

Executive Summary

The purpose of the 2022 Technical Report for the Delaware Estuary and Basin (TREB) is to assess the overall environmental condition of the watershed by examining the status and trends of key indicators that reflect the health of its natural systems. Meeting this goal is challenging because the Delaware 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 Delaware Estuary forms the lower 52% of the overall basin. The watershed spans four ecoregions, is home to 8.6 million people, and supplies drinking water to another 5 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.

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 most extensive and 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, land cover, and climate. The last section of the report includes indicators that reflect our progress in preserving and restoring natural systems. When considered together, this indicator-based report provides a comprehensive picture of the status and trends in environmental health of the Delaware Estuary and Basin.

The eight chapters of TREB are organized topically into the following sections: watershed and landscapes, climate change, water quantity, water quality, sediments, habitats, living resources, and restoration. Each section includes a number of different indicators, written by a different set of authors with expertise relevant to the topic. For each indicator, authors present and interpret the most recent available data and summarize any actions and needs that could strengthen future indicator reporting or lead to improved environmental conditions.

On balance, the results from this assessment suggest that the current health of the Delaware Estuary and Basin in 2022 is "fair," reflecting a mix of positive and negative trends. The status of many indicators is good, and others are not so good. Trends for some indicators appear to be improving, while others appear to be worsening. The overall assessment of "fair" health is unchanged from TREB 2017, TREB 2012 and the smaller State of the Estuary Report in 2008.

Although the "fair" overall health assessment is unchanged since 2008, it reflects substantial improvement compared to earlier decades for many key indicators. For example, advances in wastewater treatment and implementation of the Clean Water Act led to dramatic improvement in dissolved oxygen in the river's urban corridor over the past 40+ years. These improvements in many facets of water quality have supported healthier living resources, demonstrated by the propagation of signature species such as sturgeon and increasing public interest in river recreation. Unfortunately, the continued loss and degradation of important habitats and emerging threats associated with climate change could or may undermine the recent recovery. Meanwhile, the human population in the watershed continues to increase, resulting in expanding human activities are 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. Of particular note, future predictions for many of the key climate indicators in the 2022 TREB reflect a much higher



level of certainty compared to the 2017 TREB, largely because of more robust datasets and stronger recent trends.

Where possible, the future status and trends of indicators are also discussed in the context of the expected increase in human activities and climate change. As one example, warming water (from climate change) holds less dissolved oxygen, which is vital for aquatic animals such as fish. Oxygen deficits can also be exacerbated by excess nutrients from runoff, which in turn fuel microbial respiration. With increased water temperature and potentially greater nutrient runoff from more people, it is plausible to expect the trajectory of past improvements in dissolved oxygen conditions to reverse course. Therefore, even more effort to manage dissolved oxygen will be needed as compared to the past. This report includes many other similar examples of past successes and emerging threats.

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 in this report will be critical so that environmental managers can make adaptive decisions to maintain crucial life-sustaining ecosystem services, which 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 preserving and enhancing key life-sustaining features
- Apply an ecosystem-based approach to management that considers cumulative impacts and ecological linkages
- Facilitate collaboration among states, federal agencies and other sectors to implement the Delaware Estuary Comprehensive Conservation and Management Plan (CCMP), which was updated in 2019. The CCMP is a guiding document developed by partners involved with the Delaware Estuary Program, which is the congressionally designated National Estuary Program for the Delaware River and Bay.

The information, perspectives, and future needs stated in this report reflect the best current scientific consensus of the authors that drafted individual sections and do not necessarily represent the official views of the Partnership for the Delaware Estuary, other members of the Delaware Estuary Program, 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. Examples of key findings in this report are summarized in the table below which shows both improving and declining environmental conditions (Table 0.1). The list is not prioritized, and many similar examples can be found in various report sections. Scattered throughout the TREB are additional features that showcase recent case studies or hot topics.



Table 0.1 Top positive (A) and negative (B) findings from the 2022 Technical Report for the Delaware Estuary and Basin. Impact scores are qualitative and based on relative overall impact to estuary and basin wide health, and immediacy of action need. Impact scores of 1 for positives are very good, whereas a score of 6 for a negative is detrimental. Averaging all impact scores yields a total score of 3.5, or an overall "fair" rating for the reporting period's Estuary and Basin health.

A. Chapter	Positives		
	Indicator	Condition	Impact
Watersheds	Protected lands	Estuary and Basin has >2,900 sq mi of protected lands, with a increase by 1.3% in the last decade	2
Water Quantity	Water Withdrawals	Peak water withdrawals occurred in 2006-2007 and have subsequently declined	2
Water Quality	Dissolved Oxygen	Concentrations increased dramatically 1960s to present	1
Sediments	Total Suspended Sediment	Declined from 2005-2010 to 2017-2021, especially in the Lower Estuary (but this could also have negative effects to tidal wetlands in the Bayshore)	3
Habitats	Fish Passage	Between 2017-2021, 29 dams have been removed in the Delaware River Basin	1
Living Resources	Population Increases	Osprey, blue crab, American eel, and sturgeon populations have increased	1
Climate	Temperature	Not yet a significant increase in hot temperature extremes, despite average warming trends	3
Restoration	Habitat Type	Increase in restored acres in 2017-2022, compared to 2006-2011 and 2012-2016	2

B. Chapter	Negatives		
	Indicator	Condition	Impact
Watersheds	Land Cover	Development increased by ~17.5 acres per day from 1996-2016	6
Water Quantity	-	No negatives observed	-
Water Quality	Temperature	Water temperatures are possibly increasing, but more monitoring and analysis will be required	4
	Contaminants	Many fish consumption advisories remain; ecotoxins in pharmaceuticals and personal care products remain a concern	6
Sediments	Contaminants	Sediment contaminant concentrations highest in areas of the Estuary near Environmental Justice communities	6
Habitats	Tidal Wetlands	From 1996-2016, 340 hectares of tidal wetland were lost; percentage losses were >15% for tidal freshwater wetlands	5
Living Resources	Population Decreases	Striped Bass, Weakfish, White Perch, and freshwater mussel populations show signs of decline	5
Climate Change	Sea Level Rise	Sea levels rose between ~4-6 cm per decade from 1992-2021 in the Estuary	5
Restoration	Regulatory Climate	The time and complexity of permits required to do restoration may be increasing	4