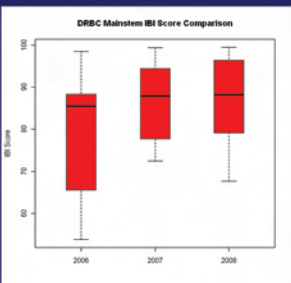
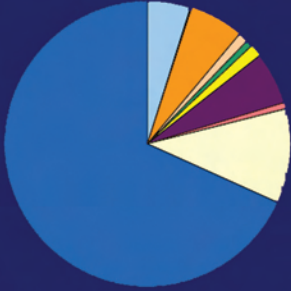
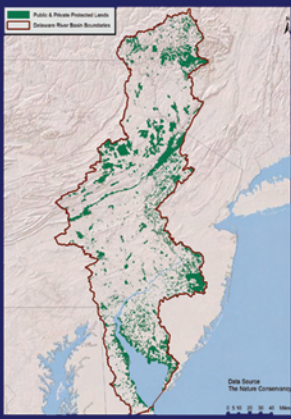


Technical Report for the Delaware Estuary & Basin



Partnership for the Delaware Estuary

2012



Abstract

The Partnership for the Delaware Estuary (PDE) periodically reports on the status and trends of environmental indicators for the health of the Delaware Estuary and River Basin, about every three to five years. The Technical Report for the Delaware Estuary and Basin analyzes best possible current data for the status and trends of a broad suite of more than 50 water, habitat, and living resource indicators. There are eight categories of indicators: watershed land use, water quantity, water quality, habitats, living resources, climate change, and restoration progress. For each indicator, scientists and managers also discuss predicted future changes in its health as well as future actions and needs to strengthen indicator reporting and to improve environmental conditions. Taken together, the findings in this report suggest that overall environmental conditions in the Delaware Estuary and river basin are fair, with a mix of both improving and declining status indicators. A companion report, the State of the Delaware Estuary 2012, uses example indicators to provide a synopsis of these results for the public.

How to Cite this Report

Partnership for the Delaware Estuary. 2012. Technical Report for the Delaware Estuary and Basin. PDE Report No. 12-01. 255 pages. www.delawareestuary.org/science_programs_state_of_the_estuary.asp. A complete section author list is available at the end of the report.

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Partnership for the Delaware Estuary

The Partnership for the Delaware Estuary is a nonprofit organization established in 1996 to take a leadership role in protecting and enhancing the Delaware Estuary, where fresh water from the Delaware River mixes with salt water from the Atlantic Ocean. It is one of 28 congressionally designated National Estuary Programs throughout the coastal United States working to improve the environmental health of the nation's estuaries. Its staff works with partners in three states to increase awareness, understanding, and scientific knowledge about the Delaware Estuary, the region's most important cultural, economic, and recreational resource.

Mission

The mission of the Partnership for the Delaware Estuary is to lead collaborative and creative efforts to protect and enhance the Delaware Estuary and its tributaries for current and future generations.

Cover Graphics

- Satellite graphic provided by by NASA
- Map of protected lands from Chapter 1
- Pie chart of water usage from Chapter 2
- Insect Picture taken by David Funk, found in Chapter 6-12
- Map of wetlands from Chapter 5B
- Wetland picture taken by Danielle Kreeger, found in Chapter 5B



Executive Summary

The Delaware Estuary and River Basin is a large and complex watershed, encompassing more than 35,000 square kilometers (>13,500 square miles) and extending from headwater streams and mountains in New York State to the coastal plain and ocean near Cape May NJ and Cape Henlopen, DE. The watershed spans four ecoregions, is home to about 9 million people, and supplies drinking water to another seven million in New York City and northern New Jersey living outside the basin. Hundreds of plant and animal species live in balance with people in diverse habitats, including many ecological treasures. The region also has a storied history, starting with rich Native American peoples and extending through the birth of the United States and the Industrial Revolution, up to the present day where it continues to function as a nationally important economic center and strategic port.

With this complex spatial and temporal landscape, it is challenging to assess the overall environmental condition of this system. Environmental indicators are aspects of the environment which can be quantified and are representative of prevailing local conditions. The approach used in this report was to gather, analyze and interpret the best and most recent data for a broad suite of more than 50 indicators that represent different facets of the natural ecosystem, such as water quality, living resources, habitats, and land cover. When considered together, this indicator-based report provides a comprehensive picture of the status and trends in environmental health of the Delaware Estuary and River Basin, showing that some conditions are good, and others are not so good; some indicators appear to be improving, while others appear to be worsening. When taken all together, the contents of this report suggest that **overall environmental conditions are fair**, with some improvements since our last State of the Estuary Report in 2008, and some conditions apparently declining.

The eight chapters of this *Technical Report on the State of the Delaware Estuary and River Basin* are organized topically into the following sections: watershed and landscapes, water quantity, water quality, sediments, aquatic habitats, living resources, climate change, and restoration progress. Each section includes a number of different indicators and was written by a different set of authors with science and management expertise relevant to the topic.

