

# **Economic Value of the Maryland Coastal Bays Watershed**

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*Prepared for*

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## Table of Contents

<b>Section</b>	<b>Page</b>
<b>List of Tables</b> .....	i
<b>List of Figures</b> .....	ii
<b>1. Introduction</b> .....	1
Objectives .....	1
An Economic Engine .....	2
History .....	3
The Watershed .....	4
Land Use .....	7
Population .....	8
<b>2. Methods</b> .....	11
Valuation Techniques .....	11
Scope of Work .....	11
<b>3. Economic Value</b> .....	13
Water Quality .....	17
Water Supply .....	19
Fish/Wildlife .....	21
Recreation .....	26
Agriculture .....	29
Forests .....	30
Public Parks .....	31
<b>4. Ecosystem Services</b> .....	32
Related Research .....	32
Watershed Ecosystem Services .....	34
<b>5. Jobs and Wages</b> .....	39
Direct/Indirect Water Jobs .....	40
National Coastal Economy .....	42
Recreation Jobs .....	43
Farm and Wetland Jobs .....	45
Environmental Jobs .....	46
<b>References</b> .....	48
<b>Appendix</b> .....	51

## List of Tables

<b>Table</b>	<b>Page</b>
1. Estimates of economic value of the Maryland Coastal Bays watershed	3
2. Top industries by economic output in the Maryland Coastal Bays watershed	3
3. States in the Coastal Bays watershed	4
4. Land use by state in the Maryland Coastal Bays watershed	8
5. Land use change in the Maryland Coastal Bays watershed	8
6. Population within the Maryland Coastal Bays watershed	9
7. Population of Maryland counties	9
8. Annual economic value of the Maryland Coastal Bays watershed	15
9. Annual economic value of the Maryland Coastal Bays watershed by state	16
10. Annual WTP for water quality benefits in New England	17
11. Annual WTP for water quality benefits in the Maryland Coastal Bays watershed	17
12. Increased property value resulting from improved water quality	18
13. Added property value due to improved water quality in Maryland Coastal Bays	19
14. Drinking water treatment costs based on percent of forested watershed	19
15. Wastewater discharge capacity in the Maryland Coastal Bays watershed	20
16. Freshwater-use values in the United States	21
17. Contributions to local economy from Chincoteague National Wildlife Refuge	22
18. Top commercial fishing ports in the United States in 2016	22
19. Hard clam landings in Maryland and Delaware	24
20. Summer flounder catch by state in 2014 and 2015	25
21. Value of fishing, hunting, wildlife/birding recreation in Maryland Coastal Bays	27
22. Economic value of recreation in the Maryland Coastal Bays watershed	27
23. Recreational powerboat expenditures in the Maryland Coastal Bays watershed	28
24. Literature review of coastal beach visitor studies in the mid-Atlantic U.S.	28
25. Delaware state parks visitation & visitor spending FY 2016/2017	29
26. Agricultural sales in the Maryland Coastal Bays watershed, 2012	29
27. Economic value of agriculture in the Maryland Coastal Bays watershed	30
28. Economic/Environmental benefits of forests in Maryland Coastal Bays watershed	30
29. Economic benefits of forests by state in the Maryland Coastal Bays watershed	30
30. State and county parks in the Maryland Coastal Bays watershed	31
31. Value of state and county parks in the Maryland Coastal Bays watershed	31
32. Ecosystem services values for Cecil County, Maryland	33
33. Forest ecosystem service values for U.S. temperate forests	33
34. Comparison of ecosystem goods and services values from various studies	34
35. Value of ecosystem goods and services in the Maryland Coastal Bays watershed	35
36. Low range of ecosystem services in the Maryland Coastal Bays watershed	38
37. High range of ecosystem services in the Maryland Coastal Bays watershed	38
38. Jobs and wages directly and indirectly related to Maryland Coastal Bays watershed	39
39. Employment in Maryland Coastal Bay counties in 2016	40
40. Maryland Coastal Bays watershed jobs and wages in 2016	40
41. Direct/indirect watershed-related jobs in Maryland Coastal Bays watershed, 2016	41
42. Sectors and industries in the ocean/coastal economy	42

43. Coastal employment, wages, and GDP in the Maryland Coastal Bays watershed	43
44. Ocean employment, wages, and GDP in the Maryland Coastal Bays watershed	43
45. Fishing, hunting, wildlife recreation jobs in Maryland Coastal Bays watershed	44
46. Outdoor recreation jobs in the Maryland Coastal Bays watershed	45
47. Farm jobs in the Maryland Coastal Bays watershed	46
48. Wetland jobs in the Maryland Coastal Bays watershed	46
49. Watershed organization jobs in the Maryland Coastal Bays watershed	46
50. Public water supply jobs in the Maryland Coastal Bays watershed	47
51. Wastewater utility jobs in the Maryland Coastal Bays watershed	47

### List of Figures

<b>Figure</b>	<b>Page</b>
1. The Maryland Coastal Bays watershed	6
2. Land cover in the Maryland Coastal Bays watershed	7
3. Population change in Worcester County, 2000-2010 and 2010-2016	10
4. Economic value of water resources	13
5. Annual economic value of the Maryland Coastal Bays watershed	14
6. Willingness to pay for improved water quality in the Maryland Coastal Bays	18
7. Major freshwater withdrawals in the Maryland Coastal Bays watershed	20
8. Commercial fish landings at Maryland Coastal Bays ports	23
9. Maryland blue crab landings	24
10. Crab landings in the Maryland Coastal Bays	25
11. Maryland commercial summer flounder harvest in pounds	26
12. Ecosystem services value of the Maryland Coastal Bays watershed, by state	34
13. Ecosystem service areas in the Maryland Coastal Bays watershed	36
14. Value of ecosystem services within the Maryland Coastal Bays watershed	36
15. Ecosystem service value of habitat in the Maryland Coastal Bays watershed	37
16. Range of ecosystem services value estimates in Maryland Coastal Bays watershed	37

## Executive Summary

The water, natural resources, and ecosystems in the Maryland Coastal Bays watershed contribute an economic value of \$1 to \$3 billion annually to the regional Delaware, Maryland, and Virginia economy. This report examines that economic value in three different ways:

- 1. Economic value directly related to the Maryland Coastal Bays watershed water resources and habitats.** The Maryland Coastal Bays watershed contributes over **\$1.2 billion** in annual economic activity from water quality, water supply, fish/wildlife, recreation, agriculture, forests, and public parks benefits. Delaware, Maryland, and Virginia each contribute **over \$200 million, \$700 million, and \$300 million**, respectively, to the Coastal Bays watershed annual economy.
- 2. Value of goods and services provided by the Maryland Coastal Bays watershed ecosystems.** Using natural capital as a measure of value, habitats in the Maryland Coastal Bays watershed provide **\$3 billion** annually in ecosystem goods and services in 2017 dollars, with a net present value (NPV) of **\$97 billion** calculated over a 100-year period. By state, the ecosystem services value of the watershed is **\$248 million** in Sussex County, Delaware; **\$1.9 billion** in Worcester County, Maryland; and **\$807 million** in Accomack County, Virginia.
- 3. Employment related to the Maryland Coastal Bays watershed resources and habitats.** Using employment as a measure of value, natural resources within the Maryland Coastal Bays watershed directly and indirectly supports over **50,000 jobs** with over **\$1.5 billion** in annual wages.

The purpose of these estimates is to demonstrate that the Maryland Coastal Bays watershed provides real and significant economic benefits to the regional economy in Delaware, Maryland, and Virginia and are worthy of investment to keep these natural resources healthy and productive. Estimates were made by taking values from existing literature and studies and applying them to the Maryland Coastal Bays watershed using ecological economics and benefits-transfer techniques described in this report. Values are converted to 2017 dollars based on the change in the Northeast Region Consumer Price Index except where noted.

Note that the values in the three categories are not summed because there is some overlap between certain values within each category that could result in double counting. For example, the jobs of fishermen that contribute to employment and wages are also a factor in the economic activity generated from fishing, and the ecosystem values of forests for water-quality benefits may be at least partially captured in the economic value of water supply. Accurately determining (and eliminating) this overlap is difficult within the scope of this analysis. Some values were not included in these estimates because the data to assess them either are not readily available or do not exist. For example, the full amount of economic activity and jobs associated with the industries that rely on the Maryland Coastal Bays watershed for their processes is not included here, because identifying those companies and gathering information on their economic activity is beyond the scope of this analysis.

# 1. Introduction

The Maryland Coastal Bays watershed supports significant ecological communities and is the economic engine that drives a large tourist water-based economy in coastal Delaware, Maryland, and Virginia. The bays support recovering oyster, hard clam, blue crab and finfish fisheries and provide for hunting, fishing, and boating recreation activities. In 1995, the Governor of Maryland petitioned Congress to designate the Maryland Coastal Bays as one of just 28 embayments in the National Estuary Program administered by the Environmental Protection Agency (EPA) under Section 320 of the Federal Clean Water Act Amendments of 1987.

Since 1999 and as revised in 2015, the Maryland Coastal Bays Program (2015) is charged with implementing a Comprehensive Conservation and Management Plan (CCMP) that guides the restoration and protection of the bay watershed. The following economic analysis is designed to comply with the following objectives of the CCMP:

CE 1.1.1. Analyze the economic contributions of farming, forestry, commercial & recreational fishing, (traditional and low impact) tourism and other natural resource dependent economic sectors in the watershed.

CE 1.1.4. Conduct an economic analysis of the value of the National Estuary Program to the watershed.

CE 1.1.5. Communicate to local businesses the benefits of ecosystem health to economic development, tourism, recreation and quality of life.

## Objectives

This report summarizes the economic value of water, natural resources, and ecosystems in the Maryland Coastal Bays watershed in Sussex County, Delaware; Worcester County, Maryland; and Accomack County, Virginia estimated as:

1. Economic activity including market and non-market value of water quality, water supply, fish/wildlife, recreation, agriculture, forests, and public parks benefits.
2. Ecosystem goods and services (natural capital) value provided by habitat such as wetlands, beaches, open water, forests, and farms.
3. Jobs and wages directly and indirectly associated with the Maryland Coastal Bays watershed.

These estimates demonstrate that the Maryland Coastal Bays watershed provides significant economic benefits to the regional economy and are worthy of investment to keep them healthy and productive. Value-transfer techniques were applied by selecting data from published literature and applying them to the Maryland Coastal Bays watershed using ecological economics techniques.

Values in the three categories above are not summed because there may be overlap and double-counting. For example, the jobs of fishermen are also a factor in economic activity from fishing. The ecosystem values of forests for water-quality benefits are at least partially captured in the economic value of water supply. Accounting for this overlap is difficult. However, each of these estimates clearly indicates that the Maryland Coastal Bays watershed is an economic engine that contributes **\$1 billion to \$3 billion** annually to the coastal Delaware, Maryland, and Virginia economy.

The estimates presented in this report can be considered in the low range because the data to assess economic value are not readily available in some categories. For example, the full amount of economic activity and jobs associated with the companies and industries that rely on the bay watershed for their processes is not included here, because identifying those companies and gathering information on their economic activity is complicated and beyond the scope of this analysis. Since some estimates were made by taking values from existing literature, the values for various activities differ greatly in how they were determined and applied to the bay's water resources making it difficult to accurately compare values across uses.

Other values, like the value of clams for filtering water, are not included in this work because they are not yet well documented in the literature on valuation. The field of ecosystem services valuation in particular is still a new and growing field. As our knowledge and understanding of these valuation techniques grows and is applied to more resources, we will continue to incorporate them in our understanding of the value of the Maryland Coastal Bays watershed.

## **An Economic Engine**

Clean water is the most valuable natural resource in the Maryland Coastal Bays watershed situated on the outer Coastal Plain along the Atlantic Ocean in Sussex County, Delaware; Worcester County, Maryland; and Accomack County, Virginia. The following report tabulates the substantial economic value of the Maryland Coastal Bays watershed. Society tends to underprice water based on its value for single uses (i.e., drinking water), and not consider its full value for all uses, such as recreation, fish and wildlife, and tourism. This report quantifies the highest multi-objective value of water for its wide range of habitat, recreation, and ecological benefits in the Maryland Coastal Bays watershed.

Previous studies indicate the Maryland Coastal Bays watershed's rivers, beaches, wetlands, and forests have long supported a multibillion dollar coastal fishing, tourism, recreation, and hunting/fishing/birding economy (Table 1). The Greeley-Polhemus Group (2001) estimated the market and non-market economic value of the coastal bays to Worcester County, Maryland was over \$500 million per year in 2000. The Maryland Coastal Bays Program (2012) reported that employee income from tourism topped \$700 million annually. The University of Maryland Institute for Government Services (2002) estimated that the annual economic impact of nature tourism and cultural activities in Worcester County was \$293 million that supported 6,927 full time jobs. The EPA National Center for Environmental Economics (2001) reported the Maryland Coastal Bays supported \$1.6 billion in economic output and 21,296 jobs with \$415 million in wages. Of the 28 National Estuary Programs throughout the U.S., the Maryland Coastal Bays

ranked 2<sup>nd</sup> in the number of tourism jobs and 3<sup>rd</sup> in tourism economic output. The EPA National Center for Environmental Economics (2001) reported that tourism alone in the Maryland Coastal Bays supported \$133 million in economic output and 2,269 jobs. Top industries in the Maryland Coastal Bays watershed include real estate, poultry, and hotel/lodging (Table 2).

**Table 1.** Estimates of economic value of the Maryland Coastal Bays watershed

Reference	Economic Output (\$ million)	Jobs	Wages (\$ million)
Greeley-Polhemus Group (2001)	500		
EPA NCEE (2001)	1,600	21,296	415
EPA NCEE (2001)	133	2,269	
University of Maryland (2002)	293		6,927
MD Coastal Bays Program (2012)	700		

**Table 2.** Top industries by economic output in the Maryland Coastal Bays watershed (EPA NCEE 2001)

Rank	Industry	Output*	Employment	Employee Compensation*
1	Real Estate	201,380	1,329	11,939
2	Poultry Processing	148,490	1,072	26,508
3	Hotels and Lodging Places	127,840	1,816	32,323
4	Eating & Drinking	120,990	3,181	46,124
5	Poultry and Eggs	86,900	286	2,993
6	New Residential Structures	51,940	419	6,569
7	Wholesale Trade	44,800	447	16,838
8	State & Local Government - Non-Education	33,000	783	25,894
9	Banking	31,160	267	7,465
10	Other State and Local Govt Enterprises	29,930	177	6,980
<b>Total</b>	<b>Maryland Coastal Bays Totals</b>	<b>1,582,510</b>	<b>21,296</b>	<b>415,002</b>

\*thousands of dollars

## History

The State of the Maryland Coastal Bays report (2004) summarizes the recent history of this valuable estuary of national significance:

- 1928 – State begins landings survey of shellfish from bays.
- 1932 – Seagrass wasting disease begins destroying grass beds.
- 1933 – Storm surge opens Ocean City inlet stabilized by U.S. Army Corps of Engineers.
- 1948 – First dredging of Sinepuxent and Isle of Wright bays.
- 1958 – Heyday of leased oyster beds, oyster disease first reported.
- 1962 – Ash Wednesday Nor'easter devastates Atlantic coast.
- 1964 – Assateague State Park established.
- 1965 – Assateague Island National Seashore established.
- 1970 – Enactment of Maryland tidal wetlands law.
- 1972 – Maryland DNR begins fish seine and trawl survey, Federal Clean Water Act passed.



1982 – Seagrasses begin recovery.  
 1983 – Last commercial oyster harvest.  
 1986 – Observed decline in summer flounder fishery.  
 1987 – Nat'l. Park Service monitors water quality in Newport, Sinepuxent, Chincoteague bays.  
 1987 - Congress establishes National Estuary Program in Federal Clean Water Act.  
 1988 – US Army Corps of Engineers, State, and locals begin beach replenishment.  
 1989 – Maryland enacts non-tidal wetland law.  
 1993 – Federal joint assessment of Maryland, Delaware, and Virginia coastal bays begins.  
 1995 – Governor nominates Maryland Coastal Bays to the National Estuary Program.  
 1996 – Maryland Coastal Bays Program established  
 1997 – Maryland DNR plants bay scallops.  
 1998 – DNR detects brown tide, monitors pfiesteria at 29 stations, Isle of Wright, Newport bays.  
 1999 – MD Coastal Bays Comprehensive Conservation and Management Plan (CCMP) adopted  
 2000 – National Coastal Assessment begins  
 2001 – Maryland DNR begins routine water quality monitoring at 45 stations.  
 2002 - Blue crab fisheries management plan in effect.  
 2003 - Coastal Bays watershed included in Critical Areas Law.  
 2004 – CCMP Phase II begins, 2004 State of the Bays Report released.  
 2009 – CCMP Phase III begins. 2009 State of the Bays Report released.

## The Watershed

Of the 144 bays and estuaries in the United States, Congress has declared 28 bays as “estuaries of national significance” as part of the National Estuary Program (NEP) under Section 320 of the Federal Clean Water Act. In 1995, the Governor of Maryland petitioned Congress to declare the Maryland Coastal Bays as one of just 28 of these nationally significant estuaries in the NEP (2007). In 1996 the Maryland Coastal Bays Program was established to implement a Comprehensive Conservation and Management Plan (CCMP) originally adopted in 1999 and amended in 2015.

The Maryland Coastal Bays are located on the Atlantic Coast of the Delmarva Peninsula and its watershed includes portions of Accomack County, Virginia; Sussex County, Delaware; Worcester County, Maryland (Figure 1). Approximately 2/3 of the Coastal Bays watershed lies in Maryland, one tenth is in Delaware, and about ¼ of the watershed is in Virginia (Table 3). In 2016, the 456-square-mile Coastal Bays watershed was home to a year-round population of 56,473 and hosts close to 400,000 summer residents in the Delaware, Maryland; and Virginia portions of the watershed.

**Table 3.** States in the Coastal Bays watershed

State	Area (mi <sup>2</sup> )	Area (%)
Delaware	49	11%
Maryland	290	64%
Virginia	117	26%
<b>Total</b>	<b>456</b>	<b>100%</b>

The Maryland Coastal Bays are enclosed by 284 miles of shoreline and 115 square miles of wetlands. The bays are very shallow with an average water depth of 5 feet, depths mostly less than 10 feet, a surface area of 107,000 acres (168 mi<sup>2</sup>), and a volume of 113 billion gallons (Dennison et al. 2016). The Maryland Coastal Bays include Assawoman Bay, Isle of Wight Bay, Sinepuxent Bay, Newport Bay, and Chincoteague Bay that are a shallow lagoon system connected to the ocean at the Ocean City and Chincoteague inlets. Tides range from 3.4 feet at Ocean City Inlet to 1.5 feet in Assawoman Bay and 0.4 feet in Chincoteague Bay. The Maryland Coastal Bays are degraded by high nutrient loads, low dissolved oxygen, and high algal levels. Since the bays are connected to the ocean by only two inlets and freshwater inputs from the relatively small watershed are limited, water in the bay is recirculated every few months.

Although the quality of the Maryland Coastal Bays ecosystem is currently in fair condition, “the water quality and biodiversity of the Coastal Bays, as a whole, are declining and the ecosystem remains extremely vulnerable to both natural and human-induced impacts which threaten to overwhelm the progress made to date.” Major areas of interest in the watersheds are Ocean City, Assateague Island National Seashore, Ocean Pines, and Berlin in Maryland; Chincoteague National Wildlife Refuge and Wallops Island National Wildlife Refuge in Virginia and Fenwick Island State Park, South Bethany, and Bethany Beach in Delaware.

