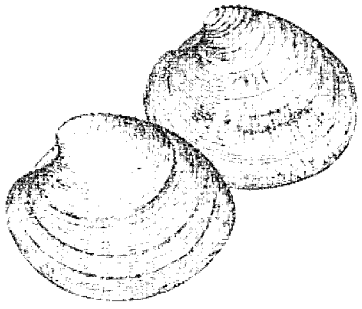
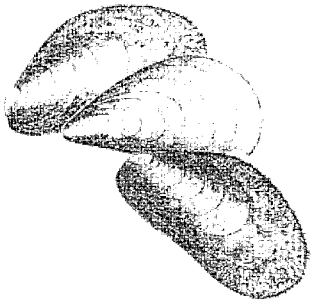
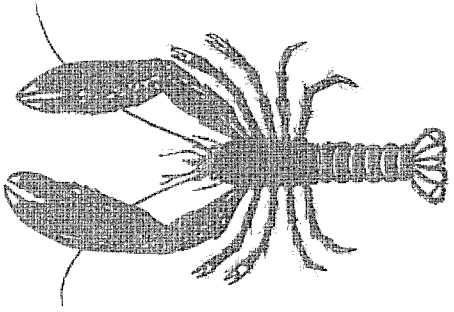
LONG ISLAND SOUND STUDY

# Annual Report 1986







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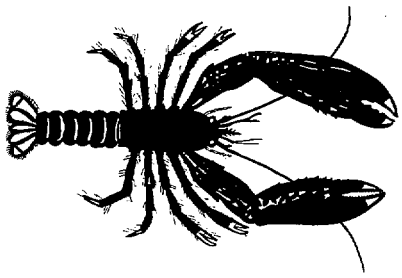

# Long Island Sound Study Annual Report 1986

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In 1984, Congress became concerned about the health of our coastal environments and established a National Estuary Program to improve the environmental quality of the nation's most important estuaries. Because the valuable resources of Long Island Sound could be jeopardized by pollution, this heavily used estuary was included in the program.

The Long Island Sound Study (LISS) is sponsored by the U.S. Environmental Protection Agency (EPA). Its primary goal is to develop a plan to preserve and protect the water quality and resources of the Sound. Congress appropriated $1 million for the LISS in both 1985 and 1986, and nearly $2 million in 1987. Funding is expected to continue through 1990 to allow enough time to develop a comprehensive plan for improved management of the Sound.

## Why Long Island Sound?

Bordered on its western end by New York City, the 110-mile-long Sound is surrounded by 14.6 million people. Not surprisingly, the threat to the environment posed by a population of this size is enormous. As a result of this population, 44 sewage treatment plants discharge processed effluent and wastes into waters entering the Sound, as do many industries.

The challenge of managing pollution in the Sound is compounded by the fact that not all of the pollution comes from readily identifiable sources such as discharge pipes. For example, runoff from land surrounding the Sound or contaminant-laden air blowing over its waters also contributes pollutants. Management of the Sound is made even more difficult because some of the aquatic pollution does not come from local sources; 80 percent of the fresh water entering Long Island Sound comes from rivers that drain states as far north as Massachusetts, New Hampshire, and Vermont.

Despite all these potential problems, the Sound is a popular spot for sportfishing, sailing, and swimming; more than 200,000 boats (recreational and commercial) are registered Sound-wide. For those with commercial interests, this "urban sea" provides vital transportation routes and rich fishing and shellfishing grounds. The commercial catch of lobsters, finfish, and shellfish exceeds $20 million annually, and in 1985, provided non-fishing consumers of seafood in the region and nationwide with over 12 million seafood meals.

Many of these recreational and commercial activities depend on a clean Sound, but they are threatened by pollution that is posing an ever-increasing threat to fish and shellfish. The Long Island Sound Study is beginning the lengthy and complicated process of identifying the source and fate of pollutants and understanding the effect of pollution on living marine resources. The purpose of the Study is to protect and improve the health of these resources and the water quality upon which they depend.

*Closed swimming areas and shellfish beds indicate a need to protect the water quality, fish, and shellfish of the Sound.*

## Master Plan to Help Preserve the Sound

The Long Island Sound Study is a five-year project involving more than 100 people from federal, interstate, state, and local agencies, universities, environmental groups, industry, and the general public. These groups are working together to identify the major environmental problems threatening the Sound and to develop a Comprehensive Conservation and Management Plan for solving them.

During the first year of the Long Island Sound Study, we have concentrated on collecting and analyzing historical data. Two of the most important questions being addressed by this phase of the Long Island Sound Study are 1) how healthy is the Sound today, and 2) is it getting cleaner or more polluted? To answer these questions and

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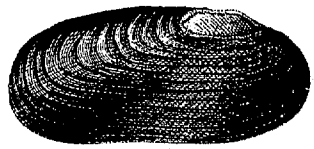


to make the best use of limited resources, the Study is focusing on three major problems:

1. Toxic contamination,
2. Low dissolved oxygen concentrations, and
3. The health of fish and shellfish.

These topics were chosen after the LISS's Management Committee surveyed managers, citizens, and scientists concerned about the Sound.

The Long Island Sound Study is examining toxic contamination to determine how widespread and severe the problem is, and what can be done to control it. We are also investigating whether contaminants are posing health risks either to animals living in the Sound or to people eating seafood caught there.

We are studying dissolved oxygen (DO) conditions in the Sound because they are low in some areas in the summer. Low oxygen levels indicate poor water quality and also can kill or displace fish and shellfish. Preliminary data suggest that summertime DO levels in bottom waters of the Sound are lower than they were in the past. Nutrients in sewage treatment plant discharges are suspected of causing the situation to worsen. The LISS is determining the extent of the DO problem, and assessing the degree to which human activities are responsible.

*Studies of fish and shellfish can help us develop pollution cleanup programs to preserve the health of these resources.*

Finally, because fish and shellfish are so important to the economy of Long Island Sound, and because the health of these organisms reflects water quality, the LISS is assessing where fish and shellfish live and what areas of the Sound are important to them. Because juveniles are particularly sensitive to pollution, we plan to use this information to determine the parts of the Sound, such as nursery areas, that need special protection.

In the remaining years of the Long Island Sound Study, we will continue to work on these environmental concerns. The long-term goals of the LISS are to

1. Protect and improve the water quality of Long Island Sound and its coves and estuaries in order to ensure that a healthy and diverse marine community is maintained;
2. Ensure that health risks associated with human consumption of shellfish and finfish are minimized;
3. Ensure that opportunity for water contact recreation activities are maximized; and
4. Ensure that social and economic benefits associated with the use of Long Island Sound are realized to the fullest extent possible by the citizens of Connecticut and New York.

We are optimistic that the environmental quality of Long Island Sound and the health of its resources can be preserved through the goals of the Long Island Sound Study. Because considerable control over the environmental condition of the Sound rests not only with local and state agencies but more importantly with individual citizens, we need your support. We urge you to get involved in the Sound. Its future depends on you.

Michael Deland
Regional Administrator, EPA Region I

Christopher Daggett
Regional Administrator, EPA Region II

Leslie Carothers
Commissioner, Connecticut Department of Environmental Protection

Thomas Jorling
Commissioner, New York State Department of Environmental Protection

# Who Manages the Long Island Sound Study?

### Policy Committee
The Policy Committee has overall responsibility for the study (see the flowchart). The committee includes the Regional Administrators from EPA Regions I and II, the New York State Commissioner of Environmental Conservation, and the Connecticut Commissioner of Environmental Protection.

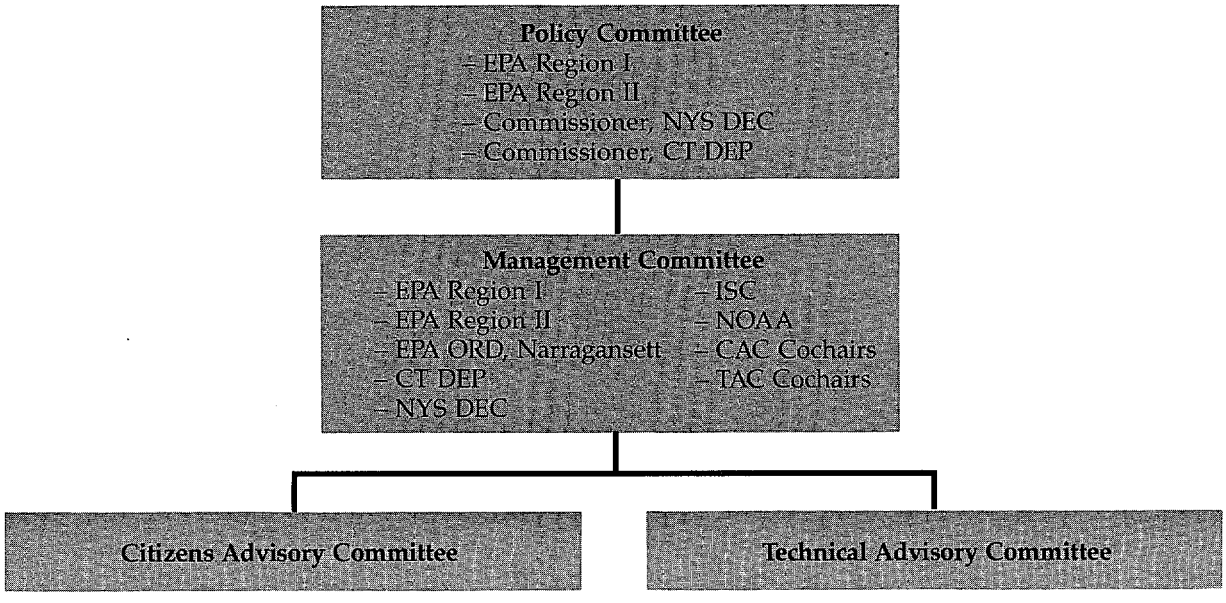
### Management Committee
The Management Committee develops goals, approves work plans, identifies monitoring and assessment activities and plans, and oversees projects. Its members are from EPA, New York State Department of Environmental Conservation (NYS DEC), Connecticut Department of Environmental Protection (CT DEP), Interstate Sanitation Commission (ISC), National Oceanic and Atmospheric Administration (NOAA), and cochairs of the Technical Advisory Committee (TAC) and Citizens Advisory Committee (CAC).

### Technical Advisory Committee
The Technical Advisory Committee (TAC) serves as a forum for technical expertise on Long Island Sound. The TAC advises the Management Committee on the scientific and technical aspects of the study. Federal, state, and local governmental agencies and universities, and scientists from research institutions provide technical input and support, and participate in various activities.

