The State of the Estuary 2018

NY/NJ HARBOR & ESTUARY PROGRAM
HUDSON RIVER FOUNDATION

Authors & Contributors
Prepared by staff of the NY-NJ Harbor & Estuary Program (HEP). HEP would like to acknowledge the input of its Management Committee, Water Quality and Restoration Work Groups, Citizens Advisory Committee and especially its Science and Technical Advisory Committee for this report.

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

Cover photo: Jamaica Bay Ecowatchers

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

Introduction and Highlights

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 shorter-term trends, providing a broad assessment of progress towards HEP's goals of improving water quality, habitat, public access, maritime 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 broad range of environmental challenges and can be found at www.hudsonriver.org/NYNJHEPStateoftheEstuary.pdf.

Water quality improvement is 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 emanating from combined sewage overflows 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.

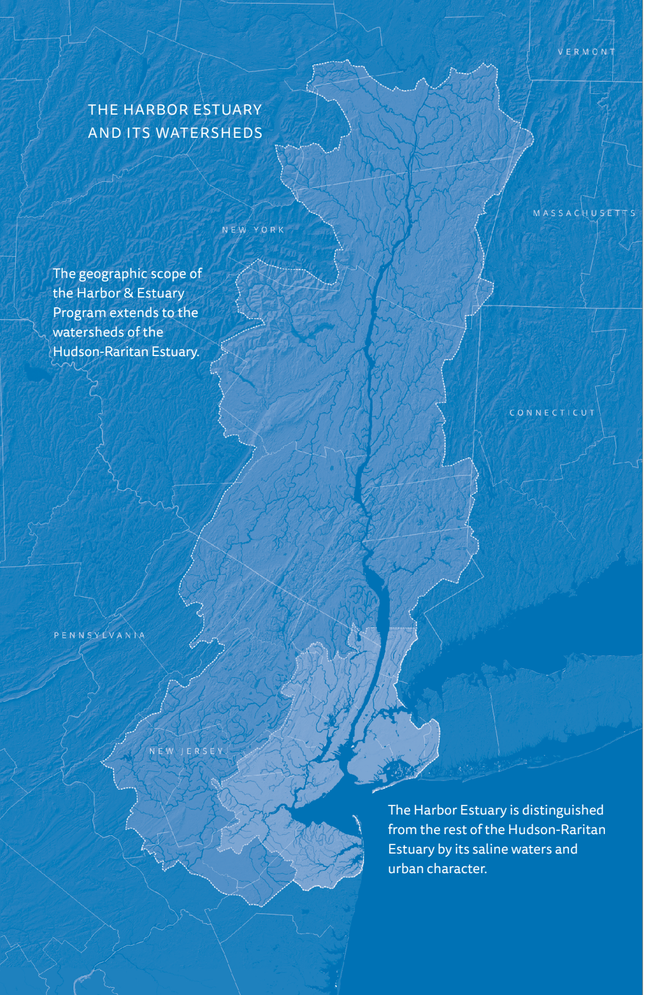
Toxic contaminants, such as heavy metals and PCBs, are decreasing in concentration in sediments or fish. The natural burial of contaminated sediments as well as the dredging of toxic sediments have reduced large sources of contamination. Average PCB concentrations in key fish species have decreased markedly. 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 37% 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 (A Day in the Life of the Hudson & Harbor, City of Water Day, and Riverkeeper Sweep) are growing in popularity every year, and there are many stewardship organizations, events, and citizen science programs that foster **community engagement**.

Trends in **habitat and ecological health** are not as promising and only the indicator for stream health is 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 health is also declining, such as the abundance of estuarine and diadromous fish and horseshoe crabs. While efforts to improve the Estuary's ecology are likely helping, such as oyster reef restoration, removing dams and reconnecting rivers and streams, the pace is not in keeping with need.

The stress on fish and wildlife caused by **climate change** makes them even more vulnerable to this loss of habitat. The data in this report illuminates the fact that 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 adjusting their behavior.

Large, intense storms anticipated by scientists matter a great deal. Many of the changes in environmental health are gradual; storms such as hurricanes Sandy, Irene, and Lee, change that gentle progression 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 disrupted by the storms, and the intensity of storm surges and wave action during the storms may have remobilized contaminated sediments.

