Lake Superior – North Watershed Monitoring and Assessment Report

Minnesota Pollution Control Agency

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List of acronyms

AMA Aquatic Management Area
AUID Assessment Unit Identification Determination
BEACH Beaches Environmental Assessment and Coastal Health
BWCAW Boundary Waters Canoe Area Wilderness
CI Confidence Interval
CWA Clean Water Act
CWLA Clean Water Legacy Act
DOP Dissolved Orthophosphate
E Eutrophic
EQuIS Environmental Quality Information System
EX Exceeds Criteria (Bacteria)
EXP Exceeds Criteria, Potential Impairment
EXS Exceeds Criteria, Potential Severe Impairment
FQA Floristic Quality Assessment
FIBI Fish-based Index of Biotic Integrity
FILLET Skin-off fillet
FILSK Skin-on fillet
FS Full Support
FWMC Flow Weighted Mean Concentration
HUC Hydrologic Unit Code
IBI Index of Biotic Integrity
IF Insufficient Information
K Potassium
LRVW Limited Resource Value Water
M Mesotrophic
MCL Maximum Contaminant Level
MDA Minnesota Department of Agriculture
MDH Minnesota Department of Health
MNDNR Minnesota Department of Natural Resources
MGS Minnesota Geological Survey
MIBI Macroinvertebrate-based Index of Biotic Integrity
MINLEAP Minnesota Lake Eutrophication Analysis Procedure
MPCA Minnesota Pollution Control Agency
MSHA Minnesota Stream Habitat Assessment
MTS Meets the Standard
N Nitrogen
Nitrate-N Nitrate Plus Nitrite Nitrogen
NA Not Assessed
NH3 Ammonia
NS Not Supporting
NT No Trend
NWI National Wetlands Inventory
OP Orthophosphate
P Phosphorous
PCB Poly Chlorinated Biphenyls
PFC Perfluorinated chemicals
PFOS Perfluorooctane sulfonate
PJG Professional Judgment Group
RNA Research Natural Area
RNR River Nutrient Region
SWAG Surface Water Assessment Grant
SWCD Soil and Water Conservation District
SWUD State Water Use Database
TALU Tiered Aquatic Life Uses
TKN Total Kjeldahl Nitrogen
TMDL Total Maximum Daily Load
TP Total Phosphorous
TSS Total Suspended Solids
UAA Use Attainability Analysis
UMD-NRRI University of Minnesota Duluth, Natural Resources Research Institute
EPA United States Environmental Protection Agency
USGS United States Geological Survey
WHORG Whole fish
WPLMN Water Pollutant Load Monitoring Network

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Executive summary

In 2013 and 2014, the Minnesota Pollution Control Agency (MPCA) conducted intensive watershed monitoring (IWM) of surface waters in the Lake Superior – North Watershed. Eighty-nine lakes and 64 streams were monitored by MPCA and local partners, collecting water chemistry and biological data that was used to assess the quality and use support of these waters. Water quality was generally good throughout the watershed; in many cases, lakes and streams ranked among the least polluted in the state of Minnesota.

No aquatic recreation impairments were identified, indicating that the streams and beaches of the Lake Superior – North Watershed are generally safe for swimming, boating, and other forms of body-contact recreation. The watershed's lakes were found to harbor low levels of nutrients and algae. However, a small number of lakes appear to be experiencing a declining trend in transparency. Although these lakes are still meeting water quality standards, the declines in transparency may be related to lakeshore development. Protection strategies should be developed for these lakes in order to prevent future impairments.

Exceptional biological communities (fish and aquatic macroinvertebrates) were documented in many streams; most streams supported brook trout and other cold-adapted fishes, and highly sensitive aquatic macroinvertebrates were widespread and abundant. These high quality streams are excellent candidates for protection efforts. Two streams were determined to carry excess loads of suspended sediment, which negatively impacts aquatic life; restoration efforts are already underway on each of these impaired streams.

Although water quality is generally good in the Lake Superior – North Watershed, and few impairments have been identified, some potential threats to aquatic resources should be mentioned. Poor land management is perhaps the most obvious source of potential stress. The watershed is dominated by forest, much of which is managed for timber products. Logging is common within the watershed, and poor harvest practices may have negative impacts on aquatic systems. The watershed's extensive road network includes many intersections with streams and rivers; these crossings may disrupt ecological connectivity and cause localized impacts to aquatic habitat. Residential development and agriculture may also contribute stress to aquatic systems, though these land uses comprise relatively small proportions of the landscape. Lakeshore development, in particular, may be of concern to many of the high quality lakes found in the watershed. Groundwater withdrawals have increased nearly 30% over the last 20 years, partly due to the rising demand for water supply for private consumption and recreational water related needs. Finally, climate change is perhaps the most relevant potential stressor for the watershed's aquatic resources. Although it is difficult to explicitly isolate its effects from that of other stressors and natural variation, evidence suggests that the region's rivers and streams will be affected by a changing climate to some extent. Land managers, community leaders, and other stakeholders should consider the best available information regarding climate change and other potential stressors when developing restoration and protection strategies for the watershed.

Introduction

Water is one of Minnesota's most abundant and precious resources. The MPCA is charged under both federal and state law with the responsibility of protecting the water quality of Minnesota's water resources. MPCA's water management efforts are tied to the 1972 Federal Clean Water Act (CWA) which requires states to adopt water quality standards to protect water resources and designated uses of those waters, such as for drinking water, recreation, fish consumption, and aquatic life. States are required to provide a summary of the status of their surface waters and develop a list of waterbodies that do not meet established standards. Such waters are referred to as "impaired waters" and the state must make appropriate plans to restore these waters, including development of Total Maximum Daily Loads (TMDLs). A TMDL is a comprehensive study determining the assimilative capacity of a water body, identifying all pollution sources causing or contributing to impairment, and an estimation of reductions needed to restore a water body so that it can once again support its designated use.

The MPCA currently conducts a variety of surface water monitoring activities that support our overall mission of helping Minnesotans protect the environment. To successfully prevent and address problems, decision makers need good information regarding the status of resources, potential and actual threats, options for addressing the threats, and data on the effectiveness of management actions. The MPCA's monitoring efforts are focused on providing that critical information. Overall, the MPCA is striving to provide information to assess, and ultimately restore and protect the integrity of Minnesota's waters.

The passage of Minnesota's Clean Water Legacy Act (CWLA) in 2006 provided a policy framework and the initial resources for state and local governments to accelerate efforts to monitor, assess, restore and protect surface waters. This work is implemented on an on-going basis with funding from the Clean Water Fund created by the passage of the Clean Water Land and Legacy Amendment to the state constitution. To facilitate the best use of agency and local resources, the MPCA has developed a watershed monitoring strategy which uses an effective and efficient integration of agency and local water monitoring programs to assess the condition of Minnesota's surface waters, and allow for coordinated development and implementation of water quality restoration and improvement projects. This approach also provides for a comprehensive review of lakes and streams in need of minor improvement to sustain their high quality.

The strategy behind the watershed monitoring approach is to intensively monitor streams and lakes within a major watershed to determine the overall health of water resources, and identify both impaired waters and those in need of additional protection. A benefit of this approach is the opportunity to address most, if not all, impairments through a coordinated TMDL process at the watershed scale, rather than the reach-by-reach and parameter-by-parameter approach that was previously employed. The watershed approach will more effectively address multiple impairments resulting from cumulative effects of point and non-point sources of pollution, and further the CWA goal of protecting and restoring the quality of Minnesota's water resources.

This watershed-wide monitoring approach was implemented in the Lake Superior – North Watershed beginning in the summer of 2013. This report provides a summary of all water quality assessment results in the Minnesota portion of Lake Superior – North Watershed (hereafter referred to as the Lake Superior – North Watershed) and incorporates all data available for the assessment process including watershed monitoring, volunteer monitoring, and monitoring conducted by local government units.

The watershed monitoring approach

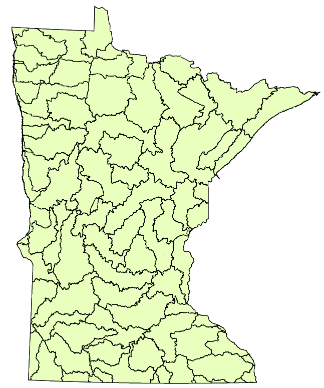


Figure 1. Major watersheds in Minnesota.

The watershed approach is a 10-year rotation for monitoring and assessing waters of the state on the level of Minnesota's 80 major watersheds (Figure 1). The major benefit of this approach is integration of monitoring resources to provide more complete and systematic assessment of water quality at a geographic scale useful for development and implementation of effective TMDLs, project planning, effectiveness monitoring and protection strategies. The following paragraphs provide details on each of the four principal monitoring components of the watershed approach. For additional information see: Watershed Approach to Condition Monitoring and Assessment (MPCA 2008).

Watershed Pollutant Load Monitoring Network

The Watershed Pollutant Load Monitoring Network (WPLMN) is a long-term program designed to measure and compare regional differences and long-term trends in water quality among Minnesota's major rivers including the Red, Rainy, St. Croix, Mississippi, and Minnesota, and the outlets of the major tributaries (8 digit HUC scale) draining to these rivers (MPCA 2016a). Since the program's inception in 2007, the WPLMN has adopted a multi-agency monitoring design that combines site specific stream flow data from United States Geological Survey (USGS) and Minnesota Department of Natural Resources (MNDNR) flow gaging stations with water quality data collected by the Metropolitan Council Environmental Services, local monitoring organizations, and MPCA to compute pollutant loads for 200 stream and river monitoring sites across Minnesota. Monitoring sites span three ranges of scale with annual loads calculated for basin and major watershed sites and seasonal loads for subwatershed sites:

Basin – Major river main stem sites along the Mississippi, Minnesota, Rainy, Red, Cedar, Des Moines, and St. Croix rivers.

Major watershed – Tributaries draining to major rivers with an average drainage area of 1,350 square miles.

Subwatershed – Branches of nodes within major watersheds with average drainage areas of approximately 300-500 square miles.

Data will also be used to assist with TMDL studies and implementation plans; watershed modeling efforts; watershed research projects, and watershed restoration and protection strategies. More information can be found at the WPLMN website.

There are three WPLMN sampling stations in the Lake Superior – North Watershed (Figure 2). The Poplar River WPLMN station drains approximately 114 square miles and monitored throughout the year. The stream gage, operated by MNDNR, is located approximately 0.5 miles upstream of Lake Superior. An average of 26 mid-stream grab samples was collected annually from this site between 2009 and 2014. Substantial development in the lower section of the watershed has taken place over the last 30 years.

The Baptism River WPLMN station drains 138 square miles and is also monitored throughout the year. The majority of the watershed runs through Tettegouche State Park. The gage is operated by MNDNR and is located approximately 0.25 miles upstream of Lake Superior. An average of 27 mid-stream grab samples was collected from this site between 2009 and 2014.

The Brule River WPLMN station drains 264 square miles. Water samples are only collected from ice out through October 31, annually. This site was sampled 24 times in 2014 and 27 times in 2015. The gage is operated by MNDNR and is located approximately 0.3 miles upstream of Lake Superior. Because of the recent establishment of the Brule River station, pollutant load data was not available at the time of this report.

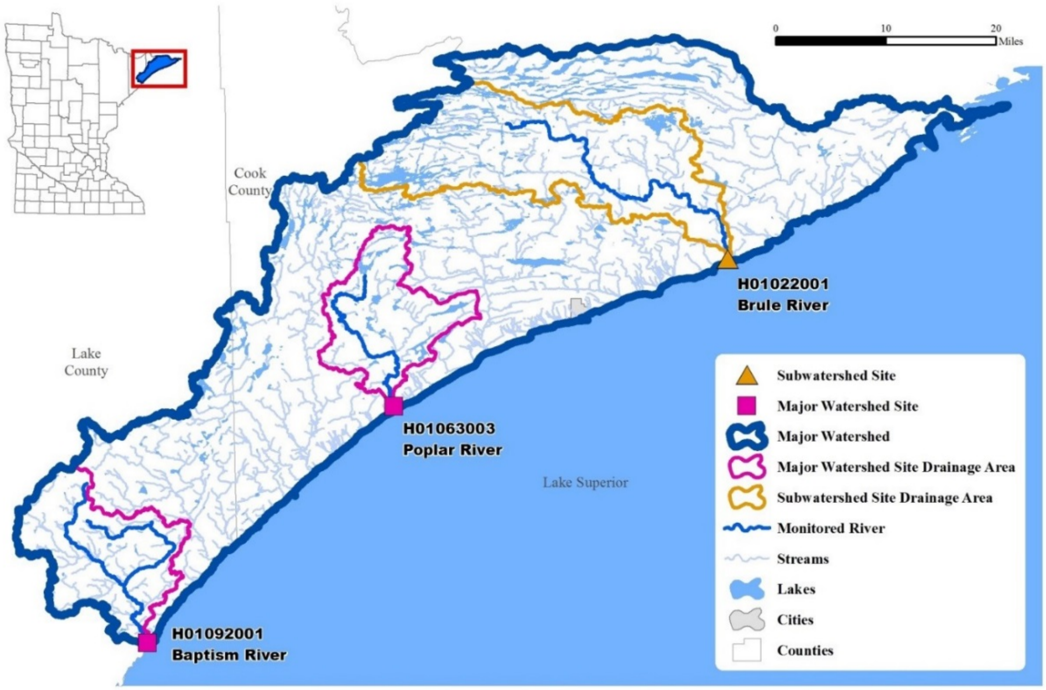


Figure 2. Watershed Pollutant Load Monitoring Network stations in the Lake Superior – North Watershed.

Intensive watershed monitoring

The IWM strategy employs a nested watershed design, targeting stream locations at both coarse and fine scales (Figure 3). Each watershed scale is defined by a hydrologic unit code (HUC). HUCs define watershed boundaries for water bodies within a similar geographic and hydrologic extent. The foundation of this approach in Minnesota is the 8-digit HUC, or “major watershed”, of which there are 80 discrete units across the state. Within each major watershed, headwaters and tributaries to larger rivers are monitored in a spatially-systematic manner so that a holistic assessment of the watershed can be conducted and problem areas identified without monitoring every stream reach. Each major watershed is the focus of attention for at least one year in the 10-year cycle.

River/stream monitoring sites are selected near watershed outlets at three different spatial scales (8-HUC, aggregated 12-HUC and 14-HUC). Different water uses are assessed at different watershed scales, based on the opportunity for each specific use. For example, fishing and swimming activities may be more common on larger rivers, but functional biological communities (e.g., fish and insects) should present at all watershed scales. Typically, the major river of each watershed is represented by the 8-HUC scale, and the outlet location monitored for biology (fish and macroinvertebrates), water chemistry, and fish contaminants to assess aquatic life, aquatic recreation, and aquatic consumption use support. The aggregated 12-HUC is a finer subwatershed scale, generally representing major tributary streams with drainage areas ranging from 75 to 150 mi^2. Each aggregated 12-HUC outlet is monitored for biology and water chemistry to assess aquatic life and aquatic recreation use support. Finer-scale watersheds (14 HUCs, typically 10-20 mi^2) that flow into aggregated 12-HUC tributaries are monitored for biology to assess aquatic life use support (Figure 4).

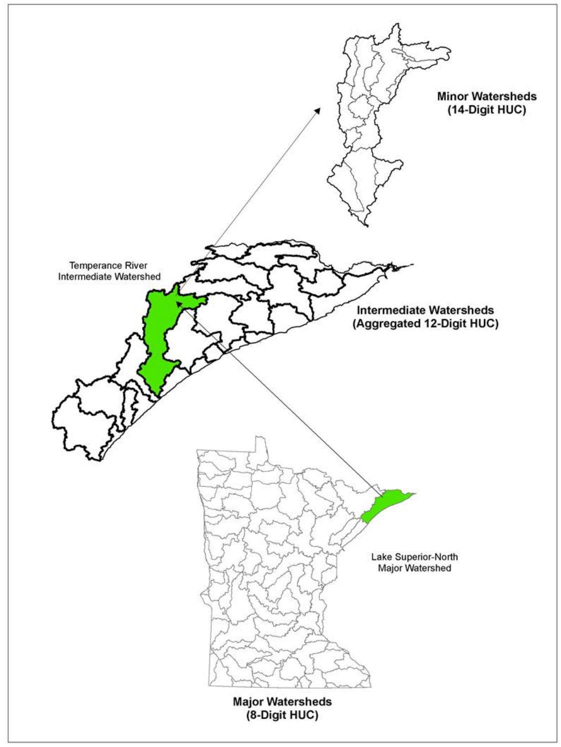


Figure 3. Intensive watershed monitoring design.

When it comes to lakes, the IWM strategy targets a representative sample of conditions and lake morphology (size and depth) within the watershed. Lakes most heavily used for recreation (all those greater than 500 acres and at least 25% of lakes 100-499 acres) are monitored for water chemistry to determine if recreational uses (e.g., swimming and wading) are being supported. Lakes are monitored during the open water season of two concurrent years, monthly between May and September. The MNDNR is in the process of developing biological indicators for lakes, but at the present time only a chemical indicator (chloride concentration) is available to determine use support for aquatic life.

Intensive watershed monitoring locations within the Lake Superior – North Watershed are shown in Figure 4 and listed in Appendix 2, Appendix 4.2, and Appendix 4.3.

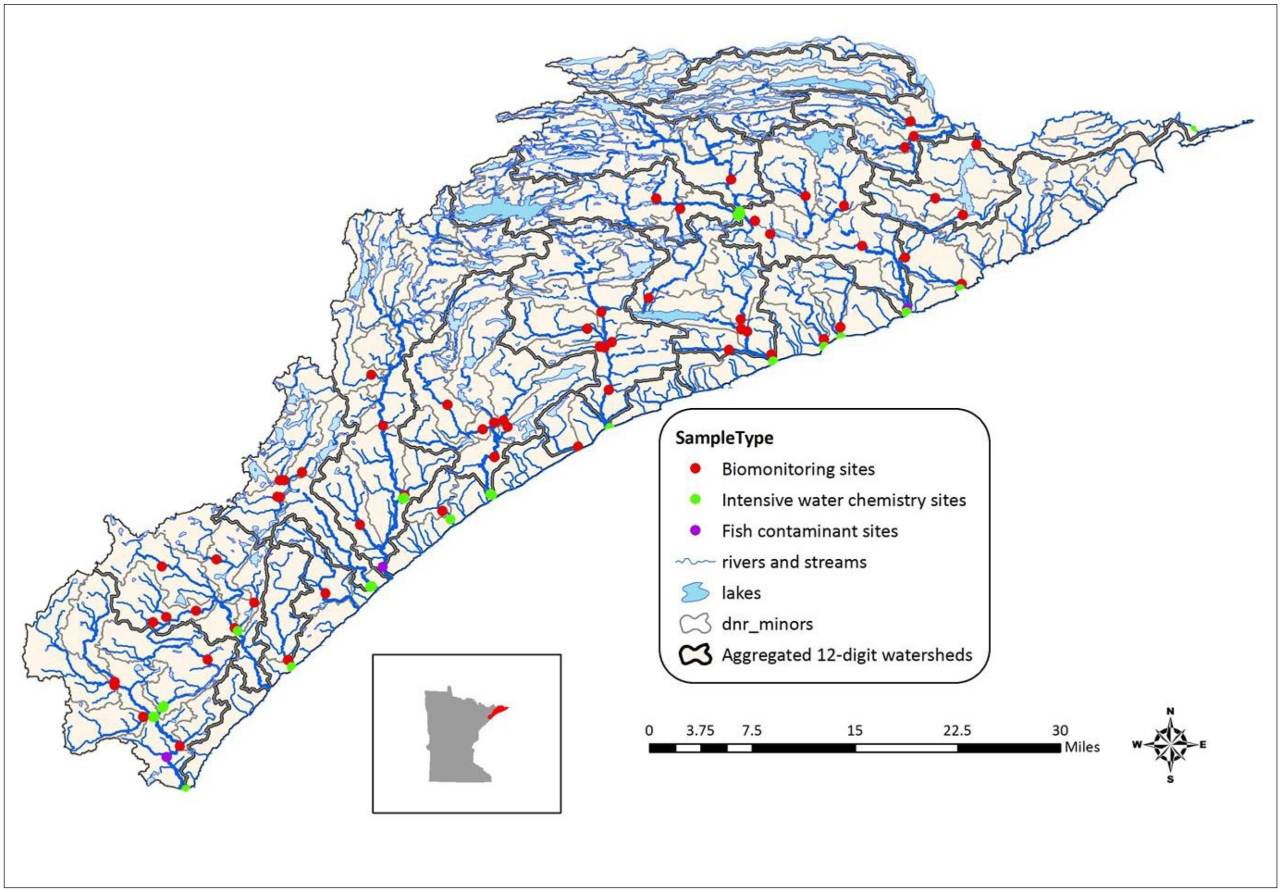


Figure 4. Intensive watershed monitoring sites (streams) in the Lake Superior – North Watershed.

Citizen and local monitoring

Citizen and local monitoring are important components of the watershed approach. The MPCA and its local partners jointly select stream and lake sites to be included in the IWM process. Funding passes from MPCA through Surface Water Assessment Grants (SWAGs) to local groups such as counties, soil and water conservation districts (SWCDs), watershed districts, nonprofits, and educational institutions to support lake and stream water chemistry monitoring. Local partners use the same monitoring protocols as the MPCA, and all monitoring data from SWAG projects are combined with the MPCA's to assess the condition of Minnesota lakes and streams. Preplanning and coordination of sampling with local citizens and governments helps focus monitoring where it will be most effective for assessment and observing long-term trends. This allows citizens/governments to see how their efforts are used to inform water quality decisions and track how management efforts effect change. Many SWAG grantees invite citizen participation in their monitoring projects; their combined participation greatly expands the overall monitoring capacity of the watershed approach.

The MPCA also coordinates two programs aimed at encouraging long term citizen surface water monitoring: the Citizen Lake Monitoring Program and the Citizen Stream Monitoring Program. Like the permanent load monitoring network, citizen volunteers monitoring a lake or stream can contribute to a long-term dataset needed to evaluate current status and trends. Citizen monitoring is especially effective in tracking water quality changes that may occur between intensive monitoring years. Figure 5 depicts locations from which citizen monitoring data were used to assess the water quality of lakes and streams in the Lake Superior – North Watershed.

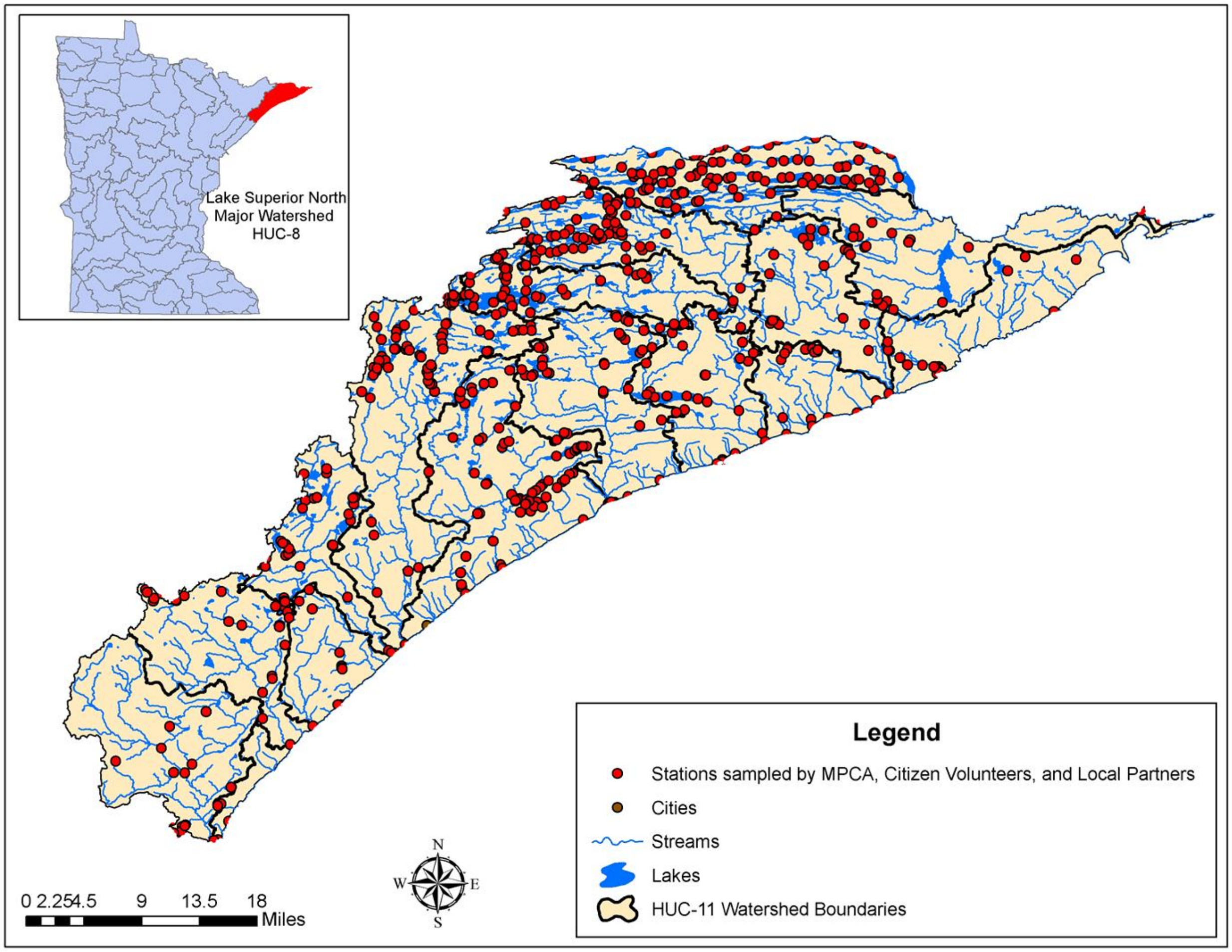


Figure 5. Citizen monitoring sites for streams and lakes in the Lake Superior – North Watershed.

Assessment methodology

The CWA requires states to report on the condition of the waters of the state every two years. This biennial report to Congress contains an updated list of surface waters that are determined to be supporting or non-supporting of their designated uses as evaluated by the comparison of monitoring data to criteria specified by Minnesota Water Quality Standards. The assessment and listing process involves dozens of MPCA staff, other state agencies and local partners. The goal of this effort is to use the best data and best science available to assess the condition of Minnesota's water resources. A thorough review of assessment methodologies is available (MPCA 2014a).

Water quality standards

Water quality standards are the fundamental benchmarks by which the quality of surface waters are measured. They may be numeric or narrative in nature, but all water quality standards define the concentrations or conditions of surface waters that allow them to meet their designated beneficial uses, such as for fishing (aquatic life), swimming (aquatic recreation) or human consumption (aquatic consumption). All surface waters in Minnesota (including lakes, rivers, streams and wetlands) are protected for aquatic life and recreation where these uses are attainable. Numeric water quality standards describe concentrations of specific pollutants that protect a specific designated use. Narrative standards are statements of conditions in and on the water, such as biological condition, that protect designated uses.

Protection of aquatic life means the maintenance of a healthy aquatic community, including fish, invertebrates and plants. Using the condition, composition, and abundance of aquatic organisms to assess water quality conditions is called "biological monitoring". Biological monitoring is a direct means to assess aquatic life use support, as a community of aquatic organisms integrates the effects of all pollutants and stressors over time. To effectively use biological indicators, the MPCA employs the Index of Biotic Integrity (IBI), a scientifically-validated combination of biological community measurements (called metrics). An IBI is comprised of multiple metrics that measure different aspects of aquatic communities (e.g., dominance by pollution tolerant species, loss of habitat specialists). Metric scores are summed together and the resulting index score characterizes the biological integrity or "health" of a stream. The MPCA has developed stream IBIs for both fish (MPCA 2014b) and macroinvertebrates (MPCA 2014c) since these communities can respond differently to various types of pollution. Because rivers and streams in Minnesota are physically, chemically, and biologically diverse, unique IBIs were developed for different types of streams. In an assessment framework, IBI scores are compared to a numeric threshold ("biocriteria") to provide a quantitative evaluation of a stream's health. In general, IBI scores above biocriteria are indicative of aquatic life use support, while scores below biocriteria are indicative of non-support. Chemical parameters are also measured and assessed against numeric standards developed to be protective of aquatic life. In Minnesota, chemical aquatic life indicators include: pH, dissolved oxygen, un-ionized ammonia nitrogen, chloride and total suspended solids.

Aquatic life use protections are divided into three tiers of biocriteria: Exceptional, General, and Modified. Exceptional Use waters support fish and macroinvertebrate communities that have minimal changes in structure and function from natural condition. General Use waters harbor "good" assemblages of fish and macroinvertebrates that have an overall balanced distribution of organisms, though some changes from natural condition are evident. At this level of condition, ecosystem functions are maintained, but possibly through redundant attributes. Modified Use waters typically reflect a legacy of extensive physical modification which limits the ability of their biological communities to attain the General Use. The Modified Use classification is essentially limited to waterbodies with channels that have been directly altered by humans (e.g., maintained for drainage, riprapped), and is determined prior to assessment based on attainment of applicable biological criteria and/or an assessment of the stream's habitat. For additional information see MPCA (2016b).

Protection of aquatic recreation means maintenance of conditions safe and suitable for swimming and other forms of water recreation. At Lake Superior beaches, and in streams, aquatic recreation is assessed by measuring the concentration of *Escherichia coli* bacteria in the water. To determine if a lake supports aquatic recreational activities, trophic status is evaluated using total phosphorus, transparency (Secchi depth) and chlorophyll *a*. Lakes that are enriched with nutrients and have abundant algal growth are eutrophic and do not support aquatic recreation.

Protection of consumption means protecting citizens who eat fish from Minnesota waters or receive their drinking water from waterbodies protected for this beneficial use. Concentrations of mercury and polychlorinated biphenyls (PCBs) in fish tissue are used to evaluate whether or not fish are safe to eat in a lake or stream, and to issue recommendations regarding how often fish from a particular water body can be safely consumed. In terms of drinking water protections, MPCA primarily measures the concentration of nitrate in the water column of lakes, rivers, and streams that are assigned this designated use.

A small percentage of Minnesota's stream miles (~1% of 92,000 miles) have been individually evaluated and re-classified as Class 7 Limited Resource Value Waters (LRVWs). These streams are characterized by an inability to achieve aquatic life standards, both currently and in the future, due to either: a) natural conditions as exhibited by poor water quality characteristics, lack of habitat or lack of water; b) the quality of the resource having been significantly (and irreversibly) altered by human activity; or c) recreational opportunities (such as fishing, swimming, wading or boating) in and on the water resource being extremely limited. While LRVW standards are not protective of aquatic life, they are still protected for industrial, agricultural, navigation and other uses. LRVWs are also protected for aesthetic qualities (e.g., odor), secondary body contact, and groundwater for use as a potable water supply. To protect these uses, LRVWs have standards for bacteria, pH, dissolved oxygen and toxic pollutants.

Assessment units

Use support assessments are made for individual waterbodies; the water body unit used for river systems, lakes, and wetlands is called the "assessment unit". A stream or river assessment unit usually extends from one significant tributary stream to another, or from headwaters to the first tributary. A stream "reach" may be further divided into two or more assessment reaches when there is a change in use classification (as defined in Minnesota Administrative Rule, Chapter 7050) or a significant morphological feature (e.g., dam, lake) interrupts the reach. As a result, the full length of a stream or river is often segmented into multiple assessment units of variable lengths.

The MPCA uses the 1:24,000 scale high resolution National Hydrologic Dataset (NHD) to define and index stream, lake, and wetland assessment units. Each river or stream reach is identified by a unique water body identifier (known as an Assessment Unit Identification Determination, or AUID), comprised of the USGS eight-digit hydrologic unit code (8-HUC) plus a three-character code that is unique within each HUC. Lake and wetland identifiers are assigned by the MNDNR. The Protected Waters Inventory provides the identification numbers for lake, reservoirs and wetlands. These identification numbers serve as the AUID and are composed of an eight-digit number indicating county, lake and bay for each basin.

Data from each AUID are evaluated for potential use impairment, and assessments of use support are limited to each individual assessment unit. A notable exception to this approach involves evaluation of rivers for contaminants in fish tissue (aquatic consumption assessments). Over the course of time it takes fish, particularly game fish, to grow to "catchable" size and accumulate unacceptable levels of pollutants, there is a good chance they have traveled a considerable distance. Recognizing that most "catchable" fish may have accumulated contaminants from multiple AUIDs over the course of their lifetime, assessment units for this purpose are typically defined by the location of significant barriers to fish movement (such as dams), and may include several "normal" assessment units.

Determining use attainment

The assessment process for beneficial uses related to human health (e.g., drinking water, aquatic recreation) is typically a simple comparison of monitoring data to numeric standards, because relationships between the standards and human health are straightforward and well-understood. In contrast, the process of assessing whether a water body supports a healthy aquatic community may be more complex, and require multiple lines of evidence to make use attainment decisions with a high degree of certainty. MPCA's "multiple lines of evidence" approach has evolved in recent years, and is outlined below and in Figure 6.

The first step in the aquatic life assessment process is largely automated, a basic summarization of data from the previous 10 years (the "assessment window"); the results are referred to as "Pre-Assessments". Data brought into the "Pre-Assessment" process are reviewed to ensure validity and appropriateness for assessment purposes. Tiered use designations are determined prior to assessments based on attainment of applicable biological criteria and assessment of the stream's habitat. Stream reaches are assigned the highest aquatic life use attained by both biological assemblages (fish and macroinvertebrates) on or after November 28, 1975. Streams that do not attain the Exceptional or General Use for both assemblages undergo a Use Attainability Analysis (UAA) to determine if a lower use is appropriate. A Modified Use may be proposed if the UAA demonstrates that the General Use is not attainable as a result of legal human activities (e.g., drainage maintenance, channel stabilization) which are limiting the biological assemblages through altered habitat. Decisions to propose a new use are made through UAA workgroups which include watershed project managers and biologists. The final approval to change a designated use is through formal rulemaking.

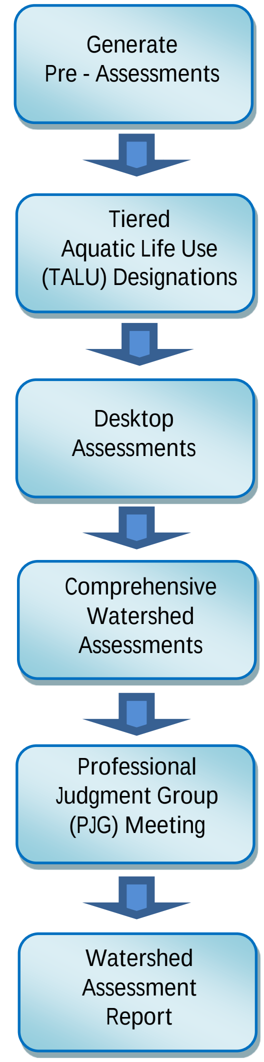


Figure 6. Flowchart of aquatic life use assessment process

The next step is a comparison of monitoring data to water quality standards. Pre-assessments are reviewed by either a biologist or water quality professional, depending on whether the parameter is biological or chemical in nature. These reviews are typically conducted at the workstation of each reviewer (i.e., "desktop") using computer applications to analyze temporal and spatial trends. This review also provides an opportunity to consider extenuating circumstances that may be associated with certain data collection events (e.g., periods of particularly high or low flow, time/date of data collection, habitat conditions).

The next step in the process is a Comprehensive Watershed Assessment meeting where reviewers convene to discuss results of parameter-specific desktop assessments for each individual water body. A comprehensive approach to water quality assessment requires organizing and evaluating information to formulate a conclusion utilizing multiple lines of evidence. Occasionally, evidence from individual parameters is not in full agreement and would result in discrepant assessments if parameters were evaluated independently. However, the overall assessment considers each piece of evidence to make a use attainment determination based on all available information. See MPCA (2014a) for guidelines and factors considered when making such determinations.

The last step in the assessment process is the Professional Judgment Group (PJG) meeting. At this meeting, results are shared and discussed with non-MPCA entities that may have been involved in data collection or that might be responsible for local watershed reports, project planning, or management activities. PJG discussions may bring additional information to light that is relevant to previous use attainment decisions, and may affect the ultimate assessment decision. Following PJG review, waterbodies that do not meet standards and therefore do not attain one or more of their designated uses are considered impaired waters and are placed on the draft 303(d) Impaired Waters List. Assessment results are communicated to the public in watershed monitoring and assessment reports.

Data management

It is MPCA policy to use all credible and relevant monitoring data to assess surface waters. The MPCA relies on data it collects along with data from other sources, such as sister agencies, local governments and volunteers. The data must meet rigorous quality assurance protocols before being used. All monitoring data required or paid for by MPCA are entered into MPCA's data system (Environmental Quality Information System, or EQuIS), and are also uploaded to the U.S. Environmental Protection Agency's (EPA) data warehouse. Data from federal- or state-funded monitoring projects are required to be stored in EQuIS (e.g., Clean Water Partnership, CWLA Surface Water Assessment Grants and TMDL program). Many local projects not funded by MPCA also choose to submit their data to the MPCA in an EQuIS-ready format so that monitoring data may be utilized in the assessment process. Prior to each assessment cycle, the MPCA makes a formal request for monitoring data to local entities and partner organizations.

Period of record

The MPCA uses data collected over the most recent 10-year period for all water quality assessments. This timeframe provides a reasonable assurance that data will have been collected over a range of weather and flow conditions and that all seasons will be adequately represented; however, data from the entire period is not required to make an assessment. The goal is to use data that best represents current water quality conditions. During the assessment process, more weight may be placed on recent data for pollutant categories such as toxics, lake eutrophication and fish contaminants.

Watershed overview

The Lake Superior – North 8-HUC drains 2,240 mi^2, of which approximately 30% lies in Canada (Figure 7). The United States' portion of the watershed includes approximately 1,570 mi^2 of Lake and Cook counties, and contains both the highest and lowest elevations found in the state of Minnesota (Eagle Mountain at 2301 feet; Lake Superior at 600 feet). All of the watershed's streams and rivers drain to Lake Superior, but there is no single "pour point" for the entire 8-HUC.

Most Lake Superior – North streams originate in upland bogs, marshes, and lakes, flow slowly through rugged glacial deposits, and finally plunge over steep rapids and waterfalls a short distance before meeting Lake Superior. Pigeon River is the largest tributary (draining 610 mi^2), and forms the international border along its entire length; less than half of the Pigeon River's catchment lies in the United States. Brule River is the 8-HUCs largest catchment entirely within the United States, draining 265 mi^2. Other sizeable Lake Superior tributaries include Temperance River, Baptism River, Poplar River, and Cascade River. The watershed is lake-rich, including more than 600 lakes, of which 578 are at least 10 acres in size. The largest lakes are Brule, Pine, Greenwood, and Devil Track (Figure 8).

The United States' portion of the watershed lies entirely within the Northern Lakes and Forest Level 3 ecoregion (Figure 9). Forest and wetland are, by far, the dominant land cover types; development and agriculture comprise a very small proportion of the watershed. Surficial geology is dominated by moraine and other glacial features, though peat is common in some areas, glacial lake deposits (sands and clays) are present in the far northeast region of the watershed, and ancient lava flows are exposed in some places, particularly along the Lake Superior shoreline.

The vast majority (81%) of the United States' portion of the watershed is under federal, state, county, or municipal administration. Approximately 14% of the watershed is in private, non-tribal ownership, and lands of the Grand Portage Band of Lake Superior Chippewa comprise approximately 5% of the watershed (Figure 10). Nearly 18% of the watershed lies within federally-protected wilderness, and another 3% lies within state parks. Based on U.S. Census Bureau block-level estimates, 5,885 people lived within the United States' portion of the watershed in 2010; population density in the watershed is less than four people per square mile. Grand Marais, a city of 1,351 residents, is the largest population center in the watershed. Other communities include Grand Portage (565 residents), Lutsen (415), Tofte (249), and Schroeder (205).

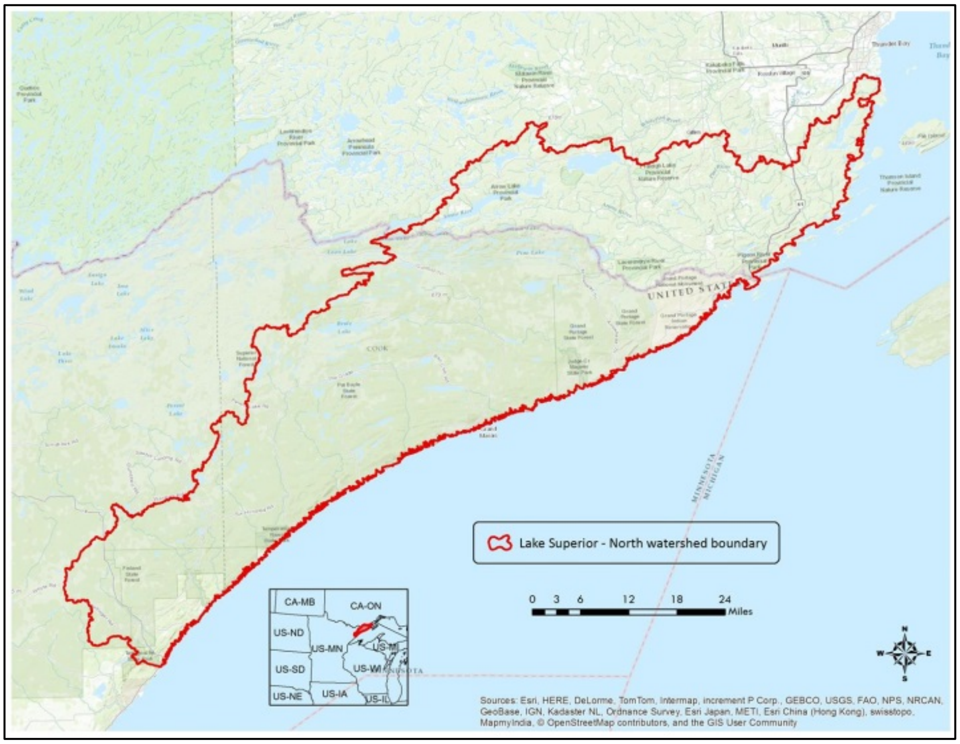


Figure 7. Geographic setting of the Lake Superior – North Watershed.

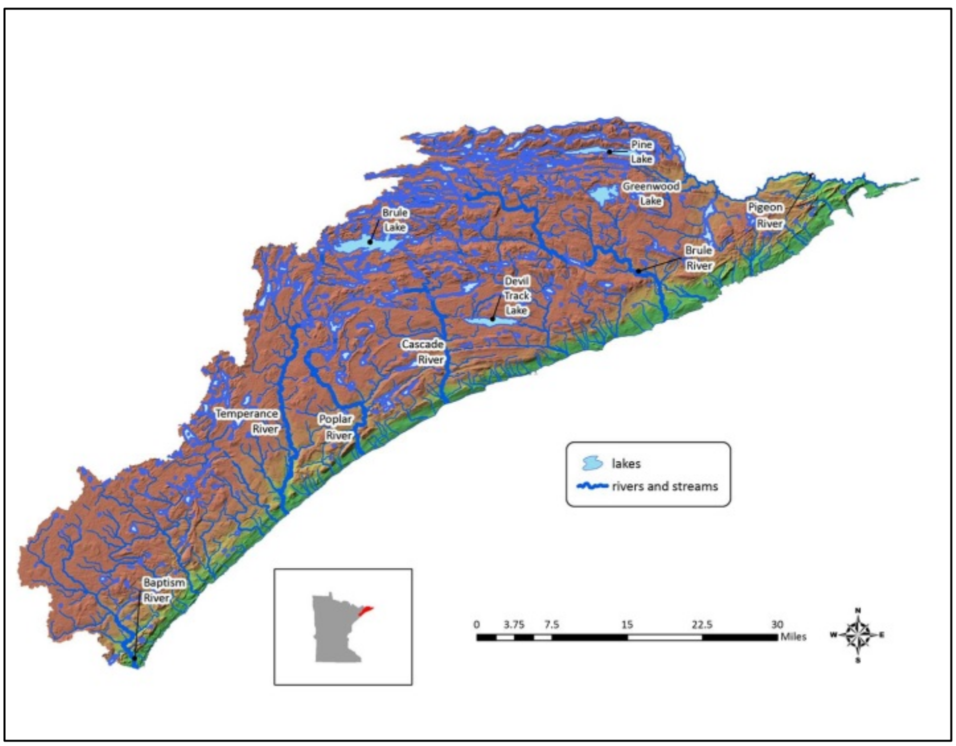


Figure 8. Major rivers and lakes of the Lake Superior – North Watershed.

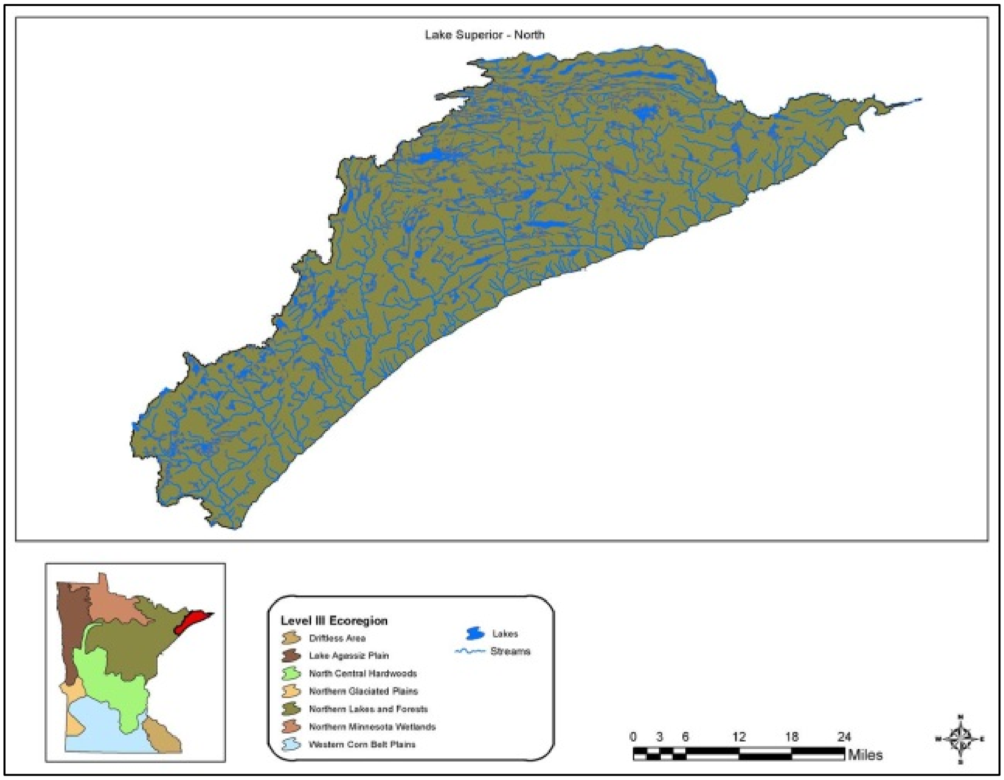


Figure 9. The Lake Superior – North Watershed within the Northern Lakes and Forest ecoregion of northeast Minnesota.

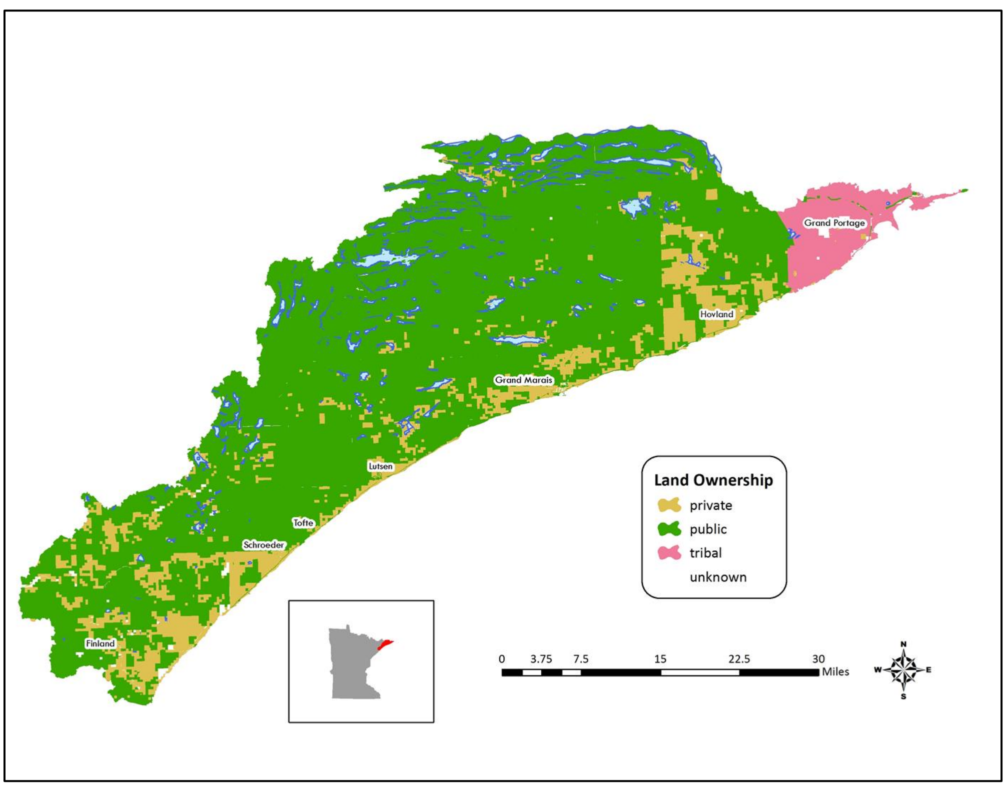


Figure 10. Land ownership in the Lake Superior – North Watershed.

Land use summary

Following the retreat of Pleistocene glaciation 10,000-14,000 years ago, forest eventually became the dominant vegetation type in the Lake Superior – North Watershed, and remains so today. The earliest known comprehensive land cover map of Minnesota, created using land survey records from the late 19th Century, suggests that that more than 80% of the watershed was covered by deciduous, coniferous, or mixed forest, with the remainder consisting of wetlands and lakes (Figure 11) (MNDNR 1988). Native Americans lived in these forests for many years, burning and clearing to facilitate travel, aid in hunting, and cultivate crops (Stearns 1997). Immigrants from Europe and the eastern United States began to arrive in the mid-1880s, and further altered the landscape through mining, logging, and other activities.

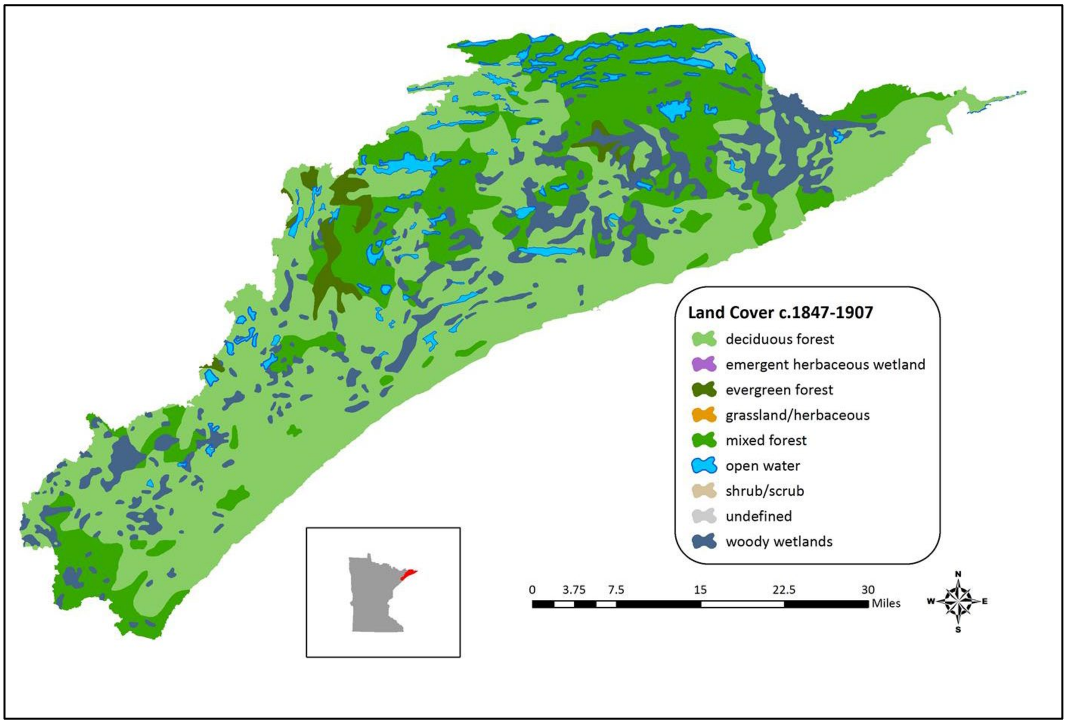


Figure 11. Land cover in the Lake Superior – North Watershed at the time of early European settlement.

Today, the watershed remains largely undeveloped and heavily forested. Contemporary mapping techniques have improved the precision and accuracy of land cover estimates, but approximately 97% of the watershed remains covered by forest, wetland, and lakes. Several small communities, scattered cabins, resorts, and residences, an airport, small industrial sites, and the road network largely comprise the 2% of the watershed classified as “developed” (Figure 12).

Logging has been the most common and widespread anthropogenic disturbance within the Lake Superior – North Watershed. Minnesota’s “logging era” reached the Lake Superior – North Watershed somewhat later than other parts of the state, due in large part to the region’s remote setting and lack of easy access to milling facilities. In other forested regions of Minnesota, rivers were used to drive logs from cutting sites to mills and large-scale timber harvest was well underway by the mid-19th Century. However, the steep and rocky nature of most Lake Superior tributaries made them poor candidates for the “river drive” method. While some timber harvest occurred in the mid-1800s on Lake Superior’s north shore, it wasn’t until railroad technology arrived in the late-1800s and early 20th Century that large-scale logging occurred within most of the Lake Superior – North Watershed (Waters 1987). The peak of logging activity occurred between 1900 and 1910, and the historical logging era was mostly over by the late 1930s (Smith and Moyle 1944) after much of the valuable white pine timber had been harvested.

Large forest fires often accompanied historical logging activity in the watershed, and became more common during drought conditions of the 1930s. The effects of logging and subsequent fires were obvious to the first scientists to conduct modern surveys in the watershed; their notes and photographs frequently document conditions similar to these observations of the Baptism River Watershed in the early 1920s:

> "Most of the country surrounding is cut-over and burnt-over, consequently very open…some original forest occurs in certain small areas…" (Surber 1922)

Unregulated timber cutting and wildfires impacted rivers, streams, and lakes, yet nearly as soon as the damage occurred, efforts were underway to rehabilitate the land and water resources of the region (Smith and Moyle 1944). As early as 1909, great acreages of cleared (and often, burned) land in the Lake Superior – North Watershed were of little interest to private parties and consolidated under state and federal administration. During the Great Depression, the Civilian Conservation Corps carried out many conservation projects on these public lands, planting trees and constructing in-stream fish habitat structures, among many other activities. As the 20th Century passed, more land was brought under public administration (particularly within the boundaries of Superior National Forest, in the Lake Superior – North watershed), with an accompanying focus of managing the land for economic and recreational activities in addition to resource extraction. Timber harvest remains an important economic activity within the watershed, but modern forestry practices follow guidelines intended to reduce the potential for negative environmental impacts.

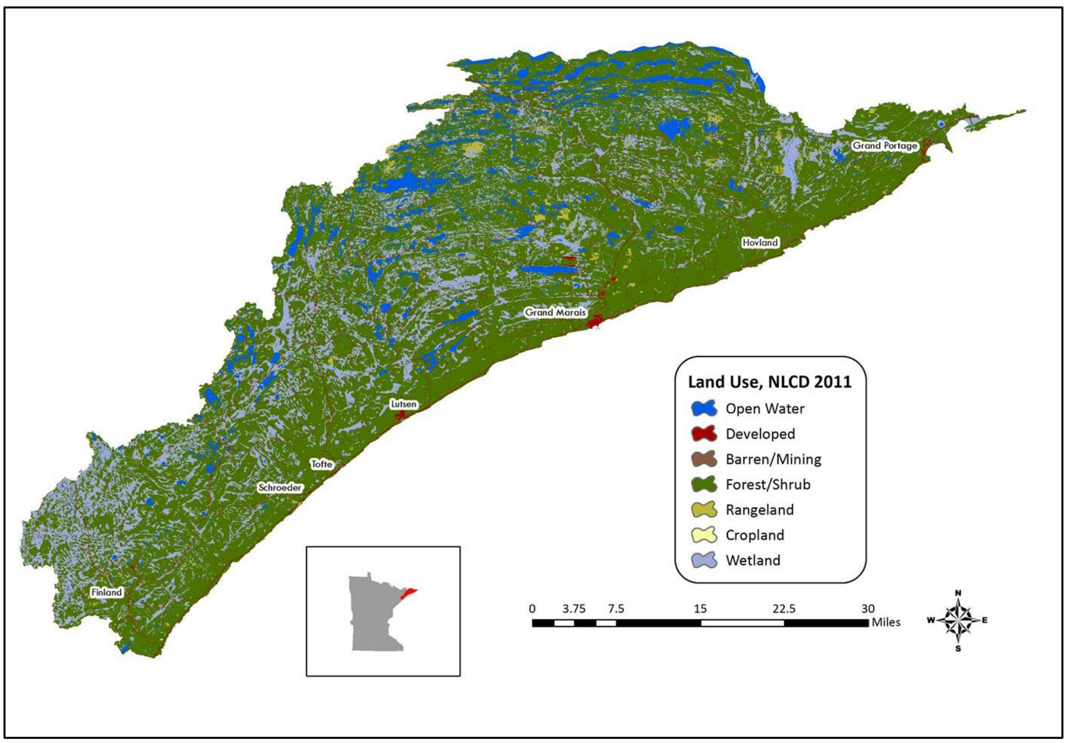


Figure 12. Contemporary land use in the Minnesota portion of the Lake Superior – North Watershed.

Surface water hydrology

The Lake Superior – North Watershed can be characterized as a group of several small- to medium-sized catchments, each of which drains to the western shore of Lake Superior. From the southwest edge of the watershed near Tettegouche State Park to the watershed's U.S. limit at the Canadian border, the major river drainages are, in order: Baptism River, Manitou River, Cross River, Temperance River, Poplar River, Cascade River, Devil Track River, Brule River, and Pigeon River. Many smaller streams are interspersed between these larger river systems and also enter Lake Superior directly.

As a result of the watershed's unique hydrography, few truly large rivers exist. Pigeon River, by far the largest, is a Strahler 4th-order stream; at low water levels a person can wade across in some places. The Pigeon drains more than twice the land area of the next largest river system (Brule River), and only nine river systems individually drain more than 50 square miles. While the upper reaches of most streams are low-gradient and wetland-influenced, the mid- and lower reaches are typically high-gradient, flowing quickly over rugged streambeds and, eventually cascading through steep canyons in the final miles before pouring into Lake Superior. Stream gradients in the lower reaches near Lake Superior commonly exceed 100 feet per mile (Figure 13, Figure 14).

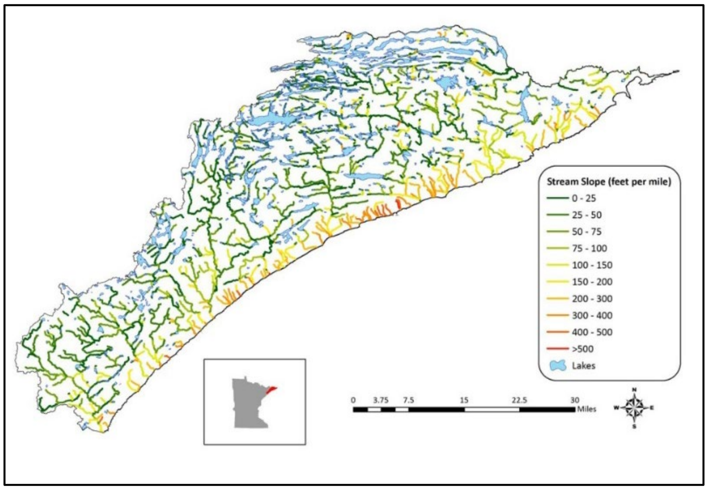


Figure 13. Stream slopes in the Minnesota portion of the Lake Superior – North Watershed.

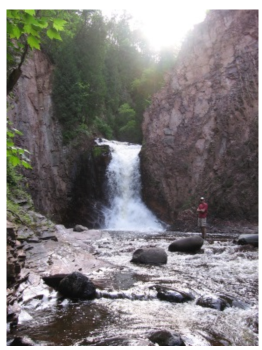


Figure 14. Examples of low- and high-gradient stream reaches in the Lake Superior – North Watershed. At left, Fourmile Creek, a low-gradient headwater stream. At right, the lower falls and canyon of the Devil Track River, near Lake Superior.

The watershed is dotted by more than 600 lakes; lakes or wetlands form the headwaters of most Lake Superior – North river systems, but individual catchments vary greatly in terms of lake and wetland composition. For example, lakes make up nearly 10% of the Brule River's catchment, and wetlands another 18%. By comparison, the Baptism River is composed of only 1% lakes but 34% wetlands. In general, wetlands are more prevalent in the southwest portion of the watershed and lakes more prevalent in the northeast.

Compared to other regions of Minnesota, the Lake Superior – North Watershed has experienced relatively little hydrologic alteration in the form of dams or channelized streams. A few streams have been re-routed for short distances from their original channels to accommodate roads or railroad grades, and dams were constructed on a few lakes and streams during the historical logging era to regulate water levels (Figure 15, Figure 16). The relative absence of hydrologic alterations in the Lake Superior – North Watershed may be attributed, at least in part, to passage of the Shipstead-Nolan Act in 1930. The act was created in response to proposals that would have created large dams and impoundments on border lakes for the purpose of hydroelectric generation, and sought to protect the natural setting of the region. Among other protections, the act prohibited alteration of natural water levels across much of Minnesota's Arrowhead region.

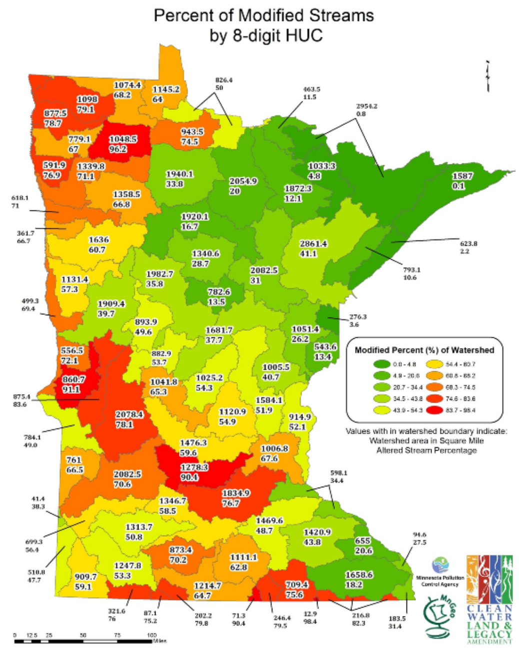


Figure 15. Percent modified streams in Minnesota, by major watershed (8-HUC).

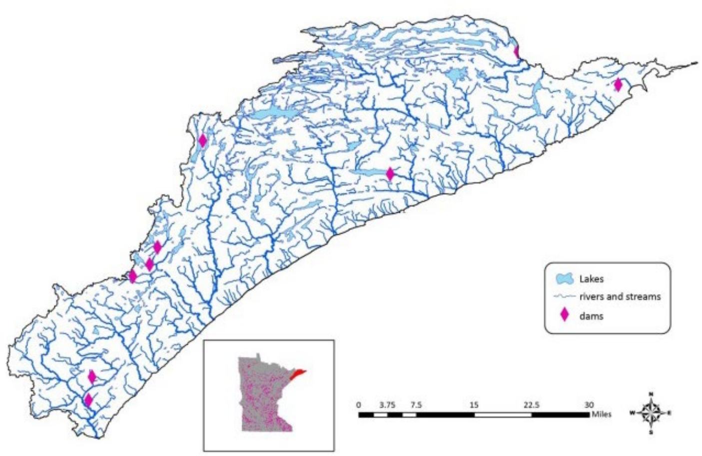


Figure 16. Dams in the Minnesota portion of Lake Superior – North Watershed, and across the State of Minnesota (inset). Data source: Army Corps of Engineers, National Inventory of Dams.

Climate and precipitation

Minnesota has a continental climate, marked by warm summers and cold winters. The mean annual temperature for the state is 4.6˚C (NOAA 2016); the mean summer temperature for the Lake Superior – North Watershed is 15.0˚C and the mean winter temperature is -11.7˚ C (MNDNR 2003).

Precipitation is an important source of water input to a watershed. Figure 17 shows two representations of precipitation for calendar year 2014. On the left is total precipitation, showing the typical pattern of increasing precipitation toward the eastern portion of the state. According to this figure, the Lake Superior – North Watershed area received 28 to 32 inches of precipitation in 2014. The display on the right shows the amount those precipitation levels departed from normal. For the Lake Superior – North Watershed, the map shows that precipitation ranged from four inches below normal to two inches above normal.

The Lake Superior – North Watershed is located in the northeast precipitation region. Figure 18 and Figure 19 display the areal average representation of precipitation in northeast Minnesota for 20 and 100 years, respectively. An areal average is a spatial average of all the precipitation data collected within a certain area presented as a single dataset. Though rainfall can vary in intensity and time of year, rainfall totals in the northeast region display no significant trend over the last 20 years. However, precipitation in northeast Minnesota exhibits a significant rising trend over the past 100 years (p=0.001). This is a strong trend and matches similar trends throughout Minnesota.

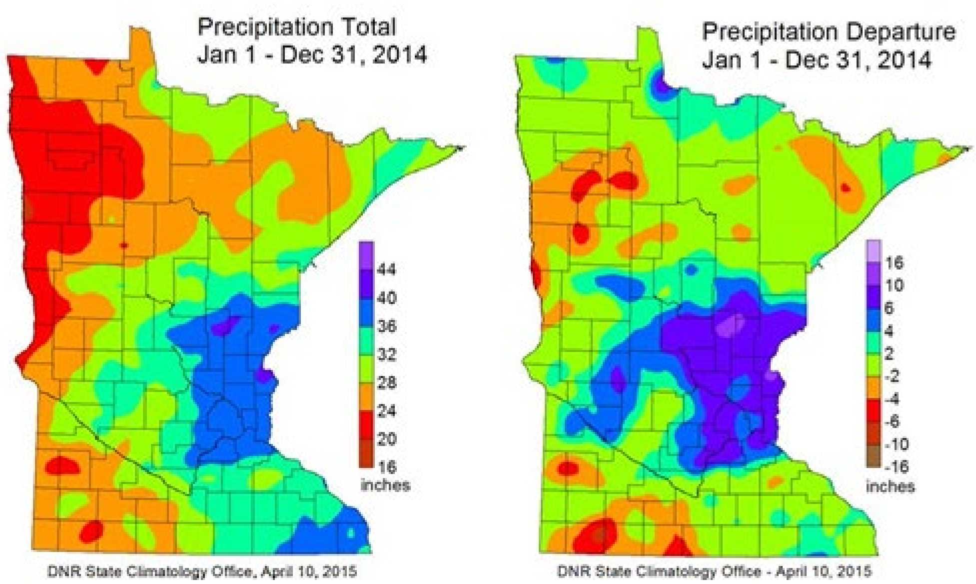


Figure 17. State-wide precipitation levels during 2014.

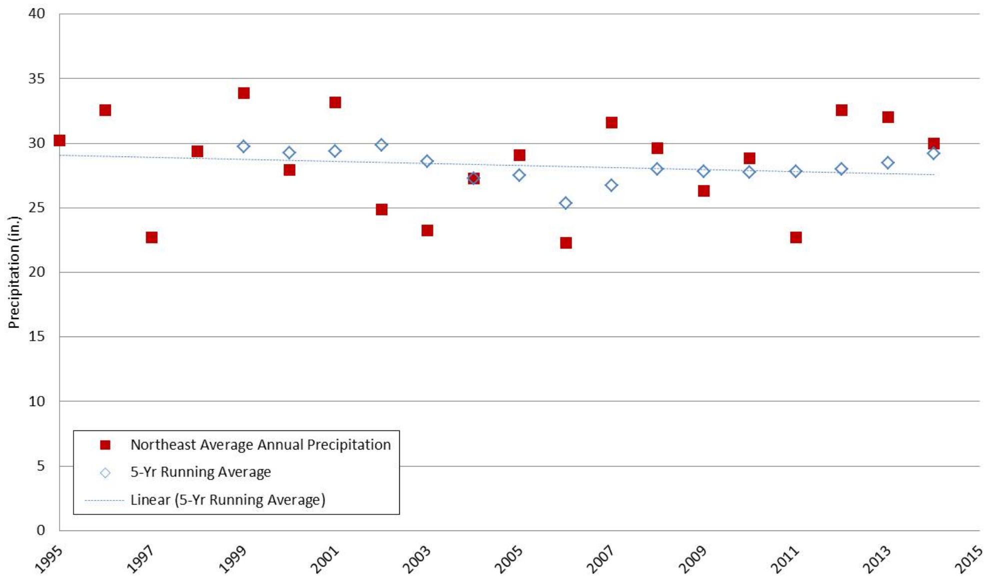


Figure 18. Precipitation trends in northeast Minnesota (1994-2014) with 5-year running average.

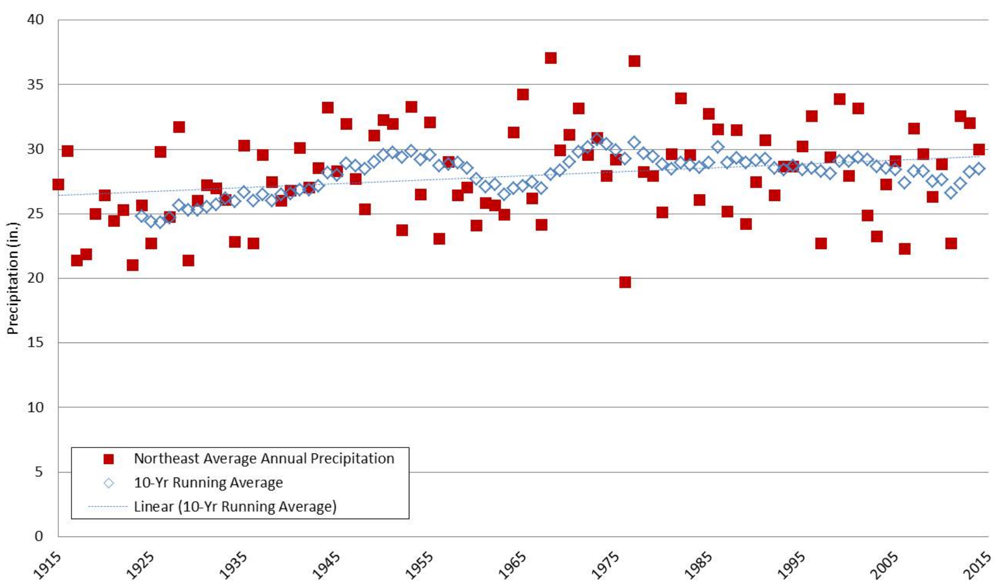


Figure 19. Precipitation trends in northeast Minnesota (1914-2014) with 10-year running average.

Hydrogeology and groundwater quality

Hydrogeology is the study of the interaction, distribution and movement of groundwater through the rocks and soil of the earth. The geology of a region strongly influences the quantity of groundwater available, the quality of the water, the sensitivity of the water to pollution and how quickly the water will be able to recharge and replenish the source aquifer. This branch of geology is important to understand as it indicates how to manage groundwater withdrawal and land use and can determine if mitigation is necessary.

Surficial and bedrock geology

The MNDNR and Minnesota Geological Survey (MGS) have collaborated to develop the County Geologic Atlas Program, with the purpose of eventually developing maps and reports of the geology and hydrogeology for all the counties in Minnesota. Each completed county atlas consists of a Part A (geology by MGS) and Part B (hydrogeology by MNDNR). For the Lake Superior – North Watershed, Part A is in progress for Lake County, but is incomplete for Cook County and Part B is incomplete for both counties. For more information on the County Geologic Atlases available, please visit: http://www.dnr.state.mn.us/waters/groundwater_section/mapping/index.html.

Surficial geology is identified as the earth material located below the topsoil and overlying the bedrock. Glacial sediment is at the surface in the Lake Superior – North Watershed, and is thin and discontinuous, with deposits of coarse loamy till and numerous lakes (MNDNR 2016a). The majority of glacial sediment at the surface is associated with the Superior and Rainy lobes. Both of these lobes originated from the northeast and have red to brown till color containing fragments of basalts, gabbro, granite, iron formation, red sandstone, slate and greenstone (MNDNR 2016a). The Superior Lobe till tends to contain more red clay while the Rainy Lobe till is sandier and course. The glacial deposits can be grouped into three categories: 1) loamy soils with coarse fragments (gravels, cobbles, stones and boulders), 2) heavy clayey soils with few coarse fragments, and 3) shallow soils on top of bedrock and lithology grouped by material texture: 1) non-calcareous till, 2) clay and silt, and 3) peat till (Figure 20) (Walczynski and Risley 2016, MGS 1982).

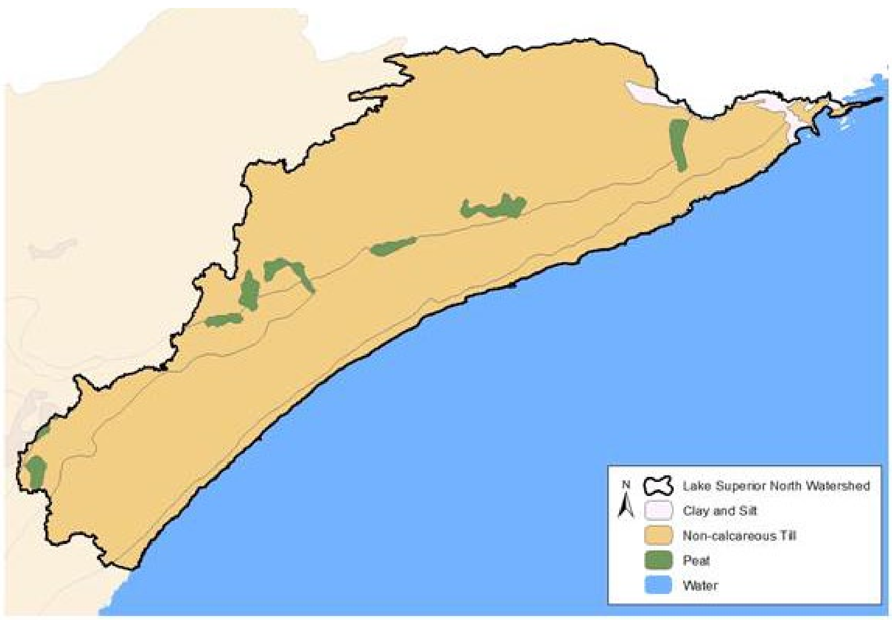


Figure 20. Quaternary geology, glacial sediments within the Minnesota portion of the Lake Superior – North Watershed.

Bedrock is the main mass of rocks that form the Earth, located underneath the surficial geology and can only be seen where weathering has exposed the bedrock. Although deposits throughout the watershed are primarily thin, the depth to bedrock ranges from exposure at the surface to over 600 feet. The bedrock is buried by deposits of the various ice lobes that reached this watershed during the last glacial period, as well as during previous glaciations in the last 2.58 million years. The bedrock geology of the Lake Superior – North Watershed consists of Precambrian crystalline rocks, which covers the extent of the watershed, and the Keweenawan Rift under Lake Superior (Figure 21).

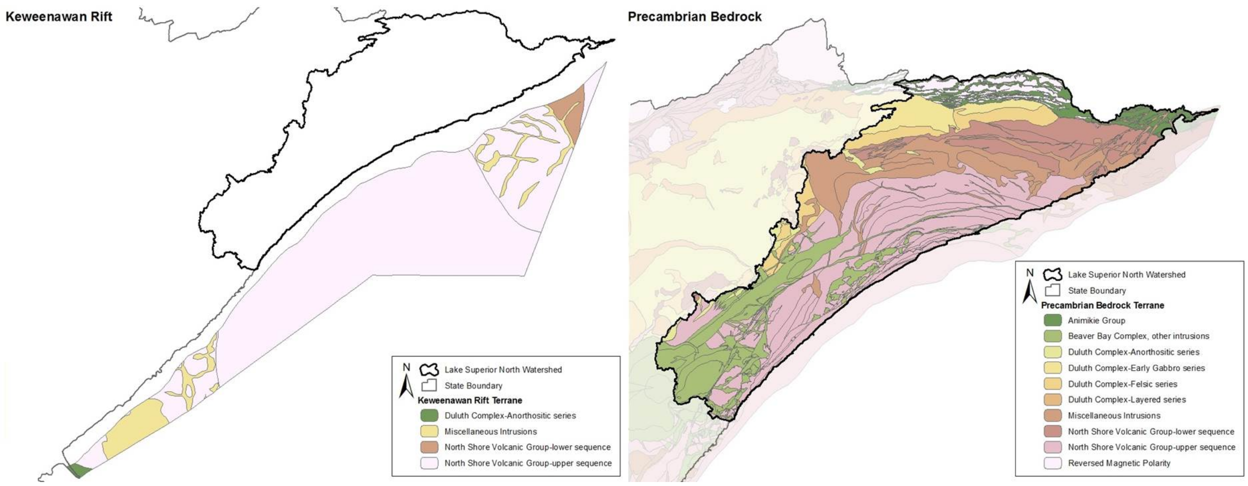


Figure 21. Bedrock geology of the Minnesota portion of the Lake Superior – North Watershed: Keweenawan Rift and Precambrian.

Groundwater provinces

The Lake Superior – North Watershed falls within two of Minnesota's six Groundwater Provinces: Arrowhead and Central Provinces (Figure 22). The majority of the watershed lies within the Arrowhead Province, which is characterized as "Precambrian rocks are exposed at the surface or drift overlying is very thin (less than 30 feet). Groundwater typically found locally in faults and fractures" (MNDNR 2001). The Central Province is located as a strip within the southwest region and is characterized by "sand aquifers in generally thick sandy and clayey glacial drift overlying Precambrian and Cretaceous bedrock" (MNDNR 2001). There is no Cretaceous bedrock within this watershed.

