LTBB Water Quality Program

Surface Water Quality Assessment Report

A summary and compilation of data taken under EPA 106 Clean Water Act Portion of the Performance Partnership Grant BG-96552408

For Data Collection Activities Completed: 1/1/17-12/31/18

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Atlas Table

Table 1 is an inventory of Tribal Water Resources updated on February 28th, 2018. The number of sites on lakes, creeks, streams, rivers and the number of wetlands monitored are only the number of what was completed and summarized for the time range that this assessment report covers. Although the completion of the LTBB Baseline study (water quality only) was active until October 2010, the data was previously assessed in the Baseline Assessment Report. The Baseline Assessment Report was submitted to EPA PPG and 106 Project Officers on May 30th, 2010. Therefore, those water quality sites are not included in this inventory. These numbers also do not reflect the total number of sites LTBB monitors since some sites are monitored on a three-year rotation.

Table 1. Atlas Table

Factor/Resource	Value
Surface area of Tribal lands (acres)	215,954
Total number of enrolled LTBB Tribal citizens	4,568
Total miles of rivers and streams on Tribal lands	408
Number of monitoring sites on rivers, streams, or creeks	24
Number of monitoring sites lakes/reservoirs/ponds on Tribal lands	16
Acres of lakes/reservoirs/ponds on Tribal lands	7,987
Acres of wetlands (including coastal)	38,757
Number of monitored wetlands	12
Miles of Great Lakes shoreline	103.5

Purpose/Description of LTBB Surface Water Protection Program (SWPP)

LTBB has always emphasized our strong connection to the Nibiish ("water" in Anishnaabemowin) and they are known as "water people". Nibiish is part of our culture, traditions and has sustained the Tribe throughout time. Without clean waters, this perpetuation would not continue.

In 2010, the LTBB Surface Water Quality Protection Program (SWQPP) completed a baseline assessment for specific water bodies within and adjacent to the 1855 Reservation Boundary. The data assessed was taken during 6-month field seasons over ten years on a biennial rotation. During this time, the program experienced new Tribal water quality issues/concerns, governmental changes, increased trust land, and a better understanding of changes in parameters and the frequency with which water bodies should be monitored.

The Wetlands Protection Program was merged with the Surface Water Quality Protection Program in August of 2013. LTBB recognizes wetlands as surface water and chose to re-name the program to Water Quality Protection Program (WQPP). In addition, merging programs provided some relief to strained budgets due to increased space costs, indirect rates and increased communication between LTBB water staff. The two water staff members have increased activities and duties and need continued training to complete Floristic Quality Assessments (FQAs). However, all wetlands have been surveyed to date and as the LTBB WQPP progresses as a regulation and compliance program, it could become less of a need to conduct FQAs unless a LTBB wetland permit has been approved through the Wetlands Statute. It may also be evaluated to be the responsibility of the program or entity who is applying for the permit to find qualified personnel to conduct the FQA. This is dependent on if our regulations will be approved in the next few years and if we will use FQA scores to regulate whether a permit will be granted or denied. Interim Regulations were completed in January 2018, by a Natural Resource staff and commission based workgroup but these regulations have not been approved by Tribal Council. LTBB WQPP may also research grant opportunities to review other functional assessments that may be useful in classifying high quality wetlands based on Tribal uses. Any data collection activities were updated and in the revised February 27, 2019 LTBB Quality Assurance Project Plan.

Although, most of our surface waters are of high quality, based on the LTBB Non-point Source Assessment Plan, the status of our clean waters is threatened by increased population and development with some waters and wetlands having impairments in non-point source pollution categories. Based on this program's progress, development of plans and assessments, and future legislation efforts, the following commitments were made for this grant period:

1. Continue to monitor and assess LTBB Reservation Boundary waters, wetlands, and any waters that impact Tribal waters and/or uses.
2. Continue to pursue tribally approved water resource protection legislation or standards.
3. Comment and participate in workgroups, trainings, conferences and/or meetings pertaining to water resources.
4. Complete nonpoint source related projects
5. Provide education and outreach on water resources to Tribal and non-Tribal communities.
6. Increase Tribal Water Programs capacity by conducting research on water issues and funding opportunities for LTBB water resource specific projects
7. Collaborate with other Tribal water resource professionals and LTBB Natural Resource Department (NRD) and Geographical Information Systems (GIS) Department programs whenever applicable or needed.
8. Evaluate and manage the WQPP and WPP.

All non-data commitments were reported extensively in our semi-annual reports, final narrative report and self-evaluation for this grant period. Therefore, Commitment 1 and the two following data activities will be the only activities assessed:

- Collect biological, chemical, and physical data and assess data results every two years by using various water quality standards, criteria, calculating metrics, correlations, and trend analysis.
- Collect biological and physical data on wetlands.

Dates, times, parameters, GPS coordinates, WQX/CDX ID, location description of water bodies/wetlands monitored were submitted in Table 2 of the 2nd Semi-Annual Report of 2017.

Monitoring Methods

Nutrient and Chemical Parameters

Water samples are collected for analysis of total nitrogen, phosphorus, suspended solids, and chloride. They are collected from streams, creeks, and rivers taking a small sample every two feet across the cross-section with a one gallon jug that is rinsed with the water to be collected. Once the water is collected, the sample is shaken and poured into the sampling bottles provided by the LTBB and contracted lab. On lakes, water samples are collected using either a Kemmerer or VanDorn water sampler. If lake stratification occurs, water samples are taken at the surface, middle, and bottom depths of the vertical water profile. If lake stratification does not occur, water samples are taken at mid-depth of the vertical profile.

Physical/Bio-physical Parameters

Hach Hydromet sondes are used to collect dissolved oxygen, temperature, conductivity, and depth and pH data in all water bodies. Sonde data is recorded every two feet across a cross-section and averaged once uploaded onto the LTBB Network. Sonde readings are recorded using the same collection method described for the collection of water samples on lakes dependent on lake stratification. On lakes that stratify, we record physical data every meter to recognize the thermocline. In addition, secchi disk and chlorophyll-α data is collected on lakes. The secchi disk is lowered three times to assure an average clarity measurement using LTBB QAPP protocol. Chlorophyll-α samples are collected using an amber bottle and are filtered on return to the LTBB Lab or within 24 hours.

In addition to using the sondes, a Sontek Flowtracker velocity meter is used to take velocity readings to calculate discharge on streams, creeks and rivers. The USGS mid-section method is used to collect velocity readings across a cross-section.

Biological Parameters

Macroinvertebrates are collected every spring on most water bodies. The program elected to not collect macroinvertebrate grabs on Sturgeon Bay and Susan Lake in 2017 and no collection in 2018 at Spring Lake, Wycamp Lake, Larks Lake and Little Traverse Bay. The total number of organisms have been low in the past in those water bodies therefore, the benefit of the data does not exceed the time it takes for the Water Quality Technician (WQT) to sort. These lakes will be surveyed for macroinvertebrates every four to six years instead of every two. Lakes have five grab sites where collection occurs in different sediment substrates in the littoral zone. Depending on hardness of the lake bottom either an Ekman Bottom Sampler or a D-frame kick-net is used. In rivers, streams, and creeks there are three established kick sites within a 100 meter reach. These kick sites are in riffle areas unless riffles are absent. If riffles are absent then grab sites were chosen in different substrates. Collection is accomplished by using a kick-net or dip net depending on the velocity of each lotic system. Samples, including substrate, are put into 500 mL bottles and preserved with 95% ethanol. Sorting of these samples are mainly completed by the WQT using a random sampling method in the off-season. Samples on all water bodies are combined for a 300+ target organism count. Identification is completed by a contracted entomologist. All contracted entomologists submit 10% of their identified macroinvertebrates to another entomologist for quality assurance purposes. Metrics and diversity scores are completed by LTBB water staff. Macroinvertebrate surveys from collection to calculations are a long and extensive process.

In July, qualitative habitat assessments are conducted at water bodies where the assessment is deemed to be representative. Habitat is assessed by observing the 100 meter reach within an area on a lotic system using the water quality site as the mid-reach point. The habitat assessment form, an LTBB modified habitat assessment form created from Grand Portage Reservation's habitat assessment and EPA habitat protocol for lakes, is taken by two staff observing conditions around the shoreline of the lake. These habitat assessments are assessed if a potential impairment may be correlated to a change in habitat condition.

Quantitative Pebble Counts are completed by two staff on lotic systems that are wadeable and as time allows. The pebble count is a LTBB modified version of Little River Band and Wentworth Protocol for substrate analysis.

Floristic Quality Assessments (FQAs), including identification of threatened, endangered and invasive species are completed on LTBB wetlands with a current target of completing three assessments per year with field visits being done in the early summer and fall seasons. Currently, WQPP staff and the LTBB Conservationist are contracting with Michigan Natural Features Inventory for the fall assessments until staff feel their plant knowledge is sufficient to complete FQAs without other entities to quality assure field identification or until regulations are approved identifying the need, process, who, and how to evaluate wetlands if a permit needs to be considered based on the current LTBB Wetland Statute.

Assessment Methods

Analysis of Water Sample Parameters

Water samples analyzed for total nitrogen, phosphorus, and chlorophyll-α are currently analyzed by CT Laboratories. Water samples collected for total chloride and suspended solids results are analyzed in the LTBB laboratory. If total chloride levels are known to be over 25 mg/L at a particular water body, the samples are sent to CT Laboratories. CT Lab's equipment can analyze samples over 25 mg/L without having to dilute the sample as much as LTBB’s equipment would need to. All samples are recorded in the LTBB log book and CT Lab's chain-of-custody procedures are followed when shipping samples.

Any results that were lab generated are quality assured by following procedures within the QAPP. Field duplicates and blanks are collected on a seasonal or two-month basis. If a water body is monitored for a six month field season, blanks and duplicates are run every two months. The LTBB contract lab, CT Labs, also run blanks and duplicates/triplicates on our samples following their own schedule. Acceptable precision for replicate samples is ±15% for both analyses. The following equation is used in precision calculation:

$$\text{Relative Percent Difference (RPD)} = \frac{(S-A) \times 100}{A}$$

Where:

S = Sample Value

A = Average of Replicate

If the results do not pass ±15% threshold (aka if the RPD is greater than 15% in either direction), they are flagged, the outlier is investigated and the data is not used in analysis. Physical parameters are checked for errors by the LTBB WQS and/or WQT.

Assessment of Parameters

2017/ 2018 parameter results for this Water Quality Assessment Report will be assessed by using LTBB draft water quality standards. Tables will be displayed in the lakes, creeks, streams, and rivers summaries showing the results and will report whether or not actual values are or are not exceeding standards/thresholds used to assess LTBB waters.

The WQPP applies LTBB draft Tribal Uses to water bodies within and adjacent to the 1855 Reservation boundaries. The LTBB WQPP has created LTBB-specific tribal water quality uses and corresponding definitions. These LTBB uses have not been approved by the LTBB Natural Resource Commission or by Tribal Council and are applied to water bodies for assessment purposes only. They are not yet applied to wetlands but will be in the future. A list of the LTBB draft Tribal Uses are available in the next section. LTBB draft Tribal Uses should be used as reference in this assessment. Tribal Uses will be listed by their acronyms in the Tribal Uses and Attainment Section. Data Summary Tables are provided within the Tribal Uses and Attainment Section for each water body data collection site indicating whether or not there were exceedances using the assessment criterion provided in the tables. Any additional information such as temperature logger data or lake profiles is provided in chart, graph or narrative form. Biological data will be assessed by using tables or graphs to display results. Sections within the Biological Data may include, quantitative pebble counts, and/or discharge rates.

Quantitative pebble counts began in 2011; therefore, if two sets of pebble counts have been completed in different years at any lotic wadeable sites the data will be compared by percentage change. If there is an increase or decrease of 10% based on specific substrate type, then habitat conditions for indigenous aquatic life and wildlife and fish habitat has not changed drastically or may be improving (Table 2). However, with only two data sets to compare and a random sampling method being used results should be considered as only a component of all parameters measured and cannot show a direct correlation in change in habitat conditions. "I" denotes increase while "D" denotes decrease.

Table 2. Ideal changes in Pebble Counts

Substrate Type	Optimum Changes in Habitat Conditions
Boulders	I
Cobble	I
Pebble	I
Gravel	I
Clay	D
Macroinvertebrate (macro)	I
Woody Debris	I
Sand	D
Silt	D
Detritus/Vegetation	I (no more than 15%)

Muck	D

The Floristic Quality Assessments (FQAs) were completed in 2017-18 and an FQA score is provided. For assessment purposes only, the characteristic of a mean Floristic Quality Index (FQI) of 35 or greater, or with a mean Coefficient of Conservatism of 6.5 or greater, as calculated using methods the Floristic Quality Assessment (FQA) for the State of Michigan will be used to define whether or not 2017 assessments defined these wetlands as high quality.

A Narrative Summary section is provided with any additional information regarding use attainment, management issues, potential causes of perturbation, or indications of higher water quality. Trend analysis is performed using all data collected by LTBB beginning in either 2000 or 2001. Trend analysis will only be displayed if trends are found. A trend will be reported on if approximately seventy percent (R^2=0.7 or higher) of the variation in the response variable can be explained by the explanatory variable using a simple linear regression. Any trends will be discussed following their respective figures or tables for individual sites.

Table 3. Macroinvertebrate Indices

Index	Acronym used in Table 4.	Description	Ranking Criteria
NLF	Northern Lakes and Forest	A Benthic Community Index to assess the biological integrity of wadeable streams in the ecoregion. Index values ranged from 10 to 50, and scores from impaired sites were significantly different than non-impaired sites (P<0.001). Index values were divided into three narrative interpretations of biological integrity (poor, fair, and good).	Good 36+ Fair 23-35 Poor <23
HBI	Hilsenhoff Biotic Index	The overall tolerance of the community in a sampled area, weighted by the relative abundance of each taxonomic group (family, genus, etc.). Organisms are assigned a tolerance number from 0 to 10 pertaining to that group's known sensitivity to organic pollutants; 0 being most sensitive, 10 being most tolerant.	Excellent 0-3.75 Very Good 3.76-4.25 Good 4.26-5 Fair 5.01-5.75 Fairly Poor 5.76-6.50 Poor 6.51-7.25 Very Poor 7.26-10.0
EPT	Ephemeroptera, Plecoptera, and Trichoptera	Three orders of macroinvertebrates that are most sensitive to pollution.	The higher number of EPT individuals in a water body, the cleaner it is.

The macroinvertebrates collected from 2017 were sorted during this reporting period and sent to a taxonmist for further ID (Rhithron). Using a spreadsheet created by staff at the Little River Band of Ottawa Indians, we are able to calculate the Northern Lakes and Forest Index, Margalef's richness, Shannon-Weiner Diversity Index, number of Ephemeroptera, Plecoptera, and Trichoptera individuals, and the Hilsenhoff Biotic Index (Table 3). According to staff at the Little River Band of Ottawa Indians, the Northern Lakes and Forest (NLF) Index is the most accurate for our geographical area.

LTBB Tribal Uses

These Tribal uses have been created by the Water Quality Protection Workgroup. These uses were signed into law in September 2016.

In addition to these Tribal Uses, an antidegradation policy is applied to Tribal waters. Antidegradation requirements provide for the protection of existing water uses and limitations on degradation of high quality waters. Water bodies monitored by the LTBB Water Quality Protection Program are assigned specific use designations.

Human Health Uses

A. Primary Contact Recreation (PCR). Waters used for any activities normally involving direct contact with water to the point of complete submergence, particularly immersion of the head, with considerable risk of ingesting water or having it come into contact with the eyes and nose, such as swimming. All surface waters are designated for this use. Supplemental criteria specific to this use are listed in Subchapter V.

B. Secondary Contact Recreation (SCR). Waters supporting any activities normally involving direct contact of some part of the body with water, but not normally involving immersion of the head or ingestion water, such as fishing, wading, dry boating, and hunting. All surface waters are designated for this use. Supplemental criteria specific to this use are listed in Subchapter V.

C. Public Water Supply (PWS). Waters that with conventional treatment can be used as a source of drinking water. Supplemental criteria specific to this use are listed in Subchapter V.

Cultural Uses

A. Traditional, Cultural or Ceremonial Uses (TCC). Waters that support vegetation and activities linked to traditional, cultural, medicinal, and/or ceremonial practices of LTBB Citizens. Supplemental criteria for this use include but are not limited to those for Primary Contact Recreation.

B. Wild Rice Areas (WRA). Surface waters that currently have or historically had the potential to sustain the growth of wild rice (Manoomin, or *Zizania palustris*) for either wildlife or human consumption. Supplemental criteria specific to this use are listed in Subchapter V.

Aquatic Life Support Uses

A. Indigenous Aquatic Life (IAL). Waters supporting a population of wildlife and indigenous aquatic life originating, living, growing, reproducing, or otherwise occurring in a particular water body, including indigenous wildlife populations that utilize the water body for subsistence, sustained growth and and/or propagation. Supplemental criteria specific to this use are listed in Subchapter V.

B. Wildlife Support (WLS). Waters that support birds, mammals, and other non-aquatic organisms that consume tribal waters or any of the various forms of aquatic life found in tribal waters.

C. Coldwater Fishery (CDW). Waters that support cold water fish species that prefer clear, cold waters and are not tolerant of extreme temperature or dissolved oxygen changes. Supplemental criteria specific to this use are listed in Subchapter V.

D. Cool Water Fishery (CLW). Waters that support cool water fish species that prefer cooler waters and are not tolerant of extreme temperature or dissolved oxygen changes. Supplemental criteria specific to this use are listed in Subchapter V.

E. Warm Water Fishery (WWF). Waters that support or are managed for populations of warm water fish species and which lack significant populations of salmonid fishes. Supplemental criteria specific to this use are listed in Subchapter V.

F. Subsistence Fishery (SUB). Waters fished by indigenous people to provide food for their families, community, or for traditional/cultural purposes. This use is also a human health and cultural use. Supplemental criteria are listed in Subchapter V.

Other Use Designations

A. Navigation Uses (NAV). Waters suitable for moving on, through, or used for following a route, usually by boat or canoe. All LTBB waters shall be of sufficient quality for use in navigation.

B. Commercial Uses (COM). Waters used for the creation, selling, or trading of a good or service. All LTBB waters shall be of sufficient quality for commercial uses.

C. Industrial Uses (IND). Waters used for the commercial production, manufacture, or construction of a goods or services. All LTBB waters shall be of sufficient quality to be used for commercial purposes.

D. Aquaculture Uses (AQA). Waters used for the commercial cultivation or production of any aquatic organisms such as but not limited to fish, mollusks, crustaceans, algae, or aquatic plants. All LTBB waters shall be of sufficient quality for aquaculture purposes.

E. Agriculture Uses (AGR). Waters used for irrigation purposes, livestock watering, and/or any other farming practices involving the use of water. All LTBB waters shall be of sufficient quality for agriculture uses.

F. Outstanding Tribal Resource Waters (OTR). These designated waters represent a unique sacred and cultural resource of the LTBB, due for example to their use, their association with the traditional value system of the LTBB, or their beauty. They are therefore given this most protective non-degradation (Tier III) status to ensure their preservation. Waters designated as Outstanding Tribal Resource Waters are listed in Section 406. Other waters whose high quality makes them an exceptional recreational, cultural, or ecological resource of the LTBB may also be designated Outstanding Tribal Resource Waters pursuant to the procedures in Section 105.

Streams, Creeks and Rivers Assessments

Boyne River

Description and Background

The Boyne River is a cold water river system approximately 24 miles in length. This river is adjacent to and affects the waters of the LTBB historical reservation. The river drains into Lake Charlevoix. The northwest shoreline of the main basin of Lake Charlevoix is the southwest boundary of the LTBB historical boundaries. The Boyne River has a drainage base of 40,320 acres and is the second-largest tributary of Lake Charlevoix.

The Boyne River is a well-known cold water fishery with fish species such as Chinook salmon, walleye, brook trout, brown trout, and rainbow trout inhabiting the river.

The Boyne City Mill Pond is located about a mile upstream of Boyne City where the river drains into Lake Charlevoix. There is also an active hydroelectric dam upstream of the mill pond used by a local ski resort for power and snow-making. Upstream on the south branch there is another old dam built in the 1900's that used to be used to power a saw mill and grist mill.

Two sites were monitored seasonally on the Boyne River during the 2017 field season. The site farthest upstream, BNR3, is located just below the old dam in Boyne Falls on the south branch. The site furthest downstream, BNR1, is located just upstream of where the main branch of the river discharges into Lake Charlevoix in Boyne City. Pebble Counts were only conducted at site BNR3.

Tribal Uses and Attainment

The Boyne River's Primary Tribal use is **CDW.** Other uses applied at both sites are **PCR** (May through October)**, SCR, IAL, WLS, SUB, NAV, COM, and IND**. All uses are supported at both sites on the Boyne River except **SUB** which needs further evaluation because of a lack of toxin data in fish.

Data Summary Tables

Table 4. Data Summary Table for Downstream Site of Boyne River (BNR1)

Parameter	Threshold Criteria	Month Collected	Parameter Result	Exceedance
Chloride	50 mg/L	February	15.76	--
		May	12.76	--
		July	17.18	--
		October	13.92	--
Total Phosphorus	50 µg/L	February	Reject	--
		May	7.30	--
		July	14.00	--
		October	19.00	--
Total Nitrogen	1 mg/L	February	0.53	--
		May	0.80	--
		July	*Not Detected	--
		October	0.33	--
Dissolved Oxygen	>7 mg/L	February	13.04	--
		May	12.30	--
		July	10.00	--
		October	10.46	--
Total Suspended Solids	25 mg/L	February	4.60	--
		May	1.60	--
		July	2.30	--
		October	3.60	--
Temperature	Coldwater Fishery	February	3.32	--
		May	9.98	--
		July	20.06	X
		October	15.33	X
Conductivity	450 µS/cm	February	429.80	--
		May	396.42	--
		July	431.53	--
		October	417.15	--
pH	6.5-9 pH units	February	7.99	--
		May	8.05	--
		July	8.40	--
		October	8.18	--

Table 5. Data Summary Table for Upstream Site of Boyne River (BNR3)

Parameter	Threshold Criteria	Month Collected	Parameter Result	Exceedance
Chloride	50 mg/L	February	10.45	--
		May	11.15	--
		July	11.43	--
		October	11.07	--
Total Phosphorus	50 µg/L	February	*Not Detected	--
		May	10.00	--
		July	22.50	--
		October	16.00	--
Total Nitrogen	1 mg/L	February	0.63	--
		May	1.10	--
		July	*Not Detected	--
		October	0.50	--
Dissolved Oxygen	>7 mg/L	February	13.34	--
		May	12.43	--
		July	9.34	--
		October	11.26	--
Total Suspended Solids	25 mg/L	February	6.00	--
		May	10.30	--
		July	10.10	--
		October	6.80	--
Temperature	Coldwater Fishery	February	3.11	--
		May	6.94	--
		July	19.42	--
		October	11.06	--
Conductivity	450 µS/cm	February	401.90	--
		May	390.89	--
		July	392.45	--
		October	413.11	--
pH	6.5-9 pH units	February	7.84	--
		May	7.95	--
		July	8.14	--
		October	8.09	--

Biological Data

Substrate

Table 6: BNR3 Pebble Count Trends.

BNR3	2013	2015	2017	RSQ
Boulders	2%	0%	4%	0.25
Cobble	4%	12%	6%	0.054065
Pebble	34%	55%	20%	0.15693
Gravel	16%	18%	18%	0.616062
Clay	0%	0%	0%	#DIV/0!
Macroinvertebrate	0%	0%	0%	#DIV/0!
Woody Debris	4%	4%	2%	0.719437
Sand	8%	4%	8%	0
Silt	6%	2%	0%	0.967048
Detritus/Vegetation	26%	4%	42%	0.176615
Muck	0%	0%	0%	#DIV/0!

Discharge Rates

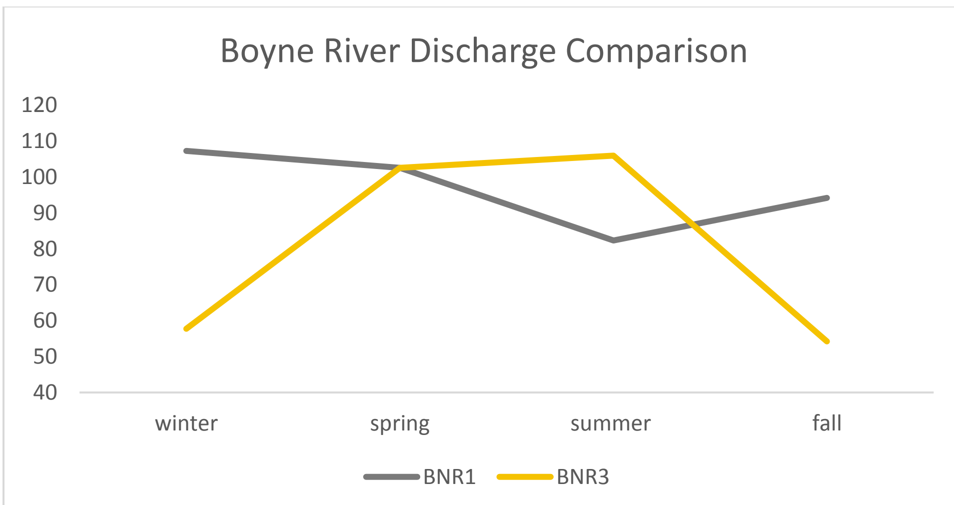


Figure 1. Boyne River Discharge Rates 2017

Boyne River was the largest river system monitored in the 2017 field season and has the highest discharge, on average, of all rivers monitored. The highest discharge calculation was recorded in the winter at the downstream site (BNR1) with a calculation of 107.3 cubic ft/sec (Figure 1).

Macroinvertebrates

Table 7. BNR1

	2013	2015	2017
Total Taxa	363	303	299
# Ephemeroptera	5	6	8
# Diptera	23	19	17
Richness (margalefs)	7.464709	7.350711	8.24
Shannon Weiner	2.283203	2.564563	3.06
% Tricoptera	4.407713	7.590759	2.675585

% crustacea and Mollusca	2.479339	0.660066	1.00
# Filterers	0	5	2
# Scrapers	0	3	5
# EPT taxa	12	14	4
HBI	4.471875	4.676923	5.33484
Score	32	38	32

Table 8. BNR3

	2013	2015	2017
Total Taxa	349	342	443
# Ephemeroptera	4	7	7
# Diptera	20	18	16
Richness (margalefs)	6.319308	6.684021	5.74
Shannon Weiner	2.691387	2.827409	2.86
% Tricoptera	6.303725	16.37427	16.93002
% crustacea and Mollusca	0	0	0.23
# Filterers	0	7	2
# Scrapers	0	1	3
# EPT taxa	11	17	3
HBI	5.515358	4.159509	4.44940
Score	30.00	42	36

Narrative Summary

Data results of the parameters monitored were within assessment criteria, with the exception of two exceedances in temperature at site BNR1 (Table 4) in the July and October. There were many salmon observed in the river during the fall at BNR1. Dissolved oxygen levels were optimum for cold water fish during all seasons. Pebble counts at BNR3 showed mostly pebbles and woody debris (**Error! Reference source not found.**).

LTBB's data will be used in a research project being spearheaded by researchers from the University of Buffalo, Indiana University and Saint Louis University. The goal of the project is to use river discharge and gauge data to create a real-time model that forecasts stream discharge, temperature and aquatic species habitat. This project is funded through a grant from the National Science Foundation.

Trends

Pebble counts show us a decreasing trend in woody debris and silt. This could be caused by increased water flows that may be flushing silt and debris downstream. Macroinvertebrate trends show us three significant increasing trends. Shannon-Weiner diversity indices for BNR1 and

BNR3 as well as The Hilsenhoff Biotic Index (HBI) for site BNR1 show increasing trends, which is good. Boyne River has significant increasing trends for the following: total phosphorous (TP) and total suspended solids (TSS) for site BNR1 as well as total chloride (Cl) and TSS for site BNR3. These trends will be monitored over time and may require some investigating to determine the source.

Bear River

Mkwa Ziibiing

<u>Description and Background</u>

The Bear River is the largest river in length that LTBB monitors and is the largest tributary in the Little Traverse Bay Watershed. The Bear River is approximately 14.6 miles long. The Bear River originates at Walloon Lake and flows into Little Traverse Bay. Springbrook Creek, an established trout stream, is a confluence to the upper stretch of the river. The last mile of the Bear River runs through the City of Petoskey and contains the steepest drop of any river in Michigan's Lower Peninsula. The geographical area was formed by glaciers and beneath the river are large limestone beds.

The City of Petoskey, where the mouth of the river flows into Little Traverse Bay, was once named “Bear River”. The Odawa Tribes historically utilized the river and surrounding land area for fishing, gathering medicines, food, and fruits, and hunting and continue to do so today. The Bear River received its name based on the historical population of bears living near the river. The Odawa people used to hunt bear throughout the river’s land base. Residents of the City of Petoskey relied heavily on the Bear River for industry and energy purposes. There were once seven dams on the river, providing power to grist and lumber mills and supplying the city and the surrounding community with electricity.

There are three sites monitored on the Bear River. The downstream site, BR1, is near the mouth of the river and upstream from the old hydroelectric dam. This dam now serves as a lamprey control structure. BR4 is the upstream site and is located approximately 65 feet downstream of Walloon Lake. BR3A is downstream of BR4 and after the confluence of Springbrook Creek. BR3A is located at a moderately to heavy used road bridge crossing.

