NEW ENGLAND INTERSTATE WATER POLLUTION CONTROL COMMISSION

INTERSTATE ENVIRONMENTAL COMMISSION

HYPOXIA IN THE FAR WESTERN LONG ISLAND SOUND AND UPPER EAST RIVER

2015 REPORT

NEIWPCC
New England Interstate Water Pollution Control Commission

Interstate Environmental Commission
A Tri-State Water and Air Pollution Control Agency
NY · NJ · CT

The New England Interstate Water Pollution Control Commission (NEIWPCC) is a not-for-profit interstate agency established by an Act of Congress in 1947 (www.neiwpcc.org). NEIWPCC serves and assists its member states – New York, Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont – by coordinating efforts that encourage cooperation among the states, developing resources that foster progress on water issues, representing the region in matters of federal policy, initiating and overseeing scientific research projects, training environmental professionals, educating the public, and providing overall leadership in water management and protection. For more than sixty years, the Commission has managed interstate water conflicts by means of sound science, coordination, and adaptation. Since May 15, 2012, NEIWPCC has served as a financial and program adviser to the Interstate Environmental Commission (IEC) to coordinate and fund efforts that benefit IEC District's jurisdictional waters as it relates to water quality, fisheries, wetlands, and recreation.

The Interstate Environmental Commission (IEC), established in 1936, is a tri-state water and air pollution control agency serving the states of New York, New Jersey, and Connecticut (www.iec-nynjct.org). The Commission's programs and activities reach far beyond its environmental mandates and date back to a time before many state and national environmental agencies were established. The Interstate Environmental Commission's area of jurisdiction – the Interstate Environmental District – runs west from New Haven, CT and Port Jefferson, NY on Long Island Sound; west from Fire Island Inlet on the southern shore of Long Island incorporating a portion of the Atlantic Ocean; and south from the borders of Rockland and Westchester Counties on the Hudson River to Sandy Hook, NJ (Figure 1). With a commitment to environmental management from a regional perspective and supported by its nationally accredited environmental laboratory, the Commission, in cooperation with the environmental departments of its member states and numerous other environmental agencies, engages in a variety of programs that include, but are not limited to: ambient water quality monitoring, providing compliance assistance to the states through facility inspections and sampling, outfall reconnaissance inspections to detect and eliminate illicit discharges at CSO and MS4 outfalls, and public education, outreach and research.

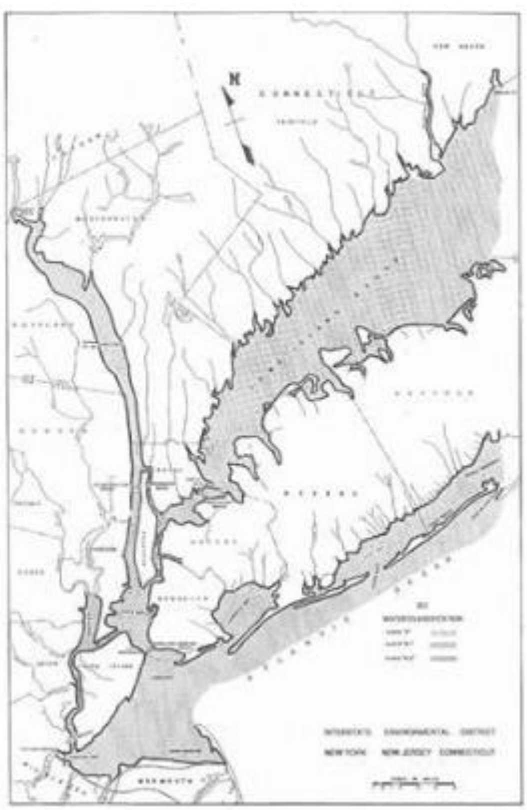


Figure 1. IEC District's Jurisdictional Area.

WHAT IS HYPOXIA?

Hypoxia is a term used to describe the condition of low dissolved oxygen concentrations in water. The Long Island Sound Study defines hypoxic waters as those that have dissolved oxygen concentrations of less than 3.0 milligrams per liter (mg/L). While this benchmark is used to identify the onset of hypoxia, biological stresses on aquatic organisms have been observed when dissolved oxygen concentrations fall below 5.0 mg/L. Additionally, aquatic organisms that are in early life stages are far more susceptible to the effects of hypoxia compared to free swimming adults due to increased sensitivity and an inability to effectively mobilize. Dissolved oxygen concentrations of 5.0 mg/L or greater are considered to be protective of marine life.

Natural chemical and physical factors can induce hypoxic conditions in aquatic environments; however, human activities may also impact hypoxia in water systems, such as Long Island Sound, an estuary which regularly experiences periods of hypoxia in the summer.

Hypoxia has been identified as an issue of great concern for water quality in the Sound. Hypoxic events result from a variety of factors, including nutrient loading and water stratification due to seasonal variation. Stratification in Long Island Sound's water column is directly impacted by density and temperature gradients. Excess nutrient loading into Long Island Sound can come from many sources including wastewater treatment plant effluent, runoff, fertilizers, atmospheric deposition of nitrogen, and erosion of nutrient rich soil.

