

Monitoring Long Island Sound - 18 years of water quality data

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Background

Since 1991, the Connecticut Department of Environmental Protection (CT DEP) has conducted an intensive year-round water quality monitoring program on Long Island Sound. Water quality is monitored by staff aboard the Department's Research Vessel *John Dempsey*. These data are used to quantify annual trends and differences in water quality parameters relevant to hypoxia, especially nutrients, temperature, and chlorophyll. These data are also used to evaluate the effectiveness of the management program to reduce nitrogen concentrations.



R/V John Dempsey

Sampling Design

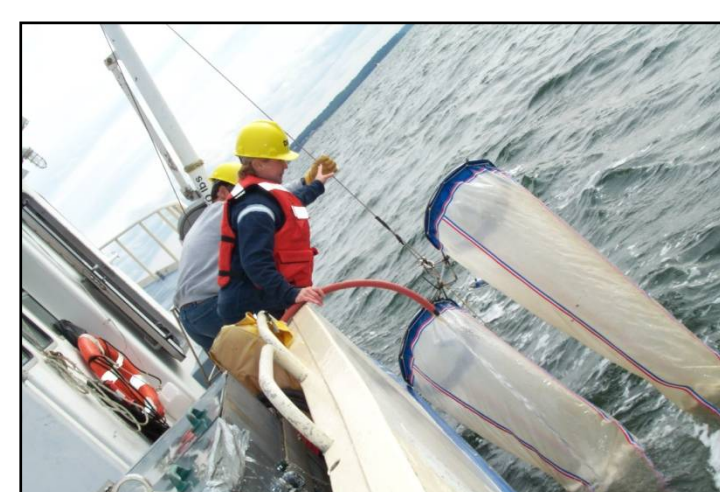
In 1994, CT DEP established 48 permanent sampling stations (Figure 1) to monitor hypoxia during the summer months of June, July, August and September. Seventeen of these are also sampled year round as part of the monthly water quality monitoring program. Originally, the sampling was aimed at evaluating the effects of dissolved oxygen concentrations on fish abundance and determining the temporal and spatial extent of hypoxia. Sampling stations were selected to reflect the varied sediment types and water depths found across the Sound with more sites concentrated in the west, where hypoxia was generally more severe.

In situ measurements are collected using a CTD equipped with auxiliary dissolved oxygen, fluorometer, and photosynthetically-active radiation (PAR) sensors.



Deploying the CTD and rosette

Water samples are collected using a Rosette Sampler at three depths: five (5) meters off the bottom, two (2) meters below the surface and additionally, during the summer hypoxia surveys, at one (1) meter off the bottom. Samples are analyzed for chemical parameters including particulate and dissolve nutrients (silica, carbon, nitrogen, ammonia, nitrate + nitrite, phosphorus, orthophosphate), chlorophyll a, and total suspended solids.



Retrieving the zooplankton net

Zooplankton samples are collected from six stations (B3, D3, F2, H4, I2, K2) and sent to researchers at the University of Connecticut for species composition, abundance, community structure, and spatial and temporal distribution throughout the Sound.

