2020 Water Quality Report, Milton, Massachusetts

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Background

The Neponset River Watershed Association (NepRWA) has been collecting water quality data in Milton and throughout the Neponset River watershed since 1996. Samples are collected by volunteers through the Community (formerly Citizen) Water Monitoring Network (CWMN) and by NepRWA staff through the Hot Spot program. Data gathered by the CWMN volunteers are used to track the health of the Neponset River and its tributaries, and to locate pollution sources (hot spots) for follow-up sampling. There are ten permanent CWMN stations within and bordering the Town of Milton; three on Pine Tree Brook, three on Unquity Brook and four on the Neponset River (Figure 1). CWMN stations are sampled once per month between May and October. Waterbodies in Milton are tested for *Escherichia coli* (*E.coli*), total phosphorus, pH, dissolved oxygen, temperature, and flow rate. NER150, NER200, and PTB047 are also tested for ortho-phosphate, total nitrogen, and ammonia. The parameters discussed in this report are limited to those that are tested at every site including *E. coli*, total Phosphorus, pH, and dissolved oxygen. The raw water quality data are available upon request.

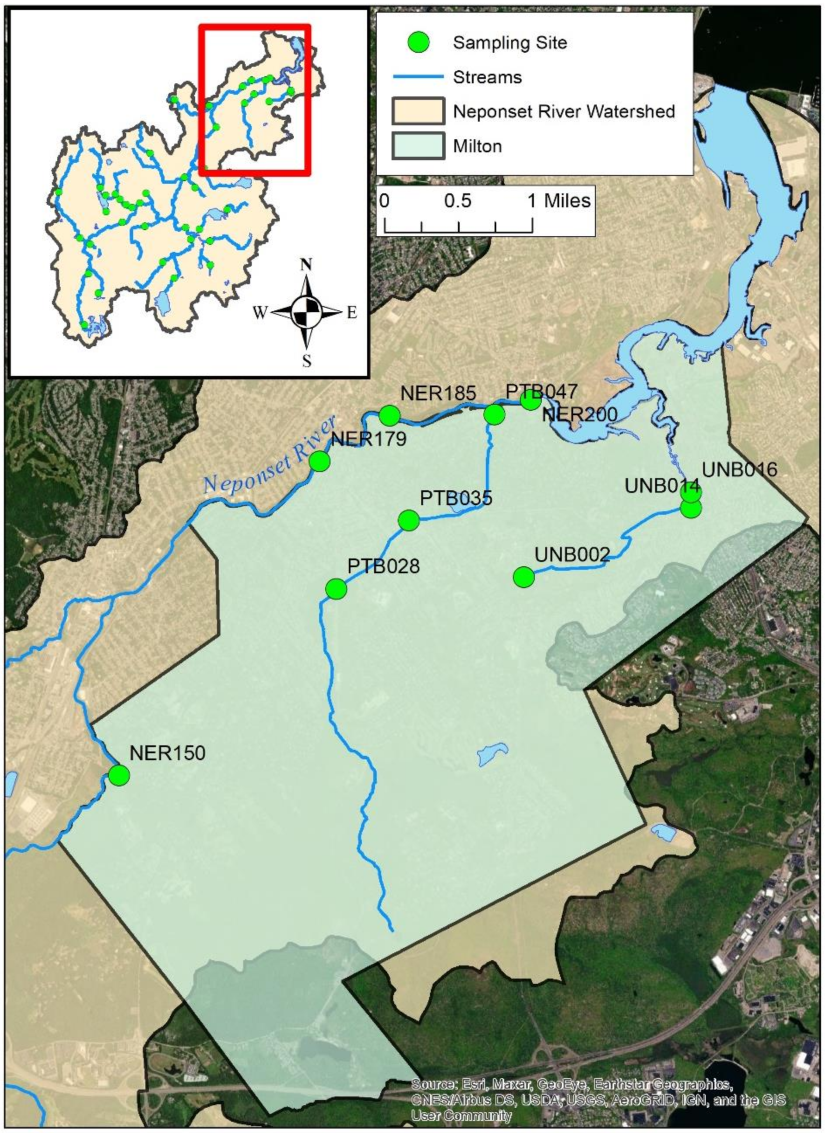

Figure 1: Map of the CWMN sites in Milton, Massachusetts.

The concentration of *E. coli* bacteria is used to assess a waterbody's safety for "contact recreation" through activities such as swimming, fishing, boating, and wading. The presence of *E. coli* is evidence of fecal contamination and is an indicator of the likely presence of other, more dangerous, pathogens associated with human and animal waste. The most common sources of *E. coli* include improper disposal of pet waste in streets, lawns, and catch basins. Additional common sources include sewer or septic system malfunctions and discharges of organic wastes from household or commercial garbage. Wildlife waste also contains *E. coli*, however elevated concentrations from wildlife are typically associated with human activities, such as feeding ducks. Management interventions to reduce *E. coli* loads can include education on pet waste disposal, proper management of solid waste, frequent cleaning of catch basins, filtration stormwater best management practices (BMPs) to reduce the runoff that reaches a waterbody, and rapid identification and repair of sewage leaks and spills.

Phosphorus is a required plant nutrient that is often the "limiting nutrient" in freshwater ecosystems. Therefore, the concentration of available phosphorus in a freshwater waterbody will often control the rate of aquatic plant growth (the other required nutrients are typically present at proportionately higher levels). *Excess* phosphorus creates *excess* biomass, especially algae, in a process called eutrophication. When the excess plants and algae die, the process of decomposition consumes dissolved oxygen, and in extreme cases dissolved oxygen levels get too low to support aquatic animals such as fish. Other impacts of eutrophication include unattractive and smelly algal blooms and destruction of underwater plant communities through reduced light penetration. Elevated phosphorus concentrations can cause *harmful* algal blooms (HABs), such as cyanobacteria that produce toxins harmful to people. Phosphorus sources can include wet (from rain) or dry (from sprinklers) weather runoff from parking lots, streets/gutters, and lawns. These surfaces contain phosphorus from fertilizers, organic matter (leaves, grass clippings), soil, garbage, and pet waste. Interestingly, phosphorus can also accumulate on these surfaces from atmospheric deposition. Illegal dumping of organic matter such as leaves in or near waterways or catch basins is a common problem. Poorly maintained septic systems, illicit discharges of sewage, and naturally occurring dead aquatic plant materials are additional sources.

