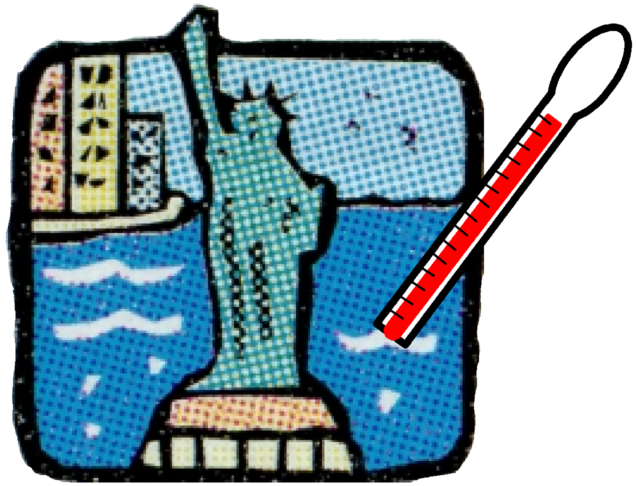
HARBOR HEALTH / HUMAN HEALTH



An Analysis of Environmental Indicators for the NY/NJ Harbor Estuary

New York / New Jersey
Harbor Estuary Program

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Report Credits

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Introduction

The health of the NY/NJ Harbor Estuary and the health of the more than 20 million people who live near it are inextricably related. Contaminants that enter our waters tend to bioaccumulate in fish and shellfish, sometimes causing warnings about their consumption to be issued. High levels of bacteria in the water can cause shellfish beds and beaches to be closed to human use to prevent people from getting sick. Steps that have been taken to protect or improve the environment often have as their ultimate goal the protection of human health, such as requiring sewage to be treated before it is released to our waterways. How do we know whether the steps that have been taken to safeguard the estuary have resulted in improvements in the environment or a decrease in risk to human health? We can look at trends in environmental indicators, vital signs of the status of the estuary. In some cases, where data have been collected over a number of years for a particular indicator, we can look at "temporal" trends; in other cases where data are collected at different locations at the same time, we can look at "spatial" trends to tell how different areas of the estuary compare to one another. Here we report on trends in environmental indicators recommended by the Harbor Estuary Program that are related to human health. Temporal and spatial trends are assessed as the existing data allow, and references to go to for further information are listed.

Generally, the news is good. Thanks to programs implemented under Federal and State environmental statutes, raw sewage and toxic materials are no longer discharged to the estuary to the extent they used to be. As a result, levels of contaminants in sediments and fish and concentrations of bacteria in the water have decreased over time. However, there is still room for much improvement. Consumption advisories against eating fish and shellfish caught in the estuary remain in effect due to levels of contaminants in their flesh. Combined sewer overflows (CSOs) still contribute raw sewage to our waterways when it rains. And some shellfish beds have remained closed for decades. Citizens, regulators, and scientists still must work together to realize the Harbor Estuary Program's vision: to establish and maintain a healthy and productive Harbor/Bight ecosystem with full beneficial uses.

Figure 1: The core area of concern for the NY/NJ Harbor Estuary Program (Harbor Core Area)

What is the NY/NJ Harbor Estuary Program?

The Harbor Estuary Program (HEP) is one of 28 National Estuary Programs around the country working to protect, preserve and restore our nation's estuarine treasures. The National Estuary Program is administered by EPA under the authorization of the Clean Water Act. Each program develops a Comprehensive Conservation and Management Plan (CCMP), a blueprint for restoration of each estuary. The HEP's CCMP was completed in 1996 and signed by Governor Whitman of New Jersey, Governor Pataki of New York, and Jeanne Fox, the Regional Administrator of the US EPA, on behalf of Carol Browner, the EPA Administrator. The HEP is now in the implementation phase, carrying out the more than 250 commitments and recommendations for action outlined in the CCMP. While most of the actions to be implemented are the responsibility of the states of New York and New Jersey, many other entities, including federal and local agencies, non-profit organizations, HEP work groups, business interests, and others have many responsibilities outlined in the plan as well.

Figure 2: Watershed of the NY/NJ Harbor

Geography: a Word about Watersheds

For the purposes of this report, we have focused on examining data collected in what is referred to as the Harbor Core Area (see Figure 1). However, activities that take place throughout the 16,000 square mile watershed (Figure 2) of the Harbor impact the estuary's health. Pesticides applied to agricultural land or lawns, industrial chemicals discharged to Hudson River tributaries, and sewage effluent from the entire watershed can eventually end up in the estuary. Accordingly, environmental protection actions need to consider this entire area in order to truly address the estuary's problems. This view of environmental protection is called a watershed approach to management.

Data Availability

For each of the indicators described in this report, there is a small bar graph representing the data availability for that indicator. These graphs show whether there are sufficient and easily obtainable data that adequately describe trends in that indicator spatially and over time.

Use of Benchmarks

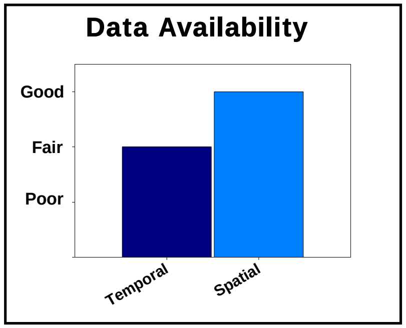
In presenting the spatial and temporal trends of the various indicators, this report employs the mostly widely used reference levels, or *benchmarks,* for each indicator. However, it is important to note that some of the benchmarks, particularly those related to toxic chemicals, are not universally accepted. Because of a number of factors, including our incomplete, though evolving, understanding of the human health effects of the contaminants of concern, these benchmarks will continue to be debated and updated in future years as new information is developed.

One example is the use of the *Effects Range* benchmark in the discussion of sediment contaminant concentrations. This measure has been endorsed by some agencies, criticized by others, and debated within the scientific community. It is, however, widely used as guidance, although it will likely be refined or perhaps even abandoned in the future as new research results become available.

Another example is the assessment of fish tissue concentrations in terms of U.S. Food and Drug Administration (FDA) action limits. In this document these limits are used as reference points because they are the only numeric government enforceable standards in effect in this region. However, it is important to recognize that the action limit for PCBs – 2 parts per million (ppm) – is 17 years old and increasingly criticized for failing to take into account current information about PCB health effects, especially in relation to recreational fish consumption patterns. More recent health guidance developed by eight states bordering the Great Lakes, using more current science, sets guidelines for fish consumption at much lower concentrations than the standing FDA limits.

Therefore, the use of the benchmarks in this report should not be viewed as endorsement of them by the authors or the Harbor Estuary Program. Futhermore, they must not be interpreted as absolute threshold limits for triggering human health effects. In many instances, it is likely that effects can occur at levels below the benchmarks.

Sediment Contamination



One of the most challenging and serious problems that the estuary faces is contamination of its sediments with a variety of organic and inorganic toxins, including PCBs, dioxin, mercury and other heavy metals, pesticides, and polycyclic aromatic hydrocarbons (PAHs, derivatives of petroleum and other products). While some of these contaminated sediments are vestiges of the pre-Clean Water Act industrial harbor, there are still active direct sources, including industrial discharges, leaks and spills and landfills and inputs from sewage treatment plants, combined sewer overflows and tributaries. These persistent contaminants cause a number of ecological and economic problems. One of the main pathways for contaminants to accumulate in the tissue of fish and shellfish people eat is through the food chain: contaminants build up in the bottom-associated organisms that feed in the sediments, which can then be consumed by blue crabs, striped bass, or any of the other estuary residents we would like to eat (see the discussions of contaminants in fish tissue [p. 15] and PCBs in striped bass [p. 13]). Another problem is that the disposal of contaminated sediment, dredged from the Harbor to ensure that the Port is navigable, is expensive and contentious.

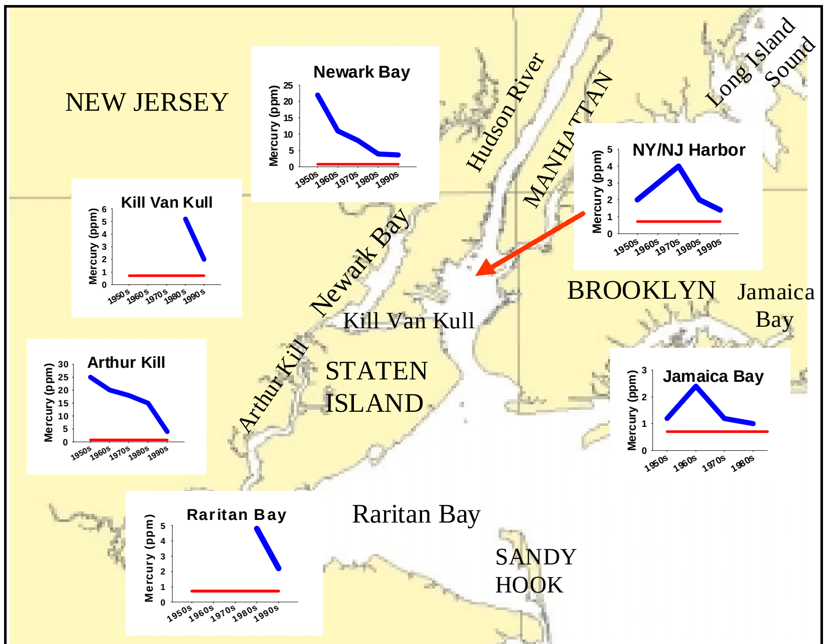


Figure 3: Trends in mercury concentrations in sediment. Red line indicates ER-M (see text). Data from Bopp 2000.

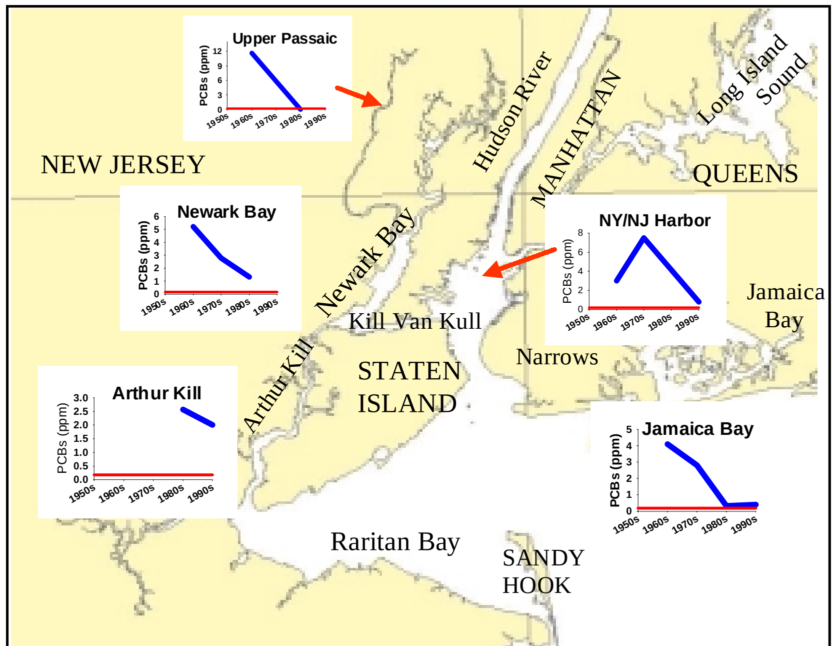


Figure 4: Trends in total PCB concentrations in sediment. Red line indicates ER-M (see text). Data from Bopp 2000.

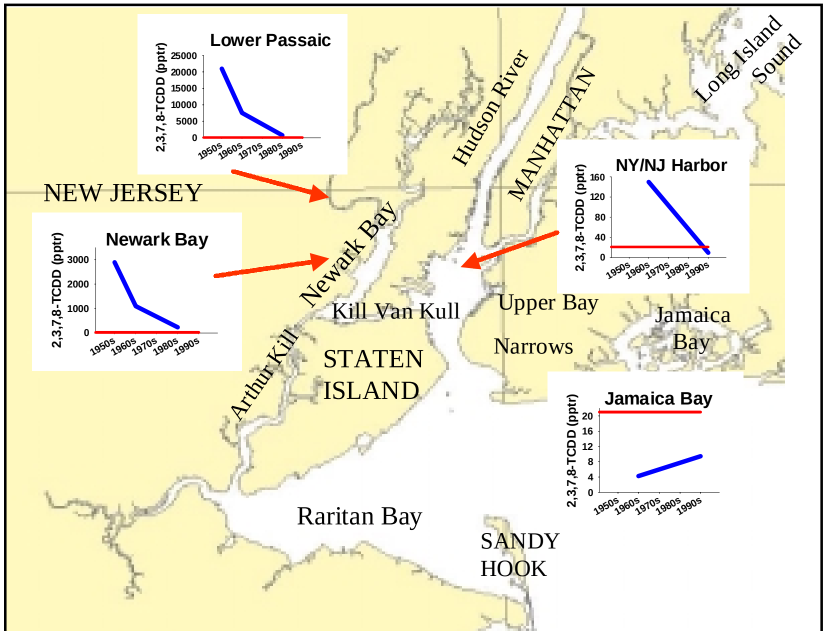


Figure 5: Trends in dioxin (2,3,7,8-TCDD) concentrations in sediment. Red line indicates ER-M (see text). Data from Bopp 2000.

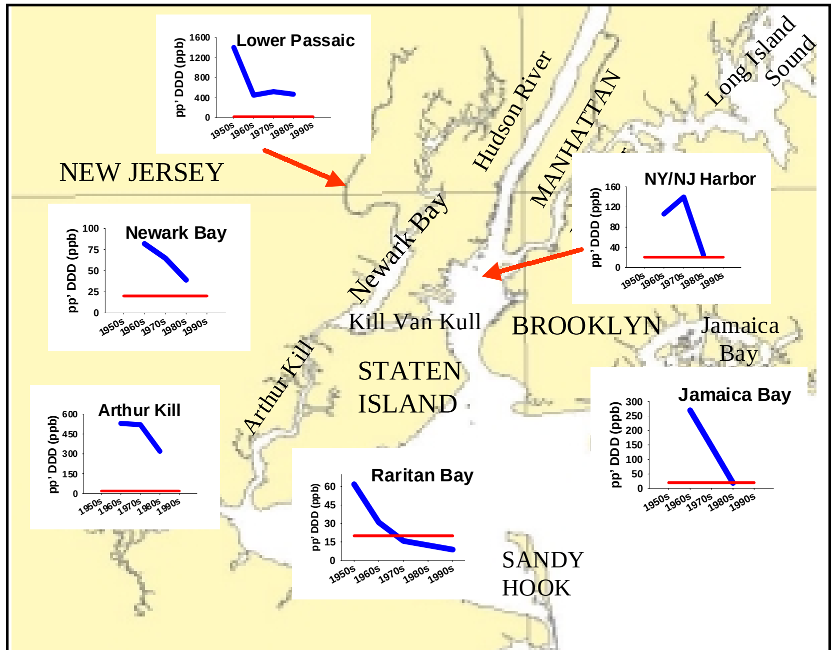


Figure 6: Trends in DDT (p,p-DDD) concentrations in sediment. Red line indicates ER-M (see text). Data from Bopp 2000.

Figures 3 through 6 show trends over time in sediment concentrations of mercury, PCBs, dioxin, and DDT (a pesticide), four contaminants which are of concern in the harbor and for which there are data describing their concentrations over time. These data were generated from taking cores — intact columns — of sediment from areas in the estuary where sediment is deposited in a uniform way. By looking at contaminant concentrations at different depths in the core which correspond to particular years or spans of years, a history of sediment contamination at that site can be generated.

