Long Island Sound Water Quality Monitoring Program

July 2025

From the Connecticut Department of Energy and Environmental Protection

(HYJUL25)

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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.

The HYJUL25 survey was conducted 14-16 July 2025 aboard the R/V John Dempsey. A total of 39 stations were sampled.

Weather

Precipitation and temperature are important factors that influence both the environment and human safety.1 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.1 Higher temperatures lead to increased forest fire risk, and can fuel more intense storms that endanger coastal communities.

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.

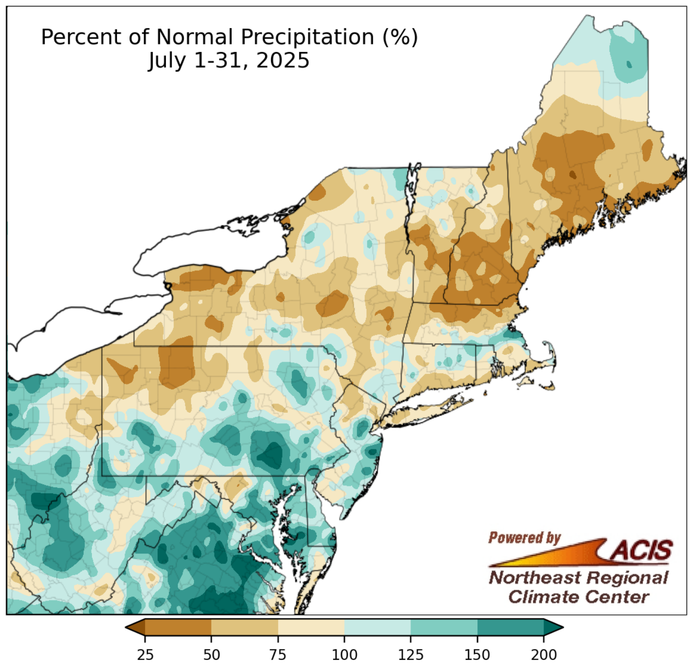
Bridgeport. CT was higher on average this July with Bridgeport having an average temperature of 78.2 °F which is +2.5 °F above normal ranking it their July to be the 6th hottest of all-time hottest rank. Similarly, Hartford, CT had an average temperature of 76.3 °F which is +2.0 °F above normal ranking this their 18th. Meanwhile in New York, Islip had an average temperature of 78.5 °F which is +3.5 °F above normal ranking it their 2nd all time hottest July. LaGuardia Airport, NY had the least amount of temperature change with the average being Avg = 81.0 °F which is +1.8 °F above normal ranking this July to be their 9th all time hottest. However like Islip, JFK Airport, NY had a large increase in average temperature with the average being 79.9 °F which is +3.8 °F above normal ranking this July their 2nd hottest of all time. Overall, all stations had an increase in temperature this July.

The amount of rain in CT varied drastically. In Bridgeport, CT the rain was about 1.35 inches on average which is 41% of the normal amount (3.32 in) making this July their 10th driest on record. In contrast Hartford, CT had on average 7.81 inches of rain this July which is 187% above normal (4.17 in) making this July their 8th wettest. New York also had a similar variety of precipitation amount. In Islip, NY it rained 5.64 inches on average which is 173% above normal (3.36 in) ranking this their 8th wettest July. However, the other two locations of New York, LaGuardia Airport and JFK Airport, had less precipitation overall. For instance, LaGuardia, NY only had 3.05 inches of rain on average which is 71% of normal (4.30 in) and JFK Airport only had 3.13 inches of rain on average which is 81% of normal (3.86). Overall the stations monitored were mixed in the levels of precipitation.

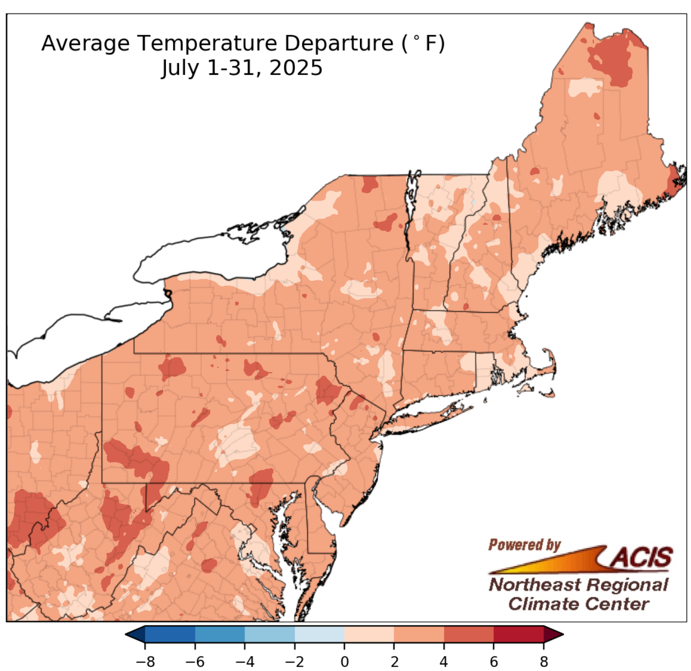
All data and images were from the Northeast Regional Climate Ceneter's Website. Furthermore, to see the average temperature and precipitation of other areas in the Northeast please read the blog located at https://www.nrcc.cornell.edu/.

NRCC Graphics for August 1, 2025

Temperature data across the Northeast for the last month

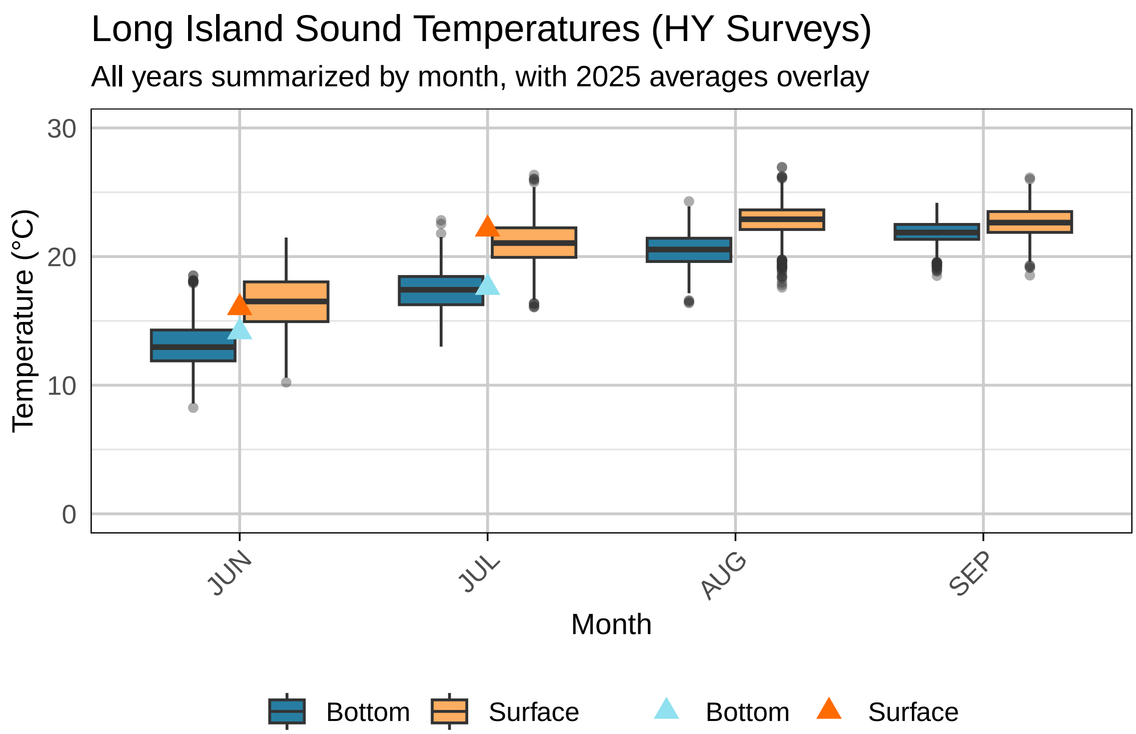


Precipitation data across the Northeast for the last month



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 (orange and blue triangles).