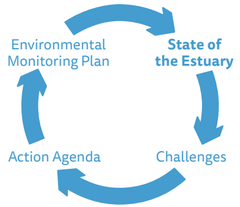


About the Estuary and the NY-NJ Harbor & Estuary Program

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 supports 12 square miles of tidal wetlands, more than 200 fish species, and over 300 bird species. The Estuary also provides crucial resources for more than 14 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.[1] Our Environmental Monitoring Plan[2] shows where data is being collected about the Estuary by public agencies, universities, and civic organizations.



1. www.hudsonriver.org/NYNJHEPActionAgenda.pdf
2. www.hudsonriver.org/NYNJHEPEnvMonitoring.pdf

Indicators at a Glance

WATER QUALITY

Indicators	Long Term Trend	Short Term Trend
Dissolved Oxygen	↗	↗
Enterococcus	↗	~
Nitrogen	↗	↗
Water Temperature	↘	~
Debris Collected by Skimmers and Booms	●	↗
Debris Collected on Beaches	↗	↗
Microplastics	●	●
Chemical Contaminants of Emerging Concern	●	●

HABITAT AND ECOLOGICAL HEALTH

Indicators	Long Term Trend	Short Term Trend
Benthic Index of Biotic Integrity	~	●
Estuarine and Diadromous Fish Abundance	↘	~
Established Oyster Beds	●	●
Whale and Dolphin Abundance	●	●
Tributary Habitat Connectivity	●	●
Riparian Area Integrity	●	↘
Stream Health Bioassessment	↗	●
Percent and Distribution of Natural Shorelines	●	●
Horseshoe Crab Abundance	●	↘
Submerged Aquatic Vegetation	●	↘
Area of Coastal Forest and Grassland	●	↘
Area of Wetlands	↘	↘
Nesting Pairs of Harbor Herons	~	↘

PORT AND MARITIME (Toxic Contamination)

Indicators	Long Term Trend	Short Term Trend
Metals in Sediments	~	●
PAHs in Sediments	↗	●
Dioxin in Sediments	↗	~
PCBs	↗	↗

PUBLIC ACCESS AND STEWARDSHIP

Indicators	Long Term Trend	Short Term Trend
Publicly Accessible Waterfront	●	↗
On-Water Access	●	↗
On-Water Programs	●	↗

COMMUNITY ENGAGEMENT

Indicators	Long Term Trend	Short Term Trend
Capacity of Stewardship Organizations	●	●
Participation in Stewardship Events	●	↗
Participation in Citizen Science	●	●

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

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.

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.**

Photos: PVSC

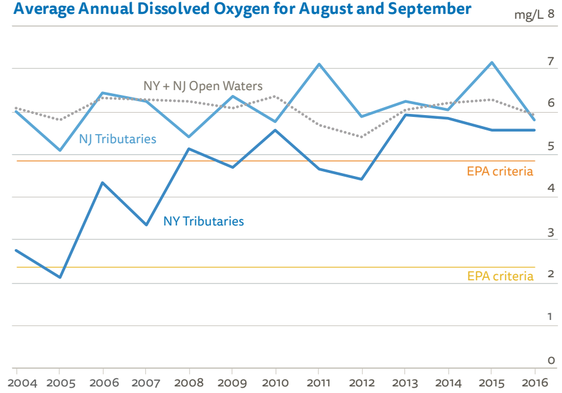
Dissolved Oxygen

Long Term Trend: Improving
Short Term Trend: Improving

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. This is 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 more 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 in 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.

Average Annual Dissolved Oxygen for August and September



Sources: New Jersey Harbor Dischargers Group, Ambient Water Quality Monitoring. New York City Department of Environmental Protection, Harbor Survey Program.

Pathogens

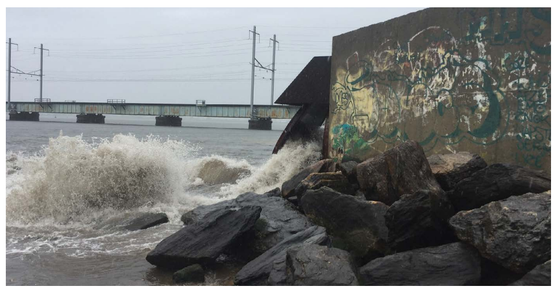
Long Term Trend: Improving
Short Term Trend: Not Trending

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 in separated systems storm drainage would enter surrounding waterways untreated. However, during storm events, runoff combined with sanitary sewage can exceed the capacity of treatment plants and is diverted and released through sewer outfalls directly into the waterways to avoid backups of drains 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.