During the past 30 years levels of most of these contaminants have decreased on average by about an order of magnitude (10-fold). This decrease is due mainly to the implementation of a number of control measures required by the Clean Water Act, in particular a strict permitting system for the discharge of these chemicals into our waterways and improved sewage treatment that removes from sewage effluent suspended particles to which many of these contaminants adhere. In addition, DDT and PCBs are now banned from production in the United States, so there are no active discharges of these chemicals (although leaks and spills of stored material are still a potential source to the estuary). The horizontal red line on each of these plots indicates the ER-M (effects range - median; see box on page 9) for that contaminant. In almost all cases contaminant levels in all areas are approaching or below that level. PCBs in the Arthur Kill and Newark Bay

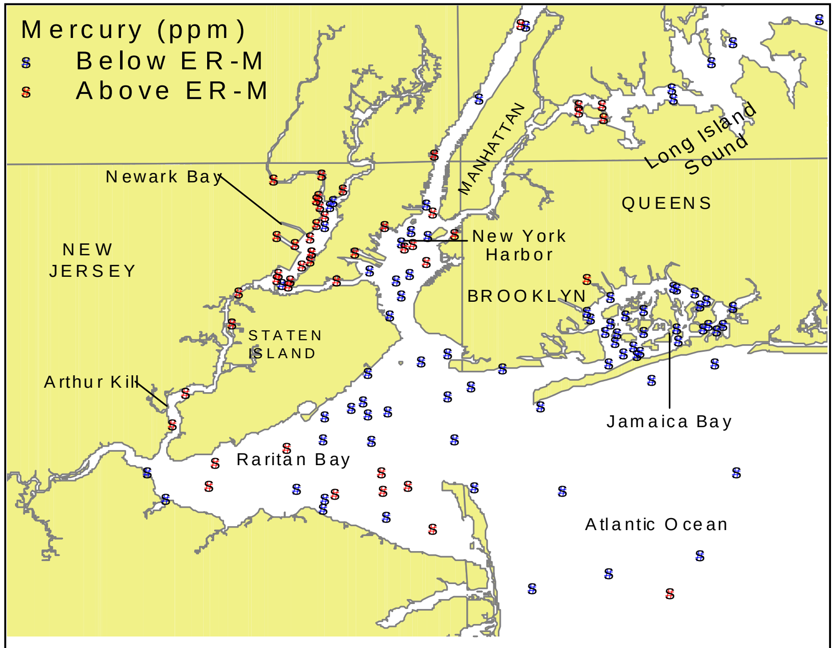


Figure 7: Mercury in sediments as compared to ER-M value (see text). Data from EPA 1998b

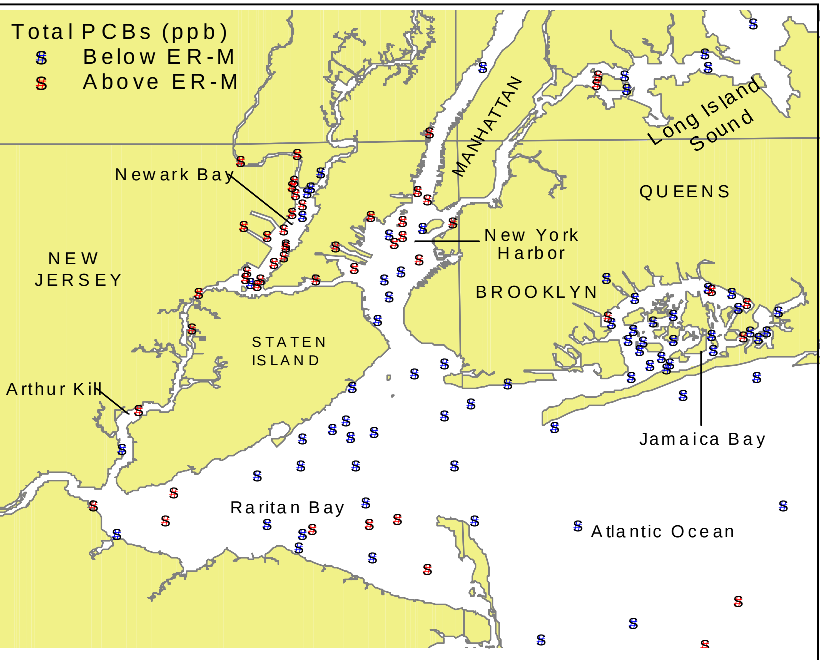


Figure 8: Total PCBs in sediments as compared to ER-M value (see text). Data from EPA 1998b

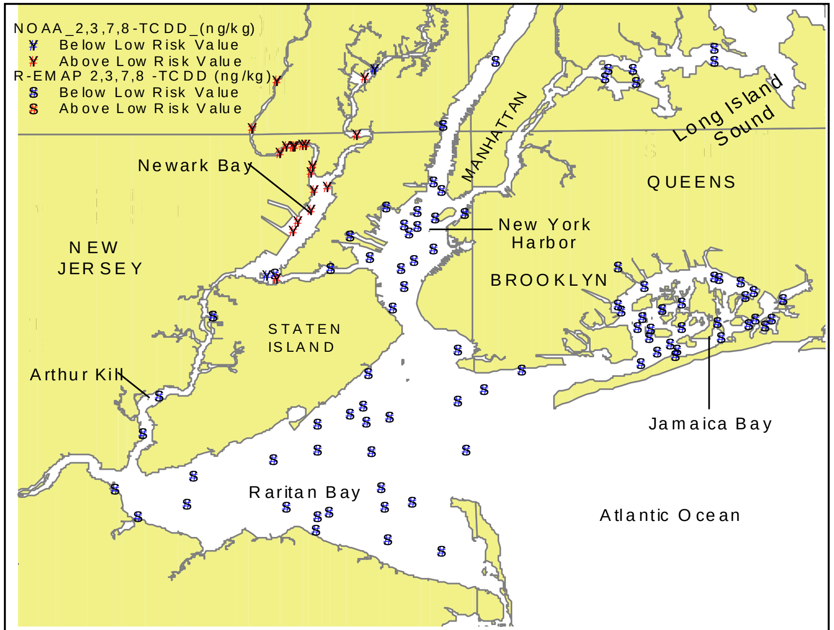


Figure 9: Dioxin (2,3,7,8-TCDD) in sediments as compared to EPA guidance value (see text). Data from EPA 1998b and NOAA 1995

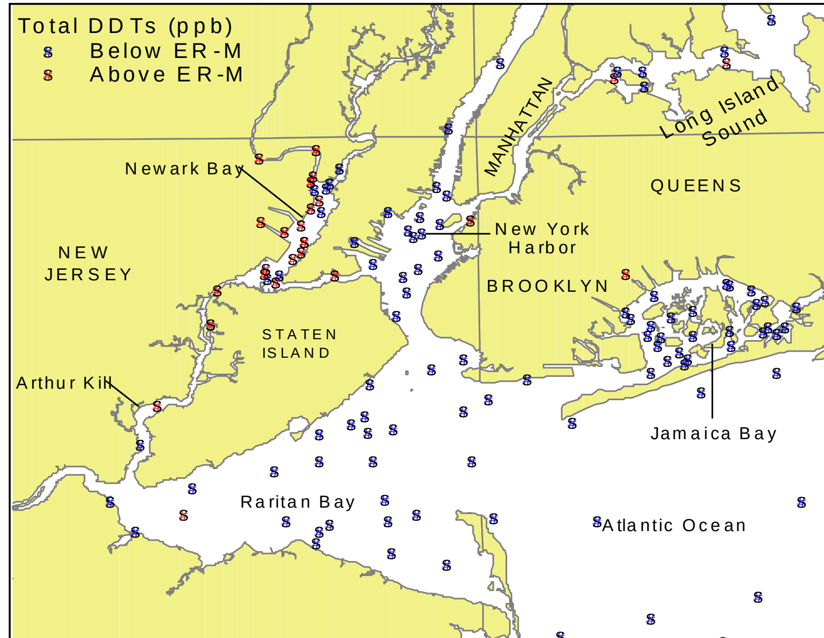


Figure 10: Total DDTs in sediments as compared to ER-M value (see text). Data from EPA 1998b

What is an Effects Range - Median?

The ER-M is a way of correlating sediment contamination with observed effects in organisms and communities. An ER-M is the median sediment contaminant concentration from a set of data where adverse biological effects have been observed. These values are not regulatory guidelines and they indicate only a correlation, rather than a causal relationship, but they are among the only guidance numbers available to examine the potential effects of sediment contamination. For dioxin, the EPA guidance value is slightly different from the ER-M and represents the sediment concentration at which there is high risk to mammalian wildlife consuming food contaminated with dioxin.

still exceed the ER-M in this analysis, as does mercury in many of the basins studied. DDT levels are high in the Lower Passaic River and just above the ER-M in Newark Bay and the Arthur Kill. Levels of some other important contaminants, notably PAHs, have not decreased at the same rates and are still of concern in the Harbor.

Figures 7 through 10 show the most recently-available data (1993 and 1994) on concentrations of the same contaminants geographically. Red symbols on all of the maps indicate sediment concentrations of that contaminant exceed the ER-M in that location. The most obvious consistency in these data is that the Newark Bay/Kills complex has the most exceedances for all chemicals. PCBs (Figure 5) and to a lesser extent mercury (Figure 6) are fairly widespread in the estuary while DDT and dioxin are more concentrated in the Passaic River, Newark Bay and the Arthur Kill. This distribution is at least partially due to the Diamond Alkali Superfund Site on the Passaic River, where there are high levels of dioxin and DDT at an old industrial site.

Although the news about trends in sediment contamination is generally good, many of these contaminant levels still exceed sediment quality guidelines, and cause dredged material to be categorized as too contaminated to dispose of in the ocean at the Historic Area Remediation Site (HARS), the old "Mud Dump Site." In addition, many important sources of these contaminants are still not known. The HEP has sponsored a major effort to quantify those sources, called the Contamination Assessment and Reduction Project (CARP), which is seeking to identify and quantify the sources of contaminants and then take steps to reduce or eliminate the most significant sources. Some of the non-point sources to the Harbor, such as CSOs, are suspected to be major contributors to the levels of contaminants in the estuary's sediments, but are very difficult and expensive to abate, so major challenges lie ahead. The CARP will also provide additional data points to the data sets used in this analysis, so that the trends can be updated to the present time.

For more information on sediment contamination:

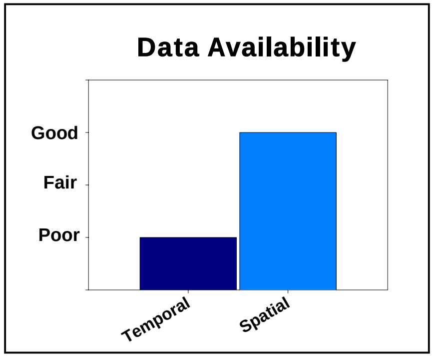
www.harborestuary.org/carp

www.rpi.edu/locker/69/000469/dx/harbor.www/harbor.html

ccma.nos.noaa.gov/NSandT/New_NSandT.html

www.epa.gov/emap/html/remap/two/nynjharbor.html

Sediment Toxicity



One way to determine the quality of marine sediments is to conduct toxicity testing with test organisms such as clams or small shrimp-like animals called amphipods. The amphipods are collected from pristine areas and brought into laboratories to be used in the experiments. Typically, these organisms are exposed to both clean and test sediments in experimental tanks for 10 days, and then the surviving animals are counted. The number surviving in the test sediments is compared to the number that survived in clean sediments to determine the effect of the test sediments on survival of the animals. Different testing programs have varying definitions of what results indicate that sediments are "toxic," but regardless of the definition, it is important to understand that these tests are designed to look at the impacts of sediment quality on the health of the

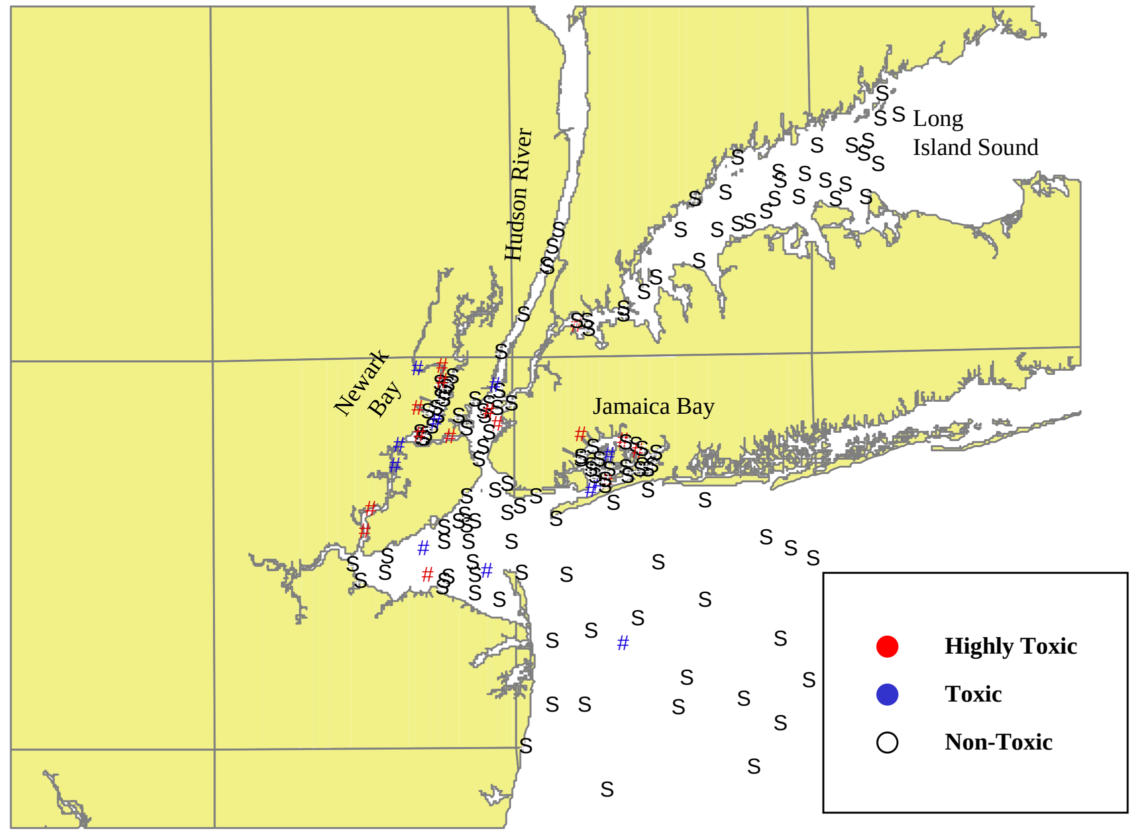


Figure 11: R-EMAP sediment toxicity results (using amphipod survival). Toxic sites are those at which less than 80% amphipod survival was observed compared to a control; at Highly Toxic sites less than 60% survival was observed. Data from US EPA 1998b

marine environment, not necessarily on human health. These tests also indicate toxicity caused by the mixture of contaminants in the test sediments -- they integrate the effects of multiple chemicals.

