2021 Water Quality Report, Milton, Massachusetts

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Background

The Neponset River Watershed Association (NepRWA) has been collecting water quality data both in Milton and throughout the Neponset River watershed since 1996. As part of the Community Water Monitoring Network (CWMN), volunteers collect monthly water samples annually from May to October. Data gathered by the CWMN volunteers are used to track the health of the Neponset River and its tributaries, inform the public about threats to human health and wildlife, 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). Waterbodies in Milton are tested for *Escherichia coli* (*E.coli*), total phosphorus, pH, dissolved oxygen, and temperature. 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.

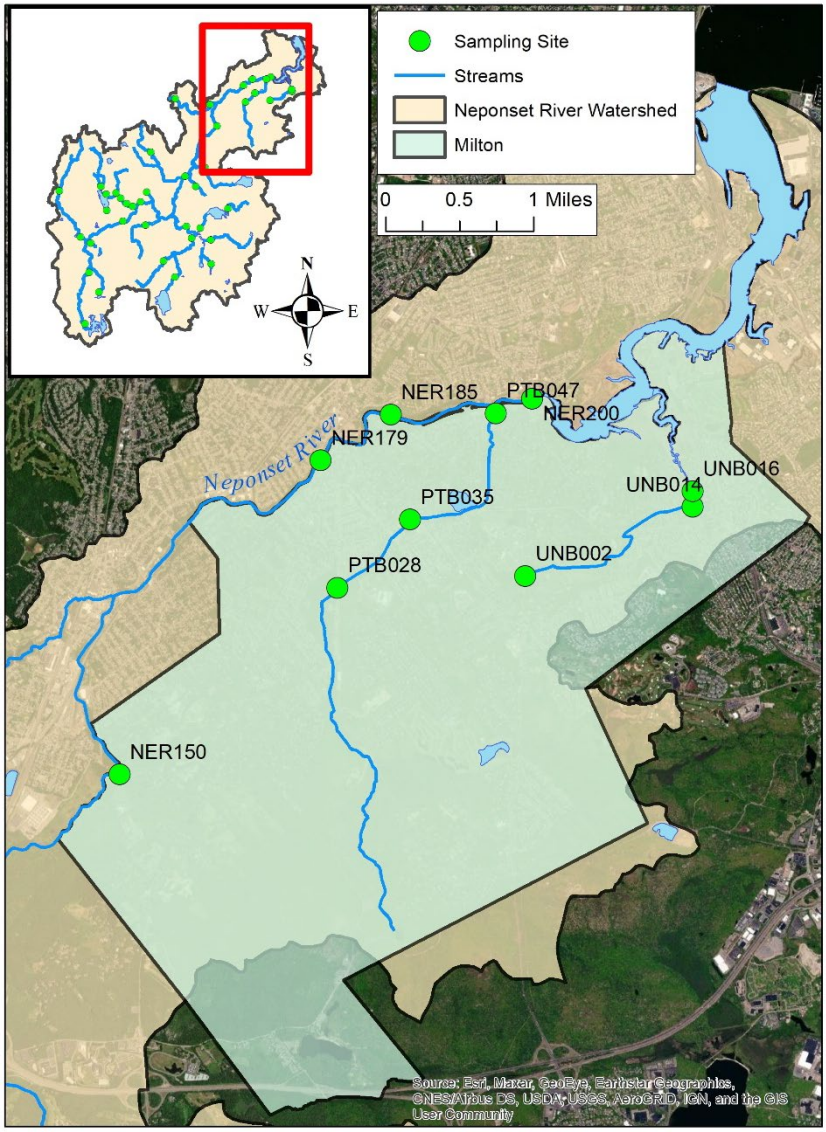

Figure 1: Map of the CWMN sites in Milton, Massachusetts.

E. coli bacteria concentration is used by NepRWA and the Commonwealth to assess a waterbody's safety for "contact recreation" through activities such as swimming (primary contact) and boating (secondary contact). The presence of *E. coli* is not necessarily hazardous itself, but it provides evidence of fecal contamination and is an indicator that other, more dangerous, pathogens associated with human and animal waste might be present. The most common source of excess *E. coli* in our watershed is the 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,* so some amount of *E. coli* in waterbodies is normal. However, elevated concentrations from wildlife are typically due to human activities, such as feeding ducks or large populations of geese. 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. This means that plants and algae will grow until the lack of phosphorus limits them. 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, leading to a process called eutrophication. When these excess plants and algae die, the process of decomposition by bacteria and other decomposers consumes dissolved oxygen from the water. 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 loss of underwater plant communities due to reduced light penetration in turbid and algae-rich waters. Elevated phosphorus concentrations can also cause *harmful* algal blooms (HABs), where toxins are produced by the algae. A notable culprit is cyanobacteria, which produce toxins harmful to people and pets as well as wildlife.

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, from fine dust particles and aerosols. 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 acidic the water is, with low pH meaning the water is more acidic than neutral, and high pH meaning it is more basic or alkaline. Water that is too acidic or too basic can be toxic to aquatic life. The pH is influenced by soil and bedrock characteristics, groundwater seepage, acid rain, carbon dioxide in the atmosphere, 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 can sustain higher concentrations 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 increase levels of DO due to atmospheric mixing. Aquatic plants also generate oxygen via photosynthesis during daytime hours. 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 rain or shine on the second Thursday of the month during the sampling season. This means that weather is not a criterion in determining when to collect water quality data. This allows our sampling program to address the different conditions that occur in our waterbodies in wet vs. dry weather. Rain events result in significant increases in street runoff via stormwater and overland flow into our rivers, which can significantly alter the concentrations of bacteria, nutrients, and other chemicals. In 2021, 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, both 2021 and 2020 had more sampling events occur during dry weather than any year since 2016, when all six sampling events occurred during dry weather. This lack of additional data during wet weather suggests we should be cautious in any improvements in parameters, especially for *E. coli*, as the relative improvement may reflect wet vs. dry dynamics rather than real improvements to water quality or 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 2011.

Year	Dry (days)	Wet (days)
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
2021	5	1

Escherichia coli (E. coli)

In Massachusetts, the criteria that defines acceptable levels of *E.coli* in Class B waterbodies (waterbodies that support wildlife, swimming, and boating, but not drinking) is set by both single sample maximum and a geometric mean. For sites in Milton, no single sample should

exceed 235 Colony Forming Units (CFU) per 100 mL (the single sample standard), nor should the geometric mean of at least 5 samples taken within the same season exceed 126 CFU/100mL (the seasonal standard). For ease of interpretation, NepRWA calculates the geometric mean on the whole sampling season (6 sampling events).