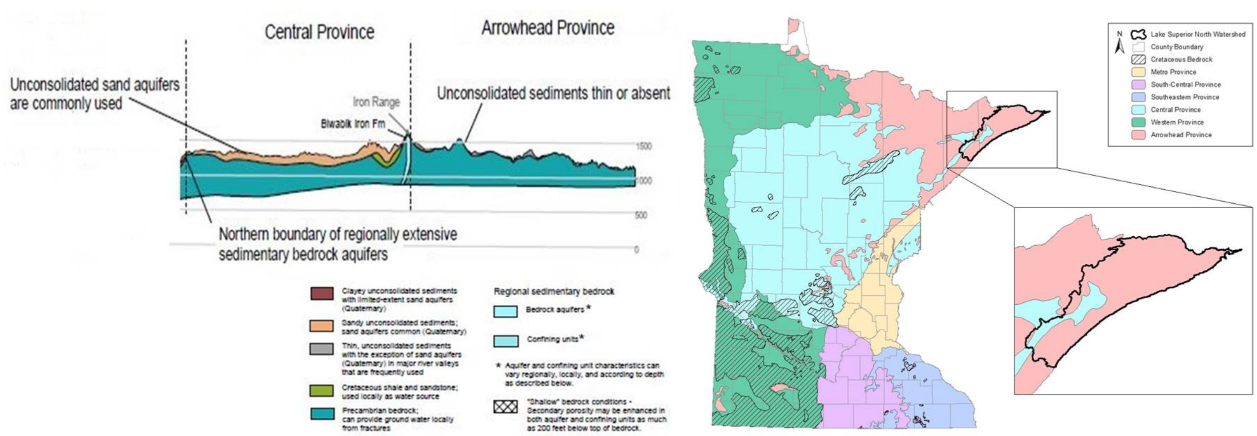


Figure 22. Central and Arrowhead Province generalized cross section (Source: MNDNR, 2001).

Aquifers

Groundwater aquifers are layers of water-bearing rocks that readily transmit water to wells and springs. As precipitation hits the surface, it infiltrates through the soil zone and into the void spaces within the geologic materials underneath the surface, saturating the material and becoming groundwater (Zhang 1998). The water table is the uppermost portion of the saturated zone, where the pore-water pressure is equal to local atmospheric pressure. The geologic material determines the permeability and availability of water within the aquifer. Minnesota's groundwater system is comprised of three types of aquifers: 1) igneous and metamorphic bedrock aquifers, 2) sedimentary rock aquifers, and 3) glacial sand and gravel aquifers (MPCA 2005). The Lake Superior North - Watershed lies primarily within igneous and metamorphic rock aquifers, with the Precambrian aquifers as the dominant source for groundwater withdrawal and the Quaternary Buried Artesian Aquifer and the Quaternary Water Table Aquifer as the primary Quaternary sources.

Groundwater pollution sensitivity

Since bedrock aquifers are typically covered with thick till, they are normally better protected from contaminant releases at the land surface. It is also less likely that withdrawals from these wells would have a direct and significant impact on local surface water bodies. In contrast, surficial aquifers are typically more likely to 1) be vulnerable to contamination, 2) have direct hydrologic connections to local surface water, and 3) influence the quality and quantity of local surface water. The MNDNR is currently working on a hydrogeological atlas focused on the pollution sensitivity of the bedrock surface. It is being produced county-by-county and is not completed for the Lake Superior – North Watershed at this time. Until the hydrogeological atlas is finished, a 1989 statewide evaluation of groundwater contamination susceptibility completed by the MPCA is utilized to determine aquifer pollution vulnerability. This display is not intended to be used on a local scale, but as a regional-scale screening tool. According to this data, the Lake Superior – North Watershed is estimated to have primarily low level contamination susceptibility, most likely due to the Precambrian bedrock aquifers, which tend to have relatively impermeable surface deposits (Figure 23) (Porcher 1989).

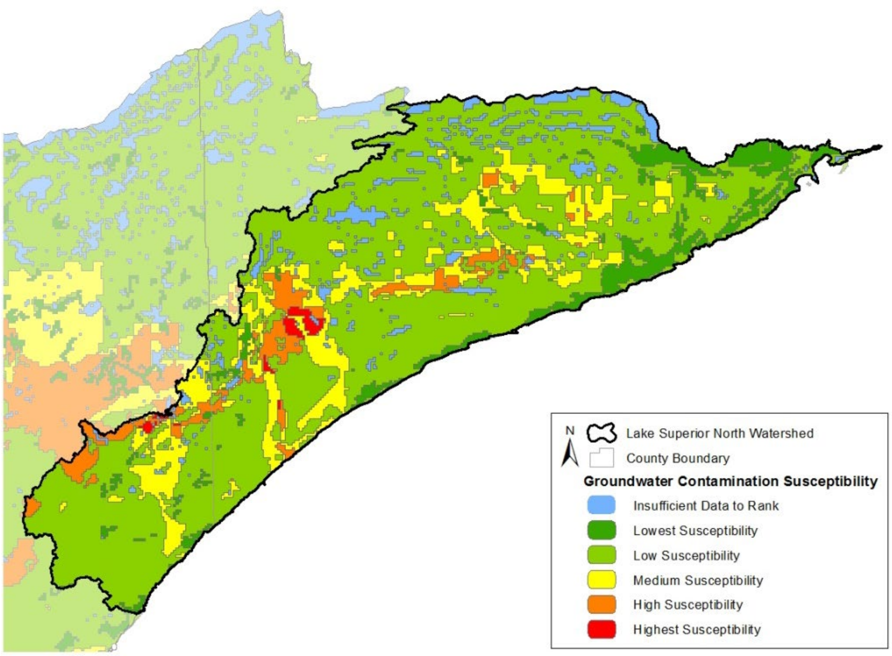


Figure 23. Groundwater contamination susceptibility for the Lake Superior – North Watershed.

Groundwater potential recharge

Groundwater recharge is one of the most important parameters in the calculation of water budgets, which are used in general hydrologic assessments, aquifer recharge studies, groundwater models, and water quality protection. Recharge is a highly variable parameter, both spatially and temporally, making accurate estimates at a regional scale difficult to produce. The MPCA contracted the USGS to develop a statewide estimate of recharge. The result is a gridded data structure of spatially distributed recharge estimates that can be easily integrated into regional groundwater studies. The full report of the project as well as the gridded data files are available at: [https://gisdata.mn.gov/dataset/geos-gw-recharge-1996-2010-mean.](https://gisdata.mn.gov/dataset/geos-gw-recharge-1996-2010-mean)

Recharge of these aquifers is important and limited to areas located at topographic highs, those with surficial sand and gravel deposits, and those along the bedrock-surficial deposit interface (Figure 24). Typically, recharge rates in unconfined aquifers are estimated at 20 to 25% of precipitation received, but can be less than 10% of precipitation where glacial clays or till are present (USGS 2007). For the Lake Superior – North Watershed, the average annual potential recharge rate to surficial materials ranges from 3.7 to 17.8 inches per year, with an average of 10.5 inches per year (Figure 25). The statewide average potential recharge is estimated to be 4 inches per year with 85% of all recharge ranging from 3 to 8 inches per year (Figure 26). When compared to the statewide average potential recharge, the Lake Superior – North Watershed receives a higher average and range of potential recharge, mostly likely attributed to the variability of the thin surficial sediment distribution of the area.

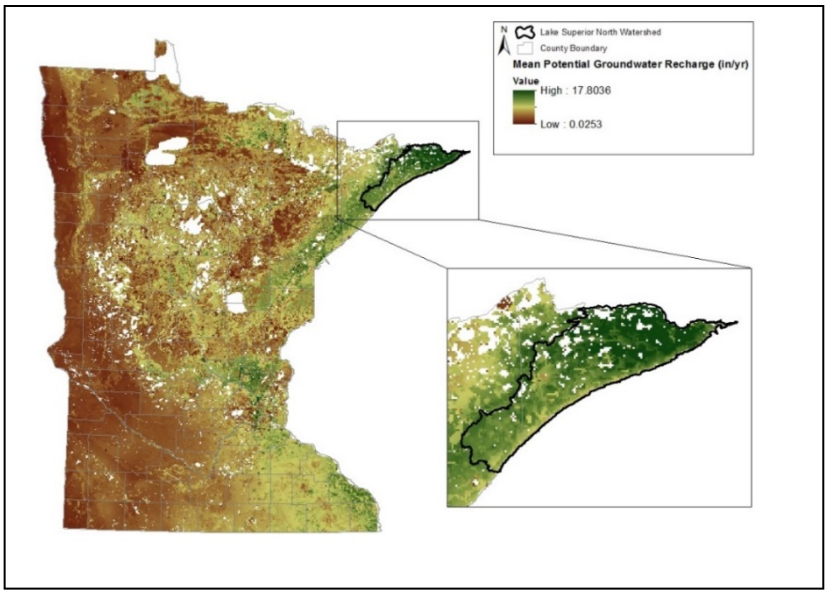


Figure 24. Average annual potential recharge rate to surficial materials in the Lake Superior – North Watershed (1996-2010).

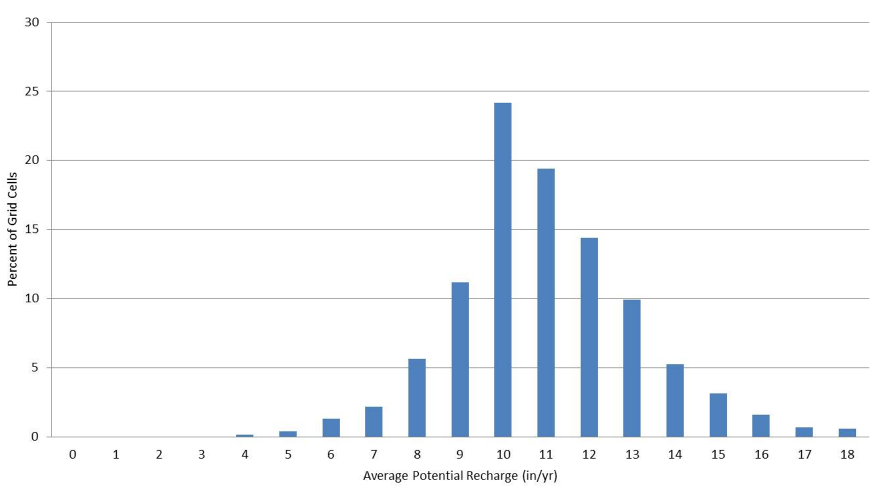


Figure 25. Average annual potential recharge rate percent of grid cells in the Lake Superior – North Watershed (1996-2010).

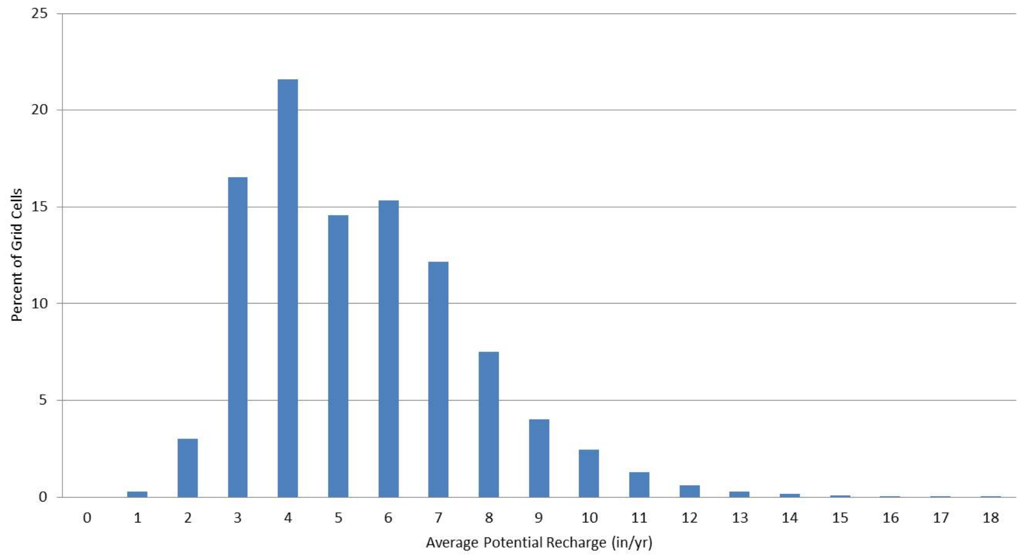


Figure 26. Average annual potential recharge rate percent of grid cells statewide (1996-2010).

Wetlands

Wetlands are common in the Lake Superior North Watershed. National Wetlands Inventory (NWI) data estimate 174,808 acres of wetlands—which is approximately 17% of the watershed area (Figure 27). This coverage is near the statewide wetland coverage rate of 19% (Kloiber and Norris 2013). Forested wetlands are the predominant type and include: coniferous swamps and bogs (dominated by black spruce, tamarack, and/or white cedar) and hardwood (black ash) swamps.

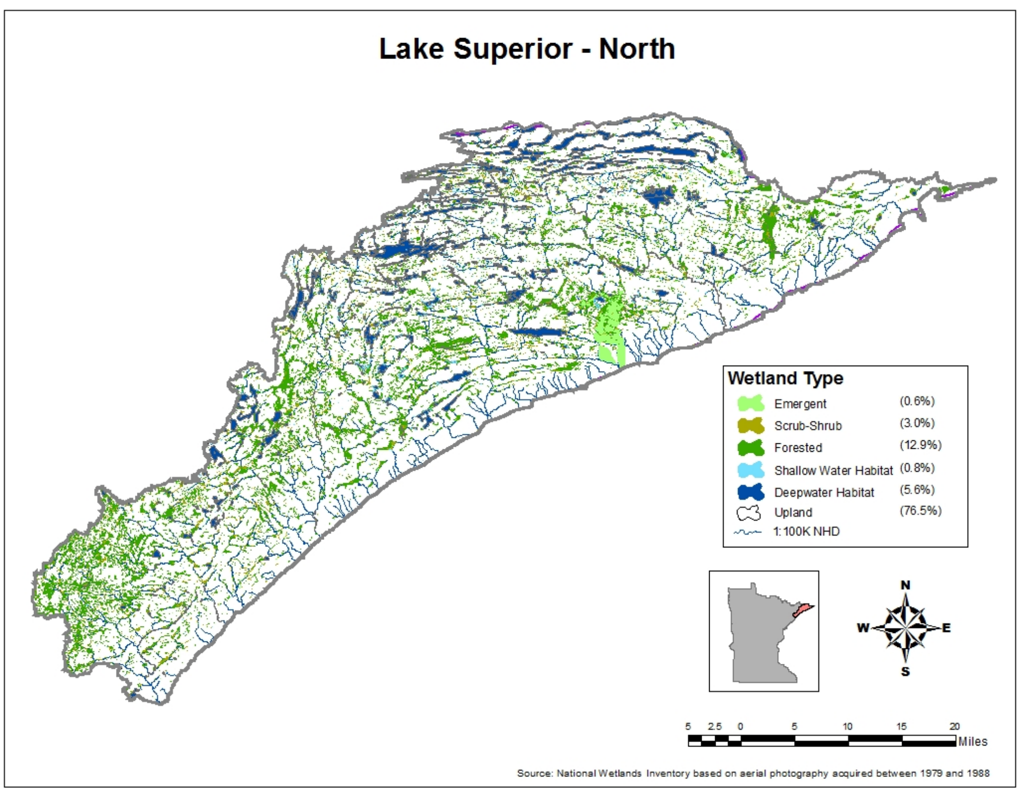


Figure 27. Wetlands and surface water in the Minnesota portion of the Lake Superior – North Watershed. The percent of the watershed occupied by general wetland types is provided in the legend. Note: a large polygon is incorrectly recorded as emergent wetland in NWI located adjacent to the Devil Track River.

Glacial scouring and moraines from multiple glacial advances have helped form the topographic relief found in the Lake Superior North Watershed today (MGS 1997). Numerous small to moderately sized wetlands have formed in the depressions and swales left behind. Due to the relatively cool-wet climate of the region, the majority of these wetlands are peat forming swamps and bogs—where organic soils have developed due to saturated conditions. As peat has low hydrologic conductivity, excess precipitation can slowly runoff the wetland surface via saturation-overland flow (Acreman and Holden 2013). These peat forming wetlands serve as the source waters and/or significantly contribute water for many of the streams in the watershed. Saturation-overland flow waters from wetlands typically are high in dissolved organic material (e.g., staining), low in dissolved oxygen, and may have low pH. In addition, beaver activity is high in the watershed and numerous beaver ponds and meadows (grass and sedge dominated wetlands that form when dams fail and ponds partially drain) occur along small streams throughout the watershed. Artificial wetland drainage is minimal in the watershed, as development pressure is low and a significant portion is in the protected Boundary Waters Canoe Area Wilderness (BWCAW). Finally, it should be noted that wild rice has been documented in many lakes virtually throughout the watershed, and may also be present in an unknown number of wetlands and low gradient streams.

Watershed-wide data collection methodology

Watershed Pollutant Load Monitoring Network

Intensive water quality sampling occurs at all WPLMN sites. Thirty-five samples per year are allocated for basin and major watershed sites and 25 samples per season (ice out through October 31) for subwatershed sites. Because correlations between concentration and flow exist for many of the monitored analytes, sampling frequency is typically greatest during periods of moderate to high flow (Figure 28, Figure 29). Because these relationships can also shift between storms or with season, computation of accurate load estimates requires frequent sampling of all major runoff events.

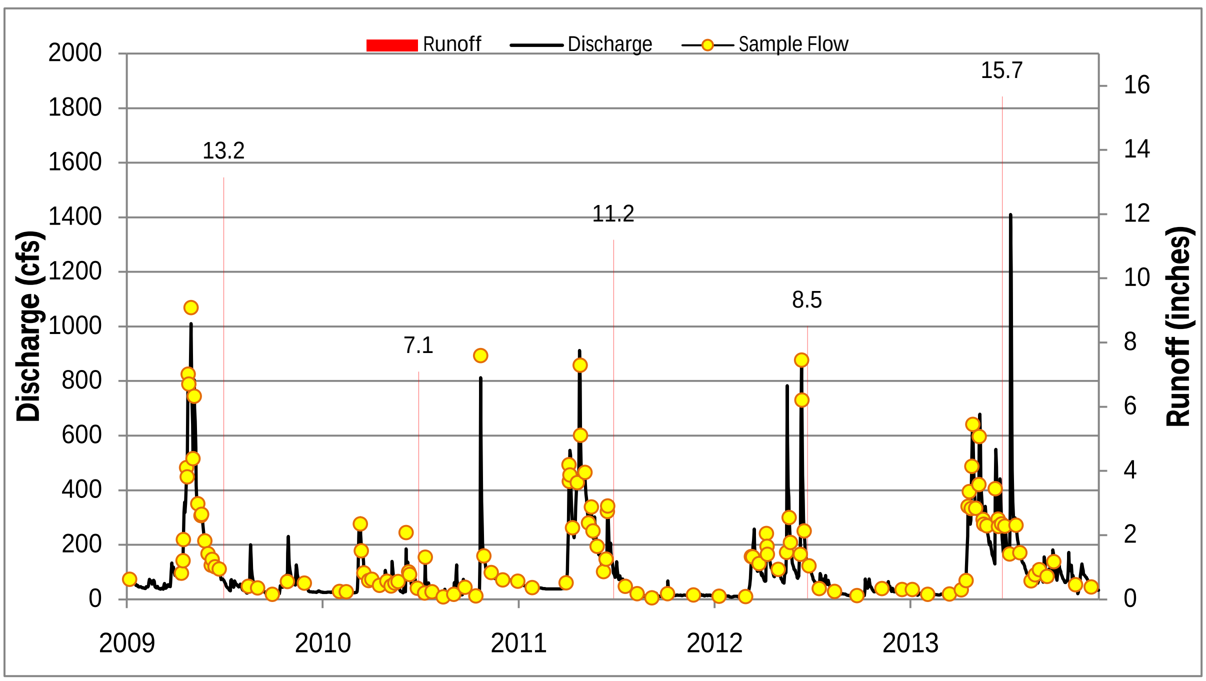


Figure 28. Hydrograph, sampling regime, and annual runoff for the Poplar River.

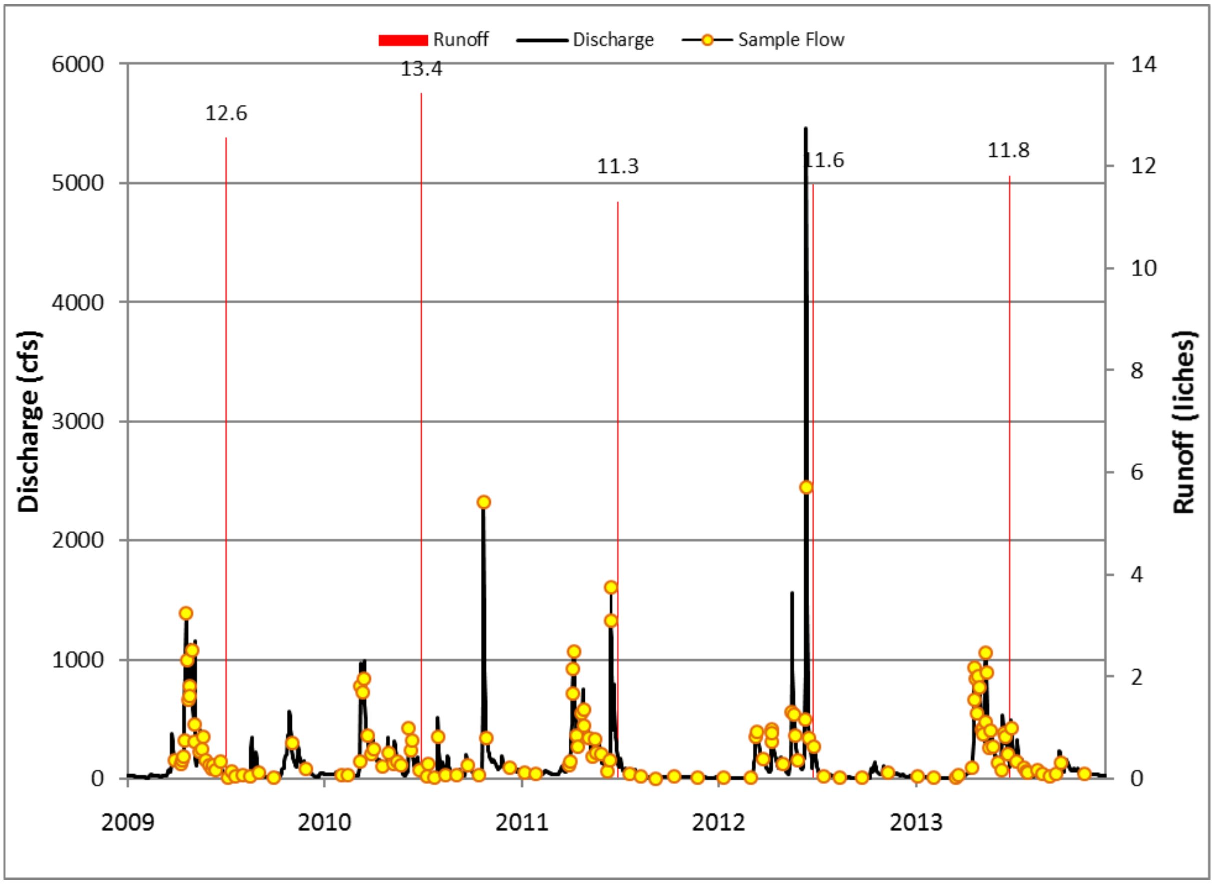


Figure 29. Hydrograph, sampling regime, and annual runoff for the Baptism River.

Low flow periods are also sampled and are well represented but sampling frequency tends to be less as concentrations are generally more stable when compared to periods of elevated flow. Despite discharge related differences in sample collection frequency, this staggered approach to sampling generally results in samples being well distributed over the entire range of flows.

Annual water quality and daily average flow data are coupled in the "FLUX32," pollutant load model, originally developed by Dr. Bill Walker and recently upgraded by the U.S. Army Corp of Engineers and the MPCA to compute pollutant loads for all WPLMN monitoring sites. FLUX32 allows the user to create seasonal or discharge constrained concentration/flow regression equations to estimate pollutant concentrations and loads on days when samples were not collected. Primary output includes annual and daily pollutant loads and flow weighted mean concentrations. Loads and flow weighted mean concentrations are calculated for total suspended solids (TSS), total phosphorus (TP), dissolved orthophosphate (DOP), nitrate plus nitrite nitrogen (Nitrate-N), and total Kjeldahl nitrogen (TKN).

Stream water sampling

Eighteen water chemistry stations were sampled from May through September in 2013 and again June through August of 2014 to provide sufficient water chemistry data to assess all components of Aquatic Life and Recreation Use Standards. These "10x" stations were typically placed at the outlet of each subwatershed (aggregated 12-digit HUC). This monitoring was conducted by MPCA staff and by local government partners via SWAGs. Grantees in this watershed included Cook and Lake County SWCDs and the University of Minnesota Duluth's Natural Resources Research Institute (UMD-NRRI). See Appendix 1 for definitions of stream chemistry analytes monitored in this study. See Appendix 2 for locations of stream water chemistry monitoring sites.

Stream flow methodology

The MPCA and MNDNR monitor stream water quantity and quality at dozens of locations across the state. Monitoring stations are typically located on major rivers, at mouths of major watersheds, and at the mouths of some aggregated 12-HUC subwatersheds. These data are available at the MNDNR/MPCA Cooperative Stream Gaging webpage (http://www.dnr.state.mn.us/waters/csg/index.html).

Stream biological monitoring

The stream biological monitoring component of iIWM in the Lake Superior – North Watershed was carried out during the summers of 2013 and 2014; MPCA crews sampled fish and macroinvertebrates at 72 sites on 63 stream segments in the watershed. For the most part, these sites were located near the outlets of minor watersheds (14-HUC), but road access and proximity to lakes necessitated alternate locations in some cases. An effort was made to ensure that biomonitoring sites were largely representative of stream conditions within the broader watershed context.

The watershed assessments carried out in 2015 were based on all suitable data collected within a 10-year timeframe (between the years 2005 and 2014), but most assessment-level data was collected during the summer of 2013. Some supplemental data was also collected during the summer of 2015 to inform final assessment decisions. Biological information that was not used in the assessment process may be important for stressor identification and may also be used to evaluate long-term trends in subsequent reporting cycles.

Fish- and macroinvertebrate-based IBIs were used to evaluate the health of stream biological communities. Individual IBIs have been developed for different regions and types of streams to encompass the broad variability of lotic habitats found across Minnesota. Nine different fish IBIs (FIBIs) and nine different macroinvertebrate IBIs (MIBIs) were developed for the state's streams; for each assemblage type, seven IBIs are applicable to warm- and coolwater streams, and two are applicable to coldwater streams. Each IBI uses a unique suite of metrics, scoring functions, impairment thresholds, and confidence intervals (CIs). More information regarding IBI classification criteria, metrics, and biocriteria can be found in Appendix 4.1.

In general, IBI scores above the impairment threshold and upper CI indicate that the stream reach supports aquatic life, while scores below the impairment threshold and lower CI indicate that the stream reach does not support aquatic life. When an IBI score falls within the confidence interval, additional information plays a larger role in the assessment decision. For example, consideration may be given to the presence, absence, and magnitude of local- and watershed-scale stressors. Other indicators (e.g., water chemistry, physical habitat, condition of other biological assemblages) may also provide important contextual information to inform the biological assessment. IBI results for each individual biological monitoring station can be found in Appendix 4.

Fish contaminants

Minnesota Department of Natural Resource (MNDNR) fisheries staff collected fish for the Fish Contaminant Monitoring Program. When fish are collected as part of the MPCA's IWM, the MPCA biomonitoring staff attempt to collect up to five piscivorous (top predator) fish and five forage fish. All fish collected by the MPCA are analyzed for mercury and the two largest individual fish are analyzed for PCBs. Monitoring of fish contaminants in the 1970s and 1980s showed high concentrations of PCBs were primarily a concern downstream of large urban areas in large rivers, such as the Mississippi River, and in Lake Superior. Therefore, PCBs are now tested where high concentrations in fish were measured in the past and the major watersheds are screened for PCBs in the watershed monitoring collections.

Captured fish were wrapped in aluminum foil and frozen until they were thawed, scaled (or skinned), filleted, and ground to a homogenized tissue sample. Homogenized fillets were placed in 125 mL glass jars with Teflon™ lids and frozen until thawed for lab analysis. The Minnesota Department of Agriculture (MDA) analyzed the samples for mercury and PCBs. If fish were tested for perfluorochemicals (PFCs), whole fish were shipped to AXYS Analytical Laboratory, which analyzed the homogenized fish fillets for 13 PFCs. Of the measured PFCs, only perfluorooctane sulfonate (PFOS) is reported because it bioaccumulates in fish to levels that are potentially toxic and a reference dose has been developed.

The MPCA assesses the results of the fish contaminant analyses for waters that exceed impairment thresholds. The Impaired Waters List is prepared by the MPCA and submitted every even year to the EPA. The MPCA has included waters impaired for contaminants in fish on the Impaired Waters List since 1998. Impairment assessment for PCBs (and PFOS when tested) in fish tissue is based on the fish consumption advisories prepared by the Minnesota Department of Health (MDH). If the consumption advice is to restrict consumption of a particular fish species to less than a meal per week the MPCA considers the lake or river impaired. The threshold concentration for impairment (consumption advice of one meal per month) is an average fillet concentration of 0.22 mg/kg for PCBs (and 0.200 mg/kg for PFOS).

Before 2006, mercury in fish tissue was assessed for water quality impairment based on MDH's fish consumption advisory. An advisory more restrictive than a meal per week was classified as impaired for mercury in fish tissue. Since 2006, a water body has been classified as impaired for mercury in fish tissue if 10% of the fish samples (measured as the 90th percentile) exceed 0.2 mg/kg of mercury, which is one of Minnesota's water quality standards for mercury. At least five fish samples per species are required to make this assessment and only the last 10 years of data are used for statistical analysis. MPCA's Impaired Waters List includes waterways that were assessed as impaired prior to 2006 as well as more recent impairments.

Lake water sampling

MPCA staff, local government partners (such as SWCD staff), UMD-NRRI, and citizen volunteers cooperatively sampled numerous lakes within the watershed in 2013 and 2014. This monitoring was done to collect a sufficient dataset for assessment of aquatic recreational use. This involves at least eight paired total phosphorus, chlorophyll-a, and Secchi transparency measurements over a minimum of two years collected from June through September. These data are averaged to determine summer-mean values, and compared to standards before an assessment is made.

Sampling methods are similar among monitoring groups (MPCA 2015). The lake water quality assessment standard requires eight observations/samples within a 10-year period for phosphorus, chlorophyll-a, and Secchi transparency. Lakes entirely within the BWCAW were assessed using high resolution satellite imagery interpreted by remote sensing experts at the University of Minnesota (http://water.umn.edu/). Lake transparency measurements at 5 year intervals over the past 30 years were reviewed and those measurements that were above the more stringent thresholds (20%) on all dates were considered fully supporting (FS). The threshold value is 2.4 meters and applies to Class 2B cool and warm water lakes, stream trout lakes, and lake trout lakes. If any year does not meet the 2.4-meter threshold value, the assessment is considered insufficient information (IF).

Lake Superior beach monitoring

Aquatic recreation use of Lake Superior beaches is assessed using the coastal waters definition and EPA's Beaches Environmental Assessment and Coastal Health (BEACH) Act water quality standards for all bacterial monitoring sites on public Lake Superior shoreline sites. Most beaches are monitored weekly from Memorial Day to Labor Day, while some are monitored twice weekly. To ensure use of the most recent data, data for the most recent 5-year period are used. When sufficient samples are collected per individual month or 30-day time period, individual monthly geometric means are calculated and compared to the monthly geometric mean and individual maximum standards (126 and 235 E. coli organisms per 100 mL of water, respectively). These standards are more restrictive that the E. coli standards applicable to Minnesota's inland streams. If more than 10% of these values exceed standards the beach is assessed as not supporting (NS) aquatic recreation.

Approximately 46 public beaches on the Lake Superior Shoreline and the St. Louis Bay from Duluth to Grand Portage are regularly monitored by staff from the MDH, Grand Portage Reservation, and Cook County to determine bacteria concentrations and assess the relative risk to the public of water contamination. Grand Portage has jurisdiction over their beaches, and their own standards and water quality assessment methods. For the remaining beaches, if bacteria levels exceed EPA standards, a beach advisory or "water contact not recommended" sign is posted at the beach. Only local municipalities, such as cities or counties, have the authority to formally close a beach to public recreation. Additional information on Lake Superior Beach monitoring can be found at http://www.mnbeaches.org/beaches/lksuperior/index.html and http://grandportagebeaches.com/.

Groundwater monitoring

Clean groundwater is essential to the health of Minnesota residents, as approximately 75% of Minnesota's population receives their drinking water from groundwater. The MPCA's Ambient Groundwater Monitoring Program monitors trends in statewide groundwater quality by sampling for a comprehensive suite of chemicals including nutrients, metals, and volatile organic compounds. These ambient wells represent a mix of deeper domestic wells and shallow monitoring wells. The shallow wells interact with surface waters and exhibit impacts from human activities more rapidly. Available data from federal, state and local partners are used to supplement reviews of groundwater quality in the region.

Groundwater/surface water withdrawals

The MNDNR permits all high capacity water withdrawals where the pumped volume exceeds 10,000 gallons/day or 1 million gallons/year. Permit holders are required to track water use and report back to the MNDNR yearly. Information on the program and the program database are found at: http://www.dnr.state.mn.us/waters/watermgmt_section/appropriations/wateruse.html

The changes in withdrawal volume detailed in this report are a representation of water use and demand in the watershed and are taken into consideration when the MNDNR issues permits for water withdrawals. Other factors not discussed in this report but considered when issuing permits include: interactions between individual withdrawal locations, cumulative effects of withdrawals from individual aquifers, and potential interactions between aquifers. This holistic approach to water allocations is necessary to ensure the sustainability of Minnesota's groundwater resources.

Groundwater quantity

Monitoring wells from the MNDNR Observation Well Network track the elevation of groundwater across the state. The elevation of groundwater is measured as depth to water in feet and reflects the fluctuation of the water table as it rises and falls with seasonal variations and anthropogenic influences. Data from these wells and others are available at: http://www.dnr.state.mn.us/waters/groundwater_section/obwell/waterleveldata.html.

Wetland monitoring

The MPCA is actively developing methods and building capacity to conduct wetland quality monitoring and assessment. Our primary approach is biological monitoring—where changes in biological communities may be indicating a response to human-caused impacts. The MPCA has developed IBIs to monitor the macroinvertebrate condition of depressional wetlands that have open water and the Floristic Quality Assessment (FQA) to assess vegetation condition in all of Minnesota's wetland types. For more information about the wetland monitoring (including technical background reports and sampling procedures) please visit the MPCA Wetland Monitoring and Assessment webpage.

The MPCA currently does not monitor wetlands systematically by watershed. Alternatively, the overall status and trends of wetland quality in the state and by major ecoregion is being tracked through probabilistic monitoring. Probabilistic monitoring refers to the process of randomly selecting sites to monitor; from which, an unbiased estimate of the resource can be made. Probabilistic survey results may provide a reasonable approximation of the current wetland quality in the watershed. As few open water depressional wetlands exist in the watershed the focus will be on vegetation quality results of all wetland types.

Individual 10-HUC subwatershed results

10-HUC subwatersheds

Assessment results for aquatic life and recreation use are presented for each 10-HUC subwatershed within the Lake Superior – North Watershed. The primary objective is to portray all full support and impairment listings within a subwatershed resulting from the complex and multi-step assessment and listing process. (A summary table of assessment results for the entire 8-HUC watershed including aquatic consumption, and drinking water assessments (where applicable) is included in Appendix 3). The 10-HUC scale provides a robust assessment of water quality condition at a practical size for development, management, and implementation of effective TMDLs and protection strategies. Graphics presented for each 10-HUC subwatershed depict assessment results from the 2015 Assessment Cycle as well as any impairment listings from previous assessment cycles. Discussion of assessment results focuses primarily on the intensive watershed monitoring effort conducted in 2013 and 2014, but also considers available data from the last ten years.

The following pages provide an account of each Lake Superior – North 10-HUC subwatershed. Each account includes a brief description of the subwatershed and summary tables for each of the following: a) stream aquatic life and aquatic recreation assessments, b) stream habitat quality, c) channel stability, d) water chemistry at the outlet(s) of one or more major streams, and e) lake aquatic recreation assessments. Following the summary tables, a narrative summary describes assessment results in greater detail, as well as any pertinent water quality projects completed or planned for the subwatershed. A brief description of each summary table is provided below.

Stream assessments

A table for each 10-HUC subwatershed summarizes stream aquatic life and aquatic recreation assessments. These tables primarily reflect results of the 2015 assessment process (2016 EPA reporting cycle); however, impairments from previous assessment cycles are also included and distinguished from new impairments via cell shading (see table footnotes). These tables also denote results of comparing each individual aquatic life and aquatic recreation indicator to their respective criteria (i.e., standards); determinations made during the desktop phase of the assessment process. Aquatic life assessments are derived from analysis of biological (fish and invert IBIs), dissolved oxygen, turbidity, chloride, pH and un-ionized ammonia (NH3) data; assessment of aquatic recreation in streams is based solely on bacteria (E. coli or fecal coliform levels) data. Included in each table is the specific aquatic life use classification for each stream reach: cold water community (2A); cool or warm water community (2B); or indigenous aquatic community (2C). Where applicable and sufficient data exists, assessments of other designated uses (e.g., class 7, drinking water, aquatic consumption) are discussed in the summary section of each aggregated 10-HUC subwatershed as well as in the watershed-wide results and discussion section.

Stream habitat results

Habitat information is recorded during each biological sampling event and summarized for each 10-HUC. These tables convey results of the Minnesota Stream Habitat Assessment (MSHA) survey, which evaluates habitat within and surrounding each biomonitoring reach; this information can indicate potential stressors impacting fish and macroinvertebrate communities (e.g., siltation, eutrophication) as well as document particularly robust or beneficial habitat conditions. The MSHA score is comprised of five scoring categories including: adjacent land use, riparian zone conditions, substrate conditions, fish cover, and channel morphology. Scores for each of these habitat categories are summed for a total possible score of 100 points. The 10-HUC summary tables include category scores, total MSHA score, and a narrative habitat condition rating for each biomonitoring site. In cases where multiple biomonitoring visits occurred at the same station, individual visit scores have been averaged. The final row in each table displays average MSHA scores and a composite rating for the 10-HUC subwatershed.

Subwatershed outlet water chemistry results

These summary tables display water chemistry results for monitoring station(s) representing outlets of 10-HUC subwatersheds. This data and others collected within the 10-year assessment window can provide valuable insight on water quality characteristics and potential parameters of concern within the watershed. Parameters included in these tables are those most closely related to water quality standards or expectations used for assessing aquatic life and recreation. While not all water chemistry parameters of interest have established water quality standards, ecoregional expectations have been developed for a number of parameters; these expectations are used to identify attainable conditions for an ecoregion, against which stream water quality data can be evaluated (McCollor and Heiskary 1993).

Lake assessments

A summary of lake water quality is provided in the following subwatershed sections. Basic lake monitoring, using the Minnesota Lake Eutrophication Analysis Procedure (MINLEAP) model, was completed for lakes with sufficient data. MINLEAP was developed by MPCA lake scientists and has long been used as an effective lake management tool. The model uses basic empirical lake models and regressions to predict in-lake total phosphorus (and subsequently chlorophyll-a and Secchi transparency) based on lake morphometry, watershed characteristics and historical surface water quality and metrological datasets. Assessment results for all lakes in the Lake Superior – North Watershed are available in Appendix 3.2. Lake models and corresponding morphometric inputs can be found in Appendix 5.2.

Arrow River subwatershed HUC 0401010101

The Arrow River subwatershed straddles the U.S./Canada border, and drains 29 square miles of Cook County. Water reaches Lake Superior via Rose Lake, and Arrow Lake and Arrow River in Ontario before flowing into the Pigeon River.

The vast majority (93%) of the subwatershed is publicly owned (mostly federal land), and nearly two-thirds lies within the BWCAW. More than 90% of the land cover consists of forest and lakes, and wetland makes up most of the rest. Development is present at very low levels, mostly in the form of lakeshore residences, cabins, and resorts. The subwatershed includes 21 lakes, 11 greater than 100 acres in size, the largest of which are South, Rose, Daniels, Bearskin, Duncan, and Hungry Jack. Stream habitat is largely restricted to short reaches between lakes; as a result, no stream monitoring was conducted in the Arrow River subwatershed.

Arrow River subwatershed summary

Lake water quality is good in the Arrow River subwatershed. Four lakes were assessed as supporting aquatic recreational use based on low levels nutrients and algae. Bearskin and Hungry Jack are popular recreational lakes with extensive water quality datasets (more than 20 years of Secchi transparency data); both lakes have very clear water and low phosphorus concentrations, and trends appear to be stable over time (Figure 30, Figure 31). Five lakes within the BWCAW were assessed as supporting aquatic recreational use based on remotely-sensed transparency data. There are no Lake Superior beaches in this subwatershed.

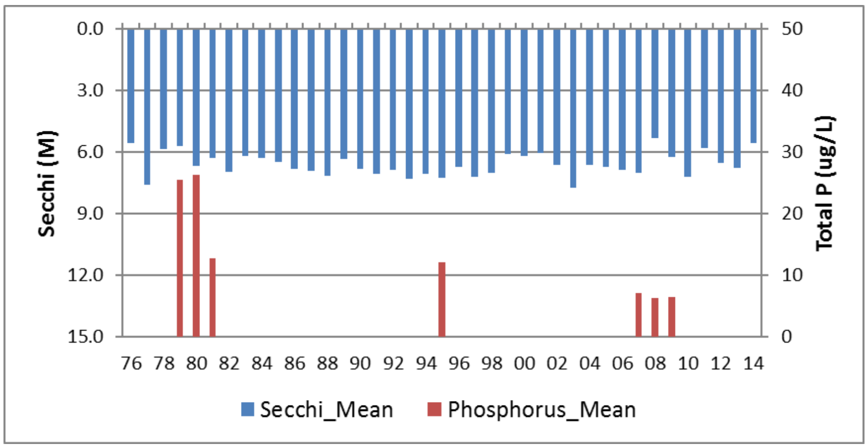


Figure 30. Bearskin Lake water quality trends, 1976-2014.

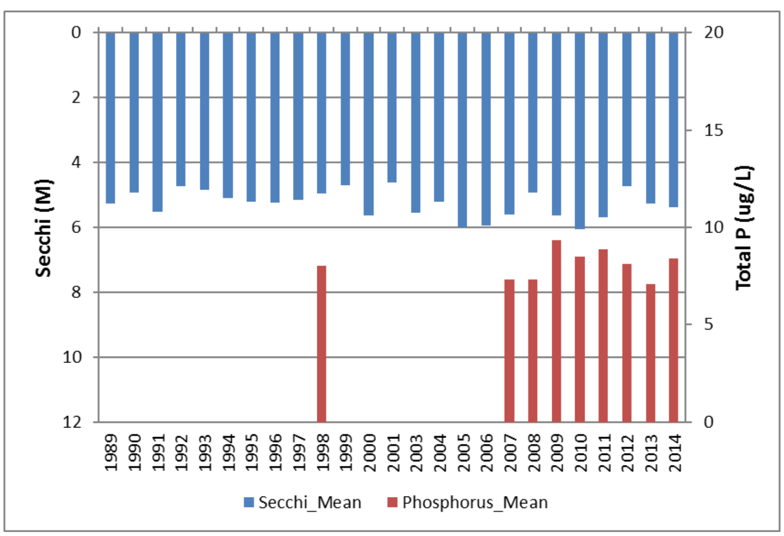


Figure 31. Hungry Jack Lake water quality trends, 1989-2014.

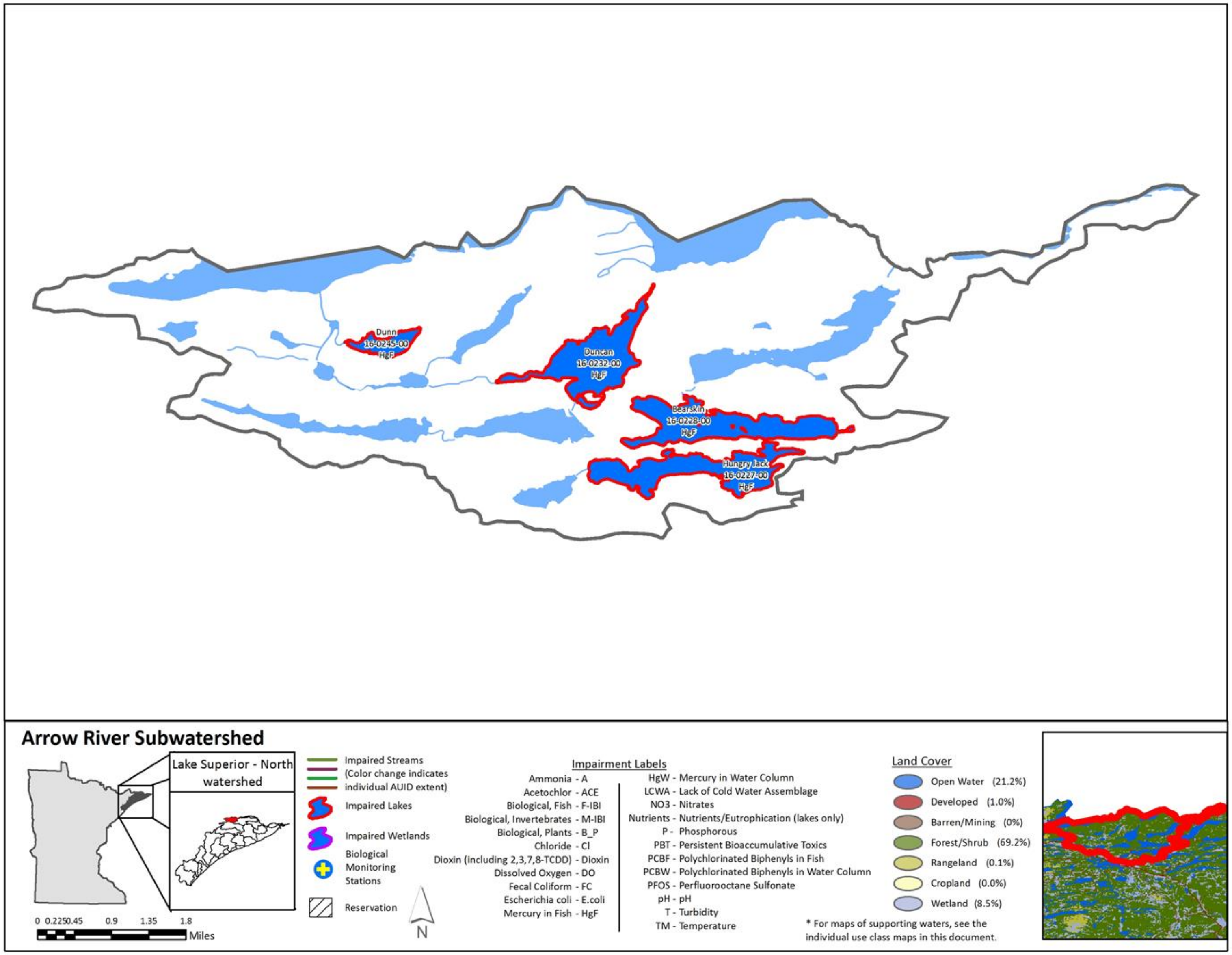


Figure 32. Arrow River subwatershed, currently listed impaired waters (by parameter) and land use.

Table 1. Lake assessments for Arrow River subwatershed.

Name	DNR Lake ID	Area (acres)	Trophic Status	% Littoral	Max. Depth (m)	Mean Depth (m)	CLMP Trend	Mean TP (µg/L)	Mean chl-a (µg/L)	Mean Secchi (m)	AQR Support Status	AQL Support Status
Bearskin	16-0228-00	487	O	19	24		NT	6.4	1.8	6.4	FS	NA
Birch	16-0247-00	243	O	29	21		NT	8.1	2.3	5.5	FS	NA
Daniels	16-0150-00	505	O	19	27		NT			5.3	FS*	NA
Duncan	16-0232-00	464	O	27	35		NT			5.5	FS*	NA
Hungry Jack	16-0227-00	457	O	40	22		NT	8.2	2.5	5.5	FS	NA
Leo	16-0198-00	103	O	37	9		NT	9.9	2.5	4.5	FS	NA
Rose	16-0230-00	622	O	31	27		NT			5.3	FS*	NA
Rove	16-0137-00	38	O	70	9		NT			4.6	NA	NA
South	16-0244-00	664	O		43		NT			6.1	FS*	NA
Watap	16-0138-00	71	O		14		NT			4.7	FS*	NA

Abbreviations:
D -- Decreasing/Declining Trend
I -- Increasing/Improving Trends
NT – No Trend
E - Eutrophic
M – Mesotrophic
O – Oligotrophic
FS – Full Support
NS – Non-Support
IF – Insufficient Information

Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use
* = assessment-level transparency dataset collected via remote sensing

Pigeon River subwatershed HUC 0401010102

The Pigeon River subwatershed drains 203 square miles along Cook County's border with Ontario. Pigeon River is the largest watercourse, flowing east from headwater lakes in the "Vento Unit" of the BWCAW to its confluence with Lake Superior near the community of Grand Portage. The subwatershed contains 100 lakes that are five acres or larger, including some of the largest lakes in the entire Lake Superior – North Watershed. The largest, Pine Lake, is entirely within the BWCAW and covers more than 2,000 acres; other large lakes include: Clearwater, Mountain, West Pike, East Pike, and East Bearskin. Swamp River Reservoir is another important hydrologic feature of the subwatershed, comprising more than 3,500 acres of wetlands and open water habitat. Tributaries to the Pigeon River include Royal River, Stump River, Portage Brook, and Swamp River. The Arrow River, another major tributary, drains mostly Canadian lands.

Land use consists almost entirely of wetland, forest, and open water, though a small developed area exists near the border crossing of U.S. Highway 61, and a few lakes have developed shorelines. Approximately 35% of the subwatershed lies within the BWCAW, and the easternmost 12% of the subwatershed lies within the Grand Portage Reservation. Privately-owned land makes up approximately 7% of the subwatershed but is mostly clustered in a few specific areas: the western shore of Clearwater Lake off the Gunflint Trail; the general area surrounding McFarland Lake; the shoreline of Tom Lake; and an area north of Tom Lake that includes the headwaters of Irish Creek and Swamp River.

Pigeon River subwatershed summary

Water quality in the Pigeon River subwatershed is generally good; no aquatic life or aquatic recreation impairments were identified among the eleven lakes and seven streams where enough data was collected to make water quality assessments. Remotely-sensed transparency data (derived from satellite imagery) was used to assess aquatic recreation in several BWCAW lakes. Three streams (Portage Brook, Irish Creek, Swamp River) met Exceptional Use biocriteria based on fish and macroinvertebrate IBI scores – protection strategies should be developed for these high-quality systems. The remote and heavily forested nature of the Pigeon River subwatershed likely contributes to its excellent water quality.

The Royal River, a significant tributary to the Pigeon River, drains a lake-dominated landscape mostly in the BWCAW. Several of these lakes met aquatic recreation standards for nutrients, algae, and transparency, including Clearwater, East Bearskin, and Aspen. Clearwater Lake has been monitored for many years by MPCA, Cook County, the U.S. Forest Service and citizen volunteers, and is among the clearest lakes in the state with a long-term mean Secchi depth of nine meters (29 feet) (Figure 33). Six BWCAW lakes were assessed as fully supporting aquatic recreation using remotely-sensed transparency data (Table 2).

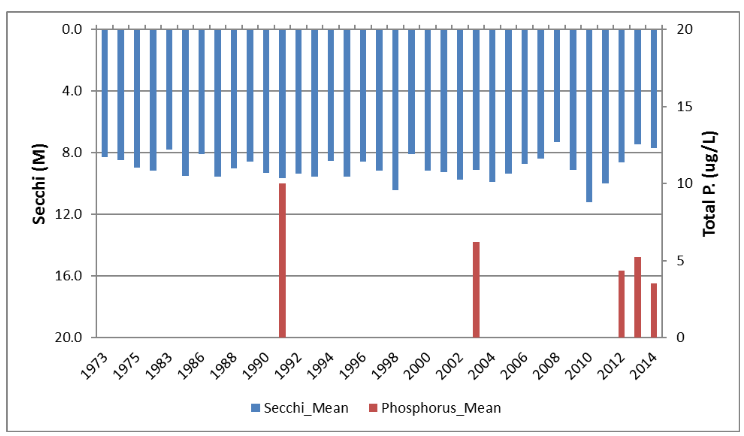


Figure 33. Clearwater Lake water quality trends, 1973-2014.

Near the pour point of the Royal River, fish and macroinvertebrate communities were monitored as part of a randomized statewide survey of rivers and streams. This monitoring occurred during the summer of 2015 (too late for formal inclusion in the 2015 assessment cycle), but it should be noted that the relatively short reach of the Royal River connecting Royal Lake and North Fowl Lake possessed excellent instream habitat, and was dominated by sensitive fishes and macroinvertebrates (e.g., Longnose Dace, *Chimarra*, *Micrasema*). The Royal River appears to possess excellent water quality, reflecting the wilderness nature of its catchment.

Moving south, Stump River is the next major tributary to the Pigeon River, flowing west-to-east from headwater lakes in the BWCAW. The surficial geology of the lower reaches is dominated by glacial lake clays, which are unusual in this otherwise moraine-dominated region of the state; these sediments may contribute turbidity to the stream (and downstream reaches of the Pigeon River) at high flow levels. The Stump River harbors Lake Chub and other coolwater species, but no coldwater fishes (e.g., Brook Trout, sculpin) were found at the MPCA biomonitoring station near the Arrowhead Trail; water temperatures appear to be warmer than the neighboring stream to the south, Portage Brook (discussed below). However, a few stenothermic macroinvertebrate taxa were observed (e.g., *Ephemerella*, *Rhyacophila*, *Eukiefferiella*), and coldwater IBI scores for both fish and macroinvertebrate assemblages indicated support for aquatic life. The macroinvertebrate community is particularly rich in caddisfly taxa; twenty different caddis genera have been recorded from biomonitoring station 97LS071. While Stump River currently meets biological criteria for coldwater streams, its thermal regime appears to be more "cool" than "cold". The stream's thermal regime is likely influenced by natural watershed conditions (e.g., surface water drainage from Stump Lake, extensive low gradient reaches, beaver activity), but portions of the catchment have experienced extensive logging which may also contribute to stream warming. Emphasis should be placed on maintaining cool water temperatures in Stump River, as further warming could potentially eliminate some of the sensitive cool- and coldwater taxa that the stream currently supports.

Figure 34. Lake Chub (Couesius plumbeus), listed by the state of Minnesota as a "Species of Special Concern".

Portage Brook, another east-flowing tributary to the Pigeon River, originates in Devilfish Lake, a popular recreational lake in Grand Portage State Forest. The lake was found to have low levels of nutrients and algae and was assessed as supporting aquatic recreation. Nearby Chester Lake also appears to have good water quality, but not enough samples were collected to make a formal water quality assessment. Downstream of the Arrowhead Trail, Portage Brook supports a wild Brook Trout population as well as Lake Chub (Figure 34), a state-listed Species of Special Concern). Several sensitive, stenothermic insects were collected (e.g., Rhyacophila, Glossosoma, Boyeria grafiana), indicating cold, well-oxygenated conditions and low sediment loads. Fish and macroinvertebrate IBI scores on this lower reach of Portage Brook met exceptional use biocriteria. Upstream of the Arrowhead Trail, Portage Brook met general use biocriteria; MIBI scores were higher than downstream, but FIBI scores were lower. The upstream biomonitoring site (13LS001) lies on an extremely steep section of the stream, and fish sampling may have been affected by higher than normal water levels – it's possible that additional monitoring at normal summer baseflows would result in exceptional FIBI scores, but available data indicates that this reach supports general use. A barrier falls near the Arrowhead Trail may also prevent upstream migration of certain sensitive fish species (e.g., Lake Chub) into the upstream reaches of Portage Brook.

For most of its length, Portage Brook flows through a remote, forested landscape, almost entirely administered by the U.S. Forest Service and the State of Minnesota. This landscape is far from pristine, however; many lands in the catchment are actively managed for forest products and large cutover areas can be observed throughout. Additionally, Portage Brook's headwater lakes are popular recreation destinations, and Chester Lake contains Rainbow Smelt, an exotic invasive fish species. Protection strategies for the exceptional biological communities found downstream of the Arrowhead Trail may focus on maintaining good water quality in the headwater lakes, and encouraging forest management practices that promote stream shading and reduce erosion.

South of Portage Brook, the Swamp River drains approximately 50 square miles. The river originates in Tom Lake which met aquatic recreation standards for phosphorus, chlorophyll-*a*, and Secchi transparency. However, it is one of the few lakes in Cook County with a declining and statistically significant trend in transparency (Figure 35); transparency has declined by about one foot over the past several years and appears to be approaching the 2m Secchi transparency standard for Class 2B lakes. The specific cause of this decline is unknown, and TP levels remain well below the 30 parts per billion (ppb) standard, but Tom Lake is among the most developed lakes in the Lake Superior – North Watershed. Additionally, recent inspections indicated that more than 76% of subsurface sewage treatment systems on Tom Lake were non-compliant with county requirements. Failing septic systems have been linked to eutrophication in freshwater lakes, and steps are being taken to address this threat to Tom Lake's water quality (BWSR 2014).

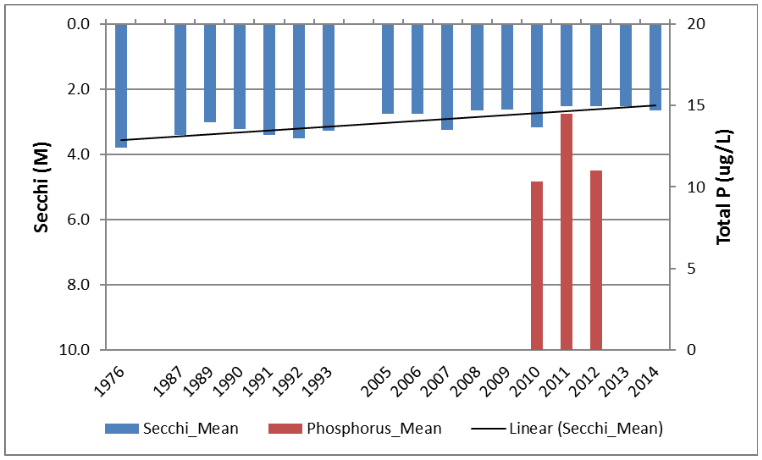


Figure 35. Tom Lake water quality trends, 1976-2014.

From Tom Lake, the Swamp River flows approximately 4.5 miles south and east to Swamp River Reservoir, a large impoundment constructed during the Civilian Conservation Corps era. The reservoir effectively separates the upper 4.6 miles of the Stump River from the lower mile of stream before it enters the Pigeon River. Biological indicators suggested that both upper and lower reaches of Swamp River have good water quality, but the upstream reach met exceptional use biocriteria while the lower reach only met general use. The macroinvertebrate community was particularly robust upstream of the reservoir, including several sensitive, stenothermic taxa (e.g., *Diplectrona modesta*, *Trissopelopia ogemawi*, *Glossosoma intermedium*) that were not found downstream of the reservoir. Downstream of the reservoir, the macroinvertebrate community did include some sensitive taxa (e.g., *Boyeria grafiana, Acroneuria lycorias*) but was more dominated by chironomids. Fish communities were similar both up- and downstream of the reservoir, including sensitive coolwater taxa (e.g., Lake Chub, Longnose Dace) but no coldwater species were found at either Swamp River biomonitoring station. Brown Trout were recorded at the lower station in 1998, though the stream has never been stocked with this species and the nearest other confirmed record is from Chester Lake, in the headwaters of Portage Brook.

While construction of Swamp Lake Reservoir may have caused some degradation of downstream biological assemblages (through hydrologic alteration and/or warming), the now-impounded portion of Swamp River always flowed through a wide, flat valley. The natural stream channel was likely low gradient and wide, though perhaps less so than the contemporary "channel". Although biological indicators are more robust upstream of the reservoir compared to downstream, it is difficult to attribute these differences to the impoundment. Apart from the possible influence of the reservoir, forestry activities and road crossings are the other most likely sources of stress for aquatic resources in the Swamp River catchment (though see Tom Lake discussion above).

Figure 36. Slimy Sculpin (*Cottus cognatus*), a small, bottom-dwelling fish that requires clean, cold water.

Irish Creek (531), a tributary to the Swamp River, appears to be one of the highest-quality trout streams in the Lake Superior – North Watershed; it supports Brook Trout, Slimy Sculpin (Figure 36), and a diverse macroinvertebrate community dominated by sensitive, stenothermic taxa. Twelve different "coldwater" insects have been recorded from Irish Creek, including the dragonfly *Boyeria grafiana* (a state-listed Species of Special Concern) and the MPCA's only record of the caddisfly *Oligostomis*. IBI scores for both fish and macroinvertebrates met exceptional use biocriteria, and the thermal regime of the creek ranks among the coldest in northern Minnesota. Irish Creek's watershed is almost entirely forested, but includes a relatively high proportion of private land, particularly near its headwaters; protection strategies for this catchment should promote land-use practices on private property that that maintain and enhance water quality, promote cold water temperatures, and protect aquatic habitat. Like many other trout streams in this part of the state, Irish Creek contains several constructed habitat features which require maintenance to remain effective; if these structures are damaged or degrade over time, they may cause sediment aggradation and other negative impacts to aquatic habitat.

The Pigeon River's water quality is excellent, reflecting its forested landscape and low level of development. A monitoring station at the Highway 61 International Bridge consistently indicated well-oxygenated conditions (the station is downstream of a high-gradient reach), and low concentrations of nutrients, dissolved minerals, and chlorophyll-a. A few exceedances of Minnesota's TSS standard were observed (Table 4), but were largely restricted to high flow events (i.e., spring snowmelt). These occasional high sediment loads may be the result of streambank erosion at higher flow levels. Although most water quality indicators suggest good water quality in the Pigeon River, not enough samples were collected to make a formal supporting assessment for aquatic life. A sufficient, assessment-level E. coli dataset was collected, indicating low levels of bacteria and conditions supportive of aquatic recreation on and in the Pigeon River.

Table 2. Aquatic life and recreation assessments on stream reaches: Pigeon River subwatershed.

AUID ***ReachName*** Reach Description	**Biological Station ID**	**Reach Length (miles)**	**Use Class**	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia - NH3	Pesticides***	Eutrophication: Phosphorus	Response Indicator	**Aquatic Life**	**Aquatic Rec. (Bacteria)**
04010101-542 ***Stump River*** *T64 R3E S8, west line to Pigeon R*	97LS071 15LS056	8.8	CWg	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--	SUP	--
04010101-D54 ***Portage Brook*** *Headwaters (Unnamed lk 16-0864-00) to CSAH 16*	13LS001	3.1	CWg	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--	SUP	--
04010101-D55 ***Portage Brook*** *CSAH 16 to Pigeon R*	98LS041	5.9	CWe	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--	SUP	--
04010101-531 ***Irish Creek*** *Headwaters to Swamp River Reservoir*	92LS015	7.1	CWe	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--	SUP	--
04010101-B66 ***Swamp River*** *Stevens Lk to T63 R4E S20, east line*	97LS072	1.9	CWe	MTS	MTS	IF	IF	MTS	--	IF	IF	--	IF	--	SUP	--
04010101-543 ***Swamp River*** *Swamp River Reservoir to Pigeon R*	13LS048	1.1	CWg	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--	SUP	--
04010101-501 ***Pigeon River*** *South Fowl Lk to Pigeon Bay*		31.2	WWg	--	--	IF	IF	IF	MTS	MTS	MTS	--	MTS	--	IF	SUP

Abbreviations for Indicator Evaluations: **---** = No Data, **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use; = insufficient information.
Abbreviations for Use Class: **WWg** = warmwater general, **WWm** = Warmwater modified, **WWe** = Warmwater exceptional, **CWg** = Coldwater general, **CWe** = Coldwater exceptional,
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Table 3. Minnesota Stream Habitat Assessment (MSHA): Pigeon River subwatershed.

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate 0-27	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	92LS015	Irish Creek	5.0	15.0	25.4	8.0	32.0	85.4	Good
3	97LS071	Stump River	5.0	10.8	21.3	13.0	25.7	75.8	Good
2	15LS056	Stump River	5.0	13.5	26.5	13.0	27.5	85.5	Good
1	13LS048	Swamp River	5.0	14.0	24.0	11.0	25.0	79.0	Good
1	97LS072	Swamp River	5.0	14.0	24.0	13.0	27.0	83.0	Good
2	13LS001	Portage Brook	5.0	13.5	22.9	12.5	22.0	75.9	Good
1	98LS041	Portage Brook	5.0	14.0	22.0	13.0	27.0	81.0	Good
Average Habitat Results: *Pigeon River Subwatershed*			5.0	13.5	23.7	11.9	26.6	80.8	Good

Qualitative habitat ratings

- = Good: MSHA score above the median of the least-disturbed sites (MSHA>66)
- = Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)
- = Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

Table 4. Outlet water chemistry results: Pigeon River subwatershed.

Station location:	**Pigeon River, 5 mi. NE of Grand Portage, at US-61 bridge**						
STORET/EQuIS ID:	**S007-325**						
Station #:	0401010102-01, Pigeon River						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**WQ Standard[1]**	**# of WQ Exceedances[2]**
Ammonia-nitrogen	ug/L	9	0.1	0.5	0.3	16	0
Chloride	mg/L	9	1.1	1.2	1.1	230	0
Dissolved Oxygen	mg/L	20	7.6	12	9.7	7	0
pH		18	7	8.1	7.5	6.5 – 8.5	0
Secchi Tube	100 cm	20	6	80	54	> 55	8
Total suspended solids	mg/L	9	5.6	290	50.2	10	6
Phosphorus	ug/L	7	8	18	13	50	0
Chlorophyll-a, Corrected	ug/L	16	0.7	4.5	2	7	0
Escherichia coli (geometric mean)	MPN/100ml	15	27	44	34	126	0
Escherichia coli	MPN/100ml	15	17	170	41	1260	0
Inorganic nitrogen (nitrate and nitrite)	mg/L	16	0.07	0.2	0.1		
Kjeldahl nitrogen	mg/L	16	0.3	1.4	0.6		
Orthophosphate	ug/L	0					
Pheophytin-a	ug/L	15	1	16.6	3.3		
Specific Conductance	uS/cm	19	40	84	67		
Temperature, water	deg °C	19	7.3	23.2	16.5		
Sulfate	mg/L	9	3	3.7	3.4		
Hardness	mg/L	9	34	69	41		

[1]Secchi Tube standards are surrogate standards derived from the total suspended solids standard of 10 mg/L.

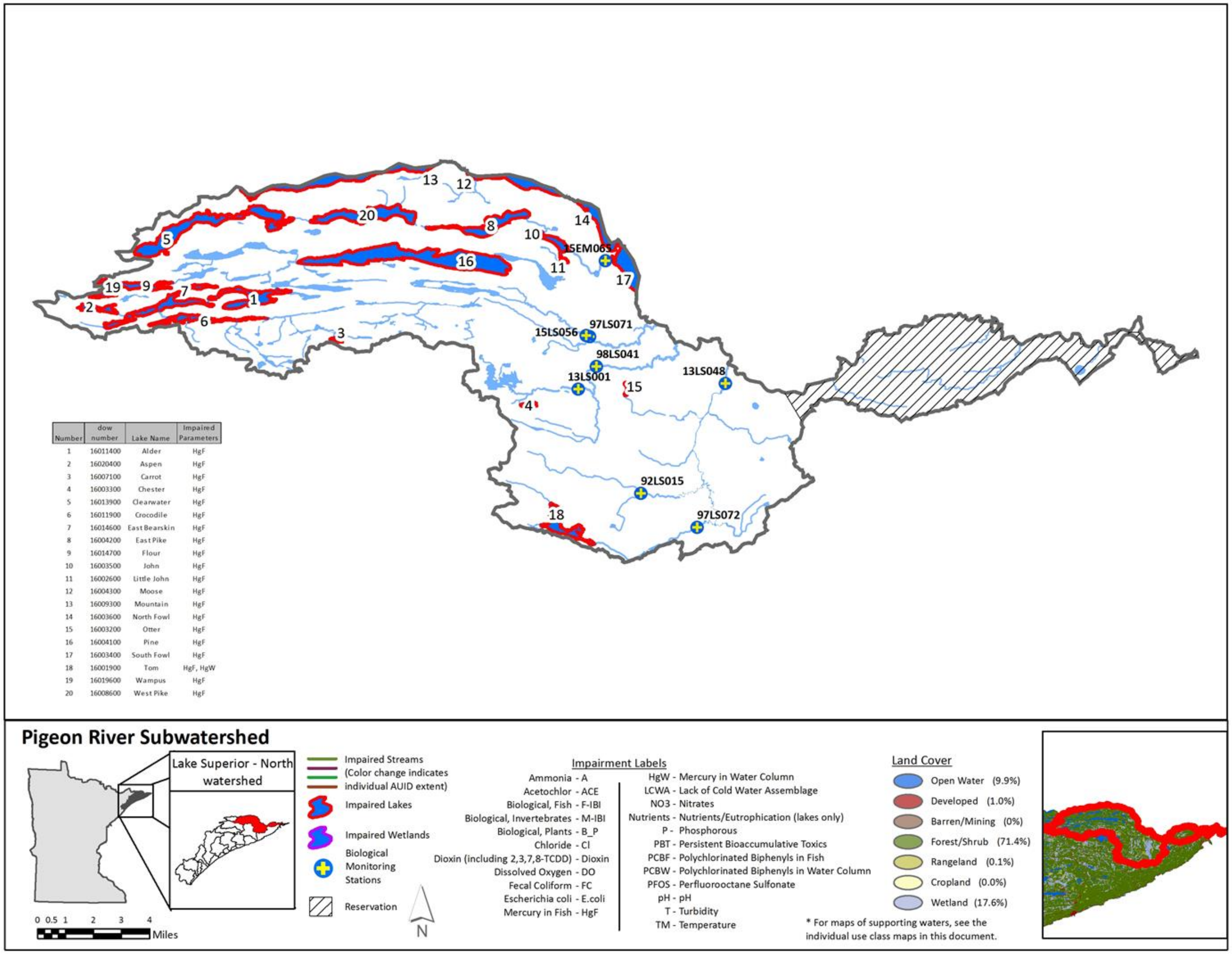
****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Pigeon River subwatershed, a component of the IWM work conducted between May and September from [2013-2014]. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Table 5. Lake assessments for Pigeon River subwatershed.

Name	DNR Lake ID	Area (acres)	Trophic Status	% Littoral	Max. Depth (m)	Mean Depth (m)	CLMP Trend	Mean TP (µg/L)	Mean chl-a (µg/L)	Mean Secchi (m)	AQR Support Status	AQL Support Status
Aspen	16-0204-00	137	M	69	8		NT	16.6	7.8	2.8	FS	IF
Caribou	16-0141-00	451	O		17		NT			4.2	FS*	NA
Chester	16-0033-00	49	O		11		NT	7.0	2.4	3.2	IF	IF
Clearwater	16-0139-00	1338	O				NT	4.3	1.4	8.6	FS	NA
Deer	16-0136-00	74	M		9		NT			2.6	NA	NA
Devilfish	16-0029-00	412	M	58	12		NT	12.1	3.7	2.7	FS	NA
East Bearskin	16-0146-00	570	O	47	20		NT	10.0	3.3	3.5	FS	IF
East Pike	16-0042-00	547	O	25	15		NT			4.7	FS*	NA
Flour	16-0147-00	323	M	34	23		NT	12.2	2.4	5.5	IF	NA
Gadwell	16-0060-00	20		38	16		NT				NA	NA
John	16-0035-00	181	M	100	6		NT			2.7	IF	IF
Little Caribou	16-0142-00	50	M	85	6		NT			2.1	IF	NA
Little John	16-0026-00	38	O	100	2		NT			5.4	IF	NA
McFarland	16-0027-00	380	O		15		NT			4.9	IF	NA
Moon	16-0117-00	142	M		9		NT			3.0	NA	NA
Moose	16-0043-00	455	O				NT			5.4	FS*	NA
Mountain	16-0093-00	834	O	23	61		NT			6.5	FS*	NA
North Fowl	16-0036-00	318	M	100	3		NT			2.2	IF	NA
Otter	16-0032-00	73	O	100	3		NT			6.1	IF	IF
Pine	16-0041-00	2110	O		34		NT			5.8	FS*	NA
Royal	16-0025-00	23	O				NT	10.0	0.7	0.6	NA	NA
Tom	16-0019-00	406	M	58	11		D	12.5	4.2	2.7	FS	IF
Vale	16-0061-00	23		54	10		NT				NA	NA
West Pike	16-0086-00	755	O	31	37		NT			6.2	FS*	NA

Abbreviations:
D -- Decreasing/Declining Trend
I -- Increasing/Improving Trends
NT – No Trend
E - Eutrophic
M – Mesotrophic
O – Oligotrophic
FS – Full Support
NS – Non-Support
IF – Insufficient Information

Key for Cell Shading: ☐ = existing impairment, listed prior to 2014 reporting cycle; ☐ = new impairment; ☐ = full support of designated use
* = assessment-level transparency dataset collected via remote sensing



Number	dow number	Lake Name	Impaired Parameters
1	16011400	Alder	HgF
2	16020400	Aspen	HgF
3	16007100	Carrot	HgF
4	16003300	Chester	HgF
5	16013900	Clearwater	HgF
6	16011900	Crocodile	HgF
7	16014600	East Bearskin	HgF
8	16004200	East Pike	HgF
9	16014700	Flour	HgF
10	16003500	John	HgF
11	16002600	Little John	HgF
12	16004300	Moose	HgF
13	16009300	Mountain	HgF
14	16003600	North Fowl	HgF
15	16003200	Otter	HgF
16	16004100	Pine	HgF
17	16003400	South Fowl	HgF
18	16001900	Tom	HgF, HgW
19	16019600	Wampus	HgF
20	16008600	West Pike	HgF

Figure 37. Pigeon River subwatershed, currently listed impaired waters (by parameter) and land use characteristics.

Flute Reed River subwatershed HUC 0401010103

The Flute Reed River subwatershed drains 94 square miles of Cook County, approximately half of which lies within the Grand Portage Reservation. The Reservation River and Flute Reed River are the largest streams, each draining approximately 16 square miles; the rest of the subwatershed drains to Lake Superior via a number of small direct tributaries. Only a few lakes are found in the subwatershed, the largest of which form the headwaters of the larger streams; wetlands are relatively rare, as well. This general lack of hydrologic storage affects the flow patterns of the subwatershed's streams, which tend to rise and fall quickly following rain events. Forest is the dominant land cover type, but there is a moderately-high level of development relative to the Lake Superior – North Watershed as a whole. Most development is found near the communities of Hovland and Grand Portage, which together encompass approximately 650 residents. The subwatershed also includes a relatively high proportion of privately-owned lands, for this region of the state.

Flute Reed River subwatershed summary

The Flute Reed River was the only stream monitored in this subwatershed. Two reaches were identified as impaired for aquatic life based on high levels of suspended sediment; one of these was already on Minnesota's Impaired Waters List for excess turbidity. The watershed is known for its flashy hydrology and erodible soils, which contribute to high sediment loads during snowmelt and rain events. A citizen organization (Flute Reed River Partnership) and Cook County SWCD have been active in watershed monitoring and restoration activities since the original impairment designation in 2010.

Water quality monitoring conducted near the river's confluence with Lake Superior confirmed the original turbidity listing of the Flute Reed's lower mile. Thirty-seven percent of TSS samples exceeded the 10 mg/L standard, and 72% of Secchi tube samples exceeded the TSS surrogate value of 55 cm. Phosphorus concentrations were also relatively high, slightly below the 50 µg/L river eutrophication standard for northern Minnesota. High phosphorus concentrations may be associated with the high clay content of the river's suspended sediment; phosphorus is often bound to erosive clays. Monitoring further upstream has indicated that TSS exceedances commonly occur throughout the lower several miles of river, and a new aquatic life impairment was identified based on high levels of suspended sediment. The river is significantly clearer near its headwaters (Figure 38, Figure 39); at the uppermost crossing of North Road (biomonitoring station 13LS038) the river would likely meet standards for TSS and Secchi transparency were this section assessed independently. Levels of dissolved oxygen and pH were similar to other streams in the Lake Superior – North Watershed. Bacteria levels were low and indicated support of aquatic recreational use.

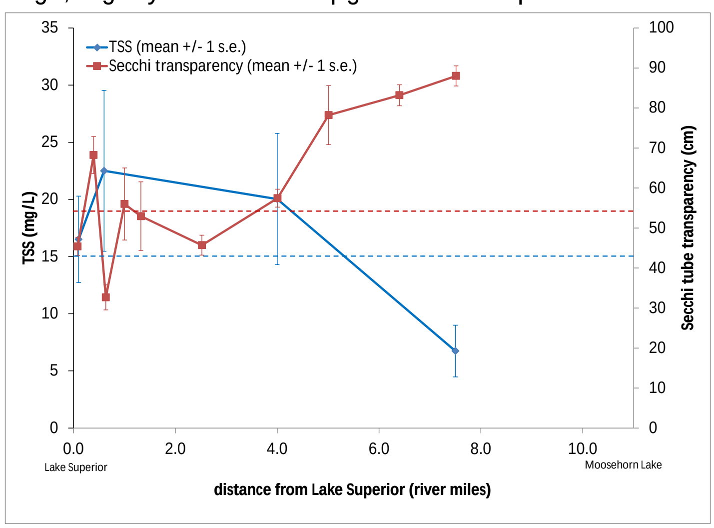


Figure 38. Longitudinal trends in levels of total suspended solids (blue) and Secchi transparency (red) in the Flute Reed River. Red and blue dashed lines aquatic life standards for the two indicators. Data aggregated across multiple years.

In the upper reaches of the Flute Reed River, where suspended sediment levels are relatively low, biological communities are in good- to excellent condition. The fish community met general use biocriteria and was composed mainly of minnows, including some sensitive species (e.g., Northern Redbelly Dace, Finescale Dace, Pearl Dace). Many of these species are often found in streams near or running through wetland habitats, and their presence may reflect the extensive beaver pond complexes found on and adjacent to the upper river. No trout were found in the upper reaches of the Flute Reed, though summer water temperatures may be suitable for their survival. Macroinvertebrate assemblages were particularly robust in the upper river, including several sensitive and stenothermic taxa (e.g., Epeorus, Ephemerella, Lype diversa).

Figure 39. Characteristic transparency conditions in the upper reaches of the Flute Reed River (left), and lower reaches of the Flute Reed River (right).

