2009

New York Harbor Water Quality Report

Environmental Protection

Michael R. Bloomberg, Mayor
Caswell F. Holloway, Commissioner

Cover photo: A flock of Double-crested Cormorants, American Oystercatchers and Common Terns in Jamaica Bay

2009

New York Harbor Water Quality Report

THE CITY OF NEW YORK
OFFICE OF THE MAYOR
NEW YORK, NY 10007

August 2010

Dear Friends:

This report marks a significant milestone for New York City: the 100th year of comprehensive water quality monitoring of New York Harbor.

As a result of intensive investments, our harbor waters are healthier today than they have been in a century. Our Administration has made water quality improvements a top priority, and aquatic life is now thriving in many areas. As part of *PlaNYC*, our comprehensive plan for building a truly sustainable city, we are committed to opening 90 percent of our waterways for recreational use by 2030.

The full account presented here of the health of New York Harbor shows the significant improvements we've made — and is another important step in our efforts to build a greener, greater New York in the years to come.

Sincerely,

Michael R. Bloomberg
Mayor

NYC Environmental Protection

The New York City Department of Environmental Protection (DEP) is proud to present the 2009 Harbor Water Quality Report, which reviews the health of New York City's waterways. DEP treats more than a billion gallons of wastewater that New Yorkers produce every day, and Mayor Bloomberg has invested billions of dollars to enhance that treatment — and thereby improve water quality throughout New York Harbor. We are also making unprecedented investments to increase stormwater capture, which reduces the combined sewer overflows (CSOs) into our surrounding waterways. Based on actual rainfall data, our combined CSO capture rate was 76 percent in 2009, and we expect that amount to increase as new investments like the Paerdegat Basin and Alley Creek CSO Retention Facilities go online. The CSO Long-Term Control Plan, the Bronx River Floatables Control program, and the removal of CSO sediments at outfalls across the City will also increase protection of the City's waterways.

In 2010 our success has continued. In February, we announced that New York City's 14 wastewater treatment plants are meeting monthly Clean Water Act standards for pollutant removal — for the first time ever. And just last month we started removing 4000 pounds per day of nitrogen from our discharges to Jamaica Bay — the first milestone in a historic agreement that Mayor Bloomberg announced this past spring.

The City is adopting sustainable, low impact strategies as it incorporates green infrastructure as a central element of its current and future efforts to reduce CSOs. Green infrastructure adds trees, vegetation and other natural features to our local streetscapes and prevents pollution from occurring by capturing rainwater before it enters our sewer system. These projects are cost-effective and beautify our communities, too! Reorienting our approach to capturing stormwater and preventing CSOs will require a great deal of coordination with community, business, agency, state, and federal partners, and we look forward to working with them as we move forward with innovative and sustainable solutions.

Sincerely,

Caswell F. Holloway
Commissioner

www.nyc.gov/dep

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Introduction

The City of New York's (City) Harbor Survey Program is one of the longest continuous regional water quality monitoring programs in the United States, reaching its 100th year in 2009. The milestones achieved since the program started a century ago are being documented in a separate report that will be published this fall to celebrate the program's centennial.

The Harbor Survey has greatly evolved from the initial monitoring efforts conducted by the Metropolitan Sewerage Commission during 1909, which were done in response to public outcry about fouled waterways impacting their quality of life. At the time a handful of locations around Manhattan were assessed. The survey grew over the years to encompass the entire City, now consisting of 55 stations: 36 stations located throughout the open waters of the harbor, and 19 stations located in smaller tributaries. The number of water quality parameters measured has also increased from five in 1909 to more than 20 today.

Throughout the past century, harbor water quality has improved dramatically. Within the last generation, many New Yorkers have again begun to use local waterways for recreation. These improvements in water quality have been directly associated with infrastructure investments, including major construction and upgrades at all 14 in-City wastewater treatment plants (WWTPs) and increased capture of storm runoff. Today, all sewage generated in the City on a dry-weather day is now treated to full Clean Water Act standards.

To further improve and protect New York City's ambient waterways, DEP has been investing in sustainable practices to address flooding, conducting programs to remove floatables and debris from the waterways, and organizing beach clean-ups and protection programs. These include the Floatable Action and Boom and Skim program, Shoreline Survey–Sentinel Monitoring, and Enhanced Beach Protection programs. Wet Weather capture is being addressed by the construction of combined sewage overflow (CSO) retention tanks and the introduction of Best Management Practices (BMPs), also known as green infrastructure, to capture run-off and reduce flooding in parts of the city. DEP's Long Term Control Plan (LTCP) is evaluating still-impaired water bodies and their drainage basins in the city. Its goal is to develop comprehensive plans that will attain and maintain each waterbody's "best use" classification, based on NYS Department of Environmental Conservation (DEC) standards.

This Annual New York Harbor Water Quality Report includes data collected by DEP during 2009. 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, dissolved oxygen, chlorophyll 'a' and Secchi transparency. A discussion of enterococci bacteria, which US EPA is now using as a sewage indicator, is also included in this year's report.

The breeze and the views are perfect for sailing in Jamaica Bay

Synopsis of Four Major Indicators of Environmental Change

Fecal Coliform (FC) Bacteria – Fecal coliform concentrations are measured in NY Harbor as human health-related indicators of sewage-related pollution. Fecal coliform are a group of bacteria primarily found in human and animal intestines and are associated with sewage waste. 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.

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. Chlorophyll 'a' levels above 20 ug/L are considered indicative of enriched, eutrophic conditions.

Eutrophication – Eutrophication is an increase in the rate of organic matter in an ecosystem, 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 have greater importance to understanding eutrophication problems in salt water.

Dissolved Oxygen (DO) – The levels of oxygen dissolved in the water column are critical for 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.

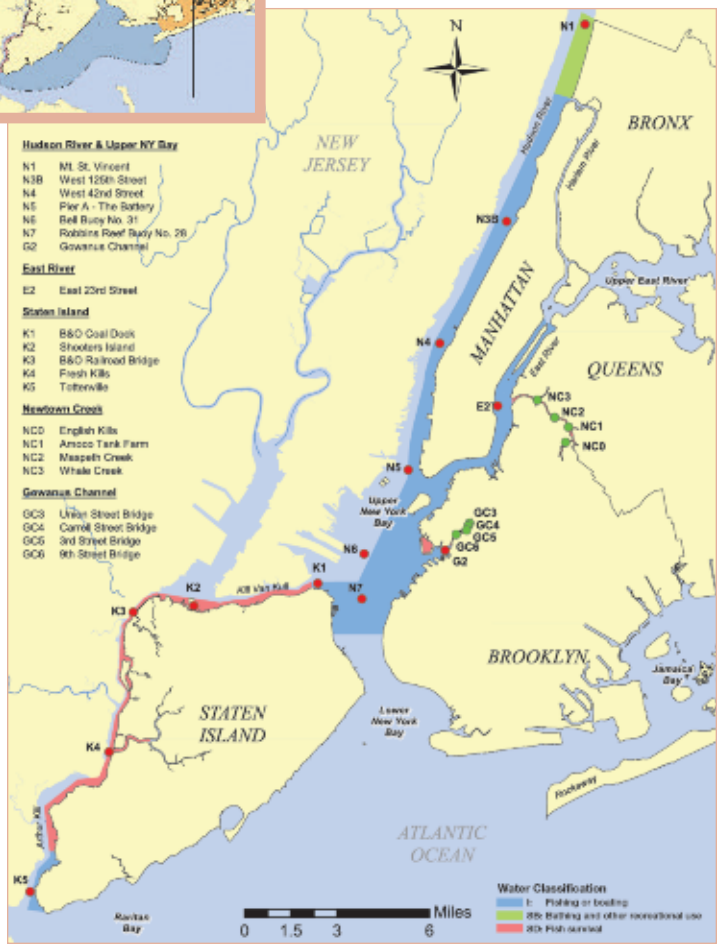
Secchi Transparency – A Secchi disk is used to estimate the clarity of surface waters. High Secchi transparency (greater than 5.0 feet) is indicative of clear water, with declines in transparency typically due to high suspended solids concentrations or plankton blooms. Low Secchi readings (less than 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 New York State Department of Environmental Conservation (NYSDEC) standards to quantify ecosystem health or degradation. NYSDEC standards reflect a range of acceptable water quality conditions corresponding to the State-designated "best usage" of the water body. Common uses and NYSDEC standards for fecal coliform and dissolved oxygen are noted in the following chart.

