The State of the Estuary 2018
Trends in habitat and ecological health are not as promising and only a few indicators for stream health are showing an improving trend. Since the early 2000s, critical wetland, riparian and coastal forest habitat has been lost to urban development, often despite state and federal regulations. Several indicators show habitat is also declining, such as the abundance of otter and freshwater fish and brown trout. While efforts to improve the Estuary's ecology are steadily helping, such as oyster reef restoration, removing dams and reconnecting rivers and streams, the pace is not in keeping with need. The storms of 2012 and wildcat climatic change makes them even more vulnerable to this line of attack. The data in this report illuminates the fact climate change is not a distant threat: it is affecting the Hudson-Raritan Estuary right now. The Estuary’s waters are warming and species are responding by shifting their ranges and adapting their behavior.

Large, intense storms anticipated by scientific matters a great deal. Many of the changes in environmental health are gradual: storms such as hurricane Sandy, Irene, and Irene, change that people appreciate and tend to affect environmental health dramatically. Some indicators that were improving, such as area of submerged aquatic vegetation and the health of benthic organisms living at bottom of the Estuary, were dramatically disrupted by the storms, and the intensity of storm surges and wave action during the storms may have remobilized contaminated sediments.

The State of the Estuary Report compiles the best available data for 31 indicators selected by scientific and technical experts convened by the New York – New Jersey Harbor & Estuary Program (HEP). This scientific information is used to illuminate long-term (roughly 30 years) and short-term trends, providing a broad assessment of progress towards HEP’s goals of improving water quality, habitat, public access, marine operations, and community engagement. This summary document highlights some key indicators and trends, the complete New York – New Jersey Harbor & Estuary Program’s 2018 State of the Estuary Report covers a broader range of environmental challenges and can be found at www.hudsonriver.org/NYNJHEPStateoftheEstuary.

Water quality improvement in the Harbor Estuary’s biggest success story. The short and long-term trends for most water quality indicators show that conditions are improving over time. Dissolved oxygen levels in the water, critical for fish survival, are increasing. There is less garbage floating in the water and along the shoreline than there was 20 years ago. While pathogenic contamination has also decreased over the long-term, bacterial contamination stemming from combined sewage outflows and stormwater is sporadically high in many places and regularly high in a few parts of the Harbor Estuary, and continues to restrict swimming and the desirability of other water sports and recreation.

Toxic contaminants, such as heavy metals and PCBs, are decreasing in concentration in sediments or fish. The natural burial of contaminated sediments as well as the dredging of toxic sediments have reduced large sources of contamination. Average PCB concentrations in key fish species have decreased markedly. However, many contaminants are persistent. Some of them, such as mercury, remain at concentrations that are toxic to marine life and dangerous for human consumption in seafood. Sediments that are highly contaminated also affect the maritime economy, as they are costly for port operators to dredge.

Public access and stewardship in the Harbor Estuary is improving. As water quality has improved, the number of public parks, boat launches, and people engaging in water sports and recreational programming has increased over the short-term. There is more access to the waters of the Harbor Estuary, with 73% of the shoreline being located in parks and other public spaces, allowing more people to enjoy the water and fostering a stewardship ethic in surrounding communities. Three of the Estuary’s largest stewardship events are the City of Water Day, A Day in the Life of the Hudson, and Riverkeeper Sweep. These events are growing in popularity every year, and there are many more stewardship organizations, events, and community engagement.

Introduction and Highlights

The State of the Estuary 2018

New York – New Jersey Harbor & Estuary Program
1 Battery Place, Suite 915, New York, NY 10004
www.hudsonriver.org/NYNJHEPStateoftheEstuary.pdf

Cover photo: Jamaica Bay Ecowatchers

Design and data visualization by Sara Eichner and the Spatial Analysis and Visualization Initiative at Pratt Institute.

EPA Disclaimer

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The salty and more urban portion of the larger Hudson-Raritan Estuary, the Harbor Estuary is defined by the mixing of fresh and salt water that creates its rich, productive, and diverse ecosystem. Every day, the incoming tides bring roughly 57 billion gallons of saltwater from the ocean, and an average of 80 billion gallons of water is returned to the ocean, including nearly two billion gallons of wastewater. This tidal flux and the nutrients that it carries support 12 square miles of tidal wetlands, more than 200 fish species, and over 300 bird species. The Estuary also provides essential resources for more than six million people living along the Harbor Estuary’s waterways, including recreational and economic benefits.