Biological communities in the lower reaches of the Flute Reed are also in good condition, but may experience stress from elevated levels of suspended sediment. Macroinvertebrate IBI scores declined from upstream to downstream, but still met general use biocriteria along the river's entire length. Several sensitive and stenothermic taxa were found in the lower reaches of the Flute Reed, including *Boyeria grafiana*, a dragonfly on Minnesota's list of Species of Special Concern. The fish community composition of the lower river is influenced by seasonal habitat utilization by migratory Rainbow Trout ("steelhead"), which enter the stream from Lake Superior each spring to spawn. Young steelhead utilize the lower reaches of the Flute Reed for one or two summers, and these small trout were well-represented in fish samples collected at the easternmost crossing of North Road. Fish IBI scores met general use biocriteria on this lower reach.

No lakes in the Flute Reed River subwatershed had enough data to make water quality assessments. However, the subwatershed does include several Lake Superior beaches with assessment-level datasets. At the Chicago Bay Boat Launch Beach (near the Flute Reed River confluence), bacteria levels consistently met standards and indicated full support of swimmable use. Several other beaches within the Grand Portage Reservation were monitored by Grand Portage environmental staff; most of these beaches were along Grand Portage Bay. MPCA assessment methods suggest full support on 12 of 13 beaches; high concentrations of bacteria were occasionally observed at one beach, but it has been assessed as fully supporting aquatic recreation by Grand Portage environmental staff. More information on Grand Portage's beach monitoring program is available at http://www.grandportagebeaches.com/.

Table 6. Aquatic life and recreation assessments on stream reaches: Flute Reed River subwatershed.

AUID *ReachName* Reach Description	Biological Station ID	Reach Length (miles)	Use Class	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia - NH3	Pesticides***	Eutrophication: Phosphorus	Response Indicator	Aquatic Life	Aquatic Rec. (Bacteria)
04010101-D31 **Flute Reed River** Headwaters (Moosehorn Lk 16-0015-00) to Unnamed cr	13LS038 86LS015	10.3	CWg	MTS	MTS	MTS	EXS	EXS	--	MTS	IF	--	MTS	--	IMP	--
04010101-D32 ***Flute Reed River*** *Unnamed cr to Lk Superior*	13LS027	0.8	CWg	MTS	MTS	MTS	EXS	EXS	MTS	MTS	MTS	--	MTS	--	IMP	SUP

Abbreviations for Indicator Evaluations: **---** = No Data, **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use; = insufficient information.
Abbreviations for Use Class: **WWg** = warmwater general, **WWm** = Warmwater modified, **WWe** = Warmwater exceptional, **CWg** = Coldwater general, **CWe** = Coldwater exceptional,
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Table 7. Minnesota Stream Habitat Assessment (MSHA): Flute Reed River Subwatershed

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate 0-27	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
2	13LS038	Flute Reed River	5.0	13.5	19.9	11.5	21.5	71.4	Good
1	86LS015	Flute Reed River	1.0	11.0	17.8	11.0	22.0	72.4	Good
1	13LS027	Flute Reed River	5.0	12.0	23.6	10.0	26.0	76.6	Good
Average Habitat Results: *Flute Reed River Subwatershed*			3.7	12.2	20.4	10.8	23.2	73.5	Good

Qualitative habitat ratings

= Good: MSHA score above the median of the least-disturbed sites (MSHA>66)
= Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)
= Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

Table 8. Outlet water chemistry results: Flute Reed River subwatershed.

Station location:	**Flute Reed River, at Cook County Road 88, in Hovland**						
STORET/EQuIS ID:	**S004-283**						
Station #:	0401010103-01, Flute Reed River Frontal - Lake Superior						
Parameter	Units	# of Samples	Minimum	Maximum	Mean	WQ Standard[1]	# of WQ Exceedances[2]
Ammonia-nitrogen	ug/L	10	0.01	3.6	1	16	0
Chloride	mg/L	10	2.3	13.7	4.5	230	0
Dissolved Oxygen	mg/L	38	9.2	13.3	10.5	7	0
pH		42	6.6	8.3	7.6	6.5 – 8.5	0
Secchi Tube	100 cm	51	5	100	40	> 55	37
Total suspended solids	mg/L	35	1	160	19	10	13
Phosphorus	ug/L	22	10	168	47	50	9
Chlorophyll-a, Corrected	ug/L	0				7	
Escherichia coli (geometric mean)	MPN/100ml	16	16	75	47	126	0
Escherichia coli	MPN/100ml	16	2	1732	226	1260	1
Inorganic nitrogen (nitrate and nitrite)	mg/L	10	0.04	0.2	0.1		
Kjeldahl nitrogen	mg/L	10	0.4	1	0.7		
Orthophosphate	ug/L	0					
Pheophytin-a	ug/L	0					
Specific Conductance	uS/cm	43	27	207	84		
Temperature, water	deg °C	53	0.6	21.6	14.4		
Sulfate	mg/L	10	<3	<3	<3		
Hardness	mg/L	10	25.8	84.7	45.1		

[1]Secchi Tube standards are surrogate standards derived from the total suspended solids standard of 10 mg/L.

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Flute Reed River Subwatershed, a component of the IWM work conducted between May and September from [2013-2014]. This specific data does not necessarily reflect all data that was used to assess the AUID.**

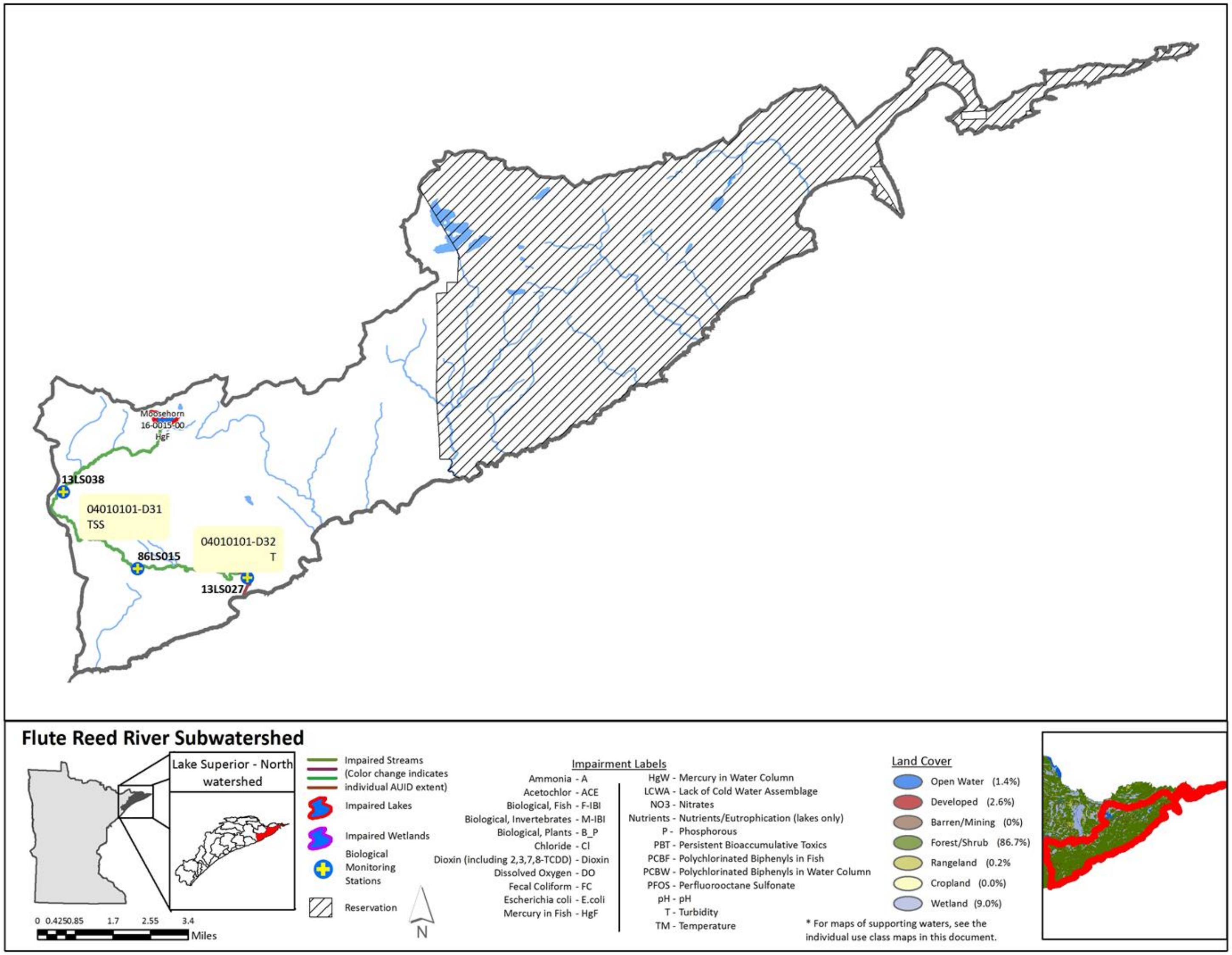


Figure 40. Flute Reed River subwatershed, currently listed impaired waters (by parameter) and land use characteristics.

Brule River subwatershed HUC 0401010104

The Brule River subwatershed drains 265 square miles of Cook County, including 180 lakes, some of which rank among the largest in the Lake Superior – North Watershed (e.g., Brule, Greenwood). Brule River is the major watercourse, with two branches draining distinct regions. The South Brule River originates in Brule Lake, flowing east through several BWCAW lakes and draining approximately 77 square miles. The North Brule originates in a series of BWCAW lakes west of the Gunflint Trail and flows first east, then south, draining approximately 90 square miles. The two branches come together just downstream of Greenwood Lake Road's junction with the Gunflint Trail; the mainstem river then flows southeast through Northern Light Lake and finally to Lake Superior. The final eight miles of the Brule flow through Judge C.R. Magney State Park, over steep rapids and waterfalls. Several tributaries enter the Brule along its length, the largest of which are Poplar Creek, Greenwood River and Assinika Creek.

Land use is dominated by forest, wetland, and lakes; the small amount of development in the subwatershed is largely limited to the Gunflint Trail corridor, particularly the "mid-trail" area near Poplar Lake. Land ownership is primarily public and administered by the federal government, and approximately 39% of the subwatershed lies within the BWACW. Private land is clustered in two areas: the mid-trail area near Poplar Lake, and the lower portion of the watershed, particularly the Mons Creek and Gauthier Creek drainages.

Brule River subwatershed summary

Aquatic life and recreation parameters for lakes, rivers and streams of the Brule River subwatershed consistently indicated good-to-excellent water quality. FIBI and MIBI scores were high, and streams were characterized by low levels of sediment, nutrients, and bacteria. Several streams were identified as exceptional biological resources. Lakes were characterized by low levels of nutrients and algae, though shoreline development is increasing on some lakes and may result in associated impacts to water quality. No aquatic life or aquatic recreation impairments were identified among the twenty-five lakes and nine streams where enough data was collected to make water quality assessments. Several BWCAW lakes were assessed as supporting aquatic recreation based on remotely-sensed transparency data. Three streams (Brule River, Bluff Creek, Greenwood River) met Exceptional Use biocriteria based on high fish and macroinvertebrate IBI scores; protection strategies should be developed for these high-quality systems. Other high-quality streams did not meet exceptional use biocriteria for both biological assemblages but support rare and/or sensitive aquatic organisms and should also be considered in protection planning efforts. Potential improvement opportunities in the subwatershed include repair of a damaged culvert on Assinika Creek.

South Brule River

The South Brule River drains nearly 77 square miles, much of which lies within the BWCAW. Its headwaters include Brule Lake, at 4,700 acres the largest lake in the Lake Superior – North Watershed. Brule Lake is unique in having two outlets that each drain to different subwatersheds; the eastern outlet flows through a series of smaller lakes to the South Brule River, while the western outlet drains to the Temperance River. Brule Lake was monitored by the MPCA in the early 1980s; TP concentrations were low at that time. Recent data on Brule Lake includes a limited Secchi transparency dataset; transparency has ranged from 3-6 meters, indicating good water quality. Transparency data derived from satellite imagery indicates that the lake is meeting aquatic recreation standards.

East of Brule Lake, East and West Twin are small, lightly-developed lakes separated by a narrow isthmus of land, and drain to the South Brule River via Bluff Creek. Both lakes met water quality standards for aquatic recreation, though East Twin is shallower and more productive than West Twin. Maintaining good water quality in the Twin Lakes may be an important component of protection strategies for Bluff

Creek, which flows north towards the South Brule. Bluff Creek is a high-quality coldwater stream that supports Brook Trout, Lake Chub, and sensitive macroinvertebrates such as the stonefly *Amphinemura;* Bluff Creek met exceptional use biocriteria based on fish and macroinvertebrate IBI scores. Fiddle Creek enters the South Brule just upstream of the Bluff Creek confluence, and is another cold, high-quality stream that supports Brook Trout and Lake Chub. The macroinvertebrate community of Fiddle Creek was particularly outstanding, including several sensitive taxa (e.g., *Glossosoma intermiedium*, *Rhyacophila, Alloperla*).

After receiving Bluff and Fiddle Creeks, the South Brule River continues flowing east towards the Gunflint Trail and its confluence with the North Brule. Along this section, the river alternates between short, steep sections of rapids and longer low-gradient reaches. The river is wide and tannin-stained along much of its length, providing warm and cool-water habitat for aquatic life. In-stream habitat rated only "fair" at a biomonitoring station just upstream of the Gunflint Trail, but these habitat features are more likely the product of natural low-gradient characteristics than degradation (Figure 41). Biological indicators at this location suggested excellent water quality, and intensive water chemistry monitoring indicated low levels of sediment, nutrients, and bacteria. Sensitive coolwater fish species such as Smallmouth Bass and Burbot were found in this section of the South Brule, as was the dragonfly Boyeria grafiana (a state-listed Species of Special Concern).

Figure 41. South Brule River biomonitoring site 13LS008.

North Brule River

The headwaters of the North Brule River are a series of small- to moderate-sized lakes west of the Gunflint Trail. Among these is Caribou Lake, which was monitored as part of a special project to develop baseline water quality conditions on a handful of heavily-used BWCAW lakes; the project was a partnership between the Superior National Forest, the MPCA, and Vermilion Community College. Caribou Lake fully supports aquatic recreation; phosphorus, chlorophyll-a, and Secchi transparency were low and at expected levels for a shallow, cool water lake within the BWCAW.

Poplar Lake lies to the north of Caribou Lake, and drains to the North Brule via Poplar Creek. Poplar Lake has a long term water quality dataset, and is one of the few lakes in Cook County with a statistically significant decline in transparency. Transparency has declined by about one meter since the late 1980s (Figure 42). Additionally, lake trout have recently been extirpated from the lake, and a restocking effort was unsuccessful in re-establishing the species. The lake is now managed by the MNDNR primarily for walleye and northern pike. It's likely that the extirpation of Poplar Lake's Lake Trout was the result of several factors including naturally marginal cold water habitat, overfishing, and lakeshore development. However,

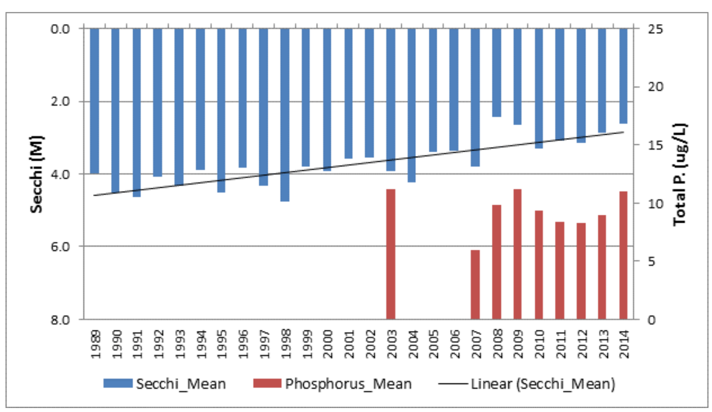


Figure 42. Poplar Lake water quality trends, 1989-2014.

Poplar Lake continues to be a high-quality, oligotrophic lake that meets Class 2A water quality standards for aquatic recreation.

Upper reaches of the North Brule flow through remote country, and were not monitored in the course of this study. However, biomonitoring stations located along its middle and lower reaches revealed that the river supports Brook Trout, Lake Chub, and other sensitive fish species, as well as many sensitive macroinvertebrates (e.g., *Boyeria grafiana*, *Leuctra*, *Rhyacophila*). This reach met Exceptional Use biocriteria based on fish and macroinvertebrate IBI scores; watershed planning efforts should try to protect these outstanding biological communities. An intensive water chemistry monitoring station located at the Greenwood Lake Road consistently met water quality standards for sediment, dissolved oxygen, nutrients, and bacteria across two years of intensive sampling. Lullaby Creek, a North Brule tributary, was monitored in 2015 and found to support wild Brook Trout and several stenothermic macroinvertebrate taxa (e.g., *Heleniella*, *Diplectrona modesta*, *Amphinemura*). Cold tributaries like Lullaby Creek provide important spawning, rearing, and thermal refugia for organisms in larger rivers, and are integral components of watersheds' biological integrity.

Brule River mainstem

For nearly four miles between the North/South Brule confluence and Northern Light Lake, the Brule River is considered a warmwater stream. Biological communities indicate excellent water quality; the fish community is dominated by species sensitive to pollution and habitat degradation, including Burbot, Longnose Dace, and Lake Chub. The macroinvertebrate community is diverse and includes many sensitive taxa. Timber Creek, a small, cold tributary, enters the Brule along this stretch and supports a wild Brook Trout population as well as sensitive macroinvertebrates that require cold water temperatures (e.g., *Diplonectra modesta*, *Rhyacophila*, *Amphinemura*). Pine Mountain Lake, a small stream trout lake north of Timber Creek, was found to have excellent water quality and was assessed as supporting aquatic recreation.

Figure 43. Larval form of *Glossosoma sp.*, a "saddle-case maker" caddisfly that inhabits cold, rocky streams.

Just downstream of Northern Light Lake, Assinika Creek enters the Brule River from the north. This stream drains 18 square miles of forest and wetlands, and is identified "Stony Creek" on some maps. Fish and macroinvertebrate communities were monitored at a single location upstream of Forest Road 141. Biological communities indicated good water quality, particularly the macroinvertebrate assemblage which included *Glossosoma intermedium* (Figure 43) and other coldwater taxa. Brook Trout were not observed during the 2013 fish survey, but Assinika Creek is a designated trout stream and trout have been noted in past surveys by MPCA and MNDNR. The MPCA biomonitoring reach was located immediately upstream of a damaged culvert that may inhibit fish passage and negatively impact in-stream physical habitat. Logging occurred adjacent to the stream in the mid-1990s, and loss of riparian shading may have warmed the stream to some extent, though extensive beaver activity in the watershed likely contributes to warming, as well. The MNDNR stream management plan for Assinika Creek recommends maintaining watershed integrity, water quality, and flow stability by promoting mature forest in the watershed, long-lived conifer species in riparian zones, and protection of riparian zones in accordance with Minnesota Forest Resource Council (MFRC) forest management guidelines. Improvement opportunities for this stream include development and maintenance of a robust, long-lived forested stream corridor, as well as culvert repair or replacement.

The Greenwood River enters the Brule River downstream of Assinika Creek, and drains 26 square miles of forest, wetlands, and lakes, including its source, Greenwood Lake. This 2,000-acre lake has been monitored as a long term Sentinel Lake by the MPCA and MNDNR since 2010, and was an MPCA Ecoregion Reference lake in the 1980s. A detailed report on Greenwood was recently completed, and describes in detail the lake's setting, fishery, and water quality conditions (MPCA 2015b). Secchi, total phosphorus, and chlorophyll-a have been relatively consistent over the course of the Sentinel Lakes monitoring (Figure 44). A management concern for the lake is its infestation with the exotic spiny water flea. Ester Lake, a smaller stream trout lake just east of Greenwood and also draining to the Greenwood River, was found to have excellent water quality and was assessed as supporting aquatic recreation.

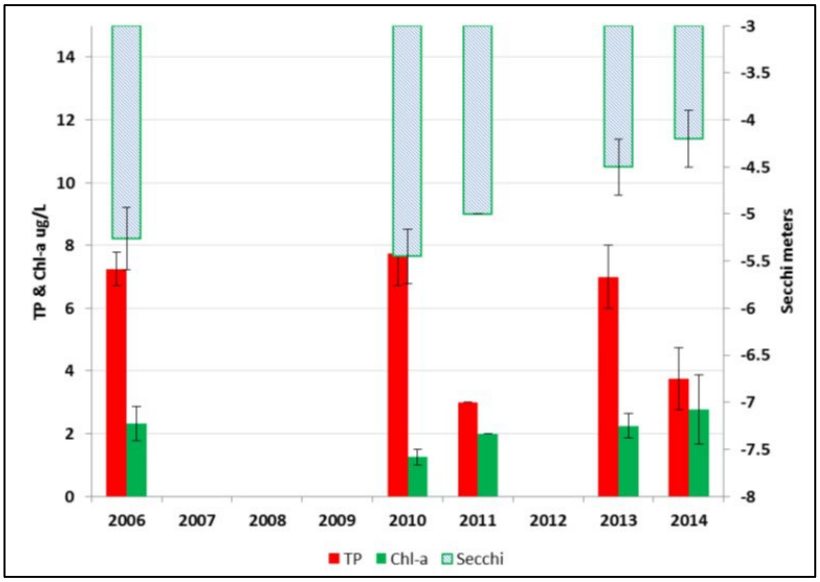


Figure 45. Greenwood Lake Water Quality Trends, 2006-2014.

Figure 44. Greenwood River upstream of the Greenwood Lake Road.

The Greenwood River (Figure 45), a major tributary to the Brule River, was monitored for fish and macroinvertebrate communities at a single location upstream of the Greenwood Lake Road. At this location, fish and macroinvertebrate IBI scores meet Exceptional Use biocriteria. The stream is notable for its population of Longnose Sucker, which is common across northern North America but relatively rare in Minnesota. The species is often found in Lake Superior and short reaches of Lake Superior tributaries below barrier falls, but only a few records of inland, fluvial populations exist. Historic distribution records suggest the Longnose Sucker was once more common and widespread within the Lake Superior – North Watershed; reasons for its apparent decline are unclear, but the species is thought to be sensitive to impacts such as warming and sedimentation. The Greenwood River also supports Lake Chub, a wild Brook Trout population and a diverse macroinvertebrate community. The macroinvertebrate community is particularly rich in caddisfly taxa; 22 different caddis genera have been recorded from biomonitoring station 97LS074. The presence of these and other sensitive organisms indicate excellent water quality and habitat conditions, and this unique resource should be prioritized for protection efforts.

The 18 miles of the mainstem Brule River downstream of Northern Light Lake are characterized by stretches of slow water interspersed with rapids, until the last several miles before it enters Lake Superior, where the river tumbles over a series of waterfalls, ledges, and rapids. Much of this reach is remote and difficult to access; as a result, most monitoring has occurred near Lake Superior, upstream of Highway 61. At this location, fish and macroinvertebrate IBI scores indicated good water quality and many years of intensive water chemistry data collection confirm that the excellent water quality observed in in upper reaches of the Brule is maintained to the river's confluence with Lake Superior. Minor exceedances of the TSS and pH standards sometimes occur during periods of high or low flow but are not abnormal.

Table 9. Aquatic life and recreation assessments on stream reaches: Brule River subwatershed. Reaches are organized upstream to downstream in the table.

AUID *ReachName* Reach Description	Biological Station ID	Reach Length (miles)	Use Class	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia - NH3	Pesticides***	Eutrophication: Phosphorus	Response Indicator	Aquatic Life	Aquatic Rec. (Bacteria)
04010101-D30 ***Brule River*** *BWCA boundary to South Brule R*	15LS053 13LS007 98LS034	12.6	CWe*	MTS	MTS	MTS	IF	IF	MTS	MTS	MTS	--	MTS	--	SUP	SUP
04010101-814 ***Lullaby Creek*** Headwaters to Brule R	15LS052	1.8	CWe	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--	SUP	--
04010101-541 ***South Brule River*** *Headwaters (Lower Trout Lk 16-0175-00) to Brule R*	13LS008	7.7	WWg	MTS	MTS	MTS	MTS	MTS	MTS	MTS	MTS	--	MTS	--	SUP	SUP
04010101-737 ***Fiddle Creek*** *Unnamed cr to South Brule R*	13LS039	1.7	CWg	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--	SUP	--
04010101-646 ***Bluff Creek*** *East Twin Lk (16-0145-00) to South Brule R*	13LS051	2.7	CWe	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--	SUP	--
04010101-596 ***Brule River*** *South Brule R to Northern Light Lk*	10EM120 13LS009	3.8	WWg	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--	SUP	--
04010101-546 ***Timber Creek*** *Headwaters to Brule R*	92LS001	3.4	CWg	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--	SUP	--
04010101-594 ***Assinika Creek*** *Assinika Lk to Brule R*	98LS036	5.0	CWg	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--	SUP	--
04010101-528 ***Greenwood River*** *Greenwood Lk to Brule R*	97LS074	7.3	CWe	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--	SUP	--
04010101-502 ***Brule River*** *Greenwood R to Lk Superior*	10EM056 13LS010 13LS055	13.2	CWg	MTS	MTS	MTS	MTS	MTS	MTS	MTS	MTS	--	MTS	--	SUP	SUP

Abbreviations for Indicator Evaluations: --- = No Data, MTS = Meets Standard; EXS = Fails Standard; IF = Insufficient Information
Abbreviations for Use Support Determinations: -- = No Data, NA = Not Assessed, IF = Insufficient Information, SUP = Full Support (Meets Criteria); IMP = Impaired (Fails Standards)
Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use; = insufficient information.
Abbreviations for Use Class: WWg = warmwater general, CWg = Coldwater general, CWe = Coldwater exceptional, *Assessments completed using proposed use classifications changes not yet written into rule

Table 10. Minnesota Stream Habitat Assessment (MSHA): Brule River subwatershed.

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate 0-27	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
2	98LS034	Brule River	5.0	12.5	24.7	12.5	21.5	76.2	Good
3	13LS007	Brule River	5.0	12.7	23.5	12.0	27.0	80.1	Good
1	15LS053	Lullaby Creek	5.0	14.0	24.0	9.0	21.0	73.0	Good
1	13LS008	South Brule River	5.0	11.0	15.9	14.0	12.0	57.9	Fair
3	13LS039	Fiddle Creek	5.0	11.5	21.2	13.3	24.3	75.4	Good
2	13LS051	Bluff Creek	5.0	13.5	19.1	15.5	17.5	70.6	Good
2	13LS009	Brule River	5.0	11.0	19.0	12.0	20.0	67.0	Good
1	92LS001	Timber Creek	5.0	13.5	22.0	14.0	18.0	72.5	Good
1	98LS036	Assinika Creek	5.0	13.0	20.5	15.0	31.0	84.5	Good
1	97LS074	Greenwood River	5.0	13.0	23.4	17.0	28.0	86.3	Good
1	13LS010	Brule River	5.0	15.0	23.4	14.0	24.0	81.3	Good
1	10EM056	Brule River	5.0	12.0	22.1	12.0	26.0	77.1	Good
Average Habitat Results: *Brule River Subwatershed*			5.0	12.7	21.6	13.4	22.5	75.2	Good

Qualitative habitat ratings

- = Good: MSHA score above the median of the least-disturbed sites (MSHA>66)
- = Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)
- = Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

Table 11. Outlet water chemistry results: Brule River.

Station location:	**Brule River, at Judge C.R. Magney State Park, upstream of US-61 bridge**						
STORET/EQuIS ID:	**S000-251**						
Station #:	040101010104-01, Lower Brule River						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**WQ Standard[1]**	**# of WQ Exceedances[2]**
Ammonia-nitrogen	ug/L	21	< .002	50	1.7	16	0
Chloride	mg/L	21	1.1	1.8	1.4	230	0
Dissolved Oxygen	mg/L	45	7.4	12.6	9.3	7	0
pH		40	6.1	8.4	7.3	6.5 – 8.5	1
Secchi Tube	100 cm	45	35	>100	79	> 55	6
Total suspended solids	mg/L	21	1.2	11	3.8	10	1
Phosphorus	ug/L	7	8	18	13	50	0
Chlorophyll-a, Corrected	ug/L	10	0.7	2.5	1.6	7	0
Escherichia coli (geometric mean)	MPN/100ml	35	17	25	20	126	0
Escherichia coli	MPN/100ml	35	10	66	27	1260	0
Inorganic nitrogen (nitrate and nitrite)	mg/L	28	0.1	0.2	0.01		
Kjeldahl nitrogen	mg/L	28	0.4	0.7	0.5		
Orthophosphate	ug/L	0					
Pheophytin-a	ug/L	10	1	3.5	2.1		
Specific Conductance	uS/cm	42	25.5	84.1	49.4		
Temperature, water	deg °C	42	2.3	23.2	15.9		
Sulfate	mg/L	22	1.6	3.7	2.3		
Hardness	mg/L	21	13	39	20.7		

[1]Secchi Tube standards are surrogate standards derived from the total suspended solids standard of 10 mg/L.

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Brule River Subwatershed, a component of the IWM work conducted between May and September from [2013-2014]. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Table 12. Outlet water chemistry results: North Brule River.

Station location:	North Brule River, at Greenwood Lake Road						
STORET/EQuIS ID:	S007-326						
Station #:	0401010104-02, Upper Brule River						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**WQ Standard[1]**	**# of WQ Exceedances[2]**
Ammonia-nitrogen	ug/L	9	0.01	0.8	0.3	16	0
Chloride	mg/L	9	<1	<1	<1	230	0
Dissolved Oxygen	mg/L	19	7.8	12.6	9.1	7	0
pH		17	6.1	8.6	7.3	6.5 – 8.5	1
Secchi Tube	100 cm	19	>100	>100	>100	> 55	0
Total suspended solids	mg/L	9	1.2	11	3.4	10	1
Phosphorus	ug/L	13	5	16	9	50	0
Chlorophyll-a, Corrected	ug/L	0				7	
Escherichia coli (geometric mean)	MPN/100ml	15	22	27	24	126	0
Escherichia coli	MPN/100ml	15	10	66	26	1260	0
Inorganic nitrogen (nitrate and nitrite)	mg/L	9	<0.05	0.1	0.1		
Kjeldahl nitrogen	mg/L	9	0.4	0.6	0.5		
Orthophosphate	ug/L	0					
Pheophytin-a	ug/L	0					
Specific Conductance	uS/cm	17	27	66	38		
Temperature, water	deg °C	18	2.3	22.6	15.5		
Sulfate	mg/L	9	1.6	2.4	2		
Hardness	mg/L	9	13	22	18		

[1]Secchi Tube standards are surrogate standards derived from the total suspended solids standard of 10 mg/L.
****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the North Brule River Aggregated 12-HUC, a component of the IWM work conducted between May and September from [2013-2014]. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Table 13. Outlet water chemistry results: South Brule River.

Station location:	**South Brule River, at Gunflint Trail**						
STORET/EQuIS ID:	**S007-327**						
Station #:	0401010104-03, South Brule River						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**WQ Standard[1]**	**# of WQ Exceedances[2]**
Ammonia-nitrogen	ug/L	9	0.04	1	0.3	16	0
Chloride	mg/L	9	<1	1.8	<	230	0
Dissolved Oxygen	mg/L	19	7.4	12.5	8.8	7	0
pH		17	6.5	7.8	7.2	6.5 – 8.5	0
Secchi Tube	100 cm	14	35	>100	>100	> 55	2
Total suspended solids	mg/L	9	1.6	5.2	2.8	10	0
Phosphorus	ug/L	10	5	20	11	50	0
Chlorophyll-a, Corrected	ug/L	0				7	
Escherichia coli (geometric mean)	MPN/100ml	15	21	33	25	126	0
Escherichia coli	MPN/100ml	15	13	110	31	1260	0
Inorganic nitrogen (nitrate and nitrite)	mg/L	9	<0.05	0.2	<0.05		
Kjeldahl nitrogen	mg/L	9	0.5	0.7	0.6		
Orthophosphate	ug/L	0					
Pheophytin-a	ug/L	0					
Specific Conductance	uS/cm	18	25	80	40		
Temperature, water	deg °C	18	2.3	23	16		
Sulfate	mg/L	9	1.8	2.6	2.2		
Hardness	mg/L	9	13	21	18		

[1]Secchi Tube standards are surrogate standards derived from the total suspended solids standard of 10 mg/L.

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the South Brule River Aggregated 12-HUC, a component of the IWM work conducted between May and September from [2013-2014]. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Table 14. Lake assessments: Brule River subwatershed.

Name	DNR Lake ID	Area (acres)	Trophic Status	% Littoral	Max. Depth (m)	Mean Depth (m)	CLMP Trend	Mean TP (µg/L)	Mean chl-a (µg/L)	Mean Secchi (m)	AQR Support Status	AQL Support Status
Allen	16-0320-00	45	M	100	4		NT			2.3	IF	NA
Banadad	16-0350-00	173	M		15		NT			2.1	FS*	NA
Brule	16-0348-00	4219	M	31	18		NT			3.7	FS*	NA
Cam	16-0397-00	55	M	49	17		NT			4.1	IF	NA
Caribou	16-0240-00	248	O	80	8		NT	7.5	6.6	2.0	FS	IF
Davis	16-0435-00	319	M		20		NT			3.4	FS*	NA
East Twin	16-0145-00	169	M	93	6	2.4	NT	19.7	8.3	2.4	FS	NA
Esther	16-0023-00	82	O		35		NT	10.3	3.8	2.6	FS	NA
Gasket	16-0909-00	4	E				NT			2.0	IF	NA
Gaskin	16-0319-00	382	O		18		NT			4.1	FS*	NA
Greenwood	16-0077-00	2025	O	27	101	9.8	NT	6.1	2.1	5.0	FS	IF
Henson	16-0314-00	114	M		9		NT			2.4	IF	NA
Horseshoe	16-0241-00	187	M		6		NT			2.1	IF	NA
Jackal	16-0222-00	33	M	76	9		NT			2.9	NA	NA
Jump	16-0910-00	7	M				NT			2.5	IF	NA
Kroft	16-0168-00	22	M	100	3		NT			2.0	NA	NA
Little Trout	16-0170-00	125	M		15		NT			4.9	NA	NA
Lizz	16-0199-00	23	M		9		NT			2.9	FS*	NA
Lost	16-0022-00	75	O	99	20		NT	10.7	7.5	1.8	IF	NA
Lower Cone	16-0393-00	70	M	86	8		NT				NA	NA
Lower Trout	16-0175-00	129	M	100	2		NT	11.0	1.4	1.7	NA	NA
Lux	16-0223-00	50	M	87	6		NT			2.3	NA	NA
Meeds	16-0307-00	348	M	42	13		NT			2.1	FS*	NA

Abbreviations: D -- Decreasing/Declining Trend; I -- Increasing/Improving Trends; NT – No Trend; E - Eutrophic; M – Mesotrophic; O – Oligotrophic; FS – Full Support; NS – Non-Support; IF – Insufficient Information

Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use
* = assessment-level transparency dataset collected via remote sensing

Name	DNR Lake ID	Area (acres)	Trophic Status	% Littoral	Max. Depth (m)	Mean Depth (m)	CLMP Trend	Mean TP (µg/L)	Mean chl-a (µg/L)	Mean Secchi (m)	AQR Support Status	AQL Support Status
Mid Cone	16-0391-00	72	M	51	9		NT			3.0	FS*	NA
Misquah	16-0225-00	52	M	27	19		NT			2.6	IF	NA
Morgan	16-0220-00	82	O	49	14		NT			4.4	NA	NA
Mulligan	16-0389-00	25	M	40	19		NT			3.4	FS*	NA
Northern Light	16-0089-00	371	M	100	11		NT	15.8	0.9	1.3	IF	IF
Omega	16-0353-00	149	M		16		NT			3.8	FS*	NA
One Island	16-0298-00	24	E	98	6		NT			1.4	FS*	NA
Pillsbery	16-0318-00	66	M		6		NT			3.0	IF	NA
Pine Mountain	16-0108-00	105	O	68	30		NT	8.8	2.2	2.5	FS	NA
Poplar	16-0239-00	758	O	40	22	6.5	D	9.5	3.7	3.1	FS	IF
Ram	16-0174-00	68	M	42	12		NT			3.3	FS*	NA
Road	16-0200-00	14	E	100	5		NT			1.9	IF	NA
Rum	16-0169-00	47	M		5		NT			1.2	NA	NA
Rush	16-0299-00	261	M	50	16		NT			2.3	IF	NA
Squint	16-0202-00	17	M	78	6		NT			2.6	FS*	NA
Swan	16-0268-00	200	M	27	30		NT			3.2	FS*	NA
Upper Cone	16-0412-00	79	M	29	14		NT			2.4	FS*	NA
Vista	16-0224-00	160	M	91	12		NT			2.7	FS*	NA
Wanihigan	16-0349-00	47	M		12		NT			3.4	FS*	NA
Wench	16-0398-00	24	M	47	18		NT			3.8	FS*	NA
West Twin	16-0186-00	132	M	70	0		NT	10.1	4.0	3.3	FS	NA
Winchell	16-0354-00	870	O	27	37		NT			4.7	FS*	NA

Table 14. Lake assessments: Brule River subwatershed (continued).

Abbreviations: **D -- Decreasing/Declining Trend** **E - Eutrophic** **FS – Full Support**
I -- Increasing/Improving Trends **M – Mesotrophic** **NS – Non-Support**
NT – No Trend **O – Oligotrophic** **IF – Insufficient Information**

Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use
* = assessment-level transparency dataset collected via remote sensing

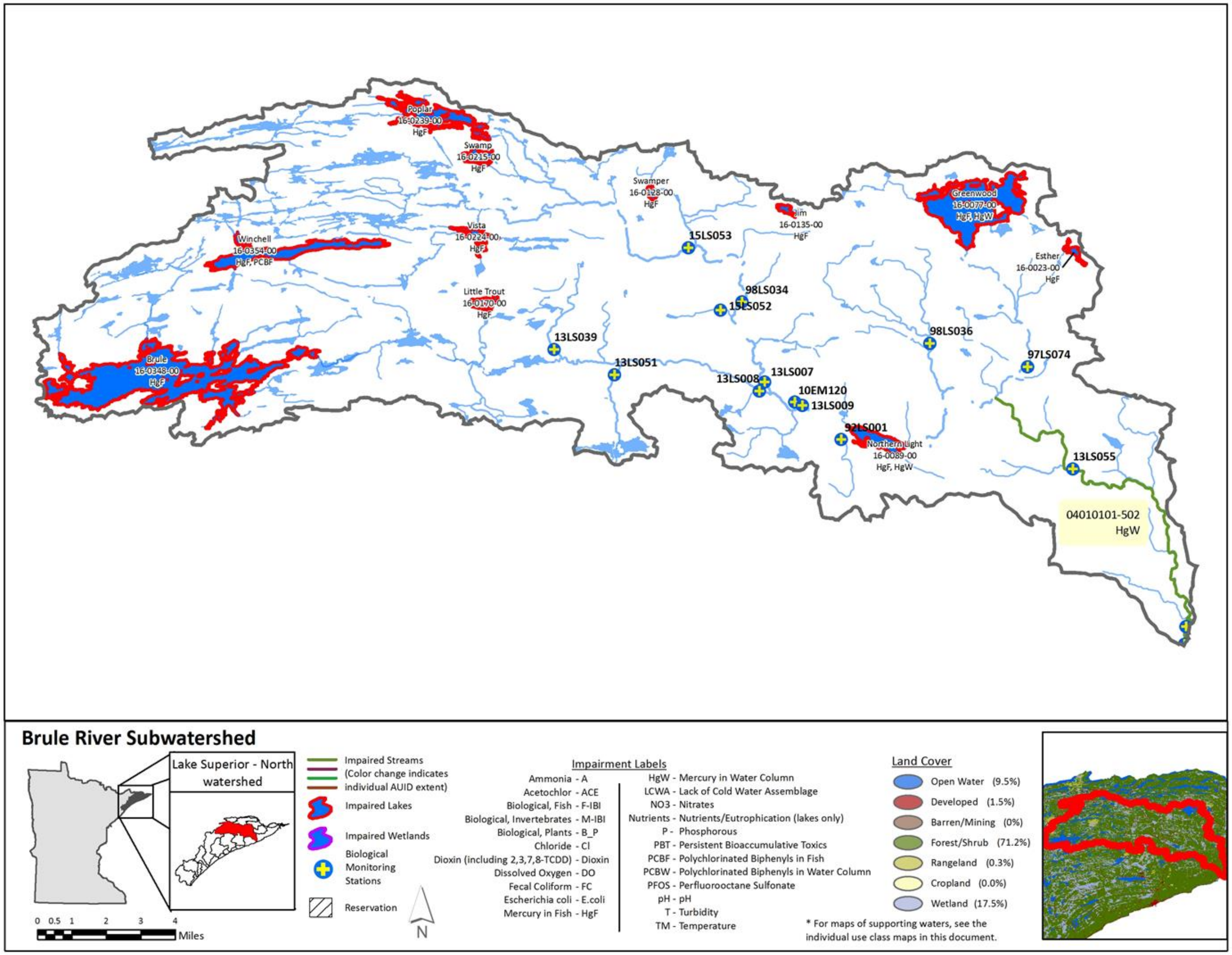


Figure 46. Brule River subwatershed, currently listed impaired waters (by parameter) and land use characteristics.

Devil Track River subwatershed HUC 0401010105

The Devil Track River subwatershed drains approximately 137 square miles of Cook County. The subwatershed includes 35 lakes, the largest of which, Devil Track Lake, covers more than 1,800 acres. Devil Track River is the major watercourse, draining approximately 73 square miles at its confluence with Lake Superior just east of Grand Marais; the rest of the watershed is drained by several smaller direct tributaries to Lake Superior. The Devil Track River begins at the outlet of Devil Track Lake (itself fed by Junco Creek) and picks up several tributaries as it flows first east, then south towards Lake Superior. As the river approaches the Gunflint Trail community of Maple Hill, Elbow Creek enters from the north, draining Elbow Lake. Downstream of the Gunflint Trail, in the final two miles before encountering Lake Superior, the Little Devil Track River enters from the west followed by Woods Creek from the north. The river has carved a deep canyon along its final few miles, and tumbles over several waterfalls and rapids just before it reaches Lake Superior at the community of Croftville.

Land use in the subwatershed is dominated by forest and wetland; while development levels remain relatively low, the Devil Track River subwatershed's proportion of developed land is highest among all Lake Superior – North subwatersheds. Developed areas are concentrated in and around the city of Grand Marais, smaller outlying communities, and along the Gunflint Trail corridor. Runways and associated facilities at the Grand Marais/Cook County Airport represent another significant developed area. A few farms are located in the subwatershed; agricultural land use is otherwise relatively rare in the Lake Superior – North watershed. Land ownership is primarily public but a significant proportion of lands are privately-owned, mostly clustered along the Gunflint Trail corridor and the Maple Hill area.

Devil Track River subwatershed summary

Aquatic life and recreation indicators for lakes, rivers and streams of the Devil Track River subwatershed consistently reflected good-to-excellent water quality. FIBI and MIBI scores were high, and streams were characterized by low levels of sediment, nutrients, and bacteria. Six streams met exceptional use biocriteria based on FIBI and MIBI scores; protection strategies should be developed for these and other outstanding stream resources found throughout the Devil Track subwatershed. Lakes were characterized by low levels of nutrients and algae, and none were found to be impaired for aquatic recreation. However, lake transparency appears to be declining in Devil Track Lake. Several Lake Superior beaches were monitored in the course of this study – all were found to be supporting aquatic recreation, although high concentrations of bacteria were often recorded at the Grand Marais Downtown Beach, particularly after rain events.

Devil Track River

The Devil Track River is the major watercourse of this subwatershed, but its true headwaters (upstream of Devil Track Lake) are known as Junco Creek. The creek's headwaters include Musquash, Trestle Pine, and Kemo Lakes, trout lakes west of the Gunflint Trail which have excellent water quality. Fish and macroinvertebrate communities of Junco Creek were monitored between Junco Lake and Devil Track Lake. The creek was found to support Brook Trout and several sensitive macroinvertebrates (e.g., Epeorus, Boyeria grafiana). The fish community included some wetland-oriented species (e.g., Iowa Darter), which are likely utilizing on-channel beaver impoundments that are common along the creek's length. In general, the biological communities of Junco Creek indicated good habitat and water quality.

Junco Creek enters Devil Track Lake just downstream of Cook County Highway 8. Devil Track Lake encompasses 1,800 acres and is one of the most developed lakes in the Lake Superior – North Watershed. In addition to many private residences, the lake's shoreline also features a large campground and a sea plane base. Devil Track Lake has been monitored for many years; the long-term water quality dataset indicates a declining trend in Secchi transparency (Figure 47). Since 2000, transparency has dropped about 0.5 m (1.5 feet). However, phosphorus concentrations have remained fairly consistent, and the lake was assessed as supporting aquatic recreation.

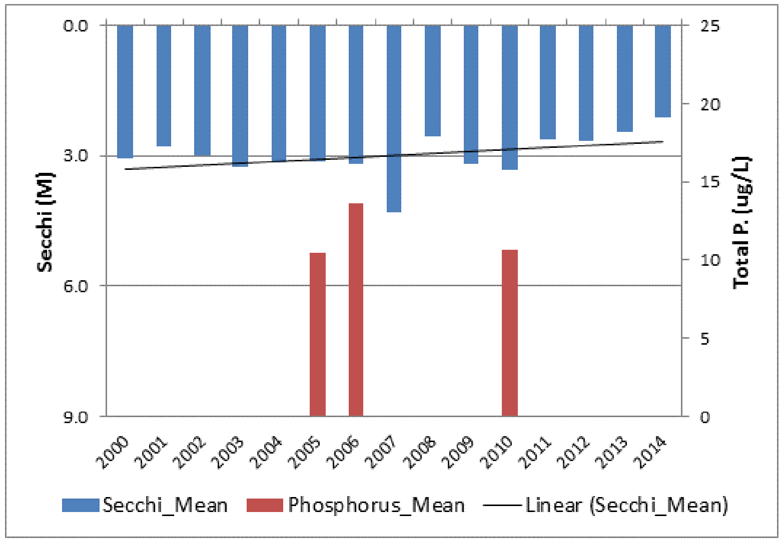


Figure 47. Devil Track Lake water quality trends.

The Devil Track River exits the east end of Devil Track Lake and flows nearly nine miles to its confluence with Lake Superior at Croftville. Along its length, MPCA monitored fish and macroinvertebrates at several locations; with the exception of the final two miles just upstream of Lake Superior, the Devil Track was found to support exceptional biological communities. Biological monitoring stations were located both up- and downstream of the Gunflint Trail, as well as off the Superior Hiking Trail closer to Lake Superior. Brook Trout and Slimy Sculpin were found throughout the river, and many sensitive macroinvertebrates were collected from multiple stations. Just upstream of Highway 61, fish communities met exceptional use biocriteria, but macroinvertebrate communities were less robust, likely due to natural factors associated with the stream's highly-confined, canyon-like characteristics. Within the Devil Track canyon, steep stream slopes and a highly confined flood plain produce a combination of scoured, bedrock-dominated pools interspersed with runs and rapids dominated by unstable, shifting substrates. Large wood is rare in certain reaches of the canyon, apparently carried downstream or into the floodplain by high flow events. The habitats found in the Devil Track canyon may be difficult for certain indicator macroinvertebrates to colonize, but are likely natural, and not due to watershed degradation. The biological communities of this lowermost reach indicated support for aquatic life, but an exceptional use designation is not warranted due to the lower MIBI scores. Intensive water chemistry monitoring at Highway 61 indicated some high levels of suspended sediment and phosphorus (which is bound to soil particles) during high flows, but water quality was generally good and the river was determined to be meeting aquatic life and recreation standards.

Near the Gunflint Trail community of Maple Hill, Elbow Creek enters the Devil Track from the north. Elbow Creek drains approximately 20 square miles, including Binigami and Elbow Lakes, Class 2B (warmwater) lakes that were found to have low levels of phosphorus and chlorophyll-a. Elbow Creek was monitored near its confluence with the Devil Track River, where it supports exceptional biological communities, including wild Brook Trout, Slimy Sculpin and many sensitive macroinvertebrates (e.g, Epeorus, Glossosoma, Leuctra). The MPCA monitors Elbow Creek every other year as part of its Long-Term Biological Monitoring Program, which is designed to detect shifts in biological condition associated with broad-scale environmental fluctuations (e.g., climate change).

Downstream of Maple Hill, the next major tributary is the Little Devil Track River, which enters from the west and drains approximately eight square miles of forest and wetlands south and east of Devil Track Lake. Fish and macroinvertebrate communities were monitored near the Gunflint Trail; wild Brook Trout and Slimy Sculpin were present, and many sensitive macroinvertebrates were collected (e.g., Rhithrogena, Epeorus, Rhyacophila). IBI scores met exceptional use biocriteria and indicate a high-quality biological resource. As such, the Little Devil Track River should be prioritized for protection. The river's catchment encompasses a relatively high proportion of private land (37%); these parcels are largely concentrated along the river's lower reaches (near the Gunflint Trail), but significant amounts of private land also exist along Monker Creek in the river's headwaters. Most of the Little Devil Track's private parcels remain relatively undeveloped, but due to its proximity to Grand Marais, this area may experience increased development in the near future. Protection strategies may require collaboration with individual landowners to ensure that ongoing development does not degrade habitat and water quality in the Little Devil Track River. Opportunities for improvement include stabilization of at least one eroding streambank that was noted in the course of biomonitoring surveys; this location corresponds with a power line clearing a short distance upstream of the Gunflint Trail.

Woods Creek drains slightly more than two square miles, rising in headwater springs and ponds east of Maple Hill. The upper portion of the creek is slow-moving and heavily-influenced by beaver activity and man-made impoundments, but within about a mile the creek begins a rapid descent towards Lake Superior. It flows through a steep, forested ravine, over rapids and small waterfalls before entering the Devil Track River approximately a quarter-mile from Lake Superior. MPCA monitored fish and macroinvertebrate communities at two locations on Woods Creek: at Cook County Road 58, and off of the Superior Hiking Trail about a half-mile upstream of the county road. Brook Trout were found at both locations, and several sensitive macroinvertebrates were collected (e.g., Amphinemura, Epeorus, Rhithrogena). Rainbow Trout (likely young steelhead) were captured at CR58, as well. IBI scores met exceptional use biocriteria, and indicate excellent water quality and cold water temperatures. In fact, Woods Creek (in its lower reaches) appears to be one of the colder streams in the entire Lake Superior – North Watershed, capable of supporting trout and aquatic insects that are sensitive to warming. However, the stream does face some potential threats to habitat, water quality and biological integrity. Longitudinal connectivity for fish communities may be impacted both by natural barriers and a perched culvert at Cook County Road 58 (Figure 48), and signs of geomorphic instability are evident (Figure 49).

Figure 48. Perched culvert, Woods Creek at Cook County Road 58.

Figure 49. Heavily-eroded bank on Woods Creek, upstream of Cook County Road 58.

Channel instability may be negatively affecting in-stream habitat, though it's unclear to what extent this instability is caused by natural versus anthropogenic factors. It is clear that upstream portions of Woods Creek have been impounded (both by beavers and private landowners) and altered by ditching and diversions, which may have affected the streams flow regime. One of the watershed's few farms straddles a portion of the creek, and the stream channel in this area appears to have experienced some physical impacts. Monitoring data from the upstream reaches of Woods Creek are extremely limited, which precludes a formal assessment of aquatic life at this time, though (as noted above) the downstream reach supports exceptional biological communities. Recommended protection strategies for Woods Creek may focus on agricultural best management practices (BMPs), channel restoration, and improved connectivity in the upstream portion of the watershed, bank stabilization work along the lower reaches, and facilitating fish passage.

Kimball Creek and Kadunce River

To the east of the Devil Track River lie two smaller Lake Superior tributaries: Kimball Creek and Kadunce River. Kimball drains approximately 14 square miles and Kadunce drains approximately 11 square miles. The headwaters of Kimball Creek are formed by a series of stream trout lakes just east of the Gunflint Trail: Boys, Mink, and Kimball lakes were all found to have excellent water quality and were assessed as fully supporting aquatic recreation. MPCA monitored Kimball Creek near Highway 61, where the stream had excellent water quality with low levels of nutrients, sediment, and bacteria. Biological indicators (fish and macroinvertebrates) reflected excellent water quality and habitat conditions; IBI scores met exceptional use biocriteria. The fish community consisted entirely of trout (Brook and Rainbow) and the pollution-intolerant Slimy Sculpin. The macroinvertebrate community also consisted of relatively few taxa, and was dominated by highly sensitive organisms that require clean, cold water. The biological assemblages of Kadunce River (also monitored near Highway 61) closely resembled those found in Kimball Creek; relatively simple communities dominated by highly-sensitive fish and aquatic insects (e.g., Brook Trout, *Glossosoma*, *Baetis tricaudatus*, *Rhyacophila*). Stonefly taxa richness was particularly outstanding; seven different genera were collected in a single sample from the Kadunce River. IBI scores easily met exceptional use biocriteria, and water quality was excellent, as measured by consistently low concentrations of nutrients, sediment, ions, and bacteria. Kimball Creek and Kadunce River are among the watershed's best examples of high-quality, coldwater streams and should be prioritized for protection.

Trout Lake is one of the headwater sources of the Kadunce River and has long been monitored by the MPCA and local partners. It was an MPCA ecoregion reference lake, and is included in MNDNR and MPCA's long term Sentinel Lakes program (MPCA 2011). Trout is a "Super Sentinel" lake and, as such, is also subject to detailed climate change modeling conducted by the USGS. Water quality has remained fairly consistent through time (Figure 50,Figure 51), and recent data indicate a continuation of past trends. Trout Lake is one of the clearest lakes in Cook County, and was assessed as meeting recreational use standards for lake trout lakes.

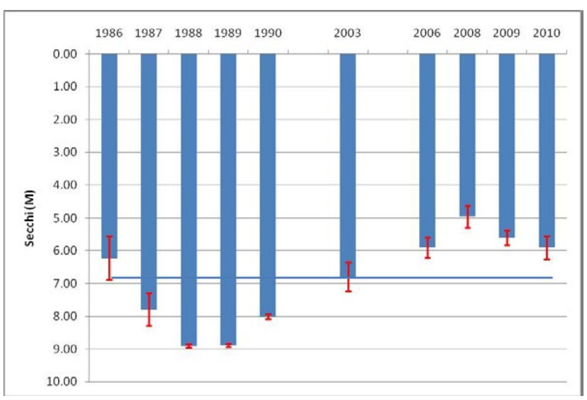


Figure 50. Secchi transparency trends for Trout Lake.

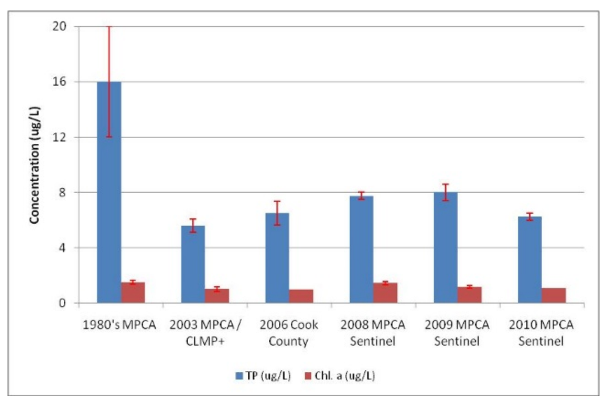


Figure 51. Long-term total phosphorus and chlorophyll-a data for Trout Lake.

Table 15. Aquatic life and recreation assessments on stream reaches: Devil Track River subwatershed. Reaches are organized upstream to downstream in the table.

AUID *ReachName* Reach Description	Biological Station ID	Reach Length (miles)	Use Class	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia - NH3	Pesticides***	Eutrophication: Phosphorus	Response Indicator	**Aquatic Life**	**Aquatic Rec. (Bacteria)**
04010101-601 ***Junco Creek*** Junco Lk to Devil Track Lk	13LS006	3.9	CWg	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--	SUP	--
04010101-717 ***Elbow Creek*** Unnamed cr to Devil Track R	05LS005	0.8	CWe	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--	SUP	--
04010101-566 ***Little Devil Track River*** Unnamed cr to Devil Track R	97LS073	2.7	CWe	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--	SUP	--
04010101-D61 ***Woods Creek*** -90.2650 47.7964 to Devil Track R	13LS052 14LS400 15LS059	1.8	CWe	MTS	MTS	IF	--	--	--	IF	IF	--	IF	--	SUP	--
04010101-D79 ***Devil Track River*** Devil Track Lk to Unnamed cr	13LS040 13LS046 15LS057	6.6	CWe	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--	SUP	--
04010101-D80 ***Devil Track River*** Unnamed cr to Lk Superior	86LS004	2.0	CWg	MTS	MTS	MTS	IF	IF	MTS	MTS	MTS	--	MTS	--	SUP	SUP
04010101-532 ***Kimball Creek*** Headwaters to Lk Superior	13LS011	9.0	CWe	MTS	MTS	MTS	MTS	MTS	MTS	MTS	MTS	--	MTS	--	SUP	SUP
04010101-D53 ***Kadunce River (Kadunce Creek)*** -90.1484 47.8261 to Lk Superior	13LS050	2.7	CWe	MTS	MTS	IF	MTS	MTS	MTS	MTS	MTS	--	MTS	--	SUP	SUP

Abbreviations for Indicator Evaluations: **---** = No Data, **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use; = insufficient information.
Abbreviations for Use Class: **WWg** = warmwater general, **CWg** = Coldwater general, **CWe** = Coldwater exceptional, *Assessments completed using proposed use classifications changes not yet written into rule

Table 16. Minnesota Stream Habitat Assessment (MSHA): Devil Track River subwatershed.

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate 0-27	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	13LS006	Junco Creek	5.0	12.0	22.0	15.0	32.0	86.0	Good
1	05LS005	Elbow Creek	5.0	14.0	22.0	13.0	23.0	77.0	Good
2	97LS073	Little Devil Track River	5.0	13.5	21.5	13.0	30.0	83.0	Good
3	13LS052	Woods Creek	4.2	10.2	25.0	8.7	17.3	65.3	Fair
1	14LS400	Woods Creek	5.0	12.5	24.0	9.0	24.0	74.5	Good
2	15LS059	Woods Creek	5.0	12.0	25.0	11.5	22.5	76.0	Good
1	13LS040	Devil Track River	5.0	14.5	21.2	17.0	28.0	85.7	Good
1	13LS046	Devil Track River	3.5	13.0	23.5	13.0	22.0	75.0	Good
1	15LS057	Devil Track River	5.0	10.0	20.0	13.0	24.0	72.0	Good
2	86LS004	Devil Track River	5.0	12.0	20.6	9.5	28.5	75.6	Good
1	13LS011	Kimball Creek	5.0	14.0	19.8	10.0	30.0	78.8	Good
1	13LS050	Kadunce River	5.0	15.0	25.0	13.0	32.0	90.0	Good
Average Habitat Results: *Devil Track River Subwatershed*			4.8	12.7	22.5	12.1	26.1	78.2	Good

Qualitative habitat ratings

= Good: MSHA score above the median of the least-disturbed sites (MSHA>66)
= Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)
= Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

Table 17. Outlet water chemistry results: Devil Track River (Devil Track River subwatershed).

Station location:	**Devil Track River, 2.5 miles NE of Grand Marais**						
STORET/EQuIS ID:	**S000-909**						
Station #:	0401010105-01, Devil Track River						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**WQ Standard[1]**	**# of WQ Exceedances[2]**
Ammonia-nitrogen	ug/L	14	0.05	3.6	0.5	16	0
Chloride	mg/L	10	1	1.8	1.4	230	0
Dissolved Oxygen	mg/L	39	8.8	12.7	10.1	7	0
pH		42	6.9	8	7.5	6.5 – 8.5	0
Secchi Tube	100 cm	42	10	100	78	> 55	4
Total suspended solids	mg/L	31	1	105	11	10	6
Phosphorus	ug/L	20	5	117	22	50	3
Chlorophyll-a, Corrected	ug/L	0				7	
Escherichia coli (geometric mean)	MPN/100ml	9	7	12	10	126	0
Escherichia coli	MPN/100ml	9	3	15	8	1260	0
Inorganic nitrogen (nitrate and nitrite)	mg/L	10	0.05	0.2	0.1		
Kjeldahl nitrogen	mg/L	10	0.3	0.6	0.4		
Orthophosphate	ug/L	0					
Pheophytin-a	ug/L	0					
Specific Conductance	uS/cm	42	31	96	53		
Temperature, water	deg °C	42	1.1	20.8	14.8		
Sulfate	mg/L	10	<3	<3	<3		
Hardness	mg/L	10	19.6	45.6	27.1		

[1]Secchi Tube standards are surrogate standards derived from the total suspended solids standard of 10 mg/L.

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Devil Track River Subwatershed, a component of the IWM work conducted between May and September from [2013-2014]. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Table 18. Outlet water chemistry results: Kimball Creek (Devil Track River subwatershed).

Station location:	**Kimball Creek, E of Grand Marais, at US-61**						
STORET/EQuIS ID:	**S000-865**						
Station #:	0401010105-01, Kimball Creek						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**WQ Standard[1]**	**# of WQ Exceedances[2]**
Ammonia-nitrogen	ug/L	10	0.03	2.4	0.6	16	0
Chloride	mg/L	10	1.1	1.9	1.4	230	0
Dissolved Oxygen	mg/L	18	8.5	12.2	10.4	7	0
pH		19	7.1	8.4	7.7	6.5 – 8.5	0
Secchi Tube	100 cm	18	56	>100	>100	> 55	0
Total suspended solids	mg/L	10	1	3	1.8	10	0
Phosphorus	ug/L	10	7	20	11	50	0
Chlorophyll-a, Corrected	ug/L	0				7	
Escherichia coli (geometric mean)	MPN/100ml	15	3	13	6	126	0
Escherichia coli	MPN/100ml	15	<1	613	55	1260	0
Inorganic nitrogen (nitrate and nitrite)	mg/L	10	0.05	0.2	0.1		
Kjeldahl nitrogen	mg/L	10	0.5	1.4	0.8		
Orthophosphate	ug/L	0					
Pheophytin-a	ug/L	0					
Specific Conductance	uS/cm	18	2	117	62		
Temperature, water	deg °C	19	9.3	19.3	14.5		
Sulfate	mg/L	10	<3	<3	<3		
Hardness	mg/L	10	18.5	52.8	35.8		

[1]Secchi Tube standards are surrogate standards derived from the total suspended solids standard of 10 mg/L.

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Kimball Creek minor watershed, a component of the IWM work conducted between May and September from [2013-2014]. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Table 19. Outlet water chemistry results: Kadunce River (Devil Track River subwatershed).

Station location:	Kadunce River, NE of Grand Marais, at US-61						
STORET/EQuIS ID:	S000-864						
Station #:	0401010105-01, Kadunce River						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**WQ Standard[1]**	**# of WQ Exceedances[2]**
Ammonia-nitrogen	ug/L	15	0.03	1.2	0.03	16	0
Chloride	mg/L	15	1.5	2.5	2	230	0
Dissolved Oxygen	mg/L	25	6.2	10.1	8	7	2
pH		29	6.5	8.3	7.3	6.5 – 8.5	0
Secchi Tube	100 cm	31	85	>100	>100	> 55	0
Total suspended solids	mg/L	15	<1	4	1.8	10	0
Phosphorus	ug/L	15	7	22	14	50	0
Chlorophyll-a, Corrected	ug/L	0				7	
Escherichia coli (geometric mean)	MPN/100ml	24	4	24	14	126	0
Escherichia coli	MPN/100ml	24	7	488	91	1260	0
Inorganic nitrogen (nitrate and nitrite)	mg/L	15	0.03	0.2	0.07		
Kjeldahl nitrogen	mg/L	15	0.4	1.3	0.7		
Orthophosphate	ug/L	0					
Pheophytin-a	ug/L	0					
Specific Conductance	uS/cm	26	40	106	72		
Temperature, water	deg °C	29	10.1	24.2	17.8		
Sulfate	mg/L	15	<3	<3	<3		
Hardness	mg/L	15	18.8	48.1	34.5		

[1]Secchi Tube standards are surrogate standards derived from the total suspended solids standard of 10 mg/L.

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Kadunce River minor watershed, a component of the IWM work conducted between May and September from [2013-2014]. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Table 20. Lake assessments: Devil Track River subwatershed.

Name	DNR Lake ID	Area (acres)	Trophic Status	% Littoral	Max. Depth (m)	Mean Depth (m)	CLMP Trend	Mean TP (µg/L)	Mean chl-a (µg/L)	Mean Secchi (m)	AQR Support Status	AQL Support Status
Binagami	16-0098-00	114	M		5		NT	15.6	5.0	2.2	FS	NA
Boys	16-0044-00	24	O	100	4		NT	11.6	2.2	2.4	FS	NA
Devil Track	16-0143-00	1828	M	34	15	7	D	12.3	4.1	3.1	FS	IF
Elbow	16-0096-00	380	M	100	3		NT	19.2	6.0	1.2	FS	IF
Kemo	16-0188-00	192	O	23	21		NT	7.7	3.6	4.3	FS	NA
Kimball	16-0045-00	79	O	95	5		NT	11.8	3.0	3.7	FS	NA
Mink	16-0046-00	57	M	100	5		NT	13.6	3.6	3.1	FS	NA
Musquash	16-0104-00	131	O	47	8		NT	7.0	2.0	3.5	FS	NA
Pine	16-0194-00	95	O	49	10		NT	5.7	3.0	3.6	FS	NA
Trout	16-0049-00	258	O	23	23	10	NT	7.0	1.4	5.4	FS	IF

Abbreviations:

D -- Decreasing/Declining Trend
I -- Increasing/Improving Trends
NT – No Trend

E - Eutrophic
M – Mesotrophic
O – Oligotrophic

FS – Full Support
NS – Non-Support
IF – Insufficient Information

Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use
* = assessment-level transparency dataset collected via remote sensing

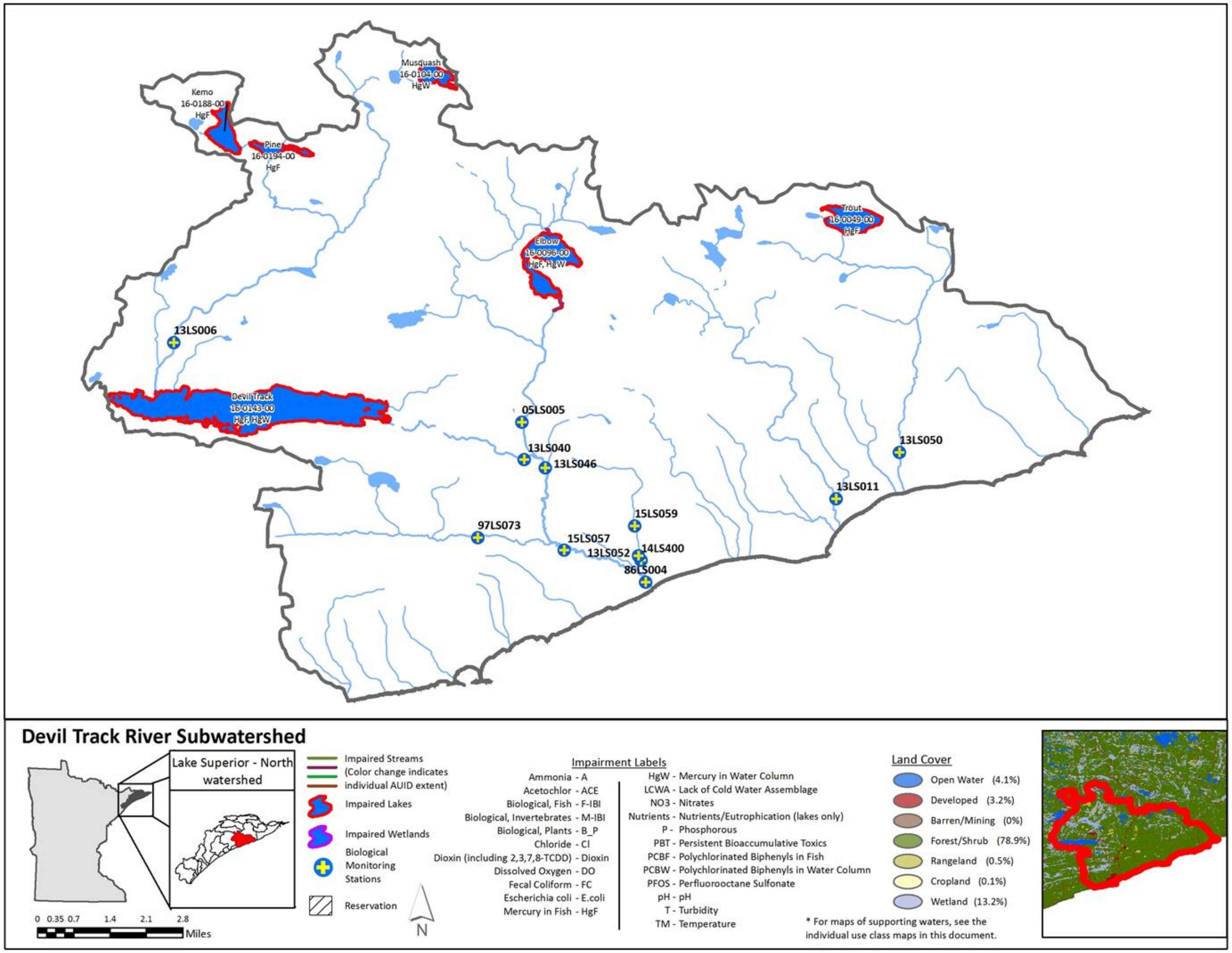


Figure 52. Devil Track River subwatershed, currently listed impaired waters (by parameter) and land use characteristics.

Cascade River subwatershed HUC 0401010106

The Cascade River subwatershed drains approximately 137 square miles of Cook County, a landscape that encompasses Minnesota's highest point (Eagle Mountain) and lowest elevation (Lake Superior). It includes 53 lakes, seven of which are greater than 100 acres in size. Cascade River is the major watercourse, draining approximately 112 square miles at its confluence with Lake Superior; the rest of the watershed is drained by small direct tributaries to Lake Superior. Several lakes southeast of Brule Lake form the headwaters of the north Branch of the Cascade River, while Cascade Lake is the origin of the Cascade River mainstem. As the river flows south towards Lake Superior, it picks up several tributaries and flows through Cascade River State Park for its final 3.5 miles.

Land cover within the subwatershed is almost entirely forest and wetland, with a small proportion of open water. Development is sparse, mostly restricted to resorts, residences, and state park facilities along Minnesota Highway 61, though some residential development and a few farms are found in the eastern part of the subwatershed, along Cook County Highway 7. More than 90% of lands within the subwatershed are in public ownership, most under federal administration. Private lands are clustered immediately west of Grand Marais, mostly in the headwaters of Cut Face Creek and other small direct tributaries to Lake Superior.

Cascade River subwatershed summary

Aquatic life and recreation indicators for lakes, rivers and streams of the Cascade River Subwatershed consistently reflected good-to-excellent water quality. FIBI and MIBI scores were high, and streams were characterized by low levels of sediment, nutrients, and bacteria. Two streams (Cascade River, Spruce Creek) met exceptional use biocriteria based on FIBI and MIBI scores; protection strategies should be developed for these outstanding stream resources. Lakes were characterized by low levels of nutrients and algae, though shoreline development is increasing on some lakes and may result in associated impacts to water quality. Lake transparency appears to be declining in Deer Yard Lake. The subwatershed includes one Lake Superior beach (Cut Face Creek Wayside Rest), where bacteria levels were consistently low and met aquatic recreation standards.

Figure 53. Larval form of *Parapsyche*, a caddisfly listed as "threatened" by the State of Minnesota.

The Cascade River's headwaters include seven lakes that were monitored in the course of this study; in all these lakes, concentrations of total phosphorus, chlorophyll-a, and Secchi transparency were at expected levels for this high quality landscape and indicated mesotrophic conditions (all assessed lakes are Class 2B waters). On the Cascade River, stream fish and macroinvertebrate communities were monitored at three locations between the Thompson Creek confluence and Pike Lake Road. IBI scores were consistently high and met exceptional use biocriteria. Brook Trout and Slimy Sculpin were found at all three stations, and Rainbow Trout were found at the farthest downstream station (95LS012). Pollution-intolerant macroinvertebrates were abundant throughout the Cascade River system. Several highly-sensitive caddisflies were observed (Lepidostoma, Chimarra, Parapsyche, Apatania, Glossosoma), as well as the stonefly Acroneuria and the dragonfly Boyeria grafiana. Parapsyche (Figure 53) is a state-listed as "threatened" and has been found at only a handful of locations across Minnesota. Boyeria grafiana is more widespread, but listed as a "special concern" species. The sensitive organisms found in the Cascade River indicate high-quality habitat, cold, clear water, and well-oxygenated conditions; protection strategies are warranted for this outstanding resource. At an intensive water chemistry monitoring station near Highway 61, no samples exceeded aquatic life standards for suspended sediment, dissolved oxygen, and nutrients. Bacteria levels were consistently low and met aquatic recreation standards.

Nester Creek and Mississippi Creek enter the Cascade River near its midpoint, just upstream of Forest Road 157. Both streams were found to support aquatic life based on FIBI and MIBI scores. Both of these streams' watersheds are mostly undeveloped and heavily-forested, and their waters support Brook Trout and pollution-intolerant insects. The macroinvertebrate community of Mississippi Creek was particularly robust, including high densities of sensitive caddisflies such as Micrasema rusticum and Lepidostoma.

Spruce Creek (also known as Deer Yard Creek) is a direct tributary to Lake Superior entering the lake just west of the Cascade River. The headwater source of the creek, Deer Yard Lake, has a relatively high level of development for this part of the state, mostly cabins and residences clustered along its north shore. Transparency in Deer Yard Lake has been monitored since 1991, and appears to be declining by about one foot per decade, a statistically-significant trend (Figure 54). However, total phosphorus concentrations have remained relatively low and the lake was found to be meeting aquatic recreation standards. Spruce Creek's fish and macroinvertebrate communities were monitored near Highway 61, in Cascade River State Park, where it was found to support Brook Trout and many sensitive macroinvertebrates. IBI scores met exceptional use biocriteria, indicating excellent water quality and habitat conditions.

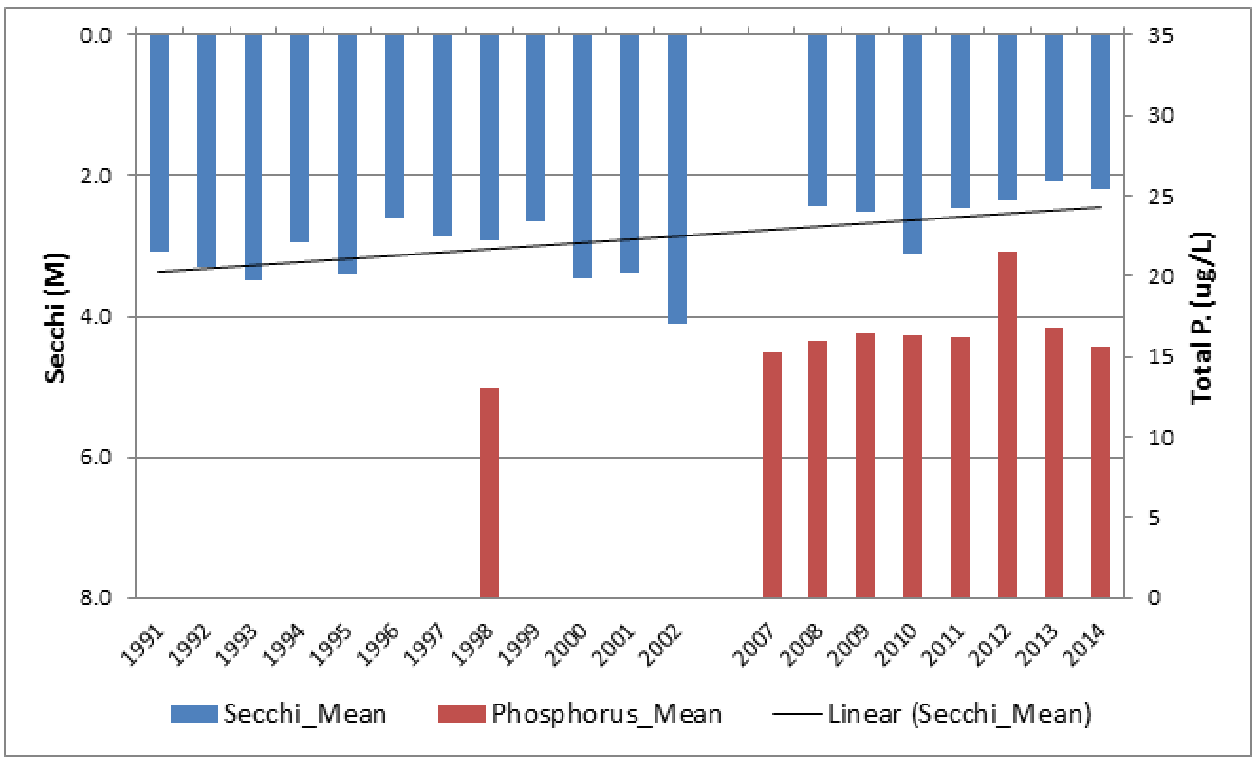


Figure 54. Deer Yard Lake water quality trends, 1991-2014.

Table 21. Aquatic life and recreation assessments on stream reaches: Cascade River subwatershed. Reaches are organized upstream to downstream in the table.

AUID ***ReachName*** Reach Description	**Biological Station ID**	**Reach Length (miles)**	**Use Class**	**Aquatic Life Indicators:** Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia - NH3	Pesticides***	**Eutrophication** Phosphorus	Response Indicator	**Aquatic Life**	**Aquatic Rec. (Bacteria)**
04010101-682 ***Nester Creek*** Headwaters to Cascade R	05LS008	4.9	CWg	MTS	MTS	IF	IF	IF	--	IF	--	--	IF	--	SUP	--
04010101-841 ***Mississippi Creek*** Unnamed cr to Little Mississippi Cr	13LS015	5.5	CWg	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--	SUP	--
04010101-590 ***Cascade River*** N Br Cascade R to Lk Superior	13LS013 95LS012 95LS013	14.4	CWe	MTS	MTS	MTS	MTS	MTS	MTS	MTS	MTS	--	MTS	--	SUP	SUP
04010101-615 ***Spruce Creek (Deer Yard Creek)*** Unnamed cr (Ward Lk outlet) to Lk Superior	13LS012	3.2	CWe	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--	SUP	--

Abbreviations for Indicator Evaluations: **---** = No Data, **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use; = insufficient information.
Abbreviations for Use Class: **WWg** = warmwater general, **CWg** = Coldwater general, **CWe** = Coldwater exceptional, *Assessments completed using proposed use classifications changes not yet written into rule

Table 22. Minnesota Stream Habitat Assessment (MSHA): Cascade River subwatershed.

