

MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY
WATER RESOURCES DIVISION
JULY 2019

STAFF REPORT

Biological survey of selected stations in the Au Sable River and Black River Watersheds in Otsego, Alpena, Crawford, Oscoda, and Alcona Counties, Michigan, June-August 2017 and June-December 2018

Introduction

Staff of the Michigan Department of Environment, Great Lakes, and Energy (EGLE) conducted biological and physical habitat surveys of selected water bodies in the Au Sable River and Black River watersheds (HUC8_04070007; HUC8_04070003) from June to August 2017 as part of the Surface Water Assessment Section (SWAS) five-year rotating basin monitoring design. Macroinvertebrate and habitat surveys were completed at two probabilistic sites and 11 trend sites following SWAS Procedure 51 for wadeable streams (Creal *et al.*, 1996; Michigan Department of Environmental Quality [MDEQ], 1990a). Three additional sites within the North Branch Au Sable River watershed were surveyed in 2017 to address targeted monitoring requests. Additional biological surveys of the North Branch Au Sable River were completed in June 2018 and *in situ* water chemistry monitoring of pH occurred from October to December 2018.

Specific monitoring objectives were to:

- 1) Assess the current status and condition of individual assessment units and determine whether Water Quality Standards (WQS) are being met.
- 2) Evaluate biological integrity temporal trends.
- 3) Address monitoring requests submitted by internal and external customers.
- 4) Identify nonpoint sources (NPS) of water quality impairment or concern.

Watershed Information

The Au Sable River watershed drains over 1,900 square miles in the northeastern Lower Peninsula of Michigan and is situated almost entirely within the Northern Lakes and Forest Ecoregion (Omernik, 1988). The Au Sable River is known for its coldwater fisheries and relatively natural landscape. A 23-mile segment of the Au Sable River between Mio Pond and Alcona Pond is nationally designated as a Scenic River under the National Wild and Scenic Rivers Act (1968) and a large portion of the watershed is protected as Natural River under Michigan's Natural Rivers Program (Part 305, Natural Rivers, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended [NREPA]). Detailed information on the geography, history, geology, hydrology, morphology, water quality, and biological communities of the Au Sable River watershed can be found in the Michigan Department of Natural Resources (DNR) Fisheries Division's "Au Sable River Assessment" (Zorn and Sendek, 2001).

The Black River watershed encompasses approximately 200 square miles in the northeastern Lower Peninsula within the Northern Lakes and Forest Ecoregion (Omernik, 1988). It is situated to the northeast of the Au Sable River watershed and contains two main rivers, the Black River and Devils River. Land use is similar to the Au Sable River watershed with forest dominating the landscape; however, agriculture and urban areas make up a greater portion of the Black River watershed.

Historical Sampling Efforts in Recent Years

Au Sable River Watershed

- In 1997, 24 biological surveys were completed within the Au Sable River watershed (MDEQ, 2001). Macroinvertebrate communities ranged from Acceptable to Excellent, while habitat conditions ranged from Fair to Excellent. Water chemistry grab samples were examined for nutrients and conventional pollutants at nine stations and did not exceed WQS. In 1998, water chemistry data from the Au Sable River watershed indicated water quality was generally very good except for PCBs and DDT, which exceeded WQS in some sites tested near the mouth (MDEQ, 2001).
- In 2002, ten biological surveys and 12 habitat surveys were completed within the watershed. Macroinvertebrates were characterized as Acceptable or Excellent, while habitat was rated as Good or Excellent (MDEQ, 2003a).
- In 2007, biological surveys were completed at 29 sites in the Au Sable River watershed. Macroinvertebrate communities ranged from Acceptable to Excellent, while habitat conditions ranged from Good to Excellent (MDEQ, 2008a).
- In 2012, biological surveys were completed at 25 sites using Procedure 51 and at two sites using SWAS Procedure 22 for nonwadeable rivers (MDEQ, 2013). All Procedure 51 sites scored Acceptable or Excellent for macroinvertebrates and Good to Excellent for habitat, with the exception of two sites that scored Marginal for habitat in the Pine River sub-watershed (MDEQ, 2015a).

Black River Watershed

- In 1998 (MDEQ, 2000) and 2002 (MDEQ, 2003b), biological surveys were conducted on the Black River and Devils River at two sites. In the Black River, macroinvertebrates were found to be Acceptable in both years with very similar communities. Habitat was Fair in 1998 and Good in 2002. In the Devils River, macroinvertebrates were Acceptable in both years, while habitat was Good in 1998 and Excellent in 2002.
- In 2007, biological surveys were completed at seven sites within the Black River watershed (MDEQ, 2008b). Habitat was Good or Excellent in all sites. Macroinvertebrate communities were Acceptable in five sites, Excellent in one site, and Poor in one site (although the Poor site had limited flow and Procedure 51 may not have been appropriate).
- In 2012, biological surveys were completed at six sites using Procedure 51. Sites had Acceptable to Excellent macroinvertebrate communities and Marginal to Excellent habitat conditions (MDEQ, 2015a).

Methods

Biological surveys were completed at 16 sites in the Au Sable and Black River watersheds from June to August 2017 (Table 1, Figure 1) and at three sites in June 2018. All biological surveys were completed following SWAS Procedure 51 (MDEQ, 1990a).

Procedure 51 assigns a score to macroinvertebrate communities and habitat conditions using metrics that rate macroinvertebrates as Excellent (> 4), Acceptable (+ 4 to - 4), or Poor (< 4) based on the macroinvertebrate community composition and structure, and habitat as Excellent (> 154), Good (105 to 154), Marginal (56 to 104), or Poor (< 56) based on several parameters that describe instream and riparian conditions (Creal *et al.*, 1996).

Site Selection

Two site selection methods were used to assess the Au Sable River and Black River watersheds in 2017: (1) stratified random; and (2) targeted. Thirteen randomly selected sites were assigned to support the SWAS Status (two sites) and Trend (11 sites) Program. These sites will be used, in part, to determine attainment status for the Other Indigenous Aquatic Life and Wildlife (OIALW) designated use component of Rule 100 ([R 323.1100\[e\]](#)) of the Part 4 Rules, WQS, promulgated under Part 31, Water Resources Protection, of the NREPA, and will be used to facilitate a measurement of biological community temporal trends (Procedure 27; MDEQ, 2015b).

Targeted sites were solicited from internal and external customers in the fall of 2016. Requests were then ranked following a series of meetings involving Water Resources Division (WRD) managers, watershed biologists, permit biologists, NPS staff, district staff, and water quality/topic specialists based on the severity of the water quality concern, potential ongoing impacts to surface waters, available resources, division priorities, and other factors. These rankings were then used to determine the requests to be fulfilled in 2017. Three stations within the Au Sable River watershed were selected for targeted monitoring in 2017 and are detailed below (Objective 3).

Figure 1. Status, Trend, and Targeted Sites within the Au Sable and Black River Watersheds 2017.

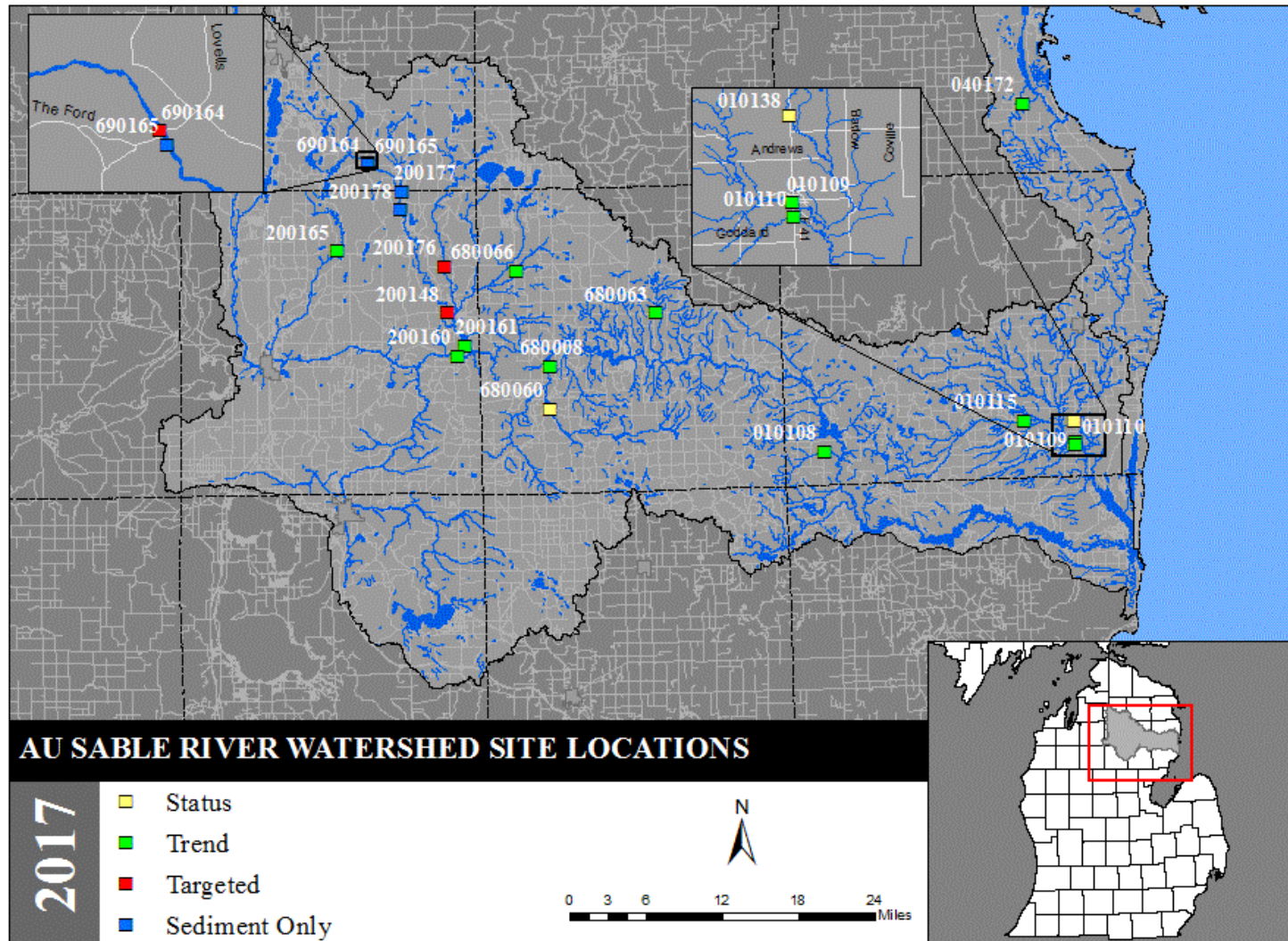


Table 1. Sites Sampled in the Au Sable and Black River Watersheds in 2017.

STATUS										
STORET	Waterbody	Location	Latitude	Longitude	AUID	Date	Macro Score	Category	Habitat Score	Category
010138	Van Etten Creek	F-41 (South Crossing)	44.57385	-83.42265	040700070607-02	6/13/2017	-2	Acceptable	104	Marginal
680060	East Branch Big Creek (South)	two track off Galloway Road	44.60415	-84.25842	040700070405-01	6/15/2017	5	Excellent	167	Excellent
TREND										
STORET	Waterbody	Location	Latitude	Longitude	AUID	Date	Macro Score	Category	Habitat Score	Category
010108	Smith Creek	2-track of Aldrich Rd.	44.54727	-83.82204	040700070706-03	6/28/2017	3	Acceptable	163	Excellent
200165	East Branch AuSable River	d/s Co. Rd. 612	44.78823	-84.59661	040700070305-01	6/15/2017	3	Acceptable	187	Excellent
680066	Wright Creek	Co. Rd 489 (Bear Lake Road)	44.76320	-84.30732	040700070209-02	6/14/2017	6	Excellent	147	Good
680008	Big Creek	Brown Cabin Rd. (Co Rd 487)	44.65209	-84.25894	040700070406-01	6/14/2017	6	Excellent	183	Excellent
200161	North Branch AuSable River	2-track east off McMasters Bridge Rd	44.67763	-84.39378	040700070210-01	6/14/2017	8	Excellent	187	Excellent
200160	Au Sable River	2-track west off McMasters Bridge Rd.	44.66604	-84.40448	040700070310-01	6/28/2017	7	Excellent	160	Excellent
010115	South Branch Pine River	end of Buhl Rd @ turnaround. Hiking trail to south. 3-5 mile walk.	44.57699	-83.50333	040700070605-01	6/28/2017	8	Excellent	161	Excellent
010109	Pine River	F41 (Somers) Rd.	44.55165	-83.42383	040700070608-01	8/16/2017	3	Acceptable	125	Good
010110	Duvall Creek	d/s F41 (Somers) Rd.	44.54683	-83.42156	040700070608-02	6/28/2017	5	Excellent	160	Excellent
680063	Perry Creek	Kneeland Road	44.71057	-84.08753	040700070503-01	6/14/2017	5	Excellent	160	Excellent
040172	Berlinski Creek	two-track off Carriveau Rd (west)	44.93823	-83.48918	040700030403-01	6/13/2017	4	Acceptable	175	Excellent
TARGETED										
STORET	Waterbody	Location	Latitude	Longitude	AUID	Date	Macro Score	Category	Habitat Score	Category
690164	North Branch AuSable River	The Ford (Upstream)	44.88811	-84.54309	040700070207-01	6/15/2017	4	Acceptable	169	Excellent
200148	North Branch AuSable River	North Down River Rd.	44.71650	-84.41981	040700070210-01	6/16/2017	4	Acceptable	170	Excellent

200176	West Branch Big Creek	Town Line Road Bridge (downstream)	44.76887	-84.42445	040700070208-01	6/16/2017	6	Excellent	180	Excellent
SEDIMENT ONLY										
200177	North Branch AuSable River	Two track off Twin Bridge Rd.	44.85526	-84.48983	040700070210-01	6/16/2017	NA	NA	NA	NA
200178	North Branch AuSable River	Sheep Access	44.83387	-84.49315	040700070210-01	6/16/2017	NA	NA	NA	NA
690165	North Branch AuSable River	The Ford (Downstream)	44.88663	-84.54197	040700070207-01	6/16/2017	NA	NA	NA	NA

2017 Sampling Results Summary of Findings by Monitoring Objective

Objective 1: Assess the current status and condition of individual assessment units and determine whether WQS are being met

In 2017, habitat and aquatic macroinvertebrate community assessments were completed at a total of 16 stations in the Au Sable and Black River watersheds, two of which were randomly selected statewide status sites. Results for the remaining 14 sites are shown in Table 1 and discussed in detail under Objectives 2 and 3. All stations monitored for macroinvertebrates in 2017 were meeting the OIALW Designated Use.

Van Etten Creek at F41 (STORET 010138)

Van Etten Creek is a tributary to the Pine River in Alcona County, Michigan. In 2017, the channel upstream of the road stream crossing was very uniform and consisted of clay and silt substrate for approximately 100 meters upstream, above which the channel narrowed considerably and became more sinuous (the lower end of this narrowed section was also sampled). The 100 meters section of uniform channel appears to be the result of past dredging. There was little instream vegetation throughout the reach; however, there was a good amount of overhanging vegetation and habitat conditions scored Marginal (104). The macroinvertebrate community scored Acceptable (-2) with 23 taxa present. However, chironomids made up over 60% of the community and only 3 mayfly and 2 caddisfly taxa were found.



Photo 1. Van Etten Creek at F41 2017

East Branch Big Creek (South) at 2-track off Galloway Road (STORET 680060)

East Branch Big Creek is a tributary to Big Creek (south of the mainstem Au Sable River) near Luzerne. This site had not been previously sampled. The macroinvertebrate community at this site scored Excellent (5) with 20 taxa present, including 2 mayfly taxa, 7 caddisfly taxa, and 2 stonefly taxa. Ephemeroptera, Plecoptera, and Trichoptera (EPT) taxa made up 61% of the community. Habitat conditions also scored Excellent (167) at this site; however, sedimentation was evident, and a lack of pool variability was noted. Large woody debris, coarse particulate organic matter, and fine particulate organic matter were abundant in the reach and aquatic vegetation covered approximately 25% of the stream bottom providing good macroinvertebrate habitat.



Photo 2. East Branch Big Creek (South) at 2-track off Galloway Road 2017

Objective 2: Evaluate biological integrity temporal trends

Ten sites within the Au Sable River watershed were monitored once every five years from 2007 to 2017 (Table 2) to assess biological integrity temporal trends. Trends in macroinvertebrate scores were evaluated using linear mixed models (watershed-wide) as described in SWAS Procedure 27 (MDEQ, 2015b). One of the 10 sites was not sampled in 2007, and therefore, was removed from the analysis. No watershed-wide trend was evident from 2007 to 2017 in the Au Sable River watershed.

East Branch Au Sable River Downstream of County Road 612 (STORET 200165)

The East Branch Au Sable River is a tributary to the Au Sable River. The site downstream of County Road 612 is characterized by a wide, partially braided channel with a good diversity of macroinvertebrate habitat. Much of the stream channel was made up of shallow depositional areas covered in silt and inundated rushes. The active channel however, consisted of harder gravel and sand substrate with a moderate amount of woody debris and channel complexity.

The East Branch Au Sable River downstream of County Road 612 was surveyed as part of SWAS's Trend program in 2007, 2012, and 2017. In all three years the site had a macroinvertebrate community that scored Acceptable (2007: 1; 2012: 4; and 2017: 3) with more taxa found in 2012 and 2017 than in 2007, along with a greater percentage of EPT taxa. Habitat scores increased by roughly 20 points between years (2007: 143; 2012: 161; and 2017: 187) with the greatest increases in Epifaunal Substrate/Available cover, Pool Variability, and Channel Sinuosity. Some of these increases may have been due to interpretation differences among observers or natural variability, as this channel is not as clearly defined as others in the region and observers flipped between calling the river a glide/pool and riffle/run stream.



Photo 3. East Branch Au Sable River at County Road 612 2017

Au Sable River at 2-track west off McMasters Bridge Road (STORET 200160)

This site on the Au Sable River is approximately 0.5 miles upstream of the McMasters Bridge Access. It is a reach typical of the mainstem Au Sable River and is approximately 65 to 85 feet wide, and 2.5 feet deep with very fast flow (unsafe to measure in 2017). The river in this section is characterized by cobble, gravel, and sand substrate with instream vegetation limited to depositional areas along the margins of the river. The surrounding landscape is almost entirely forest with a fair number of homes/cabins along the banks of the river but few other influences.



Photo 4. Au Sable River at 2-track west off McMasters Bridge Road 2017.

Macroinvertebrate community scores have remained fairly constant since 2007, with communities rated as Excellent (7) in 2007, Excellent (5) in 2012, and Excellent (7) in 2017 with 36 to 40 taxa present in samples across years. The lower score in 2012 was due to a greater percent dominant taxa, and a lower percent mayfly composition (9% compared to 26% in 2007 and 32% in 2017), and was likely due to sampling or natural variability between years. Habitat conditions scored Excellent in all years with very similar metric scores among categories (2007: 190; 2012: 178; and 2017: 172).

Wright Creek at County Road 489 (STORET 680066)

Wright Creek is a small tributary to East Branch Big Creek (north). This reach was bordered by thick tag alders within the flood plain and mixed, mostly coniferous, forest in the surrounding landscape. Available habitat included a moderate amount of undercutts, very heavy overhanging vegetation, and heavy aquatic macrophytes.

In 2012, the macroinvertebrate community scored Acceptable (3), while in 2017 it scored Excellent (6) with 10 more taxa present than in the 2012 survey. Habitat conditions however scored similar between years, if not better in 2012, with Excellent (164) conditions in 2012 and Good (147) conditions in 2017. This site was not sampled in 2007.

North Branch Au Sable River at 2-track east off McMasters Bridge Road (STORET 200161)

The North Branch Au Sable River is a major tributary to the Au Sable River. This site is approximately 1.5 miles upstream of the confluence with the mainstem Au Sable River and is characteristic of the lower North Branch Au Sable River with a moderate amount of overhanging vegetation, large woody debris, and rootwads. There was a good amount of channel complexity and the substrate consisted of mostly gravel with some sand and silt.

Macroinvertebrates scored Acceptable (4) in 2007, Excellent (5) in 2012, and Excellent (8) in 2017. Percent EPT taxa has increased from 31% (2007), to 67% (2012), and 70% (2017) of the community. Habitat has been consistently rated as Excellent since 2007 (2007: 165; 2012: 179; and 2017: 187).



Photo 5. Wright Creek at County Road 489 2017



Photo 6. North Branch Au Sable River at 2 track off McMasters Bridge Road 2017

Big Creek at Brown Cabin Road (STORET 680008)

Big Creek (south) is a fairly wide (~50 feet), tributary to the Au Sable River with a good mix of instream substrate, vegetation, and available cover. The stream has a natural riparian area made up of a mix of cedars, tamaracks, shrubs, and herbaceous vegetation with the exception of a few houses bordering the stream near Bear Lake Road.