### Citizens Advisory Committee
The Citizens Advisory Committee (CAC) includes representatives of citizen and user groups interested in Long Island Sound. Its role is to communicate citizen concerns about pollution problems back to the Management Committee. Members of the CAC include Connecticut Audubon, Huntington Audubon, Project Oceanology, and The Sounds Conservancy, along with other local environmental organizations, educational institutions, town conservation commissions, fishermen, and representatives of industry.

A subcommittee of the CAC is the CAC Steering Committee. Meeting more frequently, the CAC Steering Committee assists the Study by managing the dissemination of information about the Study to the public. It also provides specific advice on Study activities for the CAC. The Long Island Sound Taskforce (LIST) of the Oceanic Society received support from the Long Island Sound Study to provide administrative support for the CAC and the CAC Steering Committee, sponsor informational conferences and workshops, and provide information about the LISS in its quarterly newsletter, The Long Island Report.

**The Long Island Sound Study Management Structure**



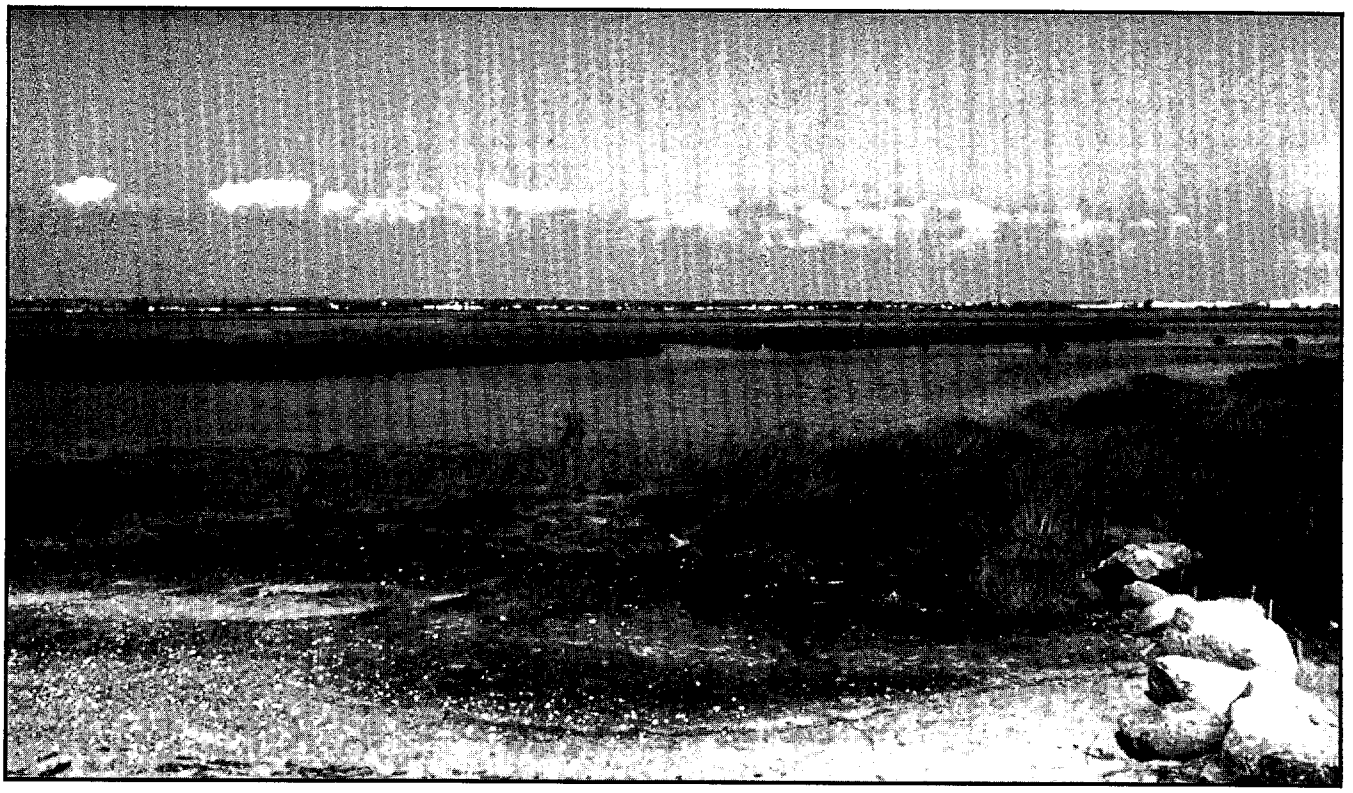
**Integrating Historical Data with Current Research**

To begin the water quality study, Long Island Sound Study researchers are characterizing the trends and known extent of pollution. Many individual studies have been conducted in the Sound over the years, but until now, they have not been organized in a way that lets us assess the pollution-related trends in the Sound. During the first year of the Long Island Sound Study, we have devoted substantial effort to characterizing the health of the Sound by collecting and analyzing existing data.

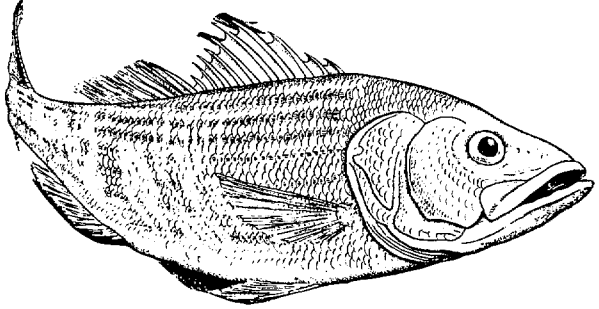
Studies done in the past are important tools for assessing whether conditions are declining or improving, and they offer a cost-effective basis against which to judge the Sound's current water quality and resource health.

In combination with studies of present conditions, historical data can help scientists answer such questions as where are the most contaminated areas in the Sound? What are the sources of contamination? Where are animals being exposed to contaminants? Where should we concentrate cleanup efforts?

The goal of this characterization is to develop a computerized collection of technical information about the Sound as a whole. We are identifying the causes, sources, and seriousness of the major environmental threats – toxic contaminants and low dissolved oxygen concentrations – and considering how fish and shellfish react to these problems. The studies that investigate these concerns are discussed in the next three sections of this report.



*The Long Island Sound Study is a five-year project that aims to identify the major environmental problems threatening the Sound and to develop a Comprehensive Conservation and Management Plan to solve them. Through this Study, we are optimistic that the unique environment of the estuary can be preserved.*



# The Extent and Effects of Toxic Contamination of the Sound

The Long Island Sound Study is concerned about toxic contaminants because they can affect both the health of fish and shellfish that live in the Sound and the health of people who eat this seafood. The contaminants of concern include metals (such as copper, cadmium, and mercury) and organic compounds (such as polychlorinated biphenyls [PCBs], polycyclic aromatic hydrocarbons [PAHs], and the pesticides DDT and chlordane). PCBs and PAHs are highly toxic chemicals that persist in minute concentrations in the environment; PCBs were used by several industries including the electronics industry, and PAHs come from petroleum or are produced as by-products of the burning of organic materials.

Under the sponsorship of the LISS, the agencies listed above have begun compiling historical data on the contamination of water, fish, and sediments, and also collecting new samples to fill any data gaps. The CT DEP, NYS DEC, ISC, and NOAA analyzed historical data to assess the distribution of toxic organic compounds and metals in water, sediments, and organisms in the Sound. NYS DEC coordinated studies on toxic compounds in fish and sediments; CT DEP organized studies on metals in shellfish; and ISC summarized studies on organic compounds and metals in water. NOAA's Mussel Watch Program is generating further data on toxic contaminants in mussels and sediments at nine locations in the Sound in an attempt to add to the database. In addition, NOAA compiled an inventory of contaminants entering the Sound to determine the sources of pollution in different areas of the Sound. This study is discussed in the section, Low Dissolved Oxygen in the Sound.

**Contamination Studies**

**Contamination and Water Quality**
Interstate Sanitation Commission (ISC)

**Contamination in Finfish, Lobsters, and Eels**
New York State Department of Environmental Conservation (NYS DEC)

**Contamination in Fish and Shellfish**
Connecticut Department of Environmental Protection (CT DEP)

**The Mussel Watch Project in Long Island Sound**
Ocean Assessments Division, National Oceanic and Atmospheric Administration (NOAA)

**Contamination in Sediments**
National Marine Fisheries Service, National Oceanic and Atmospheric Administration (NOAA)

The objectives of the four studies were to

1. Create a database on toxic contaminants in marine resources;
2. Identify contaminants of concern;
3. Determine which species are most contaminated;
4. Identify general spatial patterns; and
5. Identify general temporal patterns.

Managers of Long Island Sound will use the results of these toxic contaminant studies to identify "hot spots" of pollution in the Sound and to develop pollution abatement plans and monitoring programs to detect any improvement in the Sound's health.

*The Long Island Sound Study is studying toxic contamination to determine how widespread and severe the problem is, and what can be done control it.*

## Tracking Trends in Organic Compounds and Metals in the Water

Many water quality studies have been conducted over the years by the Interstate Sanitation Commission (ISC), New York City Department of Environmental Protection (NYC DEP), CT DEP, and the New York counties of Nassau, Suffolk, and Westchester. For the Long Island Sound Study, ISC synthesized these organizations' data on heavy metals and organic chemicals in the water column.

As is true of most historical assessments, ISC encountered several problems in attempting this synthesis. For example, different agencies used different sampling methods and the emphasis was on western sites. Because few data were collected in the east, ISC has information on PCBs and heavy metals for only the western 20 percent of the study area. The ISC scientists hoped to combine the ISC and NYC DEP data, but could not do so because ISC reported data from surface samples, whereas NYC DEP reported values averaged from bottom and surface samples. In addition, ISC researchers found that the data covered limited time periods. Nonetheless, ISC was able to analyze six different data sets, including EPA data for 1970 – 1973, ISC data for 1975 to the present, and NYC DEP data for 1974 to the present.

Sufficient data were available to discern spatial trends in the concentration of metals in the water column. For instance, the amounts of cadmium and lead in the water column decreased from west to east. As can be seen in Figure 1, copper concentrations in the western Sound were generally comparable to the eastern Sound, except for about one-fourth of the western samples that had very high concentrations. The major source of this copper is thought to be leaching from copper pipes commonly used in household plumbing. This copper could enter the Sound through discharge from sewage treatment plants, which are particularly numerous in the western Sound.