The Maryland Coastal Bays Program (2012) reported the following numbers for the watershed:

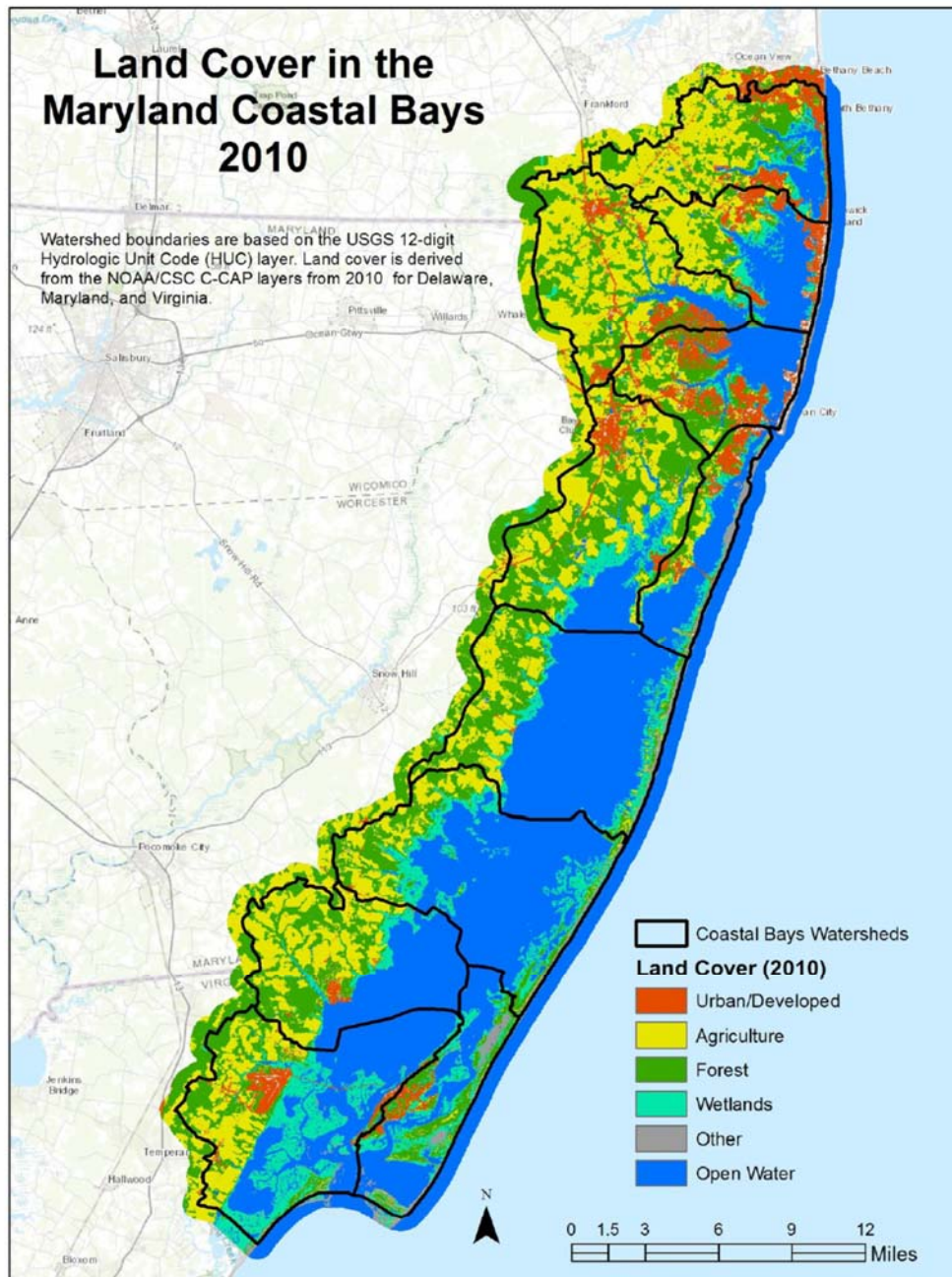
Shoreline	284 miles
Wetlands drained	25,000 acres
Forests lost	60,000 acres
Watershed area	456 square miles
Chesapeake watershed	64,000 square miles
Average depth of coastal bays	3.5 feet
Annual visitors to bay watershed	8.5 million
Fishing/crabbing economy	\$21 million
Employee income from tourism	\$700 million
Year-round population in 2010	37,000
Year-round population by 2020	50,000
Ocean City visitors summer weekends	300,000
Reptile/amphibian species	59 species
Fish species	115 species
Bird species	360 species
Mammal species	44 species
Rare, threatened, endangered species	108 species



**Figure 1.** The Maryland Coastal Bays watershed (MCBP 2015)

## Land Use

According to the NOAA Coastal Services Center (2010), 456-square mile Maryland Coastal Bays watershed is covered by 7% urban developed land, 38% marine/water/bay, 1% beach/dune, 25% wetlands, 23% agricultural land, and 7% forest (Figure 2 and Table 4). Between 1996 and 2010, the watershed lost almost 2 mi<sup>2</sup> of wetlands, 3 mi<sup>2</sup> of agriculture, and 0.2 mi<sup>2</sup> of forest and gained 4.2 mi<sup>2</sup> of urban land (Table 5).



**Figure 2.** Land cover in the Maryland Coastal Bays watershed (NOAA CSC 2010)

**Table 4.** Land use by state in the Maryland Coastal Bays watershed  
(NOAA CSC 2010)

Land Use	Sussex Co. DE, 2010 (mi <sup>2</sup> )	Worcester Co. MD, 2010 (mi <sup>2</sup> )	Accomack Co. VA, 2010 (mi <sup>2</sup> )	Watershed Total, 2010 (mi <sup>2</sup> )
Agriculture	21.1	67.2	15.0	103.3
Barren	0.0	0.3	1.8	2.2
Forest	2.6	20.0	8.2	30.7
Urban	7.6	18.4	5.2	31.2
Water	4.7	111.0	51.9	167.6
Beach/Dune	0.2	3.4	1.6	5.3
Freshwater Wetlands	10.3	45.0	12.8	68.1
Saltwater Wetlands	2.6	24.9	19.9	47.3
<b>Total</b>	<b>49.2</b>	<b>290.1</b>	<b>116.4</b>	<b>455.6</b>
Land Use	(%)	(%)	(%)	2010 (%)
Agriculture	42.9%	23.2%	12.9%	22.7%
Barren	0.0%	0.1%	1.6%	0.5%
Forest	5.4%	6.9%	7.0%	6.7%
Urban	15.4%	6.3%	4.5%	6.8%
Water	9.5%	38.3%	44.6%	36.8%
Beach/Dune	0.5%	1.2%	1.4%	1.2%
Freshwater Wetlands	20.9%	15.5%	11.0%	14.9%
Saltwater Wetlands	5.2%	8.6%	17.1%	10.4%
<b>Total</b>	<b>100.0%</b>	<b>100.0%</b>	<b>100.0%</b>	<b>100.0%</b>

**Table 5.** Land use change in the Maryland Coastal Bays watershed  
(NOAA CSC 1996 and 2010)

Land Use	1996 (mi <sup>2</sup> )	2010 (mi <sup>2</sup> )	Change (mi <sup>2</sup> )
Agriculture	106.2	103.3	-2.9
Barren	2.1	2.2	0.1
Forest	30.9	30.7	-0.2
Urban	26.9	31.2	4.2
Water	167.2	167.6	0.4
Beach/Dune	5.1	5.3	0.1
Freshwater Wetlands	69.3	68.1	-1.2
Saltwater Wetlands	48.0	47.3	-0.7
<b>Total</b>	<b>455.6</b>	<b>455.6</b>	<b>0.0</b>

## Population

In 2016, the 456-square-mile Coastal Bays watershed in Sussex County, Delaware; Worcester County, Maryland; and Accomack County, Virginia was home to a year-round population of 56,473 and a summer population of close to 400,000 summer residents during the high tourist season (U.S. Census Bureau 2016). Within the watershed, 23% of the population resides in Delaware, 64% in Maryland, and 13% in Virginia (Table 6). Between 2000 and 2010, Worcester County population increased by 10.7% from 46,543 to 54,451 (Figure 3). Between 2010 and 2016, Worcester County population remained constant (Table 7). During 2000-2010, Worcester

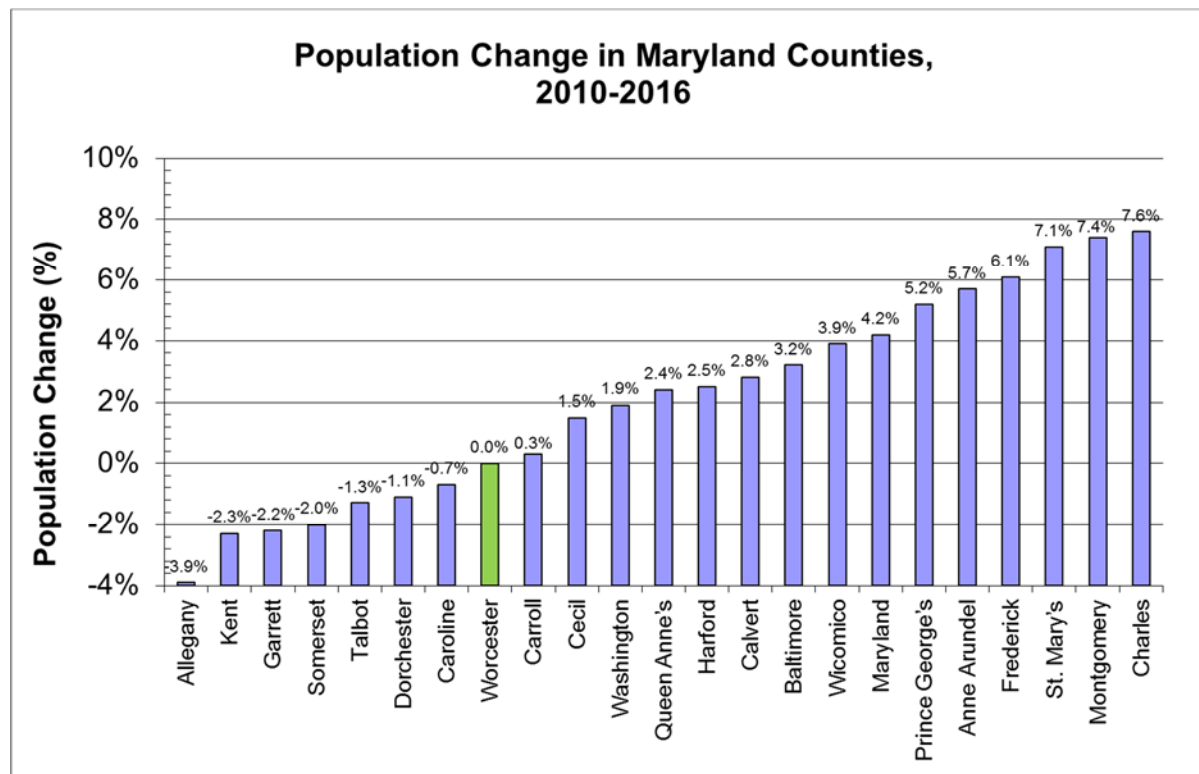
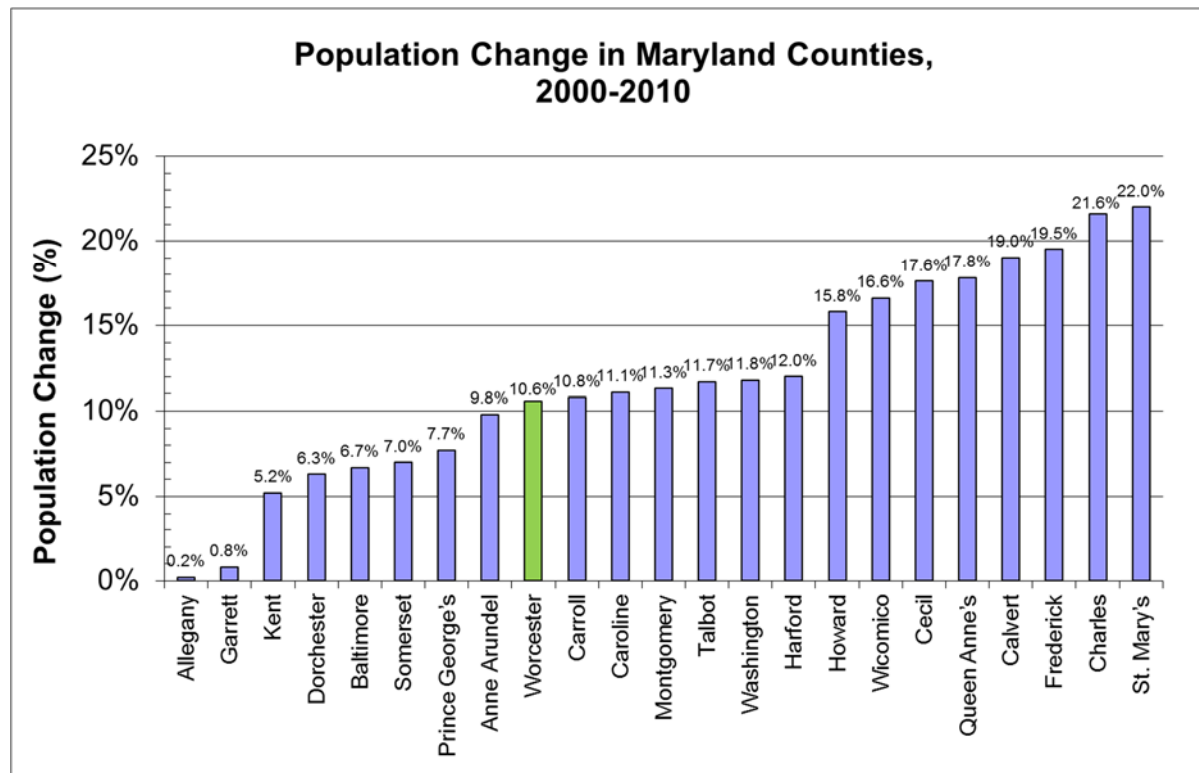
County's population growth rate of 10.7% ranked 9<sup>th</sup> highest of Maryland's 24 counties and during 2010-2016 the growth rate of 0% ranked 8<sup>th</sup> highest among the state's counties U.S. Census Bureau 2000, 2010, 2016).

**Table 6.** Population within the Maryland Coastal Bays watershed  
(U.S. Census Bureau 2016)

State	Year-round Pop.	Summer Pop.	%
Delaware	13,220	93,638	23%
Maryland	36,389	257,744	64%
Virginia	6,864	48,618	12%
<b>Total</b>	<b>56,473</b>	<b>400,000</b>	<b>100%</b>

**Table 7.** Population of Maryland counties  
(U.S. Census Bureau 2010 and 2016)

County	2010	2016	Change (2010-2016)	% Change (2010-2016)
Allegany	75,087	72,130	-2,957	-3.9%
Anne Arundel	537,650	568,346	30,696	5.7%
Baltimore	804,911	831,026	26,115	3.2%
Calvert	88,736	91,251	2,515	2.8%
Caroline	33,081	32,850	-231	-0.7%
Carroll	167,138	167,656	518	0.3%
Cecil	101,108	102,603	1,495	1.5%
Charles	146,560	157,705	11,145	7.6%
Dorchester	32,618	32,258	-360	-1.1%
Frederick	233,382	247,591	14,209	6.1%
Garrett	30,095	29,425	-670	-2.2%
Harford	244,828	251,032	6,204	2.5%
Howard	287,129	317,233	30,104	10.5%
Kent	20,191	19,730	-461	-2.3%
Montgomery	971,952	1,043,863	71,911	7.4%
Prince George's	863,379	908,049	44,670	5.2%
Queen Anne's	47,788	48,929	1,141	2.4%
St. Mary's	105,148	112,587	7,439	7.1%
Somerset	26,470	25,928	-542	-2.0%
Talbot	37,782	37,278	-504	-1.3%
Washington	147,430	150,292	2,862	1.9%
Wicomico	98,733	102,577	3,844	3.9%
<b>Worcester</b>	<b>51,451</b>	<b>51,444</b>	<b>-7</b>	<b>0.0%</b>
<b>Maryland</b>	<b>5,773,786</b>	<b>6,016,447</b>	<b>242,661</b>	<b>4.2%</b>



**Figure 3.** Population change in Worcester County, 2000-2010 and 2010-2016 (U.S Census Bureau 2010 and 2016)

## 2. Methods

### Valuation Techniques

The University of Delaware derived the economic value of the Maryland Coastal Bays watershed from published studies that employed the following valuation techniques:

**Avoided Cost:** Society sustains costs if certain ecosystems were not present or are lost. For instance, the loss of wetlands may increase economic costs from flood damage.

**Replacement Cost:** Natural services are lost and replaced by more expensive human systems. For instance, forests provide water-filtration benefits that would be replaced by costly water-filtration plants.

**Net Factor Income by Enhancement of Income:** Improved water quality is known to enhance fishing productivity and boost fishing jobs/wages.

**Travel Cost:** Visitors are willing to pay to travel and purchase food and lodging to visit ecosystems and natural resources for tourism, boating, hunting, fishing, and birding.

**Hedonic Pricing:** Residents may be willing to pay more for higher property values along scenic bay and river coastlines with improved water quality.

**Contingent Valuation:** Valuation by survey of individual preferences to preserve ecosystems. People may be willing to pay more in fees or water rates to preserve river and bay water quality.

### Scope of Work

The University of Delaware established the economic value of the Maryland Coastal Bays watershed according to the following scope of work.

- 1. Area of Interest:** The area of interest is defined as the 456-square mile Maryland Coastal Bays watershed in Sussex County, Delaware; Worcester County, Maryland; and Accomack County, Virginia. The University of Delaware developed ArcGIS map layers of watersheds, population, ecosystems, habitat, and land use/land cover to perform the analysis.
- 2. Literature Review:** Gather published literature and socioeconomic data relevant to the watersheds of the Maryland Coastal Bays including databases from the U.S. Census Bureau, U.S. Bureau of Labor Statistics, U.S. Department of Agriculture, U.S. Forest Service, U.S. Fish and Wildlife Service, and U.S. National Park Service.
- 3. Annual Economic Value:** Estimate the direct (market) and indirect (non-market) economic value of agriculture, water quality, water supply, fishing, hunting, recreation, boating,



ecotourism, and navigation by utilizing population, employment, industrial activity, and land-use data. Total economic activity is the sum of direct and indirect uses, option demand, and non-use values (Ingraham and Foster 2008). Direct-use (market) values are derived from the sale or purchase of natural goods such as drinking water, boating, recreation, and commercial fishing. Indirect (non-market) values are benefits from ecosystems such as water filtration by forests and flood control/habitat protection from wetlands. Option demand is public willingness to pay for benefits from water quality or scenic value of the water resources. Non-use (existence) values are treasured by a public who may never visit the resource but are willing to pay to preserve the existence of the resource. Where noted, values are converted to 2017 dollars based on the change in the Consumer Price Index (CPI) in the Northeast Region as reported by the Bureau of Labor Statistics.

**4. Ecosystem Services:** Tabulate the market value of natural resources (ecosystem services value) in the Maryland Coastal Bays watershed for habitat such as wetlands, forests, farmland, and open water. Ecosystem services (ecological services) are economic benefits provided to society by nature such as water filtration, flood reduction, and drinking water supply. Using ArcGIS, map and tabulate ecosystem areas (acres) using land cover data in the following classifications: (a) freshwater wetlands, (b) marine, (c) farmland, (d), forest, (e) barren, (f) saltwater wetland, (g) urban, (h) beach/dune, and (i) open freshwater. Review published research studies and gather economic value (\$/acre) data for these ecosystem goods and services: (a) carbon sequestration, (b) flood control, (c) drinking water supply, (d) water-quality filtration, (e) waste treatment and assimilation, (f) nutrient regulation, (g) fish and wildlife habitat, (h) recreation and aesthetics. Compute ecosystem services value by multiplying land-use area (acres) by ecosystem value (\$/acre).

