Mississippi River (Headwaters) Watershed Monitoring and Assessment Report

Minnesota Pollution Control Agency

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List of acronyms

AUID Assessment Unit Identification Determination

CCSI Channel Condition and Stability Index

CD County Ditch

CI Confidence Interval

CLMP Citizen Lake Monitoring Program

CR County Road

CSAH County State Aid Highway

CSMP Citizen Stream Monitoring Program

CWA Clean Water Act

CWLA Clean Water Legacy Act

DNR Minnesota Department of Natural Resources

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

FS Full Support

FWMC Flow Weighted Mean Concentration

H Hypereutrophic

HUC Hydrologic Unit Code

IBI Index of Biotic Integrity

IF Insufficient Information

K Potassium

LRVW Limited Resource Value Water

M Mesotrophic

MCES Metropolitan Council Environmental Services

MDA Minnesota Department of Agriculture

MDH Minnesota Department of Health

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

NHD National Hydrologic Dataset

NH3 Ammonia

NS Not Supporting

NT No Trend

OP Orthophosphate

P Phosphorous

PCB Poly Chlorinated Biphenyls

PWI Protected Waters Inventory

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

USGS United States Geological Survey

WPLMN Water Pollutant Load Monitoring Network

Contents

Figures

Tables

Executive summary

The Mississippi River (Headwaters) Watershed (HUC 09020301), located within the Upper Mississippi River Basin, drains 1,255,105 acres in northcentral Minnesota. The watershed is bordered by seven major watersheds and spans across six counties which include: Becker, Beltrami, Cass, Clearwater, Hubbard and Itasca. There are many lakes in the watershed, offering exceptional fishing, boating, and other recreational opportunities. Some of the state's most well known fisheries reside within the watershed, most notably Lake Winnibigoshish, Cass Lake, and Lake Bemidji. It is here that the Mississippi River begins its journey to the Gulf of Mexico. This report will focus on the tributaries to the Mississippi River, which include the Deer River, Little Mississippi River, Schoolcraft River, Turtle River, Third River, Vermillion River, and Hennepin Creek. Numerous smaller named and unnamed tributaries were also sampled and assessed during this survey. A separate report will document the assessment results on the Mississippi River, not just in this watershed but also all the way down to St. Anthony Falls in Minneapolis.

In 2013, the Minnesota Pollution Control Agency (MPCA) began an intensive watershed monitoring (IWM) effort of rivers, streams and lakes within the Mississippi River (Headwaters) Watershed. Then in 2015, many of these waterbodies were assessed for aquatic life, aquatic recreation, and aquatic consumption use support. In all, 30 stream segments (AUIDs) and 133 lakes were assessed. All but one stream segment assessed within the watershed met its aquatic life and/or aquatic recreation use standards. Four stream segments were not assessed due to insufficient data, modified channel condition or because they are classified as limited resource waters. One hundred and sixteen lakes within the watershed had sufficient data to assess aquatic recreation. Fifteen of the assessed lakes failed to meet the state's lake eutrophication standard and were deemed impaired for aquatic recreation. In addition, 62 lakes were sampled but the data was not sufficient for an assessment of aquatic recreation. All 45 lakes that were assessed for aquatic life based on the condition of fish communities supported the use.

Similar to lakes, fish and macroinvertebrate communities in streams throughout the watershed were in good condition. The Schoolcraft River from Fontenac Creek to Lake Plantangenet was designated as supporting exceptional aquatic life based on the fish and macroinvertebrate communities. This reach should be protected for its diverse biological community. The only biological impairment within the watershed is for a poor fish community in Fisherman's Brook (07010101-741).

Much of the Mississippi River (Headwaters) Watershed consists of dense forest and wetlands; the wetlands in particular have profound effects on the character of rivers and streams. For example, wetlands formed by beaver dams can influence the composition of the aquatic community and can sometimes make it difficult or impossible to collect biological samples from some stream reaches. In addition, wetland influenced streams often have low levels of dissolved oxygen (DO) due the interaction of water and organic matter in the wetland soils. In this watershed, many low oxygen readings were associated with wetland influences and therefore most of this data was deemed not assessable due to natural factors.

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 their water resources and the 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 water bodies 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 the development of Total Maximum Daily Loads (TMDLs). A TMDL is a comprehensive study determining the assimilative capacity of a waterbody, identifying all pollution sources causing or contributing to impairment, and an estimation of the 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 the 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, to restore or 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 to allow for coordinated development and implementation of water quality restoration and improvement projects.

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, identify impaired waters, and to identify waters in need of additional protection. The benefit of the approach is the opportunity to begin 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 often historically employed. The watershed approach will more effectively address multiple impairments resulting from the 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 Mississippi River (Headwaters) Watershed beginning in the summer of 2013. This report provides a summary of all water quality assessment results in the Mississippi River (Headwaters) Watershed and incorporates all data available for the assessment process including watershed monitoring, volunteer monitoring and monitoring conducted by local government units.

I. The watershed monitoring approach

The watershed approach is a 10-year rotation for monitoring and assessing waters of the state on the level of Minnesota's 81 major watersheds (Figure 1). The major benefit of this approach is the integration of monitoring resources to provide a more complete and systematic assessment of water quality at a geographic scale useful for the 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) (http://www.pca.state.mn.us/publications/wq-s1-27.pdf).

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. 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 (DNR) flow gaging stations with water quality data collected by the Metropolitan Council Environmental Services (MCES), 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 mainstem sites along the Mississippi, Minnesota, Rainy, Red, Des Moines, and St. Croix rivers

Major Watershed – tributaries draining to basin rivers with an average drainage area of 1,350 square miles (8-digit HUC scale)

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

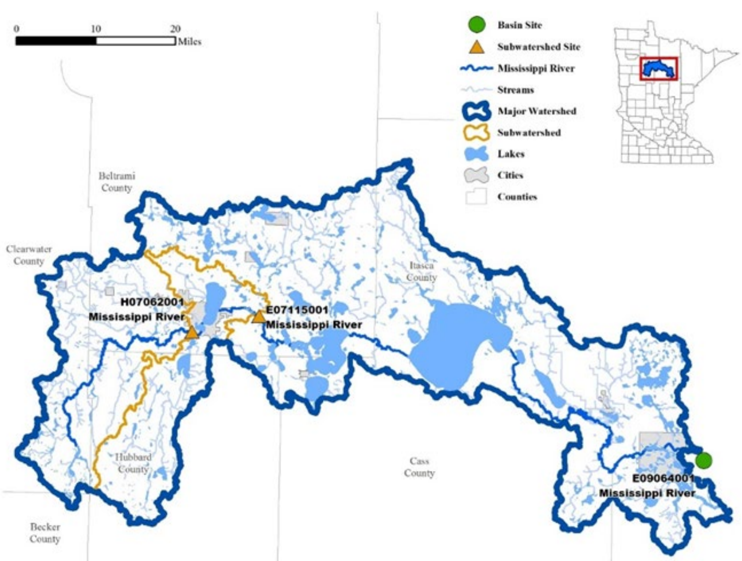

Figure 1. WPLMN monitoring sites in the Mississippi River (Headwaters) Watershed

The Mississippi River at Grand Rapids site near MSH 169 (DNR/MPCA ID 09064001, USGS ID 05211000, EQuIS ID S003-656) is the furthest downstream WPLMN monitoring site in the Mississippi River (Headwaters) Watershed and drains an area of approximately 6140 square miles (Figure 1). The gage is operated by the United States Geological Survey and is located just downstream of the Lake Pokegama outlet in downtown Grand Rapids. An average of 24 grab samples per year were collected from this site between 2010 and 2013. Two subwatershed sites were established in the watershed during 2015, the Mississippi River west of Bemidji, CR11 (DNR/MPCA ID 07062001, EQuIS ID S001-897), and the Mississippi River east of Bemidji, CR12 (DNR/MPCA ID 07115001, EQuIS ID S002-034).

WPLMN data will also be used to assist with Total Maximum Daily Load (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: https://www.pca.state.mn.us/water/watershed-pollutant-load-monitoring-network.

Intensive watershed monitoring

The intensive watershed monitoring strategy utilizes a nested watershed design allowing the sampling of streams within watersheds from a coarse to a fine scale (Figure 2). Each watershed scale is defined by a hydrologic unit code (HUC). These HUCs define watershed boundaries for water bodies within a similar geographic and hydrologic extent. The foundation of this approach is the 81 major watersheds (8-HUC) within Minnesota. Using this approach, many of the smaller headwaters and tributaries to the main stem river are sampled in a systematic way so that a more 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 within the 10-year cycle.

River/stream sites are selected near the outlet of each of three watershed scales, 8-HUC, 12-HUC and 14-HUC (Figure 2). Within each scale, different water uses are assessed based on the opportunity for that use (i.e., fishing, swimming, supporting aquatic life such as fish and insects). The major river watershed is represented by the 8-HUC scale. The outlet of the major 8-HUC watershed (purple dot in Figure 3) is sampled for biology (fish and macroinvertebrates), water chemistry and fish contaminants to allow for the assessment of aquatic life, aquatic recreation and aquatic consumption use support. The 12-HUC is the next smaller subwatershed scale, which generally consists of major tributary streams with drainage areas ranging from 75 to 150 mi2. Each 12-HUC outlet (green dots in Figure 3) is sampled for biology and water chemistry for the assessment of aquatic life and aquatic recreation use support. Within each 12-HUC, smaller watersheds (14 HUCs, typically 10-20 mi2), are sampled at each outlet that flows into the major 12-HUC tributaries. Each of these minor subwatershed outlets is sampled for biology to assess aquatic life use support (red dots in Figure 3).

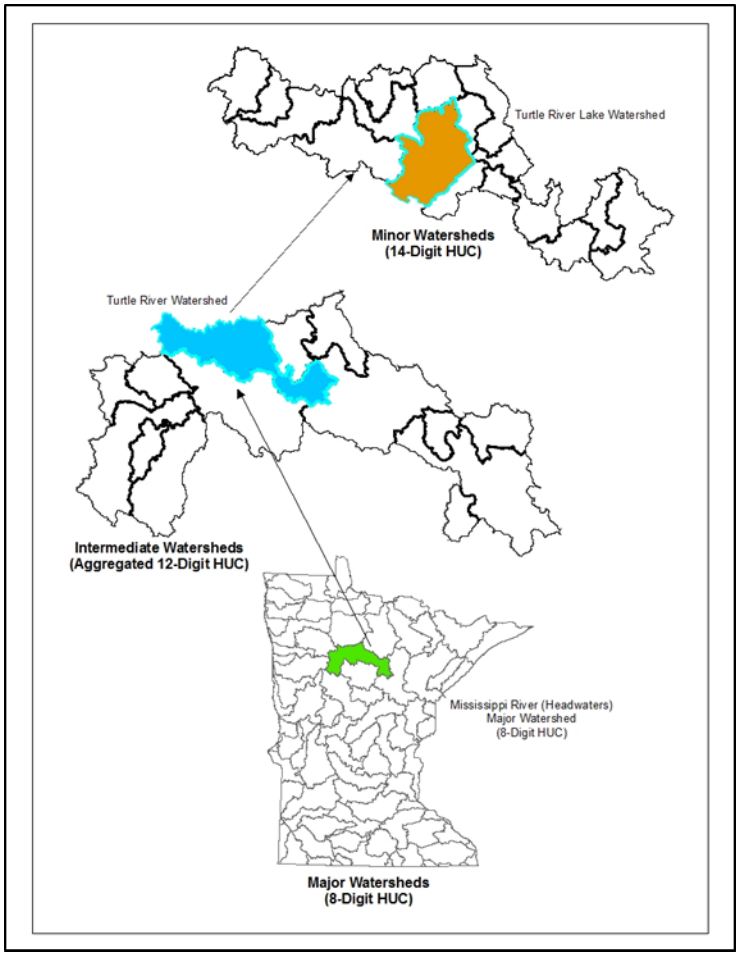

Figure 2. The intensive watershed monitoring design.

Within the intensive watershed monitoring strategy, lakes are selected to represent the range of conditions and lake type (size and depth) found 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, such as swimming and wading, are being supported. Lakes are sampled monthly from May-September for a two-year period.

Specific locations for sites sampled as part of the intensive monitoring effort in the Mississippi River (Headwaters) Watershed are shown in Figure 3 and are listed in Appendix 2, Appendix 4.2, and Appendix 4.3.

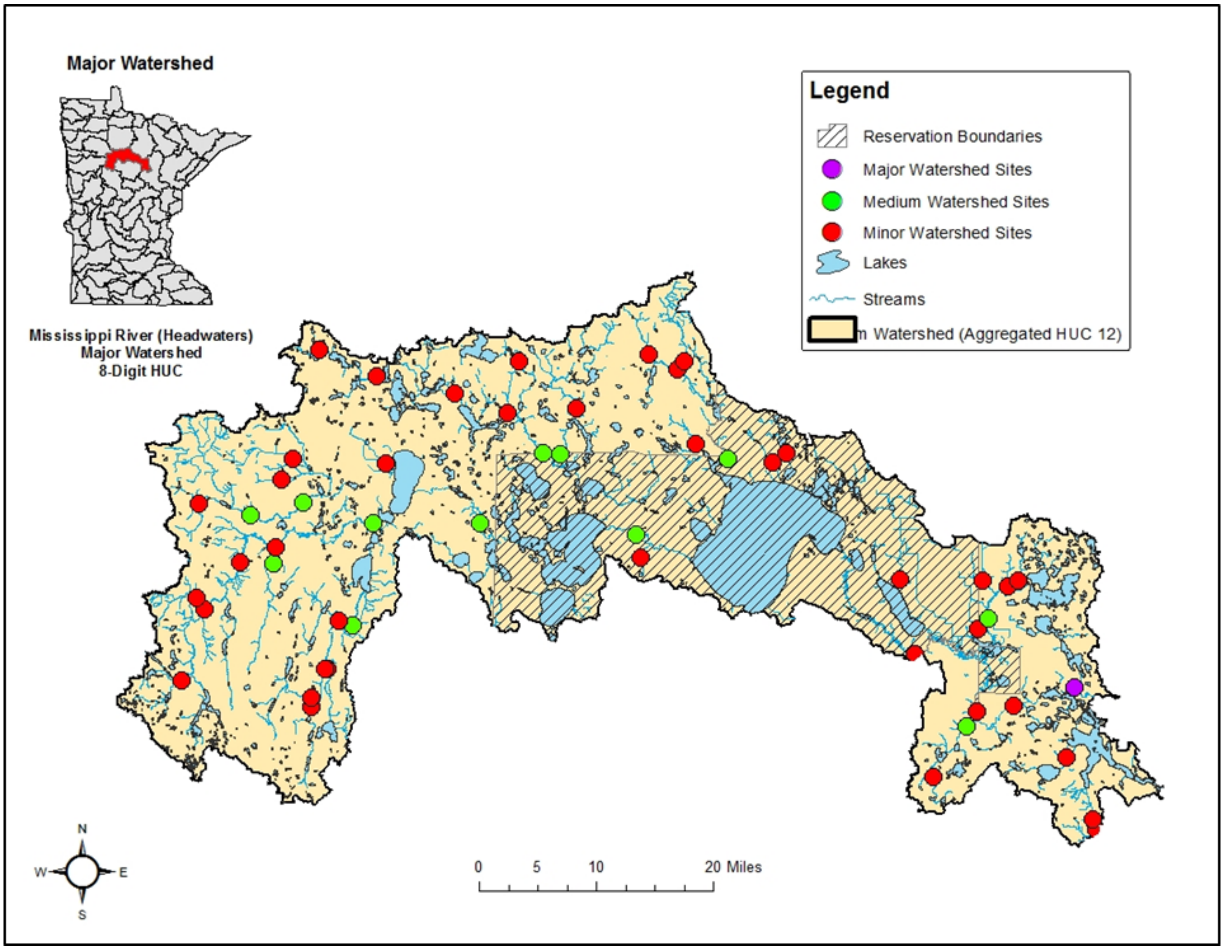

Figure 3. Intensive watershed monitoring sites for streams in the Mississippi River (Headwaters) Watershed.

Citizen and local monitoring

Citizen and local monitoring is an important component of the watershed approach. The MPCA and its local partners jointly select the stream sites and lakes to be included in the intensive watershed monitoring 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 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 the ability to see how their efforts are used to inform water quality decisions and track how management efforts affect change. Many SWAG grantees invite citizen participation in their monitoring projects and their combined participation greatly expand our overall capacity to conduct sampling.

The MPCA also coordinates two programs aimed at encouraging long term citizen surface water monitoring: The Citizen Lake Monitoring Program (CLMP) and the Citizen Stream Monitoring Program (CSMP). Like the permanent load monitoring network, having citizen volunteers monitor a given lake or stream site monthly and from year to year can provide the long-term picture needed to help evaluate status and trends. Citizen monitoring is especially effective at helping to track water quality changes that occur in the years between intensive monitoring years. Figure 4 provides an illustration of the locations where citizen-monitoring data were used for assessment in the Mississippi River (Headwaters) Watershed.

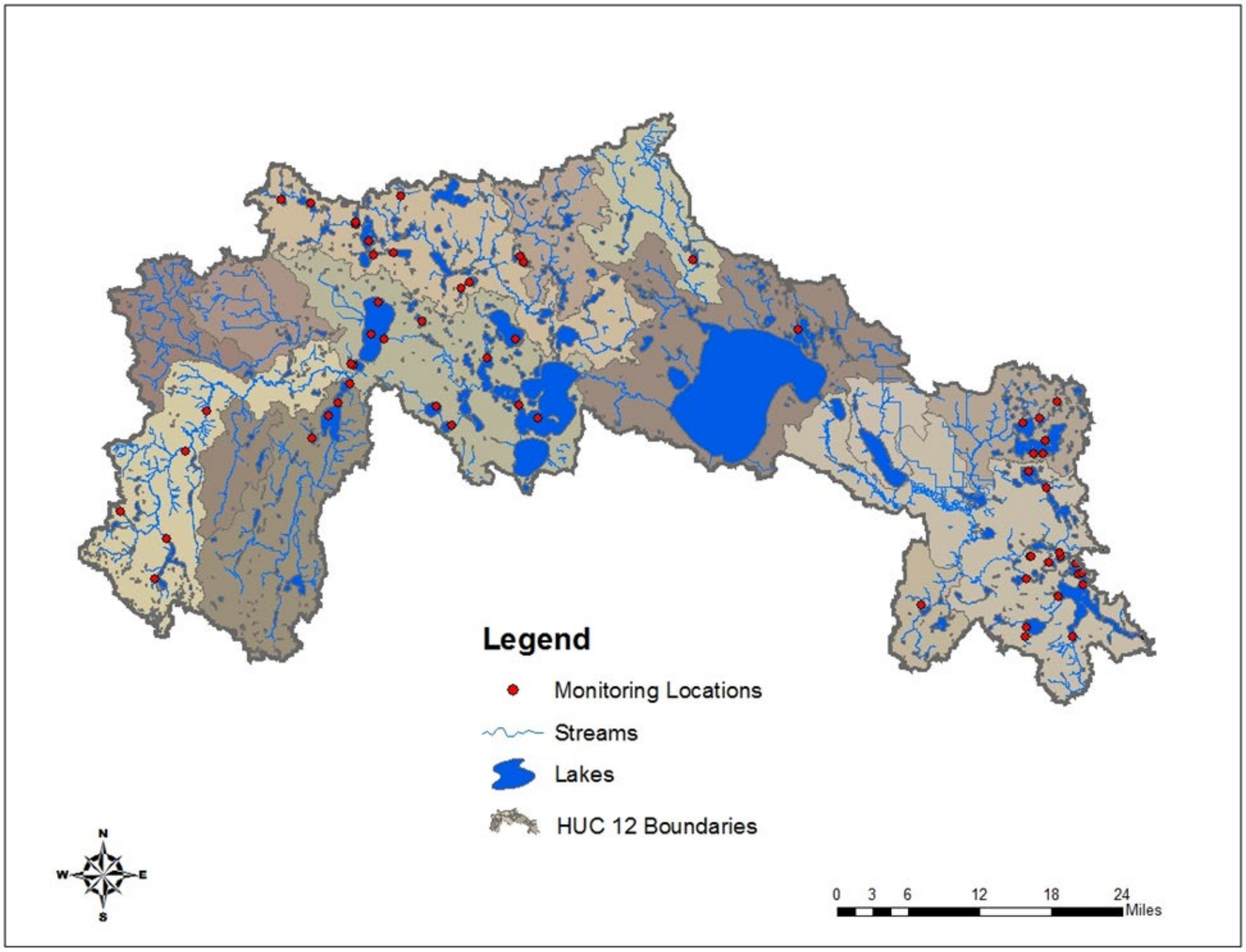

Figure 4. Monitoring locations of local groups, citizens and the MPCA lake monitoring staff in the Mississippi River (Headwaters) Watershed.

II. 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 (Minn. R. ch. 7050 2008; https://www.revisor.leg.state.mn.us/rules/?id=7050). 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. For a thorough review of the assessment, methodologies see: Guidance Manual for Assessing the Quality of Minnesota Surface Waters for the Determination of Impairment 305(b) Report and 303(d) List (MPCA 2012). https://www.pca.state.mn.us/sites/default/files/wq-iw1-04.pdf.

Water quality standards

Water quality standards are the fundamental benchmarks by which the quality of surface waters are measured and used to determine impairment. These standards can be numeric or narrative in nature and 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 represent concentrations of specific pollutants in water that protect a specific designated use. Narrative standards are statements of conditions in and on the water, such as biological condition, that protect their designated uses.

Protection of aquatic life means the maintenance of a healthy aquatic community, including fish, invertebrates and plants. The sampling of aquatic organisms for assessment is called biological monitoring. Biological monitoring is a direct means to assess aquatic life use support, as the aquatic community tends to integrate the effects of all pollutants and stressors over time. To effectively use biological indicators, the MPCA employs the Index of Biotic Integrity (IBI). This index is a scientifically validated combination of measurements of the biological community (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 site. The MPCA has developed IBI's for (fish and macroinvertebrates) since these communities can respond differently to various types of pollution. Because the rivers and streams in Minnesota are physically, chemically, and biologically, diverse IBI's are developed separately for different stream classes to account for this natural variation. Further interpretation of biological community data is provided by an assessment threshold or biocriteria against which an IBI score can be compared within a given stream class. In general, an IBI score above this threshold is indicative of aquatic life use support, while a score below this threshold is indicative of non-support. Additionally, chemical parameters are measured and assessed against numeric standards developed to be protective of aquatic life, including pH, DO, un-ionized ammonia nitrogen, chloride and turbidity.

Protection for aquatic life uses are divided into three tiers: Exceptional, General, and Modified. Exceptional Use waters support fish and macroinvertebrate communities that have minimal changes in structure and function from the natural condition. General Use waters harbor "good" assemblages of fish and macroinvertebrates that can be characterized as having an overall balanced distribution of the assemblages and with the ecosystem functions largely maintained through redundant attributes. Modified Use waters have been extensively altered through legacy physical modifications, which limit the ability of the biological communities to attain the General Use. Currently the Modified Use is only applied to waters with channels that have been directly altered by humans (e.g., maintained for drainage, riprapped). These tiered uses are determined before assessment based on the attainment of the applicable biological criteria and/or an assessment of the habitat. For additional information, see: https://www.pca.state.mn.us/water/tiered-aquatic-life-use-talu-framework.

Protection of aquatic recreation means the maintenance of conditions safe and suitable for swimming and other forms of water recreation. In streams, aquatic recreation is assessed by measuring the concentration of E. coli bacteria in the water. To determine if a lake supports aquatic recreational activities its trophic status is evaluated, using total phosphorus (TP), secchi depth and chlorophyll-a as indicators. Lakes 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. The 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 the frequency that fish from a particular water body can be safely consumed. For lakes, rivers and streams that are protected as a source of drinking water the MPCA primarily measures the concentration of nitrate in the water column to assess this designated use.

A small percentage of stream miles in the state (~1% of 92,000 miles) have been individually evaluated and re-classified as a Class 7 Limited Resource Value Water (LRVW). These streams have previously demonstrated that the existing and potential aquatic community is severely limited and cannot achieve aquatic life standards either by: a) natural conditions as exhibited by poor water quality characteristics, lack of habitat or lack of water; b) the quality of the resource has been significantly altered by human activity and the effect is essentially irreversible; or c) there are limited recreational opportunities (such as fishing, swimming, wading or boating) in and on the water resource. While not being protective of aquatic life, LRVWs are still protected for industrial, agricultural, navigation and other uses. Class 7 waters 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, Class 7 waters have standards for bacteria, pH, DO and toxic pollutants.

Assessment units

Assessments of use support in Minnesota are made for individual waterbodies. The waterbody 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 the 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 Minn. R., ch. 7050) or when there is a significant morphological feature, such as a dam or lake, within the reach. Therefore, a stream or river is often segmented into multiple assessment units that are variable in length. The MPCA is using 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 waterbody identifier (known as its 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 DNR. The Protected Waters Inventory (PWI) 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.

It is for these specific stream reaches or lakes that the data are evaluated for potential use impairment. Therefore, any assessment of use support would be limited to the individual assessment unit. The major exception to this is the listing of rivers for contaminants in fish tissue (aquatic consumption). 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. The impaired reach is defined by the location of significant barriers to fish movement such as dams upstream and downstream of the sampled reach and thus often includes several assessment units.

Determining use attainment

For beneficial uses related to human health, such as drinking water or aquatic recreation, the relationship is well understood and thus the assessment process is a relatively simple comparison of monitoring data to numeric standards. In contrast, assessing whether a waterbody supports a healthy aquatic community is not as straightforward and often requires multiple lines of evidence to make use attainment decisions with a high degree of certainty. Incorporating a multiple lines of evidence approach into MPCA's assessment process has been evolving over the past few years. The current process used to assess the aquatic life use of rivers and streams is outlined below and in Figure 5.

The first step in the aquatic life assessment process is largely an automated process performed by logic programmed into a database application where all data from the 10 year assessment window is gathered; the results are referred to as 'Pre-Assessments'. Data filtered into the "Pre-Assessment" process is then reviewed to insure that data is valid and appropriate for assessment purposes. Tiered use designations are determined before data is assessed based on the attainment of the applicable biological criteria and/or an assessment of the habitat. Stream reaches are assigned the highest aquatic life use attained by both biological assemblages 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 can be proposed if the UAA demonstrates that the General Use is not attainable because 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 biology leads. The final approval to change a designated use is through formal rulemaking.

The next step in the aquatic life assessment process is a comparison of the monitoring data to water quality standards. Pre-assessments are then reviewed by either a biologist or water quality professional, depending on whether the parameter is biological or chemical in nature. These reviews are conducted at the workstation of each reviewer (i.e., desktop) using computer applications to analyze the data for potential temporal or spatial trends as well as gain a better understanding of any extenuating circumstances that should be considered (e.g., flow, time/date of data collection, or habitat).

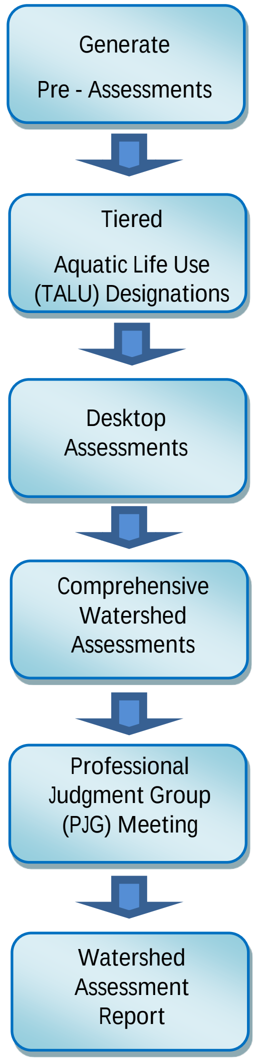

Figure 5. Flowchart of aquatic life use assessment process.

The next step in the process is a Comprehensive Watershed Assessment meeting where reviewers convene to discuss the results of their desktop assessments for each individual waterbody. Iimplementing a comprehensive approach to water quality assessment requires a means of organizing and evaluating information to formulate a conclusion utilizing multiple lines of evidence. Occasionally, the evidence stemming from individual parameters do not agree and would result in discrepant assessments if the parameters were evaluated independently. However, the overall assessment considers each piece of evidence to make a use attainment determination based on the preponderance of information available. See the *Guidance Manual for Assessing the Quality of Minnesota Surface Waters for the Determination of Impairment 305(b) Report and 303(d) List* (MPCA 2012) https://www.pca.state.mn.us/sites/default/files/wq-iw1-04.pdf for guidelines and factors considered when making such determinations.

