The Shore at Risk

The Threats Facing New Jersey's Coastal Treasures, and What it Will Take to Address Them

ENVIRONMENT NEW JERSEY
RESEARCH & POLICY CENTER

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Executive Summary

The Jersey shore is an incomparable recreational resource and natural treasure. But the health of the shore is in jeopardy. The warning signs are clear: declining populations of hard clams and seagrasses, increases in harmful algae blooms and jellyfish, continued problems with bacterial contamination at beaches, and problems with low dissolved oxygen levels in our near-shore waters.

There is no single cause of the problems facing the shore, but scientists have narrowed in on one culprit that is at the root of many of these challenges: the rapid development of houses, businesses, highways and parking lots in shore counties over the past several decades.

New Jerseyans have rallied time and again to save the shore. By taking action now to reduce the environmental impacts of development and address other ecological threats, New Jersey can protect the health of the shore for generations to come.

Rapid development in counties along the shore is a major contributor to water quality problems.

- The population of Ocean County has more than doubled since 1970, with 370,000 new residents moving into the county over the last four decades. During the summer, the population of the Barnegat Bay-Little Egg Harbor watershed doubles from 500,000 people to more than 1 million.

- Development brings with it an increase in "impervious surfaces"—roads, parking lots, roofs, etc.—that channel rainwater contaminated with fertilizers, pesticides and other pollutants into waterways. In 1972, development covered 18 percent of the Barnegat Bay-Little Egg Harbor watershed, which includes most of Ocean County and a sliver of Monmouth County. Now, development covers more than 30 percent of the watershed.

- The U.S. Geological Survey estimates that 66 percent of the nitrogen pollution flowing into Barnegat Bay-Little Egg Harbor estuary comes from surface water, with most of the surface water discharge coming from

the Metedeconk River and Toms River basins, which have experienced intensive development in recent years. Nitrogen is a key nutrient pollutant that fuels harmful algae blooms.

- Development also alters the natural flow of water along the shore. Each year, for example, 25 billion gallons of freshwater is withdrawn from surface water and groundwater sources in the Barnegat Bay watershed, with 14 billion gallons of that discharged as treated wastewater into the Atlantic Ocean. Excessive water withdrawals can contribute to changes in the salinity of estuaries such as Barnegat Bay, while depletion of groundwater in coastal communities can lead to saltwater intrusion of drinking water supplies, as has already occurred on Cape May.

Waterways along the shore experience nutrient pollution, low levels of dissolved oxygen, bacterial contamination and other problems that jeopardize wildlife and human recreation.

- Barnegat Bay-Little Egg Harbor and New Jersey's more southerly inland bays from Great Bay (at the mouth of the Mullica River) south to Cape May are considered by the National Oceanic and Atmospheric Administration (NOAA) to be highly eutrophic—meaning that they are susceptible to nutrient-fueled algae blooms that harm aquatic ecosystems and have the potential to deprive waterways of oxygen. Water quality conditions in Barnegat Bay-Little Egg Harbor have worsened over the past decade, while NOAA projects that nutrient related symptoms in the southern coastal bays are likely to worsen in the years to come.

- The entire Atlantic coast of New Jersey, from Sandy Hook to Cape May, along with some coastal bays, has been designated as "impaired" for dissolved oxygen by the New Jersey Department of Environmental Protection. Low dissolved oxygen levels have the potential to harm sea life—a low dissolved oxygen episode off the Jersey shore in 1976, for example, generated a 3,000 square mile "dead zone," resulted in a federal disaster area declaration, and caused $1.33 billion in lost sales in the seafood industry.

- The number of beach closing days has risen in recent years, from 79 days in 2005 to 180 days in 2009. Most closures are due to detected or anticipated bacterial contamination. In addition, New Jersey experienced medical waste wash-ups on beaches in each of the three summers from 2007 to 2009, after many years in which such incidents were rare or non-existent.

- The Oyster Creek Nuclear Generating Station at the southern end of Barnegat Bay imposes its own damage on coastal ecosystems. Since 1992, at least 15 endangered or threatened sea turtles have been found dead at the intakes to the plant's cooling system. Those impacts are in addition to the regular discharge of heated water to the bay.

Water quality problems on the shore are damaging wildlife and have the potential to harm recreation and New Jersey's economy.

- Barnegat Bay-Little Egg Harbor has lost much of its seagrass and shellfish population**.** Hard clam harvests in Barnegat Bay-Little Egg Harbor declined by more than 99 percent

between the early 1970s and 2000, and bay scallops—which sustained a busy fishery in the 1950s—are virtually absent from the bay today. Seagrasses such as eelgrass, which provide shelter and food for a variety of fish species in the bay, have experienced a similar steep decline, with aboveground eelgrass biomass in the bay having declined by 50 percent between 2004 and 2006.

- New Jersey's coastal waters have seen regular blooms of harmful algae, including "red tides," "green tides" and "brown tides" that trigger oxygen depletion and can be toxic to sea life and, in some cases, humans. Brown tide, which appeared in Barnegat Bay-Little Egg Harbor for the first time in 1995, is particularly hazardous to bay scallops.

- Barnegat Bay-Little Egg Harbor has also seen repeated "eruptions" of stinging sea nettle jellyfish since they first arrived in the bay in 2000. Research suggests that nutrient pollution can enhance jellyfish blooms, which have periodically driven swimmers from the water in recent summers.

- Numerous species of fish—including many migratory fish such as winter flounder and weakfish—depend on Barnegat Bay-Little Egg Harbor and New Jersey's near-shore waters as spawning or nursery grounds. The impact of the ecological decline of Barnegat Bay and other Atlantic coastal bays on the declining populations of these fish is unknown. The same is true of the many migratory birds that use New Jersey's coastal bays as a stop-over on their migrations.

- The decline of shellfish and finfish stocks in coastal bays and in the Atlantic has harmed New Jersey's once-vibrant fishing industry. The number of clammers in Barnegat Bay has reportedly fallen from 250 to eight since the 1950s, while the state's total commercial catch from all fisheries in 2008 was just 30 percent of its peak level in the 1950s.

- Threats to water quality and wildlife along the shore also imperil the state's tourism industry, which creates $28 billion in economic impact in the state annually. New Jersey's four coastal counties account for six out of every 10 tourism dollars spent in the state. More than 400,000 jobs statewide are linked to the tourism industry, including a growing number of jobs linked to "ecotourism," such as hunting, fishing and wildlife watching.

New Jersey must take strong and immediate action to protect the shore. Among the most important steps are:

- **Curbing nutrient pollution of shore waters** by reducing the nutrient content of fertilizer; encouraging proper fertilizer application; establishing strong numerical standards for nitrogen pollution in waterways to accompany the state's narrative standards; requiring the use of best practices to limit pollution from new development; and moving forward with the establishment of enforceable limits on the amount of nitrogen allowed into Barnegat Bay-Little Egg Harbor and New Jersey's ocean waters.

- **Protecting coastal waterways from excessive runoff** by requiring new development to create no new net flow of stormwater into rivers, streams, and bays; establishing stormwater utilities to improve the management of stormwater near the shore, including the

upgrading of outdated pollution control basins; upgrading shore-bound waterways to Category 1 status, which requires the preservation of vegetated buffer zones alongside waterways to slow runoff and filter pollution; and preserving existing stormwater and coastal protection rules.

- **Reducing the ecological threat from the Oyster Creek Nuclear Generating Station** by finalizing a new water discharge permit for the plant that requires the construction of cooling towers within the next three years—a step that will dramatically reduce fish kills and thermal pollution from the plant.

- **Increasing monitoring and study of coastal pollution problems and their impacts** by ramping up water monitoring efforts in New Jersey's near-shore ocean waters; assessing coastal waters for a full range of indicators of water quality and biological health; and moving toward daily, same-day testing for bacterial contamination at New Jersey's beaches.

- **Enforcing existing laws,** including requiring counties to finally complete wastewater management plans that lay out how they plan to address their future water and sewer needs and address environmental impacts from stormwater.

- **Curbing sprawl** by encouraging redevelopment in urban areas and ensuring that new development occurs in ways that use land efficiently and reduce the addition of impervious surfaces.

- **Protecting land to preserve water quality**, by developing a long-term funding source for New Jersey's popular and environmentally critical land preservation programs.

Introduction

If there is one thing most New Jersey residents share, it's an appreciation for—and fierce pride in—our shore.

While in much of America, the Jersey shore brings to mind images of casinos, beauty pageants, kitschy seaside amusements and now MTV reality shows, we know that our shore is much more than that. It is also a place of incomparable beauty, a place where anyone can simply get away from it all for a few hours or a few days, something that has special value for residents of the nation's most densely populated state.

We also know that the shore is an ecological treasure. Its back bays and coastal estuaries are home to an amazing assortment of fish, birds and other creatures. Its coves and sand beaches host nesting and migratory birds. Our ocean waters have long been productive fishing grounds, sustaining generations of fishers.

So, it's no surprise that when the shore is threatened, New Jersey residents fight back. When rampant, uncontrolled development along the shore and filling of wetlands threatened the beauty and ecological vitality of the shore, we passed legislation in the early 1970s to better plan for future development along the coast. When medical waste washed up on our beaches in the 1980s, we became national leaders in beach monitoring, pursued upgrades to our sewage treatment systems, and cracked down on water polluters, while our representatives in Congress led the drive for a long overdue ban on the dumping of sewage and medical waste into the Atlantic Ocean.

