



The Barnegat Bay Beat

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Special Edition: STATE OF THE BAY

The creation of the 2005 State of the Bay Report was the collaborative work of many partnering organizations and committed individuals. The environmental indicators adopted by the Barnegat Bay National Estuary Program (BBNEP), six of which are presented in this report, were selected by the BBNEP Science and Technical Advisory Committee. These indicators were incorporated in a Monitoring Program Plan, which was approved by the Environmental Protection Agency in 2003. Information on the status and trends for each indicator was provided by appropriate organizations and individual experts, as listed below. The technical adequacy of the report was reviewed by the BBNEP Science and Technical Advisory Committee. Numerous individuals contributed additional content and/or provided valuable feedback, and their contributions are gratefully acknowledged.

The Barnegat Bay-Little Egg Harbor estuary is a dynamic, complex system that greatly influences the region's economy, communities, quality of life, and environment. To gauge its relative health and the progress of efforts to protect and restore estuarine resources, the Barnegat Bay National Estuary Program has established plans to track key environmental indicators and evaluate their status and trends. This special edition communicates the status and trends of six of these indicators.

The State of the Bay Technical Report can be viewed in its entirety at http://www.bbep.org/downloads/state_of_bay_tech.pdf



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SUBMERGED AQUATIC VEGETATION

Submerged aquatic vegetation (SAV) is a key indicator of the environmental health of the Barnegat Bay-Little Egg Harbor estuary. SAV can be defined as benthic plants that grow totally underwater. Seagrasses are an important element of the bay ecosystem because they harness energy and nutrients that are consumed by other organisms. The seagrass beds also serve as essential habitat for a host of organisms, such as shellfish, finfish, and waterfowl. However, in recent years, seagrasses in the estuary have suffered due to declining water quality, dredging, brown tides, benthic algal infestation, boat scarring, and disease.

Seagrasses rank among the most sensitive indicators of long-term water quality and can be used as a measurement of coastal ecosystem health. Negative changes in the strength and distribution of these vascular plants generally signal a decline in aquatic ecosystem health. During the last 30 years, significant declines in SAV have occurred in New Jersey estuaries, resulting in the reduction of essential fish habitat and the potential loss of commercially and recreationally important species. SAV surveys showed evidence of a decline in the seagrass extent between the late 1970's and the mid-1990's, especially in the northern reaches of the bay.

Investigators at the Grant F. Walton Center for Remote Sensing and Spatial Analysis (CRSSA) at Rutgers University (Cook College) and the Jacques Cousteau National Estuarine Research Reserve (JCNERR) are monitoring SAV beds in the estuary. They conducted an extensive SAV mapping project during 2003 to better understand the present status of the seagrass habitats. This project, directed by Dr. Richard G. Lathrop of CRSSA, was conducted using advanced digital camera equipment flown in an airplane along the entire length of the estuary. Color imagery was taken 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 of the seagrass beds. The aerial overflight was complemented with boat-based surveys up and down the bay to determine species type -- i.e., eelgrass (*Zostera marina*) or widgeon grass (*Ruppia maritima*), percent cover, blade height, and sediment type. Additional studies to evaluate and monitor local SAV beds are being conducted by researchers at the Jacques Cousteau National Estuarine Research Reserve and Montclair State University.

The primary limiting environmental factor for SAV in New Jersey is adequate light. It is well recognized that significant reduction of light transmission negatively impacts seagrass growth and production. Additionally, it has been demonstrated that various sources of light reduction components exist and include phytoplankton, epiphytes, and macroalgae, as well as land runoff causing general turbidity. Consequently, light reduction may significantly impair the natural recovery of SAV in regions that have undergone losses and may reduce the effectiveness and survival of expansive beds. It is this light reduction that is the most critical control of SAV in Barnegat Bay.

Additional information needed to assess the health of the SAV resource includes determining the relationships among brown-tide and macroalgal blooms and the health and biomass of SAV in Barnegat Bay. These two factors -- brown-tide and macroalgal blooms -- have been shown to negatively impact SAV and other living resources. To determine the future success of SAV in the bay, it will be necessary to understand how these variables impact seagrass beds. Perhaps the most critical data gap relates to the value of widgeon grass as a habitat. While studies have focused on eelgrass, there is little understanding of the role of widgeon grass in Barnegat Bay. It will be important to link the value of each seagrass species to the health of the bay.