The pH of a waterbody is a measure of how much free hydrogen ion (H+) is present in the water—a lot of free hydrogen ion leads to acidity (low pH) and low amounts of free hydrogen ion leads to more basic conditions (high pH). Water that is too acidic or too basic can be toxic to aquatic life. The pH is influenced by bedrock characteristics, groundwater seepage, acid rain, or heavy loading of tannin rich leaves/needles.

Adequate concentrations of dissolved oxygen (DO) are necessary to support fish, amphibians, mollusks, aquatic insects, and other invertebrate species. Many environmental drivers impact the DO levels in a water body. For example, cooler water temperatures sustain higher levels of DO, which is why there is often a seasonal trend in DO concentration: low levels in the warm months and higher levels in the colder months. Rapid mixing and turbulence (such as riffles or step pools) also result in high levels of DO due to atmospheric mixing. Alternatively, large amounts of decaying organic matter consume dissolved oxygen as microorganisms degrade the organic matter and lower levels of DO result. Excessive phosphorous that causes eutrophic conditions is also closely associated with low dissolved oxygen levels because it drives plant growth and subsequent decomposition. In thermally stratified lakes, oxygen deficient conditions can occur in the deeper portions of the water where there is no atmospheric mixing and no photosynthesis (the two sources of DO in aquatic systems). In the summer, ponds and lakes typically have warmer surface waters and thus lower surface DO concentrations. Management interventions that can increase DO levels include increasing riparian shading to maintain lower water temperatures, removing obsolete dams, reducing excessive water diversions, and reducing decaying organic matter though the reduction of phosphorous runoff and other drivers of eutrophication.

Results and Discussion

Monthly sampling events occur on predetermined days each month, which means the weather is not a criterion in determining when to collect the water quality data. However, rain events can significantly alter the concentrations of various parameters by washing bacteria, nutrients, and other chemicals from land surfaces into the river. In 2020, five sampling days occurred during dry periods and just one sampling date occurred during a wet period. A wet period is defined as greater than 0.1 inches of precipitation within the 48-hour period preceding a sampling event. As shown in Table 1, 2020 had more sampling events occur during dry weather since 2016 when all six sampling events occurred during dry weather. The implication of this result is that any improvements in certain parameters like *E. coli* may be a result from the disproportionate sampling during dry weather as opposed to real changes in water quality or real changes in the frequency of sewage spills.

Table 1: The number of water quality sampling days that occurred during dry or wet weather since year 2010.

Year	Dry (days)	Wet (days)
2010	5	1
2011	3	3
2012	2	4
2013	5	1
2014	4	2
2015	4	2
2016	6	0
2017	4	2
2018	3	3
2019	3	3
2020	5	1

Escherichia coli (E. coli)

In Massachusetts there are two criteria that define acceptable levels of *E.coli* in Class B waterbodies (waterbodies that support wildlife, swimming, and boating, but not drinking). In Class B waters, no single sample shall exceed 235 Colony Forming Units (CFU) per 100 ml (the single sample standard), and/or the geometric mean of at least 5 samples taken within the same season shall not exceed 126 CFU/100ml (the seasonal standard).

In 2020 maximum *E. coli* levels at all ten of the sampling sites exceeded the 235 cfu/100mL single sample limit (Table 2). The highest levels were observed in Pine Tree Brook (PTB) 047 and Unquity brook (UNB) 002. Remarkably, the minimum *E. coli* level at PTB047 was above the single sample limit. The geometric means were above the seasonal standard at all ten sites (Table 2). Site PTB028 was close to being in the acceptable range, geometric mean = 131cfu/100mL.

Table 2: The maximum, average, minimum, and geometric mean levels of *E. coli* at the ten sampling sites in Milton, MA, year 2020. N=6 for each site except UNB002 where N = 5.

Sampling Site	Maximum	Average	Minimum	Geometric Mean
NER150	410	187	31	147
NER179	3650	760	63	239
NER185	3650	841	148	408
NER200	933	341	10	144
PTB028	717	236	41	131
PTB035	1660	722	52	490
PTB047	10500	2173	345	822
UNB002	24200	6415	74	1715
UNB014	4880	1272	41	532
UNB016	1270	603	30	363

In 2020 there was only wet weather event that was sampled, and nine out of the ten sites had levels that were greater than 235cfu/100ml (NER150 was within the acceptable range, *E. coli* = 201 cfu/10mL). It is important to note that even during dry weather many of the sites had concentrations that exceeded the single sample standard. In 2020, of the five sampling events that occurred in dry weather, at least one sample exceeded the standard at each of the 10 sites (the maximum dry weather water sample levels in 2020 ranged from 382 – 4350cfu/100ml).

Using data from 2010 onward, wet weather events generally lead to higher *E. coli* levels in the Neponset River (Figure 2), Pine Tree Brook (Figure 3), and Unquity brook (Figure 4). The levels during wet weather almost always exceed levels during dry events and similarly almost always exceed the single sample standard. Unquity Brook appears to have the greatest problem with *E. coli* of any of the streams in Milton. Site UNB002, the headwaters of Unquity Brook, has had the highest *E. coli* levels since 2018 during the wet weather events of all sites and on more than one occasion suggesting a systemic problem as opposed to a one-time spill event. The 2020 dry weather values at site UNB002 were also high compared to the other sites, which could potentially suggest contamination resulting from discharges or leaks.