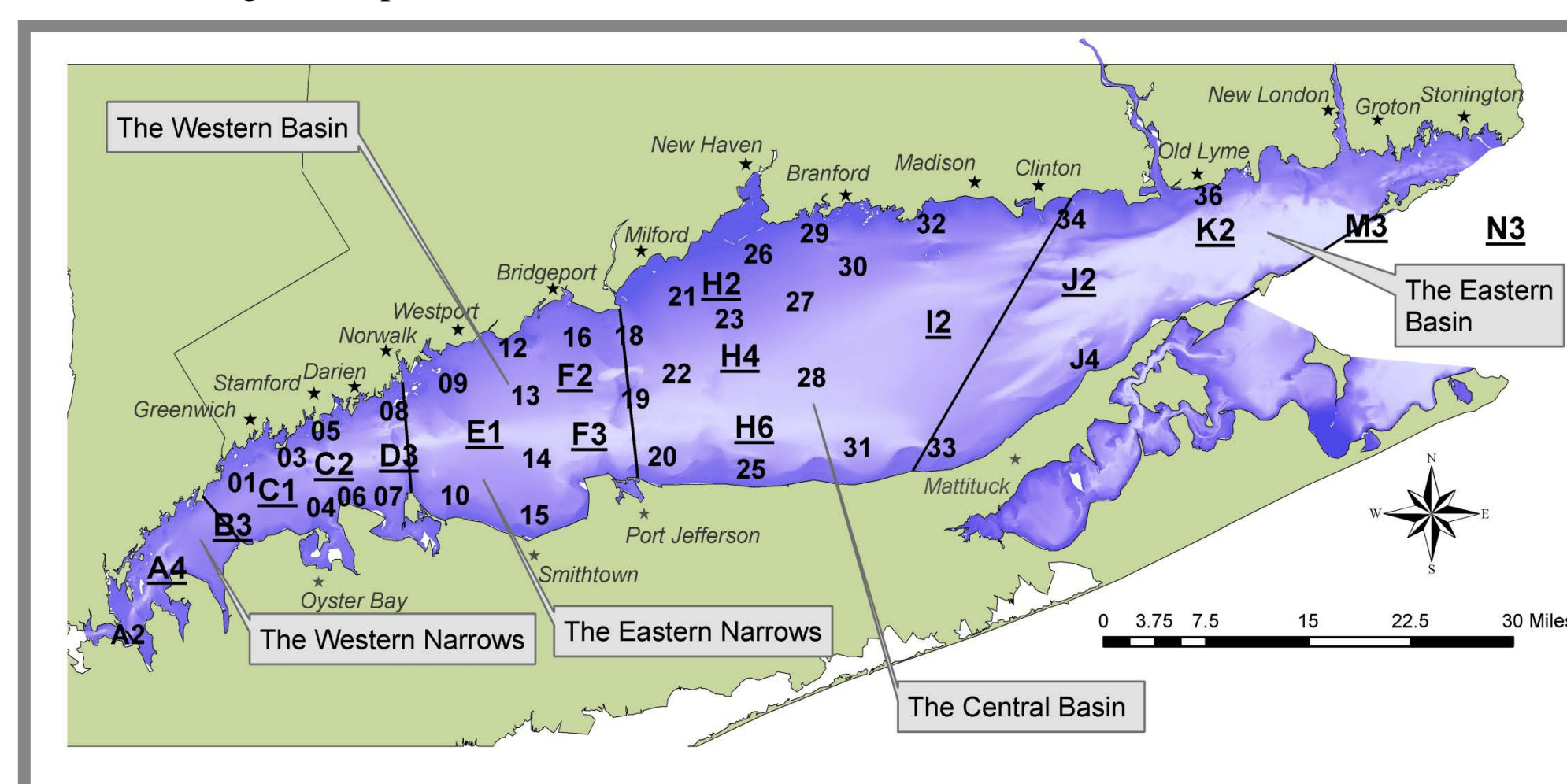


Figure 1. Long Island Sound Water Quality Monitoring Program Sampling Stations. Bolded underlined stations are sampled year-round. The remaining stations are sampled only during the summer months as part of the hypoxia surveys. N3 and A2 are no longer sampled.

Hypoxia

Hypoxia, or low dissolved oxygen ("DO") concentrations in the water, is defined under current Connecticut Water Quality Standards (2002) as DO concentrations below 3.5 mg/L. Hypoxic conditions have occurred in the Sound every year of the survey (Figures 2 and 3). The area affected by hypoxia is concentrated in the Narrows and Western Basin. Statistics for hypoxia events in Long Island Sound are summarized below.

