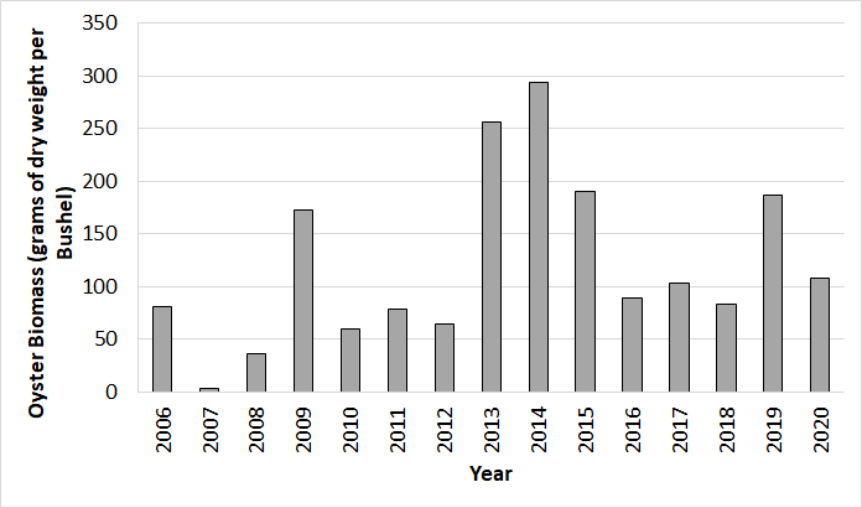


Figure B.36-4. Oyster biomass (grams of dry weight per bushel of material) in NOAA Code 368 (Patuxent River Upper) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey on Broome Island bar.

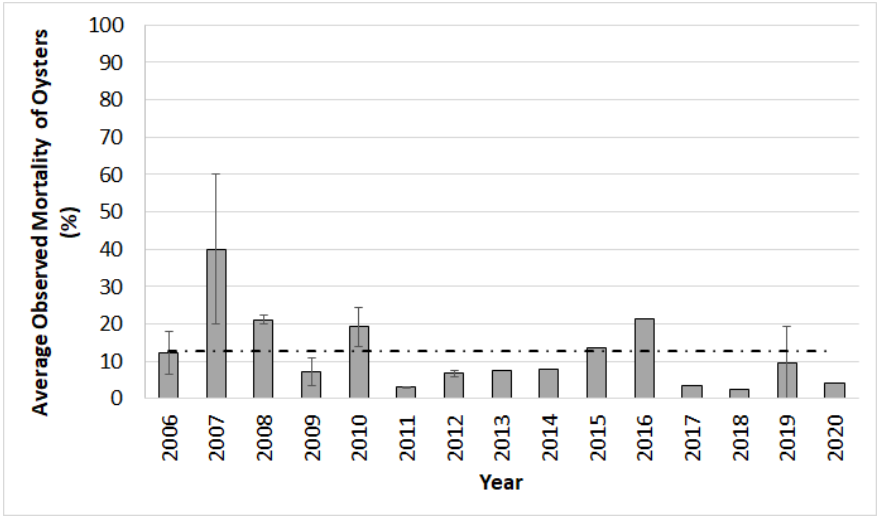


Figure B.36-5. Average annual observed mortality of market-sized and small-sized oysters in NOAA Code 368 (Patuxent River Upper) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey. The dashed line represents the 2006-2020 baywide average observed mortality. Error bars represent ± 1 standard error.

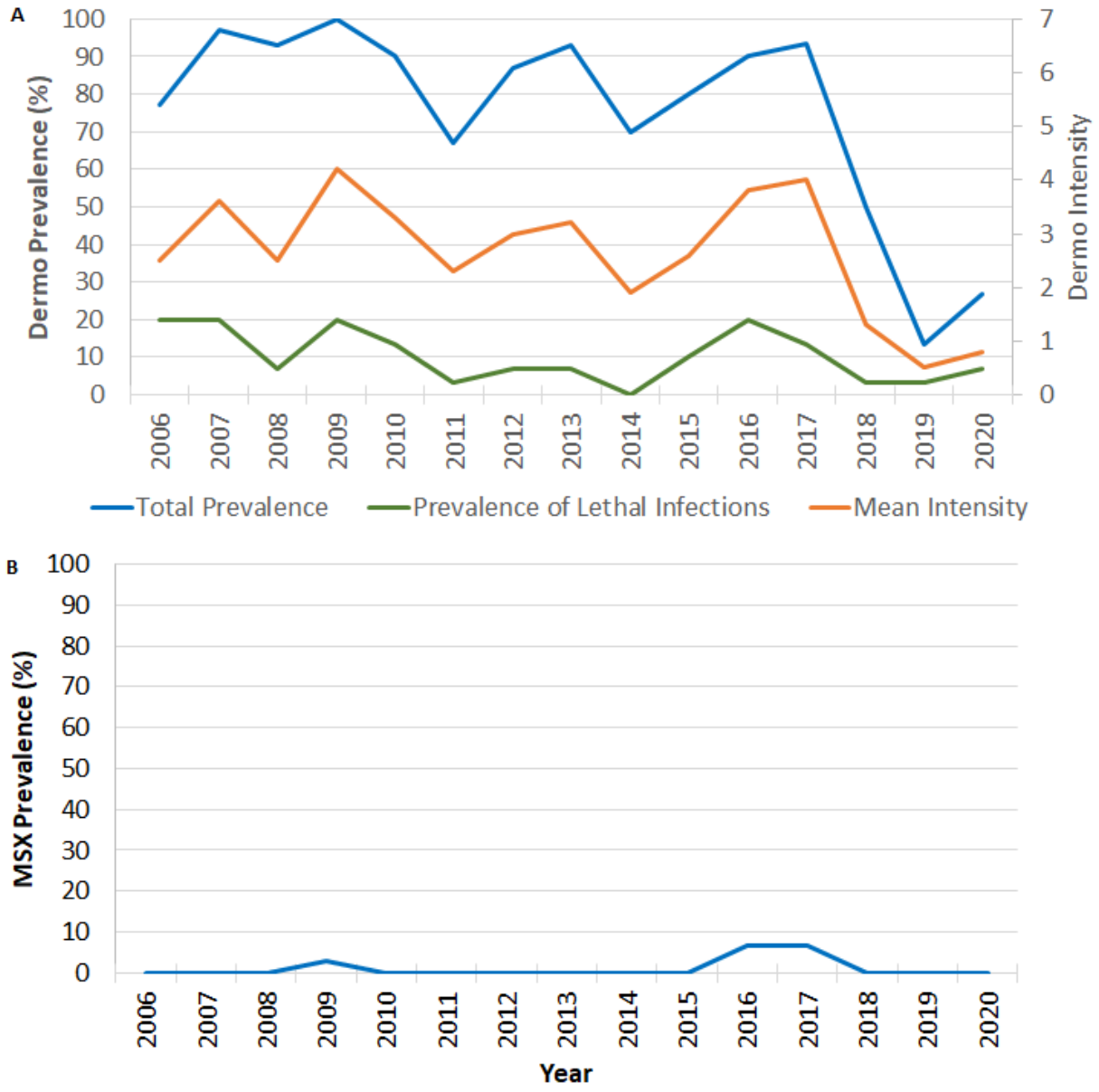


Figure B.36-6. Oyster disease prevalence and intensity in NOAA Code 368 (Patuxent River Upper) occurring outside of the current sanctuary area. (A) Dermo prevalence and mean intensity (B) MSX prevalence (intensity is not examined). Data from Maryland's Annual Fall Oyster Dredge Survey on Broome Island bar.

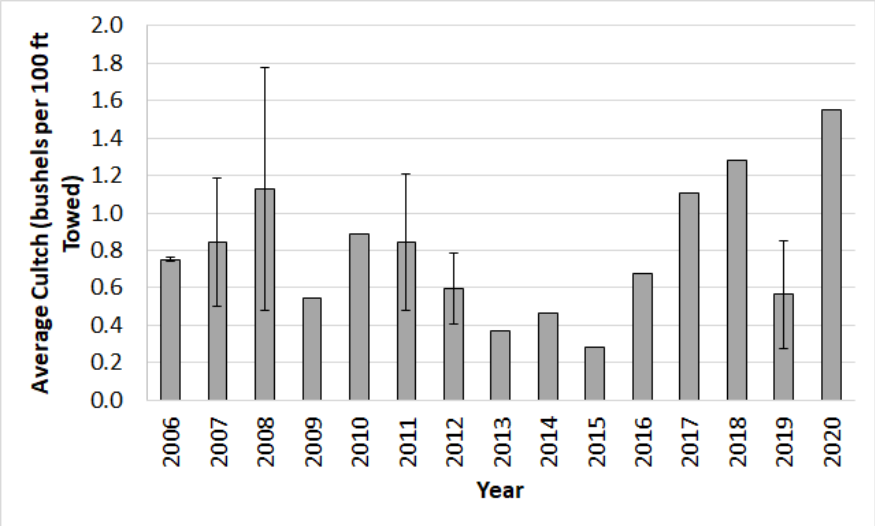


Figure B.36-7. Average cultch (live and dead oysters and loose shell) in NOAA Code 368 (Patuxent River Upper) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey. Error bars represent ± 1 standard error.

