

Hypoxia Summary Report

HYSEP26

Background

Hypoxia is a condition in which low or depleted dissolved oxygen concentrations are observed in the waters of Long Island Sound (LIS). Hypoxia impacts up to half of the LIS waters each summer. The primary cause of hypoxia is excess nitrogen from human sources. These sources include sewage treatment plant discharges, storm water runoff and atmospheric deposition.

The water temperature of Long Island Sound plays a crucial role in influencing hypoxia levels through several interconnected mechanisms. As water temperature increases, its ability to dissolve oxygen decreases, meaning warmer water naturally holds less dissolved oxygen. Additionally, higher temperatures elevate the metabolic rates of aquatic organisms, leading to increased oxygen consumption and further depletion of oxygen levels. Thermal stratification during warmer months results in a less dense, warmer layer sitting atop a denser, cooler layer, preventing the mixing of oxygen-rich surface waters with the deeper layers. This lack of mixing can isolate the bottom layers from essential oxygen, leading to hypoxia. Warmer temperatures also contribute to increased nutrient runoff from surrounding lands, enriching the water with nitrogen and phosphorus, which stimulate the growth of algae and phytoplankton. When these algae die and decompose, the process consumes a significant amount of oxygen, exacerbating hypoxia. Furthermore, higher temperatures boost the biological oxygen demand due to heightened activity levels of bacteria and microorganisms decomposing organic matter, further reducing oxygen levels. Consequently, the combination of reduced oxygen solubility, thermal stratification, enhanced nutrient runoff, eutrophication, and increased biological oxygen demand due to warmer water temperatures creates conditions where dissolved oxygen levels fall below the thresholds necessary to support healthy marine life, resulting in hypoxic zones in Long Island Sound.

Dissolved oxygen (DO) levels below 3.0 mg/L are considered hypoxic in LIS. Hypoxic conditions cause impairment and, in some cases, death to aquatic life. Some studies have found DO can become limiting below 4.8 mg/L for sensitive fish species, while more tolerant species are not affected until DO falls below 2.0 mg/L (Simpson et. al., 1995, 1996).

Since 1991, the Connecticut Department of Energy and Environmental Protection (CT DEEP) has conducted an intensive water quality monitoring program on Long Island Sound (LIS). The program is funded through a grant from the U.S. Environmental Protection Agency's (EPA) Long Island Sound Partnership. Data from the surveys are used to quantify and identify annual trends and differences in water quality parameters relevant to hypoxia, in particular nutrients, temperature, and chlorophyll. These data are also used to evaluate the effectiveness of the LIS management programs' efforts to reduce anthropogenic nitrogen inputs, since nitrogen is a primary contributor to the excessive algae growth that leads to hypoxia in LIS.

During the summer (June - September), surveys across LIS are conducted at bi-weekly intervals to better define the areal extent and duration of hypoxia. During these surveys stations are sampled for in-situ parameters including dissolved oxygen, temperature, pH, and salinity. The sampling calendar lists the expected survey dates.

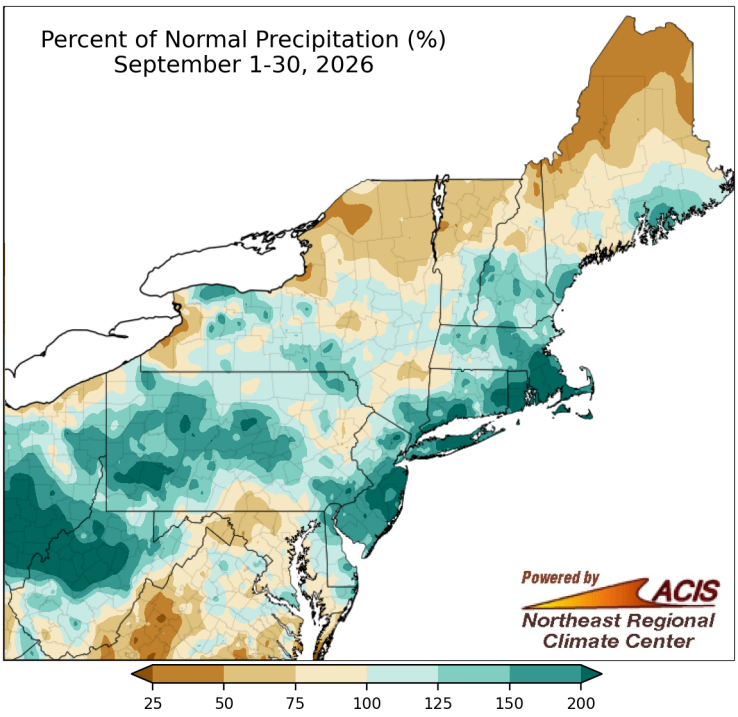
Here we present the results of the HYSEP26 survey that was conducted 6-8 September 2026 aboard the R/V Sound Outlook. A total of 36 stations were sampled.