Over the past few decades, New Jersey has invested billions of dollars to preserve land, upgrade sewage treatment systems, and make other improvements—all with the goal of protecting the shore. The state invested $5 billion in sewage treatment systems alone between 1972 and 1999.[1]

Now, however, the shore faces a new set of threats. Scientists warn that the Barnegat Bay-Little Egg Harbor Estuary—New Jersey's largest coastal bay and a critical ecological resource not just for New Jersey but also the nation—is feeling the effects of an influx of pollution from the new suburban developments that have sprouted up over the past several decades in Ocean and Monmouth counties. Even beyond Barnegat Bay, there are signs that coastal waterways are under strain.

This time, the threats facing the shore

are less dramatic than needles washing up on a beach. Today's threat to the shore results from polluted runoff from dozens of tributaries across hundreds of square miles. It is a direct result of rampant development in New Jersey's coastal counties over the last several decades, which has upset the delicate ecological balance of our coastal waters.

The most recent scientific research suggests that New Jersey needs to take urgent action to protect water quality at the shore. This report summarizes much of that evidence and describes actions the state can take to protect the shore.

New Jerseyans have a long history of rallying to protect the shore. Now, it's time to do it again.

Trouble at the Shore

When New Jersey residents think of "the shore," images come to mind of sandy beaches, fishing, boating and other water sports, and perhaps boardwalks and other seaside attractions.

But the shore is more than just a playground for people. It is comprised of delicate and vital ecosystems. Most New Jersey beachgoers now understand this. Conscientious shoregoers don't leave trash on the beach, walk on sand dunes, or dump waste over the side of their boats.

Other human activities, however, some of them taking place far away from the

New Jersey's shore counties have experienced rapid development over the past several decades, resulting in an increase in runoff pollution that carries nutrients and other pollutants into coastal waters.
Credit: K.L. Kohn, Shutterstock.com

shore, are putting the ecological health of the shore at risk. There are increasingly strong signs that the quality of water and the health of plant and animal communities in the state's coastal waters are in jeopardy, threatening the progress New Jersey residents have made in recent decades to preserve the health of the shore.

Water Quality

Intensive Development Leads to Troubled Waters

Jackson Township is a good place to start when seeking to understand the problems now facing the Jersey shore.

Jackson—which is known as the home of Six Flags Great Adventure—is not located along the shore. At its nearest point, the township is more than 10 miles away. But Jackson does sit astride the watersheds of the Metedeconk River and the Toms River, both of which flow into Barnegat Bay, an ecologically vital nursery for fish that populate the waters off the Jersey shore.

Jackson is also one of the most rapidly developing municipalities in fast-growing Ocean County. In 1960, Jackson Township was home to fewer than 6,000 people. By 1970, the population had tripled, and by 2007, it had nearly tripled again, to 53,000 people. Across Ocean County as a whole, population has more than doubled since 1970, with the county adding 370,000 people and becoming the fastest-growing county in New Jersey.[2] During the summer, the population of the Barnegat Bay-Little Egg Harbor watershed—which includes most of Ocean County and a sliver of Monmouth County—doubles again, from roughly 500,000 to more than 1 million.[3]

As Ocean County's population has increased, forests and fields increasingly have been replaced by houses, driveways, roads, parking lots and landscaped lawns. In 1972, development covered 18 percent of the Barnegat Bay-Little Egg Harbor watershed. Now, development covers more than 30 percent of the watershed.[4]

Development in Jackson and other towns like it in Ocean County has upended the delicate ecology of the shore region in several ways:

Figure 1. Changes in Land Use in New Jersey Coastal Counties, 1986-2007[5]

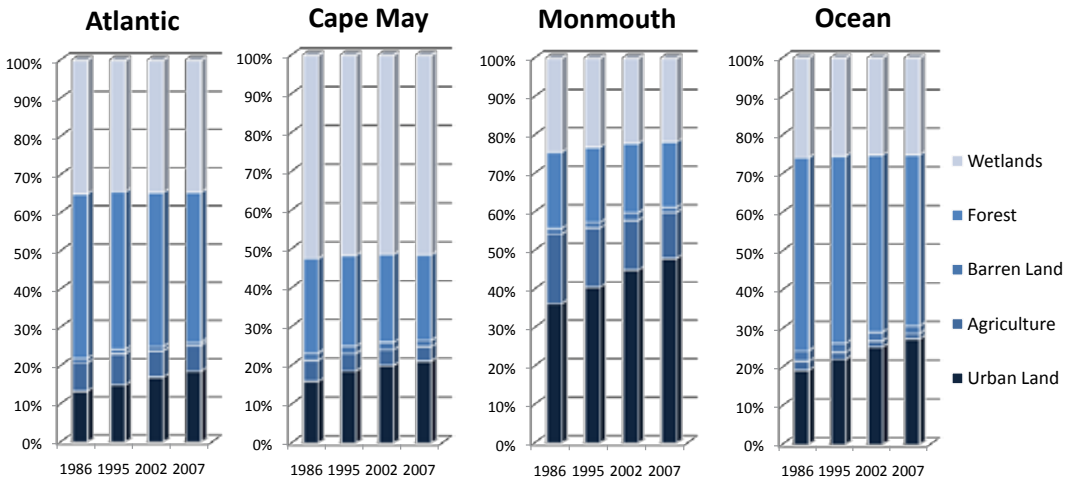
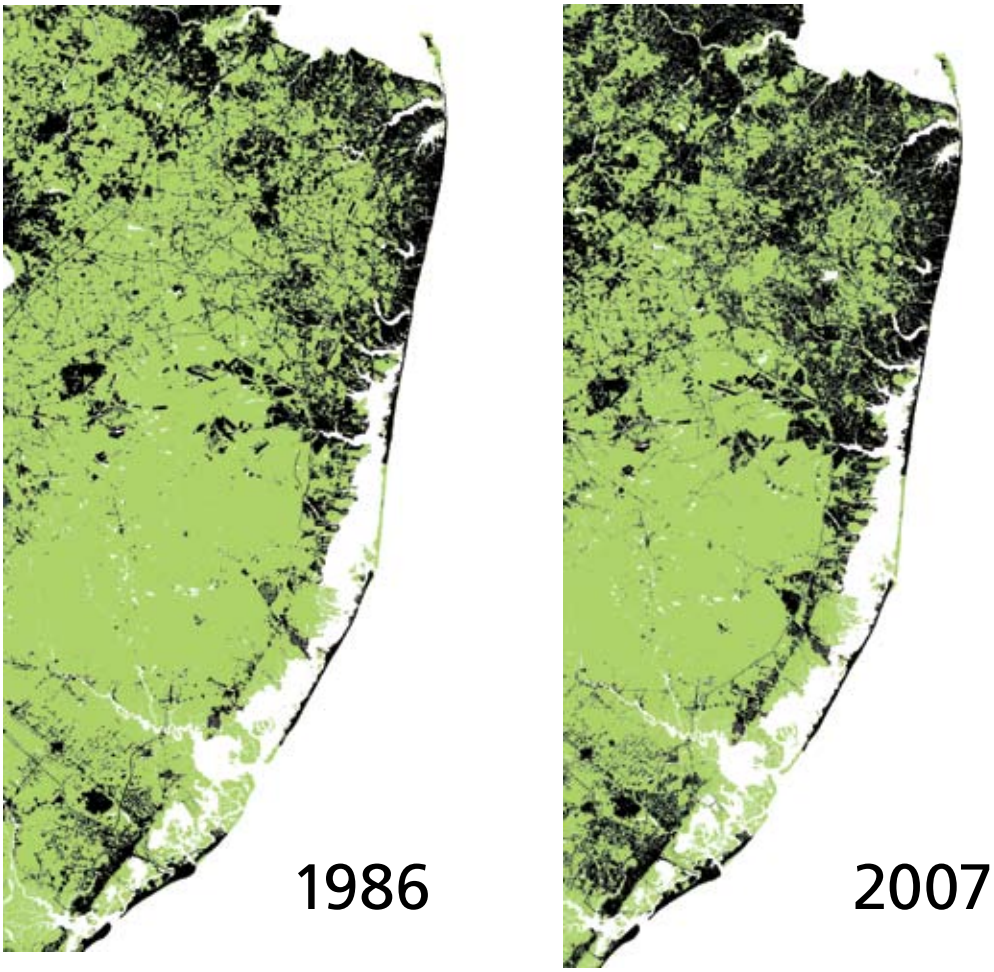


Figure 2. Urban Land in Coastal New Jersey (dark=urban)[6]



Increase in Impervious Surfaces

With more development comes more pavement. ***Impervious surfaces*** such as roofs, roads, parking lots and driveways channel stormwater into detention basins and storm sewers that discharge into the area's rivers and streams. Along with that water comes pollutants such as sediment, chemicals and fertilizers. In the Metedeconk River watershed at the northern end of the Barnegat Bay watershed, impervious surfaces now cover 17 percent of the land area.[7] Scientific evidence shows that watersheds with greater than 10 percent impervious land cover are at greater risk of ecological damage to streams.[8]

Research has shown that waterways in areas of the Barnegat Bay watershed that have experienced greater levels of development also tend to have higher concentrations of nitrogen—a nutrient that triggers unhealthy blooms of algae.[9] More development could be around the corner: a 2001 analysis by Rutgers University researchers showed that existing zoning laws would allow a further 50 percent increase in impervious surface in the watershed compared with 1995 levels.[10]

There are several ways to minimize the damage development can cause to waterways. One way is by using features—such as permeable pavement and rain gardens—in new or existing developments that allow rainfall to percolate into the ground or to be efficiently absorbed by plants. Another way is to preserve vegetated land along streambanks, known as "buffer zones." Vegetated buffer zones reduce the flow of runoff into waterways, and plants along streambanks can effectively absorb excess nutrients, such as nitrogen, that would otherwise damage ecosystems.[11]

In the Barnegat Bay watershed, however, much of this crucial streamfront habitat has already been developed. Between 1995 and 2006, more than 150 acres of forests or wetlands along streams were converted to urban development each year in the Barnegat Bay watershed.[12]

Increased Nutrient Pollution

Development also brings with it increased use of chemical fertilizers used to keep grass green and plants growing. These fertilizers contain ***nutrients***—such as nitrogen and phosphorus. Nutrients are indispensible to the growth of plants—including phytoplankton, the microscopic plants (many of them forms of algae) that are the base of the marine food chain. Just as applying fertilizer contributes to faster and more vigorous plant growth, so too does increasing the amount of nutrients in waterways fuel the growth of algae.

