

Section A.45: Tred Avon River Sanctuary

The Tred Avon River Sanctuary, created in 2010, is located in the upper reaches of the Tred Avon River, a tributary of the Choptank River (Figure A.45-1). The sanctuary is in a low salinity (less than 12 ppt) region and encompasses 4,149 acres of which 1,152 (28%) is historic oyster bottom (as charted in the Yates Oyster Survey from 1906 to 1912 plus its amendments). There are 27 historic oyster bars within the sanctuary¹. The Tred Avon River Sanctuary is one of the sanctuaries chosen for large-scale oyster restoration under the Chesapeake Watershed Agreement. A proportion of the sanctuary is designated by Maryland Department of the Environment (MDE) as restricted shellfish harvest areas based on the potential for contamination of shellfish with fecal coliform and other bacteria.

Bottom Habitat Characteristics

The area that is now the sanctuary was surveyed during the Bay Bottom Survey (1974 to 1983) to determine its bottom type (Figure A.45-2). Of the 1,513 acres surveyed within the sanctuary, 962 acres (64%) were classified as oyster reef habitat. In 2008, Maryland Geological Survey conducted a side scan sonar survey of the area. Of the 1,622 acres surveyed, 241 (15%) were classified as oyster reef habitat, indicating a substantial loss of oyster habitat since the Bay Bottom Survey.

Restoration and Replenishment Activities

Between 1990 and the establishment of the sanctuary in 2010, approximately 305,000 bushels of dredged and fresh shell and 34,000 bushels of wild seed were planted (Table A.23-1). As part of large-scale oyster restoration in support of the Chesapeake Bay Agreement, the U.S. Army Corps of Engineers constructed 16 acres of granite and shell reefs in 2015. A portion of these reefs was then seeded with hatchery-reared spat on shell.

Marylanders Grow Oysters, a public outreach program, has planted oysters since 2008 at two sites in the Tred Avon River Sanctuary. A third planting site within the Tred Avon River is located within the Oxford Laboratory Sanctuary. In 2016, growers tended 750 cages and planted approximately 220,000 oysters in both sanctuaries within the Tred Avon River.

¹ See chart 16 for bar names and locations in the State of Maryland Shellfish Closure Areas Book <http://dnr2.maryland.gov/fisheries/Pages/oysters/index.aspx>

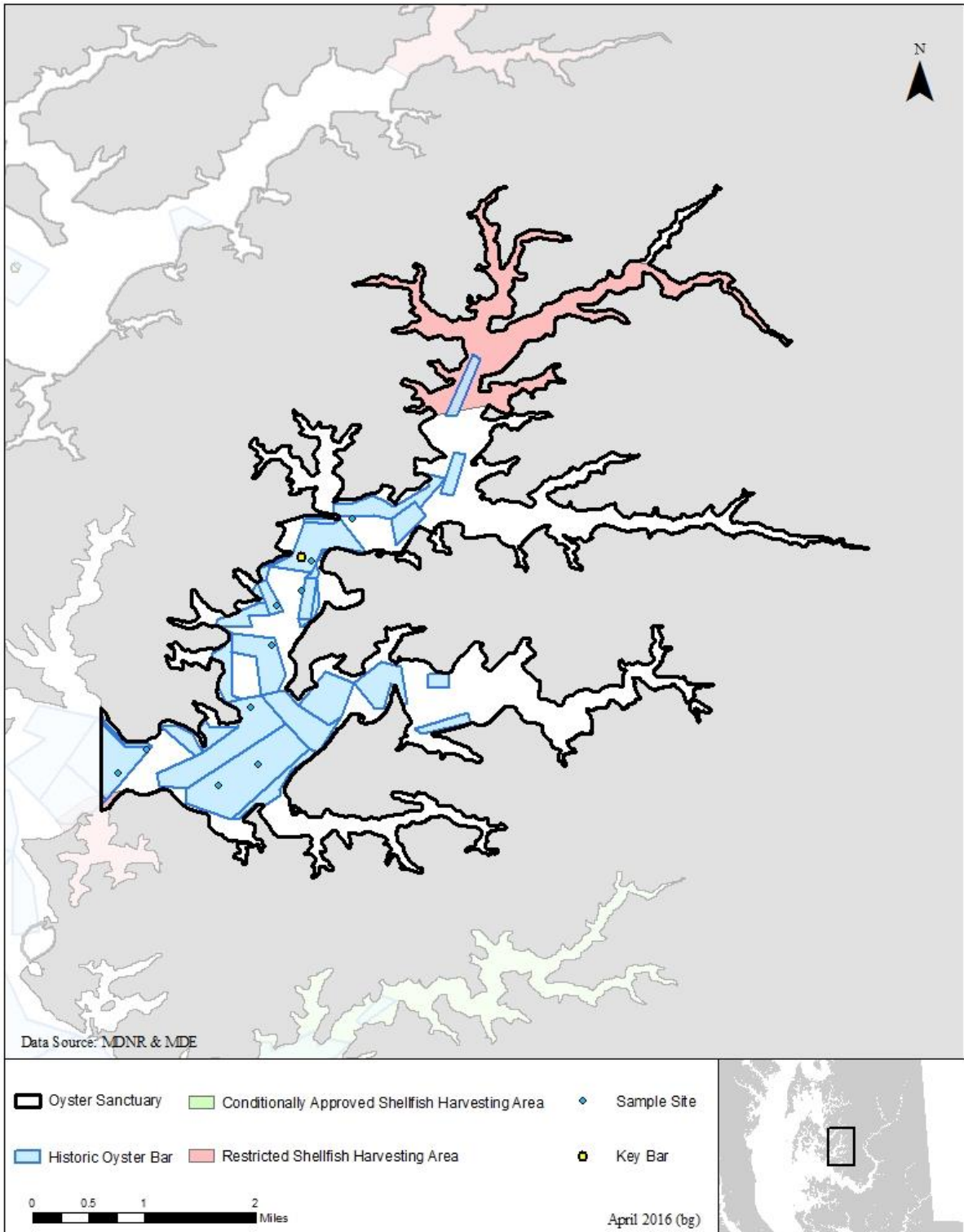


Figure A.45 -1. Tred Avon River Sanctuary.