Weather

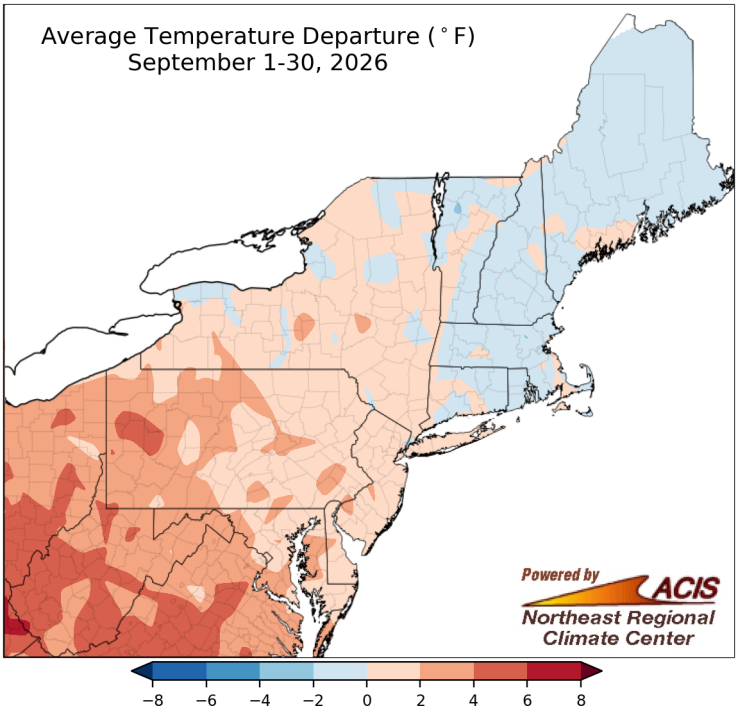
Precipitation and temperature are important factors that influence both the environment and human safety. Heavy rain can lead to flooding in vulnerable municipalities across the Northeast. Increased precipitation also reduces salinity in estuaries, which affects sensitive organisms that rely on these habitats as nurseries. On the other hand, decreased precipitation increases the risk of drought, which negatively affects crops and increases the risk of forest fires, especially when combined with rising temperatures. Higher temperatures lead to increased forest fire risk, and can fuel more intense storms that endanger coastal communities. Drought conditions could also also potentially assist hypoxia management efforts by reducing nutrient inputs and improving nutrient removal efficiency at waste water treatment plants; however, this has yet to be shown conclusively for LIS.

A summary of weather conditions across the coastal portion of the Long Island Sound watershed follows to provide context for CTDEEP's surveys and the formation and progression of hypoxic conditions. All data and images are excerpted from the Northeast Regional Climate Center's Website. Additional information on average temperature and precipitation of other areas in the Northeast is available in the NRCC's blog located at https://www.nrcc.cornell.edu/.

Where is the sun? The trend of wet weather continued through the second half of September. For Islip, NY September 2026 was the wettest of record with a whopping 8.76 inches of precipitation recorded (243% of normal rainfall 3.60 inches). September 2026 was the 4th wettest on record for Bridgeport, CT with a total of 8.22 inches of precipitation falling, 208% of the normal 3.96 inches. Hartford, CT, Central Park, JFK, and LaGuardia Airport all logged above average precipitation during the month of September. Much of the precipitation was associated with an extreme rainfall event on 13 September and an early season Nor'easter that swept through the region between 24 and 26 September.



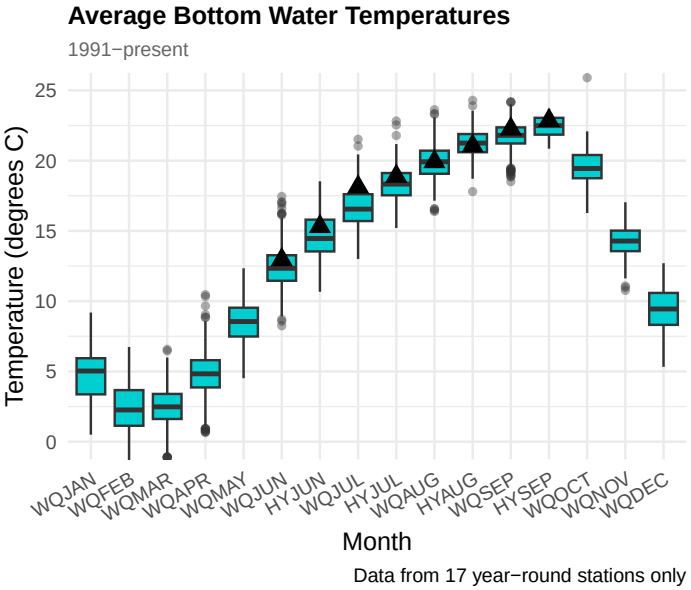
The month ended with September temperatures being slightly below normal across the LIS coastal region, ranging from 67.0°F in Bridgeport to 70.4°F at LaGuardia.



Water Temperature

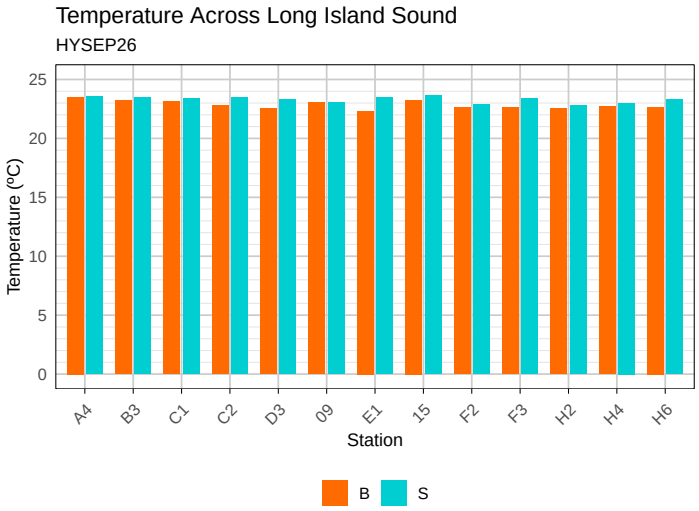
The graph below displays the range and median of the average monthly surface (orange boxes) and bottom (blue boxes) water temperature of Long Island Sound as recorded by CTDEEP during the year-round water quality surveys from 1991-present. The graph also displays the average temperature for the current survey (black triangles).

