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MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
WATER RESOURCES DIVISION
JULY 2016

STAFF REPORT

Biological and water chemistry surveys of selected stations in the Platte and Betsie Rivers watersheds and other coastal watersheds in Benzie, Leelanau, Grand Traverse, and Manistee Counties, Michigan, June 2013.

Introduction

Biological and physical habitat conditions of selected water bodies in the Platte River and Betsie River watersheds in Benzie and Manistee Counties, the Crystal River in Leelanau County, and Herring Creek and Bowens Creek in Benzie and Manistee Counties were assessed by staff of the Michigan Department of Environmental Quality (MDEQ), Surface Water Assessment Section (SWAS), in June 2013. The primary objectives of the assessments were:

1. Assess the current status and condition of individual water bodies and determine if Michigan Water Quality Standards (WQS) are being met.
2. Satisfy monitoring requests submitted by internal and external customers.
3. Identify nonpoint sources (NPS) of water quality impairment.
4. Gather water quality data needed for fiscal year (FY) 2013 and FY 2014 Total Maximum Daily Load (TMDL) development or delisting.
5. Evaluate biological integrity temporal trends.

Watershed Information

The Platte River is a coldwater designated stream (Michigan Department of Natural Resources [MDNR], 1997) that originates approximately 30 miles upstream from its confluence with Lake Michigan. There are only three listed warmwater tributaries in the Platte River watershed (Table 1; (MDNR, 1997)). The Platte River starts as an outlet of Long Lake in the western portion of Grand Traverse County. A watershed management plan is available for Long Lake (Partnership, 2009). A channel connects Long Lake with Lake Dubonnet, which is the result of an impoundment of the Platte River. The river continues to flow west downstream of Lake Dubonnet into Benzie County and then north into Lake Ann. It then continues west and south. Just before US-31 crosses the river, the Platte River State Fish Hatchery discharges to the Platte River. Stanley, Kinney, Carter, and Collison Creeks enter the Platte River upstream of the village of Honor. The North Branch Platte River meets up with the outlet of Little Platte Lake (805 acres) and then continues south until it meets with the Platte River just upstream of the confluence with Platte Lake (approximately four square miles). Platte Lake has a very active watershed and lake improvement group and their Web site includes many links to available data and a watershed management plan (LPLA, 2014). Downstream of Platte Lake, the Platte River continues for approximately five miles before emptying into Lake Michigan. The Platte River watershed has an area of approximately 528 square miles.

Table 1. Warmwater designated streams in the Platte River watershed [adapted (MDNR, 1997)]

Stream	Township, Range, Section	County
Unnamed Creek	T26N, R13W, S04	Benzie
Lower Woodcock Lake Outlet	T27N, R13W, S28	Benzie
Harvey Lake Outlet	T27N, R13W, S28	Benzie

The Betsie River is a coldwater designated stream, with the exception of the portion that is upstream of the Grass Lake Flooding Dam. However, an MDNR, Fisheries Division, report (Tonello, in press) noted that the Betsie River does not have as many cold, groundwater inputs as other northern Michigan rivers. The Betsie River begins in the western portion of Grand Traverse County approximately 50 miles upstream of its confluence with Lake Michigan. The uppermost part of the watershed starts with Mason Creek, a tributary to Duck Lake. Duck Lake is connected to Green Lake and the outlet from Green Lake is the Betsie River. As noted, there is a small dam that backs up the Betsie River near the Grass Lake outlet. Downstream of this dam the gradient increases and the Betsie River picks up in velocity as it flows southwest for approximately 15 miles where it then turns west and north near Crystal Mountain, in Manistee County. It then flows north and west into Benzie County for approximately 15 miles until it crosses US-31, then flows further west 10 more miles until it reaches Betsie Lake, before meeting up with Lake Michigan just south of Crystal Lake. The Little Betsie River joins the main branch just upstream of Thompsonville. Carter, Dair, and Rice Creeks are three additional, smaller tributaries to the Betsie River. The Betsie River watershed has an area of approximately 335 square miles.

The Platte River and Betsie River watersheds are located primarily in the Newago Outwash Plain subsection ecosystem, which consists of outwash plains and excessively well-drained sandy soils. However, the lower most portions flow through the Manistee District, which consists of sand dunes, sand lake plain, ground and end moraines, and outwash (Albert, 1995. Version 3 Update June 1998). The portion of the Platte River downstream of Platte Lake is within the Sleeping Bear Dunes National Lakeshore (NPS, 2014). All stations are located in the North Central Hardwood Forests (NCHF) ecoregion (Omernik & Gallant, 2010).

The Herring Creek watershed is located in Benzie County south of the Betsie River watershed and the Bowen's Creek watershed is located south of the Herring Creek watershed in Manistee County. Both of these creeks are designated as coldwater (MDNR, 1997) and are relatively small in area (25 mi^2). Both watersheds are in the Manistee subdistrict (Albert, 1995. Version 3 Update June 1998) and are in the NCHF ecoregion (Omernik & Gallant, 2010). Land use estimates for the Platte River and Betsie River watersheds as well as coastal streams such as Herring and Bowens Creeks are presented in Tables 2 and 3.

Table 2. Land use summary for the Platte River, Betsie River, and other nearby watersheds in northwest Michigan.

Watershed	Natural	Developed	Cultivated Agriculture	Hay or Pasture	Water	Other
Platte River	76%	7%	8%	1%	8%	0%
Betsie River	74%	9%	6%	1%	10%	0%
Crystal River, Otter, Herring, & Bowens	67%	8%	10%	3%	9%	3%

Table 3. More detailed land use estimates for 12-digit watersheds in the Platte River and Betsie River and nearby northwest Michigan watersheds. The orange to green color variation is to help quickly interpret the table. Orange indicates a land use characteristic that is relatively more stressful on aquatic ecosystems, while shades of yellow are less stressful, and shades of green are more beneficial to aquatic ecosystems. The percent water is not an indicator of stress and thus is all one color of green.

		Total Area	Natural Area		Total Developed		Total Agriculture		Cultivated Agriculture		Hay or Pasture		Lost Wetlands		Water		Impervious Area	
12 digit HUC	Waterbody	square miles	square miles	percent	square miles	percent	square miles	percent	square miles	percent	square miles	percent	square miles	percent	square miles	percent	square miles	percent
	Platte River Watershed																	
040601040201	Long Lake-Platte River	23	10	44%	2.1	9%	5.5	24%	4.8	21%	0.69	3%	0.01	2%	5.1	23%	0.01	3%
040601040202	Bronson Lake-Platte River	27	21	77%	2.4	9%	1.6	6%	1.2	4%	0.42	2%	0.00	1%	2.4	9%	0.03	9%
040601040203	Pearl Lake	30	23	77%	1.5	5%	4.3	14%	3.9	13%	0.45	1%	0.00	1%	0.8	3%	0.01	2%
040601040204	North Branch Platte River	46	39	85%	2.5	6%	2.9	6%	2.6	6%	0.31	1%	0.00	1%	1.4	3%	0.04	8%
040601040205	Collison Creek-Platte River	46	41	88%	2.9	6%	2.4	5%	2.0	4%	0.39	1%	0.01	1%	0.1	0%	0.06	12%
040601040206	Platte River	21	13	64%	1.5	7%	1.0	5%	0.8	4%	0.15	1%	0.00	1%	4.9	23%	0.01	6%
	Betsie River Watershed																	
040601040301	Duck Lake	35	23	66%	3.0	9%	5.4	15%	4.3	13%	1.02	3%	0.01	2%	3.3	10%	0.02	6%
040601040302	Green Lake	21	15	68%	2.4	11%	0.6	3%	0.6	3%	0.07	0%	0.00	2%	3.7	17%	0.02	9%
040601040303	Little Betsie River	46	42	92%	2.1	5%	1.1	2%	1.0	2%	0.05	0%	0.00	1%	0.4	1%	0.01	3%
040601040304	Dair Creek-Betsie River	54	48	88%	4.5	8%	1.7	3%	1.6	3%	0.15	0%	0.01	1%	0.0	0%	0.02	4%
040601040305	Crystal Lake Outlet	44	22	49%	4.4	10%	2.5	6%	2.3	5%	0.20	0%	0.01	2%	15.5	35%	0.09	21%
040601040306	Rice Creek-Betsie River	27	20	76%	2.1	8%	4.3	16%	3.8	14%	0.54	2%	0.00	2%	0.0	0%	0.00	2%
040601040307	Betsie River downstream of Crystal Lake outlet	15	10	67%	2.3	15%	2.3	15%	2.1	14%	0.15	1%	0.01	4%	0.4	2%	0.01	4%
	Other Smaller Coastal Lake Michigan Watersheds																	
040601040401	Shalda Creek	59	42	72%	4.6	8%	6.8	12%	5.6	10%	1.20	2%	0.01	1%	2.9	5%	0.03	5%
040601040402	Crystal Run	46	31	68%	2.5	5%	1.3	3%	1.0	2%	0.23	0%	0.00	1%	10.1	22%	0.06	14%
040601040403	Otter Creek	25	17	68%	1.8	7%	0.7	3%	0.6	3%	0.02	0%	0.00	1%	0.4	1%	0.01	3%
040601040404	Arcadia Lake	25	17	70%	1.6	6%	5.7	23%	4.2	17%	1.43	6%	0.00	1%	0.3	1%	0.03	11%
040601040405	Portage Lake	25	13	53%	2.7	11%	5.5	22%	4.1	17%	1.34	5%	0.01	2%	3.4	14%	0.01	2%
040601040406	Herring Creek	40	26	63%	3.3	8%	7.8	19%	6.5	16%	1.32	3%	0.01	2%	2.1	5%	0.01	2%

The amount of impervious area in the Platte River and Betsie River watersheds is between 2 and 21 percent (Table). Impervious surfaces are those areas on the land that cannot effectively absorb water and pass it through to the groundwater table. Examples include; decks, patios, paved gravel roads, crushed stone driveways, parking areas, and sidewalks. Impervious area is closely linked to areas of development. The amount of total wetlands lost since presettlement times in the Platte River and Betsie River watersheds (1-4 percent) is relatively low when compared to the entire state [40 percent;(Fizzell, 2014)]. The highest percent of wetlands lost in the watersheds presented in this report, is 4 percent in the Betsie River watershed downstream of the Crystal Lake outlet (Table 3).

