Long Island Sound Study

A Partnership to Restore and Protect the Sound

SOUND HEALTH

STATUS AND TRENDS IN THE HEALTH OF LONG ISLAND SOUND

{2010}

WELCOME!

The Sound Health Report Tracks Key Measures of the Health of Long Island Sound

Millions of people visit Long Island Sound each year to swim, boat, and enjoy the view, enriching their own lives and stimulating the local economy. Below the surface of this 110-mile long body of water and along its 600 miles of coastline, hundreds of species of finfish, birds, and other animals also call the Sound their home.

Maintaining this healthy ecosystem, while balancing human uses, presents a challenge. Hundreds of years of development have compromised the Sound's ability to fully function as a natural resource. At times, for example, oxygen levels in some areas of the Sound drop to levels that could cause fish to flee or die. The legacy of pollution discharged into the Sound from industrial sources also has led to state advisories on how much fish can be consumed without health concerns.

Progress, however, has been made in cleaning up the Sound since the 1970s when the environmental movement first put a spotlight on polluted waterways. More recently, the Long Island Sound Study (LISS) has been implementing a comprehensive management plan to restore the ecosystem that recognizes human habitation as integral to the Sound's character (*see sidebar, below*).

The purpose of this report, *Sound Health 2010,* is to look back at environmental conditions in the Sound and its watershed over the last two years and compare them to conditions from the last 20 to 30 years (a separate report, *Protection and Progress*, details the management actions taken to improve the Sound).

Sound Health 2010 uses environmental indicators—developed from data collected by research and monitoring programs—that highlight trends in pollutant levels, land use and development, water quality, living resources, and sensitive habitat. From this snapshot, *Sound Health 2010* addresses questions such as: Is the water cleaner? Are the fish safe to eat? Is the water safe to swim in? Are fish still abundant?

We encourage you to look at the data and analyses, and assess for yourself the health of the Sound. To learn more, go to the Status and Trends Web page at *www.longislandsoundstudy.net/status-and-trends* for the complete indicator set. Also, at *www.LIShealth.net* you will find links to learn more about the health of the Sound from organizations such as the Environmental Protection Agency, Connecticut Department of Environmental Protection and the New York State Department of Environmental Conservation.

Sound Health 2010 is being circulated in newspapers in communities across the Sound in New York and Connecticut and posted on the newly designed Web site, *www.longislandsoundstudy.net*. The report, issued biennially, was started 10 years ago to better inform citizens about the efforts to restore and protect the Sound. With this knowledge, citizens can become stewards of the Sound, galvanizing support in their local community, participating in volunteer efforts, and engaging in the types of behaviors that reduce pollution and keep the Sound a special place. ✻

THE FOUR BEARDED ROCKLING, *Enchelyopus cimbrius,* photographed in a rocky seafloor habitat in western Long Island Sound. The fish is one of about 50 to 70 different species surveyed each year in the Long Island Sound Trawl Survey (*p. 11*). The fish gets its name from the four whisker-like organs it has beneath its head.

What is the 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 LISS visit the *About Us* section of *www.longislandsoundstudy.net.*

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ON THE COVER

Cunner, *Tautogolabrus adspersus,* and juvenile blackfish, *Tautaug onitis,* swim near an underwater eelgrass meadow off Fishers Island in New York. The Fishers Island coastline is a Long Island Sound Stewardship Area.

ABBREVIATION KEY

CT DEP Connecticut Department of Environmental Protection
EPA U.S. Environmental Protection Agency
FWS U.S. Fish and Wildlife Service
LISS Long Island Sound Study
NOAA National Oceanic and Atmospheric Administration
NYSDEC New York State Department of Environmental Conservation
UCONN University of Connecticut
Unsure about a term used in this report?
See *www.LIShealth.net* for a definition.

CREDITS: *Eelgrass off Fishers Island (cover)*, photo courtesy of Cornell Cooperative Extension Marine Program (*www.seagrassli.org*); *Rockling,* photo by Robert Bachand.

{HYPOXIA + NUTRIENTS}

SOUND POINTS

- Hypoxia occurs in waters when oxygen drops to levels that cannot support fish and other wildlife. In the Sound, hypoxia is most severe in the western basin.
- In 2010, the area of hypoxia was the third smallest since 1987.

Find a link to an animation of how hypoxia is formed, and LISS's complete water quality indicators dataset, at *www.LIShealth.net.*

Plants produce oxygen during photosynthesis, absorbing the sun's energy to grow. But in coastal waters, excessive growth of microscopic plants, also called phytoplankton or algae, can lead to conditions that have the opposite effect—life-threatening depletion of oxygen.

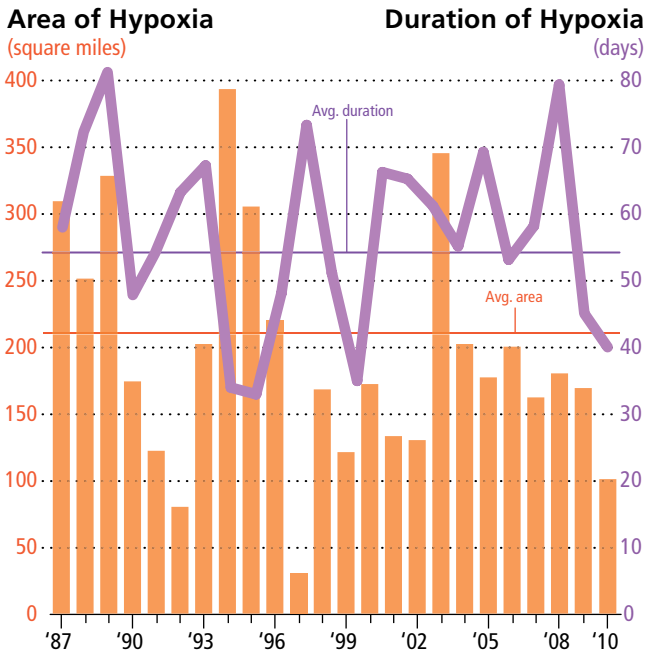
This condition, called hypoxia, results when the organic matter produced by the algae sinks to the bottom. Bacteria decompose the organic matter, consuming oxygen in the process. Waters are considered hypoxic when oxygen drops to levels too low to support fish and shellfish. Hypoxia can kill non-mobile marine organisms such as clams or worms, and cause the large scale migration of mobile animals, such as fish, to seek oxygenated water elsewhere.

In the Sound, hypoxia occurs mostly in the summer months and usually in the western basin and narrows (*see Conditions by Basin, p. 8*). From 1987 through 2010, the maximum area of hypoxia averaged 195 square miles—an area about nine times the size of Manhattan. The area of hypoxia has been below average for 11 out of the last 15 years. The summer of 2010 was the third least severe year of hypoxia since 1987, with hypoxia affecting 101 square miles. The duration of hypoxia in 2010 was 40 days, the fourth shortest duration since 1987, and 14 days fewer than average.

There are many factors that contribute to hypoxia. The region's large population and development patterns have increased the supply of nutrients into the Sound, particularly nitrogen, stimulating increased plant production. Major sources of nitrogen include deposition from power plants and vehicles, fertilizer runoff, and treated sewage discharged from wastewater treatment plants.

There are also physical, chemical, biological, and geographical factors that affect hypoxia. Warmer water in the summer naturally holds less oxygen than colder winter waters. Also, during the summer the surface water of the Sound warms and forms a distinct layer floating over the bottom water, which is denser due to greater salinity and cooler temperatures. This layering (or stratification) of the water column leads to a pycnocline, a sharp density gradient that restricts oxygen-rich surface waters from mixing with the less oxygenated bottom. Wind intensity and direction can also affect the degree of mixing between surface and bottom waters. Coves and protected harbors also can restrict the circulation of oxygen-rich tidal waters. ✻

THE NUMBER OF DAYS of hypoxia (*purple line*) and the area of hypoxia (*orange bars*) have varied from year to year since the Long Island Sound Water Quality Monitoring Program began in 1987. Hypoxia in the Sound is defined as dissolved oxygen levels at 3 mg/L or less.



A SCIENTIST samples concentrations of *A. fundyense,* an organism that can produce a neurotoxin, during a May 2008 cruise in Northport Harbor aboard the Stony Brook University research vessel *Mako II.*

Harmful Algal Blooms in Long Island Sound

IN 2008, 10,000 ACRES of shellfish beds were closed by the NYSDEC Shellfish Sanitation Division for six weeks because of a harmful algal bloom in the Long Island harbors of Northport, Centerport, and Huntington. The bloom was likely a result of above average temperatures, nutrients discharged from a wastewater treatment plant, and wind patterns that spread the bloom and nutrients out of Northport Harbor and into adjacent waters, according to a research project led by Stony Brook University scientist Christopher Gobler.

Gobler's research team collected water quality samples in 17 sites in the Northport-Huntington Bay complex in 2007 and 2008 to examine the causes of an algal bloom of the phytoplankton species *Alexandrium fundyense*. Commonly known as red tide, *A. fundyense* blooms are becoming increasingly common in coastal areas and are a concern because this algae can produce saxitoxins, a type of neurotoxin. These toxins can be ingested by shellfish such as mussels or clams. Humans who eat the shellfish can get paralytic shellfish poisoning, which can lead to severe illness or death. In the Sound, blooms containing elevated levels of saxitoxins were first detected in 2006 when 2,000 acres of shellfish beds were closed for six weeks in the same harbor complex.

The research showed that the nitrogen taken up by the bloom of *A. fundyense* in 2008 was likely supplied by a wastewater treatment plant in Northport Harbor. In addition, temperatures that were above average from late winter and early spring, and that stabilized near 15°C from mid-April to June, created an ideal growing environment for *A. fundyense* to bloom. Southeasterly winds also may have spread the blooms from Northport Harbor to the entire Northport-Huntington Bay complex.

Gobler's team also found that ammonium, a waste product in treated sewage, promoted the formation of *A. fundyense* blooms and increased toxicity of the blooms. Gobler and co-investigators Theresa Hattenrath of Stony Brook and Donald Anderson of Woods Hole Oceanographic Institution reported their findings in the May 2010 issue of *Harmful Algae.* The research was supported by funding from the LISS Research Grant program and from NYSDEC.

CREDITS: *Alexandrium fundyense,* photo by Christopher Gobler; *LIS Field Sampling,* photo by Theresa Hattenrath.
SOURCES: *Area and Duration of Hypoxia* chart, LIS Water Quality Monitoring Program/CT DEP.

{TOXIC CONTAMINANTS}

SOUND POINTS

- Many toxic contaminants are declining as a result of environmental regulations, banning of toxic products, and a decline in manufacturing.
- The osprey, a bird of prey once threatened with extinction, is on the rebound in coastal areas such as the Sound thanks to reduced levels of DDT, a pesticide.
- Despite progress, "biomagnification" of existing contaminants can harm aquatic life and humans.

The discharge of toxic chemicals into the Sound has often been associated with manufacturing processes and the burning of fossil fuels to power industry. During the industrial revolution, heavy metals started to accumulate in the sediments of the Sound. Concentrations of mercury off Norwalk Harbor, for example, increased by more than 1,300 percent from 1820 to 1955.

But with the advent of environmental regulation, product bans, and a decline in manufacturing, concentrations of many contaminants in the sediments began to drop in the mid-20th century. Sediment concentrations of mercury, for example, have dropped by more than a third, and copper and zinc have declined as well. Since 1988, toxic chemical discharges into the Sound and its tributaries, including air emissions and water discharges, have decreased by 91.5 percent, according to the EPA's Toxics Release Inventory (TRI) database, which tracks more than 650 chemicals.

Concentrations of contaminants have also decreased in some fish and wildlife in the Sound. Mirroring national trends, polychlorinated biphenyls (PCBs), potentially cancer-causing chemicals, have been declining in blue mussels at several sites monitored by NOAA. Since mussels are non-mobile and filter and accumulate particles from the water, measuring the contaminant levels in their tissue is a good indicator of contaminants in the immediate environment.

