**Targeted Watershed Assessment Report for Streams on the South Side of Big Green Lake**

 **Green Lake County, Wisconsin**

**December 2021**

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**Purpose**

This Targeted Watershed Assessment (TWA) reevaluated the water quality of the southern Big Green Lake sub-watershed after watershed improvements had been implemented. A TWA in this sub-watershed was conducted in 2011 and 2014 for baseline (pre-restoration) data. The 2011 and 2014 surveys included collection of a baseline water quality assessment on the south side of Big Green Lake, including total phosphorus (TP), habitat, fish, and aquatic macroinvertebrates. In 2019, the intent of the TWA was to repeat the TP, habitat, fish and macroinvertebrate monitoring to evaluate the changes in the aquatic community and nutrient concentrations before and after Best Management Practices (BMP) installations.

**Methods**

During the growing season of 2019, TP samples were collected by volunteers at 7 locations once per month from May through October (Table 1, Map 1). All samples were collected using the standard DNR grab sampling method for a total of 42 samples (Table 1 & 5) (WDNR 2015). All TP samples were shipped to Wisconsin State Laboratory of Hygiene (WISLH) for analysis. The WISLH entered all sample analysis data into the Surface Water Integrated Monitoring System (SWIMS) database.

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| **SWIMS Station ID** | **Site Name** | **Surface Water WBIC** |
| 10033838 | Hill Creek Upstream of Spring Grove Road | 146200 |
| 10021317 | Roy Creek Upstream County O | 148200 |
| 243026 | Spring Creek Upstream of County Hwy K | 148000 |
| 10042146 | Unnamed Tributary to White Creek Upstream from Scott Hill Rd | 5027243 |
| 10041578 | Unnamed Tributary to Hill Creek Upstream from Scott Hill Road | 5027219 |
| 243059 | White Creek at Spring Grove Road | 146600 |
| 10012583 | Wuerches Creek at Hwy B | 148300 |

**Table 1: Total Phosphorus Monitoring Sites Sampled in the Southern Big Green Lake sub-Watershed May Through October 2019.**



**Map 1: Sample Locations for the 2019 Targeted Watershed Assessment in the Southern Big Green Lake sub-Watershed.**

Eight locations were sampled for aquatic macroinvertebrates between October and November 2019 (Table 2, Map 1). All sites were sampled using the WDNR *Guidelines for the Standard Collection of Macroinvertebrate Samples from Wadable Streams v2.0* (WDNR 2017). A D-shaped kicknet with 600-micron mesh was used at all sites by standing upstream from the net and placing it firmly on the stream bed while digging into the substrate with the heel or toe to free the macroinvertebrates from the substrate. Riffles were targeted at each of the sites, but if none were present then, available gravel, overhanging vegetation, woody debris, or other vegetation would be sampled. For a representative sample of the aquatic macroinvertebrate community, a minimum of 100 aquatic macroinvertebrates collected in each sample was targeted. The aquatic macroinvertebrates were preserved in a 70-80% ethanol solution inside quart “Mason” jars. If necessary, multiple “Mason” jars were used per sample depending upon how much sediment and organic material was collected with the aquatic macroinvertebrates. Within the next 24 hours, the samples were re-preserved with another 70-80% ethanol solution. Samples were taken to the UWSP Aquatic Biomonitoring Laboratory (ABL) for lowest possible taxonomic identification. Staff at the ABL entered the data into the SWIMS database.

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| **SWIMS Station ID** | **Site Name** | **Surface Water WBIC** |
| 10051172 | Hill Creek at Lakeview Road | 146200 |
| 10041576 | Roy Creek Downstream of County Hwy O | 148200 |
| 10021317 | Roy Creek 200 Feet Above County Hwy O | 148200 |
| 243026 | Spring Creek Upstream of County Hwy K | 148000 |
| 10041578 | Unnamed Tributary to Hill Creek Upstream from Scott Hill Road | 5027219 |
| 10042146 | Unnamed Tributary to White Creek Upstream from Scott Hill Rd | 5027243 |
| 243059 | White Creek Upstream Spring Grove Road | 146600 |
| 10012583 | Wuerches Creek at Hwy B | 148300 |