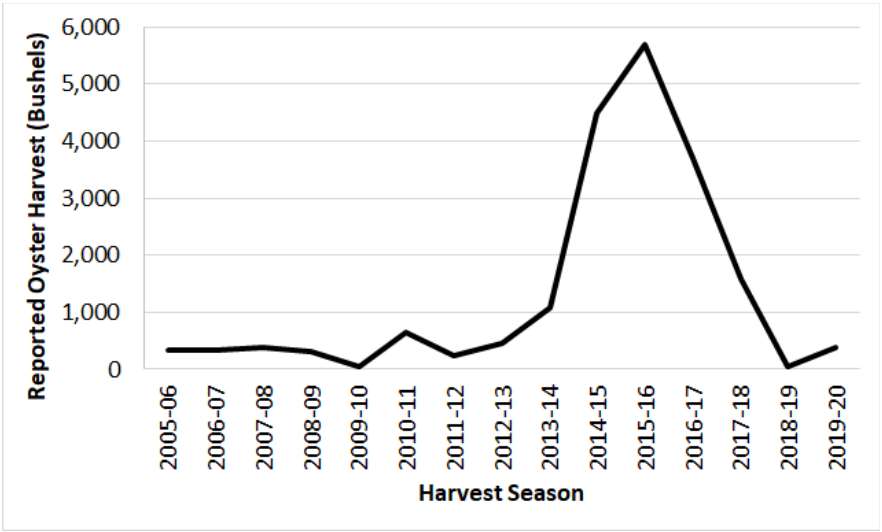


Figure B.36-8. Oyster harvest reported from seafood dealer buy tickets (harvest seasons 2005-2006 to 2019-2020) in NOAA Code 368 (Patuxent River Upper). Since 2010, 79% of the NOAA Code area has been a sanctuary where harvest is prohibited.

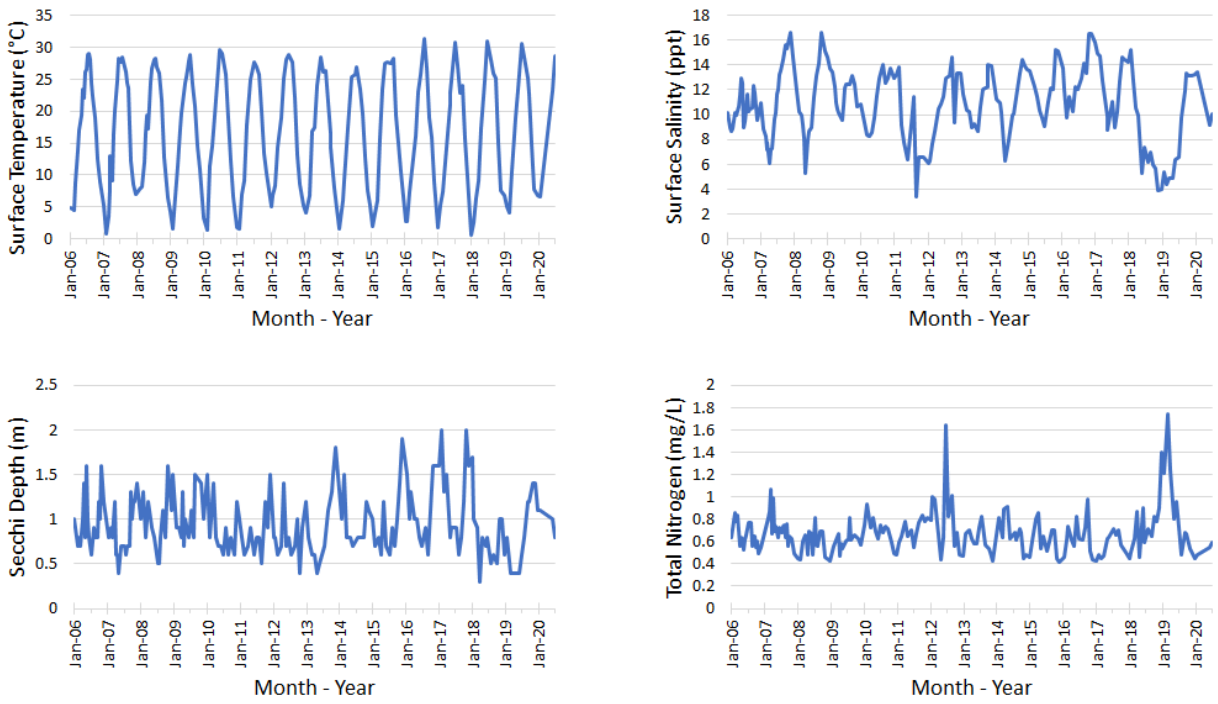


Figure B.36-9. Water quality data collected at Station LE1.1 in NOAA Code 368 (Patuxent River Upper). Data from Chesapeake Bay Program Data Hub.

## Section B.37: NOAA Code 437 – Harris Creek

NOAA Code 437 encompasses Harris Creek, a tributary of the Choptank River, and is located in Maryland's mid-eastern portion of Chesapeake Bay. The entire NOAA Code is 7,176 acres and has 18 historic oyster bars[46]. The Harris Creek Sanctuary encompasses 64% (4,647 acres) of the NOAA Code. This section focuses on information collected within the NOAA Code occurring outside of the current sanctuary area. This equates to 2,529 surface acres. There are 1,506 acres of historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments) located within the NOAA Code and outside the sanctuary. As of 2020, there are 1,823 acres within the NOAA Code designated as a Public Shellfish Fishery Area (PSFA). Aquaculture leasing is prohibited within PSFA boundaries. This NOAA Code is located within Maryland's medium-salinity region (Zone 2).

Information available for this NOAA Code includes:

- NOAA Code map (Figure B.37-1)
- Summary statistics (Table B.37-1)
- Abundance per year (Figure B.37-2)
- Shell height frequencies (Figure B.37-3)
- Biomass per year (Figure B.37-4)
- Observed mortality (Figure B.37-5)
- Dermo and MSX per year (Figure B.37-6)
- Cultch per year (Figure B.37-7)
- Harvest (Figure B.37-8)

Fall Survey results indicated that, while spat density was stable from 2011-2015 to 2016-2020, densities of small and markets decreased. However, small and market densities were still higher than the average in 2006-2010. Biomass increased in 2016-2020 compared to the previous time periods. Mortality was higher in 2016-2020 but below the long term baywide average. Cultch decreased in 2016-2020 compared to both 2011-2015 and 2006-2010.

Between 2006 and 2020, approximately 29 thousand bushels of shell were planted to enhance the commercial public fishery in this NOAA Code outside of the current sanctuary area.

Harvest for the NOAA Code has been reported on seafood dealer buy tickets for all years of the 15-year time series. This includes past harvest data from areas in the NOAA Code that are currently in a sanctuary area, but weren't when the harvest occurred prior to the sanctuary being established. Since 2010, 64% of the NOAA Code area has been a sanctuary where harvest is prohibited. Harvest reported ranged from about 135 bushels in the 2009-10 season to a maximum of approximately 8 thousand bushels in the 2014-15 season. Power dredging was used to obtain the majority of the harvest.

We are unaware of any continuous water quality monitoring in this area.

[46] 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

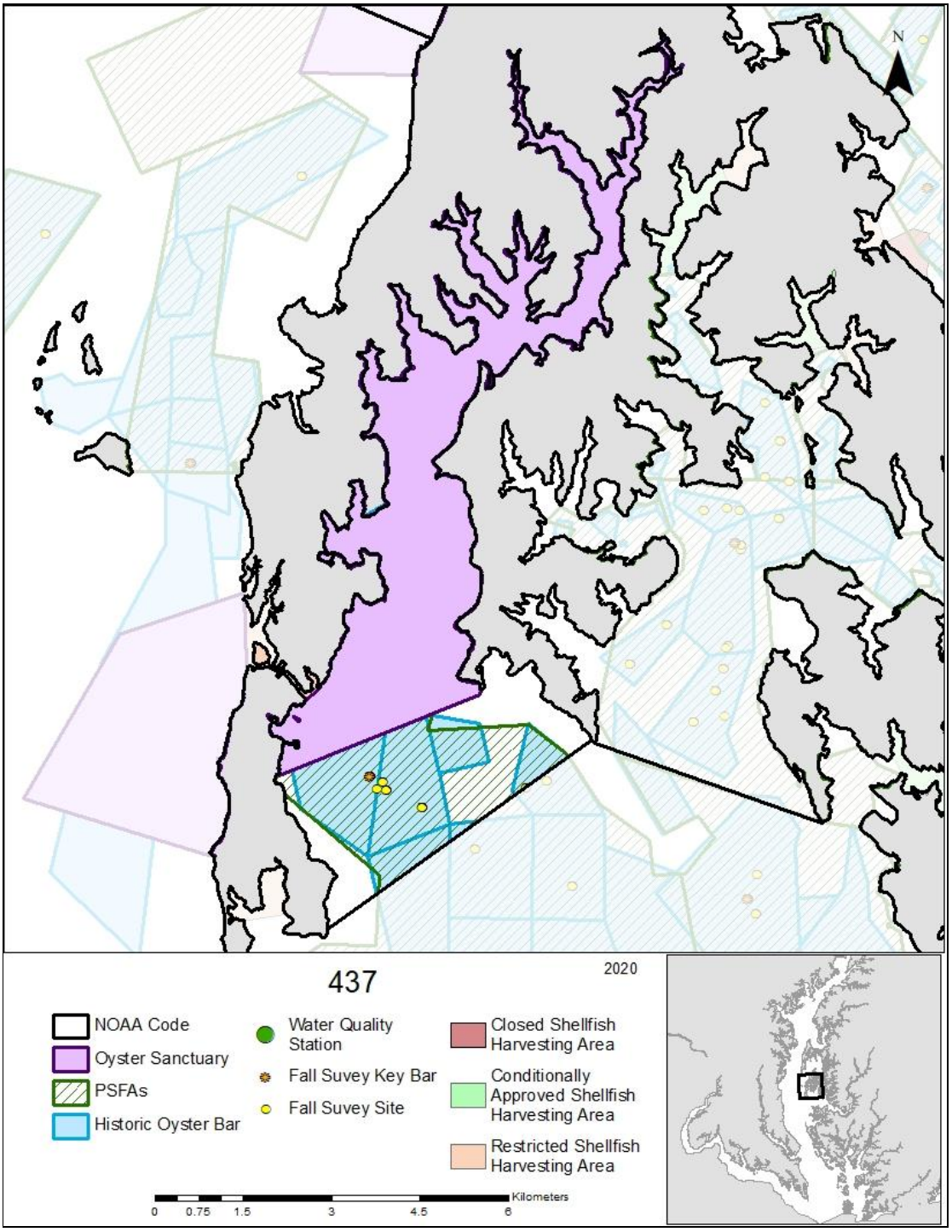


Figure B.37-1. Map of NOAA Code 437 (Harris Creek). Fall Survey sites may not be sampled every year. Fall Survey key bars may consist of a key bar, disease bar or both.