The New York – New Jersey Harbor & Estuary Program (HEP) helps bring together diverse stakeholders including scientists, citizens, and policymakers to work towards the goal of fishable and swimmable waterways for people and wildlife called for by the Clean Water Act. HEP was created in 1988 by the U.S. Environmental Protection Agency (EPA) at the request of the governors of New York and New Jersey. The Hudson River Foundation manages the Program and provides the non-federal match to funds received from the EPA under the Clean Water Act.

Working with its many partners, HEP is addressing the challenges identified in this report. There are 40 specific actions in the 2017-2022 Action Agenda. Our Environmental Monitoring Plan shows where data is being collected about the Estuary by public agencies, universities, and civic organizations.

## About the Estuary and the NY-NJ Harbor & Estuary Program

### WATER QUALITY Indicators

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Long Term Trend</th>
<th>Short Term Trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dissolved Oxygen</td>
<td></td>
<td></td>
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<tr>
<td>Enterococcus</td>
<td></td>
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<tr>
<td>Nitrogen</td>
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<tr>
<td>Water Temperature</td>
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<tr>
<td>Debris Collected by Skimmers and Booms</td>
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<tr>
<td>Debris Collected on Beaches</td>
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<td>Microplastics</td>
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<td>Chemical Contaminants of Emerging Concern</td>
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### HABITAT AND ECOLOGICAL HEALTH Indicators

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<tr>
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<tr>
<td>Eutrophic and Drediform Fish Abundance</td>
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<td>Established Oyster Beds</td>
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<td>Whales and Dolphins Abundance</td>
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<td>Tributary Habitat Connectivity</td>
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<td>Riparian Area Integrity</td>
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<td>Stream Health Bioassessment</td>
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<td>Percent and Distribution of Natural Shorelines</td>
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<td>Horsehoe Crab Abundance</td>
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<td>Submerged Aquatic Vegetation</td>
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<td>Anadromous Coastal Forest and Grassland</td>
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<tr>
<td>Area of Wetlands</td>
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<td>Nesting Pairs of Harbor Herons</td>
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### PORT AND MARITIME (Toxic Contamination) Indicators

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<th>Indicator</th>
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<td>PAHs in Sediments</td>
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<td>Dioxin in Sediments</td>
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<td>PCBs</td>
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### PUBLIC ACCESS AND STEWARDSHIP Indicators

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<td>On-Water Access</td>
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<td>On-Water Programs</td>
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### COMMUNITY ENGAGEMENT Indicators

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<td>Capacity of Stewardship Organizations</td>
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<tr>
<td>Participation in Stewardship Events</td>
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<td></td>
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<tr>
<td>Participation in Citizen Science</td>
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</tr>
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</table>

### TREND IDENTIFIERS

- Indicates a trend that is improving in terms of environmental health
- Indicates a trend that is deteriorating in terms of environmental health
- Indicates that the data are not trending, are stable or variable
- Indicates that there are insufficient data to determine a trend or that this type of analysis is not applicable

The State of the Estuary 2018
1. Water Quality

**Goal Statement:**
Reduce the sources of pollution so that the waters of the Harbor Estuary will meet the fishable/swimmable goal of the Clean Water Act.

---

Fish and other aquatic organisms breathe the oxygen found in the water column and tend to swim away from areas of low dissolved oxygen. Very low dissolved oxygen (hypoxia) can cause fish kills and affect predator-prey relationships. Low dissolved oxygen occurs when algae in the water column bloom and sink, causing biochemical reactions that reduce oxygen and produce carbon dioxide. These algae blooms are a normal phenomenon, but become problematic when excess nutrients in the water allow algae to bloom too rapidly. These most problematic in slow-moving tributaries and deeper parts of the estuary where the water is not well mixed. In the Harbor Estuary, excess nutrients mostly come from sewage. Low dissolved oxygen is most common in the late summer when the algae is most active, warmer waters hold less oxygen and the water column in deeper areas may be partially stratified, preventing mixing of surface and bottom waters.

Incidents of low dissolved oxygen have decreased significantly throughout the Harbor Estuary. Low dissolved oxygen levels were once common throughout the Harbor Estuary, but upgrades to wastewater treatment plants in New York City and New Jersey have dramatically improved conditions. Average dissolved oxygen concentrations during the critical summer months of August and September are largely above 4.8 mg/L, a concentration that is supportive of growth and reproduction in marine life. Even small rivers and tributaries, which are less well-flushed and more impacted by stormwater and combined sewer overflows than the Harbor’s open waters, have shown, on average, a significant improvement.