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate 0-27	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	05LS008	Nester Creek	5.0	15.0	20.8	13.0	25.0	78.8	Good
1	13LS015	Mississippi Creek	5.0	15.0	26.0	16.0	27.0	89.0	Good
1	13LS013	Cascade River	5.0	12.5	21.0	14.0	34.0	86.5	Good
1	95LS012	Cascade River	5.0	13.5	23.6	12.0	25.0	79.1	Good
1	95LS013	Cascade River	5.0	11.5	19.6	12.0	34.0	82.1	Good
1	13LS012	Spruce Creek (Deer Yard Creek)	5.0	11.0	21.8	12.0	20.0	69.8	Good
Average Habitat Results: *Cascade River Subwatershed*			5.0	13.1	22.1	13.2	27.5	80.9	Good

Qualitative habitat ratings

= Good: MSHA score above the median of the least-disturbed sites (MSHA>66)

= Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)

= Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

Table 23. Outlet water chemistry results: Cascade River subwatershed.

Station location:	**Cascade River SW of Grand Marais, at US-61 bridge**						
STORET/EQuIS ID:	**S000-253**						
Station #:	0401010106-01, Cascade River						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**WQ Standard[1]**	**# of WQ Exceedances[2]**
Ammonia-nitrogen	ug/L	10	< 5	0.9	0.15	16	0
Chloride	mg/L	10	1.6	4.3	2.9	230	0
Dissolved Oxygen	mg/L	19	7	10.8	8.5	7	0
pH		20	6.9	8.3	7.5	6.5 – 8.5	0
Secchi Tube	100 cm	22	55	> 100	93	> 55	0
Total suspended solids	mg/L	10	<1	11	2.8	10	0
Phosphorus	ug/L	10	5	23	13	50	0
Chlorophyll-a, Corrected	ug/L	0				7	
Escherichia coli (geometric mean)	MPN/100ml	17	5	19	11	126	0
Escherichia coli	MPN/100ml	17	7	142	35	1260	0
Inorganic nitrogen (nitrate and nitrite)	mg/L	10	0.03	0.2	0.1		
Kjeldahl nitrogen	mg/L	10	0.3	1.4	0.7		
Orthophosphate	ug/L	0					
Pheophytin-a	ug/L	0					
Specific Conductance	uS/cm	20	33	116	64		
Temperature, water	deg °C	21	8.8	25	18.2		
Sulfate	mg/L	10	<3	<3	<3		
Hardness	mg/L	10	20.8	50.4	35.9		

[1]Secchi Tube standards are surrogate standards derived from the total suspended solids standard of 10 mg/L.

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Cascade River Aggregated 10-HUC, a component of the IWM work conducted between May and September from [2013-2014]. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Table 24. Lake assessments: Cascade River subwatershed.

Name	DNR Lake ID	Area (acres)	Trophic Status	% Littoral	Max. Depth (m)	Mean Depth (m)	CLMP Trend	Mean TP (µg/L)	Mean chl-a (µg/L)	Mean Secchi (m)	AQR Support Status	AQL Support Status
Ball Club	16-0182-00	199	O	81	8	3	NT	10.6	3.4	3.7	FS	NA
Cascade	16-0346-00	467	M	100	6	2	NT	12.8	4.2	2.5	FS	IF
Deer Yard	16-0253-00	338	M		6	4	D	16.7	4.9	2.4	FS	IF
Little Cascade	16-0347-00	260	M	100	3	1	NT	14.1	5.3	1.4	FS	IF
Mark	16-0250-00	129	E		2		NT	31.0			IF	NA
McDonald	16-0235-00	92		100	2		NT				IF	IF
Swamp	16-0256-00	90	M	100	2		NT	16.0	2.9	1.5	NA	NA
Tomash	16-0345-00	94	E	100	1		NT			1.1	IF	NA
Two Island	16-0156-00	750	O	96	8	2	NT	10.5	2.5	2.6	FS	IF
Ward	16-0248-00	38	M	100	4		NT	18.1	3.6	2.0	FS	NA

Abbreviations:
D -- Decreasing/Declining Trend
I -- Increasing/Improving Trends
NT – No Trend
E - Eutrophic
M – Mesotrophic
O – Oligotrophic
FS – Full Support
NS – Non-Support
IF – Insufficient Information

Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use
* = assessment-level transparency dataset collected via remote sensing

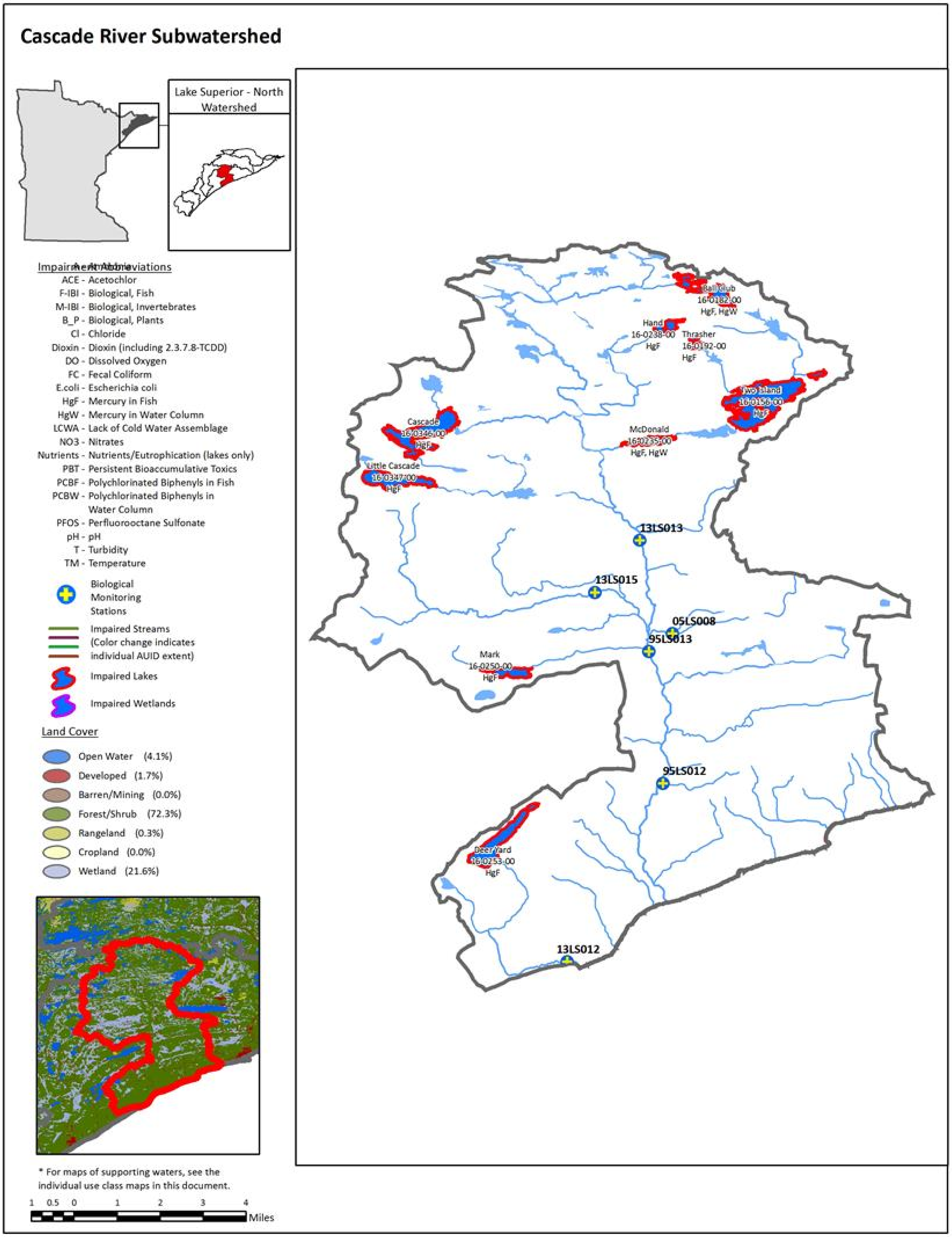


Figure 55. Cascade River subwatershed, currently listed impaired waters (by parameter) and land use characteristics.

Poplar River subwatershed HUC 0401010107

The Poplar River subwatershed drains approximately 393 square miles of Cook County, a small fraction of which lies within the BWCAW. The subwatershed contains 43 lakes, which provide an important source of baseflow to rivers and streams. Poplar River is the major watercourse, draining approximately 113 square miles at its confluence with Lake Superior near Lutsen. The rest of the watershed is drained by direct tributaries to Lake Superior, the largest of which is the Onion River.

Land cover within the subwatershed is mostly forest and wetland, with a small proportion of open water; development is present at moderate levels compared to the Lake Superior – North Watershed as a whole, in the form of small communities (Lutsen, Tofte), residences, resorts, and lakeshore homes. The lower portion of the Poplar River is surrounded by a ski resort, golf course, and development associated with Highway 61. Land ownership is 86% public and 14% private; privately-owned lands are mainly clustered along the lower portion of Poplar River and smaller tributaries, and also around certain lakes, but isolated blocks of private forestland are also found throughout the subwatershed.

Poplar River subwatershed summary

Aquatic life and recreation indicators for lakes, rivers, and streams of the Poplar River subwatershed consistently reflected good water quality. In general, FIBI and MIBI scores were high, and streams were characterized by low levels of sediment, nutrients, and bacteria. One stream (Mistletoe Creek) met exceptional use biocriteria based on FIBI and MIBI scores; protection strategies should be developed for these and other high-quality streams found throughout the subwatershed. The upper portion of the subwatershed, in particular, is lightly-developed and may present excellent opportunities to protect high-quality stream resources. Some streams in this region currently support coldwater biota but may experience stressful summer temperatures. The lower Poplar River has been listed as impaired for aquatic life for several years, based on high levels of suspended sediment. However, recent implementation of best management practices appears to have reduced sediment loads, and biological indicators suggest that water quality is good on this lower reach. The Poplar River subwatershed is lake-rich, and none were found to be impaired for aquatic recreation.

The headwaters of the Poplar River are formed by a series of lakes off of “The Grade” (U.S. Forest Service Road 153). Several of these lakes (Boulder, Crescent, Gust, Lichen) were monitored in the course of this study and were found to be supporting aquatic recreation based on low levels of nutrients and algae. In the short sections of flowing water between these lakes, the Poplar River is considered a warm or cool water stream. As it exits this lake-dominated region, the river is a designated trout stream and flows southeast towards the confluence of several tributaries. Fish and macroinvertebrate communities were monitored at two locations upstream of these tributaries; IBI scores indicated good water quality and habitat conditions. Brook Trout were present at both stations, and many sensitive macroinvertebrates were collected. The macroinvertebrate community at the Barker Lake Road (biomonitoring station 89LS003) was particularly robust, including several sensitive dragonfly and stonefly taxa (e.g., *Boyeria grafiana*, *Cordulegaster, Acroneuria, Isoperla*).

Several tributaries enter the Poplar River about halfway between its headwaters and Lake Superior. Within the span of three river miles, four streams join the Poplar in rapid succession, roughly tripling the river’s drainage area. Tait River, Mistletoe Creek, and Caribou Creek come together in a mostly-roadless, heavily-forested landscape of some 1,800 acres, bordered by the Caribou Trail to the east, the Honeymoon Trail to the north, and the Barker Lake Road to the west. Barker Creek enters upstream of Tait River, draining another lightly-developed, forested catchment. Downstream of this area, the Poplar flows approximately eight miles to Lake Superior without picking up any major tributaries; much of this reach is low-gradient, wetland-influenced, and warmer than the headwaters, which may effectively segregate biological assemblages of the upper and lower Poplar River catchment. The landscape of the upper Poplar River includes many lightly-developed, high-quality lakes and several Brook Trout streams that also support rare, sensitive macroinvertebrates. However, this area has experienced increased development in recent years; protection strategies should ensure that these unique resources are not degraded.

The Tait River drains several lakes, including Christine, Clara, Tait, and White Pine, all of which were found to be supporting aquatic recreation based on low levels of nutrients and algae. Tait Lake is an MPCA/MNDNR Sentinel Lake, and has been intensively monitored since 2009 (MPCA 2012). The stream exits Lake Christine near the Honeymoon Trail and flows south through a remote, forested landscape for less than two miles before entering Mistletoe Creek a short distance upstream of the Poplar River. Tait River appears to have good water quality and in-stream habitat, but thermal conditions may be warmer than that of neighboring streams. Brook Trout are present, though water temperatures were frequently in their "stressful" range during the summer of 2013. Likewise, the macroinvertebrate community includes many sensitive taxa, but few coldwater obligates. The caddisfly *Leucotrichia* is found here, as well as in neighboring streams. This insect prefers cool, clear streams with abundant coarse substrate, and is an indicator of excellent water quality. While it has been found in other regions of Minnesota, the next nearest records are from southern St. Louis County, nearly 100 miles away (Figure 56). This disjunctive population is an example of the of unique, high-quality biological resources that inhabit the upper Poplar River subwatershed.

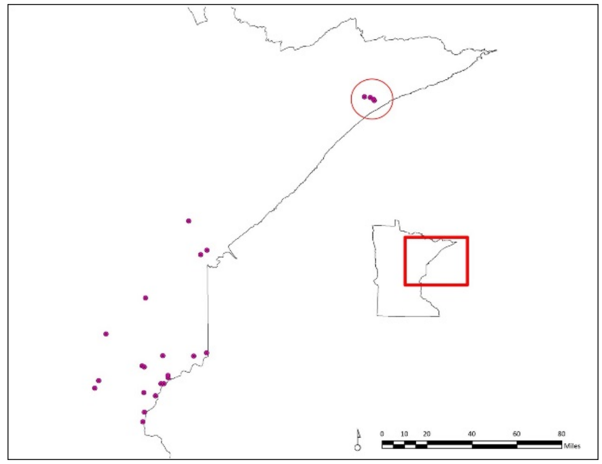


Figure 56. MPCA records of the caddisfly *Leucotrichia*. Note disjunctive population (circled) found in the upper portion of the Poplar River Watershed.

Tait River meets general use biocriteria based on FIBI and MIBI scores, but some of its organisms may be vulnerable to extirpation if additional warming of the stream occurs. The watershed includes several lakes, some of which are also relatively shallow, and these sources of warm surface water likely contribute to the stream's marginal coldwater thermal regime. Maintaining intact riparian zones along the stream (to provide shade) and protection of localized groundwater inputs are likely to be important protection strategies for Tait River.

Mistletoe Creek's watershed includes relatively few lakes; Mistletoe Lake in the creek's headwaters is the only lake larger than 100 acres, and was determined to support aquatic recreation based on low levels of phosphorus and algae. Fish and macroinvertebrate communities of Mistletoe Creek were monitored at the Caribou Trail, where Brook Trout, Mottled Sculpin, and Longnose Dace were present, as well as several macroinvertebrate taxa that require cold, clear water (e.g., *Rhithrogena*, *Rhyacophila*, *Glossosoma, Leucotrichia*). IBI scores met exceptional use biocriteria. Mistletoe Creek appears to be one of the colder streams in this portion of the subwatershed, and may provide thermal refuge for Brook Trout and other stenothermic organisms when temperatures rise in adjacent streams (e.g., Tait River). The lowermost 1.3 miles of Mistletoe Creek flow through privately-owned lands.

Caribou Creek consists of two miles of flowing water between Caribou Lake and the Poplar River, and drains a lake-dominated landscape. Caribou and Pike are the two largest lakes in the subwatershed and have some of the most-intensely developed shorelines in the entire Lake Superior – North Watershed; Caribou Lake has more than 10 docks per mile of shoreline (highest in the HUC-8) while Pike has more than six docks per shoreline mile (ranked 3rd in the HUC-8). Caribou has an extensive water quality dataset with annual transparency data collected since 1976. A robust total phosphorus dataset has also been collected, primarily by the Caribou Lake Property Owners Association. The Association has done extensive work to monitor the lake and the health of its watershed for many years, including working with Cook County on septic system inspections and improvements. Total phosphorus concentrations in Caribou Lake have declined, from near 30 µg/L in the late 1970s to approximately 20 µg/L in recent years (Figure 57). There is no long term trend in Secchi transparency; the long term mean is 2.1 meters, and Caribou Lake meets water quality standards for swimmable use. Agnes Lake, a small, shallow, undeveloped lake that contributes flow to Caribou Creek, slightly exceeded state standards for phosphorus and chlorophyll levels; these exceedances were likely due to natural factors and the lake lacked an assessment-level water quality dataset.

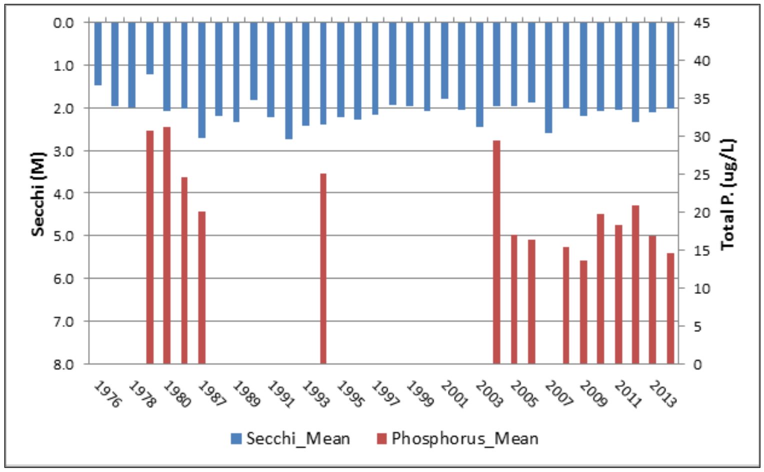


Figure 57. Caribou Lake water quality trends.

Caribou Creek was monitored just downstream of the Caribou Trail crossing, as the creek exits Caribou Lake through a wetland. The stream supports Brook Trout and meets general use biocriteria based on FIBI and MIBI scores, but, like Tait River, water temperatures appear to be marginal for support of coldwater biota. No coldwater obligate macroinvertebrate taxa were recorded (though *Leucotrichia* was present), and water temperatures during the summer of 2013 were in the "stressful" range for Brook Trout nearly half the time. In-stream habitat and riparian conditions surrounding the Caribou Creek biomonitoring site rated among the highest across the entire Lake Superior – North Watershed, yet neither FIBI nor MIBI scores met exceptional use biocriteria for coldwater streams; the creek's thermal regime may be the most likely explanation for these lower-than-expected scores. Caribou Creek enters the Poplar River in a broad, low-gradient valley, where both the creek and river are slow-moving, wetland-influenced, and warmer than upstream reaches. While cooler stream habitats are not far away (e.g. Mistletoe Creek, the upper Poplar River), and could provide a refuge for trout during periods of thermal stress, the cold- and cool water-adapted organisms of Caribou Creek may be sandwiched between unsuitable habitat both upstream and downstream. Much like Tait River, riparian shading and protection of groundwater inputs are likely to be critical protection strategies for Caribou Creek. Because the creek is so closely connected to Caribou Lake, continuing to maintain good water quality in the lake may also be an important strategy for maintaining biological integrity of the creek. Finally, a large gravel pit is located on the north side of Caribou Creek; while the stream remains buffered by approximately 100 meters of relatively intact riparian forest, surface-groundwater interactions may be affected by this local disturbance.

The lower Poplar River was monitored in two locations. Macroinvertebrates were collected at a remote snowmobile trail crossing approximately two miles upstream of where the river begins to make its steep descent to Lake Superior. In 2013, the river at this location was wide, rocky, and deep, making sampling difficult, but the M-IBI score indicated good water quality and sensitive insects were present (*Nigronia*, *Lepidostoma*, *Baetis tricaudatus, Glossosoma*). Fish were not sampled in 2013 due to high flows, but more recent monitoring indicates that Brook Trout, Mottled Sculpin, and other sensitive fishes utilize this reach of the Poplar River. Water temperatures at this location were warmer than at the next upstream biomonitoring station on the Poplar River (89LS003), likely reflecting extensive low-gradient, wetland-influenced reaches between the two sites.

Closer to Lake Superior, a "10x" intensive water chemistry station was established on Superior National Golf Course, at a location that has been monitored by MPCA and partners since 2005. The dataset confirmed the existing turbidity/TSS impairment as 13 of 63 samples exceeded the 10 mg/L Class 2A water quality standard. A smaller proportion of Secchi tube samples exceeded a TSS surrogate standard of 55 cm. Erosion and suspended sediment have been recognized as issues in the lower Poplar River for many years. Landowners and local resource managers have pursued BMPs for sediment mitigation concurrently with TMDL investigative studies. These BMPs appear to have resulted in improved water quality conditions in the Poplar River, and a continued decrease in sediment loading should be expected. An analysis of estimated daily TSS concentrations from load monitoring calculations during the period April through September indicates that the percent of days exceeding the TSS water quality standard decreased from nearly 30% prior to BMP implementation to about 9% following implementation (Figure 58).

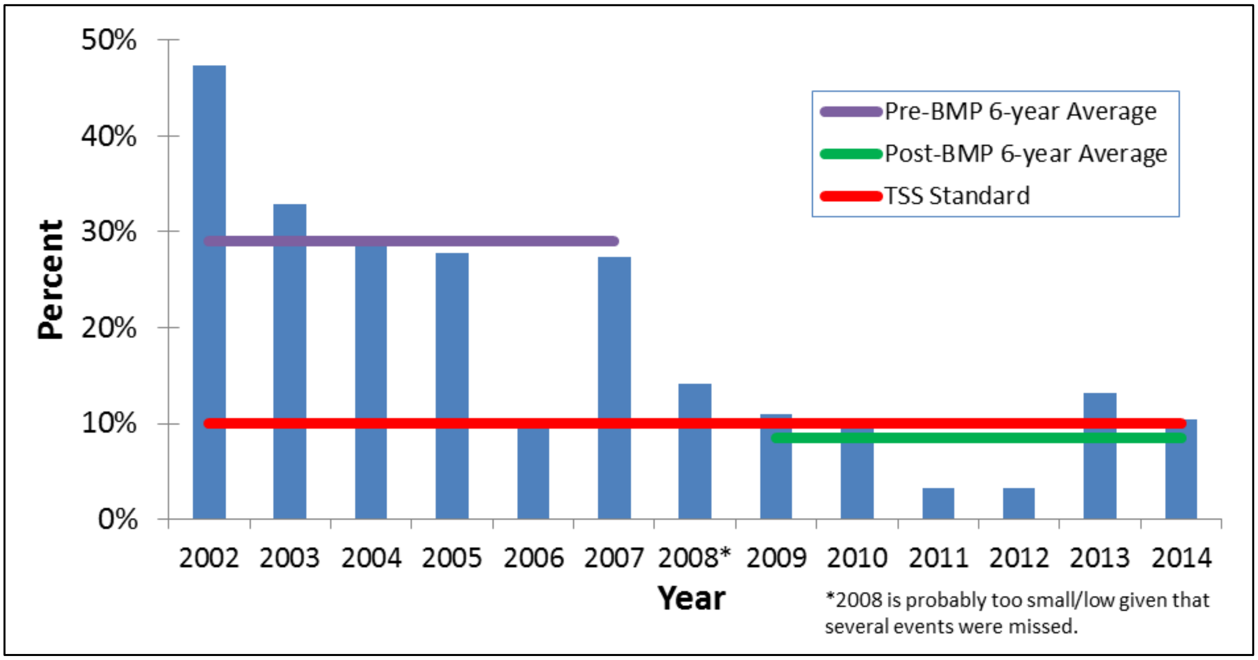


Figure 58. Poplar River, percent exceedance of 2A TSS standard, based on estimated daily April-September concentrations, 2002-2014.

Other conventional water chemistry parameters such as phosphorus, nitrogen, and pH indicated good water quality in the Poplar River. No bacteria samples exceeded standards, and the stream was assessed as full supporting aquatic recreation. Fish and macroinvertebrate communities indicated generally good water quality and aquatic habitat; Brook Trout were present as were several sensitive and stenothermic insects (e.g., *Rhithrogena*, *Epeorus*, *Glossosoma*, *Nigronia*).

The Onion River drains approximately nine square miles west of the Poplar River, entering Lake Superior though a steep canyon at Ray Berglund State Wayside. A barrier falls located 0.25 miles upstream of Lake Superior prevents fish migration into headwater reaches. The watershed is lightly developed and nearly entirely administered by Superior National Forest. Onion River Road represents the only development in the watershed, a gravel surface used to access hiking, ski, and snowmobile trails. An intensive water chemistry monitoring station was established at a snowmobile trail crossing near the Onion River Road, where water quality was excellent. Concentrations of bacteria, nutrients, sediment, and ions were consistently low (there were two minor exceedances of the Secchi tube standard).

Bacteria levels were consistently low, and clearly indicated full support for aquatic recreational use. Fish and macroinvertebrate communities were monitored a short distance upstream, off of the Superior Hiking Trail. At this location, IBI scores met general use biocriteria, indicating good water quality and habitat conditions. Brook Trout and Pearl Dace were the only fish species observed, and several sensitive macroinvertebrate taxa were collected (e.g., *Chimarra*, *Glossosoma*, *Acroneuria*, *Epeorus*). While the stream's watershed is almost completely forested and undeveloped, it contains no lakes and experiences low late summer baseflows. Low flows and warm summer temperatures may be sources of stress for the Onion River's Brook Trout and stenothermic macroinvertebrates. Because the upper reaches of the Onion are hydrographically isolated, these communities may be at particularly vulnerable to extirpation. Most of the Onion River's watershed remains roadless, forested, and administered by Superior National Forest; protection strategies should focus on maintaining forest characteristics that protect baseflows and provide shade to the stream and its tributaries.

Table 25. Aquatic life and recreation assessments on stream reaches: Poplar River subwatershed. Reaches are organized upstream to downstream in the table.

AUID *ReachName* Reach Description	Biological Station ID	Reach Length (miles)	Use Class	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia - NH3	Pesticides***	Eutrophication: Phosphorus	Response Indicator	**Aquatic Life**	**Aquatic Rec. (Bacteria)**
04010101-592 ***Poplar River*** T61 R4W S10, north line to Mistletoe Cr	89LS003 97LS102	13.8	CWg	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--	SUP	--
04010101-567 ***Tait River*** Christine Lk to Mistletoe Cr	13LS054	1.8	CWg	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--	SUP	--
04010101-536 ***Mistletoe Creek*** Halls Pond to Poplar R	97LS101	4.6	CWe	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--	SUP	--
04010101-614 ***Caribou Creek*** Caribou Lk to Poplar R	13LS016	2.2	CWg	MTS	MTS	IF	IF	IF	--	IF	--	--	IF	--	SUP	--
04010101-612 ***Poplar River*** Mistletoe Cr to Superior Hiking Trail bridge	13LS014	5.5	CWg	--	MTS	MTS	MTS	MTS	MTS	MTS	--	--	MTS	--	SUP	SUP
04010101-613 ***Poplar River*** Superior Hiking Trail bridge to Lk Superior	13LS056	2.8	CWg	MTS	MTS	MTS	EXS	EXS	MTS	MTS	MTS	--	MTS	--	IMP	SUP
04010101-535 ***Onion River*** Headwaters to Lk Superior	13LS047	6.1	CWg	MTS	MTS	MTS	MTS	MTS	MTS	MTS	MTS	--	MTS	--	SUP	SUP

Abbreviations for Indicator Evaluations: **---** = No Data, **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use; = insufficient information.
Abbreviations for Use Class: **WWg** = warmwater general, **CWg** = Coldwater general, **CWe** = Coldwater exceptional, *Assessments completed using proposed use classifications changes not yet written into rule

Table 26. Minnesota Stream Habitat Assessment (MSHA): Poplar River subwatershed.

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate 0-27	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	13LS047	Onion River	5.0	11.5	22.8	15.0	31.0	85.3	Good
1	97LS101	Mistletoe Creek	5.0	12.0	22.0	13.0	29.0	81.0	Good
1	13LS054	Tait River	5.0	13.0	24.0	14.0	25.0	81.0	Good
1	89LS003	Poplar River	5.0	12.0	18.0	13.0	34.0	82.0	Good
1	97LS102	Poplar River	5.0	11.0	25.4	8.0	22.0	71.4	Good
2	13LS056	Poplar River	3.5	9.5	25.5	13.0	18.0	69.5	Good
1	13LS016	Caribou Creek	5.0	15.0	26.0	14.0	30.0	90.0	Good
Average Habitat Results: *Poplar River Subwatershed*			4.8	12.0	23.4	12.9	27.0	80.0	Good

Qualitative habitat ratings

- = Good: MSHA score above the median of the least-disturbed sites (MSHA>66)
- = Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)
- = Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

Table 27. Outlet water chemistry results: Poplar River subwatershed.

Station location:	**Poplar River at Golf Course Bridge, near Lutsen, MN**						
STORET/EQuIS ID:	**S004-406**						
Station #:	0401010107-01, Poplar River						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**WQ Standard[1]**	**# of WQ Exceedances[2]**
Ammonia-nitrogen	ug/L	21	0.001	6.1	0.6	16	0
Chloride	mg/L	21	0.6	1.3	0.9	230	0
Dissolved Oxygen	mg/L	35	7.8	11.9	9.3	7	0
pH		35	6.6	8.2	7.1	6.5 – 8.5	0
Secchi Tube	100 cm	52	18	>100	80	> 55	6
Total suspended solids	mg/L	63	1.2	41	7.9	10	13
Phosphorus	ug/L	35	3	46	14	50	0
Chlorophyll-a, Corrected	ug/L	12	0.4	1.1	0.7	7	0
Escherichia coli (geometric mean)	MPN/100ml	26	23	34	32	126	0
Escherichia coli	MPN/100ml	26	1	200	37	1260	0
Inorganic nitrogen (nitrate and nitrite)	mg/L	50	0.06	0.8	0.3		
Kjeldahl nitrogen	mg/L	20	0.3	0.8	0.5		
Orthophosphate	ug/L	21	<5	<5	<5		
Pheophytin-a	ug/L	12	0.1	4.6	1.1		
Specific Conductance	uS/cm	30	48	83	58		
Temperature, water	deg °C	35	4.2	24.9	16.5		
Sulfate	mg/L	21	1.7	3.4	2.5		
Hardness	mg/L	22	12.6	37	24.1		

[1]Secchi Tube standard is a surrogate for the total suspended solids standard of 10 mg/L.

****Values in the table were compiled from data collected between May and September of 2013 and 2014, at the Poplar River Subwatershed outlet. This work was a component of Intensive Watershed Monitoring, but data from other locations on this water body may also have been used in the assessment process.**

Table 28. Outlet water chemistry results: Onion River.

Station location:	Onion River, W. of Forest Road 336, 8 miles SE of Tofte, MN						
STORET/EQuIS ID:	S007-415						
Station #:	0401010107-01, Onion River						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**WQ Standard[1]**	**# of WQ Exceedances[2]**
Ammonia-nitrogen	ug/L	11	0.01	0.7	0.3	16	0
Chloride	mg/L	11	<1	1.5	1.1	230	0
Dissolved Oxygen	mg/L	16	8.4	22	11.7	7	0
pH		19	7.1	8.2	7.7	6.5 – 8.5	0
Secchi Tube	100 cm	19	30	>100	71	> 55	2
Total suspended solids	mg/L	11	<1	3	1.5	10	0
Phosphorus	ug/L	11	13	20	16	50	0
Chlorophyll-a, Corrected	ug/L	0				7	
Escherichia coli (geometric mean)	MPN/100ml	15	8	22	13	126	0
Escherichia coli	MPN/100ml	15	1	816	79	1260	0
Inorganic nitrogen (nitrate and nitrite)	mg/L	11	0.03	0.5	0.1		
Kjeldahl nitrogen	mg/L	11	0.4	1.6	0.8		
Orthophosphate	ug/L	0					
Pheophytin-a	ug/L	0					
Specific Conductance	uS/cm	19	34	440	74		
Temperature, water	deg °C	19	2.4	22.1	14.8		
Sulfate	mg/L	11	<3	<3	<3		
Hardness	mg/L	11	18.3	42.2	28.8		

[1]Secchi Tube standard is a surrogate for the total suspended solids standard of 10 mg/L.

****Values in the table were compiled from data collected between May and September of 2013 and 2014, at the Onion River minor watershed outlet. This work was a component of Intensive Watershed Monitoring, but data from other locations on this water body may also have been used in the assessment process.**

Table 29. Lake assessments: Poplar River subwatershed.

Name	DNR Lake ID	Area (acres)	Trophic Status	% Littoral	Max. Depth (m)	Mean Depth (m)	CLMP Trend	Mean TP (µg/L)	Mean chl-a (µg/L)	Mean Secchi (m)	AQR Support Status	AQL Support Status
Agnes	16-0359-00	66	E	100	2		NT	31.2	9.9	0.6	IF	NA
Barker	16-0358-00	147	M	98	5		NT	20.5	4.6	0.9	FS	NA
Bigsby	16-0344-00	97	M	100	1		NT	18.6	2.4	1.3	IF	NA
Bouder	16-0383-00	125	E	98	5		NT	24.2	5.9	1.2	FS	NA
Caribou	16-0360-00	718	M	59	9	4	NT	17.8	7.6	2.1	FS	NA
Christine	16-0373-00	193	M	100	2		NT	16.3	3.9	1.6	FS	NA
Clara	16-0365-00	393	M	100	5		NT	15.6	4.3	2.5	FS	IF
Crescent	16-0454-00	746	M		8	3	NT	16.5	6.3	2.5	FS	IF
Gust	16-0380-00	140	M	100	2		NT	19.8	4.1	1.3	FS	NA
Holly	16-0366-00	75	E	100	2		NT			1.5	IF	NA
Lichen	16-0382-00	267	M	97	5		NT	17.8	5.6	1.1	FS	NA
Mistletoe	16-0368-00	146	M	100	2		NT	15.2	3.9	1.1	FS	NA
Pike	16-0252-00	811	O	35	12	7	NT	8.5	2.1	5.7	FS	IF
Tait	16-0384-00	354	O	100	5	2	NT	11.8	4.0	2.3	FS	IF
White Pine	16-0369-00	331	M	100	2		NT	18.7	5.2	1.8	FS	NA

Abbreviations:
D -- Decreasing/Declining Trend
I -- Increasing/Improving Trends
NT – No Trend
E - Eutrophic
M – Mesotrophic
O – Oligotrophic
FS – Full Support
NS – Non-Support
IF – Insufficient Information

Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use
* = assessment-level transparency dataset collected via remote sensing

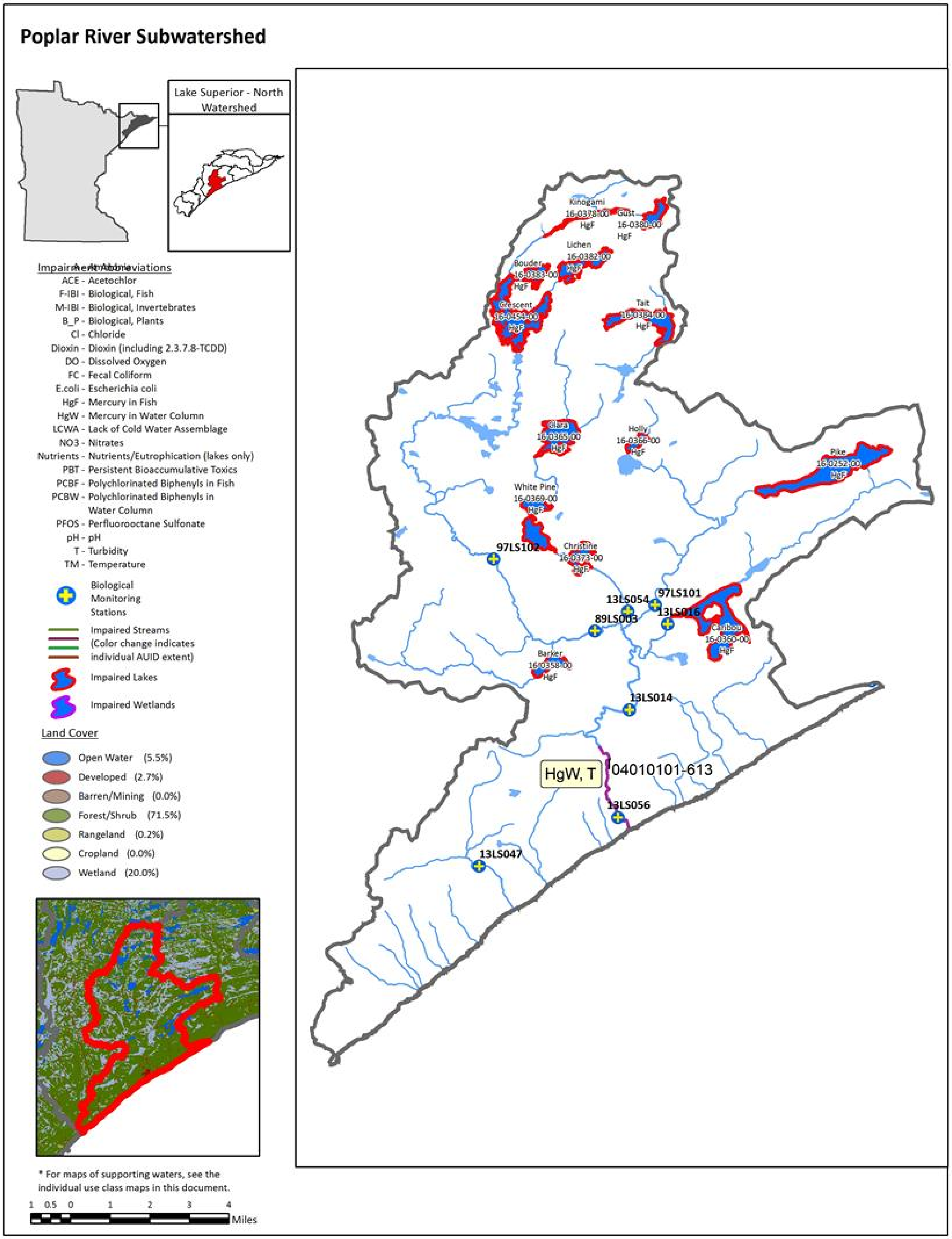


Figure 59. Poplar River subwatershed, currently listed impaired waters (by parameter) and land use characteristics.

Temperance River subwatershed HUC 0401010108

The Temperance River 10-HUC drains approximately 184 square miles of Cook County and includes 66 lakes, of which 16 are greater than 100 acres in size. Alton and Sawbill are the largest lakes, covering 1,076 and 944 acres, respectively. Temperance River is the major watercourse, originating in BWCAW lakes and flowing south towards Lake Superior. Upper reaches of the Temperance River flow through lakes and ponds, alternating between low-gradient reaches and short sections of rapids. Several tributaries contribute flow in this upper section, including Vern River, Pipe Creek, Kelso River, Burnt Creek, and Sawbill Creek. Many of these upper tributaries are entirely within the BWCAW. The middle section of Temperance River is characterized by frequent moderate-grade rapids and riffles, with fewer pooled sections. Tributaries to this portion of the Temperance include Plouff Creek, Torgerson Creek, and Pancake Creek. The lower section of the Temperance River is high-gradient, flowing through a broad valley that narrows to a gorge in Temperance River State Park, before entering Lake Superior between Schroeder and Tofte. Tributaries to this lower section include Sixmile Creek, Blind Temperance Creek, and Heartbreak Creek.

The Temperance River subwatershed has less development than its neighboring subwatershed to the east (Poplar River), limited to a few scattered residences, seasonal cabins, and campgrounds. Forest and wetland are the dominant land cover types, and open water makes up most of the remaining area. Approximately 98% of the subwatershed is in public ownership, and 35% is within the BWCAW.

Temperance River subwatershed summary

Aquatic life and recreation indicators for lakes, rivers, and streams of the Temperance River subwatershed consistently reflected good water quality. In general, FIBI and MIBI scores were high, and streams were characterized by low levels of sediment, nutrients, and bacteria. An upper reach of the Temperance River met exceptional use biocriteria based on FIBI and MIBI scores, as did two tributaries (Heartbreak Creek, Sixmile Creek); protection strategies should be developed for these and the other high-quality aquatic resources found throughout the subwatershed. Five lakes in the subwatershed were assessed as supporting aquatic recreation based on high water clarity and low levels of nutrients and algae. The subwatershed includes one Lake Superior beach (at Temperance River State Park); bacteria levels were consistently low, indicating support for aquatic recreation.

The Temperance River's headwaters are lake-dominated. Two BWCAW lakes (Whack, North Temperance) supported aquatic recreation based on satellite-derived transparency data, while three other headwater lakes (Alton, Homer, Star) were assessed based on field-collected data. Alton Lake was monitored in 2014-2015 as part of a special project on heavily-used BWCAW lakes. Water quality was excellent; phosphorus concentrations were low and Secchi transparency averaged 4.1 meters. Transparency in Homer Lake appears to be relatively stable, and has increased slightly in recent years (Figure 60). Other BWCAW lakes have been sporadically monitored by volunteers; in general, transparency in these lakes is at expected levels.

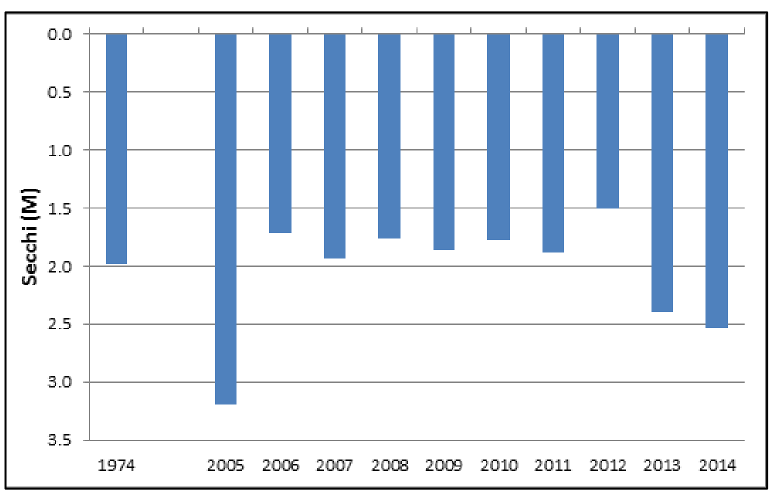


Figure 60. Homer Lake transparency (Secchi depth), 2005-2014.

Plouff Creek was the uppermost Temperance River tributary monitored in the course of this study. The creek enters the Temperance River from the west, draining a remote, wetland-dominated landscape south of Alton Lake. Plouff was monitored just downstream of the Sawbill Trail, and was found to support Brook Trout and Mottled Sculpin, the presence of which indicate good water quality, cold temperatures, and excellent habitat conditions. Likewise, the macroinvertebrate community included several sensitive taxa, including some stenothermic insects (*Isoperla*, *Rhyacophila*, *Heterotrissocladius*). The macroinvertebrate fauna of Plouff Creek appears to be particularly rich in caddisfly taxa; 19 different genera have been recorded from the Sawbill Trail site. Fish and macroinvertebrate IBI scores indicated support for aquatic life, but it should be noted that some sensitive taxa that were present in the late 1990s have not been observed in recent years (e.g., Longnose Dace, *Glossosoma*, *Acroneuria*, *Boyeria*). Beaver activity is prevalent along most of Plouff Creek, and likely is a strong determinant of habitat and temperature conditions, which in turn play an important role in structuring biotic communities.

The upper Temperance River was monitored just west of the Sawbill Trail, near the USFS Temperance River Campground. At this location, the river supports Brook Trout, Slimy Sculpin, and other sensitive fish species. The macroinvertebrate assemblage also indicated excellent water quality, supporting sensitive and stenothermic insects (*Boyeria grafiana*, *Epeorus*, *Glossosoma*, *Chimarra*). Fish and macroinvertebrate IBI scores met exceptional use biocriteria on this highly scenic stretch of the river.

Several miles downstream, Sixmile Creek enters the Temperance River from the east, draining a mostly-undisturbed landscape of wetland and forest. The creek supports Brook Trout and Mottled Sculpin, as well as many sensitive macroinvertebrates (*Chimarra*, *Glossosoma*, *Epeorus*); IBI scores met exceptional use biocriteria. Near the confluence of the two streams, Sixmile Creek is substantially colder than the Temperance River. In addition to contributing cold water to the Temperance, the creek itself likely provides important thermal refugia for trout and other stenothermic organisms when temperatures in the mainstem river reach stressful levels. Cold tributaries like Sixmile Creek are important components of larger rivers' biological integrity, and should be included in protection strategies for these larger systems.

The Temperance River was monitored near the Sixmile Creek confluence, at the Forest Road 166 ("600 Road") crossing. An intensive water chemistry monitoring station indicated excellent water quality; concentrations of nutrients, sediment, dissolved ions, and bacteria were consistently low, with only a few minor exceedances of the pH water quality standard (Table 32). Biological communities also indicated a high-quality resource; FIBI and MIBI scores either met exceptional use biocriteria or rated just below the threshold. Brook Trout, Mottled Sculpin, and Longnose Sucker were present, as were many sensitive macroinvertebrates.

In 2015, fish and macroinvertebrates were monitored at two additional Temperance River sites downstream of Forest Road 166. Data from these biological surveys was not available during the formal assessment process, but support the aquatic life assessment decisions for this reach. Both fish and macroinvertebrate communities indicated good water quality and habitat conditions. Brook Trout were found at both stations, Brown Trout were captured at one station, and Longnose Sucker was captured at one station. Sensitive macroinvertebrates found at both stations included: *Epeorus*, *Glossosoma*, and *Acroneuria*. Macroinvertebrates were also collected farther downstream on the Temperance River, off the Temperance River Road, just before the river begins its steep descent to Lake Superior. MIBI scores at this location were near exceptional use biocriteria, indicating that the excellent water quality documented at upstream locations on the Temperance River is maintained for its entire length.

Heartbreak Creek was monitored at Forest Road 166, west of the Temperance River and several miles upstream of the creek's confluence. This station is monitored every other year as part of MPCA's long-term biological monitoring program. The creek drains a minimally-disturbed landscape of forest and wetlands, and appears to be one of the coldest streams in the Lake Superior – North Watershed; during the summers of 2014 and 2015, water temperatures were within the Brook Trout “growth range” (<20 C) nearly the entire time.

Heartbreak Creek supports outstanding fish and macroinvertebrate assemblages, comprised mostly of taxa that require cold, clear, well-oxygenated water. The fish community included only Brook Trout, Longnose Dace, and sculpin (both Mottled and Slimy Sculpin have been recorded). The macroinvertebrate community included a diversity of highly-sensitive aquatic insects, several of which have been found at only a few locations across the state (e.g., *Alloperla*, *Soyedina*, *Ameletus*, *Apatania*, *Isogenoides*). Stonefly and caddisfly diversity is particularly outstanding in Heartbreak Creek; eight different stonefly genera and fourteen different caddis genera have been recorded from biomonitoring site 97LS075. Fish and macroinvertebrate IBI scores met exceptional use biocriteria and indicate excellent water quality and habitat conditions. Like Sixmile Creek, Heartbreak Creek likely provides important thermal refugia for the Temperance River’s coldwater biota.

Heartbreak Creek joins the Temperance River in a remote valley, part of a vast and mostly roadless area of nearly 6,000 acres bordered by the Sawbill Trail to the east, Forest Road 166 to the north, and the Temperance River Road to the west. The southern portion of this valley lies within Temperance River State Park, but most lands are under the administration of Superior National Forest. This riverscape, encompassing the lower Temperance River and several tributaries, is notable for its size, undeveloped nature, and the high quality of its aquatic resources; these waters should be high priority targets for protection efforts. As noted above, the upper portion of the Temperance River subwatershed also includes high quality resources, but most of this region (excluding lands within the BWCAW) is intersected by roads and logging is widespread. Protection efforts should also focus on the upper portion of the Temperance River subwatershed, but the lower, largely intact portion of the subwatershed may present unique opportunities to preserve near reference-quality aquatic habitats.

Figure 61. Temperance River near the Temperance River Road.

Since the early 1980s, the lower 26 miles of the Temperance River (Figure 61) have been included in the Nationwide Rivers Inventory of free-flowing river segments that are believed to possess one or more “outstandingly remarkable” natural or cultural values judged to be of more than local or regional significance (NPS 2011). Superior National Forest currently manages the Temperance River’s riparian corridor as an “Eligible Wild, Scenic and Recreational River”, a designation which emphasizes land and resource conditions that provide for interim protection of river corridors that meet eligibility criteria specified in the federal Wild and Scenic Rivers Act (SNF 2004). Formal inclusion of the Temperance River in the Wild and Scenic Rivers Act would require an act of the U.S. Congress or the Secretary of the Interior, but is an example of a unique opportunity to provide lasting protection for high quality aquatic resources in the Lake Superior – North Watershed.

Table 30. Aquatic life and recreation assessments on stream reaches: Temperance River subwatershed.

AUID *ReachName* Reach Description	Biological Station ID	Reach Length (miles)	Use Class	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia - NH3	Pesticides***	Eutrophication: Phosphorus	Response Indicator	**Aquatic Life**	**Aquatic Rec. (Bacteria)**
04010101-568 ***Plouff Creek*** Paoli Lk to Temperance R	98LS029	11.3	CWg	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--	SUP	--
04010101-D56 ***Temperance River*** T61 R4W S4, north line to Sixmile Cr	13LS053	15.1	CWe	MTS	MTS	IF	IF	IF	--	IF	--	--	IF	--	SUP	--
04010101-B35 ***Sixmile Creek*** Unnamed cr to Temperance R	91LS002	3.3	CWe	MTS	MTS	IF	IF	IF	--	IF	--	--	IF	--	SUP	--
04010101-569 ***Heartbreak Creek*** Unnamed cr to Temperance R	97LS075	3.8	CWe	MTS	MTS	IF	IF	IF	--	IF	--	--	IF	--	SUP	--
04010101-D57 ***Temperance River*** Sixmile Cr to Lk Superior	13LS020 15EM033 15LS063 81LS001	9.9	CWg	MTS	MTS	MTS	MTS	MTS	IF	MTS	MTS	--	MTS	--	SUP	SUP

Abbreviations for Indicator Evaluations: **---** = No Data, **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use; = insufficient information.
Abbreviations for Use Class: **WWg** = warmwater general, **CWg** = Coldwater general, **CWe** = Coldwater exceptional, *Assessments completed using proposed use classifications changes not yet written into rule

Table 31. Minnesota Stream Habitat Assessment (MSHA): Temperance River subwatershed.

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate 0-27	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	98LS029	Plouff Creek	5.0	14.0	20.7	16.0	29.0	84.7	Good
1	13LS053	Temperance River	5.0	11.5	20.5	11.0	32.0	80.0	Good
1	97LS075	Heartbreak Creek	5.0	14.0	23.7	6.0	27.0	75.7	Good
1	91LS002	Sixmile Creek	5.0	13.5	26.0	12.0	28.0	84.5	Good
1	13LS020	Temperance River	5.0	14.0	24.0	13.0	29.0	85.0	Good
2	15EM033	Temperance River	5.0	10.8	26.0	7.5	22.0	71.3	Good
2	15LS063	Temperance River	5.0	12.8	23.2	9.5	27.0	77.5	Good
1	81LS008	Temperance River	5.0	11.0	22.6	5.0	27.0	70.6	Good
Average Habitat Results: *Temperance River Subwatershed*			5.0	12.7	23.3	10.0	27.6	78.7	Good

Qualitative habitat ratings

= Good: MSHA score above the median of the least-disturbed sites (MSHA>66)

= Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)

= Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

Table 32. Outlet water chemistry results: Temperance River subwatershed.

Station location:	**Temperance River, NW of Tofte at Superior National Forest Road 166**						
STORET/EQuIS ID:	**S000-265**						
Station #:	0401010108-01, Temperance River						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**WQ Standard[1]**	**# of WQ Exceedances[2]**
Ammonia-nitrogen	ug/L	15	0.003	1.4	0.1	16	0
Chloride	mg/L	10	<1	1.3	0.8	230	0
Dissolved Oxygen	mg/L	19	8.3	12	9.4	7	0
pH		19	5.8	7.3	6.6	6.5 – 8.5	4
Secchi Tube	100 cm	19	>100	>100	>100	> 55	0
Total suspended solids	mg/L	11	<5	<5	<5	10	0
Phosphorus	ug/L	14	7	18	14	50	0
Chlorophyll-a, Corrected	ug/L	12	<0.5	1.1	0.7	7	0
Escherichia coli (geometric mean)	MPN/100ml	14	9	27	14	126	0
Escherichia coli	MPN/100ml	14	1	79	17	1260	0
Inorganic nitrogen (nitrate and nitrite)	mg/L	10	0.02	0.2	0.05		
Kjeldahl nitrogen	mg/L	10	0.3	0.8	0.5		
Orthophosphate	ug/L	0					
Pheophytin-a	ug/L	12	0.1	4.6	1.1		
Specific Conductance	uS/cm	19	25	51	36		
Temperature, water	deg °C	19	4.8	24	16.7		
Sulfate	mg/L	10	1.7	2.8	2.3		
Hardness	mg/L	11	12.6	24.4	19.3		

[1]Secchi Tube standard is a surrogate for the total suspended solids standard of 10 mg/L.
****Values in the table were compiled from data collected between May and September of 2013 and 2014, at the Temperance River Subwatershed outlet. This work was a component of Intensive Watershed Monitoring, but data from other locations on this water body may also have been used in the assessment process.**

Table 33. Lake assessments: Temperance River subwatershed.

Name	DNR Lake ID	Area (acres)	Trophic Status	% Littoral	Max. Depth (m)	Mean Depth (m)	CLMP Trend	Mean TP (µg/L)	Mean chl-a (µg/L)	Mean Secchi (m)	AQR Support Status	AQL Support Status
Ada	16-0515-00	26	E	100	4		NT			0.8	IF	NA
Alton	16-0622-00	960	O	31	22	7	NT	4.8	2.8	4.1	FS	IF
Baker	16-0486-00	14	E	100	3		NT			0.9	IF	NA
Burnt	16-0477-00	363	M	68	7		NT			2.4	IF	NA
Homer	16-0406-00	436	M	90	7		NT	14.6	5.3	2.1	FS	IF
Jack	16-0521-00	126	E	100	3		NT			1.6	NA	NA
Juno	16-0402-00	216	M	94	7		NT			2.6	IF	NA
Kelly	16-0476-00	171	M	100	3		NT			2.3	IF	NA
Kelso	16-0706-00	138	E	100	3		NT			1.4	IF	NA
Lujenida	16-0705-00	22	E				NT			1.1	IF	NA
Moore	16-0489-00	60	O	100	2		NT	12.0	3.4	1.1	NA	NA
North Temperance	16-0456-00	194	O		15		NT			4.1	FS*	NA
Peterson	16-0478-00	91	M		5		NT	14.0	2.4	2.2	IF	NA
Sawbill	16-0496-00	828	M	58	12		NT			2.5	IF	NA
Smoke	16-0495-00	172	E	82	5		NT			1.8	IF	NA
South Temperance	16-0457-00	213	M		7		NT			3.4	IF	NA
Star	16-0405-00	105	M	100	4		NT	18.8	9.2	1.3	FS	NA
Sunhigh	16-0663-00	50	E				NT			0.9	IF	NA
Vern	16-0409-00	127	E	65	13		NT			2.0	IF	NA
Weird	16-0520-00	31	E	100	2		NT			1.4	IF	NA
Whack	16-0410-00	30	E	77	8		NT			1.4	FS*	NA
Wonder	16-0664-00	76	E	100	3		NT			1.2	IF	NA

Abbreviations: **D -- Decreasing/Declining Trend** **E - Eutrophic** **FS – Full Support** I **-- Increasing/Improving Trends**
M **– Mesotrophic** NS **– Non-Support**
NT **– No Trend** O **– Oligotrophic** **IF – Insufficient Information**

Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use* = assessment-level transparency dataset collected via remote sensing

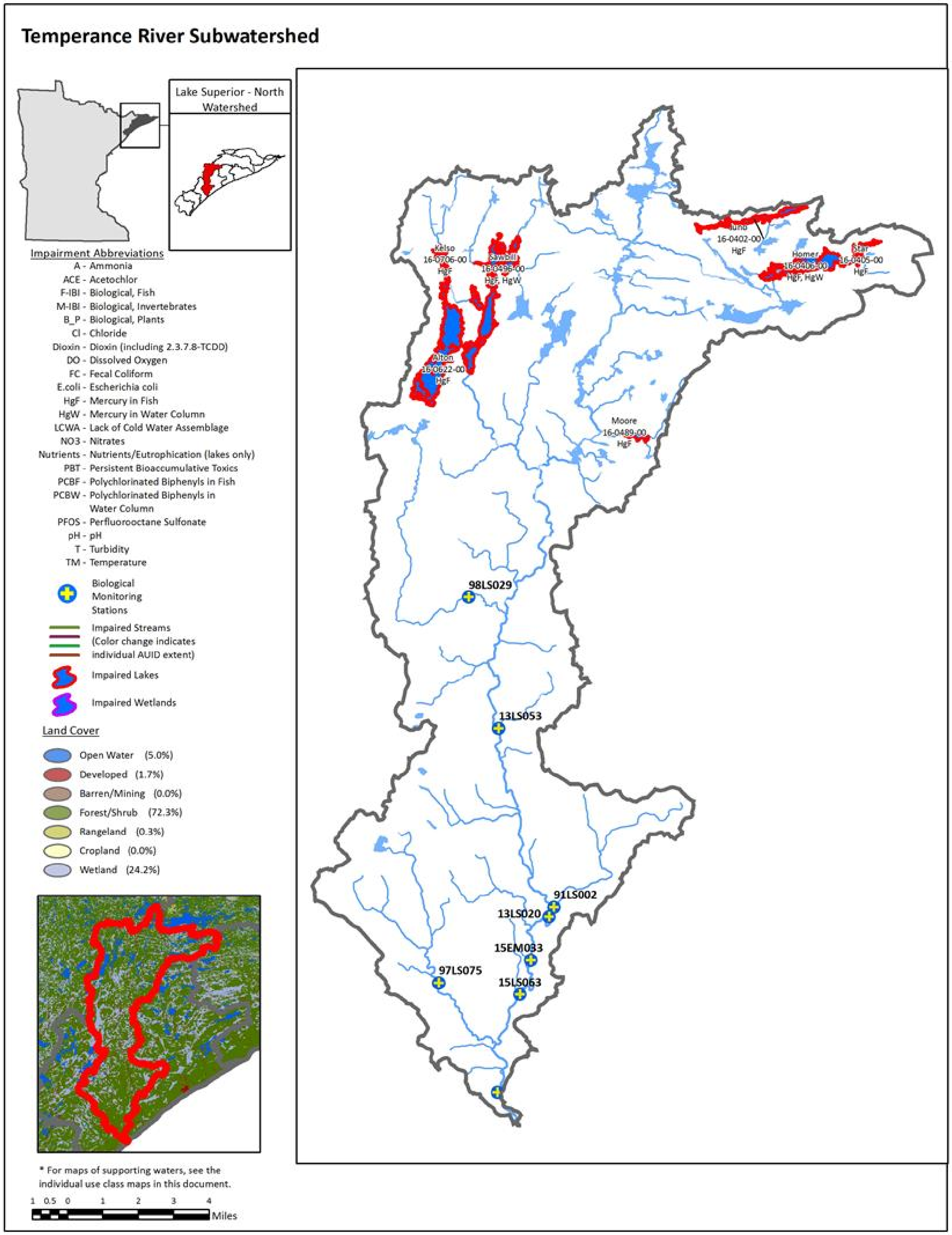


Figure 62. Temperance River subwatershed, land use characteristics and currently listed impaired waters by parameter.

Cross River subwatershed HUC 0401010109

The Cross River subwatershed drains 108 square miles of Lake and Cook counties and includes 51 lakes, of which 16 are greater than 100 acres in size. Cross River is the major watercourse, originating in headwater lakes north of Schroeder and draining 76 square miles at its confluence with Lake Superior. The lower portion of the Cross River flows through Temperance River State Park, over steep rapids and waterfalls before entering Lake Superior. The Cross River is notable in being one of the few North Shore tributaries that was used for log drives around the turn of the 20th Century. To facilitate these log drives, dams and bank protection structures were installed, and the stream channel straightened in places. Though log drives on Cross River ended nearly 100 years ago, the effects of these modifications can still be observed in the contemporary channel. Two Island River is the other major stream in this subwatershed, draining 20 square miles where it enters Lake Superior at Taconite Harbor.

Land use in the subwatershed is primarily forest and wetland, with a smaller open water component. Development levels are generally low, but relatively high when compared to the Lake Superior – North watershed as a whole. Most development is found along the shore of Lake Superior, including the community of Schroeder and industrial facilities at Taconite Harbor. Some residential and seasonal properties are found in the middle and upper portions of the subwatershed, particularly along lakeshores. Land ownership is primarily public (83%, mostly federal); privately-owned lands are clustered around the lower reaches of Two Island River and in the upper watershed along lakeshores.

About 6% of the Cross River subwatershed lies within protected areas, primarily near Lake Superior. More than 2,700 acres of Temperance River State Park surrounds the lower reaches of the Cross River. Just west of the state park, Superior National Forest manages nearly 1,500 acres of the Two Island River catchment in a relatively undisturbed state as a Research Natural Area (RNA).

Cross River subwatershed summary

Aquatic life and recreation indicators for lakes, rivers, and streams of the Cross River subwatershed consistently reflected good water quality. In general, FIBI and MIBI scores were high, and streams were characterized by low levels of sediment, nutrients, and bacteria. The lowermost reach of the Cross River met exceptional use biocriteria based on FIBI and MIBI scores, as did two tributaries (Wanless Creek, Houghtaling Creek) and also the lowermost reach of the Two Island River; protection strategies should be developed for these and the other high-quality aquatic resources found throughout the subwatershed. Eight lakes in the subwatershed were assessed as supporting aquatic recreation. The subwatershed includes two Lake Superior beaches, the Schroeder Town Park Beach and the Sugarloaf Cove Beach. Data indicate support of swimmable use; bacteria concentrations were consistently low at both locations.

The headwater lakes that feed the Cross River are mostly undeveloped, though several have campgrounds and some are dotted with cabins and resorts. Some of these lakes are shallow and tend to be bog-stained; these are typically more productive than the deeper clearer lakes. Among these headwater lakes, Elbow, Timber, Toohey, and Whitefish were monitored and found to support aquatic recreation based on low levels of nutrients and algae. Whitefish Lake is one of the clearest lakes in this portion of the Lake Superior – North Watershed, with an average Secchi transparency of 4.3 meters.

The Cross River exits Cross River Lake and flows south towards Forest Road 170 ("The Grade"). As it approaches and crosses under The Grade, the river picks up four major tributaries within approximately one mile, more than tripling its drainage area. The first tributary is Wilson Creek, less than a half-mile long and draining Wilson Lake, the subwatershed's largest lake at 652 acres. Wilson Lake and Little Wilson Lake both support aquatic recreation based on low levels of nutrients and algae. Wilson Lake has been monitored for many years by the MPCA, USFS, and citizen volunteers. The lake is very clear, with an average Secchi transparency of 4.6 meters, which appears to be stable over time (Figure 63). Wilson Creek's fish community appears to reflect the stream's proximity to both Wilson Lake and the Cross River. The stream supports lake-oriented species like Yellow Perch, but also fluvial species like Longnose Dace. Like other streams in this area, Wilson Creek supports Tadpole Madtom, a species closely related to bullheads and catfish. The species was not recorded from the Lake Superior – North Watershed prior to 2001, and was likely introduced via "bait bucket release" into a lake or river; as a rule, introductions of non-native species should be discouraged as they may negatively affect native species and ecosystem function. In general, the fish and macroinvertebrate communities of Wilson Creek indicated good water quality and habitat conditions. The presence of Longnose Dace and Blacknose Shiner suggest that this stream consistently carries low levels of suspended sediment (as would be expected for a lake outlet), and several sensitive aquatic insects were collected (e.g., *Leuctra*, *Chimarra*¸ *Lepidostoma*).

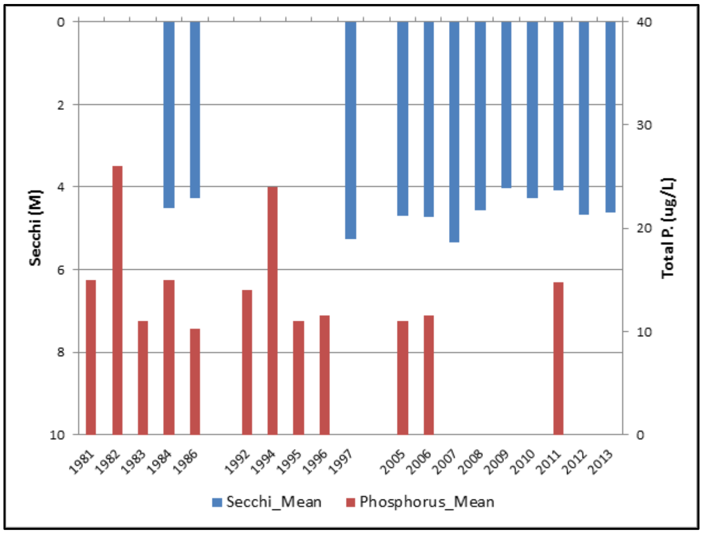


Figure 63. Wilson Lake water quality trends, 1981-2013.

The Cross River was monitored just downstream of Forest Road 170; it is a Designated Trout Stream at this location, but no trout were captured during the fish survey. However, the fish assemblage was dominated by the pollution-intolerant Longnose Dace, and the sensitive Blacknose Shiner was also present, indicating good water quality. The macroinvertebrate community also indicated good water quality, including two stenothermic stoneflies (*Leuctra*, *Isoperla*) and several other sensitive taxa (*Nigronia*, *Lepidostoma*). Water temperatures in the summer of 2013 were in the "stress" or "lethal" ranges for Brook Trout more than half the time, suggesting this portion of the Cross River has a thermal regime that is marginal for trout.

Further downstream of Forest Road 170, Fourmile Creek enters the Cross River from the east, draining a lake-dominated landscape and meandering slowly west from Fourmile Lake. Fourmile Lake and Richey Lake contribute flow to Fourmile Creek; both were monitored in the course of this study and were found to support aquatic recreation based on low levels of nutrients and algae. Both lakes are shallow and relatively productive for this part of the state. Fourmile Creek was monitored downstream of the Richey Lake Road, where the creek supports Yellow Perch, Northern Pike, and sensitive non-game species such as Iowa Darter and Longnose Dace; FIBI scores met general use biocriteria. The macroinvertebrate community consisted of a mix of fluvial and lentic taxa, but included sensitive insects such as *Chimarra*, *Oxyethira*, and *Acerpenna*.

Slightly more than a half-mile downstream of Fourmile Creek, Houghtaling Creek enters the Cross River from the west. Houghtaling and its major tributary, Wanless Creek, were both monitored at Forest Road 1855, where both streams are high-quality coldwater habitats. IBI scores from both streams met exceptional use biocriteria, reflecting the presence of Brook Trout, Mottled Sculpin, and macroinvertebrates that require clear, cold water. *Apsectrotanypus* (a type of midge that lives in small, cold streams) has been found in both Wanless and Houghtaling; MPCA has recorded this insect at only three other locations across the state of Minnesota. Other sensitive, stenothermic insects found in Wanless and Houghtaling included *Chimarra*, *Emphemerella*, *Nigronia*, and *Glossosoma nigrior*. Caddisfly taxa richness was particularly outstanding in Wanless Creek, with 16 different genera observed in a single sample. A damaged culvert was noted just downstream of the Wanless Creek biomonitoring station; this culvert appears to be causing sedimentation upstream of the road crossing. Repair or replacement of this culvert should be a high priority, considering Wanless Creek's high quality biological communities.

The lower Cross River was monitored off of the Superior Hiking Trail, about a mile upstream of its confluence with Lake Superior. Here the river cascades down a steep hillside and water temperatures tend to be colder than in the upper reaches. Water quality was excellent at this location; over two summers of intensive water chemistry monitoring no samples exceeded water quality standards. Bacteria levels were consistently low and indicated support of aquatic recreation. An electrofishing survey indicated the lower river supports both Rainbow Trout (which are stocked as fry) and wild Brook Trout, while the macroinvertebrate community included six stenothermic taxa (*Rhithrogena*, *Epeorus*, *Leuctra*, *Glossosoma nigrior*, *Eukiefferiella*, *Baetis tricaudatus*) and several other highly-sensitive insects (*Chimarra*, *Acroneuria*). Fish and macroinvertebrate IBI scores met exceptional use biocriteria.

Figure 64. The lower Cross River, near Schroeder, at the Superior Hiking Trail.

Fish and macroinvertebrate communities of the Two Island River were monitored at two locations: four miles west of Schroeder at Cook County Highway 1, and also at a remote location farther upstream, accessed via the North Shore State Trail. Brook Trout were found at both locations, and the stenothermic Slimy Sculpin was found at the lower station. The macroinvertebrate communities included nine stenothermic taxa and several other highly-sensitive insects, including a state-listed "species of special concern", the dragonfly *Boyeria grafiana*. Fish and macroinvertebrate IBI scores met exceptional use biocriteria, indicating excellent coldwater habitat and water quality.

Most of the Cross River subwatershed is forested and undeveloped, but it does include an extensive road network. Road-stream crossings are particularly concentrated in the Two Island River catchment (11 crossings are found in the stream's 19 square miles of drainage area), and some may negatively impact stream function and inhibit ecological connectivity. Potential barriers in the form of poorly-functioning road crossings have documented on both the Two Island River and tributaries such as Fredenberg Creek. Protection strategies for the Cross River subwatershed's high-quality streams should include a focus on maintaining ecological connectivity through its many road-stream intersections. Emphasis may also be placed on minimizing new road-stream crossings, where possible. For example, the middle and lower reaches of Cross River flow through remote national forest lands, crossed by only a few roads and trails. Between Forest Road 166 and Temperance River State Park, the Cross flows for approximately four miles, crossed by no roads and only one snowmobile trail. Between Forest Roads 166 and 170, another five miles of the Cross River remains uncrossed by roads. As mentioned above, this section of Cross River is characterized by excellent water quality and habitat, and supports exceptional biological communities.

Table 34. Aquatic life and recreation assessments on stream reaches: Cross River subwatershed. Reaches are organized upstream to downstream in the table.

AUID *ReachName* Reach Description	Biological Station ID	Reach Length (miles)	Use Class	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia - NH3	Pesticides***	Eutrophication: Phosphorus	Response Indicator	Aquatic Life	Aquatic Rec. (Bacteria)
04010101-519 ***Cross River*** Cross River Lk to Fourmile Cr	13LS024	2.0	CWg	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--	SUP	--
04010101-692 ***Wilson Creek (Cross River Tributary)*** T60 R6W S24, west line to Cross R	13LS041	0.3	WWg*	MTS	MTS	IF	--	--	--	IF	IF	--	IF	--	SUP	--
04010101-525 ***Fourmile Creek*** Headwaters (Fourmile Lk 16-0639-00) to Cross R	13LS022	2.9	WWg	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--	SUP	--
04010101-783 ***Wanless Creek*** Headwaters (Dam Five Lk 38-0053-00) to Houghtaling Cr	13LS043	2.7	CWe	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--	SUP	--
04010101-570 ***Houghtaling Creek*** Headwaters to Unnamed cr	10EM152	5.5	CWg	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--	SUP	--
04010101-571 ***Houghtaling Creek*** Unnamed cr to Unnamed cr	85LS020	1.7	CWe	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--	SUP	--
04010101-518 ***Cross River*** Fourmile Cr to Lk Superior	13LS025	14.8	CWe	MTS	MTS	MTS	IF	MTS	--	MTS	MTS	--	IF	--	SUP	SUP
04010101-547 ***Two Island River*** Unnamed cr to Lk Superior	10EM168 13LS023	11.4	CWe	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--	SUP	--
04010101-B62 ***Unnamed creek (Sugar Loaf Creek)*** T58 R5W S20, west line to Lk Superior	--	1.5	CWg	--	--	IF	IF	MTS	MTS	MTS	MTS	--	MTS	--	IF	--

Abbreviations for Indicator Evaluations: --- = No Data, MTS = Meets Standard; EXS = Fails Standard; IF = Insufficient Information
Abbreviations for Use Support Determinations: -- = No Data, NA = Not Assessed, IF = Insufficient Information, SUP = Full Support (Meets Criteria); IMP = Impaired (Fails Standards)
Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use; = insufficient information.
Abbreviations for Use Class: WWg = warmwater general, CWg = Coldwater general, CWe = Coldwater exceptional, *Assessments completed using proposed use classifications changes not yet written into rule

Table 35. Minnesota Stream Habitat Assessment (MSHA): Cross River subwatershed.

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate 0-27	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	13LS024	Cross River	5.0	14.0	19.0	12.0	31.0	81.0	Good
1	13LS041	Wilson Creek (Cross River Tributary)	5.0	15.0	22.0	12.0	24.0	78.0	Good
1	13LS022	Fourmile Creek	5.0	12.0	20.4	12.0	24.0	73.4	Good
1	13LS043	Wanless Creek	5.0	15.0	11.4	17.0	26.0	74.4	Good
1	10EM152	Houghtaling Creek	5.0	14.0	22.2	11.0	23.0	75.2	Good
1	85LS020	Houghtaling Creek	5.0	15.0	22.6	16.0	22.0	80.6	Good
1	10EM168	Two Island River	5.0	13.0	22.0	12.0	22.0	74.0	Good
1	13LS023	Two Island River	5.0	11.5	20.9	16.0	34.0	87.4	Good
1	13LS025	Cross River	5.0	11.5	25.3	10.0	27.0	78.8	Good
Average Habitat Results: *Cross River Subwatershed*			5.0	13.4	20.6	13.1	25.9	78.1	Good

Qualitative habitat ratings

- = Good: MSHA score above the median of the least-disturbed sites (MSHA>66)
- = Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)
- = Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

Table 36. Outlet water chemistry results: Cross River subwatershed.

Station location:	Cross River, 1 mi. NW of Schroeder at snowmobile trail bridge						
STORET/EQuIS ID:	S007-548						
Station #:	0401010109-01, Cross River						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**WQ Standard[1]**	**# of WQ Exceedances[2]**
Ammonia-nitrogen	ug/L	11	0.001	3.6	0.3	16	0
Chloride	mg/L	11	0.4	0.9	0.7	230	0
Dissolved Oxygen	mg/L	19	8.6	12.5	9.9	7	0
pH		19	6.7	7.5	7.1	6.5 – 8.5	0
Secchi Tube	100 cm	19	98	>100	>100	> 55	0
Total suspended solids	mg/L	11	<5	<5	<5	10	0
Phosphorus	ug/L	11	10	23	15	50	0
Chlorophyll-a, Corrected	ug/L	0				7	
Escherichia coli (geometric mean)	MPN/100ml	15	4	20	10	126	0
Escherichia coli	MPN/100ml	15	1	55	15	1260	0
Inorganic nitrogen (nitrate and nitrite)	mg/L	11	0.03	0.2	0.07		
Kjeldahl nitrogen	mg/L	10	0.5	0.8	0.6		
Orthophosphate	ug/L	0					
Pheophytin-a	ug/L	0					
Specific Conductance	uS/cm	18	36	65	49		
Temperature, water	deg °C	19	4.5	22	16		
Sulfate	mg/L	11	1.9	3.3	2.6		
Hardness	mg/L	11	17.8	32	25.7		

1Secchi Tube standard is a surrogate for the total suspended solids standard of 10 mg/L.

**Values in the table were compiled from data collected between May and September of 2013 and 2014, at the Cross River Subwatershed outlet. This work was a component of Intensive Watershed Monitoring, but data from other locations on this water body may also have been used in the assessment process.

Table 37. Lake assessments: Cross River subwatershed.

Name	DNR Lake ID	Area (acres)	Trophic Status	% Littoral	Max. Depth (m)	Mean Depth (m)	CLMP Trend	Mean TP (µg/L)	Mean chl-a (µg/L)	Mean Secchi (m)	AQR Support Status	AQL Support Status
Crooked	38-0024-00	267	O	91	6		NT	10.0	9.5	1.8		
Crooked (East Bay)	38-0024-01	170	O		6	2	NT	10.2	6.3	2.8	FS	IF
Dyers	16-0634-00	69		85	7	3	NT				IF	IF
Elbow (main basin)	16-0805-01	485	M		7		NT	12.7	6.0	2.4	FS	IF
Four Mile	16-0639-00	586	M	98	6	2	NT	21.7	7.0	1.8	FS	IF
Little Wilson	38-0051-00	55	O	81	6		NT	9.6	4.9	2.2	FS	IF
Richey	16-0643-00	100	E	100	2		NT	28.8	8.0	1.4	FS	NA
Timber	16-0654-00	281	E		4		NT			1.7	IF	NA
Toohey	16-0645-00	363	M	100	3	2	NT	23.3	6.0	1.0	FS	IF
Whitefish	38-0060-00	341	O	56	15	5	NT	10.5	3.6	4.3	FS	IF
Wilson	38-0047-00	652	M	37	16	6	NT	12.8	4.0	4.6	FS	IF

Abbreviations:

D -- Decreasing/Declining Trend
I -- Increasing/Improving Trends
NT – No Trend

E - Eutrophic
M – Mesotrophic
O – Oligotrophic

FS – Full Support
NS – Non-Support
IF – Insufficient Information

Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use
* = assessment-level transparency dataset collected via remote sensing

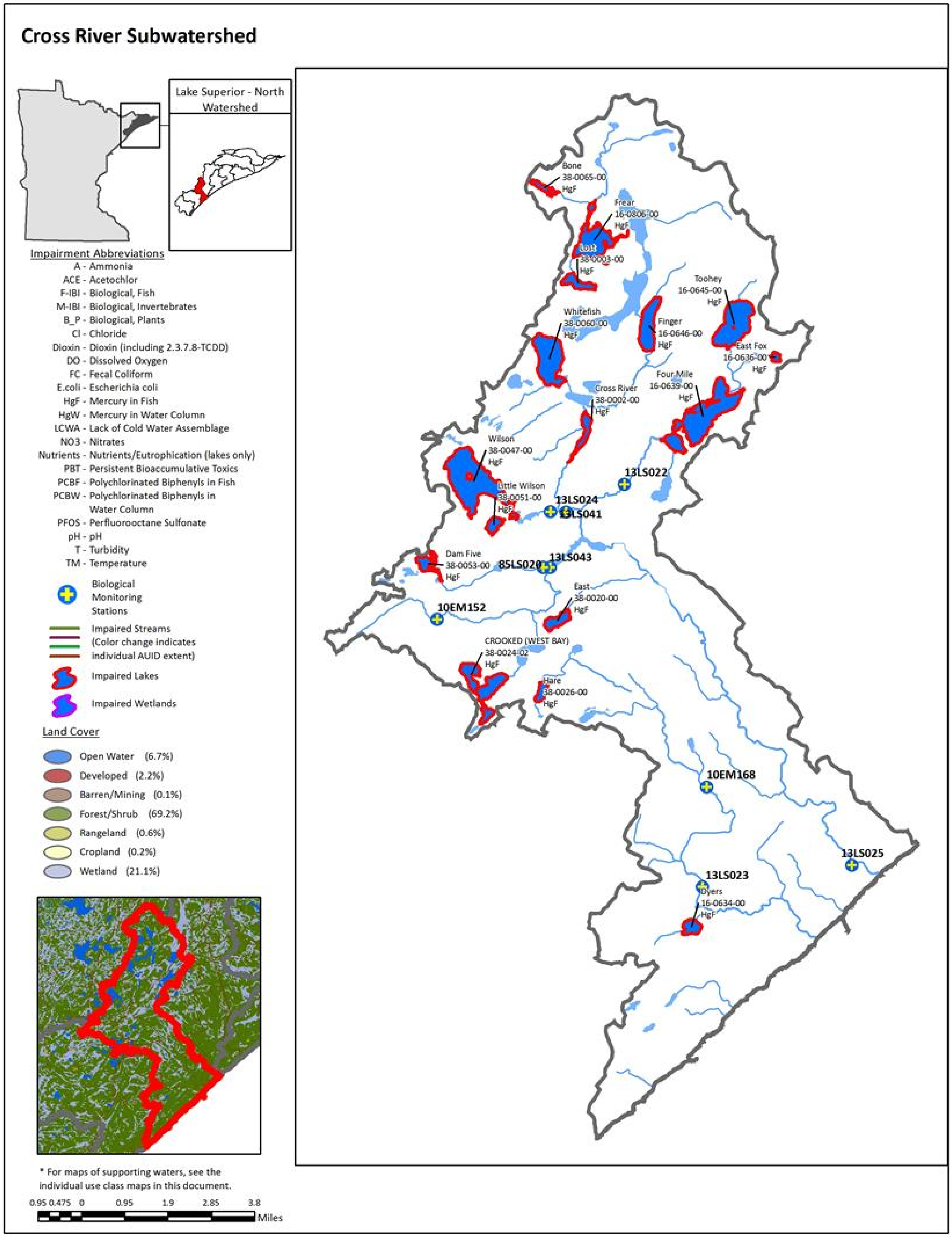


Figure 65. Cross River subwatershed, land use characteristics and currently listed impaired waters by parameter.