The high amount of land use that remains as wetlands and other natural areas is likely one factor leading to the high quality habitat and macroinvertebrate communities found in these watersheds. It should be noted that although habitat and macroinvertebrate communities were rated at the high end of acceptable (scores 0-4), only one station scored excellent (Bowens Creek) with a score of 5 (Table 4). This is not unusual for watersheds in the NCHF ecoregion, but does differ from other high quality northern Michigan watersheds in the Northern Lake and Forest ecoregion, which often have scores in the excellent range.

Historical Sampling Efforts and Information

The most recent surveys of the Betsie River and Platte River watersheds were conducted in 2008 (Wesener, 2011). Aquatic macroinvertebrate community and habitat assessments were conducted at 11 stations. Macroinvertebrate ratings were all acceptable with the exception of an unnamed tributary to Platte Lake rating poor. Habitat ratings ranged from good to excellent. The fish community was sampled in the coldwater designated Crystal River downstream of Fisher Lake. The fish community consisted of several species of fish including king and coho salmon but no resident salmonid fish species.

Prior surveys conducted in the Betsie River and Platte River watersheds included those conducted in 2003 (Zbytowski, 2007b and 2007c). Aquatic macroinvertebrate community and habitat assessments were conducted at 10 stations. Macroinvertebrate communities were rated acceptable at all stations and were found to have good or excellent habitat conditions.

Unnamed Tributary to Platte Lake

This tributary was sampled in 2003 and 2008, and was visited in 2009 upstream of US-31. In 2003, staff from the SWAS and Cadillac District Office conducted a chemical and biological survey of the tributary in response to a water quality complaint of strong odors and a change in color of the stream. It was determined that the west branch of this groundwater-fed stream was being impacted by contaminated groundwater that was venting from an illicit fruit waste disposal to a gravel pit, located up-gradient of the stream (Wesener, 2011). The waste was at least partially removed from the pit, but groundwater and soils were already contaminated. Poor macroinvertebrate conditions were found in the stream in 2003 and 2008 and degraded habitat conditions consisting of orange bacterial slimes and accumulated organic matter that would not decompose were found in 2003, 2008, and 2009. Macroinvertebrate surveys were not conducted in 2009 due to unchanged degraded habitat conditions since the 2008 survey. Additional reports written as a result of the 2003 investigation are available (Smith, 2003; Walker, 2003) and indicate elevated conductivity, total phosphorus, and metals concentrations, biological oxygen demand (BOD), and total organic carbon. Modeling indicates the dissolved oxygen (DO) concentrations did not meet WQS further downstream in the unnamed tributary. Additional remediation, including the installation of an air sparge system, occurred in

late 2014 (Eric Chatterson and Janice Heuer, MDEQ, personal communication, 2015). Results of this effort are not yet available.

DO and BOD sampling were conducted in 2013 to determine current attainment status and to determine if a TMDL is needed (Carpenter, 2013). Results indicated the west branch of the unnamed tributary was not meeting the 7.0 milligrams per liter minimum DO WQS. Additional sampling in 2014 indicated that water from one sample from the west branch did not meet the WQS of 10 parts per billion for arsenic. Unnatural color, bacterial slimes, and odor also remained a problem (Carpenter, 2014).

Methods

The macroinvertebrate community and/or physical habitat was qualitatively assessed at each of 17 stations (Figure 1 and Table 4) using the SWAS Procedure 51 (Creal et al., 1996; MDEQ, 1990) for wadeable streams. If a station is at a road crossing, it is sampled upstream unless otherwise noted. The macroinvertebrate and fish communities were assessed and scored with metrics that rate water bodies from excellent (+5 to +9 [macroinvertebrates], +5 to +10 [fish]) to poor (-5 to -9 [macroinvertebrates], -5 to -10 [fish]). Scores from +4 to -4 are rated acceptable. Negative scores in the acceptable range are considered to be at the lower end of acceptable, while positive scores in the acceptable range are considered to be at the higher end of acceptable. Habitat evaluations are based on 10 metrics, with a maximum total score of 200. A station habitat score of >154 is characterized as having excellent habitat, 105-154 is good, 56-104 is marginal, and <56 is poor. Only the macroinvertebrate community scores are used to determine attainability of the Other Indigenous Aquatic Life and Wildlife (OIALW) designated use. Habitat scores and individual metrics are used to help better understand the macroinvertebrate scores (Creal et al., 1996; MDEQ, 1990).

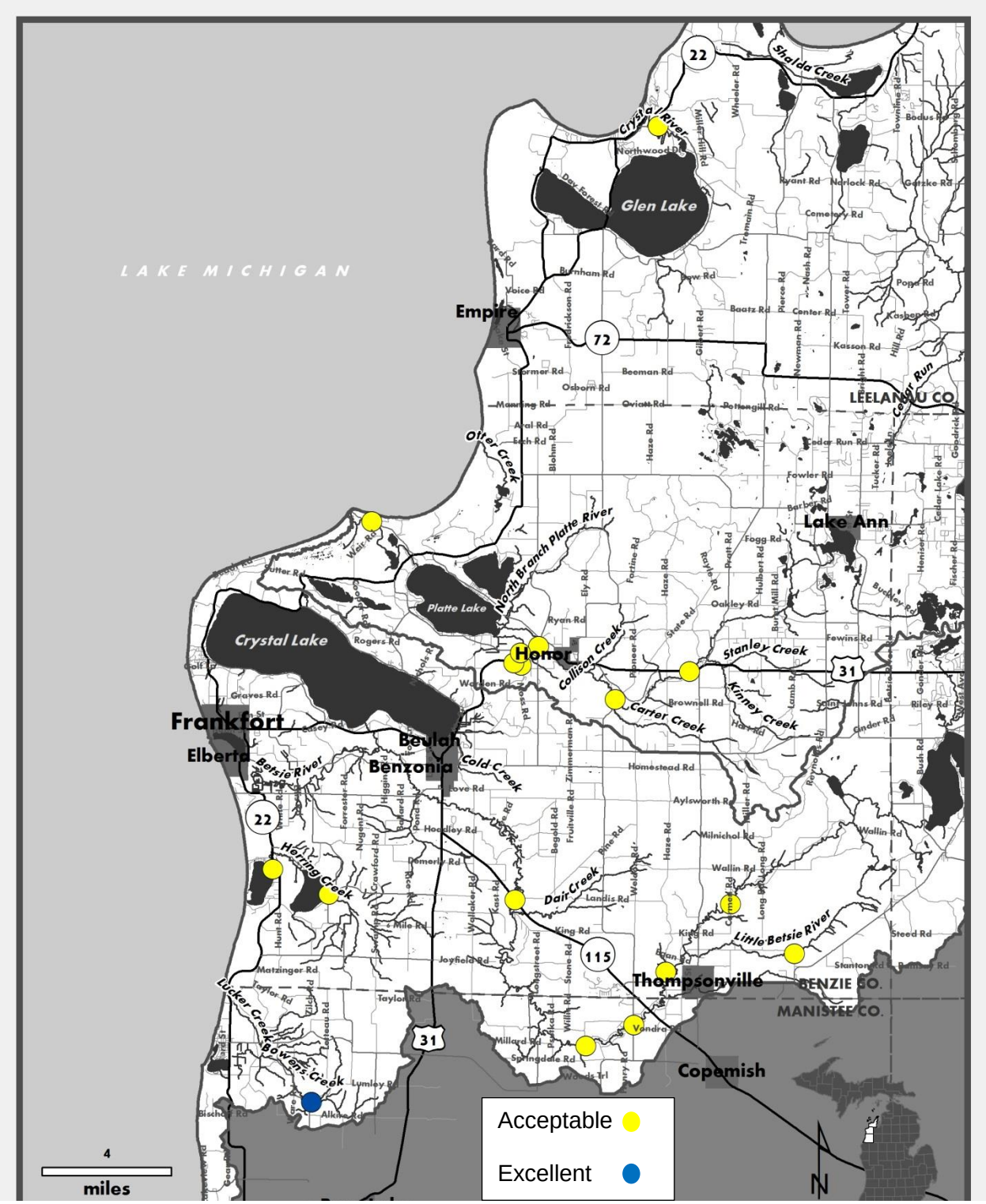

Figure 1. Map of the Platte and Betsie River watersheds and adjacent smaller watersheds. Dots represent macroinvertebrate community survey stations and resultant ratings in June 2013.

Table 4. Summary of the aquatic habitat and macroinvertebrate community evaluations for selected stations in the Platte River and Betsie River and adjacent Lake Michigan coastal watersheds, June 2013.

