

Oyster Population Estimates for the Maryland Portion of Chesapeake Bay 1994 – 2006

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INTRODUCTION

The Chesapeake Bay 2000 Agreement established a goal of increasing the Chesapeake Bay oyster population 10-fold by 2010 from its 1994 level of abundance. Upon the adoption of this goal, the National Oceanic and Atmospheric Administration Chesapeake Bay Stock Assessment Committee and U.S. Environmental Protection Agency Chesapeake Bay Program jointly funded an interstate research project to estimate the 1994 baseline population of oysters and to develop a methodology for producing annual oyster population estimates that could be used to measure progress toward achieving the 10-fold goal. This collaborative project between the Maryland Department of Natural Resources (MD DNR) and Virginia Institute of Marine Sciences resulted in annual oyster population estimates of small and market size oysters (spat estimates were not included) for the period 1994-2002. Estimates of the oyster population in Virginia have been produced annually since 2002. Oyster population estimates in Maryland have not been updated since 2002 until now primarily because of a lack of documentation of the methodology used to compute the 1994-2002 estimates. This report provides documentation for the methodology used to estimate Maryland's oyster population from 1994 to 2002, presents the assumptions associated with the estimates, and provides estimates of abundance through 2006.

METHODS

Oyster abundance was based on estimates of suitable oyster habitat and estimates of oyster density in each of eight basins in the Maryland portion of Chesapeake Bay. The steps used to calculate the population estimates are presented as follows.

Step 1 - Delineation of Maryland Basins

The Maryland portion of the Chesapeake Bay was divided into eight basins. This was done in an attempt to account for the significant observed variation in oyster abundance among basins. The following eight basins were established: 1) Chester River; 2) Eastern Bay; 3) Choptank River; 4) Little Choptank River; 5) Tangier Sound; 6) Potomac River; 7) Patuxent River; and 8) Chesapeake Bay mainstem (Figure 1).

Step 2 - Calculation of Available Oyster Habitat in Maryland Basins

Maryland's oyster population estimates are based on multiplying the annual measured oyster density by the amount of available oyster habitat within each basin. The most recent comprehensive survey of available oyster habitat is the Maryland Bay Bottom Survey (MBBS), conducted between 1976 and 1983. (Note: A digital dataset of the MBBS is available from MD DNR.) It is widely accepted in the scientific community that the amount and quality of existing oyster habitat in Maryland has declined significantly since the MBBS survey was conducted. Because the oyster population estimates are based on the amount and quality of available habitat, changes in habitat availability and quality since the MBSS was completed needed to be taken into account in our study.

A survey was conducted by the MD DNR Cooperative Oxford Laboratory between 1999 and 2000 at 15 oyster bars located throughout the Maryland portion of the Chesapeake Bay (Smith et al. 2005). The objective of the 1999-2000 MD DNR survey was to assess the relative abundance of oyster habitat within the cultch bottom classifications of both the 1978-1983 MBBS and a survey conducted by C.C. Yates between 1906-1911. The 15 bars surveyed were believed to be a fair representation of bars typically found in the Chesapeake Bay based upon a similarity of bottom types found at each bar. The MBBS classified oyster habitat into the following seven bottom classes: cultch, mud with cultch, sand with cultch, mud, sand, hard bottom and leased bottom (Smith et al. 2001). Areas of bottom with generous amounts of oyster shell were classified as cultch, while areas of scattered oyster shell were classified as either sand with cultch or mud with cultch. The cultch, sand with cultch and mud with cultch classifications were later categorized as either high quality habitat, low quality habitat, or lost habitat, for the purposes of this oyster population estimation effort (Table 1).

Results from the MD DNR survey confirmed anecdotal reports of significant loss of available oyster habitat within Maryland over the past 20 years. Only 2.37% of high quality oyster bottom habitat reported by the MBBS remained. Of the remaining high quality bottom habitat defined by the MBBS, 26.80% had degraded to low quality bottom classification consisting of heavily sedimented shell with sand or mud, and 68.58% was completely lost to sand or mud (Table 1). Overall, there was a 70.83% decline of available oyster habitat within the high quality bottom classifications defined by the MBBS. Given the significant level of habitat degradation on the high quality bottom since the MBBS was conducted, these population estimate calculations assumed a complete loss of low quality habitat identified in the MBBS survey.