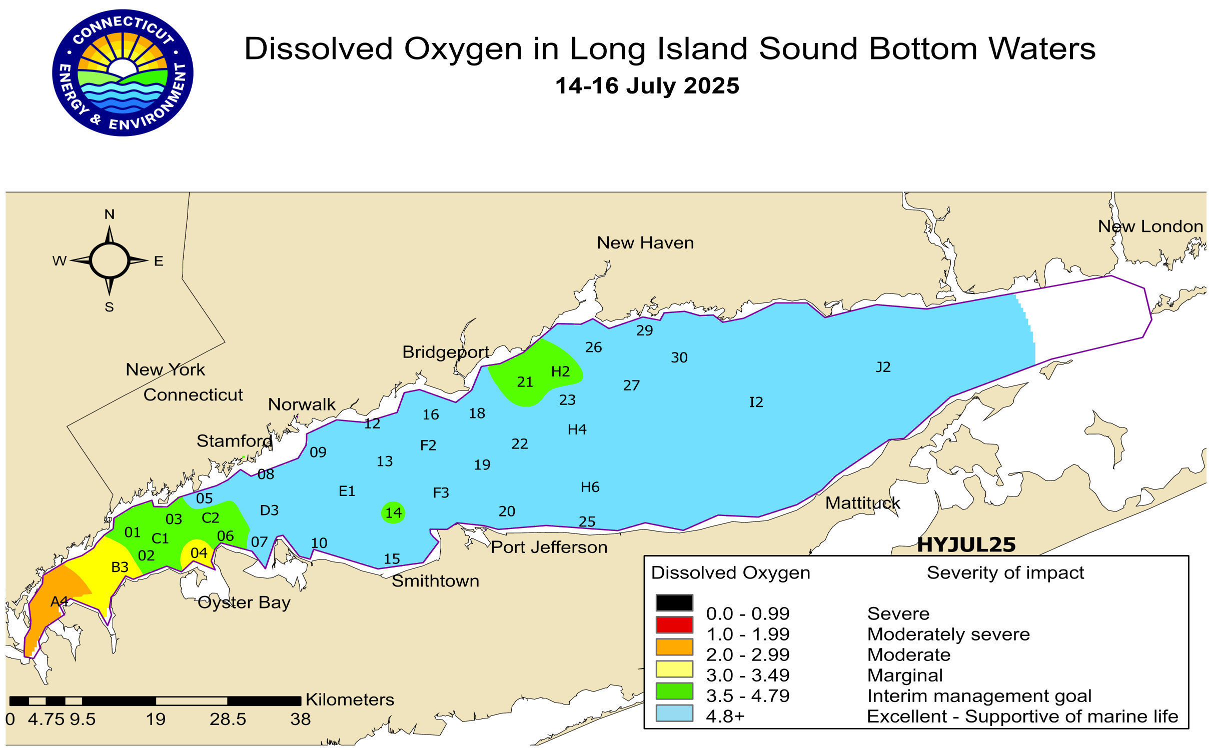
Delta T (ΔT) represents the difference between surface and bottom water temperatures. Variations in water temperature contribute to stratification, which in turn exacerbates hypoxic conditions. Typically, shallower coastal stations exhibit the smallest temperature differences due to their increased susceptibility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

Overall, across the 17 stations analyzed, bottom temperatures showed a mild decrease with an average change of -0.38°C with stations like C1 (-1.09°C) and E1 (-1.00°C) showing the strongest decreases. In contrast, surface temperatures experienced a significant increase with an average change of +0.72°C, pointing to widespread warming at the surface level. Notable increases occurred at H6 (+1.45°C), F3 (+1.32°C), H2 (+1.21°C),H4 (+1.10°C),I2 (+1.19°C), and C2 (+1.02°C)

Spatial Distribution of Bottom Water Dissolved Oxygen Levels

During the HYJUL25 survey, one station had dissolved oxygen concentrations below 3.0 mg/L, 2 stations were between 3.0 and 3.5 mg/L, and 9 stations were between 3.5 and 4.8 mg/L.

46.8 km^2 (18.07 mi^2) of bottom water had DO concentrations below 3.0 mg/L; 71.1 km^2 (27.45 mi^2) were between 3.0 and 3.5 mg/L; and 203.3 km^2 (78.49 mi^2) were between 3.5 and 4.8 mg/L.



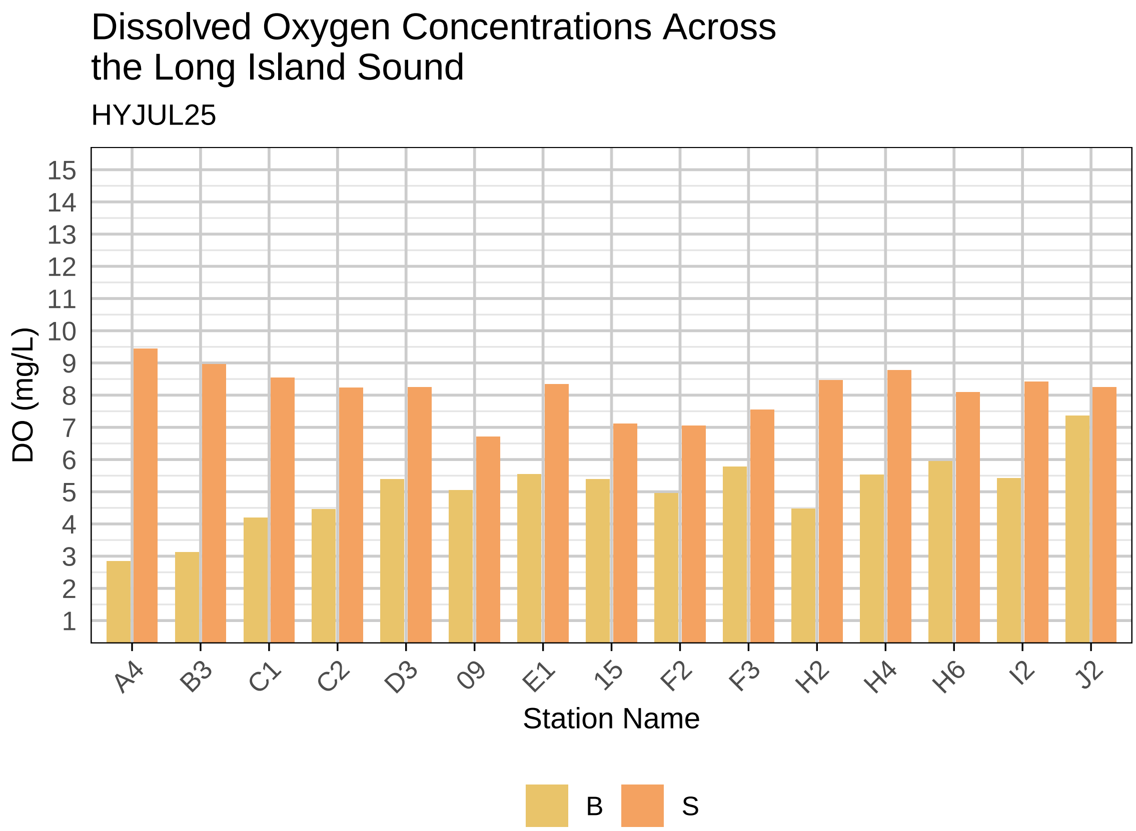
Dissolved Oxygen

Dissolved oxygen is essential for the survival of aquatic organisms, and therefore one of the most important indicators of water quality.[3] There are methods to increasing oxygen levels in a water body. For one, wind is able to aerate the water, allowing oxygen to dissolve into surface waters. Secondly, oxygen is a byproduct of photosynthesis, and can be introduced to the water through aquatic plants.[3]

