

# **Economic Value of the Barnegat Bay Watershed**

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*Prepared for*

The Barnegat Bay Partnership  
Toms River, N.J.

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## Executive Summary

The water, natural resources, and ecosystems in the Barnegat Bay watershed contribute an economic value of \$2 to \$4 billion annually to the New Jersey economy. This report examines that economic value in three different ways:

- 1. Economic value directly related to the Barnegat Bay watershed water resources and habitats.** The Barnegat Bay watershed contributes over \$4 billion in annual economic activity from water quality, water supply, fish/wildlife, recreation, agriculture, forests, and public parks benefits.
- 2. Value of goods and services provided by Barnegat Bay watershed ecosystems.** Using natural capital as a measure of value, habitat in the Barnegat Bay watershed provide \$2.3 billion annually in ecosystem goods and services in 2010 dollars, with a net present value (NPV) of \$73.3 billion calculated over a 100-year period.
- 3. Employment related to Barnegat Bay watershed resources and habitats.** Using employment as a measure of value, natural resources within the Barnegat Bay watershed directly and indirectly supports over 60,000 jobs with over \$2 billion in annual wages.

The purpose of these estimates is to demonstrate that the Barnegat Bay watershed provides real and significant economic benefits to the Garden State 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 Barnegat Bay watershed using ecological economics and benefits-transfer techniques described in this report. Values are converted to 2010 dollars based on the change in the Northeast Region Consumer Price Index except where noted.

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

The estimates presented in this report are as inclusive as could be due to a lack of data for some economic sectors, nor are they meant to be used to compare and contrast uses of Barnegat Bay's water resources for their value. Some values were not included in these estimates because the data to assess them either are not readily available or do not exist. For example, the full amount of economic activity and jobs associated with the industries that rely on the Barnegat Bay watershed for their processes is not included here, because identifying those companies and gathering information on their economic activity is beyond the scope of this analysis.

## **1. Introduction**

In August 2011, Governor Chris Christie established the clean up of the Barnegat Bay as a matter of State-wide environmental and economic importance by signing several bills that authorized \$16 million in funding for a 10-Point Comprehensive Action Plan for the Barnegat Bay. The New Jersey Department of Environmental Protection is funding 25 Barnegat Bay watershed restoration projects in Ocean County, Barnegat Township, Berkeley Township, Howell, Jackson, Lacey Township, Manchester Township, Toms River, and Stafford Township.

The *State of the Bay Report 2011* issued by the Barnegat Bay Partnership (2011) used recent and ongoing research to assess the environmental conditions of the Barnegat Bay as part of the National Estuary Program. A majority of the environmental indicators examined in the report show that conditions in the bay are declining, and that the decline can be “largely attributed to increasing watershed development and associated increases in non-point source nitrogen loads.” The increase in nitrogen entering the bay contributes to “excessive production, also known as eutrophication, which is marked by nuisance algal blooms, low dissolved oxygen, and other adverse effects that stress the biota of the bay.” Many are concerned that the decline in conditions will negatively impact the multibillion dollar Barnegat Bay-based economy.

### **Objectives**

This report summarizes the economic value of water, natural resources, and ecosystems in the Barnegat Bay watershed in Ocean County and Monmouth County, New Jersey 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 Barnegat Bay watershed.

These estimates demonstrate that the Barnegat Bay 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 Barnegat Bay 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 the above estimates clearly indicates that the Barnegat Bay watershed is an economic engine that contributes between \$2 and \$4 billion annually to the New Jersey economy.

The estimates presented in this report can be considered in the low range because the data to assess economic value are not readily available in some categories. For example, the full amount

of economic activity and jobs associated with the companies and industries that rely on the bay watershed for their processes is not included here, because identifying those companies and gathering information on their economic activity is complicated and beyond the scope of this analysis. Since some estimates were made by taking values from existing literature, the values for various activities differ greatly in how they were determined and applied to the bay's water resources making it difficult to accurately compare values across uses.

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

## **An Economic Engine**

Clean water is the most valuable natural resource in the Barnegat Bay watershed situated on the outer Coastal Plain near Long Beach Island on the Atlantic Ocean in Ocean and Monmouth counties, New Jersey. The following report tabulates the substantial economic value of the Barnegat Bay watershed in Ocean County, New Jersey, the 2<sup>nd</sup> fastest growing county in the Garden State. Society tends to under price 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 Barnegat Bay watershed.

Previous studies indicate the Barnegat Bay and rivers, beaches, wetlands, and forests have long supported a multi-billion dollar coastal fishing, tourism, recreation, and hunting/fishing/birding economy. In 1995, tourists spent \$1.71 billion in Ocean County and accounted for 45,000 recreation jobs with \$631 million in wages (BBNEP 2002). Longwoods International (1988) found that tourists expended \$1.67 billion in Ocean County and accounted for 51,300 jobs with \$726 million in wages (Table 1). Approximately 45 miles or 1/3 of the Jersey Shore is in Ocean County where the tourism industry alone generates \$3.35 billion in revenue for the local economy (Ocean County Planning Board 2011).

**Table 1.** Tourism economy in Ocean County, New Jersey in 1988  
(Longwoods International 1988)

<b>Annual Activity</b>	<b>\$ million</b>	<b>Jobs</b>
Tourist Expenditure	1,670	
Restaurants	520	
Retail Sales	501	
Lodging	274	
Auto/Travel Expenses	240	
Recreation Expenses	132	
Jobs		51,300
Wages	726	
State Taxes Generated	220	
Local Taxes Generated	89	

New Jersey has 130 miles of Atlantic Ocean coastline that is the source of \$8 billion in coastal tourism expenditures and \$1 billion in commercial fishing and aquaculture revenue. The New Jersey Division of Travel and Tourism (2011) noted that Ocean County ranked 3rd highest in tourism expenditures after Atlantic and Cape May counties and had the largest increase in tourism sales among the four shore counties in 2011 with an 8.3% increase compared to Monmouth County (4.3%), Cape May County (4.5%), and Atlantic County (1.5%).

In 2011, Ocean County tourism fueled a \$4 billion annual economy with \$1.3 billion in lodging, \$0.9 billion in food/beverage, \$0.8 billion in retail, \$0.5 billion in recreation, and \$0.4 billion in transportation expenditures. The tourism industry generated \$3.35 billion to the Ocean County economy in 2010. Ocean County tourism contributed \$432 million in state and local taxes in 2011 with \$295 million from Ocean County property tax revenues. The Ocean County Board of Taxation (2012) reported the assessed value of property tax ratables is \$95.1 billion (Table 2).

**Table 2.** Ocean County assessed property tax valuation of ratables  
(Ocean County Board of Taxation 2012)

District	Ratables (\$ billion)	District	Ratables (\$ billion)
Barnegat	2.24	Long Beach	7.57
Barnegat Light	0.99	Manchester	3.96
Bay Head	1.59	Mantoloking	1.61
Beach Haven	1.67	Ocean	1.24
Beachwood	1.02	Ocean Gate	0.26
Berkeley	5.11	Pine Beach	0.30
Brick	10.61	Plumstead	1.05
Toms River	16.32	Pt. Pleasant	3.25
Eagleswood	0.24	Pt. Pleasant Beach	2.46
Harvey Cedars	1.23	Seaside Heights	0.84
Island Heights	0.35	Seaside Park	1.16
Jackson	6.70	Ship Bottom	1.12
Lacey	4.29	South Toms River	0.28
Lakehurst	0.19	Stafford	4.37
Lakewood	6.29	Surf City	1.54
Lavallette	1.88	Tuckerton	0.43
Little Egg Harbor	2.91	<b>Total</b>	<b>95.09</b>

## History

The Barnegat Bay has always been a plentiful and prosperous place ever since the indigenous people of the Barnegat Bay, the Lenni Lenape, subsisted on oysters, clams, mussels, fish and bird eggs, muskrat, deer, otter, and beaver. The aboriginal Americans picked cranberries, strawberries, and blueberries, and taught the early European settlers how to grow corn, potatoes, peanuts, tobacco, beans and squash.

One of the first Europeans to explore the coast was Englishman Henry Hudson who anchored the *Half Moon* off Barnegat Inlet in 1609 while searching for an inner passage to the Orient. Dutch



Captain Cornelius Mey's 1614 map marked places like *Barendegat* (Inlet of Breakers) and *Eyre Haven* (Harbor of Eggs or Egg Harbor). Pirates were said to have buried treasure near the bay and Spanish coins have been found on the Long Island beaches.

The early colonial coastal economy relied on beaver trapping, whaling, milling, and oystering. In the early 1700s, whaler Aaron Inman built a home near present-day Surf City on Long Beach Island. In 1704, Edward Andrews built a gristmill on a beaver pond. In 1719, a law was passed that prohibited oyster harvests from May 10 to September 1. In the 1760s, sawmills were operating along Ocean County creeks and Toms River was a growing port town where fish and lumber were shipped by schooner to New York and Philadelphia.

During the Revolutionary War, American privateers harassed the British Navy from the secluded coastal coves. Skirmishes were fought over the salt works on the bay. The British killed 40 American troops during a raid at the Batsto bog iron works in the Pine Barrens interior.

During the 19<sup>th</sup> century, timber from the inland forests fed the shipbuilding industry that later produced the Barnegat Bay sneak box, a small sailboat specially adapted for clamming and hunting in the shallow bay. Coastal storms often changed the seascape in the "Graveyard of the Atlantic" where over 30 ship wrecks occurred in 1830 and 350 people died in the wreck of the *Powhatan* off LBI in spring 1854. The U.S. Life Saving Service built houses of refuge for ship wreck survivors at 5-mile intervals along the beach. Island Beach Life Saving Station No. 14 was replaced in 1849. In 1835 a 40 feet high lighthouse was built at Barnegat Inlet and later replaced in 1858 with a 172 feet lighthouse. Cranberry bogs were dug in 1860s in the Pine Barrens swamps and the industry grew until the cranberry glut at the turn of the 20<sup>th</sup> century.

Today, Ocean County is one of the top 25 fastest growing counties in the nation (by population) with the largest concentration of retirement communities in the U.S. Tourism and health care are the two largest employers in the Barnegat Bay region.

## **The Watershed**

EPA designated Barnegat Bay as an Estuary of National Significance as part of the EPA National Estuary Program on July 10, 1995 (BBNEP 2002). The 670 mi<sup>2</sup> Barnegat Bay watershed is home to 576,000 year-round and 1.5 million summer residents in 33 towns in Ocean County and several municipalities in Monmouth and Burlington Counties, New Jersey. The Barnegat Bay watershed is flat to gently rolling with elevations that range from near 100 feet in the sandy Pine Barren forests in the interior to sea level with many streams flowing east into the bay (Figure 1).

The Barnegat Bay is a 96 mi<sup>2</sup> coastal lagoon covering the mouth of the bay itself (64.5 mi<sup>2</sup>), Little Egg Harbor (20.5 mi<sup>2</sup>), Great Bay (7.6 mi<sup>2</sup>), and Manahawkin Bay (3.6 mi<sup>2</sup>). Barnegat Bay is a shallow (3 to 23 feet deep), 43 mile long lagoon estuary with a surface area of 64 mi<sup>2</sup> and a volume of 6.4 billion gallons (BBNEP 2002). The Barnegat Bay recirculates ocean water every 3 months primarily through Barnegat Inlet. The overall condition of Barnegat Bay is fair based on ratings of water quality, sediment, benthics, and fish tissue contaminants (EPA 2007).

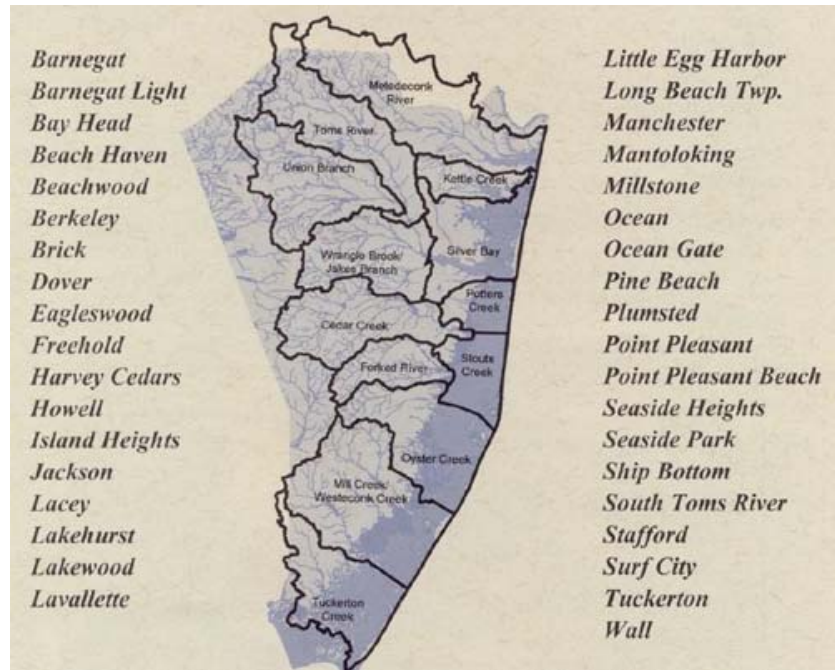


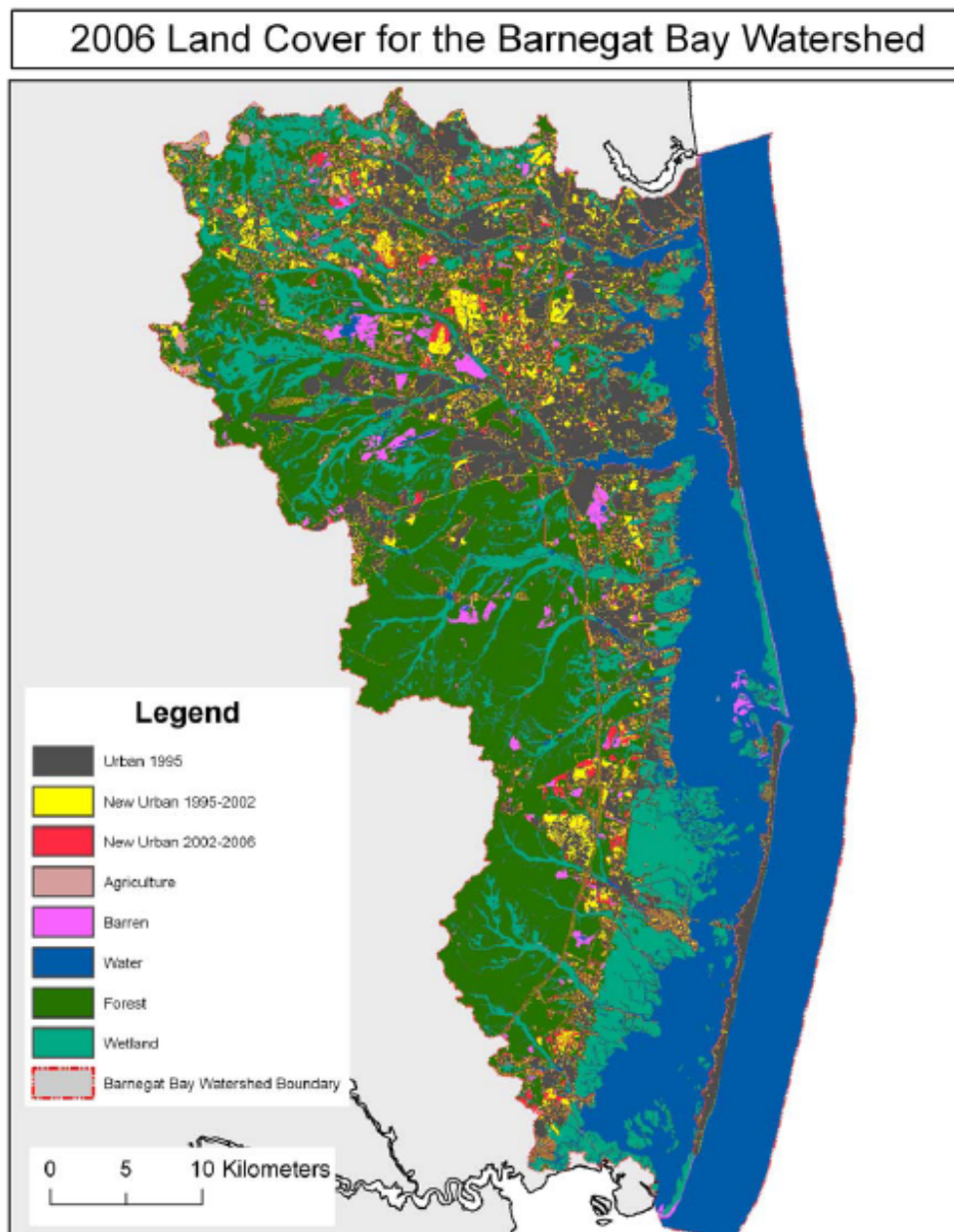
Figure 1. The Barnegat Bay watershed

## Land Use

About 1/4 of the Barnegat Bay watershed is covered by developed land. The watershed is covered by 36% forest, 22% urban, 21% wetlands, 18% water/bay, 2% barren, and 1% agricultural land uses (Figure 2). Between 2002 and 2007, the watershed lost 11 mi<sup>2</sup> of forest, 0.8 mi<sup>2</sup> of agriculture, and 0.8 mi<sup>2</sup> of wetlands and gained 12.2 mi<sup>2</sup> of urban land (Table 3).