Site PTB047 had a high *E. coli* level recorded during the single wet weather event in 2020. Because we only sampled once during wet weather, we cannot say whether this was the result of a one-time sewage contamination event, or if there is a systemic problem during rain events. However, in past years there have been high levels during rain events.

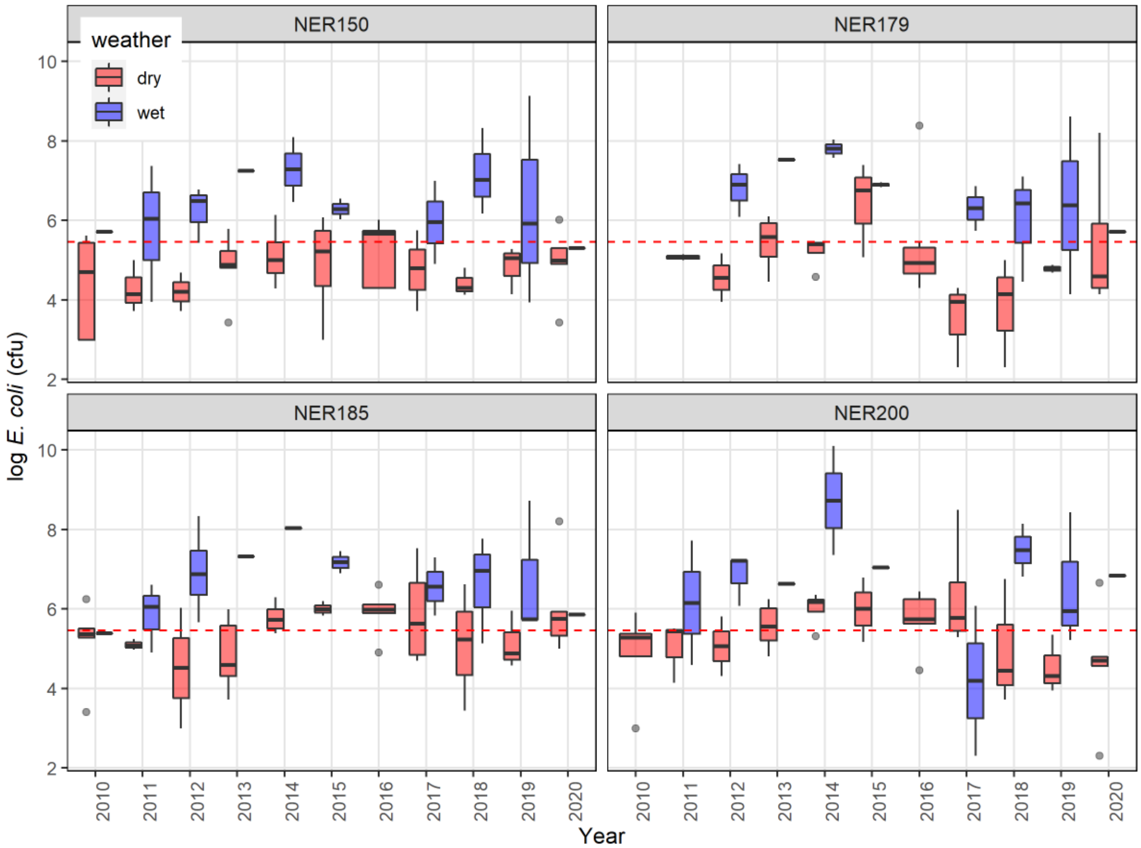

Figure 2: *E. coli* levels at the four sampling sites on the Neponset River from years 2010 to 2020. Levels are grouped by weather (blue = wet, red = dry). The red dashed line at y = log(235) shows the single sample maximum acceptable threshold. Boxplot statistics: The lower and upper hinges correspond to the first and third quartiles (the 25th and 75th percentiles). The upper whisker extends from the hinge to the largest value no further than 1.5 * IQR from the hinge (where IQR is the inter-quartile range, or distance between the first and third quartiles). The lower whisker extends from the hinge to the smallest value at most 1.5 * IQR of the hinge. Data beyond the end of the whiskers are called "outlying" points and are plotted individually.

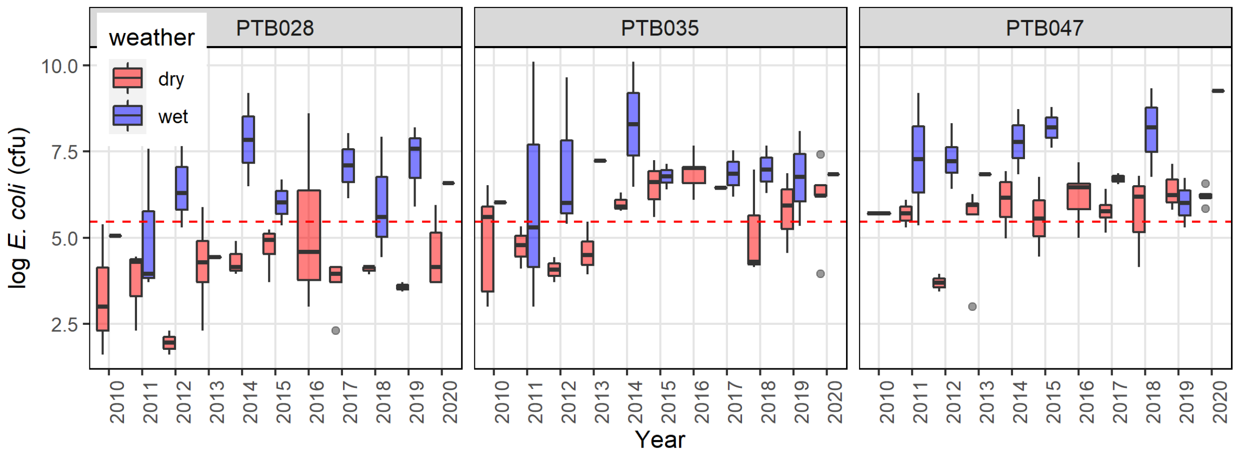

Figure 3: *E. coli* levels at the three sampling sites on Pine Tree Brook from years 2010 to 2020. Features are the same as in Figure 2.

