2011
NEW YORK HARBOR WATER QUALITY REPORT

NYC Environmental Protection

Michael R. Bloomberg, Mayor
Carter H. Strickland, Jr., Commissioner

Environmental Protection

Dear Friends,

The New York City Department of Environmental Protection (DEP) is proud to release the 2011 Harbor Water Quality Report. Since 1909, DEP has routinely collected samples from dozens of harbor water sampling stations throughout the year that measure four basic parameters: fecal coliform, dissolved oxygen, chlorophyll 'a', and secchi transparency. Taken together, these four metrics give a clear indication that the overall health of the city's surrounding waterways continues to improve to levels not witnessed in more than a century.

Under Mayor Bloomberg's leadership, the city has invested more than $10 billion to improve the quality of our harbor waters. Depite a four-alarm fire at the North River Wastewater Treatment Plant in July 2011, Hurricane Irene in August 2011, and the wettest summer on record, harbor water quality continued to improve in 2011.

Keeping our harbor waters as pristine as possible is not just a matter of aesthetics; it directly impacts New Yorkers' quality of life, and is a key factor in the continued growth and prosperity of the City. A clean, healthy harbor is a place where people want to work, play, and raise a family. A waterfront that is safe and inviting will attract the new investments that have been made possible by Mayor Bloomberg's visionary re-zonings of large parts of the city, including Greenpoint/Williamsburg in Brooklyn and Hunters Point South in Queens. That's why we will continue to make the investments necessary to sustain and extend this progress, and why improving the quality of New York Harbor is a major component of *Strategy 2011-2014*, our far-reaching strategic plan to make DEP the safest, most effective, cost-efficient, and transparent water utility in the nation.

I hope you will take the time to learn more about what we do by visiting www.nyc.gov/dep.

All the best,

Carter H. Strickland, Jr.

Carter H. Strickland, Jr.
Commissioner

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Introduction

The New York City Harbor Survey has been reporting on the condition of the City's waterways since 1909. The survey was initiated by the Metropolitan Sewerage Commission in response to public outcry about fouled waterways, at a time when most of the sewage generated in the city was released without any treatment. Since then, the survey has grown, both in the number of sites monitored (from 20 in 1909 to 71 in 2011) and the types of parameters that are monitored. In 2011, DEP began posting water quality sampling data on our website.

DEP collects harbor samples at stations weekly from June through September, and every other week from October through May. In addition, the New York City Department of Health and Mental Hygiene conducts water quality monitoring at all New York City beaches on a daily basis during the summer.

The information presented in the Harbor Water Survey is used by municipal planners, regulatory agencies, academic institutions, and local citizens to develop sound public policies. Over the past decade, the City has invested more than $10 billion in wastewater treatment and control, and harbor water quality is on average the highest it has been since the monitoring program began.

To further improve and protect New York City's waterways, DEP has invested in sustainable practices to address flooding, conducted programs to remove floatables and debris from the waterways, and organized beach clean-up and protection programs. These include the Floatable Action and Boom and Skim programs, Shoreline Survey/Sentinel Monitoring, and Enhanced Beach Protection.

This annual New York Harbor Water Quality Report provides data collected by the New York City Department of Environmental Protection (DEP) during 2011. It is presented in four sections, each delineating a geographic region within the harbor. Four water quality parameters, used as key indicators, are evaluated: fecal coliform bacteria, chlorophyll 'a,' dissolved oxygen, and Secchi transparency. A discussion of enterococci bacteria, which the US Environmental Protection Agency is now using as a water quality indicator, is also included in this year's report.

Harbor-Wide Improvements

According to Central Park precipitation records, 2011 was the wettest year (72.81") in Central Park with a record rainfall of 25.3" between June and August; and August was the wettest calendar month ever with 18.95" of rain. The excessive precipitation during the summer caused short-term spikes in fecal coliform levels, which is typical after heavy rains cause the wastewater system to discharge combined sewer overflow (CSO). Fecal Coliform counts were elevated throughout the New York harbor area after record rainfalls on August 14 (5.81") and after Hurricane Irene on August 27-28 (6.87"). The regional average fecal coliform count was 181 cells/100mL in 2011, compared to 31 cells/100mL in 2010.

To meet the sampling schedule for Long Term Control Plans, DEP added six tributary stations the Harbor Survey to bring the total number of sampling stations to 71 in 2011.

In 2011, average summer surface temperature reached 22.94 °C, the second highest average since 1968. The record was set in 1991 when the average temperature reached 22.96 °C.

In comparison to 2010, the summer geometric means increased to 96 cells/100mL for fecal coliform and 5 cells/100mL for Enterococci. However, both remained well below the New York State Department of Environmental Conservation (DEC) standards for bathing and recreational use.

In summer 2011, harbor-wide average dissolved oxygen for both surface and bottom waters remained high: 6.6 mg/L and 5.8 mg/L, respectively.

Harbor-wide, chlorophyll 'a' averaged 11 µg/L in surface water in the summer of 2011, a decrease from 15 µg/L in 2010. The most significant chlorophyll 'a' reductions can be found in Jamaica Bay as a result of upgrades to wastewater treatment plants.

Secchi transparency continued to decline in 2011. Total Suspended Solids (TSS) have increased slightly, from an average of 8 mg/L in surface waters and 11 mg/L in bottom waters in 2010 to 12 mg/L and 19 mg/L in 2011, respectively. Average Secchi depth decreased from 4.0 ft in 2010 to 3.7 ft in 2011. An increased in wet sampling days were the primary cause of increased turbidity in New York Harbor. In the summer of 2011 there were 16 wet weather sampling days, compared to 10 in 2010. Another contributing factor was the massive inflow of sediments from upriver sources throughout the Hudson and Mohawk Valleys.

Harbor-Wide Fecal Coliform and Enterococci

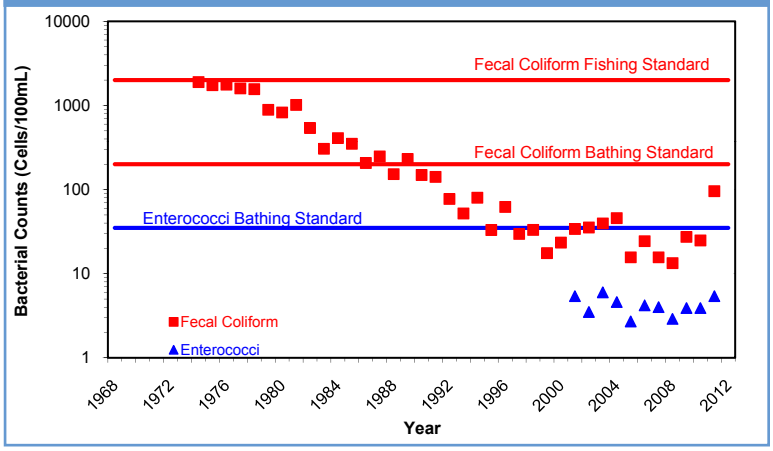


Figure 1

Harbor-Wide Dissolved Oxygen

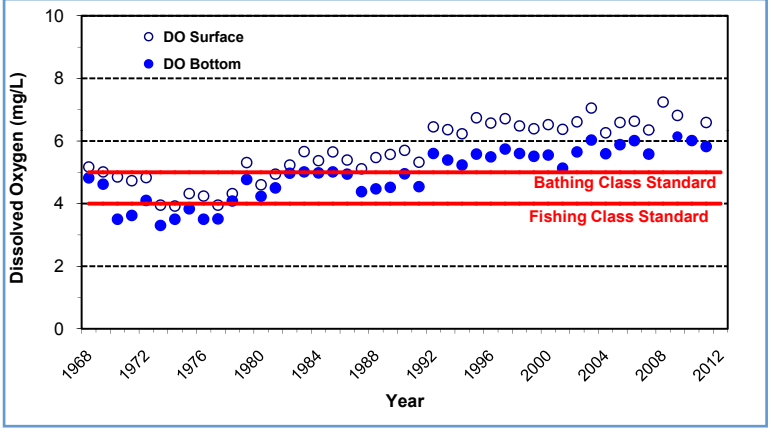


Figure 2

Harbor-Wide Chlorphyll 'a' and Secchi Depth

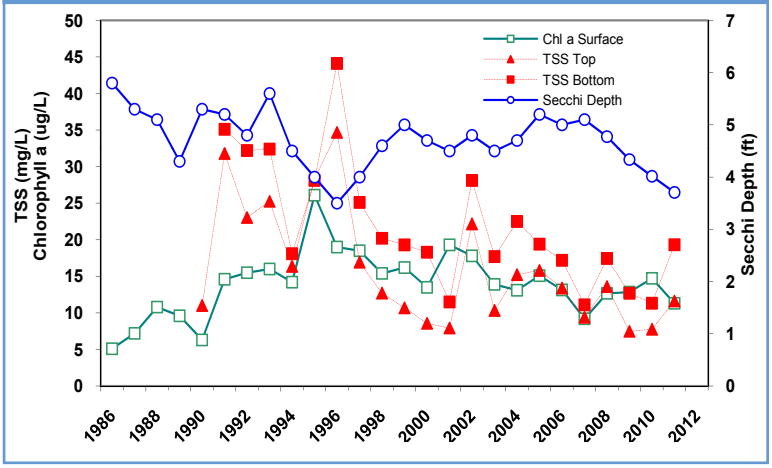


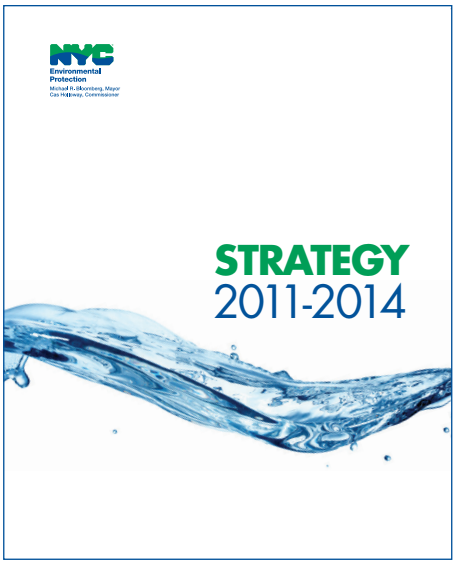
Figure 3

The NYC Green Infrastructure Plan

New York Harbor is the cleanest it has been in more than 100 years of testing. In September 2010, Mayor Bloomberg unveiled the *NYC Green Infrastructure Plan*, which will improve harbor water quality even further by capturing and retaining stormwater runoff before it enters the sewer system. New York City, like other older urban centers, is largely serviced by a combined sewer system where stormwater and wastewater are carried through a single pipe. During heavy storms, the system often reaches capacity and must discharge a mix of stormwater and wastewater—called a combined sewer overflow, or CSO—into New York Harbor. The plan, which includes $2.4 billion in public and private spending for green infrastructure, will reduce these sewer overflows by 40% by 2030. This approach will also save billions over the next 20 years because it will reduce more costly investments in traditional sewage retention projects, like tanks and tunnels. Green infrastructure uses vegetation, soils, and other structural elements to absorb and evaporate water and to mimic natural areas and hydrologic cycles. These types of projects are a key component of *PlaNYC*'s sustainability effort because they also shade and cool the city, improve air quality, and increase property values. These characteristics, the minimal energy and manpower required for operation, and the relatively quick installation mean that green infrastructure can be cost-effective and provide immediate benefits.

