Economic Value of the Maryland Coastal Bays Watershed

(in Delaware, Maryland, and Virginia)

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Prepared for

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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 **$1.8 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 $300 million, $1.2 billion, 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. Some values were not included in these estimates because the data to assess them either are not readily available or do not exist. 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. Also, the report does not include real estate value or the value of propery taxes and federal/state income taxes.

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 historically supported oyster, hard clam, blue crab and finfish fisheries and provides 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 bays' water resources making it difficult to accurately compare values across uses.

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. 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 2nd in the

number of tourism jobs and 3rd in tourism economic output. 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		
USEPA NCEE (2001)	1,600	21,296	415
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
Total	Maryland Coastal Bays Totals	1,582,510	21,296	415,002

*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.
1993 - Maryland DNR initiates annual shellfish surveys of the Coastal Bays
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; and 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^2)	Area (%)
Delaware	49	11%
Maryland	290	64%
Virginia	117	26%
Total	**456**	**100%**

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, 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. 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
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), now the Office for Coastal Management, the 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^2 of wetlands, 3 mi^2 of agriculture, and 0.2 mi^2 of forest and gained 4.2 mi^2 of urban land due to new development (Table 5).

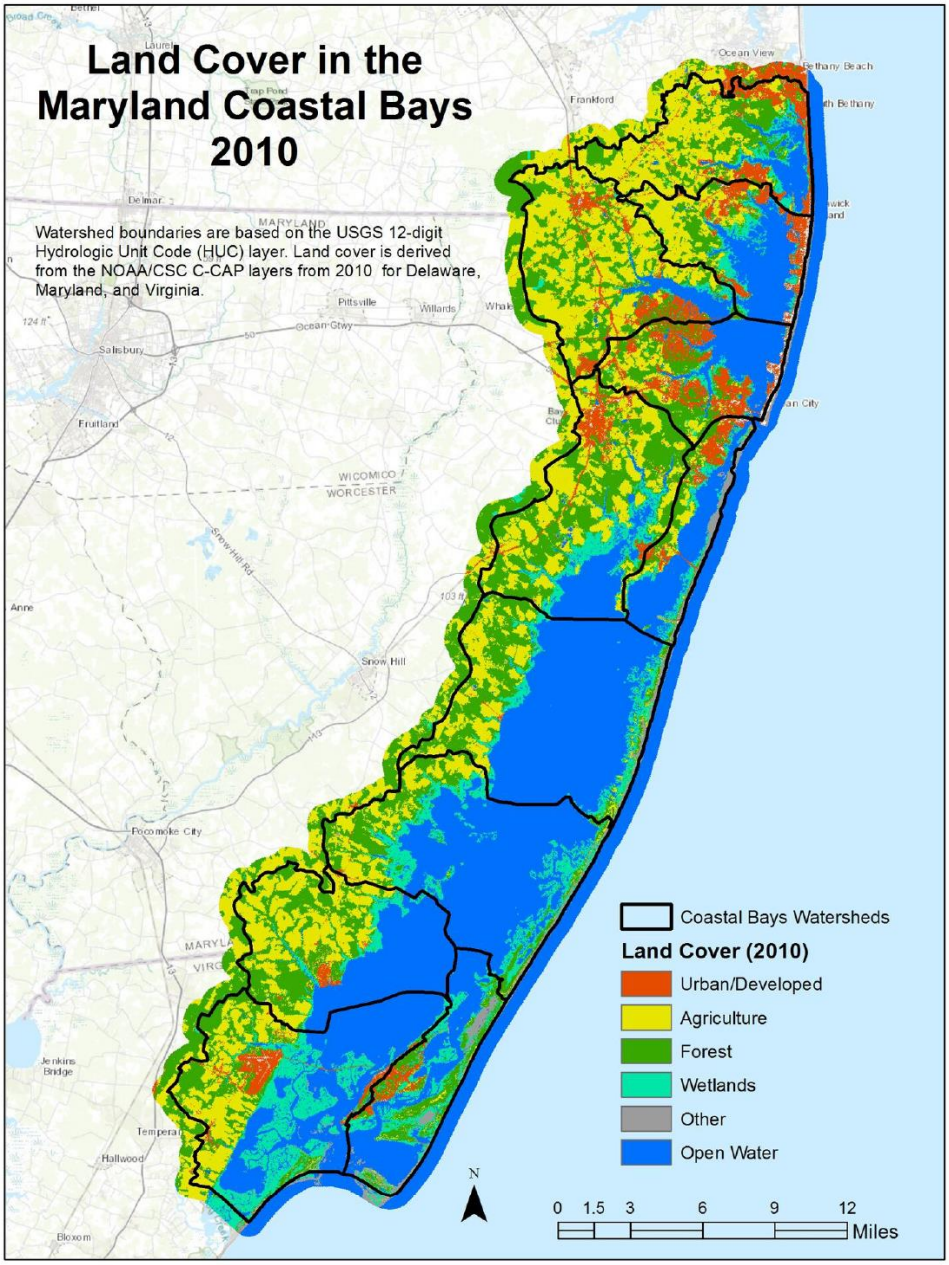


Figure 2. Land cover in the Maryland Coastal Bays watershed (NOAA CSC 2010)

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

Land Use	Sussex Co. DE, 2010 (mi^2)	Worcester Co. MD, 2010 (mi^2)	Accomack Co. VA, 2010 (mi^2)	Watershed Total, 2010 (mi^2)
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
Total	**49.2**	**290.1**	**116.4**	**455.6**
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%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**

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

Land Use	1996 (mi^2)	2010 (mi^2)	Change (mi^2)
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
Total	**455.6**	**455.6**	**0.0**

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

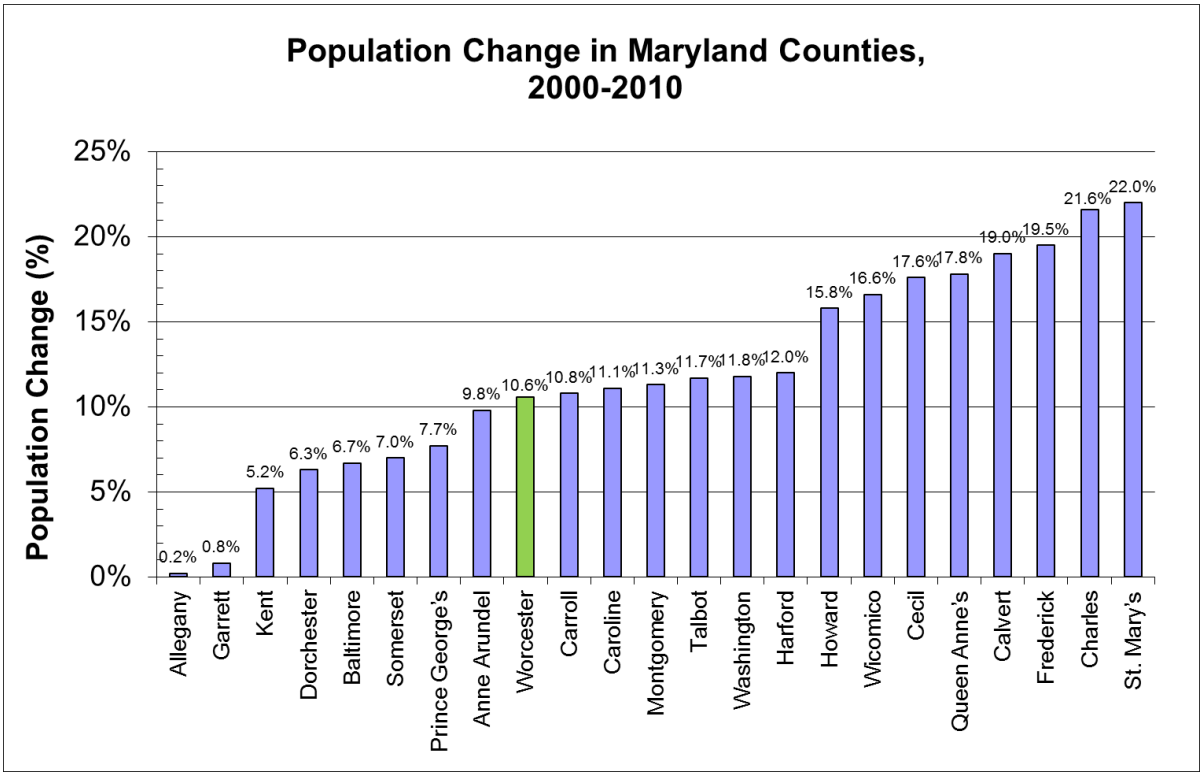
County's population growth rate of 10.6% ranked 9th highest of Maryland's 24 counties and during 2010-2016 the growth rate of 0% ranked 8th highest among the state's counties U.S. Census Bureau 2000, 2010, 2016).