Data for organic chemicals (pesticides and PCBs) were too limited for researchers to draw any conclusions about the distribution of these contaminants.

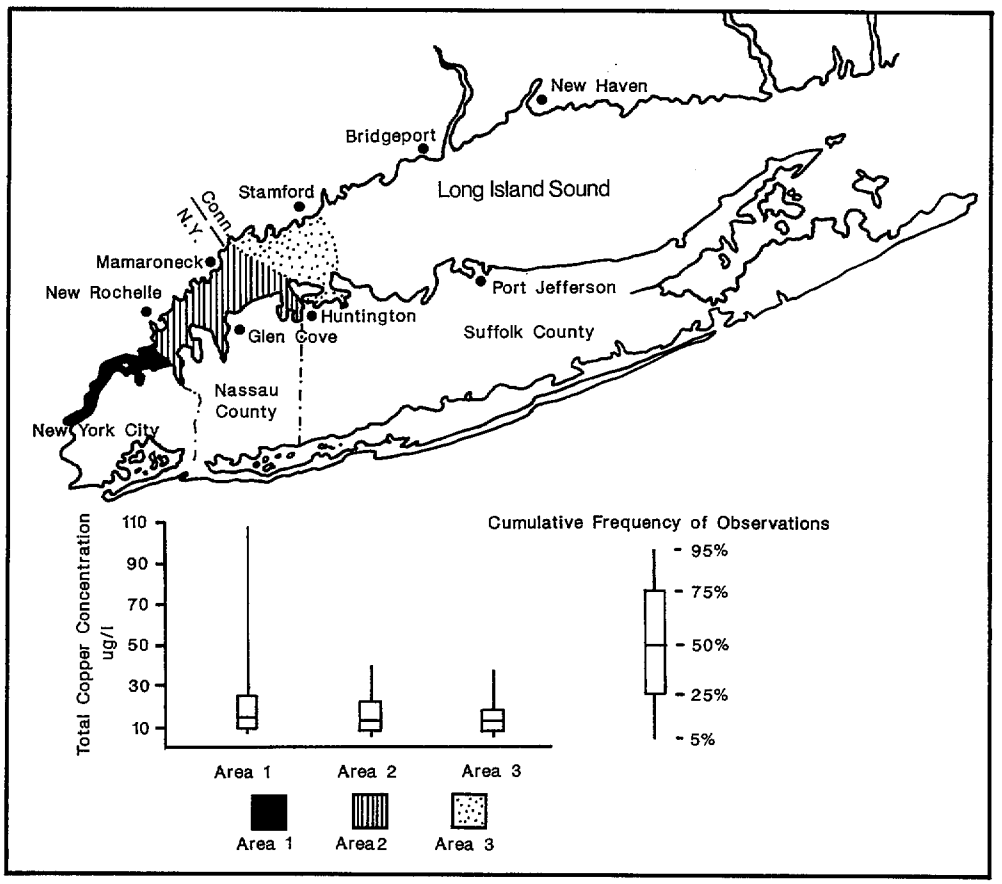



*Figure 1.*
*Total copper distribution in Western Long Island Sound waters showing that although median (50%) concentrations are similar, Area 1 sometimes has high concentrations. (From Interstate Sanitation Commission).*

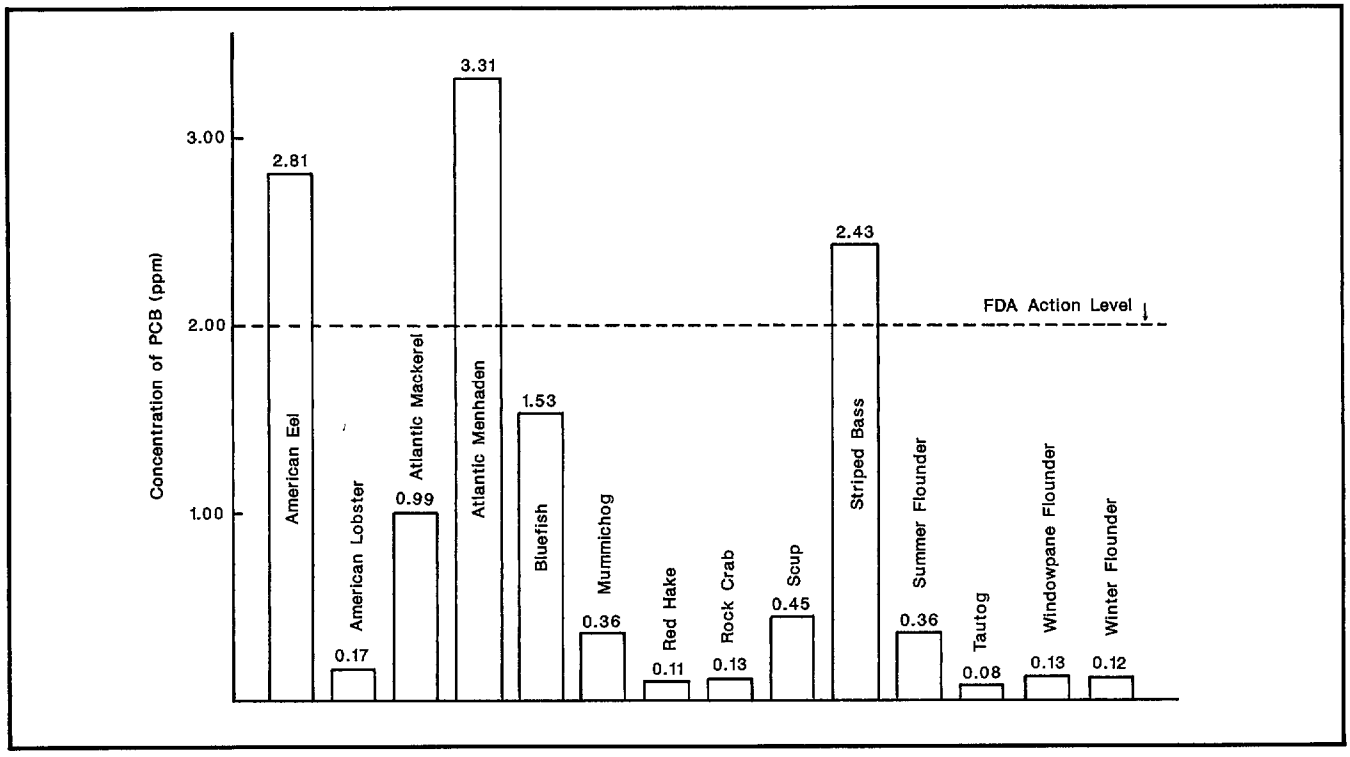



*Figure 2.*
*Historical concentrations of PCBs by species. (From New York State Department of Environmental Conservation).*

As a result of ISC's study, the LISS will recommend standardized sampling methods so that data collected throughout the Sound by different agencies can, in the future, be compared and combined into a common database.

## Distribution of Contamination Varies in Finfish, Lobsters, and Eels

Because consumption of contaminated seafood is an ongoing concern, New York State Department of Environmental Conservation (NYS DEC) has been measuring contaminants in Long Island Sound fish and shellfish for many years. Some species are of more concern than others because they tend to accumulate higher levels of contaminants. For example, eels, menhaden, and striped bass accumulate higher concentrations of PCBs than many other species that spend all or part of their lives in Long Island Sound (Figure 2). The Food and Drug Administration (FDA) has set an Action Level for PCBs for 2 parts per million (ppm), and seafood with levels above this are banned from interstate transportation. This level, in turn is used by states for developing consumption advisories for all fisheries.

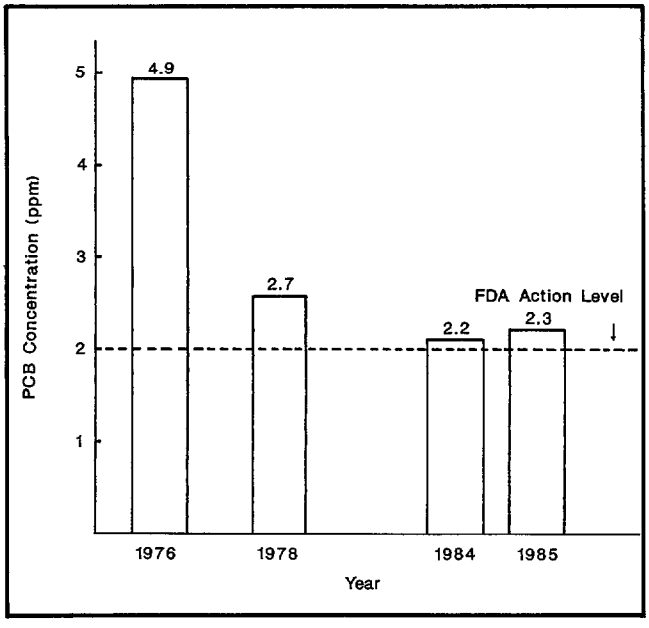



*Figure 3.*
*PCBs persist in striped bass over time. (From New York State Department of Environmental Conservation).*

PCB contamination is a problem that is likely to be with us for years to come. NYS DEC examined data on PCBs in striped bass, and found persistent levels above the FDA Action Level of 2 ppm (Figure 3). Although in the figure there appears to be a reduction between 1976 and 1978, sample sizes in 1976 were small, and the data thus may have been anomalously high. It is noteworthy that the levels have not dropped significantly between 1978 and 1985.

In 1986, NYS DEC measured contaminants in eels and lobsters in the Sound. Eels are good indicators of an area's condition because they stay close to the sediments, do not migrate much as juveniles and immature adults, and tend to overwinter in the harbors they frequent. Lobsters were chosen for study because of their commercial importance and because they also remain in close contact with bottom sediments. NYS DEC collected twenty-five eels at each of seven locations, and analyzed them individually for PCBs, organochlorine pesticides (DDT, chlordane, dieldrin, and others), and metals. At each of four sites, ten male and ten female adult lobsters also were collected, and contaminants measured in the tail and claw meat as well as the hepatopancreas (tomalley, which is a delicacy to some lobster eaters).

The analyses of eels and lobsters demonstrated that the levels of dieldrin, DDT, and DDT breakdown products were well below the Food and Drug Administration's (FDA) Tolerance Level for these compounds. Most chlordane concentrations were also below the FDA Tolerance Level, except in four eels from harbors in the western Sound.