Strategy 2011-2014

In February 2011, Mayor Michael R. Bloomberg and then Environmental Protection Commissioner Cas Holloway unveiled *Strategy 2011-2014*, a far-reaching strategic plan that lays out 100 distinct initiatives to make DEP the safest, most efficient, cost-effective, and transparent water utility in the nation. Each initiative directly advances one of DEP's core functions: serving nine million water customers; supplying and treating more than one billion gallons of water every day; making cost-effective infrastructure investments; and achieving a sustainable quality of life for all New Yorkers. The plan, the product of a year of analysis and outreach, builds on *PlaNYC*, Mayor Bloomberg's sustainability blueprint for New York City. From improving harbor water quality to harnessing clean renewable energy, *Strategy 2011-2014* includes bold and achievable initiatives that will improve New Yorkers' quality of life—at a price they can afford. The plan will guide DEP's investments and operations over the next four years, and DEP will publish an annual report card on the progress of each initiative. For more information or to download the Strategy, visit www.nyc.gov/dep.



"Building on the successes of the past eight years, DEP has developed this exciting strategic plan that lays out the next generation of improvements to our water system, as well as ambitious strategies such as a *Green Infrastructure Plan* to reduce combined sewer overflows that will transform the City and improve water quality."

— Mayor Michael R. Bloomberg

Four Major Indicators of Environmental Change

Fecal Coliform - Fecal coliform concentrations are measured in New York Harbor as human health-related indicators of wastewater-related pollution. Fecal coliform are a group of bacteria primarily found in human and animal intestines and are associated with wastewater. These bacteria are widely used as indicator organisms to show the presence of such wastes in water and the possible presence of pathogenic (disease-producing) bacteria.

Dissolved Oxygen - The levels of oxygen dissolved in the water column are critical for the respiration of most aquatic life forms, including fish and invertebrates such as crabs, clams, zooplankton, etc. Dissolved oxygen concentration is, therefore, one of the most universal indicators of overall water quality and a means of determining habitat and ecosystem conditions.

Chlorophyll 'a' - Chlorophyll 'a' is a green pigment found in most macro-algae and phytoplankton. It is vital for photosynthesis, which allows plants to obtain energy from light. Chlorophyll 'a' found in phytoplankton can be used as an indicator of primary productivity, which is the necessary base of the food chain in the water. These organisms respond quickly to environmental changes, and their abundance may serve as a measure of water and ecosystem quality. Overgrowth of primary producers can cause eutrophication. High concentrations of nutrients in water that promote algae growth, Chlorophyll 'a' levels above 20 µg/L are considered indicative of eutrophic conditions.

Eutrophication is a common phenomenon in marine coastal waters. In contrast to freshwater systems, nitrogen is more commonly the key limiting nutrient of marine waters; thus, nitrogen levels are important to understanding eutrophication problems in salt water.

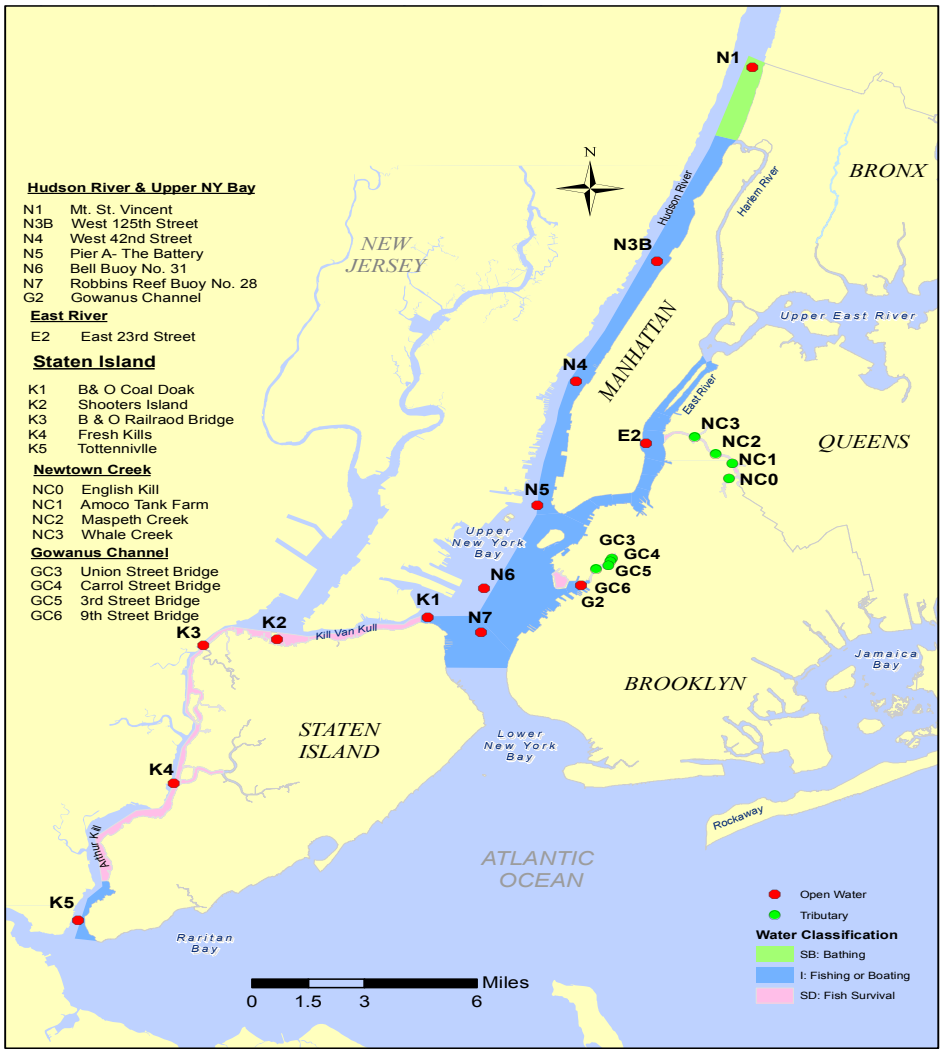
Secchi Transparency - A Secchi disk is used to estimate the clarity of surface waters. High Secchi transparency (greater than 5.0 feet) is indicative of clear water, with declines in transparency typically due to high suspended solids concentrations or plankton blooms. Low Secchi readings (less than 3.0 feet) are typically associated with degraded waters. These conditions are indicative of light-limiting conditions, which in turn affect primary productivity and nutrient cycling.

Coliform and dissolved oxygen indicators are used in DEC standards to quantify ecosystem health or degradation, and reflect a range of acceptable water quality conditions corresponding to the State-designated "best usage" of the water body. Common uses and DEC standards for fecal coliform and dissolved oxygen are noted in the following chart.

Common Water Use and Standards for Fresh and Saline Waters

Class	Best Usage of Water	Fecal Coliform Concentration	Dissolved Oxygen Level (Never-less-than)	Enterococcus
SA	Shellfishing and all other recreational use	No standard	5.0 mg/L	No standard
SB	Bathing and other recreational use	Monthly geometric mean less than or equal to 200 cells/100mL from 5 or more samples	5.0 mg/l	(Monthly geometric mean) <35 cells/100mL (Single sample) Max 10+ cells/100mL
I	Fishing or boating	Monthly geometric mean less than or equal to 2,000 cells/100mL from 5 or more samples	4.0 mg/L	No standard
SD	Fish survival	No standard	3.0 mg/L	No standard

The Inner Harbor



The Inner Harbor is defined as the area including the Hudson River from the New York City-Westchester line through the Battery to the Verrazano Narrows; the Lower East River to the Battery; and the Kill Van Kull–Arthur Kill system. This area contains 13 Harbor Survey monitoring stations that have been grouped together because of common water uses and functions. Waters of the Inner Harbor are often continuous through connecting branches or straits and cover a large and diverse geographic expanse.

Most of the Inner Harbor Area, excluding the Kills, is classified by DEC for uses such as fishing or boating. Most of the area in the Kills is classified for fish survival only, with the exception of the far southern reach of Arthur Kill, which is designated for fishing and boating. The Hudson River, from North of Spuyten Duyvil to Westchester County, is designated for bathing.

FECAL COLIFORM

Fecal coliform summer monthly geometric means for the 13 stations in the Inner Harbor complied with DEC standards. Geometric mean concentrations were, however, higher than the past few years due to the significant precipitation during 2011. Water quality as estimated by Enterococcus concentration, which EPA determined to be a better indicator than fecal coliform concentration, fared better during 2011. All monitoring stations had averages less than 15 cells/100mL, which complied with the bathing standard of 35 cells/100mL; only two out of 21 samples at Mt. St. Vincent (N1) and Hudson River had single Enterococci readings exceeding the bathing standard at 104 cells/100mL, the maximum single sample requirement for the areas. Both of these samples followed severe rain events.