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%
Total	**56,473**	**400,000**	**100%**

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%
Worcester	**51,451**	**51,444**	**-7**	**0.0%**
Maryland	**5,773,786**	**6,016,447**	**242,661**	**4.2%**



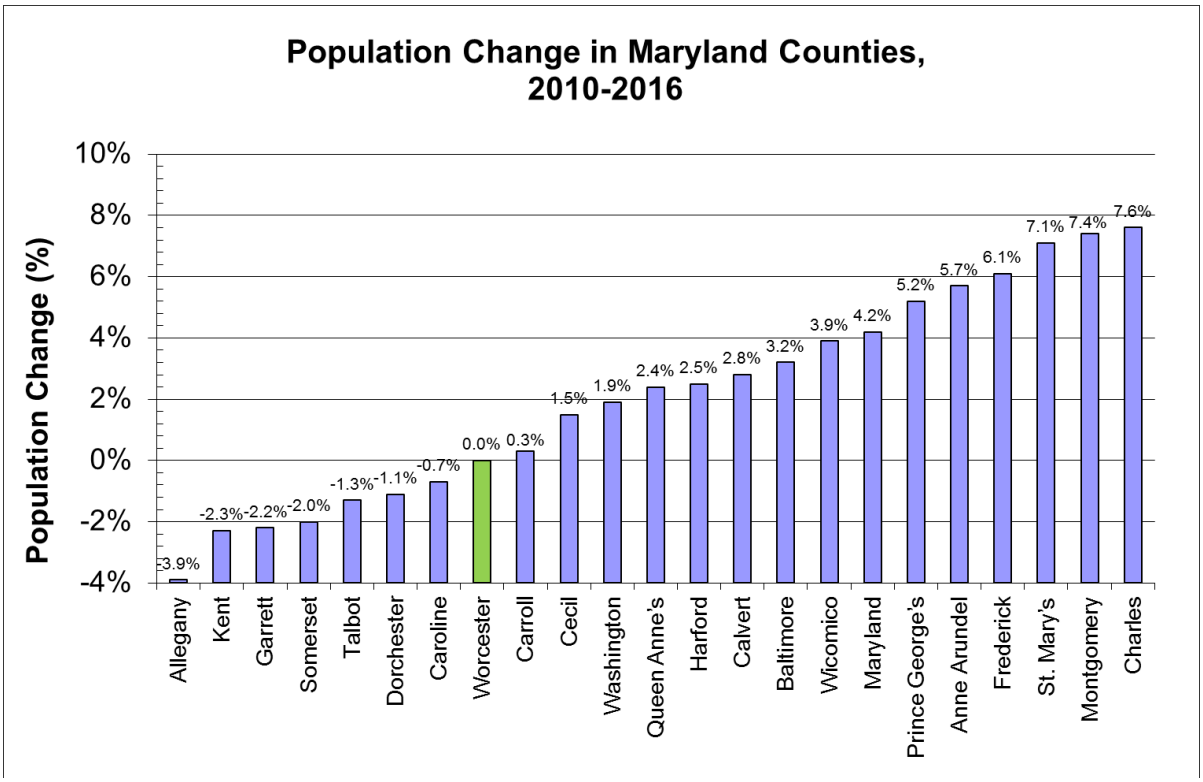


Figure 3. Population change in Worcester County, 2000-2010 and 2010-2016 (U.S Census Bureau 2010 and 2016)

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.

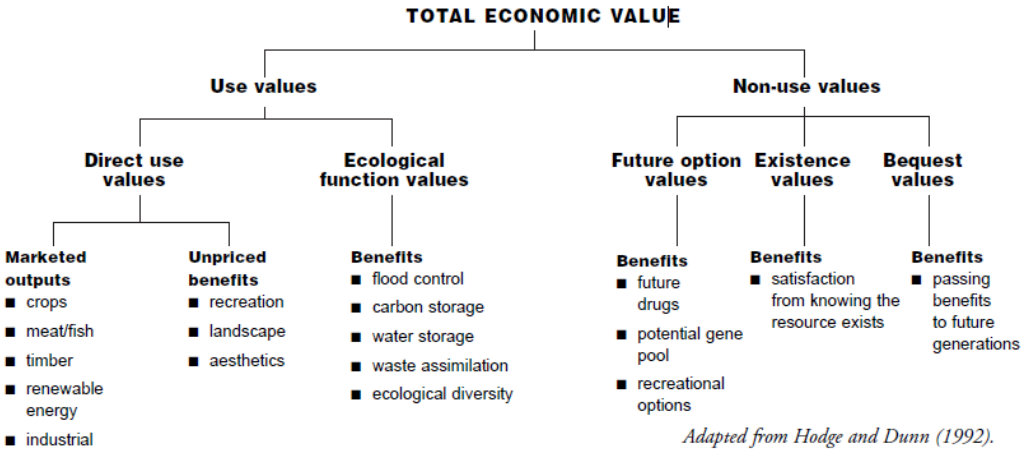


Figure 4. Economic value of water resources (Hodge and Dunn, 1992)

The economic value of the Maryland Coastal Bays watershed from water quality, water supply, fish/wildlife, recreation, agriculture, forests and public parks benefits exceeds $1.8 billion annually, including over $300 million in Delaware, $1.2 billion in Maryland, and $300 million in Virginia (Figure 5 and Tables 8 and 9).

Water Quality	$95 million
Water Supply	$14 million
Fish/Wildlife	$371 million
Recreation	$1.2 billion
Agriculture	$98 million
Forests	$23 million
Public Parks	$98 million
Total	**> $1.8 billion**