Example of submerged aquatic vegetation-*Zostera marina* (eelgrass)

Photograph by Dr. Paul Bologna, Montclair State University

SHELLFISH BEDS

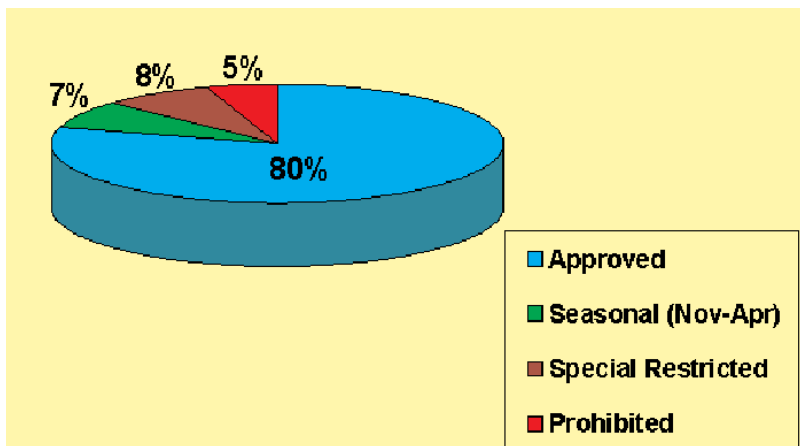
Although shellfish harvests continue in Barnegat Bay, increasing pressure on the industry has resulted from the growing human population along its shores and throughout its watershed. As a result of rapidly declining hard clam stocks, the demise of the bay scallop, and limited abundance of the soft clam, commercial shellfishing has been severely curtailed. Along with the increase in development and human activity comes the potential for shellfish to be contaminated with pollutants. The New Jersey Department of Environmental Protection's Bureau of Marine Water Monitoring monitors shellfish growing waters to ensure that shellfish within these and other state waters are safe to consume. Shellfish growing water classifications are updated on a yearly basis to produce Shellfish Growing Waters Classification Charts for the state of New Jersey.



Boating and related activities associated with marinas can add pollutants to back baywaters

The status of shellfish growing waters classifications provides a good indicator of progress in improving estuarine water quality because it integrates results of water quality testing and pollution source surveys to establish the shellfish water classifications. A limitation of the indicator is that although it provides a measure of water quality in terms of public health and potential for disease transmission, it is not geared towards measuring the status of shellfish populations or the ecological health of the estuary.

Shellfish water classifications in New Jersey consist of four main types: *Approved*, *Seasonal*, *Special Restricted*, and *Prohibited*. In determining classifications, the potential impacts from possible sources of contamination are considered. Most of the waters within the Barnegat Bay and Little Egg Harbor estuary (80%) are of high water quality and are classified as *Approved* for shellfish harvesting. Of the changes in shellfish classifications for these waters during 2000-2004, 80% (336 acres) were upgraded, and 20% (84 acres) were downgraded.



Shellfish Growing Water Classifications for Barnegat Bay - Little Egg Harbor, 2000-2004.

Shellfish water classifications in New Jersey consist of four main types:

- **Approved** waters are the highest water quality. In *Approved* waters, shellfish can be harvested for consumption without any restrictions.
- **Seasonal** waters, as the name implies, are open to harvest for a portion (season) of each year when water quality meets the same criteria as *Approved* waters.
- **Special Restricted** areas are moderately polluted waters that are condemned for the harvest of oysters, clams, and mussels EXCEPT harvesting for further processing and purification prior to consumption. Further processing involves placing the shellfish in high quality water for a period of time sufficient to purge the shellfish of pollutants.
- **Prohibited** waters exist where the harvest of oysters, clams, and mussels cannot occur under any circumstances.

BATHING BEACHES

For the past twenty-five years, the Ocean County Health Department (OCHD) has obtained and analyzed water-quality samples from all public bathing beaches in the county on a weekly basis between Memorial Day and Labor Day. Results are used by the OCHD to determine whether beaches are to remain open for bathing or closed to bathing. Results of bathing beach monitoring provide an indication of the bacterial health of the waters that are utilized for recreational bathing. Closure statistics for beaches on the bay, freshwater lakes and rivers provide an indication of the amount of bacteria from various sources that is being flushed from the watershed into the waterways that eventually flow into the bay. The number of brackish water beach closures in a particular year provides an indication of the extent to which the use of the bay for recreational bathing is impaired by these various sources. Closure statistics also provide a general indication of the non-point source loadings from these sources that include contaminants other than bacteria. Stormwater typically contains suspended solids, nutrients, organic carbon, petroleum hydrocarbons, heavy metals, and pesticides, in addition to bacteria.