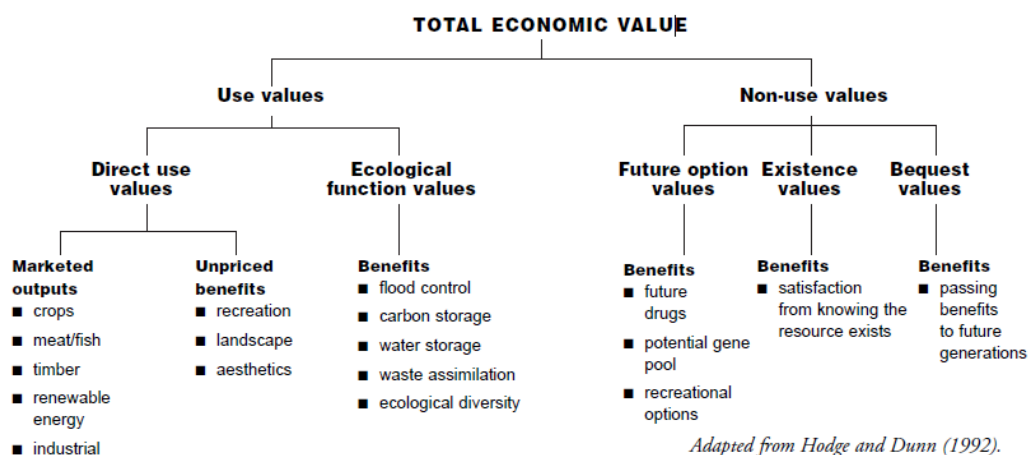
Ecosystem services are estimated using value (benefits) transfer where published data and literature from similar watersheds are reviewed and applied to the resource in question. Value-transfer techniques include selecting data from published literature from another watershed or study area and applying the dollars-per-acre values to the Maryland Coastal Bays watershed land-use areas. While primary research data from the area in question is preferable and is used in many cases in this report, value transfer is the next best practical way to value ecosystems, especially when, in the absence of such data, the worth of ecosystems have previously been deemed zero.

**5. Jobs and wages:** Obtain employment and wage data from the U.S. Department of Labor, U.S. Census Bureau, National Ocean Economics Program, and other sources. Estimate direct/indirect jobs by North American Industry Classification System (NAICS) codes such as shipbuilding, marine transportation/ports, fisheries, recreation, minerals, trade, agriculture, and others. NAICS data were supplemented with farm jobs data from the USDA Agricultural Statistics Bureau, U.S. Fish and Wildlife Service ecotourism jobs data, and jobs provided by water purveyors and watershed organizations.

**6. Report:** Prepare a report and GIS mapping that summarizes (1) annual economic value of activities related to the Maryland Coastal Bays watershed, (2) ecosystem goods and services (natural capital), and (3) jobs and wages directly and indirectly related to the bay and watershed.

### 3. Economic Value

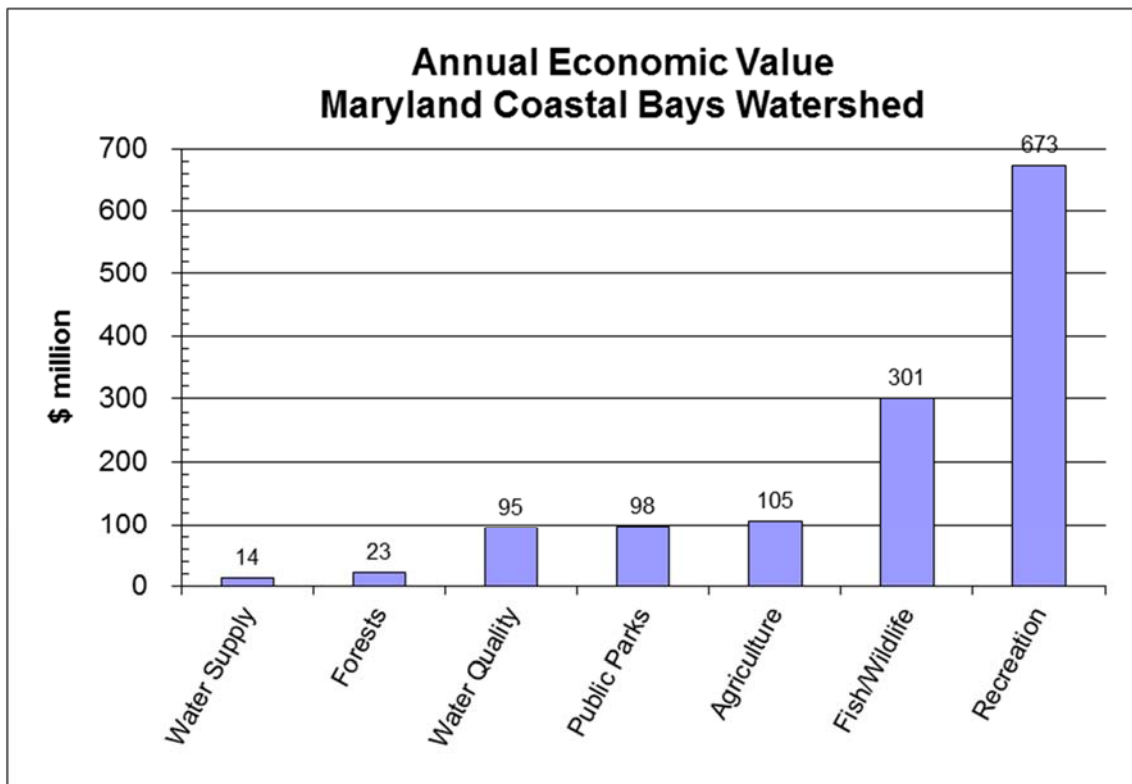
Hodge and Dunn (1992) illustrated the total economic value of water resources based on use and non-use values (Figure 4). Use values include direct values, such as market goods from sales of crops, fish, and timber; unpriced benefits from recreation and aesthetic view sheds; and ecological-function values (ecosystem services) from flood control, water storage, and waste-assimilation services of wetland and forest habitat. Non-use values include future-option values such as future drug discoveries from wetland plants and future recreation, existence values from satisfaction that a water resource exists but may never be visited, and bequest values such as preserving water quality for future generations.



**Figure 4.** Economic value of water resources  
(Hodge and Dunn, 1992)

The economic value of the Maryland Coastal Bays watershed from water quality, water supply, fish/wildlife, recreation, agriculture, forests and public parks benefits exceeds \$1.2 billion annually including \$200 million in Delaware, \$700 million in Maryland, and \$300 million in Virginia (Figure 5 and Tables 8 and 9).

Water Quality	\$95 million
Water Supply	\$14 million
Fish/Wildlife	\$301 million
Recreation	\$673 million
Agriculture	\$105 million
Forests	\$23 million
Public Parks	\$98 million
<b>Total</b>	<b>&gt; \$1.2 billion</b>



**Figure 5.** Annual economic value of the Maryland Coastal Bays watershed

**Table 8.** Annual economic value of the Maryland Coastal Bays watershed

Activity	Economic Value (\$ million)	Source
<b>Water Quality</b>		
Boatable (Summer pop. 400,000 @ WTP = \$16.28/person)	6	Helm, Parsons, and Bondelid (2003)
Fishable (Summer pop. 400,000 @ WTP = \$16.30/person)	7	Helm, Parsons, and Bondelid (2003)
Swimmable (Summer pop. 400,000@WTP = \$139.08/person)	56	Helm, Parsons, and Bondelid (2003)
Increased Property Value (+8% over 20 years)	21	EPA (1973), Austin et al. (2007)
Water Treatment by Forests (\$16/mgd @ 4 mgd)	0.1	Trust for Public Land and AWWA (2004)
Wastewater Treatment (2.6 mgd @ \$5.00/1000 gal)	5	MDOE and VIMS (2013)
<b>Water Supply</b>		
Public Water Supply (23 mgd @ \$1.168/1,000 gal)	10	USGS (2010), NJWSA (2012)
Irrigation Water Supply (10.6 mgd @ \$1.13/1000 gal)	4	Frederick et al. 1996, USGS (2010)
Thermoelectric Power Water Supply (\$44 acre-foot)	0	USGS (2010)
Industrial Water Supply (1.4 mgd @ \$0.76/1000 gal)	0.4	Frederick et al. 1996, USGS (2010)
<b>Fish/Wildlife</b>		
National Wildlife Refuge (7.5 million visits/yr)	239	Carver and Caudill (2007)
Commercial Fish Landings (\$1.65/lb)	11	NOEP (2016)
Hard Clams (160,000 lb @ \$5.15/lb)	0.9	NOEP (2016), MDE (2015)
Blue Crab (1.7 million lb @ \$1.74/lb)	3	NOEP (2016) MDE (2015)
Summer Flounder (158,970 lb @ \$3.93/lb)	0.6	NOEP (2016), MDE (2015),
Fishing (\$24 to \$49/trip/day)	18	USFWS (2011)
Hunting (\$14 to \$45/trip/day)	10	USFWS (2011)
Wildlife/Bird-watching (\$23 to \$66/trip/day)	18	USFWS (2011)
<b>Recreation</b>		
Outdoor Recreation (31,000 participants)	150	Outdoor Industry Association (2016)
Powerboating (DE, VA, MD rank 7 <sup>th</sup> , 17 <sup>th</sup> , 23 <sup>rd</sup> in boat sales)	21	National Marine Manufacturers Assoc. (2014)
Beach Visits (39.8 million visitor days @ \$6.89/day)	274	Parsons et al. (1999)
National Parks (2.3 million recreation visits/yr)	98	National Park Service (2016)
State Parks (500,000 visitors @ \$259/visit)	130	Rockport Analytics (2017)
<b>Agriculture</b>		
Nursery, crop, poultry, livestock (353 farms on 66,098 ac)	105	USDA Census of Agriculture (2014)
<b>Forests</b>		
Carbon Storage (\$827/ac)	16	Nowak et al. and U.S. Forest Service (2008)
Carbon Sequestration (\$29/ac)	0.6	Nowak et al. and U.S. Forest Service (2008)
Air-Pollution Removal (\$266/ac)	5	Nowak et al. and U.S. Forest Service (2008)
Building Energy Savings (\$56/ac)	1	Nowak et al. and U.S. Forest Service (2008)
Avoided Carbon Emissions (\$3/ac)	0.1	Nowak et al. and U.S. Forest Service (2008)
<b>Public Parks</b>		
Health Benefits (\$9,734/ac)	72	Trust for Public Land (2009)
Community Cohesion (\$2,383/ac)	18	Trust for Public Land (2009)
Stormwater Benefit (\$921/ac)	7	Trust for Public Land (2009)
Air-Pollution Control (\$88/acr)	0.7	Trust for Public Land (2009)
<b>Coastal Bays Watershed</b>	<b>&gt;\$1.2 billion</b>	

Note: Total economic value is rounded down to avoid double-counting.

**Table 9.** Annual economic value of the Maryland Coastal Bays watershed by state

Activity	DE Economic Value (\$ million)	MD Economic Value (\$ million)	VA Economic Value (\$ million)	Total Economic Value (\$ million)
<b>Water Quality</b>				
Boatable (Summer pop. 400,000 @ WTP = \$16.28/person)	1.5	4	0.8	6
Fishable (Summer pop. 400,000 @ WTP = \$16.30/person)	1.5	4	0.8	7
Swimmable (Summer pop. 400,000@WTP = \$139.08/person)	13	36	7	56
Increased Property Value (+8% over 20 years)	2	13	5	21
Water Treatment by Forests (\$16/mgd @ 4 mgd)	0.01	0.1	0.04	0.1
Wastewater Treatment (2.6 mgd @ \$5.00/1000 gal)		5		5
<b>Water Supply</b>				
Public Water Supply (23 mgd @ \$1.168/1,000 gal)		10		10
Irrigation Water Supply (10.6 mgd @ \$1.13/1000 gal)		4		4
Thermoelectric Power Water Supply (\$44 acre-foot)		0		0
Industrial Water Supply (1.4 mgd @ \$0.76/1000 gal)		0.4		0.4
<b>Fish/Wildlife</b>				
National Wildlife Refuge (7.5 million visits/yr)			239	239
Commercial Fish Landings (\$1.65/lb)		6	5	11
Hard Clams (160,000 lb @ \$5.15/lb)	0.1	0.7	0.1	0.9
Blue Crab (1.7 million lb @ \$1.74/lb)		3		3
Summer Flounder (158,970 lb @ \$3.93/lb)		0.6		0.6
Fishing (\$24 to \$49/trip/day)	3	13	3	18
Hunting (\$14 to \$45/trip/day)	1	6	2	10
Wildlife/Bird-watching (\$23 to \$66/trip/day)	4	11	3	18
<b>Recreation</b>				
Outdoor Recreation (31,000 participants)	46	88	19	150
Powerboating (DE, VA, MD rank 7 <sup>th</sup> , 17 <sup>th</sup> , 23 <sup>rd</sup> in boat sales)	14	6	1	21
Beach Visits (39.8 million visitor days @ \$6.89/day)		274		274
National Parks (2.3 million recreation visits/yr)		98		98
State Parks (500,000 visitors @ \$21/visit)	60	70		130
<b>Agriculture</b>				
Nursery, crop, poultry, livestock (353 farms on 66,098 ac)	17	45	43	105
<b>Forests</b>				
Carbon Storage (\$827/ac)	1.4	11	4	16
Carbon Sequestration (\$29/ac)	0.05	0.4	0.1	0.6
Air-Pollution Removal (\$266/ac)	0.4	3	1.4	5
Building Energy Savings (\$56/ac)	0.1	0.7	0.3	1
Avoided Carbon Emissions (\$3/ac)	0.05	0.04	0.01	0.1
<b>Public Parks</b>				
Health Benefits (\$9,734/ac)	33	39		72
Community Cohesion (\$2,383/ac)	8	10		18
Stormwater Benefit (\$921/ac)	3	4		7
Air-Pollution Control (\$88/acr)	0.3	0.4		0.7
<b>Coastal Bays Watershed</b>	<b>&gt;\$200 million</b>	<b>&gt;\$700 million</b>	<b>&gt;\$300 million</b>	<b>&gt;\$1.2 billion</b>

Note: Total economic value is rounded down to avoid double-counting.

## Water Quality

### Improved Water Quality

Helm, Parsons, and Bondelid (2003) from the University of Delaware measured the economic benefits of improved water-quality to recreational users in New England in Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, and Connecticut and found per person willingness to pay (WTP) for good water quality was \$8.25 for boating, \$8.26 for fishing, and \$70.47 for swimming use support in 1994 dollars. Adjusting to 2017 dollars based on change in the Consumer Price Index (CPI) in the Northeast Region from the Bureau of Labor Statistics, per person WTP is \$16.28 for boating, \$16.30 for fishing, and \$139.08 for swimming (Table 10).

**Table 10.** Annual WTP for water quality benefits in New England

WQ Use Support	WTP per person <sup>1</sup> (\$1994)	WTP per person <sup>2</sup> (\$2017)
Boatable	\$8.25	\$16.28
Fishable	\$8.26	\$16.30
Swimmable	\$70.47	\$139.08
<b>Total</b>	<b>\$86.98</b>	<b>\$171.66</b>

1. Helm, Parsons, and Bondelid (2003). 2. Adjusted to 2017 based on 3% annual change in Northeast Region CPI.

In 2016, the Coastal Bays watershed population ranged from 56,473 year-round to 400,000 during the summer tourist season. Based on value transfer from the New England study, WTP for improved Coastal Bays water quality ranges from low bound of \$10 million for year round population to high bound of \$69 million for the summer population (Table 11 and Figure 6).

**Table 11.** Annual WTP for water quality benefits in the Maryland Coastal Bays watershed

WQ Use Support	Year-round Population	Summer Population	WTP/person <sup>1</sup> (\$2017)	Low WTP (\$2017)	High WTP (\$2017)
Boatable	56,473	400,000	\$16.28	919,380	6,512,000
Fishable	56,473	400,000	\$16.30	920,510	6,520,000
Swimmable	56,473	400,000	\$139.08	7,854,265	55,632,000
<b>Coastal Bays Total</b>	<b>56,473</b>	<b>400,000</b>	<b>\$171.66</b>	<b>9,694,155</b>	<b>68,664,000</b>
Boatable	13,220	93,638	\$16.28	215,222	1,524,427
Fishable	13,220	93,638	\$16.30	215,486	1,526,299
Swimmable	13,220	93,638	\$139.08	1,838,638	13,023,173
<b>Delaware</b>	<b>13,220</b>	<b>93,638</b>	<b>\$171.66</b>	<b>2,269,345</b>	<b>16,073,899</b>
Boatable	36,389	257,744	\$16.28	592,413	4,196,072
Fishable	36,389	257,744	\$16.30	593,141	4,201,227
Swimmable	36,389	257,744	\$139.08	5,060,982	35,847,036
<b>Maryland</b>	<b>36,389</b>	<b>257,744</b>	<b>\$171.66</b>	<b>6,246,536</b>	<b>44,244,335</b>
Boatable	6,864	48,618	\$16.28	111,746	791,501
Fishable	6,864	48,618	\$16.30	111,883	792,473
Swimmable	6,864	48,618	\$139.08	954,645	6,761,791
<b>Virginia</b>	<b>6,864</b>	<b>48,618</b>	<b>\$171.66</b>	<b>1,178,274</b>	<b>8,345,766</b>

1. Helm, Parsons, and Bondelid (2003) adjusted to \$2017 based on change in Northeast Region CPI.

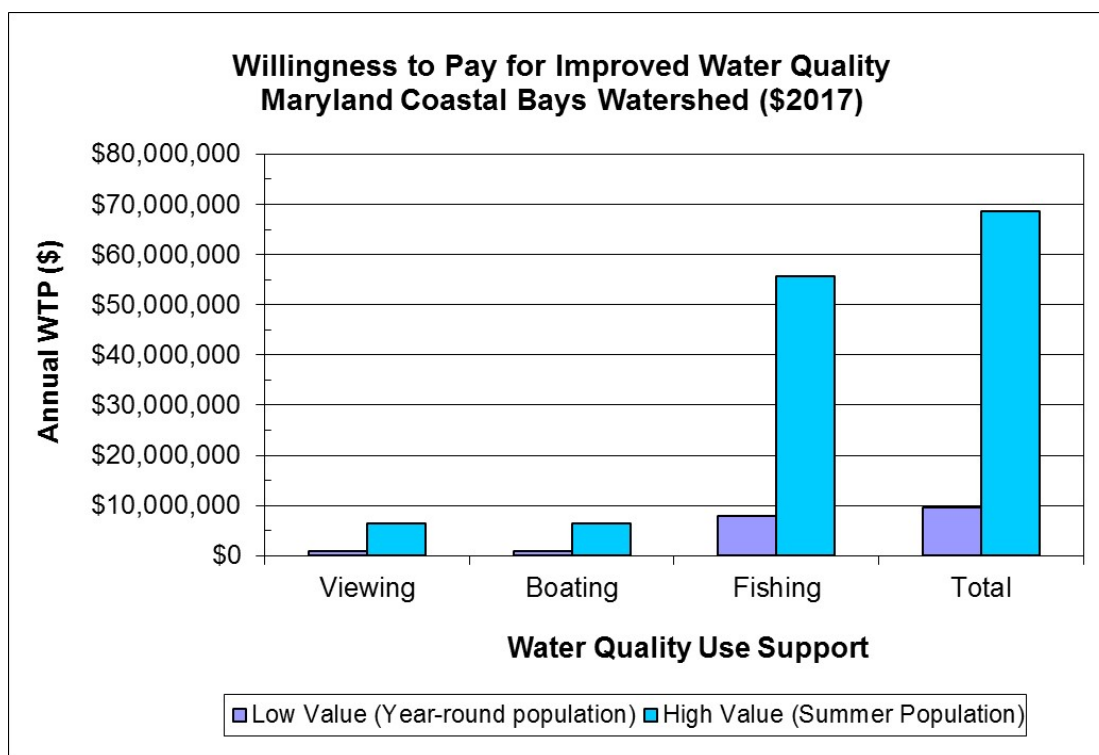


Figure 6. Willingness to pay for improved water quality in the Maryland Coastal Bays

### Increased Property Value

Studies along rivers and bays in the U.S. indicate that improved water quality can increase shoreline property values by 4% to 18% (Table 12). The EPA (1973) estimated improved water quality can raise property values by up to 18% next to the water, 8% at 1,000 feet from the water, and 4% at 2,000 feet from the water. Leggett et al. (2000) estimated improved bacteria levels to meet water quality standards along the western shore of the Chesapeake Bay in Maryland could raise property values by 6%. Poor et al. (2007) studied 1,377 residential property sales in the St. Mary’s River watershed on the western shore of Chesapeake Bay and concluded that a 1 mg/l increase in dissolved inorganic nitrogen reduced the average (\$200,936 property value of a house by \$17,642 or 8.8%. Austin et al. (2007) from the Brookings Institution projected that investing \$26 billion to restore the Great Lakes would increase shore property values by 10%.