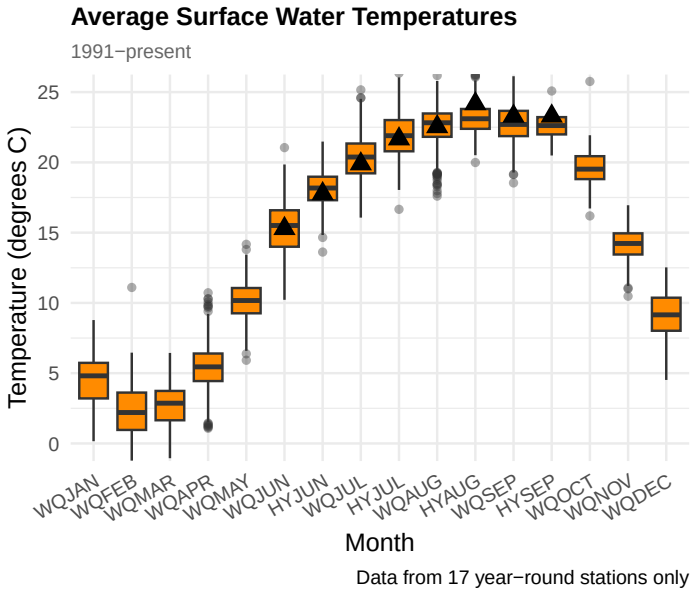
During the HYSEP26 survey, the average surface temperature was 23.32 ºC and the average bottom temperature was 22.89 ºC. The highest surface temperature was 23.62 at Station 15, and the lowest surface temperature was 22.81 at Station H2. The highest bottom temperature was 23.51 ºC at Station A4 and the lowest bottom temperature was 22.33 at Station E1.

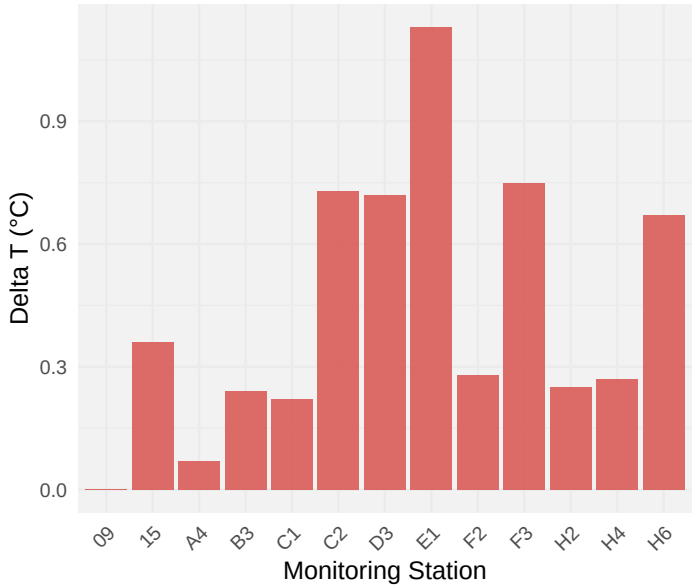


Delta T

Delta T (ΔT) represents the difference between surface and bottom water temperatures. Variations in water temperature contribute to stratification, which in turn exacerbates hypoxic conditions. Typically, shallower coastal stations exhibit smaller temperature differences due to their increased susceptibility to mixing, weather, and anthropogenic influences. The greater the Delta T, the higher the potential for severe hypoxia.







The average delta T (Surface minus Bottom) was 0.44

°C (Median = 0.28 °C, SD = ±0.33 °C). The minimum temperature difference observed was 0 °C at station 09, representing a well-mixed water column. The maximum Delta T was 1.13 °C at station E1, indicating persistent stratification.

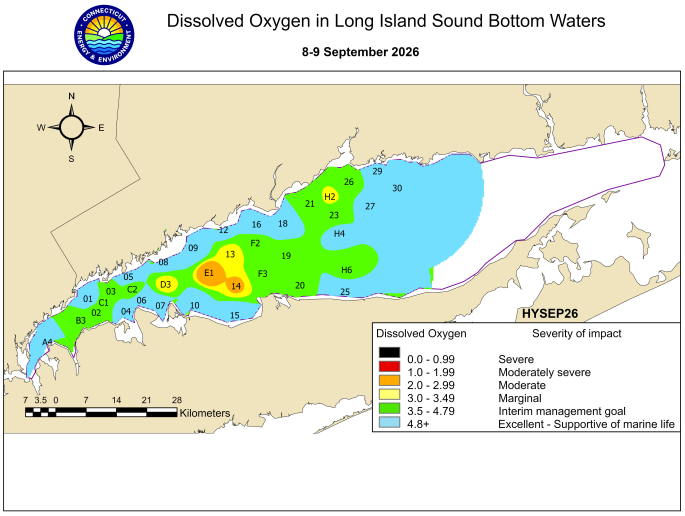
Dissolved Oxygen

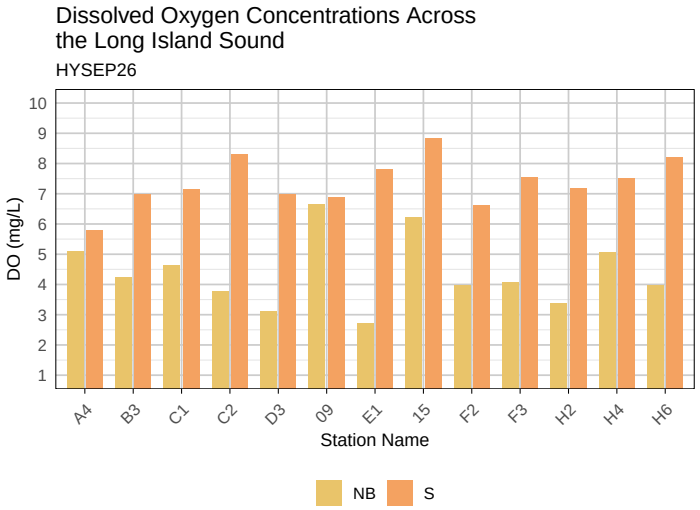
Spatial Distribution of Bottom Water Dissolved Oxygen Levels

During the HYSEP26 survey, the average surface dissolved Oxygen (DO) concentration was 7.05 mg/L and the average near bottom DO concentration was 4.89 mg/L. The highest surface DO concentration was 8.85 at Station 15, and the lowest surface DO was 5.04 at Station 26. The highest bottom DO concentration was 7.54 mg/L at Station 25 and the lowest bottom DO was 2.72 at Station E1. 2 stations had a surface or bottom dissolved oxygen concentration below 3 mg/L, which is considered hypoxic.