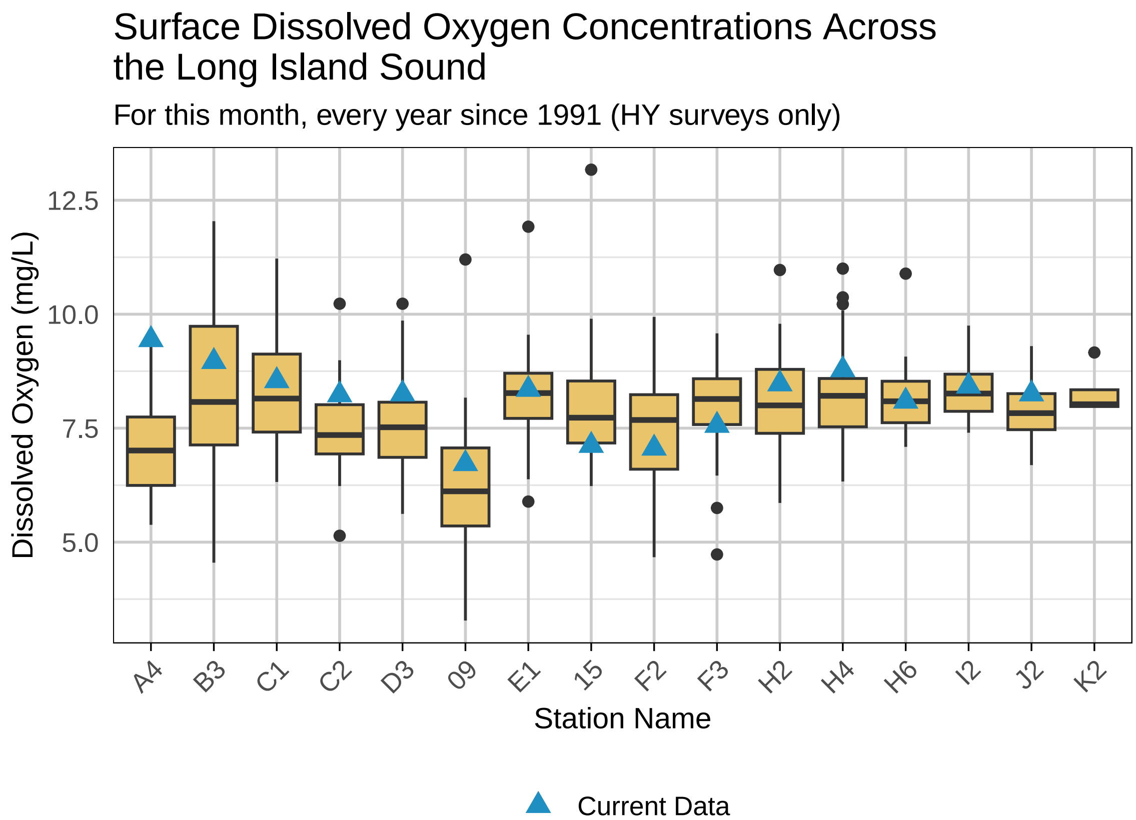
Colder water can hold more oxygen than warm water. Furthermore, freshwater is able to absorb more oxygen than saltwater, so waters with lower salinity levels often have higher DO concentrations.

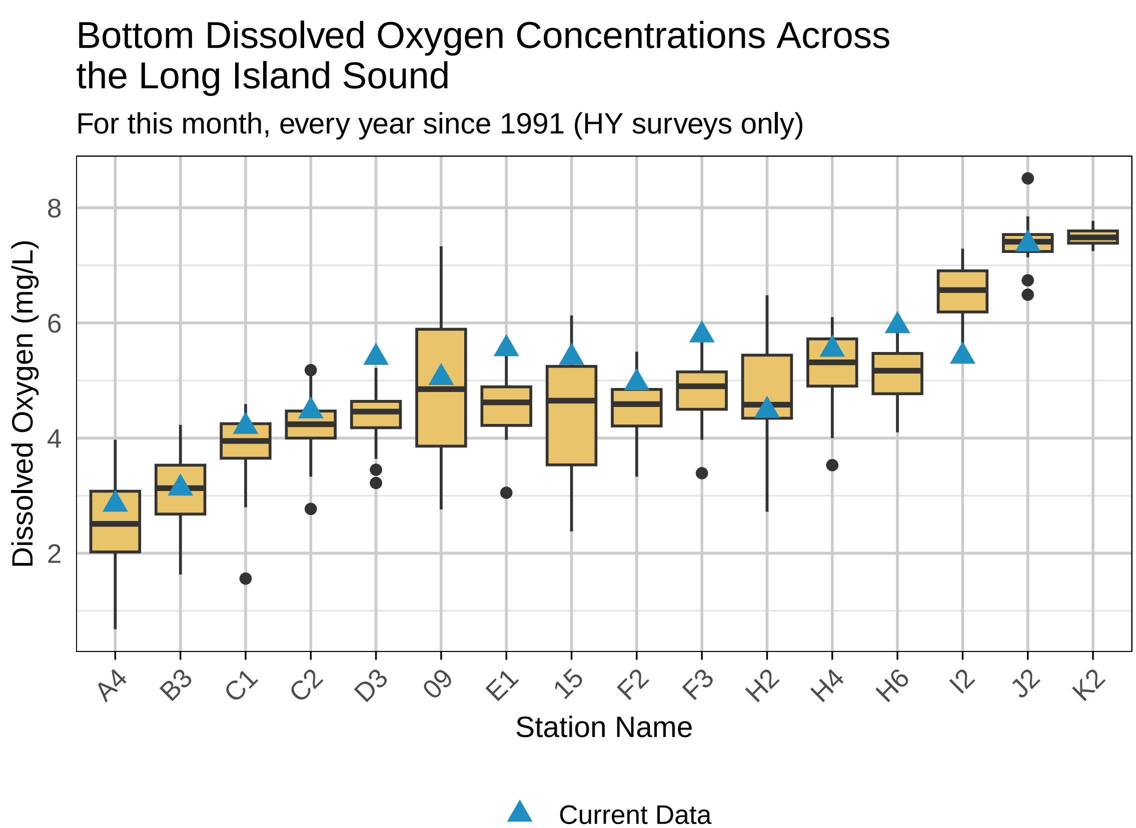
In the HYJUL25 survey, the average surface dissolved Oxygen (DO) concentration was 8.15 mg/L and the average bottom DO concentration was 5.04 mg/L. The highest surface DO concentration was 9.44 at Station A4, and the lowest surface DO was 6.72 at Station 09. The highest bottom DO concentration was 7.37 mg/L at Station J2 and the lowest bottom DO was 2.85 at Station A4. 1 station has a surface or bottom dissolved oxygen concentration below 3 mg/L, which is considered hypoxic.

Measured Dissolved Oxygen level across the Long Island Sound by station



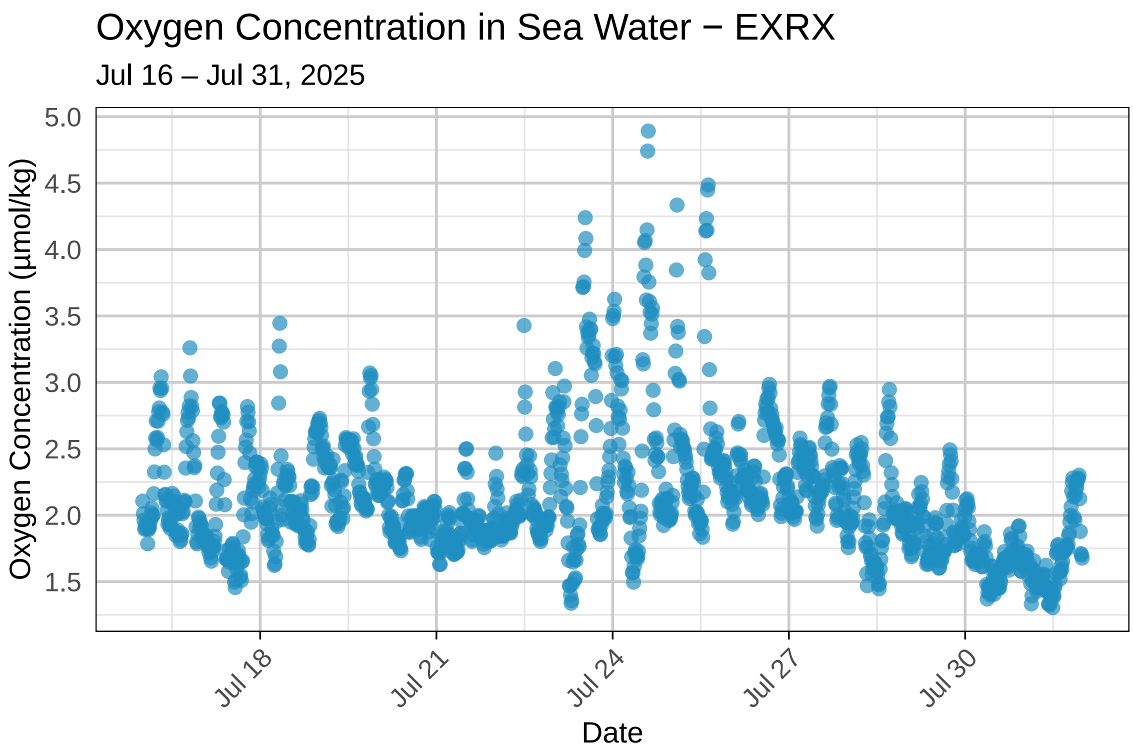
Comparing the average Long Island Sound DO values for each month since 1991