- Average Date of Onset- July 4 (± 8 days)
- Average End Date- September 10 (± 13 days)
- Average Maximum Area- 297 mi² (± 105 mi²)
- Average Duration- 68 days (± 12 days)

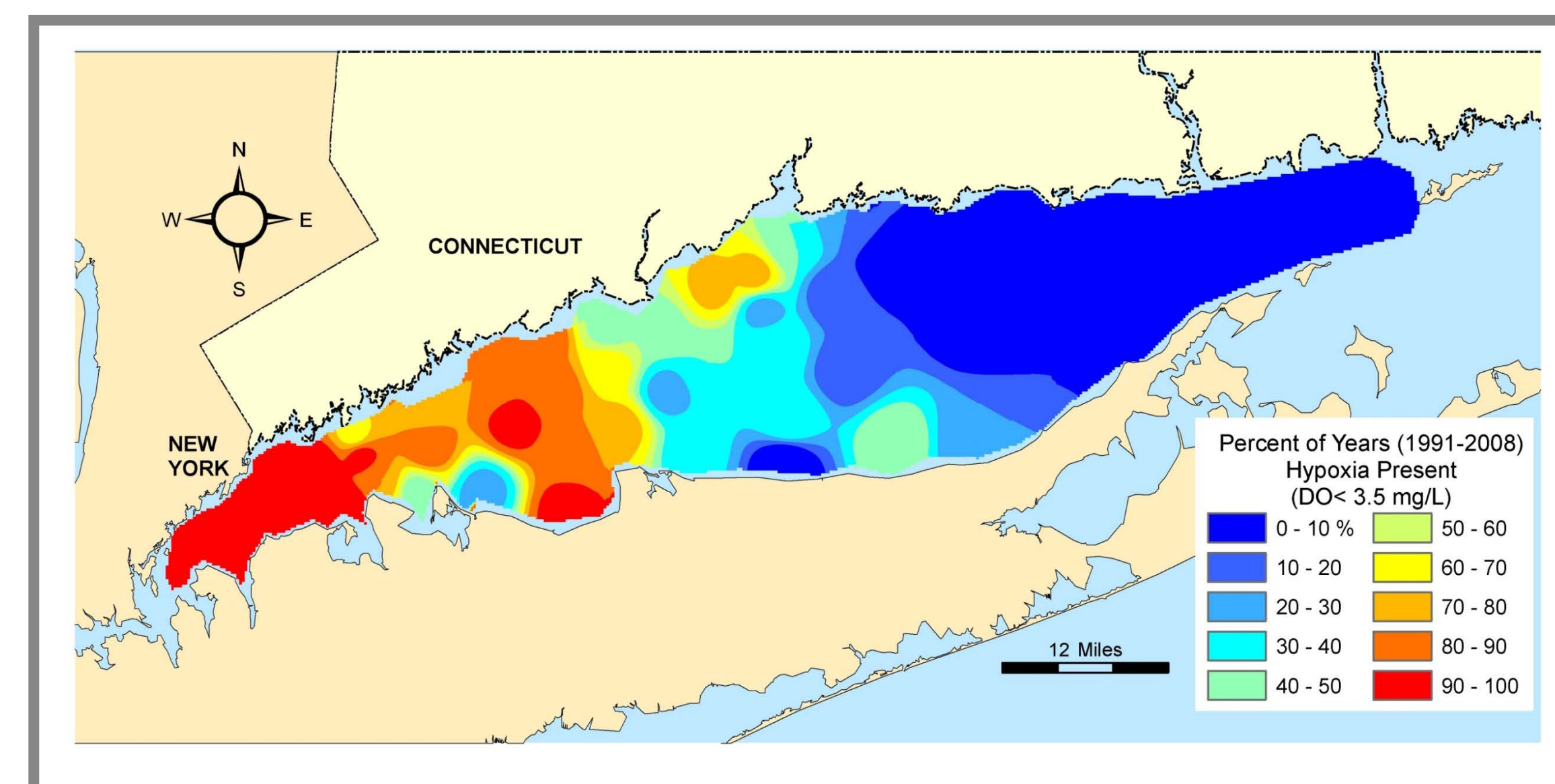


Figure 2. Frequency of hypoxic conditions in the bottom waters of Long Island Sound