Figure 11 shows the results of toxicity testing conducted under EPA's Regional Environmental Monitoring and Assessment Program (R-EMAP) in 1993. This program exposed amphipods for 10 days to sediment samples from 28 different sites in six basins: the New York Bight Apex, Jamaica Bay, Western Long Island Sound, Newark Bay, Raritan Bay and the Upper Harbor/East River and to clean reference sediments. The results are expressed as amphipod survival as a percent of the survival observed in the reference tanks, such that if the same number of amphipods survived in the test sediments and the reference, the score would be 100%. If the percent survival was less than 80% at a site, those sediments are considered to be toxic. If survival was less than 60%, that site is considered to be highly toxic. The map in Figure 11 shows the "toxic" sites as blue dots and the "highly toxic" sites as red dots.

This analysis shows that the highest number of toxic sites was found in Newark Bay, with 11 of the 28 samples taken in the Bay classified as toxic or highly toxic. Jamaica Bay also seems to be an area of concern: 7 of the 28 samples taken there were found to be toxic or highly toxic. The areas of least concern with respect to sediment toxicity are Western Long Island Sound and the Bight Apex. Overall, the R-EMAP survey concluded that an estimated 75 km^2, or 15%, of the Harbor was toxic to amphipods and an additional 40 km^2 (8% of the total area) was highly toxic.

The National Oceanic and Atmospheric Administration (NOAA) conducted a variety of types of sediment toxicity testing throughout the Harbor in 1991. The four types of tests they used were (1) the amphipod toxicity test used by R-EMAP, (2) measuring the mortality rates and (3) development of clam larvae, and (4) examining the amount of bioluminescence (light production) exhibited by certain species of bacteria. Figure 12 shows sampling sites where statistically significant toxicity was observed in at least one of the four tests. Each circle represents a mean of three stations at that location.

Like the R-EMAP results in Figure 11, this analysis shows Newark Bay and the Kills to be areas of concern with respect to sediment toxicity. However, the East River and Sandy Hook Bay also show up as toxic in this analysis. Note that Jamaica Bay was not sampled in this program.

Taken together, these surveys suggest that there is some concern about sediment toxicity in most parts of the harbor. The sites of the most significant toxicity are generally consistent with the patterns of surface sediment concentrations of many contaminants (PCBs, DDT, mercury and dioxin; see Figures 7-10 and the discussion of sediment contamination). NOAA also measured concentrations of a variety of contaminants in the sediments at the sites it tested for toxicity, and found correlations between the amount of toxicity observed and contaminant concentration. For example, there was a strong relationship between amphipod survival in the toxicity tests and the concentration of total PCBs in the sediments. However, these analyses and correlations are not enough to prove that these sediment contaminants caused the toxicity observed. The relationship between toxicity and contaminant concentration is, thus far, *correlative* and not *causal*. In order to determine what exactly is causing the toxicity, whether it is a single contaminant or the additive effects of multiple contaminants or other

Sites in which toxicity results were significant in at least one test
S Non-toxic sites

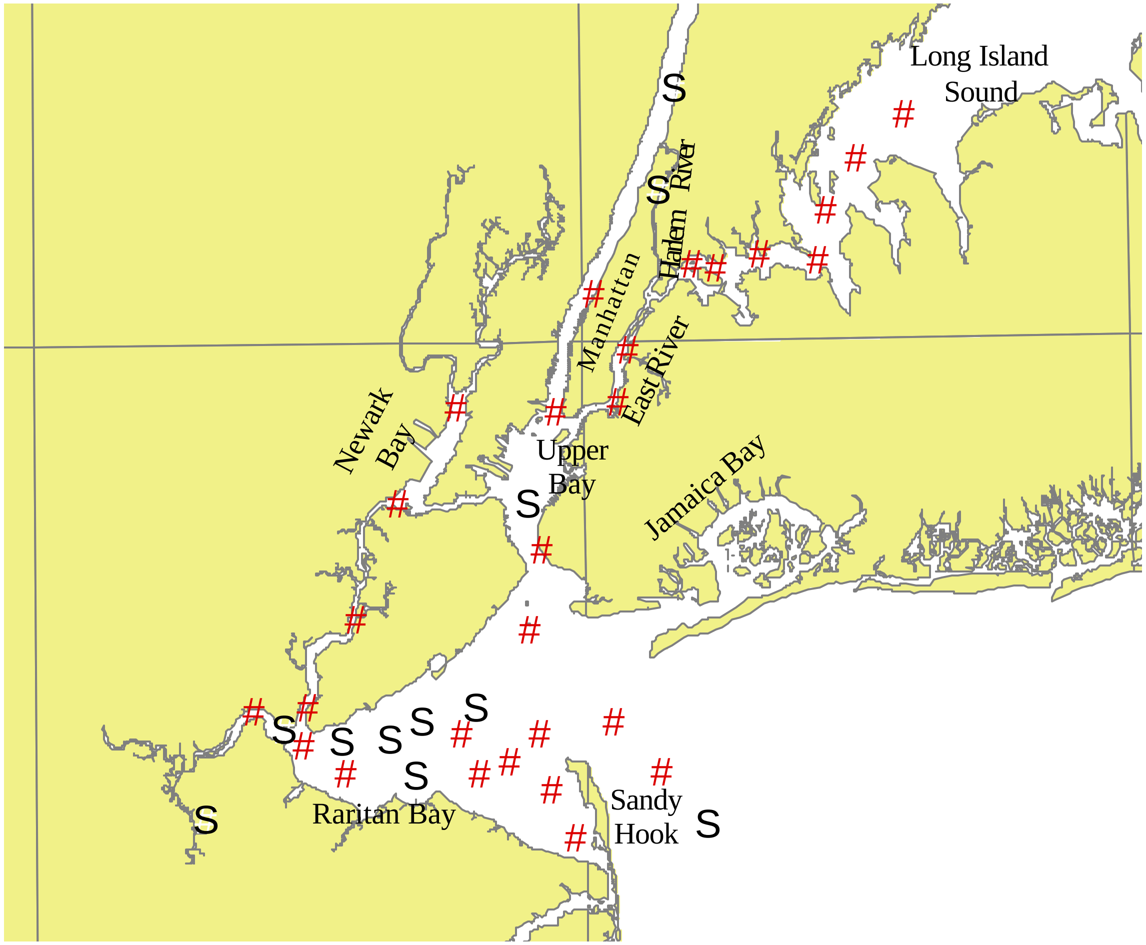


Figure 12: Results of four sediment toxicity testing methods. Red dots show sites where significant toxicity was observed in at least one of the four tests (see text for test descriptions). Data from NOAA 1995

stressors, Toxicity Identification Evaluations (TIEs) must be performed. These tests are specifically designed to determine what causes toxicity observed in toxicity tests. More of this kind of work needs to be done in the Harbor.

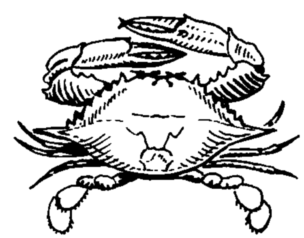
For more information on sediment toxicity:

Long, Ed et. al. 1995. NOAA Technical Memorandum NOS ORCA 88. Magnitude and Extent of Sediment Toxicity in the Hudson-Raritan Estuary.

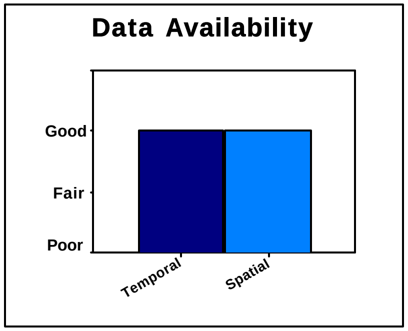
www.epa.gov/emap/html/remap/two/nynjharbor.html

www.cerc.usgs.gov/pubs/sedtox

response.restoration.noaa.gov/cpr/sediment/sediment.html



PCBs in Striped Bass



The most recognizable representative of the Hudson River Estuary's fish fauna is probably the striped bass, a prominent member of the aquatic community along the entire East Coast. Wherever it is found -- and regulations allow them to be harvested -- you can be sure that enthusiastic anglers and commercial fishers are not far behind. The Hudson River's striped bass population is the second largest on the East Coast.

Unfortunately, as with many other fish and crustacean species in our estuary, the flesh of striped bass is contaminated with a variety of organic chemicals, including PCBs. PCBs, or polychlorinated biphenyls, are a class of organic compounds used in a variety of consumer products and industrial applications from the 1940s to the 1970s, most notably in the production of capacitors and other electronic equipment by General Electric in the towns of Fort Edward and Hudson Falls, NY. During those decades, approximately 1.3 million pounds of PCBs were discharged to the river from the GE facilities, where they spread downstream and were found in unacceptably high levels in the flesh of resident and migratory fishes. Consequently, all fishing was banned in the upper river (a catch-and-release policy was implemented in 1995), the commercial fishery in the river was closed, and advisories on the consumption of striped bass and other species were issued throughout the estuary.

In addition to the GE facilities, there are sources of PCBs in the harbor itself, which are in the process of being quantified by the Harbor Estuary Program's Contaminant Assessment and Reduction Project. Contaminant research suggests that about half of the load of PCBs to New York Harbor comes over the Troy dam from the GE site and half is from local sources.

Figure 13 shows that levels of PCBs in striped bass greatly exceeded the 2 parts per million Food and Drug Administration action limit for commercial sale of fish (the red dotted line on the graph) when data were taken in the mid-1970s. As PCBs were no longer being actively discharged to the river, levels declined in striped bass throughout the 1970s and 1980s. In 1991, PCB levels increased again due to

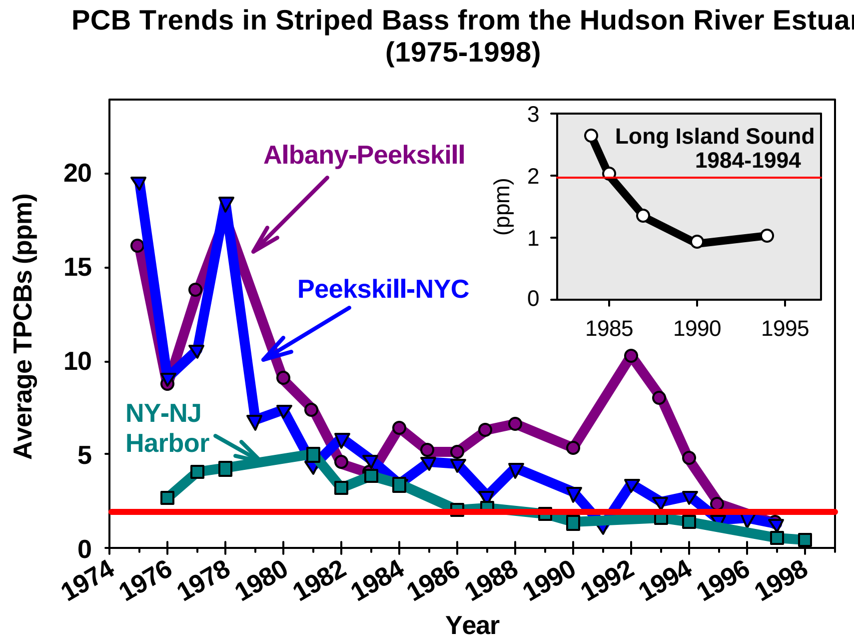


Figure 13: PCBs in striped bass. Red line indicates FDA guideline of 2 ppm. Data from Sloan 1995, Sloan 1999, and Sloan and Hattala 1991

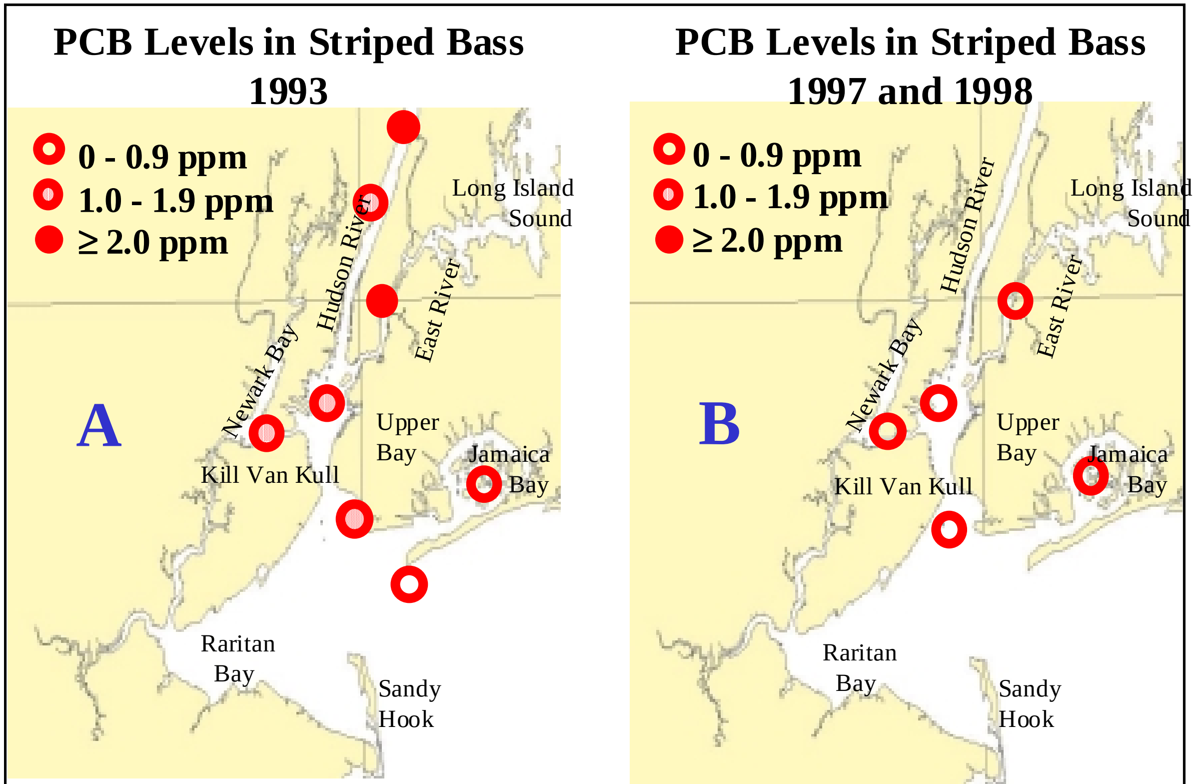


Figure 14 (A and B): Levels of PCBs in striped bass in 1993 and 1997/1998. Data from Sloan 1995, Sloan 1999, and Sloan and Hattala 1991

documented releases of PCB-bearing oil after the collapse of an abandoned mill structure adjacent to a GE facility. This increase is evident in the "Albany-Peekskill" line in Figure 13. Data from Long Island Sound fish are shown in the inset of Figure 13 for comparison purposes. Note that levels in Long Island Sound fish have also been decreasing over time, and are much lower than the 2 ppm level.

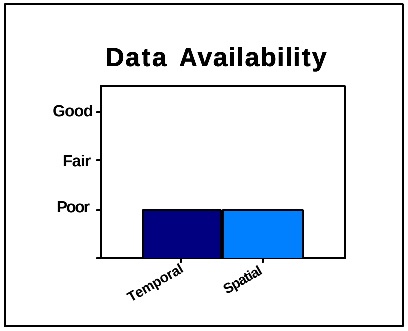
Levels in the Harbor Estuary have continued to decrease since the early '90s, and in the lower estuary average concentrations are now below the FDA guideline of 2 parts per million. These recent lower levels have prompted New York State to begin an evaluation of whether the current ban on the commercial harvest of striped bass can be lifted. Both New York and New Jersey continue to issue health advisories on the consumption of striped bass caught in the estuary. For a more complete discussion of fish consumption advisories, see the "Contaminants in Fish Tissue" section of this report (page 15) and the sidebar on consumption advisories.