Table 3. Land use in Ocean County, New Jersey in the Barnegat Bay watershed (NJDEP)

Land Use	2002 (mi <sup>2</sup> )	2007 (mi <sup>2</sup> )	Change (mi <sup>2</sup> )
Agriculture	9.9	9.1	-0.8
Barren	14.1	12.2	-1.9
Forest	286.5	275.5	-11.0
Urban	158.3	170.5	12.2
Water	131.8	134.1	2.3
Wetlands	157.3	156.5	-0.8
Total	757.9	757.9	0.0
	<b>2002 (%)</b>	<b>2007 (%)</b>	
Agriculture	1.3%	1.2%	
Barren	1.9%	1.6%	
Forest	37.8%	36.4%	
Urban	20.9%	22.5%	
Water	17.4%	17.7%	
Wetlands	20.8%	20.6%	
Total	100.0%	100.0%	



**Figure 2.** Land cover in the Barnegat Bay watershed in 2006 (NJDEP)

## Population

In 2010, the Barnegat Bay watershed population in Ocean County ranged from 576,567 during the winter to 1,500,000 during the summer tourist season (Ocean County Planning Board 2011). Between 2000 and 2010, the Ocean County population grew by 59,992 people (11.7%) from 513,686 to 576,567 (Table 4). Ocean County gained the most population of any county and is the 2<sup>nd</sup> fastest growing county in New Jersey after Gloucester County (Figure 3). Since 1930, the population grew 1,644% or 16 times the growth rate of New Jersey (115%) during the 80 years.

**Table 4.** Population of New Jersey counties  
(U.S Census Bureau 2010 and Ocean County Planning Board 2011)

County	2000	2010	Change 2000-2010	% Change 2000-2010
Atlantic	253,038	274,549	18,674	7.4%
Bergen	885,329	905,116	9,921	1.1%
Burlington	424,547	448,734	21,561	5.1%
Camden	507,648	513,657	10,231	2.0%
Cape May	102,307	97,265	-6,216	-6.1%
Cumberland	146,362	156,898	11,383	7.8%
Essex	792,302	783,969	-22,658	-2.9%
Gloucester	256,340	288,288	33,580	13.1%
Hudson	609,422	634,266	-11,498	-1.9%
Hunterdon	122,553	128,349	7,481	6.1%
Mercer	351,561	366,513	14,661	4.2%
Middlesex	752,705	809,858	38,033	5.1%
Monmouth	617,127	630,380	26,978	4.4%
Morris	471,338	492,276	17,180	3.6%
<b>Ocean</b>	<b>513,686</b>	<b>576,567</b>	<b>59,992</b>	<b>11.7%</b>
Passaic	490,803	501,226	975	0.2%
Salem	64,213	66,083	2,129	3.3%
Somerset	298,915	323,444	27,954	9.4%
Sussex	144,618	149,265	6,500	4.5%
Union	523,149	536,499	3,277	0.6%
Warren	102,958	108,692	6,680	6.5%
<b>New Jersey</b>	<b>8,430,921</b>	<b>8,791,894</b>		<b>3.3%</b>

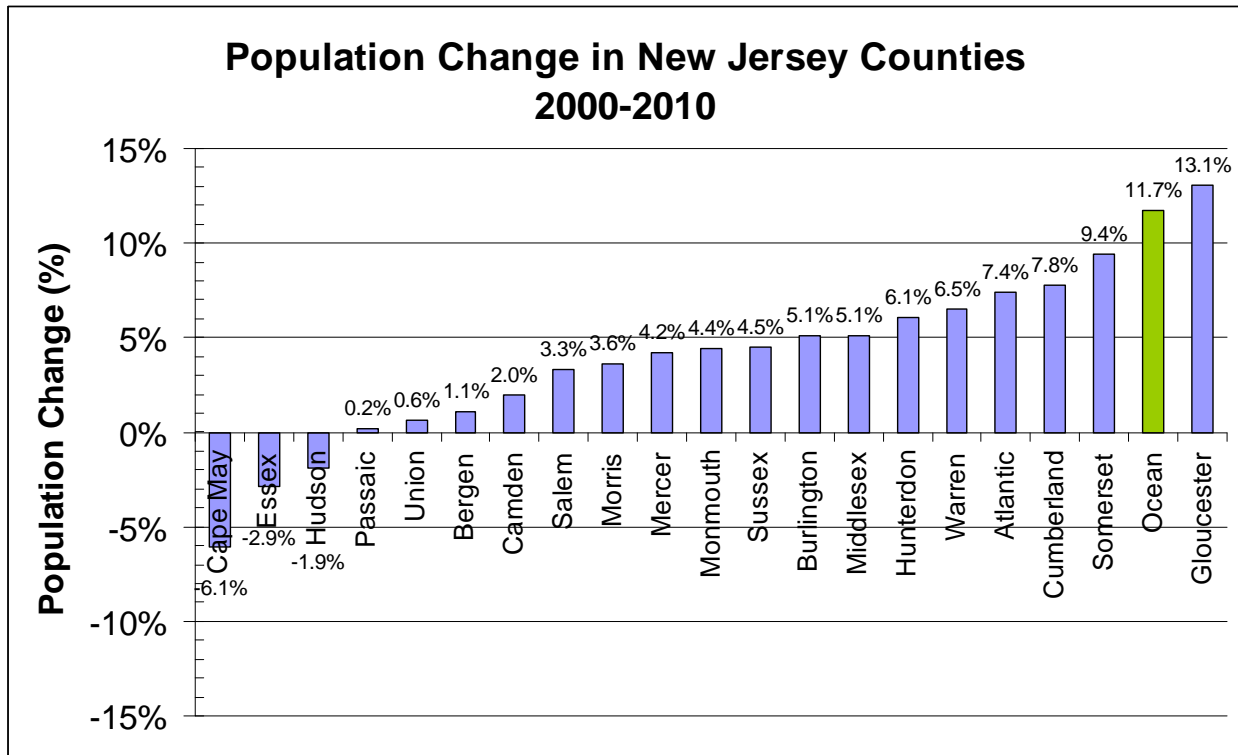
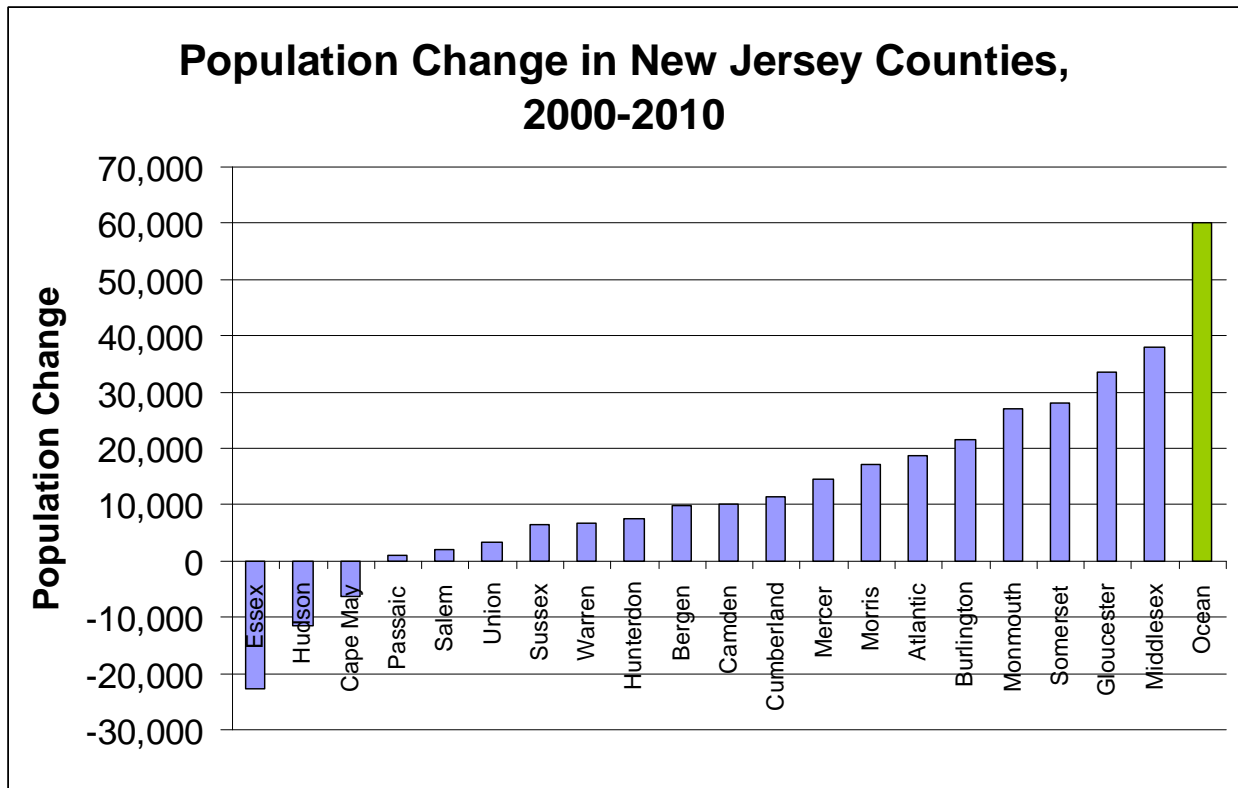


Figure 3. Population change in New Jersey counties, 2000-2010 (U.S Census Bureau 2010 and Ocean County Planning Board 2011)

## Employment

In 2010, the total employment in Ocean County was 236,590 (Table 5). Most jobs are provided by health care, government, and retail trades (Table 6).

**Table 5.** Employment by municipality in Ocean County, New Jersey in 2010  
(Ocean County Data Book)

Town	Employed	Town	Employed
Barnegat Township	7,314	Manchester Township	10,058
Barnegat Light Borough	348	Mantoloking Borough	163
Bay Head Borough	697	Ocean Township	3,436
Beach Haven Borough	592	Ocean Gate Borough	1,184
Beachwood Borough	6,118	Pine Beach Borough	1,138
Berkeley Township	11,411	Plumsted Township	4,353
Brick Township	37,073	Point Pleasant Borough	11,295
Eagleswood Township	801	Point Pleasant Beach Borough	2,879
Harvey Cedars Borough	163	Seaside Heights Borough	1,672
Island Heights Borough	940	Seaside Park Borough	1,254
Jackson Township	25,031	Ship Bottom Borough	755
Lacey Township	12,423	South Toms River Borough	1,892
Lakehurst Borough	1,277	Stafford Township	11,836
Lakewood Township	22,926	Surf City Borough	685
Lavallette Borough	1,207	Toms River Township	44,324
Little Egg Harbor Township	8,254	Tuckerton Borough	1,776
Long Beach Township	1,486	<b>Ocean County Total</b>	<b>236,690</b>

**Table 6.** Ocean County employment by industry, 2008  
(NJDLWD 2012)

Industry	Jobs (2008)	%
Health Care	30,850	18.0%
Government	28,300	16.5%
Retail Trade	27,000	15.7%
Accommodation/Food	13,150	7.7%
Other	13,300	7.7%
Construction	9,050	5.3%
Services	7,650	4.5%
Professional, Scientific, Technical	6,250	3.6%
Arts, Entertainment, Recreation	5,800	3.4%
Waste Management and Remediation	5,400	3.1%
Manufacturing	5,300	3.1%
Finance and Insurance	4,150	2.4%
Education	3,900	2.3%
Wholesale Trade	3,550	2.1%
Transportation and Warehousing	2,600	1.5%
Real Estate and Rental	2,450	1.4%
Information	1,450	0.8%
Utilities	1,150	0.7%
Companies and Enterprise	300	0.2%
Mining	100	0.1%
<b>Total Nonfarm Employment</b>	<b>171,700</b>	<b>100.0%</b>

## 2. Methods

### Valuation Techniques

The University of Delaware derived the economic value of the Barnegat Bay 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 Barnegat Bay watershed according to the following scope of work.

**1. Area of Interest:** The area of interest is defined as the Barnegat Bay watershed in Ocean County and Monmouth County including the bay and coastal barrier islands in New Jersey. 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 Barnegat Bay including databases from the U.S. Census Bureau, U.S. Bureau of Labor Statistics, U.S. Department of Agriculture, U.S. Forest Service, and U.S. Fish and Wildlife 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. Values are converted to 2010 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 Barnegat Bay 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 Barnegat Bay 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.

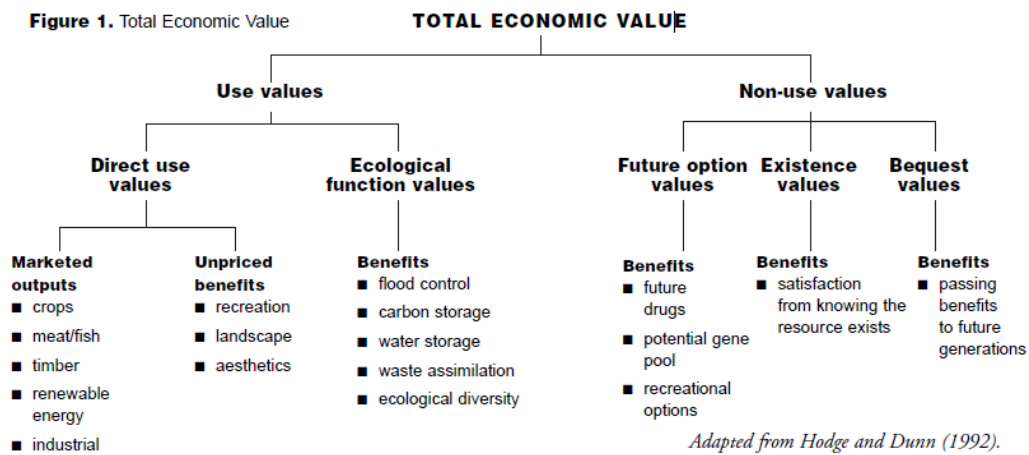
**5. Jobs and wages:** Obtain employment and wage data from the U.S. Department of Labor, U.S. Census Bureau, National Ocean Economics Program, and other sources. Estimate direct/indirect jobs by North American Industry Classification System (NAICS) codes such as shipbuilding, marine transportation/ports, 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 Barnegat Bay watershed, (2) ecosystem goods and services (natural capital), and (3) jobs and wages directly and indirectly related to the bay and watershed in 2010 dollars.



### 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 Barnegat Bay watershed from water quality, water supply, fish/wildlife, recreation, agriculture, forests and public parks benefits exceeds \$4 billion (Figure 5 and Table 7).