Despite progress, even reduced concentrations from industrial sources can put aquatic life and humans at risk. For example, airborne deposits from power plant and incinerator emissions are a continuing source of mercury to the Sound. The mercury can become attached to fine particles of sediment in the water. The contaminated sediments eventually settle to the seafloor, mostly in areas of weak currents in the western Sound, where they are less likely to be flushed out, but can become resuspended and pose a threat to wildlife (*see biomagnification diagram, below*).

Industrial plants and power plants are not the only sources of toxic contaminants discharged into the Sound. Household cleaning products, automobile exhausts, and the application of pesticides on farms, lawns, and gardens are other examples. Scientists also are concerned about the possible health and reproductive effects caused by chemicals from pharmaceuticals, personal care products, and plastics that are flushed down drains and toilets. Much more research is needed to fully understand the effect these chemicals may have on aquatic life. ✻

PCB Levels Decline

PCBS, organic compounds with the potential to cause neurological and reproductive problems, have declined in bluefish and striped bass in the Sound, according to a LISS-funded study. As a result of these and other toxicity test findings, New York and Connecticut health officials updated fish consumption advisories by increasing the amount of these fish that can be eaten at safe levels.

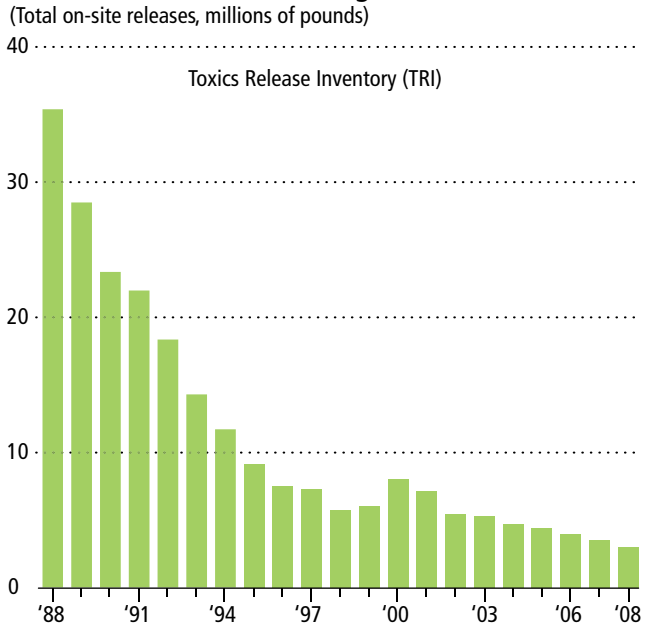
For the project, CT DEP collected fish in 2006 and 2007 and provided them to NYSDEC for analysis. The PCB concentrations, compared to fish samples from 1985 to 1987, declined by 82 percent in striped bass and 70 percent in bluefish.

The research also revealed that fish collected in the recent study had fewer lipids—organic compounds such as fats and oils—than earlier samples. Since PCBs bind to lipids in organisms, the project results suggest leaner bluefish and striped bass may have accounted for lower PCB concentrations. Leaner fish could be the result of increased competition for food, or changes in available food sources. The project found that mercury, which binds to proteins and not to lipids, did not change significantly from previous studies.

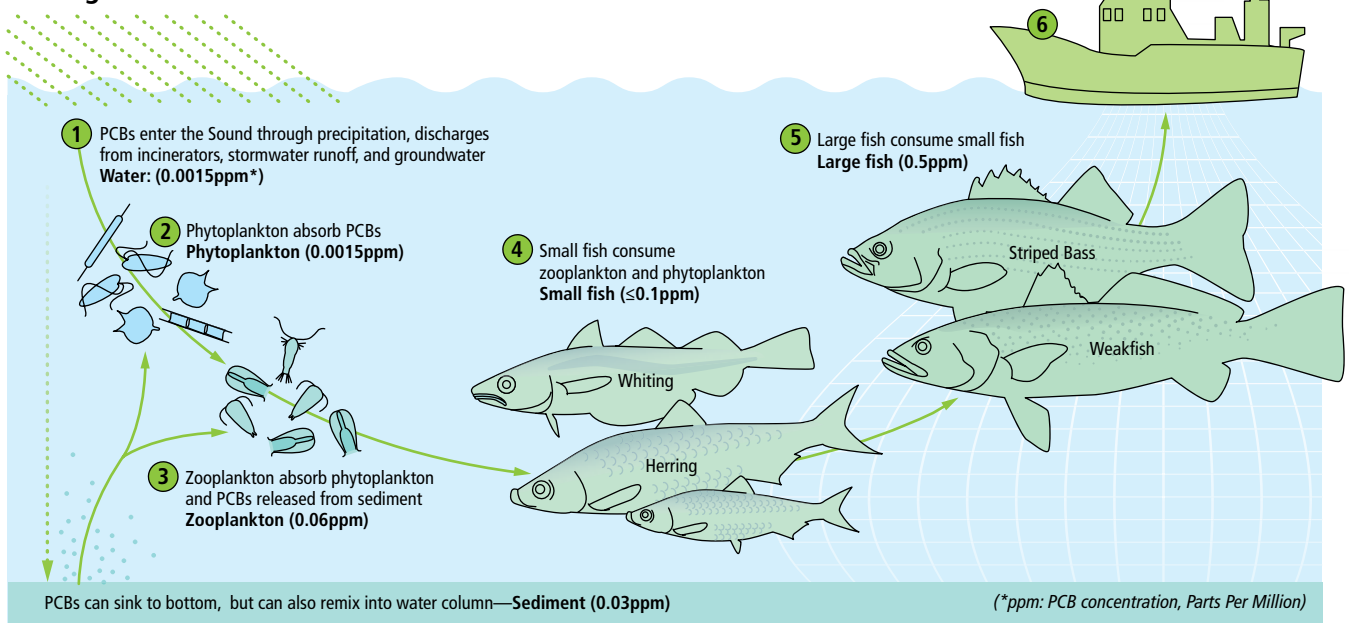
EPA banned most uses of PCBs, organic chemicals with many industrial uses, in 1979, but they are still present in products produced prior to the ban. PCBs released into the environment are slow to degrade, and still exist in the air, soil, and water (see *www.LIShealth.net* for links to the full report and the state fish consumption advisories).

TRI *(chart):* Chemical discharges into the Sound's watershed decreased by 91.5 %, from 35.1 million to 3 million pounds, from 1988 to 2008. **BIOMAGNIFICATION** *(diagram)*: Plankton can absorb contaminants such as PCBs from the water column. As PCBs cycle up the food chain, their concentrations increase in the tissues of shellfish, fish, and birds. As a result, health departments issue food consumption advisories suggesting limits on the amount of fish humans should eat.

Industrial Chemical Discharges (NY and CT)
(Total on-site releases, millions of pounds)



Biomagnification of PCBs



CREDITS: *Biomagnification diagram,* Illustration by Lucy Reading-Ikkanda, with special thanks to Larry Skinner.
SOURCES: *Industrial Chemical Discharges* chart, EPA 2008 Toxics Release Inventory.

{PATHOGENS}

SOUND POINTS

- 80% of pollution in the marine environment comes from the land. One of the biggest sources is stormwater runoff, which occurs when rainwater hits the land and picks up pollutants on its way to the closest body of water.
- Polluted stormwater runoff can lead to the closing of coastal beaches and shellfish beds.

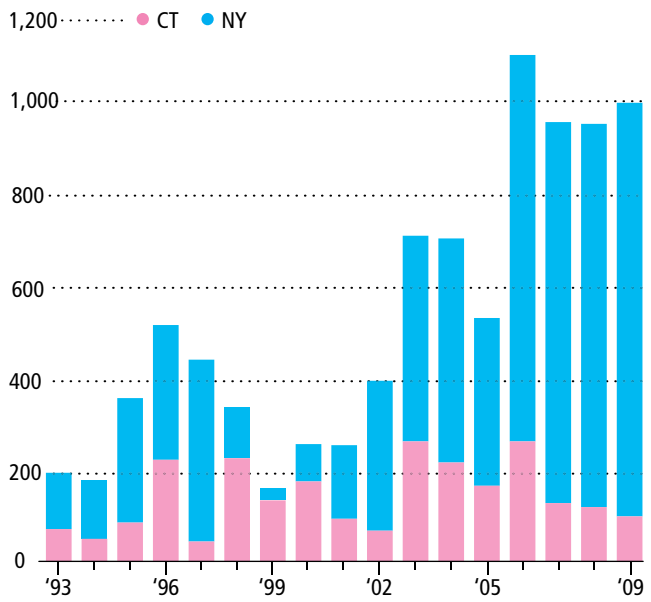
For many, the most obvious sign of poor water quality occurs when a "no swimming" or "no shellfishing" sign gets posted because of potential pathogen contamination. Pathogens are disease-causing bacteria and viruses that enter the Sound from inadequately treated human sewage and domestic and wild animal wastes. Sources of pathogens include stormwater runoff carrying animal waste from paved surfaces and lawns, and human waste from improperly maintained septic systems. While modern wastewater treatment plants effectively remove pathogens, some cities still use an early generation of sewer system that collects stormwater runoff and sanitary sewage into the same pipe. During dry weather, these combined sewer systems transport wastewater to the sewage treatment plant. During rainfall, if the combined wastewater and stormwater volume exceeds the capacity of the plant, the system overflows and excess wastewater is discharged directly into the Sound without adequate treatment. Other sources of pathogens can be leaking sewage pipes, illegal connections that bring sanitary waste to storm drains, sewage treatment equipment failure, and discharge of sewage from boats.

Generally, the Sound's 193 monitored bathing beaches are safe for swimming. To avoid illnesses caused by pathogens, health departments will close beaches when monitoring data indicate contamination or "preemptively" after a rainstorm at sites known to be susceptible to contamination. Most of the closings happen in the western Sound, where many beaches are downstream from densely populated areas that have more potential sources of pollution. Many of these beaches also are located in narrow, protected harbors, where there is less mixing action with cleaner waters from the open Sound. In general, the number of beach closures per year is dependant on the number of rainfall events.

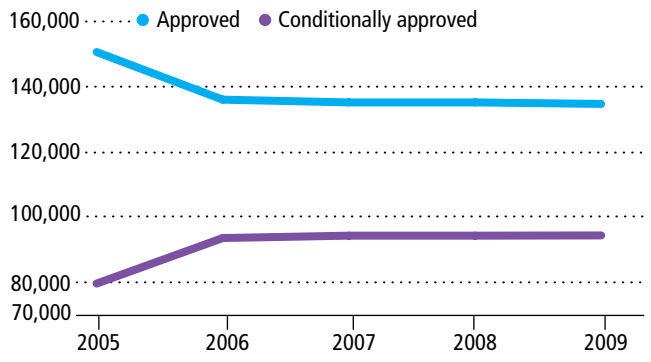
Shellfish beds are also regularly monitored to assure that shellfish harvested in commercial and recreationally approved areas are safe to eat. Resource managers in Connecticut are concerned that inland and coastal development (and associated impervious surfaces) have resulted in increased stormwater runoff and elevated bacteria levels in coastal shellfish growing waters. This has resulted in a need to downgrade beds from approved (where beds stay open unless there is a rainfall event of greater than three inches) to conditionally approved (where rainfall events less than three inches can trigger automatic temporary closures, based on location). Polluted runoff is a significant reason why almost 16,000 acres of approved growing areas were downgraded from 2005 to 2009. In New York, most certified shellfish beds are in open areas of the Sound away from where stormwater discharges could potentially have an impact. ✻

BEACH CLOSURES increase in years with frequent rainstorms (*top*). Approved shellfish beds were downgraded to conditionally approved, in part because of high bacteria counts after rain events (*middle*). Volunteers collect hundreds of pounds of debris per mile every year at coastal cleanups (*bottom*).