Chapter	Ten Positives		Ten Negatives	
	Indicator	Condition	Indicator	Condition
Watersheds	Ecosystem Services	Worth >\$12 billion annually	Forest Cover	Declined almost 50 square miles (127 km ²) 1996-2006
Water Quantity	Consumptive Use (Public)	Declined per capita 1990-2008	Consumptive Use (Industry)	Increased about 20% between 1994-2008
Water Quality	Dissolved Oxygen	Increased dramatically 1960s to present	Nutrients	Nitrogen remains high relative to other estuaries
	pH	Increasing slightly despite global acidification risk	Contaminants	Exceeds risk-thresholds for consumption of many fish
Sediments	Total Organic Carbon	Decreased, suggesting lower organic pollution	Sediment Budget	Sediment removal exceeds inputs, possibly impairing estuary habitats
Aquatic Habitats	Fish Passage (Rivers)	>160 km now accessible on Lehigh and Schuylkill Rivers, since 1990	Tidal Wetlands	Acreage decreased >2% 1996-2006, mainly from salt marsh loss
Living Resources	Horseshoe Crabs	Male spawning activity increased 1999-2010	Atlantic Sturgeon	Despite young-of-year fish seen in 2009, the species is now federally endangered
	Striped Bass	Once nearly extirpated, the current population is a major spawning stock	Freshwater Mussels	Abundance and range continues to decline
Climate	Ice Jams	Decreased over period of record	Precipitation	Increased, especially in past 30 years, increasing flooding
Restoration Progress	Habitat Type	Progress among types matches current priorities	Funding	Investment is very low compared to other large estuaries



For example, the climate change chapter considers long-term changes in air temperature, precipitation, extremes in air temperature and precipitation, snow cover, wind speed, stream flow, ice jams, and sea level. For each indicator, the authors discuss predicted future conditions as well as actions and needs that could strengthen future indicator reporting or lead to improved environmental conditions. Examples of key findings in this report are summarized in the previous table which shows both improving and declining environmental conditions. The list is not prioritized, and many more similar examples can be found in various report sections.

The information in this report should be interpreted carefully because changes in some indicators do not necessarily reflect declining or improving conditions per se, but instead reflect natural variability. For example, it is possible that some species or conditions are actually improving at the expense of others, due to complex ecological inter-relationships. In some cases, this report effort was hampered because some components of the ecosystem that could serve as strong indicators were not able to be included due to insufficient data. The development of this report therefore allows us to assess not only the state of the environment, but also the state of our knowledge and understanding. Furthermore, the restoration chapter is a new attempt to begin using available data to assess our management progress in preserving, enhancing and restoring environmental conditions, in addition to assessing intrinsic environmental conditions (which is the focus of most of the rest of this report.) A synopsis of results pertaining to the Delaware Estuary (the lower 52% of the basin) is being produced in a companion *2012 State of the Delaware Estuary Report*.

Where possible, the future status and trends of indicators are also discussed. The human population in the watershed is expected to increase by 80% by 2100. This is likely to increasingly tax our natural resources and require management diligence, especially with regard to water withdrawals, forest cutting, wetland loss, and development. These challenges will be exacerbated by a shifting climate, especially increasing temperature, precipitation, sea level, and salinity. The cumulative impacts to natural resources from both anthropogenic alterations and shifting climate conditions are difficult to predict. Hence, continued careful monitoring of the indicators reported here will be critical so that environmental managers can make adaptive decisions to sustain crucial life-sustaining ecosystem services, which we know are worth billions of dollars per year. Specifically, to address future environmental challenges while preserving prosperity in the region, agencies, scientists, and others must work together to:

- Sustain and strengthen the effectiveness of monitoring, protection and restoration efforts by focusing on a set of shared, strategic priorities
- Set science-based goals that plan for change as part of the natural landscape
- Adopt realistic environmental targets that focus on the preservation and augmentation of key life-sustaining features
- Apply an ecosystem-based approach to management that considers cumulative impacts

Facilitating this collaborative effort is part of what the Partnership for the Delaware Estuary seeks to do as the National Estuary Program for the Delaware River and Bay.

Taken together, the report indicates that the overall environmental integrity of the Delaware Estuary and River Basin is fair, having improved significantly in recent decades but still facing some old problems as well as some emerging challenges. Continued loss and degradation of important habitats and emerging threats associated with climate change threaten to undermine the recent recovery. Achieving measurable improvements in these indicators requires action by a wide variety of public and private partners over an extended period of time.

The information, perspectives and future goals stated in the Technical Report for the Delaware Estuary and Basin reflect the best current scientific consensus of the authors that drafted individual sections and do not necessarily represent the official views or goals of the Partnership for the Delaware Estuary or any other participating entity or specific author. This report is a collective, peer reviewed effort which attempted to coordinate a consistent style and content among sections; however, the written presentations and depth of analysis will reflect (or vary in accordance with) the availability of data, methods of presentation, and analytical rigor that are appropriate for different fields and different writing styles of various authors.



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Introduction

The 2011 Technical Report for the Delaware Estuary and Basin (TREB) reviews the status and trends in extent or health of numerous environmental indicators as a way to take a scientific look at the current health of the Delaware Estuary and River Basin.