Water Quality	\$245 million
Water Supply	\$59 million
Fish/Wildlife	\$189 million
Recreation	\$1,527 million
Agriculture	\$12 million
Forests	\$208 million
Public Parks	\$1,770 million
<b>Total</b>	<b>&gt; \$4 billion</b>

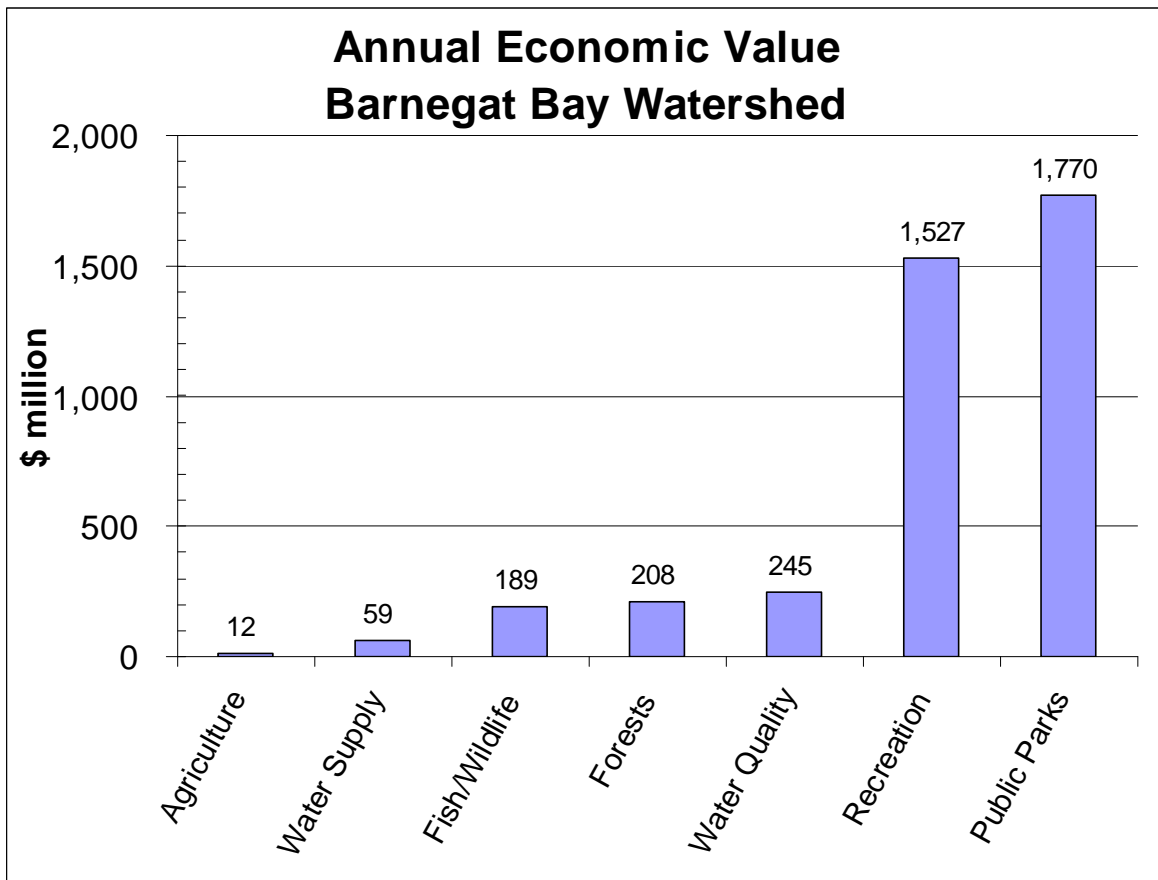


Figure 5. Annual economic value of the Barnegat Bay watershed

**Table 7.** Annual economic value of the Barnegat Bay watershed

Activity	2010 (\$ million)	Source
<b>Water Quality</b>		
Boatable (WTP = 13.20/person)	20	University of Delaware (2003)
Fishable (WTP = 13.22/person)	20	University of Delaware (2003)
Swimmable (WTP = \$112.75/person)	170	University of Delaware (2003)
Increased Property Value (+8% over 20 years)	33	EPA (1973), Brookings Institute (2010)
Water Treatment by Forests (\$75/mgd)	2	Trust for Public Land and AWWA (2004)
Wastewater Treatment	0	Ocean County (2010)
<b>Water Supply</b>		
Drinking Water Supply (\$1.168/1,000 gallons)	23	USGS (2005), NJWSA (2012)
Irrigation Water Supply (\$300/acre-foot)	1	Resources for Future (1996), USGS (2005)
Thermoelectric-Power Water Supply (\$44 acre-	34	USGS (2005)
Industrial Water Supply (\$200/acre-foot)	1	Resources for Future (1996), USGS (2005)
<b>Fish/Wildlife</b>		
National 7 Refuge	4	Carver and Caudill (2007)
Commercial Fish Landings (\$0.60/lb)	49	NMFS, Nat'l Ocean Econ. Program (2009)
Hard Clams (\$5.50/lb)	0.1	NMFS
Blue Crab (\$1.10/lb)	1	NMFS
Summer Flounder (\$10.26/trip, 2.5 million trips)	25	Liggett in Bricker et al. (2007)
Fishing (11-18 trips/angler, \$17-\$53/trip)	58	U.S. Fish and Wildlife Service (2007)
Hunting (16 trips/hunter, \$16-50/trip)	11	U.S. Fish and Wildlife Service (2007)
Wildlife/Bird-watching (8-13 trips/yr, \$15-	41	U.S. Fish and Wildlife Service (2007)
<b>Recreation</b>		
Swimming (\$13.40/trip)	33	URI (2002), Leeworthy and Wiley (2001)
Boating (\$30.00/trip)	28	URI (2002), Leeworthy and Wiley (2001)
Fishing (\$62.79/trip)	60	URI (2002), Leeworthy and Wiley (2001)
Wildlife/Bird Watching (\$77.73/trip)	138	URI (2002), Leeworthy and Wiley (2001)
Power-Boating (22,505 registered boaters)	590	Marine Trades Assn. of New Jersey (2008)
Outdoor Recreation (228,000 participants)	256	Outdoor Industry Foundation (2006)
Beach Visits (\$27.66/visitor day, 45 mi coast)	395	Seneca (2011), Parsons et al. 1999, others
State Parks (\$21/visit, 32,601 acres)	27	Mates and Reyes (2006), NJDEP
<b>Agriculture</b>		
Nursery, crop, poultry, livestock value	12	USDA Census of Agriculture 2007 (2009)
<b>Forests</b>		
Carbon Storage (\$827/ac)	145	U.S. Forest Service (2008)
Carbon Sequestration (\$29/ac)	5	U.S. Forest Service (2008)
Air-Pollution Removal (\$266/ac)	47	U.S. Forest Service (2008)
Building Energy Savings (\$56/ac)	10	U.S. Forest Service (2008)
Avoided Carbon Emissions (\$3/ac)	1	U.S. Forest Service (2008)
<b>Public Parks</b>		
Health Benefits (\$9,734/ac)	1,313	Trust for Public Land (2009)
Community Cohesion (\$2,383/ac)	321	Trust for Public Land (2009)
Stormwater Benefit (\$921/ac)	124	Trust for Public Land (2009)
Air-Pollution Control (\$88/acr)	12	Trust for Public Land (2009)
<b>Barnegat Bay Watershed</b>	<b>&gt;4 billion</b>	

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

## Water Quality

### Improved Water Quality

Helm, Parsons, and Bondelid (2003) measured the economic benefits of water-quality improvements to recreational users in the New England states of Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, and Connecticut 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 use support in 1994 dollars. Adjusting to 2010 dollars based on the change in the Consumer Price Index (CPI) in the Northeast Region as reported by the Bureau of Labor Statistics, per person WTP is estimated at \$13.20 for boating, \$13.22 for fishing, and \$112.75 for swimming uses (Table 8).

**Table 8.** Annual willingness to pay for water quality benefits in New England

WQ Use Support	WTP per person <sup>1</sup> (\$1994)	WTP per person <sup>2</sup> (\$2010)
Boatable	\$8.25	\$13.20
Fishable	\$8.26	\$13.22
Swimmable	\$70.47	\$112.75
<b>Total</b>	<b>\$86.98</b>	<b>\$139.17</b>

1. Helm, Parsons, and Bondelid (2003).
2. Adjusted to 2010 based on change in Northeast Region CPI (BLS).

In 2010, the Barnegat Bay watershed population in Ocean County ranged from 576,567 year-round to 1,500,000 during the summer tourist season (Ocean County Planning Board 2011). Based on value transfer data from the study in six New England states, WTP for improved water quality in the Barnegat Bay watershed ranges from low value of \$80 million for year round population to high value of \$209 million for the summer population (Table 9 and Figure 6).

**Table 9.** Annual willingness to pay for water quality benefits in the Barnegat Bay watershed

WQ Use Support	Year-round Population	Summer Population	WTP per person <sup>1</sup> (\$2010)	Low Value WTP (\$2010)	High Value WTP (\$2010)
Boatable	576,567	1,500,000	\$13.20	7,610,684	19,800,000
Fishable	576,567	1,500,000	\$13.22	7,622,216	19,830,000
Swimmable	576,567	1,500,000	\$112.75	65,007,929	169,125,000
<b>Total</b>	<b>576,567</b>	<b>1,500,000</b>	<b>\$139.17</b>	<b>\$80,240,829</b>	<b>\$208,755,000</b>

1. Helm, Parsons, and Bondelid (2003) and adjusted to \$2010 based on change in Northeast Region CPI.

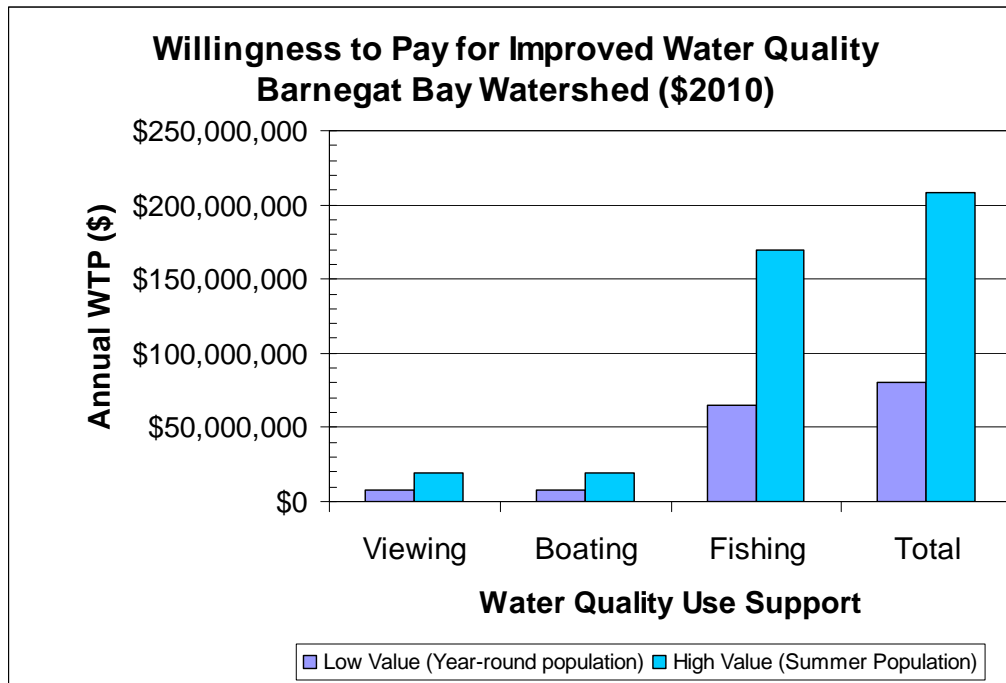


Figure 6. Willingness to pay for improved water quality in the Barnegat Bay watershed

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

**Table 10.** Increased property value resulting from improved water quality

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

With improved water quality, property values within 2,000 feet of the Barnegat Bay 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 Barnegat Bay is bounded by 119 miles shoreline. If the median household property value in Ocean County is \$283,100 per acre, then properties within 2,000 feet of the bay have an estimated value of \$8.2 billion. Property values within 2,000 feet of the water would increase by 8% or \$653 million due to improved water quality (Table 11). Since increased property value is a one-time benefit, the annual value over a 20-year period is estimated at \$33 million.

**Table 11.** Added property value due to improved water quality in Barnegat Bay watershed

Bay Shore (mi)	Bay Shore (ft)	Area within 2000 ft of Bay (ac)	Property Value @ \$283,100/ac	Increased Value @ 8%	Annual Value 20 years
119	628,320	28,848	\$8,166,868,800	\$653,349,504	\$32,667,475

**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 12). If the public drinking water supply is 54.5 mgd and forests cover 176,320 acres (275 mi<sup>2</sup> or 36%) of the Barnegat Bay watershed, then loss of these forests would increase drinking water treatment costs by \$75 per mgd (\$139/mgd @ 0% forested minus \$64/mgd @ 36% forested) or \$4,088/day or \$1.5 million/year.

**Table 12.** 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 in Ocean County have a total capacity of just over 80 million gallons per day (mgd) and include 40 pumping stations, 200 miles of force main and gravity lines, and three ocean outfall lines (Ocean County Planning Board 2011). There are no wastewater discharges directly to the Barnegat Bay watershed. The three WWTP’s discharge about 52 mgd to the Atlantic Ocean (Figure 7) and include the Northern WPCP at Brick Township (22.7 mgd), Central WPCF (20.4 mgd), and Southern WPCF (7.1 mgd). The Barnegat Bay is not called upon to provide wastewater assimilation services.

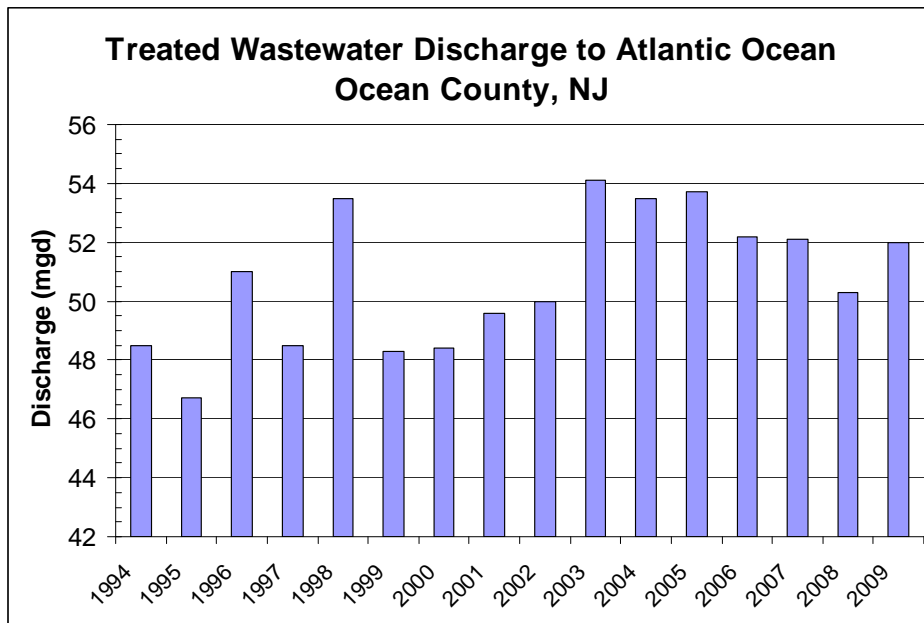


Figure 7. Ocean County wastewater discharges to the Atlantic Ocean (NJDEP)

## Water Supply

### Drinking Water Supply

The U.S. Geological Survey (2005) reported that Ocean County surface and groundwater withdrawals totaled 77.2 mgd including 54.5 mgd for public water supply, 8.0 mgd for domestic wells, 7.5 mgd for mining, 4.2 mgd for irrigation, and 3.1 mgd for industrial uses (Figure 8). 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 this rate, the value of untreated public water supplies in the Barnegat Bay watershed (54.5 mgd) is \$63,656 per day or \$23.2 million per year.

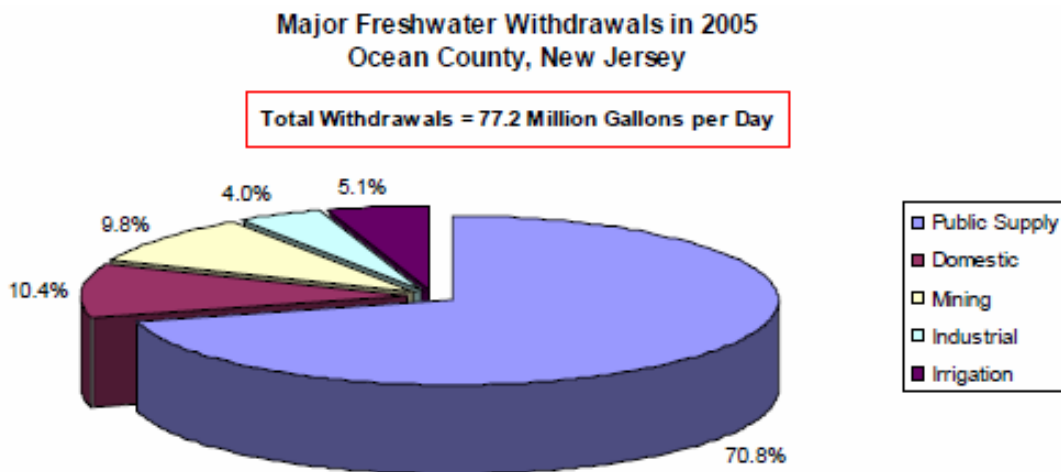


Figure 8 Major freshwater withdrawals in Ocean County, New Jersey in 2005 (USGS)

### 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 \$300/ac-ft (\$0.92/1,000 gal) in 2010 dollars, adjusting for change in the CPI (Table 13). In 2007, 4,423 acres of cropland (1% of the Barnegat Bay watershed) were cultivated and 1,090 acres were irrigated in Ocean County (USDA 2009). Annual irrigation-water needs from June through September are 9 inches for corn, soybeans, and grain (2,600 gpd/ac for 1,090 irrigated acres or 2.4 mgd). In the Barnegat Bay watershed, the annual value of water needed to irrigate 9 inches of water over 1,090 acres at a use value of \$300/ac-ft is \$245,250/yr.

