



This document contains overall and specific condition of the Barnegat Bay National Estuary Program from the National Estuary Program Coastal Condition Report. The entire report can be downloaded from <http://www.epa.gov/owow/oceans/nepccr/index.html>

National Estuary Program Coastal Condition Report

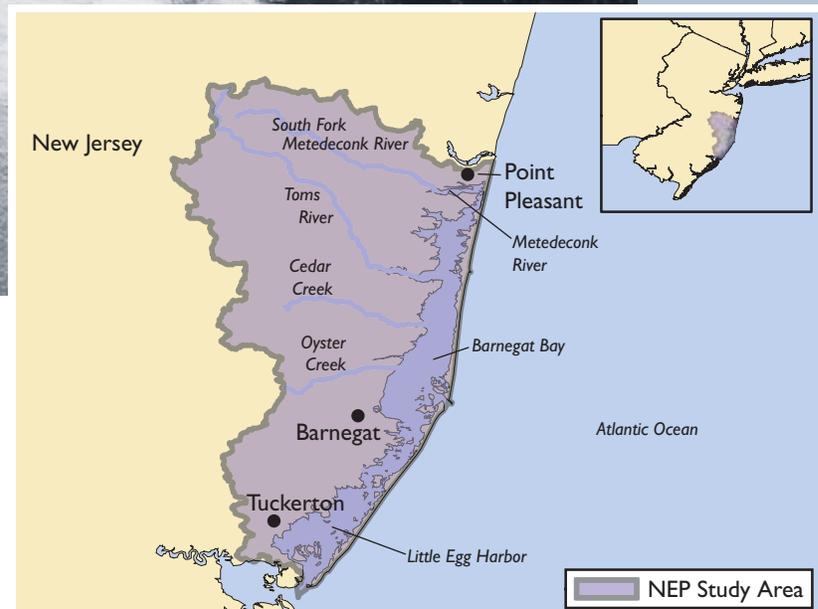
Chapter 3: Northeast National Estuary Program Coastal Condition, Barnegat Bay National Estuary Program

June 2007

Barnegat Bay National Estuary Program



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Background

Barnegat Bay in New Jersey covers more than 42 miles of shoreline, from Point Pleasant Canal to Little Egg Harbor Inlet, and stretches over all of Ocean and parts of Monmouth counties (BBNEP, 2005a). Habitats found within the Barnegat Bay watershed vary from coastal dunes and marshes (much of these areas have been heavily developed) to the New Jersey pine barrens—a distinctive pine forest characterized by sandy soils and fire-adapted plant species, such as pitch pine, and protected from extensive development. Barnegat Bay is protected from the open ocean by a system of barrier island dunes. The Bay itself is very shallow, with

a relatively small amount of fresh water flowing from tributaries and a limited connection to the ocean. Groundwater is the source of most of the freshwater input to the estuary (BBNEP, 2003), with additional freshwater input coming from several major tributary rivers, including the Metedeconk and Toms rivers, as well as the Cedar and Oyster creeks.

EPA designated Barnegat Bay an Estuary of National Significance on July 10, 1995 (BBNEP, 2002). Although long recognized for its great aesthetic, economic, and recreational value, the Bay is now affected by an array of human impacts that potentially threaten its ecological

integrity. More than 500,000 people live within the 660-mi² area of the Barnegat Bay watershed, and the area's population more than doubles during the summer season. In the last half-century, the Barnegat Bay area has undergone dramatic development due to increasing population growth, with land uses changing from principally undeveloped and agricultural land to residential development (BBNEP, 2002). To help protect and preserve the ecological integrity of this estuary, the Barnegat Bay National Estuary Program (BBNEP) has instituted public participation efforts with citizens and other watershed stakeholders who live, work, and recreate in the Bay area.

Environmental Concerns

During the 1990s, the municipalities surrounding Barnegat Bay reported population growth that exceeded 20% per year on average (BBNEP, 2002). The development that accompanied this increased population growth has resulted in significant land-use changes. Boat traffic in Barnegat Bay has also grown, raising concerns about general use conflicts and impacts on the Bay's water quality. Since its inception in 1995, the BBNEP has focused on several of the area's environmental concerns, including the following:

- Non-point source pollution and water quality degradation
- Habitat loss and alteration
- Human activities and competing uses
- Water supply protection.

Population Pressures

The population of the 3 NOAA-designated coastal counties (Burlington, Monmouth, and Ocean) coincident with the BBNEP study area increased by 132% during a 40-year period, from 0.67 million people in 1960 to almost 1.55 million people in 2000 (Figure 3-76) (U.S. Census Bureau, 1991; 2001). This rate of population growth for the BBNEP study area is more than five times the population growth rate of 24% for the collective NEP-coincident coastal counties of the Northeast Coast region. In 2000, the population density of the BBNEP's 3 coastal counties was 807 persons/mi², slightly lower than the population density of 1,055 persons/mi² for the collective NEP-coincident

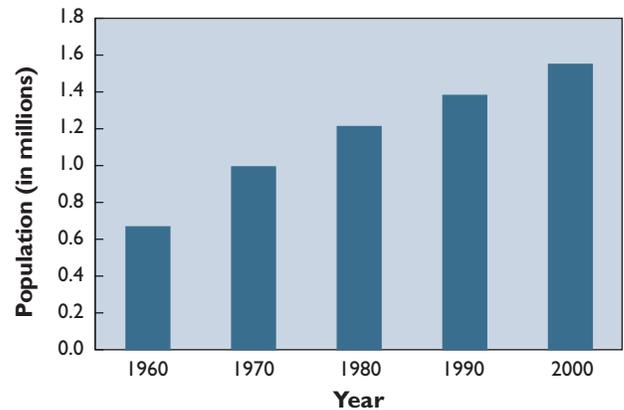


Figure 3-76. Population of NOAA-designated coastal counties of the BBNEP study area, 1960–2000 (U.S. Census Bureau, 1991; 2001).

coastal counties of the Northeast Coast region (U.S. Census Bureau, 2001).