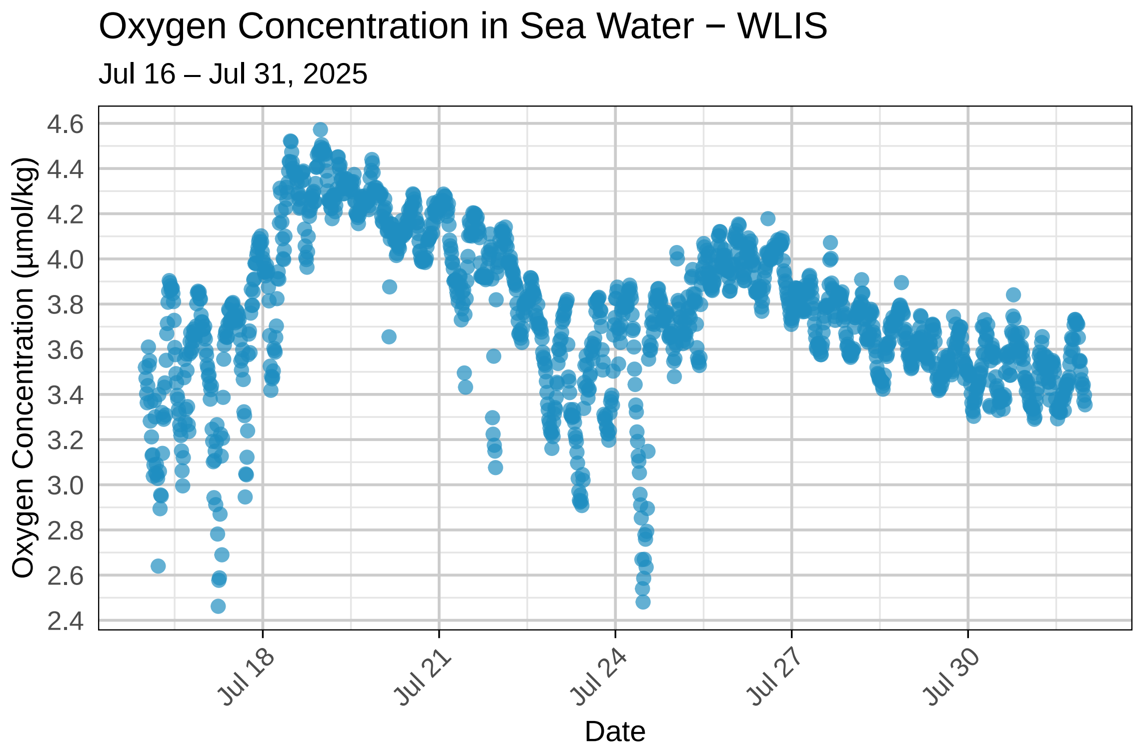


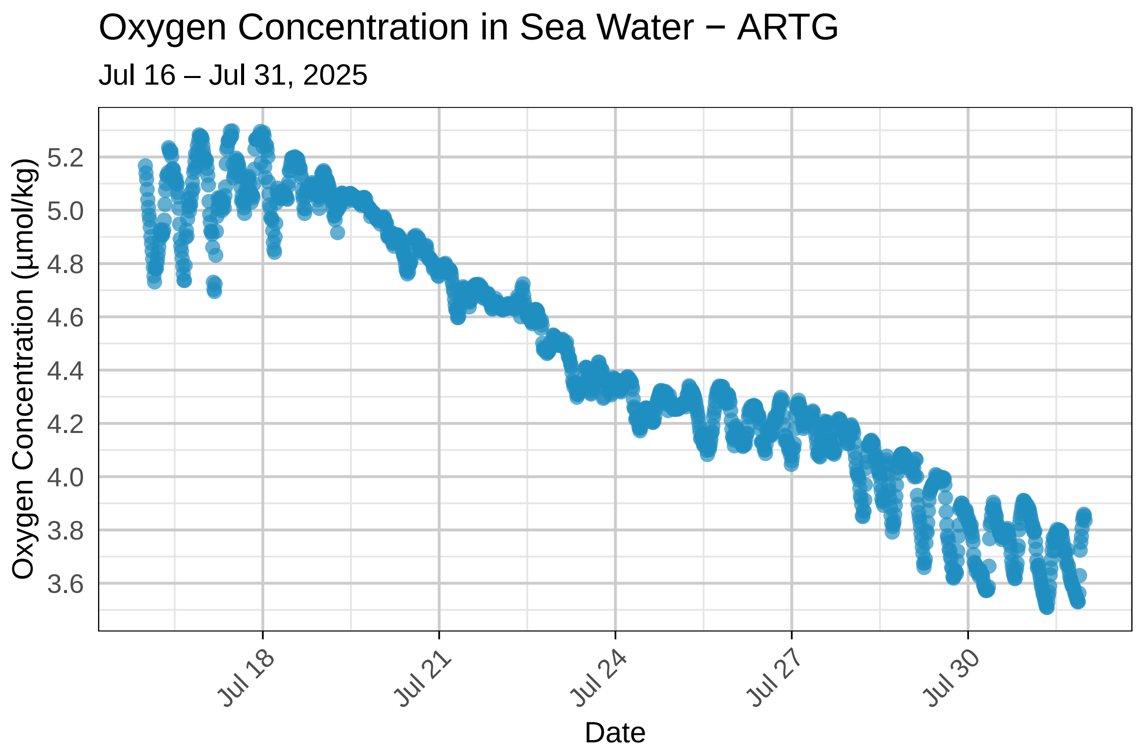


Recent Dissolved Oxygen Levels at EXRX, WLIS, and ARTG Stations

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 time series data from the LISICOS buoys (downloaded from the UCONN ERDDAP server) for the period surrounding the HYJUL25 survey.




Oxygen Concentration in Sea Water − WLIS
Jul 16 – Jul 31, 2025
Oxygen Concentration (µmol/kg)
4.6
4.4
4.2
4.0
3.8
3.6
3.4
3.2
3.0
2.8
2.6
2.4
Jul 18
Jul 21
Jul 24
Jul 27
Jul 30
Date

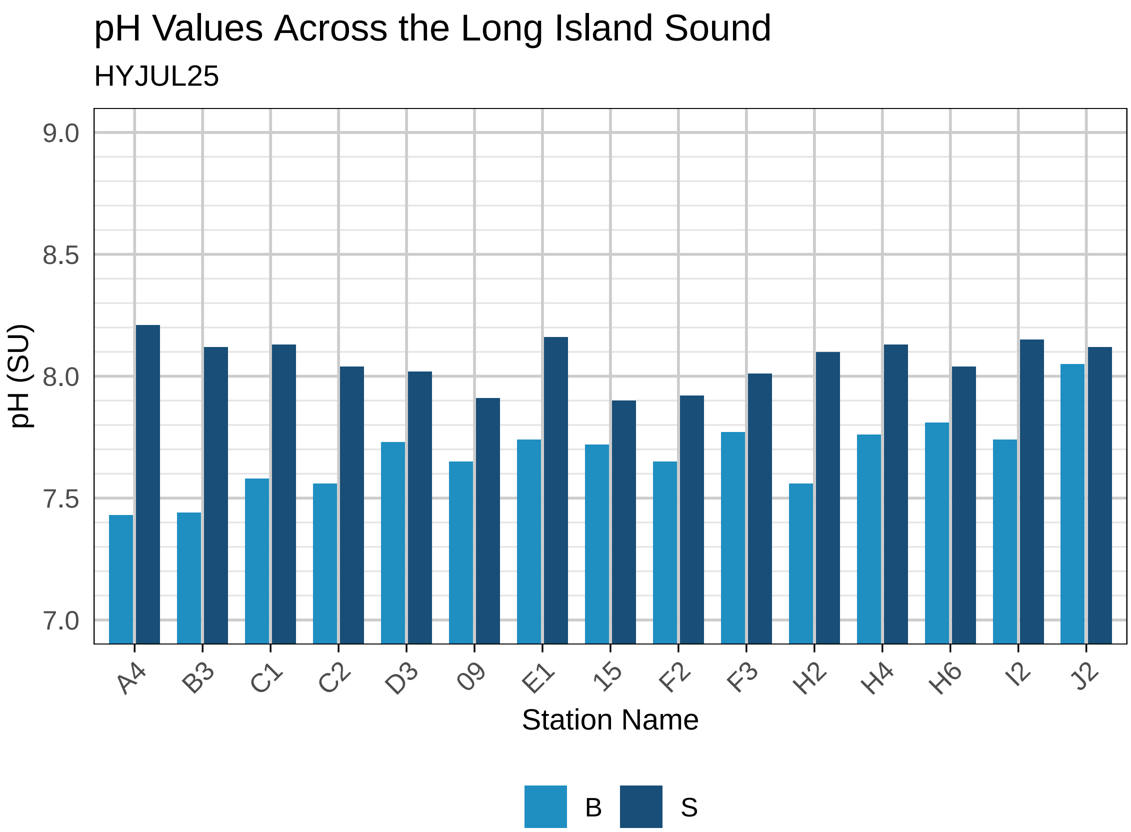

Oxygen Concentration in Sea Water − ARTG
Jul 16 – Jul 31, 2025
Oxygen Concentration (µmol/kg)
5.2
5.0
4.8
4.6
4.4
4.2
4.0
3.8
3.6
Jul 18
Jul 21
Jul 24
Jul 27
Jul 30
Date

