**2021 Water Quality Monitoring Results for Lake Weyauwega Sub-watershed of the Waupaca River Watershed**

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**Hannah Vorrie – Watershed Restoration Coordinator**

**Methods**

During the growing season of 2021, Total Phosphorus (TP) and Total Nitrogen (TN) samples were collected at 8 locations twice per month in May and June, and once per month in July through October (Figure 1, Table 1). In addition, Nitrates + Nitrites as Nitrogen (NO3 +NO2 as N) samples were collected at 4 of the sites. All samples were collected using the standard WDNR grab sampling method for a total of 156 samples. Grab samples were missed in the month of October at the Unnamed wetland outlet ditch to Lake Weyauwega US Haire Rd site and the Unnamed Trib to Lake Weyauwega US County AA site. Following the protocol of Wisconsin Consolidated Assessment and Listing Methodology (WisCALM 2016), neither baseflow nor storm or snowmelt event sampling were targeted during this project. All nutrient samples were shipped to Wisconsin State Laboratory of Hygiene (WISLOH) for analysis. The WISLOH entered all sample analysis data into the WDNR Surface Water Integrated Monitoring System (SWIMS) database. Aquatic Macroinvertebrate sampling, wadable fish surveys, temperature monitoring, and qualitative habitat surveys were not conducted in 2021.

Map

Description automatically generated

Figure : 2021 sample locations within the Lake Weyauwega-Waupaca River watershed.

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| **SWIMS Station ID** | **Site Name** | **Surface Water WBIC** |
| 10048059 | Unnamed Trib to Lake Weyauwega US County AA | 5020640 |
| 10048060 | Unnamed wetland outlet ditch to Lake Weyauwega US Haire Rd | NA |
| 10047756 | Whiskey Creek US Hwy 10 | 5021203 |
| 10047757 | Unnamed Trib to the Waupaca River US Harrington Rd East | 5020550 |
| 10047758 | Unnamed Trib to Waupaca River at Harrington Rd West | 258000 |
| 10045054 | Unnamed Trib to Waupaca River at Hwy 54 | 258100 |
| 10044777 | Unnamed Tributary to Waupaca River (WBIC 5021414) US Den Ed Rd | 5021414 |
| 10047759 | Unnamed Trib to Waupaca River at Galilee Rd | 5021414 |

Table 1: Nutrient Monitoring Sites sampled May through October 2021.

**Results**

Sample TP results ranged from as low as 0.0281 mg/L at Unnamed Trib to Lake Weyauwega US Hwy 10 in May to as high as 0.446 mg/L at Unnamed Trib to Lake Weyauwega US County AA in June (Table 2, Figure 2). Of the 62 TP samples collected, 13 met the State Water Quality Standard of 0.075 mg/L. All 8 sampling locations had an average TP concentration (mg/L) exceeding the Wisconsin Administrative Code ch. NR 102.06(3)(b) water quality criteria (WQC) for creeks at 0.075 mg/L.

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Location** | **May (1)** | **May (2)** | **June (1)** | **June (2)** | **July** | **Aug.** | **Sep.** | **Oct.** | **Average** |
| Whiskey Creek US Hwy 10 | 0.0281 | 0.0744 | 0.119 | 0.105 | 0.217 | 0.0706 | 0.0724 | 0.0737 | 0.09503 |
| Unnamed Trib to the Waupaca River US Harrington Rd East | 0.0346 | 0.0644 | 0.0845 | 0.0848 | 0.239 | 0.151 | 0.135 | 0.131 | 0.11554 |
| Unnamed Trib to Waupaca River at Harrington Rd West | 0.0393 | 0.118 | 0.107 | 0.0888 | 0.241 | 0.121 | 0.135 | 0.0512 | 0.11266 |
| Unnamed Trib to Waupaca River at Hwy 54 | 0.0412 | 0.0757 | 0.0815 | 0.0733 | 0.199 | 0.117 | 0.176 | 0.0962 | 0.10749 |
| Unnamed Trib to Waupaca River US Den Ed Rd | 0.0467 | 0.334 | 0.121 | 0.115 | 0.259 | 0.272 | 0.103 | 0.0828 | 0.16669 |
| Unnamed Trib to Waupaca River at Galilee Rd | 0.046 | 0.117 | 0.185 | 0.118 | 0.278 | 0.309 | 0.0996 | 0.0846 | 0.15465 |
| Unnamed wetland outlet ditch to Lake Weyauwega US Haire Rd | 0.0831 | 0.133 | 0.113 | 0.271 | 0.165 | 0.367 | 0.106 | NA | 0.17687 |
| Unnamed Trib to Lake Weyauwega US County AA | 0.112 | 0.133 | 0.103 | 0.446 | 0.219 | 0.245 | 0.118 | NA | 0.19657 |

Table 2: Total Phosphorus concentrations and averages of samples collected.