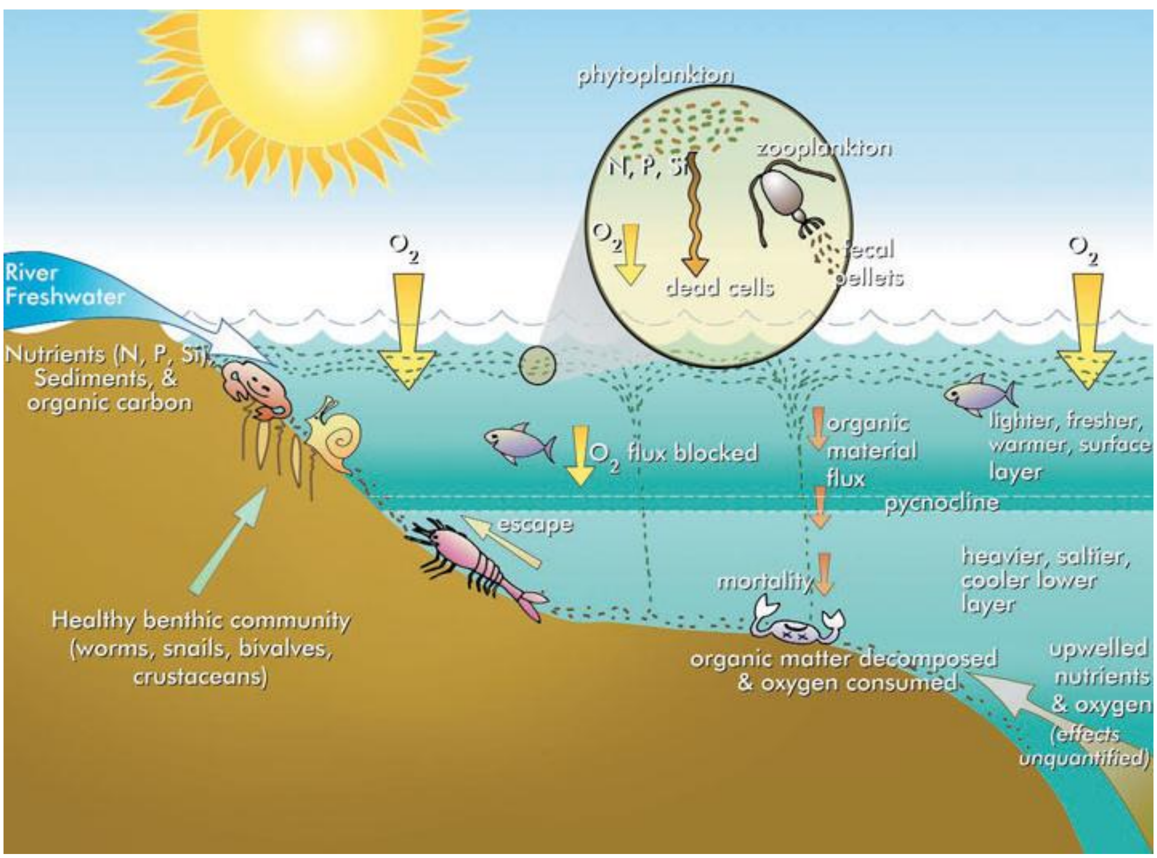


Figure 2. Eutrophication Diagram. http://www2.epa.gov/sites/production/files/2015-03/eutro_big.jpg

The amount of nutrients in the Sound directly correlates with the rate of primary production. Decomposition of biomass that results from primary production causes hypoxic conditions. Figure 2 above illustrates the process of eutrophication; excess nutrients promote algae growth and as these algae decompose, oxygen is consumed in the process, thus resulting in hypoxia. Stratification prevents the mixing of oxygen rich surface waters with oxygen deficient bottom waters. Without mixing, bottom waters cannot receive adequate oxygen to sustain aquatic life.

THE LONG ISLAND SOUND

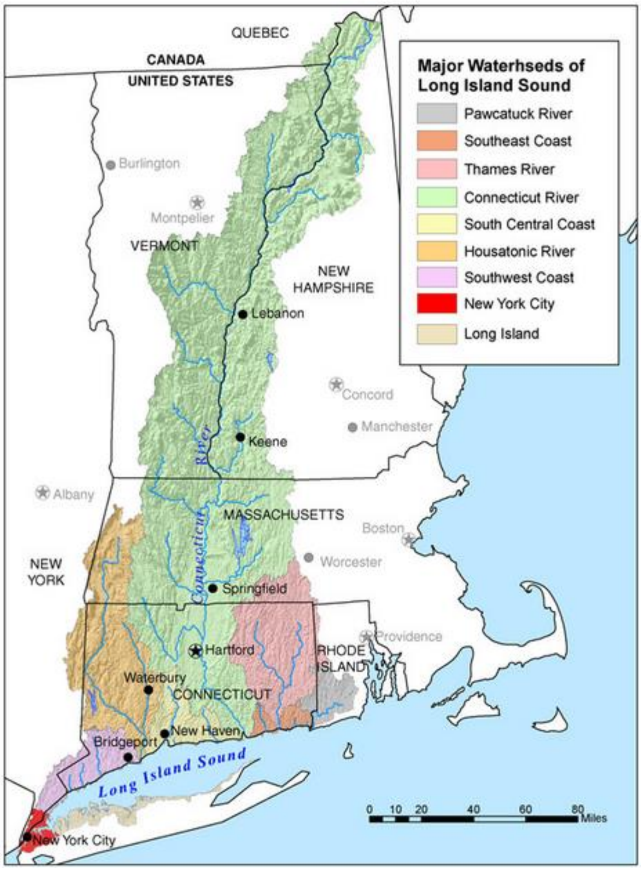


Figure 3. Long Island Sound Watershed.
http://nh.water.usgs.gov/project/ct_atlas/n_model.htm

Designated as an estuary of national significance by Congress in 1987, the Long Island Sound is home to a diverse network of flora and fauna and over 4 million people. It is an estuary of recreational, commercial, and socioeconomic value. The Sound is bordered by the states of Connecticut and New York and has a watershed area extending through Maine and Quebec that encompasses over 16,000 square miles and 9 million people (Figure 3). Over time, the Sound has been subject to the effects of increased nutrient loading as a result of urbanization and changes in land use. Seasonal weather patterns, particularly during the summer months, exacerbate the effects of nutrient loading, causing hypoxic conditions in the Sound, most prominently in the Western Basin. This, in turn, negatively impacts the water quality of this estuary, the ecosystem services and resources it provides, and the habitat that is home to many of its many species.

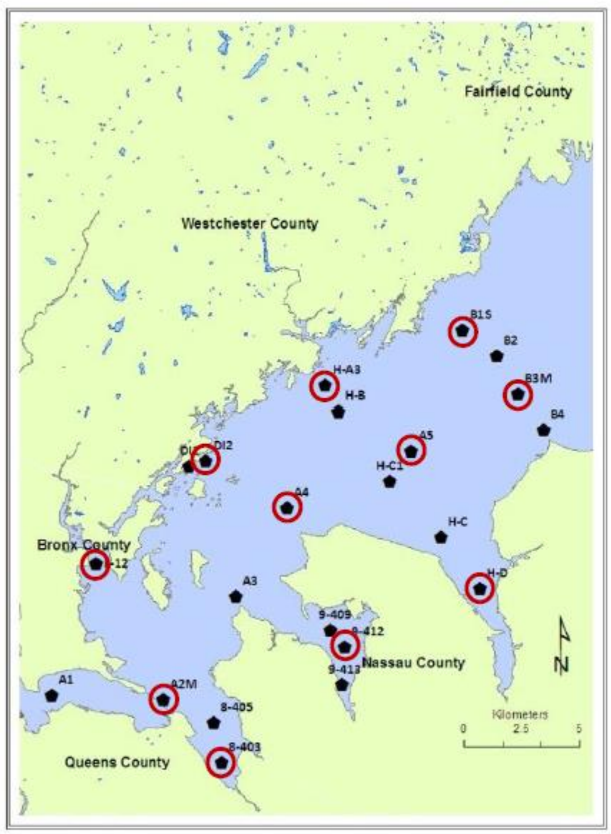
In response to the critical need to document summer hypoxic conditions in Long Island Sound and its embayments as defined in the Long Island Sound Study's Comprehensive Conservation and Management Plan, IEC District has monitored dissolved oxygen, as well as key water quality parameters relevant to hypoxia, in far western Long Island Sound since 1991. The purpose of this report is to present the 2015 results from the IEC District's Western Long Island Sound Monitoring Program. Data and results focus primarily in the area of hypoxia and related parameters.

