Economic Value
of the
Delaware Inland Bays Watershed

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Prepared for

DELAWARE CENTER FOR THE
INLAND BAYS
Research. Educate. Restore.

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Executive Summary

The water, natural resources, and ecosystems in the 327-square mile Delaware Inland Bays watershed in Sussex County, Delaware contribute an economic value of **$1.5 billion to $4.3 billion** annually to the Delaware economy as measured in three different ways:

1. **Employment related to the Inland Bays watershed:** The coastal economy in and around the Inland Bays watershed in 2018 supported over **70,000 jobs with $3 billion in wages** with **$8.2 billion in economic production and $853 million in Federal, state, and local taxes**. This finding amounts to a 19% increase of 11,200 jobs in 6 years since 2012 or a 3% increase annually. This finding of 19% job growth a decade after the onset of the 2008 recession indicates the coastal economy in the Inland Bays watershed was indeed strengthening.

2. **Economic value of activities supported by the Inland Bays.** The Inland Bays watershed contributes over **$4.4 billion** in annual economic activity from water quality and quantity ($92 million), improved property value $2.2 billion), fishing/hunting/birding ($58 million), outdoor recreation $935 million), parks ($682 million), and agriculture ($433 million).

3. **Value of ecosystem goods and services provided by Inland Bays watershed habitat.** Using natural capital as a measure of value, habitat such as wetlands, forests, open water, and farms in the Inland Bays watershed provide **$1.5 billion** annually in ecosystem goods and services based on 2017 land use/land cover data.

The purpose of these estimates is to demonstrate that the Inland Bays watershed provides real and significant economic benefits to the regional economy in Delaware 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 Inland Bays watershed using ecological economics and benefits-transfer techniques described in this report. Values are converted to (2020) dollars based on the annual change (approximately 3%) in the Northeast Region Consumer Price Index (CPI) except where noted.

The Delaware Inland Bays with a watershed of 327 mi^2 and seasonal population of 248,000 has an economic value of $4.4 billion annually, quite significant given other national estuary programs are valued at: Barnegat Bay (758 mi^2, pop. 1,500,000, $4.0 billion), MD Coastal Bays (455 mi^2, pop. 400,000, $1.8 billion), and Nanticoke River (826 mi^2, pop. 90,195, $2.6 billion)

Note that the values in the three categories are not summed because there is some overlap between certain values within each category that could result in double counting. For example, the jobs of fishermen that contribute to employment and wages are also a factor in the economic activity generated from fishing, and the ecosystem values of forests for water quality benefits may be at least partially captured in the economic value of water supply. Accurately determining (and eliminating) this overlap is difficult within the scope of this analysis. Some values were not included in these estimates because the data are not readily available or do not exist.

The preparation of this report was guided by a group of community stakeholders that met on multiple occasions to advise the development of its content.

Chapter 1 : Introduction

Delaware's Inland Bays and their watershed are environmental and economic treasures. Located at the convergence between land and sea, their diversity of productive coastal ecosystems supports a thriving and growing economic activity. Now more than ever, new residents and visitors desire a lifestyle in this watershed that is centered on the beauty and recreation provided by the coast.

Sport fishing, boating, kayaking, RVing, and wildlife watching are increasingly popular activities that combined with with real estate, restaurants, and construction have created a tremendous economy in the Inland Bays watershed. This value is inherent in the decades long effort to protect and restore these estuaries of national significance. However, their specific value has gone largely unquantified.

Placing economic value on the Bays and their watershed is essential to educate the general public and policy makers so that they can make informed choices about investments in the management of natural resources. The health of coastal ecosystems directly affects the vitality and resilience of coastal communities. All residents, businesses, and levels of government have a stake in the restoration of the Inland Bays and the added value this will contribute to the economy.

Objectives

This report summarizes the economic value of water, natural resources, and ecosystems of the Inland Bays watershed in Sussex County, Delaware estimated in three ways as:

1. Jobs and wages directly/indirectly associated with the Inland Bays watershed utilizing the IMPLAN model for 2012 and updated to 2018 coupled with U.S. Bureau of Labor Statistics data that estimates coastal and watershed-related jobs, wages, taxes and changes over time.

2. Economic activity including market and non-market value related to water quality/quantity, improved property value, fishing/hunting/birding, outdoor recreation, parks, and agriculture benefits supported by the Inland Bays watershed.

3. Ecosystem goods and services (natural capital) value provided by habitat such as wetlands, forests, open water, and farms for 2012 and 2017 land use/land cover data.

   These values are intended to educate both the general public and policy makers on the local, county, state, and federal level about the value of the Inland Bays and their watershed. It is intended that this information be considered when by policy makers consider how to invest in projects and programs that support the restoration of healthy water quality in the Inland Bays and the management of their waterways. A number of case studies a presented to highlight certain economic aspects or activities of importance to the Inland Bays. The preparation of this report was guided by a group of community stakeholders that met on multiple occasions to advise the development of its content.

The Inland Bays and their Watershed

The Delaware Inland Bays are three shallow coastal lagoons situated behind a narrow barrier island that separates them from the Atlantic Ocean. They are unique places where freshwater flowing from the land mixes with saltwater that flows through the Indian River and Ocean City Inlets. The Bays are dynamic, continually changing in response to human activities and the climate. Saltmarshes, tidal flats, bay grass meadows, oyster reefs, and saltwater creeks can all be experienced in this watershed.

The Inland Bays watershed is 327 square miles of eastern Sussex County, Delaware where water falling on the land drains to the Inland Bays. Starting at Lewes and Cape Henlopen State Park at the southern edge of the entrance to Delaware Bay, the area extends southward 24 miles along the Atlantic shoreline to the Maryland state line. It includes the coastal communities of Rehoboth Beach, Dewey Beach, Bethany Beach, South Bethany, and Fenwick Island.

At the Maryland state line, the watershed boundary extends westward approximately 16 miles to the western edge of the Great Cypress Swamp and thence along an arcuate line extending northwestward about 19 miles to Georgetown, the county seat of Sussex. Along this boundary, starting at the Maryland State Line and proceeding northward, the towns of Selbyville, Frankford, Dagsboro, Millsboro, and Georgetown are connected by U.S. Route 113. The northern border of the Inland Bays and Delaware Bay watershed roughly parallels State Route 9 and extends from Georgetown northeastward back to Lewes and Cape Henlopen State Park.

The Bays were thought to be generally healthy several decades ago. However, after years of accumulated nutrient pollution and habitat loss, driven by changes in the landscape, the conditions of the Bays have declined. There were once clear waters, plentiful bay grasses, productive oyster reefs, and oxygen levels that support diverse and abundant fish populations. Now the Bays are generally murky, dominated by algae, have very few bay grasses or oysters, and have unhealthy dissolved oxygen levels.

Summary of water quality conditions (to be added).
Summary of waterway management conditions (to be added).

However, thanks to decades of planning and action from businesses, farmers, scientists, residents, and government, the health of the Bays has turned a corner and many indicators of water quality are showing improvement.

In 2014, the Delaware Senate passed Concurrent Resolution No. 64 forming the Delaware Waterways Management and Financing Advisory Committee for the purpose of developing and submitting recommendations for sustainable and dedicated funding for waterway management activities to address this shortfall. The Committee determined that $3 to $5 million was needed annually to meet the state's waterway management needs. As a result, Senate Bill 260 increased the boater registration fees to raise approximately $1 million annually for waterway management, leaving a $2 to $4 million shortfall.

The Delaware Inland Bays is part of a Sussex County coastal economy where visitors spent $346 per trip or $113 per day in shopping, dining, and beaches and tourism accounts for $2.15 billion

in expenditures and supports 18,780 jobs or 43% of the state's total (Shifflet and Rockport Analytics 2018).

National Estuary Program

The protection of the Delaware Inland Bays largely began 50 years ago in 1969, a year before the first Earth Day. The Delaware Center for the Inland Bays was established as a nonprofit organization in 1994 under the auspices of the Inland Bays Watershed Enhancement Act (Title 7, Chapter 76). Its creation was the culmination of more than 20 years of active public participation and investigation into the decline of the Inland Bays and the remedies for the restoration and preservation of the watershed. Delaware's Inland Bays were designated an "estuary of national significance in 1988 by the U.S. Congress making the Center for the Inland Bays one of the 28 National Estuary Programs (NEP). The Center oversees implementation of the Comprehensive Conservation and Management Plan and its 2012 Addendum.

The CCMP is a partner-based blueprint for protecting and restoring the health of the estuary. This study meets Action B "Communicate the benefits to economic development, tourism, recreation, and quality of life of achieving water quality goals as well as the risks of failure to achieve these goals," of Objective 5. "Communicate environmental results to inform legislators and raise citizen awareness about the state of the Inland Bays and its watershed" of the Plan's Outreach & Education Focus Area. The study was made possible by the support of guidance signatories to the CCMP including Sussex County Council, the Sussex County Association of Town, and the Delaware Department of Natural Resources and Environmental Control; as well as the Environmental Protection Agency (EPA).

Land Use of the Watershed

Land use in 2017 in the Inland Bays watershed (Figure 1.1 and Table 1.1) is distributed as farmland (30%), developed/urban (22%), freshwater wetlands (15%), forest (14%), marine/bay (11%), saltwater wetlands (4.4%), barren (1.2%), open water (1%), and beach/dune (0.9%). Natural habitat such as wetlands, forests, bay/open water, and beaches cover nearly half of the bay watershed.

Table 1.1. Land use in the Inland Bays watershed, 2017

Land Use	Total (mi^2)	% of Total
Farmland	98	30%
Developed/Urban	73	22%
Freshwater Wetlands	49	15%
Forest	46	14%
Marine/Bay	37	11%
Saltwater Wetlands	15	4%
Open Water	4	1%
Barren	4	1%
Beach/Dune	3	1%
Total	**327**	**100%**

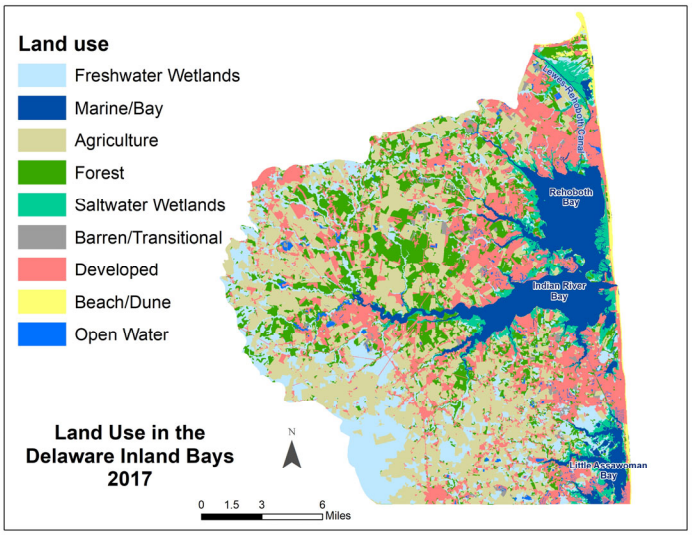


Figure 1.1. Land use in the Delaware Inland Bays watershed, 2017

Population

In 2017 the 327-square-mile Inland Bays watershed had a year-round population of 114,495, more than double the 1990 population of 50,000 (U.S. Census Bureau). According to U.S. Census Bureau 5-year estimates (2017) there are 36,000 seasonal housing units in the Inland Bays watershed with 30,390 in census block groups adjacent to the bays (Figure 1.2). The 30,390 seasonal housing units house an additional 123,000 summer residents. Also, the Southern Delaware Tourism Council indicates 5,000 hotel/motel rooms are booked between Memorial Day and Labor Day that adds 10,000 people to the seasonal population. The year-round population of the inland bays (114,495) plus the seasonal (123,000) and hotel/motel population (10,000) indicates the summer population of the Inland Bays watershed is 247,495 or more than twice the year-round population.

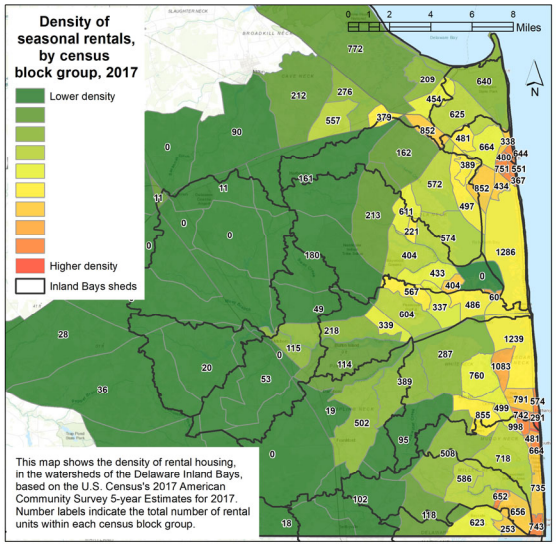


Figure 1.2. Seasonal housing units in the Inland Bays watershed (US Census Bureau 2017)

Chapter 2 : Jobs and Wages

This chapter updates a 2012 Delaware Sea Grant IMPLAN model to 2018 employment conditions to estimate the change in direct, indirect, and induced jobs for the Delaware coastal economy in and around the Inland Bays watersheds. The University of Delaware also obtained employment and wage data from the U.S. Bureau of Labor Statistics and U.S. Census Bureau to estimate direct/indirect jobs by North American Industry Classification System (NAICS) codes for watershed-related jobs such as shipbuilding, marine transportation/ports, fisheries, recreation, minerals, trade, agriculture, and others. NAICS jobs data are supplemented with farm jobs data from the USDA Agricultural Statistics Bureau, U.S. Fish and Wildlife Service ecotourism jobs data, NOAA wetland jobs, and jobs provided by water and wastewater utilities.

The analysis finds the coastal economy in and around the Delaware Inland Bays watershed in Sussex County supports over 70,000 jobs with $3 billion in wages based on a 2018 update of a 2012 Delaware Sea Grant IMPLAN model. Over 38,000 direct/indirect watershed-related jobs with $0.9 billion in wages are supported by the Inland Bays based on 2016 U.S. Bureau of Labor Statistics data and environmental jobs data from the U.S. Fish & Wildlife Service, Outdoor Industry Association, USDA, and NOAA (Table 2.1).