In 2021 maximum *E. coli* levels at all ten of the sampling sites exceeded the 235 CFU/100mL single sample limit and the 126 CFU/100mL seasonal geometric average (Table 2). The highest levels were observed in Unquity Brook (UNB014 & UNB016). Remarkably, the minimum *E. coli* level at PTB047 was also above the single sample limit, meaning that every sample for the season failed to meet swimming standards. Broadly speaking, the mainstem of the Neponset sites faired better than either tributary

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	**3870**	781	52	**207**
NER179	**1050**	353	86	**222**
NER185	**1140**	388	20	**219**
NER200	**1260**	380	52	**213**
PTB028	**8160**	1709	30	**217**
PTB035	**3260**	873	156	**486**
PTB047	**4880**	1624	243	**840**
UNB002	**3870**	1648	63	**907**
UNB014	**17300**	5054	457	**1903**
UNB016	**24200**	8289	85	**1085**

In 2021 there was only wet weather event that was sampled. All 3 Uniquity Brook sites had their maximum (or tied for maximum) *E. coli* levels during September's dry weather sampling, suggesting a persistent issue related to sewage leakage rather than inflows from stormwater and runoff. However, the September event also had elevated bacteria levels at every site, as well as elevated total phosphorus (Figures 2-4).

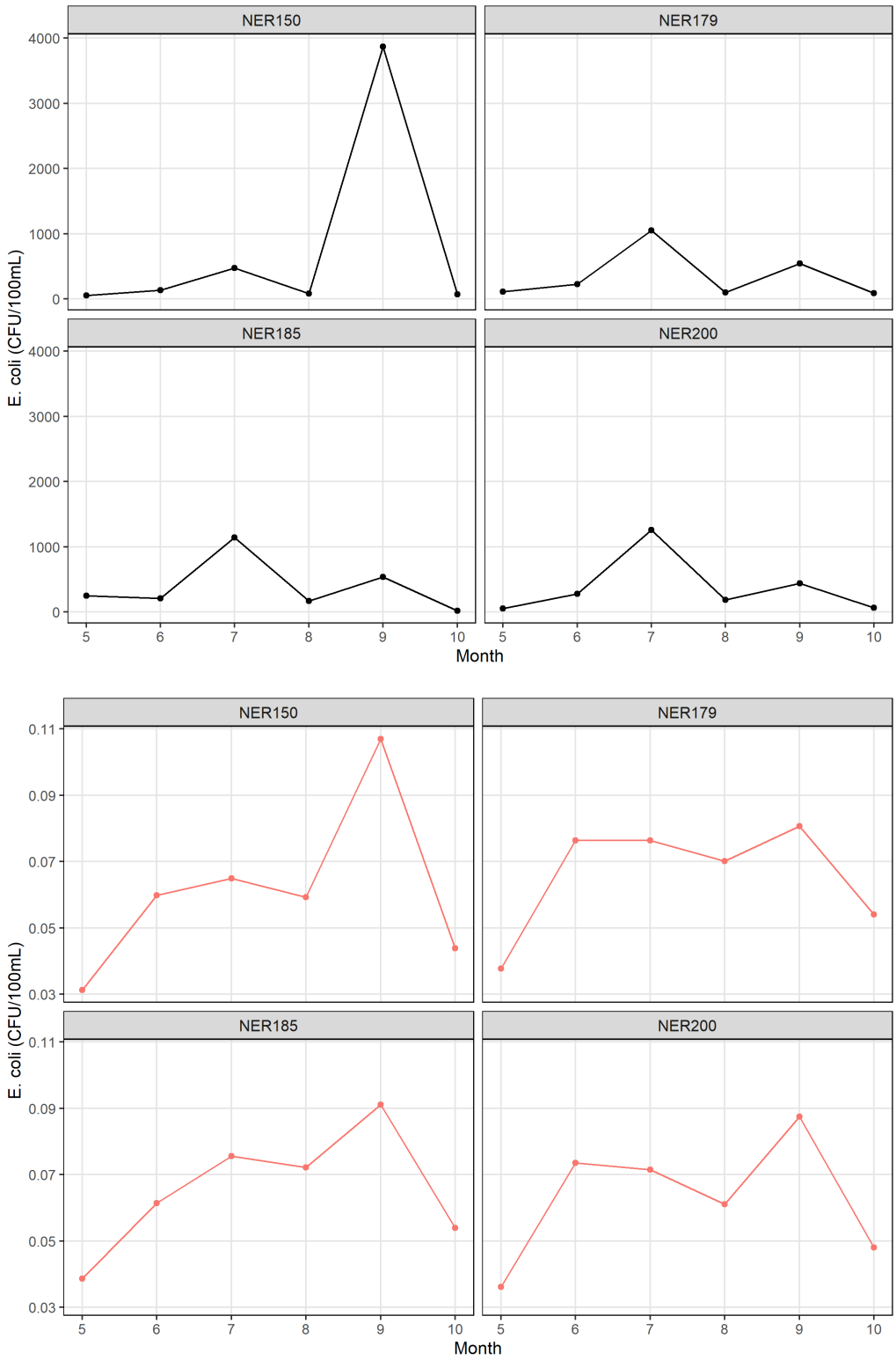

Figure 2: *E.coli* and total phosphorus values at the Milton Neponset sampling sites for the 2021 year by sampling month. Black lines represent *E. coli* and red lines represent total phosphorus concentrations.