<u>Tribal Uses and Attainment</u>

The following Tribal uses are applied to the Bear River: **PCR (May through October), SCR, TCC, IAL, WLS, CDW, SUB, NAV, COM, and IND**. The primary use at all sites is **CDW.** All Tribal uses are supported based on LTBB data results. **SUB** needs further evaluation because of a lack of toxin data in fish.

Data Summary Tables

Table 9. Data Summary Table for Downstream Site of Bear River (BR1)

Parameter	Threshold Criteria	Month Collected	Parameter Results 2018	Exceedance
Chloride	50 mg/L	February	14.000	--
		May	20.180	--
		July	19.520	--
		October	17.350	--
Total Phosphorus	50 µg/L	February	*Not Detected	--
		May	9	--
		July	13	--
		October	22	--
Total Nitrogen	1 mg/L	February	0.800	--
		May	0.100	--
		July	0.200	--
		October	0.120	--
Dissolved Oxygen	$\geq$ 7 mg/L	February	13.872	--
		May	9.868	--
		July	8.844	--
		October	12.798	--
Total Suspended Solids	25 mg/L	February	2.800	--
		May	4.800	--
		July	15.100	--
		October	-11.700	Reject
Temperature	Coldwater Fishery	February	0.195	--
		May	17.269	--
		July	20.865	--
		October	5.825	--
Conductivity	450 µS/cm	February	338.905	--
		May	349.692	--
		July	402.962	--
		October	324.154	--
pH	6.5-9 pH units	February	6.981	--
		May	7.957	--
		July	8.220	--
		October	7.628	--

Table 10. Data Summary Table for Midstream Site of Bear River (BR3A)

Parameter	Threshold Criteria	Month Collected	Parameter Results 2018	Exceedance
Chloride	50 mg/L	February	N/A	--
		May	N/A	--
		August	11.600	--
		October	8.230	--
Total Phosphorus	50 µg/L	February	N/A	--
		May	11	--
		August	18	--
		October	18	--
Total Nitrogen	1 mg/L	February	N/A	--
		May	*Not Detected	--
		August	0.400	--
		October	0.069	--
Dissolved Oxygen	$\geq$ 7 mg/L	February	N/A	--
		May	6.282	--
		August	5.702	X
		October	10.408	--
Total Suspended Solids	25 mg/L	February	N/A	--
		May	Reject	--
		August	2.800	--
		October	0.050	--
Temperature	Coldwater Fishery	February	N/A	--
		May	15.283	--
		August	25.707	X
		October	4.944	--
Conductivity	450 µS/cm	February	N/A	--
		May	338.438	--
		August	363.333	--
		October	315.480	--
pH	6.5-9 pH units	February	N/A	--
		May	7.935	--
		August	7.948	--
		October	7.444	--

Table 11. Data Summary Table for Upstream Site of Bear River (BR4)

Parameter	Threshold Criteria	Month Collected	Parameter Results 2018	Exceedance
Chloride	50 mg/L	February	16.370	--
		May	13.880	--
		August	14.630	--
		October	9.830	--
Total Phosphorus	50 µg/L	February	*Not Detected	--
		May	8	--
		August	8	--
		October	7	--
Total Nitrogen	1 mg/L	February	0.700	--
		May	0.100	--
		August	0.400	--
		October	0.360	--
Dissolved Oxygen	≥ 7 mg/L	February	13.365	--
		May	12.293	--
		August	7.856	--
		October	11.323	--
Total Suspended Solids	25 mg/L	February	0.500	--
		May	-0.500	--
		August	0.300	--
		October	0.050	--
Temperature	Coldwater Fishery	February	1.674	--
		May	6.591	--
		August	27.708	X
		October	8.558	--
Conductivity	450 µS/cm	February	283.231	--
		May	282.077	--
		August	312.769	--
		October	296.615	--
pH	6.5-9 pH units	February	7.538	--
		May	7.597	--
		August	8.265	--
		October	8.115	--

Biological Data

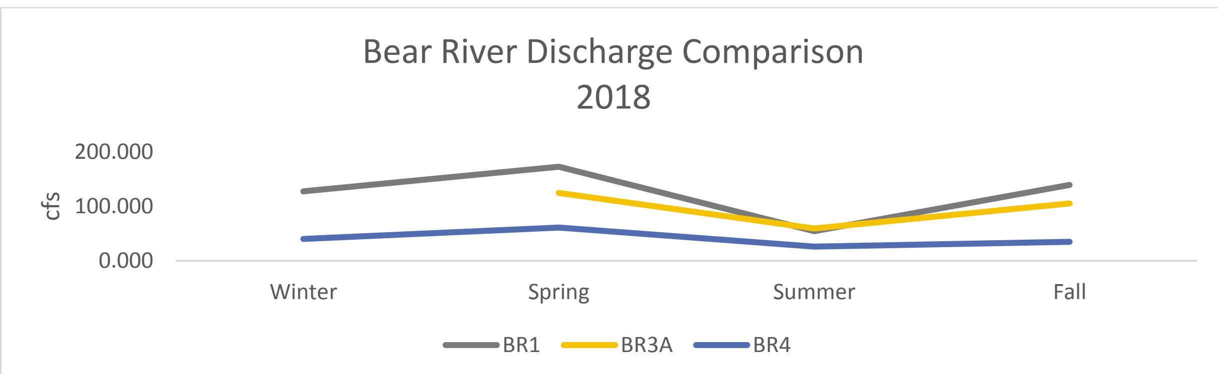
Substrate

Table 12: BR4 Pebble counts

BR4	2011	2014	2016	2018	RSQ
Boulders	12%	29%	0%	7%	0.167599
Cobble	14%	14%	9%	9%	0.740582
Pebble	52%	43%	25%	33%	0.699009
Gravel	6%	4%	45%	22%	0.363572
Clay	0%	0%	0%	0%	#DIV/0!
Macroinvertebrates	8%	0%	0%	0%	0.700935
Woody Debris	4%	2%	16%	13%	0.582845
Sand	4%	4%	0%	9%	0.110473
Silt	0%	2%	5%	2%	0.466452
Detritus/Vegetation	0%	2%	0%	2%	0.265582
Muck	0%	0%	0%	2%	0.52648

Discharge Rates

Figure 2. Bear River Discharge Rates 2018



Macroinvertebrates

Table 13: BR1 Macroinvertebrate trends

	2011	2014	2016	2018
Total Taxa	366	233	262	305
# Ephemeroptera	8	1	7	4
# Diptera	23	23	14	21
Richness (margalefs)	15.24743	5.686989784	5.926357	7.17
Shannon Weiner	3	2.37799893	2.893936	3.11
% Tricoptera	3.278689	6.43776824	5.343511	2.622951

% crustacea and Mollusca	8.743169	6.86695279	2.671756	10.16
# Filterers	6	1	0	5
# Scrapers	3	0	0	3
# EPT taxa	15	5	12	12
HBI	5.723636	5.534246575	4.896552	5.05096
NLF Score	40	26	34	34

Table 14. BR4 Macroinvertebrate trends

	2011	2014	2016	2018
Total # of individuals	175	266	314	321
# Ephemeroptera	0	1	0	2
# Diptera	16	13	16	18
Richness (margalefs)	6.58304142	3.761084	5.565805	5.20
Shannon Weiner	3	1.490203	2.310137	2.36
% Tricoptera	9.14285714	63.90977	42.99363	45.17134
% crustacea and Mollusca	0.57142857	4.135338	13.05732	10.59
# Filterers	4	2	0	4
# Scrapers	1	0	0	2
# EPT taxa	2	3	7	6
HBI	5.89115646	3.69863	4.986842	5.27907
NLF Score	28	30	30	32

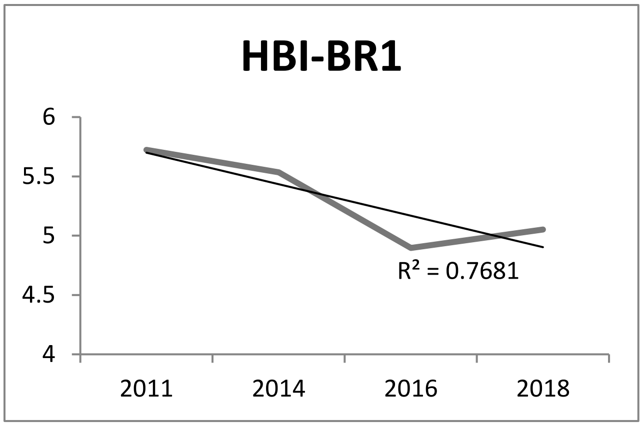
Narrative Summary

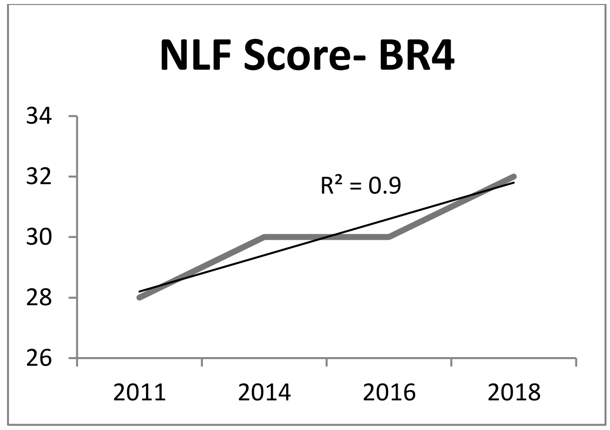
Concerning water quality parameters, there were 3 exceedances total for the Bear River in 2018. In August, the DO and Temperature were measured past threshold limits for site BR3A as well as temperature for site BR4. Pebble counts, which were only collected at site BR4, the majority of the makeup of the substrate collected there was classified as “pebble” and “gravel”.

Trends

There was reportable trend for the Bear River. Dissolved oxygen for site BR3A is showing a decreasing trend. Reasons for this are unknown but will be monitored over time. The Hilsenhoff Biotic Index (HBI) for site BR1 is showing a decreasing trend and the National Lakes and Forests Score (NLF) for BR4 is showing an increasing trend. BR4 is located in a park where the mow to water’s edge and experience a lot of in stream activity which could be a cause for decrease. These trends will be monitored over time. Table below illustrates trends in pebble counts for the most upstream site of the Bear River (BR4). R-squared values indicate decreasing trends in cobble and macroinvertebrates.

Figures 3&4. Macroinvertebrate trends on the Bear River





Big Sucker Creek
Chinmebine Ziibiinhs

Description and Background

Big Sucker Creek is a perennial stream that originates from O'Neal Lake and flows into Lake Michigan. The land surrounding Big Sucker Creek is owned by the State of Michigan. The land that the creek is located in is managed by the State of Michigan Department of Natural Resources (MDNR) and is completely within the boundaries of Wilderness State Park. The land cover is forested and forested wetland. The area in which the creek meanders is remote and is only exposed to minimal disturbance by human land use activities. The creek is used by recreational fisherman and the land is used by outdoor enthusiasts such as hikers, campers, snowmobilers, bikers and birdwatchers.

There are currently two areas of creek that are monitored. The upstream site, BSC1, is directly downstream of the headwaters of the creek below the dam at O'Neal Lake. In early fall of 2014, the dam failed leaving the lake to begin draining into Big Sucker Creek. The data summary tables will show if this draining caused change to the parameters measured and will be summarized in the narrative summary section.

Tribal Uses and Attainment

The Primary use for Big Sucker Creek is **IAW.** Other Tribal uses applied are **CLW** (at the downstream site) and **WWF** at the upstream site**, TCC** and **PCR** (May-October). The upstream site has been classified as a warm water fishery due to the site being so near to Oneal Lake and the dam. O'Neal Lake's water is largely groundwater and spring fed, however, the lake level is shallow which allows for the water to heat up based on seasonal air temperature and may not be conducive to cold water fish species. Downstream however, at the mouth, the creek has been fed by springs and groundwater seeps throughout its meander through a very shaded lowland wetland.

Data Summary Tables

Table 15. Data Summary Table for Upstream site of West Branch of Big Sucker Creek (BSC1)

Parameter	Threshold Criteria	Month Collected	Parameter Results 2018	Exceedance
Chloride	50 mg/L	February	4.450	--
		May	2.910	--
		August	4.570	--
		October	3.800	--
Total Phosphorus	50 µg/L	February	*Not Detected	--
		May	7.000	--
		August	14.000	--
		October	16.000	--
Total Nitrogen	1 mg/L	February	0.800	--
		May	0.300	--
		August	0.240	
		October	0.410	--
Dissolved Oxygen	$\geq$ 7 mg/L	February	9.583	--
		May	10.205	--
		August	6.350	--
		October	12.049	--
Total Suspended Solids	25 mg/L	February	-0.500	--
		May	0.800	--
		August	2.300	--
		October	-1.950	Reject
Temperature	Coldwater Fishery	February	3.157	--
		May	15.430	--
		August	26.074	--
		October	6.925	--
Conductivity	450 µS/cm	February	328.100	--
		May	198.636	--
		August	348.625	--
		October	288.000	--
pH	6.5-9 pH units	February	6.615	--
		May	7.725	--
		August	7.806	--
		October	7.940	--

Table 16. Data Summary Table for Downstream site of West Branch of Big Sucker Creek (BSC1B)

Parameter	Threshold Criteria	Month Collected	Parameter Results 2018	Exceedance
Chloride	50 mg/L	February	N/A	--
		May	3.090	--
		August	4.430	--
		October	4.620	--
Total Phosphorus	50 µg/L	February	N/A	--
		May	8	--
		August	21	--
		October	11	--
Total Nitrogen	1 mg/L	February	N/A	--
		May	0.300	--
		August	0.130	--
		October	0.330	--
Dissolved Oxygen	$\geq$ 7 mg/L	February	N/A	--
		May	9.274	--
		August	6.768	--
		October	11.228	--
Total Suspended Solids	25 mg/L	February	N/A	--
		May	1.300	--
		August	2.800	--
		October	105.800	Reject
Temperature	Coldwater Fishery	February	N/A	--
		May	14.401	--
		August	20.168	--
		October	6.883	--
Conductivity	450 µS/cm	February	N/A	--
		May	195.833	--
		August	349.583	--
		October	270.692	--
pH	6.5-9 pH units	February	N/A	--
		May	7.234	--
		August	7.893	--
		October	7.672	--

Biological Data

Substrate

Table 17: BSC1 Pebble count trends

BSC1	2012	2015	2016	2018	RSQ
Boulders	0%	0%	0%	2%	0.537778
Cobble	12%	0%	0%	0%	0.751111
Pebble	24%	0%	0%	0%	0.751111
Gravel	14%	2%	0%	0%	0.829804
Clay	0%	0%	0%	0%	#DIV/0!
Macroinvertebrates	0%	0%	0%	0%	#DIV/0!
Woody Debris	4%	32%	56%	18%	0.179715
Sand	30%	18%	0%	34%	0.005513
Silt	4%	18%	28%	0%	0.001309
Detritus	12%	30%	16%	44%	0.62843
Muck	0%	0%	0%	2%	0.537778

Table 18: BSC1B Pebble Count for 2018

Site ID: BSC1B	Date: 7/17/2018
Substrate Type	**Percent**
Boulders	2%
Cobble	10%
Pebble	10%
Gravel	2%
Clay	0%
Aquatic Macroinvertebrates	0%
Woody Debris	12%
Sand	12%
Silt	0%
Detritus/Vegetation	30%
Muck	22%
TOTAL	100%

Discharge Rates

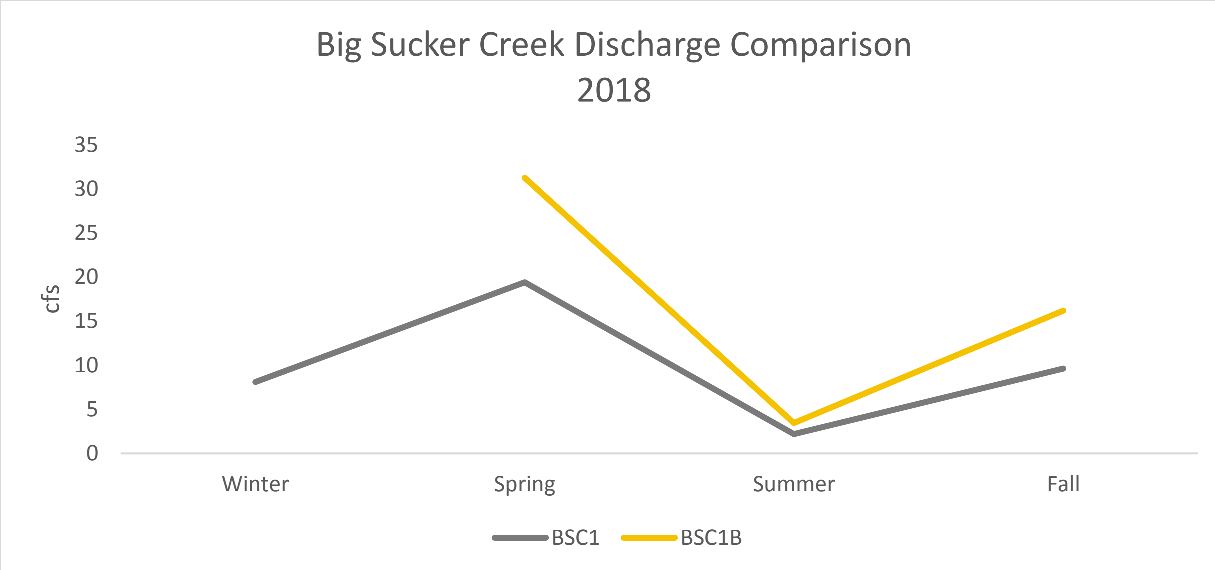


Figure 5. Big Sucker Creek Discharge Rates 2018

Macroinvertebrates

Below are figures that illustrate these trends. For reference, "I" denotes an increase in 2018 from 2016, "D" denotes a decrease in 2018 from 2016 and "N" indicates no change in 2018 from 2016.

Table 19: BSC Macroinvertebrate trends

BSC1	2018		BSC1B	2018	
Total Taxa	351	I	Total Taxa	322	D
# Ephemeroptera	1	N	# Ephemeroptera	2	N
# Diptera	12	D	# Diptera	22	D
Richness (margalefs)	4.265639	D	Richness (margalefs)	8.139160181	D
Shannon Weiner	1.575948	D	Shannon Weiner	2.834370371	I
% Tricoptera	5.413105	I	% Tricoptera	1.552795031	I
% crustacea and Mollusca	9.97151	D	% crustacea and Mollusca	13.66459627	D
# Filterers	5	I	# Filterers	4	I
# Scrapers	1	I	# Scrapers	1	I
# EPT taxa	5	D	# EPT taxa	12	I
HBI	0.904215	D	HBI	5.307692308	I
NLF Score	32	I	NLF Score	26	I

Narrative Summary

TSS data was rejected in October for these sites because there was some technical difficulties with a scale. We deemed the data inaccurate.

Trends

pH at BSC1B is showing a decreasing trend. There are decreasing trends in both cobble and pebble at BSC1. We only just started collecting pebble count data at BSC1B so there is no trends to report. There was one case where macroinvertebrate trends were reportable which is the National Lakes and Forests score (NLF) for site BSC1.

West Branch of the Maple River

Ninaatig Ziibiing

Description and Background

The West Branch of the Maple River is 17 miles long and drains 93 square miles of land. It originated in the southern area of the Pleasantview Swamp, which is fed by Brush Creek and Cold Creek. Brush Creek drains from Larks Lake, which is also part of the Maple River drainage area. The West Branch meets the East Branch at Lake Kathleen and together they form the Maple River. The Maple River flows into Burt Lake at Maple Bay, and is part of the Cheboygan River Watershed. The upstream portion of the West Branch of the Maple River is low-gradient with minimal groundwater influence, less flow than downstream, organic and sandy substrate, and warmer temperatures than downstream. In the middle and downstream reaches of the river, the gradient becomes higher, the flow becomes stronger, groundwater influence increases, the substrate changes from sandy organic substrate to cobble and gravel, and water temperatures get colder. The West Branch is considered an exceptional brook trout stream based on surveys conducted by the Michigan Department of Natural Resources (Godby, 2009).

There are currently two monitoring sites on the West Branch of the Maple River. There is an upstream monitoring location (BCMR2) located on Ely Bridge Road and a downstream monitoring site (BCMR1) located between US 31 North and the Emmet County snowmobile bridge.

Tribal Uses and Attainment

The following Tribal uses are applied on the West Branch of the Maple River: **PCR** (May through October)**, SCR, IAL, WLS, CDW, SUB, NAV, COM, and IND.** Primary uses at BCMR1 and BCMR2 are **CDW**. All Tribal uses applied to the West Branch of the Maple River are supported with the exemption of **SUB** which needs further evaluation because of a lack of toxin data in fish.

Data Summary Tables

Table 20. Data Summary Table for Upstream site of West Branch of Maple River for 2017 (BCMR1)

Parameter	Threshold Criteria	Month Collected	Parameter Result	Exceedance
Chloride	50 mg/L	February	6.62	--
		May	6.30	--
		August	7.39	--
		October	6.36	--
Total Phosphorus	50 µg/L	February	12.00	--
		May	8.50	--
		August	14.00	--
		October	22.00	--

Total Nitrogen	1 mg/L	February	0.38	--
		May	0.90	--
		August	*Not Detected	--
		October	0.30	--
Dissolved Oxygen	≥ 7 mg/L	February	11.63	--
		May	9.49	--
		August	8.52	--
		October	10.28	--
Total Suspended Solids	25 mg/L	February	4.10	--
		May	2.60	--
		August	1.80	--
		October	2.60	--
Temperature	Coldwater Fishery	February	2.31	--
		May	12.64	--
		August	16.06	--
		October	8.04	--
Conductivity	450 µS/cm	February	286.24	--
		May	254.29	--
		August	335.50	--
		October	293.24	--
pH	6.5-9 pH units	February	7.46	--
		May	7.93	--
		August	8.11	--
		October	7.69	--

Table 21. Data Summary Table for Downstream Site of West Branch of Maple River for 2017 (BCMR2)

Parameter	Threshold Criteria	Month Collected	Parameter Result	Exceedance
Chloride	50 mg/L	February	5.28	--
		May	5.66	--
		August	5.97	--
		October	4.61	--
Total Phosphorus	50 µg/L	February	6.70	--
		May	6.20	--
		August	18.00	--
		October	17.00	--
Total Nitrogen	1 mg/L	February	0.29	--
		May	1.00	--
		August	*Not Detected	--

		October	0.60	--
Dissolved Oxygen	> 7 mg/L	February	9.49	--
		May	7.82	--
		August	7.83	--
		October	8.45	--
Total Suspended Solids	25 mg/L	February	2.50	--
		May	2.00	--
		August	1.50	--
		October	3.30	--
Temperature	Coldwater Fishery	February	0.68	--
		May	13.37	--
		August	21.87	X
		October	8.15	--
Conductivity	450 µS/cm	February	261.56	--
		May	223.12	--
		August	333.94	--
		October	252.06	--
pH	6.5-9 pH units	February	7.34	--
		May	7.51	--
		August	8.14	--
		October	7.36	--

Biological Data

Substrate

Table 22. BCMR2 Pebble Count for 2017

Site ID: BCMR2	Date: 8/1/2017
Substrate Type	**Percent**
Boulders	0.00%
Cobble	2.22%
Pebble	0.00%
Gravel	11.11%
Clay	0.00%
Aquatic Macroinvertebrates	6.67%
Woody Debris	4.44%
Sand	66.67%
Silt	4.44%
Detritus/Vegetation	4.44%
Muck	0.00%

TOTAL	100.00%

Table 23: BCMR1 Pebble Count Trends

BCMR1	2011	2013	2015	2017	RSQ
Boulders	10%	4%	2%	0%	0.914286
Cobble	12%	14%	14%	12%	0.007274
Pebble	20%	40%	48%	55%	0.930739
Gravel	12%	18%	24%	22%	0.803104
Clay	0%	0%	0%	0%	#DIV/0!
Macroinvertebrates	0%	0%	0%	0%	#DIV/0!
Woody Debris	10%	12%	2%	0%	0.769231
Sand	28%	4%	8%	8%	0.439425
Silt	6%	8%	0%	2%	0.495987
Detritus/Vegetation	2%	0%	2%	0%	0.2
Muck	0%	0%	0%	0%	#DIV/0!

Discharge Rates

The Maple River discharge rates met expectations for a river of this size (Figure). Flows were highest in the spring and lowest in the summer and fall.

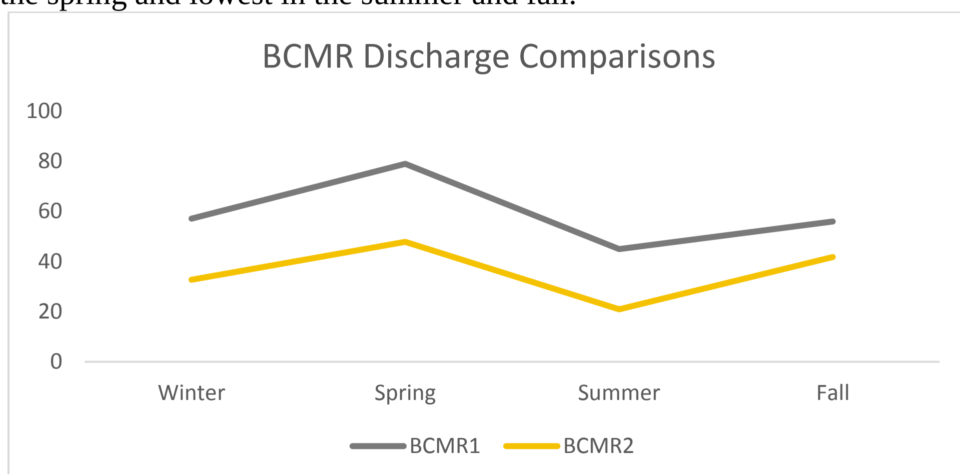


Figure 6. Maple River Discharge Rates 2017

Macroinvertebrates

Table 24. BCMR1 Macroinvertebrate trends

	2011	2013	2015	2017
Total # of individuals	364	323	299	316
# Ephemeroptera	4	6	5	4
# Diptera	24	16	19	16
Richness (margalefs)	10.68312	6.750147	6.841573	6.95
Shannon Weiner	3	3.134245	2.879846	2.69

% Tricoptera	7.417582	24.14861	8.361204	11.39241
% crustacea and Mollusca	0.549451	0	0	0.00
# Filterers	4	0	4	5
# Scrapers	2	0	3	0
# EPT taxa	10	13	14	2
HBI	5.535032	3.589641	4.169903	5.14463
NLF Score	34	36.00	34	36

Table 25. BCMR2 Macroinvertebrate trends

	2011	2013	2015	2017
Total # of individuals	330	343	298	173
# Ephemeroptera	3	3	7	5
# Diptera	28	28	29	16
Richness (margalefs)	12.58818	8.736272	10.18063	8.34
Shannon Weiner	3	3.214737	3.527571	3.38
% Tricoptera	1.515152	3.498542	8.053691	1.734104
% crustacea and Mollusca	7.575758	8.45481	6.040268	27.75
# Filterers	3	0	8	2
# Scrapers	2	0	2	3
# EPT taxa	7	9	14	6
HBI	6.859712	6.302239	6.868687	6.30769
NLF Score	32	30.00	36	24

Narrative Summary

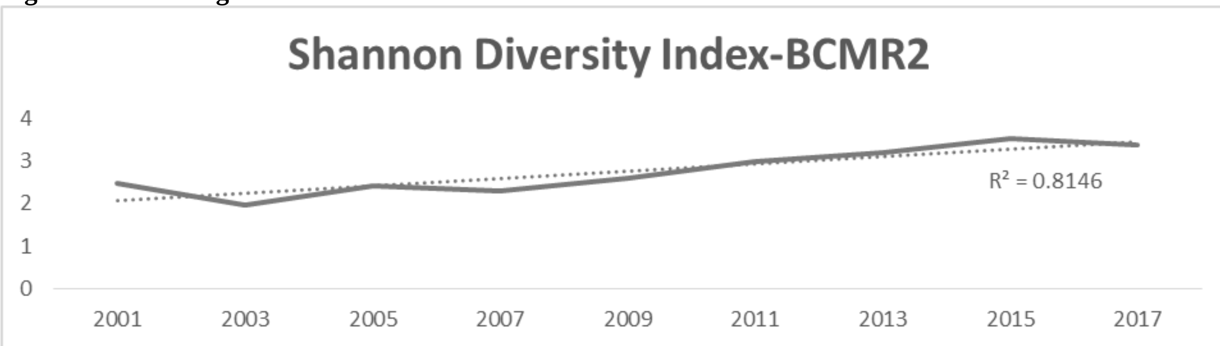
All data results are relatively low in terms of a detriment to water quality. There was only one exceedance found on this river in 2017 and that was a temperature exceedance found in August at BCMR2 (Table).

MDOT remodeled a snowmobile crossing over the creek in 2015. Trees were removed along the streambank and silt fences were installed during bridge construction. There were not any significant changes to the temperature found at the downstream site, but there was a slight uptick in total suspended solids. This could have been due to the snowmobile bridge project or the removal of undersized culverts upstream on Robinson Road in 2015, which could have returned natural or delayed sediment to the river. Pebble counts at BCMR2 showed a large percentage of sand which was expected (Table). In the future we hope to find a decrease in the amount of sand due to the removal of undersized culverts in 2014. Pebble counts at BCMR shows largely gravel and pebbles.