Table 2.1. Jobs and wages related to the Delaware Inland Bays watershed

Sector	Jobs	Wages ($ billion)	Data Source
Coastal Economy IMPLAN Analysis	70,145	3.0	Latham and Lewis (2012) updated to 2018
Direct/Indirect Watershed-Related	38,562	0.9	U.S. BLS (2016), USFWS (2011), OIA (2016), USDA (2017), NOAA (2013)
Inland Bays Watershed	**>70,000**	**>$3 billion**	

Coastal IMPLAN Analysis

As the economy recovered from the 2008 recession, University of Delaware economists Latham and Lewis (2012) utilized an IMPLAN model to estimate the employment related to the coastal economy in Delaware for a study area that included the Inland Bays watershed and a portion of the Delaware Bay coast to the north (Figure 2.1). The 2012 Delaware Sea Grant study found the coastal economy contributed 58,945 direct, indirect, and induced jobs with $2.5 billion in annual wages and generated $6.9 billion in economic production and $711 million in additional Federal, state, and local taxes (Table 2.2). Direct effects are jobs/payroll directly supported by coastal activities such as boating and tourism (Figure 2.2). Indirect effects are jobs and payrolls of businesses such as suppliers and transportation services that support coastal activities. Induced effects are jobs and payroll created throughout the economy when direct jobs spend on services such as meals and consumer goods.

Employment in Sussex County, Delaware rose 19% from 68,708 jobs in 2012 to 81,788 jobs by 2018 according to the U.S. Bureau of Labor Statistics so this suggests that the coastal economy rose at a proportionate rate. An updated IMPLAN analysis for the study area utilizing employment data for Sussex County found the 2018 coastal economy contributed 70,145

direct/indirect/induced jobs with $3.0 billion in annual wages, $8.2 billion in economic production, and $853 million in generated taxes for a 19% increase of 11,200 jobs in 6 years since 2012 or a 3% increase annually (Table 2.3). This finding of 19% job growth over 6 years a decade after the onset of the 2008 recession indicates the coastal economy in the Inland Bays watershed was strengthening. Top ten industries that support the coastal economy include medical, food, health, government, real estate, and retail (Table 2.4). Appendix A summarizes coastal industries included in the IMPLAN analysis organized by US Bureau of Labor NAICS code such as marine transportation, living resources, marinas, tourism, and navigation. The Delaware Inland Bays watershed is a jobs engine.

Table 2.2. Contributions of the coastal economy to the State of Delaware from IMPLAN, 2018 (UDWRC updated to 2018 from Latham and Lewis 2012)

IMPLAN Economic Activity	2018 Jobs	2018 Wages ($ million)	2018 Production[1] ($M)	2018 Taxes ($ million)
Direct Coastal Activity	47,481	1,878	4,935	
Indirect Supplier Activity	9,676	525	1,535	
Induced from Employee Spending	12,988	585	1,755	
Total	**70,145**	**2,989**	**8,225**	**853**

Table 2.3. Contributions of the coastal economy to Delaware from IMPLAN, 2012-2018

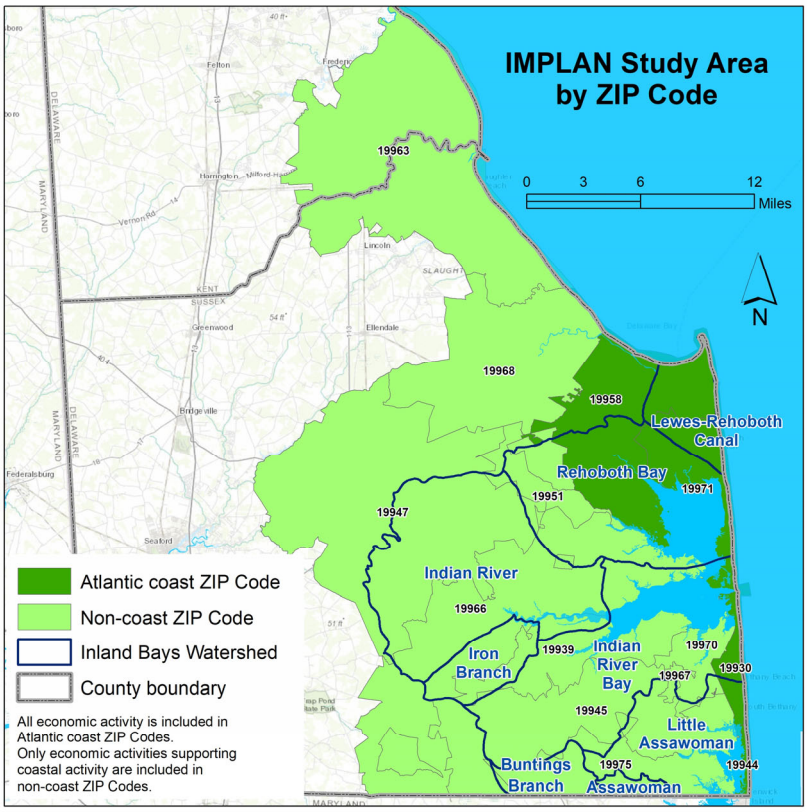
IMPLAN Economic Activity	2012 Jobs[1]	2012 Wages[1] ($ million)	2012 Production[1] ($ million)	2012 Taxes Paid[1] ($ million)	2018 Jobs[2]	2018 Wages[2] ($ million)	2018 Production[1] ($ million)	2018 Taxes Paid[1] ($ million)
Direct Coastal Activity	39,900	1,578	4,147		47,481	1,878	4,935	
Indirect Supplier Activity	8,131	441	1,290		9,676	525	1,535	
Induced from Employee Spending	10,914	492	1,475		12,988	585	1,755	
Total	**58,945**	**2,512**	**6,912**	**711**	**70,145**	**2,989**	**8,225**	**853**

. 1. Latham and Lewis 2012. 2. UDWRC updated to 2018 employment

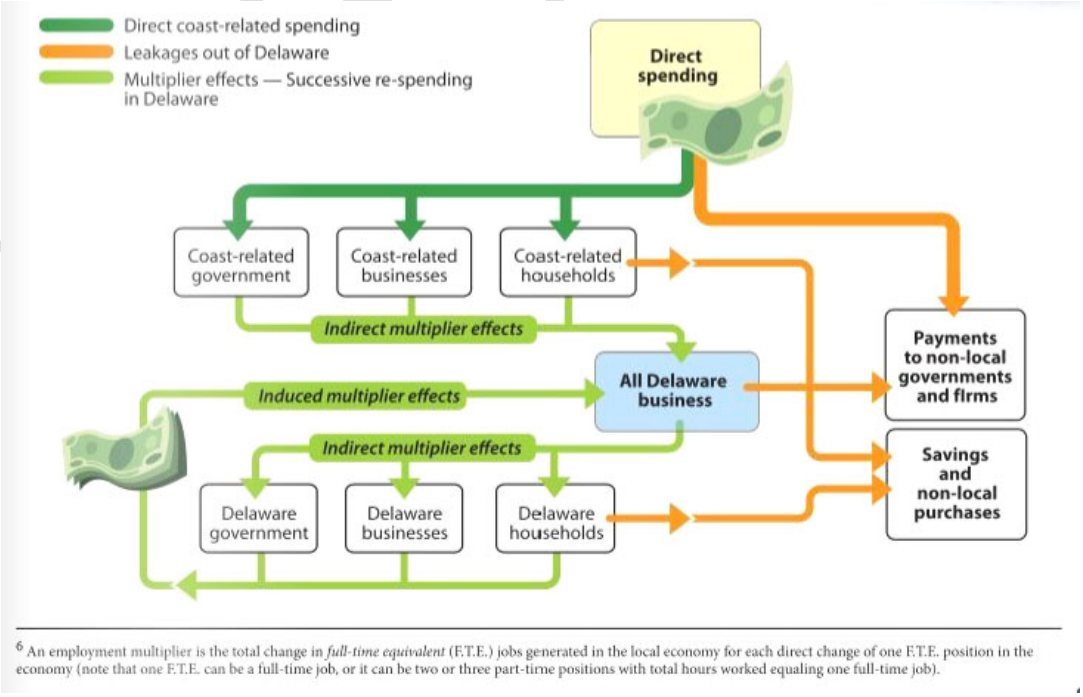
Table 2.4. Ten industries impacted by coastal economic activity in Delaware from IMPLAN

Industry	2012 Jobs[1]	2012 Wages[1] ($ million)	2018 Jobs[2]	2018 Wages[2] ($ million)
Hospitals, nursing homes, and other medical care facilities	2,706	205,483,728	3,247	246,580,474
Food services and drinking places	7,332	163,932,752	8,798	196,719,302
Offices of physicians, dentists, and other health practitioners	1,883	141,326,648	2,260	169,591,978
State and local government other other than education	1,956	132,436,396	2,347	158,923,675
Real estate rental and management establishments	4,128	63,221,538	4,954	75,865,846
Retail stores - food and beverage	1,822	51,198,950	2,186	61,438,740
Employment placement services including temporary workers	1,638	50,876,013	1,966	61,051,216
Business, professional, labor, political, civic, social, homeowners	2,580	47,206,746	3,096	56,648,095
Retail stores - clothing and accessories	1,715	35,183,764	2,058	42,220,517
Services to buildings, janitorial, landscaping, carpet/upholstery, etc.	1,435	33,162,843	1,722	39,795,412

. 1. Latham and Lewis 2012. 2. UDWRC updated to 2018 employment



` **2.1.** IMPLAN study area map for Delaware coastal economy (UDWRC 2020 based on Latham and Lewis 2012)



[6] An employment multiplier is the total change in *full-time equivalent* (F.T.E.) jobs generated in the local economy for each direct change of one F.T.E. position in the economy (note that one F.T.E. can be a full-time job, or it can be two or three part-time positions with total hours worked equaling one full-time job).

Figure 2.2. Employment multiplier Effects (Latham and Lewis 2012)

Direct/Indirect Water Jobs

The Inland Bays watershed supports 12,051 direct and 26,511 indirect jobs for a total of 38,562 jobs with over $900 million in annual wages based on U.S. Bureau of Labor Statistics (2016) employment data by NAICS code in Sussex County, Delaware. Industries directly associated with the Inland Bays watershed such as water/sewer construction, water utilities, fishing, recreation, tourism, and ports employed 12,051 people with $321 million in wages (Table 2.5). Also, 26,511 indirect jobs and wages of $579 million were supported by purchases of goods/services by direct jobs earners estimated by a multiplier of 2.2 for direct jobs and 1.8 for direct wages (Latham and Stapleford 1990).

Table 2.5. Direct and indirect watershed jobs in the Inland Bays watershed

NAICS	NAICS Code	Sussex County Jobs	Sussex County Wages	Direct[1] Watershed Jobs	Direct Wages (x$1,000)	Indirect[2] Watershed Jobs	Indirect Wages (x$1,000)
Water and sewer construction	23711	123	5,695	63	2,894	139	5,209
Agriculture & forestry	115	215	9,921	109	5,041	240	9,074
Fish & seafood markets	44522	63	2,769	32	1,407	70	2,533
Mining, quarrying	21	31	1,675	16	851	35	1,532
Sporting/recreational goods	42391	8	465	4	236	9	425
Boat dealers	441222	181	8,085	92	4,108	202	7,394
Amusement parks & arcades	713	170	4,568	86	2,321	189	4,178
Amusement/recreation	7139	1,269	26,817	645	13,627	1,419	24,529
Golf courses	71391	595	16,203	302	8,233	664	14,819
Fitness/recreational sports	71394	416	5,656	211	2,874	464	5,173
Accommodation	721	1,807	40,987	918	20,827	2,020	37,489
Hotels & motels	72111	1,521	32,969	773	16,753	1,701	30,155
Bed-and-breakfast inns	721191	30	616	15	313	33	563
Recreational vehicle camps	7212	257	7,402	131	3,761	288	6,770
Full-service restaurants	72211	4,963	81,019	2,522	41,169	5,548	74,104
Food service contractors	72231	143	4,095	73	2,081	161	3,746
Coastal, water transport	483	22	1,133	11	576	24	1,037
Scenic/sightseeing transport	487	18	259	9	132	20	238
Architectural, engineering	5413	318	17,647	162	8,967	356	16,141
Civic & social organizations	8134	632	11,872	321	6,033	706	10,859
Waste management services	562	227	13,870	115	7,048	253	12,686
Fishing/Hunting/Wildlife				1,242	43,000	2,732	77,400
Outdoor Recreation:				3,433	113,500	7,553	204,300
Farm Jobs:				627	9,500	1,379	17,100
Wetland Jobs				31	641	68	1,154
Water Supply Jobs				78	4,300	172	7,740
Wastewater Utility Jobs:				30	1,600	66	2,880
Total		**13,009**	**293,723**	**12,051**	**321,793**	**26,511**	**579,228**

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

In addition to watershed-related jobs reported by the BLS NAICS database, the Delaware Inland Bays watershed supports employment in fishing/hunting/wildlife recreation (1,242 jobs), outdoor recreation (3,433 jobs, $113.5 million wages), farms (627 jobs, $9.5 million wages), wetlands (31 jobs, $641,171 wages), water supply (78 jobs, $4.3 million wages), and wastewater (30 job,

$1.6 million wages). At an average salary of $32,843, fishing, hunting, and bird/wildlife-associated recreation accounts for 1,242 jobs for $40.8 million in annual economic activity in the Inland Bays watershed from the 2011 U.S. Fish and Wildlife Service survey. The Outdoor Industry Association (2016) concluded outdoor recreation contributed to 29,000 jobs in Delaware and scaling for population the Inland Bays watershed contributes 3,433 jobs and $113.5 in wages. In 2017, the 289 farms in the Inland Bays watershed employed 627 workers with wages of $9.5 million (USDA 2017). The NOAA Office for Coastal Management (2013) estimates wetlands in the Inland Bays watershed support 31 commercial fishing jobs and $641,171 in wages. According to the American Water Works Association, the average salary of a water-system employee is $55,407 and water utilities in the watershed employ 78 jobs with wages of $4.3 million. Seven wastewater utilities in the watershed employ 30 staff with an average salary of $55,000 and wages of $1.6 million.

Chapter 3 : Economic Value by Activity Type

This chapter estimates the economic value of sectors supported by the Delaware Inland Bays watershed including water quality/quantity, increased property value, fishing/hunting/birding, outdoor recreation, parks, and agriculture. The University of Delaware derived the economic value of the Delaware Inland Bays watershed from published studies that employ valuation techniques such as **avoided cost** (society sustains costs if certain ecosystems are not present or are lost), **replacement cost** (natural services are lost and replaced by more expensive human systems such as 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 river coastlines with improved water quality), and **contingent valuation** (valuation by survey of individual preferences to preserve ecosystems where people may be willing to pay more in fees or water rates to preserve river water quality).

Hodge and Dunn (1992) illustrated the economic value of water resources based on use and non-use values (Figure 3.1). 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.

