Abstract: The Barnegat Bay watershed in Ocean County, New Jersey includes a valuable estuary and ecosystems where tourism fuels a $4 billion annual economy and $432 million in state and local income taxes with $95.1 billion in property tax ratables. The annual economic value of the Barnegat Bay watershed is at least $4 billion based on estimates of economic activity, ecosystem services, and jobs and wages related to the waters of the watershed. The Barnegat Bay watershed contributes $4 billion in annual economic activity from public parks ($1.8 billion), recreation ($1.5 billion), water quality (245 million), forests ($208 million), fish/wildlife ($189 million), water supply ($59 million), and agriculture ($12 million) benefit. The value of natural goods and services from ecosystems in the Barnegat Bay watershed is Delaware Basin is $2.3 billion from freshwater wetlands ($908 million or $13,621/ac), marine/bay ($778 million or $10,005/ac), forests ($282 million or $1,978/ac), and saltwater wetlands ($155 million or $7,236/ac) that provide the highest ecosystems goods and services values. The Barnegat Bay watershed supports over 60,000 direct and indirect jobs with over $2 billion in annual wages in the coastal, fishing/hunting/birding, farm, tourism, recreation, water/wastewater, and watershed sectors. This research demonstrates the Barnegat Bay watershed provides significant economic benefits to the region and is worthy of investments by elected officials and decision-makers to protect and restores these estuarine resources.
March 8, 2018

Editor
Estuaries & Coasts
Journal of the Coastal & Estuarine Research Federation

Dear Colleague:

Thank you for the opportunity to submit the enclosed manuscript “Economic Value of the Estuary and Ecosystems in the Barnegat Bay Watershed” for review and publication in an upcoming edition of Estuaries & Coasts.

Warmly,

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School of Public Policy and Administration
Newark, Delaware 19716
Economic Value of the Estuary and Ecosystems in the Barnegat Bay Watershed

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School of Public Policy and Administration
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Abstract: The Barnegat Bay watershed in Ocean County, New Jersey includes a valuable estuary and ecosystems where tourism fuels a $4 billion annual economy and $432 million in state and local income taxes with $95.1 billion in property tax ratables. The annual economic value of the Barnegat Bay watershed is a least $4 billion based on estimates of economic activity, ecosystem services, and jobs and wages related to the waters of the watershed. The Barnegat Bay watershed contributes $4 billion in annual economic activity from public parks ($1.8 billion), recreation ($1.5 billion), water quality (245 million), forests ($208 million), fish/wildlife ($189 million), water supply ($59 million), and agriculture ($12 million) benefit. The value of natural goods and services from ecosystems in the Barnegat Bay watershed is Delaware Basin is $2.3 billion from freshwater wetlands ($908 million or $13,621/ac), marine/bay ($778 million or $10,005/ac), forests ($282 million or $1,978/ac), and saltwater wetlands ($155 million or $7,236/ac) that provide the highest ecosystems goods and services values. The Barnegat Bay watershed supports over 60,000 direct and indirect jobs with over $2 billion in annual wages in the coastal, fishing/hunting/birding, farm, tourism, recreation, water/wastewater, and watershed sectors. This research demonstrates the Barnegat Bay watershed provides significant economic benefits to the region and is worthy of investments by elected officials and decision-makers to protect and restore these estuarine resources.

Keywords: watershed; estuary; ecological economics; ecosystem services

Introduction

Many economists agree that water is an undervalued resource. The dilemma inherent in defining the economic value of water goes back two centuries to the 1776 Wealth of Nations when Adam Smith described the “diamond-water paradox” (EPA 2012). If water is more valuable to society than a precious gem, then why is drinking water sold for a penny per 100 gallons or not valued at all as an ecological resource in the river? Society tends to underprice water based on its marginal value for single uses (i.e. drinking water) and not consider the full value for all of its myriad uses. If water is society’s most valuable substance, then the Barnegat Bay in coastal New Jersey that holds 6.4 billion gallons of salt water is an invaluable economic resource.

Natural systems provide substantial economic value in terms of ecosystems goods and services (Table 1). The estimated annual value of global natural capital ranges from $33 trillion (Costanza et al. 1997) to $125 trillion (Costanza et al. 2014). Ingraham and Foster (2008) concluded the ecosystem services value of the U.S. National Wildlife Refuge System was $27 billion. The New Jersey Department of Environmental Protection (NJDEP) found the value of habitat in the Garden State was $20 billion (Mates and Reyes 2007). The Greeley-Polhemus Group (1993) estimated the Delaware Estuary supported $24 billion in sales and $25 million in sport fishing non-market value. Watersheds and ecosystems in the First State of Delaware are valued at $6.7 billion annually (Narvaez et al. 2012).
Table 1. Economic Value of Nature and Ecosystems Around the World

<table>
<thead>
<tr>
<th>Setting</th>
<th>Value</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>World-wide</td>
<td>$33 trillion</td>
<td>Costanza et al. 1997</td>
</tr>
<tr>
<td>World-wide</td>
<td>$125 trillion</td>
<td>Costanza et al. 2014</td>
</tr>
<tr>
<td>U.S. National Wildlife Refuge System</td>
<td>$27 billion</td>
<td>Ingraham and Foster 2008</td>
</tr>
<tr>
<td>New Jersey</td>
<td>$20 billion</td>
<td>Mates and Reyes 2007</td>
</tr>
<tr>
<td>Delaware Estuary</td>
<td>$24 billion</td>
<td>Greeley-Polhemus Group 1993</td>
</tr>
<tr>
<td>Delaware</td>
<td>$6.7 billion</td>
<td>Narvaez et al. 2012</td>
</tr>
</tbody>
</table>

Watersheds have significant economic value and restoration of these resources can result in favorable benefit-cost ratios for society. The University of Maryland reported in 1988 that the Chesapeake Bay was worth $678 billion and the Chesapeake Blue Ribbon Panel (2003) reported with the rise in the cost of living the value of the bay exceeded $1 trillion. The Brookings Institution (Austin et al. 2007) estimated restoration of the Great Lakes would cost $26 billion and provide tourism, fishing, recreation, property value, and water treatment benefits that would exceed $50 billion, a 2:1 benefit/cost ratio. The Everglades Foundation concluded the Comprehensive Everglades Restoration Plan (CERP) would provide $6 billion in benefits with a benefit/cost ratio of 4:1 and generate 443,000 jobs over 50 years (McCormick 2010).

Previous studies indicate the Barnegat Bay watershed and its rivers, beaches, wetlands, and forests in Ocean County, New Jersey have long supported a multi-billion-dollar coastal tourism, recreation, and hunting/fishing/birding economy (Table 2). 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 tourists expended $1.67 billion annually in Ocean County and accounted for 51,300 jobs with $726 million in wages. Approximately 45 miles or one third 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).

