

NEW YORK HARBOR

WATER QUALITY SURVEY

EXECUTIVE SUMMARY



RUDOLPH W. GIULIANI, MAYOR
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WHAT IS THE NEW YORK CITY DEP HARBOR SURVEY?

The Harbor Survey, funded primarily by NYC DEP and performed by the DEP's Marine Sciences Section, monitors the quality of the Harbor waters and identifies the impacts of the City's pollution control programs on these waters. This program provides the longest documented assessment of human impacts on the City's water environment. Through its sampling of a number of water quality and human-health related indicators, this survey: identifies changes in the environmental health and ecosystem quality of New York Harbor; describes long-term water quality trends; and provides a unique data base for regional scientists, educators, and private citizens.

NYC DEP performed its **88th Water Quality Survey of the New York Harbor in 1997**. The current monitoring program has developed from an effort begun by the Metropolitan Sewerage Commission in 1909, in response to public concerns about gross pollution in the Harbor. This program has continued to expand since the early 1900's when only twelve stations were used to record the impacts of sewage pollution. At present, DEP's Marine Sciences Section monitors 53 stations throughout the Harbor, measuring over a dozen water quality parameters for both surface and bottom waters.





WHAT IS THE STATE OF THE ENVIRONMENT IN NEW YORK HARBOR?

Based on water quality indicators and other performance measures, there is evidence that New York Harbor's environment is cleaner and the water quality better than they have been since the turn of the century. These range from the reestablishment of breeding populations of peregrine falcons and other waterfowl in several areas of the Harbor, to improved benthic (bottom-dwelling) communities in the lower New York Bay, and include:

- the opening of all NYC public beaches since 1992 and the lifting of wet-weather swimming advisories for all but three of these beaches;
- the upgrading of 68,000 acres of shellfish beds since 1985 and the removal of shellfishing restrictions for 30,000 acres off of the Rockaways and in Raritan Bay;
- signs of the reestablishment of shortnose sturgeon;
- decreases in chemical concentrations in fish tissues and a subsequent relaxing of state advisories on human consumption of striped bass in parts of the Hudson River;
- a 50-90% reduction from peak levels of priority pollutants in fine-grained sediment in the Hudson River.

HOW DID NEW YORK CITY ACCOMPLISH THESE IMPROVEMENTS?



New York City has implemented a suite of aggressive and innovative pollution control programs. In addition to these programs, NYC DEP has continued to develop and upgrade its sewage treatment system. These actions, together with operational improvements implemented over the past 10 years, have paid off. Today, NYC DEP has:

- virtually eliminated raw sewage discharges;
- reduced illegal discharges by more than 70%;
- increased wet-weather related floatables capture to almost 70%;
- increased capture of rainfall that enters the combined sewer system to an average of 41%;
- reduced toxic metals loading to the wastestream from industrial sources by over 90%.



HOW DOES THE HARBOR SURVEY PROGRAM MONITOR THE WATERS?

NYC DEP monitors a number of common water quality indicators. These include human health indicators, such as sewage-related coliform bacteria; and environmental health

indicators such as dissolved oxygen, nutrients, and plankton. Together these indicators provide information relative to the water's sanitary and aesthetic quality, ability to sustain aquatic life, and ecosystem productivity.

FIGURE 1

HARBOR SURVEY SAMPLING LOCATIONS



Water samples are collected from onboard the Harbor Survey Vessel, the Osprey, an aluminum-hulled 55-foot twin-engine diesel craft, at each of 53 stations (**Figure 1**) approximately 2-4 times per summer month. Additional year-round sampling (two times per month) for many parameters has been performed since October 1990.

A description of some of the major indicators used by the DEP Harbor Survey are described below.

FECAL COLIFORM 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 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.

DISSOLVED OXYGEN

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

NUTRIENTS

Nutrients, natural life-sustaining substances, are critical to maintaining an appropriate balance for the health and productivity of aquatic systems. High levels of nutrients or *eutrophication* is considered detrimental to aquatic habitats and diminishes the recreational value of these waters.

PLANKTON

Phytoplankton, minute free-floating aquatic plants and animals (zooplankton) form the basis of the food web. Since these organisms respond quickly to environmental changes, their abundance and diversity may serve as a measure of water quality and an indicator of greater ecosystem change.

The Harbor Survey analyzes plankton directly and measures chlorophyll 'a' (as a surrogate for phytoplankton) to provide an assessment of ecosystem health.