Big Creek at Brown Cabin Road was surveyed twice in 2007, once in 2012, and once in 2017. In all surveys macroinvertebrates scored Excellent with very similar communities (2007: 5 and 6; 2012: 6; and 2017: 6). Habitat conditions also scored quite high in all years with ratings of Good (150) and Excellent (165) in 2007, Excellent (167) in 2012, and Excellent (183) in 2017.

Perry Creek at Kneeland Road (STORET 680063)

Perry Creek is a tributary to the Au Sable River in central Oscoda County. The stream in this section is ~10 feet wide and ~0.7 feet deep. Substrate is mostly sand and silt with some gravel. The stream has an intact riparian zone consisting of thick tag alders along the banks and mixed forest in the surrounding area.

Macroinvertebrate communities have remained relatively similar since 2007 with slightly lower scores in 2012 (2007: 5; 2012: 3; and 2017: 5). Fewer stonefly taxa and a greater percentage of dominant taxa (chironomidae) led to the lower score in 2012, although scores did not differ by much and were likely the result of year to year and sampling variability. Habitat scores mirrored macroinvertebrate scores with the lowest score recorded in 2012 (2007: 136; 2012: 120; and 2017: 160).



Photo 7. Big Creek at Brown Cabin Road 2017



Photo 8. Perry Creek at Kneeland Road 2017

Smith Creek at 2-track off Aldrich Road (STORET 10108)

Smith Creek is a tributary to the Au Sable River downstream of Alcona Pond Dam. The upper end of the tributary contains a fair amount of agriculture, while the lower section (downstream of South Branch Road) is almost entirely forested. The trend site on Smith Creek is off of a horse trail that crosses the river approximately 1.25 miles east of Brodie Road. This section of stream had abundant instream woody debris and a good amount of undercut banks and overhanging vegetation. Substrate was primarily sand and silt with some gravel and clay present.

In 2007, the macroinvertebrate community at this site was Excellent (5), while in 2012 it was Acceptable (1) and in 2017 it was Acceptable (3). Differences were due to more stonefly taxa in 2007 (n=2) compared to 2012 and 2017 (n=1), more caddisfly taxa in 2007 and 2017 (n=6) compared to 2012 (n=4), a greater percentage of mayflies in 2007 and 2017 compared to 2012, and a greater percentage of caddisflies in 2007 compared to 2012 and 2017. Habitat was Excellent in all three years with extremely close scores (2007: 162; 2012: 161; 2017: 163). The habitat scores are not surprising as this is a relatively untouched section of river with little alteration. It is likely that the differences in macroinvertebrate score were due to natural or sampling variability since the site appears to have changed little throughout the 15-year period.

South Branch Pine River at end of Buhl Road at turnaround (STORET 10115)

The South Branch Pine River is a tributary to the Pine River, which is a major tributary to the Au Sable River. The trend site is located near the end of Buhl Road and just

upstream of the old Buhl dam site. Removal of Buhl Dam was completed in 2017, prior to the survey. Macroinvertebrates scored Excellent at this site in 2007 (8), 2012 (9), and 2017 (8). Habitat scored Excellent (177) in 2007, Good (147) in 2012, and Excellent (161) in 2017.



Photo 9. Smith Creek at 2-track off Aldrich Road 2017



Photo 10. South Branch Pine River at end of Buhl Road 2017

Duvall Creek at F41 (STORET 10110)

Duvall Creek is a tributary to the Pine River just downstream of the South Branch Pine River. The stream had a moderate amount of overhanging vegetation, large woody debris, rootwads, and heavy undercut banks. Substrate was primarily sand with some clay, silt, gravel, and cobble. Duvall Creek had an Acceptable macroinvertebrate community in 2007 (4) and 2012 (4), and an Excellent community in 2017 (5). Communities were similar between years with 25-35 taxa present, 2-4 mayfly taxa, 4-7 caddisfly taxa present, and 1 stonefly taxa present. Habitat varied between years scoring Good (121) in 2007, Marginal (99) in 2012, and Excellent (160) in 2017. The greatest difference between years is that in 2012 the site was scored as a riffle/run stream, whereas in 2007 and 2017 it was scored as a glide/pool stream. Being a lower gradient stream, the site naturally scored better as glide/pool stream than a riffle/run stream. Additionally, the relatively consistent macroinvertebrate scores indicate that the habitat differences were likely more a factor of the procedure used than an actual change in habitat quality.

Pine River at F41 (STORET 10109)

The Pine River is a major tributary to the Au Sable River. One site on the Pine River upstream of F41 was surveyed in 2007, 2012, and 2017. Macroinvertebrates at this site scored Excellent (7) in 2007, Acceptable (4) in 2012, and Acceptable (3) in 2017. Differences in scores were due to an increased percent dominant taxa (although different taxa) in 2012 (28% corixidae) and 2017 (30% caenidae) compared to 2007 (17% chironomidae) and more surface air breathers in 2012 (30%) and 2017 (10%) than in 2007 (<1%). However, the number of taxa found was greater in 2017 (42) and 2012 (37), than in 2007 (31). Habitat was fairly similar among years scoring Good (111) in 2007, Marginal (102) in 2012, and Good (125) in 2017.



Photo 11. Duvall Creek at F41, 2017



Photo 12. Pine River at F41, 2017.

Berlinski Creek at 2-track off Carriveau Road (STORET 040172)

Berlinski Creek is located within the Black River watershed. The stream at this site was located within a heavily wooded area and contained a good mix of substrate, moderate large woody debris, but little undercut banks, overhanging vegetation, aquatic macrophytes, or rootwads. The macroinvertebrate community in Berlinski Creek scored Acceptable in 2007 (4), Excellent (6) in 2012, and Acceptable (4) in 2017. Habitat was Excellent in 2007 (178), 2012 (167), and 2017 (175).

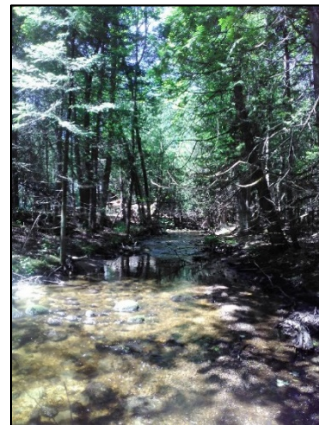


Photo 13. Berlinski Creek at 2-track off Carriveau Road 2017.

Table 2. Procedure 51 Macroinvertebrate and Habitat Scores for Trend Sites for last 3 cycles.

		2007				2012				2017			
STORET	Waterbody	Macroinvertebrates		Habitat		Macroinvertebrates		Habitat		Macroinvertebrates		Habitat	
		Score	Category	Score	Category	Score	Category	Score	Category	Score	Category	Score	Category
010108	Smith Creek	5	Excellent	162	Excellent	1	Acceptable	161	Excellent	3	Acceptable	163	Excellent
200165	E. B. Au Sable R.	1	Acceptable	143	Good	4	Acceptable	161	Excellent	3	Acceptable	187	Excellent
680066	Wright Creek	3	Acceptable	145	Good	3	Acceptable	164	Excellent	6	Excellent	147	Good
680008	Big Creek	5	Excellent	150/165	Good/Excellent	6	Excellent	167	Excellent	6	Excellent	183	Excellent
200161	No. Br. Au Sable	4	Acceptable	165	Excellent	5	Excellent	179	Excellent	8	Excellent	187	Excellent
200160	Au Sable River	7	Excellent	190	Excellent	5	Excellent	178	Excellent	7	Excellent	160	Excellent
010115	So. Br. Pine River	8	Excellent	177	Excellent	9	Excellent	147	Good	8	Excellent	161	Excellent
010109	Pine River	7	Excellent	111	Good	4	Acceptable	102	Marginal	3	Acceptable	125	Good
010110	Duvall Creek	4	Acceptable	121	Good	4	Acceptable	99	Marginal	5	Excellent	160	Excellent
680063	Perry Creek	5	Excellent	136	Good	3	Acceptable	120	Good	5	Excellent	160	Excellent
40172	Berlinski Creek	4	Acceptable	178	Excellent	6	Excellent	167	Excellent	4	Acceptable	175	Excellent

Objective 3: Address monitoring requests submitted by internal and external customers

In the fall of 2016, SWAS received a request from the Anglers of the Au Sable, a local environmental conservation organization, to monitor the North Branch Au Sable River. Anglers were concerned about possible low numbers of trout in the river and they requested water chemistry, sediment chemistry, and dissolved oxygen sampling at three sites (two on the North Branch Au Sable and one on West Branch Big Creek) to help identify potential water quality issues in the river.

The North Branch Au Sable River is a major tributary to the Au Sable River in southeast Otsego County and northeast Crawford County. Several tributaries flow into the North Branch Au Sable River, the largest of which is Big Creek (North). Big Creek (North) flows into the North Branch Au Sable River approximately three miles upstream of the confluence of the North Branch Au Sable River and mainstem Au Sable River. It drains approximately 52% of the North Branch Au Sable River watershed and consists of the West Branch, Middle Branch, and East Branch Big Creeks.

2017 Monitoring

Three sites, two on the North Branch Au Sable River and one on West Branch Big Creek, were surveyed in 2017 to evaluate overall water quality in the North Branch Au Sable River and address angler concerns. SWAS surveyed water chemistry, sediment chemistry, macroinvertebrate communities, and habitat conditions at these three sites (along with macroinvertebrates and habitat at a trend site on the North Branch Au Sable River).



Photo 14. North Branch Au Sable River at the Ford 2017

Water Chemistry

Water Chemistry samples were taken in May, July, September, and November and were analyzed for Total Phosphorus, Ortho Phosphate, Kjeldahl Nitrogen, Nitrate, Nitrite, Ammonia, DOC, TSS, Sulfate, Chloride, Alkalinity, Lead, Arsenic, and Copper. In situ sonde readings of Dissolved Oxygen, Temperature, Conductivity, and pH were also taken at all 3 sites in May, July, September, and November. Water chemistry parameters were chosen either because SWAS had historical data that could be used for comparison or because they have been shown to negatively impact aquatic organisms at high concentrations.

To determine if concentrations of water chemistry samples taken in 2017 were at levels that would be expected for this area, they were compared to some of SWAS's Water Chemistry Monitoring Program (WCMP) probabilistic sites with similar attributes (*i.e.*, those located in forested watersheds *and* the Northern Lakes and Forest Ecoregion; Figure 2). WCMP probabilistic sites are sites that were randomly chosen (now fixed) and are used to determine the overall status of certain water chemistry parameters across the state. Although site-specific differences in stream and watershed attributes (e.g., stream order, geology, etc.) might explain observed differences in water chemistry geographically or temporally within the basin, there is little historical data for many of the measured parameters within the North Branch Au Sable River Basin. Therefore, comparison to sites with similar land cover and ecoregions throughout the state (WCMP Probabilistic sites) enables at least some reference as to what might be expected in similar basins. However, if recent historical data (*i.e.*, post 1980) within the North Branch Au Sable River or its tributaries existed for water chemistry parameters (*i.e.*, within previous biosurvey reports), 2017 concentrations were also compared to those results (Figure 2).



Photo 15. North Branch Au Sable River at North Down River Road 2017

Several of the water chemistry parameters analyzed in 2017 were measured at levels below the reporting limit, or the concentration at which the laboratory can confidently quantify a parameter. Arsenic, Copper, Lead, and Ortho Phosphate were below the reporting limit at all sites in all 4 months and consequently Arsenic, Copper, and Lead were below their respective WQS (There is no quantitative standard for Ortho Phosphate). Ammonia was below the reporting limit in 44% of samples, Nitrate/Nitrite in 42% of samples, and Total Suspended solids in 25% of samples. Other water chemistry parameters were within the realm of what would be expected based on WCMP probabilistic sites and historic data from the North Branch Au Sable River and its tributaries (although data is limited for several parameters: Figure 2).

Sediment Chemistry

Surficial sediment samples were collected in June 2017 from three sites on the North Branch Au Sable River upstream of Lovells and analyzed for Michigan 10 metals, Iron, Nickel, and Total Organic Carbon (Figure 1; Table 1). Site locations were chosen within

the reach upstream of Lovells because the most likely source of any unnatural quantities of pollutants would likely have come from this area based on land cover (*i.e.*, the majority of the landscape bordering much of the lower and middle North Branch Au Sable River is natural, while the upper reaches contain a greater proportion of unnatural land use types). All sediment chemistry samples taken in 2017 were below Threshold Effect Concentrations (Table 3), or the concentration below which adverse effects are not expected to occur (MacDonald *et al.*, 2000).



Photo 16. West Branch Big Creek at Townline Road 2017.

Table 3. Sediment chemistry results from North Branch Au Sable River 2017 (Note Total Organic Carbon analysis completed by Pace Analytical, other analyses completed by ELGE Laboratory).

		SITE		N.B. AuSable @ Sheep Access		N.B. AuSable @ Two Track off Twin Bridge Rd.		N.B. AuSable @ The Ford (Downstream)	
		STORET		200178		200177		690165	
		DATE SAMPLED		16-Jun-17		16-Jun-17		16-Jun-17	
		MATRIX		Soil/Sediment		Soil/Sediment		Soil/Sediment	
Analyte	Units	RDL	RL	Result	Result	Result	Result	Result	
% Total Solids	%	0.1	0.1	60.5	75.2	71.8			
Mercury	mg/kg	0.07	0.08	<0.08	<0.07	<0.07			
Arsenic	mg/kg dry	0.5	0.5	4.5	2	2.2			
Barium	mg/kg dry	1	1	17	10	11			
Cadmium	mg/kg dry	0.2	0.2	<0.2	<0.2	<0.2			
Chromium	mg/kg dry	2	2	<2.0	<2.0	2.1			
Copper	mg/kg dry	1	1	1.3	1.4	1.8			
Iron	mg/kg dry	0.5	0.5	5800	4300	4500			
Lead	mg/kg dry	1	1	1.2	<1.0	1			
Nickel	mg/kg dry	1	1	3.9	3.1	3.7			
Selenium	mg/kg dry	0.2	0.2	<0.2	<0.2	<0.2			
Silver	mg/kg dry	0.1	0.1	<0.1	<0.1	<0.1			
Zinc	mg/kg dry	1	1	9.3	5.5	6.2			
TOC	%	--	0.1	1.5	0.86	0.52			

Macroinvertebrate Community and Habitat Conditions

Prior to 2017, macroinvertebrate data had not been collected by SWAS at any location on the North Branch Au Sable River since 2007 with the exception of the Trend Site, which is at the downstream end of the tributary, near the confluence with the Au Sable River (2-track off McMaster's Bridge Road; Table 4). Macroinvertebrate data was last collected from the Ford site in 1984 (MDEQ, 1993), from the North Down River Road site in 2002 (MDEQ, 2003a), and from the West Branch Big Creek site in 1997 (MDEQ, 2001; Figure 3).

In 2017, the North Branch Au Sable River upstream of the Ford had an Acceptable macroinvertebrate community (4), with 27 taxa present, 5 of which were mayfly taxa and 9 of which were caddisfly taxa. Mayflies made up 22% of the community and caddisflies made up 26% of the community. The river in this area is a wide, braided channel, with mostly gravel and sand substrate. Artificial habitat, including anchored logs are common throughout this reach. In 2017, habitat conditions scored Excellent (169), with the lowest scores being for embeddedness and frequency of riffles, likely due to a combination of historical logging practices that over-widened the river (Zorn and Sendek, 2001 and Coopes *et al.*, 1974) and the naturally coarse sand dominated stream bed in much of the upper North Branch Au Sable River.

In 2017, the North Branch Au Sable River at North Down River Road also had an Acceptable macroinvertebrate community (4) with 31 taxa present, six of which were mayfly taxa, seven of which were caddisfly taxa, and two of which were stonefly taxa. Mayflies made up 45% of the community (Ephemerellidae alone made up 35%), while caddisflies made up 15% of the community. Habitat conditions scored Excellent (170) with a good amount of substrate complexity, riparian vegetation, and bank stability. However, there was little instream large woody debris and the majority of what little did exist appeared to be artificial.

In 2017, the North Branch Au Sable River off a 2-track off McMasters Bridge Road had an Excellent (8) macroinvertebrate community with 33 taxa present, eight of which were mayfly taxa, eight of which were caddisfly taxa, and two of which were stonefly taxa. Mayflies made up 26% of the community, and caddisflies made up 42% of the community. Habitat conditions scored Excellent (187) with a good mix of macroinvertebrate habitat, substrate, and morphological diversity. Artificial habitat additions were also evident throughout this reach as in the other reaches surveyed on the North Branch Au Sable River.

The West Branch Big Creek downstream of Townline Road had an Excellent (6) macroinvertebrate community with 28 taxa present, four of which were mayfly taxa, eight of which were caddisfly taxa, and two of which were stonefly taxa. Mayflies made up 18% of the community, and caddisflies 42% of the community. Habitat conditions scored Excellent (180) with a good diversity of instream habitat and a largely unaltered riparian zone.

Figure 3. Map of historical biosurvey locations on the North Branch Au Sable River from 1997-2017 (for score details see Table 4).

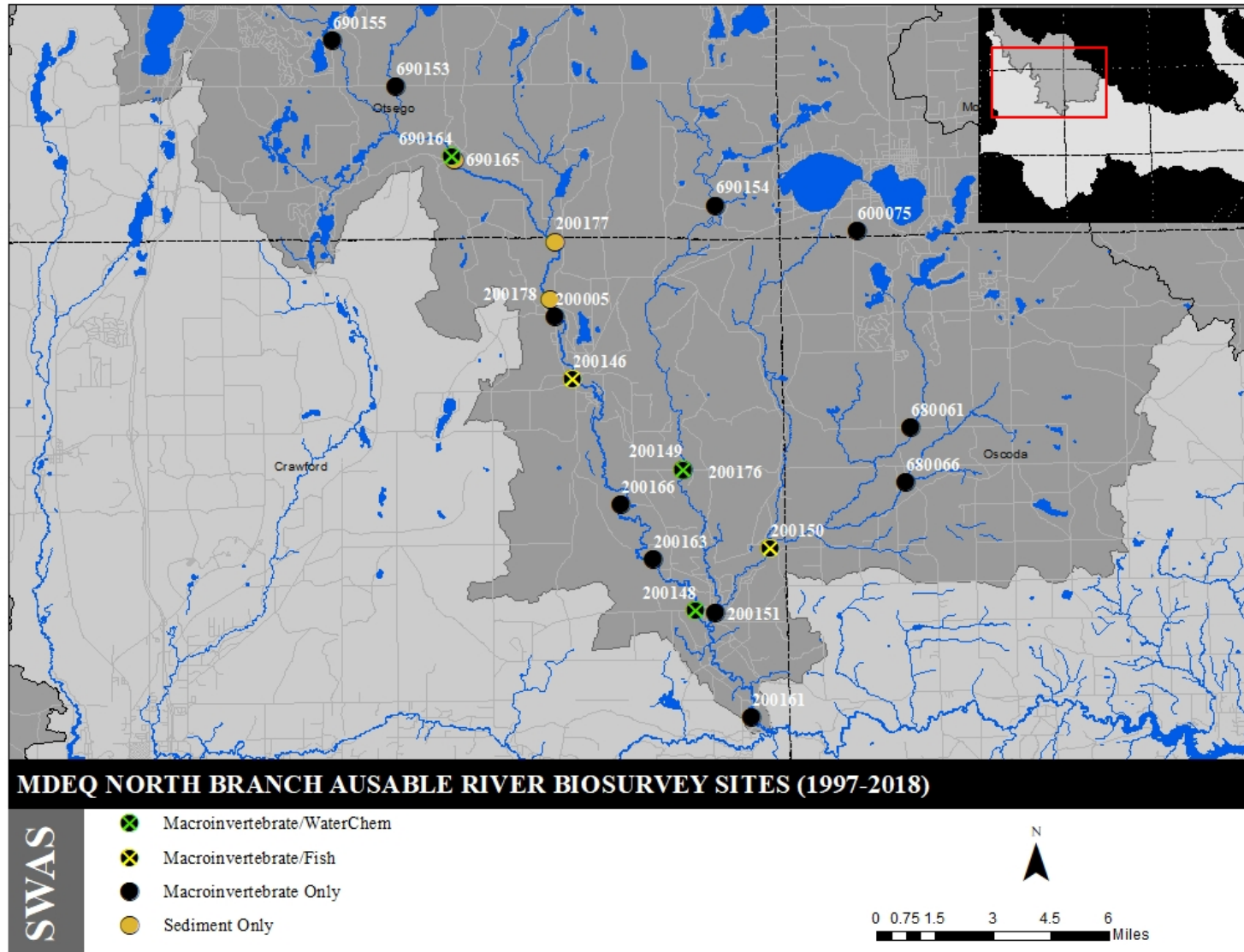


Table 4. Biosurveys on the North Branch Au Sable River and tributaries 1997-2017.