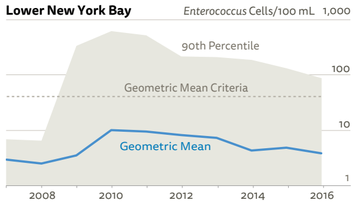
Over the long term, pathogen contamination has decreased with time due to upgrades in wastewater treatment. However, over the past decade, *Enterococcus* averages have varied widely throughout the Harbor Estuary. Newark Bay and nearby tributaries like the Hackensack and Passaic Rivers have never experienced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

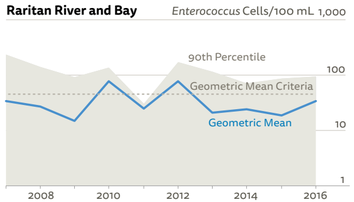
The majority of the water quality monitoring in our estuary occurs by boat near the center of the channel; however, untreated sewage and stormwater through CSOs and other wet weather discharge are released at the shoreline. While official bathing beaches are monitored, boat launch sites and other shorelines where people regularly come into contact with the water are not regularly tested by public agencies.

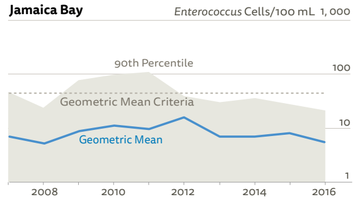


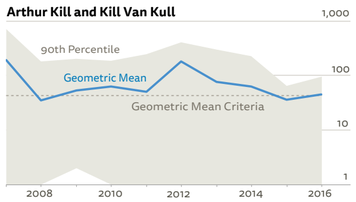
Photos: Left: Combined Sewer Overflow (CSO), Raritan Riverkeeper. Right: Citizens Water Quality Testing program, Rob Buchanan.