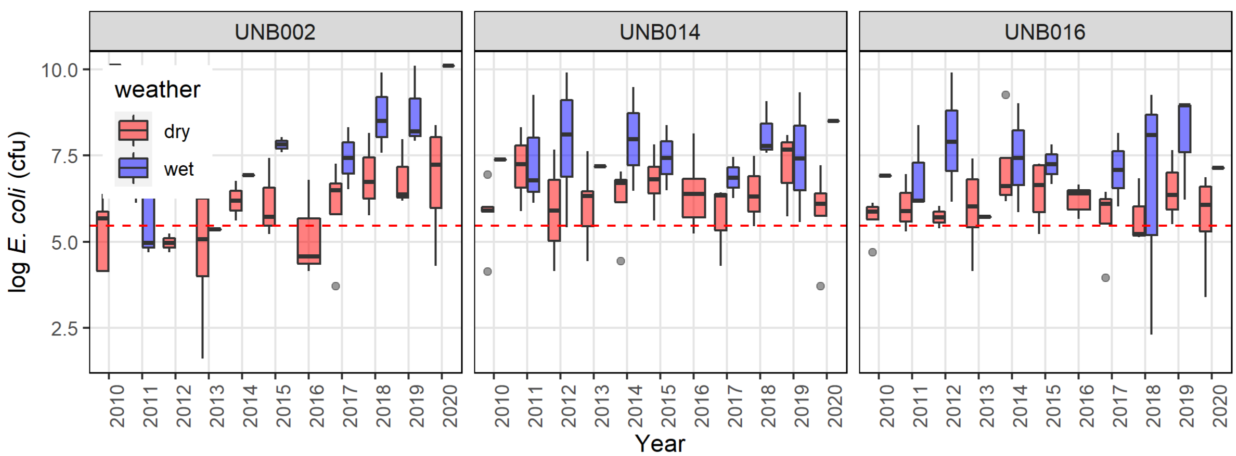

Figure 4: *E. coli* levels at the three sampling sites on Unquity Brook from years 2010 to 2020. Features are the same as in Figure 2.

Phosphorus

The state of Massachusetts does not provide numerical phosphorus standards for classification of water quality impairments. Instead, the Massachusetts Department of Environmental Protection (MassDEP) uses a narrative standard that considers the EPA gold book standard, dissolved oxygen levels, and excessive primary producer growth. The EPA gold book standard identifies an average of at least three samples exceeding 0.1mg/l as the upper threshold for flowing waters (we consider all ten sampling sites in Milton to be in this category) and 0.05mg/l for streams entering a lake/reservoir. Dissolved oxygen and excess primary producer growth like algal blooms are used as evidence that the Phosphorus levels are causing an impact to the stream ecology.

In 2020, two sites in Milton had a season average that exceeded 0.1mg/l Phosphorus: UNB002 (mean = 0.25 mg/l) and PTB035 (mean = 0.17 mg/l) (Table 3). The other eight sampling sites were below the threshold. Levels at site UNB002 exceeded the threshold during all six of the sampling events (minimum = 0.13mg/l).

Table 3: The maximum, average, and minimum values of total phosphorus recorded during 2020 at the 10 sampling sites in Milton. Bolded rows have a seasonal average that exceed the EPA gold book standard for total Phosphorus. N=6 for each site except N=5 for UNB002.

Site	Maximum (mg/l)	Average (mg/l)	Minimum (mg/l)
NER150	0.12	0.07	0.05
NER179	0.11	0.07	0.04
NER185	0.12	0.06	0.04
NER200	0.12	0.06	0.04
PTB028	0.14	0.08	0.04
PTB035	**0.43**	**0.17**	**0.04**
PTB047	0.13	0.08	0.06
UNB002	**0.34**	**0.25**	**0.13**
UNB014	0.08	0.07	0.05
UNB016	0.11	0.09	0.06

The levels of total Phosphorus in 2020 appear similar to past years in the Neponset River sites (Figure 5). Overall, phosphorus levels in the Neponset River do not appear to be a concern. The high levels at site NER150 in 2016 did not occur in any years since. On Pine Tree Brook, levels appear to be increasing annually at all three sites since 2015 based on visual observation of the data (Figure 6). Levels have generally remained below the 0.1mg/l threshold in past years (except PTB035 in 2016), but in year 2020, site PTB035 values exceeded the threshold four times, site PTB047 values exceeded the threshold two times, and site PTB028 values exceeded the threshold once time. Similarly, total phosphorus levels on Unquity appear to be increasing annually at all three sites since 2015 (Figure 7). Total phosphorus values continue to be generally below the 0.1mg/l threshold at UNB014 and UNB016. However, at site UNB002 the levels increased substantially in 2020 and exceeded the EPA total phosphorus threshold at all six sampling events.