pH

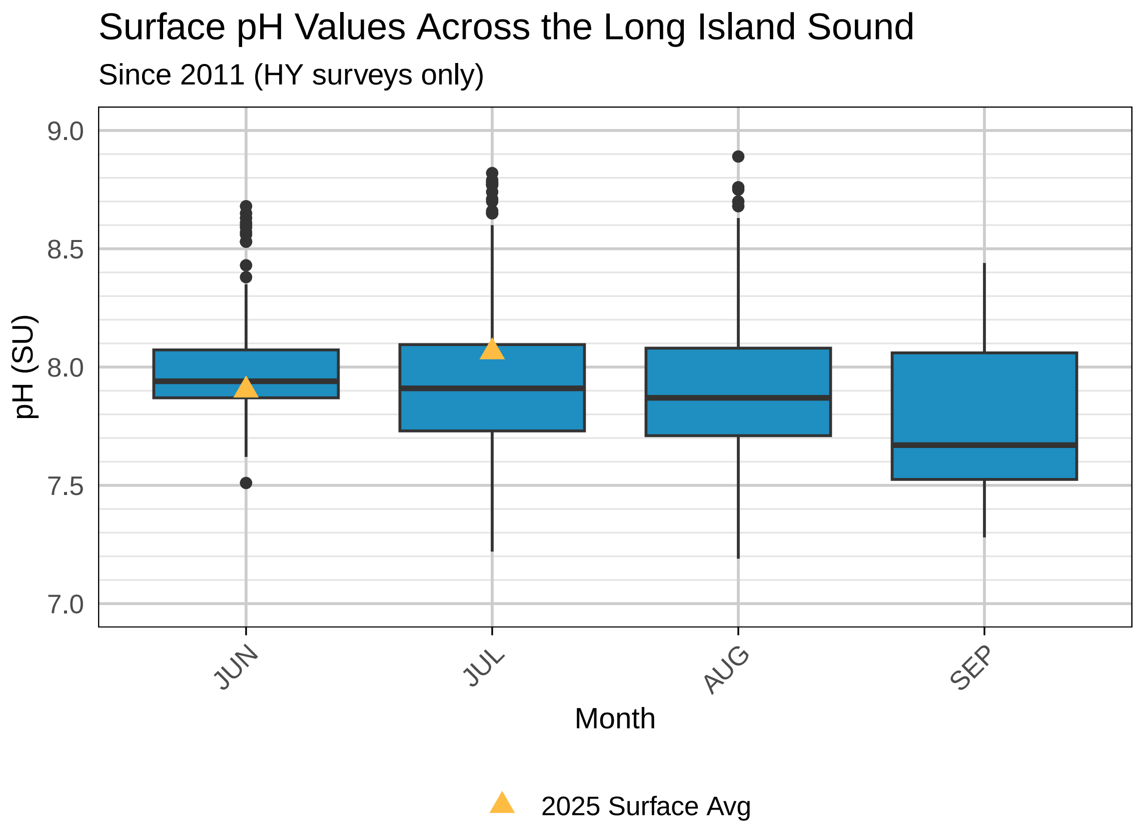
Ocean acidification has detrimental effects on marine life. Waters with a lower pH value, and therefore a greater acidity, have fewer carbonate ions. Calcifying species use available carbonate ions to produce their calcium carbonate shells. Therefore, ocean acidification harms the growth of calcifying 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.

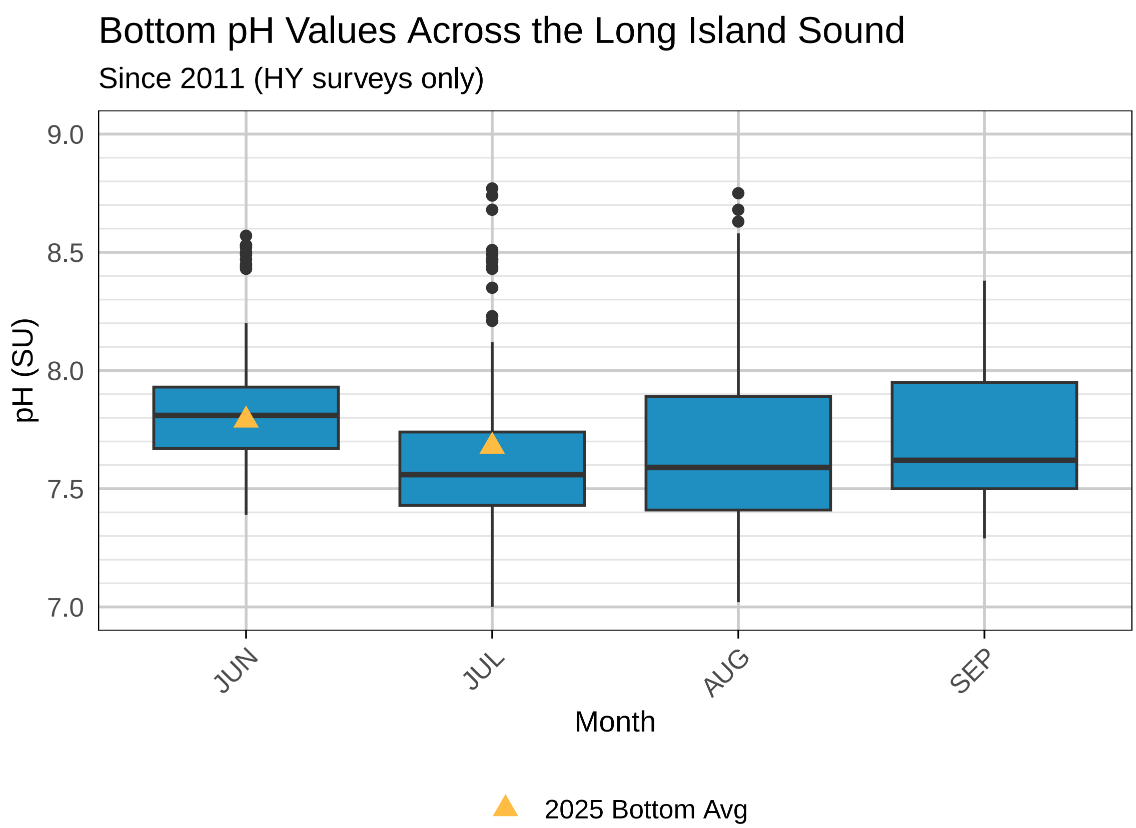
The average acidity of the ocean is around 8.1. This is a 0.06 decrease since 1985. However, the average pH of the Long Island Sound has been found to decrease by 0.04 each decade - a much more drastic change.[2]

The average surface and bottom pH from all stations across the LIS during the HYJUL25 survey were 8.06 and 7.68 respectively. The highest surface pH was 8.21 at Station A4, and the lowest surface pH was 7.9 at Station 15. The highest bottom pH was 8.05 at Station J2 and the lowest bottom pH was 7.43 at Station A4.