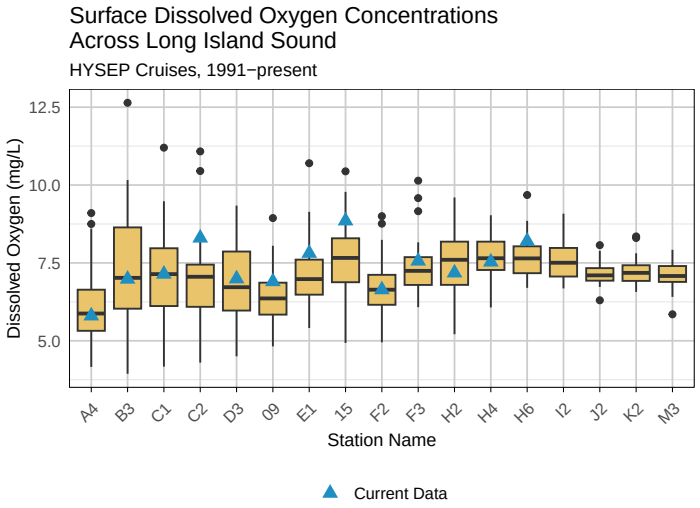
During the HYSEP26 survey, monitoring revealed 2 stations within the moderate Severity of Impact Category, 3 stations within the marginal Severity of Impact Category, 13 stations within the interim goal Severity of Impact Category, and 18 stations within the excellent Severity of Impact Category.

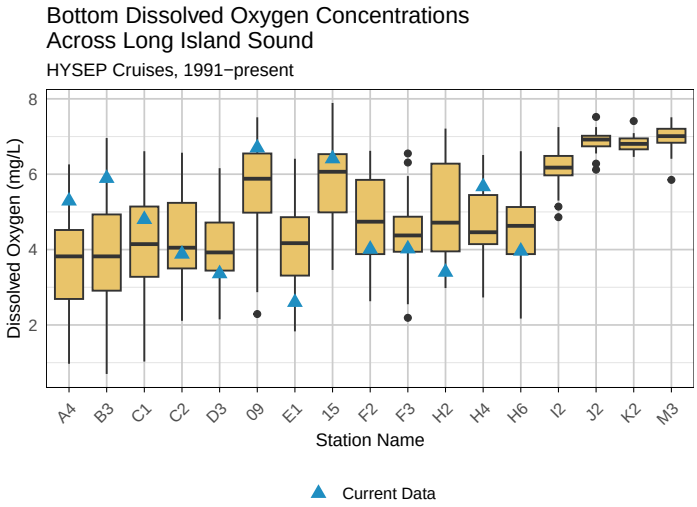
There were 16.99 square miles (44.00 square km) of bottom water with DO concentrations below 3.0 mg/L. There were 302.86 square miles (784.41 square km) with concentrations between 3.0 and 4.8 mg/L.





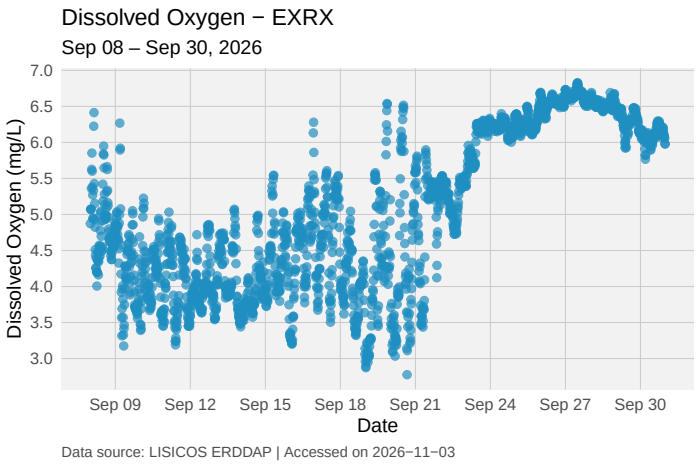
Comparing the average Long Island Sound DO values Measured During WQAUG surveys since 1991 Surface DO concentrations at 7 of the 13 year-round stations sampled during the HYSEP26 survey were above the median values recorded over the 35 years of the survey. Six (6) of the 13 stations had bottom dissolved oxygen concentrations above the median values while 7 stations were below the median.