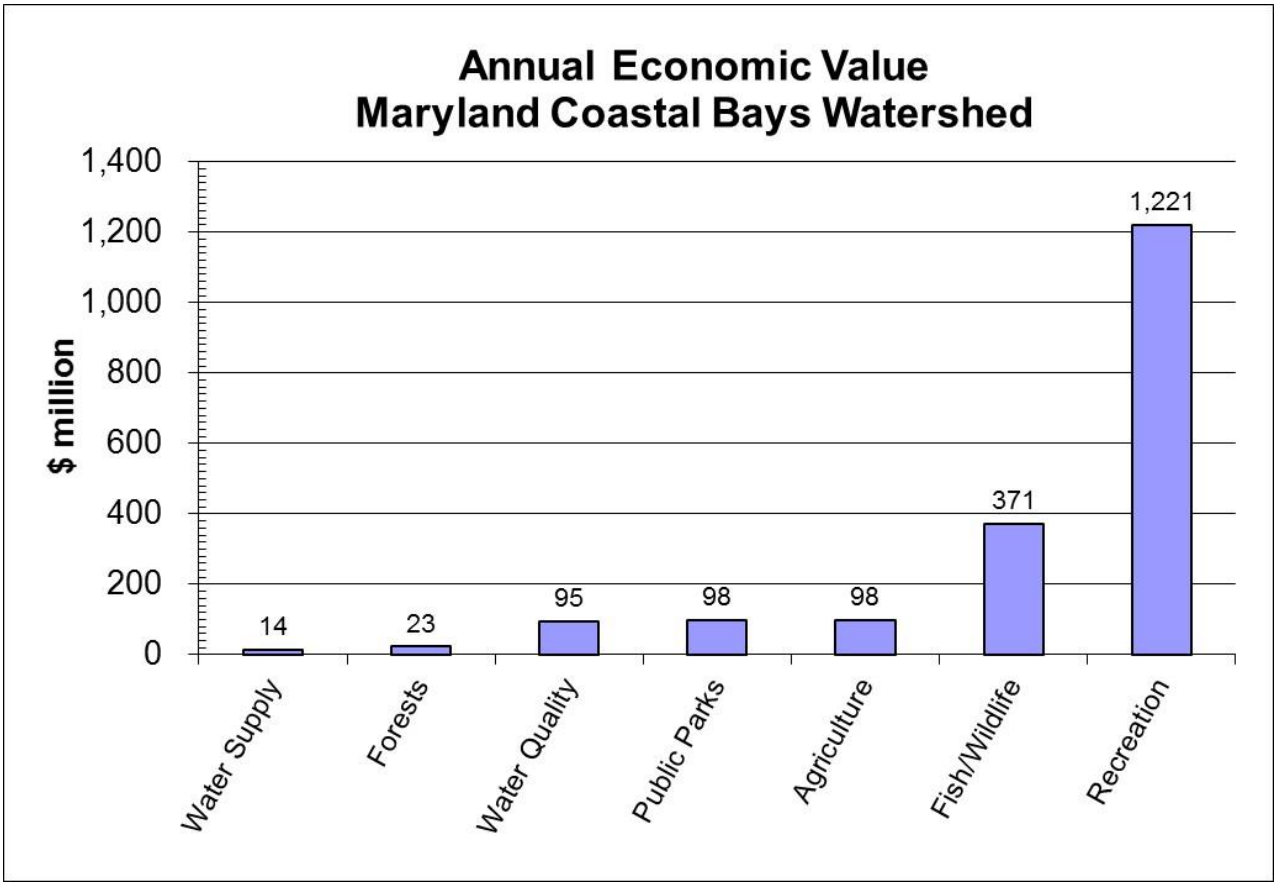


Figure 5. Annual economic value of the Maryland Coastal Bays watershed

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

Activity	Economic Value ($ million)	Source
Water Quality		
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, Leggett et al. 2000, Poor et al.
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)
Water Supply		
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)
Fish/Wildlife		
Fishing Charters (14 charters at $5 million)	70	Ocean City Fishing charters
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)
Recreation		
Outdoor Recreation (99,000 participants)	509	Outdoor Industry Association (2016)
Powerboating (DE, VA, MD rank 7th, 17th, 23rd 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 (1.2 million visitors @ $259/visit)	319	Rockport Analytics (2017)
Agriculture		
Nursery, crop, poultry, livestock (343 farms on 46,087 ac)	98	USDA Census of Agriculture (2014)
Forests		
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)
Public Parks		
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)
Coastal Bays Watershed	**>$1.8 billion**	

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)
Water Quality				
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
Water Supply				
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
Fish/Wildlife				
Fishing Charters (14 charters at $5 million)		70		70
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
Recreation				
Outdoor Recreation (99,000 participants)	151	294	63	509
Powerboating (DE, VA, MD rank 7th, 17th, 23rd 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 (1.2 million visitors @ $259/visit)	60	259		319
Agriculture				
Nursery, crop, poultry, livestock (343 farms on 46,087 ac)	17	45	36	98
Forests				
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
Public Parks				
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
Coastal Bays Watershed	**>$300 million**	**>$1.2 billion**	**>$300 million**	**>$1.8 billion**

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[1] ($1994)	WTP per person[2] ($2017)
Boatable	$8.25	$16.28
Fishable	$8.26	$16.30
Swimmable	$70.47	$139.08
Total	**$86.98**	**$171.66**

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[1] ($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
Coastal Bays Total	**56,473**	**400,000**	**$171.66**	**9,694,155**	**68,664,000**
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
Delaware	**13,220**	**93,638**	**$171.66**	**2,269,345**	**16,073,899**
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
Maryland	**36,389**	**257,744**	**$171.66**	**6,246,536**	**44,244,335**
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
Virginia	**6,864**	**48,618**	**$171.66**	**1,178,274**	**8,345,766**

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

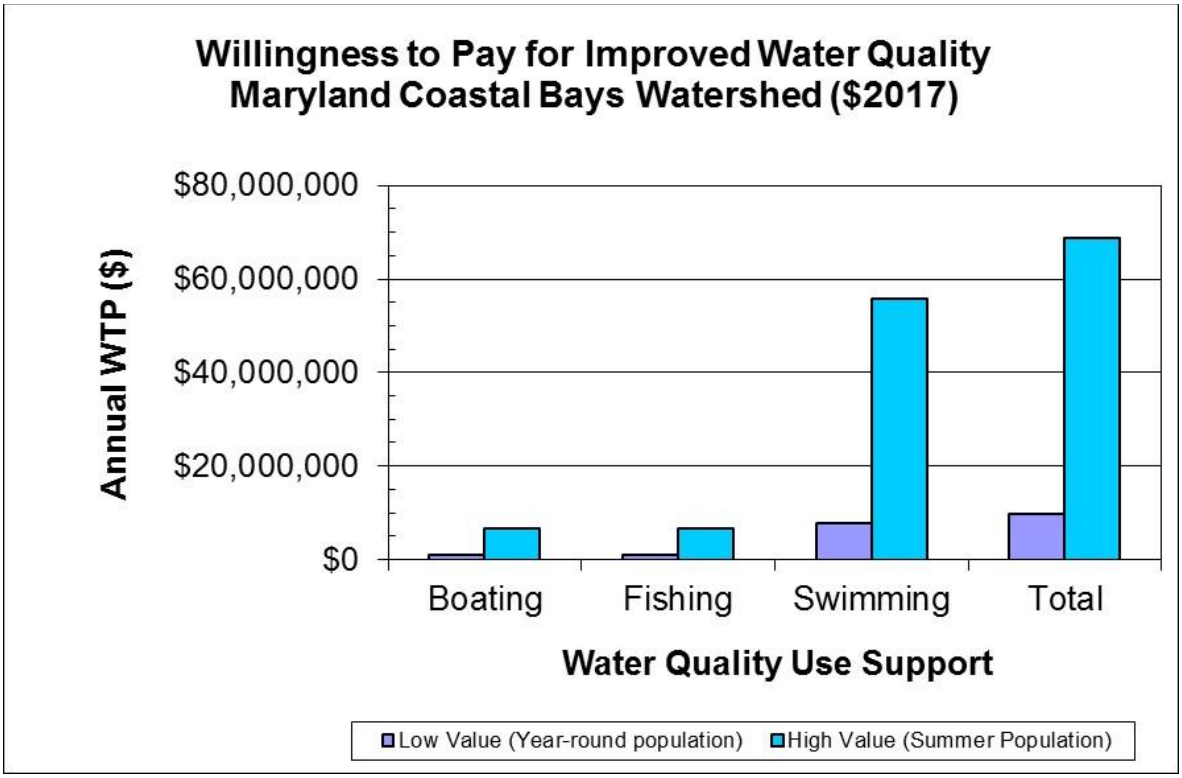


Figure 6. Willingness to pay for improved water quality in the Maryland Coastal Bays

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). In the San Diego Bay, Kanawha, Ohio, and Willamette River, Oregon watersheds, the USEPA (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%.

Table 12. Increased property value resulting from improved water quality

Study	Watershed	Increased Property Value
USEPA (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%

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)

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
Total	**284**	**1,499,520**	**68,848**	**$5,193**	**$415**	**$20.8**

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 million gallons per day (mgd) and forests cover 19,673 acres (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
	Total	**2.6**

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.

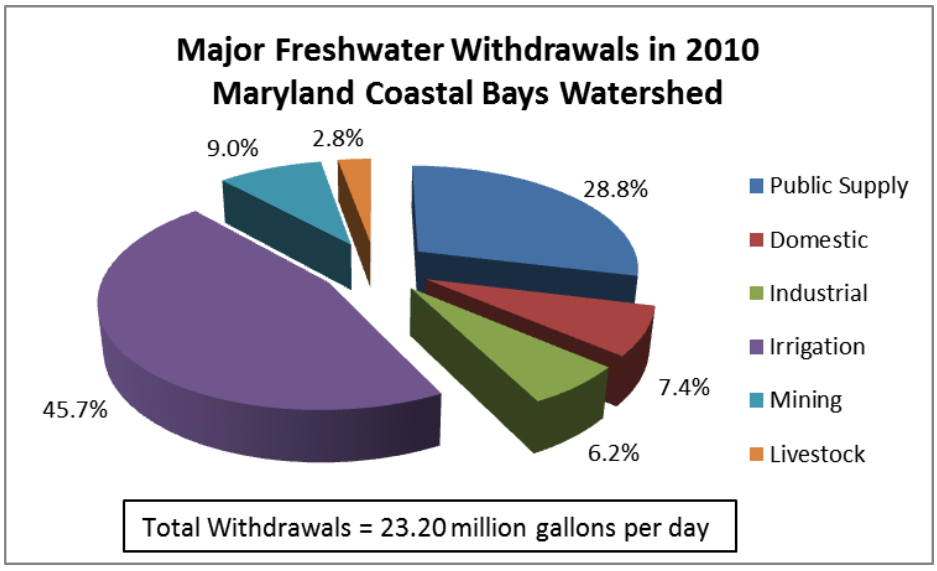


Figure 7. Major freshwater withdrawals in the Maryland Coastal Bays watershed (USGS 2010**)**

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 Coastal Bays watershed in Delaware, Maryland, and Virginia 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[1] ($/acre-ft.)	2017 Median[2] ($/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

Fishing Charters

Presently there are 14 fishing charters docked in the Maryland Coastal Bays watershed (Figure 8). If annual revenue is $5 million per charter, then the economic value of fishing charters in the watershed is $70 million per year.