Nutrient enrichment of waterways can have major, negative impacts on aquatic ecosystems. Nutrients can fuel "blooms" of algae that reduce the amount of light that can penetrate the water, keeping seagrasses from receiving the sunlight they need to grow. In addition, when large amounts of algae in a bloom die, the process of decomposition can consume much of the oxygen in a waterway. This oxygen depletion can trigger fish kills or force marine creatures to flee to more oxygen-rich waters.

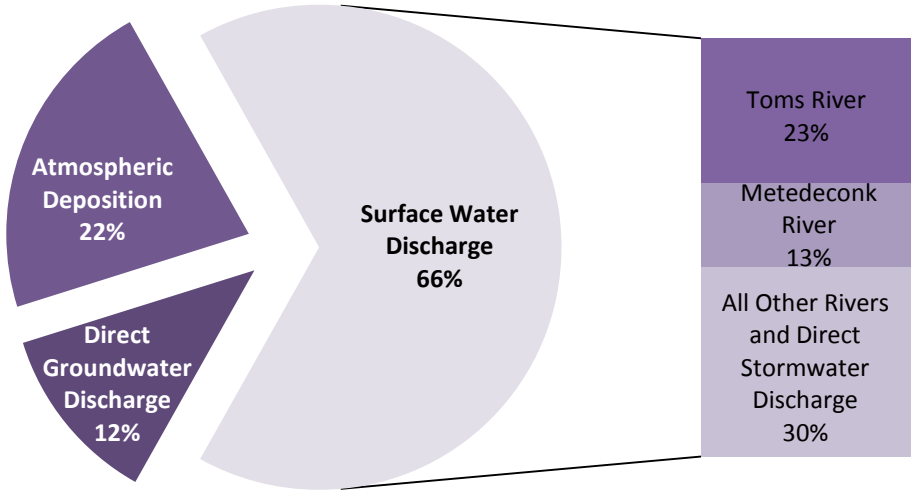
As a result, nutrient enrichment can result in serious damage to important ecosystems. In the Barnegat Bay-Little Egg Harbor watershed, nutrients from suburban lawns and farm fields combine with discharges from sewage treatment plants, animal waste and septic system discharges to affect the health of the area's rivers and streams and, eventually, its coastal waters. The U.S. Geological Survey estimates that 66 percent of the nitrogen flowing into the Barnegat Bay-Little Egg Harbor Estuary comes from surface water, with most of that discharge coming from the Toms River and Metedeconk River basins, which have experienced intensive development in recent years.[13] (See Figure 3.) Another draft study estimates residential fertilization alone is responsible for between 8 and 15 percent of the nitrogen pollution in Barnegat Bay.[14]

Nutrients can find their way into New Jersey's coastal bays via another path: groundwater. Southern New Jersey is a flat, coastal plain with sandy soils. Its main aquifer—the Kirkwood-Cohansey aquifer—sits close to the surface, supplies freshwater to rivers and streams, and has a direct hydrological connection with the state's coastal bays. Direct groundwater discharge to Barnegat Bay is responsible for approximately 12 percent of nitrogen delivery to the bay. However, unlike surface runoff, which can deliver nutrients to the bay quickly in the wake of a heavy rainfall, nitrogen can take years to decades to find its way to the bay via groundwater.[16]

Changes in Freshwater Flows

Development also impacts the water cycle in ways that damage waterways. The ecological health of New Jersey's coastal bays depends on a fine balance of freshwater and saltwater. In Barnegat Bay-Little Egg Harbor, for example, the salinity of the water varies from the northern, freshwater influenced part of the bay to the southern end at Little Egg Harbor. The bay depends upon infusions of freshwater from rivers

Figure 3. Sources of Nitrogen Loading to Barnegat Bay[15]



and streams—as well as from groundwater recharge—to remain in balance.

Prior to large-scale development of the shore area, rainfall would be taken up by trees and plants, with the remainder recharging underground aquifers and providing a source of freshwater for streams and bays. Development, however changes the flow of water along the coast in several ways.

- Impervious surfaces channel stormwater runoff directly into rivers and streams before it can seep into the ground to recharge the aquifer, reducing groundwater availability and carrying pollutants directly into waterways.

- Increasing amounts of water are removed from the aquifer to supply clean water for residential and commercial needs, further depleting groundwater supplies.

- The water that goes down the drain in homes or businesses is then treated and, in Ocean County, is released directly into the ocean, entirely bypassing local rivers and Barnegat Bay. Keeping treated wastewater out of coastal bays reduces the potential for pollution of those waterways, but it results in the diversion of freshwater from the bay to the ocean.

Development in the Barnegat Bay watershed has profoundly altered the flow of water in the region. In 1999, for example, 25.9 billion gallons of freshwater were withdrawn from groundwater and surface water supplies in the Barnegat Bay watershed, with the vast majority of that water—22.5 billion gallons—used to supply potable water to the region's growing population. At the other end of the pipe, about 14.4 billion gallons of treated wastewater were discharged into waterways, almost all of it into the Atlantic Ocean.[17] This 14.4 billion gallons of treated wastewater is water that would otherwise have maintained water levels in aquifers or flowed into Barnegat Bay.

During the summer, when water use in the region increases along with its population, as much as 60 million gallons per day

of treated wastewater is released into the ocean. During times of drought, that diversion of freshwater can amount to as much as one-third of the freshwater that would otherwise flow into the bay.[18] A 1997 study by the U.S. Geological Survey estimated that water withdrawals have reduced the base flow of some streams by as much as 12 percent in the Toms River, Metedeconk River, and Kettle Creek watersheds from pre-development levels, and that projected increases in groundwater withdrawals would likely reduce river flow further.[19]

The diversion of freshwater from aquifers and streams can have several important impacts. Reduced flow of freshwater into Barnegat Bay can alter the salinity of the bay, disrupting bay ecosystems.[20] In addition, aquifer depletion can enable the intrusion of saltwater into groundwater supplies, rendering them unusable for drinking water. Saltwater intrusion has already affected wells in Seaside Heights and Point Pleasant Beach.[21]

Changes in water flows have affected shore communities beyond Barnegat Bay. In Cape May County, depletion of groundwater supplies has become so severe that saltwater has begun to intrude into drinking water wells.[22] The city of Cape May was forced to build a $5 million desalination plant, completed in 1998, to meet its drinking water needs.

Today Barnegat Bay, Tomorrow the Entire Coast?

The examples above were drawn primarily from the Barnegat Bay-Little Egg Harbor Estuary. Barnegat Bay is, in many ways, the "canary in the coal mine" for all of New Jersey's coastal bays. The bay's watershed has experienced more intense development than other coastal watersheds over the past several decades. In addition, the bay is relatively shallow, and is infrequently flushed with sea water due to its few, narrow openings—making it a prime candidate for ecological damage.

But all of the challenges that currently affect Barnegat Bay-Little Egg Harbor have the potential to affect other New Jersey coastal bays. The intense development of Ocean County over the past 30 years has not yet been matched in Atlantic or Cape May counties. (See Figure 1, page 8.) Moreover, preservation of the Pinelands—one of New Jersey's signal environmental accomplishments of the 20th century—has thus far succeeded in protecting the quality of groundwater and surface water flowing to the shore and has reduced development pressure inland.

The watershed of the Mullica River and Great Bay, just south of Barnegat Bay, provides a useful contrast. As noted above, 30 percent of the Barnegat Bay watershed is now developed.[23] In the Mullica Bay watershed, however, 88 percent of the land was in an unaltered state as of 2000, with urban development covering less than 7 percent of the land.[24] Accelerated development along the Mullica River, or in other South Jersey watersheds, could result in similar challenges to those now facing Barnegat Bay-Little Egg Harbor, making it imperative that efforts to address water quality problems at the shore also include efforts to prevent similar problems from occurring elsewhere.

Evidence of Water Quality Problems

The evidence of water quality problems along the shore is growing. Water quality problems begin in the tributaries that feed New Jersey's coastal bays, and progress to the bays themselves. Near-shore ocean waters also exhibit water quality problems, such as low dissolved oxygen, which scientists are working to understand and address.

Tributary Rivers and Streams

Nutrient pollution of rivers and streams is not always obvious. Water testing can detect elevated levels of the nutrients

themselves, or can measure the effects of nutrient pollution, such as low dissolved oxygen or high levels of biological oxygen demand. Nutrients fuel the growth of algae, which then decompose, reducing the amount of dissolved oxygen in the water. Low dissolved oxygen can make it difficult for fish or other organisms to thrive—it can even create so-called "dead zones" in which there is so little available oxygen that fish cannot survive. Rivers and streams in the coastal region also experience other water quality problems—from excessive bacteria counts to toxic pollution—that can affect the health of local ecosystems.

