S.3484 NEW YORK-NEW JERSEY WATERSHED PROTECTION ACT

AUGUST 17, 2022

New York-New Jersey Harbor, Image: Justin Leibow

ACKNOWLEDGEMENTS

Great egrets in New Jersey wetlands

Image: EarthShare NJ

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TABLE OF CONTENTS

Great Falls (Passaic River)

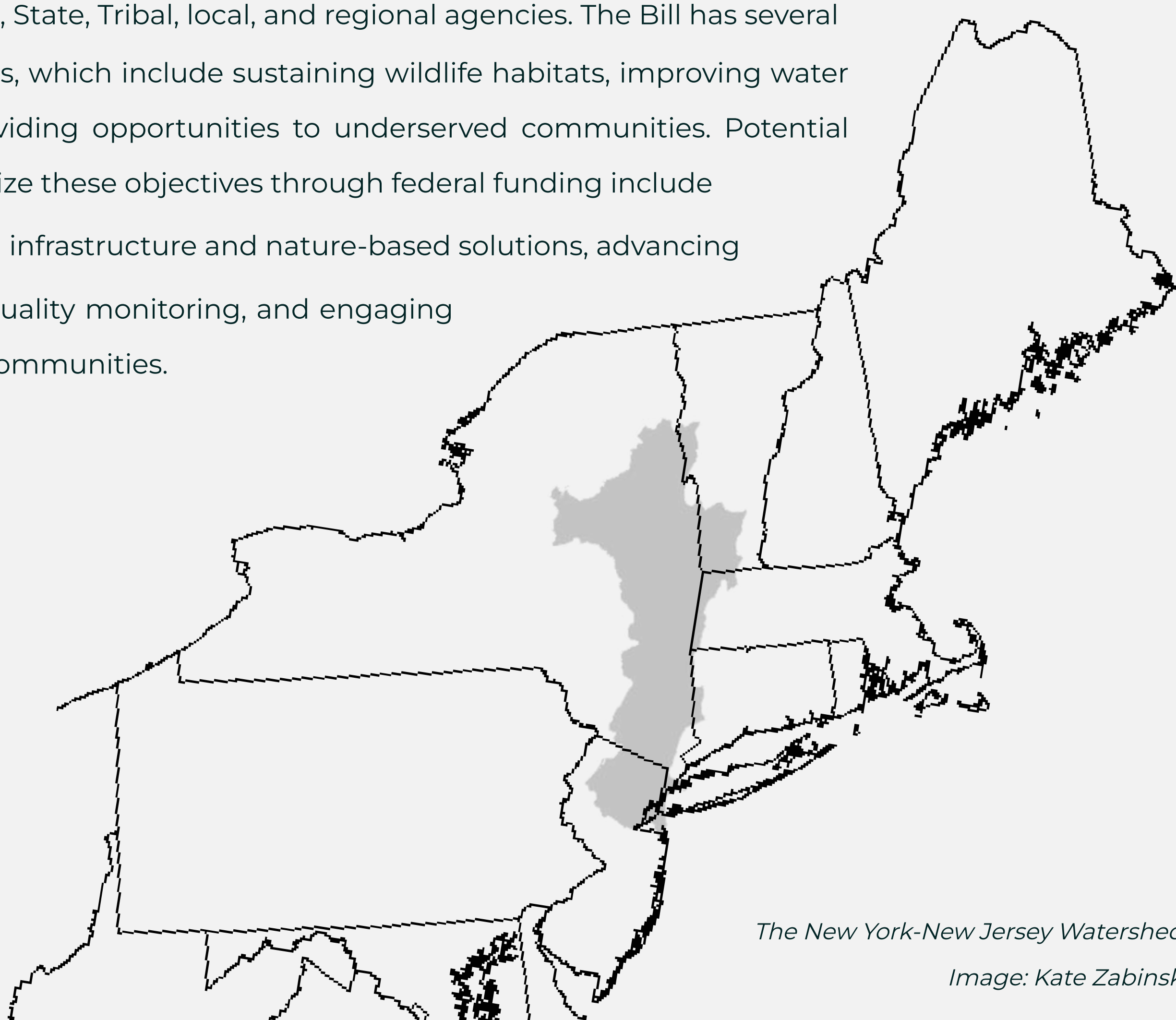
Image: Firoz Ansari

EXECUTIVE SUMMARY

The New York-New Jersey Watershed Protection Act, S.3484, aims to protect and restore the watersheds that flow into New York-New Jersey Harbor and the associated estuaries, which are the Hudson, Mohawk, Raritan, Passaic, Hackensack, and Bronx River Watersheds, as well as the Hudson River Estuary.

As one of the most densely populated and socioeconomically important regions of the United States, the New York-New Jersey Watershed serves more than 15 million people. The Watershed is responsible for generating approximately $60 billion annually through tourism, commercial fishing, and recreational activities. The Hudson River alone provides vital services and habitat for close to 85% of all fish and wildlife in New York State, several of which have been classified as endangered (The State of the Hudson, 2020).

Led by the Department of the Interior, S.3484 aims to coordinate restoration and protection efforts between Federal, State, Tribal, local, and regional agencies. The Bill has several overarching goals, which include sustaining wildlife habitats, improving water quality, and providing opportunities to underserved communities. Potential strategies to realize these objectives through federal funding include leveraging green infrastructure and nature-based solutions, advancing environmental quality monitoring, and engaging and educating communities.



The New York-New Jersey Watershed,

Image: Kate Zabinsky

HOME TO

15 million people

THE MOST POPULOUS WATERSHED
IN THE UNITED STATES

Port of Newark

Image: Crains New York

INTRODUCTION TO S.3484

Bear Mountain Bridge, Cortlandt, NY Image: Clay Banks

The Watershed currently faces serious threats such as water pollution that harm the ecosystems and industries of the region. Climate change impacts are another significant concern, as storms, floods, and rising sea levels increasingly disrupt the lives of those inhabiting the region. Coastal areas are home to a wide range of species, many now at risk. Wetlands–which perform important functions such as storm buffering and flood mitigation–are being destroyed at higher rates. Moreover, many residents' access to clean water and enjoyment of wildlife has been compromised due to a history of inequity and underinvestment.

S.3484 was introduced into the Senate in January 2022 by Senator Cory Booker [D-NJ], along with his co-sponsors, Senator Robert Menendez [D-NJ], Senator Kristen Gillibrand [D-NY], and Senator Chuck Schumer [D-NY]. It was then referred to the Committee on Environment and Public Works. The proposed Bill establishes the New York-New Jersey Watershed Restoration Program, which seeks to provide technical assistance and coordinate protection and restoration activities between public and private stakeholders and conservation partners. These efforts would be overseen by the Department of the Interior, in consultation with agencies at Federal, State, Tribal, local, and regional levels. Facilitated by the National Fish and Wildlife Service, S.3484 also implements the voluntary New York-New Jersey Watershed Restoration Grant Program within the larger non-regulatory Watershed Restoration Program to fund restoration and protection activities. The grant program would allocate $50 million per year from FY2022 to FY2027 to finance these new and ongoing projects. The goal of the New York-New Jersey Watershed Protection Act is to improve issues of water quality and habitat loss, protect wildlife and ecosystem health, and provide access to natural resources and economic opportunity, all while prioritizing the needs of communities facing environmental injustice.

ANNUAL ECONOMIC IMPACT

$90.5 billion

BUSINESS AND PERSONAL WAGES FROM THE NEW YORK-NEW JERSEY HARBOR

$60.7 billion

TOTAL WATERSHED REVENUE FROM TOURISM, COMMERCIAL FISHING, AND RECREATION

$1.3 billion

VALUE OF MOHAWK RIVER TOURISM INDUSTRY

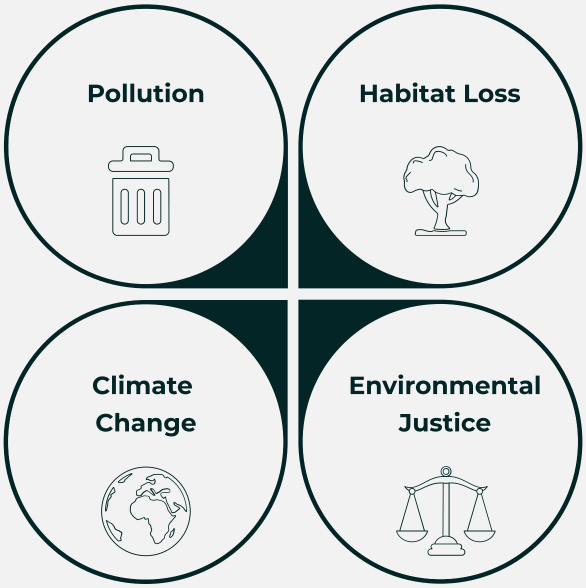
$8.5 billion

FEDERAL, STATE, AND LOCAL TAX REVENUE FROM NY-NJ HARBOR

629,000

JOBS SUPPORTED BY THE NEW YORK-NEW JERSEY HARBOR

PROBLEMS ADDRESSED BY S.3484



Pollution

Pollution damages ecosystems and erodes public access to the natural resources of the Watershed. Between 1976 and 1995, New York banned recreational fishing in 40 miles of the non-tidal freshwater Hudson. The next year, nearly 200 miles of the Hudson River were closed to commercial fishing due to pollution (Office of Response and Restoration, n.d.; Da Silva et. al, 2021). The following section introduces the main sources of pollution threatening the New York-New Jersey Watershed.

