MICHIGAN DEPARTMENT OF
ENVIRONMENT, GREAT LAKES, AND ENERGY

Water Resources Division (WRD)
Surface Water Assessment Section (SWAS)

STAFF REPORT
MI/EGLE/WRD-22/020

Macroinvertebrate and Stream Habitat Surveys of the Flat River Watershed, Michigan

June-August 2018

CONTENTS

INTRODUCTION

Michigan has over 76,000 miles of rivers and streams. Understanding the quality of those waters is an important part of the Michigan Department of Environment, Great Lakes, and Energy's (EGLE) mission to protect Michigan's environment and public health by managing air, water, land, and energy resources. All of Michigan's watersheds are surveyed once every five years. As part of that effort, the Flat River watershed was sampled in 2018; this report includes the information collected as part of that survey.

Water quality can be measured different ways including sampling macroinvertebrate and fish communities and collecting water or sediment samples. EGLE biologists sample macroinvertebrates and fish living in our rivers and streams because some are more sensitive to pollution than others. In general, macroinvertebrate and fish communities in healthy streams include those sensitive to pollution.

Looking at the quality of the physical habitat is helpful in understanding what may be limiting the kinds of life in a stream. Habitat includes the wood, rocks, gravel, silt, and sand in the stream or river and the vegetation in the water and along the shore. Typically, a range of habitats provides for diverse types of macroinvertebrates and fish.

Sometimes water or sediment samples are collected as indicators of potential pollution. Chemicals analyzed from these samples can be compared to levels expected and determined to be safe and helps to provide additional clues to possible water quality problems. Michigan has developed Water Quality Standards (WQS) to help with this comparison process; the WQS are rules that tell us the levels of various pollutants and other water quality conditions necessary for our rivers, streams, wetlands, and lakes to function properly.

All surface waters in Michigan are protected for "designated uses" such as swimming and wading, warmwater fish communities, eating fish, aquatic life, and wildlife. All rivers, streams, lakes, ponds, drains, creeks, and the Great Lakes must be clean enough and meet WQS to support these uses. Parts of the Flat River watershed are also protected for coldwater fish since some of streams are cold enough for trout and salmon. Additionally, parts of the Flat River and select tributaries are recognized as having rich historical values and is designated as one of Michigan's Natural Rivers, allowing extra regulations to preserve, protect, and enhance the river for the use and enjoyment of current and future generations (Michigan Department of Natural Resources [MDNR], 1979). All sites surveyed are used to assess the ability to support designated uses through the Integrated Report process.

WATERSHED INFORMATION

A watershed is all the land that drains to a lake or stream. The Flat River watershed is in the central part of Michigan's Lower Peninsula and is a major tributary to the Grand River. The watershed covers approximately 564 square miles in Ionia, Kent, Mecosta, and Montcalm Counties. There are 33 known dams in the watershed with 18 of them being lake control or wildlife flooding structures (Kent Conservation District, 2016). Five of those dams are major structures, causing fish barriers, in the mainstem of the Flat River consisting of Greenville Dam (Montcalm County), Belding Dam (Ionia County), Whites Bridge Dam (Ionia County), Fallasburg Dam (Kent County), and King Milling Dam (Kent County; Hanshue and Harrington, 2017).

LAND USE

Land use in a watershed is important to water quality. Here is an example of a publication that can be found online to explain the connection between land use and water quality. The dominant land use in the Flat River watershed is cultivated crops (34 percent) followed by natural terrestrial (24 percent), wetlands (16 percent), pasture/hay (14 percent), developed (9 percent), and open water (3 percent) (United States Geological Survey [USGS], 2014). Natural areas, especially wetlands, act as natural sponges and allow rainwater to soak into the ground, reducing the amount of water that runs off the land, filtering pollutants, and recharging groundwater. This leads to protecting water quality, minimizing flooding, and stabilizing our shorelines and stream banks. As development of land occurs, the amount of

pavement, roofing, and other hard surfaces increases, and the amount of vegetation decreases, and therefore, more water (and thus pollutants) quickly reaches our streams and lakes. The amount of total wetlands lost since pre-settlement times in the Flat River watershed is about 8 percent, compared to the 40 percent lost across the entire state (Fizzell, 2014). The highest percent of wetlands lost (15 percent) in a subwatershed of the Flat River watershed, is in Alder Creek Drain near the village of Person. For more details on the land use in this watershed, please see the online Watershed Monitoring Story Map.

HISTORIC SAMPLING EFFORTS

Table 1 is a summary of the reports available from the last two decades. For more information about older reports and results or for any other questions about this watershed, please contact the watershed biologist by finding their contact information on the Watershed Monitoring Story Map.

Table 1. Historical EGLE biosurvey reports available for the Flat River watershed.

Survey Year	Report Citation Report Number	Finding/Comments
2013	Knoll Wilmes, M., 2015 #MI/DEQ/WRD-15/043	• Macroinvertebrate community samples collected at 12 wadeable stations with ratings of acceptable or excellent. • Habitat ratings ranged from marginal to excellent. • Several sites had culverts restricting the flow of water, 1 site had signs of a flashy system with bank erosion and 1 site experienced a large decrease in the number of macroinvertebrate taxa since 2008.
2008	Walterhouse, M., 2009 #MI/DEQ/WB-09/056	• Macroinvertebrate community samples collected at 19 wadeable stations with ratings of acceptable or excellent. • Habitat ratings ranged from good to excellent. • Fish community samples were collected at 2 warmwater streams with ratings of acceptable and excellent.
2003	Rockafellow, D., 2003 #MI/DEQ/WD-03/130	• Macroinvertebrate community samples collected at 20 stations, with ratings of excellent or acceptable. • Habitat ratings ranged from good to excellent. • Fish community samples were collected at 2 warmwater streams with ratings of acceptable and excellent. A sample was collected at one coldwater stream and showed 14 percent salmonids consisting of brook trout. • Water chemistry data for nutrients was collected at 25 stations and WQS were met at all stations, but 17 stations had ammonia and/or total phosphorus above the average refence site values in the Southern Michigan Northern Indian Till Plains (SMNITP) ecoregion.