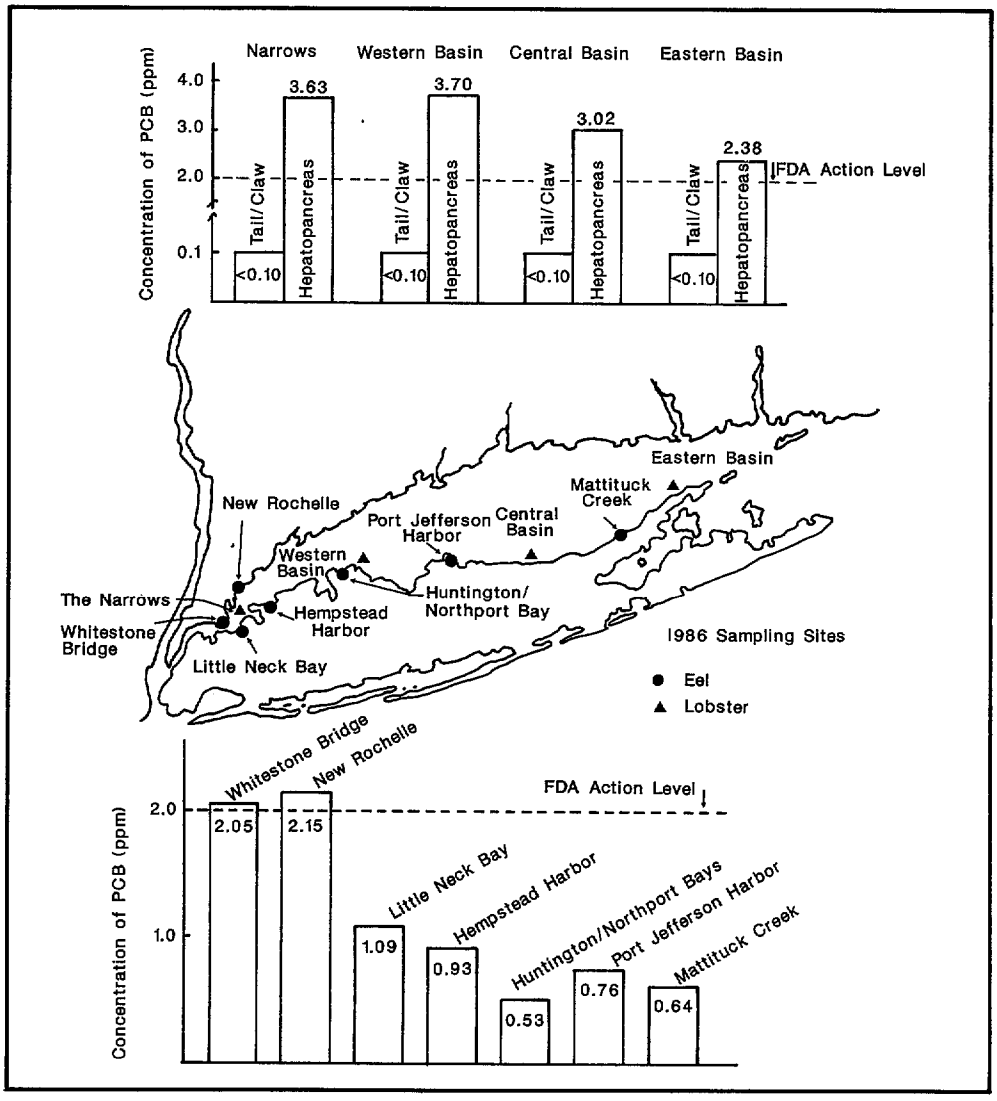


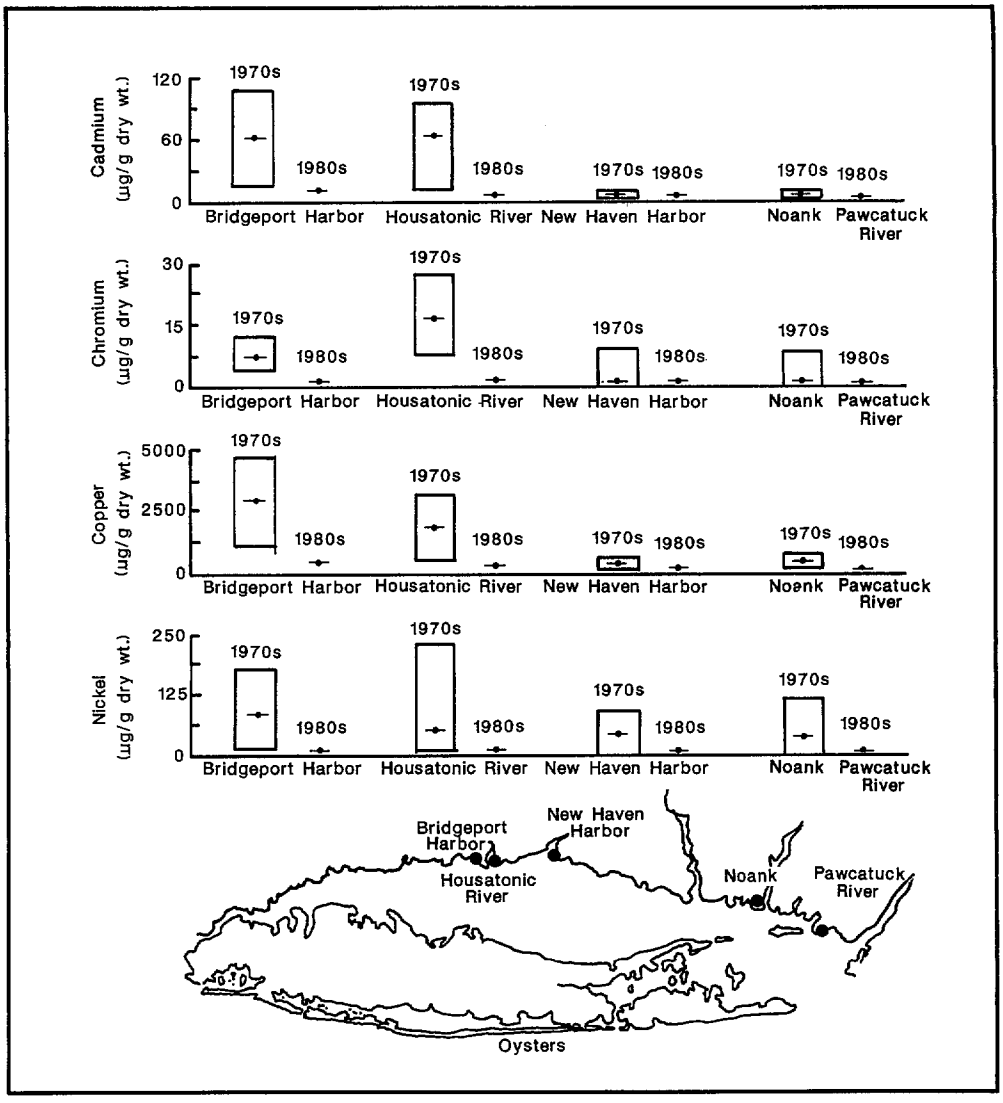

*Figure 4.*
*Mean concentration of PCBs in American lobster (top) and American eel (bottom). (From New York State Department of Environmental Conservation).*

NYS DEC's 1986 data showed, however, that eels in the western Sound have elevated concentrations of PCBs, as did the hepatopancreas of lobsters caught in all parts of the Sound (Figure 4). NYS DEC scientists also noted an east to west trend in PCB concentrations: levels in eels and in lobster hepatopancreas in the west tended to be higher than those in the east. The tail and claw meat of lobsters, however, had negligible levels of PCBs. NYS DEC tried to compare the concentration of PCBs in eels and lobsters over time, but did not have enough historical data to detect any long-term trends. The New York State Department of Health has evaluated the lobster and eel data to determine whether any fishery advisories are warranted and has concluded that no new advisories are necessary.

CT DEP scientists analyzed some samples of blackfish, winter flounder, lobsters, and oysters from Connecticut waters for pesticides and PCBs. Their data were consistent with the NYS DEC results for these species; concentrations were generally low except for elevated concentrations in lobster hepatopancreas.

## Are Metal Concentrations in Fish and Shellfish Decreasing?

When analyzing the historical data, CT DEP recognized a need to collect current contaminant data for comparison with historical data to show temporal trends. To obtain this data, CT DEP conducted a reconnaissance survey to identify locations, organisms, and contaminants of concern that may require more detailed investigations.



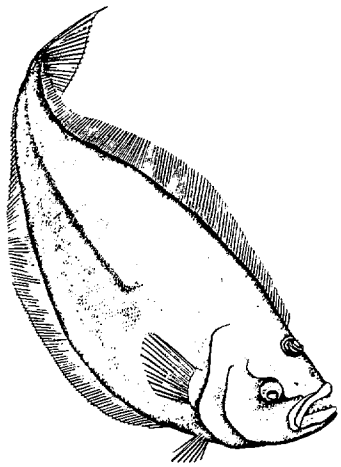



*Figure 5.*
*The mean and range of concentrations (ug/g dry wt) of selected heavy metals in oysters collected in the 1970s compared to those collected in the 1980s. (1970s data from Feng and Ruddy, and 1980s data from CT DEP Reconnaissance Survey).*

Based on their commercial and recreational value, widespread availability, and limited (or total lack of) migrations, winter flounder, blackfish, lobsters, and oysters were collected and analyzed for heavy metals (cadmium, chromium, copper, lead, mercury, nickel, and zinc), PCBs, and pesticides. Scientists collected finfish and lobsters from seven sites throughout the Sound, and oysters from ten locations along the Connecticut coast. Finfish fillets, lobster hepatopancreas (tomalley) and tails and claw meat, and oyster soft tissues were analyzed from each sampling site because these tissues are the parts people usually eat and are thus of most concern to both scientists and consumers.

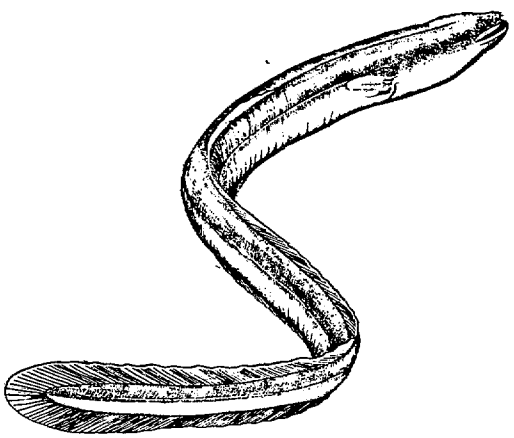
This study showed that winter flounder and blackfish fillets and lobster tails and claws had much lower metal concentrations than lobster hepatopancreas and oysters. In general, the highest concentrations of metals were found near Bridgeport and the Housatonic River. For instance, oysters from Bridgeport Harbor, Black Rock Harbor, and the Housatonic River had higher levels of cadmium, chromium, copper, and nickel than was observed in other locations (Figure 5).