Trends

BCMR1 has an increasing trend in dissolved oxygen. There are increasing trends for boulders, pebbles, gravel and woody debris which is all ideal for fish spawning at BCMR1. The Shannon-Weiner Diversity index for site BCMR2 is showing increasing trends. This could be due to the removal of an undersized culvert immediately downstream from sample site that allows for free movement of organisms.

Figure 7. Increasing macroinvertebrate index at BCMR2.



Five Mile Creek

Ziibiwiing

<u>Description and Background</u>

Five Mile Creek is the second largest tributary of Little Traverse Bay, and is a cold water spring-fed perennial creek. The creek has a heavily shaded canopy through most of the land it meanders, keeping the water cool. The creek flows into a trout pond, then into an old mill pond. Both ponds are on private land. After the private land, the creek flows through a cedar swamp owned by the Little Traverse Conservancy and meanders through forested private land until it discharges into Little Traverse Bay.

There is a monitoring site upstream (FMC3) located just below the mill pond and a site downstream by the mouth of the creek (FMC1). The WQPP staff was given permission by the land owner to monitor at both sites. Staff in turn have supplied the land owner access to the water quality information collected and are informed by the landowner of any water quality issues concerning Five Mile Creek. Issues reported by the landowner in recent years are increased beaver and deer activity along the creek's corridor.

Five Mile Creek is listed as a Designated Trout Stream under the authority Section 48701 by the MDNR. Common fish living in the creek include but are not limited to: rainbow, brown, and brook trout.

<u>Tribal Uses and Attainment</u>

The Primary Tribal use on both Five Mile Creek sites is **CDW**. Other Tribal uses include **PCR (May through October), SCR, IAL, WLC, SUB, NAV, COM**, and **IND.** All uses are fully supported at both sites on Five Mile Creek except **SUB. SUB** needs further evaluation because of a lack of toxin data in fish.

Data Summary Tables

Table 26. Data Summary Table for Downstream site of Five Mile Creek for 2018 (FMC1)

Parameter	Threshold Criteria	Month Collected	Parameter Results 2018	Exceedance
Chloride	50 mg/L	February	7.300	--
		May	12.200	--
		August	6.260	--
		October	7.050	--
Total Phosphorus	50 µg/L	February	18.000	--
		May	65.000	X
		August	17.000	--
		October	7.000	--
Total Nitrogen	1 mg/L	February	0.700	--
		May	0.800	--
		August	0.600	--
		October	0.550	--
Dissolved Oxygen	$\geq$ 7 mg/L	February	14.550	--
		May	13.098	--
		August	10.303	--
		October	12.633	--
Total Suspended Solids	25 mg/L	February	4.500	--
		May	135.800	X
		August	6.100	--
		October	-4.450	Reject
Temperature	Coldwater Fishery	February	0.633	--
		May	5.738	--
		August	14.397	--
		October	7.260	--
Conductivity	450 µS/cm	February	347.667	--
		May	203.750	--
		August	379.000	--
		October	356.000	--
pH	6.5-9 pH units	February	7.730	--
		May	7.625	--
		August	8.213	--
		October	8.060	--

Table 27: Data Summary Table for Upstream site of Five Mile Creek for 2018 (FMC3)

Parameter	Threshold Criteria	Month Collected	Parameter Results 2018	Exceedance
Chloride	50 mg/L	February	4.170	--
		May	5.350	--
		August	3.530	--
		October	5.080	--
Total Phosphorus	50 µg/L	February	20.000	--
		May	22.000	--
		August	14.000	--
		October	14.000	--
Total Nitrogen	1 mg/L	February	0.700	--
		May	1.000	X
		August	0.600	--
		October	0.550	--
Dissolved Oxygen	≥ 7 mg/L	February	13.730	--
		May	12.283	--
		August	9.928	--
		October	12.115	--
Total Suspended Solids	25 mg/L	February	9.000	--
		May	25.300	X
		August	2.300	--
		October	-2.450	Reject
Temperature	Coldwater Fishery	February	1.808	--
		May	7.123	--
		August	16.080	--
		October	7.650	--
Conductivity	450 µS/cm	February	292.000	--
		May	204.000	--
		August	315.500	--
		October	333.500	--
pH	6.5-9 pH units	February	7.545	--
		May	7.440	--
		August	8.055	--
		October	7.828	--

Biological Data

Substrate

Table 28 and 29: FMC1 Pebble Count Trends

FMC1	2012	2014	2016	2018	RSQ
Boulders	8%	8%	24%	11%	0.162373
Cobble	16%	26%	22%	23%	0.3078
Pebble	48%	30%	30%	57%	0.071588
Gravel	14%	18%	6%	4%	0.665564
Clay	0%	0%	0%	0%	#DIV/0!
Macroinvertebrates	0%	0%	0%	0%	#DIV/0!
Woody Debris	8%	4%	2%	0%	0.965714
Sand	4%	12%	12%	4%	0.000473
Silt	0%	0%	4%	0%	0.066667
Detritus	2%	2%	0%	0%	0.8
Muck	0%	0%	0%	0%	#DIV/0!

FMC3	2012	2014	2016	2018	RSQ
Boulders	2%	4%	8%	0%	0.005714
Cobble	6%	26%	6%	16%	0.018182
Pebble	46%	32%	48%	64%	0.475728
Gravel	8%	4%	10%	10%	0.3
Clay	0%	0%	0%	0%	#DIV/0!
Macroinvertebrates	0%	0%	0%	0%	#DIV/0!
Woody Debris	2%	4%	6%	0%	0.04
Sand	22%	0%	0%	10%	0.197561
Silt	4%	12%	22%	0%	0.000707
Detritus	10%	10%	0%	0%	0.8
Muck	0%	8%	0%	0%	0.066667

Discharge Rates

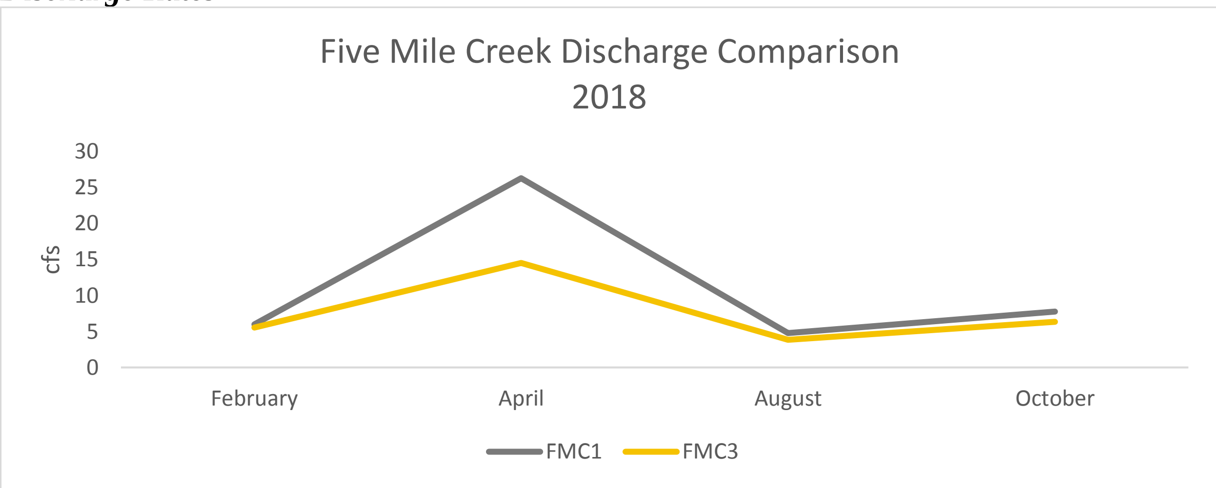


Figure 8. Five Mile Creek Discharge Rates 2018

Macroinvertebrates

Table 30 & 31: Five Mile Creek Macroinvertebrate trends

FMC1	2012	2014	2016	2018
Total Taxa	320	152	193	307
# Ephemeroptera	1	2	2	0
# Diptera	10	18	16	18
Richness (margalefs)	3.640574097	4.976232993	5.70050657	4.71
Shannon Weiner	2.114710215	2.382005821	2.763593	
% Tricoptera	4.6875	5.921052632	5.18134715	2
% crustacea and Mollusca	2.1875	4.605263158	7.25388601	0.33
# Filterers	1	2	0	3
# Scrapers	1	1	0	1
# EPT taxa	8	6	7	6
HBI	5.291666667	3.8	5.354330709	6.18408
NLF Score	28	30	28	28

FMC3	2012	2014	2016	2018
Total Taxa	567	339	326	305
# Ephemeroptera	1	2	2	1
# Diptera	17	14	13	17
Richness (margalefs)	5.047033	4.462753	5.184125	5.59
Shannon Weiner	2.469541	2.469762	1.717559	2.19
% Tricoptera	7.407407	15.04425	4.294479	17.04918
% crustacea and Mollusca	1.763668	7.669617	67.17791	1.64
# Filterers	4	1	0	3
# Scrapers	1	1	0	1
# EPT taxa	8	8	9	9
HBI	5.040404	5.425926	7.072165	4.35821
NLF Score	32	30	22	34

Narrative Summary

There were 4 exceedances observed for Five Mile Creek during sampling in 2018 and these all occurred in May at both FMC1 and FMC3. At FMC1, TP and TSS were seen to be above threshold limits and TN and TSS at FMC3 were also observed to follow this pattern. Other trends observed are posted in the tables and figures above for each respective site, where available.

Trends

Temperature for FMC1 and the pH for site FMC3 are showing decreasing trends. The decrease in temperature is unknown but since the dam failure in 2016, we would expect to see continuing decreases in temperature. There is a significant decrease in woody debris at FMC1. This could be due to the failing dam in 2016 or the result of heavy rains washing the debris out.

Minnehaha Creek

Description and Background

Minnehaha Creek is a tributary to Crooked Lake. It flows through a large wetland complex before it reaches the lake. Minnehaha Creek is a designated trout stream with Type 1 trout stream regulations. According to the Michigan Department of Natural Resources (MDNR)'s West Branch Minnehaha Creek 2003 Survey Analysis, two species of trout (brown and brook) were collected, in addition to three other species of fish representing a coldwater fish community. Brook trout were the most abundant game fish encountered and the Creek was noted as being a brook trout nursery.

Tribal Uses and Attainment

The Primary Tribal use on the Minnehaha Creek is **CLW** and **SCR**. Other Tribal uses include **PCR (May through October), SCR, IAL, WLC, SUB, NAV, COM**, and **IND.** All uses are fully supported at both sites on Minnehaha except **SUB. SUB** needs further evaluation because of a lack of toxin data in fish.

Data Summary Tables

Table 32. Data Summary Table for Minnehaha sampling site (MAC1)

Parameter	Threshold Criteria	Month Collected	Parameter Results 2018	Exceedance
Chloride	50 mg/L	May	8.661417	--
		June	8.724917	--
		July	9.359919	--
		August	8.026416	--
		September	8.597917	--
		October	9.359919	--
Total Phosphorus	50 µg/L	May	13	--
		June	23	--
		July	17	--
		August	14	--
		September	Reject	--
		October	18	--

Total Nitrogen	1 mg/L	May	0.9	--
		June	0.6	--
		July	0.72	--
		August	0.97	--
		September	Reject	--
		October	0.9	--
Dissolved Oxygen	≥ 7 mg/L	May	10.382	--
		June	9.036667	--
		July	9.516667	--
		August	10.14667	--
		September	9.956667	--
		October	12.32333	--
Total Suspended Solids	25 mg/L	May	2.8	--
		June	22.5	--
		July	8	--
		August	3.5	--
		September	2.8	--
		October	0.3	--
Temperature	Coldwater Fishery	May	12.274	--
		June	14.82	--
		July	14.32667	--
		August	13.92	--
		September	14.41333	--
		October	5.156667	--
Conductivity	450 µS/cm	May	399.8	--
		June	375	--
		July	404	--
		August	396	--
		September	391	--
		October	370.3333	--
pH	6.5-9 pH units	May	7.92	--
		June	7.83	--
		July	8.016667	--
		August	8.036667	--

	September	8.036667	--
	October	7.89	--

Biological Data

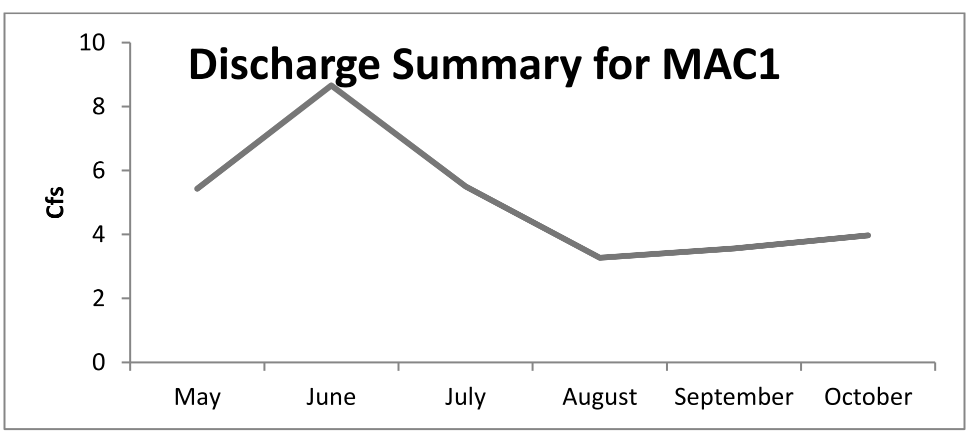
Substrate

Table 33. MAC1 Pebble Count

Site ID: MAC1	Date: 7/23/2018
Substrate Type	**Percent**
Boulders	0%
Cobble	0%
Pebble	6%
Gravel	16%
Clay	0%
Aquatic Macroinvertebrates	0%
Woody Debris	41%
Sand	35%
Silt	0%
Detritus/Vegetation	2%
Muck	0%
TOTAL	100%

Discharge Summary

Figure 8. Minnehaha Creek Discharge Rates 2018



Macroinvertebrates

Table 34: MAC1 Macroinvertebrate data

	2018
Total Taxa	136
# Ephemeroptera	1
# Diptera	15
Richness (margalefs)	5.292454
Shannon Weiner	2.754234
% Tricoptera	6.617647
% crustacea and Mollusca	9.558824
# Filterers	1
# Scrapers	1
# EPT taxa	7
HBI	3.80597
Score	30

Narrative Summary

There were no exceedances observed for Minnehaha Creek during sampling in 2018. Temperature and dissolved oxygen are at ideal levels for coldwater fish species and the discharge summary is a typical graph.

Trends

Because the Minnehaha Creek was only sampled for one year, trends are not able to be determined at this time.

Tannery Creek

Giigoonhkaamik

Description and Background

Tannery Creek is a cold water creek and is the third largest tributary in the Little Traverse Bay Watershed. This creek is the most impacted creek within the LTBB Reservation. Tannery Creek is approximately 5 miles long and is a perennial spring-fed creek. The creek meanders through agricultural land, a golf course, and areas of dense development. All land surrounding the creek is owned privately. Historically, a tannery was located on the creek, hence its name. When the tannery was in operation it has been said that Tannery Creek was highly polluted due to the continuous discharge of toxic tannery waste into the creek. This historical overview is purely documented from verbal accounts.

LTBB has two monitoring sites on Tannery Creek. The upstream site, TYC2A, is located on private property and permission is sought before each field season. This site is close to the origin of the creek and experiences minimal human disturbance. The downstream site, TYC1A is located about 100 feet upstream from the mouth of the creek. To view a map of these site locations please see Appendix, Map 7.

Tribal Uses and Attainment

The following Tribal uses are applied to Tannery Creek: **PCR** (May through October)**, SCR, IAL, WLS, CDW, SUB, NAV, COM, and IND**. The primary use at TYC2A is **IAL and WLS.**

The primary use at TYC1A is **CDW**. All Tribal Uses are fully supported. **SUB** needs further evaluation because of a lack of toxin data in fish.

Data Summary Tables

Table 35. Data Summary Table for Downstream Site (TYC1A)

Parameter	Threshold Criteria	Month Collected	Parameter Result	Exceedance
Chloride	50 mg/L	February	43	--
		April	36	--
		August	32	--
		October	35	--
Total Phosphorus	50 µg/L	February	8.20	--
		April	7.30	--
		August	22.00	--
		October	46.00	--
Total Nitrogen	1 mg/L	February	1.40	X
		April	1.20	X
		August	0.20	--
		October	1.59	X
Dissolved Oxygen	$\geq$ 7 mg/L	February	14.35	--
		April	10.37	--
		August	9.48	--
		October	9.77	--
Total Suspended Solids	25 mg/L	February	2.50	--
		April	0.30	--
		August	3.80	--
		October	30.90	X
Temperature	Coldwater Fishery	February	0.54	--
		April	14.13	X
		August	18.36	--
		October	15.83	X
Conductivity	450 µS/cm	February	469.20	X
		April	555.50	X
		August	573.00	X
		October	573.20	X
pH	6.5-9 pH units	February	7.19	--
		April	8.29	--
		August	8.34	--
		October	8.25	--

Table 36. Data Summary Table for Upstream site (TYC2A)

Parameter	Threshold Criteria	Month Collected	Parameter Result	Exceedance
Chloride	50 mg/L	February	23.79	--
		April	24.31	--
		August	20.07	--
		October	23.84	--
Total Phosphorus	50 µg/L	February	12.00	--
		April	8.60	--
		August	25.00	--
		October	27.00	--
Total Nitrogen	1 mg/L	February	0.81	--
		April	1.10	X
		August	*Not Detected	--
		October	1.12	X
Dissolved Oxygen	> 7 mg/L	February	9.85	--
		April	7.70	--
		August	6.54	X
		October	7.90	--
Total Suspended Solids	25 mg/L	February	3.6	--
		April	9.8	--
		August	9.6	--
		October	9.8	--
Temperature	Coldwater Fishery	February	1.00	--
		April	13.52	X
		August	17.30	--
		October	16.43	X
Conductivity	450 µS/cm	February	503.00	X
		April	509.33	X
		August	545.00	X
		October	510.00	X
pH	6.5-9 pH units	February	7.17	--
		April	7.55	--
		August	7.65	--
		October	7.61	--

Biological Data

Substrate

Table 37. TYC1A Pebble Count

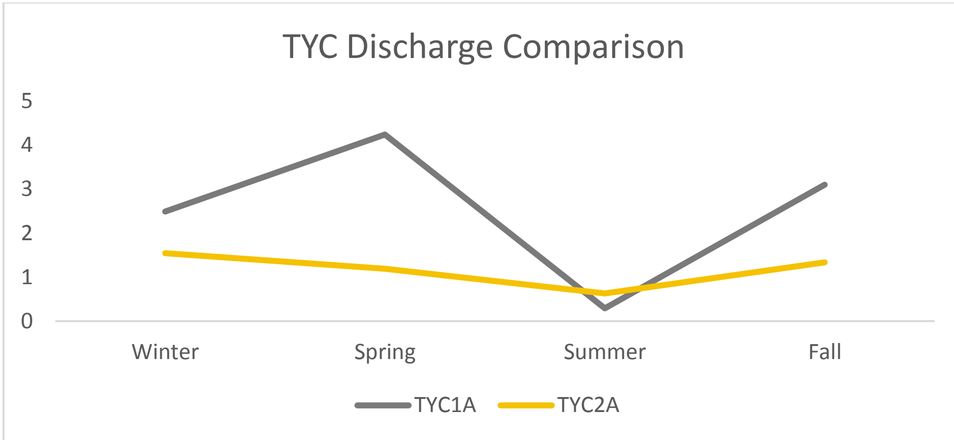
TYC1A	2011	2013	2015	2017	RSQ
Boulders	0%	8%	10%	8%	0.589575
Cobble	8%	18%	10%	18%	0.30883
Pebble	22%	32%	52%	20%	0.018287
Gravel	26%	22%	10%	18%	0.43693
Clay	0%	0%	0%	0%	#DIV/0!
Macroinvertebrates	0%	0%	0%	0%	#DIV/0!
Woody Debris	0%	6%	4%	10%	0.757009
Sand	28%	2%	12%	24%	3.3E-05
Silt	8%	2%	2%	0%	0.8
Detritus	2%	10%	0%	0%	0.188235
Muck	0%	0%	0%	0%	#DIV/0!
Man-made	6%	0%	0%		0.75

Table 38. TYC2A Pebble Count

TYC2A	2011	2013	2017	RSQ
Boulders	2%	4%	0%	0.428571
Cobble	0%	2%	0%	0.035714
Pebble	0%	0%	0%	#DIV/0!
Gravel	2%	0%	0%	0.571429
Clay	0%	0%	0%	#DIV/0!
Macroinvertebrates	0%	0%	0%	#DIV/0!
Woody Debris	18%	22%	14%	0.428571
Sand	16%	4%	60%	0.737073
Silt	42%	22%	10%	0.892857
Detritus	20%	46%	16%	0.094939
Muck	0%	0%	0%	#DIV/0!

Discharge Summary

Figure 9. Tannery Creek Discharge Rates 2017



Macroinvertebrates

Table 39 & 40: Tannery Creek Macroinvertebrate trends

TYC1A	2011	2013	2015	2017
Total Taxa	264	305	432	290
# Ephemeroptera	3	0	1	1
# Diptera	11	12	9	12
Richness (margalefs)	7.711692	3.496313	2.471811	4.409264
Shannon Weiner	3	1.96379	1.330181	1.773147
% Tricoptera	1.515152	0	1.157407	1.034483
% crustacea and Mollusca	21.21212	19.67213	10.64815	14.48276
# Filterers	3	0	0	3
# Scrapers	0	0	1	0
# EPT taxa	7	0	2	7
HBI	5.364055	5.138686	5.677596	5.421053
NLF Score	28	22.00	24	24

TYC2A	2011	2013	2015	2017
Total Taxa	121	251	179	282
# Ephemeroptera	1	0	0	2
# Diptera	19	22	16	18
Richness (margalefs)	6.04697	5.972361	4.241057	6.74
Shannon Weiner	2.478194	2.281987	2.271995	2.84
% Tricoptera	3.305785	1.593625	0.558659	2.12766
% crustacea and Mollusca	38.01653	45.01992	6.703911	17.38
# Filterers	2	0	2	3
# Scrapers	1	0	0	2
# EPT taxa	6	6	1	9
HBI	4.495575	5.239316	6.284768	6.52381
NLF Score	24	22.00	24	22

Narrative Summary
Tannery Creek had several exceedances, which is not surprising because it travels through a heavily urbanized area. The downstream site, TYC1A, had exceedances in conductivity during every sampling event (Table). There were also temperature exceedances in the spring and fall, a total suspended solid exceedance in the fall and total nitrogen exceedances in the winter, spring, and fall. Pebble counts show mainly sand and pebbles (Table). The beavers that had caused many issues in 2015 at the upstream site, TYC2A, appeared to have moved out of the area and the creek has, for the most part, found its original channel. There are still a few issues or remnant activity causing problems at the culvert (Figure). In 2017 there were several exceedances at TYCA (Table). Conductivity was exceeded in every sampling event and temperature was exceeded in spring and fall, the most crucial times for fish spawning. Dissolved oxygen in the summer was below the 7 mg/L standard for coldwater fish species. Total nitrogen was exceeded in the spring and fall as well. Pebble counts showed over half of the substrate is comprised of sand.

Total chloride levels are much higher at Tannery Creek than creeks with similar morphology. This is due to land use surrounding this creek, such as agriculture and development. The total chloride level at both sampling sites is the highest reported in any creek during the 2017 season (**Error! Reference source not found.**).

Trends
There is an increase in woody debris at the downstream site, and at the upstream site there is a decrease in silt and an increase in sand. The creek has found its channel again after the beaver have moved out. There was one unique case for Tannery Creek where macroinvertebrate trends were noticeable/ reportable. The Hilsenhoff Biotic Index (HBI) for site TYC2A met the r-squared threshold criteria (rsq > .7) for LTBB's standard of reporting on trends.

Figure 10. TYC2A macroinvertebrate trend

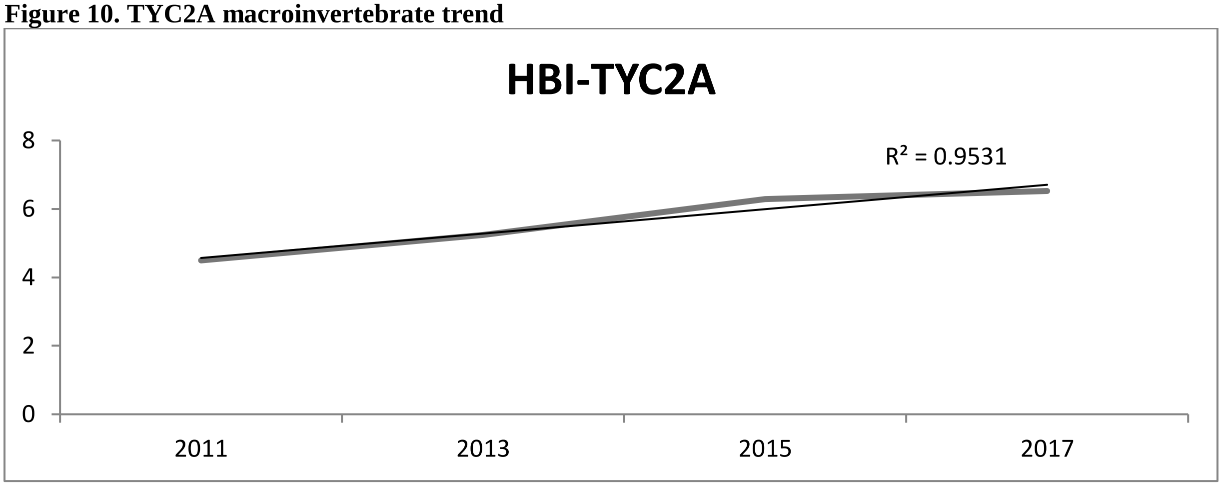


Figure 11. TYC2A in spring 2017. Upstream side of the culvert.

Silver Creek

Description & Background

Silver Creek is a perennial stream that flows north eventually merging with the Minnehaha creek before flowing into the southern portion of Crooked Lake. The land use of this watershed is primarily agriculture, open areas and wetland. This is a popular fishing creek for tribal citizens and the community as a whole.

Tribal Uses & Attainment

The Primary Tribal use on the Minnehaha Creek is CLW and SCR. Other Tribal uses include PCR (May through October), SCR, IAL, WLC, SUB, NAV, COM, and IND. All uses are fully supported at both sites on Minnehaha except SUB. SUB needs further evaluation because of a lack of toxin data in fish.

Data Summary Tables

Table 41. Data Summary Table for site SRC1.

Parameter	Threshold Criteria	Month Collected	Parameter Results 2018	Exceedance
Chloride	50 mg/L	May	5.093	--

		June	5.207	--
		July	4.966	--
		August	4.458	--
		September	5.182	--
		October	5.271	--
Total Phosphorus	50 µg/L	May	10.000	--
		June	18.000	--
		July	13.000	--
		August	15.000	--
		September	15.000	--
		October	18.000	--
Total Nitrogen	1 mg/L	May	0.400	--
		June	0.400	--
		July	0.400	--
		August	0.680	--
		September	0.890	--
		October	0.500	--
Dissolved Oxygen	$\geq$ 7 mg/L	May	11.012	--
		June	10.085	--
		July	10.498	--
		August	10.932	--
		September	11.150	--
		October	12.510	--
Total Suspended Solids	25 mg/L	May	3.000	--
		June	7.800	--
		July	0.500	--
		August	1.000	--
		September	-21.200	--
		October	1.050	--
Temperature	Coldwater Fishery	May	14.778	--
		June	13.488	--
		July	13.550	--
		August	13.282	--

		September	13.367	--
		October	5.544	--
Conductivity	450 µS/cm	May	360.000	--
		June	346.000	--
		July	360.200	--
		August	360.000	--
		September	354.000	--
		October	353.400	--
pH	6.5-9 pH units	May	8.098	--
		June	7.790	--
		July	8.048	--
		August	8.016	--
		September	7.943	--
		October	7.872	--

Biological Data

Substrate

Table 42. SRC1 Pebble count

Site ID: SRC1	Date: 7/23/2018
Substrate Type	**Percent**
Boulders	0%
Cobble	0%
Pebble	0%
Gravel	10%
Clay	0%
Aquatic Macroinvertebrates	0%
Woody Debris	49%
Sand	33%
Silt	0%
Detritus/Vegetation	6%
Muck	2%
TOTAL	100%

Discharge Rates

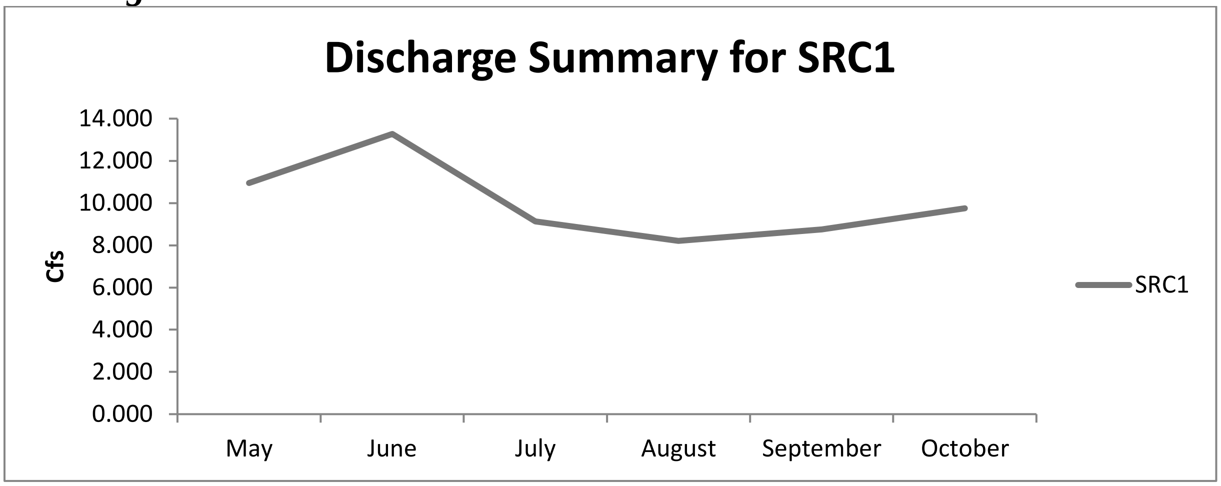


Figure 12. Silver Creek Discharge rates for 2018

Macroinvertebrates

Table 43: Silver Creek Macroinvertebrate data

	2018
Total Taxa	324
# Ephemeroptera	2
# Diptera	19
Richness (margalefs)	6.227573
Shannon Weiner	2.720856
% Tricoptera	2.469136
% crustacea and Mollusca	1.54321
# Filterers	4
# Scrapers	0
# EPT taxa	10
HBI	4.800752
Score	30

<u>Narrative Summary</u>

There were no exceedances observed for Silver Creek during sampling in 2018. Temperature and dissolved oxygen are at ideal levels for coldwater fish species and the discharge summary is a typical graph.