Table 12. Increased property value resulting from improved water quality

Study	Watershed	Increased Property Value
EPA (1973)	San Diego Bay, Calif.	
- Next to water	Kanawha, Ohio	18%
- 1000 ft from water	Willamette River, Ore.	8%
- 2000 ft from water		4%
Leggett et al. (2000)	Chesapeake Bay	6%
Poor et al. (2007)	Chesapeake Bay	9%
Austin et al. (2007)	Great Lakes	10%

With improved water quality, property values within 2,000 feet of the Maryland Coastal Bays and its tidal tributaries are estimated to increase by 8% which is the adjusted midpoint between 18% next to the water and 4% at 2000 ft from the water. The Maryland Coastal Bays is bounded by a 284-mile shoreline with 31 miles in Delaware, 182 miles in Maryland, and 74 miles in Virginia. In 2015, the average land value in Maryland near the coastal bays was \$75,429 per acre. Therefore, properties within 2,000 feet of the bay have an estimated value of \$5.2 billion. Property values within 2,000 feet of the water would increase by 8% or \$415 million due to improved water quality (Table 13). Since increased property value is a one-time benefit, the annual value over a 20-year period is estimated at \$20.8 million or \$2.2 million in Delaware, \$13.3 million in Maryland, and \$5.3 million in Virginia.

**Table 13.** Added property value due to improved water quality in Maryland Coastal Bays (EPA 1973, Leggett et al. 2000, Poor et al. 2007, Austin et al. 2007)

State	Bay Shore (mi)	Bay Shore (ft)	Area within 2000 ft of Bay (ac)	Property Value @ \$75,429/ac (\$ million)	Increased Value @ 8% (\$ million)	Annual Value 20 yr (\$ million)
DE	31	163,680	7,515	\$567	\$45	\$2.2
MD	182	960,960	44,121	\$3,328	\$266	\$13.3
VA	74	390,720	17,939	\$1,353	\$108	\$5.3
<b>Total</b>	<b>284</b>	<b>1,499,520</b>	<b>68,848</b>	<b>\$5,193</b>	<b>\$415</b>	<b>\$20.8</b>

### Water Treatment by Forests

Forests provide significant water-quality and water-treatment benefits. The Trust for Public Land and American Water Works Association (2004) found for every 10% increase in forested watershed land, drinking water treatment and chemical costs are reduced by approximately 20% (Table 14). If the public drinking water supply is 23 mgd and forests cover 19,673 acres (30.7 mi<sup>2</sup> or 6.7%) of the Maryland Coastal Bays watershed, then loss of these forests would increase drinking water treatment costs by \$16 per mgd (\$139/mgd @ 0% forested minus \$123/mgd @ 6.7% forested) or \$368/day or \$134,000/year (\$11,000 in Delaware, \$87,000 in Maryland, and \$36,000 in Virginia).

**Table 14.** Drinking water treatment costs based on percent of forested watershed (Trust for Public Land and AWWA 2004)

Watershed Forested	Treatment Costs (\$/mg)	Change in Costs
0%	139	21%
10%	115	19%
20%	93	20%
30%	73	21%
40%	58	21%
50%	46	21%
60%	37	19%



### Wastewater Treatment

Three wastewater treatment plants have a total capacity of 2.6 mgd (MDOE and VIMS 2013) that discharge to the Maryland Coastal Bays (Table 15). The average wastewater rate in the watershed is \$5.00 per 1,000 gallons which for an average residence of 4 people (at 50 gpcd) is a fee of \$365 per year. The total market value based on treated wastewater rates in the Maryland Coastal Bays watersheds is \$13,000 per day or \$4.8 million per year.

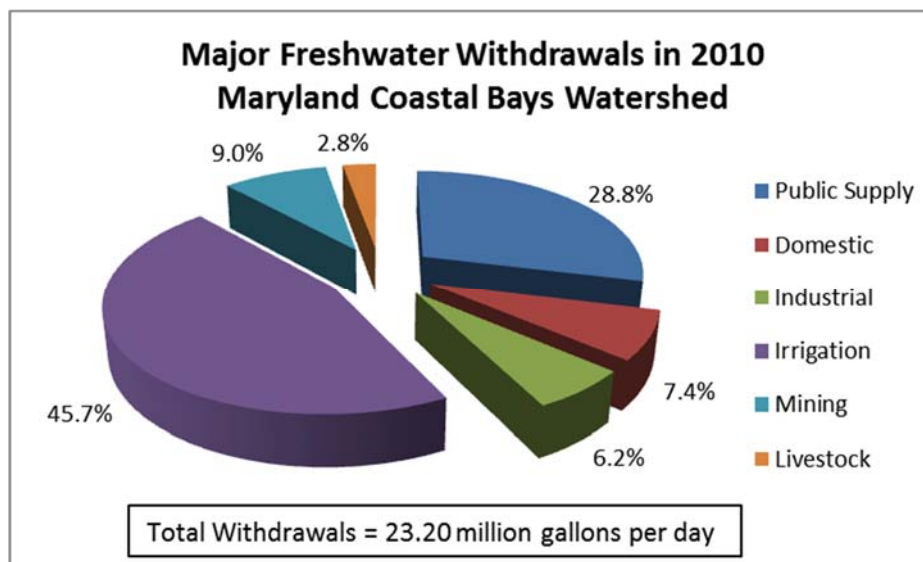
**Table 15.** Wastewater discharge capacity in the Maryland Coastal Bays watershed (MDOE and VIMS 2013)

State	Wastewater Utility	Flow (mgd)
MD	Ocean Pines WWTP	2.5
MD	Assateague Island Nat'l Seashore WWTP	0.012
MD	Newark WWTP	0.07
	<b>Total</b>	<b>2.6</b>

### Water Supply

#### Public Water Supply

The U.S. Geological Survey (2010) reported that fresh surface and groundwater withdrawals in Sussex County, Delaware; Worcester County, Maryland; and Accomack County, Virginia totaled 140 mgd including 23 mgd for public water supply, 8.9 mgd for domestic wells, 3.4 mgd for mining, 86.0 mgd for irrigation, 2.0 mgd for livestock, and 17.2 mgd for industrial uses (Figure 7). The New Jersey Water Supply Authority (2012) established the value of raw (untreated) public water supplies from the Manasquan system at \$1,168 per million gallons. At \$1,168 per million gallons, the value of untreated public water supplies in the Maryland Coastal Bays watershed 23 mgd is \$26,864 per day or \$9.8 million per year.



**Figure 7.** Major freshwater withdrawals in the Maryland Coastal Bays watershed (USGS 2010)

## Irrigation Water Supply

In a study of the economic value of freshwater in the United States, Resources for the Future (Frederick et al. 1996) estimated the median value of irrigation water withdrawals was \$198/ac-ft in 1996 dollars or \$368/ac-ft (\$1.13/1,000 gal) in 2017 dollars, adjusting for 3% annual change in the CPI (Table 16). During 2010, 54,667 acres of cropland in the Maryland Coastal Bays watershed (19% of watershed) were cultivated and 14,904 acres were irrigated (USDA 2014). These values are based on 2010 land use data and county-level data from USDA Census, scaled by proportion of farmland within the watershed. Annual irrigation-water needs from June through September are 9 inches for corn, soybeans, and grain (2,600 gpd/ac for 14,904 irrigated acres or 38.75 mgd). In the Maryland Coastal Bays watershed, the annual value of water needed to irrigate 9 inches of water over 14,904 acres at a use value of \$368/ac-ft is \$4.1 million.

**Table 16.** Freshwater-use values in the United States

Use	1996 Median <sup>1</sup> (\$/acre-ft.)	2017 Median <sup>2</sup> (\$/acre-ft.)	2017 Median (\$/1,000 gal)
Navigation	\$10.00	\$18.60	\$0.06
Irrigation	\$198.00	\$368.34	\$1.13
Industrial Process	\$132.00	\$245.56	\$0.76
Thermoelectric Power	\$29.00	\$53.95	\$0.17

1. Frederick et al. 1996. 2. Adjusted to \$2017 based on change in Northeast Region CPI (BLS).

In 2010, the USGS estimated irrigation water withdrawals totaled 10.6 mgd in the Maryland Coastal Bays watershed. At an irrigation use value of \$1.13/1000 gal in 2017 dollars, the estimated annual value of water withdrawals (10.6 mgd) to irrigate cropland in the Maryland Coastal Bays watershed is \$4.4 million.

## Thermoelectric-Power Water Supply

There are no thermoelectric power plants in the Maryland Coastal Bays watershed.

## Industrial Water Supply

According to the USGS (2010), industrial-water withdrawals totaled 1.4 mgd in the Maryland Coastal Bays watershed. If the median market value of industrial withdrawals is \$132/ac-ft in 1996 dollars (Frederick et al. 1996) or \$246/ac-ft. (\$0.76/1,000 gal) in 2017 dollars, then the value of industrial-water withdrawals (1.4 mgd) in the Maryland Coastal Bays watershed is \$1,094 per day or \$399,456 per year.

## Fish/Wildlife

### National Wildlife Refuge

There are two national wildlife refuges (NWR) in the Maryland Coastal Bays watershed – Chincoteague and Wallops Island, both in Virginia. The U.S. Fish and Wildlife Service (Carver

and Caudill 2007) estimated the 14,000-acre Chincoteague National Wildlife Refuge was the most visited refuge in the nation, with 7.5 million visits, visitor recreation expenditures of \$239 million, and 3,766 jobs with \$95 million in wages (Table 17). Wallops Island NWR at the NASA launch pad is not open to the public and therefore does not have fish/wildlife expenditures.

**Table 17.** Contributions to local economy from Chincoteague National Wildlife Refuge (Carver and Caudill 2007)

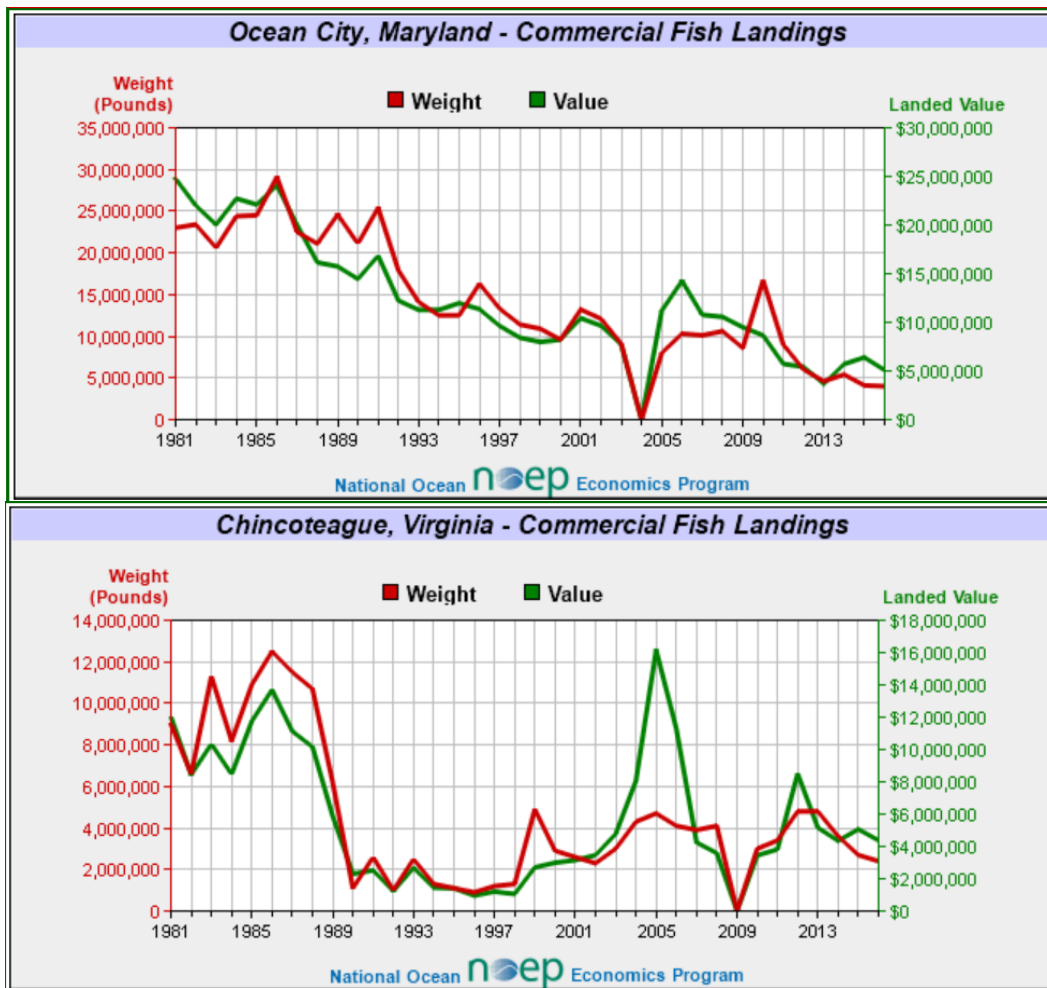
Activity	Visitors	Expenditures (\$2006)	Jobs	Wages (\$)
Birding, Hiking, Beach	7,337,494	\$213,002,900		
Hunting	2,592	\$125,500		
Fishing	145,200	\$5,293,200		
<b>Total</b>	<b>7,485,286</b>	<b>\$238,692,600</b>	<b>3,766</b>	<b>\$94,856,700</b>

### Commercial Fish Landings

Using data from the National Marine Fisheries Service (NMFS), the National Ocean Economics Program (2016) reported the Ocean City, Maryland and Chincoteague, Virginia ports are the 115<sup>th</sup> and 122<sup>nd</sup> most valuable commercial fishing ports in the United States with \$5.7 million and \$4.9 million in annual fish landings, respectively (Table 18 and Figure 8). Taken together, the combined ports in the Maryland Coastal Bays would be the 87<sup>th</sup> most valuable commercial fishing port in the United States with \$10.6 million in landed value.

**Table 18.** Top commercial fishing ports in the United States in 2016 (NOEP 2016)

Rank	Port	Weight (lb)	Port	Landed Value
1	Dutch Harbor-Unalaska, AK	770,000,000	New Bedford, MA	\$326,500,000
2	Aleutian Islands (Other), AK	508,000,000	Dutch Harbor-Unalaska, AK	\$198,000,000
3	Empire-Venice, LA	440,000,000	Empire-Venice, LA	\$122,000,000
4	Kodiak, AK	417,000,000	Naknek-King Salmon, AK	\$108,000,000
5	Reedville, VA	321,300,000	Kodiak, AK	\$107,000,000
6	Pascagoula-Moss Point, MS	285,000,000	Honolulu, HI	\$106,000,000
7	Alaska Penninsula (Other), AK	243,000,000	Aleutian Islands (Other), AK	\$105,000,000
8	Intracoastal City, LA	215,000,000	Alaska Penninsula (Other), AK	\$85,000,000
9	Naknek-King Salmon, AK	170,000,000	Cape May-Wildwood, NJ	\$84,700,000
10	Westport, WA	108,300,000	Bristol Bay (Other), AK	\$76,000,000
94	Morro Bay, CA	4,300,000	Port Clyde, ME	\$7,800,000
95	Ocean City, MD	4,000,000	Tacoma, WA	\$7,800,000
96	Cameron, LA	4,000,000	Fort Bragg, CA	\$7,300,000
97	Panama City, FL	4,000,000	Portsmouth, NH	\$7,100,000
98	Fairhaven, MA	3,900,000	Morro Bay, CA	\$7,100,000
99	Newington, NH	3,900,000	Neah Bay, WA	\$7,000,000
100	Willapa Bay, WA	3,800,000	Naples, FL	\$7,000,000
115	Belford, NJ	2,500,000	Ocean City, MD	\$5,700,000
116	Chincoteague, VA	2,400,000	New London, CT	\$5,100,000
117	San Diego, CA	2,200,000	Cortez, FL	\$5,000,000
118	Stonington, CT	2,100,000	Ft. Pierce-St.Lucie, FL	\$5,000,000
119	Ft. Pierce-St.Lucie, FL	2,000,000	Iberia, LA	\$5,000,000
120	Fernandina, Beach, FL	2,000,000	Fernandina, Beach, FL	\$5,000,000
121	Portsmouth, NH	2,000,000	Port St. Joe, FL	\$5,000,000
122	Naples, FL	2,000,000	Chincoteague, VA	\$4,900,000
125	Blaine, WA	1,800,000	Savannah, GA	\$3,100,000



**Figure 8.** Commercial fish landings at Maryland Coastal Bays ports (NOEP 2016)

### Hard Clams

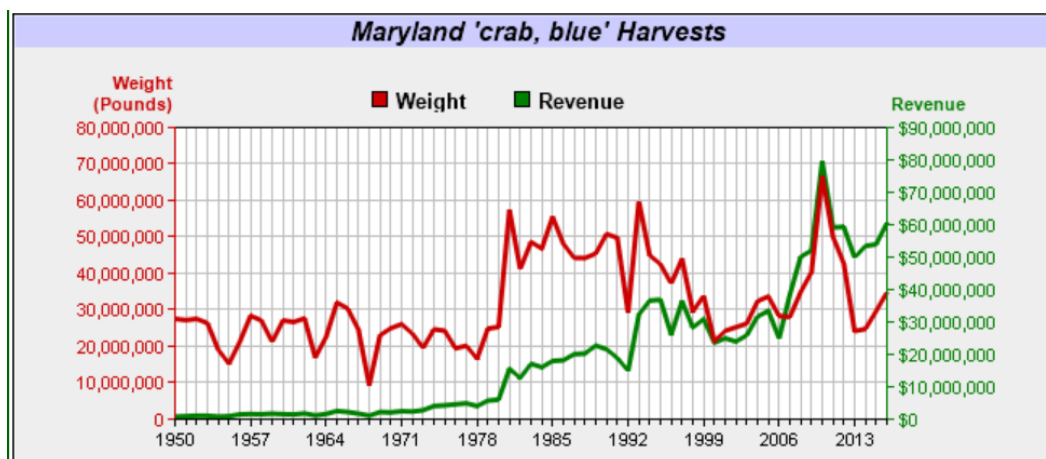
The northern quahog or hard clam has historically declined due to excessive mechanical harvesting in the Maryland Coastal Bays. Hard clam population density baselines were established in the Maryland Coastal Bays in the 1950’s, and severely decreased in subsequent decades. It was not until the last 10 years that increases above the 1953 baseline in some areas have been achieved. According to the Maryland Fisheries Management Plan Report (2015), little or no hard clam commercial landings have occurred since the 2008 ban on mechanical dredging. In 2016, a bill was introduced to reinstate mechanical harvesting, but it was tabled. In the 1990’s, hard clam landings rarely exceeded 25,000 pounds annually in the Maryland Coastal Bays. NMFS data (NOEP 2016) indicates hard clam landings in the Maryland Coastal Bays peaked in 2002 with over 160,000 pounds of hard clams. Table 19 below displays the statewide landings in Maryland and Delaware since 2000, which also display similar trends to those recorded in the Coastal Bays. If 160,000 pounds of hard clams at \$5.15/lb were landed in the Coastal Bays in 2002, then the peak landed value is estimated to be \$840,000.

