FAIRFIELD COUNTY
RIVER REPORT

Harbor Watch | 2022

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2022
Fairfield County River Report

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This report includes data on:
Ash Creek Watershed (Ash Creek, Rooster River, Londons Brook, Horse Tavern Brook), Bruce Brook, Deadman's Brook, Farmill River, Fivemile River, Indian River, Island Brook, Keelers Brook, Muddy Brook, Noroton River, Norwalk River, Pequonnock River, Pumpkin Ground Brook Watershed (Pumpkin Ground Brook, Cemetery Pond Brook), Rippowam River, Sasco Brook, Saugatuck River, Stony Brook, and Success Lake Watershed.

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About Harbor Watch

The mission of Harbor Watch is to improve water quality and ecosystem health in Connecticut.

Each day we strive to reach this goal through research in the lab and field, collaboration with our partners, and education of students and the public. Harbor Watch addresses pollution threats to Long Island Sound and educates the next generation of scientists through hands-on research and experiential learning. As part of the larger organization of Earthplace, the work performed by Harbor Watch also supports the mission of Earthplace to build a passion in our community for nature and the environment through education, experience, and action.

Since its inception, Harbor Watch has trained over 1,000 high school students, college interns, and adult volunteers in the work of protecting and improving the biological integrity of Long Island Sound and has monitored hundreds of sites for a variety of physical and biological parameters.

In 2022, Harbor Watch:

- Studied 495 field sites in Fairfield County, CT
- Conducted biweekly, May-September monitoring of 22 rivers in 13 towns
- Trained 165 high school and college students in a combination of in-person and virtual education experiences
- Processed over 2500 water samples for bacteria concentration analysis in our laboratory

Visit www.harborwatch.org for more information!

Acknowledgements

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Key Terms and Information

Acronyms and jargon:

- CT DEEP: Connecticut Department of Energy and Environmental Protection
- MPN/100 mL: Most probable number per 100 mL. This is a unit of measurement for bacteria concentrations based on statistics rather than direct counts of specific colonies.
- mg/L: Milligrams per liter. This is a unit of measurement, used in this report to quantify dissolved oxygen concentrations.
- Geomean: A geometric mean is a way to average a set of values but reduce the impact of outliers which occur infrequently.

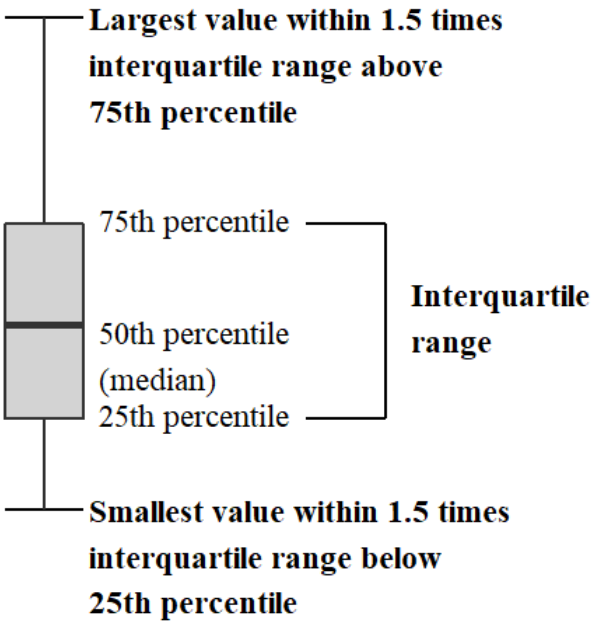
Study Site Naming:

Sites are numbered with the lowest number being closest to the mouth of the river where it meets a larger body of water (e.g., Long Island Sound). Sites with the highest numbers are located furthest upstream.

Terms/Symbols in Tables:

"N/A" - Indicates that a sample was not taken at that time for reasons including issue with incubation, or no sample was collected.
">" – Indicates that the results exceeded the reporting limit.
"<" – Indicated that the results were less than the reporting limit.
"Wet" - Rainfall is indicated as "Wet" if ≥ 0.1 inches of rain fell within 2 days prior to sampling.
"Dry" - Rainfall is indicated as "Dry" if ≤ 0.1 inches of rain fell within 2 days prior to sampling.

How to Read a Boxplot:



- **Outside value**-Value is >1.5 times and <3 times the interquartile range beyond either end of the box

Graphic adapted from DeCicco, 2022

Disclaimer: Every effort has been made to ensure the accuracy of the information presented in this report. If you notice anything in this report that you believe may be an error, we welcome that or any other feedback. Please contact us by email at harborwatch@earthplace.org.

Methods Summary

Each river was visited approximately twice per month from May through September for a total of 10 sampling days per river. Sites were selected based on access and representativeness of the river, with effort made to space sites evenly throughout the length of the river being studied. Monitoring was carried out under a Quality Assurance Project Plan approved by the CT DEEP in April 2022 (RFA #22043).

Monitoring teams left Earthplace in Westport, CT in the morning to begin sampling and would return within 2-4 hours. Each team was comprised of fully trained Harbor Watch staff or student interns, sometimes accompanied by volunteers. At each site, a water sample was collected and kept on ice. Water temperature, dissolved oxygen, and conductivity were measured at each site using a YSI Pro2030 meter.

Upon return to the Harbor Watch laboratory, the water samples were analyzed for total coliform and *E. coli* or enterococci using enzyme substrate methods set forth in Standard Methods (SM9223B). Indicator bacteria concentrations were evaluated using the criteria published in the CT DEEP Surface Water Quality Standards on 10/10/13 (Table 1). Because the rivers we tested do not contain designated swim areas, the "all other recreational uses" criteria will apply for analyses in this report. For additional information on methodology, please refer to the approved QAPP. A summary of deviations from the QAPP can be found on page 86 of this report.

Table 1. CT DEEP criteria for *E. coli* and enterococci levels as applied to recreational use, effective 10/10/13. Highlighted cells represent criteria used by Harbor Watch in this report.

Designated Use	**Class**	**Indicator**	**Criteria**
Designated Swimming	AA, A, B	*Escherichia coli*	Geomean less than 126/100 mL; Single Sample Maximum 235/100 mL
Non-designated Swimming	AA, A, B	*Escherichia coli*	Geomean less than 126/100 mL; Single Sample Maximum 410/100 mL
All Other Recreational Uses	AA, A, B	*Escherichia coli*	Geomean less than 126/100 mL; Single Sample Maximum 576/100 mL
Designated Swimming	SA, SB	*Enterococci*	Geomean less than 35/100 mL; Single Sample Maximum 104/100 mL
All Other Recreational Uses	SA, SB	*Enterococci*	Geomean less than 35/100 mL; Single Sample Maximum 500/100 mL

Results and Discussion

From May through September 2022, 22 waterways (categorized into 18 watersheds) were monitored by Harbor Watch across 13 towns in Fairfield County, CT (Table 2). There were 134 unique sampling locations that were monitored a minimum of 8 times each (unless otherwise stated in each section). Many of these rivers did not meet the state criteria for acceptable bacteria concentrations (Table 3) and are likely acting as conduits for sewage pollution to Long Island Sound.

In the 22 waterways studied, 87% of sites exceeded (i.e., had concentrations indicative of fecal contamination) the CT DEEP geomean criterion (< 126 MPN/100 mL for freshwater sites or < 35 MPN/100 mL for estuarine sites) (Figure 1), and 96% of sites exceeded the secondary single sample maximum criterion of 576 MPN/100 mL for freshwater sites or 500 MPN/100 mL for estuarine sites at least one during the sampling season (Figure 2). The Norwalk River had the fewest exceedances of the CT DEEP geomean criteria for bacteria. There was an 10-way tie for the most exceedances, with 100% of the sites studied on Ash Creek Watershed, Bruce Brook, Indian River, Island Brook, Keelers Brook, Muddy Brook, Pequonnock River, Sasco Brook, Saugatuck River, and Success Lake failing the CT DEEP geomean criteria for bacteria (Table 3).

Data were collected on these Fairfield County waterways for multiple reasons. Harbor Watch aims to better understand the ecological health of our watersheds by monitoring dissolved oxygen, conductivity, water temperature, and indicator bacteria concentrations (*E. coli* in freshwater and enterococci in brackish or saltwater), and to make these data available for use by interested stakeholders. A secondary objective is to use the data collected to assess where sewage pollution sources may be located so that we can perform further investigation. Once sources of sewage pollution are identified, Harbor Watch works with our municipal partners to ensure that the issue is fixed. Track-down surveys were conducted on projects in Bridgeport, Darien, Fairfield, New Canaan, Norwalk, Stamford, Stratford, and Westport in 2022. Track-down surveys are ongoing and will continue year-round as field conditions allow. Our process of repetitive bacteria testing has a history of success in identifying point sources of pollution such as leaking sanitary sewer lines, broken sewer laterals, and pipes illegally hooked into the storm water system. In 2022, with the help of our municipal partners, we located 7 illicit connections to stormwater systems. At the time of this publication, each source is in the process of being removed. The frequent incidence of failing bacteria concentrations observed over this monitoring season (Figure 1, Table 1) indicates that there is still much work to be done to improve the overall water quality of the Long Island Sound Watershed. We look forward to tackling these issues head on with our partners!

Table 2. Percentage of study sites in each municipality that exceeded the CT DEEP geomean criteria for indicator bacteria. *Sites that are located at the border of two towns have been included in the count for each town.

	Number of Sites*	% Failing Geomean Criteria	Rivers
Bridgeport	18	100%	Ash Creek Watershed, Bruce Brook, Island Brook, Pequonnock River, Success Brook
Darien	7	100%	Fivemile River, Noroton River
Fairfield	14	100%	Ash Creek Watershed, Sasco Brook
Monroe	1	100%	Farmill River
New Canaan	14	57%	Fivemile River, Noroton River, Rippowam River
Norwalk	15	87%	Fivemile River, Keelers Brook, Norwalk River, Stony Brook
Ridgefield	5	40%	Norwalk River
Shelton	8	75%	Farmill River, Pumpkin Ground Brook Watershed
Stamford	12	100%	Noroton River, Rippowam River
Stratford	16	88%	Bruce Brook, Pumpkin Ground Brook Watershed
Trumbull	4	100%	Ash Creek Watershed, Island Brook, Success Lake
Westport	37	95%	Deadman's Brook, Indian River, Muddy Brook, Sasco Brook, Saugatuck River, Stony Brook
Wilton	3	67%	Norwalk River

Table 3. Percentage of study sites in each watershed that exceeded the CT DEEP geomean criteria for indicator bacteria.

	Number of Sites	% Failing Geomean Criteria	Towns
Ash Creek Watershed	12	100%	Bridgeport, Fairfield, Trumbull
Bruce Brook	9	100%	Bridgeport, Stratford
Deadman's Brook	9	89%	Westport
Farmill River	8	75%	Monroe, Shelton
Fivemile River	10	80%	Darien, New Canaan, Norwalk
Indian River	4	100%	Westport
Island Brook	5	100%	Bridgeport, Trumbull
Keelers Brook	5	100%	Norwalk
Muddy Brook	6	100%	Westport
Noroton River	8	75%	Darien, New Canaan, Stamford
Norwalk River	13	62%	Norwalk, Ridgefield, Wilton
Pequonnock River	3	100%	Bridgeport
Pumpkin Ground Brook Watershed	7	71%	Shelton, Stratford
Rippowam River	11	73%	New Canaan, Stamford
Sasco Brook	9	100%	Fairfield, Westport
Saugatuck River	4	100%	Westport
Stony Brook	6	83%	Norwalk, Westport
Success Lake	5	100%	Bridgeport, Trumbull

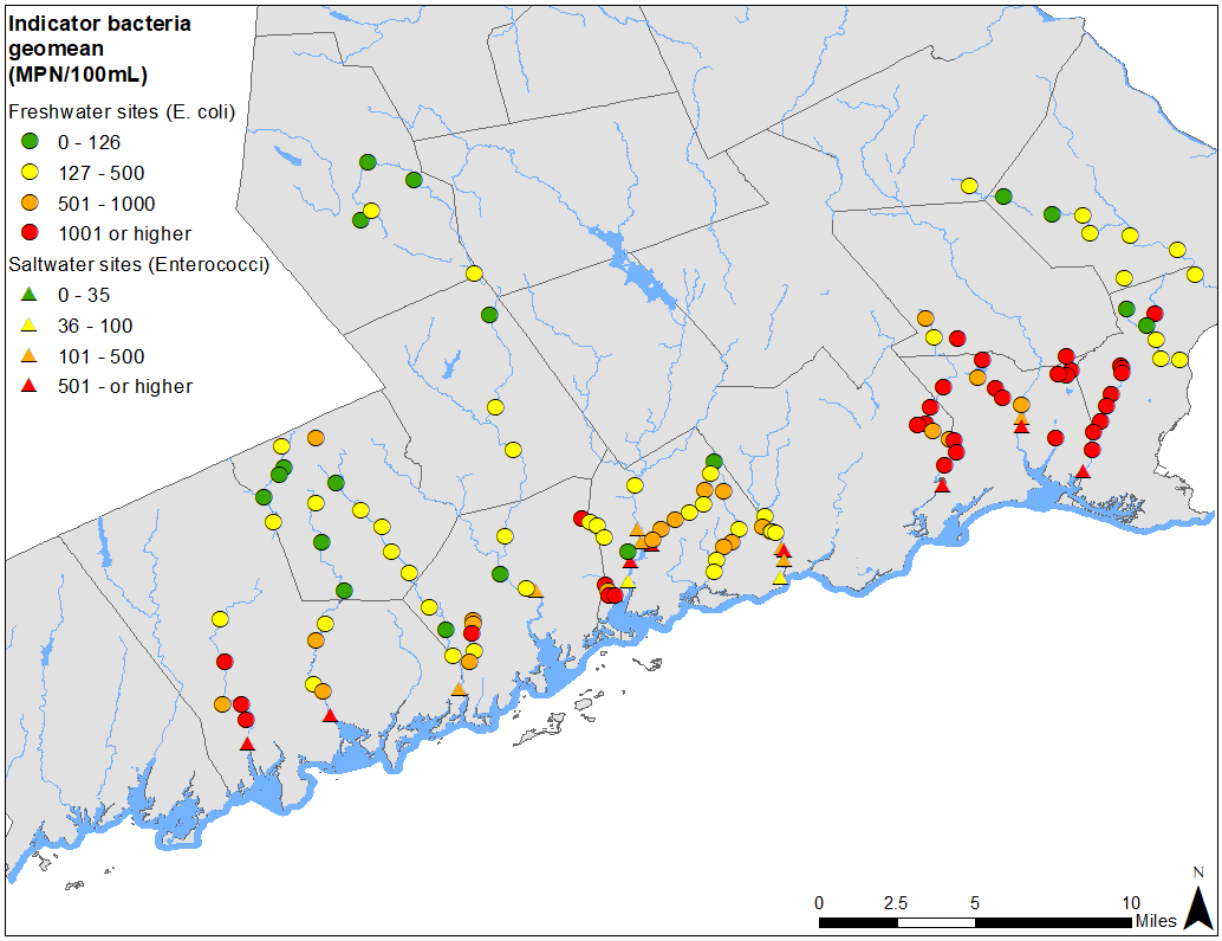


Figure 1. Map of 2022 sampling locations and *E. coli* or enterococci concentrations for each site. The bacteria concentrations for each site were compared to the state criteria for recreational waters (Table 1). Passing sites (green) had a geomean less than 126 MPN/100 mL for *E. coli* or 35 MPN/100 mL for enterococci.

Thirty-seven percent of sampling locations exceeded the CT DEEP single sample maximum 1-25% of the time, indicating that only one or two sampling events exceeded the maximum during the monitoring season (assumes that 8-10 samples were taken per site). This is likely correlated to wet weather events when fecal matter enters our waterways untreated. Sources may include, but are not limited to animal and pet waste runoff, failing septic systems, and combined sewer systems having to use their overflows.

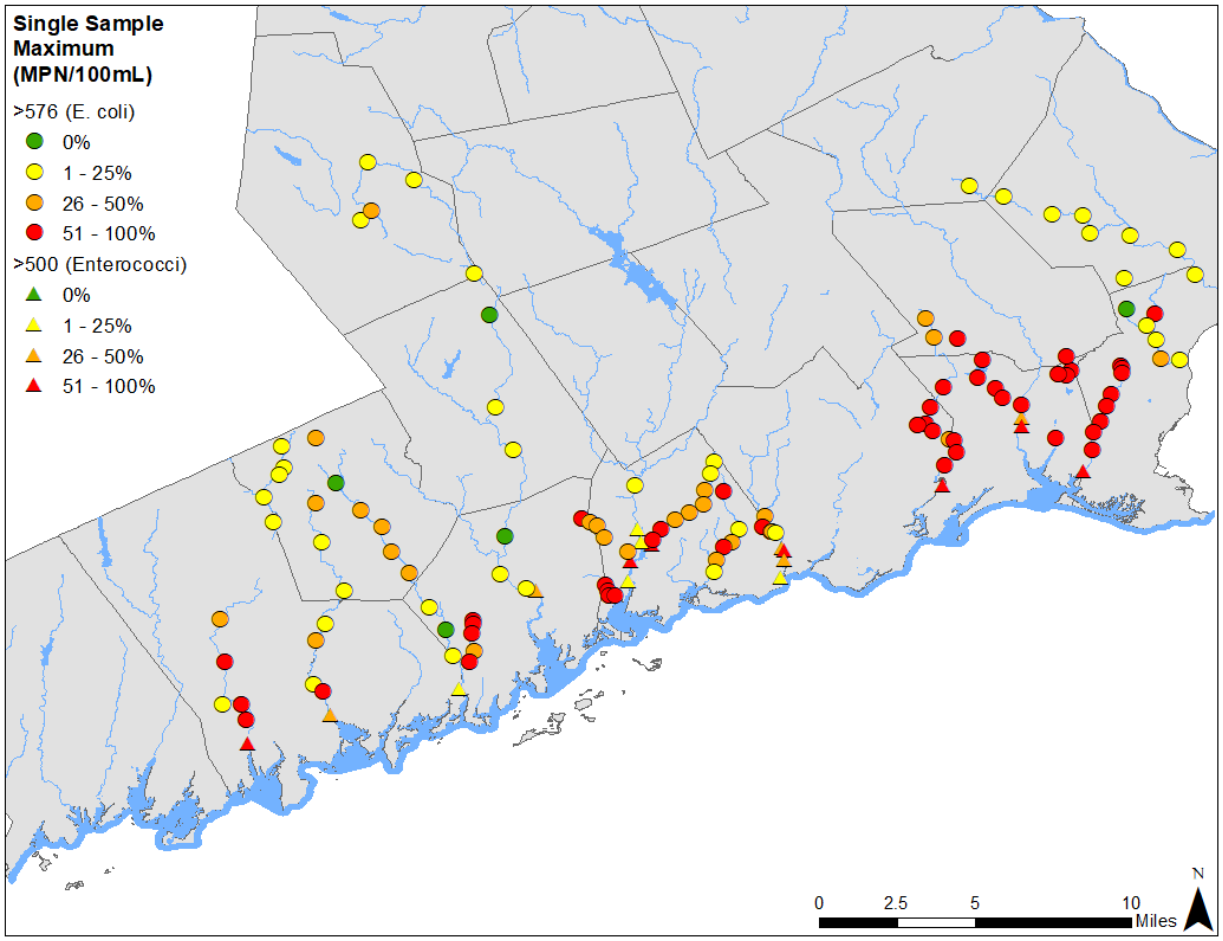


Figure 2. Map of 2022 sampling locations and percentage of *E. coli* and enterococci samples failing the CT DEEP single sample maximum criterion for recreational waters at each site. Passing sites (green) had none of their samples exceeding 576 MPN/100 mL for *E. coli* and 500 MPN/100 mL for enterococci.

The CT DEEP criterion for dissolved oxygen is set at a minimum of 5 mg/L anytime for freshwater and 3 mg/L acutely for saltwater (State of Connecticut Department of Energy and Environmental Protection [CT DEEP], 2015a). Fourteen percent of all observed dissolved oxygen readings did not meet the CT DEEP minimum criteria in 2022. The Pequonnock River had the highest frequency of low dissolved oxygen readings with 29% of observed readings below 5 mg/L for freshwater sites and 3 mg/L for saltwater sites. Prolonged periods of low dissolved oxygen can be harmful to marine and aquatic organisms. Low dissolved oxygen can be the result of low flow (which was observed at many sampling locations due to the nature of the site, and/or the lack of rainfall during the monitoring season) or the decomposition of organic matter. Additionally, cold water can hold more dissolved oxygen than warm water, therefore it is common to see a decrease in dissolved oxygen concentrations as the monitoring season progresses into the heat of the summer and water temperature increases.

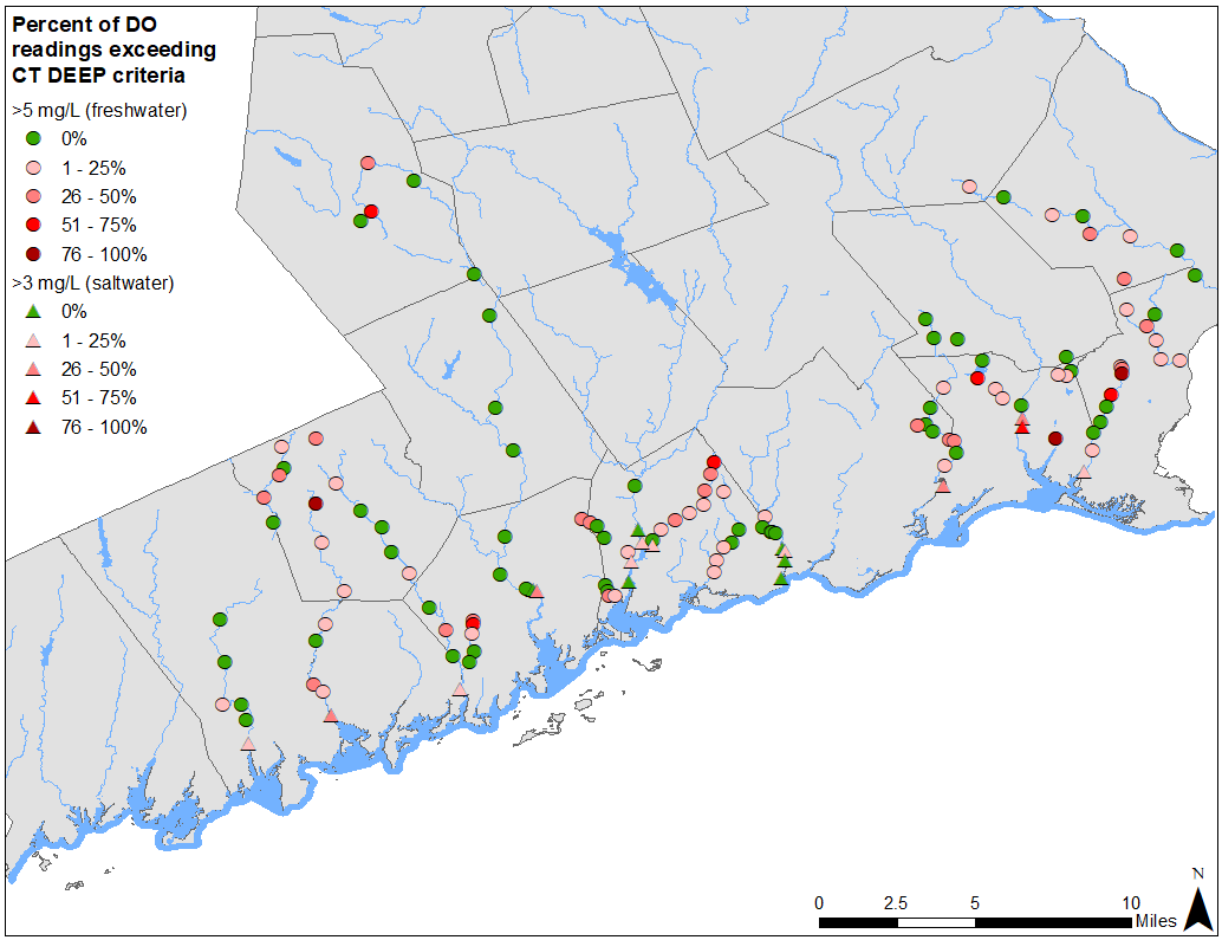


Figure 3. Map of 2022 river sampling locations and percentage of individual dissolved oxygen readings less than the CT DEEP minimum criterion of 5 mg/L anytime for freshwater and 3 mg/L acutely for saltwater sites.

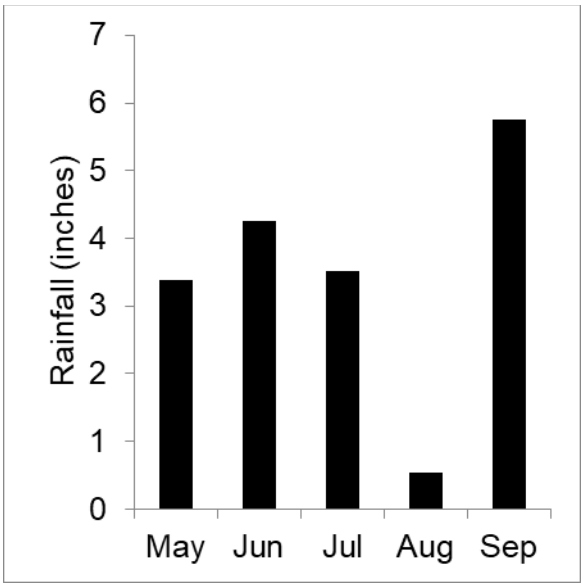


Figure 4. Monthly rainfall totals for 2022 (Norwalk Health Department Rain Gauge).

In the following sections, we present a data summary of each of the 18 watersheds monitored by Harbor Watch during 2022.

1. Ash Creek Watershed
(Ash Creek, Rooster River, Horse Tavern Brook, and Londons Brook)

The Ash Creek Watershed encompasses portions of Fairfield, Bridgeport, Trumbull, and Easton, CT. The watershed is approximately 9,800 acres or 15.3 square miles (CT DEEP, 2013). There are multiple tributaries that discharge to Ash Creek including Rooster River, Horse Tavern Brook, Londons Brook, and Ox Brook. Harbor Watch has been monitoring the Ash Creek Watershed annually since 2016, with the exception of 2019.

Indicator bacteria: Bacteria concentrations in the watershed have historically exceeded CT DEEP criteria. Concentrations have also fluctuated through the years, with a decrease in the average of geomeans over the last three years (Figure 1.1). In 2022, all of the sites studied exceeded the CT DEEP geomean criteria for indicator bacteria (Figure 1.2). Additionally, 72% of all samples processed in the Ash Creek Watershed exceeded the CT DEEP single sample maximum criteria (Table 1.1). Pollution track-down work to locate sources of elevated concentrations was conducted in partnership with the City of Bridgeport and Town of Fairfield. Testing identified a number of hot spots where additional testing is needed, as well as a direct illicit connection to a stormwater system discovered in October. Appropriate measures are being taken to remove the known source from the watershed. Sampling is proposed to continue in 2023 to track changes in water quality.

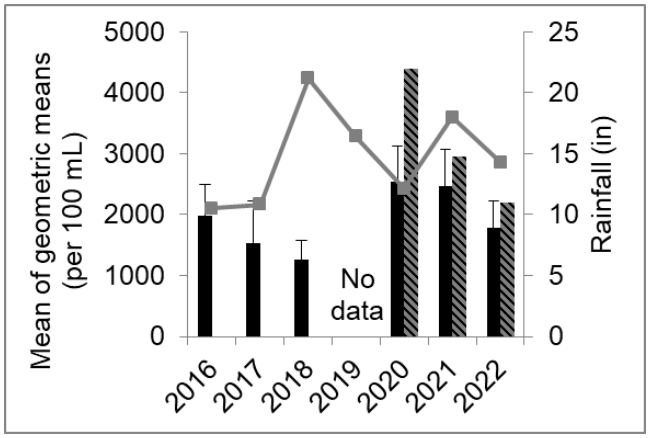


Figure 1.1. (Left) Mean of freshwater site geomeans (black bars) and saltwater site geomeans (striped bars) from 2016-2022 and total rainfall from May through September each year (grey squares and line).

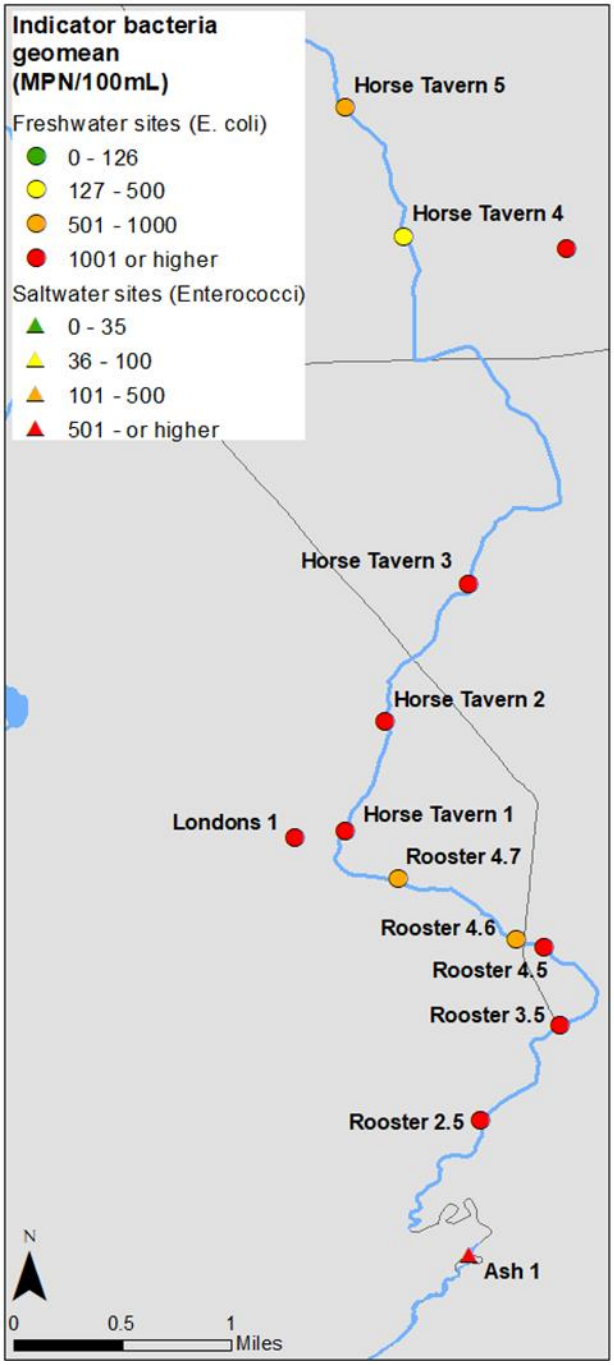


Figure 1.2. (Right) Geomean of bacteria concentrations at each site in 2022. Unlabeled site is located on Island Brook (see chapter 7).

Table 1.1. Ash Creek Watershed *E. coli* and enterococci concentrations (MPN/100mL), geomeans, and percentage of samples exceeding the CT DEEP single sample maximum. Rainfall data gathered from the website, Weather Spark (n.d.).

	Indicator bacteria	5/9/2022	5/18/2022	6/1/2022	6/15/2022	6/28/2022	7/27/2022	8/9/2022	8/16/2022	9/1/2022	9/22/2022	Geomean	% exceeding SSM
Horse Tavern 5	*E. coli*	193	179	980	198	1633	507	516	165	372	>9678	528	30%
Horse Tavern 4	*E. coli*	29	80	2420	150	4839	121	62	155	977	5654	348	40%
Horse Tavern 3	*E. coli*	313	649	>2420	1733	2518	1396	836	504	1086	22397	1772	80%
Horse Tavern 2	*E. coli*	980	690	3973	944	4479	759	825	500	82	>24196	1215	80%
Horse Tavern 1	*E. coli*	225	1414	>4839	606	4185	1334	2603	295	202	>24196	1346	70%
Londons 1	*E. coli*	921	1454	>4839	1230	4813	816	259	364	195	>24196	1301	70%
Rooster 4.7	*E. coli*	1300	1150	>4839	767	4813	733	457	129	8	>24196	861	70%
Rooster 4.6	*E. coli*	727	456	>4839	1140	4813	538	67	86	25	>24196	663	50%
Rooster 4.5	*E. coli*	>2420	1741	>9678	24196	8664	4719	6511	928	755	51721	4987	100%
Rooster 3.5	*E. coli*	>2420	2240	>9678	1201	12033	6896	492	860	706	48391	3075	90%
Rooster 2.5	*E. coli*	>2420	>4839	>9678	1081	5794	1789	1354	2142	1785	>48392	3550	100%
Ash 1	Enterococci	305	443	14136	776	15531	1518	1467	6131	5794	1354	2184	80%
Weather		Wet	Dry	Wet	Wet	Wet	Wet	Dry	Dry	Dry	Wet		

Table 1.2. GPS coordinates and site locations for the Ash Creek Watershed.

Site Name	Latitude	Longitude	Site location notes	River Name
Horse Tavern 5	41.24438	-73.23205	Revere Lane	Horse Tavern Brook
Horse Tavern 4	41.23572	-73.22811	Chestnut Hill Road	Horse Tavern Brook
Horse Tavern 3	41.21243	-73.22382	Vincellette Street	Horse Tavern Brook
Horse Tavern 2	41.20316	-73.22940	Wilson Street	Horse Tavern Brook
Horse Tavern 1	41.19585	-73.23199	Stratfield Road	Horse Tavern Brook
Londons 1	41.19538	-73.23540	Montauk Street	Londons Brook
Rooster 4.7	41.19260	-73.22850	Cornell Road	Rooster River
Rooster 4.6	41.18858	-73.22064	Brooklawn Avenue	Rooster River
Rooster 4.5	41.18807	-73.21872	Capitol Avenue	Rooster River
Rooster 3.5	41.18283	-73.21771	Brooklawn Avenue	Rooster River
Rooster 2.5	41.17648	-73.22304	North Avenue (Route 1)	Rooster River
Ash 1	41.16745	-73.22369	Commerce Drive/State Street Ext	Ash Creek

Dissolved oxygen and water temperature: Dissolved oxygen readings in the watershed varied by site throughout the season (Figure 1.3). While the majority of readings met the CT DEEP minimum criteria, 13 individual dissolved oxygen readings were observed below 5 mg/L at freshwater sites Horse Tavern 3, Londons 1 Rooster 4.6, Rooster 4.5, and Rooster 2.5, and three individual dissolved oxygen readings were observed below 3 mg/L at saltwater site Ash 1. The low readings were predominantly observed during late July through early September when water temperature increased (Figure 1.4) and water levels dropped throughout the county.