Trends

Because Silver Creek was only sampled for one year, trends are not able to be determined at this time.

Susan Creek

Description & Background

Susan Creek is an intermittent stream that originates at Susan Lake and is a tributary of the Little Traverse Bay Watershed. Susan Creek is approximately 5 miles long. Much of the area that Susan Creek meanders through is privately owned. The surrounding land includes forested wetlands and agricultural, residential, industrial, and conservancy land. Fifty-five acres of this land is Tribal conservation land known as the Taimi Hoag Natural Area.

This geographic area surrounding Susan Lake and Susan Creek has cultural significance to the Tribe. The area surrounding and adjacent to Susan Creek was traveled by the Odawa bands when migrating north. There is still an active Native American church and burial ground near the headwaters. Susan Lake and Creek were and are still used for fishing, hunting, and gathering. Spear fishing was an active way to fish for trout, steelhead and suckers during the spring and fall runs (when salmon and trout would attempt to spawn) in Susan Creek. The LTBB Taimi Hoag Natural Area is open to Tribal citizens for fishing, hunting, and gathering with proper licenses.

The Tribe manages the area of the creek that is within LTBB Taimi Hoag Natural Area and collaborates with the Little Traverse Conservancy (LTC) in maintaining the trails and any other upkeep within these areas. LTC has preserve land that connects to the LTBB conservation land.

A short portion of the creek has been walked by WQ staff, from SNC2A downstream to a footbridge. Staff found large cobble beds alternating with areas of sand, mud, and/or silt. Woody debris were dense throughout the creek, as were the presence of damsel flies

There are two monitoring sites on Susan Creek. The downstream site (SNC1A) was monitored May-October from 2011-2015. Previously, SNC1 was the downstream site, which was last reported on in LTBB's Baseline Assessment Report 2000-2010. SNC1A is the preferred monitoring site, as it is on Tribal trust land, allowing us to see if the creek is meeting draft tribal water quality standards. SNC1A is located within the Taimi Hoag Natural Area and is upstream of the mouth and U.S. 31 North. The upstream site, SNC2A, was moved from the previous SNC2 in 2007, since SNC2 capturing data from Susan Lake rather than from upstream of the Tribal property on Susan Creek like it was intended. SNC2A is located downstream of lowland wetland areas and some agricultural land. It is within the LTC Susan Creek Preserve property.

To view a map with exact monitoring locations please see Map 4, Appendix A.

Tribal Uses & Attainment

The following Tribal uses are applied to Susan Creek **PCR** (May through October)**, SCR, IAL, WLS, CLW, SUB, NAV, COM, and IND**. The primary uses at both sites are **IAL** and **WLS.** All Tribal uses except **SUB** are supported based on LTBB data results. **SUB** needs further evaluation because of a lack of toxin data in fish. Previously, Susan Creek was assessed as a warmwater fishery with routes for anadromous salmonids. Based on baseline temperatures, it will be assessed as a coolwater fishery (CLW) in this report. Fish populations are still unknown. LTBB plans to conduct fish assessments before the next report, so this designation may change.

The following sections report on specific exceedances in the reporting period as well as a complete baseline assessment.

Data Summary Tables

Table 44. Data Summary Table for Downstream Site (SNC1A)

Parameter	Threshold Criteria	Month Collected	Parameter Result	Exceedance
Chloride	50 mg/L	February	12.45	--
		May	15.25	--
		July	22.1	--
		October	12.55	--
Total Phosphorus	50 µg/L	February	15.00	--
		May	7.20	--
		July	11.00	--
		October	28.00	--
Total Nitrogen	1 mg/L	February	3.80	X
		May	1.00	--
		July	1.10	X
		October	1.20	X
Dissolved Oxygen	≥ 6 mg/L	February	13.97	--
		May	11.91	--
		July	9.42	--
		October	9.82	--
Total Suspended Solids	25 mg/L	February	3.50	--
		May	2.30	--
		July	11.30	--
		October	22.30	--
Temperature	Coolwater Fishery	February	-0.03	--
		May	8.46	--
		July	17.38	--
		October	12.59	--
Conductivity	450 µS/cm	February	404.67	--
		May	352.00	--
		July	399.00	--
		October	329.00	--
pH	6.5-9 pH units	February	8.18	--
		May	8.00	--
		July	8.44	--
		October	7.77	--

Table 45: Data Summary Table for Upstream Site (SNC2A)

Parameter	Threshold Criteria	Month Collected	Parameter Result	Exceedance

Chloride	50 mg/L	February	13.14	--
		May	14.61	--
		July	21.72	--
		October	12.92	--
Total Phosphorus	50 µg/L	February	*Not Detected	--
		May	12.00	--
		July	*Not Detected	--
		October	26.00	--
Total Nitrogen	1 mg/L	February	1.40	X
		May	1.10	X
		July	1.30	X
		October	0.70	--
Dissolved Oxygen	> 6 mg/L	February	12.90	--
		May	10.56	--
		July	8.32	--
		October	8.75	--
Total Suspended Solids	25 mg/L	February	3.60	--
		May	2.30	--
		July	5.50	--
		October	13.50	--
Temperature	Coolwater Fishery	February	-0.06	--
		May	12.62	--
		July	20.58	--
		October	12.63	--
Conductivity	450 µS/cm	February	405.60	--
		May	357.00	--
		July	397.00	--
		October	330.80	--
pH	6.5-9 pH units	February	7.45	--
		May	8.07	--
		July	8.30	--
		October	7.65	--

Biological Data

Substrate

Table 46 & 47: Susan Creek Pebble Count Trends

SNC1A	2011	2013	2014	2015	2017	RSQ
Boulders	0%	15%	4%	0%	4%	0.002339

Cobble	14%	6%	8%	12%	18%	0.178102
Pebble	14%	25%	48%	36%	38%	0.505949
Gravel	30%	8%	10%	8%	6%	0.666756
Clay	0%	0%	0%	0%	0%	#DIV/0!
Macroinvertebrates	0%	0%	0%	0%	0%	#DIV/0!
Woody Debris	12%	17%	14%	16%	20%	0.75431
Sand	24%	13%	10%	12%	10%	0.655388
Silt	6%	8%	6%	0%	2%	0.452456
Detritus	0%	8%	0%	14%	0%	0.00969
Muck		0%	0%	2%	2%	0.666667

SNC2A	2011	2013	2014	2015	2017	RSQ
Boulders	0%	2%	0%	0%	2%	0.180425
Cobble	4%	12%	16%	2%	0%	0.128178
Pebble	6%	28%	26%	24%	46%	0.832355
Gravel	20%	10%	18%	24%	10%	0.072518
Clay	0%	0%	0%	0%	2%	0.5625
Macroinvertebrates	0%	0%	0%	0%	0%	#DIV/0!
Woody Debris	14%	26%	16%	26%	23%	0.280234
Sand	36%	10%	14%	4%	17%	0.350472
Silt	20%	6%	8%	8%	0%	0.796402
Detritus	0%	6%	0%	12%	0%	0.015625
Muck	0%	0%	0%	0%	0%	#DIV/0!
Barbed Wire			2%			#DIV/0!

Discharge Rates

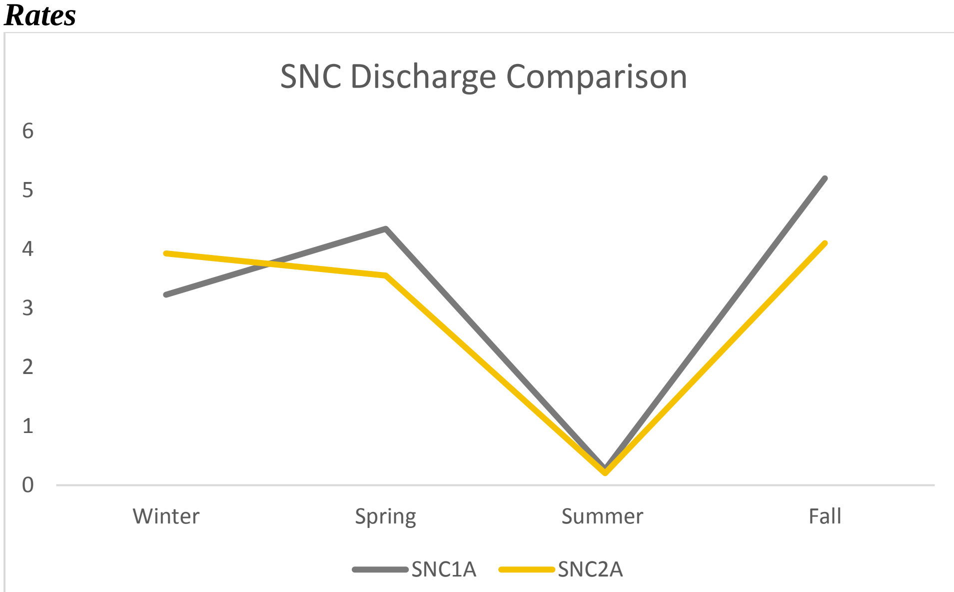


Figure 13. Susan Creek Discharge Rates 2017

Macroinvertebrates
Analyses were run on macroinvertebrate ID for 2017-18 by LTBB Staff as well as an auxiliary agency (Rhithron). Results were then generated and trends were able to be determined. Below are figures that illustrate these trends. For reference, "I" denotes an increase in 2017 from 2015, "D" denotes a decrease in 2017 from 2015 and "N" indicates no change in 2017 from 2015.

Table 48: Susan Creek Macroinvertebrate trends

SNC1A		SNC2A	
Total Taxa	I	Total Taxa	I
# Ephemeroptera	I	# Ephemeroptera	I
# Diptera	D	# Diptera	D
Richness (margalefs)	I	Richness (margalefs)	D
Shannon Weiner	I	Shannon Weiner	I
% Tricoptera	D	% Tricoptera	D
% crustacea and Mollusca	D	% crustacea and Mollusca	I
# Filterers	D	# Filterers	D
# Scrapers	D	# Scrapers	N
# EPT taxa	D	# EPT taxa	I
HBI	I	HBI	D
NLF Score	N	NLF Score	I

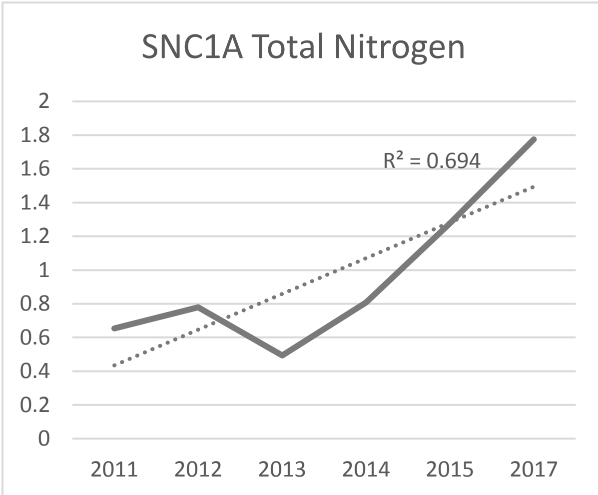
Narrative Summary

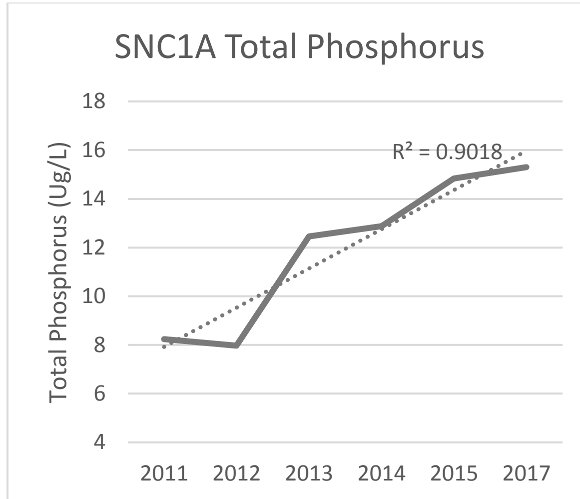
Data collected at both sites indicate low disturbances to water quality (Table 45 and Table46). The only parameter that did not fall within standards was total nitrogen. SNC2A exceeded standards in winter, spring, and summer and SNC1A exceeded standards in winter, summer, and fall. The most likely cause of this is the agriculture upstream. Pebble counts at both sites found primarily pebbles and woody debris (Table 48).

Trends

TN and TP for SNC1A are showing increasing trends. There is a farm located upstream which could be the cause. There was a significant increase in woody debris at SNC1A and an increase in pebbles and silt at SNC2A. We will try to complete more targeted monitoring in 2019. The HBI for site SNC1A is showing an increasing trend, despite the other trends we are seeing in TN and TP.

Figures 14 & 15. TN and TP trends





Van Creek

<u>Description and Background</u>

Van Creek is a tributary of the East Branch of the Maple River. The creek is approximately 8 miles long and the East Branch of the Maple River is classified as a Blue Ribbon Trout Stream by the State of Michigan. LTBB has a 75.7 acre wild game preserve, Waawaashkesh, where seeps and groundwater contribute to the origin of the Creek. Van Creek has been included in the WQPP monitoring design since 2011. To establish a baseline, monitoring occurred May-October every year. However, due to time constraints, vacancy in staff, and the issuance of an approved QAPP, monitoring did not begin until June of 2011. Two stretches of the creek are within two land bases owned by the Tribe. Therefore, EPA approved standards and uses could be applied on these reaches.

VNC2, the upstream site, is located on an 80 acre parcel owned by the Tribe with portions of the property and wetland used for aquaculture. The LTBB Fish Hatchery is located adjacent to this site and the water from the fish ponds are discharged into the wetlands connecting to the creek. Discharge from the hatchery occurred for a linear test performance on 10/25/2013 with approximately 400,000 gallons discharged from both ponds that were at half of their capacity. From 8/5/2014-8/7/2014 approximately 966,000 gallons of pond water was discharged from Ponds A and B (slowly drained at the same time). Pond discharge also occurred on 6/13/17 (pond A) & 6/14/17 (pond B) with approximately 483,000 gallons of pond water discharged into the wetland areas on the south side of the creek. The Hatchery is installing a recirculating water system in 2018 that should reduce the amount of water used by 95-99%.

VNC1, the downstream site has a narrow cross section and occasionally dries up in the summer months. Downstream of VNC1 there is an active beaver activity creating a flooded area on a private landowner's property. While the landowner enjoys the wetland habitat that this activity creates, another landowner downstream complains of flooding. To view a map of these sites' locations please reference Map 5 in the Appendix.

LTBB is planning on restoring a failing road stream crossing at Van Creek and Reed Road in 2018. The Emmet County Road Commission put in relief culverts on Reed Road in 2016 due to this undersized culvert and the presence of beavers. Two culverts on the Petoskey-Mackinaw Bike Trail and another crossing on Van Rd. are scheduled to be upgraded the following year.

Tribal Uses and Attainment

The following Tribal uses are applied to Van Creek: **PCR** (May through October)**, SCR, TCC, IAL, WLS, CDW, NAV, COM, IND, and AQA**. The primary use at both sites is **IAW.** The primary use and all other uses are supported at VNC2. All uses are supported at Van Creek except for **CDW**, due to temperatures and dissolved oxygen.

Data Summary Tables

Table 49. Data Summary Table VNC1

Parameter	Threshold Criteria	Month Collected	Parameter Result	Exceedance
Chloride	50 mg/L	February	12	--
		April	6.46	--
		October	12.51	--
Total Phosphorus	50 µg/L	February	*Not Detected	--
		April	12.00	--
		October	160.00	X
Total Nitrogen	1 mg/L	February	*Not Detected	--
		April	0.90	--
		October	1.90	X
Dissolved Oxygen	≥ 7 mg/L	February	5.28	X
		April	4.13	X
		October	3.44	X
Total Suspended Solids	25 mg/L	February	1.10	--
		April	Reject	--
		October	12.80	--
Temperature	Coldwater Fishery	February	1.11	--
		April	12.91	X
		October	14.05	X
Conductivity	450 µS/cm	February	350.75	--
		April	316.67	--
		October	468.50	X
pH	6.5-9 pH units	February	7.86	--
		April	7.30	--
		October	7.49	--

Table 50. Data Summary Table for VNC2

Parameter	Threshold Criteria	Month Collected	Parameter Result	Exceedance
Chloride	50 mg/L	April	1.73	--
		July	1.87	--
		October	2.36	--
Total Phosphorus	50 µg/L	April	*Not Detected	--
		July	Reject	--
		October	45.00	--
Total Nitrogen	1 mg/L	April	0.90	--
		July	0.70	--
		October	0.90	--
Dissolved Oxygen	> 7 mg/L	April	3.57	X
		July	3.07	X
		October	4.75	X
Total Suspended Solids	25 mg/L	April	Reject	--
		July	4.10	--
		October	22.30	--
Temperature	Coldwater Fishery	April	12.02	--
		July	21.87	X
		October	13.85	X
Conductivity	450 µS/cm	April	291.00	--
		July	375.00	--
		October	408.80	--
pH	6.5-9 pH units	April	7.27	--
		July	7.59	--
		October	7.26	--

Biological Data

Pebble Counts: There were no pebble counts done for either site at Van Creek.

Macroinvertebrates

Table 51 & 52: VNC Macroinvertebrate trends

	2012	2013	2014	2015	2016	2017
Total Taxa	335	365	277	367	293	373
# Ephemeroptera	0	3	1	0	1	2
# Diptera	13	9	16	15	5	11
Richness (margalefs)	2.579921	3.220395	4.800839	4.233441	3.697071	5.40
Shannon Weiner	1.363982	1.043824	2.157112	1.953619	1.725314	2.16
% Tricoptera	0.597015	1.369863	8.303249	0.817439	2.047782	1.876676

% crustacea and Mollusca	0	0	0	0.544959	4.778157	5.90
# Filterers	2	0	3	2	0	2
# Scrapers	0	0	1	1	0	2
# EPT taxa	2	6	8	3	5	5
HBI	6.225904	6	5.337838	6.23494	6.203922	6.35897
NLF Score	24	28.00	30	24	22	26

	2012	**2013**	**2014**	**2015**
Total Taxa	148	36	186	289
# Ephemeroptera	1	1	1	4
# Diptera	26	11	27	36
Richness (margalefs)	6.203459	4.464885	7.271688	8.823903
Shannon Weiner	2.934284	2.389013	3.117642	3.341287
% Tricoptera	1.351351	11.11111	9.677419	2.076125
% crustacea and Mollusca	8.108108	25	2.150538	10.38062
# Filterers	2	0	2	3
# Scrapers	0	0	0	0
# EPT taxa	2	3	6	8
HBI	6.883212	6.647059	7.613636	6.264574
NLF Score	22	22.00	26	32

Discharge Rates

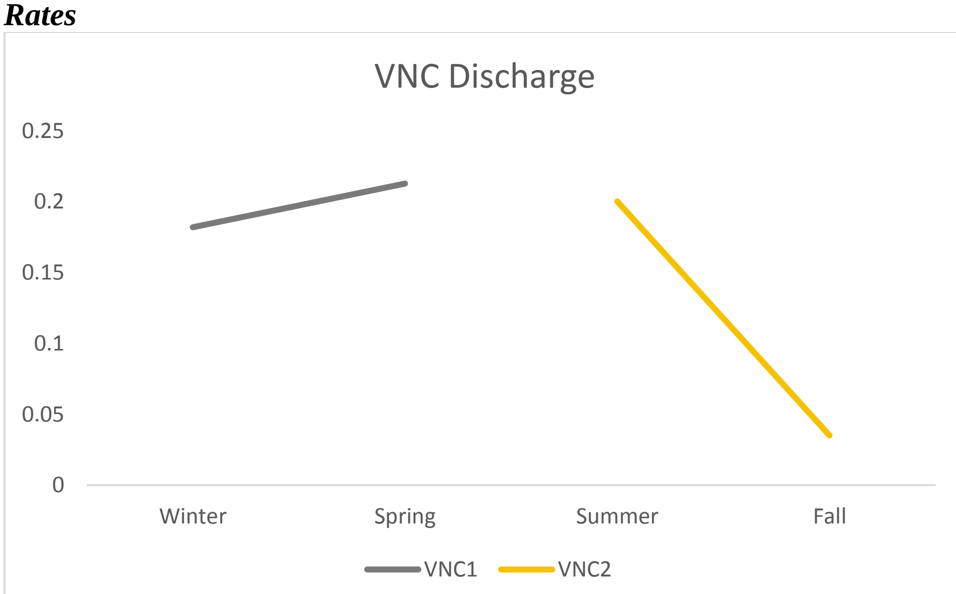


Figure 16. Van Creek Discharge Comparisons 2018

Discharge measurements were sporadic on Van Creek because of beaver dam and construction activities (Figure). Construction on Van Creek in the summer prevented us from accessing the VNC1 site. Water was unmoving in the fall due to a berm created downstream of the crossing at

VNC1. VNC2 was frozen in the winter and we monitored it via kayak in the spring, which made us unable to use the FlowTracker. In the summer and fall we moved our monitoring to a wadeable stretch of the creek 35 meters downstream from the normal site.

Narrative Summary

The upstream site, VNC2, was completely frozen over in the winter and therefore was not monitored that season. In the spring, the site was sampled via kayak because beavers have created a large dam just downstream of the monitoring site, halting the flow of water and creating a very large and deep pool (Figure 17). Discharge was not monitored in the spring. In the summer and fall we decided to monitor below the dam about 35 meters. The dissolved oxygen in the spring, summer and fall were below standards for a coldwater fishery (and even for a warmwater fishery) (Table 49 and 50).

Our site downstream, VNC1, went under restoration over the summer. We were able to complete normal sampling in the winter and spring. In the summer, trees had been cut down and the ditch, where the creek was located was excavated. The new culvert was in place by August, as were the relief culverts. The new concrete box culvert was put in perpendicular to US31, unlike the old culverts which appeared to try and keep the original direction of the stream, in a southeast direction. Our visit to the site in August revealed to us that the creek has now taken a new route, from a failing culvert under the Petoskey-Mackinaw bike trail directly under US31 via the relief culvert. We will photo monitor this site in 2018 and sample again in 2019.

There was an exceedance in the fall of total phosphorus and total nitrogen at VNC1. This is due to the fact that MDOT seeded the ditch with turf grass and fertilizer. Dissolved oxygen was below the standard for a coldwater fishery in all the seasons we monitored and temperature was above the standard in the spring and fall. This is not surprising due to the failing culvert and the construction that took place. Conductivity was also exceeded in the fall.

Trends

Chloride and discharge for site VNC1 are showing increasing trends. The National Lakes and Forests score for site VNC2 is increasing.

Figure 17. April sampling at VNC2 via kayak (background of photo)

Figure 18. VNC1/US-31 HWY Construction in July

Figure 19. New culvert at VNC1 and US-31 HWY in August

Figure 20. VNC1 in October

Carp River

Description and Background

The Carp River begins at Paradise (Carp) Lake, flowing over 10 miles to Lake Michigan in Cecil Bay. It is home to the federally endangered Hungerford's Crawling Water Beetle. The land surrounding the Carp River is a mix of state land, private land and a county park at the mouth. Most of the river is forested and there is some beaver activity. The tribe owns a 300 acre farm, Ziibimijwang, located on both sides of about a one mile reach of the river.

There are three monitoring sites on the river; the upstream (CPR3) site is north of the culverts on Munger Road, the midsection (CPR2) is located on LTBB trust property (Ziibimijwang) on Gill Road, and the downstream (CPR1) site is located at Cecil Bay Park near the mouth. The middle site (CPR2, located on tribal trust property) was electroshocked by the IFWP in 2014 and 2015. Both warm and cold water fish species were present.

LTBB is planning to restore the Gill Road crossing in 2019. The crossings at Reed Road and Munger Road are also planned to be restored by Conservation Resource Alliance and LTBB in the future.

Tribal Uses and Attainment

The Primary use for Carp River is **IAW.** Other Tribal uses applied are **PCR** (May-October), **SCR, IAL, WLS, CDW, SUB, NAV, COM, IND, AGR, OTR**. Fish were observed in the downstream and upstream monitoring sites. All sites supported all uses assigned, except for **SUB**, which needs further evaluation because of a lack of toxin data in fish. The river receives an **OTR** designation as it is home to the federally-threatened Hungerford's Crawling Water Beetle (*Brychius hungerfordi*).