Many important tributaries to New Jersey's coastal bays have been impacted by nutrient pollution to the extent that they have been designated as "impaired" for aquatic life by the New Jersey Department of Environmental Protection. In the Barnegat Bay-Little Egg Harbor watershed, parts of the Metedeconk River and Forked River have been declared impaired due to low dissolved oxygen, while sections of the Toms River and Muddy Ford Brook have been declared impaired due to excessive concentrations of phosphorus, which, along with nitrogen, is a key nutrient capable of fueling algae growth.[25]

In the Mullica River/Great Bay watershed, sections of the Mullica River are impaired for dissolved oxygen and phosphorus, while sections of the Wading River, Indian Cabin Creek, Landing Creek, Oswego River and other waterways are impaired for dissolved oxygen. Further south, the Great Egg Harbor River (and Great Egg Harbor Bay) similarly exhibit low dissolved oxygen.[26]

Other water quality problems in rivers and streams near the coast include:

- **Pathogens** – Bacteria are found throughout nature, but certain types of bacteria can cause human health problems. Environmental agencies test waterways for several types of bacteria, some of which can cause health problems on their own, while others may be indicators that fecal waste from humans or animals is present in the water. Malfunctioning sewer and septic systems, farms, and polluted stormwater are all potential sources of harmful bacteria, otherwise known as ***pathogens***.

  Many water bodies in New Jersey's coastal areas have been listed as "impaired" for pathogens, including the Toms River, the Metedeconk River, the Forked River, the Batsto River, the Mullica River and the Great Egg Harbor River.[27]

  Excessive levels of pathogens can lead to beach closings or to the closure of estuaries for shellfish harvesting.

- **Toxic substances** – New Jersey's industrial and agricultural legacy—combined with the ability of dirty air to deposit pollutants in our waterways—has left the state with many waterways that are impaired due to the presence of toxic chemicals. Persistent toxic chemicals such as PCBs and DDT, despite having been banned for decades, continue to be present in sediments in many shore-area waterways and in the tissues of fish caught in New Jersey waters.[28] Similarly, mercury deposited from air pollution drifting over New Jersey from coal-fired power plants in other states has resulted in statewide fish consumption advisories.

Coastal Bays

New Jersey's coastal bays from Sandy Hook to Cape May are extremely sensitive to nutrient pollution delivered from upstream. Estuaries such as Barnegat Bay-Little Egg Harbor are narrow, shallow, tend to be poorly flushed and receive

Bacteria from polluted stormwater, malfunctioning sewer and septic systems, and farms trigger periodic closures of some New Jersey beaches. Credit: Richard A. McGuirk, Shutterstock.com

waters from large, highly developed watersheds.[29]

Barnegat Bay-Little Egg Harbor and New Jersey's more southerly inland bays from Great Bay south to Cape May are considered highly ***eutrophic***—meaning that they are susceptible to nutrient-fueled algae blooms that harm aquatic ecosystems and have the potential to deprive waterways of oxygen.[30] According to a 2007 National Oceanic and Atmospheric Administration report, water quality conditions in Barnegat Bay have worsened over the past decade, while the agency projects that nutrient related symptoms in the southern coastal bays are likely to worsen in the years to come.[31]

Nutrient pollution isn't the only problem facing coastal bays. The diversion of surface and ground water for human consumption has reduced freshwater flows to Barnegat Bay, which has the potential to alter salinity in the bay. Higher salinity levels have been linked with nuisance algae blooms such as brown tide (see page 19).

Bacterial contamination is also a significant problem in some coastal bays. Portions of Barnegat Bay have been listed as impaired due to pathogens, and the bay has experienced both beach closures and the closure of shellfish areas due to the presence of harmful bacteria.

Impacts of the Oyster Creek Nuclear Generating Station

The Oyster Creek Nuclear Generating Station, located near Barnegat Bay in Lacey Township, poses its own unique ecological threats. The plant, which is the oldest operating nuclear plant in the United States, and which recently had its operating license extended for another 20 years, draws vast amounts of water from Barnegat Bay for cooling. Indeed, the plant's cooling system is capable of consuming a volume of water greater than 2 percent of the volume of Barnegat Bay *every day*.[32]

The plant's impact on the bay includes:

- **Trapping of sea animals against the mesh screens that protect the plant's cooling intake pipes.** Over the course of the plant's history, dozens of sea turtles and millions of fish and invertebrates have been trapped against the screens. Indeed, over a recent two-year period (September 2005 to September 2007), more than 5 million organisms—more than 80 percent of them grass shrimp, sand shrimp and blue crab—were trapped, or "impinged," against the screens.[33] Between 1992 and 2006, 41 sea turtles—all of them listed as endangered or threatened species—were found (many of them impinged) at the intakes of the Oyster Creek Nuclear Generating Station. Of those turtles, 15 were found dead, with federal officials estimating that nine of those had been killed at the intakes.[34]

- **Killing of eggs, larvae and juvenile sea animals that find their way past the protective screens and into the plant's cooling system.** Over a recent two-year period, nearly 2 billion organisms entered the plant's cooling system, including many creatures that form the base of the bay's food web, such as sand shrimp, blue crab, menhaden and bay anchovy.[35] These losses can have an impact on the health of fish populations in the bay (see below).

- **Thermal pollution**, which affects the bay's ecosystem. The cooling water that the Oyster Creek Nuclear Generating Station removes from Barnegat Bay is released, after passing through the plant, at significantly higher temperatures. During the winter, the heat from the Oyster Creek Nuclear Generating Station's discharge attracts some species of fish that would ordinarily migrate out of the area to warmer waters. These fish are at risk of dying in the sudden drops in temperature that result when the plant is shut down for maintenance or unplanned outages.[36] Between 2000 and 2006, the plant experienced three such "cold shock" fish kills, which were responsible for the death of more than 5,000 fish.[37] Sudden spikes in water temperatures, as can occur when the plant's dilution pump system malfunctions, can also cause fish kills. One 2002 malfunction caused the temperature of the plant's discharge canal to increase to more than 100° F for several hours, resulting in the death of more than 5,800 fish.[38]

- **Discharges of chlorine and radionuclides from the plant**, which also have the potential to affect aquatic life in the bay. Chlorine, which is used to remove bacteria and other organisms that can foul the plant's cooling system, can be toxic to aquatic organisms. Releases of radioactive substances known as radionuclides are also regular occurrences at the plant, with unknown impacts on wildlife and humans. In addition, in 2009, radioactive tritium was discovered leaking into groundwater under the Oyster Creek Nuclear Generating Station. Tritium from the leak has already reached the Cohansey aquifer and state officials believe that tritium has reached the plant's intake and discharge canals, which connect to Barnegat Bay.[39]

Ocean Water Quality

When people think about water quality at New Jersey's Atlantic beaches, the first question that usually comes to mind is whether the water is safe for swimming. But the safety of swimmers is not the only

important issue when it comes to ocean water quality. The vibrant array of fish and other sea life that dwells off the coast depends on clean water.

The entire Atlantic coast of New Jersey, from Sandy Hook to Cape May, has been designated as "impaired" for dissolved oxygen by the New Jersey Department of Environmental Protection.[40] Bouts of ***anoxia*** (low dissolved oxygen) or ***hypoxia*** (no dissolved oxygen) have occurred off the coast of New Jersey for at least the last several decades. In 1976, for instance, a massive "red tide" event off the Jersey shore led to the depletion of dissolved oxygen and a die-off of marine life. The event generated a 3,000 square mile "dead zone," resulted in a federal disaster area declaration, and caused $1.33 billion in lost sales in the seafood industry.[41] Low dissolved oxygen was also thought to be the culprit behind the massive die-off of menhaden in Delaware Bay during 2010.[42] Scientists are still working to understand what impact the recurrent low dissolved oxygen problems off the Jersey shore may have on sea life.

What causes low dissolved oxygen in New Jersey's coastal waters? The culprit, as with rivers and coastal bays, is an excess of nutrients, which fuel the growth of algae and lead to the depletion of oxygen levels when those organisms die off. Nutrient enrichment of coastal waters is a cause of algal blooms and oxygen depletion, and the number of coastal waters experiencing these problems has increased over the last several decades.[43]

The more difficult question facing scientists is where the nutrients that fuel New Jersey's coastal oxygen depletion are coming from. The emerging answer is that nutrient enrichment of New Jersey's coastal waters is the result of a mixture of human-caused and natural factors.