Chlorophyll 'a' is a plant pigment, the concentration of which in water is used as an estimate of productivity or phytoplankton abundance.





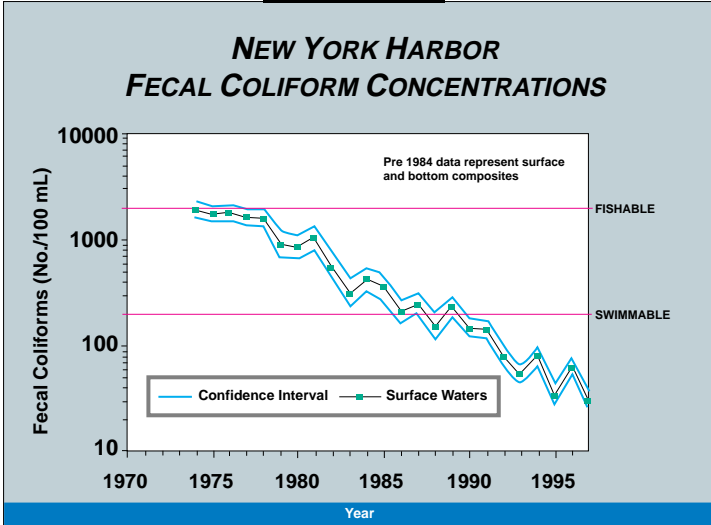
WHAT DOES THE HARBOR SURVEY SHOW?

The Harbor Survey began measuring fecal coliforms in 1974 to determine the sanitary quality of Harbor Waters. As depicted in **Figure 2**, fecal coliform concentrations in New York Harbor have decreased nearly two orders-of-magnitude from 1974 through 1997, with the most marked changes occurring from 1974 through 1987. These declines are primarily due to the abatement of raw sewage discharges through construction and upgrading of water pollution control plants (WPCPs). Further improvements since 1989 are attributed to increased surveillance and maintenance of the entire sewage collection system.

Untreated or partially treated sewage contains very high concentrations of coliform, which has been associated with the presence of pathogenic organisms. For this reason, New York State DEC has set fecal coliform standards to ensure that water quality is appropriate to support “best-use” classifications, such as swimming or fishing.

The above noted improvements to water quality as based on fecal coliform data are shown in **Figure 3**. Here, progressive improvement for four time periods (each reflective of enhanced sewage treatment and operational controls) is portrayed in terms of best-use classifications. While 1974 waters (Fig. 3a) did not meet levels appropriate for fishing in the inner Harbor area, nor swimming standards in outlying waters, significant improvement can be seen following plant expansion and upgrades (3b) and start-up of the City’s last two WPCPs (3c). Together, operation of the North River and Red Hook plants ended the discharge of 210 million gallons per day (mgd) of untreated sewage to the Manhattan and Brooklyn shorelines. Further water quality improvements (3d) are attributable to increased surveillance and maintenance of the entire sewage collection, which have resulted in the abatement of 2.2 mgd of illegal discharges, reduced raw sewage bypassing by 5.0 mgd, and increased capture of rainfall that enters the combined sewer system to an average of 41%, and over 90% in some drainage basins.