Common Water Use and NYSDEC Standards For Fresh and Saline Waters

Class	Best Usage of Waters	Fecal Coliform	Dissolved Oxygen (never-less-than)	Enterococcus
SA	Shellfishing and all other recreational use	No standard	5.0 mg/L	
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 104 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	
SD	Fish survival	No standard	3.0 mg/L	

Inner Harbor Area



The Inner Harbor is defined as the area including: the Hudson River from the NYC-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 due to common water uses and functions as well as similarities in point-source loadings. 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 NYSDEC as I, for uses such as fishing or boating. Most of the area in the Kills is classified for fish survival only (SD), with the exception of the far southern reach of Arthur Kill, which is designated as Class I. The Hudson River, from North of Spuyten Duyvil to Westchester County, is designated for Bathing (SB).

FECAL COLIFORM

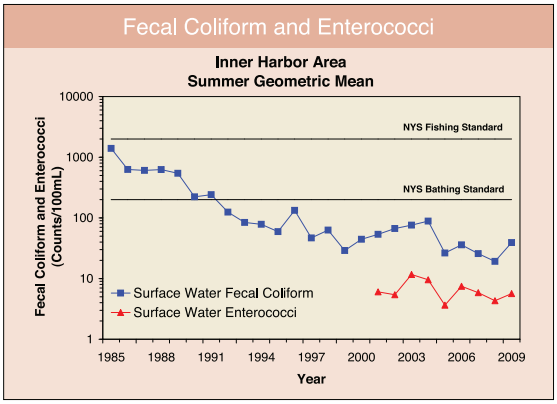
Water quality as estimated by fecal coliform (FC) concentrations was superior for the Inner Harbor in the summer of 2009. The regional average was 39 cells/100 mL, increasing from 19 cells/100 mL in 2008. All monitoring sites in the area complied with the monthly FC standard of 200 cells/100 mL.

Past data has indicated that the Inner Harbor is prone to episodic degradation following rain events due to additional FC loadings from storm drains and combined sewer overflows (CSOs). Under these conditions, 12 of 13 sites exceeded the Bathing Standard. Note: Wet Weather advisories for the New York City beaches may still be issued by NYC DOHMH under certain conditions.

Water quality as estimated by Enterococcus concentrations was also superior for the Inner Harbor in 2009. The regional summer geometric mean was 6 cells/100 mL; all monitoring sites had averages <10 cells/100 mL which complied with the Bathing Standard of 35 cells/100 mL for Enterococcus.

TRENDS

Fecal coliform levels in the Inner Harbor have dramatically declined over the last three decades, with levels since 1997 well below the Bathing Standard. The averaged FC counts have declined from 2000 cells/100 mL in the early '70s to below 100 cells/100 mL since early 1990. This improvement has allowed for the opening of Inner Harbor waters to most recreational activities. The progress has been attributed to the cessation of raw sewage dumping through the full build-out of New York City's Wastewater Treatment Plants (WTPs), the elimination of illegal discharges into the waterbody and the reduction of CSOs. Year-to-year variations have become more apparent with the reduction of FC to levels below standards.

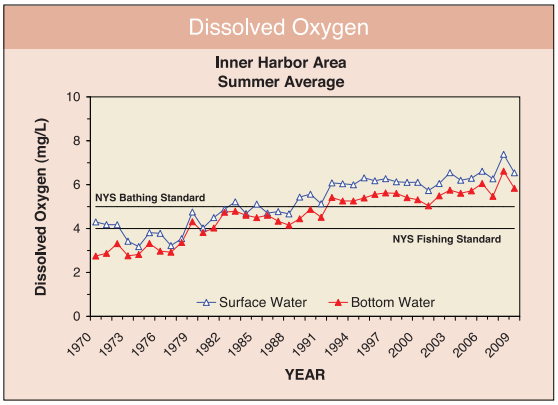


Enterococcus levels in the Inner Harbor have been monitored since 2001. The averages for the past nine years have been consistently well below the Bathing Standard of 35 cells/100 mL.

DISSOLVED OXYGEN

In 2009, summer Dissolved Oxygen (DO) values averaged 6.5 mg/L for surface waters and 5.8 mg/L for bottom waters. They were down from 2008 values of 7.4 mg/L for surface waters and 6.6 mg/L for bottom waters.

Discrete DO measurements of surface and bottom waters complied with NYSDEC standards 97% and 92% of the time for surface and bottom waters. There was a total of 17 to 18 samples taken for each sampling location during the summer (June–September) 2009.



TRENDS

Average summer surface DO values in the Inner Harbor have risen to levels above NYSDEC standards for primary contact recreation and commercial fisheries since the late 1980s. Bottom water DO values have risen from approximately 3.0 mg/L in 1970 to 5.8 mg/L at present. There is an increase between 0.4–1.3 mg/L for each decade.

Herring Gull enjoying a snack

Inner Harbor Area

*Statue of Liberty as seen from DEP's **Harbor Survey Vessel Osprey**.*

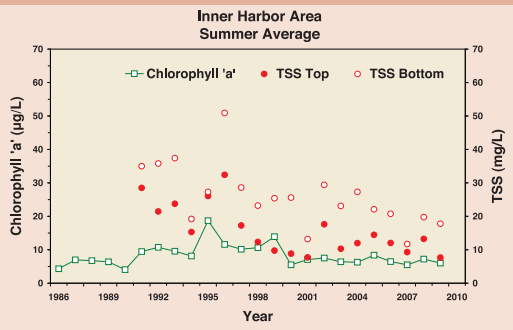
CHLOROPHYLL 'a'

The average chlorophyll 'a' concentration in the Inner Harbor was 6.0 ug/L in summer 2009. Excluding station K5 at the mouth of Arthur Kill, the stations in this region averaged less than 10 ug/L Chlorophyll 'a'. Raritan Bay typically has high chlorophyll 'a' averages, thus the proximity of K5 to the bay contributed to a rather high summer average of 20.7 ug/L.

The Gowanus Canal station (G2) average chlorophyll 'a' decreased markedly from last year (14.5 ug/L), with an average of 7.9 ug/L this summer. In mid-summer, some individual samples can be as high as 38.8 ug/L, indicating possible eutrophic conditions.

The Newtown Creek stations, which are not included in the regional data, average chlorophyll 'a' between 23.9 ug/L at the mouth of the creek and 38.4 ug/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.