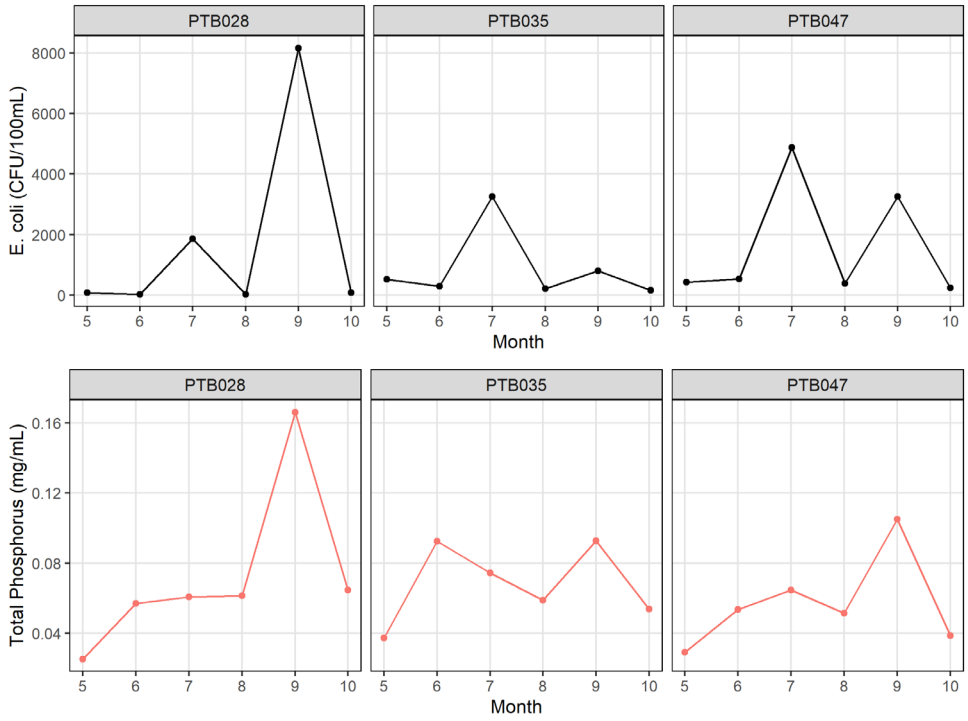

Figure 3: *E.coli* and total phosphorus values at the Milton Pine Tree Brook sampling sites for the 2021 year by sampling month. Black lines represent *E. coli* and red lines represent total phosphorus concentrations.

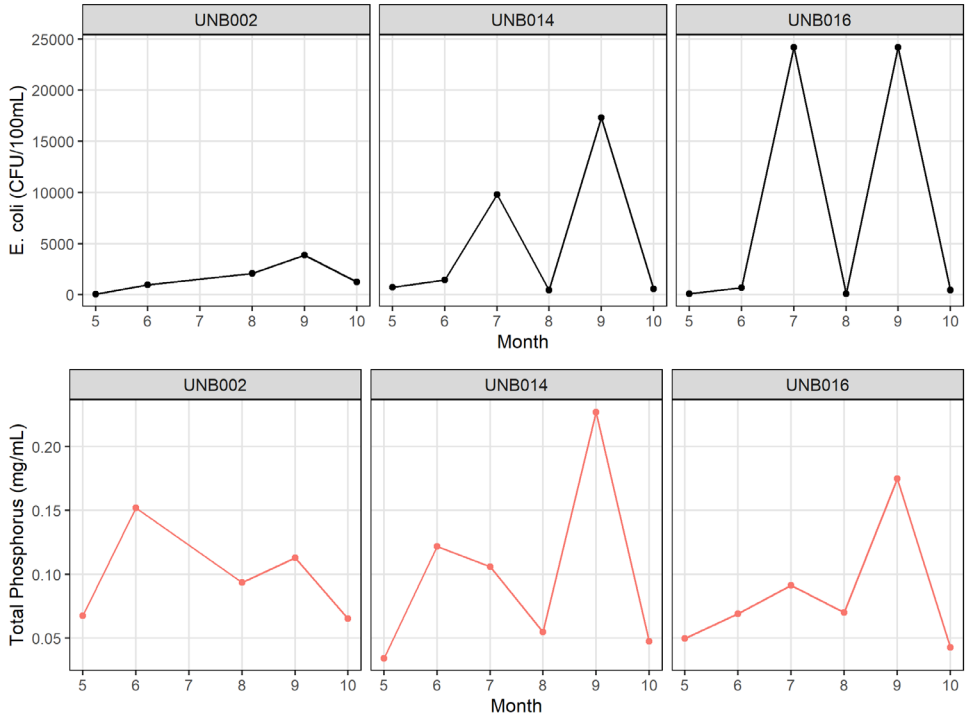

Figure 4: *E.coli* and total phosphorus values at the Milton Pine Tree Brook sampling sites for the 2021 year by sampling month. Black lines represent *E. coli* and red lines represent total phosphorus concentrations.

Using data from 2011 onward, wet weather events generally lead to higher *E. coli* levels in the Neponset River (Figure 5), Pine Tree Brook (Figure 6), and Unquity brook (Figure 7). 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, with levels above the criteria consistently even in dry weather. Both the wet weather and September event resulted in the highest *E. coli* values in the last 10 years at UNB016. The 2021 wet weather event was missed at UNB002, but past evidence suggests the values would have been equally high. Site PTB047 had a high *E. coli* level recorded during the single wet weather events in 2020 and 2021. While this is only 1 sample a year, the repeat pattern across years suggests a systemic problem during rain events.