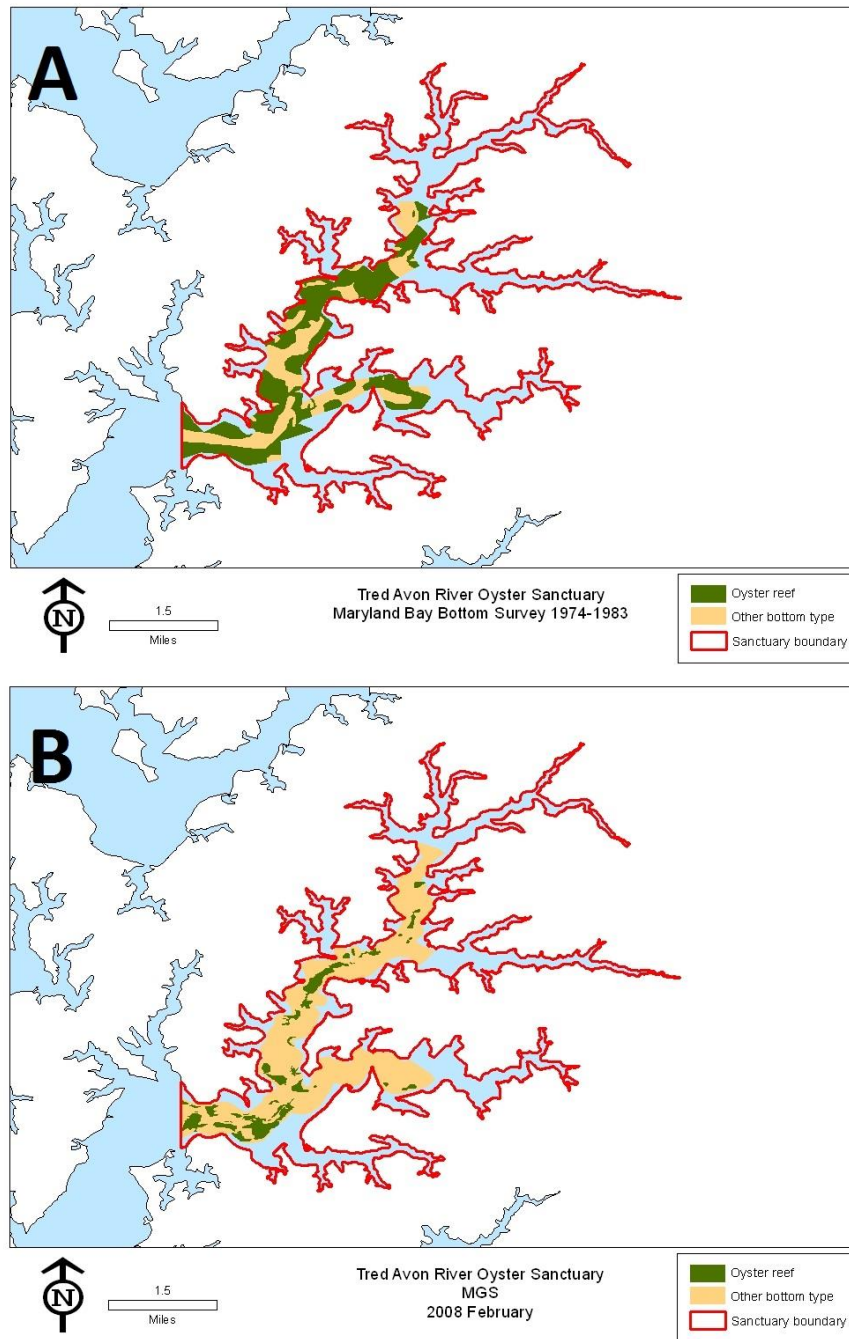


Figure A.45 -2. Tred Avon River Sanctuary bottom types. (A) Data from Maryland Bay Bottom Survey from 1974-1983. (B) Data from Maryland Geological Survey in 2008. Tan and green colored areas depict areas examined during the surveys.

Table A.44-1. Replenishment and restoration planting activities occurring since 1990 in the area now established as the Tred Avon River Sanctuary. S = planting activity occurring after the sanctuary was established in 2010.

Year	Planting Substrate Type	Area Planted (acres)	Thousands of Bushels Planted	Millions of Spat Planted
1996	Dredged Shell	23.39	148.1	-
1997	Dredged Shell	34.92	102.5	-
1998	Fresh Shell	2.60	6.3	-
1998	Wild Seed	28.19	17.0	-
2000	Dredged Shell	4.38	48.6	-
2001	Wild Seed	8.29	15.0	-
2002	Wild Seed	3.35	2.5	-
2009	Hatchery Spat-on-Shell	6.92	-	14.07
2015 (S)	Stone	10	262.3	-
2015 (S)	Mixed Shell	6	146.6	-
2015 (S)	Hatchery Spat-on-Shell	2.57	-	10.18

Oyster Population Characteristics

The Fall Survey has sampled two to six oyster bars in this area since 1990 with an average of five oyster bars sampled annually. Some of the samples were taken on sites slated for large-scale restoration, although none of these had been restored as of the writing of this report. The average number of live oysters per bushel (market, small, and spat) was similar before and after sanctuary creation (Table A.45-2; Figure A.45-3). The average number of small-sized oysters per bushel decreased slightly after sanctuary establishment, whereas the number of market-sized oysters increased during this time period. The increase in market-sized oysters may be due to cessation of harvest.

Table A.45-2. Oyster population characteristics based on the Fall Survey before and after the establishment of the Tred Avon River Sanctuary in 2010. Values are given as mean \pm standard error.

	1990-2009	2010-2015
Number of Years Sampled / Number of Samples	20 / 88	6 / 35
Number of Live Oysters per Bushel	90 \pm 14	82 \pm 4
Number of Live Small-Sized Oysters per Bushel	33 \pm 7	22 \pm 8
Number of Live Market-Sized Oysters per Bushel	36 \pm 4	57 \pm 11
Live Oyster Biomass (g Dry Weight per Bushel)	96 \pm 12.4	168 \pm 19.4
Mortality (%)	26.3 \pm 4.6	8.1 \pm 1.5

Patent tong population surveys were conducted in different areas within the sanctuary in 2012 and 2013 (Figures A.45-4), prior to any large-scale restoration work. The samples of these two surveys were combined in the results of this section. The average density of live oysters was 3.46 \pm 0.48 oysters m⁻² (mean \pm standard error, n= 222). The density of small-sized oysters was similar to the density of market-sized oysters (1.71 \pm 0.31 and 1.75 \pm 0.24 oysters m⁻², respectively). Sixty-four percent of the samples collected contained no live oysters or boxes. Oyster density increased with volume of shell (Figure A.45.5).

The actively restored areas (seed plantings on both natural bottom and constructed reefs) within the sanctuary will be monitored at three and six years after the activities occur to determine if the areas meet restoration goals as defined by the Oyster Metrics Team². The first monitoring will occur in 2018. Reference sites within the sanctuary were established to gauge the effectiveness of restoration treatments and will be monitored at the same time as the restoration sites. The reference sites were areas that were suitable for restoration with seed or substrate and seed, but left unrestored. These areas were not true controls in that they were not exact replicates of the treated sites (exact replicates are not possible given variation in flow, salinity, and bottom type). Furthermore, it is not possible to isolate the reference sites from the treated sites, and restoration on treated sites may affect reference sites. For example, as oysters grow on treated sites, they may provide larvae to adjacent reference sites. Given these caveats, reference sites still provide valuable information on effectiveness of restoration efforts, and these sites will be monitored along with actively restored areas.