Station #	Stream Name	Road Crossing	STORET #	County	TRS	Township	Latitude	Longitude	Habitat Rating	Habitat Score	Macroinvertebrate Rating	Macroinvertebrate Score	S/T/Tr	AUID#
1	Crystal River	Crystal View Road/County Road 675	450230	Leelanau	29N14WS23	Glen Arbor	44.90346	-85.96353	Good	131	Acceptable	-1	T	040601040402-02
2	Platte River	Upstream US-31	100222	Benzie	26N14WS02	Benzonia	44.65946	-85.94398	Excellent	169	Acceptable	3	T	040601040205-01
3	Platte River	Pioneer Road (Case Bridge)	100059	Benzie	26N14WS15	Homestead	44.64697	-85.99063	Excellent	157	Acceptable	3	S	040601040205-01
4	Platte River	Indian Hill Road	100061	Benzie	26N14WS08	Homestead	44.37004	-86.03892	Good	134	Acceptable	3	T	040601040205-01
*	East Branch Unnamed Tributary to Platte Lake	off Covey Road	100188	Benzie	26N14WS07	Benzonia	44.66214	-86.04966	Good	145	Acceptable	3	T	040601040206-01
*	West Branch Unnamed Tributary to Platte Lake	Upstream US-31	100192	Benzie	26N14WS07	Benzonia	44.66326	-86.05419	Good	128	Acceptable	-2	T	040601040206-02
*	Unnamed Tributary to Platte Lake	Platte Lake Road	100248	Benzie	26N14WS08	Benzonia	44.66783	-86.05007	Good	135	Acceptable	-3	T	040601040206-02
5	Platte River	Eldorado Park	100251	Benzie	27N15WS20	Lake	44.72649	-86.14364	Excellent	178	Acceptable	1	T	040601040206-NA
6	Little Betsie River	Nessen Road	100242	Benzie	25N13WS27	Colfax	44.53319	-85.87830	Good	147	Acceptable	0	S	040601040303-01
7	Betsie River	Carmen Road	100250	Benzie	25N13WS20	Colfax	44.55536	-85.91827	Excellent	163	Acceptable	3	S	040601040303-01
8	Betsie River	Haze Road	100249	Benzie	25N14WS36	Weldon	44.52499	-85.95891	Excellent	155	Acceptable	3	S	040601040304-01
9	Betsie River	Kurick Road	510117	Manistee	24N14WS02	Springdale	44.50132	-85.97895	Excellent	166	Acceptable	1	T	040601040304-01
10	Betsie River	off Old Grade Road	510255	Manistee	24N14WS09	Springdale	44.49200	-86.00900	Excellent	161	Acceptable	3	Tr	040601040304-01
11	Betsie River	M-115	100078	Benzie	25N14WS19	Weldon	44.55725	-86.05336	Excellent	158	Acceptable	4	S	040601040306-01
12	Herring Creek	Elberta Resort Road	100216	Benzie	25N16WS14	Blaine	44.57077	-86.20513	Excellent	161	Acceptable	1	T	0470601040406-02
13	Herring Creek	Gorivan Rd.	100229	Benzie	25N15WS19	Blaine	44.55957	-86.17014	Good	136	Acceptable	-1	T	040601040406-01
14	Bowens Creek	Iverson Road	510268	Manistee	24N16WS24	Arcadia	44.46668	-86.18077	Good	139	Excellent	5	S	040601040404-NA

S/T/Tr = status, targeted, trend station

* No station number given because data is also presented in a separate report (Lipsey, 2014)

Site Selection

Two site-selection methods were used to assess the Platte River and Betsie River watersheds in 2013: (1) stratified random; and (2) targeted. Seven randomly selected sites were assigned to support the SWAS Status and Trend Program. These sites will be used to estimate the watershed attainment status for the OIALW designated use component of R 323.1100(e) of the Michigan WQS, and the trend stations will be used to facilitate a measurement of biointegrity temporal trends.

The remaining stations within the Platte River and Betsie River watersheds and neighboring coastal watersheds were selected for targeted monitoring to support and answer concerns and questions of stakeholders or staff. Two stations were targeted on the Platte River upstream of US-31 near the Platte River State Fish Hatchery and the Betsie River at Kurick Road because they are long-term trend stations for the MDNR, Fisheries Division, and long-term macroinvertebrate and habitat data will complement the information they have collected. At the time of this report's release, the MDNR data was not yet available (Heather Hettinger, MDNR, Fisheries Division, personal communication, 2015).

Summary of Findings by Monitoring Objective

Objective 1: Assess the current status and condition of individual waters of the state and determine whether Michigan WQS are being met.

In 2013, 12 randomly selected sites within the northwest Michigan watershed group (which includes all watersheds that are tributaries to Lake Michigan from Arcadia Lake north to Mackinaw City; and includes 6 sites within the Platte River and Betsie River watersheds and Bowens Creek) were sampled to support attainment status calculation. Based on the probabilistic monitoring aspect of this watershed group survey, 100 +/- 22 percent of the randomly selected sites supported the OIALW designated use using biological monitoring procedures. Percent attainment was calculated by dividing the number of random sites that met WQS by the total number of random locations ((12 / 12)100 = 100 percent). This value is coupled with a 95 percent confidence interval to provide our estimation of certainty, meaning there is 95 percent certainty that the true proportion of attainment in the northwest Michigan watershed group is between 78 and 100 percent.

In 2013, aquatic macroinvertebrate community and habitat assessments were conducted at 11 additional targeted stations in the Platte River and Betsie River and adjacent Lake Michigan coastal watersheds (Table 4 and Figure 1). The OIALW designated use was being met at all stations. Detail about these random and targeted assessments are summarized below.

UNNAMED TRIBUTARY TO PLATTE LAKE

Three stations were sampled in an unnamed tributary to Platte Lake (Table 1). The three stations had good (slightly impaired) habitat ratings and acceptable macroinvertebrate scores. The lowest score (-3) was found in the west branch of the tributary that is being impacted by groundwater that was contaminated by a food processing waste. A separate report explaining, in detail the situation in this creek and the results of biosurveys and quantitative macroinvertebrate and periphyton community sampling is available (Lipsey, 2014) and therefore the biosurvey stations have not been assigned numbers in this report. Water chemistry results taken in the past indicate arsenic and DO WQS are not being met in that watershed. Details of those results can be found below under Objective 4 and in separate reports (Carpenter, 2013 and 2014).

Table 1. Macroinvertebrate community and habitat scores and ratings for three stations in an unnamed tributary to Platte Lake, Benzie County, Michigan. September 2013.

Station	Stream Name	Road Crossing	STORET #	County	TRS	Township	Latitude	Longitude	Habitat Evaluation		Macroinvertebrate Community		AUID#
									Rating	Score	Rating	Score	
P51a	East Branch Unnamed Tributary to Platte Lake	US-31	100252	Benzie	26N14WS07	Benzonia	44.664890	-86.051450	Good	145	Acceptable	3	040601040206-02
P51b	West Branch Unnamed Tributary to Platte Lake	Upstream of US-31	100192	Benzie	26N14WS07	Benzonia	42.663230	-86.054210	Good	135	Acceptable	-3	040601040206-01
P51c	Unnamed Tributary to Platte Lake	Platte Lake Road	100248	Benzie	26N14WS08	Benzonia	44.667830	-86.050070	Good	128	Acceptable	-2	040601040206-03

STORET # = Is a national database site number identifier
AUID = Assessment Unit Identifier and is based on National Hydrologic Unit Codes

CRYSTAL RIVER

The Crystal River was sampled at Crystal View Road/County Road 675 (Station 1; Table 4) due to a 2008 monitoring request from the Sleeping Bear National Park biologist. The glide/pool habitat was rated good (131; slightly impaired; Table 2). This portion of the river has a large amount of canoe, kayak, and tubing traffic. While sampling, SWAS staff witnessed at least two different groups either portaging the road crossing or using one of the three culverts (three feet in diameter) as conduits under the road. These three culverts do not seem to be allowing sufficient flow to move through them resulting in sediment deposition upstream of the culverts and a very wide channel with a uniform stream bottom lacking pool habitat diversity. It would be a good candidate for replacement with a bridge or larger natural bottom culvert in the future. The riparian area consisted of cedar forests and a grassy area lacking trees. The substrate at this station consisted primarily of sand with silt-laden edges. The velocity of the stream was very slow except where large woody debris was present and the current picks up to expose gravel substrate. The water was relatively warm at 70 degrees Fahrenheit (F). The macroinvertebrate community scored at the lower end of acceptable (-2; Table 3 and 8).

PLATTE RIVER

The Platte River was sampled at 4 stations (2, 3, 4, and 5). The most upstream station 2 was located upstream of US-31 and downstream of the Platte River State Fish Hatchery (Figure 2). This station is also a trend station for the MDNR, Fisheries Division. The riffle run habitat at Station 2 was rated excellent (169; nonimpaired; Table 6). There were a lot of willow trees growing within the stream channel providing large woody debris, rootwads, and habitat structure for pool development and habitat diversity. Cobble and gravel were available for colonization with sand deposition at constricted areas. Silty areas were restricted to the edge. Filamentous algae, emergent, and submergent vegetation were present. The macroinvertebrate community scored at the higher end of acceptable (3; Table 3 and 8).

Figure 2. Station 2, Platte River upstream of US-31 near Veterans Park.

Station 3 was located on the Platte River upstream of Pioneer Road (Case Bridge). The riffle/run habitat was rated excellent (157; nonimpaired; Table 2). The substrate at this station consisted primarily of a flat gravel area with silt and sand concentrated on the outside of the bend among emergent vegetation (Figure 3). The uniform depth of the station meant a lack of habitat complexity and pool depth diversity. The riparian area was fairly intact with the

Figure 3. Station 3. Platte River upstream of Pioneer Road.

exception of a house that had a lawn that was mowed to the edge. The macroinvertebrate community scored at the higher end of acceptable (3; Table 3 and 8).

Station 4 on the Platte River was located just downstream of Honor at Indian Hill Road. This site is sampled by a local volunteer group out of the Benzie County Conservation District. The glide/pool habitat at Station 4 was rated good (134; slightly impaired; Table 9). The majority of the substrate at this station consisted of sand with very little cobble or gravel. Deep fast pools were present where there was large woody debris; however, large woody debris was not common and it was often silt-laden and thus not great habitat for colonization. A large amount of macrophytes, overhanging vegetation, and rootwads were the primary substrate available for colonization of biota. Riprap and cement blocks had been placed on the right bank to help control erosion. The road crossing consisted of two ten-foot culverts, which seemed large enough; however, the angle of the culverts did not seem to match the natural angle of the stream and thus a deep pool was being formed just upstream of the culvert. The riparian area had been impacted by the placement of a home on the right bank with hardened shoreline. On the left bank was a house with mowed lawn and further upstream the riparian area was primarily wetlands. The macroinvertebrate community scored at the higher end of acceptable (3; Table 6 and 11).

Station 5 at El Dorado Park off Lake Michigan Drive was the most downstream station sampled on the Platte River (Figure 4). The riffle/run habitat at was rated excellent (178; nonimpaired;

Figure 4. Station 5, Platte River near the mouth at El Dorado Park, Sleeping Bear Dunes National Park.

Table 5). A mix of habitat types was available for colonization. Clean gravel and cobble and firm sand was present along with backwater areas. There was a large sand deposit on the inside of the bend. The riparian area was intact but the right bank was missing shrubs and grasses. Large woody debris was present, but not abundant. The macroinvertebrate community scored acceptable (1; Table 6 and 11).