**Table 2: Aquatic Macroinvertebrate Monitoring Sites Sampled in the Southern Big Green Lake sub-watershed in 2019.**

Quantitative habitat surveys were conducted at 7 locations between October 2019 and July 2020 (Table 3, Map 1). All sites were surveyed following the WDNR *Guidelines for Evaluating Habitat of Wadable Streams* (2002). Each quantitative habitat survey station length was 35 times the mean stream width of the survey station. Following the determination of station length, the station was divided into 12 transects. At each transect, substrate, sedimentation, erosion, water depth, and riparian land use data were collected. Water Quality staff entered the quantitative habitat data into the WDNR Fisheries and Habitat Management Database (FMDB).

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| **SWIMS Station ID** | **Site Name** | **Surface Water WBIC** |
| 10051172 | Hill Creek at Lakeview Road | 146200 |
| 10041576 | Roy Creek Downstream of County Hwy O | 148200 |
| 10021317 | Roy Creek 200 Feet Above County Hwy O | 148200 |
| 243026 | Spring Creek Upstream of County Hwy K | 148000 |
| 10041578 | Unnamed Tributary to Hill Creek Upstream from Scott Hill Road | 5027219 |
| 243059 | White Creek Upstream Spring Grove Road | 146600 |
| 10012583 | Wuerches Creek Upstream from County Road B | 148300 |

**Table 3: Quantitative Habitat Survey Locations in the Southern Big Green Lake sub-watershed Conducted in 2019 and 2020.**

Between July and August 2019, wadable fish surveys were conducted at 6 sites (Table 4). The 6 wadable fish surveys were conducted following the WDNR *Guidelines for Assessing Fish Communities of Wadable Streams in Wisconsin v2.0* (WDNR 2018). All 6 wadable sites were surveyed during the guidance-recommended summertime survey period. The wadable fish survey stations were a minimum of 35 times the mean stream width (overall minimum of 100 meters, overall maximum of 400 meters). A 12 Volt, 18 Amp Hour battery-powered backpack shocker was used for all 6 sites based upon the streams’ smaller width and depth. Stream flow and water chemistry was recorded at each site prior to conducting the fish survey. Catch per effort sampling procedures were used for this project (no particular species was targeted, all captured). A single upstream pass was made using 0.125-inch mesh nets to collect the fish. At the end of the station, captured fish were identified and counted and all game fish were measured for length. Once all data was collected, the fish were returned to the creek. Fish survey data was entered into the FMDB by WDNR Water Quality staff.

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| --- | --- | --- |
| **SWIMS Station ID** | **Site Name** | **Surface Water WBIC** |
| 10051172 | Hill Creek at Lakeview Road | 146200 |
| 10041576 | Roy Creek Downstream of County Hwy O | 148200 |
| 10021317 | Roy Creek 200 Feet Above County Hwy O | 148200 |
| 243026 | Spring Creek Upstream of County Hwy K | 148000 |
| 243059 | White Creek Upstream Spring Grove Road | 146600 |
| 10012583 | Wuerches Creek Upstream from County Road B | 148300 |

**Table 4: Wadable Fish Survey** **Locations in the Southern Big Green Lake sub-watershed Conducted between July and August 2019.**

Onset Hobo Pendant thermistors were deployed to collect temperature data from May through October 2019 at 7 locations (Table 5, Map 1). Temperature measurements were taken once per hour at each location from May through October. Temperature measurements were taken with an Onset Hobo Pendant thermistor attached to a fence post driven into the stream bed of the creek. The thermistor was attached to the fence post in such a manner as to suspend the thermistor in the water column low enough to stay under water in low flow conditions and high enough to not get buried in bottom substrate (~ 6 inches above the bottom). The thermistor was placed in a shaded location when possible. Temperature data were uploaded into the SWIMS database by WDNR Water Quality staff.