The last step in the assessment process is the Professional Judgment Group meeting. At this meeting, results are shared and discussed with entities outside of the MPCA that may have been involved in data collection or that might be responsible for local watershed reports and project planning. Information obtained during this meeting may be used to revise previous use attainment decisions (e.g., sampling events that may have been uncharacteristic due to annual climate or flow variation, local factors such as impoundments that do not represent the majority of conditions on the AUID). 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 also included 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 EQuIS (Environmental Quality Information System), MPCA's data system and are uploaded to the US Environmental Protection Agency's data warehouse. Data for monitoring projects with federal or state funding are required to be stored in EQuIS (e.g., Clean Water Partnership, CWLA SWAGs 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 the monitoring data may be utilized in the assessment process. Prior to each assessment cycle, the MPCA sends out a 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 time frame 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 for the entire period is not required to make an assessment. The goal is to use data that best represents current water quality conditions. Therefore, recent data for pollutant categories such as toxics, lake eutrophication and fish contaminants may be given more weight during assessment.

III. Watershed overview

The Mississippi River (Headwaters) Watershed drains 1,961 square miles in north central Minnesota. As the name implies, this watershed contains the headwaters of the Mississippi River, which originates at Lake Itasca. From its headwaters, the Mississippi River flows 2,320 miles and drains 33 states before its outlet at the Gulf of Mexico (NPS, 2016). The size of the river channel varies greatly along its journey, however it reaches its smallest and widest points while still within the Headwaters Watershed; the river is narrowest (approximately 20 feet wide) as it leaves Lake Itasca, its source, and widest (approximately 11 miles wide) at Lake Winnibigoshish (NPS, 2016). The watershed is home to Itasca State Park, which was established in 1891 and is Minnesota's oldest state park. Each year, approximately 500,000 visitors tour the park to see its abundant wildlife, old growth white pine forests, and exceptional water resources. The watershed includes parts of Becker, Beltrami, Cass, Clearwater, Hubbard, and Itasca Counties. Much of the central portion of the watershed is contained within the Leech Lake Indian Reservation.

The Mississippi River is protected along its first 466 miles, making it the longest stretch of protected river in the United States. Regulations allow local areas of government to limit intensive land use along the river's corridor, which can help protect the rivers quality. The protection is administered by the Mississippi Headwaters Board (MHB), which is made up of counties located along the protected stretch of river. The main stem river will not be covered in the results and discussion portion of this report; the river was monitored and assess as part of a Large River Monitoring and Assessment strategy which was piloted on the Upper Mississippi River in 2013 (https://www.pca.state.mn.us/water/large-river-monitoring).

The Mississippi River (Headwaters) Watershed lies in the eastern portion of the Northern Lakes and Forest (NLF) Ecoregion (Figure 6). The NLF is dominated by relatively nutrient-poor glacial soils, which support the growth of coniferous and northern hardwood forests (Omernik, 1988). This heavily forested ecoregion is made-up of many steep, rolling hills, broad lacustrine basins, and extensive sandy outwash plains (Omernik, 1988). Soils within this ecoregion are generally thicker than those to the north and lack the arability of soils in the adjacent ecoregions to the south (Omernik, 1988). Lakes are numerous throughout the NLF ecoregions and are clearer and less productive than those that are located to the south (Omernik, 1988). Throughout the NLF many Precambrian granitic bedrock outcropping exists between shallow-to-deep moraine deposits left by the last glacier retreat that dates back to 12,000 years ago (Omernik, 1988).

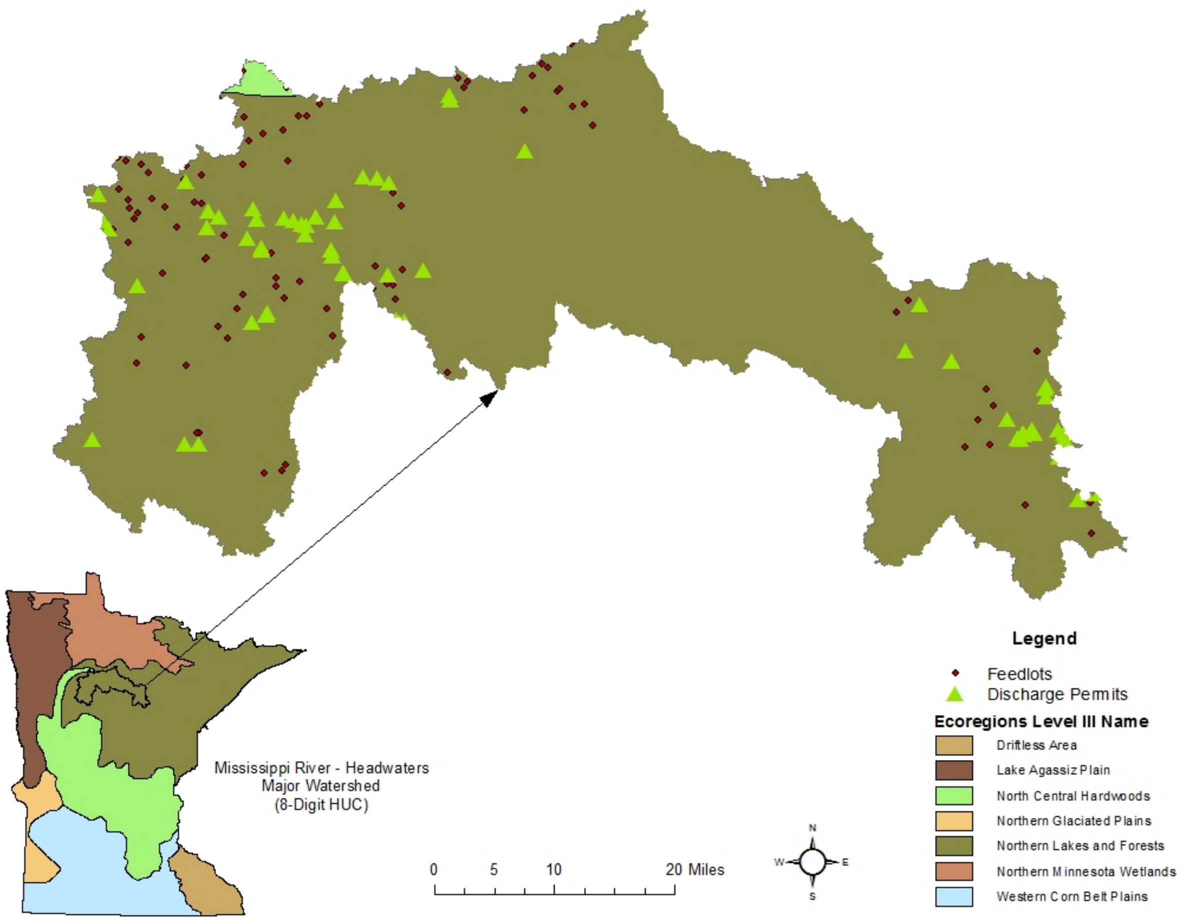

Figure 6. Location of feedlots and permitted facilities in the Mississippi River (Headwaters) Watershed within the Northern lakes and Forest ecoregion of North-Central Minnesota Land use summary.

Land use summary

Historically, mature coniferous forests, abundant lakes, and low-lying wetlands dominated The Upper Mississippi River (Headwaters) Watershed. The Dakota tribe was first to occupy the area in the early 1600's, followed by the Ojibwa Bands in the mid 1700's. The area was rich in fur and timber, which quickly drew the interest of European settlement. Prior to the 18th century, the fur trade was booming and became one of the main economic providers of the time. By the end of the century, over-trapping and a lower demand quickly dissolved the fur trade. During the early to mid-1800, logging took over as the primary industry in Minnesota. Large stands of old growth white pine drew thousands of loggers to the area. As technology advanced and the speed of log transportation increased, timber stands were quickly cleared, in return opening new land for settlement. Settlers began pushing further north into northern Minnesota; land that was occupied by the Ojibwa. In 1855, a treaty with the Mississippi Band of Chippewa Indians ceded their lands within northern Minnesota to the United States Government. The treaty was responsible for the creation of the Leech Lake Indian Reservation (MAICC, 2016). However, the treaties in place at the time did not allow loggers to harvest the any of abundant red and white pine stands on reservation lands. This changed in 1889 by ways of the Nelson Act, which opened reservation lands to logging. After years of extensive timber harvest, there was a concern over runaway logging throughout the reservation (MAICC, 2016). This prompted the creation of the 225,000 acre Minnesota National Forest in 1908, which was established to protect the remaining white and red pine on the reservation. In 1928, the forest was renamed Chippewa National Forest; today the forest consists of over 660,000 acres across Itasca, Cass, and Beltrami counties. (MAICC 2016). Despite the extensive amount of logging that has taken place throughout the watershed, the current land use remains dominated by forest (58%), with numerous wetlands (15%) and open water (14%) mixed throughout. Development across the watershed is low (2.9%) and is generally concentrated around the towns of Bemidji, Cass Lake, Cohasset, and Deer River. The remaining land use is as follows: rangeland (6.6%), cropland (1.2%), barren/mining (<1%). The Leech Lake Indian Reservation makes up much of the central portion of the watershed, from east of Bemidji to west of Deer River. This area is largely undeveloped, and contains some of the most pristine water resources in the state. Many of the lakes and streams within the reservation contain abundant stands of wild rice, which remains a central component to the bands culture.

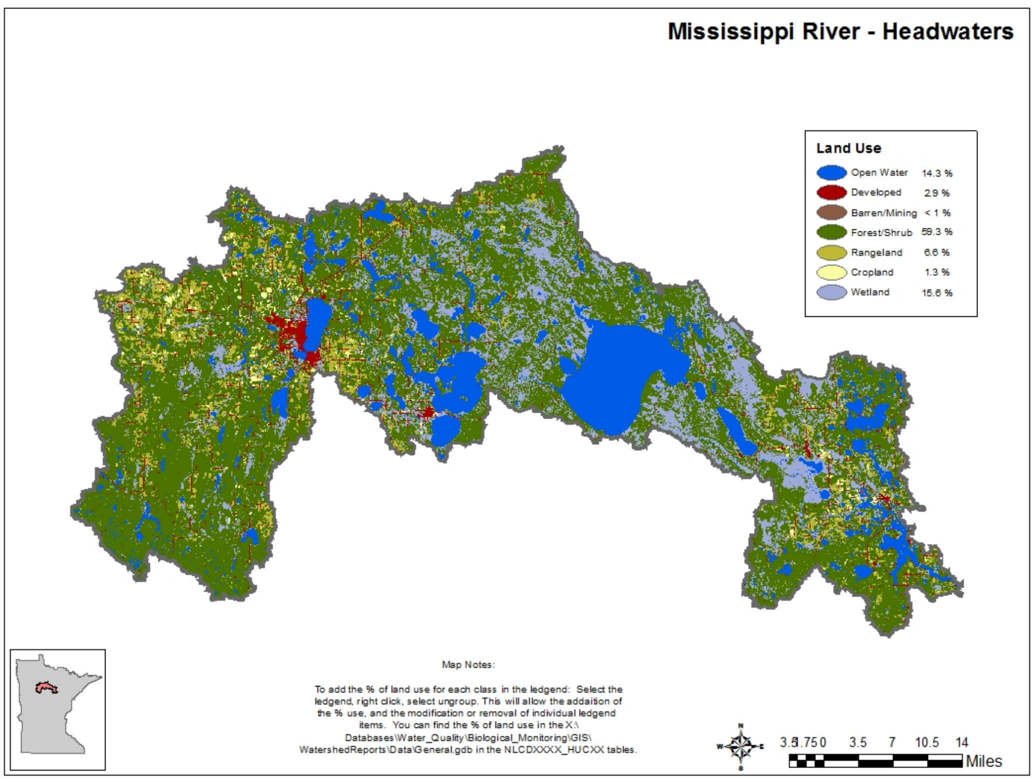

Figure 7. Land use in the Mississippi River (Headwaters) Watershed.

Surface water hydrology

The Mississippi River (Headwaters) Watershed is comprised of 14 intermediate sized watersheds (aggregated HUC 12), which contain a total of 685 river miles and more than 1000 lakes. The Mississippi River originates at Lake Itasca in Itasca State Park. Henry Rowe Schoolcraft is credited with naming the source of the Mississippi River, which he called “Itasca”, meaning “true head”. From its source, the river flows northeasterly towards the town of Bemidji, known as “The First City on the Mississippi” and the largest city within the watershed. From there, the river continues north before wrapping east and back south again towards its outlet at Lake Pokegama in Grand Rapids. Major Tributary streams to the Mississippi River within the watershed include the Little Mississippi River, Schoolcraft River, Third River, Turtle River, Deer River and many other smaller streams (The hydrology of these streams will be covered in section V). In general, most of the streams within the watershed are natural (Figure 9). This watershed provides some of the best recreational opportunities in the state with its abundant lakes and streams. Many of the lakes offer great fishing for a number of species including Smallmouth and Largemouth Bass, Walleye, Muskellunge, Crappie and Bluegill.

Historically, a number of dams were built on area lakes and rivers to aid in log transportation, control water levels, and provide electricity to local towns. Today, a number of dams still exist within the watershed. The first major dam along the Mississippi River is between Lake Bemidji and Stump Lake. Built in 1907, this is a hydroelectric dam owned and operated by the Ottertail Power Company. The dam impounds Stump Lake, and can regulate water levels on Lake Bemidji. The next downstream dam is located at the outlet of Lake Winnibigoshish and managed by the Army Core of Engineers. This dam was originally built in 1884 using 2,000,000 board feet of pine that was harvested from the area. The dam was rebuilt in 1899, substituting concrete for wooded components. The third dam is located at Ball Club Lake, which is designed to control the lake’s water level. The last major dam on the Mississippi River within this watershed is the Lake Pokegama Dam. This dam was completed in 1885 and subsequently reconstructed with concrete in 1904. The construction of this dam was historically significant because it provided a consistent flow of water throughout the season, which helped aid navigation.

The Knutson Lake Dam, just upstream of Cass Lake, was removed in 2015. The Forest Service, in collaboration with the Leech Lake Band of Ojibwa, DNR, Midwest Glacial Lakes Partnership, and the Army Corp of Engineers, completed the project. Built in the 1900’s, the purpose of this dam was to assist logging operations. More recently, the dam was being used to moderate water levels on Cass Lake and other downstream waterbodies. Due to the deteriorating condition of the dam and other factors, the Dam was removed. The removal had several immediate benefits including the restoration of fish passage along the Mississippi River upstream of Cass Lake, a reduction in shoreline erosion on Cass Lake, and the creation of spawning habitats for lithophilic spawners such as Walleye and White Sucker.

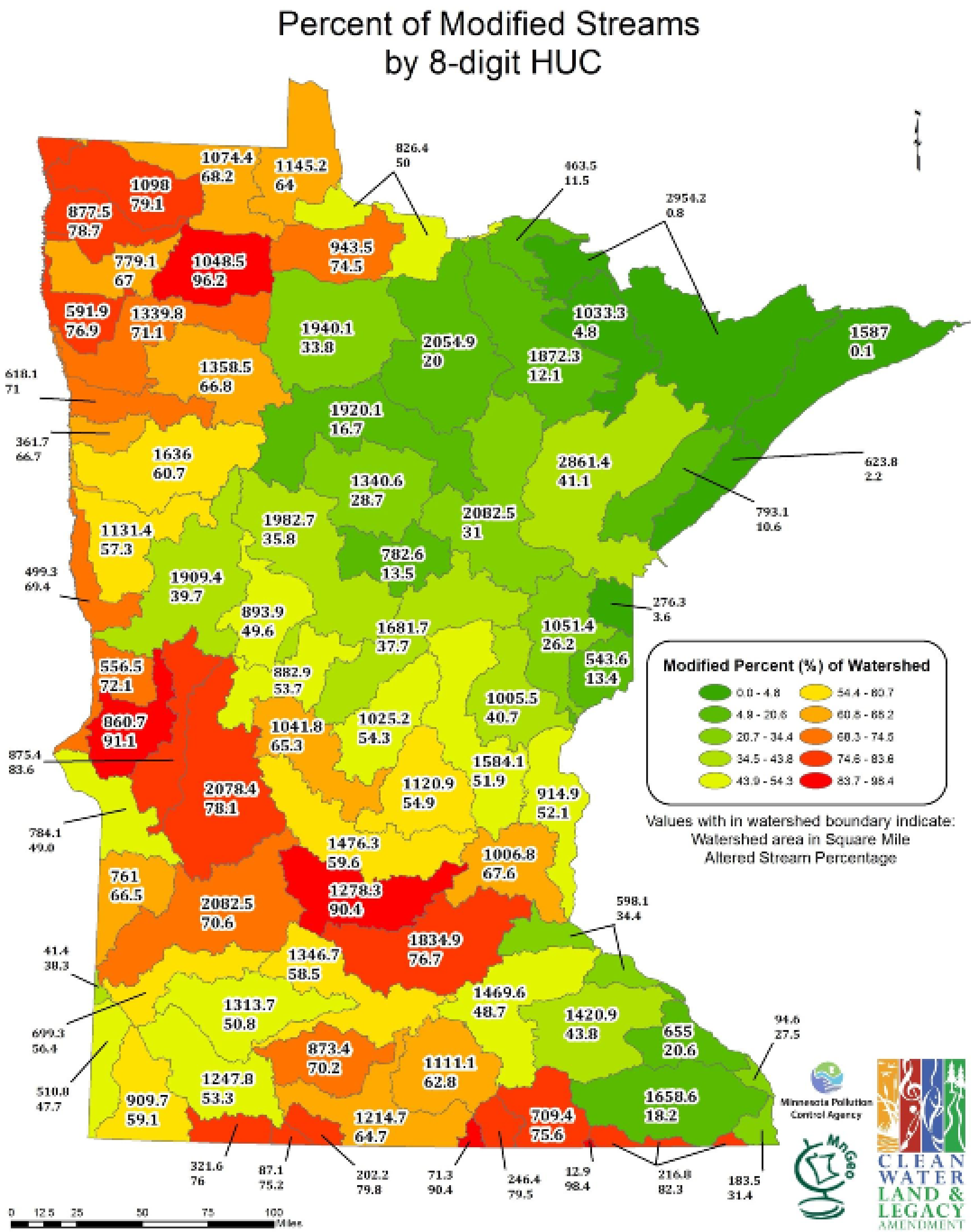

Figure 8. Map of percent modified streams by major Watershed (8-HUC).

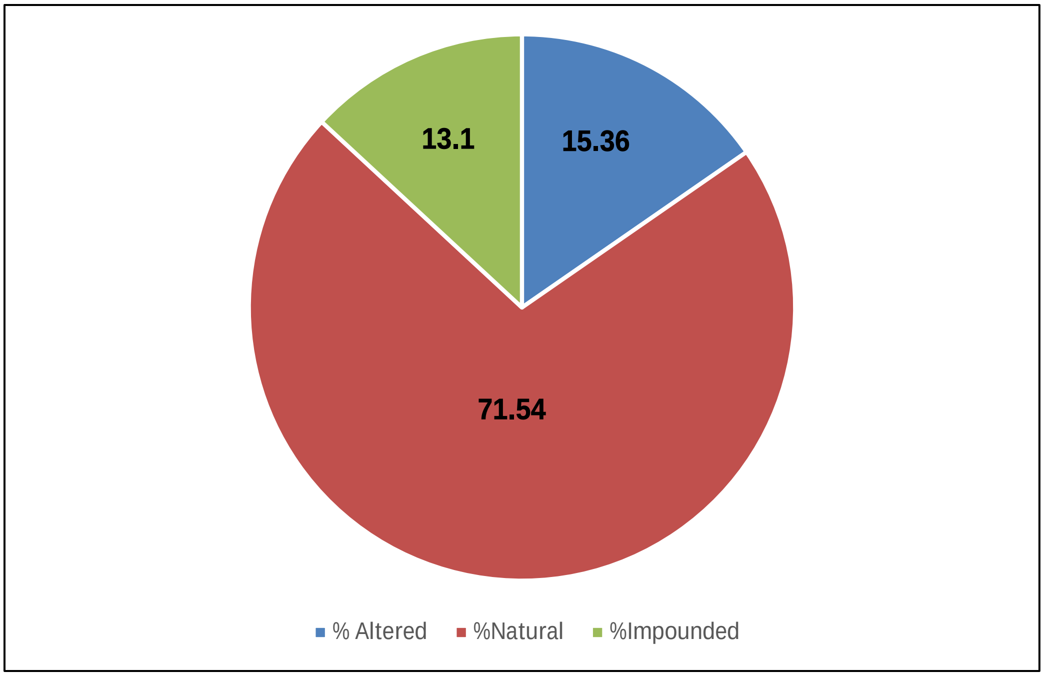

Figure 9. Comparison of natural to altered streams in the Upper Mississippi River (Headwaters) Watershed (percentages derived from the Statewide Altered Water Course project).

Climate and precipitation

Minnesota has a continental climate, marked by warm summers and cold winters. The mean annual temperature for Minnesota is 4.6˚C (NOAA, 2016); the mean summer temperature for the Mississippi River (Headwaters) Watershed is 18.3˚C and the mean winter temperature is -12.2˚ C (Minnesota State Climatology Office, 2003).

Precipitation is an important source of water input to a watershed. Figure 10 shows two representations of precipitation for calendar year 2013. 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 majority of the Mississippi River (Headwaters) Watershed area received 24 to 28 inches of precipitation in 2013. The display on the right shows the amount that precipitation levels departed from normal. For the Mississippi River (Headwaters) area, it displays that precipitation ranged from two to four inches below normal throughout the majority of the watershed, while the southwest corner received two to four inches above normal in 2013.

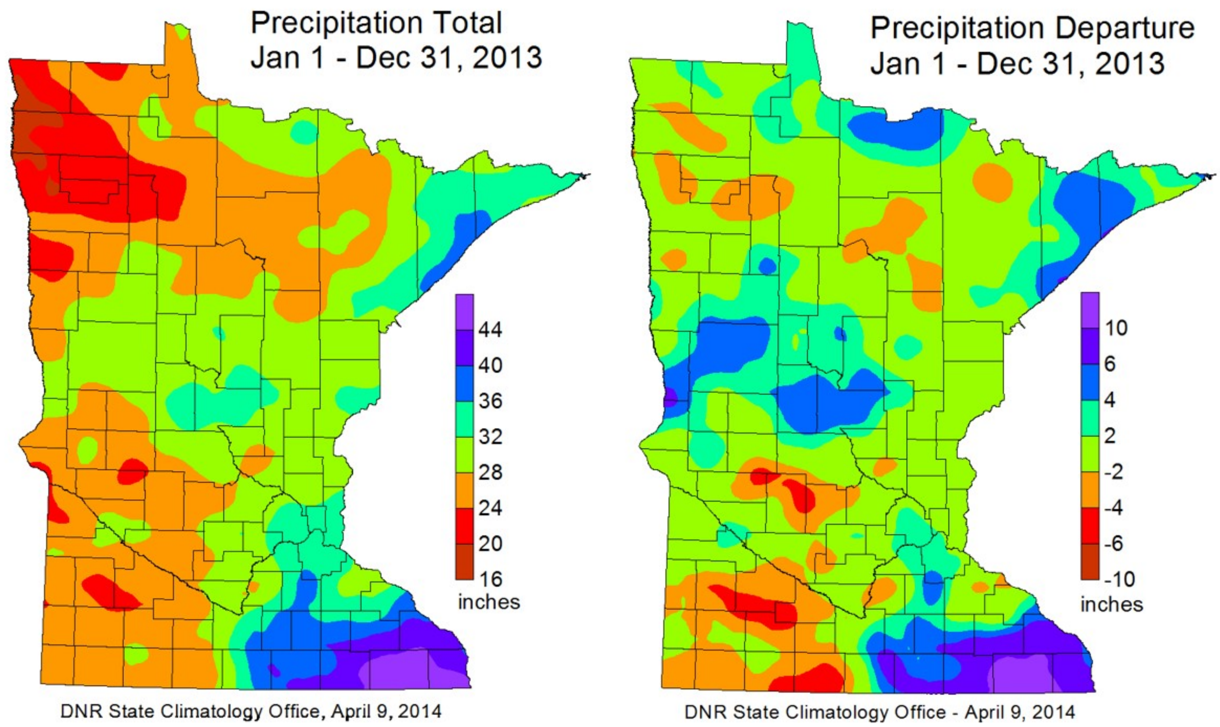

Figure 10. Statewide precipitation levels during the [2013] water year.

The Mississippi River (Headwaters) Watershed is located in the North Central precipitation region. Figure 11 and Figure 12 display the areal average representation of precipitation in North Central 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 North Central region display no significant trend over the last 20 years. However, precipitation in North Central 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.

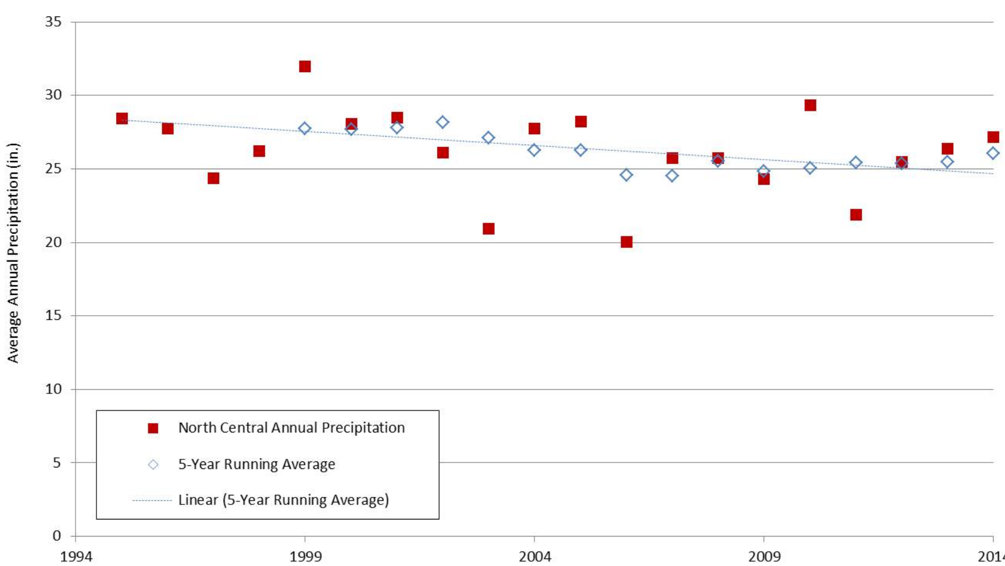

Figure 11. Precipitation trends in North Central Minnesota (1995-2014) with five-year running average.

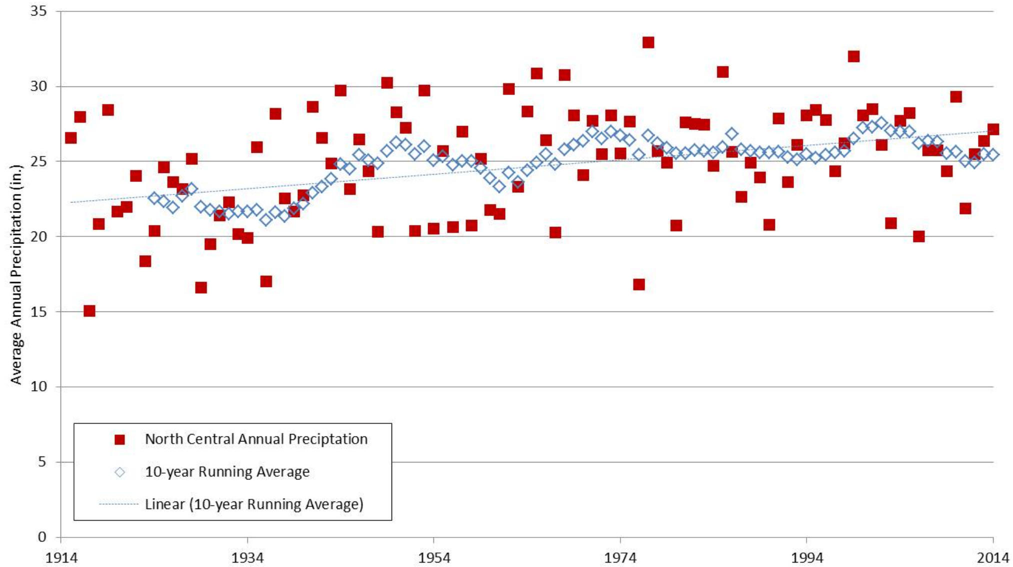

Figure 12. Precipitation trends in North Central Minnesota (1915-2014) with ten-year running average.