Survey Year	Report Citation Report Number	Finding/Comments
		• Sediment chemistry data for metals was collected at 5 stations on the Flat River with 3 of those stations having Threshold Effect Concentration and/or Predicted Environmental Concentration exceedances for 1 or more of the following metals: lead, zinc, copper, and chromium.
1998	Hanshue, S., 2002 #MI/DEQ/SWQ-02/004	• Macroinvertebrate community samples collected at 16 stations, with ratings of excellent or acceptable. • Habitat ratings ranged from fair to excellent. • Fish community samples were collected at 6 warmwater streams with ratings of acceptable and excellent. A sample was collected at 1 coldwater stream and showed 40 percent salmonids consisting of rainbow trout. • Water chemistry data were collected at all 16 sites with all but 1 site having concentrations similar to reference streams in the SMNITP. Lee Creek had elevated nutrients likely due to a localized rain event prior to sampling.
1993	Hanshue, S., 2002 #MI/DEQ/SWQ-02/004	• Macroinvertebrate community samples collected at 17 stations, with ratings of excellent or acceptable. • Habitat ratings ranged from fair to excellent. • Fish community samples were collected at 13 warmwater streams with 7 stations rating acceptable and 6 as incomplete. Four samples were collected on coldwater streams with 3 stations showing 1-44 percent salmonids consisting of brook and brown trout and the fourth containing no salmonids.

Sampling Goals:

1. Assess the current condition of individual rivers, streams, and lakes and determine whether Michigan WQS and Designated Uses are being met.
2. Evaluate water quality trends across the state and over time.
3. Satisfy targeted monitoring requests submitted by EGLE staff and external customers.
4. Provide supporting data for the development and issuance of National Pollutant Discharge Elimination System (NPDES) permits.
5. Identify nonpoint sources (NPS) of water quality pollution.

SITE-SELECTION/METHODS

In June-August 2018, 9 sites were sampled in the Flat River watershed. **Procedure 51: Qualitative Biological and Habitat Survey Protocols for Wadeable Streams and Rivers** (Michigan Department of Environmental Quality [MDEQ], 2014) was used to collect habitat

and macroinvertebrate community information. Additionally, visual assessments were conducted at 3 sites and water chemistry was collected at 1 site.

Two types of site-selection methods were used in the Flat River watershed in 2018. These include:

(1) **Trend sites:** Two sites, originally selected from a random group, became trend sites that are sampled every five years. These sites will be used for a separate statewide trend report following analysis of 2006-2020 data.

(2) **Targeted sites:** Seven targeted sites were selected because sampling was requested through our targeted monitoring request process. More information can be found on EGLE-WRD Biological Assessment Web page.

There were no randomly-selected status sites in the Flat River watershed to support the statewide condition portion of the SWAS Status and Trend Program (MDEQ, 2015).

Procedure 51 is used in streams and rivers that can be safely waded (Creal et al., 1996). This procedure evaluates macroinvertebrate communities based on several characteristics and combines all results into a one-number score that ranges from +9 to -9 (Table 2). Using the Procedure 51 score the macroinvertebrate community is rated as Excellent, Acceptable, or Poor. Habitat is rated as Excellent, Good, Marginal, or Poor based on measures that describe the habitat in the stream and along the banks of the stream.

Table 2. EGLE Procedure 51 macroinvertebrate and habitat scoring and rating system.

Macroinvertebrate Score	Macroinvertebrate Rating	Habitat Score	Habitat Rating
5 to 9	Excellent	> 154	Excellent
-4 to 4	Acceptable	105 to 154	Good
-5 to -9	Poor	56 to 104	Marginal
		<56	Poor

Macroinvertebrate community scores are one component used to evaluate the aquatic life and wildlife designated use. Habitat scores are used to help better understand what might influence the fish and macroinvertebrate scores. More information on the metrics and scoring can be found in the Procedure-51 Scoring Document.

MONITORING FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

Goal 1: Determine the condition of individual waters of the state and if Michigan WQS are being met.

All sampled stations had macroinvertebrate community ratings that were acceptable or excellent (Table 3, Figure 1). Therefore, the other indigenous aquatic life and wildlife (OIALW) designated use was being supported at all stations. Water chemistry samples were collected at one station (Suckerbrook Drain), but no attainment decisions were made based on that data. The fish community was not assessed at any Flat River sites in 2018.

The following site descriptions provide details regarding each station that are not available in Table 3 and Figure 1. Stations 2-5 will be discussed under Goal 4.

Flat River

The mainstem of the Flat River was assessed in 5 locations (Stations 1-5) but Stations 2-5 were targeted to provide supporting data for the development and issuance of NPDES permits, so those will be discussed under Goal 4. Station 1 was the furthest upstream of the mainstem sites and was sampled upstream of Almy Road in Montcalm County. The riparian zone was relatively intact on the right bank but limited on the left. Substrate consisted of cobble, gravel, coarse sand, and pockets of fine organic matter. Additional habitat for macroinvertebrate colonization and fish consisted of moderate amounts of undercut banks, overhanging vegetation, large woody debris (LWD), aquatic plants, and a few large rootwads (Photo 1).

Photo 1. Flat River upstream of Almy Road, Montcalm County, 2018.

Tributary to Six Lakes

The tributary to Six Lakes is part of the headwaters of the Flat River in Montcalm County and had 1 sampling location (Station 6) upstream of Sheridan Road. The riparian zone was an intact cedar swamp. Substrate consisted of sand and some gravel with heavy amounts detritus in the channel and silt along the banks. Additional habitat for macroinvertebrate colonization and fish consisted of moderate amounts of undercut banks, overhanging vegetation and rootwads, with some LWD and aquatic macrophytes. Despite the good habitat, this station received the lowest macroinvertebrate score in 2018 among all locations assessed in the Flat River watershed.

Suckerbrook Drain

Suckerbrook Drain was sampled at 1 location upstream of Cannonsville Road (Station 7). The riparian zone was relatively intact but was lacking mature trees. Substrate was relatively coarse consisting of cobble, gravel, and sand along with moderate amounts of detritus. Additionally, habitat for macroinvertebrate colonization consisted of moderate amounts of undercut banks and overhanging vegetation along with sparse amounts of LWD, aquatic macrophytes and rootwads (Photo 2). However, this location was relatively shallow, lacking slow-deep and fast-deep velocity-depth regimes.

Photo 2. Suckerbrook Drain upstream of Cannonsville Road, Montcalm County, 2018.

Black Creek

Black Creek in Kent Country was sampled upstream of Rooksby Street (Station 8). The riparian zone was relatively intact, but the banks were dominated by reed canary grass and the right bank was limited due to the proximity of the road in the first part of the survey reach. There is also a dry ephemeral channel present that drains into the right bank. Substrate in the creek consisted of soft sand with detritus mixed in and some gravel only in the few pools present. Additional habitat for macroinvertebrate colonization consisted of a heavy amount of LWD, a moderate amount of overhanging vegetation, and sparse amounts of undercut banks, aquatic macrophytes and rootwads.

Seely Creek

Seely Creek was sampled at 1 location upstream of Gold Lake Road (Station 9) and visually assessed at an additional 3 locations (SV1-3) that will be discussed under Goal 3. The riparian zone was lacking and especially limited on the left bank due to residential lawns (Table 12). Substrate had an almost even mix of cobble and sand with a moderate amount of detritus. Additional habitat for macroinvertebrate colonization consisted of a moderate amount of overhanging vegetation and sparce amounts of undercut banks, LWD, and rootwads.