Chlorophyll 'a' and Total Suspended Solids



TRENDS

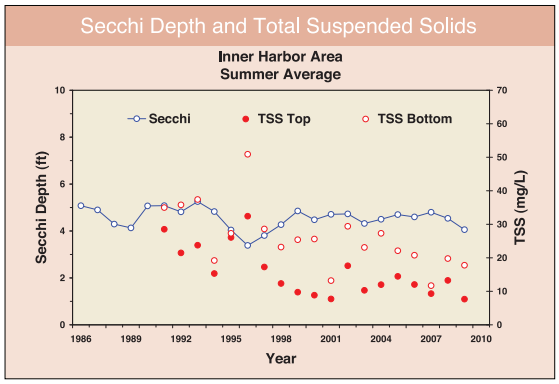
There is very little inter-annual chlorophyll 'a' variability in the Inner Harbor. The summer averages here have remained fairly constant and under 10.0 ug/L since 2000 (see figure). Massive water flow into the region from the Hudson River has been thought to be a stabilizing factor, keeping chlorophyll 'a' averages steady over the years.

SECCHI TRANSPARENCY

The Inner Harbor region encompasses many distinct sub-regions: an estuary, a near fresh water river (Hudson River), a narrow marine channel known to New Yorkers as the "East River," and an even narrower marine channel (Arthur Kill) 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 2009, the average Secchi reading was 4.1 ft in the Inner harbor area. Stations in the Staten Island Kills and East River all averaged at least 4.2 ft, while the Hudson River stations were all less than 3.0 ft. The Hudson-Estuary area can be quite turbid from freshwater influx and Secchi depths of 1.5 ft are quite common.

Newtown Creek also has low Secchi averages (all stations <3.1 ft). A contributing factor seems to be the high algal content discussed previously in the Chlorophyll 'a' section.



TRENDS

Average summer Secchi values have remained relatively constant (>4.0 ft) in the Inner Harbor area since measurements began in 1986, except in 1996 and 1997. Compared with other city open waters, there have been the least variations (<2.0 ft) over the past sampling years (see figures). This can most likely be attributed to the normal flow from the Hudson River.

Kayaking on Newtown Creek, with digester "eggs" in background

*Harbor water sampling equipment aboard **HSV Osprey***

Upper East River – Western Long Island Sound

The Upper East River–Western Long Island Sound (UER-WLIS) represents the northeastern portion of NY Harbor, from Hell Gate in the East River, up into the Western Long Island Sound (WLIS). 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 NYC–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.

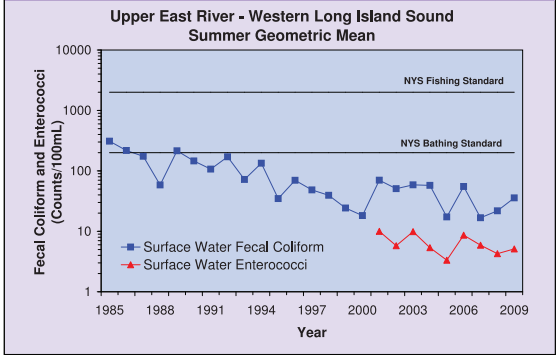
The majority of the Upper East River–Western Long Island Sound complex is classified as I, for uses such as fishing or boating, with the area east of the Bronx-Whitestone Bridge designated for Bathing (SB).

FECAL COLIFORM

In 2009, water quality continued to be superior for the Upper East River–Western Long Island Sound (UER-WLIS). Fecal Coliform (FC) concentrations for all monitoring sites except one at Flushing Creek (E15) were in compliance with their specified "best use" classifications for bathing and fishing. The summer geometric mean for this region was 36 cells/100 mL, up from 22 cells/100 mL in 2008. Eight of nine sites had averages <40 cells/100 mL.

Enterococcus concentrations were also superior for the area in 2009. The regional summer geometric mean was 5 cells/100 mL. All monitoring sites in the area complied with the Bathing Standard of 35 cells/100 mL.

Fecal Coliform and Enterococci



TRENDS

Fecal coliform (FC) concentrations have shown a downward trend for more than twenty years in the UER-WLIS region. The ongoing upgrade of wastewater treatment facilities and capture of combined sewer overflows (CSOs) were responsible for this FC reduction and will continue to have a major impact on the reduction of FC loads.

Enterococcus levels in the UER-WLIS have been monitored since 2001. The averages for the past years have been consistently well below the Bathing Standard.

Mating blue crabs require brackish and ocean waters to complete their life cycle

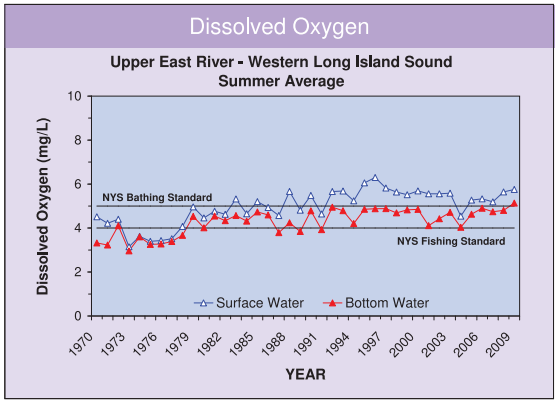
DISSOLVED OXYGEN

Average summer Dissolved Oxygen (DO) values for the Upper East River and Western Long Island Sound (UER-WLIS) vicinity met and exceeded 5.0 mg/L (conditions suitable for SB-Bathing) in surface waters at 7 of 9 sites. Average values for bottom waters at the three stations designated as SB (stations E7, E8, and E10) were <0.5 mg/L below the 5.0 mg/L NYSDEC's Bathing Standard. However, they were all greater than last year's averages at these three stations.

Average DO levels stayed fairly consistent for the past five years. Discrete DO measurements of surface and bottom waters complied with the NYSDEC standards 74% and 66% of the time, respectively. It was 79% and 64% in 2008.

This year is the first time average bottom DO in the area reached the Bathing Standard, since harbor survey sampling began. Summer DO averaged 5.8 mg/L and 5.1 mg/L for surface and bottom waters; higher than the 5.6 mg/L and 4.8 mg/L in 2008.

Although average summer bottom DO was higher than last year, incidents of hypoxia (DO <3.0 mg/L) were measured at stations E7 (three times), E8 (six times) and E10 (six times) from July 13th to August 31st. Consistent with the past couple of years, minimum DO levels were recorded in August.



TRENDS

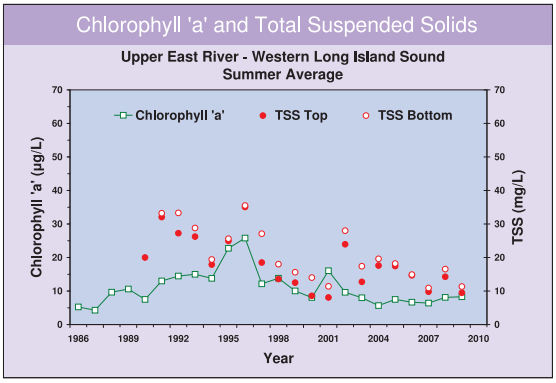
Average bottom DO values reached a record high in the UER-WLIS area in summer 2009. For the first time, average bottom DO was >5.0 mg/L which exceeded the NYSDEC Bathing Standard. The trend analysis has shown an increase in DO of about 1.0 mg/L for surface waters and 1.5 mg/L for bottom waters. Most notable are improvements in bottom waters that have risen from below fishable (4.0 mg/L) in most of the 70s to above the Bathing Standard in 2009. The trends also demonstrate stability, with a decreasing gap between surface and bottom waters, which occurred between mid-1980s to early 2000s.