New Jersey has 130 miles of Atlantic Ocean coast that supports $8 billion in coastal tourism expenditures and $1 billion in commercial fishing and aquaculture revenue (New Jersey Division of Travel and Tourism 2011). Ocean County ranked 3rd highest in the state 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. Ocean County tourism contributed $432 million in state and local taxes in 2011 with $295 million from 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. Previous Estimates of Economic Value in the Barnegat Bay watershed

<table>
<thead>
<tr>
<th>Source</th>
<th>Sector</th>
<th>Spending</th>
<th>Jobs</th>
</tr>
</thead>
<tbody>
<tr>
<td>BBNEP 2002</td>
<td>Tourism</td>
<td>$1.71 billion</td>
<td>45,000</td>
</tr>
<tr>
<td>Longwoods International 1988</td>
<td>Tourism</td>
<td>$1.67 billion</td>
<td>51,300</td>
</tr>
<tr>
<td>Ocean County Planning Board 2011</td>
<td>Tourism</td>
<td>$3.35 billion</td>
<td></td>
</tr>
<tr>
<td>Ocean Co. Board of Taxation 2012</td>
<td>State/local taxes</td>
<td>$727 million</td>
<td></td>
</tr>
</tbody>
</table>
Economic benefits as discussed herein are defined as the maximum dollar value of goods and services that individuals are voluntarily willing to pay (WTP) for improved water quality (Cech 2005). In environmental economics, WTP measures how much people are willing to pay for a given good or service regardless of whether they actually pay or not (Goulder and Kennedy 1997). Consumer surplus is the area under the demand (marginal benefit) curve above its price (or value) measured by the difference between the amount individuals actually pay and the amount they are willing to pay for a benefit such as clean drinking water or enhanced fishing due to improved water quality (Figure 1). That is, consumer surplus is the amount people are willing to pay above the price they pay for it (Thurston et al. 2009). If an individual is willing to pay $6.00 per 1000 gallons for drinking water and the price is $5.00, the consumer surplus is $1.00.

![Consumer Surplus Diagram](image)

**Figure 1.** Consumer Surplus as Willingness to Pay for Improved Water Quality

**Research Objectives**

The following research quantifies the multi-objective value of water *in toto* for its wide range of habitat, recreation, water quality, and water supply uses in the Barnegat Bay watershed in Ocean County, New Jersey along the Atlantic coast of the United States. The objective of this research is to estimate the economic value of the Barnegat Bay watershed as: (1) economic activity derived from market and nonmarket use and nonuse value of water supply, recreation, fishing, hunting boating, ecotourism, agriculture, and navigation sectors, (2) ecosystem services value (natural capital) of goods and services provided by habitat such as wetlands, forests, farms and open water, and (3) jobs/wages directly and indirectly associated with the bay and its tributaries.

**The Barnegat Bay Watershed**

The Barnegat Bay has always been a prosperous place ever since the indigenous people of the coast, the Lenni Lenape, subsisted on oysters, clams, mussels, fish, muskrat, deer, otter, and bird
eggs. 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 (see Cape May, NJ) drew a 1614 map that 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 19th 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 20th 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.

As nominated by the Governor of New Jersey, Congress directed the Environmental Protection Agency to designate the Barnegat Bay as an Estuary of National Significance as part of the National Estuary Program on July 10, 1995 (BBNEP 2002). The 670-square mile Barnegat Bay watershed is home to 576,000 year-round and 1.5 million summer residents in 33 towns in Ocean County and several towns in Monmouth and Burlington Counties, New Jersey. The Barnegat Bay watershed is flat to gently rolling with elevations that range from 100 feet in the sandy Pine Barren forests in the interior to sea level where the streams flow east into the bay (Figure 2).

The Barnegat Bay is a 96-square mile coastal lagoon covering the mouth of the bay itself (64.5 mi²), Little Egg Harbor (20.5 mi²), Great Bay (7.6 mi²), and Manahawkin Bay (3.6 mi²). Barnegat Bay is a shallow (3 to 23 feet deep), 43-mile-long lagoon estuary with 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 2. Land cover in the Barnegat Bay watershed in 2006 (NJDEP)

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 3). Between 2002 and 2007, the watershed lost 11 mi\(^2\) of forest, 0.8 mi\(^2\) of agriculture, and 0.8 mi\(^2\) of wetlands and gained 12.2 mi\(^2\) of urban land (Figure 4).

![Land Use in the Barnegat Bay watershed, 2007](image1)

**Figure 3.** Land use in the Barnegat Bay watershed, 2007 (NOAA CSC 2007)

![Land Use Change in the Barnegat Bay Watershed, 2002-2007](image2)

**Figure 4.** Land use change in the Barnegat Bay watershed, 2002-2007 (NOAA CSC 2007)

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. During this period, Ocean County gained the most population of any county in New Jersey (Figure 5). In 2010, total employment in Ocean County was 236,590 with most jobs provided by health care, government, and retail.
Methods

This research quantifies the economic value of the Barnegat Bay watershed based on three levels of analysis: (1) annual economic activity, (2) ecosystems good and services, and (3) basin-related jobs and wages. The study area is defined by the hydrologic boundaries of the Barnegat Bay watershed from the headwaters in the Pine Barrens of Central New Jersey in Ocean County and Monmouth County and extending east to the two inlets to the Atlantic Ocean at Barnegat Light and Little Egg Harbor including the bay and coastal barrier islands. We gathered from data 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, and ArcGIS map layers of census blocks.

When primary ecological valuation data from the Barnegat Bay watershed was not available, benefits transfer was used to translate data from other sites to the study area. Benefits transfer involves extrapolating benefits calculated by previous studies in other sites to the watershed in question with appropriate adjustments (EPA 2012). Benefits transfer is relatively inexpensive to implement, however, it must be applied carefully to avoid double-counting of benefits (Table 3). The benefit transfer method is most reliable when the original site and study area have similar characteristics, water quality change is similar for the two sites, and the original study used sound valuation techniques (WBCSD 2011). While it has limitations, the benefits transfer method is used here to estimate economic benefits in the Barnegat Bay watershed.

Table 3. Strengths and Weaknesses of the Benefits Transfer Approach (EPA 2012 and WBCSD 2011)

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relatively inexpensive and quick to implements</td>
<td>Must be applied transparently to avoid double counting</td>
</tr>
<tr>
<td>Most reliable when original site and study site are similar.</td>
<td>Benefits transfer only as good as the original study site</td>
</tr>
<tr>
<td>Used when too expensive or not enough time to conduct original valuation study for watershed</td>
<td>Higher degrees of uncertainty</td>
</tr>
</tbody>
</table>
The first step in benefits transfer is to identify existing study values that can be utilized for the site in question (EPA 2010). The second step is to decide whether existing values are transferable based on several criteria. Is the benefit valued comparable to the value in the existing studies? The third step is to evaluate the quality of transferred studies. If the quality of the initial study is good, then the transferred value will be more accurate. The final step is to adjust original values to reflect the characteristics of the study site. To transfer data to the Delaware River, benefits are defined based on the population in the basin who benefit from improved water quality.

Benefits are converted to 2010 dollars based on the average annual change (3%) in the Consumer Price Index (CPI) in the Northeast Region from 1991-2010 as reported by the Bureau of Labor Statistics using the following formula. The discount rate of 3% was chosen as representative of the change in interest rates for borrowing over a 20-year period up to and including the base year of 2010.

\[ B_{\$2010} = B_b(1+r)^t \]

Where:
- \( B_{\$2010} \) = Benefit in 2010 dollars
- \( B_b \) = Benefits estimated for the base year from the literature
- \( r \) = Annual change in Consumer Price Index (3%)
- \( t \) = Time in years counted from the base year through 2010

**Annual Economic Activity:** For the first level of analysis, we estimated the annual value of agriculture, water quality, water supply, fishing, hunting, recreation, boating, ecotourism, and navigation in the basin from population, employment, industrial activity, and land use data. Total economic activity is defined as the sum of direct/indirect use, option, and non-use values (Ingraham and Foster 2008). Direct use values are from natural goods such as drinking water, boating, recreation, and commercial fishing. Indirect 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 improved water quality or knowing that the scenic value of the bay will be preserved. Nonuse (existence) values accrue to a public who may never visit the resource but are willing to pay to preserve the resource for future generations.