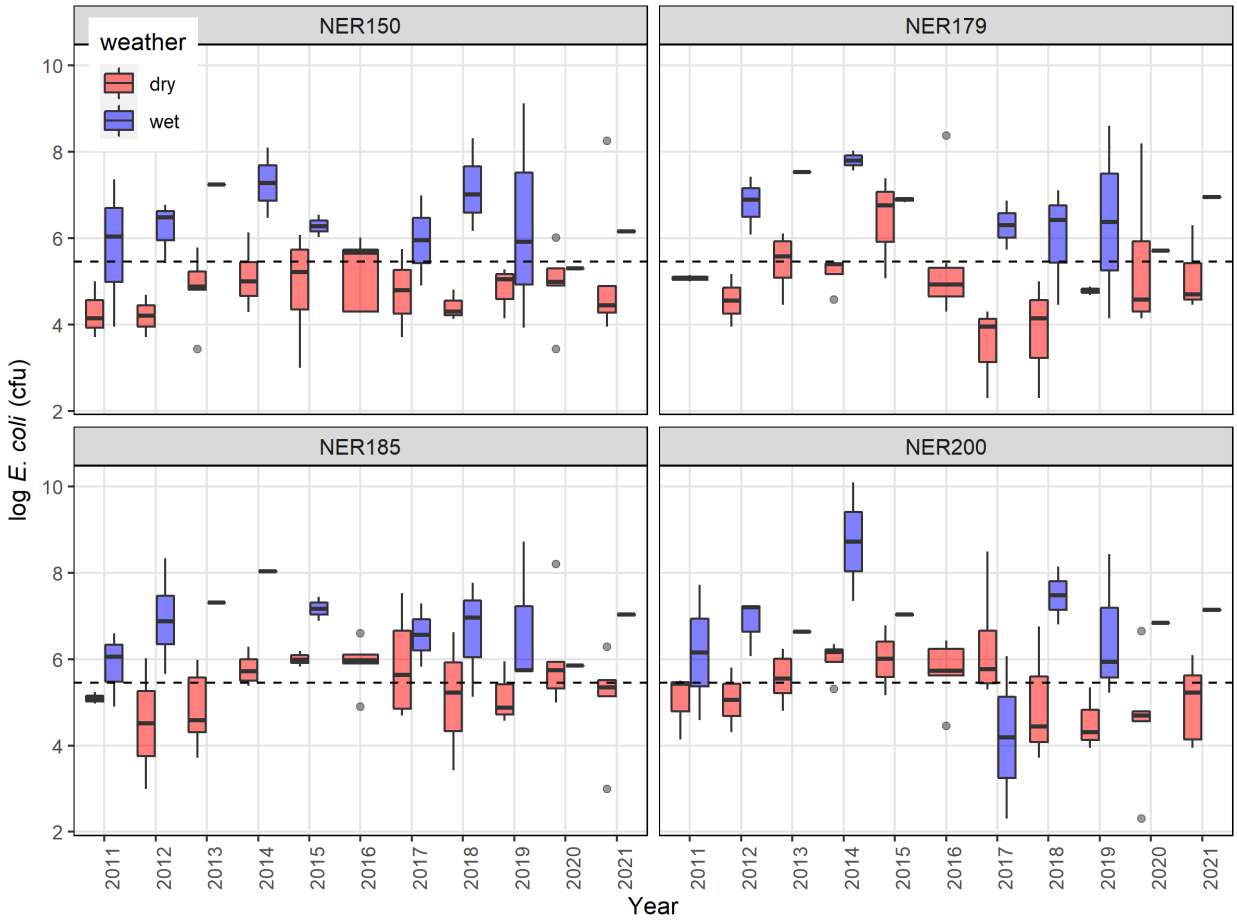

Figure 5: *E. coli* levels at the four sampling sites on the Neponset River from years 2011 to 2021. Levels are grouped by weather (blue = wet, red = dry). The black dashed line shows the single sample maximum acceptable threshold (235 CFU/100mL). The lower and upper bounds of each box correspond to the first and third quartiles (the 25th and 75th percentiles). The upper whisker extends to the largest value or no further than 1.5 * the range between these two quartiles. Similarly, the lower whisker extends from the hinge to the smallest value or 1.5 * this interquartile range. Data beyond the end of the whiskers are “outlying" points and are plotted individually.

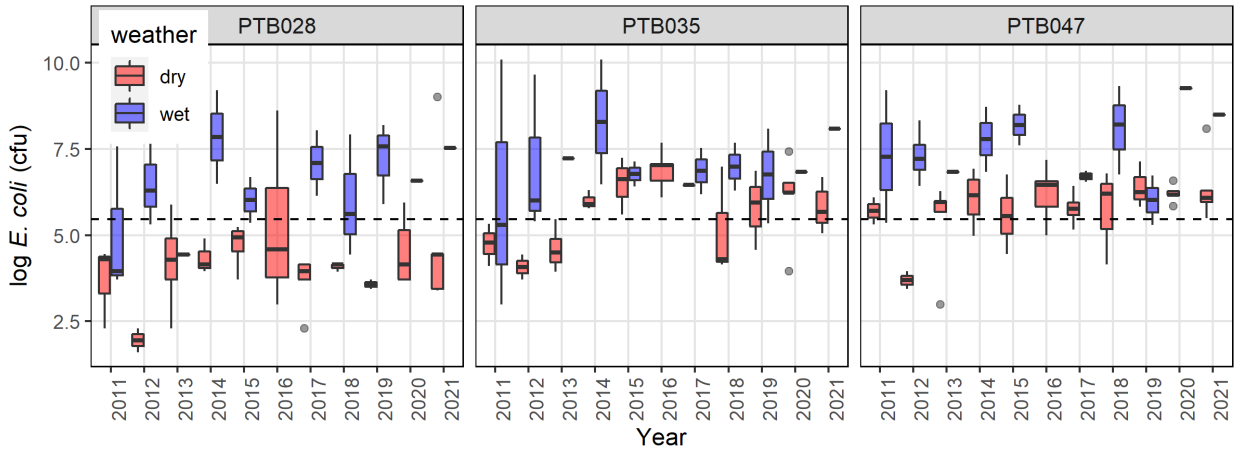

Figure 6: *E. coli* levels at the three sampling sites on Pine Tree Brook from years 2011 to 2021. Details are the same as in Figure 5.

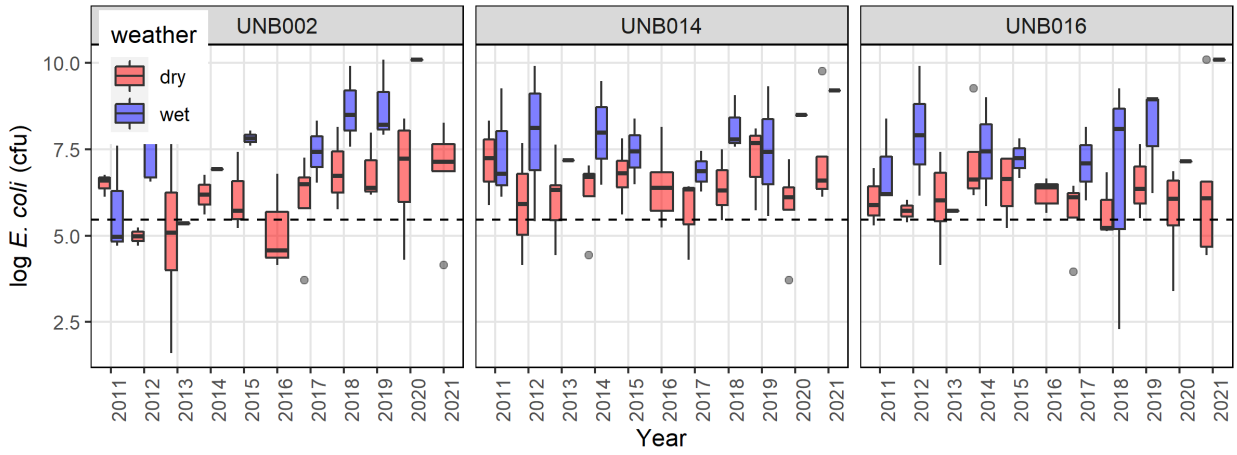

Figure 7: *E. coli* levels at the three sampling sites on Unquity Brook from years 2011 to 2021. Details are the same as in Figure 5.