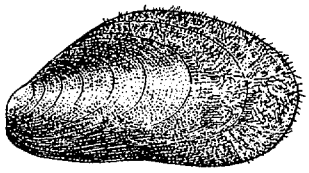
When CT DEP compared these data collected in 1985 – 1986 to oyster metal concentrations in 1972 – 1974, the data indicated that these contaminated areas had improved over the past decade. In Bridgeport and Housatonic River oysters, the levels of cadmium, chromium, copper, mercury, and zinc were currently lower than the lowest concentrations observed in an intensive study from the early 1970s. Although the 1985 – 1986 survey was not detailed enough to permit rigorous statistical analysis, the disparity in metals levels strongly suggests a reduction in metals contamination of oyster tissues in the Bridgeport and Housatonic River areas.

## Mussel Study Helps Evaluate Contamination Problem

Besides coordinating toxic contamination studies of lobsters, finfish, and eels, the Long Island Sound Study also researched contamination in mussels. Mussel Watch is a national program sponsored by NOAA to assess the environmental quality of the coastal marine environment. Approximately 150 sites along the Atlantic, Pacific, and Gulf coasts are being studied to determine the trends in toxic organic and metal inputs to the coastal waters. Nine sites were sampled in Long Island Sound: the Connecticut and Housatonic Rivers, Sheffield Island, Mamaroneck, Huntington, Hempstead, and New Haven Harbors, Throgs Neck, and Port Jefferson.

As part of this project, NOAA scientists collected mussels and sediment samples in Long Island Sound and analyzed them for metals, PAHs, PCBs, and pesticides. Mussels from intertidal and subtidal areas were collected both by hand and with dredge tows. Because certain metals are present naturally in seawater, NOAA was primarily interested in determining whether these background levels have been enriched by contamination. They found metal levels in mussels to be relatively uniform throughout the Sound. In contrast, concentrations of metals in sediments were higher in the western Sound. NOAA is currently studying the relationship between contamination in sediments and mussels.





# Low Dissolved Oxygen in the Sound

Along with assessing the toxic contamination problem in the Sound, the Long Island Sound Study is also focusing on a second major environmental concern – hypoxia. Hypoxia, or levels of dissolved oxygen (DO) below 3 ppm, is a problem that appears to be on the rise in many urban estuaries. The problem usually occurs in the summer when DO levels in the bottom waters are naturally at their annual minimum. Declining DO levels are worrisome because fish and shellfish need a certain amount of oxygen to survive, and hypoxia can either stress or kill many organisms. Although some areas may normally be hypoxic in Long Island Sound in the summer, local scientists and managers suspect that the problem has spread, and that it is being stimulated by nutrients from sewage treatment plants as well as runoff.

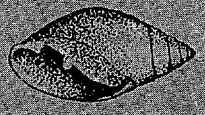
Before collecting new data on the extent of low dissolved oxygen in Long Island Sound, the National Oceanic and Atmospheric Administration (NOAA) conducted two studies of existing data. NOAA, with the assistance of the Interstate Sanitation Commission (ISC) and other agencies, collected and analyzed historical data on oxygen concentrations in western Long Island Sound to define the scope of the dissolved oxygen (DO) problem there. NOAA researchers also compiled data collected by ISC and the states on trends in discharges of nutrients and organic carbon to the Sound. Taken together, these studies characterized dissolved oxygen (DO) levels in western Long Island Sound and addressed the role of urban waste discharges in the development of hypoxic conditions in the western Sound.

Historical water quality data were identified, screened for relevance and quality, and selectively analyzed to characterize annual cycles and trends in dissolved oxygen. NOAA also evaluated data on the occurrence, distribution, and severity of hypoxia within the East River and open waters of the western Sound. The severity, timing, duration, and area of hypoxia in the Sound are influenced by variations in weather, particularly northeasterly storms during the summer, which mix oxygen from the surface down toward the bottom waters. As a result, long-term trends in dissolved oxygen concentrations due to changes in waste discharges are difficult to separate from changes due to weather patterns during a particular year.

**Dissolved Oxygen Studies**

**Low Dissolved Oxygen – an Historical Assessment**
Ocean Assessments Division and National Marine Fisheries Service, National Oceanic and Atmospheric Administration (NOAA)

**Sources of Contaminants Entering the Sound**
Ocean Assessments Division, National Oceanic and Atmospheric Administration (NOAA)



## Has Sewage Treatment Shifted the Problem East?

NOAA's first dissolved oxygen study assessed how waste discharges have affected water quality. The best data coverage for the determination of trends was for the East River and western Narrows part of the Sound. From 1969 to 1973, several institutions conducted spatially comprehensive surveys of water quality. These data cover the period when most sewage treatment plants (STPs) discharging waste to the East River were being upgraded, but a great deal of untreated sewage continued to be released during construction.

Data sets from four monitoring programs (New York City, Nassau County, Interstate Sanitation Commission, and Westchester County) from 1970 through 1986 were examined separately to understand long-term trends in dissolved oxygen in the East River and western Sound. Significant increases (or improvements) in DO concentrations were found throughout this part of the Sound over the 16-year period (Figure 6); these improvements appear to coincide with upgrading of sewage treatment plants (STPs) discharging into the East River.

Several preliminary assessments of conditions farther east, however, indicate an opposite trend or shift toward poorer water quality over the years (i.e., lower levels of dissolved oxygen). In general, upgrading the STPs lowered the amounts of organic carbon reaching the Sound. But discharges of nutrients such as nitrogen and phosphorous remained high, for the most part. Although the currents in the region are complex, scientists suspect that these nutrients are exported from the East River to the western Sound. In these areas of the Sound, aquatic vegetation may use the nutrients to grow and later sink to the bottom where their decomposition depletes the oxygen concentrations in the bottom waters.

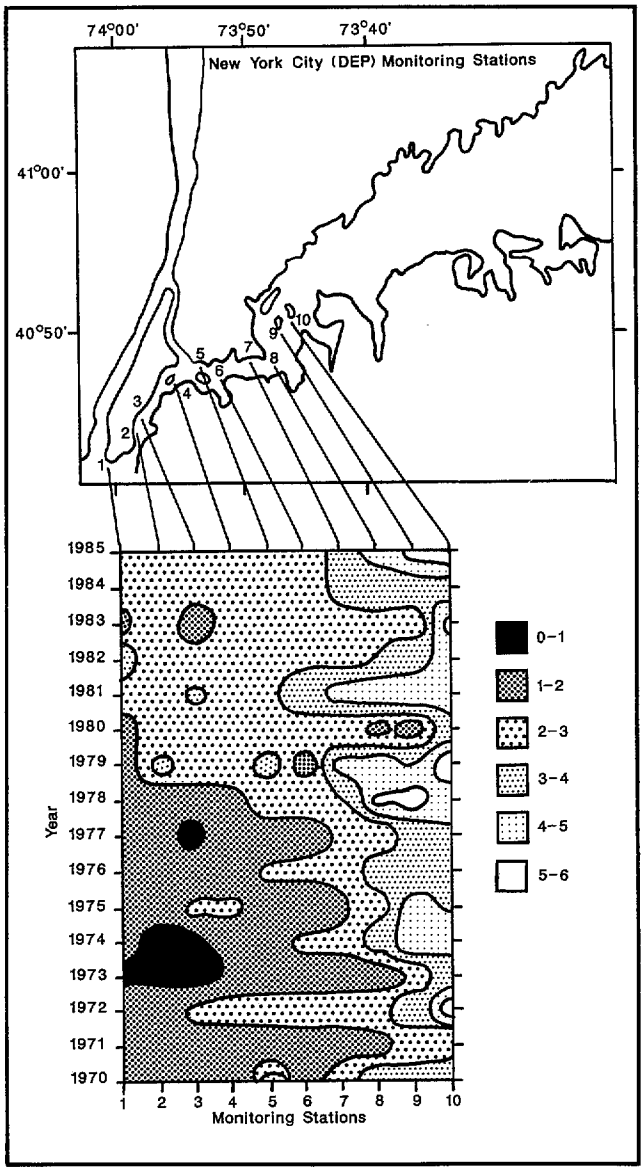



*Figure 6.*
*Annual minimum bottom dissolved oxygen (mg/l) collected during NYC DEP surveys, 1986. (From National Oceanic and Atmospheric Administration).*

NOAA found that the most severe hypoxia occurs during summer throughout the water column in the East River and, to a lesser degree, in bottom waters of the Western Narrows of the Sound. A general eastward gradient of increasing bottom dissolved oxygen, from the East River through the Narrows, Western Basin, Central Basin and eastern Sound, is evident in all historical data. However, brief episodes of hypoxia have occurred in deep waters of the Western Basin.

In short, many environmental (physical, chemical, and biological) as well as human factors interact to influence the cycles of dissolved oxygen in the Sound. To determine the impacts of different strategies to control pollution and protect the water quality of the Sound, the LISS plans to develop a water quality model to track the transport and cycling of nutrients and dissolved oxygen. Current research aims to document the spatial extent of these hypoxic events (occurrences of low DO) and to determine their impact on the living marine resources of the Sound.

## Sources of Contaminants

An important step in developing a plan to protect the water quality of Long Island Sound is to identify the sources of pollutant discharge to the Sound and to estimate the amount of pollution contributed by each source. To accomplish this, NOAA examined how pollution enters the Sound. NOAA extracted information about the pollutants discharged to the Sound from its National Coastal Pollutant Discharge Inventory, which contains estimates for all point, nonpoint, and riverine sources of pollution that discharge to coastal and oceanic waters from coastal counties. After analyzing this information, NOAA scientists were able to draw several conclusions about the major sources of waterborne pollution to Long Island Sound from Hell Gate in the East River to the Race at the Sound's eastern end.

Researchers discovered that the nine rivers entering the Sound are the major source of contaminants, and that of these, the Connecticut contributes the largest amount. The pollution loading, however, can be attributed largely to the enormous flow of these rivers; they do not necessarily carry high concentrations of toxic compounds. In fact, the quality of the water in some of the rivers is good by some definitions. Their volume, however, transports a cumulative load that makes these tributaries a potential cause for concern.