Upper East River – Western Long Island Sound

*The **North River**, one of three sludge vessels, in the East River*

CHLOROPHYLL 'a'

The stations in the Upper East River–Western Long Island Sound (UER-WLIS) averaged below 20 ug/L of chlorophyll 'a' in summer 2009. The highest averages were found at E15 (18.2 ug/L) at the head of Flushing Bay and E11 (19.0 ug/L) in Little Neck Bay. The head of Flushing Bay, being adjacent to the mouth of Flushing Creek, receives nutrient-rich water due to non-point-source runoff in the creek. Other stations in the Upper East River and Harlem River are typically low in average chlorophyll 'a' (<5.6 ug/L). The overall average for the entire region was 8.3 ug/L in summer 2009.



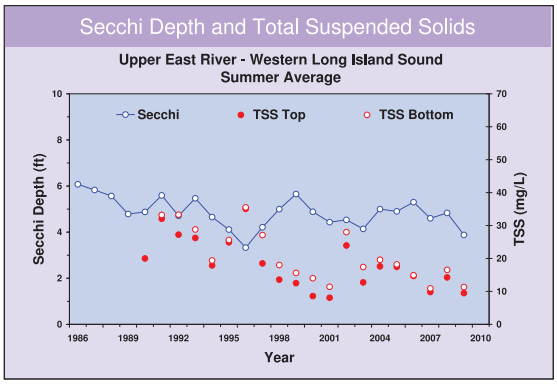
TRENDS

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

DEP is now constructing nitrogen removal processes in each of the four Upper East River Wastewater Treatment Plants to reduce nutrient discharges.

SECCHI TRANSPARENCY

In summer 2009, the average Secchi transparency for Upper East River–Western Long Island Sound (UER-WLIS) was 3.9 ft. Stations in more constricted waterways, such as Flushing Creek Mouth (E15) and Harlem River (H3), displayed low averages of less than 3.0 ft. Runoff after rainfall can contribute to turbid waters in these areas.



TRENDS

The UER-WLIS stations varied between 3.3 ft and 6.1 ft Secchi depths since 1986. The lowest average Secchi transparency of 3.3 ft in 1996 coincided with very high average chlorophyll 'a' and total suspended solids readings. Since 1996, improved Secchi transparency depths may have coincided with decreased chlorophyll 'a' in this region. In 2009, however, the regional summer average Secchi transparency dropped below 4.0 ft for the first time since the low of 1996.

*Bacteria filtration setup aboard the **HSV Osprey***

Kayaking at sunset on Jamaica Bay

Jamaica Bay

Jamaica Bay is located at the south-western 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 is in 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 nine Harbor Survey monitoring stations.

Open waters of Jamaica Bay are classified for bathing or other recreational use (SB). 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 (I), such as fishing or boating.

FECAL COLIFORM

In 2009, sanitary water quality was superior for Jamaica Bay, with summer fecal coliform (FC) concentrations below 200 cells/100 mL, the Bathing Standard for all stations, except Bergen Basin (J7).

Under wet weather conditions, the Bay experiences localized degradation. At these times, spikes in FC may temporarily exceed the Bathing Standard of 200 cells/100 mL for the entire northern portion of the Bay.

This decrease in water quality is limited to the Bay proper, as Lower New York Bay waters are not typically affected by wet weather events.

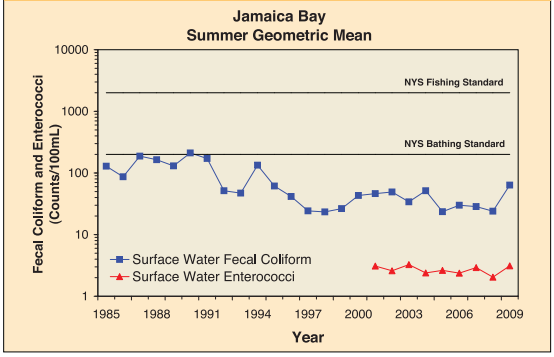
Enterococcus concentrations were also superior for Jamaica Bay in 2009. The regional summer geometric mean was 3 cells/100 mL; all monitoring sites complied with the Bathing Standard of 35 cells/100 mL.

TRENDS

Average Fecal Coliform (FC) levels in Jamaica Bay have been below the 200 cells/100 mL New York State Standard for Bathing since 1985 except in 1990 when it peaked at 210 cells/100 mL. The regional geometric mean FC was 64 cells/100 mL in summer 2009.

The DEP continues to improve its sewage system operations. Construction and operation of CSO storage tanks continue in three Jamaica Bay tributaries. Additionally, DEP skimmer vessels work to control floatable debris in Jamaica Bay, as part of the "Boom and Skim" program.

Fecal Coliform and Enterococci



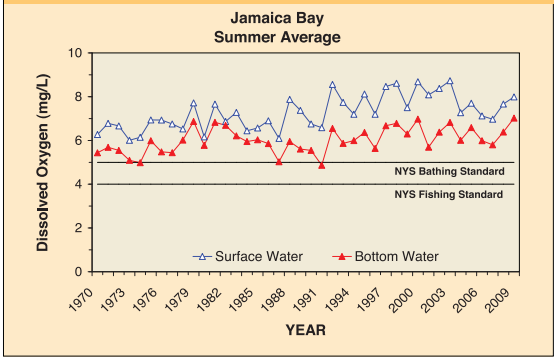
Enterococcus levels in Jamaica Bay has been consistently well below the Bathing Standard since 2001.

DISSOLVED OXYGEN

The 2009 summer averages for dissolved oxygen (DO) for surface and bottom waters surpassed the New York State Standard of never less than 5.0 mg/L for bathing (SB) at all stations except for bottom waters at station J12 (Grassy Bay).

Individual measurements comply with NYSDEC Standards in 287 of 322 measurements. Most of the lower DOs occurred at the northeastern part of Jamaica Bay. At Bergen Basin (J7) and Spring Creek (J8), with depths less than 30 ft, lower DO readings were found in both surface and bottom waters during August and September. At Grassy Bay (J12), 13 out of 18 bottom samples measured during summer 2009 did not attain the Bathing Standard; the bottom average DO was 4.1 mg/L. There were six (6) hypoxia events (DO <3.0 mg/L), all recorded at Grassy Bay (J12). Lack of bottom water circulation is the main issue at this 40 ft area.

Dissolved Oxygen



TRENDS

The regional average DO levels were well above the 5.0 mg/L Bathing Standard as early as 1970. DO variability is high within and between years. The big gap (1.8 mg/L) between surface and bottom waters has been reduced since 2004. High surface DO levels are often due to supersaturated conditions, attributable to algae blooms and eutrophic waters. Also, pH average readings of 7.8 in both surface and bottom waters were the highest within the harbor area. Individual pH readings reached 8.72 in surface water and 8.74 in bottom water.

Yellow-crowned Night Heron in Jamaica Bay

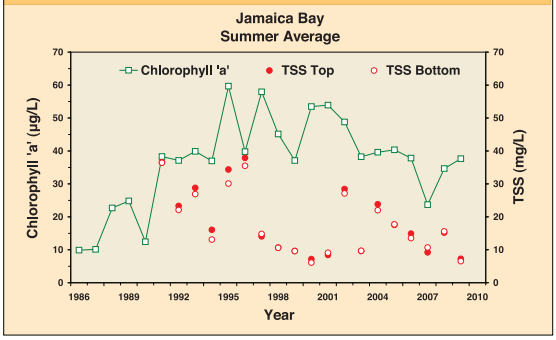
Jamaica Bay

Floatables skimmer vessel in Hendrix Creek

CHLOROPHYLL 'a'

Jamaica Bay typically has the highest chlorophyll 'a' averages in all of the city's marine waters. 2009 was no exception, with an average of 37.7 ug/L. All stations in the interior of the bay average over 35 ug/L, with the higher averages being in the north-eastern side of the bay (stations J7 and J12 chlorophyll 'a' averaged around 50 ug/L). It is not uncommon for discrete samples in the region to measure over 100 ug/L. Slow turnover of water within the bay and the nutrient-rich tributaries feeding it allow for development of large standing phytoplankton populations.