Table B.37-1. Oyster population characteristics based on the Fall Survey in the NOAA Code 437 (Harris Creek) occurring outside of the current sanctuary area. ND = No Data. Values are given as an annual mean ± standard error.

| | 2006-10 | 2011-15 | 2016-20 |
|---|---|---|---|
| Number of Years Sampled / Number of Samples | 5 / 17 | 5 / 15 | 5 / 18 |
| Number of Live Spat Oysters per square meter | 8.3 ± 5.6 | 16 ± 8.3 | 12.2 ± 6.8 |
| Number of Live Small-Sized Oysters per square meter | 11.9 ± 2.2 | 42 ± 7.6 | 19.9 ± 5.3 |
| Number of Live Market-Sized Oysters per square meter | 9.3 ± 1.7 | 29.6 ± 7.4 | 11.3 ± 1.6 |
| Live Oyster Biomass (g Dry Weight per Bushel) | 71 ± 14 | 209 ± 41 | 271 ± 41 |
| Observed Mortality (%) | 5 ± 2 | 3 ± 1 | 9 ± 2 |
| Cultch (Bushels per 100 ft Towed) | 0.57 ± 0.07 | 0.63 ± 0.11 | 0.29 ± 0.05 |
| Harvest (Bushels) | 2,975 ± 926 | 3,558 ± 1,201 | 4,985 ± 823 |
| Note: The number of samples is based on the number of samples having a value for observed mortality. There may be fewer samples per year for density, biomass, and cultch. | | | |

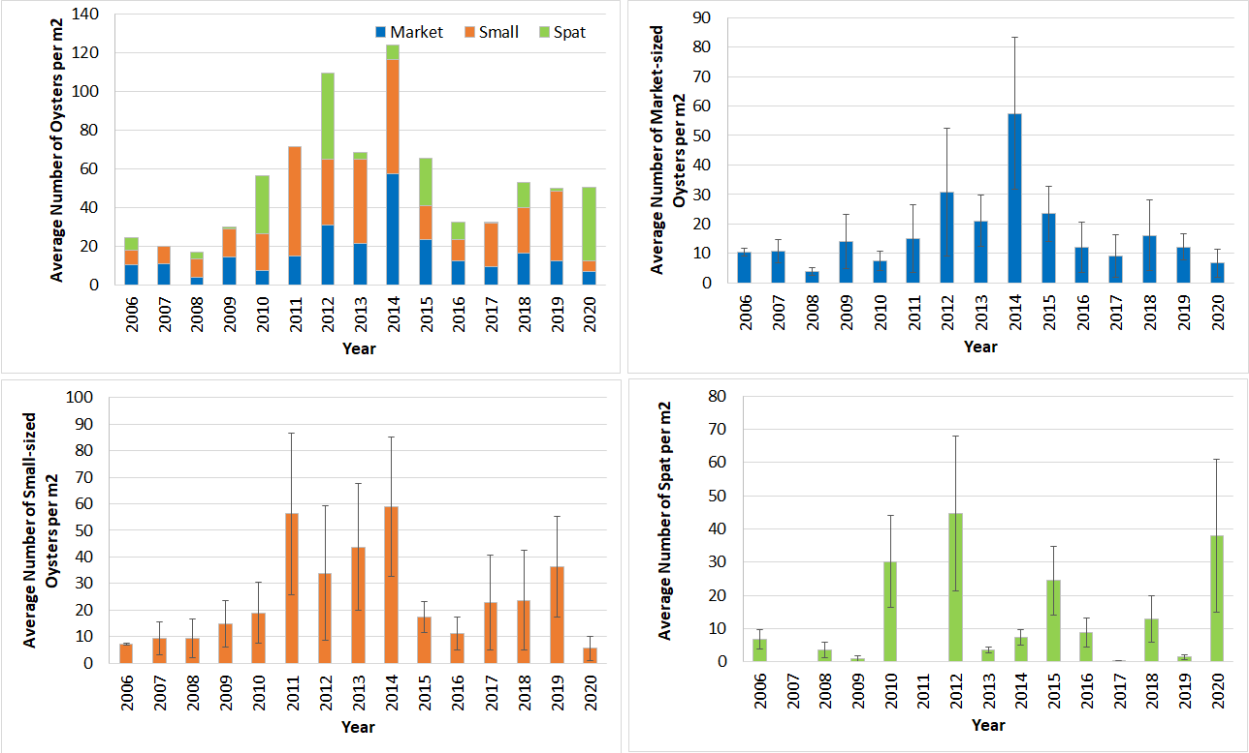


Figure B.37-2. Average number of live oysters per square meter by size class in NOAA Code 437 (Harris Creek) occurring outside of the current sanctuary area. Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales.

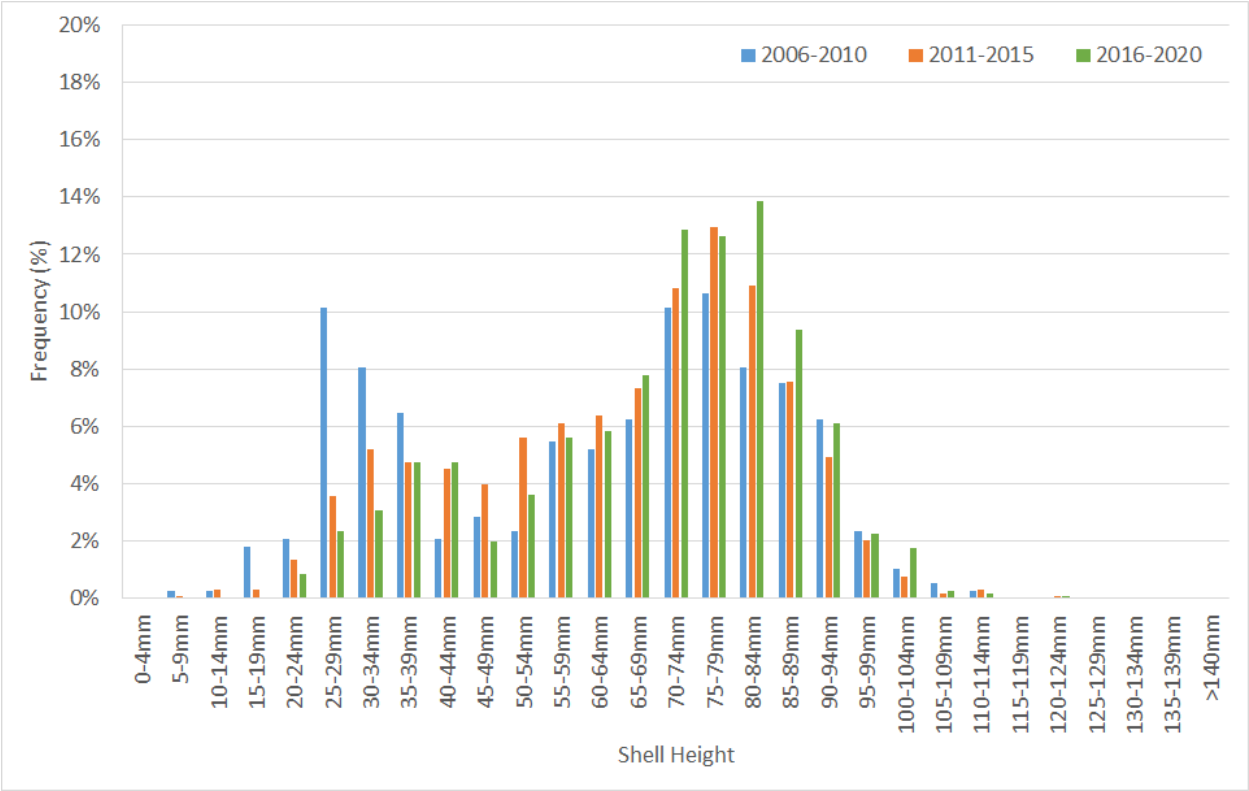


Figure B.37-3. Shell height frequencies of live oysters per bushel of material in NOAA Code 437 (Harris Creek) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey on Tilghman Wharf bar.

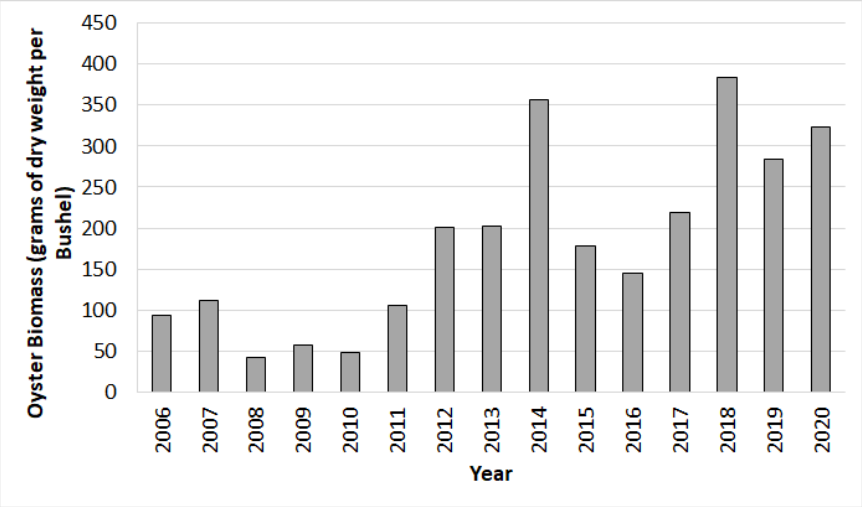


Figure B.37-4. Oyster biomass (grams of dry weight per bushel of material) in NOAA Code 437 (Harris Creek) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey on Tilghman Wharf bar.

