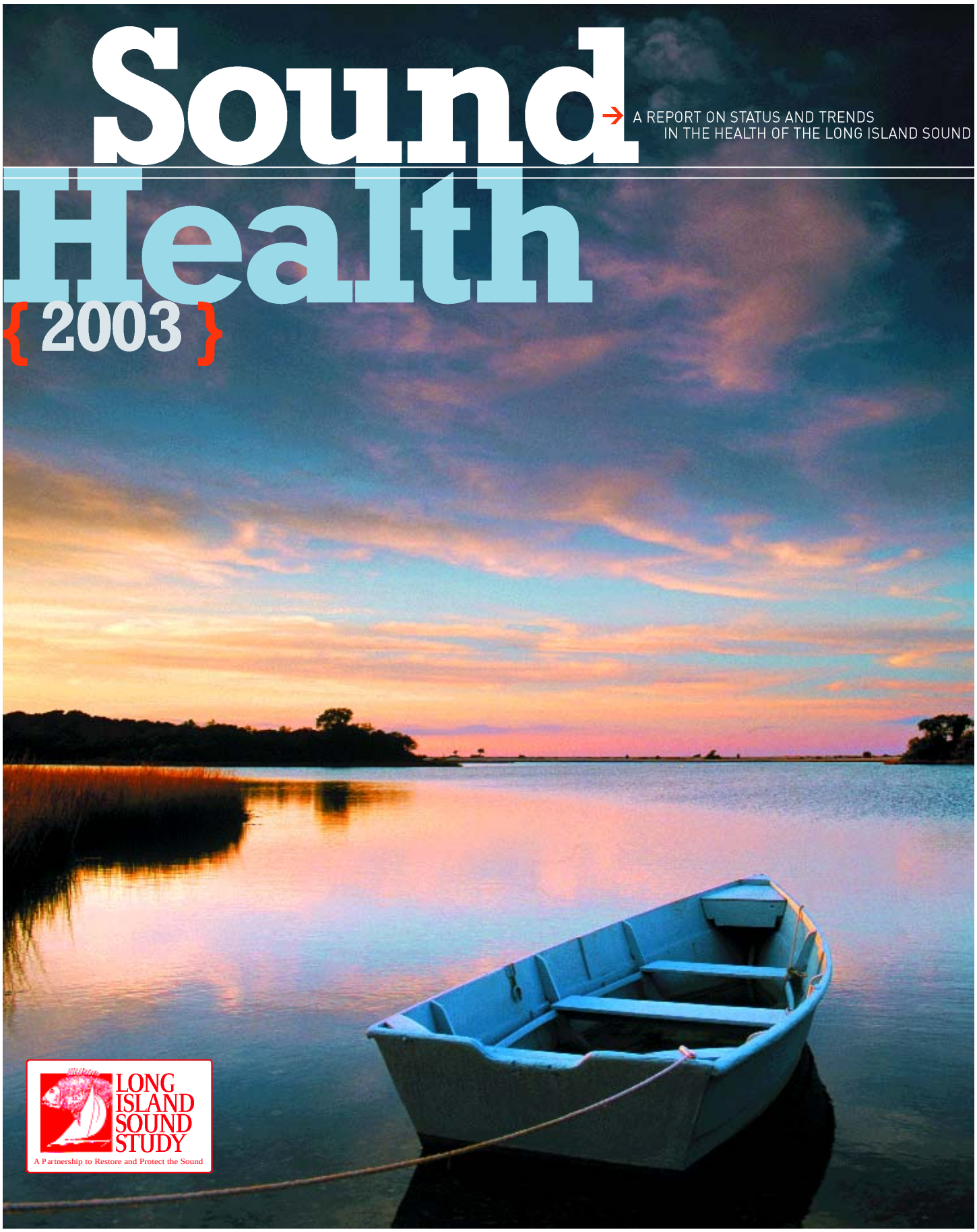
Sound Health

{ 2003 }

A REPORT ON STATUS AND TRENDS
IN THE HEALTH OF THE LONG ISLAND SOUND



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

Lobster and oyster harvests were on the rise in the 1990s; the two fisheries now face setbacks.

Shellfish Abundance

CT DEPARTMENT OF ENVIRONMENTAL PROTECTION

A FISHERIES TECHNICIAN from the Connecticut Department of Environmental Protection tags a lobster to study movement and migration in Long Island Sound.

COMMERCIAL and recreational shellfish harvesting in Long Island Sound includes **hard clams** (or quahogs), soft-shell clams (or steamers), bay scallops, blue mussels, surf clams, and razor clams. By far the most important shellfish harvested are **oysters** and **lobsters**. In the 1990s the lobster and oyster industries experienced boom years. Diseases affecting these shellfish have since threatened their commercial viability; but programs are under way to try to understand the problems and restore the fisheries.

In the late 1990s, the oyster harvest was decimated by two parasitic diseases—MSX and Dermo—that reduced the oyster population by 90 percent. MSX kills juvenile oysters, while Dermo kills adult oysters before they reproduce or reach market size. The oysters' habitat also had been damaged by siltation covering the rocks, reefs, and dead shells to which they attach.

Between 1999 and 2002, lobsters experienced "die-offs." Infections from paramoeba (a single-celled parasite), and calcinosis, a disease similar to kidney stones, appear to be largely responsible for the deaths. These diseases may be related to "stressors," including rising water temperatures and low dissolved oxygen, that have weakened the lobsters and made them susceptible to disease. Researchers also are looking into the possibility that pesticides used to control mosquitoes carrying West Nile virus may have contributed to die-offs.

While these diseases are non-threatening to humans, the subsequent oyster and lobster losses have forced fishers to quit and have hurt local industries.

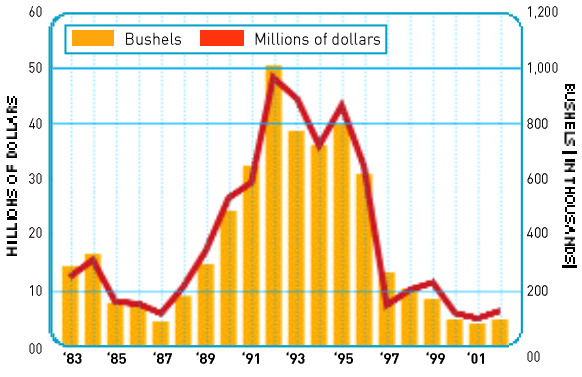
The Sound was well known for the oystering trade from the 19th to the early-20th century, and it saw a resurgence in the 1980s and 1990s. To reverse the losses from MSX and Dermo, government, industry, and scientists are working together to improve habitats and develop and plant disease-resistant oysters. This year, shell fishers have reported low mortality of the seed oysters, a promising sign that the industry can recover.

By the late 1990s the Sound's lobster harvest was the third largest in the country. In 1997 lobster fishers harvested nearly 12 million pounds of lobster (valued at almost $40 million) only to see numbers drop by about 75 percent by 2001. In an effort to understand the causes of the mortality and other diseases affecting the lobsters' health, 17 research projects have been funded under a recently-established Lobster Research Initiative.

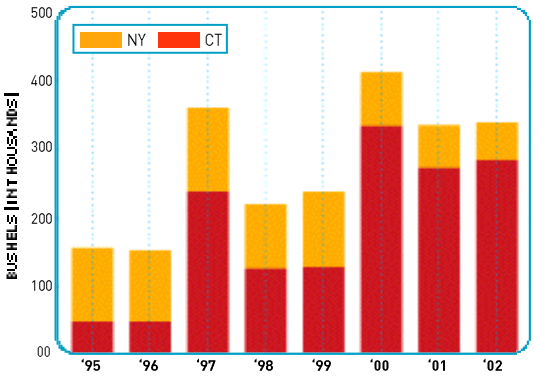
The sustainability of shellfish is important for more than economic reasons. Culturally, people enjoy eating fish that comes from local waters. Oysters, as well as mussels and clams, also provide ecological benefits by filtering algae from the water for food, thus reducing algal blooms and improving water clarity. Lobsters also fill an important niche as scavengers that eat the dead fish and worms left on the sea bed.

Some fishers have turned to clamming (below) to make up for declining oyster and lobster harvests (top & bottom, right). Hard clams, however, have a lower commercial value than oysters and lobsters.

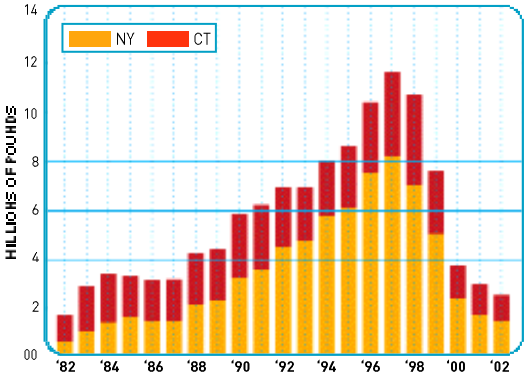
OYSTER HARVEST



HARD CLAM HARVEST



LOBSTER HARVEST



LIS FISH CONSUMPTION ADVISORIES

THESE ADVISORIES refer to sport fish 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/BCH/EEOH/webfsh.htm

SOURCES LOBSTER (CT DEP MARINE FISHERIES AND NYSDEC, BUREAU OF MARINE RESOURCES * NEW YORK 2002 NUMBERS ARE AN ESTIMATE PENDING FINAL REPORTING); OYSTERS (CT DEPT. OF AGRICULTURE AND NYS DEC); HARD CLAMS (CT DEPT. OF AGRICULTURE AND NYS DEC)

Life under the Surface

Two scientists provide a photographic peek of the undersea life of Long Island Sound.