MBBS-based adjustments to high quality habitat could not be applied to certain sections of Eastern Bay and the Choptank River (Broad Creek and Harris Creek) due to missing MBBS data. Therefore, oyster bar boundaries from the 1906-1911 Yates survey were used in these two areas (Table 1). The 1999-2000 MD DNR survey found that 85.88% of the charted oyster bars from the Yates survey have been lost to mud or sand. Only 0.95% of the charted Yates oyster bars fit the criteria for high quality and 11.29% meet low quality bottom habitat criteria. Habitat degradation of the charted Yates bars was more significant than the results based upon an assessment of the MBSS. This was expected given the earlier time period of the Yates Survey. These habitat adjustments were applied like the MBSS adjustments.

Significant amounts of fossil dredge shell and, to a lesser extent, shell retrieved from oyster packing houses have been planted in Maryland waters of Chesapeake Bay over the past four decades. The 1999-2000 MD DNR survey included an assessment of length of time after planting that fossil shell and shell from packing houses were suitable oyster habitat. Results indicated that shell plantings became moderately sedimented after an average of 5.5 years and heavily sedimented after an average of 18.6 years. For the purpose of estimating and assessing habitat for the biomass calculations, it was determined that only shell plantings 5 years old or less would be included in habitat estimates (Smith et al. 2005). Any GIS polygons designated as low quality habitat after adjustments to the MBBS and Yates surveys adjustments that overlapped shell plantings 5 years old or less were re-classified as high quality habitat. This did not result in an increase in the total amount of habitat, but simply changed the preliminary bottom classification. Total habitat only increased when the shell plantings did not overlap adjusted MBBS and Yates habitat polygons. These population estimates assumed that 1999-2003 shell plantings were constant throughout the 1994-2006 time period.

Leased oyster bottom within Maryland is another potential source of available habitat. Maryland leases are not legally permitted on charted oyster bottom, and therefore, should not overlap any habitat derived from the MBBS and Yates surveys. Because leases cannot legally occur on natural oyster bottom, lease holders commonly plant shell substrate to enhance spat settlement and/or support seed plantings. Maryland lease harvest data were reviewed to determine the level of lease activity. The average reported lease harvest was 1,424 bushels between 2000 and 2004 and 3,767 bushels between 1990 and 1999 (MD DNR 2005). Based on this level of reported activity, it was assumed that there were little or no remaining shell plantings on lease grounds over the past 5 years. Given the functional longevity of shell plantings reported by MD DNR's Cooperative Oxford Laboratory, it was further assumed that any plantings prior to 2000 were no longer providing any suitable oyster habitat

Table 2 presents the sequence of calculated values in the estimation of available oyster habitat for the Choptank River basin. Table 3 presents a summary of estimates of high and low quality habitat for all eight basins delineated in this study.

Assumptions for Step 2

1. The degradation of oyster bottom habitat reported in the MD DNR 1999-2000 survey was representative of all bars within Maryland's portion of the Chesapeake Bay.
2. There was a complete loss of available oyster habitat within the "mud with cultch" and "sand" bottom classifications reported by the MBBS survey.
3. The amount of available high and low quality habitat remained constant throughout the 1994-2006 time series.
4. Shell plantings did not provide suitable oyster habitat after 5 years.
5. Shell plantings between 1999 and 2003 were representative of shell plantings between 1994 and 2006.
6. Maryland leases did not provide any suitable oyster bottom habitat between 1994 and 2006.

Step 3 – Estimation of Oyster Density in High and Low Quality Habitat

Oyster density estimates for high quality habitat

For high quality habitat, annual estimates of oyster density were calculated using data collected in the Maryland DNR Fall Oyster Dredge Survey (Fall Survey) and estimates of the average tow area and efficiency of the oyster dredge used to collect data in the survey. Maryland's Fall Survey collects oyster size and abundance data at 43 sentinel stations located throughout Maryland's Chesapeake Bay. Bushel count data collected in 2004 and basin averages are presented in Table 4. A detailed description of the survey can be found in the MD DNR report for the 2003 and 2004 Fall Surveys (MD DNR, 2005).