Chlorophyll 'a' and Total Suspended Solids



At the mouth of Jamaica Bay (J1) and just outside the bay (J11) chlorophyll 'a' concentrations were 19.8 ug/L and 14.9 ug/L, respectively. These areas receive some oceanic water influx via Rockaway Inlet, resulting in lower chlorophyll 'a' concentrations.

Capital work at the 26th Ward Wastewater Treatment Plant is ongoing to install process equipment that will reduce nutrient discharges.

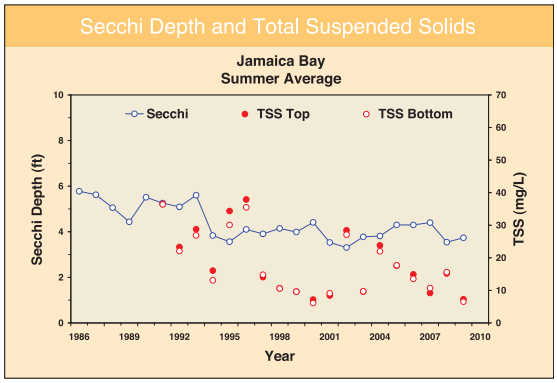
TRENDS

Inter-annual trends usually show higher chlorophyll 'a' readings in early summer, with levels settling down in August and September. Although this was true for 2005 through 2008, because the early phytoplankton bloom in the area was delayed in summer 2009, the monthly chlorophyll 'a' average peaked in August with 65.4 ug/L. Over the past 24 years chlorophyll 'a' concentrations have fluctuated rather wildly, particularly in the mid 90s.

Large blooms cover Jamaica Bay's Rosa rugosa during the summer

SECCHI TRANSPARENCY

The average Secchi transparency depth in Jamaica Bay was 3.7 ft in summer 2009. Two of the sample sites (J1 and J11) are located outside the bay proper and experience greater water exchange than sites within the bay. The Secchi depth averages for these two sites were 5.7 ft and 4.7 ft, respectively. In the interior of the bay, sample site Secchi averages were very uniform (all about 3.3 ft).

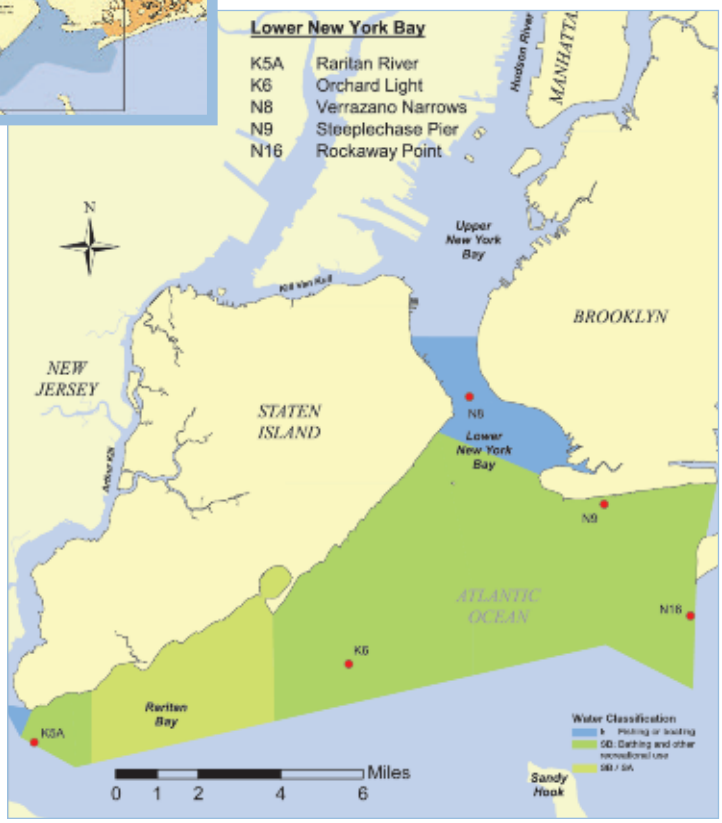


TRENDS

In Jamaica Bay, there is a loose correlation between chlorophyll 'a' averages and water column Secchi transparency. Average Secchi depths greater than 5.0 ft were typical before 1993 when chlorophyll 'a' averages were relatively low (see chlorophyll 'a' figure). Since that time, the average Secchi transparency depths have been between 3.3 ft and 4.4 ft.

Jamaica Bay Wildlife Refuge contains many diverse habitats, including this freshwater pond

Lower New York Bay – Raritan Bay



The Lower NY Bay–Raritan Bay (LNYB-RB) 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.

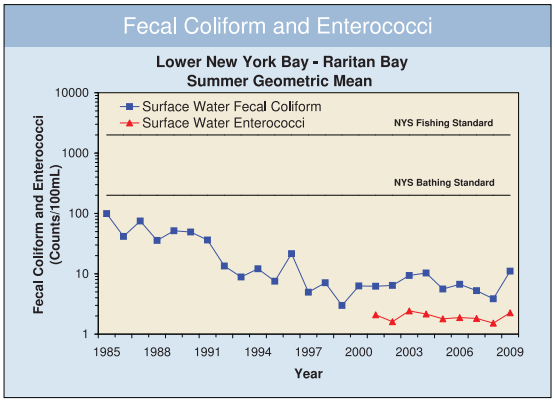
This area of the harbor is classified for bathing and other recreational use (SB). Portions of those waters are also designated for the permitted use of shellfishing (for relay to cleaner waters, but not direct consumption), having a stricter use classification of SA.

FECAL COLIFORM

In 2009, sanitary water quality as estimated by fecal coliform (FC) had the lowest values in the Lower New York Bay – Raritan Bay (LNYB-RB) as compared to other waterbodies around New York City.

Summer averages for FC numbers show waters of the LNYB-RB meet and surpass NYS Standards for this area. Three of five stations had geometric means less than 20 cells/100 mL (an order of magnitude below State Standards).

In 2009, Enterococcus concentrations were the lowest in the LNYB-RB compared to other waterbodies around New York City. All stations' averages were <3 cells/100 mL.



TRENDS

Fecal coliform (FC) concentrations for LNYB-RB show significant decline from the mid-1980s to the present time. While FC concentrations for surface waters were always below 200 cells/100 mL, average FC levels reached a low of 3 cells/100 mL in 1999. The levels have remained at or below 11 cells/100 mL since then.

These improvements have allowed for the opening of all NYC public beaches since 1992 and the lifting of wet weather swimming advisories.

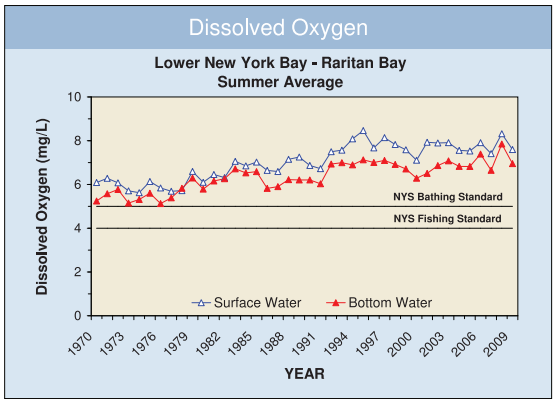
Enterococcus levels in the LNYB-RB have been consistently well below the Bathing Standard.