Oyster Size Structure

Oysters collected by the Fall Survey in this area on the Double Mills bar have measured shell heights since 1990 (Figure A.45-6). Shell heights were also measured during the two patent tong

² Allen, S., A.C. Carpenter, M. Luckenbach, K. Paynter, A. Sowers, E. Weissberger, J. Wesson, and S. Westby. 2011. Report of the Oyster Metrics Workgroup. Submitted to the Sustainable Fisheries Goal Implementation Team of the Chesapeake Bay Program. 32 pp. <http://chesapeakebay.noaa.gov/images/stories/fisheries/keyFishSpecies/oystermetricsreportfinal.pdf>

population surveys and were consistent with heights documented in the Fall Survey (Figure A.45-7). There has been an increase in the number of large oysters since the establishment of the sanctuary.

Biomass

Biomass of oysters from Double Mills has been calculated from Fall Survey samples since 1990 (Table A.45-2; Figure A.45-8). Average biomass is greater after the area was established as a sanctuary compared to prior. Annual biomass has increased steadily since 2002, with the highest biomass of 243 grams dry weight per bushel occurring in 2014. This increase is due to the increasing number of larger market sized oysters and low mortality.

Recruitment (Spatfall)

Based on Fall Survey data, spatfall from 1990 to 2015 ranged from 0 to 214 spat per bushel (Figure A.45-3). The highest spatfalls were observed 1991 and 1997, with spat counts being low since then, averaging an annual three spat per bushel.

Spat density from the patent tong population survey increased from 2012 ($0.12 \pm 0.05 \text{ m}^{-2}$) to 2013 ($0.82 \pm 0.14 \text{ m}^{-2}$).

Mortality

Based on Fall Survey box counts, the average mortality after sanctuary establishment was lower than the average mortality from before sanctuary establishment (Figure A.45-9). This follows a baywide pattern of below average mortalities since 2002. From 1990 to 2015, mortality ranged from 2% to 73%, with the highest mortality occurring during a bay-wide disease event in 2002.

Disease

From 1990 to 2015, dermo prevalence has ranged from 40% to 100%, with prevalence being generally higher prior to 2002 (Figure A.45-10). Dermo intensity ranged from 1.1 to 5.5 during the 26 year time period and in 2001, mean dermo intensity reached a lethal level (greater than 5 on a scale of 0 to 7). MSX prevalence has ranged from 0% to 33% but was only observed in 1992, 1999, and 2002.

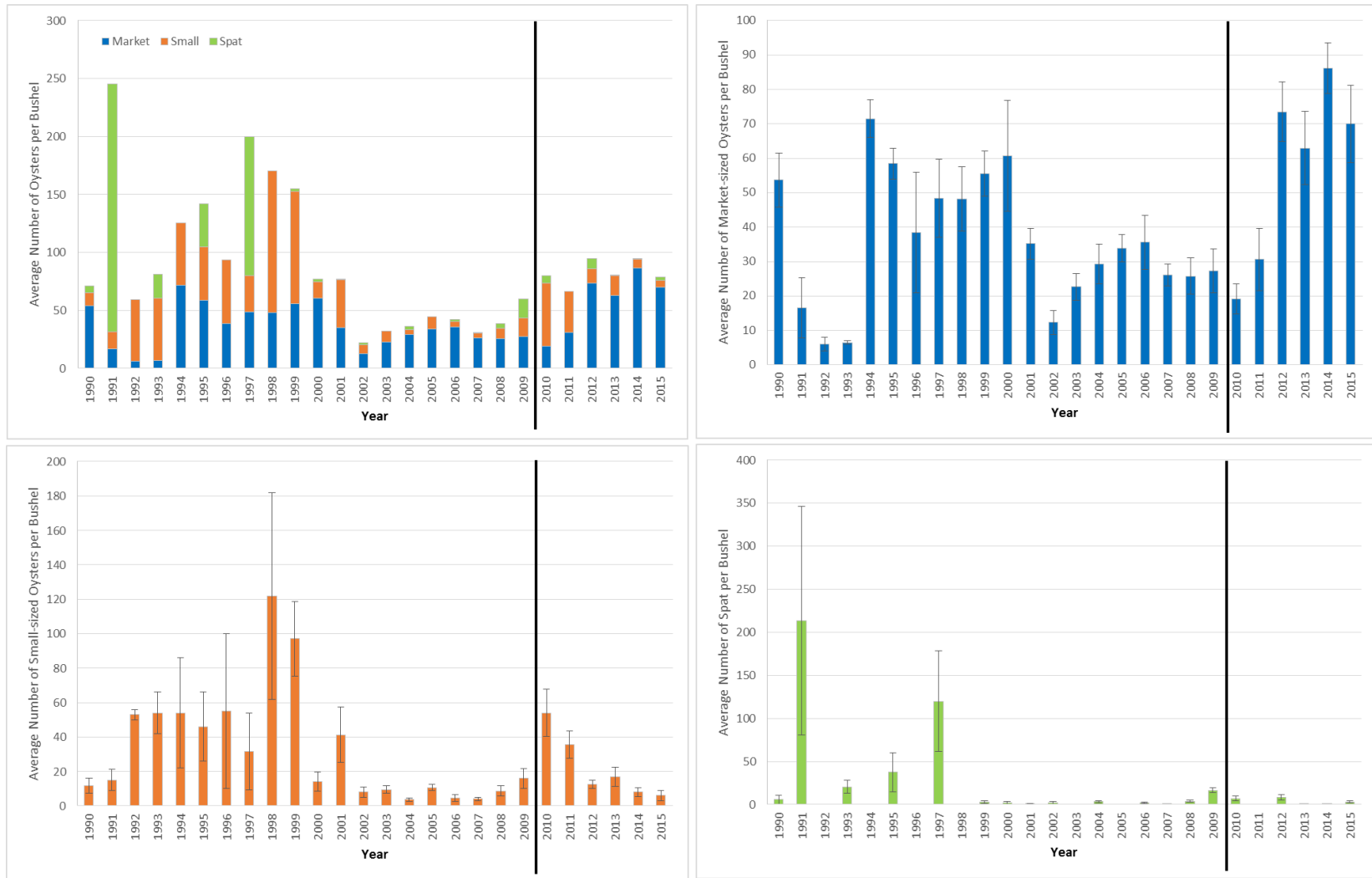


Figure A.45-3. Average number of live oysters per bushel of material by size class in the Tred Avon Sanctuary. The black line denotes the year the sanctuary was established. Error bars represent ± 1 standard error. Data from Maryland’s Annual Fall Oyster Dredge Survey. Note differing Y-axis scales.