Table 3. Procedure 51 sampling results for stations sampled in the Flat River watershed, 2018. Unless otherwise noted, stations are sampled upstream of road crossings.

Station	Stream Name	Road Crossing	STORET	Latitude	Longitude	Date 2018	Habitat Rating	Habitat Score[1]	Bug Rating	Bug Score[2]	Station Type[3]
1	Flat River	Almy Rd	590362	43.4088	-85.1500	6/21	162	Excellent	3	Acceptable	T
2	Flat River	Greenville West Dr	590366	43.1891	-85.2686	7/18	148	Good	5	Excellent	T
3	Flat River	M-57	590307	43.1803	-85.2451	7/23	150	Good	8	Excellent	T
4	Flat River	M-44	340196	43.0889	-85.2351	7/23	172	Excellent	7	Excellent	T
5	Flat River	6 Mile Rd	340261	43.0587	-85.2547	7/23	159	Excellent	3	Acceptable	T
6	Trib to Six Lakes	Sheridan Rd	590367	43.4434	-85.0850	6/21	147	Good	-3	Acceptable	T
7	Suckerbrook Drain	Cannonsville Rd	590374	43.3365	-85.1901	6/22	165	Excellent	7	Excellent	T
8	Black Creek	Rooksby St	410759	43.2720	-85.4150	8/1	146	Good	2	Acceptable	Tr
9	Seely Creek	Gold Lake Rd	340231	43.0660	-85.2690	8/2	151	Good	2	Acceptable	Tr
SV1	Seely Creek	Ashley Ave	NA	43.0802	-85.3323	6/22	NA	NA	NA	NA	SV
SV2	Seely Creek	Montcalm Ave	NA	43.0768	-85.3125	6/22	NA	NA	NA	NA	SV
SV3	Seely Creek	Bartonville Rd	340200	43.0705	-85.2926	6/22	NA	NA	NA	NA	SV

[1] **Habitat Scoring** Poor < 56**,** Marginal 56-104**,** Good 105-154**,** Excellent >154

[2] **Macroinvertebrate Scoring** Poor -9 to -5, Acceptable -4 to 4, Excellent 5-9

[3] **Tr=Trend, T= Targeted, SV= Site Visit**

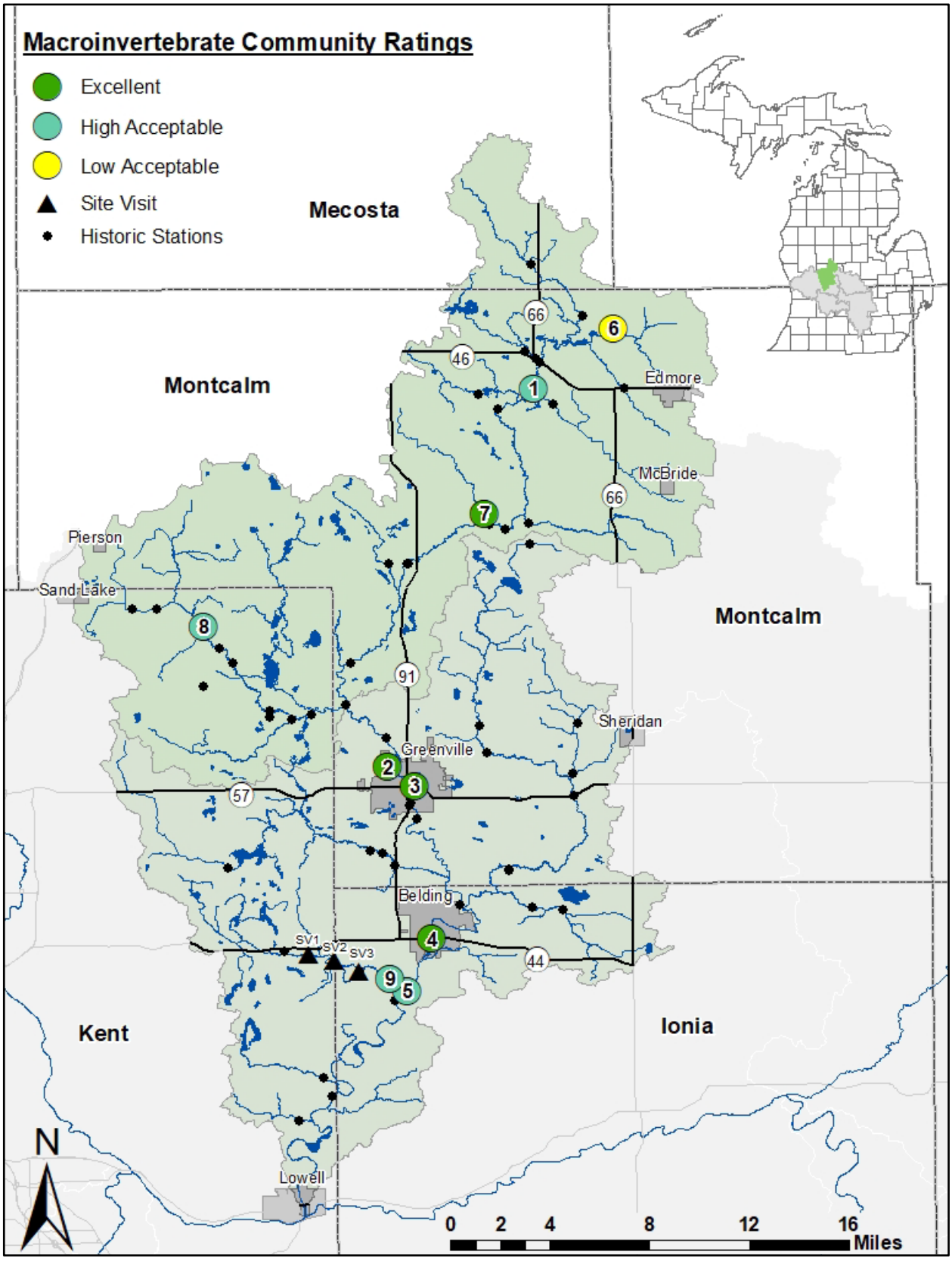

Figure 1. Macroinvertebrate ratings for stations sampled in the Flat River watershed, June-August 2018.

Goal 2: Evaluate biological integrity temporal trends.

Two sites (Stations 8 and 9) within the Flat River watershed were part of the statewide trend analysis. There were no notable changes at these locations and the statewide trend information will be summarized in a statewide report.

Goal 3: Satisfy monitoring requests submitted by EGLE staff and external customers.