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| **SWIMS Station ID** | **Site Name** | **Surface Water WBIC** |
| 10051172 | Hill Creek at Lakeview Road | 146200 |
| 10021317 | Roy Creek 200 Feet Above County Hwy O | 148200 |
| 243026 | Spring Creek Upstream of County Hwy K | 148000 |
| 10041578 | Unnamed Tributary to Hill Creek Upstream from Scott Hill Road | 5027219 |
| 10042146 | Unnamed Tributary to White Creek Upstream from Scott Hill Rd | 5027243 |
| 243059 | White Creek Upstream Spring Grove Road | 146600 |
| 10012583 | Wuerches Creek Upstream from County Road B | 148300 |

**Table 5: Temperature Monitoring Locations Sampled from May through October 2019 in the Southern Big Green Lake sub-watershed.**

**Results**

The 2019 TP sample analysis results in the Southern Big Green Lake sub-watershed ranged from 0.0207 mg/L in Spring Creek in September to 0.562 mg/L in the Unnamed Tributary to White Creek in May. The average TP concentrations for the 7 sites in this project ranged from 0.027 mg/L in Spring Creek to 0.167 mg/L the Unnamed Tributary to White Creek (Table 6, Chart 1).

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| --- | --- | --- | --- | --- | --- | --- | --- |
| **Month of Sampling**  | **Hill Creek** | **Roy Creek** | **Spring Creek** | **Un Trib to White Creek** | **Un Trib to Hill Creek** | **White Creek** | **Wuerches Creek** |
| May | 0.157 | 0.0339 | 0.0308 | 0.562 | 0.0356 | 0.0422 | 0.0454 |
| June | 0.204 | 0.112 | 0.0419 | 0.0808 | 0.0549 | 0.0457 | 0.0544 |
| July | 0.142 | 0.135 | 0.0222 | 0.0705 | 0.0529 | 0.0548 | 0.176 |
| August | 0.129 | 0.157 | 0.0268 | 0.0761 | 0.0524 | 0.0453 | 0.0916 |
| September | 0.137 | 0.104 | 0.0207 | 0.135 | 0.065 | 0.132 | 0.162 |
| October | 0.0408 | 0.0967 | 0.0213 | 0.0798 | 0.0601 | 0.558 | 0.123 |
| Average | 0.135 | 0.106 | 0.027 | 0.167 | 0.053 | 0.146 | 0.109 |

**Table 6: Total Phosphorus Concentrations and Averages (mg/L) in the Southern Big Green Lake sub-watershed in 2019.**

**Chart 1: Total Phosphorus Concentrations and Averages (mg/L) in the Southern Big Green Lake sub-watershed in 2019.**

Aquatic macroinvertebrate communities were sampled at 8 locations between October and November 2019 (Table 2 & 7, Chart 2). Some aquatic macroinvertebrate species are tolerant of environmental degradation, while some species are moderately tolerant, and some others are intolerant. Based upon the representative macroinvertebrate sample collected and their associated tolerance to environmental degradation, an Index of Biotic Integrity (MIBI) was calculated to indicate the water quality condition of the streams in the sub-watershed on the South Side of Big Green Lake. In general, the higher the MIBI score, the better the water quality rating for a wadable stream in Wisconsin. The MIBI scores in this sub-watershed ranged from 2.08 in the Unnamed Tributary to White Creek to 4.95 in the Unnamed Tributary to Hill Creek. The water quality condition categories based upon the macroinvertebrate community for the 8 sites ranged from Fair to Poor. The samples demonstrated a macroinvertebrate community indicating likely substantial impact from environmental degradation (Fair) to severe environmental degradation (Poor).

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| --- | --- | --- | --- |
| **SWIMS Station ID** | **Stream Name and Location** | **Macroinvertebrate IBI Score** | **Condition Category** |
| 10051172 | Hill Creek at Lakeview Road | 2.47 | Poor |
| 10041576 | Roy Creek Downstream of County Hwy O | 4.45 | Fair |
| 10021317 | Roy Creek 200 Feet Above County Hwy O | 3.61 | Fair |
| 243026 | Spring Creek Upstream of County Hwy K | 4.17 | Fair |
| 10041578 | Unnamed Tributary to Hill Creek Upstream from Scott Hill Road | 4.95 | Fair |
| 10042146 | Unnamed Tributary to White Creek Upstream from Scott Hill Rd | 2.08 | Poor |
| 243059 | White Creek Upstream Spring Grove Road | 3.43 | Fair |
| 10012583 | Wuerches Creek Upstream of County Hwy B | 4.27 | Fair |