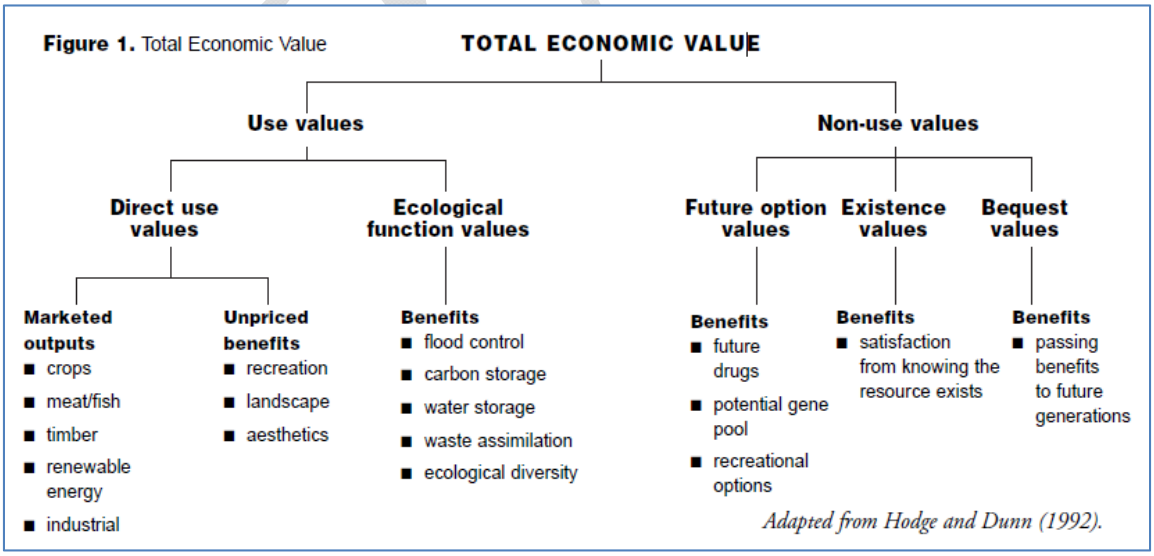


Figure 3.1. Economic value of water resources (Hodge and Dunn, 1992)

The University of Delaware finds that the economic value of the Delaware Inland Bays watershed from water quality/quantity, increased property value, fishing/hunting/birding,

outdoor recreation, parks, and agriculture benefits exceeds $4.4 billion annually (Table 3.1 and Figure 3.2).

Sector	**Annual Value**
Water Quality/Quantity	$92 million
Increased Property Value	$2,200 million
Fishing, Hunting, Birding	$58 million
Outdoor Recreation	$935 million
Parks	$682 million
Agriculture	$433 million
Total	**>$4.4 billion**

Table 3.1. Annual economic value of the Delaware Inland Bays watershed

Sector	Activity	Economic Value ($ million)	Source
Water Quality& Quality	Boatable, Fishable, Swimmable Clean Water (pop.247,495)	46	Helm, Parsons, & Bondelid (2003)
	Water Treatment by Forests ($37/mgd @ 54 mgd)	0.7	Trust for Public Land & AWWA (2004)
	Wastewater Treatment (10.52 mgd @ $5/1,000 gal)	8.9	MDOE & VIMS (2013)
	Public Water Supply (54 mgd @ $1.168/1,000 gal)	20	NJWSA (2012)
	Irrigation Supply (22 mgd @ $1.31/1,000 gal)	10.5	Frederick et al. (1996), USDA (2019)
	Industrial Supply (13.5 mgd @ $0.87/1,000 gal)	4.3	Frederick et al. (1996)
	Thermoelectric Supply (21.2 mgd @ $0.18/1,000 gal)	1.4	Frederick et al. (1996)
Property Value	Increased Property Value near Inland Bays	2,200	EPA (1973), Austin et al. (2007)
Fishing, Hunting, Birding	Hard Clams (1 million clams @ $11/dozen)	0.9	Center for Inland Bays (2016)
	Blue Crab (8 million crabs @ $1.74/lb)	9.3	NOEP (2016), MDE (2015)
	Shellfish Aquaculture (343 acres)	6.1	Beuttle (2015)
	Fish Harvest (200,000 fishing trips, 176,000 lb fish)	1.8	Center of the Inland Bays (2016)
	Fishing ($24 to $49/trip/day)	13	USFWS (2011)
	Fishing Charters (31 charter companies)	4.4	Fishing Charter Websites (2020)
	Bait and Tackle Shops		
	Hunting ($14 to $45/trip/day)	5.3	USFWS (2011)
	Wildlife/Bird-Watching ($23 to $66/trip/day)	22	USFWS (2011)
Outdoor Recreation	Water-based Recreation (115,208 participants)	335-794	OIA (2016), BEA (2019)
	Powerboating (27,523 registered boats)	106	Nat'l. Marine Manufact. Assoc. (2018)
	Marinas (20 marinas with 1,900 boat slips)	22	Assn. of Marine Industries (2018)
	Ecotour Operators	0.05	Cape Water Taxi (2020)
	Navigation Use Value	4.4	Frederick et al. (1996)
	Waterway Mgmt. (dredge 29,600 CY restore 5 ac beach)	5.0	Moffat and Nichol (2007)
	Marine Construction (143 projects over 9,186 LF)	3.8	DNREC Shoreline Permit
Parks	State Parks (2.6 million visitors)	362	Rockport Analytics (2017)
	Public Parks (20,700 ac local parks and preserves)	272	Trust for Public Land (2009)
	RV Parks (13 RV parks)	48	Phone Interviews (2020)
Agriculture	Nursery, Crop, Poultry, Livestock (289 farms)	433	DE Dept. of Ag (2010), USDA (2017)
	Inland Bays Watershed	**>$4.4 billion**	

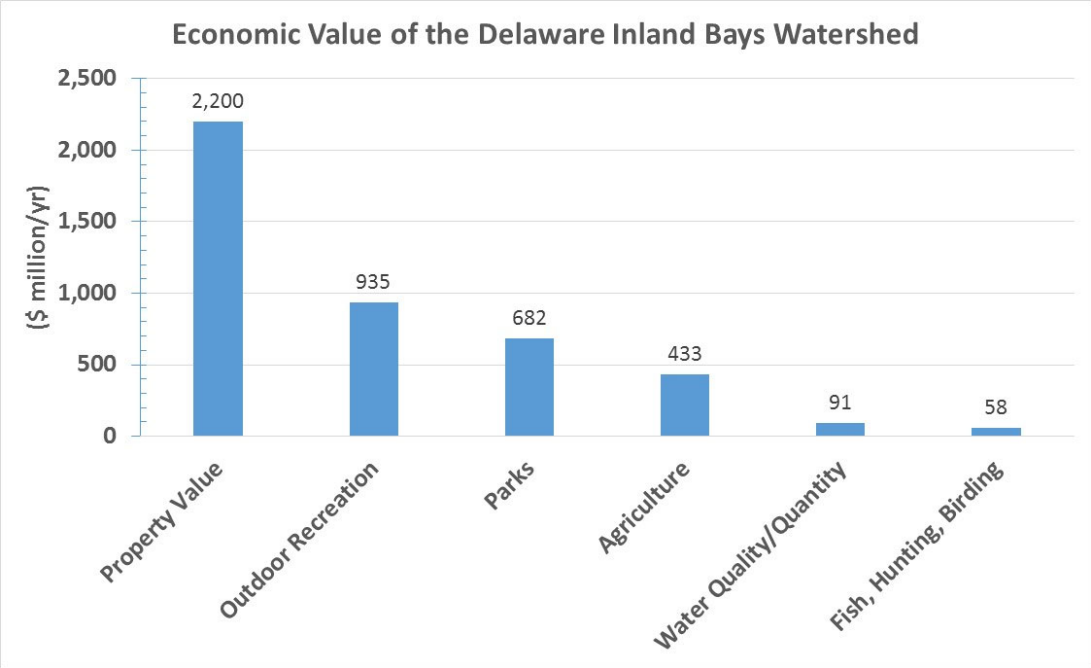


Figure 3.2. Economic value of the Inland Bays watershed, by sector

Water Quality and Quality

Boatable/Fishable/Swimmable Clean Water: Clean water leads to increased economic value in a watershed. Helm, Parsons, and Bondelid (2003) measured the benefits of water-quality improvements to recreational users in New England states and found per person willingness to pay (WTP) for good water quality ranged from $8.25 for boating, $8.26 for fishing, and $70.47 for swimming uses in 1994 dollars. They defined good (high) water quality as aesthetically pleasing able to support human contact recreation and sport fisheries at levels of biological oxygen demand (< 1.5 mg/l), total suspended solids (< 10 mg/l), dissolved oxygen (>83% saturation), and fecal coliform (< 200 MPN/100 ml). Adjusting to 2020 dollars by the change in Consumer Price Index (CPI) from the Bureau of Labor Statistics, per person WTP is $17.79 for boating, $17.81 for fishing, and $151.98 for swimming uses. In 2017, the Inland Bays watershed summer population reached 247,495. Therefore, based on values from the New England study, residents of the Inland Bays are willing to pay $46.4 million per year for improved water quality with swimmable quality at $37.6 million followed by boatable and fishable quality at $4.4 million and $4.4 million (Table 3.2).

Table 3.2. Annual WTP for water quality benefits in the Inland Bays watershed (Helm, Parsons, and Bondelid 2003 translated to $2020 by 3% annual increase in CPI)

WQ Use Support	Population	WTP/person ($2020)	WTP ($2020)
Boatable	247,495	$17.79	$4,402,936
Fishable	247,495	$17.81	$4,407,886
Swimmable	247,495	$151.98	$37,614,290
Inland Bays Total	**247,495**	**$187.58**	**$46,425,112**

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 3.3). If the public drinking water supply is 54 mgd as established later in this chapter and forests cover 29,097 acres or 14% of the Inland Bays watershed, then loss of these forests would increase drinking water treatment costs by $37 per mgd ($139/mgd @ 0% forested minus $102/mgd @ 14% forested) or $729,270/year.

Table 3.3. 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: Seven wastewater treatment plants with a capacity of 4.87 mgd discharge to the Inland Bays watershed (Table 3.4). The average wastewater rate in the watershed is $5 per 1,000 gallons which for an average residence of 4 people (at 50 gpcd) is a fee of $365 per year. The value of wastewater assimilation based on treated wastewater rates in the Inland Bays watershed is $24,350 per day or $8.9 million annually.

Table 3.4. Wastewater discharge capacity in the Inland Bays watershed

Wastewater Utility	Flow (mgd)
Inland Bays Regional	1.32
Piney Neck Regional	0.10
Wolfe Neck Regional	1.20
Retreat	0.01
Lewes	0.67
Millsboro	0.45
Selbyville	1.11
Total	**4.87**

Public Water Supply: The New Jersey Water Supply Authority (2012) established the value of raw (untreated) public water supplies at $1,168 per million gallons. At this rate, the value of untreated public water supplies allocated by DNREC in the Inland Bays watershed (54 mgd) is $63,000 per day or $19.8 million annually (Table 3.5).

Table 3.5. Economic value of public water supply in the Delaware Inland Bays watershed (NJWSA 2012 and DNREC 2012)

Public Water Systems	Allocation (mgd)	$/yr
Community	46.7	$17,052,566
Non-transient Non-community	6.2	$2,265,336
Transient Non-community	1.5	$542,419
Total	**54.4**	**$19,860,322**

Irrigation: Frederick et al. (1996) estimated the median value of irrigation withdrawals was $198/ac-ft in $1996 or $402/ac-ft ($1.31/1,000 gal) in $2020 at a 3% annual change in the CPI (Table 3.6). In the Inland Bays watershed, 64,640 acres of cropland were cultivated and 8,463 acres were irrigated (USDA 2017). Irrigation-water needs from June-September are 9 inches for corn, soybeans, and grain (2,600 gpd/ac for 8,463 irrigated acres or 22 mgd). In the Inland Bays watershed, the annual value of 9 inches of irrigation of 8,463 acres at $402/ac-ft is $10.5 million.

Table 3.6. Freshwater-use values in the United States (Frederick et al. 1996)

Use	1996 Median ($/acre-ft)	2020 Median ($/acre-ft)	2020 Median ($/1,000 gal)
Navigation	$10	$20	$0.07
Irrigation	$198	$402	$1.31
Industrial Process	$132	$268	$0.87
Thermoelectric Power	$29	$59	$0.19

Thermoelectric Power: The Indian River Power Plant in Millsboro produced 784 megawatts of electricity annually from coal and utilized 21.2 mgd of freshwater in 2014. From Frederick et al. (1996) the value of thermoelectric withdrawals was $29/ac-ft or $59/ac-ft ($0.18/1,000 gal) in $2020, therefore the value of Indian River Power Plant freshwater use is $1.4 million annually.

Industrial Water Supply: If the freshwater water use value is $132/ac-ft in $1996 (Frederick et al. 1996) or $246/ac-ft. ($0.87/1,000 gal) in $2020, then the value of industrial-withdrawals (13.5 mgd) in the Inland Bays watershed is $11,745/day or $4.3 million annually (Table 3.7).

Table 3.7. Industrial water use in the Inland Bays watershed

Water User	Withdrawal (mgd)
Allen Harim Foods, LLC	1.9
ML Joseph Construction Co	1.89
Mountaire Farms (Millsboro)	0.58
Mountaire Farms (Millsboro)	5.62
Mountaire Farms (Selbyville)	1.5
NRG Energy	1.87
NRG Energy	0.14
Total	**13.5**

Increased Property Value

Studies along rivers and bays in the U.S. indicate improved water quality can increase shoreline property values by 4% to 18% (Table 3.8). The EPA (1973) estimated improved water quality can raise property values by up to 18% next to the water, 8% at 1,000 feet, and 4% at 2,000 feet from the water. Leggett and Bockstael (2000) estimated improved bacteria levels 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 on the western shore of Chesapeake Bay and concluded a 1 mg/l increase in inorganic nitrogen reduced the $200,936 property value of a house by $17,642 or 8.8%. Austin et al. (2007) from the Brookings Institution projected that investing $26 billion to restore the Great Lakes would increase shore property values by 10%.

Table 3.8. Increased property value resulting from improved water quality

Study	Watershed	Increased Property Value
EPA (1973)		
-Next to water	San Diego Bay, CA	18%
-1,000 feet from water	Kanawha, OH	8%
-2,000 feet from water	Willamette River, OR	4%
Leggett and Bockstael (2000)	Chesapeake Bay	6%
Poor et al. (2007)	Chesapeake Bay	9%
Austin et al. (2007)	Great Lakes	10%

The Inland Bays watershed is bounded by a 12-mile ocean shoreline and includes 158 miles of bay shoreline. According to property listings, the average land value in the Inland Bays watershed adjacent to and within 2,000 ft of the bay was $5.1 million per acre or 50% more than properties worth $2.5 million per acre away from and outside of 2000 ft from the bay. Developed properties within 2,000 feet of the Bays have an estimated total value of $85 billion and developed properties beyond 2,000 feet of the Bays are valued at $41.7 billion. The increased property value due to proximity within 2,000 ft of the bay over a 20-year period is $2.2 billion annually (Tables 3.9 and 4.10).