LITTLE BETSIE RIVER

The Little Betsie River was sampled at Nessen Road (Station 6). The glide/pool habitat was rated good (147; slightly impaired;

Figure 5. Station 6, Little Betsie River upstream of Nessen Road.

Table 5). The substrate consisted entirely of shifting sand and silt. Large woody debris and overhanging alders were the primary epifaunal substrate, although the large woody debris was deeply embedded in the sand. The riparian area consisted of a very natural cedar/pine forest and swamp (Figure 5). The macroinvertebrate community scored acceptable (0; Table 6 and 11).

BETSIE RIVER

The Betsie River was sampled at five stations (7, 8, 9, 10, and 11; Figure 1, Table 4) in 2013. The most upstream was Station 7 at Carmen Road. The riffle/run habitat was rated excellent (163; nonimpaired;

Figure 6. Station 7, Betsie River upstream of Carmen Road.

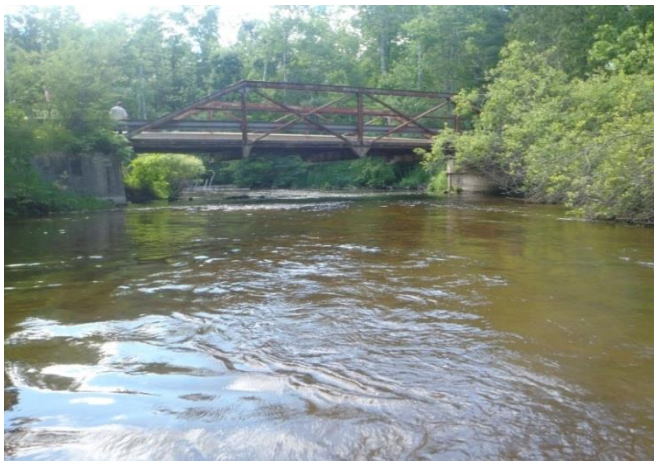

Figure 7. Station 8, Betsie River upstream of Haze Road looking downstream at an old iron bridge crossing.

Table 5). This station consisted of a fast current over clean riffles (Figure 6). The road crossing was an open bottom bridge. The substrate consisted primarily of gravel and cobble with some areas of sand deposition. Large woody debris and aquatic macrophytes were present as well. The riparian area consisted of a steep wooded bank on the left side and a house with a lawn that could be mowed to the edge, but was currently being left to grow. The macroinvertebrate community scored at the higher end of acceptable (3; Table 6 and 11).

Station 8 was sampled upstream of an old iron bridge at Haze Road (Figure 7). The riffle/run habitat was rated excellent (155; nonimpaired; Table 8). The habitat consisted of undercut banks, submerged logs, and cobble with a very unstable sandy area at the lower portion of the station. There was a fair amount of large woody debris with some embedded in the sand. The riparian area consisted of open area that was lacking large trees. It looked as if it was cleared at one point in time. The macroinvertebrate community scored at the higher end of acceptable (3; Table 9 and 14).

Figure 8. Station 10, Betsie River on private property off of Old Grade Road.

Station 9 was sampled at Kurick Road. This is the MDNR, Fisheries Division, fixed trend station for the Betsie River watershed. The road crossing consisted of four culverts, each four-feet in diameter, with a large woody debris pile present upstream of the crossing. The riffle/run habitat was rated excellent (166; nonimpaired; Table 8). The habitat consisted of undercut banks and a bit of cobble and gravel embedded in clay. There was a fairly large amount of clay (30 percent of substrate) at this station, which was unique for this watershed. In places where the banks were eroded the adjacent pools were deep. There was not as much sand substrate present at this station when compared to more upstream stations. Large woody debris was present but not in large quantities. It appeared that past stabilization efforts had been made at this station, but all that remained were the stakes that held the wood. This station has extremely high sloping banks to the road and may be a potential source of sedimentation from erosion. The riparian area consisted of a house on a high bluff as well as wooded area. The macroinvertebrate community scored as acceptable (1; Table 9 and 14).

Station 10 is located off of Old Grade Road at the Matousek residence. Permission was granted to sample this trend station. The riffle/run habitat was rated excellent (161; nonimpaired; Table 8). The habitat consisted of submerged logs, macrophytes, cobble, gravel, sand, and silt. Undercut banks were missing as well as slow deep areas. There were some portions of the bank eroding on the right side at the bends. On the left side riprap had

Figure 9. Station 11, Betsie River upstream of M-115.

been placed against the bank to save houses that were present (Figure 8). On the right side, the riparian area consisted of a pine and hardwood mix forest. The left side had a grassy wetland area that was naturally missing large trees and further downstream houses were located on the high banks. The macroinvertebrate community scored at the higher end of acceptable (3; Table 9 and 14).

Station 11 at M-115 was the most downstream station sampled on the Betsie River. The riffle/run habitat was rated excellent (158; nonimpaired; Table 8). The substrate consisted of gravel and cobble in the middle of the channel where the stream velocity was high, but there were a lot of silt and clay areas along the edges. In one area where a large woody debris dam was slowing down the stream velocity, more than three feet of shifting sand had accumulated. Aquatic vegetation was present, but only along the edges. The water was much more turbid at this station in comparison to the clear water observed at all stations sampled upstream and the stream channel was very straight (Figure 9). The riparian area consisted of cedar/pine forest with lots of moss present in the low valley. The macroinvertebrate community scored at the high end of acceptable (4; Table 9 and 14). This is the highest scoring station in the Betsie River watershed.

CRYSTAL LAKE OUTLET

The outlet of Crystal Lake was observed at M-115 in both June and September 2013 and at Mollineaux Road in September 2013. In June, SWAS staff observed extremely high flows at M-115 and in September, observed almost no flow at Mollineaux Road and M-115. This is the result of a lake level control structure downstream of Mollineaux Road. Any observations of the macroinvertebrate community would be impacted by this lake level control structure and could not be related to regulated pollutants. Therefore, it was not sampled for the OIALW designated use attainment.

HERRING CREEK

Herring Creek is located south of Frankfort and is a tributary to Upper and Lower Herring Lakes (Figure 10). It was sampled at two stations and a third station was only observed and photographed. Station 12 was sampled at Elberta Resort Road, which is located just upstream of Lower Herring Lake. This station was targeted because although volunteer monitoring noted it scored excellent in 2012, it scored acceptable (0) in 2003 (Zbytowski, 2007a). In 2013, the riffle/run habitat was rated excellent (161; nonimpaired; Table 11) and the macroinvertebrate community

Figure 10. Station 12, Herring Creek upstream of Elberta Resort Road.

scored acceptable (0; Table 12 and 17). The substrate was dominated by clean gravel. The station had a large area that was exposed to the sun and periphyton was abundant as would be expected (Figure 10). Overhanging vegetation and rootwads were also available substrate for biota but large woody debris was sparse. The riparian areas consisted of cedars and birch with houses present further upland on the left side, and on the right side houses with lawns mowed up the edge were abundant. The water was very warm at 73 degrees Fahrenheit.

Station 13 was located further upstream on Herring Creek at Gorivan Road, which is very close to the confluence with Upper Herring Lake. The glide/pool habitat was rated good (136; slightly impaired; Table 11). The substrate consisted entirely of silt and sand and it was often knee deep. Elodea was present in 70 percent of the channel. The banks were fairly steep and SWAS staff sampled upstream of a small tributary and deep pool. Large woody debris was present but often embedded deep in the sand. The stream was extremely cold at 57 degrees Fahrenheit, which is substantially cooler than Station 12 located downstream of Upper Herring Lake. The wetland riparian area consisted of mostly tag alders and red osier dogwood (Figure 11). The macroinvertebrate community scored acceptable (-1; Table 12 and 17). Herring Creek was also observed at Puttney Road, Blaine Township, Benzie County, and is discussed in detail below under Objective 3.

Figure 11. Station 13, Herring Creek upstream of Gorivan Road.

<u>BOWENS CREEK</u>

Station 14 was sampled in Bowens Creek off Iverson Road. According to the residents who live up the hill on the east side of the road, the stream had new culverts installed at Iverson Road and the road was relocated in 2012. To reach this site we crossed under a green gate on an old road running perpendicular to Iverson Road, and then headed south in a cleared area to a path that runs past some ponds

Figure 12. Station 14, Bowens Creek off Iverson Road.

(which are likely remnants of the mill). SWAS staff sampled upstream of these ponds. If Bowens Creek was sampled at Iverson Road, it would be downstream of these ponds and would not be representative of the stream reach.

The riffle/run habitat at Station 14 was rated good (139; slightly impaired; Table 11). Bowens Creek is a very cold (53 degrees Fahrenheit), spring-fed stream. Shifting sand dominated the substrate and was as deep as 1.5 feet in places. Leaf packs, undercut banks, and large woody debris were available for biota. The large woody debris made the "riffles" in this reach (Figure 12). The macroinvertebrate community scored at excellent (5; Table 12 and 17). This station was the only one sampled and reported here that scored excellent. Two families of stonefly were present with one family *(Nemouridae*) being the second most dominant family. This stream should be considered as a possible priority for protection in this watershed considering the relatively high percentage of agricultural land use (20 percent) and lost wetlands (9 percent; Table 4) for this area of the state and the fact that sedimentation of the epifuanal substrate is very severe and likely to impact the macroinvertebrate community over time.

While writing this report, it came to staff's attention that in 2011 several culverts were replaced in the upper parts of this watershed and that the lower portion of Bowens Creek was redirected into its original watercourse by plugging five diversion ditches (LRBOI, 2013). No other MDEQ data are available for Bowens Creek. The Little River Band of Ottawa Indians' 2013 report indicates that designated use attainment should be assessed in the restored channel because they obtained a -5 (poor) Procedure 51 score in 2013; however, the stream had not yet recovered from restoration activities. It would be beneficial to determine the OIALW designated use support in the restored section as well as at St. Pierre Road upstream of the restored section.

Figure 13. Station 1, Crystal River upstream of Crystal View Road looking downstream at crossing.