NCA Indices of Estuarine Condition—Barnegat Bay

The overall condition of Barnegat Bay is rated fair based on the four indices of estuarine condition used by the NCA (Figure 3-77). The water quality and sediment quality indices for Barnegat Bay are rated good to fair, and the benthic and fish tissue contaminants indices are rated fair. Figure 3-78 provides a summary of the percentage of estuarine area rated good, fair, poor, or missing for each parameter considered. This assessment is based on data from 30 NCA sites sampled in the BBNEP estuarine area in 2000 and 2001. Please refer to Tables 1-24, 1-25, and 1-26 (Chapter 1) for a summary of the criteria used to develop the rating for each index and component indicator.

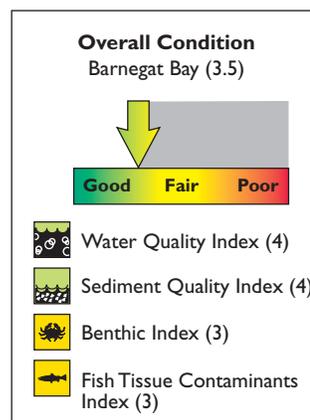


Figure 3-77. The overall condition of the BBNEP estuarine area is fair (U.S. EPA/NCA).

Barnegat Bay National Estuary Program

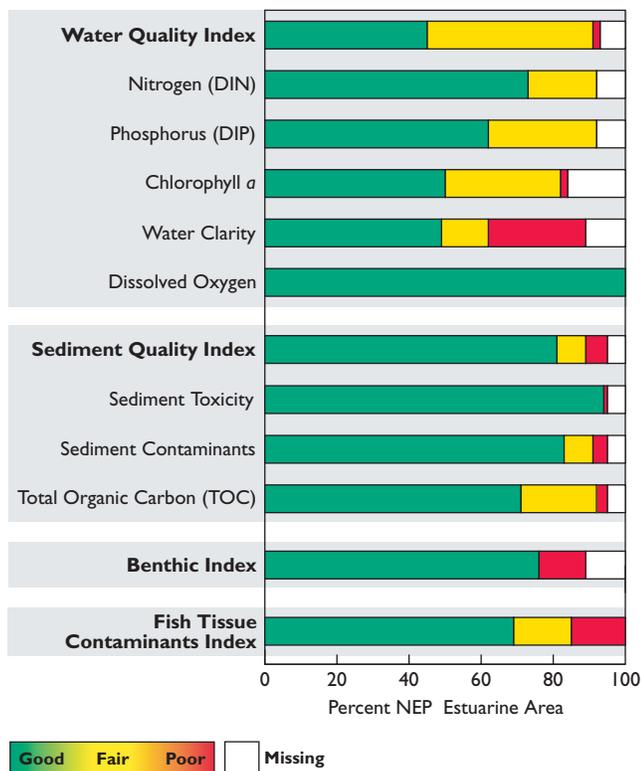


Figure 3-78. Percentage of NEP estuarine area achieving each rating for all indices and component indicators — Barnegat Bay (U.S. EPA/NCA).

Water Quality Index

The water quality index for Barnegat Bay is rated good to fair. This index was developed using NCA data on five component indicators: DIN, DIP, chlorophyll *a*, water clarity, and dissolved oxygen (Figure 3-79). Elevated DIN and DIP concentrations measured in Barnegat Bay covered one of the smallest extents of all Northeast NEP estuaries, and chlorophyll *a* concentrations were moderately high in about a third of the Bay. Water clarity was fair or poor in 40% of the Bay, in accordance with the observation that water in the southern estuaries of the Northeast Coast region is noticeably less clear than in estuaries farther north. All Barnegat Bay stations reported satisfactory dissolved oxygen levels.

Dissolved Nitrogen and Phosphorus | Barnegat Bay is rated good for DIN concentrations, with 73% of the estuarine area rated good for this component indicator, 19% of the area rated fair, and none of area rated poor. NCA data on DIN concentrations were unavailable for 8% of the BBNEP estuarine area.

Barnegat Bay is also rated good for DIP concentrations, with 62% of the area rated good, 30% of the area rated fair, and none of the estuarine area rated poor. NCA data on DIP concentrations were unavailable for 8% of the BBNEP estuarine area.

Chlorophyll *a* | Barnegat Bay is rated good for chlorophyll *a* concentrations. Fifty percent of the estuarine area was rated good for this component indicator, 32% of the area was rated fair, and 2% of the area was rated poor. NCA data on chlorophyll *a* concentrations were unavailable for 16% of the BBNEP estuarine area.