Environmental indicators are specific, measurable markers that are used to assess the condition of the environment and indicate whether conditions are improving or worsening over time (EPA 2007). Additionally, indicators help raise awareness about important environmental issues, serve as tools for evaluating the effectiveness of management actions, and can function as early warning signals for detecting adverse changes in environmental quality (EPA 2007).

This report was prepared by the Partnership for the Delaware Estuary’s Science and Technical Advisory Committee (STAC) in collaboration with many additional contributing scientists and managers, which together formed an ad hoc TREB workgroup. The suite of environmental indicators covered in this report was selected jointly by the PDE STAC and the Delaware River Basin Commission (DRBC). Indicators were chosen based on data availability and an indicator’s ability to tell something important about the status of the natural resources, water quality, and climate conditions of the Delaware Estuary and its watershed.

Efforts to produce this report began in late 2009 when the STAC met jointly with the DRBC Monitoring Advisory Committee in a series of workshops to reexamine environmental indicators used in our 2008 State of the Estuary



Report (PDE 2008) and to prepare a “next generation” set of indicators. In many cases, that wish list remains unfulfilled due to insufficient resources to obtain critical new data to fill gaps or due to comparability issues (e.g. among states) with available data. This report provides the best possible current synthesis of status and trends for the important environmental indicators that could be examined.

The purpose of this report is to compile a scientific synthesis of the most recent status and trends data into a technical report, which can serve as the basis for a new State of the Estuary Report for the public in 2012. Although data and analyses were not able to be obtained for some important resource conditions, the findings in this report do tell a story from a regional perspective and will continue to serve as a baseline for measuring the progress made toward implementing the PDE Comprehensive Conservation and Management Plan (CCMP) in the future.

In addition, this report provides guidance on future “Actions and Needs,” which are discussed for each indicator. In many cases, these actions and needs call for improved coordination and/or monitoring. Where data are currently incomplete or unavailable, PDE will continue to work with partners to improve monitoring and data management. PDE also intends to use these results to strengthen linkages between environmental monitoring, management and progress measures for CCMP implementation.

Organization of the Technical Report for the Delaware Estuary and Basin

Indicators are grouped into eight topical chapters, beginning with watershed traits and land use in Chapter 1. The Watershed chapter also provides an orientation to eleven watershed regions that were used to delineate geospatial boundaries for analysis of many of the TREB indicators in other chapters. These watershed regions extend from headwater streams in New York to the mouth of Delaware Bay between Cape May, NJ and Cape Henlopen, DE.

Water resource indicators are next discussed in Chapters 2 and 3, followed by sediment indicators in Chapter 4. Habitat-related indicators are examined in Chapter 5, distinguishing among subtidal, intertidal and non-tidal habitats. Living resources are similarly grouped as non-tidal and tidal in Chapter 6, summarizing status and trends of key animals that living primarily above or below the head of tide, respectively.

Chapter 7 focused on climate indicators, building on our last State of the Estuary report in 2008 where we introduced this category. Indicators reported in Chapters 1-7 focus on status and trends in environmental

conditions; whereas, in Chapter 8 we focus on measures of progress for improving conditions through protection and restoration efforts.

How to Use the Technical Report for the Delaware Estuary and Basin

For information on the status and trends of any specific indicator (e.g., American eels), simply refer to the appropriate section. However, to obtain an overall status summary for the Delaware Estuary and River Basin, we recommend reviewing the entire report for several reasons.

Many indicators interact through complex physical, chemical and biological relationships, and a complete review facilitates a more full understanding of the status of functional interrelationships (how the system is working) in addition to any single parameter (what is present). For example, the population abundance of some fish species may depend on others through predation or competition relationships (striped bass versus weakfish, both are never abundant at the same time). Sediment dynamics might either impair or help sustain important types of habitats, such as oyster reefs or tidal wetlands, respectively. At the same time, the naturally “muddy” traits of this estuary is thought to help to stem eutrophication problems by light shading of phytoplankton blooms, despite having high nutrient loadings. By cross-comparing results among chapters, one can obtain a better understanding of such complex interactions.

Similarly, no single indicator or chapter is diagnostic for overall environmental conditions. With respect to water quality, for example, there has been dramatic improvement in dissolved oxygen conditions in the system since the 1972 Clean Water Act, which led to widespread upgrades in wastewater treatment and other remedies. On the other hand, the system remains saddled with a contaminant legacy resulting from being the seat of the Industrial Revolution and some types of pollutants such as nitrogen continue to increase.

Because of such mixed trends, which are common for most indicator classes, it is difficult to assign any single grade (good, fair, poor) to the overall environment within watershed. Taken together, however, analysis of all chapters will provide the best possible basis for making one’s own determination of current status and trends in environmental conditions across the Delaware Estuary and River Basin.

Citation: 2007. U.S. EPA. Indicator Development for Estuaries. EPA842-B-07-004. Available at:

<http://www.epa.gov/owow/estuaries>



Map of the Delaware Estuary and River Basin with major watershed regions