Trends

Fecal coliform levels in the Inner Harbor have dramatically declined on average over the last three decades, with levels since 1997 well below the bathing standard. Average fecal coliform counts have declined from more than 2,000 cells/100mL in the early 1970s to less than 100 cells/100mL since the early 1990s. This improvement has allowed the City to open the Inner Harbor waters to most recreational activities. The progress is attributed to the cessation of raw sewage dumping through the full build-out of New York City's Wastewater Treatment Plants (WWTPs), the elimination of illegal discharges, and a reduction of CSOs through increased capture and treatment. In 2011, extremely heavy rainfall resulted in an increase in combined sewage overflows, particularly during the summer, leading to an increase in fecal coliform counts within the Inner Harbor areas.

Fecal Coliform and Enterococci Summer Geometric Mean

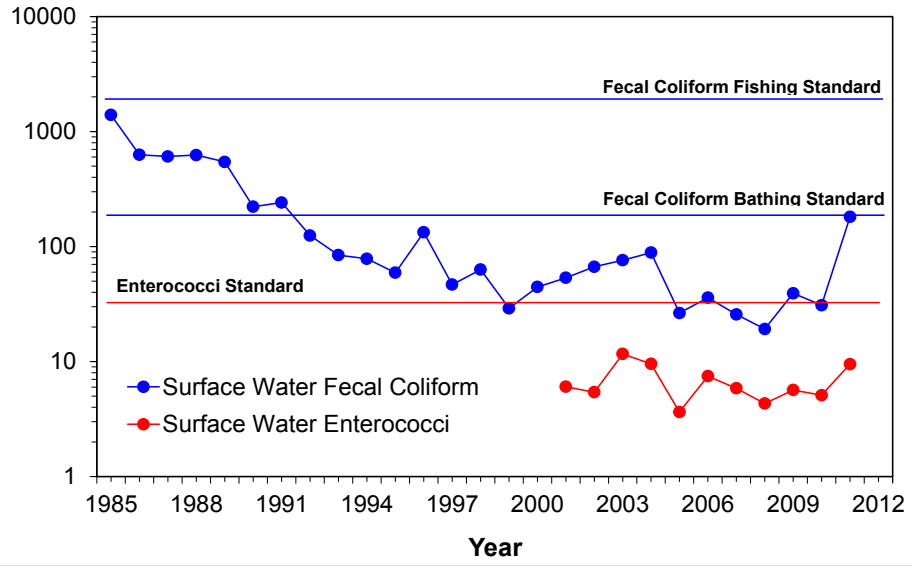


Figure 4

DEP has monitored Enterococcus levels in the Inner Harbor have been monitored since 2001. The averages for the past eleven years have varied between 4 to 12 cells/100mL which is well below the Bathing Standard of 35 cells/100mL.

DISSOLVED OXYGEN

At the Inner Harbor's 13 open water sampling stations DEP took a total of 235 dissolved oxygen (DO) samples from surface waters and 209 samples from bottom waters in the area during the summer (June—September); DO levels ranged from 3.40-11.50 mg/L and 3.01–9.51 mg/L, respectively.

In 2011, 232 (99%) surface samples and 198 (95%) bottom samples had DO levels greater than 4.0 mg/L, and 212 (90%) surface samples and 161 (77%) bottom samples had DO levels DOs greater than 5.0 mg/L. Most DO levels between 3.0-4.0 mg/L and half of the DO levels between 4.0-5.0 mg/L were found in August. All monthly averages complied with applicable DEC standards, except 3.85 mg/L at Tottenville (K5) and 4.82 mg/L at Mt. St. Vincent (N1) in August.

Trends

Average summer surface DO values in the Inner Harbor have risen to levels above DEC standards for bathing and other recreational use (5.0 mg/L) since 1989. The 2011 summer average DO levels for both surface (6.66 mg/L) and bottom (5.67 mg/L) waters remained near the past 10 years' averages of 6.5 mg/L and 5.8 mg/L, respectively.

Dissolved Oxygen Summer Average

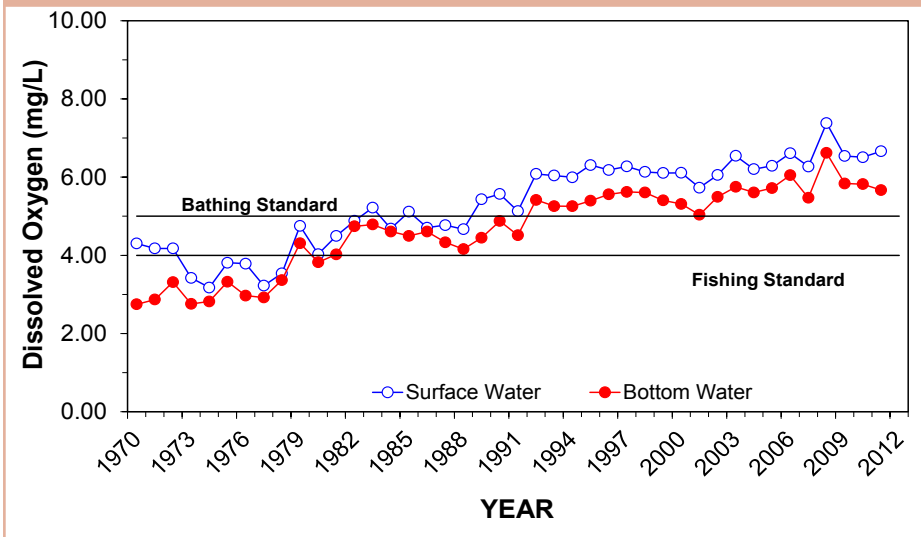


Figure 5

CHLOROPHYLL ‘a’

The average chlorophyll ‘a’ concentration in the Inner Harbor was 6.0 µg/L in the summer of 2011. The stations in the Staten Island Kills, East River, and Hudson River all had average concentration under 8 µg/L, with the exception of K5, which had an average concentration of 14.1 µg/L.

The Newtown Creek stations (NC0-NC3), which are not included in the regional data, averaged between 28.2 µg/L at the mouth of the creek and 37.7 µg/L near the head. This is typical of the creek and is likely a result of nutrient-enriched waters from runoff and minimal tidal flushing.

The average chlorophyll ‘a’ concentration at the Gowanus Canal station (G2) decreased from last year (22.9 µg/L) with an average of 12.2 µg/L this summer. Some individual samples were as high as 48.9 µg/L indicating possible eutrophic conditions in early summer. A Gowanus tributary station (GC6) adjacent to G2 had an average of 59.5 µg/L.

Trends

Over the past 10 years, the average summer chlorophyll ‘a’ concentration has been consistent and under 8.4 µg/L, except 2010 with a 12 µg/L average (see figure 6).

Massive water flow into the region from the Hudson River has been thought to be the stabilizing factor, keeping chlorophyll ‘a’ averages steady over the years.

Chlorophyll ‘a’ and Total Suspended Solids Summer Average

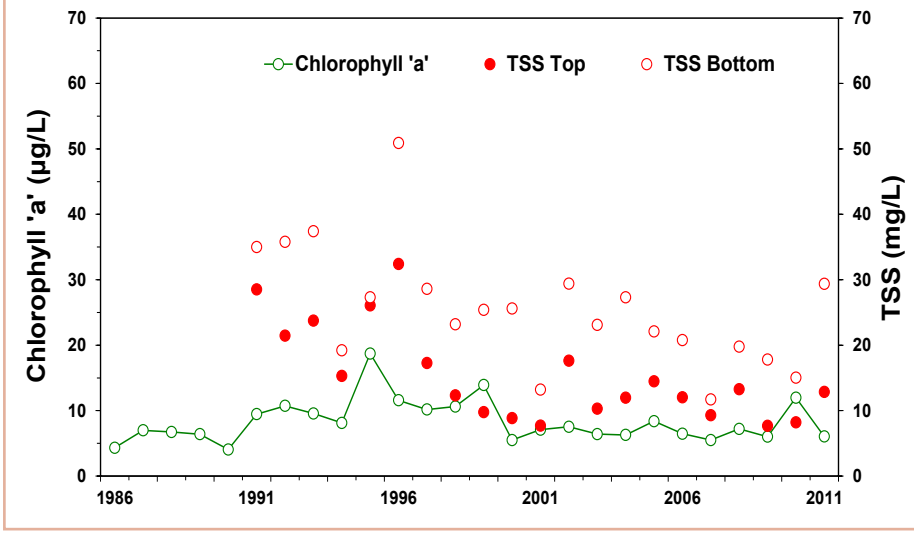


Figure 6

SECCHI TRANSPARENCY

The Inner Harbor region encompasses many distinct sub-regions: an estuary, a fresh water river, the East River, and a narrow marine channel separating New Jersey and Staten Island that is fed into by several smaller rivers and tributaries. It is beneficial to consider these sub-regions separately.

In summer 2011, the average Secchi reading was 3.1 ft in the entire Inner Harbor area. Stations in the Staten Island Kills and East River all averaged greater than 3.4 ft Secchi depth, while the Hudson River stations were all less than 3.6 ft, with lower values typical as one travels north up the river. The Hudson-Estuary area can be very turbid from freshwater influx, and Secchi depths of 1.5 ft are quite common. Newtown Creek also has low averages (all stations less than 2.7 ft). A contributing factor seems to be the high algal content and non-point source runoff in these waters.

Trends

Average summer Secchi values have remained relatively constant (>4.0 ft) in the Inner Harbor area since measurements began in 1986. However, four years marked Secchi depth averages of less than 4 ft: 1996, 1997, 2010, and 2011.

Generally there is little variation in this region over the years (see figure). This can most likely be attributed to the normal flow from the Hudson River.