A special intensive study of levels of a variety of contaminants in fish species in the Harbor was conducted under the auspices of the Harbor Estuary Program in 1993. Figure 14A shows the results of that study for PCB levels in striped bass. Generally, levels of PCBs were found to be higher upriver and decrease downstream to the lower levels observed in the New York Bight and Jamaica Bay. A later study, the results of which are shown in Figure 14B, found all levels in the lower estuary to be below 0.9 ppm, indicating improvement between 1993 and 1998.

For more information on PCBs and PCBs in striped bass:

www.epa.gov/hudson
www.epa.gov/toxteam/pcbid/defs.htm
www.dec.state.ny.us/website/dfwmr/habitat/nrd/index.htm
contaminants.fws.gov/restorationplans/HudsonRiver.cfm

Contaminants in Fish Tissue



High concentrations of contaminants in fish and shellfish tissue in the estuary cause the states of New York and New Jersey to issue consumption advisories for most estuarine species caught in sportfishing activities. The effects of these contaminants on the fish themselves are not well understood, but could include adverse impacts on reproduction, growth and development. Figures 15 through 19 show the mean and ranges of levels of a variety of contaminants in fish and shellfish species in the estuary, as measured in 1993. In most plots, the vertical line represents the level at which the US Food and Drug Administration limits commercial sale of fish; the states generally use this level as well as other considerations when conducting risk assessments on which their health advisories are based (see pages 19-20 for a more complete discussion of health advisories). The mean value measured for the given contaminant in that species is indicated by the box on the plot, and the range of values measured is indicated by the horizontal line and circles. If the range of observed concentrations of a given chemical does not exceed the established guideline (the vertical line) in a particular species, there is less cause for concern than if the observed range does exceed the limit (but it does not mean that consumption of fish below those levels is risk-free). Note that the states have not issued health advisories for the flounder species (see table on page 20). Flounders tend to be lower in contaminant levels most likely because they spend more of their time in the relatively clean Lower Bay and Bight rather than in the more contaminated areas of the Harbor.

Almost all of the mean observed concentrations (the boxes on the plots) fall below the action limit for that chemical, with the notable exceptions of dioxin (2,3,7,8-TCDD) and PCBs in blue crab and lobster hepatopancreas (the green substance commonly known as "tomalley"). The ranges of some contaminant concentrations still indicate some cause for concern in the cases of chlordane (a pesticide) in white perch and blue crab hepatopancreas, mercury in striped bass larger than 610 mm, dioxin in

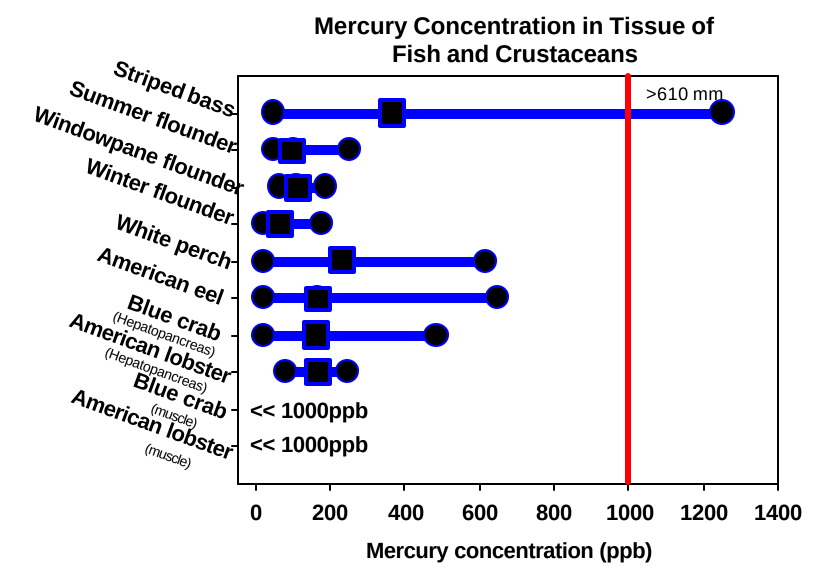


Figure 15: Mercury levels in selected finfish and crustacean species. All areas of the estuary combined. Red line indicates FDA guideline for commercial sale. Data from Skinner 1996a

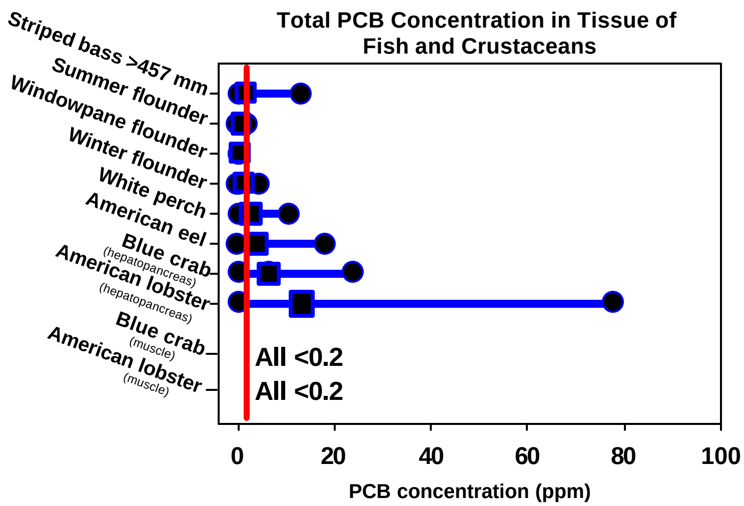


Figure 16: Total PCB levels in selected finfish and crustacean species. All areas of the estuary combined. Red line indicates FDA guideline for commercial sale. Data from Skinner 1996a

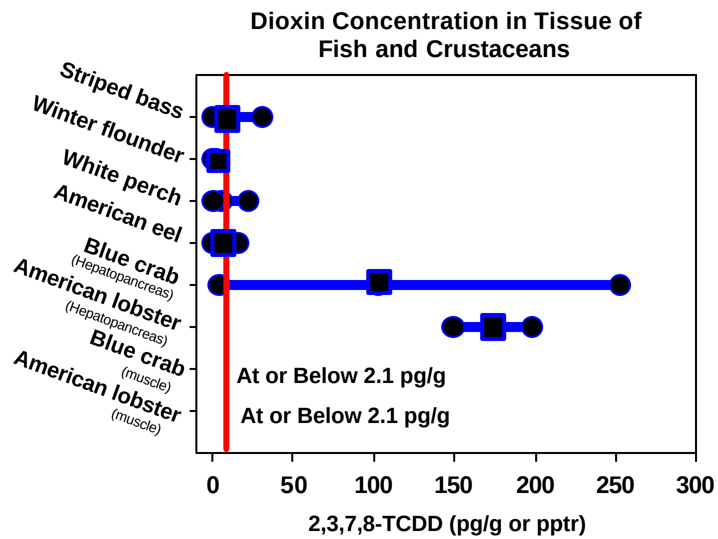


Figure 17: Dioxin (2,3,7,8-TCDD) levels in selected finfish and crustacean species. All areas of the estuary combined. Red line indicates NYS DOH limit for imposition of health advisories. Data from Skinner 1997b

striped bass and white perch, and PCBs in striped bass larger than 457 mm, winter flounder, and white perch. PCB ranges for summer flounder and windowpane flounder are also close to the action level. American eel exceed all of the guidelines except for mercury, most likely because as benthic species they live in constant close association with contaminated sediments and they do not migrate very far outside a very small home range. As a result, eels that live in contaminated areas tend to accumulate high levels of contaminants and do not depurate by migrating to cleaner areas. Note that while the levels of contaminants in crab and lobster hepatopancreas are high, the muscle tissue levels, the parts that are usually eaten, are too low to be detected. Consequently, it is advisable to refrain from eating the hepatopancreas when eating local crabs or lobsters.

Table 1 summarizes the data on these contaminants in fish and shellfish by geographic area within the estuary. An open circle in this figure means that no species are above the FDA (or NYSDOH) tolerance levels for that chemical in that basin, a half-filled circle means that one species is above the action limit and a filled circle means that two or more species are above the limit for that chemical in that basin. The geographic area in which the most exceedances of the limits were observed was the Newark Bay/Kills complex, while the Bight Apex had the fewest exceedances. The table also indicates that while PCBs and chlordane are of widespread concern throughout the estuary, DDT and mercury are not of major concern in terms of levels in fish, and dioxin is of concern in a few areas (although it has not been measured in

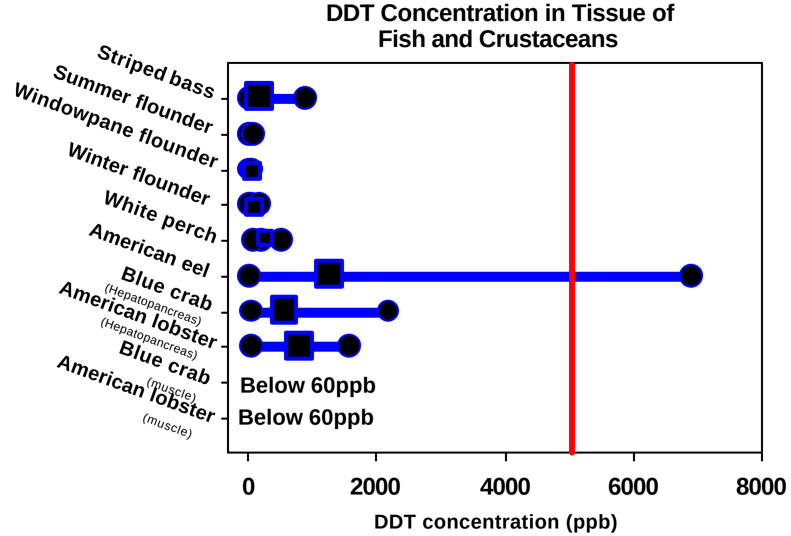


Figure 18: Total DDT levels in selected finfish and crustacean species. All areas of the estuary combined. Red line indicates FDA guideline for commercial sale. Data from Skinner 1996a

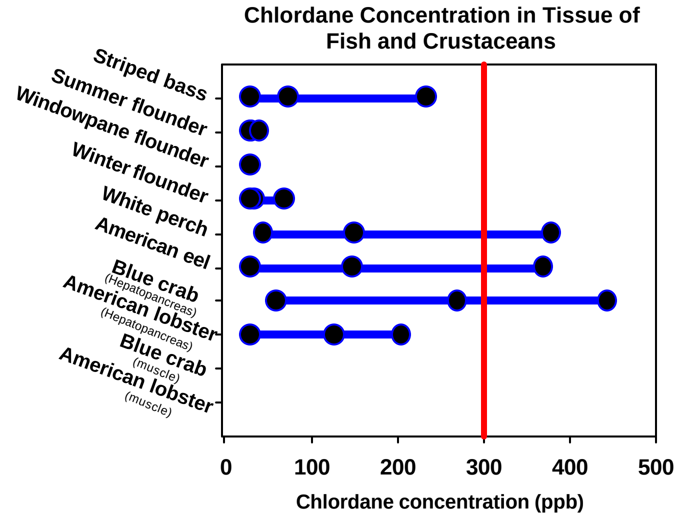


Figure 19: Chlordane levels in selected finfish and crustacean species. All areas of the estuary combined. Red line indicates FDA guideline. Data from Skinner 1996a

fish from all basins of the estuary). These results are consistent with the patterns in the levels of contaminants in the sediments in these basins (see page 5).

Taken as a whole, these results indicate that while the levels of contaminants in fish and shellfish are generally starting to decrease, reflecting the reduction in loadings of these chemicals to the environment, there are still some species, chemicals, and areas that are causes for concern with respect to human health. Health advisories issued by the two states should be followed and steps can be taken in the preparation of fish and shellfish that will reduce the risk associated with consumption of these species. See pages 19-20 for more information about the fish consumption advisories. However, even in those species where average contaminant levels are below the action levels, body burdens of contaminants may still pose a health risk to people if the fish are eaten, and may impact the animals themselves. In other words, an action limit is not a “magic” level below which there is no impact on humans or the ecosystem.

Incidence of High Contaminant Levels in Species from the Harbor Estuary

	Upper Bay	*Harlem/ East Rivers*	*Kills/ Newark Bay*	*Jamaica Bay*	*Lower Bay*	*NY Bight Apex*
PCBs	●	●	●	◐	●	◐
Chlordane	◐	●	●	●	◐	○
DDT	○	○	◐	○	○	○
Dioxins	●	ns	●	○	ns	◐
Mercury	○	◐	○	○	○	○

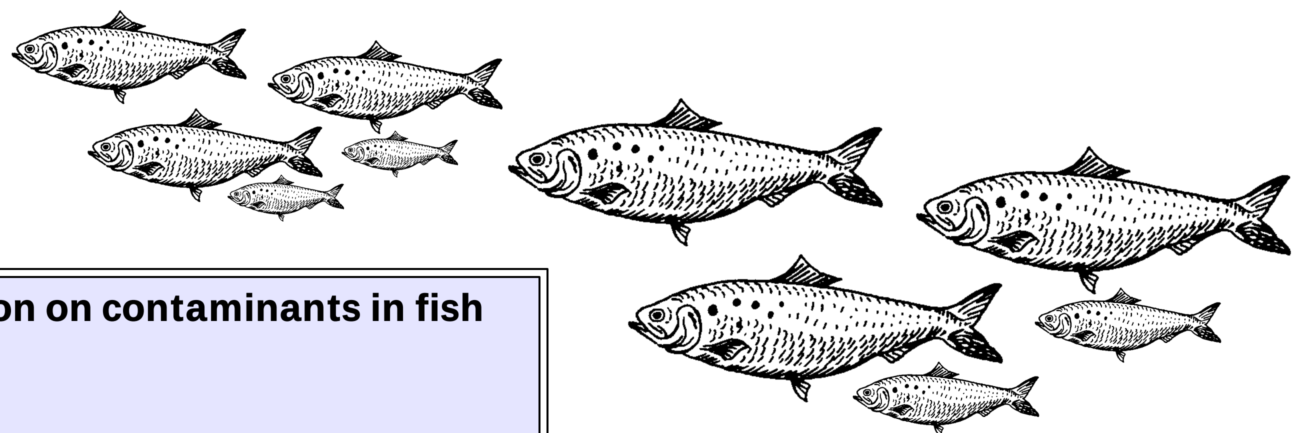
○ **No species above action limit**

◐ **1 species above action limit**

● **2 or more species above action limit**

ns **Not sampled**

Table 1: Incidence of contaminant levels in fish and crustaceans. Species included in this analysis are blue crab, American lobster, white perch, striped bass, American eel, winter flounder and windowpane flounder. Health advisories are in effect in all of the estuary segments in the table. Data from Skinner 1996a, 1996b, 1997a, 1997b



For more information on contaminants in fish and crustaceans:

www.epa.gov/ost/fish
www.health.state.ny.us/nysdoh/environ/fish.htm
www.state.nj.us/dep/dsr/njmainfish.htm
www.state.nj.us/dep/fgw/pdf/2001/digmar5.pdf

Fish Consumption Advisories in the NY / NJ Harbor Estuary

Because of the elevated levels of contaminants in fish and shellfish in the estuary, the states of New York and New Jersey both issue consumption advisories for many recreationally-caught species of fish and crustaceans.

The states consider a variety of factors in formulating their health advisories. One is how the levels of PCBs and other contaminants in the fish flesh compare to the US Food and Drug Administration action levels, by which the FDA regulates the commercial sale of fish. For a variety of reasons it is not appropriate to use *only* this level as a determining factor in devising health advisories for sportfish consumption. Other factors must also be considered, including the potential additive effects of multiple contaminants in the fish, the vulnerability of different types of individuals to disease caused by the contaminants, known *hot spots* of contamination, and the consumption rates of anglers, which are generally greater than average U.S. residents.