**Table 7: Aquatic Macroinvertebrate Index of Biotic Integrity Scores and Water Quality Condition Category in the Southern Big Green Lake sub-watershed between October and November 2019.**

**Chart 2: Aquatic Macroinvertebrate Index of Biotic Integrity Scores and Water Quality Condition Category in the Southern Big Green Lake sub-watershed in October 2019.**

Between October 2019 and July 2020, quantitative habitat surveys were conducted at 7 locations. Quantitative habitat assessments evaluate a representative stream reach (35 X Mean Stream Width) for the quantity and quality of habitat for game fish and compare the habitat to reference streams in Wisconsin. Based upon the assessment data collected during the 2019-2020 surveys, a habitat rating was calculated for the 6 creeks (Table 8, Chart 3). The habitat rating scores were relatively similar for all creeks. The habitat rating scores ranged from 50 at the Unnamed Tributary to Hill Creek to 65 at Hill and Roy Creeks (Table 8, Chart 3). Each of the 7 surveys demonstrated a Condition Category of Good.

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| --- | --- | --- | --- |
| **SWIMS Station ID** | **Stream Name and Site Location** | **Quantitative Habitat Score** | **Condition Category** |
| 10051172 | Hill Creek at Lakeview Road | 65 | Good |
| 10041576 | Roy Creek Downstream of County Hwy O | 65 | Good |
| 10021317 | Roy Creek 200 Feet Above County Hwy O | 58 | Good |
| 243026 | Spring Creek Upstream of County Hwy K | 55 | Good |
| 10041578 | Unnamed Tributary to Hill Creek Upstream from Scott Hill Road | 50 | Good |
| 243059 | White Creek Upstream Spring Grove Road | 63 | Good |
| 10012583 | Wuerches Creek Upstream from County Road B | 55 | Good |

**Table 8: Quantitative Habitat Survey Scores and Rating Conditions for 6 Creeks in the Southern Big Green Lake sub-watershed in 2019 and 2020.**

**Chart 3: Quantitative Habitat Survey Scores and Rating Conditions for 6 Creeks in the Southern Big Green Lake sub-watershed in 2019 and 2020.**

Between July and August 2019, 5 streams were surveyed for representative fish communities. Some fish species are tolerant of environmental degradation, while some species are moderately tolerant, and some others are intolerant. Based upon the representative fish collected during the survey and their associated tolerance to environmental degradation, an Index of Biotic Integrity (FIBI) was calculated to indicate the water quality of the creek (Table 9, Chart 4). The FIBI scores ranged from 10 in Roy Creek, to 50 at Spring Creek. The Condition Category for the 6 sites ranged from Poor indicating severe environmental degradation to Fair indicating likely significant impacts from environmental degradation. Four of the 6 surveys had a Condition Category of Poor, while the remaining 2 surveys had a Condition Category of Fair.

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| --- | --- | --- | --- |
| **SWIMS Station ID** | **Stream Name and Site Location** | **Fish IBI Score** | **Condition Category** |
| 10051172 | Hill Creek at Lakeview Road | 20 | Poor |
| 10041576 | Roy Creek Downstream of County O | 10 | Poor |
| 10021317 | Roy Creek Upstream of County O | 20 | Poor |
| 243026 | Spring Creek Upstream of County K | 50 | Fair |
| 243059 | White Creek Upstream of Spring Grove Road | 40 | Fair |
| 10012583 | Wuerches Creek Upstream of County B | 20 | Poor |

**Table 9: Wisconsin Wadable Fish Index of Biotic Integrity Scores and Condition Categories for 5 Creeks in the Southern Big Green Lake sub-watershed in 2019.**

**Chart 4: Wisconsin Wadable Fish Index of Biotic Integrity Scores and Condition Categories for 4 Creeks in the Southern Big Green Lake sub-watershed in 2019.**



**Photo 1-2: Fish Collected during the Fish Index of Biotic Integrity Surveys on the South side of Big Green Lake in 2019. Photos taken by John Lyons (DNR).**

Water temperature data was collected from May through October 2019 at 7 locations (Map 1). Monthly average temperatures were reported for months with complete data only. The average monthly temperatures ranged from 51.9F in White Creek in May to 75.6F in Hill Creek in July (Table 9, Chart 5). The Maximum Daily Averages (MDM) in the sub-watershed on the south side of Big Green Lake ranged from 58.3F in White Creek to 79F in Hill Creek.