Phosphorus

The Commonwealth of Massachusetts does not currently provide numerical standards for classification of water quality impairments by phosphorus alone. Instead, the Massachusetts Department of Environmental Protection (MassDEP) uses a narrative standard that considers the EPA gold book standard for phosphorus alongside 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 and 0.05mg/L for streams entering a lake/reservoir. We consider all sites in Milton to be subject to the flowing

waters guidance. 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 2021, two sites in Milton had a season average that met the 0.1mg/L Phosphorus: UNB002 (mean = 0.1 mg/L) and PTB035 (mean = 0.1 mg/L) (Table 3). The other eight sampling sites were below the threshold. However, levels at the following sites all had a single sampling event above/at the EPA guidance for flowing waters: NER150 , PTB028, PTB047, and UNB016.

Table 3: The maximum, average, and minimum values of total phosphorus recorded during 2021 at the 10 sampling sites in Milton. Bolded values represent exceedance of EPA recommended levels. Bolded site IDs have a seasonal average that exceed the EPA gold book standard for total Phosphorus. N=6 for each site except for UNB002 (N=5).

Site	Maximum (mg/l)	Average (mg/l)	Minimum (mg/l)
NER150	**0.11**	0.06	0.03
NER179	0.08	0.07	0.04
NER185	0.09	0.07	0.04
NER200	0.09	0.06	0.04
PTB028	**0.17**	0.07	0.03
PTB035	0.09	0.07	0.04
PTB047	**0.1**	0.06	0.03
UNB002	**0.15**	**0.1**	0.07
UNB014	**0.23**	**0.1**	0.03
UNB016	**0.17**	0.08	0.04

The levels of total Phosphorus in 2021 appear similar to past years in the Neponset River sites (Figure 8). Overall, phosphorus levels in the Neponset River do not appear to be a concern. The high levels at site NER150 in 2016 have not occurred in any years since. On Pine Tree Brook, levels appeared to be increasing annually at all three sites between 2015-2020, however in 2021 these values dropped to previous averages (Figure 9). We would hope to see this low baseline remain in subsequent years. Levels have generally remained below the 0.1mg/l threshold in past years (except PTB035 in 2016), but in year 2021, sites PTB028 and PTB047 exceeded the threshold one time each. Similarly, total phosphorus levels on Unquity appear to have dropped following 2020's high values, especially at UNB002. Total phosphorus values continue to be generally below the 0.1mg/l threshold at UNB014 and UNB016, while UNB002 has higher values.

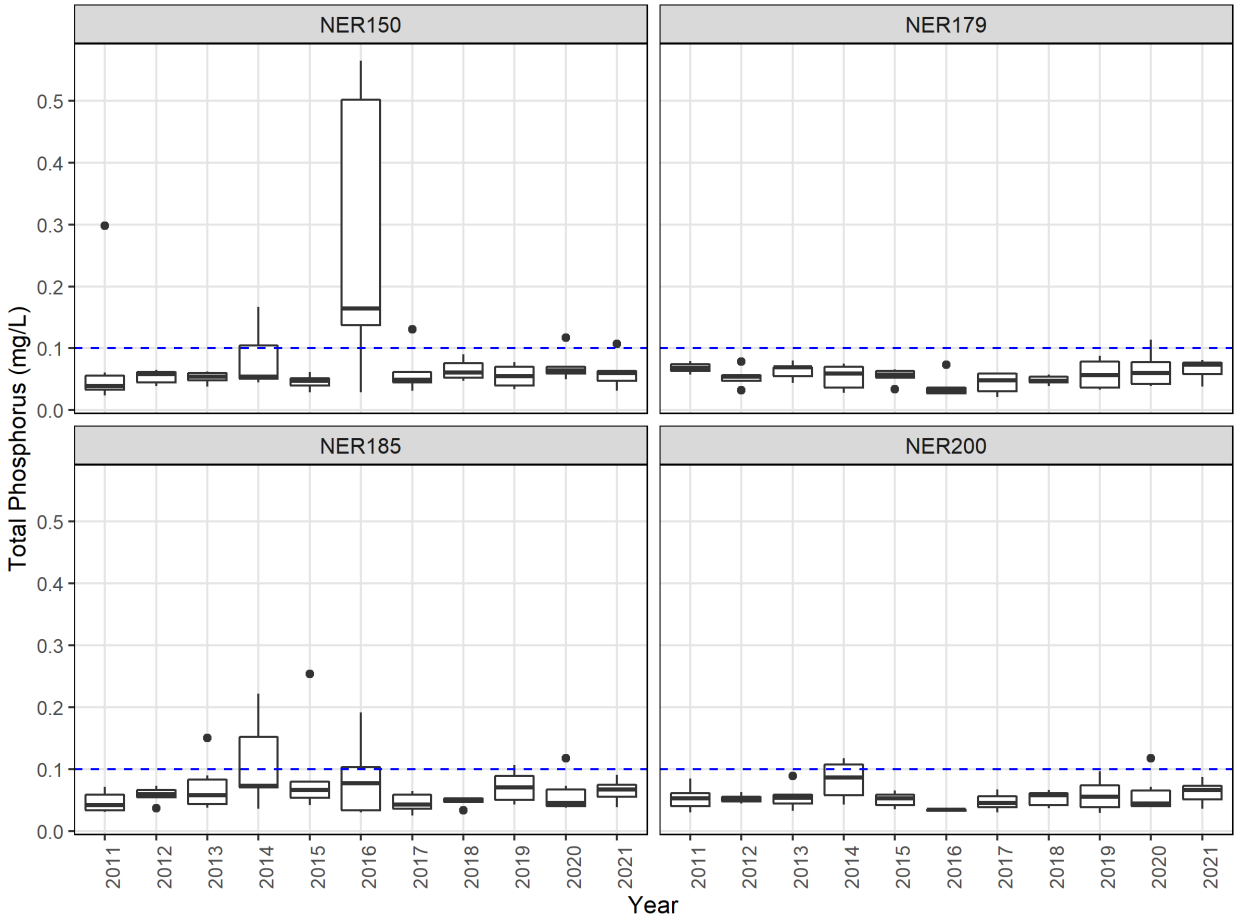

Figure 8: Total phosphorus levels at the four sites in the Neponset River from year 2011 to 2021. N > 4 each year except NER200 in 2016 (N=4) and NER179 in 2019 (N=4). The blue dashed line is at 0.1mg/l. Boxplot statistics are the same as Figure 5.