School of Atlantic Silversides in Hendrix Creek

DISSOLVED OXYGEN

Dissolved oxygen (DO) values for top and bottom waters in Lower New York Bay – Raritan Bay (LNYB-RB) complied with the NYS DO Standard of 5.0 mg/L for bathing waters during the summer of 2009, except for three violations in surface waters and seven in bottom waters. The ten readings were within 3.8–4.8 mg/L, and 7 of 10 were found at Raritan Bay (K5A). This is true despite K5A's proximity to more degraded waters in this region.

Summer average DO values in LNYB-RB have been the highest among the harbor area since 2006. The average DO measurements in summer 2009 were 7.6 mg/L in surface waters and 7.0 mg/L in bottom waters, a slight decrease from 8.3 mg/L and 7.8 mg/L in summer 2008.



TRENDS

Average summer DO concentrations have increased from 6.1 to 7.6 mg/L for surface waters, and from 5.2 to 7.0 mg/L for bottom waters from 1970 to 2009. Most of the improvement in the LNYB-RB area is attributed to improved water quality at station K5A. This improvement reflects loading decreases of sanitary waste over the years into Arthur Kill and the Raritan River.

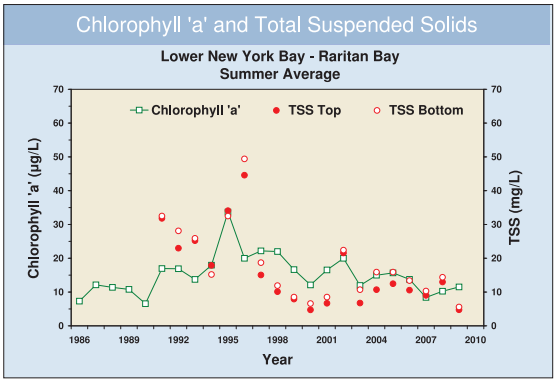
Great Egret over Jamaica Bay's salt marsh

Lower New York Bay – Raritan Bay

DEP sludge vessel approaching the Verrazano-Narrows Bridge

CHLOROPHYLL 'a'

This large region is represented by five Harbor Survey stations. In the summer of 2009 the three stations on the eastern side of this region (Lower Bay) typically had low average chlorophyll 'a' concentrations (all <5.6 ug/L). These waters are among the clearest in the city and are represented by sampling stations at the Verrazano Narrows (N8), Coney Island Beach (N9) and Rockaway Point (N16). Conversely, the Raritan Bay stations on the southeast shore of Staten Island have averages of 17.9 ug/L (K5A) and 25.5 ug/L (K6).



Raritan Bay appears to have a natural configuration ideal for the promotion of phytoplankton blooms not only in the summer, but in the winter as well. The relatively shallow area's main source of fresh water is the polluted Raritan River. 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.

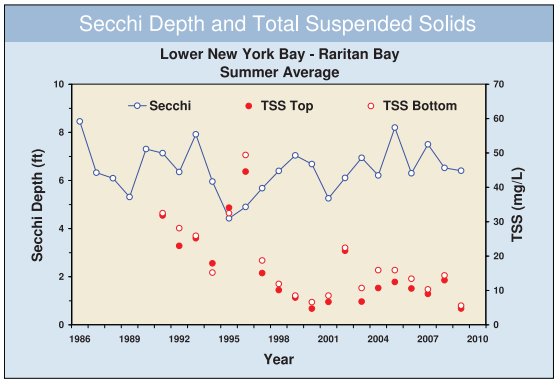
TRENDS

Given the propensity for algae blooms in Raritan Bay, this region as a whole still has a history of having fairly low summer chlorophyll 'a' averages. In fact, over the past 24 years, all but three years (1995, 1997, 1998) had averages below 20 ug/L (see figure). In 2009, the chlorophyll 'a' average was 11.5 ug/L.

Common Tern with its next meal

SECCHI TRANSPARENCY

Lower Bay waters are generally very clear. An average of 6.4 ft this year reflects good transparency at open water stations such as N16 at Rockaway Point (average of 9.4 ft) and N9 at Coney Island (8.3 ft). Levels above 5.0 ft indicate clean conditions and superior water clarity. Stations (K5A and K6) in Raritan Bay averaged lower <5.0 ft, as there are often phytoplankton blooms in the area and turbid conditions on windy days.



TRENDS

Average Secchi transparency readings in the Lower New York Bay-Raritan Bay region have remained 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). Also within this time frame, the annual Secchi averages fluctuated greatly, ranging from 4.4 ft to almost 8.0 ft in just two years. It appears the region is sensitive to annual variations that affect water clarity.

Marine Sciences staff sampling in Gowanus Canal

Harbor-Wide Improvements

Water quality conditions in 2009 remained stable or improved slightly. Harbor-wide average Dissolved Oxygen (DO) values for both surface and bottom waters remained at record highs, 6.8 mg/L and 6.2 mg/L, respectively. Fecal Coliform (FC) and Enterococci summer geometric means were well below the New York State Department of Environmental Conservation Standards for bathing and all recreational use (200 cells/100mL for FC and 35 cells/100 mL for Entero). Chlorophyll 'a', Secchi Depth and Total Suspended Solids in the historical/open waters of the harbor have remained stable with slight fluctuations.

For the first time on record, both surface and bottom average DOs at all four regions exceeded 5.0 mg/L. It was also the first time average bottom DO in the UER-WLIS region reached a record high (5.1 mg/L).

Harbor-wide average DO levels at each sampling location were all above the NYSDEC Bathing Standard of 5.0 mg/L, except for a couple of areas in UER-WLIS and Grassy Bay in Jamaica Bay (DOs between 4.1 mg/L and 4.9 mg/L).

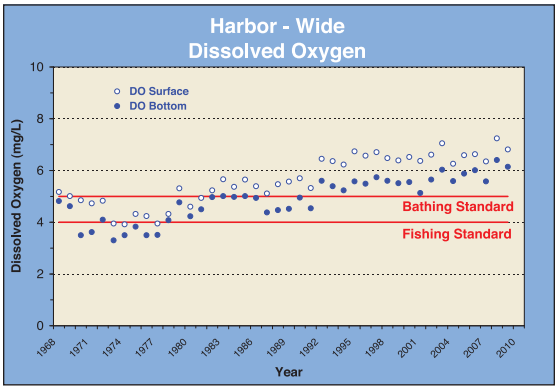
It should be noted that this year's bacterial geometric means were reported slightly high because the estimated 'Too Numerous to Count' (TNTC) values were included in the calculations.

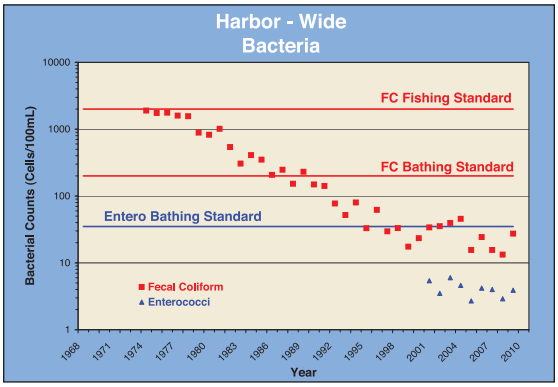
Despite the inclusion of TNTC data, the harbor's average FC count remained stable at levels in compliance with the Bathing Standard. All historical/open water stations had average FC values well below the Bathing Standard, except at Flushing Creek Mouth (E15) in UER-WLIS and Bergen Basin (J7) in Jamaica Bay. Short-term spikes do occur after rain events due to combined sewer overflow (CSO) discharges.