Manitou River subwatershed HUC 0401010110

The Manitou River subwatershed drains 139 acres of Lake and Cook counties. The subwatershed contains 34 lakes, but only 6 are greater than 100 acres in size and the largest, Ninemile, covers only 325 acres. As a result, open water comprises a relatively low proportion of the subwatershed and land cover is dominated by forest and wetland. A small amount of developed land is present, mostly in the form of roads, though some residential and seasonal cabins are scattered throughout the subwatershed.

Manitou River is the major watercourse, formed by the confluence of several tributaries. The westernmost tributary, or South Branch, drains extensive wetlands southeast of Isabella and includes the Junction Creek drainage. To the north, the North Branch arises in Delay Lake east of Isabella and picks up several unnamed tributaries as well as the Balsam Creek drainage before entering the Manitou mainstem. Farther east, Moose Creek drains small lakes and extensive wetlands before entering the mainstem river in remote country west of the former railway village of Cramer. The easternmost tributary, Ninemile Creek, arises in Ninemile Lake and flows through wetlands and Cramer Lake before entering the mainstem southwest of the Cramer townsite. Downstream of Ninemile Creek, the river enters George Crosby Manitou State Park and plunges through a steep canyon for seven miles before pouring over a waterfall directly into Lake Superior. At its confluence with Lake Superior, the Manitou River drains approximately 98 square miles.

The Manitou River subwatershed also includes several direct tributaries to Lake Superior. Caribou River is the largest, draining approximately 23 square miles west of the Cross River drainage. Other smaller direct tributaries include the Little Marais River, Little Manitou River, Kennedy Creek, and Crystal Creek.

The Manitou River subwatershed has the highest proportion of privately-owned lands among all Lake Superior – North subwatersheds (27%). The largest cluster of private lands is along the Highway 61 corridor (particularly the Little Marais River catchment) but large blocks of private land are found throughout the Manitou and Caribou River drainages. Federal land is more frequently found in northern regions of the subwatershed, while state-owned lands are more prevalent in the southern region. Lake County administers much of the South Branch Manitou River and Junction Creek catchments.

Protected lands make up approximately 8% of the Manitou River subwatershed, one of the higher proportions among Lake Superior – North subwatersheds that do not include BWCAW lands. More than 6,000 acres lie within state parks, nearly 1,300 acres are within MNDNR Aquatic Management Areas (AMAs), and more than 2,000 acres are managed by Superior National Forest as a Candidate Research Natural Area. The Nature Conservancy also manages a significant portion of the subwatershed for sustainable timber harvest.

Manitou River subwatershed summary

Aquatic life and recreation indicators for lakes, rivers and streams of the Manitou River subwatershed consistently reflected good water quality. In general, FIBI and MIBI scores were high, and streams were characterized by low levels of sediment, nutrients, and bacteria. In-stream and riparian habitat was excellent; the subwatershed's average MSHA score of 82.3 was the highest across the entire Lake Superior – North Watershed. Three streams met exceptional use biocriteria based on FIBI and MIBI scores; protection strategies should be developed for these and the other high-quality aquatic resources found throughout the subwatershed.

The North Branch of the Manitou River arises in Delay Lake, a few miles east of Isabella. Delay was monitored by Lake County in 2013 and 2014, and was found to support aquatic recreation based on Secchi transparency and low levels of phosphorus. This region of the subwatershed also includes Divide Lake, a unique, high quality soft-water seepage lake, which has been monitored by the MPCA and

Superior National Forest as an acid rain study lake. Although recent data were insufficient for an assessment of recreational use, overall the data suggest excellent water quality and oligotrophic conditions (Figure 66). From Delay Lake, the North Branch flows approximately nine miles to its confluence with the South Branch. Fish and macroinvertebrate communities were monitored at State Forest Road 307 ("General Grade Road"), where IBI scores indicated good water quality and habitat. The macroinvertebrate community was particularly robust, and the MIBI score met exceptional use biocrieria; 70 taxa were recorded, including thirteen different caddisfly genera. The fish community was dominated by minnows (Blacknose Dace, Creek Chub, and Common Shiner) but did include several Brook Trout. Beaver activity in the summer of 2013 caused partial inundation of the biomonitoring reach, which may have provided temporary habitat for the unusually large numbers of generalist minnows that were observed.

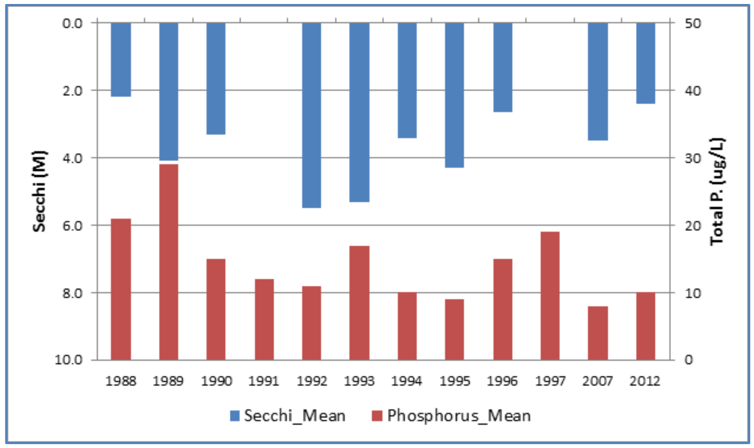


Figure 66. Divide Lake water quality trends, 1998-2012.

The South Branch of the Manitou River originates in wetlands southeast of Isabella. A headwater reach of the South Branch and a similar-sized tributary (Junction Creek), were monitored off of the "K-C Road". Mottled Sculpin were found in both streams, and the fish community of Junction Creek also included Brook Trout and Longnose Dace. The macroinvertebrate communities of both streams included many sensitive taxa, and a few stenothermic insects (e.g., Glossosoma, Amphinemura). While IBI scores indicated that both streams are adequately supporting aquatic life, the biological communities of Junction Creek were more robust, and the stream nearly met exceptional use biocriteria based on fish and macroinvertebrate IBI scores.

Downstream of Junction Creek, the South Branch was monitored at the Earl West Road. At this remote location, the stream met exceptional use biocriteria based on FIBI and MIBI scores. The fish community included Brook Trout, Longnose Dace, and Mottled Sculpin. The macroinvertebrate community included 65 taxa, several of which were stenotherms (e.g., Leuctra, Dolophilodes distinctus, Glossosoma, Baetis tricaudatus). Rheopelopia, a larval midge found at this location, has been observed by MPCA at only seven locations across the state, and appears to be restricted to cold, fast-moving streams. The presence of these highly sensitive organisms reflects the excellent water quality and habitat conditions found in the middle reaches of the Manitou River.

Much of the Moose Creek drainage is remote and relatively inaccessible, including the area where it enters the Manitou River. Cabin Creek, a tributary to Moose Creek, was monitored at Forest Road 359. At this location, FIBI and MIBI scores indicated good water quality and habitat conditions. The fish community included Brook Trout and Longnose Dace, but Mottled Sculpin were absent and have not been recorded in multiple sampling events conducted by MPCA, MNDNR, and Superior National Forest. Sculpin are abundant in the Manitou River and other tributaries in the area (e.g., Junction Creek, Ninemile Creek), and habitat and water temperatures in Cabin Creek appear suitable for the species, making their absence notable. The highest MSHA score in the Lake Superior – North Watershed was recorded at the Cabin Creek biomonitoring station, which is characterized by excellent channel development, a diversity of flow patterns and substrate types, and a riparian zone dominated by large cedar trees, the roots of which provide extensive overhead fish cover. The macroinvertebrate community was particularly robust, including 60 taxa in a single sample. Boyeria grafiana, a state-listed Species of Special Concern was observed, along with several other sensitive insects. Although Brook Trout and a few stenothermic insects were found in Cabin Creek, water temperatures appear to be warmer than other streams in the area; temperatures were in the Brook Trout stressful or lethal ranges for more than half the summer of 2013. MNDNR monitoring also indicates that thermal conditions may be only fair for Brook Trout survival and poor for growth. The geographic context of Cabin Creek likely contributes to its marginal thermal regime and may make its coldwater biota particularly vulnerable to additional warming. The stream flows for approximately three miles between shallow Cabin Lake and the Moose River (which is not a designated trout stream), and may be highly dependent upon riparian forest shading and localized groundwater contributions to provide thermal refugia during periods of stress. Protection strategies for the high-quality biological communities found in Cabin Creek should focus on maintaining stream and watershed characteristics that promote cool water temperatures in this unique resource.

Water quality and biological communities of the Manitou River were monitored downstream of the North Branch and Moose River confluences. An intensive water chemistry monitoring station was established just downstream of the Cramer Road; at this location the river had consistently low concentrations of bacteria, sediment, and nutrients. Biological indicators reflected the excellent water quality and habitat conditions; FIBI and MIBI scores met exceptional use biocriteria. MPCA biomonitoring crews have monitored this location several times since the late 1990s. Over the years, the fish community has consistently included Brook Trout, Mottled Sculpin, and Longnose Dace. The macroinvertebrate community has included 13 different mayfly genera, and eight different stenothermic insects. Thermal monitoring suggests that the Manitou River at this location is a relatively cold stream compared to others of similar size, making it a unique resource.

Figure 67. Manitou River at the Cramer Road.

Ninemile Lake is the largest lake in the subwatershed, and the headwater source of Ninemile Creek, the easternmost major tributary to the Manitou River. Ninemile Lake was found to support aquatic recreation based on Secchi transparency and low levels of phosphorus. Ninemile Creek was monitored off of the Cramer Road, upstream of Cramer Lake, where FIBI and MIBI scores met general use biocriteria and indicated good water quality and habitat conditions. The fish community was dominated by Longnose Dace and Mottled Sculpin; no Brook Trout were captured in MPCA surveys, though previous MNDNR surveys have recorded Brook Trout near this location. The macroinvertebrate community included a few stenothermic insects (e.g., Epeorus, Ephemerella, Eukiefferiella) and several other sensitive taxa.

The Caribou River is a cold, high-quality Lake Superior tributary draining forest and wetlands lying east of Ninemile Creek and the lower Manitou River. The catchment includes no significant lakes, so summer baseflow is highly dependent on springs and wetland seepage. Biota and water chemistry were monitored near the river's confluence with Lake Superior. At an intensive water chemistry monitoring station just upstream of Highway 61, water quality was excellent, characterized by low levels of bacteria, sediment, and nutrients. Biological communities were monitored a short distance upstream (above Caribou Falls) where FIBI and MIBI scores met exceptional use biocriteria. The fish community was relatively simple, composed entirely of Brook Trout, Slimy Sculpin, and Longnose Dace, and the FIBI achieved the maximum score of 100. The macroinvertebrate community included 10 stenothermic taxa and was numerically dominated by highly-sensitive caddisflies (Glossosoma nigrior, Protoptila, Lepidostoma). The stonefly Alloperla was also found at this location; MPCA has collected this insect from only eight other streams across the state, all in northeast Minnesota. An additional Caribou River station was monitored in 2015, at a remote location approximately 3.5 miles upstream of the lower biomonitoring site. The fish community was very similar to that observed at the downstream reach, consisting of the same three species plus a single Blacknose Dace. The macroinvertebrate sample was affected by a rain event and subsequent high flows, but was also similar to the downstream site, including six stenothermic insects. The mayfly Ameletus was observed at this site; MPCA has found this insect at only four other locations, all in the northeast corner of the state. The unique, high-quality biological assemblages found in the Caribou River should be prioritized for protection. Although headwater reaches of the Caribou flow through Superior National Forest lands (managed as "General Forest – Longer Rotation), the state of Minnesota is the predominant land manager along the river's lower, exceptional use reaches. A significant portion of the catchment is also in private ownership, and several private parcels include riparian forest lands. The Caribou River and its tributaries are currently crossed by relatively few roads; a low frequency of road-stream crossings may be an important contributor to the river's excellent water quality and biological communities.

The Cliffs Erie Railroad (also known as the "LTV Grade") crosses several streams in the Manitou River subwatershed (and other subwatersheds, as well). Some of these crossings may negatively affect ecological connectivity, impounding streamflow and inhibiting fish passage. The railroad is no longer in use, and these crossings currently serve little economic purpose. Improving (or removing) these crossings may represent an excellent opportunity to restore ecological connectivity and protect the high quality biological resources that utilize these stream networks.

Table 38. Aquatic life and recreation assessments on stream reaches: Manitou River subwatershed.

AUID ***ReachName*** Reach Description	**Biological Station ID**	**Reach Length (miles)**	**Use Class**	**Aquatic Life Indicators:** Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia - NH3	Pesticides***	**Eutrophication** Phosphorus	Response Indicator	**Aquatic Life**	**Aquatic Rec. (Bacteria)**
04010101-835 ***Junction Creek*** Unnamed cr to S Br Manitou R	13LS030	1.8	CWg	MTS	MTS	IF	IF	IF	--	--	--	--	IF	--	SUP	--
04010101-829 ***Manitou River, South Branch*** Unnamed cr to Unnamed cr	13LS029	1.8	CWg	MTS	MTS	IF	IF	IF	--	--	--	--	IF	--	SUP	--
04010101-661 ***Cabin Creek*** Cabin Lk to T59 R6W S20, south line	88LS016	2.9	CWg	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--	SUP	--
04010101-819 ***Manitou River (North Branch Manitou River)*** T59 R7W S19, north line to S Br Manitou R	88LS030	9.0	CWg	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--	SUP	--
04010101-827 ***Manitou River, South Branch*** Junction Cr to Mantiou R	13LS005	5.4	CWe	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--	SUP	--
04010101-534 ***Manitou River*** S Br Manitou R to Lk Superior	98LS030	11.1	CWe	MTS	MTS	MTS	MTS	MTS	MTS	MTS	MTS	--	MTS	--	SUP	SUP
04010101-862 ***Ninemile Creek*** Unnamed cr to Cramer Lk	13LS028	1.7	CWg	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--	SUP	--
04010101-575 ***Caribou River*** Unnamed cr to Unnamed cr	13LS026 15EM081	1.2	CWe	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--	SUP	--
04010101-576 ***Caribou River*** Unnamed cr to Lk Superior	--	1.0	CWg	--	--	MTS	IF	IF	MTS	MTS	MTS	--	MTS	--	--	--

Abbreviations for Indicator Evaluations: **---** = No Data, **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use; = insufficient information.
Abbreviations for Use Class: **WWg** = warmwater general, **CWg** = Coldwater general, **CWe** = Coldwater exceptional, *Assessments completed using proposed use classifications changes not yet written into rule

Table 39. Minnesota Stream Habitat Assessment (MSHA): Manitou River subwatershed.

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate 0-27	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	13LS030	Junction Creek	5.0	15.0	20.2	16.0	29.0	85.2	Good
1	13LS029	Manitou River, South Branch	5.0	15.0	22.0	12.0	29.0	83.0	Good
1	88LS016	Cabin Creek	5.0	15.0	22.0	17.0	36.0	95.0	Good
1	88LS030	Manitou River	5.0	13.0	20.2	16.0	29.0	83.2	Good
1	13LS005	Manitou River, South Branch	5.0	13.5	22.4	12.0	28.0	80.9	Good
1	98LS030	Manitou River	5.0	12.0	22.0	10.0	32.0	81.0	Good
3	13LS028	Ninemile Creek	5.0	11.2	22.1	14.3	20.3	72.9	Good
1	15EM081	Caribou River	5.0	11.5	25.0	14.0	29.0	84.5	Good
1	13LS026	Caribou River	5.0	10.0	26.0	8.0	26.0	75.0	Good
Average Habitat Results: *Manitou River Subwatershed*			5.0	12.9	22.4	13.3	28.7	82.3	Good

Qualitative habitat ratings

= Good: MSHA score above the median of the least-disturbed sites (MSHA>66)

= Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)

= Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

Table 40. Outlet water chemistry results: Manitou River subwatershed.

Station location:	**Manitou River, downstream of Lake County Road 7, at snowmobile trail bridge**						
STORET/EQuIS ID:	**S007-783**						
Station #:	0401010110-01, Manitou River						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**WQ Standard[1]**	**# of WQ Exceedances[2]**
Ammonia-nitrogen	ug/L	10	0.03	0.9	0.4	16	0
Chloride	mg/L	10	1.1	1.7	1.4	230	0
Dissolved Oxygen	mg/L	15	7.3	11.1	8.4	7	0
pH		17	6.7	8.6	7.5	6.5 – 8.5	1
Secchi Tube	100 cm	17	92	>100	>100	> 55	0
Total suspended solids	mg/L	10	1	4	2.3	10	0
Phosphorus	ug/L	10	8	23	15	50	0
Chlorophyll-a, Corrected	ug/L	0				7	
Escherichia coli (geometric mean)	MPN/100ml	14	13	40	23	126	0
Escherichia coli	MPN/100ml	14	6	547	59	1260	0
Inorganic nitrogen (nitrate and nitrite)	mg/L	10	<0.03	0.2	0.1		
Kjeldahl nitrogen	mg/L	10	<0.03	1.5	0.7		
Orthophosphate	ug/L	0					
Pheophytin-a	ug/L	0					
Specific Conductance	uS/cm	17	37	87	63		
Temperature, water	deg °C	17	9	22	17		
Sulfate	mg/L	10	<3	<3	<3		
Hardness	mg/L	19	6.3	547	54		

[1]Secchi Tube standard is a surrogate for the total suspended solids standard of 10 mg/L.

**Values in the table were compiled from data collected between May and September of 2013 and 2014, at the Manitou River subwatershed outlet. This work was a component of Intensive Watershed Monitoring, but data from other locations on this water body may also have been used in the assessment process.

Table 41. Lake assessments: Manitou River subwatershed.

Name	DNR Lake ID	Area (acres)	Trophic Status	% Littoral	Max. Depth (m)	Mean Depth (m)	CLMP Trend	Mean TP (µg/L)	Mean chl-a (µg/L)	Mean Secchi (m)	AQR Support Status	AQL Support Status
Cabin	38-0260-00	67	M		1		NT	17.0	1.1	0.8	NA	NA
Delay	38-0415-00	100	M	96	5		NT	14.8	6.5	2.3	FS	NA
Divide	38-0256-00	61	O	70	7	3	NT	9.0	7.8	3.0	IF	IF
Hoist	38-0251-00	91	M	100	2		NT			2.7	IF	NA
Ninemile	38-0033-00	294	O	97	12	1	NT	9.3	6.9	2.1	FS	IF

Abbreviations: D **-- Decreasing/Declining Trend** E **- Eutrophic** FS **– Full Support**
I -- Increasing/Improving Trends **M** – Mesotrophic **NS** – Non-Support
NT – No Trend **O** – Oligotrophic **IF** – Insufficient Information

Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use
* = assessment-level transparency dataset collected via remote sensing

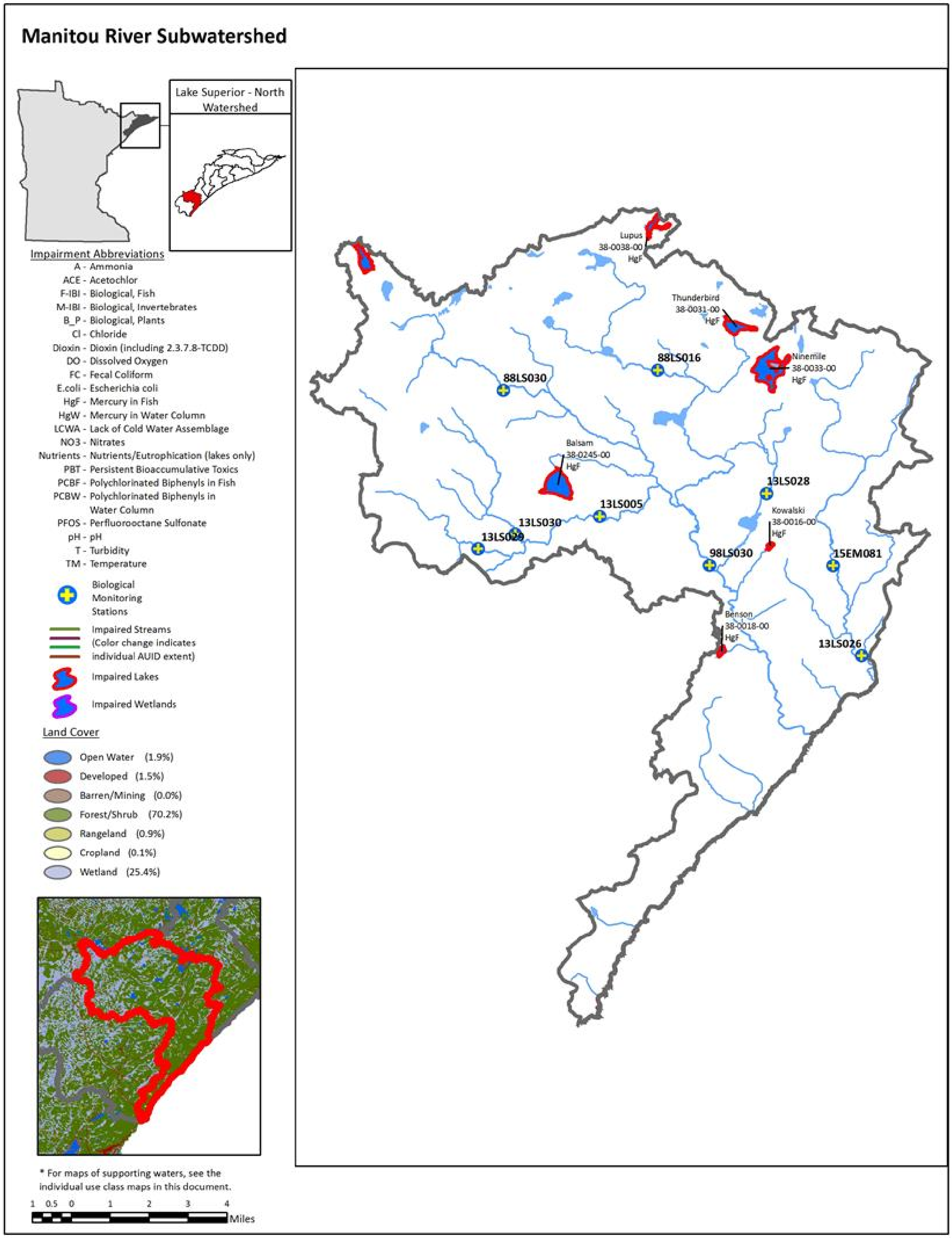


Figure 68. Manitou River subwatershed, land use characteristics and currently listed impaired waters by parameter.

Baptism River subwatershed HUC 0401010111

The Baptism River subwatershed drains 138 square miles of Lake County. The subwatershed is lightly-developed, but includes the town of Finland, a decommissioned U.S. Air Force radar station, Wolf Ridge Environmental Learning Center, and scattered rural residential development. Forest and wetland are the dominant land cover types, together comprising 96% of the subwatershed. Open water is relatively rare; the subwatershed contains 30 lakes but only two are larger than 100 acres in size.

Baptism River is the main watercourse, consisting of West and East branches that converge in the town of Finland. Headwaters of the East Branch are located north of Finland, in a series of wetlands near Murphy City. The East Branch flows east to Lake Twentythree, then southeast to a crossing of the Cramer Road, where the river picks up Schoolhouse Creek and Blesener Creek. From this point, the East Branch bends sharply to the southwest and flows through a series of shallow lakes and ponds for 6.5 miles to its confluence with the West Branch in Finland.

Headwaters of the West Branch are located in wetlands south of Isabella. The river flows south for most of its 15 miles, gradually bending to the southeast as it approaches Finland. West Branch tributaries include Crown Creek and Hockamin Creek, both entering from the west and draining landscapes dominated by forest, wetlands, and beaver ponds. Downstream of Finland, the Baptism flows approximately nine miles to its confluence with Lake Superior in Tettegouche State Park. Along the way it picks up one more sizeable tributary, Sawmill Creek, which enters from the east.

The Baptism River subwatershed includes a relatively high proportion of private lands (25%). The largest concentrations are found south and east of Finland (particularly the Sawmill Creek drainage), and also northwest of Finland, but large blocks of private land are found throughout the subwatershed. In contrast to most other Lake Superior – North subwatersheds, federal lands are relatively rare (10%); Lake County and the State of Minnesota together administer approximately 90% of the public land in the subwatershed. More than 4,000 acres of state park lands are found in the subwatershed, but few other protected areas exist.

Baptism River subwatershed summary

Aquatic life and recreation indicators for lakes, rivers and streams of the Baptism River subwatershed consistently reflected good water quality. In general, FIBI and MIBI scores were high, and streams were characterized by low levels of sediment, nutrients, and bacteria. Three streams met exceptional use biocriteria based on FIBI and MIBI scores; protection strategies should be developed for these and the other high-quality aquatic resources found throughout the subwatershed. The presence of Slimy Sculpin in Crown Creek and the West Branch is particularly notable, as they represent the southernmost verified records of the species from inland waters of the North Shore.

Crown Creek is the primary tributary to the West Branch Baptism River, and drains a larger catchment than the West Branch at the point where they converge. Fish and macroinvertebrate communities of Crown Creek were monitored a half-mile upstream of the streams' confluence; at this location, IBI scores met exceptional use biocriteria, indicating excellent water quality and coldwater habitat conditions. The fish community included Brook Trout, Slimy Sculpin, and Longnose Dace. The macroinvertebrate community was characterized by a high proportion of sensitive taxa, including six stenothermic insects and Boyeria grafiana, a state-listed Species of Special Concern.

The West Branch was monitored a half-mile upstream of the Crown Creek confluence. Habitat conditions at this site were similar to the Crown Creek station, as were fish and macroinvertebrate communities, and IBI scores also met exceptional use biocriteria. A notable addition to the macroinvertebrate community was the mayfly Ameletus, which MPCA has found at only four other locations in Minnesota, all in the northeast region of the state. The West Branch Baptism River site is MPCA's southernmost record of this insect.

Between the Crown Creek confluence and the East Branch of the Baptism River, the West Branch flows for four miles just west of Minnesota State Highway 1, paralleling the highway. Water quality and biological indicators were monitored in Finland, just upstream of the highway. At this location, nutrient, sediment, and bacteria levels were consistently low, and IBI scores met general use biocriteria. The fish community was particularly robust, including Brook Trout, Slimy Sculpin, and Longnose Dace. Two macroinvertebrate samples were collected, each of which met general use biocriteria. Several sensitive insects were present, including five stenothermic taxa. The larval stage of the dragonfly Boyeria grafiana, a state-listed Species of Special Concern, was collected from this reach of the West Branch at a station farther upstream.

Hockamin Creek enters the West Branch less than a mile upstream of the East Branch confluence. Fish and macroinvertebrate communities of Hockamin Creek were monitored downstream of the Heffelfinger Road, where IBI scores met general use biocriteria. The fish community included Brook Trout and Longnose Dace, but no sculpin was recorded in the two samples that were collected. The macroinvertebrate community was numerically dominated by caddisflies, and included four stenothermic insects. A perched culvert at the upstream end of the biomonitoring reach was noted, which may act as a barrier to fish migration at certain water levels.

Figure 69. Perched culvert on Hockamin Creek, at the Heffelfinger Road.

The East Branch Baptism River's headwaters are found in remote country north of Finland. The upper East Branch was monitored at the North Shore State Trail, a half-mile upstream of the Schoolhouse Creek confluence. At this location, FIBI and MIBI scores met exceptional use biocriteria. The fish community was dominated by Longnose Dace but also included good numbers of Brook Trout. No sculpin were observed, but several wetland-oriented fish species were present (Iowa Darter, Finescale Dace, Yellow Perch); these species likely washed down from lower-gradient upstream reaches of the East Branch. The macroinvertebrate community was particularly robust, including 62 taxa in a single sample. Six different stenothermic insects were observed, including Boyeria grafiania.

The character of the East Branch changes dramatically as it bends to the southwest at its confluence with Blesener Creek. Downstream of Blesener Creek, the East Branch consists of a succession of wide pools and ponds, interspersed with relatively short, narrow sections of rocky rapids and riffles. This reach of the East Branch was monitored one mile upstream of the West Branch confluence, at a snowmobile trail crossing. Intensive water chemistry monitoring indicated low concentrations of nutrients, sediments, and bacteria, though dissolved oxygen concentrations were slightly lower (on average) than on the West Branch, likely due to the pooled reaches immediately upstream. Water temperatures at this location were relatively warm, compared to the upstream biomonitoring location on the East Branch and similar reaches of the West Branch, again likely due to the influence of the upstream pooled areas. Fish and macroinvertebrate communities reflected these warmer conditions; the fish assemblage was dominated by minnows and included Black Bullhead (which were intentionally introduced into the headwater lake of a nearby tributary), and only two stenothermic insect taxa were observed in the macroinvertebrate sample. IBI scores indicted potential impairment, but a supporting assessment for aquatic life was made based on weight of evidence. Although the FIBI score was relatively low, the Biological Condition Gradient (BCG) rating indicated a higher-quality assemblage.

Additionally, MNDNR surveys in pooled sections of the East Branch indicate that a wild Brook Trout population persists, though these fish may utilize only certain areas during periods of thermal stress. Although no trout were observed at MPCA's stream biomonitoring station, the site wasn't fully representative of the character of the reach, and current monitoring protocols cannot accurately sample and assess the pooled sections that dominate this reach. The weight-of-evidence supporting assessment for aquatic life considered the following factors: good water quality observed at the 10x site, a supporting MIBI score, a "Level 3" BCG rating for the fish assemblage (indicating a non-impaired community), MNDNR data regarding the Brook Trout population of the reach, and the fact that habitat conditions at the biomonitoring station characterized only a small portion of the reach. It should be noted that some potential stressors are present along this reach, in the form of a road encroaching upon the stream for a significant portion of its length, and also rural residential development adjacent to the stream in a few places. Three sections of this reach already lie within MNDNR AMAs, but private ownership of riparian lands is common between Blesener Creek and the West Branch confluence. Protection strategies for this reach of the East Branch may include working with private landowners to promote riparian land uses that promote cool water temperatures (e.g., forest shading) and minimize inputs of sediment and nutrients. Efforts may also focus on minimizing impacts associated with the stream's proximity to the Cramer Road.

Downstream of Finland, the Baptism River is a larger stream, draining the combined catchments of the East and West Branches. Johnson Lake drains to this lower reach of the Baptism via a small, unnamed creek. The lake has been monitored by citizen partners (Wolf Ridge Environmental Learning Center) since 1989, and is meeting aquatic recreation standards based on low levels of nutrients and algae. There is no long-term trend in lake transparency (Figure 70), but this parameter varies from year to year.

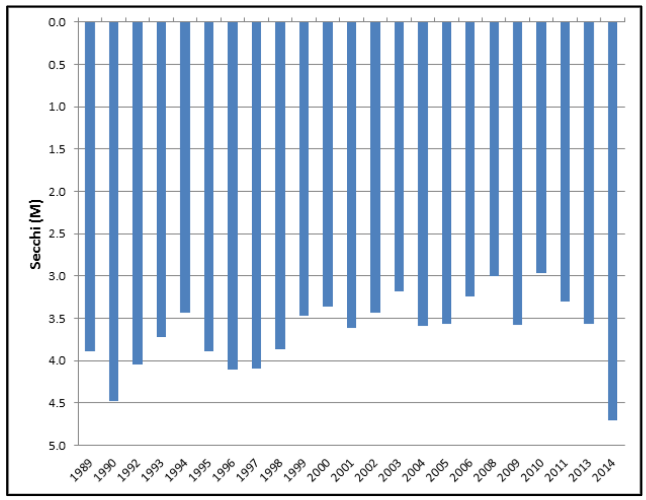


Figure 70. Johnson Lake water quality trends, 1989-2014.

Approximately 3.5 miles downstream of Finland, Sawmill Creek enters the Baptism from the east, draining about nine square miles. Fish and macroinvertebrates were monitored just upstream of the confluence, at the Cranberry Road crossing. Both Rainbow Trout (stocked as fry in the Baptism River) and Brook Trout were captured, as well as Longnose Dace, indicating good water quality and coldwater habitat. Five different stenothermic insects have been recorded from this location, as have other pollution-intolerant macroinvertebrate taxa (e.g., Chimarra, Acroneuria). A culvert replacement project was carried out just upstream of the biomonitoring station during the summer of 2013, designed to facilitate ecological connectivity as well as reduce erosion and sedimentation. Construction disturbance may have affected the macroinvertebrate community in 2013, as the 2014 MIBI score was 10 points higher. Ongoing macroinvertebrate monitoring may be particularly useful in tracking effectiveness of the culvert replacement project. It should be noted that much of the Sawmill Creek catchment consists of private land; approximately 60% of the catchment and 70% of the riparian zone are privately-owned (though a significant portion of the lower creek's riparian zone is within an AMA). Protection strategies for Sawmill Creek will likely require collaboration with private landowners.

The lowermost reach of the Baptism River was monitored at three locations downstream of Minnesota State Highway 1. The upper biological monitoring station was located at the state highway, just before the river begins its descent through a steep canyon. The fish community included both Rainbow Trout (stocked as fry at this location) and Brook Trout. The macroinvertebrate community included four stenothermic insects and high numbers of the sensitive mayfly Epeorus. Similar biological assemblages were found at a biomonitoring site further downstream, in the canyon section of the river. In general, biological indicators from this portion of the river indicate good water quality and habitat conditions. An intensive water chemistry monitoring station was located further downstream, a short distance upstream from Lake Superior and off the main entrance road for Tettegouche State Park. This location is also monitored as part of MPCA's Major Watershed Load Monitoring Network. In general, water quality was good, characterized by low levels of nutrients and sufficient levels of dissolved oxygen. A small percentage of TSS samples exceeded the 10 mg/L standard, but most exceedances were associated with high flow events and are not abnormal. Bacteria levels were low and indicated full support for aquatic recreation. The Lake Superior beach just downstream of the stream water chemistry station was also monitored for bacteria levels, which were consistently below standards and indicated full support of aquatic recreation.

The Mottled Sculpin (Cottus bairdii) appears to be absent from upstream portions of the Baptism River subwatershed, though it is ubiquitous in adjacent subwatersheds (Figure 71). The more stenothermic Slimy Sculpin (Cottus cognatus) was observed in two Baptism River tributaries (Crown Creek and the West Branch), but no Mottled Sculpin have been observed despite the prevalence of apparently suitable habitat throughout the subwatershed. The absence of C.bairdii from the upper Baptism River and its tributaries may be due to natural factors – the species was not recorded by Moyle in his early report on the stream fish communities of North Shore tributaries. It is interesting to note that C.bairdii has been recorded from multiple locations on the lower Baptism River, but only downstream of High Falls, a 100-foot drop that is the highest waterfall entirely within the State of Minnesota. It's possible that post-glacial dispersion of C.bairdii in the Lake Superior Basin occurred after Lake Superior had receded below an early incarnation of High Falls, which prevented upstream dispersal of the species. C.bairdii fills a somewhat unique niche in North Shore streams. It is commonly found in streams that are cold enough to support Brook Trout, but the coldest streams (e.g., Heartbreak Creek, Caribou River, Irish Creek) typically support the more stenothermic C.cognatus. A few streams in the Baptism River subwatershed currently support C.cognatus; if these streams warm beyond that species' thermal tolerance, there appears to be no similar species (e.g., C.bairdii) available to fill the niche. In general, the presence of sculpin is an indicator of good water quality and coldwater habitat, and their absence may be a sign of degradation.

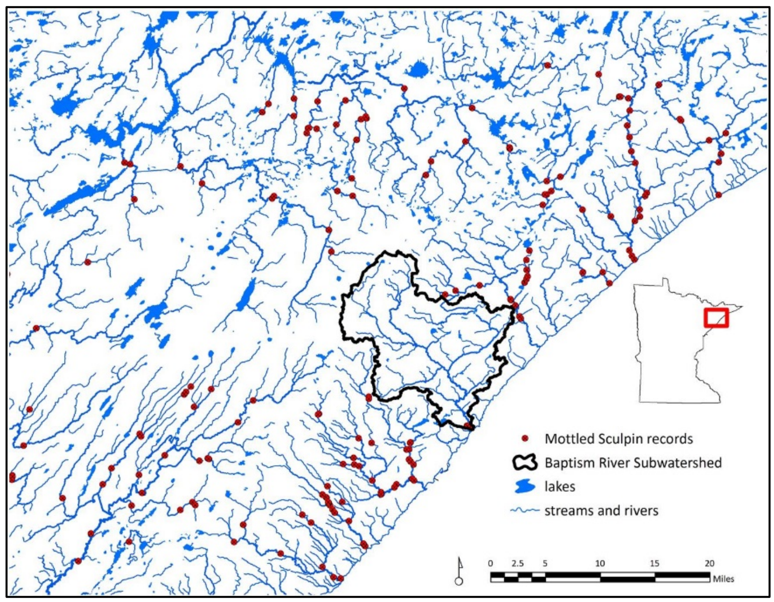


Figure 71. Mottled Sculpin (*Cottus bairdi*) records in the vicinity of the Baptism River subwatershed. Source: MPCA biomonitoring database.

Table 42. Aquatic life and recreation assessments on stream reaches: Baptism River subwatershed.

AUID *ReachName* Reach Description	Biological Station ID	Reach Length (miles)	Use Class	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia - NH3	Pesticides***	Eutrophication: Phosphorus	Response Indicator	**Aquatic Life**	**Aquatic Rec. (Bacteria)**
04010101-D50 ***Baptism River, West Branch*** -91.3381 47.4702 to Crown Cr	13LS036	2.7	CWe	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--	SUP	--
04010101-581 ***Crown Creek*** Fry Cr to Unnamed cr	13LS031	1.7	CWe	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--	SUP	--
04010101-587 ***Hockamin Creek*** Unnamed cr to W Br Baptism R	13LS034	1.5	CWg	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--	SUP	--
04010101-D49 ***Baptism River, West Branch*** Crown Cr to E Br Baptism R	13LS032	4.3	CWg	MTS	MTS	MTS	MTS	MTS	MTS	MTS	MTS	--	MTS	--	SUP	SUP
04010101-D58 ***Baptism River, East Branch*** Lk Twenty-three to Blesner Cr	13LS045	3.3	CWe	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--	SUP	--
04010101-D59 ***Baptism River, East Branch*** Blesner Cr to Baptism R	13LS033	6.5	CWg	MTS	MTS	MTS	MTS	MTS	MTS	MTS	MTS	--	MTS	--	SUP	SUP
04010101-B24 ***Sawmill Creek*** Unnamed cr to Baptism R	88LS010	1.2	CWg	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--	SUP	--
04010101-508 ***Baptism River*** W Br Baptism R to Lk Superior	10EM012 98LS035	8.8	CWg	MTS	MTS	MTS	MTS	MTS	MTS	MTS	MTS	--	MTS	--	SUP	SUP

Abbreviations for Indicator Evaluations: --- = No Data, MTS = Meets Standard; EXS = Fails Standard; IF = Insufficient Information
Abbreviations for Use Support Determinations: -- = No Data, NA = Not Assessed, IF = Insufficient Information, SUP = Full Support (Meets Criteria); IMP = Impaired (Fails Standards)
Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use; = insufficient information.
Abbreviations for Use Class: WWg = warmwater general, CWg = Coldwater general, CWe = Coldwater exceptional, *Assessments completed using proposed use classifications changes not yet written into rule

Table 43. Minnesota Stream Habitat Assessment (MSHA): Baptism River subwatershed.

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate 0-27	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	13LS036	Baptism River, West Branch	5.0	14.0	21.8	16.0	22.0	78.8	Good
1	13LS031	Crown Creek	3.0	14.0	24.0	12.0	27.0	80.0	Good
1	13LS034	Hockamin Creek	5.0	12.5	25.0	11.0	22.0	75.5	Good
1	13LS032	Baptism River, West Branch	3.5	10.0	24.0	12.0	17.0	66.5	Good
1	13LS045	Baptism River, East Branch	5.0	14.0	19.4	12.0	29.0	79.4	Good
1	13LS033	Baptism River, East Branch	5.0	10.5	26.0	17.0	27.0	85.5	Good
2	88LS010	Sawmill Creek	5.0	10.0	21.6	9.0	31.0	76.7	Good
1	98LS035	Baptism River	5.0	9.0	26.0	10.0	23.0	73.0	Good
1	10EM012	Baptism River	5.0	15.0	23.4	13.0	29.0	85.4	Good
Average Habitat Results: *Baptism River Subwatershed*			5.0	15.0	23.4	13.0	29.0	85.4	Good

Qualitative habitat ratings

= Good: MSHA score above the median of the least-disturbed sites (MSHA>66)

= Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)

= Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

Table 44. Lake assessments: Baptism River subwatershed.

Name	DNR Lake ID	Area (acres)	Trophic Status	% Littoral	Max. Depth (m)	Mean Depth (m)	CLMP Trend	Mean TP (µg/L)	Mean chl-a (µg/L)	Mean Secchi (m)	AQR Support Status	AQL Support Status
Nipisiquit	38-0232-00	56		51	6		NT				IF	IF
Johnson	38-0242-00	31	M	59	7		NT	23.0	2.2	3.4	FS	IF

Abbreviations:
D -- Decreasing/Declining Trend
I -- Increasing/Improving Trends
NT – No Trend
E - Eutrophic
M – Mesotrophic
O – Oligotrophic
FS – Full Support
NS – Non-Support
IF – Insufficient Information

Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use
* = assessment-level transparency dataset collected via remote sensing

Table 45. Outlet water chemistry results: Baptism River subwatershed, Baptism River.

Station location:	**Baptism River in Tettegouche State Park, at US-61 bridge**						
STORET/EQuIS ID:	**S000-250**						
Station #:	0401010111-01, Baptism River						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**WQ Standard[1]**	**# of WQ Exceedances[2]**
Ammonia-nitrogen	ug/L	15	0.05	50	3.6	16	1
Chloride	mg/L	10	1.7	4.3	2.9	230	0
Dissolved Oxygen	mg/L	27	7	15.3	9.8	7	0
pH		29	7	8.3	7.7	6.5 – 8.5	0
Secchi Tube	100 cm	52	7	>100	>100	> 55	6
Total suspended solids	mg/L	63	<1	50	7	10	11
Phosphorus	ug/L	34	<3	40	13	50	0
Chlorophyll-a, Corrected	ug/L	22	0.5	4.5	1.6	7	0
Escherichia coli (geometric mean)	MPN/100ml	19	17	25	20	126	0
Escherichia coli	MPN/100ml	19	1	170	24	1260	0
Inorganic nitrogen (nitrate and nitrite)	mg/L	60	<.05	1.2	0.3		
Kjeldahl nitrogen	mg/L	60	0.3	1.4	0.6		
Orthophosphate	ug/L	27	<0.005	0.026	<0.005		
Pheophytin-a	ug/L	22	0.6	16.6	2.9		
Specific Conductance	uS/cm	30	37	120	70		
Temperature, water	deg °C	30	2	25	15.7		
Sulfate	mg/L	13	1.3	2.6	2		
Hardness	mg/L	10	20	50	35		

[1]Secchi Tube standard is a surrogate for the total suspended solids standard of 10 mg/L.

**Values in the table were compiled from data collected between May and September of 2013 and 2014, at the Baptism River Subwatershed outlet. This work was a component of Intensive Watershed Monitoring, but data from other locations on this water body may also have been used in the assessment process.

Table 46. Outlet water chemistry results: Baptism River subwatershed, West Branch Baptism River.

Station location:	Baptism River, West Branch, in Finland at MN Highway 1						
STORET/EQuIS ID:	S007-545						
Station #:	0401010111-01, Baptism River						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**WQ Standard[1]**	**# of WQ Exceedances[2]**
Ammonia-nitrogen	ug/L	10	0.02	0.9	0.3	16	0
Chloride	mg/L	10	1.6	2.5	2	230	0
Dissolved Oxygen	mg/L	15	6.3	10.1	8.5	7	1
pH		17	6.5	8.3	7.3	6.5 – 8.5	1
Secchi Tube	100 cm	18	>100	>100	>100	> 55	0
Total suspended solids	mg/L	10	<1	4	2.1	10	0
Phosphorus	ug/L	10	7	22	15	50	0
Chlorophyll-a, Corrected	ug/L	0				7	
Escherichia coli (geometric mean)	MPN/100ml	14	23	33	28	126	0
Escherichia coli	MPN/100ml	14	7	488	73	1260	0
Inorganic nitrogen (nitrate and nitrite)	mg/L	10	0.03	0.2	0.1		
Kjeldahl nitrogen	mg/L	10	0.5	1.3	0.7		
Orthophosphate	ug/L	0					
Pheophytin-a	ug/L	0					
Specific Conductance	uS/cm	16	40	106	70		
Temperature, water	deg °C	17	10.1	22	17.1		
Sulfate	mg/L	10	<3	<3	<3		
Hardness	mg/L	10	18	48	32		

[1]Secchi Tube standard is a surrogate for the total suspended solids standard of 10 mg/L.

**Values in the table were compiled from data collected between May and September of 2013 and 2014, at the West Branch Baptism River outlet. This work was a component of Intensive Watershed Monitoring, but data from other locations on this water body may also have been used in the assessment process.

Table 47. Outlet water chemistry results: Baptism River subwatershed, East Branch Baptism River.

Station location:	Baptism River, East Branch, 1 mi. NE of Finland at snowmobile trail bridge						
STORET/EQuIS ID:	S007-544						
Station #:	040101010111-01, Baptism River						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**WQ Standard[1]**	**# of WQ Exceedances[2]**
Ammonia-nitrogen	ug/L	10	0.01	0.6	0.2	16	0
Chloride	mg/L	10	1.4	2.5	1.9	230	0
Dissolved Oxygen	mg/L	15	6.3	8.9	7.5	7	2
pH		18	6.3	8.3	7.2	6.5 – 8.5	1
Secchi Tube	100 cm	19	85	>100	>100	> 55	0
Total suspended solids	mg/L	10	<1	3	2	10	0
Phosphorus	ug/L	10	9	18	14	50	0
Chlorophyll-a, Corrected	ug/L	0				7	
Escherichia coli (geometric mean)	MPN/100ml	14	25	98	49	126	0
Escherichia coli	MPN/100ml	14	6	488	89	1260	0
Inorganic nitrogen (nitrate and nitrite)	mg/L	10	0.04	0.2	0.1		
Kjeldahl nitrogen	mg/L	10	0.4	0.8	0.6		
Orthophosphate	ug/L	0					
Pheophytin-a	ug/L	0					
Specific Conductance	uS/cm	16	39	93	66		
Temperature, water	deg °C	18	11.5	24.2	18.6		
Sulfate	mg/L	10	<3	<3	<3		
Hardness	mg/L	10	17.4	41.7	31.2		

[1]Secchi Tube standard is a surrogate for the total suspended solids standard of 10 mg/L.

**Values in the table were compiled from data collected between May and September of 2013 and 2014, at the East Branch Baptism River outlet. This work was a component of Intensive Watershed Monitoring, but data from other locations on this water body may also have been used in the assessment process.

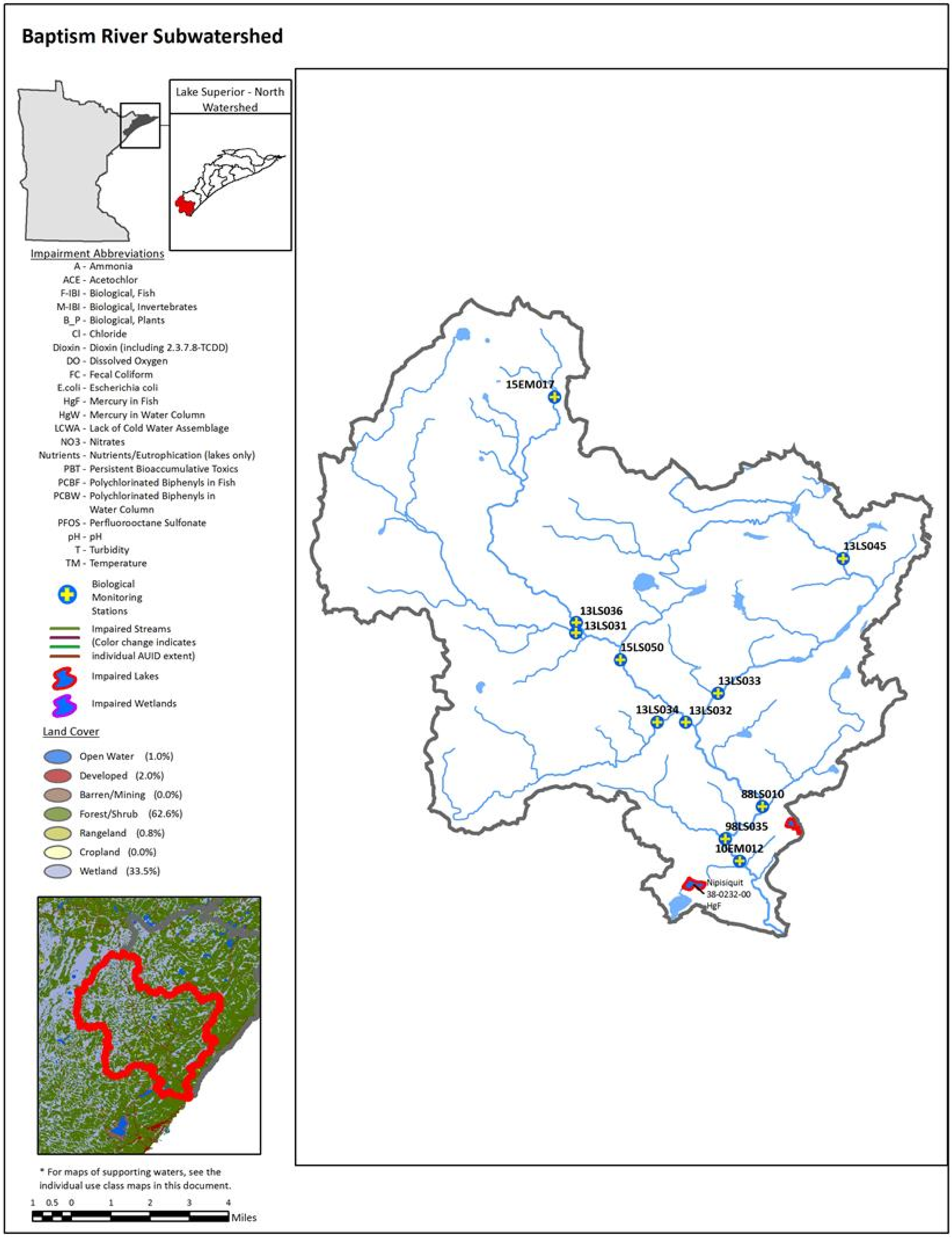


Figure 72. Baptism River subwatershed, land use characteristics and currently listed impaired waters by parameter.

Watershed-wide results and discussion

Assessment results and data summaries are included below for the entire Lake Superior – North Watershed, grouped by sample type. Summaries are provided for load monitoring conducted near the outlets of major Lake Superior tributaries, as well as aquatic life, recreation, and consumption uses in streams and lakes throughout the watershed. Groundwater monitoring results and long-term monitoring trends are included where applicable. A series of graphics provide an overall summary of assessment results by designated use, impaired waters, and fully supporting waters within the entire Lake Superior – North Watershed.

Watershed Pollutant Load Monitoring Network

Samples have been collected and loads calculated for the Poplar River and the Baptism River since 2009. The Brule River station was established in 2014; analysis and results are not available due to the short period of record.

Site Type	Stream Name	MNDNR/MPCA	EQuIS
Major Watershed	Poplar River near Lutsen, 0.2 mi upstream of MN61	H01063003	S004-406
Major Watershed	Baptism River near Beaver Bay, MN61	H01092001	S000-250
Subwatershed	Brule River near Hovland, MN61	H01022001	S000-251

Pollutant loads are influenced by land use, land management, watershed size, hydrology, climate, and other factors. Watershed size and differences in flow volume greatly influences pollutant loads; therefore, when comparing watersheds across a region or state, it is often useful to normalize the results for these differences. The flow weighted mean concentration (FWMC) is calculated by dividing the total load (mass) by the total flow volume, which normalizes load data for both spatial and volumetric difference in flow between watersheds. The FWMC is an estimate of the average concentration (mg/L) of a pollutant for the entire flow volume that passed the monitoring location over the monitoring season. This allows for the direct comparison of water quality between watersheds regardless of watershed size or annual discharge volume. In this report, WPLMN data will be expressed primarily as loads and FWMCs.

Many years of water quality data from throughout Minnesota combined with the previous analysis of Minnesota's ecoregion patterns, resulted in the development of three "River Nutrient Regions" (RNR), each with unique nutrient standards (MPCA 2013). The Poplar and Baptism Rivers' monitoring stations are located within the North RNR.

Annual flow weighed mean concentrations for the Poplar River and Baptism River were calculated for 2009 through 2013 and compared with North RNR standards (only TP and TSS river standards exist for Minnesota at this time) to give an indication of the overall water quality of the watersheds and compare year to year variability. It should be noted that while a FWMC exceeding a water quality standard is generally a good indicator that the water body is out of compliance with the RNR standard, the rule may not always hold true. Waters of the state are listed as impaired based on the percentage of individual samples exceeding the numeric standard, generally 10% and greater, over the most recent 10-year period (MPCA 2014a) and not based on comparisons with FWMCs. A river with a FWMC above a water quality standard, for example, would not be listed as impaired if less than 10% of the individual samples collected over the assessment period exceeded the standard.

Pollutant sources and source contributions affecting rivers can be diverse from one watershed to the next depending on land use, climate, soils, slopes, and other watershed factors. Regional correlations between land use, percent land disturbance, and water quality can be observed with Figure 73 and Figure 74. Elevated nutrient and sediment levels in streams and rivers can occur naturally in landscapes composed of young glacial soils, steep slopes or other natural factors; however, land use, percent disturbance and other anthropogenic influences also strongly influence measured water quality. As a general rule, elevated levels of total suspended solids (TSS) and nitrate plus nitrite-nitrogen (NO_3+NO_2-N) are regarded as "non-point" source derived pollutants originating from many small diffuse sources such as urban or agricultural runoff. Excess phosphorus and dissolved orthophosphate (DOP) can be attributed to both non-point as well as point sources such as industrial or waste water treatment plants. Major "non-point" sources of phosphorus include dissolved phosphorus from fertilizers and phosphorus adsorbed to and transported with sediment during runoff.

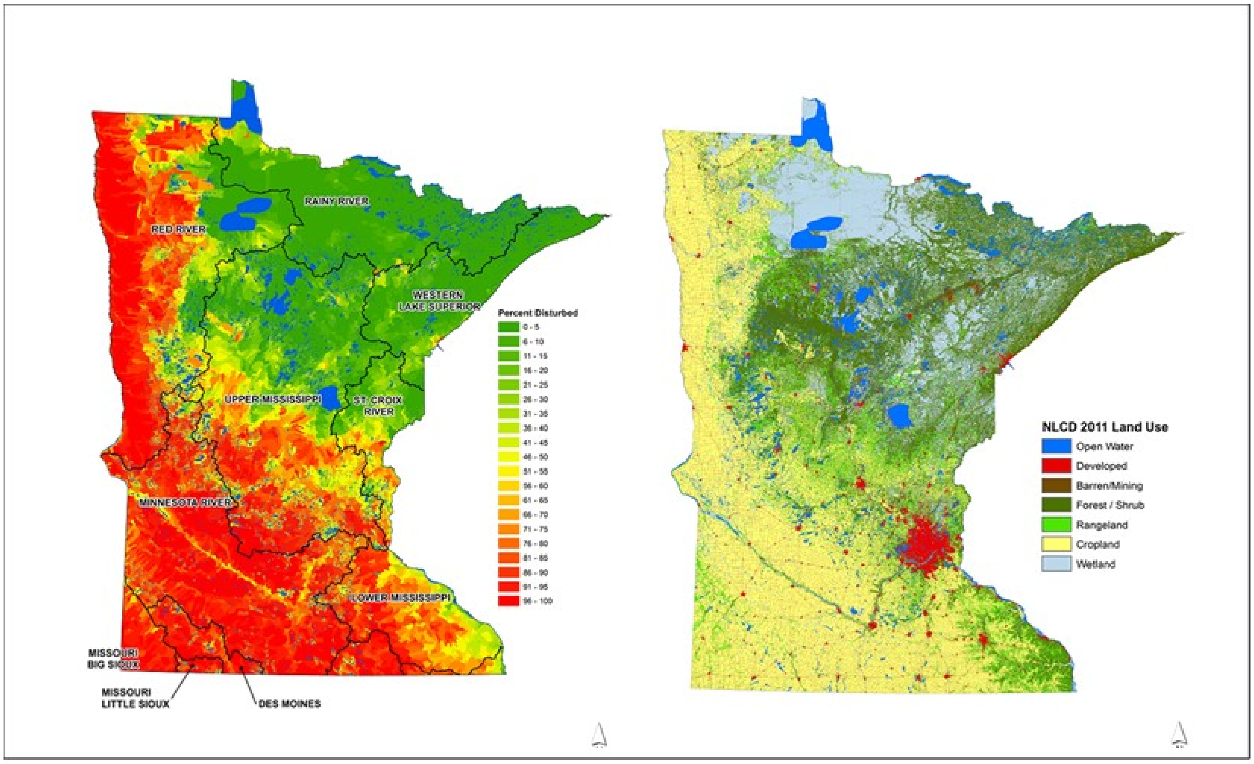


Figure 73. Percent land disturbance and NLCD 2011 land use for the state of Minnesota.

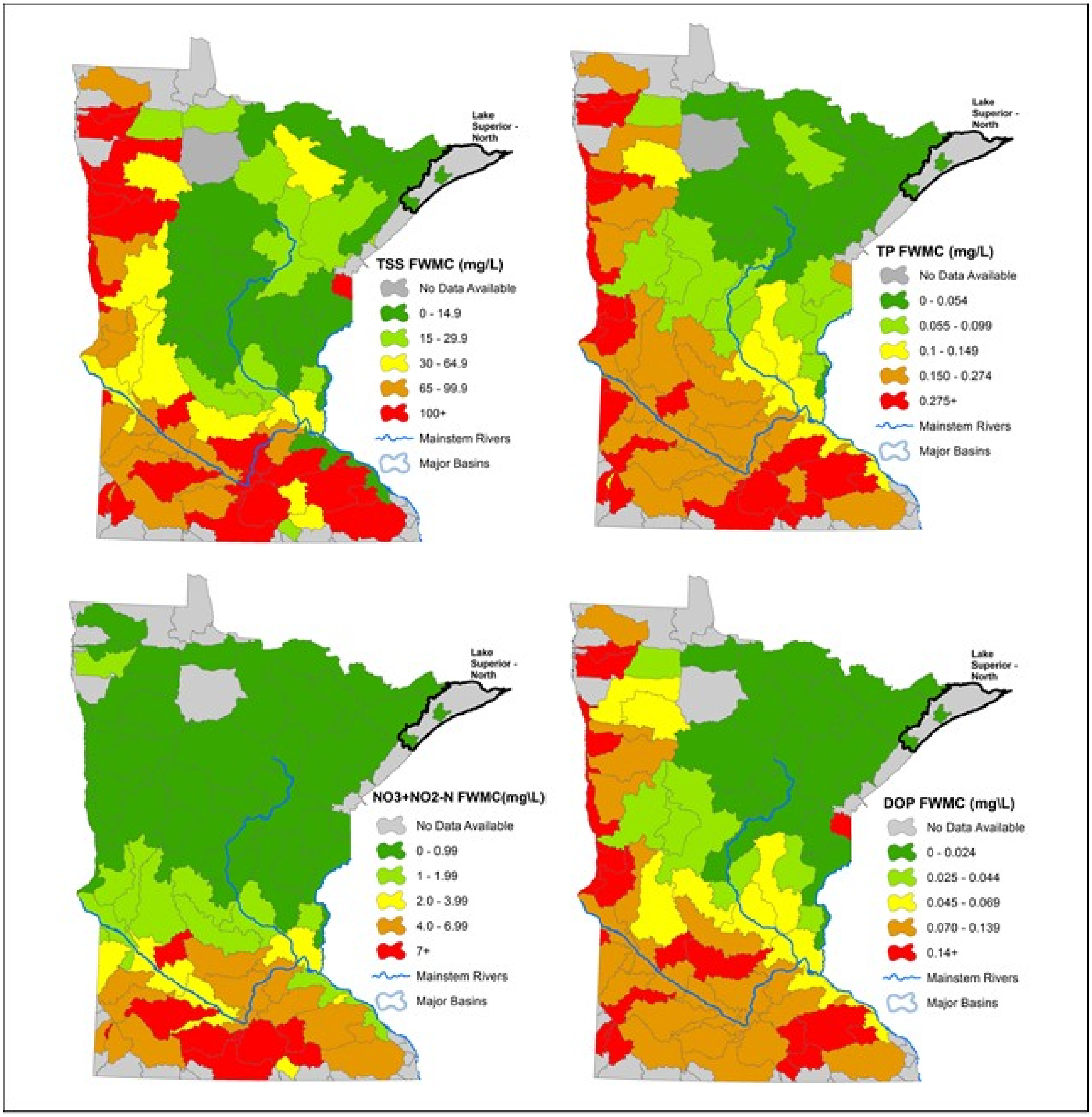


Figure 74. 2007-2013 WPLMN average annual TSS, TP, NO3-NO2-N and DOP FWMCs by major watershed.

Within a given watershed, pollutant sources and source contributions can also be quite variable from one runoff event to the next depending on factors such as: vegetative canopy development, soil conditions (frozen/unfrozen saturation level, etc.), and precipitation type, intensity, and amount. Surface erosion and in-stream sediment concentrations, for example, will typically be much higher following high intensity rain events prior to canopy development when compared to post-canopy events where soils are more protected and less surface runoff and more infiltration occur. Precipitation type and intensity can influence the major course of storm runoff, routing water through several potential pathways including overland, shallow and deep groundwater, or through artificial agricultural and urban drainage networks. Runoff pathways along with other factors determine the type and levels of pollutants transported in runoff to receiving waters and help explain between-storm and temporal differences in in-stream pollutant concentrations. Pollutant loads, the product of concentration and flow, are influenced not only by in-stream pollutant concentrations but also the volume of runoff delivered to the stream. During years when high intensity rain events provide the greatest proportion of total annual runoff, FWMCs of TSS and TP tend to be higher and DOP and NO3+NO2-N concentrations tend to be lower. In contrast, during years with high snow melt runoff and less intense rainfall events, TSS FWMCs tend to be lower while DOP and NO3+NO2-N levels tend to be elevated. Total phosphorus concentrations can be high from both runoff sources although storm generated runoff will typically have a greater proportion of sediment bound phosphorus resulting in lower DOP/TP ratios when compared to snowmelt runoff. Years with larger runoff volumes will typically have larger loads when compared to years with lesser runoff volumes. Table 48 compared to Figure 28 and Figure 29 illustrates this trend.

Table 48. Annual pollutant loads (kg) for the Poplar and Baptism rivers.

Parameter	2009		2010		2011		2012		2013	
	Poplar	Baptism	Poplar	Baptism	Poplar	Baptism	Poplar	Baptism	Poplar	Baptism
TSS	822,434	484,722	369,941	823,445	515,002	671,217	338,833	875,300	803,922	772,216
TP	1,989	2,214	1,248	2,576	1,590	2,239	*	*	*	*
DOP	604	495	423	767	534	651	370	757	547	471
NO_3+NO_2-N	18,399	17,178	10,184	20,883	15,408	17,507	16,872	24,397	23,455	23,990
TKN	48,376	61,518	36,140	91,991	50,884	66,730	42,018	86,759	71,771	73,321

*TP loads were not modeled in 2012 and 2013 due to laboratory equipment errors.

Total suspended solids

Water clarity refers to the transparency of water. Turbidity is a measure of the lack of transparency or "cloudiness" of water due to the presence of suspended and colloidal materials such as clay, silt, finely divided organic and inorganic matter, and plankton or other microscopic organisms. By definition, turbidity is caused primarily by suspension of particles that are smaller than one micron in diameter in the water column.

A strong correlation exists between TSS and turbidity. The greater the level of TSS, the murkier the water appears and the higher the measured turbidity. High turbidity results in reduced light penetration that harms beneficial aquatic species and favors undesirable algae species. An overabundance of algae can also lead to increases in turbidity, further compounding the problem. Periods of high turbidity often occur when heavy rains fall on unprotected soils. Upon impact, raindrops dislodge soil particles and overland flow transports fine particles of silt and clay into rivers and streams.

Minnesota's water quality standards for river eutrophication and total suspended solids were adopted by the state and approved by the EPA in 2015. Within the North RNR, a river is considered impaired when greater than 10% of the individual samples exceed the TSS standard of 15 mg/L (MPCA 2014a). From 2009 through 2013, 10% of the 159 water quality samples collected at the Baptism River and 13% of the 149 water quality samples from the Poplar River monitoring site exceeded this standard. Compared to other 8-digit HUC watersheds throughout the state, the average annual TSS FWMC for the Poplar and Baptism watersheds tends to be lower; in general, most northeastern watersheds have low annual FWMCs for TSS (Figure 73).

Seasonality and climate influence the timing and size of TSS loads. The majority of the average annual flow volume and average annual TSS load pass through the Baptism and Poplar watersheds between "ice-out" and early summer (Figure 76,Figure 77). This corresponds with a period when vegetative canopy is lacking or minimal. Between 2009 and 2013, 85% of the Baptism River's TSS load occurred between March and June. The Poplar River showed a later response with most of the load (81%) passing through the system between April through June. This is likely due to ice-out occurring later in the Poplar River Watershed.

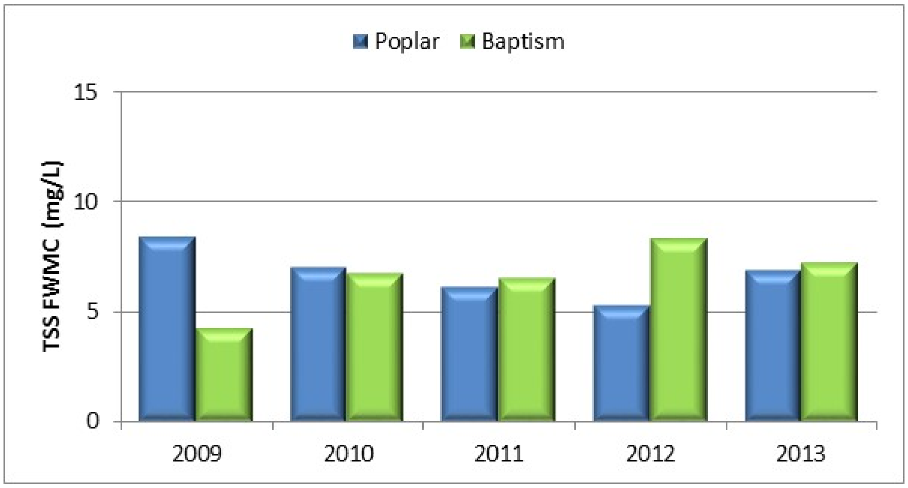


Figure 75. Total suspended solids, flow weighted mean concentrations for the Poplar and Baptism rivers.

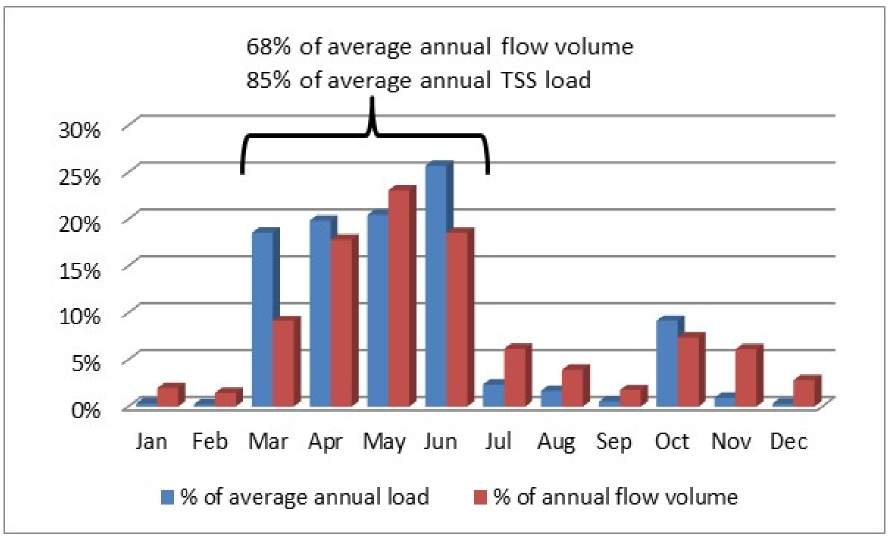


Figure 76. Monthly percentages of the average annual TSS load and flow volume for the Baptism River, 2009-2013.

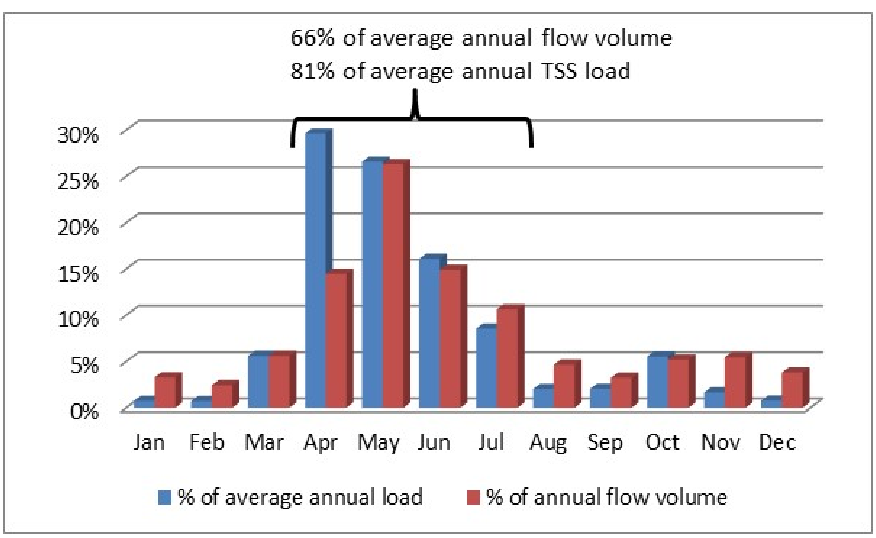


Figure 77. Monthly percentages of the average annual TSS load and flow volume for the Poplar River, 2009-2013.

Flow conditions under which violations in Minnesota's TSS standard are most likely to occur for the Poplar and Baptism rivers are best illustrated with a TSS load duration curve (Figure 78,Figure 79). A load duration curve of is a plot of daily loads computed from TSS sample concentrations plotted against the exceedance curve, above which daily loads are considered non-compliant with TSS water quality standards for the north RNR.

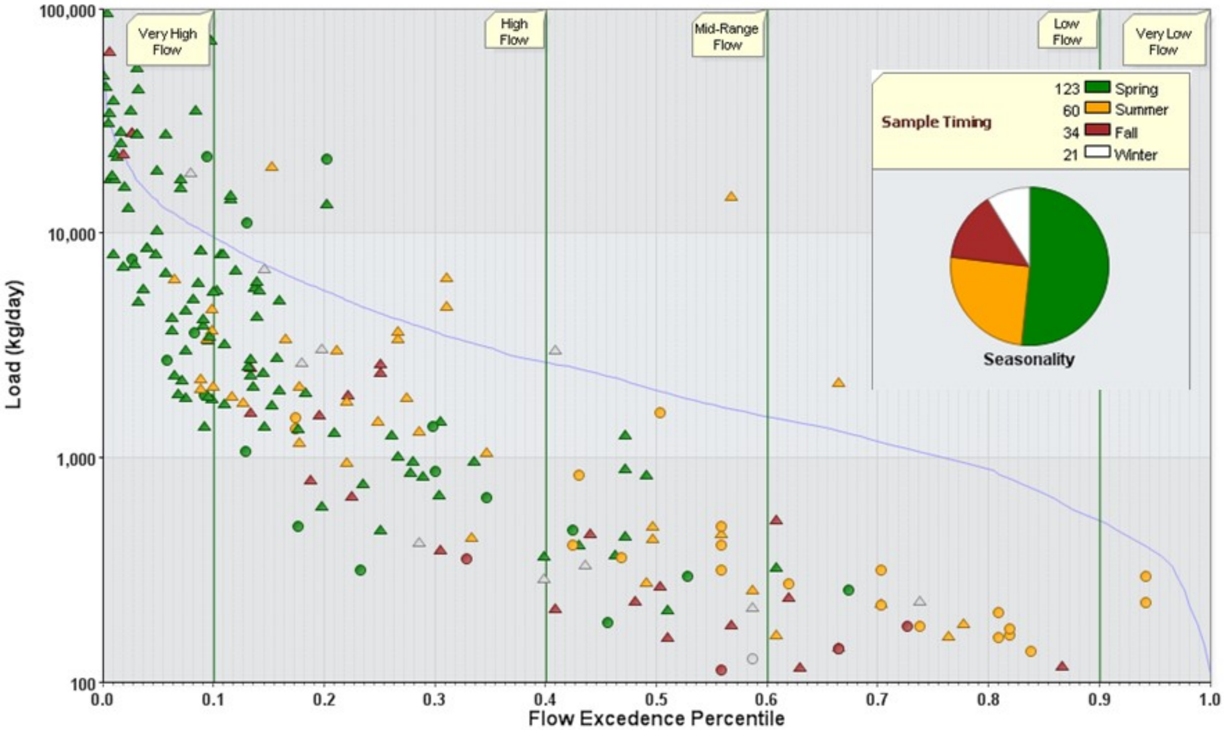


Figure 78. TSS load duration curve for the Poplar River, 1985-2015.

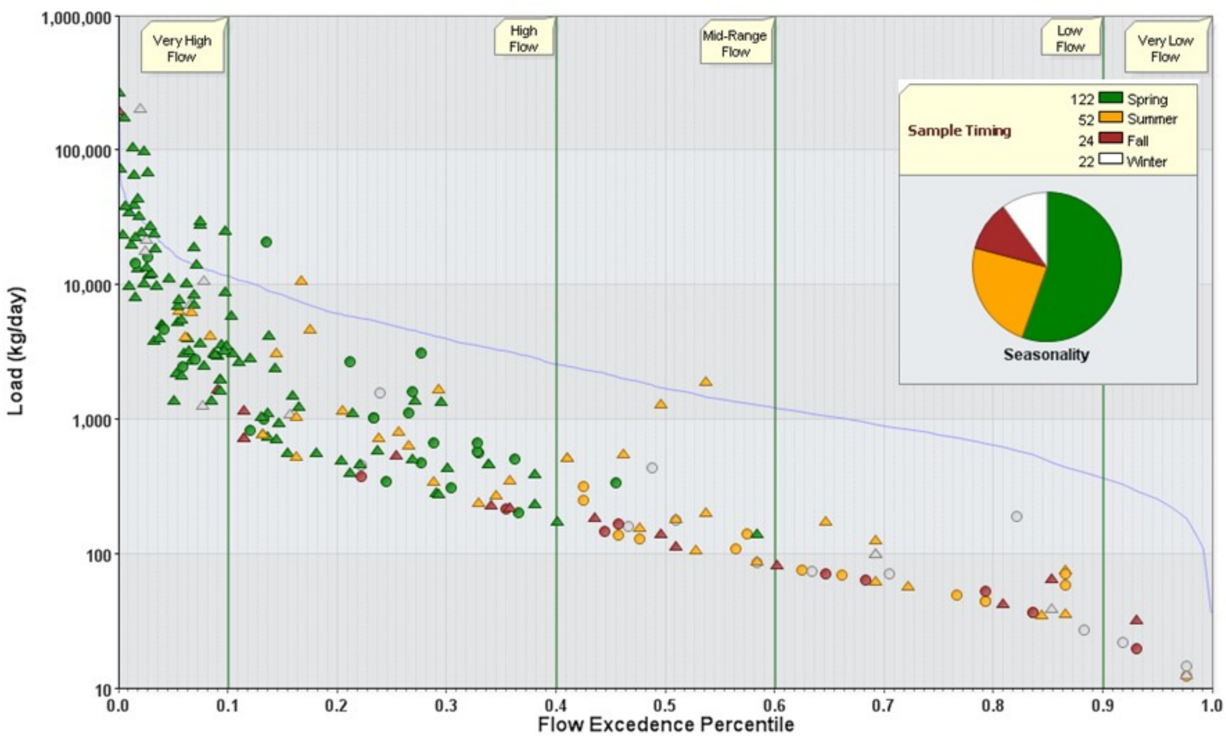


Figure 79. TSS load duration curve for the Baptism River, 2008-2015.