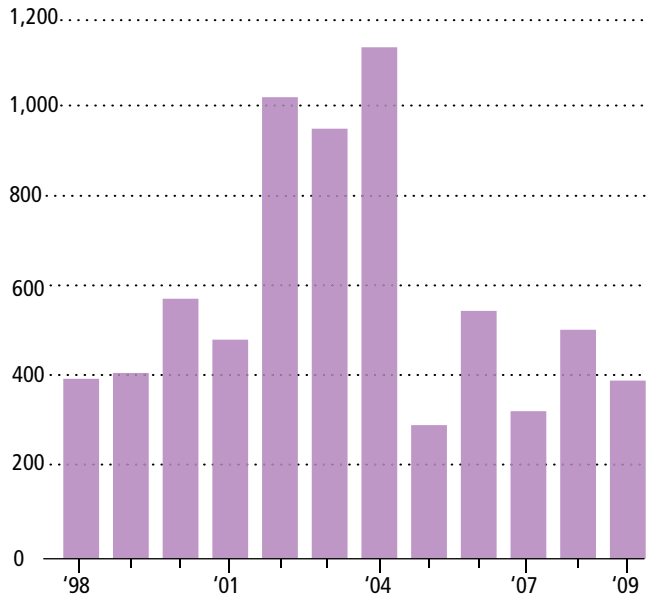
Beach Closure Days
(There are 193 monitored beaches along Long Island Sound's shoreline)

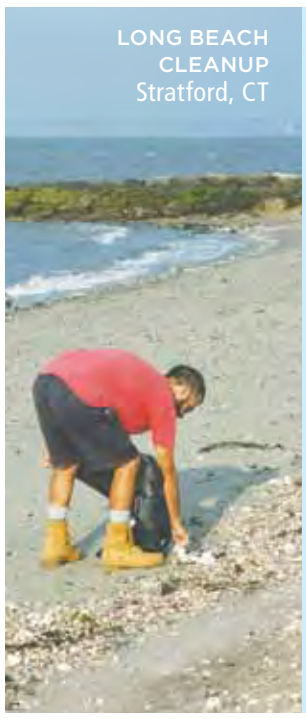


Approved Shellfish Acreage, CT
(Acres)



Beach Debris Collected
(Pounds of debris collected per mile of beach)





Coastal Debris

TRASH FLOATING IN COASTAL WATERS and bays or washed up on the beach is called floatable debris. Floatable debris reduces the enjoyment of the Sound, can be a nuisance or hazard for boaters, and can harm wildlife.

People who litter and improperly dispose of their waste are the ultimate sources of floatable debris. Litter anywhere in the Sound's drainage basin can ultimately enter the Sound, including through dumping by shoreline visitors and boaters, and when debris gets washed into storm drains and enters the Sound through its tributaries.

The New York City Department of Environmental Protection has booms or floating barriers installed at 24 locations, including nine sites that discharge into the East River and the Sound, to capture floatable debris discharged from combined sewers. In 2009, the program collected 1,600 cubic yards of debris, including 939 cubic yards from Long Island Sound sites. It also deploys a large vessel, the *Cormorant*, to capture and collect debris in open waters around New York City.

As part of the annual International Coastal Cleanup, the American Littoral Society and Save the Sound organize volunteer cleanups of area beaches. During Coastal Cleanup weekend in September 2009, volunteer crews along 140 miles of Long Island Sound beaches collected more than 55,000 pounds of debris, an average of 396 pounds of garbage per mile.

CREDITS: *Jordan Cove shellfish area closed sign,* photo by Kara Bonsack/UConn; *Beach cleanup,* photos by Save The Sound.
SOURCES: *Beach Closures* chart, CT DEP, NYSDEC, and EPA; *Approved Shellfish Beds* chart, CT Dept. of Agriculture's Aquaculture Division; and *Beach Debris Collected* chart, Save the Sound and American Littoral Society northeast chapter.

{OIL SPILLS}

SOUND POINTS

- Medium and large oil spills are rare occurrences in the Sound, but multiple contributions of small spills can pose a threat to aquatic life.
- Sources of oil spills include leaks from filling stations, boat and car engines, and illegal dumping.
- Oil that does not evaporate can break down into chemical compounds and deposit onto the seafloor. They can persist in the environment for decades.

Find links on how to report local oil spills and read the summer 2010 *Sound Update* issue on oil contamination at *www.LIShealth.net.*

Medium or large oil and gasoline spills, as defined by the Clean Water Act, are rare occurrences in Long Island Sound. Oil spills on the scale of the Gulf of Mexico disaster have never occurred here. But spills do happen, and the chemical components of oil and gasoline that dissolve in the water column or sink to the bottom and linger can become a long-term threat to marine life.

What are the sources of oil spills into the Sound?

Oil tanker accidents (near and offshore), oil transfers from barges to warehouse facilities, poorly maintained boat engines, and illegal dumping are all sources. On land, leaks from filling stations, building heating equipment and motor vehicle engines can enter storm drains and tributaries and end up in the Sound. Also, atmospheric deposits of oil and gasoline compounds from automobile and factory emissions can enter surface waters in the Sound.

How much oil or gas is spilled into the Sound each year?

It is difficult to accurately estimate how much oil from land and air ends up in the Sound. There are multiple indirect contributions from small incidents such as vehicle accidents. It is also difficult to determine the amount of oil in "mystery sheens" that are from unidentified sources such as illegal dumping. We know that from January 2006 to June 2010, the U.S. Coast Guard Long Island Sound sector responded to 791 petroleum spills in the Sound. The Coast Guard estimates that nearly 85,000 gallons of petroleum spilled from these incidents.

When was the last medium- or large-sized oil or gas spill?

The last medium-sized oil or gas spill in the Sound was in January 2006 when a barge spilled 49,000 gallons of gasoline in New Haven, while transferring oil to a terminal. In 1996, a major spill occurred in nearby Block Island Sound when a barge ran aground and spilled 829,000 gallons of home heating oil.

THE CRUMPLED SADDLE TANK from a tractor trailer rests in shallow water on the bank of the Mystic River in Groton in June 2010. The truck had struck a guard rail on the I-95 Mystic River Bridge, rupturing the saddle tank, which then fell into the river. Old Mystic firefighters deployed an oil containment boom across the river to contain the oil before it was collected.

What happens to the oil when it reaches the Sound?

Depending on weather conditions, some of the oil will evaporate into the atmosphere and some will remain dissolved in the water and enter the food chain. There it will be taken up by fish or broken down by bacteria. The rest will deposit onto the seafloor where it will be buried or broken down further. The proportions will vary with time of year, location, and sediment type.

A DUCKLING is fed with an eyedropper at the Greenburgh Nature Center after being contaminated by oil on the Bronx River in early June 2010. A building in White Plains had leaked 200 gallons of heating oil, which got into a storm drain that discharged into the river.

Is there a potential for offshore drilling in the Sound?

Drilling is unlikely, according to Ralph Lewis, the former state Geologist for Connecticut. Lewis said that the hard metamorphic rocks underneath most of Long Island Sound would be an extremely poor source of petroleum.

Do the oil/petroleum chemicals pose a threat to marine life?

The hydrocarbons tend to persist in the environment. Half lives of individual components can span from hours to decades. Once these chemicals are released, they can be consumed by small marine life and move up the food chain. Short-term and long-term exposure can have severe health related risks including suppression to the immune system, organ damage, carcinogenicity, and birth defects that can lead to a decline in population levels.

Who's responsible for responding to oil spills?

Various agencies from the federal, state, and local government respond to oil spills. The U.S. Coast Guard is the federal on-scene coordinator for oil spills that occur in the Sound and in the lower parts of rivers navigable by large boats. Further upstream, the EPA is the on-scene coordinator.

What is being done to prevent oil spills?

The number of commercial spills is decreasing due to Coast Guard efforts to deter illegal dumping through chemical "fingerprinting" to identify sources of spills. The Oil Pollution Act of 1990, which was passed following the Exxon Valdez spill in Prince William Sound, Alaska, requires safer, double-hulled vessels on boats transferring oil and other toxic substances. Boats in New York and Connecticut waters transferring toxic chemicals are also required to have booms that can be deployed immediately after an accident. Improved engines for recreational vessels are also helping to reduce leaks.

What can you do?

Recycle used oil. Maintain automobile and boat engines. If you see an oil spill on land or in the Sound contact the CTDEP Oil and Chemical Spill Response Division at 860-424-3338 or the NYSDEC spill hotline at 800-457-7352.

Penny Vlahos, a chemistry professor at UConn's Department of Marine Sciences in Groton, contributed to this section.

CREDITS: *Duckling,* photo courtesy of Greenburgh Nature Center; *Truck in river,* photo by Sean D. Elliot/The Day.

{CLIMATE CHANGE}

SOUND POINTS

- Scientists and resource managers are seeing changes in species populations as a result of warming temperatures.
- Municipalities and state and federal agencies are using climate change projections to map out what future conditions might look like on the coast as a result of climate change.

Find links on climate change adaptation efforts by New York, Connecticut and ICLEI and an article about the "Great New England Hurricane of 1938," also called the "Long Island Express," at *www.LIShealth.net.*

The United Nations' Intergovernmental Panel on Climate Change projects that heat trapped by increased greenhouse gas emissions will increase temperatures by 3.2 to 7°F by 2100, and sea levels will rise between seven and 21 inches. Some scientists expect even greater sea level rise by 2100 as a result of rapid ice melt in the Greenland and West Antarctic ice sheets.

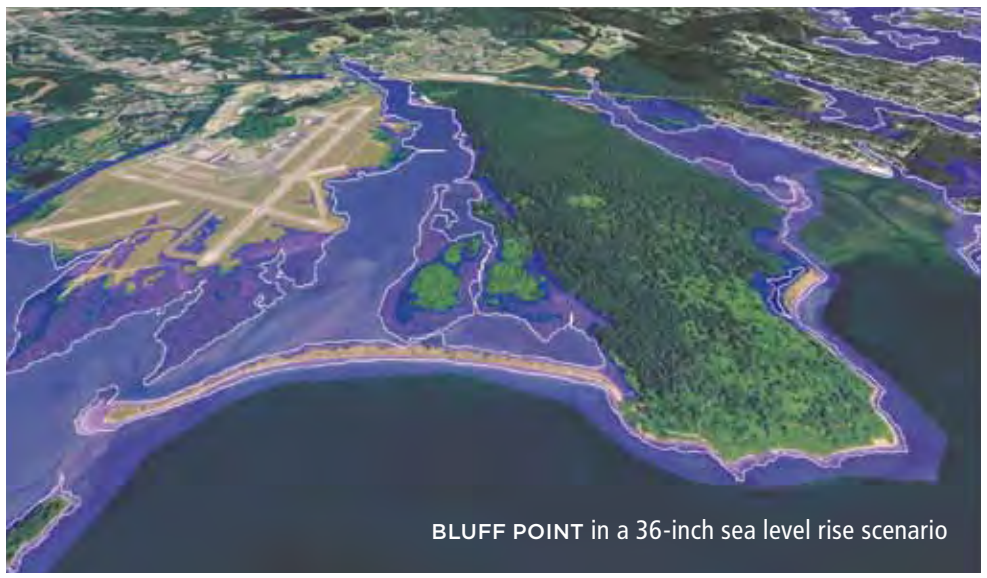
In the U.S., the Union of Concerned Scientists' Northeast Climate Impact Assessment (NECIA) projects that over the next several decades, air temperatures across the Northeast will rise 2.5 to 4°F in winter and 1.5 to 3.5°F in summer regardless of the emissions choices we make now.

The NECIA and a report from the New York City Panel on Climate Change also document climate-related changes occurring in the region since 1970, including more frequent days with temperatures above 90°F, more heavy rain events (defined as two inches or more per event), and an earlier spring snowmelt, which is causing changes to stream flows.

In Niantic Bay, in the eastern basin of the Sound, the year-round average surface water temperature has increased by about 1°C (1.8°F) since 1976, according to data collected by Millstone Environmental Laboratory. Resource managers also are finding that higher temperatures may be affecting the abundance of some finfish species and lobsters (*see pages 10 and 11*).

Both current warming trends and climate change projections prompted LISS in 2010 to fund a CT DEP partnership with ICLEI-Local Governments for Sustainability, a world-wide organization of municipalities, to assess potential impacts of climate change to the Town of Groton's coastline and infrastructure. The partnership worked with the town (as a model community) to begin planning to cost-effectively adapt to climate change. At workshops held in Groton in 2010, the New England Environmental Finance Center (NEEFC) showed what "economic flood plain" maps for residential and commercial districts would look like if the Connecticut coastline faced a sea level rise of one meter combined with a 10-year flood. In historic downtown Mystic, the economic flood plain map showed estimated losses of nearly $9 million if the town took no preventive action. But the NEEFC showed workshop participants how economic impacts could be reduced if adaptation strategies such as hurricane barriers, road elevation, wetland restoration, and building dikes were constructed in the most vulnerable areas.