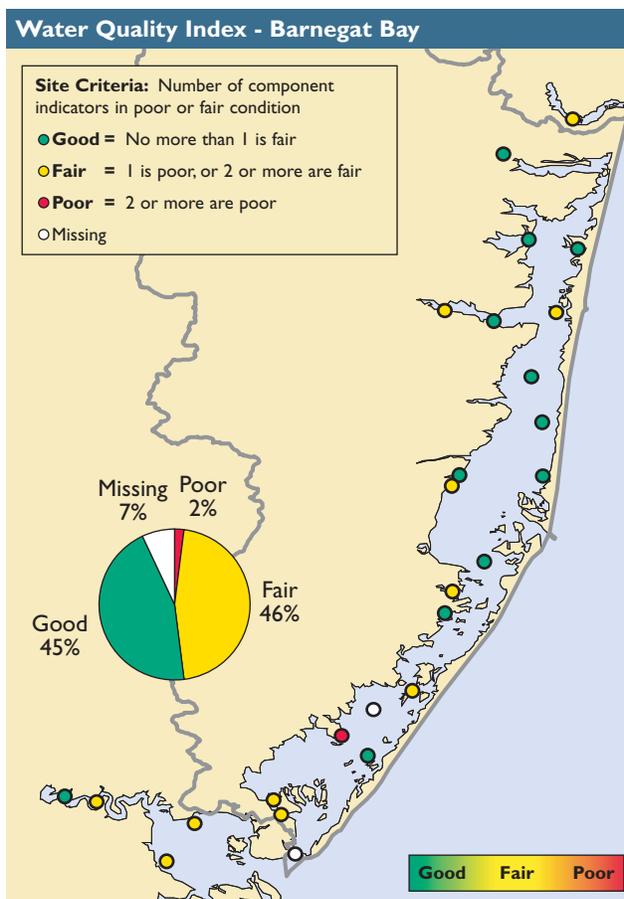


Figure 3-79. Water quality index data for Barnegat Bay, 2000–2001 (U.S. EPA/NCA).

Water Clarity | The water clarity rating for Barnegat Bay is poor. Water clarity was rated poor at a sampling site if light penetration at 1 meter was less than 10% of surface illumination. Twenty-seven percent of the estuarine area was rated poor for this component indicator, 49% of the area was rated good, and 13% of the area was rated fair. NCA data on water clarity were unavailable for 11% of the BBNEP estuarine area.

Dissolved Oxygen | Barnegat Bay is rated good for dissolved oxygen concentrations, with 100% of the estuarine area rated good for this component indicator.

 **Sediment Quality Index**

The sediment quality index for Barnegat Bay is rated good to fair. Fourteen percent of the estuarine area was classified as having fair or poor sediment quality, primarily in the Bay's tributaries (Figure 3-80). Toxic sediments were detected at only one site in Barnegat

Bay, and relatively little sediment contamination was noted (fair or poor in 12% of the Bay's estuarine area), a finding typical of the southernmost estuaries of the Northeast Coast region. TOC levels were elevated in about a quarter of the Bay's estuarine area.

Sediment Toxicity | Barnegat Bay is rated good for sediment toxicity, with only 1% of the estuarine area rated poor for this component indicator. NCA data on sediment toxicity were unavailable for 5% of the BBNEP estuarine area.

Sediment Contaminants | Barnegat Bay is rated good for sediment contaminant concentrations. Only 4% of the estuarine area was rated poor for this component indicator, and an additional 8% of the area was rated fair.

Total Organic Carbon | Barnegat Bay is rated good for sediment TOC. Seventy-one percent of the estuarine area was rated good for TOC concentrations, and 21% of the area was rated fair. Only 3% of the estuarine area was rated poor for this component indicator, and NCA data on TOC concentrations were unavailable for 5% of the BBNEP estuarine area.

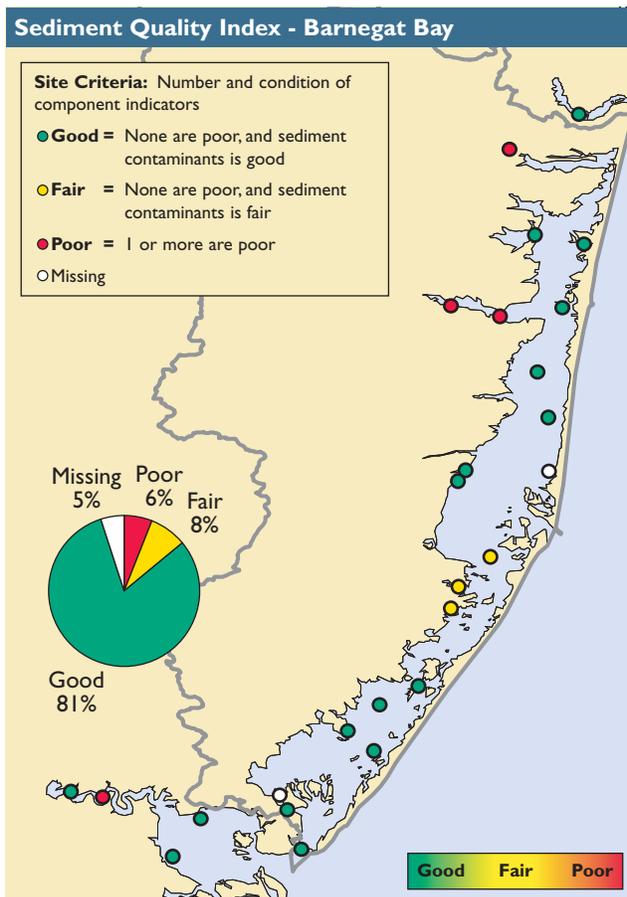


Figure 3-80. Sediment quality index data for Barnegat Bay, 2000–2001 (U.S. EPA/NCA).