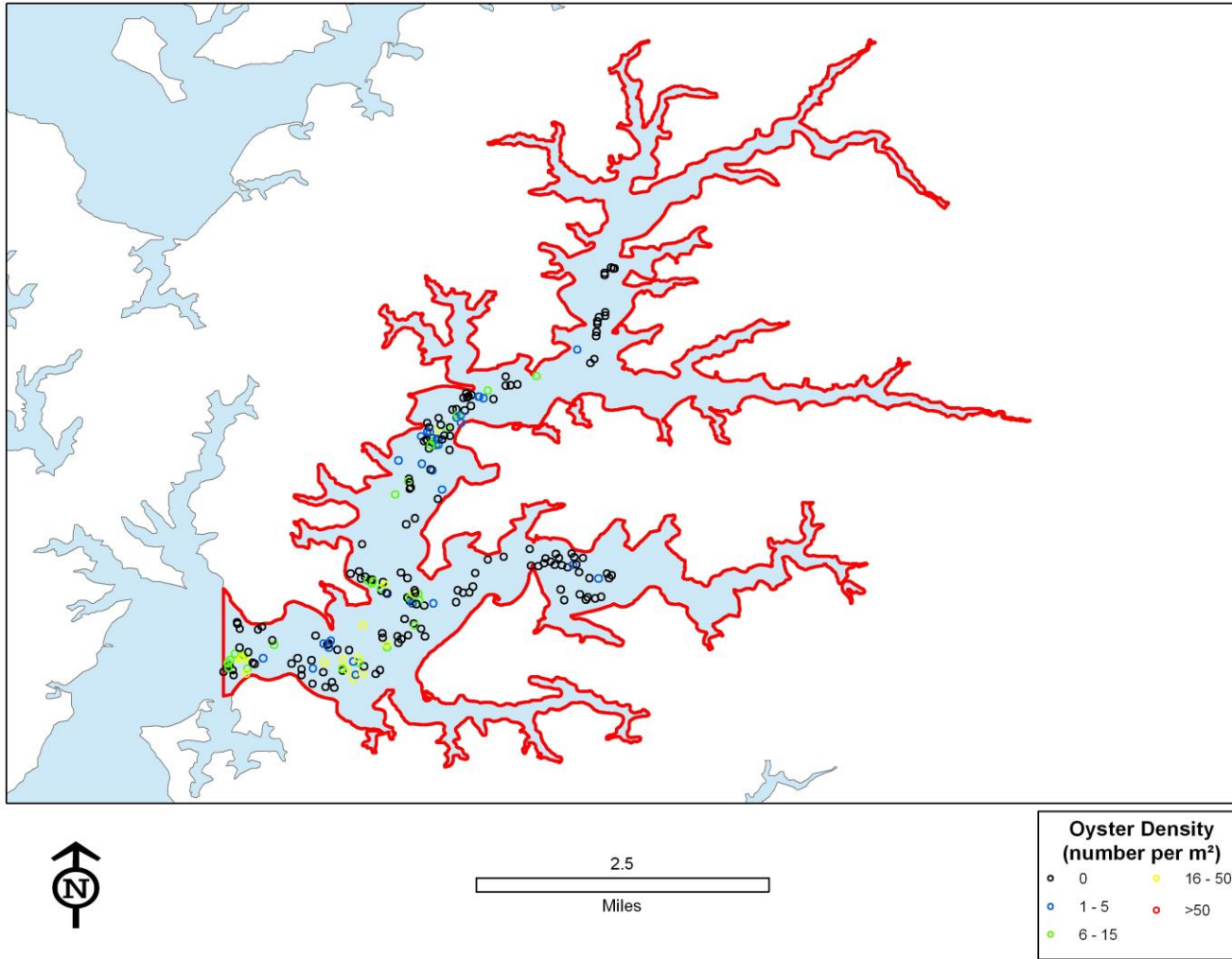


Figure A.45-4. Map of 2012 and 2013 oyster density in the Tred Avon Sanctuary. Data from Maryland Department of Natural Resources Patent Tong Population Survey.

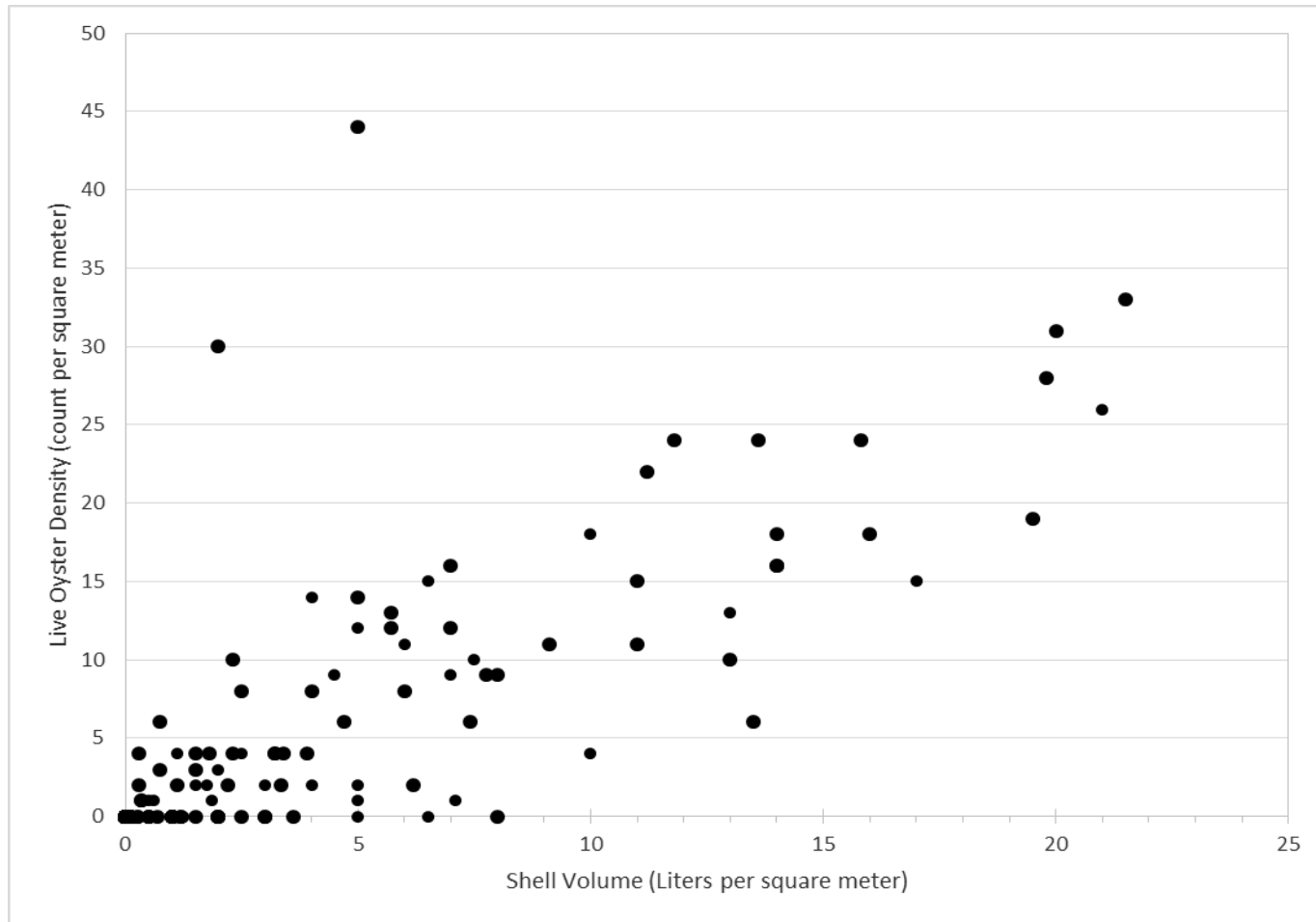


Figure A.45-5. 2012 and 2013 live oyster density vs. shell volume (liters of live oysters, boxes, and surface shell) in the Tred Avon River Sanctuary. Data from Maryland Department of Natural Resources Patent Tong Population Survey.