Objective 2: Satisfy monitoring requests submitted by internal and external customers.

Sampling of the Platte River downstream of M-22 and the Crystal River downstream of Glen Lake was requested in 2007 due to Sleeping Bear National Park staff having concerns regarding heavy recreational use of both rivers for canoeing, kayaking, and tubing. Both stations were sampled and received acceptable macroinvertebrate community ratings and good habitat ratings (Tables 6-11).

As previously noted, the Crystal River at Crystal View Road/County Road 675 is in need of a replacement stream crossing (Figure 13). SWAS staff witnessed people either portaging the road crossing or using one of the three culverts (three feet in diameter) as conduits under the road.

Macroinvertebrate community and habitat sampling occurred in the Platte River upstream of US-31 (Station 2) and in the Betsie River upstream of Kurick Road (Station 9). These stations are MDNR, Fisheries Division, fixed targeted monitoring and index stations, respectively. Macroinvertebrate community and habitat data will complement the fish community information collected on a regular basis at these stations. The macroinvertebrate community rating at Station 2 on the Platte River was acceptable tending towards excellent (Table 3 and 8). The riffle run habitat at Station 2 was rated excellent (Table 2). The MDNR Platte River Hatchery has discharged for several years upstream of this site. The MDNR has worked extremely hard to reduce total phosphorus levels in their discharge, but it is likely that historic discharges led to an increase in nutrients in the stream sediment that allows for plant growth. Filamentous algae, emergent, and submergent vegetation were present, but not at nuisance conditions.

The macroinvertebrate community in the Betsie River at Kurick Road was also rated as acceptable (Table 9 and 14) and the habitat was rated as good (Table 8). As noted above, erosion from the road crossing may be a concern, as well as the size of the multiple culverts and should be further evaluated.

Objective 3: Identify NPS of water quality impairment.

The following NPS issues were observed or investigated in the 2012 sampling season. Locations are noted in Figure 1 and

Table .

CRYSTAL RIVER AT CRYSTAL VIEW ROAD/ COUNTY ROAD 675

The road crossing is in critical need of replacement. While sampling, SWAS staff witnessed at least two different groups either portaging the road crossing or using one of the three culverts (three feet in diameter) as conduits under the road. These three culverts do not seem to be allowing sufficient flow to move through them resulting in sediment deposition upstream of the culverts and a very wide channel with a uniform stream bottom lacking pool habitat diversity. It would be a good candidate for replacement with a bridge or larger natural bottom culvert.

PLATTE RIVER AT INDIAN HILL ROAD

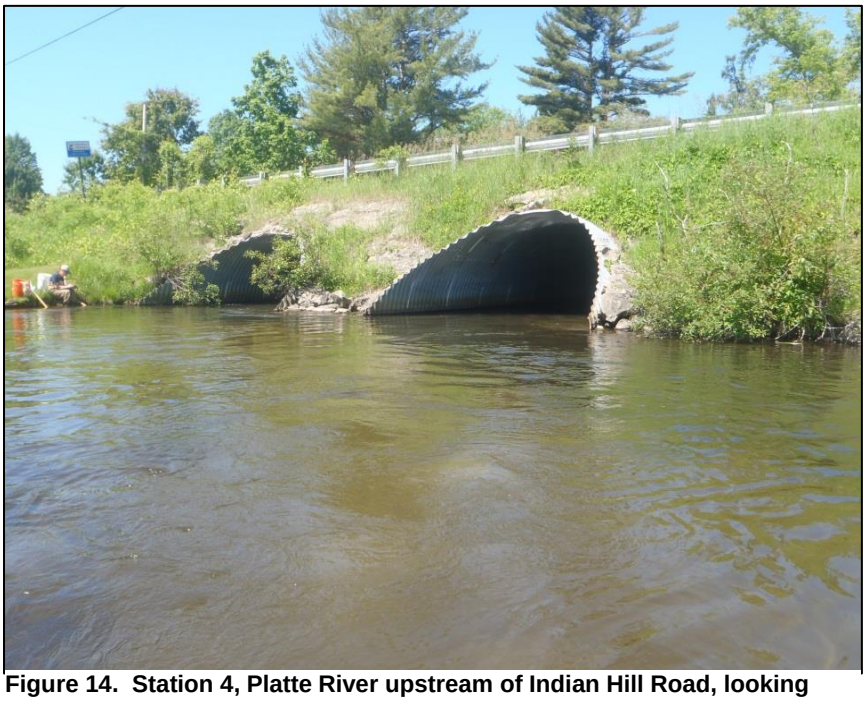

Figure 14. Station 4, Platte River upstream of Indian Hill Road, looking downstream at road crossing.

The road crossing consisted of two ten-foot culverts, which seemed sufficiently large; however, the angle of the culverts did not seem to match the natural angle of the stream and thus a deep pool was being formed just upstream of the culvert (Figure 14). Riprap and cement blocks had been placed on the right bank to help control erosion. The majority of the substrate at this station consisted of sand with very little cobble or gravel and woody debris was silt laden. The erosion and sedimentation is likely, at least partially, due to the misalignment of the culverts.

BETSIE RIVER AT KURICK ROAD

Figure 15. Station 9, Betsie River upstream of Kurick Road looking downstream with a four-culvert road crossing.

Substrate at this station included clay, which has led to bank erosion. It appeared that past stabilization efforts had been made at this station, but all that remained were the stakes that held the wood. This station has extremely high sloping banks to the road and may be a potential source of sedimentation from

erosion. The crossing consists of four culverts approximately six feet in diameter (Figure 15). A timber bridge or other large, open-bottomed culvert would likely help with large woody debris and water backing up during high flows.

Figure 16. Tributary to Herring Creek at Puttney Road. Trampling of banks from livestock evident.

HERRING CREEK AT PUTTNEY ROAD

Herring Creek was observed at Puttney Road, Blaine Township, Benzie County. At this site there was extensive unrestricted cattle access to Herrin

g Creek and multiple small intermittent tributaries (Figures 16-18). Trampling of banks from multiple animals is causing bank erosion and subsequent sedimentation to the stream. The potential for *E. coli* contamination and exceedances of the partial and total body contact recreation designated uses is extremely high. Biosurvey reports indicated livestock access has been a problem for more than ten years. This information was passed on to NPS district staff who indicated that local watershed residents are aware of the access and are trying to work with the landowners to address the issues. The landowners are agreeable to fixing the issues if someone can provide funding. Watershed residents indicated that agricultural staff were working to find funding as of 2013. In addition, NPS district staff indicated that Herring Creek has a Watershed Management Plan that has identified agriculture as the single biggest pollutant contributor. The watershed partners are encouraging the agricultural community to be involved and identify what Best Management Practices (BMP) should be included and installed to address the problems. This site should be revisited in 2018 or earlier to determine if any progress has been made in regards to installing BMPs and reducing livestock access to the stream. If nothing has been implemented, *E. coli* sampling should be conducted to determine WQS attainment of the partial and total body contact recreation designated uses.

Figure 17. Tributary to Herring Creek at Puttney Road. Bare soil along banks due to livestock access.

Figure 18. Herring Creek at Puttney Road. Evidence of recent access of livestock to long stretch of stream.

Objective 4: Gather water quality data needed for FY 2013 and FY 2014 TMDL development or delisting.

WEST BRANCH OF UNNAMED TRIBUTARY TO PLATTE LAKE

The unnamed tributary to Platte Lake had good (slightly impaired) habitat ratings and acceptable macroinvertebrate scores. The lowest score (-3; acceptable; Tables 4 and 5) was found in the west branch of the tributary that is being impacted by groundwater that was contaminated by food processing waste (Figure 19). A separate report explaining in detail the results of these Procedure 51 biosurveys and additional quantitative macroinvertebrate and periphyton community sampling is available (Lipsey, 2014). DO and BOD sampling indicated the west branch of the unnamed tributary was not meeting the 7.0 milligrams per liter minimum DO WQS (Carpenter, 2013). Sampling in 2014 indicated that water from one sample from the west branch did not meet the WQS of 10 parts per billion for arsenic. Unnatural color, bacterial slimes, and odor also remained a problem (Carpenter, 2014). The west branch of the unnamed tributary to Platte Lake will remain on the Section 303(d) nonattainment list [Goodwin et al., 2014 and 2016 (in draft)] but is listed as Category 4b (meaning that pollution control mechanisms are in place and are reasonably expected to result in attainment of the designated use within a practical time frame) because enforcement and remediation efforts are currently taking place.

Figure 19. Groundwater seep area to west branch of unnamed tributary to Platte Lake, upstream of US-31. Note reddish/brown color of bacterial slimes on substrate.

BOWENS CREEK AT ST. PIERRE ROAD

While writing this report, we became aware that in 2011 several culverts were replaced in the upper parts of this watershed and that the lower portion of Bowens Creek was redirected into its original watercourse by plugging five diversion ditches (LRBOI, 2013). No other MDEQ data are available for Bowens Creek. The Little River Band of Ottawa Indians' report indicates that designated use attainment should be assessed in the restored channel because they obtained a poor (-5) score (MDEQ, 1990) in 2013, yet the stream had not recovered from restoration activities. It would be beneficial to determine the OIALW designated use support at St. Pierre Road and within the restored reach, post recovery.

Objective 5: Evaluate biological integrity temporal trends.

One station (Station 10;

Table , Figure 1) within the Platte River watershed was randomly selected as a trend station and will be sampled every five years. Station 10 is located off of Old Grade Road. The riffle/run habitat was rated excellent. The macroinvertebrate community scored acceptable tending towards excellent (Table 9 and 14). When sufficient data have been collected, trend information will be presented in a separate report.

Conclusions and Future Monitoring Recommendations

The Platte and Betsie River watersheds have a relatively large amount of wetlands and other natural areas remaining compared to other watersheds in the state. The land use quality is directly related to the high quality habitat and macroinvertebrate communities found in these watersheds. However, NPS pollution issues such as improper placement or undersizing of culverts at road crossings (e.g. Crystal River at Crystal View Road, Platte River at Indian Hill Road, and Betsie River at Kurick Road) and livestock access to Herring Creek, should be addressed as they are likely to lead to sedimentation and habitat destruction as well as pathogen contamination and thus a reduction in water quality. It should be noted that although habitat and macroinvertebrate communities sampled at stations in this report were rated at the high end of acceptable (scores 0-4), only Bowens Creek off of Iverson Road scored excellent (5;

Table). This lower number of excellent scores is not unusual for watersheds in the NCHF ecoregion, but does differ from other high quality northern Michigan watersheds in the Northern Lake and Forest ecoregion.