Table 3.9. Property value of improved land in the Inland Bays watershed

Neighborhood	Shoreline (mi)	2000 ft. Area of Analysis (ac)	Average Land Value ($ million/ac)	Property Value ($ billion)	Annual Value 20 yr ($ billion)
Bayside	158	16,672	5.1	85.0	4.3
Away From Bay	158	16,672	2.5	41.7	2.1
Total			**2.6**	**43.3**	**2.2**

Table 3.10. Property value within 2000 feet and away from Inland Bay shoreline (Zillow 2020)

Within 2000 ft of Bay				Outside 2000 ft of Bay			
Location	Bayside Property Area (ac)	Bayside Property Value ($)	$/Acre	Location	Away From Bay Property (ac)	Away From Bay Value ($)	$/Acre
Fenwick Island	0.19	1,249,000	6,573,684	South Bethany	0.11	529,000	4,809,091
Fenwick Island	0.41	1,799,000	4,387,805	South Bethany	0.11	549,000	4,990,909
Fenwick Island	0.11	1,399,000	12,718,182	South Bethany	0.13	439,000	3,376,923
Fenwick Island	0.18	579,000	3,216,667	Bethany Beach	0.2	629,000	3,145,000
Fenwick Island	0.23	879,000	3,821,739	Bethany Beach	0.16	399,000	2,493,750
South Bethany	0.11	735,000	6,681,818	Bethany Beach	0.12	529,950	4,416,250
South Bethany	0.115	1,035,000	9,000,000	Bethany Beach	0.31	1,299,000	4,190,323
South Bethany	0.17	635,000	3,735,294	Bethany Beach	0.22	450,000	2,045,455
South Bethany	0.11	760,000	6,909,091	Dewey Beach	0.12	1,249,000	10,408,333
South Bethany	0.11	729,000	6,627,273	Rehoboth Beach	0.5	419,000	838,000
Bethany Beach	0.22	846,000	3,845,455	Rehoboth Beach	0.5	359,000	718,000
Bethany Beach	0.11	1,195,000	10,863,636	Rehoboth Beach	0.34	569,000	1,673,529
Bethany Beach	0.27	1,098,000	4,066,667	Rehoboth Beach	0.5	719,000	1,438,000
Bethany Beach	0.225	529,000	2,351,111	Rehoboth Beach	0.51	599,000	1,174,510
Bethany Beach	0.05	859,000	17,180,000	Rehoboth Beach	0.27	1,125,000	4,166,667
Dewey Beach	0.12	1,595,000	13,291,667	Rehoboth Beach	0.17	639,000	3,758,824
Dewey Beach	0.32	2,247,000	7,021,875	Millsboro	0.32	179,000	559,375

Dewey Beach	0.26	2,247,000	8,642,308	Millsboro	0.23	199,000	865,217
Rehoboth Beach	1.51	1,999,000	1,323,841	Millsboro	0.42	899,000	2,140,476
Rehoboth Beach	0.27	1,175,000	4,351,852	Millsboro	0.17	319,900	1,881,765
Rehoboth Beach	0.27	1,340,000	4,962,963	Dagsboro	0.5	344,900	689,800
Rehoboth Beach	0.32	975,000	3,046,875	Dagsboro	0.11	225,000	2,045,455
Rehoboth Beach	0.57	749,000	1,314,035	Dagsboro	0.29	379,000	1,306,897
Millsboro	0.37	425,000	1,148,649	Dagsboro	0.18	372,000	2,066,667
Millsboro	0.234	549,000	2,346,154	Dagsboro	0.39	165,000	423,077
Millsboro	0.69	735,000	1,065,217	Selbyville	0.36	449,000	1,247,222
Millsboro	0.73	649,000	889,041	Selbyville	0.15	929,000	6,193,333
Millsboro	0.42	899,000	2,140,476	Selbyville	0.51	151,408	296,878
Dagsboro	0.69	950,000	1,376,812	Selbyville	0.17	325,000	1,911,765
Dagsboro	0.96	1,125,000	1,171,875	Selbyville	1.55	1,550,000	1,000,000
Dagsboro	0.11	424,500	3,859,091	**Mean**	**0.32**	**566,305**	**2,542,383**
Dagsboro	0.32	1,135,000	3,546,875				
Dagsboro	0.21	513,000	2,442,857				
Selbyville	0.2	812,460	4,062,300				
Selbyville	0.12	1,495,000	12,458,333				
Selbyville	0.26	1,250,000	4,807,692				
Selbyville	0.2	755,000	3,775,000				
Selbyville	0.52	749,990	1,442,288				
Mean	**0.32**	**1,029,472**	**5,064,908**				

Fish/Hunting/Birding

Hard Clams: According to the 2016 State of the Delaware Inland Bays report, approximately 1 million clams are harvested commercially from the Inland Bays every year (Figure 3.3). A dozen hard clams typically cost between $6-$16 and using $11 as an average, clams commercially harvested from in the Inland Bays watershed are worth $916,667 annually. Recreational harvest of hard clams is a popular activity in the Inland Bays and annual recreational harvest is estimated as equal to commercial the commercial harvest for a total estimated value of $2 million per year.

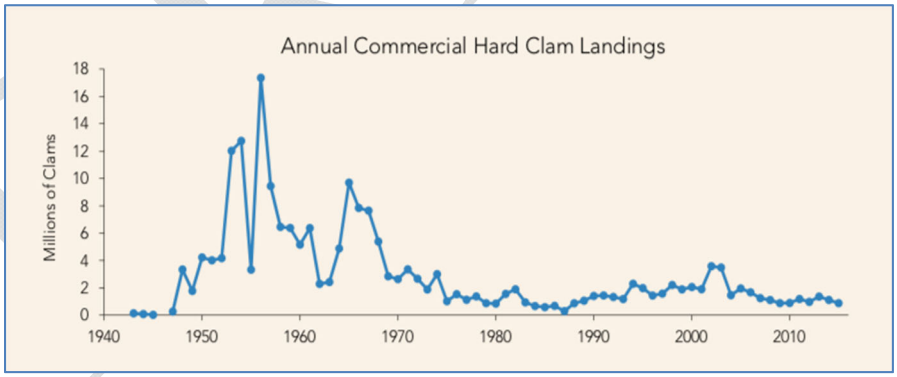


Figure 3.3. Commercial hard clam harvests in the Inland Bays from 1940-2015

Blue Crab: According to Richard Wong, a biometrician for the Delaware Department of Natural Resources and Environmental Control (DNREC), there are a total of 200 million blue crabs in the Delaware Bay. The Delaware Bay surface area is equal to 713 square miles, while the Inland Bays estuary surface area is equal to 28 square miles. By proportion, there are approximately 8 million blue crabs in the Inland Bays. At 1.5 blue crabs per pound, then 8 million crabs equal 5.3 million pounds. At $1.74 per pound, the annual value of the Bay's recreational blue crab fishery is approximately $9.3 million. It is important to note that these estimates may vary due to

assumptions about the quality and quantity of habitat between the Delaware Bay and the Inland Bays and the quality and efficiency of the recreational crab anglers may vary as well. This is no commercial harvest of blue crabs in the Inland Bays.

Shellfish Aquaculture: This section looks at the potential value of the Delaware Inland Bays oyster aquaculture harvest by evaluating existing initiatives in Rhode Island Narragansett Bay, Maryland Chesapeake Bay, and New Jersey Delaware Bay.

Oyster aquaculture is a large business along the East Coast estimated by NOAA at $120 million in 2016 and $186 million in 2017. The eastern oyster (*Crassostrea virginica*) provides ecosystem services such as (1) control phytoplankton blooms, (2) water filtration, (3) habitat for fish, (4) carbon sequestration, (5) intertidal habitat stabilization, and (6) landscape diversity (Coen et al. 2007). The eastern oyster provides ecosystem services benefits such as tons of fish landed, increased tourism spending from cleaner water, tons of nitrogen removed, and natural habitat protected that range from $2,226 to $40,064 with an average of $4,178/acre annually (Grabowski et al. 2012). Parker and Bricker (2020) from the NOAA National Ocean Service found that oyster growth at 6 sites in the Chesapeake Bay in Maryland varied from 4,000 lb to 55,000 lb/ac/yr and oyster filtration with nitrogen removal range from 62 to 1,000 lb N/ac/yr. The potential economic value provided by oyster N removal ranged $560 to $12,446,000 per farm. Oysters landings in Delaware are less than other Atlantic coast states (Figure 4.4)

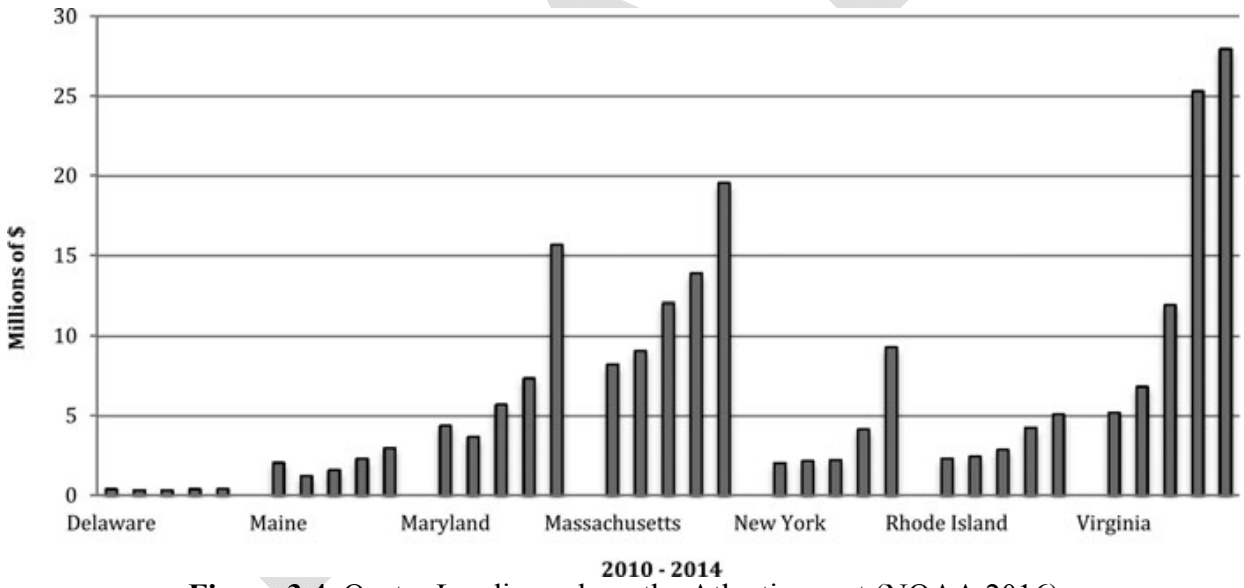


Figure 3.4. Oyster Landings along the Atlantic coast (NOAA 2016)

Rhode Island: To estimate the potential economic value of aquaculture oysters in the Delaware Inland Bays we look to the Narragansett Bay in Rhode Island. By 2019, the Rhode Island oyster aquaculture industry had 81 farms on 339 acres (Figure 4.5) with 8.3 million oysters grown for consumption with a farm gate value of $5.7 million (Beuttle 2015). Since oyster seed sales from Rhode Island aquaculturists totaled $326,796 the combined value of oyster aquaculture was $6.1 million (Figure 4.6) in an industry that employs 219 farm workers (Table 3.11). Eastern oysters (*Crassostrea virginica)*, is the most valuable cultivated fishery in Rhode Island.

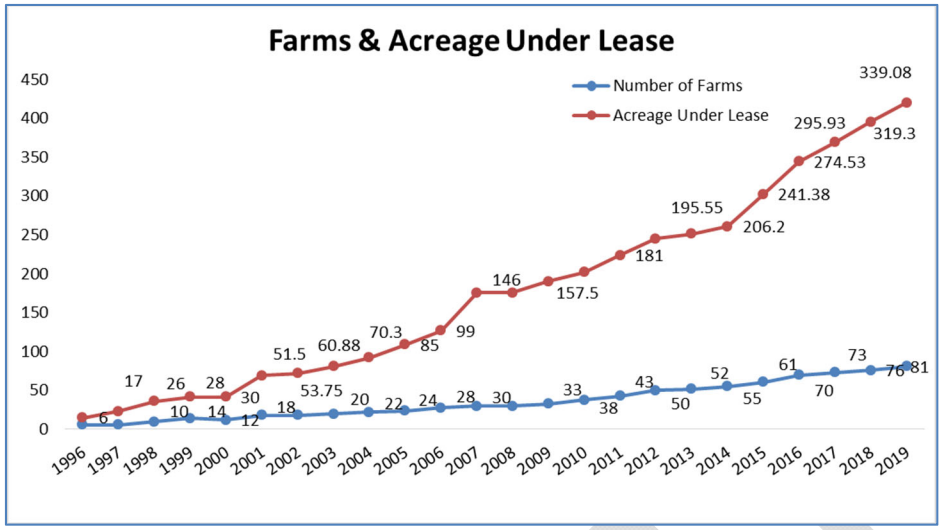


Figure 3.5. Oyster farm acreage in Rhode Island Narragansett Bay (Beuttle 2015)

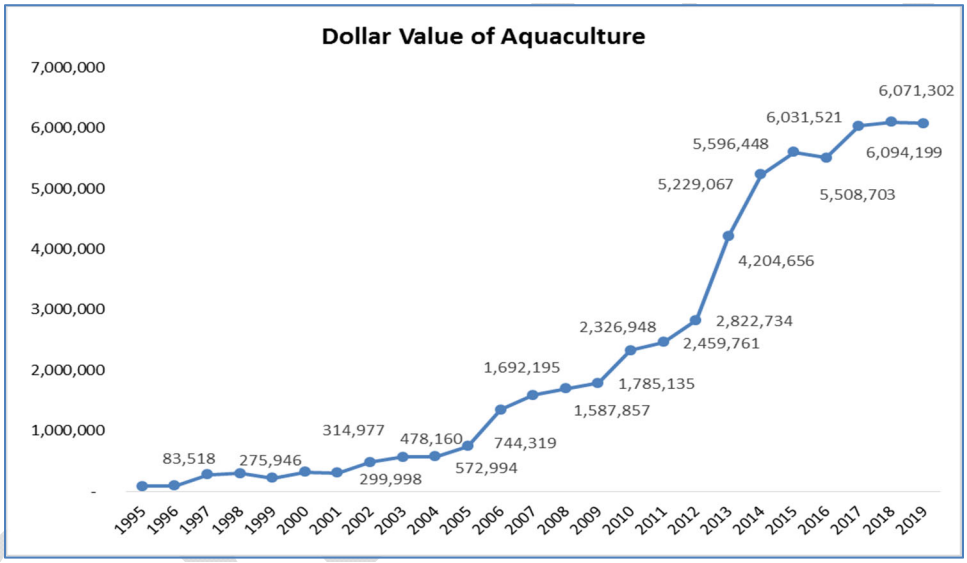


Figure 3.6. Oyster aquaculture value in Rhode Island Narragansett Bay (Beuttle 2015)

Table 3.11. Oyster aquaculture employment in Rhode Island Narragansett Bay

Year	Full-Time Year	Full-Time	Part-Time Year	Part-Time	Total
2011	23	3	26	32	84
2012	32	9	32	32	105
2013	35	13	37	42	127
2014	47	17	35	43	142
2015	47	26	39	59	171
2016	49	30	49	49	177
2017	62	27	41	64	194
2018	62	31	38	69	200
2019	59	47	46	67	219

Maryland: A study by Virginia Tech and Engle-Stone Economics (van Senten et al. 2019) for the Chesapeake Bay Foundation found that the Maryland shellfish aquaculture industry leased 5,028 acres at 245 leases in 2017 (Figure 4.7) with a harvest of 57,543 bushels in 2018 (Figure 4.8) that supported $8.1 million in annual economic output and 133 jobs (Table 3.12). Shellfish leases grew from just over 3,000 acres in 2010 to 5,028 acres by 2017. Aquaculture oyster harvest of 57,542 bushels in 2018 is down from 74,066 bushels in 2017 and many times more the initial harvest of 3,349 bushels in 2012. The total economic effect of oyster aquaculture in Maryland of $8.1 million accounts for 133 jobs from direct effects ($3.6 million), indirect effects ($1.7 million), and induced effects ($2.8 million).