Figure 1.3. Box plot of dissolved oxygen concentrations at each sampling site in the Ash Creek Watershed. The dashed red line represents the CT DEEP minimum criteria for dissolved oxygen in freshwater, which is 5mg/L. The dotted red line represents the CT DEEP minimum criteria for dissolved oxygen in saltwater, which is 3mg/L. The only saltwater sampling site in this watershed is Ash 1. The numbers above each site name is the number of samples taken at each site. For more information on what each part of the boxplot represents, please review the informational graphic in the "Key Terms and Information" section on page 4.

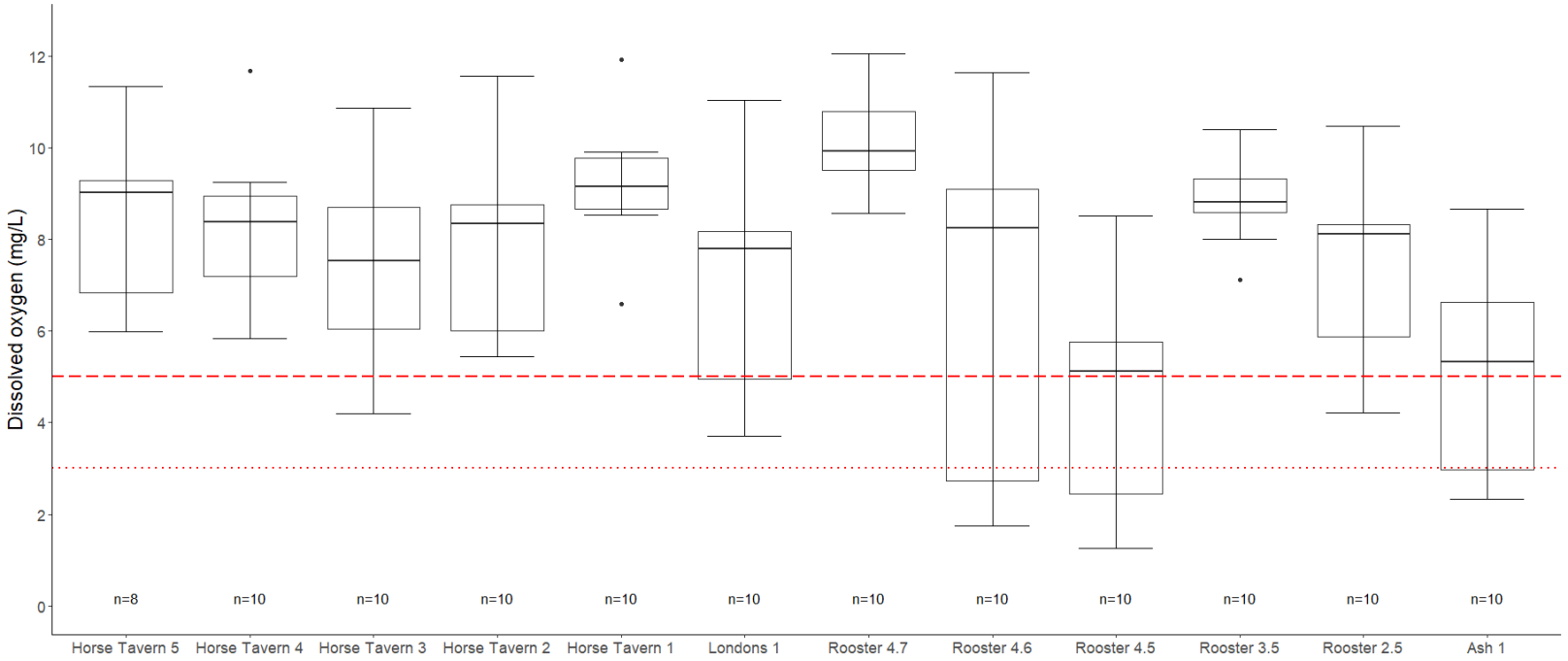
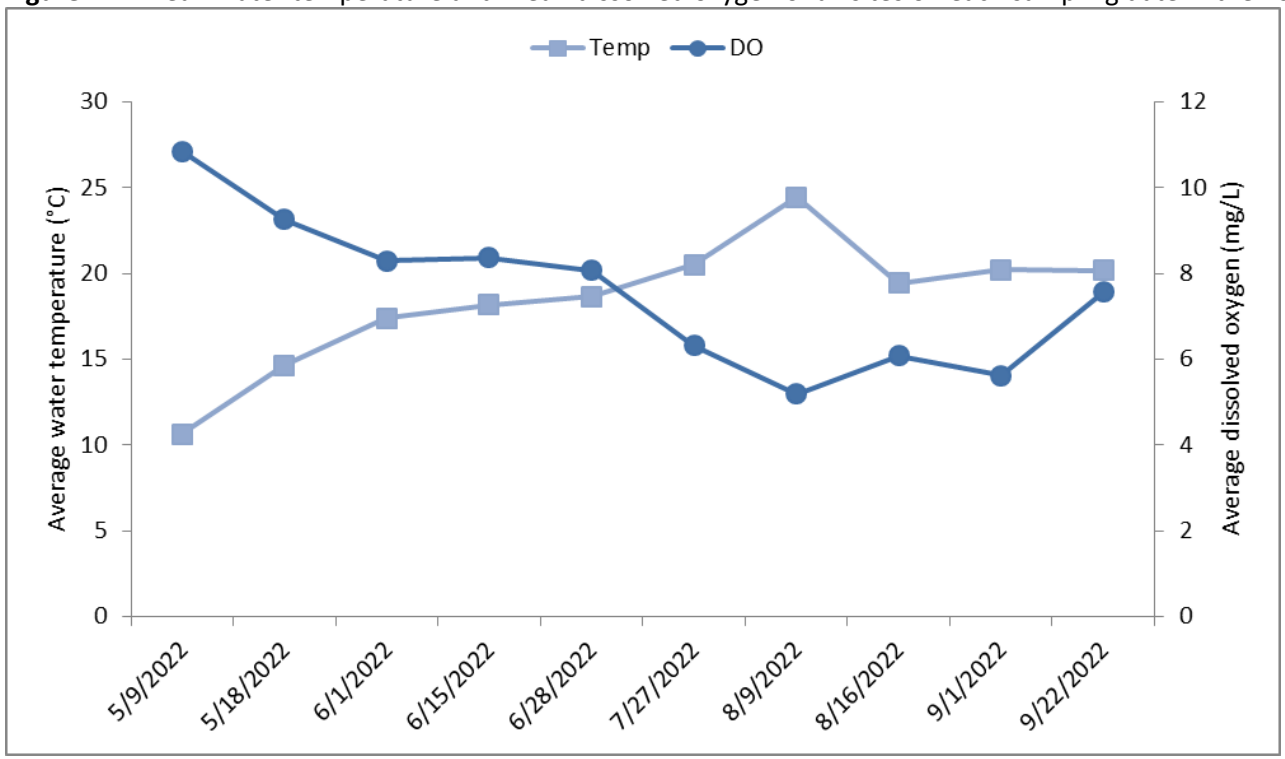
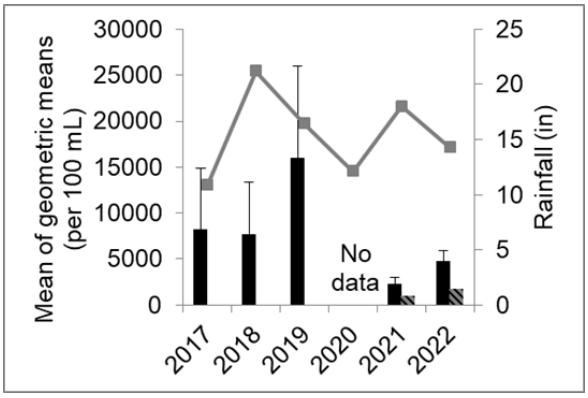


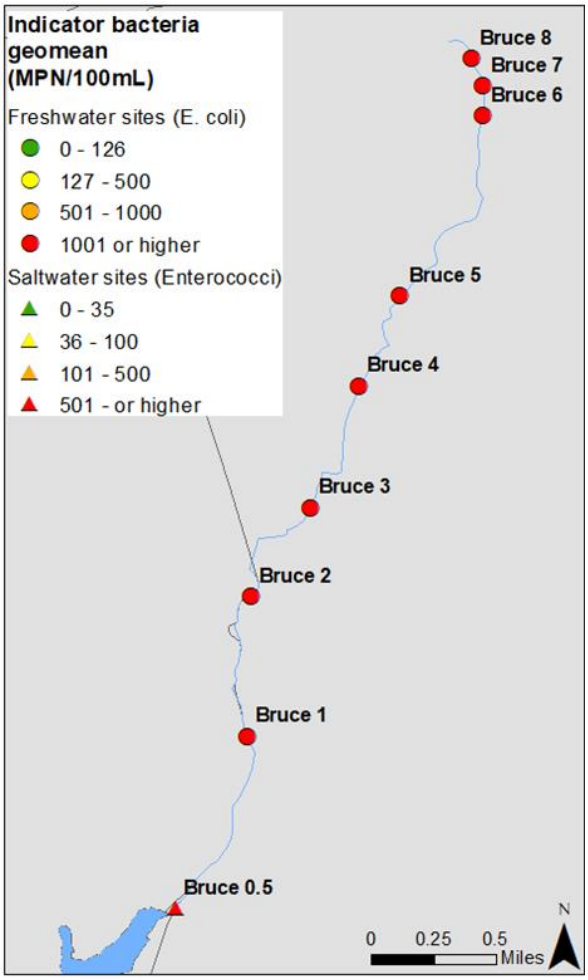
Figure 1.4. Mean water temperature and mean dissolved oxygen of all sites on each sampling date in the Ash Creek Watershed.



2. Bruce Brook

The Bruce Brook Watershed includes the Town of Stratford and the City of Bridgeport. It spans approximately 2,199 acres or 3.4 square miles (CT DEEP, 2012a) and the brook discharges into Bridgeport Harbor. This land use is divided into 94% urban area, 5% forests, 1% water, and less than 1% agriculture (CT DEEP, 2012a). The brook itself is channelized within man-made structures through a large portion of its length. Bruce Brook acts as a boundary between these two municipalities from the Route 1 corridor south to the coastline. Harbor Watch began monitoring Bruce Brook in 2017 and has continued annually, with the exception of 2020.





Indicator bacteria: Despite improvements made within the watershed through the years, thanks to the municipalities removing pollution sources to the brook, Bruce Brook continues to have poor water quality (Figure 2.1). In 2022, all of the Bruce Brook sites studied exceeded the CT DEEP geomean criteria for indicator bacteria (Figure 2.2). Additionally, 88% of all samples processed in Bruce Brook exceeded the CT DEEP single sample maximum criteria (Table 2.1). Due to construction at the bridge on Old Spring Road, sampling of Bruce 6 could not begin until mid-July, and only 6 samples were collected over the course of the monitoring season. Also, in August, the lack of rainfall and elevated temperatures resulted in the river drying up (Bruce 8 and Bruce 7) or becoming so shallow that a sample could not be collected for analysis. Harbor Watch continues to work with both the City of Bridgeport and the Town of Stratford on pollution track-down projects to locate additional sources of sewage pollution to the brook, focusing on the area between Bruce 5 and Bruce 4 as well as Bruce 2 to Bruce 1. These track-down projects will continue year-round as weather permits.

Figure 2.1. (Top) Mean of freshwater site geomeans (black bars) and saltwater site geomeans (striped bars) from 2017-2022 and total rainfall from May through September each year (grey squares and line).
Figure 2.2. (Bottom) Geomean of bacteria concentrations at each site in 2022.

Table 2.1. Bruce Brook *E. coli* and enterococci concentrations (MPN/100mL), geomeans, and percentage of samples exceeding the CT DEEP single sample maximum Rainfall data gathered from the website, Weather Spark (n.d.). Note: Bruce 6 had less than 8 samples collected.

	Indicator bacteria	5/12/2022	5/24/2022	6/2/2022	6/16/2022	7/14/2022	7/26/2022	8/11/2022	8/25/2022	9/6/2022	9/12/2022	Geomean	% exceeding SSM
Bruce 8	*E. coli*	186	1226	922	>4839	1961	3973	Dry	Dry	173289	>9678	3276	88%
Bruce 7	*E. coli*	230	2240	774	>4839	615	4839	Dry	Dry	82970	>9678	2871	88%
Bruce 6	*E. coli*	Construction	Construction	Construction	Construction	770	>4839	3466	4185	N/A	>9678	3497	100%
Bruce 5	*E. coli*	17	179	299	1300	>4839	1462	Shallow	Shallow	41058	6932	1110	63%
Bruce 4	*E. coli*	1046	1178	560	>9678	2453	1918	>9678	1989	27230	14136	3441	90%
Bruce 3	*E. coli*	1723	1086	839	>9678	5199	6131	4352	3654	38732	15531	4641	100%
Bruce 2	*E. coli*	757	1850	11199	24196	8164	17329	3873	8664	38732	48391	8971	100%
Bruce 1	*E. coli*	7227	7308	3720	>48392	576	20925	16328	4127	46111	>48392	10560	100%
Bruce 0.5	Enterococci	733	1376	6867	6131	213	8164	96	41	>24196	>24196	1673	70%
Weather		Dry	Dry	Wet	Wet	Dry	Wet	Wet	Dry	Wet	Wet		

Table 2.2. GPS coordinates and site locations for Bruce Brook.

Site Name	Latitude	Longitude	Site location notes	River Name
Bruce 8	41.22278	-73.1416	Bunnell Avenue	Bruce Brook
Bruce 7	41.22118	-73.1409	Connors Lane	Bruce Brook
Bruce 6	41.21949	-73.1409	Old Spring Road	Bruce Brook
Bruce 5	41.20915	-73.1457	Albright Avenue	Bruce Brook
Bruce 4	41.20397	-73.148	2340 Broadbridge Avenue	Bruce Brook
Bruce 3	41.19699	-73.1509	380 Canaan Road	Bruce Brook
Bruce 2	41.19188	-73.1543	102 Bowe Avenue	Bruce Brook
Bruce 1	41.18386	-73.1545	Connecticut Avenue	Bruce Brook
Bruce 0.5	41.173956	-73.1586	Hollister Avenue	Bruce Brook

Dissolved oxygen and water temperature: Dissolved oxygen readings in the watershed varied widely, specifically at the upper three sampling sites (Figure 2.3). While the majority of readings met the CT DEEP minimum criteria, 14 individual dissolved oxygen readings were observed below 5mg/L at freshwater sites Bruce 8, Bruce 7, Bruce 6, Bruce 5, and Bruce 1. One individual dissolved oxygen readings was observed below 3 mg/L at saltwater site Bruce 0.5. In July and August the water level in the brook, especially at the channelized sites, was too shallow to obtain dissolved oxygen and water temperature readings, therefore sites Bruce 6, Bruce 5, Bruce 4,and Bruce 2 had fewer than 8 dissolved oxygen or water temperature readings recorded. During this same time period, higher water temperature was observed, contributing to lower dissolved oxygen readings (Figure 2.4).

Figure 2.3. Box plot of dissolved oxygen concentrations at each sampling site along Bruce Brook. The dashed red line represents the CT DEEP minimum criteria for dissolved oxygen in freshwater, which is 5mg/L. The dotted red line represents the CT DEEP minimum criteria for dissolved oxygen in saltwater, which is 3mg/L. The only saltwater sampling site in this river is Bruce 0.5. The numbers above each site name is the number of samples taken at each site. For more information on what each part of the boxplot represents, please review the informational graphic in the "Key Terms and Information" section on page 4.

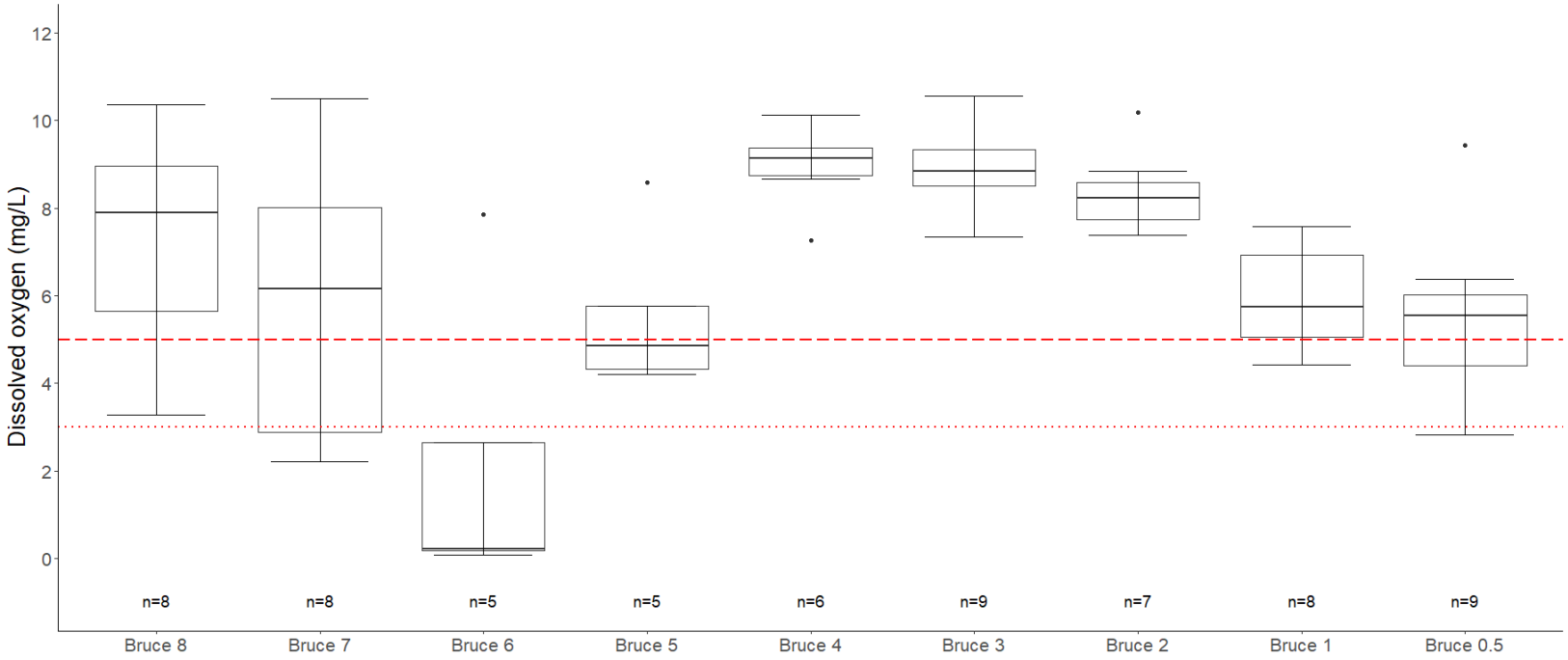
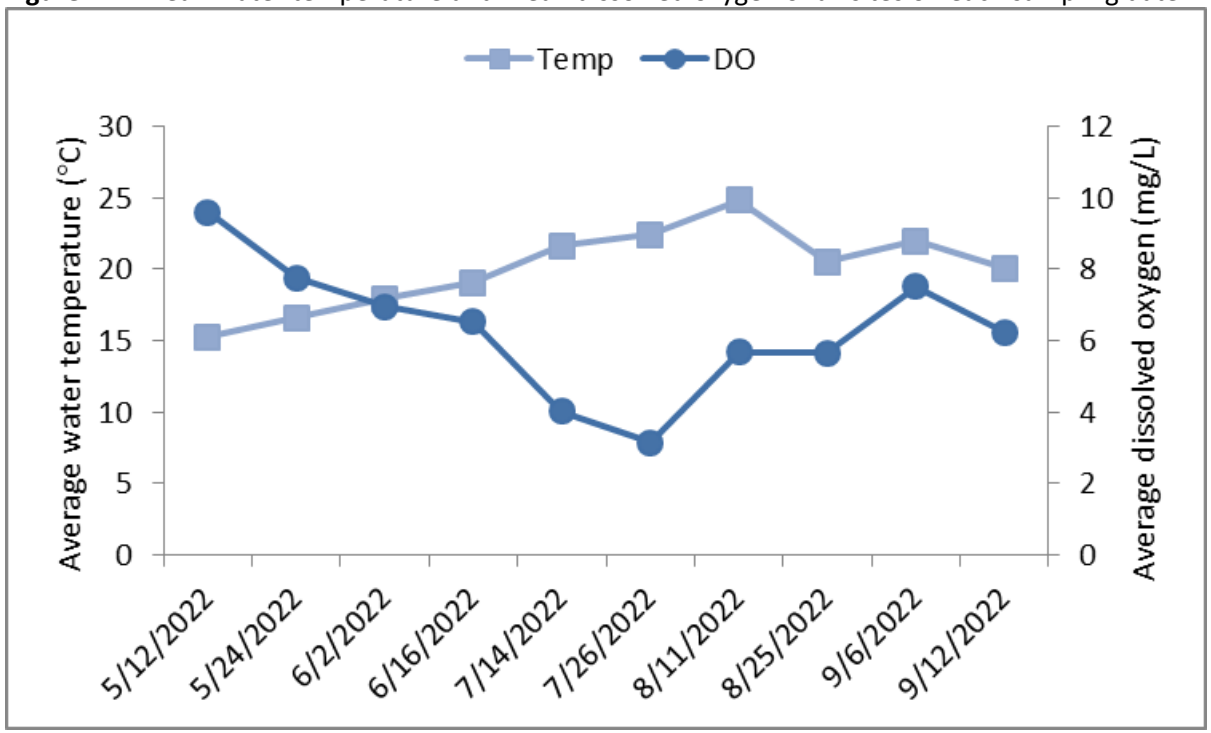


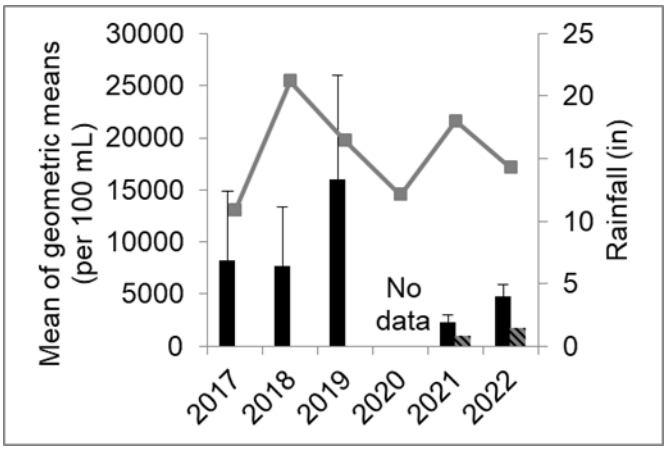
Figure 2.4. Mean water temperature and mean dissolved oxygen of all sites on each sampling date in Bruce Brook.



3. Deadman's Brook

Deadman's Brook is a tributary to the Saugatuck River located in Westport, CT. It meets the Saugatuck River between Harbor Watch study sites Saugatuck 0.5 and Saugatuck 0.25 in downtown Westport (Section 16). In the past, Harbor Watch frequently used Deadman's Brook as the focus of high school education program monitoring which always occurred through the late fall and winter. Beginning in 2017, Harbor Watch began monitoring the brook during the summer monitoring season and has continued annually, with the exception of 2020.

Indicator bacteria: In 2022, bacteria concentrations in the watershed continue to exceed the CT DEEP criteria, but overall are lower than what were observed in the late 2010s (Figure 3.1). In 2022, all but the northernmost site exceeded the CT DEEP geomean criteria for indicator bacteria (Figure 3.2). Additionally, 40% of all samples processed in Deadman's Brook exceeded the CT DEEP single sample maximum (Table 3.1).



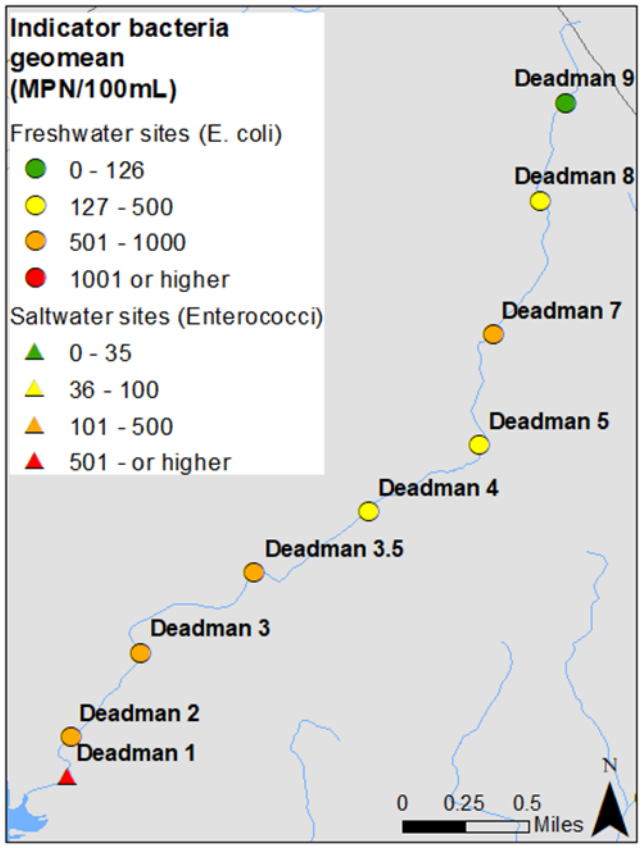


Figure 3.1. (Left) Mean of freshwater site geomeans (black bars) and saltwater site geomeans (striped bars) from 2017-2022 and total rainfall from May through September each year (grey squares and line).
Figure 3.2. (Right) Geomean of bacteria concentrations at each site in 2022.

Table 3.1. Deadman's Brook *E. coli* and enterococci concentrations (MPN/100mL), geomeans, and percentage of samples exceeding the CT DEEP single sample maximum. Rainfall data gathered from the Norwalk Health Department (n.d.).

	Indicator bacteria	5/11/2022	5/17/2022	6/2/2022	6/13/2022	7/5/2022	7/18/2022	8/10/2022	8/24/2022	8/30/2022	9/15/2022	Geomean	% exceeding SSM
Deadman 9	*E. coli*	28	22	6	62	11	7945	14	31	Dry	172	49	11%
Deadman 8	*E. coli*	29	105	649	172	236	>9678	127	34	Dry	193	206	22%
Deadman 7	*E. coli*	88	185	>2420	>4839	2420	>9678	88	79	Dry	517	633	44%
Deadman 5	*E. coli*	345	111	>2420	>4839	184	>9678	436	36	236	261	489	30%
Deadman 4	*E. coli*	199	193	>2420	1373	86	>9678	63	15	14	192	221	30%
Deadman 3.5	*E. coli*	67	78	>2420	445	172	>9678	770	1298	>2420	197	582	50%
Deadman 3	*E. coli*	39	162	2420	476	1553	>9678	1540	101	Dry	727	614	56%
Deadman 2	*E. coli*	152	326	2420	1226	649	>9678	649	Dry	Dry	517	863	63%
Deadman 1	Enterococci	145	213	4611	2909	670	19863	328	315	5172	520	1044	60%
Weather		Dry	Wet	Wet	Wet	Dry	Wet	Dry	Dry	Dry	Wet		

Table 3.2. GPS coordinates and site locations for Deadman's Brook.

Site Name	Latitude	Longitude	Site location notes	River Name
Deadman 9	41.17826	-73.33006	Tupelo Road	Deadman's Brook
Deadman 8	41.17267	-73.33152	Highland Road	Deadman's Brook
Deadman 7	41.16502	-73.33419	Silent Grove North	Deadman's Brook
Deadman 5	41.15869	-73.33498	North Avenue	Deadman's Brook
Deadman 4	41.15487	-73.34130	Leslie Lane	Deadman's Brook
Deadman 3.5	41.15141	-73.34782	Deerwood Lane	Deadman's Brook
Deadman 3	41.14682	-73.35434	Evergreen Ave	Deadman's Brook
Deadman 2	41.14199	-73.35834	Myrtle Ave	Deadman's Brook
Deadman 1	41.13975	-73.35843	Jesup Road	Deadman's Brook

Dissolved oxygen and water temperature: Median dissolved oxygen readings in the watershed generally increased downstream along the length of the brook (Figure 3.3). While the majority of readings met the CT DEEP minimum criteria, 18 individual dissolved oxygen readings were observed below 5mg/L at all freshwater sites except Deadman 2 and two individual dissolved oxygen readings were observed below 3 mg/L at saltwater site Deadman 1 from mid-June through September, when mean water temperature was higher (Figure 3.4). On 8/30, five of the nine sampling sites dried up as a direct result of the drought.

Figure 3.3. Box plot of dissolved oxygen concentrations at each sampling site along Deadman's Brook. The dashed red line represents the CT DEEP minimum criteria for dissolved oxygen in freshwater, which is 5mg/L. The dotted red line represents the CT DEEP minimum criteria for dissolved oxygen in saltwater, which is 3mg/L. The only saltwater sampling site in this river is Deadman 1. The numbers above each site name is the number of samples taken at each site. For more information on what each part of the boxplot represents, please review the informational graphic in the "Key Terms and Information" section on page 4.

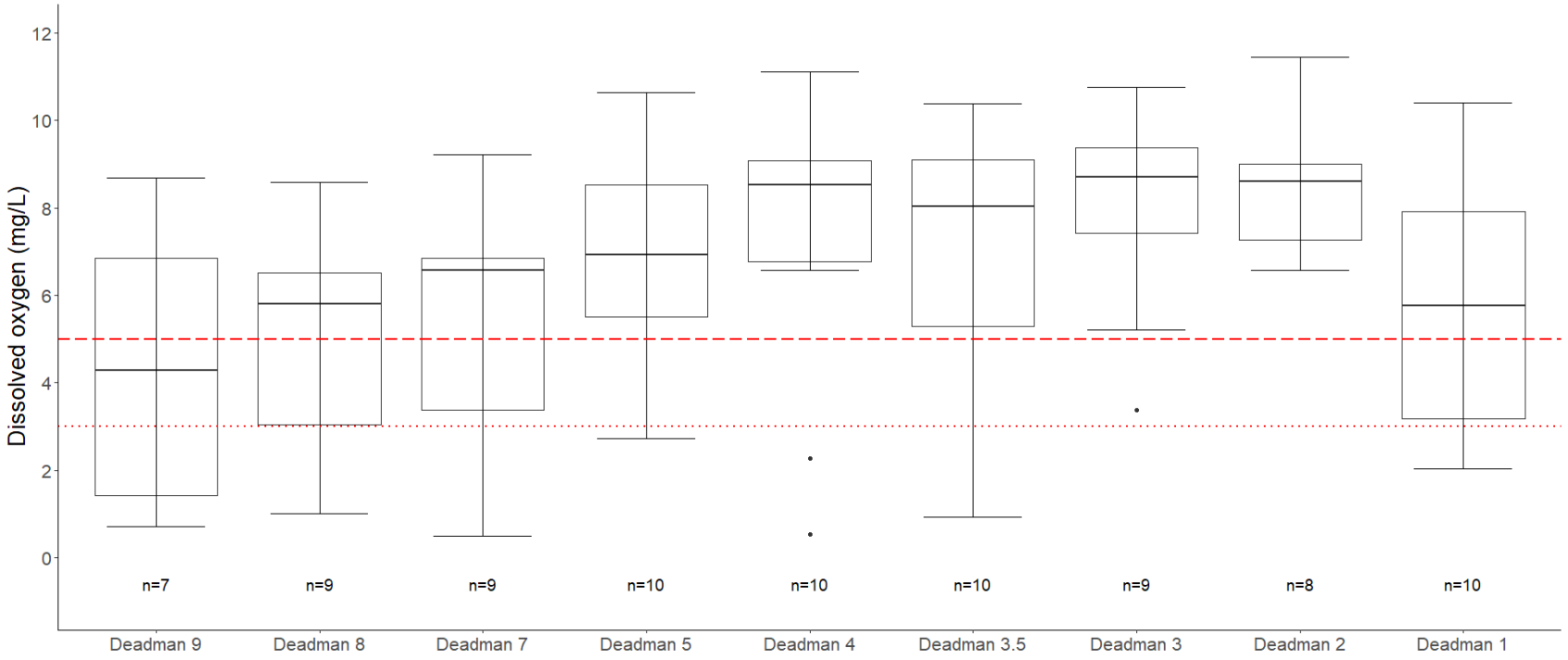
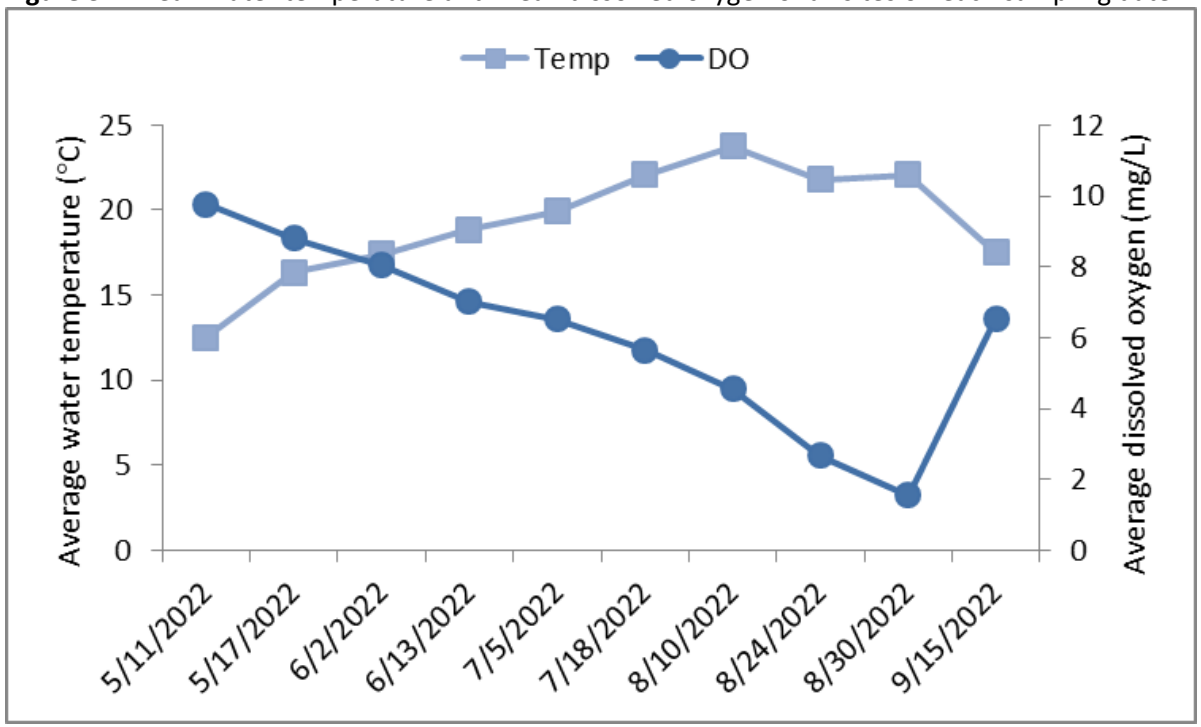


Figure 3.4 Mean water temperature and mean dissolved oxygen of all sites on each sampling date in Deadman's Brook.