Valuation methods include avoided cost which accounts for the costs if certain ecosystems are not present or lost such as the loss of wetlands that may increase economic flood damages. Replacement costs account for natural services lost and replaced by more expensive manmade systems, for instance, forests provide water filtration benefits that are replaced by costly water filtration plants. Net factor income by enhancement of income is derived where improved water quality water enhances fisheries and crabbing industries and, in turn, boosts jobs and wages. Travel cost involves visitors willing to pay to travel and visit ecosystems and natural resources for hunting, fishing, and birding. The hedonic pricing method involves residents willing to pay more for property values that are higher along scenic bay and river coastlines. Contingent valuation surveys estimate how much people may be willing to pay more in source water fees.
Ecosystem Goods and Services: For the second level of analysis, we tabulated the natural capital or value of habitat in the watershed such as wetlands, forests, farmland, and open water. Ecosystem services (ecological services) are provided by nature and represent benefits such as water filtration, flood reduction, and drinking water supply. Using GIS, we defined ecosystem areas using 2006 NOAA Coastal Services Center land cover data for wetlands, marine, farmland, forest, barren, urban, beach/dune, and riparian buffer habitats.

Ecological resources provide marketable goods and services such as timber, water, and fish and wildlife and equipment for recreation, hiking, and boating/kayaking. Natural capital are goods (commodities like water, crops, and timber that can be sold) and services (functions such as flood control, water filtration, and wildlife/fisheries habitat) provided by ecosystems such as wetlands, forests, farms, and open water. Ecosystems provide benefits for hunters, fishermen, boaters, and hikers who spend money to visit natural sites due to improved water quality.

Ecosystem services were estimated using value (benefits) transfer where published data and literature from other watersheds are transferred to the resource in question (the Delaware Basin). We computed ecosystem services value by multiplying land use area by the ecosystem value ($/acre). Value transfer involves selecting data from published literature from another watershed and applying the dollar per acre values to the basin in questions. While primary research data from the Delaware Basin is preferable and used where available in this analysis, value transfer is a practical way to value ecosystems especially when in the absence of such data the worth of ecosystems have previously been deemed zero. Values from previous studies were adjusted to $2010 based on 3% change in consumer price index (CPI) annually. Net present values were calculated based on an annual discount rate of 3% in perpetuity (over 100 years in the future).

Jobs and Wages: For the third level of analysis, we obtained employment and wage data from the U. S. Department of Labor, U. S. Census Bureau, and National Ocean Economics Program and calculated direct/indirect jobs by North American Industry Classification System (NAICS) code for shipbuilding, marine transportation/ports, fisheries, recreation, minerals, trade, agriculture, and other industries tied to the function of the rivers. Jobs/wages were scaled for each basin county from census block data. NAICS data were supplemented with farm jobs data from the USDA Agricultural Statistics Bureau, U. S. Fish and Wildlife Service ecotourism jobs data, and water supply and wastewater treatment utilities. Jobs and salaries were obtained from U. S. Bureau of Labor Statistics and U. S. Census Bureau data bases for the following scenarios:

- Total jobs in each county within the watershed classified by NAICS industry code (formerly SIC code) and then grouped by census tract.
- Direct watershed-related jobs such as water/sewer construction, living resources, maritime, tourism/recreation, ports, environmental services, and water/wastewater management for each NAICS code by state and county within the basin boundary.
- Indirect jobs/wages from purchases of goods/services by direct jobs earners in the watershed in the interlinked regional economy. Indirect jobs were estimated by multipliers of 2.2 applied to direct jobs and 1.8 to direct wages (Latham and Stapleford 1987), i.e. 100 direct jobs support 120 indirect jobs and direct wages of $1,000 provide $800 indirect wages.
Results

**Annual Economic Activity:** The value of the economy and ecology in the Barnegat Bay watershed exceeds $4 billion from public parks ($1.8 billion), recreation ($1.5 billion), water quality (245 million), forests ($208 million), fish/wildlife ($189 million), water supply ($59 million), and agriculture ($12 million) benefits (Table 4 and Figure 6).