The northern end of the Jersey shore, from Sandy Hook to the northern end of Barnegat Bay, is heavily influenced by discharge from the Hudson River and Raritan Bay, which carries vast amounts of nutrients into Atlantic waters. Freshwater from the Hudson/Raritan "plume" often flows southward along the New Jersey coast—particularly during the winter and spring months—as evidenced by the occasional deposits of floatable trash from New York/New Jersey Harbor that wash up on New Jersey beaches.[44]

A 2008 study suggests that water from the Hudson/Raritan plume may form a recirculating bulge at the mouth of New York/New Jersey Harbor, fueling the growth of algae that are later carried by currents down the New Jersey shoreline and deposited on the ocean floor, contributing to oxygen depletion off the northern part of the Jersey shore.[45]

Farther south, in areas of the coastline with recurrent oxygen depletion problems, including the central and southern portions of the shore opposite Barnegat Bay-Little Egg Harbor and the Cape May County coastline north of the Wildwoods—the movement of ocean waters and meteorological conditions appear to hold greater sway than human influence.[46] Scientists believe that oxygen depletion in these areas is likely the result of the seasonal upwelling of cold, nutrient-rich water from deep in the ocean, fueling the growth of algae in coastal waters and reducing oxygen levels.[47]

Interestingly, despite the oxygen depletion problems in many New Jersey southerly coastal bays and the high level of nutrient runoff into estuaries such as Barnegat Bay-Little Egg Harbor, scientists have not found evidence that nutrients from the bays are a major contributor to the dissolved oxygen problem in New Jersey's nearshore ocean waters. In the case of Barnegat Bay-Little Egg Harbor, the bay discharges relatively little water to the ocean and scientists estimate that 83 percent of the water that flushes out of Barnegat Bay returns to it on the incoming

tide.[48] Moreover, oxygen depletion has been found opposite the mouths of rivers, such as the Mullica River, that are relatively pristine.

In short, the oxygen depletion that occurs regularly in waters off the Jersey shore has multiple potential causes, which scientists are working to untangle and which may vary in severity from year to year. What is clear, however, is that nutrient flows to coastal waters—even from as far away as North Jersey and the Hudson River Valley—have the potential to contribute to oxygen depletion over at least portions of the shore. This finding suggests that even efforts to prevent nutrient runoff from towns or counties in the shore region may not be enough to fully protect the shore—statewide and even regional efforts are likely necessary.

Impacts on Sea Life

Pollution in New Jersey's coastal waters is having a dramatic impact on wildlife throughout the shore region—threatening the ecological health of a treasured natural resource.

What's Not There But Should Be: Seagrasses and Shellfish

Eelgrass is usually not among the first living things that people say is worth protecting along the Jersey shore. But it may be among the most important.

Eelgrass isn't pretty, and it certainly doesn't have a pretty name, but it plays an essential role in maintaining healthy populations of fish, crabs and other wildlife in Barnegat Bay. Eelgrass provides spawning

Bay scallops, which use eelgrass as a habitat, were once abundant in Barnegat Bay-Little Egg Harbor, but have virtually disappeared from the bay in recent decades. Credit: NOAA, Judd Kenworthy

and nursery grounds for several species of fish, and acts as a direct source of food for fish, turtles, ducks and sea urchins.[49] Bay scallops[50] and blue crabs[51] are among the other species that use eelgrass as habitat. In addition, the health of eelgrass and other forms of submerged aquatic vegetation (SAV) is a potentially important indicator of ecosystem health, since seagrasses depend on clear water for access to the sunlight they need to grow.

Unfortunately, eelgrass has been in steep decline in Barnegat Bay-Little Egg Harbor—offering a warning signal both about the health of the bay and the health of the many species that depend on SAV. Between 1975 and 1999, eelgrass declined by more than 60 percent in Little Egg Harbor.[52] The loss of seagrass has continued: between 2004 and 2006, the average aboveground biomass of eelgrass in Little Egg Harbor declined by approximately 88 percent, with a 50 percent decrease in Barnegat Bay over the same time period.[53]

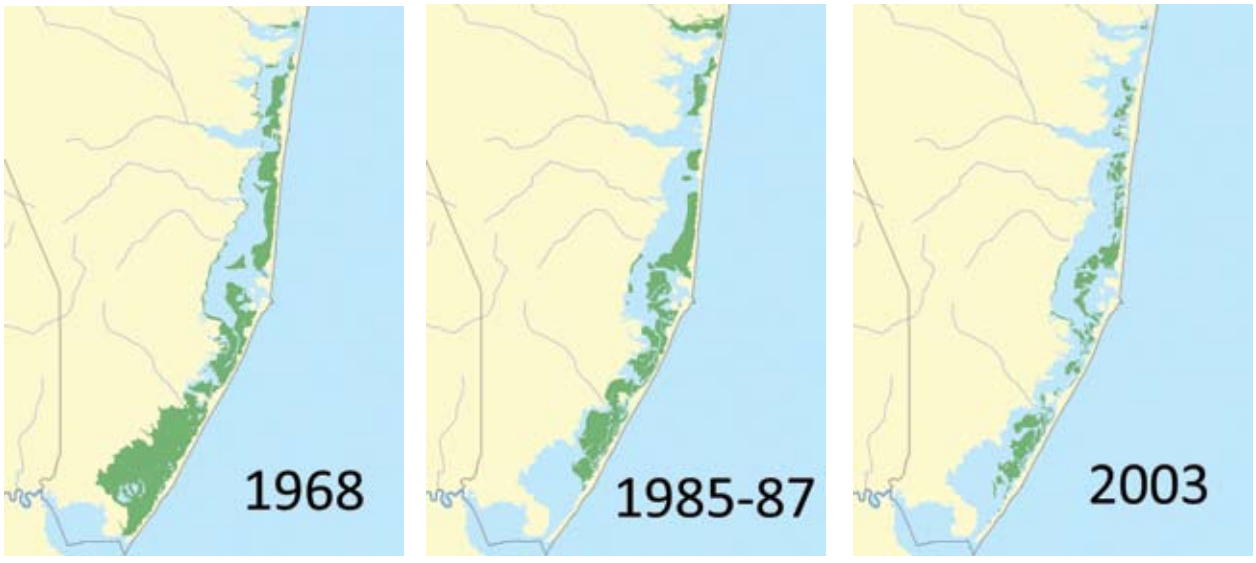
Nutrient pollution in Barnegat Bay is suspected of playing an important role in the decline in eelgrass. Algae blooms fueled by excessive nutrients can block sunlight from reaching the underwater grasses. Algae can even form in thick mats along the bottom of the bay or form directly on the grasses themselves, choking off access to sunlight.[54]

Eelgrass is not the only important species that is disappearing from Barnegat Bay. Shellfish are feeling the effects of nutrient-related pollution as well. Hard clams were once abundant in New Jersey waters and represented an important commercial fishery. In the early 1950s, as many as 1 million pounds of hard clams per year were harvested from New Jersey waters.[56] Between the early 1970s and 2000, hard clam harvests in Barnegat Bay-Little Egg Harbor declined by more than 99 percent.[57] Hard clam populations in Little Egg Harbor were found to have declined by 67 percent between the mid-1980s and 2001.[58]

Bay scallops are another species of shellfish that once thrived in Barnegat Bay but have since disappeared. Bay scallops are highly dependent on eelgrass for habitat.[59]

Bay scallops are also sensitive to the "brown tide" events that have occurred in

Figure 4. Decline in Submerged Aquatic Vegetation Coverage in Barnegat Bay (dark=seagrass)[55]



Barnegat Bay-Little Egg Harbor over the past 15 years. Brown tide was unknown in Barnegat Bay-Little Egg Harbor until 1995.[60] Unlike blooms of other types of algae, which are fueled by nutrient pollution, the role of nutrient pollution in fueling brown tide outbreaks is unclear. Instead, brown tide blooms have been associated with periods of increased salinity, higher water temperatures, and reduced freshwater flows.[61]

The decline in shellfish isn't just limited to Barnegat Bay. In recent years, there has been a dramatic reduction in landings of surf clams from waters off the Jersey shore, which represent New Jersey's biggest shellfish fishery.[62] The decline is thus far unexplained, but may be due to warming of ocean waters.[63]

What Is There But Shouldn't Be: Harmful Algae Blooms and Sea Nettles

Harmful algae blooms can wreak havoc on an ecosystem, triggering oxygen depletion, killing sea life and even, in the case of some types of toxic algae, sickening humans and pets.

Harmful algae blooms have taken several forms off the Jersey shore in recent years:

- **Red tides** – Red tide blooms have occurred regularly for at least several decades off the coast of New Jersey.[64] Red tides result from rapid blooms of algae which can be toxic to fish, shellfish and, in some circumstances, humans.[65] Red tides can also trigger oxygen depletion of waterways, as occurred during the massive 1976 oxygen depletion event off the Jersey shore. Red tides occur regularly off the northern part of the Jersey shore, typically beginning in estuaries, and extending from Raritan Bay down the coast to as far as Belmar.[66] Nutrient enrichment of coastal waters is thought to be a contributing factor to red tide blooms.

Stinging sea nettle jellyfish are a new arrival in Barnegat Bay. With three-foot-long stinging tentacles, sea nettles have become a nuisance to bathers in the bay. Credit: NOAA, Mary Hollinger

- **Green tides –** Green tides have appeared occasionally along the Jersey shore. The first major green tide bloom in the state occurred in 1984-85, sickening bathers in the Atlantic City area.[67] Green tide returned during 1996-97 in the Atlantic City/Ocean City area. Excessive nutrients are thought to contribute to the development of green tides.

- **Brown tides**, as noted earlier, have become frequent occurrences in Barnegat Bay, and have occurred as far south as Great Egg Harbor Bay.[68] Brown tide organisms harm shellfish and shade eelgrass, reducing the amount of sunlight it can obtain.[69] In

2007, a major brown tide event took place off the shore during Memorial Day weekend from Sandy Hook to Manasquan.

Harmful algae aren't the only nuisance species becoming more common at the shore. Sea nettles have come to be a major nuisance for bathers and boaters in Barnegat Bay. Unheard of in the bay prior to 2000, the stinging jellyfish have become common in recent years.[70] Difficult for swimmers to see, and with stinging tentacles that are more than three feet long, sea nettles have been experiencing "eruptions" with increasing regularity in recent years, further upsetting Barnegat Bay's delicate ecosystem and driving swimmers out of the water.