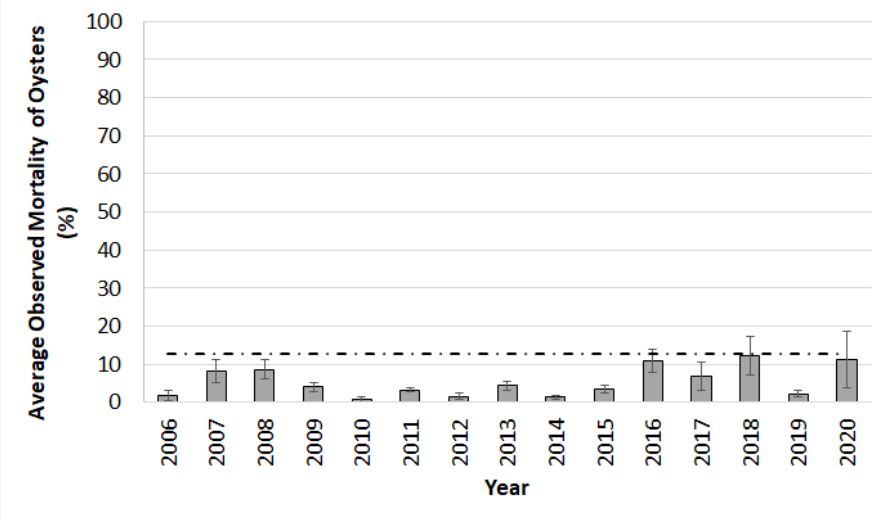


Figure B.37-5. Average annual observed mortality of market-sized and small-sized oysters in NOAA Code 437 (Harris Creek) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey. The dashed line represents the 2006-2020 baywide average observed mortality. Error bars represent ± 1 standard error.

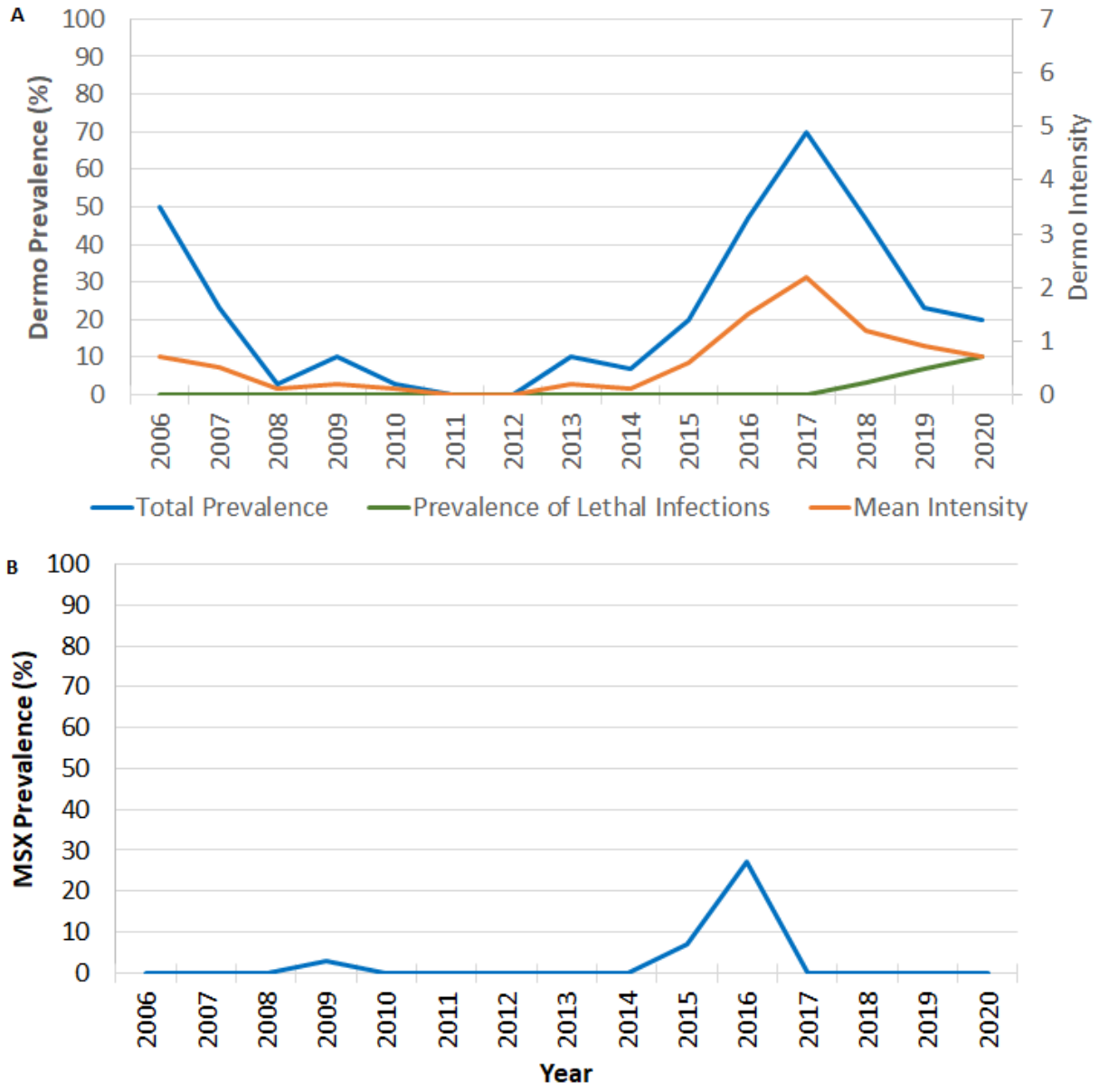


Figure B.37-6. Oyster disease prevalence and intensity in NOAA Code 437 (Harris Creek) occurring outside of the current sanctuary area. (A) Dermo prevalence and mean intensity (B) MSX prevalence (intensity is not examined). Data from Maryland's Annual Fall Oyster Dredge Survey on Tilghman Wharf bar.

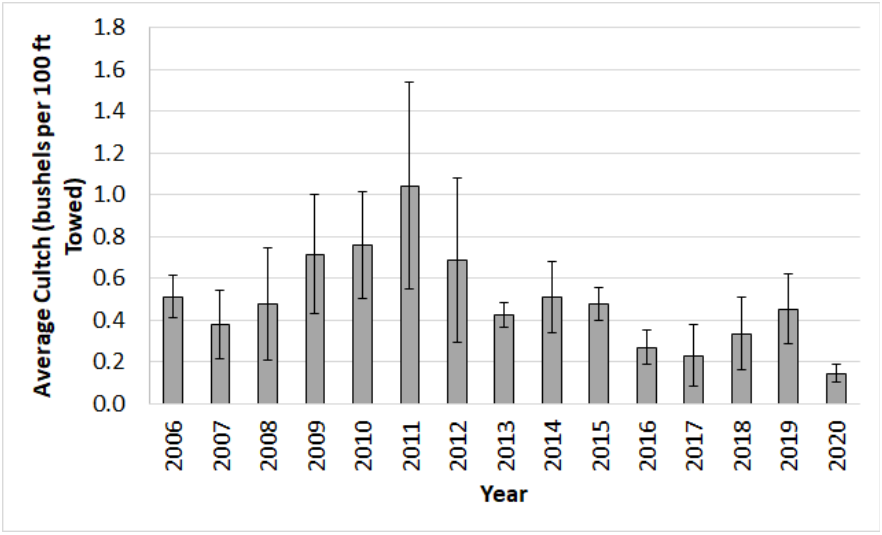


Figure B.37-7. Average cultch (live and dead oysters and loose shell) in NOAA Code 437 (Harris Creek) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey. Error bars represent ± 1 standard error.

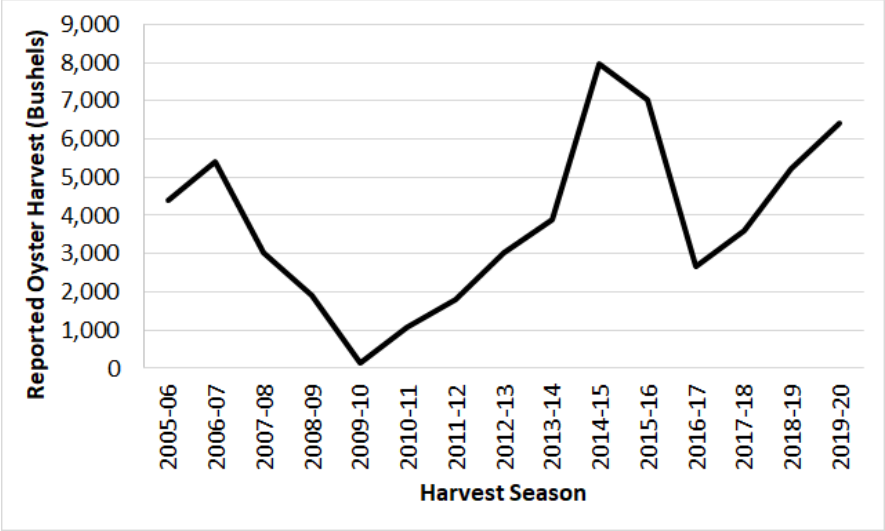


Figure B.37-8. Oyster harvest reported from seafood dealer buy tickets (harvest seasons 2005-2006 to 2019-2020) in NOAA Code 437 (Harris Creek). Since 2010, 64% of the NOAA Code area has been a sanctuary where harvest is prohibited.

## Section B.38: NOAA Code 537 – Broad Creek

NOAA Code 537 encompasses Broad Creek and is located in Maryland's mid-eastern portion of Chesapeake Bay as a tributary to the Choptank River. The entire NOAA Code is 7,747 acres and has 23 historic oyster bars[47]. There are 2,760 acres of historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments) located within the NOAA Code. None of the area within the NOAA Code is an oyster sanctuary. As of 2020, there are 5,391 acres within the NOAA Code designated as a Public Shellfish Fishery Area (PSFA). Aquaculture leasing is prohibited within PSFA boundaries. This NOAA Code is generally located within Maryland's medium-salinity region (Zone 2).