Wastewater treatment plants are the second most important source of pollution. If pollution from rivers is excluded, these plants account for more than 50 percent of 11 different pollutants discharged into the Sound (Figure 7). Four large New York City treatment plants are responsible for most of the contamination. These plants, located in Bronx and Queens, discharge their waste loads into the upper East River.

Runoff of water from urban land is the third largest source of pollution and the largest source of lead. About 80 percent of the annual urban runoff in the Long Island Sound area comes from the cities and towns along the Sound's coastline from western Suffolk County (NY) through New Haven County (CT). Water runoff from nonurban land such as farmland, pastures, and forests contributes more than half of the total suspended solids and 37 percent of the total iron estimated to have been added to the study area during 1982. Nonurban runoff is, however, a relatively minor source of other pollutants.

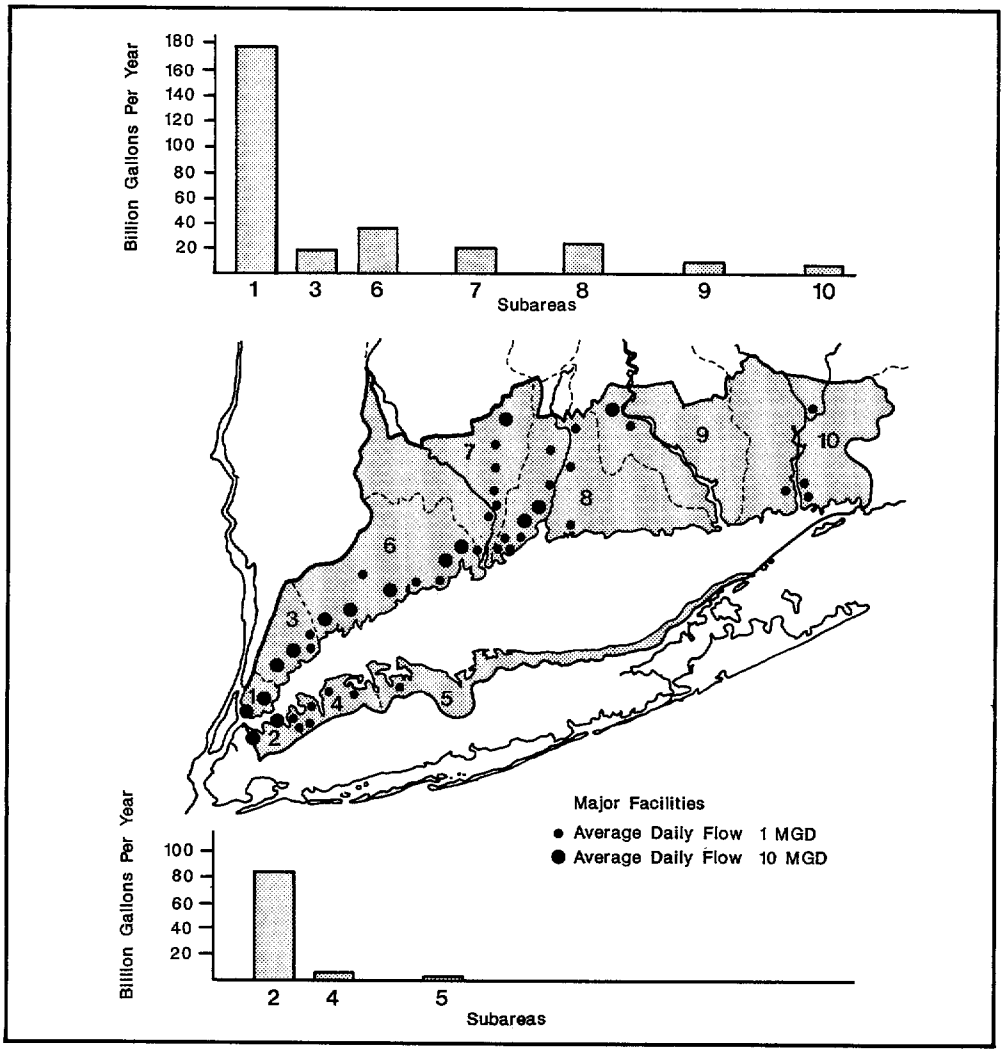
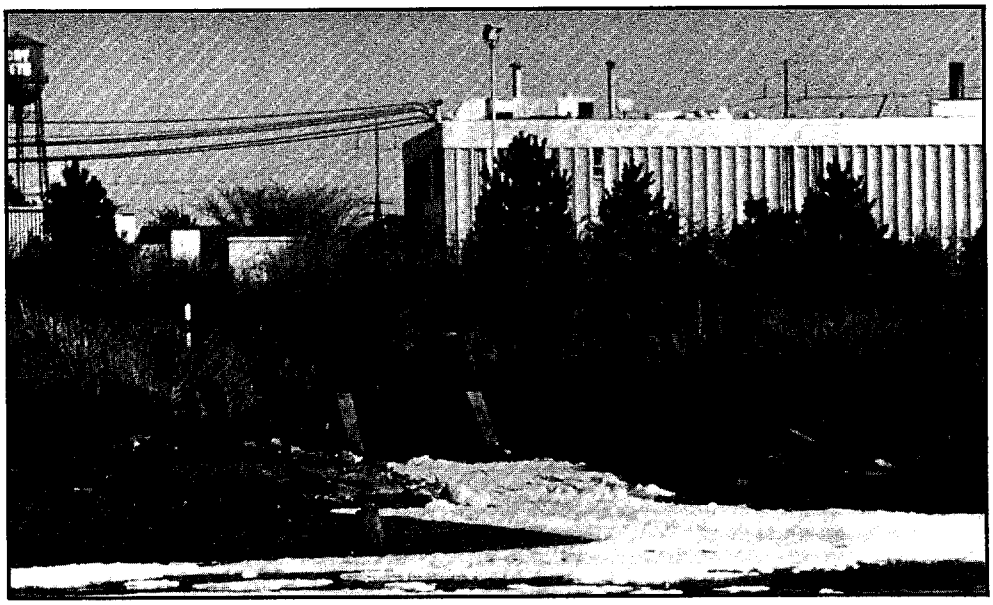


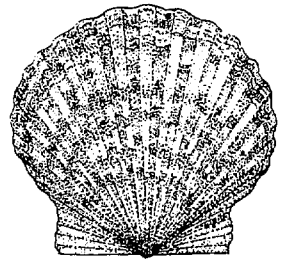

*Figure 7.*
*Annual wastewater treatment plant discharges by subarea, circa 1982 – 1984. (From National Oceanic and Atmospheric Administration).*

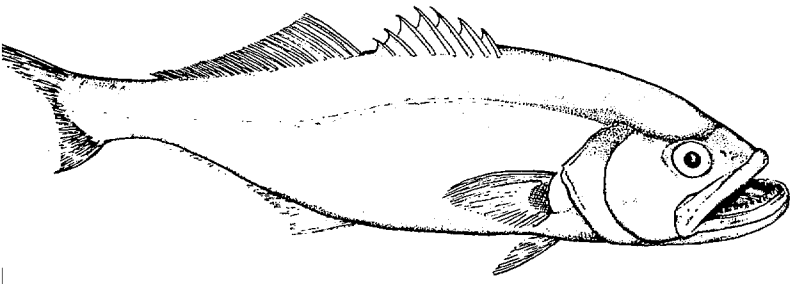


*An important step in developing a plan to protect Long Island Sound is to identify its sources of pollutant discharge and to estimate the amount of pollution contributed by each source.*

Although many industries discharge waste directly to the Sound's watershed, this is not a major source of pollution to the open Sound. Individual industries may, nevertheless, have a significant effect on the environment in the immediate area of discharge. This local effect depends on the amount and toxicity of the substances in the waste stream and the extent of dilution available in the body of water that receives the waste.

The LISS is continuing to analyze and improve the information made available through NOAA's study. For instance, many of the estimated discharges of organic compounds and metals will be updated and verified through the collection of monitoring data. Better understanding of where and how contaminants are added to Long Island Sound will make it possible to develop plans to clean up and preserve the waters of the Sound.





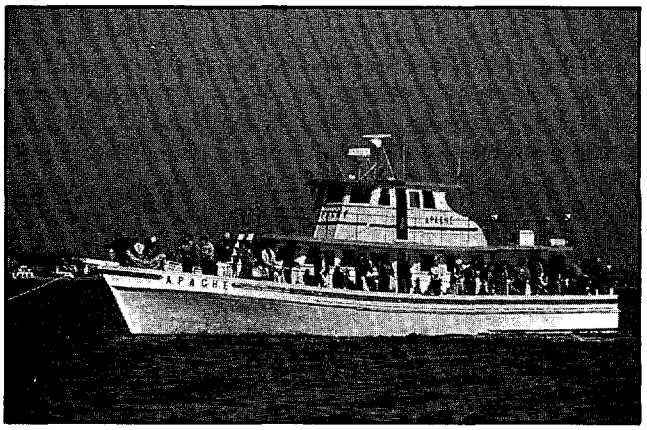
# Living Marine Resources

Most people living near the Sound are concerned about the health of its marine resources. Closed shellfish beds and diseased or declining populations of fish probably indicate poorly treated waste discharges, toxic contamination, or low levels of dissolved oxygen. As part of the overall characterization of the Sound and its resources, studies have been done to determine where fish and shellfish live and what areas of the Sound are important as their nurseries. Because reproductive and juvenile stages of fish and shellfish are particularly sensitive to pollution, the nursery areas must be protected from contaminants. We are also trying to assess whether fish populations are increasing or declining.

The Marine Fisheries Program of the CT DEP and the Ocean Assessments Division (OAD) of NOAA have examined historical data on commercially and recreationally important species to help understand how these resources have changed. Data on the effects of pollution on fish and shellfish may eventually help us develop pollution cleanup programs to improve the status of the commercial and recreational fisheries.

### Do Catch Statistics Reflect Changes in Water Quality?

One way to determine historical trends in living marine resources is to compile information on how many fish are caught each year in the Sound. Changes in the species of fish caught throughout the Sound may be related to changes in its water quality. It is important that trends in the abundance and distribution of Long Island Sound fisheries be monitored because the national demand for seafood and for marine recreational fishing opportunities is increasing and because living resources are a dynamic indicator of the quality of the marine environment. This information ultimately can be used to develop policies to control impacts of pollution on these resources.