NORTH BRANCH AUSABLE RIVER - MAINSTEM											
STORET	Lat	Long	River	Location	Year	Type	Habitat	Category	Macros	Category	
200161	44.67569	-84.3915	N.B. AuSable River	2 track off McMasters Bridge Rd.	2007	Macro	165	Excellent	4	Acceptable	
200161	44.67569	-84.3915	N.B. AuSable River	2 track off McMasters Bridge Rd.	2008	Macro	--	--	4	Acceptable	
200161	44.67569	-84.3915	N.B. AuSable River	2 track off McMasters Bridge Rd.	2008	Macro	--	--	3	Acceptable	
200161	44.67569	-84.3915	N.B. AuSable River	2 track off McMasters Bridge Rd.	2012	Macro	179	Excellent	5	Excellent	
200161	44.67569	-84.3915	N.B. AuSable River	2 track off McMasters Bridge Rd.	2017	Macro	187	Excellent	8	Excellent	
200148	44.71647	-84.4195	N.B. AuSable River	N. Down River Rd	1997	Macro	118	Excellent	5	Excellent	
200148	44.71647	-84.4195	N.B. AuSable River	N. Down River Rd	2002	Macro	180	Excellent	5	Excellent	
200148	44.71647	-84.4195	N.B. AuSable River	N. Down River Rd.	2017	Macro/ WaterChem	170	Excellent	4	Acceptable	
200163	44.73559	-84.4412	N.B. AuSable River	2 track off Lovells	2007	Macro	170	Excellent	2	Acceptable	
200166	44.7564	-84.4578	N.B. AuSable River	Dam Four Rd	2007	Macro	174	Excellent	3	Acceptable	
200146	44.80389	-84.4819	N.B. AuSable River	County Rd. 612	1990	MacroFish	117	Excellent	6	Excellent	
200005	44.82709	-84.4904	N.B. AuSable River	Twin Bridge Rd.	1997	Macro	97	Good	4	Acceptable	
200005	44.82709	-84.4904	N.B. AuSable River	Twin Bridge Rd.	2002	Macro	171	Excellent	5	Excellent	
200178	44.83387	-84.4931	N.B. AuSable River	Sheep Ranch Access	2017	Sediment	--	--	--	--	
200177	44.85526	-84.4898	N.B. AuSable River	Two Track off Twin Bridge Rd.	2017	Sediment	--	--	--	--	
690165	44.88663	-84.542	N.B. AuSable River	The Ford (downstream)	2017	Sediment	--	--	--	--	
690164	44.88811	-84.5431	N.B. AuSable River	The Ford (upstream)	2017	Macro/ WaterChem	169	Excellent	4	Acceptable	
690155	44.93203	-84.6048	N.B. AuSable River	Ranger Lake Rd.	2007	Macro	173	Excellent	4	Acceptable	
200151	44.7153	-84.4092	North Big Creek	North Down River Rd.	1997	Macro	124	Excellent	8	Excellent	
200150	44.73904	-84.3796	East Branch Big Creek-North	Walsh Rd.	1997	Macro	106	Good	5	Excellent	
200150	44.73904	-84.3796	East Branch Big Creek-North	Walsh Rd.	2001	Macro	116	Excellent	5	Excellent	
200150	44.73904	-84.3796	East Branch Big Creek-North	Walsh Rd.	2002	FishOnly	--	--	--	--	
680066	44.76252	-84.3075	Wright Creek	Bear Lake Rd.	2007	Macro	145	Good	3	Acceptable	
680066	44.76252	-84.3075	Wright Creek	Bear Lake Rd.	2012	Macro	164	Excellent	3	Acceptable	
680066	44.76252	-84.3075	Wright Creek	Bear Lake Rd.	2017	Macro	147	Good	6	Excellent	
200176	44.76887	-84.4244	West Branch Big Creek	Downstream Townline Rd.	2017	Macro/ WaterChem	180	Excellent	6	Excellent	

200149	44.7692	-84.4244	West Branch Big Creek	Townline Rd.	1997	Macro	70	Fair	5	Excellent
680061	44.78318	-84.3043	East Branch Big Creek	Farrington Road	2007	Macro	154	Good	4	Acceptable
600075	44.85711	-84.3307	Middle Branch Big Creek	Downstream County Rd. 612	2007	Macro	134	Good	2	Acceptable
690154	44.86767	-84.4049	West Branch Big Creek	Delamater Rd.	2007	Macro	196	Excellent	6	Excellent
690153	44.91425	-84.5722	Turtle Creek	Old State Road	2007	Macro	141	Good	-1	Acceptable

2018 Monitoring

In May 2018 WRD, as well as DNR Fisheries Division, received several more calls and e-mails from concerned citizens regarding the health of the North Branch Au Sable River. Several professional fishing guides and river users reported a noticeable decline in the brook trout population compared to previous years, even in comparison to 2017. In response, DNR Fisheries Division conducted several abbreviated fish surveys on May 30 and June 7, 2018, to help determine the severity and extent of the problem (personal communication; Neal Godby). The surveys found fewer brook trout than expected throughout the river prompting further evaluations by the DNR, EGLE, United States Geological Survey, and angler groups.

Macroinvertebrate Community and Habitat Conditions

In response to concerns, WRD, SWAS, conducted three Procedure 51 Habitat and Macroinvertebrate surveys on June 13 and 14, 2018, in the North Branch Au Sable River to determine the status and condition of the macroinvertebrate community and determine the extent of any observed impairments. Sites were located at Dam Four, Twin Bridge Road, and the Ford.

All three sites surveyed in June 2018 scored Excellent for both habitat and macroinvertebrates (Tables 5 and 6). All sites had Excellent macroinvertebrate diversity with 37 taxa found at Dam Four, 32 at Twin Bridge Road, and 31 at the Ford. Of these, 20 taxa at Dam Four, 18 taxa at Twin Bridges, and 15 taxa at the Ford were EPT taxa indicating excellent water quality. Further, the lack of a noticeable effect on the macroinvertebrate community suggested that an acute toxic event was likely not the cause of the trout population decline (*i.e.*, had there been a toxin released into the river, it would have likely been reflected in the macroinvertebrate community as well).

pH Monitoring

In July 2018 SWAS was informed by a local citizen of potential pH readings near and above 9 in the North Branch Au Sable River. In response to concerns, SWAS deployed four pH and temperature loggers in October (extending from the Ford to Morley Road) to better understand conditions and fluctuations throughout the river (Figures 4-7). The loggers were deployed for two months and recorded pH and temperature readings at one-minute intervals.

Daily fluctuations in pH at each of the four sites over the 8-week sampling period are shown in Figure 4. The furthest upstream site, the Ford, had the lowest pH on average throughout the day. The maximum pH observed was 8.76 at Twin Bridges, although in general, pH ranged from roughly 7.9 to 8.6 at this site. The daily rate of change in pH was fairly similar from upstream to downstream with the exception of Twin Bridges where pH rose at a faster rate and dropped at a faster rate than other sites. Differences in instream characteristics and consequently productivity may explain the differences in daily pH fluctuations between sites. pH was also generally higher in the beginning of the sampling period than the end across all sites suggesting potentially important seasonal effects of pH (Figure 5). Peak levels of pH, especially at Twin Bridge Road, during

periods of high photosynthetic rates may be concerning for aquatic life. However, further evaluation is needed to determine: (1) if pH is in fact greater during seasons with typically high photosynthetic rates (July-August); and (2) how these rates compare to background levels (*i.e.*, are high pH levels natural in this system).

Other Monitoring Efforts

Several other groups also completed monitoring on the North Branch Au Sable River in 2017 and 2018:

- In 2018, DNR Fisheries Division also completed the third year in a row of planned trout population estimates at three sites on the North Branch Au Sable River (Eamon's Landing, Twin Bridges, and Dam Four) as part of their Status and Trends Program. This enabled comparison to historical data and confirmed brook trout densities and biomass were low compared to long-term averages (personal communication; Neal Godby).
- The United States Geological Survey, in cooperation with the Mason-Griffith Founders Chapter of Trout Unlimited and others, installed passive sampling devices to evaluate the potential presence and concentration of organic contaminants in the North Branch Au Sable River. Results of the organic contaminant testing are not yet available.
- Anglers of the Au Sable River continued their yearly macroinvertebrate monitoring throughout the river in addition to assisting EGLE and DNR with their work.

Summary

A considerable amount of monitoring was completed on the North Branch Au Sable River in 2017 and 2018 as a result of the combined efforts of several governmental agencies, conservation organizations, anglers, guides, and other partners. Although the exact cause of the trout decline has not yet been identified, the information gathered provides a better understanding of the system, as well as provides better baseline data for future monitoring.

During the process of coordinating monitoring efforts among groups, additional parameters, such as flow or discharge, that are not currently being monitored were identified as important to understanding the system and should be priority parameters if additional funding becomes available. Anecdotal evidence suggests high spring flows in recent years may have played a role in the observed changes in the North Branch Au Sable River. Reports of large precipitation events in Fall of 2017 and Spring of 2018 coincided with the drop anglers observed in the trout population; however, no flow data was available for evaluation. The residual effects of several long-term, large-scale environmental and land use changes may also be playing a role in structuring the current community of the North Branch Au Sable River (*e.g.*, rise and fall of the logging industry in the late 1800s, Clean Water Act). Continued monitoring of conditions will provide more insight into what factor or combination of factors most influence the aquatic community of the North Branch Au Sable River. The SWAS will continue to

monitor the river and surrounding area as part of the Status and Trend Program and work with the DNR and others to assess its designated uses.

Objective 4: Identify NPS of water quality Concern

No severe NPS impairments were observed or noted during the surveys described in this report or during travel between stations.

Conclusions

All sites surveyed in 2017 and 2018 within the Au Sable and Black River watersheds were meeting their OIALW Designated Uses (Table 1). Trend sites have remained similar to previous years (Table 2), and no notable areas of concern were observed.

Field Work By: Kelly Turek, Aquatic Biologist
Samuel Noffke, Senior Aquatic Biologist
Bill Keiper, Senior Aquatic Biologist
Mike Alexander, Environmental Supervisor
Surface Water Assessment Section
Water Resources Division

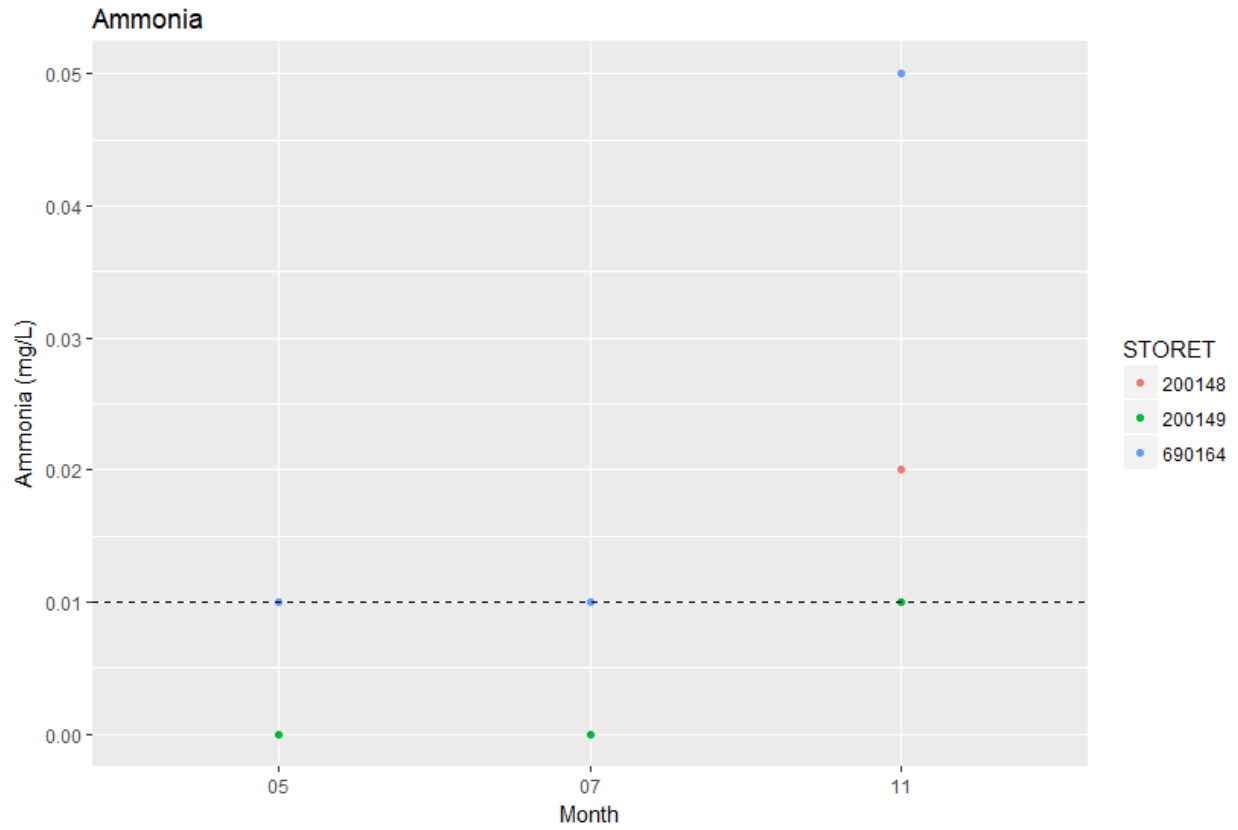
Report By: Kelly Turek, Aquatic Biologist
Surface Water Assessment Section
Water Resources Division

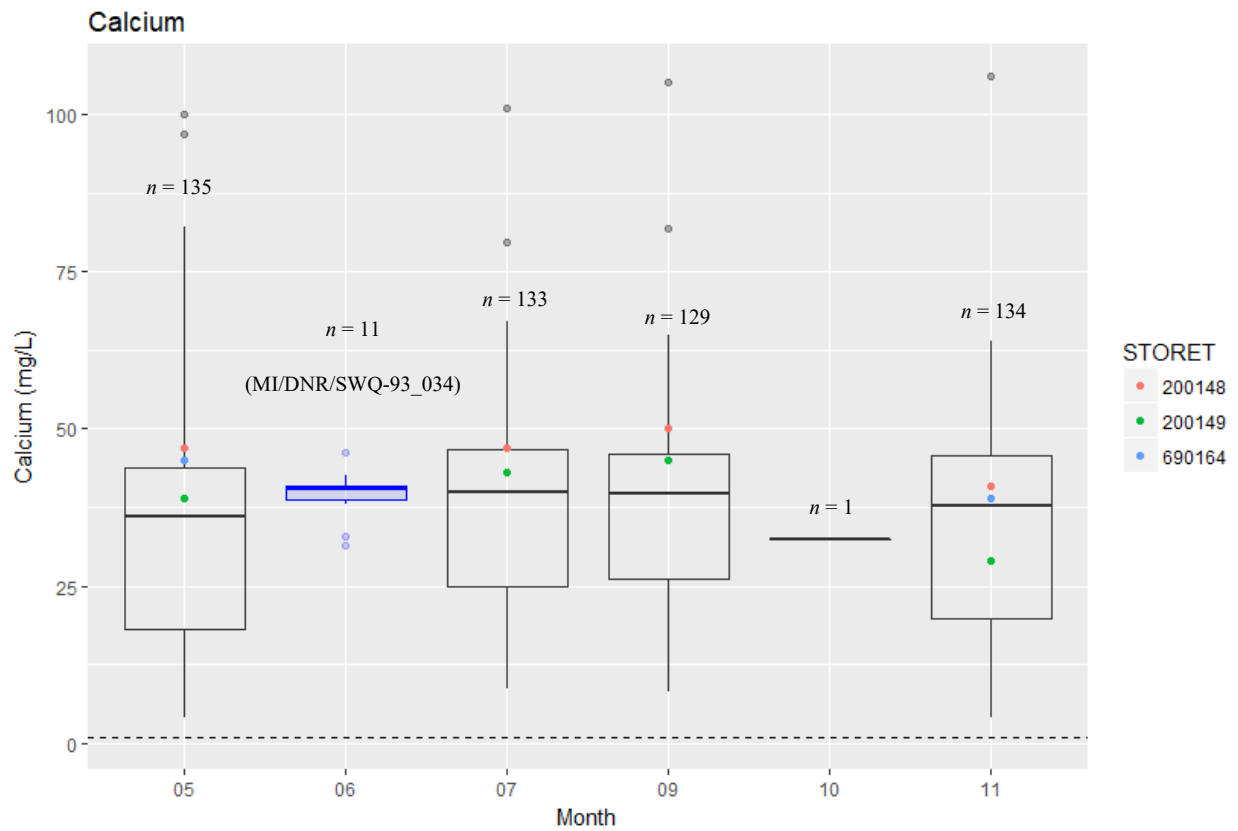
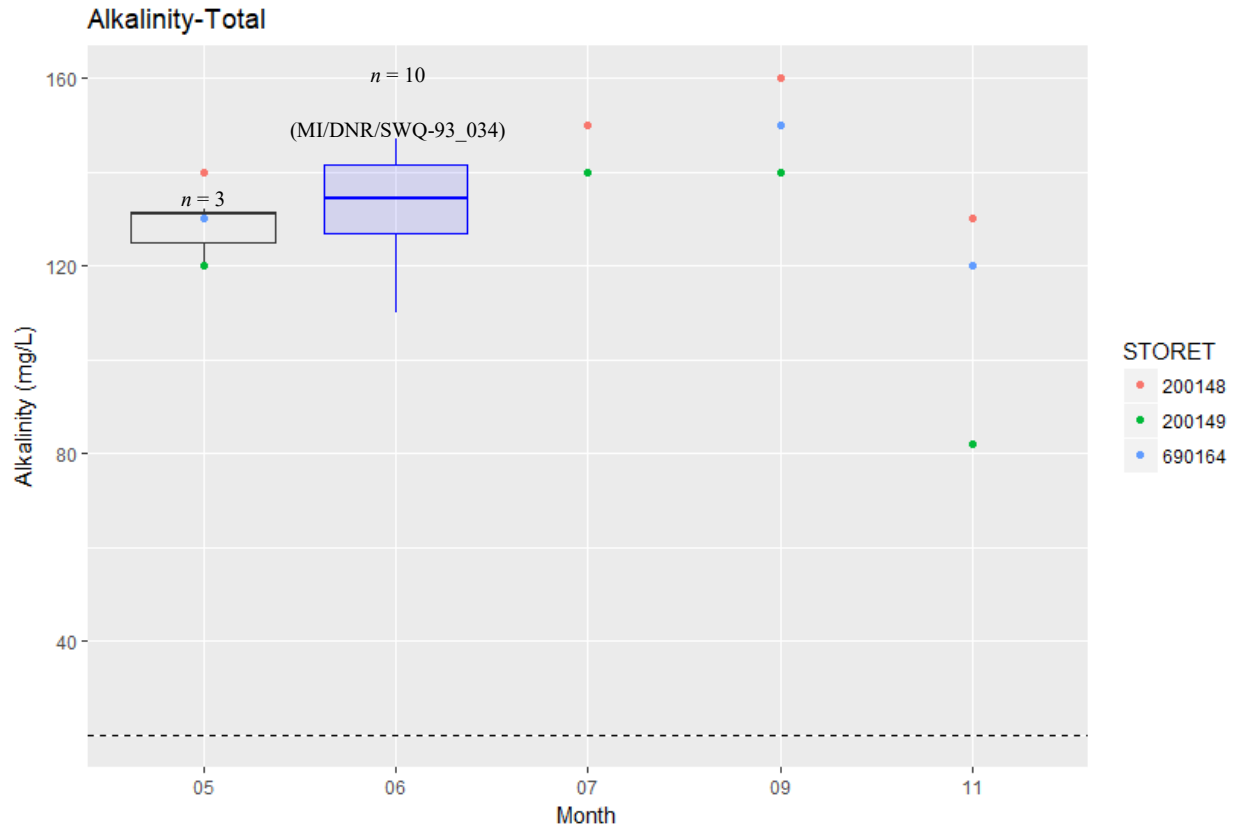
REFERENCES