PHOTOGRAPHS BY PETER AUSTER AND ROBERT DEGOURSEY

LONG ISLAND SOUND HAS BEEN CALLED THE "URBAN SEA" because of the millions of people who live close to its shoreline. But while human activities on adjacent lands do affect the Sound, below the water surface rich communities of animal and plant life life still exist. About 170 fish and 1,200 invertebrates (animals without backbones) swim and crawl in the Sound, living in unique aquatic habitats. Beautifully colored anemones, sponges, and corals attach to boulder reefs and feed on plankton and other material passing by in the water, while fish, such as tautog and cunner, swim in and out of rock crevices. In the shallow waters near the shore, fish and scallops seek out protection from predators in dense meadows of eelgrass.

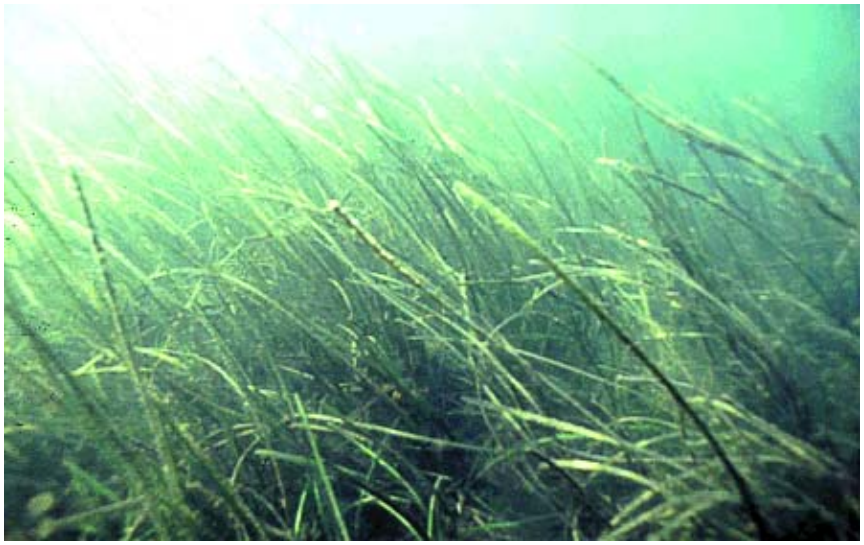
Two years ago Peter Auster and Robert DeGoursey, both divers and colleagues at the University of Connecticut in Groton, set out to give people a vivid sense of the life each has studied for more than 30 years. The two scientists produced a CD-ROM called *An Underwater Tour of Long Island Sound*, a photographic journey of the Sound.

"Most folks only see the Sound as a surface from the shoreline, sometimes pulling fish or lobsters through the interface, or simply swimming in the waters along the shoreline," said Auster, who is the Science Director of the National Undersea Research Center at the University.

The scientists wanted people to see the beauty underneath, but also gain an understanding of why that underwater environment needs to be protected.

"The conservation and sustainable use of biological diversity in the Sound will need to be based on a public understanding of the underwater landscape and the animals that live within it," said Auster. "We hoped this 'tour' would help the discussion move along."

THE ECOSYSTEM
1. SEAGRASS
2. MUD
3. SAND
4. MIDWATER
5. BOULDER REEF



1 SEAGRASS

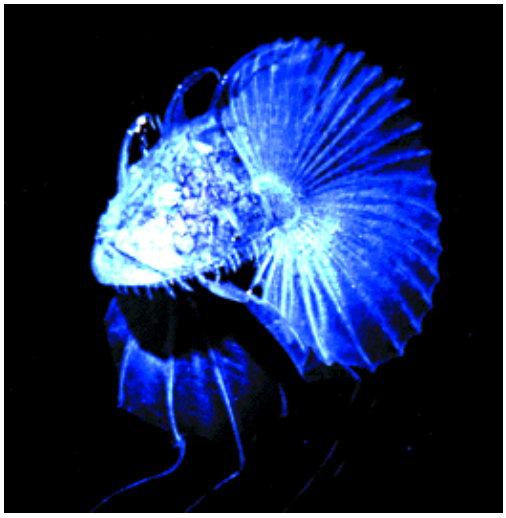
Like grasses on land, these plants are capable of photosynthesis and creating nutrients using sunlight, water, and carbon dioxide. Dense seagrass meadows and tall forests of kelp provide refuge from predators and tidal currents. Seagrass is generally seasonal. The picture above is an eelgrass *(Zostera marina)* meadow. Although eelgrass has historically existed throughout Long Island Sound, recently it may be found only along the shallows of eastern Connecticut and Fishers Island in New York.

2 MUD

In muddy habitats burrowing species, such as lobster, live on or below the surface in depressions and holes. Some species are structure producers, while many use structures produced by other organisms. For example, species like lobsters and four-bearded rockling produce bowl shaped depressions on the sediment surface. Other species, like long-finned squid, use abandoned depressions for cover. Pictured below is a mud shrimp *(Axius serratus)*, which can burrow more than three feet deep into mud. A polychaete worm *(Nereis virens)*, also below, is a predatory worm that lives within the sediments. It comes to the sediment surface and swims through the water column during spawning. Muddy habitats are found throughout the Sound, mostly in deeper waters, as well as protected nearshore areas such as Milton Harbor in Rye or Norwalk Harbor.

4 MIDWATER

The water column, from water surface to sea floor, provides a habitat for fish and crustaceans such as lobsters and crabs to feed on concentrated microscopic plants and animals called plankton. Jellyfish also provide structure in the water column. Fish resistant to the stinging cells of jellyfish in midwater have been observed using the tentacles and bells of jellyfish for shelter. Although these habitats are ephemeral in nature, they can still increase the chance of survival for individual organisms. Juvenile goosefish *(Lophius americanus)*, below, live in midwater after hatching from the egg stage, but migrate to the seafloor with age, where they prey on bottom-dwelling organisms.



3 SAND

Sand grains generally do not stick to each other, thus preventing animals from constructing solid, walled burrows. Nevertheless, many burrowing species adapt to life in these habitats. For example, many crab species can rapidly bury themselves in the sand to avoid threats. Some fish use rocks and plants to help them hold their position on the sea floor from tidal and storm currents that form sand waves and sand ripples. In sedimentary environments, pictured at top, predation may occur beneath the surface. Here a moon snail *(Lunatia heros)* plows beneath the sediment surface in search of prey. Winter flounder *(Pleuronectes americana)*, left, have adapted to catch prey on the sediment surface. Here a small fleshy mouth enhances capture of small clams and worms. Lobsters *(Homarus americanus)* form dish depressions for limited cover in sand habitats. Sandy habitats are found along the shore in more open areas, such around Greens Ledge Lighthouse, off Norwalk or Davids Island, off New Rochelle.

5 BOULDER REEF

Boulder and gravel areas are complex habitats. These areas range from large piles of boulders stretching several feet or more into the water to flat pavements of cobble and pebbles. Crevices between and under boulders, as well as sponges and anemones that are found attached to rocks, pilings, and even shellfish, provide cover from predators and refuges from currents. These varied spaces also allow for a range of sizes of organisms. Kelp forests *(Laminaria)*, left, and boulders provide complex rock reef habitats along the coast. Cunner *(Tautogolabrus adspersus)* are the most common reef fish in this region. Deadman's finger sponge *(Haliclona oculata)*, center, is seen here, attached to cobble. The frilled anemone *(Metridium senile)*, right, can appear in dense aggregations. Boulder or rock reef habitats can be found throughout the Sound, in places such as Baiting Hollow, off Long Island's North shore, or Penfield Reef, off Fairfield, Connecticut.

Finfish

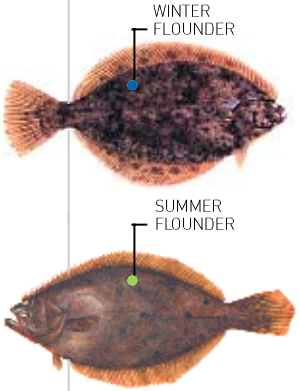
Fish populations, depressed in the 1980s and early 1990s, are on the rebound. Fishery management programs contribute to the increase.

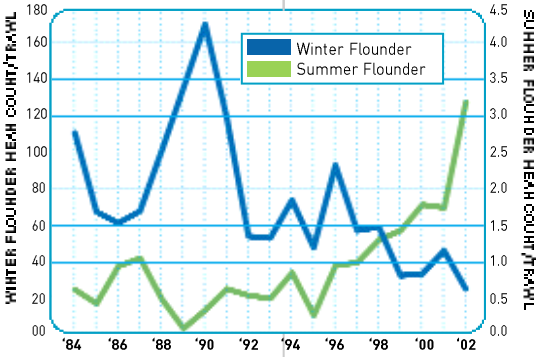
The Tale of Two Flounders

SUMMER FLOUNDER and **winter flounder** are flatfishes, types of fish which lie on their side rather than on their belly and have both eyes on one side of their head. While they share similarities, their numbers have gone in different directions in recent years.

Summer flounder are increasing in response to fishery management quotas that began in 1993. They prefer the warmer temperatures that have occurred in the Sound in recent years. But winter flounder, severely overfished in the 1980s, have not responded to efforts to restore their numbers. While winter flounder showed signs of recovery in the 1990s, continued overfishing in moderate amounts combined with their preference for cooler temperatures, and subsequent lower numbers being produced, have led to record low numbers in 2003.

Summer flounder feed on fish and squid. Winter flounder remain mostly on the sea bottom feeding on worms, clams, and shrimp.





KELLY SAVAGE of the NYS Dept. of Environmental Conservation holds a newly tagged striped bass.

IN THE LATE 1980S and early 1990s marine fish stocks plummeted 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, summer flounder (fluke), scup, tautog, and weakfish. These fish comprise 95 percent of the species sought by anglers and commercially-licensed seafood producers.