Flat River

The upper portion of the Flat River was requested for monitoring because local stakeholders have reported the river to have declining aquatic ecosystems and water levels. There was 1 site selected in this area (Station 1) to assess the habitat and macroinvertebrate communities. The macroinvertebrate community was not impaired, consisting of 31 taxa (Table 7 and Table 8) with excellent habitat to support diverse biological communities (Table 6). This site received a reduced score due to nearly a quarter of the macroinvertebrate community being dependent on air for breathing (e.g., Hemiptera). There are many factors that could lead to a higher percentage of air breathers, but one possibility is a high demand of dissolved oxygen causing diurnal swings in concentrations. Even though there are no historical records for this site, upstream of M46 there was a site visit in 2008 and again in 2013 that documented a decrease in macroinvertebrate diversity with a relatively unchanged habitat (Knoll Wilmes, 2015).

Tributary to Six Lakes

During the development of the watershed management plan, stakeholders reported concerns of declining water levels and declining aquatic habitats in this area (Six Lakes), possibly from excessive draining or pumping. There was 1 site selected for monitoring in this area (Station 6) to assess the habitat, macroinvertebrate community, and basic water quality parameters using a YSI sonde. There was good habitat (Table 9) to support diverse biological communities and the water quality data was typical of streams throughout Michigan (Table 4). However, the macroinvertebrate score (-3; Table 11) was the lowest in the watershed but still meeting the OIALW designated use. In 2003 this site was sampled using slightly different methods but appeared to have similar habitat with a slightly more diverse macroinvertebrate community. Most notably, the dominant taxon was only about 20 percent of the community compared to 45 percent in 2018 and there was a higher abundance and diversity of mayflies and caddisflies (Rockafellow, 2003).

Table 4. Water quality results for the Tributary to Six Lakes at Sheridan Road, Montcalm County, June 21, 2018.

Parameter	Station 6
Temperature (F)	60.78
DO (mg/L)	7.93
Specific Conductivity (µs/cm)	497.3
Conductivity (µs/cm)	411.7
pH	8.52
Chlorophyl (µg/L)	8.52

Suckerbrook Drain

There were concerns about the water quality in Suckerbrook Drain as it relates to agricultural practices because stakeholder sampling events showed elevated nitrate levels in the stream. This stream had previously been unassessed by EGLE so there was 1 sampling location (Station 7) selected to assess the habitat, macroinvertebrate community, and water chemistry, related to nutrients. Both the habitat (Table 9) and macroinvertebrate community (Table 10 and Table 11) had excellent ratings, suggesting that there are minimal impacts. The results of the water chemistry sample can be found in Table 5. However, comparing water chemistry results to data collected the by the Water Chemistry Monitoring Program (WCMP) probabilistic sites (PROB), there were a couple parameters that were outside of the typical range for the watershed and/or the ecoregion (Figure 2). Total phosphorus concentrations were high compared to PROB sites in the watershed but was typical for the ecoregion. Nitrate levels were higher than typically observed in either the watershed or ecoregion PROB sites.

Table 5. Water chemistry results for Suckerbrook Drain at Cannonsville Road, Montcalm County, June 21, 2018.

Parameter (mg/L)	Station 7
Ammonia	0.01
Nitrate + Nitrite	1.9
Nitrate	1.9
Nitrite	0.013
Total Phosphorus	0.048

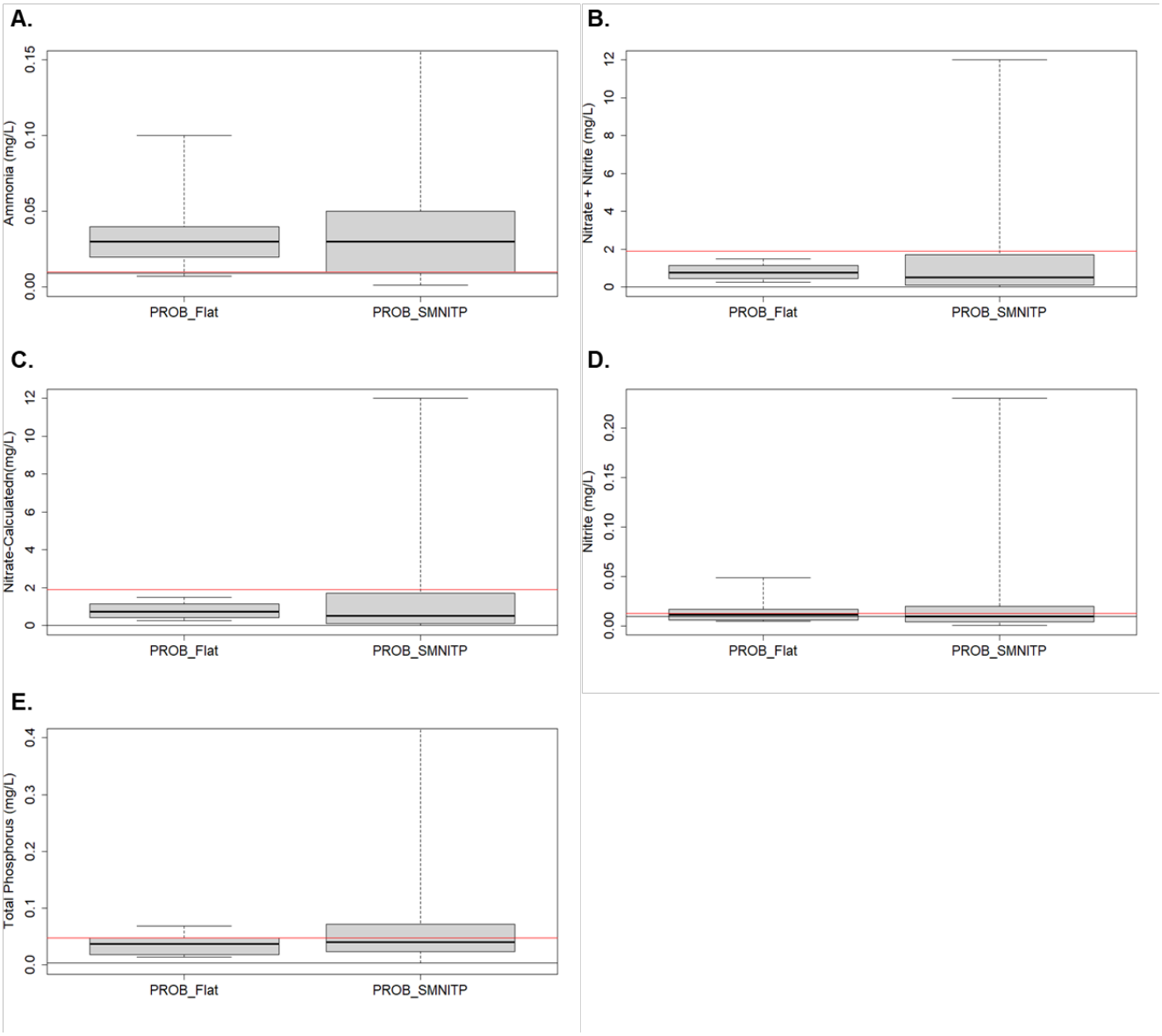

Figure 2. Suckerbrook Drain values (red line) from June 21, 2018, and detection limits (black line) compared to other WCMP PROB in the Flat River watershed (PROB_Flat) and WCMP PROB in the SMNITP EPA Level III Ecoregions (PROB_SMNITP).

