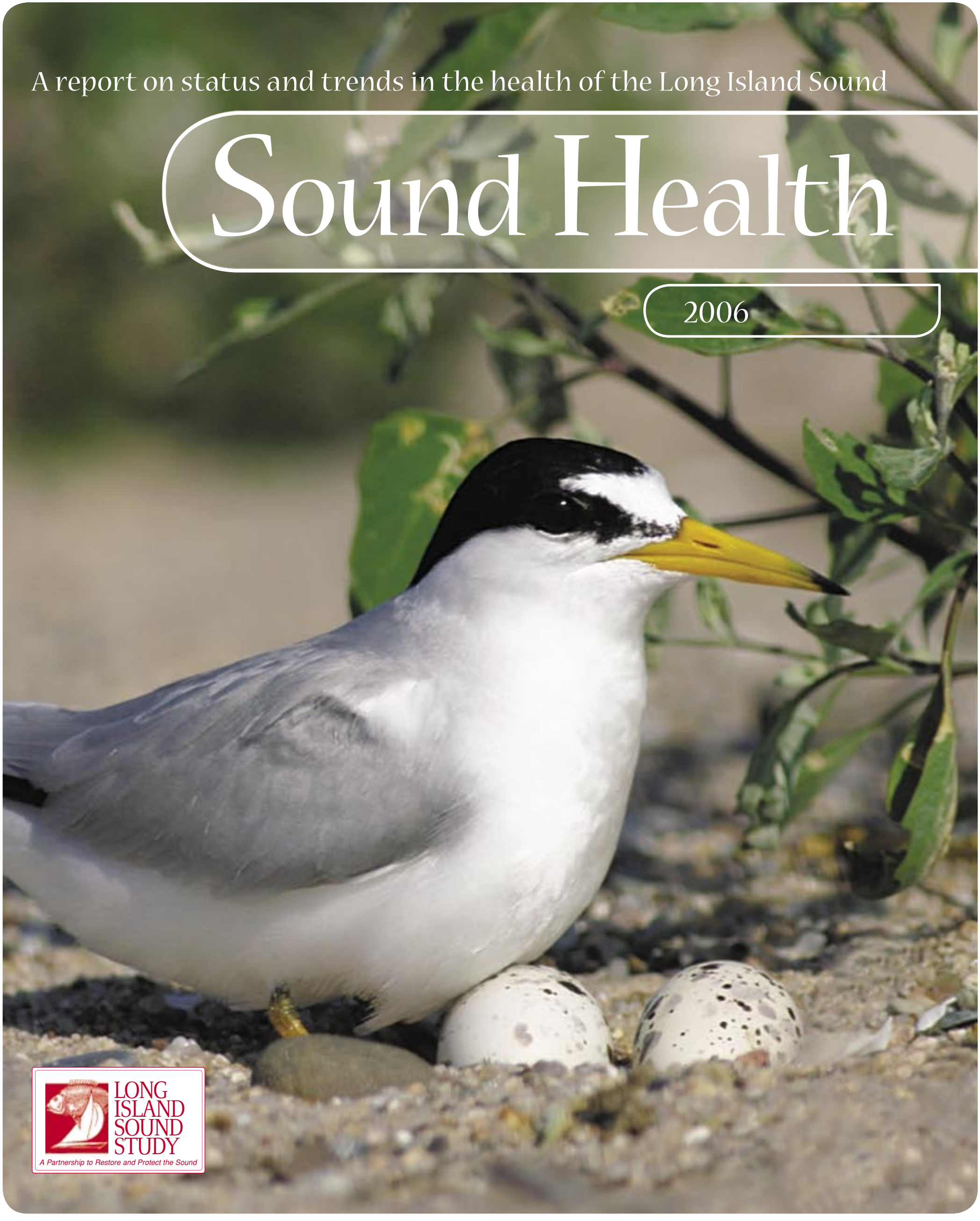
A report on status and trends in the health of the Long Island Sound

Sound Health

2006



LONG ISLAND SOUND STUDY

A Partnership to Restore and Protect the Sound

For a complete set of LISS indicators, please visit:
www.longislandsoundstudy.net/indicators

INTRODUCTION

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THE LONG ISLAND SOUND TRAWL SURVEY monitors the abundance of finfish and invertebrates in the Sound. See page 8.

Sound Health uses indicators to chart the progress in cleaning up the Sound

WHAT IS LISS?

Authorized by Congress in 1985, the Long Island Sound Study (LISS) is a collaborative effort to restore and protect the Sound. Sponsored by the U.S. Environmental Protection Agency (EPA) and the states of Connecticut and New York, partners include federal, state, interstate, and local government agencies, industries, universities, and community groups. LISS partners work together to implement a Comprehensive Conservation and Management Plan to maintain the health of the ecosystem, restore coastal habitats, and increase public awareness of the Sound. The environmental concerns affecting the Sound cross political boundaries; by working together LISS partners can share ideas, coordinate actions, and leverage scarce financial resources to protect an entire ecosystem.

For more information about the Long Island Sound Study visit:
www.longislandsoundstudy.net/about_liss

LONG ISLAND SOUND is ever changing, through the seasons, years, and centuries. Some of those changes are part of a natural cycle, as universal as the tides. Other changes are caused by human activity. With the dawn of the industrial age, as a consequence of human population growth and development, these changes accelerated and were often detrimental to Long Island Sound and the public's use of it. But change can also bring renewal and recovery.

The public expects a renewed Sound even as we continue to develop the Sound's watershed and use its resources.

The callous indifference to pollution during the early industrial development of the region was unsustainable. Inevitably, changes in public perception culminated in the environmental movement and national and state legislation was enacted to protect the nation's natural resources. Programs were established to improve water quality, preserve critical habitats, and restore living resources. As a result, the change in Long Island Sound that the public now expects is one of renewed health, even as we continue to develop the Sound's watershed and use its resources.

The purpose of *Sound Health* 2006 is to report on the changes in Long Island Sound and its watershed, and the linkages between those changes. Environmental indicators are used to present these changes and linkages, using data from researchers, agency programs, and other sources. The report highlights trends in pollutant levels, land use and development, water quality, living resources, and sensitive habitat. From this snapshot of current conditions and trends, *Sound Health* 2006, like its predecessors in 2001 and 2003, assesses the effectiveness of restoration efforts, comparing actual outcomes to goals established by the Long Island Sound Study. Is the pace of progress on target? Is the water cleaner? Are the fish safe to eat? How are uses of the Sound changing? Are there new threats that need to be addressed and old ones that remain?

The answers to these questions are often complex. Pollutant discharges are decreasing. Contaminant levels are, overall, in decline. Seals, ospreys, and striped bass have made remarkable recoveries. But there remain troubling signs of a system in distress. The harvest of lobsters remains well below levels that existed before the 1999 die-off. Some tidal marshes are turning into mud flats for unknown reasons. Increased water temperatures stress fish and other aquatic resources. And invasive species alter the food web of many habitats.

To put these trends into perspective, this report provides a sample of the more than 40 specific indicators developed by the Study to assess the ecological condition of Long Island Sound. Also included is a new water quality index (see opposite page) developed in cooperation with the U.S. Environmental Protection Agency's Office of Research and Development. Environmental indicators may seem dispassionate compared to looking at a sunrise off Mystic Harbor, or watching a flock of great egrets wading in a salt marsh in Hempstead Harbor. But indicators provide an objective measure of environmental changes and offer insight on the successes and challenges to restoring and protecting the Sound.

BARRIER BEACH HABITAT is an important breeding ground for many coastal birds. The above photo and the cover photo show least terns at one of these beaches, Sandy Point in West Haven, Connecticut. The least tern is considered a threatened species in New York and Connecticut. For more information about coastal birds, see p. 11.

COVER PHOTOGRAPH BY JULIAN HOUGH

CREDITS: *Trawl Survey* photo by Richard Howard; *Least Tern Family* photo by Julian Hough

CONDITIONS BY BASIN

Water quality in the Sound varies from basin to basin

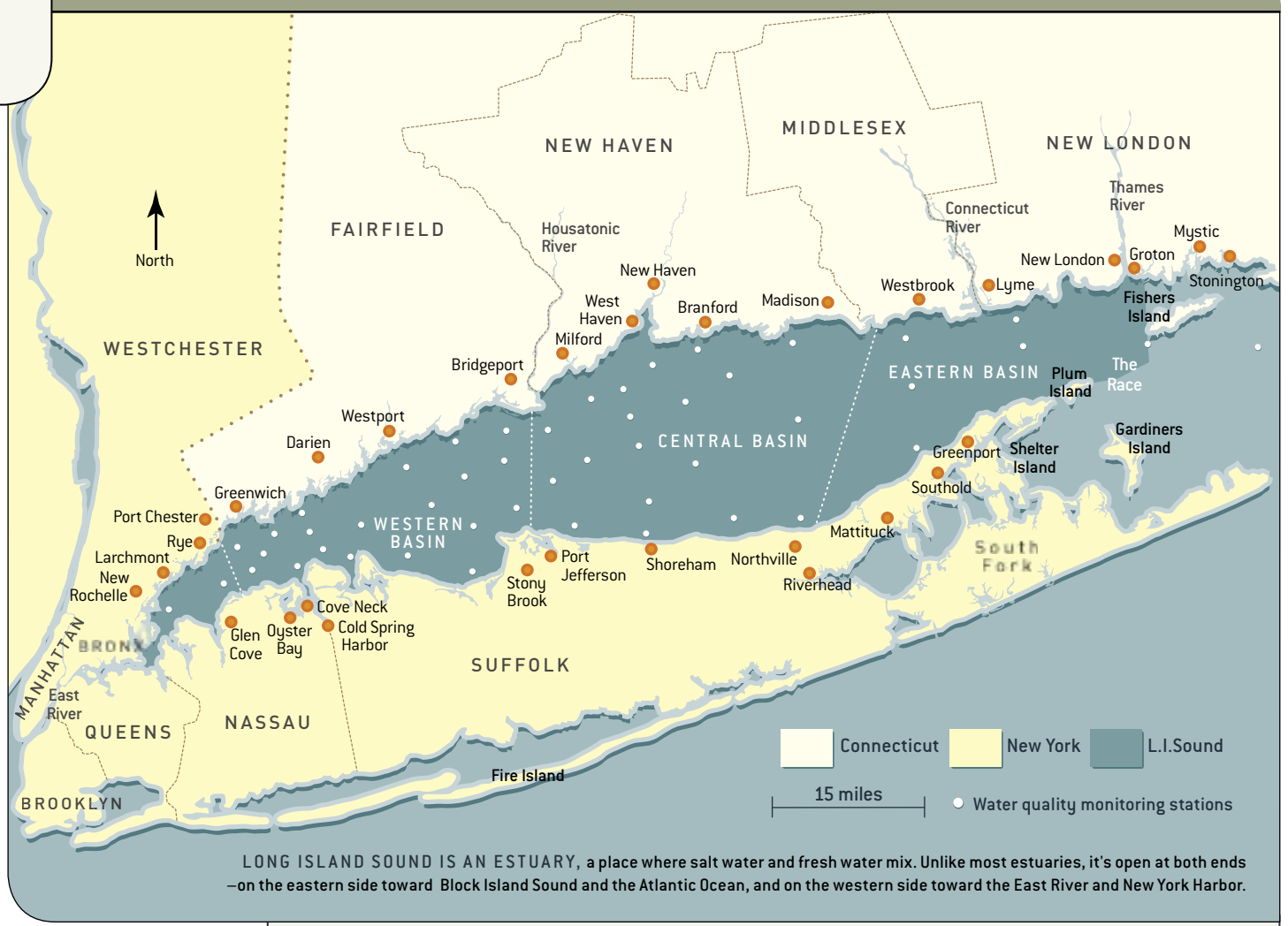
DESCRIBING THE condition of a 110-mile long water body poses a challenge. Hydrology (the movement of water) and sediment characteristics vary within each of the Sound's sub-basins, as does the degree of development along its shorelines. Conditions vary by season. And in some locations, historical contaminant discharges still affect conditions. In other words, the Sound can be described as healthy and vibrant, or distressed and impaired, depending on location, season, or issue.