Data Summary Tables

Table 53. Data Summary Table for Upstream site of Carp River (CPR3)

Parameter	Threshold Criteria	Month Collected	Parameter Results 2017	Exceedance	Parameter Results 2018	Exceedance
Chloride	50 mg/L	May	11.67	--	10.960	--
		June	13.63	--	12.344	--
		July	13.36	--	12.243	--
		August	13.37	--	8.166	--
		September	14.59	--	10.236	--
		October	11.26	--	14.656	--
Total Phosphorus	50 µg/L	May	*Not Detected	--	10.000	--
		June	*Not Detected	--	11.000	--
		July	*Not Detected	--	13.000	--

		August	11	--	11.000	--
		September	20	--	10.000	--
		October	15	--	23.000	--
Total Nitrogen	1 mg/L	May	1	--	*Not Detected	--
		June	1.1	X	0.400	--
		July	0.8	--	0.130	--
		August	*Not Detected	--	0.870	--
		September	0.6	--	0.490	--
		October	*Not Detected	--	0.360	--
Dissolved Oxygen	≥ 7 mg/L	May	10.17	--	8.956	--
		June	7.85	--	8.636	--
		July	7.91	--	8.323	--
		August	8.11	--	9.433	--
		September	8.22	--	9.388	--
		October	10	--	12.031	--
Total Suspended Solids	25 mg/L	May	1.1	--	1.300	--
		June	1.6	--	3.800	--
		July	4.5	--	0.500	--
		August	3	--	2.300	--
		September	1.5	--	2.000	--
		October	0.6	--	3.050	--
Temperature	Coldwater Fishery	May	13.28	--	19.180	--
		June	20.97	X	19.380	--
		July	22.69	X	18.484	--
		August	20.47	X	19.356	--
		September	18.32	X	13.201	--
		October	11.72	--	6.791	--
Conductivity	450 µS/cm	May	244.8	--	231.875	--
		June	262.64	--	272.600	--
		July	269	--	424.000	--
		August	260.5	--	426.000	--
		September	267.2	--	422.125	--

		October	271.73	--	226.400	--
pH	6.5-9 pH units	May	7.94	--	7.870	--
		June	7.91	--	7.847	--
		July	8.11	--	7.860	--
		August	8.04	--	7.751	--
		September	7.68	--	7.720	--
		October	7.72	--	7.729	--

Table 54. Data Summary Table for midsection of Carp River (CPR2)

Parameter	Threshold Criteria	Month Collected	Parameter Results 2017	Exceedance	Parameter Results 2018	
Chloride	50 mg/L	May	12.24	--	11.214	--
		June	12.41	--	11.367	--
		July	12.04	--	8.979	--
		August	12.26	--	8.344	--
		September	12.03	--	8.649	--
		October	12.74	--	7.620	--
Total Phosphorus	50 µg/L	May	7	--	9.000	--
		June	*Not Detected	--	17.000	--
		July	5.9	--	18.000	--
		August	12	--	13.000	--
		September	*Not Detected	--	7.000	--
		October	8.2	--	Reject	--
Total Nitrogen	1 mg/L	May	1	--	*Not Detected	--
		June	1.1	X	0.600	--
		July	0.7	--	1.700	X
		August	*Not Detected	--	0.078	--
		September	*Not Detected	--	0.360	--
		October	*Not Detected	--	*Not Detected	--
Dissolved Oxygen	≥ 7 mg/L	May	10.43	--	9.436	--
		June	9.12	--	8.822	--
		July	9.74	--	9.211	--

		August	9.33	--	10.380	--
		September	10.26	--	10.283	--
		October	10.74	--	12.081	--
Total Suspended Solids	25 mg/L	May	REJECT	--	2.800	--
		June	REJECT	--	2.800	--
		July	3.3	--	1.300	--
		August	5.1	--	0.600	--
		September	REJECT	--	0.600	--
		October	0.6	--	Reject	--
Temperature	Coldwater Fishery	May	11.76	--	15.848	--
		June	18.92	--	18.526	--
		July	18.81	--	15.576	--
		August	18.3	--	16.386	--
		September	15.66	--	12.470	--
		October	11.37	--	6.658	--
Conductivity	450 µS/cm	May	239.75	--	239.000	--
		June	284.91	--	212.923	--
		July	291	--	357.857	--
		August	281.9	--	376.143	--
		September	291.7	--	383.917	--
		October	296.8	--	235.071	--
pH	6.5-9 pH units	May	7.95	--	7.784	--
		June	8.05	--	7.732	--
		July	8.28	--	7.873	--
		August	8.15	--	7.770	--
		September	7.95	--	7.858	--
		October	7.91	--	7.849	--

Table 55. Data Summary Table for downstream Carp River (CPR1)

Parameter	Threshold Criteria	Month Collected	Parameter Results 2017	Exceedance	Parameter Results 2018	
Chloride	50 mg/L	May	10.25	--	10.871	--
		June	12.12	--	10.389	--

		July	11.85	--	9.208	--
		August	12.89	--	7.899	--
		September	11.87	--	9.576	--
		October	9.49	--	Reject	--
Total Phosphorus	50 µg/L	May	*Not Detected	--	11.000	--
		June	*Not Detected	--	13.000	--
		July	*Not Detected	--	20.000	--
		August	11	--	13.000	--
		September	8.6	--	9.000	--
		October	19	--	17.000	--
Total Nitrogen	1 mg/L	May	1.1	X	*Not Detected	--
		June	1.1	X	0.400	--
		July	0.6	--	1.200	X
		August	*Not Detected	--	0.250	--
		September	0.06	--	*Not Detected	--
		October	*Not Detected	--	0.066	--
Dissolved Oxygen	≥ 7 mg/L	May	10.91	--	10.228	--
		June	9.29	--	9.314	--
		July	9.33	--	8.269	--
		August	9.39	--	8.964	--
		September	9.74	--	9.524	--
		October	11.02	--	12.768	--
Total Suspended Solids	25 mg/L	May	2.3	--	6.300	--
		June	1.8	--	3.100	--
		July	4.8	--	2.000	--
		August	5.3	--	2.100	--
		September	1.3	--	3.600	--
		October	4.3	--	Reject	--
Temperature	Coldwater Fishery	May	11.52	--	14.811	--
		June	19.3	--	17.402	--
		July	17.83	--	20.679	--

		August	17.74	--	20.107	--
		September	15.96	--	16.224	--
		October	9.67	--	6.336	--
Conductivity	450 µS/cm	May	247	--	241.462	--
		June	299	--	290.385	--
		July	303.67	--	375.333	--
		August	296.42	--	390.667	--
		September	309.18	--	390.667	--
		October	311.75	--	238.917	--
pH	6.5-9 pH units	May	7.8	--	7.864	--
		June	8.05	--	7.916	--
		July	8.18	--	8.251	--
		August	8.12	--	8.278	--
		September	7.95	--	8.119	--
		October	7.84	--	7.740	--

Biological Data

Substrate

Tables 56-58. Carp River Pebble Counts

CPR1			
	2016	2017	2018
Boulders	14%	0%	N/A
Cobble	20%	18%	N/A
Pebble	14%	27%	N/A
Gravel	6%	20%	N/A
Clay	0%	12%	N/A
Aquatic Macroinvertebrates	0%	0%	N/A
Woody Debris	16%	2%	N/A
Sand	0%	8%	N/A
Silt	30%	6%	N/A
Detritus/Vegetation	0%	6%	N/A
Muck	0%	0%	N/A

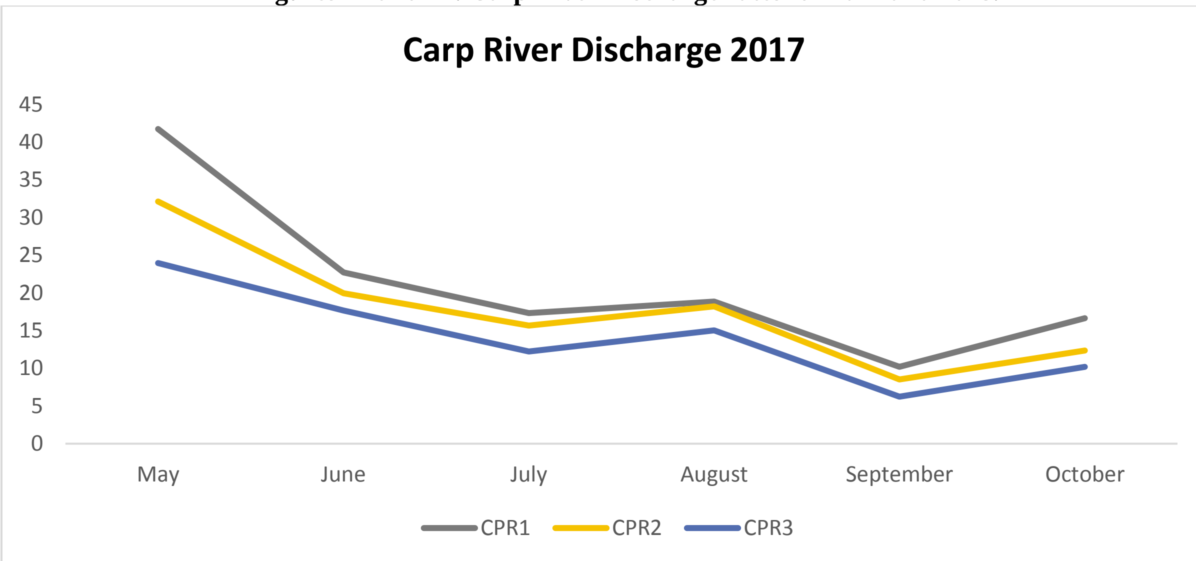
CPR2				
CPR2	2016	2017	2018	RSQ

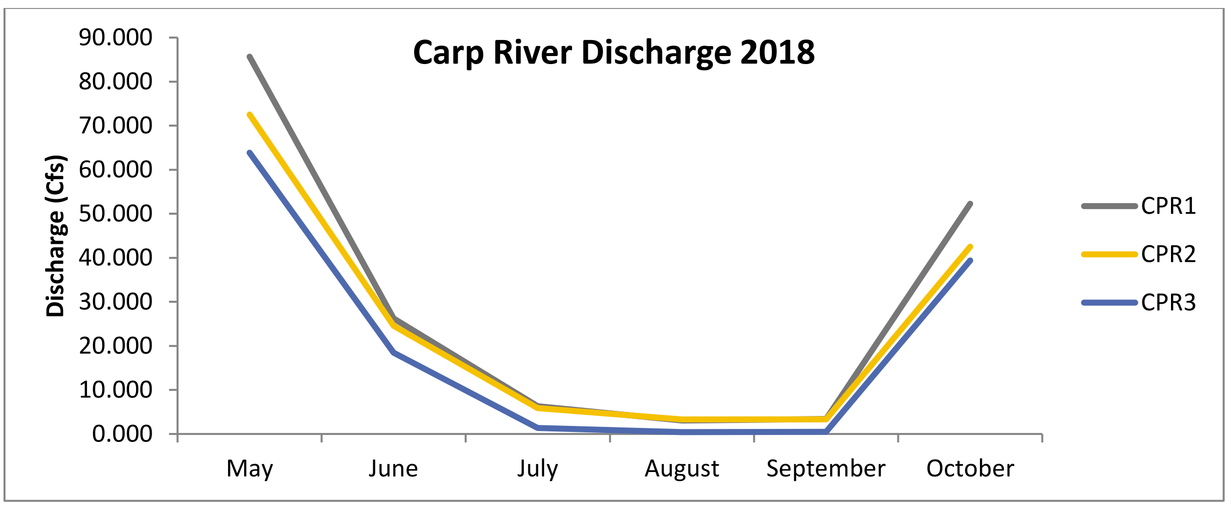
Boulders	0%	4%	0%	0
Cobble	6%	8%	2%	0.428571
Pebble	38%	12%	14%	0.687898
Gravel	4%	12%	6%	0.057692
Clay	0%	0%	0%	#DIV/0!
Macroinvertebrates	0%	0%	0%	#DIV/0!
Woody Debris	34%	30%	30%	0.75
Sand	0%	16%	46%	0.970049
Silt	18%	2%	0%	0.832192
Detritus	0%	14%	2%	0.017442
Muck	0%	2%	0%	0

CPR3				
CPR3	2016	2017	2018	RSQ
Boulders	0%	2%	0%	0
Cobble	0%	0%	8%	0.75
Pebble	12%	0%	32%	0.382653
Gravel	4%	6%	14%	0.892857
Clay	0%	0%	0%	#DIV/0!
Macroinvertebrates	0%	0%	0%	#DIV/0!
Woody Debris	16%	18%	8%	0.571429
Sand	52%	58%	34%	0.519231
Silt	0%	10%	0%	0
Detritus	2%	4%	4%	0.75
Muck	14%	2%	0%	0.854651

Discharge Rates

Figures 21 and 22: Carp River Discharge rates for 2017 and 2018.





Discharge rates at the Carp River mimic expected flows. The high discharge in August 2017 is due to a large rain event that occurred the day before sampling.

Macroinvertebrates

Table 59-61: BNR Macroinvertebrate trends

CPR1	2016	2017	2018
Total Taxa	309	368	310
# Ephemeroptera	5	10	4
# Diptera	26	15	22
Richness (margalefs)	10.4651	4.50	8.19
Shannon Weiner	3.190448	2.47	2.91
% Tricoptera	4.530744	2.717391	6.129032

% crustacea and Mollusca	1.294498	0.54	2.90
# Filterers	0	2	4
# Scrapers	0	5	4
# EPT taxa	22	5	13
HBI	4.888889	5.73209	5.45333
NLF Score	36	34	32

CPR2	2016	2017	2018
Total Taxa	327	414	334
# Ephemeroptera	3	4	2
# Diptera	24	24	20
Richness (margalefs)	8.635638	8.30	8.09
Shannon Weiner	3.380088	3.13	3.17
% Tricoptera	8.868502	3.140097	18.26347
% crustacea and Mollusca	1.529052	0.48	0.30
# Filterers	0	4	4
# Scrapers	0	5	4
# EPT taxa	16	12	19
HBI	4.325342	4.45260	3.81651
NLF Score	36	36	36

CPR3	2016	2017	2018
Total Taxa	301	308	329
# Ephemeroptera	5	3	2
# Diptera	19	19	20
Richness (margalefs)	8.235341	7.68	7.763898
Shannon Weiner	2.768774	2.70	3.372986
% Tricoptera	2.325581	0.324675	4.863222
% crustacea and Mollusca	10.299	7.14	1.823708
# Filterers	0	4	3
# Scrapers	0	6	4
# EPT taxa	16	2	17
HBI	5.058559	4.57831	4.324468
NLF Score	32	34	34

Narrative Summary

Overall, the Carp River had quite a few exceedances in water quality/ water chemistry for 2017/18. Chief among others was likely temperature at site CPR3 in 2017. Total nitrogen was also exceeded at various times across the sites. As mentioned earlier, there are 3 road stream crossings slated for removal in the next 2-3 years. We will take an in depth look at this site in the next report as the baseline assessment will be completed.

Trends

We can only look at trends for pebble counts at CPR2 and 3, it's unclear why 2018 data is missing for CPR1. There is an increase in sand and silt at CPR2 and an increase in gravel, detritus, and muck at CPR3. We will expect for these trends to change over the next couple of years as several of the culverts are being removed. There were 13 reportable trends for Carp River for the three years of data that we have. Discharge and TP has increased at all three sampling locations. pH has decreased at CPR2 & 3. DO has increased at CPR2 &3. TN has increased in CPR1 & 3. In at least one metric there is a significant decrease in scores for all three sites. This will be evaluated more closely in the next trends report.

Wycamp Creek

Description & Background

Spirit Creek, otherwise known as Wycamp Creek, is a perennial creek with rainbow trout and salmon migration observed attempting to spawn in the creek bed. Whether temperatures are able to support these fish populations during their development and all life stages need to be further investigated with fish population studies. Tribal citizens are often observed on this creek fishing for subsistence. The creek originates at Spirit Lake and flows into Lake Michigan. Prior to European settlement, Odawa people lived in the area adjacent to the mouth of Spirit Creek where it flows into Lake Michigan (Andrews). There is still a large population of Odawa living in this area. According to the Tribal uses questionnaire, Spirit Creek is the third most used creek by Tribal Citizens.

Spirit Creek's land base is owned by the State of Michigan. The upstream site (WPC2) is located on state land just below the Spirit Lake dam. Approximately 30 acres of the creek is within a conservation easement at the mouth of the creek. It is the location of the downstream monitoring site, WPC1. Near the end of the reporting period, LTBB acquired land on Wycamp Creek and we may move the downstream monitoring site there to apply Tribal uses and standards.

Tribal Uses & Attainment

The Primary use for Spirit Creek is **SUB.** Other Tribal uses applied are **PCR** (May-October), **SCR, TCC, IAL, WLS, WWF, SUB, NAV, COM, IND, OTR.** All uses except for SUB are fully supported. **SUB** needs further evaluation because of a lack of toxin data in fish.

Data Summary Tables

Table 62. Data Summary Table for Downstream site of Wycamp Creek (WPC1)

Parameter	Threshold Criteria	Month Collected	Parameter Results 2018	Exceedance
Chloride	50 mg/L	February	5.680	--
		May	3.450	--
		August	5.250	--

		October	4.640	--
Total Phosphorus	50 µg/L	February	14.000	--
		May	*Not Detected	--
		August	23.000	--
		October	12.000	--
Total Nitrogen	1 mg/L	February	0.400	--
		May	0.100	--
		August	0.900	--
		October	0.290	--
Dissolved Oxygen	$\geq$ 7 mg/L	February	13.833	--
		May	9.301	--
		August	8.422	--
		October	12.508	--
Total Suspended Solids	25 mg/L	February	0.800	--
		May	2.600	--
		August	2.500	--
		October	-3.450	Reject
Temperature	Warmwater Fishery	February	0.441	--
		May	14.116	--
		August	20.681	--
		October	5.517	--
Conductivity	450 µS/cm	February	301.545	--
		May	203.222	--
		August	258.889	--
		October	266.100	--
pH	6.5-9 pH units	February	7.284	--
		May	7.574	--
		August	8.097	--
		October	7.467	--

Table 63. Data Summary Table for Upstream site of Wycamp Creek (WPC2)

Parameter	Threshold Criteria	Month Collected	Parameter Results 2018	Exceedance
Chloride	50 mg/L	February	5.330	--
		May	3.420	--
		August	3.700	--
		October	4.500	--
Total Phosphorus	50 µg/L	February	12.000	--
		May	*Not Detected	--
		August	19.000	--

		October	14.000	--
Total Nitrogen	1 mg/L	February	0.400	--
		May	0.100	--
		August	0.600	--
		October	0.310	--
Dissolved Oxygen	$\geq$ 7 mg/L	February	11.331	--
		May	9.568	--
		August	7.390	--
		October	12.579	--
Total Suspended Solids	25 mg/L	February	-0.200	--
		May	1.100	--
		August	1.500	--
		October	-3.200	Reject
Temperature	Warmwater Fishery	February	2.687	--
		May	16.374	--
		August	27.091	--
		October	5.443	--
Conductivity	450 µS/cm	February	341.000	--
		May	200.167	--
		August	276.000	--
		October	270.600	--
pH	6.5-9 pH units	February	7.235	--
		May	7.993	--
		August	8.268	--
		October	7.911	--

Biological Data

Substrate

Table 64 and 65: Wycamp Creek Pebble Count Trends

WPC1	2012	2014	2016	2018	RSQ
Boulders	0%	0%	2%	4%	0.890909
Cobble	28%	20%	0%	14%	0.458711
Pebble	44%	46%	42%	46%	0.018182
Gravel	8%	4%	10%	8%	0.094737
Clay	4%	0%	0%	0%	0.6
Macroinvertebrates	0%	0%	0%	0%	#DIV/0!
Woody Debris	0%	12%	30%	2%	0.051064
Sand	10%	4%	0%	18%	0.108696

Silt	0%	12%	16%	0%	0.003922
Detritus	4%	2%	0%	8%	0.142857
Muck	2%	0%	0%	0%	0.6

WPC2	2012	2014	2016	2018	RSQ
Boulders	0%	2%	0%	2%	0.208288
Cobble	0%	2%	6%	0%	0.032655
Pebble	26%	39%	26%	35%	0.092984
Gravel	28%	18%	6%	27%	0.036535
Clay	0%	0%	0%	0%	#DIV/0!
Macroinvertebrates	0%	0%	0%	0%	#DIV/0!
Woody Debris	10%	22%	36%	15%	0.095793
Sand	30%	12%	0%	17%	0.296641
Silt	0%	2%	26%	0%	0.059352
Detritus	6%	2%	0%	2%	0.503656
Muck	0%	0%	0%	2%	0.6

Macroinvertebrates

Table 66 & 67: BNR Macroinvertebrate trends

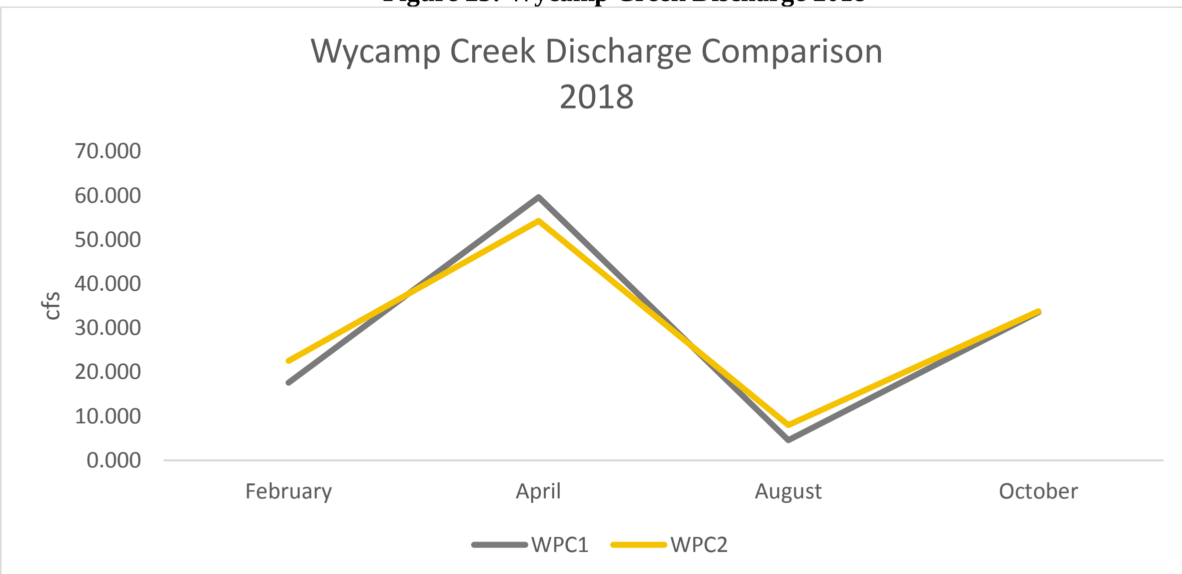
WPC1	2012	2014	2016	2018
Total Taxa	358	295	326	328
# Ephemeroptera	0	2	0	0
# Diptera	15	16	10	11
Richness (margalefs)	4.251315324	5.451052	4.147300085	3.80
Shannon Weiner	2.504972869	2.262783	2.50166433	1.58
% Tricoptera	10.33519553	10.50847	9.81595092	1.829268
% crustacea and Mollusca	0	1.016949	0	0.61
# Filterers	4	1	0	3
# Scrapers	2	2	0	2
# EPT taxa	4	8	4	6
HBI	5.355555556	5.357143	5.866906475	5.57088
NLF Score	28	28	26	28

WPC2	2012	2014	2016	2018
Total Taxa	481	1213	355	331
# Ephemeroptera	1	0	1	1
# Diptera	15	9	12	4
Richness (margalefs)	3.238412	1.54911	3.576223	2.41
Shannon Weiner	1.364262	0.274731	0.949318	0.86

% Tricoptera	1.663202	0.247321	2.816901	1.510574
% crustacea and Mollusca	0	0	0	0.91
# Filterers	5	2	0	3
# Scrapers	1	0	0	2
# EPT taxa	4	1	7	6
HBI	5.887029	5.99187	5.945087	0.88291
NLF Score	28	20	24	24

Discharge

Figure 23: Wycamp Creek Discharge 2018



<u>Narrative Summary</u>

Concerning water quality parameters, there were no exceedances on either site for Wycamp Creek. Concerning Pebble Counts, which were only collected at site BR4, the majority of the makeup of the substrate collected there was classified as "pebble", "gravel" and sand. Other trends worth reporting on were posted in various figures above when the r-squared value was above 0.7.

Trends

Pebble count trends only show a significant increase in boulders at the downstream site. There are no other significant trends to report.

2017-2018 Lake Assessments

Susan Lake

<u>Description and Background</u>

Susan Lake is a small, shallow lake with a surface area of 126 acres located in Hayes Township in Charlevoix County within the LTBB Reservation. Mud Creek is the inlet of Susan Lake and

Susan Creek is the outlet which then drains into Little Traverse Bay. The land cover around Susan Lake is a majority of residential and seasonal/residential housing, a public boat launch and access point, and forested wetland area.

Susan Lake is within a geographical area of cultural significance. This geographical area is called Kitchiossening in Anishinaabemowin, which translates in English to “Big Stone.” There is an active Native American Methodist church, Greensky Hill, overlooking Susan Lake. Greensky Hill Church was founded by a Chippewa Indian missionary, Peter Greensky, in the 1840s. There is a stand of trees that represent tribes and tribal Ogemaws (chiefs) near the church where tribes would meet to discuss tribal issues and collaborate on decisions. The lake was used by Tribal bands prior to the founding of the church. The lake was named after the pastor’s wife, Susan Walker Greensky. Native burial grounds surround the church down to the shores of Susan Lake and to Boyne City/Charlevoix Road. Historical routes of migration for the Odawa bands are adjacent to Susan Lake. During the annual migrations south and returning north, those who wished to winter here subsisted on fish and inland hunting in and around Susan Lake and Lake Charlevoix. Susan Lake was used in the past by Tribal citizens for gathering freshwater clams. Tribal citizens would gather the clams in a bucket and supply the clams with corn meal. The clams would eat the corn meal and excrete the corn meal and toxins that could be harmful if eaten (Walker-Keshick, 2011). Although this lake is used for recreation by the shoreline property owners and some visitors, the most popular use observed is fishing. Swimming is not recommended by LTBB at this lake due to the potential of an occasional outbreak of *cercarial dermatitis*, also known as swimmer’s itch. LTBB staff that swam in the water during a 2009 site visit later showed symptoms of swimmer’s itch. Whether or not this is a common seasonal occurrence is unknown. There is only one site on Susan Lake, to view a map of the lake and the monitoring location please reference Map 4 in the Appendix.

Tribal Uses and Attainment

The primary Tribal use on Susan Lake (SNL) is **WWF.** Other Tribal uses applied are **PCR (**May through October**), SCR**, **TCC, WRA, IAL, WLS, NAV, COM, IND, AGR.** All uses are supported, although it is recommended that further evaluation should be done for the use of PCR to determine if people swim in the lake. If recreational users do swim in the lake it would be recommended signage is put up to indicate the conditions under which *cercarial dermatitis* could occur.

Data Summary Tables

Table 68. Data Summary Table for Susan Lake (SNL)

Parameter	Threshold Criteria	Month Collected	Depth (m)	Parameter Result	Exceedance
		February	1.5	11.21	--
		May	1.5	10.78	--
		July	1.3	11.09	--
		October	1.5	10.86	--
Total Phosphorus	25 µg/L	February	1.5	*Not Detected	--
		June	1.5	5.1	--
		July	1.3	*Not Detected	--

		October	1.5	17	--
Total Nitrogen	1 mg/L	February	1.5	1.5	X
		June	1.5	1.1	X
		July	1.3	1	--
		October	1.5	0.7	--
Dissolved Oxygen	≥ 5 mg/L	February	1.5	4.45	X
		June	1.5	10.55	--
		July	1.3	10.15	--
		October	1.5	9.89	--
Temperature	Warmwater Fishery	February	1.5	4.12	--
		June	1.5	10.51	--
		July	1.3	23.55	--
		October	1.5	13.96	--
Chlorophyll-α	3 µg/L	June	1.5	Reject	--
		July	1.3	7.1	**X**
		October	1.5	*Not Detected	--
Conductivity	450 µS/cm	February	1.5	399	--
		June	1.5	332	--
		July	1.3	274	--
		October	1.5	287	--
pH	6.5-9 pH units	February	1.5	7.12	--
		June	1.5	8.13	--
		July	1.3	8.88	--
		October	1.5	8.28	--

Biological Data

Macroinvertebrates
No macro invertebrates were collected at Susan Lake in 2017. There are no trends to report.

Narrative Summary

Winter fish kills are possible when the dissolved oxygen drops below 4 mg/L (Barica, 1979). This has occurred in Susan Lake each sampling year, but in 2017 the dissolved oxygen was just above 4 mg/L (Table). However, this is still below the standard for a warmwater fishery. There were a couple exceedances in total nitrogen in the winter and spring. There was an exceedance in chlorophyll-α in the summer. Based on chlorophyll-α, secchi disk measurements, and total phosphorus concentrations, Susan Lake is mesotrophic.

Trends

Susan Lake is seeing an increasing trend in conductivity. While road salts could be contributing, the conductivity, this could be affect by the geology of the lake.

Lake Charlevoix

Zhiingwaak Ziibiing

Description and Background

Lake Charlevoix has two basins and connects to Lake Michigan. It is the third largest lake in Michigan with a surface area of 17,266 acres. Lake Charlevoix flows into Round Lake, then into the Pine River, and drains into Lake Michigan. Lake Charlevoix has nine tributaries that flow into it. 75% of the discharge into Lake Charlevoix is contributed to the Jordan River and the Boyne River. The deepest point in Lake Charlevoix is located in the main basin at approximately 37 meters. The Lake Charlevoix watershed encompasses over 335 square miles. Three main cities border the lake. These cities are Charlevoix, which borders the northwest corner of the north arm, Boyne City, which borders the southeast corner of the north arm, and East Jordan in the South Arm.

The majority of land cover surrounding the Lake Charlevoix shoreline is urban and built up for seasonal residential housing. Impacts on the Lake Charlevoix Watershed can be traced back to the 1800's when lumbering industries bordered the Lake Charlevoix shoreline. Potential impacts of the present time include but are not limited to: a discharge pipe for treated wastewater from Boyne City on the main basin, residential shoreline nutrient runoff, and sediment runoff at road accesses.

LTBB is a partner on the approved Lake Charlevoix Watershed Plan and represents the Tribe on the Lake Charlevoix Steering Committee. Lake Charlevoix has been identified as a lake used by Tribal Citizens for fishing, cultural/ceremonial, boating and swimming.

The Tribe has two monitoring sites on Lake Charlevoix, one per basin. The south arm, site CXL1, is smaller in volume and monitoring is completed in one of the deeper areas of the basin at 36 feet. The main basin, site CXL2 is larger in volume, connects to Round Lake, and its sampling is completed at a depth of 99 feet. To view a map of the lake and the WQPP monitoring locations please reference Map 1 in the Appendix.

Tribal Uses and Attainment

The primary Tribal use on Lake Charlevoix (CXL) is **CDW. Other designated uses are PCR** (May through October), **SCR, TCC, IAL, WLC, SUB, NAV, COM, IND,** and **AGR**. All uses are supported at Lake Charlevoix including SUB. The Great Lakes Fisheries Program (GLFP) in collaboration with the WQPP has done research on fish tissue and methyl mercury concentrations therefore **SUB** is given full support. Methyl mercury concentrations were the lowest of the five lakes monitored in 2012.