A combination of environmental conditions leading to improved recruitment (the number of young produced per year) for some species and fishery management measures to limit exploitation and rebuild stock for others has helped "turn the corner" for fishery production. However, there still remains a great deal of work to be done to improve fish stocks.

Since 1984, the Connecticut Department of Environmental Protection (CT DEP) has counted the number of species and number of fish collected (and then put back) in 46-foot otter trawls in spring and fall surveys throughout Long Island Sound. The CT DEP survey also measures the total weight of all fish caught in each trawl sample. The **biomass index** has gradually increased through the years, but spiked in 2002, largely because of a significant increase in scup, a fish whose population has increased as a result of successful management efforts.

Striped bass is an economically important finfish that was at lower abundance in the mid-1980s, but whose numbers have greatly increased. Striped bass was the first species to be targeted for stock rebuilding, beginning in 1984. Restrictive harvest limits and larger minimum size restrictions over the last 15 years have allowed the stock to grow to unprecedented levels in the Sound and other waters along the Atlantic Coast. In 1995, the striped bass was declared "officially recovered" and no longer overfished.

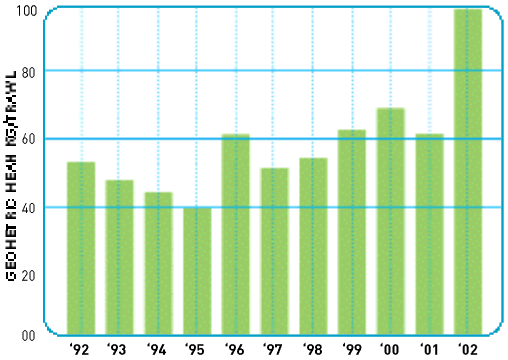
Bluefish abundance has declined in recent years after experiencing very good years in the mid-to-late 1990s. Some scientists and fishers believe they are being crowded out for space by striped bass and are moving to the Atlantic Ocean. The bluefish, a popular recreational fish, also is considered overfished, and additional management options are being considered.

Tautog, or blackfish, find the rocks and boulders left by glacial deposits in Long Island Sound an ideal "reef" habitat. Although tautog counts continue to be low, fisheries managers are optimistic that the species has begun to respond to more stringent management measures that began in 1997, as indicated by a slow rise in number of fish caught per tow over the last five years.

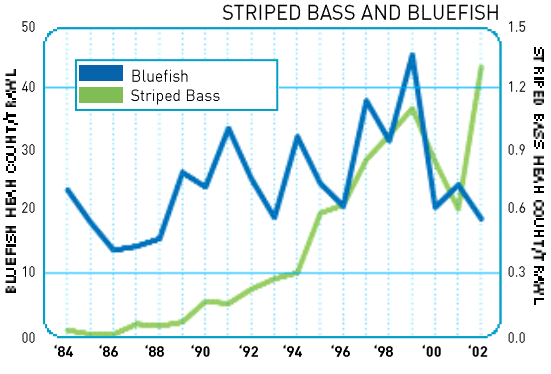
FISH TRAWL SURVEY

The biomass, the overall weight of fish caught in trawl surveys, is increasing. Many popular commercial and sport fish also are increasing in numbers, but bluefish numbers have declined in recent years. Tautog numbers, after years of decline, have increased over the past five years.

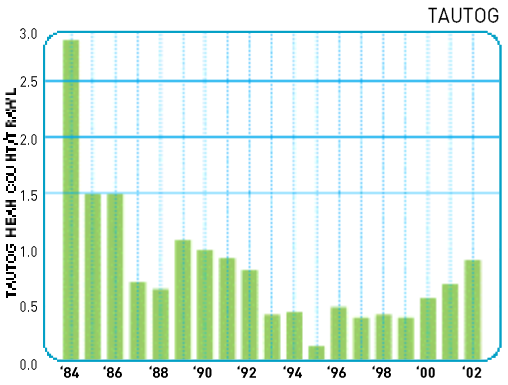
FISH BIOMASS



STRIPED BASS AND BLUEFISH



TAUTOG



SOURCES CT DEP, FISHERIES DIVISION

The return of the osprey is a great success story; efforts to restore other bird populations are still works in progress.

Coastal Birds

OSPREY

THERE ARE MORE THAN 125 SPECIES OF BIRDS, mainly waterfowl, water birds, and raptors, that rely on the Long Island Sound for food and habitat. Bird populations in and near the Sound vary seasonally. In winter, bird watchers delight at large concentrations of mergansers, scaups, scoters, mallards, black ducks, loons, cormorants, and Canada geese. Spring brings the annual migration of a wide variety of plovers, terns, sandpipers, waterfowl, herons, egrets, and songbirds.

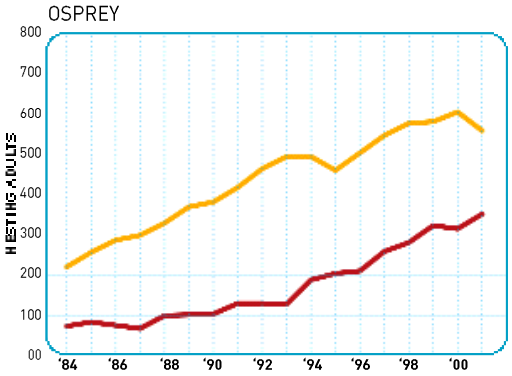
The **osprey** population around Long Island Sound fell sharply during the 1950s and 1960s due to the effects of pesticides, particularly DDT. Since the 1972 ban on most uses of DDT in the U.S., and the placement of nesting platforms in wetlands all along the Sound, the osprey population has been making a recovery. In 2002, 367 young were successfully raised in New York, which is the highest total since 1997, and in 2001, the last year Connecticut osprey figures have been tabulated, 286 were fledged. Ospreys are fish-eating birds of prey that live throughout the world. Their increasing abundance in the Sound indicates an improving ecosystem.

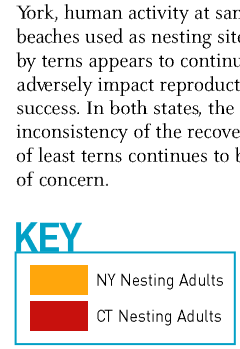
Piping plovers are small shorebirds that nest on beaches, often with least terns. Their nesting and reproduction are threatened by human intrusion, storm tides, and predators. Since protection and monitoring efforts began in 1984, nesting success has improved, resulting in more returning adults in subsequent years. Connecticut had particularly good news in 2002: of the 31 Connecticut nesting pairs, 58 young were successfully raised, an extremely high success rate.

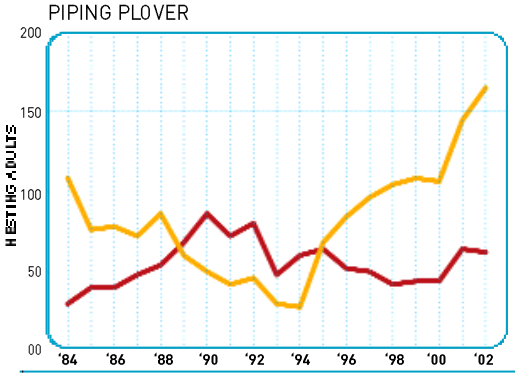
While piping plovers are increasing, the population of **least terns** is fluctuating over the last fifteen years, with relatively lower numbers present during the late 1980s and the early 1990s, and slightly higher numbers now. In Connecticut and New York, human activity at sandy beaches used as nesting sites by terns appears to continue to adversely impact reproductive success. In both states, the inconsistency of the recovery of least terns continues to be of concern.

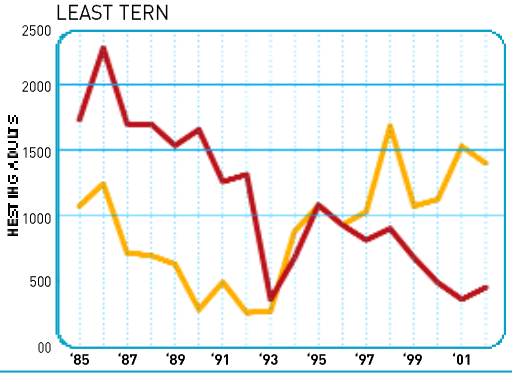
PIPING PLOVER

LEAST TERN









Salt Marsh Sparrows

BY LISTENING to bird songs and searching for nests in dense marsh vegetation, a research team at the University of Connecticut (UConn) is working to develop a method to estimate the Long Island Sound population of saltmarsh sharp-tailed sparrows and seaside sparrows.

The two birds, which live in salt marshes along the Atlantic Coast of North America, are considered to be among the highest priorities for bird conservation research in southern New England.

In particular, the saltmarsh sharp-tailed sparrow appears to reach its highest densities in the world in the Sound's salt marshes, said Dr. Chris Elphick, a UConn biologist. By studying their population and favorite habitats, researchers can get a good indication which salt marshes on Long Island Sound are healthy enough to sustain wildlife, and which sites need to be restored and protected.

Because the birds spend much of their time beneath dense marsh vegetation, counting them is no easy task. The UConn group, led by Elphick and Dr. Margaret Rubega, also a biologist at UConn, is developing a method to estimate populations by listening to singing birds, searching for nests, and counting and marking individuals.

SALTMARSH SHARP-TAILED SPARROW

SOURCES CT DEP, WILDLIFE DIVISION, AND NYS DEC

Introduction

Environmental action has breathed new life into the Sound, but more effort is needed to restore one of America's most used and valuable estuaries.

LONG ISLAND SOUND IS AN ESTUARY, a place where salt water from the ocean mixes with fresh water from rivers draining from the land. Like other estuaries, the Sound abounds in fish, shellfish, and waterfowl. It provides feeding, breeding, and nesting areas for diverse animal and plant life.