But recent work by the U.S. Environmental Protection Agency's Office of Research and Development to characterize how water quality conditions vary nationally offered an approach to quantitatively characterize water quality conditions geographically in Long Island Sound. Using an **index** of five water quality measures over a 14-year period, conditions in Long Island Sound were characterized as good, fair, or poor for each of the Sound's three major basins.

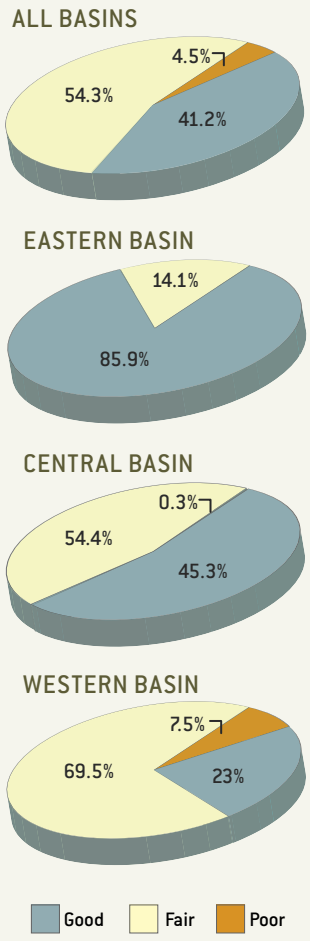
As expected, the western basin, with its densely-developed shoreline, is the most stressed, with fair water quality the majority of the time. Water quality improves in the central basin, and in the eastern basin water quality is good most of the time.

The gradient in improving water quality from west to east reflects both the decrease in population density and conditions within the basins themselves. For example, the eastern basin is deep, dipping to 350 feet at the Race, and rocky-bottomed. The narrow channel opening to Block Island Sound acts as a funnel, leading to fast moving currents that scour the bottom and actively mix the water. The western basin is shallower, generally less than 60 feet deep, with a sea bottom of fine sand and mud. Currents are weaker, and in the summer months there is little mixing between the lighter, oxygenated surface waters and the denser bottom layer. In combination with high nitrogen loads and phytoplankton production, reduced mixing leads to hypoxia in the western basin (see p. 4). The central basin is a transition zone between the two extremes. It is also the widest part of the Sound—the distance between New Haven and Shoreham Beach being 21 miles.

Future work will apply indices developed to characterize sediment quality (the amount of contaminants, toxicity of contaminants, and organic carbon levels) and the condition of the organisms living in those bottom sediments. Data to support these indices are currently being collected by Connecticut and New York through the EPA's National Coastal Assessment, with supplemental support by LISS. These indices, when combined with other indicators of water, habitat, and living resource condition, will give a more complete picture of how conditions vary geographically in Long Island Sound.



LONG ISLAND SOUND IS AN ESTUARY, a place where salt water and fresh water mix. Unlike most estuaries, it's open at both ends —on the eastern side toward Block Island Sound and the Atlantic Ocean, and on the western side toward the East River and New York Harbor.



WATER QUALITY INDEX

The EPA's National Coastal Assessment index for Long Island Sound is based on five chemical and biological measures using data from water quality samples collected by the Connecticut Department of Environmental Protection. Monthly data (from May to October, when pollution has the greatest effect on water quality), were summarized Soundwide from 1991 to 2004 and for each of the Sound's three basins. When two or more measures exceeded a poor threshold for the month, water quality was rated poor; when one measure exceeded a poor threshold, or two or more measures were fair, water quality was fair; and when no measures exceeded a poor threshold, and a maximum of one was rated fair, water quality was good.

Water Quality Index measures:

- **Dissolved Oxygen. Low oxygen levels (hypoxia) can impair the feeding, growth, and reproduction of aquatic life.**
- **Chlorophyll a. A photopigment in plants that indicates the amount of algae in water.**
- **Water Clarity. Clearer water allows light to penetrate deeper, supporting the growth of rooted aquatic plants.**
- **Nitrogen. An essential nutrient to plant growth, which, in excess, can fuel algal blooms.**
- **Phosphorous. Another nutrient that promotes algal growth.**

WATER QUALITY INDEX: From 1991-2004, the Sound's water quality had been fair to good most of the time. But the western basin close to the Sound's most populated areas did experience poor water quality that was harmful to aquatic life.

CREDITS: *LIS basins* map by Lucy Reading-Ikkanda/ CT Dept. of Environmental Protection
SOURCES: *Water Quality Index*, EPA's Office of Research and Development/Office of Water (epa.gov/owow/oceans/nccr)

To learn more about hypoxia and water quality monitoring, please visit:
www.longislandsoundstudy.net/soundhealth

NITROGEN POLLUTION AND HYPOXIA

Excess nitrogen can degrade water quality and impair habitat in the Sound

WHAT IS HYPOXIA?

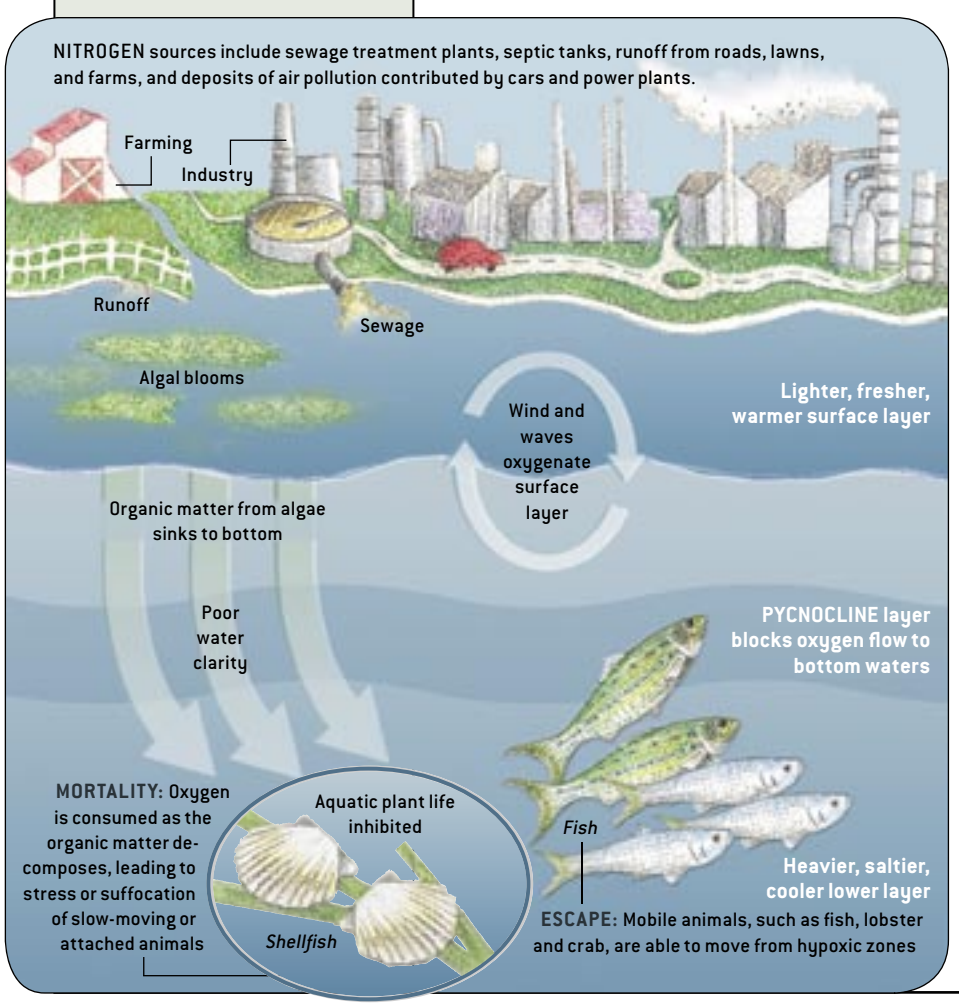
Hypoxia is defined as low levels of oxygen dissolved in the water. During the summer, the surface water of Long Island Sound heats up and forms a distinct layer "floating" over the bottom water, which is denser due to greater salinity and cooler temperatures. The layers lead to a pycnocline, a sharp density gradient that restricts the oxygen-rich surface waters from mixing with bottom waters. At the same time, nutrients, particularly nitrogen, fuel the overgrowth of planktonic algae. The organic matter (algae and waste from animals feeding on them) that sinks to the bottom is consumed by bacteria in a process that uses up oxygen.

ALEX LOCHNER AND BONNIE HICKEY of the Interstate Environmental Commission (IEC) use a water quality meter to measure dissolved oxygen conditions off Hewlett Point, Long Island, on the research vessel *Natale Colosi*. IEC is one of several organizations monitoring water quality in the Sound.

NITROGEN IS an essential nutrient used by all living things. While nitrogen gas makes up 78 percent of the atmosphere, it can't be used by plants and animals until converted into a reactive form such as ammonia or nitrogen oxides. However, just as too much carbon, in the form of carbon dioxide, is a bad thing for the atmosphere, too much nitrogen is a bad thing for some water bodies, including Long Island Sound.

In the Sound, over-enrichment of nitrogen helps to fuel the excessive growth of algae. These blooms can shade sunlight, leading to the loss of important underwater plants such as eelgrass. When the algae and waste from animals that feed on them sink to the bottom, bacteria decompose the material and consume oxygen. The low levels of dissolved oxygen that result, a condition called hypoxia, impair the feeding, growth, and reproduction of marine life. Ultimately, it can cause death for some fish and other aquatic life that cannot escape hypoxic conditions. A 2000 National Research Council report called nutrient over-enrichment one of the most significant environmental problems facing America's coastal waters.

But where does the nitrogen come from? Some of it is natural, but human activities have increased by 400 percent the discharge of nitrogen into the Sound. The increase is mainly a by-product of the food we eat; more than 150,000 pounds of nitrogen are discharged each day from wastewater treatment plants, which is about 40 percent of the total nitrogen that makes its way into the Sound. Other sources include automobiles and trucks that release nitrogen compounds into the air, which can be deposited into the water, and fertilizer and animal waste, which can drain into storm sewers and tributaries that eventually flow into the Sound.

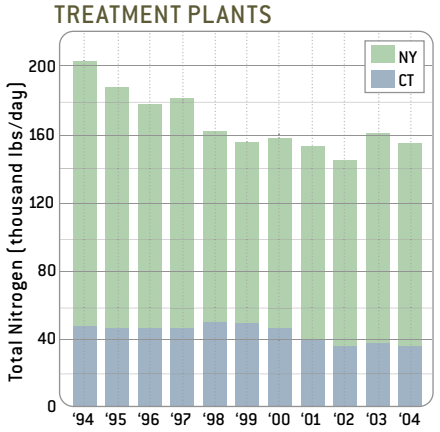


In 1990, LISS initiated a phased plan to improve oxygen levels in the Sound by **reducing nitrogen loads.** In 1998, the states of Connecticut and New York and the federal government adopted a target of reducing nitrogen loads from human sources by 58.5 percent by 2014.

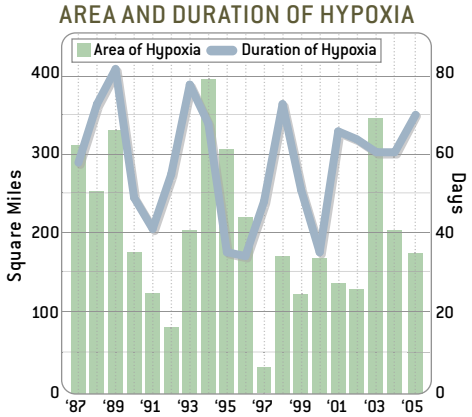
Progress has been made. Since 1994, the peak year in nitrogen discharges, 36 of the region's 105 sewage treatment plants in Connecticut and New York have been upgraded to provide biological removal of nitrogen, and more are under construction or are being proposed. These upgrades have resulted in about 47,000 fewer pounds of nitrogen entering Long Island Sound each day compared to 1994.