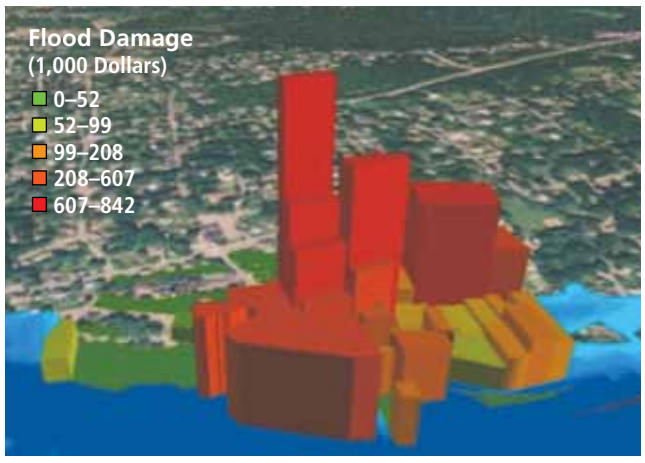
New York and Connecticut are using climate change projections to assess potential impacts to coastal areas, including state-owned parks and wildlife management areas. For example, at Bluff Point, an 806-acre park and coastal reserve in Groton, road and parking facilities are projected to be submerged under a 36-inch sea level rise scenario. Existing dunes and tidal wetlands—valuable coastal habitats that contain rare plants and animals—could also be underwater. Sea level rise projection maps help resource managers assess opportunities for coastal resources such as dunes and wetlands to migrate to upland areas. These assessments can also determine whether short-term capital improvements can protect coastal resources. ✻



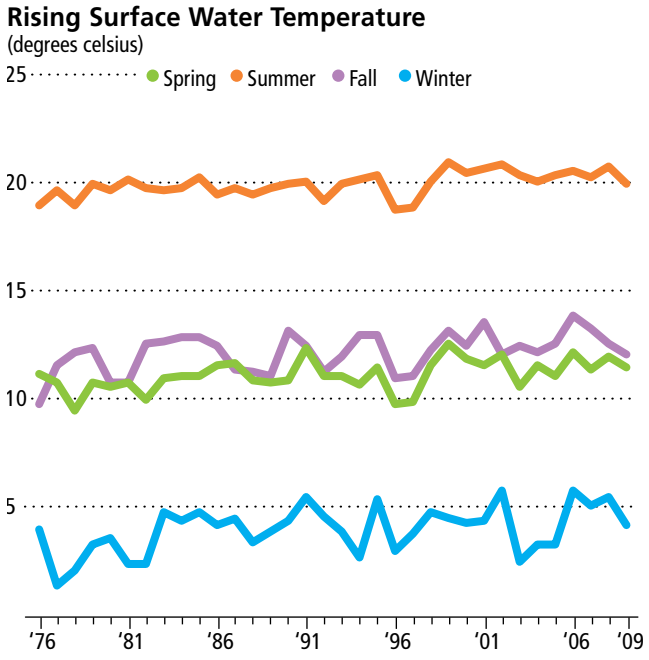
BLUFF POINT in a 36-inch sea level rise scenario

GROTON FLOODING, River Road collapse

THE PURPLE AND BLUE areas inside the white lines are coastal habitats and roads at Bluff Point that would be under water in a 36-inch sea level rise scenario (*top*); erosion from increased stream flows underneath River Road in Groton following a Nor'easter in March 2010 caused the street to collapse (*middle*); and surface water temperatures in Niantic Bay have increased since 1976 (*below*).



THE MAP SHOWS the range of losses for parcels in downtown Mystic if no adaptation actions are taken and there is a 10-year flood event occurring with 1 meter of sea level rise.



CREDITS: *Bluff Point Sea Level Rise scenario,* map by Kevin O'Brien/CT DEP; *Groton Flooding at River Road,* photo courtesy of Town of Groton Planning and Development Department; *Flood Damage in Downtown Mystic projection* map, courtesy of New England Environmental Finance Center.
SOURCES: *Surface Water Temperature* chart, Millstone Environmental Laboratory.

{CONDITIONS BY BASIN}

COASTAL CONDITION REPORT

The information used for Conditions by Basin was collected by CT DEP and Stony Brook University for the EPA's National Estuary Program Coastal Condition Report, and includes updated data from CT DEP. The EPA uses monitoring data from 28 National Estuary Programs such as the Long Island Sound Study to track conditions across coastal regions around the country.

Estuaries are transition zones between the fresh water from rivers and the saline conditions of the oceans. The nation's estuaries are a subset of U.S. coastal waters and encompass a wide variety of coastal habitats, including wetlands, salt marshes, coral reefs, mangroves and kelp forests, seagrass meadows, tidal mudflats, and upwelling areas. These habitats produce unique environments that support wildlife and fisheries and contribute substantially to the U.S. economy.

Describing the condition of a body of water 110 miles long poses a challenge. Hydrology (the movement of water) and sediment characteristics vary within each of the Sound's three basins, as does the degree of shoreline development. Water quality in any location varies by season. And in some locations, historical contaminant discharges still affect present-day conditions. In other words, the Sound can be described as healthy and vibrant, or distressed and impaired, depending on location, season, and issue.

To help understand varying conditions in coastal waters, the EPA's Office of Research and Development has developed an approach to characterize water quality and the toxicity of sediments on the seafloor. Using an index of different indicators for each of these measures, the Sound's western, central, and eastern basins can be rated as good, fair, or poor.

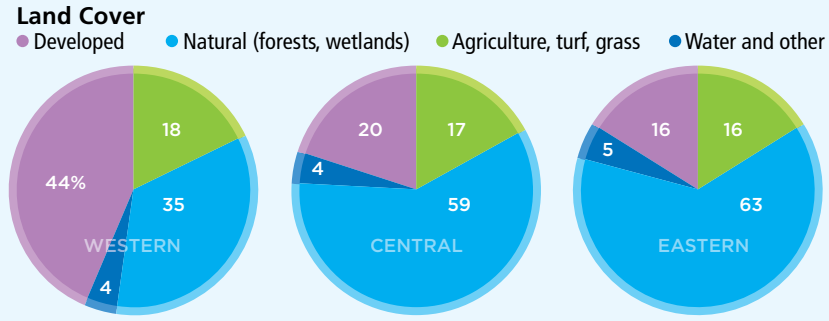
The Western Basin is the Most Stressed

The densely populated and developed western basin, which includes "the Narrows," a narrow section connecting with the East River, is the most stressed, with fair water quality the majority of the time, and with sediment conditions rated as poor for half of the basin area. Water quality improves moving eastward. The central basin has good water quality conditions more than 50 percent of the time, and the eastern basin has good conditions more than 80 percent of the time. Sediment conditions also improve in the central and eastern basins. The gradient in conditions from west to east reflects the decrease in development and human population density between basins. In the lands comprising the western Long Island Sound watershed, 44 percent of the area is developed compared to nearly 20 percent in the central watershed and 16 percent in the eastern watershed. An increase in development indicates the potential for more pollutants to be flushed from hard surfaces such as roads and parking lots into storms drains that connect to tributaries and the Sound. The higher population also contributes more sewage to wastewater treatment plants and septic systems, and more vehicle emissions that deposit air pollution into the Sound.

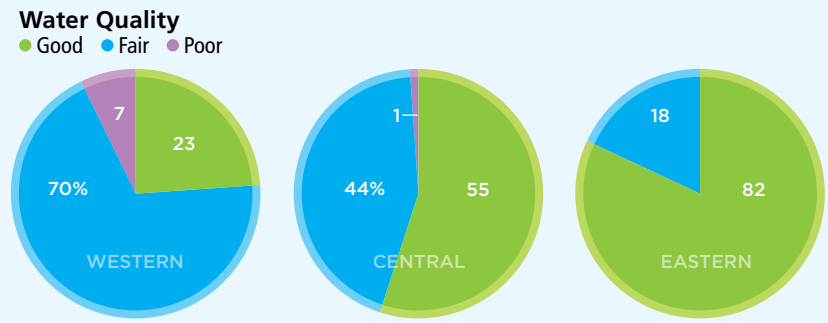
The gradient in improving conditions also reflects geological differences. For example, the eastern basin, carved out from a melted glacier, is deep, dipping to 350 feet at the Race. The narrow channel opening to Block Island Sound acts as a funnel, leading to fast moving currents that scour the bottom 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. The weak currents in the western Sound also make for conditions that are less likely to flush out toxic contaminants that settle in the fine sand. ✻

Summary of Rating Criteria:

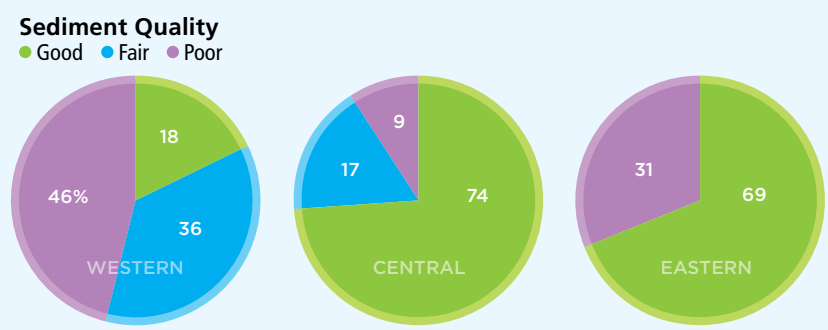
LAND COVER: Research from around the country shows that water quality tends to decline with increasing impervious coverage (the amount of hard surfaces such as parking lots and streets) within a watershed. Impacts to stream quality are pervasive once imperviousness exceeds 10 percent and are severe when it exceeds 25 percent. Development is a good indicator of impervious coverage. These charts of land cover area by basin show that the level of development decreases from the western basin to the eastern basin, while forest cover and wetlands increase.



WATER QUALITY INDEX: Excess nutrients, such as nitrogen, can lead to too much plant production (indicated by abundance of chlorophyll a, a plant pigment), which can decrease water clarity and lower concentrations of dissolved oxygen. The index includes five indicators—dissolved inorganic nitrogen, dissolved inorganic phosphorus, chlorophyll a, water clarity, and dissolved oxygen. Monthly data (from May to October, when pollution has the greatest effect on water quality) were summarized from 1991 to 2009.



SEDIMENT QUALITY INDEX: A wide variety of metals and organic substances, such as polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and pesticides are discharged into estuaries from urban, agricultural, and industrial sources from the Sound's watershed. These contaminants adsorb onto suspended particles and eventually accumulate in the sediments where they can disrupt the benthic community. The index is based on three sediment quality component indicators—sediment toxicity (measured as the survival rate of marine amphipods), concentration of contaminants, and the total organic carbon concentration. Data were collected from 2000 to 2004.



CREDITS: *Land Cover, Water Quality* and *Sediment Quality* charts, by Lucy Reading-Ikkanda.
SOURCES: *Watershed Indicator,* UCONN Center for Land Use Education and Research; *Conditions by Basins Indices,* EPA's Office of Research and Development/Office of Water

The area's dense population and development, which includes parts of New York City and surrounding suburbs, is a source of pollution in the **WESTERN WATERSHED,** and contributes to hypoxia and poor sediment quality in the western Sound (basin).

The **CENTRAL WATERSHED** is a transition zone between the levels of development in the western and eastern watersheds.

There is more undeveloped land in the **EASTERN WATERSHED** to act as a buffer to trap pollutants before they can be carried by streams into the eastern Sound (basin).

With its weaker currents and finer sediments, the **WESTERN BASIN** is more likely to trap pollutants.

The **CENTRAL BASIN** widens to 21 miles and has a simpler shoreline on Long Island than the western basin. Fine sediments begin to be deposited here.

The narrow channel and deep-bottom at the **EASTERN BASIN** and the Race lead to fast moving currents that help to flush out pollutants.