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**Dissolved Oxygen**

<table>
<thead>
<tr>
<th>Average Annual Dissolved Oxygen for August and September</th>
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<tr>
<td>EPA criteria</td>
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<td>NJ Tributaries</td>
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<td>NY Tributaries</td>
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<tr>
<td>NY + NJ Open Waters</td>
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</table>

Passaic Valley Sewerage Commission skimmer boat.

Data from beach cleanups and skimmer boat operations show that there is likely a decline over the past decade in debris found in the Harbor Estuary.

For more information, see the 2018 State of the Estuary Report.
When people swim or kayak in polluted waters, they may come in contact with harmful bacteria (pathogens) that can cause disease and sickness. These pathogens enter our waterways via sewage and stormwater outfalls flowing into the estuary. Much of the Harbor Estuary has a combined sewer system, which means that sanitary sewers in homes and businesses are connected to storm drain sewers. The benefit of a combined system is that during dry weather, street runoff can be treated before being released into local waterways, while separate systems allow storm drainage to enter surrounding waterways untreated. However, during storm events, runoff combined with sanitary sewage can exceed the capacity of treatment plants and is released and released through sewer outfalls downstream the waterways to avoid backups of frames and plumbing systems. This is called a combined sewer overflow (CSO). These events are a substantial source of pathogens, chemical contaminants, nutrients, and debris to the Harbor Estuary.

Enterococcus bacteria is a pathogen found in human and animal waste that scientists use to indicate the presence of untreated sewage, likely due to a CSO event, in the waterways. The more Enterococcus cells in a water sample, the more we can expect that water to contain pathogens that can be harmful to humans. In 1986, EPA chose Enterococcus as its preferred indicator to measure pathogens in marine waters and has set the unacceptable level for human health as greater than 35 cells/mL. Prior to the use of the more reliable Enterococcus standard, another type of bacteria called fecal coliform was used as the primary indicator for pathogens.

Over the long term, pathogens contamination has decreased with time due to improved wastewater treatment. However, over the past decade, Enterococcus averages have varied widely throughout the Harbor Estuary. Newark Bay and nearby tributaries like the Hackensack and Passaic Rivers have never experienced a year where the regional average concentration is under the acceptable 35 cells/mL criteria, whereas Jamaica Bay and the Lower New York Bay region do not have any year where the average exceeds the acceptable limit. None of these regional averages showed a significant trend in Enterococcus concentrations since 2007.

The majority of the water quality monitoring is done in the center of the channel. However, untreated sewage and stormwater through CSO and other wet weather discharge are released at the shoreline. While official bathing beaches are monitored, boat launch sites and other shorelines where people regularly come in contact with the water are not regularly tested by public agencies.

Photos: Left: Combined Sewer Overflow (CSO), Raritan Riverkeeper. Right: Citizens Water Quality Testing program, Rob Buchanan.

The geometric mean is similar to an average but it better represents the typical number in a set of values such as these. The gray area is between the 10th and 90th percentile, which is the range within which most of the measurements fall.
Habitat and Ecological Health

Goal Statement:
Protect and restore the vital habitat, ecological function, and biodiversity that provide society with renewed and increased benefits.

Horseshoe crabs
Horseshoe crabs like to spawn in gently sloping sandy beaches. Monitoring from Jamaica Bay, the most important horseshoe crab habitat in our estuary, is showing a decline in spawning horseshoe crabs over the past decade.

For more information, see the 2018 State of the Estuary Report.

Pathogens / ENTEROCOCCUS

The Citizens Water Quality Testing Program led by the New York City Water Trail Association, as well as shorelines data regularly collected by the NYC Department of Health, has shown that it is very common for shoreline waters to exceed the acceptable Enterococcus contamination criteria of 35 cells/mL. Only two locations did not exceed 35 cells/mL in 2017.

WATER QUALITY

Percent samples exceeding 35 cells/mL criteria in 2017

- 0 - 20%
- 20 - 50%
- 50 - 75%
- 75 - 100%

Source: Citizens Water Quality Testing Program, New York City Department of Health.
Estuarine and Diadromous Fish Abundance

Background

Historical accounts of the Estuary describe our waters as teeming with fish. Dramatically altered shorelines and wetlands, commercial fishing and water pollution took their toll and now fish populations are a fraction of what they once were. For example, even as recently as the 1940’s, Hudson River landings of American shad were up to 50 times what they were by the time the Hudson River fishery closed in 2010.