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

Surficial geology is identified as the earth material located below the topsoil and overlying the bedrock. Glacial sediment is at the surface in much of the Mississippi River (Headwaters) Watershed and is the parent material for the soils that have developed since glaciation. The depth to bedrock ranges from exposure at the surface to over 890 feet and 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 deposits at the surface are associated with two ice lobes, the Des Moines and Wadena lobes and post-glacial alterations to that sediment, including soil formation and peat accumulation. The glacial sediment can be grouped by material texture: 1) sand and gravel stream sediment, 2) loamy calcareous till, and 3) non-calcareous till (Figure 13).

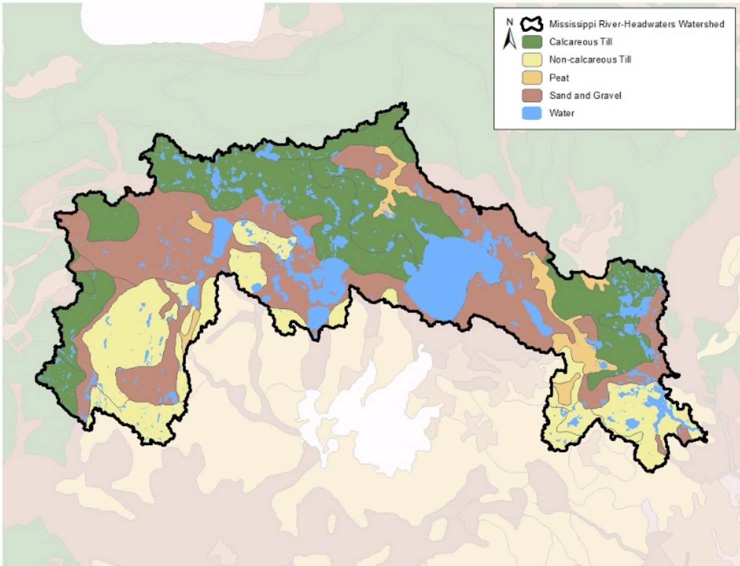

Figure 13. Quaternary geology, glacial sediments within the Mississippi River (Headwaters) Watershed (GIS Source: MGS, 1982)

Bedrock is the main mass of rocks that form the Earth, located underneath the surficial geology and can only be seen in only a few places where weathering has exposed the bedrock. The bedrock geology of the Mississippi River-Headwaters Watershed includes Precambrian crystalline rocks and cretaceous rocks in the southeast region of the watershed (Figure 14). The uppermost bedrock is the cretaceous bedrock, which is the youngest pre-glacial deposit layer, and is described as sandstone layers interbedded with thick layers of shales and are often used as the local water source (DNR, 2001).

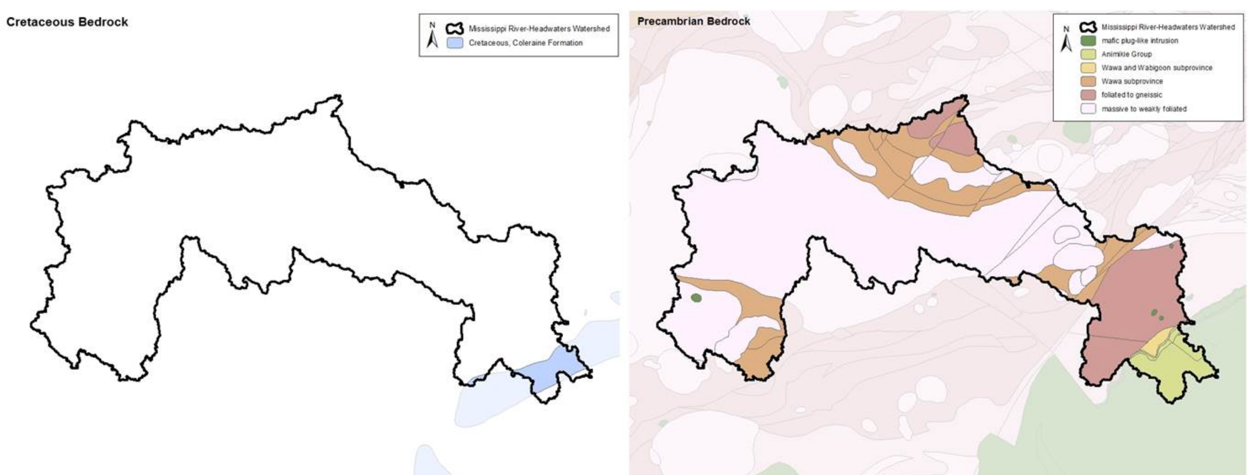

Figure 14. Bedrock geology of the Mississippi River-Headwaters Watershed: Cretaceous and Precambrian (GIS Source: MGS, 2011)

Groundwater aquifers

Groundwater aquifers are layers of water-bearing rocks that readily transmit water to wells and springs (USGS, 2015). 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 Mississippi River (Headwaters) Watershed's water sources are predominately made up of glacial sand and gravel aquifers with the Quaternary Water Table Aquifer (QWTA) and Quaternary Buried Artesian Aquifer (QBAA) as the primary sources for groundwater withdrawals.

Groundwater pollution sensitivity

Since bedrock aquifers are typically covered with thick till, they would normally be 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 DNR is 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 Mississippi River (Headwaters) 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 coarse-scale planning tool. According to this data, the Mississippi River (Headwaters) Watershed is estimated to have primarily high to highest contamination susceptibility (Figure 15) (Porcher, 1989).

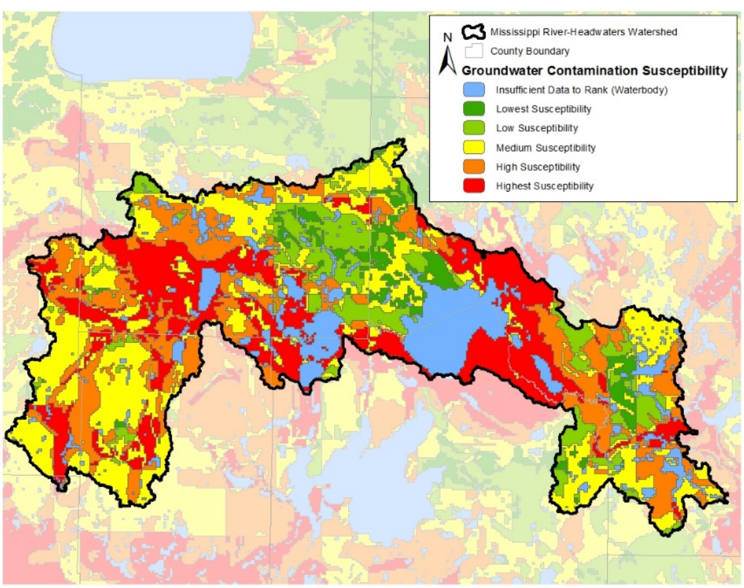

Figure 15. Groundwater contamination susceptibility for the Mississippi River (Headwaters) Watershed (GIS Source: MPCA, 1989)

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 US Geological Survey to develop a statewide estimate of recharge using the Soil-Water-Balance Code. 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.

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 16). 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 Mississippi River (Headwaters) Watershed, the average annual potential recharge rate to surficial materials ranges from 0.4 to 13.4 inches per year, with an average of 5.2 inches per year (Figure 17). The statewide average potential recharge is estimated to be four inches per year with 85% of all recharge ranging from three to eight inches per year (Figure 18). When compared to the statewide average potential recharge, the Mississippi River (Headwaters) Watershed receives a higher percent of grid cells on average of potential recharge, mostly likely attributed to the variability of the surficial sediment distribution of the area.

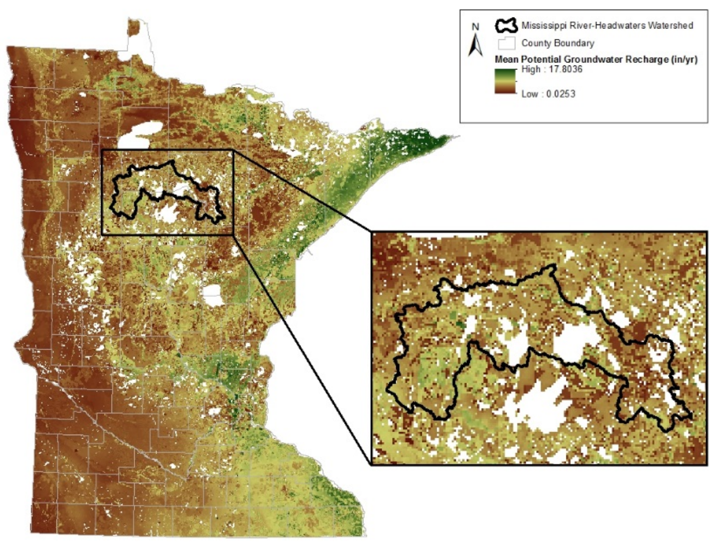

Figure 16. Average annual potential recharge rate of surficial materials in Mississippi River (Headwaters) Watershed (1996-2010)

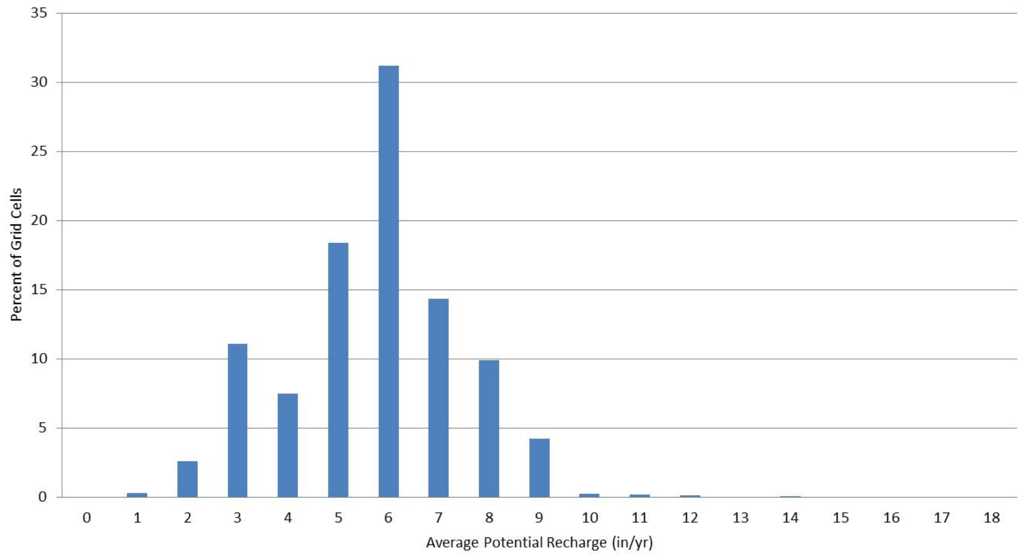

Figure 17. Average annual potential recharge rate percent of grid cells in the Mississippi River (Headwaters) Watershed (1996-2010).

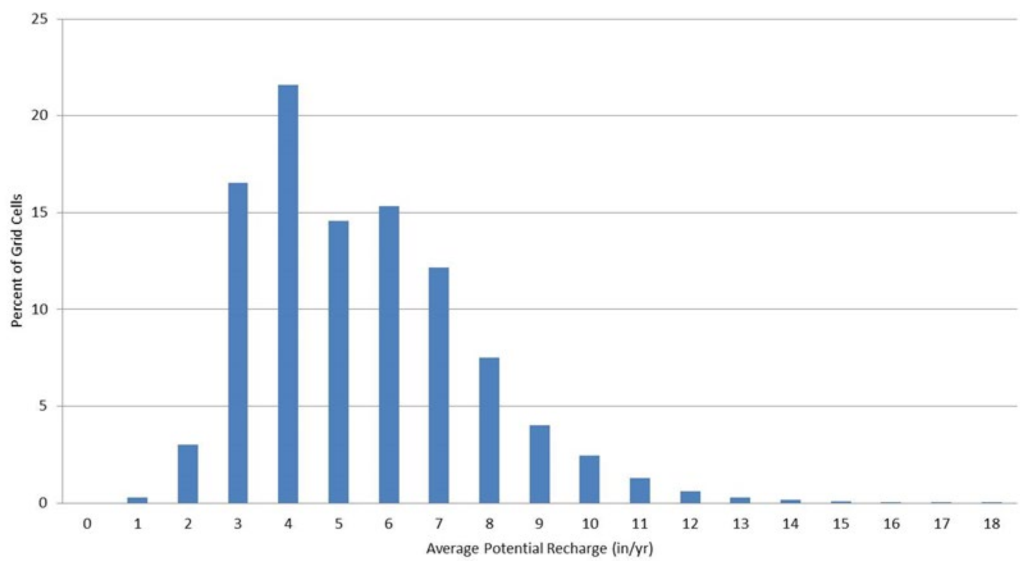

Figure 18. Average annual potential recharge rate percent of grid cells statewide (1996-2010)

Wetlands

There are approximately 291,000 acres of wetlands in the Mississippi River (Headwaters) Watershed, roughly equivalent to 24% of its total area. Forested, scrub-shrub, and emergent vegetation wetlands are well distributed across the watershed (Figure 19). Shallow open water habitat is also present in the watershed, primarily associated with the fringes (i.e., littoral zone) of lakes in the watershed. It should be noted that these estimates represent a snapshot of the location, type, and extent of wetlands occurring in the early 1980s—when aerial imagery was acquired to develop National Wetlands Inventory (NWI) maps in this part of the state.

Soil data can be used to estimate the extent of historic or pre-settlement wetlands and serve as a baseline for comparing current wetland acreage. The Natural Resources Conservation Service (NRCS) Soil Survey Geographic database, based on a summation of map units classified as "poorly drained" or “very poorly drained”, provides an estimate of approximately 319,000 acres of wetlands (~26% of watershed area) occurring in the Mississippi River (Headwaters) prior to European settlement (Soil Survey Staff, NRCS 2013). The current wetland area estimate for the watershed, based on 1980s National Wetlands Inventory data, is about 291,000 acres. A comparison of these two-time periods (i.e., pre-settlement vs. early 1980s) yields a 9% wetland loss estimate for the watershed. It should be noted, however, that the NWI might have underestimated the extent of forested wetlands in the watershed due to the difficult nature (at the time) of mapping this class of wetlands. Therefore, the estimate presented here may represent an overestimate of wetland loss in the Mississippi River (Headwaters) Watershed. Planned updates to the NWI in this region will provide better estimates of current wetland extent and loss.

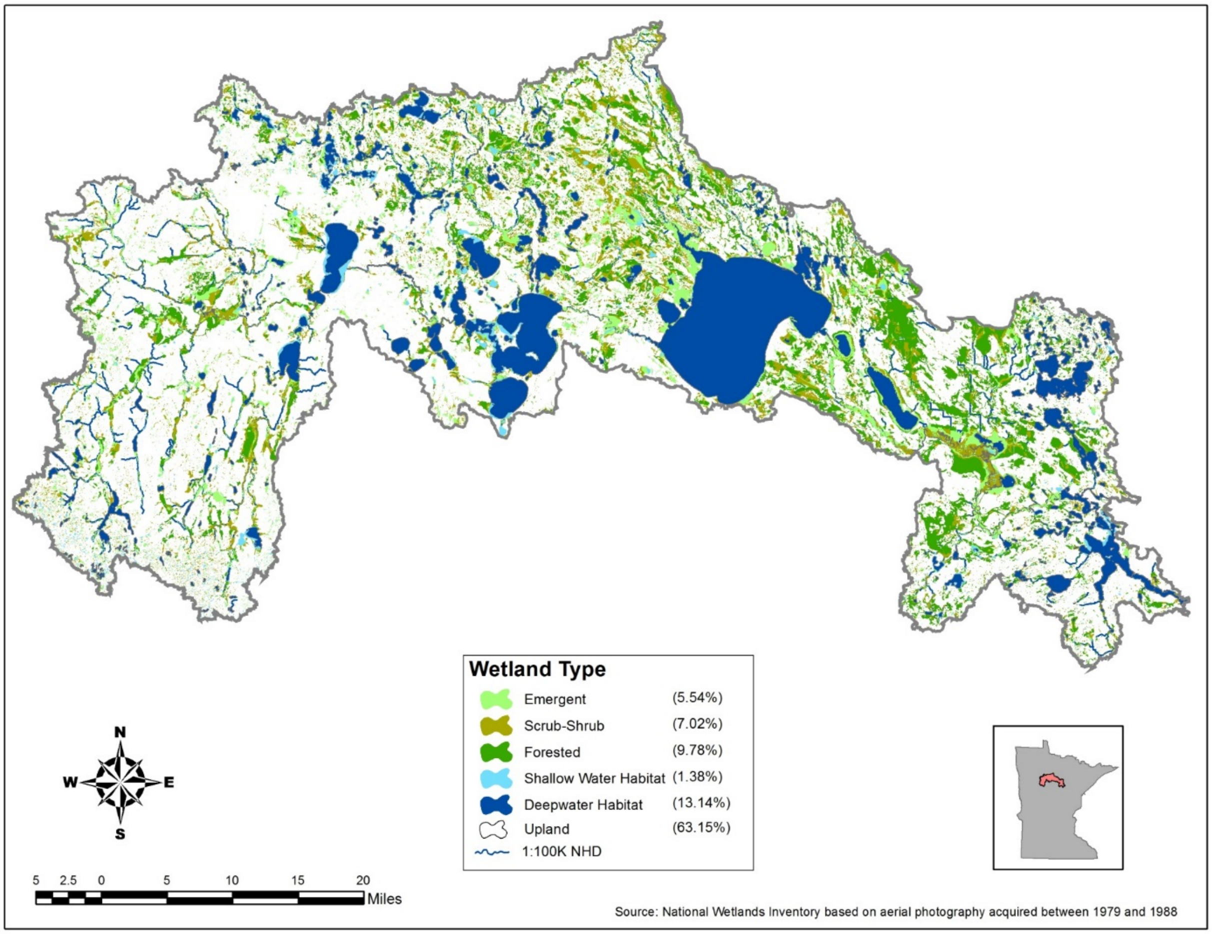

Figure 19. Wetland types and their distribution across the Mississippi River (Headwaters) Watershed.

IV. 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 1). Because these relationships can also shift between storms or with season, computation of accurate load estimates requires frequent sampling of all major runoff events. 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), TP, dissolved orthophosphate (DOP), nitrate plus nitrite nitrogen (NO_2+NO_3-N), and total Kjeldahl nitrogen (TKN).

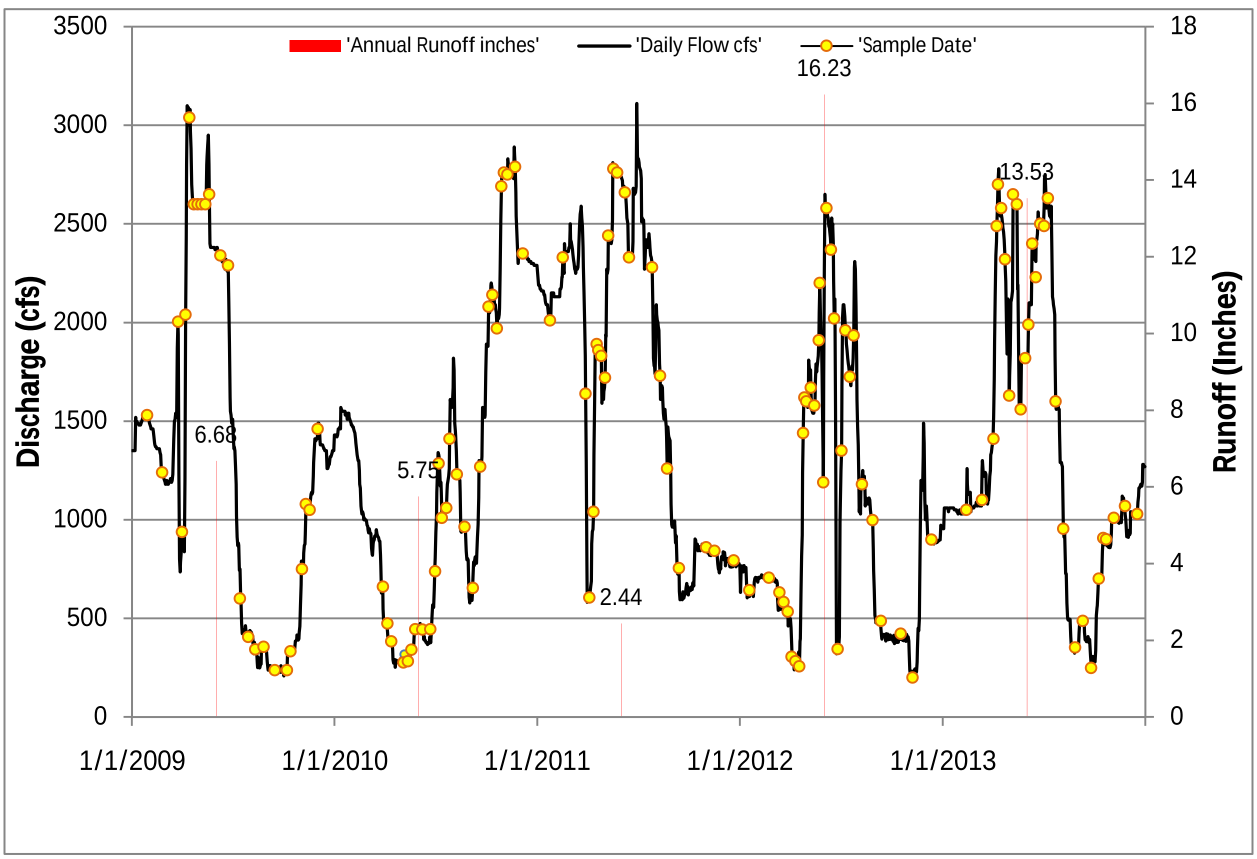

Figure 20. 2009-2013 Hydrograph, Sampling Regime and Annual Runoff for the Mississippi River at Grand Rapids, Minnesota.

Stream water sampling

Nine water chemistry stations were sampled from May through September in 2013, and again during June through August of 2014, to provide sufficient water chemistry data to assess all components of the Aquatic Life and Recreation Use Standards. Following the IWM design, water chemistry stations were placed at the outlet of each aggregated 12 HUC subwatershed that was >40 square miles in area (purple circles and green circles/triangles in (Figure 3). A SWAG was awarded to the Itasca SWCD and Headwaters Science Center to intensively collect water chemistry at these nine outlet stations. A SWAG was also awarded to the Leech Lake Band of Ojibwa in partnership with the Itasca SCWD to sample water chemistry at two of the nine chemistry stations that are located on the Leech Lake Reservation. Please refer to Appendix 2 for locations of stream water chemistry monitoring sites. See Appendix 1 for definitions of stream chemistry analytes monitored in this study. Intensive water chemistry collection stations were not placed near the outlets of the Headwaters Mississippi River, Cass Lake Mississippi River, Lake Winnibigoshish, Ball Club Lake, and Pokegama Lake Mississippi River subwatersheds due to numerous lakes, lack of riverine conditions, and or the subwatershed outlet was located on part of the main stem Mississippi River.

Stream flow methodology

MPCA and the DNR joint stream water quantity and quality monitoring data for dozens of sites across the state on major rivers, at the mouths of most of the state's major watersheds, and at the mouths of some subwatersheds are available at the DNR/PCA Cooperative Stream Gaging webpage at: http://www.dnr.state.mn.us/waters/csg/index.html.

Lake biological sampling

A total of 45 lakes were monitored for fish community health in the Mississippi River (Headwaters) Watershed. While data from the last 10 years contributed to the watershed assessments, the majority of data utilized for the 2015 assessment was collected in 2013 and 2014.

To measure the health of aquatic life at each lake, a fish index of biological integrity (IBI) was calculated based on monitoring data collected in the lake. A fish classification framework was developed to account for natural variation in community structure, which is attributed to area, maximum depth, alkalinity, shoreline complexity, and geographic location. As a result, an IBI is available for four different groups of lake classes (Schupp Lake Classification, DNR). Each IBI class uses a unique suite of metrics, scoring functions, impairment thresholds, and confidence intervals (CIs). IBI scores higher than the impairment threshold and upper CI indicate that the lake supports aquatic life. Scores below the impairment threshold and lower CI indicate that the lake does not support aquatic life. When an IBI score falls within the upper and lower confidence limits additional information may be considered when making the impairment decision such as the consideration of potential local and watershed stressors and additional monitoring information (e.g., water chemistry, physical habitat, plant surveys, and observations of local land use activities).

Stream biological sampling

The biological monitoring component of IWM in the Mississippi River (Headwaters) Watershed was completed during the summer of 2013. A total of 39 sites were established across the watershed and sampled. These sites were located near the outlets of most minor 14-HUC watersheds. In addition, two existing biological monitoring stations within the watershed were revisited in 2013. These monitoring stations were initially established in 2000 and 2009 as part of a survey to collect data for biocriteria development. While data from the last 10 years contributed to the watershed assessments, the majority of data utilized for the 2015 assessment was collected in 2013. A total of 32 AUIDs were sampled for biology in the Mississippi River (Headwaters) River Watershed. Waterbody assessments to determine aquatic life use support were conducted for 29 AUIDs. Biological information that was not used in the assessment process will be crucial to the stressor identification process and will be used as a basis for long term trend results in subsequent reporting cycles.

To measure the health of aquatic life at each biological monitoring station, indices of biological integrity (IBIs), specifically Fish and macroinvertebrate IBIs, were calculated based on monitoring data collected for each of these communities. A fish and macroinvertebrate classification framework was developed to account for natural variation in community structure which is attributed to geographic region, watershed drainage area, water temperature and stream gradient. As a result, Minnesota's streams and rivers were divided into seven distinct warm water classes and two cold water classes, with each class having its own unique Fish IBI and Invert IBI. Each IBI class uses a unique suite of metrics, scoring functions, impairment thresholds, and confidence intervals (CIs) (For IBI classes, thresholds and CIs, see Appendix 4.1). IBI scores higher than the impairment threshold and upper CI indicate that the stream reach supports aquatic life. Contrarily, 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 upper and lower confidence limits additional information may be considered when making the impairment decision such as the consideration of potential local and watershed stressors and additional monitoring information (e.g., water chemistry, physical habitat, observations of local land use activities). For IBI results for each individual biological monitoring station, see Appendix 4.1.

Fish contaminants

Mercury and PCBs were analyzed in fish tissue samples collected from the Mississippi River in 2013, by the MPCA biomonitoring staff. All other samples had previously been collected by DNR fisheries staff. Thirty-two lakes in the watershed have also been tested for mercury and PCBs in fish. Captured fish were wrapped in aluminum foil and frozen until they were thawed, scaled, filleted, and ground. The homogenized fillets were placed in 125 mL glass jars with Teflon™ lids and frozen until thawed for mercury or PCBs analyses. The Minnesota Department of Agriculture (MDA) laboratory performed all mercury and PCBs analyses of fish tissue.

Prior to 2006, mean mercury fish tissue concentrations were assessed for water quality impairment based on the Minnesota Department of Health's (MDH) fish consumption advisory. An advisory more restrictive than a meal per week was classified as impaired for mercury in fish tissue. Since 2006, a waterbody 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 are required per species to make this assessment and only the last 10 years of data are used for statistical analysis. MPCA's Impaired Waters Inventory includes waterways that were assessed as impaired prior to 2006, as well as more recently.

PCBs in fish have not been monitored as intensively as mercury in the last three decades due to monitoring completed in the 1970s and 1980s. These studies identified that high concentration of PCBs were only a concern downstream of large urban areas in large rivers, such as the Mississippi River and Lake Superior. This implied that it was not necessary to continue widespread frequent monitoring of smaller river systems as is done with mercury. However, limited PCB monitoring was included in the watershed sampling design to ensure that this conclusion is still accurate. Impairment assessment for PCBs in fish tissue is based on the fish consumption advisories prepared by the MDH. If the consumption advice is to restrict consumption of a particular fish species to less than a meal per week because of PCBs, the MPCA considers the lake or river impaired. The threshold concentration for impairment is 0.22 mg/kg PCBs and more advice that is restrictive is recommended for consumption (one meal per month).