<table>
<thead>
<tr>
<th>Activity</th>
<th>2010 ($ million)</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Recreation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boating ($30.00/trip)</td>
<td>28</td>
<td>Johnston et al. 2002, Leeworthy and Wiley 2001</td>
</tr>
<tr>
<td>Outdoor Recreation (228,000 participants)</td>
<td>256</td>
<td>Outdoor Industry Association 2006</td>
</tr>
<tr>
<td>Power-Boating (22,505 registered boaters)</td>
<td>590</td>
<td>Marine Trades Assn. of New Jersey 2008</td>
</tr>
<tr>
<td>Beach Visits ($27.66/visitor day along 45 mile coast)</td>
<td>395</td>
<td>Parsons et al. 1999, Seneca 2011</td>
</tr>
<tr>
<td><strong>Water Quality</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boatable (WTP 13.20/p., 576,000–1,500,000 pop.)</td>
<td>20</td>
<td>Helm, Parsons, and Bondelid 2003</td>
</tr>
<tr>
<td>Fishable (WTP 13.22/p., 576,000–1,500,000 pop.)</td>
<td>20</td>
<td>Helm, Parsons, and Bondelid 2003</td>
</tr>
<tr>
<td>Swimmable (WTP $112.75/p., 576,000–1,500,000 pop.)</td>
<td>170</td>
<td>Helm, Parsons, and Bondelid 2003</td>
</tr>
<tr>
<td>Water Treatment by Forests ($75/mgd)</td>
<td>2</td>
<td>Trust for Public Land and AWWA 2004</td>
</tr>
<tr>
<td>Wastewater Treatment (no discharges to bay)</td>
<td>0</td>
<td>Ocean County 2010</td>
</tr>
<tr>
<td>Increased Property Value (+8% over 20 years)</td>
<td>33</td>
<td>EPA 1973, Brookings Institute 2010</td>
</tr>
<tr>
<td><strong>Water Supply</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drinking Water Supply ($1.168/1,000 gallons)</td>
<td>23</td>
<td>USGS 2005, NJWSA 2012</td>
</tr>
<tr>
<td>Irrigation Water Supply ($300/acre-foot)</td>
<td>1</td>
<td>USDA 2009, Frederick et al. 1996</td>
</tr>
<tr>
<td>Thermoelectric-Power Water Supply ($44 acre-foot)</td>
<td>34</td>
<td>Frederick et al. 1996, USGS 2005</td>
</tr>
<tr>
<td>Industrial Water Supply ($200/acre-foot)</td>
<td>1</td>
<td>Frederick et al. 1996, USGS 2005</td>
</tr>
<tr>
<td><strong>Fish/Wildlife</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commercial Fish Landings ($0.60/lb)</td>
<td>49</td>
<td>NMFS, NOEP 2010</td>
</tr>
<tr>
<td>Fishing (11-18 trips/angler, $17-$53/trip)</td>
<td>58</td>
<td>U.S. Fish and Wildlife Service 2007</td>
</tr>
<tr>
<td>Hunting (16 trips/hunter, $16-50/trip)</td>
<td>11</td>
<td>U.S. Fish and Wildlife Service 2007</td>
</tr>
<tr>
<td>Forsythe National Wildlife Refuge, 196,000 visits/yr</td>
<td>4</td>
<td>Carver and Caudill 2007</td>
</tr>
<tr>
<td>Hard Clams (15,000 lb @ $5.50/lb)</td>
<td>0.1</td>
<td>NMFS</td>
</tr>
<tr>
<td>Blue Crab (7 million lb @ $1.10/lb)</td>
<td>1</td>
<td>NMFS, NOEP 2010</td>
</tr>
<tr>
<td>Summer Flounder ($10.26/trip, 2.5 million trips) trips/yr)</td>
<td>25</td>
<td>Liggett in Bricker et al. 2007, Lipton 2006</td>
</tr>
<tr>
<td><strong>Agriculture</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nursery, crop, poultry, livestock value ($2,600/ac)</td>
<td>12</td>
<td>USDA Census of Agriculture 2009</td>
</tr>
<tr>
<td><strong>Forests</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carbon Storage (176,000 ac @ $827/ac)</td>
<td>145</td>
<td>Nowak et al. 2008</td>
</tr>
<tr>
<td>Carbon Sequestration (176,000 ac @ $29/ac)</td>
<td>5</td>
<td>Nowak et al. 2008</td>
</tr>
<tr>
<td>Air-Pollution Removal (176,000 ac @ $266/ac)</td>
<td>47</td>
<td>Nowak et al. 2008</td>
</tr>
<tr>
<td>Building Energy Savings (176,000 ac @ $56/ac)</td>
<td>10</td>
<td>Nowak et al. 2008</td>
</tr>
<tr>
<td>Avoided Carbon Emissions (176,000 ac @ $3/ac)</td>
<td>1</td>
<td>Nowak et al. 2008</td>
</tr>
<tr>
<td><strong>Public Parks</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>State Parks ($21/visit, 32,601 acres)</td>
<td>27</td>
<td>Mates and Reyes 2006</td>
</tr>
<tr>
<td>Health Benefits ($9,734/ac)</td>
<td>1,313</td>
<td>Trust for Public Land 2009</td>
</tr>
<tr>
<td>Community Cohesion ($2,383/ac)</td>
<td>321</td>
<td>Trust for Public Land 2009</td>
</tr>
<tr>
<td>Stormwater Benefit ($921/ac)</td>
<td>124</td>
<td>Trust for Public Land 2009</td>
</tr>
<tr>
<td>Air-Pollution Control ($88/ac)</td>
<td>12</td>
<td>Trust for Public Land (2009)</td>
</tr>
<tr>
<td><strong>Barnegat Bay Watershed</strong></td>
<td>&gt;4 billion</td>
<td></td>
</tr>
</tbody>
</table>

Note: Total economic value is rounded down to avoid double-counting.
Recreation: Travel cost demand data transferred from the Peconic Estuary (Johnston et al. 2002) indicate the annual consumer surplus for swimming, boating, fishing, and bird watching/wildlife viewing totals $260 million given recreation activity in the bay watershed accounts for 883,000 participants and 11.1 million visitor days annually (Leeworthy and Wiley 2001). Paddling-based recreation such as canoeing, kayaking, and rafting in the Barnegat Bay watershed involves 228,000 participants, $257 million in gear retail and trip sales, and 3,029 jobs based on scaled estimates by population from the Outdoor Industry Association (2006). Recreational boating supported 182 marinas in the watershed (Ocean County Planning Department 2011) and 19,000 boats in commercial boats in storage. The Barnegat Bay ranked No. 1 as the most popular boating area in New Jersey with 22,505 registered boaters that represent 28% of all the boats registered in the Garden State. Recreational boating contributes $590-$740 million annually to the Barnegat Bay economy and is responsible for 5,000-6,300 jobs (Marine Trades Association of New Jersey (2008).

New Jersey had 3,965,000 annual ocean beach visits for a total of 40,881,000 beach visitor days (Seneca 2011). If the mean beach travel cost is $27.66 per visitor day in 2010 dollars (Kline and Swallow 1998, Leeworthy and Wiley 1991, Parsons et al 1999) and Ocean County beaches cover 45 miles or 35% of New Jersey’s 130-mile ocean coast, then the scaled economic value of beach visits to the Barnet Bay watershed is $395 million.
Water Quality: Swimmable ($65 to $169 million), fishable ($8 to $20 million), and boatable ($8 to $20 million) benefits due to improved water quality range from $80 to $209 million ($139 per person) for a watershed population that varies from 576,000 year-round to 1,500,000 during the summer as scaled from Helm, Parsons, and Bondelid (2003) in 2010. Loss of forests that occupy 36% of the Barnegat Bay watershed would increase treatment costs for public water supplies by $1.5 million/yr given that for every 10% increase in forest area, water treatment costs decline by 20% (Trust for Public Land and AWWA, 2004). There are no wastewater treatment plant discharges to the Barnegat Bay therefore the bay is not called upon to provide wastewater assimilation services. Property valued at $283,000/ac) within 2000 feet of the 119-mile bay shoreline will increase 8% by $653 million or $33 million/yr over 20 years due to water quality improvements in the Barnegat Bay watershed (EPA, 1973).

Water Supply: The annual economic value of water supplies withdrawn from the Barnegat Bay watershed is $59 million. The value of public drinking water supplies in the bay watershed (54.5 mgd) is $23.2 million based on the value of raw (untreated) public water supply in the Manasquan system at $1,168 per million gallons (NJWSA 2012). Irrigation withdrawals mainly for corn, soybean, and vegetable crops is rising due to warmer temperatures during the summer and the value is based on withdrawals of 4.2 mgd (USGS 2005) is $1.4 million/year given the median value of irrigation withdrawals is $0.92/1000 gal) in $2010 from Frederick et al. (1996). The economic value of water to irrigate 4,423 acres of cropland (USDA 2009) in Ocean County is $240,000 based on irrigation water needs of 9 inches from June through September at a unit value of $300/acre-foot (Frederick et al. 1996). The Oyster Creek Nuclear Generating Station withdraws 662 mgd of non-contact cooling water from the bay watershed and value of thermoelectric power plant water withdrawals is $34 million/yr based on a unit value of $0.14/1000 gallons from Frederick et al. (1996). The annual value of industrial water supply withdrawals (3.1 mgd) in the bay watershed (USGS 2005) is $690,000 based on a unit value of $200/ac ft adjusted to $2010 from Frederick et al. (1996).