Seely Creek

During the development of the watershed management plan, stakeholders reported agricultural pollutants draining into Seely Creek around Ashley Avenue (SV1) and Montcalm Avenue (SV2). Additionally, Trout Unlimited collected total phosphorus at Bartonville Road (SV3) that showed concentrations 3 times higher than any other site sampled that year but could have been due to elevated total suspended solids. However, during the site visits there were no obvious sources of pollution, no eroding banks, and nutrients were not being expressed in the form of either algae or macrophytes, so no further

sampling was conducted. Further downstream at Gold Lake Road (Station 9), there was a macroinvertebrate survey with no obvious concerns. However, there was a higher proportion of macroinvertebrates that are dependent on air for breathing (e.g., Hemiptera; Table 13 and Table 14). There are many factors that could lead to a higher percentage of air breathers, but one possibility is a high demand of dissolved oxygen causing diurnal swings in concentrations.

Goal 4: Provide supporting data for the development and issuance of NPDES permits.

Targeted monitoring was conducted throughout the Flat River (Table 3, Figure 1) at sites (Stations 2-5) in the vicinity of facilities that are authorized to discharge under an NPDES permit to assess the macroinvertebrate community, habitat quality, and nutrients to assist with development of NPDES permits. The facilities in the Flat River watershed targeted in 2018 include the Federal Mogul Corp-Greenville (MI0002836), Greenville Wastewater Treatment Plant (WWTP) (MI0020397), and the Belding WWTP (MI0020851).

The macroinvertebrate community and habitat quality were assessed at 4 locations in 2018. Sites were located upstream and downstream of the 3 targeted NPDES permitted facilities.

Habitat quality was rated good to excellent with the downstream locations rating excellent. Significant aquatic vegetation was observed at 6 Mile Road where this site is downstream of the Belding WWTP (MI0020851). The Flat River is wide at this location with depth averaging 2.5 feet across the reach. Photo 3 illustrates the dense aquatic vegetation (primarily *Potamogeton sp.*) along the right bank.

The macroinvertebrate community was rated excellent at the 3 most upstream sites while rating acceptable at the most downstream site. From upstream to downstream, the macroinvertebrate community ratings were +5, +8, +7, and +3 with total number of taxa at each site of 32, 37, 37, and 36. A good diversity of Ephemeroptera, Plecoptera, and Trichoptera (EPT) were found at the 3 most upstream sites with no Plecoptera found at the downstream site.

The habitat and macroinvertebrate community results for this objective are found in Table 6 through Table 11.

Photo 3. Flat River upstream of 6 Mile Road, Ionia County, 2018.

Goal 5: Identify potential NPS and other sources of water quality impairment.

Overall, water quality in the Flat River and its tributaries was good, but there were several targeted monitoring requests with concerns about NPS of pollution on the water quality. However, based on surveys in 2018, there were no major observations of NPS or other sources of pollution in the watershed although there were a couple locations that indicated there might be sources of pollution upstream.

The tributary to Six Lakes (Station 6) and Black Creek (Station 8) had higher levels of sediment deposition than the rest of the sites, suggesting that there might be some upstream sources considering both stations had a high percentage of agricultural land cover in their respective subwatersheds (57 percent, 55 percent, respectively; National Oceanic and Atmospheric Administration [NOAA], 2011). Despite the sedimentation and modified land cover, the overall habitat ratings for both stations were considered good. However, Station 6 had the lowest macroinvertebrate community rating (-3) despite having good habitat. Possibly the high sedimentation could be causing the lower macroinvertebrate score or there could be other stressors not observed.

Suckerbrook Drain (Station 7) is in the Mud Lake-Flat River subwatershed, which has one of the lowest coverages of natural land (34 percent) of any subwatershed in the Flat River watershed and conversely one of the highest coverages of agriculture land (59 percent) with the remainder being developed (NOAA, 2011). Despite the higher amount of altered land use, habitat and a macroinvertebrate community both rated excellent. However, the

water chemistry samples suggest that there are elevated nutrients likely coming from the agricultural or developed land uses. Total phosphorus was higher than typically observed at PROB sites in the watershed and nitrate was higher than typically observed in both the watershed and ecoregion (Figure 2). However, those nutrients were not being expressed in the form of algae or macrophyte growth likely due to the intact riparian shading the stream.

RECOMMENDATIONS

1. Flat River downstream of First Lake has potentially seen an increase in pollution-tolerant taxa over the past 10 years despite maintaining good habitat. Historical sites upstream of the current locations should be revisited to determine if a downshift in the macroinvertebrate community persists upstream of Six Lakes.
2. Flat River downstream of Belding was observed to have extensive aquatic vegetation growth. This portion of the river should be revisited to document how extensive the potential nutrient expression might be.
3. Tributary to Sixth Lake is another location that had good habitat but seems to be experiencing a decrease in the health of the macroinvertebrate community. This portion of the watershed should be targeted for monitoring upstream to see if there is a source to the decline of the community. Additionally, the current location should be revisited at some point to determine if the benthic community continues to decline.
4. Suckerbrook Drain was visited again in 2021 to conduct a macroinvertebrate survey (results pending) with no indication that the elevated nutrients documented in 2018 were being expressed. In the future, this stream should be visited at other road crossings, upstream and downstream, to determine if nutrients are being expressed and possibly determine if further investigation is needed.

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BIOSURVEY & HABITAT TABLES

Table 6. Habitat evaluations for the Flat River in Montcalm and Ionia Counties, June and July 2018.

