RICE CREEK WATERSHED STREAM HEALTH EVALUATION PROGRAM

2021-2022
STREAM MONITORING REPORT

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Local Government

The Rice Creek Watershed District

Organizations

Fortin Consulting

Special Recognition

The Rice Creek Watershed Stream Health Evaluation Program wishes to thank the following partners, without whom this program would not be possible:

Katie Farber and Connie Fortin – Fortin Consulting
Gary Averbeck and Wayne LeBlanc – SHEP Team Co-Leaders
Courtney Jones – SHEP Team Leader
Katherine Majkrzak and Darrell Majkrzak – SHEP Team Co-Leaders

2021 Rice Creek SHEP Volunteers

The 2021 Rice Creek Watershed Stream Health Evaluation Program extends our most sincere appreciation to all of the SHEP volunteers who donated their time in the stream last summer. Each of these volunteers contributed between 15 and 30 hours of volunteer service in monitoring the health of our water resources. Thank you!

Team 1: Gary Averbeck,* Wayne LeBlanc,* Barbara Bor, Linda Grundter, Laura Lyle, DanielleMcLaughlin, Tere O'Connell, John Sullivan, Kim Sullivan, Jake Thering and Ray Thering

Team 2: Courtney Jones,* Bob Bartlett, Ralph Butkowski, Gary Ellis, Michael Hagedorn, Kaden Li, Jo Ann Morse and Hanna Wallmow

Team 3: Katherine Majkrzak,* Darrell Majkrzak,* Rachel Beise, Rich Femling, Elan Majkrzak, Jennifer Olson, Lorien Radmer, Brad Sielaff and Susan Young

** SHEP Team Leader*

Rice Creek Watershed Stream Health Evaluation Program
2021 Field Monitoring Report

1.0 BACKGROUND

In an effort to obtain a more comprehensive understanding of the health of our water resources, the Minnesota Pollution Control Agency (MPCA) and other agencies have developed protocols and indices for the biological assessment of streams. Because aquatic organisms express a range of tolerances to environmental conditions, biological assessment can be a powerful quantitative tool in understanding the health of water resource and provides a more complete picture of the ecological health of our waters. The National River Watch Network states that five years of data should be collected in order to perform a biological characterization of a sample site.

In the early 1990's, Riverwatch, a national volunteer river monitoring program, was brought to Minnesota to engage schools in river monitoring. The program was started by the Mississippi Headwaters Board and taken over by Hennepin County and eventually spread across the Twin Cities metropolitan area.

In 1997, a citizen wetland monitoring program was formed by local partners and the MPCA to evaluate wetland health. Sampling methods and evaluation metrics were developed by MPCA scientists to measure the health of the local wetlands. This Wetland Health Evaluation Program (WHEP) is now an award-winning and nationally recognized program that uses citizen volunteers to monitor the biological health of local wetlands. Multiple layers of quality control, volunteer training and the use of rigorous protocols assure scientifically-valid monitoring results. Volunteers enjoy the program and, after participating, often become more engaged in wetland and watershed issues and stewardship within their communities.

The Stream Health Evaluation Program (SHEP) is a model for volunteer stream monitoring modeled after WHEP and Riverwatch. SHEP uses trained adult volunteers to evaluate the biological health of streams using advanced bioassessment protocols and indices specifically developed for this region. The program thoroughly monitors volunteer data collection and lab identification techniques to ensure compatibility with established protocols. Complete data cross-checks and programmatic evaluation ensure accurate and timely data that are quality certified.

SHEP provides local communities and watershed organizations with a premier volunteer benthic macroinvertebrate monitoring program that produces reliable data and actively engages citizens in the work of the watershed.

SHEP

- Monitors the health of valuable water resources,
- Uses research-based multiple index metrics,
- Professionally trains adult volunteers,
- Utilizes multiple levels of quality control to ensure quality results,
- Provides relevant, reliable data to local decision makers,
- Engages citizens in water resource management and assessment,

- Promotes water resource health to community members, and
- Promotes partnership between local governments, state agencies and community residents.

2.0 RICE CREEK WATERSHED SHEP

Watershed districts are special purpose units of local government whose boundaries follow those of a natural watershed. The Rice Creek Watershed District (RCWD) was established in 1972 to conserve and restore the water resources of the district for the beneficial use of current and future generations. It is a governmental organization managed by a Board of Managers appointed by the county commissions of Anoka, Ramsey and Washington Counties. About 10 percent of the watershed's surface area is occupied by lakes, the largest of which are White Bear Lake and Bald Eagle Lake. About 13 percent of the watershed consists of wetland areas.

RCWD provides most of the funds for SHEP, which is coordinated primarily by Friends of the Mississippi River (FMR) in partnership Fortin Consulting and the MPCA. Local program partners included the University of Minnesota Water Resource Center, Anoka County Parks and local landowners. Matching resources for SHEP are provided by FMR.

In 2006, RCWD staff selected SHEP monitoring sites, which were chosen to gauge the effects of recent watershed restoration and stewardship activities by being upstream or downstream of such activities. SHEP was first implemented in a pilot phase in the summer and fall of 2006 with Rice Creek Above and Below and Locke Lake Above and Below (Figure 1).

Rice Creek Above and Below sites (both of which are within the boundaries of the restoration) were selected at the beginning and end of the restoration in part to gauge the long-term stream health changes that result from this restoration activity. A third site, Rice Creek Irondale, was introduced to the program in 2012 further downstream of the restoration area, before the Rice Creek discharges into Long Lake.

Locke Lake Above and Below sites are just upstream of Rice Creek’s outflow to the Mississippi River. RCWD restoration activities involved installing shoreland restoration and shoreland stabilization measures on properties adjacent to Locke Lake.

In summer 2006, as part of a grant from the Legislative Commission on Minnesota Resources, restoration was performed at three locations along Hardwood Creek that had been identified as having severe bank erosion. Banks were stabilized and in-stream habitat improvement techniques were implemented.

In 2007, Hardwood Creek Above and Clearwater Creek were added. In 2010, Hardwood Creek Below was added, and Locke Lake Park was added in 2012.

Currently, SHEP sites include

- Northern three sites: Hardwood Creek Above, Hardwood Creek Below and Clearwater Creek
- Middle three sites: Rice Creek Above, Rice Creek Below and Rice Creek Irondale, and
- Southern three sites: Locke Lake Park, Locke Lake Above and Locke Lake Below.

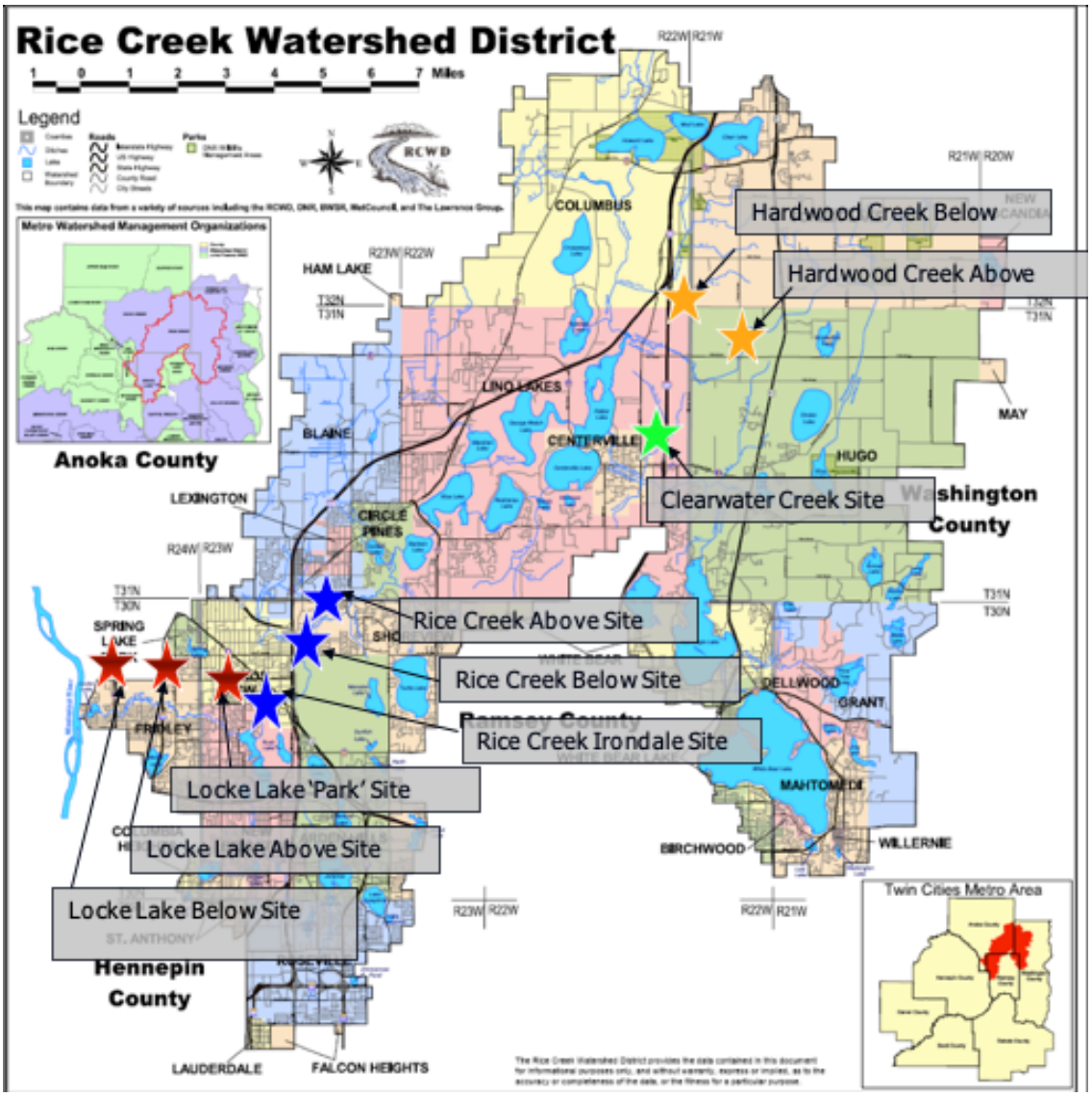

Figure 1: SHEP sampling sites in the Rice Creek Watershed District

The RWCD provides a variety of useful information on their Water Quality Reports and Plans page[1] that provides a picture of stream health and planning in the district. Total

[1] Rice Creek Watershed District Water Quality Reports and Plans, https://www.ricecreek.org/index.asp?SEC=59FA6C4B-0497-43A0-8FD3-B9D2EC83A2E3&Type=B_BASIC. Accessed 7 Mar 2021.

Maximum Daily Load (TMDL) documents are listed and referenced as well as a carp management program, lake management action plan, the 2010 State of the Lakes Report and the 2009 Stream Monitoring Report.

The Stream Monitoring Report[2] documents dissolved oxygen data, transparency, total suspended solids, phosphorus loads and chloride levels for Rice Creek, Hardwood Creek and Clearwater Creek in 2009. Data suggested that, while some impairments existed in the streams, most of the time, water quality standards were not violated, and chloride levels were not problematic.

2.1 Northern Sites: Hardwood Creek and Clearwater Creek

In 2002, Hardwood Creek was included on Minnesota's list of impaired waters because the amount, condition and diversity of aquatic life such as fish were too low. Furthermore, there was not enough oxygen in the water to support fish and aquatic insects. A TMDL collaborative study between the MPCA and RCWD began in 2004 to address the impairments on Hardwood Creek. The TMDL was approved by the MPCA in 2009.[3] In 2014, Hardwood Creek was listed as impaired for aquatic life.[4]

Midpoint sampling locations of Hardwood Creek Above and Below can be seen in Figures 2 and 3, respectively. SHEP sampling began in 2007 for Hardwood Creek Above and in 2010 at Hardwood Creek Below.

[2] 2009 Stream Monitoring Report, https://www.ricecreek.org/vertical/Sites/%7BF68A5205-A996-4208-96B5-2C7263C03AA9%7D/uploads/2009_Stream_Monitoring.pdf Accessed 11 Mar 2021.
[3] Hardwood Creek – Impaired Biota (fish) and Low Dissolved Oxygen: TMDL Project, https://www.pca.state.mn.us/water/tmdl/hardwood-creek-impaired-biota-fish-and-low-dissolved-oxygen-tmdl-project. Accessed 11 Mar 2021.
[4] Rice Creek Watershed District Impaired Waters Inventory Map https://www.ricecreek.org/vertical/Sites/%7BF68A5205-A996-4208-96B5-2C7263C03AA9%7D/uploads/RCWD_Impaired_Waters_Inventory_Map_2014%281%29.pdf. Accessed 7 Mar 2021.