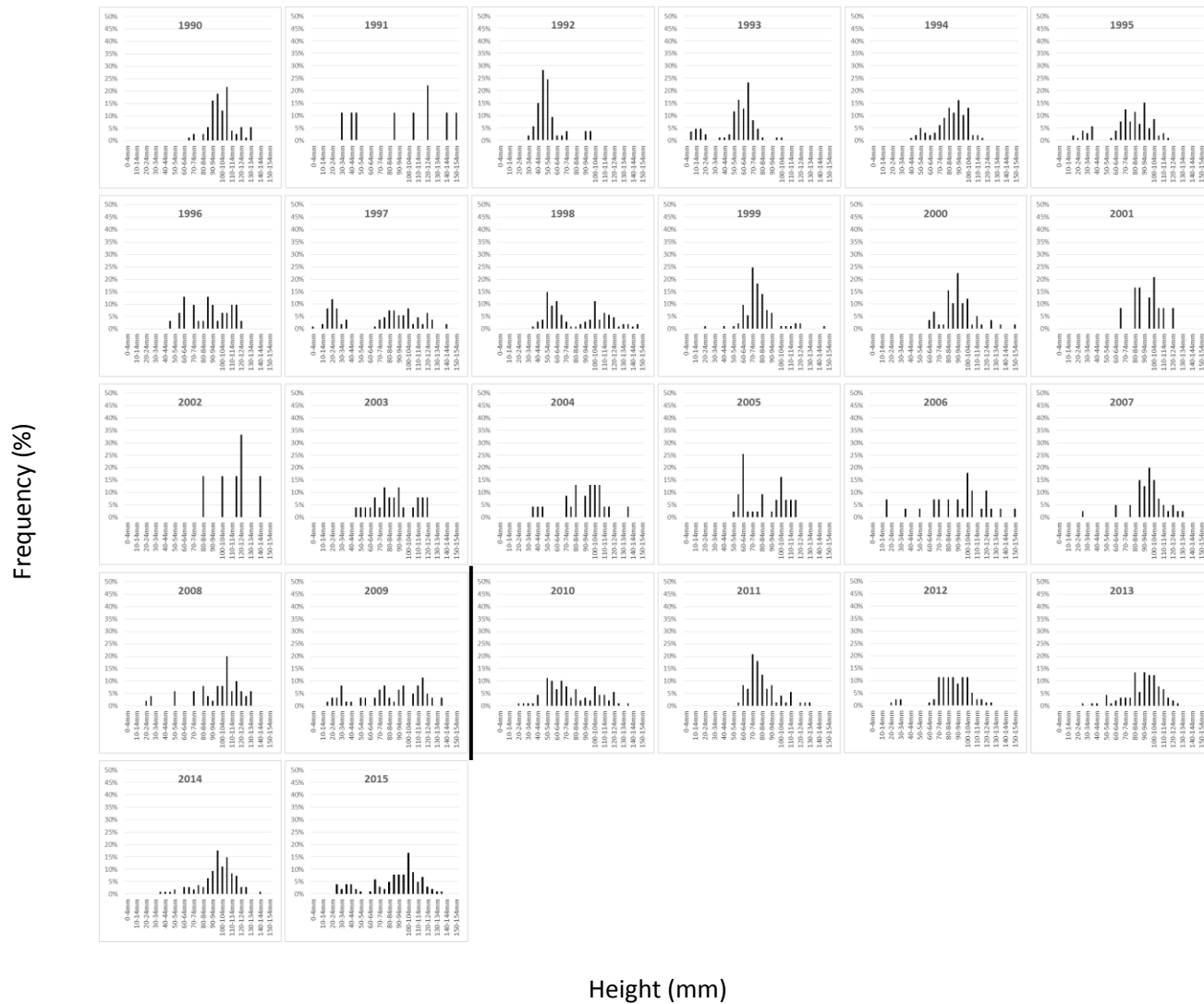


Figure A.45-6. Shell height frequencies of live oysters per bushel of material from 1990 to 2015 in the Tred Avon Sanctuary. Data from Maryland’s Annual Fall Oyster Dredge Survey on Double Mills bar. The black line denotes the year the sanctuary was established. Oyster sizes less than 37mm were not recorded by the Fall Survey at any sampling location in 2002 and 2003.