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| --- | --- | --- | --- | --- | --- | --- |
| **SWIMS Station ID** | **Stream Name and Site Location** | **June Average (F)** | **July Average (F)** | **August Average (F)** | **September Average (F)** | **Maximum Daily Average (F)** |
| 10051172 | Hill Creek at Lakeview Road | 67.6 | 75.6 | 70.9 | 65.8 | 79 |
| 10021317 | Roy Creek Upstream of County O | 57.1 | 61.4 | 59.4 |  | 65.3 |
| 243026 | Spring Creek Upstream of County K | 65.4 | 72.6 | 68.3 | 64.1 | 76.6 |
| 10041578 | Un Trib to Hill Creek US Scott Hill Road | 52.5 | 55 | 54.4 | 55.9 | 59.9 |
| 10042146 | Un Trib to White Creek US Scott Hill Road | 55.1 | 62.3 | 61.8 | 60.6 | 66.5 |
| 243059 | White Creek Upstream of Spring Grove Road | 51.9 | 53.9 | 53.3 | 53.1 | 58.3 |
| 10012583 | Wuerches Creek Upstream of County B | 60.8 | 65.2 | 60 | 59.1 | 70.7 |

**Table 9: Monthly Average and Maximum Daily Average Temperatures in the Southern Big Green Lake sub-watershed in 2019.**

**Chart 5:** **Monthly Average and Maximum Daily Average Temperatures in Southern Big Green Lake sub-watershed in 2019.**

**Discussion**

This TWA reassessed the water quality of the southern Big Green Lake sub-watershed after improvements had been implemented. Water quality monitoring was conducted in 2011 and 2014 for baseline (pre-restoration) data. In 2019 and 2020, the intent of the TWA was to repeat the TP, water temperature, habitat, fish and macroinvertebrate monitoring to compare the aquatic community and nutrient concentrations pre/post Best Management Practices (BMP) installation over time.

Success in agricultural watershed restoration can be viewed in many different forms. For example, some partners may view success as simply how many feet of streambank restored, the number of farmers signed up for BMPs, removing waters from the Impaired Waters List, increased fish habitat, and aesthetics amongst others. This project focused upon the conditions within the creeks on the south side of Big Green Lake to demonstrate potential improvements to water quality. Due to the nature of watershed water holding capacity, flood events, soil types, creek habitat, sediment deposition, and many other factors, some BMPs may have an immediate and identifiable instream water quality impact while others may take years to show a positive impact. BMPs that reduce the amount of nutrients and sediment runoff into streams and Big Green Lake always benefit their health in the long run. Comparison of the data collected in this project in 2019 and 2020 to the 2011 and 2014 water quality monitoring provides insight into the changes over time in the health of the streams.

First, the average growing season TP concentrations from 2011-2019 are listed in Table 10 and Chart 6 (WDNR 2011-2019). For the purposes of this report, the 2011 and 2014 are considered pre-restoration water quality monitoring. Roy and Wuerches Creeks decreased in growing season average from 2011 to 2019. Spring Creek and the Unnamed Tributary to Hill Creek were similar in concentration when comparing pre-restoration to 2019. The average growing season TP fluctuated in Hill Creek in the 3 seasons monitored between 2011 and 2019 (Table 10, Chart 6). Although the monitoring design of 1 sample/month at each location meets the Wisconsin Consolidated Assessment and Listing Methodology (WisCALM 2018) requirement for evaluating whether the stream should be listed as Impaired, that intensity may not be enough to measure significant increases or decreases in the results between years. Roy and Spring Creeks indicate a significant difference in the TP from pre-BMP to post-BMP implementation, while the other locations did not. Spring Creek significantly increased from 2014 to 2019, while Roy Creek decreased from 2011 to 2019. The variability in the samples collected in Hill, White, Wuerches, and the 2 unnamed tributaries was too high to recognize a significant difference from year to year. With more intense monitoring, some of this variability can be reduced. As more BMP implementation occurs in the watershed to reduce the intensity of runoff events, the variability in the samples should reduce as well.