Temperature

Water temperature plays a major role in the ecology of the Sound especially in the timing and severity of the summer hypoxia event. The temperature difference between the bottom waters and the surface waters is known as "delta T". This, along with salinity differences, creates a density gradient resulting in a stratification of water layers that hinders the oxygenated surface waters from circulating downward and mixing with the oxygen starved bottom waters. The greater the delta T the greater is the potential for hypoxia to be more severe.

The yearly average surface and bottom temperature of the Sound appear to be increasing (Figure 4).

Temperature statistics for LIS are summarized below.

- 1991-2008 average bottom temperature- 12.27°C
- 1991-2008 average surface temperature- 16.76°C
- Minimum bottom water temperature- 1.32°C recorded during WQFEB04 LIS survey
- Minimum surface water temperature- 1.22°C recorded during WQFEB04 LIS survey
- Maximum bottom water temperature- 24.03°C recorded during WQAUG04 LIS survey
- Maximum surface water temperature- 27.02°C recorded during WQAUG04 LIS survey

Total Nitrogen

In Long Island Sound, the primary limiting nutrient for algal growth that leads to low DO levels is nitrogen. Since pre-colonial times the load of nitrogen delivered to Long Island Sound has more than doubled based on estimates of the Long Island Sound Study. Sewage treatment plant discharges, atmospheric deposition, and runoff are the primary sources of nitrogen enrichment to Long Island Sound. While surface total nitrogen concentrations vary widely, they generally decrease from west to east (Figure 5).

See the following web pages for details on what the states of Connecticut and New York are doing to control nitrogen discharges to LIS.

- http://www.ct.gov/dep/cwp/view.asp?a=2719&q=325572&depNav_GID=1654
- http://www.nyc.gov/html/dep/html/harbor_water/nitrogen.shtml
- http://www.iec-nynjct.org/reports/2009/iec_annual_report.2008.pdf