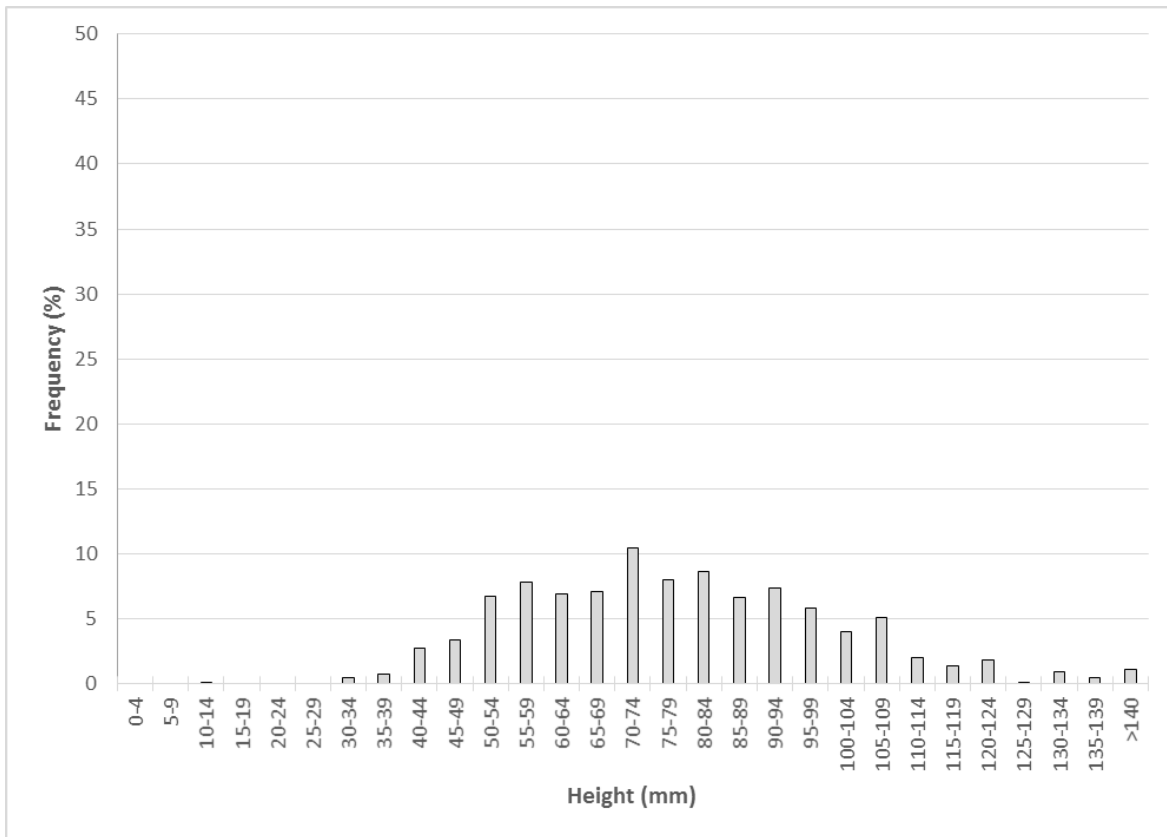


Figure A.45-7. Shell height frequencies of live oysters in the Tred Avon River Sanctuary, 2012 and 2013. Data from Maryland Department of Natural Resources Patent Tong Population Survey.

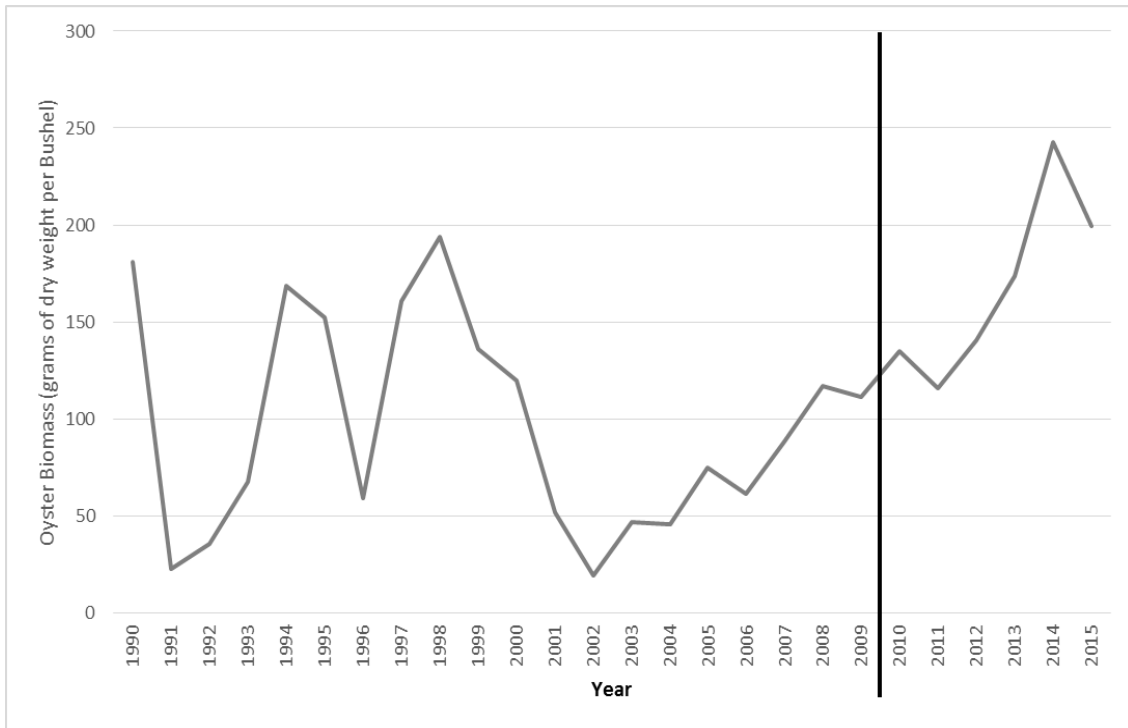


Figure A.45-8. Oyster biomass (grams of dry weight per bushel of material) from 1990 to 2015 in the Tred Avon Sanctuary. Data from Maryland’s Annual Fall Oyster Dredge Survey on Double Mills bar. Black line indicates the date the sanctuary was established.

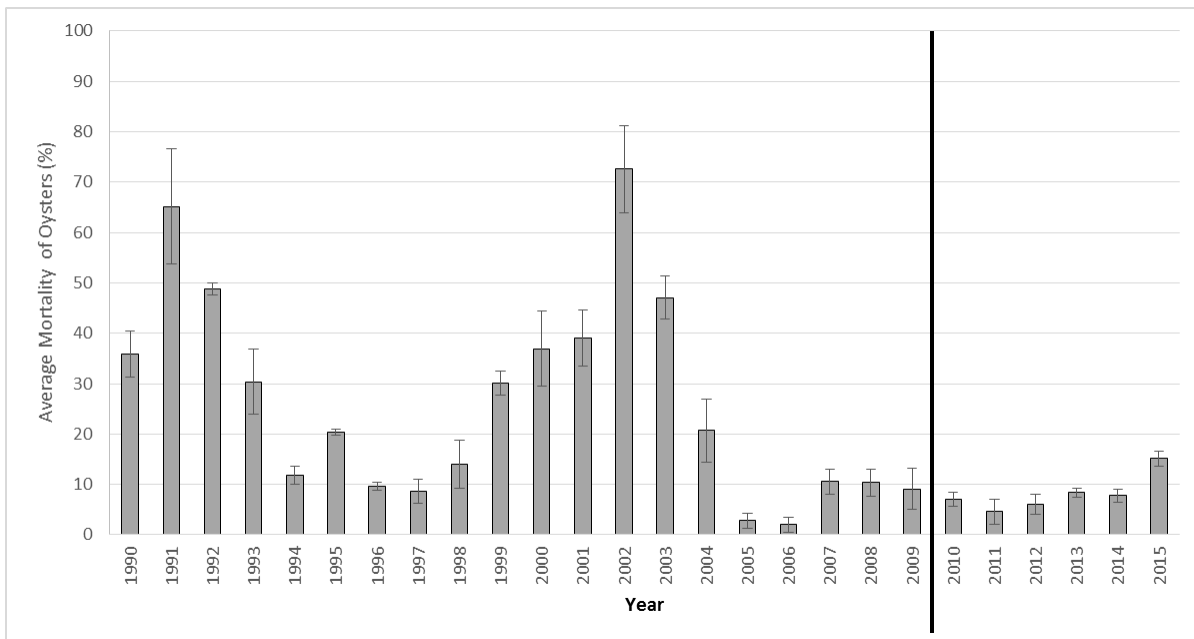


Figure A.45-9. Average mortality of market-sized and small-sized oysters from 1990 to 2015 in Tred Avon Sanctuary. Data from Maryland’s Annual Fall Oyster Dredge Survey. Black line denotes the date the sanctuary was established. Error bars represent ± 1 standard error.