Headwaters of the Toms River (BBNEP).

Barnegat Bay National Estuary Program



Benthic Index

Benthic condition in Barnegat Bay is rated fair, as evaluated by the Virginian Province Benthic Index. Four sites (13%) in Barnegat Bay merited a poor rating for benthic condition; two of these sites also reported sediment contamination (Figure 3-81).

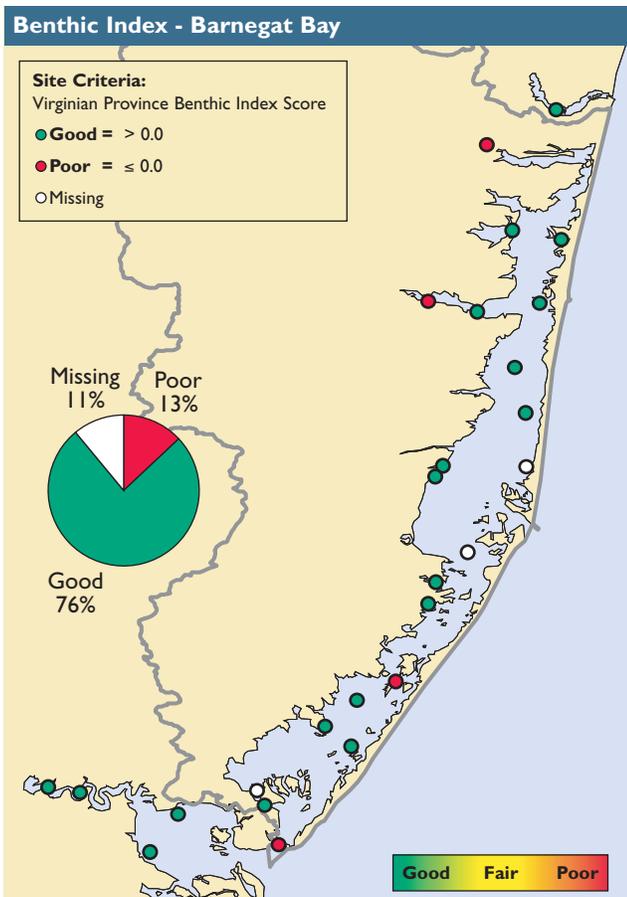


Figure 3-81. Benthic index data for Barnegat Bay, 2000–2001 (U.S. EPA/NCA).



Fish Tissue Contaminants Index

Thirteen fish samples were analyzed for chemical contaminants in Barnegat Bay, and 31% of samples were found to have elevated concentrations of mercury, the pesticide dieldrin, or PCBs (Figure 3-82); therefore, the fish tissue contaminants index for Barnegat Bay is rated fair.

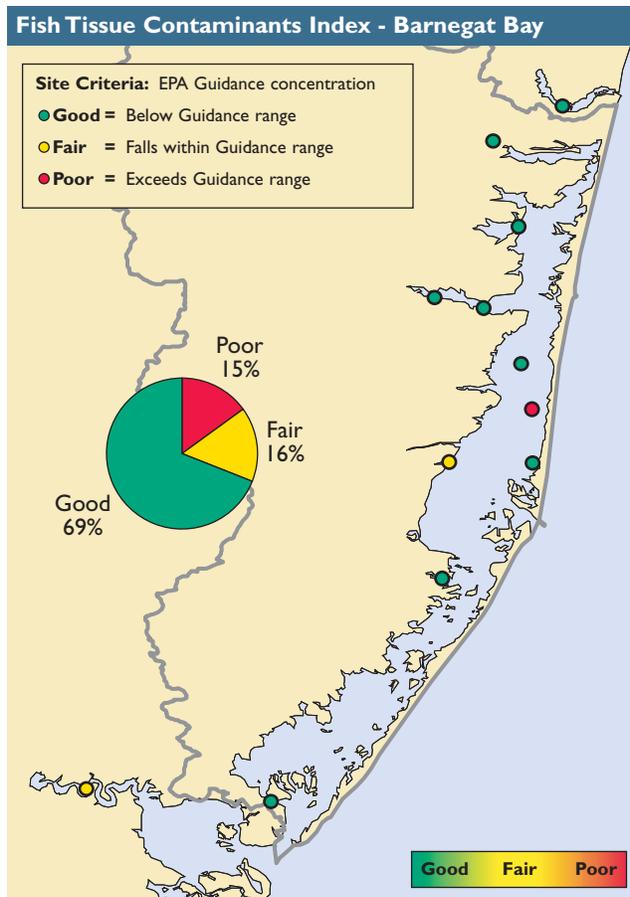


Figure 3-82. Fish tissue contaminants index data for Barnegat Bay, 2000–2001 (U.S. EPA/NCA).

Barnegat Bay National Estuary Program Indicators of Estuarine Condition

The BBNEP uses several primary indicators to evaluate environmental conditions and stressors in the Bay's estuarine area, including land-use changes; SAV distribution, abundance, and health; signature species; shellfish beds; and HABs. The BBNEP's indicators were selected based on their public acceptability, availability of historic data, and relevance to the goals set forth in the program's *Comprehensive Conservation and Management Plan* (BBNEP, 2002). Several additional indicators are used by the NJDEP, Rutgers University Institute of Marine Science, and USGS in the overall monitoring of this estuarine system (BBNEP, 2003). Based on all of these indicators, several waterbodies in the BBNEP estuarine area have been identified as impaired (Table 3-3).