Fish/Wildlife: The annual economic value of fish and wildlife in the Barnegat Bay watershed is $189 million. The annual value of commercial fish landings from the 32nd (Barnegat Light) and 36th (Point Pleasant) most valuable fishing ports in the U.S. was $48.6 million in 2010 according to the National Marine Fisheries Service (NOEP 2010). Scaled by ratio of watershed area to state area, the annual value of trip and gear expenditures for fishing ($57.9 million), hunting ($11.2 million), and wildlife/birding viewing recreation ($41.4 million) is $110.5 million in the bay watershed (USFWS 2007). 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 the monetary value from recreational visitor spending was $4.4 million which contributed to 41 jobs with $1.5 million in annual wages (Carver and Caudill (2007).

NMFS data indicates hard clam landings dropped from 1.2 million lb in 1970 to 15,000 lb in 2005 where at $5.50/lb, hard clam landings (15,000 lb) had an estimated value of $82,500. 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 and if blue crab landings in the Barnegat Bay total about 15% of New Jersey’s total commercial catch, the estimated value of the bay’s blue crab fishery is $825,000. A study of the value of mid-Atlantic recreational fisheries estimated a. Summer flounder accounts for 2.5 million trips or 42% of 5.9 million
inland fishing trips in the Barnegat Bay, therefore, at a $10.26 benefit due to increased catch per trip, the estimated benefit to summer flounder fishers from improved water quality in Barnegat Bay is $25.4 million/year (Ligget in Bricker et al. 2007, Lipton 2006, McConnell and Strand 1994).

Agriculture: 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.

Forests: The U. S. Forest Service and Delaware Center for Horticulture (Nowak et al., 2008) estimated forests in New Castle County, Delaware have carbon storage ($79/ac), carbon sequestration ($29/ac), air pollution removal ($266/ac), building energy savings ($56/yr), and avoided carbon emissions ($3/ac) benefit of $5.9 million ($827/ac) and air pollution removal of $1.9 million ($266/ac/yr). Applying these per acre multipliers, 176,320 forested acres in the Barnegat Bay watershed provide economic benefits that total $208 million/yr. These economic benefits in carbon, air pollution, and energy savings are quite significant as 34% of the bay watershed is covered by forests.

Parks: Mates and Reyes (2007) 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.

Public parks on 135,000 acres provide $1.8 billion in annual economic value to the Delaware River Basin. The Trust for Public Land (2009) found the City of Wilmington park system provides annual economic savings to the public due to health benefits from exercise in the parks ($9,734/ac), community cohesion benefit from socializing in the parks ($2,383/ac), water pollution benefits from treating stormwater ($921/ac), and air pollution mitigation by tree and shrub absorption ($88/ac). Transferring the unit values from the City of Wilmington study, public parks (135,000 ac) within the Barnegat Bay watershed provide health ($1.3 billion), community cohesion ($321 million), water pollution ($124 million), and air pollution mitigation ($12 million) benefits.

**Ecosystem Services:** Ecosystem services provided by natural habitat 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. Natural capital is the sum of goods (commodities like water, crops, and timber that can be sold) and services (functions like flood control, water filtration, and wildlife/fisheries habitat) provided by watershed ecosystems such as wetlands, forests, farms, and open water. In addition to these direct benefits, ecosystems also provide indirect benefits
such as ecotourism by hunters, fishermen, boaters, and hikers who spend money to visit natural sites and realize value from improved water quality and habitat.

Other studies have defined ecosystem services in areas near the Barnegat Bay watershed (Table 5). A Cecil County, Maryland study by the Conservation Fund found that riparian forest wetlands provide significant stormwater/flood control ($32,000/ac), water supply ($8,630/ac), and clean water ($1,925/ac) functions (Weber 2007). The NJDEP and University of Vermont estimated the value of New Jersey’s natural capital was $20 billion/yr (+/- $9 billion/year) in $2004 with a net present value of $681 billion based on a discount rate of 3% calculated over 100 years in the future (Mates and Reyes 2007). The Wilderness Society (Krieger 2001) concluded temperate forest ecosystem services from climate regulation, water supply, water quality, and recreation totaled $392/ac in $1994. A contingent value study by University of Rhode Island economists found natural resources values in the Peconic Estuary watershed on Long Island in New York ranged from $6,560/ac for wetlands to $9,979/ac for farmland in $1995 (Johnston et al. 2002). Ingraham and Foster (2008) from the University of Maryland determined ecosystem values of forests and freshwater wetlands in the National Wildlife Refuge System were $845/ac and $6,268/ac, respectively. 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 market value of agricultural crops, poultry, and livestock sold from 4,423 acres of farmland in Ocean County within the Barnegat Bay watershed was $11.5 million ($9.3 million in crops and $2.2 million in livestock/poultry) or $2,600/ac (USDA 2009).

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Freshwater wetland</td>
<td>43,685</td>
<td>11,802</td>
<td>6,268</td>
<td>15,452</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farmland</td>
<td>8,670</td>
<td></td>
<td>9,979</td>
<td>1,387</td>
<td>2,600^1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forest land</td>
<td>12,033</td>
<td>1,714</td>
<td>641</td>
<td>845</td>
<td>984</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saltwater wetland</td>
<td>28,146</td>
<td>6,269</td>
<td>6,560</td>
<td>12,580</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Undeveloped</td>
<td></td>
<td></td>
<td>2,080</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban</td>
<td>296</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beach/dune</td>
<td>42,149</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Open freshwater</td>
<td>1,686</td>
<td></td>
<td>217</td>
<td>983</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Riparian buffer</td>
<td>52,765</td>
<td>3,500</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shellfish areas</td>
<td></td>
<td></td>
<td></td>
<td>4,555</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


The estimated value of natural goods and services provided by ecosystems in the Barnegat Bay watershed (428,639 ac or 670 mi^2) is $2.3 billion (in 2010 dollars) with a net present value (NPV) of $73.3 billion based on an annual interest rate of 3% (Table 6). If lowest or highest per acre estimates of ecosystem services values from other studies were employed for value transfer in place of the NJDEP values, the value of natural resources in the Barnegat Bay watershed would range from $1.4 billion to $6.0 billion. Ecosystems within the Barnegat Bay watershed...
(Figure 7) are comprised of forests (34%), open water/marine (18%), freshwater wetlands (16%), saltwater wetlands (5%), and farmland (1%). Over 24% of the Barnegat Bay watershed is urban. Freshwater wetlands ($908 million or $13,621/ac), marine/bay ($778 million or $10,005/ac), forests ($282 million or $1,978/ac), and saltwater wetlands ($155 million or $7,236/ac) provide the highest ecosystems goods and services values (Figure 8). The natural capital value of the watershed will decrease if urban land replaces forests which currently cover 1/3 of the drainage area.