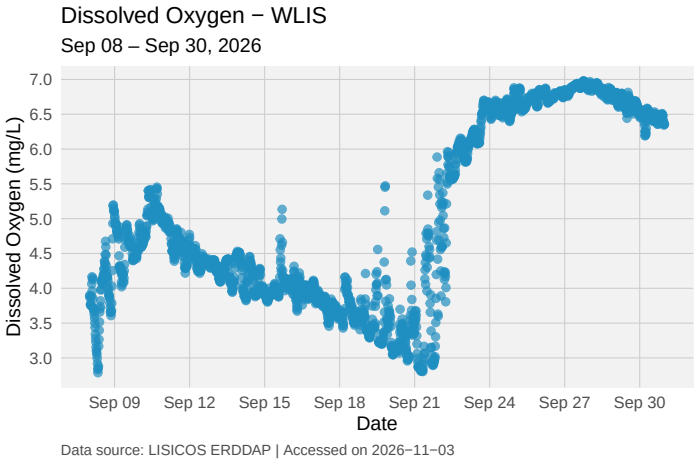


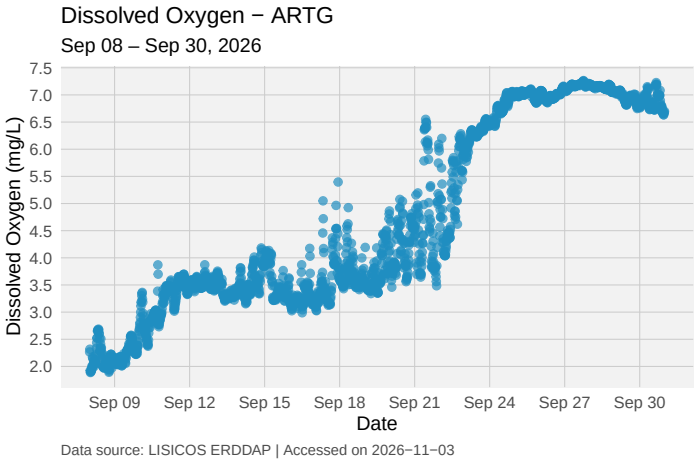


Recent Dissolved Oxygen Levels at EXRX, WLIS, and ARTG Stations

The Long Island Sound Integrated Coastal Ocean Observing System (LISICOS) collects and reports real-time continuous meteorological, water quality, and wave height data. The system is operated and maintained by the University of Connecticut with funding from the Long Island Sound Partnership and the Northeast Regional Association of Coastal Ocean Observing Systems (NERACOOS). The following graphs depict bottom water time series data from the LISICOS buoys (downloaded from the UCONN ERDDAP server) for the period immediately following the HYSEP26 survey. The buoy data show that hypoxic conditions were abated thanks to two storms that came through the area on 13 and 24-26 September (see Weather section).





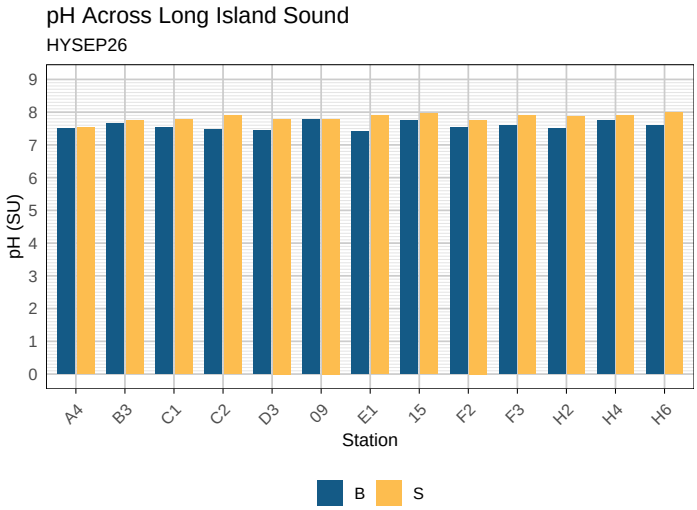


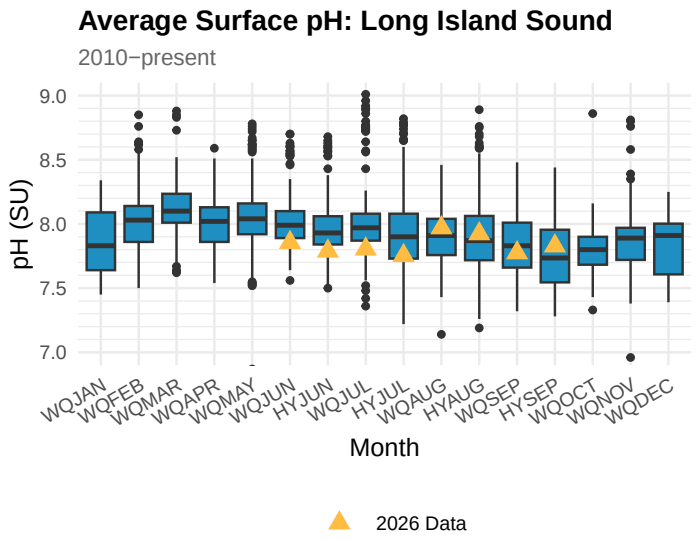
pH

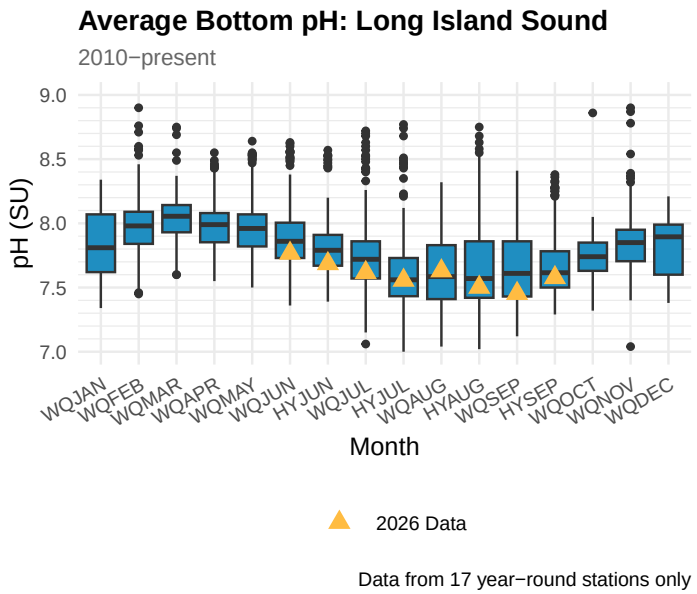
Ocean acidification refers to the process in which the pH of ocean waters decreases over time due to the absorption of atmospheric carbon dioxide (CO_2). Waters with a lower pH value, and therefore a greater acidity, have fewer carbonate ions. Calcifying species use available carbonate ions to produce their calcium carbonate shells. Therefore, ocean acidification harms the growth of calcifying species. This includes certain species of clams, oysters, and coral. Studies also show that increased ocean acidity can stunt the growth of many fish species.