Information available for this NOAA Code includes:

- NOAA Code map (Figure B.38-1)
- Summary statistics (Table B.38-1)
- Abundance per year (Figure B.38-2)
- Shell height frequencies (Figure B.38-3)
- Biomass per year (Figure B.38-4)
- Observed mortality (Figure B.38-5)
- Dermo and MSX per year (Figure B.38-6)
- Cultch per year (Figure B.38-7)
- Harvest (Figure B.38-8)

Fall Survey results indicated that while biomass and market density remained constant from 2011-2015 to 2016-2020, cultch, spat density and small density increased in 2016-2020. Trends in spat density were driven by the 2020 high spatset. Mortality remained below the long term baywide average.

Between 2006 and 2020, approximately 411 thousand bushels of shell, 53 thousand bushels of wild seed and 19 million hatchery spat-on-shell were planted to enhance the commercial public fishery in this NOAA Code outside of the current sanctuary area.

Harvest for the NOAA Code has been reported on seafood dealer buy tickets for all years out of the 15-year time series. Harvest reported ranged from about 2 thousand bushels in the 2009-10 season to a maximum of approximately 77 thousand bushels in the 2013-14 season. Hand tonging was used to obtain 70% of the harvest and power dredging 30% of the harvest.

We are unaware of any continuous water quality monitoring in this area.

[47] 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

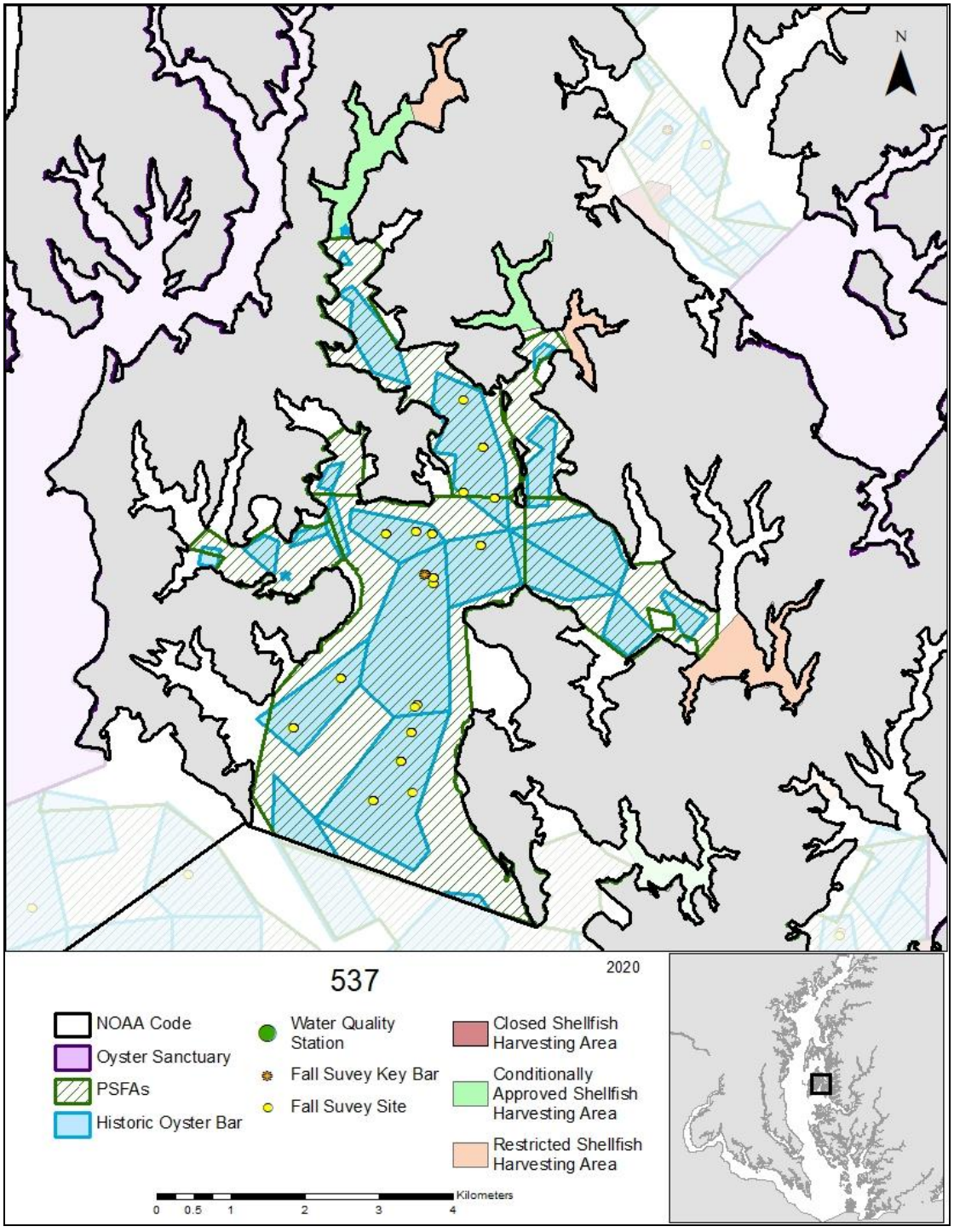


Figure B.38-1. Map of NOAA Code 537 (Broad Creek). Fall Survey sites may not be sampled every year. Fall Survey key bars may consist of a key bar, disease bar or both.

| Table B.38-1. Oyster population characteristics based on the Fall Survey in the NOAA Code 537 (Broad Creek). ND = No Data. Values are given as an annual mean ± standard error. | | | |
|---|---|---|---|
| | **2006-10** | **2011-15** | **2016-20** |
| Number of Years Sampled / Number of Samples | 5 / 57 | 5 / 59 | 5 / 60 |
| Number of Live Spat Oysters per square meter | 42.6 ± 18 | 71.4 ± 59 | 310.7 ± 235.9 |
| Number of Live Small-Sized Oysters per square meter | 103.7 ± 44.8 | 160.4 ± 25.1 | 239.1 ± 35.3 |
| Number of Live Market-Sized Oysters per square meter | 41.2 ± 9.7 | 80.3 ± 12.4 | 77.5 ± 12.5 |
| Live Oyster Biomass (g Dry Weight per Bushel) | 189 ± 36 | 385 ± 34 | 381 ± 19 |
| Observed Mortality (%) | 7 ± 2 | 5 ± 1 | 5 ± 2 |
| Cultch (Bushels per 100 ft Towed) | 1.24 ± 0.1 | 1.23 ± 0.09 | 1.58 ± 0.08 |
| Harvest (Bushels) | 19,332 ± 9,172 | 4,6042 ± 15,373 | 40,871 ± 6,899 |
| Note: The number of samples is based on the number of samples having a value for observed mortality. There may be fewer samples per year for density, biomass, and cultch. | | | |

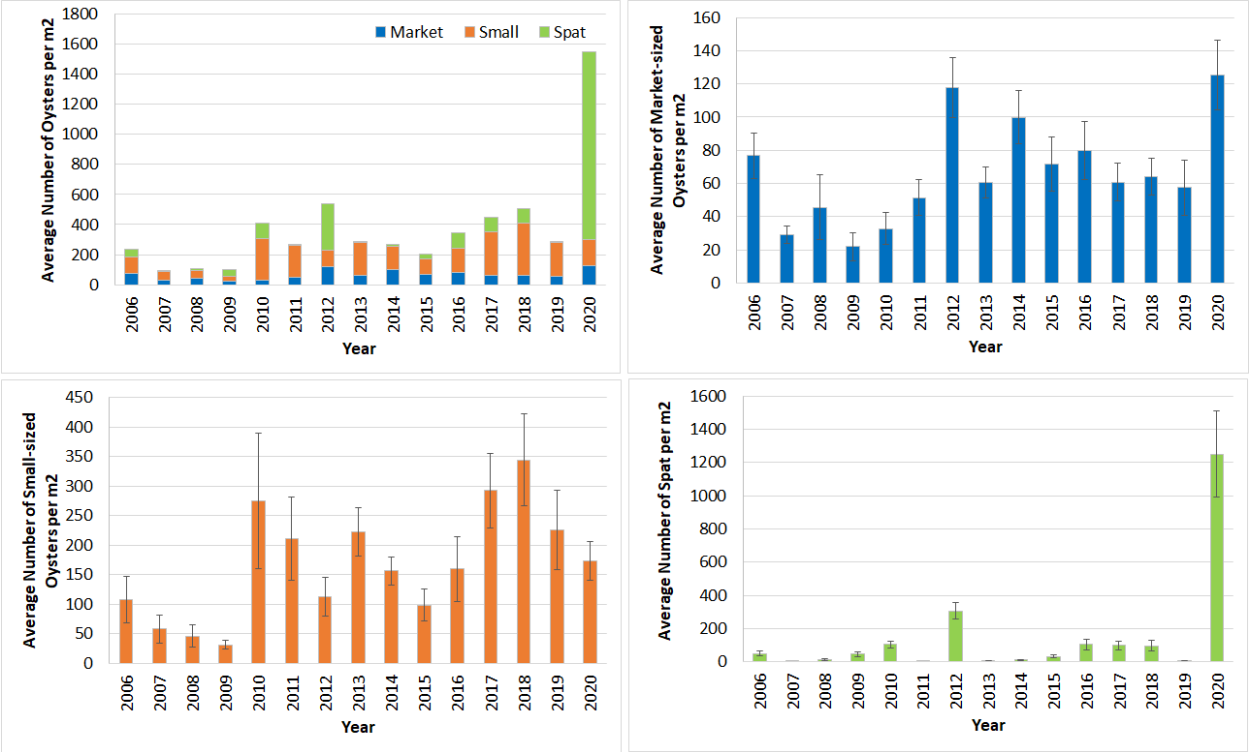


Figure B.38-2. Average number of live oysters per square meter by size class in NOAA Code 537 (Broad Creek). Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales.