4. Farmill River

The Farmill River Watershed is located in four municipalities: Monroe, Shelton, Stratford, and Trumbull, CT. The watershed is 9,657 acres and the river discharges into the Housatonic River. The land use includes 52% urban area, 43% forest, 3% water, and 2% agriculture (CT DEEP, 2012b). Harbor Watch first monitored the Farmill River in 2017 and again in 2021.

Indicator bacteria: In 2022, water quality conditions observed were consistent with what was seen in prior years (Figure 4.1). Six of the eight study sites exceeded CT DEEP geomean criteria for indicator bacteria (Figure 4.2). While any geomean above 126 MPN/100mL for *E. coli* is considered failing, it is important to note that the highest geomean observed in the Farmill River was 229 MPN/100mL at Farmill 8, which was likely driven by elevated concentrations observed during wet weather events (Table 4.1). Additionally, 14% of all samples processed in the Farmill River exceeded the CT DEEP single sample maximum criteria (Table 4.1).

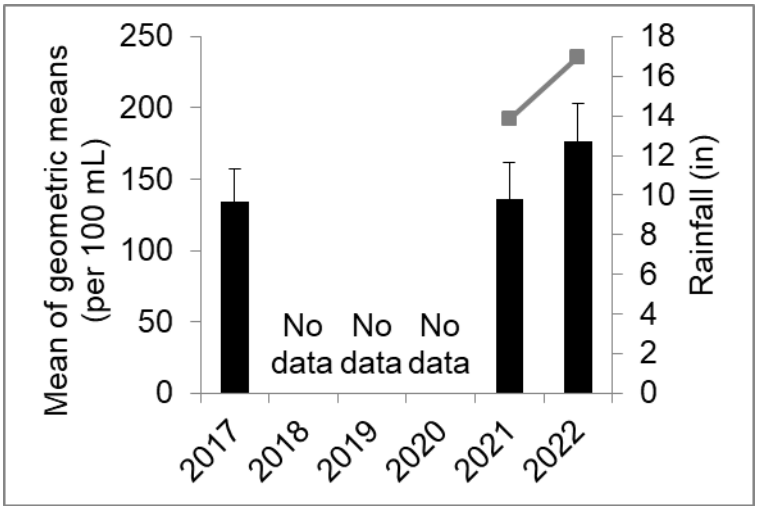


Figure 4.1. (Left) Mean of site geomeans (black bars) from 2017-2022 and total rainfall from May through September each year (grey squares and line).

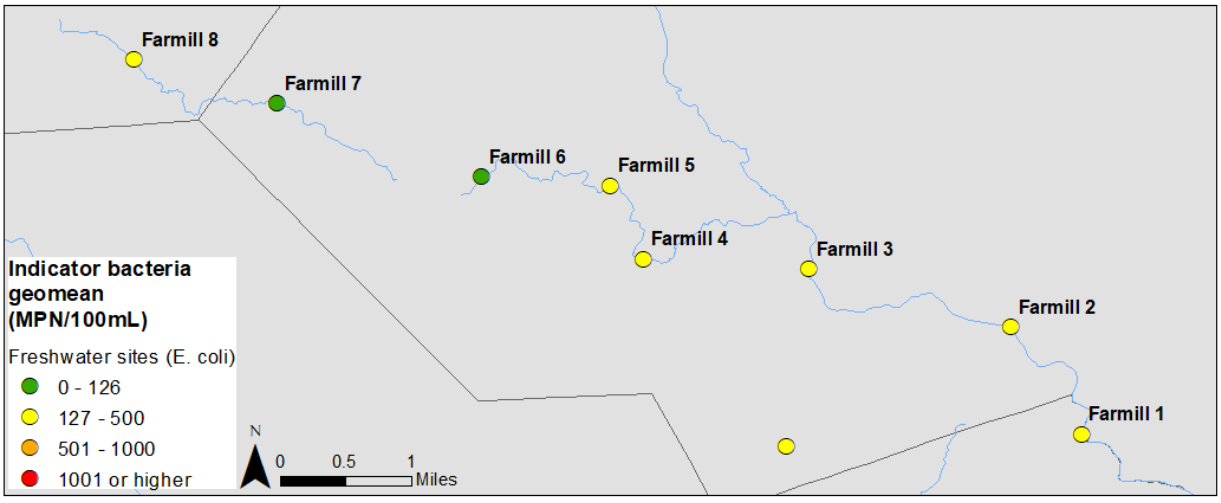


Figure 4.2. (Below) Geomean of bacteria concentrations at each site in 2022.

Table 4.1. Farmill River *E. coli* concentrations (MPN/100mL), geomeans, and percentage of samples exceeding the CT DEEP single sample maximum. Rainfall data gathered from the website, Weather Underground (n.d.).

	5/10/2022	5/18/2022	6/7/2022	6/22/2022	7/11/2022	7/28/2022	8/3/2022	8/23/2022	9/8/2022	9/15/2022	Geomean	% exceeding SSM
Farmill 8	34	66	172	548	613	86	411	461	613	308	229	20%
Farmill 7	22	44	105	61	39	16	Construction	41	411	1120	74	11%
Farmill 6	19	75	4	27	18	19	24	57	1120	261	43	10%
Farmill 5	44	272	122	276	77	125	115	613	687	345	191	20%
Farmill 4	131	108	272	91	>2420	83	88	365	575	345	232	10%
Farmill 3	689	48	61	276	214	248	248	138	436	276	203	10%
Farmill 2	113	68	122	921	72	142	119	172	>2420	461	214	20%
Farmill 1	142	67	78	291	148	260	130	238	>2420	548	225	10%
Weather	Dry	Wet	Dry	Dry	Dry	Dry	Wet	Dry	Wet	Dry		

Table 4.2. GPS coordinates and site locations for the Farmill River.

Site Name	Latitude	Longitude	Site location notes	River Name
Farmill 8	41.305748	-73.211577	Jays Road	Farmill River
Farmill 7	41.300952	-73.195789	Booth Hill Road and Mohegan Road intersection	Farmill River
Farmill 6	41.292882	-73.173302	6 Corn Hill Road	Farmill River
Farmill 5	41.291907	-73.159113	Walnut Tree Hill Road	Farmill River
Farmill 4	41.283835	-73.155510	Nichols Avenue	Farmill River
Farmill 3	41.282739	-73.137207	Buddington Road	Farmill River
Farmill 2	41.276331	-73.115018	Beard Sawmill Road	Farmill River
Farmill 1	41.264572	-73.107256	115 Yutaka Trail	Farmill River

Dissolved oxygen and water temperature: Dissolved oxygen concentrations remained relatively consistent throughout the watershed at each site (Figure 4.3). While the majority of individual dissolved oxygen readings met the CT DEEP minimum of 5 mg/L, 7 readings were observed below 5mg/L at sites Farmill 8, Farmill 6, Farmill 4, and Farmill 3 from late-July through early-September, when mean water temperature was higher (Figure 4.4).

Figure 4.3. Box plot of dissolved oxygen concentrations at each sampling site along Farmill River. The dashed red line represents the CT DEEP minimum criteria for dissolved oxygen in freshwater, which is 5mg/L. The numbers above each site name is the number of samples taken at each site. For more information on what each part of the boxplot represents, please review the informational graphic in the "Key Terms and Information" section on page 4.

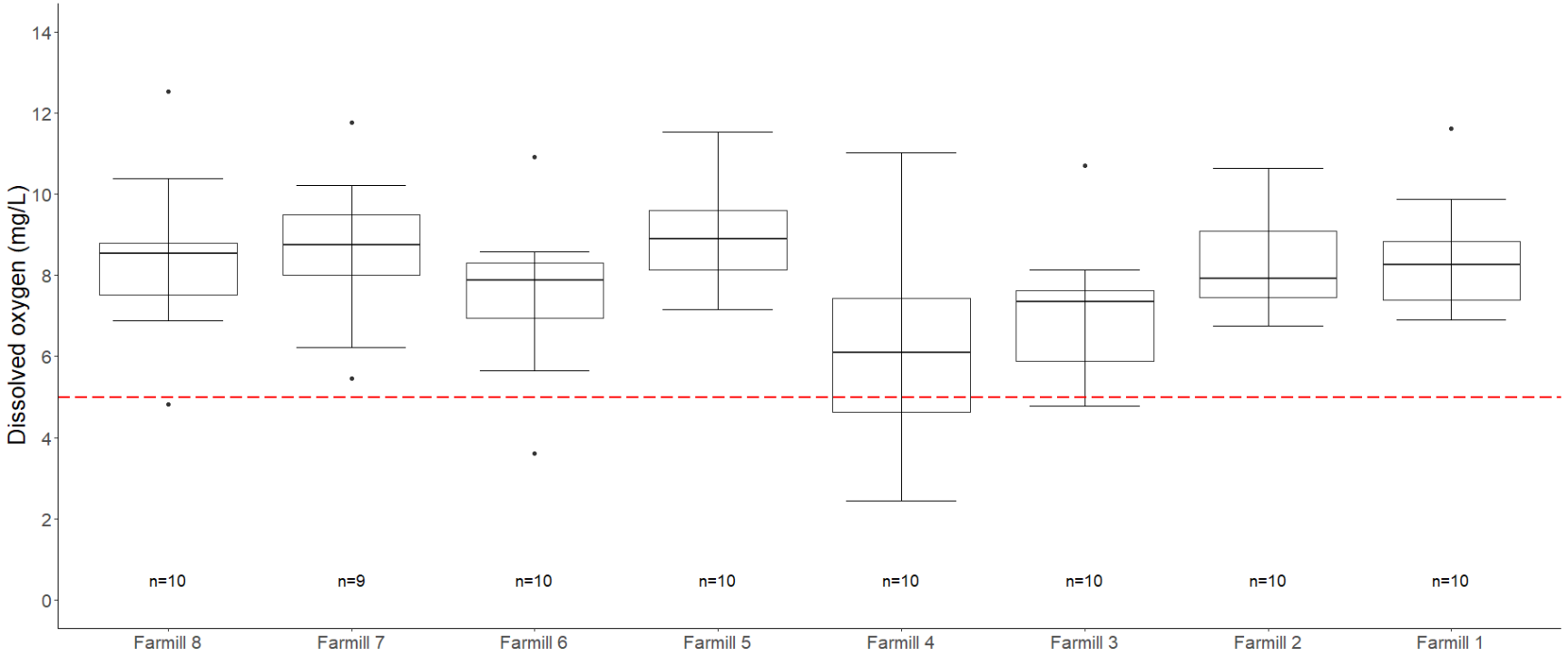
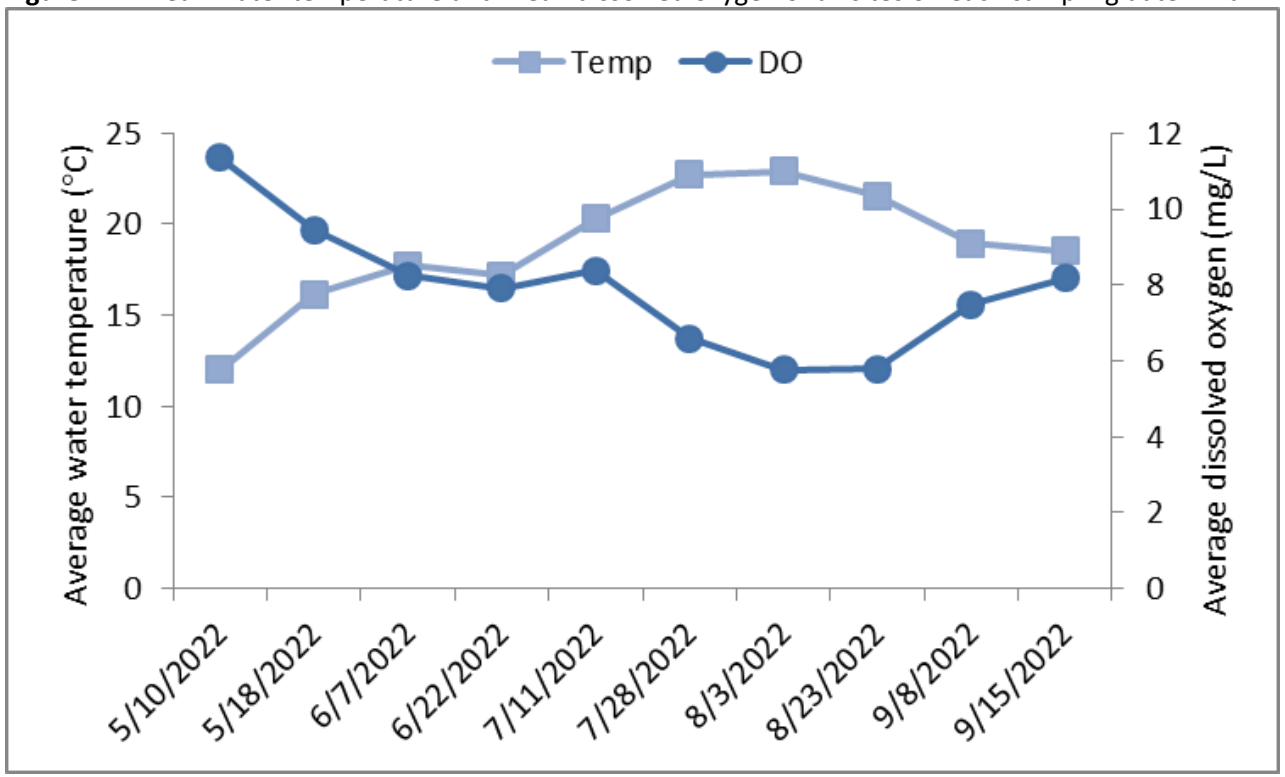
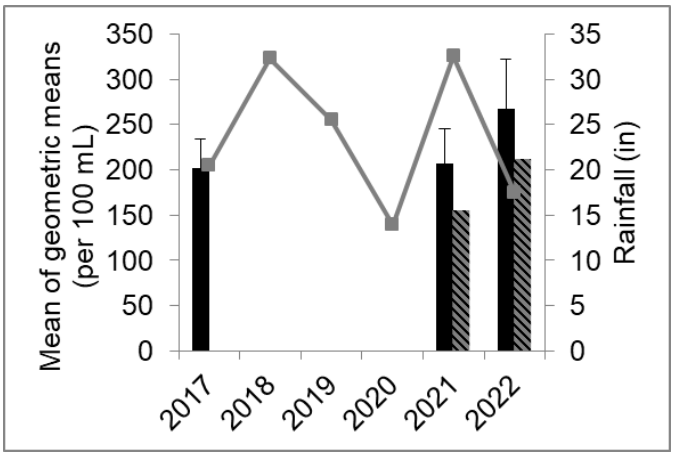


Figure 4.4. Mean water temperature and mean dissolved oxygen of all sites on each sampling date in Farmill River.



5. Fivemile River

The Fivemile River Watershed includes approximately 7,995 acres of land and extends from Pound Ridge, NY through New Canaan, Norwalk, and Darien, CT before ending at Fivemile River Harbor. Land use in the watershed consists of 81% residential areas, with the upper watershed more suburban and the lower watershed more densely populated, 13% is open space, and 6% is commercial and institutional areas (The South Western Regional Planning Agency, 2012a).



Indicator bacteria: Bacteria concentrations observed in 2022 were slightly elevated above those observed in years prior (Figure 5.1). In 2022, 8 of the 10 sampling sites exceeded the CT DEEP geomean criteria for indicator bacteria (Figure 5.2). Many sites exceeded the criteria by a small margin, likely driven by one or two elevated concentrations observed during wet events (Table 5.1). Additionally, 22% of all samples processed exceeded the CT DEEP single sample maximum criteria (Table 5.1). Harbor Watch has been working with the Town of New Canaan to isolate the elevated bacteria concentrations observed at site Fivemile 7.

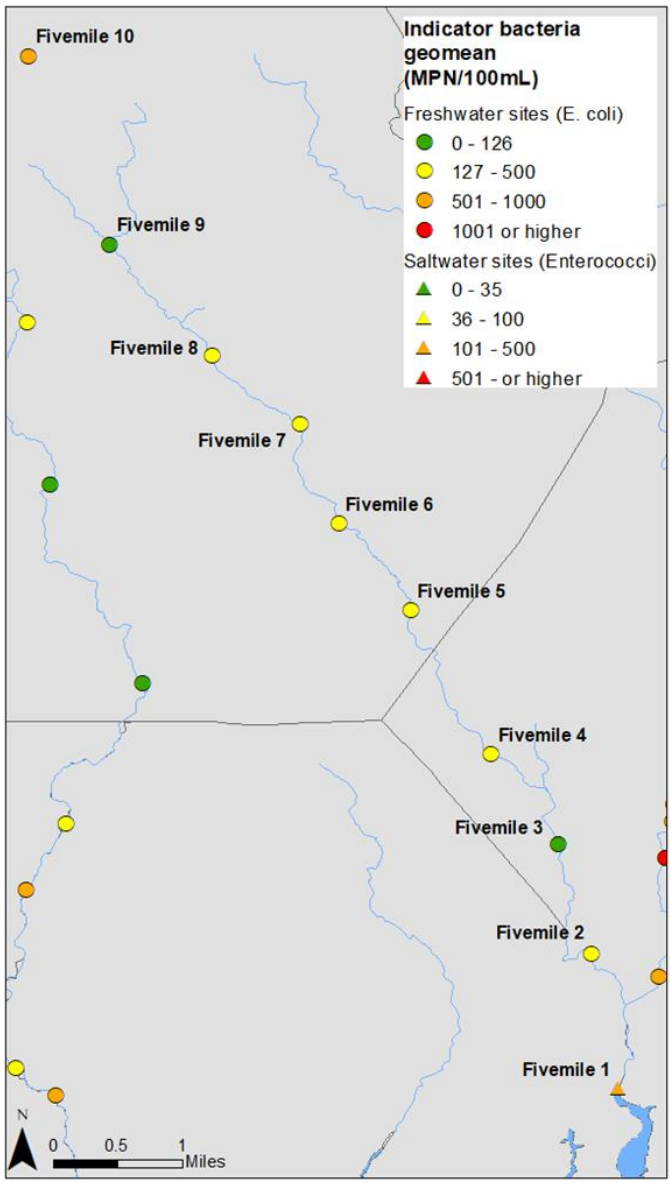


Figure 5.1. (Top) Mean of freshwater site geomeans (black bars) and saltwater site geomeans (striped bars) from 2017-2022 and total rainfall from May through September each year (grey squares and line).

Figure 5.2. (Bottom) Geomean of bacteria concentrations at each site in 2022.

Table 5.1. Fivemile River *E. coli* and enterococci concentrations (MPN/100mL), geomeans, and percentage of samples exceeding the CT DEEP single sample maximum. Rainfall data gathered from the Norwalk Health Department (n.d.).

	Indicator bacteria	5/5/2022	5/16/2022	6/8/2022	6/16/2022	7/13/2022	7/26/2022	8/2/2022	8/16/2022	8/31/2022	9/19/2022	Geomean	% exceeding SSM
Fivemile 10	*E. coli*	96	193	272	2420	656	>4839	2886	Dry	Dry	175	612	50%
Fivemile 9	*E. coli*	36	50	156	548	39	74	185	96	93	61	92	0%
Fivemile 8	*E. coli*	201	75	179	1046	>4839	127	78	102	>2420	1414	369	40%
Fivemile 7	*E. coli*	365	228	579	>2420	253	690	84	32	461	144	286	30%
Fivemile 6	*E. coli*	31	102	285	>2420	210	472	1961	268	992	110	323	30%
Fivemile 5	*E. coli*	53	135	687	830	177	198	1454	187	152	344	270	30%
Fivemile 4	*E. coli*	199	206	>2420	284	49	154	67	23	96	93	140	10%
Fivemile 3	*E. coli*	43	153	308	133	42	51	50	228	19	99	81	0%
Fivemile 2	*E. coli*	53	249	687	1414	456	308	213	55	144	131	229	20%
Fivemile 1	Enterococci	10	52	7701	345	109	7270	86	63	241	134	213	20%
Weather		Dry	Wet	Wet	Wet	Dry	Wet	Wet	Dry	Dry	Wet		

Table 5.2. GPS coordinates and site locations for the Fivemile River.

Site Name	Latitude	Longitude	Site location notes	River Name
Fivemile 10	41.189323	-73.514135	Michigan Road	Fivemile River
Fivemile 9	41.168110	-73.504929	Country Club Road	Fivemile River
Fivemile 8	41.155580	-73.493453	Smith Ridge Road	Fivemile River
Fivemile 7	41.147827	-73.483529	East Avenue	Fivemile River
Fivemile 6	41.136623	-73.479169	Old Norwalk Road	Fivemile River
Fivemile 5	41.126902	-73.471024	Nursery Road	Fivemile River
Fivemile 4	41.110687	-73.461955	Fillow Street	Fivemile River
Fivemile 3	41.100584	-73.454406	W. Cedar Street	Fivemile River
Fivemile 2	41.088194	-73.450708	Flax Hill Road	Fivemile River
Fivemile 1	41.073023	-73.447620	Cudlipp Street	Fivemile River

Dissolved oxygen and water temperature: Dissolved oxygen readings varied at each site throughout the watershed (Figure 5.3). While the majority of individual dissolved oxygen readings met the CT DEEP criteria, 8 readings were observed below 5 mg/L for freshwater sites Fivemile 10, Fivemile 9, Fivemile 5, and Fivemile 3, and one reading was observed below 3 mg/L at saltwater site Fivemile 1. Low readings were observed from mid-July through the end of August when water temperatures increased (Figure 5.4) and rainfall was low.

Figure 5.3. Box plot of dissolved oxygen concentrations at each sampling site along Fivemile River. The dashed red line represents the CT DEEP minimum criteria for dissolved oxygen in freshwater, which is 5mg/L. The dotted red line represents the CT DEEP minimum criteria for dissolved oxygen in saltwater, which is 3mg/L. The only saltwater sampling site in this river is Fivemile 1. The numbers above each site name is the number of samples taken at each site. For more information on what each part of the boxplot represents, please review the informational graphic in the "Key Terms and Information" section on page 4.

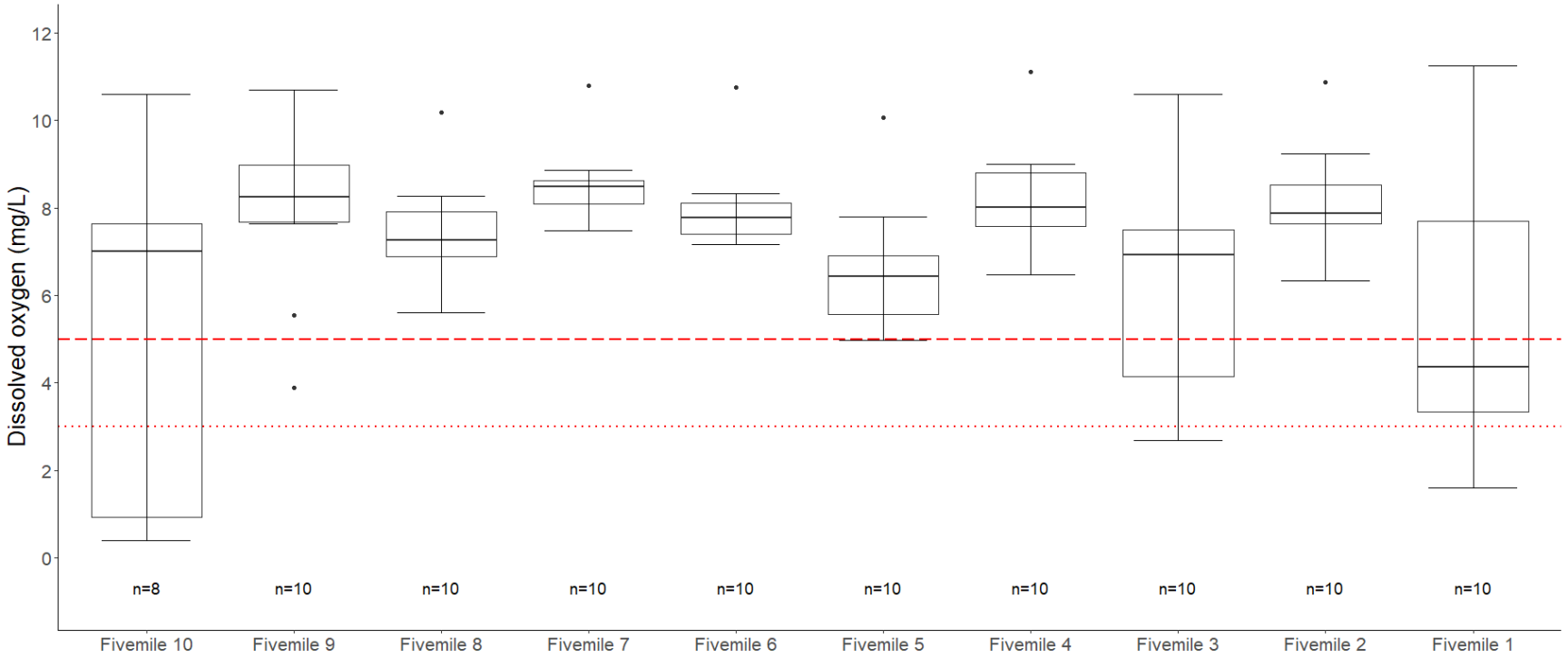
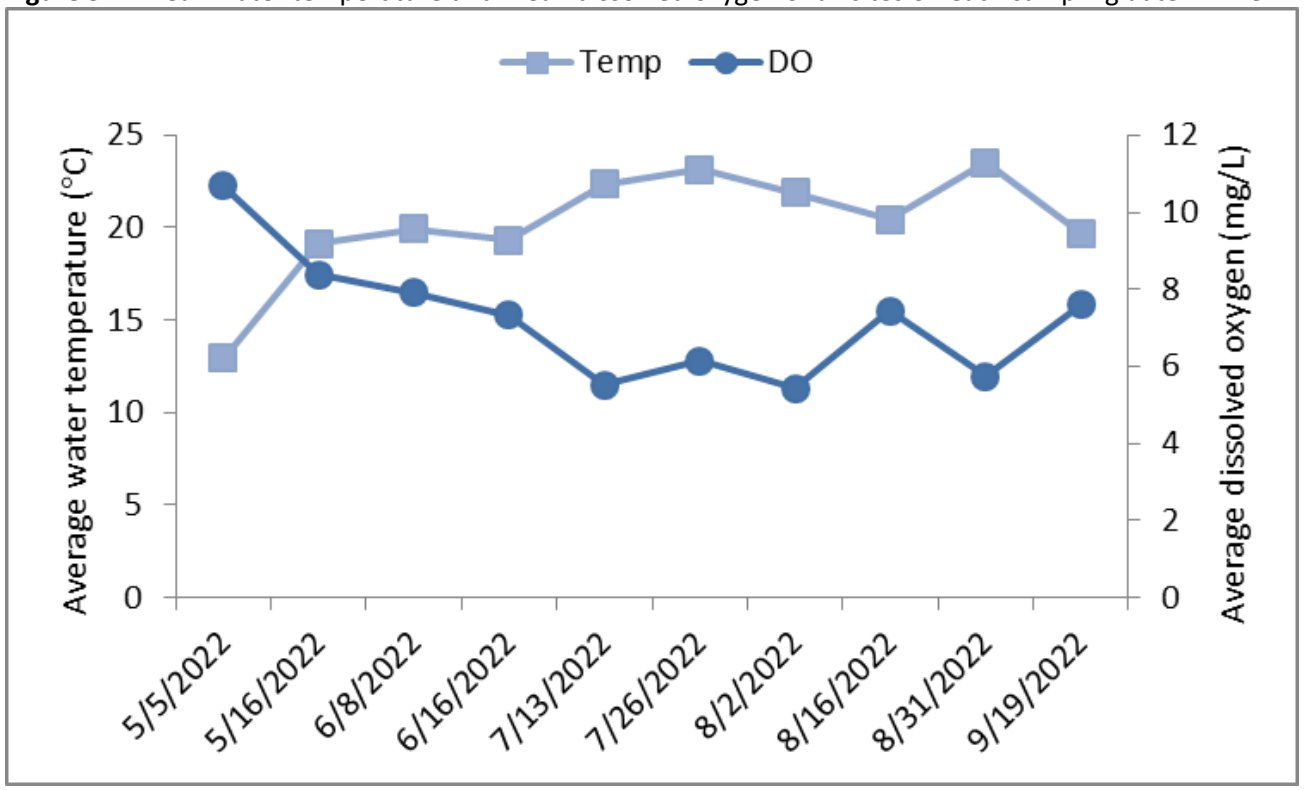


Figure 5.4. Mean water temperature and mean dissolved oxygen of all sites on each sampling date in Fivemile River.



6. Indian River

Indian River is a tributary to the Saugatuck River located in Westport, CT. It meets the Saugatuck River downstream of Harbor Watch study site Saugatuck 0.25 in downtown Westport (Section 16). Harbor Watch was asked by the Town of Westport to add Indian River to the monitoring regime in 2022 to collect baseline data on the waterway before construction in the watershed began.

Indicator bacteria: In 2022, all sites exceeded the CT DEEP geomean criteria for indicator bacteria (Figure 6.1). Additionally, 66% of all samples processed exceeded the CT DEEP single sample maximum criteria. A month into the monitoring season, a sanitary force main in Norwalk ruptured through the ground and untreated waste runoff entered a catch basin which drained to Indian River. Impact from this break can be seen on 6/16/2022 when Harbor Watch conducted a special sampling event the day after the incident (Table 6.1). Data also indicated that by 6/21/2022 the River rebounded to pre-incident levels at most sites. Sites Indian 1.5 and Indian 1 took longer to rebound because flow at these sites is much slower. The source of the elevated bacteria concentrations in the river is unknown and additional data should be collected to track-down pollution sources.

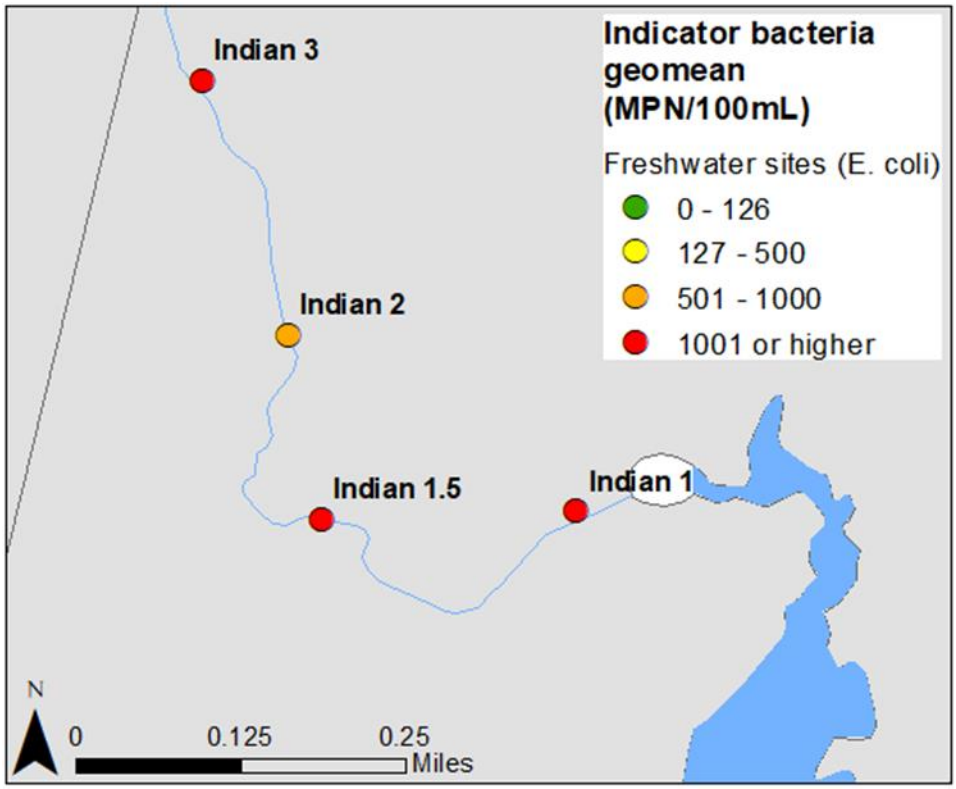


Figure 6.1. Geomean of *E. coli* concentrations at each site in 2022.

Table 6.1. Indian River *E. coli* concentrations (MPN/100mL), geomeans, and percentage of samples exceeding the CT DEEP single sample maximum. Rainfall data gathered from the Norwalk Health Department (n.d.).

	5/3/2022	5/17/2022	6/7/2022	6/16/2022	6/21/2022	6/30/2022	7/19/2022	8/10/2022	8/15/2022	8/29/2022	9/21/2022	Geomean	% exceeding SSM
Indian 3	501	1300	1120	>24196	857	1034	4611	866	3106	1045	455	1509	82%
Indian 2	201	1046	326	>24196	389	977	5475	1120	521	1034	334	968	55%
Indian 1.5	461	2420	551	>24196	529	1842	4106	1986	372	4839	1102	1642	64%
Indian 1	461	3683	523	>24196	984	1226	12033	3922	54	213	1733	1336	64%
Weather	Wet	Wet	Wet	Wet	Dry	Dry	Wet	Dry	Dry	Dry	Wet		

Table 6.2. GPS coordinates and site locations for Indian River.