**Table 19.** Hard clam landings in Maryland and Delaware (NOEP 2016)

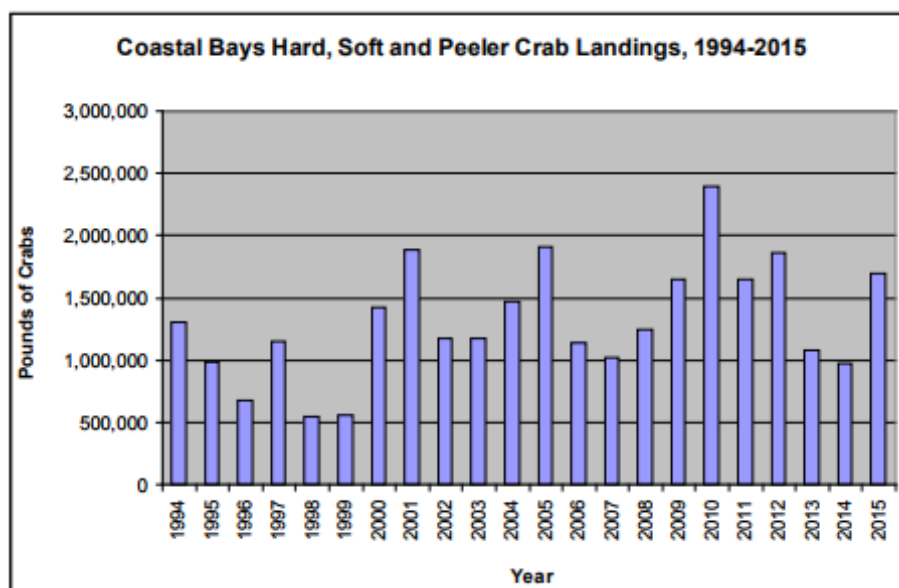
Year	Maryland (lb)	Maryland (\$)	Delaware (lb)	Delaware (\$)
2000	65,917	402,497	75,752	243,292
2001	151,114	740,237	63,505	232,902
2002	109,273	530,814	134,237	391,754
2003	43,658	220,397	140,631	434,915
2004			53,760	175,138
2005	1,643	8,078	69,081	219,848
2006				
2007	13,064	66,295		

**Blue Crab**

In 2016, 35 million pounds of blue crab worth \$61 million were harvested statewide in Maryland as depicted in Figure 9 (NOEP 2016). According to the Maryland Fishery Management Plan Report (2015), 1.7 million pounds of blue crab were harvested from the Maryland Coastal Bays (5% of the catch in Maryland). Blue crab landings in the Maryland Coastal Bays have ranged from 500,000 pounds in the late 1990’s to 2.4 million pounds in 2010 (Figure 10). If blue crab landings in the Maryland Coastal Bays totaled 1.7 million pounds in 2015, then at \$1.74 per pound, the annual value of the bay’s blue crab fishery is approximately \$3 million.



**Figure 9.** Maryland blue crab landings (NOEP 2016)



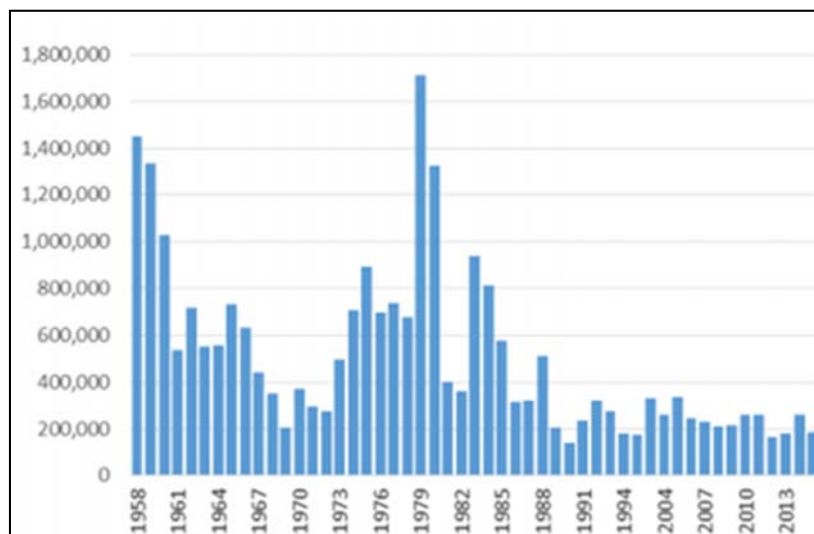
**Figure 10.** Crab landings in the Maryland Coastal Bays (MD FMP 2015)

### Summer Flounder

The Mid-Atlantic Fishery Management Council (2015) determined that 15% of the summer flounder along the East Coast are caught in Delaware, Maryland and Virginia (Table 20). The Maryland Fishery Management Plan (2015) reported the 2015 Maryland commercial summer flounder harvest was 200,000 pounds and the recreational harvest was 100,000 pounds (Figure 11). Summer flounder ranks 4<sup>th</sup> out of 72 species in finfish abundance in the Maryland Coastal Bays with annual harvests of 40,000 to 135,000 summer flounder. In 2016, 158,970 pounds of summer flounder at \$3.93/lb were caught in the Maryland Coastal Bays with a value of \$624,371 (NOEP 2016)

**Table 20.** Summer flounder catch by state in 2014 and 2015  
(Mid-Atlantic Fishery Management Council 2015)

State	2014	2015
Maine	0.0%	0.0%
New Hampshire	0.0%	0.0%
Massachusetts	4.6%	4.7%
Rhode Island	7.5%	9.8%
Connecticut	4.9%	5.8%
New York	20.7%	32.4%
New Jersey	47.8%	29.7%
Delaware	3.8%	3.1%
Maryland	3.2%	2.7%
Virginia	5.7%	9.5%
North Carolina	1.9%	2.4%
<b>Total</b>	<b>100%</b>	<b>100%</b>



**Figure 11.** Maryland commercial summer flounder harvest in pounds (MD Fishery Management Plan 2015)

### Fishing, Hunting, and Bird/Wildlife Watching

The Maryland Coastal Bays watershed has significant forest, wetlands, and marine habitat that draw fishing, hunting, and bird/wildlife watching to the region. Waterfowl include mallard, American black duck, blue-winged teal, and Canada goose. The Maryland Coastal Bays provides nesting habitat for waterfowl and shorebirds such as osprey, great egret, piping plover, herring gull, laughing gull, tri-colored herons, endangered least terns, black skimmers, and snowy egrets. Wintering species include American black duck and Atlantic Brant Geese. Birds of prey such as golden eagles, bald eagles, and hawks fly through the bay during the fall migration. The Maryland Coastal Bays sports 115 species of fish.

In Delaware, Maryland and Virginia, the U. S. Fish and Wildlife Service (2011) estimated the annual economic value of recreational fishing, hunting, birding/wildlife-viewing activities totaled was \$4.6 billion (Table 21). Trip expenditures include purchases and sales of food and lodging, transportation, and hunting, fishing, and wildlife watching equipment. Average daily trip expenditures in the 3 states range from \$24 to \$49/trip for fishing, \$14 to \$45/trip for hunting, and \$23 to \$66/trip for wildlife/bird-watching. Much of the fishing, hunting, and birding/wildlife recreation occur on farms, forests, wetlands, and open water ecosystems such as the Chincoteague National Wildlife Refuge, Assateague Island National Seashore, Assateague State Park, and Fenwick Island State Park.

The Maryland Coastal Bays watershed covers 456 square miles or 2.5%, 2.3%, and 0.3% of Delaware, Maryland, and Virginia land area, respectively. Scaling by the ratio of watershed area to state land area, the estimated annual economic value of fishing, hunting, and wildlife/birdwatching recreation in the Maryland Coastal Bays watershed is \$46 million including \$18 million from fishing, \$10 million from hunting, and \$18 million from wildlife/bird watching.

**Table 21.** Value of fishing, hunting, wildlife/birding recreation in Maryland Coastal Bays

Recreation Activity	Delaware (\$ million)	Maryland (\$ million)	Virginia (\$ million)	Total (\$ million)
Fishing	104	535	1,142	1,782
Hunting	41	264	877	1,182
Wildlife/Bird-watching	169	483	959	1,612
<b>Total</b>	<b>315</b>	<b>1,283</b>	<b>2,978</b>	<b>4,575</b>
	Delaware in watershed (\$ million)	Maryland in watershed (\$ million)	Virginia in watershed (\$ million)	Total in watershed (\$ million)
Fishing	3	13	3	18
Hunting	1	6	2	10
Wildlife/Bird-watching	4	11	3	18
<b>Total</b>	<b>8</b>	<b>30</b>	<b>8</b>	<b>46</b>

1. USFWS 2011. 2. Scaled by ratio of Maryland Coastal Bays watershed area to state areas (2.5% DE, 2.3% MD, 0.27% VA).

## Recreation

### Outdoor Recreation

The Outdoor Industry Association (2016) concluded 8 million people participated in recreation activities such as bicycling, camping, fishing, hunting, paddling, hiking, and wildlife viewing in Delaware, Maryland and Virginia who contributed \$39 billion and 335,000 jobs to the regional economy. Given the population of the 3 states total 14.7 million (DE 898,000, MD 5.8 million, and VA 8 million), by proportion outdoor recreation activity in the Maryland Coastal Bays watershed with a year-round population of 56,473 contributes \$150 million in consumer spending to the economy and 1,287 jobs with \$46 million in wages (Table 22).

**Table 22.** Economic value of recreation in the Maryland Coastal Bays watershed

Economic Activity	Delaware <sup>1</sup>	Maryland <sup>1</sup>	Virginia <sup>1</sup>	Total 3 States <sup>2</sup>
Consumer Spending	\$3.1 billion	\$14 billion	\$21.9 billion	\$39 billion
Participants	467,000	3 million	4.6 million	8.1 million
Jobs	29,000	109,000	197,000	335,000
Wages	\$959 million	\$4.4 billion	\$6.5 billion	\$11.9 billion
Economic Activity	Delaware in watershed <sup>2</sup>	Maryland in watershed <sup>2</sup>	Virginia in watershed <sup>2</sup>	MD Coastal Bays Watershed <sup>2</sup>
Consumer Spending	\$46 million	\$88 million	\$19 million	\$150 million
Participants	6,875	18,822	3,947	31,118
Jobs	427	684	169	1,287
Wages	\$14 million	\$28 million	\$6 million	\$46 million

1. Outdoor Industry Association 2016. 2. Scaled by proportion of Maryland Coastal Bays to state-wide population.



## Powerboating

The National Marine Manufacturers Association (2014) announced that Delaware, Virginia, and Maryland ranked 9th, 17th, and 23<sup>rd</sup> in the U.S. respectively in total expenditures for new powerboats, outboard engines, boat trailers, and accessories. Table 23 summarizes powerboat expenditures scaled by ratio of land area in the watershed to area of each state. Powerboat expenditures within the Maryland Coastal Bays watershed are estimated at \$21 million/year

**Table 23.** Recreational powerboat expenditures in the Maryland Coastal Bays watershed (NMMA 2014)

State	Rank Expenditures	Powerboat Expenditures (\$)	% Land of States in Watershed	Watershed Expenditures <sup>1</sup> (\$)
Delaware	7	544,000,000	2.5%	14,000,000
Maryland	23	270,000,000	2.3%	6,000,000
Virginia	17	341,000,000	0.3%	1,000,000
<b>Total</b>		<b>1,155,000,000</b>		<b>21,000,000</b>

1. Scaled by ratio of Maryland Coastal Bays watershed area to state areas (2.5% DE, 2.3% MD, 0.3% VA).

## Beach Visits

In Ocean City during May through September, 260,000 visitors are present at any given day based on the 2013 Memorial Day weekend visits of 231,000 per day, July average of 284,000 per day, and August average of 269,000 per day. This translates to 39.8 million beach visitor days annually. Studies conducted in the mid-Atlantic U.S. conclude the willingness to pay for a beach trip ranges from \$4.84 to \$31.45 activity day or \$5.95 to \$38.68 per day in 2017 dollars based on 3% annual change in the Consumer Price Index for the Northeast Region (Table 24). Using the Ocean City, Maryland beach travel cost (Parsons et al. 1999) translated to \$6.89/visitor day in 2017 dollars with 39.8 million visitor days, the economic value of beach visits is \$274 million/yr.

**Table 24.** Literature review of coastal beach visitor studies in the mid-Atlantic U.S.

State	Author/Date	WTP (\$2010/day)	WTP <sup>1</sup> \$2017/day
Massachusetts	Kline and Swallow (1998)	\$4.84	\$5.95
New Jersey	Leeworthy and Wiley (1991)	\$31.45	\$38.68
Maryland	Parsons et al. (1999)	\$5.60	\$6.89
<b>Mean</b>			<b>\$17.17</b>

1. Adjusted to 2017 dollars from change in Consumer Price Index for Northeast Region (BLS).

## National Parks

The Assateague Island National Seashore preserves almost 109 square miles of land along 40 miles of shoreline along the Atlantic Ocean. The National Park Service (2016) estimated the Assateague Seashore in Maryland had 2.3 million recreation visits in 2016 with total visitor spending of \$98.3 million including \$28 million for hotels, \$21.8 million for restaurants, \$7.1

million for recreational industries, and \$3.7 million for camping. In 2016, the Assateague Seashore expenditures supported 1,300 jobs and \$38.8 million in labor income.

## State Parks

State parks that support economic activity in the Maryland Coastal Bays watershed include Fenwick Island State Park in Delaware and Assateague State Park in Maryland that cover 1,200 acres (1.9 mi<sup>2</sup>) with attendance of 500,000 visitors per year. At \$259 per visit estimated by an economic study of the Delaware State Park system (Rockport Analytics 2017), the 500,000 visitors to the state parks in the Maryland Coastal Bays watershed contribute \$130 million annually to the regional economy in Delaware and Maryland (Table 25).

**Table 25.** Delaware state parks visitation & visitor spending FY 2016/2017 (Rockport Analytics 2017)

State Park	Attendance	\$/Visitor-Day	Spending (\$)
Fenwick Island State Park, DE	232,832	259	60,032,326
Assateague State Park, MD	270,000	259	69,930,000
<b>Total</b>	<b>502,832</b>	<b>259</b>	<b>129,962,326</b>

## Agriculture

In 2012, the value of agricultural products sold in Worcester County, Maryland; Sussex County, Delaware; and Accomack County, Virginia was \$1.14 billion (USDA 2014). Scaling by ratio of farmland in the watershed to farmland in the counties, the annual market value of agricultural products sold in the Maryland Coastal Bays watershed was \$105 million on 353 farms from nurseries, vegetables, fruit, horses, grain, poultry, cattle, and Christmas trees (Table 26 and 27).

**Table 26.** Agricultural sales in the Maryland Coastal Bays watershed, 2012

Product	Farms	Value (\$1,000)
Poultry	53	45,994
Grain	84	35,204
Nursery	13	13,758
Milk from Cows	7	3,870
Vegetable	17	1,884
Horses	25	1,877
Fruits	11	1,205
Other crops and hay	56	931
Other Animals	8	161
Hogs/Pigs	8	45
Christmas Trees	3	45
Sheep/Goats	15	39
Cattle and calves	51	10
Aquaculture	2	N/A
<b>Total</b>	<b>353</b>	<b>105,024</b>

**Table 27.** Economic value of agriculture in the Maryland Coastal Bays watershed

County	Farmland in county <sup>1</sup> (ac)	Farmland in watershed (ac)	Ratio watershed/county %	Farms in County <sup>1</sup>	Farms in watershed	Value in County <sup>1</sup> (\$ million)	Economic Value in Watershed <sup>2</sup> (\$ million)
Accomack, VA	77,389	9,578	12%	244	30	142	17
Sussex, DE	272,232	13,509	5%	1,682	83	899	45
Worcester, MD	99,304	43,011	43%	553	240	98	43
<b>Total</b>	<b>448,925</b>	<b>66,098</b>	<b>15%</b>	<b>2,479</b>	<b>353</b>	<b>1,140</b>	<b>105</b>

1. USDA Census of Agriculture (2014). 2. Scaled by ratio of farmland in watershed to farmland in counties

## Forests

The U.S. Forest Service (Nowak et al. 2008) estimated that forests provide environmental benefits such as carbon storage of \$5.9 million (\$827/acre) and air-pollution removal of \$1.9 million (\$266/acre/year). Applying these multipliers, 19,673 acres (30.9 mi<sup>2</sup>) of forests in the Maryland Coastal Bays watershed have benefits of carbon storage (\$16.3 million), carbon sequestration (\$571,000), air-pollution removal (\$5.2 million), building-energy savings (\$1.1 million) and avoided carbon emissions (\$59,000). Forests in the Coastal Bays watershed provide environmental benefits by regulating climate change, cooling, and air-emissions control including 790,520 tons of carbon storage, 27,668 tons of carbon sequestration, 791 tons of air-pollution removal, and 2,767 tons of avoided carbon emissions (Tables 28 and 29).

**Table 28.** Economic/environmental benefits of forests in Maryland Coastal Bays watershed

Benefits	Forests New Castle County <sup>1</sup>		Forests MD Coastal Bays Watershed <sup>2</sup>	
	Environmental (ton/ac)	Economic (\$/acre)	Environmental (ton)	Economic (\$)
Carbon Storage	40.00	\$827	790,520	\$16,269,311
Carbon Sequestration	1.4	\$29	27,668	\$570,508
Air Pollution Control	0.04	\$266	791	\$5,232,934
Energy Savings		\$56		\$1,101,670
Avoided Carbon Emissions	0.14	\$3	2,767	\$59,018

1. Nowak et al. (2008). 2. Computed for 19,673 acres of forest in the Maryland Coastal Bays watershed.

**Table 29.** Economic benefits of forests by state in the Maryland Coastal Bays watershed

Benefits	New Castle County <sup>1</sup> (\$/acre)	Delaware <sup>2</sup> (\$)	Maryland <sup>3</sup> (\$)	Virginia <sup>4</sup> (\$)	Coastal Bays Watershed <sup>5</sup> (\$)
Carbon Storage	827	1,371,993	10,571,541	4,326,037	16,269,311
Carbon Sequestration	29	48,111	370,707	151,699	570,508
Air Pollution Control	266	441,294	3,400,278	1,391,446	5,232,934
Energy Savings	56	92,904	715,848	292,936	1,101,670
Avoided Carbon Emissions	3	4,977	38,349	15,693	59,018
<b>Total</b>	<b>1,181</b>	<b>1,959,279</b>	<b>15,096,723</b>	<b>6,177,811</b>	<b>23,233,441</b>

1. Nowak et al. (2008). 2. 1,659 acres of forest in Delaware. 3. 12,783 acres of forest in Maryland. 4. 5,231 acres of forest in Virginia. 5. 19,673 acres of forest in Coastal Bays watershed.