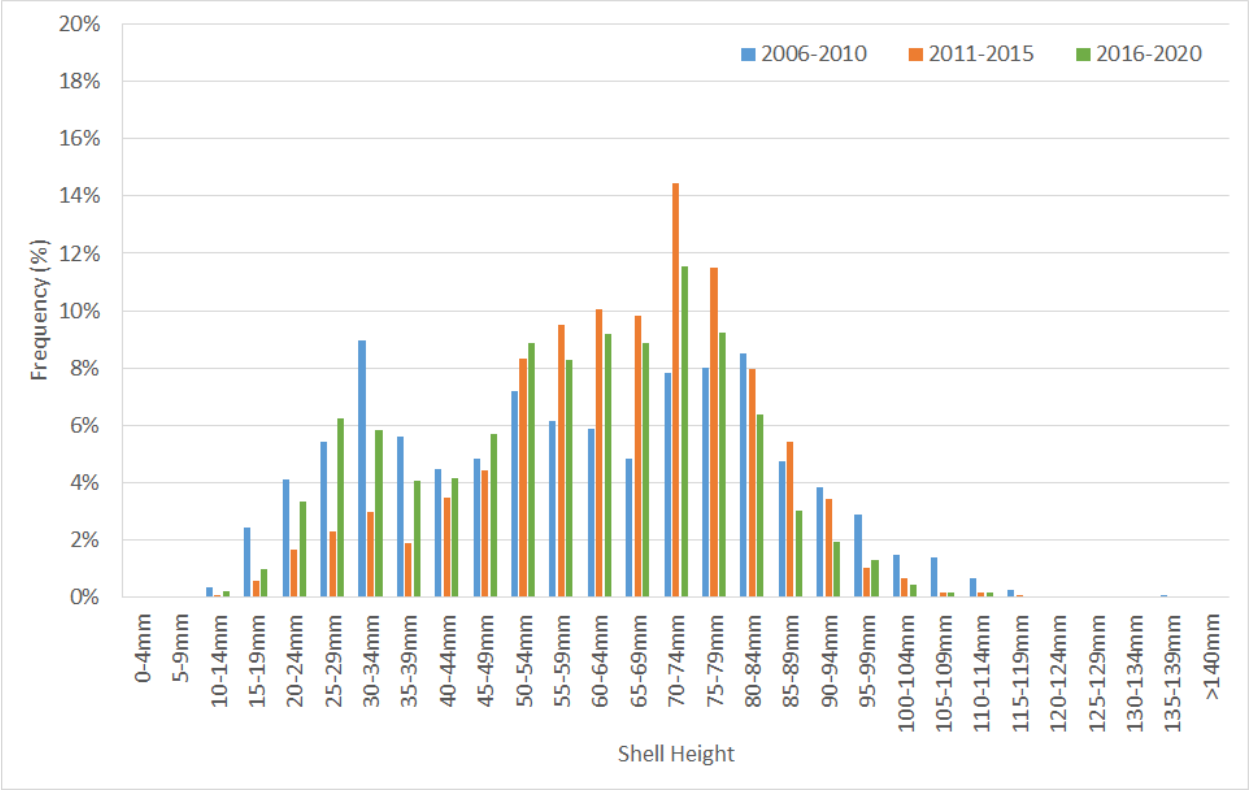


Figure B.38-3. Shell height frequencies of live oysters per bushel of material in NOAA Code 537 (Broad Creek). Data from Maryland's Annual Fall Oyster Dredge Survey on Deep Neck bar.

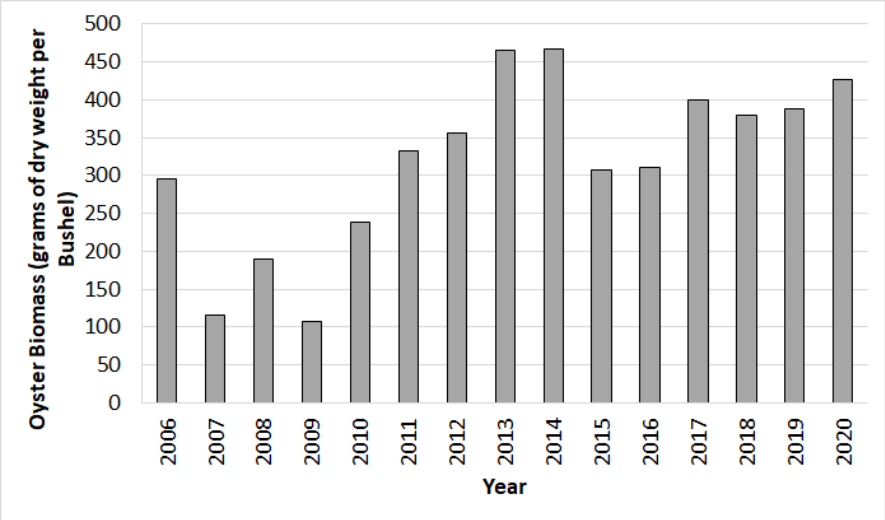


Figure B.38-4. Oyster biomass (grams of dry weight per bushel of material) in NOAA Code 537 (Broad Creek). Data from Maryland's Annual Fall Oyster Dredge Survey on Deep Neck bar.

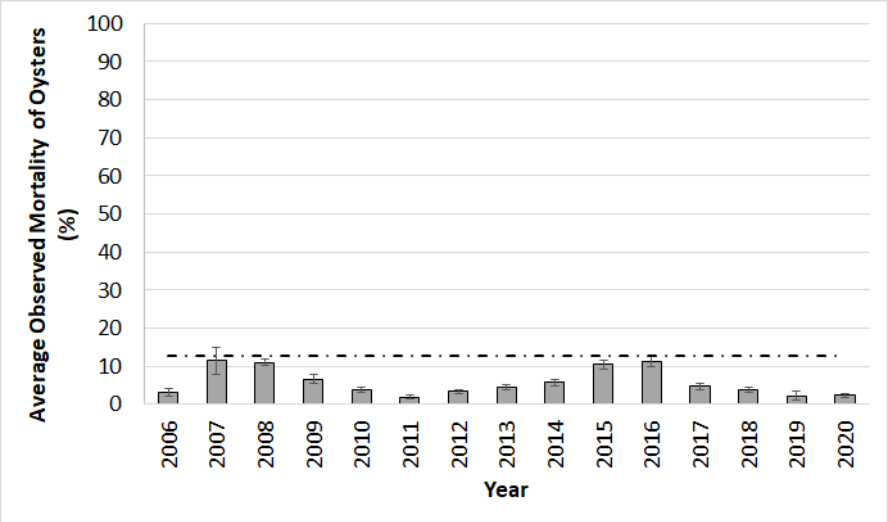


Figure B.38-5. Average annual observed mortality of market-sized and small-sized oysters in NOAA Code 537 (Broad Creek). Data from Maryland's Annual Fall Oyster Dredge Survey. The dashed line represents the 2006-2020 baywide average observed mortality. Error bars represent ± 1 standard error.

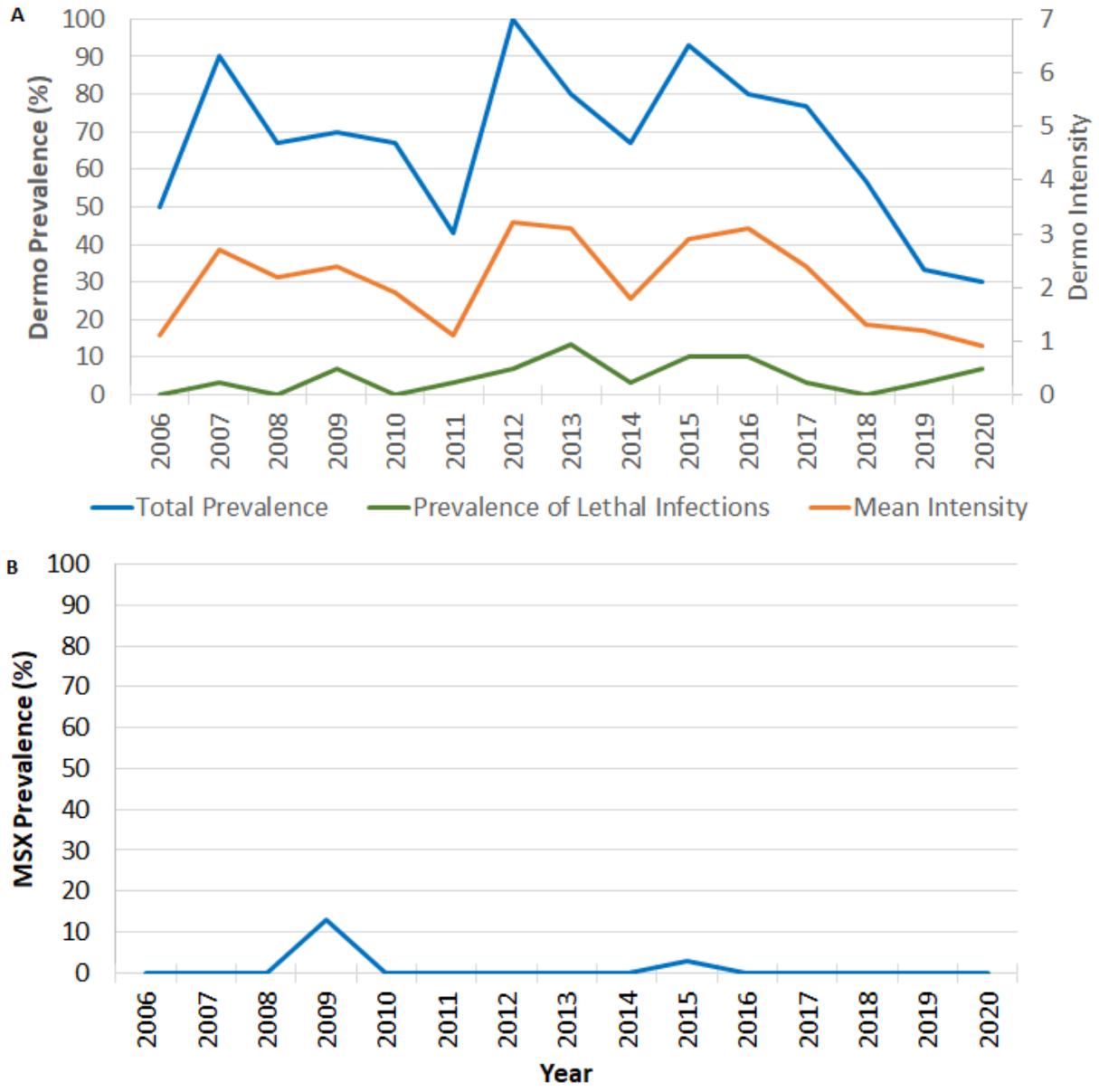


Figure B.38-6. Oyster disease prevalence and intensity in NOAA Code 537 (Broad Creek). (A) Dermo prevalence and mean intensity (B) MSX prevalence (intensity is not examined). Data from Maryland's Annual Fall Oyster Dredge Survey on Deep Neck bar.