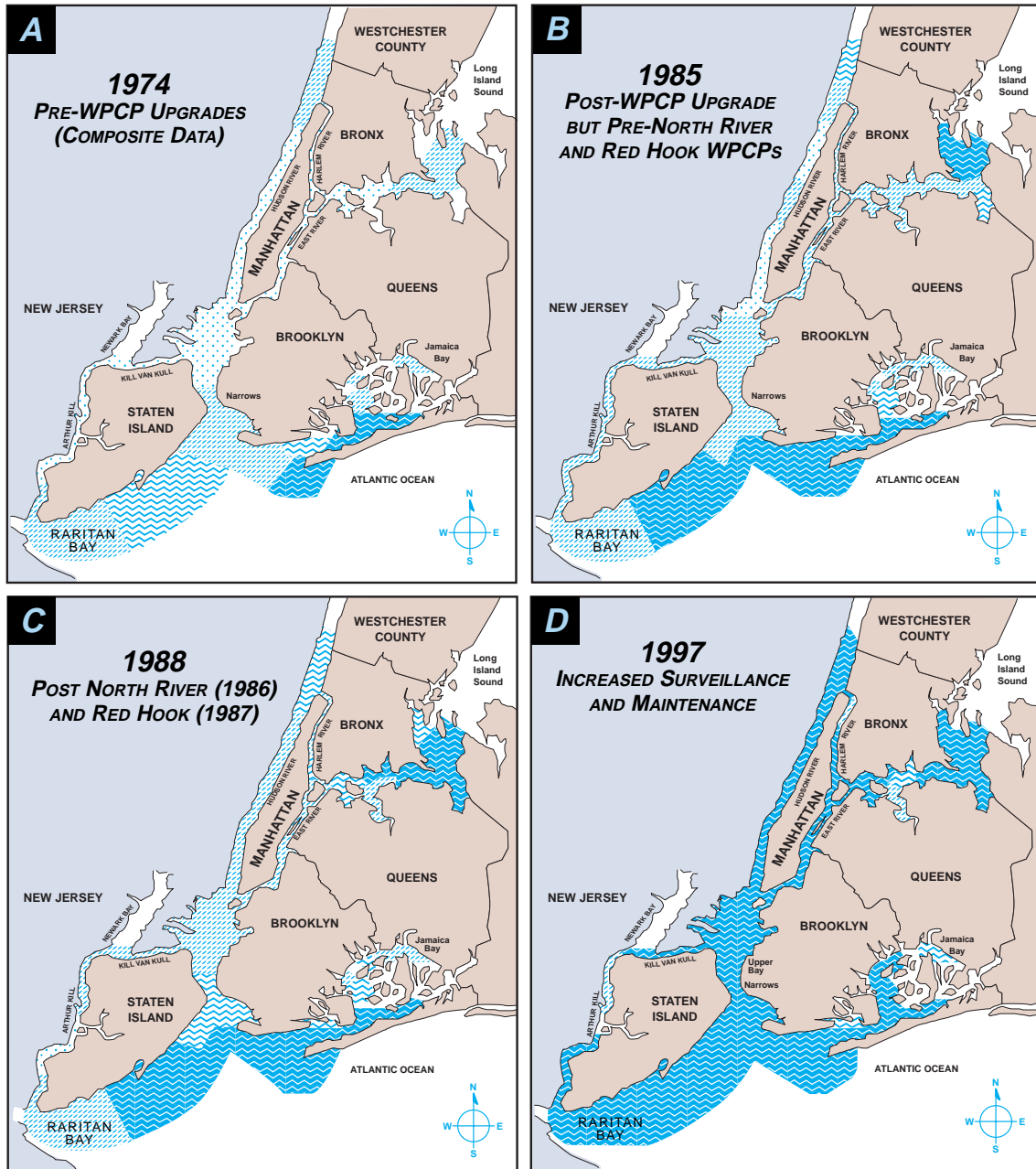
FIGURE 2



Data represents summer geometric means of 40 stations.

FIGURE 3

WATER QUALITY IMPROVEMENTS OVER FOUR TIME PERIODS
SUMMER GEOMETRIC MEANS FOR FECAL COLIFORM IN SURFACE WATERS



KEY: UNIT= Fecal Coliform Cells/100ml



NYS Best-Use Classifications: ≤ 200 FC Cells/100ml=SB (Bathing); ≤2000 FC Cells/100ml=I (Fishing)



HOW HAVE CLEANER WATERS BENEFITED NEW YORKERS?

BEACH REOPENINGS

Reduced sewage loadings to the Harbor has provided for greater recreational use of these waters. Harbor waters under dry weather conditions routinely meet their best-use classifications for fishable-swimmable, a goal projected by the Federal Clean Water Act. Harbor-wide declines in coliform loadings have led to the re-opening of Seagate Beach on Coney Island in 1988 for the first time in 40 years. In addition, South Beach and Midland Beach on Staten Island were re-opened in 1992 for the first time in 20 years.

The NYC Department of Health monitors coliform concentrations at NYC beaches to ensure that they meet swimming standards. In June of 1993 the NYC Department of Health's "wet weather advisory" was lifted at 7 of the NYC public beaches. At the remaining three city beaches, the advisory was reduced from a 48-hour ban on swimming after heavy rains to a 12-hour advisory. In 1997, there were only three instances where a public beach was closed due to water quality related problems (all instances occurred at Orchard Beach in the Bronx).