Hartford
Eastern watershed
Central watershed
Housatonic River
Connecticut River
Thames River
Mystic
Stonington
New London
Groton
Old Lyme
New Haven
Branford
Madison
Westbrook
West Haven
Western watershed
Milford
Bridgeport
Westchester
Eastern basin
The Race
Central basin
Westport
Darien
Stamford
Greenwich
Port Chester
Rye
Western basin
The Narrows
Larchmont
New Rochelle
Glen Cove
Cove Neck
Oyster Bay
Cold Spring Harbor
Port Jefferson
Shoreham
Northville
Riverhead
Stony Brook
Greenport
Southold
Mattituck
Suffolk
Bronx
Manhattan
Nassau
Queens
Kings
N
0 miles 5 10 15

Frequency of Hypoxia in Bottom Waters
(Percent of hypoxic* years, 1991– 2010)

- 0–10%
- 10–20
- 20–30
- 30–40
- 40–50
- 50–60
- 60–70
- 70–80
- 80–90
- 90–100

*concentration of 3mg/L or less

Smithtown Bay

HYPOXIC CONDITIONS: Waters in the Narrows and Smithtown Bay in the Western basin regularly turn hypoxic in the summer.

CREDITS: *Map,* by Mapping Specialists and Lucy Reading-Ikkanda; *Area and Duration of hypoxia chart,* by Lucy Reading-Ikkanda
SOURCES: *Area and Duration of Hypoxia* chart, LIS Water Quality Monitoring Program/CT DEP.

{INVERTEBRATES}

Marine invertebrates are animals without a backbone or spinal column. Some have developed hard or soft shells and exoskeletons to protect themselves. While they are an important part of the estuarine environment, some of these invertebrates, such as oysters, lobsters, and clams, also support commercial fisheries and are a culinary delight for many.

Oysters grown in the Sound are highly valued for their flavor, resulting in a high market price. Harvests were decimated in the late 1990s from high mortality rates caused by MSX, a parasitic disease. MSX, which is not harmful to humans, has since subsided. In Connecticut, efforts to rebuild stocks, including by lining shellfish beds in tributaries and coastal waters with clean shell for oysters to attach to during their spawning period, helped the oyster harvest grow to a $7.4 million business Sound-wide in 2007 from a low of $2.8 million in 2005. In 2008 and 2009, Connecticut oystermen did not report their harvests to the state because of a dispute over a possible tax on their harvests, but state resource managers believe the numbers are continuing to rise. New York also had seen increases in harvests until 2009 when many oystermen chose to go to other areas in Long Island, including the Peconics and the South Shore. In New York, unlike Connecticut, the majority of oystermen and clammers do not lease their shellfish beds, so they go where they will find the most supply.

Lobster populations have also declined dramatically, but, unlike oysters, have not shown signs of recovery. Scientists found evidence that lobsters, at an all-time high abundance in the late 1990s, with a peak harvest value of almost $40 million in 1997, suffered a die-off in 1999 when subjected to sustained, stressful environmental conditions. Known stressors include water temperatures exceeding 20.5°C, which can cause lobsters to hyperventilate. Weakened by these conditions, lobsters became susceptible to disease—including infection by parasitic amoebae—and experienced a massive die-off. In an effort to restore the population, the states have toughened limits on harvesting. To date there has been no sign of increased populations.

By 2007, the hard clam harvest had more than tripled in the past decade, in part because some lobstermen had turned to clamming as lobster harvests declined. As with oysters, there are no data on Connecticut clam harvests since 2007. New York saw a slight decrease in 2009 from the previous year, as clammers went to other areas on Long Island to harvest.

A single oyster or clam can filter up to 50 gallons of water a day, while straining food particles such as phytoplankton from the water column. In the process, they help to improve water quality by removing pollutants, including excess nitrogen. ✻

SOUND POINTS

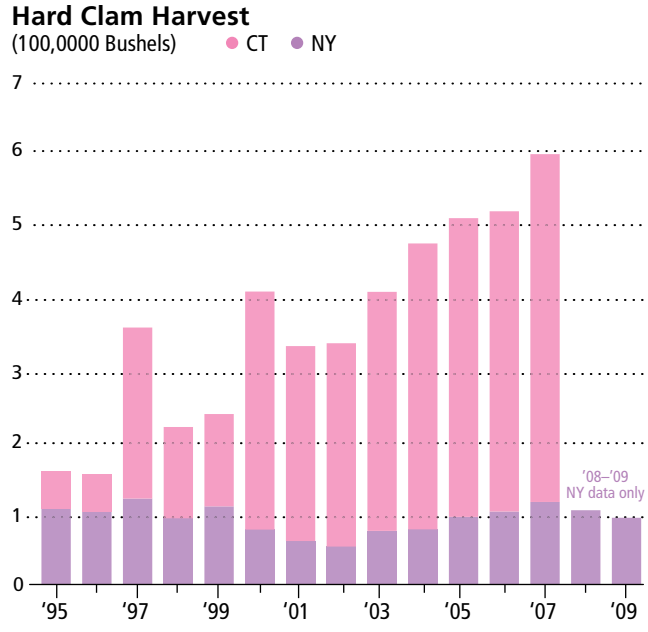
- ✻ Oyster harvests have increased as the impact of a parasitic disease in recent years has subsided.
- ✻ Lobster harvests have declined since a die-off in the late 1990s.
- ✻ Shellfish improve water quality by filtering particles from water.

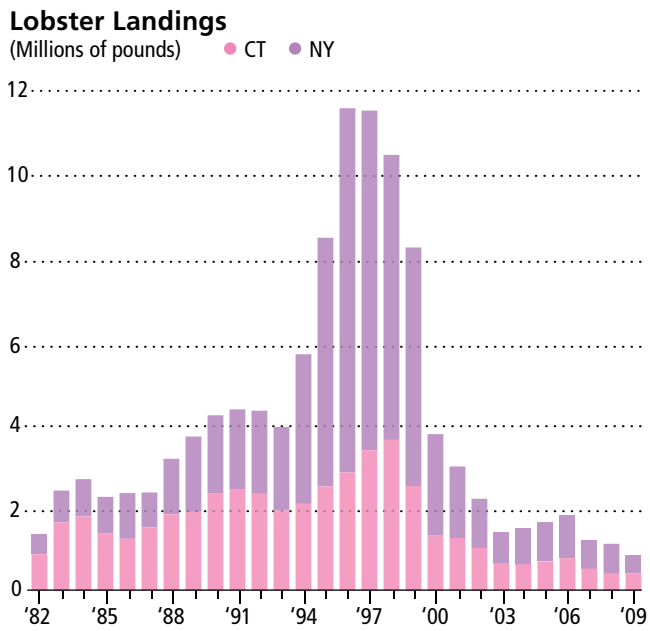
Long-finned Squid

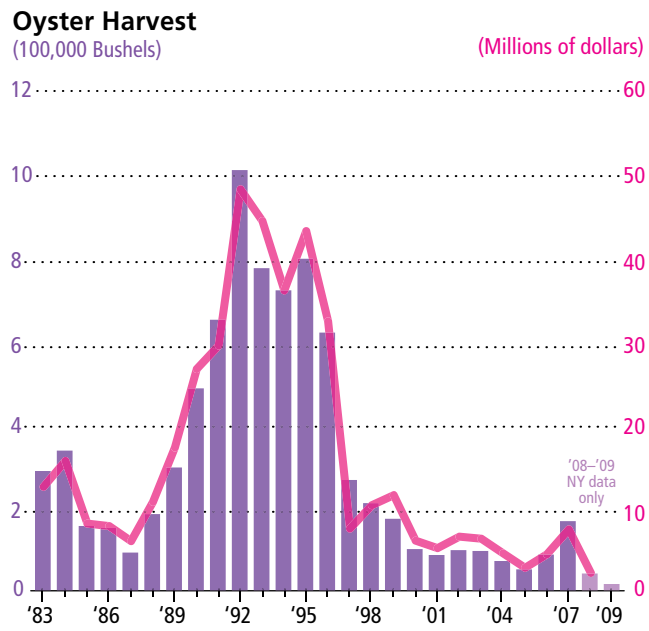
MOST PEOPLE are unaware that long-finned squid, *Loligo pealei,* are very common in the Sound. In fact, they happen to be one of the most abundant invertebrate species caught, by weight, in the Long Island Sound Trawl Survey. Squid were among the three most abundant species caught in the Survey for 16 of the last 18 years. They comprise a major component of the Sound's forage base for popular sport fish caught by anglers such as striped bass and bluefish. There is also a limited commercial harvest in the Sound of less than 35,000 pounds a year. While the squid's range extends from Newfoundland to the Gulf of Venezuela, the Sound is a very important nursery area where the species can flourish. To read about the long-finned squids unique life history, and learn more about the Survey, visit *www.LIShealth.net.*

LONG-FINNED SQUID

TOP (CLOCKWISE): Hard clam harvests have increased since 1995, but declined slightly in New York in 2009 (CT data not available in 2008 and 2009); the oyster harvest is showing signs of recovery after being decimated by a parasitic disease in the 1990s; and lobster landings continue to decline.







CREDITS: *Squid,* photo by Kurt Gottschall.
SOURCES: *Oyster and Clam harvest* charts, CT Dept. of Agriculture's Aquaculture Division and NYSDEC; *Lobster Landings* chart, Atlantic States Marine Fisheries Commission (American Lobster databsase), CT DEP and NYSDEC.

{FINFISH}

PORGIES in eelgrass on north shore of Plum Island

Pound for pound, the amount of fish in Long Island Sound has been about the same since 1992, according to the CT DEP's Long Island Sound Trawl Survey (LISTS). The Sound-wide biomass index, the annual average weight of all of the finfish species collected in the survey (about 50 to 70 different species per year), shows no significant trend up or down. This stability indicates that while the abundance of individual species may have increased or decreased in the Sound, the estuary has maintained its ability to support the same overall abundance. A stable abundance over the long term is one sign of a healthy ecosystem.

In recent years an increased abundance of scup (porgies) has made it one of the highest contributors to the biomass index. The record high index for overall biomass in 2002 (*see below*) was largely due to very high abundance of scup. There are several competing reasons why some species are enjoying record high numbers while others are declining. The species that are harvested by commercial and sport fisheries, such as scup, are subject to extensive coast-wide management designed to protect these stocks from depletion. Managed species such as scup, summer flounder, and striped bass have flourished coast-wide under their individual interstate management plans while supporting strong commercial and sport fisheries. According to the CT DEP angler survey, these fish are among the most popular caught by Connecticut anglers, who took nearly 2 million fishing trips in 2008. However, these species also may be increasing because they are tolerant of steady increases in water temperature, while others may be declining because either they cannot tolerate warmer waters or warmwater predators are depleting their numbers. For example, the abundance of winter flounder, once an important recreationally and commercially fished species, has dropped dramatically, possibly because the species is now exposed to increasing numbers of mid-Atlantic finfish predators, as well as cormorants and seals. However, warm-tolerant species such as tautog and weakfish have also dropped in abundance, indicating that there are many other variables playing a role in fashioning the mix of species found in the Sound. Since 1984 when the trawl survey began, a total of 105 finfish species and 60 invertebrate species have been recorded in the catch. Although one or two finfish species can be large contributors to a year's biomass index (for example scup made up 34 percent of the index in 2009), an average of 14 finfish species are taken in each tow in spring and 17 in the fall. This diversity is relatively high and again is a measure of the health and vitality of the Sound's marine communities. ✻

SOUND POINTS

- ✻ Species composition varies year to year, but the amount of finfish remains stable.
- ✻ Warmer temperatures in the Sound have benefited some species and hurt others.
- ✻ The Long Island Sound Trawl Survey (LISTS), run by CT DEP, has been surveying the abundance of finfish (and invertebrates) since 1984.