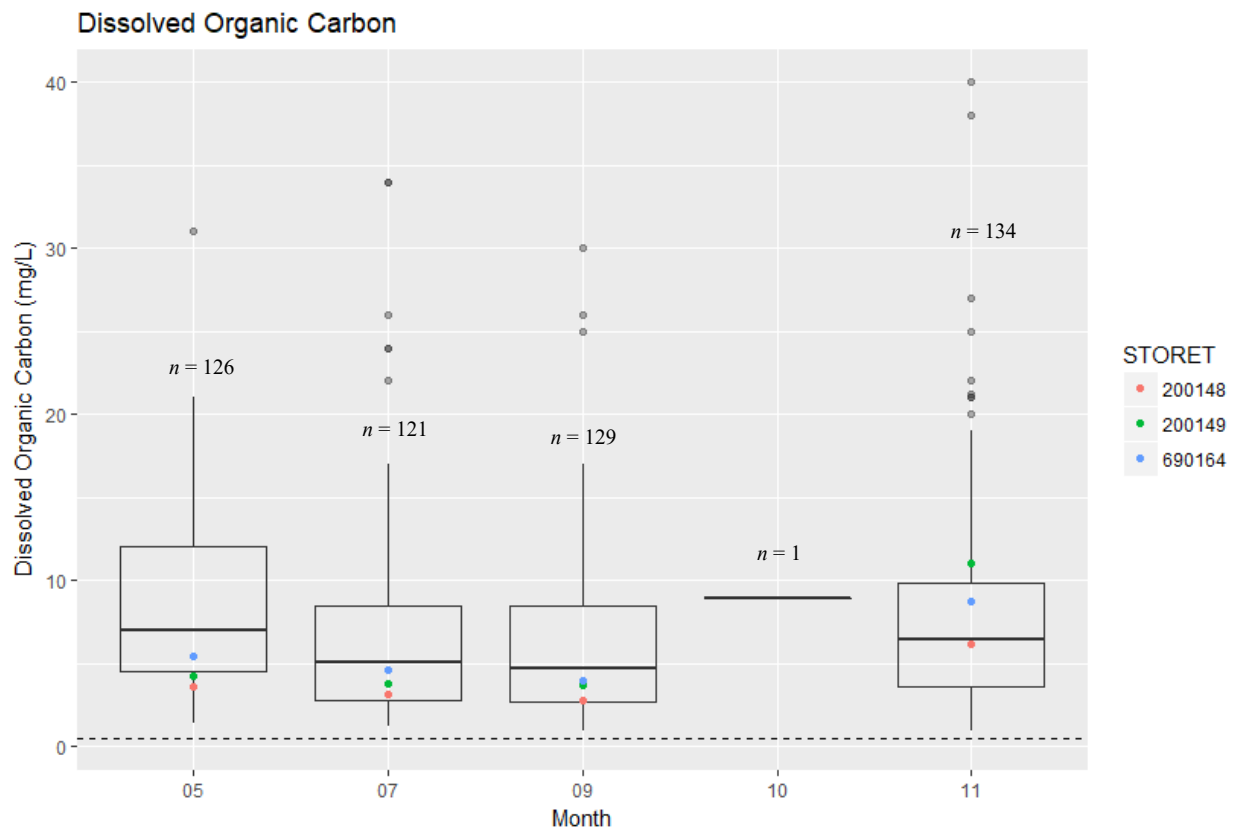
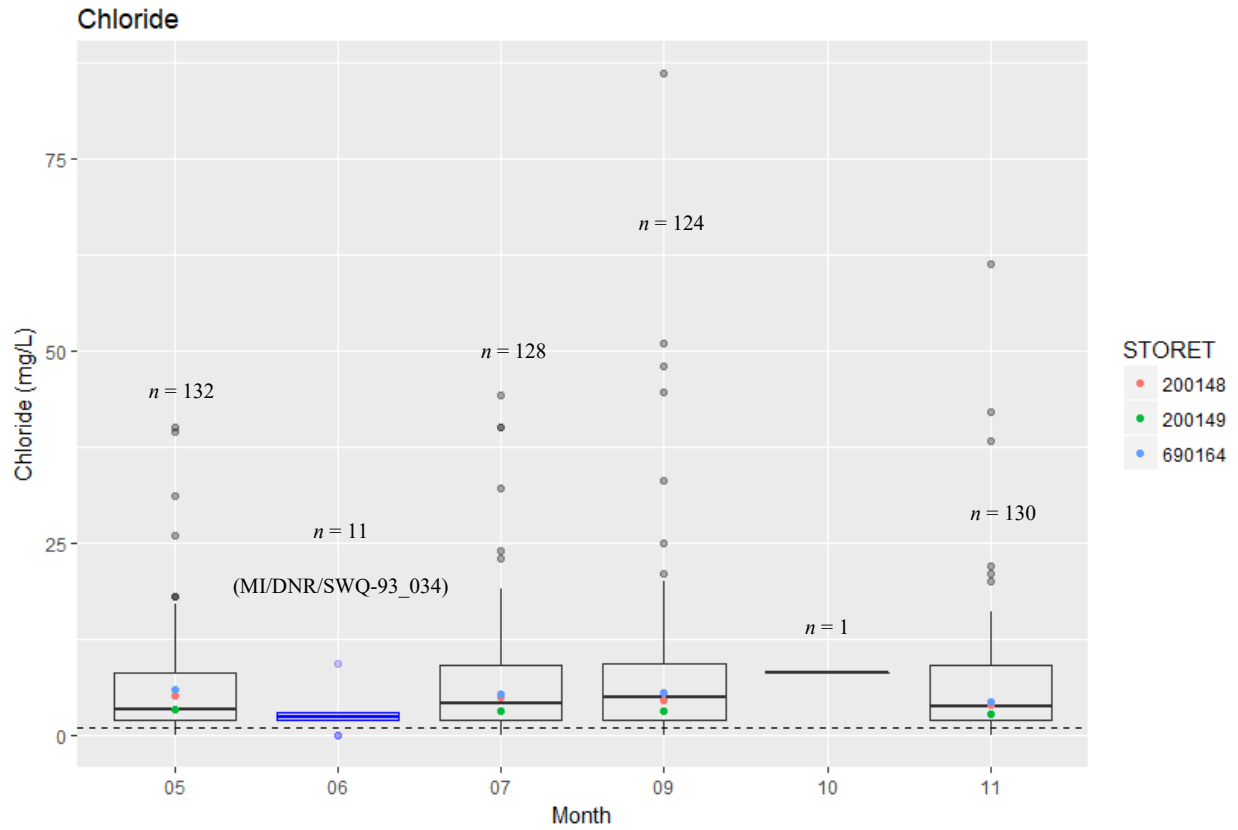
- Coopes, G.F., M. Quigley, J.S. Richards, N. Ringler, and G.E. Burgoyne, Jr. 1974. Au Sable Watershed Project Biological Report (1971-1973): An investigation into the effects of human use and development on the biology of a coldwater river system. Fisheries Management Report No. 7. June 1974, Fish Division.
- Creal, W., S. Hanshue, K. Kosek, M. Oemke, and M. Walterhouse. 1996. Update of GLEAS Procedure 51 Metric Scoring and Interpretation. Revised May 1998. MDEQ Report #MI/DEQ/SWQ-96/068.
- MacDonald D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems. Archives of Environmental Contamination and Toxicology. Vol 39: 20-31.
- MDEQ. 1990a. SWAS Procedure WRD-SWAS-051. Qualitative Biological and Habitat Survey Protocols for Wadable Streams and Rivers, April 24, 1990. Revised June 1991, August 1996, January 1997, May 2002, and December 2008. Reformatted May 2014.
- MDEQ. 1990b. Biological Survey of the North Branch Au Sable River and West Branch Big Creek in the Vicinity of the Michaywe' Golf Course, Otsego and Crawford Counties, Michigan. November 3, 1988. Report #MI/DNR/SWQ-90/038.
- MDEQ. 1993. Biological Surveys of the North Branch Au Sable and Au Sable Rivers and Selected Tributaries, Otsego, Roscommon, Crawford, Oscoda, and Alcona Counties. June 21-22, 1984 and August 31-September 2, 1992. Report #MI/DNR/SWQ-93/034.
- MDEQ. 2000. A Biological Survey of the Black River and Devils River Alcona and Alpena Counties, Michigan. September 1, 1998. Report #MI/DEQ/SWQ-00/015.
- MDEQ. 2001. Biological Survey of the Au Sable River Watershed Alcona, Crawford, Iosco, Oscoda, and Roscommon Counties, Michigan. July 14-17 and August 5-7, 1997. Report #MI/DEQ/SWQ-01/064.
- MDEQ. 2003a. Biological Survey of the Au Sable River Watershed Alcona, Crawford, Iosco, Oscoda, Otsego, and Roscommon Counties, Michigan, August 6-9, 2002. Report #MI/DEQ/WD-03/080.
- MDEQ. 2003b. A Biological Survey of the Black River and Devils River Alcona and Alpena Counties, Michigan. July 16, 2002. Report #MI/DEQ/SWQ-03/031.
- MDEQ. 2008a. Biological Survey of the Au Sable River Watershed and Selected Tributaries in Crawford, Iosco, Montmorency, Oscoda, Otsego, and Roscommon Counties, Michigan. June 11-20, 2007. Report #MI/DEQ/WB-08/010.
- MDEQ. 2008b. A Biological Survey of Lake Huron Tributaries in Alcona and Alpena Counties, Michigan. June 19-20 and July 11, 2007. Report #MI/DEQ/WB-08/046.
- MDEQ. 2013. WRD-SWAS-022. Qualitative Biological and Habitat Survey Protocols for Nonwadeable Rivers, February 2, 2013. Michigan Department of Environmental Quality, Water Resources Division, Lansing, Michigan.

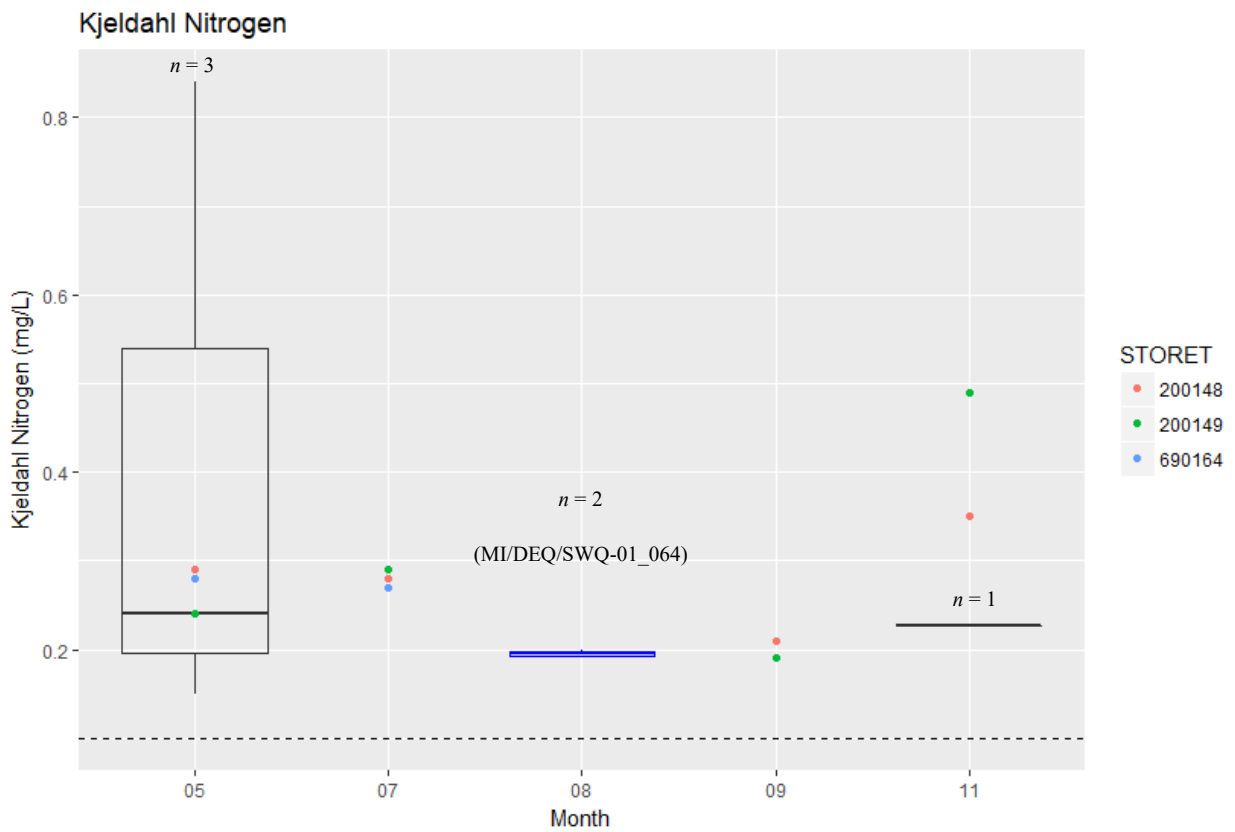
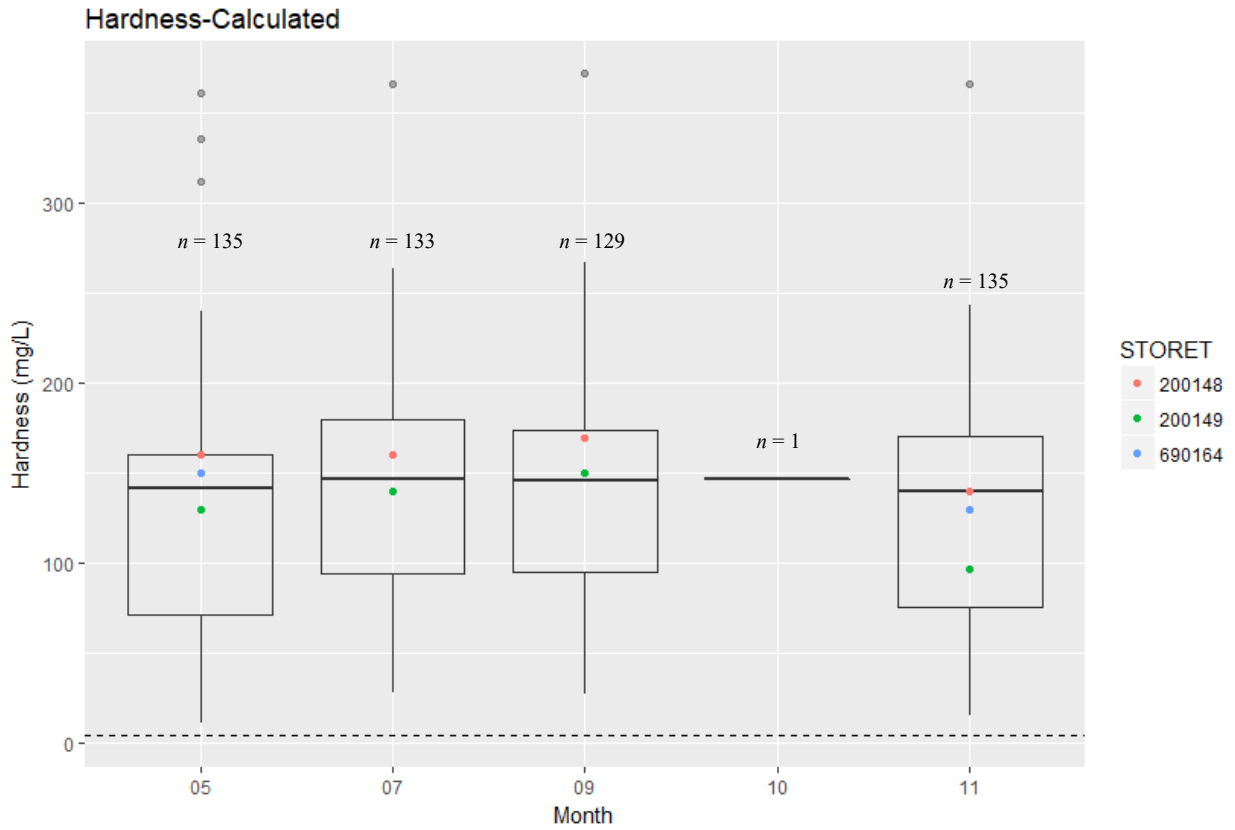
- MDEQ. 2015a. Biological Surveys of the Au Sable River and Black River Watersheds. Otsego, Crawford, Montmorency, Roscommon, Ogemaw, Oscoda, Iosco, Alcona, and Alpena Counties, Michigan. June-September 2012. Report #MI/DEQ/WRD-15/040.
- MDEQ. 2015b. SWAS Procedure WRD-SWAS-027. Biological Monitoring Status and Trend Procedure, August 4, 2015.
- Omernik, J. M., and A. Gallant. 1988. Ecoregions of the Upper Midwest States. USEPA, Environmental Research Laboratory, Corvallis, OR.
- Zorn, T.G. and S.P. Sendek. 2001. Au Sable River Assessment. DNR Fish Division Special Report No. 26, March 2001.

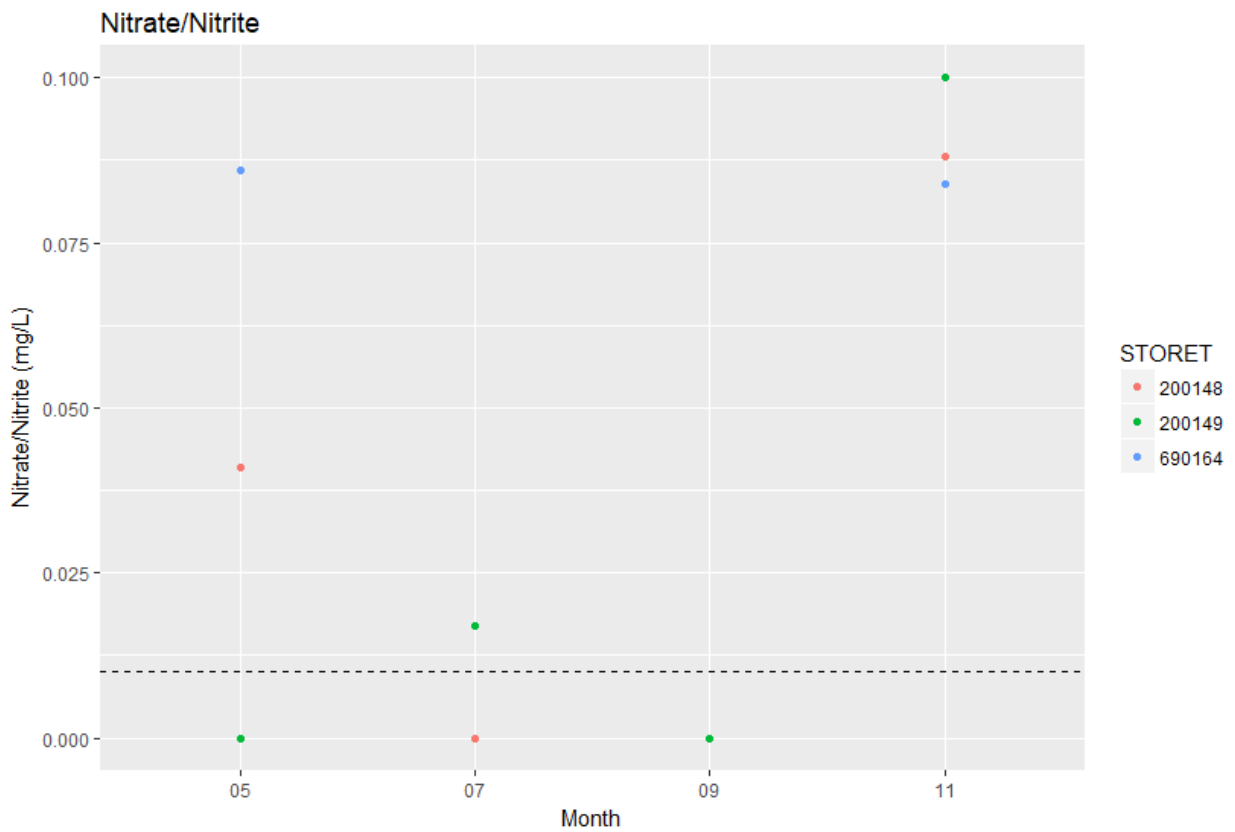
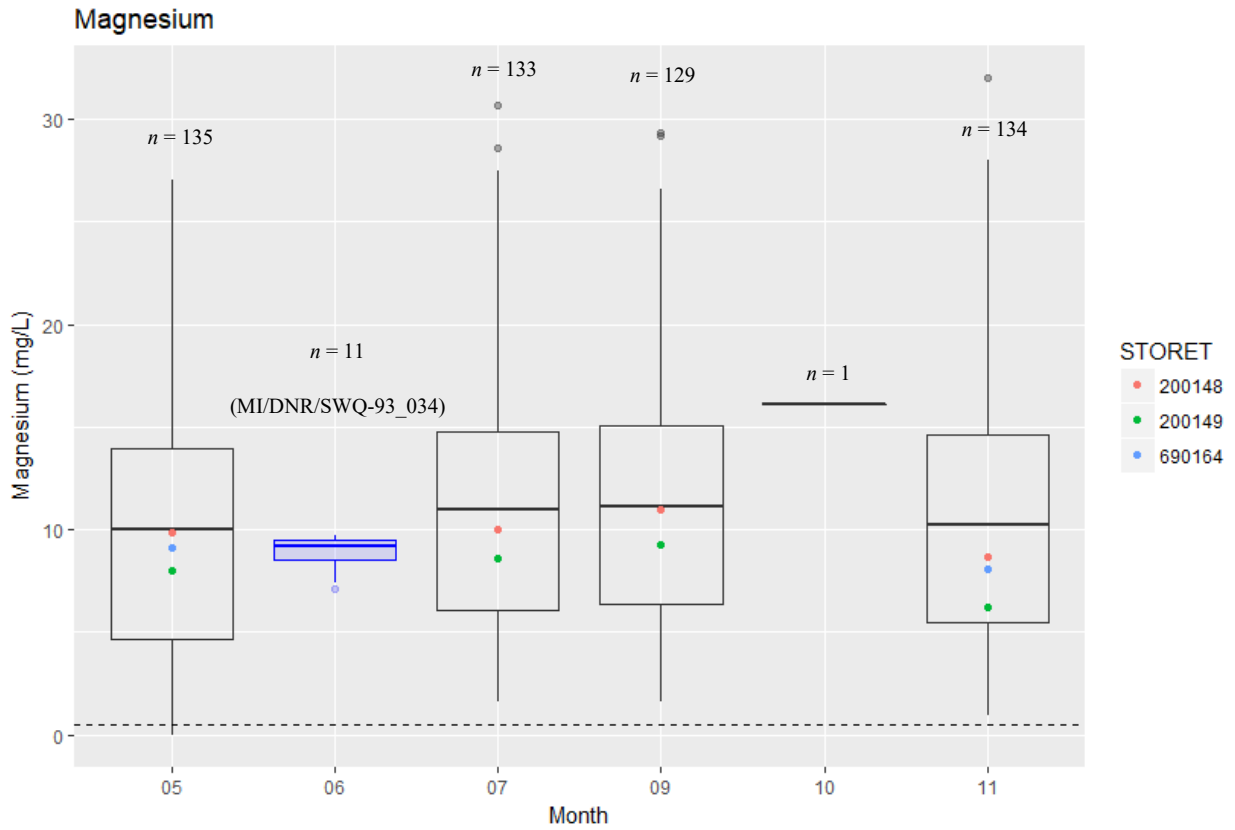
Figure 2. Select water chemistry parameter results from the North Branch Au Sable River (STORET 690164 and 200148) and West Branch Big Creek (STORET 200149) in 2017. When historic data was available, 2017 sites were compared to similar (*i.e.* within the same ecoregion and with a watershed dominated by forested land cover type) WCMP probabilistic sites (Black boxplots and grey points) and compared to historic samples taken from the North Branch Au Sable River and its tributaries (recorded in previous biosurvey reports; blue box plot and points). Sample size shown for boxplots; Report number for biosurvey report containing graphed data is shown in parentheses. Dashed line indicates the Reporting Limit.