	Station 1 Flat River at Almy Rd	**Station 2** Flat River at Greenville West Dr	**Station 3** Flat River at M-57	**Station 4** Flat River at M-44
	6/21/2018	**7/18/2018**	**7/23/2018**	**7/23/2018**
HABITAT METRICS	**GLIDE/POOL**	**RIFFLE/RUN**	**RIFFLE/RUN**	**GLIDE/POOL**
Substrate and Instream Cover				
Epifaunal Substrate/ Available Cover (20)	19	13	14	16
Embeddedness (20)	NA	NA	15	NA
Velocity/Depth Regime (20)	NA	NA	14	NA
Pool Substrate Characterization (20)	15	8	NA	17
Pool Variability (20)	13	16	NA	16
Channel Morphology				
Sediment Deposition (20)	16	14	16	17
Flow Status Maintenance Flow Volume (10)	9	9	9	10
Flow Status -Flashiness (10)	9	9	7	9
Channel Alteration (20)	19	18	17	19
Frequency of Riffles/Bends (20)	NA	NA	14	NA
Channel Sinuosity (20)	13	14	NA	14
Riparian and Bank Structure				
Bank Stability (L) (10)	9	8	8	9
Bank Stability (R) (10)	9	8	8	9
Vegetative Protection (L) (10)	9	7	8	9
Vegetative Protection (R) (10)	9	8	8	9
Riparian Vegetative Zone Width (L) (10)	4	8	6	9
Riparian Vegetative Zone Width (R) (10)	9	8	6	9
TOTAL SCORE (200):	162	148	150	172
HABITAT RATING:	**EXCELLENT**	**GOOD**	**GOOD**	**EXCELLENT**
Weather:	sunny	Sunny	cloudy	rainy
Air Temperature: ºF	72	77	69	70
Water Temperature: ºF	73	74	67	68
Average Stream Width: Feet	30.66666667	78	70	153.6666667
Average Stream Depth: Feet	1.8	2.09	2.05	2.05
Surface Velocity: Feet/Second	1.266223488	0.785440613	2.231033454	1.599635311
Estimated Flow: Cubic Feet/Second	70.93102599	128.2886335	320.1531652	527.6734773
Stream Modifications:	None	None	None	None
Nuisance Plants (Yes/No):	No	No	No	No
STORET Number:	590362	590366	590307	340196
County Code:	59	59	59	34
Town Range Section:	12N07W21	09N08W09	09N08W10	08N08W14

	Station 1 Flat River at Almy Rd	**Station 2** Flat River at Greenville West Dr	**Station 3** Flat River at M-57	**Station 4** Flat River at M-44
	6/21/2018	**7/18/2018**	**7/23/2018**	**7/23/2018**
Latitude (dd):	43.408889	43.189119	43.18029	43.09179
Longitude (dd):	-85.149722	-85.268575	-85.24516	-85.2387
Ecoregion:	SMNITP	SMNITP	SMNITP	SMNITP
Stream Type:	Warmwater	Warmwater	Warmwater	Warmwater
USGS Basin Code:	4050006	4050006	4050006	4050006

Table 7. Qualitative macroinvertebrate community sampling results for the Flat River in Montcalm and Ionia Counties, June and July 2018.

Taxa	**Station 1** Flat River at Almy Rd **6/21/2018**	**Station 2** Flat River at Greenville West Dr **7/18/2018**	**Station 3** Flat River at M-57 **7/23/2018**	**Station 4** Flat River at M-44 **7/23/2018**
PLATYHELMINTHES (flatworms)				
Turbellaria				2
ANNELIDA (segmented worms)				
Hirudinea (leeches)	1	2		1
Oligochaeta (worms)	1			2
ARTHROPODA				
Crustacea				
Amphipoda (scuds)	89	63	12	22
Decapoda (crayfish)	1	21	2	1
Isopoda (sowbugs)		1	1	6
Arachnoidea				
Hydracarina	1	2	4	5
Insecta				
Ephemeroptera (mayflies)				
Baetiscidae		1	1	1
Baetidae	2	8	32	56
Caenidae		4	2	
Ephemerellidae			4	34
Ephemeridae	4	15	5	7
Heptageniidae	6	27	32	63
Isonychiidae	1		6	6
Leptophlebiidae	13			15
Polymitarcyidae			4	4
Odonata				
Anisoptera (dragonflies)				
Aeshnidae		1	1	1
Gomphidae	1	1	1	
Zygoptera (damselflies)				
Calopterygidae	1	1	1	
Coenagrionidae	13	5		
Plecoptera (stoneflies)				
Perlidae	11	2	11	2

Taxa	**Station 1** Flat River at Almy Rd **6/21/2018**	**Station 2** Flat River at Greenville West Dr **7/18/2018**	**Station 3** Flat River at M-57 **7/23/2018**	**Station 4** Flat River at M-44 **7/23/2018**
Pteronarcyidae				
Hemiptera (true bugs)				
Corixidae	35	10		
Gerridae	25	1	2	1
Pleidae		3		
Veliidae	1			
Megaloptera				
Corydalidae (dobson flies)		2	2	
Trichoptera (caddisflies)				
Brachycentridae		1	20	9
Glossosomatidae			11	7
Helicopsychidae		1		71
Hydropsychidae	4	20	62	23
Leptoceridae	28	7	4	1
Limnephilidae	1	4	2	5
Philopotamidae			5	1
Phryganeidae	1			
Polycentropodidae		1	20	9
Coleoptera (beetles)				
Dytiscidae (total)	1			
Gyrinidae (adults)	1		2	1
Haliplidae (adults)		1		
Hydrophilidae (total)				1
Elmidae	6	11	19	20
Gyrinidae (larvae)	1		1	
Psephenidae (larvae)			6	7
Diptera (flies)				
Chironomidae	8	17	10	
Simuliidae			18	2
Stratiomyidae	1			
Tipulidae	1			
MOLLUSCA				
Gastropoda (snails)				
Ancylidae (limpets)			1	5

Taxa	**Station 1** Flat River at Almy Rd **6/21/2018**	**Station 2** Flat River at Greenville West Dr **7/18/2018**	**Station 3** Flat River at M-57 **7/23/2018**	**Station 4** Flat River at M-44 **7/23/2018**
Hydrobiidae			5	7
Lymnaeidae		1	1	
Physidae	2	55		8
Planorbidae	1	1	1	
Viviparidae	2		1	
Pelecypoda (bivalves)				
Dreissenidae			1	2
Pisidiidae	2	2	1	40
Unionidae (mussels)				1
Total Individuals	**266**	**293**	**295**	**443**

Table 8. Macroinvertebrate metric evaluation for the Flat River in Montcalm and Iona Counties, June and July 2018.