IEC District Intern collecting a sample in Little Neck Bay.

IEC DISTRICT'S WESTERN LONG ISLAND SOUND MONITORING PROGRAM

In summer 2015, IEC District conducted 12 weekly surveys between the months of June and September in far western Long Island Sound. The goal of each survey was to document hypoxic conditions and monitor for hypoxia-related parameters. IEC District's monitoring locations consist of 22 stations in far western Long Island Sound, which include both open water and embayment stations that span seven study areas: Upper East River, Eastchester Bay, Westchester County Shoreline, Mid-Long Island Sound Waters, Little Neck Bay, Manhasset Bay, and Hempstead Harbor. The map below illustrates IEC District's monitoring areas. For a more detailed description of each monitoring location, see Appendix A.

During each survey, in-situ measurements were gathered at bottom, mid, and surface depths of all 22 stations using a YSI Pro-Plus Multimeter. For stations with a depth of less than 10 meters, only surface and bottom-depth measurements were taken. In-situ parameters included depth, temperature, salinity, dissolved oxygen, pH, percentage of cloud cover, sea state, and water clarity as measured by Secchi disk depth. In addition to in-situ field parameters, surface grab samples were taken every other survey week (6 total surveys) at 11 of 22 stations. These surface grabs were collected and analyzed for total suspended solids (TSS), chlorophyll *a*, and biochemical oxygen demand (BOD) at IEC District's laboratory. In addition, a suite of nutrient parameters, which include Ammonia, Nitrate +Nitrite, Particulate Nitrogen, Total Dissolved Phosphorus, Orthophosphate/DIP, Particulate Phosphorus, Dissolved Organic Carbon, Particulate Carbon, Dissolved Silica, and Biogenic Silica were analyzed by the University of Maryland's Center for Environmental Science.



IEC District's 22 Sampling Stations in WLIS. Red circles indicate nutrient sampling sites.

All field work was conducted in accordance with the IEC District's EPA approved Quality Assurance Project Plan (QAPP) entitled *Ambient Water Quality Monitoring in the Far Western Long Island Sound*. All analyses performed by the IEC District were completed in accordance with IEC District's *Laboratory Quality Control Manual* and Standard Operating Procedures, the aforementioned EPA approved QAPP, and NEIWPCC's *Quality Management Plan*. In an effort to ensure quality of data, duplicate measurements were taken at two stations during each survey. Appendix B lists the parameters and their associated analytical methods.

HYPOXIA IN BOTTOM WATERS

Bottom water depths of Long Island Sound are most susceptible to hypoxia as the process of biomass decomposition consumes oxygen. For the purposes of this report, and to align with the Long Island Sound Study's water quality definition for hypoxia, hypoxia is defined as less than 3.0 mg/L. (Note: dissolved oxygen (DO) concentrations fluctuate depending on the time of day, tidal cycle, depth, water temperature and salinity). Figures 4 and 5 below detail the concentration of dissolved oxygen in bottom and surface waters observed this season.

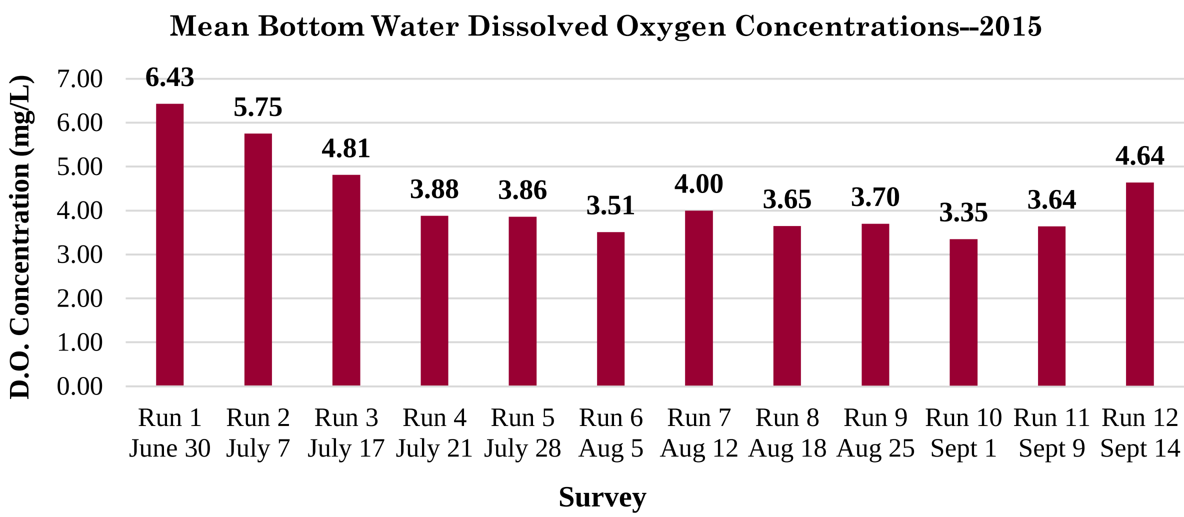


Figure 4. Mean Bottom Dissolved Oxygen Concentrations in WLIS.

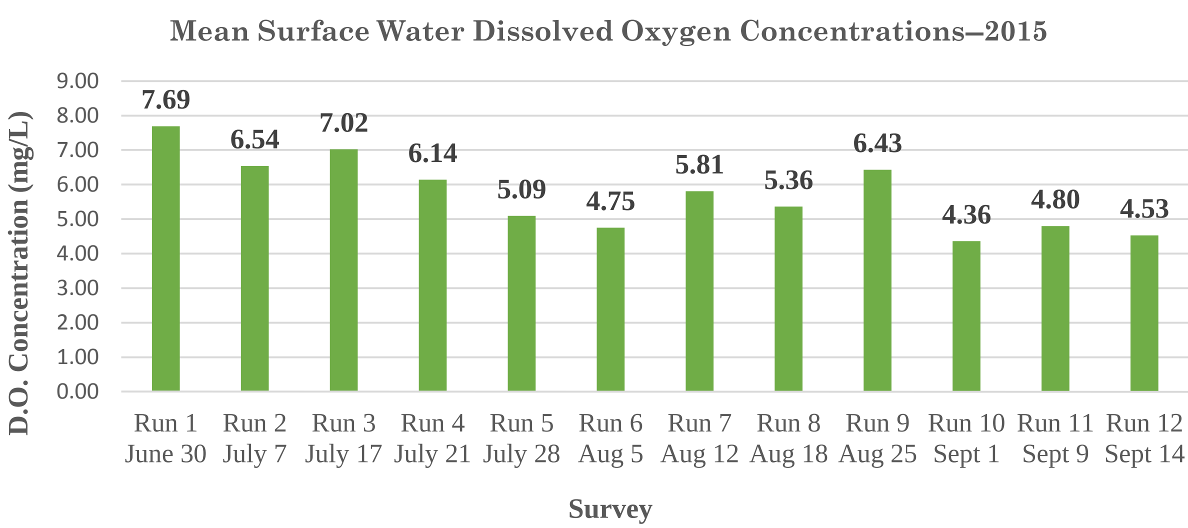


Figure 5. Mean Surface Dissolved Oxygen Concentrations in WLIS.