Lake water sampling

The MPCA sampled water chemistry on 26 lakes in the Mississippi River (Headwaters) Watershed between 2012 and 2013. SWAGs were awarded to the Itasca SWCD and Hubbard County to sample 13 lakes in the watershed in 2012 and 2013. There are currently 53 volunteers enrolled in the MPCA's CLMP who are conducting lake monitoring within the watershed. Sampling methods are similar among monitoring groups and are described in the document entitled "MPCA Standard Operating Procedure for Lake Water Quality" found at http://www.pca.state.mn.us/publications/wq-s1-16.pdf. The lake water quality assessment standard requires eight observations/samples within a 10-year period for phosphorus, chlorophyll-a and Secchi depth.

Groundwater monitoring

Groundwater quality

The MPCA 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.

There are currently 19 MPCA Ambient Groundwater Monitoring well (18 monitoring, 1 domestic) within the Mississippi River (Headwaters) Watershed. Figure 21 displays the locations of ambient groundwater wells within and around the specified watershed. Data collection ranged from 2004 to 2015; however, the majority of the wells were added in 2010. Therefore, data analysis was conducted on the current MPCA Ambient Groundwater Wells from 2010 to 2015.

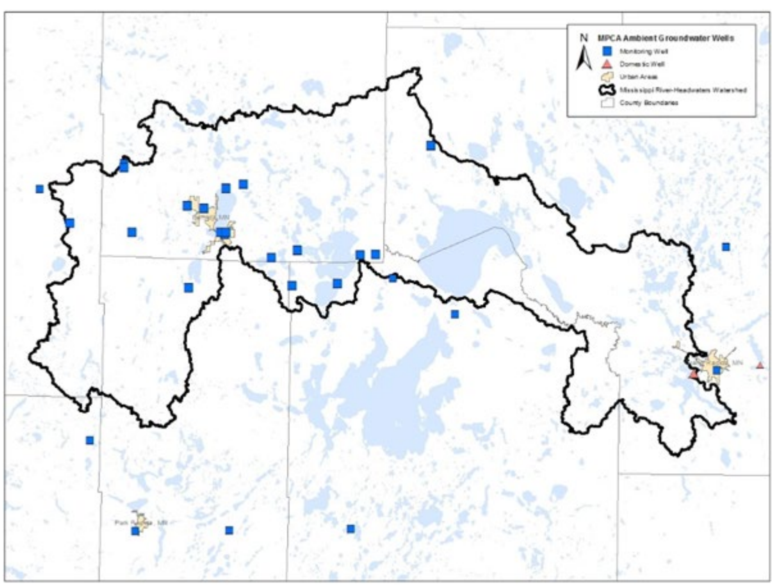

Figure 21. MPCA ambient groundwater monitoring well locations near the Mississippi River (Headwaters) Watershed (2015).

The frequency of occurrence and exceedances in drinking water standards of three chemicals; arsenic, nitrate, and chloride, in ambient groundwater are considered in this report (Figure 22). Arsenic forms primarily from the natural weathering of mineral deposits, but it can be dangerous for human consumption due to its toxicity. Arsenic was detected in 59.8% of wells in the watershed from samples collected from 2010 to 2015. However, only one well within the watershed consistently exceeded 10 micrograms per liter; the Maximum Contaminant Level (MCL) for arsenic in drinking water set by the U.S. Environmental Protection Agency (EPA). The exceedance is most likely attributed to the presence of clay deposits, resulting in low DO levels. Nitrate, a form of nitrogen, also has a MCL of 10 milligrams per liter. This limit is primarily set for the risk of methemoglobinemia (blue-baby syndrome) in infants under the age of six months. Nitrates were detected in wells in the watershed 70.6% of the time. There was one exceedance of the MCL in one well near Bemidji in 2010. Chloride has become an increasing concern in developed areas where salt is used as a deicing agent. Deicing has been linked to higher chloride concentrations in groundwater and can affect the taste of drinking water (Kroening & Ferrey, 2013). Chloride has a secondary MCL set as 250 milligrams per liter for taste. Chloride was detected 92.2% of the time with one occurrence exceeding the secondary limit in one well near Bemidji in 2014.

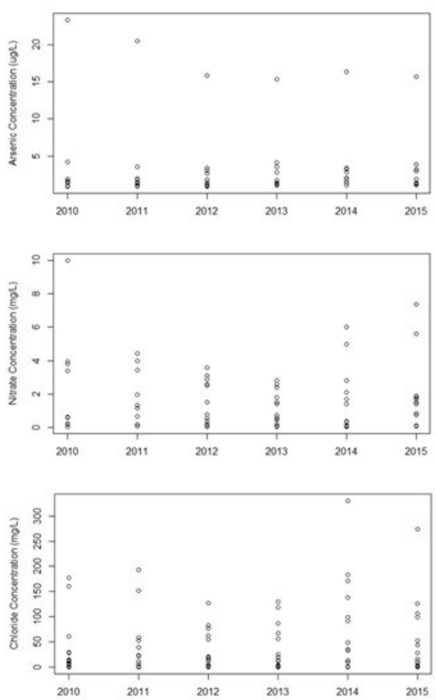

Figure 22. Ambient groundwater monitoring data for arsenic, nitrate and chloride concentrations (2010-2015).

From 1992 to 1996, the MPCA conducted baseline water quality sampling and analysis of Minnesota's principal aquifers. The baseline study determined that the groundwater quality in the Northeast Region is considered good when compared to other areas with similar aquifers, but with exceedances of drinking criteria in arsenic, beryllium, boron, manganese and selenium (MPCA, 1999a). The groundwater quality in the Northwest Region had a tendency of greater concentrations of most chemicals when compared to similar aquifers statewide. Exceedances of drinking water criteria were found in arsenic, barium, boron, manganese, molybdenum, nitrate and selenium (MPCA, 1999b). The exceedances identified were contributed to natural sources, such as geology, residence times and well construction.

Volatile organic compounds were also detected in both regions with the most commonly detected compounds associated with fuel oils, gasoline and well disinfection (MPCA, 1999a; MPCA, 1999b).

Another source of information on groundwater quality comes from the Minnesota Department of Health (MDH). Mandatory testing for arsenic of all newly constructed wells has found that 10.7% of all wells installed from 2008 to 2015 have arsenic levels above the MCL for drinking water (MDH, 2015). In the Mississippi River (Headwaters) 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 five to greater than 20% exceedances. By county, the percentages of wells identified with concentrations exceeding the MCL are as follows: Clearwater (10.5%), Beltrami (10.2%), Itasca (5.4%), Cass (4.2%) and Hubbard (1.9%) (MDH, 2015) (Figure 23). Twenty Five percent of wells within Becker County exceed the MCL, but the area of the county within the watershed is minimal and not a reflection of the watershed as a whole. For more information on arsenic in private wells, please refer to the Minnesota Department of Health's website: http://www.health.state.mn.us/divs/eh/wells/waterquality/arsenic.html.

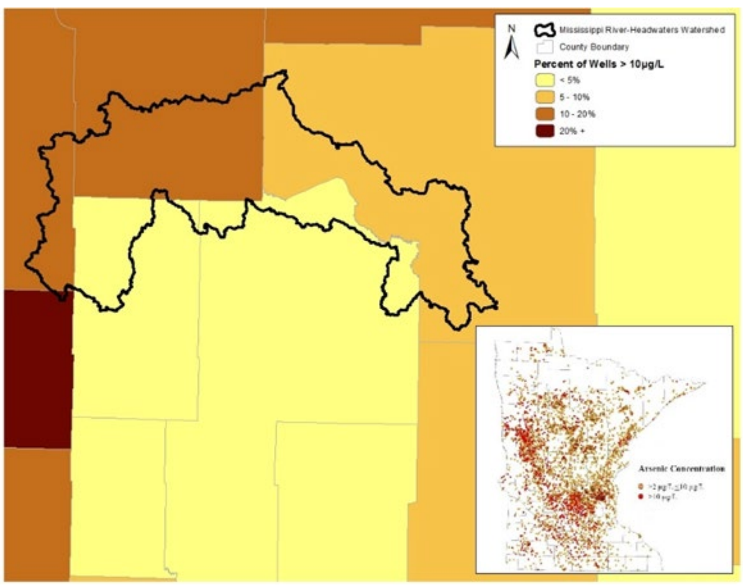

Figure 23. Percent wells with arsenic occurrence greater than the MCL per county for the Mississippi River (Headwaters) Watershed (2008-2015) (Source: MDH, 2015).

Groundwater/surface water withdrawals

The DNR permits all high capacity water withdrawals where the pumped volume exceeds 10,000 gallons per day or one million gallons per year. Permit holders are required to track water use and report to the DNR yearly. 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 DNR 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.

Further information on the DNR program and the program database are found at: http://www.dnr.state.mn.us/waters/watermgmt_section/appropriations/wateruse.html

The three largest permitted consumers of water in the state (in order) are power generation, public water supply (municipals), and irrigation (DNR, 2015e). According to the most recent USGS site-specific water-use data system (SWUDS), in 2013 the withdrawals within the Mississippi River (Headwaters) Watershed are primarily utilized for power generation (98.3%). The remaining withdrawals include: water supply (municipal and private) (1.1%), non-crop irrigation (0.21%), agricultural irrigation (0.14%), special categories including pollution containment, dust control, construction non-dewatering and others (0.12%), industrial processing (0.07%), water level maintenance (0.01%) and heating and cooling purposes (0.03%). From 1994 to 2013, withdrawals associated with industrial processing have increased significantly (p=0.001), while non-crop irrigation and water supply have also slightly increased (p=0.05). All other categories have remained relatively constant over this time-period.

Figure 24 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 total surface water withdrawals as red squares. During 1994 to 2013, groundwater withdrawals within the Mississippi River (Headwaters) Watershed exhibit a decreasing withdrawal trend (p=0.01) (Figure 25), and while surface water withdrawals appears to be decreasing, there is no statistically significant trend (Figure 25). QWTA withdrawals, which account for approximately 21% of all groundwater withdrawals, emulate the overall groundwater withdrawal trend with a slight decrease over this time period (p=0.1).

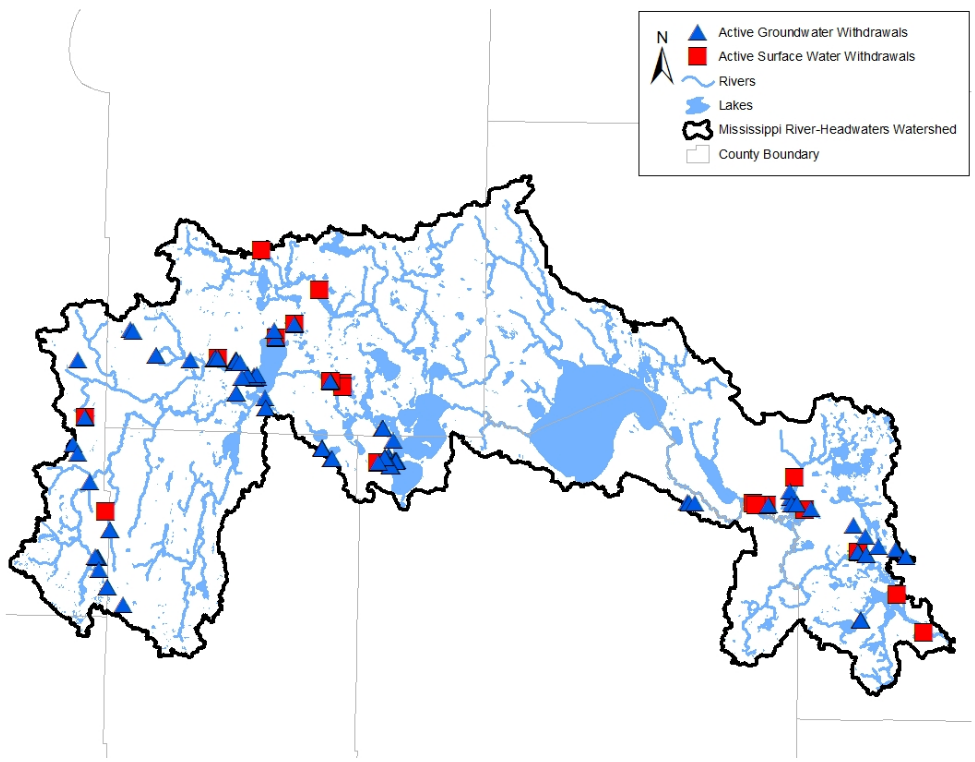

Figure 24. Locations of active status permitted high capacity withdrawals in 2013 within the Mississippi River (Headwaters) Watershed.

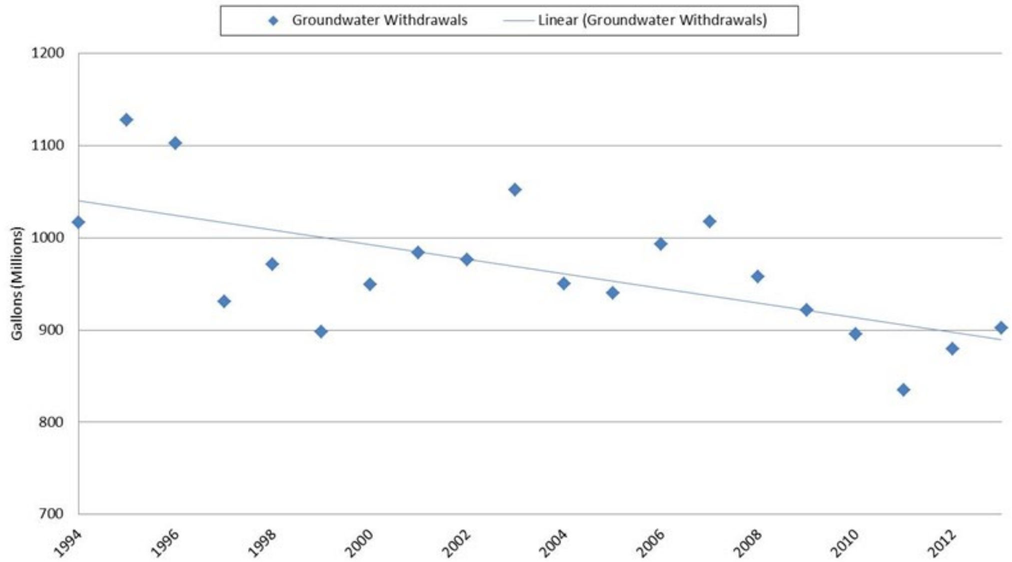

Figure 25. Total annual groundwater withdrawals in the Mississippi River (Headwaters) Watershed (1994-2013).

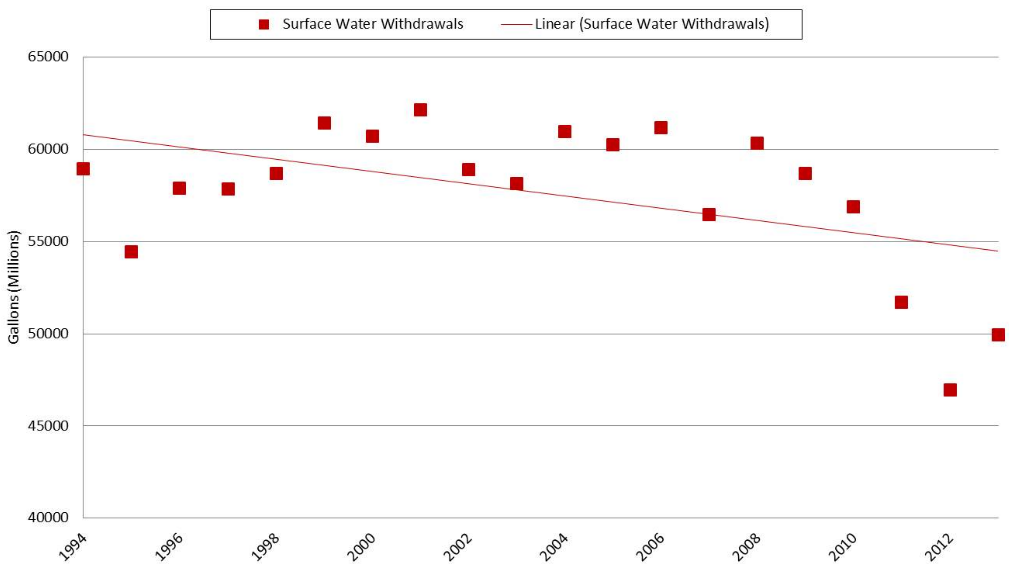

Figure 26. Total annual surface water withdrawals in the Mississippi River (Headwaters) Watershed (1994-2013)

Minnesota Department of Natural Resources Observation Wells

Monitoring wells from the DNR 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. To access the DNR Observation Well Network, please visit http://www.dnr.state.mn.us/waters/cgm/index.html.

Four DNR Observation Wells (29036, 29050, 11014 and 4025) within the Mississippi River (Headwaters) Watershed were chosen based on data availability and geologic location as representative of depth to groundwater throughout the watershed (Figure 27). Depth to Water (DTW) was collected on a monthly basis and the average annual DTW was calculated. Observation well 29036 located near Laporte in the southwest area of the watershed exhibits a decreasing trend of the water table level (p=0.05) over the last 20 years (1996-2015). Similarly, 29050 near Cass Lake in the central area and 11014 near Bena in the eastern area also exhibit a trend in decreasing water levels (p=0.1). Observation well 4025 near Solway in the northwest region displays no statistical trend in depth to groundwater on an average annual basis.

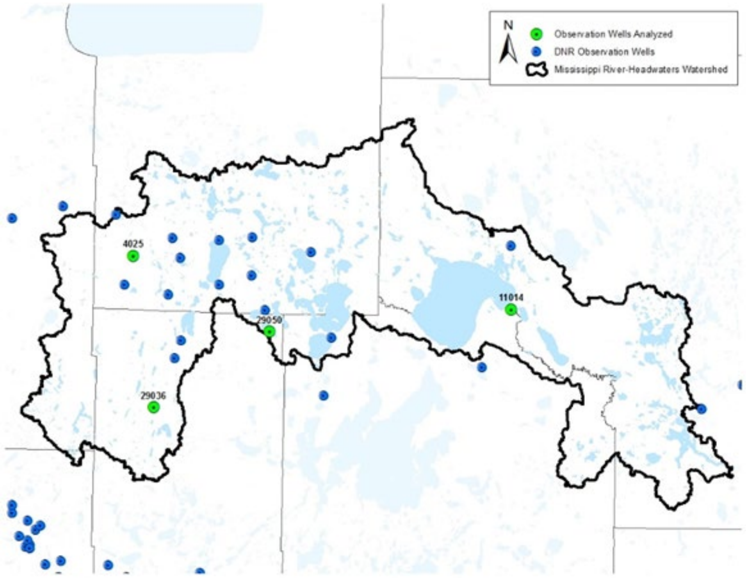

Figure 27. DNR Water Table Observation well locations within the Mississippi River (Headwaters) Watershed.

Streamflow

The United States Geological Survey (USGS) maintains real-time streamflow gaging stations across the United States. Measurements can be viewed at http://waterdata.usgs.gov/nwis/rt.

Mississippi River near Bemidji, Minnesota from water years 1996 to 2015. The data shows that although streamflow appears to be slightly decreasing, there is no statistically significant trend. Figure 29 displays July and August mean flows for water years 1995 to 2015, excluding 2002 due to lack of data, for the same water body. The data appear to be increasing in July and August, but not at a statistically significant rate. Annual and summer monthly mean streamflow is displayed in Figure 30 and Figure 31 for the Mississippi River at Ball Club, Minnesota during the water year 2008 to 2014. Although both appear to be increasing during this time-period, there is no statistically significant trend, primarily due to insufficient period of record. By way of comparison at a state level, summer monthly flows 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.

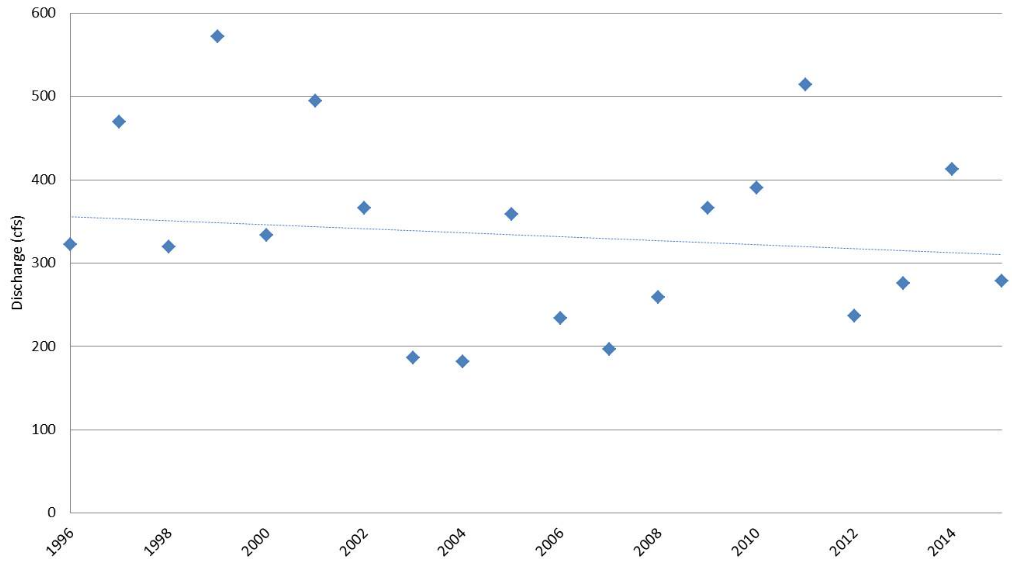

Figure 28. Annual Mean Discharge for Mississippi River near Bemidji, Minnesota (1996-2015).

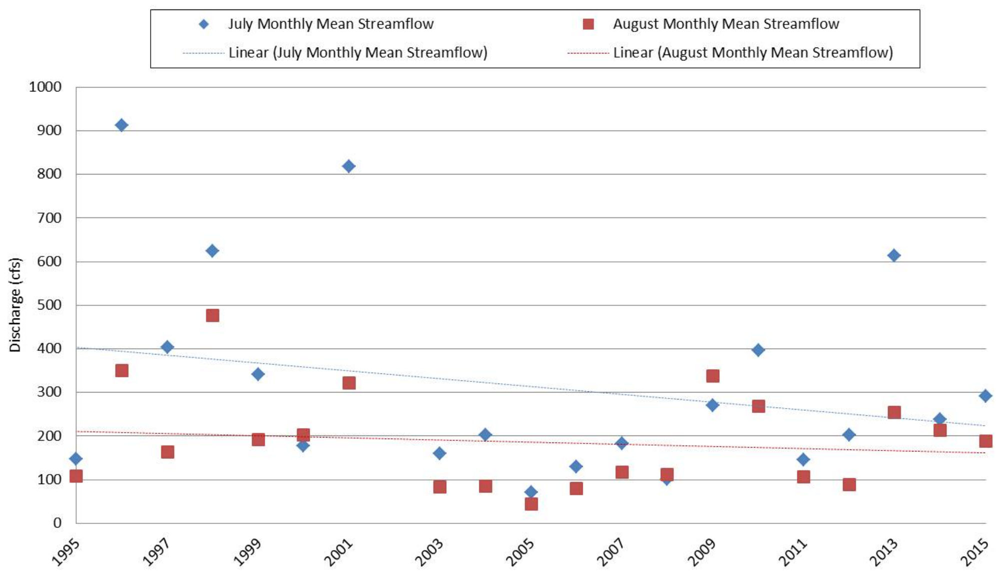

Figure 29. Mean Monthly Discharge for Mississippi River near Bemidji, Minnesota (1995-2015).

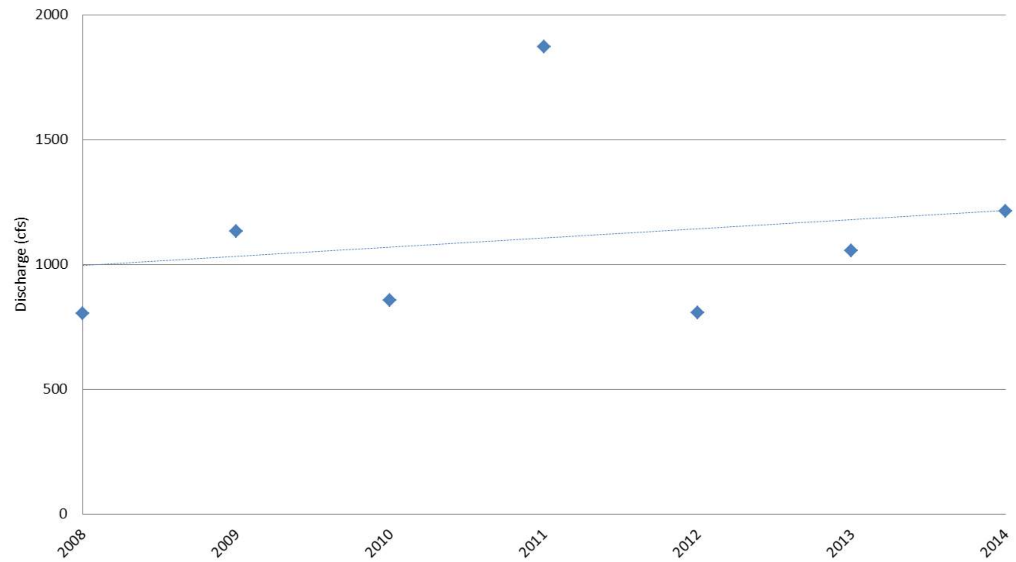

Figure 30. Annual Mean Discharge for Mississippi River at Ball Club, Minnesota (2008-2014).

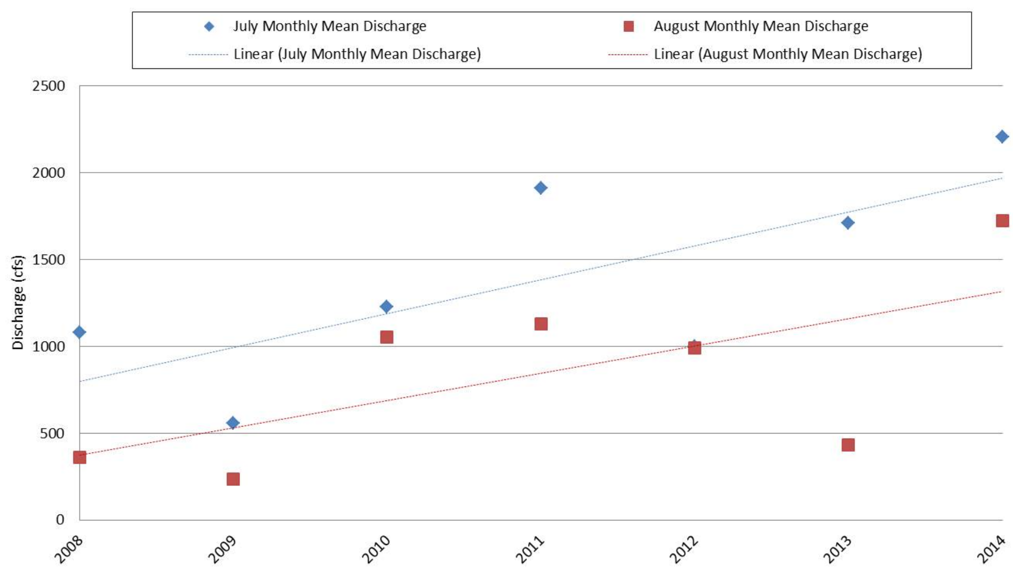

Figure 31. Mean Monthly Discharge for Mississippi River at Ball Club, Minnesota (2008-2014).

Wetland monitoring

The MPCA has developed methods and is 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 stressors. The MPCA has developed macroinvertebrate and vegetation Indices of Biological Integrity (IBIs) for depressional wetlands 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. Results from this random sample of sites are then extrapolated to the entire wetland population to provide unbiased estimates of condition. The MPCA has recently published two separate wetland quality reports, one that presents results from an initial baseline survey of vegetation quality for all wetland types (MPCA 2015) and one that presents results from the second round of the depressional wetland quality assessment (Genet 2015). The overall results of these surveys may provide reasonable approximations of current wetland conditions in the watershed.