Point Source Pollution

Point source pollution refers to pollutants discharged from a distinctly identifiable source. This includes Combined Sewer Overflows (CSOs) from sewage treatment facilities and authorized discharge from surrounding industries and wastewater facilities. CSOs occur when combined sewer systems (pipelines that collect and transport both sewage and stormwater) are overwhelmed by rainfall and discharge untreated wastewater directly into a water body (Da Silva et. al, 2021). In New York City, 60% of the wastewater system is a combined system (NYCDEP, n.d.) Rainfall of less than an inch can lead to overflows. During cases of heavy rainfall and snowmelt, New Jersey and New York's sewer systems are even more overwhelmed, causing high volumes of untreated sewage and wastewater to wash into nearby waterways, exceeding treatment plant capacity and polluting the Watershed (Da Silva et. al, 2021).

Nonpoint Source Pollution

In contrast to point source pollution, nonpoint source pollution refers to pollutants that come from a source with no single point of origin. Major examples of nonpoint source pollution are urban and agricultural runoff. Urban runoff refers to debris that is swept up by rain and melted snow from roads and concrete that flows into the Watershed without being treated. Agricultural runoff occurs when chemical fertilizers, pesticides, and herbicides are washed into waterways from farms.

Nutrient enrichment of water from runoff can lead to eutrophication, which damages the ecological and socioeconomic value of water bodies by causing excessive algal blooms and fish kills, leading to fish consumption advisories and declines in tourism (Bricker et al., 2008). Changes in water chemistry limit the productivity of organisms like phytoplankton and affect the health of the aquatic community and food web (Miller et al., 2005). For example, Dissolved Oxygen (DO) levels, an indicator for water quality and pollution, rapidly decrease with discharge of organic matter from runoff, which can be fatal for aquatic life (Ibanez, 2008).

Legacy Pollution

Legacy pollution is contamination that has remained in the environment from sources that are no longer discharging. For example, when a now defunct factory disposed of its untreated wastewater directly into the nearest water body. This wastewater contains pollutants which remain in the water and soil of the Watershed. Examples of legacy pollutants and their sources are polychlorinated biphenyls (PCBs) from electrical capacitor and transformer

CSO discharge point on the Bronx River, Image: Adi Talwar

Case Study: Marathon Battery Company, Cold Spring, NY

Reintroduced wild rice as part of the wetland reconstruction process, Image: NOAA

From 1952 to 1979, Marathon Battery Company made nickel-cadmium batteries for both military and commercial uses. The untreated wastewater from factories was dumped into the sewer system that flowed into the Hudson River and Foundry Cove, contaminating these locations with nickel, cadmium, and cobalt (NOAA DARRP, n.d.). The EPA designated this area as a Superfund site in 1981 and conducted extensive cleanup until the site was removed from the program's National Priorities List in 1996 (US EPA, n.d.). However, the EPA's latest five-year report in 2018 reveals that the issue of pollution in surrounding groundwater still persists (Turton, 2018).

manufacturing at two General Electric facilities on the Upper Hudson, dioxins and furans from Agent Orange production in New Jersey, and cadmium from battery manufacturing by the Marathon Battery Company in Cold Spring, New York (Da Silva et. al., 2021).

Aging Infrastructure

As of 2017, approximately 26% of sanitary sewer pipes in the Watershed are more than 65 years old (The State of the Hudson, 2020). This aging infrastructure makes pipes vulnerable to damage, which can lead to untreated wastewater leaking into the soil and water sources. These old systems are ill-equipped to manage the rise in wastewater volumes, which further contributes to the discharge of untreated sewage and runoff into the Watershed. Evidence shows that toxic cyanobacteria in water systems from raw sewage can be harmful to the health of both human and aquatic organisms (Kalaitzidou et al., 2022). Bacteria decomposition of organisms and materials results in oxygen depletion and alters water conditions to be uninhabitable for fish (Paerl and Otten, 2013). Ingestion of certain pathogenic bacteria may stimulate neurotoxins, which can be lethal to aquatic creatures and mammals (Carmichael, 2001). Digestive and respiratory system illnesses have been proven to be related to the ingestion of bacteria-affected municipal water supplies (Chorus and Bartram, 1999). Consumption, inhalation, and recreational use of water are major avenues for human exposure to waterborne bacteria that can lead to chronic illness (Carmichael, 2001).

Pollutants

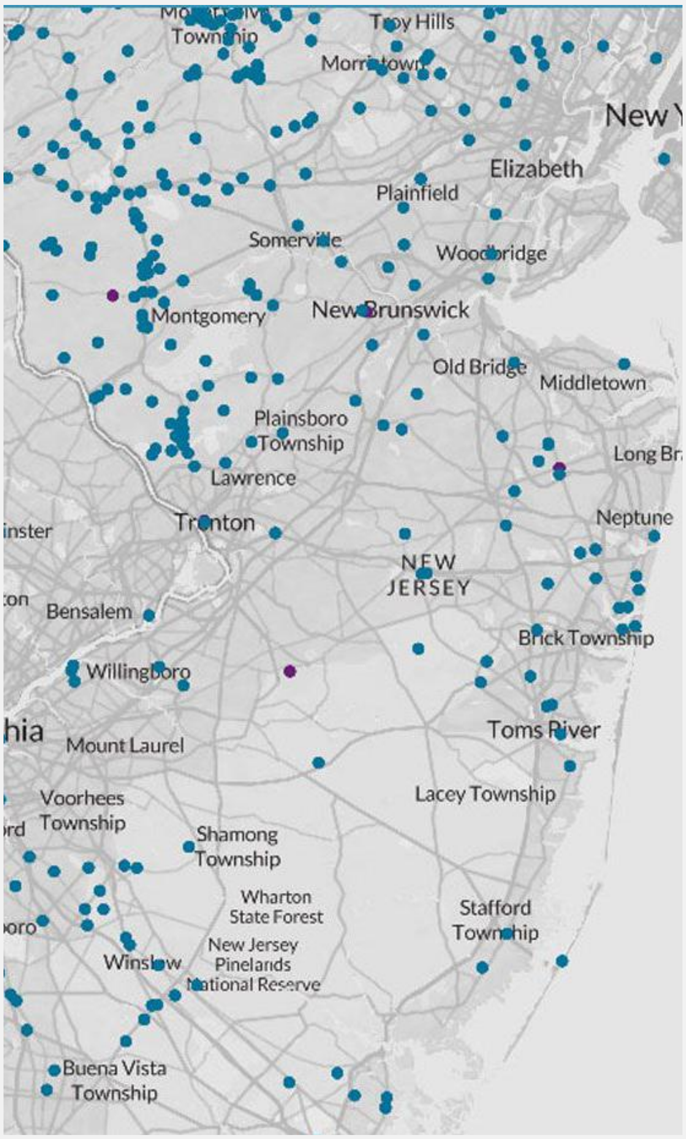
Polychlorinated Biphenyls (PCBs)

The discharge of PCBs into the Watershed arises from a legacy of unregulated pollution throughout the 19th and 20th century, and is largely the result of electrical manufacturing industries' actions during that time (Da Silva et. al., 2021). In fact, 1.3 million pounds of PCBs were deposited into the Hudson River by General Electric's capacitor manufacturing plants between 1940 and 1977 (O'Neil, 2016). PCBs are dangerous because they travel up the food chain into the human body through dietary intake of fish and other seafood (Barone et al., 2021), and can be passed to infants through breast milk (Guo et al., 2021). An increasing body of epidemiological evidence shows that PCB concentration in the body is also linked to various cardiovascular diseases such as hypertension, type II diabetes, and obesity (Perkins et. al., 2015).