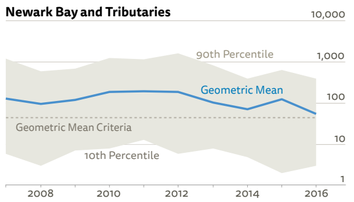
Pathogens / ***ENTEROCOCCUS***

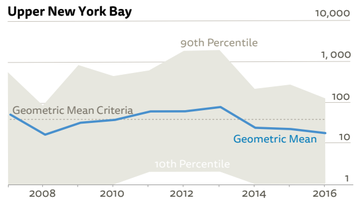


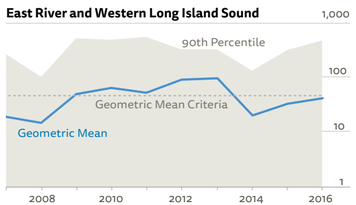






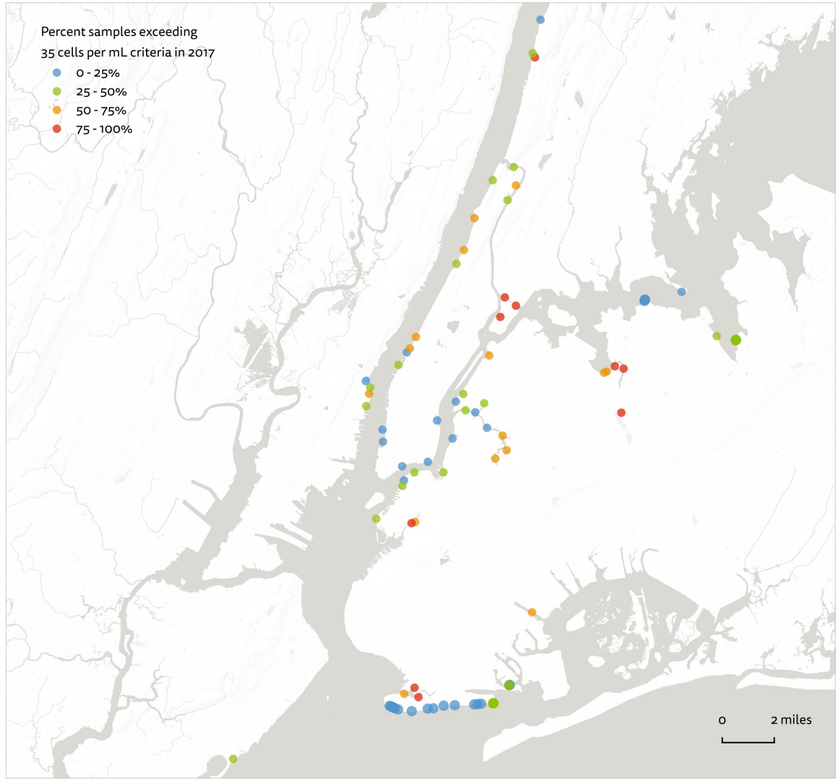






The geometric mean is similar to an average but it better represents the typical number in a set of values such as these. The gray area in between the 10th and 90th percentiles represents the range in which most of the measurements fall.

Sources: New Jersey Harbor Dischargers Group, Ambient Water Quality Monitoring. New York City Department of Environmental Protection, Harbor Survey Program.



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.

Source: Citizens Water Quality Testing Program, New York City Department of Health.

2. 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.

Photo: Don Riepe

Estuarine and Diadromous Fish Abundance

Long Term Trend: Deteriorating
Short Term Trend: Not Trending

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 higher than 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 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.

Illustrations (top left to right): Hogchoker, Atlantic sturgeon, white perch, striped bass. Hogchoker image: George Brown Goode, (Wikimedia). Other fish: Duane Raver/U.S. Fish and Wildlife Service.

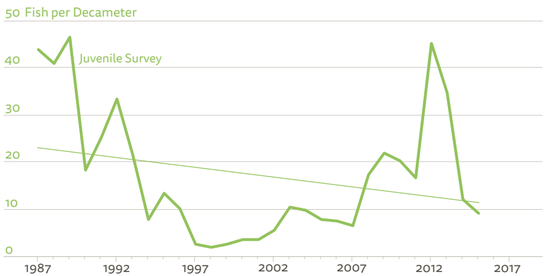
Fish Data:
Long term surveys of fish abundance in the Hudson River from the Troy Dam to Manhattan. Hogchoker and white perch are estuarine species, striped bass and Atlantic sturgeon are diadromous.

Data Sources: Hudson River Utilities Fall Shoals Juvenile Survey: 1987–2015, units: catch per decameters of water sampled. Utilities Beach Seine Survey: 1987–2015, units: catch per number of seine hauls per year. The River Project Fish Trapping.

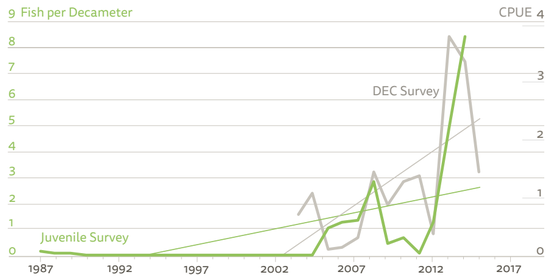
HABITAT & ECOLOGICAL HEALTH

Estuarine and Diadromous Fish Abundance

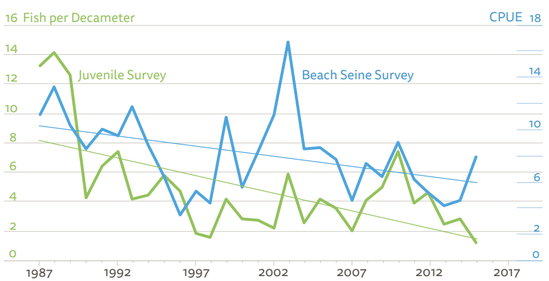
ESTUARINE: Hogchoker



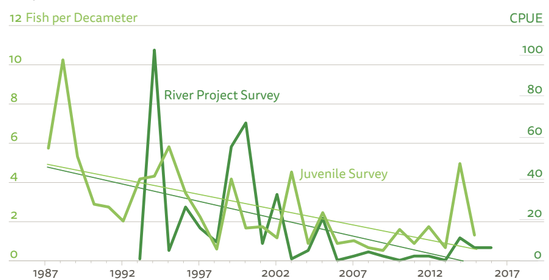
DIADROMOUS: Atlantic Sturgeon



White Perch



Striped Bass



Survey: 1993–2016, units: catch per total number of traps. New York State Department of Environmental Conservation (NYSDEC) Young of the Year or Juvenile Diadromous Surveys for striped bass (1987–2016) and Atlantic sturgeon (2004-2016), units: annual geometric mean of all hauls.