V. Individual subwatershed results

HUC-12 subwatersheds

Assessment results for aquatic life and recreation use are presented for each HUC-12 subwatershed within the Mississippi River (Headwaters). The primary objective is to portray all the full support and impairment listings within a 12-HUC 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 3.1). This scale provides a robust assessment of water quality condition at a practical size for the development, management, and implementation of effective TMDLs and protection strategies. The graphics presented for each of the HUC-12 subwatersheds contain the 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 2013, intensive watershed monitoring effort, but also considers available data from the last ten years.

The proceeding pages provide an account of each HUC-12 subwatershed. Each account includes a brief description of the subwatershed and summary tables of the results for each of the following: a) stream aquatic life and aquatic recreation assessments, b) stream habitat quality, and where applicable c) water chemistry for the HUC-12 outlet, and d) lake aquatic recreation assessments. Following the tables is a narrative summary of the assessment results and pertinent water quality projects completed or planned for the subwatershed. A brief description of each of the summary tables is provided below.

Stream assessments

A table is provided in each section summarizing aquatic life and aquatic recreation assessments of all assessable stream reaches within the subwatershed (i.e., where sufficient information was available to make an assessment). Primarily, these tables reflect the results of the 2015, assessment process/2016 EPA reporting cycle); however, impairments from previous assessment cycles are also included and are distinguished from new impairments via cell shading (see footnote section of each table). These tables also denote the 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 (see Figure 5). Assessment of aquatic life is derived from the analysis of biological (fish and invert IBIs), DO, turbidity, chloride, pH and un-ionized ammonia (NH_3) data, while the assessment of aquatic recreation in streams is based solely on bacteria (Escherichia coli or fecal coliform) data. Included in each table is the specific aquatic life use classification for each stream reach: coldwater community (2A); cool or warm water community (2B); or indigenous aquatic community (2C). Stream reaches that do not have sufficient information for either an aquatic life or aquatic recreation assessment (from current or previous assessment cycles) are not included in these tables, but are included in Appendix 3.1. 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 HUC-12 subwatershed as well as in the watershed-wide results and discussion section.

Stream habitat results

Habitat information documented during each fish sampling visit is provided in each HUC-12 subwatershed section. These tables convey the results of the Minnesota Stream Habitat Assessment (MSHA) survey, which evaluates the section of stream sampled for biology and can provide an indication of potential stressors (e.g., siltation, eutrophication) impacting fish and macroinvertebrate communities. The MSHA score is comprised of five scoring categories including adjacent land use, riparian zone, substrate, fish cover and channel morphology, which are summed for a total possible score of 100 points. Scores for each category, a summation of the total MSHA score, and a narrative habitat condition rating are provided in the tables for each biological monitoring station. Where multiple visits occur at the same station, the scores from each visit have been averaged. The final row in each table displays average MSHA scores and a rating for the HUC-12 subwatershed.

Subwatershed outlet water chemistry results

These summary tables display the water chemistry results for the monitoring station representing the outlet of the HUC-12 subwatershed. This data along with other data 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 the standards or expectations used for assessing aquatic life and recreation. While not all of the water chemistry parameters of interest have established water quality standards, McCollor and Heiskary (1993) developed ecoregion expectations for a number of parameters that provide a basis for evaluating stream water quality data and estimating attainable conditions for an ecoregion. For comparative purposes, water chemistry results for the Mississippi River (Headwaters) Watershed are compared to expectations developed by McCollor and Heiskary (1993) that were based on the 75th percentile of a long-term dataset of least impacted streams within each ecoregion.

Lake assessments

A summary of lake water quality is provided in the HUC-12 subwatershed sections where available data exists. For lakes with sufficient data, basic modeling was completed. Assessment results for all lakes in the watershed are available in Appendix 3.2. Lake models and corresponding morphometric inputs can be found in Appendix 3.2.

Little Mississippi River Subwatershed HUC 0701010101-01

The Little Mississippi River Subwatershed drains 67 miles of eastern Clearwater and southwestern Beltrami counties. Beginning just north of Daniel Lake, the Little Mississippi River flow six miles southeast to Moose Lake. From there, the river flows southeast eight miles to its confluence with Grant Creek, just north of Lake Manomin. Tributaries to the Little Mississippi River are limited to small unnamed streams. Land use within this subwatershed is predominately forest (55.5%), but also has the highest proportion of range land (30.3%) in the Mississippi River (Headwaters) Watershed. The remaining land use is a mixture of wetlands (10.7%), cropland (3.4%), developed (3.4%) and a very small percentage of open water and barren land (<2%). The water chemistry monitoring station for this subwatershed was established at Balsam Ridge Rd. NW, five miles west of Bemidji.

Table 1. Aquatic life and recreation assessments on stream reaches: Little Mississippi River Subwatershed. Reaches are organized upstream to downstream in the table.

				Aquatic Life Indicators:									Eutrophication			
AUID ***Reach Name***, *Reach Description*	**Biological Station ID**	**Reach Length (miles)**	**Use Class**	Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Phosphorous	Response Indicator	**Aquatic Life**	**Aquatic Rec. (Bacteria)**
07010101-738 ***Unnamed Creek,*** *Headwaters to Duncan Lk*	13UM149	5.94	WWg	MTS	--	IF	IF	IF	--		IF	--	IF	--	SUP	NA
07010101-517 ***Little Mississippi River,*** *Moose Lk to Grant Cr*	13UM122	8.73	WWg	MTS	MTS	NA	MTS	MTS	MTS	MTS	MTS	--	IF	--	SUP	SUP

Abbreviations for Indicator Evaluations: **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, **LRVW** = limited resource value water
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Table 2. Minnesota Stream Habitat Assessment (MSHA): Little Mississippi River Subwatershed.

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph.	MSHA Score (0-100)	MSHA Rating
2	13UM122	Little Mississippi River	5	11.5	12	12	20	60.5	Fair
2	13UM149	Unnamed Creek	3	10.5	17.4	13	20.5	67.4	Good
Average Habitat Results: *Little Mississippi River Subwatershed*			**4**	**13.25**	**14.7**	**11**	**20.25**	**64.0**	

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 3. Outlet water chemistry results: Little Mississippi River Subwatershed.

Station location:	**Little Mississippi River, Moose Lake to Grant Creek**						
STORET/EQuIS ID:	**S002-621**						
Station #:	**13UM122**						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**WQ Standard[1]**	**# of WQ Exceedances**
Ammonia-nitrogen	ug/L	11	0.0	1.0	0.4	40	0
Chloride	mg/L	10	3	5	3	230	0
Dissolved Oxygen	mg/L	19	4.2	10.7	8.5	5	0
pH		19	7.1	8.7	8.0	6.5 - 9	0
Secchi Tube	100 cm	18	100	100	100	40	0
Total suspended solids	mg/L	10	1	9	4	15	0
Phosphorus	ug/L	10	4	10	6	50	0
Chlorophyll-a, Corrected	ug/L	0	-	-	-	7	-
Escherichia coli (geometric mean)	MPN/100 ml	3	19	58	-	126	0
Escherichia coli	MPN/100 ml	15	10	350	62	1,260	0
Inorganic nitrogen (nitrate and nitrite)	mg/L	10	0.03	0.24	0.06	-	-
Kjeldahl nitrogen	mg/L	10	0.4	1.6	0.8	-	-

Orthophosphate	ug/L	0	-	-	-	-	-
Pheophytin-a	ug/L	0	-	-	-	-	-
Specific Conductance	uS/cm	19	208	436	381	-	-
Temperature, water	deg °C	19	6.8	26.4	20.0	-	-
Sulfate	mg/L	10	3	6	4	-	-
Hardness	mg/L	10	98	198	173	-	-

[1]Secchi Tube standards are surrogate standards derived from the total suspended solids standard.

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

Table 4. Lake assessments: Little Mississippi River Subwatershed.

Name	DNR Lake ID	Area (acres)	Trophic Status	Percent 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
Manomin	04-0286-00	255	E		7.6			62	13	2.0	IF	NA
Moose	04-0342-00	129	E	100	4.0	2.1	NT	50	27	1.5	NS	FS
Daniel	15-0022-00	50	M	53.5	7.9			22	6	2.8	FS	NA
Dahlberg	15-0023-00	21	M					17	3	4.5	FS	NA

Abbreviations:

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

H – Hypereutrophic
E – Eutrophic
M – Mesotrophic
O - Oligotrophic

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

Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use

Summary

The Little Mississippi River is one of the first major tributary streams to the Mississippi River, draining 66.7 miles of forest, wetlands and range. Slow flowing water, and a highly sinuous channel that consists of predominantly sand, silt, and small course substrates characterizes this river. Beaver activity within this subwatershed is common, and limited the ability to obtain some biological samples. While the landscape within this subwatershed is not entirely natural, vast areas of forest and wetlands provide an excellent riparian corridor along much of the mainstem river. Aquatic life and recreation indicators for this subwatershed consistently reflect good water quality with fish and macroinvertebrate communities that meet or exceed their respective standards and low levels of bacteria.

Unnamed Creek (07010101-738) is a headwater tributary to the Little Mississippi River. The creek drains approximately six square miles of land that is primarily used for range. Macroinvertebrates were not collected due to a beaver impoundment in 2013. The fish community sampled in 2014 indicates good water quality. For a small stream surrounded by pasture, habitat is robust (Table 2) and consisted of coarse substrates necessary to sustain riffle dwelling organisms. The fish community included Iowa Darter (a gravel spawning species) and Pearl Dace (a rather pollution intolerant species).

After receiving water from Unnamed Creek, the Little Mississippi River flows 2.2 miles to Moose Lake. Moose is a 132-acre lake near Solway that the DNR uses for walleye rearing. The outlet of the lake is regularly dammed by beavers, which may negatively impact the connectivity along the Little Mississippi River. The 8.7 miles of the Little Mississippi River downstream of Moose Lake (07010101-517) is highly sinuous, low gradient, and slow moving before its outlet at Grant Creek just upstream of Lake Manomin. An intensive water chemistry monitoring station at Balsam Ridge Rd. met most chemical parameters for aquatic life over a two-year sampling period. DO was the only parameter that fell below the standard. This data was not used for assessment due to the wetland nature of the stream. The natural flushing of organic matter from wetlands into streams causes DO levels to decline significantly. Biological communities along this reach indicate good water quality; the fish community was comprised of species typically associated with healthy warm water streams in this region of the state (e.g johnny darter, Rock Bass, creek chub, common shiner). The sample also consisted of greater redhorse, a pollution intolerant species generally found in streams with similar size and good water quality. The macroinvertebrate communities corroborate the fish data, with taxa characteristic of a healthy warm water, glide pool streams.

Data was available to assess four lakes in the Little Mississippi River Subwatershed for aquatic recreation and one lake for aquatic life. All four lakes appear to be natural impoundments of the Little Mississippi River. Daniel and Dahlberg are small lakes located on the headwaters of the Little Mississippi River. These lakes have good water quality and fully support aquatic recreation; the good water quality is likely a reflection of their small contributing watershed areas. In order to protect these lakes in the future it will be important to limit potential phosphorus inputs from agriculture and development activities in the watershed. Maintaining the forest and wetland periphery surrounding Daniel and Dahlberg will aid in limiting runoff contributions of phosphorus as well.

Moose Lake was found to be impaired for aquatic recreation due to excess nutrients. An aquatic recreation impairment suggests that during certain times of the year the lake water may not be suitable for activities like swimming. Moose Lake has a large contributing watershed that includes the Little Mississippi River as it passes through Daniel and Dahlberg and a tributary that drains the entire northern portion of the watershed. Moose Lake had high concentrations of phosphorus which in turn causes high chlorophyll-a (Chl-a) concentrations and potentially nuisance algal blooms. Moose Lake's shallow depth allows for nutrients to be recycled throughout the water column during wind events. This causes internal loading and is likely a contributor to Moose Lake's poor water quality.

Moose Lake supported aquatic life based on a fish index of biotic integrity (IBI) survey conducted in 2014. The fish IBI score was 43, which is above the impairment threshold (24) for this group despite having a low amount of nearshore sampling effort (only two seine hauls). Species sampled include three intolerant species (Blackchin Shiner, Blacknose Shiner, and Iowa Darter) and one tolerant species (Black Bullhead). Omnivores made up 33% of trap net catch biomass which is higher than expected. In addition, an aquatic plant survey was conducted in 2011, and showed a healthy plant community.

Manomin Lake is located at the pour point of the Little Mississippi River Watershed. The data collected in 2011, was not sufficient to make a formal assessment for aquatic recreation. However, the limited data that is available suggests that phosphorus levels are well above the standard. Nutrient reduction strategies should be considered throughout the entire Little Mississippi River Watershed in order to limit further degradation of Manomin's water quality.

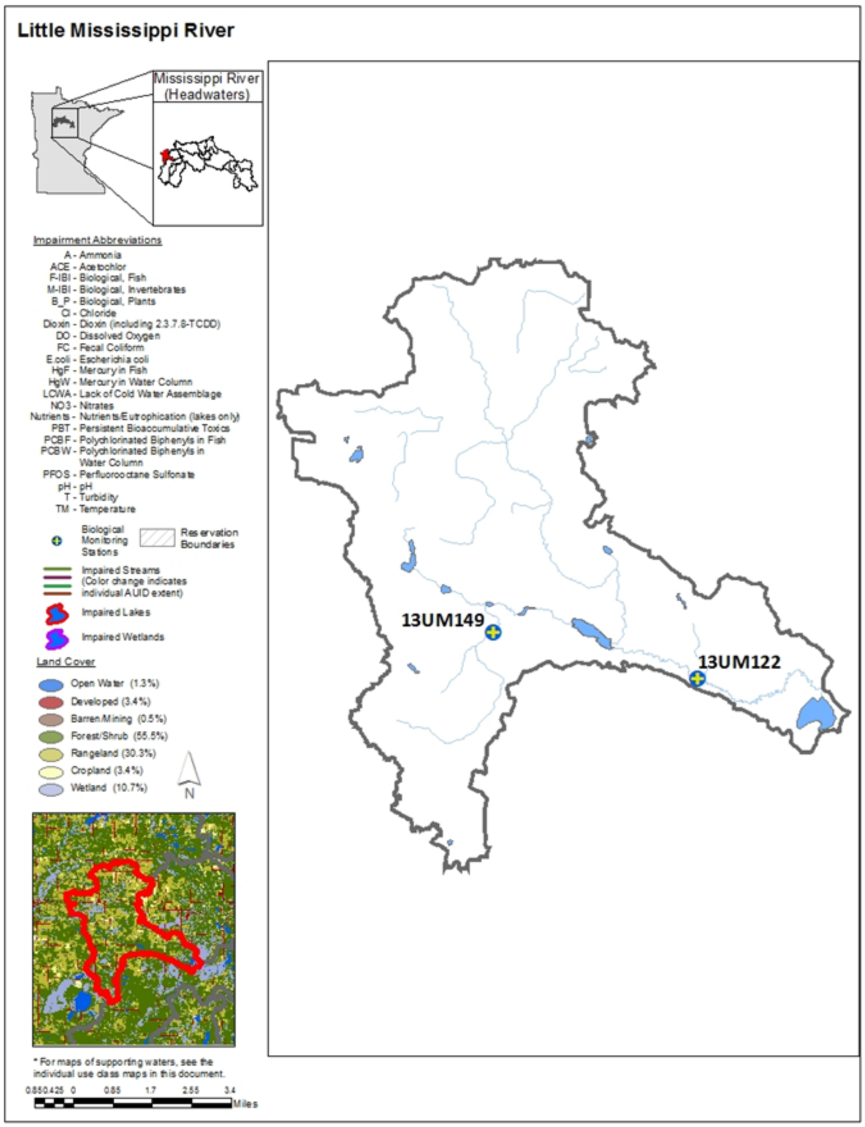

Figure 32. Currently listed impaired waters by parameter and land use characteristics in the Little Mississippi River Subwatershed.

Grant Creek Subwatershed HUC 0701010101-02

The Grant Creek Subwatershed drains 72 square miles of southwestern Beltrami County. From its headwaters, Grant Creek flows southeasterly 12 miles to Harley Lake, before turning southwest 7 miles to its confluence with the Little Mississippi River at Rice Lake. Tributaries to Grant Creek are mainly historically altered streams and dredged wetland ditches. Land use within this subwatershed is predominately forest (54.5%), followed by range (16.0%), wetland (15.0%), developed (7.3%), cropland (4.8%), open water (2.0%), and barren (<1%). The water chemistry monitoring station for this subwatershed was established downstream of Balsam Ridge Rd. NW, 5 miles west of Bemidji.

Table 5. Aquatic life and recreation assessments on stream reaches: Grant Creek Subwatershed. Reaches are organized upstream to downstream in the table.

AUID *Reach Name,* *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 -NH_3	Pesticides ***	Eutrophication: Phosphorous	Eutrophication: Response Indicator	**Aquatic Life**	**Aquatic Rec. (Bacteria)**
07010101-748 ***Unnamed Ditch,*** *T147 R35W S25, north line to Grant Cr*	13UM146	6.08	WWg	MTS	--	IF	IF	IF	--	IF	IF	--	IF	--	SUP	NA
07010101-739 ***Unnamed Creek,*** *Headwaters to Unnamed Ditch*	13UM147	4.39	WWg	NA	--	IF	IF	IF	--	IF	IF	--	IF	--	IF	NA
07010101-670 ***Grant Creek*** *Unnamed Ditch to Unnamed Cr*	10EM165	2.64	WWg	MTS	--	IF	IF	IF	--	IF	IF	--	IF	--	SUP	NA
07010101-546 ***Grant Creek*** *Grant Lk outlet to Unnamed Cr*	13UM114	4.25	WWg	NA	--	EXS	MTS	MTS	MTS	MTS	MTS	--	--	--	NA	SUP

Abbreviations for Indicator Evaluations: **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, **LRVW** = limited resource value water
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Table 6. Minnesota Stream Habitat Assessment (MSHA): Grant Creek 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	13UM146	Unnamed Ditch	5	13.5	10.6	12	15	56.1	
2	13UM147	Unnamed Creek	5	12.5	5.5	13.5	8.5	45	
1	13UM114	Grant Creek	5	9	9	12	7	42	
1	10EM165	Grant Creek	5	11	7.2	14	20	57.2	
Average Habitat Results: *Grant Creek Subwatershed*			**5**	**11.5**	**8.1**	**12.9**	**12.6**		

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 7. Outlet water chemistry results: Grant Creek Subwatershed.

Station location:	**Grant Creek, Grant Lake outlet to Unnamed Creek**						
STORET/EQuIS ID:	**S002-620**						
Station #:	**13UM114**						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**WQ Standard[1]**	**# of WQ Exceedances**
Ammonia-nitrogen	ug/L	11	0.0	1.0	0.4	40	0
Chloride	mg/L	10	4	8	6	230	0
Dissolved Oxygen	mg/L	19	1.4	8.3	4.2	5	12
pH		19	6.8	7.9	7.5	6.5 - 9	0
Secchi Tube	100 cm	19	100	100	100	40	0
Total suspended solids	mg/L	10	1	7	2	15	0
Phosphorus	ug/L	10	20	60	40	50	2
Chlorophyll-a, Corrected	ug/L	0	-	-	-	7	-
Escherichia coli (geometric mean)	MPN/100 ml	3	16	25	-	126	0
Escherichia coli	MPN/100 ml	15	4	88	28	1,260	0
Inorganic nitrogen (nitrate and nitrite)	mg/L	10	0.03	0.13	0.04	-	-
Kjeldahl nitrogen	mg/L	10	0.3	1.1	0.6	-	-
Orthophosphate	ug/L	0	-	-	-	-	-
Pheophytin-a	ug/L	0	-	-	-	-	-
Specific Conductance	uS/cm	19	173	425	364	-	-
Temperature, water	deg °C	19	5.4	25.5	19.6	-	-
Sulfate	mg/L	10	3	3	3	-	-
Hardness	mg/L	10	77	201	166	-	-

[1]Total suspended solids and Transparency tube standards are surrogate standards derived from the turbidity standard of 25.
[2]Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform.
****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Grant Creek Subwatershed, a component of the IWM work conducted between May and September in 2013 and 2014. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Table 8. Lake water aquatic recreation assessments: Grant Creek Subwatershed.

Name	DNR Lake ID	Area (acres)	Trophic Status	Percent 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
Grass	04-0216-00	233	O		1.5			10	3	1.5	FS	NA
Grant	04-0217-00	199	M	40.9	28.0	8.2		15	3	3.5	FS	FS

Abbreviations: ↘ -- Decreasing/Declining Trend; ↗ -- Increasing/Improving Trends; NT – No Trend; **H** – Hypereutrophic; **E** – Eutrophic; **M** – Mesotrophic; **FS** – Full Support; **NS** – Non-Support; **IF** – Insufficient Information

Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use

Summary

Many streams within this subwatershed have wetland characteristics making it difficult to collect assessable level data. In addition, low flows and beaver impoundments during the fall of 2013, prevented the collection of macroinvertebrates at all biological stations in the subwatershed. Monitoring along Grant Creek was limited to two AUIDs on its lower five miles. There was one biological monitoring station (10EM165) on the upper most AUID (-670). The station was sampled in 2010, as part of a statewide random monitoring survey (EMAP). The fish community indicated good conditions and met its biological standards. The lower section of Grant Creek (-666) also had one biological station (13UM114). A fish survey conducted at this station in 2013, yielded only 5 taxa, all of which are species normally associated with wetlands (Yellow Perch, Black and Brown Bullhead, Central Mudminnow, Northern Pike). In addition, DO samples collected in 2013 and 2014 were below the 5 mg/l standard 65% of the time. Low DO was likely due to a combination of factors including a low gradient stream channel, wetland influences, and groundwater inputs. As a result of the wetland stream characteristics as indicated by the fish and water chemistry data, the reach was not assessed for aquatic life.

Unnamed Creek flows into Grant Creek just downstream of Hwy 2, two miles northwest of Wilton. This creek was split into two AUID's following a use attainability review. The upper 6 miles (AUID -747) has modified warmwater habitat due to channelization. The reach was not assessed because of wetland characteristics. The lower 2.6 miles (AUID -748) is predominately natural, and was designated as general, warmwater habitat. One station (13UM146) was sampled for fish in 2013 and 2014. The 2013, sample was influenced by drought conditions during the fall of 2012. The 2014 fish sample indicated full support for aquatic life.

Two lakes were monitored within this subwatershed. Grass Lake is just west of Bemidji, Minnesota and is a large shallow lake with good water quality. Protection will be the largest priority for maintaining current water quality conditions because of its close proximity to development. Grant Lake, also west of Bemidji, Minnesota is a deep lake with good water quality. A public swimming beach is located on the north end of the southern lake basin.

Grant Lake supported aquatic life based on a fish index of biotic integrity (IBI) survey conducted in 2012. The fish IBI score was 53, which is above the impairment threshold (45) for this group but within the 90% confidence interval (54-36) of the threshold. Species sampled include one tolerant species (Green Sunfish) and six intolerant species (Banded Killifish, Blackchin Shiner, Cisco, Iowa Darter, Pugnose Shiner, and Rock Bass). The most abundant species in gill nets was Northern Pike (65% of biomass), while Cisco accounted for 9% of the biomass. Bluegill were the most abundant species in trap nets (30% of biomass) and nearshore sampling gear (49% of individuals). In addition, an aquatic plant survey was conducted in 2011, and showed a healthy plant community.

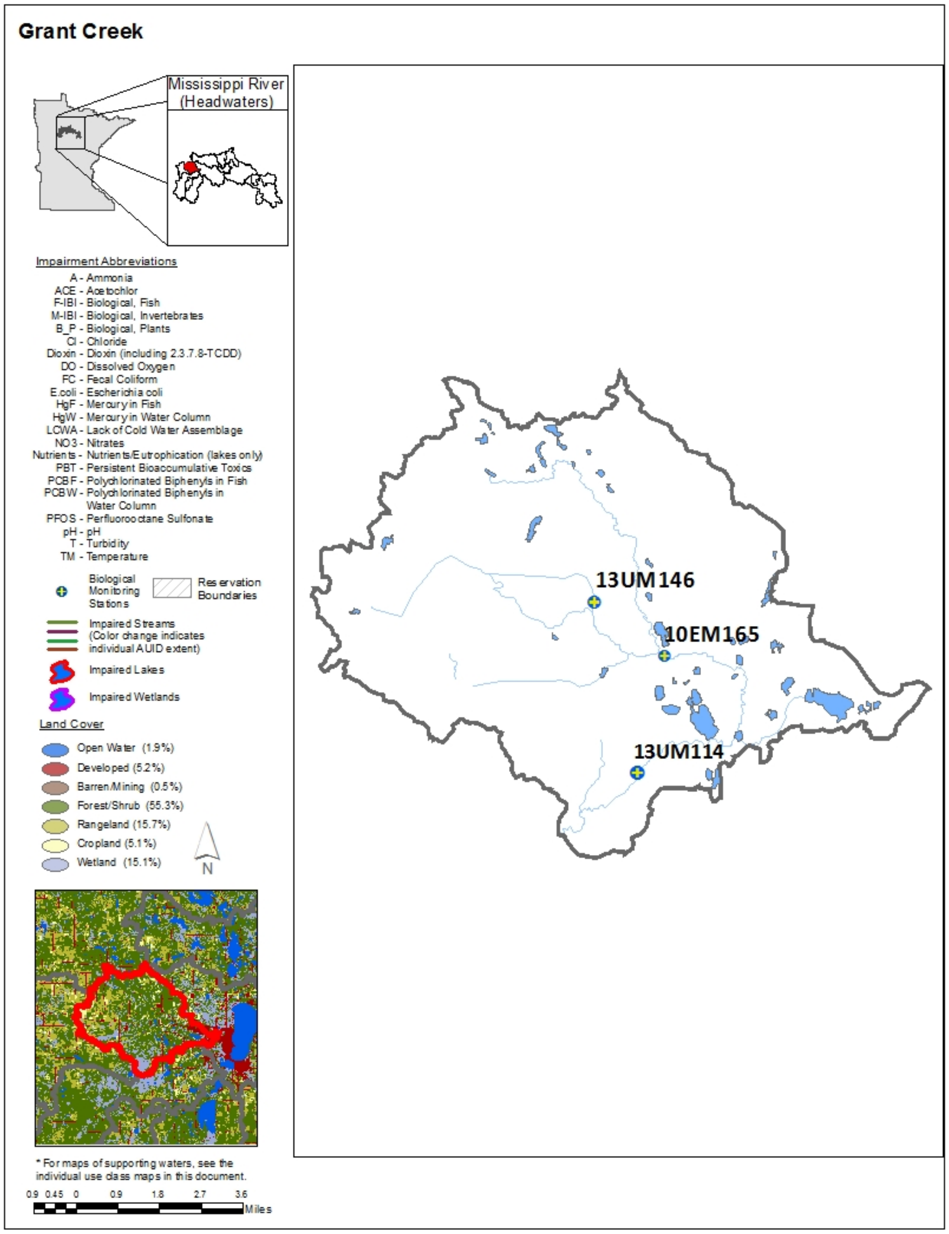

Figure 33. Currently listed impaired waters by parameter and land use characteristics in the Grant Creek Subwatershed.

Headwaters Mississippi River Subwatershed HUC 0701010102-01

The Headwaters Mississippi River Subwatershed encompasses 187 square miles of eastern Clearwater, southwestern Beltrami, and northwestern Hubbard counties. As the name implies, this subwatershed contains the headwaters of the Mississippi River, which originates at Lake Itasca. After flowing out of Lake Itasca, the Mississippi River travels 2,320 miles to its confluence with the Gulf of Mexico. Major tributaries to the Mississippi River within this subwatershed include Sucker Creek and Bear Creek. Land use within this subwatershed is predominately forest (74.1%) and wetlands (9.2%). The water chemistry monitoring station for this subwatershed was established downstream of Balsam Ridge Rd. NW, 5 miles west of Bemidji.

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

				Aquatic Life Indicators:									Eutrophication			
AUID ***Reach Name*****,** *Reach Description*	**Biological Station ID**	**Reach Length (miles)**	**Use Class**	Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Phosphorous	Response Indicator	**Aquatic Life**	**Aquatic Rec. (Bacteria)**
07010101-663 ***Sucker Creek,*** *Gould Cr to Mississippi R*	09UM083	2.39	CWg	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--	SUP	NA
07010101-631 ***Bear Creek,*** *T145 R36W S31, south line to Mississippi R*	13UM102	6.64	WWg	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--	SUP	NA

Abbreviations for Indicator Evaluations: **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, **LRVW** = limited resource value water
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Table 10. Minnesota Stream Habitat Assessment (MSHA): Headwaters Mississippi 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
3	09UM083	Sucker Creek	5	13.3	14.6	14.6	26.6	74.3	Good
1	13UM102	Bear Creek	5	14	21.6	17	32	89.6	Good
Average Habitat Results: ***Headwater Mississippi River Subwatershed***									

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. Lake assessments: Headwaters Mississippi River Subwatershed.