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| --- | --- | --- | --- |
| **Stream Sampled** | **2011** | **2014** | **2019** |
| Hill Creek | 0.107 | 0.145 | 0.135 |
| Roy Creek | 0.193 |  | 0.106 |
| Spring Creek |  | 0.0195 | 0.027 |
| Unnamed Tributary to Hill Creek |  | 0.058 | 0.053 |
| Unnamed Tributary to White Creek |  | 0.1 | 0.167 |
| White Creek | 0.0491 |  | 0.146 |
| Wuerches Creek | 0.178 |  | 0.109 |

**Table 10: Growing Season Average Total Phosphorus Concentrations (mg/L) in Streams on the South Side of Big Green Lake between 2011 and 2019.**

**Chart 6: Growing Season Average Total Phosphorus Concentrations (mg/L) in Streams on the South Side of Big Green Lake between 2011 and 2019.**

Another way of looking at the TP sample results from 2011 through 2019 is comparing the growing season medians and the lower and upper 90% confidence intervals around each (Table 11, Chart 7). This is the information used to determine whether a stream should be listed as Impaired due to the pollutant TP (WisCALM 2018). If the median of a set of monthly samples and the associated 90% confidence intervals are below the stream criterion (ex. Spring Creek), then that stream is considered to clearly meet the criterion (Wisconsin Administrative Code ch. NR 102). Conversely, if the median of a set of samples and its associated confidence intervals are above the criterion (ex. Hill Creek), then that stream is considered to exceed and should be listed as Impaired. Spring Creek and the Unnamed Tributary to Hill Creek clearly meet the stream criterion. Hill and Roy Creeks clearly exceed, and both are appropriately listed as Impaired due to the pollutant phosphorus. White Creek in 2011 clearly met the criterion and the 2019 samples may meet. More monitoring over the next 2-3 years in White Creek may be enough to delist the stream for the pollutant phosphorus.

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **2011 GSM** | **2011****LCL** | **2011 UCL** | **2014 GSM** | **2014****LCL** | **2014 UCL** | **2019 GSM** | **2019 LCL** | **2019 UCL** |
| **Hill Creek** | 0.119 | 0.069 | 0.1276 | 0.148 | 0.1185 | 0.1698 | 0.1395 | 0.087 | 0.1708 |
| **Roy Creek** | 0.172 | 0.1448 | 0.2112 |  |  |  | 0.108 | 0.0696 | 0.134 |
| **Spring Creek** |  |  |  | 0.0192 | 0.017 | 0.0217 | 0.024 | 0.022 | 0.031 |
| **Unnamed Trib to Hill Creek** |  |  |  | 0.0596 | 0.0361 | 0.074 | 0.0539 | 0.046 | 0.06 |
| **Unnamed Trib to White Creek** |  |  |  | 0.0805 | 0.0708 | 0.119 | 0.0803 | 0.072 | 0.19 |
| **White Creek** | 0.046 | 0.0407 | 0.0552 |  |  |  | 0.05025 | 0.045 | 0.155 |
| **Wuerches Creek** | 0.099 | 0.0787 | 0.1867 |  |  |  | 0.1073 | 0.069 | 0.135 |

**Table 11: Total Phosphorus Growing Season Medians and 90% Confidence Intervals from 2011-2019 for Creeks in the Southern Big Green Lake sub-watershed.**

**Chart 7: TP Growing Season Medians and Confidence Intervals from 2011-2019 for Creeks in the Southern Big Green Lake sub-watershed (red line is the Water Quality Criterion for Streams).**