Figure : Total Phosphorus concentrations and averages of samples collected compared to the 0.075 mg/L WQC.

TN analysis was also conducted on samples collected at all 8 project locations during the same sampling events as TP in 2021. TN samples were collected twice per month in May and June, and once per month in July through October. TN concentrations ranged from as low as 0.556 mg/L at Unnamed Trib to Lake Weyauwega US County AA in June to as high as 9.3 mg/L at Unnamed Trib to Lake Weyauwega US Hwy 10 in August (Table 3, Figure 3).

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| **Location** | **May (1)** | **May (2)** | **June (1)** | **June (2)** | **July** | **Aug.** | **Sep.** | **Oct.** | **Average** |
| Whiskey Creek US Hwy 10 | 6.47 | 6 | 6.65 | 4.75 | 4.85 | 9.3 | 8.61 | 6.58 | 6.65125 |
| Unnamed Trib to the Waupaca RIver US Harrington Rd East | 2.01 | 2.18 | 3.06 | 2.6 | 1.6 | 2.15 | 1.67 | 1.64 | 2.11375 |
| Unnamed Trib to Waupaca River at Harrington Rd West | 1.4 | 2.01 | 1.79 | 1.76 | 1.54 | 1.55 | 1.56 | 1.62 | 1.65375 |
| Unnamed Trib to Waupaca River at Hwy 54 | 0.993 | 1.39 | 1.64 | 1.36 | 1.4 | 1.23 | 1.16 | 1.06 | 1.27913 |
| Unnamed Trib to Waupaca River US Den Ed Rd | 7.38 | 8.23 | 9.21 | 9.06 | 8.24 | 7.88 | 8.3 | 7.66 | 8.245 |
| Unnamed Trib to Waupaca River at Galilee Rd | 6.13 | 6.57 | 7.75 | 8.09 | 7.48 | 7.33 | 8.05 | 7.05 | 7.30625 |
| Unnamed wetland outlet ditch to Lake Weyauwega US Haire Rd | 1.65 | 1.38 | 1.89 | 3.05 | 2.39 | 1.35 | 1.03 | NA | 1.82 |
| Unnamed Trib to Lake Weyauwega US County AA | 0.77 | 0.673 | 0.556 | 2.08 | 1 | 0.76 | 0.756 | NA | 0.94214 |

Table 3: Total Nitrogen concentrations and averages collected.

Figure 3:Total Nitrogen concentrations and averages of samples collected.

At 4 of the locations listed in Table 1, NO3+NO2 as N analysis was also conducted on samples collected in May through October 2021. TN concentrations ranged from no detection at Unnamed Tributary to Waupaca River at Hwy 54 from July - October to as high as 8.75 mg/L at Unnamed Trib to Lake Weyauwega US Hwy 10 in August (Table 4, Figure 4).

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| **Location** | **May (1)** | **May (2)** | **June (1)** | **June (2)** | **July** | **Aug.** | **Sep.** | **Oct.** | **Average** |
| Whiskey Creek US Hwy 10 | 5.58 | 4.64 | 5.6 | 3.94 | 3.2 | 8.75 | 7.76 | 5.66 | 5.64125 |
| Unnamed Trib to the Waupaca River US Harrington Rd East | 1.49 | 1.34 | 2.48 | 1.98 | 0.284 | 1.25 | 0.851 | 0.782 | 1.30713 |
| Unnamed Trib to Waupaca River at Harrington Rd West | 0.526 | 0.501 | 0.717 | 0.779 | 0.0884 | 0.263 | 0.2 | 0.705 | 0.47243 |
| Unnamed Tributary to Waupaca River at Hwy 54 | 0.103 | 0.0932 | 0.172 | 0.284 | ND | ND | ND | ND | 0.16305 |

Table 4: Dissolved Nitrates + Nitrites as Nitrogen concentrations of samples. (ND=No Detection)

Figure 4: Dissolved Nitrates + Nitrites as Nitrogen Concentrations of samples collected.