Site Name	Latitude	Longitude	Site location notes	River Name
Indian 3	41.12117	-73.37998	Hogan Trail	Indian River
Indian 2	41.11837	-73.37903	Hiawatha Lane Extension	Indian River
Indian 1.5	41.11635	-73.37866	Trail off Westport Train Station parking lot	Indian River
Indian 1	41.11643	-73.37585	Indian River Green	Indian River

Dissolved oxygen and water temperature: Dissolved oxygen values were relatively consistent at each site during the monitoring season with the exception of site Indian 1.5 (Figure 6.3). The widest range in values was observed at site Indian 1.5, which was located in an area where flow slowed, and was often impeded by organic debris and trash buildup. Four individual dissolved oxygen readings fell below the CT DEEP minimum of 5 mg/L at Indian 1.5 and Indian 1 during the month of August, when mean water temperature was higher (Figure 6.4) and air temperature observed in August.

Figure 6.3. Box plot of dissolved oxygen concentrations at each sampling site along Indian River. The dashed red line represents the CT DEEP minimum criteria for dissolved oxygen in freshwater, which is 5mg/L. The numbers above each site name is the number of samples taken at each site. For more information on what each part of the boxplot represents, please review the informational graphic in the "Key Terms and Information" section on page 4.

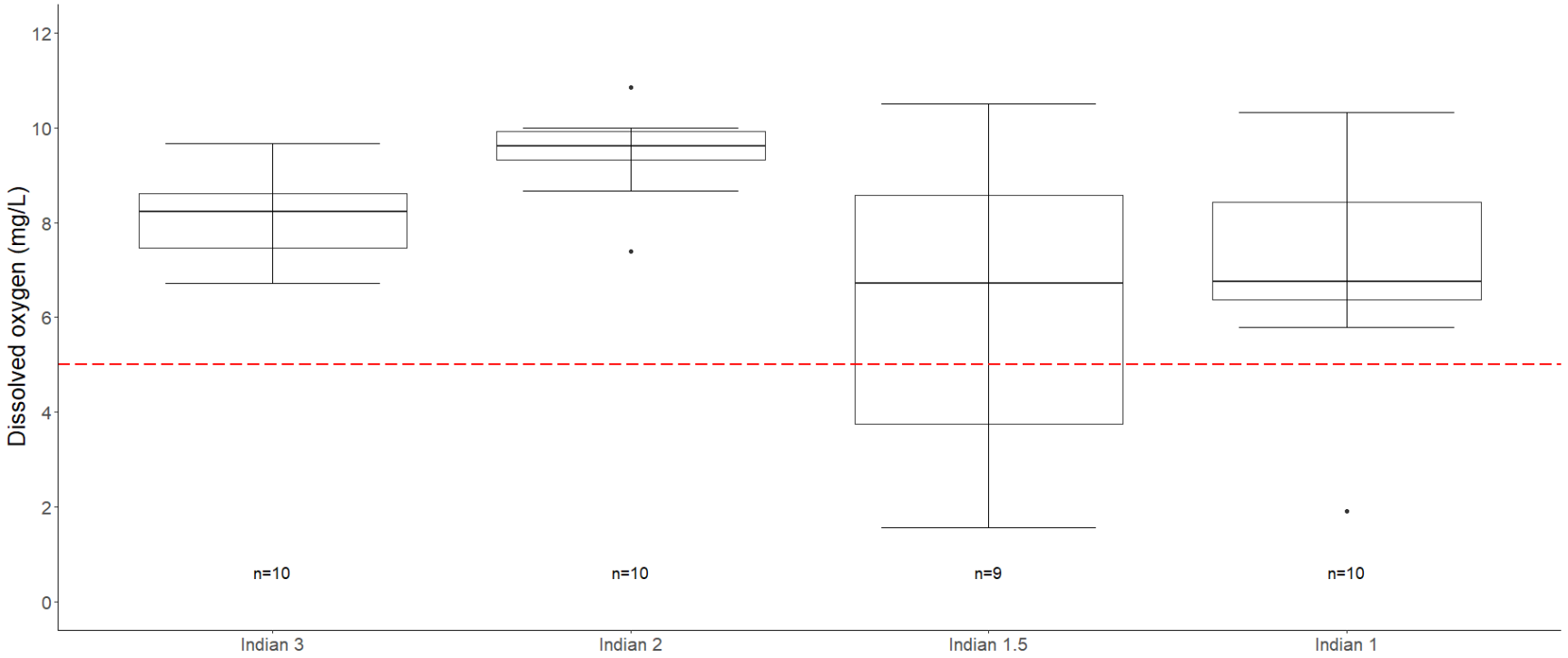
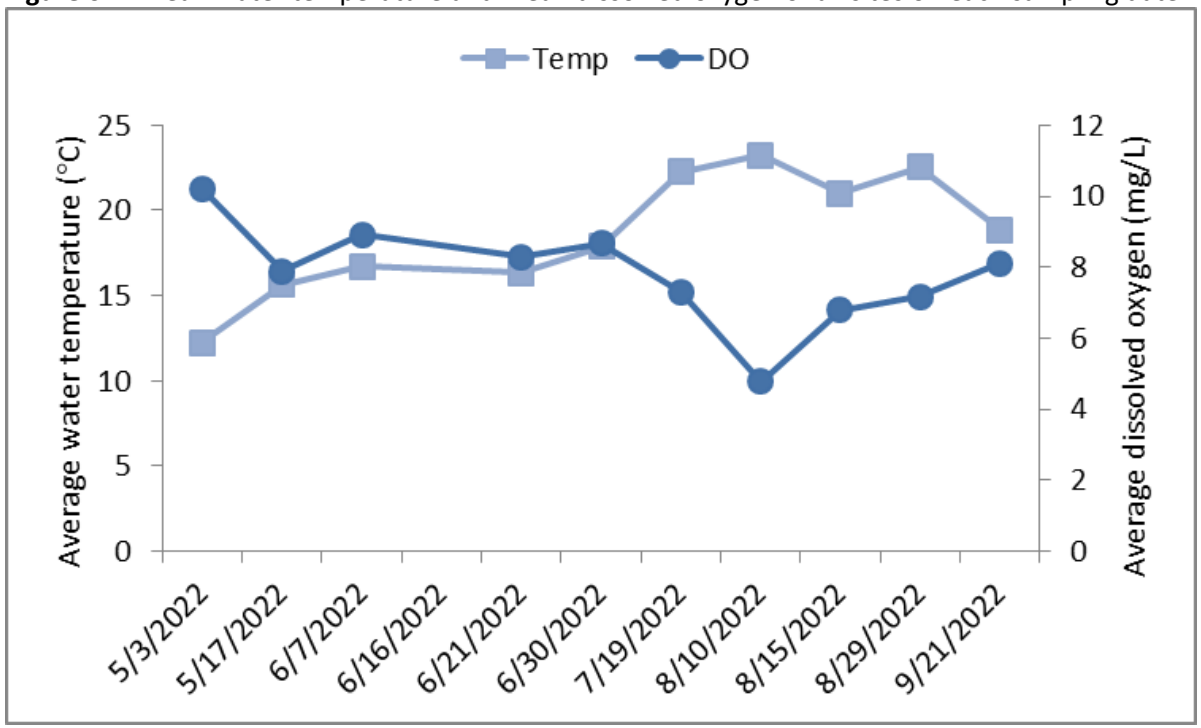


Figure 6.4. Mean water temperature and mean dissolved oxygen of all sites on each sampling date in Indian River.



7. Island Brook

Island Brook is a tributary to the Pequonnock River. It starts in Trumbull and flows south through Bridgeport before discharging to the Pequonnock River in between Harbor Watch sites Pequonnock 1 and Pequonnock 0.75 (Section 12). Island Brook was first monitored by Harbor Watch in 2022.

Indicator bacteria: All sites exceeded the CT DEEP geomean criteria for indicator bacteria (Figure 7.1). Additionally, 81% of all samples processed exceeded the CT DEEP single sample maximum criteria (Table 7.1). Harbor Watch is working with the City of Bridgeport on a 3 pollution track-down projects in the vicinity of Island 1 to improve water quality. Harbor Watch was also informed of a forced sanitary main break in the vicinity of Island 4 in June and September of 2022 which may account for the elevated concentrations observed.

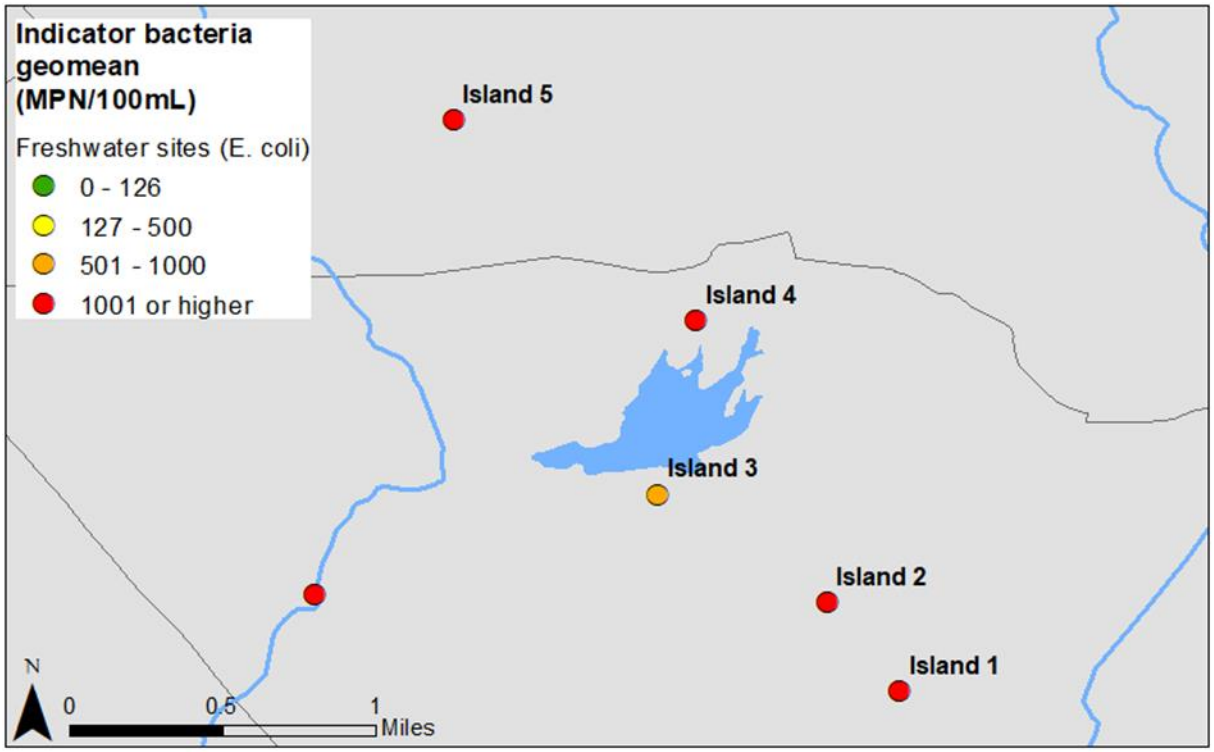


Figure 7.1. Geomean of *E. coli* concentrations at each site in 2022. Unlabeled sites are in the Ash Creek Watershed (section 1).

Table 7.1. Island Brook *E. coli* concentrations (MPN/100mL), geomeans, and percentage of samples exceeding the CT DEEP single sample maximum. Rainfall data gathered from the website, Weather Spark (n.d.).

	5/10/2022	5/26/2022	6/1/2022	6/22/2022	6/27/2022	7/27/2022	8/4/2022	8/22/2022	9/7/2022	9/13/2022	Geomean	% exceeding SSM
Island 5	102	461	378	2420	922	651	1454	Dry	5794	19863	1176	67%
Island 4	>2420	1511	>4839	9678	4884	4045	>24196	Dry	54750	31062	8033	100%
Island 3	66	613	866	>2420	1226	570	615	690	1017	373	628	70%
Island 2	579	308	961	3466	1102	953	396	471	1203	>24196	1130	70%
Island 1	>2420	4839	>9678	>24196	>241960	3267	1334	2143	2934	24196	7317	100%
Weather	Dry	Dry	Wet	Wet	Wet	Wet	Dry	Dry	Wet	Wet		

Table 7.2. GPS coordinates and site locations for the Island Brook.

Site Name	Latitude	Longitude	Site location notes	River Name
Island 5	41.234895	-73.21723	Williams Road	Island Brook
Island 4	41.225396	-73.20574	Lakeside Drive	Island Brook
Island 3	41.217179	-73.20757	Griffin Avenue	Island Brook
Island 2	41.212059	-73.19954	Chopsey Hill Road	Island Brook
Island 1	41.207835	-73.19613	Chopsey Hill Road/Pond Street	Island Brook

Dissolved oxygen and water temperature: Dissolved oxygen readings varied at each site throughout the brook (Figure 7.2). While the majority of individual dissolved oxygen readings met the CT DEEP minimum of 5 mg/L, 10 readings were observed below 5 mg/L at sites Island 3, Island 2, and Island 1. Island 3 had the highest frequency of low readings at 70%. Higher mean water temperature is a contributing factor to the low dissolved oxygen readings observed during late July to September (Figure 7.3).

Figure 7.2. Box plot of dissolved oxygen concentrations at each sampling site along Island Brook. The dashed red line represents the CT DEEP minimum criteria for dissolved oxygen in freshwater, which is 5mg/L. The numbers above each site name is the number of samples taken at each site. For more information on what each part of the boxplot represents, please review the informational graphic in the "Key Terms and Information" section on page 4.

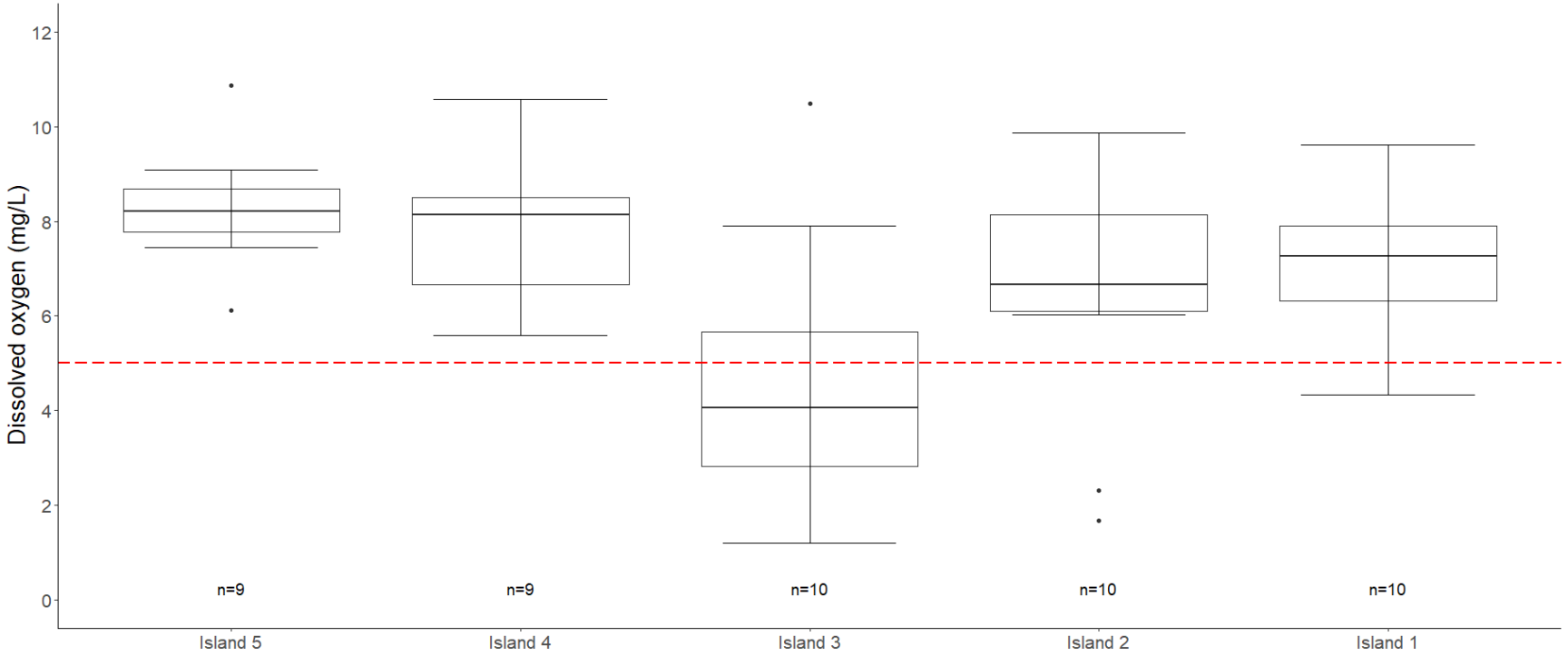
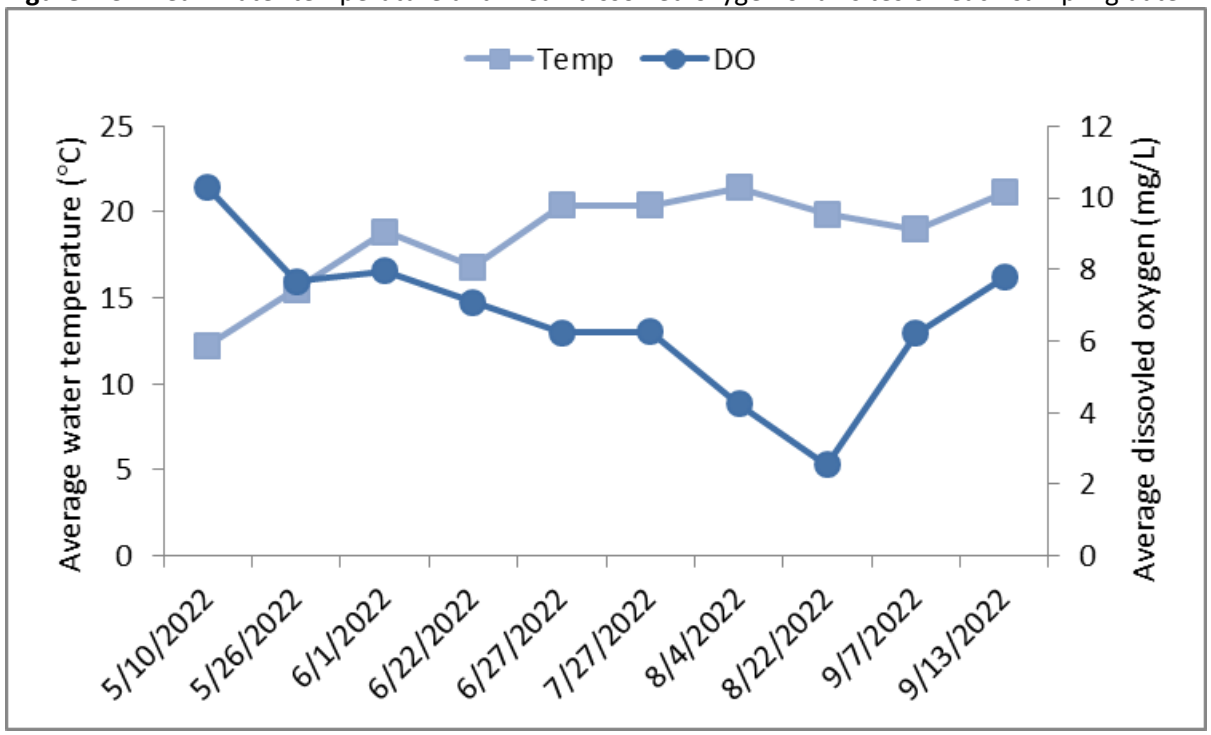
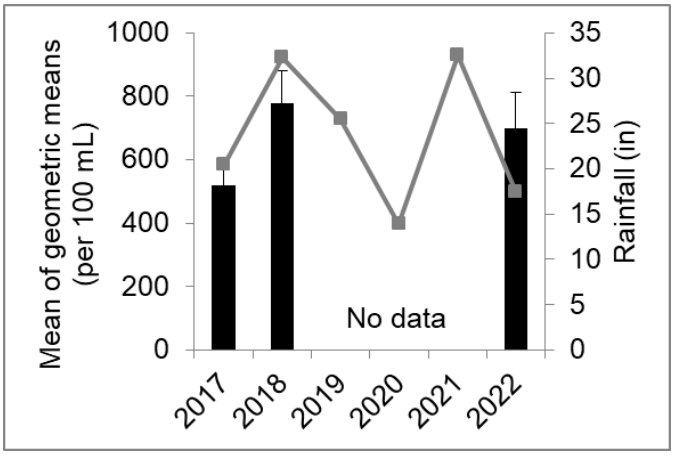


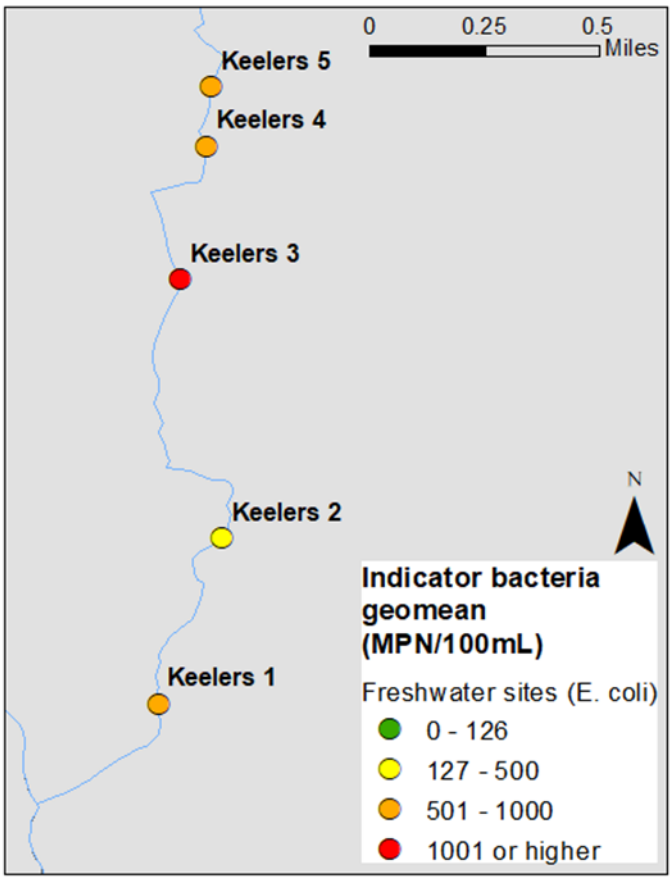
Figure 7.3. Mean water temperature and mean dissolved oxygen of all sites on each sampling date in Island Brook.



8. Keelers Brook

Keelers Brook is a small tributary to the Fivemile River and discharges to the Fivemile River between Harbor watch sites Fivemile 2 and Fivemile 1 (Section 5). The brook is located entirely in the City of Norwalk and is comprised of many small branches and a series of small ponds near its headwaters. Keelers Brook has been a waterway of interest by Harbor Watch for many years due to the elevated bacteria concentrations observed, but it wasn't until the late 2010s that the brook was monitored as part of the regular monitoring season.





Indicator bacteria: Indicator bacteria concentrations observed in 2022 are similar to those observed in 2018 (Figure 8.1). In 2022, all sites exceeded the CT DEEP geomean criteria for indicator bacteria (Figure 8.2). Additionally, 57% of all samples processed exceeded the CT DEEP single sample maximum criteria (Table 8.1). Due to construction at the bridge on Rowayton Avenue, sampling of Keelers 1 could not begin until the end of July, and only 5 samples were collected over the course of the monitoring season. Harbor Watch is currently working with the City of Norwalk to track down pollution sources in this system, particularly between Keelers 5 and Keelers 3.

Figure 8.1. (Top) Mean of site geomeans (black bars) from 2017-2022 and total rainfall from May through September each year (grey squares and line).

Figure 8.2. (Bottom) Geomean of bacteria concentrations at each site in 2022.

Table 8.1. Keelers Brook *E. coli* concentrations (MPN/100mL), geomeans, and percentage of samples exceeding the CT DEEP single sample maximum. Rainfall data gathered from the Norwalk Health Department (n.d.). Note: Keelers 1 had less than 8 samples collected.

	5/5/2022	5/16/2022	6/8/2022	6/16/2022	7/13/2022	7/26/2022	8/2/2022	8/16/2022	8/31/2022	9/19/2022	Geomean	% exceeding SSM
Keelers 5	71	99	>2420	977	977	714	749	2827	475	233	554	60%
Keelers 4	416	727	3466	1195	643	796	1164	Dry	263	575	785	67%
Keelers 3	326	228	>4839	7945	41	2190	9678	613	959	1354	1071	70%
Keelers 2	108	161	>2420	4839	279	3080	198	71	107	387	399	30%
Keelers 1	Construction	Construction	Construction	Construction	Construction	>2420	775	291	187	1414	679	60%
Weather	Dry	Wet	Wet	Wet	Dry	Wet	Wet	Dry	Dry	Wet		

Table 8.1. GPS coordinates and site locations for Keelers Brook.

Site Name	Latitude	Longitude	Site location notes	River Name
Keelers 5	41.105013	-73.441392	Scribner Avenue	Keelers Brook
Keelers 4	41.103159	-73.441534	W Cedar Street	Keelers Brook
Keelers 3	41.098950	-73.442350	Norwalk Pump Station on Route 1	Keelers Brook
Keelers 2	41.090810	-73.441050	Primrose Court	Keelers Brook
Keelers 1	41.085620	-73.443050	Rowayton Avenue	Keelers Brook

Dissolved oxygen and water temperature: Dissolved oxygen readings varied at each site throughout the brook (Figure 8.3). While the majority of individual dissolved oxygen readings met the CT DEEP minimum criteria of 5 mg/L, 10 readings were observed below 5 mg/L at sites Keelers 5, Keelers 4, and Keelers 3 from mid-June through August, when mean water temperature increased (Figure 8.4). The water at these sites moves slowly and passes through a wetland area upstream of Keelers 3 which may explain the lower oxygen readings compared to those downstream.

Figure 8.3. Box plot of dissolved oxygen concentrations at each sampling site along Keelers Brook. The dashed red line represents the CT DEEP minimum criteria for dissolved oxygen in freshwater, which is 5mg/L. The numbers above each site name is the number of samples taken at each site. For more information on what each part of the boxplot represents, please review the informational graphic in the "Key Terms and Information" section on page 4.

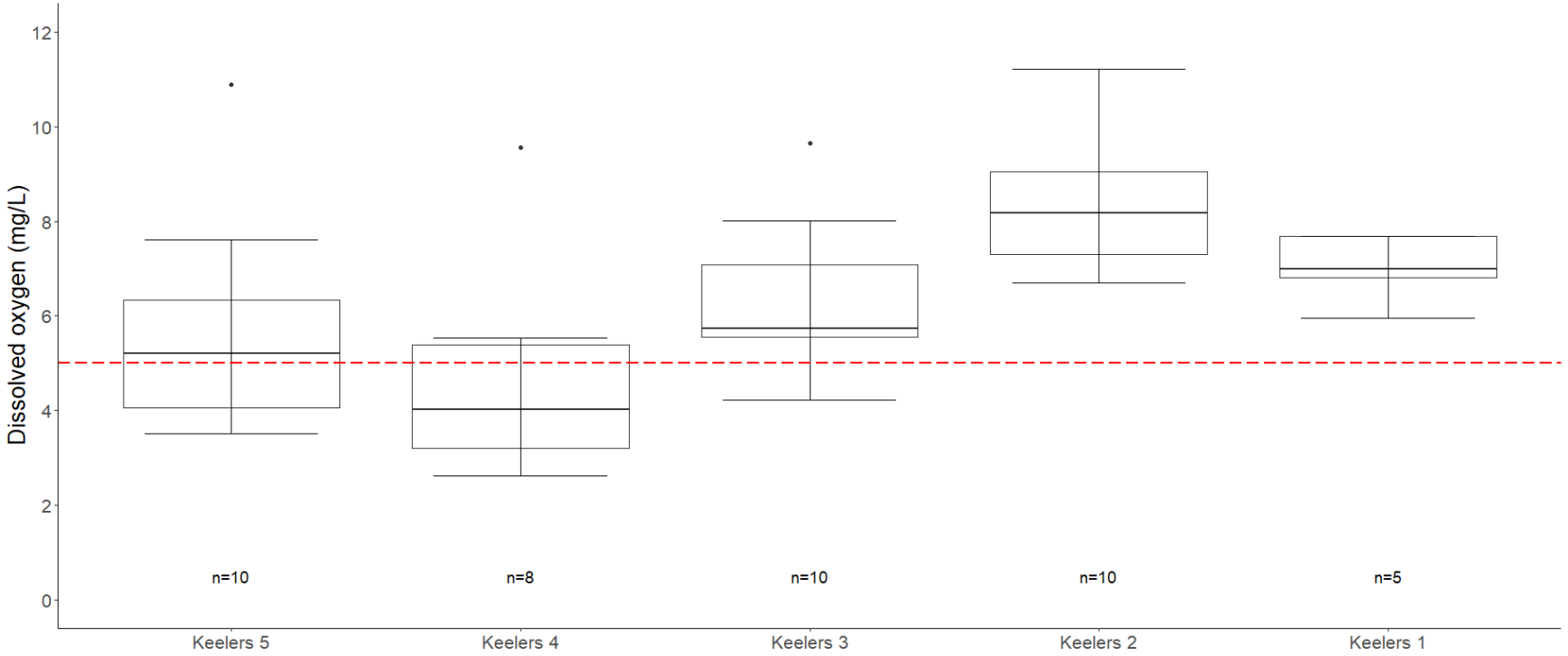
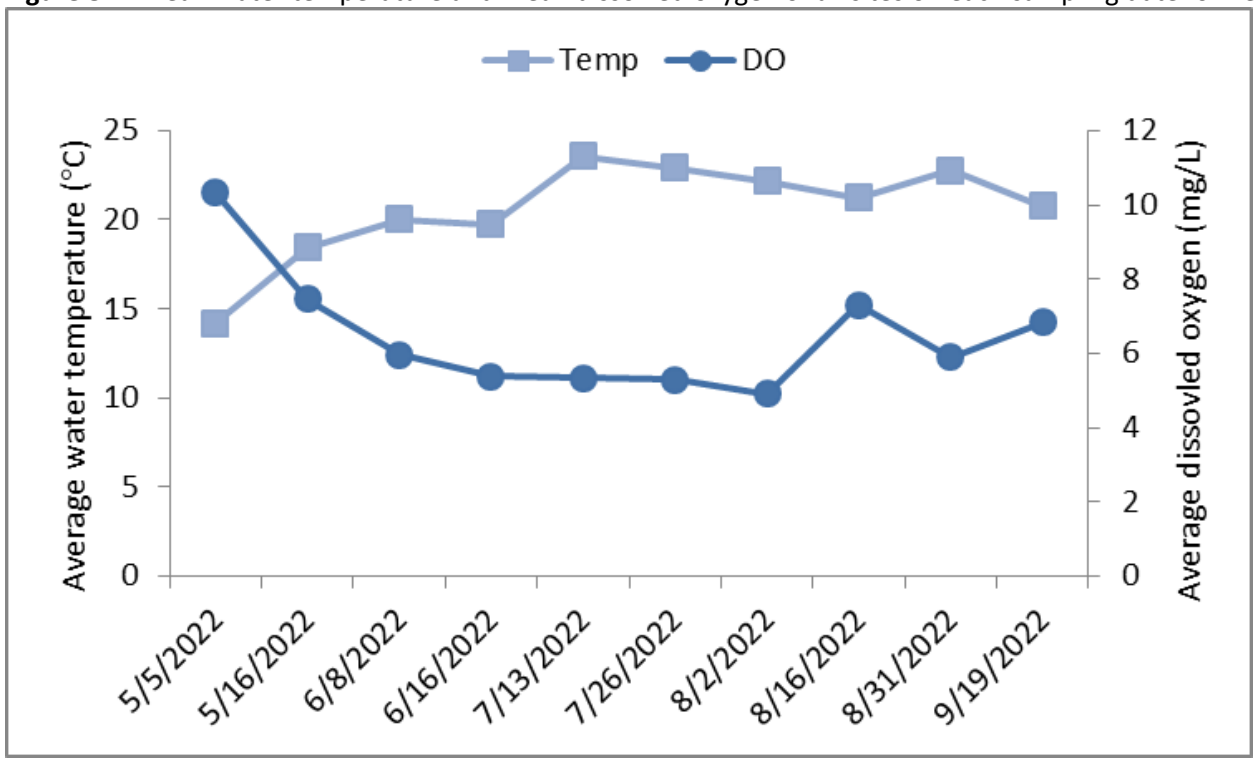


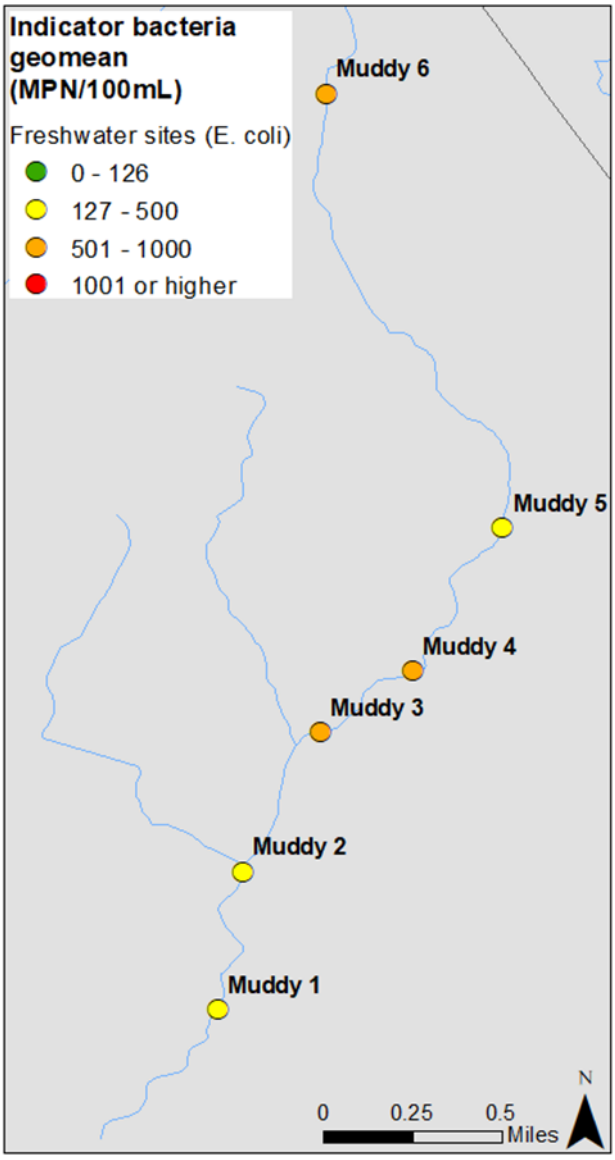
Figure 8.4. Mean water temperature and mean dissolved oxygen of all sites on each sampling date for Keelers Brook.