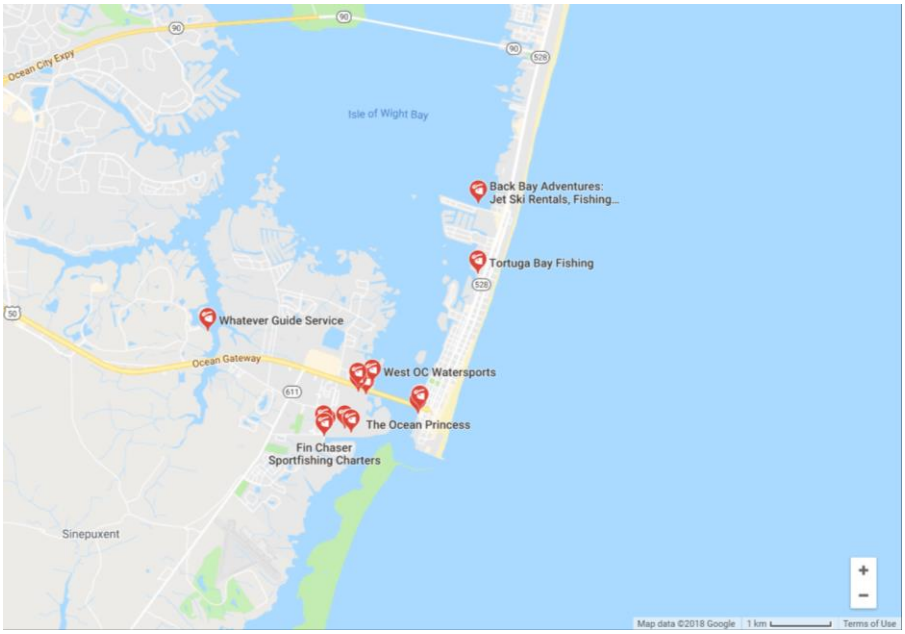


Figure 8. Fishing charters in the Maryland Coastal Bays watershed

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		
Total	**7,485,286**	**$238,692,600**	**3,766**	**$94,856,700**

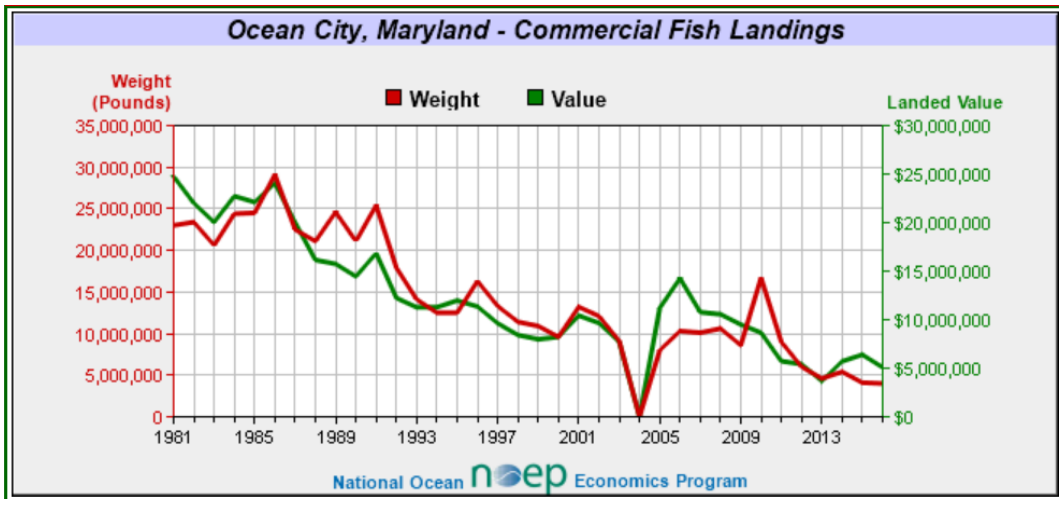
Commercial Fish Landings

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 115th and 122nd 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 9). Taken together, the combined ports in the Maryland Coastal Bays would be the 87th 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)	Rank	Port	Landed Value
1	Dutch Harbor-Unalaska, AK	770,000,000	1	New Bedford, MA	$326,500,000
2	Aleutian Islands (Other), AK	508,000,000	2	Dutch Harbor-Unalaska, AK	$198,000,000
3	Empire-Venice, LA	440,000,000	3	Empire-Venice, LA	$122,000,000
4	Kodiak, AK	417,000,000	4	Naknek-King Salmon, AK	$108,000,000
5	Reedville, VA	321,300,000	5	Kodiak, AK	$107,000,000
6	Pascagoula-Moss Point, MS	285,000,000	6	Honolulu, HI	$106,000,000
7	Alaska Penninsula (Other), AK	243,000,000	7	Aleutian Islands (Other), AK	$105,000,000
8	Intracoastal City, LA	215,000,000	8	Alaska Penninsula (Other), AK	$85,000,000
9	Naknek-King Salmon, AK	170,000,000	9	Cape May-Wildwood, NJ	$84,700,000
10	Westport, WA	108,300,000	10	Bristol Bay (Other), AK	$76,000,000
94	Morro Bay, CA	4,300,000	94	Port Clyde, ME	$7,800,000
95	Ocean City, MD	4,000,000	95	Tacoma, WA	$7,800,000
96	Cameron, LA	4,000,000	96	Fort Bragg, CA	$7,300,000
97	Panama City, FL	4,000,000	97	Portsmouth, NH	$7,100,000
98	Fairhaven, MA	3,900,000	98	Morro Bay, CA	$7,100,000
99	Newington, NH	3,900,000	99	Neah Bay, WA	$7,000,000
100	Willapa Bay, WA	3,800,000	100	Naples, FL	$7,000,000
115	Belford, NJ	2,500,000	115	Ocean City, MD	$5,700,000
116	Chincoteague, VA	2,400,000	116	New London, CT	$5,100,000
117	San Diego, CA	2,200,000	117	Cortez, FL	$5,000,000
118	Stonington, CT	2,100,000	118	Ft. Pierce-St.Lucie, FL	$5,000,000
119	Ft. Pierce-St.Lucie, FL	2,000,000	119	Iberia, LA	$5,000,000
120	Fernandina, Beach, FL	2,000,000	120	Fernandina, Beach, FL	$5,000,000
121	Portsmouth, NH	2,000,000	121	Port St. Joe, FL	$5,000,000
122	Naples, FL	2,000,000	122	Chincoteague, VA	$4,900,000
125	Blaine, WA	1,800,000	125	Savannah, GA	$3,100,000



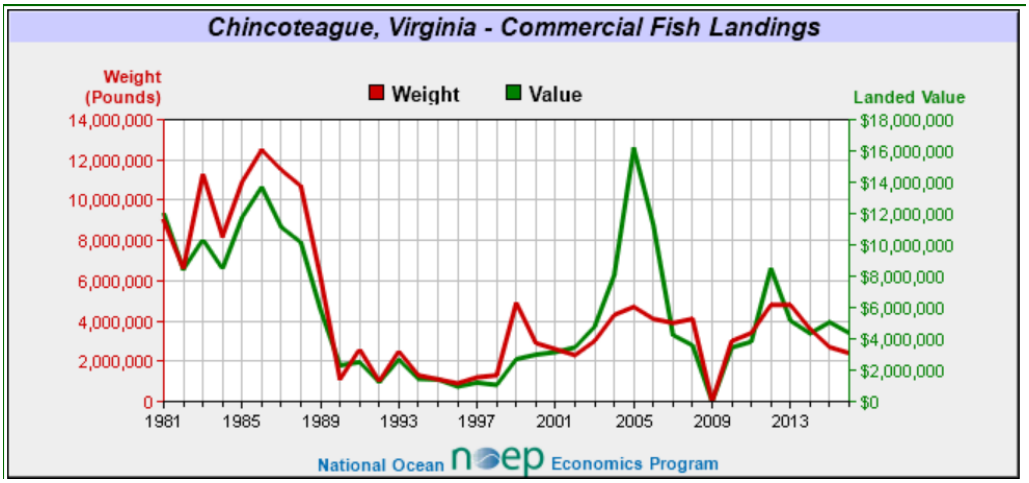


Figure 9. Commercial fish landings at Coastal Bays ports in Maryland and Virginia (NOEP 2016)

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 commercial hard clam 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. Hard clam landing data for the Virginia portion of the Coastal Bays is not available. 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. The Maryland Coastal Bays does have a growing clam aquaculture industry.