The Sound's watershed is also home to more than 8 million people, and more than 20 million people live within an hour's drive of the shore. Millions of people flock to the Sound yearly for recreation. Billions of dollars are generated annually in the regional economy from boating, commercial and sport fishing, swimming and beach going.

The ability of the Sound to support these uses is dependent on the quality of its waters, plants and animals, and habitats. But ecological health cannot be taken for granted. The Sound requires the efforts of citizens as well as scientists, environmentalists, government, and industry to maintain water quality and reverse degradation caused by centuries of pollution.

Many estuaries are only now beginning to face the intense human habitation and development the Sound has long experienced. From colonial times until fairly recently, the Sound and its watershed was used without considering the environmental impact. However, since the federal Clean Water Act became law in 1972, investments in water pollution control programs have helped to improve water quality, in spite of an increasing number of people, development, and activities. Obvious sources of pollution are now regulated and controlled through permit programs, tidal wetlands are protected, and sewage treatment plants have been built or improved.

But challenges remain. The cumulative effects of human activity have diminished the Sound's natural resources. Residents and businesses continue to pollute, including adding to the growing problem of polluted runoff—when stormwater runs over a surface contaminated with pollutants such as pesticides, fertilizer, pet waste, and motor oil, and carries them into the Sound via rivers, streams, and catch basins. To meet these challenges, the Long Island Sound Study, a partnership of government, academic institutions and citizens, crosses the political boundaries of New York and Connecticut to manage the Sound as an entire ecosystem. (CONTINUED ON PAGE 03)

What is LISS?

THE LONG ISLAND SOUND STUDY (LISS) began in 1985 as an innovative effort by the federal government and New York and Connecticut to analyze and correct the Sound's most pressing environmental problems. Two years later, under the recently established National Estuary Program, Congress designated Long Island Sound as an "Estuary of National Significance."

In its early years, Long Island Sound Study's Management Conference, consisting of citizens, environmentalists, business people, scientists, and local, state, and federal government officials, worked together to draft a plan to restore and protect the Sound.

Known as the Comprehensive Conservation and Management Plan (CCMP), and completed in 1994, the plan identifies seven issues that merit special attention: low dissolved oxygen (hypoxia); toxic contamination; pathogen contamination; floatable debris; living resources and habitat management; land use and development; and public involvement.

Many of the core issues in the plan have been followed by specific agreements. For example, in 1998, the states and federal government agreed to reduce nitrogen pollution by 58.5 percent by 2014 and restore 2,000 acres of habitats and 100 river miles of fish passage by 2008. Additional commitments to implement the CCMP were adopted in the LISS 2003 Agreement.

The Management Conference views the agreements as a chance to renew its commitment to the Plan's goals to make Long Island Sound's waters cleaner and healthier; its living resources more abundant and diverse; and its economic and recreational worth to the region even more valuable.

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MARK PARRIS, CT DEPT OF ENVIRONMENTAL PROTECTION

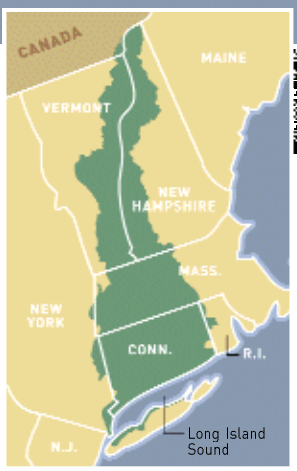
A GREAT EGRET looks out into the Sound from Sherwood Point, part of the rocky shoreline coast of Sherwood Island State Park in Westport, Connecticut.

A SUNSET at Dam Pond in East Marion, Long Island, along the Long Island Sound shore.

COVER PHOTOGRAPH BY
© BOB MCINNIS

Long Island Sound "is the first 21st-century estuary. Its issues are all about human habitation."

—GLENN R. LOPEZ, PROFESSOR OF MARINE SCIENCES AT THE STATE UNIVERSITY OF NEW YORK AT STONY BROOK*



LIS WATERSHED

LONG ISLAND SOUND— FROM THE EAST RIVER TO THE RACE

The Sound is bounded by the state of Connecticut and Westchester County on the north, New York City on the west, and by Long Island on the south. The Sound stretches 110 miles in length and measures about 21 miles across at its widest point—from New Haven to Shoreham Beach in Long Island.

HOW ARE WE DOING? In the same way economists use indicators, such as the unemployment rate, to measure the progress of the economy, we use environmental indicators to chart the progress made and challenges ahead in restoring the Sound. The concept, borrowed from industry quality improvements, is that you can't improve what you don't measure.

This report, Sound Health 2003, an update to a similar report to the public published two years ago, provides a sample of the more than 40 specific **environmental indicators** used to assess the ecological condition of Long Island Sound.

Some indicators reveal positive trends. For example, the discharge of toxic contaminants has dropped significantly in recent years thanks to stringent pollution controls and changes in manufacturing. As a result, ospreys, a majestic coastal bird that nearly became extinct because of DDT poisonings, are increasing in numbers.

Other indicators are more complicated to evaluate. Of particular concern is the pounds of lobster harvested, which have decreased dramatically in the Sound in recent years due to large die-offs. Scientists do not believe there is any single factor that caused the die-offs, and they are looking at several possible factors, including pathogenic diseases, low levels of oxygen, rising water temperatures, and pesticides.

In total, the indicators help environmental scientists and government agencies determine whether we are meeting our goals to improve water quality, to ensure abundant populations of fish and shellfish, and to improve habitats for plant and animal life undersea and on shore. Sound Health 2003 also reveals some of the challenges that lie ahead. If you are interested in looking at the full set of indicators, and in learning more about Long Island Sound, please visit us at *www.longislandsoundstudy.net*. We also hope the report piques your interest in wanting to learn more about what you can do to help. If so, check to see if there is a local group near you active in Sound issues.

FACTS

→ Long Island Sound is an estuary, a place where salt water and fresh water mix. Unlike other estuaries, it's open at both ends—through The Race to the Atlantic Ocean at the eastern end, and through the East River and New York Harbor at the western end.

Salt water flows into the Sound from the Atlantic Ocean. Approximately 90 percent of its freshwater comes from three major rivers in Connecticut: the Thames, the Housatonic, and the Connecticut.

→ The Sound's watershed, which is all the land from which water drains into the Sound, extends into Canada, and covers an area of more than 16,000 square miles. More than 8 million people live in the watershed, and more than 20 million people live within about an hour's drive of the Sound.

There are 240 monitored beaches open for swimming on Long Island Sound.

→ The average depth of the Sound is a shallow 65 feet, but it varies significantly depending on location. In the "eastern basin" depths in places exceed 300 feet. There the Sound resembles a large funnel with coarse sedimentation, a chiseled-out recession that was formed due to the melting of a glacier. The central and western basins are shallower with a surface of fine sedimentation. These basins are more likely to trap pollutants.

Long Island Sound's basins are filled with 18 trillion gallons of water.

→ The 82 sewage treatment plants in Connecticut and 23 in New York that discharge into the Sound or its tributaries contribute more than a billion gallons of treated waste water each day.

* QUOTED IN *THE NEW YORK TIMES*, MAY 25, 2003

Nitrogen Pollution & Hypoxia

Improving water quality requires reducing nitrogen pollution into the Sound.

CT DEPT. OF ENERGY AND ENVIRONMENTAL PROTECTION

A RESOURCE ASSISTANT from the LIS Water Quality Monitoring field survey measures a water sample for nutrient analysis aboard the *John Dempsey* research vessel.

THE PEW OCEANS COMMISSION has identified over-enrichment of plant nutrients, particularly nitrogen, as the greatest pollution risk for marine life and habitats in coastal waters. This over-enrichment is known as eutrophication. While nitrogen is an essential element in creating animal and plant tissue, too much nitrogen can overfertilize algae and create nuisance blooms.

When the excessive amounts of algae and microscopic animals that feed on algae die and sink to the bottom, bacteria decompose the material and consume oxygen. The low levels of dissolved oxygen that result, a condition called hypoxia, impairs the feeding, growth, and reproduction of aquatic life.

In Long Island Sound, hypoxia usually occurs from mid-July through September, and is most severe in the western basin of the Sound where there are higher nitrogen levels and less mixing with oxygenated waters.

Where does the nitrogen come from? In Long Island Sound, more than 60 percent comes from human sewage discharged into the Sound from sewage treatment plants. Other sources include runoff from animal waste and lawn fertilizer, and nitrogen oxide emissions deposited from the air.

Since 1990, the Long Island Sound Study has been implementing 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 1990, about 25 percent of the 105 **sewage treatment plants** in Connecticut and New York have been upgraded to provide biological nutrient removal of nitrogen, and more are under construction or are being proposed. These upgrades have resulted in 55,000 fewer pounds of nitrogen a day entering Long Island Sound compared to the peak year in 1994, a 28 percent decrease. Other watershed restoration strategies to reduce nitrogen have included controlling the runoff of animal waste and fertilizer that gets carried into the Sound after a rain storm.

Hypoxia, which is defined as dissolved oxygen levels less than 3 milligrams per liter of water, varies from year to year. It has become less severe in recent years compared to the 1980s, perhaps because of reduced nitrogen levels as well as by other factors, including weather patterns that affect temperature, runoff, and storms. The 16-year average for the **area of hypoxia** is 197 square miles; the 16-year average for the **duration of hypoxia** is 57 days.

The hypoxic area in 2002 was 130 square miles, below the 16-year average, but still affecting an area about four times the size of Manhattan.