This analysis focuses on two key groups of fish species: estuarine species, those that spend their life in the Estuary, and diadromous species, those that use fresh and salt water in different parts of their life cycle. Changes in fish abundance can occur for reasons other than from habitat quality. Overfishing, climate change, and shifts in predator-prey distribution can all be factors.

Both estuarine and diadromous fish populations are trending down overall. Of the 12 estuarine and diadromous species that were showing trends, only two of them were increasing. In the short term, the same group of species were not trending overall. One of the species showing a positive trend is the Atlantic sturgeon. A moratorium was placed on Atlantic sturgeon fishing in the Hudson River in 1995 along with the fishing of sub-adults in New York and New Jersey’s coastal waters. In 2006, Atlantic sturgeon were federally protected as a “near threatened” species (the listing was upgraded to endangered in 2012). As it takes 12 – 18 years for a female Atlantic sturgeon to spawn for the first time, fisheries experts believe that the increase owes to these protection efforts.

Data Sources:
- Utilities Beach Seine Survey: 1987–2015, units: catch per number of seine hauls per year.
- The River Project Fish Trapping.

Illustrations (top left to right): Hogchoker, Atlantic sturgeon, white perch, striped bass.

Fish Data: Long term surveys of fish abundance in the Hudson River. Hogchoker and white perch are estuarine species, striped bass and Atlantic sturgeon are diadromous.

The State of the Estuary 2018
Among the most productive ecosystems on earth, wetlands are a critical habitat for many of the Harbor Estuary’s wildlife species, providing nursery, spawning, feeding, and nesting areas for fish, birds, and other marine life. They provide an array of ecosystem services: cleaning the water by taking up excess nutrients, sediment, and toxic chemicals; sequestering atmospheric carbon; storing and absorbing floodwaters; and if they are large enough, protecting against storm surges. Historically misunderstood and mistreated, more than 85% of the Harbor Estuary’s historic wetlands have been lost to fill and development. Federal and state regulations now help protect the remaining wetlands in the Harbor Estuary. However, conservation has additional challenges: poor water quality can weaken marsh stability leading to erosion and accelerated rise in sea level has drowned much of our remaining tidal wetlands. In the New York portion of the Harbor Estuary, approximately 625 acres of wetland were lost between 1996 and 2010, with an average of 45 acres lost per year. In the New Jersey part of the Harbor Estuary, the loss of wetlands is much greater; approximately 3,814 acres were lost between 2002 and 2012, a 4% loss of the 2002 wetlands. Most of the wetland loss in New York occurred in tidal wetlands, while in New Jersey in forested wetlands. In both states most of the loss was due to development of homes, businesses, and other urban uses. The loss of wetlands in the result of many small alterations: only 12% of the patches lost were greater than a 1/4 acre in size.
The presence of toxic contaminants in sediments is a major factor in the economic and ecological health of the Port. Unfortunately, the Hudson-Raritan Estuary has a legacy of toxic contamination due to years of unregulated pollution. The required dredging of navigation channels and anchorages is greatly impacted by the presence of these toxic chemicals; there are few beneficial uses for contaminated sediment and the costs of disposal are expensive. Dumping of toxic chemicals, such as polychlorinated biphenyls (PCBs), into the water and shorelines used to be a common practice. PCBs are industrial chemicals that were widely used as fire suppressors and electrical insulators because of their ability to withstand high temperatures.

In 1977, the EPA banned PCBs because of strong evidence that these chemicals caused risks to human and ecological health. PCBs are particularly dangerous because of their capacity to bioaccumulate (get absorbed and concentrated in the bodies of fish and other animals) and biomagnify (increase in concentration as they move up the food chain, leading to high contamination in predator fish species). The dominant source of PCBs to the Harbor Estuary (approximately 75%) came from discharges between 1940-1980, from General Electric plants located in Fort Edward and Hudson Falls, New York. The EPA designated the 200-mile stretch of the Hudson River a Superfund Site in 1984. In 2002, GE was ordered to conduct environmental dredging of PCB-contaminated sediment in a 40-mile stretch of the Upper Hudson River, which lasted from 2009-2015. The effectiveness of the remediation project in reducing PCB burdens to fishes in the Estuary has yet to be determined. Other sources of PCBs include runoff from contaminated sites, damage or disposal of equipment containing PCBs, wastewater, and atmospheric deposition.