The average acidity of the ocean is around 8.1. This is a 0.06 decrease since 1985. However, the average pH of the Long Island Sound has been found to decrease by 0.04 each decade - a much more drastic change.[2]

The average surface and bottom pH from all stations across the LIS during the HYSEP26 survey were 7.81 and 7.58 respectively. The highest surface pH was 7.99 at Station H6, and the lowest surface pH was 7.52 at Station A4. The highest bottom pH was 7.78 at Station 09 and the lowest bottom pH was 7.41 at Station E1.







Salinity

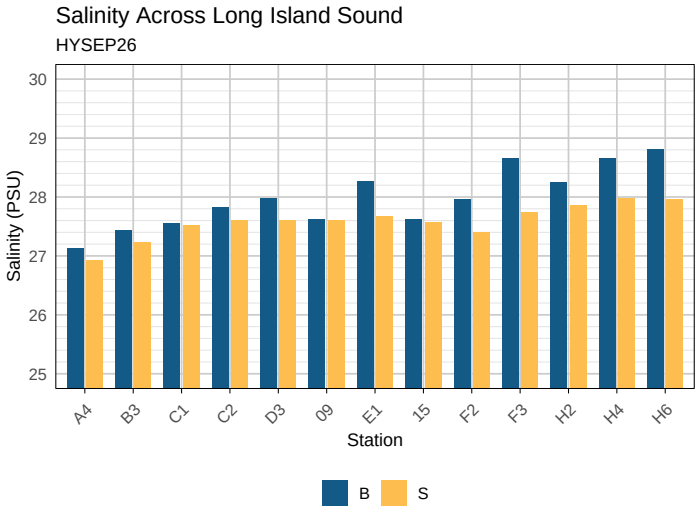
The Long Island Sound is an estuary, meaning its waters are a mix of both fresh and salt water. This is referred to as brackish water. The salt water is supplied by the Atlantic Ocean, while the majority of LIS fresh water comes from three major Connecticut Rivers: the Thames, the Connecticut, and the Housatonic - from east to west.[6] Estuaries are considered to be some of the most ecologically productive ecosystems on Earth.[6]

Many species rely on estuaries for breeding and nursing their young. Furthermore, many major marine species that spend most of their time in the ocean spend part of their life cycles within an estuary. This includes salmon, herring, and oysters.[4] The average salinity of the Long Island Sound is approximately 28 PSU, compared to the ocean, which has a higher average salinity of 35 PSU.

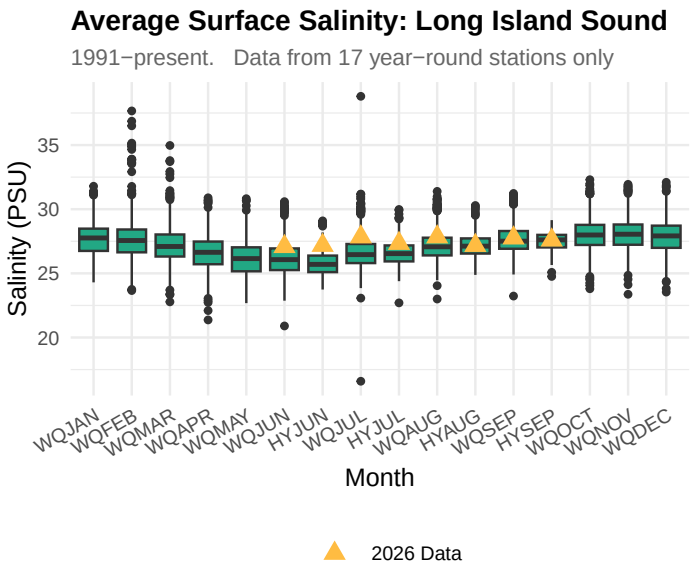
The average surface and bottom salinities from all stations across the LIS during the HYSEP26 survey were 27.55 PSU and 27.97 PSU respectively. The highest surface salinity was 27.98 PSU at Station H4, and the lowest surface salinity was 26.93 PSU at Station A4. The highest bottom salinity was 28.8 PSU at Station H6 and the lowest bottom salinity was 27.12 PSU at Station A4.

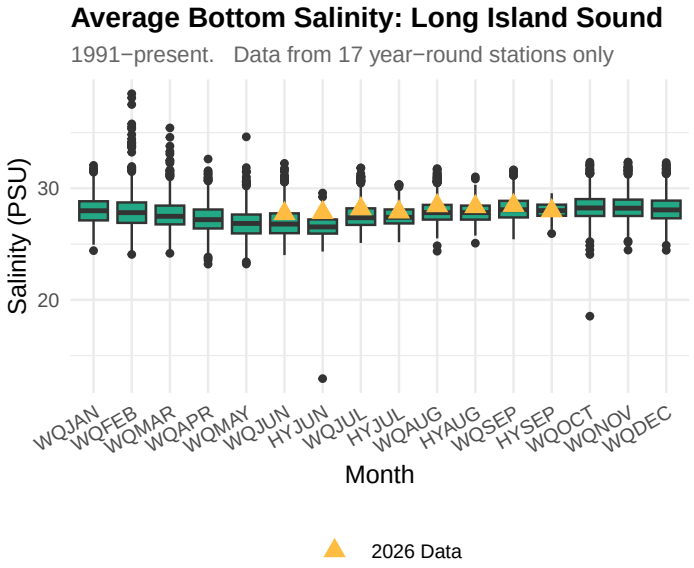
Average salinity across Long Island Sound by station

Eastern stations near the Atlantic Ocean tend to have higher salinities due to ocean exchange. The stations on the x-axis are arranged from west to east.