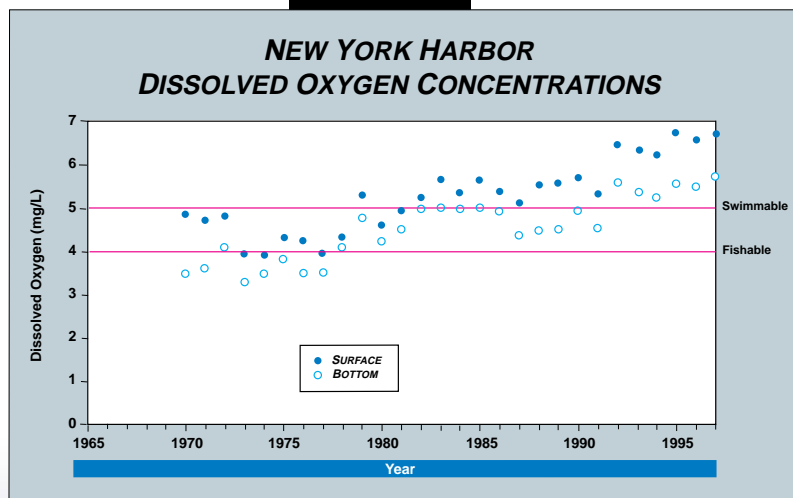


HOW HAVE CLEANER WATERS AFFECTED THE AQUATIC HABITAT?

Area-wide decreases in sewage loading have triggered greater environmental improvement in the Harbor. Indicative of this improvement are dissolved oxygen (DO) levels. When dissolved oxygen levels are too low, some fish and other organisms are not able to survive. Persistent low DO can cause a variety of sub-lethal effects, degrade habitats, and in severe cases, cause fish kills. Therefore, a higher DO level generally indicates better water quality and improved habitat for aquatic organisms.

Harbor Survey monitoring has documented significant harbor-wide increases in DO concentrations (~2mg/l) over the past 28 years (**Figure 4**). The greatest improvement has occurred in inner Harbor areas and the lower NY Bay-Raritan Bay waters. Of 53 stations monitored during the Summer of 1997, DO concentrations below 3 mg/L (defined as hypoxia) were recorded only a single time at four bottom stations in the Upper East River and Western Long Island Sound waters.

FIGURE 4



Data represents summer averages of 40 stations





Recent studies conducted by the United States Environmental Protection Agency and Connecticut Department of Environmental Protection have shown DO levels between 5 mg/L and 3.5 mg/L to be generally protective of all but the most sensitive aquatic species. Concentrations below 2 mg/L may cause severe effects, even for short periods of time. New York State standards for harbor DO range between 3 and 5 mg/L, depending, again, on the best-designated use of the waterway.

Today, average DO levels throughout the Harbor achieve standards for fishable-swimmable waters. These values met NYS standards through the Harbor in 1997, with the exception of one site in Western Long Island Sound. Average summer DO values for surface and bottom waters were never below 4 mg/L, with the vast majority of survey stations (40 of 53) having average values greater than 5 mg/L. As clearly shown in table 1, from 1992 and on, attainment of State DO standards is clearly better than previously achieved.

TABLE 1

COMPARISON OF SUMMER DISSOLVED OXYGEN (DO) AND NEW YORK STATE STANDARDS

Year	Number of Stations where average DO values were lower than the Standard	Number of Stations where DO values were lower than the Standard at least once
1986	9	45
1987	24	41
1988	20	44
1989	22	46
1990	8	39
1991	16	45
1992	2	30
1993	4	35
1994	8	35
1995	3	32
1996	5	31
1997	1	30

NYS DO standards require values to be "never-less-than" the regulatory numbers. In 1997, 30 out of the 53 Harbor Survey stations were out of compliance with the applicable standard at least once as based on either surface or bottom water measurements.

A somewhat less rigorous examination is to compare average summer DO values to standards. While not a true assessment of compliance, average values are more characteristic of summer conditions and allow for assessment of Harbor water quality improvement (or decline).



WHAT IS THE CONDITION OF THE GREATER AQUATIC ENVIRONMENT?

The Harbor Survey examines a number of other indicators to determine the status (or condition) of the aquatic environment. The discussion below focuses on inter-related parameters of nutrients, plankton, and chlorophyll 'a', to describe the current condition of the Harbor environment.