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 10 (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 11). 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.

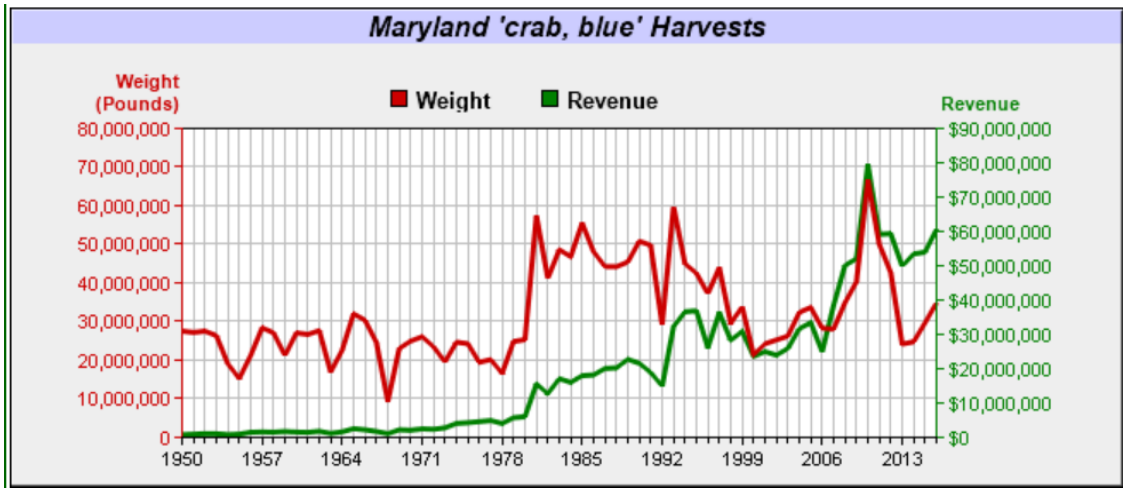


Figure 10. Maryland blue crab landings (NOEP 2016)

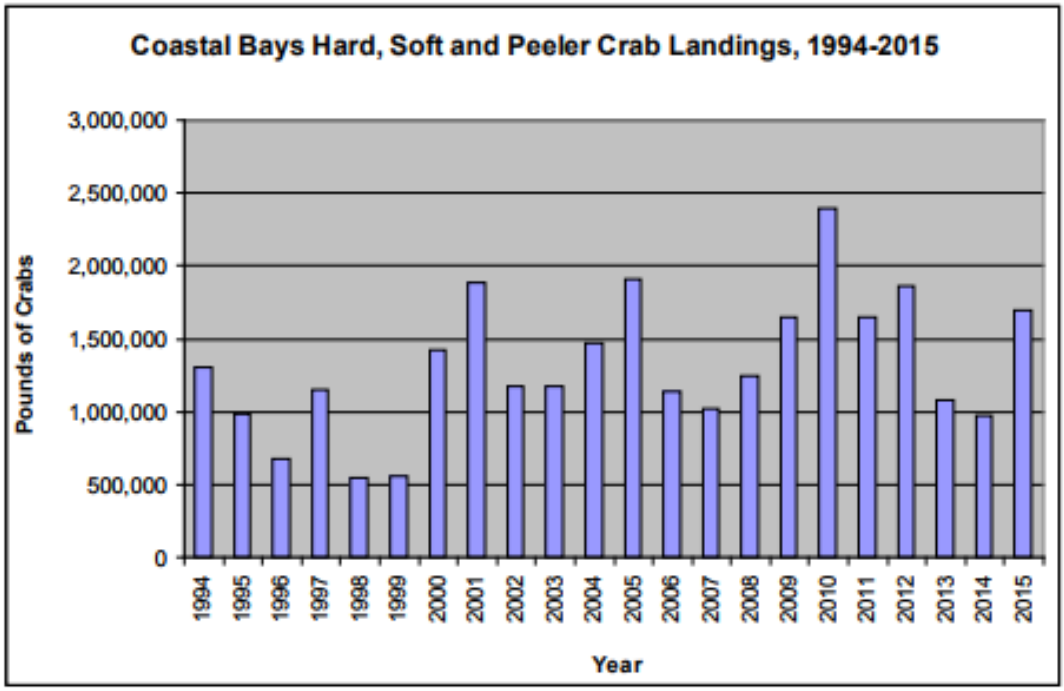


Figure 11. Crab landings in the Maryland Coastal Bays (MD FMP 2015)

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 12). 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%
Total	**100%**	**100%**

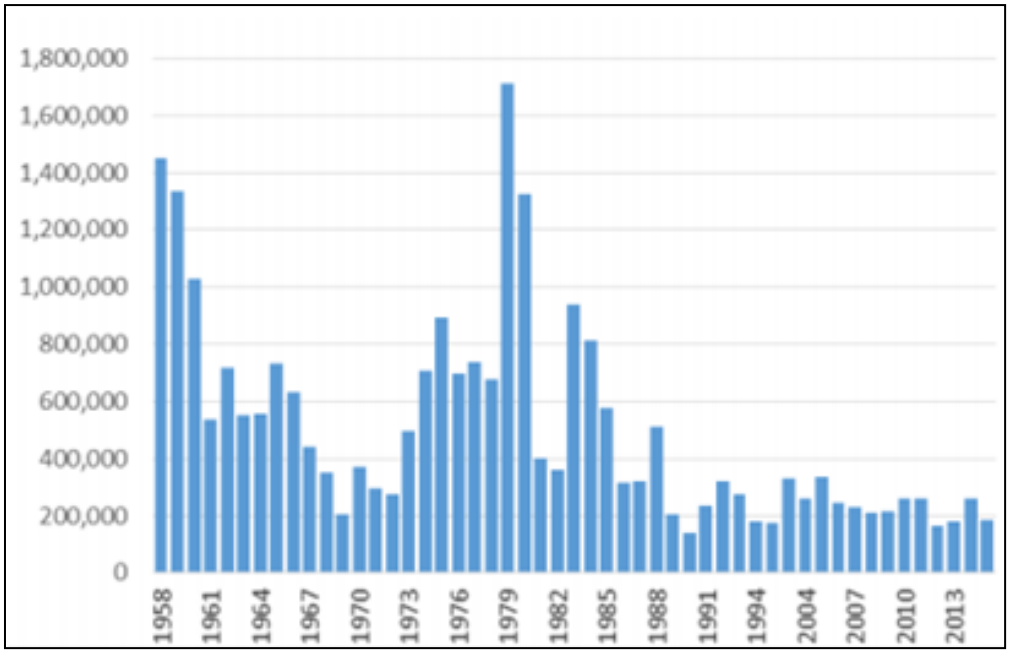


Figure 12. Maryland commercial summer flounder harvest in pounds
(MD Fishery Management Plan 2015)

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, snow geese, 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 was $4.6 billion (Table 21). 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.

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 wild-life/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
Total	**315**	**1,283**	**2,978**	**4,575**
	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
Total	**8**	**30**	**8**	**46**

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 and summer population of 400,000 contributes $509 million in spending to the economy and 4,277 jobs with $158 million in wages (Table 22).

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

Economic Activity	**Delaware[1]**	**Maryland[1]**	**Virginia[1]**	**Total 3 States[2]**
Consumer Spending	$3.1 billion	$14 billion	$21.9 billion	$39 billion
Participants	467,000	3 million	4.6 million	8.1 million
Economic Activity	**Delaware in watershed[2]**	**Maryland in watershed[2]**	**Virginia in watershed[2]**	**MD Coastal Bays Watershed[2]**
Consumer Spending	$151 million	$294 million	$63 million	$509 million
Participants	22,831	63,103	13,225	99,160

1. Outdoor Industry Association 2016. 2. Scaled by proportion of Maryland Coastal Bays watershed year round and summer population to state-wide population.

Powerboating

The National Marine Manufacturers Association (2014) announced that Delaware, Virginia, and Maryland ranked 9th, 17th, and 23rd 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 ($)**	**% Land of States in Watershed**	**Watershed Expenditures[1] ($)**
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
Total		**1,155,000,000**		**21,000,000**

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, on the average 260,000 visitors are present on 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/year.