Comparing the average Long Island Sound pH values for each month since 2011





Salinity

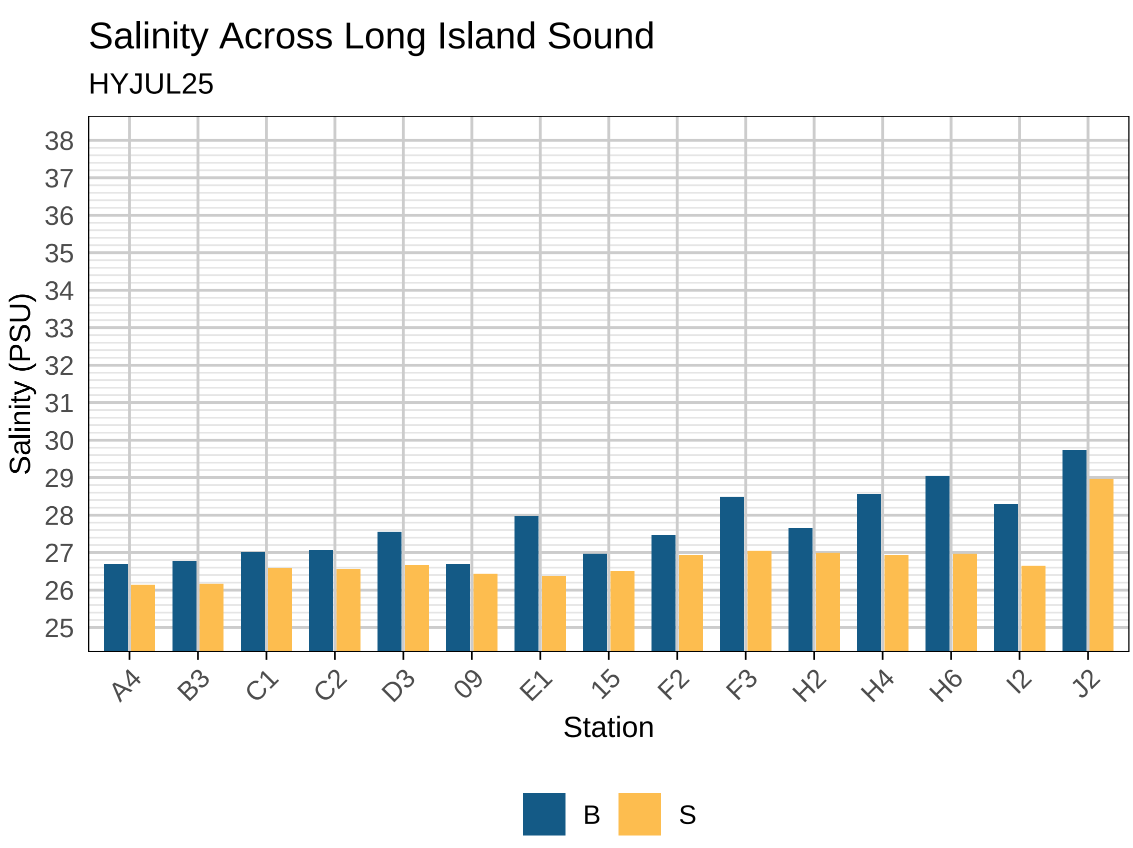
The Long Island Sound is an estuary, meaning its waters are a mix of both fresh and salt water. This is referred to as brackish water. The salt water is supplied by the Atlantic Ocean, while the majority of LIS fresh water comes from three major Connecticut Rivers: the Thames, the Connecticut, and the 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.

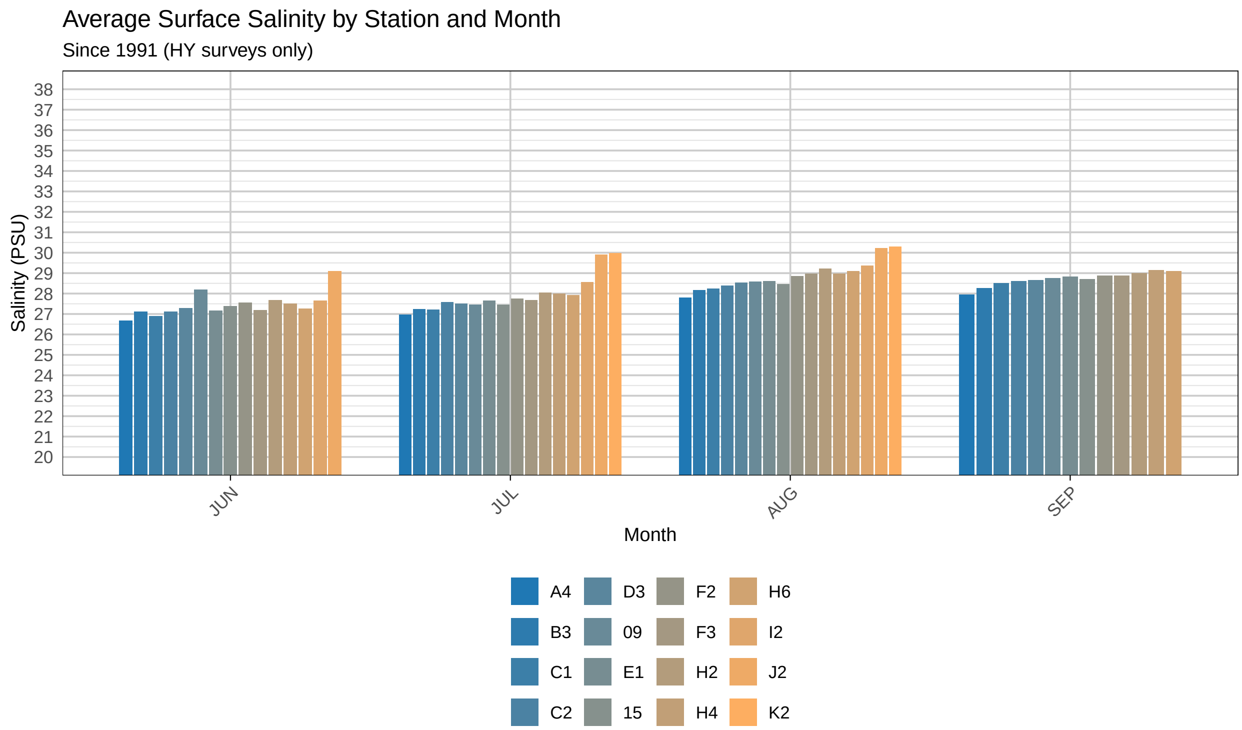
The average surface and bottom salinities from all stations across the LIS during the HYJUL25 survey were 26.79 PSU and 27.73 PSU respectively. The highest surface salinity was 28.96 PSU at Station J2, and the lowest surface salinity was 26.14 PSU at Station A4. The highest bottom salinity was 29.72 PSU at Station J2 and the lowest bottom salinity was 26.69 PSU at Stations 09 and A4.

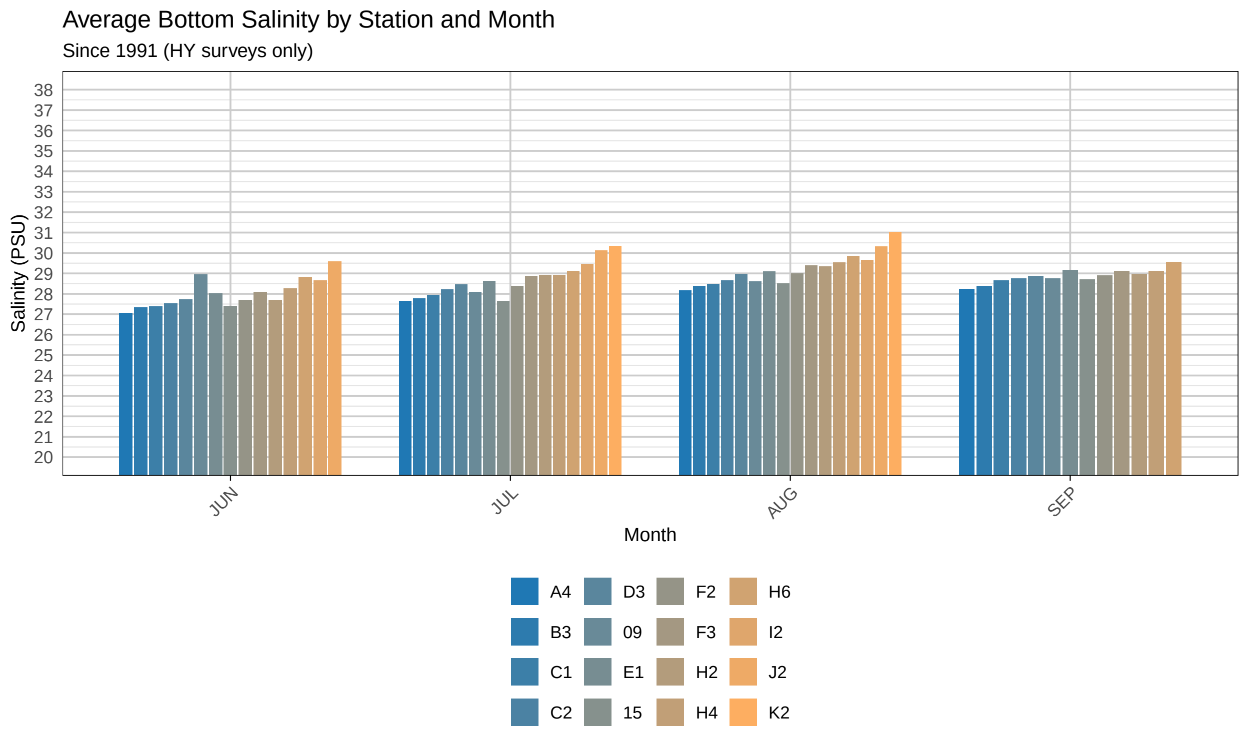
Average salinity across the Long Island Sound by station