Overall, the **area and duration of hypoxia** have become less severe in recent years compared to the 1980s, but hypoxia levels can spike as they did in 2003 when the hypoxic area covered 345 square miles, the second highest total since the water quality monitoring program began. Despite significant nitrogen reduction from sewage treatment plants, the current input of nitrogen, combined with other factors, still poses a significant threat to water quality.

NITROGEN FROM SEWAGE TREATMENT PLANTS



AREA AND DURATION OF HYPOXIA



NITROGEN POLLUTION decreased by 24% from 1994-2004, largely because of improvements to sewage treatment plants. Hypoxia varies from year to year, but appears to be improving. Even so, the western Sound still experiences bad years: in 2003, for example, the hypoxic region was 345 square miles, an area larger than the entire land mass of New York City.

CREDITS: *Water quality monitoring* photo by Peter L. Sattler, Interstate Environmental Commission.
SOURCES: *Nitrogen from Sewage Treatment Plants* (CT DEP and NYS DEC); *Area and Duration of Hypoxia* (CT DEP LIS Water Quality Monitoring Program)

To download the food web illustration, please visit:
www.longislandsoundstudy.net/soundhealth

INSIDE THE FOOD WEB

Food webs describe the feeding relationships of an ecosystem

THE MOST ABUNDANT forms of life in the Sound are too small to see. Microscopic plants, called phytoplankton, use the energy of the sun and essential nutrients, including nitrogen, as building blocks for growth. Tens of thousands of these tiny plants can exist in a drop of seawater, providing food and energy for all other forms of aquatic life through a complex web of interactions.

The amount of fish and shellfish produced in the Sound is dependent on the amount and types of plants and animals that "cycle" up the food chain as food for larger animals. In addition, the microscopic plants that aren't consumed or fully digested in this process can increase the oxygen demand in the Sound's bottom waters, causing hypoxia.

Scientists have identified key plants and animals of the Sound's food web, and have also monitored their seasonal population shifts in response to changes in water temperature, nutrient concentrations, and other factors. Tracking population changes over time will increase our understanding of the food web and how it changes in response to nitrogen reductions being implemented around the Sound.

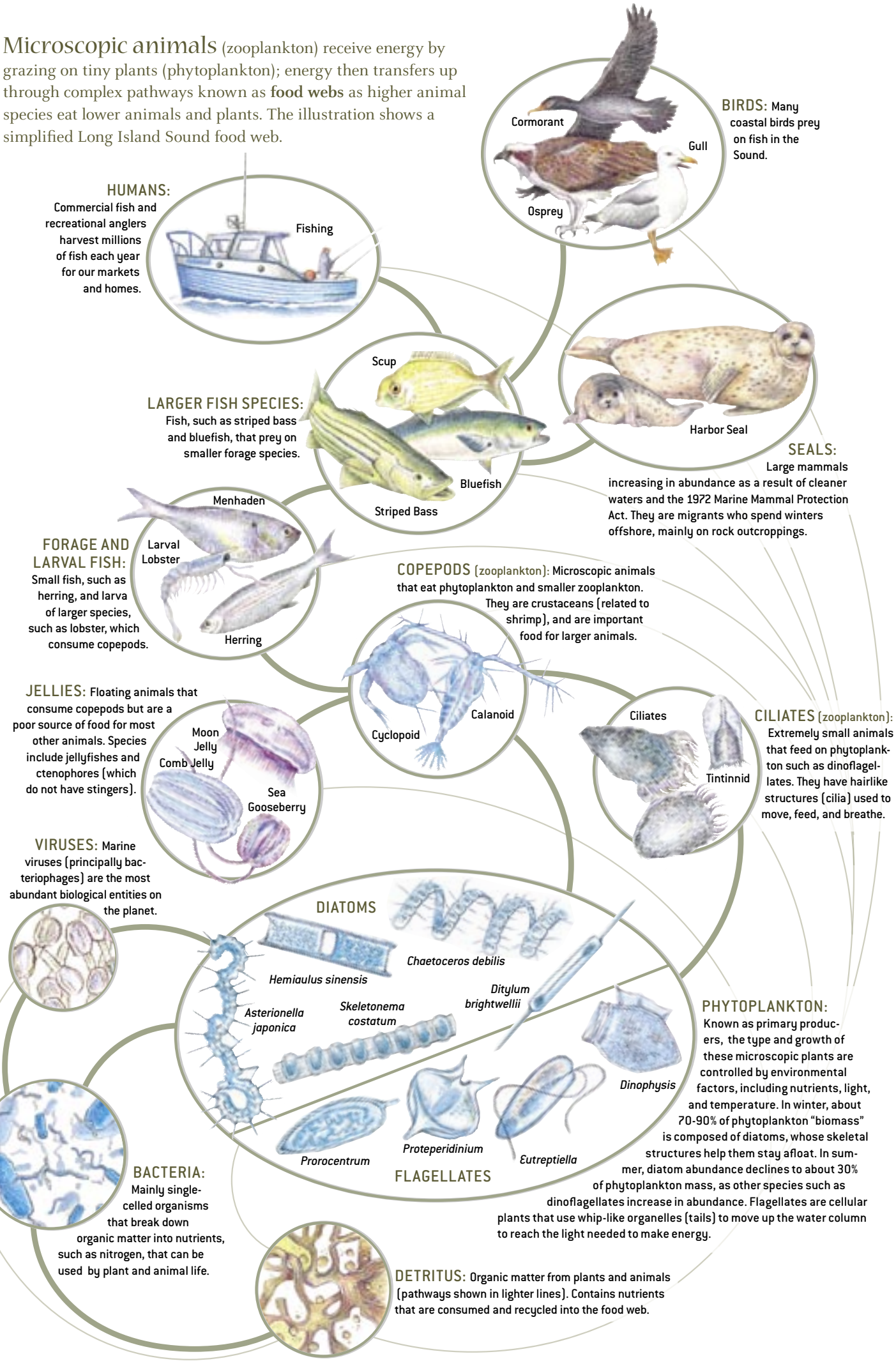
For example, in the winter and early spring, blooms of phytoplankton are dominated by diatoms. The diatoms are grazed by copepods, a small shrimp-like crustacean, 1/16 of an inch long. Copepods are a rich food source for fish, such as herring and menhaden, and the larval stages of many other aquatic species. These species, in turn, are prey for commercially and recreationally important fish, such as striped bass and bluefish.

The food web, however, changes during the summer with warmer temperatures and lower nutrient concentrations. Diatoms are joined by several types of phytoplankton, including dinoflagellates and smaller species of phytoplankton. These plants are less efficiently eaten by copepods, and are, instead, consumed by other zooplankton, such as ciliates. The ciliates then can be consumed by copepods.

Key links in the food web can also change. For example, jellyfish or ctenophores (commonly called comb jellies) can be important consumers of copepods. These gelatinous animals are a poor source of food for most other animals and, as a result, don't support production of economically valuable species.

While many of the organisms in the Sound are too small to see, they are still important elements of the food web. Scientists are working to understand how the interactions among all organisms transfer energy (food) from small plants and animals to larger species. This information will aid decision makers managing the fisheries and water quality of Long Island Sound.

Microscopic animals (zooplankton) receive energy by grazing on tiny plants (phytoplankton); energy then transfers up through complex pathways known as **food webs** as higher animal species eat lower animals and plants. The illustration shows a simplified Long Island Sound food web.



CREDIT: Illustration by Lucy Reading-Ikkanda
SOURCES: CT DEP LIS Water Quality Monitoring Program

For more information on trends in contaminant releases, please visit:
www.epa.gov/tri

TOXIC CONTAMINANTS AND PATHOGENS

PATHOGENS

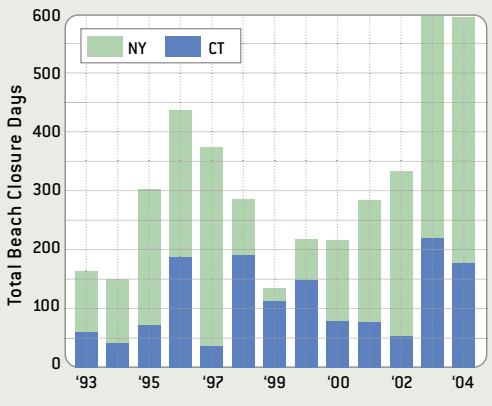
Millions of people each year enjoy swimming in more than 240 Long Island Sound beaches. But swimmers at some Long Island Sound beaches face the possibility that their beach may close for a few days during the swimming season because of possible pathogen contamination.

Pathogens are disease-causing bacteria and viruses that enter the Sound from inadequately treated human sewage and domestic and wild animal wastes. A prime source includes sewer systems that combine storm and sanitary pipes. These systems overflow after a rainstorm and carry untreated sewage to the Sound. Other "delivery systems" include vessel discharges and stormwater runoff from streets. People can become sick by swimming in contaminated waters or by eating raw or partially-cooked shellfish that contain pathogens. The concern is so great that some beaches and shellfish beds are immediately closed following a rainstorm in areas with known pathogen sources as a precaution to prevent exposure and protect public health.

Beaches and shellfish beds are closed following a rainstorm in some areas.

Steps can be taken to reopen chronically closed beaches. For example, in Mamaroneck, the beach at Harbor Island Park, closed for three years, was reopened for swimming in 2003 after the Village had installed a boom to trap pathogens. The Village also has reduced pathogens by removing an illicit discharge, repairing old sewage pipes, and planting native vegetation along riverbanks and the shoreline to filter runoff.

BEACH CLOSURE DAYS



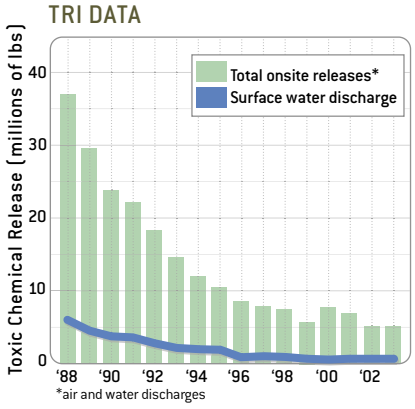
FREQUENT RAINFALL, such as what occurred in 2003 and 2004, can result in communities closing beaches as a precaution to protect swimmers from pathogens. Beaches are more likely to be closed in populated areas that have older sewer systems and more impervious surfaces, and if they are located in embayments where there is less mixing with the open waters of the Sound.

THE RECOVERY OF THE OSPREY shows the benefits of reducing toxic chemicals.

Despite big reductions, toxic chemicals still threaten aquatic life

THE DISCHARGE OF TOXIC organic chemical compounds and heavy metals into the Sound and its tributaries has often been associated with manufacturing processes, mainly from the Sound's industrial past. For example, mercury was discharged into the Housatonic River as a by-product in the manufacturing of hats. It was banned in the 1940s when its link to diseases of the nervous system became known. But manufacturing is not the only source of toxins: toxic chemicals can be released from household cleaning and pest control products, automobile exhausts, and emissions from fossil fuel power plants.

TRI DATA

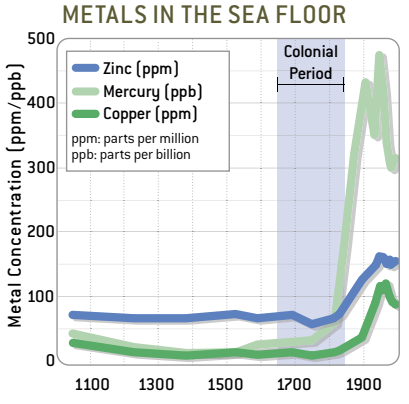


DISCHARGES OF METALS and other contaminants into the air and directly into the Sound and its tributaries are decreasing.