Changes in salinity throughout the year

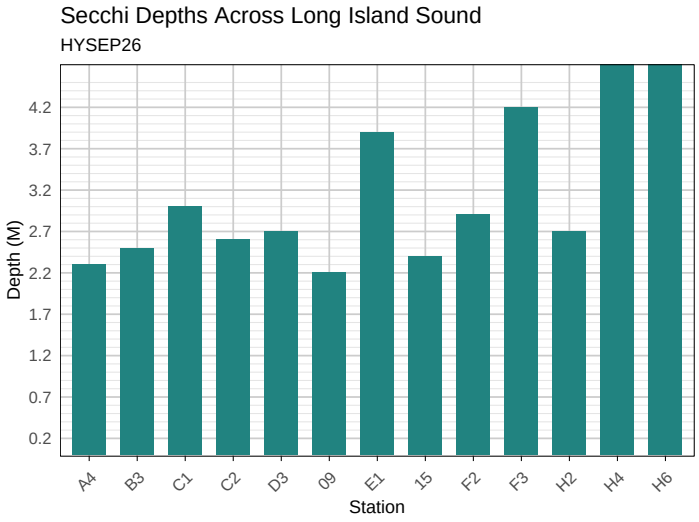




Secchi Disk Depth

Secchi disks are used to measure the transparency of a water body. They are lowered into the water until they are no longer visible to the observer. The depth of disappearance, also called the Secchi depth, is indicative of the water clarity.[7] Clarity is reduced as the presence of suspended solids, plankton, and organic matter increases.

The average secchi disk depth from all stations across the LIS during the HYSEP26 survey was 3.4 m. The greatest disk depth was 6.5 m at station H6. The lowest disk depth was 2.2 m at Station 09.



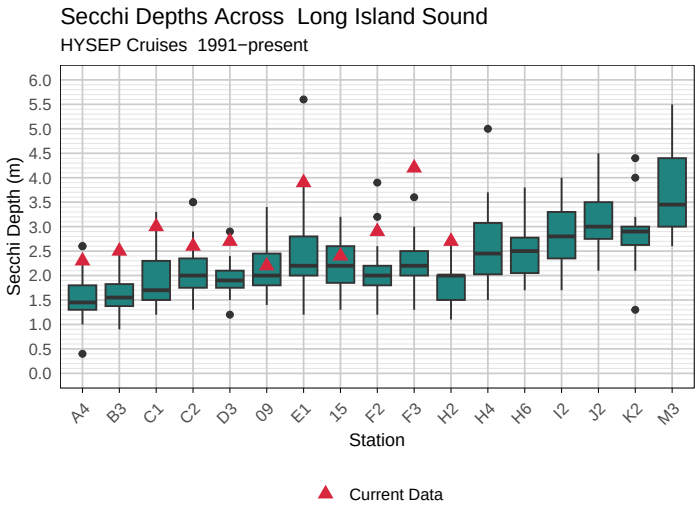
The Long Island Sound Report Card developed by Save the Sound through the LIS partnership utilizes the following thresholds:[5]

Table 1: Secchi Depth Grading Thresholds

Grade	Depth Range (m)	Score Equiv.
A	> 2.28	90–100%
B	2.12 – 2.28	80–90%
C	1.95 – 2.12	70–80%
D	1.80 – 1.95	60–70%
F	< 1.80	$< 60\%$

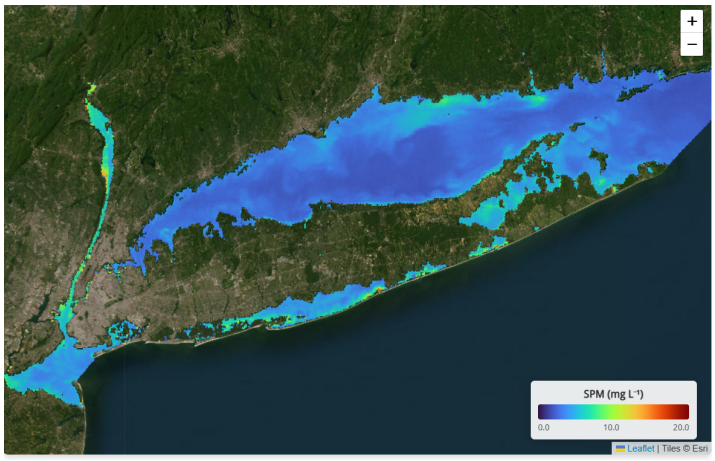
In the HYSEP26 survey, 12 stations received a grade of A, 1 station received a grade of B.