Herring Creek should be revisited in 2018 or earlier to determine if any progress has been made in regards to installing BMPs and reducing livestock access to the stream. If nothing has been implemented, *E. coli* sampling should be conducted to determine WQS attainment of the partial and total body contact recreation designated uses.

Bowens Creek should be sampled in 2018 to determine the OIALW designated use support at St. Pierre Road and within the reach that BMPs were implemented and stream restoration was attempted. Prior to the station sampled in 2013, Bowens Creek has not been sampled by SWAS staff. In addition, Bowens Creek off of Iverson Road should be considered by local watershed groups as a possible priority for protection. The macroinvertebrate community at Station 14 was the only station reported here that was rated as excellent in 2013. The Bowens Creek watershed has a relatively high percentage of agricultural land use (20 percent) and lost wetlands (9 percent; Table 3) for this area of the state.

Unnamed Tributary to Platte Lake

Water quality and biological community data is being collected and submitted annually by the responsible party of the contaminated groundwater venting to the west branch of the Unnamed Tributary to Platte Lake. SWAS staff should review this information prior to 2018 sampling. It will be nearly five years since an air sparge system has been installed to remediate the contaminated groundwater and additional monitoring of biological communities or chemical parameters by MDEQ staff may be needed at that time to determine if WQS are being met.

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Table 2. Habitat evaluation for selected stations in the Crystal and Platte River watershed, Leelanau and Benzie Counties, June 2013.

	Crystal River @	Platte River @	Platte River @
	Crystal View Road	**Upstream of US-31**	**Pioneer Road (Case Bridge)**
	GLIDE/POOL	**GLIDE/POOL**	**RIFFLE/RUN**
	Station 1	**Station 2**	**Station 3**
HABITAT METRIC			
Substrate and Instream Cover			
Epifaunal Substrate/ Available Cover (20)	13	11	17
Embeddedness (20)*			15
Velocity/Depth Regime (20)*			9
Pool Substrate Characterization (20)**	16	11	
Pool Variability (20)**	8	11	
Channel Morphology			
Sediment Deposition (20)	8	4	16
Flow Status - Maintenance Flow Volume (10)	9	10	10
Flow Status - Flashiness (10)	7	10	10
Channel Alteration (20)	15	16	18
Frequency of Riffles/Bends (20)*			12
Channel Sinuosity (20)**	7	12	
Riparian and Bank Structure			
Bank Stability (L) (10)	8	9	9
Bank Stability (R) (10)	6	8	10
Vegetative Protection (L) (10)	9	8	6
Vegetative Protection (R) (10)	6	9	10
Riparian Vegetative Zone Width (L) (10)	10	9	5
Riparian Vegetative Zone Width (R) (10)	9	6	10
TOTAL SCORE (200):	**131**	**134**	**157**
HABITAT RATING:	**GOOD (SLIGHTLY IMPAIRED)**	**GOOD (SLIGHTLY IMPAIRED)**	**EXCELLENT (NON-IMPAIRED)**
Date:	6/21/2013	6/20/2013	6/20/2013
Weather:	Cloudy	Sunny	Sunny
Air Temperature: ºF	73	75	75
Water Temperature: ºF	70	60	68
Average Stream Width: Feet	70	72	70
Average Stream Depth: Feet	1	3	1.5
Surface Velocity: Feet/Second	0.83	1.25	1.7
Estimated Flow: Cubic Feet/Second	58.1	270	178.5
Stream Modifications:	None	None	Canopy Removal
Nuisance Plants (Y/N):	N	N	N
STORET No.:	100192	100061	100248
County Code:	45	10	10
TRS:	29N14W23	26N14W31	26N14W15
Latitude (dd):	44.903139	44.70402	44.64697
Longitude (dd):	-85.962722	-86.04295	-85.99063
Ecoregion:	NCHF	NCHF	NCHF
Stream Type:	Coldwater	Coldwater	Coldwater
USGS Basin Code:	4060104	4060104	4060104

*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 3. Qualitative macroinvertebrate community sampling results at selected stations in the Crystal and Platte River watershed, Leelanau and Benzie Counties, June 2013.

	Crystal River @ Crystal View Road 6/21/2013	Platte River @ Upstream US- 31 6/20/2013	Platte River @ Pioneer Road (Case Bridge) 6/20/2013
TAXA	**Station 1**	**Station 2**	**Station 3**
PORIFERA (sponges)	1		
PLATYHELMINTHES (flatworms)			
Turbellaria			1
ANNELIDA (segmented worms)			
Hirudinea (leeches)	1	1	1
Oligochaeta (worms)	3	16	28
ARTHROPODA			
Crustacea			
Amphipoda (scuds)	103		19
Decapoda (crayfish)	2	1	1
Isopoda (sowbugs)	21		25
Arachnoidea			
Hydracarina	1	3	4
Insecta			
Ephemeroptera (mayflies)			
Baetidae	1	15	53
Caenidae	5		
Ephemerellidae		23	15
Ephemeridae			1
Heptageniidae	8	5	2
Leptophlebiidae		2	
Odonata			
Anisoptera (dragonflies)			
Aeshnidae	4	2	
Gomphidae	1		
Zygoptera (damselflies)			
Calopterygidae	5	1	
Coenagrionidae	3		
Plecoptera (stoneflies)			
Nemouridae			7
Perlidae	4		
Perlodidae		3	
Hemiptera (true bugs)			
Gerridae	1		1
Megaloptera			
Corydalidae (dobson flies)	1	1	
Sialidae (alder flies)			1
Trichoptera (caddisflies)			
Brachycentridae		35	46
Glossosomatidae			
Helicopsychidae		4	2
Hydropsychidae		58	3
Lepidostomatidae		1	4
Leptoceridae	3	5	5
Limnephilidae	1	1	
Molannidae		1	5
Philopotamidae		1	9
Polycentropodidae	1	1	1
Uenoidae		1	

	Crystal River @ Crystal View Road 6/21/2013	Platte River @ Upstream US- 31 6/20/2013	Platte River @ Pioneer Road (Case Bridge) 6/20/2013
TAXA	**Station 1**	**Station 2**	**Station 3**
Coleoptera (beetles)			
Haliplidae (adults)			1
Hydrophilidae (total)			
Elmidae	2	4	1
Diptera (flies)			
Athericidae			1
Ceratopogonidae	1	2	
Chironomidae	72	107	48
Simuliidae		6	16
Tabanidae		3	1
Tipulidae		1	
MOLLUSCA			
Gastropoda (snails)			
Bithyniidae	35	1	
Hydrobiidae	6	1	1
Physidae		2	2
Planorbidae	1		
Pelecypoda (bivalves)			
Dreissenidae	1		
Sphaeriidae (clams)	3	4	1
Unionidae (mussels)	1		
TOTAL INDIVIDUALS	292	312	306

Table 4. Macroinvertebrate metric evaluation of selected stations in the Crystal and Platte River watershed, Leelanau and Benzie Counties, June 2013.

	Crystal River @ Crystal View Road 6/21/2013		Platte River @ Upstream US-31 6/20/2013		Platte River @ Pioneer Road (Case Bridge) 6/20/2013	
	Station 1		**Station 2**		**Station 3**	
METRIC	Value	Score	Value	Score	Score	Value
TOTAL NUMBER OF TAXA	29	1	32	1	1	1
NUMBER OF MAYFLY TAXA	3	0	4	0	0	0
NUMBER OF CADDISFLY TAXA	3	0	10	1	0	1
NUMBER OF STONEFLY TAXA	1	0	1	0	0	0
PERCENT MAYFLY COMPOSITION	4.79	-1	14.42	0	-1	0
PERCENT CADDISFLY COMPOSTITION	1.71	-1	34.62	0	-1	0
PERCENT DOMINANT TAXON	35.27	0	34.29	0	17.32	1
PERCENT ISOPOD, SNAIL, LEECH	21.92	-1	1.60	0	9.48	-1
PERCENT SURFACE AIR BREATHERS	0.34	1	0.00	1	0.65	1
TOTAL SCORE		-1		3		3
MACROINVERTEBRATE COMMUNITY RATING	ACCEPTABLE		ACCEPTABLE		ACCEPTABLE	

Table 5. Habitat evaluation for selected stations in the Platte and Betsie River watersheds, Benzie County, June 2013.