9. Muddy Brook

Muddy Brook is part of the CT DEEP designated "Southwest Shoreline sub-regional basin" which is 2.8 square miles. Muddy Brook is located entirely in Westport, CT and discharges into the Sherwood Island Mill Pond. The land use for the Southwest Shoreline sub-regional basin consists of 45% developed areas, 27% turf and grasses, 24% forests, and 4% agriculture, wetlands, and utility right of ways (CT DEEP, 2015b). Harbor Watch first studied Muddy Brook in 2017 during the May-through-September monitoring season. The brook is of interest to the Town of Westport because the Sherwood Island Mill Pond is a historic area known for its swimming and shellfishing.

Indicator bacteria: Bacteria concentrations in Muddy Brook have remained relatively consistent with data collected from 2017-2019 (Figure 9.1). In 2022, all sites exceeded the CT DEEP geomean criteria for indicator bacteria (Figure 9.2). Additionally, 42% all samples processed in Muddy Brook exceeded the CT DEEP single sample maximum criteria (Table 9.1).



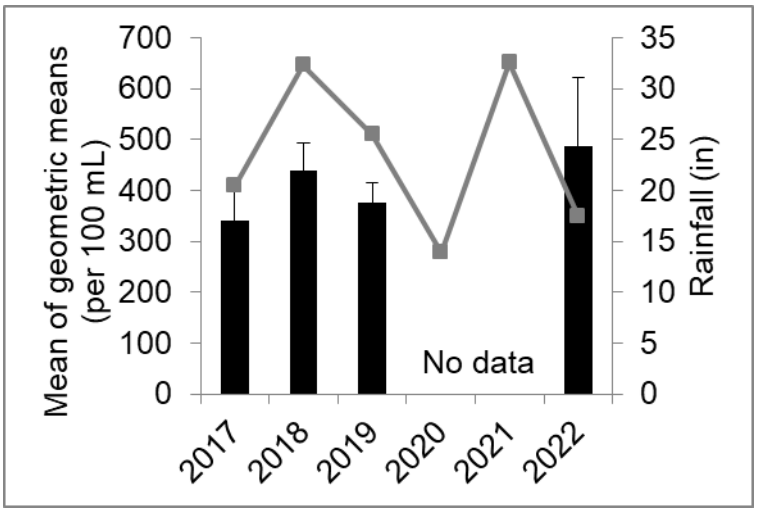


Figure 9.1. (Top) Mean of site geomeans (black bars) from 2017-2022 and total rainfall from May through September each year (grey squares and line).

Figure 9.2. (Left) Geomean of bacteria concentrations at each site in 2022.

Table 9.1. Muddy Brook E. coli concentrations (MPN/100mL), geomeans, and percentage of samples exceeding the CT DEEP single sample maximum. Rainfall data gathered from the Norwalk Health Department (n.d.).

	5/3/2022	5/17/2022	6/7/2022	6/21/2022	6/30/2022	7/19/2022	8/10/2022	8/15/2022	8/29/2022	9/20/2022	Geomean	% exceeding SSM
Muddy 6	25	67	111	1986	3106	6131	>4839	2453	407	1045	715	60%
Muddy 5	44	137	105	276	231	6488	111	193	59	142	185	10%
Muddy 4	52	172	416	387	727	7270	727	517	261	1733	515	40%
Muddy 3	62	162	687	1553	1373	12997	866	775	2827	2190	978	80%
Muddy 2	113	921	365	260	816	9804	166	78	47	>2420	404	40%
Muddy 1	201	219	345	387	517	12033	82	66	172	921	354	20%
Weather	Wet	Wet	Wet	Dry	Dry	Wet	Dry	Dry	Dry	Wet		

Table 9.2. GPS coordinates and site locations for the Muddy Brook.

Site Name	Latitude	Longitude	Site location notes	River Name
Muddy 6	41.16444	-73.32521	Bayberry Lane	Muddy Brook
Muddy 5	41.14686	-73.31809	Long Lots Road	Muddy Brook
Muddy 4	41.14107	-73.32172	Turkey Hill Road N	Muddy Brook
Muddy 3	41.13857	-73.32546	Morningside Drive S	Muddy Brook
Muddy 2	41.13293	-73.32859	Center Street	Muddy Brook
Muddy 1	41.12735	-73.32958	Greens Farms Road	Muddy Brook

Dissolved oxygen and water temperature: Dissolved oxygen readings were relatively consistent throughout the watershed (Figure 9.3). While the majority of individual dissolved oxygen readings met the CT DEEP minimum criteria of 5 mg/L, 6 readings were observed below 5 mg/L at sites Muddy 6, Muddy 3, Muddy 2, and Muddy 1 during August and September when water temperatures increased (Figure 9.4) and rainfall was low.

Figure 9.3. Box plot of dissolved oxygen concentrations at each sampling site along Muddy Brook. The dashed red line represents the CT DEEP minimum criteria for dissolved oxygen in freshwater, which is 5mg/L. The numbers above each site name is the number of samples taken at each site. For more information on what each part of the boxplot represents, please review the informational graphic in the "Key Terms and Information" section on page 4.

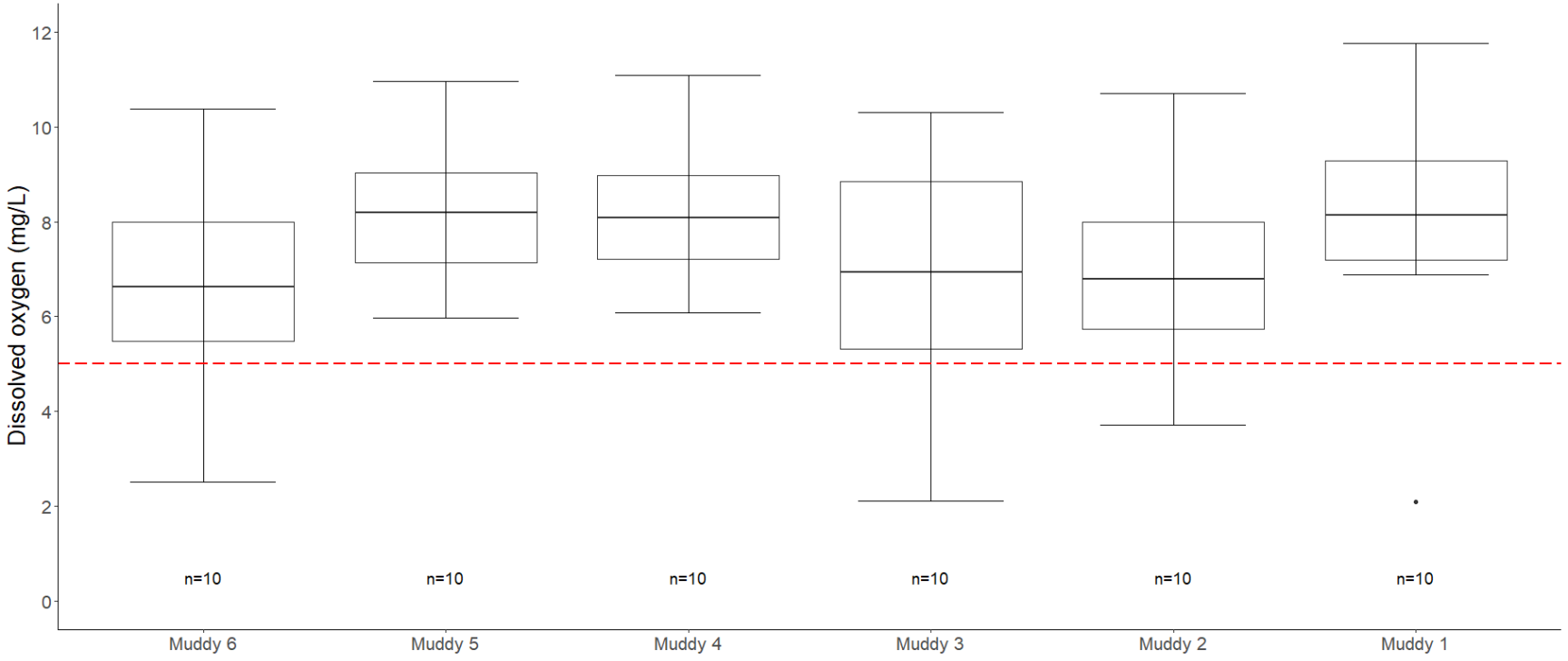
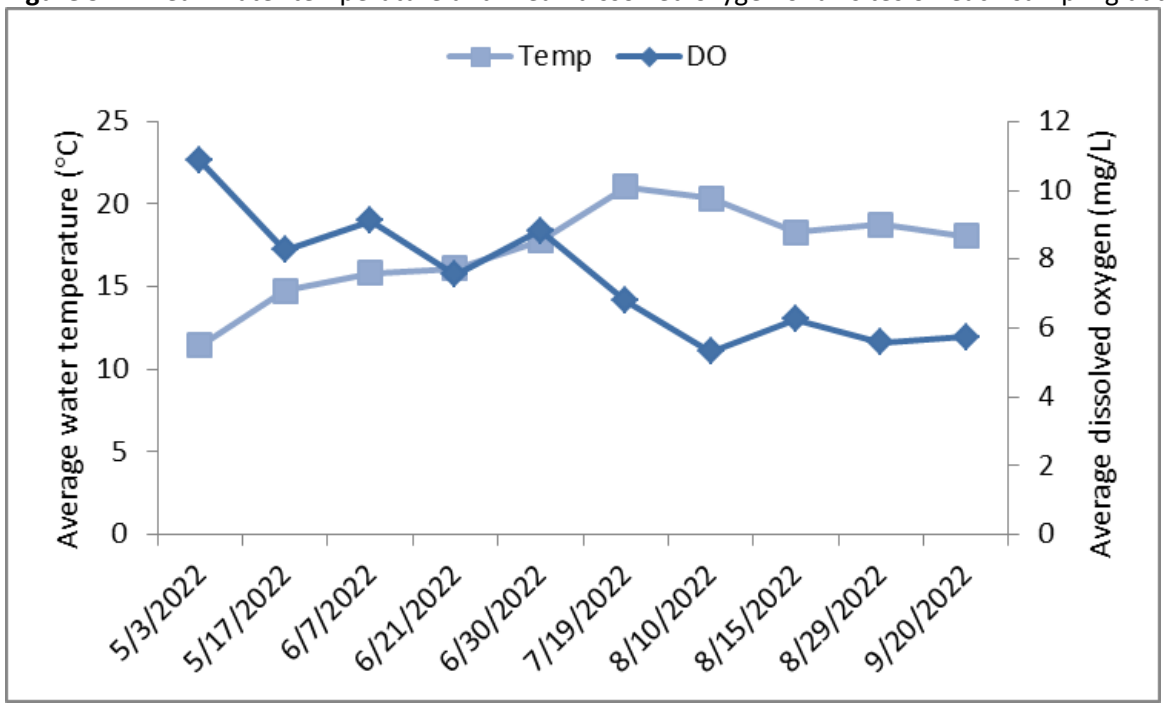


Figure 9.4. Mean water temperature and mean dissolved oxygen of all sites on each sampling date in Muddy Brook.



10. Noroton River

The Noroton River Watershed encompasses portions of Stamford, Darien, and New Canaan, CT. The watershed is approximately 7,000 acres or 11 square miles (CT DEEP, 2022). The river begins in New Canaan and flows south, forming the border of Stamford and Darien. The river discharges into Long Island Sound through Holly Pond. The land use along the river is a mixture of residential and light commercial. Harbor Watch has monitored the Noroton River for seven consecutive years, starting in 2016.

Indicator bacteria: In 2022, observed mean freshwater concentrations were slightly elevated above historic levels, but mean saltwater concentrations were slightly decreased (Figure 10.1). Bacteria concentrations at 6 of the 8 sites on the Noroton River exceeded the CT DEEP geomean criteria (Figure 10.2). Additionally, 32% of all samples processed exceeded the CT DEEP single sample maximum criteria (Table 10.1). Harbor Watch has historically worked with both the City of Stamford and Town of Darien to pinpoint sources of pollution to the River. At this time, no sources have been identified, but we continue to partner with both municipalities to investigate the reason for these elevated concentrations.

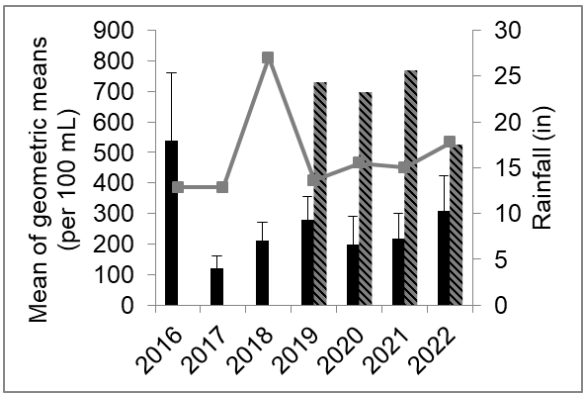


Figure 10.1. (Top) Mean of freshwater site geomeans (black bars) and saltwater site geomeans (striped bars) from 2016-2022 and total rainfall from May through September each year (grey squares and line).

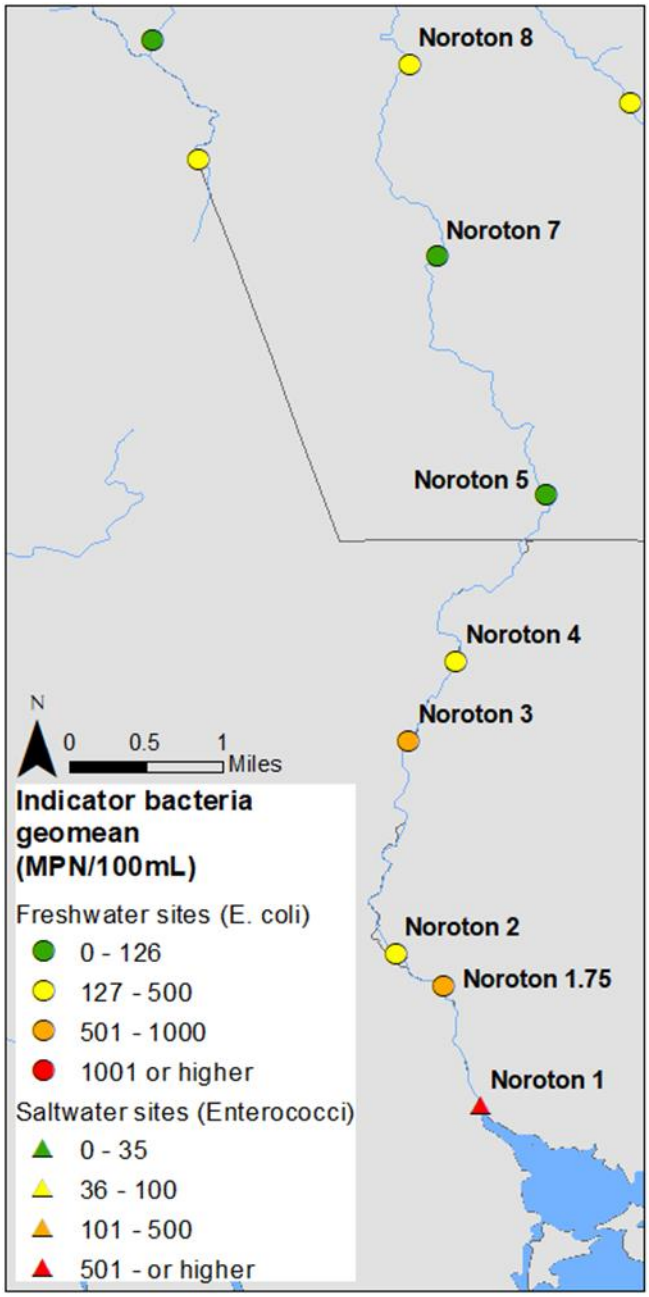


Figure 10.2. (Right) Geomean of bacteria concentrations at each site in 2022.

Table 10.1. Noroton River *E. coli* and *Enterococci* concentrations (MPN/100mL), geomeans, and percentage of samples exceeding the CT DEEP single sample maximum. Rainfall data gather from personal communication with the Town of Greenwich (M. Long, personal communication, October 12, 2022).

	Indicator bacteria	5/4/2022	5/25/2022	5/31/2022	6/15/2022	7/6/2022	7/21/2022	8/11/2022	8/18/2022	9/7/2022	9/15/2022	Geomean	% exceeding SSM
Noroton 8	*E. coli*	69	687	344	126	260	236	248	70	3683	613	295	30%
Noroton 7	*E. coli*	25	30	49	13	12	141	6	2	6932	345	44	10%
Noroton 5	*E. coli*	18	5	6	72	13	31	<1	11	1379	54	29	11%
Noroton 4	*E. coli*	5	1454	89	80	291	93	206	113	689	228	149	20%
Noroton 3	*E. coli*	50	276	517	345	1733	1373	1986	1540	899	321	591	50%
Noroton 2	*E. coli*	161	261	N/A	579	185	276	44	35	2069	365	224	22%
Noroton 1.75	*E. coli*	261	488	1300	582	1159	775	1986	626	3466	480	842	70%
Noroton 1	Enterococci	414	120	N/A	N/A	259	857	1019	794	4884	135	526	50%
Weather													

Table 10.2. GPS coordinates and site locations for the Noroton River.

Site Name	Latitude	Longitude	Site location notes	River Name
Noroton 8	41.15925	-73.51421	West Road and Greenley Road intersection	Noroton River
Noroton 7	41.14108	-73.51167	209 Frogtown Road	Noroton River
Noroton 5	41.11868	-73.50130	47 Jelliff Mill Road	Noroton River
Noroton 4	41.10290	-73.50982	137 Woodway Road	Noroton River
Noroton 3	41.09540	-73.51430	Camp Avenue	Noroton River
Noroton 2	41.07530	-73.51550	668 Connecticut 106	Noroton River
Noroton 1.75	41.072178	-73.51099	West Avenue	Noroton River
Noroton 1	41.06093	-73.50735	1308 E. Main Street	Noroton River

Dissolved oxygen and water temperature: Dissolved oxygen readings varied at each site throughout the watershed (Figure 10.3). While the majority of individual dissolved oxygen readings met the CT DEEP minimum criteria, 16 readings were observed below 5 mg/L at every freshwater site at least once, except Noroton 3, and three readings were observed below 3 mg/L at saltwater site Noroton 1. The highest frequency of low readings was observed at site Noroton 8 (80% of the time). High water temperatures in the summer months were a contributing factor to the observed low dissolved oxygen readings during this time (Figure 10.4).

Figure 10.3. Box plot of dissolved oxygen concentrations at each sampling site along Noroton River. The dashed red line represents the CT DEEP minimum criteria for dissolved oxygen in freshwater, which is 5mg/L. The dotted red line represents the CT DEEP minimum criteria for dissolved oxygen in saltwater, which is 3mg/L. The only saltwater sampling site in this river is Noroton 1. The numbers above each site name is the number of samples taken at each site. For more information on what each part of the boxplot represents, please review the informational graphic in the "Key Terms and Information" section on page 4.

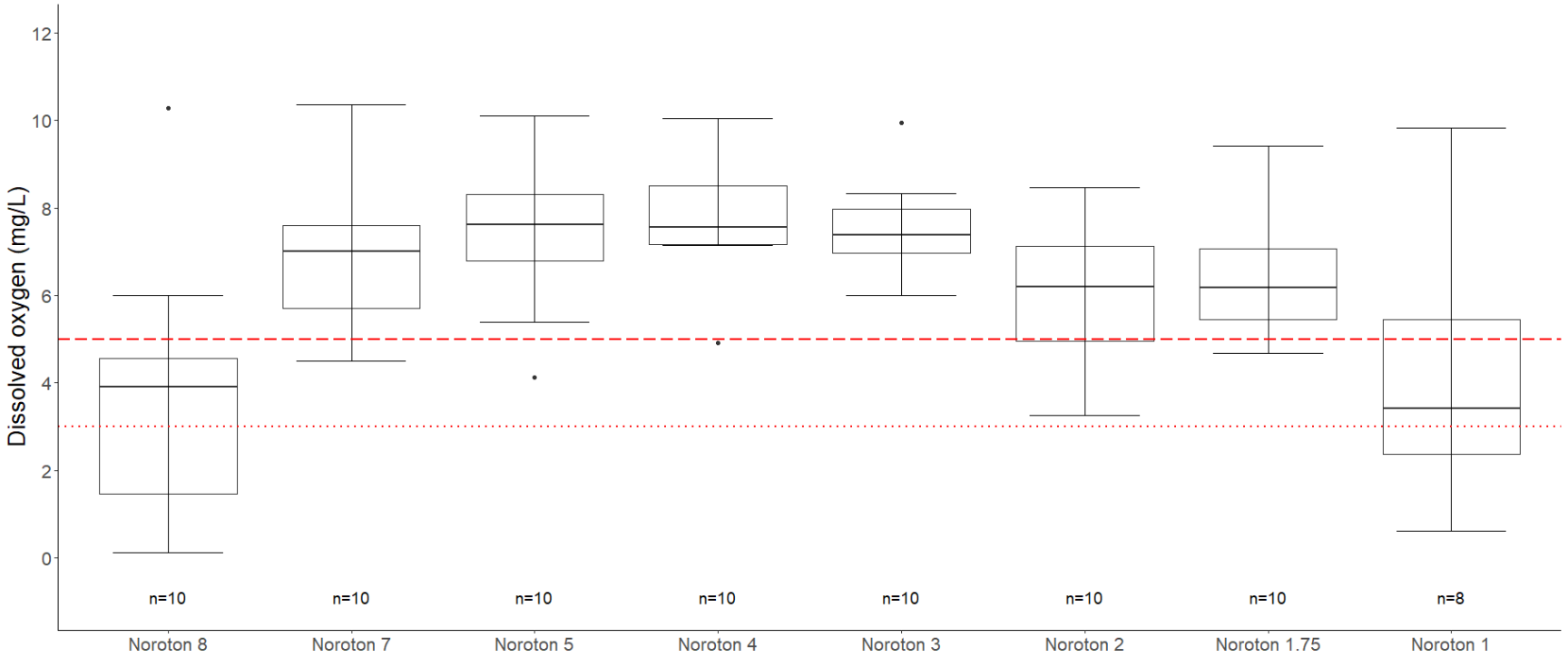
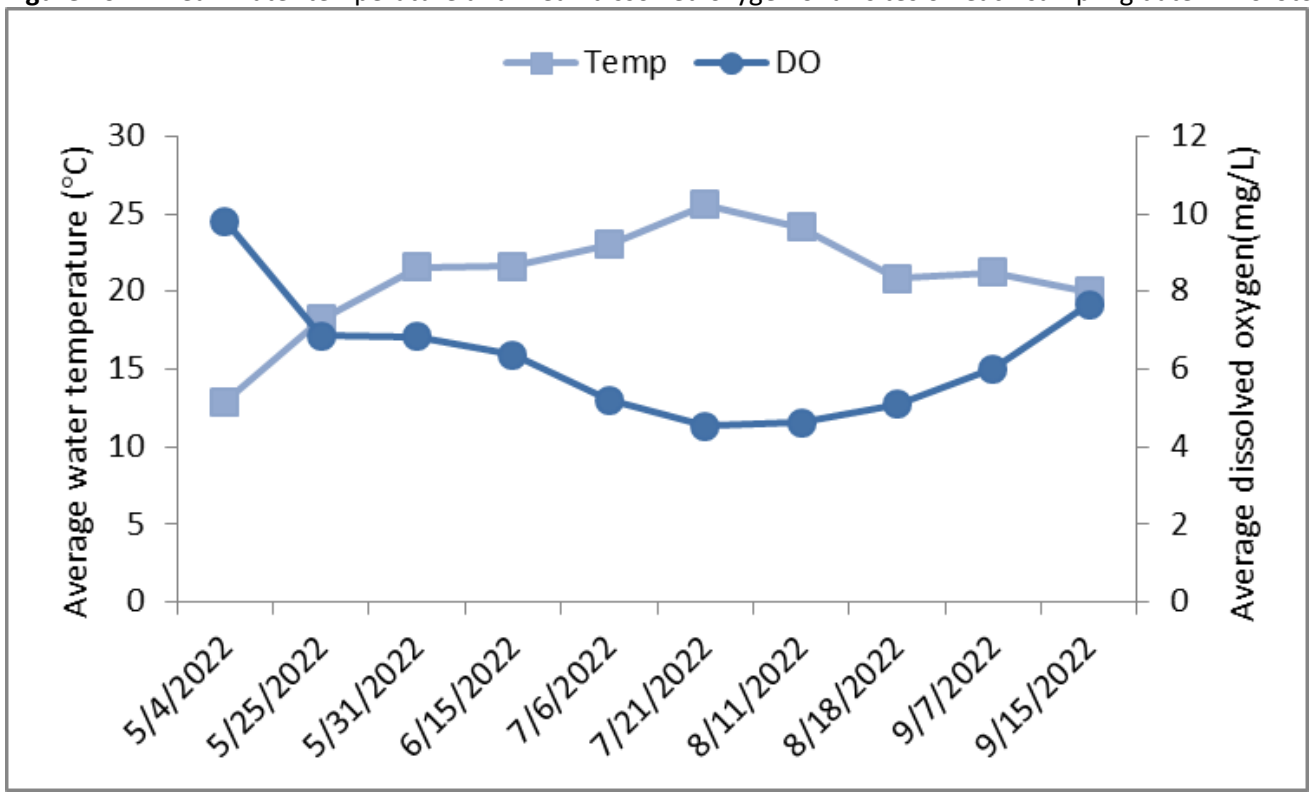
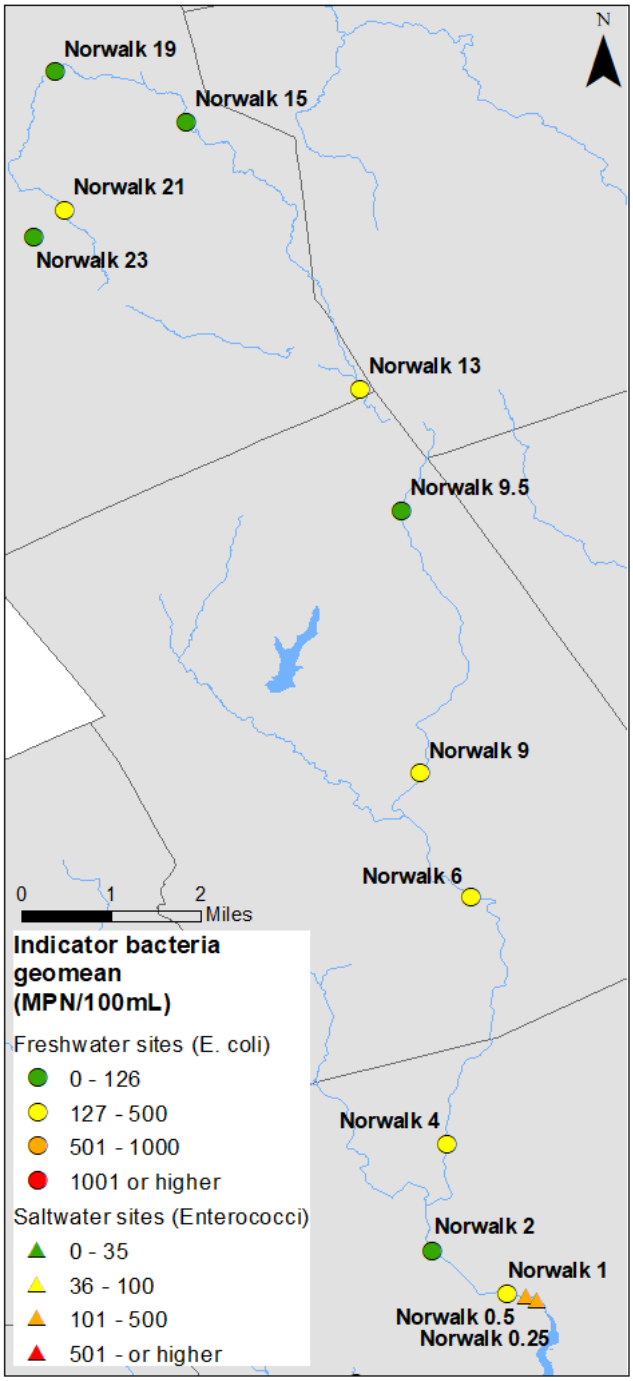


Figure 10.4. Mean water temperature and mean dissolved oxygen of all sites on each sampling date in Noroton River.



11. Norwalk River

The Norwalk River Watershed includes New Canaan, Norwalk, Redding, Ridgefield, Weston and Wilton, CT, as well as Lewisboro, NY. The watershed is roughly 40,000 acres (64.1 square miles), which is developed by commercial/light industry uses and residential neighborhoods (Norwalk River Watershed Initiative [NRWI], 1998). The main stem of the Norwalk River is approximately 20 miles in length, beginning in the Great Swamp in Ridgefield, ultimately discharging in Norwalk Harbor where the last 3 miles are a tidal estuary (NRWI, 1998). Harbor Watch has monitored the Norwalk River for over 25 years. In 2022, Harbor Watch added three sites (Norwalk 2, Norwalk 0.5 and Norwalk 0.25) to the regular monitoring schedule to gather baseline data before the City of Norwalk commences sanitary sewer projects in sections of the city throughout the lower portion of the watershed.



Indicator bacteria: Concentrations in the river are relatively similar to those that have been observed over the last four years (Figure 11.1). In 2022, 8 sites exceeded the CT DEEP geomean criteria for indicator bacteria (Figure 11.2). It is important to note that the freshwater geomeans were marginally elevated above the CT DEEP maximum criteria and were likely driven by a few elevated concentrations observed on during wet weather. Additionally, 15% of all samples processed exceeded the CT DEEP single sample maximum criteria (Table 11.1).

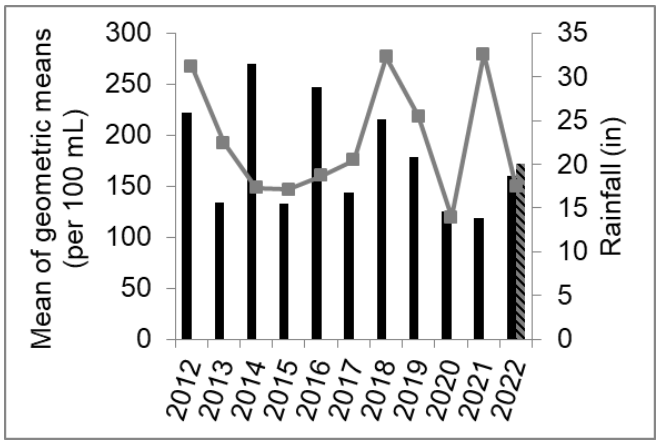


Figure 11.1. (Right) Mean of freshwater site geomeans (black bars) and saltwater site geomean (striped bar) from 2012-2022 and total rainfall from May through September each year (grey squares and line).
Figure 11.2. (Left) Geomean of bacteria concentrations at each site in 2022.

Table 11.1. Norwalk River *E. coli* and enterococci concentrations (MPN/100mL), geomeans, and percentage of samples exceeding the CT DEEP single sample maximum. Rainfall data gathered from the Norwalk Health Department (n.d.).

	Indicator bacteria	5/2/2022	5/19/2022	6/6/2022	6/23/2022	7/13/2022	7/20/2022	8/9/2022	8/18/2022	8/31/2022	9/28/2022	Geomean	% exceeding SSM
Norwalk 23	*E. coli*	727	1150	31	48	23	398	219	32	88	17	102	20%
Norwalk 21	*E. coli*	44	1443	132	345	248	156	651	291	1112	186	291	30%
Norwalk 19	*E. coli*	19	72	30	39	6	821	23	24	12	26	33	10%
Norwalk 15	*E. coli*	56	775	54	206	60	545	153	17	16	261	105	10%
Norwalk 13	*E. coli*	50	259	186	579	214	300	435	276	579	365	273	20%
Norwalk 9.5	*E. coli*	29	177	34	47	65	407	48	147	435	43	88	0%
Norwalk 9	*E. coli*	29	688	96	248	365	480	48	120	1203	142	196	20%
Norwalk 6	*E. coli*	125	621	131	199	145	398	228	67	326	53	177	10%
Norwalk 4	*E. coli*	43	420	150	222	114	496	105	131	73	66	137	0%
Norwalk 2	*E. coli*	49	1159	201	240	47	252	36	21	44	48	94	10%
Norwalk 1	*E. coli*	727	1226	186	201	145	476	179	172	248	96	265	20%
Norwalk 0.5	*Enterococci*	75	2143	109	95	292	408	181	131	132	121	194	10%
Norwalk 0.25	*Enterococci*	84	1515	146	166	52	823	189	1100	10	20	149	30%
Weather		Wet	Wet	Dry	Wet	Dry	Wet	Dry	Dry	Dry	Dry		

Table 11.2. GPS coordinates and site locations for the Norwalk River.

Site Name	Latitude	Longitude	Site location notes	River Name
Norwalk 23	41.29005	-73.49349	22 South Street	Unnamed Tributary
Norwalk 21	41.29444	-73.48843	68 Farmingville Road	Ridgefield Brook
Norwalk 19	41.31672	-73.49001	Limestone Road	Ridgefield Brook
Norwalk 15	41.30870	-73.46884	Stonehenge Road	Norwalk River
Norwalk 13	41.26550	-73.44079	787 Branchville Road	Norwalk River
Norwalk 9.5	41.24590	-73.43409	Old Mill Road	Norwalk River
Norwalk 9	41.20354	-73.43094	School Road	Norwalk River
Norwalk 6	41.18341	-73.42276	187 Danbury Road	Norwalk River
Norwalk 4	41.14349	-73.42669	10 Glover Avenue	Norwalk River
Norwalk 2	41.12632	-73.42916	New Canaan Avenue	Norwalk River
Norwalk 1	41.11947	-73.41701	40 Cross Street	Norwalk River
Norwalk 0.5	41.11893	-73.41381	Burnell Boulevard	Norwalk River
Norwalk 0.25	41.11841	-73.41201	Wall Street	Norwalk Harbor

Dissolved oxygen and water temperature: Dissolved oxygen readings within the river were relatively consistent with the exception of site Norwalk 21 which is located at the outlet of the Great Swamp and has very slow water movement, Norwalk 19 which is located at the base of a pond, and Norwalk 0.25 which is located at the upper reaches of Norwalk Harbor and has historically had poor flushing (Figure 11.3). While the majority of individual dissolved oxygen readings met the CT DEEP minimum criteria, 9 readings were observed below 5 mg/L at freshwater sites Norwalk 21, and Norwalk 19. Three readings were observed below 3 mg/L at saltwater site Norwalk 0.25 throughout the season. Mean water temperatures increased through early August, dropping after this period (Figure 11.4).