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

State	Author/Date	WTP ($2010/day)	WTP[1] $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
Mean			**$17.17**

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 with attendance of over 1.2 million visitors per year. Beach visits in Ocean City, Maryland outside of the state parks are accrued in a separate section. At $259 per visit for lodging, food, and expenditures estimated by an economic study of the Delaware State Park system (Rockport Analytics 2017), the 1.2 million visitors to the state parks in the Maryland Coastal Bays watershed contribute $319 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	60,303,488
Assateague State Park, MD	1,000,000	259	259,000,000
Total	**1,232,832**	**259**	**319,303,488**

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 watershed farmland to farmland in the counties, the annual market value of agricultural products

in the Maryland Coastal Bays watershed ranges from $98 million on 342 farms from nurseries, vegetables, fruit, horses, grain, poultry, cattle, and Christmas trees (Tables 26 and 27).

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

Product	Farms	Value ($1,000)
Poultry	49	42,774
Grain	84	35,204
Nursery	13	13,758
Milk from Cows	1	510
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	
Total	**343**	**98,443**

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

County	Farmland in county (ac)	Farmland in watershed (ac)	Ratio watershed/ county %	Value in County[1] ($ million)	Value in Watershed[3] ($ million)
Accomack, VA	77,389[1]	9,578	12%	142	17
Sussex, DE	272,232[1]	13,509	5%	899	45
Worcester, MD	62,000[2]	23,000	37%	98	36
Total	**411,621**	**46,087**	**11%**	**1,139**	**98**

1. USDA Census of Agriculture (2014). 2. Maryland Department of Agriculture. 3. 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 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[1]		Forests MD Coastal Bays Watershed[2]	
	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[1] ($/acre)	Delaware[2] ($)	Maryland[3] ($)	Virginia[4] ($)	Coastal Bays Watershed[5] ($)
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
Total	**1,181**	**1,959,279**	**15,096,723**	**6,177,811**	**23,233,441**

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). While these values are from one city and may not be applicable to public parks outside of a city context due to fewer beneficiaries, we use this data here to estimate the value of public parks in the watershed.

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.

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 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
Total		**7,442**

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	**4,515,344**
DEDFW	3,100	30,175,400	7,387,300	2,855,100	272,800	**40,690,600**
MDDNR	2,759	26,856,106	6,574,697	2,541,039	242,792	**36,214,634**
MDDNR	200	1,946,800	476,600	184,200	17,600	**2,625,200**
MDDNR	93	905,262	221,619	85,653	8,184	**1,220,718**
MDSPS	855	8,322,570	2,037,465	787,455	75,240	**11,222,730**
WCRP	91	885,794	216,853	83,811	8,008	**1,194,466**
Total	**7,442**	**72,440,428**	**17,734,286**	**6,854,082**	**654,896**	**97,683,692**

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 habitat such as wetlands, forests, farms, and open water. This section quantifies the economic valuation of ecosystem services using the benefit transfer method. Published data from other watersheds are selected and the dollars-per-acre values are applied to the Maryland Coastal Bays watershed. While primary research data from the Coastal Bays is preferable and used in this report, value transfer is the next best way to value ecosystems, especially when in the absence of such data, the worth of ecosystems have been deemed zero.

Related Research

Mates and Reyes (2007) estimated the value of New Jersey natural capital at $20 billion/year in 2004 dollars with a net present value (NPV) of $681 billion. In Maryland, Campbell (2017) calculated the annual ecosystem service value for forest ($5,767/hectare) and freshwater wetlands ($9,693/hectare). Weber (2007) from the Conservation Fund found ecosystem services values in Cecil County, Maryland stem from stormwater, water supply, and clean water functions (Table 32). The Wilderness Society (Krieger 2001) concluded forest ecosystem services for water supply, water quality, and recreation benefits totaled $392/acre in 1994 dollars or $774/acre in 2017 dollars (Table 33). The University of Maryland studied the U.S. National Wildlife Refuge System and determined ecosystem values of freshwater wetlands and forests are $6,268/acre and $845/acre (Ingraham and Foster 2008). The Audubon Society found ecosystems values in Massachusetts ranged from $984/acre for forests to $15,452/acre for saltwater wetlands (Breunig 2003). The USDA (2014) reported the goods value of agricultural products sold in Accomack County, VA; Sussex County, DE; and Worcester County, MD was $2,600/acre.

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		
Total	**12,033**	**52,765**	**43,685**	**27,529**

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

Ecosystem Good or Service	1994 Value[1] ($/ac)	2017 Value[2] ($/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
Total	**392.1**	**773.8**

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

Table 34 compares ecosystem services values from other watersheds. Data from the NJDEP study and USDA crop value of agriculture are used for value transfer to the Maryland Coastal Bays watershed as the study areas share 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 estimates for wetlands and forests and Mass. Audubon values for wetlands. NJDEP estimates are higher than the Wilderness Society for forests and U.S. National Wildlife Refuge System for freshwater wetlands and forests.

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

Ecosystem	NJDEP Mates 2007 ($/ac/yr)	Maryland Campbell 2017 ($/ac/yr)	Cecil Co. Md. 2007 ($/ac/yr)	Wilderness Society 2001 ($/ac/yr)	U.S. NWR 2008 ($/ac/yr)	Mass. Audubon 2003 ($/ac/yr)	USDA Census 2014 ($/ac/yr)
Freshwater wetland	11,802	3,900	43,685		6,268	15,452	
Marine	8,670						
Farmland	6,229					1,387	2,600
Forest	1,714	2,300	12,033	641	845	984	
Saltwater wetland	6,269		28,146			12,580	
Undeveloped							
Urban	296						
Beach/dune	42,149						
Open freshwater	1,686				217	983	
Riparian buffer	3,500		52,765				
Shellfish areas							

Watershed Ecosystem Services

The estimated value of ecosystem goods and services provided by the Maryland Coastal Bays watershed (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 13). Ecosystems (Figure 14) 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 15 and 16).

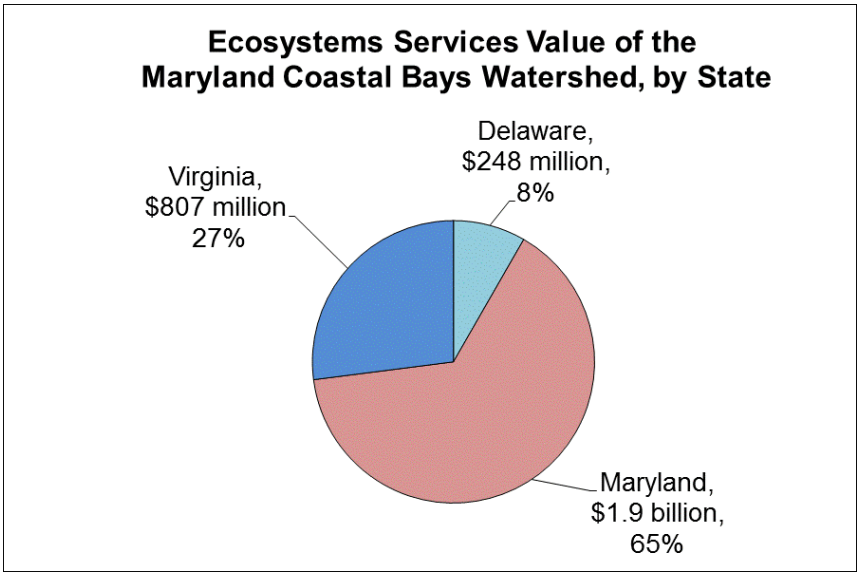


Figure 13. Annual ecosystem services value of the Maryland Coastal Bays watershed, by state

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

Ecosystem	Area (ac)	Services ($2017/ac/yr)	PV ($)	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
Delaware	**31,488**		**247,874,432**	**8,055,919,040**
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
Maryland	**185,664**		**1,931,830,528**	**62,784,492,160**
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
Virginia	**74,496**		**806,930,752**	**26,225,249,440**
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
Coastal Bays Total	**291,555**		**2,987,753,153**	**97,101,977,464**