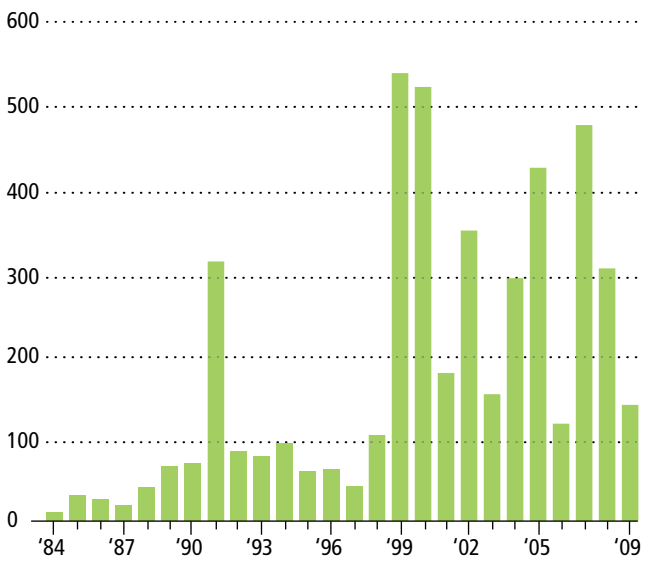
Find links to the LISTS annual report and a slide show of the Trawl Survey at *www.LIShealth.net.*

LIS Fish Consumption Advisories

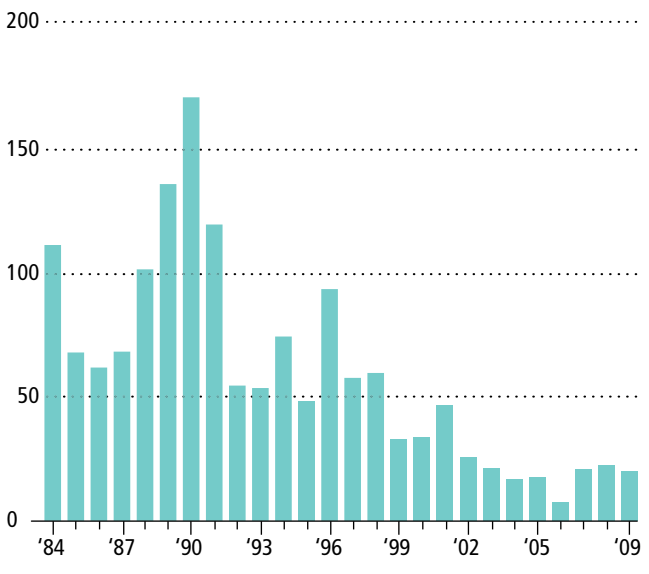
FISH CAUGHT FROM THE SOUND are a nutritious and flavorful food source, but Connecticut and New York Health Department consumption advisories should be followed, particularly by groups with the greatest risk from contaminants—women of child-bearing age and young children. Check *www.LIShealth.net* for a 2010 chart highlighting consumption advisory information from both states, and for links to the full advisories.

LEFT TO RIGHT: Scup (porgies) vary annually, but the average abundance from 1999–2009 is significantly higher than 1989–1999. Winter flounder populations are declining, perhaps because of warmer temperatures; and fish biomass is stable.

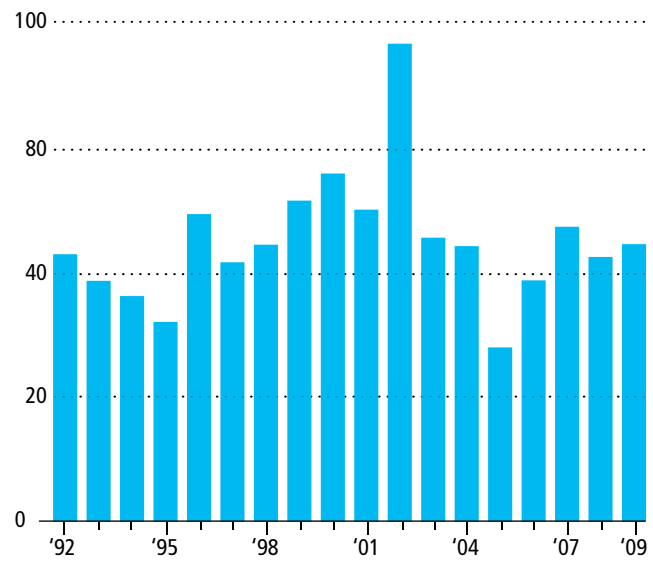
Scup Abundance
(Count per tow)



Winter Flounder Abundance
(Count per tow)



Fish Biomass Index
(Biomass geometric mean, kg per tow)



CREDITS: *Porgies in eelgrass on north shore of Plum Island* and *Winter Flounder on southwest side of Fishers Island,* photos courtesy of Cornell Cooperative Extension Marine Program (*seagrassli.org*).
SOURCES: *Scup Abundance, Winter Flounder Abundance* and *Fish Biomass* charts, CT DEP Marine Fisheries Division.

{COASTAL BIRDS}

SOUND POINTS

- More than 400 species of birds, including threatened and endangered species such as the piping plover and least tern, live along the Sound's shoreline.
- Bird populations are dependent on healthy coastal habitats.

Find links to information about birds of Long Island Sound, at *www.LIShealth.net.*

More than 400 species of birds inhabit the Sound's shoreline, with the numbers and types varying with the seasons. Spring, for example, brings the annual migration of a wide variety of plovers, terns, sandpipers, waterfowl, herons, egrets, and songbirds. But loss of coastal lands to development (*see p. 14*) has affected the ability of several species to find habitat away from human disturbance and predators. Monitoring bird populations can provide insight on the status of suitable habitat for coastal wildlife, as well as the success of specific bird conservation efforts.

Piping plovers, small shorebirds that nest on beaches, are listed as a threatened species in Connecticut and endangered in New York. 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. State wildlife officials credit intensive on-site management, including construction of predator-proof fences around nests to protect eggs for this improvement. Regulation of activities that impact beach habitats, public education campaigns, and the public's cooperation have also helped protect plover populations.

Least terns, a threatened species in New York and Connecticut, live in large colonies on the beach and plunge into nearby waters for food. Predators, human disturbances, and tidal flooding can disrupt tern nesting sites, but the terns have the potential to recolonize in other beaches within a four-state region that also includes Rhode Island and Massachusetts. In 2009, there were 6,549 least tern pairs in the region, 294 pairs above the 20-year average. During that period, the population has declined in Connecticut, but has remained stable in New York.

Colonial waterbirds, particularly long-legged wading birds, such as snowy egrets, great egrets, and black-crowned night-herons, nest primarily in groups on islands along the Atlantic coast. They typically nest within shrub and woodland habitats, and often feed on estuarine fish and invertebrates in nearby salt marshes. Although the populations have been relatively steady since 1998, there has been a relative decline in snowy egrets and night-herons since the 1970s, which may be due to predation by animals associated with humans, including rats and feral cats; additionally, a loss of nesting habitat, including that from human disturbance, a loss of wetlands important for feeding, and exposure to contaminants may have contributed to the decline. ✻

JUVENILE PIPING PLOVER

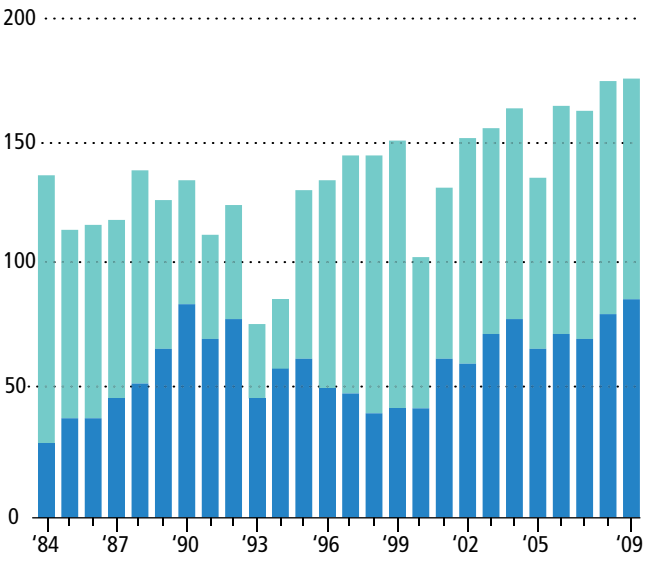
GLAUCOUS GULL, a bird rarely seen around Long Island Sound, on a snowy day at Long Beach in Stratford, CT.

Christmas Bird Count

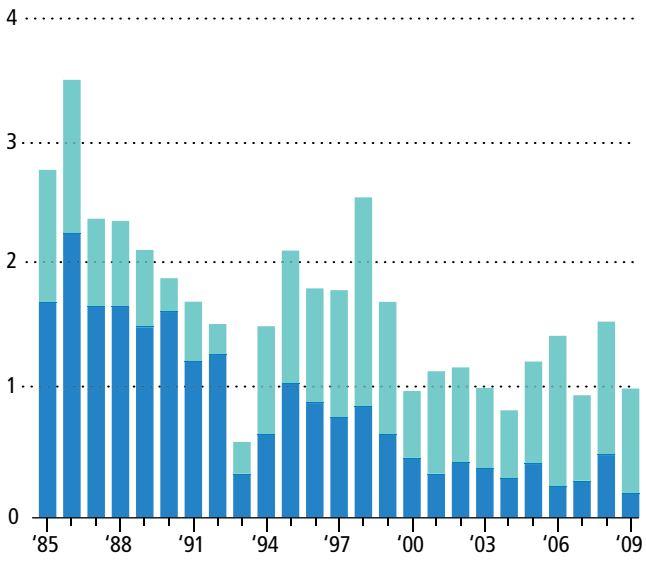
THE NATIONAL AUDUBON SOCIETY'S Christmas Bird Count (CBC) began on Christmas day in 1900 and enters its 111th year this winter. The CBC, which involves thousands of volunteers counting bird populations in hundreds of sites from mid-December to early January, is the nation's oldest and largest citizen science project. In 2009 Audubon released its birds and climate change report, which used the volunteer data to help document changes in populations and distributions of birds in relation to climate change. One of the findings was that nearly 60 percent of species that winter in North America have moved northward or inland in the 40 year period leading up to 2009, with climate playing a likely role in range shifts that can exceed hundreds of miles. Check *www.LIShealth.net* for examples of winter birds in New York and Connecticut that have been impacted by warmer temperatures.

LEFT TO RIGHT: Shorebird management programs have contributed to an increase in piping plovers, but least tern populations are still struggling; the colonial waterbird population declined in a 2007 survey, perhaps due to habitat destruction.

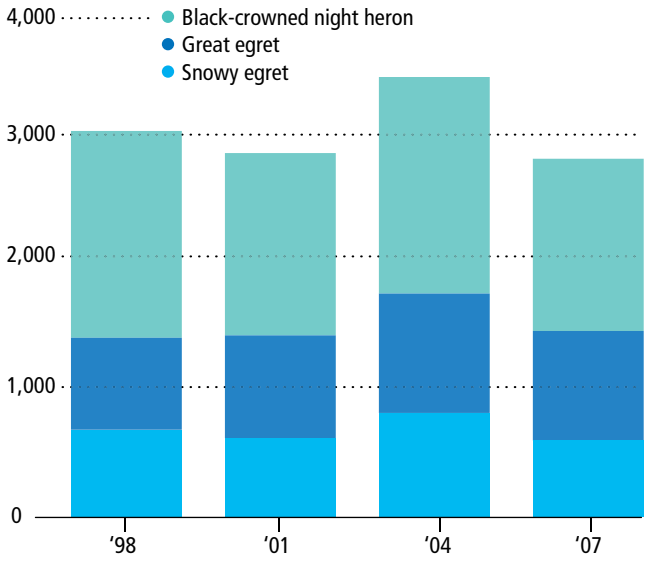
Piping Plover Count
(Nesting pairs)



Least Tern Count
(1,000 Nesting pairs)



Colonial Waterbird Count
(Nesting pairs in CT & NY, inc. Long Island & NYC)



CREDITS: *Juvenile Piping Plover,* photo by George DeCamp; *Glaucous Gull,* photo by Patirck M. Comins/Audubon CT.
SOURCES: *Colonial Waterbirds* chart, U.S. Fish and Wildlife Service SNE/NYB Coastal Ecosystems Program, NYSDEC, and CT DEP; *Piping Plover and Least Tern* charts, NYSDEC and CT DEP.

{HABITATS}

TIDAL WETLAND GRASS at Frost Creek is slumping along the creek's edges, an early sign of a grassy area converting to mudflats.