Eelgrass

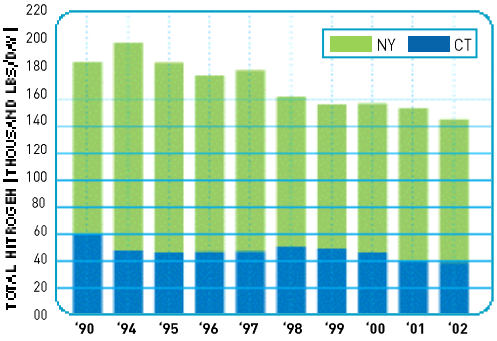
EELGRASS is a rooted plant in the shallow waters of the Sound. It serves as vital nursery habitat for many desirable fish and shellfish. It was once common along the entire coastline and in sheltered bays, harbors, rivers, and creeks. But eelgrass will not grow if algal blooms, stimulated by excess nitrogen, shade the sunlight it needs for energy. Only about 1,600 acres remain, all along the eastern shore of Connecticut where nitrogen levels are lower.

In Mumford Cove in Groton, Connecticut, reducing nitrogen appears to have rejuvenated the eelgrass beds. In 1987, a sewage pipe discharging treated sewage containing nitrogen was relocated from Mumford Cove. Since then, eelgrass has rebounded throughout the Cove, covering nearly 50 acres. Sea lettuce, an algae that had thrived in Mumford Cove when there was a rich nitrogen environment, has been drastically reduced.

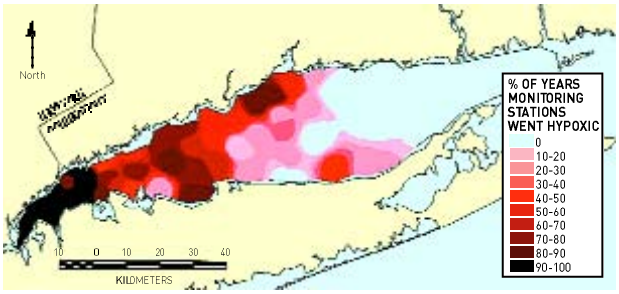
EELGRASS, which provides young fish and scallops with refuge from predators, can be restored if nitrogen pollution is reduced.

Nitrogen pollution has decreased, largely because of improvements to sewage treatment plants (top, right). Hypoxia varies from year to year, but appears to be improving, an indication that reduced nitrogen may be contributing to improved water quality (bottom, right). Up to two-thirds of the Sound still experiences hypoxia during the summer (below).

NITROGEN FROM SEWAGE TREATMENT PLANTS

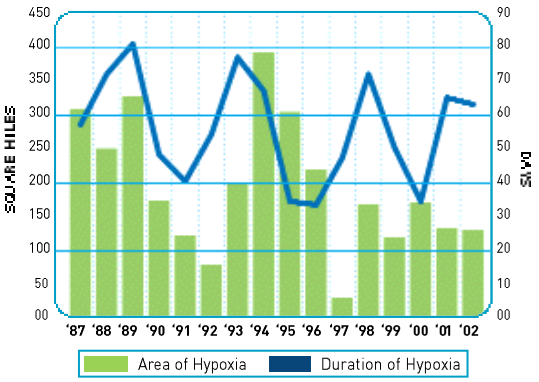


FREQUENCY OF HYPOXIA IN THE SOUND
Summer Data from 1994-2002



Hypoxia is defined as less than 3.0 mg/liter of dissolved oxygen.

HYPOXIA—AREA & DURATION



SOURCES NITROGEN FROM SEWAGE TREATMENT PLANTS [CT DEP AND NYS DEC]; HYPOXIA—AREA AND DURATION [CT DEP LIS WATER QUALITY MONITORING PROGRAM]; FREQUENCY OF HYPOXIA IN LIS WATERS [CT DEP LIS WATER QUALITY MONITORING PROGRAM] * AMERICA'S LIVING OCEANS: CHARTING A COURSE FOR SEA CHANGE, PEW OCEANS COMMISSION, MAY 2003

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. As the algae and the microscopic animals that feed on algae die and sink to the bottom, they are consumed by bacteria, which also take up oxygen in the process. A significant loss of oxygen in the bottom waters results in hypoxia, a condition that impairs the feeding, growth, and reproduction of aquatic life.

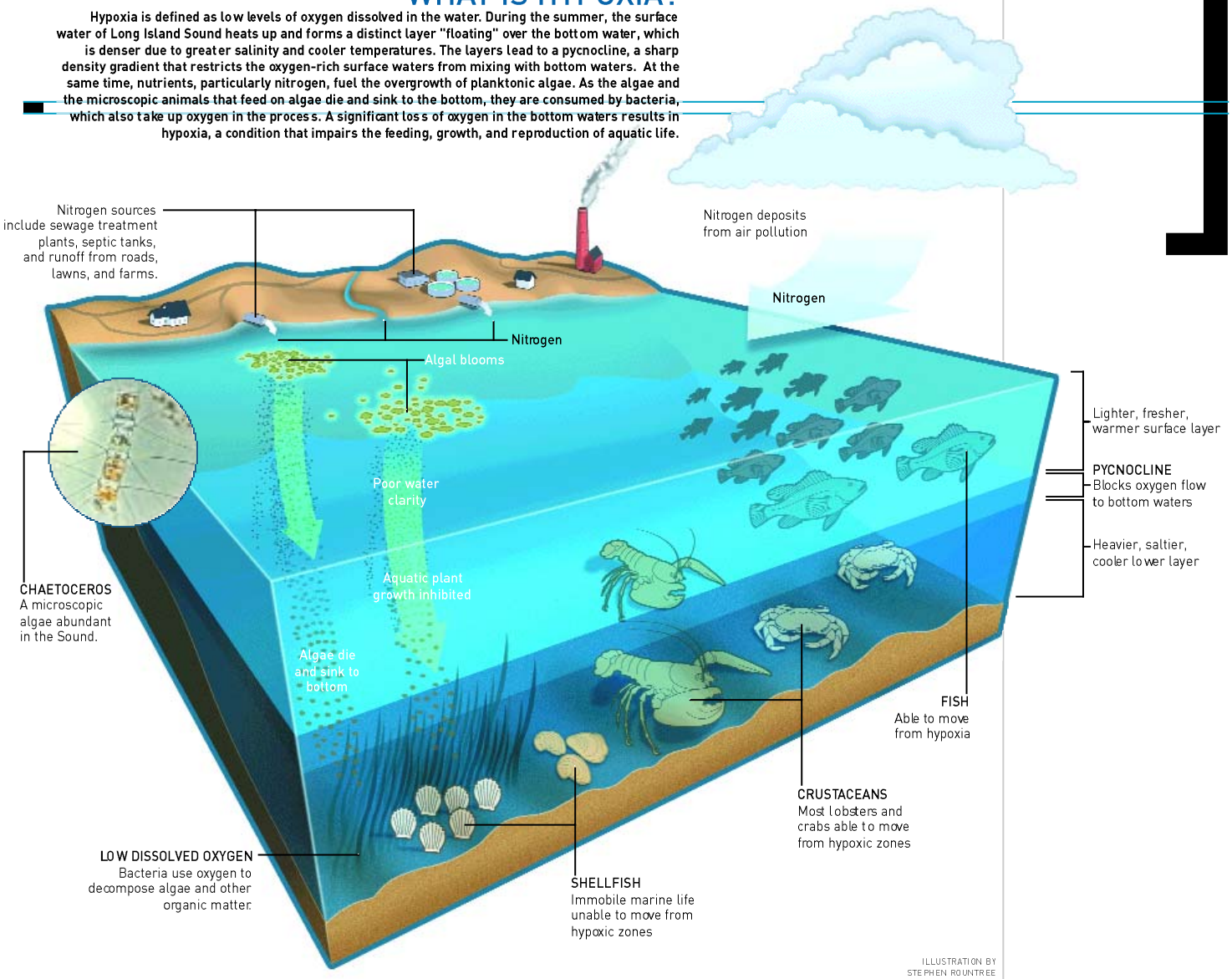


ILLUSTRATION BY STEPHEN ROUNTREE

Is Hypoxia Natural to Long Island Sound?

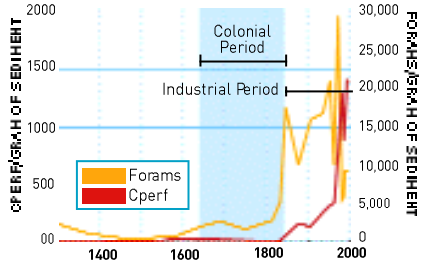
THE ANSWER APPEARS to be no. Piecing together evidence from the buried remains of simple animal and plant life found in the sea floor mud, scientists have shown that water quality degraded slowly, beginning in colonial times with deforestation, but picked up speed in the mid-19th century with industrialization and increased population.

Buried organic carbon, an indicator of increased algae production that leads to depleted oxygen levels, or hypoxia, has increased in concentration over time, according to research by a team of scientists from the U.S. Geological Survey and Wesleyan University.

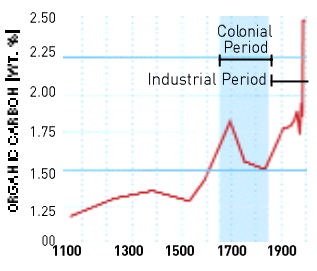
Using sediment core samples, the scientists were able to identify conditions over a time span of about a thousand years. Surface sediments reflect recent conditions; deeper layers reflect past conditions. In samples collected off the Norwalk coast, for example, the sediment two feet below the surface contains materials that accumulated on the sea floor about a thousand years ago.

The evidence from the team's research strongly suggests that the sewage derived from humans led to the overfertilization of the Sound and to hypoxia. It also led to fundamental changes to the abundance and types of animal and plant life.

"The Sound has not shrugged off all these human impacts," said Dr. Johan Varekamp, a geochemist at Wesleyan University. "It has undergone fundamental changes in water quality and ecosystem structure. Even with restoration of water quality we can not be sure that the ecosystem as a whole will directly return to its pre-industrial state."