Whereas the Fall Survey provides number of oysters per bushel of dredged material, the number of oysters per m^2 was needed for the population calculations. Therefore, the area swept to collect 1 bushel was needed. Studies were conducted in 2001, 2002, 2005 and 2006 to determine tow area of the dredge. Starting and ending positions (latitude and longitude), distance traveled and the amount of material collected (bu) for each tow were noted for all years except 2002. For 2002, a GIS program was used to translate these positions into distance traveled. The width of the original dredge used for this study was measured (33 inches) in order to calculate the area covered during the tow. This area was divided by the amount of material collected to calculate the mean area to collect a one bushel sample of material. [Earlier versions of this document used an estimate of $45 m^2/bu$, which was the recorded value developed by the original researchers. However, no supporting documentation has been found for the calculation of this value.] Re-calculation from the original data sheets provided estimates for mean and variance for each study year. The values for 2001, 2005 and 2006 were all less than 10% different from their mean. However, the value for 2002 was 46% different. Because the 2002 value was based on distances that were calculated using a different methodology than the other studies, these data were eliminated from the data set. The resultant unweighted mean value for the 2001, 2005 and 2006 sample data was $55 m^2/bu$. The 6% relative error for this mean indicated high precision for this estimate (i.e., the tow area was highly consistent over time).

The average efficiency of the dredge was also needed to translate the Fall Survey values for oyster density to population numbers. A study of dredge efficiency initiated by MD DNR in 2001 estimated an average dredge efficiency of 10% (unpublished MDNR study, 2002). To date, no documentation has been found for this value. Chai et al. (1992) found dredge efficiencies from 2 to 26% in their study that used a dredge tow distance of 131 meters. They referenced the asymptotic decrease in dredge effectiveness with tow length found by Allen and Cranfield (1976), and stated that tow distances longer than a few meters will underestimate oyster density. The mean Maryland DNR dredge tow distance is 68 meters, so our dredge efficiency value of 10% seems reasonable, as it is in the lower area of the range found by Chai et al. (1992).

Therefore the oyster density on high quality habitat was estimated as follows:

$$DH = ((BC_{\text{basin}}/(DE * TA)) * M) \quad (\text{Eqn } 1)$$

where:

DH = oyster density (oysters/acre)

BC_{basin} = annual basin average of small and market oysters per bushel of cultch material (oysters/bushel), as determined from the Fall Survey.

DE = dredge efficiency (0.10)

TA = tow area (55 m²/bu)

M = conversion factor (4046.856 m²/acre)

An example of estimating oyster density on high quality habitat for the Chester River in 2004 is provided below. Note that the mean bushel count (BC) is the only variable input parameter in these calculations.

$$\text{Oysters/acre} = ((59.5 \text{ oysters/bu}) / (0.1 * 55 \text{ m}^2/\text{bu}) * 4046.856 \text{ m}^2/\text{ac} = 43,405 \text{ oysters/ac} \quad (\text{Eqn. } 2)$$

where:

59.5 oysters/bushel = arithmetic mean of

Chester River Site 1: Buoy Rock = 34 oysters/bushel

Chester River Site 2: Old Field = 85 oysters/bushel

Oyster density estimates for low quality habitat.

Density estimates used for low quality habitat are not well documented. For the period 1994-2001, the mean oyster density was 2.02 oysters/m² (personal communication, J. Vanisko). The 2.02 oysters/m² density used is believed to be based upon data from a 1994 patent tong survey of areas categorized as "mud with cultch" and "sand with cultch" by the MBBS. The researchers could not recall the basis for the 2002 oyster density estimate of 0.36 oyster/m². We assumed that the reduction was made to account for the increase in disease mortality in recent years. Examples of estimating oyster density on low quality habitat for the Chester River before/after 2002 are provided below:

$$\text{Before 2002: Oysters/acre} = 2.02 \text{ oysters/m}^2 * 4046.856 \text{ m}^2/\text{ac} = 8,175 \text{ oysters/ac} \quad (\text{Eqn. } 3)$$

$$\text{2002 and later: Oysters/acre} = 0.36 \text{ oysters/m}^2 * 4046.856 \text{ m}^2/\text{ac} = 1,457 \text{ oysters/ac} \quad (\text{Eqn. } 4)$$

Assumptions for Step 3

1. Oyster abundance statistics developed from data collected by the Fall Survey were representative of the associated basins.
2. The Fall Survey provided a representative sample of the classified high quality habitat within each basin, including natural oyster bars, managed oyster harvest reserves and oyster sanctuaries. Even though seed densities for plantings on

sanctuaries and harvest reserve areas are significantly greater, no subsequent population estimates were available, and so were not incorporated into these calculations.