Today, federal and state programs strive to reduce toxic chemical discharges to the Sound and to minimize the toxicity of effluents from sewage treatment plants and industries. Overall, toxic releases have declined dramatically. With tighter controls, contaminant levels in the sediment and in marine life have also decreased. Since 1988, toxic chemical discharges directly into the Sound and its tributaries have decreased by 88 percent and airborne discharges throughout the entire watershed have decreased by 85 percent, according to the EPA's **Toxics Release Inventory** database. The TRI identifies the amount of chemicals used at industrial facilities that are released into the environment.

Elimination of the pesticide DDT in 1972 shows the benefits of reducing toxic chemicals. DDT had caused the thinning of osprey eggs that almost led to the extinction of the fish-eating bird of prey. Now ospreys are making a recovery in the Sound and elsewhere (see p. 11).

METALS IN THE SEA FLOOR



CONCENTRATIONS OF HEAVY METALS in the sea floor have declined, but are still high compared to the colonial period.

But toxic contamination still poses threats to aquatic life and ultimately to humans. Many contaminants, such as **mercury**, **zinc**, and **copper**, become attached to fine particles of sediment in the water. The contaminated sediments eventually settle to the sea floor, mostly in areas of weak currents in the western Sound where they are less likely to be flushed out. Under the right environmental conditions, a contaminant such as mercury can be resuspended into the water column; it can then turn into a highly toxic form of mercury that can be ingested by small aquatic life. As food cycles up the food chain, larger fish and shellfish can accumulate the mercury at higher concentrations. Also, some organic compounds such as polychlorinated biphenyls (PCBs), a known animal carcinogen and probable human carcinogen that had been used as an insulator, resist breaking down. PCBs are still found in fish tissue even though its production was banned in 1977. As a result, public health advisories are published to inform consumers of the potential risks of eating fish that may contain PCBs and other toxic contaminants.

Scientists also are becoming concerned about the possible toxic effects of chemicals used in pharmaceuticals, perfumes, and other industrial products that could enter water bodies with sewage effluent and stormwater runoff. If these chemicals are ingested by fish and accumulate, they could affect their hormone-producing endocrine systems and their ability to develop and reproduce properly. For example, Hans Laufer, PhD, a biologist at the University of Connecticut, has identified alklyphenols in lobsters in the eastern Sound. Laufer is investigating whether these chemicals, known to disrupt the endocrine system of some aquatic species, contribute to a shell disease found in lobsters. Alkylphenols have a wide variety of industrial uses, such as lining for food cans and for dental sealants. More research is needed on these "emerging contaminants" to better understand their effect on humans and the environment.

CREDIT: *Nesting osprey* photo by Don Riepe **SOURCES:** *Metals in Sea Floor* chart(Samples Taken off Norwalk Harbor) Johan C. Varekamp and Ellen Thomas (Department of Earth & Environmental Sciences, Wesleyan University, Middletown CT). Marilyn R. Buchholtz ten Brink and Ellen L.Mecray (U.S. Geological Survey, Coastal and Marine Geology Program, Woods Hole Field Center, Woods Hole, MA); *TRI Data* chart (EPA 2003 Toxics Release Inventory); *Beach Closure Days* (CT DEP and NYS DEC)

For more information about lobster research in the Sound, please visit:
www.seagrant.sunysb.edu/LILobsters

SHELLFISH ABUNDANCE

Diseases have devastated the oyster and lobster populations in the Sound

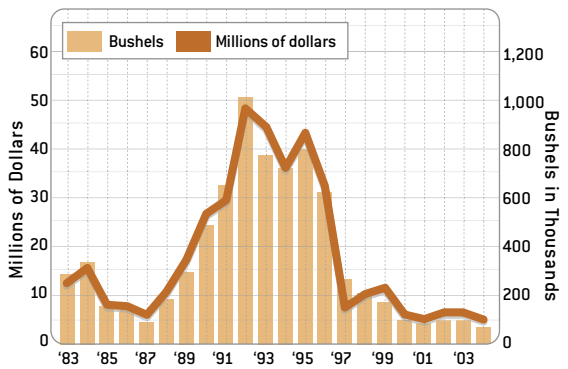
PEOPLE STILL make a living "off the sea" by harvesting shellfish from the Sound. Commercial catches include hard clams, soft-shell clams (or steamers), bay scallops, and blue mussels. Traditionally, the most economically important shellfish harvested in the Sound have been oysters and lobsters (a crustacean). But both of these animals have suffered from infections and diseases, and their poor health has hurt the marine economy, recreational fishing, and the Sound's ecosystem.

Oyster harvesting in Long Island Sound peaked in 1992, with more than 1 million bushels harvested. By 1997, the catch had declined significantly after the oysters became infected by two deadly parasitic diseases, MSX and Dermo. In 1997 the Sound's **lobster harvest** had developed into a $40 million a year industry, the largest in the U.S. But it has dropped dramatically as a result of shell disease and a series of dieoffs. As lobster and oyster harvests declined, some fishers turned to harvesting less commercially valuable shellfish, including hard clams, which increased from 158,000 bushels harvested in 1995 to 479,700 bushels harvested in 2004.

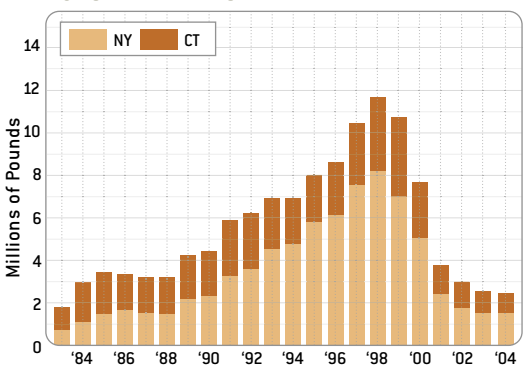
Rising water temperatures may contribute to lobster disease.

But resource managers for Connecticut's Aquaculture Division are optimistic that programs to breed disease-resistant oysters in hatcheries and allow them to reproduce in the wild will help restore a healthy population. As a result of these efforts, the survival rate of spawned oysters in the state's leased oyster beds in winter 2004-2005 more than doubled from the previous winter's rate. If the program succeeds, harvests should start to see a gradual improvement in 2007, the time these offspring reach maturity. In New York waters, most oysters are cultivated in Oyster Bay where MSX has been less severe.

AL DOVE at Stony Brook University's marine pathology laboratory performing an animal autopsy (a necropsy) on a lobster with calcinosis, a disease in which calcium deposits build up on the lobster's gills.



THE HARVEST of oysters, a commercially valuable shellfish, declined in 1997 as a result of parasitic diseases. A program is in place to breed disease-resistant oysters to try to reverse the trend.



LOBSTER HARVESTING has declined since reaching a peak of nearly 12 million pounds in 1998.

The decline in the lobster harvest prompted the creation of the Lobster Research Initiative. From 2001-2004, the initiative funded 24 projects to investigate the possible causes of a range of health problems, including a 1999 die-off and a non-fatal, but debilitating, shell disease.

While scientists found no "smoking gun" to explain the deaths, evidence indicates that lobsters, at an all-time high abundance, were subjected to sustained, stressful environmental conditions, including above average water temperatures. Weakened by these conditions, they became susceptible to disease, including infection by parasitic amoebae. By the late 1990s, temperatures consistently reached 20 degrees Celsius and higher in the summer months, the temperature at which lobsters, a cold-water species, begin to lose the ability to regulate physiological processes such as feeding, digestion, and respiration, and lose the ability to resist diseases.

"As a parasitologist looking into this I expected that we would be working on a parasite as the main problem, but you go where the data leads and in this case the data have guided us to temperature as playing the dominant role," said Alistair Dove, PhD, a researcher working at Stony Brook University's marine pathology laboratory.

It is uncertain how temperature will continue to affect the health and abundance of lobsters. For now, New York and Connecticut are working to conserve the population by instituting catch regulations that will protect lobsters from being caught before they reproduce.

The sustainability of shellfish also is important for ecological as well as economic reasons. Oysters, mussels, and clams improve water quality by filtering algae from the water for food, thus reducing algal blooms and improving water clarity. Lobsters also fill an important niche as scavengers, eating the dead fish and worms left on the sea bed.

SOME FISHERS have turned to clamming, but the commercial value of the harvest has not replaced the decline in lobster and oyster harvests.

LIS FISH CONSUMPTION ADVISORIES

These advisories refer to fish, crabs, and lobsters that people catch, and not to fish bought in stores. Due to the possibility that ingested fish will have elevated concentrations of contaminants, the New York and Connecticut health departments have issued consumption advisories for the following marine organisms:

MARINE BLUEFISH AND EELS

NY: Eat no more than one meal per week of bluefish or eels. (PCB contamination)
CT: Bluefish 13-25"—Eat no more than one meal per month. Bluefish over 25"—Eat no more than one meal per 2 months; high risk group (women of childbearing age, pregnant women, and children under 6) should not eat bluefish over 25".

MARINE STRIPED BASS

NY: Women of childbearing age and children under 15 should not eat striped bass taken from Long Island Sound west of Wading River. Others should eat no more than one meal per month from the above-mentioned area. Everyone should eat no more than one meal per week of striped bass taken from the Sound east of Wading River. (PCB contamination)
CT: High risk group should not eat striped bass. Others should not eat more than one meal per month.

CRABS AND LOBSTERS

NY: Hepatopancreas (green meat or mustard) should not be eaten (PCB, cadmium, and dioxin contamination). Discard crab or lobster cooking liquid.
CT: High risk group should avoid eating hepatopancreas. Others should not eat more than one meal per month.

For more information, visit:
www.health.state.ny.us/nysdoh/fish/fish.htm
www.dph.state.ct.us/BRS/EOHA/webfsh.htm

CREDITS: *Lobster* photo by Bob Strovink for New York Sea Grant
SOURCES: *Lobster Harvest* (CT DEP Marine Fisheries and NYSDEC, Bureau of Marine Resources * New York 2004 numbers are an estimate pending final reporting); *Oyster Harvest* (CT Dept. of Agriculture's Aquaculture Division and NYS DEC); *Hard clam* data (CT Dept. of Agriculture's Aquaculture Division and NYS DEC)

To see a slide show of the trawl survey, please visit:
www.longislandsoundstudy.net/soundhealth

KEEPING TABS ON THE FISHERY

All photos by
Richard Howard

Trawl Survey Tracks the Sound's Fish Populations

Managing a fishery starts with assessing the abundance and types of fish in the sea. But just how do you go about learning what's underneath the surface of an estuary as large as Long Island Sound? For more than 20 years, the Connecticut Department of Environmental Protection (CT DEP) has conducted a Trawl Survey throughout the Sound to track the size of fish populations. On each trawl, the crew of the research vessel *John Dempsey* works quickly and precisely to count, weigh, and measure finfish and invertebrates before returning them to the water and moving on to the next site. The samples enable resource managers to compare year to year the relative abundance of dozens of species living in Long Island Sound's varied habitats.

1 THE SAMPLE

The Trawl Survey uses a random survey method to make sure that all fish in the Sound have an equal chance of being counted. CT DEP's Marine Fisheries Division has divided the 110-mile long body of water into 500 sites, each about 2 square miles. Those sites include 12 distinct habitats, with characteristics that consist of deep or shallow water, muddy or sandy bottoms, and transition zones. Each year prior to the spring trawl season, a computer program randomly selects 200 areas to trawl from the 500 sites. Marine Fisheries Division staff then develops a cruise schedule to sample 40 sites a month for the spring trawl season (April, May, and June) and the fall trawl season (September and October). The spring sample best assesses the abundance of fish that thrive in colder water temperatures. The fall survey best assesses the abundance of fish that migrated into the Sound from coastal waters during the warmer summer months; it also counts the juvenile fish produced during the summer's spawn.