Secchi Depth and Total Suspended Solids Summer Average

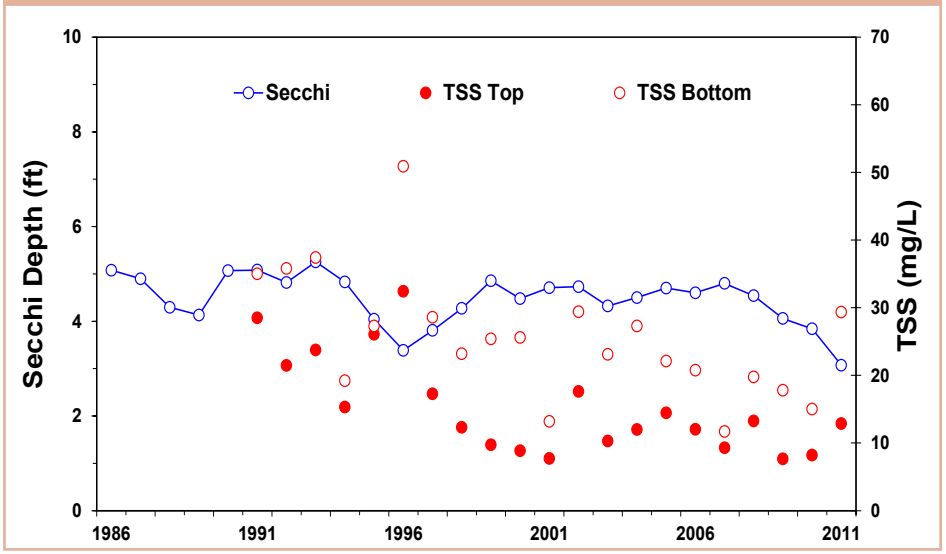
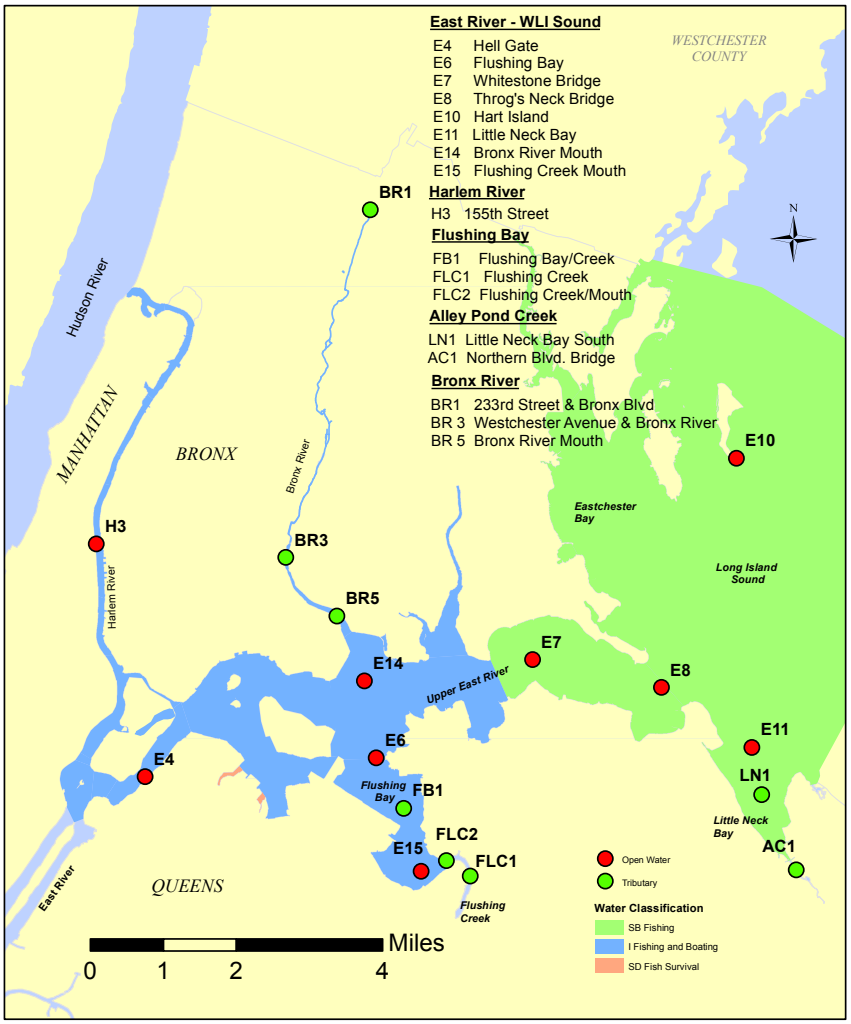


Figure 7

The Upper East River–Western Long Island Sound

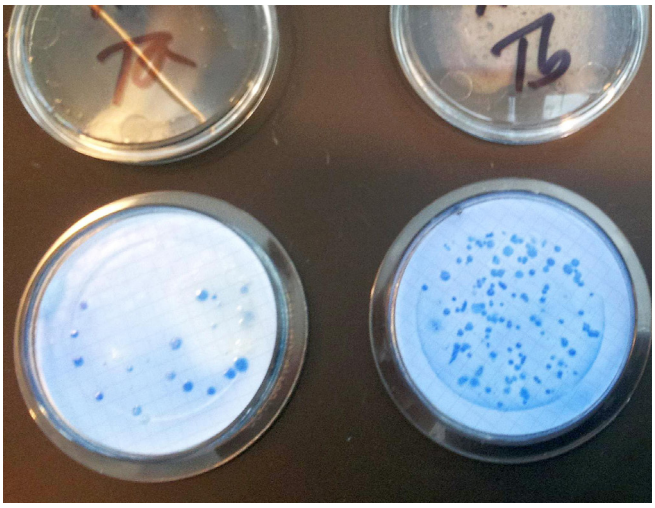


The Upper East River–Western Long Island Sound represents the northeastern portion of New York Harbor, from Hell Gate in the East River up into the Western Long Island Sound. The Harbor Survey Program provides coverage of this area, including the Harlem River and the East River, from Roosevelt Island to Hart Island at the New York City–Westchester County boundary. This area contains nine Harbor Survey monitoring stations. Waters of this vicinity, though divergent in salinity and depth, share similarities in pollutant loadings and are targeted for intensive management efforts as part of the Long Island Sound National Estuary Program.

The majority of the Upper East River–Western Long Island Sound is classified as for uses such as fishing or boating, with the area east of the Bronx-Whitestone Bridge designated for bathing.

FECAL COLIFORM

In the summer of 2011, fecal coliform counts at all nine stations were in compliance with their specified “best use” classifications for bathing (less than 200 cells/100mL) and fishing and boating (less than 2,000 cells/100mL) in Upper East River-Western Long Island Sound. New York City experienced an abnormally wet year in 2011; it was both the wettest summer and the wettest August on record. The fecal coliform summer geometric mean was 103 cells/100mL, an increase from 43 cells/100 mL in 2010. Eight out of nine stations had averages below 200 cells/100 mL, the monthly average fecal coliform levels necessary for bathing and other recreational uses; the Flushing Creek (E15) monitoring site did not meet these standards.



Enterococcus in Upper East River-Western Long Island Sound had a summer geometric mean of 8 cells/100 mL. Each site average was 33% higher than in 2010, yet all met their required classification. On August 15, after a record high rainfall the previous day, Enterococcus exceeded the standard 104 cells/100 mL throughout the region.

Trends

Fecal coliform levels have generally declined, and the region's summer geometric means have stayed below 200 cells/100 mL, the DEC standard for bathing and other recreational use. In 2011, record high rain was one of the main reason fecal coliform levels increased to an average of 103 cells/100 mL from 43 cells/100 mL in 2010. The ongoing upgrades of wastewater treatment facilities and capture of combined sewer overflows have reduced fecal coliform levels, kept water quality in compliance with the standards, and will continue to improve water quality.

Fecal Coliform and Enterococci Summer Geometric Mean

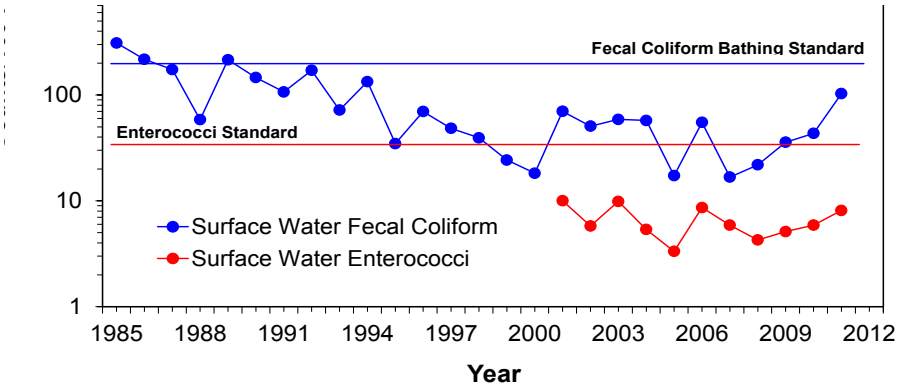


Figure 8

DEP has monitored Enterococcus levels in the Upper East River-Western Long Island Sound since 2001. The averages for the past eleven years have varied between 3 to 10 cells/100 mL which is well below the bathing standard of 200 cells/100 mL.

DISSOLVED OXYGEN

In 2011, an average summer surface dissolved oxygen (DO) level of 5.37 mg/L met and exceeded the DEC bathing standard of 5.0 mg/L. Similarly, an average summer bottom DO level of 4.67 mg/L met and exceeded the DEC fishing and boating standard of 4.0 mg/L. These levels were 5.64 mg/L and 5.18 mg/L in 2010, respectively.

During the summer, average monthly dissolved oxygen samples for five out of the nine surface water monitoring sites and three out of the eight bottom water monitoring sites met and exceeded their designated 'best usage' classifications. Most of these samples were located at 155th Street (H3) in Harlem River, Flushing Bay (E6), Flushing Creek Mouth (E15), Little Neck Bay (E11), and Hart Island (E10). All hypoxia (DO <3.0 mg/L) conditions were detected in bottom waters at the Flushing Creek Mouth (E15, once), Whitestone Bridge (E7, two times), Throg's Neck Bridge (E8, five times), and Hart Island (E10, five times) monitoring stations from July 11, 2011 to August 22, 2011. Two of the events were defined as 'wet' sampling days. A sampling event is considered 'wet' if a significant rainfall was recorded in the preceding 48 hours, with a significant rainfall defined as 0.4 inches within 24 hours or 0.2 inches within two hours. One of the 'wet' sampling days was August 15, 2011, one day after record high rainfall in Central Park. On this day, dissolved oxygen levels measured between 2.40 – 3.66 mg/L and higher fecal coliform and Enterococcus readings were also recorded within the region.

Most of minimum dissolved oxygen levels were measured in August.