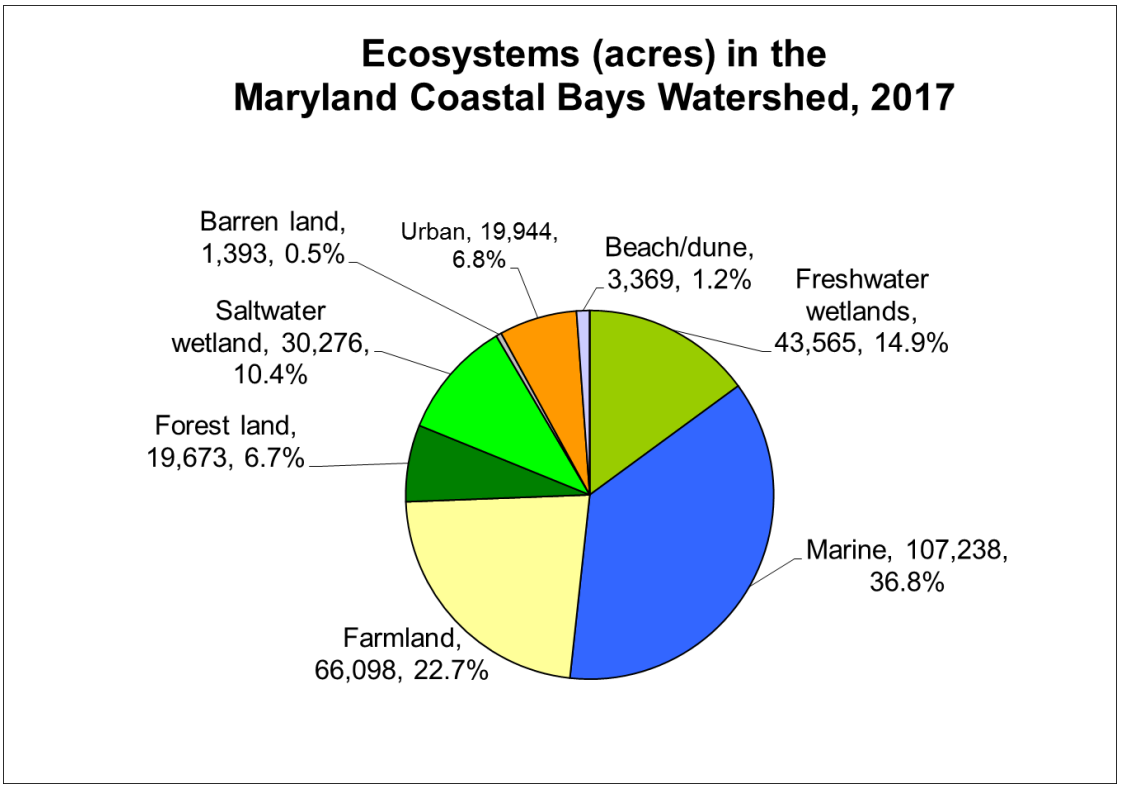


Figure 14. Ecosystem service areas in the Maryland Coastal Bays watershed

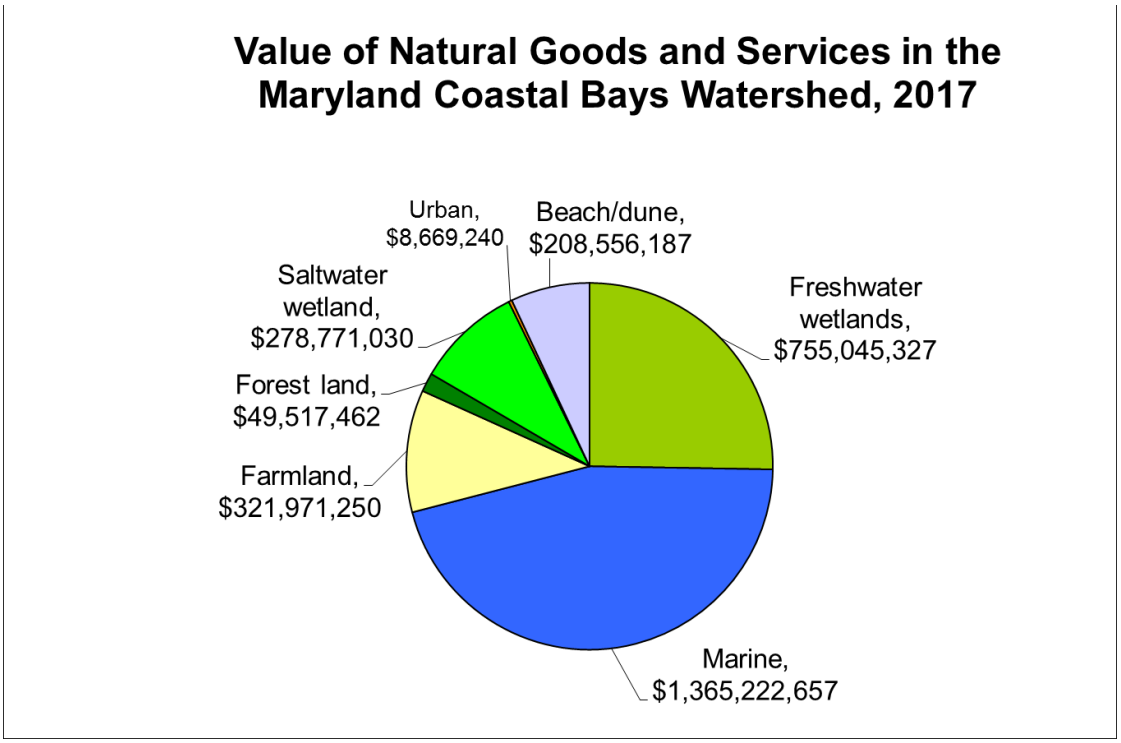


Figure 15. Annual value of ecosystem services in the Maryland Coastal Bays watershed

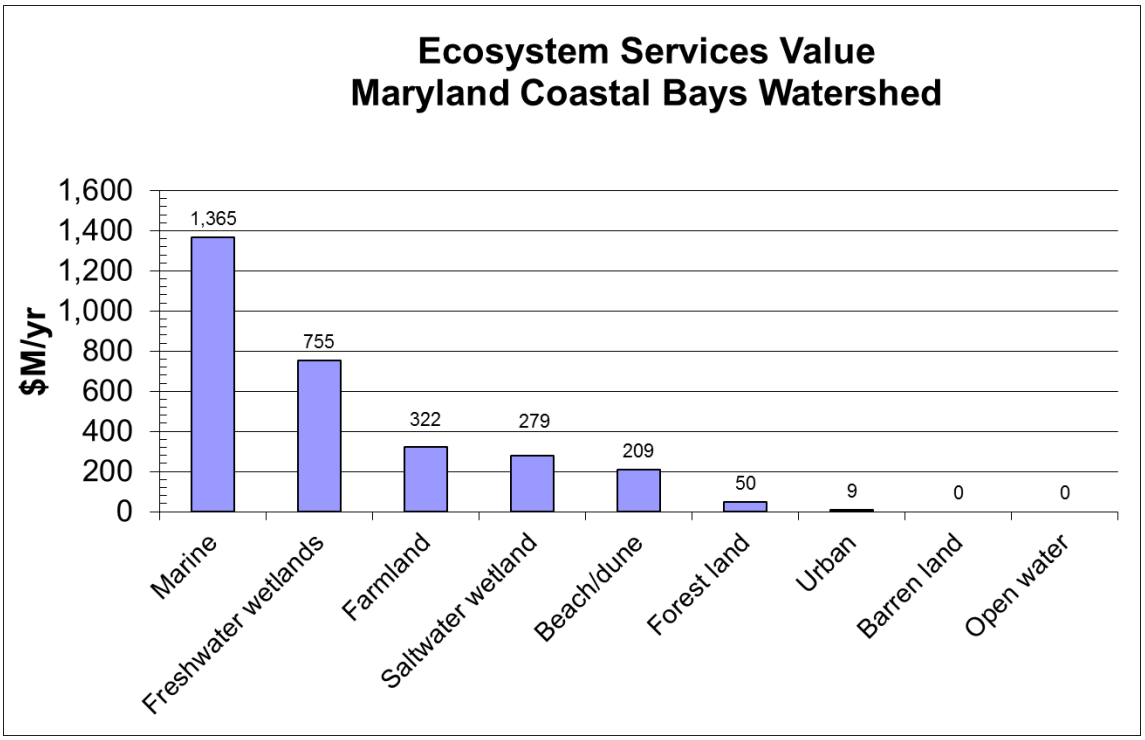


Figure 16. Ecosystem service value of habitat in the Maryland Coastal Bays watershed