2 THE HAUL

Each cruise starts at about 7 a.m., either leaving the Marine Fisheries Division's dock in Old Lyme in the eastern Sound or the state Aquaculture Division's dock located mid-Sound in Milford. Using the cruise map and a global positioning system, the captain pilots the boat to the selected sample area. When the captain reaches the site, the crew begins the work of dropping a two hundred pound trawl net to the bottom of the Sound. The cone-shaped net is removed from a reel and connected to two "otter" trawl doors on both sides of boat. The weight of the doors helps to push the net down and outward, while wires and floats help extend the net to a width of 46 feet. As the boat cruises 3.5 knots in the 2-square mile sample area, fish get swept back into the retaining bag at the back of the net (known as the codend). After 30 minutes, the net is lifted out of the water using hydraulic equipment.

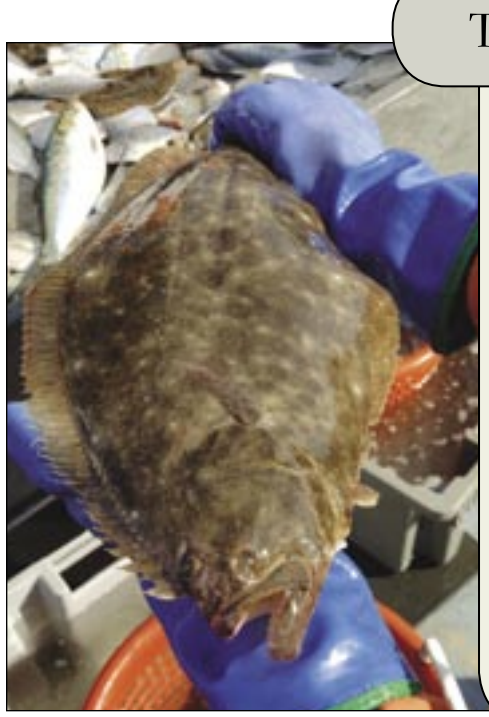
SCENES FROM THE RESEARCH VESSEL *JOHN DEMPSEY (from top, clockwise):* Checking a trawl location on the survey grid; an Atlantic herring, a "forage" species eaten by larger fish; a DEP crew member shows the transparency of the fourspot flounder; a longfin squid, an invertebrate that releases a cloud of black ink when disturbed; a horseshoe crab, an ancient species closely related to spiders; and a striped bass being released into the Sound after being counted, measured, and weighed. *Bottom, left:* A crew member logging a fish count.

3 THE COUNT

Two crew members loosen a rope at the codend to release its contents. They shake loose a diverse catch of fish onto a sorting table; the fish can range in number from the hundreds to the thousands. Working fast, the fish are sorted by species and counted, and then weighed in the aggregate by species. For many species, a subsample is put back onto the sorting table where they are measured to determine the size composition. Each lobster collected is also counted, weighed, measured, and checked for any disease. During their time on board (between 15 and 45 minutes), the fish are kept in holding tanks, and eventually released back into the Sound.

MORE SCENES *(from left, clockwise):* The crew sorting fish just released from the net; a striped sea robin, showing its unique feelers that allow it to "walk" on the sea bottom; a top view of a summer flounder (fluke); and removing a scale from a scup for lab analysis. *Bottom row:* A variety of fish; the captain raising the net with hydraulic equipment; and the research boat at the Milford dock.

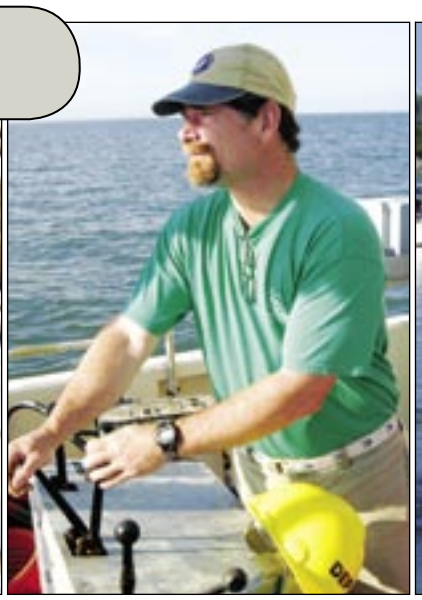
4 THE ANALYSIS



As part of the efforts to manage the fishery, resource managers need to know whether there are enough young fish to sustain a population, and whether the young are living to reach maturity. While measuring the length of fish provides a rough estimate of age, the Marine Fisheries Division also strives for precise information on age for five important sport fish. Like rings on a trunk determining the age of a tree, rings on the scales of scup and summer flounder indicate the age of the fish. On each trawl, the crew removes scales on samples of scup and summer flounder to bring back to the Marine Fisheries Division Lab in Old Lyme for analysis. Removing the scales is harmless, and the fish are returned to the Sound. But for tautog, weakfish, and winter flounder, the crew sacrifices a small sample to remove bones that can be used to determine the age of these fish.

5 THE MISSION

The Connecticut Department of Environmental Protection shares information on the relative abundance of finfish and invertebrates with fisheries programs from New York State, other Atlantic Coastal states, and regional fisheries commissions. The goal is to collect and analyze data to support regional decisions on how to protect coastal fisheries. Since fish migrate without regard to geographic boundaries, regulations to prevent overfishing require a regional approach. The fish survey has also helped the Long Island Sound Study quantify how the abundance of fishes decline in areas experiencing hypoxia (low levels of dissolved oxygen).



For more information about fish populations in the Sound, please visit:
www.longislandsoundstudy.net/soundhealth

FINFISH ABUNDANCE

Overfished in the late 1980s, the populations of some sport fish are increasing

TAUTOG, OR BLACKFISH, live year-round in the Sound. Many other fish live part of the year in the ocean, and some spawn in rivers.

IN THE LATE 1980S and early 1990s several marine fish stocks were in decline in Long Island Sound. All of the principal species supporting the recreational and commercial fisheries of the Sound were considered overfished: bluefish, striped bass, winter flounder, fluke (summer flounder), scup, tautog, and weakfish. These fish comprise 95 percent of the species sought by anglers and commercially-licensed seafood producers.

Improved recruitment (the number of young produced each year) and management to limit exploitation and rebuild stock (in the Sound and throughout the northeast) have helped to increase the population for several of these species. Annual recruitment strength depends on a number of factors including the size of the parent population, environmental conditions, food supply, and predator abundance. The reasons behind recently improved recruitment in some of the Sound's principal species are not totally understood, although lower harvest limits and increased protection of young fish are important contributing factors.

Fish populations are affected by changes in water temperature.

Changing environmental conditions have appeared to have a positive effect on some species, but have had negative consequences for others in the Sound. Some warm-water species, including black sea bass, scup, and striped bass, have done particularly well in recent years. In contrast, species that favor cold water temperatures, including winter flounder and longhorn sculpin, have experienced stock declines.

Since 1984, the Connecticut Department of Environmental Protection has provided a year-to-year comparison of relative abundance for a variety of finfish, as well as lobster and long-finned squid, in Long Island Sound (see centerfold). While dominant species in the Sound vary from year to year, the survey reveals no significant trend in the number of species found in the Sound (an average of 58 per year ranging between 50 and 70). Since a **fish biomass index** was established in 1992, there has been a slight increase in the total weight of fish found in the Sound. This increase is attributed to a greater abundance of scup in recent years.

Scup: **A dramatic increase in scup abundance took place in 1998. Since then, recruitment has been well above average every year except 2003 and survival to older age has greatly improved. Stronger recruitment is thought to have been enhanced by new protections, including larger fishing mesh size requirements and regulated fishing access areas on the offshore over-winter grounds. Abundance has fluctuated considerably since 1998, but has remained well above pre-1998 levels.**

Striped Bass: **Stringent fishery conservation measures adopted in the early 1980s, including catch limits and minimum size restrictions, helped rebuild this stock to near historic high levels in just over a decade. Like scup, abundance has fluctuated since 1998, but remains well above earlier levels.**

Tautog (blackfish): **These fish find the rocks and boulders left by glacial deposits, and manmade structures such as shipwrecks, to be ideal reef habitat. One of the few species that live year-round in the Sound, tautog have responded slowly to fishery management efforts implemented in 1997 to rebuild the stock.**

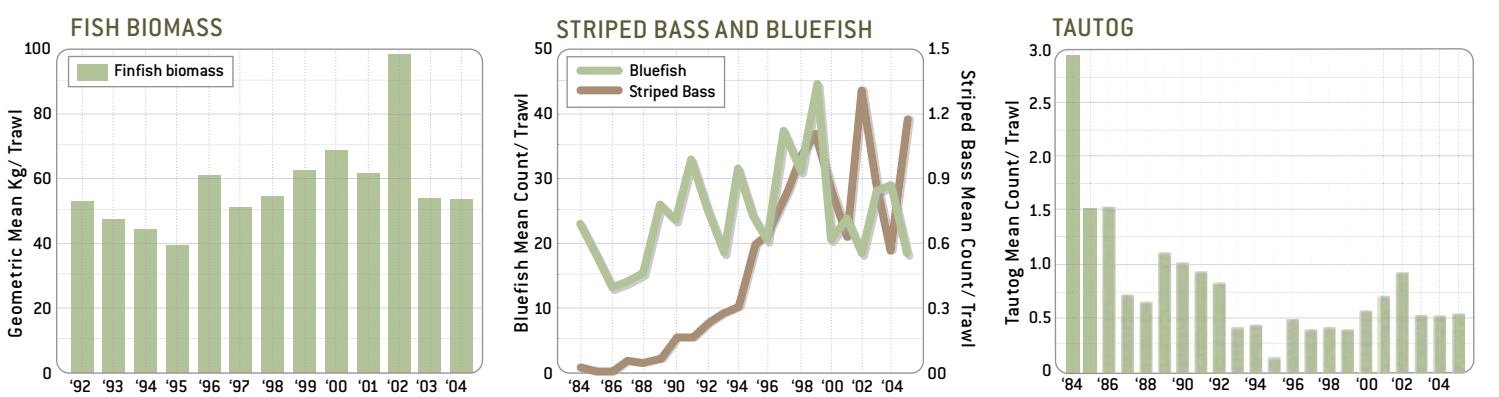
WEAKFISH

For weakfish, getting past one year of age has proved to be elusive.

Also known as sea trout, weakfish produced a record number of young in 2000, and had great years from 2002-2004. But unlike scup, another popular sport fish with a strong recruitment year, the number of older and larger weakfish has actually been dropping since 1999.

Weakfish, named for their weak mouths, may be a victim of the success of other fish that have prospered before them. Weakfish occupy some of the same habitat near the mouth of rivers as striped bass and summer flounder, and are believed to prey on the same fish. But it is also believed that these larger fish are preying on the juvenile weakfish before they have a chance to mature.

Striped bass also may be responsible for declining herring stocks such as blueback herring and American shad. These fish are anadromous, swimming upstream to freshwater to spawn. Striped bass follow schools of these fish upstream, preying on them during their journey to spawn.