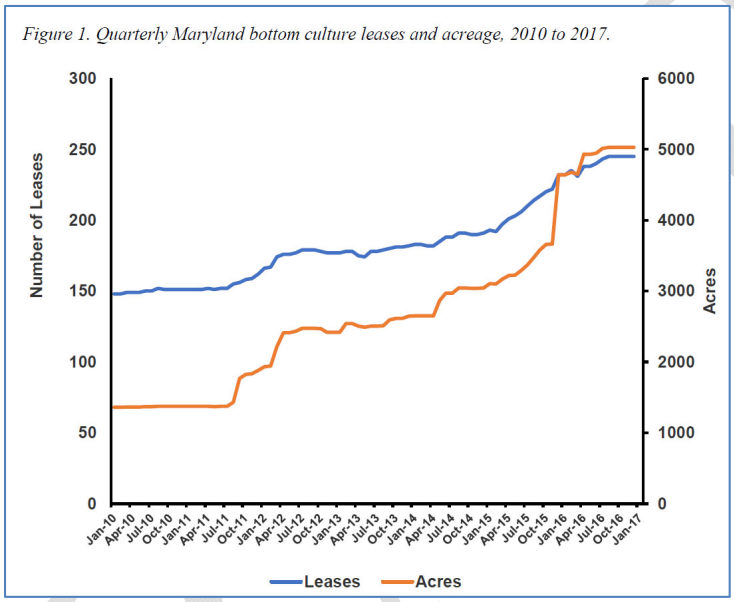


Figure 3.7. Quarterly Maryland bottom culture leases and acreage, 201-2017 (van Senten et al. 2019)

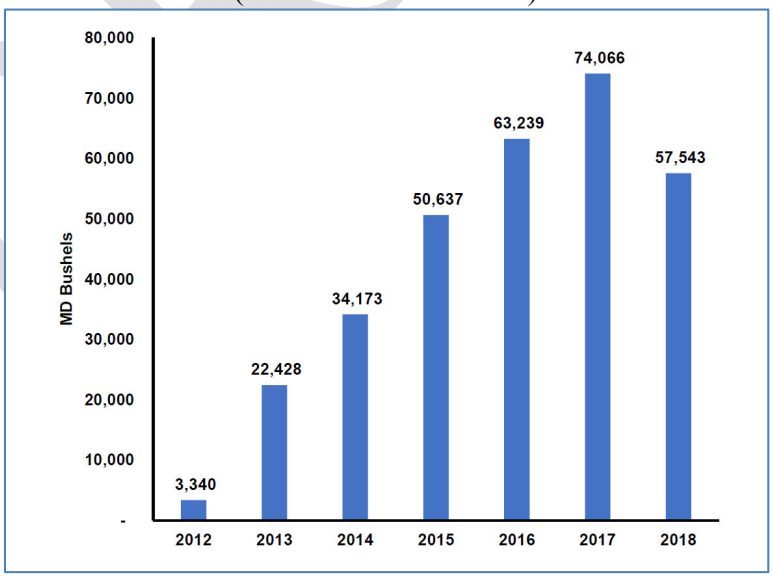


Figure 3.8. Bushels of Maryland aquaculture oysters harvested from 2012-2018 (van Senten et al. 2019)

Table 3.12. Economic impact of Maryland shellfish industry in 2018 (van Senten et al. 2019).

Impact Type	Employment	Labor Income	Total Value Added	Output
Direct Effect	103	$2,867,579	$812,435	$3,632,564
Indirect Effect	12	$644,664	$1,036,130	$1,681,742
Induced Effect	18	$960,075	$1,745,341	$2,827,283
Total Effect	**133**	**$4,472,318**	**$3,593,906**	**$8,141,589**

New Jersey: The New Jersey oyster aquaculture was reestablished in 1997 and has grown over 20 years to a harvest of 2,000,000 oysters at 19 farms along the Atlantic Ocean and Delaware Bay with a gate value of $1,370,000 by 2016 (Calvo 2018). The Rutgers Haskin Shellfish Research Laboratory found during the survey that the market price in 2016 averaged $0.62/oyster in an industry that employed 37 fulltime employees and 33 part-time workers (Figure 4.9).

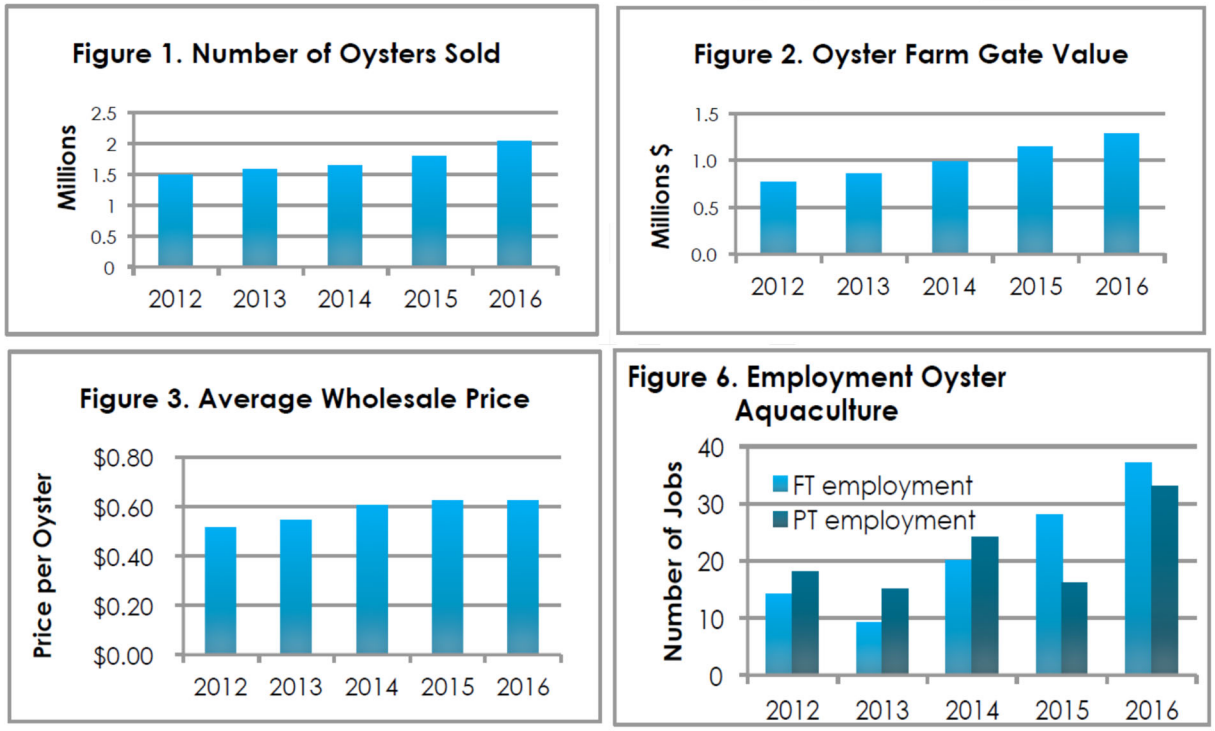


Figure 3.9. Oyster aquaculture in New Jersey along the Atlantic Ocean and Delaware Bay (Calvo 2018)

The value of oyster aquaculture along the Atlantic Seaboard ranges from:

Rhode Island Narragansett Bay	$6.1 million with 219 jobs
Maryland Chesapeake Bay	$8.1 million with 133 jobs
New Jersey Atlantic Coast and Delaware Bay	$1.4 million with 70 jobs

Delaware: Ten years ago, Delaware was the only state along the Atlantic coast that did not permit shellfish aquaculture. In the Delaware Inland Bays, just 10% to 50% of historic oyster biomass remains (Ermgassen et al. 2016) although some estimate just 1% of the historic oyster

biomass remains. Ewart (2013) found that 95% of oysters in the Inland Bays were lost during the late 20th Century with a large loss in water filtration services.

In 2013, the Delaware 147th General Assembly passed House Bill 160 regulating shellfish aquaculture in the Delaware Inland Bays. In 2014, the Delaware Shellfish Aquaculture regulations were signed by the Governor provide for shellfish aquaculture leasing and harvesting in the Delaware Inland Bays (18 DE Reg. 151 (08/01/14)).

During 2018, the first oyster seed for aquaculture was planted in the Delaware Inland Bays and Chris R. harvested oysters 9 months later in September 2018. Kecinski et al. (2017) in research sponsored by Delaware Sea Grant at the University of Delaware found that 28% of locals and13% from out-of-state are willing to buy local Delaware branded oysters at a price 16% higher than non-local oysters. In 2019, a year after the first aquaculture oysters in 30 years were planted in Rehoboth Bay, mature oysters were harvested under a program sponsored by Delaware Sea Grant (Figure 4.10 and 4.11). Chris Redefer, owner of Dewey Beach Selects, harvested the first aquaculture oysters in Rehoboth Bay for market in late 2018. Currently 6 oyster farmers harvest the bivalve for restaurants and markets from the Delaware Inland Bays:

- Chuck Gifford, Tower 13 Oyster Company, 704-641-4273, charlesgiffordiv@gmail.com
- Mark Casey, Delaware Cultured Seafood, Inc., 302-OYSTER1, www.delawareoysters.com.
- Steve Friend, Friends Clams and Oysters LLC, 302-855-1119, friendsheshe@gmail.com
- Jesse Atkinson, Delaware Delicious Oysters, 302-260-0101, DoubleDOysters@gmail.com
- Allan Davis, Inland Bays Shellfisheries LLC
- Rehoboth Bay Oyster Company

Figure 3.10. Governor Carney with Delaware Cultured Seafood oysters in Delaware Inland Bays

Figure 3.11. Delaware Sea Grant's Ed Hale assists Mark Casey with oysters in Indian River Bay

In the Delaware Inland Bays, the DNREC Shellfisheries program has allocated 343 acres or 91 acres in Indian River Bay, 43 acres in Little Assawoman Bay, and 209 acres in Rehoboth Bay for lease in to harvest oysters. Oysters on the Atlantic Coast are packaged 100 per bushel, and one bushel costs $30 on average. Since the Rhode Island Naragansett Bay oyster aquaculture beds (339 acres) are comparable in size to the leased oyster beds in the Delaware Inland Bays (343 acres) it is estimated that the Delaware oyster aquaculture industry may one day approach that of Rode Island with $6 million in sales and over 200 oyster farm jobs. At an average oyster ecosystem services value of $4,178/acre annually (Grabowski et al., 2012), the 343 acres of shellfish leases in the Delaware Inland Bays have a habitat value of $1.4 million/yr. Therefore, the total potential value of the Inland Bays oyster aquaculture industry is $7.4 million annually with $6 million in sales and $1.4 million in habitat value

Fish Harvest: The Center of the Inland Bays State of the Bays Report (2016) indicates that recreation fishing spending in Delaware was over $165 million in 2014 and "over 200 thousand fishing trips are made each year in the Bays, reeling in an estimated 176 thousand pounds of fish." At an estimated value of $10 per pound of fish, the fish harvest value is estimated at $1,760,000 annually.

Fishing, Hunting, Bird/Wildlife Watching: In Delaware, the U. S. Fish and Wildlife Service (2011) estimated the annual economic value of recreational fishing, hunting, birding/wildlife-viewing activities totaled was $315 million. Trip expenditures include purchases and sales of food and lodging, transportation, and hunting, fishing, and wildlife watching equipment. Average daily trip expenditures range from $24 to $49/trip for fishing, $14 to $45/trip for hunting, and $23 to $66/trip for wildlife/bird-watching. The Inland Bays watershed covers 327 square miles or

13% of Delaware land area. 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 Inland Bays watershed is $40.8 million including $13.5 million from fishing, $5.3 million from hunting, and $22 million from wildlife/bird watching.

Fishing Charters: Charter fishing is a popular recreation activity in the Inland Bays watershed with 31 fishing charter businesses clustered at the Lewes and Rehoboth Canal and the Indian River Inlet (Table 3.13). These businesses offer half-day (4 hour) or full-day (8 hour) charter rentals. Fishing season in Delaware is April through October or 214 days. Using half-day rates and assuming two trips daily, the total economic value of fishing charters inside the watershed totals $4.4 million annually.

Table 3.13. Fishing charters in the Inland Bays watershed

Fishing Charters	3 Amigos	Little Miss Ene
First Light Charters	Amethyst Charters	Mae B
Katydid Sport Fishing	Canyon Hunter	Michael D
Savannah Lynn Fishing Charters	Crab Claw:	Miss Donna
Ace Sport Fishing	Capt. Ike II:	Miss Ene, III
3 Amigos Sport Fishing	El Shaddai:	No Limit
El Shaddai 1 Fishing Charters	Double D's Sportfishing	Prime Hook
Gale Force Charters	Fortunate	Razorback Charters
Judy V Fishing	Gale Force Charters	Reelin & Rockin
Capt. Ike II Charters	Just Got Reel	Rusty Reel
Anglers Fishing Center	Last $	

Bait and Tackle Shops: Fishing is a popular recreational activity in the Inland Bays watershed, and 12 bait and tackle shops contribute to the local economy (Table 3.14). Economic data is being gathered for tackle shop contributions to the Inland Bays economy.