Data Summary Tables

Table 69. Data Summary Table for Lake Charlevoix (CXL1)

Parameter	Threshold Criteria	Season Collected	Depth (m)	Parameter Result	Exceedance
Chloride	50 mg/L	May	0.485	10.86	--

			6.783	10.25	--
			11.52	11.76	--
		July	0.537	10.86	--
			6.596	11.11	--
			11.58	8.85	--
		October	1.063	10.99	--
			5.009	10.10	--
			11.01	13.54	--
Total Phosphorus	25 µg/L	May	0.485	*Not Detected	--
			6.783	*Not Detected	--
			11.52	*Not Detected	--
		July	0.537	*Not Detected	--
			6.596	*Not Detected	--
			11.58	*Not Detected	--
		October	1.063	12	--
			5.009	14	--
			11.01	5.6	--
Total Nitrogen	1 mg/L	May	0.485	1.00	--
			6.783	1.10	X
			11.52	0.30	--
		July	0.537	1.20	X
			6.596	0.70	--
			11.58	0.90	--
		October	1.063	0.41	--
			5.009	0.42	--
			11.01	0.34	--
Dissolved Oxygen	≥ 7 mg/L	May	See dissolved oxygen profile graph		
		July			
		October			
Temperature	Coldwater Fishery	May	11.52	7.62	--
		July	11.58	18	--
		October	11.01	17.76	--
Chlorophyll-α	3 µg/L	May	6.783	1.2	--
		July	6.596	8.8	X
		October	5.009	12	--
Conductivity	450 µS/cm	May	0.485	318	--
			6.783	303	--
			11.52	303	--
		July	0.537	353	--
			6.596	350	--

			11.58	352	--
		October	1.063	340	--
			5.009	339	--
			11.01	328	--
pH	6.5-9 pH units	May	0.485	8.19	--
			6.783	8.05	--
			11.52	8.01	--
		July	0.537	8.45	--
			6.596	8.44	--
			11.58	8.01	--
		October	1.063	8.3	--
			5.009	8.3	--
			11.01	8.28	--

Table 70. Data Summary Table for Lake Charlevoix (CXL2)

Parameter	Threshold Criteria	Season Collected	Depth (m)	Parameter Result	Exceedance
Chloride	50 mg/L	May	0.552	11.77	--
			15.06	12.28	--
			31.02	13.09	--
		July	1.013	9.86	--
			15.09	9.35	--
			31.01	10.07	--
		October	0.576	12.71	--
			16.51	14.39	--
			31.46	13.46	--
Total Phosphorus	25 µg/L	May	0.552	*Not Detected	--
			15.06	*Not Detected	--
			31.02	*Not Detected	--
		July	1.013	*Not Detected	--
			15.09	*Not Detected	--
			31.01	5.20	--
		October	0.576	8.50	--
			16.51	9.30	--
			31.46	10.00	--
Total Nitrogen	1 mg/L	May	0.552	0.9	--
			15.06	0.8	--
			31.02	0.8	--
		July	1.013	0.6	--

			15.09	0.8	--
			31.01	0.9	--
		October	0.576	0.33	--
			16.51	0.37	--
			31.46	0.44	--
Dissolved Oxygen	≥ 7 mg/L	May	See dissolved oxygen profile graph		
		July			
		October			
Temperature	Coldwater Fishery	May	31.02	6.81	--
		July	31.01	8.21	--
		October	31.46	9.38	--
Chlorophyll-α	3 µg/L	May	15.06	8.3	X
		July	15.09	4.8	X
		October	16.51	8.1	X
Conductivity	450 µS/cm	May	0.552	331	--
			15.06	333	--
			31.02	332	--
		July	1.013	344	--
			15.09	332	--
			31.01	333	--
		October	0.576	324	--
			16.51	330	--
			31.46	330	--
pH	6.5-9 pH units	May	0.552	8.05	--
			15.06	8.05	--
			31.02	7.97	--
		July	1.013	8.58	--
			15.09	8.16	--
			31.01	7.89	--
		October	0.576	8.39	--
			16.51	7.89	--
			31.46	7.62	--

Figure 24. CXL1 Temperature Profile

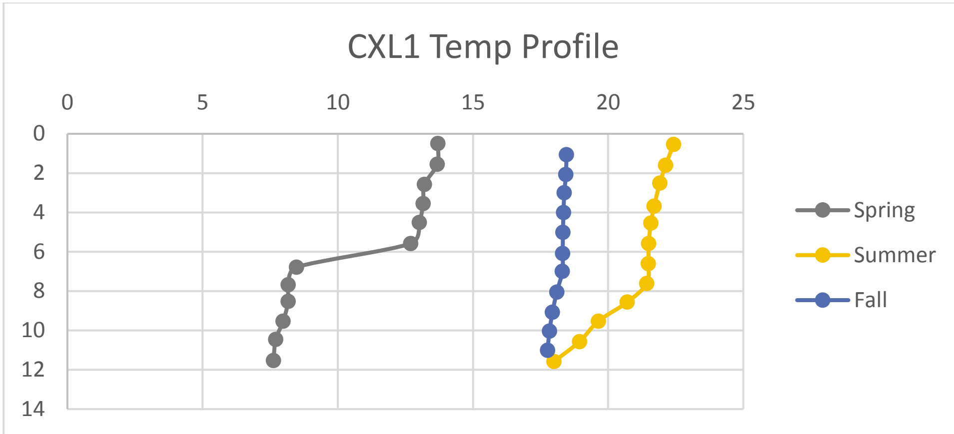


Figure 25. CXL2 Temperature Profile

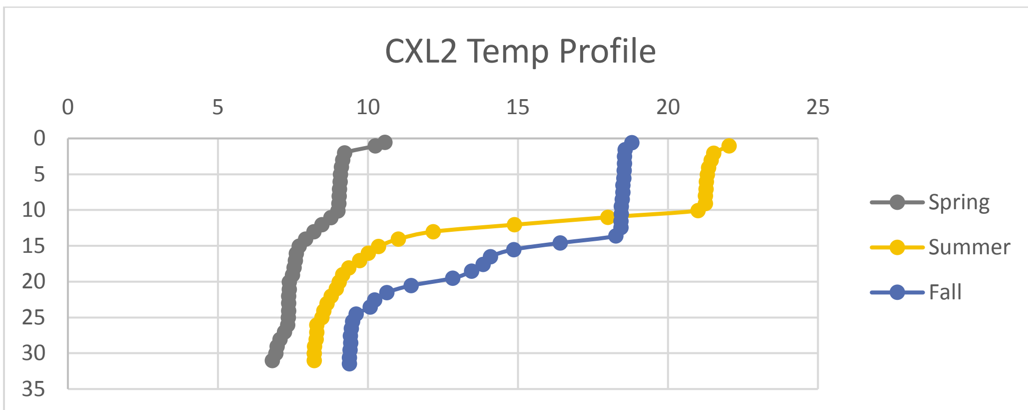


Figure 26. CXL1 Dissolved Oxygen Profile

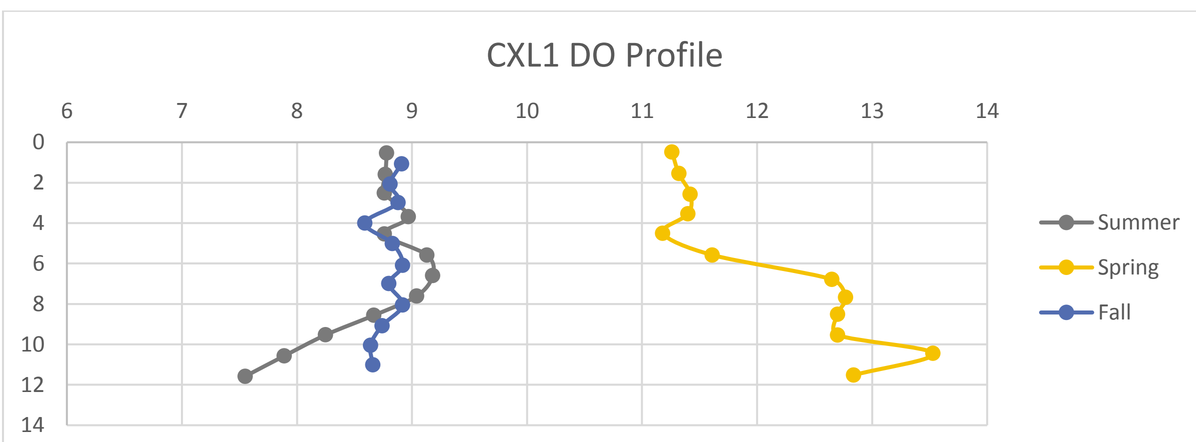
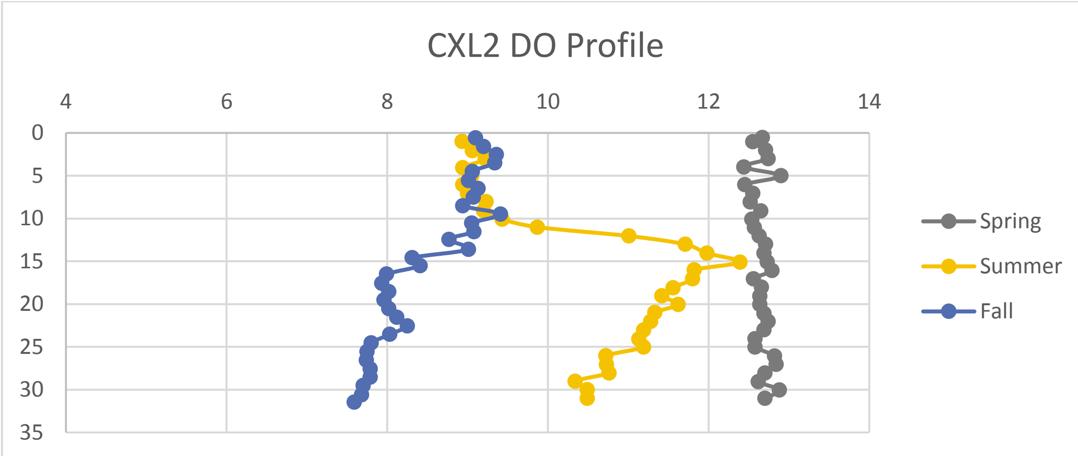


Figure 27. CXL 2 Dissolved Oxygen Profile



Biological Data

Macroinvertebrates

Table 70 is the macroinvertebrate metrics for Lake Charlevoix. There are no significant trends to report.

Table 71: Lake Charlevoix Macroinvertebrate data

Lake Charlevoix	2017
Total Taxa	246
# Ephemeroptera	6
# Diptera	15
Richness (margalefs)	8.17
Shannon Weiner	3.35
% Tricoptera	0
% crustacea and Mollusca	5.28
# Filterers	2
# Scrapers	4
# EPT taxa	8
HBI	6.60000
Score	28

<u>Narrative Summary</u>

Total chloride, total phosphorus, conductivity, pH, and temperature were within standards used to assess water quality in both basins (Table and Table). Total nitrogen levels in spring and summer at CXL1 were above the standard of 1 mg/L. The cause for this could be due to the land use surrounding the lake which is largely comprised of seasonal homes on the water. Many have monoculture lawns right to the edge of the water or beach. One township on the lake is planning to enforce its riparian buffer ordinance in 2018.

The smaller basin of Lake Charlevoix (CXL1) experienced slight seasonal thermal stratification beginning in the spring with a thermocline from 5 to 7 meters (**Error! Reference source not found.**). In the summer, the thermocline was mixing with deeper water below 7 meters. The thermocline was absent in the fall, showing that the basin had already turned over when we monitored. It turned over more quickly than the larger basin, most likely due to its smaller volume. Although this lake is dominated by warmwater fish species, it is still designated as a coldwater fishery and has other trout/salmon species with similar requirements to a steelhead.

The larger basin of Lake Charlevoix experienced seasonal thermal stratification beginning in the spring with a thermocline from 10 to 14 meters (
Figure). In the summer, the thermocline was more pronounced from 11 to 15 meters. The thermocline was still present in the fall from 14 to 25 meters. The spring and fall thermocline show the mixing that the lake was undergoing during those seasons.

Based on chlorophyll-α, secchi disk measurements, and total phosphorus concentrations, both sites are on the border of oligotrophic and mesotrophic.

Trends

Lake Charlevoix is seeing increasing trends in chloride and TP, though no exceedances reported. Both had lower levels than in years previous so we will continue to monitor this trend in the hopes that it continues to decrease.

Crooked Lake

Wewaagizigamaag Zaagigan

Description and Background

Crooked Lake is part of the 45-mile Inland Waterway. The Inland Waterway begins in Spring Lake from the southern origin and the other origin identified as the beginning of the waterway from the east is Pickerel Lake. Pickerel Lake is connected to Crooked Lake via the Pickerel Channel. Crooked Lake flows into the Crooked River to Burt Lake; Burt Lake flows into the Indian River to Mullett Lake; Mullett Lake connects to Lake Huron via the Cheboygan River.

Historically, Odawa people frequently portaged their canoes over the sand dunes near Petoskey to and from Round Lake, and then followed river courses connecting Crooked, Burt, and Mullett Lakes to Lake Huron. This route was a safer alternative to the perilous journey around Lower Michigan's northern tip through the open waters of Lake Michigan and Lake Huron.

This lake is a well-known walleye lake, indicating a viable cool-water fishery. In addition, a Tribal Elder indicated the lake is used for tradition and ceremonial purposes. The lake was the beginning route for the annual Jiimaan (canoe) crossing, which celebrates and recognizes our ancestors' journeys through the Inland Waterway. The ESP staff are aware of Tribal gatherers collecting aquatic plants from the water for traditional utilitarian objects and art.

Tribal Uses and Attainment

The primary use for Crooked Lake is **SUB**. Other Tribal uses include **PCR** (May through October), **SCR, TCC, IAL, WLC, CDW, SUB, NAV, COM, IND**, and **AGR**. **SUB** on Crooked Lake receives partial support: Crooked Lake Yellow Perch should be eaten monthly by ages 0-5 and pregnant women and weekly by ages 6-11. Ages 12+ should eat Crooked Lake Yellow Perch weekly. Crooked Lake Walleye should be eaten less than monthly by ages 0-5 and pregnant women. Ages 6+ should eat monthly (Table 90). Detailed information can be found in the Fish Consumption Study Results section on pg. 168.

Data Summary Tables

Table 72. Data Summary Table for Crooked Lake (CDL)

Parameter	Threshold Criteria	Season Collected	Depth (m)	Parameter Result	Exceedance
Chloride	50 mg/L	February	0.5	9.309	--
			6.5	8.255	--
			13.5	7.620	--
		May	0.5	11.341	--
			7.6	12.725	--
			13.4	11.989	--
		July	1	9.703	--
			7.1	9.703	--
			13	9.843	--
		October	0.5	8.204	--
			7.5	8.725	--
			15.5	8.814	--
Total Phosphorus	25 µg/L	February	0.5	*Not Detected	--
			6.5	6.000	--
			13.5	*Not Detected	--
		May	0.5	9.000	--
			7.6	9.000	--
			13.4	10.000	--
		July	1	7.000	--
			7.1	13.000	--
			13	16.000	--
		October	0.5	22.000	--
			7.5	14.000	--
			15.5	7.000	--
Total Nitrogen	1 mg/L	February	0.5	0.300	--
			6.5	0.400	--
			13.5	0.400	--

		May	0.5	0.200	--
			7.6	0.200	--
			13.4	0.300	--
		July	1	0.091	--
			7.1	0.100	--
			13	0.064	--
		October	0.5	0.081	--
			7.5	0.082	--
			15.5	0.089	--
Dissolved Oxygen	< 7 mg/L	February	See dissolved oxygen profile graph		
		May			
		July			
		October			
Temperature	Inland Lake	February	1	3.744	--
		May	1.4	11.741	--
		July	1	19.022	--
		October	1	13.017	--
Chlorophyll a	3 µg/L	May	7	*Not Detected	--
		July	6.5	3.400	X
		October	7.5	*Not Detected	--
Conductivity	450 µS/cm	February	0.5	318.000	--
			6.5	337.000	--
			13.5	352.000	--
		May	0.5	306.000	--
			7.6	306.000	--
			13.4	314.000	--
		July	1	313.000	--
			7.1	323.000	--
			13	323.000	--
		October	0.5	300.000	--
			7.5	300.000	--
			15.5	302.000	--
pH	6.5-9 pH units	February	0.5	7.42	--
			6.5	7.24	--
			13.5	7.07	--
		May	0.5	8.03	--
			7.6	8	--
			13.4	7.59	--
		July	1	8.53	--
			7.1	7.94	--

		13	7.22	--
	October	0.5	8.07	--
		7.5	8.07	--
		15.5	7.93	--

Figure 28: Crooked Lake Temperature Profile 2018

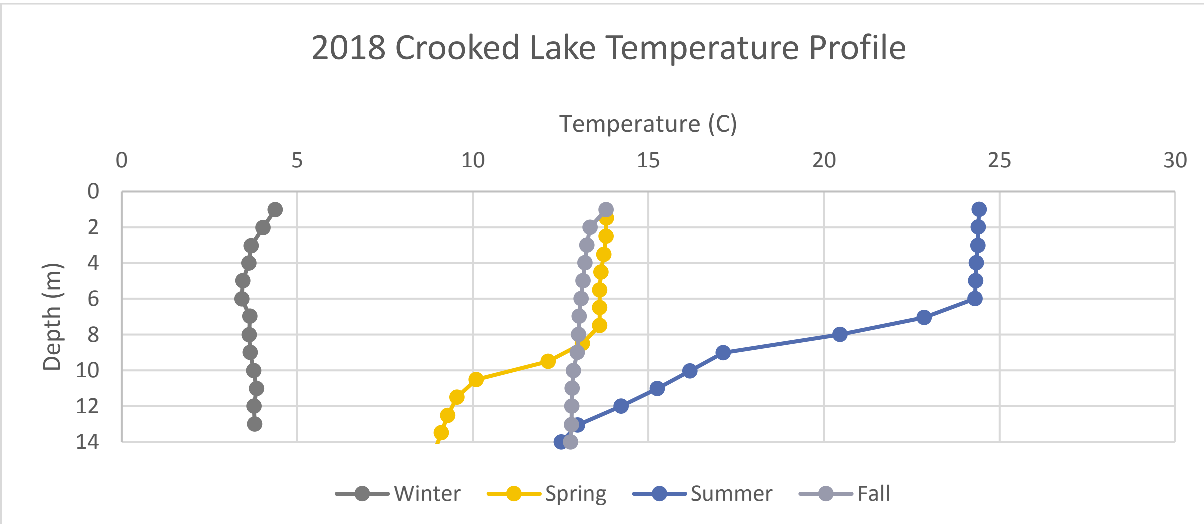
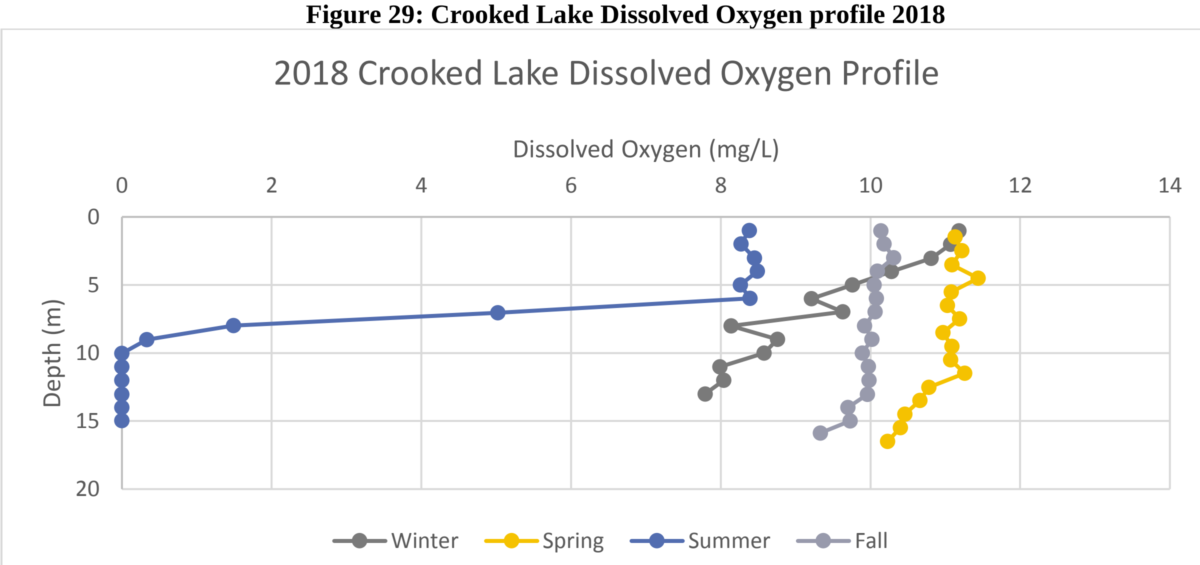


Figure 29: Crooked Lake Dissolved Oxygen profile 2018



Biological Data

Macroinvertebrates

Table 73: Crooked Lake macroinvertebrate scores

Crooked Lake	2018
Total Taxa	505
# Ephemeroptera	3

# Diptera	24
Richness (margalefs)	9.80
Shannon Weiner	2.68
% Tricoptera	0.594059
% crustacea and Mollusca	27.92
# Filterers	1
# Scrapers	2
# EPT taxa	8
HBI	5.35556
Score	26

Narrative Summary

Crooked Lake only experienced one exceedance for chlorophyll a in the summer. It should be noted that we got very low dissolved oxygen readings during the summer sampling trip. This is a very common occurrence at this monitoring site. This is liking due to the time of year where minimal mixing is happening. We do not have any concerns with regards to fish kills as we only sample one site on this lake.

Trends

Although there are no significant trends to report, there was a noticeable decrease in the Shannon diversity index. If we continue to see this in the next report we will consider collecting macroinvertebrates on a shorter rotation to better monitor it.

Sturgeon Bay

Description and Background

Sturgeon Bay used to be a lumbering community and considered a town. There was a saw mill, blacksmith shop, small general store, boarding house, and a post office where the primitive shoreline now resides. The saw mill occurred sometime in 1913. Whether it was intentionally dismantled or was simply swept away by time is a not known (Wikepedia). There are also remnants of an old railroad within the area of Sturgeon Bay. The date the railroad was pulled is also unknown, but it was likely before 1920. A few dock pilings are still visible from the air and can be observed by snorkeling. Portions of the shoreline are now owned by Bliss Township and most are owned by the State of Michigan Department of Natural Resources as a part of Wilderness State Park. This area has known endangered species that inhabit the dune areas. These include but are not limited to: Pitcher's Thistle (*Cirsium pitcheri),* Lake Huron Tansy *(Tanacetum huronense),* and the Piping Plover (*Charadrius melodus).* This area is fairly remote during the spring, fall and winter seasons. However, it is enjoyed by avid swimmers, kite boarders, windsurfers and sunning enthusiasts in the summer.

Sturgeon Bay has seen the effects of avian botulism on its shorelines, especially in 2012, when there were over 950 bird fatalities in Emmet and Charlevoix Counties. 2006, 2007, and 2010 were also years when waterfowl were impacted by avian botulism on Lake Michigan (TOMWC). More recent data on avian botulism is not available.

Tribal Uses and Attainment

Sturgeon Bay (SBB) does not have designated uses; however it will be assessed using **CDW** and **SUB** criteria. All uses are supported for this reporting period. After the results of a fish contaminant survey, we found that Lake Michigan fish can be eaten more than once weekly by all ages, except for the following exceptions:

- Lake trout, which should be eaten less than monthly by ages 0-5 and pregnant women, weekly for ages 6-11
- Smallmouth bass, which should only be eaten monthly by ages 0-5 and pregnant women weekly by ages 6+

These recommendations are due to PCB levels more so than mercury.

Data Summary Tables

Table 74. Data Summary Table for Sturgeon Bay Beach (SBB)

Parameter	Threshold Criteria	Month Collected	Depth (m)	Parameter Result	Exceedance
Chloride	50 mg/L	August	0.3	12.27	--
		October	0.48	14.63	--
Total Phosphorus	25 µg/L	August	0.3	7	--
		October	0.48	*Not Detected	--
Total Nitrogen	1 mg/L	August	0.3	*Not Detected	--
		October	0.48	0.25	--
Dissolved Oxygen	≥ 7 mg/L	August	0.3	8.65	--
		October	0.48	9.63	--
Temperature	Coldwater Fishery	August	0.3	22.56	X
		October	0.48	17.77	X
Chlorophyll-α	3 µg/L	August	0.3	3.4	X
		October	0.48	7	X
Conductivity	450 µS/cm	August	0.3	291	--
		October	0.48	281	--
pH	6.5-9 pH units	August	0.3	8.49	--
		October	0.48	8.38	--

Biological Data

Macroinvertebrates
Macroinvertebrates are not collected at Sturgeon Bay Beach.

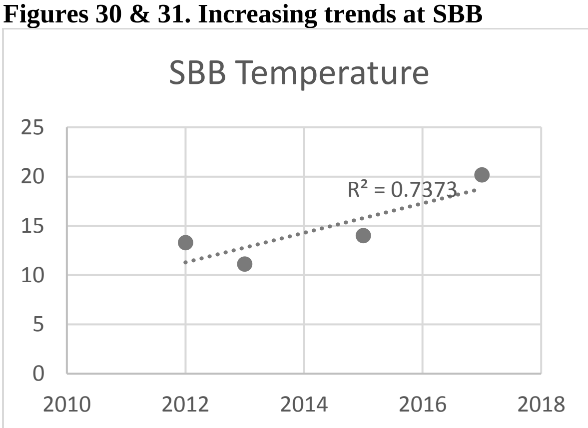
Narrative Summary

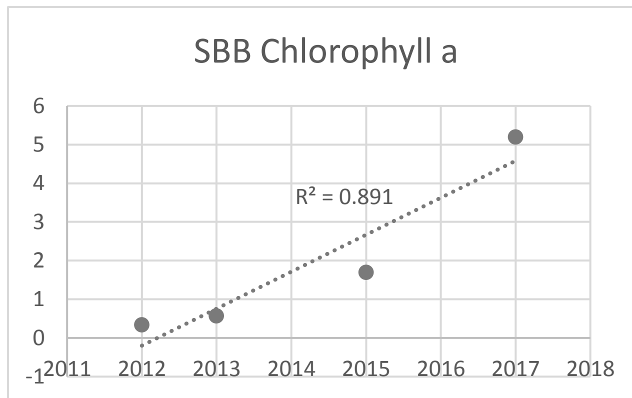
Sturgeon Bay was only sampled in the summer and fall of the 2017 season. There were exceedances in temperature in both seasons for this site, but because samples were taken by wading off the beach, this is not really a concern (Table). There were chlorophyll-α exceedances in both seasons as well. Sturgeon Bay is a primitive and relatively un-impacted shoreline although its popularity continues to increase as a public beach. The beach was not closed any days in 2017 due to high bacteria levels. No macroinvertebrates were collected at this site in 2017. Based on chlorophyll-α, secchi disk measurements, and total phosphorus concentrations, Sturgeon Bay Beach is oligotrophic/mesotrophic.

Trends

There are several significant trends at Sturgeon Bay beach. There is increasing temperature, pH, TP, and chlorophyll a. DO and TN are showing decreasing trends. Temperature and chlorophyll a were the only parameters that had exceedances so these will be monitored closely in the future.

Figures 30 & 31. Increasing trends at SBB





Larks Lake

<u>Description and Background</u>

Larks Lake is a shallow spring-fed marl lake with a surface area of 592 acres. The Larks Lake watershed is a small watershed with a land surface area of 4,640 acres. The Larks Lake watershed is a sub-watershed of the larger Cheboygan River Watershed. The Cheboygan River Watershed covers 1,461 square miles. Larks Lake drains into Brush Creek which meanders through Pleasantview Swamp. Within the Pleasantview Swamp are four “spring ponds” (called The Four Lakes) that form the headwaters of the Maple River.

Larks Lake has been seeded with wild rice by the LTBB Inland Fisheries and Wildlife program annually from 2009-2016. With the help of the LTBB WQPP the planting area has been refined and there was less than an acre of wild rice growing in the northwest corner of the lake in 2014. This site has been monitored for wild rice from 2014-2017 and 2017 revealed little to no rice. This could be due to the nature of the boom and bust cycle of rice. This lake will be continually monitored for wild rice.

Land cover surrounding the lake is seasonal and/or year round residential housing. There is a county park area with a sandy beach, a public access and boat launch area, with a predominate area of land consisting of forested lowland and wetland. In the 1900’s, there was a saw mill operation adjacent to Larks Lake and a dam at the headwaters of Brush Creek. According to the local community the dam was taken out approximately 40 years ago. Historical information was provided by local individuals attending the first meeting in accordance to the creation of the Larks Lake Watershed Plan.

There is one site monitored by LTBB on Larks Lake. To view a map of the lake and the WQPP monitoring location please reference Map 2 in the Appendix.

Tribal Uses and Attainment

The primary Tribal use on Larks Lake (LSL) is **WWF.** Other Tribal uses applied are **PCR** (May through October), **SCR, TCC, WRA, IAL, WLS, NAV, COM, IND,** and **AGR.** There is a potential of *cercarial dermatitis* to occur in this lake. All uses are supported on Larks Lake for this reporting period.

Data Summary Tables

Table 75. Data Summary Table for Larks Lake 2017 (LSL)

Parameter	Threshold Criteria	Month Collected	Depth (m)	Parameter Result	Exceedance
Dissolved Oxygen	≥ 5 mg/L	February	0.7	8.52	--
Temperature	Warmwater Fishery	February	0.7	3.71	--
Conductivity	450 µS/cm	February	0.7	344	--
pH	6.5-9 pH units	February	0.7	7.71	--

Table 76. Data Summary Table for Larks Lake 2018 (LSL)

Parameter	Threshold Criteria	Month Collected	Depth (m)	Parameter Result	Exceedance
Chloride	50 mg/L	February	1.039	7.050	--
		May	0.1	4.190	--
		July	1.005	6.300	--
		October	0.753	5.910	--
Total Phosphorus	25 µg/L	February	1.039	15.000	--
		May	0.1	9.3	--
		July	1.005	18.000	--
		October	0.753	26.000	X
Total Nitrogen	1 mg/L	February	1.039	1.000	X
		May	0.1	0.400	--
		July	1.005	0.700	--
		October	0.753	0.560	--
Dissolved Oxygen	< 5 mg/L	February	1.039	8.65	--
		May	0.1	10.43	--

		July	1.005	8.78	--
		October	0.753	11.62	--
Temperature	Warmwater Fishery	February	1.039	3.53	--
		May	0.1	17.96	--
		July	1.005	23.08	--
		October	0.753	10.74	--
Chlorophyll a	3 µg/L	May	0.1	5.100	X
		July	1.005	4.500	X
		October	0.753	2.000	--
Conductivity	450 µS/cm	February	1.039	317	--
		May	0.1	219.6	--
		July	1.005	230	--
		October	0.753	228	--
pH	6.5-9 pH units	February	1.039	7.13	--
		May	0.1	8.57	--
		July	1.005	8.63	--
		October	0.753	8.27	--

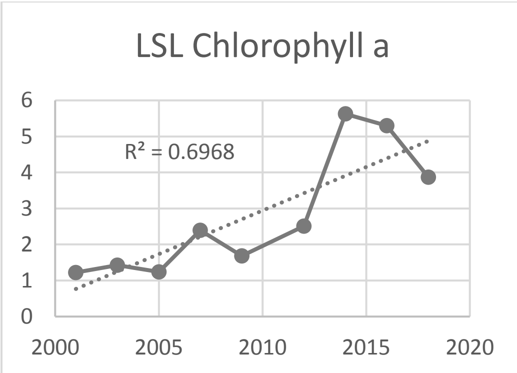
Biological Data

Macroinvertebrates
No macroinvertebrates were collected at LSL in 2018.