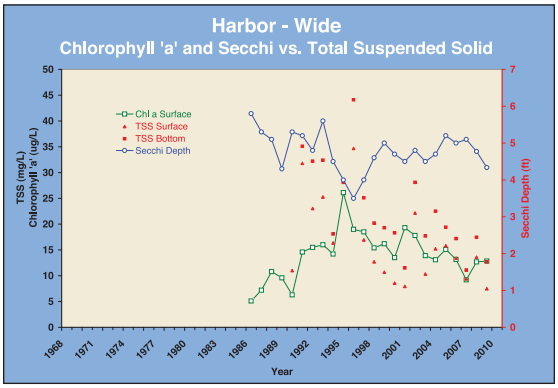
Enterococcus sampling over the last nine years has shown relatively stable average values, with spikes similar in size and frequency to the fecal coliform levels. As with the fecal averages, the enterococci averages for the historical/open water sampling locations remain well below the Bathing Standard (35 cells/100 mL). The NYC DEP's Long Term Control Plan (LTCP) is an ongoing project which has begun addressing CSOs and stormwater runoff.

In summer 2009, the harbor-wide chlorophyll 'a' average remained at the same level as in 2008; Both surface and bottom Total Suspended Solids and Secchi depth decreased.

The Harbor Survey has begun its integration into the LTCP. Additional stations in the East River (Alley Creek) and Jamaica Bay (Paerdegat Basin) have been added to our regular sampling rotation in 2009.