3. The mean dredge tow area for obtaining one bushel of sample material and the defined dredge efficiency for the Fall Survey were representative and consistent throughout the 1994-2006 time series.
4. Oyster densities for low quality habitat derived from a 1994 patent tong survey were representative and consistent from 1994-2001 and oyster density defined for low quality habitat in 2002 was representative and consistent from 2002-2006.

Step 4 – Calculation of the Estimated Oyster Population in MD Chesapeake Bay

The estimated density of oysters on high and low quality habitat for each basin was multiplied by the estimated amount of high and low quality habitat for each basin. Table 5 provides the values for this calculation for the Chester River Basin in 2004.

The estimate of Maryland's Chesapeake Bay annual population was calculated as the sum of the populations for Maryland's eight basins (Figure 2). Summary statistics from the 2004 calculation are presented in Table 6.

Step 5 – Calculation of Estimated Oyster Biomass in MD Chesapeake Bay

The estimated annual biomass of small and market oysters for each basin was calculated in two steps. In order to distribute the population among size groups, the total estimated number of small and market oysters for each basin was multiplied by the relative abundance within each 5-mm size class ≥ 35 mm. The relative abundance values were taken from the Fall Survey. This distribution was converted to biomass (grams per dry tissue weight) by the formula given below:

$$\log(10) \text{ weight} = -3.7595 + 2.062584 * \log(10) \text{ size class} \quad (\text{Jordan et al. 2002})$$

(Eqn 5)

where:

size class = length in mm of the midpoint of a given size class

Total biomass was calculated as the sum of biomass in all size classes for all basins.

RESULTS

The point estimate of the 1994 baseline population of small and market sized oysters in Maryland Chesapeake Bay was estimated to be 538.3 million oysters. The point estimate of the biomass was 704.8 million grams dry tissue weight. Although both the point estimates of the 2006 population (201.0 million oysters) and biomass (338.6 million g) are lower than the 2004 estimates, the population has actually varied without trend due to the high variance associated with the estimates (Figure 2, Table 7).

DISCUSSION

The methodology presented in this report was developed through an interstate research project jointly funded in 2000 by the National Oceanic and Atmospheric Administration Chesapeake Bay Stock Assessment Committee and U.S. Environmental Protection Agency Chesapeake Bay Program to estimate the 1994 baseline population of oysters and to develop a methodology for producing annual oyster population estimates that could be used to measure progress toward achieving the Chesapeake Bay 2000 Agreement goal of increasing the Chesapeake Bay oyster population 10-fold from its 1994 level of abundance by 2010. This methodology is based upon several critical assumptions that are identified in this report. Variance estimates for these population estimates are currently being developed and will be published as a separate report.

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Table 1. Relative abundance of high quality bottom classifications remaining from the values reported by the MBBS and Yates surveys, as reported by the 1999-2000 MD DNR Cooperative Oxford Laboratory acoustic benthic habitat survey.

Habitat Classification	Bottom Classification	MBBS	Yates
		Percent Remaining	
High Quality Habitat	Clean shell	1.16	0.62
	Lightly sedimented shell with sand	1.21	0.33
	Total	2.37	0.95
Low Quality Habitat	Heavily sedimented shell with mud	21.64	8.33
	Heavily sedimented shell with sand	5.16	2.96
	Total	26.80	11.29
Total Habitat	Total	29.17	12.24
Habitat Lost	Mud	20.58	32.52
	Sand	48.00	53.36
	Total	68.58	85.88
Other	Gravel/cobble/boulder	1.37	1.06
	Unidentified	0.88	0.82

Table 2. Values from the 2004 oyster habitat estimate for the Choptank River basin. The Choptank provides an example of the use of Yates values.