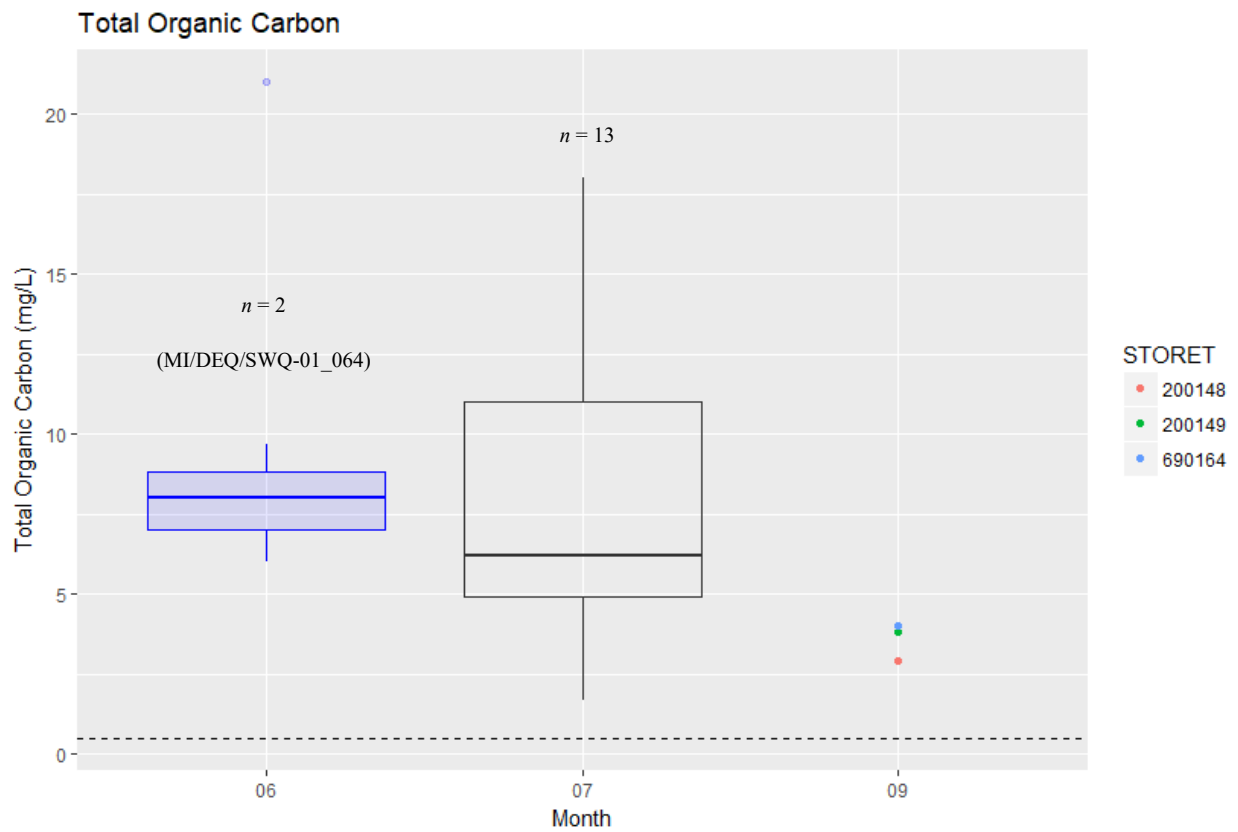
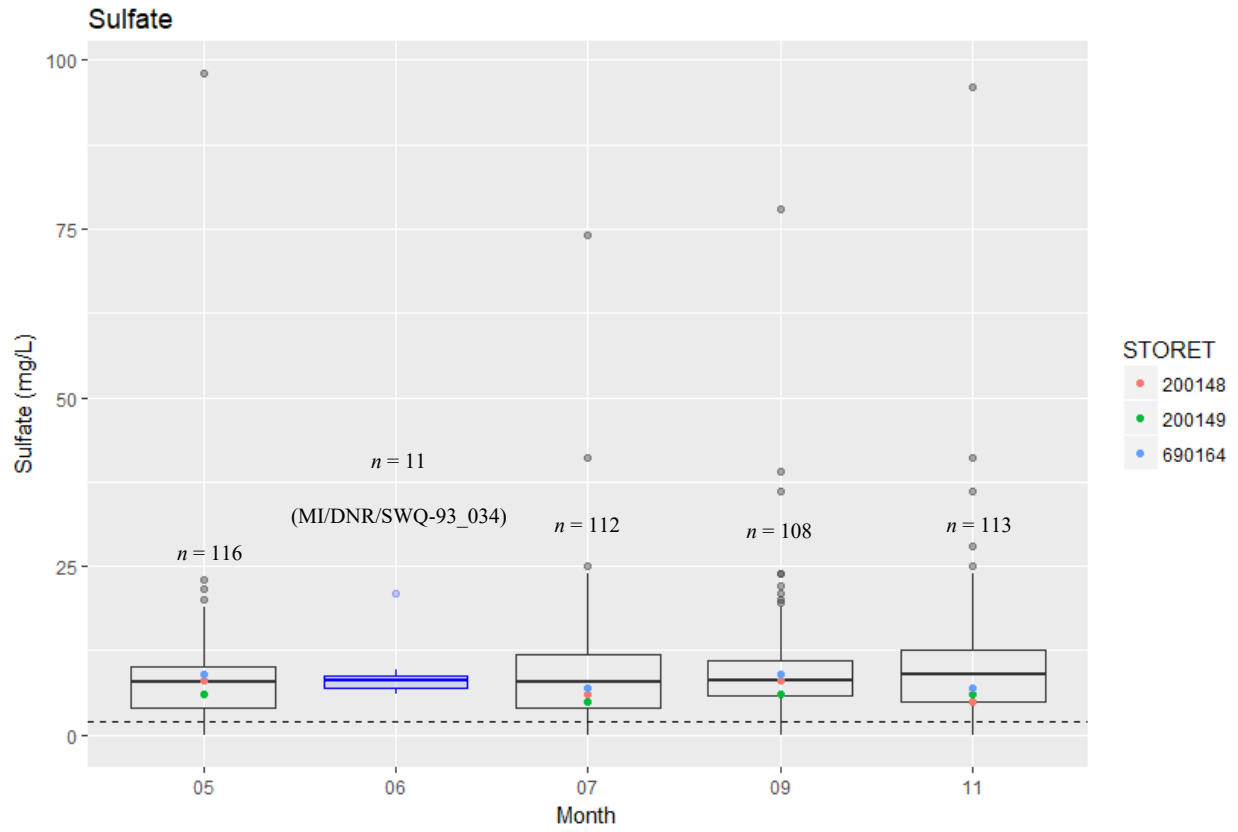


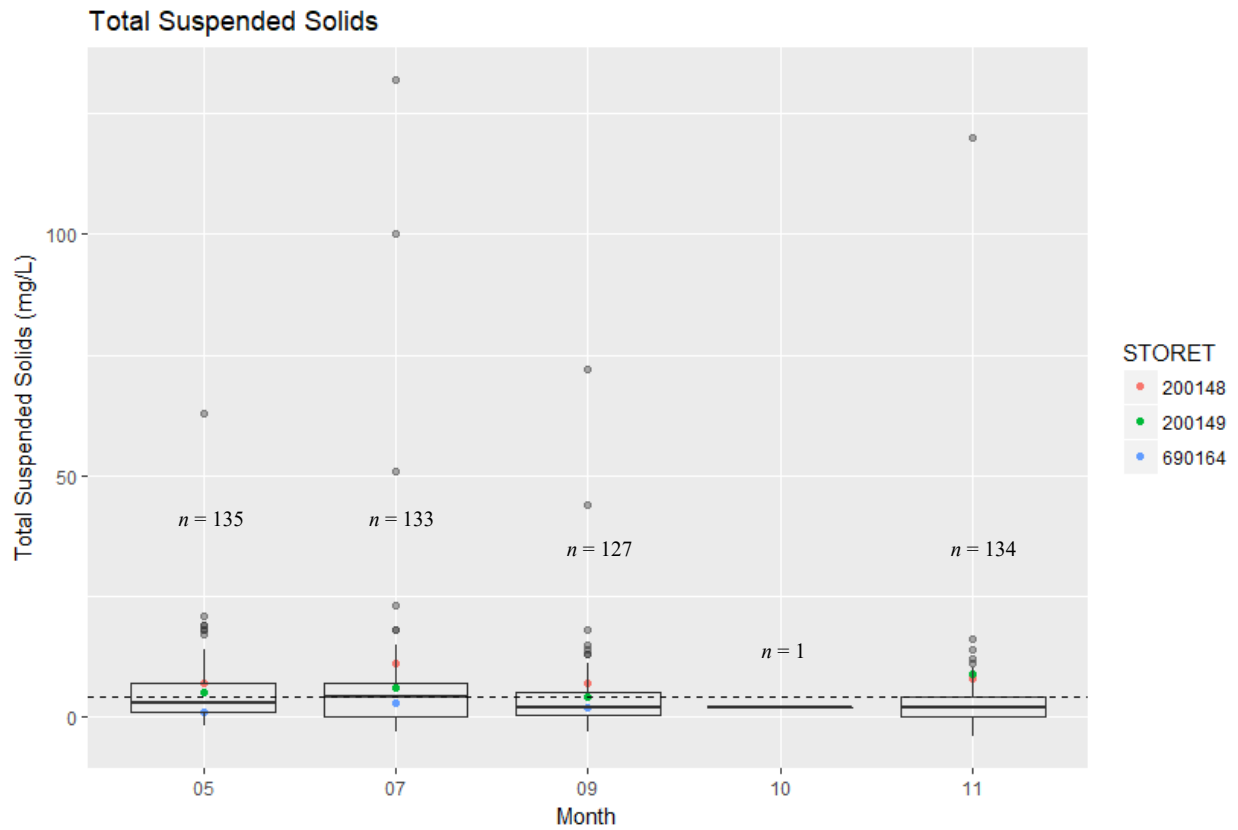
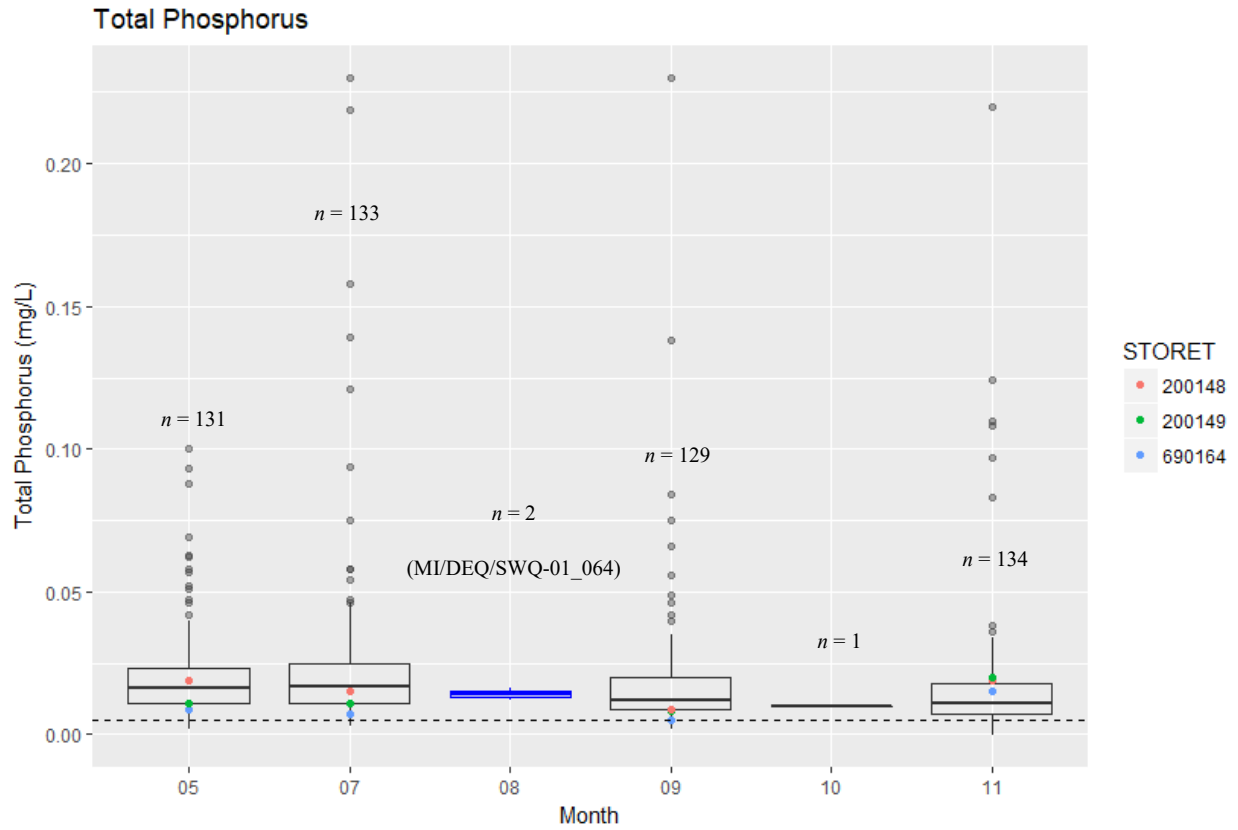


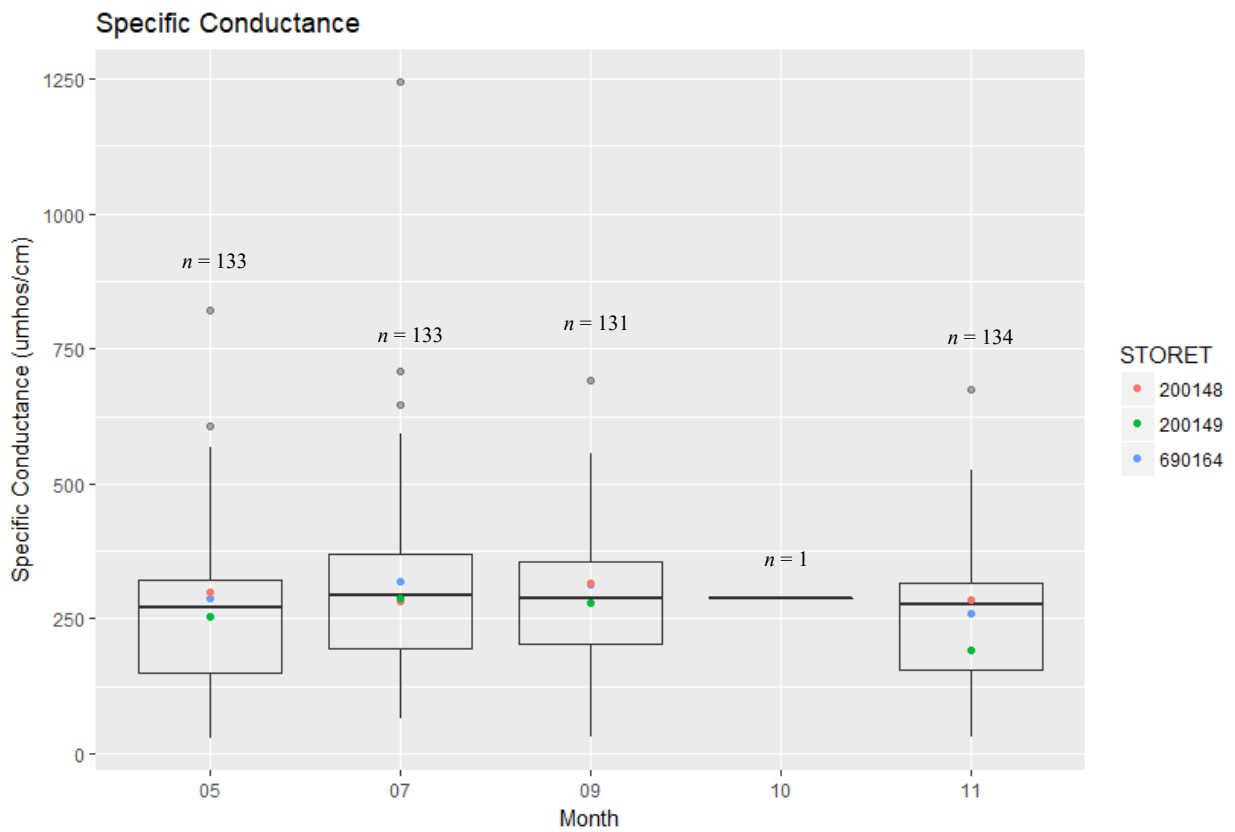
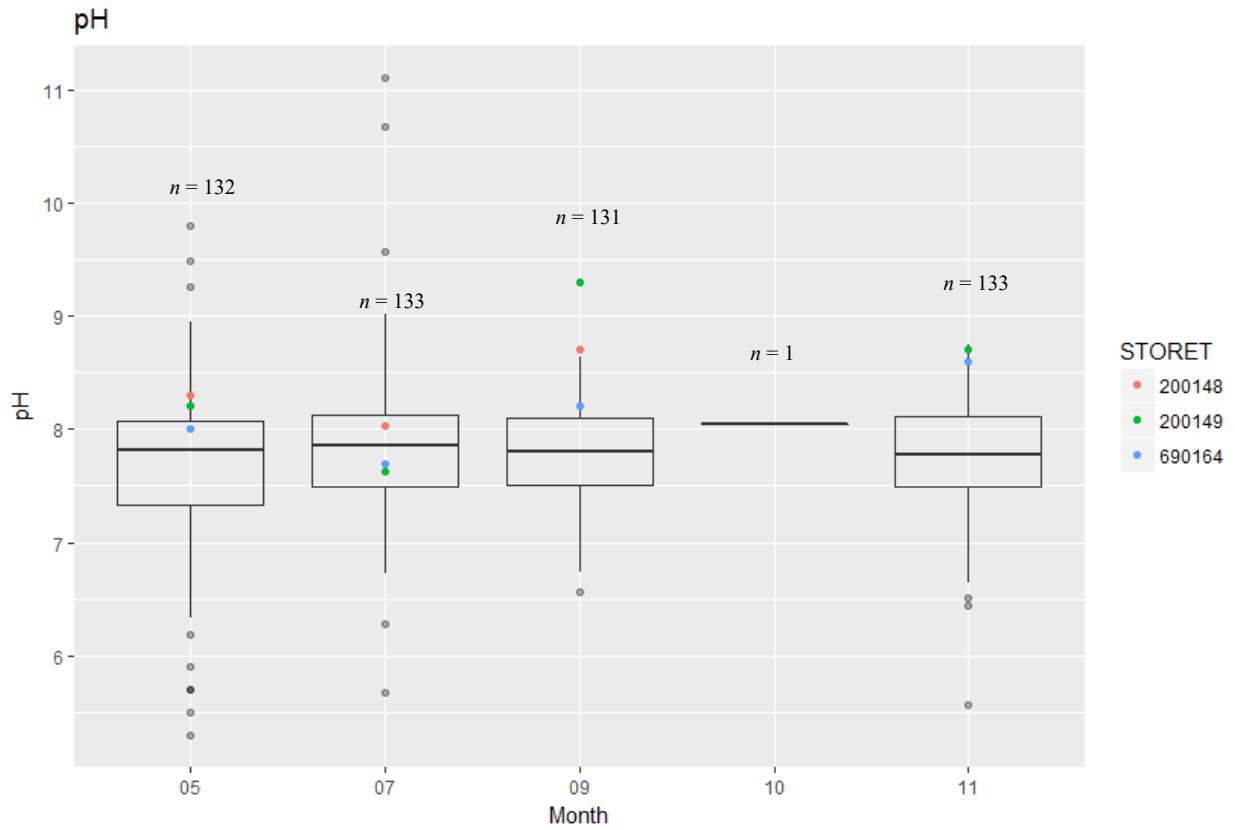