Table 6. Ecosystem Services Values in the Barnegat Bay Watershed

<table>
<thead>
<tr>
<th>Ecosystem</th>
<th>Area (ac)</th>
<th>$/ac/yr 2010</th>
<th>PV 2010 $</th>
<th>NPV $</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Low Range</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Freshwater wetlands</td>
<td>66,732</td>
<td>6,268(^5)</td>
<td>418,276,176</td>
<td>13,593,975,720</td>
</tr>
<tr>
<td>Marine</td>
<td>77,789</td>
<td>8,670(^2)</td>
<td>674,430,630</td>
<td>21,918,995,475</td>
</tr>
<tr>
<td>Farmland</td>
<td>4,205</td>
<td>1,387(^6)</td>
<td>5,832,335</td>
<td>189,550,888</td>
</tr>
<tr>
<td>Forest land</td>
<td>142,579</td>
<td>641(^3)</td>
<td>91,393,139</td>
<td>2,970,277,018</td>
</tr>
<tr>
<td>Saltwater wetland</td>
<td>21,449</td>
<td>6,269(^2)</td>
<td>134,463,781</td>
<td>4,370,072,883</td>
</tr>
<tr>
<td>Barren land</td>
<td>9,034</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Urban</td>
<td>103,746</td>
<td>296(^2)</td>
<td>30,708,816</td>
<td>998,036,520</td>
</tr>
<tr>
<td>Beach/dune</td>
<td>1,545</td>
<td>42,149(^2)</td>
<td>65,120,205</td>
<td>2,116,406,663</td>
</tr>
<tr>
<td>Open water</td>
<td>1,560</td>
<td>217(^3)</td>
<td>338,520</td>
<td>11,001,900</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>428,639</td>
<td></td>
<td>1,420,563,602</td>
<td>46,168,317,065</td>
</tr>
<tr>
<td><strong>Mid-Point Estimate</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Freshwater wetlands</td>
<td>66,732</td>
<td>13,621</td>
<td>908,934,190</td>
<td>29,540,361,169</td>
</tr>
<tr>
<td>Marine</td>
<td>77,789</td>
<td>10,005</td>
<td>778,269,265</td>
<td>25,293,751,116</td>
</tr>
<tr>
<td>Farmland</td>
<td>4,205</td>
<td>3,828</td>
<td>16,097,342</td>
<td>523,163,602</td>
</tr>
<tr>
<td>Forest</td>
<td>142,579</td>
<td>1,978</td>
<td>282,038,938</td>
<td>9,166,265,479</td>
</tr>
<tr>
<td>Saltwater wetland</td>
<td>21,449</td>
<td>7,236</td>
<td>155,209,135</td>
<td>5,044,296,887</td>
</tr>
<tr>
<td>Barren land</td>
<td>9,034</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Urban</td>
<td>103,746</td>
<td>342</td>
<td>35,440,983</td>
<td>1,151,831,952</td>
</tr>
<tr>
<td>Beach/dune</td>
<td>1,545</td>
<td>48,644</td>
<td>75,155,098</td>
<td>2,442,540,696</td>
</tr>
<tr>
<td>Open water</td>
<td>1,560</td>
<td>1,946</td>
<td>3,035,462</td>
<td>98,652,528</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>428,639</td>
<td></td>
<td>2,254,180,413</td>
<td>73,260,863,428</td>
</tr>
<tr>
<td><strong>High Range</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Freshwater wetlands</td>
<td>66,732</td>
<td>43,685(^1)</td>
<td>2,915,187,420</td>
<td>94,743,591,150</td>
</tr>
<tr>
<td>Marine</td>
<td>77,789</td>
<td>8,670(^2)</td>
<td>674,430,630</td>
<td>21,918,995,475</td>
</tr>
<tr>
<td>Farmland</td>
<td>4,205</td>
<td>9,979(^4)</td>
<td>41,961,695</td>
<td>1,363,755,088</td>
</tr>
<tr>
<td>Forest</td>
<td>142,579</td>
<td>12,033(^1)</td>
<td>1,715,653,107</td>
<td>55,758,725,978</td>
</tr>
<tr>
<td>Saltwater wetland</td>
<td>21,449</td>
<td>28,146(^1)</td>
<td>603,703,554</td>
<td>19,620,365,505</td>
</tr>
<tr>
<td>Barren land</td>
<td>9,034</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Urban</td>
<td>103,746</td>
<td>296(^2)</td>
<td>30,708,816</td>
<td>998,036,520</td>
</tr>
<tr>
<td>Beach/dune</td>
<td>1,545</td>
<td>42,149(^2)</td>
<td>65,120,205</td>
<td>2,116,406,663</td>
</tr>
<tr>
<td>Open water</td>
<td>1,560</td>
<td>1,686(^2)</td>
<td>2,630,160</td>
<td>85,480,200</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>428,639</td>
<td></td>
<td>6,049,395,587</td>
<td>196,605,356,578</td>
</tr>
</tbody>
</table>

**Figure 7.** Ecosystem service areas in the Barnegat Bay watershed

**Figure 8.** Value of ecosystem services within the Barnegat Bay watershed
Jobs and Wages: The Barnegat Bay watershed supports over 60,000 direct and indirect jobs with over $2 billion in annual wages in the coastal, fishing/hunting/birding, farm, tourism, recreation, water/wastewater, and watershed sectors (Table 7). It is noted that use of indirect jobs benefits is debated in many economic circles. While certainly not nil, indirect jobs benefits calculated by multipliers are summarized here to estimate some part of the spillover effect to the economy from jobs directly related to the waters of the Delaware Basin.

Table 7. Jobs and wages directly and indirectly related to the Barnegat Bay watershed

<table>
<thead>
<tr>
<th>Sector</th>
<th>Jobs</th>
<th>Wages ($ million)</th>
<th>Data Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indirect Watershed-Related</td>
<td>30,756</td>
<td>681</td>
<td>U.S. Census Bureau 2010</td>
</tr>
<tr>
<td>Coastal</td>
<td>11,565</td>
<td>206</td>
<td>National Coastal Economics Program 2010</td>
</tr>
<tr>
<td>Farm</td>
<td>1,045</td>
<td>50</td>
<td>Awokuse et al. 2010</td>
</tr>
<tr>
<td>Fishing/Hunting/Birding</td>
<td>3,364</td>
<td>110</td>
<td>U.S. Fish and Wildlife Service 2008</td>
</tr>
<tr>
<td>National Wildlife Refuge</td>
<td>41</td>
<td>1.5</td>
<td>Carver and Caudill 2007</td>
</tr>
<tr>
<td>Wetlands</td>
<td>360</td>
<td>23</td>
<td>NOAA Coastal Services Center 2011</td>
</tr>
<tr>
<td>Boating</td>
<td>5,000</td>
<td>200</td>
<td>Marine Trades Association of NJ 2008</td>
</tr>
<tr>
<td>Outdoor Recreation</td>
<td>3,029</td>
<td>150</td>
<td>Outdoor Industry Association 2006</td>
</tr>
<tr>
<td>State Parks</td>
<td>539</td>
<td>27</td>
<td>Mates and Reyes 20067</td>
</tr>
<tr>
<td>Watershed Organizations</td>
<td>50</td>
<td>3.1</td>
<td>N. J. Environmental Center and BLS</td>
</tr>
<tr>
<td>Water Supply Utilities</td>
<td>535</td>
<td>30</td>
<td>Ocean County water purveyors</td>
</tr>
<tr>
<td>Wastewater Utilities</td>
<td>50</td>
<td>3</td>
<td>Ocean County Utilities Authority</td>
</tr>
<tr>
<td>Barnegat Bay Watershed</td>
<td>&gt;60,000</td>
<td>&gt;$2 billion</td>
<td></td>
</tr>
</tbody>
</table>

The Barnegat Bay watershed is home to 236,590 nonfarm jobs with $12.7 billion in wages in Ocean County, New Jersey (Bureau of Labor Statistics 2010) as summarized in Table 8. Jobs directly associated with the Barnegat Bay watershed (Table 9) such as water/sewer construction, water utilities, fishing, recreation, tourism, and ports employed 25,630 people with $851 million in wages. Jobs indirectly related to the Barnegat Bay watershed (based on multipliers of 2.2 for jobs and 1.8 for salaries) employed 30,756 people with $681 million in wages.