Area Source	Bottom Class	Original Estimate	Adjustment Factor	Current Estimate of High Quality Habitat	Current Estimate of Low Quality Habitat
MBBS	High Quality	14,397.42 acres	2.37%	340.18 acres*	
			26.80%		3,859.55 acres
	Low Quality		0%		
Yates	Not specified	1,028.43 acres	0.95%	10.20 acres*	
			11.29%		115.68 acres
Shell Plantings	High Quality	164.32 acres	0 %	164.32 acres	
Leased Bottom	Not specified		0%		

* Values may vary by a maximum of 1.12 acres due to differences in decimal precision in software employed.

Table 3. Acreages for each habitat type in each basin. Total acreage shown in bold text were used to calculate the annual Maryland oyster population from 1994 – 2006.

Basin	Habitat Type*	High Quality Habitat (ac)	Low Quality Habitat (ac)	Sum
Chester	B	126.27	1,432.65	1,558.92
	P	481.23	0.00	481.23
Total		607.50	1,432.65	2,040.15
Choptank	B	340.18	3,859.55	4,199.73
	P	164.32	0.00	164.32
	Y	10.20	115.68	125.88
Total		514.70	3,975.23	4,489.93
Eastern Bay	B	76.28	865.48	941.76
	P	192.11	0.00	192.11
	Y	58.09	659.11	717.20
Total		326.48	1,524.59	1,851.07
Little Choptank	B	79.36	900.41	979.77
	P	1.00	0.00	1.00
Total		80.36	900.41	980.77
Md. Mainstem	B	1,111.05	12,605.65	13,716.70
	P	684.33	0.00	684.33
Total		1,795.38	12,605.65	14,401.03
Md. Potomac	B	300.31	3,407.26	3,707.57
	P	12.86	0.00	12.86
Total		313.17	3,407.26	3,720.43
Patuxent	B	129.24	1,466.32	1,595.56
	P	56.25	0.00	56.25
Total		185.49	1,466.32	1,651.81
Tangier	B	563.15	6,389.26	6,952.41
	P	56.89	0.00	56.89
Total		620.04	6,389.26	7,009.30
Grand Total				36,144.49

* Habitat codes are as follows:
 B = Maryland Bay Bottom Survey
 P = shell plantings
 Y = Yates survey

Table 4. Small- and market-size oysters per bushel of cultch material in samples collected by the 2004 MD DNR Fall Oyster Survey.

Basin	Water Body	Oyster Bar	Site Code	Oysters /Bu	Basin Average
Chester	Chester River	Buoy Rock	CHBR	34	59.50
Chester	Chester River	Old Field	CHOF	85	
Choptank	Broad Creek	Deep Neck	BCDN	48	24.88
Choptank	Choptank River	Cook Point	CRCP	1	
Choptank	Choptank River	Lighthouse	CRLI	8	
Choptank	Choptank River	Oystershell Point	CROS	20	
Choptank	Choptank River	Royston	CRRO	43	
Choptank	Choptank River	Sandy Hill	CRSH	20	
Choptank	Choptank River	Tilghman Wharf	CRTW	39	
Choptank	Tred Avon River	Double Mills	TADM	20	
Eastern Bay	Eastern Bay	Bugby	EBBU	64	
Eastern Bay	Eastern Bay	Hollicutts Noose	EBHN	96	
Eastern Bay	Eastern Bay	Parsons Island	EBPI	57	
Eastern Bay	Miles River	Bruffs Island	MRBI	74	
Eastern Bay	Miles River	Long Point	MRLP	42	
Eastern Bay	Miles River	Turtle Back	MRTU	152	
Little Choptank	Little Choptank	Cason	LCCA	27	22.50
Little Choptank	Little Choptank	Ragged Point	LCRP	18	
Md Mainstem	Bay North	Swan Point	BNSP	37	57.57
Md Mainstem	Middle Bay	Stone Rock	MESR	54	
Md Mainstem	Upper Bay	Hacketts	UBHA	76	
Md Mainstem	Western Shore	Butlers	WSBU	123	
Md Mainstem	Western Shore	Flagpond	WSFP	34	
Md Mainstem	Western Shore	Hog Island	WSHI	74	
Md Mainstem	Western Shore	Holland Point	WSHP	5	56.57
Md Potomac	Potomac River	Cornfield Harbor	PRCH	54	
Md Potomac	Potomac River	Lower Cedar Point	PRLC	18	
Md Potomac	Potomac River	Ragged Point	PRRP	0	
Md Potomac	St. Mary's River	Chickencock	SMCC	67	
Md Potomac	St. Mary's River	Pagan	SMPA	214	
Md Potomac	Wicomico River	Lancaster	WWLA	27	17.0
Md Potomac	Wicomico River	Mills West	WWMW	16	
Patuxent	Patuxent River	Broome Island	PXBI	17	75.20
Tangier	Fishing Bay	Goose Creek	FBGC	7	
Tangier	Holland Straits	Holland Straits	HOHO	151	
Tangier	Honga River	Normans	HRNO	12	
Tangier	Manokin River	Georges	MAGE	176	
Tangier	Nanticoke River	Wilson Shoal	NRWS	33	
Tangier	Pocomoke Sound	Marumsko	PSMA	106	
Tangier	Tangier Sound	Back Cove	TSBC	120	
Tangier	Tangier Sound	Old Womans Leg	TSOW	7	
Tangier	Tangier Sound	Piney Island	TSPI	85	
Tangier	Tangier Sound	Sharkfin Shoal	TSSS	55	