Table 3.14. Bait and tackle shops in the Inland Bays watershed

Bait and Tackle Shops	
A-Lure Bait & Tackle	Lighthouse View Bait & Tackle
Bayside Bait & Tackle	Lucky's Bait & Tackle
Fenwick Tackle	Old Inlet Bait & Tackle
Hook'em & Cook'em (Bethany)	Hook'em & Cook'em (Indian River)
Jim's Bait & Tackle	The Lead Pot
Lewes Icehouse	Tiderunners
G&E Hardware	Bethany Auto Parts
West Marine	Rick's Bait & Tackle

Outdoor Recreation

Water-based Recreation: The Outdoor Industry Association (2016) concluded 467,000 people participated in recreation such as bicycling, camping, fishing, hunting, paddling, hiking, and wildlife viewing in Delaware who contributed $3.1 billion and 29,000 jobs to the state economy. Given the population of Delaware of 967,171, by proportion outdoor recreation activity in the

Inland Bays watershed with a population of 247,495 contributes $794 million in consumer spending to the economy and 7,424 jobs with $245 million in wages (Table 3.15).

Table 3.15. Economic value of recreation in the Inland Bays watershed

Economic Activity	Delaware[1]	Inland Bays Watershed[2]
Consumer Spending	$3.1 billion	$794 million
Camping		$318 million
Fishing		$69 million
Hunting		$53 million
Water Sports		$268 million
Wildlife Watching		$57 million
Participants	467,000	119,552
Jobs	29,000	7,424
Wages	$959 million	$245 million

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

The Bureau of Economic Analysis in the U.S. Department of Commerce (2019) found the outdoor recreation economy in Delaware contributed $1.3 billion to the economy from boating/fishing, RVing, amusement parks / water parks festivals, sporting events/concerts, golf and tennis, and other supporting outdoor recreation. Given the population of Delaware is 967,171, by proportion outdoor recreation activity in the Inland Bays watershed with a summer population of 247,495 contributes $335 million in spending to the economy (Table 3.16).

Table 3.16. Outdoor recreation value added in Delaware Inland Bays Watershed, 2017 (Bureau of Economic Analysis in the U.S. Department of Commerce 2019)

State/ Watershed	Boating / Fishing ($)	RVing ($)	Other Recreation Activities ($)	Amusement Parks / Water Parks ($)	Festivals / Sporting Events / Concerts ($)	Game Areas (Golf, Tennis) ($)	Other Supporting Recreation ($)	Government Expenditures ($)	Outdoor Recreation Activities ($)
Delaware	316,284,000	53,390,000	4,421,000	168,869,000	20,225,000	11,448,000	53,363,000	775,680,000	1,309,865,000
Inland Bays	80,968,704	13,667,840	1,131,776	43,230,464	5,177,600	2,930,688	13,660,928	198,574,080	335,325,440

Power Boating: The National Marine Manufacturers Association (2018) reported 55,047 registered boats in Delaware with annual retail sales of new boats, engines, and marine accessories amounting to $213 million. Based on the proportion of marinas in the state of Delaware to the Inland Bays watershed, half of boat sales businesses are inside the watershed., therefore, there are 27,523 registered boats and $106.5 million in retail sales in the Inland Bays watershed (Table 3.17).

Table 3.17. Annual boat registrations and sales in the Inland Bays watershed

Area	Registered Boats (#)	Retail Sales ($)
Delaware	55,047	213,000,000
Inland Bays Watershed	27,523	106,500,000

Marinas: According to the Association of Marina Industries (2018), there are 41 marinas in Delaware that generated $44.9 million in economic output. The 20 marinas in the Inland Bays watershed generate $21.9 million annually (Table 3.18). From aerial photographs, 1,892 boat slips are in the Inland Bays watershed and if boat owners spend $2,500 annually to store boats, boat slips in the watershed are worth $4.7 million.

Table 3.18. Economic value of marinas in the Inland Bays watershed (Association of Marina Industries 2018)

Area	Marinas (#)	Economic Output ($/yr)	Boat Slips	Value @ $2,500/Slip ($/yr)
Delaware	41	44,874,675		
Inland Bays Watershed	20	21,890,085	1,892	$4,730,000

Eco-Tour Operators: Eco-tour businesses are a form of tourism that attracts people to natural areas. There are at least 10 eco-tour operators in the Inland Bays watershed that offer services including kayaking, paddle boarding, surfing, jet ski, and boating rentals as well as guided tours (Table 3.19). Traveling on the Inland Bays via water taxi for sightseeing purposes is provided Cape Water Tours and Taxi. Assuming one ride/week, 50 passengers/boat, and $20 per ride, water taxi businesses on the Inland Bays generate $52,000 annually.

Table 3.19. Eco-tour operators in the Inland Bays watershed

List of Eco-Tour Operators	
Cape Water Tours & Taxis	East of Maui
Coastal Kayak	Ecobay Kayak & Stand Up Paddle
Delaware Paddlesports	Island Watersports
Delmarva Board Sports Waterfront	Pirates of Lewes
Dewey Beach Watersports	Quest Kayak

Navigation Use Value: Assuming the Inland Bays is uniformly 5 feet deep, the economic value of navigation use is $2.2 million. Approximately 21,504 acres of open water exist in the Inland Bays watershed. Multiplying 21,504 acres by a depth of 5 feet provides the volume of navigable water in the watershed, 107,520 acre-feet or 35 billion gallons. In the Resources for the Future study (Frederick et al. 1996), researchers estimated the median use-value of navigation was $10/ac-ft in 1996 dollars or $20.33/ac-ft in 2020 dollars, adjusting for 3% annual change in CPI, therefore, the navigation use-value in $2020 dollars is $2.2 million.

Waterway Management: Eleven channels in the Inland Bays are dredged to improve navigation for boaters and provide material to replenish eroding beaches and restore wetlands. These waterways include the Lewes-Rehoboth Canal, Massey's Ditch, Assawoman Canal and other tributaries (Table 3.20). Contract bid dredge costs reported by DNREC were $25.25/CY at Massey's Ditch. The cost at $25/CY to dredge 5 feet of sediment from 46.5 miles of channel or 2.7 million CY annually over a 10-year cycle is $6.7 million/year. Historically, the dredge volume in 10 channels totaled 602,950 CY during 1970-2006 (Moffat and Nichol 2007).

The benefits of dredging are estimated from (1) the reuse of sandy dredge material (from Massey's Ditch for reuse on ocean beaches, (2) reuse of fine grain silty clay sediment dredge

material from tributary creeks for reuse for wetland restoration, and (3) continuance of the high value boating industry. Dredge materials is used for habitat restoration at wetlands, uplands, aquatic area, islands and beaches (Moffat and Nichol 2007). Beach nourishment requires sandy materials from channels in the Inland Bays such as Massey's Ditch. Other channels such as Bald Eagle, Love, Herring, Guinea, Pepper, Vines, and White creeks possess high amounts of fine silty clay not suitable for beach replenishment but suitable for wetland restoration.

Massey's Ditch: Over a 10-year period, 3-mile long Massey's Ditch can provide 296,000 CY of dredged sand material or 29,600 CY annually for beach replenishment to the ocean 2 miles away. If the average erosion rate of ocean beaches is 4 feet annually (Chrysalis 2007), then 29,600 CY of material can provide 200,000 SF or 4.5 acres of replenished beach. If each beach visitor occupies 100 SF/day over a 100-day season from Memorial Day to Labor Day, then 200,000 less beach visitors would go to the beach without beach replenishment from the dredged sand and at $25/day of spending by beach goers the loss is $5,000,000 annually thus the annual benefits of replenishing beaches with dredged sand from Massey's Ditch alone is $5,000,000.

Tributary Creeks: Over 10 years, the 17.8 miles of channels along Bald Eagle, Love, Herring, Guinea, Pepper, Vines, and White creeks can provide 1,000,000 CY or 100,000 CY annually of dredged fine grain silty clay sediment for wetland restoration along the shallow rim of the bay. If the average wetland restoration requires at least 2 feet of sediment to replenish the wetlands, then 100,000 CY of dredge material provides 1,350,000 SF or 31 acres of restored saltwater wetlands. If the annual ecosystem services value of saltwater wetlands is $9,208/acre, then the benefits of restoring wetlands with dredge material from the 7 tributary creeks is $285,448 annually. The cost of thin layer application of dredged material is recognized as $25,000 to $100,000/ac with unit costs of $25-$75/cy (Mohan personal communication 2020).

Boating Industry: Channel dredging in the Delaware Inland Bays allows a boating industry with $106.5 million in retail boating sales and 20 marinas that generate $22 million in economic activity with 1,900 boat slips that generate $4.7 million in leases. Recreational boating benefits provided by channel dredging are estimated by multiplying boating activity days in the Delaware Inland Bays by low and high bound estimates of daily recreation value. Low bound benefits of recreational boating is $11.6 million/year determined by multiplying 100,000 boating trips (Leeworthy et al. 2001 and 2005) by $116/day per boater transferred from Bockstael et. al (1989). High bound boating benefit is $31.5 million computed by multiplying 500,000 activity days (Leeworthy et al. 2001 and 2005) by $63/trip from Smith and Desvouges (1986).

Cost/Benefits: Estimated annual costs to dredge 2,700,000 CY of sediment over a 10-year cycle from 46.5 miles of channel in the Inlands Bays is $6.7 million, which is surpassed by benefits of reusing sandy material for beach replenishment ($5 million), wetland restoration ($285,000) and continuing the sizable boating industry with benefits that range from $11.6-$31.5 million/yr.

Dredging Costs:	$6.7 million/yr	
Dredging Benefits:	Beach Replenishment	$5 million/yr
	Wetland Restoration	$0.3 million/yr
	Boating Industry	$11.6-$31.5 million/yr

Table 3.20. Cost of dredging in the Inland Bays watershed (Moffat and Nichol 2007)

Channel	Sediment	Length (mi)	Length (ft)	Width (ft)	Depth (ft)	Volume (CF)	Sed. Depth (ft)	Sediment Volume (CY)	Dredging Cost ($25/CY)	Annual Cost ($) (10 yrs)	Dredging Volume[1] (CY)
Lewes/Rehoboth Canal	Silty sand	10	52,800	50	6	15,840,000	5	488,889	12,222,222	1,222,222	20,000 (1991)
Bald Eagle Creek	Silty clay	0.5	2,755	80	4	881,600	5	40,815	1,020,370	102,037	No data
Love Creek	Silty clay	3.7	19,536	60	6	7,032,960	5	217,067	5,426,667	542,667	115,000 (1970-71)
Herring Creek	Silty clay	5.1	27,100	60	6	9,756,000	5	301,111	7,527,778	752,778	85, 000 (1980-83)
Guinea Creek	Silty clay	1.9	10,000	60	6	3,600,000	5	111,111	2,777,778	277,778	75,450 (1977)
Massey's Ditch	Silty clay/sand	3	16,000	100	6	9,600,000	5	296,296	7,407,407	740,741	15,000 (2002)
Indian River	Silty clay	13	68,640	60	6	24,710,400	5	762,667	19,066,667	1,906,667	37,000 (1983)
Pepper Creek	Clayey silt	3	16,000	60	6	5,760,000	5	177,778	4,444,444	444,444	80,000 (1987-88)
Vines Creek	Clayey silt	0.2	1,000	60	4	240,000	5	11,111	277,778	27,778	6,500 (1994)
White Creek	Silty clay	3.4	17,700	60	6	6,372,000	5	196,667	4,916,667	491,667	135,000 (1971-72)
Assawoman Canal	Silty clay	2.7	14,000	35	3	1,470,000	5	90,741	2,268,519	226,852	34,000 (2006)
Total		**46.5**	**245,531**					**2,694,252**	**67,356,296**	**6,735,630**	**602,950**

Marine Construction: Marine construction is sizeable in the Inland Bays with 1,329 LF built at docks, piers, and boatlifts at 49 projects, 756 LF of riprap bank stabilization at 11 projects, and 7,101 LF of bulkheads at 83 projects (Tables 3.21 and 3.22). At $100/LF for docks, $130/LF for riprap, and $500/LF for bulkheads, shoreline stabilization construction totals $3,781,680.

Table 3.21. Marine construction cost of shoreline stabilization in Inland Bays watershed

Shoreline Stabilization	No. of Projects	Linear Feet	Unit Cost ($/LF)	Cost ($)
Docks/Pier/ Boatlifts	49	1,329	100	132,900
Riprap	11	756	130	98,280
Bulkhead	83	7,101	500	3,550,500
Total	**143**	**9,186**	**730**	**3,781,680**