INCREASED POPULATION & SEWAGE
Clostridium perfringens (**Cperf**), a bacterial spore found in sediments, is an indicator of the amount of sewage input to the Sound. The bacteria that produce these spores live in the guts of mammals and are capable of surviving sewage treatment. The increase in Cperf reflects the increase in treated sewage entering the Sound as a result of the increase in human population. Foraminifera (**forams**) are microscopic organisms, and an indicator of more eutrophication—the increase of algae fueled by nitrogen-rich sewage. The forams increased because its food supply, algae, became more abundant.



EUTROPHICATION
Carbon is a basic element for all life, including algae. The first peak in organic carbon burial coincides with an increase in carbon supply from the land as the forests were cleared for farming. But the second peak, starting after 1800, reflects the increased production of algae caused by nutrient enrichment. This eutrophication ultimately leads to hypoxia.

SOURCES 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). * NO LONGER WORKING WITH THE USGS.

Toxic Contaminants & Pathogens

Despite successful efforts to reduce toxics and pathogens, they still pose a threat to the Sound.

LONG ISLAND SOUND has been used as a resource and a disposal site since industrialization began. Measurable quantities of contaminants such as **mercury, zinc,** and **copper** have existed in the sea bed dating back to the mid-1800s. Toxic chemicals enter Long Island Sound from sources such as manufacturing processes, household cleaning and pest control products, automobile exhaust, and emissions from fossil fuel power plants. Stormwater pipes carry contaminants washed from roads, parking lots, disturbed land, and construction sites. Rivers and streams transport contaminants from the watershed into Long Island Sound. Rainfall deposits contaminants from the atmosphere into the Sound as well.

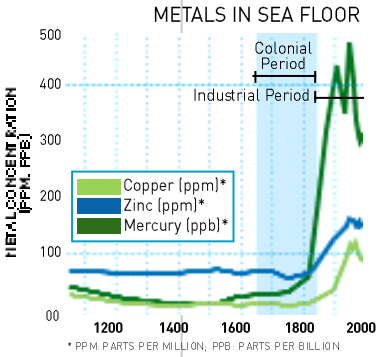
Many contaminants, such as lead, become attached to fine particles of sediment in the water. The contaminated sediments eventually settle to the sea floor, mostly in areas of weak currents in the western Sound where they are less likely to be flushed out.

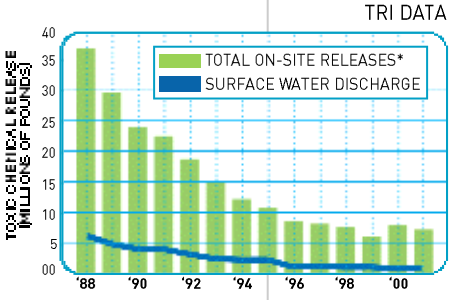
Today, federal and state programs strive to reduce toxic chemical discharges to the Sound and to minimize the toxicity of waste water from sewage treatment plants and industries. The U.S. Environmental Protection Agency maintains the **Toxics Release Inventory** (TRI), a national database that identifies the chemicals manufactured and used at industrial facilities and the annual amounts of these chemicals released in waste. Overall, toxic releases in the Sound's watershed have declined since the late 1980s. With tighter controls, levels of contaminants in the sediment and in fish and other aquatic life are decreasing.

The contaminants, however, continue to pose a threat to the Sound's health. As particles settle to the bottom, they create a reservoir of contaminants that can harm aquatic life living or feeding near the sea bottom. Fish and shellfish can, in turn, accumulate toxic contaminants, posing a human health risk. As a result, public health advisories are published to inform consumers about potential risks from eating seafood that contains higher chemical levels. For example, levels of PCBs in striped bass have been significantly reduced since PCB production was banned in 1977. However, PCB levels are still high enough for public health officials to issue advisories limiting the amount of striped bass that should be eaten (see fish consumption advisories, next page).

Scientists also are studying whether contaminants that are not routinely monitored, and whose effects are not fully understood, can pose hazards to humans and wildlife. For example, scientists are investigating whether "endocrine disruptors," chemicals found in certain pesticides, commercial chemicals, and pharmaceuticals, which enter the Sound from diverse sources, can disrupt the hormone systems of humans and wildlife.

Metals such as mercury, zinc, and copper accumulated in the sea bed with increased industrial activity, peaking from the 1950s to 1970s (below).





In recent years, discharges of metals and other contaminants into air and water are decreasing (above). But contaminants remain concentrated in the sea floor in areas of weak currents in the western and central Sound.

KINGSBURY/HEGER

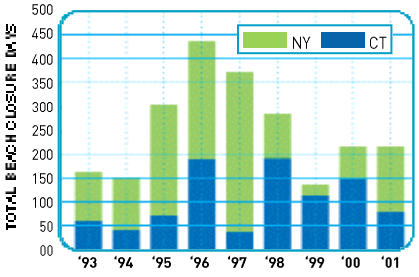
PATHOGENS, which are disease-causing bacteria and viruses, can enter Long Island Sound from inadequately treated human sewage and domestic and wild animal wastes. Some of the primary sources of pathogens to the Sound are older sewer systems that have combined stormwater and sanitary systems that overflow during rainfalls (called combined sewer overflows), failing septic systems, illegal connections to storm sewers, sanitary system malfunctions, and vessel waste discharges. People can become sick by swimming in waters contaminated by pathogens or by eating raw or partially cooked shellfish that contain pathogens. To protect public health, beaches, and many of the Sound's prime shellfish beds, are closed when there is an indication of pathogen contamination. As a result, pathogen contamination can seriously affect the region, economically and socially.

The number of days that beaches are closed to swimming increases with increased rainfall. In 2003, a rainy summer has resulted in more beach closures. Fortunately, beach closure days in recent years have been relatively rare events. In 2001, the number of beach closure days from Memorial Day to Labor Day was less than 1/2 of 1 percent for all 240 monitored beaches. But the impact is great for those communities affected by beach closure days, particularly communities with "chronic closures." The Long Island Sound 2003 Agreement calls for eliminating chronic closures, beaches that are closed for at least three days per year for at least three of the last five years, through such measures as:

- reducing the number of combined sewer overflows;
- controlling stormwater runoff; and
- minimizing mechanical breakdowns in sewer systems and sewage treatment plants that result in releases of untreated sewage.

BEACH CLOSURES

Yearly variations in closures are a product of rainfall patterns and incidents such as sewer-line ruptures. A relatively dry summer in 1999, for example, led to significantly fewer closings than in 2000 or previous years.



SOURCES METALS IN SEA FLOOR | 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|. * NO LONGER WORKING WITH THE USGS, TRI DATA |EPA 2001 TOXICS RELEASE INVENTORY|, BEACH CLOSURE DAYS|CT DEP AND NYS DEC|

Altered Landscapes

Development has destroyed or altered many vital habitats.

MANY OF THE CHANGES IN THE QUALITY of Long Island Sound are driven by changes that have occurred in the surrounding landscape. Concerns include the loss of wetlands, forests, farms, and other open spaces to increased population, development, and sprawl.

In the 20th century, the area around Long Island Sound experienced rapid population growth, starting in New York in the early part of the century and in Connecticut following World War II. The population has reached levels of more than 8 million people in Long Island Sound's watershed. More than 20 million people live within a 50 mile drive of Long Island Sound, close enough to take advantage of Long Island Sound's resources.

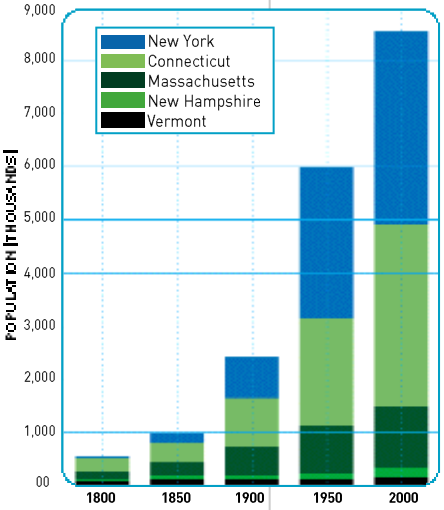
Long Island Sound's watershed covers more than 16,000 square miles in five states and part of Canada. But the most heavily populated urbanized areas closest to the Sound have the greatest environmental impact. Residential, commercial, and recreational development have increased pollution, altered land surfaces, reduced open spaces, and restricted access to the Sound. The use of the Sound as a place to dispose of human and other wastes has also increased dramatically. The "paving over" of the land has increased runoff and reduced the ability of natural landscapes to filter pollutants. Development has destroyed or altered many vital habitats, harmed native wildlife populations, and reduced breeding grounds and nursery areas of many native species.

Some trends have been positive. From the 1600s through the 1800s, forest area decreased as land was cleared for agriculture, housing, and industry. But in the 1900s many farms were abandoned and trees grew back. In Connecticut, for example, forest cover that had been as low as 25 percent in 1820 is now at about 60 percent. Healthy forests contribute to healthy rivers, and ultimately, a healthy Long Island Sound. This progress, however, is threatened by sprawl development.

Both New York and Connecticut in the past decade also have engaged in aggressive programs to purchase and protect open spaces in the Long Island Sound watershed, including forested land and beachfront access (see habitat restoration, opposite page).