**Table 13.** Freshwater-use values in the United States

Use	1996 Median <sup>1</sup> (\$/acre-ft.)	2010 Median <sup>2</sup> (\$/acre-ft.)	2010 Median (\$/1,000 gal)
Navigation	10	15	0.02
Irrigation	198	300	0.92
Industrial Process	132	200	0.61
Thermoelectric Power	29	44	0.14

1. Frederick et al. 1996. 2. Adjusted to \$2010 based on change in Northeast Region CPI (BLS).

In 2005, the USGS estimated irrigation water withdrawals totaled 4.2 mgd in Ocean County. The median market value of irrigation-water withdrawals is \$198/ac-ft in 1996 dollars (Frederick et al. 1996) or \$300/ac-ft (\$0.92/1,000 gal) in 2010 dollars based on the change in CPI. Therefore, the total annual value of water demand to irrigate cropland in Ocean County is \$1,410,360 (Table 14).

**Table 14.** Value of agriculture irrigation in the Barnegat Bay watershed

Irrigation <sup>1</sup> (mgd)	Value <sup>2</sup> (\$/day)	Value <sup>2</sup> (\$/year)
4.2 mgd	\$3,864	\$1,410,360

1. USGS 2005. 2. From Frederick et al. (1996) at \$0.92/1,000 gal.

Using data from the USDA and USGS, the annual value of water used to irrigate cropland in the Barnegat Bay watershed ranges from \$245,250 to \$1.4 million.

### Thermoelectric-Power Water Supply

Thermoelectric power plants evaporate water during cooling and produce more than 89% of the energy in the United States. About 95% of the cooling water returns to the waterway (non-consumptive use) and 5% evaporates (consumptive use). Oyster Creek Nuclear Generating Station, opposite Barnegat Inlet, started generating energy in 1969 and withdraws up to 662 mgd of non-contact cooling water from Oyster Creek and the Forked River in the Barnegat Bay watershed.



The median economic value of thermoelectric-power water withdrawals in 1996 dollars is \$29/ac-ft. (\$0.09/1,000 gal) with a range of \$9 to \$63/ac-ft. (Frederick et al. 1996). Adjusting to 2010 dollars based on the change in CPI, the median value of thermoelectric-plant water withdrawals is \$44/ac-ft or \$0.14/1,000 gallons. The value of the Oyster Creek power plant water withdrawal (662 mgd) in the Barnegat Bay watershed is \$92,680 per day or \$33.8 million per year.

Note that Governor Chris Christie's agreement with Exelon pledges to close the Oyster Creek Nuclear Generating Station water withdrawal and cooling system by December 31, 2019.

### Industrial Water Supply

In 2005, the USGS estimated that industrial-water withdrawals totaled 3.1 mgd in Ocean County in the Barnegat Bay watershed. The median market value of industrial withdrawals is \$132/ac-ft in 1996 dollars (Frederick et al. 1996) or \$200/ac-ft. (\$0.61/1,000 gal) in 2010 dollars based on the change in CPI. The value of industrial-water withdrawals (3.1 mgd) in the Barnegat Bay watershed is \$1,891 per day or \$690,215 per year.

## Fish/Wildlife

### National Wildlife Refuge

Carver and Caudill (2007) from the U.S. Fish and Wildlife Service estimated that the 47,000 acre Edwin B. Forsythe National Wildlife Refuge was the 15th most visited refuge in the nation with nearly 196,000 recreational visits in 2006 and contributions of \$2.8 million to the local economy (Table 15). The monetary value from recreational visitor spending was \$4.4 million which contributed to 41 jobs with \$1.5 million in annual wages.

**Table 15.** Contributions to local economy from Forsythe National Wildlife Refuge (Carver and Caudill 2007)

Activity	Visitors	Expenditures (\$)	Monetary (\$)	Jobs	Wages (\$)
Birding, Hiking, Beach	166,000	\$1,774,800			
Hunting	2,721	\$37,200			
Fishing	27,100	\$997,900			
<b>Total</b>	<b>195,821</b>	<b>\$2,809,900</b>	<b>\$4,400,000</b>	<b>41</b>	<b>\$1,500,000</b>

### Commercial Fish Landings

Using data from the National Marine Fisheries Service (NMFS), the National Ocean Economics Program (2010) reported the Long Beach-Barnegat and Point Pleasant, New Jersey ports are the 32<sup>nd</sup> and 36<sup>th</sup> most valuable commercial fishing ports in the United States with \$25.8 million and \$22.8 million in annual fish landings, respectively (Table 16 and Figure 9). Taken together, the combined ports in the Barnegat Bay would be the 16<sup>th</sup> most valuable commercial fishing port in the United States with \$48.6 million in annual fish landings.

**Table 16.** Top commercial fishing ports in the United States in 2010 (NOEP 2010)

Rank	Port	Weight (lb)	Port	Landed Value
1	Dutch Harbor-Unalaska, AK	515,000,000	New Bedford, MA	\$306,000,000
2	Reedville, VA	426,000,000	Dutch Harbor-Unalaska, AK	\$163,100,000
3	Kodiak, AK	325,000,000	Kodiak, AK	\$128,100,000
4	Akutan, AK	302,000,000	Naknek-King Salmon, AK	\$100,900,000
5	Empire-Venice, LA	267,000,000	Cordova, AK	\$84,300,000
6	Intracoastal City, LA	260,000,000	Akutan, AK	\$84,100,000
7	Los Angeles, CA	186,000,000	Cape May-Wildwood, NJ	\$81,000,000
8	Cameron, LA	150,000,000	Hampton Roads Area, VA	\$75,400,000
9	Cordova, AK	147,000,000	Honolulu, HI	\$71,600,000
10	New Bedford, MA	133,000,000	Seward, AK	\$69,200,000
11	Port Hueneme-Oxnard-Ventura, CA	131,000,000	Sitka, AK	\$62,200,000
12	Naknek-King Salmon, AK	124,000,000	Gloucester, MA	\$56,600,000
13	Pascagoula-Moss Point, MS	105,000,000	Homer, AK	\$56,100,000
14	Astoria, OR	100,000,000	Empire-Venice, LA	\$53,700,000
15	Westport, WA	100,000,000	Brownsville-Port Isabel, TX	\$52,500,000
16	Gloucester, MA	88,000,000	Port Arthur, TX	\$47,400,000
17	Ketchikan, AK	75,000,000	Stonington, ME	\$45,300,000
18	Seward, AK	75,000,000	Dulac-Chauvin, LA	\$45,100,000
19	Sitka, AK	74,000,000	Ketchikan, AK	\$41,300,000
20	Newport, OR	57,000,000	Westport, WA	\$38,500,000
21	Petersburg, AK	49,000,000	Los Angeles, CA	\$37,800,000
22	Cape May-Wildwood, NJ	43,000,000	Port Hueneme-Oxnard-Ventura, CA	\$37,400,000
23	Portland, ME	38,000,000	Petersburg, AK	\$36,300,000
24	Moss Landing, CA	38,000,000	Reedville, VA	\$34,200,000
25	Point Judith, RI	35,000,000	Point Judith, RI	\$32,200,000
26	Dulac-Chauvin, LA	32,000,000	Palacios, TX	\$31,900,000
27	Coos Bay-Charleston, OR	31,000,000	Newport, OR	\$30,600,000
28	Wanchese-Stumpy Point, NC	25,000,000	Astoria, OR	\$30,500,000
29	Atlantic City, NJ	24,000,000	Galveston, TX	\$28,000,000
30	Honolulu, HI	23,000,000	Bellingham, WA	\$26,900,000
31	Ilwaco-Chinook, WA	23,000,000	Intracoastal City, LA	\$26,400,000
32	Brownsville-Port Isabel, TX	22,000,000	<b>Long Beach-Barnegat, NJ</b>	<b>\$25,800,000</b>
33	Rockland, ME	22,000,000	Kenai, AK	\$25,100,000
34	Kenai, AK	21,000,000	Coos Bay-Charleston, OR	\$24,000,000
35	<b>Point Pleasant, NJ</b>	<b>20,000,000</b>	Juneau, AK	\$23,800,000
36	Port Arthur, TX	19,000,000	<b>Point Pleasant, NJ</b>	<b>\$22,800,000</b>
37	Homer, AK	19,000,000	Bon Secour-Gulf Shores, AL	\$22,500,000
38	Bellingham, WA	18,000,000	Seattle, WA	\$22,100,000
39	Monterey, CA	17,000,000	Wanchese-Stumpy Point, NC	\$22,000,000
40	Stonington, ME	17,000,000	Golden Meadow-Leeville, LA	\$21,900,000
41	Juneau, AK	16,000,000	Lafitte-Barataria, LA	\$20,400,000
42	Ocean City, MD	16,000,000	Provincetown-Chatham, MA	\$19,900,000
43	Hampton Roads Area, VA	16,000,000	Portland, ME	\$18,800,000
44	Provincetown-Chatham, MA	15,000,000	Stonington, CT	\$18,500,000
45	Lafitte-Barataria, LA	14,000,000	Ilwaco-Chinook, WA	\$17,900,000
46	Golden Meadow-Leeville, LA	14,000,000	Montauk, NY	\$17,700,000
47	Galveston, TX	13,000,000	Shelton, WA	\$17,600,000
48	Crescent City, CA	13,000,000	Atlantic City, NJ	\$17,300,000
49	Palacios, TX	13,000,000	Olympia, WA	\$16,200,000
50	Montauk, NY	12,000,000	San Francisco Area, CA	\$15,100,000
51	Boston, MA	12,000,000	Boston, MA	\$15,100,000
52	Bon Secour-Gulf Shores, AL	11,000,000	Yakutat, AK	\$14,900,000
53	Eureka, CA	10,000,000	Anacortes-La Conner, WA	\$13,600,000
54	Engelhard-Swanquarter, NC	9,000,000	Gulfport-Biloxi, MS	\$13,000,000
55	<b>Long Beach-Barnegat, NJ</b>	<b>8,000,000</b>	Delacroix-Yscloskey, LA	\$11,700,000
56	San Francisco Area, CA	8,000,000	Cameron, LA	\$11,500,000
57	Shelton, WA	7,000,000	Crescent City, CA	\$10,600,000

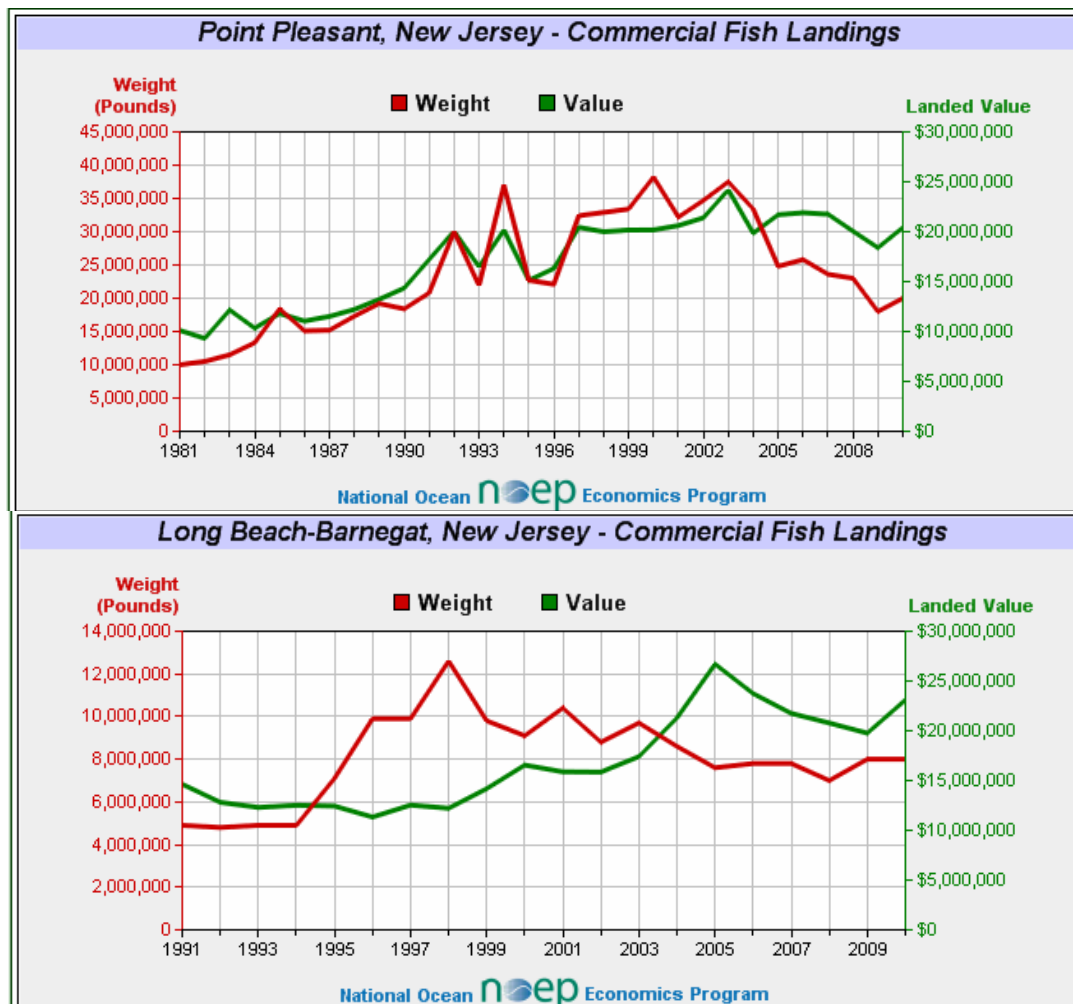
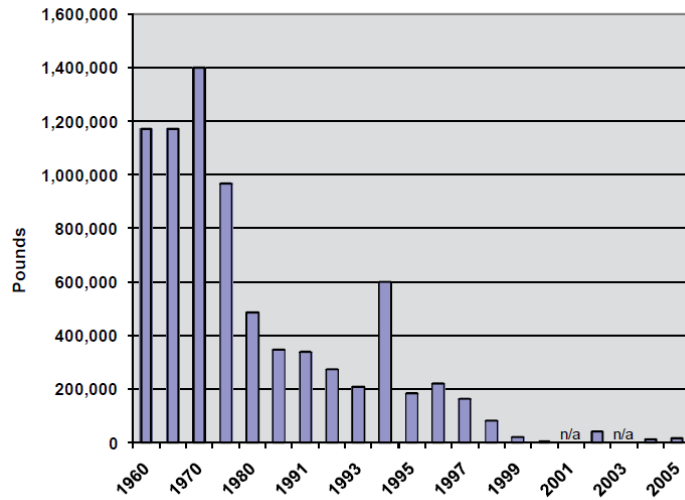


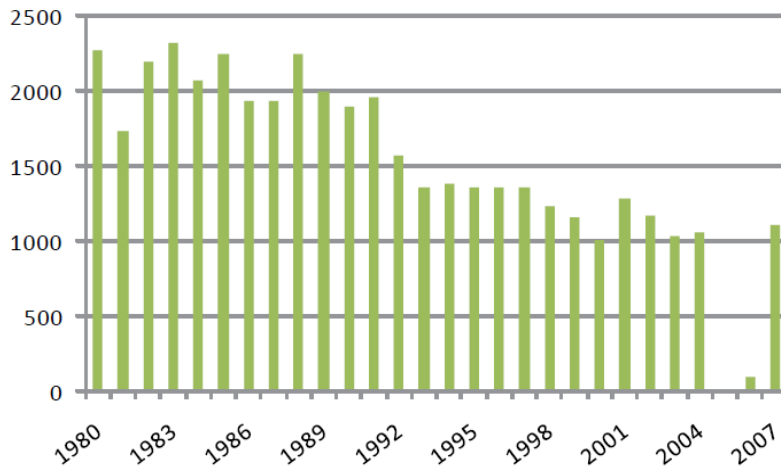
Figure 9. Commercial fish landings at Barnegat Bay ports (NOEP 2010)

### Hard Clams

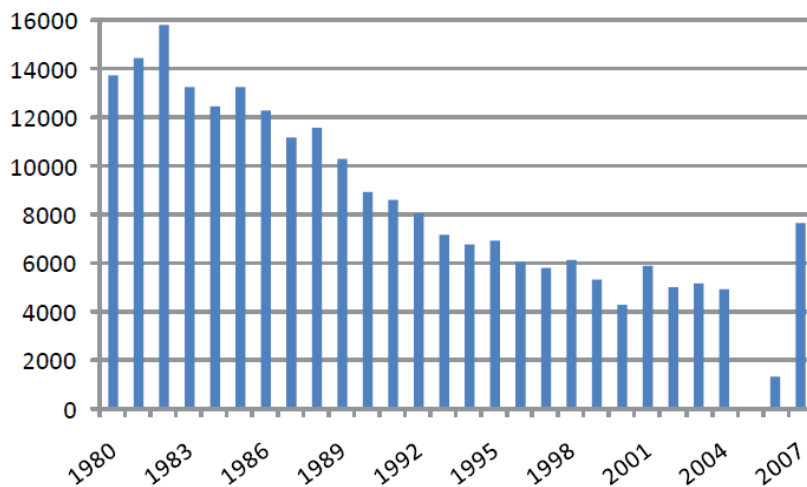
The northern quahog or hard clam is a valuable but declining fishery in the Barnegat Bay. Hard clams are most abundant in the open water of the southern Barnegat Bay and Little Egg Harbor. MacKenzie (2003) from the NOAA National Marine Fisheries Service reported in 1879 that Barnegat Bay produced 150,000 bushels of quahogs and in the 1970s the yield was 100,000 bushels. Since then, quahog landings in Barnegat Bay have fallen to 600 bushels. In 1988, hard clam landings contributed \$2.2 million or 80% of the commercial fishery in Ocean County. NMFS data indicates hard clam landings dropped from 1.2 million lb in 1970 to 350,000 lb by 1990 to 15,000 lb in 2005 (Figure 10). The decline in commercial and residential hard clam landings correspond to deceased statewide clamming licenses (Figure 11 and 12). In 2005 at \$5.50/lb, hard clam landings (15,000 lb) had an estimated value of \$82,500.