The state advisories therefore provide guidance about the amount and kind of fish, caught in specific areas, that can be consumed safely. ***In addition, both New York and New Jersey advise that women of childbearing age, infants and children under the age of 15 should not eat any of the species from any water bodies for which there are advisories.***

Table A on the next page outlines some of the fish consumption advisories issued by New York and New Jersey for estuary waters.

For full health advisories, go to
www.health.state.ny.us/nysdoh/environ/fish.htm (New York advisories) and
www.state.nj.us/dep/fgw/pdf/2001/digmar5.pdf (New Jersey advisories)

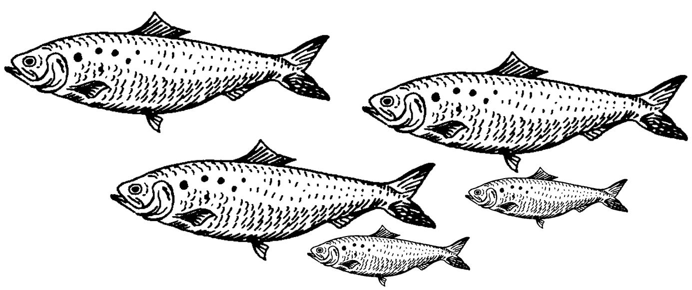
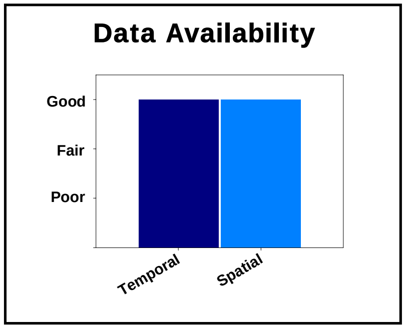


Table A: Fish consumption advisories, NY and NJ

Area	Species (note: not all species under advisories are listed here)	Chemicals of Concern	New York Advisory	New Jersey Advisory
East River & Harlem River	American eel	PCBs	Eat none	N/A
East River & Harlem River	Bluefish, striped bass	PCBs	No more than one meal per month	N/A
Hudson River, Upper Bay, Arthur Kill and Kill Van Kull	American eel	PCBs, dioxins, chlordane	No more than one meal per month	No more than one meal per week
Hudson River, Upper Bay, Arthur Kill and Kill Van Kull	Bluefish, striped bass	PCBs	No more than one meal per month	See below
Newark Bay, Hackensack River, Kills	Striped bass	PCBs, dioxins, chlordane	See above for NY advisory on Kills	Eat none
Newark Bay, Hackensack River, Kills	Bluefish over 6 lbs.	PCBs, dioxins, chlordane	See above for NY advisory on Kills	No more than one meal per week
Arthur Kill, Kill Van Kull	Blue crab	Cadmium, PCBs, dioxins, chlordane	No more than 6 crabs per week; do not eat hepatopancreas	Eat none
Hudson River, Upper Bay	Blue crab	PCBs, dioxins, chlordane	No more than 6 crabs per week; do not eat hepatopancreas	No more than one meal per week; do not eat hepatopancreas
Newark Bay, Hackensack & Passaic Rivers	Blue crab	PCBs, dioxins, chlordane	N/A	Eat none
Passaic River downstream of Dundee Dam	All species of fish and shellfish	PCBs, dioxins, chlordane	N/A	Eat none
Raritan Bay, Raritan River, Sandy Hook Bay	Bluefish over 6 lbs., striped bass	PCBs, dioxins, chlordane	N/A	No more than one meal per week
Raritan Bay, Raritan River, Sandy Hook Bay	Blue crab	PCBs, dioxins, chlordane	N/A	Do not eat hepatopancreas

In addition to these recommendations, both New York and New Jersey advise that women of childbearing age, infants and children under the age of 15 should not eat any of the species from any water bodies for which there are advisories.

Acres of Shellfish Beds Open



For more than 200 years, clams, mussels and oysters were a critical part of the Harbor's economy and of the diets of locals. Oysters in particular were large and plentiful in the harbor area, so much so that until the mid-1800s a major industry in the harbor region was the processing and export of oysters. The meats of "Rockaways," "Jamaicas," and "Amboys" were eagerly consumed, and the shells were used in construction materials. Hardshell and softshell clams were also important fisheries, particularly in Raritan Bay. As the human population increased in New York City and the surrounding region, pollution and development began to take their toll on the Harbor's water quality and on local shellfisheries. Although overharvesting and low dissolved oxygen levels in the water due to discharge of raw sewage to the Harbor caused the decline of shellfish populations in the estuary, ultimately the industry was devastated when cases of typhoid in the region were linked to contaminated oysters in 1924.

With the major improvements in sewage treatment and water quality that have occurred over the past 30 years, some areas are once again available for either direct shellfish harvest or relay (harvested shellfish are placed in clean waters to purge themselves of contaminants before being sold or consumed) or depuration (harvested shellfish are placed in tanks of cleaned treated seawater to remove contaminants from the shellfish before they are sold). State and local governments now assess the suitability of shellfish beds for harvest based on a variety of factors, primarily on levels of coliform bacteria found in the water. Other factors, such as historical water quality problems or presence of other pollutants, also influence these decisions. In New York, "administrative closures" (not based on bacterial measurements but based on circumstances known to cause shellfish to become contaminated) are maintained year-round near sewage treatment plants and near marinas in the boating season. Administrative closures are also issued in some areas after heavy rainfalls; bacterial sampling is conducted in these cases in order to determine when a bed should be reopened.

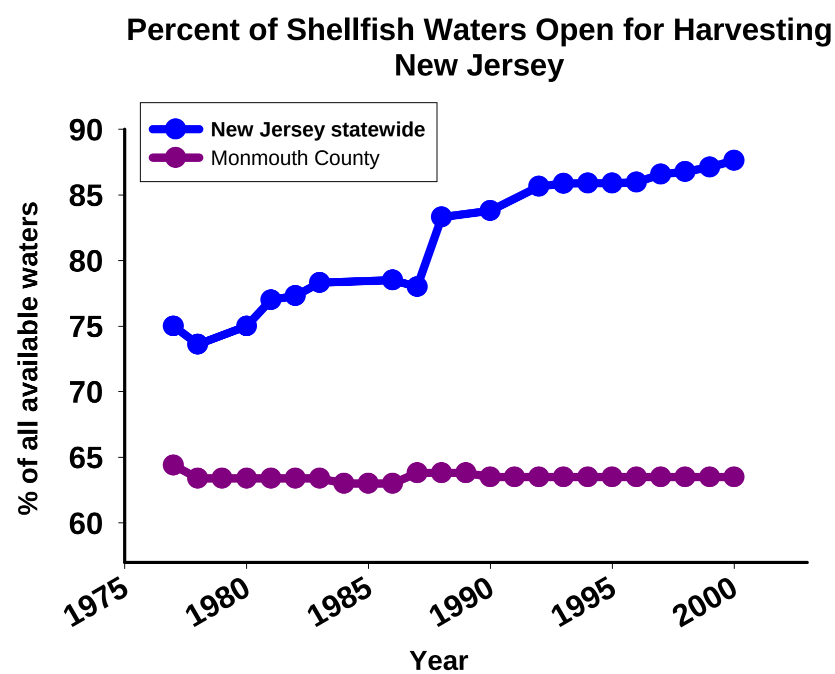


Figure 20: Shellfish beds open in New Jersey. Data from Eisele 2000

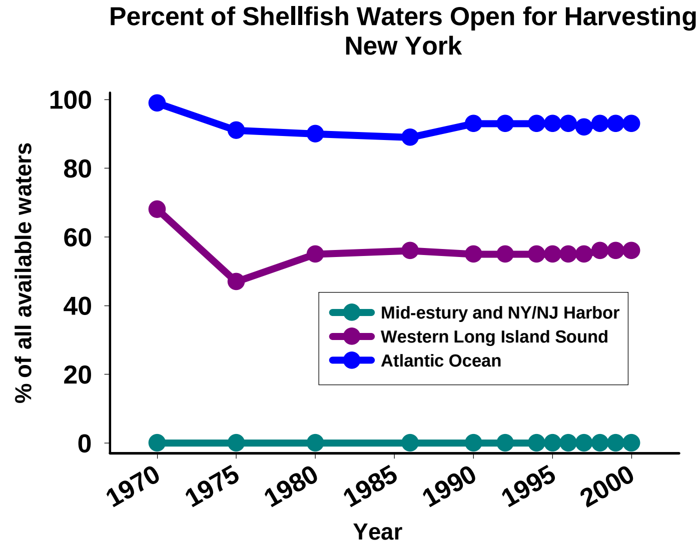


Figure 21: Shellfish beds open in New York. Data from Lewis 2000 and Barnes 2000

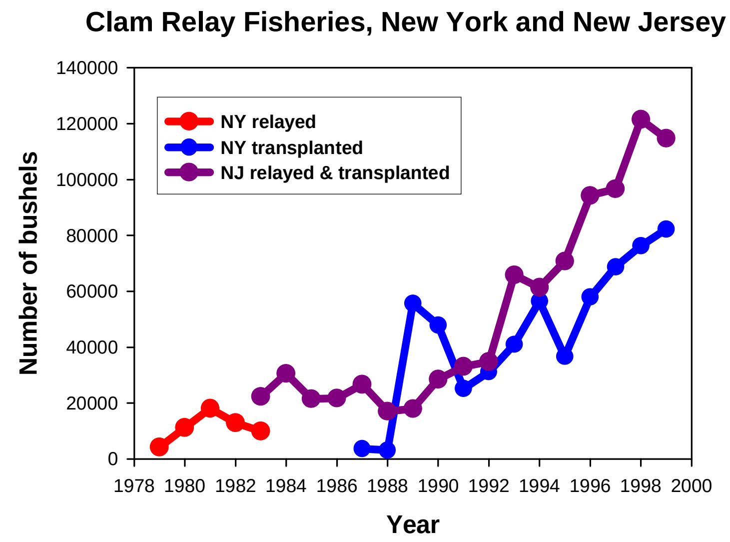


Figure 22: Relay and transplant fisheries in New York and New Jersey. Eisele 2000, Lewis 2000, Barnes 2000

While there are small differences in the ways in which the two states determine whether shellfish beds should be closed to harvest, both states follow the National Shellfish Sanitation Program guidelines established at the federal level for monitoring shellfish beds.

Figure 20 shows the percent of available shellfish bed area that has been open to harvest in the state of New Jersey from the mid-1970s to the present day. The increasing trend in open acreage statewide can be attributed to better water quality, mostly due to improved sewage treatment. However, open bed acreage in Monmouth County (Navesink and Shrewsbury Rivers, Sandy Hook and Raritan Bays) has remained fairly stable over the period shown. Many of the continuing closures are due to a variety of environmental concerns (presence of CSOs, historical chemical contamination) in addition to poor water quality (e.g., having characteristics such as low dissolved oxygen or high concentrations of coliform bacteria).

Figure 21 shows the percent of available shellfish bed area open for harvest in three New York water bodies: New York Bight, Western Long Island Sound, and the estuary from Peekskill to the Harbor. Due to concerns about persistent water quality problems and other pollution problems, direct harvest (i.e., without relay or depuration) of shellfish is not allowed anywhere in the Harbor itself. Over the time period depicted, the acreage of shellfish beds opened in the Bight and Western Long Island Sound has remained fairly stable.

Figure 22 shows the size of the relay fisheries in each state: the Raritan-Sandy Hook Bay fishery in New Jersey from the 1980s to the late 1990s and the Staten Island hard clam relay fishery from the late 1970s to the late 1990s. For New York, the red portion of the line shows bushels of clams that were relayed, or harvested from the environment and then placed in tanks on land to cleanse themselves for 48 hours. The depuration process was not used after 1983 for economic reasons. Starting in 1987 (the blue portion of the line), clams have been harvested from Raritan Bay and transplanted to areas in Long Island Sound and Peconic Bay for a minimum 21-day cleansing period. Over time, the amount of clams transplanted from Staten Island has risen from about 5,000 bushels to more than 80,000 bushels. In New Jersey, the amount of clams depurated and transplanted has grown from 20,000 bushels to about 120,000 bushels.

Generally speaking, as water quality has improved, more harvesting, particularly under the relay/depuration program, has taken place in both states, either because it has become safer to consume shellfish from the estuary or because improvements in water quality led to increases in shellfish populations and increases in the number of people harvesting shellfish commercially.

For more information on:

Shellfisheries in the estuary:

The Fisheries of Raritan Bay, by Clyde L. McKenzie, Jr. (Rutgers University Press, 1992)

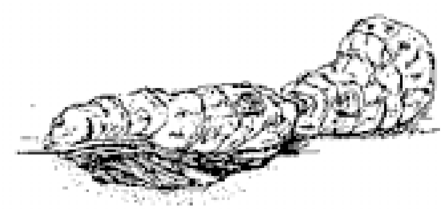
Heartbeats in the Muck, by John Waldman (Lyons Press, 1999)

Shellfish and shellfish bed monitoring:

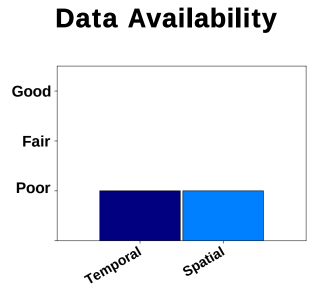
www.state.nj.us/dep/fgw/shellhome.htm
www.dec.state.ny.us/website/dfwmr/marine/index.htm
www.vertigo.hsrl.rutgers.edu
www.shellfish.org

Oyster restoration project in New York Harbor:

www.nynjbaykeeper.org



Disease Linked to Contaminated Shellfish



The decline of the shellfishing industry in the harbor, particularly the oyster fishery, was hastened when outbreaks of typhoid in the area were linked to consumption of contaminated oysters (see the section on shellfish beds, page 21). For example, in 1924 an oyster-related typhoid outbreak was traced to oysters harvested from Raritan Bay. This outbreak caused 1500 illnesses and resulted in 150 deaths. As a result, the Surgeon General of the U.S. established the National Shellfish Sanitation Program (NSSP) in 1925 to classify shellfish waters, inspect shellfish dealers, and address the public health issues associated with shellfish harvest.

Most of the shellfish that people eat are filter feeders, meaning that they pump water through their system to filter out phytoplankton (microscopic plants) as their food source. In polluted waters they may also filter and accumulate contaminants such as disease-causing bacteria and viruses. These disease-causing organisms, which usually come from human sewage sources such as combined sewer overflows, illegal sewer bypasses, sewage treatment plant malfunctions, and boat discharges, can become concentrated in the guts of the shellfish and ultimately may cause a variety of illnesses in humans. These illnesses include typhoid fever and cholera (caused by bacteria) and viral gastroenteritis and hepatitis (caused by viruses). With the advent of advanced sewage treatment in the past 30 years, sources have been greatly reduced, as has the risk of becoming sick from eating shellfish grown in Harbor waters.