Trends

Compared with the other three regions in New York harbor, average regional summer dissolved oxygen concentrations were the lowest in Upper East River-Western Long Island Sound. Since early 1990s, average surface dissolved oxygen concentrations have remained about 5.0 mg/L, meeting the DEC bathing standard, except in 2004; and average bottom dissolved oxygen concentrations have complied with the DEC fishing or boating requirement of 4.0 mg/L. The trends demonstrate stability, with an increased gap between surface and bottom waters between the mid-1980s to early 2000s.

Dissolved Oxygen Summer Average

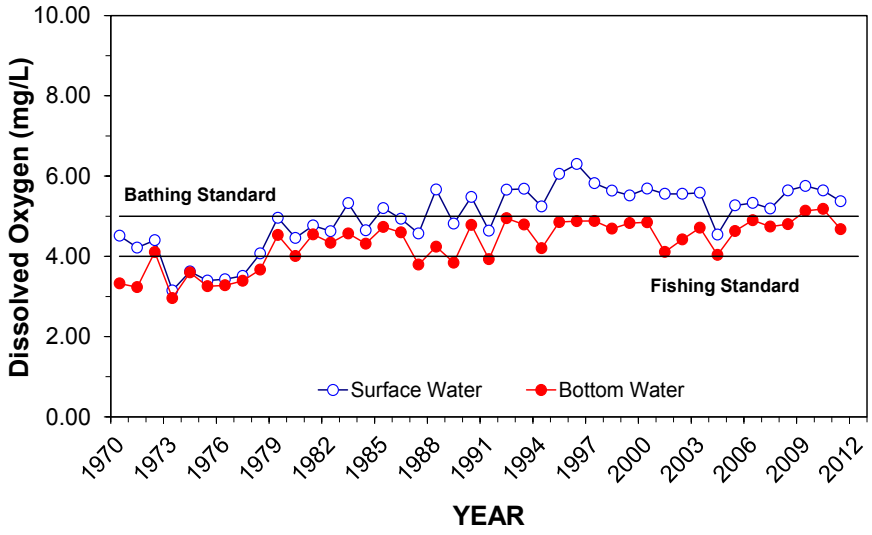


Figure 9

CHLOROPHYLL 'a'

The stations in the Upper East River–Western Long Island Sound averaged between 2.3 µg/L (E4) and 13.1 µg/L (E15) of chlorophyll 'a.' The highest averages tend to be in confined water bodies at the heads of Flushing Bay (E15, 13.1 µg/L), Flushing Creek (FLC1, 18.4 ug/L), and Little Neck Bay (LN1) monitoring stations. The highest individual sample reading was in Little Neck Bay (LN1) at 119.0 µg/L in early summer.

The head of Flushing Bay, being adjacent to the mouth of Flushing Creek, receives nutrient-rich water from the creek. The overall average for the entire region was 7.6 µg/L in 2011. Other stations in the Upper East River and Harlem River are typically low in chlorophyll 'a' (E4, E6, E7, E8, E14, and H3 all average less than 9.0 µg/L).

Trends

Long-term trends for chlorophyll 'a' in this region show summer averages in the 6–16 µg/L range dating back to 1986 (see figure 10). The two exceptions are 1995 and 1996, when concentrations averaged 22.8 µg/L and 25.8 µg/L, respectively. For the past 10 years, the summer average has been less than 10 µg/L.

DEP is constructing nitrogen removal processes at each of the four Upper East River wastewater treatment plants to reduce nutrient discharges.

Chlorophyll 'a' and Total Suspended Solids Summer Average

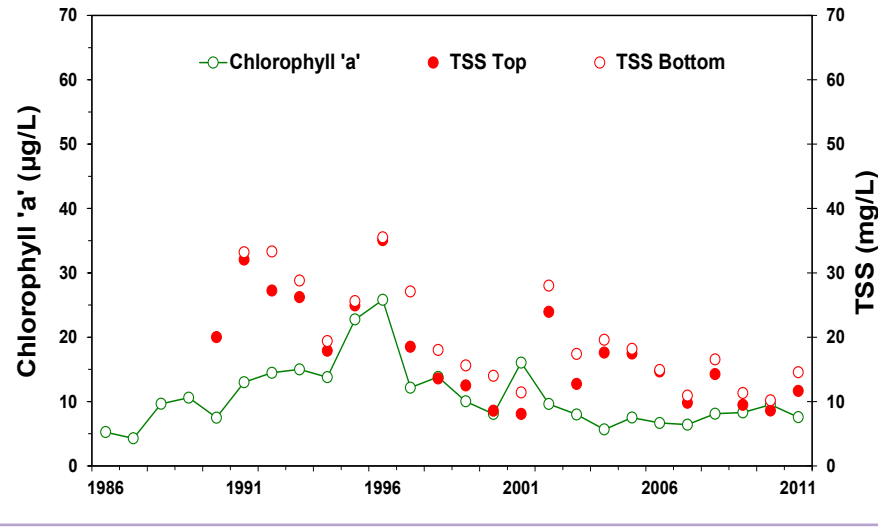


Figure 10

SECCHI TRANSPARENCY

In the summer of 2011, the average Secchi transparency for Upper East River–Western Long Island Sound was 3.6 ft. Stations in more constricted waterways, such as Flushing Creek and H3 in the Harlem River, displayed low averages of 3.0 ft or less. Runoff after rainfall and freshwater influx from the Hudson to the Harlem River can contribute to turbid waters in these areas.

Trends

The Upper East River-Western Long Island Sound regional average has varied between 3.3 and 6.1 ft Secchi depth since 1986. The lowest average transparency of 3.3 feet in 1996 coincided with very high average chlorophyll 'a' and total suspended solids readings. Since 1996, improved Secchi transparency depths may coincide with a decrease in chlorophyll 'a' or total suspended solids averages.

Secchi Depth and Total Suspended Solids Summer Average

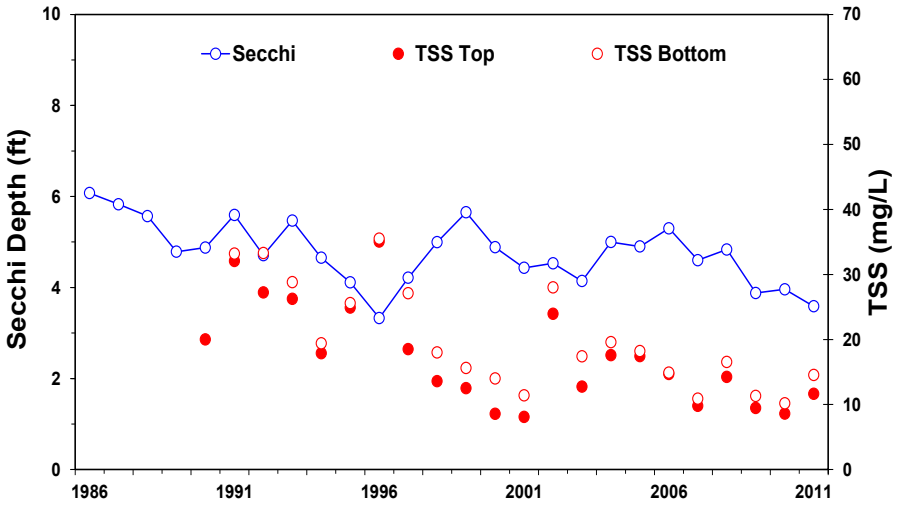
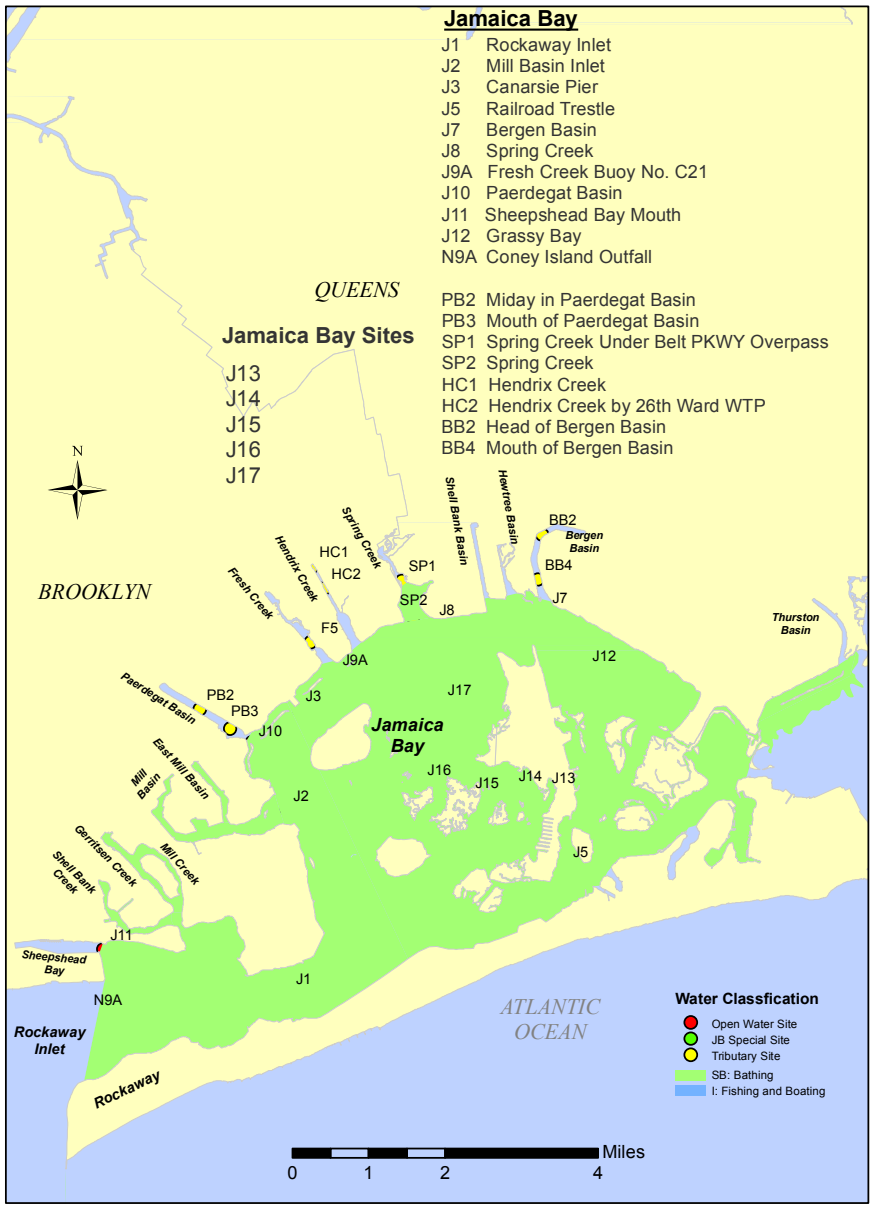


Figure 11

Jamaica Bay



Jamaica Bay is located at the southwestern end of Long Island. This urban, estuarine embayment and national park consists primarily of tidal wetlands, upland areas, and open waters. The bay and its drainage area are almost entirely within the boroughs of Brooklyn and Queens, except for a small area at the eastern end that lies within Nassau County. Jamaica Bay joins the New York Harbor to the west via the Rockaway Inlet at the tip of Breezy Point and includes the Rockaway Peninsula, which forms the southern limit of the Bay and separates it from the Atlantic Ocean. This estuarine water body, consisting of approximately 20 square miles of open water, is covered by eleven Harbor Survey monitoring stations.