	Platte River @ Indian Hill Road **GLIDE/POOL**	Platte River @ Eldorado Park **RIFFLE/RUN**	Little Betsie River @ Nessen Road **GLIDE/POOL**	Betsie River @ Carmen Road **RIFFLE/RUN**
	Station 4	**Station 5**	**Station 6**	**Station 7**
HABITAT METRIC				
Substrate and Instream Cover				
Epifaunal Substrate/ Available Cover (20)	11	18	5	18
Embeddedness (20)*		18		16
Velocity/Depth Regime (20)*		20		15
Pool Substrate Characterization (20)**	11		6	
Pool Variability (20)**	11		17	
Channel Morphology				
Sediment Deposition (20)	4	13	5	12
Flow Status - Maintenance Flow Volume (10)	10	10	10	10
Flow Status - Flashiness (10)	10	10	9	8
Channel Alteration (20)	16	18	19	18
Frequency of Riffles/Bends (20)*		17		18
Channel Sinuosity (20)**	12		16	
Riparian and Bank Structure				
Bank Stability (L) (10)	9	10	10	8
Bank Stability (R) (10)	8	8	10	9
Vegetative Protection (L) (10)	8	9	10	8
Vegetative Protection (R) (10)	9	8	10	9
Riparian Vegetative Zone Width (L) (10)	9	10	10	10
Riparian Vegetative Zone Width (R) (10)	6	9	10	4
TOTAL SCORE (200):	134	178	147	163
HABITAT RATING:	**GOOD (SLIGHTLY IMPAIRED)**	**EXCELLENT (NON-IMPAIRED)**	**GOOD (SLIGHTLY IMPAIRED)**	**EXCELLENT (NON-IMPAIRED)**
Date:	6/20/2013	6/20/2013	6/18/2013	6/18/2013
Weather:	Sunny	Sunny	Sunny	Sunny
Air Temperature: ºF	75	65	70	65
Water Temperature: ºF	60	66	59	64
Average Stream Width: Feet	72	46	30	61
Average Stream Depth: Feet	3	2	0.3	3
Surface Velocity: Feet/Second	1.25	1.25	0.83	0.6
Estimated Flow: Cubic Feet/Second	270	115	7.47	109.8
Stream Modifications:	None	None	None	None
Nuisance Plants (Y/N):	N	N	N	N
STORET No.:	100061	100251	100242	100250
County Code:	10	10	10	10
TRS:	27N14W08	27N15W20	25N13W27	25N13W20
Latitude (dd):	44.37004	44.72649	44.5331	44.55536
Longitude (dd):	-86.03892	-86.14364	-85.8782	-85.91827
Ecoregion:	NCHF	NCHF	NCHF	NCHF
Stream Type:	Coldwater	Coldwater	Coldwater	Coldwater
USGS Basin Code:	4060104	4060104	4060104	4060104

*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 community sampling results at selected stations in the Platte and Betsie watershed, Benzie County, June 2013.

	North Branch Platte River @ Downstream Indian Hill Road 6/20/2013	Platte River @ Eldorado Park 6/20/2013	Little Betsie River @ Nessen Road 6/18/2013	Betsie River @ Carmen Road 6/18/2013
TAXA	**Station 4**	**Station 5**	**Station 6**	**Station 7**
ANNELIDA (segmented worms)				
Hirudinea (leeches)	1			
Oligochaeta (worms)	10	3	4	4
ARTHROPODA				
Crustacea				
Amphipoda (scuds)	3	22	39	4
Decapoda (crayfish)	1	1		9
Isopoda (sowbugs)	6	2		33
Arachnoidea				
Hydracarina	14	2	3	3
Insecta				
Ephemeroptera (mayflies)				
Baetiscidae	1	1		
Baetidae	1	5	60	13
Ephemerellidae	15	11		14
Ephemeridae	6	1		
Heptageniidae	4	3		13
Isonychiidae				1
Leptophlebiidae	2			
Odonata				
Anisoptera (dragonflies)				
Aeshnidae	2	1	1	1
Cordulegastridae				1
Gomphidae		1		3
Macromiidae		2		
Zygoptera (damselflies)				
Calopterygidae	4		3	6
Coenagrionidae		1		
Plecoptera (stoneflies)				
Perlidae	1	23		9
Perlodidae	1		2	
Hemiptera (true bugs)				
Corixidae	1			
Gerridae			1	1
Megaloptera				
Corydalidae (dobson flies)			2	2
Sialidae (alder flies)	1			
Trichoptera (caddisflies)				
Brachycentridae	77		41	5
Helicopsychidae	9		1	2
Hydropsychidae	8	45	33	32
Hydroptilidae	1			
Lepidostomatidae	36		12	3
Leptoceridae	4	1	7	8
Limnephilidae		2	3	7
Philopotamidae		1		3
Polycentropodidae	1			1
Psychomyiidae	1			
Uenoidae				1
Coleoptera (beetles)				

	North Branch Platte River @ Downstream Indian Hill Road 6/20/2013	Platte River @ Eldorado Park 6/20/2013	Little Betsie River @ Nessen Road 6/18/2013	Betsie River @ Carmen Road 6/18/2013
TAXA	**Station 4**	**Station 5**	**Station 6**	**Station 7**
Gyrinidae (adults)		1		
Haliplidae (adults)	1			
Hydrophilidae (total)	1	1		1
Elmidae		5		18
Diptera (flies)				
Athericidae	1			
Ceratopogonidae	1	4	2	1
Chironomidae	70	83	97	37
Ptychopteridae	1		6	
Simuliidae	4	3	32	10
Tabanidae	2		1	3
MOLLUSCA				
Gastropoda (snails)				
Ancylidae (limpets)		1		
Bithyniidae		18		20
Hydrobiidae				1
Physidae	1	1	7	
Pelecypoda (bivalves)				
Dreissenidae		1		
Sphaeriidae (clams)	7	4	26	6
Unionidae (mussels)		1		
TOTAL INDIVIDUALS	300	251	383	276

Table 7. Macroinvertebrate metric evaluation of selected stations in the Platte and Betsie River watersheds, Benzie County, June 2013.

	North Branch Platte River Downstream Indian Hill Road 6/20/2013		Platte River Eldorado Park 6/20/2013		Little Betsie River Nessen Road 6/18/2013		Betsie River Carmen Road 6/18/2013	
	Station 4		**Station 5**		**Station 6**		**Station 7**	
METRIC	Value	Score	Value	Score	Value	Score	Value	Score
TOTAL NUMBER OF TAXA	36	1	31	1	22	0	34	1
NUMBER OF MAYFLY TAXA	6	1	5	1	1	-1	4	0
NUMBER OF CADDISFLY TAXA	8	1	4	0	6	1	9	1
NUMBER OF STONEFLY TAXA	2	1	1	0	1	0	1	0
PERCENT MAYFLY COMPOSITION	9.67	-1	8.37	-1	15.67	0	14.86	0
PERCENT CADDISFLY COMPOSTITION	45.67	1	19.52	0	25.33	0	22.46	0
PERCENT DOMINANT TAXON	25.67	0	33.07	0	25.33	0	13.41	1
PERCENT ISOPOD, SNAIL, LEECH	2.67	-1	8.76	-1	1.83	0	19.57	-1
PERCENT SURFACE AIR BREATHERS	1.33	0	0.80	1	1.83	0	0.72	1
TOTAL SCORE		3		1		0		3
MACROINVERTEBRATE COMMUNITY RATING	ACCEPTABLE		ACCEPTABLE		ACCEPTABLE		ACCEPTABLE	

Table 8. Habitat evaluation for selected stations in the Betsie River watershed, Benzie County, June 2013.

	Betsie River @ Haze Road RIFFLE/RUN	Betsie River @ Kurick Road RIFFLE/RUN	Betsie River @ Off Old Grade Road (Private Property) RIFFLE/RUN	Betsie River @ M-115 (West Crossing) RIFFLE/RUN
	Station 8	**Station 9**	**Station 10**	**Station 11**
HABITAT METRIC				
Substrate and Instream Cover				
Epifaunal Substrate/ Available Cover (20)	15	14	16	14
Embeddedness (20)*	13	17	15	11
Velocity/Depth Regime (20)*	18	15	16	19
Pool Substrate Characterization (20)**				
Pool Variability (20)**				
Channel Morphology				
Sediment Deposition (20)	8	14	15	8
Flow Status - Maintenance Flow Volume (10)	10	10	9	10
Flow Status - Flashiness (10)	9	6	9	9
Channel Alteration (20)	17	18	16	17
Frequency of Riffles/Bends (20)*	19	18	18	15
Channel Sinuosity (20)**				
Riparian and Bank Structure				
Bank Stability (L) (10)	8	6	8	8
Bank Stability (R) (10)	8	8	6	9
Vegetative Protection (L) (10)	7	10	8	9
Vegetative Protection (R) (10)	7	10	9	9
Riparian Vegetative Zone Width (L) (10)	9	10	8	10
Riparian Vegetative Zone Width (R) (10)	7	10	8	10
TOTAL SCORE (200):	155	166	161	158
HABITAT RATING:	**EXCELLENT (NON-IMPAIRED)**	**EXCELLENT (NON-IMPAIRED)**	**EXCELLENT (NON-IMPAIRED)**	**EXCELLENT (NON-IMPAIRED)**
Date:	6/18/2013	6/19/2013	7/19/2013	6/19/2013
Weather:	Sunny	Sunny	Partly Cloudy	Sunny
Air Temperature: °F	73	55	80	65
Water Temperature: °F	68	61	71	60
Average Stream Width: Feet	60	45	35	45
Average Stream Depth: Feet	2	3	2.75	3
Surface Velocity: Feet/Second	1.7	1.7	1.7	1.25
Estimated Flow: Cubic Feet/Second	204	229.5	163.625	168.75
Stream Modifications:	None	None	None	None
Nuisance Plants (Y/N):	N	N	N	N
STORET No.:	100249	510117	510255	100078
County Code:	10	51	51	10
TRS:	25N14W36	24N14W2	24N14W09	25N14W19
Latitude (dd):	44.52499	44.5013168	44.49317	44.55711
Longitude (dd):	-85.95891	-85.97895	-86.00453	-86.05376
Ecoregion:	NCHF	NCHF	NCHF	NCHF
Stream Type:	Coldwater	Coldwater	Coldwater	Coldwater
USGS Basin Code:	4060104	4060104	4060104	4060104

*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 9. Qualitative macroinvertebrate community sampling results at selected stations in the Betsie River watershed, Benzie County, June 2013.