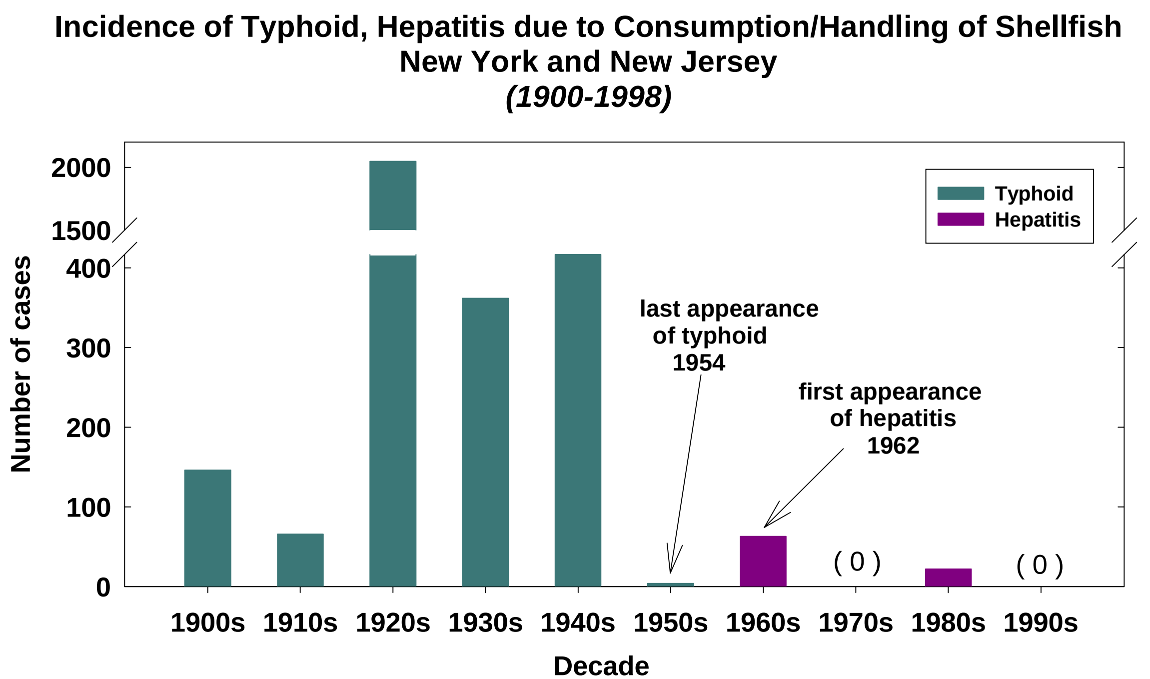


Figure 23: Incidence of typhoid and hepatitis traced to contaminated shellfish. Data from Horn 1990 and Wolf 2001

It is important to note that even shellfish harvested from seemingly pristine waters, if consumed raw, can cause disease if they have been feeding on disease-causing organisms or if they are mishandled and contaminated after

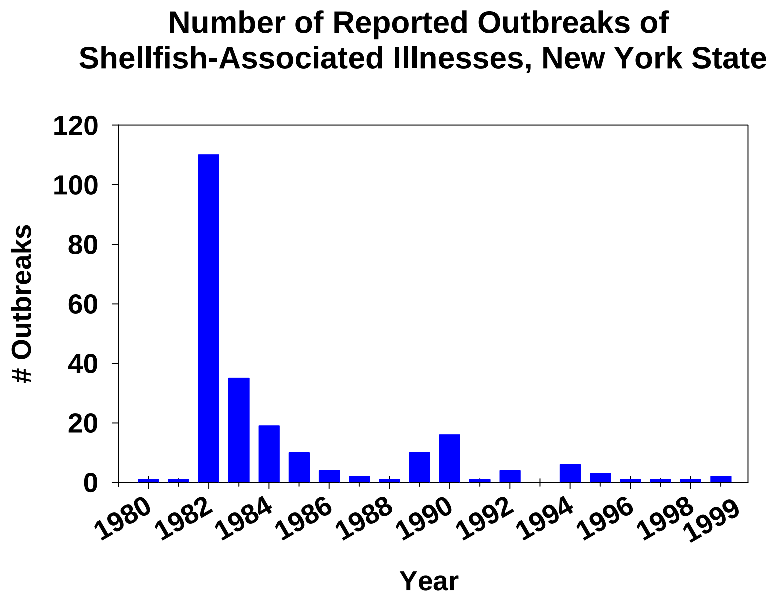


Figure 24: Shellfish-associated illness in New York. Data from Holcomb 2000

they are harvested. Consumption of any raw shellfish, regardless of where it was harvested, carries some risk which can be reduced but not necessarily eliminated by cooking.

Figure 23 shows the history of occurrence of two of the most serious shellfish-associated diseases, typhoid and hepatitis, caused by consumption of shellfish in New York and New Jersey from the early 1900s until 1988. In many cases the source of the shellfish was unknown, but was often suspected to be from New York, New Jersey or Connecticut. Note that the last known typhoid case was in 1954, and the cases of hepatitis (the first known appearance of which was in 1962) have been few.

Figure 24 is another data set compiled by the New York State Department of Health on shellfish-associated illness (most commonly gastroenteritis) recorded in New York State from 1980 to 1999. The sources of the shellfish that induced these outbreaks is frequently unknown, and may not be local in many cases. Most of the 1989 outbreaks resulted from consumption of Long Island clams, and the source of the illnesses in 1982 was most frequently traced to Rhode Island shellfish. The 1998 outbreak was traced to shellfish from Oyster Bay, Long Island. Note that the incidence of reported illness has dropped markedly since its peak in 1982. Decreases in shellfish-associated disease could be due to a number of factors, including better sewage treatment leading to reductions in concentrations of disease-causing microorganisms, more restrictions on harvest of shellfish from contaminated areas, and more awareness among the public as to the risks associated with consuming raw shellfish.

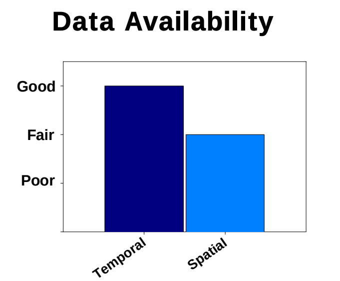
One important caveat about the data presented here: shellfish-related illness is probably under-reported and is likely to be misdiagnosed when it is reported, because the symptoms are non-specific. While the incidence of shellfish-associated disease is much lower in recent years as compared to the 1980s and previous years, it may be that the absolute numbers of cases in each year are higher than reported.

Although shellfish beds are monitored carefully for pathogenic contamination, the levels of chemical contaminants in shellfish are not as well-studied.

For more information on shellfish and disease:

www.vm.csfan.fda.gov/~mow/chap37.html
www.cdc.gov
www-seafood.ucdavis.edu
Heartbeats in the Muck, by John Waldman (Lyons Press, 1999)

Levels of Coliform Bacteria



Note: while data availability is good both temporally and spatially in New York, it is poor for New Jersey waters.

Bacteria are all around us - in the air, in the water, and even in the food we eat. Most bacteria encountered on a daily basis are harmless, or even beneficial and necessary to sustain life. However, the presence of some bacteria, namely fecal coliform bacteria, in estuary waters, is an indicator of fecal waste and therefore suggests that other, more dangerous pathogens may be present. These pathogens can be a threat to human health if we eat shellfish that have been ingesting them (see the discussion of shellfish bed closures on page 21) or sometimes if we swim in sewage-contaminated waters. The most common result of exposure to these pathogens is gastroenteritis, but more serious conditions can also result from exposure to sewage (see the discussion of shellfish-related illness on page 24).

Before we had sewage treatment plants, raw sewage was disposed of directly into our waterways, and fecal coliform and other pathogen levels were very high. Now that sewage treatment plants have been constructed and upgraded, the main source of coliform bacteria to the estuary is combined sewer overflows that route a mixture of raw sewage and street runoff directly into the estuary during and immediately after rain events when the processing capacity of the sewage treatment plants is exceeded. Other sources include illegal sewage connections, sewage treatment plant bypasses (which sometimes occur due to plant malfunctions or construction at plants), some inputs from the plants even when they are functioning properly, storm water outfalls, non-point sources such as storm runoff and leaking septic tanks, and in some areas, excessive wildlife waste.

Figure 25 shows the mean concentration of fecal coliform bacteria in the Harbor as measured during four years by the New York City Department of Environmental Protection. The progressive improvement in coliform levels is clear from these four time periods, which represent four phases in sewage treatment plant upgrades and improvements in New York City. In 1974 (Panel A), many sewage treatment plants in the New York/New Jersey area were not yet upgraded to secondary treatment, meaning that raw sewage continued to be discharged in some locations, and disinfection was sporadic. At this time, most areas exceeded bacterial standards for either fishing or bathing. In 1985, (Panel B) some upgrades had been made to existing plants but two of the City's plants were not yet built (North River and Red Hook). In Panel C, the large improvements due to the operation of those two plants (which did away with the discharge of approximately 210 million gallons per day of untreated sewage from Manhattan and Brooklyn) can be seen. Further improvements to the plants, significant reductions of illegal discharges and increased maintenance of the sewerage system caused mean coliform levels to drop even further, as shown in Panel D (1997 data).

Figure 25: Levels of coliform bacteria in NY Harbor. Data from NYC DEP 1998

SUMMER GEOMETRIC MEAN FOR FECAL COLIFORM IN SURFACE WATERS

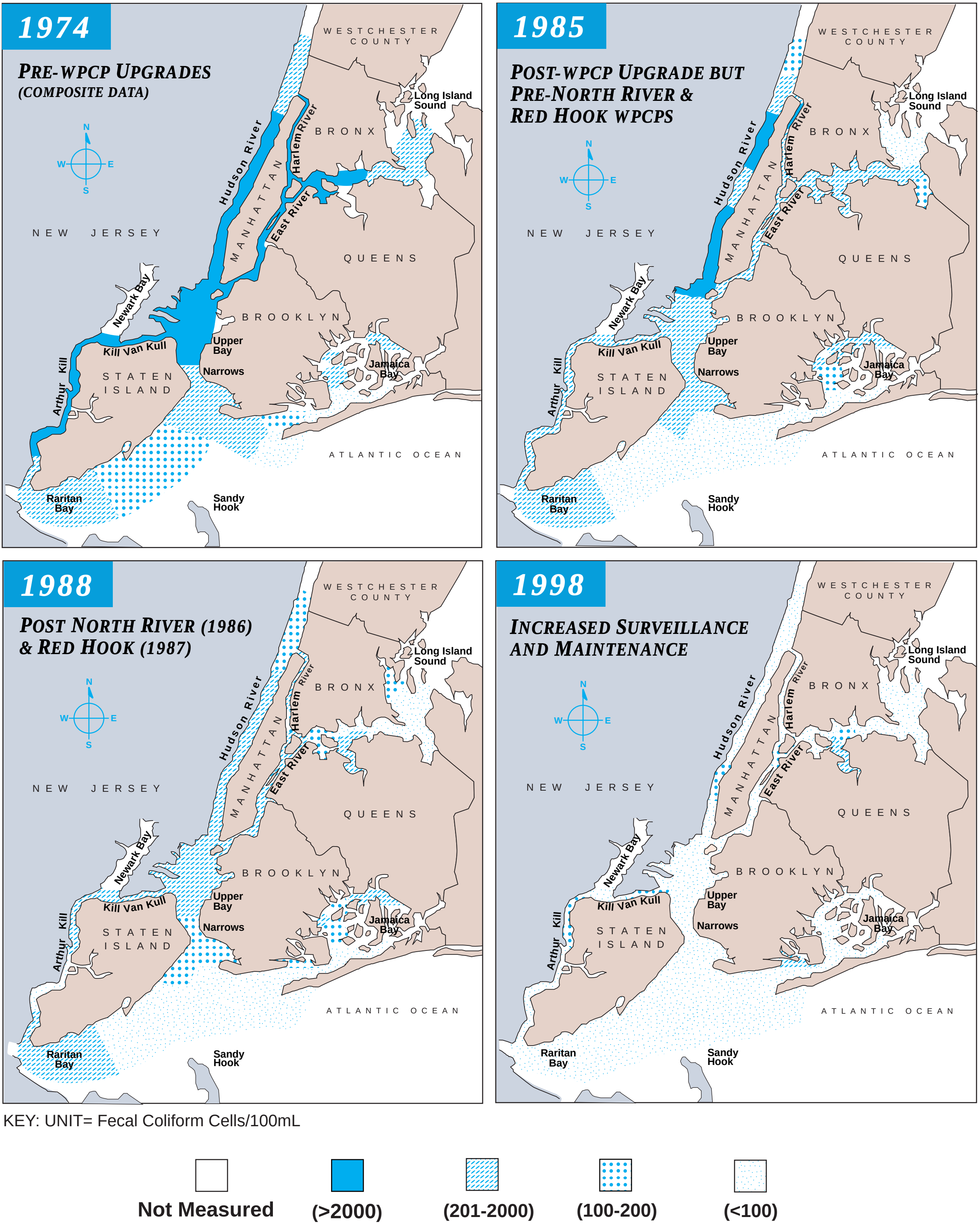


Figure 26 shows a more detailed record of fecal coliform densities for 1989-1999 for three coastal sites in New York and three in New Jersey. Because the largest source of fecal coliform to our waterways is combined sewer discharges which occur mostly when it rains, coliform levels are generally related to the amount of rainfall in a given year, with some exceptions. Levels of coliform generally decreased between 1989 and the mid-1990s, then increased again in some areas, most notably Rockaway Point, NY and Manasquan Inlet, NJ. It is important to note that in no year at any of the sites did the density of coliform approach the federal health guideline of 200 fecal coliform cells per 100 ml of water.

While fecal coliform is the most commonly monitored indicator of fecal contamination, it has certain limitations. For example, it cannot distinguish between human and animal contamination sources, but it is generally believed that human fecal contamination poses a much greater human health risk to bathers and shellfish eaters than animal waste. The presence of fecal coliform also does not correlate well with the levels of human fecal viruses, which may be more of a concern with respect to disease than bacteria. For these reasons, NJ DEP has conducted research into the utility of monitoring an alternate indicator, coliphages, which are viruses that infect one species of coliform bacteria. The results of this work are promising, but more research needs to be done before this method becomes widely used. Recent federal legislation, the BEACH Act, will require coastal states to monitor enterococcus bacteria, a more reliable and sensitive indicator, as the primary indicator for swimming waters within three years; New Jersey already uses this indicator in a limited way in addition to fecal coliform, but it is not yet used to determine whether beaches should be closed.