More than 20 secondary indicators are also used internally by the BBNEP to help evaluate environmental

changes in the Bay; however, most of these secondary indicators are considered less appropriate than the primary indicators for conveying environmental concerns to the public. A variety of secondary indicators are used for evaluating living resources; environmental stressors; and water, sediment, and habitat quality in the study area. For example, some of the secondary indicators used for water quality include dissolved oxygen, nutrient levels, salinity, turbidity, water temperature, pH, and saltwater intrusion. The program also uses measured levels of toxic contaminants in sediments to assess sediment quality in the Bay (BBNEP, 2003). Data gaps exist for many of these indicators regarding both spatial and temporal information (BBNEP, 2003). Secondary indicators for evaluating water quality, habitat, or living resources in the Bay have been approved for use by any of the BBNEP's state partners or other local agencies involved in managing the estuary system.

Table 3-3. Waterbodies Assessed as Impaired Based on the Indicators Used by the BBNEP and Partners (BBNEP, 2003)

Waterbody Name	Reach # / Location	Pollution/Impact: Water Quality Violation	Pollutant/ Biological Impact	Use Impairment
Metedeconk River Estuary		Fecal coliform		Shellfish consumption
Lake Carasaljo	Lakewood, Ocean County		Mercury in fish tissue	Fish consumption
Pohatcong/ Tukerton Lake	Ocean County	Elevated bacteria, phosphorus, sedimentation Current source: Non-point sources, including suspended solids from surrounding urban areas and bacteria and phosphorus from surrounding septic systems	Heavy macrophyte growth	Boating and fishing
Manahawkin Lake		Elevated bacteria, phosphorus Current source: Resident goose and gull populations. Former source: Surrounding septic systems, most of which have been eliminated through sewerage	Localized heavy macrophyte growth	Primary contact: Recreation Some boating and fishing impairment
Toms River Estuary	02040301-018-022	Fecal coliform		Shellfish consumption
Toms River	02040301-018-080/ nr Toms River	pH, fecal coliform		Primary contact: Aquatic life support
Barnegat Bay	Portion adjacent to Toms River	Fecal coliform		Shellfish consumption

HIGHLIGHT

SAV Distribution, Abundance, and Health in Barnegat Bay

SAV, such as seagrass, is a key indicator of the environmental health of the Barnegat Bay-Little Egg Harbor Estuary. Seagrass beds are important in maintaining the energy flow and nutrients cycling of the estuary and serve as part of the estuarine food chain. For these reasons, seagrasses rank among the most sensitive indicators of long-term water quality and can be used as a sentinel of coastal ecosystem health (Dennison et al., 1993). Seagrass beds provide a critical structural component in an otherwise barren sandy bottom, serving as essential habitat for a host of organisms, including mollusks, crabs, worms, fish, and waterfowl.

In recent years, seagrasses have suffered due to declining water quality; physical damage from dredging and resulting sedimentation; and the occurrence of brown tides, benthic algal infestations, boat scarring, and disease. To remain healthy, seagrasses are dependent on comparatively clear waters. As Barnegat Bay waters become more turbid due to HABs and suspended sediment, the light levels needed to sustain photosynthesis and seagrass productivity decrease. Nutrient enrichment of the Bay's waters, whether from runoff, atmospheric deposition, or boat wastes, promotes HABs and infestations of some types of algae that coat the seagrass blades and threaten the longevity of the seagrass beds.

During the past 30 years, significant declines in SAV have occurred in New Jersey estuaries (Lathrop and Bogner, 2001), resulting in the reduction of essential fish habitat and the potential loss of important commercial and recreational species. In addition, nutrient enrichment has caused blooms of phytoplankton and benthic macroalgae. Dinoflagellate and brown-tide blooms can reduce light availability; adversely affect SAV such as eelgrass (*Zostera marina*)