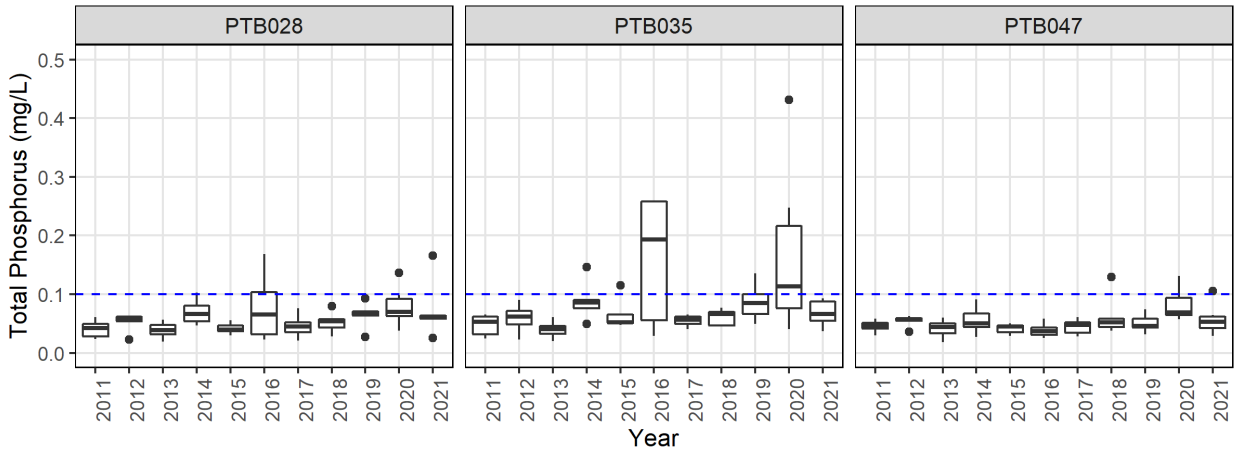

Figure 9: Total phosphorus levels at the three sites on Pine Tree Brook from year 2010 to 2020. N=6 each year. The red dashed line is at 0.1mg/l. Note that the y-axis range is different than Figure 5 and Figure 7. **Note that one extreme outlier was excluded on PTB035 in 2016, TP = 0.79.**

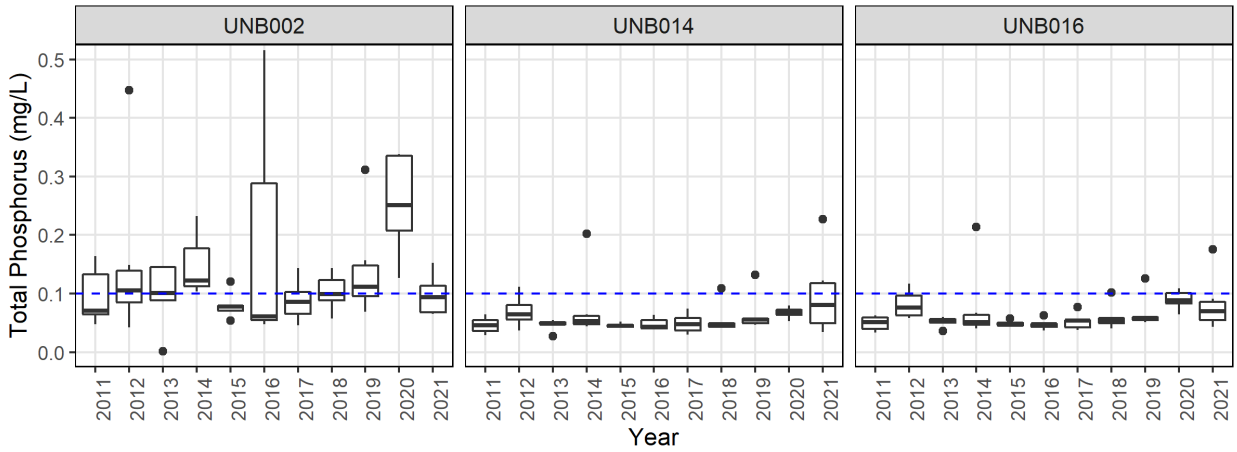

Figure 10: Total phosphorus levels at the three sites on Uniquity Brook from year 2011 to 2021. N > 4 each year except UNB002 in 2014 and 2016, when N = 3. The blue dashed line is at 0.1mg/l. **Note that one extreme outlier was excluded on UNB002 in 2013, TP = 1.00.**

pH

The Commonwealth of Massachusetts considers a pH range between 6.5 and 8.3 to be healthy for waterbodies in the state. Almost all sampling events in Milton met the pH standard in year 2021, with a notable exception for October sampling, when many sites gave slightly acidic results. We will monitor this in 2022 to determine if these changes are meaningful, as it coincides with changes to NepRWA's equipment.