Table 5. Habitat and density for the 2004 Chester River oyster population estimate.

Habitat Quality	Estimated Oyster Density (oysters/m²)	Estimated Oyster Density (oysters/acre)	Estimated Available Habitat (acres)	Estimated Oyster Population (# of oysters)
High	59.50	43,405	607.50	26,368,452
Low	0.36	1,457	1432.65	2,087,182
Total				28,455,634

Table 6. Input data and point estimates of the 2004 oyster population by basin and for all basins combined.

		Chester	Choptank	Eastern Bay	Little Choptank	Md Mainstem	Md Potomac	Patuxent	Tangier	Total
Habitat (ac)										
High quality	MBBS	126	340	76	79	1,111	300	129	563	2,726
	Yates	0	10	589	0	0	0	0	0	68
	Shell plantings	481	164	192	1	684	13	56	57	1,649
	Leased bottom	0	0	0	0	0	0	0	0	0
	<i>Total</i>	<i>608</i>	<i>515</i>	<i>326</i>	<i>80</i>	<i>1795</i>	<i>313</i>	<i>185</i>	<i>620</i>	<i>4,443</i>
Low quality	MBBS	1,433	3,860	865	900	12,606	3,407	1,466	6,389	30,927
	Yates	0	116	659	0	0	0	0	0	775
	Shell plantings	0	0	0	0	0	0	0	0	0
	Leased bottom	0	0	0	0	0	0	0	0	0
	<i>Total</i>	<i>1,433</i>	<i>3,975</i>	<i>1,525</i>	<i>900</i>	<i>12,606</i>	<i>3,407</i>	<i>1,466</i>	<i>6,389</i>	<i>31,701</i>
Density (oysters/ ac)										
	on high quality habitat	43,405	18,146	58,967	16,414	41,998	41,268	12,401	54,858	N/A
	on low quality habitat	1,457	1,457	1,457	1,457	1,457	1,457	1,457	1,457	N/A
Population										
	on high quality habitat	26,368,452	9,339,823	19,251,672	1,318,997	75,402,331	12,924,052	2,300,334	34,014,096	180,919,757
	on low quality habitat	2,087,182	5,791,386	2,221,127	1,311,779	18,364,770	4,963,929	2,136,235	9,308,309	46,184,717
	Total	28,455,634	15,131,209	21,472,799	2,630,776	93,767,102	17,887,980	4,436,568	43,322,405	227,104,473

Table 7. Maryland Oyster Population Estimates by Basin (1994-2006). (Point estimates provided without variance estimates.)