Dissolved oxygen concentrations from each station were averaged to comprise the mean DO concentration for each survey. This season, mean bottom and surface water DO concentrations did not fall below 3.0 mg/L throughout the 12 surveys. However, individual monitoring stations and larger study areas did fall below 3.0 mg/L.

FREQUENCY OF HYPOXIA BY STUDY AREA AND MONITORING LOCATION

IEC District's WLIS Monitoring Area covers seven study areas that are shown in Figure 6. The seven study areas include Upper East River, Eastchester Bay, Westchester County Shoreline, Mid-Long Island Sound Waters, Little Neck Bay, Manhasset Bay, and Hempstead Harbor. As can be discerned from Figures 7 and 8, the study areas that had the most incidences of hypoxia were mid-LIS waters, Manhasset Bay, and along the Westchester Shoreline. Three mid-LIS stations and one station in Manhasset Bay (9-413) were hypoxic for 50% or more of the season (6 or more of the 12 surveys). In contrast, embayment stations in Hempstead Harbor, Little Neck Bay, and Manhasset Bay were hypoxic for 2 or less surveys with the exception of station 9-413 in Manhasset Bay.

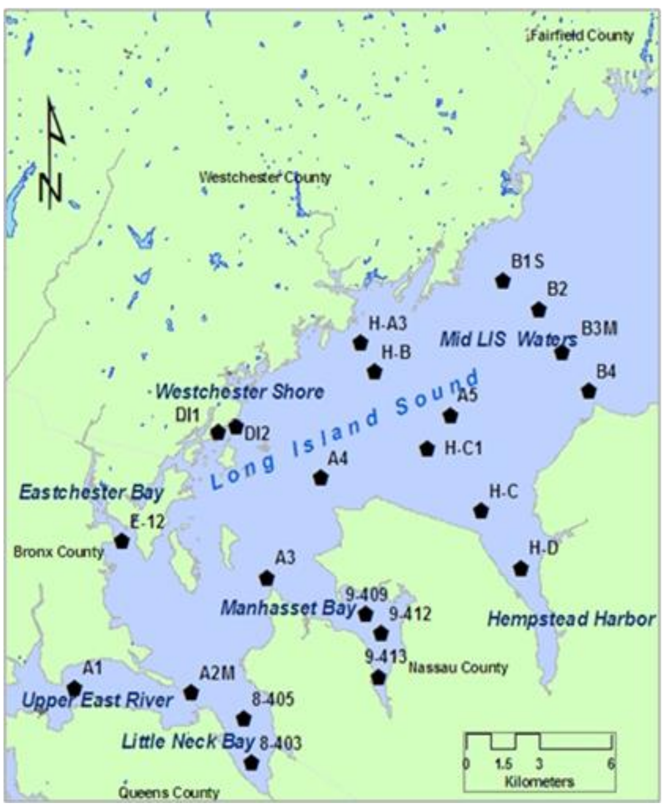


Figure 6. IEC District Study Areas in WLIS.

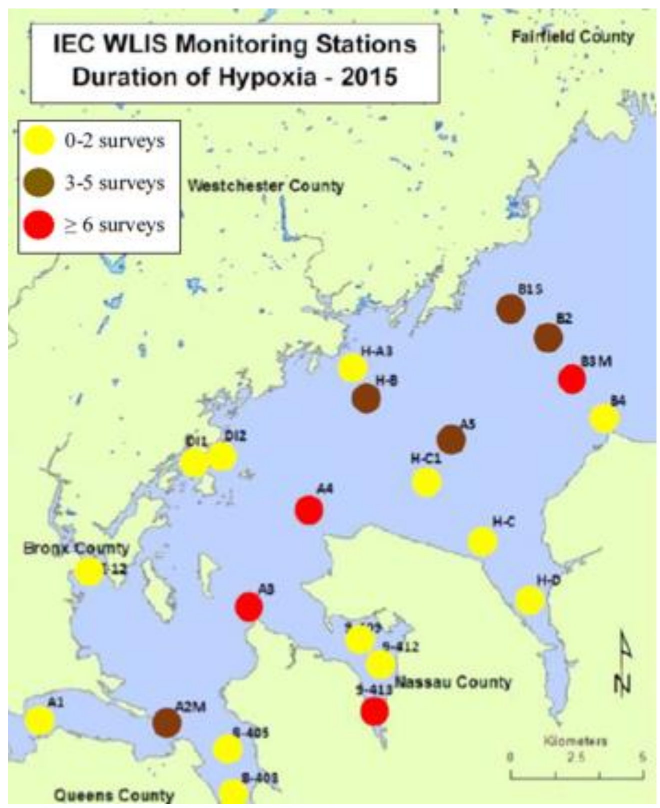


Figure 7. Duration of Hypoxia in WLIS-2015.