For both the Baptism and Poplar rivers, most exceedances of the TSS standard occur during the spring under “very high flow conditions”, when overland flow can be a significant sediment source. Certain characteristics of these watersheds (clay soils, shallow depth to bedrock and steep slopes) also contribute to high TSS concentrations during high flow conditions. As an example of the “flashy” nature of these streams, a large rain event in the Baptism River in June 2012 resulted in 57% of the annual TSS load passing through the site in only three days. Over the course of seven days in April 2011 (ice-out conditions), the Poplar transported 37% of its annual TSS load. In general, these watersheds have good water quality, but some exceedances of water quality standards occur during high flow events.

Total phosphorus

Nitrogen, phosphorus, and potassium are essential macronutrients and are required for growth by all animals and plants. In freshwater systems, phosphorus is typically the nutrient limiting growth; increasing the amount of phosphorus in a stream or lake will typically increase the growth of aquatic plants and other organisms, which in turn may impact water quality. Elevated levels of phosphorus in rivers and streams can result in: increased algae growth, reduced water clarity, reduced oxygen in the water, fish kills, altered fisheries, and toxins from cyanobacteria (blue green algae) which can affect human and animal health.

Within the north RNR, a violation of Minnesota’s water quality standard for river eutrophication occurs when the TP summer mean concentration (June through September) is at or above 0.055 mg/L, along with a summer average violation of one or more “response” variables (pH, biological oxygen demand, dissolved oxygen flux, chlorophyll-a). The 2012 and 2013 TP data was not included due to analytical equipment errors at the MDH Environmental Laboratory. Among the 2009-2011 TP data collected from the Baptism River, only 6 of 86 samples (7%) exceeded the north RNR TP standard, and only two exceedances occurred during summer months. Phosphorus levels on the Poplar River were similar; only 2 of 77 samples exceeded the north RNR standard. Total phosphorus FWMC were less than the standard in all years by over 50% (Figure 80). When compared with other 8-digit HUC watersheds in Minnesota, average annual TP FWMCs for the Poplar and Baptism rivers are very low.

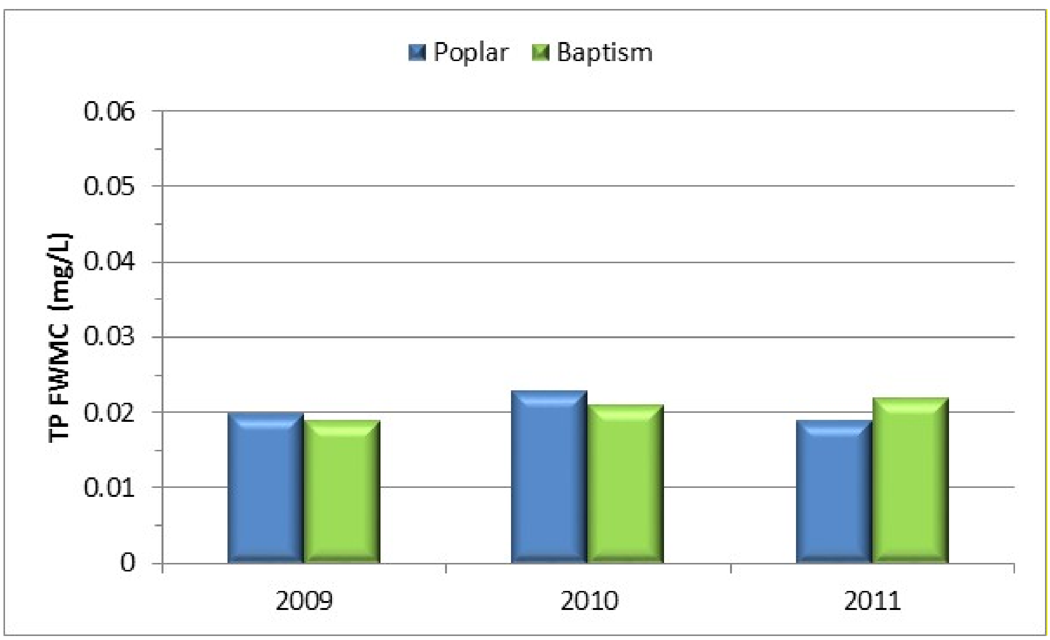


Figure 80. Total phosphorus flow weighted mean concentrations for the Poplar and Baptism rivers.

Similar to TSS, the majority of the Baptism and Poplar rivers' average annual TP loads passes through these systems between March and June. Interestingly, the Baptism River has a higher average load in March compared to the Poplar River, but in July the opposite occurs (monthly flow volume shows the same trend). Typically, the highest monthly proportion of the annual TP load for both rivers occurs in April, when ice out typically occurs (Figure 81).

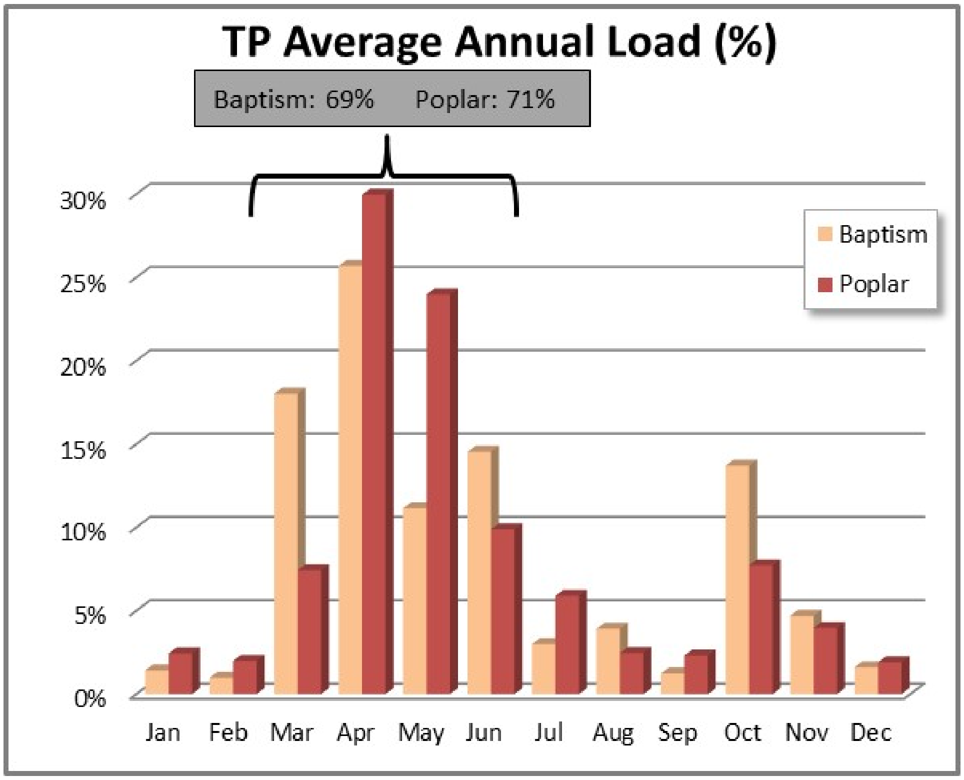


Figure 81. Monthly percentages of the average annual TP loads for the Baptism and Poplar rivers.

The highest concentrations of DOP are related to higher flows during summer months. DOP concentrations are typically somewhat elevated in March and April, but the highest concentrations are in the summer months. The two rivers' DOP:TP ratios from March and April and May through July are very similar (Table 49).

Table 49. Seasonality of DOP:TP ratios at Baptism and Poplar rivers.

	DOP:TP ratio (%)	
	March and April	**May - July**
Baptism	26	25
Poplar	31	32

Nitrate plus nitrite - nitrogen

Nitrate and nitrite-nitrogen are inorganic forms of nitrogen present within the environment that are formed through the oxidation of ammonia-nitrogen by nitrifying bacteria (nitrification). Ammonia-nitrogen is found in fertilizers, septic systems, and animal waste. Once converted from ammonia-nitrogen to nitrate and nitrite-nitrogen, they too, like phosphorus, can stimulate excessive levels of some algae species in streams. Because nitrate and nitrite-nitrogen are water soluble, transport to surface waters is enhanced through agricultural drainage. The ability of Nitrite-N to be readily converted to nitrate-nitrogen is the basis for the combined laboratory analysis of nitrate plus nitrite-nitrogen, with nitrite-nitrogen typically making up a small proportion of the combined total concentration. These and other forms of nitrogen exist naturally in aquatic environments; however, concentrations can vary drastically depending on season, biological activity, and anthropogenic inputs. Environmentally, studies have shown that the elevated nitrate-nitrogen levels in the Minnesota River basin contribute to hypoxia (low levels of dissolved oxygen) in the Gulf of Mexico. This occurs by nitrate-nitrogen stimulating the growth of algae which, through death and biological decomposition, consume large amounts of dissolved oxygen and thereby threaten aquatic life.

Nitrate-N can also be a common toxicant to aquatic organisms in Minnesota's surface waters with invertebrates appearing to be the most sensitive to nitrate toxicity. Draft Nitrate-N standards have been proposed for the protection of aquatic life in lakes and streams. A draft acute value (maximum standard) for all Class 2 surface waters is 4.1 mg/L Nitrate-N for a 1-day duration, and the draft chronic value for Class 2B (warm water) surface waters is 4.9 mg/L Nitrate-N for a 4-day duration. In addition, a draft chronic value of 3.1 mg/L nitrate- N (4-day duration) was determined for protection of Class 2A (cold water) surface waters (MPCA 2010).

Infants less than six months old who drink water with high levels of nitrate can become critically ill and develop methemoglobinemia, which is also known as "Blue Baby Syndrome". As such, the MDH has set a standard of 10 mg/L for nitrate in drinking water. For means of this discussion, data comparisons will be limited to MDH Drinking Water Standard.

From a statewide perspective, the average annual NO_3+NO_2-N FWMCs are highest in the southern part of the state (Figure 74). These FWMCs are several times higher than watersheds north of the Twin Cities metropolitan area. Watersheds characterized as having low or medium levels of nitrate generally have more land in forest or grasses, more in wetlands, more in small grains, and less land in row crops and tile drainage (MPCA 2013).

Figure 82 shows the NO_3+ NO_2-N FWMCs for the Baptism and Poplar rivers. These FWMCs are some of the lowest in Minnesota. Both sites had about 150 samples collected from 2009-2013 of which the maximum concentration was 1.7 mg/L at the Baptism and 1.8 mg/L at the Poplar.

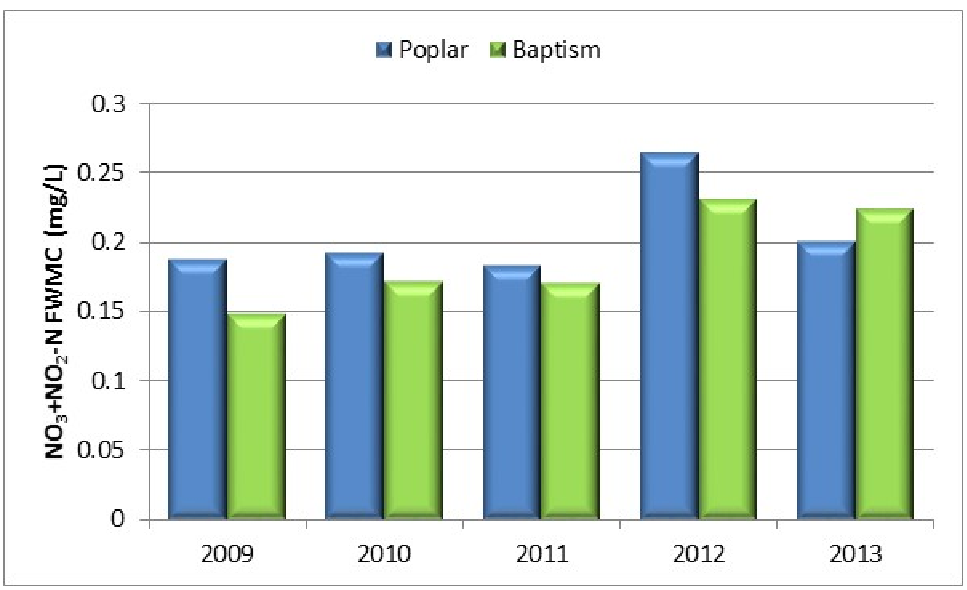


Figure 82. Nitrate + nitrite nitrogen flow weighted mean concentrations for the Poplar and Baptism rivers.

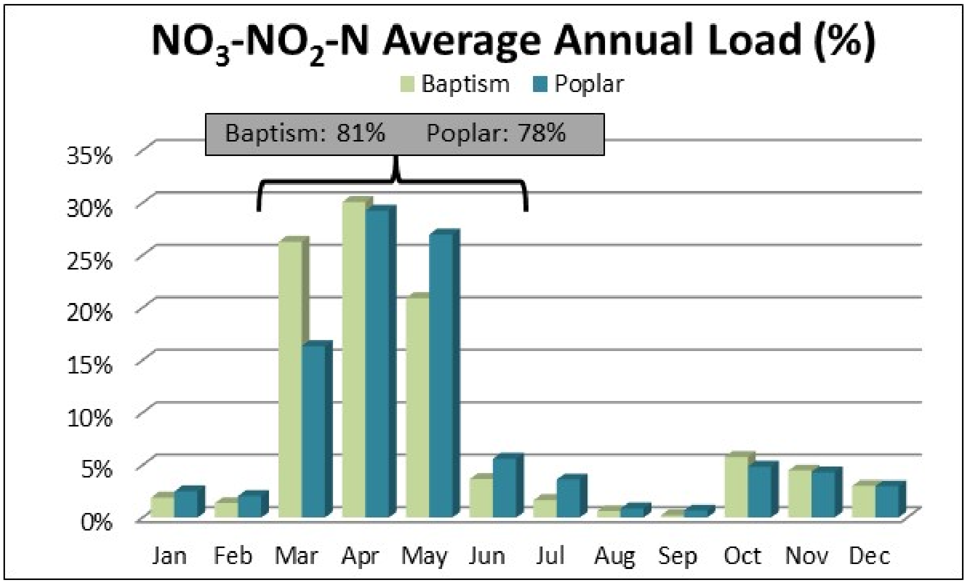


Figure 83. Nitrate + nitrite nitrogen average annual load for the Poplar and Baptism rivers.

Seasonal NO_3+ NO_2-N load dynamics are similar to TSS, TP and runoff with approximately 80% of the load (Figure 83) passing through the system beginning in March and running through the end of June. Highest concentrations are typically seen during ice out for both sites.

Annual runoff volume has a direct relationship to annual NO_3+ NO_2-N loads. The highest load for the Poplar River was in 2013 which corresponds with the highest runoff. For the Baptism, the relationship is not as evident because runoff has not varied much over the time period. In review of the concentration data, the top 10% of values occurred from March through May (there was one exception, a sample in January).

Stream water quality

Water quality assessments were conducted on 67 stream reaches (AUIDs) in the Lake Superior – North Watershed (Table 50). Of these, 63 were found to fully support aquatic life and 18 were found to fully support aquatic recreation. Three stream reaches were found to be impaired for aquatic life; in all cases the impairment was related to high levels of suspended sediment (TSS). Twenty-eight stream reaches met exceptional use biocriteria based on fish and macroinvertebrate IBI scores. No stream reaches were impaired for aquatic recreation.

Table 50. Stream water quality assessment summary, Lake Superior – North Watershed.

				TALU		Supporting		Non-supporting			
Watershed	**Area (acres)**	**Total AUIDs**	**Assessed AUIDs**	**General Use**	**Exceptional Use**	**Aquatic Life**	**Aquatic Recreation**	**Aquatic Life**	**Aquatic Recreation**	**Insufficient Data**	**Delistings**
Lake Superior - North (HUC8)	**1,015,808**	**768**	**67**	**37**	**28**	**63**	**18**	**3**	**0**	**3**	**0**
Arrow River Subwatershed	18,560	0	0	0	0	0	0	0	0	0	0
Pigeon River Subwatershed	130,176	47	7	3	3	6	1	0	0	1	0
Flute Reed River Subwatershed	60,032	49	2	2	0	0	1	2	0	0	0
Brule River Subwatershed	169,728	96	10	7	3	10	3	0	0	0	0
Devil Track River Subwatershed	87,360	133	8	2	6	8	3	0	0	0	0
Cascade River Subwatershed	87,808	86	4	2	2	4	1	0	0	0	0
Poplar River Subwatershed	97,024	60	7	5	1	6	3	1	0	0	0
Temperance River Subwatershed	117,952	79	5	2	3	5	1	0	0	0	0
Cross River Subwatershed	69,248	41	8	4	4	8	1	0	0	1	0
Manitou River Subwatershed	89,344	79	8	5	3	8	1	0	0	1	0
Baptism River Subwatershed	88,576	98	8	5	3	8	3	0	0	0	0

Lake water quality

Water quality assessments were conducted on 135 lakes in the Lake Superior – North Watershed. Of these, 89 were found to fully support aquatic recreation. No lake aquatic recreation impairments were found. Of the 27 Lake Superior beaches that were monitored in the course of this study, all were assessed as meeting recreational use, with E. coli concentrations consistently below EPA BEACH Act standards.

Table 51. Assessment summary for lake water chemistry in the Lake Superior – North Watershed.

			Supporting		Non-supporting			
Watershed	**Area (acres)**	**Lakes >10 Acres**	**# Aquatic Life**	**# Aquatic Recreation**	**# Aquatic Life**	**# Aquatic Recreation**	**Insufficient Data**	**# Delistings**
Lake Superior - North	1,015,808	578	0	89	0	0	46	0
Arrow River (0401010101)	18,560	19	0	9	0	0	0	0
Pigeon River (0401010102)	130,176	95	0	11	0	0	8	0
Flute Reed River (0401010103)	60,032	13	0	0	0	0	0	0
Brule River (0401010104)	169,728	162	0	25	0	0	12	0
Devil Track River (0401010105)	87,360	34	0	10	0	0	0	0
Cascade River (0401010106)	87,808	49	0	6	0	0	3	0
Poplar River (0401010107)	97,024	42	0	12	0	0	3	0
Temperance River (0401010108)	117,952	61	0	5	0	0	15	0
Cross River (0401010109)	69,248	49	0	8	0	0	2	0
Manitou River (0401010110)	89,344	29	0	2	0	0	2	0
Baptism River (0401010111)	88,576	25	0	1	0	0	1	0

Fish contaminant results

Mercury was analyzed in fish tissue samples collected from 140 lakes in the watershed. Polychlorinated biphenyls (PCBs) were measured in fish from 83 lakes. Sixteen fish species from the lakes were tested for contaminants. A total of 4,789 fish were collected for contaminant analysis between 1981 and 2014. Fish species are identified by codes that are defined by their common and scientific names (Table 52).

Table 52. Fish species codes, common names, and scientific names.

SPECIES	COMMON NAME	SCIENTIFIC NAME
BGS	Bluegill sunfish	Lepomis macrochirus
BKS	Black crappie	Pomoxis nigromaculatis
BKT	Brook trout	Salvelinus fontinalis
BT	Brown trout	Salmo trutta
CIS	Cisco (Lake herring)	Coregonus artedi
LT	Lake trout	Salvelinus namaycush
LWH	Lake whitefish	Coregonus clupeaformis
ML	Muskellunge	Esox masquinongy
NP	Northern pike	Esox lucius
RBT	Rainbow trout	Salmo gairdneri
SF	Pumpkinseed sunfish	Lepomis gibbosus
SMB	Smallmouth bass	Micropterus dolomieue
SPL	Splake	Salvelinus namaycush (f.) X fontinalis (m.)
WE	Walleye	Sander vitreus
WSU	White sucker	Catostomus commersoni
YP	Yellow perch	Perca flavescens

Contaminant concentrations are summarized by waterway, fish species, and year (Appendix 8). “Total Fish” is the total number of fish analyzed and “N” is the number of samples. The number of fish exceeds the number of samples when fish are combined into a composite sample. This was typically done for panfish, such as bluegill sunfish and yellow perch. “Anat.” refers to the sample anatomy. Since 1989, most of the samples have been skin-on fillets (FILSK) or for fish without scales (catfish and bullheads), skin-off fillets (FILET). Occasionally whole fish (WHORG) are analyzed.

Ninety-nine lakes are listed as impaired for mercury in fish tissue (MPCA 2014a). Impaired waters are identified in Appendix 8 with a red asterisk (*). Only Winchell Lake (1635400) is also listed as impaired for PCBs in fish tissue. All of the impaired waterways, except Holly Lake (16036600), are covered under the Statewide Mercury TMDL and do not need additional TMDLs for mercury in fish tissue.

Most of the PCB concentrations in fish tissue were near or below the reporting limit (0.01 mg/kg). The highest PCB concentration was 0.608 mg/kg in a lake trout collected from Trout Lake (16004900) in 1981.

Overall, mercury remains the dominant fish contaminant in the watershed. The Fish Contaminant Monitoring Program will continue to retest the fish from impaired waters to assess if mercury levels are changing.

Groundwater monitoring

Groundwater quality

There are currently no MPCA ambient groundwater monitoring wells within the Lake Superior – North Watershed. However, from 1992 to 1996, the MPCA conducted baseline water quality sampling and analysis of Minnesota’s principal aquifers based on hydrogeologic regions. The Lake Superior – North Watershed lies within the northeast region. The baseline study determined that the groundwater quality in this region is considered good when compared to other areas with similar aquifers, but there were some exceedances of drinking water criteria for arsenic, beryllium, boron, manganese and selenium (MPCA 1999). Concentrations of chemicals within the Precambrian aquifers were comparable to similar aquifers throughout the state and concentrations of major cations and anions were lower in the surficial and buried drift aquifers when compared to similar aquifers statewide (MPCA 1999). Many of the exceedances identified were contributed to geology, but some trace inorganic chemicals may be of concern locally. Volatile organic compounds were also detected in this region, with the most commonly detected compounds associated with well disinfection, atmospheric deposition and fuel oils (MPCA 1999).

Another source of information on groundwater quality comes from the MDH. Statewide, 10.7% of all newly constructed wells installed from 2008 to 2015 exceed 10 micrograms per liter; the maximum contaminant level (MCL) for drinking water (MDH 2015). In the Lake Superior – North Watershed, the majority of new wells are within the water quality standards for arsenic levels, but there are some exceedances to the MCL. When observing concentrations of arsenic by percentage of wells that exceed the MCL of 10 micrograms/liter per county, the watershed lays within counties that range from less than 5 to 15%. By county, the percentages of wells identified with concentrations exceeding the MCL are as follows: Cook (11.6%) and Lake (2.1%) counties (MDH 2015, Figure 84). For more information on arsenic in private wells, please refer to the MDH's website: http://www.health.state.mn.us/divs/eh/wells/waterquality/arsenic.html.

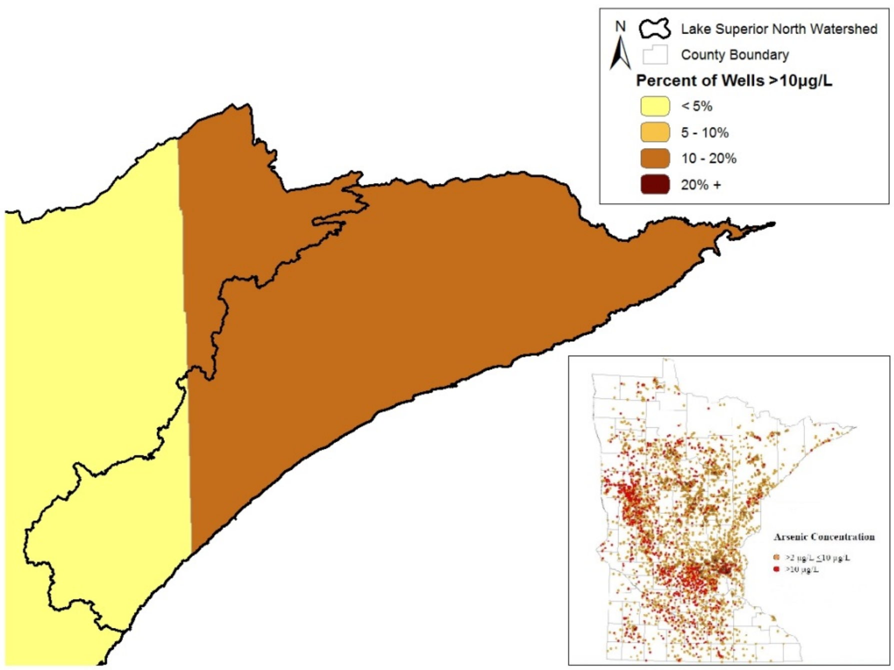


Figure 84. Percent wells with arsenic occurrence greater than the maximum contaminant level per county for the Lake Superior North Watershed (2008-2015). (Source: MDH, 2015)

Groundwater/surface water withdrawals

The three largest permitted consumers of water in Minnesota (in order) are power generation, public water supply (municipals), and irrigation (MNDNR 2015). According to the most recent USGS site-specific water-use data system (SWUDS), in 2013 the largest proportion (46.7%) of high capacity withdrawals within the Lake Superior – North Watershed were classified as "special categories" such as snow/ice making and dust control. The remaining withdrawals include: water supply (predominantly private) (41.3%), non-crop irrigation (golf courses) (11.2%), and industrial processing (0.79%). From 1994 to 2013, withdrawals associated with non-crop irrigation and special categories have increased significantly ($p=0.001$). Industrial Processing and water supply have remained relatively constant over this time

Figure 85 displays total high capacity withdrawal locations within the watershed with active permit status in 2013. Permitted groundwater withdrawals are displayed below as blue triangles and surface water withdrawals as red squares. During 1994 to 2013, groundwater withdrawals within the Lake Superior -North Watershed do not exhibit a statistically significant trend (Figure 86), while surface water withdrawals are increasing with a significant trend (p=0.001) (Figure 87).

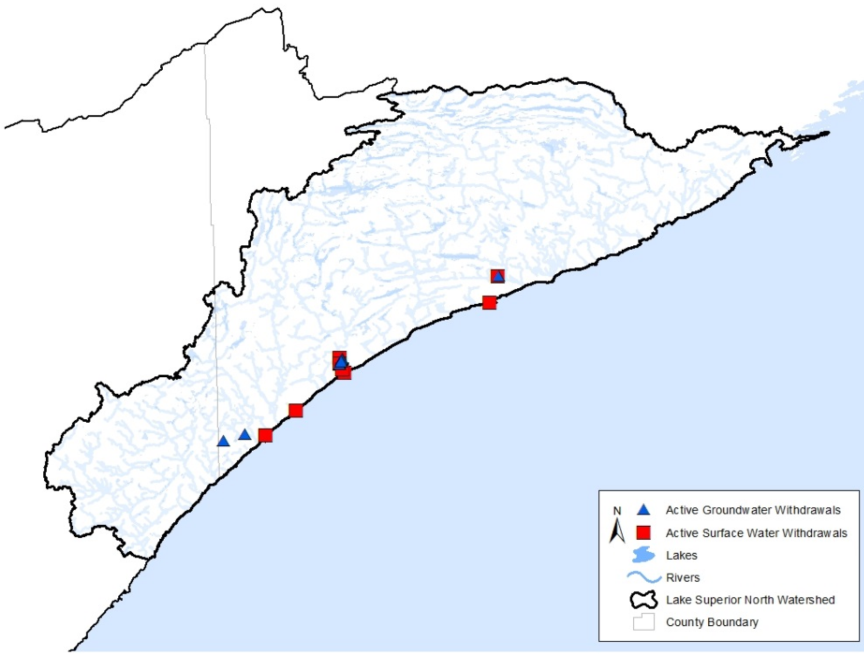


Figure 85. Locations of active status permitted high capacity withdrawals in 2013 within the Lake Superior North Watershed.

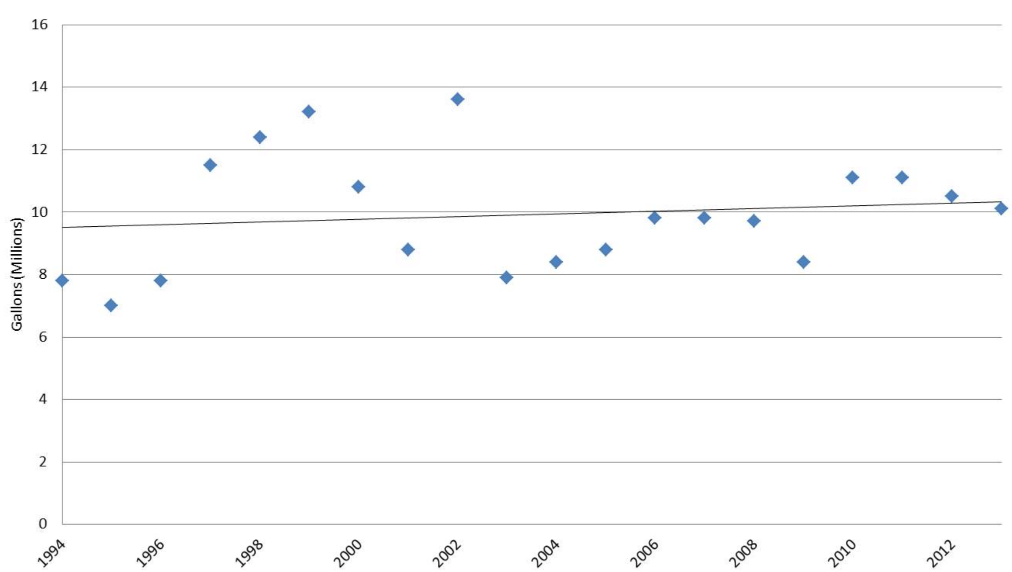


Figure 86. Total annual groundwater withdrawals in the Lake Superior North Watershed (1994-2013).

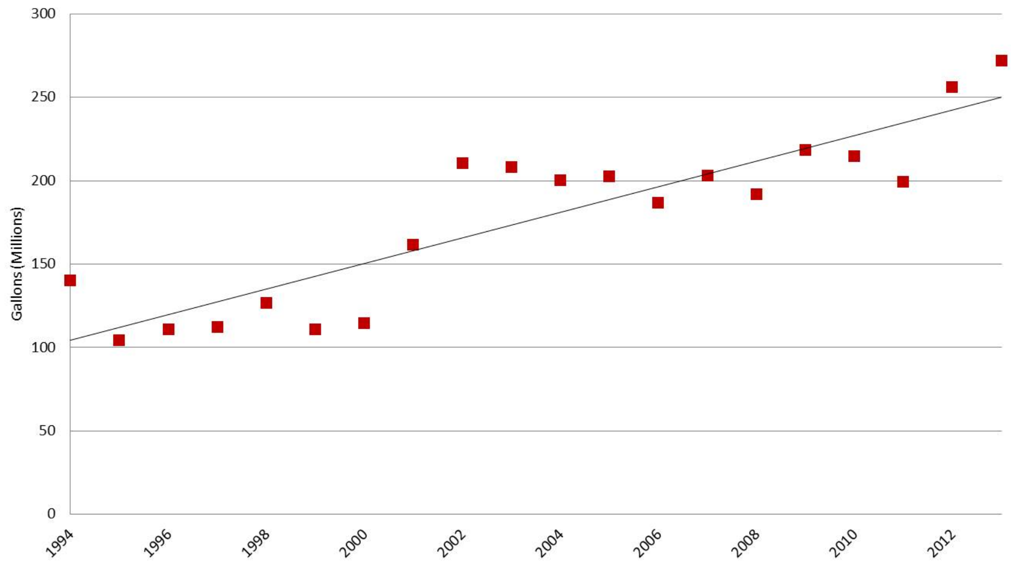


Figure 87. Total annual surface water withdrawals in the Lake Superior – North Watershed (1994-2013).

Stream flow

Streamflow data from the USGS's real-time streamflow gaging station for the Pigeon River was analyzed for annual mean discharge and summer monthly mean discharge (July and August). Figure 88 is a display of the annual mean discharge for the Pigeon River at Middle Falls near Grand Portage from water years 1996 to 2015. The data shows that although streamflow appears to be slightly decreasing, there is no statistically significant trend. Figure 89 displays July and August mean flows for water years 1996 to 2015 for the same water body. The data appear to be increasing in July and August, but not at a statistically significant rate. By way of comparison at a state level, summer month flows in Minnesota have declined at a statistically significant rate at a majority of streams selected randomly for a study of statewide trends (Streitz 2011). For additional streamflow data throughout Minnesota, please visit the USGS website: http://waterdata.usgs.gov/mn/nwis/rt.

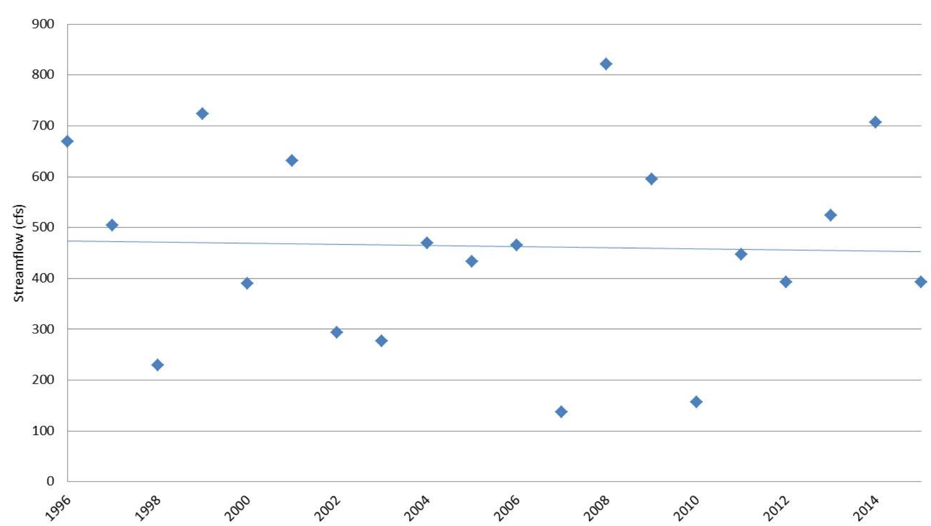


Figure 88. Annual mean discharge for Pigeon River at Middle Falls near Grand Portage, MN (1996-2015).

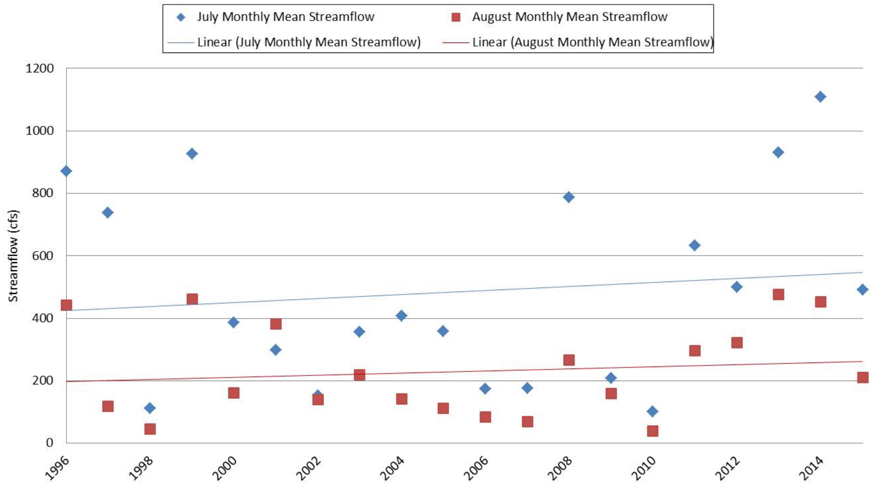


Figure 89. Mean monthly discharge for Pigeon River at Middle Falls near Grand Portage, MN (1996-2015).

Wetland condition

Overall vegetation quality is generally high in Minnesota's wetlands (Table 53). Wetlands in exceptional or good condition have had few (if any) changes in the expected native composition or the abundance distribution. However, wetland quality varies widely in different parts of the state. The vegetation quality of >80% of the wetland acreage in the Mixed Wood Shield is in exceptional-good condition. The exact opposite is true in both the Mixed Wood Plains and Temperate Prairies ecoregions—where >80% of the wetland extent is in fair or poor condition (i.e., moderate changes in native composition and structure to complete replacement by non-native invasive species). As approximately 75% of Minnesota's wetlands occur in the Mixed Wood Shield ecoregion, the high levels of good to exceptional condition found there largely masks the widespread degraded vegetation condition found in remainder of the state.

As the entire Lake Superior – North Watershed lies within the Mixed Wood Shield ecoregion, wetland vegetation quality in the watershed is expected to be high overall. A single wetland survey site was located within the watershed and was in good condition (only slight changes in the plant community compared to expected composition and abundance distribution). Wetland quality impacts are likely to be localized and associated with towns, poorly culverted roads, and/or harvesting black spruce in coniferous swamps.

Table 53. Vegetation condition of all wetlands by extent (MPCA 2015b).

Condition Category	Statewide	Mixed Wood Shield	Mixed Wood Plains	Temperate Prairies
Exceptional	49%	64%	6%	7%
Good	18%	20%	12%	11%
Fair	23%	16%	42%	40%
Poor	10%		40%	42%

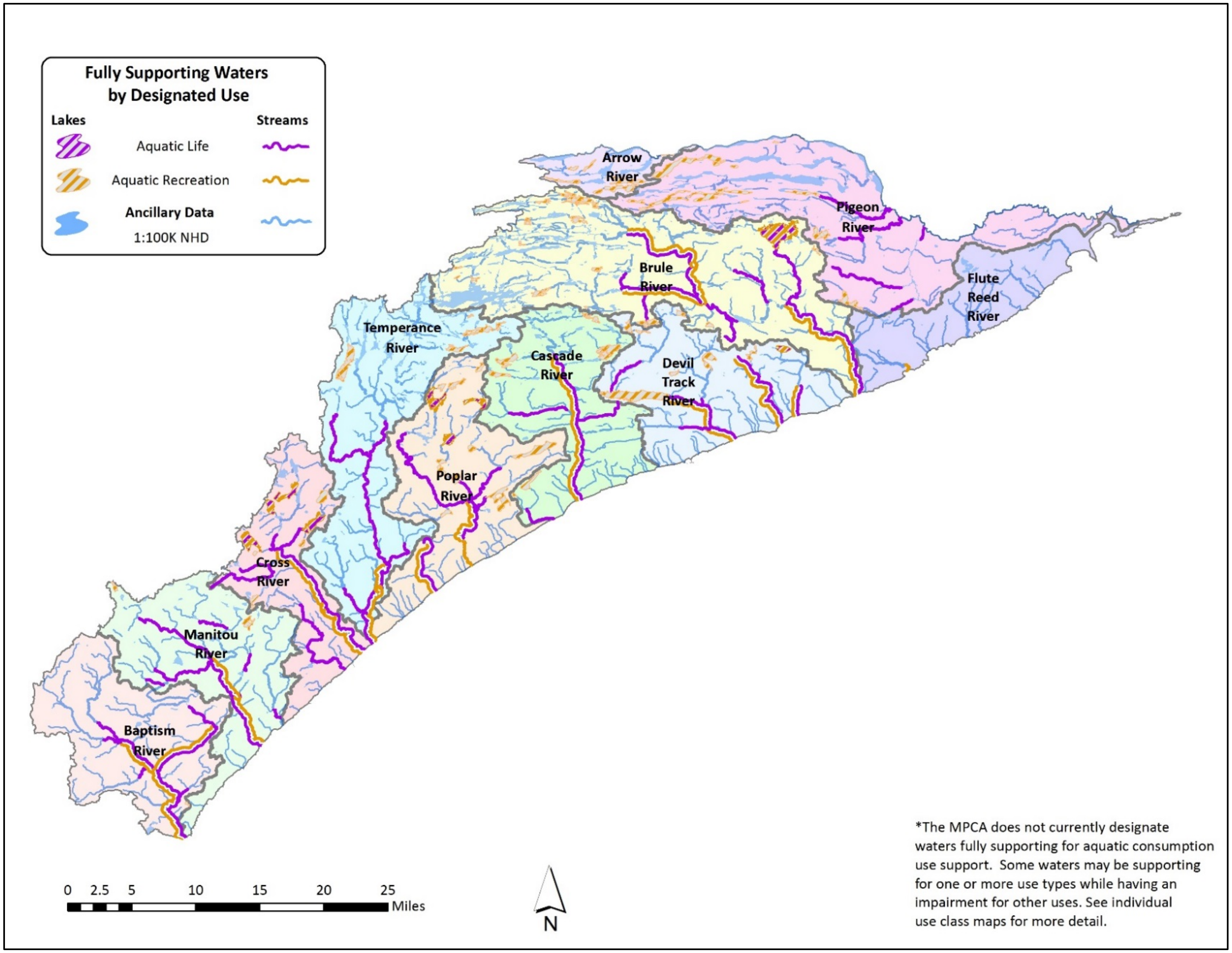


Figure 90. Fully supporting waters by designated use in the Lake Superior – North Watershed.

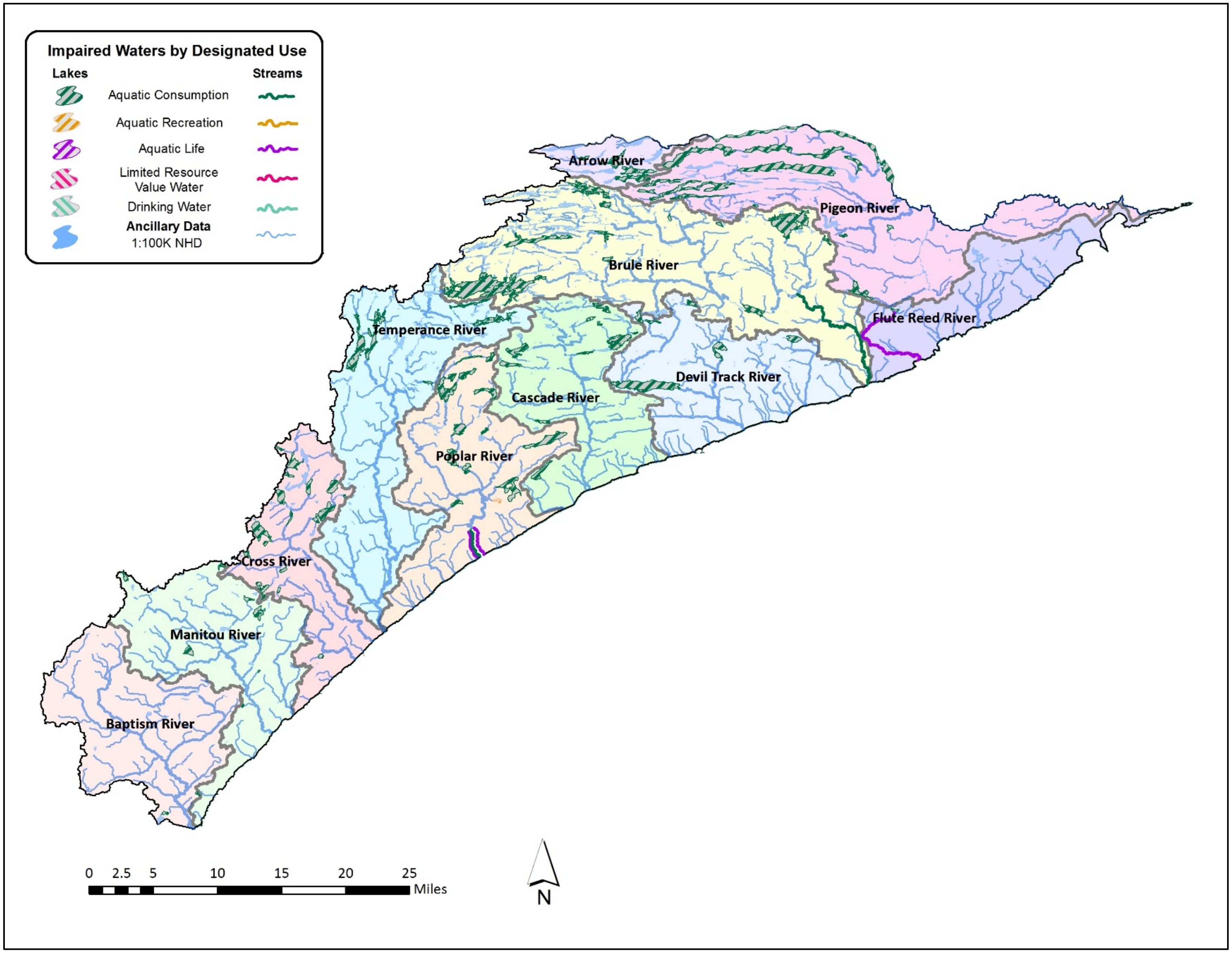


Figure 91. Impaired waters by designated use in the Lake Superior – North Watershed.

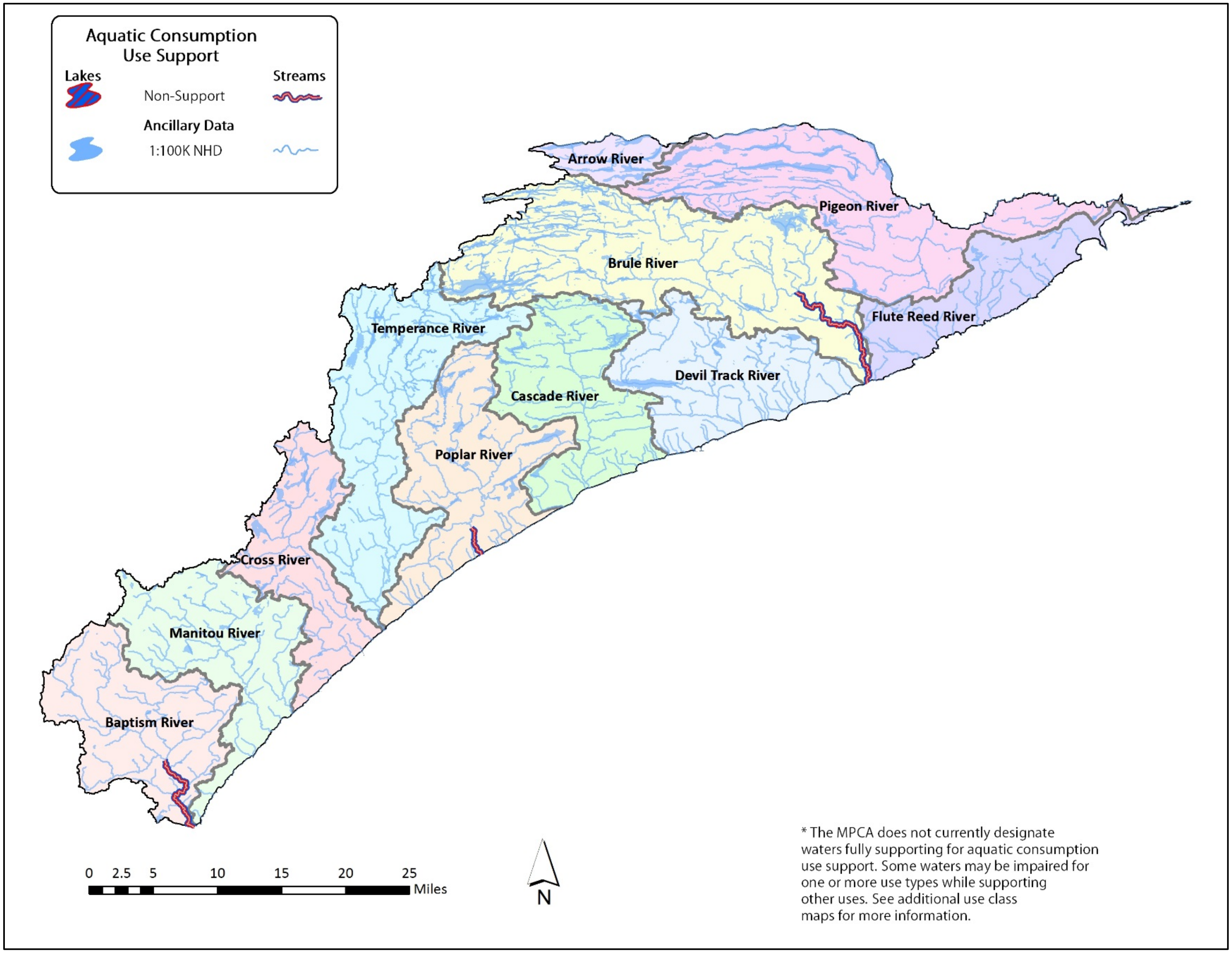


Figure 92. Aquatic consumption use support in the Lake Superior – North Watershed.

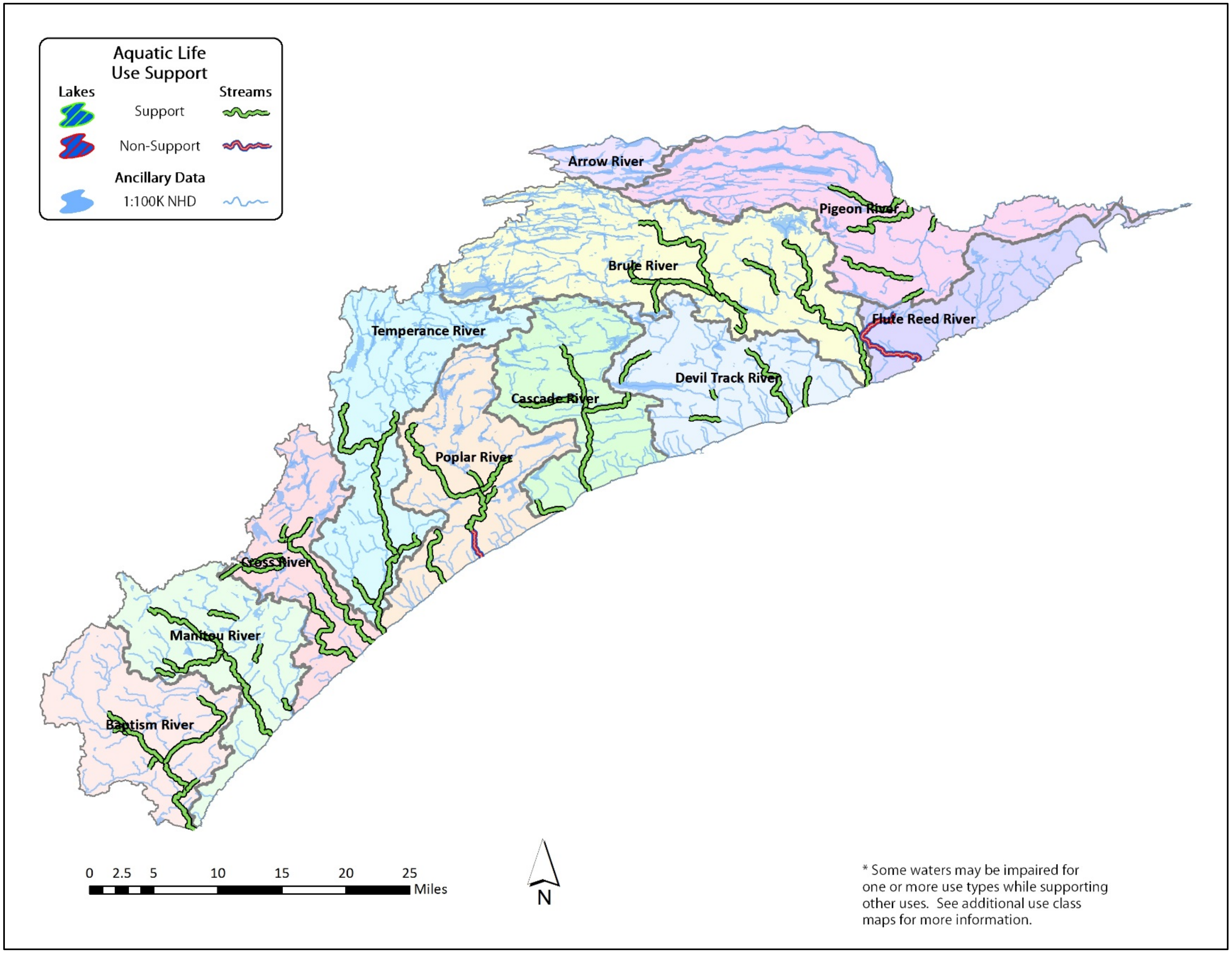


Figure 93. Aquatic life use support in the Lake Superior – North Watershed.

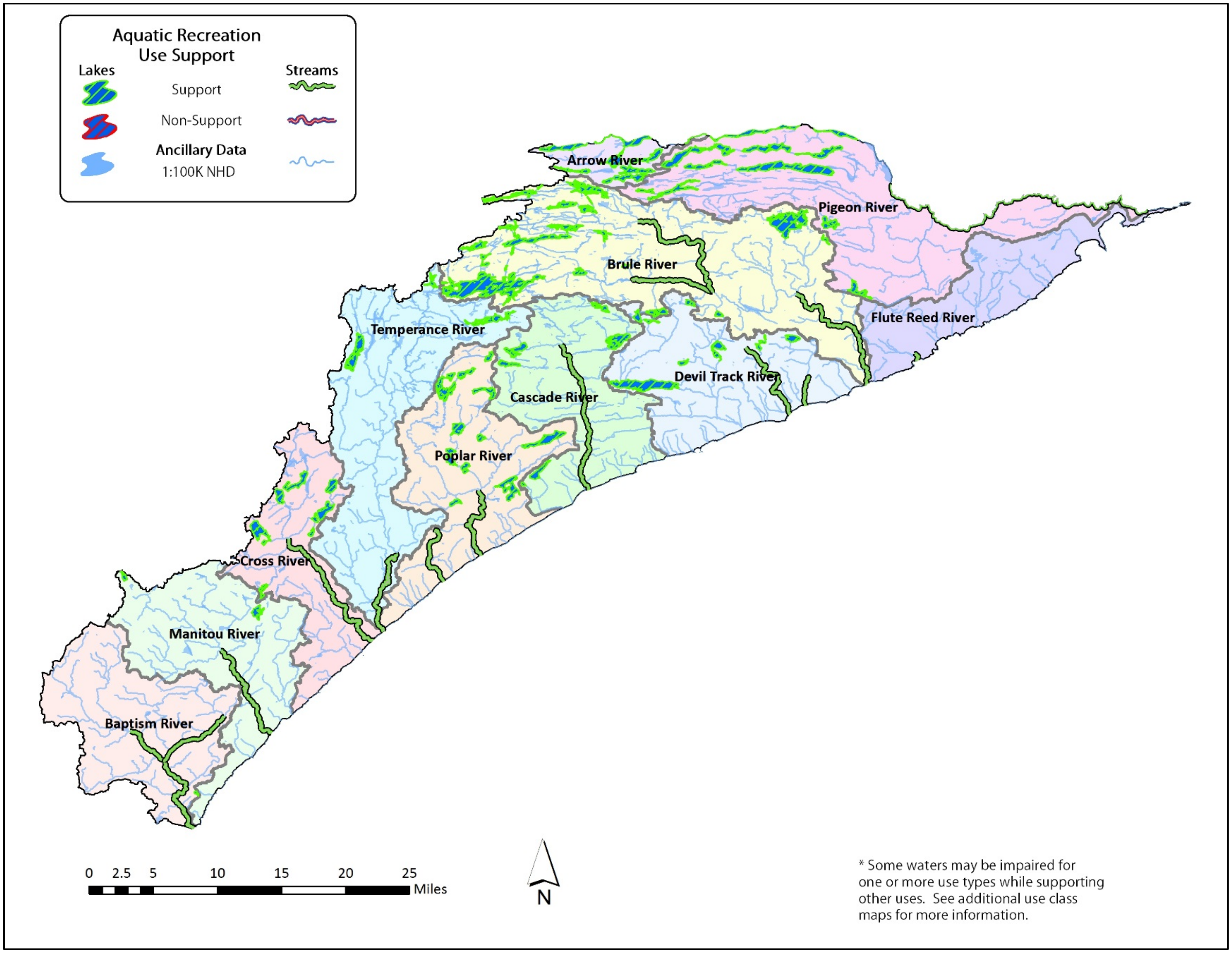


Figure 94. Aquatic recreation use support in the Lake Superior – North Watershed.

Pollutant trends for the Lake Superior – North Watershed

Water quality trends at long-term monitoring stations

The Lake Superior – North Watershed includes two long-term stream water chemistry monitoring stations (Brule River, Poplar River). Water chemistry data were analyzed for trends (Table 54) for the long term period of record (1973-2010) and near term period of record (1995-2010). There were significant decreases in TP during the long term period of record for both stations, and additionally for the short term period for the Brule River. No trends were observed at either station for TSS, nitrite/nitrate, ammonia, biochemical oxygen demand, or chloride; however, this may be the result of insufficient data, especially within the most recent time period.

Table 54. Pollutant trends in the Lake Superior – North Watershed.

	Total Suspended Solids	Total Phosphorus	Nitrite/ Nitrate	Ammonia	Biochemical Oxygen Demand	Chloride
Brule River, upstream of US-61 at Judge C.R. Magney State Park (S000-251)(BRU-0.4) (period of record 1973-2010)						
overall trend	**no trend**	**decrease**	**no trend**	**no trend**	**no trend**	**no trend**
estimated average annual change		-2.6%				
estimated total change		-63%				
1995-2010 trend	**no trend**	**decrease**	**no trend**	**no trend**	**no trend**	**no trend**
estimated average annual change		-5.0%				
estimated total change		-60%				
median concentrations first 10 years	1	0.02	0.03	0.04	1.1	2
median concentrations most recent 10 years	2	0.01	<0.05	<0.05	<0.5	1
Poplar River, between foot bridges at Lutsen Lodge (S000-261)(POP-0)(period of record 1973-2010)						
overall trend	**no trend**	**decrease**	**no trend**	**no trend**	**no trend**	**no trend**
estimated average annual change		-1.7%				
estimated total change		-48%				
1995-2010 trend	**no trend**	**no trend**	**no trend**	**no trend**	**no trend**	**no trend**
estimated average annual change						
estimated total change						
median concentrations first 10 years	2	0.04	0.04	0.03	0.9	3
median concentrations most recent 10 years	3	0.02	0.05	<0.05	0.7	2

Analysis was performed using the Seasonal Kendall Test for Trends. Trends shown are significant at the 90% confidence level. Percentage changes are statistical estimates based on the available data. Actual changes could be higher or lower. A designation of "no trend" means that a statistically significant trend has not been found; this may simply be the result of insufficient data.

Concentrations are median summer (Jun-Aug) values, except for chlorides, which are median year-round values. All concentrations are in mg/L.

Summaries and recommendations

Water quality in the Lake Superior – North Watershed is generally good, and consistently met state standards, reflecting its lightly-developed, heavily-forested landscape. Many exceptional streams were identified and outstanding water quality was noted in a number of lakes. However, a small number of streams were identified as impaired due to high levels of suspended sediment, and, although no lake water quality impairments were identified, transparency in some lakes appears to be declining.

Approximately 40% of the streams monitored in the course of this study were found to support "exceptional" biological communities. These streams typically contain Brook Trout and other fishes that require clean, cold water, including species that are rarely found outside of the Lake Superior – North Watershed (e.g., Longnose Sucker). Lake Chub, a state-listed Species of Special Concern, was found in several streams in the far northeast corner of the watershed. The macroinvertebrate communities of these exceptional streams are typically diverse, include high densities of sensitive insects, and are particularly rich in stonefly and caddisfly genera. The larval dragonfly *Boyeria grafiana*, a state-listed Species of Special Concern, was found in 22 streams and several other rare macroinvertebrates were observed in various streams across the watershed.

Exceptional streams were found throughout the Lake Superior – North Watershed, but were more concentrated in certain subwatersheds (e.g., the Devil Track River and Temperance River subwatersheds). The lowest proportions of exceptional streams were found in the two subwatersheds that include aquatic life use impairments due to high levels of suspended sediment (Poplar River subwatershed, Flute Reed River subwatershed).

Essentially all of the Lake Superior – North's exceptional streams drain minimally-developed, lightly-disturbed catchments. However, a few may be threatened by ongoing and future land use. For example, the catchment of Irish Creek contains a significant proportion of private land and is adjacent to an area that has experienced relatively rapid development in recent decades. Similarly, the Little Devil Track River drains the outskirts of the watershed's largest developed area (Grand Marais), and the river's lower reaches are completely surrounded by private land. Poor land use practices in developing areas may contribute to water quality degradation, and should be an ongoing concern in the Lake Superior – North Watershed.

Shoreland protection is an important means for maintaining water quality in lakes. Although no lake water quality impairments were identified in the Lake Superior – North Watershed, transparency appears to be declining on four lakes (Poplar, Deer Yard, Devil Track, Tom). The causes of these declines are uncertain, but it's notable that each of these lakes' shorelines ranks among the most-developed in the watershed. Efforts are underway to identify and address potential threats to lake water quality (i.e., non-compliant septic systems) on some of these lakes.

A multi-agency effort has recently been undertaken to systematically identify and prioritize watershed protection opportunities in Minnesota. The purpose of this approach is to provide state agencies and their partners with a consistent method and rationale for how to identify water bodies at risk, set reasonable goals for protection, incorporate locally held water quality values and considerations, and provide recommendations for specific protection methods. In this process, lake monitoring data is subjected to a multi-step analysis that forms a preliminary ranking of protection priorities. A combination of factors are reviewed to determine priority ranking. Among these factors are a lake's sensitivity to an increase in phosphorus, a documented decline in water quality or monitored phosphorus concentrations close to the water quality standard, and the percentage of developed land use in the area. In the Lake Superior – North Watershed, highest protection priority is suggested for six lakes: Tom, Devil Track, Hungry Jack, Poplar, Birch, and Deer Yard (Appendix 9). As mentioned above, all these lakes are currently meeting water quality standards.

Portions of the Lake Superior – North Watershed experienced rapid residential development in the 1990s. For example, the population of Cook County, which lies nearly entirely within the watershed, grew by 33% between 1990 and 2000. Although population growth has slowed in recent years, the Arrowhead Region remains an attractive destination for many people, and development is unlikely to decrease in the future. Protection strategies might employ development projections to identify the likely locations of future growth, and compare these regions with the occurrence of high-quality or at-risk aquatic resources. In situations where ongoing or future development is likely to occur in close proximity to high priority aquatic resources, protection strategies could be developed to encourage development design and related BMPs that promote good water quality and aquatic habitat.

More than 90% of lands in the Lake Superior – North Watershed are publicly-owned. While the catchments of some Lake Superior - North streams include significant proportions of protected lands, many streams drain landscapes that are largely managed for “general forestry”, and logging is often the most obvious form of disturbance on these lands. Well-managed forests provide both economic and ecological benefits, and timber harvest should not be condemned as a wholesale detriment to water quality. However, in some cases, logging and associated development (e.g., roads, culverts) may contribute to degradation of water quality and aquatic habitat via loss of riparian shading, food web alteration, and increased sedimentation. Site-level forest management guidelines (MFRC 2013) designed to mitigate impacts to water quality are an important starting point for protecting high-quality streams. It is possible that additional BMPs or management strategies may be needed to protect some high quality and sensitive aquatic resources. At a broader scale, regional collaboratives are making an effort to manage forests in a way that promotes forest health and resiliency, and at the same time protects water quality (e.g., North Shore Forest Collaborative, The Nature Conservancy).

Other localized land-use activities may contribute stress to aquatic resources in certain circumstances. For example, aggregate mining (i.e., “gravel pits”) may alter local groundwater and surface-water levels, interrupt groundwater conduit flow paths, and broadly impact thermal conditions. Portions of several streams in the Lake Superior – North Watershed (e.g., Caribou Creek, Cascade River, Ninemile Creek, Two Island River) flow closely adjacent to aggregate mining sites; some of these streams meet exceptional use biocriteria. While disturbances from aggregate mining typically are relatively small in scale, protection strategies should consider the location and proximity of aggregate mining sites relative to aquatic resources, and recommend that water quality be a consideration in their operation and potential expansion.

The Lake Superior – North Watershed’s extensive network of paved and gravel roads intersects rivers and streams at more than 300 locations, and many more crossings occur at intersections between streams and non-road features such as trails and railroads. Road crossings may directly contribute sediment, contaminants, and warm water to streams as precipitation flows across and off of road surfaces. Improperly sized or positioned culverts may affect hydrology and stream geomorphology, causing scouring and aggradation which negatively affect in-stream habitat. Stream crossings may also inhibit ecological connectivity within stream networks, in the form of reduced movement of water, energy, material, and organisms (Forman and Alexander 1998, Freeman et al. 2007). Several streams in the Lake Superior – North Watershed have crossings that may be potential impediments to connectivity or could be causing habitat degradation. Potentially problematic road crossings were observed on Assinika Creek, Fredenberg Creek, Hockamin Creek, Woods Creek, Wanless Creek, Manitou River, and Spruce Creek. Other road crossings in need of repair or redesign surely exist within the watershed; identifying and prioritizing the rehabilitation of problematic road-stream intersections should be an important component of protection strategies for the Lake Superior – North Watershed.

One of the principal concerns identified by County SWCDs for the Lake Superior North – Watershed is groundwater protection, for both quality and quantity. Groundwater withdrawals have increased nearly 30% over the last 20 years, partly due to the rising demand for water supply for private consumption and recreational water related needs. It is estimated that the development pressure is moderate in some parts of the watershed where land is converted from timberland, resorts and lakeshore into home and recreation development (USDA-NRCS). This increase in recreational development can be seen with a significant increase (p=0.001) from 1994 to 2013 in non-crop irrigation for golf courses and special categories. At this time, aquifer drawdown is now a concern; however, if water usage and land use conversion continue to increase, the probability of the water table being drawn downwards also increases. It is for this reason that the MNDNR monitors and takes precautions when permitting water use appropriations.

Groundwater quality is based on the sensitivity of the aquifers and the effects of naturally occurring and anthropogenic influences for constituents found in the water. Special consideration should be practiced in areas of high groundwater contamination susceptibility, which are sparsely located throughout the watershed. Overall, the groundwater quality of the watershed appears to be healthy, despite some exceedances of constituents, including arsenic. However, the primary source of contamination for this watershed is geology. Additional and continued monitoring will increase the understanding of the health of the watershed and its groundwater resources and aid in identifying the extent of the issues present and risk associated. Increased localized monitoring efforts will help accurately define the risks and extent of any issues within the watershed. Adoption of BMPs will benefit both surface and groundwater.

While land management, riparian and shoreland development, and road-stream intersections may represent acute threats to aquatic health in the Lake Superior – North Watershed, longer-term and more nebulous threats may be posed by climate change, and the interaction of climate change with other stressors. Many of the watershed's streams support sensitive, stenothermic organisms that depend on perennial, coldwater streams carrying low concentrations of sediment and nutrients. These habitat and water quality conditions are the result of interacting factors of climate, hydrogeology, and land cover, and may be degraded by changes in any of these factors. Predictive models incorporating climate and land use changes suggest that aquatic resources of the Lake Superior – North Watershed are likely to experience higher temperatures, reduced dissolved oxygen, increased erosion, and other associated stress in the near future (Johnson et al. 2013, Herb et al. 2014). These changes are likely to have negative effects on the health of aquatic systems, though planning and BMP implementation may mitigate some impacts. For example, understanding the importance of small, cold tributaries to the ecological integrity of larger river systems may be of critical importance in protection planning efforts. Tributaries often spawning and nursery habitat for trout and other fishes, and may serve as critical refugia for fish and other aquatic organisms during periods of thermal stress. A watershed-based focus that recognizes the connection between landscapes, riverscapes, and the condition of aquatic resources will be essential to protection and restoration efforts.

In general, aquatic habitats in the Lake Superior – North Watershed are in very good condition; streams, lakes, and wetlands rank among the highest-quality in the state, and some represent near-reference quality examples at a national scale. Stream biological monitoring surveys suggest that sensitive indicator taxa are widespread and abundant, and several rare species of fish and macroinvertebrates were observed. Many streams were designated as exceptional aquatic resources, which should provide a higher level of protection from degradation. From a protection and restoration standpoint, the watershed possesses several favorable characteristics. A relatively high proportion of its lands are already under some form of protective management (e.g., state parks, federal wilderness designation, AMAs), and much of the remainder is administered by public agencies charged with incorporating water quality considerations in their management and planning efforts. The watershed's aquatic resources are of great interest to stakeholders and the general public, and there seems to be strong public support for water quality protection and restoration efforts. This report provides a baseline assessment of water quality in the Lake Superior – North Watershed, and suggests some avenues for moving forward with restoration and protection strategies.

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Appendix 1 - Water chemistry definitions

Dissolved oxygen (DO) - Oxygen dissolved in water required by aquatic life for metabolism. Dissolved oxygen enters into water from the atmosphere by diffusion and from algae and aquatic plants when they photosynthesize. Dissolved oxygen is removed from the water when organisms metabolize or breathe. Low DO often occurs when organic matter or nutrient inputs are high, and light inputs are low.

Escherichia coli (E. coli) - A type of fecal coliform bacteria that comes from human and animal waste. E. coli levels aid in the determination of whether or not fresh water is safe for recreation. Disease-causing bacteria, viruses and protozoans may be present in water that has elevated levels of E. coli.

Nitrate plus nitrite – nitrogen - Nitrate and nitrite-nitrogen are inorganic forms of nitrogen present within the environment that are formed through the oxidation of ammonia-nitrogen by nitrifying bacteria (nitrification). Ammonia-nitrogen is found in fertilizers, septic systems and animal waste. Once converted from ammonia-nitrogen to nitrate and nitrite-nitrogen, these species can stimulate excessive levels of algae in streams. Because nitrate and nitrite-nitrogen are water soluble, transport to surface waters is enhanced through agricultural drainage. The ability of nitrite-nitrogen to be readily converted to nitrate-nitrogen is the basis for the combined laboratory analysis of nitrate plus nitrite-nitrogen (nitrate-N), with nitrite-nitrogen typically making up a small proportion of the combined total concentration. These and other forms of nitrogen exist naturally in aquatic environments; however, concentrations can vary drastically depending on season, biological activity, and anthropogenic inputs.

Orthophosphate - Orthophosphate (OP) is a water soluble form of phosphorus that is readily available to algae (bioavailable). While orthophosphates occur naturally in the environment, river and stream concentrations may become elevated with additional inputs from waste water treatment plants, noncompliant septic systems and fertilizers in urban and agricultural runoff.

pH - A measure of the level of acidity in water. Rainfall is naturally acidic, but fossil fuel combustion has made rain more acid. The acidity of rainfall is often reduced by other elements in the soil. As such, water running into streams is often neutralized to a level acceptable for most aquatic life. Only when neutralizing elements in soils are depleted, or if rain enters streams directly, does stream acidity increase.

Specific conductance - The amount of ionic material dissolved in water. Specific conductance is influenced by the conductivity of rainwater, evaporation and by road salt and fertilizer application.

Temperature - Water temperature in streams varies over the course of the day similar to diurnal air temperature variation. Daily maximum temperature is typically several hours after noon, and the minimum is near sunrise. Water temperature also varies by season as doe's air temperature.

Total Kjehldahl nitrogen (TKN) - The combination of organically bound nitrogen and ammonia in wastewater. TKN is usually much higher in untreated waste samples then in effluent samples.

Total pPhosphorus (TP) - Nitrogen (N), phosphorus (P) and potassium (K) are essential macronutrients and are required for growth by all animals and plants. Increasing the amount of phosphorus entering the system therefore increases the growth of aquatic plants and other organisms. Excessive levels of Phosphorous over stimulate aquatic growth and resulting in the progressive deterioration of water quality from overstimulation of nutrients, called eutrophication. Elevated levels of phosphorus can result in: increased algae growth, reduced water clarity, reduced oxygen in the water, fish kills, altered fisheries and toxins from cyanobacteria (blue green algae) which can affect human and animal health.

Total suspended solids (TSS) – TSS and turbidity are highly correlated. Turbidity is a measure of the lack of transparency or "cloudiness" of water due to the presence of suspended and colloidal materials such as clay, silt, finely divided organic and inorganic matter and plankton or other microscopic organisms. The greater the level of TSS, the murkier the water appears and the higher the measured turbidity.

Higher turbidity results in less light penetration which may harm beneficial aquatic species and may favor undesirable algae species. An overabundance of algae can lead to increases in turbidity, further compounding the problem.

Total suspended volatile solids (TSVS) - Volatile solids are solids lost during ignition (heating to 500 degrees C.) They provide an approximation of the amount of organic matter that was present in the water sample. ‘‘Fixed solids’’ is the term applied to the residue of total, suspended, or dissolved solids after heating to dryness for a specified time at a specified temperature. The weight loss on ignition is called ‘‘volatile solids.’’

Un-ionized ammonia (NH3) - Ammonia is present in aquatic systems mainly as the dissociated ion $NH4^+$, which is rapidly taken up by phytoplankton and other aquatic plants for growth. Ammonia is an excretory product of aquatic animals. As it comes in contact with water, ammonia dissociates into $NH4^+$ ions and ^-OH ions (ammonium hydroxide). If pH levels increase, the ammonium hydroxide becomes toxic to both plants and animals.

Appendix 2 - Intensive water chemistry monitoring stations in the Lake Superior – North Watershed

Biological Station ID	STORET/ EQuIS ID	Waterbody Name	Location	HUC-10
--	S007-325	Pigeon River	5 mi. NE of Grand Portage, at US-61 bridge	0401010102
--	S004-283	Flute Reed River	At Cook County Road 88, in Hovland	0401010103
13LS007	S007-326	North Brule River	At Greenwood Lake Road	0401010104
13LS008	S007-327	South Brule River	At Gunflint Trail	0401010104
13LS010	S000-251	Brule River	At Judge C.R. Magney State Park, upstream of US-61 bridge	0401010104
--	S000-864	Kadunce River	NE of Grand Marais, at US-61	0401010105
--	S000-865	Kimball Creek	E of Grand Marais, at US-61\	0401010105
86LS004	S000-909	Devil Track River	2.5 miles NE of Grand Marais	0401010105
--	S000-253	Cascade River	SW of Grand Marais, at US-61 bridge	0401010106
13LS056	S004-406	Poplar River	At Golf Course Bridge, near Lutsen, MN	0401010107
--	S004-415	Onion River	W. of Forest Road 336, 8 miles SE of Tofte, MN	0401010107
13LS020	S000-265	Temperance River	NW of Tofte at Superior National Forest Road 166	0401010108
13LS025	S007-548	Cross River	1 mi. NW of Schroeder at snowmobile trail bridge	0401010109
--	S004-954	Caribou River	10 mi. N of Illgen City, at US-61	0401010110
--	S007-783	Manitou River	Downstream of Lake County Road 7, at snowmobile trail bridge	0401010110
13LS033	S007-544	Baptism River, East Branch	1 mi. NE of Finland at snowmobile trail bridge	0401010111
13LS032	S007-545	Baptism River, West Branch	In Finland at MN Highway 1	0401010111
--	S000-250	Baptism River	In Tettegouche State Park, at US-61 bridge	0401010111

Appendix 3.1 - AUID table of stream assessment results by parameter and beneficial use

AUID DESCRIPTIONS					USES					WATER QUALITY STANDARDS										
										Aquatic Life Indicators:										Aquatic Recreation Indicator:
Assessment Unit ID (AUID)	Stream Reach Name	Reach Description	Reach Length (miles)	Use Class	Aquatic Life	Aquatic Recreation	Aquatic Consumption	Drinking Water	303d listed impairments	Fish	Macroinvertebrates	Dissolved Oxygen	Total Suspended Solids	Secchi Tube	Chloride	pH	Ammonia - NH3	Pesticides	Phosphorus	Bacteria
HUC 10: Pigeon River																				
04010101-542	Stump River	T64 R3E S8, west line to Pigeon R	8.8	CWg	SUP	--				MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--
04010101-D54	Portage Brook	Headwaters (Unnamed lk 16-0864-00) to CSAH 16	3.1	CWg	SUP	--				MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--
04010101-D55	Portage Brook	CSAH 16 to Pigeon R	5.9	CWe	SUP	--				MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--
04010101-531	Irish Creek	Headwaters to Swamp River Reservoir	7.1	CWe	SUP	--				MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--
04010101-543	Swamp River	Swamp River Reservoir to Pigeon R	1.1	CWg	SUP	--				MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--
04010101-B66	Swamp River	Stevens Lk to T63 R4E S20, east line	1.9	CWe	SUP	--				MTS	MTS	IF	IF	MTS	--	IF	IF	--	IF	--
04010101-501	Pigeon River	South Fowl Lk to Pigeon Bay	31.2	WWg	IF	SUP				--	--	IF	IF	IF	MTS	MTS	MTS	--	MTS	MTS
HUC 10: Flute Reed River																				
04010101-D31	Flute Reed River	Headwaters (Moosehorn Lk 16-0015-00) to Unnamed cr	10.3	CWg	IMP	--				MTS	MTS	MTS	EXS	EXS	--	MTS	IF	--	MTS	--
04010101-D32	Flute Reed River	Unnamed cr to Lk Superior	0.8	CWg	IMP	SUP				MTS	MTS	MTS	EXS	EXS	MTS	MTS	MTS	--	MTS	MTS
HUC 10: Brule River																				
04010101-502	Brule River	Greenwood R to Lk Superior	13.2	CWg	SUP	SUP				MTS	MTS	MTS	MTS	MTS	MTS	MTS	MTS	--	MTS	MTS
04010101-528	Greenwood River	Greenwood Lk to Brule R	7.3	CWe	SUP	--				MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--
04010101-541	South Brule River	Headwaters (Lower Trout Lk 16-0175-00) to Brule R	7.7	WWg	SUP	SUP				MTS	MTS	MTS	MTS	MTS	MTS	MTS	MTS	--	MTS	MTS
04010101-546	Timber Creek	Headwaters to Brule R	3.4	CWg	SUP	--				MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--
04010101-594	Assinika Creek	Assinika Lk to Brule R	5.0	CWg	SUP	--				MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--
04010101-596	Brule River	South Brule R to Northern Light Lk	3.8	WWg	SUP	--				MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--
04010101-646	Bluff Creek	East Twin Lk (16-0145-00) to South Brule R	2.7	CWe	SUP	--				MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--
04010101-737	Fiddle Creek	Unnamed cr to South Brule R	1.7	CWg	SUP	--				MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--
04010101-814	Lullaby Creek	Headwaters to Brule R	1.8	CWe	SUP	--				MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--
04010101-D30	Brule River	BWCA boundary to South Brule R	12.6	CWe*	SUP	SUP				MTS	MTS	MTS	--	--	MTS	MTS	MTS	--	MTS	MTS

Abbreviations for Indicator Evaluations: --- = No Data, MTS = Meets Standard; EXS = Fails Standard; IF = Insufficient Information

Abbreviations for Use Support Determinations: -- = No Data, NA = Not Assessed, IF = Insufficient Information, SUP = Full Support (Meets Criteria); IMP = Impaired (Fails Standards)

Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use; = insufficient information.