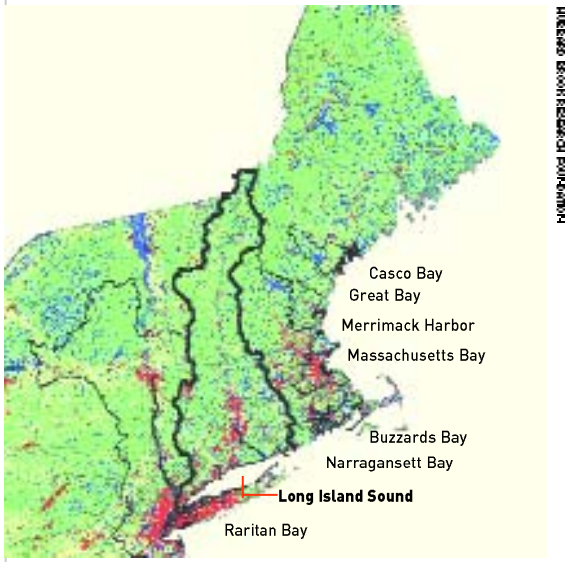
WATERSHED POPULATION

There are five states in the Long Island Sound watershed; most people live in the coastal areas in New York and Connecticut.



WATERSHED LAND COVERAGE

The area closest to the Sound includes the most densely developed watershed lands in the U.S. The impact of development to the Sound includes nitrogen pollution from sewage, polluted runoff, disturbed habitats, and restricted shore access.



HUBBARD BROOK RESEARCH FOUNDATION

DIAMONDBACK TERRAPIN

MATTHEW DRAUD, C.W. POST-L.I.U.

Terrapins

"TERRAPIN SOUP" almost proved the end for the diamondback terrapin in Long Island Sound. It nearly became hunted to extinction in the early 20th century because of its tasty and pricey meat.

Left alone after losing culinary favor, it prospered; but now the terrapin faces threats again in Long Island Sound—this time from loss of nesting habitat and raccoon predation of nests.

"Anybody who wants to live beachside is also going to be using prime terrapin nesting habitat," said Dr. Matthew Draud, a C.W. Post-Long Island University biologist who has studied Oyster Bay's terrapins since 2000.

In Oyster Bay as elsewhere, female terrapins prefer to nest in sandy areas with sparse vegetation such as beaches and dunes. They bury their eggs in the sand, eight inches underground, and cover them with pebbles and small debris. With increased human settlement these habitats disappear to make way for development, or are altered to a more vegetated landscape of lawns and gardens. The altered habitat, in turn, becomes prime foraging ground for raccoons. With their keen sense of smell, they find the eggs and eat them.

Unless nesting sites improve, it is unlikely enough turtles will reach maturity to sustain the population. Approximately 75 percent of the population of about 500 terrapins in Oyster Bay is greater than 20 years of age, while about five percent is younger than 10 years of age.

Where good, sandy habitats exist, such as in Mt. Sinai Harbor in Long Island, the turtle appears to be thriving.

SOURCES WATERSHED POPULATION: U.S. CENSUS BUREAU [2000]; THE UNIVERSITY OF VIRGINIA LIBRARY WITH THE COOPERATION AND CONSENT OF THE INTER-UNIVERSITY CONSORTIUM FOR POLITICAL AND SOCIAL RESEARCH, AND NEW YORK STATE DATA CENTER.; 1990 WATERSHED LAND COVERAGE: "NITROGEN POLLUTION: FROM THE SOURCES TO THE SEA", THE HUBBARD BROOK RESEARCH FOUNDATION

Coastal habitats, once prime lands for dredging, filling, and building, are now being protected and restored.

Habitat Restoration

A HABITAT IS A PLACE where plants and animals live. While there is still much healthy habitat in and around Long Island Sound, the overall abundance and diversity of habitats have been diminished. Incompatible uses of the Sound and its resources since the 1700s have resulted in the loss of coastal and inland wetlands, and eelgrass beds, some of Long Island Sound's most important habitats.

For example, wetlands are among the most productive ecosystems in the world, providing food, shelter, and breeding or nursery grounds for many species of wildlife. Wetlands also protect the land from flooding and erosion in stormy weather, and filter pollutants from the water. But too often they became places to fill, dredge, dump, and build. About 25 to 35 percent of the Sound's tidal wetlands were destroyed until federal and state legislation halted the practice in the early 1970s.

Now the emphasis is on restoring coastal habitats. In 1998, the states of Connecticut and New York and the federal government created the Long Island Sound Study Habitat Restoration Initiative, and adopted goals to restore 2000 acres of **coastal habitats** by the year 2008. So far, 465 acres have been restored, with a number of projects nearing completion.

ROBERT DOSCHER, WESTCHESTER COUNTY DEPT OF PLANNING

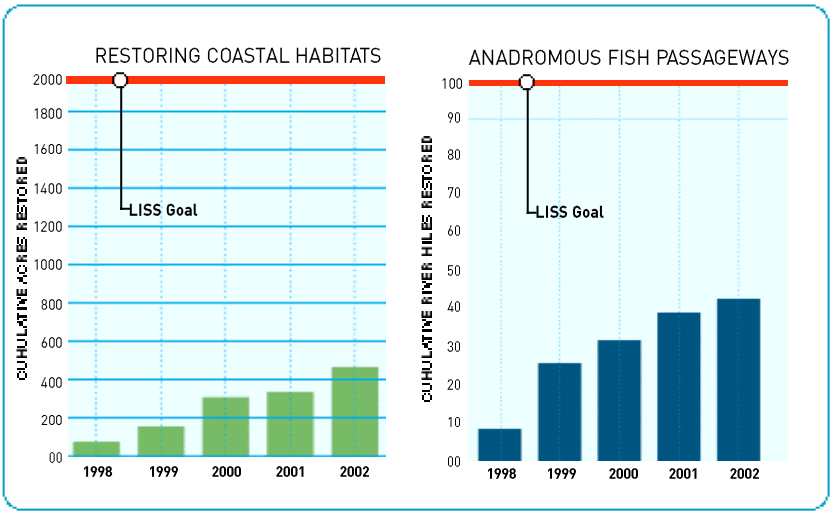
CONCRETE RUBBLE, debris, and invasive plants had long been present on a strip of land facing Long Island Sound at the Read Sanctuary in Rye. Westchester County removed the debris and invasive plants, created a dune, and planted beach grass, goldenrod, beach plum, and other native plants. The dunes also provide cover for nesting shore and other birds, such as killdeer.

Restoring habitats also include providing passageways for fish that migrate from the brackish waters of Long Island Sound to freshwater rivers and streams 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. Many of these travel routes, however, can be made accessible by the construction of fishways—concrete, wooden, or aluminum structures that allow fish to swim past the barrier.

In 1998, the Long Island Sound Study adopted a goal of restoring 100 miles of migratory river corridors for anadromous fish by 2008, either through the construction of fishways or removing the obstacle entirely. So far, 42.9 miles of rivers and streams have been restored for fish migration. As a result fish such as alewives, striped bass, blueback herring, American shad, and Atlantic salmon are now seen swimming upstream again.

Bi-state efforts also are focusing on acquiring open space parcels to protect habitats from development. In 2002, for example, Connecticut efforts included partnering with The Nature Conservancy to buy more than 15,300 acres of land and easements from a water utility for passive recreation. The purchase preserves open space lands in 28 towns. A significant New York state acquisition in 2002 was the 500-acre KeySpan property in Riverhead, Long Island. The property, which includes one mile of beachfront, had once been considered a site for a nuclear power plant.

Federal, state, and local governments are funding projects to meet 2008 goals to restore coastal habitats and fish passageways.



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

Invasive Species

NATIVE PLANTS and animals in Long Island Sound are being threatened by foreign invaders—animals and plants from other regions and sometimes other lands. After arriving here, usually through human transport, these invasive species compete for limited space in native habitats, and in some cases become the dominant species.

Not all non-native species are invasive, but such is the case with the Asian shore crab, *Hemigrapsus sanguineus.* It was first was seen off the East coast in Cape May, New Jersey, in 1988. It possibly arrived as a result of being transported in ballast water from ships arriving from China or Japan. The tiny crab, which grows to two inches in width, occupies habitats similar to native mud crabs, and in some cases has outcompeted them and larger species such as rock crab and green crab (another non-native species). In the waters off Read Sanctuary in Rye, the population of native crabs has been virtually eliminated, according to a study done by Dr. George P. Kraemer, Associate Professor of Environmental Sciences, at Purchase College of the State University of New York.

GEORGE KRAEMER, SUNY PURCHASE COLLEGE

JUVENILE ASIAN SHORE CRAB

There are several potential factors for the Asian shore crab's success, including the absence of natural controls (such as parasites that control populations in its native range), a high reproductive rate, preying on other crabs, and out-competing for food. The crab first came to the Sound in 1993, and is now seen throughout its waters.

Public Participation

Volunteers and community groups play a vital role in protecting and restoring Long Island Sound.

A STUDENT, left, discovers sponges at a SoundWaters education program in Stamford. A student, below, holds a fiddler crab aboard the schooner SoundWaters, a floating classroom operated by SoundWaters.

COURTESY OF SOUNDWATERS

DAVID HARWOOD HERSER

COURTESY OF PETER DAVIS/RIVERKEEPER

PETER DAVIS, middle, the New Haven Riverkeeper, in front of a pile of trash pulled out of the Quinnipiac River and riverbanks near the Sound during a beach cleanup. Volunteers, bottom, haul trash into a large Dumpster at Port Jefferson Harbor in Long Island during a cleanup.

Grants Support Local Actions

SINCE 1995, organizations in the Long Island Sound watershed with a proposal to clean up Long Island Sound or to educate residents about how to protect the estuary have turned to the Small Grants Program of the Long Island Sound Study for assistance.

The grants of up to $5,000 may be modest, but the reach has been great. Projects have served as a resource for several hundred teachers, helped to educate thousands of school children, and produced numerous informational signs, posters, brochures, exhibits, and events.

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.