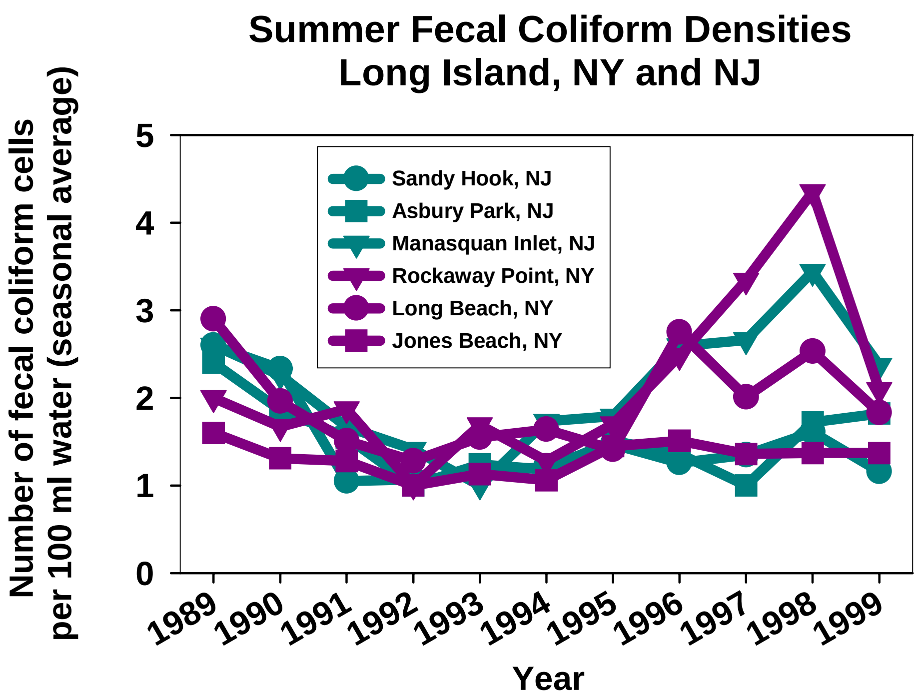
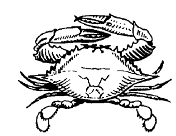


Figure 26: Fecal coliform concentrations. Data from US EPA Region 2 1989-1999

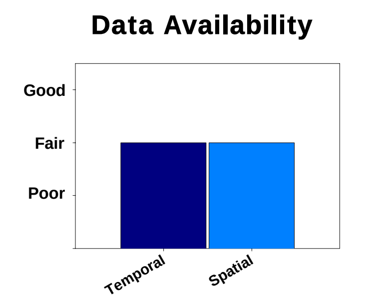


For more information on coliform levels:

NYC DEP annual Harbor Survey report, available from DEP at 212-860-9339

www.epa.gov/region02/desa/nybight/

Beach Closures



Note: while beach closure data availability is good in New Jersey, it is less consistent and harder to find for New York.

If you say that you are "going to the beach" in the New York/New Jersey region, most likely you mean you are heading to the Jersey Shore, to one of the well-known Long Island South Shore beaches such as Jones Beach, or perhaps to Long Island Sound. Except for Coney Island, New York City and the Harbor generally are not considered prime bathing destinations. However, there are a number of beaches in and near the estuary that, with water quality improvements, are becoming more attractive as conveniently accessible swimming holes. After having been closed for decades due to water quality concerns, some New York City beaches, notably Seagate Beach on Coney Island and South and Midland Beaches on Staten Island, have opened again for swimming in recent years. Some people have been swimming off Pier 26 in the Hudson River in recent years, and there has been some discussion of the feasibility of creating swimming beaches or floating pools at other points along the Hudson in Manhattan.

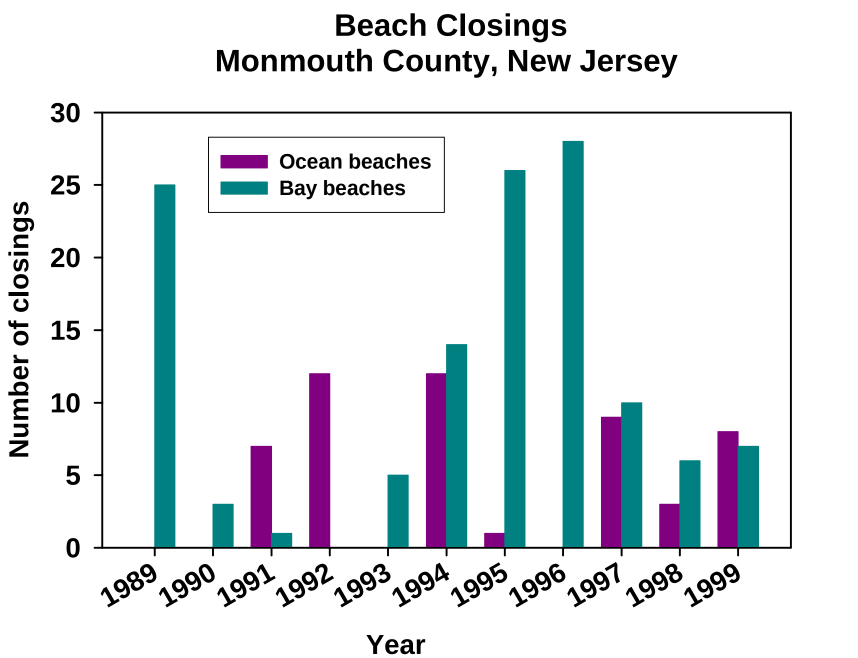


Figure 27: Beach closures in New Jersey. Data from NRDC 1991-1999

Responsibility for monitoring the water quality of bathing beaches in the estuary lies with a number of agencies, all of whom use different tests, criteria, and advisories in their monitoring programs. New Jersey has one of the most comprehensive beach monitoring programs in the country: all 127 miles of ocean and bay beaches are monitored for fecal coliform once per week during the summer. It is the only state to have a statewide mandatory beach protection program that includes a bacterial standard, testing protocol and mandatory closure requirements. New Jersey's beach monitoring protocols have been the same since 1986. New York does not have a mandatory beach monitoring program, but the Departments of Health of all coastal counties in New York, including New York City, do conduct weekly bacterial testing at all public and private beaches. In many areas, automatic preemptive closings are also issued after heavy rainfall.

What makes it unsafe to swim at a closed beach? Most beach closures are due to pathogen-contaminated stormwater runoff or combined sewer overflows which release untreated sewage into our waterways when it rains. Pathogens, including viruses, from raw sewage or runoff can cause gastroenteritis (which is actually an umbrella name for a variety of illnesses that cause vomiting, stomach ache, or related symptoms) or other infectious diseases such as hepatitis, salmonellosis, and others. A few beach closures have occurred for other isolated reasons, such as sewer line breaks and oil spills. Although some ocean beaches in New York and New Jersey were closed due to wash-ups of medical waste in the late 80s, these incidents are extremely rare and the risk to swimmers of any kind of infection is extremely small (see the Beach Debris indicator discussion, page 31).

Figure 27 shows the total number of beach closures at ocean and bay beaches of Monmouth County, New Jersey from 1989 to 1999. Figure 28 shows beach closures and advisories for New York City and Westchester and Nassau Counties, New York. Note that New York City has a standing rainfall advisory for all Bronx, Queens and Staten Island beaches which are not included in the totals on the graph. There does not appear to be a clear trend in the number of beach closures for either state over the time period shown here, most likely because so many factors combine to influence bacterial concentrations, and because advisory standards change over the years – the number of beaches monitored or the required duration of an advisory can change, for example (although as noted above, New Jersey's monitoring protocols have been the same for a number of years).

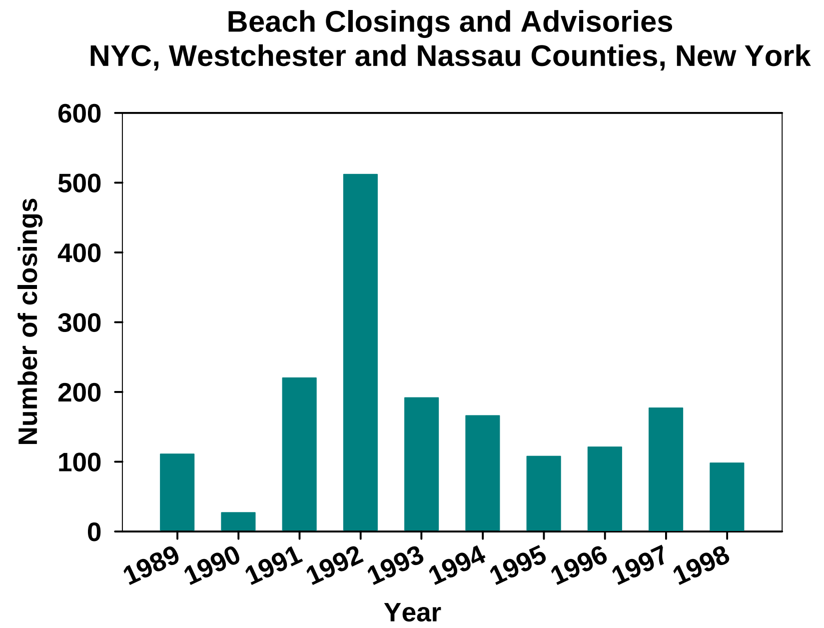


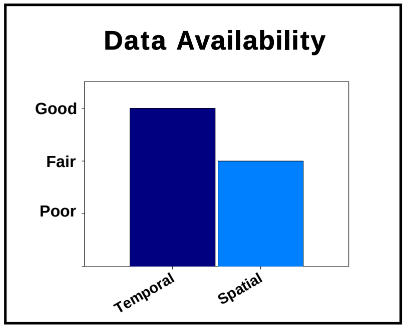
Figure 28: Beach closures in New York. Data from Natural Resources Defense Council 1991-1999. Decrease in 1993 closings was largely the result of decreased rainfall levels and changes in NYC's rainfall advisory program which included fewer beaches and reduced the duration of advisories from 48 to 12 hours.

In October of 2000, Congress passed the Beaches Environmental Assessment and Coastal Health (BEACH) Act which requires all coastal states to implement consistent and rigorous beach monitoring, closure and public notification programs based on monitoring levels of enterococcus bacteria. Enterococci have been more closely correlated with gastroenteritis in swimmers than fecal coliform, and thus will be a better indicator of health risk. Not only will beach monitoring protocols become more consistent and stringent, but the BEACH Act also requires EPA to maintain a national database of beach water quality information, so tracking this indicator should become easier in the coming years.

For more information on beach closures:

www.epa.gov/OST/beaches/technical.html
www.nrdc.org/water/oceans/ttw/titinx.asp

Floatable Debris



Although occurrence of debris in our waterways and on beaches (often called "floatables") does not pose an immediate public health threat, trash in the environment is unsightly, offensive and affects our quality of life. The perceived health threat posed by some floatables, such as the medical waste found on area beaches in 1987 and 1988, can have tremendous economic impact: the economic losses due to the New York and New Jersey beach closures in 1987 and 1988 are estimated to be between $900 million and $4 billion in New Jersey and $950 million and $2 billion in New York. In addition, floatables can pose hazards to navigation if boats hit large objects or suck smaller ones into engines and propellers, and to wildlife, which can become entangled in fishing gear or can die from ingesting some kinds of debris.

Where does this debris come from? The main sources of estuary floatables are combined sewer overflows and stormwater, both of which flush debris into local waterways when it rains. Prevailing currents can carry this debris to the Jersey shore beaches (and less frequently to New York beaches). Other sources include beach litterers and discharges from boats.

Table 2 shows the top ten constituents of trash removed from New York beaches by the American Littoral Society-sponsored volunteer Coastal Cleanup in 1994-1999 (conducted on a single day in September every year), and the occurrence of medical waste (syringes only) for comparison. Note that syringes comprise a tiny portion of what is found in these beach cleanups.

Figure 29 shows the amount of debris removed from New York (New York City, Long Island and upstate) and New Jersey shores per mile cleaned in 1989-1999. The New York beaches were cleaned by American Littoral Society volunteer crews in the Coastal Cleanup. The yearly variability in the New York data could be due to a number of factors, including how many volunteers participated in a given year, the meteorological conditions that year, and even the weather on the

Most Common Debris Items Found on New York City Beaches, 1994-1999

Debris Item	Percent (%) of Total Items
Cigarette butts	8.2
Plastic food bags/wrappers	7.5
Plastic caps/lids	6.2
Plastic beverage bottles	6.0
Foamed plastic pieces	5.2
Plastic straws	5.0
Glass pieces	4.9
Glass beverage bottles	4.2
Plastic pieces	3.7
Plastic cups/utensils	3.2
Medical waste (syringes only)	*0.2*

Table 2: Debris on NYC beaches. Data from American Littoral Society 1999

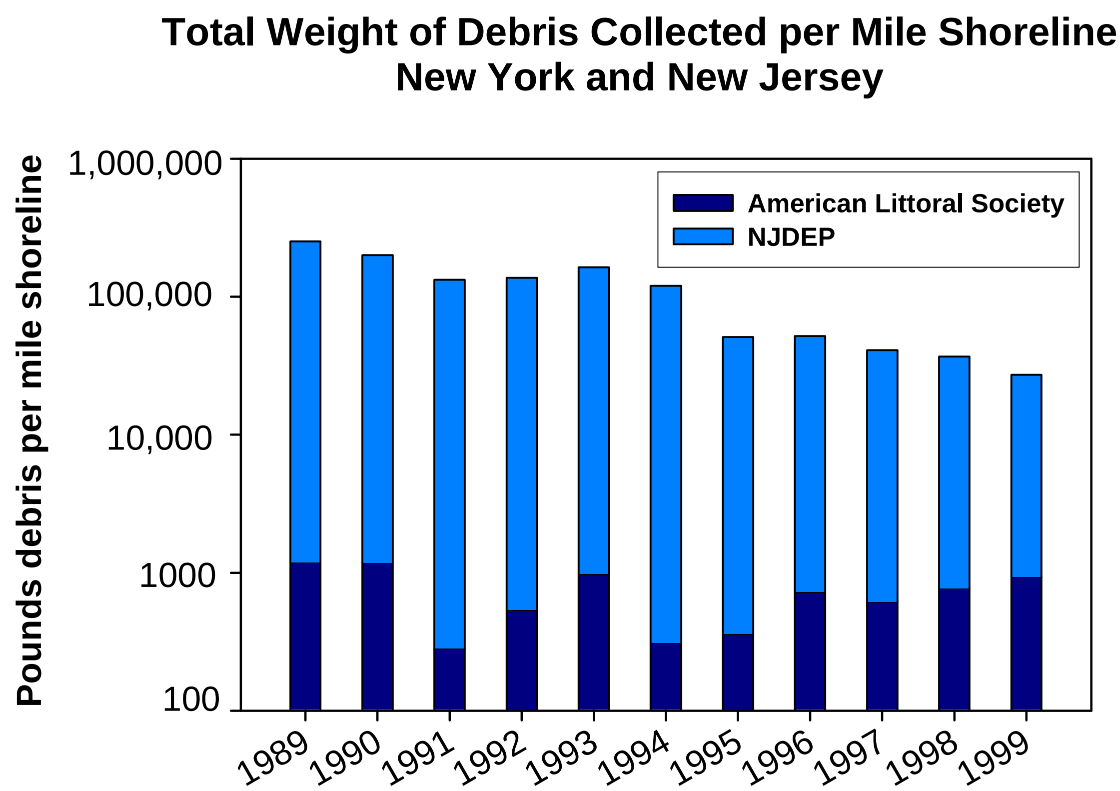


Figure 29: Debris removed from NY and NJ shores. NY beaches include those in all boroughs of New York City, Nassau, Suffolk Westchester, and upstate. Data from American Littoral Society 1999 and NJ DEP 2000

day of the beach cleanup. Nasty weather can deter even the most enthusiastic volunteers! New Jersey shorelines were cleaned by the New Jersey Department of Environmental Protection's Clean Shores program; note that the amount removed per mile of shoreline has decreased over the years for which we have data. The Environmental Protection Agency uses helicopter surveys to determine the number of "slicks" or aggregations of floatables in the harbor; that data is shown in Figure 30 for 1992 - 1998. Observations of slicks have been decreasing since 1994 (they increased from that year over previous years due to an expansion of the program area).