Former General Electric plant at Hudson Falls, that is a source of legacy pollution. Image: Riverkeeper

Perfluorooctanoic Acid (PFOA) and Perfluorooctane Sulfonic Acid (PFOS)

PFOA and PFOS (collectively known as PFAS), are the by-products of paper, food packaging, and paint manufacturing plants. These "forever chemicals" build up in the body, do not break down in the environment, and are toxic to reproductive and immune systems (Fang et al. 2008; Singh & Singh, 2019; Environmental Working Group, n.d.). In 2016, PFOA was detected in the public drinking water supply of the historic manufacturing town of Hoosick Falls, New York at far higher levels than EPA health advisory limits (NYDEC, n.d.). High rates of unusual cancer cases in the town were traced to PFOA released by Saint-Gobain Performance Plastics (an EPA Superfund site) between 1999 and 2015 (US EPA, n.d.; Lyons, 2021; NYDEC, n.d.; Ward, 2016). Additionally, research conducted by Post et al. (2013) indicates that total PFOA and PFOS levels in the water bodies of Bergen County, New Jersey exceed New Jersey Department of Environmental Protection's standard of 10 ng/L five-fold (NJDEP, 2021a). In an investigation by the Environmental Working Group, it was found that Bergen County ranked fourth nationwide for concentrations of PFOA and PFOS in drinking water (Fallon, 2020). In 2020, the New Jersey Department of Environmental Protection adopted maximum contaminant level (MCL) standards for certain PFAS chemicals (NJDEP, 2020).



Locations of PFAS in New Jersey drinking water, Image: NJ Spotlight News

Dioxins

Dioxins are a by-product of industrial processes. They are known as persistent organic pollutants (POPs) because they take a long time to break down once they enter the environment (US EPA, 2015). They are dangerous because of their tendency to accumulate and travel up the food chain by residing in the bodies of organisms that consume these chemicals (WHO, 2016). Studies reveal that short-term exposure to high levels of dioxins can lead to skin lesions and altered liver function. Long-term exposure can negatively impact the immune system, nervous system, endocrine system, and reproductive functions (WHO, 2016). Dioxin exposure has also been linked to cancer, developmental problems, and hormone interference (US EPA, 2014a).

Heavy Metals

Coal-powered energy plants and battery production plants historically discharged heavy metals such as mercury and cadmium into the Watershed. These heavy metals have been found in high concentrations in landfills and groundwater (Da Silva et. al., 2021). Existing industrial plants may also leach heavy metals into the Watershed through untreated surface runoff (Da Silva et. al., 2021). Water contaminated by heavy metals is an ongoing global public health concern, as they can enter the food chain through food consumption and drinking water (Han et al., 2020). Acute and chronic toxicity, gut disease, anemia, and cancer are correlated with high levels of heavy metal exposure (Environmental Protection Agency, 2022).

Habitat Loss and Species Endangerment

The Watershed provides vital services and habitat for fish and wildlife. These animals include several endangered species such as the shortnose sturgeon, American eel, and other reptiles, amphibians, and birds (US House, Committee on Natural Resources, 2022, p. 1).

Urban development can lead to wildlife and habitat loss. Human encroachment for urban and agricultural purposes has altered the topography of an estimated 21,661 acres of wetland and associated open water, which equates to approximately 11% of New York's land area (Huffman & Associates, Inc., 2000; Vermont DEC, 2017). This is despite the fact that wetlands provide effective flood control in urban areas (Hey and Philippi, 1995; Rojas et al., 2019). 60% of wetland in New York and 39% of wetland in New Jersey were lost between 1780 and 1980 (Dahl,

The Shortnose Sturgeon

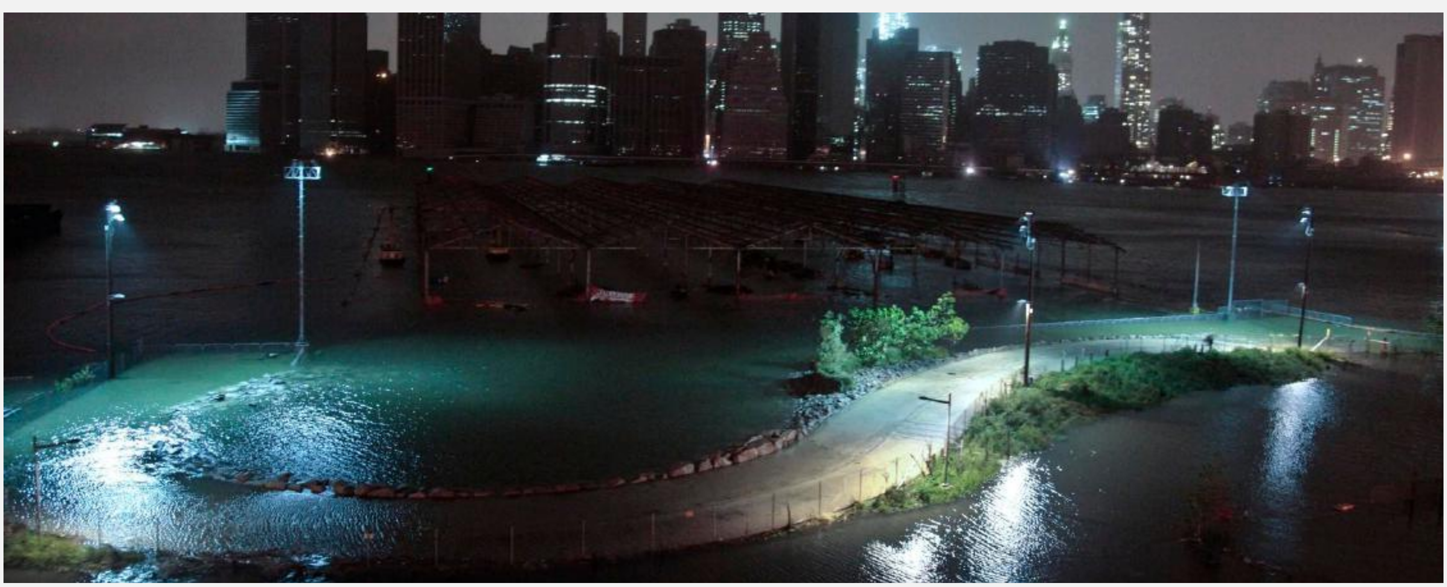
The shortnose sturgeon is the smallest of the sturgeon species found in New York State, rarely growing larger than 3.5 feet in length and 14 pounds in weight. It has a short, conical snout and rows of bony plates along its body like armor. The shortnose sturgeon is an anadromous species that migrates from saltwater to spawn in freshwater. Pollution, overfishing, habitat degradation, and human activities such as dredging have all contributed to the sharp decline in the shortnose sturgeon population (NYDEC, 2022). These threats can be addressed through constructing fish passageways, restoring habitats, improving water quality, and conducting public education (National Oceanic and Atmospheric Administration, n.d.). The shortnose sturgeon was declared an endangered species in 1967 (NOAA Fisheries, 2022). In New York State, the shortnose sturgeon currently has only one sustained population in the lower portion of the Hudson River, from the southern tip of Manhattan upriver to the Federal dam at Troy (NYDEC, 2022).

Shortnose sturgeon, Image: En-Academic

1990). As a result, minor-to-disruptive tidal flooding in the New York City metropolitan area has increased from 5 days per year in 2000 to 10-15 days per year (EDF, 2022). Moreover, flood risk is estimated to increase by an average of 26.4% in the US by 2050 due to climate change (Wing et al., 2022). The loss of wetlands is expected to impede the Watershed's ability to manage heavy floods and climate change effects. In order to alleviate erosion caused by storms and sea level rise, new erosion control infrastructure is likely to be implemented. This may lead to further loss of habitat and spawning grounds for threatened species and even contribute to the destruction of the very wetlands that provide natural flood protection and carbon sequestration by tidal vegetation (Office of Coastal Management, 2009).