**Figure 10.** Hard clam landings in Ocean County, New Jersey (NMFS)



**Figure 4.** Commercial hard clam licenses in New Jersey (NJDEP Bureau of Shellfisheries)



**Figure 12.** Residential hard clam licenses sales in New Jersey (NJDEP Bureau of Shellfisheries)

### Blue Crabs

Over a century ago, more crabbing occurred in the Barnegat Bay than in any area along the East Coast. Blue crab landings in the Barnegat Bay dropped from 1,394,230 lb in 1993 to 782,369 lb in 1997 which amounted to 23% of total New Jersey blue crab landings. The NMFS reports that in 2007 (NOEP 2010), 4.8 million lb of blue crabs were harvested in New Jersey with a landed value of \$5.5 million adjusted to 2005 dollars (Figure 13). If blue crab landings in the Barnegat Bay now total about 15% of New Jersey’s total commercial catch, the estimated value of the bay’s blue crab fishery is \$825,000.

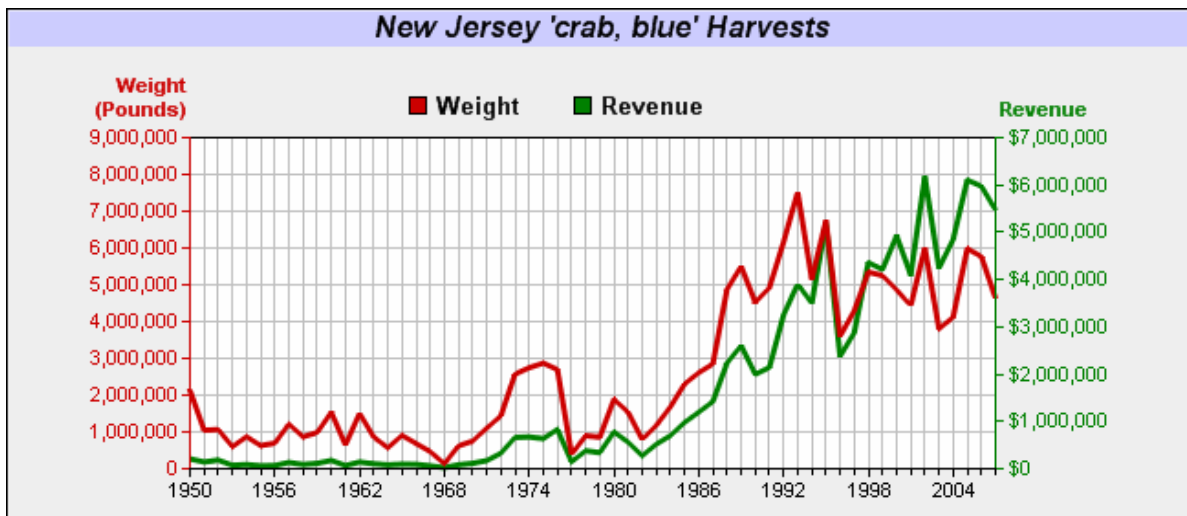
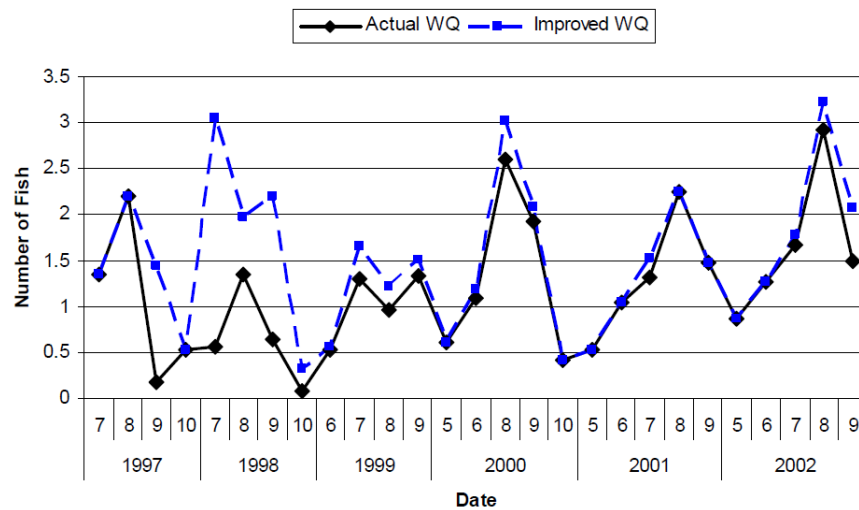


Figure 13. New Jersey blue crab landings (NOEP 2010)

### Summer Flounder

The most popular recreational fishing species in the Barnegat Bay is the summer flounder which accounts for 42% of fishing trips to the bay compared to striped bass (19% of trips) and bluefish (7.5% of trips). Ligget in Bricker et al. (2007) used a statistical model to predict summer flounder catches (Figure 14) that would occur improved water quality and as compared to existing water pollution. Lipton (2006) from the University of Maryland estimated the value of recreational fishing for summer flounder in the Barnegat Bay. A study of the value of mid-Atlantic recreational fisheries estimated a \$10.26 benefit due to increased catch per trip (McConnell and Strand 1994). Summer flounder accounts for 2.5 million trips or 42% of 5.9 million inland fishing trips in the Barnegat Bay. Therefore, the estimated benefit to summer flounder fishers from improved in water quality in Barnegat Bay is \$25.4 million/year.



**Figure 14.** Summer flounder catch with improved water quality in Barnegat Bay (Liggett in Bricker et al. 2007).

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

The Barnegat Bay watershed has significant forest, wetlands, and marine habitat that draw fishing, hunting, and bird/wildlife watching to the region. Waterfowl include mallard, American black duck, blue-winged teal, and Canada goose. The Barnegat Bay 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. Many birds of prey such as golden eagles, bald eagles, and hawks fly through the bay during the fall migration. Land birds documented at the Forsythe National Wildlife Refuge including ovenbird, scarlet tanager, yellow warbler, and pine warbler. The Barnegat Bay is an important shorebird site for red knot, dunlin, American oystercatcher, black-bellied plover, piping plover, sanderling, and semipalmated plover. A hawk watch at Island Beach State Park identified osprey, northern harrier, sharp-shinned hawk, American kestrel, and peregrine falcon. Migrating seabirds include loons, northern gannet, cormorants, and scoters.

The Barnegat Bay sports 100 species of fish in 57 families including bay anchovy, Atlantic silverside, fourspine stickleback, and spot (Able et al. undated). Recreational and commercial fisheries include winter flounder, bluefish, weakfish, summer flounder, menhaden, white perch, black sea bass, striped bass, blue crab, and hard shell clams. Bottlenose dolphins and humpback whales swim in the bay in summer. Turtles (Loggerhead, Leatherback, and Kemp Ridley, Green) migrate through in the fall. Fin whales and northern right whales swim offshore during summer. Harbor seals and gray seals feed off the beaches from December through March.

Federally listed species include: Federally endangered (peregrine falcon, roseate tern), Federally listed threatened (piping plover, swamp pink), Federal species of concern (northern pine snake, northern diamondback terrapin, black rail, pine barren boneset). State listed species include:

State-listed endangered (eastern tiger salamander, northern harrier, black skimmer, least tern, seabeach knotweed) and State-listed threatened (great blue heron, little blue heron, and osprey).

In New Jersey, the U. S. Fish and Wildlife Service (2007) estimated the annual economic value of recreational fishing, hunting, birding/wildlife-viewing activities was \$1.43 billion in \$2006. Trip expenditures include purchases and sales of food and lodging, transportation, and hunting, fishing, and wildlife watching equipment. Much of the fishing, hunting, and birding/wildlife recreation occur on farms, forests, wetlands, and open water ecosystems such as the Forsythe National Wildlife Refuge, Island Beach State Park, Double Trouble State Park, and Colliers Mills State Fish and Wildlife Management Area in Ocean County.

The Barnegat Bay watershed covers 670 mi<sup>2</sup> or 7.7% of New Jersey's land area of 8,721 mi<sup>2</sup>. Scaling by the ratio of watershed area to state land area, the estimated economic value of fishing, hunting, and wild-life/birdwatching recreation in the Barnegat Bay watershed is \$110 million annually including \$58 million from fishing, \$11 million from hunting, and \$41 million from wildlife/bird watching (Table 17).

**Table 17.** Value of fishing, hunting, wildlife/birding recreation in Barnegat Bay watershed

<b>Recreation Activity</b>	<b>New Jersey<sup>1</sup> (\$M)</b>	<b>Barnegat Bay<sup>2</sup> (\$M)</b>
<b>Fishing</b>	<b>752.3</b>	<b>57.9</b>
Trip Related	471.2	<b>36.3</b>
Equipment/other	281.1	<b>21.6</b>
<b>Hunting</b>	<b>145.9</b>	<b>11.2</b>
Trip Related	72.6	<b>5.6</b>
Equipment/other	73.3	<b>5.6</b>
<b>Wildlife/Birding</b>	<b>537.4</b>	<b>41.4</b>
Trip Related	146.3	<b>11.3</b>
Equipment/other	391.1	<b>30.1</b>
<b>Total</b>	<b>1,435.6</b>	<b>110.5</b>

1. USFWS (2007) in \$2006.

2. Scaled by ratio of Barnegat Bay watershed area to NJ area (7.7%).

## Recreation

### Boating, Fishing, and Swimming Recreation

Estuaries support a rich and significant coastal recreation economy (Pendleton undated). Leeworthy and Wiley (2001) conducted a national survey of coastal recreation and estimated that 13.4 million people in New Jersey participated in coastal water-based recreation which ranked 4<sup>th</sup> among the United States (Table 18). Beach visitation, swimming, viewing/photographing, bird watching, fishing, and motorboating are the most popular activities. Given the population of New Jersey is 8.8 million and the Barnegat Bay watershed population is 576,000, by proportion recreation activity in the bay watershed accounts for 883,000 participants and 11.1 million visitor days annually (Table 19).

**Table 18.** Coastal recreation by state  
(Leeworthy and Wiley 2001)

State	Participation Rate (% US pop.)	Participants In State	National Rank
New Jersey	3.02	6,224,769	4
New York	2.67	5,503,395	7
Delaware	1.05	2,168,108	19

Using travel cost demand methods, Johnston et al. (2002) from the University of Rhode Island, computed the consumer surplus (economic use value) for swimming, boating, recreational fishing, and bird watching/wildlife viewing in the Peconic Estuary watershed on Long Island, N.Y., at \$8.59, \$19.23, \$40.25, and \$49.83 per trip, respectively, in 1995 dollars. The consumer surplus per activity for recreational fishing in the mid-Atlantic ranged from \$17.07 to \$407.29 (Table 20). Water-quality benefits to recreational users approach \$260 million per year in the Barnegat Bay watershed based on unit values from the Peconic Estuary and then converting 1995 dollars to 2010 dollars based on the change in CPI and multiplying the 2010 figures by number of trips per year (Table 21). Wildlife viewing/bird watching (53%) and fishing (23%) are the highest recreational benefits, followed by swimming (13%) and boating (11%).

**Table 19.** Water based recreation activity in New Jersey  
(Leeworthy and Wiley 2001)

Activity	New Jersey Participants (millions)	New Jersey Visitor Days (millions)	Barnegat Bay Participants <sup>1</sup> (millions)	Barnegat Bay Visitor Days <sup>1</sup> (millions)
Beach Visitation	3.965	40.881	0.260	2.676
Swimming	3.804	37.433	0.249	2.450
Viewing/Photographing	1.076	28.538	0.070	1.868
Bird-Watching	0.795	18.804	0.052	1.231
Fishing	1.323	14.687	0.087	0.961
Motorboating	0.894	12.447	0.059	0.815
Viewing other Wildlife	0.591	8.293	0.039	0.543
Surfing	0.144	2.280	0.009	0.149
Personal Watercraft	0.246	1.895	0.016	0.124
Sailing	0.252	1.729	0.016	0.113
Wind Surfing	0.045	0.900	0.003	0.059
Water-Skiing	0.123	0.615	0.008	0.040
Hunting Waterfowl	0.012	0.240	0.001	0.016
Canoeing/Kayaking/Rowing	0.066	0.209	0.004	0.014
Snorkeling	0.110	0.110	0.007	0.007
Scuba Diving	0.047	0.047	0.003	0.003
<b>Total</b>	<b>13.493</b>	<b>169.108</b>	<b>0.883</b>	<b>11.069</b>

1. Scaled by proportion of population of Barnegat Bay watershed (576,567) to New Jersey (8.8 million) = 6.5%



**Table 20.** Literature review of coastal recreational fishing studies in the mid-Atlantic U.S.

State	Author/Date	Consumer Surplus/ Activity Day
Delaware	McConnell and Strand 1994	\$17.07-\$18.51
New Jersey	McConnell and Strand 1994	\$54.03-\$56.95

**Table 21.** Annual value of recreation benefits in the Barnegat Bay watershed

Recreational Benefit	Consumer surplus/trip <sup>1</sup> (\$1995)	Consumer surplus/trip <sup>2</sup> (\$2010)	Visitor trips/year <sup>3</sup> (millions)	Annual Value (\$)	% of Benefit
Swimming	\$8.59	\$13.40	2.450	\$32,830,000	13%
Boating	\$19.23	\$30.00	0.928	\$27,840,000	11%
Fishing	\$40.25	\$62.79	0.961	\$60,341,190	23%
Wildlife/bird watching	\$49.83	\$77.73	1.774	\$137,893,020	53%
<b>Total</b>				<b>\$258,904,210</b>	<b>100%</b>

1. Johnston et al. (2002). 2. Adjusted to 2010 dollars based on change in Northeast Region CPI (BLS). 3. Leeworthy and Wiley (2001), N.J. value scaled to Barnegat Bay watershed by proportion of population.

## Boating

Barnegat Bay is the home of a robust boating industry as a popular clean water recreation activity. In 1988, the Bay held over 53,000 boats and 116 marinas. Recreational boating including motorboats, sailboats, yachts, canoes, kayaks, and personal watercraft supported 182 marinas in the watershed (Ocean County Planning Dept. 2011). Over 19,000 boats are in commercial storage (marina slip and rack) along the Bay. The National Marine Manufacturer's Association (2010) ranked New Jersey 23rd among the states in expenditures (\$183 million) for new powerboats, engine, and trailers and 28th in boat registrations (173,994 registrations).

The Marine Trades Association of New Jersey (2008) estimated that New Jersey recreational boaters spent \$2.1 billion in 2006 and the recreational boating industry generated 18,000 jobs. New Jersey's registered recreational boaters accounted for \$2.1 billion in total recreational boating expenditures including \$938 million in annual boating expenses and \$1.1 billion on trip purchases. The average cost of a boat trip was \$273 including boat fuel (\$60/trip), fuel to travel to access point (\$24/trip), fishing supplies (\$37/trip), restaurants (\$36/trip), and boat accessories (\$35/trip). Boaters spent a total of \$6,340 on annual boating expenditures such as boat purchases (\$2,980) and seasonal rental charges for slips and moorings (\$726).