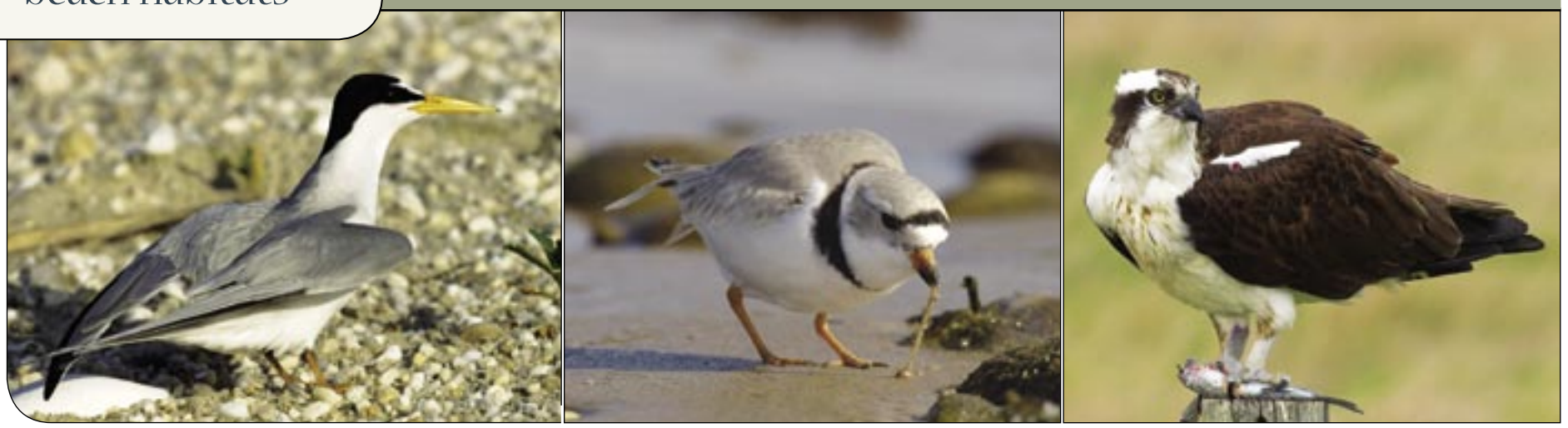


THE BIOMASS, the overall weight of fish caught in trawl surveys, is stable over time except for a steep increase in 2002 due to an increase in scup. Some sport fish have been increasing since the 1980s, including striped bass. Bluefish numbers have stayed steady since the 1980s. Tautog have not recovered from its peak years in the 1980s.

CREDIT: *Tautog* photo by Richard Howard; *Weakfish* illustration by Lucy Reading-Ikkanda
SOURCES: Graphs: CT DEP Marine Fisheries Division

Ospreys are off the endangered list, but challenges remain for birds in beach habitats

COASTAL BIRDS



LEAST TERNS *(left)* and PIPING PLOVERS *(middle)* inhabit beaches; OSPREYS *(right)* nest in tall trees or platforms.

MORE THAN 125 SPECIES OF BIRDS inhabit Long Island Sound, with the numbers and types varying with the seasons. Spring brings the annual migration of a wide variety of plovers, terns, sandpipers, waterfowl, herons, egrets, and songbirds.

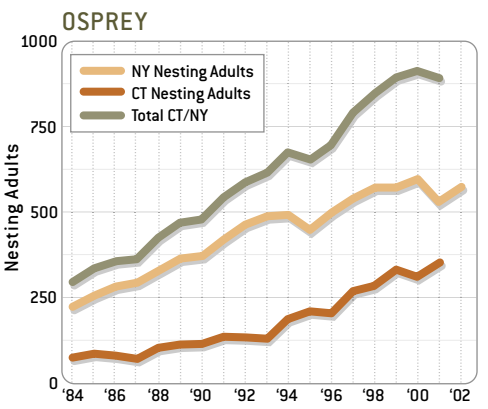
Loss of coastal lands to development (see p. 12) has directly affected the ability of several species to find habitat away from human disturbance and predators. Management efforts try to enhance existing natural areas to preserve coastal bird populations. For example, hundreds of wooden nesting platforms have been built for the osprey, a bird of prey that had been on endangered species lists in Connecticut and New York. These platforms, many built by volunteer groups, have now become the predominant habitat for a species accustomed to inhabiting tall trees along the coast. The osprey's resurgence in this area, however, would not have been possible without the nationwide ban of DDT in 1972, a pesticide that caused the thinning of osprey egg shells.

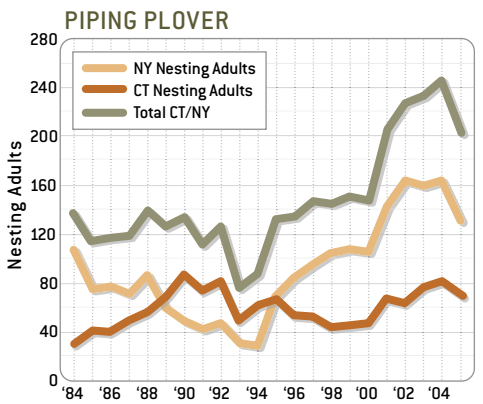
Piping plovers are small shore birds that nest on beaches, sometimes along with least terns. Their nesting and reproduction are threatened by human intrusion, storm surges, and predators. Protection efforts, including nesting enclosures and marking habitat sites with stakes and string, have led to a gradual increase in plovers in the last 20 years in New York. In 2005, however, it appears some plovers abandoned sites after their nests were destroyed following a heavy storm in May.

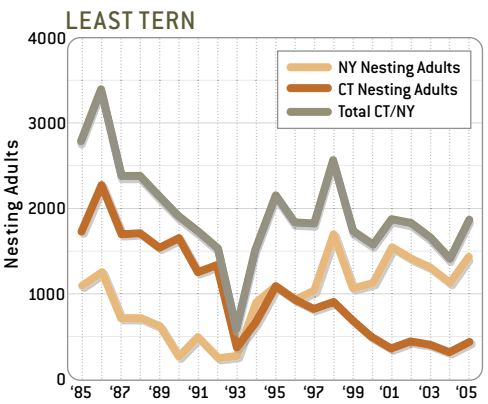
Coastal birds need healthy habitat to survive.

Least tern populations are fluctuating in New York and declining in Connecticut. Least terns live in large colonies at sandy beaches. Predation, human disturbance, a dislike of any vegetative growth in their habitats, and lack of available bait fish are all factors that result in terns migrating from the Sound. In 2005, there were impressive increases in three protected areas in Suffolk and Nassau counties, a sign of good habitat. But the terns may also have been forced out of other coastal areas because of disturbance or predation.

Salt marshes are another coastal habitat populated by many shore birds. Chris Elphick, PhD, a University of Connecticut biologist, is monitoring the nesting habits of two species of special concern, seaside sparrows and saltmarsh sharp-tailed sparrows, to help identify conditions that provide healthy salt marsh habitat.







OSPREYS, once an endangered species, have recovered thanks to the ban of DDT, and management efforts. Protecting the piping plovers' beach habitat has also helped increase their numbers, while the least tern population is generally on the decline.

GREAT BLUE HERON

WATERBIRDS

We expect to see herons, egrets, and other long-legged wading birds in the Sound, yet they are always special enough to turn our heads. Perhaps it is because these large birds, dominated by legs, neck and beak, are a visual surprise, a graceful, quiet reminder of the natural world so close to us.

An estimated 8,000 adult wading birds nest in the Sound, according to a triennial survey led by the U.S. Fish and Wildlife Service (USFWS), New York State Department of Environmental Conservation, and the Connecticut Department of Environmental Protection. "The populations of several breeding species in the Sound have been declining over the last 20 years," said Andrew MacLachlan, a USFWS biologist involved in the survey. Most long-legged wading birds nest in limited areas on isolated islands and peninsulas, usually in large colonies away from human disturbance and animal predation. The increasing number of houses, stores, boats, and shore-visiting people is a factor in these birds' declining populations. This trend will likely continue if places for wading birds to forage and raise their young are not adequately protected.

During the year, about 10 different species of long-legged water birds can be seen in the region—most likely feeding on bait fish in marshy areas of the Sound. These waterbirds include the largest of the group, the great blue heron, which stands nearly four-feet high. Although its open wings extend to six feet, this grand bird weighs only about five pounds.

CREDITS: *Least tern* photo by George DeCamp; *piping plover* photo by George DeCamp; *osprey* photo by Doug Backlund; *blue heron* photo by Frank Muller
SOURCES: CT DEP Wildlife Division, and NYS DEC

For more information about land use trends in the LIS watershed, please visit:
http://clear.uconn.edu

ALTERED LANDSCAPES

The "Urban Sea" describes the Sound's link to its heavily populated region

THE PARKING LOT at the Connecticut NEMO (Nonpoint Education for Municipal Officials) program in Haddam uses a porous pavement surface so rain can filter into the ground.

IMPERVIOUS SURFACES

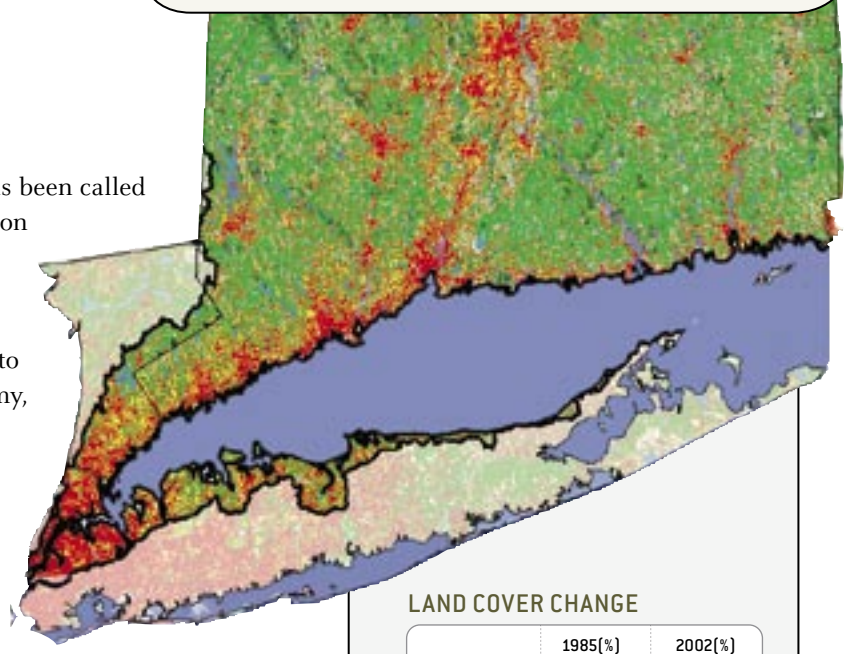
Have you ever considered the impact streets and sidewalks have on water quality?

Impervious surfaces are hard surfaces, such as asphalt, concrete, rooftops, and even highly compacted soil. After a storm, pollutants such as oil, pet waste, fertilizer, and pesticides are transported in runoff from these surfaces and drained into storm drains and tributaries. Pollutants flow to the Sound instead of degrading naturally in permeable soils. In communities with significant blacktop, stormwater rushes into waterways, leading to erosion. Studies show that impervious surfaces contribute significantly to poor water quality. According to the Center for Watershed Protection, which has compiled the results of more than 300 studies around the country, stream quality generally becomes degraded when a watershed's impervious cover reaches 10 percent, and becomes poor when impervious cover reaches 25 percent.

To find out how much impervious surface exists in the Sound's watershed, LISS funded the University of Connecticut's Center for Land use Education and Research (CLEAR) to use satellite imagery to collect data for the region. The data can be used by municipalities interested in trying to minimize increases in impervious cover to a rate consistent with population change.

As part of the grant, CLEAR also has posted information from its research on the Center Web site (*http://clear.uconn.edu*), where you can click on your town or portion of the Sound's watershed to find out just how much of these impervious surfaces exist in your community.

UConn's nonpoint source pollution Web site *(http://nemo.uconn.edu)* also has examples of how communities have reduced impervious surfaces and increased natural filtration of pollutants, including the creation of a roof top garden for a museum, and parking areas made of porous materials.



LONG ISLAND SOUND has been called the Urban Sea because of the large population living near its shores and the intense use of its waters. Almost 400 years after European explorers first came to the Sound to trade with Indians, people still are moving to the coast, enriching the bi-state area economy, but at the same time altering the natural landscape.