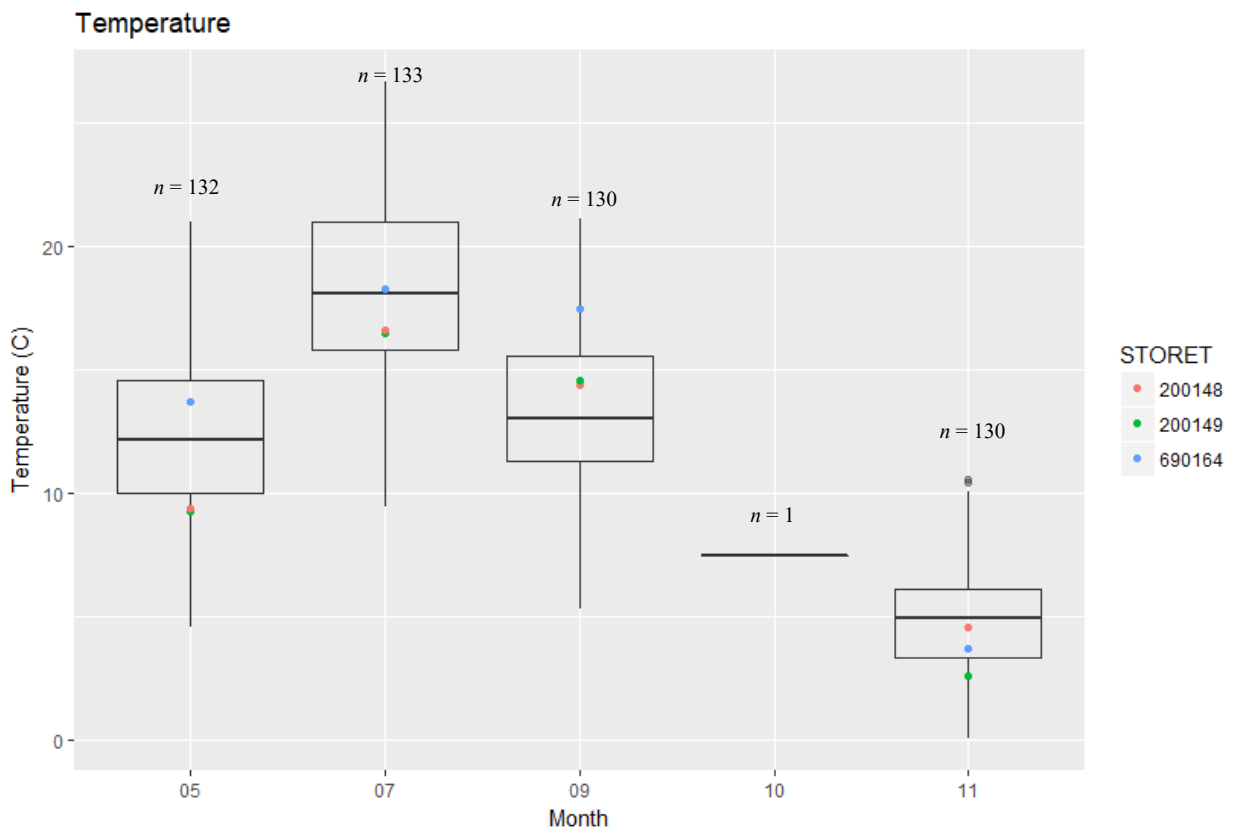
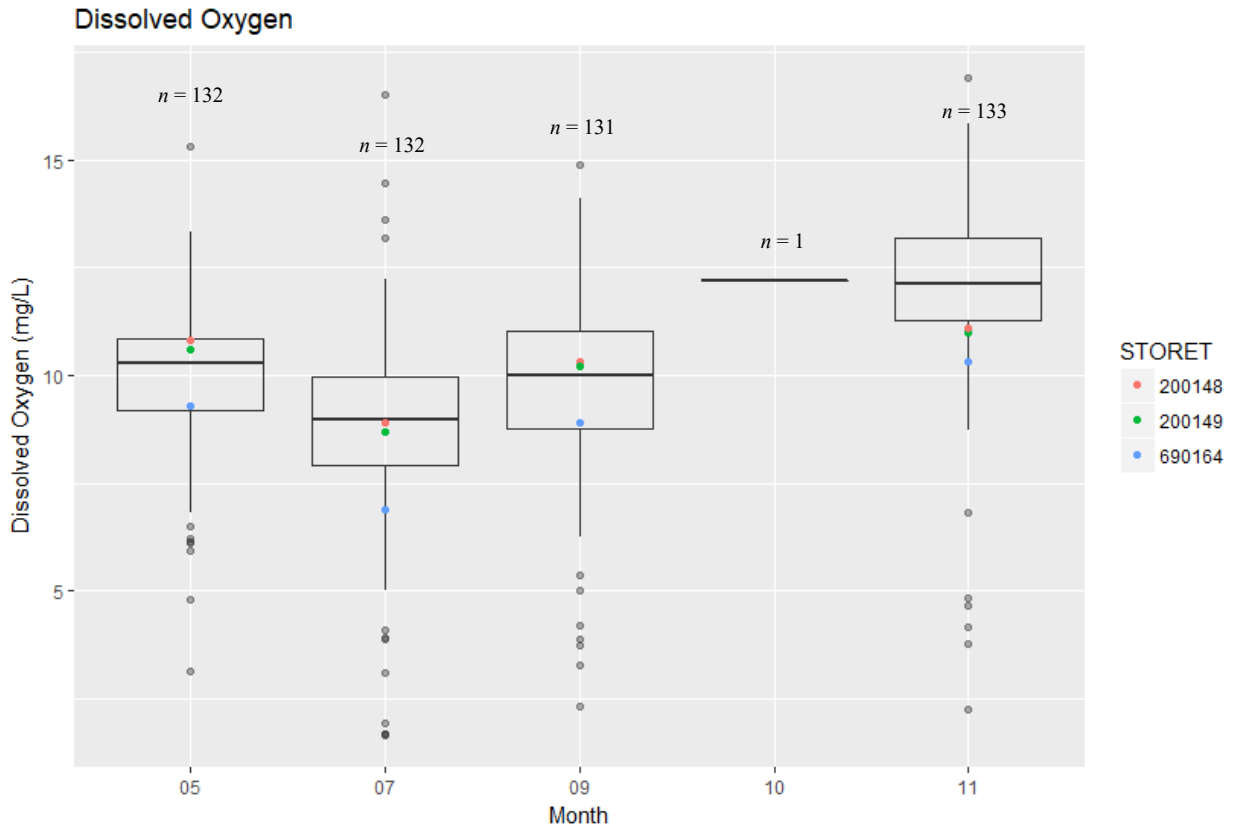


Figure 4. Boxplots determined from continuous pH data (measurement taken every one minute) summarized by hour of the day in the North Branch Au Sable River from October 10 to December 5, 2018 (first 1.5 hours of data after deployment and one hour before calibration were excluded to remove effects of physical disturbance). Boxplot whiskers represent 1.5 times the interquartile range. Points are the maximum pH value observed during each hour of the day at each site across the 8-week time frame.

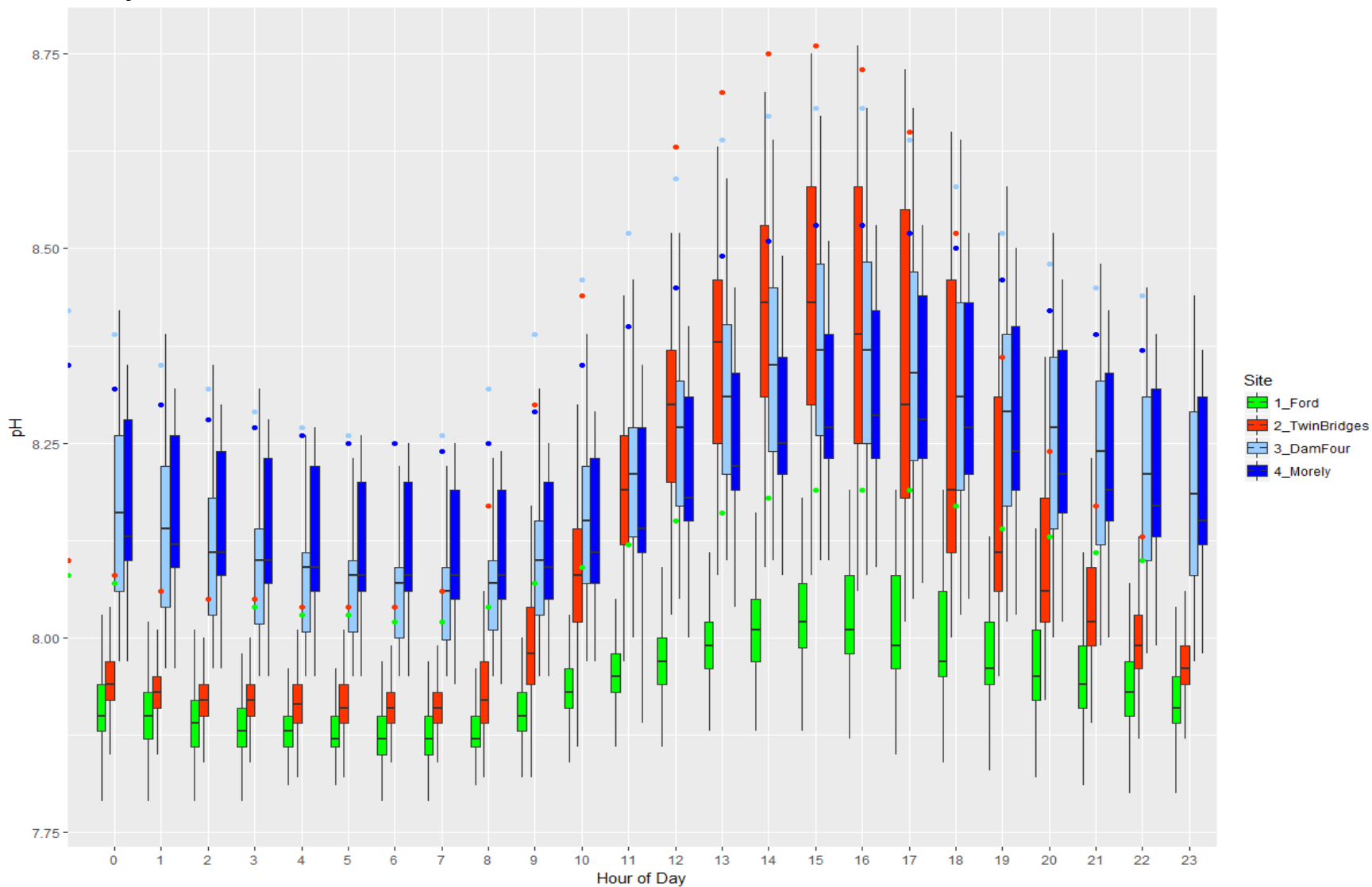


Figure 5. pH in the North Branch Au Sable River during different time periods (2-Week Period 1 = 10-10-18 to 10-24-18, Period 2 = 10-24-18 to 11-7-18, Period 3 = 11-7-18 to 11-21-18, Period 4 = 11-21-18 to 12-5-18). Boxplots whiskers represent 1.5 x interquartile range. The first 1.5 hours of data after deployment and 1 hour before calibration were excluded to remove effects of physical disturbance.

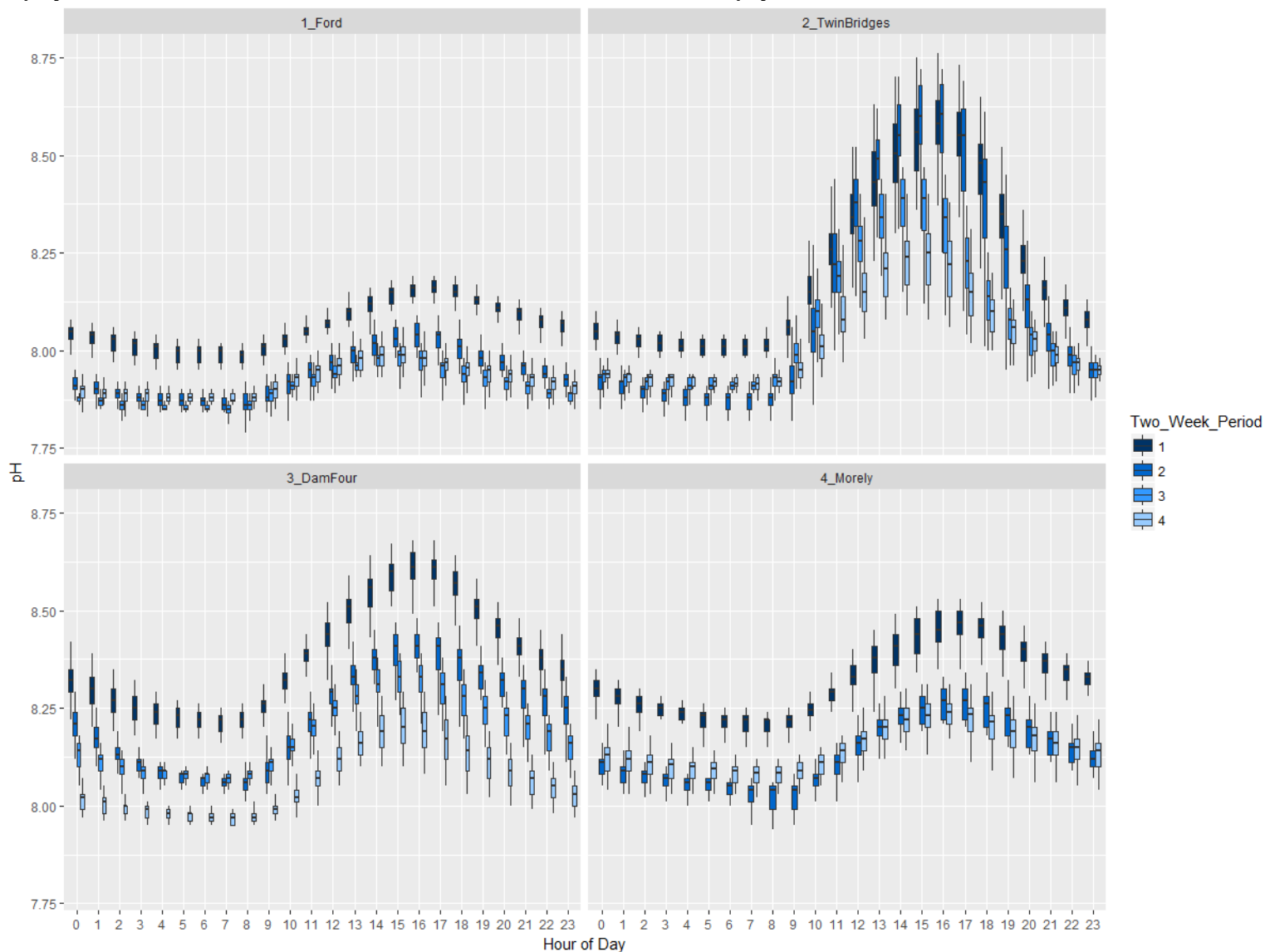


Figure 6. Boxplots determined from continuous temperature data (measurement taken every 1 minute) summarized by hour of the day in the North Branch Au Sable River from October 10 to December 5, 2018 (first 1.5 hours of data after deployment and 1 hour before calibration were excluded to remove effects of physical disturbance). Boxplot whiskers represent 1.5 times the interquartile range. Points are the maximum temperature value observed during each hour of the day at each site across the 8-week time frame.

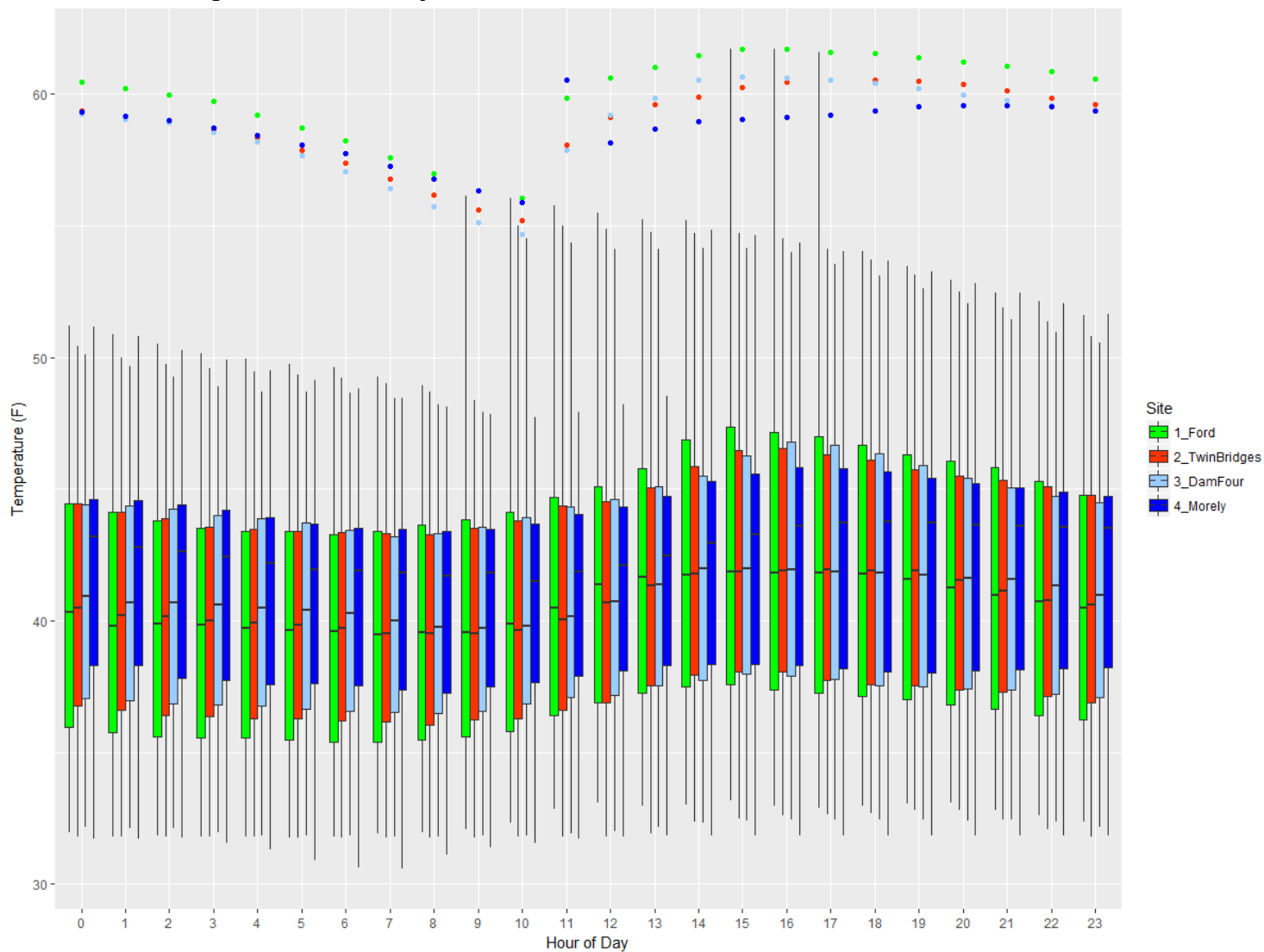


Figure 7. Temperature in the North Branch Au Sable River during different time periods (2-Week Period 1 = 10-10-18 to 10-24-18, Period 2 = 10-24-18 to 11-7-18, Period 3 = 11-7-18 to 11-21-18, Period 4 = 11-21-18 to 12-5-18). Boxplots whiskers represent 1.5 x interquartile range. The first 1.5 hours of data after deployment and 1 hour before calibration were excluded to remove effects of physical disturbance.