Wetlands

Long Term Trend: Deteriorating
Short Term Trend: Deteriorating

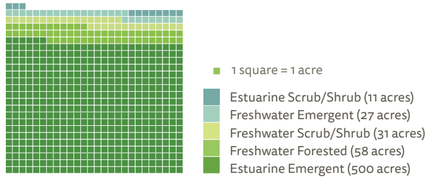
Among the most productive ecosystems on earth, wetlands are a critical habitat for many of the Harbor Estuary's wildlife species, providing nursery, spawning, feeding and nesting areas for fish, birds and other marine life. Wetlands provide an array of ecosystem services: cleaning the water by taking 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 sea level rise threatens to drown much of our remaining tidal wetlands.

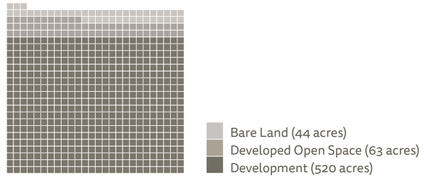
In the New York portion of the Harbor Estuary, approximately 625 acres of wetland were lost between 1996 and 2010, with an average of 45 acres lost per year. In the New Jersey part of the Harbor Estuary, the loss of wetlands is much greater; approximately 3,800 acres were lost between 2002 and 2012, a 4% loss of the 2002 wetlands. Most of the wetland loss in New York occurred in tidal wetlands and 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 is the result of many small alternations: only 12% of the patches lost were greater than 2 acres in size.

Lemon Creek, Staten Island. Isabelle Stinnette

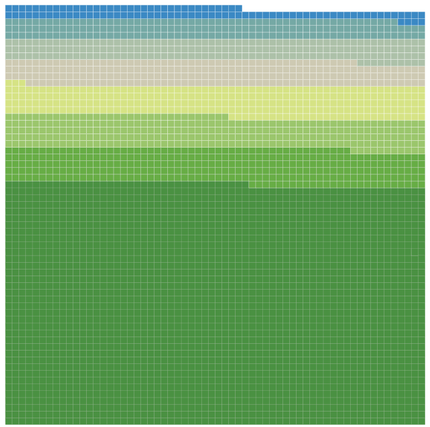
627 **Net Acres Wetlands Lost in New York**



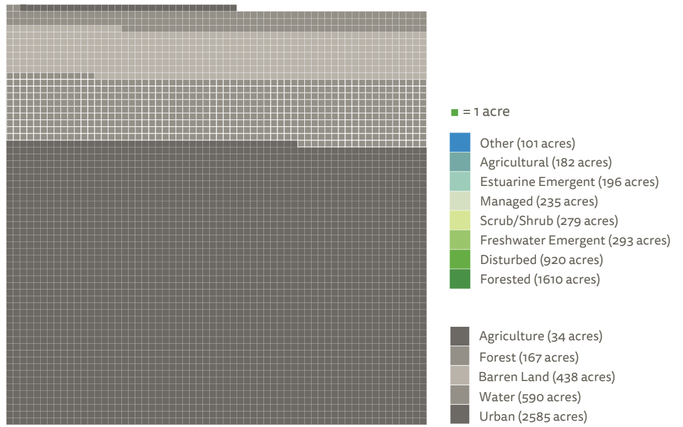
Acres New York Wetlands Replaced by:



3814 **Net Acres Wetlands Lost in New Jersey**



Acres New Jersey Wetlands Replaced by:



Sources: National Oceanic and Atmospheric Administration, Coastal Change Analysis Program (1996 – 2010; NY).
New Jersey Department of Environmental Protection, Land use/land cover datasets (2002-2012).

3. Port and Maritime

Goal Statement:
Support port and associated maritime operations so that they are both economically and ecologically viable.

Container Ships
Containers leaving the Port of New York and New Jersey. Thanks to increased regulation, the presence of PCBs and other toxic contaminants in fish and sediments have generally diminished over the long term. If this trend continues, maintaining navigation channels in the Harbor will be easier and less expensive.