In 2019, aquatic macroinvertebrate samples were collected at each of the 8 sites sampled in 2014 and the 3 sample locations in 2011 (WDNR 2011 & 2014). The MIBI scores from 2011 and 2014 were significantly higher than the 2019 score at Hill Creek (Table 12, Chart 8). The 2011 and 2014 samples in Hill Creek were collected at a different location than 2019 so that could be part of the difference in scores. The Hill Creek sample location was moved upstream to Lakeview Road, which is more suitable for wadable fish and macroinvertebrate surveys and further away from the influence of Big Green Lake. During the summer monitoring of 2019, low concentrations of dissolved oxygen (DO) (<5 mg/L) were consistently observed which will influence the macroinvertebrate community in Hill Creek.

Both upstream and downstream of County O in Roy Creek increased in MIBI scores from 2014 to 2019 (Table 12, Chart 8). The macroinvertebrate community in Spring Creek scored similarly in 2014 and 2019. The Unnamed Tributary to Hill Creek and Wuerches Creek significantly increased in MIBI score from 2014 to 2019, which indicates an increase in water quality. White Creek and its Unnamed Tributary significantly decreased in MIBI, which indicates a decrease in water quality. In streams in Wisconsin, there is some natural fluctuation in the macroinvertebrate communities from year to year. Some of the differences in pre- and post-BMP implementation MIBI scores is likely due to yearly changes in macroinvertebrate communities. To be confident in an improved macroinvertebrate community, long term monitoring should be done to account for some of that yearly fluctuation.

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| --- | --- | --- | --- |
| **Location** | **2011 MIBI** | **2014 MIBI** | **2019 MIBI** |
| Hill Creek | 4.8 | 4.42 | 2.47 |
| Roy Creek DS County O |  | 3.36 | 4.45 |
| Roy Creek US County O | 5.9 | 3.17 | 3.61 |
| Spring Creek |  | 4.3 | 4.17 |
| Unnamed Tributary to Hill Creek |  | 2.74 | 4.95 |
| Unnamed Tributary to White Creek |  | 4.57 | 2.08 |
| White Creek |  | 4.65 | 3.43 |
| Wuerches Creek | 3.18 | 3.18 | 4.27 |

**Table 12: Macroinvertebrate Index of Biotic Integrity Scores 2011-2019 in the Southern Big Green Lake sub-watershed.**

**Chart 8: Macroinvertebrate Index of Biotic Integrity Scores 2011-2019 in the Southern Big Green Lake sub-watershed.**

Quantitative habitat surveys were conducted in 2014 and 2019/2020 to compare changes to riparian corridor and instream conditions at 6 locations (Table 13, Chart 9). Increases occurred at all locations from 2014 to 2019/2020. The increases in habitat scores ranged from 2 in the Unnamed Tributary to Hill Creek to 15 in Roy Creek. Habitat within streams naturally fluctuates to some degree due to sediment transport, erosion and flow amongst others, so continued monitoring should be done to account for some of that yearly fluctuation.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Stream Name and Location** | **2014 Habitat Score** | **2014 Habitat Rating Condition Category** | **2019 /2020 Habitat Score** | **2019 Habitat Rating Condition Category** |
| Roy Creek Downstream County Hwy O | 50 | Good | 65 | Good |
| Roy Creek Upstream County Hwy O | 53 | Good | 58 | Good |
| Spring Creek | 53 | Good | 55 | Good |
| Unnamed Tributary to Hill Creek | 48 | Fair | 50 | Good |
| White Creek | 50 | Good | 63 | Good |
| Wuerches Creek | 50 | Good | 55 | Good |

**Table 13: Quantitative Habitat Score and Condition Categories 2014-2019 in the Southern Big Green Lake sub-watershed.**

**Chart 9: Quantitative Habitat Scores and Condition Categories 2014-2019 in the Southern Big Green Lake sub-watershed.**