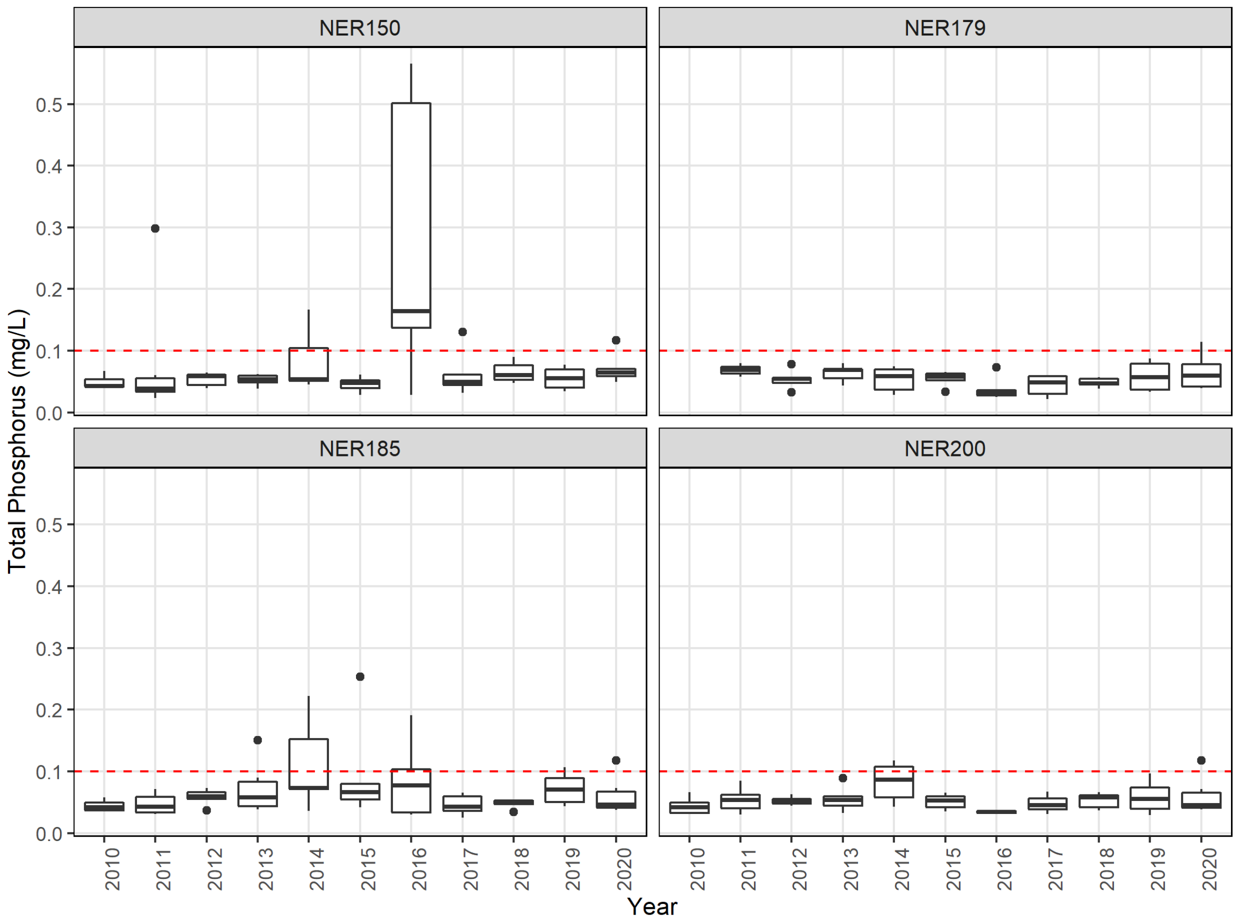

Figure 5: Total phosphorus levels at the four sites in the Neponset River from year 2010 to 2020. N=6 each year. The red dashed line is at 0.1mg/l. Boxplot statistics are the same as Figure 2.

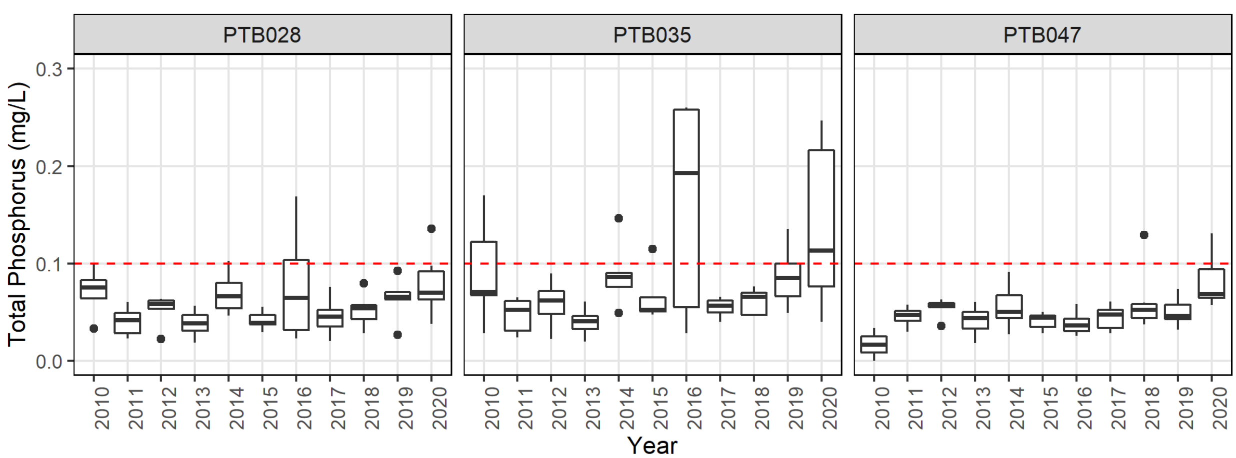

Figure 6: Total phosphorus levels at the three sites on Pine Tree Brook from year 2010 to 2020. N=6 each year. The red dashed line is at 0.1mg/l. Note that the y-axis range is different than Figure 5 and Figure 7. **Note that two extreme outliers were excluded on PTB035 in 2016, TP = 0.79 and in 2020 TP = 0.43mg/l.**