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



Changes in salinity throughout the year



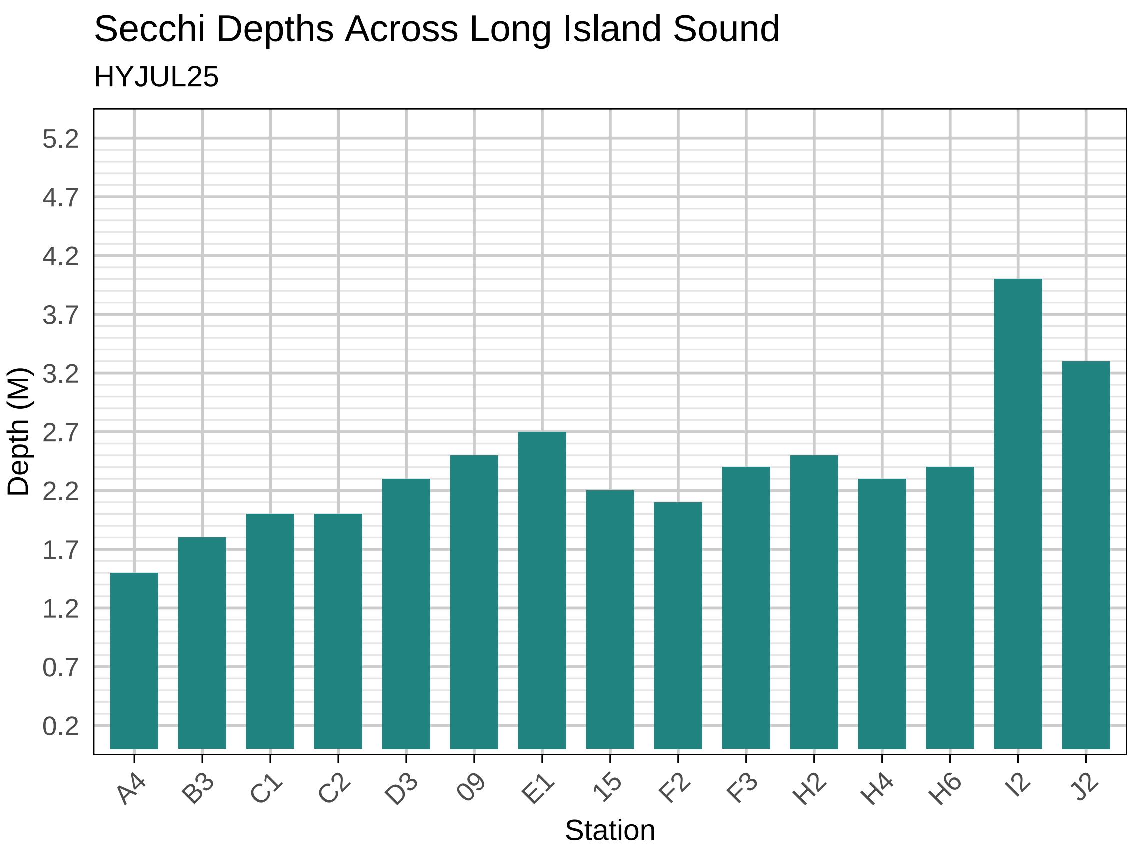


Secchi Disk Depth

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 HYJUL25 survey was 2.4 m. The greatest disk depth was 4 m at station I2. The lowest disk depth was 1.5 m at Station A4.

This survey's secchi disk depths at different stations across the Long Island Sound



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

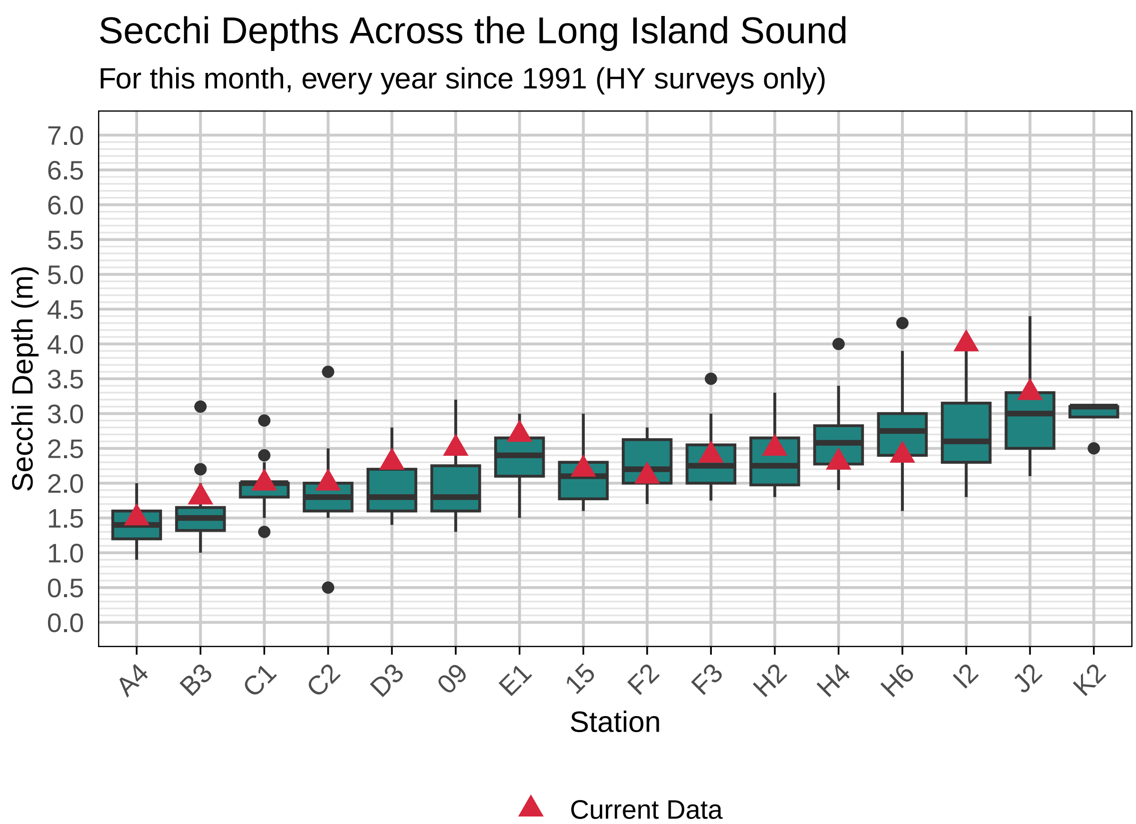
Secchi Depth Grading Thresholds

Grade	Depth Range (meters)	Score Equivalent
A	> 2.28	90–100%
B	2.12 – 2.28	80–90%
C	1.95 – 2.12	70–80%