Samples are obtained in a sterile 120ml bottle. The sampler attempts to proceed to chest depth (approximately four feet) and the sample is obtained using NJDEP methods. All samples are cooled and transported to a certified laboratory. Chain of custody forms are always used to transfer the samples. Samples are analyzed to determine the presence of indicator bacteria that are found in the digestive tracts of warm-blooded animals. If the OCHD is notified of a sample result that exceeds the state standard, then a re-sample is immediately obtained. While obtaining the re-sample the sampler will also obtain two other samples at the site, on either side of the original sample. This procedure is followed to determine if a pollutant source may be indicated.

Cedar Creek is an indicator of how bacteria-free a water body can be without the influence of storm drains. Cedar Creek could almost be considered a control regarding stormwater influence and non-point source pollution. The stream is not encumbered with storm drains, and as a result, it seldom has an elevated bacteria count.



Waterfowl, such as gulls, geese, and ducks are a significant source of fecal coliform bacteria and are considered a major cause of closures of many bathing beaches on lakes. Feeding waterfowl at these locations contributes to this problem by encouraging waterfowl to congregate near recreational lakes. Park visitors are urged not to feed the waterfowl.

The number of closures varies widely from year to year. From 1995 to 2004, the number of closures ranged from a low of 18 in 2001 to a high of 135 in 2004. This variability is attributable primarily to the number, duration, and intensity of rainfall events occurring immediately before and during the recreational bathing season. The highest number of annual closures occurred during three of the past four years.

It has been observed and documented that non-point source pollution delivered to the waters through stormwater discharges are the major contributing factor to beach closures. It is anticipated that implementation of the new stormwater regulations and other non-point source control efforts will favorably affect the current situation.

ALGAL BLOOMS

Recurring algal blooms have been documented in Barnegat Bay, which are symptomatic of eutrophication problems. The blooms have included serious brown tides and accelerated growth of drifting macroalgae. Rapid growth of other macroalgal species can also be detrimental. The spread of certain brown macroalgal species along the sediment surface of seagrass beds can hinder exchange of gases and promote the development of hypoxic/anoxic conditions that can be detrimental to the vascular plants. However, comprehensive studies of benthic macroalgae in the estuary are lacking, reflecting a significant information gap.

The presence of the brown tide-forming phytoplankton species (*A. anophagefferens*) was first reported in New Jersey coastal bays in 1988, with initial blooms documented in 1995, 1997 and 1999, 2000, 2001, and 2002. No significant bloom occurred in 2003.

Nutrient loading, particularly nitrogen, is generally correlated with the occurrence of both nuisance and toxic algal blooms. Severe toxic and noxious phytoplankton blooms are on the rise worldwide due to accelerated coastal development and associated nutrient inputs to receiving waters. These blooms are typically characterized by the explosive growth of a single phytoplankton species, which is responsible for an array of negative impacts. Excessive growth of some phytoplankton species generates harmful algal blooms (HABs), which variously encompass brown tides, yellow tides, red tides, and other types. The toxic forms are particularly dangerous to numerous organisms such as macroalgae, shellfish, finfish, as well as humans. Secondary impacts include shading effects, altered grazing patterns, and changes in trophic dynamics that are detrimental to estuarine function. A number of HAB-forming species have been recorded in the

Barnegat Bay-Little Egg Harbor Estuary, including *Dinophysis* spp., *Gymnodinium* (*Karlodinium*) spp., *Heterosigma* sp., and *Prorocentrum* spp.) (Olsen and Mahoney, 2001).

More information is needed to understand the causes of brown tide and benthic algal blooms and how to control them. Monitoring and studies are needed to determine algal bloom occurrence, identify relevant environmental factors, assess shellfish stocks (which may be affected by algal blooms), and to evaluate effects on seagrass health and productivity.



Ulva lactuca, or sea lettuce, is a drifting macroalgal species that has produced extensive organic mats and may threaten benthic habitats.

Photograph courtesy of M. Vis, Ohio University

HARMFUL ALGAL BLOOMS

Harmful Algal Blooms comprise the most serious algal blooms in estuaries, with blue-green algae, diatoms, dinoflagellates, pyrmnesiophytes, and raphidophytes well represented. They exist in three general forms :

1. Nontoxic bloom populations reaching concentrations that eventually affect important environmental factors such as dissolved oxygen, with resulting hypoxia/anoxia ending in debilitation and/or elimination of other populations.
2. Toxic bloom species that introduce toxic agents into associated food webs to the extent that upper trophic levels (including humans) are adversely affected.
3. Toxic bloom species that produce and release substances having direct and/or indirect effects on associated populations. These species are usually not harmful to humans, but are known to adversely affect other aquatic plant and animal species.