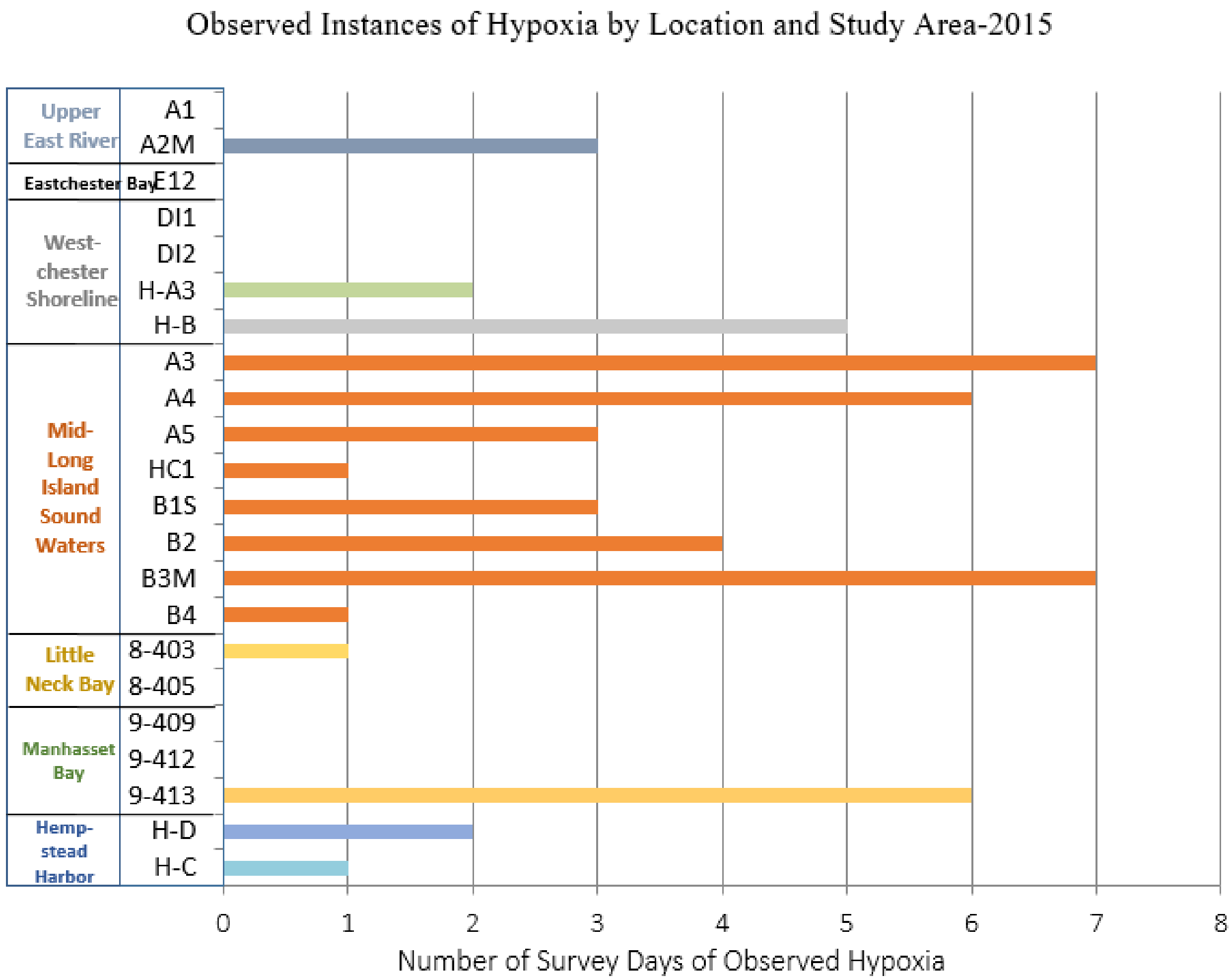


Figure 8. Hypoxia by Study Area.

Throgs Neck Bridge by Sampling Station A2M.

SURVEY OBSERVATIONS

The extent and duration of hypoxia in the Sound varies each year due to various inter-related dynamics including physical factors such as the strength of stratification in the water column, and biochemical factors, such as the degree of phytoplankton decay, which is directly related to nitrogen loading and excess nutrient concentrations. Some observed water quality conditions, including hypoxia data, are summarized in Table 1 below. Survey #8 conducted in mid-August had the highest percentage of hypoxic stations for the 2015 monitoring season.

Execution Lighthouse (station A5).

Table 1. Hypoxia Related Water Quality Observations and Calculations.

Survey	Date	% of Observed Hypoxic Stations	Mean Bottom DO (mg/L)	Mean Surface DO (mg/L)	Mean Water Column ΔT (°C)	Secchi Disk Range (m)
1	6/30/15	0%	6.43	7.69	1.33	2.5 – 6.5
2	7/9/15	0%	5.75	6.54	1.53	2.5 – 5.5
3	7/17/15	18%	4.81	7.02	1.36	2.5 – 6.5
4	7/21/15	27%	3.88	6.14	2.63	1.5 – 4.5
5	7/28/15	27%	3.86	5.09	2.39	2.0 – 5.5
6	8/5/15	18%	3.51	4.75	1.04	2.5 – 5.5
7	8/12/15	23%	4.00	5.81	0.80	3.0 – 6.5
8	8/18/15	41%	3.65	5.36	1.16	1.5 – 5.0
9	8/25/15	32%	3.70	6.43	1.17	2.5 – 6.0
10	9/1/15	23%	3.35	4.36	0.48	1.0 – 5.0
11	9/9/15	23%	3.64	4.80	0.5	2.5 – 6.0
12	9/14/15	5%	4.64	4.53	0.05	1.0 – 10.0

FREQUENCY OF HYPOXIA OVER TIME

Table 2 illustrates the number of surveys where hypoxia was observed at each sampling location during IEC District's 2013-2015 monitoring seasons. In 2015, 12 surveys were conducted, 2014 included 7 surveys, and 2013 included 11 surveys. Some stations, such as A1, 9-409, and 8-405, have had no instances of observed hypoxia over the last three monitoring periods, some have improved in the last three seasons, and others have remained the same or increased in the number of hypoxic events.

Figure 9 below visually depicts hypoxia data over the last three monitoring seasons by representing the percentage of dissolved oxygen concentrations throughout each season. This season, 9% of all DO measurements were hypoxic (< 3.00 mg/L), whereas 45% of measurements were greater than 5.00 mg/L. The western Long Island Sound has demonstrated a relatively consistent pattern, in terms of percentage of hypoxia measurements, over the last three years.

	2013	2014	2015
A1	0	0	0
A2M	2	1	3
E12	0	0	0
DI1	0	0	0
DI2	2	0	0
H-A3	2	0	2
H-B	6	2	5
A3	6	2	7
A4	5	5	6
A5	6	4	3
H-C1	5	1	1
B1S	3	0	3
B2	3	0	4
B3M	7	1	7
B4	0	0	1
8-403	0	2	1
8-405	0	0	0
9-409	0	0	0
9-412	2	0	0
9-413	5	5	6
H-D	1	1	2
H-C	4	0	1

Table 2. Number of Hypoxic Events by Station (2013-2015).