The Barnegat Bay ranked No.1 on the list from 288 respondents as the most popular boating area in the Garden State. Over 35% reported Ocean County as the most popular destination for N.J. registered boaters. More Ocean County residents are registered boaters (22,505) than in any other county and 27.9% of all New Jersey boats are docked in Ocean County. If registered boaters accounted for \$2.1 billion in recreational boating spending in New Jersey and 27.9% of NJ recreational boats docked in Ocean County and 35.1% of NJ boaters report Ocean County as the most popular destination, then by proportion boating contributes \$590-\$740 million annually to the Barnegat Bay economy and is responsible for 5,000-6,300 jobs.

## Outdoor Recreation

The Outdoor Industry Foundation (2006) concluded there were 16.3 million participants in recreation activities such as bicycling, camping, fishing, hunting, paddling, hiking, and wildlife viewing in the mid-Atlantic region (NJ, NY, Pa.) who contributed \$18.3 billion (\$15.6 billion in gear/trip sales) and 216,396 jobs to the regional economy. Given the population of the 3 states total 40.9 million (NJ 8.8 million, NY 19.4 million, and Pa. 12.7 million), by proportion outdoor recreation activity in the Barnegat Bay watershed (pop. 576,567) contributes \$256 million and 3,029 jobs to the economy including \$218 million in gear/trip sales (Tables 22 and 23).

**Table 22.** Economic value of recreation in the Barnegat Bay watershed

Economic Activity	Mid-Atlantic Region <sup>1</sup>	Barnegat Bay Watershed <sup>2</sup>
Gear/Trip Related Sales	\$15.6 billion	\$218 million
Total Contribution	\$18.3 billion	\$256 million
Participants	16.3 million	228,200
Jobs	216,396	3,029

1. Outdoor Industry Foundation 2006.

2. Scaled by proportion of Barnegat Bay to mid-Atlantic region population.

**Table 23.** Outdoor recreation activity in the Barnegat Bay watershed

Recreation	Activity	Mid-Atlantic Region <sup>1</sup>	Barnegat Bay Watershed <sup>2</sup>
Bicycling	Gear/Trip Sales	\$3,372,000,000	\$47,208,000
	# Participants	2,496,000	34,944
	Jobs	40,121	562
Camping	Gear/Trip Sales	\$7,513,000,000	\$105,182,000
	# Participants	1,874,000	26,236
	Jobs	89,384	1,251
Fishing	Gear/Trip Sales	\$1,768,000,000	\$24,752,000
	# Participants	1,890,000	26,460
	Jobs	17,195	\$241
Hunting	Gear/Trip Sales	\$731,000,000	\$10,234,000
	# Participants	450,000	6,300
	Jobs	7,234	\$101
Paddling	Gear/Trip Sales	\$784,000,000	\$10,976,000
	# Participants	1,586,000	22,204
	Jobs	9,331	\$131
Hiking	Gear/Trip Sales	\$2,411,000,000	\$33,754,000
	# Participants	3,048,000	42,672
	Jobs	28,686	402
Wildlife viewing	Gear/Trip Sales	\$1,756,000,000	\$24,584,000
	# Participants	4,990,000	69,860
	Jobs	24,445	342
Total	Gear/Trip Sales	\$18,335,000,000	\$256,690,000
	# Participants	16,334,000	228,676
	Jobs	216,396	3,030

1. Outdoor Industry Foundation 2006.

2. Scaled by proportion of Barnegat Bay to mid-Atlantic region population.

## Beach Visits

Seneca (2011) reported that New Jersey had 3,965,000 annual beach visits for a total of 40,881,000 beach visitor days. Several studies conducted in the mid-Atlantic U.S. conclude the mean consumer surplus (willingness to pay minus equilibrium price) for a beach trip ranges from \$5.36 to \$31.45 per activity day or \$7.29 to \$58.81 per day in 2010 dollars based on the change in the Consumer Price Index for the Northeast Region according to the Bureau of Labor Statistics. (Table 24). Using a mean beach travel cost of \$27.66 per visitor day in 2010 dollars with 40,881,000 visitor days, the annual economic value of New Jersey beaches is \$1.13 billion. If Ocean County beaches cover 45 miles or 35% of New Jersey's 130-mile ocean shoreline, then the scaled recreational value of beaches in the Barnegat Bay watershed is \$395 million.

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

State	Author/Date	Consumer Surplus (\$/day)	Consumer Surplus <sup>1</sup> \$2010/day
Massachusetts	Kline and Swallow (1998)	\$5.36	\$7.29
New Jersey	Leeworthy and Wiley (1991)	\$31.45	\$58.81
New Jersey	Parsons et al. (1999)	\$12.70	\$16.89
Mean			\$27.66

1. Adjusted to 2010 dollars from change in Consumer Price Index for Northeast Region (BLS).

## State Parks

New Jersey has 50 state parks, forests, and historic sites that cover 422,000 acres (659 mi<sup>2</sup>). Mates and Reyes (2006) from the NJDEP reported at a central estimate of \$21 per visit, 14.2 million visitors per year to the New Jersey state park and forest system contributed \$304 to \$347 million annually from 2000-2005 to the State economy and supported about 7,000 jobs. In fiscal year 2011, the state parks recorded 18.8 million visitors. Island Beach State Park, Byrne State Forest, Bass River State Forest, and Double Trouble State Park cover 32,601 acres in the Barnegat Bay watershed. Scaling by proportion of state parks in the watershed to the area of New Jersey (32,601 ac /422,000 ac or 7.7%), state parks in the Barnegat Bay watershed contribute approximately \$23 to \$27 million and 539 jobs to the local economy.

## Agriculture

In 2007, the USDA National Agricultural Statistics Service (2009) estimated the annual market value of agricultural products sold in Ocean County was \$11.5 million on 4,423 acres from nurseries, vegetables, fruit, horses, grain, poultry, cattle, poultry, and Christmas trees (Table 25).

**Table 25.** Agricultural sales in Ocean County, New Jersey, 2007  
(USDA 2009)

Product	Farms	Value (\$)
Nursery	45	5,645,000
Vegetable	31	2,050,000
Fruit	29	1,256,000
Horse	32	649,000
Grain	17	222,000
Poultry	39	185,000
Cattle/Dairy	16	182,000
Other Animals	14	103,000
Hay	33	81,000
Christmas Trees	23	74,000
Sheep/Goats	32	40,000
Hogs	10	27,000
Aquaculture	15	
<b>Total</b>	<b>255</b>	<b>11,515</b>

## 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, 176,320 acres (275.5 mi<sup>2</sup>) of forests in the Barnegat Bay watershed have benefits of carbon storage (\$146 million), carbon sequestration (\$5.1 million), air-pollution removal (\$47 million), and building-energy savings (\$9.8 million). Forests in the Barnegat Bay watershed provide environmental benefits by regulating climate change, cooling, and air-emissions control including 7 million tons of carbon-storage capacity, 246,848 tons of carbon sequestration, 7,053 tons of air-pollution removal, and 24,685 tons of avoided carbon-emissions capacity (Table 26).

**Table 26.** Economic and environmental benefits of forests in the Barnegat Bay watershed

Benefits	Forests New Castle County <sup>1</sup>		Forests Barnegat Bay Watershed <sup>2</sup>	
	Environmental (ton/ac)	Economic (\$/acre)	Environmental (ton)	Economic (\$)
Carbon Storage	40.00	\$827	7,052,800	\$145,816,640
Carbon Sequestration	1.4	\$29	246,848	\$5,113,280
Air Pollution Control	0.04	\$266	7,053	\$46,901,120
Energy Savings		\$56	0	\$9,873,920
Avoided Carbon Emissions	0.14	\$3	24,685	\$528,960

1. Nowak et al. (2008). 2. Computed for 176,320 acres of forest in the Barnegat Bay watershed.

## Public Parks

The Trust for Public Land (2009) found the 444-acre City of Wilmington park and recreation 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–mitigation benefits in treating stormwater (\$409,000 or \$921/ac).
- Air pollution–mitigation value from tree and shrub absorption (\$39,000 or \$88/ac).

Ocean County is covered by 134,935 acres (211 mi<sup>2</sup>) of Federal, state, county, and non profit parks and open space (Table 27). Between 2005 and 2009, 8,300 acres in the Barnegat Bay watershed were acquired by agencies to bring total publicly-owned land in the watershed to over 130,800 acres. The U.S. Fish and Wildlife Service owns 24,338 acres of open space that includes the Edwin B. Forsythe National Wildlife Refuge. Over 70,000 acres are under the stewardship of the N.J. Division of Fish and Wildlife. The N.J. Division of Parks and Forestry oversees 32,600 acres including Island Beach State Park, Double Trouble State Park, and Bass River State Forest. In Ocean County, the Natural Lands Trust protects 4,600 acres including Crossley Preserve in Berkeley Township. The Ocean County Park System has 21 recreational facility sites totaling more than 3,502 acres, including two golf courses.

**Table 27.** Federal, state, county parks and protected open space in Ocean County

Agency	Parks	Area (ac)
U.S. Fish and Wildlife Service	Edwin B. Forsythe Nat'l. Wildlife Refuge	24,338
NJ Div. Fish, Game, Wildlife	Greenwood Forest, Colliers Mills, Stafford Forge	69,857
NJ Div. Parks and Forest	Byrne State Forest, Double Trouble, Bass River, Island Beach	32,601
NJ Natural Lands Trust	Crossley Preserve, Audubon Preserve	4,637
Ocean County Park System	Wells Mills, Cattus Island, Metedeconk River	3,502
<b>Total</b>		<b>134,935</b>

Applying the City of Wilmington data for value transfer (Table 28), public parks in the Barnegat Bay watershed provide \$1.8 billion in annual economic benefits including health benefits from exercise in the parks (\$1.3 billion), community-cohesion benefits from people socializing in the parks (\$321 million), water pollution–mitigation benefits from parks in treating stormwater (\$124 million), and air pollution–mitigation value from tree and shrub absorption (\$12 million).

**Table 28.** Value of public parks in the Barnegat Bay watershed

Agency	Parks (acres)	Health Benefits (\$9,734/ac)	Community Cohesion (\$2,383/ac)	Stormwater Benefit (\$921/ac)	Air Pollution (\$88/ac)	Total
USFWS	24,338	\$236,906,092	\$57,997,454	\$22,415,298	\$2,141,744	\$319,460,588
NJDFGW	69,857	\$679,988,038	\$166,469,231	\$64,338,297	\$6,147,416	\$916,942,982
NJDP&F	32,601	\$317,338,134	\$77,688,183	\$30,025,521	\$2,868,888	\$427,920,726
NJNLT	4,637	\$45,136,558	\$11,049,971	\$4,270,677	\$408,056	\$60,865,262
Ocean Co.	3,502	\$34,088,468	\$8,345,266	\$3,225,342	\$308,176	\$45,967,252
<b>Total</b>	<b>134,935</b>	<b>\$1,313,457,290</b>	<b>\$321,550,105</b>	<b>\$124,275,135</b>	<b>\$11,874,280</b>	<b>\$1,771,156,810</b>

## 4. Ecosystem Services

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

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

### Related Research

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

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

Others have calculated the value of natural capital in ecosystems along the Atlantic seaboard and across the United States. Weber (2007) from the Conservation Fund found the largest ecosystem services values in Cecil County, Maryland are from stormwater/flood control, water supply, and clean water functions (Table 29). The Wilderness Society (Krieger 2001) concluded that forest ecosystem services for climate regulation, water supply, water quality, and recreation benefits totaled \$392/ac in 1994 dollars or \$631/ac in 2010 dollars based on change in the Northeast Region CPI (Table 30). A contingent value study by University of Rhode Island economists found that natural resources values in the Peconic Estuary watershed in Suffolk County on Long Island New York ranged from \$6,560/ac for wetlands to \$9,979/ac for farmland in 1995 dollars (Johnston et al. 2002). The University of Maryland studied the U.S. National Wildlife Refuge System and determined that ecosystem values of freshwater wetlands and forests are \$6,268/ac and \$845/ac, respectively (Ingraham and Foster 2008). The Audubon Society found the economic value of ecosystems in Massachusetts ranged from \$984/ac for forests to \$15,452/ac for saltwater wetlands (Breunig 2003). The USDA Census of Agriculture (2009) reported in 2007 the market value of agricultural products sold from 4,423 acres of cropland in Ocean County was \$11.5 million (\$9.3 million crops and \$2.2 million livestock/ poultry) or \$2,600/ac.

Table 31 compares ecosystem services values from other watersheds. Data from the NJDEP study and crop value of Ocean County agriculture are used for value transfer to the Barnegat Bay watershed as the study area shares similar ecosystems (forests/wetlands), climate (humid continental at 40 degrees north in latitude), physiographic provinces (Coastal Plain), aquifers, and soils. NJDEP ecosystem-services values are lower than Cecil County's for wetlands and forests and MassAudubon's for wetlands. NJDEP estimates are higher than the Wilderness Society's for forests and U.S. Wildlife Refuge values for freshwater wetlands and forests.

**Table 29.** Ecosystem services values for Cecil County, Maryland  
(Weber 2007)

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

**Table 30.** Forest ecosystem service values for U.S. temperate forests

Ecosystem Good or Service	1994 Value <sup>1</sup> (\$/ac)	2010 Value <sup>2</sup> (\$/ac)
Climate regulation	57.1	91.9
Disturbance regulation	0.8	1.3
Water regulation	0.8	1.3
Water supply	1.2	1.9
Erosion and sediment control	38.8	62.5
Soil formation	4.0	6.4
Nutrient cycling	146.1	235.2
Waste Treatment	35.2	56.7
Biological Control	0.8	1.3
Food Production	17.4	28.0
Raw Materials	55.8	89.8
Genetic Resources	6.5	10.5
Recreation	26.7	43.0
Cultural	0.8	1.3
<b>Total</b>	<b>392.1</b>	<b>631.3</b>

1. Krieger 2001. 2. Adjusted to 2010 dollars based on change in Northeast Region CPI (BLS).

**Table 31.** Comparison of ecosystem goods and services values from various studies

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

1. Value of natural goods only measured by crops, livestock, and poultry sold in Ocean County (USDA 2009).

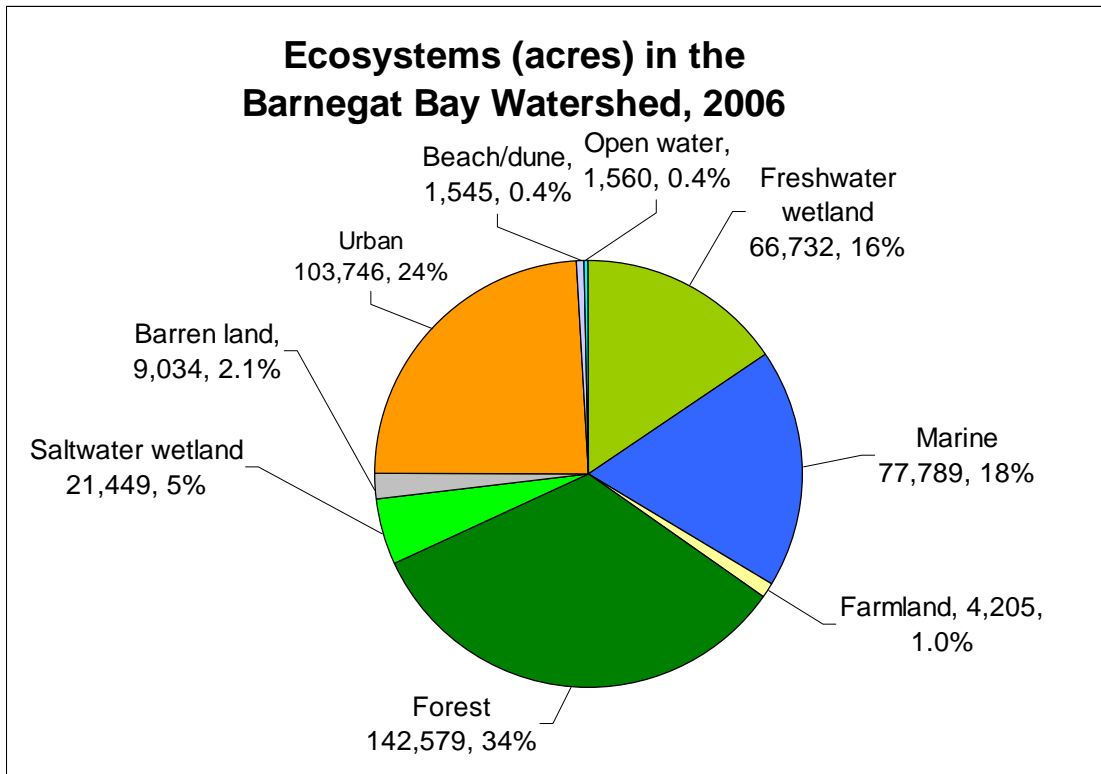
## Watershed Ecosystem Services

The estimated value of ecosystem goods and services provided by the Barnegat Bay watershed (670 mi<sup>2</sup> or 428,639 acres) is \$2.3 billion (in 2010 dollars) with a net present value (NPV) of \$73.3 billion (Table 32). Ecosystems (Figure 15) within the watershed include forests (34%), urban (24%), marine/bay (18%), freshwater wetlands (16%), and saltwater wetlands (5%), barren (2%), and farmland (1%). Freshwater wetlands (\$908 million), marine/bay (\$778 million), forests (\$282 million), and saltwater wetlands (\$155 million) provide the highest ecosystems goods and services values (Figures 16 and 17). The natural capital value of the watershed will decrease if urban land replaces forests which currently cover 1/3 of the drainage area.