FRESHWATER INPUTS

Freshwater inputs from the watershed include the flow of rivers and streams that drain to the estuary, and the direct seepage of ground water into the estuary. The role of freshwater in estuarine health is crucial. The mixing of freshwater with ocean water in the estuary results in a unique environment to support various habitats. The rate of freshwater flow into the estuary also affects the rate at which the estuary is "flushed" (the average length of time for a pollutant entering a water body to be removed by natural forces such as tides and currents, which in turn affects many water-quality and ecological processes). Freshwater inputs also dilute contaminants from a wide variety of sources. As a result of the potential for human alteration of freshwater inputs, tracking freshwater flows and maintaining an adequate rate of freshwater flow is critical to meeting estuarine water-quality and habitat goals.

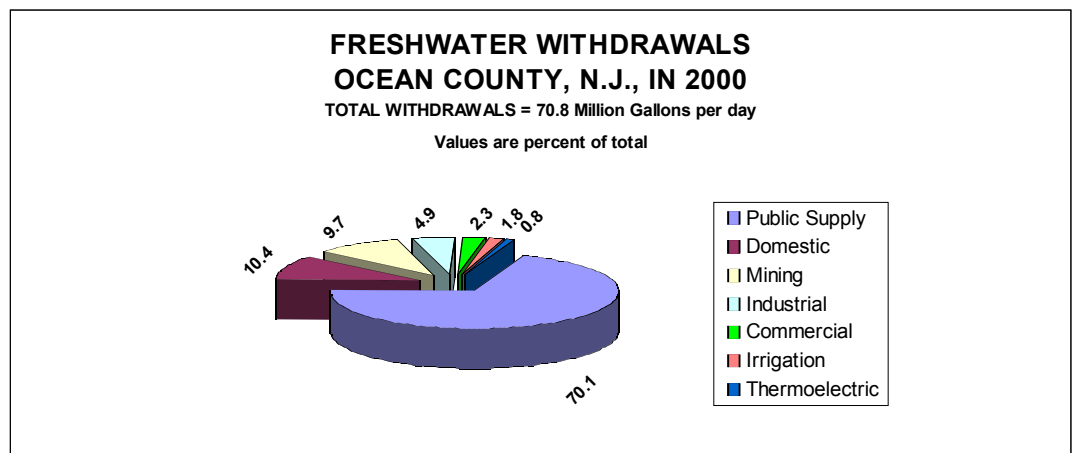
Average freshwater inputs from streams and ground-water discharge are estimated by the U.S. Geological Survey to total about 590 million gallons per day. During typical drought conditions, the total freshwater inflow to the estuary is about one-third to one-half of the average inflow. Fluctuations in annual surface discharge of freshwater at a long-term monitoring station on the Toms River range from about 60 to 155 percent of the average discharge. Below-average annual discharges since the mid-1980's have been more frequent than above-average discharges. This recent trend is likely the result of both climatic variability and the effects of human activities.

Human use and consumption of freshwater for water supply plays a major role in the amount of freshwater that enters the Barnegat Bay. Most of the freshwater withdrawn for water supply from streams and aquifers bypasses the bay after its use and is discharged to the ocean as treated wastewater. In addition to water lost through sewerage, some water is lost through crop and lawn irrigation and evaporative industrial cooling. In addition to the effects of human use of freshwater for water supply, modifications to the landscape, such as the development of impervious surfaces, can change the timing and quantity of freshwater inputs by altering hydrologic patterns.

Freshwater withdrawals from surface- and ground-water sources in Ocean County for various human uses have increased from about 56 million gallons per day in 1985 to about 71 million gallons per day in 2000. Most of the withdrawn water (70%) is for public supply. The amount of freshwater removed from the watershed through regional sewerage outfall to the ocean averages about 60 million gallons per day during high-demand summer months, equivalent to about one-third of the freshwater inflow to the estuary under extreme low-flow conditions.

Management efforts aimed at minimizing adverse effects of human activities on freshwater inputs are underway or under consideration. New stormwater regulations are being implemented that are intended to maintain natural rates of recharge in developing areas.