Name	DNR Lake ID	Area (acres)	Trophic Status	Percent 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
Bootleg	04-0211-00	297	E	76	9.1			39	21	2.0	IF	NA
Steinbrook	04-0212-00	25	O					7	2	6.5	IF	NA
Fern	04-0215-00	194	M		1.8			12	3	2.6	FS	NA
Big LaSalle	15-0001-00	234	O	18.1	14.6	7.6		12	3	3.4	FS	FS
Ozawindib	15-0005-00	158	O	41.7	24.4	7.3		9	3	9.4	FS	NA
Elk	15-0010-00	292	M	44.6	29.0	10.4	NT	13	4	3.1	FS	FS
Itasca	15-0016-00	1,058	E	41.7	13.7	4.9	NT	30	13	2.4	IF	FS
Mallard	15-0018-00	107	M	79	6.1			16	4	7.0	FS	NA
Sucker	15-0020-00	79	E					35	10	5.7	IF	NA
Long	15-0057-00	150	O	16.6	24.4		NT	8	2	5.5	FS	IF
Heart	15-0058-00	212	O		16.8			11	4	4.0	FS	FS
LaSalle	29-0309-00	231	O	7.2	64.9	25.9		10	5	3.2	FS	FS

Abbreviations:

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

H – Hypereutrophic
E – Eutrophic
M – Mesotrophic
O - Oligotrophic

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

Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use

Summary

The Headwaters of the Mississippi River Subwatershed had two assessable stream segments, each containing a single biological monitoring station. Aquatic life Indicators along both reaches reflect good water quality with fish and macroinvertebrate communities exceeding their respective standards.

Sucker Creek (AUID -663) is the first tributary stream to the Mississippi River. This creek drains approximately 20 square miles before its confluence with the Mississippi River, two miles downstream of Lake Itasca. Designated as a coldwater stream, the DNR actively manages Sucker Creek for trout. The fish community along this reach was sampled twice in 2010 and once in 2013. Brook Trout were the most abundant species collected during each visit, with a number of individuals measuring near the 11" mark. The macroinvertebrate community was sampled in 2009, 2013, and 2014, each with one visit. All three visits had stenothermic macroinvertebrate taxa present. Numerous groundwater seeps that are high in iron cause a milky cast to the water in portions of Sucker Creek. This appears to be a natural phenomenon. Habitat along this reach is excellent, and is likely contributing to the good biological communities.

Fish and macroinvertebrates were collected from a single station (13UM102) on Bear Creek (AUID 631) in 2013. Both communities indicate excellent water quality. The fish community consisted of mottled sculpin, a species generally found in cool/coldwater steams. The macroinvertebrate community included three stenothermic taxa, including *Glossosoma, Eukiefferiella, and Amphinemura*. MSHA scores were higher (89.6) than any station in the HUC 8 watershed. The stream displayed excellent channel morphology with clean coarse substrates in the riffles and runs. Due to the presence of coldwater taxa in 2013, and excellent stream habitat, a continuously recording stream temperature logger was deployed at this station during the summer of 2014. The goal of the additional temperature monitoring was to determine the streams ability to sustain coldwater organisms. The average summer temperature was 17.2 degrees, which is suitable for sensitive coldwater taxa. However, it was determined that there were not enough data at this time to change the designation from warmwater to coldwater. Another factor in the decision to maintain the warmwater designation on Bear Creek was the presence of an oversized culvert that becomes perched during lower flows. DNR conducted a geomorphology survey at this site and found issues with the culvert, and a man-made rock structure immediately downstream of the culvert. The likely purpose of this structure was to control flows, however it was installed backwards and is now creating a large scour pool downstream of the culvert. These problems should be addressed during the WRAPs process to help protect the excellent biological integrity of this stream.

Aquatic recreation and aquatic life was assessed on eight and five lakes, respectively. The headwaters of this watershed consist of many small lakes and wetlands which eventually drain to form the headwaters of the Mississippi River originating from Elk and Itasca. Moving towards the pour point of the watershed the density of lakes decrease but the size of the lake basins increase.

The majority of the lakes in this watershed are oligotrophic or mesotrophic and have good water quality that supports aquatic recreation. In general phosphorus concentrations are low and in turn so is chl-a production. These conditions allow for clear water and good transparency as shown by Secchi disk measurements. Steinbrook Lake, appears to have good water quality but does not have enough data to assess for aquatic recreation. LaSalle Lake was previously assessed in 2007 and additional monitoring data from 2013, indicates that it still supports aquatic recreation.

A few lakes, Sucker, Itasca, and Bootleg were considered eutrophic. All of these lakes had phosphorous and Chl-a concentrations at or above the Northern Lakes and Forest eutrophication standards. Lake Itasca and its contributing watershed are contained within Lake Itasca State Park. As a result, the lake is protected from land use activities that could degrade water quality. Sucker Lake has high phosphorus but the response in Chl-a and Secchi depth is unclear. Sucker Lake does not have depth information available but through aerial photography the lake appears to be shallow and ringed by aquatic plants. Phosphorus and Chl-a concentrations exceed the eutrophication standard in Bootleg Lake but with only one year of data there is not enough information to assess for aquatic recreation.

There were five lakes assessed for aquatic life using the FIBI; Big LaSalle, Elk, Itasca, Heart and LaSalle. All five lakes were considered exceptional with IBI scores ranging from 65 to 85. Intolerant species sampled at all five lakes included Banded Killifish, Rock Bass, and Iowa Darter. Cisco were captured in Big LaSalle, Elk, and Lake Itasca. The Cisco is a pelagic fish requiring well oxygenated, cool water. They are typically found in oligotrophic lakes that are greater than 35 feet in depth. Mottled Sculpin were captured in Elk and Lake Itasca. Pugnose Shiner, a fish that requires clean water with a healthy aquatic plant community was captured in Big LaSalle Lake. The tolerant fathead minnow was collected at Elk and Lake Itasca. The presence of Fathead Minnows in many lakes is thought to be the result of human introduction due to the popularity of the species as a bait for angling. Plant surveys were conducted on Big LaSalle, Elk, and Lake Itasca. The results for all three lakes were good, confirming the results of the fish surveys.

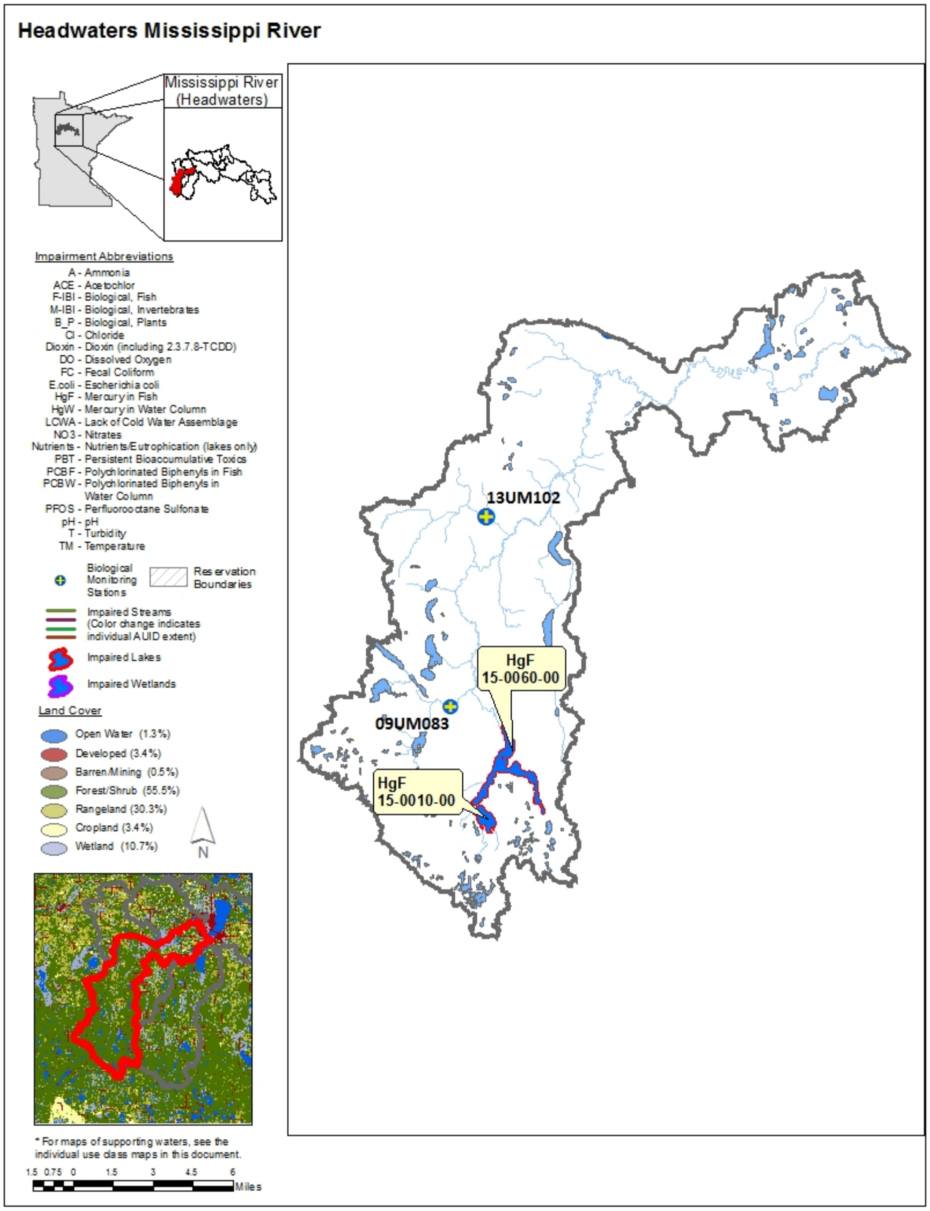

Figure 34. Currently listed impaired waters by parameter and land use characteristics in the Headwaters Mississippi River Subwatershed

Hennepin Creek Subwatershed HUC 0701010102-02

The Hennepin Creek Subwatershed, located in Hubbard and Beltrami counties, encompasses 44.24 square miles. Hennepin Creek originates in Unnamed Lake 4.5 miles north of Lake Alice and travels 13 miles north to its confluence with the Mississippi River, 2 miles south of Lake Manomin. Tributaries to Hennepin Creek include small unnamed streams and drainage ditches. Land use within the subwatershed is primarily forest (72%), with rangeland (12.5%) and wetlands (10.1%) making up a large portion of the remaining landscape. The water chemistry monitoring station on Hennepin Creek is located downstream of Wildfire Rd., 2.5 mi. NW of Fern.

Table 12. Aquatic life and recreation assessments on stream reaches: Hennepin Creek Subwatershed. Reaches are organized upstream to downstream in the table.

				Aquatic Life Indicators:									Eutrophication			
AUID ***Reach Name***, *Reach Description*	**Biological Station ID**	**Reach Length (miles)**	**Use Class**	Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Phosphorous	Response Indicator	**Aquatic Life**	**Aquatic Rec. (Bacteria)**
07010101-637 ***Hennepin Creek,*** *T145 R35W S35, west line to Mississippi R*	13UM117	8.06	WWg	MTS	MTS	IF	MTS	MTS	MTS	MTS	MTS	--	IF	--	SUP	SUP

Abbreviations for Indicator Evaluations: **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)

Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information

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, **LRVW** = limited resource value water
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Table 13. Minnesota Stream Habitat Assessment (MSHA): Hennepin Creek 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	13UM117	Hennepin Creek	5	14	19.5	13.5	23	75	Good
Average Habitat Results: *[Hennepin Creek] Subwatershed*			**5**	**14**	**19.5**	**13.5**	**23**	**75**	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 14. Outlet water chemistry results: Hennepin Creek Subwatershed.

Station location:	Hennepin Creek, T145 R35W S35, West line to Mississippi River						
STORET/EQuIS ID:	S007-549						
Station #:	13UM117						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**WQ Standard[1]**	**# of WQ Exceedances**
Ammonia-nitrogen	ug/L	11	0.0	3.7	1.4	40	0
Chloride	mg/L	10	1	3	2	230	0
Dissolved Oxygen	mg/L	19	5.3	10.0	8.0	5	2
pH		19	6.9	8.5	7.8	6.5 - 9	0
Secchi Tube	100 cm	19	100	100	100	40	0
Total suspended solids	mg/L	10	1	9	3	15	0
Phosphorus	ug/L	10	40	80	54	50	8
Chlorophyll-a, Corrected	ug/L	0	-	-	-	7	-
Escherichia coli (geometric mean)	MPN/100ml	3	33	104	-	126	0
Escherichia coli	MPN/100ml	15	16	517	98	1260	0
Inorganic nitrogen (nitrate and nitrite)	mg/L	10	0.03	0.07	0.04	-	-
Kjeldahl nitrogen	mg/L	10	0.3	0.8	0.5	-	-
Orthophosphate	ug/L	0	-	-	-	-	-
Pheophytin-a	ug/L	0	-	-	-	-	-
Specific Conductance	uS/cm	19	221	490	378	-	-
Temperature, water	deg °C	19	8.8	25.4	17.3	-	-
Sulfate	mg/L	10	3	3	3	-	-
Hardness	mg/L	10	106	245	182	-	-

[1]Secchi Tube standards are surrogate standards derived from the total suspended solids standard of 25.

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

Table 15. Lake assessments: Hennepin Creek Subwatershed .

Name	DNR Lake ID	Area (acres)	Trophic Status	Percent 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
Hennepin	29-0246-00	410	O	100	4.3			11	3	4.4	FS	FS

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

H – Hypereutrophic
E – Eutrophic
M – Mesotrophic
O - Oligotrophic

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

Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use

Summary

Hennepin Creek is the only named stream within this subwatershed, draining 44 miles of forest, wetlands and range. From its headwaters, Hennepin Creek (AUID -636) flows north, 5.6 miles to 129th Ave. This section of the river is designated as coldwater, and was stocked by the DNR with Brook Trout from 1950-1966. The only known survey of this segment was conducted in 1959, however it is not known whether Brook Trout were captured. Recent temperature data collected by the DNR suggest this segment no longer has adequate water temperatures to support Brook Trout. One probable cause for this is the abundant beaver activity occurring along the upper portions of the creek. Beaver activity, along with the extensive wetland influence, limited MPCA's ability to obtain any biological samples along this reach.

Downstream of 129th Ave, Hennepin Creek (-753) flows 8.1 miles to its confluence with the Mississippi River. This segment is designated warmwater and has never been managed for trout. One biological monitoring station (13UM117) was located approximately two miles upstream of the rivers outlet. Biological communities along this reach indicate good water quality, with fish and macroinvertebrate communities far exceeding their respective standards. The fish community consisted of 11 species and was dominated by Mottled Sculpin, a sensitive cold/cool water fish found in most trout streams. A number of sensitive macroinvertebrates were collected from Hennepin Creek. Three stenothermic macroinvertebrate taxa, two caddisflies (*Lype diversa* and *Limnephilus)* and a midge (Eukiefferiella) were found in low abundances in samples. The excellent habitat conditions (Table 13) along this reach are likely contributing to the diverse biological community. With stable banks and good channel development, this segment maintains clean coarse substrates for lithophilic spawners and dense overhanging vegetation to control water temperatures (i.e. limiting temperature spikes during warm summer days). Although this lower section of Hennepin Creek is not designated as coldwater, habitat conditions and water temperature are considerably more favorable to coldwater organisms than the already designated upstream reach. A continuously-recording stream temperature logger was deployed at 13UM117 by MPCA staff during the summer of 2013 and 2014 to determine the streams ability to sustain coldwater organisms. The data from the logger indicated that the average temperature was 18.0 and 18.1 degrees in 2013 and 2014, respectively; within the range that is suitable for trout growth.However, the designation was not changed to coldwater due to the high amount of beaver activity in the stream and the limited amount of available data.

Hennepin Lake was the only lake in this subwatershed with water quality data. Hennepin Lake fully supports aquatic recreation based on a 2007 assessment. An additional year of data collected in 2013 indicates that Hennepin Lake still supports aquatic recreation.

F-IBI scores from Hennepin Lake indicate full support for aquatic life. Two Fish IBI surveys were conducted on Hennepin Lake; one in 2008 and one in 2013. The fish survey from 2008 was not used in the assessment due to the impact from a winterkill. The fish IBI score from 2013 was 52, well above the impairment threshold of 24. The number of fish species sampled were generally low. Out of 9 species sampled, one intolerant species, a single Iowa darter, was sampled. No tolerant fish species were sampled. Gill net sampling was dominated by Northern pike. Trap nets were predominately Brown bullhead, Northern pike, and Bluegill. In addition, an aquatic plant survey was conducted in 2007 and showed a healthy plant community.

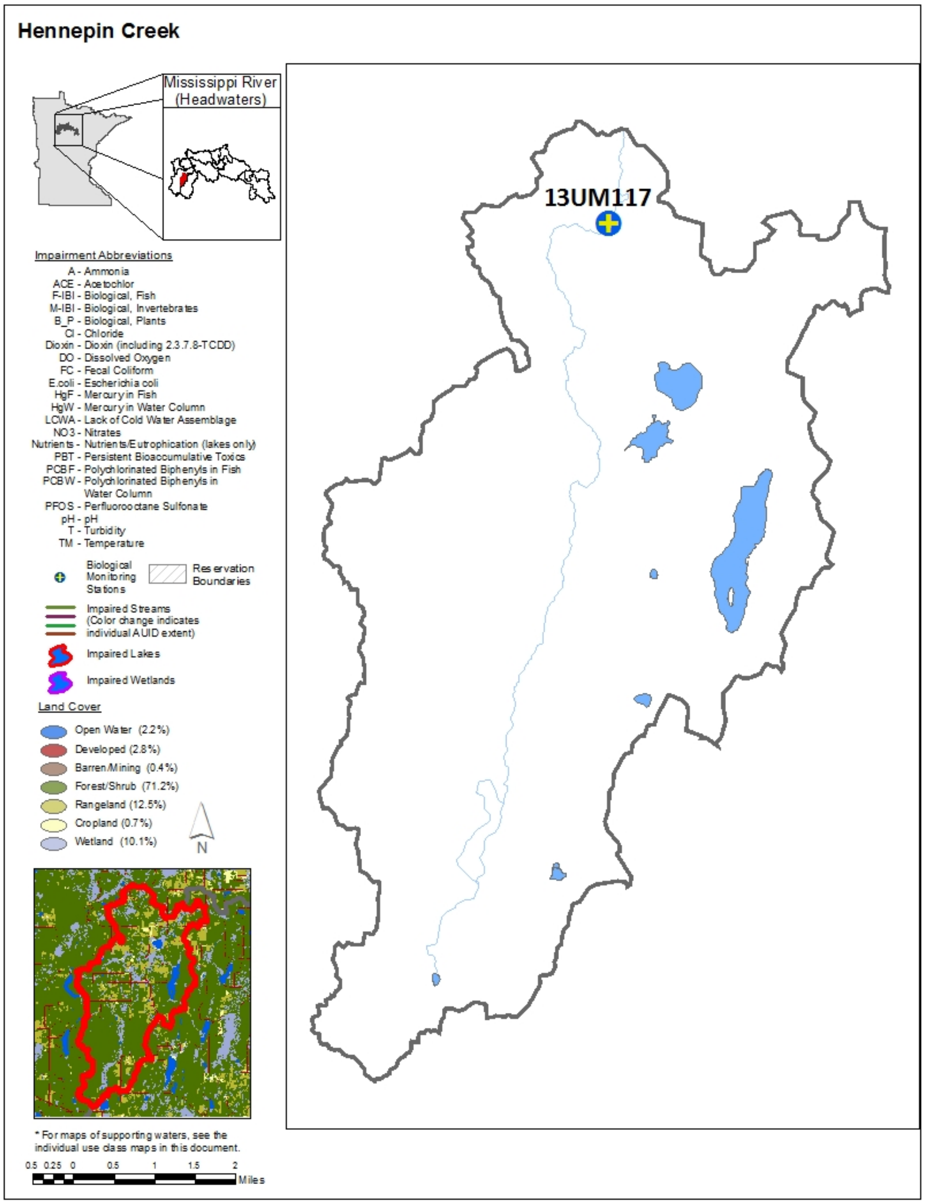

Figure 35. Currently listed impaired waters by parameter and land use characteristics in the Hennepin Creek Subwatershed.

Schoolcraft River Subwatershed HUC 0701010103-01

The Schoolcraft River Subwatershed drains 171 square miles of land within Beltrami and Hubbard countries. From its headwaters at Schoolcraft Lake, the Schoolcraft River flows northeast 27 miles to Lake Plantagenet. The river then flows through Marquette Lake and Carr Lake before its confluence with Mississippi River just south of Lake Irving. Named tributaries to the Schoolcraft River include Birch Creek, Alcohol Creek, Frontenac Creek, and Cold Creek. The landscape in this watershed is primarily forest (74%) with a number of notable lakes spread throughout. The water chemistry monitoring station for this subwatershed is represented by the outlet station 13UM134 on the Schoolcraft River at County Road 118, three miles southeast of Lake Plantagenet.

Table 16. Aquatic life and recreation assessments on stream reaches: Schoolcraft River Subwatershed. Reaches are organized upstream to downstream in the table.

AUID ***Reach Name,*** *Reach Description*	**Biological Station ID**	**Reach Length (miles)**	**Use Class**	**Aquatic Life Indicators:**									**Eutrophication**		**Aquatic Life**	**Aquatic Rec. (Bacteria)**
				Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Phosphorous	Response Indicator		
07010101-752 ***Schoolcraft River,*** *Schoolcraft Lk to Frontenac Cr*	13UM135 13UM136	19.49	WWg	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--	SUP	NA
07010101-573 ***Birch Creek*** *Lk Hattie outlet to Schoolcraft R*	00UM011	5.04	WWg	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--	SUP	NA
07010101-651 ***Frontenac Creek*** *Unnamed Lk (29-0497-00) to T145 R34W S34, south line*	13UM112	1.12	WWg	MTS	--	IF	IF	IF	--	IF	IF	--	IF	--	SUP	NA
07010101-638 ***Alcohol Creek,*** *Lk George to Schoolcraft R*	13UM100 13UM188	6.51	WWg	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--	SUP	NA
07010101-751 ***Schoolcraft River,*** *Frontenac Cr to Plantagenet Lk*	13UM134	7.78	WWe	MTS	MTS	IF	MTS	IF	MTS	MTS	MTS	--	MTS	MTS	SUP	SUP

Table 16 cont.

Abbreviations for Indicator Evaluations: **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,
LRVW = limited resource value water
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Table 17. Minnesota Stream Habitat Assessment (MSHA): Schoocraft 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
3	00UM011	Birch Creek	4.8	10	21.6	13.6	29.6	79.7	Good
2	13UM135	Schoolcraft River	5	10.5	9	10	21	55.5	Fair
1	13UM136	Schoolcraft River	5	11.5	17.8	11	22	67.3	Good
1	13UM100	Alcohol Creek	5	14	18	16	22	75	Good
1	13UM112	Fontenac Creek	5	14	9	11	15	54	Fair
3	13UM134	Schoolcraft River	5	10.8	19.3	13	20.3	68.6	Good
Average Habitat Results: *Schoolcraft River Subwatershed*			**5**	**11.8**	**15.7**	**12.4**	**21.7**	**66.7**	**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 18. Outlet water chemistry results: Schoolcraft River Subwatershed.

Station location:	Schoolcraft River, Frontenac Creek to Plantagenet Lake						
STORET/EQuIS ID:	S007-550						
Station #:	13UM134						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**WQ Standard[1]**	**# of WQ Exceedances**
Ammonia-nitrogen	ug/L	11	0.0	8.4	3.2	40	0
Chloride	mg/L	10	2	2	2	230	0
Dissolved Oxygen	mg/L	19	3.7	10.3	8.2	5	2
pH		19	6.7	8.8	7.9	6.5 - 9	0
Secchi Tube	100 cm	19	73	100	96	40	0
Total suspended solids	mg/L	10	1	23	6	15	0
Phosphorus	ug/L	10	30	90	52	50	5
Chlorophyll-a, Corrected	ug/L	0	-	-	-	7	-
Escherichia coli (geometric mean)	MPN/100ml	3	22	45	-	126	0
Escherichia coli	MPN/100ml	15	10	79	38	1260	0
Inorganic nitrogen (nitrate and nitrite)	mg/L	10	0.03	0.05	0.03	-	-
Kjeldahl nitrogen	mg/L	10	0.3	1.4	0.7	-	-
Orthophosphate	ug/L	0	-	-	-	-	-
Pheophytin-a	ug/L	0	-	-	-	-	-
Specific Conductance	uS/cm	19	215	409	360	-	-
Temperature, water	deg °C	19	8.1	29.4	19.5	-	-
Sulfate	mg/L	10	3	3	3	-	-
Hardness	mg/L	10	104	198	166	-	-

[1]Secchi Tube standards are surrogate standards derived from the total suspended solids standard of 25.

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

Table 19. Lake assessments: Schoolcraft River Subwatershed.

Name	DNR Lake ID	Area (acres)	Trophic Status	Percent 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
Marquette	04-0142-00	509	E	56.5	15.5		D	26	10	2.3	FS	FS
Plantagenet	29-0156-00	2,511	E	38.7	19.8	7.3	NT	27	13	2.5	FS	FS
Schoolcraft	29-0215-00	162	E	67.2	11.3			28	22	1.7	IF	FS
George	29-0216-00	816	M	56.8	8.8	3.7	NT	17	7	2.7	FS	FS
Paine	29-0217-00	239	M		1.8			19	3	1.8	FS	IF
Evergreen	29-0227-00	203	O	43.7	11.6			11	4	3.4	FS	FS
Little Spearhead	29-0238-00	14	O							5.3	IF	NA
Spearhead	29-0239-00	171	O	12.8	24.7		NT	12	3	4.5	FS	FS
Frontenac	29-0241-00	204	M	85	4.9			23	12	2.5	FS	FS
Alice	29-0286-00	127	E	79	6.4			39	18	2.0	NS	NA
Beauty	29-0292-00	54	M		15.2		NT	16	2	7.0	FS	NA
Lost	29-0303-00	113	E						2	1.3	IF	IF

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

Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use

Summary

The Schoolcraft River Subwatershed is home to some of the most exceptional water resources in the Mississippi River (Headwaters) Watershed. Lying in a vastly undisturbed region of the state, aquatic life and recreation indicators along the Schoolcraft River and its tributaries consistently reflect good water quality with samples meeting or exceeding their standards.

From its headwaters in a small wetland complex 5 mi. south of Lake George, the Schoolcraft River flows 1.7 miles to Schoolcraft Lake. From there, the river (AUID -752) flows north 20 miles to its confluence with Frontenac Creek. Biological samples were collected at two locations along this reach (13UM135, 13UM136) and both met their aquatic life standards. Several sensitive fish species were collected including Honryhead Chub, Log Perch, and Burbot. There was one Weed Shiner collected at 13UM136; the only station where this species was collected in the major watershed. The Weed Shiner is a sensitive species which generally prefers clean, low-gradient streams with substrates of sand, gravel, or rock (Boschung and Mayden 2004). Both of these habitat descriptions accurately describe the dominant characteristics of this reach. The macroinvertebrate community was in good condition at both biological monitoring stations. The assemblages included the stenothermic stonefly *Isoperla,* suggesting some groundwater influences.

The lower 7.8 miles of the Schoolcraft River (AUID -751) picks up gradient as it continues flowing north towards its outlet at Lake Plantanganet. This lower reach contained one biological station (13UM134) which was sampled once for fish and macroinvertebrates in 2013 and 2014. This station was also monitored intensively for water chemistry over that two-year span. The biological communities, water chemistry, and habitat data indicate this reach meets exceptional use criteria for aquatic life. The fish community included several sensitive individuals including horneyhead chub, log perch, mimic shiner, greater redhorse and muskellunge. The macroinvertebrate IBI scores were some of the highest observed in this stream class. Many sensitive taxa were present including the coldwater obligate taxa (*Isoperla*) suggesting some groundwater influence. Groundwater springs were observed in the channel near the upstream portion of the sampling reach, and excellent habitat heterogeneity was present throughout. This reach should be strongly considered for protection strategies through the WRAPs process, as it maintains some of the most exceptional water quality in the state.