Table 3.22. Marine construction projects in the Delaware Inland Bays watershed

Permittee	Comments	Permittee	Comments
Dunn, Joseph - SA '16	R/R 88 feet of bulkhead	Humphreys, John	R/R Bulkhead 40'
Brown, Richard T.SP '16	r/R bulkhead 50'; new dock 50'x3'	Boothe, Jame Kevin	install dock 25'x3'; boatlift; 2 pilings;
Miller, Michael & Susan	R/R bulkhead 241'x1'; dock 21'x3'	Radcliffe, Brian	R/R bulkhead 50'; install dock 35'x3"
Schell Brothers, Seagrass	R/R concrete fill with sandy material	Reilly, Thomas	R/R bulkhead 18" in front of existing
Schell Brothers Seagrass	R/R concrete fill with sandy material	Bittenbender, Carl	R/R bulkhead 50'
Banks Harbor Marina	to stabilize eroding marsh edges	Wernecke, Douglas	R/R bulkhead 50'; to install dock
Indian River Acres	R/R bulkhead 10'	Baier, Michael and Hope	R/R bulkhead 50'; install 4 piling boat
Whites Creek Marina	R/R bulkhead 333'; pier 20'6"x2'	Fish, John	R/R bulkhead; install new pilings
Indian Riverview Marina	R/R bulkhead 116'	Gordon, D. Brian	R/R bulkhead 50'
Conti, Daniel	R/R bulkhead 75'; remove dock	DELDOT Lighthouse Rd	replace existing pipe and failing tide
Baskin, Jeffrey	R/R wood bulkhead 55'x1'; wood dock	Rubbert, William	R/R bulkhead 175'; dock 16'x4'
White House Beach	R/R wooden Concrete bulkhead	Esler, Christian - SA '16	close in existing 12' boat ramp
Venit, Gregory	R/R rip rap 109'	Wise, Todd	R/R bulkhead 40'
Tunnell, Janice P	R/R bulkhead 100'	Terry, Michael	R/R bulkhead 40'
Murphy, Brian	R/R bulkhead 60' vinyl; dock 20'x3'	Hynson, Lawrence	R/R 50feet bulkhead
Lendzioszek, Joseph	R/R bulkhead 60' vinyl	Siems, Frederick	Bulkhead 25' R/R and Bulkhead
Ziemba, Anthony	R/R bulkhead	Cape Windsor	R/R bulkhead 30' at
Frank, Jeffery A.	R/R bulkhead 60'; replace dock 4'x15'	Diffenderffer, Ross	R/R bulkhead 50'; install floatind dock
Cropper, Elisha Wayne	R/R bulkhead 156'; 2 return walls	Rozanski, Norbert	R/R bulkhead 40'
Sroka, Cindy and David		Smith, Mildred	R/R bulkhead 50'
Anderson, Charlotte	Structures on the Lagoon side	McMullen, George - SA '16	R/R bulkhead 152'; R/R dock 20'x4'
Rosenthal Tidewater, LLC	Install kayak launch, rip-rap, coir logs	Bruce, William	R/R bulkhead 50'
Bush Revocable Trust	106 linear feet rip rap bank	Stoner, John D	R/R bulkhead 50'
Wheeler, Porter K.	R/R pier and dock; install riprap	Cavanaugh, Dan	R/R 50' bulkhead
Mueller, Gary	to R/R 75' bulkhead	Zanelotti, Kurt	R/R bulkhead 50'
Napieralski, Dennis	R/R bulkhead 272'; dock 22'x4'8"	Shirazi, Yashar - SA '15	R/R bulkhead 170'; dock 16'x4'; 1/2
Newhouse, Neil - LA '16	R/R 156.5 linear feet of bulkhead	Sevilis, Paul	R/R bulkhead 85'; dock 22'x3'; 1/2
Juliano, Richard	R/R bulkhead 65'; dock 21'x4'	Wyckoff, Barbara	R/R riip rap; install new boatlift
McLouski, Joyce - SA	R/R bulkhead 70'; dock 21'x4'	Mario Malone Enterprises	R/R bulkhead 60'
Whitney, John - SA '16	R/R bulkhead 178'	Massey's Landing Park, Inc	R/R Bulkheading; associated with SA
Pelham, Janet W.	R/R bulkhead 180'; install dock 22'x4'	Myers, Gregory	install 2 - 100'x36' HDPE culverts
3# Bayberry Rd, LLC	R/R bulkhead and dock (4x75 ft.)	Raab III, George J	R/R 222 linear feet of existing rip rap
Andrews, Debra A	R/R bulkhead 50'; dock 25'x5'	Klerlein, John, Michelle	R/R 62' of bulkhead and two 5' return
Kaufmann, Gary	R/R bulkhead 50'	Fuller, Hugh V.	SL: to construct a 145'x4' pier, 6'x30'
Jackson, Molly	R/R bulkhead; fill in boat ramp	Turner, Richard - SL '16	New lease for existing pier/ dock, old
Bauer, Bob	R/R bulkhead 50'	Angola by the Bay	R/R floating dock system; main pie
Sheaf, James	R/R bulkhead 40'	Hometown Rehoboth	rip rap placement in front of the
Evans, Michael	R/R bulkhead 40'	Hometown Rehobot	stabilize a failing bulkhead by piles
Ford, William and Carol	R/R boat ramp and 8' of bulkhead	Pot-Nets CCDS, LLC	R/R bulkhead and docks
Rowe, Joseph	R.R bulkhead and dock	Rehoboth Beach Country	R/R bulkhead 160'
Campbell, Donald L	R/R bulkhead 50'; R/R dock 15'x5	Joy Beach Property Owners	R/R bulkhead 400'; install dock 22'x3'
Shaw, George Allan	R/R bulkhead 40'	Mariner's Cove - 94 Pine	R/R Bulkhead 90'; dock 25'x4'
Madden, Michae	R/R bulkhead 50'	Mariner's Cove	R.R bulkhead 90'; dock 70'x4', double
Strauss, Emanuel;	R/R bulkhead 75'	Hukill, John	to remove unauthorized structures,
Earle, Doris	R/R bulkhead 47'; rock toe 31'x2'	Hometown Rehoboth, LLC	To repair the existing bulkhead
Varga, Ken	R/R bulkhead 50'	Atallian, Brian	R/R bulkhead 112 feet on lagoon side
Loomis, James LA	R/R 40 Linear Feet of Bulkhead	Mendola, Ronald, Cynthia	R/R bulkhead 50'
Haney, Tina	R/R Bulkhead 60'; remove PWC lift	Cochran, Robin and Karen	
Injaian, Gerald H.	R/R bulkhead 65'; dock 20'x4'; boat	Tillman, Sandra and Harry	
Lee, John W.	install new 11' bulkhead to close in		

Parks

State Parks: According to Rockport Analytics (2017), 2.5 million visitors to the Cape Henlopen, Delaware Seashore, Fenwick Island, and Holts Landing State Parks in the Inland Bays watershed contribute $362 million annually to the regional economy in Delaware (Table 3.23).

Table 3.23. Delaware state parks visitation and visitor spending (FY 2016/17)

State Park	Attendance	Visitor Spending ($/yr)
Cape Henlopen	1,276,040	$128,481,875
Delaware Seashore	1,055,759	$172,984,023
Fenwick Island	232,832	$60,032,326
Holts Landing	8,592	$103,621
Total	**2,573,223**	**$361,601,845**

Public Parks: The Trust for Public Land (2009) found the 444-acre City of Wilmington park system provides annual economic value to the public from health benefits from exercise in the parks ($9,734/acre), community-cohesion benefits as people socialize in the parks ($2,383/acre), water pollution benefits in treating stormwater ($921/acre), and air pollution–mitigation value from tree and shrub absorption ($88/acre). The Inland Bays watershed includes 20,770 acres of parks, active recreation areas, and open space such as the James Farm Ecological Preserve, Assawoman Wildlife Area, Gordon's Pond State Park Area, and Angola Neck Preserve. Using the Trust for Public Land (2009) data by value transfer (Table 3.24), public parks in the Inland Bays watershed provide $273 million in annual benefits including health benefits ($202 million), community-cohesion benefits ($49 million), water pollution benefits ($19 million), and air pollution mitigation value ($1.8 million).

Table 3.24. Value of parks and open space in Inland Bays watershed

Parks Benefits	Parks/Open Space (ac)	Value ($/ac)	Value ($)
Health Benefits	20,770	$9,734	$202,175,180
Community Cohesion	20,770	$2,383	$49,494,910
Stormwater Treatment	20,770	$921	$19,129,170
Air Pollution	20,770	$88	$1,827,760
Total	**20,770**		**$273,000,000**

RV Parks: An average cost per night of renting one RV site was calculated using rates found on the RV parks' websites. Treasure RV Park & Campground, Lighthouse Beach RV Resort, and Massey's Landing were contacted to determine the average number of RV sites. Camping season is generally 7 months or 214 days, from April to October. Assuming full capacity, RV parks in the Inland Bays watershed generate $48 million annually (Table 3.25).

Table 3.25. RV parks in the Inland Bays watershed

Inland Bays RV Parks	Average # RV Sites	Average Cost/Night	Camping Season	Economic Value ($)
Summer-Time Trailer Park	220	$78	214 days	3,672,240
Treasure RV Park & Campground	220	$78	214 days	3,672,240
Lost Lands RV Park	220	$78	214 days	3,672,240
Leisure Point Resort	220	$78	214 days	3,672,240
Holly Lake Campsites	220	$78	214 days	3,672,240
Lighthouse Beach RV Resort	220	$78	214 days	3,672,240
Massey's Landing	220	$78	214 days	3,672,240
Big Oaks Campground	220	$78	214 days	3,672,240
Pine Tree Campground	220	$78	214 days	3,672,240
Bay Shore Campground & Marina	220	$78	214 days	3,672,240
Oak Forest Park	220	$78	214 days	3,672,240
Shawn's Hideaway	220	$78	214 days	3,672,240
Port Delmarva	220	$78	214 days	3,672,240
Total				**$47,739,120**

Agriculture

The value agricultural products sold in Delaware annually to consumers is over $3.5 billion as reported by the Delaware Department of Agriculture and the U.S. Department of Agriculture (Kee and Cadwallader 2010). Scaling by the ratio of 2017 farmland in the watershed (98 mi^2) to farmland in Delaware (811 mi^2), the annual value of agricultural products in the Inland Bays watershed was $433 million on 289 farms from nurseries, vegetables, fruit, horses, grain, poultry, and cattle (USDA 2017) as summarized in Table 3.26.

Table 3.26. Economic value of agriculture in the Inland Bays watershed (Kee and Cadwallader 2010, USDA 2017)

Farmland in State (mi^2)	Farmland in Watershed (mi^2)	Farms in Watershed	Agriculture Value in State ($)	Agriculture Value in Watershed
811	98	289	$3,500,000,000	433,000,000

Chapter 4 : Ecosystem Services

This chapter summarizes the value of nature and habitat in the Inland Bays watershed. Ecosystem services (natural capital) are goods (commodities like water, crops, timber sold and services (functions like flood control, water filtration, and fisheries habitat) in wetlands, forests, farms, and open water. Ecosystem services include air filtration, water filtration, recycling nutrients, soil conservation, pollinating crops, climate regulation, and carbon sequestration. Ecosystem services (ecological services) are economic benefits provided to society by nature such as water filtration, flood reduction, and drinking water supply.

For 2012 and 2017 land use/land cover data obtained from the Delaware DNREC, the University of Delaware tabulated the value of natural resources (ecosystem services value) in the Inland Bays watershed for habitat such as wetlands, forests, farmland, and open water. 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 nearby watersheds are reviewed and applied to Inland Bays watershed. Value- transfer techniques include selecting data from published literature from another watershed or study area and applying the dollars-per-acre values to the Inland 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.

Ecosystem services value ($/ac) data from literature were translated to the Inland Bays watershed. Mates and Reyes (2007) estimated the value of New Jersey's natural capital at $20 billion annually. Weber (2007) found ecosystem services values in Cecil County, Maryland stem from flood control, water supply, and clean water functions. The Wilderness Society (Krieger 2001) concluded forest ecosystem services for climate regulation, water supply, water quality, and recreation benefits were $392/ac. The University of Rhode Island found natural resources values in the Peconic Estuary watershed ranged from $6,560/ac for wetlands to $9,979/ac for farmland (Johnston et al. 2002). The Audubon Society found ecosystem values in Massachusetts were $984/ac for forests to $15,452/ac for saltwater wetlands (Breunig 2003). The U.S. Forest Service (Nowak et al. 2008) estimated forests provide carbon storage and sequestration ($29-827/acre), air-pollution control ($266/ac), and energy savings ($56/ac) benefits. The USDA (2017) reported the market value of farm products sold in Sussex County, Delaware was $3,676/ac.

Watershed Ecosystem Services

The ecosystem goods and services value of 209,156 acres of habitat in the Inland Bays watershed in 2017 was $1.46 billion annually or $20 million less than the 2012 value of $1.48 billion (Table 4.1). Habitat changes from 2012 to 2017 include freshwater wetlands (-493 acres), farmland (-2,253 acres), forest (-1,184 acres), saltwater wetlands (-70 acres) replaced by developed land (+2,464 acres). The 2017 ecosystems habitat (Figure 4.1) in the watershed include farmland (29.9%), urban (22.3%), freshwater wetlands (15.1%), forest (13.9%), marine (11.2%), saltwater wetlands (4.4%), barren (1.2%), open water (1%), and beach/dune (0.9%). Freshwater wetlands ($546 million), farmland ($304 million), and marine ($299 million) provide the highest ecosystems services values in the Inland Bays watershed (Figures 4.2 and 4.3).

The significant economic value of habitat in the Inland Bays watershed indicates that natural systems such as wetlands, forests, farms, and the bay itself are worth investing in and protecting at the Federal, state, and local level.

Table 4.1. Ecosystem goods and services value in Inland Bays watershed, 2012 and 2017
(1. Mates and Reyes 2007 and USDA 2017 updated to $2020 based on 3% annual change in CPI.
2. 2012 and 2017 land use/land cover GIS data from Delaware DNREC)

Ecosystem	Services in $2020[1] ($/ac)	2012 Area[2] (ac)	2012 Value ($)	2017 Area[2] (ac)	2017 Value ($)	2012-2017 Change (ac)	2012-2017 Change ($)
Freshwater Wetlands	17,332	32,026	555,074,632	31,532	546,512,624	-494	-8,562,008
Marine	12,731	23,395	297,841,745	23,451	298,554,681	56	712,936
Farmland	4,871	64,694	315,124,474	62,439	304,140,369	-2,255	-10,984,105
Forest	2,517	30,283	76,222,311	29,097	73,237,149	-1,186	-2,985,162
Saltwater Wetlands	9,208	9,347	86,067,176	9,277	85,422,616	-70	-644,560
Barren	0	1,287	0	2,527	0	1,240	0
Urban/Developed	435	44,175	19,216,125	46,636	20,286,660	2,461	1,070,535
Beach/Dune	61,897	1,952	120,822,944	1,960	121,318,120	8	495,176
Open Water	2,476	1,997	4,944,572	2,236	5,536,336	239	591,764
Total		**209,156**	**1,475,313,979**	**209,156**	**1,455,008,555**	**0**	**-20,305,424**