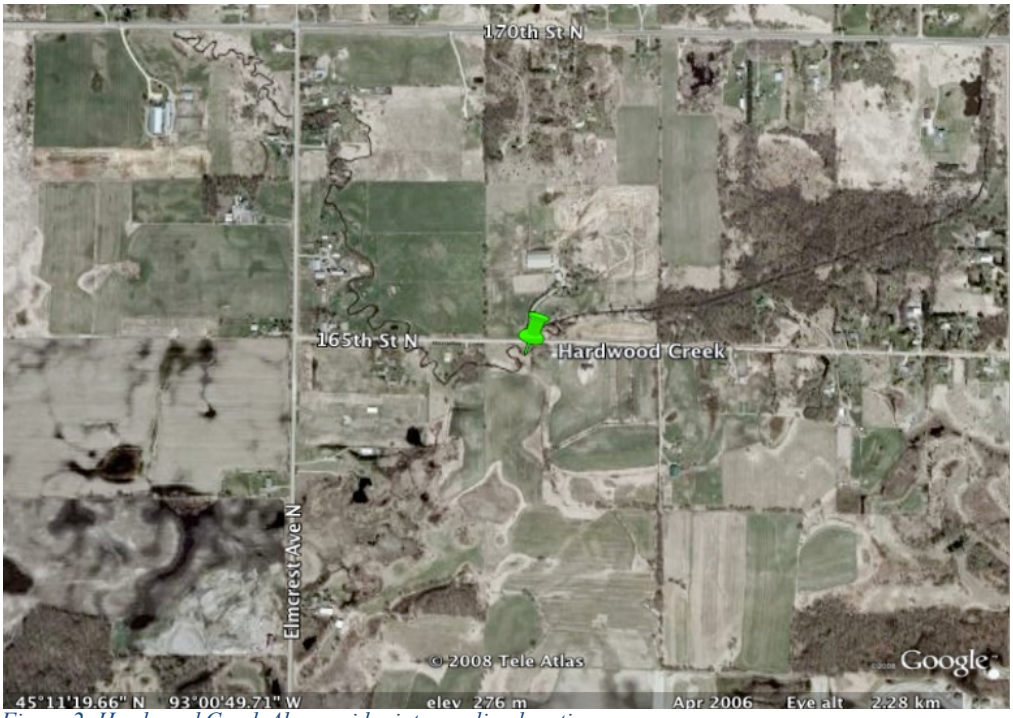

Figure 2: Hardwood Creek Above midpoint sampling location

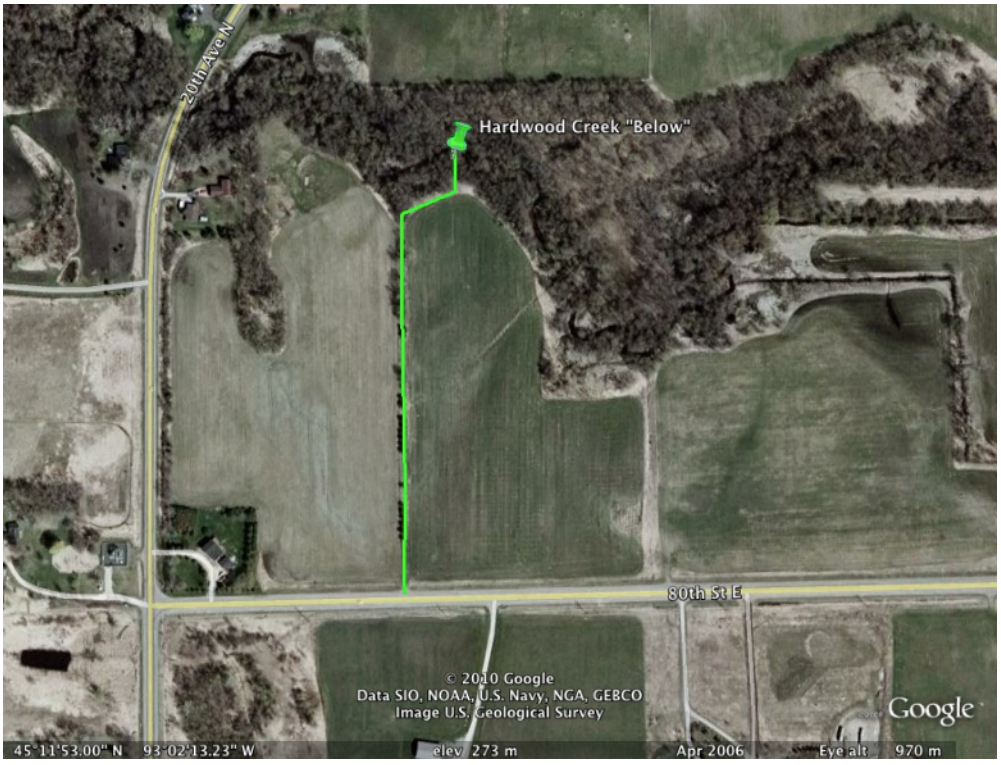

Figure 3: Hardwood Creek Below midpoint sampling location

In 2014, Clearwater Creek was also listed as impaired for aquatic life. SHEP sampling began in 2007. The midpoint sampling location of Clearwater Creek can be seen in Figure 4.

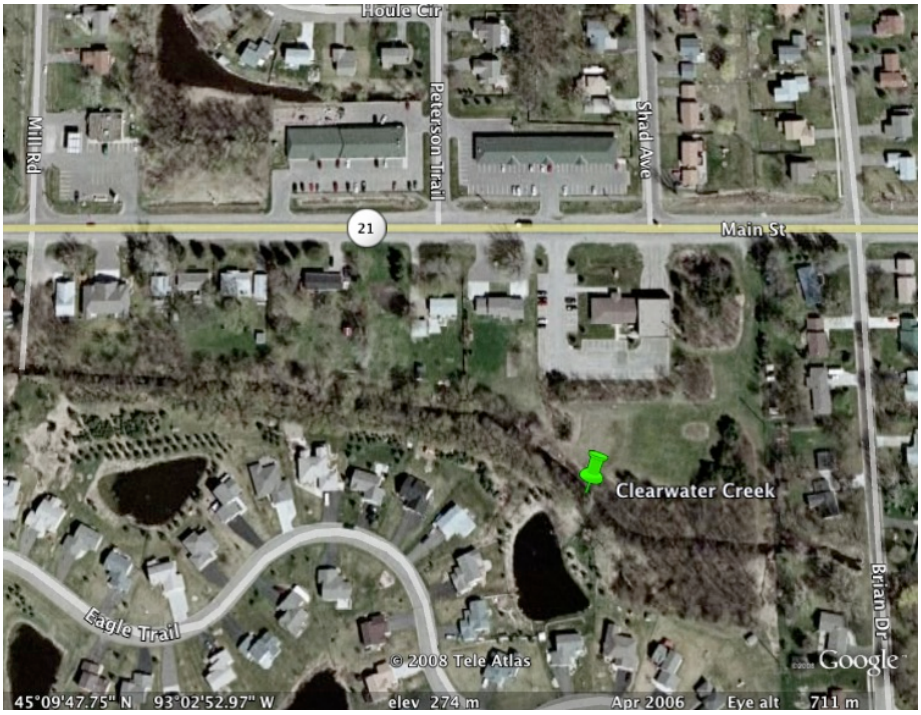

Figure 4: Clearwater Creek midpoint sampling location

2.2 Middle Sites: Rice Creek

In 2014, Rice Creek was listed as impaired for aquatic life. In 2015, RCWD and Emmons and Olivier Resources Inc. completed a re-meander and restoration of a significant reach of Rice Creek.[5] The project was entirely within Rice Creek North Regional Park and includes a stretch of Rice Creek located between County Road J, Lexington Avenue and County Road I. The goal of the project was to restore the historical winding flow path and surrounding wetland hydrology for this reach of stream, which was originally straightened in the early 1900's. Many benefits of this project, such as habitat enhancement, water quality improvement and enriched recreation opportunities, have begun to be realized. While two of the SHEP sampling sites are titled Above and Below for descriptive purposes, both sites are within the boundaries of the restoration.

SHEP sampling began in 2006 for Rice Creek Above and Below and in 2012 for Rice Creek Irondale. Midpoints of the sampling locations for Rice Creek Above and Below can be seen in Figure 5, and the midpoint sampling location for Rice Creek Irondale is shown in Figure 6.

[5] McCormick, Tori J. "Project to restore Rice Creek's meandering path already shows positives for water, wildlife." Special to the Star Tribune, Sept 5, 2019. https://www.startribune.com/project-to-restore-rice-creek-s-meandering-path-already-shows-positives-for-water-wildlife/559485082/ Accessed 7 Mar 2021.

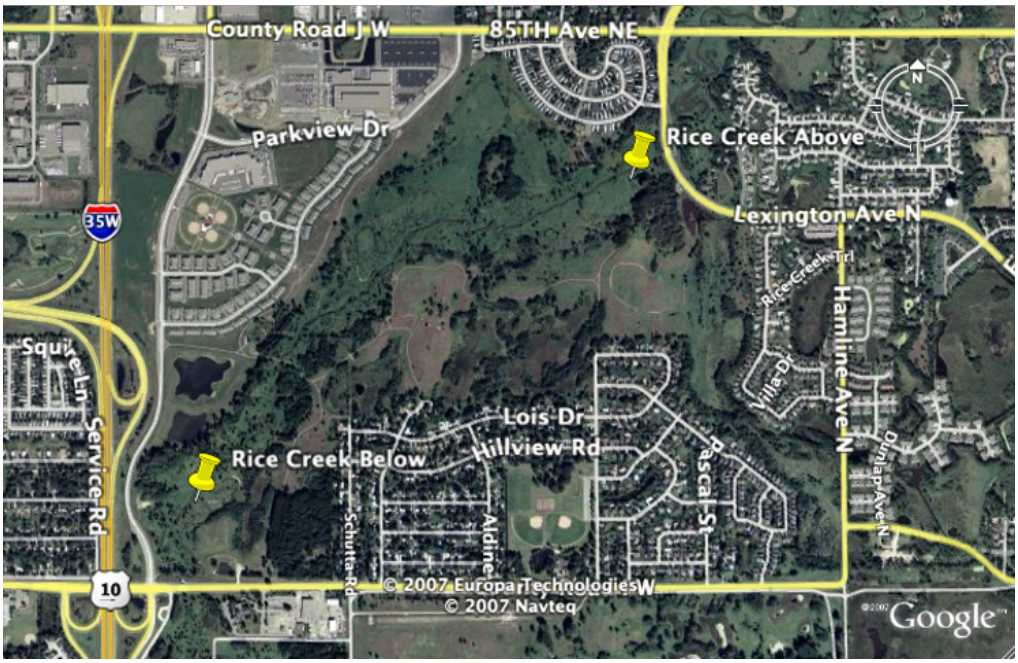

Figure 5: Rice Creek Above and Below midpoint sampling locations

Figure 6: Rice Creek Irondale midpoint sampling location

2.3 Southern Sites: Locke Lake

In 2014, Rice Creek near Locke Lake was listed as impaired for aquatic recreation and aquatic life. Restoration activities by the Rice Creek Watershed District has focused on installing shoreland restoration and shoreland stabilization measures on properties adjacent to Locke Lake.

SHEP sampling began at in 2006 at Locke Lake Above and Below and in 2012 at Locke Lake Park. Midpoints of the sampling locations for Locke Lake Above and Below can be seen in Figure 7, and the midpoint sampling location for Locke Lake Park is shown in Figure 8.

Figure 7: Locke Lake Above and Below midpoint sampling locations

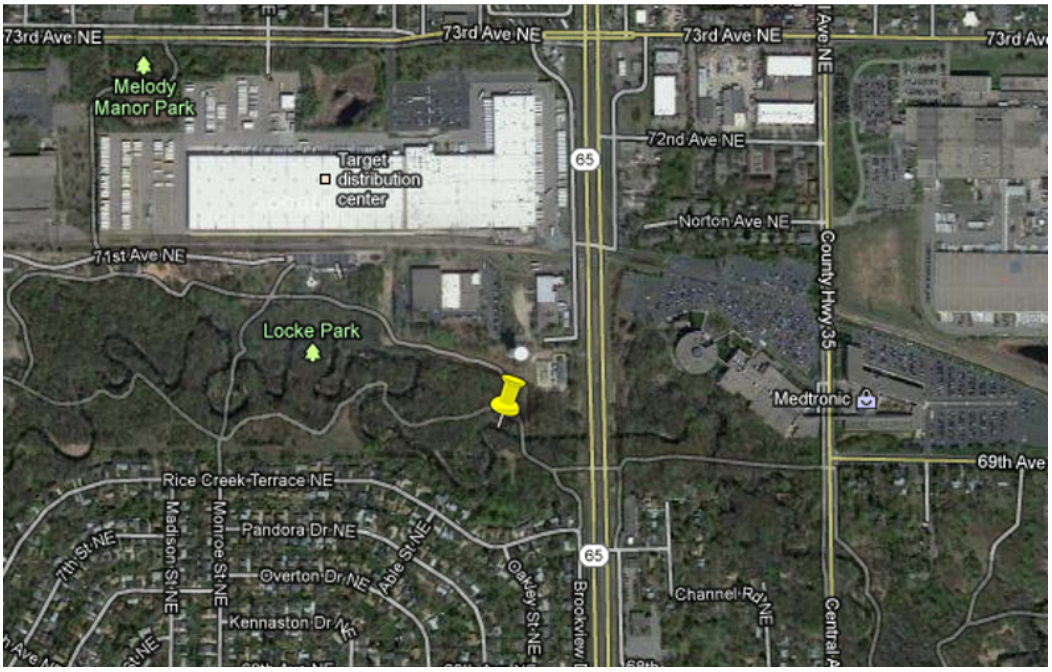

Figure 8: Locke Lake Park midpoint sampling location

3.0 SHEP OPERATIONS

3.1 Volunteer Recruitment

FMR recruits volunteers who preferably live in the Rice Creek watershed to fill spots as SHEP volunteers when needed. In 2021, FMR recruited five new volunteers, including two family members of previous volunteers, and two Rice Creek watershed residents.

Twenty-eight volunteers participated in SHEP in 2021. Volunteers were divided into three teams to monitor the nine sites. Each team was led by team leaders, who are an integral part of SHEP and were selected by project staff. Team leaders received a small stipend (unless they had matching funds requirement associated with their volunteer time) and were responsible for managing monitoring activities and communication within their team.

3.2 Team Assignments

Team leaders, team members and monitoring location assignments are listed below.

Team 1
Monitoring Locations: Hardwood Creek and Clearwater Creek
Site Names: Hardwood Creek Above, Hardwood Creek Below, Clearwater Creek
Team Leaders: Gary Averbeck and Wayne LeBlanc
Team Members: Barbara Bor, Linda Grundter, Laura Lyle, DanielleMcLaughlin, Tere O'Connell, John Sullivan, Kim Sullivan, Jake Thering and Ray Thering

Team 2
Monitoring Location: Rice Creek Area
Site Names: Rice Creek Above, Rice Creek Below, Rice Creek Irondale
Team Leaders: Courtney Jones
Team Members: Bob Bartlett, Ralph Butkowski, Gary Ellis, Michael Hagedorn, Kaden Li, Jo Ann Morse and Hanna Wallmow

Team 3
Monitoring Location: Locke Lake Area
Site Names: Locke Lake Above, Locke Lake Below, Rice Creek Park
Team Leaders: Katherine and Darrell Majkrzak
Team Members: Rachel Beise, Rich Femling, Elan Majkrzak, Jennifer Olson, Lorien Radmer, Brad Sielaff and Susan Young

3.3 Training

Advanced volunteer training is essential to the success of SHEP. In 2021, volunteers and FMR and Fortin staff met in person to review sampling methodology and give new volunteers time in a stream to practice using the equipment.