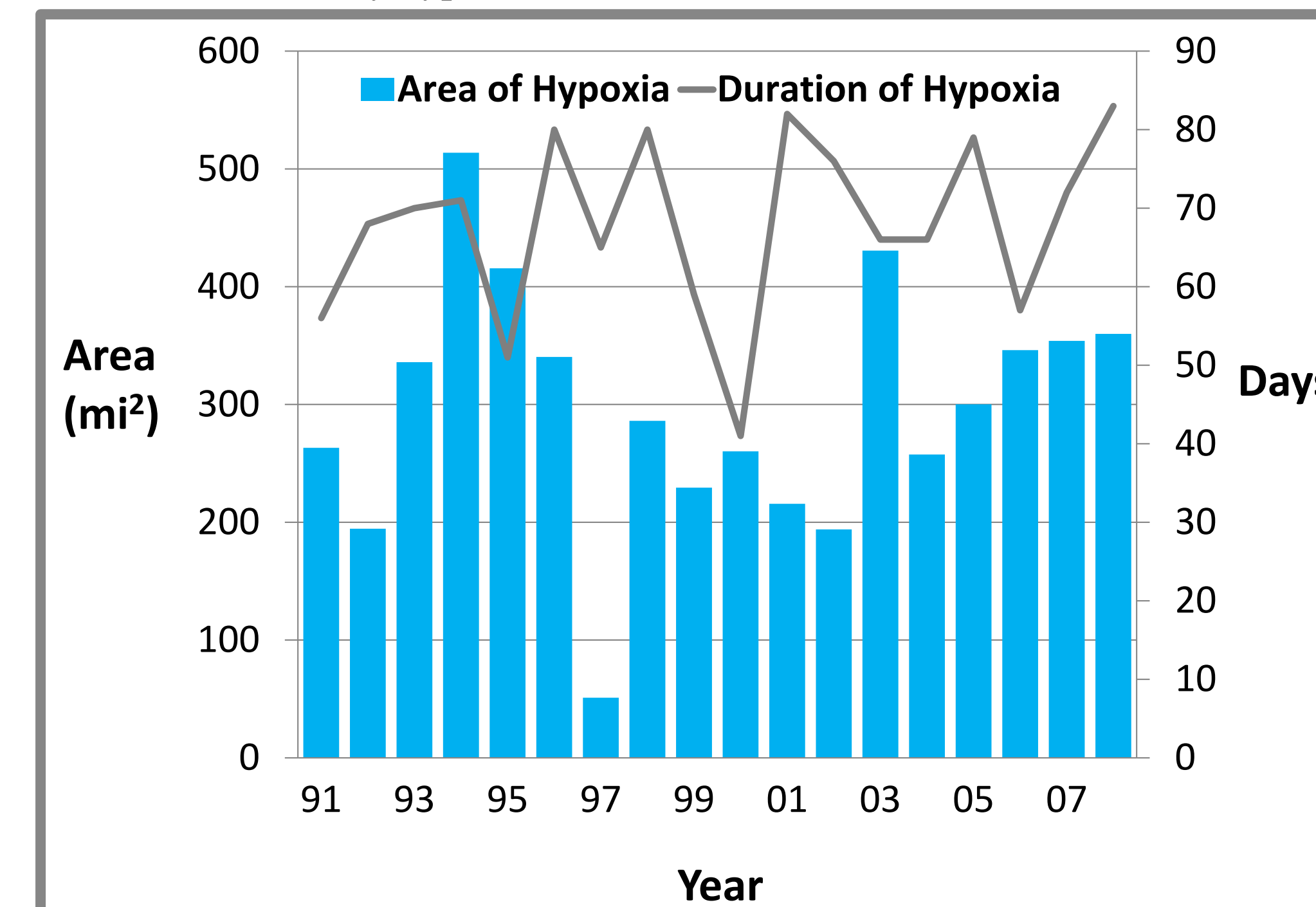


Figure 3. Area and duration of hypoxia by year in the bottom waters of LIS. Hypoxia is DO <3.5 mg/L