Grade	Depth Range (meters)	Score Equivalent
D	1.80 – 1.95	60–70%
F	< 1.80	< 60%

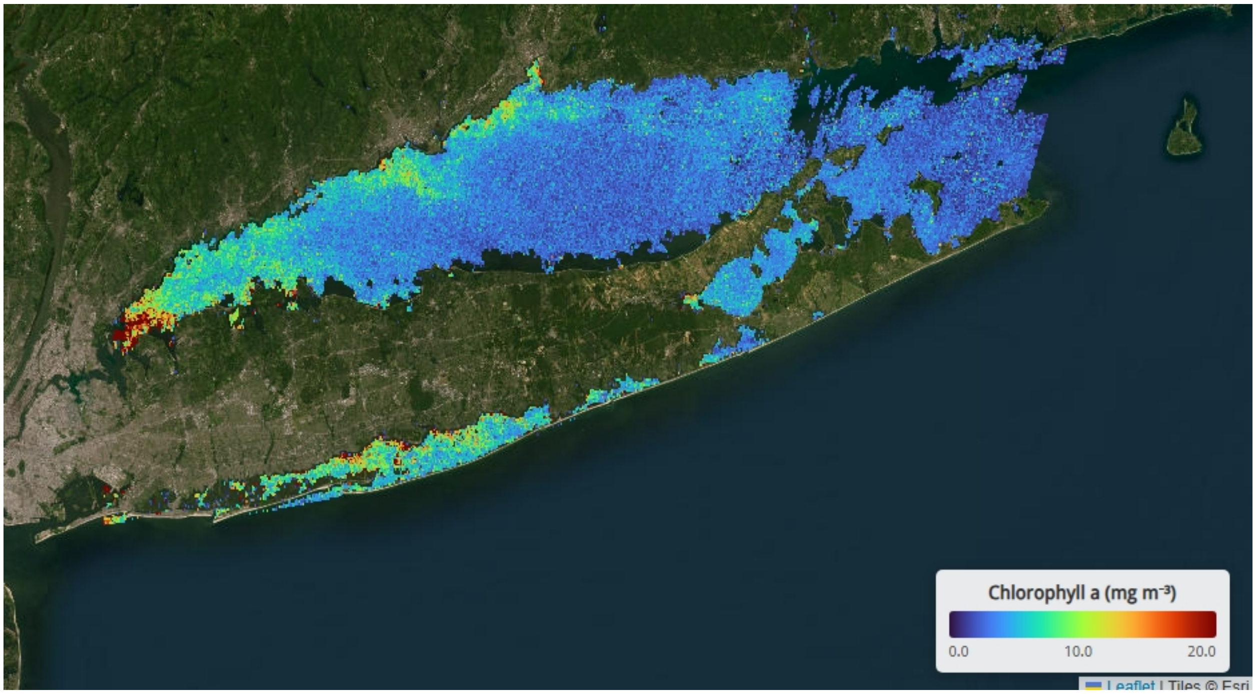
In the HYJUL25 survey, 9 stations received a grade of A, 1 station received a grade of B, 3 stations received a grade of C, 2 stations received a grade of F.

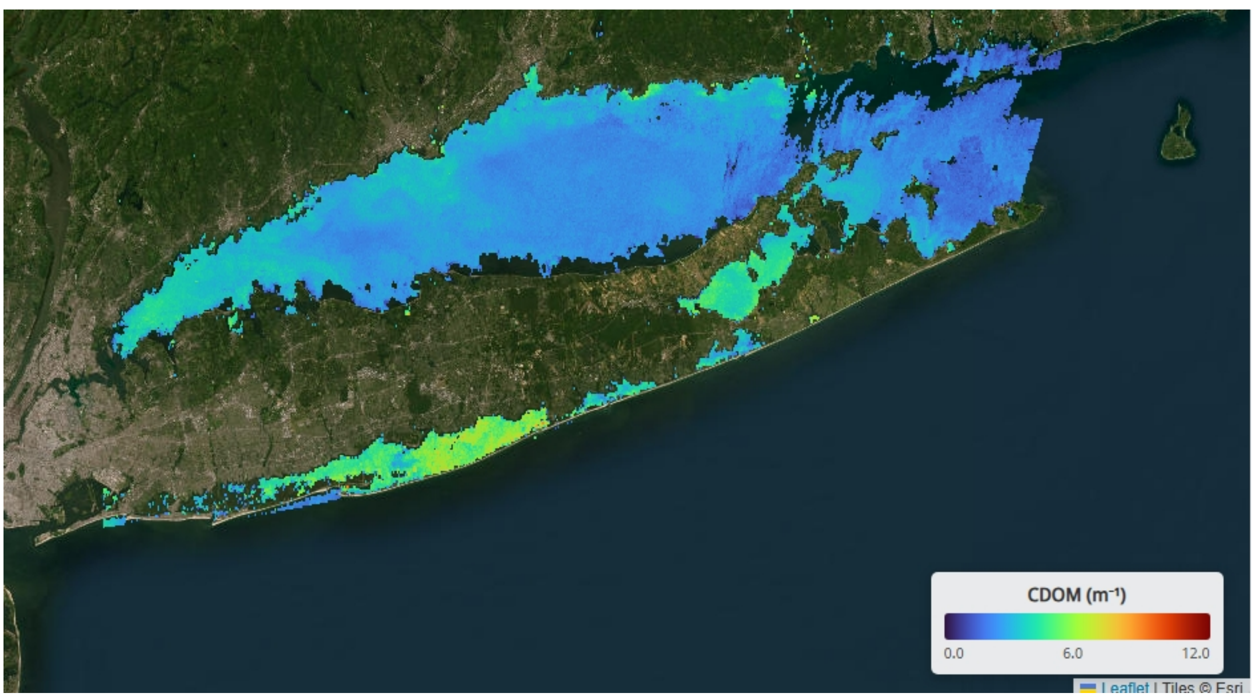
Looking at historical Secchi depth values across the Long Island Sound

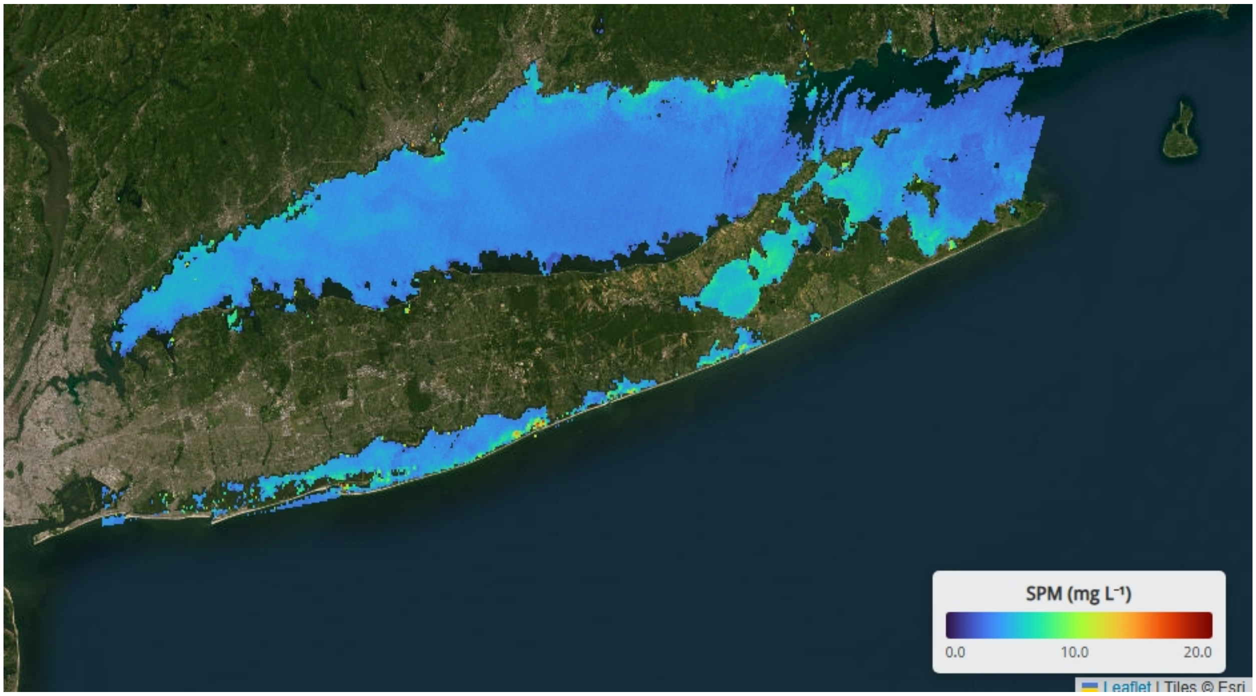


Remote sensing- CHLA, CDOM, SPM

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. The images below were collected during the HYJUL survey and excerpted from the website. CHLA imagery provides a measure of plankton biomass. CDOM and SPM provide a measure of turbidity.


Chlorophyll a (mg m⁻³)
0.0
10.0
20.0
Leaflet | Tiles © Esri


CDOM (m⁻¹)
0.0
6.0
12.0
Leaflet | Tiles © Esri



For more information: Please visit the Long Island Sound Water Quality and Monitoring Program website at: https://portal.ct.gov/deep/water/lis-monitoring/lis-water-quality-and-hypoxia-monitoring-program-overview

Or contact us: Katie.Obrien-Clayton@ct.gov 79 Elm Street Hartford, CT 06106 (860) 424-3176

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.