Volunteers participated in a training session in August of 2021, which covered safety while sampling in the field and macroinvertebrate sampling protocols set by the MPCA.[6] Former SHEP coordinator Jennifer Hadley covered FMR's COVID safety measures for field work, which included wearing a mask over mouth and nose, cleaning hands with sanitizer before and after sampling, no sharing of field sampling equipment (one person uses a particular piece of equipment the entire day) and staying six feet apart from one another.

Katie Farber from Fortin Consulting reviewed the SHEP monitoring protocol, which includes a biological assessment (collection of benthic macroinvertebrates) and a physical habitat assessment. Katie noted where to sample for macroinvertebrates, the target number of jabs and the best method of transferring samples to plastic jars. The habitat assessment review included how to measure stream flow, stream depth and stream width as well as noting water odor, temperature and appearance. Volunteers were also reminded to note general weather information from that day and from the recent past as well as when not to sample (high rainfall previous day).

After the training, FMR staff member Jennifer Hadley distributed sampling equipment to each team leader.

3.4 Field Sampling

SHEP volunteer teams monitored their sites in late August to mid-September 2021 using the MPCA's multi-habitat monitoring protocol. This approach samples major habitats in proportional representation within each sampling reach. Benthic macroinvertebrates were collected systematically from all available in-stream habitats by jabbing with a D-frame dip net. At least 20 samples or jabs were taken from across all major habitat types (snags and woody debris, vegetated banks, cobble and sand/fine sediment bottom areas) in the reach.

The physical habitat was assessed by measuring stream width, stream depth across three transects, water velocity, water temperature and appearance.

[6] Macroinvertebrate Data Collection Protocols for Lotic Waters in Minnesota, https://www.pca.state.mn.us/sites/default/files/wq-bsm3-12a.pdf. Accessed 11 Mar 2021.

3.5 Lab Identification

In fall 2021, volunteers were able to once again sort and identify macroinvertebrates. Each team coordinated the sharing of FMR's microscopes, and reserved community spaces at local buildings. The volunteers identified the taxonomic classification of benthic macroinvertebrate samples from each sampling site down to family.

Each macroinvertebrate family is assigned a pollution tolerance number between zero and 10 depending on its sensitivity to pollution. A score of zero indicates very sensitive to organic pollution. A 10 indicates very tolerant of organic pollution.

Once macroinvertebrates were identified, site reaches were scored according to the family level biotic index (FBI). FBI is the weighted average of the biotic indices for all the invertebrates in the sample. Pollution intolerant families such as stoneflies (FBI of 0 – 2) can only survive in excellent water quality (Table 1). Pollution tolerant organisms such as leeches and aquatic earthworms can live in clean water or poor-quality water. They have high FBI values (8 – 10).

FBI	Stream Health	Degree of Organic Pollution
0.00-3.75	Excellent	Organic pollution unlikely
3.76-4.25	Very good	Possible slight organic pollution
4.26-5.00	Good	Some organic pollution probable
5.01-5.75	Fair	Fairly substantial pollution likely
5.76-6.50	Fairly poor	Substantial pollution likely
6.51-7.25	Poor	Very substantial pollution likely
7.26-10.0	Very poor	Severe organic pollution likely

Table 1: Water quality evaluation using FBI scores[7]

FBI summarizes the various pollution tolerance values of all families in a sample. The score for a particular monitoring site corresponds to a likely degree of organic pollution present at that location (Table 1). As such, the FBI score is a useful tool for evaluating the general status of organic pollution in streams within a watershed.

3.6 Quality Assurance/Quality Control (QA/QC)

When volunteers identify macroinvertebrates, Katie Farber conducts QA/QC on 33% of the identified macroinvertebrates. In recent years, she has reported close to 100% accuracy rates. Because of its history of recruiting and retaining dedicated volunteers, SHEP has become a reliable source of high-quality data.

[7] Hilsenhoff, William L. "Rapid Field Assessment of Organic Pollution with a Family-Level Biotic Index." *Journal of the North American Benthological Society*, vol. 7, no. 1, 1988, pp. 65–68. *JSTOR*, www.jstor.org/stable/1467832. Accessed 7 Mar 2021.

4.0 MACROINVERTEBRATE RESULTS

First, sample size is looked at because a large sample offers more confidence for a more reliable data set. SHEP protocol requires a minimum of 100 individual invertebrates to be picked and identified per sample.

Second, the number of different macroinvertebrate families found at the site (also known as family richness) is a measure of diversity. In general, more diversity is better. Therefore, a larger number of families may reflect a healthier community than a smaller number.

The dominant family is a record of what macroinvertebrate was most abundant. Its percentage of the total invertebrate sample indicates how dominant a single family is at a site. A high percent dominance is suboptimal; it indicates a less diverse community of macroinvertebrates.

Volunteers also recorded the number of mayfly (Ephemeroptera), stonefly (Plecoptera) and caddisfly (Trichoptera) families in the sample. These families (referred to as EPT families) represent the pollution intolerant insects. A higher EPT score reflects better water quality than a lower one.

As mentioned before, the FBI score is a useful tool for evaluating the general status of organic pollution in streams within a watershed.

4.1 Hardwood Creek Above

Number of individuals:

- 119 invertebrates were identified in this sample. This is an adequate sample size.

Dominant Family:

- Gammaridae (scud)

Gammaridae have a tolerance value of 4 (moderate) on a scale of 0-10 (the lower the tolerance value, the lower their tolerance to pollution). Gammaridae are crustaceans and related to Hyalellidaes. The differentiation between the two families is a tiny flagellum found on the antennae of the Gammaridae. They can be extremely abundant in water bodies without fish and are important in the breakdown of organic matter. They generally live in shallow regions of most waterbodies, and are found in snags and vegetation. They are an important food source for fish and other invertebrate predators.[8]

Percent Dominance:

It is assumed that families are more evenly distributed among the sample if the dominant family makes up a lower percentage of the sample.

Year	Dominant Family	% Dominance	Dominant Family (2nd)	% Dominance
2021	Gammaridae	34	Chironomidae	14
2020	Gammaridae	29	Heptageniidae	21
2019	Simuliidae	29	Baetidae	26
2018	Simuliidae	42	Baetidae	26
2017	Baetidae	33	Simuliidae	30
2016	Baetidae	56	Simuliidae	15
2015	Baetidae	40	Simuliidae	35
2014	Simuliidae	35	Baetidae	24
2013	Hyalellidae	35	Heptageniidae	27
2012	Heptageniidae	40	Chironomidae	19
2011	Gammaridae	44	Simuliidae	19
2010	Gammaridae	30	Chironomidae	28
2009	Chironomidae	38	NA	NA
2008	Decapoda	25	NA	NA
2007	Hyalellidae	40	NA	NA

Table 2: Hardwood Creek Above data

Note: After dominating in 2010 and 2011, Gammaridae made up only 0.5% of the sample in 2012 and were absent in the sample collections from 2013 to 2016. In 2017, they reappeared in the samples, and Gammaridae dominates again since 2020.

[8] Bouchard, R. W., Ferrington, L. C., & Karius, M. L. (2004) *Guide to aquatic invertebrates of the Upper Midwest: Identification manual for students, citizen monitors, and Aquatic Resources Professionals*. University of Minnesota.

Number of Families (identified in a sample):
The higher the diversity the better.

Year	Number of Families
2021	16
2020	8
2019	15
2018	12
2017	17
2016	13
2015	12
2014	13
2013	12
2012	18
2011	13
2010	18
2009	18
2008	19
2007	22

Table 3: Hardwood Creek Above families

Number of EPT Families (pollution sensitive):
EPT (Ephemeroptera-Plecoptera-Tricoptera or Mayfly-Stonefly-Caddisfly) are three Orders of invertebrates with low tolerance to pollution. The more of these families in a sample, the better. More than 10-12 families is good.

Year	Number of EPT Families	Percent make-up of EPT Families	EPT Families
2021	3	22	Baetidae, Heptageniidae, Hydropsychidae
2020	3	50	Baetidae, Heptageniidae, Hydropsychidae
2019	4	50	Baetidae, Caenidae, Heptageniidae, Hydropsychidae,
2018	3	45	Baetidae, Heptageniidae, Hydropsychidae
2017	3	38	Baetidae, Heptageniidae, Hydropsychidae
2016	5	70	Baetidae, Caenidae, Heptageniidae, Hydropsychidae, Phryganeidae
2015	4	46	Baetidae, Caenidae, Heptageniidae, Hydropsychidae
2014	4	51	Baetidae, Caenidae, Heptageniidae, Hydropsychidae
2013	3	31	Baetidae, Heptageniidae, Siphlonuridae
2012	5	55	Baetidae, Caenidae, Heptageniidae, Hydropsychidae, Hydrophilidae
2011	3	9	Baetidae, Heptageniidae, Hydropsychidae
2010	3	17	Baetidae, Heptageniidae, Hydropsychidae
2009	4	NA	NA
2008	5	NA	NA
2007	3	NA	NA

Table 4: Hardwood Creek Above EPT families

Family Biotic Index (FBI):

This program identifies macroinvertebrates to the family level. Each family is assigned a tolerance value rating from 0-10. The lower the number, the more sensitive to pollution. The FBI score is the average pollution tolerance of all of the macroinvertebrates identified in a sample.

Year	FBI Score	Score Description
2021	4.8	Good – Some organic pollution probable
2020	4.3	Good – Some organic pollution probable
2019	5.2	Fair – Fairly substantial pollution likely
2018	5.0	Good – Some organic pollution probable
2017	4.9	Good – Some organic pollution probable
2016	4.8	Good – Some organic pollution probable
2015	5.2	Fair – Fairly substantial pollution likely
2014	5.2	Fair – Fairly substantial pollution likely
2013	6.2	Fairly Poor – substantial pollution likely
2012	5.0	Good – Some organic pollution probable
2011	5.0	Good – Some organic pollution probable
2010	6.0	Fairly Poor – substantial pollution likely
2009	6.6	Poor – very substantial pollution likely
2008	6.3	Fairly Poor – substantial pollution likely
2007	7.3	Very Poor – severe organic pollution likely

Table 5: Hardwood Creek Above FBI score

Summary:

Hardwood Creek Above has been sampled 15 consecutive years since 2007. In 2021, the FBI score indicates “Good” health. Overall, the FBI trend has improved since initial years of surveys, but the trend has been stable since 2011, consistently showing a stream health score of “Fair” to “Good” (with exception to 2013). Overall, the FBI score, the dominating families, the family diversity, and the EPT family representatives have been consistent for most years. In 2010 and 2013, when the scores were “Fairly Poor”, lower counts of Baetidae and higher counts of Chironomidae and Hyalellidae were present and impacted the score. Water levels and sampling locations may play a part in these differences. Baetidae and Simuliidae have heavily dominated the samples for many years. Baetidae has a tolerance value of 4 and Simuliidae has a tolerance value of 6, so the FBI score average wavering around 5 is reasonable. In 2021, Simuliidae were absent, but diversity of families rebounded. As usual, other families present are represented in smaller proportions. Variability in family representation may be caused by environmental factors including water levels, habitat availability, collection location, or other sources of disturbance in the area. Note: The summer and early fall of 2021 included very low precipitation amounts and events.

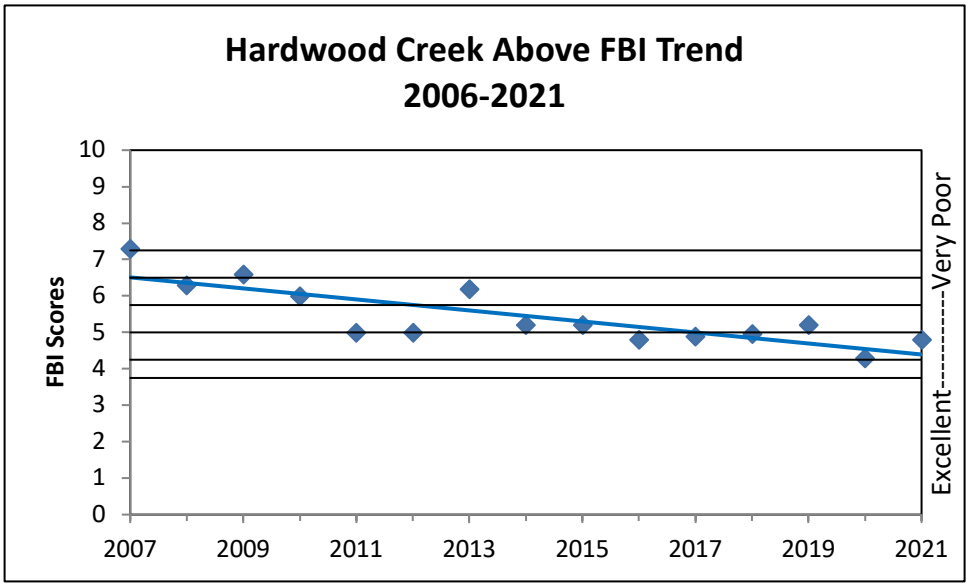

Figure 9. A stream health trend was created using scores calculated for family biotic index (FBI). Contrary to common sense, a descending trendline indicates improvement in the stream health since organisms with sensitivity to water pollution score lower on the family biotic index.

Family List – Hardwood Creek Above				
Family Name	**Tolerance Value**	**Number of Individuals 2021**	**Number of Individuals 2020**	**Number of Individuals 2019**
Asellidae (crustacean)	8	2		1
Baetidae (mayfly)	4	10	29	39
Belostomatidae (true bug)	10			3
Caenidae (mayfly)	7			1
Calopterygidae (damselfly)	5	1		
Ceratopogonidae (truefly)	6			1
Chironomidae (truefly)	6	17	10	15
Coengrionidae (damselfly)	9			2
Corixidae (true bug)	9	1		
Culicidae (truefly)	8	3		
Decapoda (crustacean)	6	7		1
Elmidae (beetle)	4	12		
Gammaridae (crustacean)	4	40	47	3
Gastropoda (snail)	7	3		
Gerridae (true bug)	na		1	
Heptageniidae (mayfly)	4	15	33	21
Hirundinea (leech)	10			4
Hydropsychidae (caddisfly)	4	1	19	14
Notonectidae	na		2	1
Pelecypoda (clam)	7	3		
Sialidae (alderfly)	4	1		
Simuliidae (truefly)	6		20	43
Tabanidae (truefly)	6	2		
Tipulidae (truefly)	3			3
Veliidae (true bug)	na	1		

Table 6: Hardwood Creek Above family list

4.2 Hardwood Creek Below

Number of individuals:

- 140 invertebrates were identified in this sample. This is an adequate sample size.