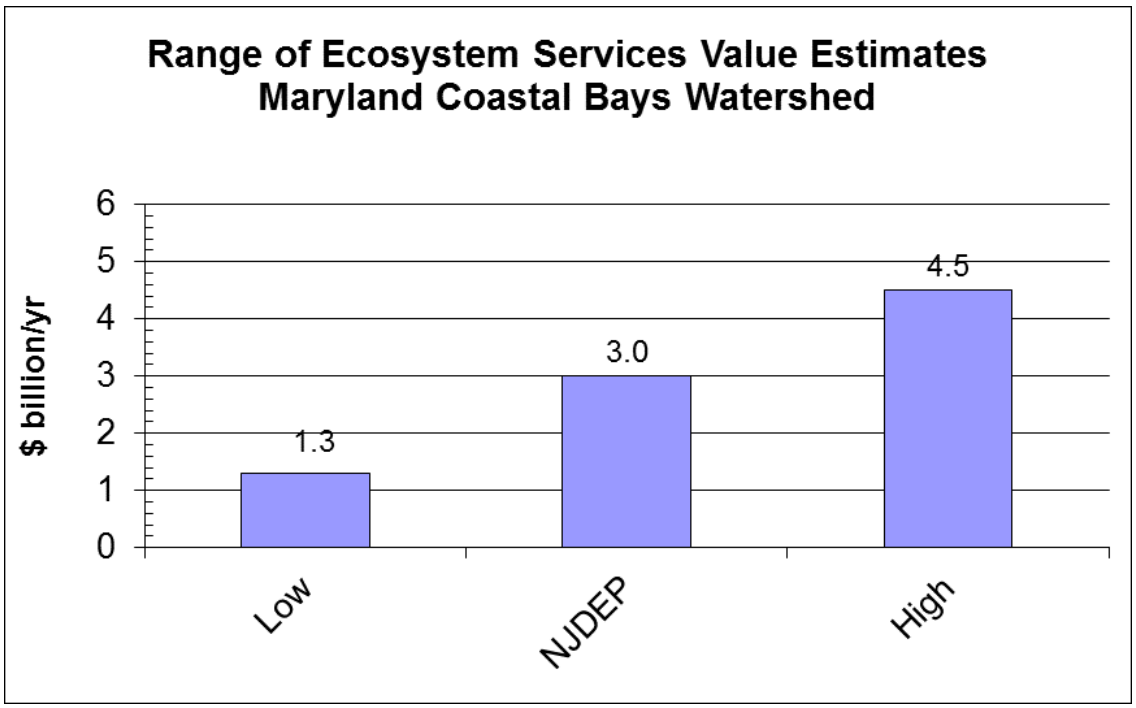


Figure 17. Range of ecosystem services value estimates in Maryland Coastal Bays watershed

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 middle of the range based on value transfer from other watersheds (Figure 17). 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 $1.3 billion per year with NPV of $41 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 $4.5 billion with NPV of $146 billion (Table 37).

Estimate	PV ($B)	NPV ($B)
Low	1.3	41.0
Midrange	3.0	97.1
High	4.5	145.6

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

Ecosystem	Area (ac)	Services ($/ac/yr)	PV ($)	NPV ($)
Freshwater wetlands	43,565	3,900[1]	260,254,800	8,458,281,000
Marine	107,238	8,670[1]	674,430,630	21,918,995,475
Farmland	66,098	1,387[7]	5,832,335	189,550,888
Forest	19,673	641[4]	91,393,139	2,970,277,018
Saltwater wetland	30,276	6,269[1]	134,463,781	4,370,072,883
Barren land	1,393	0	0	0
Urban	19,944	296[1]	30,708,816	998,036,520
Beach/dune	3,369	42,149[5]	65,120,205	2,116,406,663
Open water	0	217[5]	338,520	11,001,900
Total	**291,555**		**1,262,542,226**	**41,032,622,345**

1. Mates and Reyes 2007. 2. Campbell 2017. 3. Weber 2007. 4. Kreiger 2001.
5. Ingraham and Foster 2008. 6. Breunig 2003. 7. USGS 2014.

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

Ecosystem	Area (ac)	($/ac/yr	PV ($)	NPV ($)
Freshwater wetlands	43,565	43,685[3]	1,903,137,025	61,851,953,313
Marine	107,238	8,670[1]	929,753,460	30,216,987,450
Farmland	66,098	6,229[7]	411,724,442	13,381,044,365
Forest land	19,673	12,033[3]	236,725,209	7,693,569,293
Saltwater wetland	30,276	28,146[3]	852,148,296	27,694,819,620
Barren land	1,393	0	0	0
Urban	19,944	296[1]	5,903,424	191,861,280
Beach/dune	3,369	42,149[1]	141,999,981	4,614,999,383
Open water	0	1,686[2]	0	0
Total	**291,555**		**4,481,391,837**	**145,645,234,703**

1. Mates and Reyes 2007. 2. Campbell 2017. 3. Weber 2007. 4. Kreiger 2001.
5. Ingraham and Foster 2008. 6. Breunig 2003. 7. USGS 2014.

5. Jobs and Wages

The Maryland Coastal Bays watershed within Sussex County, Delaware; Worcester County, Maryland; and Accomack County, Virginia 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). Jobs and wages in the Maryland Coastal Bays watersheds were obtained from U.S. Bureau of Labor Statistics (2016), U.S. Census Bureau (2016), National Coastal Economics Program (2016) and other databases. 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.

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	18	1.0	
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
Coastal Bays Watershed	**>50,000**	**>$1.5 billion**	

According to North American Industrial Classification System (NAICS) code from the Bureau of Labor Statistics (2016), there were 91,014 jobs with wages of $3.2 billion in Sussex County, Delaware; Worcester County, Maryland; and Accomack County, Virginia in the Coastal Bays watershed (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
Total	**91,014**	**3,176**

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. 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. 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[1]	Direct Annual Watershed Wages[1] (x$1000)	Indirect Watershed Jobs[2]	Indirect Annual Wages2 (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
Total			**6,080**	**170,044**	**7,296**	**136,035**

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. 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 42). The watershed's ocean economy contributed 5,296 jobs with 127 million in annual wages and $310 million toward the GDP (Table 43).

Table 42. 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
Total	**24,494**	**836.65**	**2,167.70**

Table 43. 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			
Total	**5,926**	**126.58**	**310.34**

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 44). 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 44. Fishing, hunting, wildlife recreation jobs in Maryland Coastal Bays watershed

Recreation Activity	DE in watershed[1] ($ million)	MD in watershed[1] ($ million)	VA in watershed[1] ($ 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[2]	**MD Jobs in watershed[2]**	**VA Jobs in watershed[2]**	**Total Jobs in watershed[2]**
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 and found 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 45).

Table 45. Outdoor recreation jobs in the Maryland Coastal Bays watershed

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

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 46). USDA data also indicated that these farms employ about 454 jobs within the Maryland Coastal Bays watershed. The total farm wages are $5.6 million.

Table 46. Farm jobs in the Maryland Coastal Bays watershed

County	Farmland in county[1] (ac)	Farmland/ watershed (ac)	%	Farms in County[1]	Farms in watershed	Hired Farm Laborers/ watershed[1]	Farm Wages[1] ($ 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
Total	**448,925**	**66,098**	**14.72%**	**1,814**	**250**	**454**	**5.6**

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

Wetland Jobs

The NOAA Office for Coastal Management (2013) estimates that 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 47).

Table 47. Wetland jobs in the Maryland Coastal Bays watershed

County	Total Jobs In County[1]	Watershed Jobs[1]	Total Revenue In County[2] (Million)	Total Revenue In Watershed[1] (Million)	Total Wages In County[2] (Million)	Total Wages In Watershed[1] (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
Total	**17,254**	**3,349**	**$772**	**$159.7**	**$333**	**$66**

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

Several public and nonprofit watershed and environmental organizations employ at least 18 staff to work on programs to protect the Maryland Coastal Bays watershed (Table 48). Assuming that

the average salary of an environmental scientist/specialist is $61,700 (Bureau of Labor Statistics), these watershed organization jobs account for $960,000 in annual wages.

Table 48. Watershed organization jobs in the Maryland Coastal Bays watershed

Watershed	Jobs	Salaries
Assateague Coastal Trust	5	158,000
Assateague Island Alliance	3	185,100
Lower Shore Land Trust	4	246,800
Maryland Coastal Bays Program	6	370,200
Total	**18**	**960,100**

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 49).

Table 49. 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
Briddletown	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 Showelll		1	55,407
Snow Hill 3	0.3	2	110,814
Ocean City Water Department	19.0	8	440,376
Total	**23.0**	**40**	**2.201,880**

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 50). 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.

Table 50. 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
	Total	**2.6**	**5**	**275,000**

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