*Recreational fishing depends on a clean Sound, but this activity could be threatened by the increasing threat of pollution.*

**Fish and Shellfish Studies**

**Catch Statistics, 1961 – 1985**
Marine Fisheries Program, Connecticut Department of Environmental Protection (CT DEP)

**The Distribution of Finfish and Shellfish**
Ocean Assessments Division, National Oceanic and Atmospheric Administration (NOAA)

**Reproductive Success in Winter Flounder**
National Marine Fisheries Service, National Oceanic and Atmospheric Administration (NOAA)

The Marine Fisheries Program of the CT DEP is compiling a 25-year summary of catch statistics in Long Island Sound to document catches and landings of 10 to 12 species by first assessing historical data and then filling gaps with data from recent studies. The CT DEP, the NYS DEC, the National Marine Fisheries Service, and the U.S. Fish and Wildlife Service sponsored some of the sampling programs used for the fishery statistics. Statistics from the 1960s were compared to more recent data in an attempt to analyze how the Clean Water Act of 1972 has affected fisheries by improving water quality. However, the different methods of data collection used throughout the 25-year period make data comparisons difficult.

**Recreational Fishing Important in Long Island Sound**
CT DEP researchers gathered statistics for oysters, hard clams, lobsters, and finfish, and noted a recent increase in fishery yields since the 1970s. In the early 1980s, recreational fish catches exceeded commercial fish catches for many finfish species (Figure 8). Most of the commercial catch in the Sound during the 1980s has been shellfish: lobsters, oysters, and clams. To help evaluate the statistics, commercial catches of fish and hard clams were analyzed by the type of gear used to harvest them. Because sportfishing catches for many finfish species exceed commercial catches, sportfishing data for 1981 to 1985 were also evaluated to compare the two types of finfish catches.

Although the objective of this project was to create a comparable database of commercial catches during the past 25 years, the different methods of estimating catch statistics and the lack of successive data make year-by-year comparisons of the numbers and types of species caught impossible. By starting now to collect reliable and comparable commercial statistics, however, we not only ensure that future data will detect catch trends, but also that adequate populations of these important Long Island Sound resources are protected from pollution.

**Determining Areas Requiring Special Protection**
In this study of the Sound and its resources, NOAA evaluated the physical and yearly distribution of Long Island Sound fisheries stocks. By determining the areas of the Sound the fish frequent, the LISS can recommend actions to protect these areas from pollution. NOAA's contractor, Martin Marietta Environmental Systems, compiled and summarized published and unpublished fisheries studies. This collection of information provides

1. A means to identify future fisheries research needs in the Sound,
2. A tool to examine the extent of available data on the spatial and temporal distribution of fisheries resources in the Sound, and
3. A single source containing all fisheries data available on the target organisms.

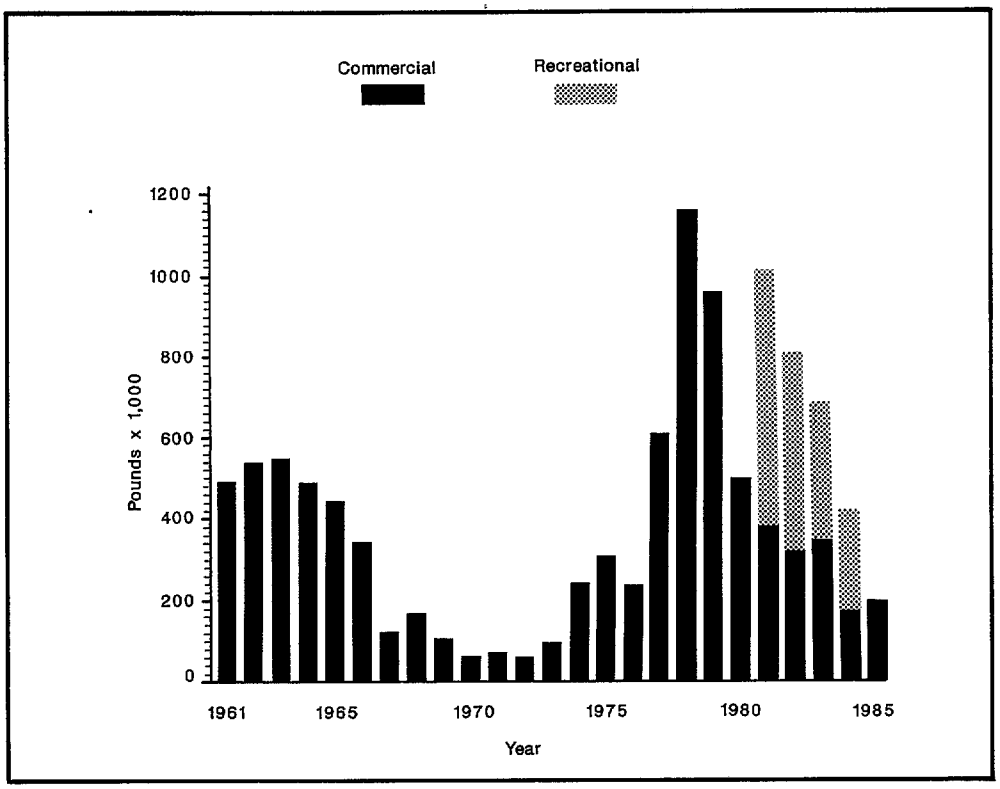
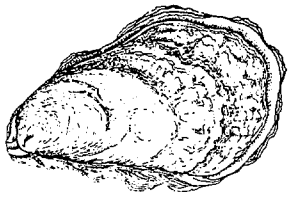
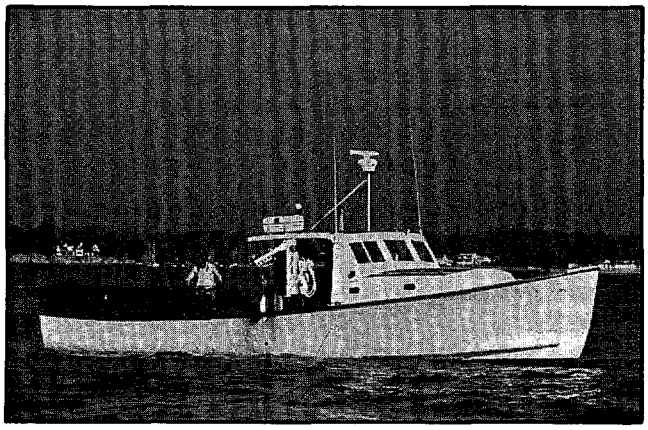



*Figure 8.*
*Catch of scup (porgy) from Long Island Sound, 1961 – 1985. (From Connecticut Department of Environmental Protection).*





*One of the most valuable resources of the Sound, its commercial catch of lobsters, finfish, and shellfish exceeds $20 million annually.*

The primary purpose of this study was to collect all quantitative spatial and year-by-year life history data on the 12 fish and 3 shellfish species with the largest economic and ecological value in the Sound. The selection of the 15 most valued fisheries was based on commercial and recreational catch records, historical abundance records, and the recommendations of fisheries researchers in the Long Island Sound region. Maps were prepared showing the distribution and density of each species by life stage (e.g., egg, larvae, juvenile, and adult) and season.

The seasonal patterns portrayed by the maps agreed with the reported life history patterns of each species. Data on the spatial and temporal distributions of fish larvae and eggs in the Sound were sparse because most sampling occurred at a few locations near power plants. Because of this lack of information, the maps could only report simple presence or absence of fish. In contrast, data on the distribution of adult and juvenile fish and lobsters, taken from otter trawls or beach seines, were extensive in all seasons except winter and included samples taken throughout most of the Sound.

The mapping showed that historically, of the species reviewed, the most abundant fish in the Sound during certain seasons included scup, windowpane flounder, and bluefish which were collected by otter trawls and gill nets. The least abundant fish species included the black seabass, striped bass, and summer flounder. Data on oysters and clams showed that numerous beds of both shellfish occurred along the Connecticut coast, but that relatively few oyster beds remained along the Long Island coast. Lobster adults and juveniles collected using trawls were abundant from spring through fall. Geographic coverage and sample sizes of lobster pot surveys were, however, too limited to adequately describe lobster distribution throughout the Sound.

### What Effect Does Water Quality Have on Fish?

To determine if pollution affects fish in the Sound, NOAA's National Marine Fisheries Service (NMFS) is studying the reproductive success of winter flounder at several sites in Long Island Sound. Pollution can affect fish reproduction adversely, with such changes ultimately affecting the recruitment of young fish into the fishery stock.

Winter flounder are considered the most important finfish in the Sound, valued by both commercial and recreational fishermen. Because they are distributed throughout the Sound, with each stock tending to remain in one general area, winter flounder are a particularly good species for the study of pollutant effects. In addition, they live on the bottom, where much of the pollution accumulates, and they spawn in most of the inshore areas of the Sound.

NOAA's NMFS study was designed to determine whether and to what extent polluted environments affect winter flounder stocks in Long Island Sound. Using several biological measurements, NOAA assessed the reproductive success of fish collected from different sites. Urban sites, such as New Haven and Hempstead Harbors which are contaminated by sewage, industrial effluents (the flow of wastes), and urban runoff, were classified as polluted or "dirty" sites. Because the inshore sites of the Sound appear more polluted in the west than in the east, sampling stations were selected along the east-west gradient to determine whether flounder reproduction is affected.