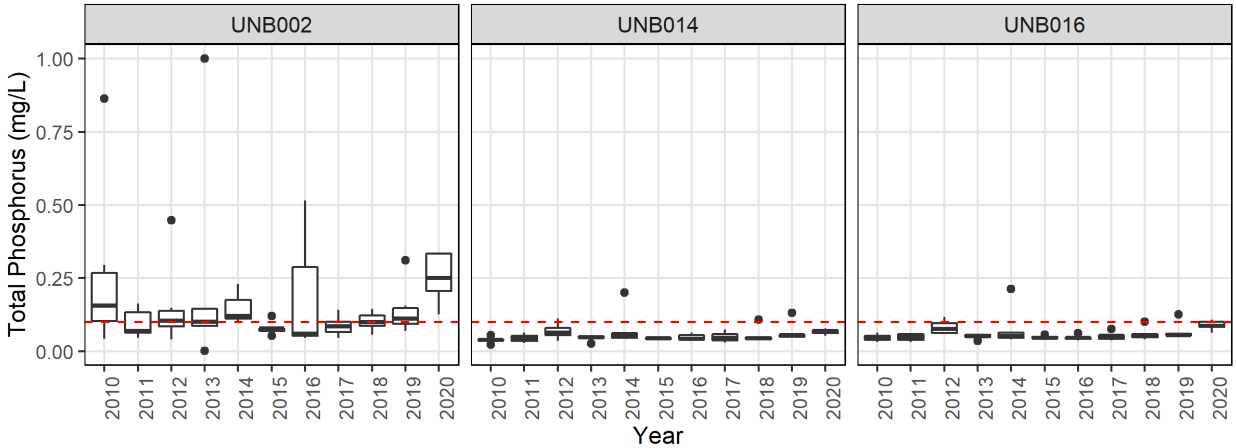

Figure 7: Total phosphorus levels at the three sites on Uniquity Brook from year 2010 to 2020. N=6 each year except UNB002 in 2020 when N = 5. The red dashed line is at 0.1mg/l.

pH

The state of Massachusetts considers a pH range of 6.5 to 8.3 a healthy range for waterbodies in the state. All sampling events in Milton met the pH standard in year 2020 except site PTB047 (pH = 6.45), NER179 (pH = 6.45), NER200 (pH = 6.44), NER150 (pH = 6.33), and UNB016 (pH = 8.63).

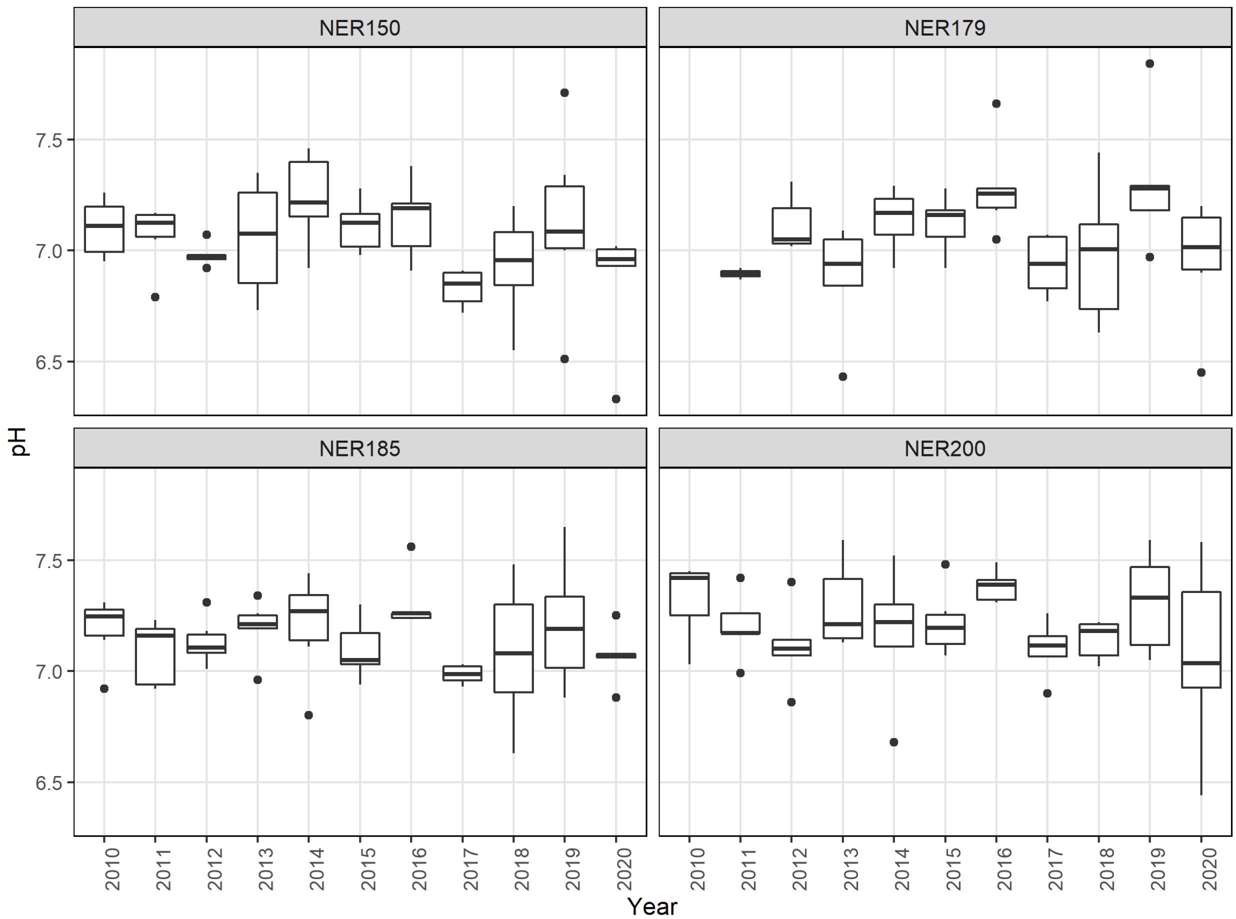

Figure 8: The pH levels at the four sites on the Neponset River. Boxplots statistics are the same as Figure 2.