Table 8. Barnegat Bay watershed jobs and wages in 2010

<table>
<thead>
<tr>
<th>Category</th>
<th>Jobs</th>
<th>Wages ($ million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Ocean County, NJ</td>
<td>236,590</td>
<td>12,700</td>
</tr>
<tr>
<td>Direct Watershed-related</td>
<td>25,630</td>
<td>851</td>
</tr>
<tr>
<td>Indirect Watershed-related</td>
<td>30,756</td>
<td>681</td>
</tr>
</tbody>
</table>
### Table 9. Direct and indirect watershed-related jobs in the Barnegat Bay watershed, 2009

<table>
<thead>
<tr>
<th>Sector</th>
<th>North American Industry Classification System (NAICS)</th>
<th>NAICS code</th>
<th>Direct Watershed Jobs(^1)</th>
<th>Direct Annual Watershed Wages(^2) (x$1000)</th>
<th>Indirect Watershed Jobs(^2)</th>
<th>Indirect Annual Wages(^2) (x$1000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction</td>
<td>Water and sewer construction</td>
<td>23711</td>
<td>0</td>
<td>6,853</td>
<td>0</td>
<td>5,482</td>
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<tr>
<td>Living Resources</td>
<td>Fishing, hunting, trapping</td>
<td>114</td>
<td>43</td>
<td>1,367</td>
<td>52</td>
<td>1,094</td>
</tr>
<tr>
<td></td>
<td>agriculture and forestry</td>
<td>115</td>
<td>21</td>
<td>191</td>
<td>25</td>
<td>153</td>
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<td>Seafood prep./ packaging</td>
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<td>Wines</td>
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<td>Fish and seafood wholesalers</td>
<td>42446</td>
<td>36</td>
<td>1,457</td>
<td>43</td>
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<td>Nursery, garden center, farm</td>
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<td>90</td>
<td>3,970</td>
<td>108</td>
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<td>Fish and seafood markets</td>
<td>44522</td>
<td>24</td>
<td>1,006</td>
<td>29</td>
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<td>Fruit and vegetable markets</td>
<td>44523</td>
<td>22</td>
<td>752</td>
<td>26</td>
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<td>Minerals</td>
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<td>61</td>
<td>3,957</td>
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<td>Electric power generation</td>
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<td>591</td>
<td>14</td>
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<td>Tourism/Recreation</td>
<td>Sporting/recreational goods</td>
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<td>31</td>
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<td>Sporting goods stores</td>
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<td>Recreational goods rental</td>
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<td>Amusement parks and arcades</td>
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<td>Amusement arcades</td>
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<td>Amusement/recreation</td>
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<td>2,402</td>
<td>52,020</td>
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<td>Golf courses(^3)</td>
<td>71391</td>
<td>295</td>
<td>9,029</td>
<td>354</td>
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<tr>
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<td>Marinras</td>
<td>71393</td>
<td>266</td>
<td>12,838</td>
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<td>Fitness/recreational sports</td>
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<td>1,584</td>
<td>20,278</td>
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<td>Amusement/recreation</td>
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<td>129</td>
<td>7,804</td>
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<td>Accommodation</td>
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<td>16,217</td>
<td>719</td>
<td>12,974</td>
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<td>Hotels and motels</td>
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<td>549</td>
<td>14,707</td>
<td>659</td>
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<td>Bed-and-breakfast inns</td>
<td>721191</td>
<td>203</td>
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<td>162</td>
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<tr>
<td></td>
<td>Recreational vehicle, camps</td>
<td>7212</td>
<td>39</td>
<td>1,307</td>
<td>47</td>
<td>1,046</td>
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<td>Full-service restaurants</td>
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<td>5,511</td>
<td>95,445</td>
<td>6,613</td>
<td>76,356</td>
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<td>Limited-service restaurants</td>
<td>722211</td>
<td>3,530</td>
<td>50,991</td>
<td>4,236</td>
<td>40,793</td>
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<td>Snack/beverage bars</td>
<td>722213</td>
<td>693</td>
<td>10,105</td>
<td>832</td>
<td>8,084</td>
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<td>Food service contractors</td>
<td>722211</td>
<td>738</td>
<td>13,705</td>
<td>886</td>
<td>10,964</td>
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<tr>
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<td>Caterers</td>
<td>722320</td>
<td>265</td>
<td>4,613</td>
<td>318</td>
<td>3,690</td>
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<tr>
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<td>Mobile food services</td>
<td>72233</td>
<td>47</td>
<td>445</td>
<td>56</td>
<td>356</td>
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<td>Transportation</td>
<td>Coastal, water transportation</td>
<td>483</td>
<td>305</td>
<td>0</td>
<td>244</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Inland water transportation</td>
<td>4832</td>
<td>15</td>
<td>192</td>
<td>18</td>
<td>154</td>
</tr>
<tr>
<td></td>
<td>Scenic/sightseeing transport.</td>
<td>487</td>
<td>1,603</td>
<td>0</td>
<td>1,282</td>
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<tr>
<td></td>
<td>Marine cargo handling</td>
<td>4883</td>
<td>46</td>
<td>2,363</td>
<td>55</td>
<td>1,890</td>
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<tr>
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<td>Navigational services/shipping</td>
<td>488320</td>
<td>60</td>
<td>1,546</td>
<td>72</td>
<td>1,237</td>
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<tr>
<td></td>
<td>Water transportation</td>
<td>48839</td>
<td>36</td>
<td>1,530</td>
<td>43</td>
<td>1,224</td>
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<tr>
<td>Environmental</td>
<td>Architectural, engineering</td>
<td>541</td>
<td>5,680</td>
<td>290,841</td>
<td>6,816</td>
<td>232,673</td>
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<tr>
<td></td>
<td>Environmental, conservation</td>
<td>813211</td>
<td>151</td>
<td>3,574</td>
<td>181</td>
<td>2,859</td>
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<tr>
<td></td>
<td>Civic and social organizations</td>
<td>8134</td>
<td>122</td>
<td>1,901</td>
<td>146</td>
<td>1,521</td>
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<tr>
<td>Water/Wastewater</td>
<td>Water, sewage systems</td>
<td>2213</td>
<td>129</td>
<td>8,636</td>
<td>155</td>
<td>6,909</td>
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<tr>
<td></td>
<td>Waste management services</td>
<td>562</td>
<td>393</td>
<td>19,443</td>
<td>472</td>
<td>15,554</td>
</tr>
</tbody>
</table>

Total                      |                                                        | 25,630     | 850,965                     | 30,756                      | 680,772                      |

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.
According to the National Ocean Economic program (2010) that tabulates jobs in the Marine Transportation, Tourism and Recreation, Living Marine Resources, Marine Construction, Ship and Boat Building, Mineral Extraction sectors, the coastal economy in Ocean County that covers nearly the entire Barnegat Bay watershed, contributed 145,966 jobs with $5.7 billion in annual wages (Table 10). The Ocean County ocean economy contributed 11,565 jobs with 206 million in wages (Table 11).