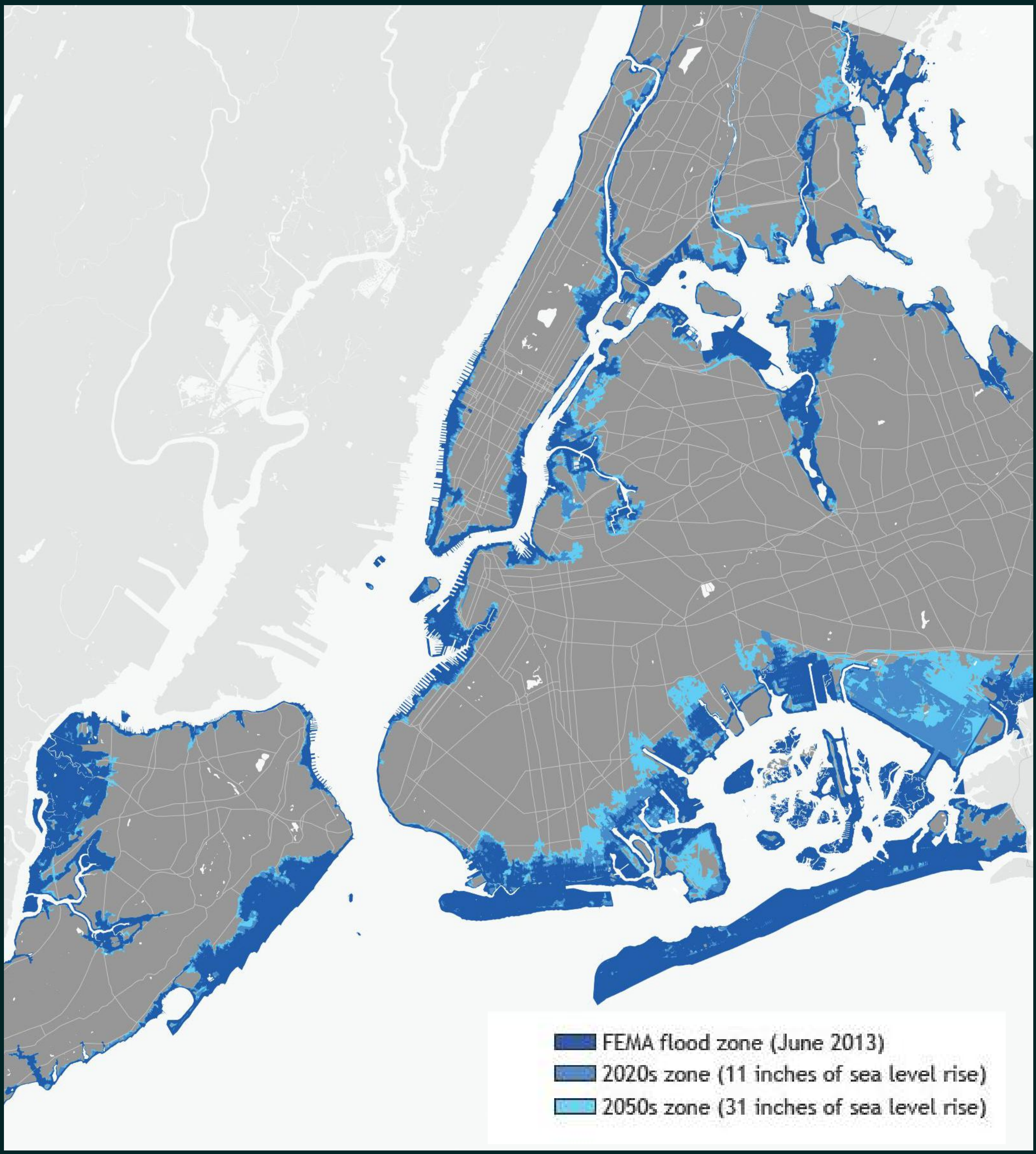
Climate Change

Climate change is an imminent threat to New York and New Jersey. Over the past century, sea level has risen on the Hudson by at least a foot, a rate that is greater than the global average (US House, Committee on Natural Resources, 2022). At the same time, extreme weather events have caused devastating infrastructure damage and loss of human life (Jiménez and Levenson, 2021; Hanchey, 2021). One example is Hurricane Ida, which brought destruction upon the homes and people of the



Flooding at a Lower East Side park (NYC) after Hurricane Sandy. Image: Bebeto Matthews

FEMA 100 Year Flood Zone Projection



FEMA's projected NYC flood zones. Image: NOAA climate.gov

Sewage flows in the Gowanus Canal after Hurricane Sandy. Image: Public Lab

Watershed region. Record-breaking rainfall, as well as tornadoes and flooding, led to the suspension of rail and subway service and power outages, and resulted in at least 50 deaths in New York and New Jersey (Jiménez and Levenson, 2021; Hanchey, 2021). In the aftermath of Hurricane Sandy, 11 billion gallons of partially treated and untreated wastewater were discharged into the New York-New Jersey Harbor Estuary (Kenward et al., 2013). Given the antiquated waste and stormwater infrastructure in the Watershed, increased precipitation levels from extreme weather events will further overwhelm sewage systems and carry more untreated waste and stormwater runoff into the region's water bodies (Pirani and Boicourt, 2018). Climate change impacts will only worsen existing environmental issues and disproportionately affect underprivileged communities residing within the Watershed (Pirani and Boicourt, 2018).

In agricultural regions of the Watershed, farms face major repercussions as a result of climate change. Agricultural practices such as forest clearing and overuse of fertilizers release greenhouse gasses, while also reducing the land's natural ability to sequester and store excess carbon (EarthJustice, n.d.). Increased rainfall can lead to soil erosion, which can increase agricultural runoff into the Watershed and affect crop yields. Extreme weather events will also damage farmlands and threaten the livelihoods of local farmers. In 2011, farmland repairs from Hurricane Irene amounted to $9.9 million (EarthJustice, n.d.).

The effects of climate change can lead to loss of biodiversity and habitat. An increase in temperature due to global warming causes higher decomposition rates in the water, which decreases dissolved oxygen concentration and threatens the health of aquatic life (Najjar et al. 2000). Areas that receive higher sewage runoff, such as the Hackensack River and the Lower Passaic River, are more prone to decreased dissolved oxygen levels (Whitehead et. al., 2009). Climatic shifts, increases in carbon dioxide levels, and extreme weather events may alter species' ranges (Pirani and Boicourt, 2018) and provide opportunities for invasive species to establish in the region (Hellman et al., 2008).

New Jersey's largest dairy farm destroyed by Hurricane Ida. Image: Farm Journal

While embracing innovative technologies to address climate change has its merits, the region can and should also leverage existing natural protections against the effects of climate change. For instance, tidal wetlands not only provide wildlife habitats, but also function as a sponge by absorbing and retaining flood waters and excess sediment during a storm. As a buffer, wetlands further protect against rising sea levels and the likely increasing frequency and intensity of storm surges due to climate change (Atmonavage and Petenko, 2018; NYDEC, 2020). The Watershed thus is a critical part of the region's strategy to mitigate the impacts of climate change.

Who Is Impacted?

The Watershed benefits all who live in and around it. It is home to 15 million people, provides habitat for 200 species of fish, and attracts $60 billion in annual revenue through tourism, commercial fishing, and recreational activities (Hudson River Estuary Action Agenda, 2021). Without protection and restoration, these communities and industries are in danger of collapse. Furthermore, social inequities will only continue to worsen if protection and restoration efforts are not enforced.

Newtown Creek Wastewater Treatment Plant.
Image: North Country Public Radio

Case Study: Wastewater Treatment Plants

New York City's 14 wastewater treatment plants (WWTPs) treat 1.3 billion gallons of wastewater every day (NYLCV, 2019). 11 of 14 waste treatment plants in New York City are located within predominantly minority communities. Noxious odors, subpar water quality, and degraded natural environments have impacted these residents for years, with little government action to address this environmental injustice (Politico, 2012).

Pollution along the Passaic River. Image: Dave Sanders

S.3484 emphasizes the prioritization of communities whose access to and enjoyment of fish, wildlife, clean water, and other natural resources has been impaired. These issues are rooted in a history of racial discrimination, residential segregation, and community disinvestment (NRDC, 2019). Many low-income and minority communities reside close to Superfund sites in the Watershed. These are sites such as manufacturing facilities, processing plants, landfills, and mining sites that have been contaminated by the dumping or improper management of hazardous waste and are now designated for cleanup by the EPA (US EPA, 2017c). Residents' proximity to hazardous waste sites leads to greater vulnerability to pollution exposure, health risks, and other consequences due to their reliance on the Watershed for fishing, recreation, and other needs (Office of Response and Restoration, n.d.).

Equitable public access to the waterways and shorelines of the Watershed region is a long-standing obstacle that has been exacerbated by the negative effects of climate change. Within the Watershed, more than 50% of the residents living in flood-hazard areas are considered low and middle-income individuals (Rebuild by Design, 2022). Due to urban planning, these communities have less access to waterfront recreation facilities (Sustainable South Bronx, 2008). In addition, residents in this region face higher rates of pollutant-

Case Study: TCDD and Agent Orange

Post-dredging sludge along the Passaic.
Image: Adam Anik

In New Jersey, the Toxin Tetrachlorodibenzodioxin (TCDD), a type of dioxin released from herbicide production (Ortiz, 2020) contaminated more than 10,000 acres of land near predominantly minority communities (NOAA, 2021). TCDD has been heavily investigated due to its presence as a contaminant in some batches of the herbicide Agent Orange, which was used as a defoliant during the Vietnam War. Studies are being conducted to determine the link between TCDD and cancers and diabetes (WHO, 2016).