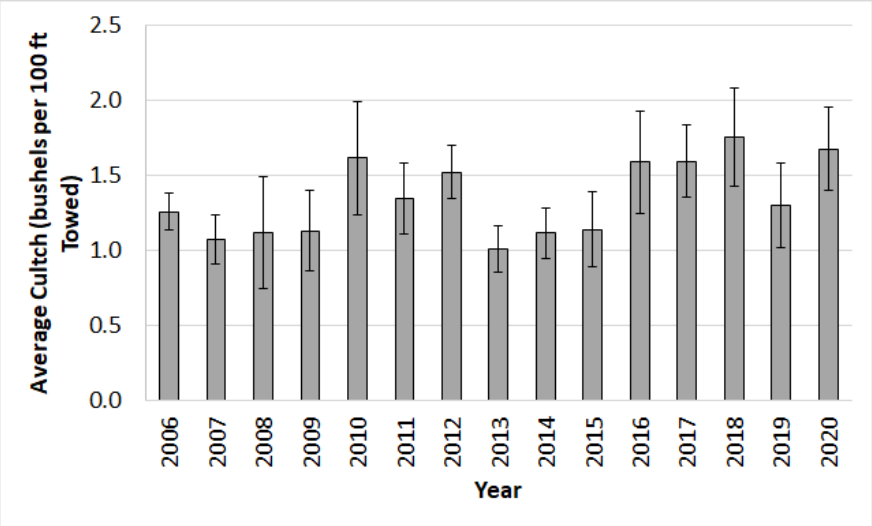


Figure B.38-7. Average cultch (live and dead oysters and loose shell) in NOAA Code 537 (Broad Creek). Data from Maryland's Annual Fall Oyster Dredge Survey. Error bars represent ± 1 standard error.

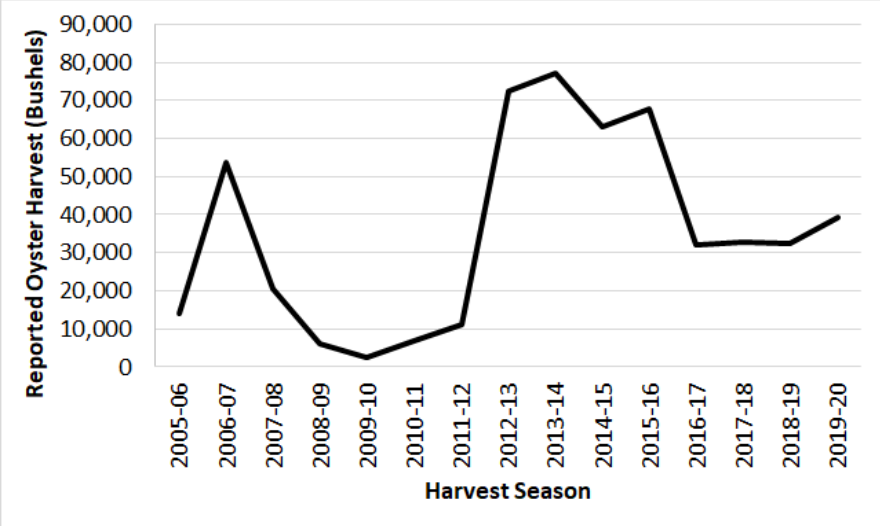


Figure B.38-8. Oyster harvest reported from seafood dealer buy tickets (harvest seasons 2005-2006 to 2019-2020) in NOAA Code 537 (Broad Creek).

## Section B.39: NOAA Code 637 – Tred Avon River

NOAA Code 637 encompasses the Tred Avon River and is located in Maryland's mid-eastern portion of Chesapeake Bay. The entire NOAA Code is 6,497 acres and 34 historic oyster bars[48], of which 64% (4,184 total acres) falls within the Tred Avon River and Oxford Sanctuaries. This section focuses on information collected within the NOAA Code occurring outside of the current sanctuary areas. This equates to 2,313 surface acres. There are 1,304 acres of historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments) located within the NOAA Code that are not within a sanctuary. As of 2020, there are 1,683 acres within the NOAA Code designated as a Public Shellfish Fishery Area (PSFA). Aquaculture leasing is prohibited within PSFA boundaries. The non-sanctuary portion of this NOAA Code is located within Maryland's medium-salinity region (Zone 2).

Information available for this NOAA Code includes:

- NOAA Code map (Figure B.39-1)
- Summary statistics (Table B.39-1)
- Abundance per year (Figure B.39-2)
- Observed mortality (Figure B.39-3)
- Cultch per year (Figure B.39-4)
- Harvest (Figure B.39-5)

Fall Survey results indicated that small and market sized oyster densities decreased slightly in 2016-2020 compared to the 2011-2015 time period; however, it was still above the 2006-2010 time period. Spat density increased during the 2016-2020 time period and, even without the one sample taken on a hatchery spat-on-shell planting in 2020, spat density was double the 2015-2019 average. This is due to the high natural spatfall in 2020. Mortality continued to be around or below the long-term average during 2016-2020.

Between 2006 and 2020, approximately 5 thousand bushels of wild seed and 15 million hatchery spat-on-shell were planted to enhance the commercial public fishery in this NOAA Code outside of the current sanctuary area.

Harvest for the NOAA Code has been reported on seafood dealer buy tickets for 14 years out of the 15-year time series. This includes past harvest data from areas in the NOAA Code that are currently in a sanctuary area, but weren't when the harvest occurred prior to the sanctuary being established. Since 2010, 64% of the NOAA Code area has been a sanctuary where harvest is prohibited. Harvest reported ranged from less than 40 bushels in the 2010-11 season to a maximum of approximately 4 thousand bushels in the 2015-16 season. Hand tonging was used to obtain the majority of the harvest.

We are unaware of any continuous water quality monitoring in this area.

[48] 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

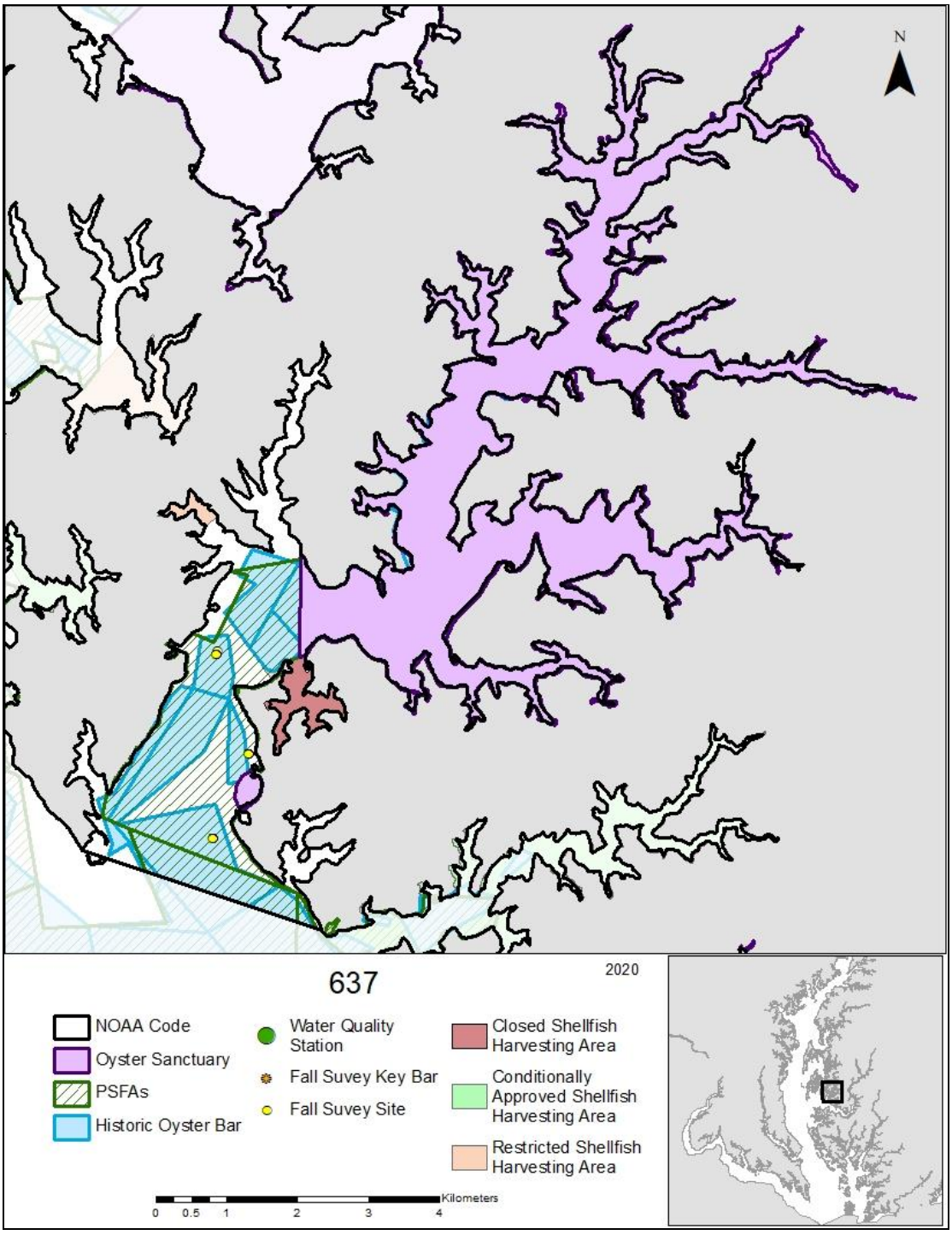


Figure B.39-1. Map of NOAA Code 637 (Tred Avon River). Fall Survey sites may not be sampled every year.