Research in the Chesapeake Bay suggests that the increased population of sea nettles is linked to nutrient pollution.[71] Studies of apparent increases in jellyfish worldwide suggest that nutrients may encourage jellyfish reproduction or alter food chains in ways that are advantageous to jellyfish, and note that some species of jellyfish are able to survive in waters with low dissolved oxygen.[72] Fish that would prey on jellies are believed to be driven out by low dissolved oxygen, leaving jellyfish to compete with fish and other organisms for food.[73]

Other changes in and around Barnegat Bay are also suspected of contributing to the growth of sea nettle populations, including changes in salinity levels and the construction of more human-made structures (such as docks and jetties) in the waterway.[74]

Beyond the Bay: Impacts on Fish and Birds

The decline in water quality and degradation of ecosystems in Barnegat Bay-Little Egg Harbor and other New Jersey coastal waters have impacts that extend to the rest of the shore and beyond, with the potential to affect fish populations along the Atlantic shelf as well as migratory birds that pass through the area.

Barnegat Bay and other New Jersey coastal bays play a critical role as spawning and/or nursery areas for finfish that live in Atlantic waters. Of the fish in Barnegat Bay-Little Egg Harbor, only 31 percent are year-round residents. Most fish migrate from the bay to warmer waters during the wintertime.[75] Recent scientific study has found that the fish species that inhabit Little Egg Harbor are largely similar to those in nearby ocean waters, suggesting that many fish species spend part of their year or lifespan in both environments.[76]

One such fish that spends time both in coastal bays and ocean waters is the weakfish. Weakfish are migratory fish that exist along the Atlantic coast from Florida to Nova Scotia, and are heavily dependent on estuaries such as Barnegat Bay for reproduction. Spawning occurs from mid-May through mid-June, typically in estuaries or in nearshore waters, with young weakfish abiding in nursery habitats such as estuaries and the mouths of coastal rivers and streams.[77] Both juvenile and adult weakfish leave the bay by November to head to warmer waters.

Weakfish populations have been crashing all along the Atlantic seaboard for more than a decade, and are now below the level thought to assure the healthy continuation of the species.[78] Studies suggest that the problem lies with juvenile weakfish not making it to adulthood. While the exact cause of the decline in weakfish populations is unknown, there are many potential contributing factors, including increased predation by striped bass, declines in the availability of the smaller fish that make up its diet (such as menhaden), or impacts from nutrient enrichment of coastal waterways.[79]

Another important fish species under threat is winter flounder, which inhabits

Atlantic waters from Labrador to Georgia.[80] Winter flounder once represented an important fishery off the mid-Atlantic coast, but experienced a steep decline due to overfishing. While winter flounder have shown some signs of recovery in the northern waters of the Gulf of Maine, that has not been the case in the mid-Atlantic region.[81] Commercial landings of winter flounder in southern New England and the mid-Atlantic declined by 90 percent between 1966 and 2005, when they experienced a record low.[82] There are a range of potential causes for the decline of winter flounder and its failure to recover in the mid-Atlantic, but the condition of estuaries—where winter flounder spawn during the winter months and juveniles can be found year-round—is one potential factor.[83] Juvenile winter flounder live among submerged aquatic vegetation—including eelgrass—using the vegetation to hide from predators.[84] As noted earlier, Barnegat Bay has experienced significant declines in eelgrass beds in recent decades. In addition, contaminated sediments and damage from nuclear plants such as the Oyster Creek Nuclear Generating Station may also play a role. A 1989 study, for example, estimated that the Oyster Creek Nuclear Generating Station's cooling system could cause the adult population of winter flounder in Barnegat Bay to decline by 2.1 percent.[85]

The decline of forage fish—such as bay anchovy and menhaden—also has dangerous implications for Atlantic finfish. Bay anchovy have historically been the most common fish found in Barnegat Bay-Little Egg Harbor in terms of sheer numbers, and they are an important source of food for many larger fish. Bay anchovy have been documented to be on the decline in Delaware Bay, and face several threats in Barnegat Bay.[86] The Oyster Creek Nuclear Generating Station's cooling system causes the loss of approximately 137 million adult bay anchovy every year, reducing the amount of anchovy that serve as forage in the bay by 12.4 percent.[87] In addition, research has shown that low levels of dissolved oxygen can kill anchovy eggs and larvae.[88]

The fish and other sea life of Barnegat Bay and New Jersey's near-shore waters also serve as a source of food for migratory birds. New Jersey's Atlantic Coast is a major stopover point for migratory birds, while Barnegat Bay-Little Egg Harbor hosts numerous colonies of nesting birds such as black skimmers, least terns, ibises and egrets.[89]

A case study in the delicate interaction between the life patterns of migratory birds and their prey is the decline of the red knot, a ten-and-a-half inch long shorebird that stops annually in Delaware Bay on its annual migration from the southern tip of South America to northern Canada.[90] In Delaware Bay, the red knot feasts on the eggs of horseshoe crabs, providing it with the energy it needs to complete the arduous journey. However, in recent years, the number of horseshoe crabs in Delaware Bay has declined by approximately 75 percent, in large part, it is thought, to overfishing. The red knot has experienced a similar decline in population, of about 50 percent since 1997.[91] Despite recent efforts to limit harvesting of horseshoe crabs, the red knot continues to decline. The birds, which once descended on Delaware Bay in the hundreds of thousands—are now listed as threatened by the state of New Jersey.[92]

The red knot is not the only migratory shorebird whose populations in Delaware Bay have declined in recent years. The sanderling and semipalmated sandpiper are among five other species that have seen their numbers in Delaware Bay decline by about 65 percent.[93] All of these species, including the red knot, have also been known to use Barnegat Bay-Little Egg Harbor as a stopover on their migratory path.[94]

The loss of crabs and other sea life that provide food for migratory and nesting birds is not the only threat these birds

Eggs of the endangered black skimmer, which nests along the Jersey shore, have potentially harmful levels of toxic mercury. The number of black skimmers in Barnegat Bay has been falling for years, though it is unknown whether toxic contamination has contributed to the decline. Credit: U.S. Fish and Wildlife Service, Gary Kramer.

face. Development along the shoreline; disturbance from boats, jet skis, humans and pets; and beach replenishment projects can all damage bird habitat. Moreover, birds are susceptible to contamination with toxic chemicals that accumulate up the food chain. For example, one study found that the black skimmer—a beach nesting bird that is listed as endangered by the state of New Jersey—has higher levels of toxic mercury in its eggs than other birds in Barnegat Bay and that the mercury concentrations found in the eggs were high enough to cause harmful effects. Black skimmers, unlike the other birds studied, eat only fish, particularly large fish, which tend to have the highest concentrations of toxic chemicals. The number of black skimmers in Barnegat Bay has been falling for years, though it is unknown whether toxic contamination has contributed to the decline.[95]

These examples show that the decline of coastal ecosystems such as Barnegat Bay has far-reaching effects on life in New Jersey's ocean waters and beyond.

Impacts on People

For many New Jerseyans, the shore area is an incomparable natural playground—a place to relax and enjoy nature. Declining water quality and threats to wildlife have the potential to erode New Jerseyans' ability to enjoy the shore, while also damaging the state's economy.

Beach Closings

The public image of the Jersey shore was badly damaged by the medical waste spills of the late 1980s, which made the shore synonymous with pollution. Since then, state and federal governments and many individual New Jersey residents have undertaken painstaking efforts to protect and restore the shore. The ocean dumping of sewage sludge was banned in 1992, sewage treatment plants up and down the shore improved their operations, and the state undertook more aggressive efforts to protect the crucial wetlands and shorefront habitats that are the foundation of the shore's vibrant ecosystem.

Those efforts have paid off, but the Jersey shore still faces its share of pollution problems that cause beaches to be closed or the enjoyment of beachgoers to be reduced. The number of beach closing days increased in recent years from 79 days in 2005 to 180 days in 2009.[96] Indeed, while New Jersey's beaches once seemed on a path toward continual improvement, old problems have re-emerged and others have been insufficiently addressed.

The problem of medical waste washing up on the shore was one that was thought to be solved years ago. Between 1991 and 2002, there was not a single beach closing in New Jersey caused by floatable debris.[97] Yet, each summer from 2007 to 2009 saw medical waste again wash up onto the Jersey shore.

In 2007, trash, including syringes, caused the shutdown of scattered beaches from Raritan Bay to Sea Isle City.[98] A

medical waste wash-up occurred again in 2008, though that incident was the result of illegal dumping of waste by a Pennsylvania dentist.[99] In 2009, medical waste of unknown origin washed up on beaches from North Surf City to Barnegat Light.[100] Each year, New Jersey removes approximately 4 million pounds of garbage from its beaches, including trash that washes onto the beaches from the New York/New Jersey Harbor area.[101]

Bacterial contamination of the state's ocean beaches is not nearly as big of a problem as it once was, but closures still occur. Public health authorities routinely close down beaches in Sea Girt and Spring Lake for precautionary reasons after even moderate rainfalls due to the discharge of pathogens from Wreck Pond, a tidal waterway just off the shore that serves as a sink for wastewater discharges from the highly developed surrounding area.[102] Bacterial contamination of the Wreck Pond watershed is so severe that tests undertaken of several tributary streams during one study found fecal coliform and enterococcus bacteria "too numerous to count."[103] Rainfall causes pathogens from Wreck Pond to wash into the ocean, triggering precautionary beach closings.