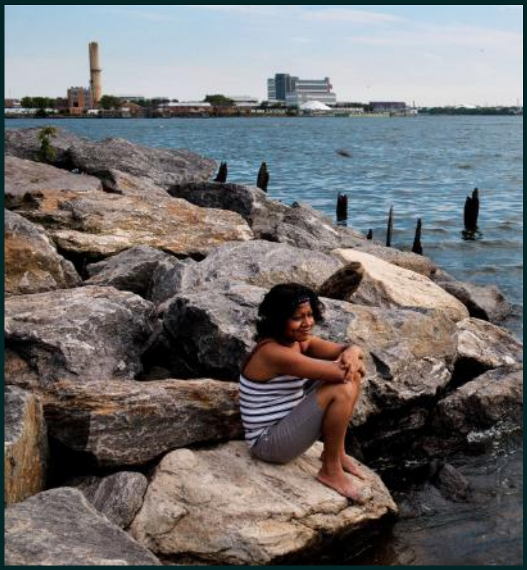
caused chronic diseases such as diabetes and hypertension (Ortiz, 2020). Despite effective local and state partnerships, the New York-New Jersey Watershed still suffers from a history of federal underinvestment (US House, Committee on Natural Resources, 2022). Such issues demonstrate the severe lack of equity and the urgent need for environmental justice.

Rationale Behind Federal Government Action

Since the Watershed falls under the jurisdiction of both New York and New Jersey, S.3484 calls upon the federal government to act as an overarching authority that coordinates restoration efforts and financially supports said activities. Currently, several Federal, State, Tribal, and nonprofit organizations have initiatives to revitalize and protect the Watershed. However, they mainly operate independently from one another. To optimize their impact and build greater capacity, government support is necessary to implement a comprehensive, Watershed-wide conservation strategy (US House, Committee on Natural Resources, 2022, p. 3). Given their traditionally close relationship with Tribal nations, it further stands to reason that the Department of the Interior would lead coordination efforts. Collaboration between the Department of the Interior and these entities will enhance efforts to safeguard and restore the Watershed. This endeavor will require significant investment beyond the capacity of any single organization. According to a report from the U.S. Army Corps of Engineers (2020, p. 3), the initial funding requirements of habitat restoration for the Hudson River alone is estimated to be $44.6 million. As such, S.3484 solicits the federal government to support capacity building and fund eligible projects that work toward the long-term restoration and protection of the New York-New Jersey Watershed.

Case Study: Waterfront Justice Project, New York City Environmental Justice Alliance

In 2010, under the leadership of then Mayor Michael Bloomberg, Significant Maritime Industrial Areas were designated as locations to concentrate heavy industry and other polluting infrastructure. The New York City Environmental Justice Alliance found that six out of the seven Areas were located in low-income communities of color such as the South Bronx, Sunset Park, and Brooklyn Navy Yard. Furthermore, these areas are in storm surge zones, placing these industries at higher risk of extreme weather events while also elevating the threat of pollution exposure (Aguirre, n.d.).



Hardened shoreline of the Bronx River.
Image: New York Times

PROPOSED SOLUTIONS

Water Quality | **Habitat Restoration** | **Climate Change** | **Environmental Justice**

Improving and Maintaining Water Quality

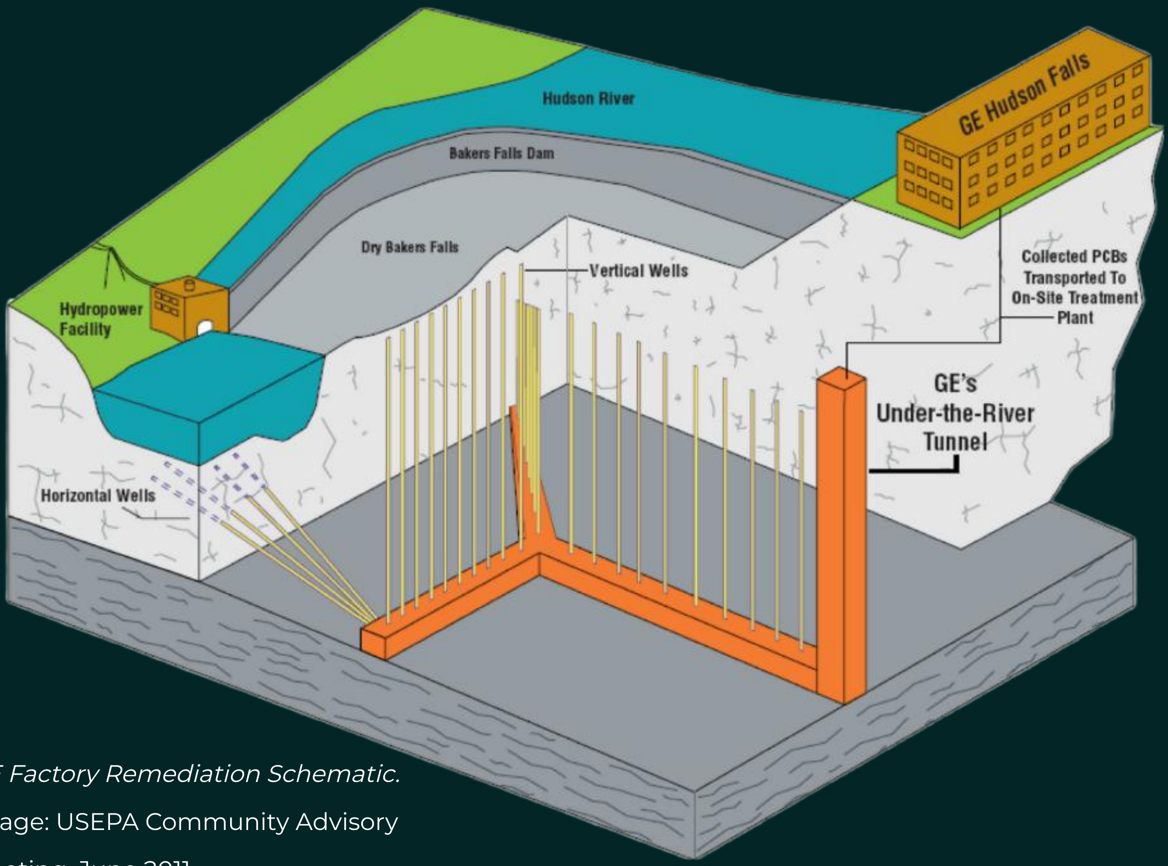
Preventing pollution at its source is the most effective way to protect water quality. Curbing pollution, particularly by limiting the use of hazardous chemicals at factories and farms, significantly reduces contaminant levels in water bodies. Regulatory permits, pollution fines, and best management practices may be implemented to manage this issue (Texas A&M University, 2014).

As pollution cannot be completely eliminated, filtering and treating wastewater before water discharges into water bodies is needed to reduce harmful effects. However, existing treatment systems are old and have not been effectively maintained for years. In order to minimize additional pollution caused by blockage, cracking, and infiltration, one method that is least harmful to the environment is to reseal and reline the pipes to improve flow capacity. Aging infrastructure can be repaired through "No-Dig" or trenchless technology (Borough of Keyport, n.d.). Pipes are resealed, fortified, or replaced without surface excavation, reducing the carbon footprint from manufacturing, transportation, installation, and pipeline materials by about 50% (Lu, Matthews, and Iseley, 2020). In 2018, infiltration issues were found in the pipelines of Nyack, New York. As a result of sewer upgrades such as sewer sliplining and pipe replacement projects, the number of sewage overflow events in Nyack reduced from 7-12 to 1-3 annually (Hellauer, 2018).

Pollution remediation involves the removal of pollutants from the water. The cleanup of contaminated sites can be achieved through strategies such as monitored natural recovery, capping the contaminated sediment with clean material, or dredging and excavating sediment from the bottom of waterbeds (Ortiz, 2020; US EPA, 2017b).