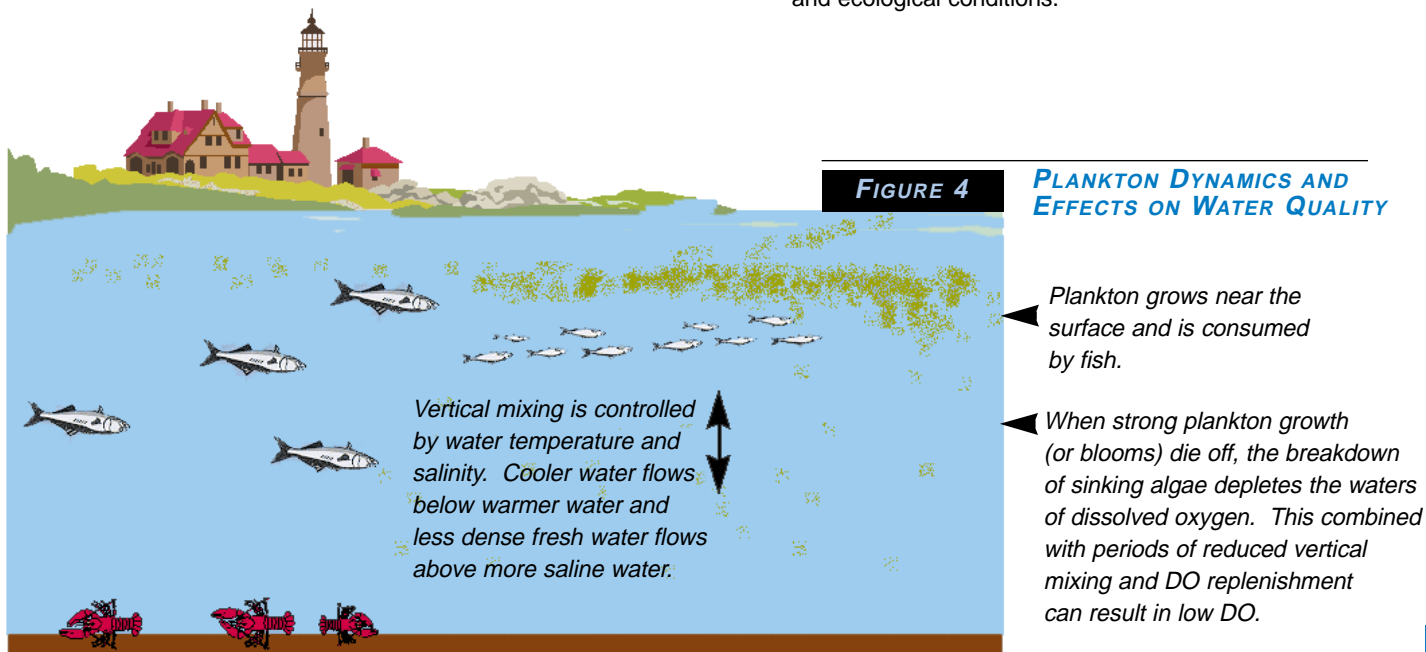
NUTRIENTS

When nutrients are added to a waterbody at excessive rates, waters may become enriched, resulting in a dramatic increase in productivity (plankton growth). Over-enrichment (or *eutrophication*) is a threat to water quality due to the cycle of excessive plankton growth and decay that it can trigger (see **Figure 5**). *Eutrophication* may produce symptoms that are not uncommon to portions of the Harbor during summer months. These include: reduced transparency; excessive plankton growth; low DO; and in extreme cases, fish kills. Together, these conditions may degrade habitat and reduce fish and shellfish productivity.

Trend analysis on 13 years of data reveals little significant change in nutrient concentrations for most Harbor Survey stations. Nitrogen and phosphorous, used as indicators of nutrient enrichment, continue to be found in high concentrations for most Harbor waters. This is likely due to consistent nutrient discharges from both point and nonpoint sources. Stations which have exhibited an increase in nutrients over time are located in Jamaica Bay and Flushing Bay. Both of those embayments seasonally display characteristics of eutrophic conditions.

NYC DEP is currently involved in a regional effort to implement aggressive actions for reducing Harbor nutrient loadings over the next 15 years.

Advanced secondary processes and innovative biological nutrient removal technologies are now being implemented and evaluated by NYC as part of the Long Island Sound Study agreement. This agreement calls for cost-effective reduction actions to be revisited every five years, pursuant to improved technologies and ecological conditions.



PLANKTON

The presence of algae or phytoplankton are reflective of water quality, with certain species and higher plankton concentrations evidence of eutrophic conditions or other water quality conditions.