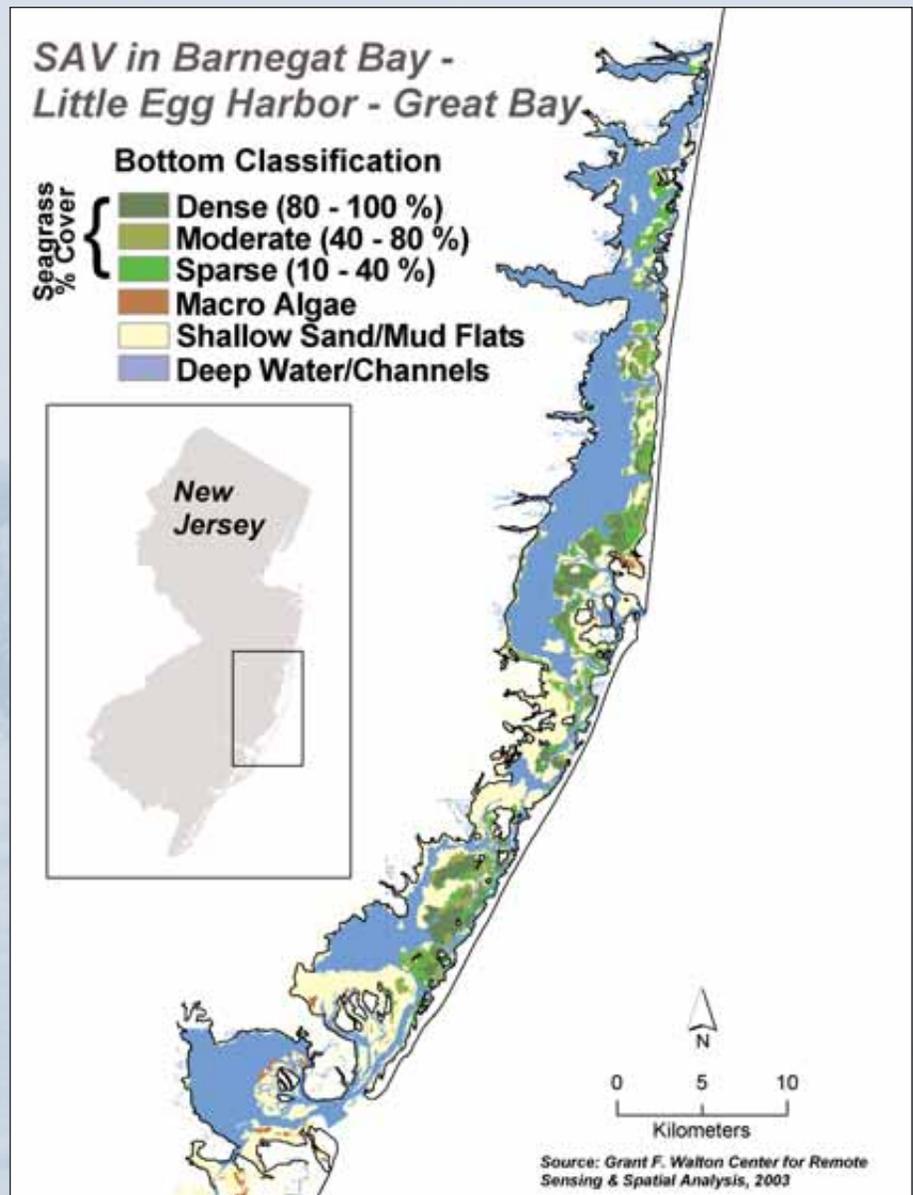
(Dennison et al., 1989); and cause negative impacts on other living resources (Bricelj and Lonsdale, 1997). Brown-tide blooms are now a recurring phenomenon in the coastal bays of New Jersey, New York, and Maryland. In response to shading stress, it appears that eelgrass may also be susceptible to infection by “wasting disease” (*Labyrinthula zosterae*) (Bologna and Gastrich, unpublished data). This disease, which decimated eelgrass beds worldwide during the 1930s (den Hartog, 1987), may signal a significant decline in water quality. Aside from the impacts of wasting disease on eelgrass, large-scale losses of SAV habitat can occur due to the additional physiological stress associated with HABs.

Status and Trends

Investigators led by Dr. Richard G. Lathrop at the Grant F. Walton Center for Remote Sensing and Spatial Analysis (CRSSA) at Rutgers University and the Jacques Cousteau NERR are monitoring SAV beds in the Barnegat Bay-Little Egg Harbor Estuary. During 2003, these researchers conducted an extensive SAV mapping project to better understand the present status of the estuary's seagrass habitats. This project was conducted using advanced digital images shot from an aircraft-mounted camera flown along the entire length of the estuary. Color imagery was used in the spring (May 4 and 5, 2003), before Bay waters became too turbid, thereby enabling the researchers to visualize the Bay bottom and determine the location and extent of the seagrass beds. The aerial imaging was complemented by boat-based surveys in the Bay to determine species type (e.g., eelgrass, widgeon grass [*Ruppia maritima*]), percent coverage, blade height, and sediment type. Using these advanced computer-aided interpretation techniques, researchers were able to map precisely the location, areal extent, and percent coverage of the seagrass beds in great detail. The resulting maps documented 12,804 acres of seagrass beds in the Barnegat Bay-Little Egg Harbor Estuary (see map) (Lathrop, 2004).

SAV distribution in the Barnegat Bay-Little Egg Harbor Estuary appears to have remained reasonably stable when compared with the maps of the period from 1990–2000. This stability is a positive outcome considering the continued development of the watershed, as well as the severe brown-tide occurrences that were

prevalent in the Bay during 2001 and 2002. However, the condition of the indicator appears to have changed substantially from previous years. Since 1968, for example, periodic mapping surveys in the Barnegat Bay-Little Egg Harbor Estuary indicated significant shifts in seagrass distribution. In particular, earlier surveys showed evidence of a decline in the seagrass extent between the late 1970s and the mid-1990s, especially in the northern areas of the Bay. Boat-based surveys conducted between 1996 and 1999 mapped 15,025 acres of seagrass. A decline of approximately 2,220 acres, or 15% of seagrass beds, appears to have occurred between the late 1990s and 2003 maps. Rather than representing a significant decline in seagrass, the difference in acreage is most likely due to a change in mapping techniques and the timing of the aerial imagery acquisition (Lathrop, 2004).



SAV coverage in Barnegat Bay and Little Egg Harbor (Grant F. Walton CRSSA).

Water and Sediment Quality

The following four primary indicators help the BBNEP measure water and sediment quality in Barnegat Bay:

- Number (and duration) of bathing beach closures
- Acres of shellfish beds open/closed
- Presence of HABs (e.g., acres of coverage)
- Freshwater inputs to the Bay (e.g., changes in stream flow, water allocation).