**Discussion**

The Weyauwega Lake – Waupaca River Watershed Management Plan was approved in 2019 with goals to improve surface water quality, increase citizens’ awareness of water quality issues in the watershed, reduce runoff volume and flood levels during peak storm events, and conserve and restore aquatic and terrestrial habitat. Baseline water quality data was collected in 2017 and follow-up monitoring was collected in 2021. In both years, the average TP concentration across all monitoring locations was greater than Wisconsin Administrative Code ch. NR 102 Water Quality Criteria (WQC) for streams at 0.075 mg/L (Figure 5). Average TN and Average NO3+NO2 values in 2017 and 2021 were also compared and are shown in Figure 6 and 7. As was noted from the 2017 monitoring data, the 2021 monitoring data indicated high concentrations of TP and TN in most of the sampled creeks. The data presented in this summary support the need for implementing management actions targeting nutrient reduction.

Figure 5: Comparison of Average TP concentrations in 2017 and 2021.

Figure 6: Comparison of Average TN concentrations in 2017 in 2021.

Figure 7: Comparison of Average NO3+NO2 in 2017 in 2021.

All 8 of the sites monitored for TP had a median concentration greater than the Wisconsin Administrative Code ch. NR 102 Water Quality Criteria (WQC) for streams at 0.075 mg/L. An impairment assessment was conducted to verify whether the Lake Weyauwega sub-watershed TP concentrations met the WQC or if the waterbodies should be placed on the EPA Clean Water Act Section 303d Impaired Waters List (CWA 303d IWL). The impairment assessment protocol requires a statistical approach to assess stream and river TP data against the applicable water quality criterion (WisCALM 2016). This approach involves the calculation of a 90% confidence limit around the median of a TP sample dataset. If the lower 90% confidence limit (LCL) exceeds the criterion for TP, then that stream segment (assessment unit) is considered to be exceeding the criterion. 90% confidence limits were calculated using all TP data points in 2017 and 2021 (Table 5, Figure 8). Whiskey Creek US HWY 10 was the only stream where the LCL met the WQC for TP water quality while every other stream “Cleary Exceeded” the WQC. The stream TP WQC does not apply to the wetland ditch to Lake Weyauwega upstream of Haire Rd; however, the confidence limits were calculated for reference. In 2017, two of the 11 tributary sample sets’ LCL met the WQC (Table 6).

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| **Location** | **TP Upper 90% Confidence Limit** | **TP Median** | **TP Lower 90% Confidence Limit** | **Relation to Criteria** |
| Whiskey Creek US Hwy 10 | 0.097 | 0.093 | 0.071 | May Exceed |
| Unnamed Trib to the Waupaca RIver US Harrington Rd East | 0.124 | 0.112 | 0.091 | Clearly Exceeds |
| Unnamed Trib to Waupaca River at Harrington Rd West | 0.139 | 0.112 | 0.091 | Clearly Exceeds |
| Unnamed Trib to Waupaca River at Hwy 54 | 0.114 | 0.092 | 0.077 | Clearly Exceeds |
| Unnamed Trib to Waupaca River US Den Ed Rd | 0.152 | 0.115 | 0.105 | Clearly Exceeds |
| Unnamed Trib to Waupaca River at Galilee Rd | 0.163 | 0.117 | 0.112 | Clearly Exceeds |
| Unnamed wetland outlet ditch to Lake Weyauwega US Haire Rd | 0.172 | 0.14 | 0.129 | N/A |
| Unnamed Trib to Lake Weyauwega US County AA | 0.177 | 0.133 | 0.119 | Clearly Exceeds |

Table 5: TP 90% Confidence limits in relation to WQC.

Figure :90% Confidence limits compared to the TP WQC.

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| **Location** | **TP Lower 90%**  **Confidence Limit** | **Criterion Exceedance Level** |
| Un Trib to Waupaca R at Hwy 54 | 0.062 | Meets |
| Un Trib to Waupaca R at Harrington Rd West | 0.11 | Exceeds |
| Un Trib to the Waupaca R US Harrington Rd East | 0.0936 | Exceeds |
| Un wetland outlet ditch to Lake Weyauwega US Haire Rd | 0.1343 | N/A |
| Un Trib to Lake Weyauwega US County AA | 0.1053 | Exceeds |
| Un Trib to Waupaca R US Galilee Rd West\* | 0.077 | Exceeds |
| Un Trib to Waupaca R at Airport Rd | 0.078 | Exceeds |
| Un Trib to Waupaca R US 325m Galilee Rd East | 0.0733 | Meets |
| Un Trib to Waupaca R at Galilee Rd East | 0.0832 | Exceeds |
| Un Trib to Waupaca R US Den Ed Rd | 0.0856 | Exceeds |
| Whiskey Creek US Hwy 10 | 0.0826 | Exceeds |

Table 6: 2017 TP lower confidence limits.