Open waters of Jamaica Bay are classified for bathing or other recreational use. Areas within the Bay's tributaries and dead-end canals are prone to reduced water quality due to direct surface runoff and poor flushing. These areas are designated for secondary contact use, such as fishing or boating.

FECAL COLIFORM

In the summer of 2011, eight out of eleven monitoring sites had fecal coliform monthly geometric means below 200 cells/100 mL and met the DEC bathing standard, not including the Grassy Bay (J12), Spring Creek (J8), and Bergen Basin (J7) monitoring sites. Fecal coliform geometric means in the northern portion of the bay (all five sites) were higher than the DEC swimming and bathing standard in August and September due to the wet weather.

Enterococcus readings were well below DEC standards in 2011. During the summer, all individual readings met DEC swimming and bathing standards (104 cells/100 mL, maximum for a single sample), except on one of the wet days (September 8, 2011) at J2, J10, and J9A. The regional summer geometric mean was 2 cells/100mL; all site monthly means complied with the DEC bathing standard of 35 cells/100 mL.

Trends

Average fecal coliform concentrations in Jamaica Bay have been below the 200 cells/100 mL DEC bathing standard since 1985, except in 1990 when fecal coliform levels peaked at 210 cells/100 mL. The regional geometric mean was 93 cells/100 mL in the summer of 2011.

DEP continues to improve its wastewater treatment operations with the construction and operation of combined sewer overflow storage tanks. Additionally, DEP skimmer vessels work to control floatable debris in Jamaica Bay as part of the "Boom and Skim" program.

Since 2001, Enterococcus summer geometric means in Jamaica Bay have consistently met the DEC bathing standard. This is one of the areas that has least Enterococcus average variation, ranging between 2 to 3 cells/100mL.

Fecal Coliform and Enterococci Summer Geometric Mean

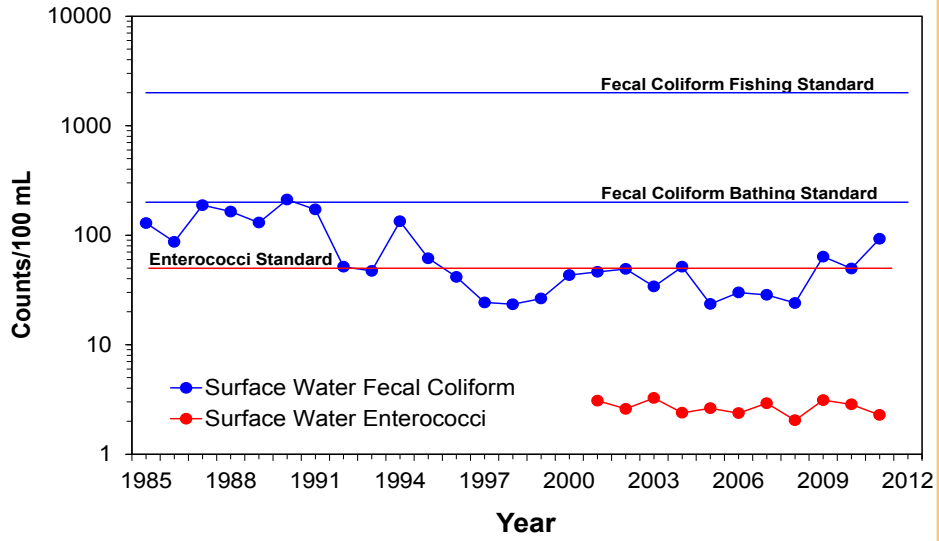


Figure 12

DISSOLVED OXYGEN

In Jamaica Bay, summer dissolved oxygen (DO) averages for both surface and bottom waters surpassed the DEC standard of never less than 5.0 mg/L for bathing at 10 of the 11 monitorion stations.

During the summer, 84% of surface water samples and 75% of bottom water samples complied with the DEC standard of never less than 5.0 mg/L. Seven out of nine bottom samples with DO less than 3.0 mg/L were found at J12. The hypoxia conditions (indicated by DO levels less than 3.0 mg/L) began in late June through the end of August, mainly due to a lack of bottom water circulation at this station. The other two hypoxia conditions were recorded at Bergen basin on August 17, 2011 and Canarsie Pier on August 24, 2011.

Trends

Jamaica Bay regional summer average DO levels reached well above the DEC 5.0 mg/L bathing standard as early as 1970, except 1991. The average DO levels in this region are among the highest in New York Harbor. The considerable difference in DO levels between surface and bottom waters has been reduced since 2004. High surface dissolved oxygen concentrations are often due to supersaturated conditions, attributable to algae blooms and eutrophic waters.

Dissolved Oxygen Summer Average

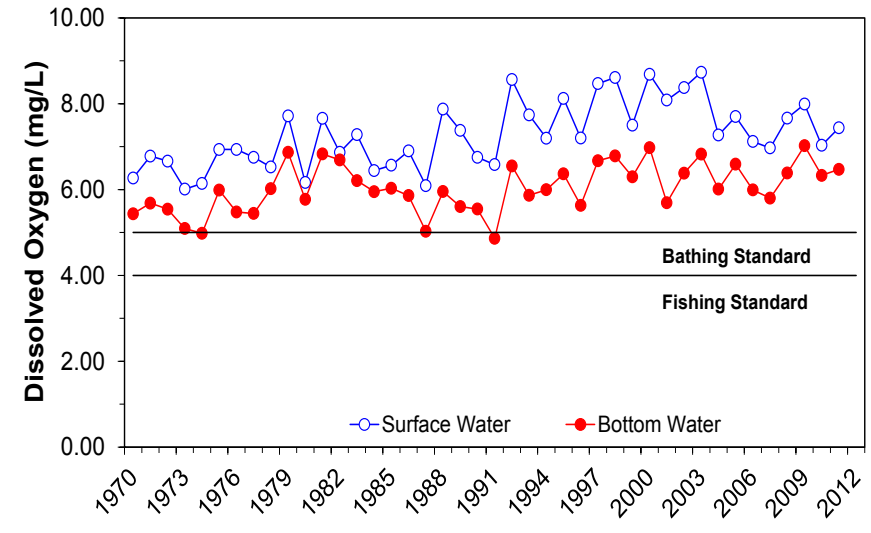


Figure 13

CHLOROPHYLL ‘a’

Jamaica Bay typically has the highest chlorophyll ‘a’ averages in all of New York Harbor. In 2011, chlorophyll ‘a’ averaged 29.4 µg/L. Most stations in the region average fairly high (greater than 20 µg/L) with the highest occurring in the eastern half of the bay (J7; 61.5 µg/L and J12; 44.2 µg/L). J7 at the mouth of Bergen Basin recorded a season high concentration of 200.3 µg/L on June 1, 2011. Several new shallow water stations in the center of the bay all averaged more than 25 µg/L. Slow turnover of water within the bay and the nutrient-rich tributaries feeding it allow for development of large standing phytoplankton populations year round.

Trends

Chlorophyll ‘a’ summer averages in Jamaica Bay were less than 25 µg/L before 1990. Chlorophyll ‘a’ summer averages increased to 38.3 µg/L in 1991 and have remained above 34 µg/L since, with the exception of the 2007 average of 23.7 µg/L, which seems to be an outlier. In 2010, summer averages dropped to 28 µg/L and remain consistent with the 2011 average of 29 µg/L. Over the past 26 years chlorophyll ‘a’ concentrations have fluctuated, particularly in the mid 1990s.

Concentrations at the western end of the bay are lower due to better mixing with ocean waters. In 2011, J1, J11, and N9A averaged 18.8 µg/L, 19.9 µg/L, and 8.1 µg/L, respectively.

DEP is installing equipment that will remove nitrogen from wastewater at the 26th Ward and Jamaica Wastewater Treatment Plants. Nitrogen, which humans excrete from protein metabolism, is a nutrient for microorganisms. Work thus far completed at 26th Ward has already reduced nitrogen dischcarges by more than 8,000 pounds per day into Jamaica Bay.