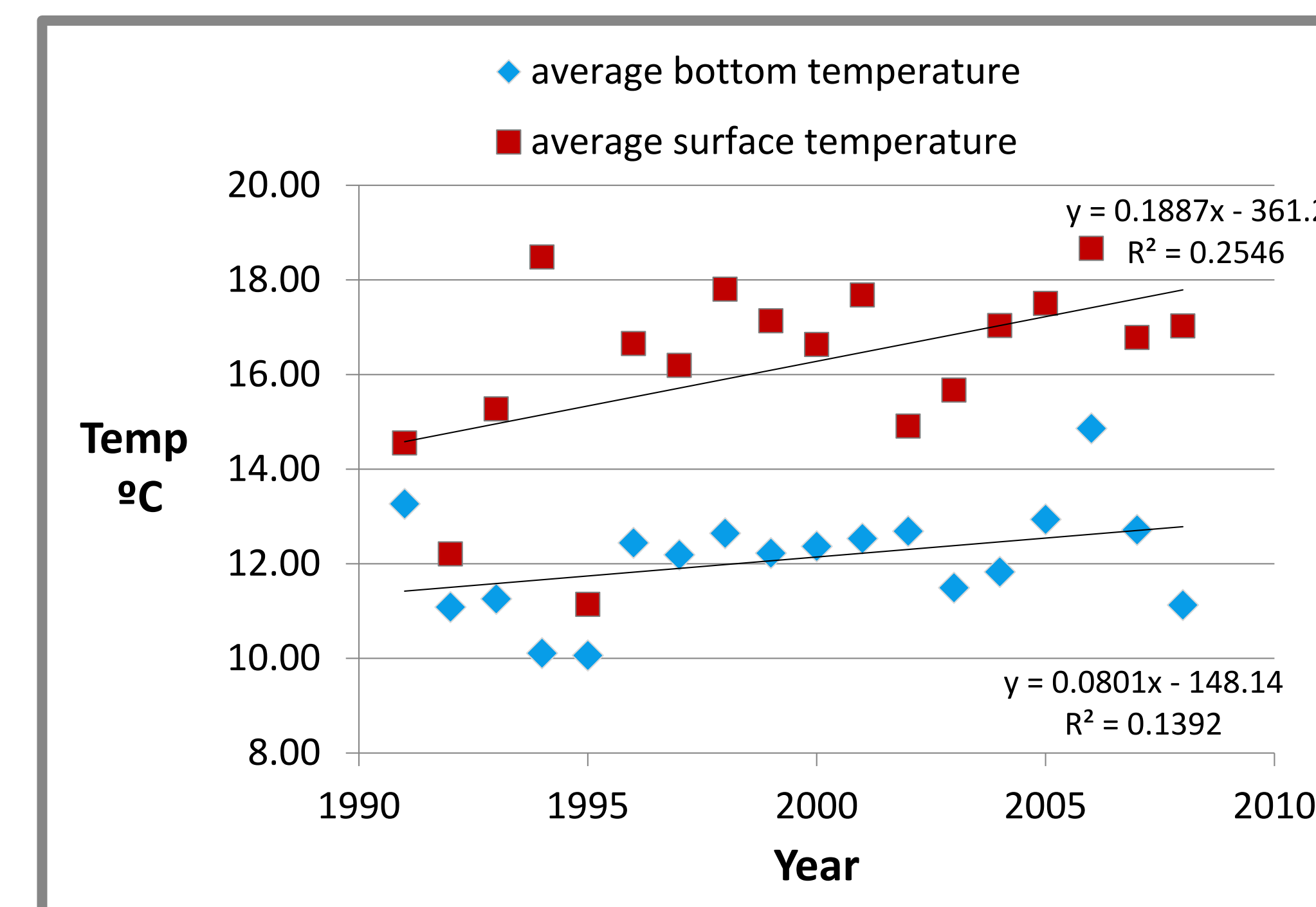


Figure 4. Yearly average surface and bottom water temperatures of Long Island Sound from 1991-2008.