Figure 11.3. Box plot of dissolved oxygen concentrations at each sampling site along Norwalk River. The dashed red line represents the CT DEEP minimum criteria for dissolved oxygen in freshwater, which is 5mg/L. The dotted red line represents the CT DEEP minimum criteria for dissolved oxygen in saltwater, which is 3mg/L. The only saltwater sampling sites in this river is Norwalk 0.25 and Norwalk 0.5. The numbers above each site name is the number of samples taken at each site. Norwalk 0.5 is not included in this figure because the field meter could not reach the water at the site to obtain readings. For more information on what each part of the boxplot represents, please review the informational graphic in the "Key Terms and Information" section on page 4.

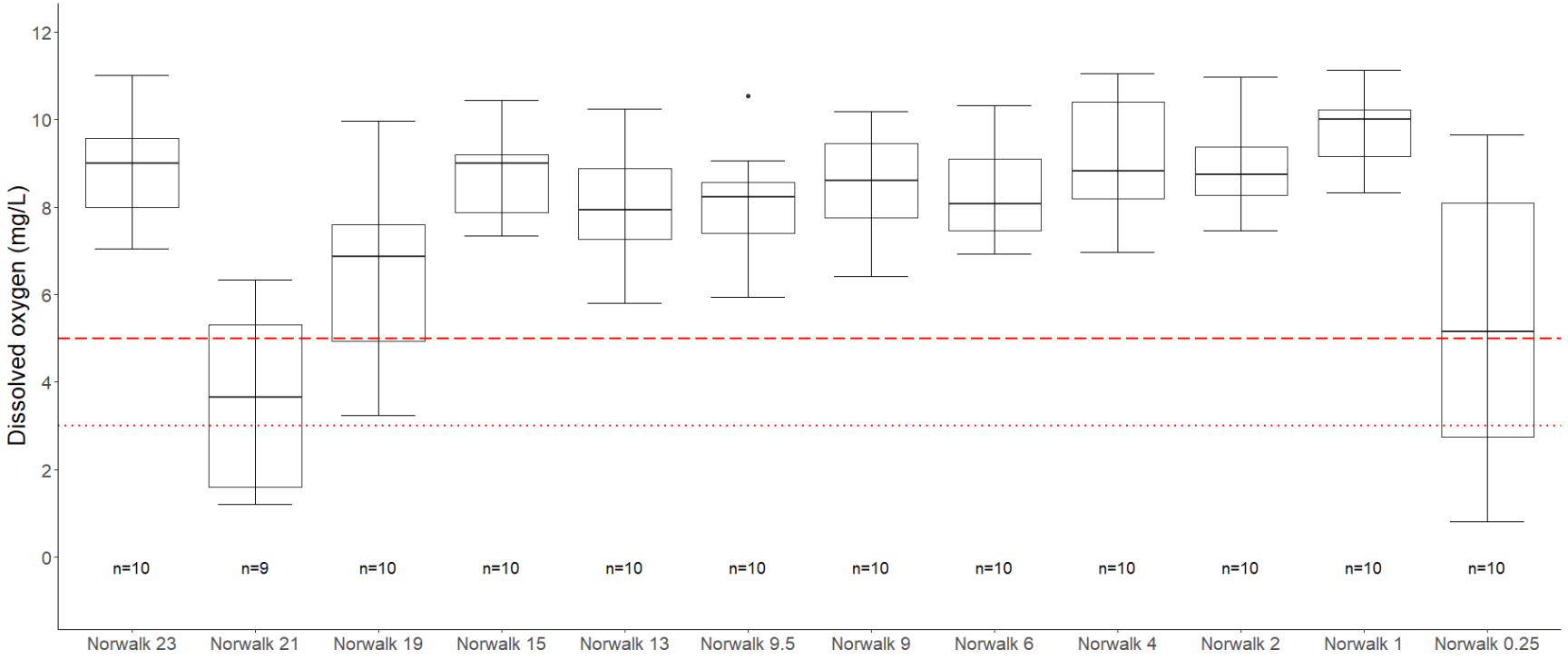
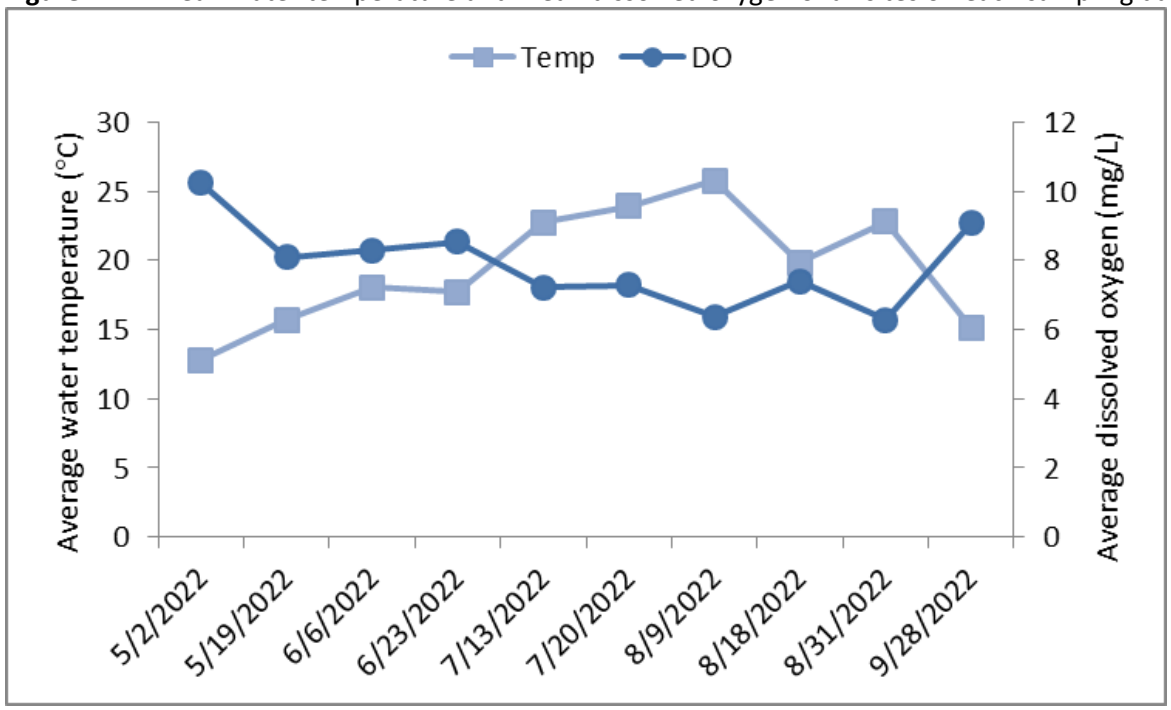


Figure 11.4. Mean water temperature and mean dissolved oxygen of all sites on each sampling date in Norwalk River.



12. Pequonnock River

The Pequonnock River Watershed is located primarily in Monroe, Trumbull, and Bridgeport, with small portions in Shelton and Newtown, CT. The watershed is roughly 29 square miles. Land use within the watershed transitions from lightly developed in Monroe, to residential in Trumbull and northern Bridgeport, then into commercial and old industrial uses near the mouth at Bridgeport Harbor (Pequonnock River Initiative, 2011). Harbor Watch first monitored the River in 2009 and since then has monitored different portions of the river each year. In 2022, Harbor Watch monitored the lowest freshwater site (Pequonnock 1) and added two brackish sites downstream to determine the impact of Island Brook (Section 7) on the river.

Indicator bacteria: All three sites exceeded the CT DEEP geomean criteria for indicator bacteria (Figure 12.1). Additionally, 57% of all samples processed in the Pequonnock River exceeded the CT DEEP single sample maximum criteria (Table 12.1). Harbor Watch is working on a track-down project with the City of Bridgeport upstream of Pequonnock 1.

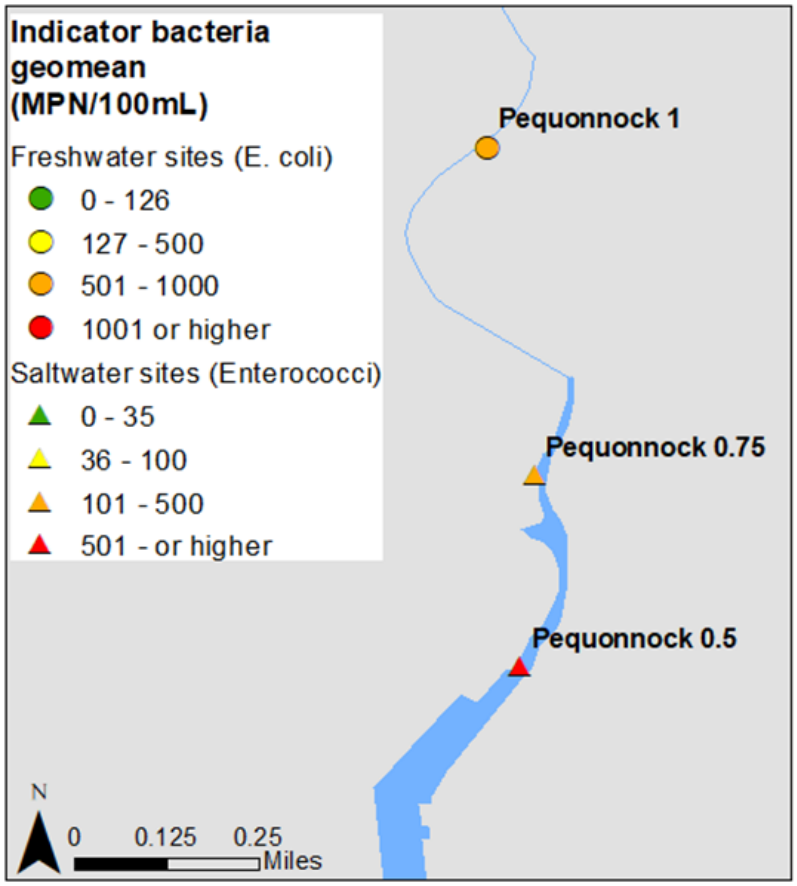


Figure 12.1. 2022 geometric mean of bacteria concentrations at each site.

Table 12.1. Pequonnock River *E. coli* and enterococci concentrations (MPN/100mL), geomeans, and percentage of samples exceeding the CT DEEP single sample maximum. Rainfall data gathered from the website, Weather Spark (n.d.).

	Indicator bacteria	5/10/2022	5/26/2022	6/1/2022	6/22/2022	6/27/2022	7/27/2022	8/4/2022	8/22/2022	9/7/2022	9/13/2022	Geomean	% exceeding SSM
Pequonnock 1	*E. coli*	88	93	613	921	325	1298	1454	>4839	2559	738	694	70%
Pequonnock 0.75	Enterococci	96	155	809	934	299	935	213	379	4884	399	467	40%
Pequonnock 0.5	Enterococci	10	201	6488	1722	1246	528	450	279	3255	1467	623	60%
Weather		Dry	Dry	Wet	Wet	Wet	Wet	Dry	Dry	Wet	Wet		

Table 12.2. GPS coordinates and site locations for the Pequonnock River.

Site Name	Latitude	Longitude	Site location notes	River Name
Pequonnock 1	41.20460	-73.18765	Glenwood Park	Pequonnock River
Pequonnock 0.75	41.198176	-73.18669	Island Brook Road	Bridgeport Harbor
Pequonnock 0.5	41.194435	-73.18699	River Street	Bridgeport Harbor

Dissolved oxygen and water temperature: Dissolved oxygen readings varied more in the saltwater sites in the Pequonnock River than those observed at the freshwater site, Pequonnock 1 (Figure 12.3). While no individual dissolved oxygen readings were observed below 5 mg/L at site Pequonnock 1, 8 readings were observed below 3 mg/L at saltwater sites Pequonnock 0.75 and Pequonnok 0.5 throughout the monitoring season. Average water temperatures slowly increased throughout the monitoring season, dropping slightly in September (Figure 12.4).

Figure 12.3. Box plot of dissolved oxygen concentrations at each sampling site along Pequonnock River. The dashed red line represents the CT DEEP minimum criteria for dissolved oxygen in freshwater, which is 5mg/L. The dotted red line represents the CT DEEP minimum criteria for dissolved oxygen in saltwater, which is 3mg/L. Pequonnock 0.5 and Pequonnock 0.75 are saltwater sites. The numbers above each site name is the number of samples taken at each site. For more information on what each part of the boxplot represents, please review the informational graphic in the "Key Terms and Information" section on page 4.

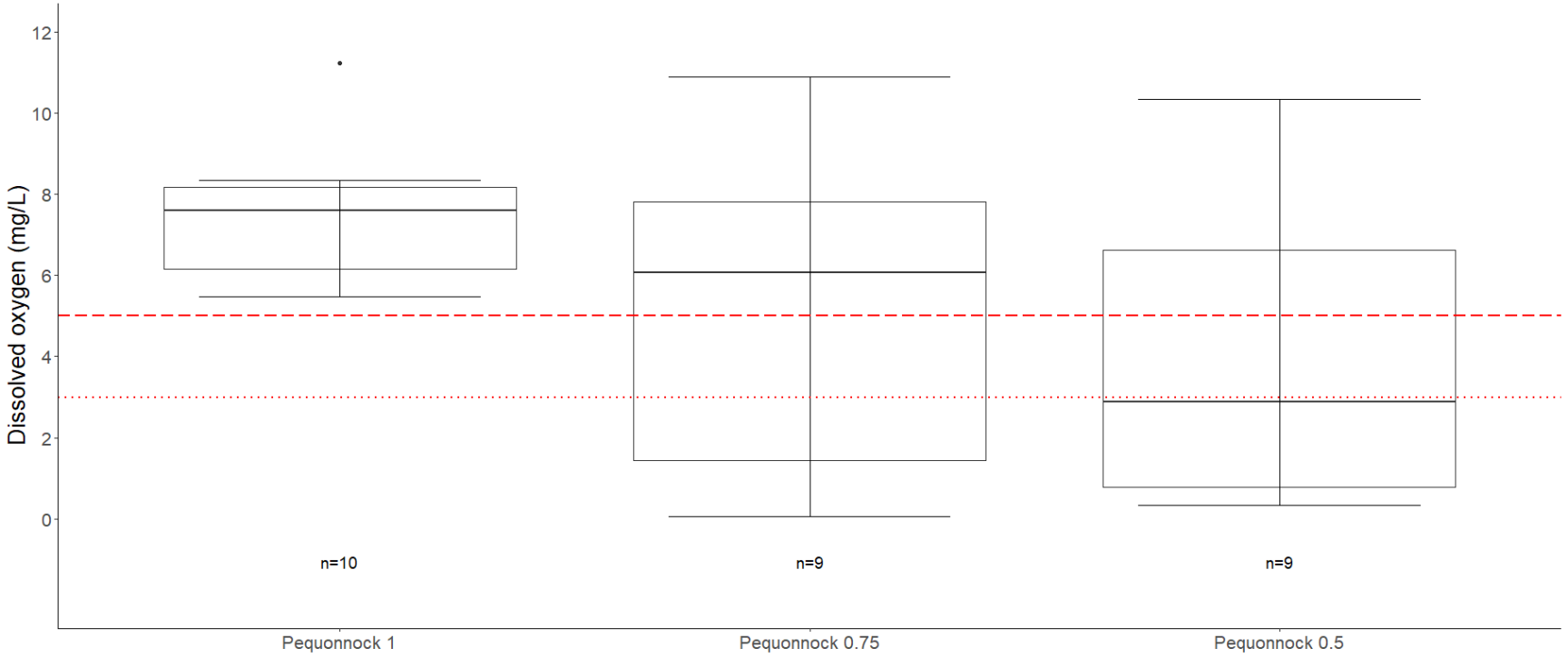
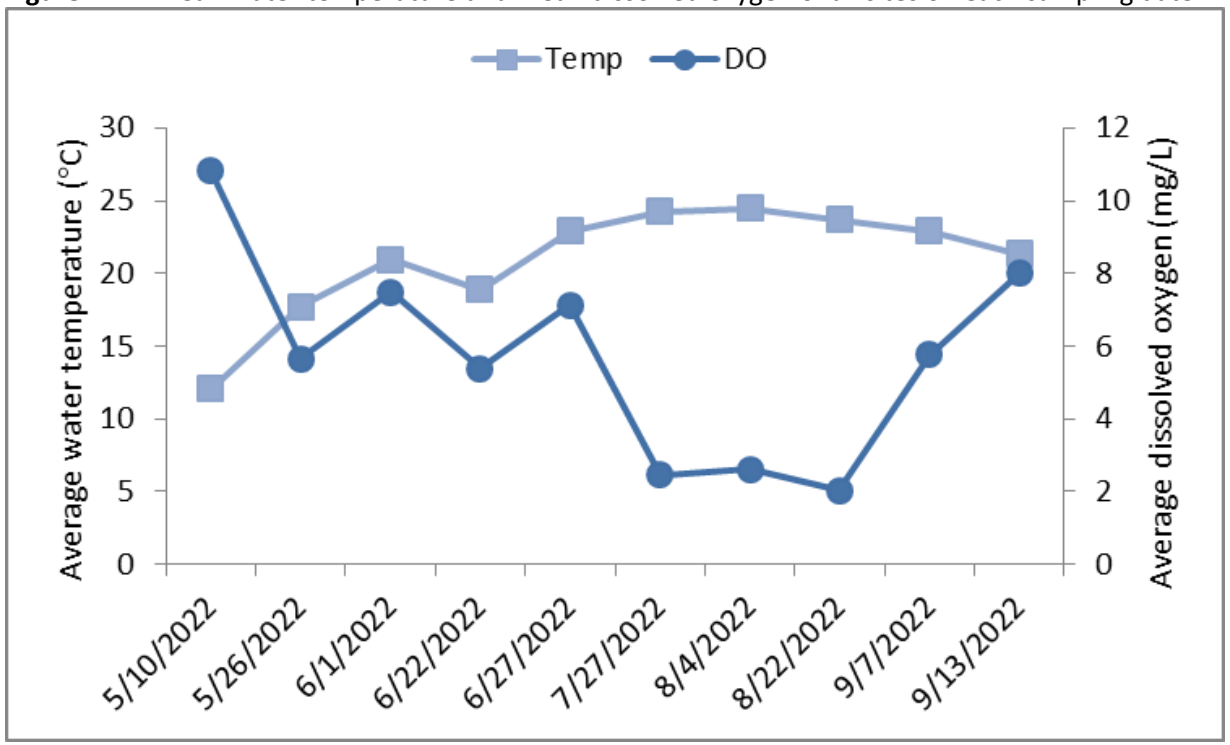


Figure 12.4. Mean water temperature and mean dissolved oxygen of all sites on each sampling date in the Pequonnock River.



13. Pumpkin Ground Brook Watershed
(Pumpkin Ground Brook and Cemetery Pond Brook)

The Pumpkin Ground Brook Watershed covers 3799 acres or 5.9 square miles in Shelton, Stratford, and Trumbull (CT DEEP, 2022). The Brook flows south out of Trapp Falls Reservoir and discharges into the Housatonic River. Land use in the watershed is a mix of commercial areas, open space, and residential lots. Harbor Watch monitored within the Pumpkin Ground Brook Watershed for the first time in 2022. The Pumpkin Ground Brook and Cemetery Pond Brook were listed as having insufficient information for assessment by CT DEEP due to lack of data, which is what encouraged Harbor Watch to conduct monitoring (CT DEEP, 2022). Public access to the Cemetery Pond Brook was difficult, resulting in only 1 site being monitored.

Indicator bacteria: Five sites in the watershed exceeded the CT DEEP geomean criteria for indicator bacteria. Additionally, 23% of all samples processed exceeded the CT DEEP single sample maximum criteria (Table 13.1).

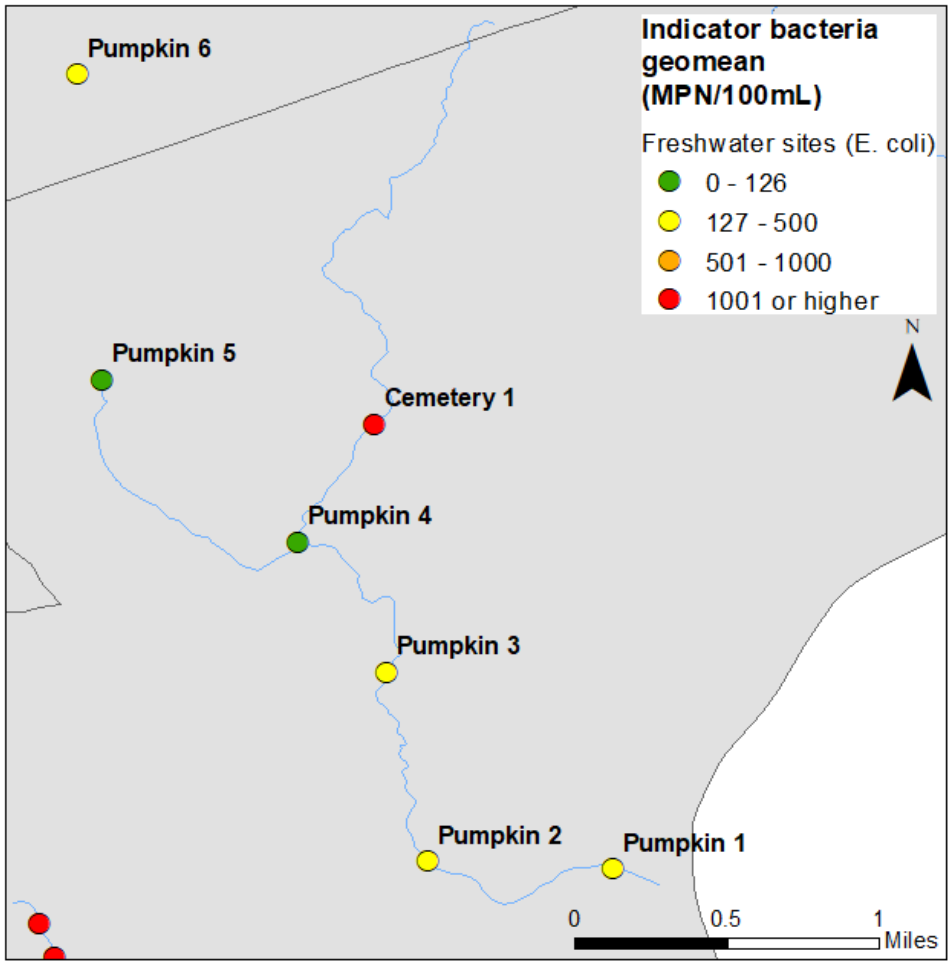


Figure 13.1. Geomean of bacteria concentrations at each site in 2022. Unlabeled sites are located on Bruce Brook (Section 2).

Table 13.1. Pumpkin Ground Brook Watershed *E. coli* concentrations (MPN/100mL), geomeans, and percentage of samples exceeding the CT DEEP single sample maximum. Rainfall data gathered from the website Weather Spark (n.d.).

	5/11/2022	5/25/2022	6/9/2022	6/21/2022	6/29/2022	7/21/2022	8/2/2022	8/17/2022	8/30/2022	9/21/2022	Geomean	% exceeding SSM
Pumpkin 6	1	N/A	>2420	328	435	299	387	38	66	114	131	11%
Pumpkin 5	1	N/A	66	4	3	34	2	1	2	5	4	0%
Cemetery 1	118	N/A	>2420	326	821	1741	2827	1454	>4839	458	1021	67%
Pumpkin 4	48	N/A	>2420	13	517	133	71	31	162	28	100	11%
Pumpkin 3	101	N/A	>2420	155	488	345	345	488	161	261	329	11%
Pumpkin 2	129	613	>2420	816	870	276	1733	96	156	517	468	50%
Pumpkin 1	167	N/A	>4839	93	308	210	387	45	28	237	202	11%
Weather	Dry	Dry	Wet	Dry	Wet	Dry	Wet	Wet	Dry	Wet		

Table 13.2. GPS coordinates and site locations for Pumpkin Ground Brook Watershed.

Site Name	Latitude	Longitude	Site location notes	River Name
Pumpkin 6	41.263189	-73.13976	Huntington Street	Unnamed
Pumpkin 5	41.248675	-73.13859	Beaver Dam Road	Pumpkin Ground Brook
Cemetery 1	41.246544	-73.12562	Peters Lane	Cemetery Pond Brook
Pumpkin 4	41.240933	-73.12932	Circle Drive	Pumpkin Ground Brook
Pumpkin 3	41.234739	-73.12505	Chapel Street	Pumpkin Ground Brook
Pumpkin 2	41.225759	-73.12309	Whippoorwill Lane	Pumpkin Ground Brook
Pumpkin 1	41.225372	-73.11427	Main Street	Pumpkin Ground Brook

Dissolved oxygen and water temperature: Dissolved oxygen readings in the watershed varied by site throughout the watershed (Figure 13.2). While the majority of individual dissolved oxygen readings met the CT DEEP minimum criteria of 5 mg/L, 14 readings were observed below 5 mg/L at all Pumpkin Ground Brook sampling locations at least once. Low dissolved oxygen values were observed from late-July through September when water temperatures increased (Figure 13.3).

Figure 13.2. Box plot of dissolved oxygen concentrations at each sampling site in the Pumpkin Ground Brook Watershed. The dashed red line represents the CT DEEP minimum criteria for dissolved oxygen in freshwater, which is 5mg/L. The numbers above each site name is the number of samples taken at each site. For more information on what each part of the boxplot represents, please review the informational graphic in the "Key Terms and Information" section on page 4.

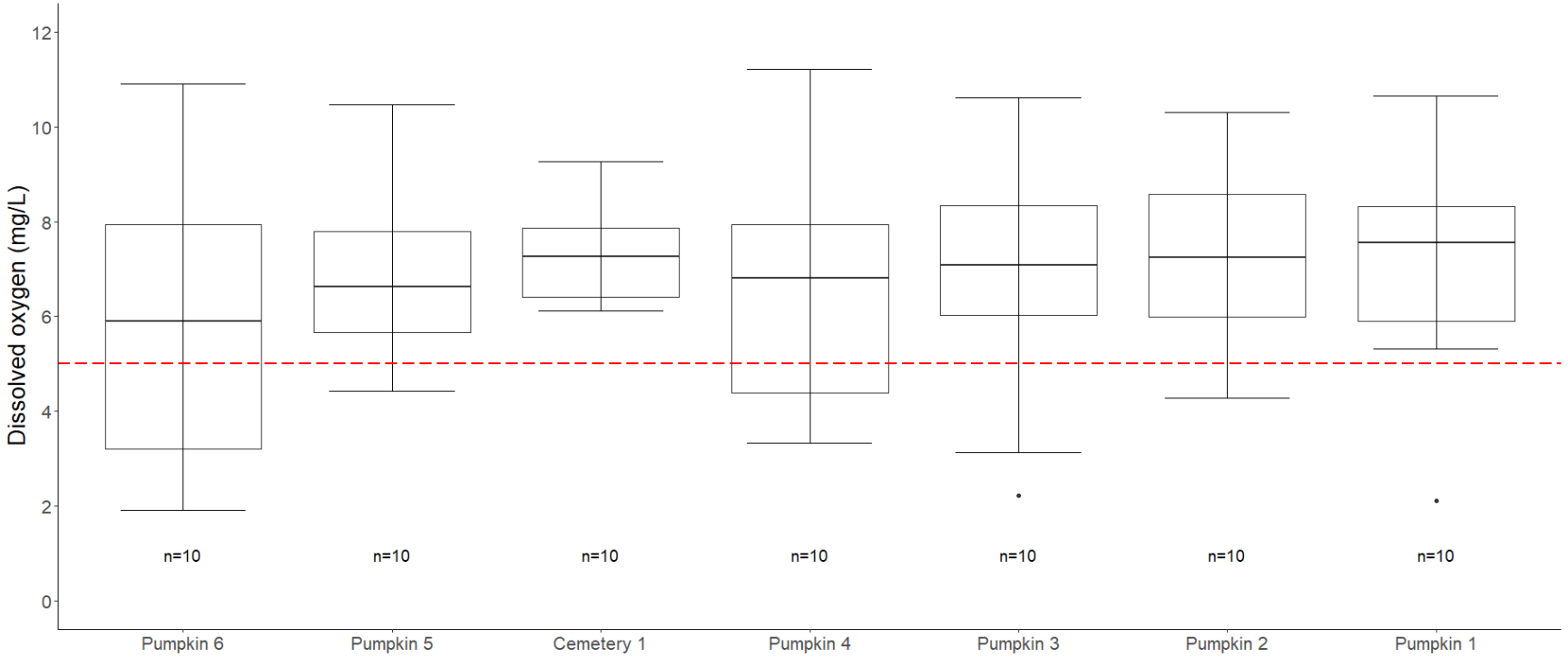
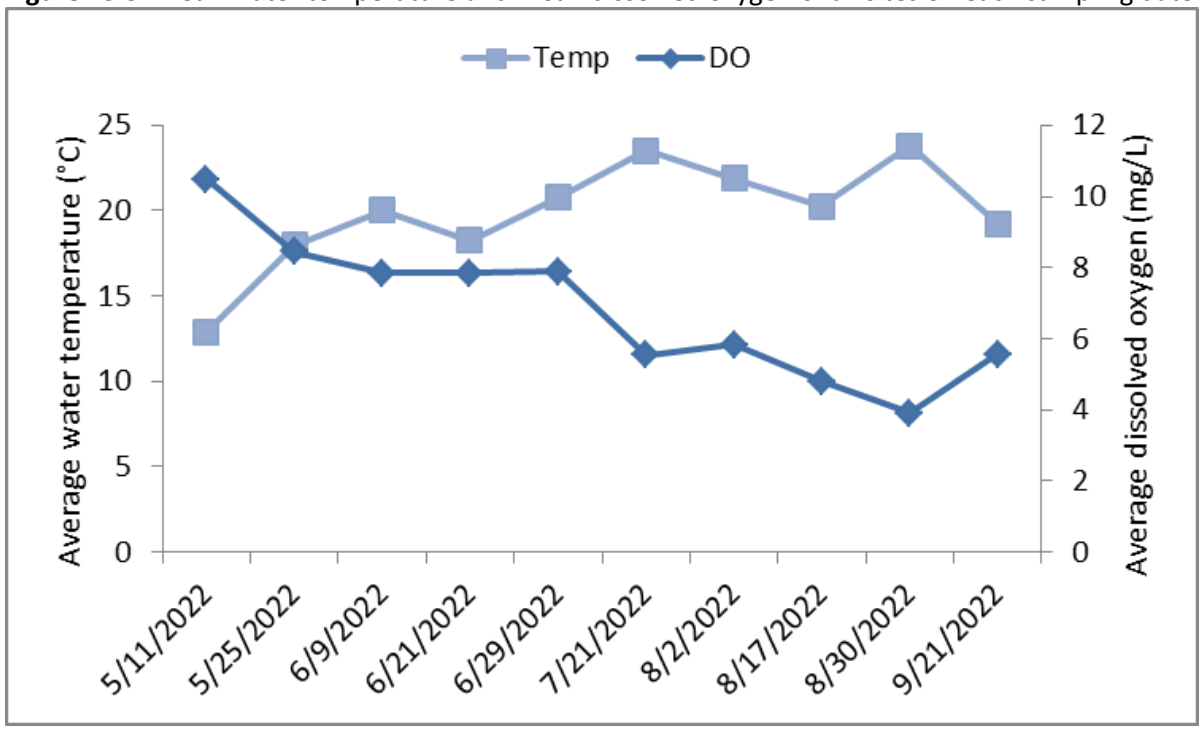
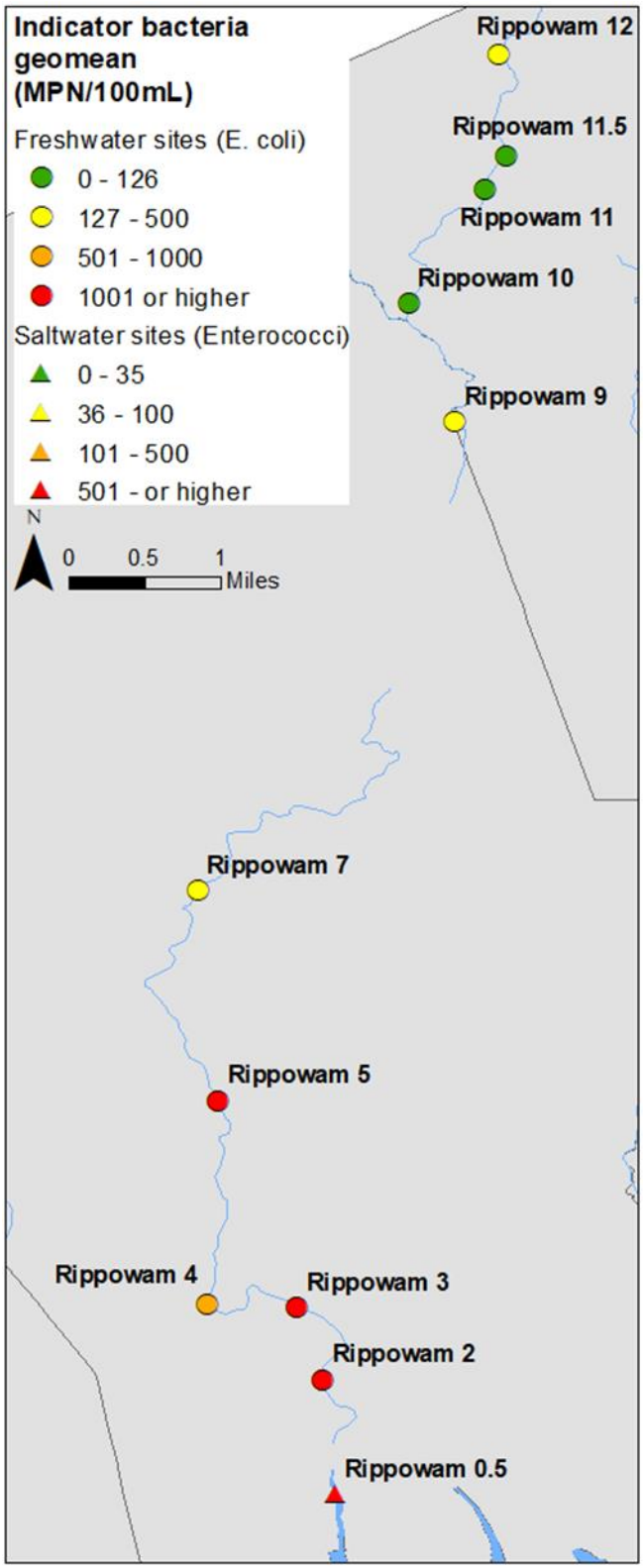


Figure 13.3. Mean water temperature and mean dissolved oxygen of all sites on each sampling date in the Pumpkin Ground Brook Watershed.