Chlorophyll ‘a’ and Total Suspended Solids Summer Average

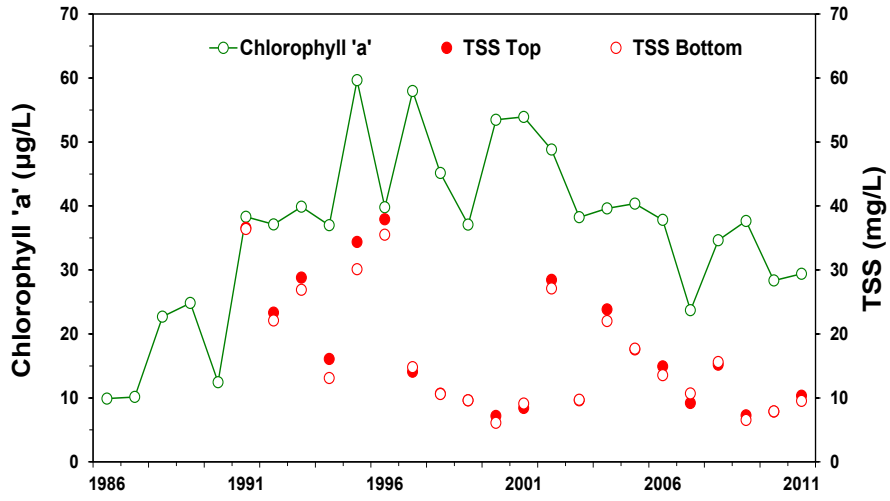


Figure 14

SECCHI TRANSPARENCY

The average Secchi depth in Jamaica Bay was 3.8 ft in 2011. Most of the stations in the bay proper average between 3 and 4 ft Secchi depth except for J1 at the entrance of the bay (4.5 ft), J11 at the mouth of Sheepshead Bay (4.4 ft), and N9A at the Coney Island outfall (6.6 ft). Paerdegat Basin averaged 3 ft or less due to turbid conditions from runoff and algal content. The station with the lowest chlorophyll 'a' average, N9A (8.1 µg/L), also had the highest Secchi depths (6.6 ft). Conversely, the highest chlorophyll 'a' average in the bay at J7 (61.5 µg/L) was associated with the lowest Secchi average (2.9 ft).

Secchi Depth and Total Suspended Solids Summer Average

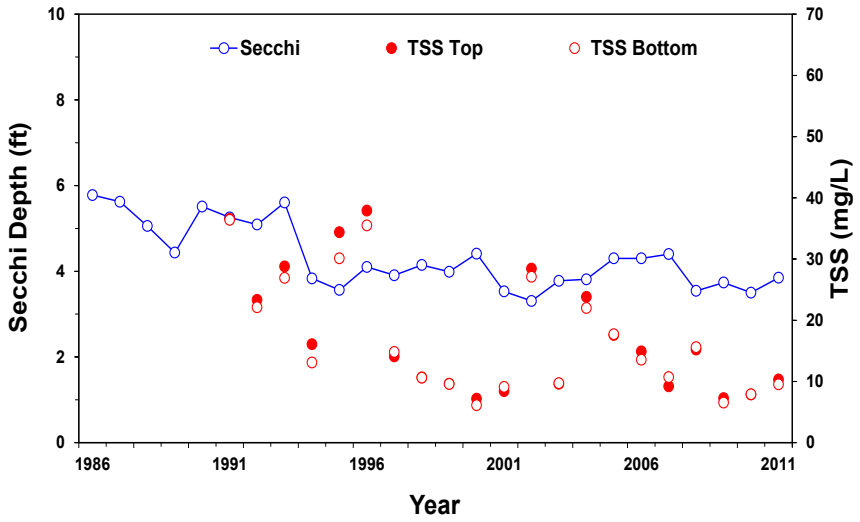
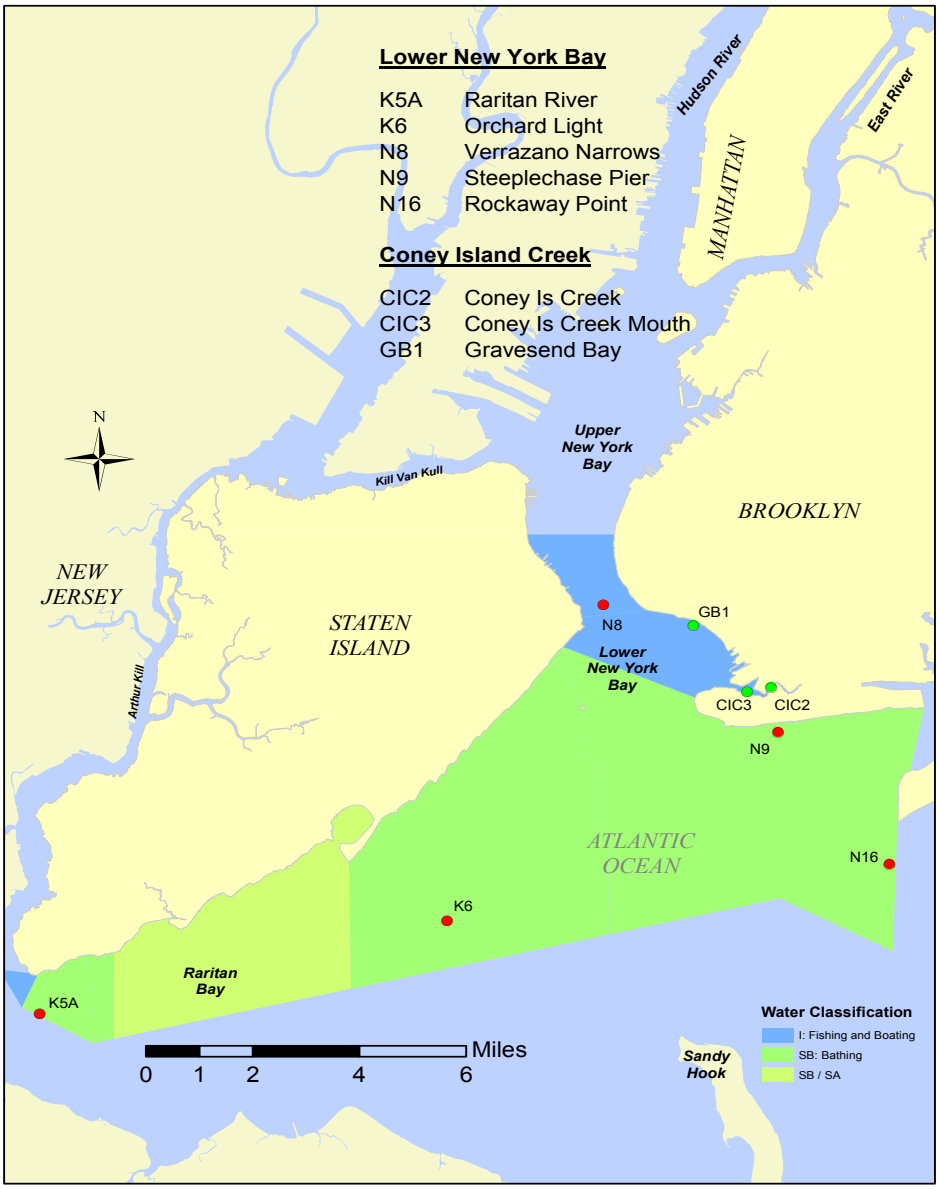


Figure 15

Trends

Average Secchi depths greater than 5.0 ft were typical before 1993, when chlorophyll 'a' averages where relatively low (see figure 15). For the last four years, average Secchi transparency depths were between 3.5 to 3.8 ft.

The Lower NY Bay–Raritan Bay



The Lower New York Bay–Raritan Bay vicinity represents the most oceanic portion of the Harbor Survey Program. This area of 100 square miles is represented by five Harbor Survey monitoring stations and is composed mostly of open shallow waters, partially confined by Brooklyn's Coney Island to the north, Staten Island to the northwest, and New Jersey's Middlesex and Monmouth counties and Sandy Hook to the south. The remainder of its eastern boundary is open to Rockaway Inlet and the greater Atlantic Ocean.

This area of the harbor is classified for bathing and other recreational use. Portions of those waters are also designated for the permitted use of shellfishing (for relay to cleaner waters, but not direct consumption).

FECAL COLIFORM

As has been the trend, the Lower New York Bay-Raritan Bay had the lowest levels of fecal coliform in the region in 2011. Summer monthly averages for fecal coliform met and surpassed DEC standards in this region, except at Verrazano Narrows (N8) during July and August. This was due to a bypasses at the North River Wastewater Treatment Plant after a fire on July 20, 2011 and excessive rainfall in the month of August. Because most of the stations are located in oceanic portion of the New York Harbor, they are less impacted by CSOs near the shore.

In 2011, Enterococcus concentrations were lowest in the Lower New York Bay-Raritan Bay compared to other waterbodies around New York City. All stations' monthly geometric means were less than 15 cells/100mL.

Trends

Fecal coliform concentrations in Lower New York Bay-Raritan Bay have significantly declined since the early 1990s. Summer geometric means for fecal coliform have stayed below 30 cells/100 mL since 1992. This region has the lowest bacteria concentrations in New York harbor.

Enterococcus levels in the Lower New York Bay-Raritan Bay have been consistently well below the DEC bathing standard. Ten out of eleven years' summer averages had 2 cells/100 mL and there were only 3 cells/100 mL in 2010.

Fecal Coliform and Enterococci Summer Geometric Mean

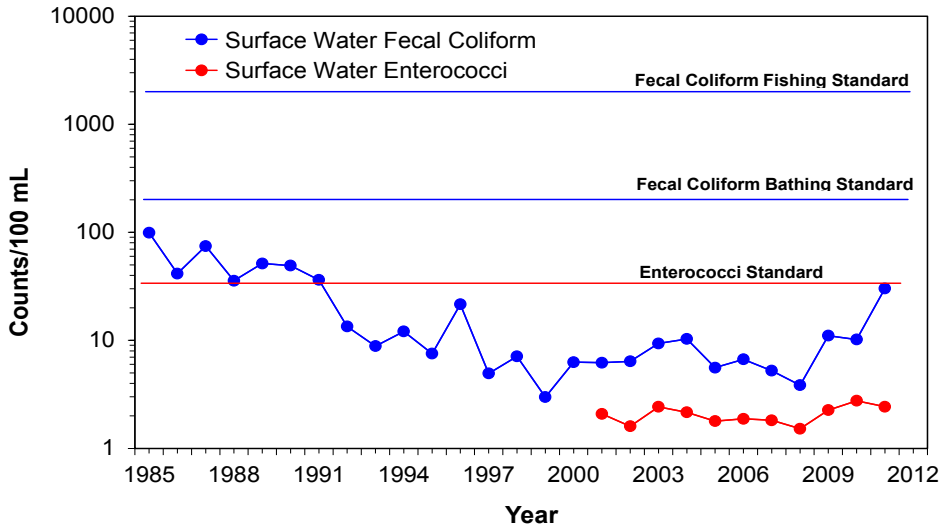


Figure 16

DISSOLVED OXYGEN

Most of dissolved oxygen (DO)values for surface and bottom waters in Lower New York Bay–Raritan Bay complied with the DEC standard of never less than 5.0 mg/L for bathing during the summer of 2011; 75 out of 79 (95%) surface water samples and 67 out of 73 (92%) bottom water samples met their required DO standards. The lower DOs (3.37-4.94 mg/L) were found in August 2011 at Raritan Bay (K5A).