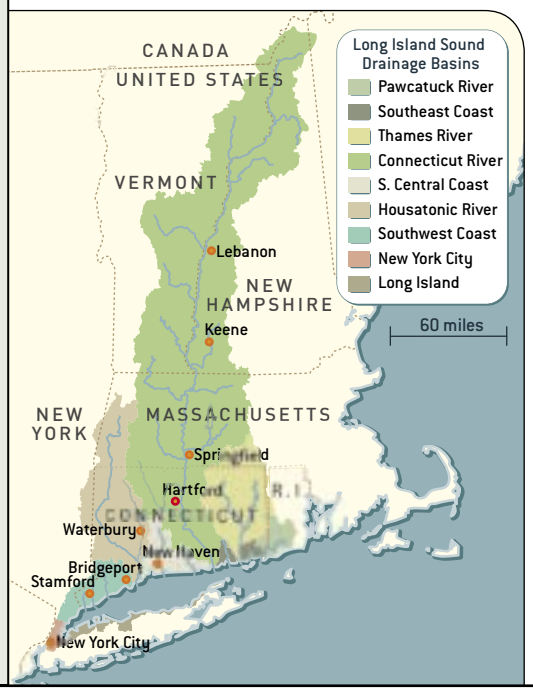
An estimated 8.6 million people live in Long Island Sound's 16,000-square-mile watershed, which includes 6 states and a small portion of Quebec—a population increase of more than 8 percent since 1980. More than 60 percent live near the coast in Connecticut and New York. In addition, more than 20 million people live within a 50-mile drive of Long Island Sound.

Connecticut's development is increasing at almost twice the rate of population.

Such intensive development has reduced open space and restricted access. The "paving over" of the land has increased runoff and reduced the filtration and processing function of natural landscapes. Development has destroyed or altered many vital habitats, harmed native wildlife populations, and reduced breeding grounds and nursery areas for many native species.

Even development far from the coast can affect coastal water quality, since pollution anywhere in the watershed flows to the Sound. Since the 1980s, Connecticut's forest cover has been declining as forested land has made way for new roads and development. This decrease is a reversal of a decades-old trend of forest recovery coinciding with fewer farms, and the use of fossil fuels for energy instead of wood. In Connecticut, **development** is increasing at almost twice the rate of **population**, indicating that the state is experiencing spread-out development patterns that some people describe as sprawl.

Government and non-profit groups protect valuable natural resources by preserving open space through acquisitions. In Westchester County, for example, different levels of government are working together to turn Davids Island, a former army base off the coast of New Rochelle, into a park (see p. 14). Another approach to protecting natural resources involves "smart growth" development that targets areas with existing infrastructure for growth, and leaves pristine areas alone. Communities also can reduce the amount of paved areas to increase natural filtration of pollutants before substances such as pesticides and motor oil can run off into tributaries and flow to the Sound.

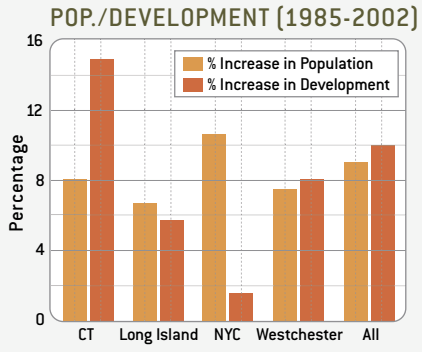


A WATERSHED is land that collects and transfers rainwater, sediments, and dissolved materials into a waterway, such as a river, lake, or estuary. The Sound's watershed is 16,000 square miles, and includes six states and a part of Quebec. It includes nine sub-watersheds. About 90% of the Sound's fresh water comes from three Connecticut rivers: the Thames, the Housatonic, and the Connecticut.

LAND COVER CHANGE

	1985(%)	2002(%)
Developed	18	21
Turf	5	5
Grasses	10	11
Forest	62	57
Water	3	3
Wetlands	1	1
Other	1	2

POP./DEVELOPMENT (1985-2002)



FROM 1985 TO 2002 157 square miles of land was developed in the Sound's watershed in NY and CT, while 231 square miles of forest area was lost. In CT, development increased at nearly twice the rate of population, while in New York City, population increased faster than land development.

CREDITS: *Parking lot* photo by CT NEMO Program; *LIS Watershed* map by Lucy Reading-Ikkanda (Source: US Geological Survey)
SOURCES: *Land cover* map/charts from Univ. of Connecticut Center for Land Use Education and Research (CLEAR)

The goal is to restore 2,000 acres of coastal habitat and 100 river miles for fish passage

HABITAT RESTORATION

URBANIZATION led to erosion along the Sheldrake River in Mamaroneck. The Westchester County Planning Department, with federal funding, restored the riverbanks and planted vegetation to help prevent erosion, provide wildlife habitat, and filter stormwater runoff from nearby pavement. The netting *(top right)* anchored the vegetation until the roots established themselves.

SINCE COLONIAL TIMES, humans have altered the Sound's coastal habitats by concentrating housing, commerce, and recreation near the water. While there is still much healthy habitat in and around the Sound, the overall abundance and diversity of natural areas have been diminished. Development and increased population have resulted in the loss of coastal and inland wetlands, and eelgrass beds in the shallow, near-shore areas.

Wetlands are among the most productive ecosystems in the world, providing food, shelter, and breeding or nursery grounds for many species of wildlife. They also protect the land from flooding and erosion in stormy weather, and filter pollutants from the water. In the past, the value of wetlands was not recognized and they became places to fill, dredge, and build. About 25 to 35 percent of the Sound's tidal wetlands were destroyed before federal and state legislation halted the practice in the early 1970s.

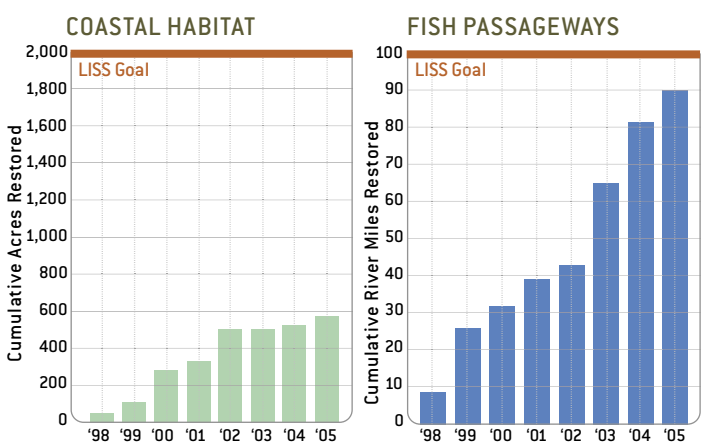
While laws and regulations now protect wetlands from losses through development, they cannot reverse the past damage. In response, the Long Island Sound Study established a Habitat Restoration Initiative in 1998 to restore 2000 acres of habitat by 2008. By 2005, the Habitat Restoration Initiative has restored 572.5 acres, which is 28.6 percent of the goal. The pace of restoration in the last couple of years has slowed in part because most of the easier and larger projects were the first to be completed. New projects involve costly and time-consuming details, including using special excavation equipment to remove debris on sensitive lands.

New restoration projects are often costlier, and include time-consuming details.

The Study also adopted a goal to restore passage to 100 river miles by 2008 for fish that migrate from the brackish waters of Long Island Sound to freshwater rivers, streams, and lakes to reproduce. The ability of anadromous fish to swim up river to spawn has been limited by physical barriers such as dams, culverts, tidal gates, and sections of river with inadequate water volume. By 2005, 90.2 miles of rivers have been restored for fish migration, either by removing the obstruction entirely or by the creation of fishways to bypass the obstacles. As a result, such fish as alewives, smelt, blueback herring, and American shad are swimming upstream again.

Tidal wetlands are also being lost due to "submergence." Resource managers and scientists are investigating why several salt marshes in Connecticut and New York have turned into mudflats in the past 20 years. Theories include subsidence of the landscape, sea level rise due to climate change, human disturbances, and disease of marsh vegetation.

Bi-state efforts are also focusing on identifying the most significant unprotected and undeveloped parcels greater than five acres with an aim to develop strategies to protect these valuable habitats from development. The states are particularly interested in identifying land adjacent to the 33 proposed inaugural areas of the Long Island Sound Stewardship Initiative (see back cover).



THE HABITAT RESTORATION INITIATIVE is close to completing its goal of restoring fish passageways, but is only 28.6% toward its goal of restoring 2,000 acres of habitat.

EELGRASS RESTORATION

In the early 20th century, acres of a rooted underwater plant known as eelgrass dotted the shoreline of the North Shore of Long Island.

By 2004, only 11.5 acres at Mulford Point in Orient, a hamlet in the Town of Southold, remained. But now eelgrass is growing in St. Thomas Point, 3.5 miles to the west of Mulford Point, thanks to a project developed by Cornell University Cooperative Extension of Suffolk County. The project is partially funded with a grant from the Long Island Sound Futures Fund.

In fall 2004, Cornell's staff test-planted about 1,000 shoots in the open waters off St. Thomas Point. After observing the vegetation increasing five-fold, they decided to go ahead with planting 30,000 shoots in the spring and fall of 2005. An additional 20,000 shoots will be planted in spring 2006 to complete the 2-acre meadow. To ensure that the rhizomes would not be washed away, divers anchored them under rocks.

With the eelgrass established, striped bass, winter flounder, and summer flounder have been observed feeding on the smaller bait fish that gather around the restored eelgrass meadow. The restored eelgrass also will help protect the shoreline from erosion by dampening the impact of wave energy from storms. As a result of the success, the Cornell team in 2005 was looking at two other nearby sites for restoration.

Eelgrass had grown along the coast throughout Long Island Sound, but now only about 1,600 acres, mainly in Connecticut waters, remain, according to a 2003 survey conducted for the Study by the U.S. Fish and Wildlife Service. Scientists and resource managers believe that in many cases eelgrass disappeared, especially in the Sound's coves and embayments, because excess nitrogen overfertilized the meadows, causing algal blooms to block the sunlight eelgrass needed to survive.

A DIVER planting eelgrass at St. Thomas Pt.

CREDITS: *Sheldrake River restoration* photo by Robert Doscher, Westchester County Dept. of Planning (source: Sheldrake River, *www.westchestergov.com/planning/environmental/AquaticRestorationSites*); *Eelgrass restoration* photo by Chris Pickerell, Cornell University Cooperative Extension of Suffolk County. SOURCES: *Coastal Habitat Restored*: CT DEP, Office of Long Island Sound programs and NYS DEC Bureau of Marine Resources; Miles of Streams Restored for Anadromous Passage: CT DEP, Office of Long Island Sound Programs

For more information about Long Island Sound grant programs, please visit:
www.longislandsoundstudy.net/grants

PUBLIC PARTICIPATION

A clean and healthy Sound depends on the desire of the people of the region

GRANTS SUPPORT LOCAL ACTIONS

Long Island Sound residents often learn about the wonders of Long Island Sound, and the need to protect their precious resource, from education projects sponsored by municipalities, schools and non-profit groups. The Long Island Sound Study and its partners contribute by providing financial assistance to these efforts.

Since 1995, the Small Grants Program of the Long Island Sound Study has provided grants of up to $5,000 to organizations for cleanup projects or to educate residents about how to protect the Sound. In 2005, 15 community groups received $67,255 in grants.

In recent years grants have been awarded for projects as varied as a planetarium show on the Sound's lobster fishery, promotional materials to educate boaters about clean boating practices, a count of harbor seals, beach cleanups, and retrofitting floating docks into aquaculture platforms to teach the public about the lifecycles of shellfish.

Since 1992, Connecticut's Long Island Sound License Plate Program has provided public outreach grants of up to $25,000. In 2005, the the program awarded five public outreach and education grants totaling $73,976.

In 2005, a new grant program joined the effort—the Long Island Sound Futures Fund. The program, initiated by the Study and administered by the National Fish and Wildlife Foundation, gave almost $1 million in grants in 2005, including $195,000 for eight education and outreach projects.