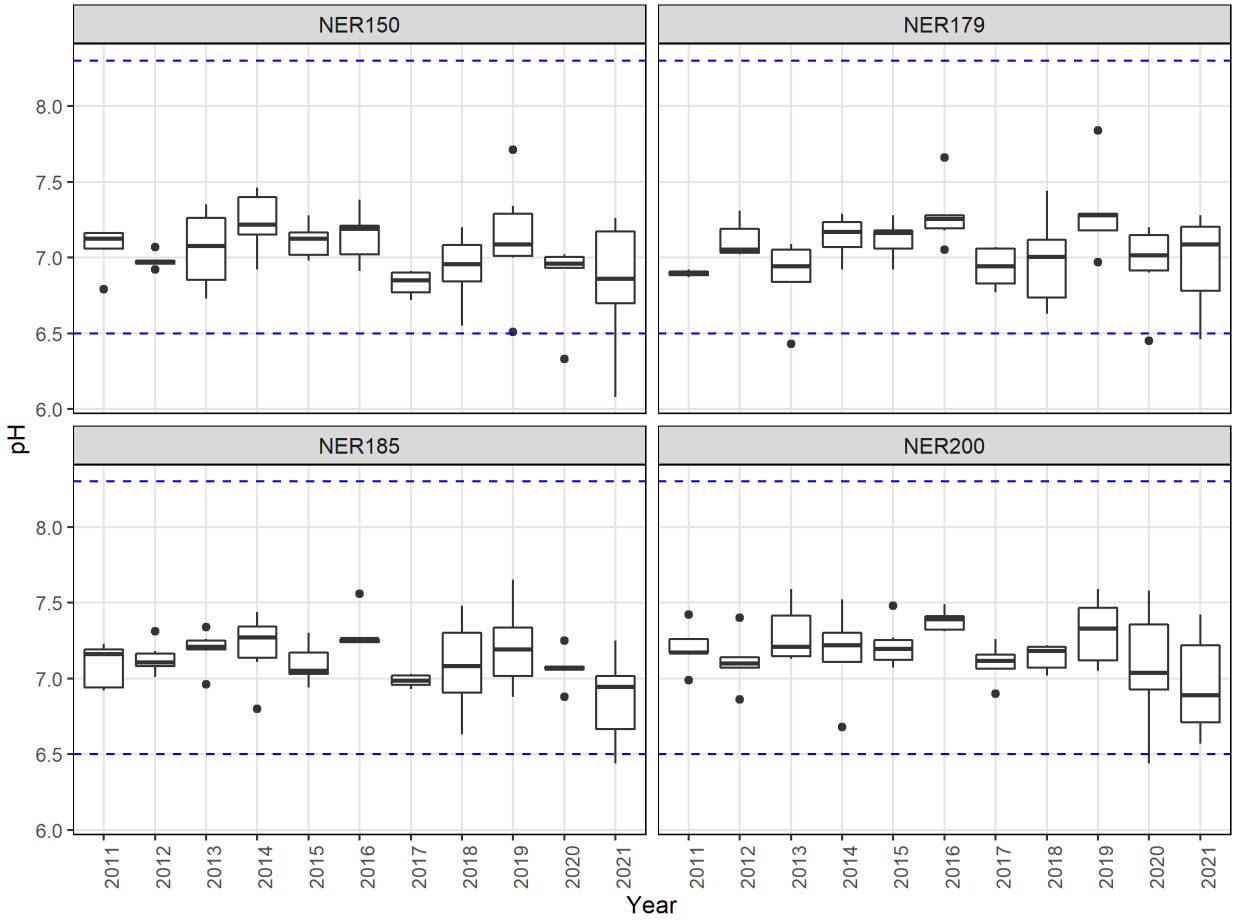

Figure 11: The pH levels at the four sites on the Neponset River. Boxplots statistics are the same as Figure 5.

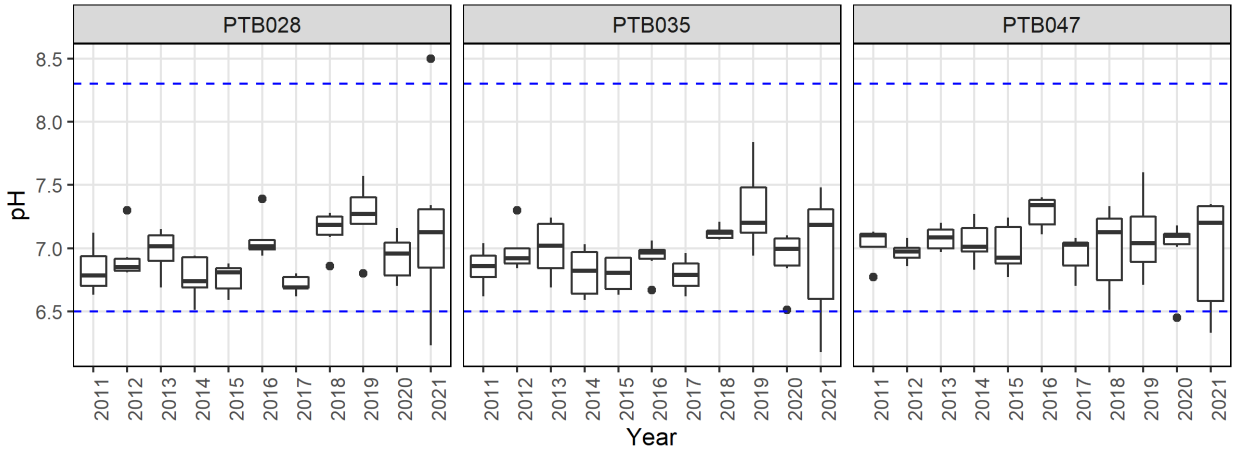

Figure 12: The pH levels at the three sites on Pine Tree Brook. Boxplots statistics are the same as Figure 5.

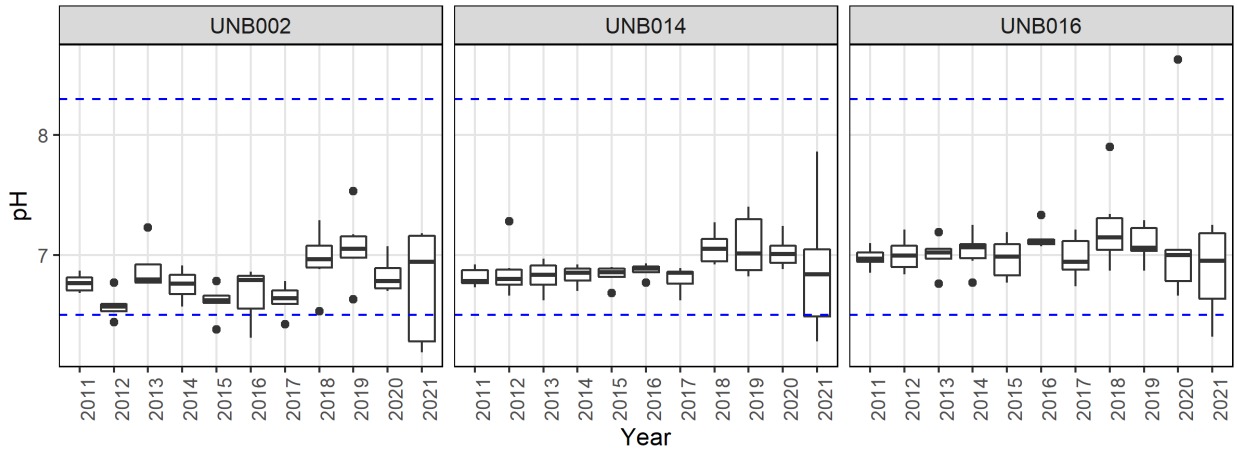

Figure 13: The pH levels at the three sites on Unquity Brook. Boxplots statistics are the same as Figure 5.

Dissolved Oxygen:

The Commonwealth of Massachusetts considers DO levels below 5 mg/L to be stressful to all aquatic organisms and 6 mg/L to be stressful to certain species of fishes that require colder water. Pine Tree Brook is listed as a Coldwater Fish Resource by the Massachusetts Division of Fisheries and Wildlife so we apply the 6 mg/l threshold for those three sites and the 5mg/l threshold for the sites on Unquity Brook and the Neponset River. However, it is important to note that the Massachusetts DEP does not recognize Pine Tree Brook as a cold-water fishery stream and they are therefore not regulated as such under the Surface Water Quality Standards.