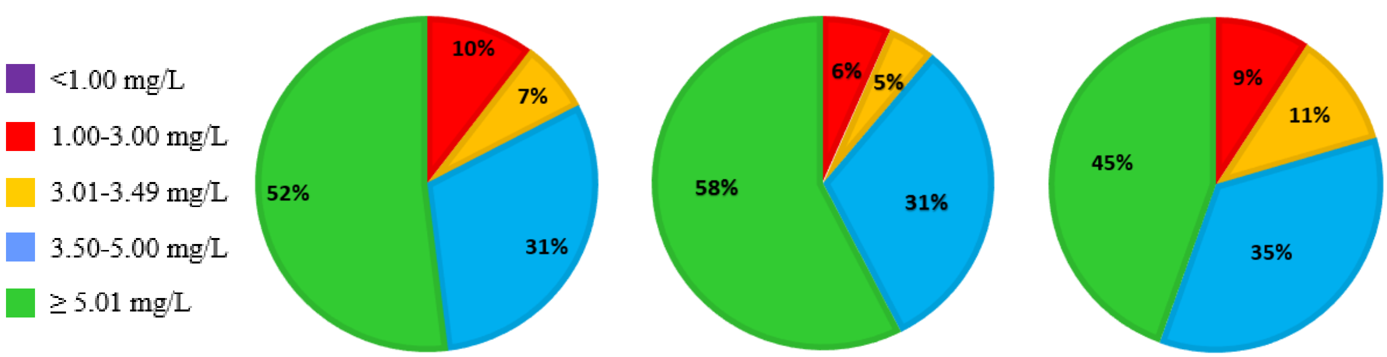


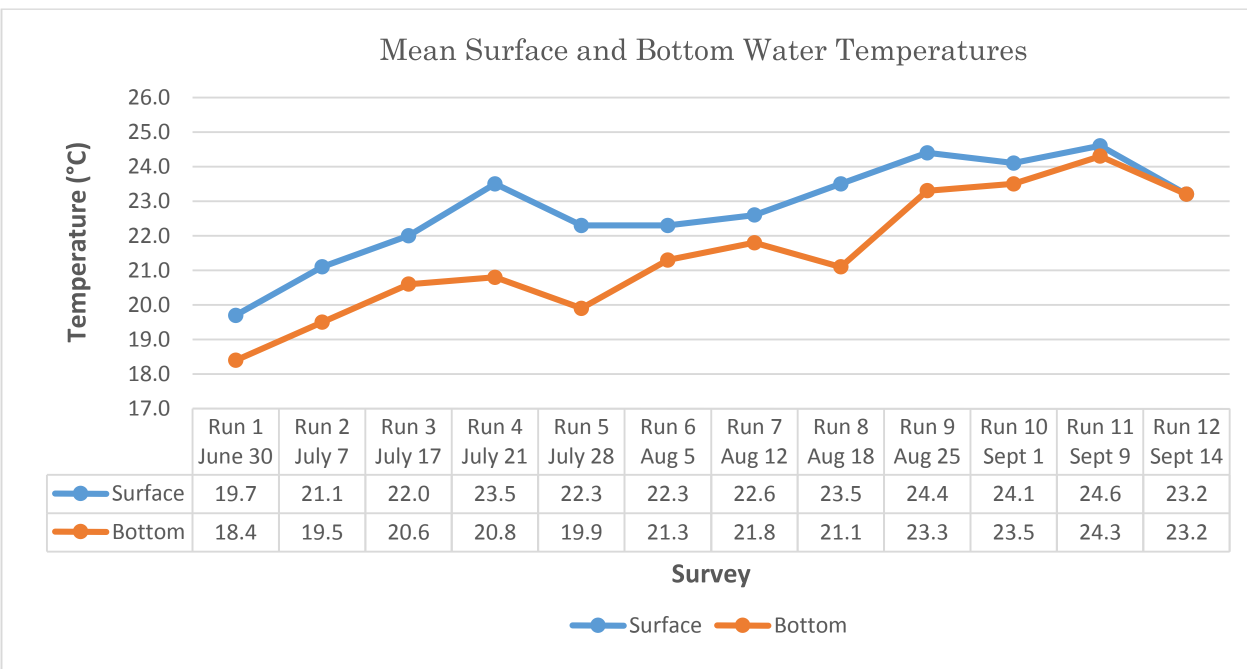
Figure 9. Percentage of Dissolved Oxygen Concentrations between 2013-2015.

WATER TEMPERATURE

Performing sample analysis at the IEC District Laboratory.

The temperature of Long Island Sound plays an integral role in the severity of hypoxia. During the summer months, warmer temperatures cause Long Island Sound waters to stratify due to temperature differences associated with depth. This results in the formation of a thermocline and a pycnocline. The presence of a thermocline and pycnocline inhibit mixing between surface and bottom water layers, thus intensifying the severity of hypoxia. However, as fall approaches, water temperatures become cooler and storm events become more frequent, resulting in vertical mixing between surface and bottom water layers. The mixing of these layers restores oxygen throughout the water column, most importantly at deeper depths. This, in turn, reduces the extent of hypoxia.

Figure 10 below graphically depicts the changes in mean water temperatures in both surface and bottom layers that were observed during each survey. As the summer progressed, temperatures throughout the water column increased. The highest temperatures were observed during the third week of July and mid-August to mid-September, with mean surface and bottom waters peaking at 24.6 °C and 23.5 °C, respectively.



	Run 1 June 30	Run 2 July 7	Run 3 July 17	Run 4 July 21	Run 5 July 28	Run 6 Aug 5	Run 7 Aug 12	Run 8 Aug 18	Run 9 Aug 25	Run 10 Sept 1	Run 11 Sept 9	Run 12 Sept 14
Surface	19.7	21.1	22.0	23.5	22.3	22.3	22.6	23.5	24.4	24.1	24.6	23.2
Bottom	18.4	19.5	20.6	20.8	19.9	21.3	21.8	21.1	23.3	23.5	24.3	23.2

Figure 10. Mean Temperatures in Surface and Bottom Waters.

DISSOLVED OXYGEN AND TEMPERATURE: 25 YEARS

Table 3 below summarizes the highest (bold), lowest (underlined), and mean summer temperatures; the mean temperature change; and the percentage of hypoxic surface and bottom waters since 1991 in the far western Long Island Sound.

Table 3. Dissolved Oxygen and Temperature Data and Calculations 1991-2015.

Year	Mean Summer Temp. (ºC)		Mean ΔT (ºC)	Mean Summer DO (mg/L)		% Hypoxic Measurements (DO<3.0 mg/L)	
	Surface	Bottom		Surface	Bottom	Surface	Bottom
1991	22.2	21.5	0.65	6.47	4.21	0	24.2
1992	21.1	19.9	1.22	7.10	4.72	0	6.8
1993	21.8	20.3	1.49	6.88	4.19	0.93	24.1
1994	21.5	19.8	1.62	6.49	4.09	4.17	33.3
1995	22.3	20.8	1.46	6.85	5.24	0	3.5
1996	21.4	20.0	1.36	6.52	4.09	1.44	17.8
1997	21.5	19.8	1.63	6.97	5.15	1.55	19.3
1998	21.9	20.7	1.13	6.27	4.21	0	17.5
1999	22.6	21.2	1.32	6.40	3.91	0	25.4
2000	21.4	20.5	0.84	7.82	4.55	0	15.0
2001	22.0	20.8	1.12	6.59	3.19	3.83	47.0
2002	22.6	21.2	1.45	6.10	3.46	5.33	43.8
2003	21.1	19.2	1.85	6.81	3.50	2.89	37.8
2004	21.4	20.1	1.36	5.37	2.65	9.13	**68.9**
2005	22.9	20.9	**2.00**	7.36	3.50	3.31	44.1
2006	21.6	19.8	1.81	6.27	3.53	4.62	40.7
2007	21.2	19.7	1.51	7.10	4.10	2.23	19.1
2008	22.0	20.7	1.26	6.07	2.97	4.31	60.4
2009	22.0	20.3	1.70	**8.28**	4.25	1.59	27.5
2010	22.9	21.5	1.47	6.25	3.84	**11.3**	28.2
2011	22.3	21.0	1.33	5.95	4.05	1.14	21.5
2012	**23.3**	**22.1**	1.21	5.98	3.53	4.53	36.4
2013	22.4	21.0	1.37	6.58	4.10	0.40	24.7
2014	21.3	20.3	0.99	6.92	**5.62**	4.35	13.6
2015	22.8	21.5	1.20	5.71	4.27	2.25	17.4

The 2012 season was the warmest, as can be discerned from surface and bottom water temperatures that are highlighted in bold. The highest mean ΔT was in 2005. The greatest percentage of hypoxia in surface was in 2004 and 2010 for bottom waters.