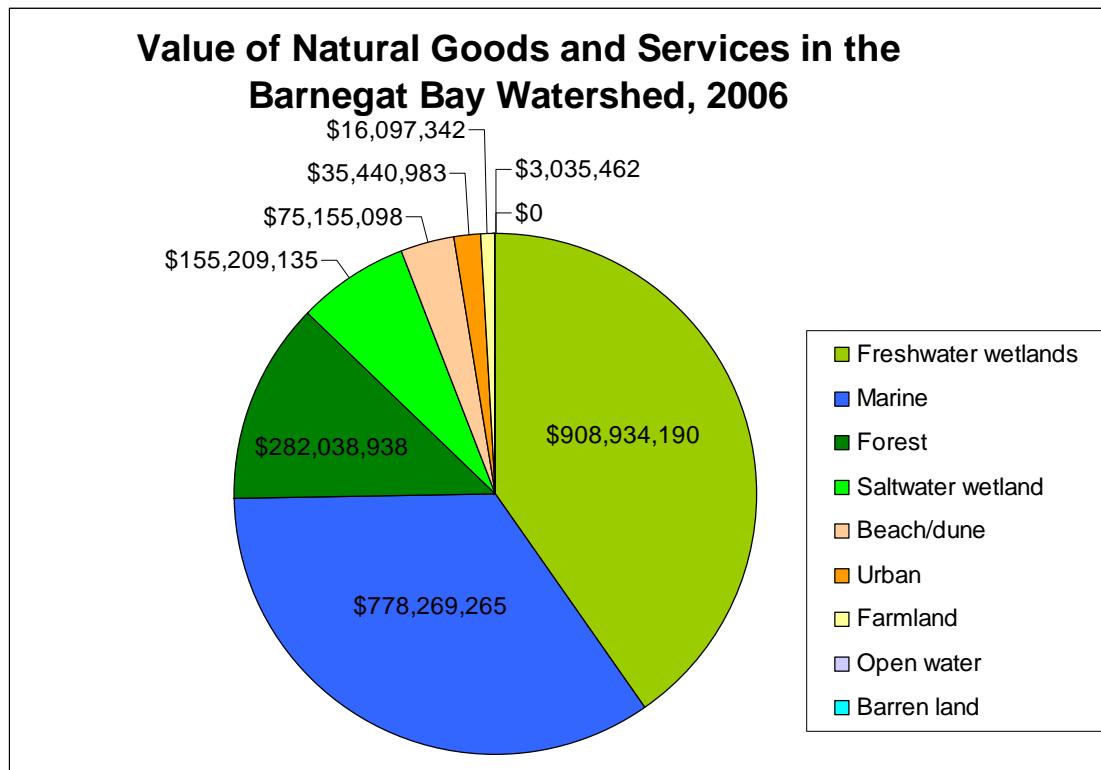
**Table 32.** Value of ecosystem goods and services in the Barnegat Bay watershed

Ecosystem	Area (ac)	Services (\$/ac/yr)	PV (\$)	NPV (\$)
Freshwater wetlands	66,732	13,621	908,934,190	29,540,361,169
Marine	77,789	10,005	778,269,265	25,293,751,116
Farmland	4,205	3,828	16,097,342	523,163,602
Forest	142,579	1,978	282,038,938	9,166,265,479
Saltwater wetland	21,449	7,236	155,209,135	5,044,296,887
Barren land	9,034	0	0	0
Urban	103,746	342	35,440,983	1,151,831,952
Beach/dune	1,545	48,644	75,155,098	2,442,540,696
Open water	1,560	1,946	3,035,462	98,652,528
<b>Total</b>	<b>428,639</b>		<b>2,254,180,413</b>	<b>73,260,863,428</b>





**Figure 15.** Ecosystem service areas in the Barnegat Bay watershed



**Figure 16.** Value of ecosystem services within the Barnegat Bay watershed

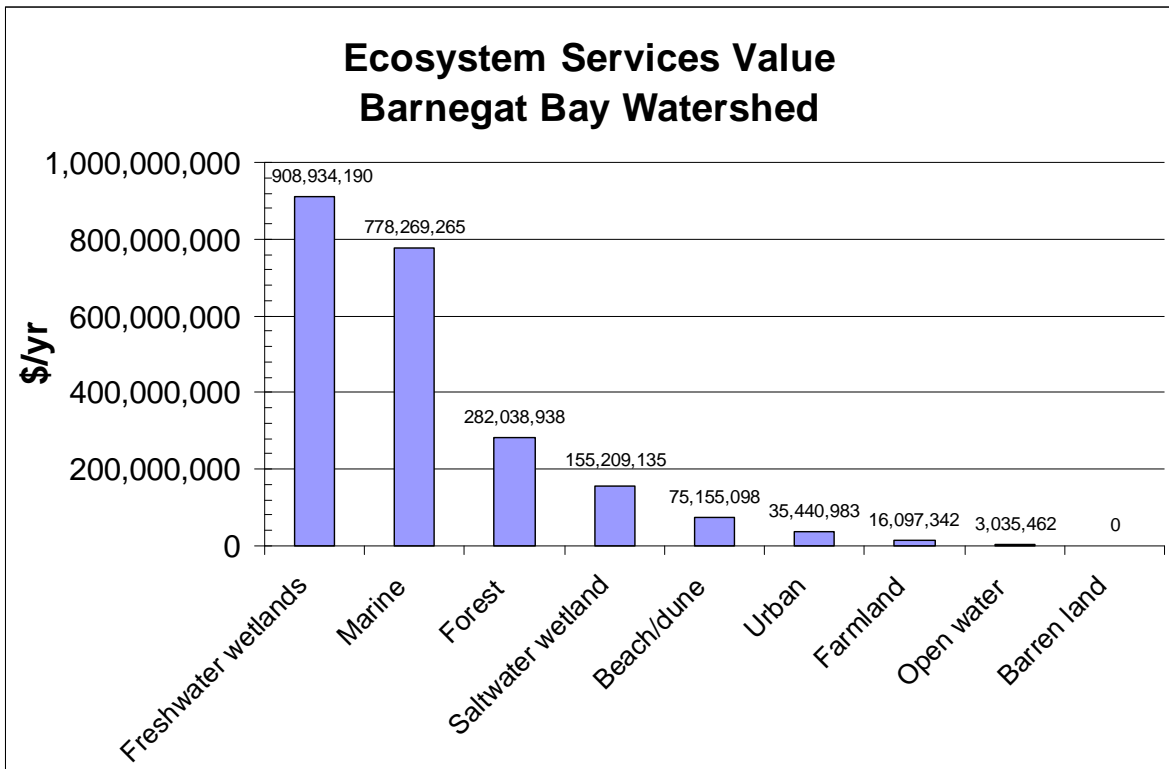


Figure 17. Ecosystem service value of habitat in the Barnegat Bay watershed

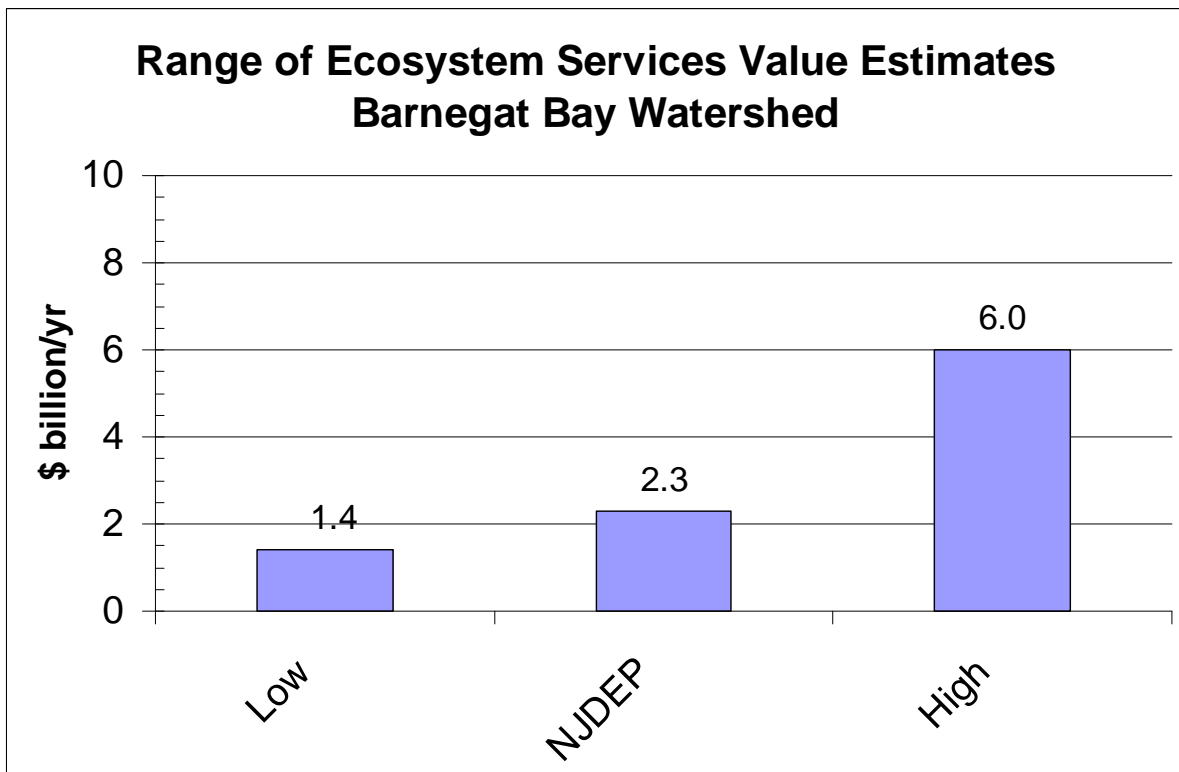


Figure 18. Range of ecosystem services value estimates in the Barnegat Bay watershed

Ecosystem services in the Barnegat Bay watershed using data from the NJDEP and USDA crop values are worth \$2.3 billion in 2010 dollars or \$73.3 billion (NPV), which are conservatively in the lower end of the range based on value transfer from other watersheds (Figure 18). If lower per acre estimates of ecosystem services from other studies were used instead of the NJDEP values, ecosystem services in the Barnegat Bay watershed would be \$1.4 billion per year with NPV of \$46.2 billion (Table 33). If higher per acre estimates from other studies were used, the value of ecosystems in the Barnegat Bay watershed would be \$6.0 billion with NPV of \$196.6 billion (Table 34).

<u>Estimate</u>	<u>PV (\$B)</u>	<u>NPV (\$B)</u>
Low	1.4	46.2
NJDEP	2.3	73.3
High	6.0	196.6

**Table 33.** Low range of ecosystem services in the Barnegat Bay watershed

Ecosystem	Area (ac)	Services (\$/ac/yr)	PV (\$)	NPV (\$)
Freshwater wetlands	66,732	6,268 <sup>5</sup>	418,276,176	13,593,975,720
Marine	77,789	8,670 <sup>2</sup>	674,430,630	21,918,995,475
Farmland	4,205	1,387 <sup>6</sup>	5,832,335	189,550,888
Forest land	142,579	641 <sup>3</sup>	91,393,139	2,970,277,018
Saltwater wetland	21,449	6,269 <sup>2</sup>	134,463,781	4,370,072,883
Barren land	9,034	0	0	0
Urban	103,746	296 <sup>2</sup>	30,708,816	998,036,520
Beach/dune	1,545	42,149 <sup>2</sup>	65,120,205	2,116,406,663
Open water	1,560	217 <sup>5</sup>	338,520	11,001,900
<b>Total</b>	<b>428,639</b>		<b>1,420,563,602</b>	<b>46,168,317,065</b>

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

**Table 34.** High range of ecosystem services in the Barnegat Bay watershed

Ecosystem	Area (ac)	(\$/ac/yr)	PV (\$)	NPV (\$)
Freshwater wetlands	66,732	43,685 <sup>1</sup>	2,915,187,420	94,743,591,150
Marine	77,789	8,670 <sup>2</sup>	674,430,630	21,918,995,475
Farmland	4,205	9,979 <sup>4</sup>	41,961,695	1,363,755,088
Forest land	142,579	12,033 <sup>1</sup>	1,715,653,107	55,758,725,978
Saltwater wetland	21,449	28,146 <sup>1</sup>	603,703,554	19,620,365,505
Barren land	9,034	0	0	0
Urban	103,746	296 <sup>2</sup>	30,708,816	998,036,520
Beach/dune	1,545	42,149 <sup>2</sup>	65,120,205	2,116,406,663
Open water	1,560	1,686 <sup>2</sup>	2,630,160	85,480,200
<b>Total</b>	<b>428,639</b>		<b>6,049,395,587</b>	<b>196,605,356,578</b>

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

## 5. Jobs and Wages

The ocean and coastal economy in New Jersey provides for a \$5.95 billion GDP and supports 7,981 establishments and 101,443 jobs with \$3.43 billion in annual wages (NOEP 2009).

The Barnegat Bay watershed is a jobs engines with water resources and habitat that supports over 60,000 direct and indirect jobs with over \$2 billion in annual wages in the coastal, agriculture, fishing/hunting/birding, tourism, recreation and water supply sectors (Table 35).

**Table 35.** Jobs and wages directly and indirectly related to the Barnegat Bay watershed

Sector	Jobs	Wages (\$ million)	Data Source
Direct Watershed-Related	25,630	851	U.S. Bureau of Labor Statistics (2010)
Indirect Watershed-Related	30,756	681	U.S. Census Bureau (2010)
Coastal	11,565	206	National Coastal Econ. Program (2010)
Farm	1,045	50	Awokuse et al., (2010)
Fishing/Hunting/Birding	3,364	110	U.S. Fish and Wildlife Service (2008)
National Wildlife Refuge	41	1.5	Carver and Caudill (2007)
Wetlands	360	23	NOAA Coastal Services Center (2011)
Boating	5,000	200	Marine Trades Assn. of NJ (2008)
Outdoor Recreation	3,029	150	Outdoor Industry Foundation (2006)
State Parks	539	27	Mates and Reyes (2006)
Watershed Organizations	50	3.1	N. J. Environmental Center and BLS
Water Supply Utilities	535	30	Ocean County water purveyors
Wastewater Utilities	50	3	Ocean County Utilities Authority
<b>Barnegat Bay Watershed</b>	<b>&gt;60,000</b>	<b>&gt;\$2 billion</b>	

Jobs and wages in the Barnegat Bay watersheds were obtained from U.S. Bureau of Labor Statistics (2010) and U.S. Census Bureau (2010) databases. Note the NAICS database does not include jobs for certain known water-related industries, such as commercial fishing and boat building; therefore the columns are left blank. Hence, watershed-related jobs are likely undercounted. Barnegat Bay watershed-related jobs are tabulated for three categories: (1) total jobs in Ocean County, (2) direct Barnegat Bay watershed jobs, and indirect watershed jobs.

Total jobs in Ocean County, New Jersey by NAICS code from the Bureau of Labor Statistics (2010) indicate there were 236,590 nonfarm jobs in Ocean County with wages of \$12.7 billion (Table 36).

Direct Barnegat Bay 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 Ocean County, New Jersey. Industries directly associated with the Barnegat Bay watershed (such as water/sewer construction, water utilities, fishing, recreation, tourism, and ports) employed 25,630 people with \$851 million in wages (Table 37).

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 30,756 people with \$681 million in wages (Table 38).