Case Study: Cleaning the Central Hudson Gas and Electric Manufacturing Plant

Before remediation of this Superfund Site in Newburgh, New York, coal tar contamination in the sediments posed a major concern. This issue originated long before nationwide pipeline networks introduced natural gas to the region, when coal was used to produce gas for heating, lighting, and cooking at manufacturing plants along the Hudson River. These plants started operating in the 1800s, and when they closed a century later, the legacy of coal tar leakage remained. Coal tar contains toxins that are harmful to human health (Scenic Hudson, n.d.). Remediation strategies for the site included soil removal, dredging, and capping with clean materials. The cleanup removed harmful compounds and 7,500 gallons of coal tar from the groundwater (The State of the Hudson, 2020). Despite agreement that the river's health is not optimal, the EPA decided in 2019 that GE had successfully completed its commitments (Poughkeepsie Journal, 2022).



GE Factory Remediation Schematic.
Image: USEPA Community Advisory Meeting, June 2011

Cover crops in the Hudson Valley, Image: Hudson Valley Farm Hub

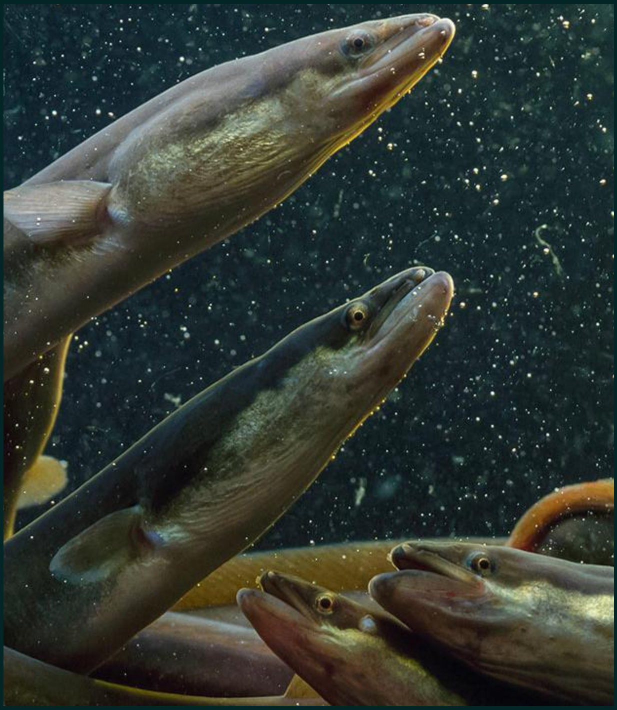
Habitat Restoration and Protection

Urbanization, agriculture, and other anthropogenic activities have led to the encroachment of human development and impervious structures on streams and other natural habitats. This causes increased flood vulnerability, habitat loss, and a decline in water quality. Rehabilitating habitats through improved agricultural practices, redesigned bridges and culverts, and nature-based solutions such as riparian buffer zones, oyster reefs, and living shorelines are solutions for restoring the Watershed.

Improving current agricultural practices is a vital solution to improve the health of the Watershed. For example, cover crops are plants such as legumes, cereals, broadleaf species, and grasses that are planted in fields between growing seasons as an alternative to leaving fields fallow after cash crops are harvested (Bertrand, Roberts and Walker, 2022). Studies show that cover crops enhance soil and water health, prevent soil erosion, improve water infiltration, and mitigate the effects of climate change through carbon sequestration. The Environmental and Energy Studies Institute estimates that 20 million acres of cover crops can sequester an amount of carbon equivalent to the emissions of 13 million vehicles every year (Bertrand, Roberts and Walker, 2022). In Walton, NY, with support from the Watershed Agricultural Council, winter rye grass seeds are planted in corn fields as cover crops after harvest season (NYSH News, 2019). Additionally, funding was granted to farms in Mohawk Valley and the Hudson region to support best management practices for preventing pollution

Case Study: Removing the Wappingers Creek Dam to Protect the American Eel

The Wappingers Creek Dam in New York was a barrier to the movement of the American eel and other resident cold-water fish (The State of the Hudson, 2020). It disrupted natural flow and sediment regimes, creating artificial habitats that favored non-native and invasive species. In 2016, the dam was removed, which reestablished connectivity to over five miles of upstream habitat while allowing the stream to return to a natural free-flowing condition. The American eel population in the Hudson River has significantly increased—as of 2020, more than 400,000 eels were caught at several sites along the Hudson Estuary, compared to 10,000 in 2009 (Mount and Hudson River Estuary Program, 2020).



American eels. Image: science.org

from entering waterways, such as implementing cover crops and vegetative buffers alongside streams (New York Governor's Press Office, 2021).

As water flows across fields, it often pools in natural depressions. This movement of water can cause soil erosion and carry chemical pollutants and natural debris (Rhea, 2022). The use of grassed waterways is an important solution to this problem, especially as climate change brings more rainfall to agricultural areas. These waterways are channels planted with vegetation to slow water flow and improve soil stability, thereby reducing erosion and runoff (National Resources Conservation Service New York, n.d.). Grassed waterways have been proposed in this Watershed as an effective, low-cost agricultural practice. They have the same purpose as solutions like riparian buffers: to reduce pollution from farms, restore streams, and strengthen climate change resiliency (National Resources Conservation Service New York, n.d., New Jersey Water Supply Authority/Watershed Protection Programs Division, n.d.).

Fish encounter issues in their habitats such as culverts that are often too tall for fish to jump, the water inside the culvert can be too shallow and fast for fish to traverse, and the upstream opening of the culvert may become blocked by debris (NOAA Fisheries, 2019). An alternative fish-friendly culvert design is an open-bottom culvert, which is a semi-circular or elliptical arch that does not disrupt the natural flow of a river, while also allowing easy entry for fish and other wildlife.

Additionally, fishways (upstream) and fish bypasses (downstream) provide water connection between each side of the dam to facilitate fish migration in areas where dams block the natural flow of water. A fishway is a ladder that fish utilize to complete their upstream migration, while a fish bypass is a channel for juvenile fish to traverse from upstream to downstream (Beckwith et. al., 2013). In 2015, a fishway was installed at the 182nd Street Dam on the Bronx River to provide a path for migratory fish such as the alewife herring and blue black herring to reach their freshwater spawning grounds upstream (Bronx River Alliance, 2014).

Fish ladder in the Bronx River. Image: Bronx River Alliance

Mitigating and Adapting to Climate Change

Green infrastructure is an essential management approach that provides ecological, economic, and community benefits. Green infrastructure refers to any vegetative infrastructure system that enhances the natural environment. Green infrastructure can be divided into two main categories: natural infrastructure such as wetlands, forests, parks, and gardens, and Low Impact Development (LID), which uses natural and engineered infiltration and storage techniques to control stormwater (Green Infrastructure Ontario, 2021). Under LID techniques, natural assets include rain gardens, green roofs, and urban trees, while engineered assets refer to solutions such as permeable pavement and rain barrels. Green infrastructure often requires lower operating and repair costs than traditional human-engineered gray infrastructure projects such as dams, water treatment plants, or seawalls (Ahern, 2012).

Green roofs are rooftops with a layer of natural vegetation that reduce air pollution, enhance stormwater management, and mitigate urban heat island effect. Green roofs make buildings more energy efficient by maintaining a stable surface temperature

Green roof on NYC Parks' Five Borough Administrative Building. Image: NYC Parks despite intense sunshine (Dowdey, 2007). Due to this natural insulation, green roofs diminish the need for cooling technologies such as air conditioning, and decrease associated air pollution (US EPA, 2014b).

Permeable pavement is composed of a porous material that allows rainwater and surface runoff to slowly percolate into the soil below. This reduces the volume of stormwater runoff, which prevents wastewater systems from becoming overwhelmed and decreases water pollution into the Watershed (NJDEP, 2021). Additionally, their porous design helps reduce pavement temperatures, as the trapped water can evaporate easily and absorb latent heat (Rutgers Today, 2019).

Stormwater basins prevent flooding and erosion by capturing stormwater runoff and slowly releasing it (Rutgers University, n.d.). In the natural environment, only 10% of precipitation runs off while 50% returns into the soil (CEAP Cropland Modeling Team, 2011). Retrofitting less effective stormwater basins will increase groundwater infiltration and decrease sediment loading into the Watershed.

Nature-based solutions leverage natural features and processes to address environmental challenges (NPS, 2019). A living shoreline is one example that utilizes natural materials such as plants, sand, or rock to form a stable and protected coastal edge (NOAA Fisheries, 2022b). The natural vegetation is combined with a harder shoreline structure, such as oyster reefs, rock sills, or anchored large wood, to augment shoreline durability (NOAA, n.d.).