Dominant Family:

- Gammaridae (scud)

Gammaridae have a tolerance value of 4 (moderate) on a scale of 0-10 (the lower the tolerance value, the lower their tolerance to pollution). Gammaridae are crustaceans and related to Hyalellidaes. The differentiation between the two families is a tiny flagellum found on the antennae of the Gammaridae. They can be extremely abundant in water bodies without fish and are important in the breakdown of organic matter. They generally live in shallow regions of most waterbodies, and are found in snags and vegetation. They are an important food source for fish and other invertebrate predators.[9]

Percent Dominance:

It is assumed that families are more evenly distributed among the sample if the dominant family makes up a lower percentage of the sample.

Year	Dominant Family	% Dominance	Dominant Family (2nd)	% Dominance
2021	Gammaridae	29	Culicidae	18
2020	Bivalvia	61	Chironomidae	19
2019	Gammaridae	49	Baetidae	16
2018	Baetidae	19	Chironomidae	18
2017	Gammaridae	49	Chironomidae	10
2016	Gammaridae	86	Chironomidae/Coengrionidae/Baetidae	3 (each)
2015	Gammaridae	65	Baetidae	10
2014	Gammaridae	63	Hydropsychidae	14
2013	Gammaridae	24	Heptageniidae	22
2012	Gammaridae	51	Chironomidae	19
2011	Gammaridae	60	Baetidae	12
2010	Gammaridae	38	Chironomidae	15

Table 7: Hardwood Creek Below data

Note: Gammaridae dominated samples for most years, but only made up 3.5% of the sample in 2018 and 8% in 2020.

[9] Bouchard, R. W., Ferrington, L. C., & Karius, M. L. (2004) *Guide to aquatic invertebrates of the Upper Midwest: Identification manual for students, citizen monitors, and Aquatic Resources Professionals*. University of Minnesota.

Number of Families (identified in a sample):
The higher the diversity, the better.

Year	Number of Families
2021	19
2020	9
2019	14
2018	17
2017	17
2016	9
2015	13
2014	10
2013	15
2012	20
2011	11
2010	16

Table 8: Hardwood Creek Below families

Number of EPT Families (pollution sensitive):
EPT (Ephemeroptera-Plecoptera-Tricoptera or Mayfly-Stonefly-Caddisfly) are three Orders of invertebrates with low tolerance to pollution. The more of these families in a sample, the better. More than 10-12 families is good.

Year	Number of EPT Families	Percent make-up of EPT Families	EPT Families
2021	1	6	Heptageniidae
2020	4	11	Baetidae, Caenidae, Heptageniidae, Potamanthidae
2019	3	24	Baetidae, Heptageniidae, Hydropsychidae
2018	5	37	Baetidae, Caenidae, Heptageniidae, Hydropsychidae, Polymitarcyidae
2017	3	20	Baetidae, Heptageniidae, Hydropsychidae
2016	2	4	Baetidae, Heptageniidae
2015	4	22	Baetidae, Heptageniidae, Hydropsychidae, Leptoceridae
2014	3	29	Baetidae, Heptageniidae, Hydropsychidae
2013	4	34	Baetidae, Caenidae, Heptageniidae, Hydropsychidae
2012	4	17	Baetidae, Ephemeridae, Heptageniidae, Hydropsychidae
2011	3	27	Baetidae, Heptageniidae, Hydropsychidae
2010	3	17	Baetidae, Heptageniidae, Hydropsychidae

Table 9: Hardwood Creek Below EPT families

Family Biotic Index (FBI):

This program identifies macroinvertebrates to the family level. Each family is assigned a tolerance value rating from 0-10. The lower the number, the more sensitive to pollution. The FBI score is the average pollution tolerance of all of the macroinvertebrates identified in a sample.

Year	FBI Score	Score Description
2021	5.8	Fairly Poor – Substantial organic pollution likely
2020	6.2	Fairly Poor – Substantial organic pollution likely
2019	4.8	Good – Some organic pollution probable
2018	5.1	Fair – Fairly substantial pollution likely
2017	4.5	Good – Some organic pollution probable
2016	4.3	Good – Some organic pollution probable
2015	4.4	Good – Some organic pollution probable
2014	4.2	Very good – possible slight organic pollution
2013	4.9	Good – Some organic pollution probable
2012	4.6	Good – Some organic pollution probable
2011	4.4	Good – Some organic pollution probable
2010	5.1	Fair – Fairly substantial pollution likely

Table 10: Hardwood Creek Below FBI score

Summary:

Hardwood Creek Below has been sampled 12 consecutive years since 2010. In 2021, the FBI score indicated "Fairly poor" health which is declined compared to the history of surveys at this site. The family diversity is high, but only one sensitive family was represented in 2021. Gammaridae reclaimed dominance of the sample which is typical of this site. The FBI scores of 2020 and 2021 are tipping the health trend which has been stable throughout the previous 10 years of sampling. The FBI score appears to reflect the percentage of dominance by the Gammaridae. Because the tolerance value of Gammaridae is 4, when it over-dominates it reflects a healthier FBI score. Variability in family representation may be caused by environmental factors including water levels, habitat availability, collection location, or other sources of disturbance in the area. Note: The summer and early fall of 2021 included very low precipitation amounts and events.

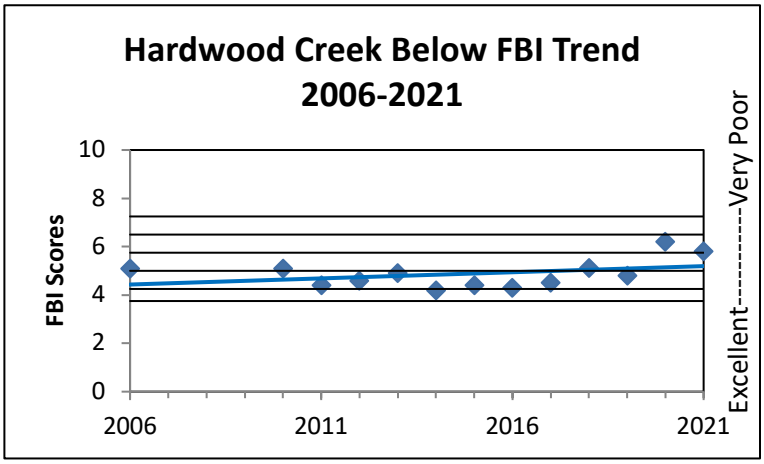

Figure 10. A stream health trend was created using scores calculated for family biotic index (FBI). Contrary to common sense, a descending trendline indicates improvement in the stream health since organisms with sensitivity to water pollution score lower on the family biotic index.

Family List – Hardwood Creek Below				
Family Name	**Tolerance Value**	**Number of Individuals 2021**	**Number of Individuals 2020**	**Number of Individuals 2019**
Asellidae (crustacean)	8	2		
Baetidae (mayfly)	4		4	19
Belostomatidae (true bug)	10	1		5
Caenidae (mayfly)	7		1	
Calopterygidae	5	2		
Chironomidae (truefly)	6	8	21	5
Coengrionidae (damselfly)	9	8		1
Corixidae (true bug)	9	10		1
Culcidae (truefly)	8	25		
Dolichopodidae (truefly)	4	1		
Elmidae (beetle)	4	19		
Gammaridae (crustacean)	4	40	9	58
Gerridae (true bug)	na	7	1	1
Heptageniidae (mayfly)	4	8	6	8
Hydrophilidae (beetle)	5		1	
Hydropsychidae (caddisfly)	4			1
Notonectidae (true bug)	na	1		
Oligochaeta (aquatic worm)	8	1		
Pelecypoda (clam)	7		69	9
Pleidae (true bug)	na	1		
Potamanthidae (mayfly)	4		1	
Pyralidae (aquatic moth)	5	1		
Sialidae (alderfly)	4	2		1
Simuliidae (truefly)	6		9	9
Stratiomyidae (truefly)	8	2		
Veliidae (true bug)	6	1		

Table 11: Hardwood Creek Below family list

4.3 Clearwater Creek

Number of individuals:

- 130 invertebrates were identified in this sample. This is an adequate sample size.

Dominant Family:

- Gammaridae (scud)

Gammaridae have a tolerance value of 4 (moderate) on a scale of 0-10 (the lower the tolerance value, the lower their tolerance to pollution). Gammaridae are crustaceans and related to Hyalellidaes. The differentiation between the two families is a tiny flagellum found on the antennae of the Gammaridae. They can be extremely abundant in water bodies without fish and are important in the breakdown of organic matter. They generally live in shallow regions of most waterbodies, and are found in snags and vegetation. They are an important food source for fish and other invertebrate predators.[10]

Percent Dominance:

It is assumed that families are more evenly distributed among the sample if the dominant family makes up a lower percentage of the sample.

Year	Dominant Family	% Dominance	Dominant Family (2nd)	% Dominance
2021	Gammaridae	27	Elmidae	20
2020	Chironomidae	29	Hydropsychidae	23
2019	Hydropsychidae	45	Simuliidae	30
2018	Gammaridae	34	Hydropsychidae	22
2017	Gammaridae	37	Hydropsychidae	31
2016	Gammaridae	51	Chironomidae	19
2015	Gammaridae	67	Veliidae	12
2014	Simuliidae	32	Gammaridae	23
2013	Gammaridae	58	Chironomidae	17
2012	Gammaridae	56	Heptageniidae	19
2011	Gammaridae	43	Hydropsychidae	20
2010	Gammaridae	76	Hydropsychidae	8
2009	Hydropsychidae	17	Hyalellidae	14
2008	Chironomidae	26	NA	NA
2007	Heptageniidae	19	NA	NA

Table 12: Clearwater Creek data

[10] Bouchard, R. W., Ferrington, L. C., & Karius, M. L. (2004) *Guide to aquatic invertebrates of the Upper Midwest: Identification manual for students, citizen monitors, and Aquatic Resources Professionals*. University of Minnesota.

Number of Families (identified in a sample):
The higher the diversity, the better.

Year	Number of Families
2021	17
2020	8
2019	7
2018	12
2017	15
2016	5
2015	10
2014	11
2013	12
2012	16
2011	19
2010	10
2009	18
2008	18
2007	19

Table 13: Clearwater Creek families

Number of EPT Families (pollution sensitive):
EPT (Ephemeroptera-Plecoptera-Tricoptera or Mayfly-Stonefly-Caddisfly) are three Orders of invertebrates with low tolerance to pollution. The more of these families in a sample, the better. More than 10-12 families is good.

Year	Number of EPT Families	Percent make-up of EPT Families	EPT Families
2021	1	2	Hydropsychidae
2020	1	23	Hydropsychidae
2019	2	51	Baetidae, Hydropsychidae
2018	1	34	Hydropsychidae
2017	1	31	Hydropsychidae
2016	1	17	Hydropsychidae
2015	3	8	Baetidae, Hydropsychidae, Leptoceridae
2014	2	13	Heptageniidae, Hydropsychidae
2013	3	4.5	Heptageniidae, Hydropsychidae, Leptoceridae
2012	2	20	Heptageniidae, Hydropsychidae
2011	4	28	Baetidae, Heptageniidae, Hydropsychidae, Leptoceridae
2010	2	9	Heptageniidae, Hydropsychidae
2009	5	36	Baetidae, Caenidae, Heptageniidae, Hydropsychidae, Phrygaenidae
2008	4	NA	NA
2007	4	NA	NA

Table 14: Clearwater Creek EPT families

Family Biotic Index (FBI):
This program identifies macroinvertebrates to the family level. Each family is assigned a tolerance value rating from 0-10. The lower the number, the more sensitive to pollution. The FBI score is the average pollution tolerance of all of the macroinvertebrates identified in a sample.

Year	FBI Score	Score Description
2021	5.0	Good – Some organic pollution probable
2020	4.8	Good – Some organic pollution probable
2019	4.8	Good – Some organic pollution probable
2018	4.7	Good – Some organic pollution probable
2017	4.5	Good – Some organic pollution probable
2016	4.6	Good – Some organic pollution probable
2015	4.4	Good – Some organic pollution probable
2014	5.6	Fair – Fairly substantial pollution likely
2013	4.9	Good – Some organic pollution probable
2012	4.6	Good – Some organic pollution probable
2011	4.7	Good – Some organic pollution probable
2010	4.5	Good – some organic pollution probably
2009	6.3	Fairly Poor – Substantial pollution likely
2008	5.7	Fair – Fairly substantial pollution likely
2007	5.9	Fairly Poor – Substantial pollution likely

Table 15: Clearwater Creek FBI score

Summary:
Clearwater Creek has been sampled 15 consecutive years since 2007. The FBI scores are consistent, scoring "Good" most years, and the health trend is stable. Gammaridae has dominated most years, including 2021. The diversity is high in 2021; however, there is a low representation of sensitive species. Variability in family representation and percent make-up may be caused by environmental factors including water levels, habitat availability, collection location, or other sources of disturbance in the area. Note: The summer and early fall of 2021 included very low precipitation amounts and events.