Other approaches, including beneficial reuse of reclaimed wastewater; conjunctive use of surface water, unconfined aquifers, and confined aquifers; and aquifer storage and recovery, are being considered to help limit the effects of water demand on water resources.



Distribution of 2000 freshwater withdrawals among different water-use categories, Ocean County, New Jersey. (Source: U.S. Geological Survey Aggregated Water-Use Data System)

LAND USE / LAND COVER

Land use by humans is a primary cause of ecological change at many scales. Several land use/change indicators have been identified as potentially valuable to the Barnegat Bay National Estuary Program. These indicators include changes in the extent of 1) altered vs. unaltered land, 2) interior forest land, 3) public open space, and 4) impervious surface cover. Altered land would be defined as land that has been altered by humans, such as developed land or land used for agriculture or surface mining. Unaltered land refers to forests and wetlands. The interior forest indicator looks at the amount of both the upper watershed and wetland areas and subtracts out a 90m boundary around these areas adjacent to altered areas. The public open space indicator tracks that amount of publicly owned land, both land that is developed and undeveloped.

Based on satellite imagery, The Rutgers University Center for Remote Sensing & Spatial Analysis (CRSSA) has mapped land cover at varying levels of detail for the Barnegat Bay watershed for the years of 1972, 1984, 1995 and more recently 2001. Data for 2001 show that development represents approximately 30% of the watershed area and that development within the Barnegat Bay watershed increased by 7,255 acres since 1995. The amount of altered

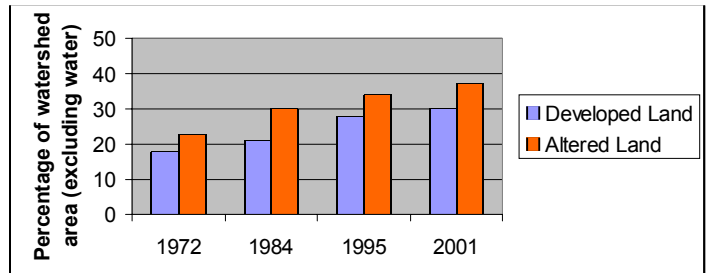
land (total of developed, cultivated/grassland and bare land) in 2001 is estimated to be 131,311 acres or approximately 37% of the watershed. **As of March 2004, there were approximately 122,500 acres of publicly-owned land in the Barnegat Bay watershed (approximately 34% of the watershed).** Development within the Barnegat Bay watershed has increased from 18% to 21% to 28% to 30% during the years 1972, 1984, 1995 and 2001, respectively.

(Note: This publicly-owned land may not have necessarily been set aside for natural resources conservation purposes, but, due to its existing uses and conditions, it may serve that purpose. A prime example in the Barnegat Bay watershed is Lakehurst Naval Air Station, which includes extensive areas of valuable wildlife habitat.)

Additional information is needed on the more recent changes in impervious surface cover within the Barnegat Bay watershed. The New Jersey Department of Environmental Protection Land Use Mapping Program was established to map land use and impervious surface statewide. The NJDEP has contracted to have color-infrared aerial photography acquired statewide. This aerial photography has then been further processed to produce digital orthophotography. Based on this aerial photographic data, the NJDEP has contracted out the detailed mapping of land use. The first land



Development along the barrier island in the Barnegat Bay watershed
Photo courtesy of: www.aerialpictures.org



Developed and altered land (excluding water) by year for the Barnegat Bay watershed.

use mapping for the Barnegat Bay watershed is for 1986. In 1995, imagery was acquired, and in addition to land use type, estimates of impervious surface cover were mapped. This data set has been updated recently with 2002 photography. Once the 2002 imagery has been interpreted (expected to be completed in 2005), a closer examination of trends in altered vs. unaltered land use and impervious surface cover will be possible. Comprehensive, up-to-date information with accurate boundaries on the publicly owned land is still not readily available in a digital GIS format. There is no single repository of such data across all ownerships (e.g., federal, state, county, municipal and non-governmental organization).

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Fishin' for Ideas

We welcome all contributions and story ideas for inclusion into *The Barnegat Bay Beat*. Please contact Shannon Shinault via email at sshinault@ocean.edu for more information.

The Barnegat Bay Beat is a quarterly newsletter produced by the Barnegat Bay National Estuary Program. The Barnegat Bay National Estuary Program is a partnership of federal, state and local interests. Our office is located on campus at Ocean County College, College Drive, Toms River, New Jersey.

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