	Station 1 Flat River at Almy Rd		**Station 2** Flat River at Greenville West Dr		**Station 3** Flat River at M-57		**Station 4** Flat River at M-44	
	6/21/2018		**7/18/2018**		**7/23/2018**		**7/23/2018**	
METRIC	Value	Score	Value	Score	Value	Score	Value	Score
Total Number of Taxa	31	1	32	1	37	1	37	1
Number of Mayfly Taxa	5	1	5	1	8	1	8	1
Number of Caddisfly Taxa	4	0	5	1	6	1	7	1
Number of Stonefly Taxa	1	1	2	1	2	1	2	1
Percent Mayfly Composition	9.77	0	18.77	1	29.15	1	41.99	1
Percent Caddisfly Composition	12.78	0	11.26	0	35.25	1	26.41	0
Percent Dominant Taxon	33.46	0	21.50	0	21.02	0	16.03	1
Percent Isopod, Snail, Leech	2.26	1	20.48	-1	3.39	1	6.09	0
Percent Surface Air Breathers	24.06	-1	5.12	1	1.36	1	0.68	1
TOTAL SCORE		**3**		**5**		**8**		**7**
Macroinvertebrate Community Rating	**Acceptable**		**Excellent**		**Excellent**		**Excellent**	

Table 9. Habitat evaluations for the Flat River in Ionia County, Trib to Six Lakes and Suckerbrook Drain in Montcalm County, and Black Creek in Kent County, June-August 2018.

	Station 5 Flat River at 6 Mile Rd	**Station 6** Trib to Six Lakes at Sheridan Rd	**Station 7** Suckerbrook Drain at Cannonsville Rd	**Station 8** Black Creek at Rooksby St
	7/23/2018	**6/21/2018**	**6/22/2018**	**8/1/2018**
HABITAT METRICS	**GLIDE/POOL**	**RIFFLE/RUN**	**RIFFLE/RUN**	**GLIDE/POOL**
Substrate and Instream Cover				
Epifaunal Substrate/ Available Cover (20)	12	15	15	16
Embeddedness (20)	NA	NA	17	NA
Velocity/Depth Regime (20)	NA	NA	10	NA
Pool Substrate Characterization (20)	16	10	NA	16
Pool Variability (20)	10	8	NA	13
Channel Morphology				
Sediment Deposition (20)	17	11	18	12
Flow Status Maintenance Flow Volume (10)	9	8	9	9
Flow Status -Flashiness (10)	9	8	9	5
Channel Alteration (20)	18	20	19	15
Frequency of Riffles/Bends (20)	NA	NA	14	NA
Channel Sinuosity (20)	14	14	NA	13
Riparian and Bank Structure				
Bank Stability (L) (10)	9	9	9	8
Bank Stability (R) (10)	9	9	9	9
Vegetative Protection (L) (10)	9	9	9	8
Vegetative Protection (R) (10)	9	9	9	8
Riparian Vegetative Zone Width (L) (10)	9	9	9	5
Riparian Vegetative Zone Width (R) (10)	9	8	9	9
TOTAL SCORE (200):	159	147	165	146
HABITAT RATING:	**EXCELLENT**	**GOOD**	**EXCELLENT**	**GOOD**
Weather:	Cloudy	Sunny	Cloudy	Partly cloudy
Air Temperature: ºF	70	64	65	83
Water Temperature: ºF	70	61	56	68
Average Stream Width: Feet	165	15	8.4	16
Average Stream Depth: Feet	2.5	0.7	0.9	0.8
Surface Velocity: Feet/Second	1.941530692	0.653110048	0.741282051	0.333863275
Estimated Flow: Cubic Feet/Second	795.6392774	7.891311005	5.313509744	8.2

	Station 5 Flat River at 6 Mile Rd	**Station 6** Trib to Six Lakes at Sheridan Rd	**Station 7** Suckerbrook Drain at Cannonsville Rd	**Station 8** Black Creek at Rooksby St
	7/23/2018	**6/21/2018**	**6/22/2018**	**8/1/2018**
Stream Modifications:	None	None	None	Canopy removal
Nuisance Plants (Yes/No):	No	N	No	No
STORET Number:	340261	590303	590374	410759
County Code:	34	59	59	41
Town Range Section:	08N08W22	12N07W12	11N07W18	10N09W07
Latitude (dd):	43.058679	43.443758	43.3365	43.237
Longitude (dd):	-85.254771	-85.085035	-85.1901	-85.415
Ecoregion:	SMNITP	SMNITP	SMNITP	SMNITP
Stream Type:	Warmwater	Warmwater	Warmwater	Warmwater
USGS Basin Code:	4050006	4050006	4050006	4050006

Table 10. Qualitative macroinvertebrate community sampling results for the Flat River in Ionia County, Trib to Six Lakes and Suckerbrook Drain in Montcalm County, and Black Creek in Kent County, June-August 2018.

Taxa	**Station 5** Flat River at 6 Mile Rd	**Station 6** Trib to Six Lakes at Sheridan Rd	**Station 7** Suckerbrook Drain at Cannonsville Rd	**Station 8** Black Creek at Rooksby St
	7/23/2018	**6/21/2018**	**6/22/2018**	**8/1/2018**
ANNELIDA (segmented worms)				
Hirudinea (leeches)	1			
Oligochaeta (worms)		4	1	3
ARTHROPODA				
Crustacea				
Amphipoda (scuds)	60	111	80	89
Decapoda (crayfish)	1	4	4	8
Isopoda (sowbugs)	24			
Arachnoidea				
Hydracarina			1	1
Insecta				
Ephemeroptera (mayflies)				
Baetidae	39		31	2
Caenidae			1	
Ephemerellidae	1		3	
Ephemeridae	1		1	
Heptageniidae	8	1	14	21
Isonychiidae	2			
Leptophlebiidae	2		1	
Polymitarcyidae	4			
Odonata				
Anisoptera (dragonflies)				
Aeshnidae	4	4	6	1
Cordulegastridae			1	
Gomphidae			2	3
Macromiidae	1			
Zygoptera (damselflies)				
Calopterygidae	5	14	3	17
Plecoptera (stoneflies)				
Perlidae			16	

Taxa	**Station 5** Flat River at 6 Mile Rd **7/23/2018**	**Station 6** Trib to Six Lakes at Sheridan Rd **6/21/2018**	**Station 7** Suckerbrook Drain at Cannonsville Rd **6/22/2018**	**Station 8** Black Creek at Rooksby St **8/1/2018**
Hemiptera (true bugs)				
Belostomatidae				1
Corixidae	1			4
Gerridae	4	14		2
Nepidae				1
Pleidae		2		2
Veliidae	1	14	3	2
Megaloptera				
Corydalidae (dobson flies)		3	6	1
Trichoptera (caddisflies)				
Brachycentridae	3	7	8	
Glossosomatidae	12			
Helicopsychidae	10			2
Hydropsychidae	14	2	37	18
Leptoceridae	1		2	7
Limnephilidae	1	4	1	5
Polycentropodidae	1		1	3
Uenoidae			2	
Lepidoptera (moths)				
Pyralidae	1			
Coleoptera (beetles)				
Gyrinidae (adults)	6	1	1	1
Hydrophilidae (total)			1	1
Elmidae	3	14	18	23
Psephenidae (larvae)	5			
Diptera (flies)				
Ceratopogonidae			1	
Chironomidae	2	40	6	16
Culicidae				2
Dixidae		2	1	1
Simuliidae	3		4	
Stratiomyidae		3		
Tabanidae				4