Abbreviations for Use Class: WWg = warmwater general, CWg = Coldwater general, CWe = Coldwater exceptional, *Assessments completed using proposed use classifications changes not yet written into rule

Appendix 3.1 - AUID table of stream assessment results (by parameter and beneficial use) (continued)

AUID DESCRIPTIONS					USES					WATER QUALITY STANDARDS: Aquatic Life Indicators:										Aquatic Recreation Indicator:
Assessment Unit ID (AUID)	Stream Reach Name	Reach Description	Reach Length (miles)	Use Class	Aquatic Life	Aquatic Recreation	Aquatic Consumption	Drinking Water	303d listed impairments	Fish	Macroinvertebrates	Dissolved Oxygen	Total Suspended Solids	Secchi Tube	Chloride	pH	Ammonia - NH3	Pesticides	Phosphorus	Bacteria
HUC 10: Devil Track River																				
04010101-D80	Devil Track River	Unnamed cr to Lk Superior	2.0	CWg	SUP	SUP				MTS	MTS	MTS	IF	IF	MTS	MTS	MTS	--	MTS	MTS
04010101-D79	Devil Track River	Devil Track Lk to Unnamed cr	6.6	CWe	SUP	--				MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--
04010101-532	Kimball Creek	Headwaters to Lk Superior	9.0	CWe	SUP	SUP				MTS	MTS	MTS	MTS	MTS	MTS	MTS	MTS	--	MTS	MTS
04010101-566	Little Devil Track River	Unnamed cr to Devil Track R	2.7	CWe	SUP	--				MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--
04010101-601	Junco Creek	Junco Lk to Devil Track Lk	3.9	CWg	SUP	--				MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--
04010101-D61	Woods Creek	-90.2650 47.7964 to Devil Track R	1.8	CWe	SUP	--				MTS	MTS	IF	--	--	--	IF	IF	--	IF	--
04010101-717	Elbow Creek	Unnamed cr to Devil Track R	0.8	CWe	SUP	--				MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--
04010101-D53	Kadunce River (Kadunce Creek)	-90.1484 47.8261 to Lk Superior	2.7	CWe	SUP	SUP				MTS	MTS	IF	MTS	MTS	MTS	MTS	MTS	--	MTS	MTS
HUC 10: Cascade River																				
04010101-590	Cascade River	N Br Cascade R to Lk Superior	14.4	CWe	SUP	SUP				MTS	MTS	MTS	MTS	MTS	MTS	MTS	MTS	--	MTS	MTS
04010101-615	Spruce Creek (Deer Yard Creek)	Unnamed cr (Ward Lk outlet) to Lk Superior	3.2	Cwe	SUP	--				MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--
04010101-682	Nester Creek	Headwaters to Cascade R	4.9	CWg	SUP	--				MTS	MTS	IF	IF	IF	--	IF	--	--	IF	--
04010101-841	Mississippi Creek	Unnamed cr to Little Mississippi Cr	5.5	CWg	SUP	--				MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--
HUC 10: Poplar River																				
04010101-535	Onion River	Headwaters to Lk Superior	6.1	CWg	SUP	SUP				MTS	MTS	MTS	MTS	MTS	MTS	MTS	MTS	--	MTS	MTS
04010101-536	Mistletoe Creek	Halls Pond to Poplar R	4.6	CWe	SUP	--				MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--
04010101-567	Tait River	Christine Lk to Mistletoe Cr	1.8	CWg	SUP	--				MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--
04010101-592	Poplar River	T61 R4W S10, north line to Mistletoe Cr	13.8	CWg	SUP	--				MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--
04010101-612	Poplar River	Mistletoe Cr to Superior Hiking Trail bridge	5.5	CWg	SUP	SUP				--	MTS	MTS	MTS	MTS	MTS	MTS	--	--	MTS	MTS
04010101-613	Poplar River	Superior Hiking Trail bridge to Lk Superior	2.8	CWg	IMP	SUP				MTS	MTS	MTS	EXS	EXS	MTS	MTS	MTS	--	MTS	MTS
04010101-614	Caribou Creek	Caribou Lk to Poplar R	2.2	CWg	SUP	--				MTS	MTS	IF	IF	IF	--	IF	--	--	IF	--

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Appendix 3.1 - AUID table of stream assessment results (by parameter and beneficial use) (continued)

AUID DESCRIPTIONS					USES					WATER QUALITY STANDARDS: Aquatic Life Indicators:										WATER QUALITY STANDARDS: Aquatic Recreation Indicator:
Assessment Unit ID (AUID)	Stream Reach Name	Reach Description	Reach Length (miles)	Use Class	Aquatic Life	Aquatic Recreation	Aquatic Consumption	Drinking Water	303d listed impairments	Fish	Macroinvertebrates	Dissolved Oxygen	Total Suspended Solids	Secchi Tube	Chloride	pH	Ammonia - NH3	Pesticides	Phosphorus	Bacteria
HUC 10: Temperance River																				
04010101-568	Plouff Creek	Paoli Lk to Temperance R	11.3	CWg	SUP	--				MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--
04010101-569	Heartbreak Creek	Unnamed cr to Temperance R	3.8	CWe	SUP	--				MTS	MTS	IF	IF	IF	--	IF	--	--	IF	--
04010101-B35	Sixmile Creek	Unnamed cr to Temperance R	3.3	CWe	SUP	--				MTS	MTS	IF	IF	IF	--	IF	--	--	IF	--
04010101-D56	Temperance River	T61 R4W S4, north line to Sixmile Cr	15.1	CWe	SUP	--				MTS	MTS	IF	IF	IF	--	IF	--	--	IF	--
04010101-D57	Temperance River	Sixmile Cr to Lk Superior	9.9	CWg	SUP	SUP				MTS	MTS	MTS	MTS	MTS	IF	MTS	MTS	--	MTS	MTS
HUC 10: Cross River																				
04010101-518	Cross River	Fourmile Cr to Lk Superior	14.8	CWe	SUP	SUP				MTS	MTS	MTS	IF	MTS	--	MTS	MTS	--	IF	MTS
04010101-519	Cross River	Cross River Lk to Fourmile Cr	2.0	CWg	SUP	--				MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--
04010101-525	Fourmile Creek	Headwaters (Fourmile Lk 16-0639-00) to Cross R	2.9	WWg	SUP	--				MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--
04010101-547	Two Island River	Unnamed cr to Lk Superior	11.4	CWe	SUP	--				MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--
04010101-570	Houghtaling Creek	Headwaters to Unnamed cr	5.5	CWg	SUP	--				MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--
04010101-571	Houghtaling Creek	Unnamed cr to Unnamed cr	1.7	CWe	SUP	--				MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--
04010101-692	Wilson Creek (Cross River Tributary)	T60 R6W S24, west line to Cross R	0.3	WWg	SUP	--				MTS	MTS	IF	--	--	--	IF	IF	--	IF	--
04010101-783	Wanless Creek	Headwaters (Dam Five Lk 38-0053-00) to Houghtaling Cr	2.7	CWe	SUP	--				MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--
HUC 10: Manitou River																				
04010101-534	Manitou River	S Br Manitou R to Lk Superior	11.1	CWe	SUP	SUP				MTS	MTS	MTS	MTS	MTS	MTS	MTS	MTS	--	MTS	MTS
04010101-575	Caribou River	Unnamed cr to Unnamed cr	1.2	CWe	SUP	--				MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--
04010101-576	Caribou River	Unnamed cr to Lk Superior	1.0	CWg	--	--				--	--	MTS	IF	IF	MTS	MTS	MTS	--	MTS	--
04010101-661	Cabin Creek	Cabin Lk to T59 R6W S20, south line	2.9	CWg	SUP	--				MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--
04010101-819	Manitou River (North Branch Manitou River)	T59 R7W S19, north line to S Br Manitou R	9.0	CWg	SUP	--				MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--
04010101-827	Manitou River, South Branch	Junction Cr to Mantiou R	5.4	CWe	SUP	--				MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--
04010101-829	Manitou River, South Branch	Unnamed cr to Unnamed cr	1.8	CWg	SUP	--				MTS	MTS	IF	IF	IF	--	--	--	--	IF	--
04010101-835	Junction Creek	Unnamed cr to S Br Manitou R	1.8	CWg	SUP	--				MTS	MTS	IF	IF	IF	--	--	--	--	IF	--
04010101-862	Ninemile Creek	Unnamed cr to Cramer Lk	1.7	CWg	SUP	--				MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--

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Appendix 3.1 - AUID table of stream assessment results (by parameter and beneficial use) (continued)

AUID DESCRIPTIONS					USES						WATER QUALITY STANDARDS										
											Aquatic Life Indicators:										Aquatic Recreation Indicator:
Assessment Unit ID (AUID)	Stream Reach Name	Reach Description	Reach Length (miles)	Use Class	Aquatic Life	Aquatic Recreation	Aquatic Consumption	Drinking Water	303d listed impairments		Fish	Macroinvertebrates	Dissolved Oxygen	Total Suspended Solids	Secchi Tube	Chloride	pH	Ammonia - NH3	Pesticides	Phosphorus	Bacteria
HUC 10: Baptism River																					
04010101-508	Baptism River	W Br Baptism R to Lk Superior	8.8	CWg	SUP	SUP					MTS	MTS	MTS	MTS	MTS	MTS	MTS	MTS	--	MTS	MTS
04010101-581	Crown Creek	Fry Cr to Unnamed cr	1.7	CWe	SUP	--					MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--
04010101-587	Hockamin Creek	Unnamed cr to W Br Baptism R	1.5	CWg	SUP	--					MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--
04010101-B24	Sawmill Creek	Unnamed cr to Baptism R	1.2	CWg	SUP	--					MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--
04010101-D49	Baptism River, West Branch	Crown Cr to E Br Baptism R	4.3	Cwg	SUP	SUP					MTS	MTS	MTS	MTS	MTS	MTS	MTS	MTS	--	MTS	MTS
04010101-D50	Baptism River, West Branch	-91.3381 47.4702 to Crown Cr	2.7	CWe	SUP	--					MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--
04010101-D58	Baptism River, East Branch	Lk Twenty-three to Blesner Cr	3.3	CWe	SUP	--					MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--
04010101-D59	Baptism River, East Branch	Blesner Cr to Baptism R	6.5	CWg	SUP	SUP					MTS	MTS	MTS	MTS	MTS	MTS	MTS	MTS	--	MTS	MTS

Abbreviations for Indicator Evaluations: --- = No Data, MTS = Meets Standard; EXS = Fails Standard; IF = Insufficient Information
Abbreviations for Use Support Determinations: -- = No Data, NA = Not Assessed, IF = Insufficient Information, SUP = Full Support (Meets Criteria); IMP = Impaired (Fails Standards)
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Appendix 3.2 - Assessment results for lakes in the Lake Superior – North Watershed

Lake ID	Lake Name	Subwatershed	Lake Area (ha)	Watershed Area (acres)	% Littoral	Max. Depth (m)	Mean Depth (m)	AQR Support Status
16-0515-00	Ada	Temperance River	11		100	4.0		IF
16-0359-00	Agnes	Poplar River	27		100	1.5		IF
16-0320-00	Allen	Brule River	18	13298	100	3.6		IF
16-0622-00	Alton	Temperance River	388	2674	31	21.9	7.1	FS
16-0204-00	Aspen	Pigeon River	55	1503	69	7.6		FS
16-0486-00	Baker	Temperance River	6		100	3.0		IF
16-0182-00	Ball Club	Cascade River	81	848	81	8.2	2.7	FS
16-0350-00	Banadad	Brule River	70	1002		14.6		FS*
16-0358-00	Barker	Poplar River	59	5882	98	4.6		FS
16-0228-00	Bearskin	Arrow River	197	3911	19	23.7		FS
16-0344-00	Bigsby	Poplar River	39		100	1.2		IF
16-0098-00	Binagami	Devil Track River	46	373		4.6		FS
16-0247-00	Birch	Arrow River	98	1284	29	21.0		FS
16-0383-00	Bouder	Poplar River	51	1163	98	5.2		FS
16-0044-00	Boys	Devil Track River	10		100	4.0		FS
16-0348-00	Brule	Brule River	1707	21274	31	18.2		FS*
16-0477-00	Burnt	Temperance River	147	2569	68	7.0		IF
38-0260-00	Cabin	Manitou River	27			0.9		NA
16-0397-00	Cam	Brule River	22		49	17.3		IF
16-0240-00	Caribou	Brule River	100	3228	80	7.9		FS
16-0141-00	Caribou	Pigeon River	183	4753		17.3		FS*
16-0360-00	Caribou	Poplar River	291	10892	59	9.0	4.0	FS
16-0346-00	Cascade	Cascade River	189	3555	100	5.5	2.4	FS
16-0033-00	Chester	Pigeon River	20			10.6		IF
16-0373-00	Christine	Poplar River	78	12340	100	1.8		FS
16-0365-00	Clara	Poplar River	159	7861	100	4.6		FS
16-0139-00	Clearwater	Pigeon River	541	4431				FS
16-0454-00	Crescent	Poplar River	302	7927		7.6	2.7	FS
38-0024-00	Crooked	Cross River	108	847	91	5.5		
38-0024-01	Crooked (East Bay)	Cross River	69			5.5	2.4	FS
16-0150-00	Daniels	Arrow River	204	6590	19	27.4		FS*
16-0435-00	Davis	Brule River	129	1487		19.5		FS*
16-0136-00	Deer	Pigeon River	30			9.4		NA
16-0253-00	Deer Yard	Cascade River	137	1251		6.1	4.0	FS
38-0415-00	Delay	Manitou River	40	454	96	5.2		FS
16-0143-00	Devil Track	Devil Track River	740	21759	34	15.2	7.1	FS
16-0029-00	Devilfish	Pigeon River	167	2663	58	12.2		FS
38-0256-00	Divide	Manitou River	25		70	6.7	3.4	IF
16-0232-00	Duncan	Arrow River	188	3970	27	35.3		FS*
16-0634-00	Dyers	Cross River	28		85	7.0	2.7	IF
16-0146-00	East Bearskin	Pigeon River	231	11868	47	20.4		FS
16-0042-00	East Pike	Pigeon River	221	11653	25	15.2		FS*
16-0145-00	East Twin	Brule River	68	1016	93	5.8	2.4	FS
16-0096-00	Elbow	Devil Track River	154	5981	100	2.7		FS
16-0805-01	Elbow (Main Basin)	Cross River	196			7.0		FS
16-0023-00	Esther	Brule River	33			35.0		FS
16-0147-00	Flour	Pigeon River	131	1204	34	22.8		IF
16-0639-00	Four Mile	Cross River	237	6650	98	5.9	2.1	FS

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Key for Cell Shading: = existing impairment, listed prior to 2015 reporting cycle; = new impairment; = full support of designated use.

Appendix 3.2 - Assessment results for lakes in the Lake Superior - North Watershed (continued)

Lake ID	Lake Name	Subwatershed	Lake Area (ha)	Watershed Area (acres)	% Littoral	Max. Depth (m)	Mean Depth (m)	AQR Support Status
16-0060-00	Gadwell	Pigeon River	8		38	15.8		NA
16-0909-00	Gasket	Brule River	2					IF
16-0319-00	Gaskin	Brule River	155	8706		18.2		FS*
16-0077-00	Greenwood	Brule River	819	6821	27	101.0	9.8	FS
16-0380-00	Gust	Poplar River	57	729	100	1.8		FS
16-0314-00	Henson	Brule River	46	2030		9.1		IF
38-0251-00	Hoist	Manitou River	37	2607	100	1.5		IF
16-0366-00	Holly	Poplar River	30		100	1.5		IF
16-0406-00	Homer	Temperance River	176	4761	90	6.7		FS
16-0241-00	Horseshoe	Brule River	76	23618		6.1		IF
16-0227-00	Hungry Jack	Arrow River	185	2479	40	21.6		FS
16-0521-00	Jack	Temperance River	51	20089	100	3.0		NA
16-0222-00	Jackal	Brule River	13		76	9.1		NA
16-0035-00	John	Pigeon River	73	44921	100	6.1		IF
38-0242-00	Johnson	Baptism River	13		59	7.3		FS
16-0910-00	Jump	Brule River	3					IF
16-0402-00	Juno	Temperance River	87	1915	94	7.0		IF
16-0476-00	Kelly	Temperance River	69	23123	100	3.0		IF
16-0706-00	Kelso	Temperance River	56	3226	100	3.0		IF
16-0188-00	Kemo	Devil Track River	78	1270	23	20.7		FS
16-0045-00	Kimball	Devil Track River	32		95	4.9		FS
16-0168-00	Kroft	Brule River	9		100	3.0		NA
16-0198-00	Leo	Arrow River	42	538	37	8.5		FS
16-0382-00	Lichen	Poplar River	108	1576	97	5.2		FS
16-0142-00	Little Caribou	Pigeon River	20		85	6.1		IF
16-0347-00	Little Cascade	Cascade River	105	1046	100	2.7	1.2	FS
16-0026-00	Little John	Pigeon River	15		100	2.4		IF
16-0170-00	Little Trout	Brule River	51	478		15.2		NA
38-0051-00	Little Wilson	Cross River	22		81	6.4		FS
16-0199-00	Lizz	Brule River	9			9.4		FS*
16-0022-00	Lost	Brule River	30		99	20.0		IF
16-0393-00	Lower Cone	Brule River	28		86	7.6		NA
16-0175-00	Lower Trout	Brule River	52	35649	100	1.8		NA
16-0705-00	Lujenida	Temperance River	9					IF
16-0223-00	Lux	Brule River	20		87	6.1		NA
16-0250-00	Mark	Cascade River	52	2430		1.5		IF
16-0235-00	McDonald	Cascade River	37		100	1.5		IF
16-0027-00	McFarland	Pigeon River	154	30641		14.9		IF
16-0307-00	Meeds	Brule River	141	2173	42	12.5		FS*
16-0391-00	Mid Cone	Brule River	29		51	9.1		FS*
16-0046-00	Mink	Devil Track River	23		100	4.6		FS
16-0225-00	Misquah	Brule River	21		27	18.5		IF
16-0368-00	Mistletoe	Poplar River	59	2717	100	1.5		FS
16-0117-00	Moon	Pigeon River	57	1729		9.1		NA
16-0489-00	Moore	Temperance River	24		100	2.4		NA
16-0043-00	Moose	Pigeon River	184	14483				FS*
16-0220-00	Morgan	Brule River	33		49	13.7		NA
16-0093-00	Mountain	Pigeon River	338	7423	23	60.8		FS*

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Appendix 3.2 - Assessment results for lakes in the Lake Superior – North Watershed (continued)

Lake ID	Lake Name	Subwatershed	Lake Area (ha)	Watershed Area (acres)	% Littoral	Max. Depth (m)	Mean Depth (m)	AQR Support Status
16-0389-00	Mulligan	Brule River	10		40	18.8		FS*
16-0104-00	Musquash	Devil Track River	53	485	47	7.9		FS
38-0033-00	Ninemile	Manitou River	119	1256	97	12.2	0.9	FS
38-0232-00	Nipisiquit	Baptism River	23		51	5.5		IF
16-0036-00	North Fowl	Pigeon River	129	64516	100	3.0		IF
16-0456-00	North Temperance	Temperance River	79	1368		15.2		FS*
16-0089-00	Northern Light	Brule River	150	118075	100	11.0		IF
16-0353-00	Omega	Brule River	60	956		15.5		FS*
16-0298-00	One Island	Brule River	10		98	6.1		FS*
16-0032-00	Otter	Pigeon River	30		100	3.3		IF
16-0478-00	Peterson	Temperance River	37	25899		4.9		IF
16-0252-00	Pike	Poplar River	328	3956	35	12.2	6.5	FS
16-0318-00	Pillsbery	Brule River	27			6.1		IF
16-0194-00	Pine	Devil Track River	38		49	10.3		FS
16-0041-00	Pine	Pigeon River	854	28852		34.4		FS*
16-0108-00	Pine Mountain	Brule River	42	752	68	30.0		FS
16-0239-00	Poplar	Brule River	307	6987	40	22.2	6.5	FS
16-0174-00	Ram	Brule River	28	159	42	12.2		FS*
16-0643-00	Richey	Cross River	40	463	100	2.1		FS
16-0200-00	Road	Brule River	6		100	4.6		IF
16-0230-00	Rose	Arrow River	252	29292	31	27.4		FS*
16-0137-00	Rove	Arrow River	15		70	9.1		NA
16-0025-00	Royal	Pigeon River	9					NA
16-0169-00	Rum	Brule River	19			4.6		NA
16-0299-00	Rush	Brule River	106	2654	50	16.4		IF
16-0496-00	Sawbill	Temperance River	335	13228	58	12.2		IF
16-0495-00	Smoke	Temperance River	70	712	82	4.6		IF
16-0244-00	South	Arrow River	269	6033		42.6		FS*
16-0457-00	South Temperance	Temperance River	86	2486		7.3		IF
16-0202-00	Squint	Brule River	7		78	6.1		FS*
16-0405-00	Star	Temperance River	42	2310	100	4.0		FS
16-0663-00	Sunhigh	Temperance River	20					IF
16-0256-00	Swamp	Cascade River	36		100	2.1		NA
16-0268-00	Swan	Brule River	81	27307	27	30.4		FS*
16-0384-00	Tait	Poplar River	143	2708	100	4.6	2.4	FS
16-0654-00	Timber	Cross River	114	7400		3.6		IF
16-0019-00	Tom	Pigeon River	164	3990	58	10.6		FS
16-0345-00	Tomash	Cascade River	38		100	1.4		IF
16-0645-00	Toohey	Cross River	147	2660	100	3.3	1.5	FS
16-0049-00	Trout	Devil Track River	104	1148	23	23.4	10.2	FS
16-0156-00	Two Island	Cascade River	304	6066	96	8.2	2.4	FS
16-0412-00	Upper Cone	Brule River	32		29	14.0		FS*
16-0061-00	Vale	Pigeon River	9		54	10.3		NA
16-0409-00	Vern	Temperance River	51	10946	65	12.8		IF
16-0224-00	Vista	Brule River	65	5294	91	12.2		FS*
16-0349-00	Wanihigan	Brule River	19			12.2		FS*
16-0248-00	Ward	Cascade River	15		100	4.0		FS
16-0138-00	Watap	Arrow River	29	1846		14.0		FS*
16-0520-00	Weird	Temperance River	13		100	2.1		IF

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Appendix 3.2 - Assessment results for lakes in the Lake Superior – North Watershed (continued)

Lake ID	Lake Name	Subwatershed	Lake Area (ha)	Watershed Area (acres)	% Littoral	Max. Depth (m)	Mean Depth (m)	AQR Support Status
16-0398-00	Wench	Brule River	10		47	17.9		FS*
16-0086-00	West Pike	Pigeon River	306	8840	31	36.5		FS*
16-0186-00	West Twin	Brule River	53	540	70	0.0		FS
16-0410-00	Whack	Temperance River	12		77	8.2		FS*
16-0369-00	White Pine	Poplar River	134	10404	100	1.5		FS
38-0060-00	Whitefish	Cross River	138	1731	56	14.9	4.6	FS
38-0047-00	Wilson	Cross River	264	3353	37	16.1	5.8	FS
16-0354-00	Winchell	Brule River	352	5718	27	36.5		FS*
16-0664-00	Wonder	Temperance River	31		100	3.0		IF

Abbreviations:
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N/A – Not Assessed
IF – Insufficient Information

Key for Cell Shading: = existing impairment, listed prior to 2015 reporting cycle; = new impairment; = full support of designated use.

Appendix 4.1 - Minnesota statewide IBI thresholds and confidence limits

Class #	Class Name	Use Class	Exceptional Use Threshold	General Use Threshold	Modified Use Threshold	Confidence Limit
Fish						
1	Southern Rivers	2B, 2C	71	49	NA	±11
2	Southern Streams	2B, 2C	66	50	35	±9
3	Southern Headwaters	2B, 2C	74	55	33	±7
10	Southern Coldwater	2A	82	50	NA	±9
4	Northern Rivers	2B, 2C	67	38	NA	±9
5	Northern Streams	2B, 2C	61	47	35	±9
6	Northern Headwaters	2B, 2C	68	42	23	±16
7	Low Gradient	2B, 2C	70	42	15	±10
11	Northern Coldwater	2A	60	35	NA	±10
Invertebrates						
1	Northern Forest Rivers	2B, 2C	77	49	NA	±10.8
2	Prairie Forest Rivers	2B, 2C	63	31	NA	±10.8
3	Northern Forest Streams RR	2B, 2C	82	53	NA	±12.6
4	Northern Forest Streams GP	2B, 2C	76	51	37	±13.6
5	Southern Streams RR	2B, 2C	62	37	24	±12.6
6	Southern Forest Streams GP	2B, 2C	66	43	30	±13.6
7	Prairie Streams GP	2B, 2C	69	41	22	±13.6
8	Northern Coldwater	2A	52	32	NA	±12.4
9	Southern Coldwater	2A	72	43	NA	±13.8

Appendix 4.2 - Biological monitoring results – fish IBI

Assessment Unit (AUID)	Biological Station ID	Stream Segment Name	Drainage Area (mi^2)	Fish IBI Class	General Use Threshold	Exceptional Use Threshold	FishIBI	Sample Date
Pigeon River Subwatershed								
04010101-D75	15EM065	Royal River	72	Northern Streams	47	61	72	7/29/2015
04010101-542	15LS056	Stump River	14	Northern Coldwater	35	60	61	7/22/2015
04010101-542	97LS071	Stump River	14	Northern Coldwater	35	60	32	8/6/2013
04010101-542	97LS071	Stump River	14	Northern Coldwater	35	60	25	8/12/2014
04010101-D54	13LS001	Portage Brook	7	Northern Coldwater	35	60	24	6/25/2013
04010101-D54	13LS001	Portage Brook	7	Northern Coldwater	35	60	53	8/6/2013
04010101-D55	98LS041	Portage Brook	14	Northern Coldwater	35	60	63	6/25/2013
04010101-531	92LS015	Irish Creek	8	Northern Coldwater	35	60	81	8/14/2013
04010101-531	92LS015	Irish Creek	8	Northern Coldwater	35	60	77	7/22/2015
04010101-B66	97LS072	Swamp River	9	Northern Coldwater	35	60	65	6/25/2013
04010101-543	13LS048	Swamp River	49	Northern Coldwater	35	60	58	8/6/2013
Flute Reed River Subwatershed								
04010101-D31	13LS038	Flute Reed River	6	Northern Coldwater	35	60	53	6/25/2013
04010101-D31	13LS038	Flute Reed River	6	Northern Coldwater	35	60	33	8/12/2014
04010101-D32	13LS027	Flute Reed River	15	Northern Coldwater	35	60	60	8/12/2014
Brule River Subwatershed								
04010101-D30	15LS053	Brule River	64	Northern Streams	47	61	70	7/29/2015
04010101-D30	98LS034	Brule River	81	Northern Coldwater	35	60	90	8/28/2013
04010101-D30	98LS034	Brule River	81	Northern Coldwater	35	60	80	9/16/2015
04010101-D30	13LS007	Brule River	89	Northern Coldwater	35	60	79	8/28/2013
04010101-D30	13LS007	Brule River	89	Northern Coldwater	35	60	73	9/16/2014
04010101-D30	13LS007	Brule River	89	Northern Coldwater	35	60	85	7/29/2015
04010101-814	15LS052	Lullaby Creek	1	Northern Coldwater	35	60	76	7/22/2015
04010101-646	13LS051	Bluff Creek	4	Northern Coldwater	35	60	74	6/26/2013
04010101-646	13LS051	Bluff Creek	4	Northern Coldwater	35	60	68	8/21/2013
04010101-737	13LS039	Fiddle Creek	5	Northern Coldwater	35	60	34	6/26/2013
04010101-737	13LS039	Fiddle Creek	5	Northern Coldwater	35	60	46	8/12/2014
04010101-541	13LS008	South Brule River	77	Northern Streams	47	61	70	8/28/2013
04010101-594	98LS036	Assinika Creek	13	Northern Coldwater	35	60	54	8/27/2013
04010101-596	13LS009	Brule River	172	Northern Streams	47	61	82	8/12/2014
04010101-546	92LS001	Timber Creek	3	Northern Coldwater	35	60	65	6/24/2013
04010101-528	97LS074	Greenwood River	21	Northern Coldwater	35	60	69	8/14/2013
04010101-502	13LS010	Brule River	264	Northern Coldwater	35	60	52	8/13/2013
04010101-502	10EM056	Brule River	265	Northern Coldwater	35	60	45	7/20/2010
04010101-502	10EM056	Brule River	265	Northern Coldwater	35	60	70	7/21/2015
Devil Track River Subwatershed								
04010101-D53	13LS050	Kadunce River	11	Northern Coldwater	35	60	80	8/27/2013
04010101-532	13LS011	Kimball Creek	14	Northern Coldwater	35	60	93	8/13/2013
04010101-601	13LS006	Junco Creek	19	Northern Coldwater	35	60	48	8/22/2013
04010101-717	05LS005	Elbow Creek	19	Northern Coldwater	35	60	89	8/7/2013
04010101-D79	13LS040	Devil Track River	37	Northern Coldwater	35	60	85	8/5/2013
04010101-D79	13LS046	Devil Track River	59	Northern Coldwater	35	60	78	9/4/2013
04010101-D80	86LS004	Devil Track River	73	Northern Coldwater	35	60	74	8/29/2013
04010101-D80	86LS004	Devil Track River	73	Northern Coldwater	35	60	84	9/11/2013
04010101-566	97LS073	Little Devil Track River	7	Northern Coldwater	35	60	78	7/31/2013
04010101-566	97LS073	Little Devil Track River	7	Northern Coldwater	35	60	78	9/17/2013
04010101-D61	15LS059	Woods Creek	2	Northern Coldwater	35	60	62	7/22/2015
04010101-D61	13LS052	Woods Creek	2	Northern Coldwater	35	60	81	8/11/2014
04010101-D61	13LS052	Woods Creek	2	Northern Coldwater	35	60	75	7/22/2015
04010101-D61	14LS400	Woods Creek	2	Northern Coldwater	35	60	90	8/11/2014
Cascade River Subwatershed								
04010101-590	13LS013	Cascade River	54	Northern Coldwater	35	60	80	9/4/2013
04010101-841	13LS015	Mississippi Creek	11	Northern Coldwater	35	60	57	8/7/2013
04010101-590	95LS013	Cascade River	89	Northern Coldwater	35	60	73	9/5/2013
04010101-590	95LS012	Cascade River	106	Northern Coldwater	35	60	79	9/10/2013
04010101-682	05LS008	Nester Creek	5	Northern Coldwater	35	60	52	7/31/2013
04010101-615	13LS012	Spruce Creek (Deer Yard Creek)	8	Northern Coldwater	35	60	69	6/24/2013
04010101-615	13LS012	Spruce Creek (Deer Yard Creek)	8	Northern Coldwater	35	60	86	7/8/2015

Appendix 4.2 - Biological monitoring results – fish IBI (continued)

Assessment Unit (AUID)	Biological Station ID	Stream Segment Name	Drainage Area (mi^2)	Fish IBI Class	General Use Threshold	Exceptional Use Threshold	FishIBI	Sample Date
Poplar River Subwatershed								
04010101-567	13LS054	Tait River	20	Northern Coldwater	35	60	39	8/20/2013
04010101-536	97LS101	Mistletoe Creek	16	Northern Coldwater	35	60	57	8/20/2013
04010101-614	13LS016	Caribou Creek	17	Northern Coldwater	35	60	52	8/14/2013
04010101-592	97LS102	Poplar River	29	Northern Coldwater	35	60	67	8/20/2013
04010101-592	89LS003	Poplar River	46	Northern Coldwater	35	60	49	9/4/2013
04010101-613	13LS056	Poplar River	113	Northern Coldwater	35	60	65	8/12/2013
04010101-613	13LS056	Poplar River	113	Northern Coldwater	35	60	54	9/17/2014
04010101-535	13LS047	Onion River	8	Northern Coldwater	35	60	81	8/1/2013
Temperance River Subwatershed								
04010101-568	98LS029	Plouff Creek	14	Northern Coldwater	35	60	54	8/19/2013
04010101-D56	13LS053	Temperance River	128	Northern Coldwater	35	60	64	9/3/2013
04010101-569	97LS075	Heartbreak Creek	14	Northern Coldwater	35	60	100	8/15/2013
04010101-569	97LS075	Heartbreak Creek	14	Northern Coldwater	35	60	96	7/22/2015
04010101-B35	91LS002	Sixmile Creek	9	Northern Coldwater	35	60	66	7/31/2013
04010101-D57	13LS020	Temperance River	151	Northern Coldwater	35	60	66	9/11/2013
04010101-D57	15EM033	Temperance River	157	Northern Coldwater	35	60	85	7/30/2015
04010101-D57	15LS063	Temperance River	159	Northern Coldwater	35	60	71	7/30/2015
Cross River Subwatershed								
04010101-519	13LS024	Cross River	32	Northern Coldwater	35	60	40	9/10/2013
04010101-692	13LS041	Wilson Creek	5	Northern Headwaters	42	68	54	8/13/2013
04010101-525	13LS022	Fourmile Creek	12	Low Gradient	42	70	54	7/16/2013
04010101-570	10EM152	Houghtaling Creek	2	Northern Coldwater	35	60	44	8/11/2010
04010101-571	85LS020	Houghtaling Creek	8	Northern Coldwater	35	60	69	8/8/2013
04010101-783	13LS043	Wanless Creek	4	Northern Coldwater	35	60	72	8/8/2013
04010101-518	13LS025	Cross River	76	Northern Coldwater	35	60	66	9/9/2013
04010101-547	10EM168	Two Island River	7	Northern Coldwater	35	60	70	6/22/2010
04010101-547	13LS023	Two Island River	12	Northern Coldwater	35	60	90	6/26/2013
Manitou River Subwatershed								
04010101-573	15EM081	Caribou River	14	Northern Coldwater	35	60	99	7/1/2015
04010101-575	13LS026	Caribou River	22	Northern Coldwater	35	60	100	7/23/2013
04010101-819	88LS030	Manitou River	13	Northern Coldwater	35	60	43	9/18/2013
04010101-835	13LS030	Junction Creek	7	Northern Coldwater	35	60	70	7/29/2013
04010101-829	13LS029	Manitou River, South Branch	6	Northern Coldwater	35	60	47	7/30/2013
04010101-827	13LS005	Manitou River, South Branch	17	Northern Coldwater	35	60	68	9/12/2013
04010101-661	88LS016	Cabin Creek	13	Northern Coldwater	35	60	48	9/10/2013
04010101-534	98LS030	Manitou River	77	Northern Coldwater	35	60	77	9/19/2013
04010101-534	98LS030	Manitou River	77	Northern Coldwater	35	60	88	7/21/2015
04010101-862	13LS028	Ninemile Creek	7	Northern Coldwater	35	60	69	7/17/2013
04010101-862	13LS028	Ninemile Creek	7	Northern Coldwater	35	60	48	8/13/2014
04010101-862	13LS028	Ninemile Creek	7	Northern Coldwater	35	60	59	7/2/2014
Baptism River Subwatershed								
04010101-581	13LS031	Crown Creek	26	Northern Coldwater	35	60	75	7/22/2013
04010101-587	13LS034	Hockamin Creek	16	Northern Coldwater	35	60	44	7/8/2014
04010101-D51	15EM017	Baptism River, West Branch	5	Northern Coldwater	35	60	50	7/23/2015
04010101-D50	13LS036	Baptism River, West Branch	18	Northern Coldwater	35	60	95	7/18/2013
04010101-D49	13LS032	Baptism River, West Branch	74	Northern Coldwater	35	60	65	7/23/2013
04010101-D58	13LS045	Baptism River, East Branch	19	Northern Coldwater	35	60	62	8/27/2013
04010101-D59	13LS033	Baptism River, East Branch	35	Northern Coldwater	35	60	27	7/23/2013
04010101-508	98LS035	Baptism River	127	Northern Coldwater	35	60	83	7/22/2013
04010101-508	10EM012	Baptism River	132	Northern Coldwater	35	60	90	7/21/2010
04010101-B24	88LS010	Sawmill Creek	9	Northern Coldwater	35	60	55	8/13/2014

Appendix 4.3 - Biological monitoring results – macroinvertebrate IBI

Assessment Unit (AUID)	Biological Station ID	Stream Segment Name	Drainage Area (mi^2)	Invert IBI Class	General Use Threshold	Exceptional Use Threshold	Invert IBI	Sample Date
Pigeon River Subwatershed								
04010101-D75	15EM065	Royal River	72	Northern Forest Streams RR	53	82	59	7/29/2015
04010101-542	15LS056	Stump River	14	Northern Coldwater	32	52	38	8/10/2015
04010101-542	97LS071	Stump River	14	Northern Coldwater	32	52	46	9/10/2013
04010101-542	97LS071	Stump River	14	Northern Coldwater	32	52	43	8/12/2014
04010101-D54	13LS001	Portage Brook	7	Northern Coldwater	32	52	78	9/10/2013
04010101-D55	98LS041	Portage Brook	14	Northern Coldwater	32	52	63	9/10/2013
04010101-531	92LS015	Irish Creek	8	Northern Coldwater	32	52	67	9/10/2013
04010101-531	92LS015	Irish Creek	8	Northern Coldwater	32	52	58	8/10/2015
04010101-B66	97LS072	Swamp River	9	Northern Coldwater	32	52	74	9/10/2013
04010101-543	13LS048	Swamp River	49	Northern Coldwater	32	52	54	9/10/2013
Flute Reed River Subwatershed								
04010101-D31	13LS038	Flute Reed River	6	Northern Coldwater	32	52	72	9/10/2013
04010101-D31	13LS038	Flute Reed River	6	Northern Coldwater	32	52	68	9/1/2015
04010101-D31	86LS015	Flute Reed River	8	Northern Coldwater	32	52	54	9/15/2015
04010101-D32	13LS027	Flute Reed River	15	Northern Coldwater	32	52	39	9/10/2013
04010101-D32	13LS027	Flute Reed River	15	Northern Coldwater	32	52	44	9/2/2015
Brule River Subwatershed								
04010101-D30	15LS053	Brule River	64	Northern Forest Streams RR	53	82	72	8/11/2015
04010101-D30	98LS034	Brule River	81	Northern Coldwater	32	52	59	8/28/2013
04010101-D30	98LS034	Brule River	81	Northern Coldwater	32	52	44	9/16/2014
04010101-D30	98LS034	Brule River	81	Northern Coldwater	32	52	56	8/11/2015
04010101-D30	13LS007	Brule River	89	Northern Coldwater	32	52	70	8/28/2013
04010101-D30	13LS007	Brule River	89	Northern Coldwater	32	52	64	9/16/2014
04010101-D30	13LS007	Brule River	89	Northern Coldwater	32	52	67	8/11/2015
04010101-814	15LS052	Lullaby Creek	1	Northern Coldwater	32	52	62	8/11/2015
04010101-646	13LS051	Bluff Creek	4	Northern Coldwater	32	52	52	8/21/2013
04010101-737	13LS039	Fiddle Creek	5	Northern Coldwater	32	52	63	8/13/2013
04010101-737	13LS039	Fiddle Creek	5	Northern Coldwater	32	52	71	9/15/2014
04010101-541	13LS008	South Brule River	77	Northern Forest Streams GP	51	76	75	8/13/2013
04010101-594	98LS036	Assinika Creek	13	Northern Coldwater	32	52	53	8/27/2013
04010101-596	10EM120	Brule River	171	Northern Forest Streams RR	53	82	66	8/18/2010
04010101-596	13LS009	Brule River	172	Northern Forest Streams RR	53	82	77	8/12/2014
04010101-546	92LS001	Timber Creek	3	Northern Coldwater	32	52	51	8/13/2013
04010101-528	97LS074	Greenwood River	21	Northern Coldwater	32	52	60	9/17/2013
04010101-502	13LS055	Brule River	246	Northern Coldwater	32	52	49	9/17/2013
04010101-502	13LS010	Brule River	264	Northern Coldwater	32	52	63	9/17/2013
04010101-502	10EM056	Brule River	265	Northern Coldwater	32	52	46	8/18/2010
04010101-502	10EM056	Brule River	265	Northern Coldwater	32	52	54	8/11/2015

Appendix 4.3 - Biological monitoring results – macroinvertebrate IBI (continued)

Assessment Unit (AUID)	Biological Station ID	Stream Segment Name	Drainage Area (mi^2)	Invert IBI Class	General Use Threshold	Exceptional Use Threshold	Invert IBI	Sample Date
Devil Track River Subwatershed								
04010101-D53	13LS050	Kadunce River	11	Northern Coldwater	32	52	75	8/27/2013
04010101-532	13LS011	Kimball Creek	14	Northern Coldwater	32	52	53	9/17/2013
04010101-601	13LS006	Junco Creek	19	Northern Coldwater	32	52	62	8/22/2013
04010101-717	05LS005	Elbow Creek	19	Northern Coldwater	32	52	65	8/21/2013
04010101-717	05LS005	Elbow Creek	19	Northern Coldwater	32	52	71	9/1/2015
04010101-D79	13LS040	Devil Track River	37	Northern Coldwater	32	52	59	8/21/2013
04010101-D79	13LS046	Devil Track River	59	Northern Coldwater	32	52	59	8/12/2013
04010101-D79	13LS046	Devil Track River	59	Northern Coldwater	32	52	44	8/21/2013
04010101-D79	15LS057	Devil Track River	68	Northern Coldwater	32	52	57	8/13/2015
04010101-D80	86LS004	Devil Track River	73	Northern Coldwater	32	52	43	8/13/2013
04010101-D80	86LS004	Devil Track River	73	Northern Coldwater	32	52	44	8/11/2015
04010101-566	97LS073	Little Devil Track River	7	Northern Coldwater	32	52	49	8/13/2013
04010101-566	97LS073	Little Devil Track River	7	Northern Coldwater	32	52	66	9/1/2015
04010101-D61	15LS059	Woods Creek	2	Northern Coldwater	32	52	56	8/13/2015
04010101-D61	13LS052	Woods Creek	2	Northern Coldwater	32	52	50	8/13/2013
04010101-D61	13LS052	Woods Creek	2	Northern Coldwater	32	52	56	8/13/2015
Cascade River Subwatershed								
04010101-590	13LS013	Cascade River	54	Northern Coldwater	32	52	61	8/13/2013
04010101-841	13LS015	Mississippi Creek	11	Northern Coldwater	32	52	59	9/17/2013
04010101-590	95LS013	Cascade River	89	Northern Coldwater	32	52	64	8/12/2013
04010101-590	95LS012	Cascade River	106	Northern Coldwater	32	52	54	8/12/2013
04010101-682	05LS008	Nester Creek	5	Northern Coldwater	32	52	48	8/14/2013
04010101-615	13LS012	Spruce Creek (Deer Yard Creek)	8	Northern Coldwater	32	52	52	8/12/2013
04010101-615	13LS012	Spruce Creek (Deer Yard Creek)	8	Northern Coldwater	32	52	68	8/12/2015
Poplar River Subwatershed								
04010101-567	13LS054	Tait River	20	Northern Coldwater	32	52	60	8/20/2013
04010101-536	97LS101	Mistletoe Creek	16	Northern Coldwater	32	52	56	8/20/2013
04010101-614	13LS016	Caribou Creek	17	Northern Coldwater	32	52	52	8/14/2013
04010101-592	97LS102	Poplar River	29	Northern Coldwater	32	52	49	8/20/2013
04010101-592	97LS102	Poplar River	29	Northern Coldwater	32	52	56	9/2/2015
04010101-592	89LS003	Poplar River	46	Northern Coldwater	32	52	75	9/11/2013
04010101-592	89LS003	Poplar River	46	Northern Coldwater	32	52	74	9/15/2015
04010101-612	13LS014	Poplar River	106	Northern Coldwater	32	52	36	8/20/2013
04010101-613	13LS056	Poplar River	113	Northern Coldwater	32	52	35	9/11/2013
04010101-535	13LS047	Onion River	8	Northern Coldwater	32	52	46	8/14/2013

Appendix 4.3 - Biological monitoring results – macroinvertebrate IBI (continued)

Assessment Unit (AUID)	Biological Station ID	Stream Segment Name	Drainage Area (mi^2)	Invert IBI Class	General Use Threshold	Exceptional Use Threshold	Invert IBI	Sample Date
Temperance River Subwatershed								
04010101-568	98LS029	Plouff Creek	14	Northern Coldwater	32	52	43	8/19/2013
04010101-568	98LS029	Plouff Creek	14	Northern Coldwater	32	52	47	8/12/2015
04010101-D56	13LS053	Temperance River	128	Northern Coldwater	32	52	55	8/14/2013
04010101-569	97LS075	Heartbreak Creek	14	Northern Coldwater	32	52	67	9/11/2013
04010101-569	97LS075	Heartbreak Creek	14	Northern Coldwater	32	52	60	8/12/2015
04010101-B35	91LS002	Sixmile Creek	9	Northern Coldwater	32	52	56	8/14/2013
04010101-D57	13LS020	Temperance River	151	Northern Coldwater	32	52	41	8/14/2013
04010101-D57	13LS020	Temperance River	151	Northern Coldwater	32	52	58	9/2/2015
04010101-D57	15EM033	Temperance River	157	Northern Coldwater	32	52	42	7/30/2015
04010101-D57	15EM033	Temperance River	157	Northern Coldwater	32	52	52	9/2/2015
04010101-D57	15LS063	Temperance River	159	Northern Coldwater	32	52	52	8/13/2015
04010101-D57	81LS001	Temperance River	184	Northern Coldwater	32	52	44	8/14/2013
04010101-D57	81LS001	Temperance River	184	Northern Coldwater	32	52	54	9/2/2015
Cross River Subwatershed								
04010101-519	13LS024	Cross River	32	Northern Coldwater	32	52	59	9/11/2013
04010101-692	13LS041	Wilson Creek	5	Northern Forest Streams RR	53	82	62	8/8/2013
04010101-525	13LS022	Fourmile Creek	12	Northern Forest Streams GP	51	76	73	9/11/2013
04010101-570	10EM152	Houghtaling Creek	2	Northern Coldwater	32	52	27	8/18/2010
04010101-571	85LS020	Houghtaling Creek	8	Northern Coldwater	32	52	76	9/11/2013
04010101-783	13LS043	Wanless Creek	4	Northern Coldwater	32	52	75	9/11/2013
04010101-518	13LS025	Cross River	76	Northern Coldwater	32	52	56	8/14/2013
04010101-547	10EM168	Two Island River	7	Northern Coldwater	32	52	53	8/19/2010
04010101-547	13LS023	Two Island River	12	Northern Coldwater	32	52	60	8/15/2013
Manitou River Subwatershed								
04010101-575	13LS026	Caribou River	22	Northern Coldwater	32	52	57	9/11/2013
04010101-819	88LS030	Manitou River	13	Northern Coldwater	32	52	74	9/9/2013
04010101-835	13LS030	Junction Creek	7	Northern Coldwater	32	52	51	7/30/2013
04010101-829	13LS029	Manitou River, South Branch	6	Northern Coldwater	32	52	46	7/31/2013
04010101-827	13LS005	Manitou River, South Branch	17	Northern Coldwater	32	52	53	7/31/2013
04010101-661	88LS016	Cabin Creek	13	Northern Coldwater	32	52	67	9/9/2013
04010101-534	98LS030	Manitou River	77	Northern Coldwater	32	52	59	9/19/2013
04010101-534	98LS030	Manitou River	77	Northern Coldwater	32	52	49	8/12/2015
04010101-862	13LS028	Ninemile Creek	7	Northern Coldwater	32	52	42	9/9/2013

Appendix 4.3 - Biological monitoring results – macroinvertebrate IBI (continued)

Assessment Unit (AUID)	Biological Station ID	Stream Segment Name	Drainage Area (mi^2)	Invert IBI Class	General Use Threshold	Exceptional Use Threshold	Invert IBI	Sample Date
Baptism River Subwatershed								
04010101-581	13LS031	Crown Creek	26	Northern Coldwater	32	52	74	9/17/2013
04010101-587	13LS034	Hockamin Creek	16	Northern Coldwater	32	52	70	9/12/2013
04010101-D50	13LS036	Baptism River, West Branch	18	Northern Coldwater	32	52	56	9/12/2013
04010101-D49	15LS050	Baptism River, West Branch	55	Northern Coldwater	32	52	51	8/12/2015
04010101-D49	13LS032	Baptism River, West Branch	74	Northern Coldwater	32	52	47	9/17/2013
04010101-D49	13LS032	Baptism River, West Branch	74	Northern Coldwater	32	52	41	8/12/2015
04010101-D58	13LS045	Baptism River, East Branch	19	Northern Coldwater	32	52	61	8/27/2013
04010101-D59	13LS033	Baptism River, East Branch	35	Northern Coldwater	32	52	33	9/17/2013
04010101-508	98LS035	Baptism River	127	Northern Coldwater	32	52	31	9/12/2013
04010101-508	10EM012	Baptism River	132	Northern Coldwater	32	52	34	8/25/2010
04010101-508	10EM012	Baptism River	132	Northern Coldwater	32	52	29	8/12/2015
04010101-508	10EM012	Baptism River	132	Northern Coldwater	32	52	28	9/1/2015
04010101-B24	88LS010	Sawmill Creek	9	Northern Coldwater	32	52	30	8/15/2013
04010101-B24	88LS010	Sawmill Creek	9	Northern Coldwater	32	52	41	8/13/2014

Appendix 5.1 - Minnesota's ecoregion-based lake eutrophication standards

Ecoregion	TP µg/L	Chl-a µg/L	Secchi meters
NLF – Lake Trout (Class 2A)	< 12	< 3	> 4.8
NLF – Stream trout (Class 2A)	< 20	< 6	> 2.5
NLF – Aquatic Rec. Use (Class 2B)	< 30	< 9	> 2.0
NCHF – Stream trout (Class 2A)	< 20	< 6	> 2.5
NCHF – Aquatic Rec. Use (Class 2B)	< 40	< 14	> 1.4
NCHF – Aquatic Rec. Use (Class 2B) Shallow lakes	< 60	< 20	> 1.0
WCBP & NGP – Aquatic Rec. Use (Class 2B)	< 65	< 22	> 0.9
WCBP & NGP – Aquatic Rec. Use (Class 2B) Shallow lakes	< 90	< 30	> 0.7

Appendix 5.2 - MINLEAP model estimates of phosphorus loads for lakes, Lake Superior – North Watershed

Lake ID	Lake Name	Obs TP (µg/L)	MINLEAP TP (µg/L) *	Obs Chl-a (µg/L)	MINLEAP Chl-a (µg/L)	Obs Secchi (m)	MINLEAP Secchi (m)	Avg. TP Inflow (µg/L)	TP Load (kg/yr)	Background TP (µg/L)	% P Retention	Outflow (hm3/yr)	Residence Time (yrs)	Areal Load (m/yr)	Trophic Status
16-0019-00	Tom	13	16	4.3	4	2.7	3.5	35	136	10	53	3.9	1.8	2.4	M
16-0143-00	Devil Track	12	20	4.1	5	3.1	2.9	34	721	10	57	21.4	2.5	2.8	M
16-0227-00	Hungry Jack	8	12	2.5	3	5.5	4.4	38	98	9	68	2.6	5.1	1.3	O
16-0239-00	Poplar	10	14	3.7	3	3.1	3.9	35	241	9	60	6.9	2.9	2.2	M
16-0247-00	Birch	8	12	2	2	5.5	4.6	38	50	8	69	1.3	5.7	1.4	O
16-0253-00	Deer Yard	17	14	5	3	2.4	3.9	41	56	14	66	1.3	4.1	0.9	M
16-0049-00	Trout	7	10	1	2	5.4	5.2	40	48	8	74	1.2	8.9	1.1	O
16-0077-00	Greenwood	6	10	2	2	5	5.4	42	314	8	77	7.4	10.9	0.9	O
16-0139-00	Clearwater	4	8	2	1	8.7	6.7	42	214	6	82	5.1	19.3	0.9	O
16-0147-00	Flour	12	11	2	2	5.6	5	41	54	8	74	1.3	8.8	1	O
16-0228-00	Bearskin	6	11	2	2	6.4	4.9	36	140	7	70	3.9	6.4	1.9	O
16-0252-00	Pike	9	12	2	3	5.7	4.4	39	160	12	68	4.1	5.2	1.3	O
38-0033-00	Ninemile	9	17	7	4	2.1	3.4	40	53	15	58	1.3	2.3	1.1	M
16-0145-00	East Twin	20	18	8	4	2.4	3.2	37	39	12	53	1	1.6	1.5	M
16-0146-00	East Bearskin	10	16	3	4	3.5	3.5	32	367	9	50	11.3	1.5	4.7	M
16-0186-00	West Twin	10	14	4	3	3.3	4	41	23	10	66	0.6	4.3	1.1	M
16-0198-00	Leo	10	14	3	3	4.5	3.9	38	21	10	62	0.6	3.3	1.4	O
16-0204-00	Aspen	17	18	8	4	2.8	3.3	34	51	11	49	1.5	1.3	2.6	M
16-0360-00	Caribou	18	18	8	4	2.1	3.2	33	348	14	46	10.5	1.1	3.6	M
16-0365-00	Clara	16	21	4	6	2.5	2.8	32	243	15	35	7.5	0.5	4.8	M
16-0384-00	Tait	12	18	4	5	2.3	3.1	36	97	14	49	2.7	1.3	1.9	M
38-0047-00	Wilson	13	13	4	3	4.6	4.2	38	133	11	66	3.5	4.4	1.3	M

Abbreviations: **H** – Hypereutrophic **M** – Mesotrophic --- No data
E – Eutrophic **O** – Oligotrophic

* all lakes modeled with a stream inflow phosphorus concentration of 30 ug/L, to match watershed conditions as closely as possible

Appendix 6 – Fish species found during biological monitoring surveys

Common Name	Number of Stations	Number of Individuals
brook trout	74	1545
creek chub	65	1426
longnose dace	65	2397
blacknose dace	50	1832
white sucker	45	375
central mudminnow	41	278
common shiner	24	326
slimy sculpin	23	812
lake chub	21	447
mottled sculpin	20	118
brook stickleback	19	73
northern pike	17	48
northern redbelly dace	16	55
smallmouth bass	16	41
burbot	15	135
rainbow trout	13	523
johnny darter	10	34
pumpkinseed	10	29
fathead minnow	8	79
yellow perch	7	25
finescale dace	6	21
pearl dace	6	197
blacknose shiner	5	9
Iowa darter	5	28
tadpole madtom	5	45
walleye	5	5
longnose sucker	4	9
brown trout	2	3
hybrid Phoxinus	2	6
rock bass	2	6
black bullhead	1	3
black crappie	1	3
brassy minnow	1	8
threespine stickleback	1	8

Appendix 7 – Macroinvertebrate taxa found during biological monitoring surveys

Taxonomic Name	Number of Stations	Number of Individuals	TSN
Hydroida			#N/A
Hydridae	1	1	#N/A
Oligochaeta			#N/A
Oligochaeta	46	221	#N/A
Promenetus exacuous	6	16	#N/A
Gastropoda			#N/A
Amnicola	1	14	70747
Ferrissia	26	146	76569
Gyraulus	19	68	76592
Helisoma	1	4	76599
Helisoma anceps	3	3	76600
Hydrobiidae	13	183	#N/A
Lymnaeidae	6	11	76483
Menetus	3	10	76626
Micromenetus	1	1	76643
Physa	21	103	76677
Physella	1	1	76698
Planorbella	1	1	76654
Planorbidae	7	17	76591
Valvata	3	6	#N/A
Veneroida			#N/A
Pisidiidae	48	525	#N/A
Amphipoda			#N/A
Crangonyx	1	4	95081
Hyalella	23	478	94025
Decapoda			#N/A
Cambaridae	1	1	97336
Orconectes	14	27	97421
Ephemeroptera			#N/A
Acentrella	6	43	100801
Acentrella parvula	8	23	609530
Acentrella turbida	45	450	568574
Acerpenna	24	97	568546
Acerpenna pygmaea	9	90	206620
Ameletus	3	5	100996
Anafroptilum	3	15	#N/A
Baetidae	16	60	100755
Baetis	33	175	100800
Baetis brunneicolor	11	41	100825
Baetis flavistriga	43	313	100835

Taxonomic Name	Number of Stations	Number of Individuals	TSN
Baetis intercalaris	10	94	100808
Baetis tricaudatus	28	410	100817
Caenidae	1	1	101467
Caenis	3	5	101478
Caenis diminuta	3	7	101483
Caenis hilaris	13	53	101486
Callibaetis	1	1	100903
Diphetor hageni	5	5	568598
Epeorus	48	514	100626
Ephemera	2	2	101526
Ephemerella	36	168	101233
Ephemerellidae	21	102	101232
Ephemeroptera	1	3	100502
Eurylophella	43	132	101324
Eurylophella bicolor	1	1	101334
Eurylophella funeralis	2	34	101332
Heptagenia	4	7	100602
Heptageniidae	25	95	100504
Isonychia	12	34	101041
Iswaeon	11	70	776928
Labiobaetis propinquus	8	32	568605
Leptophlebiidae	31	187	101095
Leucrocuta	46	412	100676
Maccaffertium	49	309	697957
Maccaffertium luteum	1	1	698222
Maccaffertium mediopunctatum	1	2	698469
Maccaffertium modestum	2	3	698232
Maccaffertium vicarium	28	203	698255
Paraleptophlebia	32	323	101187
Plauditus	12	54	568553
Procloeon	3	7	206622
Pseudocloeon propinquum	1	12	568681
Rhithrogena	16	126	100572
Serratella	1	2	101395
Serratella serrata	8	15	185976
Stenacron	8	37	100713
Stenonema	2	9	100507
Stenonema femoratum	2	4	100516
Teloganopsis deficiens	7	13	776981
Tricorythodes	7	51	101405

Taxonomic Name	Number of Stations	Number of Individuals	TSN
Odonata			#N/A
Aeshna	4	8	101603
Aeshna umbrosa	4	5	101605
Aeshnidae	12	15	101596
Anisoptera	2	3	101594
Argia	2	2	102139
Boyeria	14	23	101645
Boyeria grafiana	25	47	101646
Boyeria vinosa	5	18	101647
Calopterygidae	19	70	102043
Calopteryx	11	40	102052
Calopteryx aequabilis	15	42	102056
Calopteryx maculata	6	9	102055
Coenagrionidae	6	12	102077
Cordulegaster	10	14	102027
Cordulegaster maculata	2	2	102031
Corduliidae	7	12	102020
Dromogomphus	1	1	101730
Gomphidae	38	83	101664
Gomphus	4	5	101665
Hagenius	1	1	101734
Hetaerina	6	19	102048
Libellula	1	1	101893
Macromiinae	1	1	#N/A
Neurocordulia	2	2	101934
Ophiogomphus	10	28	101738
Ophiogomphus carolus	3	5	101745
Ophiogomphus rupinsulensis	5	5	101740
Somatochlora	3	6	101947
Plecoptera			#N/A
Acroneuria	19	70	102917
Acroneuria abnormis	20	62	102919
Acroneuria lycorias	39	155	102918
Agnetina	4	11	102975
Alloperla	4	6	103203
Amphinemura	9	43	102540
Capniidae	8	37	102643
Chloroperlidae	1	1	103202
Isogenoides	6	15	103124
Isoperla	9	32	102995
Leuctra	8	11	102844
Leuctridae	8	12	102840
Nemouridae	3	4	102517

Taxonomic Name	Number of Stations	Number of Individuals	TSN
Paracapnia	5	6	102804
Paragnetina media	34	139	102968
Paraleuctra	1	3	102887
Perlidae	44	276	102914
Perlodidae	12	34	102994
Plecoptera	1	1	102467
Pteronarcys	23	50	102471
Soyedina	1	3	102556
Taeniopterygidae	1	1	102788
Taeniopteryx	12	51	102789
Hemiptera			#N/A
Aquarius	3	3	717547
Belostoma	1	2	103684
Belostoma flumineum	3	4	103689
Corixidae	1	1	103364
Gerridae	3	5	103801
Hesperocorixa	1	1	103444
Rhagovelia	4	7	103886
Rheumatobates	2	7	103802
Sigara	1	1	103369
Coleoptera			#N/A
Anacaena	3	6	112878
Dubiraphia	15	66	114126
Dytiscidae	3	4	111963
Elmidae	2	3	114093
Gyrinus	3	3	112654
Haliplus	1	2	111858
Helophorus	1	1	113106
Hydraena	7	10	112757
Hydrophilidae	2	3	112811
Hygrotus	1	1	112200
Liodessus	2	4	112580
Macronychus	1	4	114212
Macronychus glabratus	9	41	114213
Nebrioporus	1	1	728251
Optioservus	71	519	114177
Stenelmis	32	83	114095
Megaloptera			#N/A
Corydalidae	3	5	115023
Nigronia	36	69	115028
Sialis	6	9	115002

Taxonomic Name	Number of Stations	Number of Individuals	TSN
Lepidoptera			#N/A
Lepidoptera	2	4	117232
Parapoynx	6	17	117714
Trichoptera			#N/A
Agabus	1	1	111966
Agarodes distinctus	1	2	116984
Apatania	4	5	115935
Brachycentridae	1	1	116905
Brachycentrus	3	48	116906
Brachycentrus americanus	4	9	116912
Brachycentrus numerosus	3	8	116910
Ceraclea	19	83	116684
Ceratopsyche	58	1443	115570
Ceratopsyche alhedra	20	234	115596
Ceratopsyche bronta	20	278	115577
Ceratopsyche morosa	23	464	115580
Ceratopsyche slossonae	26	148	115586
Ceratopsyche sparna	50	782	115589
Ceratopsyche vexa	1	2	115575
Cheumatopsyche	42	317	115408
Chimarra	60	638	115273
Chimarra obscura	1	3	115276
Chimarra socia	2	50	115279
Diplectrona modesta	7	40	115402
Dolophilodes	2	27	115319
Dolophilodes distinctus	43	522	115322
Glossosoma	19	184	117159
Glossosoma intermedium	27	737	117162
Glossosoma lividum	1	1	117196
Glossosoma nigrior	34	543	117164
Glossosomatidae	34	195	117120
Goera	3	6	116423
Helicopsyche borealis	14	71	117020
Hesperophylax designatus	1	3	116008
Hydatophylax	1	2	115995
Hydatophylax argus	13	39	115997
Hydropsyche	9	67	115453
Hydropsyche betteni	14	57	115454
Hydropsyche dicantha	4	31	115465
Hydropsyche placoda	1	9	115487
Hydropsyche simulans	1	14	115481
Hydropsychidae	40	786	115398
Hydroptila	28	256	115641

Taxonomic Name	Number of Stations	Number of Individuals	TSN
Hydroptilidae	19	37	115629
Ithytrichia clavata	2	3	115824
Lepidostoma	68	869	116794
Leptoceridae	4	4	116547
Leucotrichia pictipes	3	4	115631
Limnephilidae	26	106	115933
Lype diversa	5	14	115392
Mayatrichia ayama	9	19	115812
Micrasema	4	16	116958
Micrasema gelidum	1	8	116969
Micrasema rusticum	20	281	116961
Molanna	6	9	116474
Mystacides	6	21	116598
Nectopsyche diarina	1	3	116663
Nemotaulius hostilis	4	7	116434
Neophylax	1	1	116046
Neophylax concinnus	3	5	116047
Neophylax oligius	1	2	116057
Neotrichia	3	3	115833
Neureclipsis	17	59	117095
Nyctiophylax	3	4	117104
Oecetis	10	33	116607
Oecetis avara	8	15	116608
Oecetis furva	2	7	603100
Oecetis testacea	23	143	603269
Oligostomis	1	1	115900
Oxyethira	22	109	115779
Parapsyche apicalis	1	1	115557
Philopotamidae	6	9	115257
Phryganeidae	7	14	115867
Phylocentropus	3	3	115361
Polycentropodidae	16	38	117043
Polycentropus	17	42	117044
Protoptila	9	71	115221
Psilotreta indecisa	2	7	116503
Psychomyia flavida	7	16	115341
Psychomyiidae	4	28	115334
Ptilostomis	8	15	115868
Pycnopsyche	5	9	116409
Rhyacophila	8	8	115097
Rhyacophila angelita	1	2	115099
Rhyacophila fuscula	9	21	115133
Rhyacophila invaria	2	6	115150

Taxonomic Name	Number of Stations	Number of Individuals	TSN
Rhyacophila minor	1	6	115147
Triaenodes	3	13	116565
Trichoptera	3	3	115095
Uenoidae	7	22	568757
Diptera			#N/A
Ablabesmyia	8	13	128079
Allocladius	1	4	#N/A
Anopheles	2	3	125956
Antocha	18	50	119656
Apsectrotanypus	1	1	128021
Atherix	40	293	130929
Bezzia	2	10	127778
Bezzia/Palpomyia	3	5	#N/A
Brillia	18	22	128477
Cardiocladius	20	26	128511
Ceratopogonidae	13	38	127076
Chelifera	1	1	136305
Chironomidae	1	1	127917
Chironomini	6	23	129229
Chrysops	1	1	131078
Conchapelopia	12	20	128130
Corynoneura	14	23	128563
Cricotopus	47	276	128575
Culicidae	1	3	125930
Diamesa	1	1	128355
Dicranota	12	13	121027
Dicrotendipes	2	2	129428
Dixa	1	1	125810
Dixella	3	14	125854
Empididae	11	12	135830
Ephydridae	6	13	146893
Eukiefferiella	43	107	128689
Glyptotendipes	1	2	129483
Hemerodromia	40	159	136327
Heterotrissocladius	2	2	128737
Hexatoma	2	2	120094
Labrundinia	3	3	128173
Larsia	2	16	128183
Lauterborniella agrayloides	3	4	129526
Limnophila	1	1	120164
Limnophyes	10	18	128776
Limonia	1	1	119704
Lopescladius	6	7	128811

Taxonomic Name	Number of Stations	Number of Individuals	TSN
Micropsectra	45	515	129890
Microtendipes	44	203	129535
Nanocladius	16	21	128844
Neoplasta	7	16	136352
Neostempellina reissi	4	4	#N/A
Nilotanypus	7	10	128202
Nilothauma	8	11	129548
Orthocladiinae	27	47	128457
Orthocladius	42	153	128874
Orthocladius (Symposiocladius)	9	18	568523
Parachironomus	2	2	129564
Paracricotopus	1	1	128962
Parakiefferiella	6	35	128968
Paralauterborniella	1	1	129616
Paramerina	1	1	128207
Parametriocnemus	40	147	128978
Paratanytarsus	6	12	129935
Pentaneura	2	3	128215
Phaenopsectra	4	5	129637
Polypedilum	69	747	129657
Potthastia	1	1	128408
Probezzia	2	3	127729
Procladius	6	17	128277
Psectrocladius	2	3	129018
Pseudosmittia	1	2	129071
Rheocricotopus	17	32	129086
Rheopelopia	2	2	128226
Rheotanytarsus	58	506	129952
Roederiodes	15	19	135893
Sciomyzidae	1	1	144653
Simulium	71	1636	126774
Stempellina	3	9	129962
Stempellinella	39	206	129969
Stenochironomus	29	86	129746
Sublettea coffmani	4	5	129976
Synorthocladius	11	24	129161
Tabanus	1	1	131527
Tanypodinae	14	27	127994
Tanytarsini	17	88	129872
Tanytarsus	31	173	129978
Thienemanniella	20	36	129182
Thienemannimyia	9	62	128236
Thienemannimyia Gr.	57	230	#N/A

Taxonomic Name	Number of Stations	Number of Individuals	TSN
Tipula	13	40	119037
Tipulidae	4	9	118840
Tribelos	8	33	129820
Trissopelopia ogemawi	6	16	128252
Tvetenia	72	559	129197
Wiedemannia	1	1	135920
Xenochironomus xenolabis	4	4	129838
Xylotopus par	15	34	129209
Zavrelimyia	5	11	128259
Nematoda			#N/A
Nemata	11	14	563956
Nematoda	2	2	#N/A
Unclassified			#N/A
Acari	62	211	733321
Helobdella stagnalis	1	1	#N/A
Hirudinea	33	91	#N/A
Ostracoda	2	18	#N/A
Turbellaria	7	11	#N/A

Appendix 8 - Fish contaminant summary statistics by waterway-species-year

*Impaired for mercury in fish tissue as of 2014 Draft Impaired Waters List; categorized as EPA Class 4a for waters covered by the Statewide Mercury TMDL

**Impaired for mercury in fish tissue as of 2014 Draft Impaired Waters List; categorized as EPA Class 5 for waters needing a TMDL.

Species codes are defined in Table 52. FILSK – edible fillet, skin-on.