### Table 10. Coastal employment, wages, and GDP in Ocean County, New Jersey (NOEP 2010)

<table>
<thead>
<tr>
<th>Sector</th>
<th>Employment</th>
<th>Wages ($ million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction</td>
<td>6,690</td>
<td>324.8</td>
</tr>
<tr>
<td>Financial Activities</td>
<td>5,873</td>
<td>269.4</td>
</tr>
<tr>
<td>Education/Health Services</td>
<td>46,938</td>
<td>2,064.7</td>
</tr>
<tr>
<td>Information</td>
<td>1,151</td>
<td>76.9</td>
</tr>
<tr>
<td>Leisure/Hospitality</td>
<td>18,825</td>
<td>310.4</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>4,500</td>
<td>221.3</td>
</tr>
<tr>
<td>Natural Resources/Mining</td>
<td>264</td>
<td>9.3</td>
</tr>
<tr>
<td>Other Services</td>
<td>5,212</td>
<td>137.0</td>
</tr>
<tr>
<td>Professional/Business</td>
<td>10,873</td>
<td>463.7</td>
</tr>
<tr>
<td>Public Administration</td>
<td>10,434</td>
<td>626.5</td>
</tr>
<tr>
<td>Trade/Transportation/Utilities</td>
<td>33,993</td>
<td>1,132</td>
</tr>
<tr>
<td>Misc.</td>
<td>1,213</td>
<td>31.6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>145,966</strong></td>
<td><strong>5,667,588.5</strong></td>
</tr>
</tbody>
</table>

### Table 11. Ocean/coastal employment, wages, and GDP in Ocean County, New Jersey (NOEP 2010)

<table>
<thead>
<tr>
<th>Sector</th>
<th>Employment</th>
<th>Wages ($ million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marine Construction</td>
<td>181</td>
<td>9.6</td>
</tr>
<tr>
<td>Living Resources</td>
<td>57</td>
<td>1.1</td>
</tr>
<tr>
<td>Minerals</td>
<td>78</td>
<td>4.7</td>
</tr>
<tr>
<td>Tourism &amp; Recreation</td>
<td>11,089</td>
<td>183.5</td>
</tr>
<tr>
<td>Marine Transportation</td>
<td>160</td>
<td>7.2</td>
</tr>
<tr>
<td>Ship and Boat Building</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>11,565</strong></td>
<td><strong>206.1</strong></td>
</tr>
</tbody>
</table>

In 2007 there were 255 farms in Ocean County, New Jersey with in the Barnegat Bay watershed (USDA 2007). The USDA estimates each farm employs 4.1 full time equivalent jobs so farming provides 1,045 jobs with $50.3 million in wages in the bay watershed. The average annual salary per ecotourism job is $32,843 using data from the U.S. Fish and Wildlife Service (2001) report on fishing, hunting, and wildlife associated recreation. If fishing, hunting, and bird/wildlife associated recreation in the Barnegat Bay watershed accounts for $110.5 million in annual economic activity in 2006 dollars, then fishing, hunting, and wildlife associated recreation provides for 3,364 jobs.
Recreational pursuits that rely on clean and plentiful water resources in the Barnegat Bay watershed provide thousands of jobs in the regional economy. The 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 (Carver and Caudill 2007). At an average salary of $32,843, fishing, hunting, and bird/wildlife-associated recreation accounts 3,364 jobs in the Barnegat Bay watershed (USFWS 2007). The NOAA Coastal Services Center (2011) estimates wetlands cover 160 mi² (25%) of Ocean County and support 360 commercial, recreational, and charter fishing jobs in Barnegat Bay watershed with $22.7 million in wages. 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, therefore, by proportion recreational boating in the Barnegat Bay watershed is responsible for 5,000 jobs with $200 million in wages (Marine Trades Association of New Jersey 2008). Scaled estimates from the Outdoor Industry Association (2006) indicates recreation activities such as bicycling, camping, fishing, hunting, paddling, hiking, and wildlife viewing in the Barnegat Bay watershed (pop. 576,567) contributes 3,029 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 and these state parks in support 539 jobs with $27 million in the local economy.

Public and private water utilities withdraw over 53 mgd of drinking water from surface and groundwater supplies in Ocean County and at an average salary of 55,407, the water utilities employ at least 535 jobs with annual wages of $29.6 million. The Ocean County Utilities Authority employs 50 staff who operate 3 wastewater treatment plants with a capacity of 80 mgd and serve 36 towns in Ocean County and Monmouth County, New Jersey. Thirteen nonprofit watershed and environmental organizations employ at least 50 professionals with an average salary of $61,700 who earn at least $3.1 million in wages on programs to restore the watersheds in the Barnegat Bay watershed.

**Discussion and Conclusions**

The Barnegat Bay watershed in Ocean County, New Jersey includes a valuable estuary and ecosystems where tourism fuels a $4 billion annual economy and $432 million in state and local income taxes with $95 billion in property tax ratables (Ocean County Board of Taxation 2012). The annual economic value of the Barnegat Bay watershed is a least $4 billion based on estimates of economic activity, ecosystem services, and jobs and wages related to the waters of the watershed. The Barnegat Bay watershed contributes $4 billion in annual economic activity from public parks ($1.8 billion), recreation ($1.5 billion), water quality (245 million), forests ($208 million), fish/wildlife ($189 million), water supply ($59 million), and agriculture ($12 million) benefits. The value of natural goods and services from ecosystems in the Barnegat Bay watershed is $2.3 billion from freshwater wetlands ($908 million or $13,621/ac), marine/bay ($778 million or $10,005/ac), forests ($282 million or $1,978/ac), and saltwater wetlands ($155 million or $7,236/ac). The Barnegat Bay watershed that supports over 60,000 direct and indirect jobs with over $2 billion in annual wages in the coastal, fishing/hunting/birding, farm, tourism, recreation, water/wastewater, and watershed sectors.

This analysis demonstrates that the natural resources of the Barnegat Bay watershed provide real and significant economic benefits to the regional economy and are worthy of investment to keep
them healthy and productive. It is important to note that the economic values in the three categories described above may not be summed because there is some measure of overlap between certain values within each category that could result double-counting. It is also important to note that the estimates presented in this report are not meant to be used to compare/contrast different uses of the basin for their value. Some values were not included in these estimates because the data to assess them is not readily available, or does not exist. Values for the activities and resources vary in how they were applied by value transfer techniques from nearby watersheds to the Barnegat Bay watershed making it difficult to accurately compare values across uses and activities. Gathering more primary economic data from research in the Barnegat Bay watershed (such as local willingness to pay for clean water surveys) would improve comparability of information across uses as well as make value estimates more comprehensive by including confidence intervals with range and error bar estimates.

This economic analysis documents the worth of the Barnegat Bay watershed as an economic, ecological, and civic resource. The economic data presented in this analysis may be useful in translating the value of the Barnegat Bay watershed to the public. Elected officials, public decision makers, and public, private, nonprofit organizations may use the economic data in make the case to set priorities for investment in the Barnegat Bay watershed. States, counties, and municipalities may employ this monetary data by linking the economy of the watershed to state, regional, and local economic development and workforce development programs. This research demonstrates the Barnegat Bay watershed provides significant economic benefits to the region and is worthy of priority investments by elected officials and decision-makers to protect and restore these natural resources.

References


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