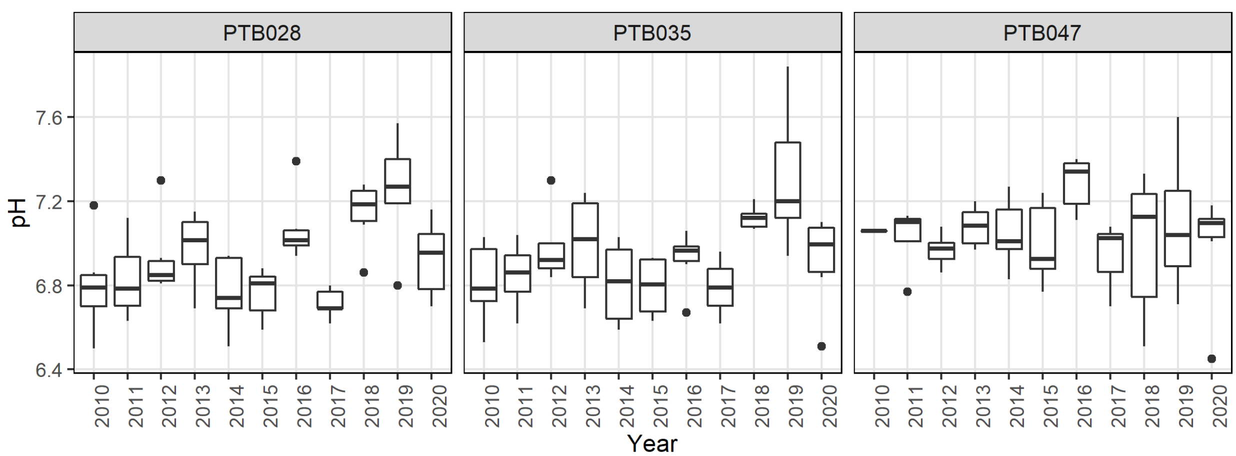

Figure 9: The pH levels at the three sites on Pine Tree Brook. Boxplots statistics are the same as Figure 2.

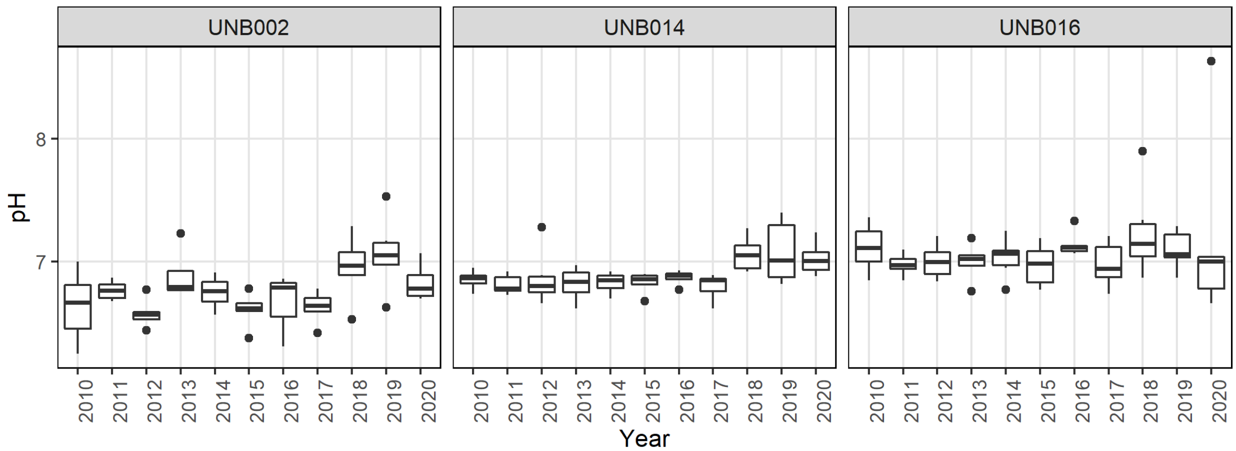

Figure 10: The pH levels at the three sites on Unquity Brook. Boxplots statistics are the same as Figure 2.

Dissolved Oxygen:

The state of Massachusetts considers DO levels below 5 mg/L to be stressful to all aquatic organisms and 6mg/L to be stressful to certain species of fishes that require cold water.

In 2020, monthly DO levels were similar to the average monthly levels (Figure 11). The sites on the Neponset River generally remain above the 5mg/l threshold. In August 2020 values dipped below this threshold at NER150 (DO = 4.14mg/l) and NER200 (DO = 4.63mg/l). Site NER150 experienced DO levels that were well below the ten-year mean in August, September, and October. The upper two sites on Pine Tree Brook (PTB028 and PTB035) experience low DO levels in the summer months whereas the lower site, PTB047, has adequate DO levels throughout the year. In August of 2020 site PTB028 experienced the lowest DO levels of any site in 2020 (DO = 2.95mg/l), which is also lower than the ten-year mean. The low dissolved oxygen concentrations on Pine Tree Brook are particularly worrisome because it is a cold-water resource stream according to the Massachusetts Division of Fisheries and Wildlife and it supports a population of Brook trout. Site UNB002, had low DO levels in 2020 (a low of 4.01mg/l in June, but note that DO data was not collected in July and August when levels reach the lowest values) and previous years. The two lower sites on Unquity Brook (UNB014 and UNB016) experience high DO levels and interestingly they do not display the typical ‘U-shaped’ pattern of values decreasing through the summer and then increasing in the Fall.