SALINITY

Salinity, measured in parts per thousand (ppt), quantifies the salt content in water. It is an important water quality parameter for interpreting observed dissolved oxygen concentrations as salinity can affect algal growth. In addition, most aquatic species have preferred salinity ranges. Freshwater inputs (from rivers or runoff) to Long Island Sound lower salinity through dilution. In addition, runoff can deliver associated pollutions and solids. The graph below (Figure 11) depicts mean salinity data during the 2015 sampling season in both surface and bottom waters. It is important to note that surface salinity is consistently less than that of bottom waters due to stratification. Cooler and denser bottom waters have a higher salinity than warmer, less dense surface waters.

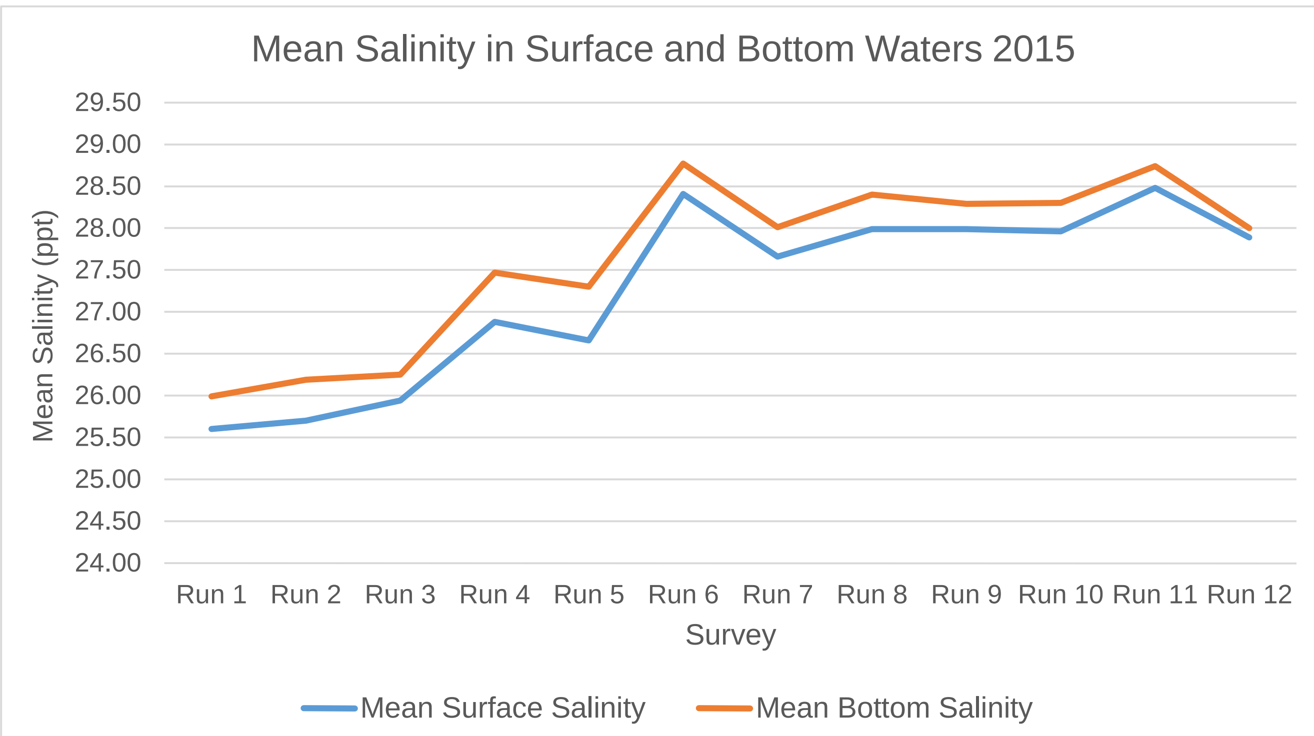


Figure 11. Mean Salinity in Surface and Bottom Waters

WATER CLARITY AND SECCHI DISK DEPTH

The depth to which light penetrates water is known as “water clarity.” Water clarity is an indirect measure of suspended solids and can be referred to as transparency. Water clarity can be affected by various biological, chemical, and physical factors. It is greater at lower temperatures because particles do not stay in suspension as well as in higher temperatures. Filter feeders can also positively affect water clarity via physical or biological removal of particles. Water clarity can be negatively affected by the following:

- Runoff and erosion induced by anthropogenic or natural causes
- Biological and chemical factors in the water column (i.e. algal blooms due to excess nutrients and subsequent die off)
- Physical dynamics, including tidal height, wind, and currents can stir up bottom sediments and keep particles in suspension

IEC District environmental analyst measuring water clarity.

Water clarity is an important parameter because:

- Suspended solids may result in low dissolved oxygen
- Suspended solids can settle out and harm delicate habitats and species (can interfere with feeding as well)
- Suspended solids block sunlight, limiting phytoplankton and aquatic vegetation
- Suspended solids may indicate runoff which may have other negative effects

A Secchi disk is used to measure water clarity by lowering it in the water until the disk disappears, and raised until it reappears. The depth at which the disk disappears and reappears is known as the Secchi disk depth, measured in meters The table below provides details about water clarity in the far western Long Island Sound this season.

Table 4. Summary statistics for 2015 Secchi disk depth data.

	Sample Count (n)	Secchi Depth (ft.)					
		Mean	**High**	**Low**	**Median**	**Variance**	**Standard Deviation**
2015 Season	264	4.1	10.0	1.0	4.0	1.42	1.19
6/30/2015	22	4.3	6.5	2.5	4.5	1.01	1.00
7/7/2015	22	4.1	5.5	2.5	4.3	0.65	0.81
7/17/2015	22	3.9	6.5	2.5	3.5	1.42	1.19
7/21/2015	22	3.2	4.5	1.5	3.5	0.71	0.84
7/28/2015	22	4.3	5.5	2.0	4.5	1.01	1.01
8/5/2015	22	4.0	5.5	2.5	4.3	1.19	1.09
8/12/2015	22	5.1	6.5	3.0	5.5	1.26	1.12
8/18/2015	22	3.7	5.0	1.5	4.0	0.66	0.81
8/25/2015	22	4.4	6.0	2.5	4.3	1.13	1.06
9/1/2015	22	3.4	5.0	1.0	3.5	0.86	0.92
9/9/2015	22	4.3	6.0	2.5	4.5	1.06	1.03
9/14/2015	22	4.5	10.0	1.0	4.5	3.75	1.94

The lowest value of the 2015 season was 1.0 m observed during Survey 10 (9/1/15) in Manhasset Bay and Survey 12 (9/14/15) in Little Neck Bay. The highest value of 10.0 m was observed during Survey 12 at Matinecock Point.

pH

IEC District has been collecting and recording pH data since the LIS monitoring program started in 1991. This data is critical to the emerging issue of ocean acidification. A portion of the carbon dioxide that exists in the atmosphere is absorbed by the oceans. Through a series of chemical reaction, mixing seawater and carbon dioxide results in an increase in acidity and causes unfavorable conditions for bottom dwelling calcifying organisms that form the bottom of the food web. The table below (Table 5) summarizes pH data that was collected during the 2015 monitoring season.