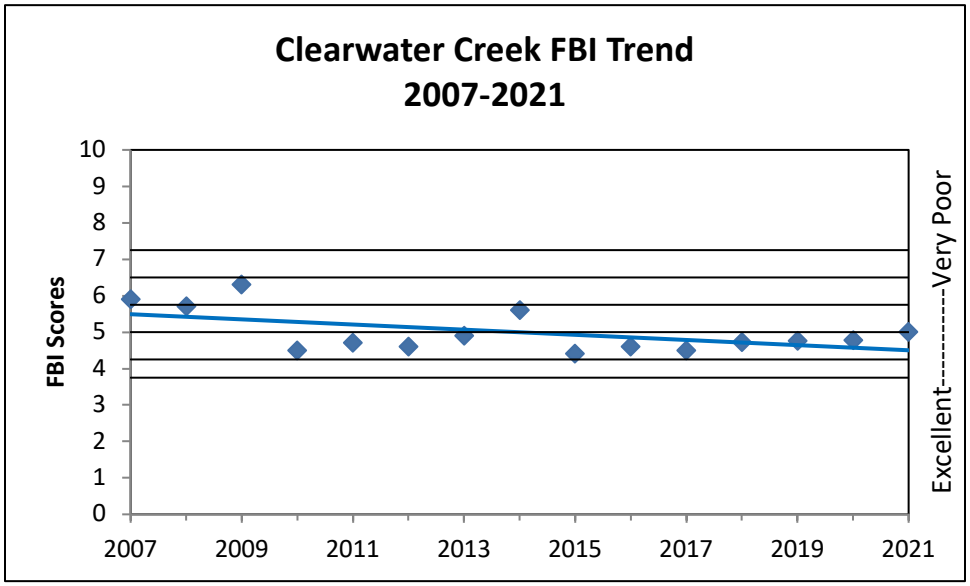

Figure 11. A stream health trend was created using scores calculated for family biotic index (FBI). Contrary to common sense, a descending trendline indicates improvement in the stream health since organisms with sensitivity to water pollution score lower on the family biotic index.

Family List – Clearwater Creek				
Family Name	**Tolerance Value**	**Number of Individuals 2021**	**Number of Individuals 2020**	**Number of Individuals 2019**
Asellidae (crustacean)	8	2		
Baetidae (mayfly)	4		10	10
Belostomatidae (true bug)	10	1		
Calopterygidae (damselfly)	5		3	4
Chironomidae (truefly)	6	7	31	10
Collembola (springtail)	10	1		
Decapoda (crustacean)	6	18		2
Dytiscidae (beetle)	5	1		
Elmidae (beetle)	4	26	17	
Gammaridae (crustacean)	4	35	24	19
Gastropoda (snails)	7	14	2	
Gerridae (true bug)	na	5		
Hirudinea (leech)	10	3		
Hyalellidae (crustacean)	8	1		
Hydropsychidae (caddisfly)	4	3	25	82
Oligochaeta (worm)	8		1	
Simuliidae (truefly)	6	1	4	54
Stratiomyidae	8	1		
Tipuliidae (truefly)	3	2		
Veliidae (true bug)	6	9		

Table 16: Clearwater Creek family list

4.4 Rice Creek Above

Number of individuals:

- 114 invertebrates were identified in this sample. This is an adequate sample size.

Dominant Family:

- Hyalellidae (scud)

Hyalellidae have a tolerance value of 8 (high) on a scale of 0-10 (the lower the tolerance value, the lower their tolerance to pollution). Hyalellidae are crustaceans. They can be extremely abundant in water bodies without fish and are important in the breakdown of organic matter. They generally live in shallow regions of most waterbodies, and are found in snags and vegetation. They are an important food source for fish and other invertebrate predators.[11]

Percent Dominance:

It is assumed that families are more evenly distributed among the sample if the dominant family makes up a lower percentage of the sample.

Year	Dominant Family	% Dominance	Dominant Family (2nd)	% Dominance
2021	Hyalellidae	35	Chironomidae	30
2020	Chironomidae	53	Simuliidae	29
2019	Corixidae	52	Hyalellidae	19
2018	Chironomidae	59	Hydropsychidae	15
2017	Chironomidae	41	Hyalellidae	29
2016	Chironomidae	65	Hyalellidae	15
2015	Chironomidae	62	Coengrionidae	22
2014	Chironomidae	61	Gammaridae	15
2013	Chironomidae	81.5	Pleidae	7
2012	Coengrionidae	53	Hyalellidae	34
2011	Hyalellidae	70	Coengrionidae	9
2010	Hyalellidae	66	Caenidae	14
2009	Chironomidae	51	Coengrionidae	28
2008	Hyalellidae	38	NA	NA
2007	Coengrionidae	55	NA	NA
2006	Coengrionidae	87	NA	NA

Table 17: Rice Creek Above data

[11] Bouchard, R. W., Ferrington, L. C., & Karius, M. L. (2004) *Guide to aquatic invertebrates of the Upper Midwest: Identification manual for students, citizen monitors, and Aquatic Resources Professionals*. University of Minnesota.

Number of Families (identified in a sample):
The higher the diversity, the better

Year	Number of Families
2021	6
2020	12
2019	7
2018	11
2017	14
2016	6
2015	8
2014	11

Year	Number of Families
2013	13
2012	10
2011	15
2010	11
2009	11
2008	14
2007	5
2006	11

Table 18: Rice Creek Above families

Number of EPT Families (pollution sensitive):
EPT (Ephemeroptera-Plecoptera-Tricoptera or Mayfly-Stonefly-Caddisfly) are three Orders of invertebrates with low tolerance to pollution. The more of these families in a sample, the better. More than 10-12 families is good.

Year	Number of EPT Families	Percent make-up of EPT Families	EPT Families
2021	0	0	NA
2020	4	14	Baetidae, Caenidae, Hydropsychidae, Phrygaenidae
2019	0	0	NA
2018	2	17	Baetidae, Hydropsychidae
2017	1	0.8	Baetidae
2016	1	2.5	Hydropsychidae
2015	2	1	Baetidae, Caenidae
2014	1	3	Caenidae
2013	1	0.2	Leptoceridae
2012	4	8	Baetidae, Caenidae, Branchycentridae, Hydropsychidae
2011	3	8	Baetidae, Caenidae, Hydropsychidae
2010	6	28	Caenidae, Leptohyphidae, Hydropsychidae, Leptoceridae, Limnephilidae, Polycentropodidae
2009	3	7	Baetidae, Hydropsychidae, Oligonueriidae
2008	2	NA	NA
2007	0	0	NA
2006	2	NA	NA

Table 19: Rice Creek Above EPT families

Family Biotic Index (FBI):

This program identifies macroinvertebrates to the family level. Each family is assigned a tolerance value rating from 0-10. The lower the number, the more sensitive to pollution. The FBI score is the average pollution tolerance of all of the macroinvertebrates identified in a sample.

Year	FBI Score	Score Description
2021	7.1	Poor – very substantial organic pollution likely
2020	5.8	Fairly Poor – substantial pollution likely
2019	7.9	Very Poor – severe organic pollution likely
2018	6.0	Fairly Poor – substantial pollution likely
2017	7.3	Very Poor – severe organic pollution likely
2016	6.7	Poor – very substantial pollution likely
2015	6.9	Poor – very substantial pollution likely
2014	5.9	Fairly poor – substantial pollution likely
2013	6.1	Fairly poor – substantial pollution likely
2012	8.3	Very Poor – severe organic pollution likely
2011	7.8	Very Poor – severe organic pollution likely
2010	7.3	Very Poor – severe organic pollution likely
2009	7.0	Poor – very substantial pollution likely
2008	7.0	Poor – very substantial pollution likely
2007	7.9	Very Poor – severe organic pollution likely
2006	8.8	Very Poor – severe organic pollution likely

Table 20: Rice Creek Above FBI score

Summary:

Rice Creek Above has been sampled 16 consecutive years since 2006. In 2021, the FBI score indicated “Poor” health. The number of families and sensitive families is very low and resembles 2019 data. FBI scores have been variable and ranged between “Fairly Poor” to “Very Poor” since 2006. The number of families and percentage make-up varies from year to year, and are usually unevenly distributed. Hyalellidae and Chironomidae have frequently dominated the samples. Pollution-sensitive (EPT) families have usually made-up a very minor proportion of the sample collection every year, and in 2021 were not represented. Variability in family representation may be caused by environmental factors including water levels, habitat availability, collection location, or other sources of disturbance in the area. Note: The summer and early fall of 2021 included very low precipitation amounts and events.

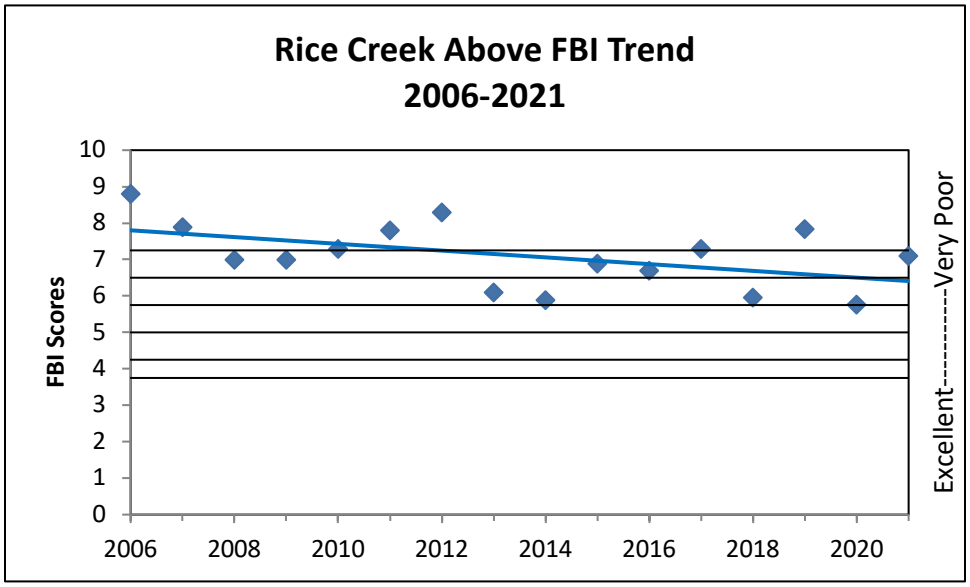

Figure 11. A stream health trend was created using scores calculated for family biotic index (FBI). Contrary to common sense, a descending trendline indicates improvement in the stream health since organisms with sensitivity to water pollution score lower on the family biotic index.

Family List – Rice Creek Above				
Family Name	**Tolerance Value**	**Number of Individuals 2021**	**Number of Individuals 2020**	**Number of Individuals 2019**
Asellidae (crustacean)	8		1	
Baetidae (mayfly)	4		1	
Caenidae (mayfly)	7		1	
Chironomidae (truefly)	6	34	269	26
Calopterygidae (damselfly)	5	1		
Coengrionidae (damselfly)	9	25	4	6
Corixidae (true bug)	9			94
Elmidae (beetle)	4		1	
Gammaridae (crustacean)	4	12	2	18
Gastropoda (snail)	7		3	
Haliplidae (beetle)	7			1
Hyalellidae (crustacean)	8	40	8	34
Hydropsychidae (caddisfly)	4		69	
Phryganeidae (caddisfly)	4		1	
Simuliidae (true fly)	6		146	1
Tipuliidae (true fly)	3	1		

Table 21: Rice Creek Above family list

4.5 Rice Creek Below

Number of individuals:

- 129 invertebrates were identified in this sample. This is an adequate sample size.

Dominant Family:

- Coengrionidae (broad-winged damselfly)

Coengrionidae have a tolerance value of 9 (high) on a scale of 0-10 (the lower the tolerance value, the lower their tolerance to pollution). They are the most diverse and abundant family of damselflies in the Upper Midwest. They are found in a wide range of habitats including ponds and flowing waters. Most commonly they are found at the margins of lakes and in wetlands, but some species are found in streams clinging to rocks and vegetation.[12]

Percent Dominance:

It is assumed that families are more evenly distributed among the sample if the dominant family makes up a lower percentage of the sample.

Year	Dominant Family	% Dominance	Dominant Family (2nd)	% Dominance
2021	Coengrionidae	33	Hyalellidae	23
2020	Chironomidae	53	Simuliidae	12
2019	Chironomidae	34	Simuliidae	29
2018	Chironomidae	75	Gammaridae	14
2017	Chironomidae	61	Hyalellidae	31
2016	Chironomidae	53	Coengrionidae, Hyalellidae	17 (each)
2015	Chironomidae	54	Coengrionidae	21
2014	Chironomidae	67	Hyalellidae	13
2013	Chironomidae	72	Gastropoda	8
2012	Hyalellidae	40	Chironomidae	12
2011	Hyalellidae	75	Simuliidae	10
2010	Hyalellidae	80	Coengrionidae	9
2009	Simuliidae	64	Chironomidae	19
2008	Corixidae	34	NA	NA
2007	Chironomidae	63	NA	NA
2006	Coengrionidae	65	NA	NA

Table 22: Rice Creek Below data

[12] Bouchard, R. W., Ferrington, L. C., & Karius, M. L. (2004) *Guide to aquatic invertebrates of the Upper Midwest: Identification manual for students, citizen monitors, and Aquatic Resources Professionals*. University of Minnesota.

Number of Families (identified in a sample):

The higher the diversity, the better

Year	Number of Families
2021	12
2020	10
2019	11
2018	9
2017	5
2016	8
2015	9
2014	9

Year	Number of Families
2013	16
2012	17
2011	15
2010	15
2009	8
2008	7
2007	10
2006	12

Table 23: Rice Creek Below families

Number of EPT Families (pollution sensitive):

EPT (Ephemeroptera-Plecoptera-Tricoptera or Mayfly-Stonefly-Caddisfly) are three classes of invertebrates with low tolerance to pollution. The more of these families in a sample, the better. More than 10-12 families is good.

Year	Number of EPT Families	Percent make-up of EPT Families	EPT Families
2021	2	4	Baetidae, Hydroptilidae
2020	2	13	Hydropsychidae, Phryganeidae
2019	3	14	Baetidae, Hydropsychidae, Phryganeidae
2018	2	3	Caenidae, Hydropsychidae
2017	0	0	NA
2016	2	10	Caenidae, Hydropsychidae
2015	3	3	Caenidae, Hydropsychidae, Leptoceridae
2014	2	7	Caenidae, Hydropsychidae
2013	0	0	NA
2012	0	0	NA
2011	3	3	Baetidae, Caenidae, Hydropsychidae
2010	4	7	Caenidae, Tricorythidae, Leptoceridae, Sericostomatidae
2009	2	4	Hydropsychidae, Hydroptilidae
2008	7	NA	NA
2007	10	NA	NA
2006	12	NA	NA

Table 24: Rice Creek Below EPT families

Family Biotic Index (FBI):

This program identifies macroinvertebrates to the family level. Each family is assigned a tolerance value rating from 0-10. The lower the number, the more sensitive to pollution. The FBI score is the average pollution tolerance of all of the macroinvertebrates identified in a sample.