**Table 36.** Employment by municipality in Ocean County, New Jersey in 2010

<b>Town</b>	<b>Employed</b>	<b>Town</b>	<b>Employed</b>
Barnegat Township	7,314	Manchester Township	10,058
Barnegat Light Borough	348	Mantoloking Borough	163
Bay Head Borough	697	Ocean Township	3,436
Beach Haven Borough	592	Ocean Gate Borough	1,184
Beachwood Borough	6,118	Pine Beach Borough	1,138
Berkeley Township	11,411	Plumsted Township	4,353
Brick Township	37,073	Point Pleasant Borough	11,295
Eagleswood Township	801	Point Pleasant Beach Borough	2,879
Harvey Cedars Borough	163	Seaside Heights Borough	1,672
Island Heights Borough	940	Seaside Park Borough	1,254
Jackson Township	25,031	Ship Bottom Borough	755
Lacey Township	12,423	South Toms River Borough	1,892
Lakehurst Borough	1,277	Stafford Township	11,836
Lakewood Township	22,926	Surf City Borough	685
Lavallette Borough	1,207	Toms River Township	44,324
Little Egg Harbor Township	8,254	Tuckerton Borough	1,776
Long Beach Township	1,486	<b>Ocean County Total</b>	<b>236,690</b>

**Table 37.** Barnegat Bay watershed jobs and wages in 2010

<b>Category</b>	<b>Jobs</b>	<b>Wages (\$ million)</b>
Total Ocean County, NJ	394,918	18,800
Direct Watershed-related	19,715	1,103
Indirect Watershed-related	24,070	883

**Table 38.** Direct and indirect watershed-related jobs in the Barnegat Bay watershed, 2009

Sector	North American Industry Classification System (NAICS)	NAICS code	Direct Watershed Jobs <sup>1</sup>	Direct Annual Watershed Wages <sup>1</sup> (x\$1000)	Indirect Watershed Jobs <sup>2</sup>	Indirect Annual Wages <sup>2</sup> (x\$1000)
Construction	Water and sewer construction	23711	0	6,853	0	5,482
Living Resources	Fishing, hunting, trapping	114	43	1,367	52	1,094
	agriculture and forestry	115	21	191	25	153
	Seafood prep./ packaging	3117			0	0
	Wineries	31213			0	0
	Fish and seafood wholesalers	42446	36	1,457	43	1,166
	Nursery, garden center, farm	44422	90	3,970	108	3,176
	Fish and seafood markets	44522	24	1,006	29	805
	Fruit and vegetable markets	44523	22	752	26	602
Minerals	Mining, quarrying	21	61	3,957	73	3,166
	Electric power generation	2211	1,079	117,145	1,295	93,716
Boat Building	Ship and boat building	3366	12	591	14	473
Tourism/Recreation	Sporting/recreational goods	42391	31	1,481	37	1,185
	Sporting goods stores	45111	256	5,893	307	4,714
	Recreational goods rental	532292		431	0	345
	Commercial water transport.	532411			0	0
	Recreational vehicle dealers	44121	88	4,327	106	3,462
	Boat dealers	441222	285	13,160	342	10,528
	Museums, historical sites	712			0	0
	Amusement parks and arcades	7131		37,931	0	30,345
	Amusement arcades	71312	303	8,812	364	7,050
	Amusement/recreation	7139	2,402	52,020	2,882	41,616
	Golf courses/	71391	295	9,029	354	7,223
	Marinas	71393	266	12,838	319	10,270
	Fitness/recreational sports	71394	1,584	20,278	1,901	16,222
	Amusement/recreation	71399	129	7,804	155	6,243
	Accommodation	721	599	16,217	719	12,974
	Hotels and motels	72111	549	14,707	659	11,766
	Bed-and-breakfast inns	721191		203	0	162
	Recreational vehicle, camps	7212	39	1,307	47	1,046
	Full-service restaurants	7221	5,511	95,445	6,613	76,356
	Limited-service restaurants	722211	3,530	50,991	4,236	40,793
	Snack/beverage bars	722213	693	10,105	832	8,084
	Food service contractors	72231	738	13,705	886	10,964
	Caterers	722320	265	4,613	318	3,690
	Mobile food services	72233	47	445	56	356
Transportation	Coastal, water transportation	483		305	0	244
	Inland water transportation	4832	15	192	18	154
	Scenic/sightseeing transport.	487		1,603	0	1,282
	Marine cargo handling	4883	46	2,363	55	1,890
	Navigational services/shipping	488320	60	1,546	72	1,237
	Water transportation	48839	36	1,530	43	1,224
Environmental	Architectural, engineering	541	5,680	290,841	6,816	232,673
	Environmental, conservation	813211	151	3,574	181	2,859
	Civic and social organizations	8134	122	1,901	146	1,521
Water/Wastewater	Water, sewage systems	2213	129	8,636	155	6,909
	Waste management services	562	393	19,443	472	15,554
<b>Total</b>			<b>25,630</b>	<b>850,965</b>	<b>30,756</b>	<b>680,772</b>

1. Direct jobs/wages are those directly related to the Barnegat Bay 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 (2010) summarized the coastal and ocean economy in the United States for the following industrial sectors: Marine Transportation, Tourism and Recreation, Living Marine Resources, Marine Construction, Ship and Boat Building, Mineral Extraction (Table 39). According to the NOEP, the coastal economy in Ocean County, which covers nearly the entire Barnegat Bay watershed, contributed 145,966 jobs, representing \$5.7 billion in annual wages and \$13.1 billion toward New Jersey's gross domestic product or GDP (Table 40). The Ocean County ocean economy contributed 11,565 jobs with 206 million in annual wages and \$388 million toward the GDP (Table 41).

**Table 39.** Sectors and industries in the ocean/coastal economy  
(NOEP 2010)

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

**Table 40.** Coastal employment, wages, and GDP in Ocean County, New Jersey (NOEP 2010)

Sector	Employment	Wages (\$ million)	GDP (\$ million)
Construction	6,690	324.8	630.0
Financial Activities	5,873	269.4	1,517.6
Education/Health Services	46,938	2,064.7	2,009.6
Information	1,151	76.9	262.7
Leisure/Hospitality	18,825	310.4	610.2
Manufacturing	4,500	221.3	453.1
Natural Resources/Mining	264	9.3	23.9
Other Services	5,212	137.0	332.6
Professional/Business	10,873	463.7	782.1
Public Administration	10,434	626.5	2,472.4
Trade/Transportation/Utilities	33,993	1,132	2,546.9
Misc.	1,213	31.6	1,471.2
<b>Total</b>	<b>145,966</b>	<b>5,667,588.5</b>	<b>13,112.3</b>

**Table 41.** Ocean/coastal employment, wages, and GDP in Ocean County, New Jersey (NOEP 2010)

Sector	Employment	Wages (\$ million)	GDP (\$ million)
Marine Construction	<b>181</b>	9.6	17.0
Living Resources	57	1.1	2.3
Minerals	78	4.7	2.9
Tourism & Recreation	11,089	183.5	354.5
Marine Transportation	160	7.2	11.4
Ship and Boat Building			
<b>Total</b>	<b>11,565</b>	<b>206.1</b>	<b>388.1</b>

## Farm Jobs

In 2007 there were 255 farms in Ocean County (USDA 2007). The USDA estimates agriculture employs about 4.1 full time jobs per farm so farming accounts for at 1,045 jobs in the Barnegat Bay watershed. Assuming the average wage is \$48,100, total farm wages are \$50.3 million.

## Fishing/Hunting/Bird and Wildlife Recreation Jobs

The average annual salary per ecotourism job is \$32,843 using figures from the 2001 U.S. Fish and Wildlife Service report on fishing, hunting, and wildlife-associated recreation (NJDEP 2007). Fishing, hunting, and bird/wildlife-associated recreation in Ocean County in the Barnegat Bay watershed account for \$110.5 million in annual economic activity in 2006 dollars. At an average salary of \$32,843, fishing, hunting, and bird/wildlife-associated recreation accounts



3,364 jobs in the Barnegat Bay watershed (Table 42). 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 Barnegat Bay watershed.

**Table 42.** Jobs from fishing, hunting, and wildlife/birding recreation in Barnegat Bay watershed

Recreation Activity	New Jersey <sup>1</sup> (\$ million)	Barnegat Bay <sup>2</sup> (\$ million)	Jobs <sup>3</sup>
<b>Fishing</b>	<b>752.3</b>	<b>57.9</b>	<b>1,763</b>
Trip Related	471.2	36.3	
Equipment/other	281.1	21.6	
<b>Hunting</b>	<b>145.9</b>	<b>11.2</b>	<b>341</b>
Trip Related	72.6	5.6	
Equipment/other	73.3	5.6	
<b>Wildlife/Birding</b>	<b>537.4</b>	<b>41.4</b>	<b>1,261</b>
Trip Related	146.3	11.3	
Equipment/other	391.1	30.1	
<b>Total</b>	<b>1,435.6</b>	<b>110.5</b>	<b>3,364</b>

1. USFWS (2007) in \$2006. 2. Scaled by ratio of Barnegat Bay watershed to NJ land area (7.7%). 3. Jobs estimated at \$32,843 average salary.

## National Wildlife Refuge

Carver and Caudill (2007) from the U.S. Fish and Wildlife Service estimated the 47,000 acre Edwin B. Forsythe National Wildlife Refuge was the 15th most visited refuge in the nation and contributed to 41 jobs with \$1.5 million in annual wages.

## Wetland Jobs

The NOAA Coastal Services Center (2011) estimates wetlands cover 160 mi<sup>2</sup> (25% of Ocean County) and support 360 commercial, recreational, and charter fishing jobs in Barnegat Bay watershed with \$2.3 million in business output and \$22.7 million in wages.

## Boating Jobs

The Marine Trades Association of New Jersey (2008) estimated that New Jersey recreational boaters spent \$2.1 billion in 2006 and the boating industry generated 18,000 jobs. If registered boaters accounted for \$2.1 billion in total recreational boating expenditures in New Jersey and 27.9% of N.J. recreational boats are docked in Ocean County and 35.1% of N.J. boaters report Ocean County as the most popular destination, then by proportion recreational boating in the Barnegat Bay watershed is responsible for 5,000 to 6,300 jobs.

## Outdoor Recreation

The Outdoor Industry Foundation (2006) concluded that 16.3 million participants in watershed-based recreation activities such as bicycling, camping, fishing, hunting, paddling, hiking, and

wildlife viewing in the mid-Atlantic region (New Jersey, New York, and Pennsylvania) and contributed 216,396 jobs. Given the population of the three states total 40.9 million (NJ 8.8 million, NY 19.4 million, and Pa. 12.7 million), by proportion outdoor recreation activity in the Barnegat Bay watershed (pop. 576,567) contributes 3,029 jobs (Table 43).

**Table 43.** Outdoor recreation jobs in the Barnegat Bay watershed

Recreation	Mid-Atlantic Region <sup>1</sup>	Barnegat Bay Watershed <sup>2</sup>
Bicycling	40,121	562
Camping	89,384	1,251
Fishing	17,195	\$241
Hunting	7,234	\$101
Paddling	9,331	\$131
Hiking	28,686	402
Wildlife viewing	24,445	342
<b>Total</b>	<b>216,396</b>	<b>3,030</b>

1. Outdoor Recreation Foundation 2006.

2. Scaled by ratio of Barnegat Bay to mid-Atlantic region population

## State Parks

New Jersey has 50 state parks, forests, and historic sites that cover 422,000 acres (659 mi<sup>2</sup>). 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. Island Beach State Park, Byrne State Forest, Bass River State Forest, and Double Trouble State Park cover 32,601 acres in the Barnegat Bay watershed. Scaling by proportion of area of state parks in the watershed to New Jersey land area, (32,601 ac /422,000 ac or 7.7%), state parks in the Barnegat Bay watershed support 539 jobs in the local economy.

## Watershed Organization Jobs

A baker's dozen of nonprofit watershed and environmental organizations employ at least 50 staff to work on programs to protect the Barnegat Bay watershed (Table 44). Assuming that the average salary of an environmental scientist/specialist is \$61,700 (Bureau of Labor Statistics), these watershed organization jobs account for \$3.1 million in annual wages.

**table 44.** Watershed organization jobs in the Barnegat Bay watershed

Watershed Organization	Jobs	Salaries
Alliance for a Living Ocean	2	123,400
American Littoral Society -	7	431,900
Barnegat Bay Partnership	8	493,600
Cooper Environmental Center	2	123,400
Clean Ocean Action -	1	61,700
Clean Ocean and Shore Trust -	1	61,700
Experience Barnegat Bay-	10	617,000
Manasquan River Watershed Association -	2	123,400
Natural Lands Trust	5	308,500
New Jersey Pinelands Commission -	8	493,600
Pinelands Preservation Alliance	2	123,400
ReClam The Bay -	1	61,700
Save Barnegat Bay	1	61,700
<b>Total</b>	<b>50</b>	<b>3,085,000</b>

## Water Supply Jobs

Public and private water utilities withdraw over 53 mgd of drinking water from surface-water and groundwater supplies in Ocean County. According to the American Water Works Association, the average salary of a water-system employee is \$55,407. Water supply utilities in the Barnegat Bay watershed employ at least 535 jobs with annual wages of \$29.6 million (Table 45).

## Wastewater Utility Jobs

The Ocean County Utilities Authority employs 50 staff who operate three wastewater treatment facilities with a capacity of 80 million gallons per day and 31 municipalities in Ocean County and 5 municipalities in Monmouth County.

**Table 45.** Public water supply jobs in the Barnegat Bay watershed

Water Purveyor	Population Served	Jobs	Salaries
United Water Toms River Dover Twp	123,174	50	2,770,350
Brick Township MUA Brick Twp	80,494	40	2,216,280
NJAWCO Swimming River Plant Lakewood Twp	61,925	30	1,662,210
Jackson Twp MUA	28,000	20	1,108,140
Manchester Twp Water Utility	26,877	20	1,108,140
Lacey Twp MUA	26,240	20	1,108,140
Long Beach Twp Brant Beach	25,295	20	1,108,140
Lavallette Water Dept Lavallette	25,000	20	1,108,140
Little Egg Harbor Twp MUA	22,075	20	1,108,140
Beach Haven Water Dept	20,000	20	1,108,140
Seaside Heights Water Dept.	20,000	20	1,108,140
Stafford Twp Water	19,812	19	1,052,733
Point Pleasant Water Dept.	19,600	19	1,052,733
Lakewood Twp MUA	17,201	17	941,919
Barnegat Twp Water Sewer	15,300	15	831,105
Crestwood Village W Co Manchester Twp	15,163	15	831,105
Seaside Park Water Dept.	15,000	15	831,105
Surf City Water Dept.	12,000	12	664,884
Aqua NJ Eastern Division Berkeley Twp	12,000	12	664,884
Ship Bottom Water Dept.	12,000	12	664,884
Point Pleasant Beach Water Dept.	12,000	12	664,884
Ocean Twp MUA	10,981	10	554,070
Beachwood Water Dept	10,765	10	554,070
NJ American Water Co-Ortley Beach	10,000	10	554,070
Harvey Cedars Water Dept.	9,900	9	498,663
Berkeley Twp MUA	8,960	8	443,256
Tuckerton Water & Sewer Dept.	6,285	6	332,442
NJ American Water Co. Ocean Co. Lakewood Twp	4,835	5	277,035
Shore Water Company Berkeley Twp	4,800	5	277,035
Barnegat Light Water Dept.	4,148	4	221,628
Naval Air Eng. Station	3,200	3	166,221
Ocean Gate Water Dept.	3,200	3	166,221
Lakehurst Water Dept.	2,250	2	110,814
Cedar Glen Lakes Water Co.	2,060	2	110,814
Long Beach Twp Water Dept.	2,000	2	110,814
Pine Beach Water Dept.	1,950	2	110,814
Island Heights Water Dept.	1,750	2	110,814
Stafford Twp MUA	1,553	2	110,814
Pinewood Estates-Barnegat Twp.	1,493	2	110,814
New Egypt Water Company	1,416	2	110,814
Long Beach Twp High Bar Harbor	1,230	2	110,814
Cedar Glen West Water Co Manchester Twp.	1,190	2	110,814
Jackson Twp Water Dept.	816	2	110,814
Long Beach Twp North Beach	800	2	110,814
Cedar Glen Homes Inc Manchester Twp	800	2	110,814
South Wind Mobile Home Jackson Twp	625	1	55,407
Oak Tree Mobile Home Park Jackson Twp	516	1	55,407
Manchester Manor Nursing	475	1	55,407
Manchester Twp Water Lacey Road	450	1	55,407
Jackson Estates Mobile Home Park	440	1	55,407
Jensen's Deep Run	400	1	55,407
Crystal Lake Health Care	382	1	55,407
NJ American Water Co.-Pelican Island	300	1	55,407
<b>Total</b>		<b>535</b>	<b>29,642,745</b>

## Appendix - Employment Codes by Industry, 2009

(U. S. Bureau of Labor Statistics)

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

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

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

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



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