Looking at historical Secchi depth values across the Long Island Sound

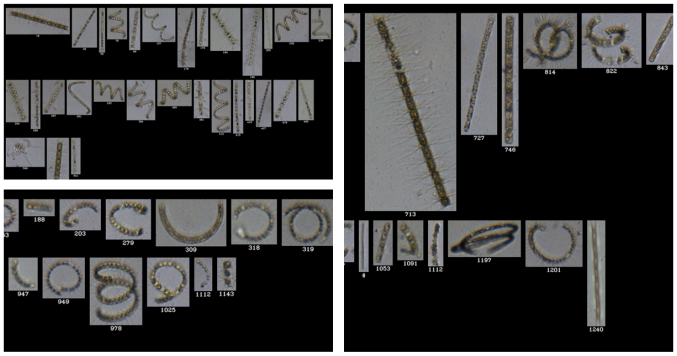


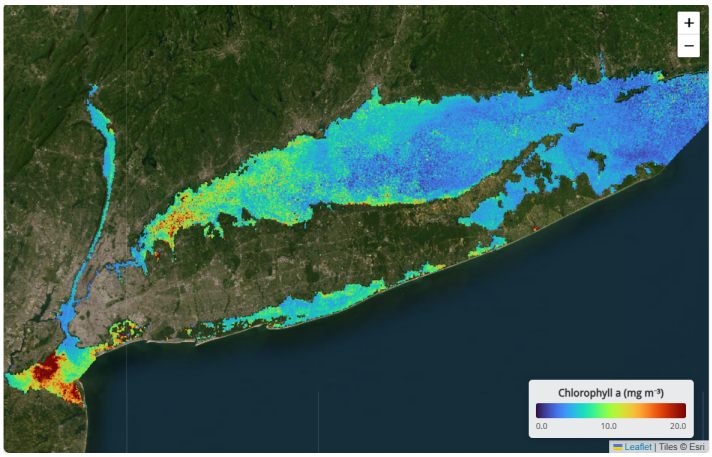
Remote sensing- CHLA, CDOM, SPM

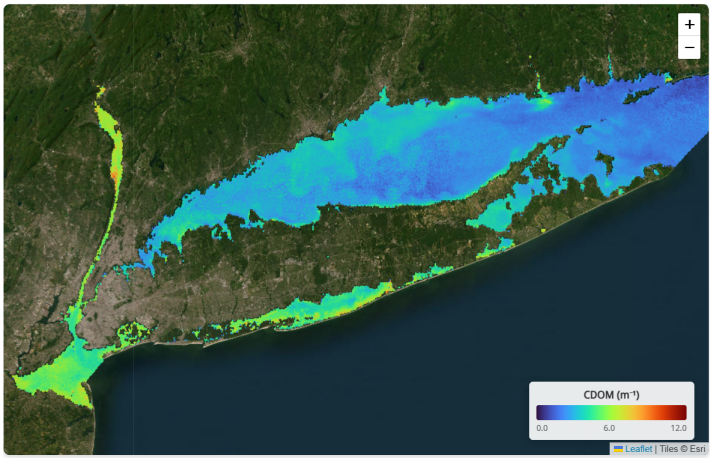
The LIS Ocean Color Website curated by the Tzortziou Bio-optics Lab at the City University of New York displays Long Island Sound optimized chlorophyll (CHLA), colored dissolved organic matter (CDOM), and suspended particulate matter (SPM) remote sensing imagery. These images showing bloom conditions are from 7 September 2026. CHLA imagery provides a measure of plankton biomass. CDOM and SPM provide a measure of turbidity.



Researchers from the Lamont Doherty Lab at Columbia University joined Matt and Captain Tommy on a boat transit day to collect additional phytoplankton samples from Long Island Sound following another large East Coast (*K. mikimotoi*) bloom event. Unlike the offshore coastal shelf waters, LIS was dominated by chain-forming diatoms, mostly *Chaetoceros* sp. The *Chaetoceros* bloom was also noted in Groton by UConn researcher Fernando Gomez Perez and by Emily Marquis of the CT Bureau of Aquaculture who also reported a *Pseudo-nitzschia* bloom in East Lyme (no toxins detected).







References

[1] "Climate Change Indicators: Weather and Climate." Environmental Protection Agency, U.S. EPA, 26 Mar. 2025, www.epa.gov/climate-indicators/weather-climate.

[2] "Climate Explained: Ocean Acidification." Save the Sound, Save the Sound, 30 Oct. 2023, www.savethesound.org/2023/10/23/climate-explained-ocean-acidification/.

[3] "Learn More: Dissolved Oxygen." Sarasota County Wateratlas, USF Water Institute, 2001, sarasota.wateratlas.usf.edu/library/learn-more/learnmore.aspx?toolsection=lm_dissolvedox.

[4] "Life in an Estuary." National Ocean and Atmospheric Association, U.S. Department of Commerce, 25 Mar. 2025, www.noaa.gov/education/resource-collections/marine-life/life-in-estuary.

[5] "Long Island Sound Report Card." Save the Sound, www.savethesound.org/report-card. Accessed 13 June 2025.

[6] Van Patten, Peg, et al. "Sound Facts." UConn.Edu, Connecticut Sea Grant, 2009, seagrant.uconn.edu/wp-content/uploads/sites/1985/2020/09/SoundFactsFinal.2009.pdf.

[7] "What Is a Secchi Disk?" The Robert Carlson Secchi Dip-In, North American Lake Management Society (NALMS), www.nalms.org/secchidipin/monitoring-methods/the-secchi-disk/what-is-a-secchi-disk/. Accessed 13 June 2025.

Li, M., Y. J. Lee, J. M. Testa, Y. Li, W. Ni, W. M. Kemp, and D. M. Di Toro (2016), What drives interannual variability of hypoxia in Chesapeake Bay: Climate forcing versus nutrient loading?, Geophys. Res. Lett., 43, 2127–2134, doi:10.1002/2015GL067334.

Hagy III, James & Boynton, W. & Keefe, Carolyn & Wood, Kathryn. (2004). Hypoxia in Chesapeake Bay, 1950–2001: Long-term change in relation to nutrient loading and river flow. Estuaries. 27. 634-658. 10.1007/BF02907650.

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Visit the Long Island Sound Water Quality and Monitoring Program website

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