## Public Parks

The Trust for Public Land (2009) found the 444-acre City of Wilmington park system provides annual economic value and savings to the public from health benefits from exercise in the parks (\$4,322,000 or \$9,734/ac), community-cohesion benefits as people socialize in the parks (\$1,058,000 or \$2,383/ac), water pollution benefits in treating stormwater (\$409,000 or \$921/ac), and air pollution–mitigation value from tree and shrub absorption (\$39,000 or \$88/ac).

The Maryland Coastal Bays watershed includes 7,442 acres of state and county parks and state wildlife management areas (Table 30). The Delaware Division of Parks and Recreation manages 344 acres of Fenwick Island State Park and the Division of Fish and Wildlife manages 3,100 acres of the Assawoman Wildlife Area. The Maryland Department of Natural Resources manages the 200-acre Isle of Wight Wildlife Management Area. The Maryland Park Service protects 855 acres of Assateague State Park. Worcester County Recreation and Parks owns 7 parks on 100 acres within the Maryland Coastal Bays watershed.

**Table 30.** State and county parks in the Maryland Coastal Bays watershed

Agency	Parks	Area (ac)
DE Division of Parks and Recreation	Fenwick Island State Park	344
DE Division of Fish and Wildlife	Assawoman Wildlife Area	3,100
MD Department of Natural Resources	E. A. Vaughn Wildlife Management Area	2,759
MD Department of Natural Resources	Isle of Wight Wildlife Management Area	200
MD Department of Natural Resources	Sinepuxent Bay Wildlife Management Area	93
MD State Park Service	Assateague State Park	855
MD Worcester County Parks	Bishopville, Herring Creek, Homer Gudelsky, Showell, etc.	91
<b>Total</b>		<b>7,442</b>

Applying the Trust for Public Land (2009) data by value transfer (Table 31), public parks in the Maryland Coastal Bays watershed provide \$98 million in annual benefits including health benefits from exercise in the parks (\$72 million), community-cohesion benefits from people socializing in the parks (\$17 million), water pollution benefits from parks in treating stormwater (\$7 million), and air pollution mitigation value from tree and shrub absorption (\$0.6 million).

**Table 31.** Value of state and county parks in the Maryland Coastal Bays watershed  
(Trust for Public Land 2009)

Agency	Parks (acres)	Health Benefits @ \$9,734/ac (\$)	Community Cohesion @ \$2,383/ac (\$)	Stormwater Benefit @ \$921/ac (\$)	Air Pollution @ \$88/ac (\$)	Total (\$)
DEDPR	344	3,348,496	819,752	316,824	30,272	<b>4,515,344</b>
DEDFW	3,100	30,175,400	7,387,300	2,855,100	272,800	<b>40,690,600</b>
MDDNR	2,759	26,856,106	6,574,697	2,541,039	242,792	<b>36,214,634</b>
MDDNR	200	1,946,800	476,600	184,200	17,600	<b>2,625,200</b>
MDDNR	93	905,262	221,619	85,653	8,184	<b>1,220,718</b>
MDSPS	855	8,322,570	2,037,465	787,455	75,240	<b>11,222,730</b>
WCRP	91	885,794	216,853	83,811	8,008	<b>1,194,466</b>
<b>Total</b>	<b>7,442</b>	<b>72,440,428</b>	<b>17,734,286</b>	<b>6,854,082</b>	<b>654,896</b>	<b>97,683,692</b>

## 4. Ecosystem Services

Ecosystem services (natural capital) are the sum of goods (commodities like water, crops, and timber that can be sold) and services (functions like flood control, water filtration, and fisheries habitat) provided by watershed habitat such as wetlands, forests, farms, and open water. The following studies were examined to estimate ecosystem-services values for the Maryland Coastal Bays watershed:

- Cecil County green infrastructure study by the Conservation Fund, Annapolis, Md. (2007)
- Mates and Reyes with the NJDEP and the University of Vermont (2007)
- Ecosystem services value of forests by the Wilderness Society (2001)
- Ecosystem services value of Peconic Estuary watershed by University of Rhode Island (2002)
- U.S. National Wildlife Refuges by University of Maryland and Nature Conservancy (2008)
- Economic value of ecosystem services in Massachusetts by the Audubon Society (2003).

### Related Research

Ecosystem services include air filtration, water filtration, recycling nutrients, soil conservation, pollinating crops and plants, climate regulation, carbon sequestration, flood/stormwater control, and hydrologic-cycle regulation. Ecological resources provide marketable goods and services such as timber, fish and wildlife recreation, hiking, and boating/kayaking.

The Mates and Reyes (2007) partnered with the NJDEP and University of Vermont and estimated the value of New Jersey's natural capital at \$20 billion/year in 2004 dollars with a net present value (NPV) of \$681 billion. NPV takes the value of a dollar today and projects it into the future summed annually over a lifetime (say 100 years) given the annual value is discounted by a rate (3%) due to inflation based on the Consumer Price Index.

Others have calculated the value of natural capital in ecosystems along the Atlantic seaboard and across the United States. Weber (2007) from the Conservation Fund found the largest ecosystem services values in Cecil County, Maryland are from stormwater/flood control, water supply, and clean water functions (Table 32). The Wilderness Society (Krieger 2001) concluded that forest ecosystem services for climate regulation, water supply, water quality, and recreation benefits totaled \$392/ac in 1994 dollars or \$774/ac in 2017 dollars based on change in the Northeast Region CPI (Table 33). A contingent value study by University of Rhode Island economists found that natural resources values in the Peconic Estuary watershed in Suffolk County on Long Island New York ranged from \$6,560/ac for wetlands to \$9,979/ac for farmland in 1995 dollars (Johnston et al. 2002). The University of Maryland studied the U.S. National Wildlife Refuge System and determined that ecosystem values of freshwater wetlands and forests are \$6,268/ac and \$845/ac, respectively (Ingraham and Foster 2008). The Audubon Society found the economic value of ecosystems in Massachusetts ranged from \$984/ac for forests to \$15,452/ac for saltwater wetlands (Breunig 2003). The USDA Census of Agriculture (2014) reported the market value of agricultural products sold from cropland in Accomack County, Virginia; Sussex County, Delaware; and Worcester County, Maryland was \$2,600/ac.

Table 34 compares ecosystem services values from other watersheds. Data from the NJDEP study and crop value of Ocean County agriculture are used for value transfer to the Maryland Coastal Bays watershed as the study area shares similar ecosystems (forests/wetlands), climate (humid continental at 40 degrees north in latitude), physiographic provinces (Coastal Plain), aquifers, and soils. NJDEP ecosystem-services values are lower than Cecil County's for wetlands and forests and Mass. Audubon's for wetlands. NJDEP estimates are higher than the Wilderness Society for forests and U.S. Wildlife Refuge for freshwater wetlands and forests.

**Table 32.** Ecosystem services values for Cecil County, Maryland  
(Weber 2007)

Ecosystem Service	Upland Forest (\$/ac/yr)	Riparian Forest/Wetland (\$/ac/yr)	Nonriparian Wetlands (\$/ac/yr)	Tidal Marsh (\$/ac/yr)
Carbon sequestration	31	65	65	65
Clean air	191	191	191	
Soil and peat formation	17	946	450	1,351
Stormwater/flood control	679	32,000	32,000	1,430
Water supply	8,630	8,630	8,630	
Clean water	1,100	1,925	1,100	11,000
Erosion/sediment control	151	3,418	151	12,700
Water temperature regulation		4,450		
Pest control	50	50	50	
Pollination	75	75	75	
Wood products	142			
Recreation, fish, wildlife habitat	486	534	534	544
Community services savings	439	439	439	439
Increase in property values	42	42		
<b>Total</b>	<b>12,033</b>	<b>52,765</b>	<b>43,685</b>	<b>27,529</b>

**Table 33.** Forest ecosystem service values for U.S. temperate forests

Ecosystem Good or Service	1994 Value <sup>1</sup> (\$/ac)	2017 Value <sup>2</sup> (\$/ac)
Climate regulation	57.1	112.7
Disturbance regulation	0.8	1.6
Water regulation	0.8	1.6
Water supply	1.2	2.4
Erosion and sediment control	38.8	76.6
Soil formation	4.0	7.9
Nutrient cycling	146.1	288.3
Waste Treatment	35.2	69.5
Biological Control	0.8	1.6
Food Production	17.4	34.3
Raw Materials	55.8	110.1
Genetic Resources	6.5	12.8
Recreation	26.7	52.7
Cultural	0.8	1.6
<b>Total</b>	<b>392.1</b>	<b>773.8</b>

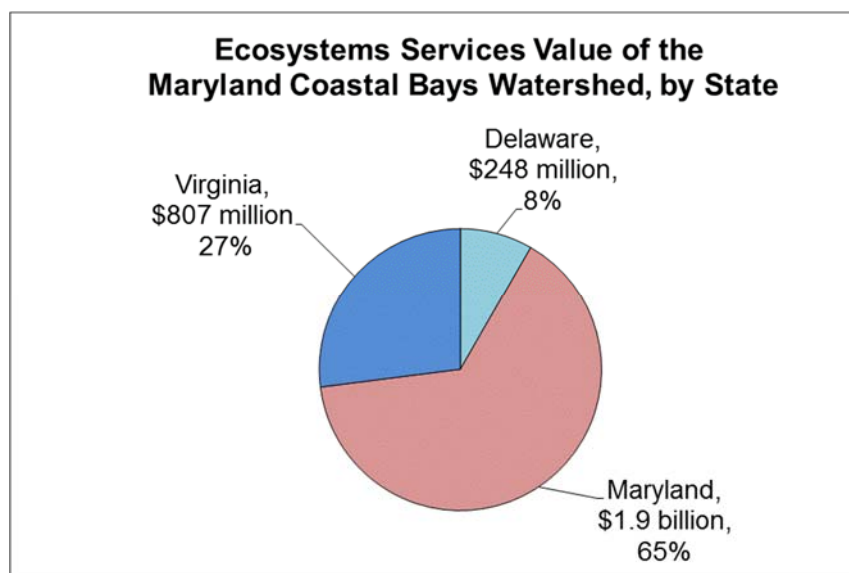
1. Krieger 2001. 2. Adjusted to 2017 dollars based on change in Northeast Region CPI (BLS).

**Table 34.** Comparison of ecosystem goods and services values from various studies

Ecosystem	Cecil Co. Md. 2006 (\$/ac/yr)	NJDEP 2007 (\$/ac/yr)	Wilderness Society 2001 (\$/ac/yr)	Peconic Estuary 1995 (\$/ac/yr)	U.S. Wildlife 2008 (\$/ac/yr)	Mass. Audubon 2003 (\$/ac/yr)	USDA Census <sup>1</sup> 2014 (\$/ac/yr)
Freshwater wetland	43,685	11,802			6,268	15,452	
Marine		8,670					
Farmland		6,229		9,979		1,387	2,600
Forest land	12,033	1,714	641		845	984	
Saltwater wetland	28,146	6,269		6,560		12,580	
Undeveloped				2,080			
Urban		296					
Beach/dune		42,149					
Open freshwater		1,686			217	983	
Riparian buffer	52,765	3,500					
Shellfish areas				4,555			

## Watershed Ecosystem Services

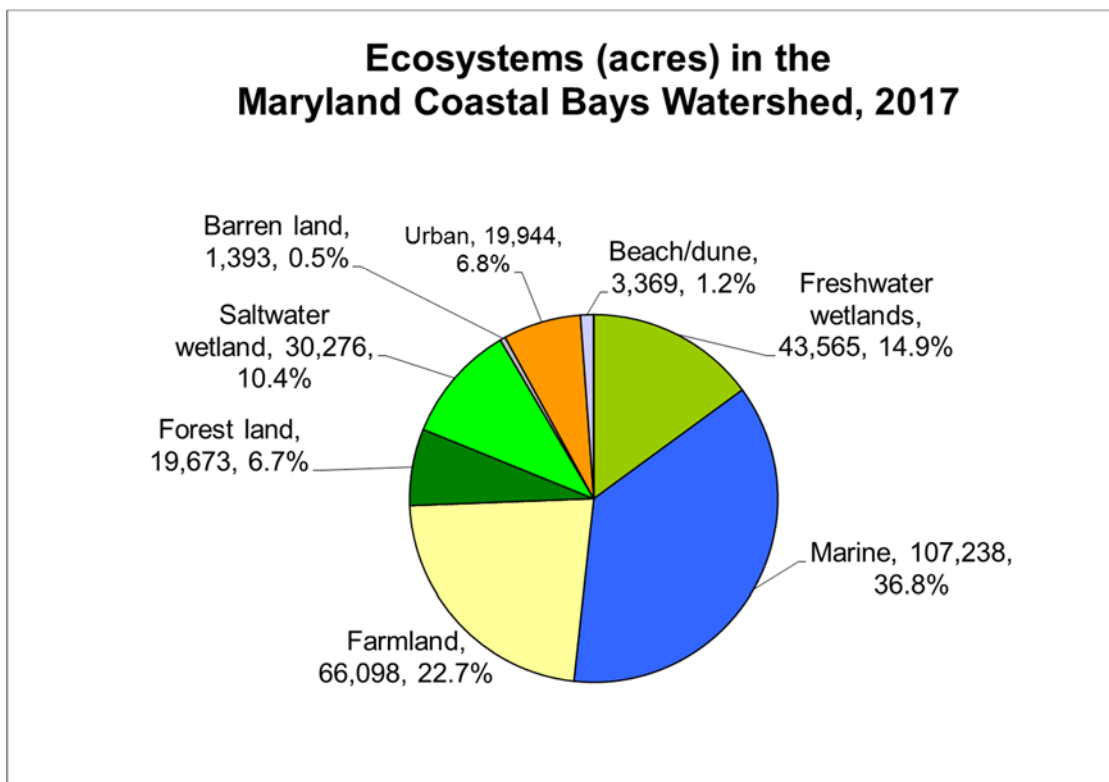
The estimated value of ecosystem goods and services provided by the Maryland Coastal Bays watershed (456 mi<sup>2</sup> or 291,555 acres) is \$3.0 billion (in 2017 dollars) with a net present value (NPV) of \$97.1 billion (Table 35). By state, the ecosystem services value of the Coastal Bays watershed is \$248 million in Sussex County, Delaware; \$807 million in Accomack County, Virginia; and \$1.9 billion in Worcester County, Maryland (Figure 12). Ecosystems (Figure 13) in the watershed include marine/bay (36.8%), farmland (22.7%), freshwater wetlands (14.9%), saltwater wetlands (10.4%), urban (6.8%), barren (0.5%), and forests (6.7%). Marine/bay (\$1,365 million), freshwater wetlands (\$755 million), farmland (\$322 million) and saltwater wetlands (\$279 million) provide the highest ecosystems services values (Figures 14 and 15).

**Figure 12.** Ecosystem services value of the Maryland Coastal Bays watershed, by state

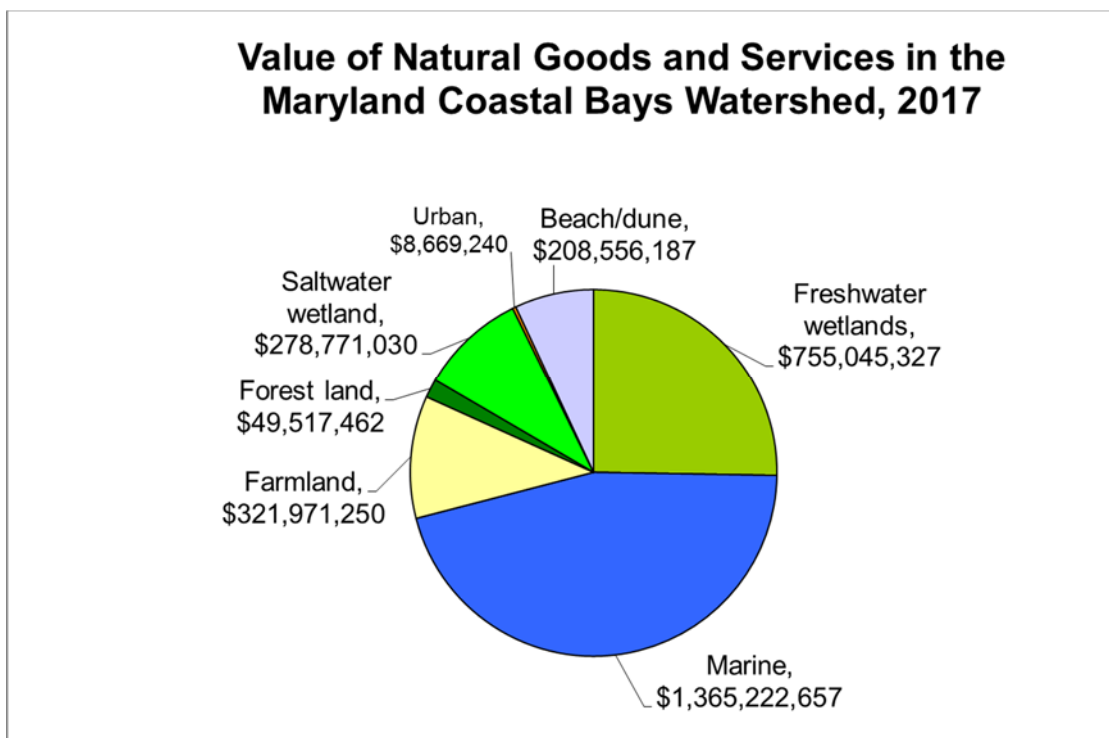
**Table 35.** Value of ecosystem goods and services in the Maryland Coastal Bays watershed

Ecosystem	Area (ac)	Services (\$/ac/yr)	PV (\$)	NPV (\$)
Freshwater wetlands	6,592	17,332	114,252,544	3,713,207,680
Marine	3,008	12,731	38,294,848	1,244,582,560
Farmland	13,504	4,871	65,777,984	2,137,784,480
Forest	1,664	2,517	4,188,288	136,119,360
Saltwater wetland	1,664	9,208	15,322,112	497,968,640
Barren land	64	0	0	0
Urban	4,864	435	2,115,840	68,764,800
Beach/dune	128	61,897	7,922,816	257,491,520
Open water	0	2,476	0	0
<b>Delaware</b>	<b>31,488</b>		<b>247,874,432</b>	<b>8,055,919,040</b>
Freshwater wetlands	28,800	17,332	499,161,600	16,222,752,000
Marine	71,040	12,731	904,410,240	29,393,332,800
Farmland	43,008	4,871	209,491,968	6,808,488,960
Forest	12,800	2,517	32,217,600	1,047,072,000
Saltwater wetland	15,936	9,208	146,738,688	4,769,007,360
Barren land	128	0	0	0
Urban	11,776	435	5,122,560	166,483,200
Beach/dune	2,176	61,897	134,687,872	4,377,355,840
Open water	0	2,476	0	0
<b>Maryland</b>	<b>185,664</b>		<b>1,931,830,528</b>	<b>62,784,492,160</b>
Freshwater wetlands	8,192	17,332	141,983,744	4,614,471,680
Marine	33,216	12,731	422,872,896	13,743,369,120
Farmland	9,600	4,871	46,761,600	1,519,752,000
Forest	5,248	2,517	13,209,216	429,299,520
Saltwater wetland	12,736	9,208	117,273,088	3,811,375,360
Barren land	1,152	0	0	0
Urban	3,328	435	1,447,680	47,049,600
Beach/dune	1,024	61,897	63,382,528	2,059,932,160
Open water	0	2,476	0	0
<b>Virginia</b>	<b>74,496</b>		<b>806,930,752</b>	<b>26,225,249,440</b>
Freshwater wetlands	43,565	17,332	755,045,327	24,538,973,129
Marine	107,238	12,731	1,365,222,657	44,369,736,337
Farmland	66,098	4,871	321,971,250	10,464,065,619
Forest	19,673	2,517	49,517,462	1,609,317,528
Saltwater wetland	30,276	9,208	278,771,030	9,060,058,463
Barren land	1,393	0	0	0
Urban	19,944	435	8,669,240	281,750,294
Beach/dune	3,369	61,897	208,556,187	6,778,076,093
Open water	0	2,476	0	0
<b>Coastal Bays Total</b>	<b>291,555</b>		<b>2,987,753,153</b>	<b>97,101,977,464</b>