The Schoolcraft River has three major tributary streams that were sampled for biology; from upstream to downstream they are: Birch Creek (AUID -573), Alcohol Creek (AUID -638), and Frontenac Creek (AUID -651). Biological indicators for these streams all met their standards. Macroinvertebrate communities in Alcohol and Birch Creek were in good condition and included a few coldwater obligate taxa (*Isoperla*, *Gammarus*, and *Eukiefferella*) suggesting some groundwater influence. Macroinvertebrates were not collected in Frontenac Creek due to a large beaver dam that was created upstream of the road crossing sometime after the fish were sampled.

Nine lakes in the subwatershed were assessed for aquatic recreation. George, Paine, Evergreen, Spearhead and Beauty all met eutrophication standards and had low concentrations of phosphorus and Chl-a. These lakes have good water quality and should be protected to maintain current conditions. Frontenac meets eutrophication standards for phosphorus and Secchi but the Chl-a concentrations were high, exceeding the standard. Frontenac Lake's shallow depth along with its large littoral area likely contribute its increased Chl-a production as compared to other lakes within this watershed.

Three lakes, Marquette, Plantagenet, and Schoolcraft had phosphorus concentrations that were just below the eutrophication standards. Marquette and Plantagenet are located just upstream of the Schoolcraft River watershed pour point. As a result, both lakes receive phosphorus contributions from the entire upstream portion of the watershed. Marquette Lake shows evidence of a decreasing Secchi trend. The median transparency at Marquette Lake from 1975 to 2014 decreased by 0.60 feet per decade. Considering the variability over the years, the plausible rate of change in Secchi depth readings in Marquette Lake ranges from “no change” to a decrease of 1.24 feet per decade.

Schoolcraft Lake is located in the headwaters portion of this subwatershed. Schoolcraft Lake would be considered impaired for aquatic recreation use if phosphorus concentrations were slightly higher (>30 ug/L). Both Chl-a and Secchi data show a response to phosphorus concentrations that exceed the eutrophication standards. This indicates that Schoolcraft Lake has the potential to produce nuisance algae blooms if phosphorus concentrations become elevated.

Lake Alice is the only lake in the Schoolcraft River Watershed that does not meet the eutrophication standards. Phosphorus and Chl-a both exceed the standard while Secchi depth is at the standard with a limited, four measurement, data set. Waters contributing to Alice are primarily wetland drainage from an Unnamed Creek. Some shoreline development does exist around the periphery of the lake.

There was not enough data to assess Lost and Little Spearhead Lakes for aquatic recreation; only Secchi depth data was available. However, Little Spearhead had 64 Secchi measurements with an average transparency of 5.3 meters indicating good water quality.

Aquatic life was assessed on seven lakes in the subwatershed; Plantagenet, Schoolcraft, George, Evergreen, Spearhead, Marquette, and Frontenac. All seven lakes were in good condition and were considered full support based on fish IBI scores. F-IBI scores ranged from 42 to 74. Blackchin Shiner was found on all but George Lake. Ciscoes were found in Spearhead, the deepest lake in the subwatershed, and Marquette. Spearhead, Marquette, and Plantagenet are all considered to have exceptional fish communities. Fathead minnows were found in Schoolcraft and Plantagenet; it is believed that the presence of this species is due to human introduction of this popular bait minnow. Plant surveys were conducted Plantagenet, Schoolcraft, George, Evergreen, and Frontenac. The results for these five lakes indicated a healthy plant community.

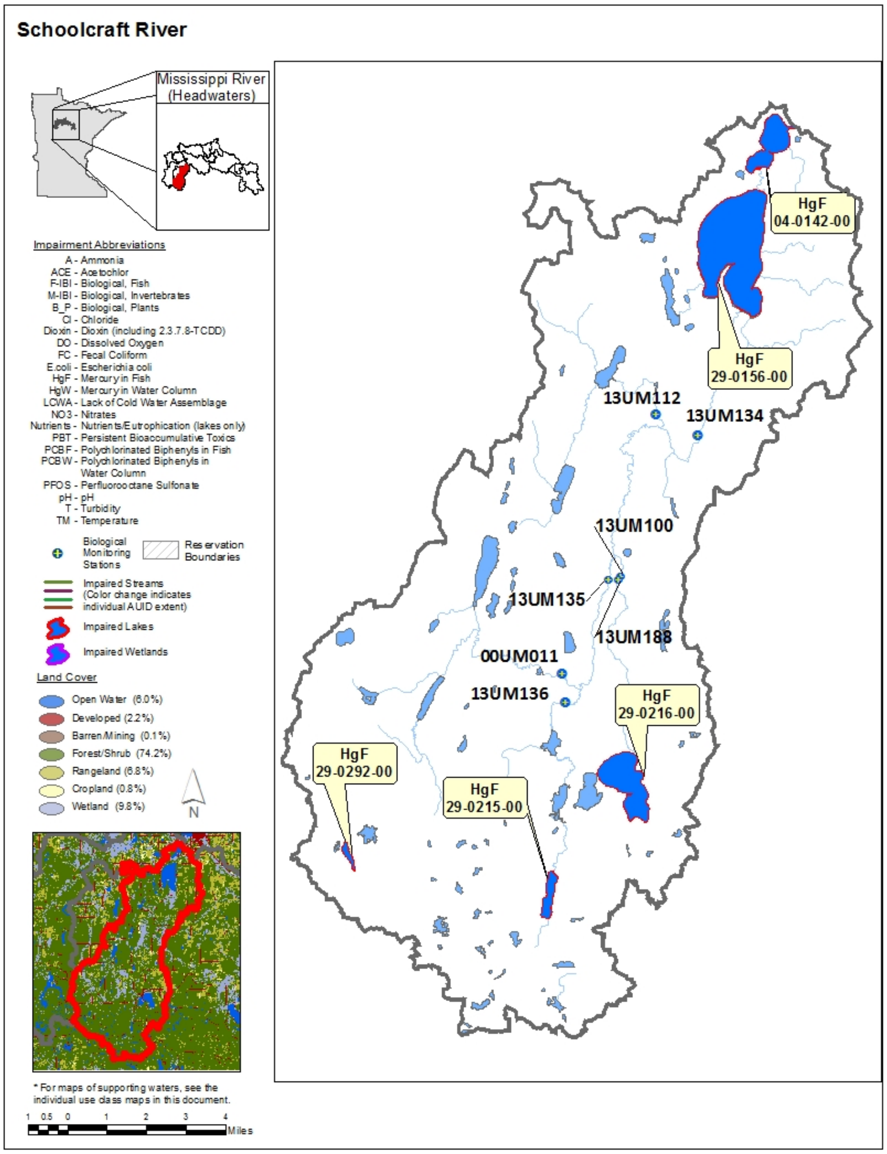

Figure 36. Currently listed impaired waters by parameter and land use characteristics in the Schoolcraft River Subwatershed.

Turtle River Subwatershed

HUC 0701010104-01

The Turtle River Subwatershed contains some of the most lake rich areas in the Mississippi River (Headwaters) Watershed, encompassing 220 square miles across Beltrami and Itasca Counties. From its headwaters at Stray Horse Lake, the Turtle River flows to the southwest for 54 miles through numerous lakes before dumping into the north end of Cass Lake. Land use within the watershed is primarily forest (52.7%), with a significant amount of wetlands (24.2%) and open water (12.5%). Numerous named and unnamed tributaries flow into the Turtle River, most notably the North Turtle River which drains the entire 75 square mile North Turtle River Subwatershed. The towns of Turtle River and Tenstrike lie within this subwatershed. The water chemistry monitoring station (13UM153) on the Turtle River is located off Birchmont Beach Rd NE, 6 mi. north of Cass Lake.

Table 20. Aquatic life and recreation assessments on stream reaches: Turtle River Subwatershed. Reaches are organized upstream to downstream in the table.

AUID ***Reach Name***, *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 -NH_3	Pesticides ***	Eutrophication: Phosphorous	Eutrophication: Response Indicator	**Aquatic Life**	**Aquatic Rec. (Bacteria)**
07010101-510 ***Turtle River,*** *Headwaters (Stray Horse Lk 04-0246-00) to Cass Lk*	13UM157 13UM156 13UM155 13UM154 13UM153	53.95	WWg	MTS	MTS	IF	MTS	MTS	MTS	MTS	MTS	--	IF	--	SUP	SUP
07010101-551 ***Gull River,*** *Erickson Lk to Nelson Lk outlet*	13UM116	4.44	WWg	NA	MTS	IF	IF	IF	--	IF	IF	--	IF	--	SUP	NA

Abbreviations for Indicator Evaluations: **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, **LRVW** = limited resource value water
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Table 21. Minnesota Stream Habitat Assessment (MSHA): Turtle 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	13UM116	Gull River	5	12.25	19.8	14.5	23.5	75.1	Good
1	13UM153	Turtle River	5	10	13.8	15	15	58.8	Fair
1	13UM154	Turtle River	5	13.5	13.2	13	24	68.7	Good
1	13UM155	Turtle River	5	9	14	13	19	60	Fair
1	13UM156	Turtle River	3.25	13	12.4	15	32	75.65	Good
Average Habitat Results: *Turtle River Subwatershed*			**4.65**	**11.55**	**14.6**	**14.1**	**22.7**	**67.6**	**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 22. Outlet water chemistry results: Turtle River Subwatershed.

Station location:	**Turtle River, at Mission Road North East .5 miles of Sugar Bush, MN**						
STORET/EQuIS ID:	**S007-621**						
Station #:	**13UM153**						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**WQ Standard[1]**	**# of WQ Exceedances**
Ammonia-nitrogen	ug/L	15	0.2	32.3	7.9	40	0
Chloride	mg/L	10	4	8	5	230	0
Dissolved Oxygen	mg/L	14	0.1	11.6	6.2	5	5
pH		14	7.2	8.7	8.1	6.5 - 9	0
Secchi Tube	100 cm	20	53	100	98	40	0
Total suspended solids	mg/L	10	1	27	5	15	1
Phosphorus	ug/L	10	11	36	25	50	0
Chlorophyll-a, Corrected	ug/L	-	-	-	-	7	-
Escherichia coli (geometric mean)	MPN/100ml	2	9	19	-	126	0
Escherichia coli	MPN/100ml	15	6	41	16	1260	0
Inorganic nitrogen (nitrate and nitrite)	mg/L	10	0.10	1.00	0.33	-	-
Kjeldahl nitrogen	mg/L	10	0.7	3.5	1.3	-	-
Orthophosphate	ug/L	-	-	-	-	-	-
Pheophytin-a	ug/L	-	-	-	-	-	-
Specific Conductance	uS/cm	14	291	338	323	-	-
Temperature, water	deg °C	14	6.9	24.3	18.6	-	-
Sulfate	mg/L	10	2	3	3	-	-
Hardness	mg/L	9	149	177	165	-	-

[1]Secchi Tube standards are surrogate standards derived from the total suspended solids standard of25.

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

Table 23. Lake assessments: Turtle River Subwatershed.

Name	DNR Lake ID	Area (acres)	Trophic Status	Percent 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
Rice	31-0942-00	35	H							0.5	IF	NA
Burns	04-0001-00	115	E	100	2.1			60	13	1.2	NS	NA
Kitchi	04-0007-00	1,815	E	52.1	17.4	4.6		30	15	2.3	IF	NA
Moose	04-0011-00	593	M	42.4	21.6			19	4	4.0	FS	FS
Popple	04-0014-00	94	M					14	2	1.2	FS	IF
Little Rice	04-0015-00	116	E	70.8	7.9			24	7	2.5	FS	NA
Big Rice	04-0031-00	628	E	100	4.0			39	5	2.4	IF	NA
Meadow	04-0050-00	101	M	72	8.5			20	5	2.9	FS	NA
South Twin	04-0053-00	217	M	27.4	14.6		NT	15	2	5.6	FS	IF
North Twin	04-0063-00	317	O	41.9	19.8		I	10	2	5.4	FS	FS
Gull	04-0064-00	140	E		5.5			35	9	2.1	IF	IF
Long	04-0076-00	400	O	47	25.3		I	10	2	5.8	FS	NA
Buck	04-0097-00	42	E				NT	27	16	1.1	IF	NA
Turtle River	04-0111-00	1,744	E	38.4	19.2	5.8		24	10	2.8	FS	FS
School	04-0114-00	185	E					32	11	1.0	IF	NA
Gull	04-0120-00	2,252	E	66.8	8.8	3.4	NT	25	10	2.5	FS	FS
Three Island	04-0134-00	733	M	93.7	7.6		NT	21	5	3.6	FS	FS
Beltrami	04-0135-00	714	O	55.2	15.2		D	12	4	3.7	FS	FS
Movil	04-0152-00	851	M	55.6	15.5		I	13	4	4.0	FS	FS
Lindgren	04-0153-00	69	M	51.9	21.0			16	5	3.2	FS	NA
Larson	04-0154-00	200	E	92	14.6			39	16	2.1	NS	NA
Little Turtle	04-0155-00	461	E	60.8	7.9		D	34	14	2.0	NS	FS
Black	04-0157-00	267	M	51	12.8		NT	23	6	2.7	FS	NA
Turtle	04-0159-00	1,591	M		13.7	4.0	NT	18	6	3.3	FS	FS
Fox	04-0162-00	166	M	89.9	5.8		NT	14	4	4.1	FS	IF
Campbell	04-0196-00	449	E	46.7	7.6			28	9	2.1	IF	FS
Long	04-0227-00	665	E	95	4.6			27	7	3.0	FS	NA

Deer	04-0230-00	293	M	45.1	12.8		NT	17	5	3.4	FS	FS
Wolf	04-0234-00	88	M					21	3	2.7	FS	NA
Peterson	04-0235-00	252	O					9	2	1.2	FS	NA
Pony	04-0237-00	109	E					29	4	3.2	FS	NA

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

H – Hypereutrophic
E – Eutrophic
M – Mesotrophic
O - Oligotrophic

FS – Full Support
NS – Non-Support
I**F** – Insufficient Information

Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use

Summary

The Turtle River (07010101-510) begins at Stray Horse Lake in the northwestern corner of the Mississippi River (Headwaters) Watershed. From there, it flows Southeasterly 54 miles through a series of lakes before its outlet into Cass Lake. The series of lakes, known as the "Turtle Chain", are well known for their numerous recreational opportunities. The river is generally low gradient, and contains abundant habitat for fish and wildlife. Dense stands of wild rice line the margins along much of the river. Water quality indicators for aquatic life and recreation along the Turtle River and its tributaries consistently met their standards with low levels of bacteria and many sensitive fish and invertebrate species found throughout.

Five biological monitoring stations were established along the Turtle River. Due to the number of lakes, it was difficult to establish monitoring stations at the outlet of all minor watersheds (14-HUC) while staying at least one mile upstream or downstream lakes, per MPCA protocol. Both fish and macroinvertebrate communities consistently met their standards. Two sensitive fish species (Longear Sunfish and Pugnose Shiner) were captured at the downstream station (13UM153); the only station that they were captured in the major watershed. Longear Sunfish is listed as a species of greatest conservation need in Minnesota and is a species of concern in Wisconsin. Their distribution is extremely spotty, and currently there are only 37 known lakes/streams where they are documented in Minnesota (Porterfield, 2008). They require clean water, good flow with good run/pool morphology, and clean vegetation dispersed on the stream bed; all of these are characteristics of the Turtle River along this reach. Also collected at this location was the Pugnose Shiner, which is listed as a species of special concern in Minnesota. Similar to the Longear Sunfish, the Pugnose Shiner requires good water quality. Three sensitive caddis taxa (*Neureclipsis*, *Ceraclea*, and *Oxyethira*) were collected from this reach, corroborating the fish sample. It will be important that protective measures such as BMPs (Best Management Practices) be implemented along the Turtle River to protect this resource from anthropogenic stressors.

Aquatic recreation and aquatic life were assessed at 24 and 11 lakes, respectively. The Turtle River flows through the middle of this lake rich subwatershed. Some of the lakes that the Turtle River passes through act as a phosphorus sinks while others pass phosphorus loads to lakes further downstream. Lakes that the Turtle River does not directly flow through tend to have small contributing watersheds.

The majority of lakes that the Turtle River flows through support aquatic recreation. Deer and Long Lakes are at the headwaters of the Turtle River and have good water quality. Just downstream water quality starts to diminish at Campbell Lake, which has a short stream segment connecting it to the Turtle River. Campbell Lake is near the eutrophication standard and should be considered vulnerable to any further water quality degredation. Directly downstream of Campbell, Little Turtle, exceeds the eutrophication standard and was listed as impaired for aquatic recreation use in 2007. Data collected on Little Turtle since the 2007 assessment shows that Little Turtle is still impaired. Phosphorus concentrations near the bottom of the water column during July and August of 2013 were much higher than its surface waters. Given Little Turtle's moderate depth and 61% littoral area, mixing during storm events could cause internal loading of phosphorus from lake bed sediments. Downstream of Little Turtle the water quality progressively gets better after flowing into Turtle and Movil Lakes. Turtle appears to be a phosphorus sink, reducing available phosphorus from upstream lakes. Downstream of Movil Lake, phosphorus concentrations are similar in Beltrami, Fox and Three Island Lakes. Water quality remains good through Turtle River Lake until entering Big Rice and Kitchi near the pour point of the watershed. Big Rice is a shallow lake that has high phosphorus but does not have the response in Chl-a and Secchi to be considered impaired for aquatic recreation. Little Rice is a small lake between Big Rice and Kitchi and meets aquatic recreation. Kitchi is the last lake to receive water from the Turtle River before it exits the watershed. Phosphorus concentrations in Kitchi Lake are near the eutrophication standard. The lake should be considered vulnerable because it susceptible to phosphorus loads moving throughout the entire Turtle River Watershed.

A small portion of the Turtle River Subwatershed drains from the east into Kitchi Lake. Two lakes, Moose and Popple, are full support for aquatic recreation. Burns Lake also drains from the east and was found to be impaired due to natural background conditions. Burns' watershed consists of predominately wetland and forest with no development and negligible human impacts in its contributing watershed area.

Multiple lakes should be considered vulnerable; Gull (04-0064-00), Buck, and School all have phosphorus concentrations near the eutrophication standard and show a potential response in Chl-a concentrations. Limiting any future contributions of phosphorus due to human activity in the contributing watershed areas of these lakes will be key to preventing water quality degradation.

Larson Lake was the found to be impaired for aquatic recreation even though the lake is relatively isolated and has a small contributing watershed area. Larson is shallow and has a 92% littoral area. This likely allows for internal loading of phosphorus. Larson's shoreline periphery should be protected to ensure that land use practices do not contribute additional phosphorus to the lake.

Beltrami and Little Turtle were found to have a potential decreasing trend in Secchi transparency. The trend was calculated from a fairly robust dataset that included a minimum of eight years of Secchi data. It will be important to monitor these lakes in the future in order to better understand changes in water quality.

Eleven lakes were assessed for aquatic life use using the FIBI: Moose, North Twin, Turtle River, Gull, Big Bass, Beltrami, Movil, Little Turtle, Turtle, Campbell, and Deer. Blackchin Shiner was found in all but Movil and Little Turtle Lake. Cisco, a pelagic fish requiring well oxygenated cold water were found in Turtle River, Beltrami, Movil, Little Turtle, Turtle, Campbell, and Deer Lakes. Beltrami and North Twin each had considerable amounts of Smallmouth Bass; likely the result of human introduction, as they are not stocked for game fish management. Human introduction likely led to the introduction of Fathead Minnows on Campbell Lake. North Twin, Turtle River, Big Bass, Beltrami, Turtle, and Deer lakes fish communities are considered to be exceptional and would be high priorities for protection efforts. Aquatic plant surveys were used to assess aquatic life on all of the FIBI lakes, with the exception of Lake Movil and Little Turtle Lake. All of the lakes had a healthy aquatic plant community.

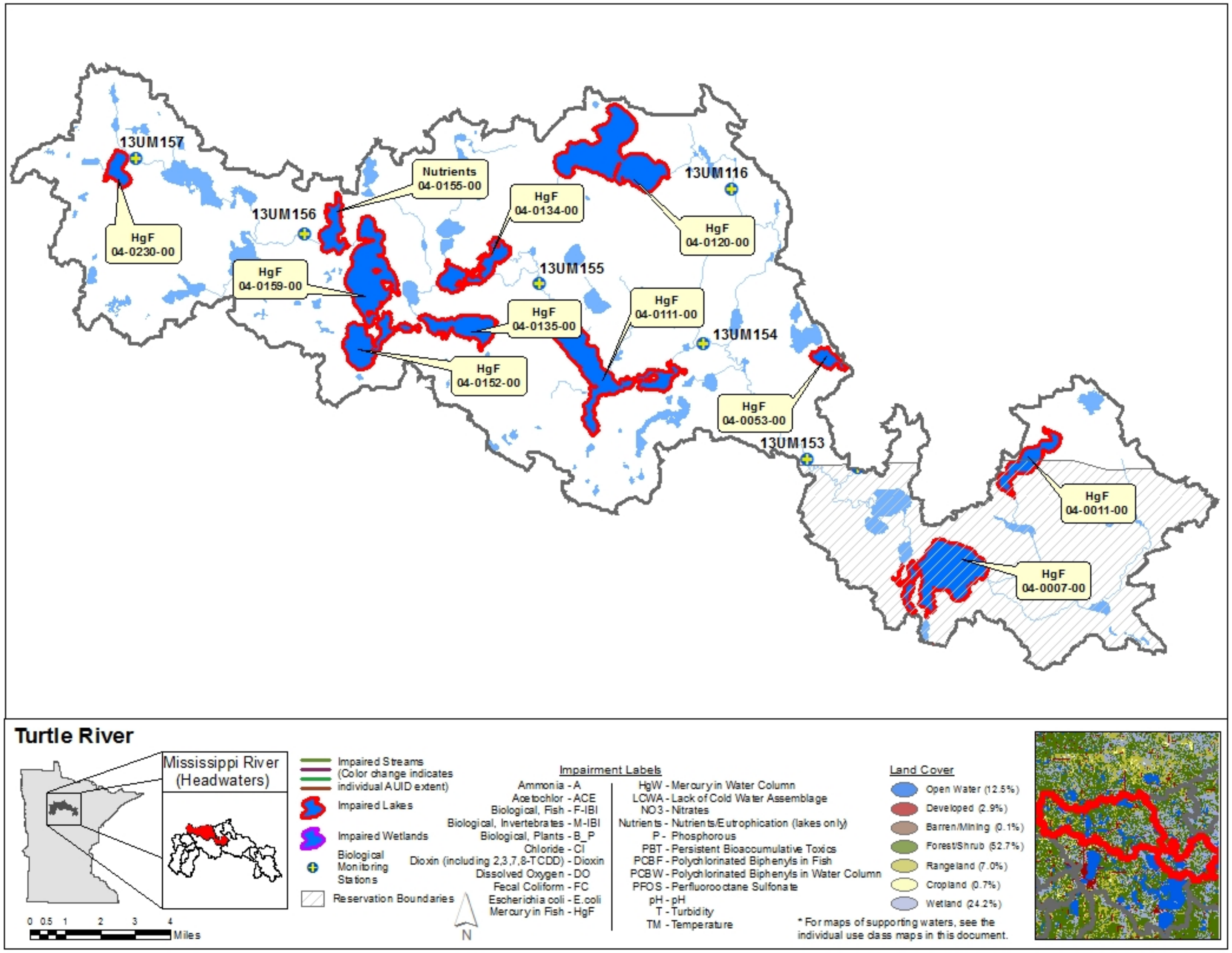

Figure 37. Currently listed impaired waters by parameter and land use characteristics in the Mississippi River (Headwaters) Subwatershed.

North Turtle River Subwatershed HUC 0701010104-02

The North Turtle River Subwatershed drains 75 square miles of Beltrami County. From its headwaters at Little Gilstad Lake, the North Turtle River flows 3.9 miles to Rabideau Lake. From there, the river flows 20 miles to its confluence with the Turtle River. Along its course, the North Turtle River flows through numerous lakes and wetlands, most notably Pimushe Lake. The landscape in this subwatershed is primarily forest (51.6%) and wetlands (35%). The water chemistry monitoring station for this subwatershed is represented by the outlet station 13UM130 on the North Turtle River at Birchmont Beach Rd NE, 2.3 miles south of Lake Pimushe.

Table 24. Aquatic life and recreation assessments on stream reaches: North Turtle River Subwatershed. Reaches are organized upstream to downstream in the table.

AUID *Reach Name*, *Reach Description*	Biological Station ID	Reach Length (miles)	Use Class	Aquatic Life Indicators:									Eutrophication		Aquatic Life	Aquatic Rec. (Bacteria)
				Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Phosphorous	Response Indicator		
07010101-570 ***North Turtle River,*** *Little Rice Pond outlet to Pimushe Lk*	13UM131	2.45	WWg	MTS	--	IF	IF	IF	--	IF	IF	--	IF	--	SUP	NA
07010101-548 ***North Turtle River,*** *Pimushe Lk to Turtle R*	13UM130	4.66	WWg	MTS	MTS	IF	MTS	MTS	MTS	IF	MTS	--	IF	--	SUP	SUP

Abbreviations for Indicator Evaluations: **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, **LRVW** = limited resource value water
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Table 25. Minnesota Stream Habitat Assessment (MSHA): North Turtle 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	13UM131	North Turtle River	5	12	10	17	19	63	Fair
1	13UM130	North Turtle River	5	11.5	12.6	16	27	72.1	Good
Average Habitat Results: *North Turtle River Subwatershed*			**5**	**11.75**	**11.3**	**16.5**	**23**	**67.6**	**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 26. Outlet water chemistry results: North Turtle River Subwatershed.

Station location:	North Turtle River, at CSAH 20, 15 miles East North East of Bemidji, MN						
STORET/EQuIS ID:	S003-921						
Station #:	13UM130						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**WQ Standard[1]**	**# of WQ Exceedances**
Ammonia-nitrogen	ug/L	15	ND	ND	ND	40	0
Chloride	mg/L	14	3	6	4	230	0
Dissolved Oxygen	mg/L	15	6.1	11.9	8.0	5	0
pH		15	7.7	8.4	8.0	6.5 - 9	0
Secchi Tube	100 cm	20	100	100	100	40	0
Total suspended solids	mg/L	11	1	10	4	15	0
Phosphorus	ug/L	11	20	41	28	50	0
Chlorophyll-a, Corrected	ug/L	1	1.4	1.4	1.4	7	-
Escherichia coli (geometric mean)	MPN/100ml	2	9	35	-	126	0
Escherichia coli	MPN/100ml	15	4	219	43	1260	0
Inorganic nitrogen (nitrate and nitrite)	mg/L	11	0.05	1.00	0.32	-	-
Kjeldahl nitrogen	mg/L	11	0.7	4.3	1.2	-	-
Orthophosphate	ug/L	1	5	5	5	-	-
Pheophytin-a	ug/L	-	-	-	-	-	-
Specific Conductance	uS/cm	15	275	496	326	-	-
Temperature, water	deg °C	10	1.5	6.0	2.5	-	-
Sulfate	mg/L	15	7	23	18	-	-
Hardness	mg/L	9	150	278	180	-	-

[1]Secchi Tube standards are surrogate standards derived from the total suspended solids standard of

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

Table 27. Lake assessments: North Turtle River Subwatershed.

Name	DNR Lake ID	Area (acres)	Trophic Status	Percent 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
Little Moose	04-0008-00	230	M					12	5	1.1	FS	NA
Anderson	04-0019-00	87	M		1.5			16	3	2.5	FS	NA
Gilstad	04-0024-00	251	M	38	16.8			21	5	2.7	FS	FS
Pimushe	04-0032-00	1,220	M	52	12.2	4.9	NT	23	12	2.9	FS	IF
Benjamin	04-0033-00	32	O	49.7	39.0			10	3	5.5	FS	IF
Rabideau	04-0034-00	654	M	89.3	9.1			13	5	3.1	FS	FS
Rice Pond	04-0059-00	154	M	112	1.5			19	3	1.2	FS	NA
Hanson	04-0066-00	94	E		1.5			36	19	0.8	NS	NA
Dutchman	04-0067-00	176	M	99.9	1.5			20	6	1.4	FS	NA

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

H – Hypereutrophic
E – Eutrophic
M – Mesotrophic
O - Oligotrophic

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

Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use

Summary

Originating at Little Gilstad Lake, the North Turtle River flows approximately 20 miles to its outlet at the Turtle River, 1 mi. west of Big Rice Lake. The river is heavily influenced by wetlands, and can be characterized by slow moving water, abundant aquatic vegetation and mostly fine sediments. Aquatic life Indicators for this subwatershed consistently reflect good water quality with fish and macroinvertebrate communities meeting, or exceeding, their respective standards. Fish communities sampled at two stations (13UM131, 13UM130) each contained blackchin shiners, a species normally associated with healthy wetland streams. This species requires very clean water, and abundant clean aquatic vegetation.