	Chester	Choptank	Eastern Bay	Little Choptank	Md Mainstem	Md Potomac	Patuxent	Tangier	Total
1994	50,931,713	84,921,147	22,545,307	14,922,786	171,339,200	57,650,274	13,069,161	122,881,578	538,261,167
1995	49,602,212	78,397,351	19,925,492	18,147,001	165,726,123	64,210,209	16,452,005	92,621,698	505,082,090
1996	54,255,468	81,964,318	27,427,690	16,241,783	187,055,815	49,915,425	17,263,887	80,092,569	514,216,955
1997	84,612,425	68,728,991	25,879,617	12,929,635	152,441,841	56,377,451	17,669,828	77,333,447	495,973,236
1998	90,373,600	101,958,110	97,090,957	15,919,361	166,474,533	72,793,607	16,587,319	73,579,232	634,776,719
1999	91,038,350	92,571,353	59,619,661	15,040,030	175,829,661	47,239,232	17,263,887	87,058,222	585,660,398
2000	89,265,681	78,068,814	45,647,314	15,831,428	154,125,764	42,082,666	22,405,809	80,590,116	528,017,593
2001	52,039,632	59,248,367	29,333,010	10,877,861	154,499,970	36,795,554	13,475,103	74,031,547	430,301,043
2002	19,592,289	13,019,189	12,938,552	1,487,645	60,275,743	8,815,035	4,030,627	36,809,068	156,968,148
2003	32,444,139	12,268,248	15,677,450	2,103,177	110,232,127	32,150,128	9,307,863	72,134,878	286,318,010
2004	28,455,634	15,131,209	21,472,799	2,630,776	93,767,102	17,887,980	4,436,568	43,322,405	227,104,473
2005	27,790,883	25,644,376	21,433,105	2,865,264	118,651,742	12,372,413	6,330,961	25,636,885	240,725,629
2006	30,228,303	26,160,648	16,391,945	3,832,529	81,792,538	13,710,509	8,090,039	20,751,882	200,958,393

Table 8. Maryland Oyster Biomass Estimates (kg dry weight by basin, 1994-2006). (Point estimates provided without variance estimates.)

	Chester	Choptank	Eastern Bay	Little Choptank	Main Stem	Md Potomac	Patuxent	Tangier	Total
1994	100,604	94,992	42,493	10,646	246,705	67,277	27,441	114,605	704,762
1995	70,485	94,478	33,632	19,283	250,377	65,921	28,462	104,964	667,602
1996	71,374	103,967	30,102	19,281	235,172	62,334	22,442	112,748	657,422
1997	96,792	101,459	35,789	17,274	252,742	77,386	36,089	114,803	732,335
1998	105,304	110,356	89,998	20,978	219,640	84,986	37,697	113,062	782,022
1999	139,880	120,713	71,672	19,039	258,226	54,954	45,612	112,437	822,531
2000	125,837	116,362	66,038	17,820	253,229	47,230	30,073	74,682	731,269
2001	84,176	87,227	46,411	13,053	208,766	48,182	18,442	84,761	591,017
2002	38,197	23,450	18,123	16,929	93,820	13,881	7,941	34,818	247,158
2003	55,923	18,329	22,099	1,373	129,819	18,447	7,339	63,505	316,834
2004	42,286	23,390	28,610	2,654	134,323	16,281	5,539	54,488	307,572
2005	51,360	35,148	30,594	3,751	173,022	20,802	11,413	41,754	367,844
2006	67,381	41,156	28,145	5,116	122,600	26,074	11,707	36,388	338,566

Figure 1. Map showing the 8 Maryland basins used in oyster population estimates.