Year	FBI Score	Score Description
2021	7.7	Very Poor – severe organic pollution likely
2020	5.7	Fair – Fairly substantial pollution likely
2019	5.9	Fairly Poor – substantial pollution likely
2018	5.9	Fairly Poor – substantial pollution likely
2017	6.7	Poor – very substantial pollution likely
2016	6.7	Poor – very substantial pollution likely
2015	6.8	Poor – very substantial pollution likely
2014	6.2	Fairly Poor – substantial pollution likely
2013	6.4	Fairly Poor – substantial pollution likely
2012	7.4	Very Poor – severe organic pollution likely
2011	7.8	Very Poor – severe organic pollution likely
2010	7.8	Very Poor – severe organic pollution likely
2009	6.3	Fairly Poor – substantial pollution likely
2008	7.3	Very Poor – severe organic pollution likely
2007	6.9	Very Poor – severe organic pollution likely
2006	8.3	Very Poor – severe organic pollution likely

Table 25: Rice Creek Below FBI score

Summary:

Rice Creek Below has been sampled 16 consecutive years since 2006. In 2021, the FBI score indicated “Very Poor” health. FBI scores have been variable and ranged between “Fairly Poor” to “Very Poor” since 2006. The family make-up varies, and the families are unevenly distributed. Samples are often heavily dominated by pollution tolerant families, with low representation of sensitive species. Chironomidae, Coengrionidae, and Hyalellidae are the only three families of invertebrates that have been in the samples consistently. FBI has indicated higher stream health in years when population sizes of Chironomidae were found in higher numbers, and Coengrionidae and Hyalellidae were found in lower numbers. Variability in family representation may be caused by environmental factors including water levels, habitat availability, collection location, or other sources of disturbance in the area. Note: The summer and early fall of 2021 included very low precipitation amounts and events.

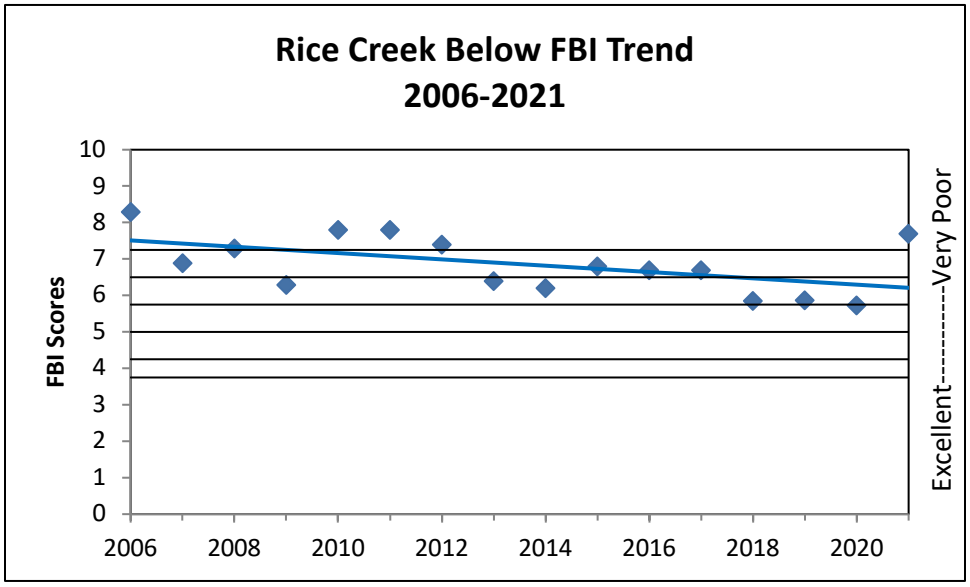

Figure 12. A stream health trend was created using scores calculated for family biotic index (FBI). Contrary to common sense, a descending trendline indicates improvement in the stream health since organisms with sensitivity to water pollution score lower on the family biotic index.

Family List – Rice Creek Below				
Family Name	**Tolerance Value**	**Number of Individuals 2021**	**Number of Individuals 2020**	**Number of Individuals 2019**
Baetidae (mayfly)	4	4		2
Belostomatidae (true bug)	10			3
Ceratopogonidae (truefly)	6		1	
Chironomidae (truefly)	6	19	73	69
Coengrionidae (damselfly)	9	42	3	9
Corixidae (true bug)	9	4		
Culicidae (truefly)	8	9		
Empididae (truefly)	6			1
Gammaridae (crustacean)	4	6	10	20
Gastropoda (snail)	7	1		
Gerridae (true bug)	na	5		
Hyalellidae (crustacean)	8	29	5	16
Hydropsychidae (caddisfly)	4		17	27
Hyrdroptilidae (caddisfly)	4	1		
Nematoda (round worms)	5		1	
Nepidae (true bug)	8		1	
Phrygaenidae (caddisfly)	4		1	1
Pleidae (true bug)	na	8		
Pyralide (aquatic moth)	5	1		
Scirtidae (beetle)	7			1
Simuliidae (truefly)	6		27	71

Table 26: Rice Creek Below family list

4.6 Rice Creek Irondale

Number of individuals:

- 153 invertebrates were identified in this sample. This is an adequate sample size.

Dominant Family:

- Chironomidae (non-biting midge)

Chironomidae have a tolerance value of 6 (moderate) on a scale of 0-10 (the lower the tolerance value, the lower their tolerance to pollution). They are a very abundant and diverse group of aquatic insects, and it is common for them to dominate samples.[13]

Percent Dominance:

It is assumed that families are more evenly distributed among the sample if the dominant family makes up a lower percentage of the sample.

Year	Dominant Family	% Dominance	Dominant Family (2nd)	% Dominance
2021	Chironomidae	31	Hyalellidae	24
2020	Chironomidae	69	Hydropsychidae	22
2019	Hyalellidae	51	Chironomidae	17
2018	Chironomidae	82	Hyalellidae	9
2017	Chironomidae	44	Coengrionidae	16
2016	Chironomidae	47	Hyalellidae, Corixidae	14 (each)
2015	Hyalellidae	39	Chironomidae	38
2014	Chironomidae	60	Hyalellidae	13
2013	Chironomidae	46	Hyalellidae/Oligochaeta	16 (each)
2012	Chironomidae	61	Coengrionidae	21

Table 27: Rice Creek Irondale data

Number of Families (identified in a sample):

The higher the diversity, the better

Year	Number of Families
2021	17
2020	10
2019	11
2018	9
2017	11
2016	7
2015	8
2014	13
2013	13
2012	13

Table 28: Rice Creek Irondale families

[13] Bouchard, R. W., Ferrington, L. C., & Karius, M. L. (2004) *Guide to aquatic invertebrates of the Upper Midwest: Identification manual for students, citizen monitors, and Aquatic Resources Professionals*. University of Minnesota.

Number of EPT Families (pollution sensitive):
EPT (Ephemeroptera-Plecoptera-Tricoptera or Mayfly-Stonefly-Caddisfly) are three classes of invertebrates with low tolerance to pollution. The more of these families in a sample, the better. More than 10-12 families is good.

Year	Number of EPT Families	Percent make-up of EPT Families	EPT Families
2021	3	5	Baetidae, Caenidae, Hydroptilidae
2020	3	23	Baetidae, Hydropsychidae, Phrygaeidae
2019	1	10	Hydropsychidae
2018	3	6	Baetidae, Caenidae, Hydropsychidae
2017	3	14	Baetidae, Ephemeridae, Hydropsychidae
2016	2	20	Caenidae, Hydropsychidae
2015	2	16	Baetidae, Hydropsychidae
2014	3	3	Baetidae, Caenidae, Hydropsychidae
2013	1	1	Hydropsychidae
2012	2	2	Baetidae, Heptageniidae

Table 29: Rice Creek Irondale EPT families

Family Biotic Index (FBI):
This program identifies macroinvertebrates to the family level. Each family is assigned a tolerance value rating from 0-10. The lower the number, the more sensitive to pollution. The FBI score is the average pollution tolerance of all of the macroinvertebrates identified in a sample.

Year	FBI Score	Score Description
2021	7.2	Poor – very substantial pollution likely
2020	5.4	Fair – fairly substantial pollution likely
2019	7.2	Poor – very substantial pollution likely
2018	6.1	Fairly Poor – substantial pollution likely
2017	6.4	Fairly Poor – substantial pollution likely
2016	6.7	Poor – very substantial pollution likely
2015	6.7	Poor – very substantial pollution likely
2014	6.0	Fairly Poor – substantial pollution likely
2013	6.8	Poor – very substantial pollution likely
2012	6.8	Poor – very substantial pollution likely

Table 30: Rice Creek Irondale FBI score

Summary:
Rice Creek Irondale has been sampled ten consecutive years since 2012. In 2021, the FBI score indicated “Poor” health. Chironomidae (tolerance value of 6) has dominated most years. Chironomidae, Coengrionidae, Hyalellidae, and Hydropsychidae are constantly collected most years. The family diversity is often unevenly distributed with pollution tolerant families over-dominating the samples. The FBI trend shows stable health. Variability in family representation may be caused by environmental factors including water levels, habitat availability, collection location, or other sources of disturbance in the area. Note: The summer and early fall of 2021 included very low precipitation amounts and events.

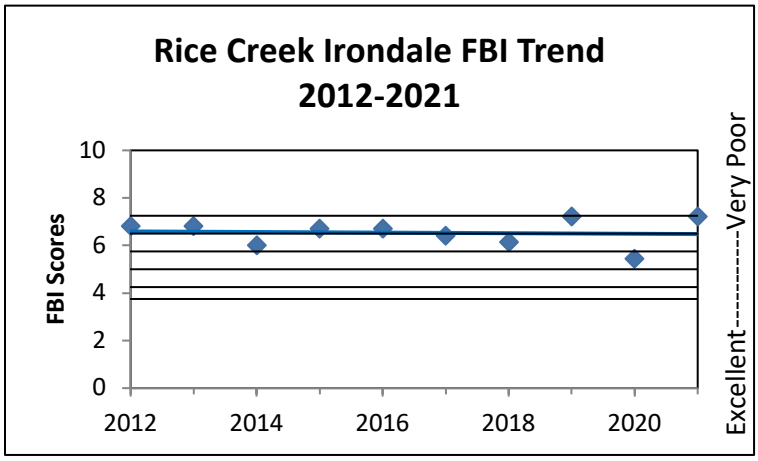

Figure 13. A stream health trend was created using scores calculated for family biotic index (FBI). Contrary to common sense, a descending trendline indicates improvement in the stream health since organisms with sensitivity to water pollution score lower on the family biotic index.

Family List – Rice Creek Irondale				
Family Name	**Tolerance Value**	**Number of Individuals 2021**	**Number of Individuals 2020**	**Number of Individuals 2019**
Asellidae (crustacean)	8		4	
Baetidae (mayfly)	4	5	2	
Belostomatidae (true bug)	10	2	1	2
Caenidae (mayfly)	7	1		
Ceratopogonidae (truefly)	6		1	1
Chironomidae (truefly)	6	48	156	25
Coengrionidae (damselfly)	9	36		4
Corixidae (true bug)	9	3		1
Culicidae (truefly)	8	2		
Dytiscidae (beetle)	5	1		
Gammaridae (crustacean)	4	7	5	11
Gastropoda (snail)	7	2		
Haliplidae (beetle)	7	2		
Hyalellidae (crustacean)	8	37	2	75
Hydrophilidae (beetle)	5	1		
Hydropsychidae (caddisfly)	4		50	14
Hydroptilidae (caddisfly)	4	1		
Notonectidae (true bug)	na	1		
Oligochaeta (aquatic worm)	8			1
Pelecypoda (clams)	7	2		
Phryganeidae (caddisfly)	4		1	
Pleidae (true bug)	na	2		
Scirtidae (beetle)	7			1
Simuliidae (truefly)	6		1	11
Turbellaria (flatworm)	4		5	

Table 31: Rice Creek Irondale family list

4.7 Locke Lake Above

Number of individuals:

- 207 invertebrates were identified in this sample. This is an adequate sample size.

Dominant Family:

- Chironomidae (non-biting midge)

Chironomidae have a tolerance value of 6 (moderate) on a scale of 0-10 (the lower the tolerance value, the lower their tolerance to pollution). They are a very abundant and diverse group of aquatic insects, and it is common for them to dominate samples.[14]

Percent Dominance:

It is assumed that families are more evenly distributed among the sample if the dominant family makes up a lower percentage of the sample.

Year	Dominant Family	% Dominance	Dominant Family (2nd)	% Dominance
2021	Chironomidae	27	Baetidae	18
2020	Baetidae	76	Hydropsychidae	13
2019	Simuliidae	40	Baetidae	31
2018	Chironomidae	56	Baetidae	17
2017	Simuliidae	79	Baetidae	7
2016	Simuliidae	62	Baetidae	17
2015	Hydropsychidae	53	Chironomidae	16
2014	Hydropsychidae	67	Chironomidae	14
2013	Hydropsychidae	42	Nematoda	25
2012	Chironomidae	29	Baetiscidae	23
2011	Simuliidae	63	Baetidae	17
2010	Chironomidae	46	Hyalellidae	15
2009	Chironomidae	35	Hydropsychidae	11
2008	Chironomidae	30	NA	NA
2007	Baetidae	22	NA	NA
2006	Hydropsychidae	58	NA	NA

Table 32: Locke Lake Above data

[14] Bouchard, R. W., Ferrington, L. C., & Karius, M. L. (2004) *Guide to aquatic invertebrates of the Upper Midwest: Identification manual for students, citizen monitors, and Aquatic Resources Professionals*. University of Minnesota.