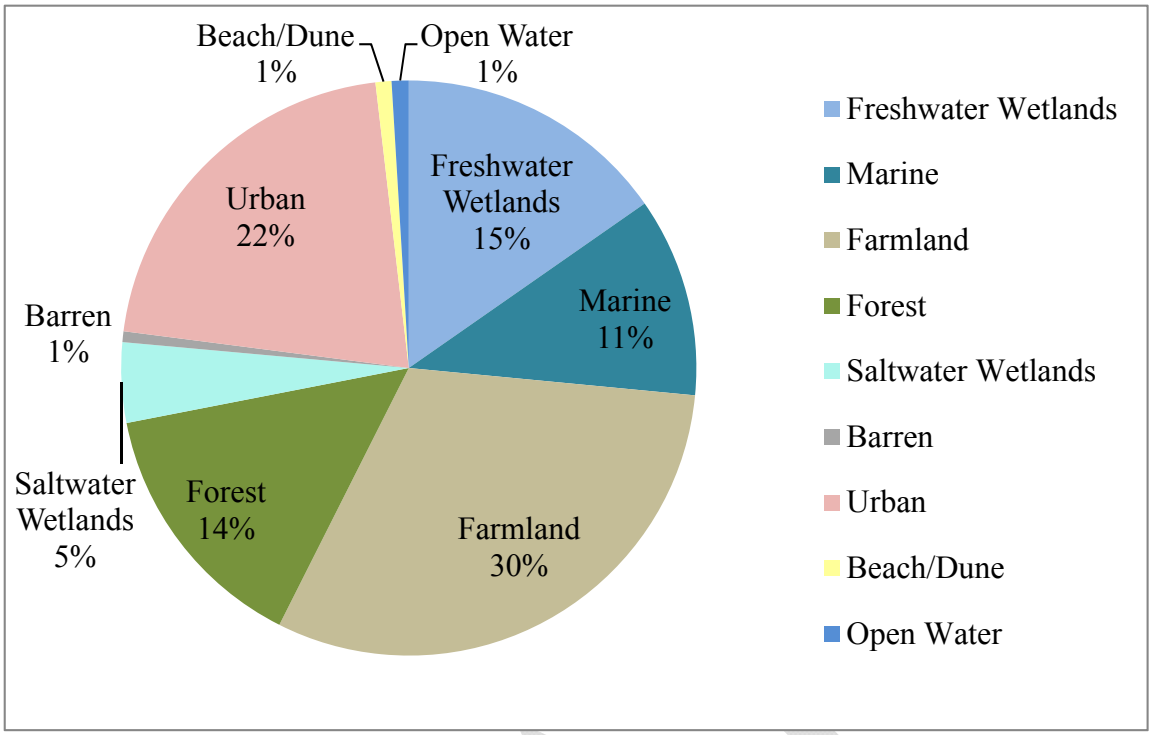


Figure 4.1. Ecosystems habitat in the Inland Bays watershed, 2017

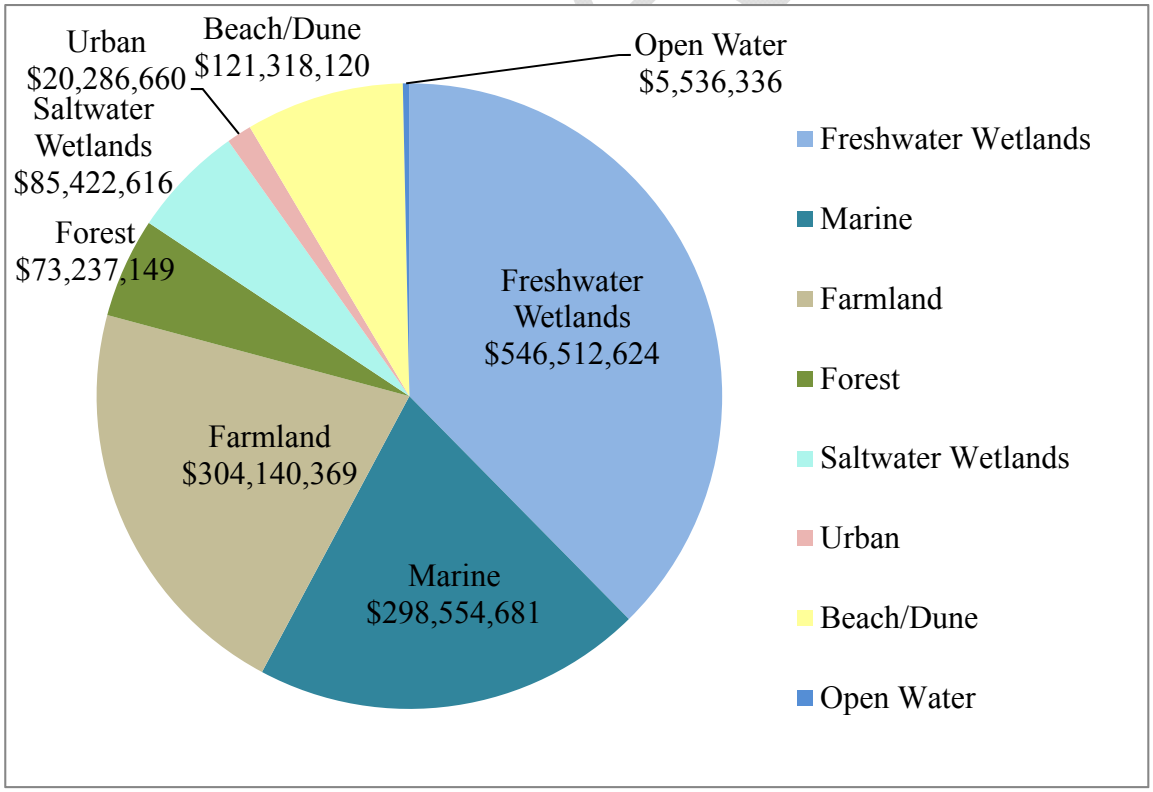


Figure 4.2. Value of natural goods/services in the Inland Bays watershed, 2017

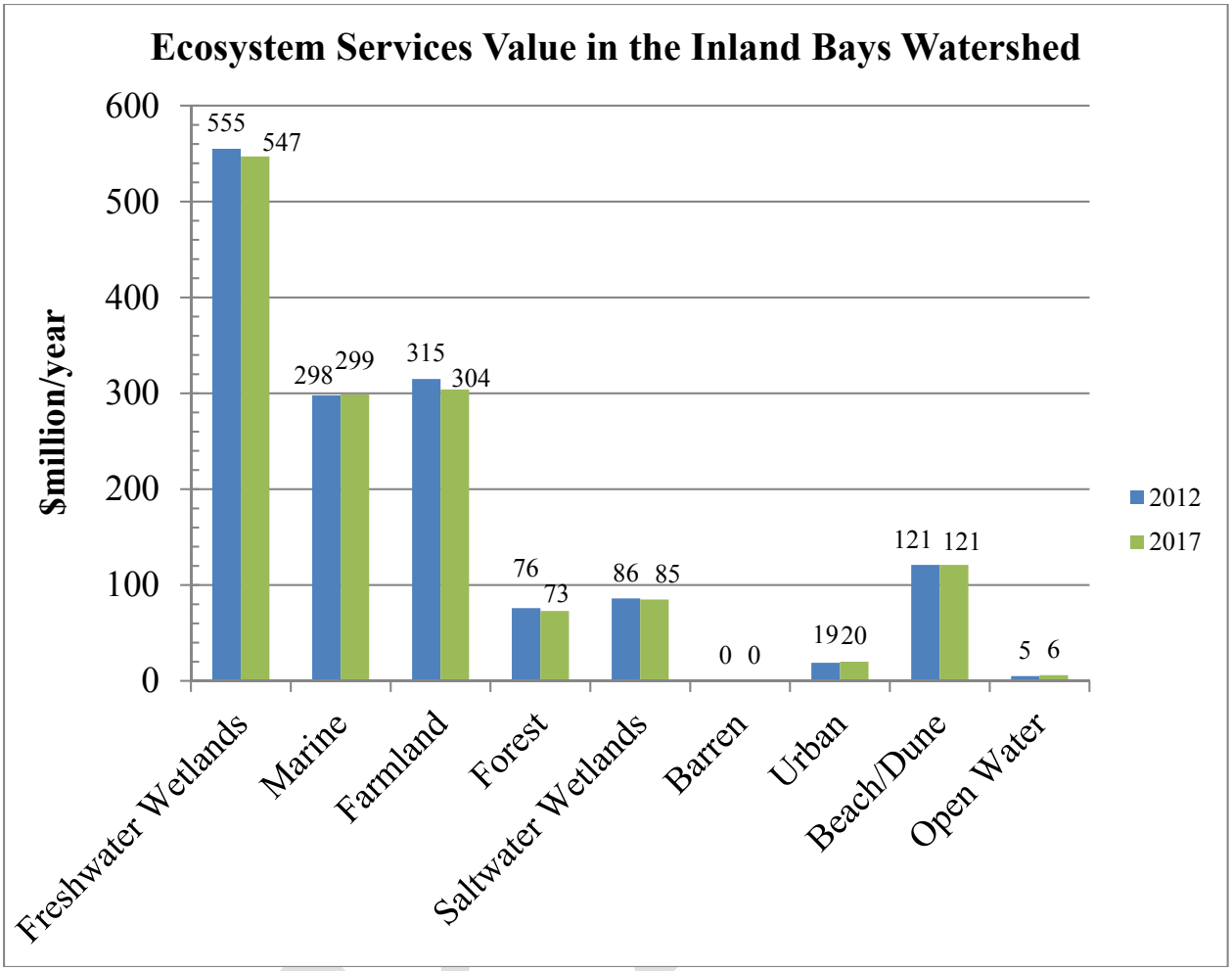


Figure 4.3. Ecosystem services value in the Inland Bays watershed, 2012-2017

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Appendix Table 1. NAICS-based Definition of Coast Industries: List of Industry Sectors Considered to Be Coast Industries by Either the BLS or the University of Massachusetts Study or Both

The North American Industry Classification System (NAICS) is the standard used by Federal statistical agencies in classifying business establishments for the purpose of collecting, analyzing, and publishing statistical data related to the U.S. business economy.

Green highlights categories that are only in BLS's definition; Blue highlights categories that are only in Massachusetts' definition; Yellow highlights categories that are shown in both BLS's and Massachusetts' definitions.

Sector and Industry_BLS Definition	Sector and Industry_Massachusetts Definition	NAICS Code	NAICS Industry(1997)
Construction			
Marine related Construction		237120	Oil and gas pieline and related structures
		237990	Other heavy and cicil engineering construction
Living reasources	**Commercial Seafood Industries**		
Fish hatcheries and aquaculture	Fishing Supplies and Services	112511	Finfish farming and fish hatcheries
		112512	Shellfish farming
		112519	Other Animal Aquculture
Fishing	Commercial Fishing	114111	Finfish fishing
		114112	Shellfish fishing
		114119	Other Marine Fishing
Seafood processing	Seafood processing and Wholesaling	311711	Seafood canning
		311712	Fresh and Frozen seafod processing
		424460	Fish and Seafood Merchant Wholesalers
	Retail and Food Sercice Seafood Sales	445220	Fish and Seafood Markets
		545390	Other Direct Selling Establishments (part)
Minerals			
Limeston, sand and gravel		212321	Construction sand and gravel mining
		212322	Industrial sand mining
Oil and gas exploration and pruduction		211111	Crude petroleum and natural gas extraction
		213111	Drilling oil and gas wells
		213112	Support activites for oil and gas operations
		541360	Geophysical exploration and mapping services
Ship and boat building	**Ship and Boat Building and Repair**		
		326199	All Other Plastics Product Manufacturing (part)
		326299	All Other Rubber Product Manufacturing (part)
		421860	Transportation Equipment and Supplies (except Motor Vehicle)Merchant Wholesalers (part)
Boat buliding and repair		336612	Boat building and repair
Ship bulding and repair		336611	Ship building and repair
Tourism and recreation	**Tourism and recreation**		
		423910	Sporting and Recreational Goods and Supplies Merchant Wholesalers
		451110	Sporting Goods Stores
		561510	Travel Agencies
		561520	Tour Operators
		561591	Convention and Visitors Bureaus
		561599	All Other Travel Arrangement and Reservation Services
		712110	Museums
		712120	Historical Sites
		721199	All Other Traveler Accommodation
		721214	Recreational and Vacation Camps (except Campgrounds)

NAICS-based Definition of Coastal-related Industry (cont.)

** Green color highlights categories that are only shown in BLS's definition; Blue color highlights categories that are only shown in Massachusetts' definition; Yellow color

		339920	Sporting and Athletic Goods Manufacturing
		487110	Scenic and Sightseeing Transportation, Land (part)
		487210	Scenic and Sightseeing Transportation, Water (part)
		611699	All Other Miscellaneous Schools and Instruction (part)
		711110	Theater Companies and Dinner Theaters (part)
		711190	Other Performing Arts Companies (part)
		711219	Other Spectator Sports (part)
		711320	Promoters of Performing Arts, Sports, and Similar Events without Facilities (part)
		713210	Casinos (except Casino Hotels)
		713290	Other Gambling Industries (part)
		713920	Skiing Facilities
		713940	Fitness and Recreational Sports Centers (part)
		721120	Casino Hotels
		721310	Rooming and Boarding Houses (part)
		722310	Food Service Contractors
		722320	Caterers
		722410	Drinking Places (Alcoholic Beverages)
Boat dealers		441222	Boat dealers

Appendix Table 1. NAICS-based Definition of Coast Industries: List of Industry Sectors Considered to Be Coast Industries by Either the BLS or the University of Massachusetts Study or Both

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Green highlights categories that are only in BLS's definition; Blue highlights categories that are only in Massachusetts' definition; Yellow highlights categories that are shown in both BLS's and Massachusetts' definitions.

Sector and Industry_BLS Definition	Sector and Industry_Massachusetts Definition	NAICS Code	NAICS Industry(1997)
Eating and drinking places		722110	Full service restaurants
		722211	Limited service eating places
		722212	Cafeterias
		722213	Snack and nonalcoholic beverage bars
Hotels and lodging places		721110	Hotels (except casino hotels) and motels
		721191	Bed and breakfast inns
Marinas		713930	Marinas
Recreational vehicles,parks, and campsites		721211	RV parks and recreational camps
Scenic water tours		487210	Scenic and sightseeing transportation, water
Sporting goods		339920	Sporting and athletic goods manufacturing
Amusement and recreation services		487990	Scenic and sightseeing transportation, other
		611620	Sports and recreation instruction
		532292	Recreation goods rental
		713990	Amusement and recreation services, not elsewhere classified
Zoos and aquaria		712130	Zoos and botanical gardens
		712190	Nature parks and other similar institutions
Transportation			
Deep sea freight		483111	Deep sea freight transportation
		483113	Coastal and Great Lakes freight transportation
Marine passenger transportation		483112	Deep sea passenger transportation
		483114	Coastal and Great Lakes passenger
		483211	Inland Water Freight Transportation
		483212	Inland Water Passenger Transportation
Marine transportation services		488310	Port and harbor operations
		488320	Marine cargo handling
		488330	Navigational services to shipping
		488390	Other support activities for water transportation
		532411	Commercial Air, Rail, and Water Transportation Equipment Rental and Leasing (part)
Search and navigation equipment		334511	Search, detection, navigation, guidance, aeronautical and nautical system, and instrument manufacturing
		493110	General warehousing and storage
		493120	Refrigerated warehousing and storage
		493130	Farm product warehousing and storage
	Marine Science, Technology and Education		
	Instrumentation and Equipment	334519	Other Measuring and Controlling Device Manufacturing (part)
	Electronic and Electrical Equipment, except computers	333618	Other Engine Equipment Manufacturing (part)
		334419	Other Electronic Component Manufacturing (part)
	Marine Services	541370	Surveying and Mapping (except Geophysical) Services (part)
		811213	Communication Equipment Repair and Maintenance (part)
		811219	Other Electronic and Precision Equipment Repair and Maintenance (part)
		813312	Environment, Conservation and Wildlife Organizations (part)
		541330	Engineering Services (part)
		54171	Research and Development in the Physical, Engineering, and Life Sciences (part)
	Marine Materials and Supplies		
	Marine Materials	325510	Paint and Coating Manufacturing (part)
	Industrial and Commercial Machinery	336399	All Other Motor Vehicle Parts Manufacturing (part)
		333120	Construction Machinery Manufacturing
		333923	Overhead Traveling Crane, Hoist, and Monorail System Manufacturing (part)
	Marine-Related Infrastructure		
		234990	All Other Heavy Construction (part)
		924110	Administration of Air and Water Resource and Solid Waste Management Programs (part)
	Coastal Real Estate Development	524128	Other Direct Insurance (except Life, Health, and Medical) Carriers (part)
		531210	Offices of Real Estate Agents and Brokers
		531311	Residential Property Managers
		531312	Nonresidential Property Managers
		531320	Offices of Real Estate Appraisers