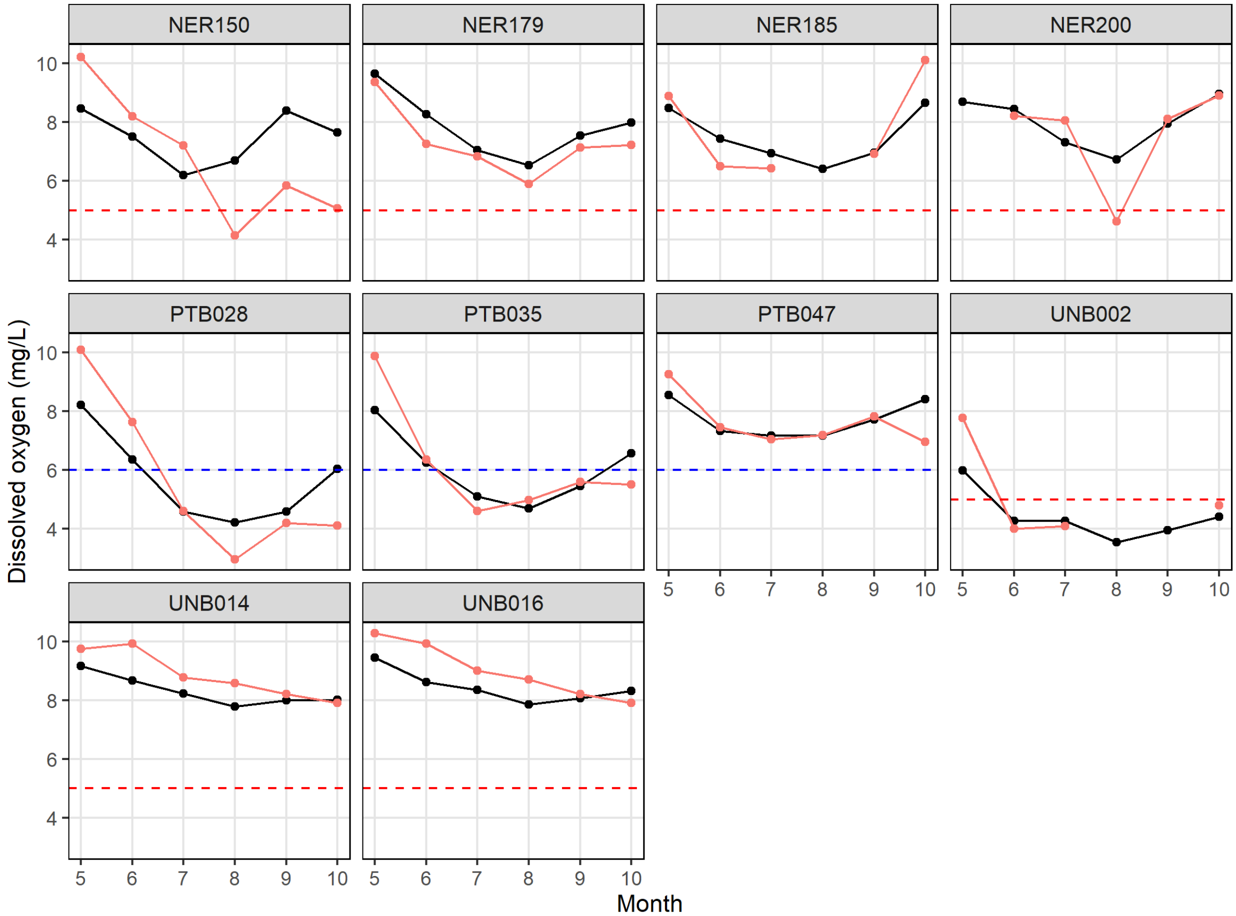

Figure 11: Monthly dissolved oxygen levels at the ten sites in Milton. The black line shows the mean monthly value from 2010 to 2020 and the red line shows the 2020 values. The red dashed line is at dissolved oxygen = 5mg/l and the blue dashed line is at dissolved oxygen = 6mg/l because Pine Tree Brook is listed as a cold water stream by Massachusetts Division of Fisheries and Wildlife (but note that Pine Tree Brook is not listed as a cold water fishery stream by the MassDEP and as such is it not regulated as a cold water stream by the MA surface water quality standards).

Conclusion

All sites in Milton experience high *E. coli* levels. Identification of the source of high levels will help with implementing management interventions. Very high levels during a single sampling event could be caused by a one-time sewage leaks or contamination whereas consistent high levels suggest a systemic problem that needs to be identified. Similarly, high levels during the wet weather could suggest a problem with runoff whereas high levels during dry weather could suggest an issue with urban discharge. The Neponset Mainstem sites are impacted by illicit discharges coming from Boston, which could direct additional hotspot sampling after review Boston Water and Sewer IDDE results. While just a few sites in Milton suffer from high total Phosphorus levels, primary producer data is needed to identify impacts to the ecology. Additionally, total Phosphorus levels are increasing annually in Pine Tree Brook and Unquity Brook, which we recommend investigating to identify the source that is contributing to this trend. Dissolved oxygen is generally at acceptable levels throughout the sampling sites in Milton except UNB002 and PTB028. Two additional sites on the Neponset River also appear to have DO problems during the hottest time of year, NER150 and NER200. Finally, pH does not appear to be a problem at any sites in Milton. Table 4 outlines the top parameters of concern by site and recommendations of next steps.

Table 4: Major parameters of concern by site with recommendations on first steps to address the problem. DO = dissolved oxygen.

Site	Major parameters of concern	Recommendation
UNB002	*E. coli*	• Follow up on results of past *E. coli* investigations and infrastructure repairs. • Review town MS4 IDDE results and follow up as needed. • Identify the source of the *E. coli* (for example, bird, dog, human)
	Phosphorus	• Identify sources of Phosphorus and assess why it's increasing. • Survey for primary producers and determine if high levels are impacting the ecology.
	DO	• Identify cause of repeated low levels. • Assess primary producer growth in the summer and/or dead organic matter loads.
UNB014	Phosphorus	• Identify sources of Phosphorus and assess why it is increasing

UNB016	Phosphorus	• identify sources of Phosphorus and assess why it is increasing
PTB047	*E. coli*	• Follow up on results of past *E. coli* investigations. • Review town MS4 IDDE results and follow up as needed.
	Phosphorus	• identify sources of Phosphorus and assess why it is increasing
PTB035	Phosphorus	• Identify sources of Phosphorus and assess why it is increasing. • Assess primary producer and determine if high levels are impacting the ecology.
PTB028	Phosphorus	• identify sources of Phosphorus and assess why it is increasing
	summer/fall DO	• Assess summertime flow and shading • Assess primary producer growth in the summer and/or dead organic matter loads
NER150	August DO	• Assess flow in August and shading
NER200	August DO	• Assess flow in August and shading