Narrative Summary
Temperature, conductivity, dissolved oxygen and pH were within assessments standards and thresholds in the winter of 2017 (Table 75). Ice coverage for this lake during the sampling event was 12 inches. For 2018, there were four exceedance occurrences for Larks Lake. For TP, the threshold was exceeded in October. For TN, the threshold was exceeded in February. For Chlorophyll a the threshold was twice exceeded, once in May and once in July.

Trends
Larks Lake is showing an increasing trend in chlorophyll a. This is something we will play close attention to in the future though it appears as though it may be on the decline.

Figure 32. Chlorophyll a trend



Spirit/Wycamp Lake

Mnido Zaagigan

Description and Background

Spirit Lake is a shallow lake located in Bliss Township with a small section of the east side in Cross Village Township in Northern Emmet County. It is 610 acres in size. The area surrounding Spirit Lake is primarily forested and forested wetland. The majority of the land that surrounds Spirit Lake is owned by the State of Michigan with approximately 200 acres owned by a private land owner. Over 400 acres of the land surrounding Spirit Lake is used as a private hunting preserve.

The two townships that encompass Spirit Lake have a large population of LTBB citizens. The lake and adjacent grounds are used for ceremonies, hunting, fishing, and gathering by the Odawa people. Natural resources are gathered for food, ceremonies, art and crafts, and medicinal practices. The lake area was and still may be used as a meeting place for Odawa elder gatherings. A historical & cultural land use report was completed on July 25, 2006 by Wes Andrews. This report includes an inventory of historical information, cultural resources, and recommendations for the management of Spirit Lake.

The historical community encompassing Spirit Lake known as Wycamp Creek Village is eligible to be listed in the National Register of Historical Places due to the cultural resources it provides. This area and the outlet, Wycamp Creek, was used as part of a sawmill operation years ago known as the Wycamp Sawmill.

The LTBB NRD has written a management plan for Spirit Lake. As quoted in the Wycamp Management Plan, "The goals of the Natural Resource Department are to manage fisheries and wildlife populations for the benefit of Tribal members for the next seven generations. With this in mind, the Tribe will make recommendations on management that will help protect the natural resources of Spirit Lake. The overall goal of this lake plan is to apply an ecosystem management system approach that recognizes the interrelated nature of air, land, water and all life. This watershed approach is intended to include the whole system and focus on the interrelationships of the lake environment and the biotic communities."

Management issues in the past have been related to water quantity versus water quality. Water levels and dam control have been a concern in the past to LTBB citizens and the surrounding community. In 1960, a court-ordered water level was instated on Spirit Lake. The water level should be no more than 611.0 feet above mean sea level in winter and 611.8 feet above mean sea level in summer (Jansma, 1960). LTBB NRD has put at least one staff gage at the dam in the lake to monitor the lake level. This staff gauge allows LTBB NRD Inland Fisheries and Wildlife (IFW) to monitor water fluctuations and the effects on aquatic life, fish, wildlife and wild rice growth.

Wild rice has been planted by the LTBB IFW consistently since 2006, and in the past four years it has been hand-thrown in the same area. There is only one monitoring site on Spirit Lake and to view a map of the lake and the WQPP monitoring location please reference Map 5 in the Appendix.

Tribal Uses and Attainment

The primary Tribal use on Spirit Lake (WPL) is **TCC.** Other Tribal uses applied are **PCR** (May through October)**, SCR, WRA, IAL, WLS, WWF, SUB, NAV, COM, IND,** and **AGR**. All uses are fully supported at WPL except **SUB**, which receives partial support. Wycamp Lake bluegill, smallmouth bass, and yellow perch can be eaten more than once weekly by Ages 12+. Ages 6-11 can eat smallmouth bass and yellow perch weekly. Ages 0-5 and women can eat smallmouth bass.

Data Summary Tables

Table 77. Data Summary Table for Wycamp Lake 2017 (WPL)

Parameter	Threshold Criteria	Month Collected	Depth (m)	Parameter Result	Exceedance
Dissolved Oxygen	≥ 5 mg/L	February	0.85	13.22	--
Temperature	Warmwater Fishery	February	0.85	3.01	--
Conductivity	450 µS/cm	February	0.85	370	--
pH	6.5-9 pH units	February	0.85	7.34	--

Table 78. Data Summary Table for Wycamp Lake 2018 (WPL)

Parameter	Threshold Criteria	Month Collected	Depth (m)	Parameter Result	Exceedance
Chloride	50 mg/L	February	N/A	4.930	--
		May	1.064	3.580	--
		July	1.012	5.170	--
		October	0.748	4.940	--
Total Phosphorus	25 µg/L	February	N/A	16.000	--
		May	1.064	*Not Detected	--

		July	1.012	17.000	--
		October	0.748	25.000	X
Total Nitrogen	1 mg/L	February	N/A	0.500	--
		May	1.064	*Not Detected	--
		July	1.012	*Not Detected	--
		October	0.748	*Not Detected	--
Dissolved Oxygen	< 5 mg/L	February	N/A	N/A	--
		May	1.064	10.570	--
		July	1.012	8.390	--
		October	0.748	10.680	--
Temperature	Warmwater Fishery	February	N/A	N/A	--
		May	1.064	2.390	--
		July	1.012	24.610	X
		October	0.748	14.880	--
Chlorophyll a	3 µg/L	May	1.064	11.000	X
		July	1.012	*Not Detected	--
		October	0.748	*Not Detected	--
Conductivity	450 µS/cm	February	N/A	N/A	--
		May	1.064	363	--
		July	1.012	278	--
		October	0.748	277	--
pH	6.5-9 pH units	February	N/A	N/A	--
		May	1.064	6.340	X
		July	1.012	8.640	--
		October	0.748	8.180	--

Biological Data

Macroinvertebrates

Macroinvertebrates were not collected in 2018 at Wycamp Lake, therefore there is no metrics to report on nor any new trends.

Narrative Summary

There were no exceedances in the winter of 2017. The water was super saturated at 13.22 mg/L. In 2018, there were four instances of exceedance that were observed in Wycamp Lake. In October, the threshold for TP was exceeded. In July, the temperature threshold was exceeded. And in May, both thresholds for Chl a and pH were exceeded. Overall Wycamp Lake appears to be rather stable though it is unknown at this time what the cause of the exceedances are.

Trends

There were no reportable trends for Wycamp Lake for 2018 as the r-squared values did not meet LTBB's threshold criteria for reporting on trends.

O’Neal Lake

Description and Background

O’Neal Lake is a small shallow lake located in Northern Emmet County. It drains from Lawrence Lake and has one outlet, a dam at the headwaters of Big Sucker Creek. The dam failed in September 2014 and is awaiting replacement/repair, which is due to occur in 2017. In 2018, the dam repair was completed.

Prior to the dam failure, O’Neal Lake was approximately 145 acres in surface area. It is unknown what its surface area during this reporting period was. O’Neal Lake is part of the Lake Michigan watershed with the mouth of Big Sucker Creek flowing out into Lake Michigan. The land cover surrounding O’Neal Lake is predominantly forested wetland and some upland. The area surrounding O’Neal Lake is owned by the MDNR, State of Michigan and 8 parcels on the west side of the lake are owned by private owners, according to the 2003 Emmet County Plat Book. Prior to the dam failure, the lake had many dead inundated trees on the west side and has a heavy amount of aquatic vegetation throughout the lake, including wild rice planted by the LTBB NRD Inland Fisheries and Wildlife Program. The trees now have dried roots, the aquatic vegetation is either decreased or now land and the wild rice isn’t looking healthy or as abundant as it did before the dam failure.

It is ironic the dam failed, as its condition has been a point of contention since 2007. It had been in service since 1952. The dam was in need of repairs in 2007 and the main MDNR contact for managing O'Neal Lake, Wildlife Habitat Biologist Brian Mastenbrook, was contacted about the condition of the dam by riparian property owners. Mr. Mastenbrook wanted to implement a lake drawdown to breakdown the aquatic vegetation to release the nutrients within the plants, aerate the soil, and re-establish productivity in the substrate before a new dam was to be installed. The projected time to replenish the conditions of the substrate was estimated to be two to three years. The MDNR held a public meeting in early 2008, which resulted in clear opposition of this management technique by the local community. LTBB’s WQPP and Inland Fisheries and Wildlife Program (IFWP) had been collecting data on this lake for over 15 years. One of the concerns from the local community was what this management decision was based on. MDNR has indicated that scientific data was not used in this decision other than a couple observation site visits. LTBB decided to present all of the data collected in, near and adjacent to the lake to the public at the O'Neal Lake Informational Meeting held on August 27th, 2009. Data indicated that loons and other avian species, geese, eagles and osprey all nest and feed on fish in the lake; there is a viable pan fishery, potential for wild rice growth, the lake is a cultural/ceremonial area for Tribal Citizens, water quality supports aquatic life and wildlife, and native plant communities exist to feed wildlife and provide habitat. LTBB IFWP also does frequent flights for eagle research and was able to supply photos of areas already available to waterfowl throughout Wilderness State Park. At this point in time, LTBB was only providing ecological information for the local community to understand O'Neal Lake diversity and functions. Later that year, the LTBB Natural Resource Commission declared that O'Neal Lake was a viable fishery. There was a discussion to collaborate with the MDNR to create and implement a lake management plan but this did not happen. There was some minimal work done to minimize leakage and some additional boards were added to the top of the dam.

In the fall of 2014, the dam unexpectedly failed, allowing for the lake to drawdown and drain into Big Sucker Creek. Engineers contracted with the MNDR have completed their draft engineering report with three different solutions and these solutions were presented at the first of many meetings that will take place in effort to come up with a solution to this problem. The engineering report is still in draft phase and has not been released to the public. LTBB will be an active participant in these meetings. The LTBB NRD staff and Director will be part of the solution, particularly with a financial contribution depending on what the final solution is. The data summary table and narrative summary will indicate if there have been changes to the water chemistry or parameters taken in the fall following the drawdown compared to the spring, summer and previous year's datasets. It is important to note that change in water quality parameters may not be present immediately after or during this drawdown. The WQPP recommendation would be to review all data taken from LTBB NRD to include wildlife and fish data to present it with a whole ecosystem approach. We are not aware of what alternative was chosen, but construction will occur in 2017. To view a map of the lake and the WQPP monitoring location please reference Map 6 in the Appendix.

Tribal Uses and Attainment

The primary Tribal use on O'Neal Lake (OLL) was **WWF.** Other Tribal uses **include PCR (**May through October**), SCR, TCC, WRA, NAV, COM, IND,** and **AGR.** The **WWF** use is not being met due to temperature. We will monitor Oneal Lake temperature again before the dam goes back in. These uses will need further evaluation and support is dependent on the managed use and future outcome of the lake.

Data Summary Tables

Table 79. Data Summary Table for Lake ONeal 2018 (OLL)

Parameter	Threshold Criteria	Month Collected	Depth (m)	Parameter Result	Exceedance
Chloride	50 mg/L	February	N/A	N/A	--
		May	0.53	4.229	--
		July	0.787	4.102	--
		October	0.881	3.899	--
Total Phosphorus	25 µg/L	February	N/A	N/A	--
		May	0.53	10.000	--
		July	0.787	17.000	--
		October	0.881	18.000	--
Total Nitrogen	1 mg/L	February	N/A	N/A	--
		May	0.53	*Not Detected	--
		July	0.787	0.500	--
		October	0.881	*Not Detected	--
Dissolved Oxygen	< 5 mg/L	February	N/A	N/A	--
		May	0.53	9.430	--

		July	0.787	8.340	--
		October	0.881	11.140	--
Temperature	Warmwater Fishery	February	N/A	N/A	--
		May	0.53	19.140	X
		July	0.787	23.620	--
		October	0.881	10.810	--
Chlorophyll a	3 µg/L	Spring	0.53	1.800	--
		Summer	0.787	2.400	--
		Fall	0.881	2.000	--
Conductivity	450 µS/cm	February	N/A	N/A	--
		May	0.53	248	--
		July	0.787	338	--
		October	0.881	303	--
pH	6.5-9 pH units	February	N/A	N/A	--
		May	0.53	8.180	--
		July	0.787	8.370	--
		October	0.881	8.010	--

Biological Data

Macroinvertebrates

In 2018, macroinvertebrates were collected and results were generated. Because macroinvertebrates were not collected in previous years at O'Neal Lake, trend data was not able to be generated. Results for 2018 are below. There was a decrease in the Shannon Diversity index. We expected to see this because macroinvertebrates have not been collected on this lake since the dam failed in 2014. The dam was restored in the fall of 2017.

Table 80: OLL Macroinvertebrate data

O'Neal Lake	2018
Total Taxa	34
# Ephemeroptera	1
# Diptera	10
Richness (margalefs)	4.820834
Shannon Weiner	2.490541
% Tricoptera	0
% crustacea and Mollusca	38.23529
# Filterers	1
# Scrapers	0
# EPT taxa	2
HBI	6.285714
Score	20

Narrative Summary
There was only one instance where threshold values were exceeded in Lake O'Neal and that occurred in May of 2018. Other trends for Lake O'Neal are not currently available. The dam on this lake failed in 2014 and was restored in fall of 2017. The lake, which had found its original stream channel from 2014-2017 quickly restored itself to pre dam failure conditions.

Trends
There are no reportable trends for O'Neal Lake.

Round Lake
Waawiyegamag

Description and Background

Round Lake is a small shallow spring-fed lake with a surface area of 353.4 acres. There is one inlet creek connected to the north arm of Spring Lake and an outlet creek connecting to Crooked Lake. Round Lake is part of the Lake Huron Watershed. Historically, Odawa people frequently portaged their canoes over the sand dunes near Petoskey to and from Round Lake and then followed river courses connecting Crooked, Burt, and Mullett Lakes to Lake Huron. These connected water bodies are collectively called the Inland Waterway. Adjacent to Round Lake is the location of a historical Odawa event called the Hiawatha Pageant.

Round Lake's present land coverage consists of seasonal and residential homes, condominiums, two nature preserves (Fotchman and Round Lake), a small beach, and a public boat launch and access site. An area of Round Lake is buoyed off to minimize disturbance of the loon's nesting area. There is a diversity of waterfowl on this lake as well. There is a population of walleye in Round Lake and fishermen frequent the lake, especially in the winter. Recreation is the dominant use on this lake. There is one monitoring location on Round Lake where data is collected at mid-depth of the water column approximately 2.1 meters.

Tribal Uses and Attainment

The primary Tribal use on Round Lake (RDL) is **WWF.** Round Lake has been stocked by the MDNR in the past with walleye. The last stocking was in May of 1998 according to the MDNR fish stocking website. Stocking has not continued by the MDNR because the department believes natural reproduction productivity is absent or minimal for walleye. Warm water fish in Round Lake according to LTBB NRD fish surveys conducted in summer and fall of 2009 consist of but are not limited to blue gill, sand shiners, rock bass, northern pike and largemouth bass. LTBB fish surveys conclude that Round Lake is a viable warm water fishery with natural reproduction of warm water fish species (Haynes, 2009). Oher Tribal uses applied are **PCR** (May through October), **SCR, IAL, WLS, NAV, COM, IND,** and **AGR**. All uses are supported.

Data Summary Tables

Table 81. Data Summary Table for Round Lake (RDL)

Parameter	Threshold Criteria	Month Collected	Depth (m)	Parameter Result	Exceedance
Chloride	50 mg/L	February	3.035	28.000	--
		May	N/A	28.000	--
		July	2.018	28.000	--
		October	1.992	28.000	--
Total Phosphorus	25 µg/L	February	3.035	*Not Detected	--
		May	N/A	6.000	--
		July	2.018	15.000	--
		October	1.992	16.000	--
Total Nitrogen	1 mg/L	February	3.035	1.100	X
		May	N/A	0.100	--
		July	2.018	0.059	--
		October	1.992	0.290	--
Dissolved Oxygen	< 5 mg/L	February	3.035	3.170	X
		May	N/A	N/A	--
		July	2.018	9.090	--
		October	1.992	11.040	--
Temperature	Warmwater Fishery	February	3.035	6.320	X
		May	N/A	N/A	--
		July	2.018	24.590	X
		October	1.992	12.270	--
Chlorophyll a	3 µg/L	Spring	N/A	0.900	--
		Summer	2.018	*Not Detected	--
		Fall	1.992	2.000	--
Conductivity	450 µS/cm	February	3.035	555	--
		May	N/A	N/A	--
		July	2.018	302	--
		October	1.992	290	--
pH	6.5-9 pH units	February	3.035	6.880	--
		May	N/A	N/A	--
		July	2.018	8.710	--
		October	1.992	8.250	--

Biological Data

Macroinvertebrates

Table 82: Round Lake Macroinvertebrate data

Round Lake	2018
Total Taxa	294
# Ephemeroptera	3
# Diptera	20
Richness (margalefs)	8.80
Shannon Weiner	3.09
% Tricoptera	5.102041
% crustacea and Mollusca	21.09
# Filterers	1
# Scrapers	2
# EPT taxa	11
HBI	6.76768
Score	28

<u>Narrative Summary</u>

There were four exceedances observed in 2018. In February, TN, DO and Temperature were all passed exceedance values. Temperature was also exceeded in July.

Trends

There are no significant trends to report.

Spring Lake

Tikibi Zaagigan

<u>Description and Background</u>

Spring Lake has two basins, the south and north arm; these arms are separated by a road and an educational wetland boardwalk and park. This lake is located adjacent to M-119, a highly used road going from the City of Petoskey to Harbor Springs. On the north side of the south arm there is a steep slope that is forested and on top of this slope are condominiums. There is only one residential home on the north arm. These lake arms are surrounded by infrastructure such as roads, commercial buildings, condominiums, or park facilities.

Bear Creek Township, who owns the properties on these lake arms, began stocking fish in the south arm in May of 2007. At that time, the stocked species were hybrid sunfish, largemouth bass, and fathead minnows. No minutes from the Parks and Recreation Committee Meetings show additional stocking, although the matter was discussed in 2012.

Both arms are shallow in depth, with the south arm having a surface area of 6.7 acres and the north arm having a surface area of 10.1 acres. The water level is controlled by a water structure (open or shut culvert) between the two arms to prevent flooding. There is one monitoring location per arm. SGL1 is in the south arm and SGL2 is in the north arm.

Tribal Uses and Attainment

The primary Tribal use on Spring Lake (SGL1 & 2) is **IAW.** Other uses applied are **PCR (**May through October)**, SCR, IAL, WWF, NAV, COM, IND,** and **AGR.**

Other Tribal uses applied are**, WWF** and **SCR** (May through October)**. IAW, IAL,** and **WWF** are fully supported at this time but need to be re-evaluated every two years to detect whether adverse trends for chloride and conductivity continue as well as potential for winter fish kills.

Table 83: Data Summary Table for SGL1

Parameter	Threshold Criteria	Month Collected	Depth (m)	Parameter Result	Exceedance
Chloride	50 mg/L	February	1.713	78.000	X
		May	1.477	80.000	X
		July	0.952	68.000	X
		October	0.959	53.000	X
Total Phosphorus	25 µg/L	February	1.713	*Not Detected	--
		May	1.477	*Not Detected	--
		July	0.952	11.000	--
		October	0.959	11.000	--
Total Nitrogen	1 mg/L	February	1.713	2.800	X
		May	1.477	1.700	X
		July	0.952	0.800	--
		October	0.959	1.400	X
Dissolved Oxygen	< 5 mg/L	February	1.713	8.750	--
		May	1.477	12.050	--
		July	0.952	10.920	--
		October	0.959	12.120	--
Temperature	Warmwater Fishery	February	1.713	0.140	--
		May	1.477	12.860	--
		July	0.952	26.030	X
		October	0.959	5.750	--
Chlorophyll a	3 µg/L	Spring	1.477	Reject	X
		Summer	0.952	10.000	X
		Fall	0.959	2.000	--
Conductivity	450 µS/cm	February	1.713	725	X
		May	1.477	659	X
		July	0.952	548	X
		October	0.959	633	X
pH	6.5-9 pH units	February	1.713	6.720	--

		May	1.477	7.680	--
		July	0.952	8.040	--
		October	0.959	7.930	--

Table 84. Data Summary table for SGL2

Parameter	Threshold Criteria	Month Collected	Depth (m)	Parameter Result	Exceedance
Chloride	50 mg/L	February	1.713	60.000	X
		May	1.477	50.000	X
		July	0.952	48.000	--
		October	0.959	39.000	--
Total Phosphorus	25 µg/L	February	1.713	*Not Detected	--
		May	1.477	9.000	--
		July	0.952	17.000	--
		October	0.959	*Not Detected	--
Total Nitrogen	1 mg/L	February	1.713	2.100	X
		May	1.477	1.300	X
		July	0.952	0.800	--
		October	0.959	1.400	X
Dissolved Oxygen	< 5 mg/L	February	1.713	0.380	X
		May	1.477	12.790	--
		July	0.952	8.070	--
		October	0.959	13.860	--
Temperature	Warmwater Fishery	February	1.713	4.280	--
		May	1.477	12.440	--
		July	0.952	24.700	X
		October	0.959	6.810	--
Chlorophyll a	3 µg/L	Spring	1.477	7.100	X
		Summer	0.952	8.600	X
		Fall	0.959	3.700	X
Conductivity	450 µS/cm	February	1.713	679	X
		May	1.477	574	X
		July	0.952	450	X
		October	0.959	503	X
pH	6.5-9 pH units	February	1.713	6.610	--
		May	1.477	7.530	--
		July	0.952	7.740	--
		October	0.959	7.990	--

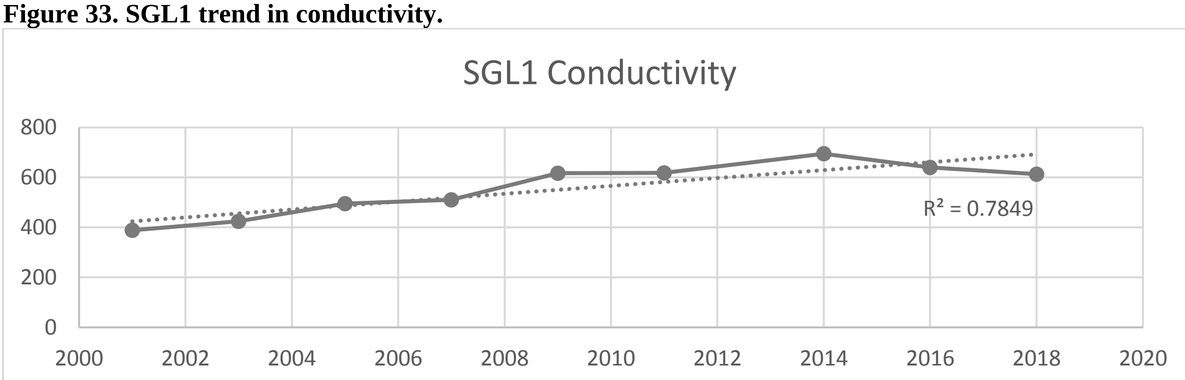
Biological Data

Macroinvertebrates
Macroinvertebrates were not collected from Spring Lake in 2018.

Narrative Summary
Chloride, TN, temperature, chlorophyll and conductivity had exceedances at both sites throughout the year. We will look into any restoration projects that we could implement at this site to mitigate these issues.

Trends
There is an increasing trend in conductivity at SGL1. This water body has the highest conductivity of any water body we monitor and we consistently see exceedances.

Figure 33. SGL1 trend in conductivity.



Little Traverse Bay

Wikwedonsing

Description and Background
Little Traverse Bay is the fourth largest bay of Lake Michigan. Little Traverse Bay Watershed includes Bay Harbor Lake (a flooded quarry adjacent to Lake Michigan), Bear River, Hay Marsh Creek, Spring Brook, Tannery Creek, and Five Mile Creek. Cities within the Little Traverse Bay are Charlevoix, Petoskey, and Harbor Springs.

LTBB citizens have been dependent on the bay historically and presently. Historically, the bay was used for agriculture, potable water, transportation, hunting, ceremonial/cultural use, trapping, and fishing purposes. The bay has served as a site for purposes such as a water to be crossed in the Annual Jiimaan celebration acknowledging our ancestor's migratory routes, traditional weddings, and ceremonies. The shoreline of Little Traverse Bay was a common burial ground for Odawa People who have passed.

The State of Michigan stocked 20,000 Brown Trout in Little Traverse Bay during the reporting period. The Tribe stocked 89,819 lake herring over the same period in Harbor Springs and Petoskey. Other fish found in Little Traverse Bay include but are not limited to: salmon, rainbow trout, whitefish, lake trout, bass and perch

LTB1 is located just north of the Petoskey waterfront and LTB2 is located west of the Petoskey State Park.

Tribal Uses and Attainment

Little Traverse Bay does not have designated uses, however it will be assessed for **PCR** (May through October)**, SCR, PWS, TCC, IAL, WLS, CDW, NAV, COM, IND, AGR, TCC, SUB, and OTR.**

All uses are supported for this reporting period. After the results of a fish contaminant survey, we found that Lake Michigan fish can be eaten more than once weekly by all ages, except for the following exceptions:

- Chinook Salmon, which should only be eaten weekly by ages 0-11 and pregnant women
- Walleye and yellow perch, which should only be eaten weekly by ages 0-5 and pregnant women (**Error! Reference source not found.**).