The number and duration of beach closures in the BBNEP study area is an indicator of water quality and is measured to help determine if bathing areas are safe for public use. The NJDEP helps report on levels of fecal coliform bacteria recorded in water samples and evaluates swimming conditions in the waters of Barnegat Bay. New Jersey's surface water quality standards in for recreational contact with estuarine waters specify that fecal coliform levels should be below a mean of 50/100 mL within 1,500 feet of the shoreline. From 1988 to 1998, 834 beach closings were registered in the estuary as a result of elevated fecal coliform counts in water samples (BBNEP, 2002). Fecal coliform bacteria data collected by the USGS/NJDEP water quality network have shown an improvement in the Toms River area between 1988 and 1992 (BBNEP, 2001).

The number of acres of shellfish beds that are open or closed for harvesting is also a good indicator of pathogen levels in the Bay. Bacterial standards for shellfish harvesting are set by the Interstate Shellfish Sanitation Conference. New Jersey uses fecal coliform measures to determine the areas of Barnegat Bay that are safe for shellfishing and the areas that are of potential risk to public health. The general trend in the BBNEP study area during the past 30 years has been toward fewer restrictions on shellfish harvesting. The largest areas of shellfish-harvesting restriction occur in the tributaries of Barnegat Bay, from Toms River northward, and along the barrier island in the same portion of the Bay. The harvesting of shellfish from all man-made lagoons and marinas is also prohibited (BBNEP, 2001).

The presence and growth of HABs is another indicator of water quality in the BBNEP system. Brown tides caused by a toxic dinoflagellate

(*Aureococcus anophagefferens*) have had severe effects on eelgrass beds, and the damage associated with these blooms has occurred with increasing frequency. Brown tides may also reduce local fishing, swimming, and boating activities in the estuary. HABs are monitored for frequency of occurrence, area/extent, and intensity, and the abundance and species composition of HABs provides information about changing water quality conditions (BBNEP, 2003). Educational information about the effects of these blooms has been made available to the public through local newspapers and outreach materials from the Rutgers University Cooperative Extension.

Freshwater inputs to Barnegat Bay are monitored closely as another primary indicator of water quality and environmental stress. The *New Jersey Statewide Water Supply Master Plan* (NJDEP, 1996) identifies the Barnegat Bay watershed as an area that will experience a significant water supply deficit by the year 2040. Despite this prediction, withdrawal of potable water for this area is almost completely consumptive because most wastewater is discharged to the ocean. These actions result in saltwater intrusion and reduced stream flow. Modifications to the Barnegat Bay landscape also change the natural hydrology by reducing recharge and increasing runoff. Monitoring surface water discharge is the most cost-effective means to monitor freshwater inputs (BBNEP, 2003). The USGS measures short- and long-term changes in base flow and water consumption in the northern part of the Bay, but continuous gauging is not available in the southern part of this system.



Osprey nest at Island Beach State Park, Seaside Park, NJ (BBNEP).

Habitat Quality

The following two measures are primary indicators used by BBNEP to evaluate habitat loss and/or changes in quality of land in the watershed:

- SAV distribution and abundance (acres)
- Land-use change (acres).

Land-use change in the Barnegat Bay watershed is a major indicator used to evaluate environmental changes to this ecosystem. The developed area of the Bay watershed increased from 18% in 1972 to 28% in 1995 (BBNEP, 2002). With more than 70% of the Barnegat Bay shoreline already developed, the remaining undeveloped shoreline areas are especially valuable as open space (BBNEP, 2003).

The BBNEP monitors shoreline habitats, island nesting habitats, and other sensitive areas as secondary indicators of habitat quality (BBNEP, 2003). Salt marshes are one of these sensitive habitats. Roughly 90% percent of Barnegat Bay's salt marshes are protected by some form of public conservation ownership (e.g., national wildlife refuge, state game management area, state/local park, or private conservation trust) (BBNEP, 2001). A variety of shorebirds and colonial nesting birds, such as common terns (*Sterna hirundo*), black skimmers (*Rhynchops niger*), and Forster's terns (*Sterna forsteri*), nest almost exclusively on salt marsh or dredge spoil islands for protection from mammalian predators. Sixty-one Barnegat Bay islands have been ranked for their importance as nesting habitat for common terns, black skimmers, and Forster's terns, based on data collected from the mid-1970s to the present (BBNEP, 2003). Other critical wildlife habitat areas that should receive special consideration are coastal dune scrub/shrub and large areas of cultivation/grassland. Dune grass and shrub vegetation serve a useful role in stabilizing dunes and protecting beaches against wind and wave erosion. Extensive remnants of these habitats exist at Island Beach State Park and at the Holgate section of Forsythe National Wildlife Refuge. The dune scrub/shrub and woodland communities of the barrier islands fronting Barnegat Bay have largely been destroyed or substantially altered (BBNEP, 2002).

Living Resources

The BBNEP uses several signature species as primary indicators of the living resources in the Bay. These species include the following:

- Hard clams
- Colonial nesting waterbirds
- Osprey.

The hard clam (*Mercenaria mercenaria*) is an important commercial and recreational fishery species that lives in the fine-grained sediments and SAV beds of the Bay. Hard clams are a good indicator of estuarine health because they are long-lived and have a wide distribution throughout the Bay (BBNEP, 2003). Hard clam populations have decreased over time (BBNEP, 2002), with the amount of hard clams harvested in Barnegat Bay falling from about 820,000 pounds to approximately 65,000 pounds between 1989 and 1997 (BBNEP, 2001).