In 2021, monthly DO levels were similar to the average monthly levels for most sites (Figure 14), however NER150 and UNB002 both showed lower than average DO values. With the exception of NER150, the sites on the Neponset River remained above the 5mg/l threshold. NER150 dipped below the threshold from June-September. The upper two sites on Pine Tree Brook (PTB028 and PTB035) typically experience low DO levels in the summer months whereas the lower site, PTB047, has adequate DO levels throughout the year. Notably in 2021, DO values were higher than the average in both upstream sites. 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 known population of Brook Trout. Site UNB002, typically has DO levels, however in 2021 these values were improved and above the DEP criteria. The two lower sites on

Unquity Brook (UNB014 and UNB016) have high DO levels both on average and in 2021, and it is fairly consistent across the sampling season, instead of dipping in the summer as is typical at other sites.

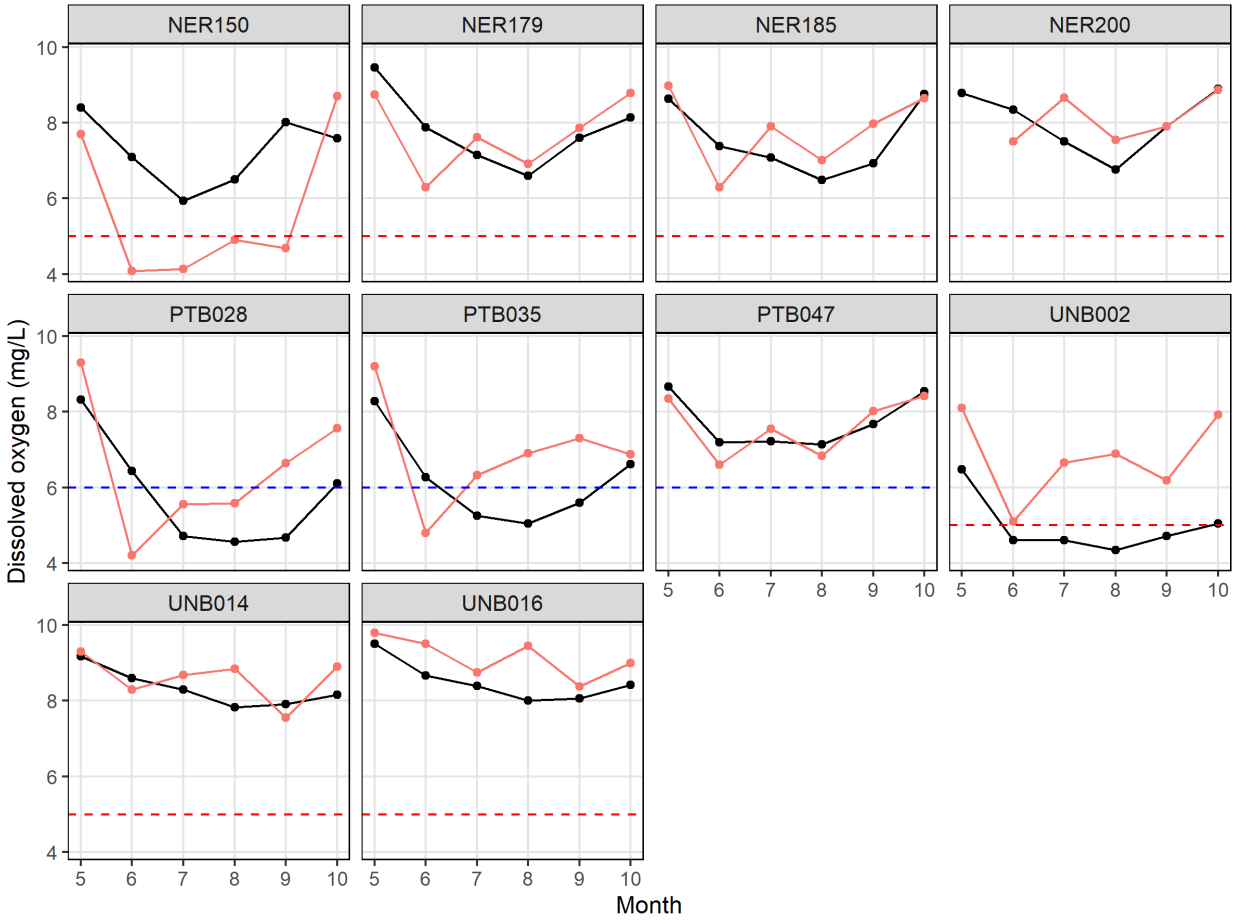

Figure 14: Monthly dissolved oxygen levels at the ten sites in Milton. The black line shows the mean monthly value from 2011 to 2021 and the red line shows the 2021 values. The red dashed line is at dissolved oxygen = 5mg/l and the blue dashed line is at dissolved oxygen = 6mg/l because Pine Tree Brook is listed as a coldwater fishery resource stream by Massachusetts Division of Fisheries and Wildlife.

Conclusion

All sites in Milton experience high *E. coli* levels. These values are high in wet weather, however other sites also experience problematic values in dry sampling weather as well. Identification of the source of high levels will help with implementing management interventions. This can be addressed through investigation of potential sewer leaks or DNA source tracking (human vs pets vs wildlife). 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 reviewing 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 increased through 2020 at Pine Tree Brook and Unquity Brook. While this dropped in 2021, we recommend investigating to identify the source that contributed to this trend in the event that the issue is not fully resolved. Dissolved oxygen is generally at acceptable levels throughout the sampling sites in Milton except UNB002, PTB028, and PTB035. NER150 on the Neponset River also appear to have DO problems during the hottest time of year. Finally, pH does not appear to be a significant problem at any sites in Milton, though the increased acidity merits attention in 2022. 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) with DNA source tracking
	Phosphorus	• Identify sources of Phosphorus and assess increased through 2020 and what has changed. • Survey for primary producers (chlorophyll or macrophytes) and determine if sites with high levels are impacting the ecology.
	DO	• Identify cause of low values on average.

		• Assess primary producer growth in the summer and/or dead organic matter loads.
UNB014	Phosphorus	• Identify sources of Phosphorus and assess increased through 2020 and what has changed.
UNB016	Phosphorus	• Identify sources of Phosphorus and assess increased through 2020 and what has changed.
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 increased through 2020 and what has changed.
PTB035	Phosphorus	• Identify sources of Phosphorus and assess increased through 2020 and what has changed. • Assess primary producer and determine if high levels are impacting the ecology.
PTB028	Phosphorus	• Identify sources of Phosphorus and assess increased through 2020 and what has changed.
	summer/fall DO	• Assess early summer flow and shading issues • Assess primary producer growth in the summer and/or dead organic matter loads
NER150	August DO	• Assess flow in June-September, potential eutrophication and any issues with decaying material