Summer DO averages in Lower New York Bay-Raritan Bay have been the highest among New York City's harbor water since 1970. The average DO measurements in summer 2011 were 7.1 mg/L in surface waters and 6.6 mg/L in bottom waters; they were 7.6 mg/L and 7.2 mg/L in the summer of 2010.

Dissolved Oxygen Summer Average

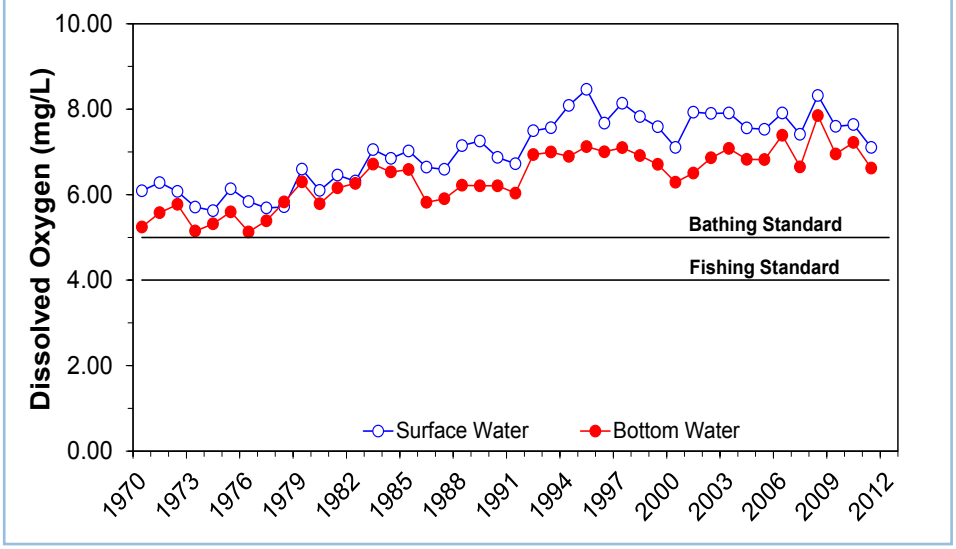


Figure 17

Trends

In Lower New York Bay–Raritan Bay, DO levels have increased about 1 mg/L for both surface and bottom waters from 1970 to 1990 and remained between 7.0-8.5 mg/L in surface waters and 6.0-7.8 mg/L in bottom waters thereafter.

CHLOROPHYLL 'A'

The Lower New York Bay–Raritan Bay varies in chlorophyll 'a' concentrations, however the regional average dropped to 10.4 µg/L in 2011. Stations near Raritan Bay had higher concentrations, whereas the Verrazano Narrows (N8), Coney Island Beach (N9), and Rockaway Inlet (N16) were among the clearest waters in the city (all less than 8 µg/L average). The K5A and K6 monitoring stations near Raritan Bay averaged 11.7 and 20.6 µg/L, respectively.

Raritan Bay appears to have a natural configuration ideal for the promotion of phytoplankton blooms. The relatively shallow area's main source of fresh water is the polluted Raritan River; it also receives waters from Arthur Kill and some smaller tributaries in New Jersey. Stations K5 and K4 in Arthur Kill had averages of 14.1 and 5.1 µg/L, respectively. Flushing from the Hudson River is inhibited by surrounding shoals, such as Old Orchard Shoal. Tidal exchange with oceanic waters does occur, but is inhibited somewhat by Sandy Hook.

Chlorophyll 'a' and Total Suspended Solids Summer Average

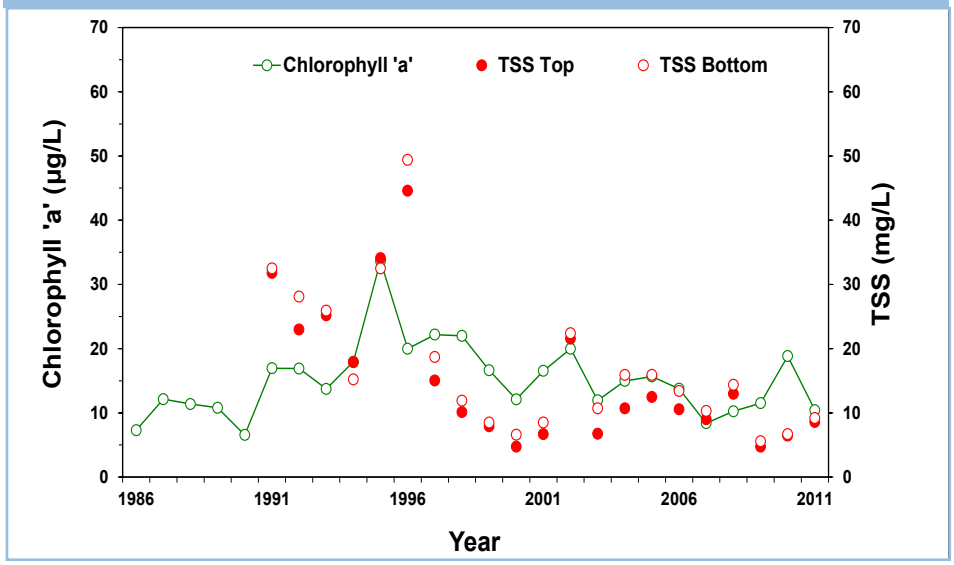


Figure 18

Trends

Given the propensity for algae blooms in Raritan Bay, this region as a whole has a history of fairly low summer chlorophyll 'a' averages. Over the past 26 years, all but three years (1995, 1997, 1998) had averages below 20 µg/L (see figure). In 2011, the chlorophyll 'a' average was 10.4 µg/L.

SECCHI TRANSPARENCY

Lower Bay waters are generally very clear. An average of 5.1 ft in 2011 reflects good transparency at open water stations such as N16 at Rockaway Point (average of 7.2 ft) and N9 at Coney Island (6.2 ft). Levels above 5.0 ft indicate clean conditions and superior water clarity. Stations in Raritan Bay averaged lower (less than 4 ft) as there are often phytoplankton blooms in the area and turbid conditions on windy days due to the shallow waters outside the main shipping channel.

Secchi Depth and Total Suspended Solids Summer Average

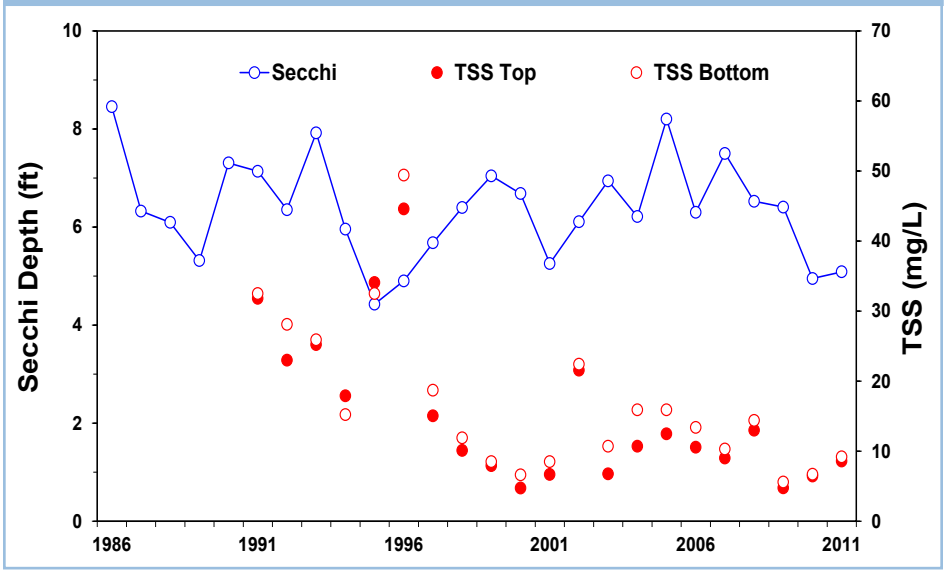


Figure 19

Trends

Average Secchi transparencies in the Lower New York Bay–Raritan Bay region have remained at or above 5.0 ft since 1986, with the exceptions of 1995 and 1996. The drop coincided with a large increase in chlorophyll 'a' in 1995 (see figure 19). Also within this time frame, the annual Secchi averages fluctuate greatly, ranging from 4.4 ft to almost 8 ft. It appears the region is sensitive to annual variations that affect water clarity. The highest Secchi depth average recorded in 1986 (8.5 ft) coincided with the second-lowest chlorophyll 'a' average of 7.3 µg/L.


2011 NYC DEP Harbor Survey Monitoring Stations
N
WESTCHESTER COUNTY
BRONX
NEW JERSEY
MANHATTAN
QUEENS
BROOKLYN
STATEN ISLAND
ATLANTIC OCEAN
Long Island Sound
Hudson River
Harlem River
East River
Upper East River
Upper New York Bay
Lower New York Bay
Newark Bay
Kill Van Kull
Arthur Kill
Raritan Bay
Sandy Hook
Rockaway
Jamaica Bay
N1
BR1
H3
N3B
BR3
BR5
E14
E7
E8
E10
E11
LN1
AC1
E6
FB1
FLC2
FLC1
E15
E4
TR2
N3C
TR1
N4
E2
NC3
NC2
NC1
NC0
N5
GC3
GC4
GC5
GC6
G2
N6
K1
N7
K2
K3
K4
K5
K5A
K6
N8
GB1
CiC3
CiC2
N9
N9A
N16
J11
J1
HC1
HC2
SP1
SP2
BB2
BB4
J7
J8
F5
J9A
J12
PB2
J3
J17
PB3
J10
J2
J16
J14
J13
J15
J5
0
2.5
5
10
Miles
Conventional Stations
Tributary Stations
Triathlon Stations
Coast Line
Upper East River- Western LIS
Lower New York Bay
Inner Harbor
Jamaica Bay


NYC
Environmental
Protection