Number of Families (identified in a sample):

The higher the diversity, the better

Year	Number of Families
2021	16
2020	9
2019	11
2018	14
2017	9
2016	9
2015	9
2014	9

Year	Number of Families
2013	9
2012	18
2011	12
2010	13
2009	18
2008	14
2007	12
2006	12

Table 33: Locke Lake Above families

Number of EPT Families (pollution sensitive):

EPT (Ephemeroptera-Plecoptera-Tricoptera or Mayfly-Stonefly-Caddisfly) are three classes of invertebrates with low tolerance to pollution. The more of these families in a sample, the better. More than 10-12 families is good.

Year	Number of EPT Families	Percent make-up of EPT Families	EPT Families
2021	4	34	Baetidae, Heptageniidae, Hydropsychidae, Hydroptilidae
2020	3	89	Baetidae, Hydropsychidae, Philopotomidae
2019	2	33	Baetidae, Hydropsychidae
2018	2	18	Baetidae, Hydropsychidae
2017	1	7	Baetidae
2016	3	24	Baetidae, Hydropsychidae, Philopotomidae
2015	2	55	Baetidae, Hydropsychidae
2014	2	69	Hydropsychidae, Psychomyiidae
2013	2	44	Hydropsychidae, Hydroptilidae
2012	6	45	Baetiscidae, Heptageniidae, Hydropsychidae, Hydroptilidae, Philoptamidae, Psychomyiidae
2011	3	28	Baetidae, Hydropsychidae, Philoptamidae
2010	4	15	Baetidae, Heptageniidae, Hydropsychidae, Philoptamidae
2009	3	20	Baetiscidae, Heptageniidae, Hydropsychidae
2008	4	NA	NA
2007	3	NA	NA
2006	2	NA	NA

Table 34: Locke Lake Above EPT families

Family Biotic Index (FBI):

This program identifies macroinvertebrates to the family level. Each family is assigned a tolerance value rating from 0-10. The lower the number, the more sensitive to pollution. The FBI score is the average pollution tolerance of all of the macroinvertebrates identified in a sample.

Year	FBI Score	Score Description
2021	5.1	Fair – fairly substantial pollution likely
2020	4.1	Very Good – possible slight organic pollution
2019	5.6	Fair – fairly substantial pollution likely
2018	5.7	Fair – fairly substantial pollution likely
2017	5.8	Fairly Poor – substantial pollution likely
2016	5.5	Fair – fairly substantial pollution likely
2015	4.5	Good – some organic pollution probable
2014	4.4	Good – some organic pollution probable
2013	4.9	Good – some organic pollution probable
2012	5.2	Fair – fairly substantial pollution likely
2011	5.4	Fair – fairly substantial pollution likely
2010	5.9	Fairly Poor – substantial pollution likely
2009	6.1	Fairly Poor – substantial pollution likely
2008	5.7	Fair – fairly substantial pollution likely
2007	5.5	Fair – fairly substantial pollution likely
2006	5.0	Fair – fairly substantial pollution likely

Table 35: Locke Lake Above FBI score

Summary:

Locke Lake Above has been sampled 16 consecutive years since 2006. In 2021, the FBI score rebounded to “Fair” health. The FBI trend is stable, but the FBI scores appear to be undulating. Stream health scores have ranged between “Fairly Poor” to “Very Good”. More years of data may display a continual pattern. Over the years of monitoring, the distribution of families has been uneven, and usually over-dominated by a single family. In 2021, the family diversity is greater and more balanced in comparison to prior years. Variability in family representation may be caused by environmental factors including water levels, habitat availability, collection location, or other sources of disturbance in the area. Note: The summer and early fall of 2021 included very low precipitation amounts and events.

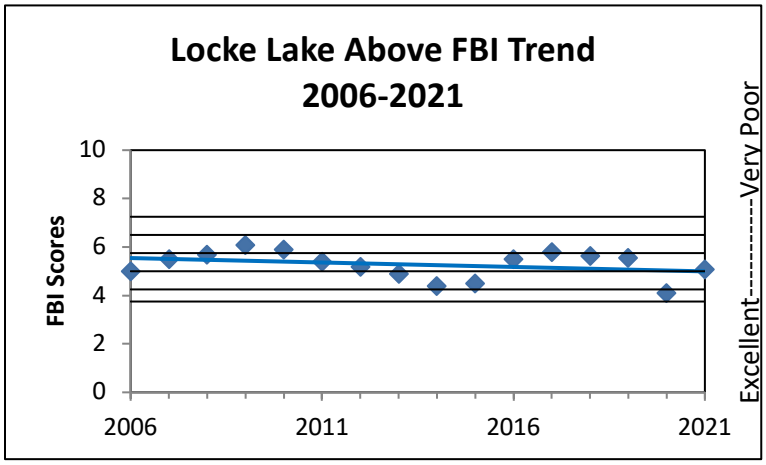

Figure 14. A stream health trend was created using scores calculated for family biotic index (FBI). Contrary to common sense, a descending trendline indicates improvement in the stream health since organisms with sensitivity to water pollution score lower on the family biotic index.

Family List – Locke Lake Above				
Family Name	**Tolerance Value**	**Number of Individuals 2021**	**Number of Individuals 2020**	**Number of Individuals 2019**
Asellidae (crustacean)	8	1		
Baetidae (mayfly)	4	38	111	55
Chironomidae (truefly)	6	55	4	18
Coengrionidae (damselfly)	9			1
Corixidae (truebug)	9	1		
Decapoda (crustacean)	6	17		2
Elmidae (beetle)	4	34	6	
Gammaridae (crustacean)	4			1
Gerridae (true bug)	na	1		
Heptageniidae (mayfly)	4	5		
Hirundinea (leech)	10			3
Hyalellidae (crustacean)	8	3		11
Hydracarina (aquatic spider)	na	1		
Hydropsychidae (caddisfly)	4	27	19	4
Hydroptilidae (caddisfly)	4	1		
Nematoda (round worm)	5		1	6
Oligochaeta (aquatic worm)	8	3	1	6
Pelecypoda (clams)	7	18		
Philopotamidae (caddisfly)	3		1	
Pyralidae (aquatic moth)	5	1		
Simuliidae (truefly)	6	1	3	71

Table 36: Locke Lake Above family list

4.8 Locke Lake Below

Number of individuals:

- 204 invertebrates were identified in the sample. This is an adequate sample size.

Dominant Family:

- Hydropsychidae (Common net-spinning caddisflies)

Hydropsychidae have a tolerance value of 4 (moderate) on a scale of 0-10 (the lower the tolerance value, the lower their tolerance to pollution). Hydropsychidae are collectors/filterers. They are restricted to flowing waters, and are most commonly collected from areas with cobble or bedrock substrate where solid structures are available on which to attach their nets. They glean material that is collected in their nets. In some situations, such as below pond outflows and downstream of sewage treatment plants, they can reach large densities.[15]

Percent Dominance:

It is assumed that families are more evenly distributed among the sample if the dominant family makes up a lower percentage of the sample.

Year	Dominant Family	% Dominance	Dominant Family (2nd)	% Dominance
2021	Hydropsychidae	53	Baetidae	32
2020	Hydropsychidae	66	Chironomidae	25
2019	Chironomidae	38	Simuliidae	25
2018	Chironomidae	64	Hydropsychidae	9
2017	Simuliidae	54	Chironomidae	26
2016	Simuliidae	73	Hydropsychidae	13
2015	Chironomidae	72	Hydropsychidae	13
2014	Hydropsychidae	49	Chironomidae, Simuliidae	18 (each)
2013	Chironomidae	57	Hydropsychidae	57
2012	Chironomidae	61	Hydropsychidae	61
2011	Simuliidae	80	Chironomidae	80
2010	Chironomidae	42	Philopotomidae	42
2009	Hydropsychidae	47	Chironomidae	28
2008	Hydropsychidae	42	NA	NA
2007	Chironomidae	37	NA	NA
2006	Chironomidae	43	NA	NA

Table 37: Locke Lake Below data

[15] Bouchard, R. W., Ferrington, L. C., & Karius, M. L. (2004) *Guide to aquatic invertebrates of the Upper Midwest: Identification manual for students, citizen monitors, and Aquatic Resources Professionals*. University of Minnesota.

Number of Families (identified in a sample):

The higher the diversity, the better.

Year	Number of Families
2021	10
2020	9
2019	13
2018	15
2017	11
2016	7
2015	10
2014	9

Year	Number of Families
2013	14
2012	15
2011	13
2010	11
2009	12
2008	10
2007	9
2006	8

Table 38: Locke Lake Below families

Number of EPT Families (pollution sensitive):

EPT (Ephemeroptera-Plecoptera-Tricoptera or Mayfly-Stonefly-Caddisfly) are three Orders of invertebrates with low tolerance to pollution. The more of these families in a sample, the better. More than 10-12 families is good.

Year	Number of EPT Families	Percent make-up of EPT Families	EPT Families
2021	3	86	Baetidae, Hydropsychidae, Philopotamidae
2020	3	81	Baetidae, Hydropsychidae, Philopotamidae
2019	3	24	Baetidae, Hydropsychidae, Philopotamidae
2018	2	14	Baetidae, Hydropsychidae
2017	2	10	Baetidae, Hydropsychidae
2016	2	17	Baetidae, Hydropsychidae
2015	1	13	Hydropsychidae
2014	2	56	Baetidae, Hydropsychidae
2013	2	25	Baetidae, Hydropsychidae
2012	3	23	Heptageniidae, Hydropsychidae, Philopotamidae
2011	3	11	Baetidae, Hydropsychidae, Philopotamidae
2010	5	41	Baetidae, Hydropsychidae, Hydroptilidae, Philopotamidae, Polycentropodidae
2009	2	53	Baetidae, Hydropsychidae
2008	3	NA	NA
2007	2	NA	NA
2006	3	NA	NA

Table 39: Locke Lake Below EPT families

Family Biotic Index (FBI):

This program identifies macroinvertebrates to the family level. Each family is assigned a tolerance value rating from 0-10. The lower the number, the more sensitive to pollution. The FBI score is the average pollution tolerance of all of the macroinvertebrates identified in a sample.

Year	FBI Score	Score Description
2021	4.2	Very Good – possible slight organic pollution
2020	4.0	Very Good – possible slight organic pollution
2019	5.5	Fair – fairly substantial pollution likely
2018	5.5	Fair – fairly substantial pollution likely
2017	5.8	Fairly Poor – substantial pollution likely
2016	5.7	Fair – fairly substantial pollution likely
2015	5.7	Fair – fairly substantial pollution likely
2014	4.8	Good – some organic pollution probable
2013	5.6	Fair – fairly substantial pollution likely
2012	5.6	Fair – fairly substantial pollution likely
2011	5.7	Fair – fairly substantial pollution likely
2010	5.0	Good – some organic pollution probable
2009	5.0	Good – some organic pollution probable
2008	5.1	Good – some organic pollution probable
2007	5.7	Fair – fairly substantial pollution likely
2006	5.3	Fair – fairly substantial pollution likely

Table 40: Locke Lake Below FBI score

Summary:

Locke Lake Below has been sampled 16 consecutive years since 2006. In 2021, the FBI score indicated “Very Good” health. The FBI trend appears stable. The FBI scores have remained consistent throughout most years of sampling. The EPT families represented are similar throughout the years; however, the proportion of their make up in the samples has fluctuated. The number of families represented is variable each year. The dominant family has shifted from year to year; however, similar tolerance values for families represented are similar, so scores are only slightly affected. Sensitive species have heavily dominated the samples in 2020 and 2021, and representation of families is similar, as well. Chironomidae, Simuliidae, and Hydropsychidae have traded in dominance over the years of surveys. Though the FBI scores are healthy and sensitive species dominate the sample, the low diversity and disproportion of families is not ideal. Variability in family representation may be caused by environmental factors including water levels, habitat availability, collection location, or other sources of disturbance in the area. Note: The summer and early fall of 2021 included very low precipitation amounts and events.

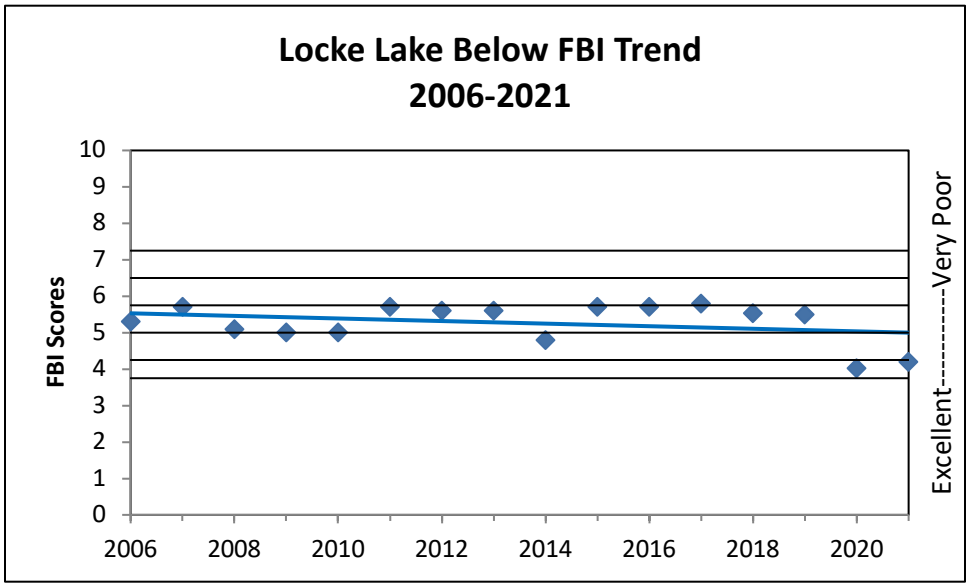

Figure 15. A stream health trend was created using scores calculated for family biotic index (FBI). Contrary to common sense, a descending trendline indicates improvement in the stream health since organisms with sensitivity to water pollution score lower on the family biotic index.