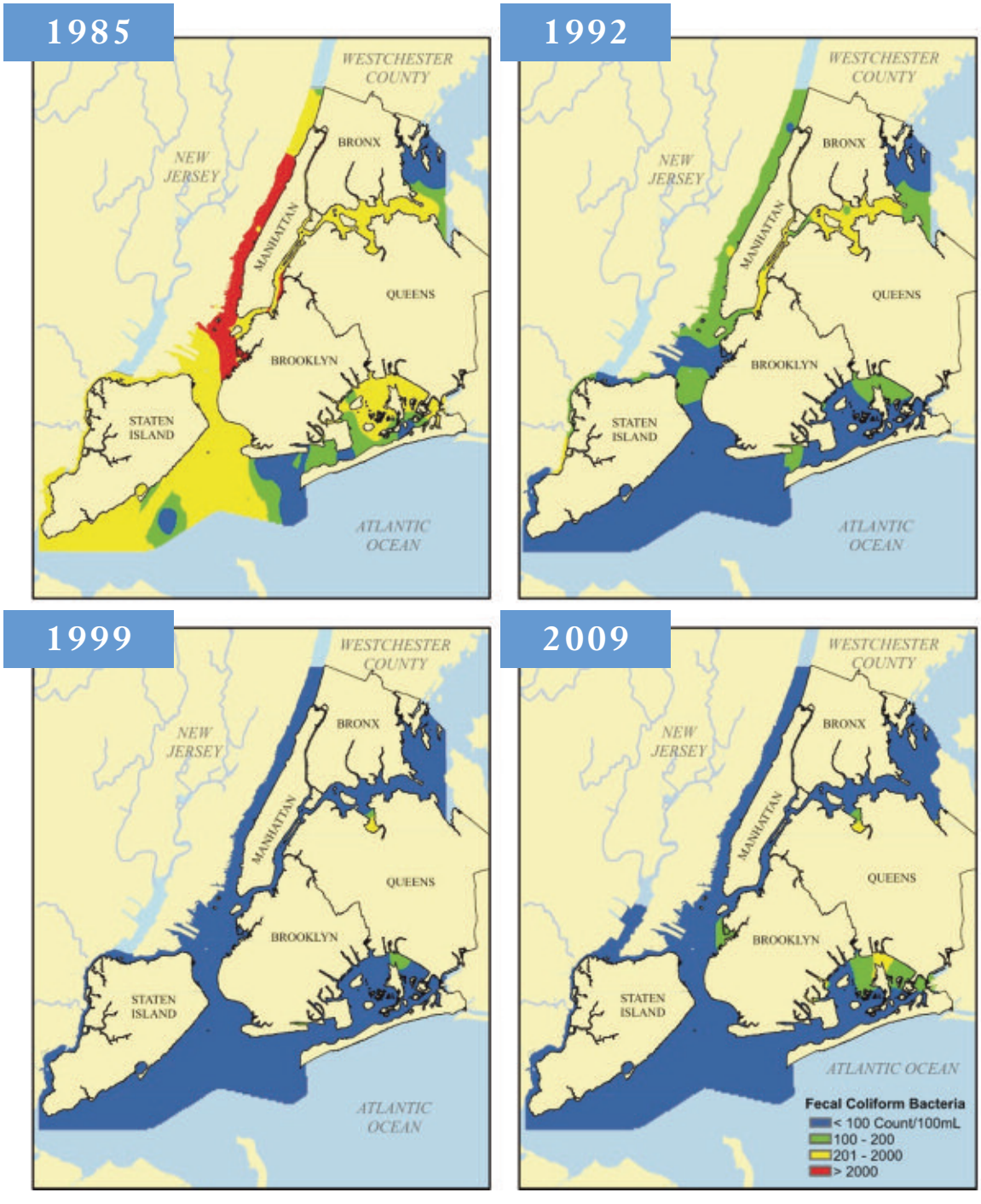






Harbor-Wide Water Quality Improvements Over Four Time Periods

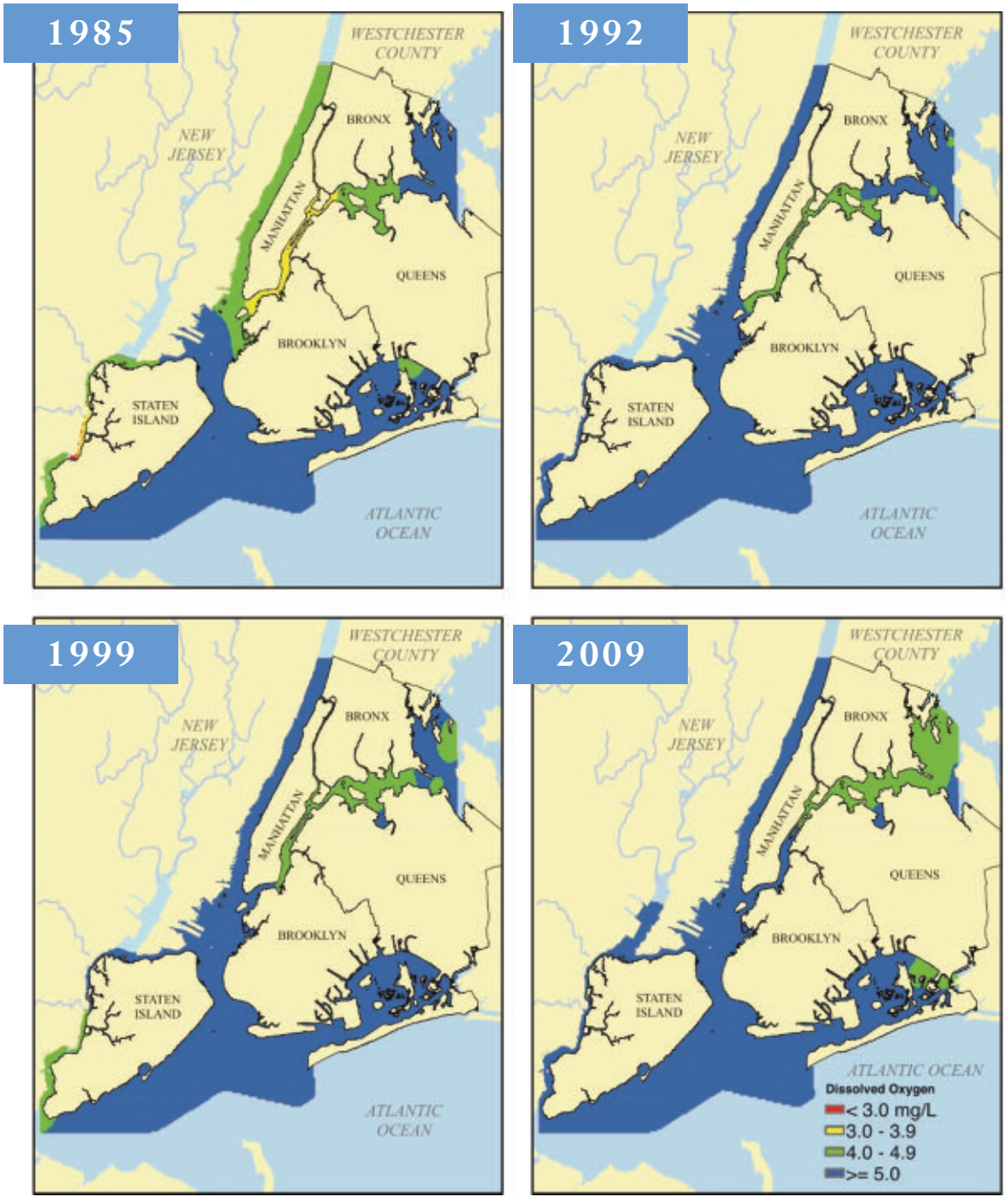
SUMMER GEOMETRIC MEANS FOR
FECAL COLIFORM IN SURFACE WATERS



NYS Best-Use Classifications: ≤200 FC/100 mL=SB (Bathing); ≤2000 FC/100 mL=I (Fishing).
NYC DOHMH requirements preclude bathing near sewer outfalls and where rainfall may substantially increase coliform levels.

Harbor-Wide Water Quality Improvements Over Four Time Periods

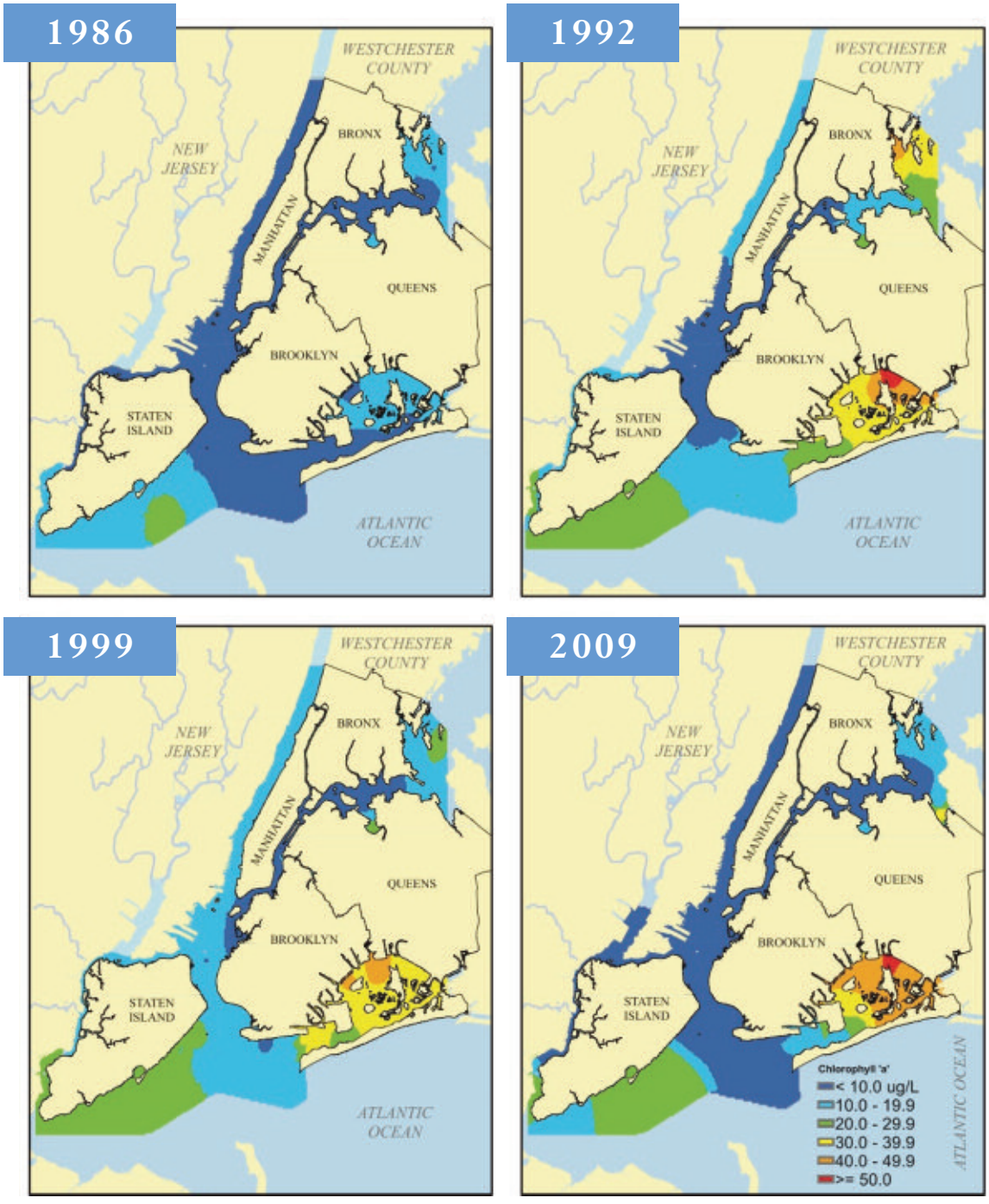
SUMMER AVERAGES FOR
DISSOLVED OXYGEN IN BOTTOM WATERS



NYS Best-Use Classifications: DO >5 mg/L=SB (Bathing); DO >4 mg/L=I (Fishing); DO >3 mg/L=SD (Fish Survival)

Harbor-Wide Water Quality Improvements Over Four Time Periods

SUMMER AVERAGES FOR
CHLOROPHYLL 'a' IN SURFACE WATERS



Chlorophyll 'a' >20 ug/L = Eutrophic conditions

2009 NYC DEP HARBOR SURVEY STATIONS

NYC DEP WASTEWATER TREATMENT PLANTS AND CSOs

Acknowledgments

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Credits: Photos taken by Carl Ambrose and Scott Foster, New York City DEP Photographers, and by Naji Yao, Stavros Georgiadis and Markus Koelbl, Marine Sciences Section, New York City DEP. Photos on pages 4, 7, 11, 13 (bottom), 15, 19 (bottom) and 21 (top) and cover, courtesy of Don Riepe/Jamaica Bay Guardian.

NYC Environmental Protection

HSV Osprey *working in Jamaica Bay*

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