For more information you can call the LISS/New York Sea Grant Office at (631) 632-9216. Since 1993, Connecticut's Long Island Sound License Plate Program also has provided grants of up to $25,000 to Connecticut groups; for more information call (860) 424-3034.

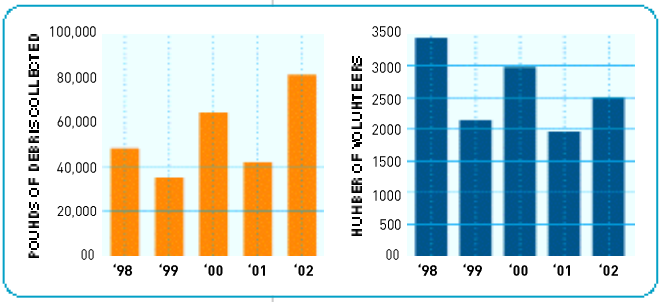
HOW DOES THE PUBLIC participate in the cleanup of Long Island Sound?

Volunteers help clean beaches from the debris washed up on shore; birding groups help to protect the nesting sites of coastal birds; boating groups help to educate boaters about clean marinas and boating; neighborhood committees help to identify sites for wetland restoration, and at times do the restoration work as well; and nonprofit groups give children and adults hands-on education on the science, history and culture of Long Island Sound.

Most importantly, these efforts and others help to build awareness among the general public, government agencies, and businesses of the reasons why the Sound needs to be protected.

Their participation does make a difference. In Westchester County, for example, citizen volunteers worked with the county Department of Planning and local municipalities to create a management plan to control a growing problem: the impact of stormwater after it runs over a surface contaminated with pollutants such as fertilizers, pesticides, and oil and grease, and carries those pollutants into the Sound. As part of the effort to control stormwater runoff, the volunteers walked through Westchester communities to identify degraded areas of streams and wetlands that should be restored so vegetation can once again perform its vital role of trapping contaminants before they enter streams and eventually the Sound. Many of these sites are now being restored through funding from municipal, county, state, and federal sources.

LIS COASTAL CLEANUP



SOURCE AMERICAN LITTORAL SOCIETY AND CT SEA GRANT

As part of the International Coastal Cleanup, an international program sponsored by the Ocean Conservancy, volunteers gather to comb beaches or dive underwater for cigarette butts, plastic bags, bottles, straws, and other litter on the third Saturday of September. In New York and Connecticut, volunteers clean up debris in about 80 Long Island Sound sites in efforts coordinated by the American Littoral Society and Save the Sound. The volunteers collect an average of about 53,000 pounds a year along 82 miles of shoreline. In 2002, more than 2,000 volunteers participated.

What You Can Do

As a resident of the Long Island Sound watershed, here are some simple things you can do to help restore and protect Long Island Sound.

IN THE 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. Dispose of it properly: either in the toilet or sealed in a plastic bag and put in the garbage.**
- Wash your car on a grassy area if possible, 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.

IN AND AROUND THE SOUND

- Don't be a litterbug. Never throw litter, especially plastic, into the street, down storm drains, or onto the beach. Rainfall carries the trash into the sewers where it eventually travels into the Sound.
- **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 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 bathing areas.

What More Do We Need to Do?

WHILE PROGRESS is being made toward achieving 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. It is apparent that continued research and monitoring is necessary to answer the questions:

- What caused the die-offs of lobster in the Sound?
- What effects do temperature, hypoxia, and toxic contamination have on living resources in the Sound?
- How will the Long Island Sound ecosystem respond to continued nitrogen reductions?
- What effect does dredged material disposal have on the Sound?
- How does atmospheric deposition of pollutants affect water quality in the Sound?
- What more can people do to help restore and protect Long Island Sound?
- How will global warming and sea level rise affect the Sound?

The Long Island Sound Study will incorporate new information to refine and expand environmental indicators in future Sound Health reports.

NYC PARKS & RECREATION/NATURAL RESOURCE GROUP

BRONX RIVER ALLIANCE AMERICORPS volunteers and New York City parks staff clear debris from a mudflat on the Bronx River, part of the Sound's watershed. They are preparing to restore a salt marsh.

CONTACTS

Key agency and organization contacts for Long Island Sound:

FEDERAL

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

EPA National Estuary Program
202-566-1256
www.epa.gov/owow/estuaries

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

CONNECTICUT

CT Dept. of Environmental Protection
860-424-3020
dep.state.ct.us

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

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

NEW YORK

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

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

NYS DEC Spill Hotline
800-457-7362

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

SEA GRANT COLLEGE PROGRAMS

Connecticut Sea Grant
860-405-9127
www.seagrant.uconn.edu

New York Sea Grant
631-632-6905
www.seagrant.sunysb.edu

GENERAL CONTACTS

Long Island Sound Watershed Alliance
203-354-0036
www.savethesound.org

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

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 Sound's Comprehensive Conservation and Management Plan completed in 1994.

Mark Tedesco, director,
EPA Long Island Sound Office

SOUND HEALTH UPDATE
Editor: Robert Burg
Technical Editors: Mark Parker (CT DEP) and Rick D'Amico (NYS DEC)

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If you are interested in receiving our newsletter, Sound Update, or have comments or questions for the Long Island Sound Study, contact us by:

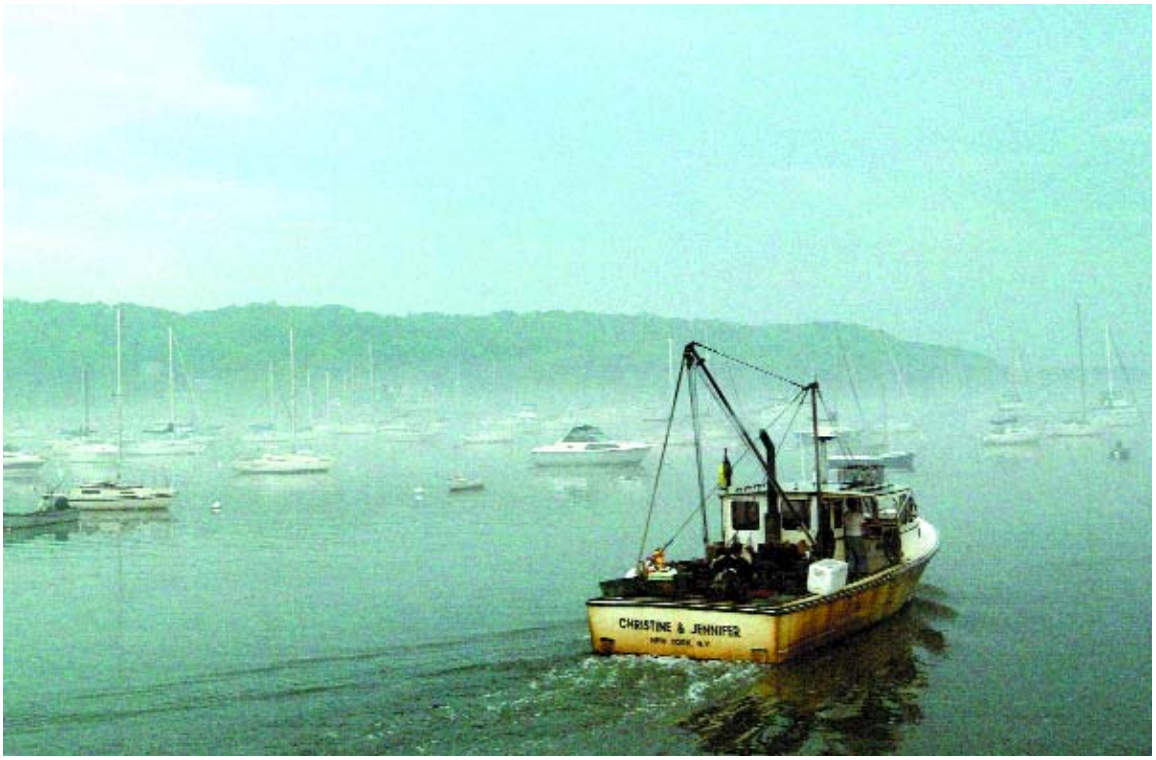
E-MAIL
info@longislandsoundstudy.net

TELEPHONE
203-977-1541 (CT)
631-632-9216 (NY)

MAIL
EPA Long Island Sound Office
Stamford Government Center
888 Washington Blvd.
Suite 6-5
Stamford, CT 06904-2152

Long Island Sound Study Public Outreach Coordinator
New York Sea Grant
146 Suffolk Hall
State University of New York
Stony Brook, NY 11794-5002

Visit us on the web at:
www.longislandsoundstudy.net



IN SEPTEMBER, Americans pay special attention to estuaries—unique places such as Long Island Sound where fresh water from rivers meets the sea.

On the last Saturday of the month communities across the country celebrate their estuaries with a variety of special events. Most of these events are hosted by two federal programs, the National Estuarine Research Reserves program and the National Estuary Program. Long Island Sound Study is one of 28 estuary programs that belong to the National Estuary Program.

Other activities held in September include the International Coastal Cleanup, on the third Saturday of the month, the National Coastweek, and Estuary Live, an interactive Web-based "field trip."

You can learn more about these activities by visiting these websites:
www.estuaries.gov
www.estuarylive.org
www.coastalcleanup.org

You can also learn more about our estuary, Long Island Sound, by visiting *www.longislandsoundstudy.net*; and other estuaries by visiting:

www.epa.gov/owow/estuaries/
www.epa.gov/owow/estuaries/kids/
www.whatsanestuary.com
www.anep-usa.org

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

A COMMERCIAL LOBSTER BOAT passes recreation boats in Northport, Long Island. Long Island Sound is a 110-mile estuary surrounded by Connecticut, Westchester, New York City, and Long Island. It generates billions of dollars to the economy, and provides habitats for plant and animal life.