Long Island Sound is an estuary, where the ebb and flow of oceanic saltwater meets and mixes with freshwater from rivers and streams. A dozen distinct habitats help this unique environment of brackish waters and tidal extremes to function (*see sidebar*). Two habitats, tidal wetlands and eelgrass meadows, are particularly important because of the ecosystem benefits they provide.

Tidal wetlands are among the most productive ecosystems in the world, providing food, shelter, and breeding or nursery grounds for many species of wildlife. The salt marsh vegetation in these wetlands also protects the land from flooding and erosion in stormy weather, and filters pollutants contained in stormwater runoff.

In the past, the value of wetlands was not recognized. They were viewed largely as breeding grounds for mosquitoes and, as a result, as places to fill, dredge, and build. About 25 to 35 percent of the Sound's tidal wetlands were lost before federal and state legislation regulated the practice in the early 1970s. Despite protection and restoration efforts, marsh grasses are still disappearing, with hundreds of acres converting to mudflats in the past 35 years. For example, mudflats at Frost Creek in Oyster Bay increased from five to 44 acres, while marsh grasses declined from 69 to 45 acres. A survey of four wetland sites in Long Island, including Frost Creek, revealed that salt marsh grasses declined from 434 to 346 acres from 1974 to 2005. In Connecticut, a survey of six wetland complexes in southwestern Connecticut revealed that salt marsh grasses declined from 230 acres to 177 acres from 1974 to 2004.

The reasons for this marsh loss are not yet understood. Possible contributing factors include sea level rise flooding the marsh, insufficient sediment supplies to the marsh from upstream sources to balance moderate sea level rise, erosion of sediments caused by the force of wave action from boat wakes, and the indirect effect of local dredging.

Eelgrass is a rooted underwater grass along the coast that provides food and nesting grounds for fish and helps to prevent beach erosion. It is now found only in the eastern basin. Its abundance plummeted in the 1930s due to a fungal disease, and continued to decline for decades as a result of poor water quality attributed to the effects of nitrogen pollution from sewage discharges and stormwater runoff.

A LISS-funded 2009 survey conducted by FWS identified 1,980 acres of eelgrass, all in the eastern Sound, compared to 1,559 acres surveyed in 2002. Improved monitoring techniques that may have identified acreage unaccounted for in the earlier survey may be partially responsible for the increase in acres observed. Continued monitoring will be required to determine long-term trends. ✻

SOUND POINTS

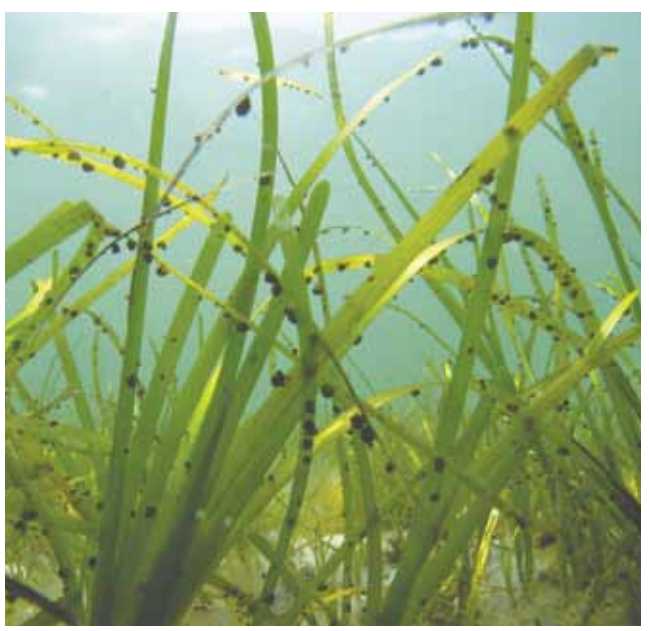
✻ Tidal wetlands are a critically important habitat along the shoreline. Until the 1970s, the value of wetlands was not widely recognized.

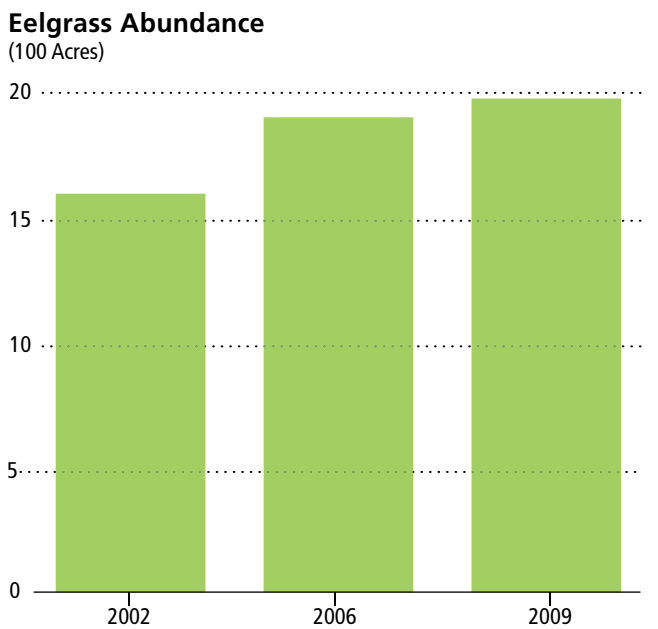
✻ Despite efforts to protect them, some wetlands are losing vegetation and converting to mudflats.

✻ Eelgrass is an important underwater plant for fish and other wildlife.

Find a link to Long Island's Seagrass Conservation Web site, and information about the Sound's different habitats at *www.LIShealth.net.*

THE SNAIL *Lacuna vincta* on blades of eelgrass off Fishers Island.





Critical Habitats

The coast contains 12 habitats identified by LISS's Habitat Restoration Initiative as vital to the animals and plants that live in the estuarine environment.

BEACHES AND DUNES: Transitional sandy or cobble shoreline area between the land and the Sound.

CLIFFS AND BLUFFS: Steep coastal slopes of glacial sands and till that are created through long-term wave erosion and sea-level rise.

ESTUARINE EMBAYMENTS: Confined areas of the Sound that have narrow inlets and significant freshwater inflow.

COASTAL AND ISLAND FORESTS: Forest stands in coastal areas and on islands that are of particular importance to nesting colonial water birds.

FRESHWATER WETLANDS: Transitional zone between the land and fresh water.

COASTAL GRASSLANDS: Open glacial outwash plains dominated by tall grasses.

INTERTIDAL FLATS: Shallow areas of bays and harbors, devoid of vegetation, that lie between the spring high- and low-tide marks.

ROCKY INTERTIDAL ZONE: Areas of intermittently exposed bedrock characterized by attached species such as barnacles, algae, and mussels.

RIVERINE MIGRATORY CORRIDORS: River systems that drain to brackish waters such as the Sound, providing a link for migratory fish to travel between freshwater and saltwater.

SUBMERGED AQUATIC VEGETATION: Rooted plants, such as eelgrass and widgeon grass, that grow on shallow bay bottoms below the spring low-tide mark.

SHELLFISH BEDS: Clusters of oysters and blue mussels on the seafloor near the shore.

TIDAL WETLANDS: The transitional zone between coastal land and water. Areas are dominated by rooted plants flooded by the tide, and provide critical habitat for many species. Wetlands also help trap sediments, store flood water, and reduce wave energy during storms.

CREDITS: *Lacuna vincta on eelgrass off Fishers Island,* photo courtesy of Cornell Cooperative Extension Marine Program (*www.SeagrassLI.org*); *Frost Creek (Oyster Bay),* photo by Heather Young.
SOURCES: *Eelgrass Acreage* chart, U.S. Fish and Wildlife Service SNE/NYB Coastal Ecosystems Program.

{ALTERED LANDSCAPES}

SOUND POINTS

- Water quality of a stream, river, lake or estuary, such as the Sound, declines when there is an increase in development within the watershed.
- Development increased by 18.1% in Connecticut from 1985 to 2006 and by 2.7% in New York from 1985 to 2002.

Find links to CLEAR's reports on development in Long Island Sound and fragmented forests at *www.LIShealth.net.*

Many visit Long Island Sound to swim, fish, boat, or just to relax and enjoy the views. Millions more live and work near the Sound, exacting a price on this body of water sometimes referred to as the *Urban Sea*. Four hundred years after European explorers first came to the Sound to trade with American Indians, people still are moving to the coast, enriching the bi-state area economy, but altering the natural landscape and, in turn, the Sound and its tributaries.

FORESTS ARE being converted to "fragmented" forests, or to developed areas, including near the Barn Island Wildlife Management Area, a Stewardship Initiative site.

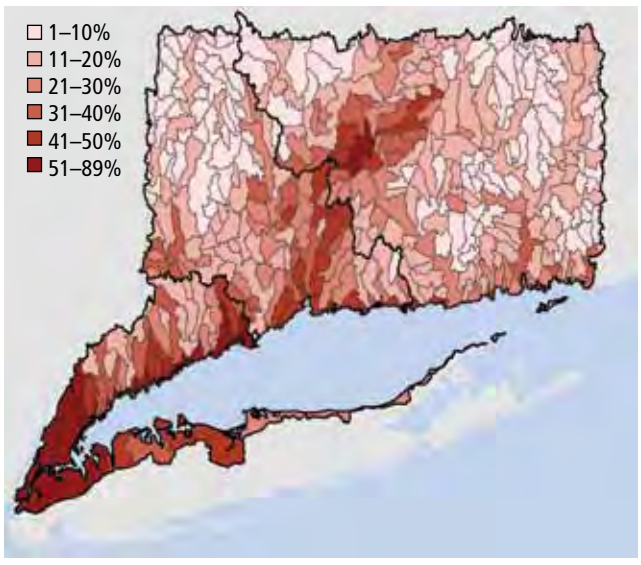
From 1980 to 2006, the population in the New York and Connecticut portion of the Sound's watershed increased from 6.3 million to 7.2 million (the population of the entire watershed, which extends into parts of Massachusetts, New Hampshire, Vermont, and Rhode Island, increased from 7.8 million to 8.8 million). Population growth leads to development that adds parking lots, rooftops, streets, and other hard surfaces to the "built" environment. Hundreds of studies around the U.S. suggest that water quality and overall stream health decline when impervious surfaces exceed 10 percent in a watershed (the area of land that drains into a body of water). When the impervious area in a watershed exceeds 25 percent, stream conditions become severely degraded. In many of the local subwatersheds surrounding the western basin of the Sound, developed land exceeds 51 percent, and can be as high as 89 percent. Without vegetation and healthy soils filtering pollutants, stormwater runoff can carry pesticides, pathogens, motor oil, debris, and excess nutrients into storm drains and streams. These pollutants eventually flow into the Sound.

Development now is spreading to more sparsely populated areas of the region, which could affect the area of the Sound with the best water quality. A study by UConn's Center for Land Education and Research (CLEAR) shows that watersheds in eastern Connecticut experienced higher relative rates of development, between 41 and 85 percent, from 1985 to 2006, compared to central and western watersheds. In total, the area of developed lands in Connecticut increased by 18.1 percent (144.7 square miles) from 1985 to 2006. The amount of developed area in the New York watershed increased by 2.7 percent (6.5 square miles) from 1985 to 2002.

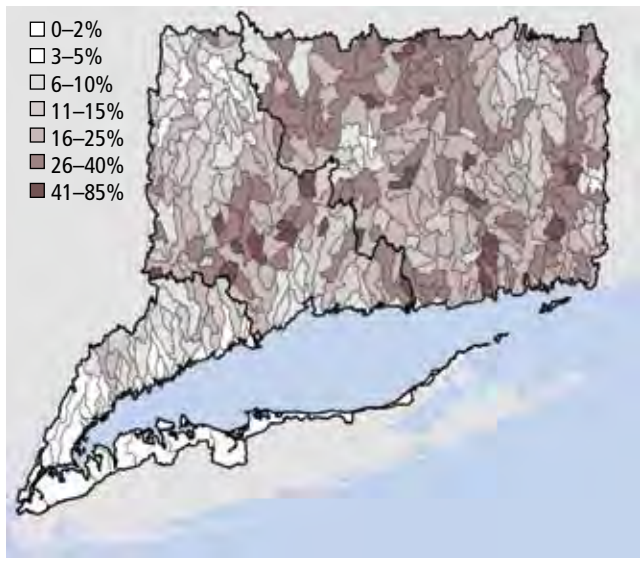
While inland areas have gained in population, about 4.6 million people still live within 15 miles of the coast, the area with the greatest impact to the Sound. The most densely developed areas, including New York City, are in the western Sound, the region that also has the poorest water quality. ✻

THE SOUND'S subwatersheds are more developed in the western Sound region (*left*), but subwatersheds in the eastern Sound region are showing the greatest percent increase in development since 1985 (*right*).