Stormwater basin in Somerset. NY, Image: New Jersey Water Supply Authority / Watershed Protection Programs Divison

Case Study: Oysters for Coastline Protection

Oysters bring together the four priorities of the Bill in their role of improving water quality, restoring habitats, mitigating climate change, and promoting environmental justice. Oysters are natural filter feeders that trap nutrients and contaminants. One oyster can filter about 50 gallons of water in a single day (Chesapeake Bay Program, 2010). A successful example is the Billion Oyster Project, which is restoring oyster reefs in the New York-New Jersey Harbor. The project started in 2014, and as of today, more than 75 million live oysters have been restored and more than 8,000 NYC public school students have engaged with the project (Billion Oyster Project, n.d.).

In 2020, the New York Restoration Project installed a living shoreline at Swindler Cove in Northern Manhattan that featured Oyster Castles, marsh plants, and ribbed mussels (Bronx & Harlem River Watersheds Urban Waters Federal Partnership, 2021, p.14). Oyster Castles are concrete blocks placed along the shoreline to improve wave attenuation and breakdown. The concrete is formulated at a specific pH to be habitable for oyster larvae to grow on it and build the living reef. The ribbed mussels attach to the roots of the marsh vegetation and protect the roots while also assisting with the breaking of storm waves and the filtering of polluted runoff from land. Reef seeding also restores habitats for other wildlife (New York Restoration Project, 2020). In addition to restoring clean water and providing habitat, oyster reefs form complex three-dimensional structures that act as breakwaters, reducing the impact and height of waves. This prevents erosion of coastlines and mitigates flood damage that has worsened with climate change (McCann, 2019).

An oyster reef entering New York Harbor. Image: CNN

Shirley Chisholm State Park in Brooklyn. Image: Nathan Kensinger

Promoting Environmental Justice

S.3484 highlights limited access to the Watershed as a key environmental justice issue. As such, priorities of the Bill are capacity building through education, public engagement, and increased access to natural resources. People often lack the financial and organizational resources to address issues affecting their communities. Green spaces such as wetlands not only provide important ecosystem services, but also an avenue for education programs, community building, and recreation (Bronx River Alliance, 2014; NYDEC, 2022). Restored urban forests and grasslands such as Pelham Bay Park and Shirley Chisholm State Park increase public waterfront and green space access, improve environmental quality, provide environmental education on local ecosystems and wildlife, and support recreational activities such as fishing, biking, and hiking (NY Parks, Recreation and Historic Preservation, n.d.; NYC Parks, n.d.). At the same time, engaging communities in decision-making and solution implementation is crucial. For example, South Bronx Unite is a local nonprofit that brings together residents, community organizations, and academic institutions to improve and protect the social, environmental, and economic future of the neighborhood. South Bronx Unite is currently advocating for the Mott Haven-Port Morris Waterfront Plan, which aims to provide access for 100,000 people to a public waterfront that has been inaccessible for decades (South Bronx Unite, n.d.).

CHALLENGES AND CONTROVERSIES

Stormwater and Wastewater Management

Habitat Restoration and Protection

Green Infrastructure and Nature-based Solutions

Stormwater and Wastewater Management

Trenchless Technologies

Trenchless technologies are techniques that reseal, fortify, or replace pipes without digging into the ground. As opposed to the traditional open-cut methodology, trenchless technologies are advantageous because they reduce social costs such as disruptions to residents and business operations, and high carbon footprints (Lu, Matthews, and Iseley, 2020). However, depending on the length and depth of the pipe that needs an upgrade, trenchless technology may not be the most energy-efficient method (Malone et al., 2019). Another issue is that many trenchless technologies only insert new pipes into the old ones. While this stops sewer pipes from further leaking, the old pipes still rust and contaminate groundwater. The inserted new pipe's diameter is also smaller than the existing pipe, resulting in a lower capacity.

Dredging

Dredging is the act of physically removing contaminated soil from the bottom of water bodies. This process creates storm-like conditions under the water, stirring and spreading the contaminated sediment (Thibodeaux & Duckworth, 2001). Evidence from the Passaic River cleanup program indicates that dredging may not completely eliminate contaminants (Hurdle, 2016). In addition, sand caps, the technique applied by EPA to encourage revegetation in the past 10 years, can be inefficient, as they may be washed away by water flow (Hurdle, 2016). Dredging is also known to cause harm to habitats and wildlife (US EPA, 2017a).

Stormwater Basin Retrofits

Infiltration basins are structures with highly permeable components. They are effective at recharging groundwater, and hence are a useful design for maintaining groundwater quality and quantity (US EPA, 1999). However, infiltration basins are not suitable for areas with soil compaction or poor permeability. A large area of the Watershed is in an urban setting (72% impervious surfaces), which limits the viability of infiltration basins (Valderrama, 2017). Lastly, when an infiltration basin is clogged and takes more than three days to drain, it can become a breeding ground for mosquitoes, which are major carriers of water-borne disease (Caldwell et al., 2021). Thus, infiltration basins require regular maintenance. The EPA recommends a monthly inspection to ensure that the basin is stable, clear, and free from erosion (NPDES, 2021).

Habitat Restoration and Protection

Cover Crops

Cover crops are planted between periods of normal crop production to enhance soil health, increase water availability, and slow erosion. One major concern, however, is that cover crops overutilize water and reduce soil water availability to the primary crops. In addition, increased water infiltration, energy, and labor investments are required to plant cover crops, making farmers less motivated to implement the practice (Hoorman and Sundermeier, 2017). Pesticides or fertilizers that are used in the planting process are also a potential source of agricultural runoff, which will introduce more nitrogen and phosphorus or other contaminants into local waterways.

Grassed Waterways

Grassed waterways are beneficial for slowing water flow and improving soil stability.

Arthur Kill grassed waterway between New Jersey and Staten Island. Image: NewJersey.com