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

Photo: Kate Boicourt

PCBs

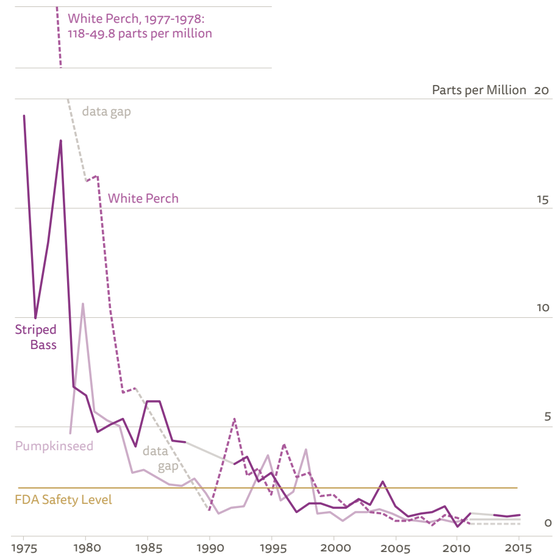
Long Term Trend: Improving
Short Term Trend: Improving

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 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.

Annual Average Total PCBs by Species (data skips some years)

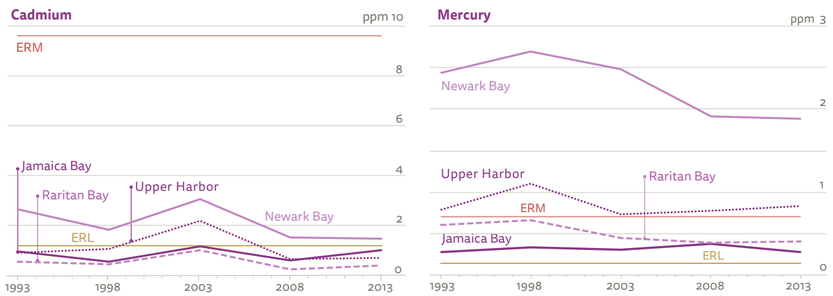


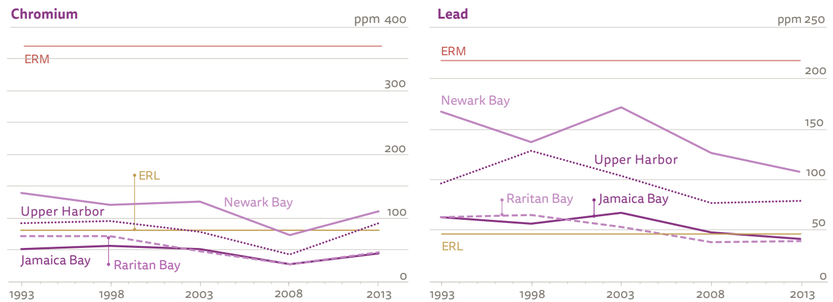
Source: NYSDEC Contaminant Monitoring Program

Metals in Sediments

Long Term Trend: Not Trending
Short Term Trend: Insufficient Data

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 in or near the sediments and several of them are capable of bioaccumulating (building up in biological tissues) or biomagnifying (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.