DOWID	Waterway	Species	Year	Anat.	Total Fish	N	Length (in)			Mercury (mg/kg)			PCBs (mg/kg)			
							Mean	Min	Max	Mean	Min	Max	N	Mean	Max	< RL
16001500	MOOSEHORN*	SPL	1995	FILSK	11	3	16.3	12.7	19.6	0.233	0.210	0.270	1	0.010	0.010	Y
16001900	TOM*	LWH	1990	FILSK	14	3	17.9	12.6	22.2	0.125	0.094	0.150	3	0.015	0.026	Y
			2013	FILSK	5	1	18.3	18.3	18.3	0.107	0.107	0.107				
		NP	2006	FILSK	2	2	18.5	13.4	23.5	0.109	0.104	0.113				
		WE	1982	FILSK	3	1	12.0	12.0	12.0	0.190	0.190	0.190				
			1990	FILSK	20	3	17.1	11.7	22.2	0.353	0.140	0.540	3	0.010	0.010	Y
			1996	FILSK	10	10	14.5	8.2	19.1	0.264	0.111	0.537				
			2001	FILSK	6	6	15.4	10.8	20.0	0.285	0.100	0.892				
			2006	FILSK	10	10	16.4	12.2	26.9	0.323	0.091	1.051				
			2013	FILSK	7	7	13.1	11.5	15.3	0.188	0.154	0.253				
		YP	1990	FILSK	8	1	6.4	6.4	6.4	0.075	0.075	0.075	1	0.010	0.010	Y
			2001	FILSK	5	1	8.1	8.1	8.1	0.086	0.086	0.086				
			2013	FILSK	5	1	9.5	9.5	9.5	0.121	0.121	0.121				
16002300	ESTHER*	RBT	1994	FILSK	3	1	10.9	10.9	10.9	0.034	0.034	0.034				
		SPL	1994	FILSK	5	2	11.5	10.1	12.9	0.175	0.120	0.230	1	0.010	0.010	Y
		WSU	1994	FILSK	5	1	16.4	16.4	16.4	0.230	0.230	0.230				
16002600	LITTLE JOHN*	NP	2006	FILSK	6	6	19.2	17.0	22.2	0.193	0.168	0.213				
		WE	2006	FILSK	3	3	14.9	14.2	15.9	0.101	0.087	0.119				
		YP	2006	FILSK	2	1	9.0	9.0	9.0	0.081	0.081	0.081				
16002700	MCFARLAND	LWH	2013	FILSK	3	1	20.8	20.8	20.8	0.041	0.041	0.041				
		NP	1991	FILSK	3	2	20.0	17.7	22.3	0.150	0.120	0.180	1	0.010	0.010	Y
		WE	1991	FILSK	11	2	14.6	13.5	15.6	0.086	0.072	0.100	1	0.010	0.010	Y
			2013	FILSK	7	7	15.8	11.2	27.2	0.150	0.068	0.301				
		WSU	1991	FILSK	6	2	19.8	19.0	20.5	0.145	0.130	0.160	1	0.010	0.010	Y
		YP	1991	FILSK	6	1	9.3	9.3	9.3	0.079	0.079	0.079				
			2013	FILSK	5	1	6.0	6.0	6.0	0.032	0.032	0.032				
16002900	DEVILFISH	LT	1982	FILSK	5	2	20.9	17.0	24.8	1.700	1.600	1.800				
		WE	1985	FILSK	9	2	15.9	14.2	17.5	0.600	0.600	0.600				
			2004	FILSK	4	4	19.3	12.2	24.6	0.583	0.149	0.777				
16003100	LOFT	BKT	1990	FILSK	8	1	14.2	14.2	14.2	0.190	0.190	0.190	1	0.010	0.010	Y
16003200	OTTER**	NP	1995	FILSK	4	2	19.5	17.8	21.1	0.465	0.410	0.520	1	0.010	0.010	Y
			2007	FILSK	7	7	20.4	19.0	21.3	0.785	0.655	0.909				

DOWID	Waterway	Species	Year	Anat.	Total Fish	N	Length (in)			Mercury (mg/kg)			PCBs (mg/kg)			
							Mean	Min	Max	Mean	Min	Max	N	Mean	Max	< RL
16003300	CHESTER*	BT	1994	FILSK	9	3	15.3	13.4	17.0	0.213	0.160	0.280	1	0.038	0.038	
			2010	FILSK	4	4	16.1	12.8	17.8	0.388	0.229	0.545				
			2014	FILSK	2	2	15.8	13.7	17.8	0.512	0.330	0.693				
		WSU	1994	FILSK	4	1	19.3	19.3	19.3	0.200	0.200	0.200				
16003400	SOUTH FOWL*	NP	1993	FILSK	12	3	18.3	14.0	22.0	0.161	0.094	0.210	1	0.010	0.010	Y
		WE	1993	FILSK	19	3	16.6	12.2	20.2	0.230	0.100	0.360	1	0.010	0.010	Y
		WSU	1993	FILSK	12	2	19.7	18.2	21.1	0.120	0.100	0.140	1	0.010	0.010	Y
		YP	1993	FILSK	6	1	10.7	10.7	10.7	0.078	0.078	0.078				
16003500	JOHN*	NP	1991	FILSK	11	3	26.6	18.0	40.9	0.397	0.230	0.720	2	0.010	0.010	Y
			1996	FILSK	10	10	22.4	11.7	33.5	0.351	0.072	0.785				
			2001	FILSK	18	18	22.3	12.7	33.0	0.296	0.089	0.946	1	0.010	0.010	Y
			2006	FILSK	7	7	23.7	15.9	31.3	0.399	0.177	0.611				
		WE	1991	FILSK	3	1	16.8	16.8	16.8	0.160	0.160	0.160	1	0.010	0.010	Y
			2006	FILSK	3	3	17.9	15.9	18.9	0.327	0.286	0.373				
		WSU	1991	FILSK	4	1	17.7	17.7	17.7	0.120	0.120	0.120	1	0.010	0.010	Y
		YP	1991	FILSK	10	1	9.2	9.2	9.2	0.094	0.094	0.094				
16003600	NORTH FOWL*	WE	1998	FILSK	8	8	17.1	12.3	28.2	0.191	0.063	0.700				
		WSU	1998	FILSK	5	1	17.7	17.7	17.7	0.045	0.045	0.045				
		YP	1998	FILSK	5	1	10.8	10.8	10.8	0.063	0.063	0.063				
16004100	PINE*	LWH	1997	FILSK	8	1	21.1	21.1	21.1	0.130	0.130	0.130	1	0.030	0.030	
		WE	1997	FILSK	9	9	19.3	12.8	23.1	0.191	0.110	0.370	2	0.020	0.030	Y
		YP	1997	FILSK	5	1	5.9	5.9	5.9	0.073	0.073	0.073				
16004200	EAST PIKE*	SMB	1989	FILSK	6	2	15.1	14.0	16.2	0.240	0.120	0.360				
			2002	FILSK	5	5	12.6	10.5	14.5	0.178	0.113	0.245				
16004300	MOOSE*	LT	1987	FILSK	4	4	24.3	19.5	29.0	1.023	0.340	1.500	4	0.066	0.080	
			1998	FILSK	2	2	24.0	21.1	26.9	0.265	0.160	0.370	2	0.020	0.030	
		LWH	1998	FILSK	8	1	21.1	21.1	21.1	0.160	0.160	0.160				
		WE	1987	FILSK	8	8	19.6	11.9	26.6	0.609	0.280	0.780				
			1998	FILSK	10	10	18.0	12.0	24.0	0.323	0.100	0.880				
16004600	MINK	RBT	1994	FILSK	8	1	12.3	12.3	12.3	0.077	0.077	0.077				
		SPL	1994	FILSK	7	2	13.2	12.2	14.1	0.120	0.120	0.120	1	0.010	0.010	
16004900	TROUT*	CIS	1996	FILSK	3	1	19.8	19.8	19.8	0.240	0.240	0.240	1	0.020	0.020	
		LT	1981	FILSK	5	2	24.0	16.5	31.5	0.605	0.210	1.000	2	0.320	0.608	
			1984	FILSK	5	1	16.0	16.0	16.0	0.200	0.200	0.200				
			1990	FILSK	6	3	16.3	12.7	20.8	0.227	0.110	0.420	3	0.050	0.091	
			1996	FILSK	6	3	18.5	14.3	23.3	0.260	0.120	0.410	2	0.030	0.050	Y
			2007	FILSK	8	8	13.7	11.6	15.9	0.209	0.141	0.253				
			2013	FILSK	12	12	15.2	12.0	25.8	0.325	0.169	0.719				
		RBT	2007	FILSK	1	1	11.9	11.9	11.9	0.041	0.041	0.041				
		YP	1996	FILSK	3	1	11.1	11.1	11.1	0.230	0.230	0.230				
			2013	FILSK	5	1	9.2	9.2	9.2	0.269	0.269	0.269				
16007100	CARROT*	BKT	1992	FILSK	8	1	11.8	11.8	11.8	0.230	0.230	0.230	1	0.010	0.010	Y

DOWID	Waterway	Species	Year	Anat.	Total Fish	N	Length (in)			Mercury (mg/kg)			PCBs (mg/kg)			
							Mean	Min	Max	Mean	Min	Max	N	Mean	Max	< RL
16007700	GREENWOOD*	CIS	1996	FILSK	5	1	14.5	14.5	14.5	0.230	0.230	0.230	1	0.010	0.010	Y
			2013	FILSK	5	1	16.0	16.0	16.0	0.504	0.504	0.504				
		LT	1983	FILSK	8	3	17.8	13.9	22.2	0.173	0.090	0.300				
			1986	FILSK	11	11	17.4	12.4	26.9	0.490	0.410	0.620				
			1990	FILSK	6	4	21.7	12.8	36.6	0.197	0.098	0.440	4	0.020	0.050	Y
			1996	FILSK	10	2	13.8	11.7	15.9	0.160	0.130	0.190	1	0.010	0.010	Y
			2005	FILSK	13	13	16.2	12.4	21.7	0.258	0.204	0.375	1	0.010	0.010	Y
			2009	FILSK	11	11	18.4	16.3	21.1	0.288	0.185	0.422				
			2013	FILSK	15	15	17.1	12.9	28.8	0.307	0.160	0.889				
		NP	2013	FILSK	1	1	21.0	21.0	21.0	0.260	0.260	0.260				
		SMB	1999	FILSK	6	6	12.4	10.7	14.8	0.262	0.130	0.440	1	0.010	0.010	Y
			2005	FILSK	1	1	9.7	9.7	9.7	0.122	0.122	0.122				
		WSU	1996	FILSK	1	1	18.0	18.0	18.0	0.490	0.490	0.490				
16008000	SHOE	BKT	1995	FILSK	6	2	14.2	13.1	15.3	0.145	0.120	0.170	1	0.010	0.010	Y
		SPL	1995	FILSK	2	1	11.3	11.3	11.3	0.130	0.130	0.130				
16008600	WEST PIKE*	LT	1989	FILSK	12	4	20.5	13.6	28.1	0.273	0.090	0.430	4	0.050	0.050	Y
			1996	FILSK	20	5	20.9	14.4	28.5	0.230	0.090	0.530	4	0.040	0.110	Y
		SMB	1996	FILSK	5	1	15.0	15.0	15.0	0.350	0.350	0.350				
16008900	NORTHERN LIGHT*	NP	1982	FILSK	12	3	21.6	17.0	27.7	0.237	0.170	0.340				
			1995	FILSK	16	16	21.1	12.9	32.4	0.276	0.114	0.549				
			2000	FILSK	20	20	21.3	12.4	30.2	0.319	0.130	1.080				
			2007	FILSK	5	5	21.8	16.0	31.4	0.324	0.148	0.558				
		SF	2008	FILSK	4	1	7.5	7.5	7.5	0.153	0.153	0.153				
		SMB	2008	FILSK	3	3	9.8	9.3	10.8	0.169	0.149	0.179				
		WE	1982	FILSK	2	1	26.5	26.5	26.5	1.040	1.040	1.040				
			1989	FILSK	9	4	19.4	12.9	24.6	0.765	0.170	1.540				
		YP	2007	FILSK	7	1	9.2	9.2	9.2	0.149	0.149	0.149				
16009300	MOUNTAIN**	LT	1992	FILSK	21	4	21.5	13.6	31.5	0.313	0.140	0.630	2	0.047	0.054	
		WSU	1992	FILSK	8	1	10.1	10.1	10.1	0.056	0.056	0.056				
16009600	ELBOW*	NP	1994	FILSK	19	5	21.9	14.0	34.5	0.308	0.210	0.520				
			2000	FILSK	5	5	20.1	16.2	24.6	0.220	0.170	0.310				
			2010	FILSK	6	6	17.5	14.0	19.3	0.217	0.147	0.295				
		WE	1994	FILSK	16	5	18.3	12.3	25.7	0.393	0.150	0.775	1	0.010	0.010	Y
			2000	FILSK	5	5	17.7	14.4	20.8	0.382	0.150	1.030				
			2010	FILSK	8	8	17.4	12.7	24.7	0.445	0.181	1.059				
		WSU	1994	FILSK	8	1	19.4	19.4	19.4	0.170	0.170	0.170				
			2000	FILSK	6	1	19.9	19.9	19.9	0.160	0.160	0.160				
		YP	1994	FILSK	9	1	7.8	7.8	7.8	0.076	0.076	0.076				
			2000	FILSK	7	1	7.7	7.7	7.7	0.080	0.080	0.080				
			2010	FILSK	5	1	8.1	8.1	8.1	0.220	0.220	0.220				
16009700	PICKEREL	NP	1993	FILSK	9	3	22.1	17.3	27.1	0.081	0.061	0.100	1	0.010	0.010	Y

DOWID	Waterway	Species	Year	Anat.	Total Fish	N	Length (in)			Mercury (mg/kg)			PCBs (mg/kg)			
							Mean	Min	Max	Mean	Min	Max	N	Mean	Max	< RL
		WSU	1993	FILSK	2	1	17.4	17.4	17.4	0.010	0.010	0.010	1	0.010	0.010	Y
16009800	BINAGAMI	WE	1989	FILSK	3	1	12.9	12.9	12.9	0.180	0.180	0.180				
16010400	MUSQUASH**	SPL	1982	FILSK	10	2	15.5	13.4	17.6	0.220	0.210	0.230				
			2001	FILSK	6	6	14.0	10.2	16.4	0.116	0.077	0.182	2	0.010	0.010	Y
		WSU	2001	FILSK	8	1	15.2	15.2	15.2	0.119	0.119	0.119				
16010800	PINE MOUNTAIN	BKT	1993	FILSK	8	1	11.4	11.4	11.4	0.059	0.059	0.059	1	0.030	0.030	
16011400	ALDER*	LT	1992	FILSK	5	2	19.1	12.9	25.3	0.088	0.035	0.140	2	0.024	0.034	
		NP	1992	FILSK	1	1	26.0	26.0	26.0	0.320	0.320	0.320	1	0.010	0.010	Y
		WE	1992	FILSK	12	2	14.9	11.8	17.9	0.210	0.140	0.280	1	0.010	0.010	Y
		WSU	1992	FILSK	6	2	19.7	18.0	21.4	0.210	0.120	0.300	1	0.010	0.010	
16011900	CROCODILE*	WE	1991	FILSK	18	3	17.1	12.4	22.1	0.253	0.150	0.330	2	0.010	0.010	Y
		WSU	1991	FILSK	8	1	16.9	16.9	16.9	0.110	0.110	0.110	1	0.010	0.010	Y
16012800	SWAMPER*	NP	1996	FILSK	6	2	25.5	17.4	33.5	0.985	0.320	1.650	1	0.010	0.010	Y
		WE	1996	FILSK	4	2	15.0	11.2	18.7	0.445	0.120	0.770				
		WSU	1996	FILSK	5	1	18.1	18.1	18.1	0.250	0.250	0.250				
		YP	1996	FILSK	7	1	11.5	11.5	11.5	0.400	0.400	0.400				
16013500	JIM*	LT	1994	FILSK	7	3	21.6	17.0	26.0	0.325	0.230	0.465	3	0.016	0.029	Y
		WSU	1994	FILSK	4	1	17.3	17.3	17.3	0.058	0.058	0.058				
16013900	CLEARWATER*	CIS	1991	FILSK	14	2	15.3	13.6	17.0	0.225	0.210	0.240	1	0.025	0.025	
			1999	FILSK	8	1	12.3	12.3	12.3	0.090	0.090	0.090	1	0.012	0.012	
		LT	1991	FILSK	16	3	17.7	13.6	23.7	0.210	0.150	0.300	3	0.042	0.082	
			1999	FILSK	6	6	14.9	13.8	15.7	0.110	0.090	0.170	5	0.014	0.027	Y
		SMB	1999	FILSK	3	3	14.9	14.7	15.3	0.237	0.180	0.280	1	0.010	0.010	Y
		YP	1999	FILSK	5	1	8.2	8.2	8.2	0.100	0.100	0.100				
16014300	DEVIL TRACK*	LWH	1990	FILSK	2	1	18.6	18.6	18.6	0.046	0.046	0.046	1	0.010	0.010	Y
			1999	FILSK	3	1	19.8	19.8	19.8	0.100	0.100	0.100	1	0.010	0.010	Y
		NP	1982	FILSK	4	2	20.3	18.0	22.5	0.340	0.260	0.420				
			1999	FILSK	4	4	25.1	22.3	28.7	0.448	0.220	0.690	1	0.010	0.010	Y
			2006	FILSK	9	9	20.4	13.6	26.2	0.298	0.124	0.486				
			2009	FILSK	7	7	21.7	16.5	30.2	0.330	0.118	0.926				
		SMB	1999	FILSK	5	5	13.2	10.8	14.5	0.210	0.160	0.270				
			2009	FILSK	5	5	13.9	13.0	16.0	0.326	0.227	0.494				
		WE	1982	FILSK	3	1	12.2	12.2	12.2	0.320	0.320	0.320				
			1990	FILSK	16	4	19.5	12.0	26.3	0.670	0.180	1.400	4	0.010	0.010	Y
			1996	FILSK	10	10	14.5	7.5	19.9	0.227	0.087	0.470				
			1999	FILSK	5	5	14.5	12.4	19.5	0.232	0.120	0.540				
			2006	FILSK	13	13	11.6	9.5	12.6	0.159	0.090	0.212				
			2009	FILSK	4	4	14.6	12.1	15.9	0.226	0.186	0.265				
		YP	1990	FILSK	10	1	8.1	8.1	8.1	0.170	0.170	0.170	1	0.010	0.010	Y
			1999	FILSK	7	1	7.7	7.7	7.7	0.110	0.110	0.110				
16014500	EAST TWIN	WE	1989	FILSK	6	2	14.9	12.6	17.2	0.110	0.060	0.160				

DOWID	Waterway	Species	Year	Anat.	Total Fish	N	Length (in)			Mercury (mg/kg)			PCBs (mg/kg)			
							Mean	Min	Max	Mean	Min	Max	N	Mean	Max	< RL
			2005	FILSK	8	8	13.2	12.1	16.1	0.059	0.021	0.084				
16014600	EAST BEARSKIN*	LT	1998	FILSK	4	4	20.1	17.4	22.1	0.127	0.083	0.170	4	0.014	0.018	Y
			2004	FILSK	1	1	19.2	19.2	19.2	0.043	0.043	0.043				
			2009	FILSK	3	3	18.4	14.2	21.6	0.142	0.080	0.177				
			2012	FILSK	1	1	19.3	19.3	19.3	0.113	0.113	0.113				
		NP	1982	FILSK	8	3	23.5	17.4	31.0	0.430	0.180	0.800				
			1998	FILSK	7	7	22.8	16.6	27.4	0.316	0.120	0.470				
			2009	FILSK	7	7	20.9	19.4	26.6	0.338	0.228	0.636				
			2012	FILSK	6	6	21.2	16.3	28.3	0.395	0.176	0.864				
		SMB	1998	FILSK	3	3	13.4	11.0	15.5	0.230	0.160	0.280				
			2009	FILSK	2	2	14.9	14.5	15.3	0.344	0.288	0.400				
			2012	FILSK	2	2	14.0	13.6	14.4	0.233	0.174	0.292				
		WE	1982	FILSK	4	2	17.0	13.0	21.0	0.625	0.250	1.000				
			1998	FILSK	5	5	18.1	13.4	22.7	0.356	0.150	0.610				
			2004	FILSK	2	2	13.0	12.9	13.1	0.169	0.147	0.191				
			2012	FILSK	6	6	15.8	11.6	24.4	0.423	0.206	1.104				
16014700	FLOUR*	CIS	1991	FILSK	12	2	15.2	14.1	16.3	0.083	0.070	0.095	1	0.010	0.010	Y
			2001	FILSK	4	1	15.6	15.6	15.6	0.135	0.135	0.135	1	0.010	0.010	Y
		NP	1991	FILSK	2	2	30.4	25.2	35.6	0.385	0.280	0.490	2	0.010	0.010	Y
		SMB	1991	FILSK	6	2	13.2	10.8	15.6	0.200	0.170	0.230	1	0.010	0.010	Y
			2001	FILSK	5	5	12.8	8.9	15.9	0.200	0.089	0.326				
		WE	1991	FILSK	7	2	14.7	14.2	15.2	0.092	0.074	0.110	1	0.010	0.010	Y
		YP	1991	FILSK	8	1	6.9	6.9	6.9	0.083	0.083	0.083				
16015000	DANIELS	LT	1992	FILSK	15	3	16.7	11.5	20.9	0.087	0.075	0.094	2	0.019	0.024	
		WSU	1992	FILSK	8	2	19.1	17.9	20.2	0.145	0.140	0.150	1	0.022	0.022	
		YP	1992	FILSK	2	1	9.0	9.0	9.0	0.140	0.140	0.140				
16015500	PIT*	NP	1994	FILSK	10	3	16.3	13.5	19.3	0.263	0.200	0.340				
		WSU	1994	FILSK	7	1	19.2	19.2	19.2	0.160	0.160	0.160	1	0.010	0.010	Y
		YP	1994	FILSK	3	1	8.0	8.0	8.0	0.180	0.180	0.180				
16015600	TWO ISLAND*	BGS	2012	FILSK	9	2	7.2	6.4	8.0	0.071	0.064	0.077				
		NP	1982	FILSK	9	3	22.9	19.0	26.3	0.400	0.380	0.440				
			1989	FILSK	4	2	22.4	18.2	26.5	0.300	0.260	0.340				
			2008	FILSK	9	9	25.2	19.5	29.6	0.449	0.193	0.811				
			2012	FILSK	8	8	21.3	16.8	23.7	0.268	0.144	0.352				
		SMB	1997	FILSK	4	4	11.9	9.5	13.6	0.175	0.130	0.260	1	0.010	0.010	Y
			2012	FILSK	3	3	10.0	9.0	10.6	0.232	0.216	0.242				
		WE	1982	FILSK	2	1	17.0	17.0	17.0	0.410	0.410	0.410				
			1989	FILSK	9	3	17.9	14.2	21.1	0.583	0.290	0.740				
			1997	FILSK	10	10	16.2	13.1	22.5	0.276	0.130	0.710	2	0.010	0.010	Y
			2008	FILSK	8	8	17.4	12.8	21.2	0.498	0.125	1.049				
			2012	FILSK	8	8	17.0	14.6	20.8	0.275	0.194	0.388				

DOWID	Waterway	Species	Year	Anat.	Total Fish	N	Length (in)			Mercury (mg/kg)			PCBs (mg/kg)			
							Mean	Min	Max	Mean	Min	Max	N	Mean	Max	< RL
		WSU	1997	FILSK	7	1	18.9	18.9	18.9	0.160	0.160	0.160				
		YP	1997	FILSK	5	1	9.8	9.8	9.8	0.160	0.160	0.160				
16015700	DICK	NP	2001	FILSK	3	3	18.6	15.3	20.7	0.263	0.115	0.339				
16016700	DISLOCATION	YP	2010	FILSK	4	1	6.9	6.9	6.9	0.096	0.096	0.096				
16017000	LITTLE TROUT*	LT	1989	FILSK	6	2	15.7	12.5	18.8	0.150	0.100	0.200	2	0.050	0.050	Y
			2002	FILSK	5	5	17.4	13.1	19.8	0.333	0.116	0.470				
16017400	RAM	LT	1993	FILSK	15	4	18.4	10.0	25.4	0.086	0.042	0.170	3	0.010	0.010	Y
		RBT	1993	FILSK	3	1	15.6	15.6	15.6	0.016	0.016	0.016	1	0.010	0.010	Y
		WSU	1993	FILSK	8	1	17.7	17.7	17.7	0.120	0.120	0.120				
16017500	BOWER TROUT	NP	1989	FILSK	3	2	22.6	15.7	29.5	0.310	0.240	0.380				
		WE	1989	FILSK	6	2	15.7	13.3	18.0	0.215	0.160	0.270				
16018200	BALL CLUB**	NP	1983	FILSK	5	2	20.9	18.6	23.1	0.170	0.120	0.220				
			1986	FILSK	7	2	18.8	16.9	20.6	0.290	0.200	0.380				
			2004	FILSK	1	1	21.7	21.7	21.7	0.181	0.181	0.181				
		WE	1982	FILSK	10	3	18.1	12.6	24.2	0.287	0.210	0.410				
			1983	FILSK	3	1	17.0	17.0	17.0	0.130	0.130	0.130				
			1986	FILSK	10	2	15.9	14.0	17.7	1.350	1.300	1.400				
			1989	FILSK	3	1	13.3	13.3	13.3	0.140	0.140	0.140				
			1995	FILSK	26	16	14.7	8.3	20.4	0.489	0.162	1.177	1	0.010	0.010	Y
			2004	FILSK	5	5	13.4	11.5	18.3	0.097	0.055	0.181				
			2012	FILSK	12	12	15.5	11.8	19.4	0.287	0.185	0.445				
		WSU	1995	FILSK	2	1	17.4	17.4	17.4	0.150	0.150	0.150				
16018600	WEST TWIN	WE	1989	FILSK	3	1	14.3	14.3	14.3	0.150	0.150	0.150				
16018800	KEMO*	LT	1993	FILSK	13	4	16.5	9.4	23.5	0.230	0.100	0.400	4	0.047	0.110	
			2012	FILSK	6	6	15.8	12.3	21.5	0.122	0.072	0.238				
		SPL	1993	FILSK	6	2	11.9	9.3	14.5	0.115	0.089	0.140	1	0.023	0.023	
16019100	THRUSH*	BKT	1987	FILSK	17	17	13.5	10.0	17.0	0.212	0.150	0.330				
			1993	FILSK	11	11	10.2	7.8	13.0	0.140	0.087	0.210	1	0.010	0.010	Y
16019200	THRASHER*	BKT	1995	FILSK	6	2	15.7	14.6	16.7	0.355	0.350	0.360				
		SPL	1995	FILSK	7	2	15.3	13.0	17.6	0.435	0.340	0.530	1	0.010	0.010	Y
16019300	MIT	NP	1989	FILSK	5	2	19.6	17.9	21.2	0.620	0.500	0.740				
			2005	FILSK	3	3	21.9	21.2	22.5	1.354	0.843	1.698				
			2011	FILSK	7	7	20.1	19.1	21.6	0.719	0.572	1.020				
		WE	1989	FILSK	2	2	15.3	12.5	18.1	0.435	0.300	0.570				
			2005	FILSK	1	1	17.3	17.3	17.3	0.821	0.821	0.821				
			2011	FILSK	4	4	15.4	11.2	20.5	0.561	0.214	0.996				
16019400	PINE*	BKT	1995	FILSK	1	1	15.6	15.6	15.6	0.260	0.260	0.260	1	0.010	0.010	Y
		SPL	1995	FILSK	5	1	11.6	11.6	11.6	0.060	0.060	0.060				
		WSU	1995	FILSK	5	1	16.9	16.9	16.9	0.100	0.100	0.100				
16019600	WAMPUS*	YP	1995	FILSK	10	1	7.7	7.7	7.7	0.220	0.220	0.220				
			2012	FILSK	5	1	7.6	7.6	7.6	0.183	0.183	0.183				
16019800	LEO	RBT	2000	FILSK	4	4	13.2	12.4	13.9	0.058	0.040	0.080				

DOWID	Waterway	Species	Year	Anat.	Total Fish	N	Length (in)			Mercury (mg/kg)			PCBs (mg/kg)			
							Mean	Min	Max	Mean	Min	Max	N	Mean	Max	< RL
		WE	2000	FILSK	4	4	22.4	19.7	24.9	0.293	0.250	0.370				
16019900	LIZZ	BKT	1998	FILSK	6	6	13.5	12.0	15.1	0.103	0.073	0.140	5	0.010	0.011	Y
16020200	SQUINT	NP	2013	FILSK	6	6	17.8	15.0	20.6	0.203	0.127	0.308				
		WE	1982	FILSK	5	2	15.5	13.1	17.9	0.245	0.140	0.350				
			1985	FILSK	5	1	16.3	16.3	16.3	0.320	0.320	0.320				
			2013	FILSK	3	3	16.3	12.8	18.7	0.311	0.160	0.504				
		YP	2013	FILSK	5	1	8.4	8.4	8.4	0.099	0.099	0.099				
16020400	ASPEN*	NP	1989	FILSK	6	3	22.5	19.0	26.7	0.283	0.240	0.340				
			1992	FILSK	12	3	21.5	16.9	25.4	0.360	0.200	0.500	1	0.010	0.010	Y
			2001	FILSK	4	4	19.7	16.1	21.3	0.381	0.318	0.435				
			2005	FILSK	8	8	18.0	14.4	21.6	0.205	0.109	0.465				
			2008	FILSK	8	8	23.3	18.5	40.3	0.409	0.201	1.223				
			2012	FILSK	7	7	19.9	18.2	23.0	0.354	0.206	0.488				
		SMB	2008	FILSK	1	1	14.3	14.3	14.3	0.206	0.206	0.206				
			2012	FILSK	4	4	14.3	12.3	17.4	0.294	0.241	0.448				
		WE	1989	FILSK	6	3	17.3	11.9	22.3	0.260	0.100	0.450				
			1992	FILSK	13	2	15.1	12.1	18.0	0.230	0.130	0.330	1	0.010	0.010	Y
			2001	FILSK	2	2	14.7	13.3	16.1	0.286	0.245	0.326				
			2005	FILSK	9	9	15.8	13.6	21.2	0.251	0.121	0.560				
			2008	FILSK	7	7	18.7	16.6	20.0	0.374	0.257	0.664				
			2012	FILSK	8	8	16.0	11.8	23.2	0.257	0.148	0.525				
		YP	1992	FILSK	4	1	10.1	10.1	10.1	0.230	0.230	0.230				
16021500	SWAMP*	NP	1993	FILSK	5	1	20.6	20.6	20.6	0.140	0.140	0.140				
		WE	1993	FILSK	18	5	18.3	12.1	25.0	0.332	0.068	0.740	1	0.010	0.010	Y
		WSU	1993	FILSK	4	1	15.4	15.4	15.4	0.071	0.071	0.071				
		YP	1993	FILSK	8	1	8.0	8.0	8.0	0.078	0.078	0.078				
16022000	MORGAN	NP	1984	FILSK	5	1	21.6	21.6	21.6	0.330	0.330	0.330				
16022400	VISTA**	NP	1993	FILSK	6	3	24.7	17.3	30.0	0.537	0.270	0.700	1	0.010	0.010	Y
		WE	1993	FILSK	11	4	15.9	11.4	20.3	0.435	0.230	0.880	1	0.010	0.010	Y
		WSU	1993	FILSK	5	1	17.6	17.6	17.6	0.200	0.200	0.200	1	0.010	0.010	Y
		YP	1993	FILSK	3	1	7.8	7.8	7.8	0.250	0.250	0.250				
16022700	HUNGRY JACK*	NP	2008	FILSK	2	2	23.9	23.8	24.0	0.173	0.136	0.210				
			2012	FILSK	2	2	28.3	24.4	32.1	0.445	0.284	0.606				
		SMB	1991	FILSK	16	2	13.7	12.0	15.3	0.180	0.160	0.200	1	0.010	0.010	Y
			2008	FILSK	2	2	11.2	10.5	11.8	0.134	0.125	0.143				
		WE	1991	FILSK	15	3	16.8	11.1	22.0	0.230	0.100	0.360	2	0.010	0.010	Y
			2001	FILSK	4	4	21.8	17.6	29.5	0.323	0.178	0.632	1	0.010	0.010	
			2008	FILSK	3	3	15.0	14.1	16.0	0.105	0.097	0.109				
			2012	FILSK	6	6	15.3	12.6	21.4	0.204	0.115	0.468				
		WSU	2001	FILSK	2	1	16.7	16.7	16.7	0.047	0.047	0.047				
		YP	1991	FILSK	10	1	7.8	7.8	7.8	0.067	0.067	0.067				
			2001	FILSK	5	1	9.1	9.1	9.1	0.048	0.048	0.048				

DOWID	Waterway	Species	Year	Anat.	Total Fish	N	Length (in)			Mercury (mg/kg)			PCBs (mg/kg)			
							Mean	Min	Max	Mean	Min	Max	N	Mean	Max	< RL
			2012	FILSK	5	1	7.7	7.7	7.7	0.123	0.123	0.123				
16022800	BEARSKIN*	LT	1993	FILSK	24	4	19.9	13.6	27.2	0.206	0.032	0.460	3	0.018	0.032	Y
		SMB	1993	FILSK	6	2	12.6	10.8	14.3	0.179	0.077	0.280				
16023000	ROSE	LT	1987	FILSK	2	2	23.0	16.0	30.0	0.935	0.370	1.500	1	0.094	0.094	
16023200	DUNCAN*	CIS	1993	FILSK	13	2	14.8	13.8	15.8	0.135	0.120	0.150	1	0.020	0.020	
			2001	FILSK	3	1	15.8	15.8	15.8	0.139	0.139	0.139	1	0.010	0.010	Y
		LT	1993	FILSK	17	3	16.1	13.7	18.6	0.057	0.046	0.067	2	0.013	0.013	
			2001	FILSK	5	5	22.4	15.4	30.1	0.383	0.039	1.033	5	0.020	0.040	Y
		SMB	1993	FILSK	2	1	12.5	12.5	12.5	0.095	0.095	0.095				
			2001	FILSK	5	5	11.6	10.6	12.5	0.100	0.077	0.127				
		YP	1993	FILSK	2	1	11.7	11.7	11.7	0.100	0.100	0.100				
16023400	MOSS	LT	1995	FILSK	5	2	16.9	15.3	18.4	0.047	0.043	0.051	1	0.010	0.010	Y
		WSU	1995	FILSK	6	2	19.3	18.1	20.4	0.110	0.100	0.120				
16023500	MCDONALD*	NP	1982	FILSK	10	2	19.9	18.9	20.8	0.220	0.200	0.240				
			1996	FILSK	10	10	18.0	14.0	21.1	0.165	0.091	0.246				
			2001	FILSK	12	12	18.3	15.0	23.1	0.193	0.113	0.381				
			2004	FILSK	26	26	18.9	15.1	25.2	0.166	0.106	0.303				
			2007	FILSK	6	6	23.2	18.0	28.6	0.390	0.301	0.588				
		SMB	2007	FILSK	6	6	15.6	14.0	17.8	0.256	0.203	0.308				
		WE	1996	FILSK	5	5	18.4	14.6	21.9	0.270	0.112	0.416				
			2007	FILSK	1	1	17.5	17.5	17.5	0.367	0.367	0.367				
		YP	2004	FILSK	1	1	12.6	12.6	12.6	0.177	0.177	0.177				
16023800	HAND**	NP	2001	FILSK	8	8	22.1	18.2	25.4	0.605	0.212	1.197				
		WE	2001	FILSK	4	4	19.0	16.3	20.6	0.837	0.304	1.187				
16023900	POPLAR*	LWH	1995	FILSK	4	1	18.4	18.4	18.4	0.240	0.240	0.240	1	0.010	0.010	Y
		NP	1982	FILSK	5	2	22.1	17.6	26.5	0.285	0.180	0.390				
			1993	FILSK	4	1	17.9	17.9	17.9	0.190	0.190	0.190				
			1995	FILSK	10	3	18.8	14.2	23.1	0.227	0.140	0.290				
			2006	FILSK	9	9	17.0	13.8	18.6	0.126	0.061	0.215				
			2012	FILSK	8	8	19.5	17.2	21.8	0.267	0.145	0.387				
		SMB	1993	FILSK	2	1	12.0	12.0	12.0	0.120	0.120	0.120				
			1995	FILSK	3	2	12.4	10.0	14.7	0.245	0.160	0.330				
			2006	FILSK	1	1	9.5	9.5	9.5	0.124	0.124	0.124				
		WE	1993	FILSK	8	1	13.9	13.9	13.9	0.220	0.220	0.220				
			1995	FILSK	5	1	15.6	15.6	15.6	0.260	0.260	0.260				
			2006	FILSK	1	1	15.8	15.8	15.8	0.313	0.313	0.313				
			2012	FILSK	1	1	15.6	15.6	15.6	0.208	0.208	0.208				
		WSU	1993	FILSK	13	2	19.1	17.3	20.9	0.146	0.081	0.210	1	0.010	0.010	Y
			1995	FILSK	5	1	18.2	18.2	18.2	0.290	0.290	0.290				
		YP	1993	FILSK	4	1	8.2	8.2	8.2	0.170	0.170	0.170				
16024400	SOUTH	LT	1987	FILSK	17	14	18.7	12.3	24.2	0.401	0.060	2.000	1	0.085	0.085	
			2011	FILSK	5	5	27.8	25.6	30.5	0.541	0.408	0.734				

DOWID	Waterway	Species	Year	Anat.	Total Fish	N	Length (in)			Mercury (mg/kg)			PCBs (mg/kg)			
							Mean	Min	Max	Mean	Min	Max	N	Mean	Max	< RL
16024500	DUNN*	LT	1994	FILSK	10	2	16.2	14.5	17.8	0.260	0.200	0.320	1	0.010	0.010	Y
16024700	BIRCH	LT	1994	FILSK	4	2	13.5	12.2	14.7	0.123	0.056	0.190				
		RBT	1994	FILSK	12	3	15.8	12.7	20.7	0.071	0.048	0.110	1	0.010	0.010	Y
			2007	FILSK	1	1	17.8	17.8	17.8	0.046	0.046	0.046				
		SMB	2007	FILSK	3	3	12.5	10.0	14.6	0.098	0.048	0.127				
		SPL	2007	FILSK	3	3	10.5	10.0	11.0	0.058	0.054	0.062				
		WSU	1994	FILSK	6	1	18.4	18.4	18.4	0.083	0.083	0.083				
16025000	MARK*	NP	1993	FILSK	16	3	17.5	13.6	21.1	0.297	0.190	0.470	1	0.010	0.010	Y
		WSU	1993	FILSK	11	2	14.8	12.7	16.9	0.090	0.069	0.110				
16025200	PIKE*	LWH	1995	FILSK	6	1	20.9	20.9	20.9	0.092	0.092	0.092	1	0.010	0.010	Y
		NP	1983	FILSK	3	1	21.9	21.9	21.9	0.170	0.170	0.170				
			1989	FILSK	3	1	24.8	24.8	24.8	0.260	0.260	0.260				
			1995	FILSK	9	5	23.3	16.1	32.5	0.278	0.160	0.540	1	0.010	0.010	Y
			2006	FILSK	13	13	20.1	15.2	30.2	0.280	0.136	0.902				
			2009	FILSK	5	5	20.7	18.6	24.6	0.311	0.282	0.352				
		SMB	2009	FILSK	2	2	14.2	11.6	16.7	0.431	0.194	0.668				
		WE	1983	FILSK	5	1	17.7	17.7	17.7	0.190	0.190	0.190				
			1989	FILSK	9	3	17.4	13.9	21.9	0.310	0.220	0.410				
			1995	FILSK	15	4	18.0	13.2	23.1	0.275	0.150	0.480				
			2006	FILSK	5	5	16.4	13.6	20.2	0.304	0.115	0.613				
			2009	FILSK	2	2	14.2	12.5	15.8	0.163	0.105	0.220				
		YP	1995	FILSK	8	1	10.0	10.0	10.0	0.084	0.084	0.084				
16025300	DEER YARD*	WE	1992	FILSK	11	4	13.7	11.7	15.5	0.330	0.180	0.610	1	0.010	0.010	Y
			2001	FILSK	6	6	13.4	12.2	14.6	0.249	0.175	0.342				
			2007	FILSK	6	6	13.4	11.9	16.8	0.384	0.186	0.823				
			2013	FILSK	6	6	15.6	12.4	28.0	0.361	0.138	1.308				
		WSU	1992	FILSK	11	4	18.0	16.3	19.8	0.208	0.190	0.230	2	0.010	0.010	Y
			2001	FILSK	3	1	16.0	16.0	16.0	0.086	0.086	0.086				
16026700	VERNON	SMB	1998	FILSK	4	4	13.1	12.4	13.6	0.178	0.140	0.210				
		WE	1998	FILSK	1	1	20.4	20.4	20.4	0.370	0.370	0.370				
16026800	SWAN	NP	1998	FILSK	1	1	25.2	25.2	25.2	0.300	0.300	0.300				
		SMB	1998	FILSK	2	2	15.7	13.7	17.7	0.450	0.280	0.620				
		WE	1998	FILSK	4	4	18.0	12.4	22.7	0.415	0.180	0.650				
16029900	RUSH	NP	1982	FILSK	11	2	24.0	21.3	26.7	0.815	0.780	0.850				
16031400	HENSON	NP	1998	FILSK	1	1	20.2	20.2	20.2	0.210	0.210	0.210				
		SF	1998	FILSK	2	1	5.6	5.6	5.6	0.066	0.066	0.066				
16031900	GASKIN	WE	1990	FILSK	1	1	16.9	16.9	16.9	0.530	0.530	0.530	1	0.010	0.010	Y
16034600	CASCADE*	NP	1986	FILSK	7	2	19.3	17.8	20.8	0.305	0.190	0.420				
			1998	FILSK	9	9	22.4	16.6	35.8	0.197	0.071	0.350				
			2007	FILSK	6	6	21.4	17.8	26.7	0.183	0.110	0.275				
			2012	FILSK	6	6	19.2	16.2	22.1	0.178	0.129	0.253				
		WE	1986	FILSK	12	3	17.4	12.6	21.3	0.533	0.340	0.660				

DOWID	Waterway	Species	Year	Anat.	Total Fish	N	Length (in)			Mercury (mg/kg)			PCBs (mg/kg)			
							Mean	Min	Max	Mean	Min	Max	N	Mean	Max	< RL
			1998	FILSK	9	9	16.0	12.2	21.5	0.223	0.095	0.650				
			2007	FILSK	6	6	16.3	13.7	20.2	0.297	0.127	0.567				
			2012	FILSK	6	6	16.4	14.2	18.0	0.238	0.176	0.309				
		WSU	1998	FILSK	6	1	19.8	19.8	19.8	0.081	0.081	0.081				
		YP	2012	FILSK	4	1	7.7	7.7	7.7	0.083	0.083	0.083				
16034700	LITTLE CASCADE**	NP	1982	FILSK	15	3	21.8	17.4	26.8	0.640	0.410	0.960				
			1993	FILSK	13	3	20.8	12.8	26.9	0.543	0.390	0.720	1	0.010	0.010	Y
			1996	FILSK	10	10	19.3	13.8	25.8	0.414	0.279	0.664				
			2005	FILSK	22	22	21.3	18.4	35.9	0.653	0.489	1.555				
			2010	FILSK	15	15	20.4	16.3	23.9	0.509	0.388	0.724				
		YP	1993	FILSK	7	1	9.4	9.4	9.4	0.320	0.320	0.320				
16034800	BRULE*	CIS	1996	FILSK	3	1	16.3	16.3	16.3	0.210	0.210	0.210	1	0.020	0.020	
		NP	1983	FILSK	7	2	18.9	17.6	20.2	0.240	0.190	0.290				
			1986	FILSK	8	8	23.9	16.0	30.2	0.634	0.340	1.200				
			2009	FILSK	14	14	18.6	15.5	20.6	0.243	0.163	0.302				
		WE	1983	FILSK	5	1	18.5	18.5	18.5	0.440	0.440	0.440				
			1986	FILSK	12	12	16.6	12.4	21.5	0.743	0.290	2.300				
			1996	FILSK	23	14	16.3	11.4	20.8	0.234	0.100	0.395				
		WSU	1996	FILSK	5	1	21.2	21.2	21.2	0.150	0.150	0.150				
16035400	WINCHELL*	LT	1992	FILSK	18	4	20.1	14.2	27.0	0.685	0.390	1.400	2	0.161	0.260	
		NP	1992	FILSK	2	2	33.4	26.3	40.5	0.885	0.270	1.500	1	0.220	0.220	
		WSU	1992	FILSK	6	1	16.3	16.3	16.3	0.094	0.094	0.094	1	0.019	0.019	
16035800	BARKER*	NP	1991	FILSK	4	3	22.2	18.4	26.6	0.437	0.370	0.560	2	0.010	0.010	Y
		WE	1991	FILSK	9	2	15.0	11.5	18.5	0.280	0.170	0.390	1	0.010	0.010	Y
		YP	1991	FILSK	8	1	6.6	6.6	6.6	0.130	0.130	0.130				
16036000	CARIBOU*	NP	1986	FILSK	2	1	23.0	23.0	23.0	0.260	0.260	0.260				
			1989	FILSK	3	1	19.2	19.2	19.2	0.140	0.140	0.140				
			1992	FILSK	17	3	21.8	18.5	26.3	0.207	0.120	0.300	1	0.010	0.010	Y
			2011	FILSK	6	6	19.4	16.2	25.0	0.205	0.129	0.307				
			2014	FILSK	8	8	22.3	17.8	30.5	0.336	0.281	0.430				
		SMB	2011	FILSK	1	1	15.9	15.9	15.9	0.257	0.257	0.257				
		WE	1986	FILSK	9	2	15.9	12.8	18.9	0.155	0.130	0.180				
			1989	FILSK	2	1	21.9	21.9	21.9	0.340	0.340	0.340				
			1992	FILSK	15	3	19.2	12.8	28.2	0.236	0.062	0.490	1	0.043	0.043	
			2011	FILSK	7	7	14.8	12.9	18.1	0.174	0.124	0.301				
			2014	FILSK	8	8	15.2	11.6	18.5	0.207	0.146	0.259				
		WSU	1992	FILSK	8	1	18.2	18.2	18.2	0.038	0.038	0.038	1	0.010	0.010	Y
		YP	1992	FILSK	8	1	10.2	10.2	10.2	0.094	0.094	0.094				
			2014	FILSK	6	1	5.5	5.5	5.5	0.095	0.095	0.095				
16036500	CLARA*	BGS	2007	FILSK	3	1	4.9	4.9	4.9	0.096	0.096	0.096				
		NP	2007	FILSK	4	4	20.1	19.0	20.8	0.400	0.368	0.431				

DOWID	Waterway	Species	Year	Anat.	Total Fish	N	Length (in)			Mercury (mg/kg)			PCBs (mg/kg)			
							Mean	Min	Max	Mean	Min	Max	N	Mean	Max	< RL
		WE	1991	FILSK	17	4	19.4	13.0	26.2	0.505	0.100	0.900	3	0.063	0.100	
			1996	FILSK	10	10	16.9	8.2	30.2	0.419	0.091	1.894				
		WSU	1991	FILSK	10	2	15.0	12.6	17.4	0.096	0.032	0.160	1	0.050	0.050	
		YP	1991	FILSK	7	1	11.2	11.2	11.2	0.210	0.210	0.210				
16036600	HOLLY*	NP	1989	FILSK	6	2	19.7	18.0	22.0	0.365	0.290	0.440				
			2007	FILSK	1	1	19.3	19.3	19.3	0.266	0.266	0.266				
		WE	1989	FILSK	5	3	16.5	13.5	20.2	0.270	0.040	0.450				
			2007	FILSK	9	9	18.0	13.1	25.5	0.363	0.249	0.621				
			2008	FILSK	8	8	13.7	11.3	17.5	0.264	0.161	0.595				
16036900	WHITE PINE*	NP	1998	FILSK	4	4	17.9	17.1	18.2	0.058	0.046	0.070				
		WE	1998	FILSK	6	6	17.4	12.6	24.6	0.175	0.038	0.470				
		WSU	1998	FILSK	6	1	18.5	18.5	18.5	0.058	0.058	0.058				
		YP	1998	FILSK	7	1	9.7	9.7	9.7	0.069	0.069	0.069				
16037300	CHRISTINE*	NP	1989	FILSK	6	2	20.5	16.7	24.2	0.345	0.170	0.520				
			2001	FILSK	6	6	22.3	14.6	36.3	0.298	0.106	0.784				
		WE	1989	FILSK	3	2	14.3	12.1	16.5	0.135	0.120	0.150				
		WSU	2001	FILSK	4	1	19.1	19.1	19.1	0.189	0.189	0.189				
		YP	2001	FILSK	10	1	7.9	7.9	7.9	0.055	0.055	0.055				
16037800	KINOGAMI*	WE	2002	FILSK	2	2	17.2	15.4	19.0	0.714	0.459	0.968				
		WSU	2002	FILSK	5	1	18.6	18.6	18.6	0.197	0.197	0.197				
16038000	GUST*	NP	2011	FILSK	1	1	17.3	17.3	17.3	0.115	0.115	0.115				
		SMB	2011	FILSK	8	8	13.1	10.2	15.4	0.121	0.089	0.224				
		WE	1991	FILSK	17	3	17.6	12.7	22.6	0.272	0.065	0.530	2	0.010	0.010	Y
			2011	FILSK	8	8	14.2	11.8	15.9	0.103	0.059	0.134				
		YP	2011	FILSK	6	2	10.1	9.2	11.0	0.055	0.055	0.055				
16038200	LICHEN*	WE	1991	FILSK	18	3	17.6	13.2	22.4	0.397	0.200	0.630	2	0.010	0.010	Y
16038300	BOUDER*	SMB	2007	FILSK	6	6	12.3	11.3	13.6	0.252	0.164	0.441				
		WE	2002	FILSK	4	4	15.4	12.1	18.7	0.176	0.131	0.226				
		WSU	2002	FILSK	2	1	15.7	15.7	15.7	0.039	0.039	0.039				
16038400	TAIT*	NP	1995	FILSK	8	3	21.0	17.2	25.2	0.347	0.220	0.470	1	0.010	0.010	Y
			2011	FILSK	8	8	20.9	17.4	28.6	0.167	0.108	0.307				
			2013	FILSK	7	7	21.7	17.6	27.1	0.337	0.193	0.520				
		WE	1995	FILSK	16	4	16.6	13.1	21.1	0.423	0.210	0.930				
			2011	FILSK	8	8	15.7	12.6	19.5	0.251	0.109	0.370				
			2013	FILSK	7	7	16.4	12.9	19.9	0.292	0.150	0.489				
		WSU	1995	FILSK	7	1	18.6	18.6	18.6	0.300	0.300	0.300				
		YP	1995	FILSK	10	1	10.2	10.2	10.2	0.230	0.230	0.230				
			2011	FILSK	6	2	9.1	6.7	11.5	0.091	0.047	0.135				
			2013	FILSK	9	2	9.8	8.6	10.9	0.141	0.095	0.186				
16039800	WENCH	BKT	1981	FILSK	5	1	15.2	15.2	15.2	0.110	0.110	0.110	1	0.025	0.025	Y
			1984	FILSK	5	1	14.9	14.9	14.9	0.180	0.180	0.180				
			2007	FILSK	2	2	19.2	19.1	19.2	0.212	0.199	0.225				

DOWID	Waterway	Species	Year	Anat.	Total Fish	N	Length (in)			Mercury (mg/kg)			PCBs (mg/kg)			
							Mean	Min	Max	Mean	Min	Max	N	Mean	Max	< RL
16040200	JUNO**	NP	2000	FILSK	7	7	20.4	17.0	23.5	0.340	0.200	0.610				
		WE	2000	FILSK	7	7	17.0	12.5	22.4	0.537	0.240	0.990				
		WSU	2000	FILSK	5	1	20.3	20.3	20.3	0.310	0.310	0.310				
16040500	STAR**	NP	2000	FILSK	5	5	18.3	15.0	22.4	0.468	0.290	0.760				
		WE	2000	FILSK	2	2	16.9	14.6	19.2	0.560	0.390	0.730				
		WSU	2000	FILSK	4	1	20.1	20.1	20.1	0.220	0.220	0.220				
16040600	HOMER*	NP	1982	FILSK	6	2	19.6	18.0	21.2	0.275	0.240	0.310				
			1993	FILSK	16	4	21.9	17.9	25.7	0.308	0.180	0.400	1	0.010	0.010	Y
			1996	FILSK	10	10	17.9	12.3	23.0	0.179	0.106	0.381				
			2004	FILSK	11	11	19.7	11.3	26.9	0.334	0.094	1.051				
		WE	1993	FILSK	15	4	16.2	11.7	21.3	0.280	0.160	0.450	1	0.010	0.010	Y
			2004	FILSK	10	10	14.5	9.2	19.0	0.288	0.126	1.080				
		WSU	1993	FILSK	8	2	19.0	17.3	20.6	0.140	0.110	0.170	1	0.010	0.010	Y
16041200	UPPER CONE	NP	1981	FILSK	4	1	22.0	22.0	22.0	0.520	0.520	0.520	1	0.025	0.025	Y
			1984	FILSK	5	2	21.1	17.6	24.5	0.620	0.450	0.790				
			1987	FILSK	8	8	19.0	16.5	25.4	0.541	0.270	1.200				
		SMB	1981	FILSK	5	1	13.8	13.8	13.8	0.440	0.440	0.440	1	0.025	0.025	Y
		WE	1981	FILSK	5	1	17.6	17.6	17.6	0.700	0.700	0.700	1	0.025	0.025	Y
			1984	FILSK	5	1	14.5	14.5	14.5	0.400	0.400	0.400				
			1987	FILSK	6	6	17.8	14.0	19.8	0.742	0.320	1.200				
16043500	DAVIS	NP	1982	FILSK	5	1	22.6	22.6	22.6	0.660	0.660	0.660				
16045300	RICE	WE	2001	FILSK	2	2	13.1	13.0	13.2	0.092	0.086	0.098				
		WSU	2001	FILSK	5	1	16.4	16.4	16.4	0.067	0.067	0.067				
		YP	2001	FILSK	5	1	7.1	7.1	7.1	0.052	0.052	0.052				
16045400	CRESCENT*	ML	1982	FILSK	5	1	23.1	23.1	23.1	0.210	0.210	0.210				
			1993	FILSK	12	3	26.2	21.6	30.2	0.242	0.097	0.380	1	0.010	0.010	Y
		NP	2014	FILSK	8	8	26.5	22.6	30.8	0.552	0.226	0.890				
		SMB	2005	FILSK	3	3	9.8	8.8	10.3	0.111	0.069	0.142				
		WE	1982	FILSK	9	2	15.0	12.7	17.3	0.310	0.210	0.410				
			1993	FILSK	14	2	13.2	10.3	16.0	0.158	0.055	0.260				
			2002	FILSK	5	5	14.4	12.8	18.4	0.144	0.092	0.237				
			2005	FILSK	8	8	15.1	12.4	18.4	0.135	0.094	0.185				
			2014	FILSK	6	6	14.1	12.2	16.0	0.191	0.148	0.257				
		WSU	1993	FILSK	12	2	20.3	18.7	21.8	0.090	0.079	0.100	1	0.010	0.010	Y
		YP	2002	FILSK	1	1	7.8	7.8	7.8	0.079	0.079	0.079				
			2005	FILSK	7	1	7.7	7.7	7.7	0.100	0.100	0.100				
16048800	MARSH	NP	2000	FILSK	3	3	17.8	14.6	20.4	0.353	0.330	0.370				
		WSU	2000	FILSK	4	1	17.6	17.6	17.6	0.280	0.280	0.280				
		YP	2000	FILSK	3	1	9.6	9.6	9.6	0.220	0.220	0.220				
16048900	MOORE*	NP	1996	FILSK	3	2	18.5	15.7	21.2	0.195	0.130	0.260	1	0.010	0.010	Y
		WSU	1996	FILSK	6	1	17.5	17.5	17.5	0.170	0.170	0.170				
		YP	1996	FILSK	10	1	6.7	6.7	6.7	0.170	0.170	0.170				

DOWID	Waterway	Species	Year	Anat.	Total Fish	N	Length (in)			Mercury (mg/kg)			PCBs (mg/kg)			
							Mean	Min	Max	Mean	Min	Max	N	Mean	Max	< RL
16049600	SAWBILL*	NP	1982	FILSK	11	3	23.6	18.1	30.5	0.400	0.280	0.490				
			1989	FILSK	1	1	26.3	26.3	26.3	0.550	0.550	0.550				
			1996	FILSK	10	10	17.4	11.0	21.9	0.148	0.066	0.283				
			2013	FILSK	6	6	19.1	15.3	21.7	0.241	0.162	0.340				
		SMB	2013	FILSK	3	3	12.8	11.6	14.3	0.173	0.149	0.203				
		WE	1982	FILSK	1	1	20.3	20.3	20.3	0.440	0.440	0.440				
			1989	FILSK	6	2	15.7	14.1	17.2	0.535	0.260	0.810				
			1996	FILSK	5	5	12.9	10.0	16.3	0.137	0.072	0.223				
			2013	FILSK	6	6	13.9	10.9	20.3	0.252	0.173	0.518				
		YP	2013	FILSK	5	1	8.3	8.3	8.3	0.140	0.140	0.140				
16062200	ALTON*	NP	1986	FILSK	12	12	22.4	16.7	28.8	0.247	0.140	0.450				
			1996	FILSK	10	10	23.2	10.6	31.0	0.263	0.082	0.490				
		WE	1986	FILSK	9	9	19.5	15.0	22.8	0.336	0.030	0.720				
			1990	FILSK	3	1	17.8	17.8	17.8	0.240	0.240	0.240	1	0.010	0.010	Y
			1996	FILSK	6	6	19.2	15.2	28.2	0.259	0.124	0.683				
			2003	FILSK	24	24	14.8	11.3	25.5	0.204	0.072	0.795				
			2008	FILSK	24	24	15.5	10.8	28.2	0.397	0.089	2.208				
16063400	DYERS*	NP	1998	FILSK	24	24	22.1	12.5	29.9	0.270	0.120	0.550				
			2004	FILSK	23	23	18.8	13.2	30.8	0.441	0.206	1.230				
			2008	FILSK	24	24	20.5	13.8	24.4	0.343	0.151	0.574				
			2014	FILSK	15	15	23.0	20.8	25.7	0.480	0.338	0.636				
16063600	EAST FOX**	NP	2007	FILSK	8	8	33.3	25.6	42.2	0.488	0.306	0.647				
16063900	FOUR MILE*	NP	1989	FILSK	4	2	19.1	17.7	20.4	0.205	0.190	0.220				
		WE	1989	FILSK	6	2	16.1	13.9	18.2	0.185	0.150	0.220				
			2001	FILSK	7	7	14.8	9.7	18.4	0.343	0.171	0.523				
			2006	FILSK	22	22	16.2	13.0	20.2	0.251	0.146	0.495				
16064500	TOOHEY*	NP	1982	FILSK	9	4	24.6	17.9	32.2	0.575	0.370	0.750				
			1992	FILSK	11	2	20.0	18.6	21.3	0.365	0.320	0.410				
		WE	1989	FILSK	8	3	17.4	12.6	21.1	0.573	0.220	0.760				
			1992	FILSK	20	3	16.5	13.0	20.5	0.603	0.330	0.980				
			2007	FILSK	6	6	14.3	13.7	15.2	0.246	0.169	0.418				
			2012	FILSK	6	6	15.5	13.5	17.0	0.333	0.197	0.486				
		WSU	2007	FILSK	3	1	14.3	14.3	14.3	0.066	0.066	0.066				
			2012	FILSK	5	1	16.2	16.2	16.2	0.092	0.092	0.092				
		YP	1992	FILSK	6	1	11.0	11.0	11.0	0.240	0.240	0.240				
			2007	FILSK	10	1	10.7	10.7	10.7	0.154	0.154	0.154				
			2012	FILSK	10	2	11.1	10.1	12.1	0.147	0.127	0.167				
16064600	FINGER*	BKS	2011	FILSK	4	1	5.7	5.7	5.7	0.027	0.027	0.027				
		NP	2011	FILSK	8	8	19.6	15.2	28.2	0.220	0.088	0.395				
		WE	1984	FILSK	5	1	16.3	16.3	16.3	0.210	0.210	0.210				
			1999	FILSK	8	8	19.0	11.9	22.9	0.466	0.110	0.670	1	0.010	0.010	Y
			2011	FILSK	8	8	14.9	12.2	17.9	0.154	0.099	0.218				

DOWID	Waterway	Species	Year	Anat.	Total Fish	N	Length (in)			Mercury (mg/kg)			PCBs (mg/kg)			
							Mean	Min	Max	Mean	Min	Max	N	Mean	Max	< RL
		WSU	1999	FILSK	8	1	18.6	18.6	18.6	0.210	0.210	0.210				
			2011	FILSK	5	1	19.1	19.1	19.1	0.179	0.179	0.179				
		YP	1999	FILSK	6	1	7.2	7.2	7.2	0.060	0.060	0.060				
16065400	TIMBER	NP	1989	FILSK	3	1	24.2	24.2	24.2	0.380	0.380	0.380				
		WE	1989	FILSK	7	3	17.7	13.8	23.0	0.480	0.280	0.840				
16070600	KELSO*	NP	2007	FILSK	6	6	17.5	15.6	20.6	0.385	0.268	0.501				
		YP	2007	FILSK	11	1	7.7	7.7	7.7	0.256	0.256	0.256				
16080500	ELBOW*	NP	1984	FILSK	5	1	21.5	21.5	21.5	0.300	0.300	0.300				
			1986	FILSK	4	2	19.9	18.6	21.2	0.335	0.260	0.410				
			2009	FILSK	7	7	20.8	16.6	27.5	0.440	0.247	0.612				
		WE	1986	FILSK	15	3	17.4	13.1	22.3	0.420	0.210	0.730				
			1992	FILSK	15	2	15.1	13.7	16.4	0.165	0.120	0.210	1	0.010	0.010	Y
			2009	FILSK	6	6	14.6	13.7	17.5	0.242	0.183	0.468				
16080600	FREAR**	WE	1984	FILSK	5	1	17.0	17.0	17.0	0.350	0.350	0.350				
			1998	FILSK	10	10	17.1	14.8	26.0	0.755	0.370	1.720				
			2009	FILSK	15	15	15.2	12.6	19.1	0.539	0.330	0.765				
		WSU	1998	FILSK	5	1	19.5	19.5	19.5	0.310	0.310	0.310				
16090500	FEATHER	BKT	2014	FILSK	8	8	11.9	10.5	12.8	0.131	0.114	0.147				
38000200	CROSS RIVER**	BKS	2013	FILSK	10	2	10.3	9.6	10.9	0.205	0.196	0.213				
		NP	1995	FILSK	18	5	21.7	13.9	33.5	0.532	0.400	0.830	1	0.010	0.010	
			2013	FILSK	6	6	21.4	15.7	26.6	0.607	0.451	0.824				
		WE	1995	FILSK	14	5	16.4	12.4	20.9	0.530	0.320	0.760				
			2013	FILSK	3	3	17.8	15.3	20.4	0.677	0.578	0.733				
		WSU	1995	FILSK	8	1	20.4	20.4	20.4	0.440	0.440	0.440				
			2013	FILSK	5	1	18.9	18.9	18.9	0.210	0.210	0.210				
		YP	1995	FILSK	10	1	9.8	9.8	9.8	0.220	0.220	0.220				
			2013	FILSK	10	2	8.7	8.2	9.2	0.342	0.333	0.350				
38000300	LOST**	NP	2010	FILSK	8	8	22.6	21.1	25.8	0.575	0.408	0.848				
		WSU	2010	FILSK	3	1	19.7	19.7	19.7	0.316	0.316	0.316				
		YP	2010	FILSK	4	1	6.3	6.3	6.3	0.105	0.105	0.105				
38001600	KOWALSKI**	NP	2007	FILSK	8	8	22.6	19.1	25.5	0.664	0.406	0.985				
38001800	BENSON*	SPL	1993	FILSK	11	2	11.9	9.3	14.4	0.315	0.310	0.320	1	0.010	0.010	Y
			2014	FILSK	8	8	14.3	10.3	17.5	0.281	0.204	0.445				
38002000	EAST*	BKT	1999	FILSK	8	8	12.6	10.1	16.4	0.299	0.160	0.620	1	0.018	0.018	
		WSU	1999	FILSK	5	1	15.2	15.2	15.2	0.050	0.050	0.050				
		YP	1999	FILSK	6	1	9.6	9.6	9.6	0.420	0.420	0.420				
38002400	CROOKED	NP	2014	FILSK	8	8	23.9	18.8	30.7	0.478	0.327	0.669				
		SMB	2002	FILSK	5	5	11.1	10.5	11.5	0.274	0.222	0.309				
			2014	FILSK	15	15	13.6	10.0	17.9	0.409	0.274	0.757				
		WE	1992	FILSK	16	3	17.3	12.7	20.5	0.373	0.180	0.600	1	0.013	0.013	
			2002	FILSK	5	5	18.7	17.4	20.2	0.581	0.465	0.777				
			2010	FILSK	15	15	16.9	12.6	21.5	0.384	0.184	0.603				

DOWID	Waterway	Species	Year	Anat.	Total Fish	N	Length (in)			Mercury (mg/kg)			PCBs (mg/kg)			
							Mean	Min	Max	Mean	Min	Max	N	Mean	Max	< RL
			2014	FILSK	15	15	16.5	12.1	19.8	0.511	0.294	0.757				
		YP	2002	FILSK	8	1	9.6	9.6	9.6	0.181	0.181	0.181				
38002600	HARE*	BKT	2011	FILSK	8	8	10.7	9.3	14.5	0.141	0.014	0.492				
38002800	ECHO	RBT	2013	FILSK	6	6	13.8	11.5	16.3	0.085	0.041	0.162				
		SPL	2013	FILSK	6	6	13.9	11.3	19.6	0.137	0.111	0.160				
38002900	GOLDENEYE	BKT	2014	FILSK	6	6	12.7	11.6	14.1	0.207	0.185	0.228				
38003100	THUNDERBIRD*	NP	1995	FILSK	5	2	23.4	19.2	27.6	0.255	0.180	0.330	1	0.010	0.010	
		WE	1995	FILSK	15	4	15.9	12.1	20.7	0.368	0.210	0.510				
			2013	FILSK	6	6	17.5	13.8	25.3	0.417	0.260	0.972				
		WSU	2013	FILSK	5	1	17.1	17.1	17.1	0.217	0.217	0.217				
		YP	2013	FILSK	5	1	7.9	7.9	7.9	0.160	0.160	0.160				
38003300	NINEMILE*	NP	2004	FILSK	23	23	19.3	17.5	22.0	0.449	0.337	0.717				
			2013	FILSK	12	12	22.8	18.6	29.2	0.408	0.312	0.570				
		WE	1991	FILSK	15	3	17.3	13.6	21.1	0.540	0.240	0.860	2	0.010	0.010	Y
			1995	FILSK	14	14	15.2	8.3	29.1	0.387	0.155	1.098				
			2013	FILSK	12	12	17.3	13.5	26.5	0.431	0.259	0.818				
		WSU	1991	FILSK	18	3	17.6	14.4	20.8	0.204	0.062	0.290	1	0.010	0.010	Y
		YP	1991	FILSK	10	1	8.3	8.3	8.3	0.160	0.160	0.160				
38003800	LUPUS*	NP	1998	FILSK	10	10	21.8	19.7	23.5	0.214	0.190	0.290				
		WSU	1998	FILSK	5	1	15.2	15.2	15.2	0.060	0.060	0.060				
38004700	WILSON*	NP	1981	FILSK	3	1	22.2	22.2	22.2	0.190	0.190	0.190	1	0.025	0.025	Y
			1984	FILSK	2	1	17.5	17.5	17.5	0.170	0.170	0.170				
			1993	FILSK	13	3	19.6	13.6	25.4	0.163	0.140	0.210	1	0.010	0.010	Y
			2011	FILSK	8	8	22.2	16.4	30.2	0.334	0.177	0.589				
		WE	1981	FILSK	5	1	20.1	20.1	20.1	0.380	0.380	0.380	1	0.025	0.025	Y
			1984	FILSK	5	1	18.2	18.2	18.2	0.360	0.360	0.360				
			1987	FILSK	10	10	17.4	13.5	22.3	0.425	0.180	0.810				
			1993	FILSK	18	3	16.2	11.4	21.6	0.261	0.072	0.510	1	0.017	0.017	
			1996	FILSK	10	10	15.0	7.5	22.4	0.226	0.058	0.676				
			2001	FILSK	23	23	14.5	10.6	26.2	0.162	0.029	0.671				
			2011	FILSK	15	15	16.6	12.2	21.5	0.277	0.117	0.490				
		WSU	1993	FILSK	13	2	17.2	14.5	19.9	0.059	0.034	0.083	1	0.017	0.017	
		YP	1993	FILSK	5	1	10.5	10.5	10.5	0.160	0.160	0.160				
38005100	LITTLE WILSON*	NP	1994	FILSK	3	2	20.5	18.3	22.6	0.305	0.260	0.350	1	0.010	0.010	Y
			2001	FILSK	6	6	20.8	19.1	23.1	0.292	0.238	0.369				
		WE	1994	FILSK	5	1	15.4	15.4	15.4	0.190	0.190	0.190				
			2001	FILSK	6	6	16.5	13.4	19.2	0.328	0.129	0.454				
			2008	FILSK	9	9	17.9	13.2	23.9	0.299	0.112	0.693				
			2012	FILSK	6	6	15.5	13.8	20.3	0.121	0.085	0.249				
		WSU	1994	FILSK	8	1	19.2	19.2	19.2	0.088	0.088	0.088				
			2001	FILSK	4	1	20.0	20.0	20.0	0.142	0.142	0.142				

DOWID	Waterway	Species	Year	Anat.	Total Fish	N	Length (in)			Mercury (mg/kg)			PCBs (mg/kg)			
							Mean	Min	Max	Mean	Min	Max	N	Mean	Max	< RL
			2008	FILSK	1	1	20.0	20.0	20.0	0.096	0.096	0.096				
			2012	FILSK	5	1	18.0	18.0	18.0	0.058	0.058	0.058				
		YP	2012	FILSK	5	1	8.1	8.1	8.1	0.084	0.084	0.084				
38005300	DAM FIVE*	NP	1994	FILSK	4	2	20.7	19.2	22.2	0.170	0.140	0.200				
		WE	1994	FILSK	15	4	16.0	13.0	18.9	0.223	0.110	0.380	1	0.010	0.010	Y
		WSU	1994	FILSK	8	1	20.0	20.0	20.0	0.150	0.150	0.150				
38005400	ALGER	NP	2014	FILSK	6	6	21.0	18.8	25.2	0.169	0.156	0.188				
		WSU	2014	FILSK	5	1	17.1	17.1	17.1	0.134	0.134	0.134				
		YP	2014	FILSK	10	1	8.2	8.2	8.2	0.082	0.082	0.082				
38006000	WHITEFISH*	NP	1989	FILSK	4	2	18.3	15.7	20.9	0.270	0.260	0.280				
			2000	FILSK	6	6	20.3	16.6	22.0	0.197	0.150	0.270				
			2010	FILSK	7	7	28.8	19.9	36.3	0.492	0.255	0.745				
		WE	1989	FILSK	6	2	15.0	13.8	16.1	0.325	0.230	0.420				
			2000	FILSK	7	7	15.0	12.0	18.4	0.246	0.130	0.360				
			2010	FILSK	8	8	16.3	13.2	22.6	0.320	0.185	0.870				
		WSU	2000	FILSK	4	1	19.1	19.1	19.1	0.130	0.130	0.130				
			2010	FILSK	3	1	20.9	20.9	20.9	0.357	0.357	0.357				
		YP	2000	FILSK	10	1	9.4	9.4	9.4	0.150	0.150	0.150				
			2010	FILSK	9	2	9.2	8.3	10.1	0.164	0.132	0.196				
38006500	BONE**	BT	2007	FILSK	5	5	12.0	9.3	13.7	0.319	0.043	0.673				
		RBT	2007	FILSK	5	5	11.6	10.6	12.5	0.120	0.093	0.165				
		SPL	2007	FILSK	6	6	13.3	12.3	14.3	0.441	0.252	0.567				
38023200	NIPISIQUIT*	NP	2000	FILSK	14	14	21.9	17.2	25.7	0.150	0.060	0.260				
			2009	FILSK	7	7	22.6	21.0	25.9	0.281	0.204	0.406				
		WE	2009	FILSK	10	10	17.3	14.5	20.2	0.218	0.093	0.350				
38024200	JOHNSON*	WE	1999	FILSK	14	14	15.6	12.2	19.5	0.164	0.070	0.290	1	0.010	0.010	Y
			2009	FILSK	11	11	18.9	12.5	22.1	0.385	0.085	0.560				
38024500	BALSAM*	BKT	2000	FILSK	6	6	12.9	9.5	14.6	0.453	0.370	0.510				
		WSU	2000	FILSK	4	1	17.6	17.6	17.6	0.130	0.130	0.130				
38025600	DIVIDE	RBT	1992	FILSK	13	2	15.2	14.2	16.2	0.190	0.180	0.200	2	0.015	0.020	Y
			1998	FILSK	10	10	13.7	9.6	19.0	0.071	0.030	0.130	1	0.040	0.040	
		SPL	2005	FILSK	8	8	14.9	12.9	18.9	0.136	0.113	0.176				
38025700	CROSSCUT	BKT	2014	FILSK	7	7	10.2	8.9	12.0	0.056	0.024	0.106				
38041500	DELAY*	NP	1989	FILSK	8	3	23.1	18.8	27.6	0.453	0.220	0.600				
		SMB	1989	FILSK	3	1	11.8	11.8	11.8	0.320	0.320	0.320				
			2007	FILSK	5	5	12.3	11.2	14.7	0.324	0.257	0.375				
		WE	1989	FILSK	9	3	18.0	13.6	20.9	0.450	0.200	0.630				

Appendix 9 – Prioritization of lake protection efforts

Trend codes: IF – insufficient data, N - no evidence of trend, D – decreasing trend

Trend slope description codes: NA – not applicable, N – no evidence of trend, S – strong evidence of trend, LT – evidence of long-term trend

DNR ID	Lake_ID for TP/ Impairment	Lake Name	Depth Class	Lake Acres	Watershed Acres	Impaired (Y/N)?	% Disturbed Land Use	Mean TP (ug/L)	Years TP	Mean Secchi (m)	Trend	Trend Slope Description	Predicted Load (pounds/year)	Target TP (ug/L)	Load Target (pounds/year)	Load Goal (pounds/year)	Load Reduction Goal (pounds/year)	Priority Class
16035900	16035900	Agnes	Shallow	68	11,954	N	2%	31.3	2	0.60	IF	NA	1097	28.2	980	1042	55	High
16062200	16062200	Alton	Deep	969	2,674	N	0%	4.9	2	3.96	N	N	133	2.2	65	126	7	High
16020400	16020400	Aspen	Deep	141	1,503	N	2%	16.6	3	2.89	IF	NA	139	13.9	115	132	7	High
16025700	16025700	Babble	Shallow	21	3,555	N	2%	31.0	1				313	25.9	256	298	16	High
16018200	16018200	Ball Club	Deep	206	848	N	1%	16.1	5	3.49	N	N	94	11.4	67	89	5	High
16035800	16035800	Barker	Deep	149	5,882	N	2%	20.5	6	1.19	IF	NA	477	17.2	397	453	24	High
16022800	16022800	Bearskin	Deep	509	3,911	N	2%	12.8	8	6.61	N	N	374	7.0	216	355	19	Higher
38001800	38001800	Benson	Deep	19	62,798	N	1%	9.3	3				1123	7.1	847	1067	56	High
16034400	16034400	Bigsby	Deep	95	10,892	N	2%	19.3	3	1.17	IF	NA	759	16.2	634	721	38	High
16009800	16009800	Binagami	Deep	117	373	N	1%	15.6	2	2.24	IF	NA	44	15.3	42	41	2	High
16024700	16024700	Birch	Deep	236	1,284	N	4%	8.1	2	5.51	N	N	82	7.5	77	78	4	Highest
16038300	16038300	Bouder	Deep	129	1,163	N	3%	24.3	4	1.56	IF	NA	156	22.4	144	149	8	High
16017500	16017500	Bower Trout	Shallow	133	35,649	N	0%	11.0	1	1.70	IF	NA	891	9.2	736	847	45	High
16004400	16004400	Boys	Shallow	24	8,791	N	2%	11.6	1	2.36	IF	NA	240	9.7	197	228	12	High
16034800	16034800	Brule	Deep	4,327	21,274	N	0%	9.5	5	4.98	N	N	1745	7.4	1418	1658	87	High
38026000	38026000	Cabin	Shallow	66	7,943	N	1%	17.0	1	0.80	IF	NA	320	14.2	262	304	16	High
16024000	16024000	Caribou	Deep	246	3,228	N	2%	7.5	1	2.20	IF	NA	132	6.3	111	126	7	Higher
16036000	16036000	Caribou	Deep	721	10,892	N	2%	21.0	16	2.10	N	N	1209	17.1	993	1149	60	High
16007100	16007100	Carrot	Deep	30	7,762	N	0%	13.0	1				292	10.9	240	277	15	High
16034600	16034600	Cascade	Deep	452	3,555	N	2%	13.0	2	2.52	IF	NA	261	12.4	251	248	13	Higher
16003300	16003300	Chester	Deep	52	10,492	N	2%	13.3	15	3.96	N	N	447	9.6	319	425	22	High
16037300	16037300	Christine	Shallow	184	12,340	N	2%	16.3	2	1.57	IF	NA	619	15.8	600	588	31	High
16036500	16036500	Clara	Deep	388	7,861	N	1%	15.3	3	2.25	IF	NA	538	12.6	445	511	27	High
16013900	16013900	Clearwater	Deep	1,344	4,431	N	1%	4.7	6	8.99	N	N	236	4.0	205	224	12	Higher
38001400	38001400	Cramer	Shallow	68	5,553	N	3%	16.6	3				247	14.3	209	235	12	High
16045400	16045400	Crescent	Deep	755	7,927	N	1%	16.5	2	2.36	IF	NA	712	13.2	574	676	36	High
38002400	38002401	Crooked	Deep	272	847	N	1%	9.9	7	3.73	IF	NA	61	6.4	39	58	3	Higher
16043500	16043500	Davis	Deep	323	1,487	N	0%	19.0	1	3.83	IF	NA	231	15.9	195	220	12	High
16025300	16025300	Deer Yard	Deep	343	1,251	N	1%	16.3	10	2.90	D	S	153	14.9	140	145	8	Highest
38041500	38041500	Delay	Deep	102	454	N	0%	14.9	2	2.36	IF	NA	44	14.0	42	42	2	High
16014300	16014300	Devil Track	Deep	1,876	21,759	N	2%	12.1	4	2.96	D	LT	1715	10.7	1534	1629	86	Highest
16002900	16002900	Devilfish	Deep	405	2,663	N	1%	12.0	3	2.94	IF	NA	207	10.8	187	196	10	High
38025600	38025600	Divide	Deep	61	17,114	N	1%	15.0	12	3.67	N	N	747	10.9	533	710	37	High
16063400	16063400	Dyers	Deep	69	12,223	N	2%	22.8	4	2.05	IF	NA	873	19.0	723	829	44	High
16014600	16014600	East Bearskin	Deep	593	11,868	N	1%	10.3	2	3.61	IF	NA	688	9.3	625	654	34	High
16014500	16014500	East Twin	Deep	173	1,016	N	1%	19.8	2	2.39	IF	NA	122	18.6	115	116	6	High
38002800	38002800	Echo	Deep	42	1,256	N	4%	11.0	1	8.00	IF	NA	73	9.2	61	69	4	High
16080500	16080501	Elbow	Deep	528	9,176	N	1%	13.1	5	2.47	IF	NA	608	11.7	543	578	30	High
16009600	16009600	Elbow	Shallow	408	5,981	N	1%	19.2	2	1.25	IF	NA	502	18.5	485	477	25	High
16002300	16002300	Esther	Deep	77	16,954	N	1%	10.3	4	2.76	N	N	570	8.6	474	541	28	High
16014700	16014700	Flour	Deep	330	1,204	N	2%	10.8	2	5.46	N	N	116	9.5	103	110	6	Higher
16063900	16063900	Four Mile	Deep	593	6,650	N	2%	21.8	2	1.76	IF	NA	739	18.2	621	702	37	High
38002900	38002900	Goldeneye	Deep	10	1,256	N	4%	12.0	1				51	10.0	42	49	3	High
16007700	16007700	Greenwood	Deep	2,043	6,821	N	0%	8.7	9	5.21	N	N	592	6.2	440	563	30	High
16038000	16038000	Gust	Shallow	143	729	N	2%	19.9	3	1.44	IF	NA	76	17.4	66	73	4	High
38002600	38002600	Hare	Deep	48	12,223	N	2%	24.0	1	3.00	IF	NA	868	20.1	717	825	43	High

DNR ID	Lake_ID for TP/ Impairment	Lake Name	Depth Class	Lake Acres	Watershed Acres	Impaired (Y/N)?	% Disturbed Land Use	Mean TP (ug/L)	Years TP	Mean Secchi (m)	Trend	Trend Slope Description	Predicted Load (pounds/year)	Target TP (ug/L)	Load Target (pounds/year)	Load Goal (pounds/year)	Load Reduction Goal (pounds/year)	Priority Class
16040600	16040600	Homer	Deep	434	4,761	N	1%	14.6	2	2.03	N	N	383	12.2	322	364	19	High
16022700	16022700	Hungry Jack	Deep	474	2,479	N	3%	7.8	11	5.31	N	N	151	7.1	138	144	8	Highest
16038100	16038100	Jock Mock	Deep	20	1,046	N	1%	14.0	1	3.80	IF	NA	56	11.7	46	54	3	High
38024200	38024200	Johnson	Deep	36	88,571	N	2%	23.0	3	3.66	N	N	4140	17.1	3018	3933	207	High
16018800	16018800	Kemo	Deep	189	1,270	N	0%	7.8	2	4.36	N	N	76	7.0	69	72	4	High
16004500	16004500	Kimball	Deep	77	8,791	N	2%	11.8	1	3.72	IF	NA	343	9.9	284	326	17	High
16019800	16019800	Leo	Deep	102	538	N	1%	9.9	6	4.40	N	N	38	8.9	34	36	2	High
16038200	16038200	Lichen	Deep	253	1,576	N	2%	17.9	2	1.08	IF	NA	168	14.9	140	160	8	High
16034700	16034700	Little Cascade	Shallow	262	1,046	N	1%	14.1	2	1.42	IF	NA	90	13.3	84	85	4	High
38005100	38005100	Little Wilson	Deep	55	3,353	N	0%	9.6	2	2.17	IF	NA	116	9.0	108	110	6	High
16003100	16003100	Loft	Deep	14	15,807	N	1%	14.0	1				568	11.7	468	540	28	High
16002200	16002200	Lost	Shallow	76	169,752	N	1%	12.8	2	1.61	IF	NA	3648	10.9	3066	3466	182	High
16025000	16025000	Mark	Shallow	126	2,430	N	2%	31.0	1				295	25.9	243	280	15	Higher
16002700	16002700	McFarland	Deep	386	30,641	N	1%	9.4	1	5.03	N	N	1165	7.9	981	1107	58	High
38023300	38023300	Micmac	Deep	137	600	N	0%	17.5	1				71	14.6	59	67	4	High
16004600	16004600	Mink	Deep	57	8,791	N	2%	13.6	1	3.11	IF	NA	385	11.4	319	366	19	High
16036800	16036800	Mistletoe	Shallow	145	2,717	N	2%	15.3	2	1.11	IF	NA	159	14.8	153	151	8	High
16019300	16019300	Mit	Deep	87	6,066	N	1%	9.0	1	3.00	IF	NA	227	7.5	190	216	11	High
16048900	16048900	Moore	Shallow	61	2,139	N	3%	12.0	1	1.10	IF	NA	85	10.0	70	81	4	High
16004300	16004300	Moose	Deep	1,026	14,483	N	0%	8.0	1	5.26	IF	NA	889	6.7	761	844	44	High
16010400	16010400	Musquash	Deep	131	485	N	2%	7.0	2	3.77	IF	NA	25	6.5	23	24	1	Higher
38003300	38003300	Ninemile	Deep	297	1,256	N	4%	11.5	5	2.69	IF	NA	80	8.0	55	76	4	Higher
38023200	38023200	Nipisiquit	Deep	59	88,571	N	2%	17.7	3	4.00	IF	NA	3600	12.2	2453	3420	180	High
16008900	16008900	Northern Light	Shallow	378	118,075	N	1%	13.5	2	1.29	IF	NA	3715	8.1	2185	3529	186	High
16047500	16047500	Pancore	Deep	31	22,593	N	1%	6.7	3				363	5.6	303	344	18	High
16013300	16013300	Peanut	Shallow	9	7,762	N	0%	141.0	1	0.30	IF	NA	3250	118.0	2642	3088	163	High
16047800	16047800	Peterson	Deep	94	25,899	N	1%	14.0	1	2.14	IF	NA	1023	11.7	849	972	51	High
16025200	16025200	Pike	Deep	814	3,956	N	1%	8.6	3	5.55	N	N	275	8.3	264	261	14	Higher
16019400	16019400	Pine	Deep	98	13,903	N	1%	6.8	2	3.67	IF	NA	324	5.8	278	308	16	High
16010800	16010800	Pine Mountain	Deep	106	752	N	1%	8.9	2	2.48	IF	NA	41	8.3	38	39	2	High
16037500	16037500	Pipe	Deep	285	1,120	N	0%	24.0	1				203	20.1	171	193	10	High
16023900	16023900	Poplar	Deep	764	6,987	N	3%	9.6	10	3.67	D	S	455	8.7	417	432	23	Highest
16064300	16064300	Richey	Shallow	101	463	N	2%	28.9	2	1.35	IF	NA	75	27.3	71	71	4	High
38024800	38024800	Sonju	Shallow	37	23,839	N	2%	18.2	3				908	12.8	612	862	45	High
16020200	16020200	Squint	Deep	16	6,987	N	3%	35.0	4	3.00	IF	NA	719	29.3	590	683	36	High
16040500	16040500	Star	Shallow	107	2,310	N	1%	18.9	2	1.68	IF	NA	189	18.5	186	180	9	High
16025600	16025600	Swamp	Shallow	92	36,767	N	1%	16.0	1	1.50	IF	NA	1327	13.4	1095	1261	66	High
16038400	16038400	Tait	Deep	355	2,708	N	1%	11.2	7	2.21	N	N	172	8.2	126	164	9	High
16016000	16016000	Thompson	Shallow	18	21,759	N	2%	14.0	1				630	11.7	516	599	32	High
16019100	16019100	Thrush	Deep	15	6,066	N	1%	5.5	7	6.50	IF	NA	95	3.4	57	91	5	High
16001900	16001900	Tom	Deep	404	3,990	N	3%	12.1	4	2.99	D	LT	292	10.7	258	277	15	Highest
16064500	16064500	Toohey	Shallow	369	2,660	N	1%	23.4	5	1.02	IF	NA	327	23.0	322	311	16	High
16004900	16004900	Trout	Deep	259	1,148	N	1%	8.4	16	6.40	N	N	85	4.7	48	81	4	Higher
16015600	16015600	Two Island	Deep	754	6,066	N	1%	11.9	2	2.66	IF	NA	406	10.6	363	385	20	High
16041200	16041200	Upper Cone	Deep	81	5,464	N	0%	11.0	4	3.03	IF	NA	268	8.9	217	255	13	High
16024800	16024800	Ward	Shallow	39	5,403	N	1%	17.7	3	2.10	IF	NA	290	15.0	242	276	15	High
16039800	16039800	Wench	Deep	23	21,274	N	0%	10.5	4	4.30	IF	NA	612	7.6	433	581	31	High
16018600	16018600	West Twin	Deep	134	540	N	1%	10.2	2	3.18	IF	NA	39	9.4	36	37	2	High
16036900	16036900	White Pine	Shallow	346	10,404	N	1%	18.7	2	1.60	IF	NA	751	18.3	732	713	38	High
38006000	38006000	Whitefish	Deep	346	1,731	N	2%	10.5	2	4.31	IF	NA	132	10.0	126	125	7	Higher
38004700	38004700	Wilson	Deep	650	3,353	N	0%	14.8	12	4.59	N	N	370	10.5	268	352	19	High