Table 5. pH Data and Calculations.

	2015 pH Data Summary					
	Mean Surface pH	**Mean Bottom pH**	**High Surface pH**	**High Bottom pH**	**Low Surface pH**	**Low Bottom pH**
2015 Season	7.59	7.44	8.38	8.01	7.02	7.05
6/30/2015	7.86	7.65	8.03	7.88	7.41	7.34
7/7/2015	7.75	7.65	8.06	7.98	7.44	7.45
7/17/2015	7.83	7.59	8.38	8.01	7.29	7.35
7/21/2015	7.74	7.45	8.19	7.98	7.05	7.25
7/28/2015	7.60	7.43	7.97	7.70	7.21	7.16
8/5/2015	7.56	7.45	7.92	7.66	7.26	7.33
8/12/2015	7.55	7.41	7.78	7.72	7.18	7.18
8/18/2015	7.52	7.37	7.79	7.75	7.16	7.22
8/25/2015	7.75	7.49	7.99	7.92	7.40	7.33
9/1/2015	7.35	7.30	7.66	7.45	7.09	7.17
9/9/2015	7.23	7.19	7.42	7.39	7.03	7.05
9/14/2015	7.34	7.35	7.46	7.45	7.02	7.22

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ACKNOWLEDGEMENTS:

Many thanks to the support of the US EPA, Long Island Sound Study.

APPENDIX A
NEIWPCC-IEC District Long Island Sound Study Sampling Stations

		LOCATION		
STATION	WATER COLUMN DEPTH (meters)	LATITUDE NORTH D M S	LONGITUDE WEST D M S	DESCRIPTION
E-12	4	40-51-16	73-48-34	Eastchester Bay mid-channel at N 6
A1	26	40-48-12	73-49-36	East of Whitestone Bridge
A2M	35	40-48-06	73-47-00	East of Throgs Neck Bridge
8-403	3	40-46-38	73-45-38	Little Neck Bay - ~0.2 nm W of yellow nun “B”
8-405	3	40-47-33	73-45-49	Little Neck Bay - ~0.15 nm North of LNB mid-channel buoy
A3	12	40-50-30	73-45-18	Hewlett Point South of Fl G 4 Sec “29”
9-409	4	40-49-44	73-43-05	Manhasset Bay
9-412	4	40-49-20	73-42-45	Manhasset Bay
9-413	3	40-48-26	73-42-49	Manhasset Bay
A4	35	40-52-35	73-44-06	East of Sands Point, mid-channel
A5	13	40-53-54	73-41-12	~2.6 nm East of Execution Lighthouse
B1S	15	40-56-42	73-40-00	Porgy Shoal South of Fl G 4 Sec R “40”
B2	20	40-56-06	73-39-12	Matinecock Point 1.6 nm North of Gong “21”
B3M	19	40-55-12	73-38-42	Matinecock Point 0.7 nm North of Gong “21”
B4	15	40-54-24	73-38-06	Matinecock Point South of Gong “21”
DI1	10	40-53-33	73-46-24	Davids Island North of Nun “10A”
DI2	6	40-53-40	73-46-00	Davids Island East of Nun “4”
H-A3	3	40-55-24	73-43-12	Delancy Point South of Can “1”
H-B	12	40-54-48	73-42-54	0.7 nm Southeast of Daymarker Fl R 4 Sec
H-C	8	40-51-54	73-40-30	Hempstead Harbor East of R Bell “6”
H-C1	11	40-53-12	73-41-42	Hempstead Harbor~ 2.0 nm East of Sands Point
H-D	7	40-50-42	73-39-36	Hempstead Harbor East of Can “9”

Nutrient, chlorophyll a, TSS, and BOD samples will be collected from stations in **Bold**.

APPENDIX B
NEIWPCC-IEC District Parameters and Associated Analytical Methods, Minimum Detection Limits, and Laboratory Reporting Limits

Analytes	*Analytical Method*	*Method Detection Limit*	*Laboratory Reporting Limit*
Temperature	SM2550 B-00	-5 to 65 °C	-5 to 65 °C
Dissolved Oxygen	SM 4500-O G-11	0-20 mg/L	0-20 mg/L
Chlorophyll *a*	SM 20 10200H 1+2	3.7 µg/L	3.7µg/L
pH	SM 4500-H B-11	0 to 14 SU	0 to 14 SU
Salinity	SM 19-20 2520 B	0 to 70 ppt	0 to 70 ppt
Total Suspended Solids (TSS)	SM 2540D 97,-11	0.1-20,000 mg/L	0.1 to 20,000 mg/L
Biochemical Oxygen Demand	SM 5210B-01,-11	3mg/L	3 mg/L
Particulate Carbon*	EPA 440	0.0633 mg/L	0.263mg/L
Particulate Nitrogen*	EPA 440	0.0105 mg/L	0.033 mg/L
Particulate Phosphorus*	EPA 365.1	0.0021 mg/L	0.0070 mg/L
Biogenic Silica*	EPA 366.0	0.01mg/L	0.03 mg/L
Dissolved Silica*	EPA 366.0	0.01 mg/L	0.03 mg/L
Orthophosphate (DIP)*	EPA 365.1	.0006 mg/L	.0025 mg/L
Total Dissolved Phosphorus*	EPA 365.1	0.0015 mg/L	0.0045mg/L
Dissolved Organic Carbon*	EPA 415.1	0.24 mg/L	0.05mg/L
Total Dissolved Nitrogen*	EPA 353.2	0.05 mg/L	0.15 mg/L
Ammonia*	EPA 350.2	0.001 mg/L	0.010 mg/L
Nitrate+Nitrite* (cadmium reduction method)	EPA 353.2	0.0007 mg/L	0.0035 mg/L
Nitrate+Nitrite (enzyme reduction method)	EPA 353.2	0.007 mg/L	0.0175mg/L

*Analyses for these parameters were performed by UMCES CBL NASL in Solomons, MD.