Beach closings, however, are not necessarily the best way to judge the threat posed by bacterial contamination. The state of New Jersey samples most beaches once a week during the summertime, and the most common method of testing for bacterial contamination requires approximately 24 hours to deliver results. When a test reads positive for unsafe levels of bacteria, the water is retested, and only after a *retest* shows elevated bacteria counts is a beach required to be closed.[104] In other words, a mandated beach closing undertaken by New Jersey (or other states) tells how safe the water was to swim in a couple of days previous to the closing being issued, not how safe it is to swim that day.

Moreover, an absence of beach closings does not mean that there was a lack of positive tests for bacterial contamination. According to the Natural Resources Defense Council, six New Jersey beaches—Beachwood Beach West (Beachwood), Maxon Ave. Beach (Pt. Pleasant), Central Beach (Island Heights), West Beach (Pine Beach), and Angelsea Ave. Beach (Ocean Gate), along with the area near the Wreck Pond outfall in Spring Lake, had levels of bacteria that exceeded safety standards in more than 25 percent of tests in 2009.[105]

New Jersey and other states are working to develop and implement rapid methods of testing that would allow for same-day detection of elevated bacteria levels along beaches.

Economic Impacts

A healthy shore is critically important for a healthy New Jersey economy. Pollution of shore waters has a number of direct economic impacts.

Tourism

Tourism is a major economic engine for New Jersey. The tourism industry had a total economic impact of $28 billion for the state in 2008, with nearly two-thirds of tourism expenditures coming from out-of-state visitors.[106] More than 400,000 jobs statewide are linked to the tourism industry.[107]

For New Jersey's coastal areas tourism is even more important. The state's four coastal counties—Monmouth, Ocean, Atlantic and Cape May—accounted for six out of every 10 tourist dollars spent in New Jersey, with tourism accounting for more than 40 percent of the total economies of Atlantic and Cape May counties.[108]

Major pollution incidents can make a dramatic impact on tourism at the shore, as the medical waste wash-ups of the late 1980s demonstrate.

Summer visits to the beach (as well as visits to the Atlantic City casinos) are likely the major drivers of the region's tourism

economy. But "ecotourism"—tourism aimed specifically at enjoying the natural environment—is a significant and growing part of the shore economy. The state's marine recreational fishery drew 7.4 million visits from anglers in 2008, the second-highest number of any state along the Atlantic coast, behind only Florida.[109] Wildlife-related recreation—which includes hunting, fishing, and wildlife watching—accounted for $1.6 billion in spending in New Jersey in 2006.[110] Accounting for indirect economic benefits, a study by the state of New Jersey estimated that ecotourism has a $3.1 billion economic impact on the state, sustaining about 37,000 jobs.[111]

In particular areas of the shore, ecotourism can have an even more important impact. Cape May, for example, is an internationally recognized birding hot spot. As far back as 1991, 100,000 birders per year were visiting the area, providing a $10 million boost to the local economy.[112]

Preservation of the shore's wildlife and water quality is, therefore, essential to maintaining a strong tourism economy—benefiting both shore communities and New Jersey as a whole.

Fishing

Commercial and recreational fishing are economically important industries in the shore area. New Jersey's commercial fishery industry brought in $169 million in revenue in 2008.[113] But New Jersey's fishing industry has been struggling for decades. The state's 2008 catch of 162 million pounds is less than a third of the record catch of 540 million pounds in 1956.[114] It is also down by approximately 20 percent since 1994. New Jersey's fishing industry now relies on just two fisheries—the Atlantic sea scallop and clam fisheries—for 72 percent of annual revenue.[115]

Key fisheries in New Jersey have disappeared or gone into serious decline. Bay

New Jersey's marine recreational fishery drew 7.4 million visits from anglers in 2008, the second-highest number of any state on the Atlantic coast, behind only Florida. Credit: NOAA, Edward J. Pastula

scallops, which once inhabited eelgrass meadows in Barnegat Bay, drew as many as 100 to 150 boats during the heyday of the scallop fishery in the late 1950s and 1960s.[116] By 1974, the bay scallop harvest had declined to a small fraction of its previous level, and today bay scallops are all but absent from Barnegat Bay.

The hard clam fishery in Barnegat Bay has followed a similar trajectory. According to one Rutgers University researcher, the state has lost more than 900 clammers in the last two decades, with many of those losses in Ocean County.[117] According to one estimate, Barnegat Bay supported approximately 250 hard clam fishermen in the 1950s; by 2002, their numbers had dwindled to roughly eight.[118] As noted earlier, warmer ocean temperatures are suspected in the decline of surf clams off the Atlantic coast, one of New Jersey's last remaining major fisheries.

New Jersey's coastal fisheries are already far less productive than they were decades ago. Continued pollution in the shore area threatens even those fisheries that survive.

Saving the Shore

The threats facing the Jersey shore today are different from those of the past. Highly visible sources of pollution—such as sewage dumping and medical waste—are largely (though not entirely) relics of the past. Instead, the current ecological crisis facing coastal bays such as Barnegat Bay-Little Egg Harbor and the larger shore region is the result of human activities far upstream—from the application of fertilizer on suburban lawns to the construction of new roads and parking lots.

In addition, we now know that a healthy ecosystem means more than just clean beaches. Where once New Jerseyans focused on preserving swimmable beaches or economically important fish species, science now tells us that preserving species such as eelgrass or small, forage fish can be equally important to preserving a healthy ecosystem.

New Jersey has come a long way in the effort to protect our shore. Now, it is time for New Jersey to take strong action to protect the ecological and recreational resources of the shore for generations to come.

Reducing Nutrient Pollution

The first critical task to protecting the shore is to reduce the flow of nutrients into shore waters. Among the steps the state should take include:

- **Reducing nutrient content of fertilizer and ensuring proper application.** Fertilizer is a key contributor to elevated nutrient levels in Barnegat Bay and other New Jersey waterways. New Jersey has several tools to reduce the flow of nutrients from fertilizer into waterways. First, the state should adopt limits on the nutrient content of fertilizer, severely restricting the amount of phosphorus (which is generally unnecessary for the growing of healthy lawns in New Jersey) and reducing the amount of nitrogen. A study in Michigan found that ordinances to reduce phosphorus content in fertilizer can have significant, rapid effects in reducing phosphorus levels in streams.[119] In addition, state or local governments can establish reasonable restrictions on fertilizer use to reduce

nutrient runoff—for example, by prohibiting fertilizer applications during the winter months or immediately adjacent to waterways.

Many New Jersey municipalities have adopted, or will soon adopt, fertilizer ordinances to improve water quality in local streams. Adopting strong rules on a statewide basis would ensure that such improvements take place statewide and would ease compliance.

- **Establishing strong numeric standards for nitrogen pollution in waterways**. Currently, there is no numeric standard for the acceptable level of nitrogen pollution in New Jersey's waterways. Instead, the state has a vague narrative standard intended to prevent nutrient pollution that "render[s] the waters unsuitable for the existing or designated uses due to objectionable algal densities, nuisance aquatic vegetation, abnormal diurnal fluctuations in dissolved oxygen or pH, changes to the composition of aquatic ecosystems, or other indicators of use impairment caused by nutrients."[120]

  The U.S. EPA has long recommended that states adopt numeric standards for nutrient pollution, on the grounds that they "provide measurable, objective water quality baselines against which to measure environmental progress" and make it easier to establish and implement pollution reduction goals.[121]

  New Jersey currently has both narrative and numeric standards for phosphorus—an approach that both sets a firm, measurable benchmark for phosphorus levels while also acknowledging that different levels of nutrients have different impacts in different waterways. The state should adopt strong numeric criteria for nitrogen to complement its existing narrative standard and retain its criteria for phosphorus.

- **Establishing total maximum daily loads for nutrient-contaminated waterways and ocean waters.** The federal Clean Water Act requires states to adopt plans to return water quality in polluted waterways to a level that supports their "designated uses" (e.g., fishing, swimming, drinking water supply, etc.) A key tool for achieving waterway restoration is the establishment of total maximum daily loads (TMDLs), which are science-based limits on the amount of a given pollutant that a waterway can sustain while still supporting its designated uses. Once a TMDL has been established, the pollutant load can be divided among known sources of pollution and trigger a host of actions—from reductions in the level of pollution allowed from industrial facilities to programs to reduce runoff pollution—designed to achieve the target.

  New Jersey has adopted TMDLs for phosphorus pollution in a number of waterways, and these TMDLs are already driving action to reduce phosphorus pollution. New Jersey is moving forward, along with New York, with development of a TMDL for nutrients for New York/New Jersey Harbor to address the low dissolved oxygen problems there (which also have the potential to affect the Jersey shore), but has not proceeded with the development of TMDLs to address the low dissolved oxygen conditions in Barnegat Bay-Little Egg Harbor despite mounting scientific evidence pointing to the role of nitrogen in

fueling algae blooms in the bay. Both Barnegat Bay-Little Egg Harbor and New Jersey's near-shore ocean waters have been given a "medium" priority for TMDL development by the state of New Jersey.[122]

Development and enforcement of TMDLs are technically complex and long-term tasks that should not detract from other efforts to reduce nutrient pollution of coastal waters. However, New Jersey should proceed with development of a TMDL for nutrient pollution of Barnegat Bay-Little Egg Harbor in order to guide future efforts to reduce nutrient pollution and provide a basis for evaluating progress.