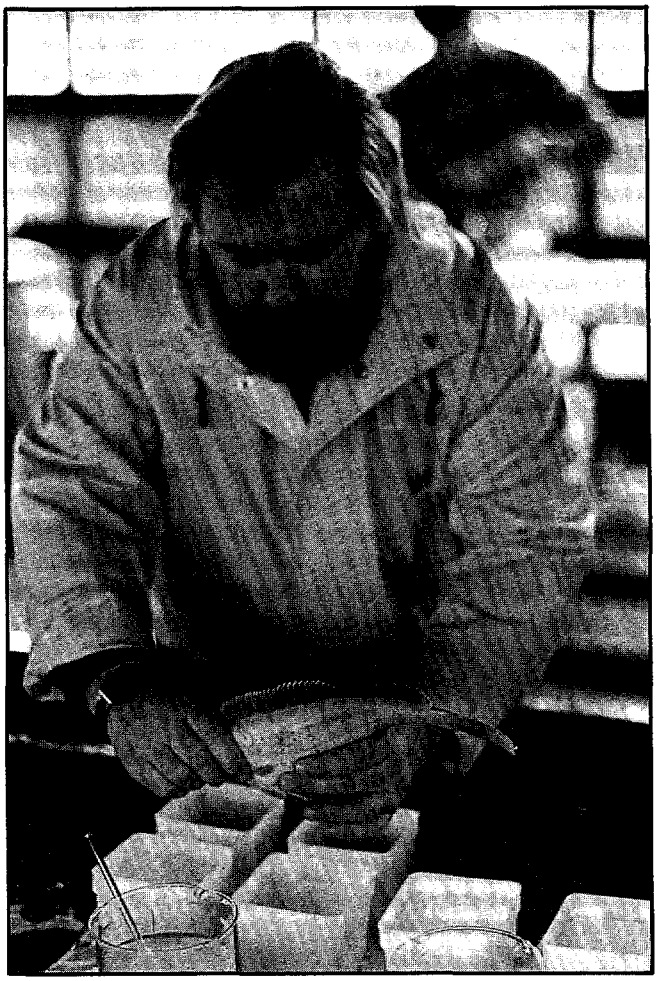
### Pollution May Cause Abnormal Reproduction

Factors that affect reproductive success may be both natural (temperature, salinity, dissolved oxygen, food availability, and predation) or human-related (overfishing, pollution, and habitat degradation). Pollution influences reproduction in two ways; directly, by inhibiting or preventing the normal development of embryos and survival of larvae; and indirectly, by reducing the overall health of the fish so that they produce fewer eggs or eggs of poor quality, having low food reserves for embryonic and larval growth as well as having chromosomal damage and a low rate of cell division.

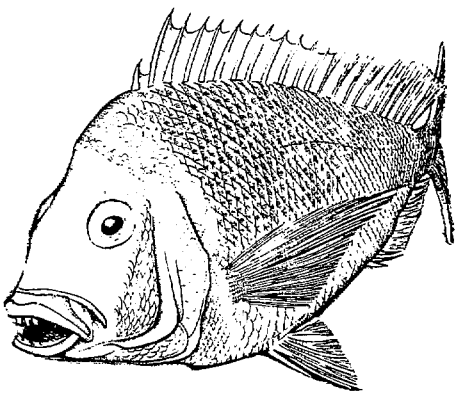
NOAA studied the seasonal profiles of the biology and metabolism of winter flounder from four sites in one study. For separate reproduction success studies, fish were sampled intensively during the spawning season, January through March. During this season, fish were collected by trawl from six stations, and the eggs were stripped from the females, fertilized, and raised in the laboratory. NOAA scientists measured several indicators of reproductive success: hatching success; developmental abnormalities in the larvae, eggs and embryos that could be lethal; size and condition of the yolk sac; relative cleavage rates of the embryos; and genetic defects in several stages of embryonic development.

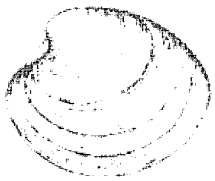
NOAA scientists noted a transfer of PCBs from the flounder liver to ovaries during the deposition of yolk material, which occurs from December through February. Researchers are also measuring the PCB levels in eggs to determine if there is any transfer of PCBs from ovarian tissue into the yolk material. Fish collected from New Haven Harbor had eggs that produced smaller larvae with more physical defects than did fish from other stations in the Sound.

Genetic studies also showed that fish from heavily industrialized areas produced fewer healthy embryos and larvae than fish from less industrialized areas. NOAA scientists are still working on the difficult extrapolation: to determine how these measurable effects of pollution on the various aspects of reproduction actually affect the total numbers of fish in Long Island Sound. Similar studies in reproductive success are being conducted on hard clams from the Sound.



*The Long Island Sound Study is investigating the reproductive success of fish to determine if pollution is affecting this sensitive function. Above, a researcher is stripping the eggs from a winter flounder as part of this study.*





# The Future of the Long Island Sound Study

The results of the first-year projects indicate several potential problems that require more detailed study. These include higher levels of toxic contamination in the western Sound and near the Housatonic River, the spreading eastern extent of low levels of dissolved oxygen, and the concern that fish and shellfish are adversely affected by these factors. Not only will the Long Island Sound Study continue research to address these environmental problems, it also expects to develop a Comprehensive Conservation and Management Plan for Long Island Sound by the end of the fifth year of the Study.

Research during the first year shows that sediments in the urbanized parts of the Sound have high concentrations of toxic contaminants, such as metals and PCBs. The Marine Sciences Research Center at the State University of New York in Stony Brook is examining sedimentary processes in the Sound to determine whether these toxic substances will continue to be released from the sediments to the Sound's waters after other sources of contamination are controlled.

Other contamination studies will provide improved estimates of the amount of organic chemicals and metals released to the Sound by industrial and municipal discharges. In addition, the health departments in New York and Connecticut will evaluate the levels of contaminants in fish and shellfish to determine if any fishery advisories are warranted.

Historical data on dissolved oxygen showed that low oxygen concentrations were found mainly in the western part of the Sound, with the possibility that the problem extends well into the Sound. A preliminary survey in August 1986 confirmed this possibility. The disturbing results indicated that low levels of dissolved oxygen extended farther east than expected, at least as far as New Haven and Port Jefferson.

The Marine Sciences Institute at the University of Connecticut will conduct intensive sampling during the summer of 1987 to determine how long oxygen concentrations remain low and how far to the east the low oxygen waters extend. These survey results will be used by other scientists to help develop a water quality model of the Sound. The model will be used to predict the effect of management options such as reducing discharges of nutrients and how that might effect dissolved oxygen concentrations in the western Sound.

Although we have compiled information on the levels of contaminants in the waters and sediments in the Sound, we do not know enough about their impact on the kinds and amounts of fish caught in Long Island Sound. Through direct mortality or by increasing a fish's vulnerability, pollutants may affect all life stages of a species. But the Sound's fish population is also affected by fishing pressure and changes in habitats (for example, loss of wetlands).

The Populations Dynamics Branch of the National Marine Fisheries Service will provide a method for using the results of biological research on the effects of contaminant exposure on winter flounder reproduction to determine the effects of pollution on the size and yield of estuarine fishery populations. Other work by NYS DEC, CT DEP, and Connecticut Department of Agriculture will expand the coverage of current fishery surveys to include the waters of the western Sound where water quality is poorest and map the location of shellfish resources throughout the Sound.

## The Challenge Continues

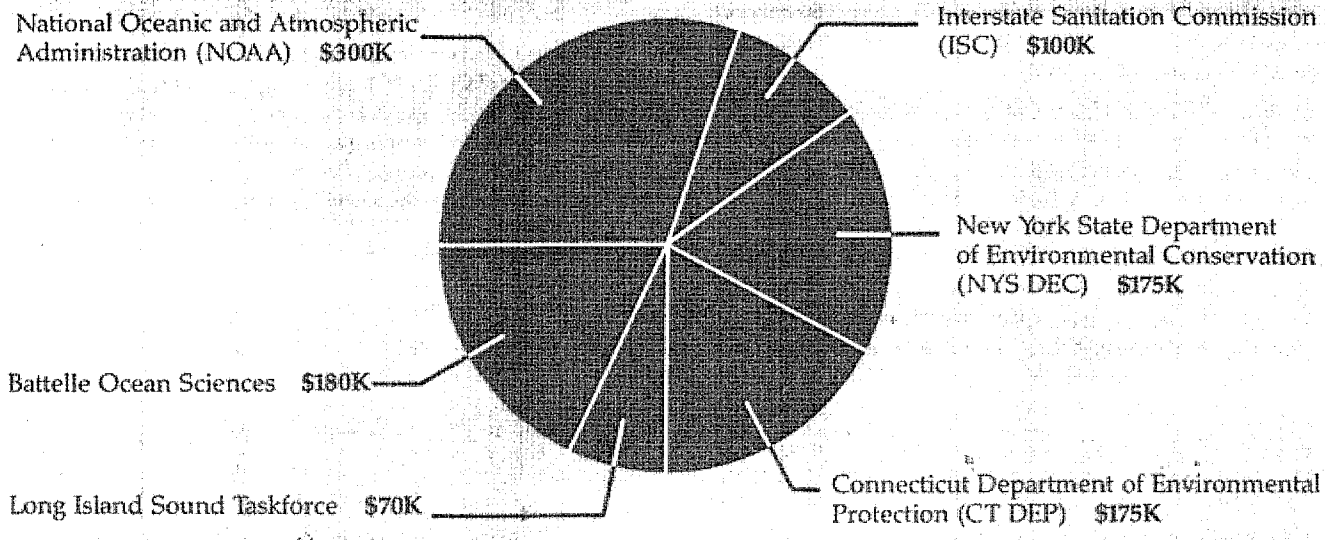
All of these studies reflect the Long Island Sound Study's pledge to preserve the Sound. But much remains to be done. We need to resolve the threat of dissolved oxygen depletion and toxic contaminants and to create action plans for improving water and resource quality.

The intensity of our commitment to produce a cleaner Sound gives us energy to face the challenges ahead. We have seen how our past abuse of this valuable resource has had measurable negative effects. Obviously, the Long Island Sound Study cannot protect the Sound alone; responsibility for all these problems rests with each of us. Until we collectively demonstrate greater respect for our environment by paying attention to the consequences of how we dispose of metals and chemicals, dump our trash, treat our sewage, and fertilize our lawns and fields, no real progress will be made. But for now, we can take encouragement from the initial progress of our studies and continue to add to and use this information to create a healthier Sound for future generations to enjoy.

## Funding

| Agency and Program | Amount |
|---|---|
| **National Oceanic and Atmospheric Administration (NOAA)** | |
| The Mussel Watch Project in Long Island Sound | $48K |
| Sources of Contaminants Entering the Sound | $25K |
| Low Dissolved Oxygen – an Historical Assessment | $50K |
| The Distribution of Finfish and Shellfish | $45K |
| Reproductive Success in Winter Flounder | $132K |
| Total NOAA | $300K |

| Agency and Program | Amount |
|---|---|
| **Interstate Sanitation Commission (ISC)** | |
| Contamination and Water Quality | $100K |
| **New York State Department of Environmental Conservation (NYS DEC)** | |
| Contamination in Finfish, Lobsters, and Eels | $175K |
| **Connecticut Department of Environmental Protection (CT DEP)** | |
| Contamination in Fish and Shellfish, and Catch Statistics, 1961 – 1985 | $175K |
| **Long Island Sound Taskforce** | |
| Public Education | $70K |
| **Battelle Ocean Sciences** | |
| Long Island Sound Database | $150K |
| Administrative Program Support | $30K |
| Total Battelle | $180K |



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