14. Rippowam River

The Rippowam River Watershed covers 37.5 square miles from the NY State border, through parts of New Canaan, Ridgefield, and Stamford, CT, where it discharges into Stamford Harbor. The southern portion of the basin is commercial, industrial, and urban and the northern portion is largely suburban, and forested (CT DEEP, 2011). This river is also known locally as the Mill River. Due to a long-term construction project, site Rippowam 8 (located at the intersection of Wire Mill Road and High Ridge Road) was not monitored during 2022.



<u>Indicator bacteria:</u> Harbor Watch has been monitoring the Rippowam River since 2017, and concentrations within the watershed have been observed to increase slightly each of the last three years (Figure 14.1). Eight sites exceeded the CT DEEP geomean criteria for indicator bacteria (Figure 14.2). Additionally, 38% of all samples processed in the Ripopowam River exceeded the CT DEEP single sample maximum criteria (Table 14.1).

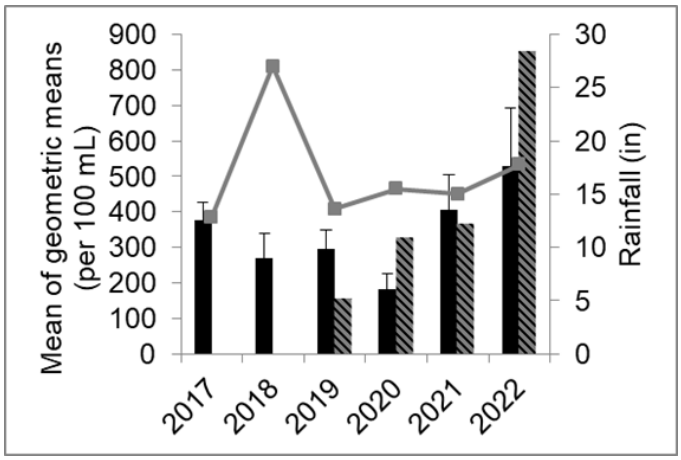


Figure 14.1. (Above) Mean of freshwater site geomeans (black bars) and saltwater site means (striped bars) from 2017-2022 and total rainfall from May through September each year (grey squares and line).

Figure 14.2. (Left) Geomean of bacteria concentrations at each site in 2022.

Table 14.2. Rippowam River *E. coli* and enterococci concentrations (MPN/100mL), geomeans, and percentage of samples exceeding the CT DEEP single sample maximum. Rainfall data gather from personal communication with the Town of Greenwich (M. Long, personal communication, October 12, 2022).

	Indicator bacteria	5/2/2022	5/26/2022	5/31/2022	6/14/2022	7/12/2022	7/18/2022	8/8/2022	8/25/2022	9/1/2022	9/22/2022	Geomean	% exceeding SSM
Rippowam 12	*E. coli*	39	48	23	156	210	7945	276	193	548	>4839	263	20%
Rippowam 11.5	*E. coli*	20	33	41	70	53	3683	20	11	27	980	68	20%
Rippowam 11	*E. coli*	36	11	21	36	43	1045	579	26	70	24	57	20%
Rippowam 10	*E. coli*	20	40	49	147	690	87	109	Dry	96	102	89	11%
Rippowam 9	*E. coli*	73	56	80	145	99	1844	86	488	115	579	173	20%
Rippowam 7	*E. coli*	113	104	228	172	921	6932	104	Construction	Construction	>4839	443	38%
Rippowam 5	*E. coli*	73	365	548	649	816	9678	1733	3106	1642	4045	1104	70%
Rippowam 4	*E. coli*	365	365	261	488	365	1302	456	345	336	3466	521	20%
Rippowam 3	*E. coli*	1553	551	651	977	775	>9678	550	498	504	9678	1185	60%
Rippowam 2	*E. coli*	1733	582	690	2092	321	>9678	N/A	857	525	>9678	1393	78%
Rippowam 0.5	Enterococci	1789	359	203	576	520	>24196	N/A	269	554	1722	854	67%
Weather		Wet	Dry	Dry	Wet	Dry	Wet	Wet	Dry	Dry	Wet		

Table 14.1. GPS coordinates and site locations for the Rippowam River.

Site Name	Latitude	Longitude	Site location notes	River Name
Rippowam 12	41.18524	-73.52999	Oenoke Ridge	Rippowam River
Rippowam 11.5	41.17561	-73.52919	West Road	Rippowam River
Rippowam 11	41.17234	-73.53126	Dans Highway	Rippowam River
Rippowam 10	41.16153	-73.53843	Ponus Ridge Road	Rippowam River
Rippowam 9	41.15023	-73.53412	Cascade Road	Rippowam River
Rippowam 7	41.10559	-73.5586	Cedar Heights Road	Rippowam River
Rippowam 5	41.08559	-73.55664	Long Ridge Road	Rippowam River
Rippowam 4	41.06617	-73.55763	Cold Spring Road	Rippowam River
Rippowam 3	41.06593	-73.54912	Bridge Street	Rippowam River
Rippowam 2	41.05904	-73.54664	W North Street	Rippowam River
Rippowam 0.5	41.04813	-73.54542	Richmond Hill Avenue	Rippowam River

Dissolved oxygen and water temperature: Dissolved oxygen readings varied at each site throughout the river. While the majority of individual dissolved oxygen readings met the CT DEEP minimum criteria, 11 readings were observed below 5 mg/L at freshwater sites Rippowam 12, Rippowam 11, Rippowam 10, and Rippowam 4, and one reading was observed below 3 mg/L at saltwater site Rippowam 0.5 from mid-July through early-September. Mean water temperatures were higher during these months (Figure 14.4).

Figure 14.3. Box plot of dissolved oxygen concentrations at each sampling site along Rippowam River. The dashed red line represents the CT DEEP minimum criteria for dissolved oxygen in freshwater, which is 5mg/L. The dotted red line represents the CT DEEP minimum criteria for dissolved oxygen in saltwater, which is 3mg/L. The only saltwater site along this river is Rippowam 0.5. The numbers above each site name is the number of samples taken at each site. For more information on what each part of the boxplot represents, please review the informational graphic in the "Key Terms and Information" section on page 4.

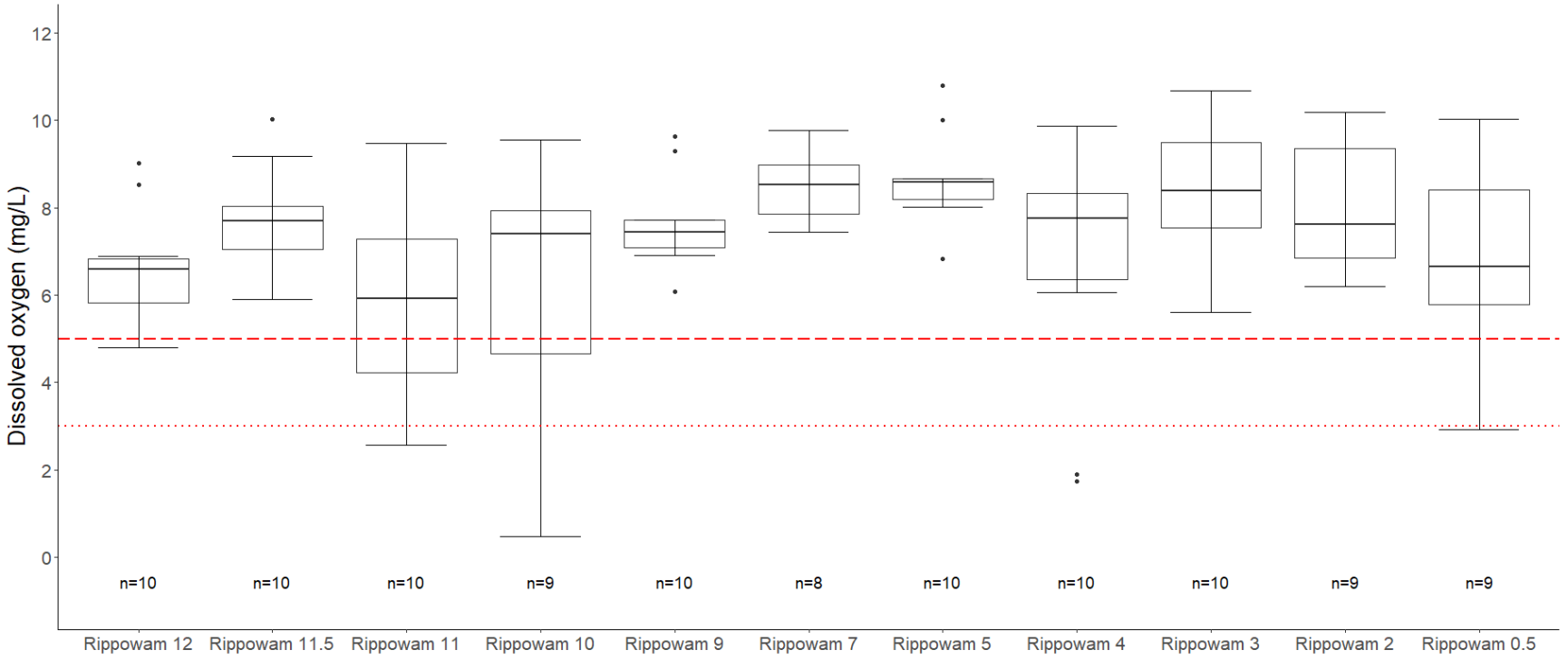
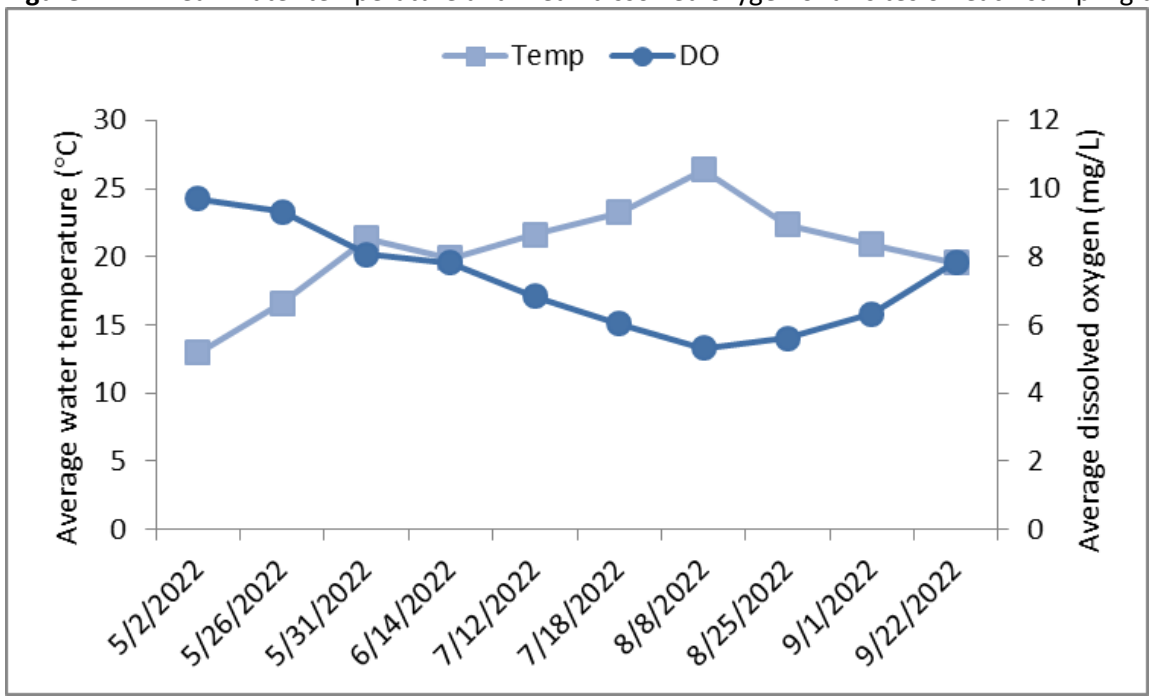


Figure 14.4. Mean water temperature and mean dissolved oxygen of all sites on each sampling date for Rippowam River.



15. Sasco Brook

The Sasco Brook Watershed falls within Westport, Fairfield, and Easton, CT. The watershed is approximately 6,600 acres or about 10 square miles. The watershed consists of 55% woods, wetlands, and water surfaces, 32% of low density residential areas and open recreational spaces, 7% urban areas, and 6% agricultural lands. (Sasco Brook Pollution Abatement Committee, 2011). Sasco Brook discharges into Long Island Sound at Southport Beach. Harbor Watch has conducted monitoring in various portions of the watershed throughout the years. Most recently, efforts have been focused on the lower portion of the watershed.

Indicator bacteria: Bacteria concentrations in the lower portion of the watershed have slowly increased over the last 5 years (Figure 15.1). In 2022, all sites exceeded the CT DEEP geomean criteria for indicator bacteria (Figure 15.2). Additionally, 43% of all samples processed in Sasco Brook exceeded the CT DEEP single sample maximum criteria (Table 15.1).

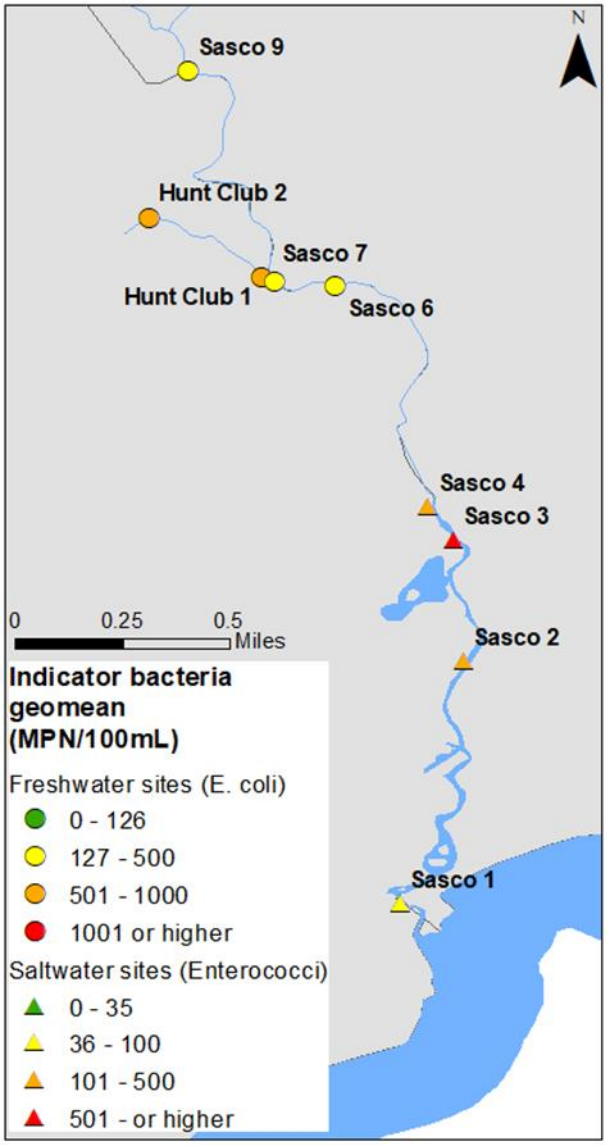


Figure 14.1. (Below) Mean of freshwater site geomeans (black bars) and saltwater site geomeans (striped bars) from 2017-2022 and total rainfall from May through September each year (grey squares and line).

Figure 14.2. (Left) Geomean of bacteria concentrations at each site in 2022.

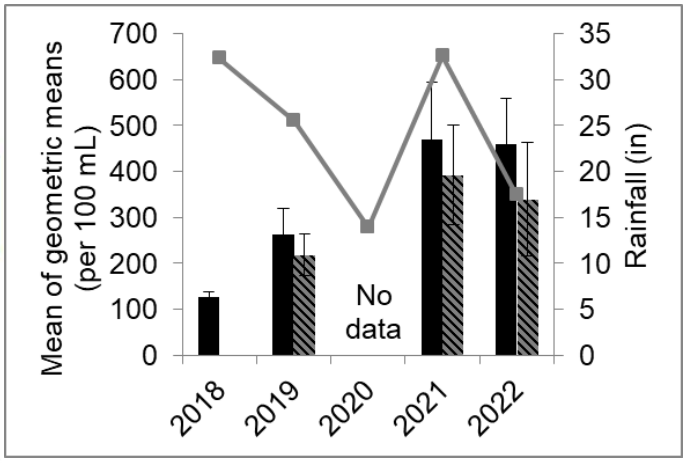


Table 15.1. Sasco Brook *E. coli* and enterococci concentrations (MPN/100mL), geomeans, and percentage of samples exceeding the CT DEEP single sample maximum. Rainfall data gathered from the Norwalk Health Department (n.d.).

	Indicator bacteria	5/9/2022	5/24/2022	6/9/2022	6/23/2022	7/14/2022	7/28/2022	8/1/2022	8/22/2022	9/8/2022	9/21/2022	Geomean	% exceeding SSM
Sasco 9	*E. coli*	34	147	>2420	236	980	921	821	275	1226.28	419.64	444	50%
Hunt Club 2	*E. coli*	109	162	>2420	1300	649	816	1454	279	1034.42	1453.98	669	70%
Hunt Club 1	*E. coli*	228	138	>2420	>2420	866	649	1842	229	2068.84	299.64	697	60%
Sasco 7	*E. coli*	47	193	>2420	1120	88	109	727	82	1203.33	99.18	264	40%
Sasco 6	*E. coli*	38	162	>2420	206	142	326	496	66	1119.87	61.02	224	20%
Sasco 4	Enterococci	10	121	>24196	426	906	909	2064	272	398.6	97.9	432	40%
Sasco 3	Enterococci	31	135	>24196	620	638	733	6131	546	528.4	186.9	628	70%
Sasco 2	Enterococci	52	63	10112	727	173	336	2282	75	74.5	40.9	243	30%
Sasco 1	Enterococci	<10	31	14136	10	85	41	480	20	<10	20.2	56	10%
Weather		Wet	Wet	Wet	Wet	Dry	Wet	Wet	Dry	Wet	Wet		

Table 15.2. GPS coordinates and site locations for Sasco Brook.

Site Name	Latitude	Longitude	Site location notes	River Name
Sasco 9	41.15280	-73.30605	210 Hulls Farm Road	Sasco Brook
Hunt Club 2	41.14786	-73.30736	Bulkley Avenue N	Unnamed Tributary
Hunt Club 1	41.14587	-73.30357	Ulbrick Lane	Unnamed Tributary
Sasco 7	41.14573	-73.30314	8 Ulbrick Lane	Sasco Brook
Sasco 6	41.14556	-73.30111	Old Road	Sasco Brook
Sasco 4	41.13813	-73.29793	Route 1	Sasco Brook
Sasco 3	41.13702	-73.29708	408 Greens Farm Road	Sasco Brook
Sasco 2	41.13293	-73.29675	32 Westway Road	Sasco Brook
Sasco 1	41.12478	-73.29888	Pequot Avenue	Sasco Brook

Dissolved oxygen and water temperature: Dissolved oxygen readings varied at each site throughout the watershed (Figure 15.3). While the majority of individual dissolved oxygen readings met the CT DEEP minimum criteria, 1 individual reading was observed below 5 mg/L at freshwater site Sasco 9 and a single reading was observed below 3 mg/L at saltwater site Sasco 3. These low readings were observed in July and August when water temperatures were highest (Figure 15.4).

Figure 15.3. Box plot of dissolved oxygen concentrations at each sampling site along Sasco Brook. The dashed red line represents the CT DEEP minimum criteria for dissolved oxygen in freshwater, which is 5mg/L. The dotted red line represents the CT DEEP minimum criteria for dissolved oxygen in saltwater, which is 3mg/L. Sasco 4, Sasco 3, Sasco 2, and Sasco 1 are all saltwater sites. The numbers above each site name is the number of samples taken at each site. For more information on what each part of the boxplot represents, please review the informational graphic in the "Key Terms and Information" section on page 4.

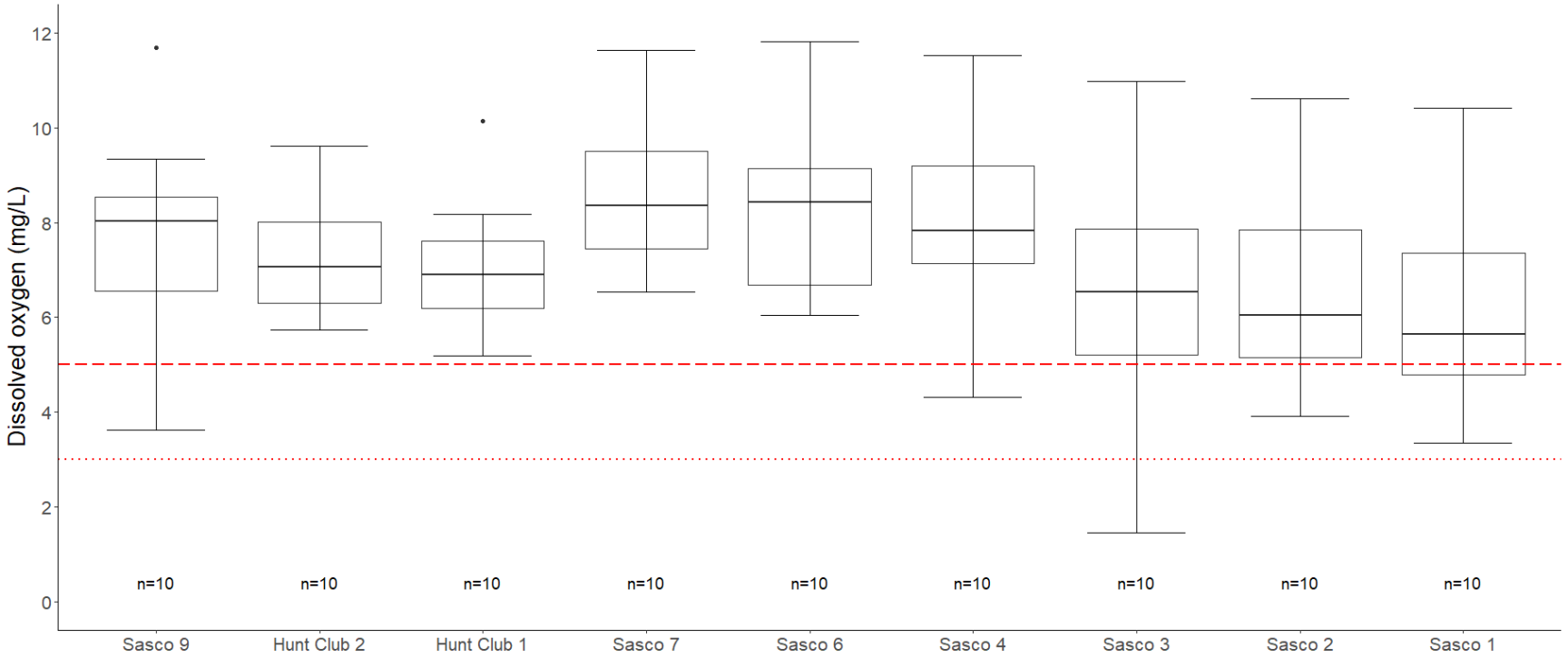
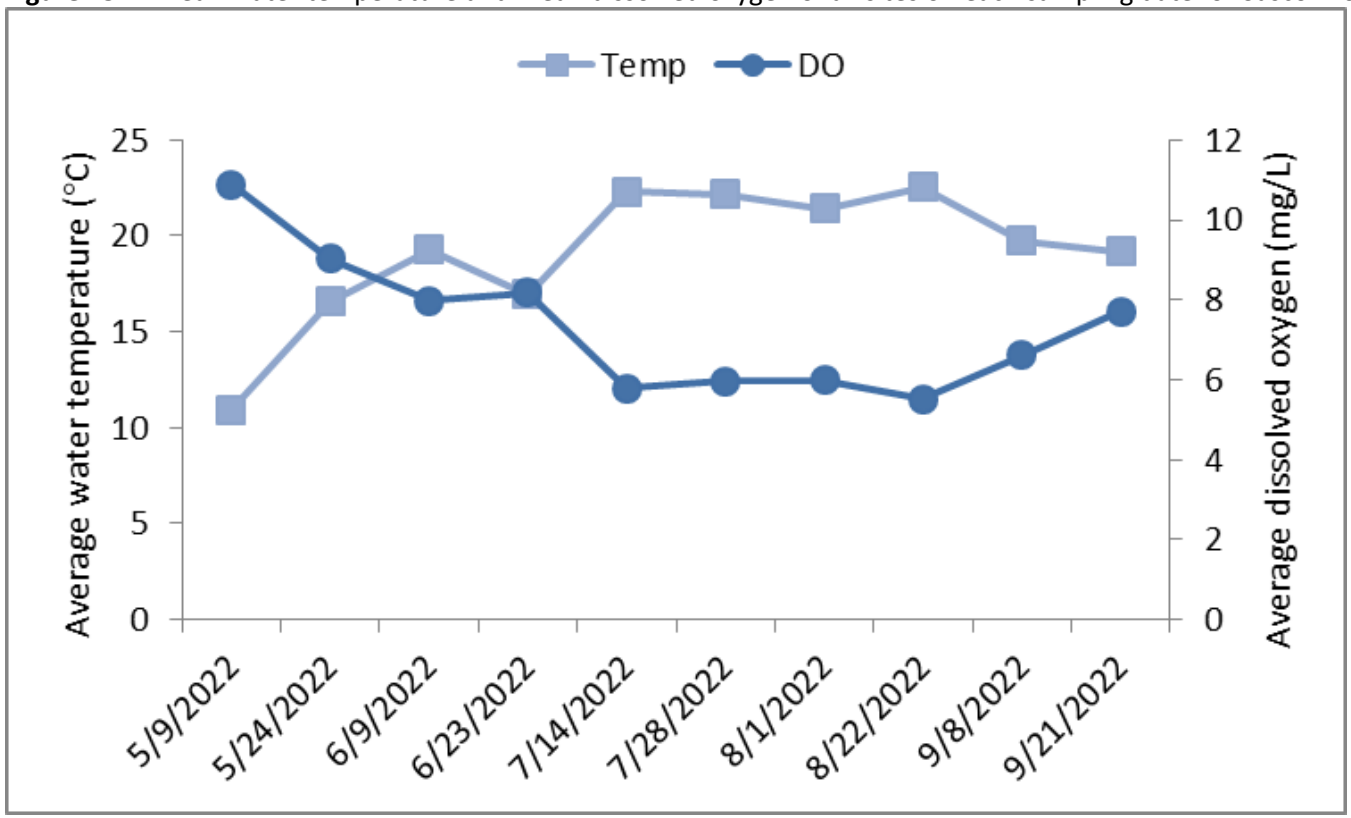


Figure 15.4. Mean water temperature and mean dissolved oxygen of all sites on each sampling date for Sasco Brook.



16. Saugatuck River

The Saugatuck River Watershed is located in Danbury, Ridgefield, Bethel, Redding, Wilton, Weston, Easton, Westport, and Norwalk, CT. The watershed is approximately 57,000 acres (89.1 square miles) and is defined by two main drainage basins: the Saugatuck River and the West Branch of the Saugatuck River. The land use is a combination of protected preserve (31%) around the Saugatuck Reservoir, residential (67%), and light commercial, industrial, and institutional (2%) (The South Western Regional Planning Agency, 2012b). The Saugatuck River discharges into Long Island Sound at Saugatuck Harbor. Harbor Watch has conducted monitoring in various portions of the watershed throughout the years, but in 2022 efforts were focused on the lower portion of the watershed.

Indicator bacteria: Bacteria concentrations in the lower portion of the watershed have remained relatively consistent over the last 4 years (Figure 16.1). All sites exceeded the CT DEEP geomean criteria for indicator bacteria (Figure 16.2). Additionally, 18% of all samples processed in the Saugatuck River exceeded the CT DEEP single sample maximum criteria (Table 16.1).

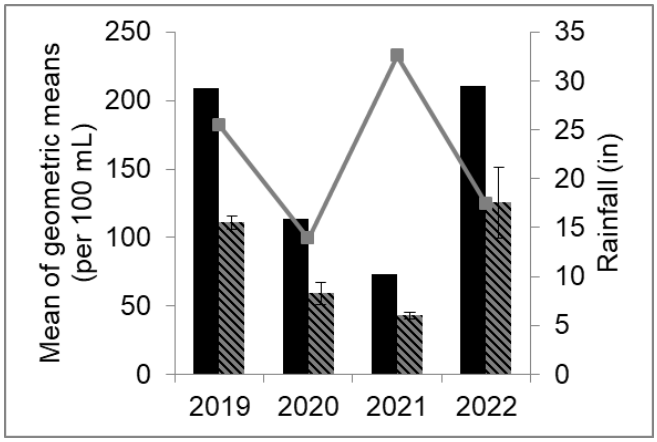


Figure 16.1. (Top) Mean of freshwater site geomeans (black bars) and saltwater site geomeans (striped bars) from 2017-2022 and total rainfall from May through September each year (grey squares and line).

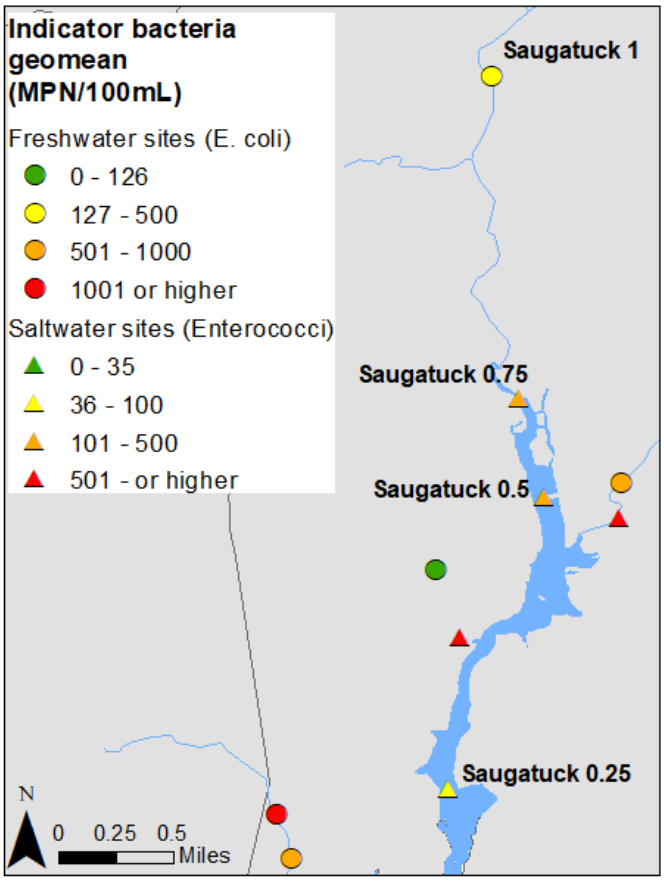


Figure 16.2. (Bottom) Geomean of bacteria concentrations at each site in 2022. Unlabeled sites are located on Indian River (Section 6), Stony Brook (Section 17), and Deadman's Brook (Section 3).

Table 16.1. Saugatuck River *E. coli* and enterococci concentrations (MPN/100mL), geomeans, and percentage of samples exceeding the CT DEEP single sample maximum. Rainfall data gathered from the Norwalk Health Department (n.d.).

	Indicator bacteria	5/12/2022	5/23/2022	6/8/2022	6/14/2022	7/7/2022	7/25/2022	8/1/2022	8/15/2022	9/6/2022	9/14/2022	Geomean	% exceeding SSM
Saugatuck 1	*E. coli*	44	93	416	72	61	135	291	112	4611	1159	211	20%
Saugatuck 0.75	Enterococci	<10	51	420	52	63	226	74	30	2613	677	120	20%
Saugatuck 0.5	Enterococci	<10	31	2481	63	84	41	481	175	4106	420	173	20%
Saugatuck 0.25	Enterococci	20	98	301	20	31	<10	134	95	4106	84	83	10%
Weather		Dry	Wet	Wet	Wet	Dry	Wet	Wet	Dry	Wet	Wet		

Table 16.2. GPS coordinates and site locations for the Saugatuck River.

Site Name	Latitude	Longitude	Site location notes	River Name
Saugatuck 1	41.16748	-73.36647	Pulloff by Michele Ln on Clinton Avenue	Saugatuck River
Saugatuck 0.75	41.14719	-73.36469	Kings Highway North	Saugatuck River
Saugatuck 0.5	41.14098	-73.36312	State Street East	Saugatuck River
Saugatuck 0.25	41.12274	-73.36912	Bridge Street	Saugatuck River

Dissolved oxygen and water temperature: Sites Saugatuck 1 and Saugatuck 0.25 had relatively consistent observed dissolved oxygen readings throughout the season, while sites Saugatuck 0.75 and Saugatuck 0.5 had a wider range in observed readings (Figure 16.3). The majority of individual readings met the CT DEEP minimum criteria, but two readings were observed below 3 mg/L at saltwater site Saugatuck 0.5. These readings were observed during the August and September sampling events, likely driven by the warmer water temperatures (Figure 16.4) and low rainfall.

Figure 16.3. Box plot of dissolved oxygen concentrations at each sampling site along the Saugatuck River. The dashed red line represents the CT DEEP minimum criteria for dissolved oxygen in freshwater, which is 5mg/L. Saugatuck 1 is the only freshwater site along the river. The dotted red line represents the CT DEEP minimum criteria for dissolved oxygen in saltwater, which is 3mg/L. The numbers above each site name is the number of samples taken at each site. For more information on what each part of the boxplot represents, please review the informational graphic in the "Key Terms and Information" section on page 4.