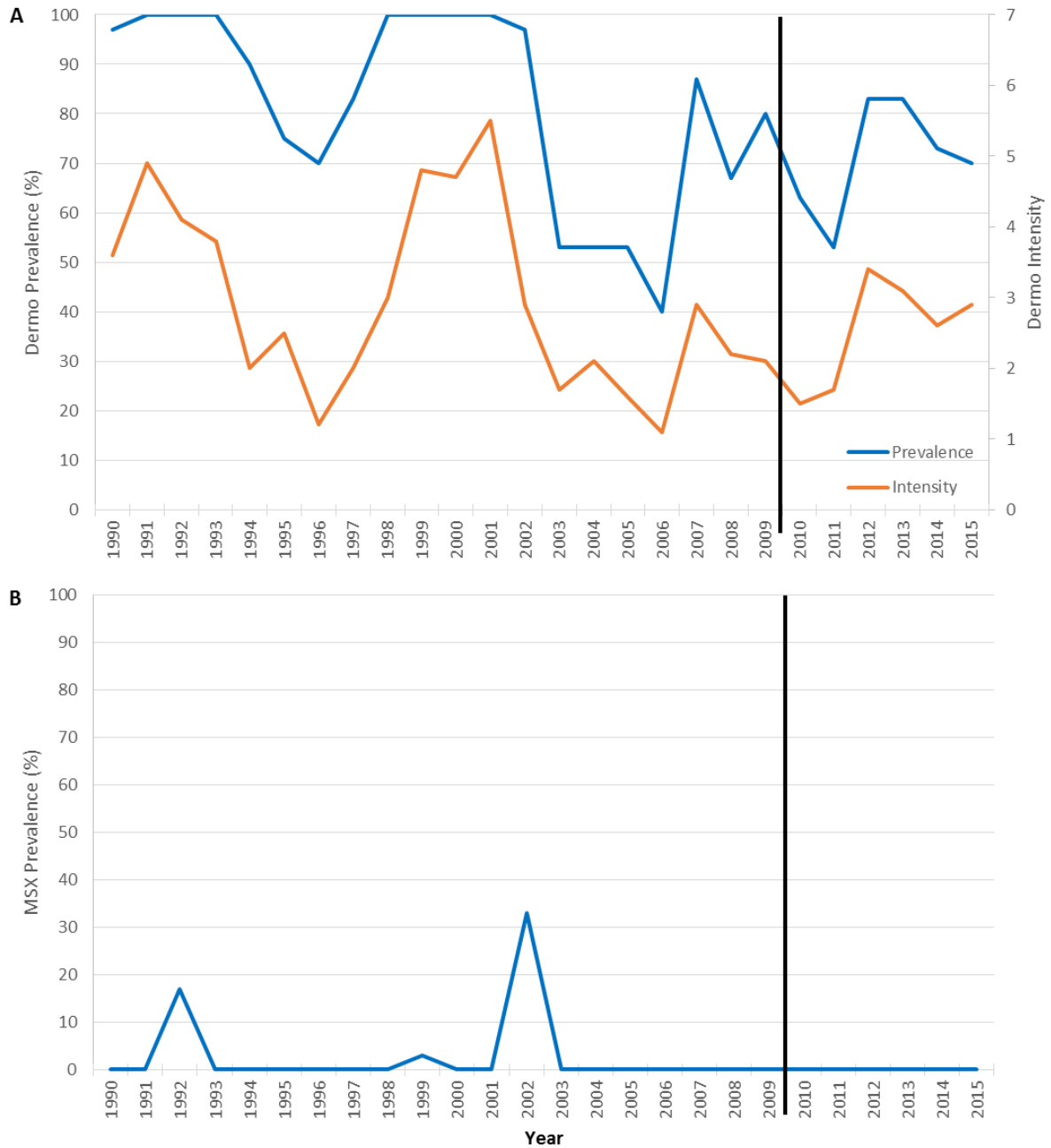


Figure A.45-10. Oyster disease prevalence and intensity from 1990 to 2015 in the Tred Avon Sanctuary. (A) Dermo prevalence and intensity (B) MSX prevalence (intensity is not examined). Data from Maryland’s Annual Fall Oyster Dredge Survey on Double Mills bar.

Harvest

The sanctuary encompasses 60% of the 6,869 acres in NOAA Code 637. Harvest reported by seafood dealers prior to the establishment of the sanctuary was highest in the 1990-1991 season at 22,456 bushels (Figure A.45-11). The second highest harvest of 11,709 occurred during the 1998-1999 season. From 1990 to 2009 the average harvest per season was 3,380 bushels. In the 2009-2010 harvest season, commercial waterman reported a catch of 37 bushels in the NOAA Code.

After the establishment of the sanctuary, harvest reported by both seafood dealers reports and harvesters increased despite the decrease in area open to fishing. In the 2015-2016 season, between 3,206 and 4,008 bushels were harvested in the Tred Avon River outside the sanctuary. Based on seafood dealer reports, this is the highest harvest since the 2000-2001 season.