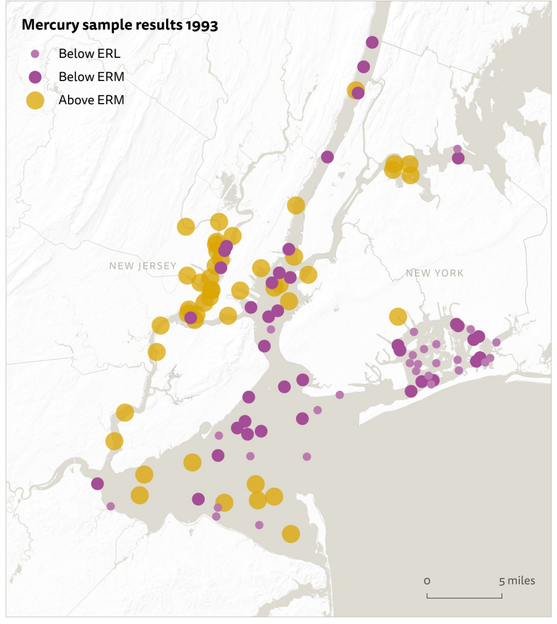


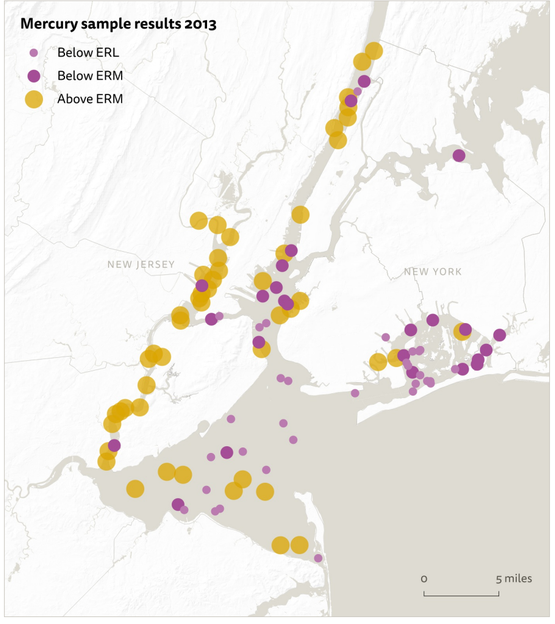


Source: EPA Regional Environmental Monitoring and Assessment Program

Mercury

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.





Source: EPA Regional Environmental Monitoring and Assessment Program

4. 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.

Photo: City of Water Day, Waterfront Alliance

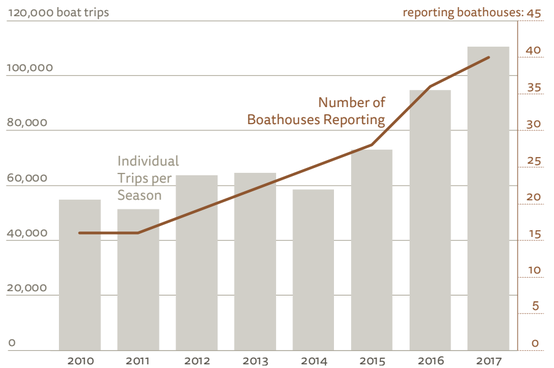
On-water Programs

Short Term Trend: Insufficient Data
Short Term Trend: Improving

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, stand up paddleboarding, rowing, environmental education, surfing, sailing, 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.

Photo: Ian Douglas

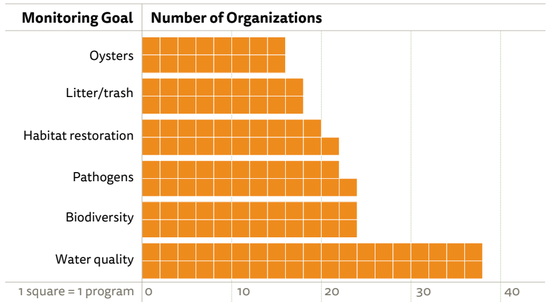
Participation in Citizen Science

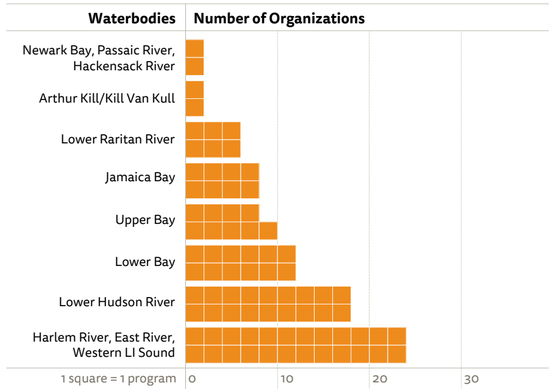
- Long Term Trend: Insufficient Data
- Short Term Trend: Insufficient Data

Citizen science programs bring together stewardship organizations, the academic community, and members of the public to conduct scientific research on the health and ecology of the Harbor Estuary. Also known as participatory or community-led science, these programs advance scientific literacy, especially among youth, and can fill critical gaps in monitoring and stewardship data for agency managers, scientists, and policy makers. The relative abundance of citizen science programs is an indicator of community interest and capacity to help conserve our waterways and wildlife.

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, fecal pathogens, and habitat restoration success. These programs are monitoring a total of 31 different water bodies throughout the Harbor Estuary.

49 Citizen Science Organizations





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**.

NY/NJ HARBOR & ESTUARY PROGRAM

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