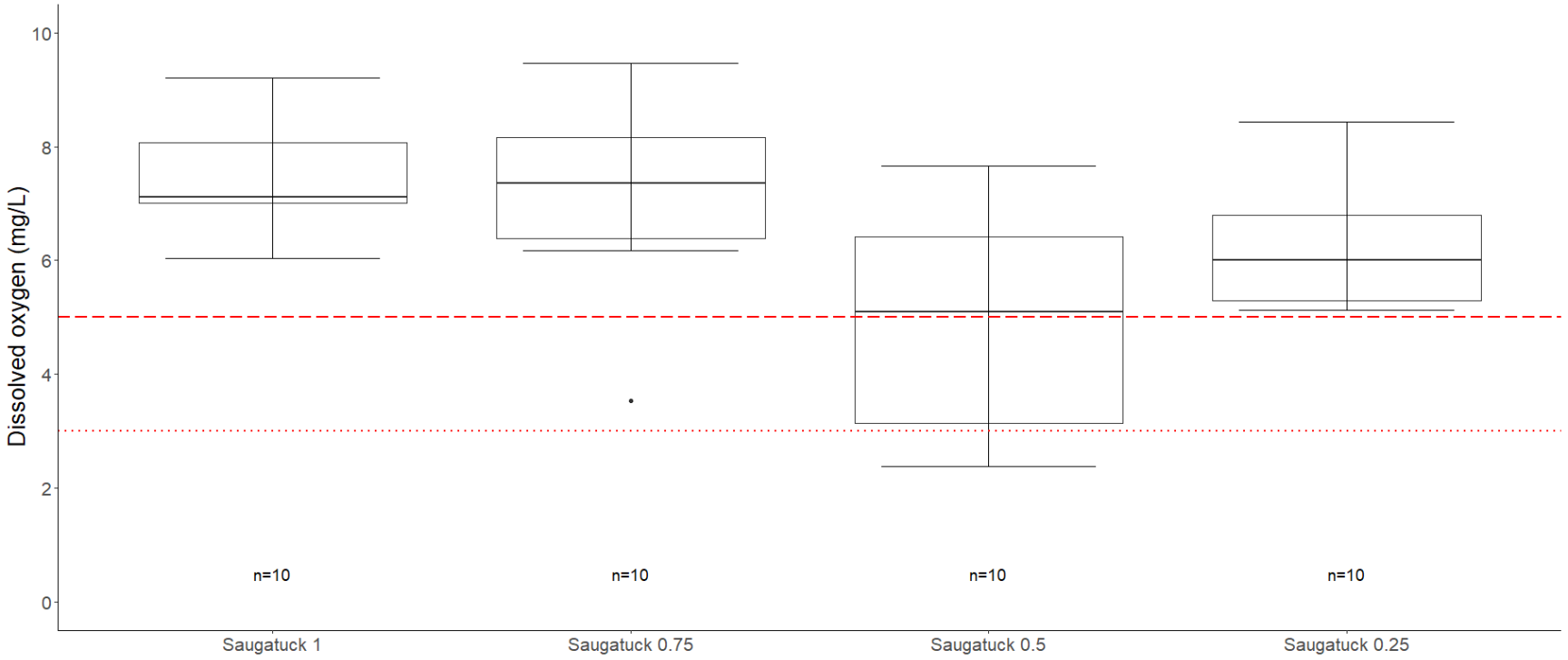
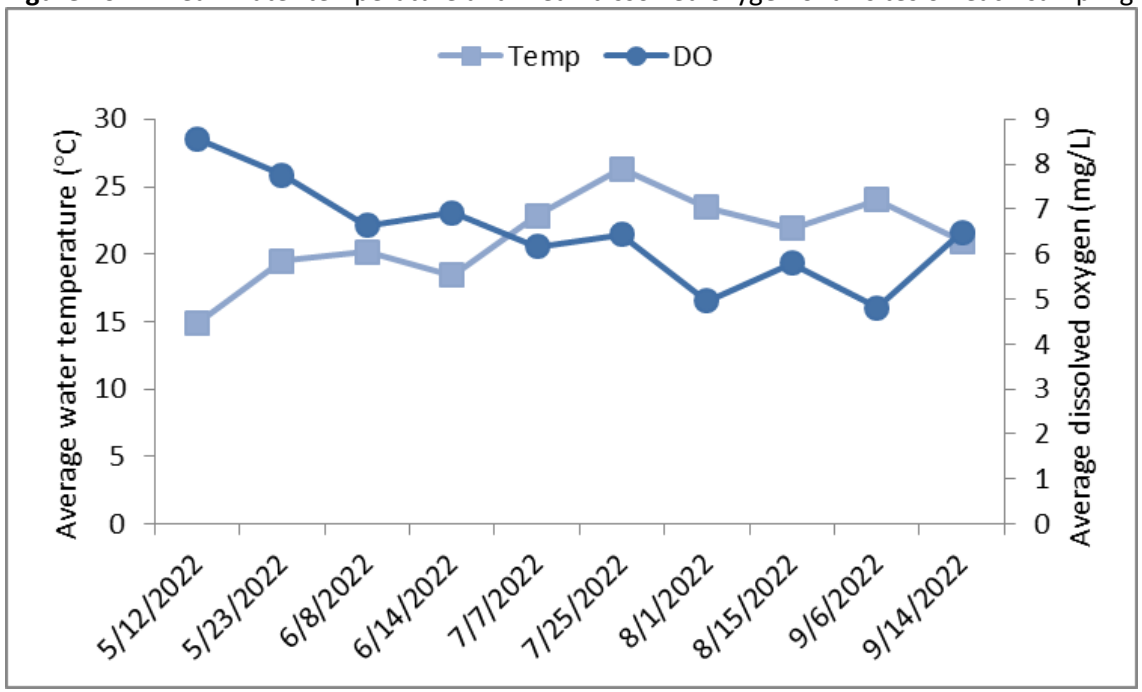


Figure 16.4. Mean water temperature and mean dissolved oxygen of all sites on each sampling date for Saugatuck River.



17. Stony Brook

Stony Brook is a tributary to the Saugatuck River located in Westport, CT. The brook meets the river on the west bank of Saugatuck Harbor between Harbor Watch sites Saugatuck 0.5 and Saugatuck 0.25 (Section 16). The watershed is residential at its headwaters and shifts to commercial as it flows towards Saugatuck Harbor. Part of the river flows through a nature sanctuary. While Harbor Watch has done intermittent studies of Stony Brook in the past as part of its student education programs, 2020 was the first year in which a comprehensive study was conducted during the summer monitoring season.

Indicator bacteria: Bacteria concentrations observed in 2022 at the lower 4 sites are similar to those observed in 2020, while concentrations observed at Stony 6 and Stony 5 in 2022 are elevated above 2020 observations (Table 17.1). Five sites exceeded the CT DEEP geomean criteria for indicator bacteria (Figure 17.1). Additionally, 42% of all samples processed in Stony Brook exceeded the CT DEEP single sample maximum criteria (Table 17.2). A pollution track-down project in conjunction with the Town of Westport is ongoing in the lower portion of the watershed, focusing on the increase in bacteria concentrations from Stony 2 to Stony 1. One explanation for low concentrations observed at Stony 2 compared to the rest of the brook may be due to the treatment of Nash's Pond (located between Stony 3 and Stony 2) with copper sulfate, an algaecide that has an unintended consequence of reducing observed bacteria concentrations (Leah Nash, personal communication; Grey and Steck, 2001).

Site	2020 Geomean	2022 Geomean
Stony 6	609	1022
Stony 5	146	453
Stony 4	572	437
Stony 3	321	356
Stony 2	165	125
Stony 1	380	524

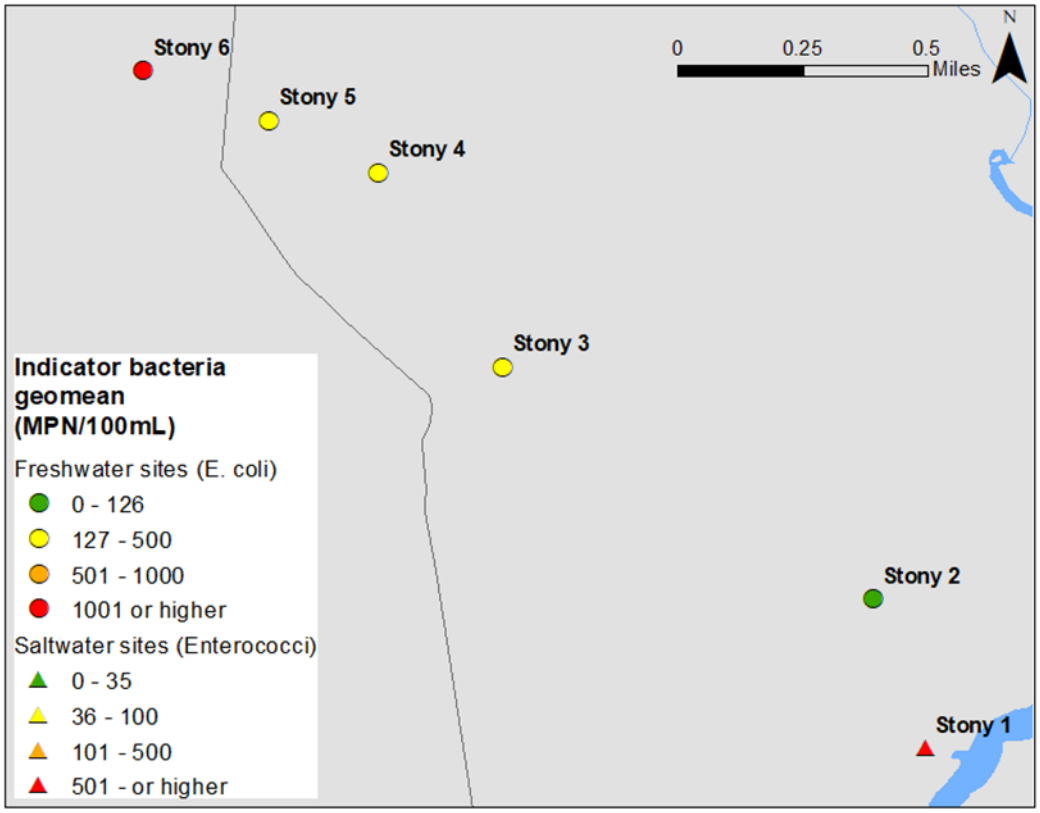


Table 17.1. (Top) Geomeans at each sampling site in 2020 and 2022.
Figure 17.1. (Bottom) 2022 geomean of bacteria concentrations at each site.

Table 17.2. Stony Brook *E. coli* and enterococci concentrations (MPN/100mL), geomeans, and percentage of samples exceeding the CT DEEP single sample maximum. Rainfall data gathered from the Norwalk Health Department (n.d.).

	Indicator bacteria	5/12/2022	5/23/2022	6/8/2022	6/14/2022	7/7/2022	7/25/2022	8/1/2022	8/15/2022	9/6/2022	9/14/2022	Geomean	% exceeding SSM
Stony 6	*E. coli*	119	1203	>4839	498	437	870	2827	195	15648	1102	1022	60%
Stony 5	*E. coli*	111	361	>2420	259	71	66	1046	160	7701	2407	453	40%
Stony 4	*E. coli*	88	228	>2420	135	261	105	365	99	19863	1961	437	30%
Stony 3	*E. coli*	64	147	1011	80	114	166	961	61	>24196	1583	356	40%
Stony 2	*E. coli*	12	63	42	61	52	111	34	727	2489	1313	125	30%
Stony 1	Enterococci	30	465	1658	663	N/A	73	677	233	19863	836	524	56%
Weather		Dry	Wet	Wet	Wet	Dry	Wet	Wet	Dry	Wet	Wet		

Table 17.3. GPS coordinates and site locations for Stony Brook.

Site Name	Latitude	Longitude	Site location notes	River Name
Stony 6	41.15178	-73.391	Newtown Avenue	Stony Brook
Stony 5	41.150327	-73.38739	Partrick Road	Stony Brook
Stony 4	41.148829	-73.38424	Earthplace sanctuary	Stony Brook
Stony 3	41.143217	-73.38062	Stony Brook Road	Stony Brook
Stony 2	41.136532	-73.36993	Post Road	Stony Brook
Stony 1	41.132228	-73.36838	Sylvan Lane	Stony Brook

Dissolved oxygen and water temperature: Dissolved oxygen readings in the watershed varied by sites throughout the season (Figure 17.2). While the majority of readings met the CT DEEP minimum criteria, 7 individual dissolved oxygen readings were observed below 5 mg/L at freshwater sites Stony 6, Stony 5, and Stony 2, and one individual dissolved oxygen reading was observed below 3 mg/L at saltwater sites Stony 1. Low readings were observed predominantly during July and August when water temperatures increased (Figure 17.3) and rainfall was low.

Figure 17.2. Box plot of dissolved oxygen concentrations at each sampling site along Stony Brook. The dashed red line represents the CT DEEP minimum criteria for dissolved oxygen in freshwater, which is 5mg/L. The dotted red line represents the CT DEEP minimum criteria for dissolved oxygen in saltwater, which is 3mg/L. The only saltwater site along this brook is Stony 1. The numbers above each site name is the number of samples taken at each site. For more information on what each part of the boxplot represents, please review the informational graphic in the "Key Terms and Information" section on page 4.

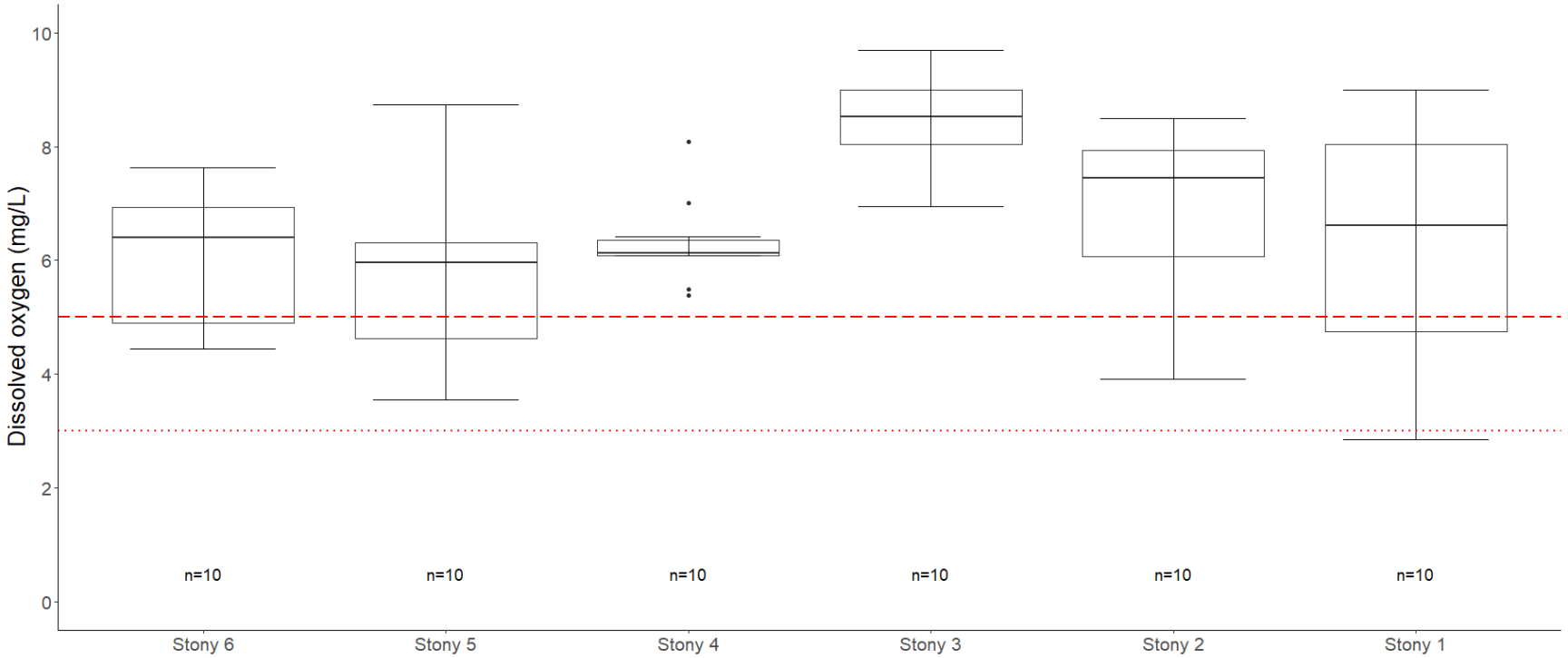
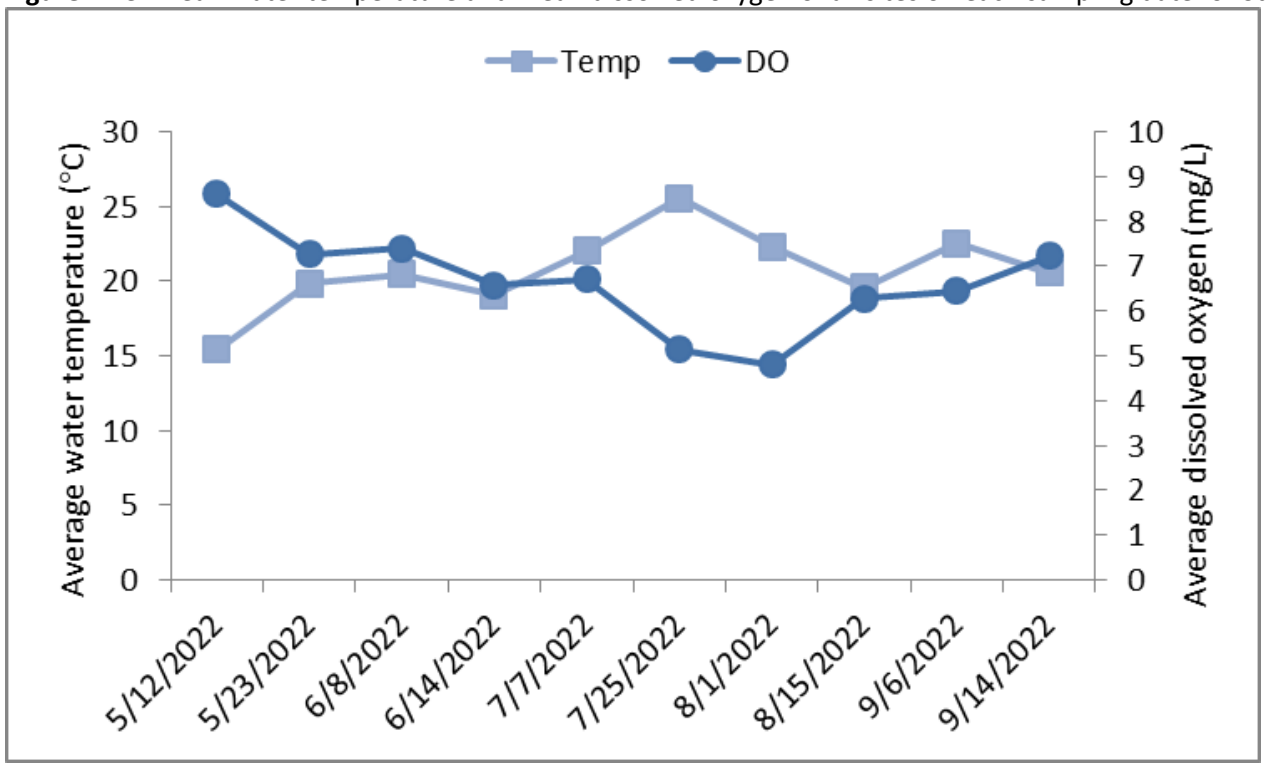


Figure 17.3. Mean water temperature and mean dissolved oxygen of all sites on each sampling date for Stony Brook.



8. Yellow Mill Channel Watershed

The Yellow Mill Channel Watershed is approximately 2900 acres or 4.5 square miles and is located in Bridgeport, Trumbull, and Stratford (CT DEEP, 2022). Four tributaries feed into Success Lake, a man-made lake located at the previous site of Remington Arms, then drain south into Bridgeport Harbor through the Yellow Mill Channel. The first time Harbor Watch monitored this watershed was in 2022.

Indicator bacteria: All sites exceeded the CT DEEP geomean criteria for indicator bacteria (Figure 18.1). Additionally, 88% of all samples processed in the watershed exceeded the CT DEEP single sample maximum criteria (Table 18.1).

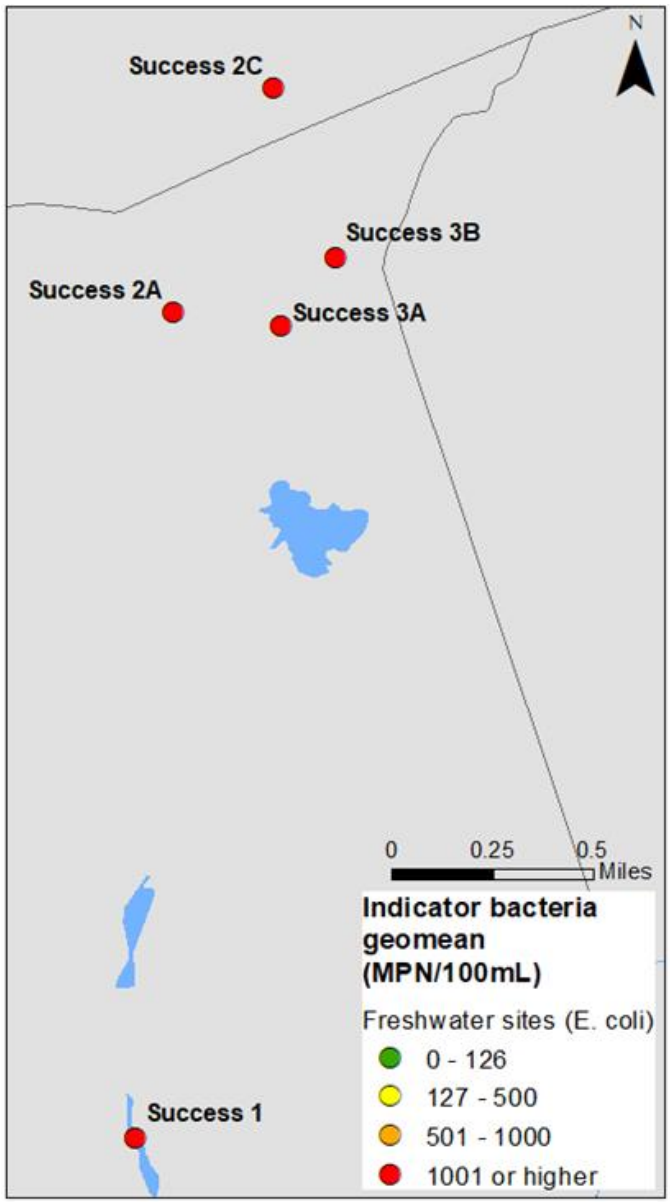


Figure 18.1. Geomean of bacteria concentrations at each site in 2022.

Table 18.1. Success Lake watershed *E. coli* concentrations (MPN/100mL), geomeans, and percentage of samples exceeding the CT DEEP single sample maximum. Rainfall data gathered from the websiteWeather Spark (n.d.).

	5/12/2022	5/24/2022	6/2/2022	6/16/2022	7/14/2022	7/26/2022	8/11/2022	8/25/2022	9/6/2022	9/12/2022	Geomean	% exceeding SSM
Success 3B	579	>2420	1159	>2420	1150	>4839	2599	1642	29093	>9678	2767	100%
Success 3A	308	579	1733	N/A	1203	3973	3973	2453	46111	>9678	2649	89%
Success 2C	111	291	548	1733	N/A	2092	Dry	Dry	41058	>9678	1589	57%
Success 2A	517	1046	3973	1379	2092	3466	Dry	Dry	34411	Dry	2570	86%
Success 1	745	1733	1733	>4839	>4839	4813	6212	>24196	17890	14136	4991	100%
Weather	Dry	Dry	Wet	Wet	Dry	Wet	Dry	Dry	Wet	Wet		

Table 18.2. GPS coordinates and site locations for the Success Lake watershed.

Site Name	Latitude	Longitude	Site location notes	River Name
Success 3B	41.220581	-73.16449	Broadbridge Road	Unnamed Tributary
Success 3A	41.218122	-73.16643	Fairfax Road	Unnamed Tributary
Success 2C	41.226659	-73.16671	Juniper Ridge Road	Unnamed Tributary
Success 2A	41.218623	-73.17028	E Pasadena Place	Unnamed Tributary
Success 1	41.188979	-73.17162	Grant Street	Yellow Mill Channel

Dissolved oxygen and water temperature: Dissolved oxygen readings were similar throughout the tributaries upstream of the lake (Figure 18.2). While the majority of readings met the CT DEEP minimum of 5 mg/L, 9 individual dissolved oxygen readings were observed below 5 mg/L. Success 1 had observed readings below 5 mg/L 7 times, and Success 3A and Success 2A each had one observed readings less than 5 mg/L. Water levels throughout the watershed were impacted by increased water temperatures (Figure 18.3), increased air temperatures, and low rainfall, especially sites Success 2A and Success 2C, both of which dried up in August.

Figure 18.2. Box plot of dissolved oxygen concentrations at each sampling site in Success Lake watershed. The dashed red line represents the CT DEEP minimum criteria for dissolved oxygen in freshwater, which is 5mg/L. The numbers above each site name is the number of samples taken at each site. For more information on what each part of the boxplot represents, please review the informational graphic in the "Key Terms and Information" section on page 4.

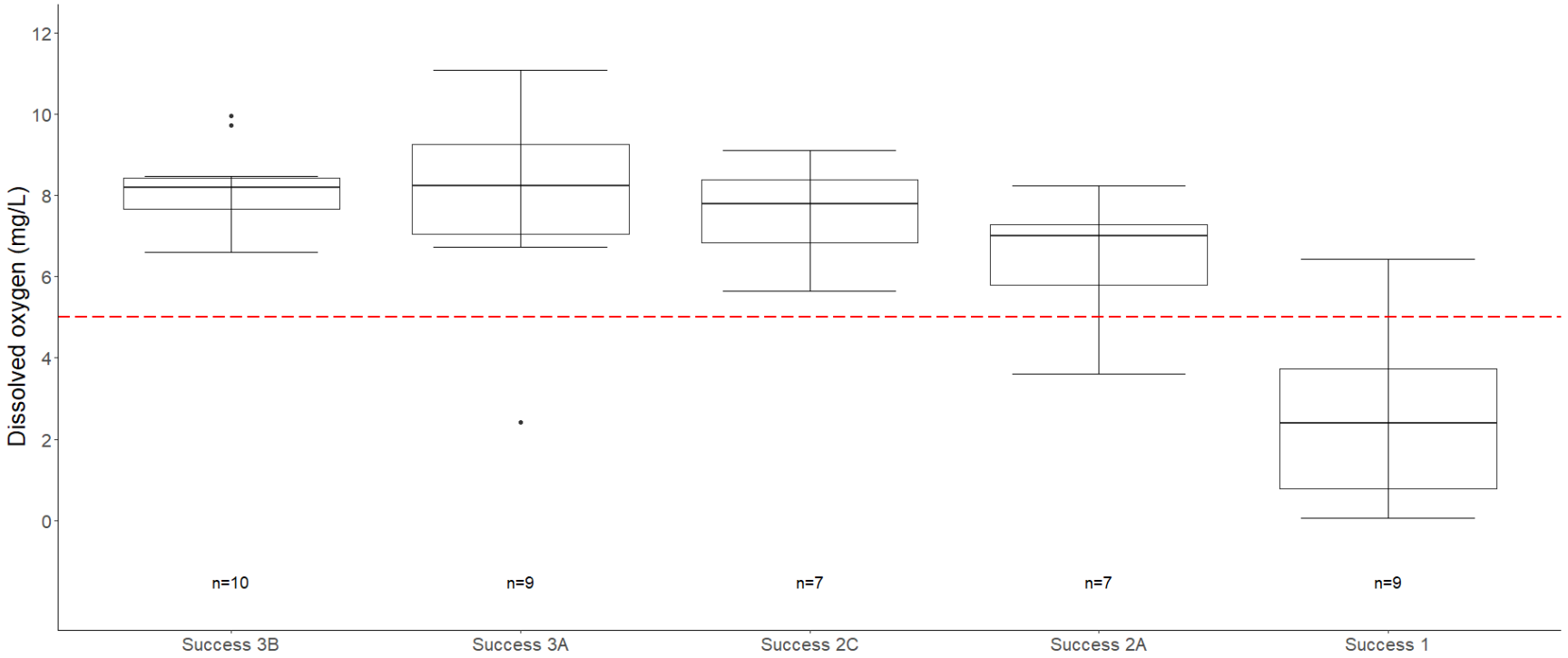
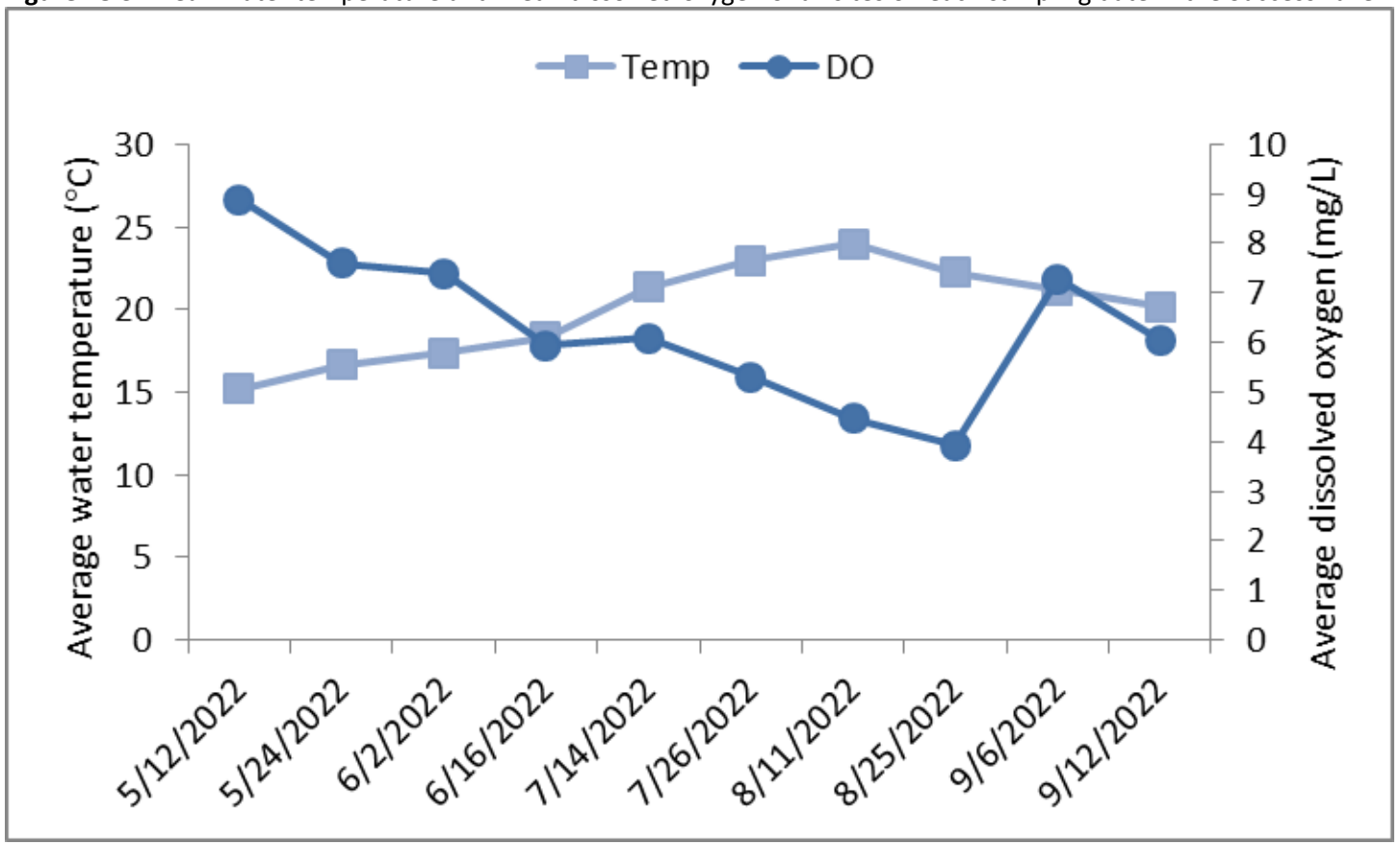


Figure 18.3. Mean water temperature and mean dissolved oxygen of all sites on each sampling date in the Success Lake watershed.



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QAPP Deviation Summary

Project Name: Fairfield County Water Quality Monitoring (RFA #22043)

Monitoring Organization: Harbor Watch, a program of Earthplace, Inc.
10 Woodside Lane, Westport, CT 06880

Approved for: Monitoring Season 2022

1.4 Project Organization

Table 1: Project Manager change from Sarah Crosby to Nicole Spiller

1.6 Project/Task Description

Table 2: Sample location Adjustments – due to safety, construction, or access some sites were modified our drop, see changes below

- Cemetery 3 was dropped due to access
- Cemetery 2 was dropped due to access
- Noroton 1.5 was switched to Noroton 1
- Rippowam 8 was dropped due to bridge construction
- Success 4 was dropped due to access
- Success 3C was dropped due to access
- Success 2B was dropped due to access

1.9 Documents and Records

- Training - not all types of trainings were completed on the first day due to time constraints, but was all completed within the first week

2.1 Sampling Design

- On some occasions, when there were staffing restraints occurred, a team of one would collects samples as opposed to a team of two or more
- Table 5:
    - The laboratory replicate for indicator bacteria was changed from “1 per sampling day per laboratory team” to “1 per individual per sampling day”
    - Not every site was collected a minimum of 8 times for indicator bacteria, due to construction or water levels being too shallow/dry. These sites are listed below:
        - Bruce 6 - 6 times
        - Keelers 1 - 5 times
        - Success 2A - 7 times
    - Not every site was collected a minimum of 8 times for dissolved oxygen, temperature, conductivity, due to construction, water levels being too shallow/dry, or instrument issues. These sites are listed below:
        - Bruce 6 - 5 times
        - Bruce 5 - 5 times
        - Bruce 4 - 6 times
        - Bruce 2 - 7 times

- Deadman 9 - 7 times
- Keelers 1 - 5 times
- Success 2C - 7 times
- Success 2A - 7 times

2.7 Instrument/Equipment Calibration and Frequency

- Dissolved oxygen percent saturation was checked on the at each site, if percent the was ±2% of the manufactures recommendations it was re-calibrated and re-calibration was denoted on data sheet.

Summary

All data produced are acceptable to the Project QA officers and any notes about process change will be updated in future QAPP submissions.