Family List – Locke Lake Below				
Family Name	**Tolerance Value**	**Number of Individuals 2021**	**Number of Individuals 2020**	**Number of Individuals 2019**
Baetidae (mayfly)	4	65	10	71
Chironomidae (truefly)	6	13	12	139
Decapoda (crustacean)	6	4		3
Elmidae (beetle)	4	6	1	
Empididae (truefly)	6	1	1	
Gammaridae (crustacean)	4			4
Gastropoda (snails)	7			1
Gerridae (true bug)	na	2		
Hirundinea (leech)	10			1
Hyalellidae (crustacean)	8			8
Hydropsychidae (caddisfly)	4	108	100	15
Nematoda (round worm)	5			24
Pelecypoda (clams)	7			7
Philopotamidae (caddisfly)	3	2	12	1
Scirtidae (beetle)	7		1	
Simuliidae (truefly)	6	2	6	90
Tabanidae (truefly)	6	1		
Tipulidae (truefly)	3		3	3
Turbellaria (flatworms)	4		6	

Table 41: Locke Lake Below family list

4.9 Locke Lake Park

Number of individuals:

- 159 invertebrates were identified in this sample. This is an adequate sample size.

Dominant Family:

- Chironomidae (non-biting midge)

Chironomidae have a tolerance value of 6 (moderate) on a scale of 0-10 (the lower the tolerance value, the lower their tolerance to pollution). They are a very abundant and diverse group of aquatic insects, and it is common for them to dominate samples.[16]

Percent Dominance:

It is assumed that families are more evenly distributed among the sample if the dominant family makes up a lower percentage of the sample.

Year	Dominant Family	% Dominance	Dominant Family (2nd)	% Dominance
2021	Chironomidae	44	Baetidae	13
2020	Baetidae	47	Hydropsychidae	41
2019	Simuliidae	57	Chironomidae	15
2018	Chironomidae	45	Simuliidae	32
2017	Simuliidae	66	Oligochaeta	10
2016	Simuliidae	71	Baetidae	15
2015	Hydropsychidae	63	Chironomidae	23
2014	Hydropsychidae	48	Chironomidae	27
2013	Nematoda	56	Hydropsychidae, Oligochaeta	10 (each)
2012	Chironomidae	32	Hydropsychidae	20

Table 42: Locke Lake Park data

Number of Families (identified in a sample)

The higher the diversity, the better.

Year	Number of Families
2021	17
2020	8
2019	11
2018	15
2017	7
2016	6
2015	10
2014	11
2013	11
2012	14

Table 43: Locke Lake Park families

[16] Bouchard, R. W., Ferrington, L. C., & Karius, M. L. (2004) *Guide to aquatic invertebrates of the Upper Midwest: Identification manual for students, citizen monitors, and Aquatic Resources Professionals*. University of Minnesota.

Number of EPT Families (pollution sensitive):
EPT (Ephemeroptera-Plecoptera-Tricoptera or Mayfly-Stonefly-Caddisfly) are three classes of invertebrates with low tolerance to pollution. The more of these families in a sample, the better. More than 10-12 families is good.

Year	Number of EPT Families	Percent make-up of EPT Families	EPT Families
2021	6	29	Baetidae, Hydrosychidae, Philopotomidae, Polycentropodidae, Brachycentridae, Capniidae
2020	2	87	Baetidae, Hydropsychidae
2019	3	14	Baetidae, Caenidae, Hydropsychidae
2018	2	14	Baetidae, Hydropsychidae
2017	1	10	Baetidae
2016	2	23	Baetidae, Hydropsychidae
2015	2	70	Baetidae, Hydropsychidae
2014	2	48	Baetidae, Hydropsychidae
2013	1	10	Hydropsychidae
2012	3	28	Baetidae, Hydropsychidae, Philopotamidae

Table 44: Locke Lake Park EPT families

Family Biotic Index (FBI):
This program identifies macroinvertebrates to the family level. Each family is assigned a tolerance value rating from 0-10. The lower the number, the more sensitive to pollution. The FBI score is the average pollution tolerance of all of the macroinvertebrates identified in a sample.

Year	FBI Score	Score Description
2021	5.2	Fair – fairly substantial pollution likely
2020	4.2	Very Good – possible slight organic pollution
2019	5.9	Fairly Poor – substantial pollution likely
2018	5.7	Fair – fairly substantial pollution likely
2017	5.7	Fair – fairly substantial pollution likely
2016	5.5	Fair – fairly substantial pollution likely
2015	4.6	Good – some organic pollution probable
2014	4.9	Good – some organic pollution probable
2013	5.5	Fairly Poor – substantial pollution likely
2012	4.7	Good – some organic pollution probable

Table 45: Locke Lake Park FBI score

Summary:
Locke Lake Park has been sampled ten consecutive years since 2012. In 2021, the FBI score rebounded to “Fair” health. The FBI scores are variable, though the health trend is stable. The dominant family is variable each year. In 2021, the family diversity is high, as well as the number of sensitive species represented in the sample. However, the sample is still over-dominated by Chironomidae and distribution among the families is unbalanced. Variability in family representation may be caused by environmental factors including water levels, habitat availability, collection location, or other sources of disturbance in the area. Note: The summer and early fall of 2021 included very low precipitation amounts and events.

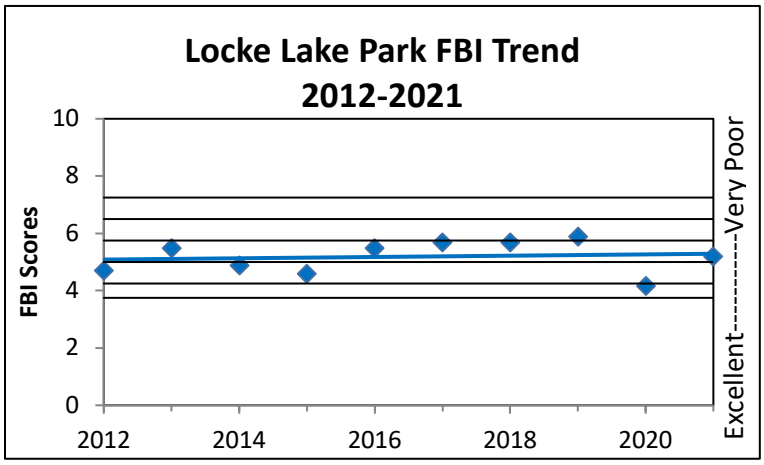

Figure 16. A stream health trend was created using scores calculated for family biotic index (FBI). Contrary to common sense, a descending trendline indicates improvement in the stream health since organisms with sensitivity to water pollution score lower on the family biotic index.

Family List – Locke Lake Park				
Family Name	**Tolerance Value**	**Number of Individuals 2021**	**Number of Individuals 2020**	**Number of Individuals 2019**
Baetidae (mayfly)	4	21	86	12
Blephariceridae (truefly)	0	1		
Brachycentridae (caddisfly)	1	1		
Caenidae (mayfly)	7			1
Calopterygidae	5	1		
Capniidae (stonefly)	1	1		
Chironomidae (truefly)	6	70	17	31
Decapoda (crayfish)	6	7		
Dryopidae (beetle)	5	1		
Elmidae (beetle)	4	17	1	
Empididae (true fly)	6	3		4
Gerridae (true bug)	na	1		
Hirundinea (leech)	10			2
Hyalellidae (Talitridae)	8			16
Hydracarina (aquatic spider)	4	1		
Hydropsychidae (caddisfly)	4	21	75	16
Nematoda (round worm)	5		1	12
Oligochaeta (aquatic worm)	8	4		2
Pelecypoda (clam)	7	7	1	
Philopotomidae (caddisfly)	3	1		
Polycentropodidae (caddisfly	1	1		
Scirtidae (beetle)	7			1
Simuliidae (true fly)	6		2	120
Turbellaria (flat worm)	4		2	

Table 46: Locke Lake Park family list

5.0 SUMMARY OF RESULTS

5.1 Improving

Hardwood Creek Above, Clearwater Creek, Rice Creek Above and Rice Creek Below all seem to be improving through the years that SHEP has sampled at those sites (Figure 18).

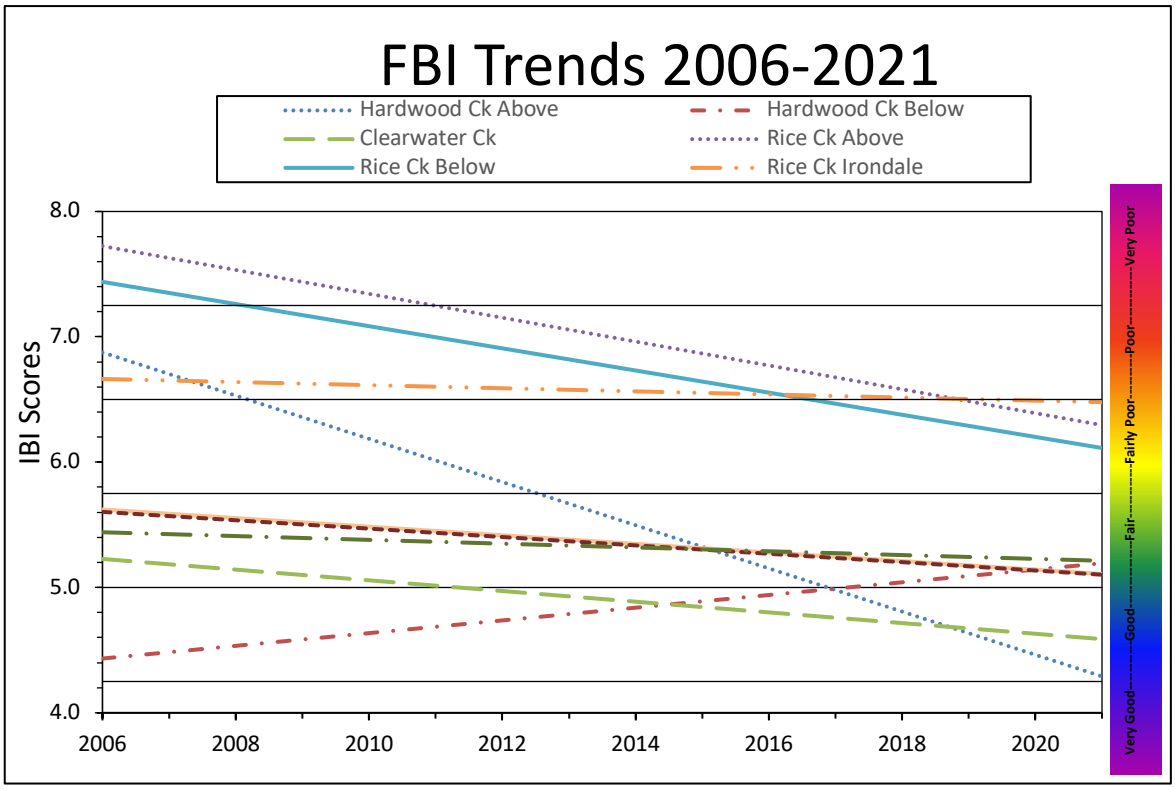

Figure 17: FBI trends for monitoring sites from 2006 to 2021. The trend graph is inverted. Increasing trends appear to be decreasing on graph. Lower FBI numbers indicate healthier streams. Rice Creek Irondale and Locke Lake Park sites not included because monitoring began at later date than other sites.

5.2 Stable

Rice Creek Irondale, Locke Lake Above, Locke Lake Below and Locke Lake Park all appear stable (Figure 17).

5.3 Worsening

While Hardwood Creek Below has had some very healthy scores, in 2021, the site still obtained a high score of 5.8. Luckily, though, the poorest historical FBI value remained 8.8 at the Rice Creek Above site in 2006. Thus, its health appears to be worsening (Figure 17).

5.4 Status in 2021

Figure 11 shows each sampling location's FBI score and stream health rating for 2020. Variability may be caused by environmental factors including water levels, habitat availability or other sources of disturbance in the area.

While SHEP volunteers collect data on the physical habitat, SHEP limits their analysis of physical stream data, as it is can be subjective in description and placement of data collection – not only from team to team but from year to year depending on who is collecting the data. Thus, SHEP only provides macroinvertebrate data to provide a picture of stream health and changes throughout time.

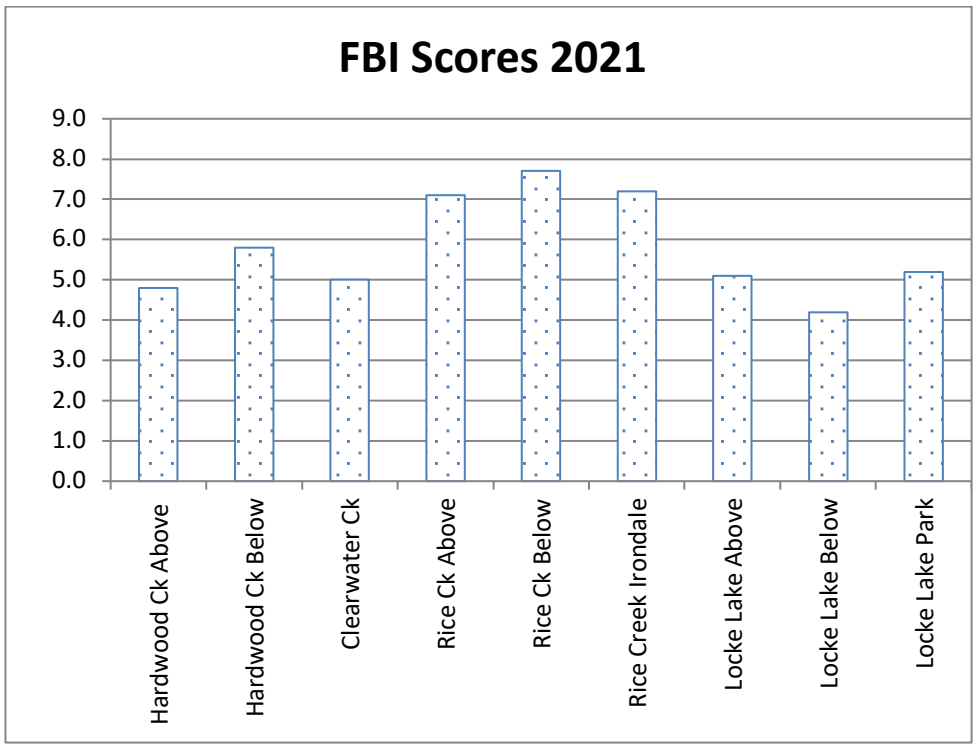

Figure 18: Stream health rating for SHEP sampling sites in 2021