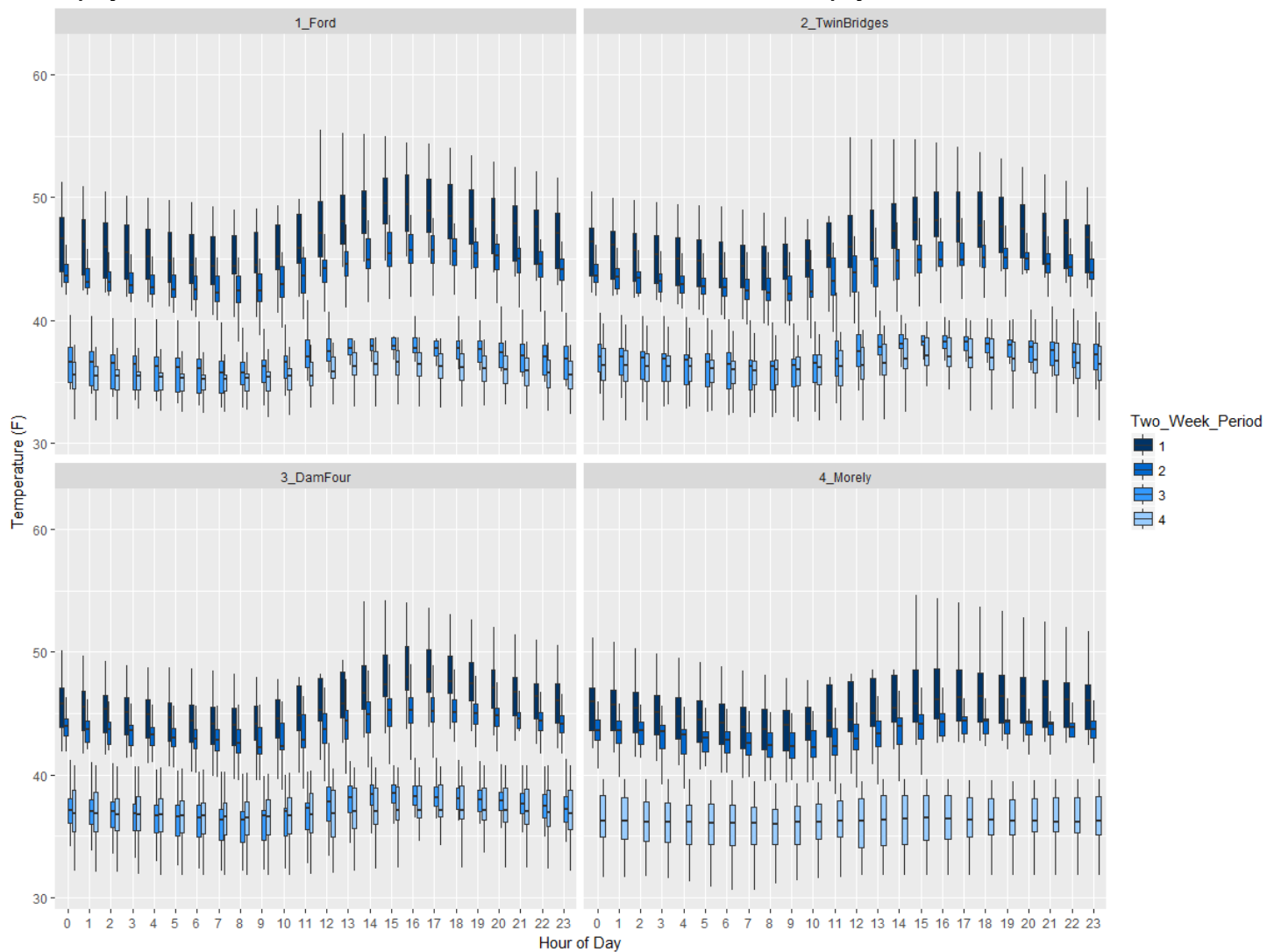


Table 5. Habitat evaluation for selected stations in the Au Sable and Black River watersheds Otsego, Alpena, Crawford, Oscoda, and Alcona Counties June-August 2017 and June 2018.

	East Branch AuSable	AuSable River	Wright Creek	North Branch AuSable
	Downstream from County Road 612	Wiseman Trail West of McMaster Bridge Road	Bear Lake Road	2 Track off McMasters Bridge Road
	6/15/2017	6/28/2017	6/14/2017	6/14/2017
	GLIDE/POOL	RIFFLE/RUN	GLIDE/POOL	RIFFLE/RUN
HABITAT METRIC				
Substrate and Instream Cover				
Epifaunal Substrate/ Avail Cover (20)	18	18	8	19
Embeddedness (20)*		18		18
Velocity/Depth Regime (20)*		17		19
Pool Substrate Characterization (20)**	18		13	
Pool Variability (20)**	18		11	
Channel Morphology				
Sediment Deposition (20)	19	18	16	18
Flow Status - Maint. Flow Volume (10)	10	10	10	10
Flow Status - Flashiness (10)	10	9	9	9
Channel Alteration (20)	19	19	20	20
Frequency of Riffles/Bends (20)*		20		18
Channel Sinuosity (20)**	18		13	
Riparian and Bank Structure				
Bank Stability (L) (10)	10	7	10	10
Bank Stability (R) (10)	10	8	10	10
Vegetative Protection (L) (10)	8	7	7	9
Vegetative Protection (R) (10)	9	7	7	9
Riparian Vegetation Zone Width (L) (10)	10	7	10	9
Riparian Vegetation Zone Width (R) (10)	10	7	3	9
TOTAL SCORE (200):	187	172	147	187
HABITAT RATING:				
	EXCELLENT	EXCELLENT	GOOD	EXCELLENT
Date:	6/15/2017	6/28/2017	6/14/2017	6/14/2017
Weather:	partlycloudy	cloudy	partlycloudy	partlycloudy
Air Temperature: °F	74	65	71	80
Water Temperature: °F	73	60	66	68
Ave. Stream Width: Feet	45	80	5	110
Ave. Stream Depth: Feet	0.5	2.5	0.5	1.5
Surface Velocity: Feet/Second	1.8		0.7	3.5
Estimated Flow: Cubic Feet/Second	70.8		1.9	564.5
Stream Modifications:	none	none	none	none
Nuisance Plants (Y/N):	N	N	N	N
STORET No.:	200165	200160	680066	200161
County Code:	20	20	68	20
TRS:	28N02W30	26N01W11	27N01W03	26N01W02
Latitude (dd):	44.78794	44.66635	44.76252	44.67569
Longitude (dd):	-84.59722	-84.40427	-84.30752	-84.39149
Ecoregion:	NLAF	NLAF	NLAF	NLAF
Stream Type:	Coldwater	Coldwater	Warmwater	Coldwater
USGS Basin Code:	4070007	4070007	4070007	4070007
* Applies only to Riffle/Run stream Surveys,				

** Applies only to Glide/Pool stream Surveys

Note: Individual metrics may better describe conditions directly affecting the biological community while the Habitat Rating describes the general riverine environment at the site(s).

Table 5. Habitat evaluation for selected stations in the Au Sable and Black River watersheds Otsego, Alpena, Crawford, Oscoda, and Alcona counties June-August 2017 and June 2018.

	Big Creek	Perry Creek	Smith Creek	South Branch Pine River
	Brown Cabin Road	Kneeland Road	2 Track off from Aldrich	Buhl Road
	6/14/2017	6/14/2017	6/28/2017	6/28/2017
	GLIDE/POOL	GLIDE/POOL	GLIDE/POOL	RIFFLE/RUN
HABITAT METRIC				
Substrate and Instream Cover				
Epifaunal Substrate/ Avail Cover (20)	19	9	14	15
Embeddedness (20)*				18
Velocity/Depth Regime (20)*				16
Pool Substrate Characterization (20)**	16	9	12	
Pool Variability (20)**	16	17	18	
Channel Morphology				
Sediment Deposition (20)	16	15	10	16
Flow Status - Maint. Flow Volume (10)	10	10	10	10
Flow Status - Flashiness (10)	9	9	8	5
Channel Alteration (20)	20	20	20	13
Frequency of Riffles/Bends (20)*				16
Channel Sinuosity (20)**	18	13	19	
Riparian and Bank Structure				
Bank Stability (L) (10)	10	9	9	7
Bank Stability (R) (10)	10	9	9	7
Vegetative Protection (L) (10)	10	10	7	9
Vegetative Protection (R) (10)	10	10	7	9
Riparian Vegetation Zone Width (L) (10)	10	10	10	10
Riparian Vegetation Zone Width (R) (10)	9	10	10	10
TOTAL SCORE (200):	183	160	163	161
HABITAT RATING:	EXCELLENT	EXCELLENT	EXCELLENT	EXCELLENT
Date:	6/14/2017	6/14/2017	6/28/2017	6/28/2017
Weather:	cloudy	partlycloudy	partlycloudy	sunny
Air Temperature: °F	68	55	73	72
Water Temperature: °F	57	60	56	60
Ave. Stream Width: Feet	49	10	12	20
Ave. Stream Depth: Feet	2	0.7	1	1
Surface Velocity: Feet/Second	2.5	1.1	0.9	3.2
Estimated Flow: Cubic Feet/Second	236.9	8	10.9	55.1
Stream Modifications:	none	none	none	Habitatimp,BankStab
Nuisance Plants (Y/N):	N	N	N	N
STORET No.:	680008	680063	010108	010115
County Code:	68	68	01	01
TRS:	26N01E12	27N03E21	25N05E22	25N08E08
Latitude (dd):	44.6522	44.7105	44.5476	44.57713
Longitude (dd):	-84.2586	-84.0874	-83.8221	-83.50319
Ecoregion:	NLAF	NLAF	NLAF	NLAF
Stream Type:	Coldwater	Coldwater	Coldwater	Coldwater

USGS Basin Code:	4070007	4070007	4070007	4070007
* Applies only to Riffle/Run stream Surveys				
** Applies only to Glide/Pool stream Surveys				
Note: Individual metrics may better describe conditions directly affecting the biological community while the Habitat Rating describes the general riverine environment at the site(s).				

Table 5. Habitat evaluation for selected stations in the Au Sable and Black River watersheds Otsego, Alpena, Crawford, Oscoda, and Alcona counties June-August 2017 and June 2018.

	Duval Creek	Pine River	Berlinski Creek (West)
	downstream F41 (Somers Road)	F-41 (Somers Road)	Off Cariveau Road
	6/28/2017	8/16/2017	6/13/2017
	GLIDE/POOL	GLIDE/POOL	RIFFLE/RUN
HABITAT METRIC			
Substrate and Instream Cover			
Epifaunal Substrate/ Avail Cover (20)	13	8	17
Embeddedness (20)*			18
Velocity/Depth Regime (20)*			15
Pool Substrate Characterization (20)**	15	8	
Pool Variability (20)**	16	11	
Channel Morphology			
Sediment Deposition (20)	15	10	13
Flow Status - Maint. Flow Volume (10)	10	9	9
Flow Status - Flashiness (10)	5	3	9
Channel Alteration (20)	18	17	20
Frequency of Riffles/Bends (20)*			19
Channel Sinuosity (20)**	16	16	
Riparian and Bank Structure			
Bank Stability (L) (10)	7	5	9
Bank Stability (R) (10)	7	4	9
Vegetative Protection (L) (10)	9	8	9
Vegetative Protection (R) (10)	9	9	9
Riparian Vegetation Zone Width (L) (10)	10	8	10
Riparian Vegetation Zone Width (R) (10)	10	9	9
TOTAL SCORE (200):	160	125	175
HABITAT RATING:	EXCELLENT	GOOD	EXCELLENT
Date:	6/28/2017	8/16/2017	6/13/2017
Weather:	sunny	cloudy	sunny
Air Temperature: °F	61	65	68
Water Temperature: °F	64	62	64
Ave. Stream Width: Feet	8	55	9
Ave. Stream Depth: Feet	1.2	2.5	0.4
Surface Velocity: Feet/Second	1	1.6	1.6
Estimated Flow: Cubic Feet/Second	9.7	240.4	6.2
Stream Modifications:	none	none	none
Nuisance Plants (Y/N):	N	N	N
STORET No.:	010110	010109	040172
County Code:	01	01	04
TRS:	28N08E23	25N08E23	29N08E05
Latitude (dd):	44.5468	44.5507	44.93745
Longitude (dd):	-83.4219	-83.4221	-83.49062
Ecoregion:	NLAF	NLAF	NLAF
Stream Type:	Warmwater	Warmwater	Coldwater
USGS Basin Code:	4070007	4070007	4070003
* Applies only to Riffle/Run stream Surveys			
** Applies only to Glide/Pool stream Surveys			

Note: Individual metrics may better describe conditions directly affecting the biological community while the Habitat Rating describes the general riverine environment at the site(s).

Table 5. Habitat evaluation for selected stations in the Au Sable and Black River watersheds Otsego, Alpena, Crawford, Oscoda, and Alcona counties June-August 2017 and June 2018.

	Van Etten Creek	East Branch Big Creek-South
	F-41 (South Crossing)	Boardwalk off Galloway Rd
	6/13/2017	6/15/2017
	GLIDE/POOL	GLIDE/POOL
HABITAT METRIC		
Substrate and Instream Cover		
Epifaunal Substrate/ Avail Cover (20)	6	12
Embeddedness (20)*		
Velocity/Depth Regime (20)*		
Pool Substrate Characterization (20)**	7	13
Pool Variability (20)**	11	8
Channel Morphology		
Sediment Deposition (20)	3	18
Flow Status - Maint. Flow Volume (10)	10	10
Flow Status - Flashiness (10)	4	8
Channel Alteration (20)	15	20
Frequency of Riffles/Bends (20)*		
Channel Sinuosity (20)**	8	18
Riparian and Bank Structure		
Bank Stability (L) (10)	9	10
Bank Stability (R) (10)	9	10
Vegetative Protection (L) (10)	8	10
Vegetative Protection (R) (10)	8	10
Riparian Vegetation Zone Width (L) (10)	3	10
Riparian Vegetation Zone Width (R) (10)	3	10
TOTAL SCORE (200):	104	167
HABITAT RATING:	MARGINAL	EXCELLENT
Date:	6/13/2017	6/15/2017
Weather:	sunny	partlycloudy
Air Temperature: °F	72	65
Water Temperature: °F	74	55
Ave. Stream Width: Feet	11.5	46
Ave. Stream Depth: Feet	2.4	1.6
Surface Velocity: Feet/Second	0.424647816	1.318226121
Estimated Flow: Cubic Feet/Second	11.06971927	104.1691575
Stream Modifications:	dredged	none
Nuisance Plants (Y/N):	N	N
STORET No.:	010138	680060
County Code:	1	68
TRS:	25N8E11	26N01E36
Latitude (dd):	44.5738458	44.60599
Longitude (dd):	-83.42265378	-84.25835
Ecoregion:	NLAF	NLAF
Stream Type:		Coldwater

USGS Basin Code:	4070007	4070007
* Applies only to Riffle/Run stream Surveys		
** Applies only to Glide/Pool stream Surveys		
Note: Individual metrics may better describe conditions directly affecting the biological community while the Habitat Rating describes the general riverine environment at the site(s).		

Table 5. Habitat evaluation for selected stations in the Au Sable and Black River watersheds Otsego, Alpena, Crawford, Oscoda, and Alcona counties June-August 2017 and June 2018.

	North Branch AuSable	North Branch AuSable	North Branch AuSable	West Branch Big Creek
	The Ford	N Down River Rd	2 Track off McMasters Bridge Road	Downstream Townline Rd.
	6/15/2017	6/16/2017	6/14/2017	6/16/2017
	RIFFLE/RUN	RIFFLE/RUN	RIFFLE/RUN	GLIDE/POOL
HABITAT METRIC				
Substrate and Instream Cover				
Epifaunal Substrate/ Avail Cover (20)	18	16	19	17
Embeddedness (20)*	12	13	18	
Velocity/Depth Regime (20)*	15	19	19	
Pool Substrate Characterization (20)**				16
Pool Variability (20)**				15
Channel Morphology				
Sediment Deposition (20)	17	18	18	18
Flow Status - Maint. Flow Volume (10)	10	10	10	10
Flow Status - Flashiness (10)	10	7	9	8
Channel Alteration (20)	20	18	20	20
Frequency of Riffles/Bends (20)*	7	18	18	
Channel Sinuosity (20)**				18
Riparian and Bank Structure				
Bank Stability (L) (10)	10	9	10	10
Bank Stability (R) (10)	10	9	10	10
Vegetative Protection (L) (10)	10	9	9	9
Vegetative Protection (R) (10)	10	9	9	9
Riparian Vegetation Zone Width (L) (10)	10	10	9	10
Riparian Vegetation Zone Width (R) (10)	10	5	9	10
TOTAL SCORE (200):	169	170	187	180
HABITAT RATING:				
	EXCELLENT	EXCELLENT	EXCELLENT	EXCELLENT
Date:	6/15/2017	6/16/2017	6/14/2017	6/16/2017
Weather:	partlycloudy	partlycloudy	partlycloudy	partlycloudy
Air Temperature: °F	80	59	80	68
Water Temperature: °F	74	62	68	65
Ave. Stream Width: Feet	25	55	110	28
Ave. Stream Depth: Feet	1.2	2	1.5	1
Surface Velocity: Feet/Second	2	2.3	3.5	2.1
Estimated Flow: Cubic Feet/Second	76.6	290.2	564.5	65.8
Stream Modifications:	habitatimp	habitatimp,bankstab	none	none
Nuisance Plants (Y/N):	N	N	N	N
STORET No.:	690164	200148	200161	200176
County Code:	69	20	20	20
TRS:	29N02W22	27N01W22	26N01W02	27N01W3
Latitude (dd):	44.88811	44.71647	44.67569	44.76886579
Longitude (dd):	-84.54309	-84.41946	-84.39149	-84.42444835
Ecoregion:	NLAF	NLAF	NLAF	NLAF
Stream Type:		Coldwater	Coldwater	
USGS Basin Code:	4070007	4070007	4070007	4070007

* Applies only to Riffle/Run stream Surveys
 ** Applies only to Glide/Pool stream Surveys

Note: Individual metrics may better describe conditions directly affecting the biological community while the Habitat Rating describes the general riverine environment at the site(s).

Table 5. Habitat evaluation for selected stations in the Au Sable and Black River watersheds Otsego, Alpena, Crawford, Oscoda, and Alcona counties June-August 2017 and June 2018.

	North Branch AuSable	North Branch AuSable River	North Branch AuSable
	Dam Four Road	Twin Bridge Rd	The Ford
	6/14/2018	6/13/2018	6/13/2018
	RIFFLE/RUN	RIFFLE/RUN	RIFFLE/RUN
HABITAT METRIC			
Substrate and Instream Cover			
Epifaunal Substrate/ Avail Cover (20)	19	18	16
Embeddedness (20)*	20	19	18
Velocity/Depth Regime (20)*	20	15	15
Pool Substrate Characterization (20)**			
Pool Variability (20)**			
Channel Morphology			
Sediment Deposition (20)	20	14	19
Flow Status - Maint. Flow Volume (10)	10	10	10
Flow Status - Flashiness (10)	10	10	10
Channel Alteration (20)	18	18	19
Frequency of Riffles/Bends (20)*	20	16	20
Channel Sinuosity (20)**			
Riparian and Bank Structure			
Bank Stability (L) (10)	10	10	10
Bank Stability (R) (10)	10	10	10
Vegetative Protection (L) (10)	10	8	9
Vegetative Protection (R) (10)	10	8	9
Riparian Vegetation Zone Width (L) (10)	10	8	10
Riparian Vegetation Zone Width (R) (10)	10	8	10
TOTAL SCORE (200):	197	172	185
HABITAT RATING:			
	EXCELLENT	EXCELLENT	EXCELLENT
Date:	6/14/2018	6/13/2018	6/13/2018
Weather:	Sunny	Sunny	Partly Cloudy
Air Temperature: °F	60	70	70
Water Temperature: °F	58	69	71
Ave. Stream Width: Feet	88	111	50.5
Ave. Stream Depth: Feet	1	1.5	1
Surface Velocity: Feet/Second			
Estimated Flow: Cubic Feet/Second			
Stream Modifications:	Habitat Impr	Habitat Impr	Bank Stab; Habitat Impr
Nuisance Plants (Y/N):	N	N	N
STORET No.:	200166	200005	690164
County Code:	20	20	69
TRS:	27N01W16	28N02W13	29N02W22
Latitude (dd):	44.7564	44.82709	44.88811
Longitude (dd):	-84.4578	-84.49039	-84.54309
Ecoregion:	NLAF	NLAF	NLAF
Stream Type:	Coldwater	Coldwater	
USGS Basin Code:	4070007	4070007	4070007

* Applies only to Riffle/Run stream Surveys
 ** Applies only to Glide/Pool stream Surveys

Note: Individual metrics may better describe conditions directly affecting the biological community while the Habitat Rating describes the general riverine environment at the site(s).