**Figure 13.** Ecosystem service areas in the Maryland Coastal Bays watershed



**Figure 14.** Value of ecosystem services within the Maryland Coastal Bays watershed

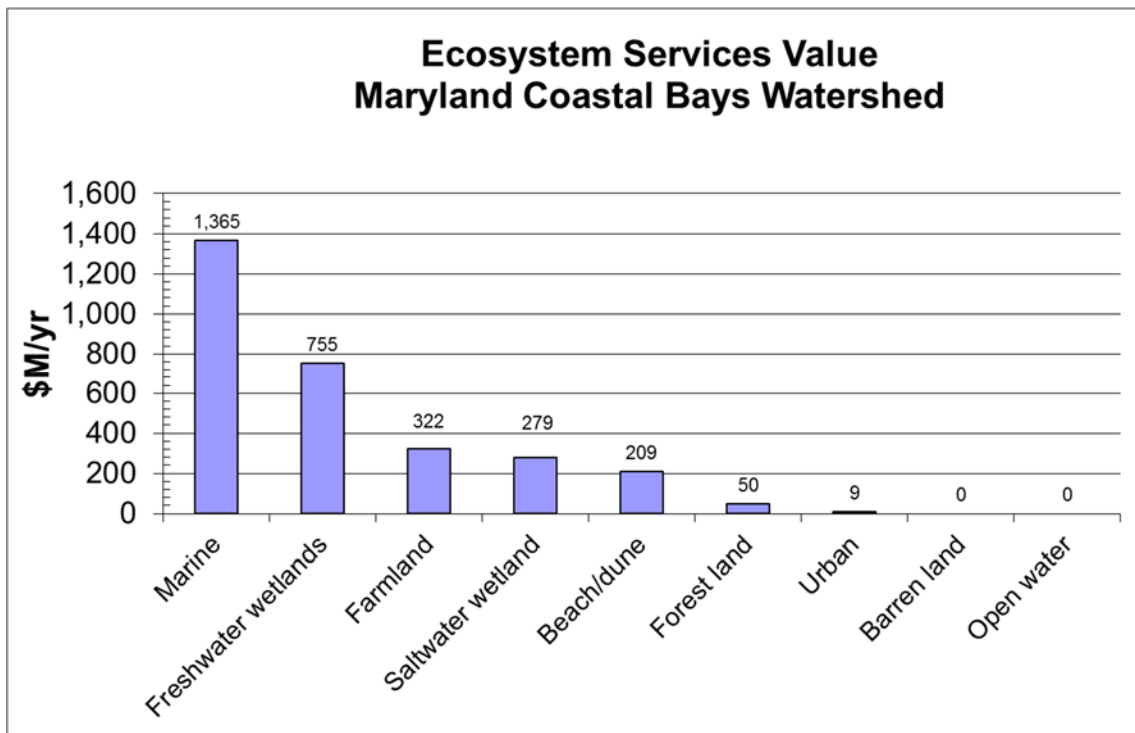


Figure 15. Ecosystem service value of habitat in the Maryland Coastal Bays watershed

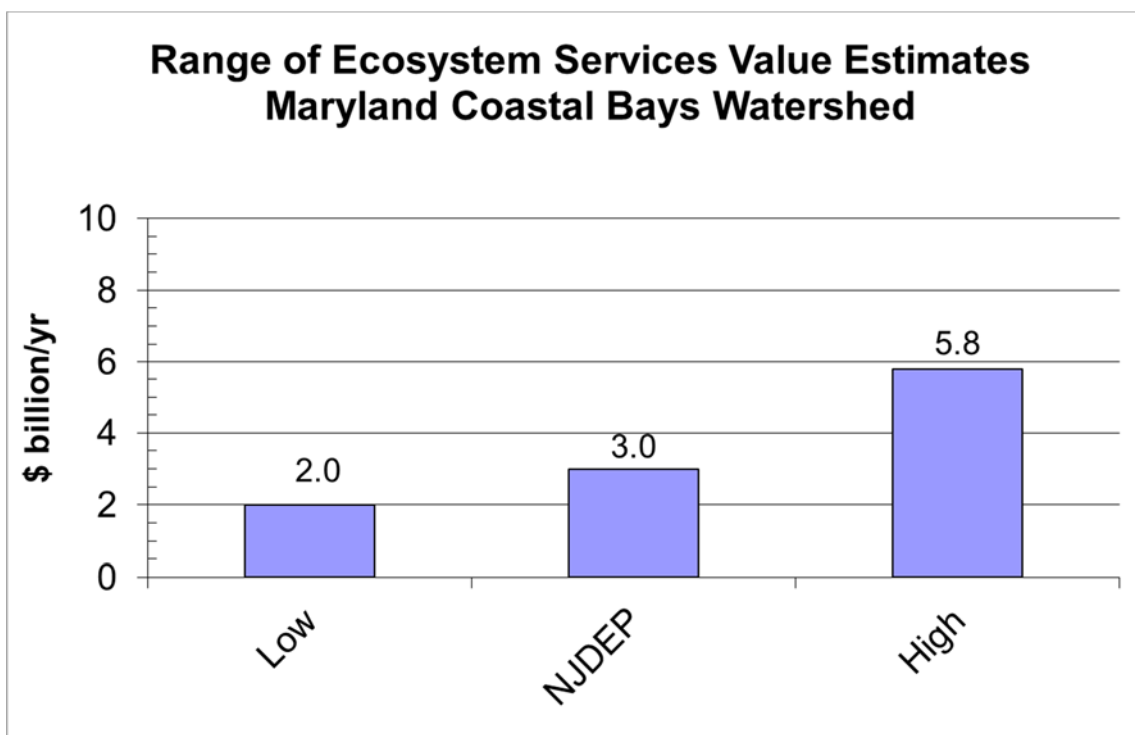


Figure 16. Range of ecosystem services value estimates in Maryland Coastal Bays watershed

Ecosystem services in the Maryland Coastal Bays watershed using data from the NJDEP and USDA crop values are worth \$3.0 billion in 2017 dollars or \$97.5 billion (NPV), which are

conservatively in the lower end of the range based on value transfer from other watersheds (Figure 16). If lower per acre estimates of ecosystem services from other studies were used instead of the NJDEP values, ecosystem services in the Maryland Coastal Bays watershed would be \$2.0 billion per year with NPV of \$65.7 billion (Table 36). If higher per acre estimates from other studies were used, the value of ecosystems in the Maryland Coastal Bays watershed would be \$5.8 billion with NPV of \$189 billion (Table 37).

<u>Estimate</u>	<u>PV (\$B)</u>	<u>NPV (\$B)</u>
Low	2.0	65.7
Midrange	3.0	97.5
High	5.8	188.5

**Table 36.** Low range of ecosystem services in the Maryland Coastal Bays watershed

<b>Ecosystem</b>	<b>Area (ac)</b>	<b>Services (\$/ac/yr)</b>	<b>PV (\$)</b>	<b>NPV (\$)</b>
Freshwater wetlands	43,565	7,709 <sup>5</sup>	335,832,756	10,914,564,566
Marine	107,238	10,663 <sup>2</sup>	1,143,484,371	37,163,242,074
Farmland	66,098	1,706 <sup>6</sup>	112,752,125	3,664,444,055
Forest land	19,673	788 <sup>3</sup>	15,508,945	504,040,699
Saltwater wetland	30,276	7,710 <sup>2</sup>	233,429,113	7,586,446,175
Barren land	1,393	0	0	0
Urban	19,944	364 <sup>2</sup>	7,260,352	235,961,436
Beach/dune	3,369	51,838 <sup>2</sup>	174,662,524	5,676,532,019
Open water	0	267 <sup>5</sup>	0	0
<b>Total</b>	<b>291,555</b>		<b>2,022,930,185</b>	<b>65,745,231,023</b>

1. Cecil Co., Md. 2006. 2. NJDEP 2007. 3. Wilderness Society 2001.  
4. Peconic Estuary 1995. 5. Ingraham and Foster 2008. 6. Breunig 2003.

**Table 37.** High range of ecosystem services in the Maryland Coastal Bays watershed

<b>Ecosystem</b>	<b>Area (ac)</b>	<b>(\$/ac/yr)</b>	<b>PV (\$)</b>	<b>NPV (\$)</b>
Freshwater wetlands	43,565	53,727 <sup>1</sup>	2,340,595,715	76,069,360,733
Marine	107,238	10,663 <sup>2</sup>	1,143,484,371	37,163,242,074
Farmland	66,098	12,273 <sup>4</sup>	811,213,737	26,364,446,450
Forest land	19,673	14,799 <sup>1</sup>	291,137,489	9,461,968,379
Saltwater wetland	30,276	34,616 <sup>1</sup>	1,048,029,321	34,060,952,948
Barren land	1,393	0	0	0
Urban	19,944	364 <sup>2</sup>	7,260,352	235,961,436
Beach/dune	3,369	51,838 <sup>2</sup>	174,662,524	5,676,532,019
Open water	0	2,074 <sup>2</sup>	0	0
<b>Total</b>	<b>291,555</b>		<b>5,816,383,509</b>	<b>189,032,464,038</b>

1. Cecil Co., Md. 2006. 2. NJDEP 2007. 3. Wilderness Society 2001. 4. Peconic Estuary 1995.  
5. Ingraham and Foster 2008. 6. Breunig 2003.

## 5. Jobs and Wages

The ocean and coastal economy in Sussex County, Delaware; Worcester County, Maryland; and Accomack County, Virginia provides for a \$10.8 billion GDP and supports 110,505 jobs with \$4.09 billion in annual wages (NOEP 2016). The Maryland Coastal Bays watershed within these counties is a jobs engine with water resources and habitat that supports over 50,000 direct and indirect jobs with over \$1.5 billion in annual wages in the coastal, agriculture, fishing/hunting/birding, tourism, recreation and water supply sectors (Table 38).

**Table 38.** Jobs and wages directly and indirectly related to Maryland Coastal Bays watershed

Sector	Jobs	Wages (\$ million)	Data Source
Direct Watershed-Related	6,080	170	U.S. Bureau of Labor Statistics (2016)
Indirect Watershed-Related	7,296	136	U.S. Census Bureau (2016)
Coastal	24,494	837	National Coastal Economics Program (2016)
Fishing/Hunting/Birding	1,396	45.9	U.S. Fish and Wildlife Service (2011)
White Marlin Open	130	4.9	MD Dept. of Business & Economic Development (2009)
National Wildlife Refuge	44	1.5	U.S. Fish and Wildlife Service (2014)
National Parks	1,300	38.8	National Park Service (2016)
Boating	126	1.4	Marine Trades Association of Maryland (2017)
Outdoor Recreation	7,845	274	Outdoor Industry Association (2016)
State Parks	274	8.2	Mates and Reyes (2006)
Farm	454	5.6	USDA Agriculture Census (2014)
Wetlands	3,349	66	NOAA Office for Coastal Management (2013)
Watershed Organizations	25	1.5	
Water Supply Utilities	40	2.2	MDOE 2015
Stormwater Utility	4	0.2	Town of Berlin, MD
Wastewater Utilities	5	0.3	MDOE and VIMS 2013
<b>Coastal Bays Watershed</b>	<b>&gt;50,000</b>	<b>&gt;\$1.5 billion</b>	

Jobs and wages in the Maryland Coastal Bays watersheds were obtained from U.S. Bureau of Labor Statistics (2016) and U.S. Census Bureau (2016) databases. Note the NAICS database does not include jobs for certain known water-related industries, such as commercial fishing and boat building therefore the columns are left blank. Hence, watershed-related jobs are likely to be undercounted. Maryland Coastal Bays watershed-related jobs are tabulated for three categories: (1) total jobs within Sussex County, Delaware, Worcester County, Maryland, and Accomack County, Virginia, (2) direct and indirect Maryland Coastal Bays watershed jobs and (3) jobs in bay-related categories such as farm, fishing, hunting, boating, etc.

Total jobs in Sussex County, Delaware, Worcester County, Maryland, and Accomack County, Virginia by NAICS code from the Bureau of Labor Statistics (2015) indicate there were 91,014 jobs with wages of \$3.2 billion (Table 39).

**Table 39.** Employment in Maryland Coastal Bay counties in 2016

County	Employed	Wages (\$ million)
Accomack, Virginia	8,344	241
Sussex, Delaware	65,247	2,335
Worcester, Maryland	17,423	600
<b>Total</b>	<b>91,014</b>	<b>3,176</b>

## Direct/Indirect Water Jobs

Direct watershed-related jobs such as water/sewer construction, living resources, maritime, tourism/recreation, ports, environmental services, and water/wastewater management determined for each NAICS code in Accomack County, Virginia, Sussex County, Delaware, and Worcester County, Maryland. Industries directly associated with the Maryland Coastal Bays watershed (such as water/sewer construction, water utilities, fishing, recreation, tourism, and ports) employed 6,080 people with \$170 million in wages (Table 40). Indirect jobs and wages funded by purchases of goods/services by direct jobs earners are estimated by a multiplier of 2.2 for direct jobs and 1.8 for direct wages (Latham and Stapleford, 1990). The United Nations Environment Programme (2011) estimates each tourism job generates 1.5 indirect jobs. For this report, we assume that each direct watershed job funds 1.2 indirect jobs and a dollar in direct wages funds \$0.80 in indirect wages. Indirect jobs in the watershed (based on multipliers of 2.2 for jobs and 1.8 for salaries) employed 7,296 people with \$136 million in wages (Table 41).

**Table 40.** Maryland Coastal Bays watershed jobs and wages in 2016

Category	Jobs	Wages (\$ million)
Total for 3 Counties	38,410	1,007
Direct Watershed-related	6,080	170
Indirect Watershed-related	7,296	136

**Table 41.** Direct/indirect watershed-related jobs in Maryland Coastal Bays watershed, 2016

Sector	North American Industry Classification System (NAICS)	NAICS code	Direct Watershed Jobs <sup>1</sup>	Direct Annual Watershed Wages <sup>1</sup> (x\$1000)	Indirect Watershed Jobs <sup>2</sup>	Indirect Annual Wages <sup>2</sup> (x\$1000)
Construction	Water and sewer construction	23711	7	322	9	257
Living Resources	Fishing, hunting, trapping	114	13	400	15	320
	agriculture and forestry	115	18	572	22	458
	Seafood prep./ packaging	3117				
	Wineries	31213				
	Fish and seafood wholesalers	42446	4	129	5	104
	Nursery, garden center, farm	44422				
	Fish and seafood markets	44522	10	223	12	178
	Fruit and vegetable markets	44523				
	Minerals	Mining, quarrying	21			
	Electric power generation	2211	21	2,079	25	1,663
Boat Building	Ship and boat building	3366				
Tourism/Recreation	Sporting/recreational goods	42391	37	1,721	44	1,377
	Sporting goods stores	45111	10	197	12	157
	Recreational goods rental	532292	41	858	49	686
	Commercial water transport.	532411				
	Recreational vehicle dealers	44121				
	Boat dealers	441222	2	74	2	59
	Museums, historical sites	712	35	604	42	484
	Amusement parks and arcades	7131				
	Amusement arcades	71312	30	870	36	696
	Amusement/recreation	7139	570	12,371	685	9,897
	Golf courses/	71391	33	860	39	688
	Marinas	71393	120	2,851	144	2,281
	Fitness/recreational sports	71394	148	2,759	178	2,207
	Amusement/recreation	71399	185	4,086	222	3,269
	Accommodation	721	1,933	46,884	2,319	37,507
	Hotels and motels	72111	1,848	45,076	2,218	36,061
	Bed-and-breakfast inns	721191	21	393	25	314
	Recreational vehicle, camps	7212	20	506	25	405
	Full-service restaurants	7221				
	Food service contractors	72231	5	195	6	156
Caterers	722320	3	47	3	38	
Mobile food services	72233	1	6	1	5	
Transportation	Coastal, water transportation	483				
	Inland water transportation	4832				
	Scenic/sightseeing transport.	487	13	247	15	198
	Marine cargo handling	4883				
	Navigational services/shipping	488320				
	Water transportation	48839				
Environmental	Architectural, engineering	541	821	42,461	986	33,969
	Environmental, conservation	813211	1	58	1	47
	Civic and social organizations	8134	89	1,451	107	1,161
Water/Wastewater	Water, sewage systems	2213				
	Waste management services	562	29	1,442	35	1,154
<b>Total</b>			<b>6,080</b>	<b>170,044</b>	<b>7,296</b>	<b>136,035</b>

1. Direct jobs/wages are those directly related to the Maryland Coastal Bays watershed using county level data and scaling by proportion of county population within the watershed. 2. Indirect jobs/wages are derived from purchases of goods and services by direct jobs earners by multipliers of 2.2 for jobs and 1.8 for wages.

## National Coastal Economy

The National Ocean Economics Program (2016) summarized the coastal and ocean economy in the United States for the following industrial sectors: Marine Transportation, Tourism and Recreation, Living Marine Resources, Marine Construction, Ship and Boat Building, Mineral Extraction (Table 42). According to the NOEP, the coastal economy in Sussex County, Delaware, Worcester County, Maryland, and Accomack County, Virginia, which is in the Maryland Coastal Bays watershed, contributed 24,494 jobs, representing \$837 million in annual wages and \$2.17 billion toward the three counties' gross domestic product or GDP (Table 43). The watershed's ocean economy contributed 5,296 jobs with 127 million in annual wages and \$310 million toward the GDP (Table 44).