Protecting Coastal Waterways from Excessive Runoff

Reducing the runoff from developed areas near the shore reduces the flow of nutrients and sediment into coastal waterways and ensures the recharge of aquifers, helping to stabilize freshwater flows into Barnegat Bay and other coastal estuaries. New Jersey can take several measures to protect coastal waterways from runoff:

- **Adopt "net zero impact" requirements for stormwater runoff from new development.** Scientific evidence links increases in the amount of impervious surfaces in a watershed with degradation of water quality. In places such as the Barnegat Bay-Little Egg Harbor watershed that have experienced rapid development in recent decades, the problem of runoff pollution has become acute. There are ways in which new developments can be designed to reduce—or even eliminate—their production of stormwater runoff. The use of perforated pavement, rain gardens, rainwater storage and other features can dramatically reduce stormwater runoff from a development. Developers should be required to adopt these or other features in new developments. And all forms of construction and development should be required to follow best management practices to reduce runoff pollution.

- **Establish stormwater utilities to improve management of stormwater near the shore.** Over the last several decades, New Jersey has made great progress in improving antiquated sewer infrastructure in the shore region. Much less progress has been made in improving stormwater management facilities—the storm drains and culverts that carry stormwater directly to rivers and streams as well as the detention basins and other facilities that are intended to protect waterways from uncontrolled runoff. Proper design and maintenance of stormwater facilities is critical, but responsibility for maintaining the facilities is usually held either by developers or by cash-strapped municipalities. Creation of dedicated "stormwater utilities" would result in organizations whose job it is to properly maintain existing stormwater facilities and build new ones to reduce the flow of runoff into waterways. New Jersey should make the replacement or repair of failing stormwater management facilities a top priority.

- **Upgrade shore-bound waterways to Category 1 status.** New Jersey's Category 1 waters are those with "exceptional ecological significance, exceptional recreational significance, exceptional water supply significance, or exceptional fisheries resources."[123] Category 1 waters enjoy strong

protection against any backsliding in water quality. Development along the banks of Category 1 waterways is also severely restricted, with many kinds of development prohibited within a 300-foot buffer zone around the waterway.[124] Many waterways in the shore region already enjoy Category 1 status, including Barnegat Bay itself. However, because of the unique ecological value of New Jersey's coastal waters, and the urgent need to reduce runoff pollution of those waters, all shore-bound waterways should enjoy Category 1 status and the state should enforce and uphold protections for current Category 1 waters that feed the shore.

- **Don't weaken existing stormwater and coastal protection rules.** Gov. Christie's Red Tape Review Group has recommended considering ending the state's role in ensuring that municipalities follow New Jersey's stormwater management rules. State review, rather than being duplicative, acts as an important backstop to ensure that municipalities are carrying out their responsibilities to protect the state's waterways. Indeed, a recent review by Delaware Riverkeeper of one township's implementation of stormwater regulations found many episodes of non-compliance with the rules—non-compliance that can result in additional contaminated runoff reaching rivers, lakes and ocean waters.[125] To protect the shore, New Jersey needs more aggressive enforcement of stormwater regulations, not less, and the state should preserve and improve upon its current framework for stormwater management.

  In addition, the state should refrain from weakening other water quality rules targeted by the Red Tape Review Group, including changes that would make it easier to develop alongside streambanks.

- **Promote alternatives to sprawling development.** New Jersey's shore counties have experienced dramatic growth in the past several decades—most of it in the form of low-density sprawl. Sprawling, car-dependent development requires large amounts of pavement for roads and parking lots, and also devotes large amounts of land to lawns. Local and state governments should encourage forms of development that are more compact and less car-dependent, thereby reducing the impact of sprawl on New Jersey waterways.

Reducing the Ecological Threat from the Oyster Creek Nuclear Generating Station

The Oyster Creek Nuclear Generation Station has a massive impact on the ecological health of Barnegat Bay, destroying vast numbers of marine creatures and returning heated water to the bay. The state should act to reduce the ecological threat posed by Oyster Creek.

- **Finalize the water discharge permit for the Oyster Creek Nuclear Generating Station and require the construction of cooling towers within the next three years.** The New Jersey Department of Environmental Protection has proposed a water discharge permit for the Oyster Creek Nuclear Generating Station that would require replacement of the facility's current "once-through" cooling system with a "closed loop" system

that would include the use of cooling towers. Closed-loop cooling reduces water intake and outflow for cooling by roughly 70 percent, with corresponding declines in the number of sea creatures that are damaged by the facility's cooling system.[126] Moreover, closed-loop cooling reduces thermal pollution, curbing the plant's ecological impact on the bay. The state should move forward with approval of the permit, but, recognizing the imminent threat that the Oyster Creek Nuclear Generating Station's operation poses to the health of the bay, the state should require the construction of cooling towers at the plant on a faster-than-proposed schedule, within three years.

Increasing Monitoring and Study of Coastal Pollution Problems and Their Impacts

New Jerseyans need better tools to understand the problems facing the shore and to measure progress toward water quality goals. While research conducted by state and federal government scientists and New Jersey-based researchers at Rutgers and other universities has added greatly to our understanding of the threats facing the shore, there is still much work to be done to get a full picture of how human activities are affecting the shore. To increase the public's understanding of coastal pollution, the state should:

- **Increase the frequency of testing at New Jersey's beaches.** Currently, New Jersey's ocean and bay beaches are tested once a week for bacteria that can put swimmers at risk of illness. Once a week testing is not frequent enough to protect swimmers, nor to provide a complete picture of the progress the state is making toward ensuring safe swimming at all of its beaches. In contrast to the state's weekly testing, the EPA recommends daily testing for pathogens at high-priority beaches.[127] As a state that has historically demonstrated leadership in taking action to protect swimmers, New Jersey should move toward testing its most popular beaches at least 2 to 3 times per week, with the ultimate goal of providing daily testing to protect beachgoers. In addition, the state should continue to explore the use of rapid testing methods that can tell the public whether a particular beach is safe for swimming that day, rather than having to wait 24 hours for results.

- **Assess coastal waters for pollution levels and ecological health.** As described in this report, the health of certain species—such as eelgrass or shellfish—is a key indicator of the health of the ecosystem as a whole. Moreover, there are close connections between the health of coastal estuaries, such as Barnegat Bay-Little Egg Harbor, and that of New Jersey's near-shore waters. The state of New Jersey must be much more aggressive in monitoring New Jersey's coastal waters using biological indicators, including measurements of the abundance of shellfish, aquatic vegetation, and healthy communities of organisms on the ocean floor. Only by tracking the biological health of coastal bays and ocean waters—and setting goals for the restoration of healthy ecosystems in these waters—can the state ensure that it is making progress toward restoration of the shore.

  It is important to note, however, that the state should not introduce

monitoring for biological indicators at the expense of traditional measures of water quality. New Jersey must have measurements of both the volume of pollution in coastal waters **and** the biological impacts of that pollution if it is to chart a course to a cleaner and healthier shore.

- **Boost monitoring of offshore waters.** Only in recent years, and as the result of a great deal of monitoring and study, has New Jersey come to appreciate the magnitude of the threats facing coastal estuaries such as Barnegat Bay-Little Egg Harbor. Yet, there has not been a similar investment in monitoring and study of New Jersey's near-shore waters. For example, while the state acknowledges the regular appearance of low dissolved oxygen levels off the Jersey shore, only now are researchers beginning to understand the effects of oxygen depletion on fish or other organisms that live in the state's nearshore waters.

  The state does operate a Coastal Water Quality Monitoring Network with sampling stations in near-shore ocean waters, but sampling at many of these stations is carried out irregularly. The state is also working with Rutgers University to undertake remote sensing of algae blooms off New Jersey's coast, which will provide additional, near real-time estimates of algal blooms. New Jersey should continue to expand these efforts and conduct additional monitoring and study to determine how pollution is affecting the health of New Jersey's near-shore ocean waters.

Enforcing Existing Laws

New Jersey's existing environmental laws hold many tools to reduce pollution of our shore waters, if they are properly enforced. The highest priority should be for New Jersey to:

- **Require completion of wastewater management plans.** Since 1990, New Jersey has required municipalities to develop wastewater management plans that project municipalities' future growth, the extent and location of sewer and septic service, and how the municipality plans to meet future water supply needs.[128] These plans are critical to ensure that future development takes place in a way that is consistent with the protection of water resources and the sustainability of water supplies. However, the state has historically been lax in ensuring that municipalities carry out their responsibility to maintain updated wastewater management plans—as of 2005, only 14 such plans were up to date, while 55 were never adopted and 110 were out of date.[129]

  In 2008, the state adopted new rules that assigned counties the responsibility for adopting and implementing wastewater management plans, with a requirement to submit new plans by April 2009.[130] As of late 2009, however, only one county had an approved wastewater management plan in place. Moreover, in 2010, the Christie administration gave counties yet another year to comply with the requirement.[131] After two decades, it is time for the state and county governments to get serious about planning for New Jersey's future water needs in a way that ensures the health of our rivers, streams and coastal waters.

Protecting Land to Preserve Water Quality

One of the great shining successes of New Jersey's efforts to preserve water quality along the shore is the protection of the Mullica River watershed, which runs primarily through the New Jersey Pinelands. The example of Pinelands preservation shows that land preservation can play an important role in ensuring the ecological health of our waterways. New Jersey residents have repeatedly expressed support for land preservation through their approval of bond issues for the Green Acres program, with the most recent bond issue for a two-year extension of the program approved by voters in 2009. However, Green Acres and other critical land preservation programs remain without a stable, dedicated, long-term source of funding. To ensure that the state has the resources available to protect lands critical to water quality, the state should develop a long-term funding source for its land preservation efforts.

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