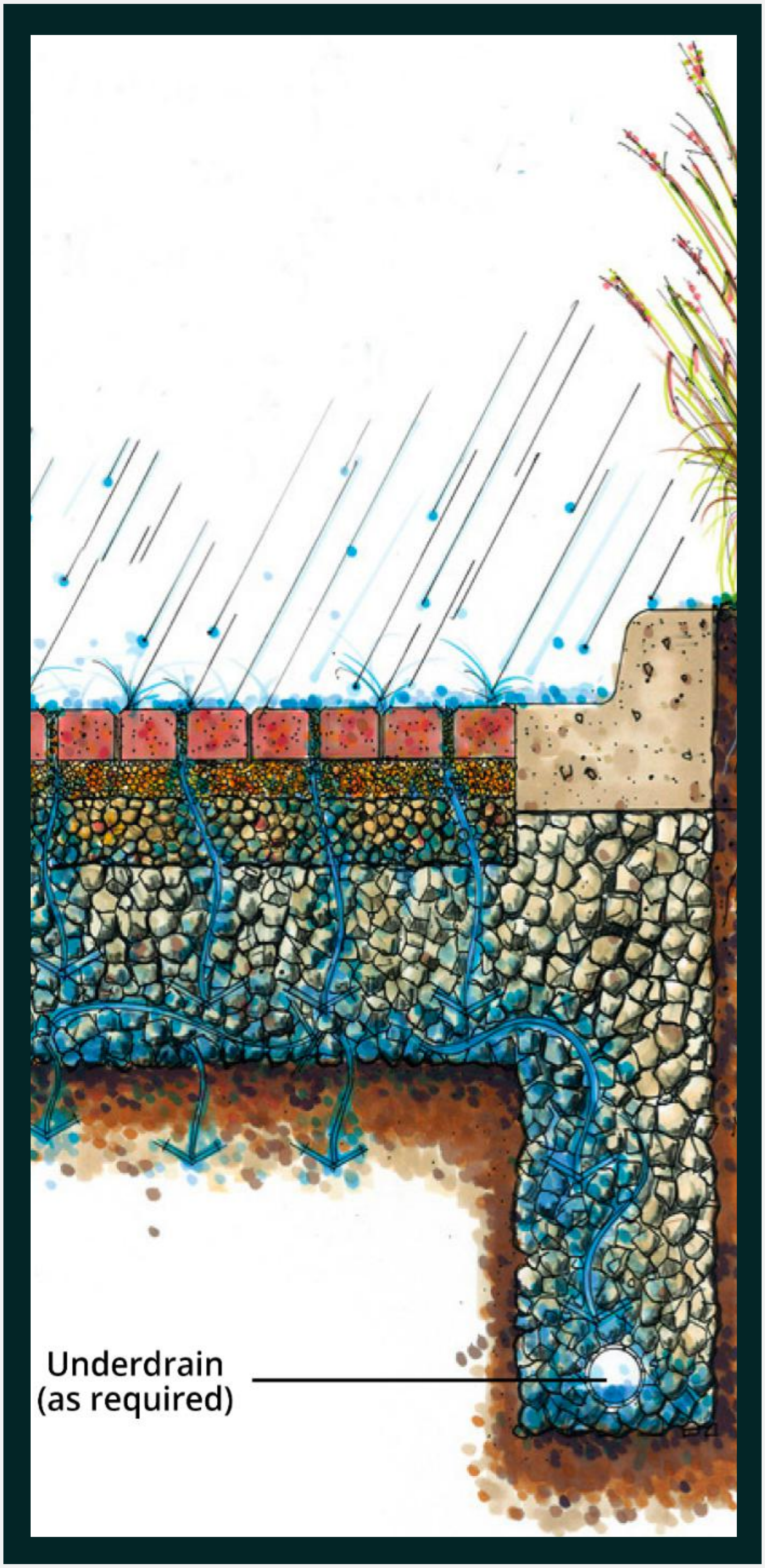


Diagram of permeable pavers. Image: Cypress Creek Project

However, the capacity of grassed waterways to reduce sediment transport and runoff depends on topography and runoff velocity (National Resources Conservation Service Iowa, n.d.). The ability of grassed waterways to reduce sediment transport is primarily based on sediment settling (the process by which particles settle to the bottom of water) due to reduced runoff velocity and infiltration of sediment-laden runoff (Fiener & Auerswald, 2003). Hence, grassed waterways are not suitable for places with higher stormwater release rates like New York City and Jersey City, as compared to areas such as upstate New York (NJDEP, 2014.; NYCDEP, n.d.; AQUALIS, 2022).

Green Infrastructure and Nature-based Solutions

Permeable Pavements

Permeable pavements, which are capable of rainwater absorption and mitigation of surface water runoff, have disadvantages from both physical and resource standpoints. Permeable pavements are susceptible to installation failure (Antunes et al. 2018). They may also expose groundwater to contaminants such as fuel leaks from vehicles and toxic chemicals from runoff (City of Virginia Beach, n.d.). Furthermore, there are limitations of scale at which these

Maintaining a green roof in New Jersey. Image: Sempergreen

permeable surfaces can be implemented. Currently, porous paving is only suitable for low-speed and low-volume areas such as parking lots and commercial areas (Weiss et al., 2019). Thus, applicability in many urban areas of the Watershed is limited.

Green Roofs

Green roofs are designed to absorb precipitation and to ease city sewer system pressure. The slope of the roof and load-bearing capacity are two limitations to green roof implementation. Water outflow and uneven drainage can occur with a steep roof (GSA, 2011). The weight of the rooftop will also increase over time with the increase of vegetation growth. According to New York's construction guidance on roof loads, conventional roofs are designed to bear 20 pounds per square foot (NYC Gov, 2008). Therefore, engineers need to consider rooftop weight capacity as well as incorporate waterproof mechanisms and heavyweight supporting structures for saturated rooftops. Detailed assessment and pre-construction work for rooftop upgrades are needed to prevent leaking and weight overload.

Oyster Reefs and Living Shorelines

Wetland habitat restoration helps with flood vulnerability, pollutant removal and filtration, and latent water release to groundwater and streams. Oyster reefs can effectively reduce the impact and height of waves, prevent erosion of the coastline, and mitigate flood risk. However, ocean acidification makes it difficult for shellfish to produce their shells, which means that oyster reefs may become less effective as ocean pH continues to decrease as a result of climate change (Olick, 2019). Restoring oysters to New York-New Jersey Harbor is challenging in particular due to suboptimal environmental conditions and economic limitations. Oysters can live in the intertidal zone in estuaries that have a warmer climate, but in the New York-New Jersey Harbor, oysters are mainly limited to subtidal environments. As a high-energy environment, the Harbor is subject to strong currents, both naturally and from boat traffic. Restored oysters must be secured in place with cages or other structures, which is logistically difficult and costly (McCann, 2019). Furthermore, contaminated water bodies can make the oysters more stressed and susceptible to disease (The State of the Hudson, 2020).

Living shorelines, such as wetlands and coastal habitats, are more resilient against erosion and severe storms. However, they are often more difficult to design and install compared to conventional hardened structures (SERC, 2016). In addition, shoreline hardening can accelerate erosion and loss of wetlands and beaches (Gittman et al., 2015).

Salt marsh in NJ near urban development. Image: NewJersey.com

MEASURING SUCCESS

Gathering water quality samples in a tributary of the Ashokan reservoir. Image: Piotr Redlinski

Performance measurement is crucial to evaluating the success of the New York-New Jersey Watershed Restoration Program. In order to conduct measurements, it is essential to first define what constitutes success, and then relate data collected to specific goals and outcomes.

The data collected should quantify the inputs, processes, outputs, and outcomes of a program. Inputs are the resources needed to carry out restoration work, and can include labor, materials, equipment, and facilities, as well as political and financial support. Processes refer to the sequence of tasks involved in transforming program inputs into outputs. Outputs are the results of the resources put into the process. Finally, outcomes are the consequences or results produced from the outputs. For the New York-New Jersey Watershed Protection Act, the inputs of creating a Watershed Restoration Program seek to realize outcomes such as clean water, restored habitats and wildlife populations, greater environmental justice, and resilience of the Watershed to climate change. By quantifying the inputs, processes, and outputs of each activity in the Restoration Program, we may better measure and understand whether intended outcomes of each activity were achieved.

Performance Measurement

INPUT	PROCESS	OUTPUT	OUTCOME
Implementation of agricultural best management practices	• Cover crops • Grassed waterways • Stream fencing • Terrace farming	Water with decreased levels of: • Nitrogen • Chlorophyll-*a*	Improved water quality
Implementation of stormwater and wastewater best management practices	• Enhancement and repair of existing gray infrastructure • Stormwater basin retrofits	Reduction of CSO events Water with decreased levels of: • Nitrogen • Chlorophyll-*a* • Pathogenic bacteria (*Enterococcus*) • Floatable debris • Contaminants of emerging concern (e.g. microplastics, pesticides)	
Green infrastructure / urban Low Impact Development (LID)	• Permeable pavements • Rain gardens • Green roofs		
Wildlife habitat restoration	• Wetland • Forests • Meadows • Parks		
Wildlife habitat recovery	• Oyster reef restoration		
Removal of stream barriers	• Dam removal • Culvert redesign	Improvements in: • Migratory species populations • Hydrological flows • Water quality	Habitat restoration
Green infrastructure / nature-based solutions	• Wetland restoration • Oyster reefs restoration • Riparian buffers	Improvements in: • Habitat coverage • Number of native species • Reduction of invasive species • Hydrological flows • Water quality	

INPUT	PROCESS	OUTPUT	OUTCOME
Green infrastructure / LID	• Parks • Urban wetlands • Rain gardens • Trees	Reductions in: • Stormwater flow • Flooding • Urban heat island effect Improvement in air quality	Climate change mitigation
Increased access to the Watershed for low-income communities	• Identify areas where access and improvements in waterfront facilities is needed • Build access points • Improve waterfront facilities	Improvements in: • Access to waterfront recreation • Proximity to waterways • Size and quality of waterfront facilities	Environmental justice

Measurable performance indicators are necessary to achieve the goals established in S.3484: improve water quality, restore habitats, mitigate climate change, and promote environmental justice. Identifying valid and reliable performance indicators of the desired outputs and outcomes enables data-informed decision making. Metrics such as the monitoring of water quality, nutrient levels, and fish health and populations provide important insight into the progress made on solving these problems and the efficacy of the solutions. Additionally, remediation efforts and preventive measures to maintain current conditions are just as important as implementing innovative approaches for restoring the Watershed. Specific and feasible performance indicators help assess resources needed, monitor success, and modify the program as needed to inform decision makers and improve management strategies well into the future.

Signs pointing toward major contamination sites at the Gowanus Canal (Brooklyn), Image: Kate Zabinsky

CONCLUSION

S.3484, The New York-New Jersey Watershed Protection Act, aims to protect and restore the region by providing federal funding to remediate the region and advance coordination between government and local entities. While an annual provision of $50 million is a significant commitment, the rehabilitation of the Watershed is a massive long-term undertaking that will require continual support and investment.

Proposed solutions include enhanced stormwater and wastewater management, contaminant cleanup, green infrastructure, and improved agricultural practices. These efforts work toward restoring habitats and improving water quality.

Under S.3484, federal funding would be allotted toward restoration and protection initiatives to preserve the region's cultural, ecological, and economic value. These projects will enhance ecosystem health, promote climate change resilience, and increase sustainable commercial and recreational access to the New York-New Jersey Watershed.

New York City seen from the New Jersey Meadowlands. Image: Princeton University

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S.3484 The New York-New Jersey Watershed Protection Act of 2022

Summer Workshop MPA-ESP Program