**Table 42.** Sectors and industries in the ocean/coastal economy  
(NOEP 2016)

Sector	Industry	NAICS Code
Construction	Marine Construction	237120, 237990
Living Resources	Fishing	
	Fish Hatcheries and Aquaculture	112511, 112512
	Seafood Markets	445220
	Seafood Processing	311711, 311712
Offshore Minerals	Limestone, Sand and Gravel	212321, 212322
	Oil and Gas Exploration	211111, 213111,
	Oil and Gas Production	213112, 541360
Ship and Boat Building	Boat Building and Repair	336611
	Ship Building and Repair	336612
Tourism and Recreation	Amusement and Recreation Services	487990, 611620, 532292, 713990
	Boat Dealers	441222
	Eating and Drinking Places	722110, 722211, 722212, 722213
	Hotels and Lodging Places	721110, 721191
	Marinas	713930
	Recreation Vehicle Parks and Campgrounds	721211
	Scenic Water Tours	487,210
	Sporting Goods Retailers	339920
Transportation	Zoos, Aquaria	712130, 712190
	Deep Sea Freight Transportation	483111, 483113
	Marine Passenger Transportation	483112
	Marine Transportation Services	483114
	Search and Navigation Equipment	334511
	Warehousing	4931100, 493120, 493130

**Table 43.** Coastal employment, wages, and GDP in the Maryland Coastal Bays watershed (NOEP 2016)

Sector	Employment	Wages (\$ million)	GDP (\$ million)
Construction	1,196	49.54	97.98
Financial Activities	1,096	45.20	328.68
Education/Health Services	4,074	189.23	190.86
Information	179	9.07	39.87
Leisure/Hospitality	7,537	169.64	383.23
Manufacturing	1,790	68.07	284.13
Natural Resources/Mining	171	6.85	17.63
Other Services	732	21.28	54.37
Professional/Business	1,708	78.87	135.91
Public Administration	1,555	71.36	325.30
Trade/Transportation/Utilities	4,457	127.55	309.74
<b>Total</b>	<b>24,494</b>	<b>836.65</b>	<b>2,167.70</b>

**Table 44.** Ocean employment, wages, and GDP in the Maryland Coastal Bays watershed (NOEP 2016)

Sector	Employment	Wages (\$ million)	GDP (\$ million)
Marine Construction	24	0.91	1.68
Living Resources	13	0.39	2.88
Minerals			
Ship and Boat Building			
Tourism & Recreation	5,889	125.28	305.78
Marine Transportation			
<b>Total</b>	<b>5,926</b>	<b>126.58</b>	<b>310.34</b>

## Recreation Jobs

### Fishing/Hunting/Wildlife Recreation

The average annual salary per ecotourism job is \$32,843 using figures from the 2011 U.S. Fish and Wildlife Service survey of fishing, hunting, and wildlife-associated recreation. Fishing, hunting, and bird/wildlife-associated recreation in the Maryland Coastal Bays watershed account for \$45.9 million in annual economic activity in 2011 dollars. At an average salary of \$32,843, fishing, hunting, and bird/wildlife-associated recreation accounts 1,396 jobs in the Maryland Coastal Bays watershed (Table 45). While this estimate of ecotourism jobs is not exact, it provides a reasonable estimate of the jobs provided by fishing, hunting, and bird/wildlife-associated recreation in the Maryland Coastal Bays watershed.



**Table 45.** Fishing, hunting, wildlife recreation jobs in Maryland Coastal Bays watershed

Recreation Activity	DE in watershed <sup>1</sup> (\$ million)	MD in watershed <sup>1</sup> (\$ million )	VA in watershed <sup>1</sup> (\$ million )	Total in watershed (\$ million)
Fishing	2.588	12.510	3.097	18.195
Hunting	1.011	6.173	2.378	9.563
Wildlife/Bird-watching	4.209	11.299	2.600	18.107
Total	7.807	29.982	8.075	45.864
	DE Jobs in watershed <sup>2</sup>	MD Jobs in watershed <sup>2</sup>	VA Jobs in watershed <sup>2</sup>	Total Jobs in watershed <sup>2</sup>
Fishing	79	381	94	554
Hunting	31	188	72	291
Wildlife/Bird-watching	128	344	79	551
Total	238	913	246	1,396

1. USFWS 2011 and prorated by ratio of estuary watershed to state area: Del. (2.5%), MD (2.3%), and VA (0.3%). 2. Jobs estimated at \$32,843 average salary.

### White Marlin Open

The White Marlin Open in Ocean City, Maryland employs 130 jobs with \$5 million in wages (Maryland Department of Business and Economic Development 2015).

### National Wildlife Refuge

The U.S. Fish and Wildlife Service (Carver and J. Caudill 2007 estimated the 14,000-acre Chincoteague National Wildlife Refuge was one of the most visited refuges in the nation, with almost 1.4 million visits in 2010 and contributed to 44 jobs with \$1.53 million in annual wages.

### National Parks

The Assateague Island National Seashore preserves almost 109 square miles of land along 40 miles of shoreline. The National Park Service (2016) estimated the Assateague Seashore had 2.3 million recreation visits in 2016. Total visitor spending in the Assateague Seashore in 2016 was \$98.3 million including \$28 million for hotels, \$21.8 million for restaurants, \$7.1 million for recreational industries, and \$3.7 million for camping. In 2016, the Assateague Seashore expenditures supported 1,300 jobs and \$38.8 million in labor income.

### Boating Jobs

The University of Maryland conducted a study in 2014 to find that recreational boating generates approximately \$2.4 billion in economic impact in Maryland. The Marine Trades Association of Maryland (2017) estimated that the boating industry generated about 126 jobs and \$1.43 million

in wages in the Maryland Coastal Bays watershed, which include industries such as mechanics service, marine engineers and architects, boat operators and composites fiberglass.

## Outdoor Recreation

The Outdoor Industry Association (2016) concluded that outdoor recreation contributed to 335,000 jobs in the Delaware, Maryland and Virginia. Given the population of the three states total is 281,725, by proportion outdoor recreation activity in the Maryland Coastal Bays watershed (pop. 56,473) contributes 7,845 jobs and \$274 million in wages (Table 46).

**Table 46.** Outdoor recreation jobs in the Maryland Coastal Bays watershed

County	Total Jobs In State <sup>2</sup>	Watershed Jobs <sup>1</sup>	Total Wages In State (\$ million) <sup>2</sup>	Total Wages In Watershed (Million) <sup>1</sup>
Sussex	29,000	937	\$959	\$31
Worcester	109,000	2,058	\$4,400	\$83
Accomack	197,000	4,851	\$6,500	\$160
<b>Total</b>	<b>335,000</b>	<b>7,845</b>	<b>\$11.9 B</b>	<b>\$274</b>

1. Prorated by ratio of jobs in the state to jobs in watershed: Del. (3.3%), MD (1.9%), and VA (2.5%). 2. Outdoor Industry Association 2016

## State Parks

There are two state parks within the Maryland Coastal Bays watershed – Fenwick Island State Park, Delaware with roughly 500,000 annual visitors, and Assateague State Park, Maryland, with 56,411 annual visitors. Mates and Reyes (2006) from the NJDEP reported at a central estimate of \$21 per visit, 14.2 million visitors per year from 2000-2005 to the New Jersey state park and forest system supported about 7,000 jobs. If 14.2 million visitors to New Jersey state parks supported 7,000 jobs, then the 556,411 annual visitors in the two state parks in the Maryland Coastal Bays watershed supports 274 jobs. According to the Delaware Office of Management and Budget, the average park ranger salary is roughly \$30,000, which would translate to approximately \$8.2 million in wages.

## Farm and Wetland Jobs

### Farm Jobs

In 2012 there were a total of 1,814 farms in Sussex, Worcester, and Accomack Counties which were made up of 448,925 acres of land (USDA 2014). By scaling this data according to the percentage of farmland within the Maryland Coastal Bays watershed, this accounts for a total of 250 farms (Table 47). USDA data also indicated that these farms employ would about 454 jobs within the Maryland Coastal Bays watershed. The total farm wages are \$5.6 million.

**Table 47.** Farm jobs in the Maryland Coastal Bays watershed

County	Farmland in county <sup>1</sup> (ac)	Farmland/watershed (ac)	%	Farms in County <sup>1</sup>	Farms in watershed	Hired Farm Laborers/watershed <sup>1</sup>	Farm Wages <sup>1</sup> (\$ million)
Accomack, VA	77,389	9,578	12.38%	1,214	28	109	1.5
Sussex, DE	272,232	13,509	4.96%	374	60	163	2.2
Worcester, MD	99,304	43,011	43.31%	226	162	182	1.8
<b>Total</b>	<b>448,925</b>	<b>66,098</b>	<b>14.72%</b>	<b>1,814</b>	<b>250</b>	<b>454</b>	<b>5.6</b>

1. NOAA CSC 2010. 2. USDA Census of Agriculture (2014)

## Wetland Jobs

The NOAA Office for Coastal Management (2013) estimates that the 115 mi<sup>2</sup> wetlands in the Maryland Coastal Bays watershed support 3,349 commercial, recreational, and charter fishing jobs in the watershed with \$160 million in business output and \$66 million in wages (Table 48).

**Table 48.** Wetland jobs in the Maryland Coastal Bays watershed

County	Total Jobs In County <sup>1</sup>	Watershed Jobs <sup>1</sup>	Total Revenue In County <sup>2</sup> (Million)	Total Revenue In Watershed <sup>1</sup> (Million)	Total Wages In County <sup>2</sup> (Million)	Total Wages In Watershed <sup>1</sup> (Million)
Sussex	8527	498	\$348	\$20.3	\$161	\$9.4
Worcester	7553	2529	\$381	\$127.5	\$155	\$51.9
Accomack	1174	322	\$43	\$11.8	\$17	\$4.7
<b>Total</b>	<b>17,254</b>	<b>3,349</b>	<b>\$772</b>	<b>\$159.7</b>	<b>\$333</b>	<b>\$66</b>

1. Prorated by ratio of wetland in the watershed to county area: Del. (5.8%), MD (33.5%), and VA (27.5%).

2. NOAA Office for Coastal Management

## Environmental Jobs

### Watershed Organization Jobs

Over a half dozen public and nonprofit watershed and environmental organizations employ at least 25 staff to work on programs to protect the Maryland Coastal Bays watershed (Table 49). Assuming that the average salary of an environmental scientist/specialist is \$61,700 (Bureau of Labor Statistics), these watershed organization jobs account for \$1.5 million in annual wages.

**Table 49.** Watershed organization jobs in the Maryland Coastal Bays watershed

Watershed	Jobs	Salaries
Assateague Coastal Trust	5	308,500
Assateague Island Alliance	3	185,100
Environmental Alliance for Senior Involvement	3	185,100
Lower Shore Land Trust	4	246,800
Maryland Coastal Bays Program	6	370,200
Worcester Environmental Trust	4	246,800
<b>Total</b>	<b>25</b>	<b>1,542,500</b>

## Water Supply Jobs

Public/private water utilities withdraw over 23 mgd of drinking water from groundwater supplies in the Maryland Coastal Bays watershed. According to the American Water Works Association, the average salary of a water-system employee is \$55,407. Water supply utilities in the watershed employ at least 40 jobs with annual wages of \$1.8 million (Table 50).

**Table 50.** Public water supply jobs in the Maryland Coastal Bays watershed

Water Purveyor	Capacity (mgd)	Jobs	Salaries
Assateague Pointe	0.03	1	55,407
Berlin	0.5	4	221,628
Bridgetown	0.01	1	55,407
The Landings 2	0.1	2	110,814
Mystic Harbour		1	55,407
Pocomoke	0.5	5	277,035
Ocean City21		1	55,407
Ocean Pines 5	1.5	6	332,442
Pocomoke 4	0.9	5	277,035
Riddle Farms 2	0.2	3	166,221
Village of Showell		1	55,407
Snow Hill 3	0.3	2	110,814
Ocean City Water Department	19.0	8	440,376
<b>Total</b>	<b>23.0</b>	<b>40</b>	<b>2,201,880</b>

## Stormwater Utility Jobs

The Town of Berlin, Maryland operates a stormwater utility that employs 4 staff with an average salary of \$55,000 for total wages of \$220,000.

## Wastewater Utility Jobs

Public wastewater utilities discharge 2.6 mgd to the Maryland Coastal Bays watershed (MDOE and VIMS 2013). The four wastewater utilities employ 5 staff, at an average salary of \$55,000 the annual wages are \$275,000 (Table 51).

**Table 51.** Wastewater utility jobs in the Maryland Coastal Bays watershed (MDOE and VIMS 2013)

State	Wastewater Utility	Flow (mgd)	Jobs	Salaries
MD	Ocean Pines WWTP	2.5	4	220,000
MD	Assateague Island Nat'l Seashore WWTP	0.012	1	55,000
MD	Newark WWTP	0.07	1	55,000
	<b>Total</b>	<b>2.6</b>	<b>5</b>	<b>275,000</b>

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## Appendix - Employment Codes by Industry, 2009

(U. S. Bureau of Labor Statistics)

Industry		NAICS Code
Agriculture, Forestry, Fishing and Hunting		11
	Crop Production	111
	Animal Production	112
	Aquaculture	1125
	Forestry and Logging	113
	Fishing, Hunting and Trapping	114
	Fishing	1141
	Support Activities for Agriculture and Forestry	115
Mining, Quarrying, and Oil and Gas Extraction		21
	Oil and Gas Extraction	211
	Mining (except Oil and Gas)	212
	Nonmetallic Mineral Mining and Quarrying	2123
	Support Activities for Mining	213
Utilities		22
	Utilities	221
	Electric Power Generation, Transmission and Distribution	2211
	Natural Gas Distribution	2212
	Water, Sewage and Other Systems	2213
Construction		23
	Construction of Buildings	236
	Residential Building Construction	2361
	Nonresidential Building Construction	2362
	Heavy and Civil Engineering Construction	237
	Land Subdivision	2372
	Highway, Street, and Bridge Construction	2373
	Other Heavy and Civil Engineering Construction	2379
	Specialty Trade Contractors	238
Manufacturing		31
	Food Manufacturing	311
	Seafood Product Preparation and Packaging	3117
	Beverage and Tobacco Product Manufacturing	312
	Textile Mills	313
	Textile Product Mills	314
	Apparel Manufacturing	315
	Apparel Knitting Mills	3151
	Leather and Allied Product Manufacturing	316
	Wood Product Manufacturing	321
	Paper Manufacturing	322
	Petroleum and Coal Products Manufacturing	324
	Chemical Manufacturing	325
	Basic Chemical Manufacturing	3251
	Resin, Synthetic Rubber, and Artificial Synthetic Fibers and Filaments Manufacturing	3252
	Pesticide, Fertilizer, and Other Agricultural Chemical Manufacturing	3253



	Pharmaceutical and Medicine Manufacturing	3254
	Paint, Coating, and Adhesive Manufacturing	3255
	Soap, Cleaning Compound, and Toilet Preparation Manufacturing	3256
	Other Chemical Product and Preparation Manufacturing	3259
	Plastics and Rubber Products Manufacturing	326
	Nonmetallic Mineral Product Manufacturing	327
	Cement and Concrete Product Manufacturing	3273
	Lime and Gypsum Product Manufacturing	3274
	Other Nonmetallic Mineral Product Manufacturing	3279
	Primary Metal Manufacturing	331
	Fabricated Metal Product Manufacturing	332
	Machinery Manufacturing	333
	Computer and Electronic Product Manufacturing	334
	Computer and Peripheral Equipment Manufacturing	3341
	Communications Equipment Manufacturing	3342
	Audio and Video Equipment Manufacturing	3343
	Semiconductor and Other Electronic Component Manufacturing	3344
	Navigational, Measuring, Electromedical, and Control Instruments Manufacturing	3345
	Manufacturing and Reproducing Magnetic and Optical Media	3346
	Electrical Equipment, Appliance, and Component Manufacturing	335
	Transportation Equipment Manufacturing	336
	Motor Vehicle Manufacturing	3361
	Motor Vehicle Body and Trailer Manufacturing	3362
	Motor Vehicle Parts Manufacturing	3363
	Aerospace Product and Parts Manufacturing	3364
	Railroad Rolling Stock Manufacturing	3365
	Ship and Boat Building	3366
	Other Transportation Equipment Manufacturing	3369
	Furniture and Related Product Manufacturing	337
	Miscellaneous Manufacturing	339
Wholesale Trade		42
	Merchant Wholesalers, Durable Goods	423
	Merchant Wholesalers, Nondurable Goods	424
	Wholesale Electronic Markets and Agents and Brokers	425
Retail Trade		44
	Motor Vehicle and Parts Dealers	441
	Furniture and Home Furnishings Stores	442
	Electronics and Appliance Stores	443
	Electronics and Appliance Stores	4431
	Building Material and Garden Equipment and Supplies Dealers	444
	Food and Beverage Stores	445
	Health and Personal Care Stores	446
	Gasoline Stations	447
	Clothing and Clothing Accessories Stores	448
	Sporting Goods, Hobby, Book, and Music Stores	451
	General Merchandise Stores	452
	Miscellaneous Store Retailers	453
	Nonstore Retailers	454
Transportation and Warehousing		48

	Air Transportation	481
	Scheduled Air Transportation	4811
	Nonscheduled Air Transportation	4812
	Rail Transportation	482
	Rail Transportation	4821
	Water Transportation	483
	Deep Sea, Coastal, and Great Lakes Water Transportation	4831
	Inland Water Transportation	4832
	Support Activities for Water Transportation	4883
	Truck Transportation	484
	General Freight Trucking	4841
	Specialized Freight Trucking	4842
	Transit and Ground Passenger Transportation	485
	Urban Transit Systems	4851
	Interurban and Rural Bus Transportation	4852
	Taxi and Limousine Service	4853
	School and Employee Bus Transportation	4854
	Charter Bus Industry	4855
	Other Transit and Ground Passenger Transportation	4859
	Pipeline Transportation	486
	Pipeline Transportation of Crude Oil	4861
Information		51
	Publishing Industries (except Internet)	511
	Motion Picture and Sound Recording Industries	512
	Broadcasting (except Internet)	515
	Telecommunications	517
	Data Processing, Hosting, and Related Services	518
	Other Information Services	519
Finance and Insurance		52
	Monetary Authorities-Central Bank	521
	Credit Intermediation and Related Activities	522
	Securities, Commodity Contracts, and Other Financial Investments and Related Activities	523
	Insurance Carriers and Related Activities	524
	Funds, Trusts, and Other Financial Vehicles	525
Real Estate and Rental and Leasing		53
	Real Estate	531
	Rental and Leasing Services	532
	Lessors of Nonfinancial Intangible Assets (except Copyrighted Works)	533
Professional, Scientific, and Technical Services		54
	Professional, Scientific, and Technical Services	541
	Management, Scientific, and Technical Consulting Services	5416
	Scientific Research and Development Services	5417
Management of Companies and Enterprises		55
	Management of Companies and Enterprises	551
Administrative and Support and Waste Management and Remediation Services		56
	Administrative and Support Services	561
	Travel Arrangement and Reservation Services	5615
	Waste Management and Remediation Services	562
Educational Services		61

	Educational Services	611
	Colleges, Universities, and Professional Schools	6113
	Technical and Trade Schools	6115
	Educational Support Services	6117
Health Care and Social Assistance		62
	Ambulatory Health Care Services	621
	Hospitals	622
	Nursing and Residential Care Facilities	623
	Social Assistance	624
Arts, Entertainment, and Recreation		71
	Performing Arts, Spectator Sports, and Related Industries	711
	Museums, Historical Sites, and Similar Institutions	712
	Amusement, Gambling, and Recreation Industries	713
	Other Amusement and Recreation Industries	7139
Accommodation and Food Services		72
	Accommodation	721
	Traveler Accommodation	7211
	RV (Recreational Vehicle) Parks and Recreational Camps	7212
	Rooming and Boarding Houses	7213
	Food Services and Drinking Places	722
Other Services (except Public Administration)		81
	Repair and Maintenance	811
	Personal and Laundry Services	812
	Religious, Grantmaking, Civic, Professional, and Similar Organizations	813
	Social Advocacy Organizations	8133
	Business, Professional, Labor, Political, and Similar Organizations	8139
	Private Households	814
Public Administration		92
	Executive, Legislative, and Other General Government Support	921
	Justice, Public Order, and Safety Activities	922
	Administration of Human Resource Programs	923
	Administration of Environmental Quality Programs	924
	Administration of Housing Programs, Urban Planning, Community Development	925
	Administration of Economic Programs	926
	Space Research and Technology	927
	National Security and International Affairs	928