Table B.39-1. Oyster population characteristics based on the Fall Survey in the NOAA Code 637 (Tred Avon River) occurring outside of the current sanctuary area. ND = No Data. Values are given as an annual mean ± standard error.

| | 2006-10 | 2011-15 | 2016-20 |
|---|---|---|---|
| Number of Years Sampled / Number of Samples | 5 / 15 | 5 / 15 | 5 / 16 |
| Number of Live Spat Oysters per square meter | 3.6 ± 1.2 | 6.6 ± 4.9 | 23.9 ± 22.1 |
| Number of Live Small-Sized Oysters per square meter | 5.8 ± 1.5 | 49.6 ± 22.7 | 32 ± 13.4 |
| Number of Live Market-Sized Oysters per square meter | 21.1 ± 5.7 | 78.1 ± 11 | 53.4 ± 7.9 |
| Live Oyster Biomass (g Dry Weight per Bushel) | ND | ND | ND |
| Observed Mortality (%) | 9 ± 1 | 7 ± 2 | 9 ± 2 |
| Cultch (Bushels per 100 ft Towed) | 1.09 ± 0.16 | 1.82 ± 0.4 | 1.61 ± 0.42 |
| Harvest (Bushels) | 100 ± 31 | 1,246 ± 538 | 2,118 ± 607 |
| Note: The number of samples is based on the number of samples having a value for observed mortality. There may be fewer samples per year for density, biomass, and cultch. | | | |

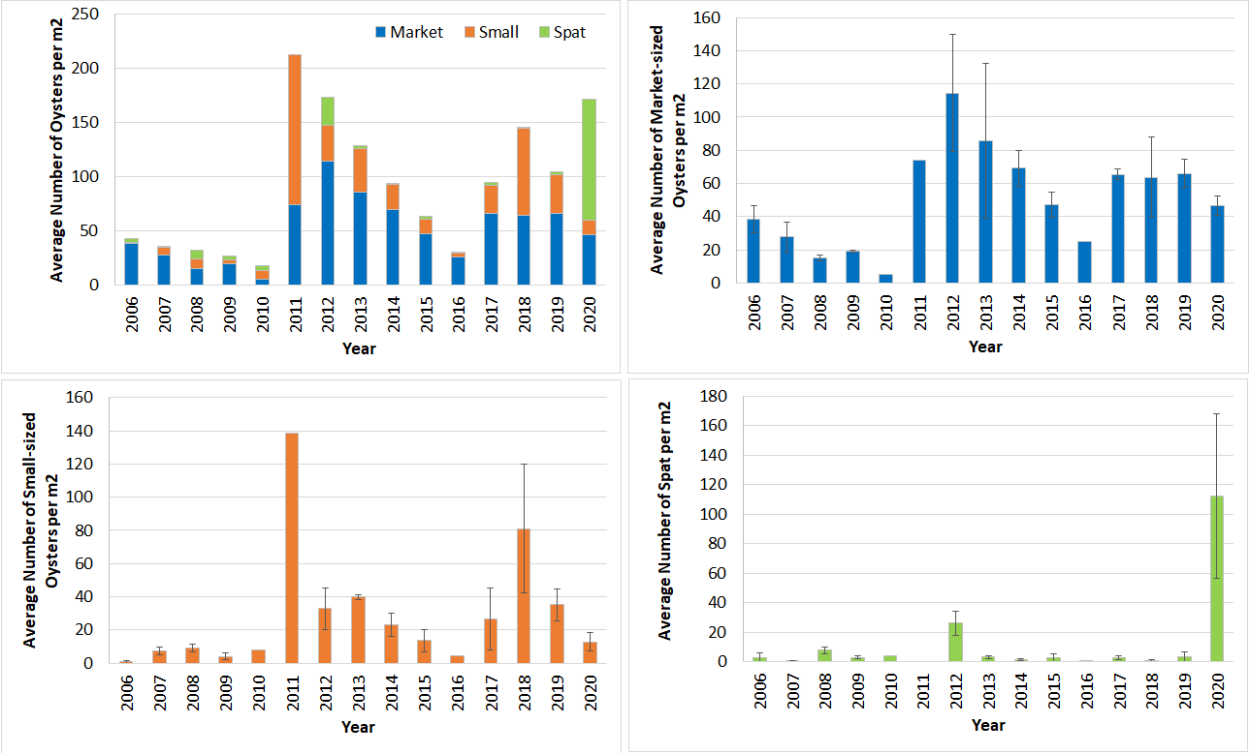


Figure B.39-2. Average number of live oysters per square meter by size class in NOAA Code 637 (Tred Avon River) occurring outside of the current sanctuary area. Error bars represent ± 1 standard error. Data from Maryland's Annual Fall Oyster Dredge Survey. Note differing Y-axis scales.

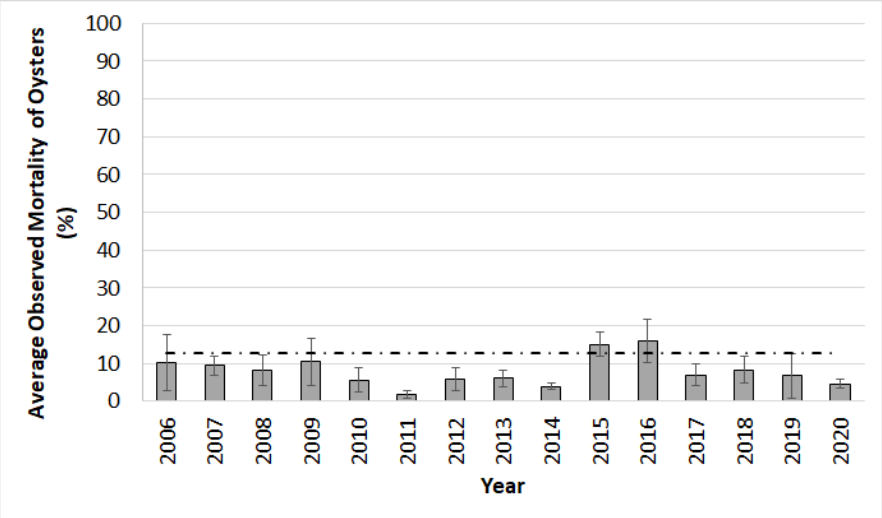


Figure B.39-3. Average annual observed mortality of market-sized and small-sized oysters in NOAA Code 637 (Tred Avon River) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey. The dashed line represents the 2006-2020 baywide average observed mortality. Error bars represent ± 1 standard error.

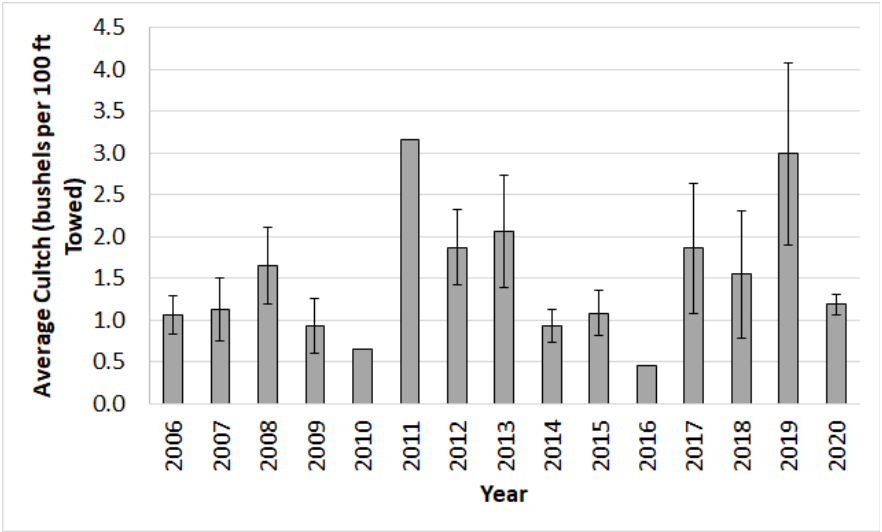


Figure B.39-4. Average cultch (live and dead oysters and loose shell) in NOAA Code 637 (Tred Avon River) occurring outside of the current sanctuary area. Data from Maryland's Annual Fall Oyster Dredge Survey. Error bars represent ± 1 standard error.

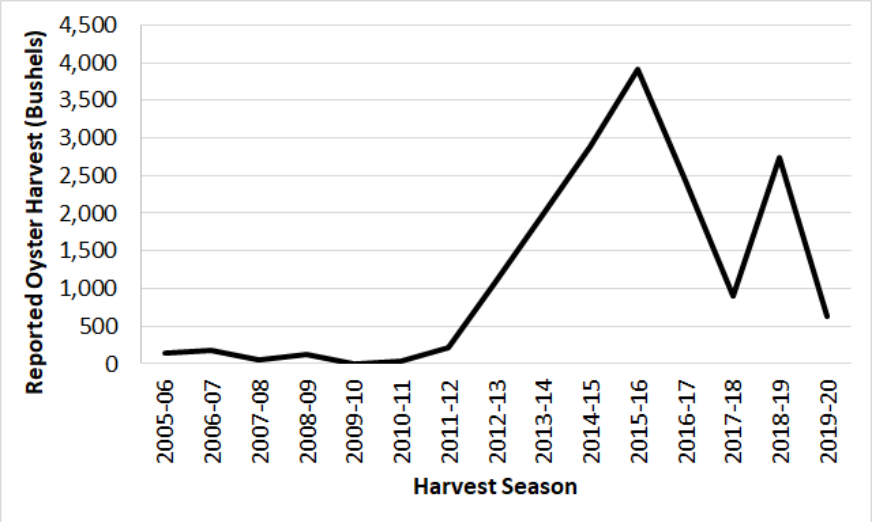


Figure B.39-5. Oyster harvest reported from seafood dealer buy tickets (harvest seasons 2005-2006 to 2019-2020) in NOAA Code 637 (Tred Avon River). Since 2010, 64% of the NOAA Code area has been a sanctuary where harvest is prohibited.