Taxa	**Station 5** Flat River at 6 Mile Rd **7/23/2018**	**Station 6** Trib to Six Lakes at Sheridan Rd **6/21/2018**	**Station 7** Suckerbrook Drain at Cannonsville Rd **6/22/2018**	**Station 8** Black Creek at Rooksby St **8/1/2018**
Tipulidae		1		
MOLLUSCA				
Gastropoda (snails)				
Ancylidae (limpets)	7		1	2
Hydrobiidae	7			
Physidae	51			8
Planorbidae	1	1		
Viviparidae		1		1
Pelecypoda (bivalves)				
Dreissenidae	1			
Pisidiidae	4	2		
Total Individuals	**292**	**249**	**258**	**252**

Table 11. Macroinvertebrate metric evaluation for the Flat River in Ionia County, Trib to Six Lakes and Suckerbrook Drain in Montcalm County, and Black Creek in Kent County, June-August 2018.

	Station 5 Flat River at 6 Mile Rd		**Station 6** Trib to Six Lakes at Sheridan Rd		**Station 7** Suckerbrook Drain at Cannonsville Rd		**Station 8** Black Creek at Rooksby St	
	7/23/2018		**6/21/2018**		**6/22/2018**		**8/1/2018**	
METRIC	Value	Score	Value	Score	Value	Score	Value	Score
Total Number of Taxa	36	1	22	0	31	1	31	1
Number of Mayfly Taxa	7	1	1	-1	6	1	2	0
Number of Caddisfly Taxa	7	1	3	0	6	1	5	1
Number of Stonefly Taxa	0	-1	0	-1	1	1	0	-1
Percent Mayfly Composition	19.52	1	0.40	-1	19.77	1	9.13	0
Percent Caddisfly Composition	14.38	0	5.22	0	19.77	0	13.89	0
Percent Dominant Taxon	20.55	0	44.58	-1	31.01	0	35.32	0
Percent Isopod, Snail, Leech	31.16	-1	0.80	1	0.39	1	4.37	0
Percent Surface Air Breathers	5.82	1	13.65	0	1.94	1	6.35	1
TOTAL SCORE		**3**		**-3**		**7**		**2**
Macroinvertebrate Community Rating	**Acceptable**		**Acceptable**		**Excellent**		**Acceptable**	

Table 12. Habitat evaluations for Seely Creek in Ionia County, August 2018.

	Station 9 Seely Creek at Gold Lake Rd
	8/2/2018
HABITAT METRICS	**GLIDE/POOL**
Substrate and Instream Cover	
Epifaunal Substrate/ Available Cover (20)	15
Embeddedness (20)*[1]	16
Velocity/Depth Regime (20)*[1]	14
Pool Substrate Characterization (20)**[2]	NA
Pool Variability (20)**[2]	NA
Channel Morphology	
Sediment Deposition (20)	18
Flow Status -Maintenance Flow Volume (10)	10
Flow Status -Flashiness (10)	9
Channel Alteration (20)	18
Frequency of Riffles/Bends (20)*[1]	13
Channel Sinuosity (20)**[2]	NA
Riparian and Bank Structure	
Bank Stability (L) (10)	9
Bank Stability (R) (10)	9
Vegetative Protection (L) (10)	5
Vegetative Protection (R) (10)	9
Riparian Vegetative Zone Width (L) (10)	1
Riparian Vegetative Zone Width (R) (10)	5
TOTAL SCORE (200):	151
HABITAT RATING:	**GOOD**
Weather:	rainy
Air Temperature: ºF	75
Water Temperature: ºF	
Average Stream Width: Feet	28
Average Stream Depth: Feet	0.8
Surface Velocity: Feet/Second	1.217948718
Estimated Flow: Cubic Feet/Second	27.33
Stream Modifications:	none
Nuisance Plants (Yes/No):	No

	Station 9 Seely Creek at Gold Lake Rd
	8/2/2018
STORET Number:	340231
County Code:	34
Town Range Section:	08N08W21
Latitude (dd):	43.066
Longitude (dd):	-85.269
Ecoregion:	SMNITP
Stream Type:	Warmwater
USGS Basin Code:	4050006

Table 13. Qualitative macroinvertebrate community sampling results for Seely Creek in Ionia County, August 2018.

Taxa	**Station 9** Seely Creek at Gold Lake Rd **8/2/2018**
PORIFERA (sponges)	
PLATYHELMINTHES (flatworms)	
Turbellaria	
NEMATOMORPHA (roundworms)	
ANNELIDA (segmented worms)	
Hirudinea (leeches)	1
ARTHROPODA	
Crustacea	
Amphipoda (scuds)	48
Decapoda (crayfish)	7
Arachnoidea	
Hydracarina	7
Insecta	
Ephemeroptera (mayflies)	
Baetidae	3
Ephemeridae	1
Heptageniidae	8
Isonychiidae	1
Leptophlebiidae	1
Odonata	
Anisoptera (dragonflies)	
Aeshnidae	1
Gomphidae	2
Zygoptera (damselflies)	
Calopterygidae	43
Hemiptera (true bugs)	
Belostomatidae	1
Corixidae	18

Taxa	**Station 9** Seely Creek at Gold Lake Rd **8/2/2018**
Gerridae	27
Notonectidae	1
Megaloptera	
Corydalidae (dobson flies)	2
Trichoptera (caddisflies)	
Brachycentridae	1
Helicopsychidae	1
Hydropsychidae	17
Leptoceridae	3
Coleoptera (beetles)	
Dytiscidae (total)	1
Elmidae	9
Diptera (flies)	
Chironomidae	19
Culicidae	1
Dixidae	2
Simuliidae	4
Tabanidae	1
Tipulidae	2
MOLLUSCA	
Gastropoda (snails)	
Ancylidae (limpets)	1
Hydrobiidae	1
Physidae	4
Planorbidae	1
Pelecypoda (bivalves)	
Pisidiidae	5
Total Individuals	**245**

Table 14. Macroinvertebrate metric evaluation for Seely Creek in Ionia County, August 2018.

METRIC	Station 9 Seely Creek at Gold Lake Rd 8/2/2018 Value	Score
Total Number of Taxa	34	1
Number of Mayfly Taxa	5	1
Number of Caddisfly Taxa	4	0
Number of Stonefly Taxa	0	-1
Percent Mayfly Composition	5.71	0
Percent Caddisfly Composition	8.98	0
Percent Dominant Taxon	19.59	1
Percent Isopod, Snail, Leech	3.27	1
Percent Surface Air Breathers	20.00	-1
TOTAL SCORE		**2**
Macroinvertebrate Community Rating	**Acceptable**	