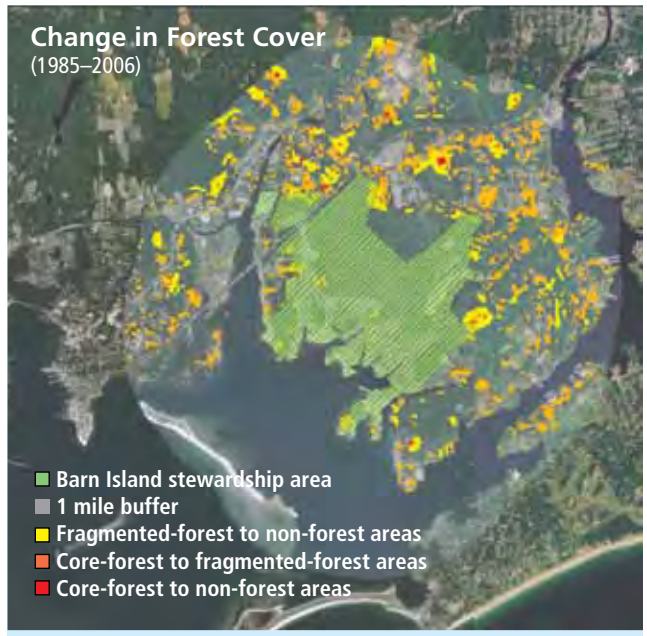
Percent of Developed Area
(NY: 2002, CT: 2006)



Change in Developed Area
(NY: 1985–2002, CT: 1985–2006)



Change in Forest Cover
(1985–2006)



Forest Loss in CT

FROM THE EARLY to the mid-20th century forests were replacing abandoned farms in Connecticut as populations moved to the cities. Today, forests cover more of the state than other types of land use. But with increases in development, the state is beginning to lose some of its forests again. According to research by CLEAR, 185 square miles of forest were converted to non-forest from 1985 to 2006—a six percent loss. The forested area totals 2,922 square miles, about 59 percent of the state. The lost area is more than the size of Greenwich, Stamford, Darien, New Canaan, Norwalk, and Wilton combined. The CLEAR study also revealed that about two-thirds of the forested land that remains is "fragmented"—defined as the division of large forest tracts into smaller areas bounded by roads and other development. Unfragmented forests consisting of at least 250 acres in size are called "core forests."

Connecticut's coastal communities also faced the same rate of forest decline as the entire state, losing about five square miles. Some of these areas were close to public lands designated as Long Island Sound Stewardship Initiative sites. For example, within one mile of the boundaries of the Barn Island Wildlife Management Area in Stonington, 405 acres of core and fragmented forest were lost, and 200 acres of core forest were converted to fragmented forest. Within one mile of the boundaries of the internationally recognized Connecticut River tidal wetlands complex, 1,476 acres of core and fragmented forest were lost, and 1,501 acres of forest were converted from core forest to fragmented forest.

Connecticut's coastal forests are dominated by oaks, hickories, tulip poplar, black cherry, and sassafras, and they provide critical habitat for wildlife, including birds.

CREDITS: *Barn Island,* photo courtesy of CT DEP.
SOURCES: *Change in Developed Area and Percent of Developed Area*, maps and data from UConn CLEAR; *Change in Forest Cover,* map by Artem Treyger, data from UConn CLEAR.

{WHAT YOU CAN DO}

There are many ways that you can help, by changing some simple things you do around your home, community, and the Sound. Remember, we all affect the Sound. Trash we leave on the ground or liquids we pour down the drain can eventually lead to Long Island Sound and pollute it. Here are are some simple things you can do to restore and protect Long Island Sound. Find more helpful tips at *www.longislandsoundstudy.net/get-involved/what-you-can-do*.

AT HOME

When it comes to fertilizer more is not better. Healthy lawns help prevent erosion, but excess fertilizer that is not absorbed by your lawn or garden can be carried away with the rain and end up in Long Island Sound. Use organic, slow-release fertilizers, test your soil before applying and never fertilize before a rainstorm! Strive for zero runoff on your property.

Consult with your public works department about how to **properly dispose of items that contain hazardous chemicals,** such as electronics, batteries, fluorescent bulbs. Also consult your public works department about proper disposal of used motor oil or household chemicals. Never pour used motor oil in a storm drain. Find return/recycling locations at *www.Earth911.org*.

Maintain your septic system by having it inspected every year and pumped out every three to five years. Nutrients that leak into the soil from septic system tanks that are not working properly may eventually run into the Sound.

Conserve water to reduce the volume of waste water that must be treated by a wastewater treatment plant or septic system. Repair leaking faucets, toilets, and pumps. Only use dishwashers and clothes washers when fully loaded. Purchase EPA "WaterSense" products. Take short showers instead of baths, and avoid letting faucets run unnecessarily. This will increase the efficiency of treatment and save you money.

Scoop up your pet's waste. Pathogens that are found in pet waste are harmful and contribute to beach closures. Flush waste down the toilet, or seal it in a plastic bag and dispose of it in the trash.

Flushing unwanted medicines can pollute the Sound since most wastewater treatment plants and septic tanks cannot break down harmful chemicals found in medicines. If your household trash goes to an incinerator, **dispose of unwanted medicines in the trash** (but first make sure to dilute them in water and mix some salt, coffee grounds, or dirt in them to prevent misuse). If your trash does not go to an incinerator, contact your town's household hazardous waste department to ask about pharmaceutical take back programs.

Wash your car on a grassy area, so the ground can filter the water naturally. Use soap sparingly and try to use non-phosphate biodegradable detergents. Empty the bucket of soapy water down the sink, not in the street. Best of all, go to a car wash.

Use environmentally-friendly landscaping techniques that require less fertilizer and use native plants. These practices help prevent sediment and nutrients, like nitrogen and phosphorus, from reaching the Sound, and can also provide habitat for native wildlife. Pesticides can also be washed off your property and carried into the Sound, so eliminate or reduce the use of pesticides on your lawn and garden. Instead, hand pick or screen out pests, choose native pest-resistant plants, or use low toxicity sprays.

Conserve energy to help reduce greenhouse gas emissions and pollutants that can deposit into bodies of water like the Sound.

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 cleanups. If you smoke, always use an ashtray and empty ashtrays into the garbage, not into a storm drain or onto the street. Contact the NYSDEC or CT DEP to report illegal dumping.

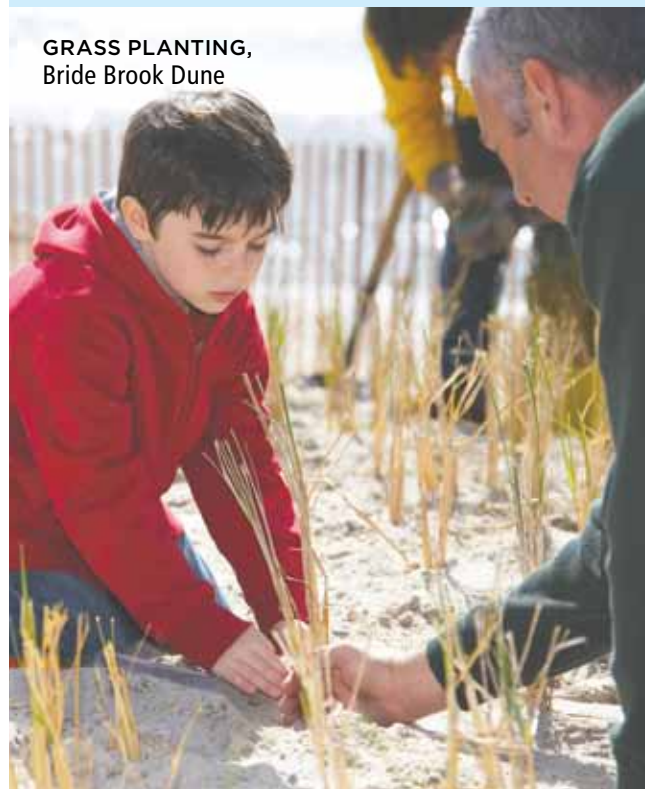
Be sure your boat is working properly and not leaking contaminants. Remember, it is illegal to discharge boat wastes in Connecticut coastal waters and some New York harbors. Contact the CT DEP or NYSDEC for information about pumpout facilities.

When fishing, be sure to **obey fishery regulations and handle fish in a manner that is responsible and sustainable** so there will be plenty of fish for years to come! For state fishing regulations, please contact the NYSDEC or the CT DEP.

Never feed geese and other waterbirds. 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. ✻

Volunteer Where You Live

THERE ARE MANY ORGANIZATIONS in Connecticut and New York that need your help protecting Long Island Sound! One quick way to find out who's doing what is to check LISS's volunteer Web page. It features links to more than 50 organizations that are seeking volunteers to clean beaches, identify and tag horseshoe crabs, monitor water quality, volunteer to lead nature walks, and much, much more. Just about anywhere along the Sound's 600 miles of coastline or along the rivers and streams in upland areas, are groups that are doing their share to protect habitats and wildlife, and improve water quality. Visit *www.longislandsoundstudy.net* and click the volunteer box to see how you can get involved.



GRASS PLANTING, Bride Brook Dune

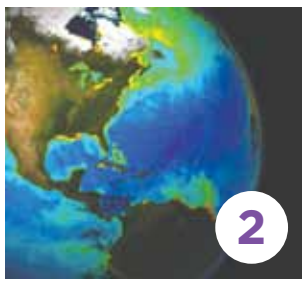
WEST RIVER CLEANUP, New Haven

CREDITS: *Fertilizer man inset,* photo courtesy of Washington State Dept. of Ecology, King County; *Dune planting,* photo by R. Lorenz for CFE (Save the Sound); *West River Cleanup,* photos courtesy of Save the Sound.

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.

{WHAT'S ON THE WEB}

Long Island Sound Study has redesigned its Web site. We've made it easier for you to find hundreds of pages of information about the Sound and about the efforts by our partners to restore and protect it. We've also added new pictures, new photo presentations, and video clips. In the future, expect more features to help you discover what makes the Sound special, and what you can do to keep the Sound healthy. ✻



WHAT YOU CAN FIND

(1) Status and Trends
Visit our Web site within a Web site to find the full set of indicators used for *Sound Health*. Learn more about water quality, fish and wildlife populations, and land use and habitats in our area.

(2) What's a Dead Zone?
In the multimedia gallery, view an animation on how a dead zone (body of water with low dissolved oxygen) is formed.

(3) Habitat Restoration Database
Click on the habitat restoration database in our habitat section and learn about more than 150 projects that have improved fish passage and restored coastal habitats.

(4) Tour Long Island Sound
Visit our "Tour of Long Island Sound" page to view dozens of pictures featuring the underwater and coastline habitats of the Sound.

(5) Listen to the Sound
Go to the audio clips section to find eight podcasts that explore the efforts to improve water and protect fish and wildlife in the Sound.

(6) Get involved
Learn what you can do to get involved to protect the Sound.

Find us on Facebook by clicking the Facebook link at *www.longislandsoundstudy.net.*

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.

SOUND HEALTH 2010

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CREDITS: *Fourspot flounder (LIS Fish Trawl Survey),* photo by Richard Howard; *Earth image,* animation by NOAA Environmental Visualization Lab; *Branford Fishway restoration,* photo courtesy of Branford Land Trust; *Sea star,* photo courtesy of CT Sea Grant Living Treasures; *CT DEP research vessel John Dempsey (LIS Fish Trawl Survey),* photo by Richard Howard; and *Gulf Beach cleanup,* photo by Kathy Nemec-Lucas Photography for Save the Sound.