Table 85: Data summary table for LTB1

Parameter	Threshold Criteria	Season Collected	Depth (m)	Parameter Result	Exceedance
Chloride	50 mg/L	February	1m	N/A	--
			16m	N/A	--
			32m	N/A	--
		May	.5m	16.396	--
			15.5m	15.761	--
			29.5m	16.802	--
		July	1m	13.767	--
			15m	12.929	--
			31m	13.373	--
		October	1m	11.684	--
			15m	16.002	--
			29.4m	13.132	--
Total Phosphorus	25 µg/L	February	1m	N/A	--
			16m	N/A	--
			32m	N/A	--
		May	.5m	*Not Detected	--
			15.5m	*Not Detected	--
			29.5m	*Not Detected	--
		July	1m	*Not Detected	--
			15m	*Not Detected	--
			31m	*Not Detected	--
		October	1m	*Not Detected	--
			15m	*Not Detected	--
			29.4m	*Not Detected	--

Total Nitrogen	1 mg/L	February	1m	N/A	--
			16m	N/A	--
			32m	N/A	--
		May	.5m	0.300	--
			15.5m	0.300	--
			29.5m	0.300	--
		July	1m	0.300	--
			15m	0.300	--
			31m	0.300	--
		October	1m	0.290	--
			15m	0.290	--
			29.4m	0.290	--
Dissolved Oxygen	< 7 mg/L	February	See dissolved oxygen profile graph		
		May			
		July			
		October			
Temperature	Great Lake	February	1m	N/A	--
		May	.5m	3.174	--
		July	1m	17.113	--
		October	1m	11.260	--
Chlorophyll a	3 µg/L	May	15.5m	5.100	X
		July	15m	8.100	X
		October	15m	N/A	--
Conductivity	450 µS/cm	February	1m	N/A	--
			16m	N/A	--
			32m	N/A	--
		May	.5m	269.000	--
			15.5m	269.000	--
			29.5m	271.000	--
		July	1m	287.000	--
			15m	283.000	--
			31m	278.000	--
		October	1m	280.000	--
			15m	280.000	--
			29.4m	281.000	--
pH	6.5-9 pH units	February	1m	N/A	--
			16m	N/A	--
			32m	N/A	--
		May	.5m	7.509	--
			15.5m	7.49	--

			29.5m	7.57	--
		July	1m	8.269	--
			15m	8.28	--
			31m	8.08	--
		October	1m	8.266	--
			15m	8.27	--
			29.4m	8.29	--

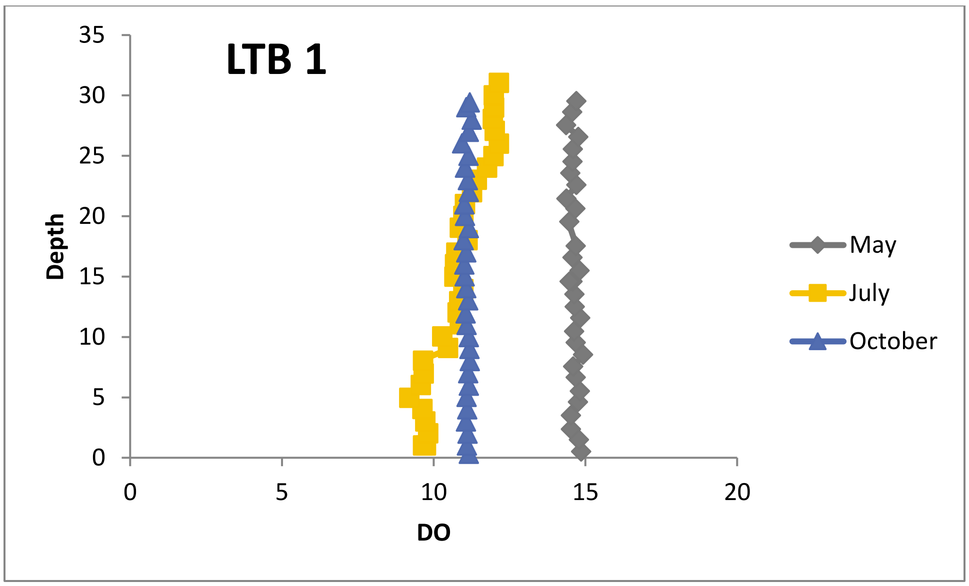
Table 86: Data summary table for LTB2

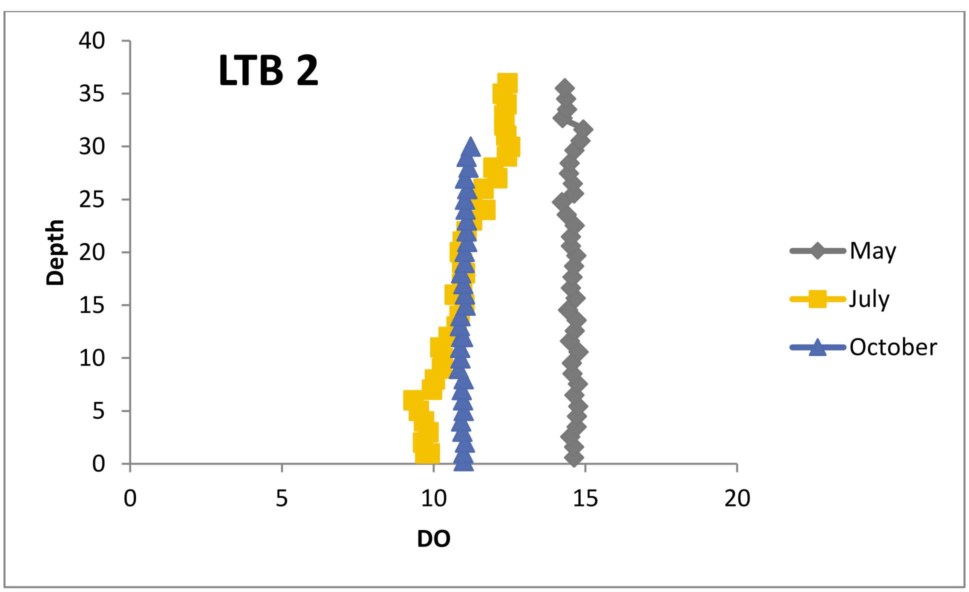
Parameter	Threshold Criteria	Season Collected	Depth (m)	Parameter Result	Exceedance
Chloride	50 mg/L	February	1m	N/A	--
			16m	N/A	--
			32m	N/A	--
		May	.5m	13.780	--
			17.67m	12.662	--
			37m	13.284	--
		July	1m	13.462	--
			18m	13.983	--
			36m	13.056	--
		October	.27m	8.204	--
			14.98m	9.589	--
			30m	9.157	--
Total Phosphorus	25 µg/L	February	1m	N/A	--
			16m	N/A	--
			32m	N/A	--
		May	.5m	*Not Detected	--
			17.67m	*Not Detected	--
			37m	*Not Detected	--
		July	1m	*Not Detected	--
			18m	*Not Detected	--
			36m	*Not Detected	--
		October	.27m	*Not Detected	--
			14.98m	*Not Detected	--

			30m	*Not Detected	--
Total Nitrogen	1 mg/L	February	1m	N/A	--
			16m	N/A	--
			32m	N/A	--
		May	.5m	0.300	--
			17.67m	0.300	--
			37m	0.300	--
		July	1m	0.300	--
			18m	0.300	--
			36m	0.300	--
		October	.27m	0.290	--
			14.98m	0.280	--
			30m	0.280	--
Dissolved Oxygen	< 7 mg/L	February	See dissolved oxygen profile graph		
		May			
		July			
		October			
Temperature	Great Lake	February	1m	N/A	--
		May	.5m	3.526	--
		July	1m	16.203	--
		October	.27m	11.328	--
Chlorophyll a	3 µg/L	May	17.67m	5.100	X
		July	18m	4.200	X
		October	14.98m	*Not Detected	--
Conductivity	450 µS/cm	February	1m	N/A	--
			16m	N/A	--
			32m	N/A	--
		May	.5m	270.000	--
			17.67m	269.000	--
			37m	269.000	--
		July	1m	284.000	--
			18m	282.000	--
			36m	277.000	--
		October	.27m	282.000	--
			14.98m	282.000	--
			30m	282.000	--
pH	6.5-9 pH units	February	1m	N/A	--
			16m	N/A	--
			32m	N/A	--

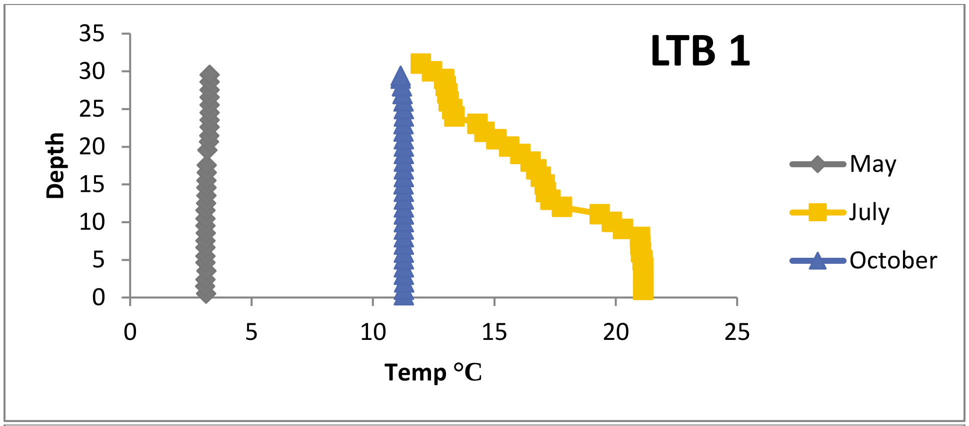
	May	.5m	7.21	--
		17.67m	7.48	--
		37m	7.54	--
	July	1m	8.47	--
		18m	8.26	--
		36m	8.08	--
	October	.27m	8.21	--
		14.98m	8.27	--
		30m	8.25	--

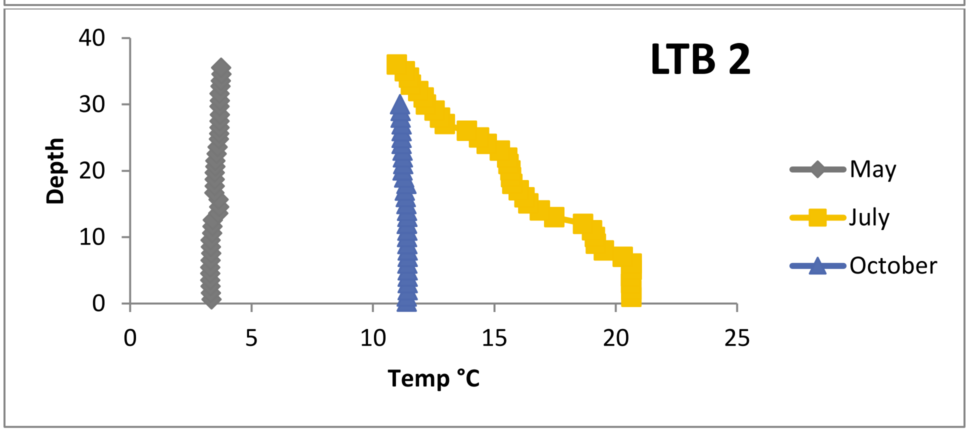
Figures 34 & 35: LTB1 and LTB2 DO Profile 2018





Figures 36 & 37: LTB1 and LTB 2 Temperature profile





Biological Data

Macroinvertebrates
Macroinvertebrates were not collected during 2018.

Narrative Summary
For both sites in Little Traverse Bay, chlorophyll a in May and July were the only exceedances to have been observed. No other trends or exceedances were reportable.

Trends
At both sites there in an increasing trend in dissolved oxygen.

Wetlands

The FQI with and without adventives is over 35 for all the wetlands monitored in 2017 (Table 31) and all but one in 2018. This is expected due to the location of the Bindiigen (gas station property). These wetlands are considered high quality. Designated uses include **PCR, SCR, TCC, IAL,** and **WLS** for all wetlands. All uses are fully supported.

Trends
Most wetland sites only have 3 years of data so no trend analysis was completed.

Table 87. Wetlands FQA Summary

Year	Site Name	Total # Acres	Total # of Plants	Total # of Native Plants	Total # of Non-native Plants	Native FQI	FQI - All Species	Native Mean C	Mean C All Plants	Native Mean Wetness (W)	Mean Wetness (W) For All Plants
2017	Cross Village	8.39	137	99	38	41.8	36.3	4.2	3.1	-1.3	-0.3
	Drier Road	79	162	149	13	47.1	50	3.7	4.1	-1.4	-1.6
	Kings Inn	23	185	158	27	50.3	50.3	4.3	3.7	-1.4	-0.9
	Ziibimijwang	75.2	182	164	18	51.3	48.6	4	3.6	-1	-0.8
2018	Waawaashkesh	51.4	159	142	17	48.9	46.7	4.1	3.7	-1.1	-0.7
	Bindiigen	2	95	74	11	31	27.3	3.6	2.8	-1.3	-0.5
	Taimi Hoag	54.3	183	153	30	46	46	4.1	3.4	-1.2	-0.8
	Pond Street	65.2	230	198	32	68.9	45.5	4.9	4.2	-1.8	-1.3

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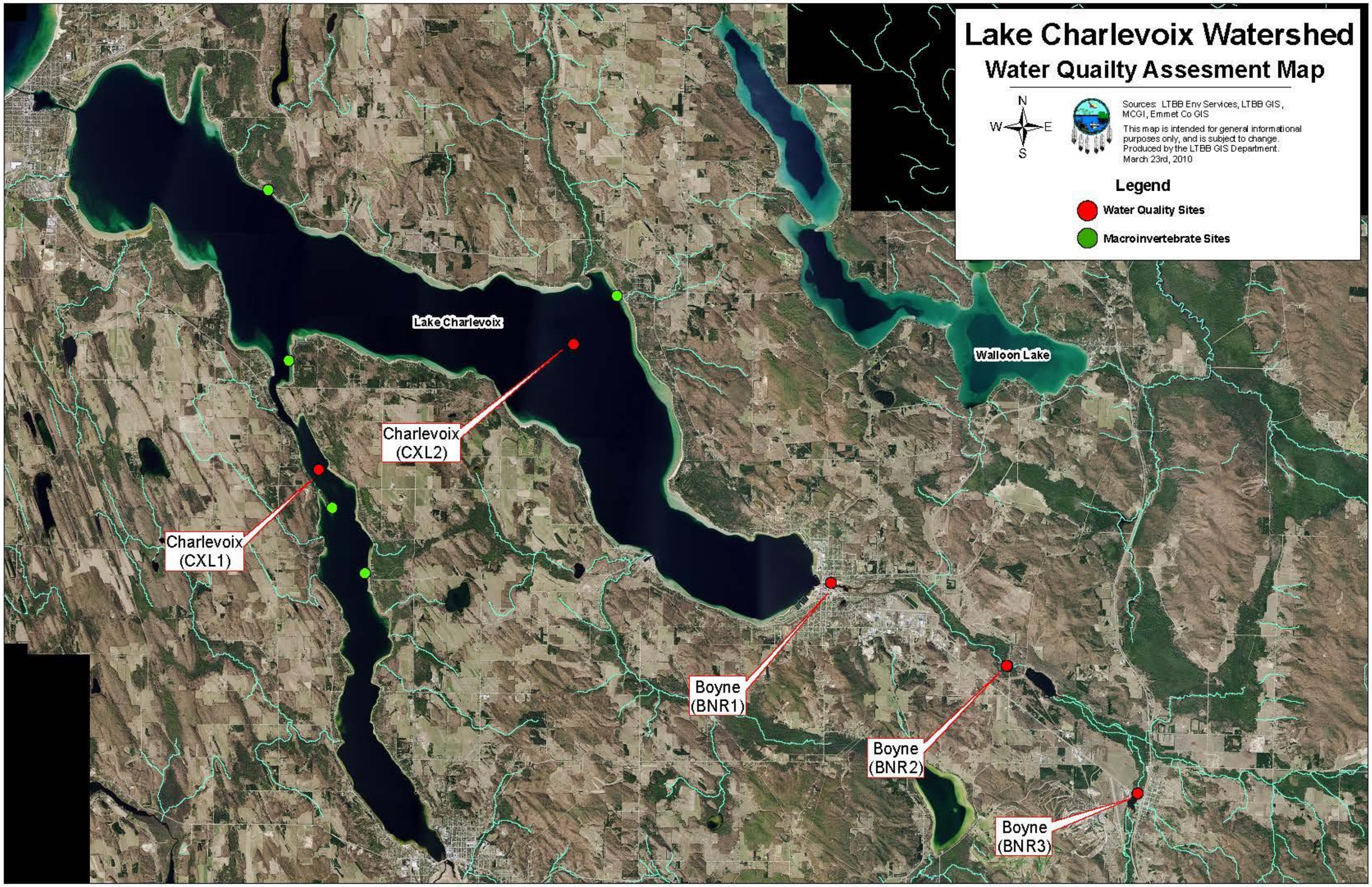
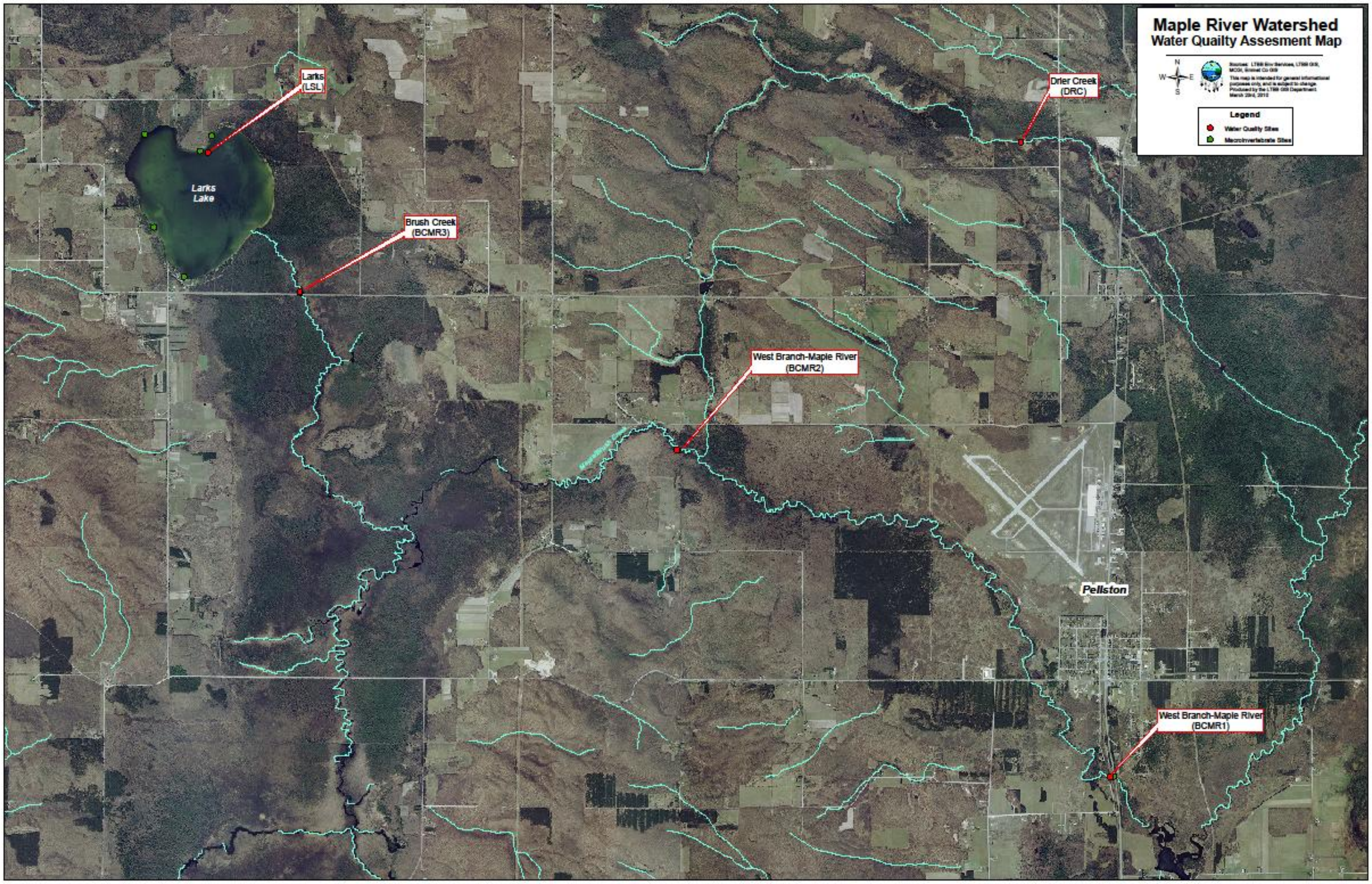
Appendix A. Maps

Map 1. Lake Charlevoix Watershed

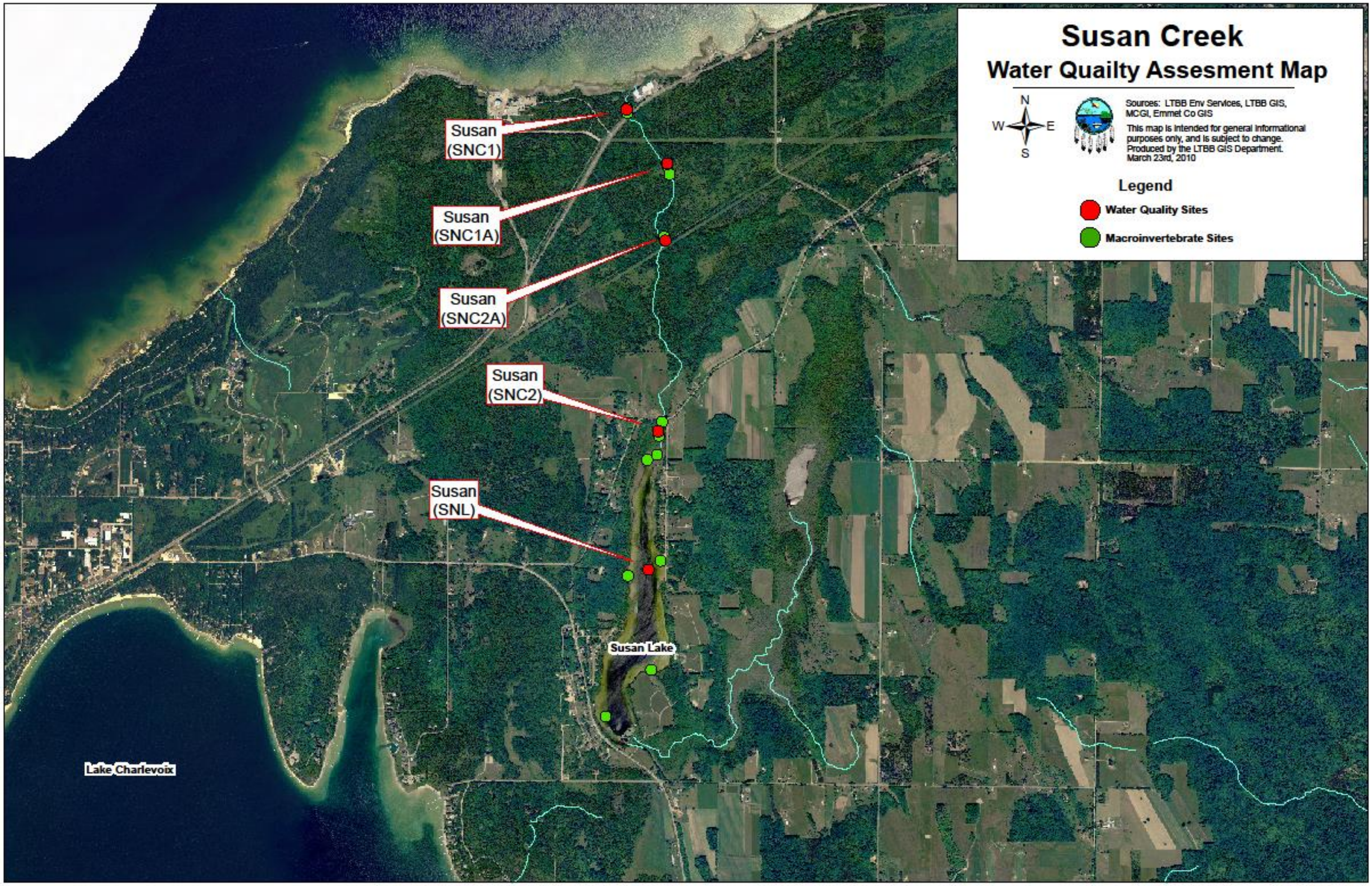


Map 2. Maple River Watershed

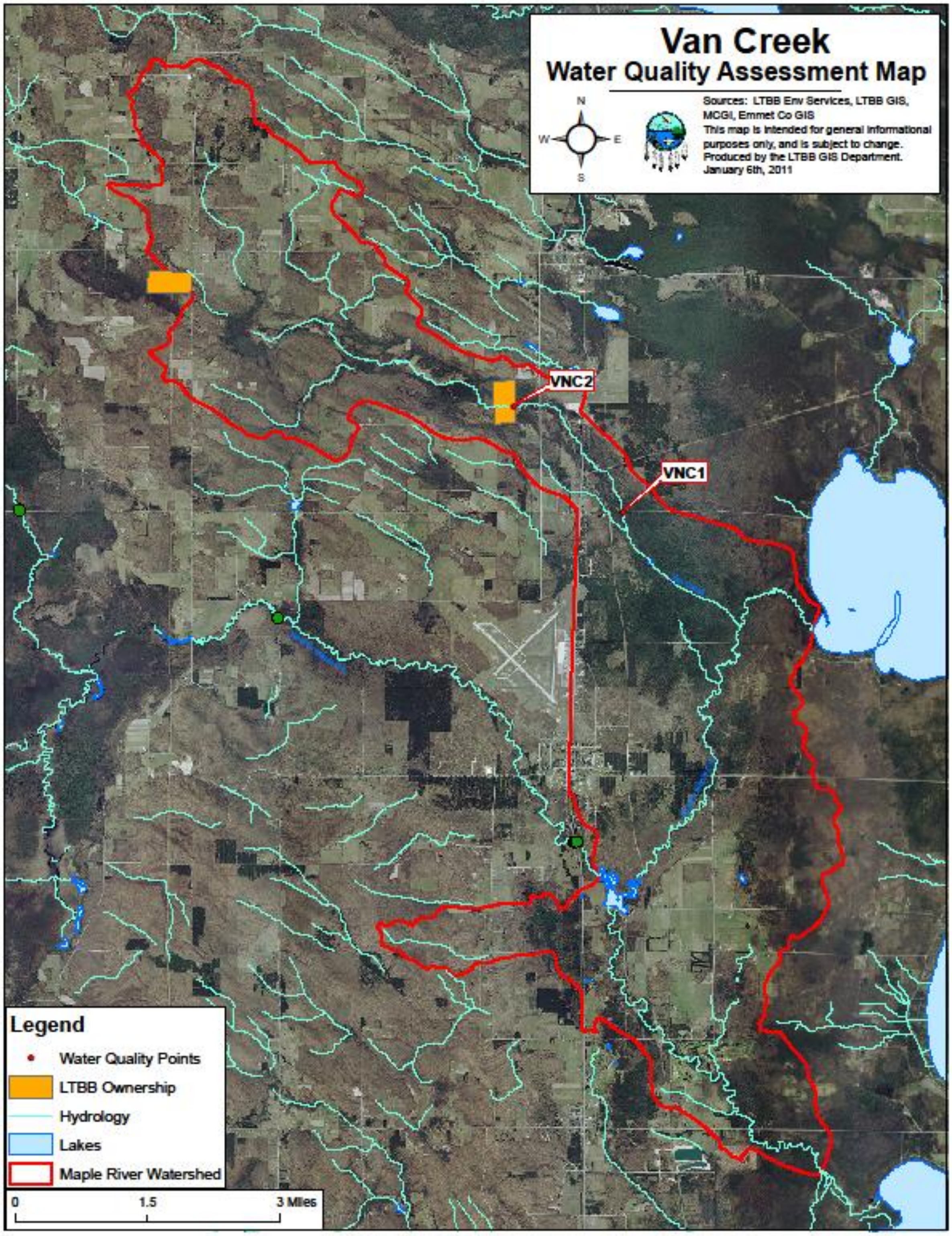


Map 3. Wycamp Creek Watershed

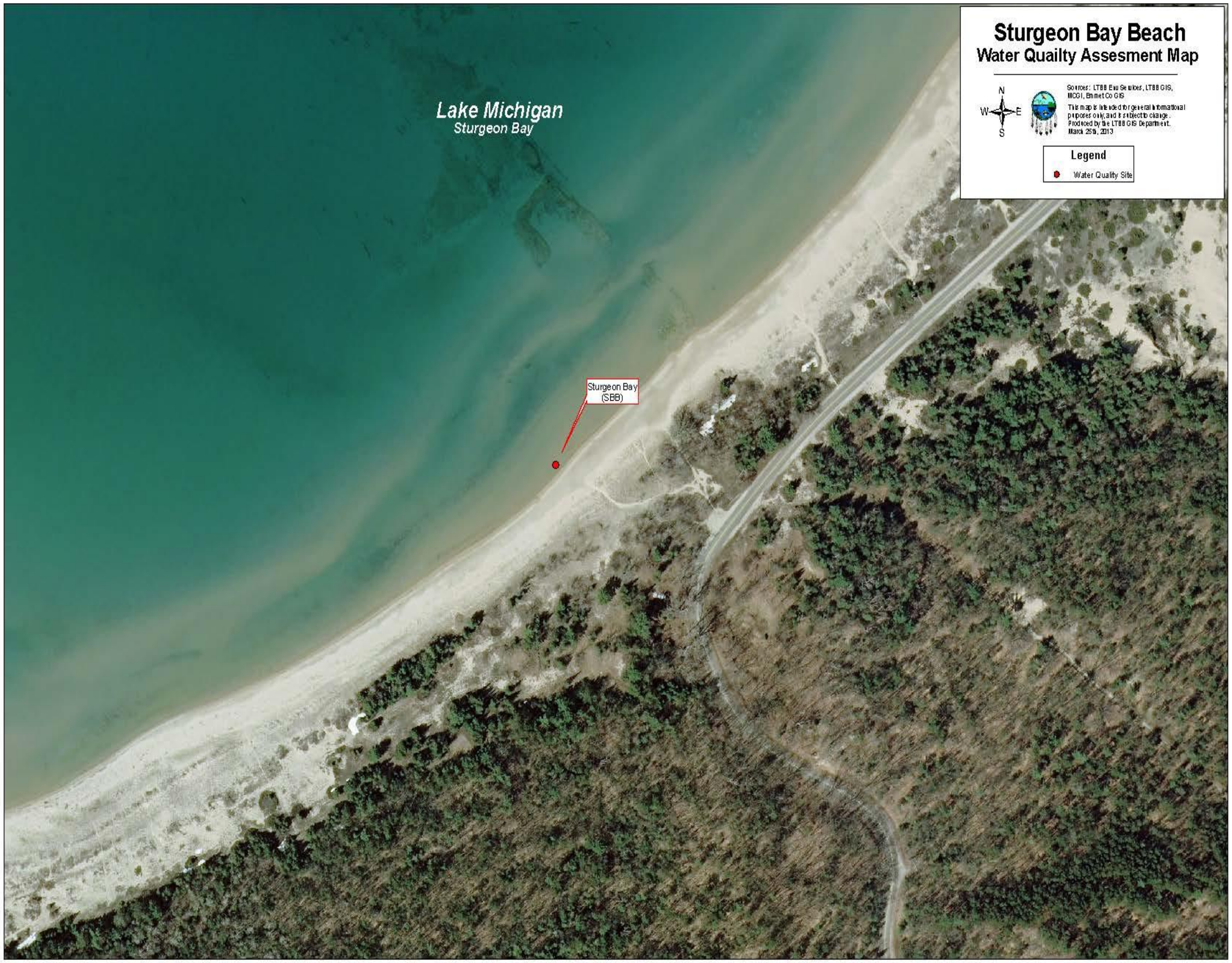
Map 4. Susan Creek Watershed



Map 5. Van Creek Watershed



Map 6. Sturgeon Bay Watershed



<u>**Map 7. Little Traverse Bay Watershed**</u>