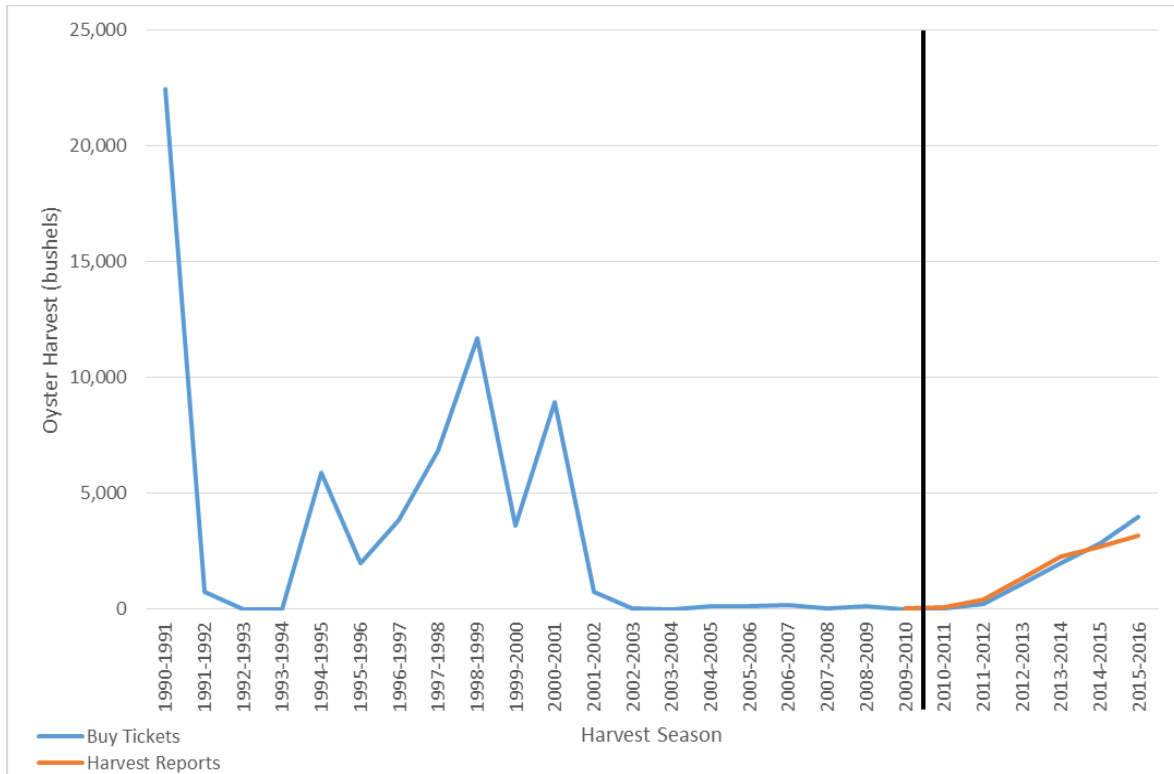


Figure A.45-11. Oyster harvest reported from seafood dealer buy tickets (1990-2016) and harvester reports (2009-2016) in NOAA Code 637 (Tred Avon River). In 2010, 60% of NOAA Code became an oyster sanctuary (denoted by the black line) where harvest is prohibited.

Environmental Conditions and Ecosystem Services

The Chesapeake Bay Program Data Hub records monthly water quality data at station XFH2312 (38.7052, -76.1468) in this area. Data were only collected from 2006 to 2008 and thus cannot be used to examine water quality before and after sanctuary establishment (Figure A.45-12). Surface water quality was analyzed for salinity, water temperature, secchi disk depth, total suspended solids, total nitrogen, and chlorophyll a. Water quality was favorable for oysters during the period examined.

Researchers from NOAA, Virginia Institute of Marine Sciences, and the Smithsonian Environmental Research Center are studying fish and crustacean usage of restored oyster reefs in the Tred Avon River³. Baseline data are currently being collected and will be compared to data collected after restoration activities are complete.

³ NOAA. 2016. 2016 Oyster Reef Ecosystem Services Research Update.
<http://chesapeakebay.noaa.gov/images/stories/habitats/2016oresresearchupdate.pdf>

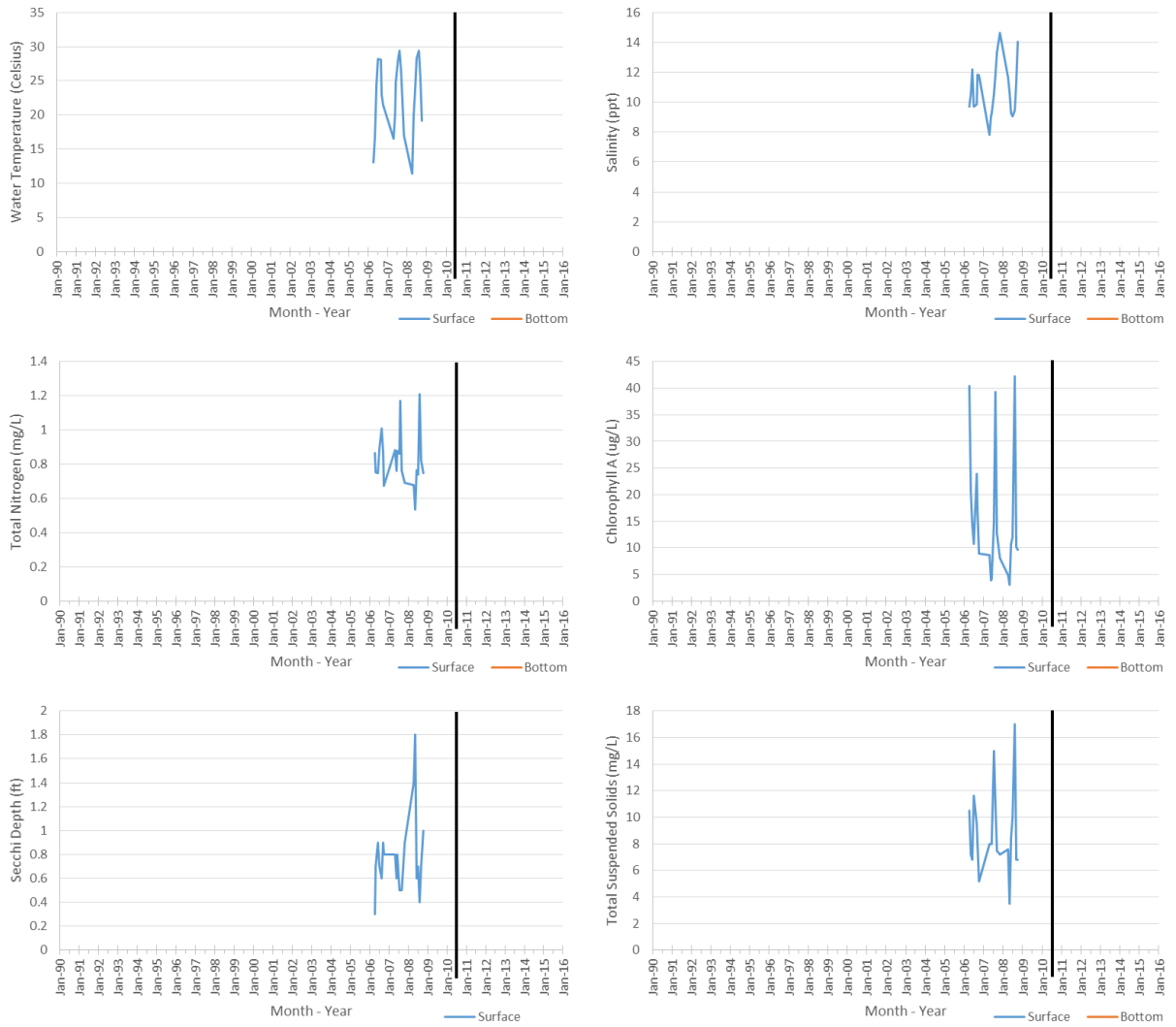


Figure A.45-12. Water quality data collected at Station XFH2312 within the area now established as Tred Avon River Sanctuary from 2006 to 2008. Black line denotes the date the sanctuary was established. Data from the Chesapeake Bay Program Data Hub.