The Harbor Estuary Program's predecessor, the New York Bight Restoration Program, initiated a Floatables Action Plan in the Harbor in the late 1980s to prevent debris from getting into the waterways and to remove it from waterways once it gets there. This program includes the operation of "skimmer vessels" by the Army Corps of Engineers and the New York City Department of Environmental Protection that cruise the Harbor removing floating debris. Figure 31 shows the tons of debris removed by those programs (note that the NYCDEP program was initiated in 1994) from 1988 - 1997; there does not seem to be a directional trend in this data. However, the EPA considers the Floatables Action Plan to be very successful, as it has eliminated beach closures due to floatables in New Jersey and Long Island and has instituted a better mechanism for notifying beach operators of potential wash-ups of floating debris

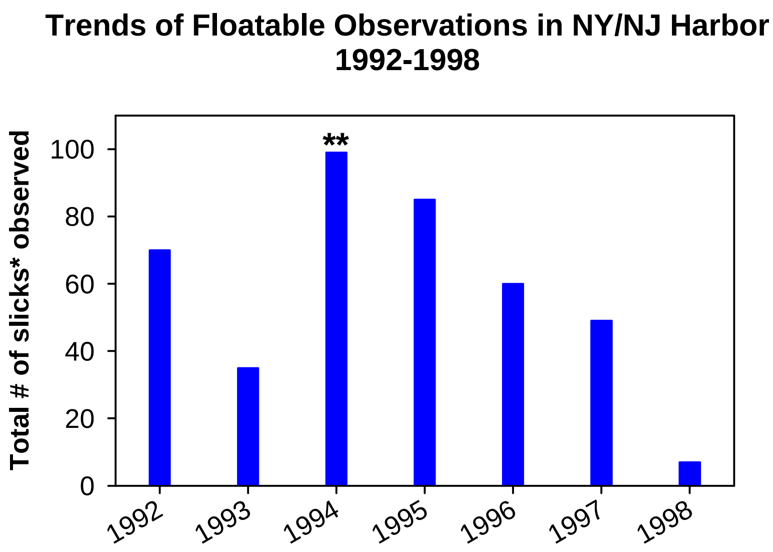


Figure 30: Floatables slicks observed in NY Harbor. A slick is defined as an "aggregation of floating debris of indefinite width and a minimum length of approximately 400 meters." **In 1994, surveillance areas were increased, resulting in the large increase in that year. Data from US EPA 1999

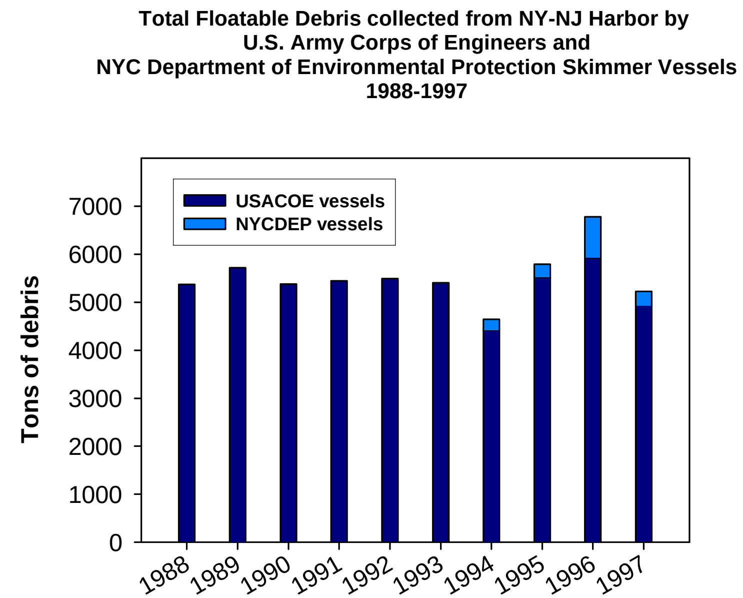


Figure 31: Floatable debris removed by skimmer vessels from NY Harbor. NYC DEP's skimmer vessel collection program was initiated in 1994. US ACOE program uses 3 vessels, NYC DEP's program uses 5 vessels. Data from US EPA 1998a

For more information on floatable debris:

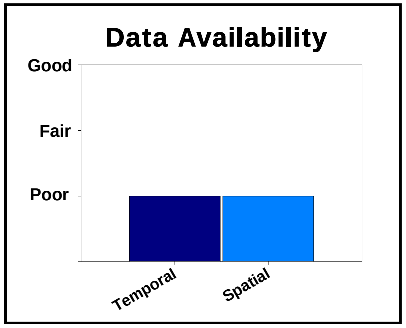
www.alsnyc.org
www.cmc-ocean.org/cleanupbro/index/php3
www.epa.gov/owow/oceans/debris
www.nyc.gov/html/dep/html/float.html
www.vims.edu/cbnerr/teach/debris/index.html

To volunteer for beach clean-ups:

In NY: Contact the American Littoral Society at 800-449-0790 or 718-471-2166, or visit their web site at www.alsnyc.org

In NJ: Contact Clean Ocean Action at 732-872-0111

Harmful Algal Blooms



Microscopic algae, or phytoplankton, are at the bottom of most marine food chains and are therefore critical to sustaining life on the entire planet. Typically, in early spring as mid-Atlantic waters begin to warm and nutrients become available, local waters experience a phytoplankton bloom. There is also a smaller bloom in the fall. Under a variety of special circumstances which are not well understood, a small number of algal species can undergo blooms of very high density at other times of the year, with a variety of undesirable results. These blooms of a single species with some harmful attribute, lasting from days to months, are referred to as Harmful Algal Blooms (HABs). Depending on the species and severity of the bloom, HABs can cause fish and shellfish kills, and can concentrate in the flesh of edible species, causing illness and even death if fish or shellfish from bloom areas are consumed. Some species are skin irritants, causing discomfort to bathers. Although most of these incidents occur in coastal waters, in 1990 six fishermen on Georges Bank 100 miles east of Cape Cod, MA almost died from consuming mussels they caught in their nets that had been exposed to a toxic bloom. These more severe and dangerous impacts of blooms have not been observed in this region to date; the worst impact of HABs observed in New York and New Jersey (other than impacts on shellfish of brown tide, referred to below) has been rashes experienced by bathers in the vicinity of some blooms.

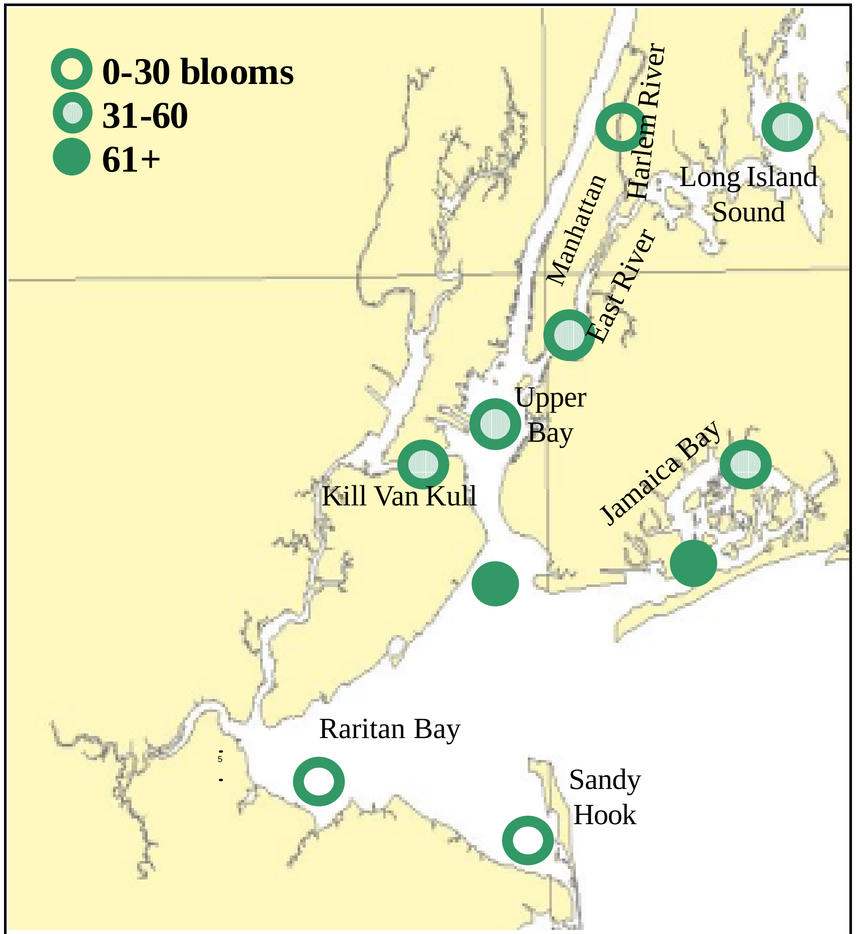


Figure 32: Total number of blooms 1975-1995. Blooms defined as Chlorophyll-a levels 2x mean. Data from Cosper and Cerami 1996

The causes of HABs are not known with much certainty, although there does seem to be a correlation between poor water quality (decreased dissolved oxygen and an overabundance of nutrients, for example) and the occurrence of blooms.

In our estuary, there are a number of agencies that record the occurrence and extent of these blooms, including NYC DEP, NJ DEP, the Interstate Environmental Commission, and the National Park Service.

Table 3: Number of documented blooms of corresponding severity levels. Blue = blooms observed in coastal waters; green = blooms observed in inner bays. Numbers indicate numbers of blooms of that severity in that time period. Severity data is based on documented observations of blooms of specific species. These data are not based on routine chlorophyll-a measurements. Observations most likely increased in all areas following the 1976 bloom of the dinoflagellate *Ceratium tripos* in New Jersey coastal waters. Data from Cosper and Cerami 1996.

Year	BLOOM SEVERITY →									
	Discolors water and reduces clarity		Causes hypoxia		Harmful to shellfish/fish		Itching/ respiratory ills in humans		Food poisoning in humans	
1957-1960		4								
1961-1965	1	5						4		
1966-1970							1	5		
1971-1975								5		
1976-1980	8	7	1		1			1		
1981-1985	9	9		1		1	3			
1986-1990	8	10		2	1					
1990-1995	5	10		1	1					

Figure 32 shows the total number of blooms (defined in this case as a chlorophyll-a concentration twice the long-term mean for that area) recorded by all monitoring programs between 1975 and 1995. The map indicates that the Lower Bay and lower Jamaica Bay are the areas most prone to blooms, but this information does not tell us anything about the impact of those blooms on the ecosystem or human health.

Table 3 summarizes the severity of documented blooms between 1957 and 1995 in coastal waters and inner bays of the Harbor Estuary and New York Bight. The numbers in each column represent the number of blooms in that time period of that severity. These numbers are not based on measurements of chlorophyll-a as in Figure 32, but instead are based on documented observations of blooms in which qualified personnel determined the species of the bloom as well as its other characteristics. Note that none of the blooms were severe enough to cause food poisoning in humans and most of the blooms only discolored the water and reduced water clarity. After a relatively severe extensive dinoflagellate bloom in New Jersey coastal waters in 1976, bloom monitoring increased, probably accounting for the higher numbers of blooms recorded in later years.

One type of bloom that is not included in these data sets is “brown tide,” which has had a devastating effect on the scallop fisheries in Long Island and has started to appear in New Jersey coastal waters as well. This species has not been observed to bloom in the Harbor, but it has appeared in Great South Bay, Long Island. We also have not experienced blooms of *Pfiesteria piscicida* in this area. This mysterious dinoflagellate has caused fish kills and even neurological damage in people from North Carolina to Delaware. There is some evidence that a non-toxic form of *Pfiesteria* exists in some New York waters, but it has yet to bloom. Very little is known about what causes *Pfiesteria* to bloom.

For more information about harmful algal blooms:

www.redtide.whoi.edu/hab/
www.nwfsc.noaa.gov/hab/blooms.htm
state-of-coast.noaa.gov/bulletins/html/hab_14/intro.html

Conclusions

Taken as a whole, the data presented in this report paint a complex picture of the health of the estuary and the effect that conditions in the estuary are having on human health in our region. Generally, the health of the estuary is improving. Levels of contaminants in sediments and fish have been decreasing, as are levels of coliform bacteria in our waterways. On a regional scale, more shellfish beds are open for harvest, and more beaches are open for bathing. Fewer people are getting sick from eating contaminated shellfish.

However, there is still much room for improvement, and the actions that need to be taken now to continue the positive trends in the state of the environment are more expensive, more contentious and more difficult than ever before. CSOs are of particular concern, as they are significant sources of pathogens, toxic contaminants, floatables, and nutrients. Source control, rather than clean-up after the fact, needs to be the focus of floatables and toxics actions.

It is crucial that better long-term monitoring programs be implemented in order to track progress in the coming years and decades. Table 4 summarizes the data availability graphs presented in each chapter: it is clear from this table that although many indicators are being measured, existing monitoring programs are inadequate to fully describe temporal and spatial trends for many HEP indicators. In some cases, data availability might be inconsistent between New York and New Jersey; for example, New Jersey's beach monitoring program is

Indicator	Data Availability	
	Temporal	Spatial
Sediment Contamination	Fair	Good
Sediment Toxicity	Poor	Good
PCBs in Striped Bass	Good	Good
Contaminants in Fish	Poor	Poor
Shellfish Bed Openings	Good	Good
Illness/Contaminated Shellfish	Poor	Poor
Coliform Bacteria	Good	Fair
Beach Closures	Fair	Fair
Floatable Debris on Beaches	Good	Fair
Harmful Algal Blooms	Poor	Poor

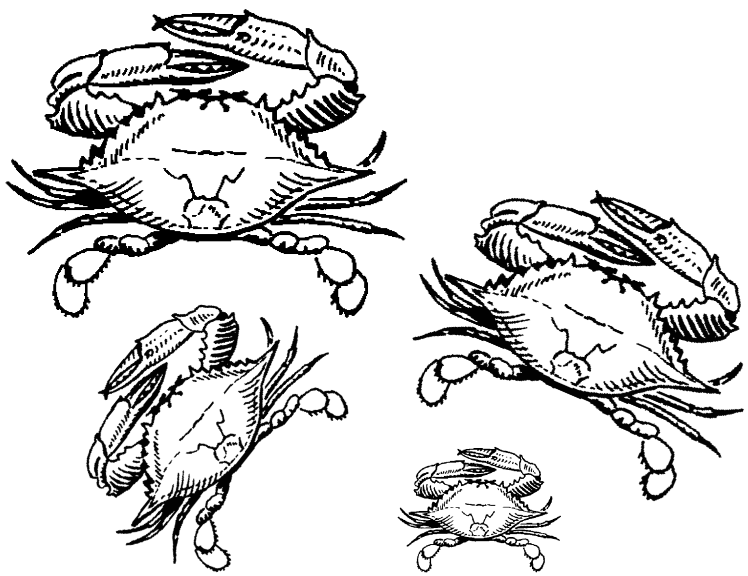
Poor Fair Good

Table 4: Data availability for HEP indicators. This table summarizes the data availability tables that accompany each chapter in this report.

much better coordinated and more complete than New York's, and New York City DEP's Harbor Survey, which collects data on parameters such as coliform bacteria levels, does not extend to New Jersey waters. In addition, the data that are being collected for some of the indicators can be difficult to find or to use. New monitoring programs need to be implemented or existing ones improved for the following parameters in order for future reports of this kind to be better able to gauge the health of the estuary:

- Incidence of harmful algal blooms
- Sediment contamination
- Sediment toxicity
- Disease caused by consuming contaminated shellfish
- Levels of contaminants in fish and shellfish tissue, other than PCBs in striped bass
- Coliform bacteria outside of New York City waters
- Beach closures in New York

In addition, a few indicators recommended by the HEP could not be included in this report at all, due to a complete lack of data, including loadings of contaminants, levels of coliphages, and incidence of human illness related to bathing at local beaches. It is critical that resources be identified to monitor the health of the estuary.



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