Direct plankton counts and chlorophyll 'a' concentrations (a surrogate for phytoplankton) can vary in some areas dramatically over a period of days. This is due to the formation and dissipation of algal blooms which respond rapidly to environmental conditions. In the Harbor, high phytoplankton concentrations or *blooms* are most common in outlying areas (Western Long Island Sound and Lower NY Bay-Raritan Bay) and embayments (Flushing Bay and Jamaica Bay). Blooms are cyclic in their intensity and appear highest in early spring and late summer, with diatoms and green algae being predominate in the Harbor. High chlorophyll 'a' concentrations, common

to some areas of the Harbor, are typically associated with high phytoplankton growth, a decline in water transparency, and an increase in DO variability between top and bottom waters; conditions symptomatic of eutrophication.

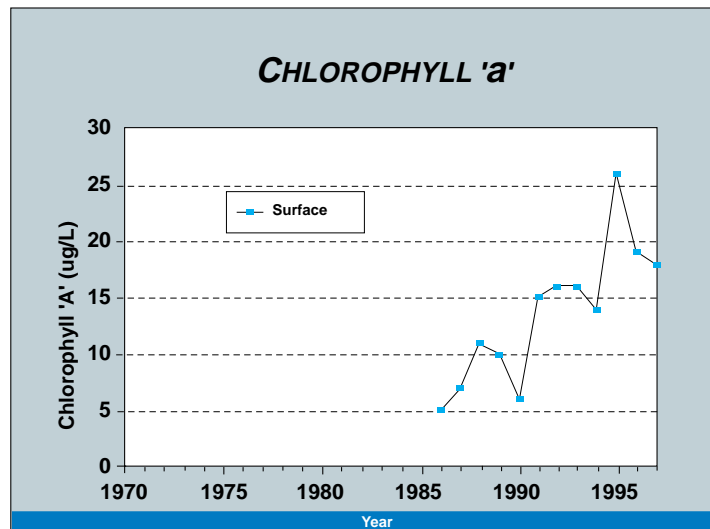
For most of the Harbor, however, phytoplankton concentrations are considered moderate and water quality conditions indicative of eutrophication are rare or only short-lived.

Trend analysis for chlorophyll 'a' reveals significant harborwide increases since 1989, (**Figure 6**) with some decline relative to peak 1995 concentrations. Further examination of this data shows harborwide trends to be largely influenced by strong chlorophyll 'a' increases in Jamaica Bay waters.

Future Harbor Survey efforts will further explore the effective use of plankton (and its relationship with chlorophyll 'a') as indicators of water quality and ecosystem health.

FIGURE 6

NEW YORK HARBOR CHLOROPHYLL 'a' CONCENTRATIONS



Data represents summer averages of 40 stations.



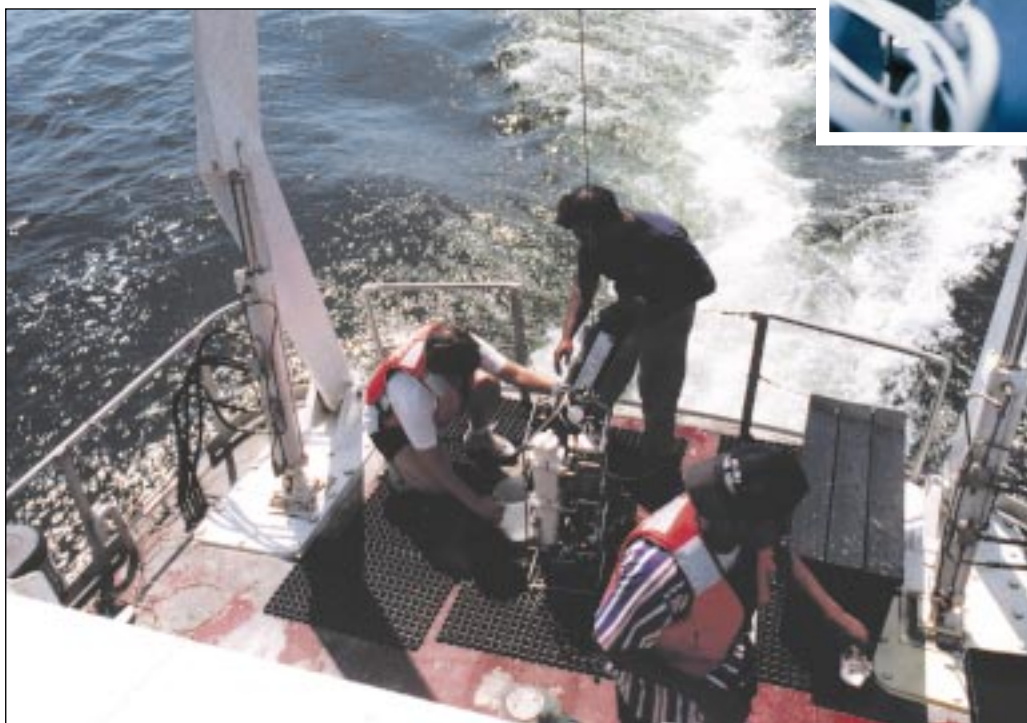
WHAT GREATER ECOSYSTEM IMPROVEMENTS HAVE BEEN DOCUMENTED?