Barnegat Bay provides nesting habitat for 20 species of colonial waterbirds, including 10 species of long-legged wading birds, 6 species of terns, 3 species of gulls, black skimmers, and piping plover. These birds are good indicators of the living resources in the Bay because they have high sensitivities to chemical contaminants, human disturbance, the availability of resources, and the overall quality of the available habitat. Since 1985, the NJDEP has conducted ground and aerial surveys to assess the abundance of these birds. These surveys have indicated that some species have experienced population decreases due to habitat loss, human disturbance, and predation (BBNEP, 2003).

The NJDEP conducts an annual census of the osprey population in the Bay to record the number of nesting pairs and fledglings success (BBNEP, 2003). Statewide, the number of ospreys increased between 1975 and 1998, from 50 to more than 250 nests. Although specific data for Barnegat Bay are unavailable, the Bay has historically been an important nesting area for this species. Osprey populations in the region are limited by available nesting habitat, predation, exposure to toxics, and human disturbance (BBNEP, 2001).

The BBNEP also uses several secondary indicators to assess living resources, including the abundance of shellfish and finfish, the composition and abundance of benthic communities, and the presence of rare plant and animal populations (BBNEP, 2003).

Environmental Stressors

Several of the BBNEP's secondary indicators can be used to evaluate the impact of human activities in the estuary. These indicators include the following:

- Amount and type of floatable debris
- Number of registered boats.

For example, boating is a popular activity in the study area. A variety of different watercraft support 182 marinas in the Barnegat Bay watershed (BBNEP, 2002). Between 1979 and 1988, the estimated number of boats in the Bay increased from 30,000 to 53,200 (BBNEP, 2001).

Current Projects, Accomplishments, and Future Goals

Some of the recent environmental success stories achieved in the Barnegat Bay system include the following:

- On June 6, 2003, EPA announced the establishment of a No-Discharge Zone in Barnegat Bay. This designation prohibits boats from releasing treated or untreated sewage into the Bay. Roughly 75 marinas in Ocean County maintain land-based pump-out stations to further reduce illegal discharges of sewage (Ocean County Department of Planning, 2006).
- In 2004, the BBNEP, in partnership with the Jacques Cousteau NERR, implemented a multi-tiered public education approach aligned with the NJDEP's Phase II Municipal Stormwater Permitting Program. A steering committee of interested county, academic, and local educational organizations was formed to provide outreach and assistance to the 37 municipalities within the Bay's watershed on new Phase II stormwater regulations. Examples of the committee's services include workshops, technical assistance, public outreach assistance, and stormwater resources.

In addition, the BBNEP developed and implemented six Phase II Municipal Stormwater Roundtables in 2005 to help the municipalities achieve compliance with the new state regulations. The Ocean County Department of Planning also supplied matching funds to assist municipalities with the development of their EPA-required Stormwater Pollution Prevention Plans.

- The BBNEP and the Ocean County Department of Planning funded the purchase of dune grass for a restoration project on Island Beach State Park, where the BBNEP contributed more than 15,000 plants (Lynch, 2003).
- Between October 2003 and September 2005, more than 3,200 acres of habitat in the Bay's watershed were preserved by state, county, and municipal agencies (BBNEP, 2005b).
- The BBNEP and its partner, the Rutgers University Institute of Marine and Coastal Science, have recently completed a demographic investigation of SAV in Barnegat Bay. This investigation included an assessment of the potential impacts of benthic macroalgae and brown tides. The BBNEP has also partnered with Montclair State University to assess the effects of harmful macroalgal blooms on the Bay's SAV.
- The BBNEP, in partnership with Rutgers University, USGS, and the NJDEP, has established two



Mobile pump-out stations, such as the boat shown here, help reduce sewage discharges to Barnegat Bay (BBNEP).

water quality monitoring stations and data loggers in the Bay to record and deliver real-time data to an NJDEP Web site. These data loggers monitor some of the BBNEP's secondary indicators, such as turbidity, salinity, and dissolved oxygen (NJDEP, 2006). The BBNEP and other partner agencies plan to deploy several more data loggers at additional sites in the near future.

- The Ocean County Soil Conservation District is working in the Barnegat Bay watershed to increase groundwater recharge in developed areas by establishing Rain Garden Basins and repairing poorly constructed retention basins. In addition, the District is working to establish outdoor classrooms and rain gardens at schools throughout the watershed. Four outdoor classrooms were established in 2005, and the District has a goal to establish 50 classrooms in Ocean County by the year 2009 (BBNEP, 2005c).
- The Rutgers Cooperative Research and Extension of Ocean County has partnered with the BBNEP and Ocean County to educate citizens about the Bay, its watersheds, and human impacts on the estuary by using hard clams and oysters as living

representatives of the Bay's ecosystem. The group is also working with volunteers to seed and grow hard clams in the Bay.

Conclusion

The overall condition of Barnegat Bay is rated fair based on the four indices of estuarine condition used by the NCA survey. Non-point source pollution/water quality degradation, habitat loss and alteration, human activities and competing uses, and water supply protection remain the most critical environmental concerns in Barnegat Bay. The apparent decline in SAV beds is a cause for concern and warrants further investigation. Some causes of habitat loss/fragmentation and the decline of fish and wildlife species in the BBNEP study area are not well understood. Similarly, although there is a clear indication that human development has led to declining water quality (associated with non-point source pollution), quantifying this impact on water quality and aquatic habitats in the estuary is more difficult. More research is warranted on the relationship between habitat loss and alteration in the estuary watershed and the impacts on nesting birds and other wildlife in the ecosystem.



Barnegat Lighthouse, Long Beach Island, NJ (BBNEP).