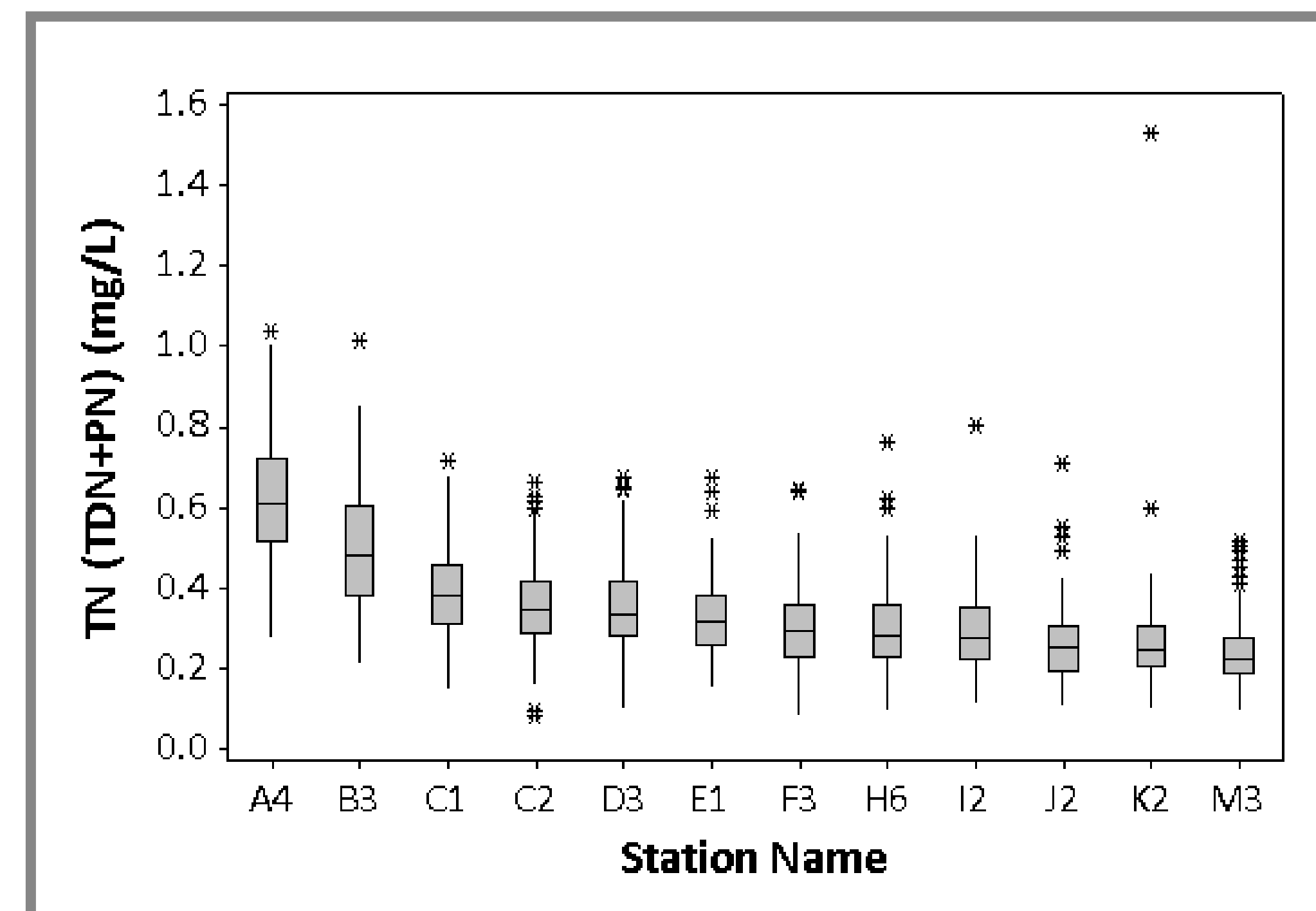


Figure 5. Boxplot of total nitrogen concentrations in the surface waters of Long Island Sound from 1991-2008.

Data Usage

Clean Water Act Assessment (§305(b) and 303(d))

Under Section 305(b) of the Clean Water Act, States are required to monitor, assess, and report on the quality of their waters in relation to designated uses established by the State's Water Quality Standards. Section 303(d) of the CWA requires each State to compile a list identifying those waters not meeting water quality standards and assign a priority ranking for each impaired water body for Total Maximum Daily Load development. Connecticut prepared its first Integrated 305(b)/303(d) Report in 2006, following national efforts to consolidate reporting requirements and in accordance with guidance provided by the Environmental Protection Agency.



Fish Kill, Branford River, CT

Data collected by the CT DEP monitoring program are used to assess the Aquatic Life Use (ALUS) for LIS.

LIS has been impaired for ALUS due to low DO since 1992. In the current 2008 Integrated Report, LIS was divided into 210 assessment units (Figure 6). Of those only:

- 24 fully support the ALUS,
- 71 are impaired for ALUS,
- and 115 are not assessed.

61 of the impairments are due to low DO.

A nitrogen Total Maximum Daily Load (TMDL) was approved by EPA in 2001 which requires a 58.5% load reduction from all sources to LIS by 2014. The TMDL is currently being updated and revised.