FOR THE CLEANUP of Long Island Sound to be a success, "the Sound depends on more than the commitments of government agencies and regulated entities: it depends on the will and desire of the people of the region."

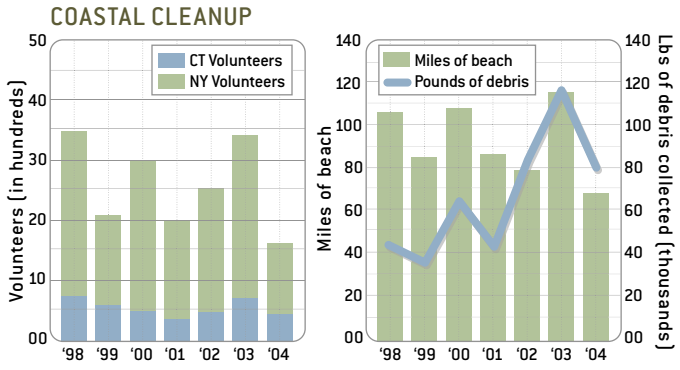
Those words from Long Island Sound Study's Comprehensive Conservation and Management Plan are as true today as they were when they were written more than a decade ago.

An informed public has a powerful voice in protecting the Sound. Twenty years ago, for example, citizens and community groups in Westchester's Sound Shore region opposed a development proposal for 50-story apartment towers for Davids Island, the site of a former 80-acre Army base off the New Rochelle coast. The public's concern helped to defeat the proposal. Local, county, and federal governments are now planning to clean up the island, which includes many dilapidated buildings, and preserve the island as park land.

Volunteer efforts contribute to the Sound's restoration.

Community groups also provide crucial support for restoration efforts. For example, volunteer beach crews help clean debris from beaches, birding organizations help to protect the nesting sites of coastal birds, boating groups help to educate boaters about clean marinas, neighborhood committees help identify sites for wetland restoration and assist in restoration work as well, and non-profit groups give children and adults hands-on opportunities to experience the science, history, and culture of Long Island Sound.

As part of the International Coastal Cleanup, an international program sponsored by the Ocean Conservancy, volunteers gather each year on the third Saturday of September to comb beaches or dive underwater for cigarette butts, plastic bags, bottles, straws, and other litter. About 2,250 volunteers participate each year, with numbers fluctuating year to year depending on the weather. Volunteers clean up debris at about 80 Long Island Sound sites in efforts coordinated by the American Littoral Society in New York and Save the Sound in Connecticut. The volunteers collected an average of 53,000 pounds of trash each year along 82 miles of shoreline.



EACH YEAR, HUNDREDS OF VOLUNTEERS pick up thousands of pounds of trash along the Sound's beaches as part of the International Coastal Cleanup.

PUBLIC PARTICIPATION *(top, counter clockwise):* James from Solar Youth's Citywide Steward Program, holding a green crab at Hammonasset Beach State Park; Bruce Adams, Harbor Master of Northport Harbor in Long Island, and Ailene Rogers of the Water Logging Program of the Cornell University Cooperative Extension of Suffolk Co., displaying equipment used to test for water clarity and levels of dissolved oxygen; Nelson and Elvin from Solar Youth's summer program canoeing at Lake Wintergreen, which is part of the West River watershed in New Haven.

CREDITS: *Solar Youth* photos *(top and bottom left)* by Joanne Sciulli; *Water Logging Program* photo *(bottom right)*, Cornell University Cooperative Extension of Suffolk County, with funding provided by the Fairleigh S. Dickinson, Jr. Foundation, the Davenport Family Foundation, and the New York State Fund.
SOURCES: *Coastal Cleanup* graphs, American Littoral Society and CT Sea Grant

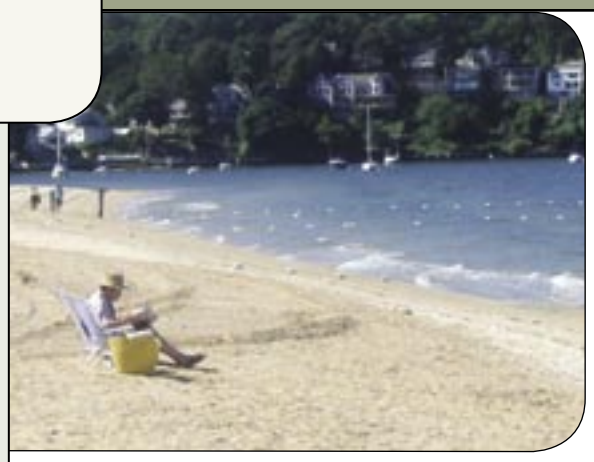
WHAT YOU CAN DO

Individual actions can help to restore and protect the Sound

CHALLENGES AHEAD

While progress is being made toward achieving the goals of the Long Island Sound Study's Comprehensive Conservation and Management Plan, much remains to be accomplished. Examination of the environmental indicators in this report allows us to identify our successes and recognize the need for further management and study. To identify and meet the challenges ahead, further research and monitoring is needed in a number of areas:

- **How can environmental indicators be integrated to provide an overall assessment of progress toward meeting restoration objectives?**
- **What are the cumulative impacts of activities on the full suite of ecosystem functions and services?**
- **What are the appropriate baselines from which to compare degraded aspects of ecosystem condition and function?**



AT HOME

- Use environmentally friendly landscaping techniques that require less fertilizer, prevent erosion, and use native plants. This helps prevent sediments and nutrients, like nitrogen and phosphorus, from reaching Long Island Sound, and provides habitat for native species.
- Leave grass clippings on the lawn to recycle nutrients. Start a compost pile to reduce the amount of waste you put into the garbage disposal or garbage can.
- Use a soil test kit to determine the amount of fertilizer needed. More is NOT better for your plants or for reducing the effects of overloading the Sound with nutrient-rich runoff. Learn how to practice environmentally sound gardening.
- Preserve any wetlands on your property, even small areas.
- Conserve water at home and in the office to reduce the volume of waste water that must be treated by a sewage treatment plant or septic system. This will increase the efficiency of treatment and save you money.
- Use safe, non-toxic alternatives for cleaning and for controlling pests.
- Take household chemicals to a recycling center instead of pouring them down drains or putting them in the trash. REMEMBER: substances poured down drains, storm sewers, or on the land are likely to be transported to Long Island Sound.
- Never pour motor oil or other auto fluids down a drain or sewer or discard them with the trash (in Connecticut and New York, it's against the law!)
- Maintain your septic system by having it pumped out every three to five years.
- Scoop up pet waste. Flush waste down the toilet or seal it in a plastic bag, and dispose it in the garbage.
- Wash your car on a grassy area, so the ground can filter the water naturally. Use soap sparingly and try to use nonphosphate biodegradable detergents. Empty the bucket of soapy water down the sink, not in the street. Best of all, go to a car wash.

IN AND AROUND THE SOUND

- Don't be a litterbug. Never throw litter, into the street, down storm drains, or onto the beach. Rainfall carries the trash into the sewers where it eventually travels into the Sound. Cigarette butts, which contain non-biodegradable filters, make up the largest percentage of litter collected during beach clean-ups.
- Be a responsible boater. Remember, it is illegal to discharge wastes from a Type III (holding tank) marine sanitation device. Pumpout facilities must be used to prevent release of pathogens directly into coastal waters.
- Never feed geese and other water birds. This encourages them to stay through the winter and gather in flocks. Their droppings, which contain bacteria and nitrogen, can contaminate shellfish beds and may cause the closing of beaches.

OFFSHORE/ONSHORE *(top, clockwise)*: A beachgoer enjoying a sunny day at Centerport Beach off Huntington Bay; divers from the Atlantic Steamer Fire Company Water Rescue scooping up debris, including a credit card found at the bottom of Oyster Bay in Long Island, at an International Coastal Cleanup event; a volunteer picking up trash for a shoreline cleanup day at Astoria Park in Queens (along the East River).

CONTACTS

Key agency and organization contacts for Long Island Sound:

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EPA Long Island Sound Office
CT 203-977-1541
NY 631-632-9216
www.longislandsoundstudy.net

EPA National Estuary Program
202-566-1240
www.epa.gov/owow/estuaries

U.S. Fish and Wildlife Service
401-364-9124
www.fws.gov

CONNECTICUT

CT Dept. of Environmental Protection
860-424-3000
www.dep.state.ct.us

Oil and Chemical Spill Response (24-hour hotline)
860-424-3338

CT Dept. of Public Health
860-509-8000
www.dph.state.ct.us

NEW YORK

NYS Dept. of Environmental Conservation, Bureau of Marine Resources
631-444-0430
www.dec.state.ny.us

NYS DEC Spill Hotline
800-457-7362
www.dec.state.ny.us

NYS Dept. of State Division of Coastal Resources
518-474-6000
www.dos.state.ny.us

NYS Dept. of Health
800-458-1158
www.health.state.ny.us

SEA GRANT COLLEGE PROGRAMS

Connecticut Sea Grant
860-405-9128
www.seagrant.uconn.edu

New York Sea Grant
631-632-6905
www.nyseagrant.org

INTERSTATE AGENCIES

Interstate Environmental Commission
212-582-0380
www.iec-nynjct.org

New England Interstate Water Pollution Control Commission
978-323-7929
www.neiwpcc.org

CREDITS: *Astoria/Long Island City Waterfront Parks Catalyst Project* photo *(bottom left)* by Helen Ho, City Parks Foundation; *Centerport Beach* photo *(top)* by Ailene Rogers, Cornell University Cooperative Extension of Suffolk County; *International Coastal Cleanup Day* photo *(right)* by Kyle Rabin, Friends of the Bay

LONG ISLAND SOUND STUDY SPONSORS:

THE LONG ISLAND SOUND STUDY is a cooperative effort involving researchers, regulators, user groups and other concerned organizations and individuals. These people are working together to protect and improve the health of the Sound by implementing the Study's Comprehensive Conservation and Management Plan, completed in 1994.

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Roosevelt Rowing, courtesy of The Sagamore Hill National Historic Site, National Park Service.

"There can be no greater issue than that of conservation in this country."

Theodore Roosevelt, Confession of Faith Speech, Progressive National Convention, Chicago, August 6, 1912

AS PRESIDENT, Theodore Roosevelt protected an astonishing 230,000,000 acres of parkland, forests, bird refuges, and game preserves. From creating the first national bird refuge, Pelican Island in Florida, to protecting the Sequoias in California, Roosevelt aspired to conserve lands and protect wildlife, while he encouraged Americans to appreciate the nation's natural wonders. A native New Yorker, Roosevelt also was inspired by the natural environment of Long Island Sound. As a teenager, Roosevelt kept a journal of the animals (mostly birds) he observed near the Oyster Bay home his family had rented. From 1887 until his death in 1919 he lived at Sagamore Hill, where he enjoyed the spectacular view of Oyster Bay Harbor and Cold Spring Harbor. The Long Island Sound Study is working to continue his legacy of conservation with the Long Island Sound Stewardship Initiative. The Stewardship Initiative seeks to identify significant ecological and recreational areas around the Sound for protection and enhancement through voluntary conservation partnerships.

For more information about the Stewardship Initiative's 33 proposed inaugural areas (including the Oyster Bay National Wildlife Refuge and Shu Swamp Nature Preserve, adjoining Sagamore Hill), see *www.longislandsoundstudy.net/stewardship.*

LONG ISLAND SOUND STUDY
A Partnership to Restore and Protect the Sound

THEODORE ROOSEVELT enjoyed rowing in the Sound on a St. Lawrence skiff, birding along the shore of Oyster Bay and Cold Spring Harbor, and appreciating the seascape and landscape from his hilltop home. He raised six children at Sagamore Hill and declared in his autobiography, "there is no healthier and pleasanter place in which to bring up children."

The report was developed for the Long Island Sound Study by the New England Interstate Water Pollution Control Commission through a cooperative agreement with the U.S. Environmental Protection Agency. NEIWPCC