Three different fish species: white perch, pumpkinseed and striped bass, are showing less PCB contamination on average in their tissues with time. Though not universally recognized by public health experts, the FDA fish consumption recommendation for PCBs in fish is two parts per million (ppm). Annual averages for striped bass fell below 2 ppm for the first time in 1996, while white perch and pumpkinseed averages dropped under 2 ppm in 1999 and have not exceeded the standard since then. However, consumption advisories are not based on averages and individual white perch, striped bass and pumpkinseed caught still regularly have concentrations of greater than 2 ppm.
Maps from 1993 and 2013 show varying levels of mercury contamination in surface sediments from highly toxic (yellow, Above ERM) to likely nontoxic (light purple, Below ERL). Average mercury concentrations for Raritan Bay are decreasing but no other parts of the Harbor Estuary are showing a decline and concentrations are still high enough to harm marine life and make most local seafood inedible.

The State of the Estuary 2018

Mercury

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The State of the Estuary 2018

Metals in Sediments

The most problematic metals in the Harbor Estuary are mercury, cadmium, chromium and lead. Each of these metals has a negative effect on the health of the animals that live (or near the sediments and several of them are capable of biomagnifying (building up in biological tissues) or bioaccumulating (increasing in concentration as the contamination moves from prey to predator species). The concentration of these metals have mostly remained constant throughout the monitoring period from 1993-2013, with significant decreases only in Raritan Bay for mercury and lead. This stability may represent the leveling-off of a trend of improving conditions from historic levels of contamination prior to the 1990s.

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Public Access and Stewardship

Goal Statement: Improve public access to the waters of the Estuary and the quality of experience at public spaces along the waterfront.

Waterfront Access
Better water quality, changing land uses, and public interest has fueled new parks and other public spaces along the waterfront. About 37% of the Estuary’s shoreline is now publicly accessible. For more information, see the 2018 State of the Estuary Report.

On-water Programs

The New York–New Jersey Harbor Estuary is the biggest public space in the nation’s largest metropolitan area. Access to the Estuary’s waters influences the quality of life for its millions of residents, and has been positively correlated with physical activity levels and public health. There are dozens of organizations providing on-water programs that get people on the water in human-powered boats such as canoes, kayaks, and paddleboards. Some organizations additionally provide environmental education and other supplemental programs. These water sports and recreational programs are critical for fostering a connection with and stewardship of the Estuary, especially for young people.

The number of individual human-powered boat trips is increasing annually as is the number of operating boathouses. Forty-three organizations reported putting 110,400 individuals on the water in human-powered boats in 2017. This is more than double the number of people on the water in 2010. Programs offered included kayaking, canoeing, standup paddleboarding, rowing, environmental education, sailing, surfing, pontooning, and surf skiing.

Annual Human-Powered Boat Trips

The number of annual boat trips offered by 43 responding organizations around the Estuary. Data does not account for repeat individuals. Data Sources: Waterfront Alliance Boathouse Survey, 2017. Photo: City of Water Day, Joaquin Cotton.
5. Community Engagement

Goal Statement: Foster community stewardship and involvement in decisions about the Harbor Estuary.

Participation
Participation in estuary stewardship events, like City of Water Day, is increasing over time. More people are becoming aware of this great resource that we share. See participation rates from three of the Estuary’s largest events in the 2018 State of the Estuary Report.

For more information, see the 2018 State of the Estuary Report.

Citizen Science Organizations

Organizations throughout the Harbor Estuary are conducting citizen science programming for a variety of purposes. The most common indicators being measured are water quality, biodiversity, fiscal pathogens, and habitat restoration success. These programs are monitoring a total of 51 different water bodies throughout the Harbor Estuary.

Participation in Citizen Science

Long Term Trend: Insufficient Data
Short Term Trend: Insufficient Data

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<thead>
<tr>
<th>Monitoring Goal</th>
<th>Waterbodies</th>
<th>Number of Organizations</th>
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<tr>
<td>Oysters</td>
<td>Newark Bay, Passaic River, Hackensack River</td>
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<tr>
<td>Litter/trash</td>
<td>Arthur Kill/Kill Van Kull</td>
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<tr>
<td>Habitat restoration</td>
<td>Lower Raritan River, Jamaica Bay, Upper Bay</td>
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<tr>
<td>Pathogens</td>
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<tr>
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</table>

Source: 2016 HEP Citizens Advisory Committee Survey
The indicators in this summary represent a small fraction of the analysis that can be found in the 2018 State of the Estuary Report (along with all references) at Hudsonriver.org/NYNJHEPStateoftheEstuary.pdf.