	Betsie River @ Haze Road 6/18/2013	Betsie River @ Kurick Road 6/19/2013	Betsie River @ Off Old Grade Road (Private Property) 7/19/2013	Betsie River @ M-115 (West Crossing) 6/19/2013
TAXA	**Station 8**	**Station 9**	**Station 10**	**Station 11**
PLATYHELMINTHES (flatworms)				
Turbellaria		1	1	
ANNELIDA (segmented worms)				
Hirudinea (leeches)	1	1	1	
Oligochaeta (worms)	6	40	36	18
ARTHROPODA				
Crustacea				
Amphipoda (scuds)	3	20	1	2
Decapoda (crayfish)	3	1	6	1
Isopoda (sowbugs)	7	10	3	
Arachnoidea				
Hydracarina	8	2		2
Insecta				
Ephemeroptera (mayflies)				
Baetidae	16	43	29	24
Caenidae				4
Ephemerellidae	31	36	8	18
Heptageniidae	24	1	4	5
Isonychiidae	4		1	4
Tricorythidae			3	
Odonata				
Anisoptera (dragonflies)				
Aeshnidae	4			
Gomphidae	2	1		1
Zygoptera (damselflies)				
Calopterygidae	4	2	5	2
Plecoptera (stoneflies)				
Perlidae	14	1	1	3
Pteronarcyidae		1	1	3
Hemiptera (true bugs)				
Gerridae		2	1	
Veliidae	1			
Megaloptera				
Corydalidae (dobson flies)	1	1		
Sialidae (alder flies)			1	
Trichoptera (caddisflies)				
Brachycentridae	2	13	3	28
Glossosomatidae			1	
Helicopsychidae	2			1
Hydropsychidae	12	41	108	40
Lepidostomatidae	2	1		
Leptoceridae	3	1	5	1
Limnephilidae	25	1	1	4
Philopotamidae	1			4
Polycentropodidae				16
Psychomyiidae				1
Uenoidae	1			
Coleoptera (beetles)				

	Betsie River @ Haze Road 6/18/2013	Betsie River @ Kurick Road 6/19/2013	Betsie River @ Off Old Grade Road (Private Property) 7/19/2013	Betsie River @ M-115 (West Crossing) 6/19/2013
TAXA	**Station 8**	**Station 9**	**Station 10**	**Station 11**
Gyrinidae (adults)	1			
Hydrophilidae (total)	1	1		1
Elmidae	22	4	22	10
Diptera (flies)				
Athericidae	1	1	33	4
Ceratopogonidae	2	1		2
Chironomidae	28	73	25	79
Simuliidae	4	5	3	1
Tabanidae	1		2	1
Tipulidae		2	10	
MOLLUSCA				
Gastropoda (snails)				
Ancylidae (limpets)	1		1	2
Bithyniidae	1			6
Hydrobiidae	1			
Physidae	2	3	4	3
Pelecypoda (bivalves)				
Sphaeriidae (clams)	1		8	12
TOTAL INDIVIDUALS	243	310	328	303

Table 10. Macroinvertebrate metric evaluation of selected stations in the Betsie River watershed, Benzie County, June 2013.

	Betsie River @ Haze Road 6/18/2013		Betsie River @ Kurick Road 6/19/2013		Betsie River @ Off Old Grade Road (Private Property) 7/19/2013		Betsie River @ M-115 (West Crossing) 6/19/2013	
	Station 8		**Station 9**		**Station 10**		**Station 11**	
METRIC	Value	Score	Value	Score	Value	Score	Value	Score
TOTAL NUMBER OF TAXA	37	1	29	1	30	1	32	1
NUMBER OF MAYFLY TAXA	4	0	3	0	5	1	5	1
NUMBER OF CADDISFLY TAXA	8	1	5	0	5	0	8	1
NUMBER OF STONEFLY TAXA	1	0	2	1	2	1	2	1
PERCENT MAYFLY COMPOSITION	30.86	1	25.81	0	13.72	0	18.15	0
PERCENT CADDISFLY COMPOSTITION	19.75	0	18.39	-1	35.98	0	31.35	0
PERCENT DOMINANT TAXON	12.76	1	23.55	0	32.93	0	26.07	0
PERCENT ISOPOD, SNAIL, LEECH	5.35	-1	4.52	-1	2.74	-1	3.63	-1
PERCENT SURFACE AIR BREATHERS	1.23	0	0.97	1	0.30	1	0.33	1
TOTAL SCORE		3		1		3		4
MACROINVERTEBRATE COMMUNITY RATING	ACCEPTABLE		ACCEPTABLE		ACCEPTABLE		ACCEPTABLE	

Table 11. Habitat evaluation for selected stations in the Herring and Bowens Creek watersheds, Benzie and Manistee Counties, June 2013.

	Herring Creek @ Elberta Resort Road **RIFFLE/RUN**	Herring Creek @ Gorivan Road **GLIDE/POOL**	Bowens Creek off Iverson Road **RIFFLE/RUN**
	Station 12	**Station 13**	**Station 14**
HABITAT METRIC			
Substrate and Instream Cover			
Epifaunal Substrate/ Available Cover (20)	17	6	8
Embeddedness (20)*	18		2
Velocity/Depth Regime (20)*	14		18
Pool Substrate Characterization (20)**		13	
Pool Variability (20)**		13	
Channel Morphology			
Sediment Deposition (20)	16	6	4
Flow Status - Maintenance Flow Volume (10)	10	10	10
Flow Status - Flashiness (10)	9	10	10
Channel Alteration (20)	16	15	17
Frequency of Riffles/Bends (20)*	17		16
Channel Sinuosity (20)**		13	
Riparian and Bank Structure			
Bank Stability (L) (10)	9	9	9
Bank Stability (R) (10)	9	9	9
Vegetative Protection (L) (10)	9	9	8
Vegetative Protection (R) (10)	4	8	8
Riparian Vegetative Zone Width (L) (10)	9	8	10
Riparian Vegetative Zone Width (R) (10)	4	7	10
TOTAL SCORE (200):	161	136	139
HABITAT RATING:	**EXCELLENT (NON-IMPAIRED)**	**GOOD (SLIGHTLY IMPAIRED)**	**GOOD (SLIGHTLY IMPAIRED)**
Date:	6/19/2013	6/21/2013	6/19/2013
Weather:	Sunny	Cloudy	Sunny
Air Temperature: ºF	70	70	75
Water Temperature: ºF	73	57	53
Average Stream Width: Feet	23	18	7
Average Stream Depth: Feet	0.7	3	1
Surface Velocity: Feet/Second	1	1	1
Estimated Flow: Cubic Feet/Second	16.1	54	7
Stream Modifications:	None	None	Relocated
Nuisance Plants (Y/N):	N	N	N
STORET No.:	100216	100229	510268
County Code:	10	10	51
TRS:	25N16W14	25N15W19	24N16W24
Latitude (dd):	44.57077	44.55957	44.46668
Longitude (dd):	-86.20513	-86.17014	-86.18077
Ecoregion:	NCHF	NCHF	NCHF
Stream Type:	Coldwater	Coldwater	Coldwater
USGS Basin Code:	4060104	4060104	4060104

*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 12. Qualitative macroinvertebrate community sampling results at selected stations in the Herring and Bowens Creek watersheds, Benzie and Manistee Counties, June 2013.

	Herring Creek @ Elberta Resort Road 6/19/2013	Herring Creek @ Gorivan Road 6/21/2013	Bowens Creek off Iverson Road 6/19/2013
TAXA	**Station 12**	**Station 13**	**Station 14**
ANNELIDA (segmented worms)			
Hirudinea (leeches)		1	
Oligochaeta (worms)	18	1	1
ARTHROPODA			
Crustacea			
Amphipoda (scuds)		27	26
Decapoda (crayfish)	1		
Isopoda (sowbugs)	5	42	
Arachnoidea			
Hydracarina	1	7	7
Insecta			
Ephemeroptera (mayflies)			
Baetidae	7	61	30
Ephemerellidae	5		
Ephemeridae		1	
Heptageniidae	7		
Odonata			
Anisoptera (dragonflies)			
Aeshnidae	1	1	
Corduliidae			1
Zygoptera (damselflies)			
Calopterygidae	1	1	
Plecoptera (stoneflies)			
Leuctridae			7
Nemouridae		1	47
Perlidae	2		
Hemiptera (true bugs)			
Saldidae		1	
Veliidae		2	
Megaloptera			
Corydalidae (dobson flies)	1		
Trichoptera (caddisflies)			
Helicopsychidae	2		
Hydropsychidae	59	7	14
Lepidostomatidae		4	19
Leptoceridae	2		
Limnephilidae	1	8	
Odontoceridae			1
Philopotamidae	10		
Polycentropodidae	1		
Rhyacophilidae			1
Uenoidae	1		
Coleoptera (beetles)			
Dytiscidae (total)		1	1
Haliplidae (adults)		1	
Hydrophilidae (total)	1	2	1
Elmidae	21		1
Diptera (flies)			
Athericidae			7

	Herring Creek @ Elberta Resort Road 6/19/2013	Herring Creek @ Gorivan Road 6/21/2013	Bowens Creek off Iverson Road 6/19/2013
TAXA	**Station 12**	**Station 13**	**Station 14**
Ceratopogonidae	2		1
Chironomidae	22	30	57
Dixidae		4	1
Simuliidae	99	57	51
Stratiomyidae		1	
Tabanidae	1	1	2
Tipulidae			1
MOLLUSCA			
Gastropoda (snails)			
Bithyniidae	3		
Physidae	1	10	1
Planorbidae		2	
Pelecypoda (bivalves)			
Sphaeriidae (clams)		3	1
TOTAL INDIVIDUALS	275	277	279

Table 13. Macroinvertebrate metric evaluation of selected stations in the Herring and Bowens Creek watersheds, Benzie and Manistee Counties, June 2013.

	Herring Creek @ Elberta Resort Road 6/19/2013		Herring Creek @ Gorivan Road 6/21/2013		Bowens Creek off Iverson Road 6/19/2013	
	Station 12		**Station 13**		**Station 14**	
METRIC	Value	Score	Value	Score	Value	Score
TOTAL NUMBER OF TAXA	26	1	26	1	23	1
NUMBER OF MAYFLY TAXA	3	0	2	0	1	0
NUMBER OF CADDISFLY TAXA	7	1	3	0	4	1
NUMBER OF STONEFLY TAXA	1	0	1	0	2	1
PERCENT MAYFLY COMPOSITION	6.91	-1	22.38	0	10.75	0
PERCENT CADDISFLY COMPOSTITION	27.64	0	6.86	-1	12.54	-1
PERCENT DOMINANT TAXON	36.00	0	22.02	1	20.43	1
PERCENT ISOPOD, SNAIL, LEECH	3.27	-1	19.86	-1	0.36	1
PERCENT SURFACE AIR BREATHERS	0.36	1	2.89	-1	0.72	1
TOTAL SCORE		1		-1		5
MACROINVERTEBRATE COMMUNITY RATING	ACCEPTABLE		ACCEPTABLE		EXCELLENT	

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