Table 6. Qualitative macroinvertebrate sampling results at selected stations in the Au Sable and Black River watersheds Otsego, Alpena, Crawford, Oscoda, and Alcona counties June-August 2017 and June 2018.

TAXA	East Branch AuSable Downstream from County Road 612 6/15/2017 200165	AuSable River Wiseman Trail West of McMaster Bridge Road 6/28/2017 200160	Wright Creek Bear Lake Road 6/14/2017 680066	North Branch AuSable 2 Track off McMasters Bridge Road 6/14/2017 200161
PORIFERA (sponges)			1	
PLATYHELMINTHES (flatworms)				
Turbellaria	2			
ANNELIDA (segmented worms)				
Oligochaeta (worms)	5	10	12	23
ARTHROPODA				
Crustacea				
Amphipoda (scuds)	1	9	2	
Decapoda (crayfish)	1		4	
Isopoda (sowbugs)		4		1
Arachnoidea				
Hydracarina	25	2	8	8
Insecta				
Ephemeroptera (mayflies)				
Baetiscidae		1		1
Baetidae	31	21	20	1
Caenidae			26	
Ephemerellidae	24	40		70
Ephemeridae				1
Heptageniidae		7	3	2
Isonychiidae		2		1
Leptophlebiidae	6			1
Tricorythidae	10	10	1	1
Odonata				
Anisoptera (dragonflies)				
Aeshnidae	3	1	4	
Cordulegastridae			1	
Gomphidae	12	1	3	2
Zygoptera (damselflies)				
Calopterygidae	2	1	3	2
Coenagrionidae	2		1	
Plecoptera (stoneflies)				

Perlidae	5	5	12	6
Perlodidae				1
Hemiptera (true bugs)				
Corixidae		1		
Gerridae	3			
Nepidae			1	
Megaloptera				
Corydalidae (dobson flies)	1	6	1	1
Trichoptera (caddisflies)				
Brachycentridae	1	6		29
Glossosomatidae		1		
Helicopsychidae		17		38
Hydropsychidae	6	31	12	41
Lepidostomatidae		5	1	2
Leptoceridae	9	9	2	5
Limnephilidae	3	1		1
Philopotamidae	6	6		7
Phryganeidae		1	1	
Polycentropodidae		1		1
Coleoptera (beetles)				
Hydrophilidae (total)			1	
Elmidae	6	6	16	6
Diptera (flies)				
Athericidae		3		3
Ceratopogonidae	3		11	1
Chironomidae	30	22	47	8
Dixidae			4	
Simuliidae	13	3	29	22
Tipulidae			2	
MOLLUSCA				
Gastropoda (snails)				
Ancylidae (limpets)			3	
Bithyniidae	37		3	
Lymnaeidae		1		6
Physidae		12	1	1
Planorbidae			1	
Pleuroceridae		4		
Viviparidae		2		1
Pelecypoda (bivalves)				
Sphaeriidae (clams)	6	1	13	3
Unionidae (mussels)	1			
TOTAL INDIVIDUALS	254	254	250	297

East Branch AuSable	AuSable River Wiseman Trail	Wright Creek	North Branch AuSable
Downstream from County Road 612	West of McMaster Bridge Road	Bear Lake Road	2 Track off McMasters Bridge Road
6/15/2017	6/28/2017	6/14/2017	6/14/2017

METRIC	200165		200160		680066		200161	
	Value	Score	Value	Score	Value	Score	Value	Score
TOTAL NUMBER OF TAXA	28	1	36	1	33	1	33	1
NUMBER OF MAYFLY TAXA	4	0	6	1	4	1	8	1
NUMBER OF CADDISFLY TAXA	5	0	10	1	4	1	8	1
NUMBER OF STONEFLY TAXA	1	0	1	0	1	1	2	1
PERCENT MAYFLY COMPOSITION	27.95	1	31.89	1	20.00	0	26.26	1
PERCENT CADDISFLY COMPOSITION	9.84	0	30.71	1	6.40	0	41.75	1
PERCENT DOMINANT TAXON	14.57	1	15.75	1	18.80	0	23.57	0
PERCENT ISOPOD, SNAIL, LEECH	14.57	-1	9.06	0	3.20	1	3.03	1
PERCENT SURFACE AIR BREATHERS	1.18	1	0.39	1	0.80	1	0.00	1
TOTAL SCORE		3		7		6		8
MACROINVERTEBRATE COMMUNITY RATING		Acceptable		Excellent		Excellent		Excellent

Table 6. Qualitative macroinvertebrate sampling results at selected stations in the Au Sable and Black River watersheds Otsego, Alpena, Crawford, Oscoda, and Alcona counties June-August 2017 and June 2018.

	Big Creek Brown Cabin Road	Perry Creek Kneeland Road	Smith Creek 2 Track off from Aldrich	South Branch Pine River Buhl Road
	6/14/2017	6/14/2017	6/28/2017	6/28/2017
TAXA	680008	680063	10108	10115

ANNELIDA (segmented worms)				
Hirudinea (leeches)	2	1		
Oligochaeta (worms)	11	6	2	1
ARTHROPODA				
Crustacea				
Amphipoda (scuds)	34	1	31	19
Decapoda (crayfish)		1		1
Isopoda (sowbugs)	1	1		
Arachnoidea				
Hydracarina	25	1	1	2
Insecta				
Ephemeroptera (mayflies)				
Baetiscidae	4			
Baetidae	18	13	29	19
Caenidae				1
Ephemerellidae	34		28	74
Ephemeridae	23			
Heptageniidae	5	5	7	13
Leptophlebiidae		7		
Tricorythidae	1		1	25
Odonata				
Anisoptera (dragonflies)				
Aeshnidae		1		1
Cordulegastridae		8		
Gomphidae	1			1
Zygoptera (damselflies)				
Calopterygidae		13		1
Plecoptera (stoneflies)				
Leuctridae	1			
Nemouridae		1		
Perlidae		2	12	
Perlodidae	3			2
Pteronarcyidae	1			9
Hemiptera (true bugs)				
Gerridae	9	5	1	
Mesoveliidae	2			
Veliidae		6		
Megaloptera				
Corydalidae (dobson flies)	1	1	1	1
Sialidae (alder flies)	1	1		
Trichoptera (caddisflies)				
Brachycentridae	10		6	19
Glossosomatidae				1
Helicopsychidae				20
Hydropsychidae	3	11	10	27
Hydroptilidae	1		1	
Lepidostomatidae	1	16	19	22
Leptoceridae	6			5
Limnephilidae	12	2	8	1
Molannidae		1		

Table 6. Qualitative macroinvertebrate sampling results at selected stations in the Au Sable and Black River watersheds Otsego, Alpena, Crawford, Oscoda, and Alcona counties June-August 2017 and June 2018.

	Duvall Creek downstream F41 (Somers Road)	Pine River F-41 (Somers Road)	Berlinski Creek (West) Off Carriveau Road
	6/28/2017	8/16/2017	6/13/2017
TAXA	10110	10109	40172

ANNELIDA (segmented worms)			
Hirudinea (leeches)		1	
Oligochaeta (worms)	1	9	1
ARTHROPODA			
Crustacea			
Amphipoda (scuds)	49	4	131
Decapoda (crayfish)	3	1	1
Arachnoidea			
Hydracarina		7	4
Insecta			
Ephemeroptera (mayflies)			
Baetiscidae		5	
Baetidae	24	76	9
Caenidae	3	2	
Ephemeridae		4	
Heptageniidae	13	16	6
Isonychiidae	2	1	
Leptophlebiidae			1
Tricorythidae		13	
Odonata			
Anisoptera (dragonflies)			
Aeshnidae	2	1	4
Cordulegastridae	3		1
Gomphidae	4	2	
Zygoptera (damselflies)			
Calopterygidae	20	3	2
Plecoptera (stoneflies)			
Perlidae	1	1	4
Perlodidae			5
Pteronarcyidae		1	
Hemiptera (true bugs)			
Corixidae		15	
Gerridae	3	3	4
Mesoveliidae		1	
Megaloptera			
Corydalidae (dobson flies)	1	1	1
Sialidae (alder flies)		1	2
Trichoptera (caddisflies)			
Brachycentridae		2	1
Helicopsychidae		1	
Hydropsychidae	6	6	18
Lepidostomatidae			1
Leptoceridae	4	5	
Limnephilidae	3		11
Molannidae			1
Philopotamidae			4
Phryganeidae	1		
Uenoidae	1		1
Coleoptera (beetles)			

Dytiscidae (total)		1	
Gyrinidae (adults)		1	
Haliplidae (adults)	1	1	
Dryopidae	1		5
Elmidae	42	12	27
Diptera (flies)			
Athericidae	1	7	2
Ceratopogonidae		1	1
Chironomidae	32	29	64
Culicidae		1	
Dixidae			1
Simuliidae	30	3	3
Stratiomyidae		1	
Tabanidae		2	
Tipulidae	11	1	2
MOLLUSCA			
Gastropoda (snails)			
Ancylidae (limpets)		1	
Lymnaeidae	1	2	
Physidae	1	10	2
Pelecypoda (bivalves)			
Sphaeriidae (clams)		1	2
TOTAL INDIVIDUALS	264	256	322

METRIC	Duvall Creek		Pine River		Berlinski Creek (West)	
	downstream F41 (Somers Road)		F-41 (Somers Road)		Off Carriveau Road	
	6/28/2017		8/16/2017		6/13/2017	
	10110		10109		40172	
	Value	Score	Value	Score	Value	Score
TOTAL NUMBER OF TAXA	28	1	42	1	32	1
NUMBER OF MAYFLY TAXA	4	1	7	1	3	0
NUMBER OF CADDISFLY TAXA	5	1	4	0	7	1
NUMBER OF STONEFLY TAXA	1	0	2	1	2	1
PERCENT MAYFLY COMPOSITION	15.91	0	45.70	1	4.97	0
PERCENT CADDISFLY COMPOSITION	5.68	0	5.47	0	11.49	0
PERCENT DOMINANT TAXON	18.56	0	29.69	-1	40.68	-1
PERCENT ISOPOD, SNAIL, LEECH	0.76	1	5.47	0	0.62	1
PERCENT SURFACE AIR BREATHERS	1.89	1	9.77	0	1.24	1
TOTAL SCORE		5		3		4

MACROINVERTEBRATE COMMUNITY RATING

Excellent

Acceptable

Acceptable

Table 6. Qualitative macroinvertebrate sampling results at selected stations in the Au Sable and Black River watersheds Otsego, Alpena, Crawford, Oscoda, and Alcona counties June-August 2017 and June 2018.

TAXA	Van Etten Creek F-41 (South Crossing) 6/13/2017 10138	East Branch Big Creek- South Boardwalk off Galloway Rd 6/15/2017 680060
<hr/>		
ANNELIDA (segmented worms)		
Hirudinea (leeches)	4	
Oligochaeta (worms)	4	7
ARTHROPODA		
Crustacea		
Amphipoda (scuds)	11	15
Decapoda (crayfish)	2	
Arachnoidea		
Hydracarina	9	8
Insecta		
Ephemeroptera (mayflies)		
Baetidae	8	20
Caenidae	5	
Ephemerellidae	1	44
Odonata		
Zygoptera (damselflies)		
Calopterygidae	8	
Plecoptera (stoneflies)		
Capniidae		1
Nemouridae		1
Hemiptera (true bugs)		
Belostomatidae		1
Corixidae	2	
Mesoveliidae	1	
Pleidae	1	
Megaloptera		
Sialidae (alder flies)		1
Trichoptera (caddisflies)		
Brachycentridae		8
Hydropsychidae	6	
Hydroptilidae		24
Lepidostomatidae		2
Leptoceridae	3	36
Limnephilidae		13
Polycentropodidae		1
Rhyacophilidae		1
Coleoptera (beetles)		
Dytiscidae (total)	4	
Elmidae	16	
Diptera (flies)		
Ceratopogonidae	1	
Chironomidae	154	32
Simuliidae		23
Tabanidae	2	7

Tipulidae	1	
MOLLUSCA		
Gastropoda (snails)		
Bithyniidae	5	
Physidae	6	
Pelecypoda (bivalves)		
Pisidiidae	1	3
<hr/>		
TOTAL INDIVIDUALS	255	248

Table 2B. Macroinvertebrate metric evaluation of

METRIC	Van Etten Creek F-41 (South Crossing) 6/13/2017 10138		East Branch Big Creek-South Boardwalk off Galloway Rd 6/15/2017 680060	
	Value	Score	Value	Score
TOTAL NUMBER OF TAXA	23	0	20	0
NUMBER OF MAYFLY TAXA	3	0	2	-1
NUMBER OF CADDISFLY TAXA	2	-1	7	1
NUMBER OF STONEFLY TAXA	0	-1	2	1
PERCENT MAYFLY COMPOSITION	5.49	0	25.81	1
PERCENT CADDISFLY COMPOSITION	3.53	0	34.27	1
PERCENT DOMINANT TAXON	60.39	-1	17.74	0
PERCENT ISOPOD, SNAIL, LEECH	5.88	0	0.00	1
PERCENT SURFACE AIR BREATHERS	3.14	1	0.40	1
TOTAL SCORE		-2		5
MACROINVERTEBRATE COMMUNITY RATING		Acceptable		Excellent

Table 6. Qualitative macroinvertebrate sampling results at selected stations in the Au Sable and Black River watersheds Otsego, Alpena, Crawford, Oscoda, and Alcona counties June-August 2017 and June 2018.

	North Branch AuSable	North Branch AuSable	North Branch AuSable	West Branch Big Creek
	The Ford	N Down River Rd	2 Track off McMasters Bridge Road	Downstream Townline Rd.
	6/15/2017	6/16/2017	6/14/2017	6/16/2017
TAXA	690164	200148	200161	200176
<hr/>				
PLATYHELMINTHES (flatworms)				
Turbellaria	2			
ANNELIDA (segmented worms)				
Oligochaeta (worms)	20	6	23	14
ARTHROPODA				
Crustacea				
Amphipoda (scuds)	12			17
Decapoda (crayfish)	4			1
Isopoda (sowbugs)		43	1	29
Arachnoidea				
Hydracarina	1	2	8	
Insecta				
Ephemeroptera (mayflies)				
Baetiscidae			1	
Baetidae	5	9	1	13
Ephemerellidae	14	96	70	20
Ephemeridae		1	1	
Heptageniidae	30	8	2	15
Isonychiidae		1	1	
Leptophlebiidae	1		1	
Tricorythidae	7	9	1	1
Odonata				
Anisoptera (dragonflies)				
Gomphidae		1	2	2
Zygoptera (damselflies)				
Calopterygidae	7	1	2	2
Plecoptera (stoneflies)				
Perlidae		1	6	
Perlodidae		1	1	5
Pteronarcyidae				1
Hemiptera (true bugs)				
Corixidae		2		1
Megaloptera				
Corydalidae (dobson flies)			1	
Sialidae (alder flies)				1
Trichoptera (caddisflies)				
Brachycentridae	4	4	29	15
Helicopsychidae	9	13	38	12

Hydropsychidae	8	2	41	31
Lepidostomatidae	5	1	2	31
Leptoceridae	21	19	5	9
Limnephilidae	4	2	1	5
Molannidae	1			1
Philopotamidae	3		7	6
Polycentropodidae		1	1	
Uenoidae	12			
Coleoptera (beetles)				
Elmidae	6	2	6	16
Diptera (flies)				
Athericidae		1	3	2
Ceratopogonidae		1	1	
Chironomidae	38	15	8	12
Simuliidae	3	2	22	1
Stratiomyidae		1		
Tabanidae		1		
Tipulidae	2			1
MOLLUSCA				
Gastropoda (snails)				
Bithyniidae	6	1		
Hydrobiidae	19			
Lymnaeidae			6	
Physidae		5	1	1
Viviparidae			1	
Pelecypoda (bivalves)				
Sphaeriidae (clams)	11	21	3	
TOTAL INDIVIDUALS	255	273	297	265

METRIC	North Branch AuSable		North Branch AuSable		North Branch AuSable 2 Track off McMasters Bridge Road		West Branch Big Creek	
	Value	Score	Value	Score	Value	Score	Value	Score
TOTAL NUMBER OF TAXA	27	0	31	1	33	1	28	1
NUMBER OF MAYFLY TAXA	5	1	6	1	8	1	4	0
NUMBER OF CADDISFLY TAXA	9	1	7	1	8	1	8	1
NUMBER OF STONEFLY TAXA	0	-1	2	1	2	1	2	1
PERCENT MAYFLY COMPOSITION	22.35	1	45.42	1	26.26	1	18.49	0
PERCENT CADDISFLY COMPOSITION	26.27	0	15.38	0	41.75	1	41.51	1
PERCENT DOMINANT TAXON	14.90	1	35.16	-1	23.57	0	11.70	1
PERCENT ISOPOD, SNAIL, LEECH	9.80	0	17.95	-1	3.03	1	11.32	0
PERCENT SURFACE AIR BREATHERS	0.00	1	1.10	1	0.00	1	0.38	1

TOTAL SCORE 4 4 8 6

MACROINVERTEBRATE COMMUNITY RATING Acceptable Acceptable Excellent Excellent

Table 6. Qualitative macroinvertebrate sampling results at selected stations in the Au Sable and Black River watersheds Otsego, Alpena, Crawford, Oscoda, and Alcona counties June-August 2017 and June 2018.

TAXA	North Branch AuSable Dam Four Road 6/14/2018 200166	North Branch AuSable River Twin Bridge Rd 6/13/2018 200005	North Branch AuSable The Ford 6/13/2018 690164
------	--	--	--

PLATYHELMINTHES (flatworms)

Turbellaria 1 2

ANNELIDA (segmented worms)

Hirudinea (leeches) 1

Oligochaeta (worms) 12 7 5

ARTHROPODA

Crustacea

Amphipoda (scuds) 8 1 3

Decapoda (crayfish) 1 1 1

Isopoda (sowbugs) 43 44

Arachnoidea

Hydracarina 1 1 3

Insecta

Ephemeroptera (mayflies)

Baetiscidae 1

Baetidae 25 20 13

Caenidae 2

Ephemerellidae 53 7 14

Heptageniidae 6 14 21

Isonychiidae 1

Leptophlebiidae 1

Tricorythidae 9 16 13

Odonata

Anisoptera (dragonflies)

Gomphidae 1 1 2

Zygoptera (damselflies)

Calopterygidae 1 2 3

Plecoptera (stoneflies)

Perlidae 1 4 1

Perlodidae 1 1

Hemiptera (true bugs)

Corixidae 1

Trichoptera (caddisflies)

Brachycentridae 22 40 1

Glossosomatidae 2

Helicopsychidae 47 23 11

Hydropsychidae	18	20	10
Hydroptilidae	1		
Lepidostomatidae	12	2	6
Leptoceridae	14	18	10
Limnephilidae	4	2	2
Molannidae	1	1	2
Philopotamidae	1	2	1
Polycentropodidae	2	1	4
Uenoidae	2	1	41
Coleoptera (beetles)			
Elmidae	4	2	3
Diptera (flies)			
Athericidae	3		
Ceratopogonidae		2	
Chironomidae	33	21	33
Simuliidae	4	1	1
Tabanidae		1	1
Tipulidae	1	2	1
MOLLUSCA			
Gastropoda (snails)			
Hydrobiidae			24
Lymnaeidae	1		
Physidae	1		1
Pelecypoda (bivalves)			
Pisidiidae	4	1	14
TOTAL INDIVIDUALS	343	262	248

METRIC	North Branch AuSable Dam Four Road 6/14/2018 200166		North Branch AuSable River Twin Bridge Rd 6/13/2018 200005		North Branch AuSable The Ford 6/13/2018 690164	
	Value	Score	Value	Score	Value	Score
TOTAL NUMBER OF TAXA	37	1	32	1	31	1
NUMBER OF MAYFLY TAXA	6	1	6	1	4	0
NUMBER OF CADDISFLY TAXA	12	1	10	1	10	1
NUMBER OF STONEFLY TAXA	2	1	2	1	1	0
PERCENT MAYFLY COMPOSITION	27.70	1	22.90	1	24.60	1
PERCENT CADDISFLY COMPOSITION	36.73	1	41.98	1	35.48	1
PERCENT DOMINANT TAXON	15.45	1	16.79	1	16.53	1
PERCENT ISOPOD, SNAIL, LEECH	13.12	-1	16.79	-1	10.48	0
PERCENT SURFACE AIR BREATHERS	0.29	1	0.00	1	0.00	1
TOTAL SCORE		7		7		6
MACROINVERTEBRATE COMMUNITY RATING		Excellent		Excellent		Excellent