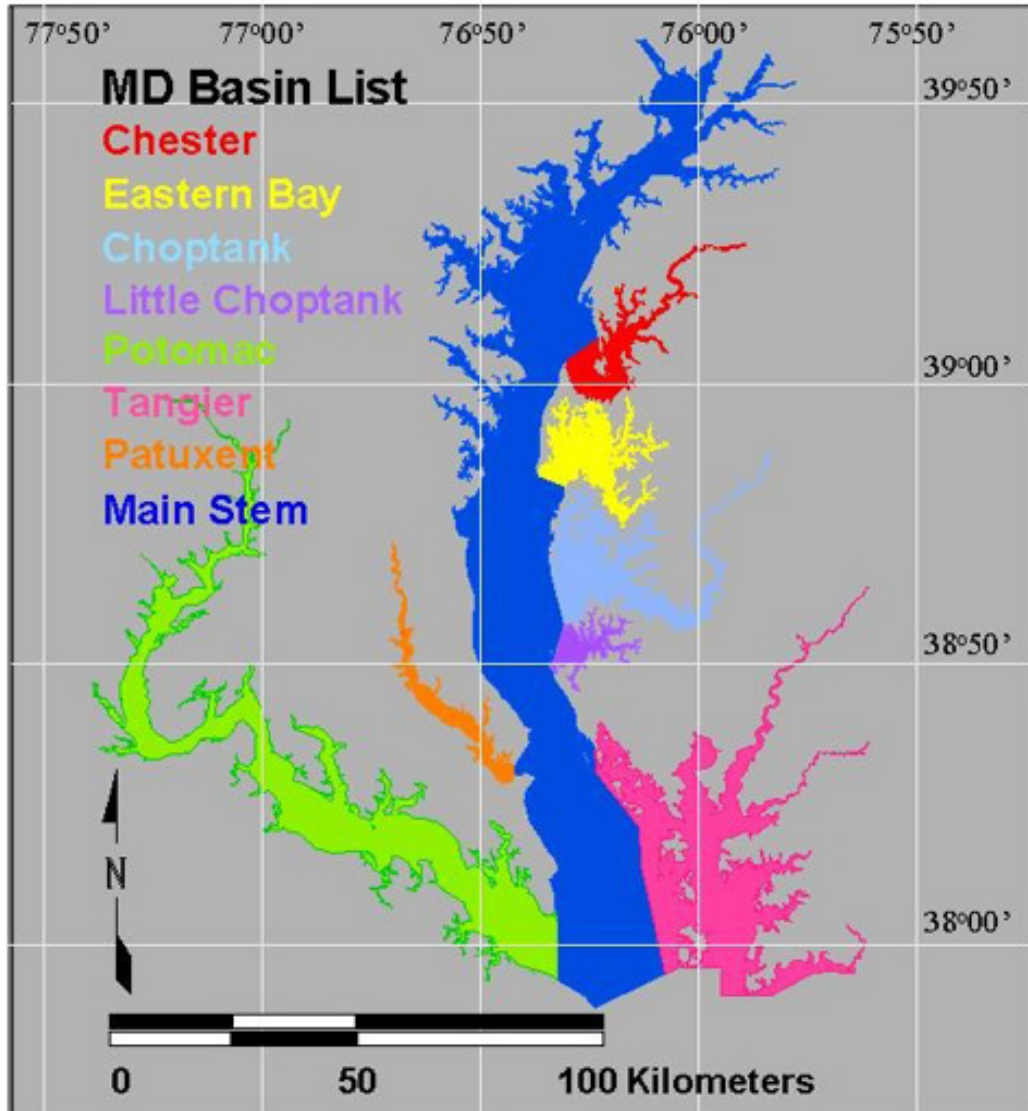


Figure 2. Maryland Chesapeake Bay Oyster Population - Point Estimates for 1994-2006.

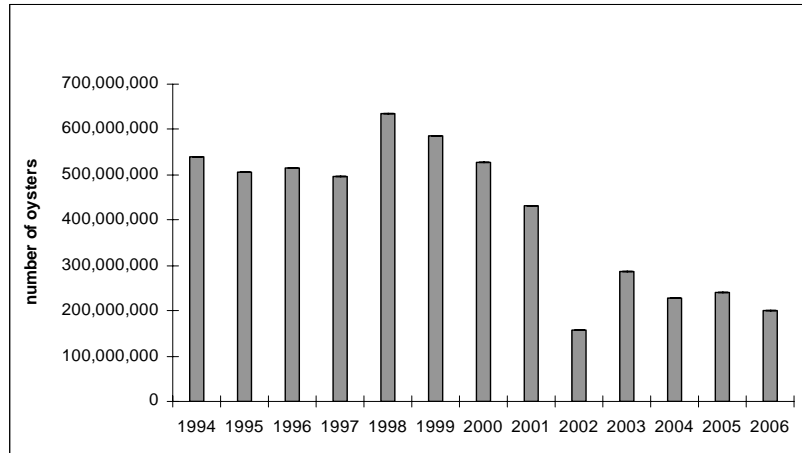


Figure 3. Maryland Chesapeake Bay Oyster Biomass- Point Estimates for 1994-2006.