Besides the improvements described above, the below findings provide further evidence of ecosystem improvement in New York Harbor:

- the re-establishment of breeding populations of peregrine falcons in several areas of the Harbor, herons, egrets and other wading birds in the Arthur Kill and Kill Van Kull, and ospreys in Jamaica Bay;
- the heavy re-infestation of woodpilings and pier structures by marine wood-borers and other marine life;
- fewer water quality related beach closings in NY and NJ and the virtual elimination of closures due to floatables (the last floatables closure occurring in 1989 for NYC and 1991 for NJ beaches);

- decreases in lead concentrations in the estuary and nationwide due to the federal ban on tetraethyl lead gasoline; sediment decreases of PCBs and the insecticides p,p-DDD and chlordane; and, the dramatic recovery of the 12-mile sludge disposal site in the NY Bight since dumping there ended in late 1987.

In the future, the *Harbor Survey Program* will strive to provide data more representative of ecological change, in addition to its primary data collection efforts.





WHAT REMAINS TO BE DONE?

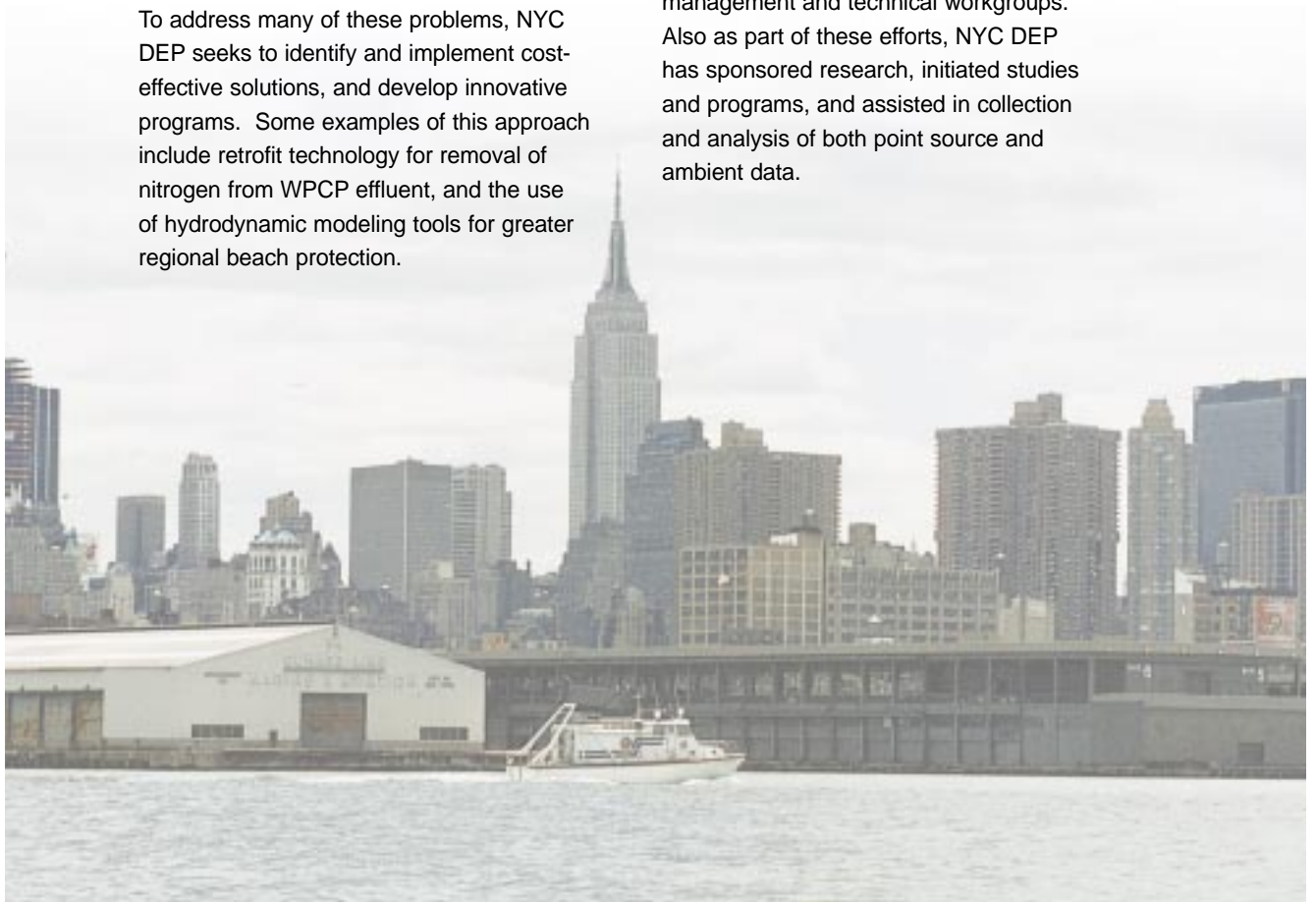
CONTINUING CHALLENGES

While the milestones noted above reflect important improvements to regional water and environmental quality, efforts to further enhance the region's estuarine resources continue. Despite noteworthy improvement to New York Harbor and its environs, many environmental problems are still unresolved. These concerns include: periodically closed shellfish beds and beaches; episodically low dissolved oxygen; areas of high sediment contaminant concentrations and problems with dredge disposal; floatables; fishing advisories; over-fishing; and, accelerating nonpoint source pollution from continued over-development within the drainage area.

To address many of these problems, NYC DEP seeks to identify and implement cost-effective solutions, and develop innovative programs. Some examples of this approach include retrofit technology for removal of nitrogen from WPCP effluent, and the use of hydrodynamic modeling tools for greater regional beach protection.

Many of the challenges which remain defy political boundaries and require a regional approach, involving many stakeholders throughout the estuarine drainage basin. These stakeholders often include a broad array of political entities. Effective environmental solutions must therefore address a diversity of priorities and needs.