Fish community surveys were conducted in 2019 at 5 locations surveyed in 2014 (WDNR 2014) (Table 14, Chart 10). No significant changes to the FIBI scores from 2014 to 2019. Just as the MIBI scores, long term monitoring is needed to evaluate changes to the fish community over time. One characteristic change to the fish community in the streams surveyed in 2011, 2014 and 2019 was an increase in the percentages of the fish communities intolerant to habitat degradation (% intolerant) over time. The % intolerant in a fish community has been found to decrease as phosphorus increases (USGS 2006). The change in the % intolerant fish ranged from a 13% decrease in Wuerches Creek to 36% increase in Roy Creek (Table 15, Chart 11). Both survey locations in Roy Creek increased in the % intolerant fish in 2019 over previous years. This may be due to the decrease in TP concentration and indicates that habitat and/or water quality is improving. In White Creek, although the % intolerants decreased slightly, Brown Trout (Salmo trutta) were collected during the survey that had not been collected in a survey since 2000. Brown Trout are an indicator of good water quality.

|  |  |  |  |
| --- | --- | --- | --- |
| **Location** | **2011** | **2014** | **2019** |
| Roy Creek DS County O |  | 10 | 20 |
| Roy Creek US County O | 10 | 20 | 20 |
| Spring Creek |  | 50 | 50 |
| White Creek |  | 40 | 40 |
| Wuerches Creek | 20 | 20 | 20 |

**Table 14: Fish Index of Biotic Integrity Scores 2011-2019 in the Southern Big Green Lake sub-watershed.**

**Chart 10: Fish Index of Biotic Integrity Scores 2011-2019 in the Southern Big Green Lake sub-watershed.**

|  |  |  |  |
| --- | --- | --- | --- |
| **Location** | **2011** | **2014** | **2019** |
| Roy Creek DS County O |  | 35 | 71 |
| Roy Creek US County O | 31 | 43 | 48 |
| Spring Creek |  | 0 | 7 |
| White Creek |  | 86 | 82 |
| Wuerches Creek | 75 | 66 | 62 |

**Table 15: Fish Community % Intolerants from 2011 to 2019 in Streams in the Southern Big Green Lake sub-watershed.**

**Chart 11: Fish Community % Intolerants from 2011 to 2019 in Streams in the Southern Big Green Lake sub-watershed.**

**Conclusions**

The purpose of this project was to reevaluate the water quality within the streams to assess the impacts from watershed improvement implementation. Broad water quality improvements were not observed in the streams since the monitoring conducted in 2011 and 2014; however, some of the 2019 results may indicate the health of the streams is improving. The macroinvertebrate communities did not indicate any water quality improvements. The fish community surveyed indicates a shift to a higher percentage of environmental degradation intolerant fish present in Roy Creek which could be associated with the improvements to habitat and/or water quality. Roy Creek decreased in TP concentration from 2011 to 2019 while Spring Creek increased. Low concentrations of dissolved oxygen and excessive phosphorus in Hill Creek limit its potential for having a robust fish and aquatic life community. Continued monitoring in White Creek over the next 2-3 years may be enough to delist for the pollutant TP. Long term monitoring of the fish and macroinvertebrate communities is needed to demonstrate the changes to water quality in these streams.

**References**

USGS (United States Geological Survey) (Robertson, D.M. et. al.). 2006. Nutrient Concentrations and Their Relations to the Biotic Integrity of Wadeable Streams in Wisconsin.

WDNR (Wisconsin Department of Natural Resources). 2010. Wisconsin Administrative Code ch. NR 102: Water Quality Standards for Wisconsin Surface Waters.

WDNR (Wisconsin Department of Natural Resources) (Johnson et. al.). 2011. An Assessment of Hill, Roy, Silver, and Wuerches Creeks (303d Impaired Waters).

WDNR (Wisconsin Department of Natural Resources). 2015. Nutrient Chemistry Grab Sampling Method V3.3.

WDNR (Wisconsin Department of Natural Resources). 2017. Guidelines for the Standard Collection of Macroinvertebrate Samples from Wadeable Streams v2.0

WDNR (Wisconsin Department of Natural Resources). 2018. Wisconsin Consolidated Assessment and Listing Methodology Guidance Document.

WDNR (Wisconsin Department of Natural Resources). 2018. Guidelines for Assessing Fish Communities of Wadeable Streams in Wisconsin v2.0.