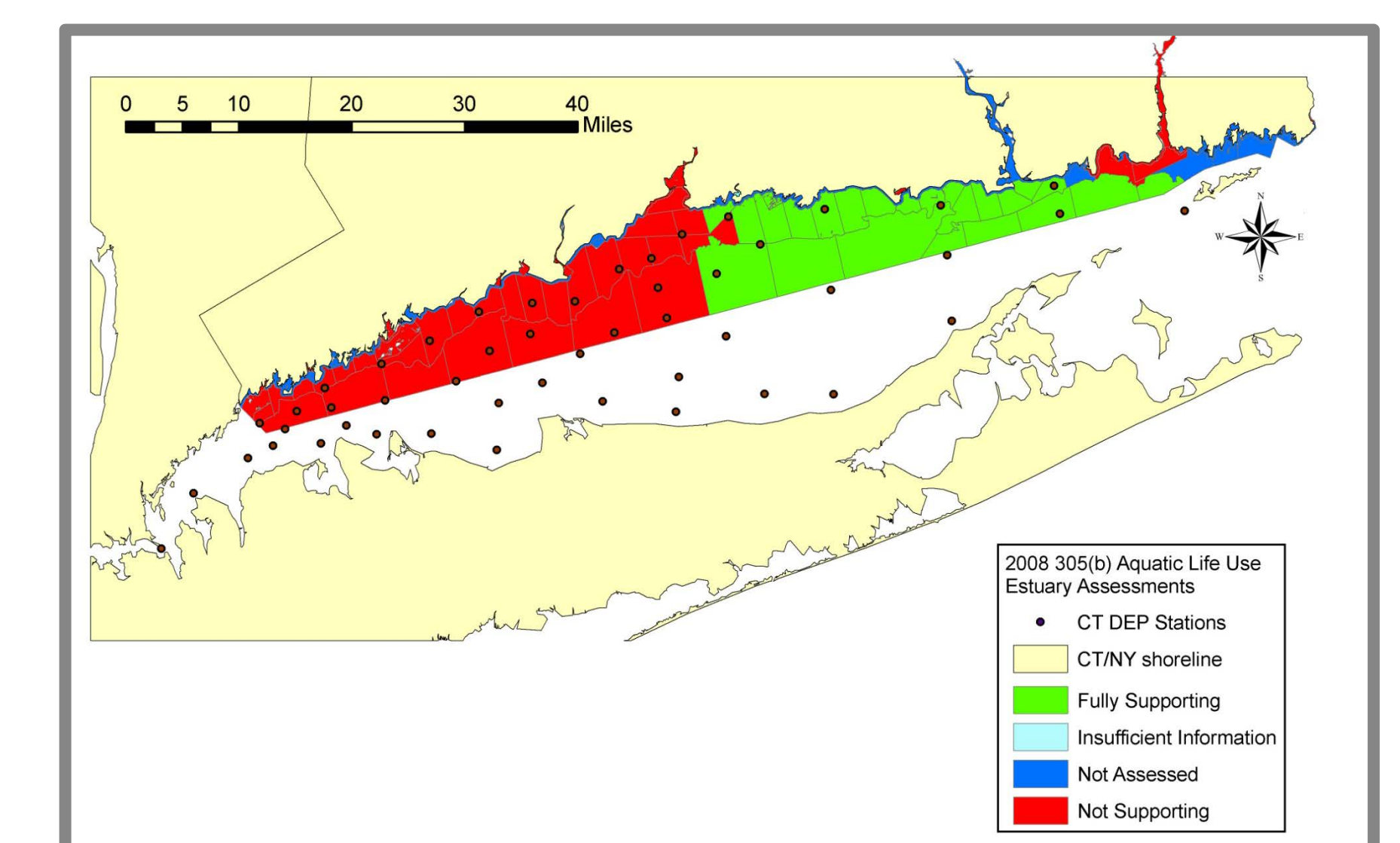


Figure 6. Estuarine Segments assessed in the 2008 Integrated Report for the Aquatic Life Use

Acknowledgments

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For further information

Please contact katie.obrien-clayton@ct.gov. More information on this and related projects can be obtained at www.ct.gov/dep/lis. Data are available online at the LISICOS webpage <http://lisicos.uconn.edu/>.