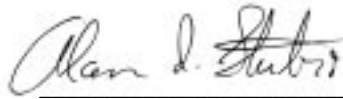
To best meet these challenges, NYC DEP has been active in two National Estuary Programs: *The New York/New Jersey Harbor Estuary Program* & *The New York Bight Restoration Plan*, and the *Long Island Sound Study*. NYC DEP has been a major participant in these regional efforts by means of its involvement in policy, management and technical workgroups. Also as part of these efforts, NYC DEP has sponsored research, initiated studies and programs, and assisted in collection and analysis of both point source and ambient data.



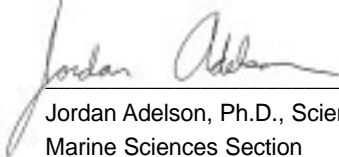
ACKNOWLEDGEMENTS

The Harbor Survey Program is made possible through the cooperative efforts of the New York City Department of Environmental Protection's Bureau of Wastewater Pollution Control, Marine Sciences Section, Special Projects Laboratory, and the Marine Section.

The City of New York
Department of Environmental Protection
Bureau of Wastewater Pollution Control
Marine Sciences Section
April 10, 1998



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IS MORE INFORMATION AVAILABLE?

This report briefly summarizes the quality of the Harbor's waters. For more information and a complete description of NYC DEP's monitoring and analysis of conditions in the Harbor, see the full ***New York Harbor Water Quality Survey***.

Concurrent with the Harbor Survey, several other DEP programs actively collect a variety of water quality and point source data.

Examples of these programs include:

- *the Combined Sewer Overflow Abatement Program;*
- *the Shoreline Survey Program;*
- *Storm Water Monitoring;*
- *Toxics Trackdown;*
- *the Landfill Remediation Program;*
- *the Citywide Floatables Program;*
- *Effluent Biomonitoring; and,*
- *Wetlands Protection.*

Data from these programs are also available upon request.

For more information about the Harbor Water Quality Survey or related NYC DEP programs, or to report suspected pollution of our waterways, please contact DEP's 24-Hour Help Center at 718-DEP-HELP (337-4357), or visit our Web site at:

www.ci.nyc.ny.us/dep



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BUREAU OF WASTEWATER POLLUTION CONTROL*



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