Aquatic recreation assessments were conducted on nine lakes in the North Turtle River Subwatershed; two lakes were assessed for aquatic life. Hanson Lake, did not support aquatic recreation due to natural background conditions. Baumgartner Lake was not assessed because data from only one visit was available. The remaining eight lakes all have good water quality and fully support aquatic recreation. Three lakes, Gilstad, Rabideau, and Pimushe are flow through lakes on the North Turtle River. Little Moose, Anderson, and Benjamin Lakes have small isolated watersheds that do not drain to the North Turtle River. All of these lakes should have protection as there first priority in order to maintain current water quality conditions.

Fish IBI surveys were conducted on Gilstad Lake and Rabideau Lakes. The seining effort on both lakes was less than desired. Nonetheless, the IBI scores indicated support for aquatic life. The fish communities in both lakes included two intolerant species, the Blackchin Shiner and Cisco. Two additional intolerant species, the Iowa Darter and Rock Bass, were found in Gilstadt. Tolerant species present in the seine halls included the Black Bullhead in Rabideau and the Fathead Minnow in Gilstadt. The presence of Fathead Minnows is thought to be the result of human introduction due to the popularity of the species as bait for angling. Biomass in gill nets in both lakes was dominated by Northern Pike, Cisco, and Walleye while biomass in trap nets was comprised largely of Bluegill. Crappies and Northern Pike also comprised a significant portion of trap net biomass in Gilstad and Rabideau Lakes, respectively. In addition, aquatic plant surveys conducted on both lakes in 2011, and showed a healthy plant community.

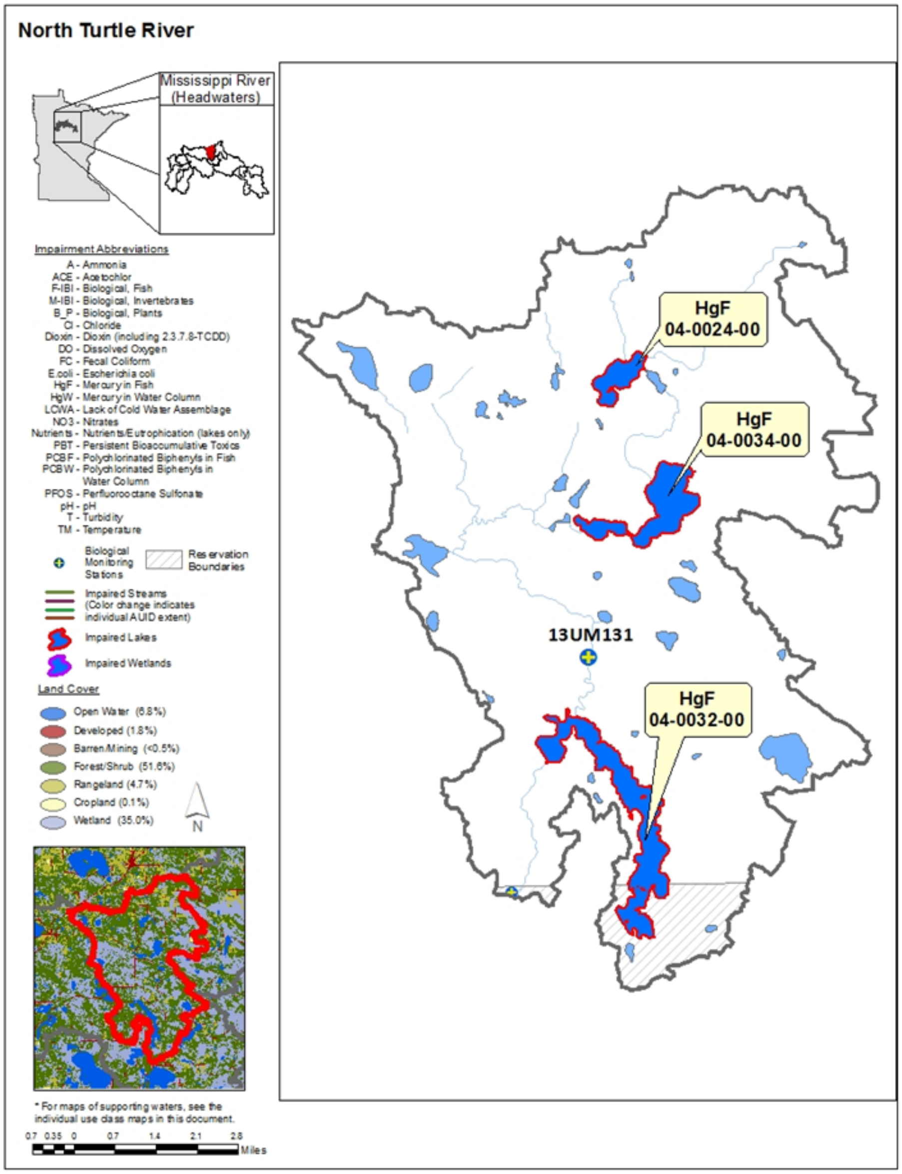

Figure 38. Currently listed impaired waters by parameter and land use characteristics in the North Turtle River Subwatershed.

Cass Lake-Mississippi River Subwatershed HUC 0701010105-01

The Cass Lake-Mississippi River Subwatershed drains approximately 247 square miles, making it the second largest sub-watershed within the Mississippi River (Headwaters) Watershed. Located within portions of Beltrami, Hubbard and Cass Counties, the subwatershed includes several notable lakes including Bemidji, Cass, Big, Andrusia. Streams within this subwatershed are limited to small unnamed tributaries to the Mississippi River. Land use consists of forest (39.4%), open water (25.7%), and wetlands (17.1%). There is a fair amount of developed land (7.1%) which is concentrated around the towns of Bemidji and Cass Lake. Due to the abundance of lakes near this subwatershed's outlet, no water chemistry monitoring station was established.

Table 28. Aquatic life and recreation assessments on stream reaches: Cass Lake-Mississippi River Subwatershed. Reaches are organized upstream to downstream in the table.

AUID ***Reach Name***, *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 -NH_3	Pesticides ***	Eutrophication: Phosphorous	Eutrophication: Response Indicator	**Aquatic Life**	**Aquatic Rec. (Bacteria)**
07010101-750 ***Unnamed Creek,*** *Unnamed Cr to Lk Bemidji*	13UM148	1.94	WWg	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--	SUP	NA

Abbreviations for Indicator Evaluations: **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, **LRVW** = limited resource value water
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Table 29. Minnesota Stream Habitat Assessment (MSHA): Cass Lake-Mississippi 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	13UM148	Unnamed Creek	4.6	11	11.5	12.5	22	61.6	Fair
Average Habitat Results: *Cass Lake Mississippi River Subwatershed*			**4.6**	**11**	**11.5**	**12.5**	**22**	**61.6**	**Fair**

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 30. Lake assessments: Cass Lake-Mississippi River Subwatershed.

Name	DNR Lake ID	Area (acres)	Trophic Status	Percent 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
Midge	29-0066-00	538	E	95.2	7.3		I	29	8	4.3	IF	FS
Grace	29-0071-00	867	E	38.3	12.8	5.5	NT	29	12	4.2	IF	IF
Schram	04-0005-00	130	M		1.2			20	4	1.1	FS	NA
Cass	04-0030-00	15,948	M		36.6	8.5	D	15	4	3.3	FS	NA
Drewery	04-0036-00	155	M		0.9			15	3	0.9	FS	NA
Andrusia	04-0038-00	1,579	M	28	18.3	7.3	I	20	8	3.3	FS	NA
Silver	04-0039-00	127	O	62.1	10.7			12	3	5.6	FS	NA
Ten	04-0041-00	163	M	112.4	0.6			12	4	1.1	FS	NA
Buck	04-0042-00	352	M	32.9	16.2			14	4	3.6	FS	NA
Lost	04-0043-00	129	M		9.1			14	6	2.9	FS	NA
Windigo	04-0048-00	193	M	65	6.1	2.7		13	4	2.5	FS	NA
Big	04-0049-00	3,558	M	59	10.7	4.3	NT	14	4	3.6	FS	IF
Flora	04-0051-00	178	M	99.4	4.9			22	5	1.4	FS	NA
Wolf	04-0079-00	1,072	M	35.6	17.4	6.7	I	24	10	3.1	FS	NA
Swenson	04-0085-00	410	O		23.2		I	8	2	7.4	FS	NA
Unnamed	04-0099-00	36	M					13	3	3.9	FS	NA
Little Bass	04-0110-00	363	M	84	6.7		NT	13	4	5.1	FS	NA
Stump	04-0130-01	324	M	81	7.0	2.4	I	24	6	3.1	FS	IF
Bemidji (main lake)	04-0130-02		E		23.2	10.1	NT	30	12	2.8	IF	FS
Big Bass (west basin)	04-0132-01	51	M		5.2			13	4	1.1	FS	NA
Big Bass (east basin)	04-0132-02	334	M		5.2		NT	16	4	3.7	FS	FS
Irving	04-0140-00	661	E	89.6	4.9	2.4	NT	67	39	1.5	NS	FS
Carr	04-0141-00	42	M	46.5	9.1					2.9	IF	NA
Pike Bay	11-0415-00	4,729	M	47	29.0	7.3		20	3	4.6	FS	IF
Moss	11-0485-00	202	M		6.7			17	2	2.9	FS	NA
Little Wolf	11-0505-00	526	E	49.8	7.3	3.7		32	16	2.4	IF	FS

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

Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use

Summary

The Cass Lake- Mississippi River subwatershed is dominated by lakes; most of the stream segments are short (< 2 miles) connectors between lakes. For this reason, only one stream segment (-750) was sampled for aquatic life. This is a small, two-mile long tributary to Lake Bemidji. The creek is low gradient, and substrates consist of primarily fine sediments. One biological monitoring station (13UM148) was established along this reach. Both fish and macroinvertebrates were collected in 2013, and all biological data indicates this stream supports aquatic life.

Aquatic recreation and aquatic life were assessed on 21 and 5 lakes, respectively. The majority of lakes are in the eastern portion of this watershed. The Mississippi river flows through six lake basins; Irving, Bemidji, Stump, Wolf, Andrusia, and Cass, likely impacting phosphorous concentrations within them. The primary concern for this watershed is the impact that development in Bemidji has on phosphorus concentrations in Lake Irving and other downstream waters including Cass Lake, the pour point of this watershed.

Lakes that receive flow from the Mississippi River show a progressive decrease in phosphorus concentrations starting from Lake Irving to Cass Lake. Lake Irving is the only impaired lake in this watershed unit. Phosphorus concentrations are more than double the eutrophication standard and high amounts of Chl-a are being produced. Just downstream in Lake Bemidji phosphorus concentrations are significantly reduced from concentrations observed in Irving. However, Lake Bemidji phosphorus concentrations are near the standard; the lake is functioning as a sink for phosphorus and a buffer for waterbodies that are further downstream. Lake Bemidji's large size combined with its mean depth of 10.3 m likely allow for the assimilation of phosphorus into lake bed sediments. Stump Lake is downstream of Lake Bemidji and is a long narrow lake that acts as a widened channel of the Mississippi River. Stump Lake and Wolf Lake located further downstream on the Mississippi River both support aquatic recreation. Wolf Lake has the same phosphorus concentration as Stump Lake but has slightly higher Chl-a values likely resulting from a longer residence time. Phosphorus concentrations in Andrusia Lake are further reduced before entering Cass Lake. Andrusia also receives flow from Big Lake to the north which supports aquatic recreation. Phosphorus and Chl-a concentrations in Cass Lake are even less, likely a result of it large size and depth. Cass Lake has excellent water quality and is a highly valued resource. Cass Lake also serves as the pour point for this watershed unit.

Grace, Midge, and Little Wolf have phosphorus and Chl-a concentrations that fluctuate around the eutrophication standard. Grace Lake, assessed in 2007, fully supported aquatic recreation. The 2015 assessment results were inconclusive since it was right at the eutrophication standard. These vulnerable lakes have relatively small watersheds that consist of a mixture of development and forested land use. If phosphorus concentrations increase they will likely exceed the eutrophication standard. All three lakes and the Mississippi River drain into Wolf Lake which currently supports aquatic recreation. The combination of phosphorus loading to Wolf Lake from Grace, Midge, and Little Wolf along with the Mississippi River suggest that Wolf Lake should continue to be monitored and contributing watershed areas should have protection strategies in place.

Many additional lakes; Unnamed (04-0099-00), Big Bass, Little Bass, Swenson, Flora, Ten, Silver, Lost, Buck, Schram, Windigo, Drewery, and Moss have good water quality and also support aquatic recreation.

Six lakes were assessed for aquatic life using the FIBI: Midge, Grace, Bemidji, Big Bass, Irving, and Little Wolf. Exceptional fish communities were identified in Bemidji, Big Bass, Irving, and Little Wolf lakes. Banded Killifish, Iowa Darter, and Rock Bass were common intolerant species found in most of the lakes. Ciscoes were found in Lake Bemidji, a lake with well oxygenated cold water at depth. Fathead minnows were present in Lake Bemidji, Lake Irving, and Little Wolf Lake; these species are present as a result of human introduction, likely from improper disposal of bait fish. Grace Lake is considered vulnerable; sampling in 2013 and 2015 both yielded results right at or just below the impairment threshold. It is considered a high priority for protection efforts. Aquatic plant surveys were used to assess aquatic life on all of the FIBI lakes, with the exception of Big Bass and Little Wolf Lake. All of the lakes surveyed had healthy aquatic plant communities.

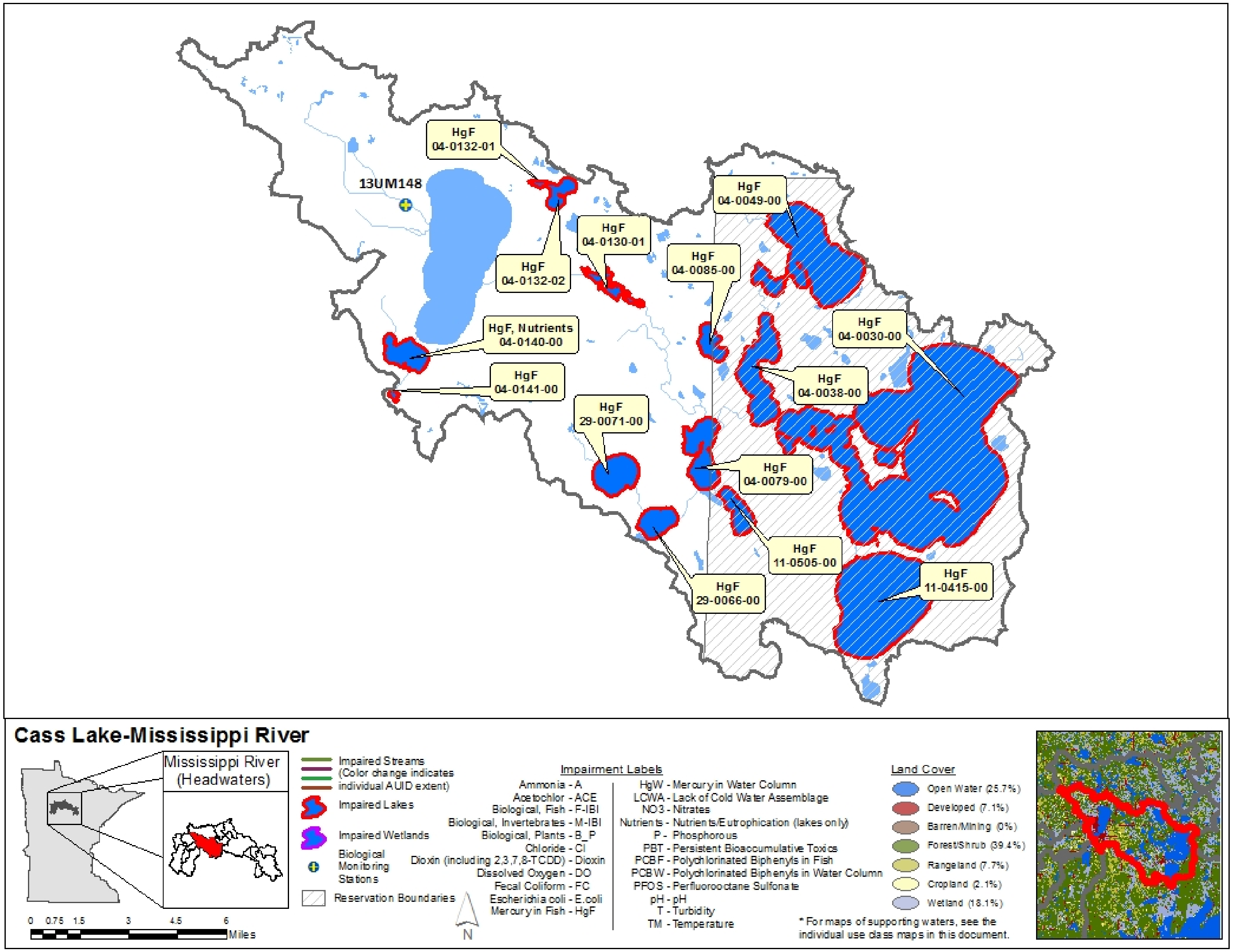

Figure 39. Currently listed impaired waters by parameter and land use characteristics in the Cass Lake-Mississippi River Subwatershed.

Third River Subwatershed

HUC 0701010106-01

The Third River Subwatershed drains 88 square miles of Itasca and Beltrami counties. From its headwaters at Skimmerhorn Lake, the Third River flows southeasterly 25 miles to its confluence with Lake Winnibigoshish. There are a number of named and unnamed tributary streams to the Third River, most notably Moose Creek, which drains 10 miles square miles of land in the northeastern portion of the watershed. The landscape within this subwatershed is almost entirely natural, with forest, wetlands and open water making up approximately 95% of the land use. The water chemistry monitoring station for this subwatershed is represented by the outlet station 00UM007 on the Third River at Forest Road 2171, just upstream of Lake Winnibigoshish.

Table 31. Aquatic life and recreation assessments on stream reaches: Third River Subwatershed. Reaches are organized upstream to downstream in the table.

				Aquatic Life Indicators:									Eutrophication			
AUID ***Reach Name,*** *Reach Description*	**Biological Station ID**	**Reach Length (miles)**	**Use Class**	Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Phosphorous	Response Indicator	**Aquatic Life**	**Aquatic Rec. (Bacteria)**
07010101-581 ***Moose Creek,*** *Unnamed Cr to Third R*	13UM129	9.33	WWg	NA	MTS	IF	IF	IF	--	IF	IF	--	IF	--	SUP	NA
07010101-526 ***Third River,*** *Skimmerhorn Lk to Lk Winnibigoshish*	13UM160 13UM142 00UM007	24.82	WWg	MTS	MTS	IF	MTS	MTS	MTS	IF	MTS	--	IF	--	SUP	SUP

Abbreviations for Indicator Evaluations: **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, **LRVW** = limited resource value water
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Table 32. Minnesota Stream Habitat Assessment (MSHA): Third 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
3	00UM007	Third River	4.75	10.6	19.8	14	19.6	68.85	Good
1	13UM142	Third River	5	11	13.5	15	23	67.5	Good
1	13UM160	Third River	5	10	16	11	14	56	Fair
1	13UM129	Moose Creek	5	13	9	12	19	58	Fair
1	99UM001	Moose Creek	4.5	9	10.5	11	17	52	Fair
Average Habitat Results: *Third River Subwatershed*			**4.8**	**10.7**	**15.5**	**13**	**18.9**	**62**	**Fair**

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 33. Outlet water chemistry results: Third River Subwatershed.

Station location:	Third River, Skimmerhorn Lake to Lake Winnibigoshish						
STORET/EQuIS ID:	S002-290						
Station #:	00UM007						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**WQ Standard[1]**	**# of WQ Exceedances**
Ammonia-nitrogen	ug/L	15	1	1	1	40	0
Chloride	mg/L	10	1	4	2	230	0
Dissolved Oxygen	mg/L	13	4.5	11.1	7.0	5	2
pH		14	7.5	8.4	8.0	6.5 - 9	0
Secchi Tube	100 cm	20	95	100	100	40	0
Total suspended solids	mg/L	10	1	19	4	15	1
Phosphorus	ug/L	10	29	77	53	50	6
Chlorophyll-a, Corrected	ug/L	1	2.4	2.4	2.4	7	-
Escherichia coli (geometric mean)	MPN/100ml	2	13	17	-	126	0
Escherichia coli	MPN/100ml	15	3	250	46	1260	0
Inorganic nitrogen (nitrate and nitrite)	mg/L	10	0.10	1.00	0.35	-	-
Kjeldahl nitrogen	mg/L	10	0.8	2.6	1.3	-	-
Orthophosphate	ug/L	0	-	-	-	-	-
Pheophytin-a	ug/L	0	-	-	-	-	-
Specific Conductance	uS/cm	14	216	288	254	-	-
Temperature, water	deg °C	14	6.3	24.5	18.7	-	-
Sulfate	mg/L	10	1	2	2	-	-
Hardness	mg/L	9	118	151	137	-	-

[1]Secchi Tube standards are surrogate standards derived from the total suspended solids standard.

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

Table 34. Lake assessments: Third River Subwatershed.

Name	DNR Lake ID	Area (acres)	Trophic Status	Percent 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
Sioux	31-0907-00	71	M	79	9.1					2.7	NA	NA
Dixon	31-0921-00	550	E	77.6	8.8		NT	36	15	1.8	NS	IF
Decker	31-0934-00	236	E	100	3.0		NT	38	21	1.0	NS	IF
Coleman	31-0943-00	50	E		3.7					1.4	IF	NA
Damon	31-0944-00	69	E		3.0			74	27	0.5	NA	NA

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

H – Hypereutrophic
E – Eutrophic
M – Mesotrophic
O - Oligotrophic

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

Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use

Summary

The Third River is a highly sinuous, low gradient stream located in an undeveloped portion of the Upper Mississippi River (Headwaters) Watershed. The biological monitoring stations within this subwatershed were limited to the Third River and Moose Creek. Beaver activity was common, and limited the ability to obtain some biological samples. Overall, aquatic life and aquatic recreation Indicators throughout the subwatershed consistently reflect good water quality.

Three biological monitoring stations (13UM160, 13UM142, 00UM007) were sampled along the 25-mile-long reach of the Third River (AUID -526) from Skimmerhorn Lake to its outlet at Lake Winnibigoshish. The fish and macroinvertebrate communities were dominated by species that are normally associated with healthy wetland streams. Habitat ratings along the Third River show mixed results ranging from good to fair; however healthy aquatic plants and stable banks were noted at all stations. The reach also met the standard for bacteria and is considered full support for aquatic recreation.

Moose Creek (AUID – 581) is a headwater tributary to the Third River. Similar to the Third River, this creek is influenced by wetlands and has extensive beaver activity (i.e. beaver dams). One station (13UM129) was sampled for fish and macroinvertebrates in 2013. The macroinvertebrate sample was two points below the exceptional use threshold. Numerous sensitive taxa were collected including Gammarus, Dubiraphia, and Stenelmis. The fish community was poor, even for a low gradient stream. The poor fish results were not expected because disturbance within the subwatershed is minimal and all of the chemical parameters indicate support. A review of areal imagery indicated that a loss of stream connectivity due to large beaver dams downstream of the site appear to be the main fish stressor. Therefore, the water chemistry and macroinvertebrate indicators were used to assess this reach and the overall assessment for aquatic life was full support.

Aquatic recreation was assessed on Dixon and Decker lakes. Based on a previous assessment in 2007, both lakes do not support aquatic recreation. The new information collected in 2013 from Dixon Lake indicates that phosphorus concentrations are below the eutrophication standard but the Chl-a concentrations and Secchi readings are still high. The additional data collected from Decker lake in 2013 and 2014 indicates that phosphorus, Chl-a, Secchi averages still exceed the eutrophication standards and confirm the 2007 impaired status of the lake.

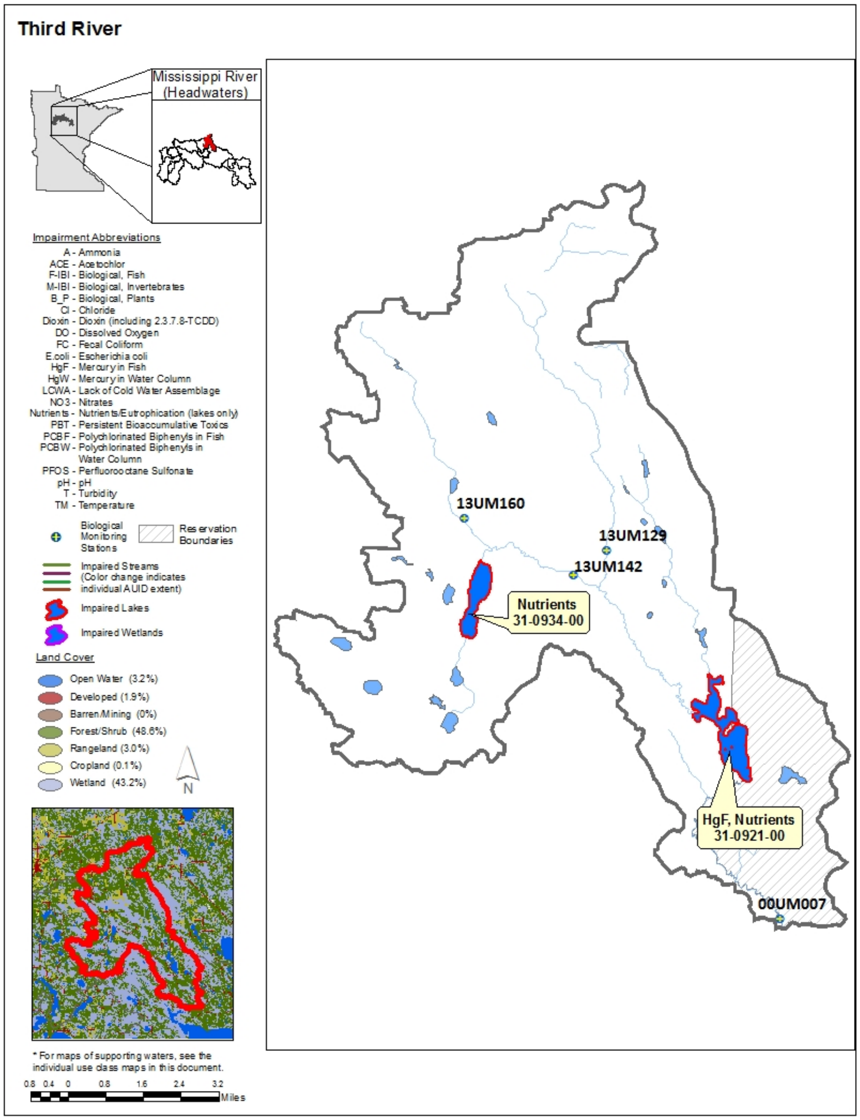

Figure 40. Currently listed impaired waters by parameter and land use characteristics in the Third River Subwatershed.

Lake Winnibigoshish Subwatershed HUC 0701010107-01

The Lake Winnibigoshish Subwatershed drains 198 square miles across Itasca and Cass counties. As the name implies, this subwatershed contains Lake Winnibigoshish which is the largest lake in the watershed, and the fourth largest lake in Minnesota (58,544 acres). The Mississippi River reaches 11 miles wide on Lake Winnibigoshish, which is wider than any point on its 2,350 mile journey to the Gulf of Mexico. There are several tributary streams that flow into Lake Winnibigoshish within this subwatershed, most notably the, Pigeon River, Castle Creek, and Raven Creek. This subwatershed lies primarily within the Leech Lake Indian Reservation, and land use is almost entirely natural with a mixture of forest (35.2%), open water (35%), and wetlands (28%). No water chemistry monitoring station was established for this subwatershed.

Table 35. Aquatic life and recreation assessments on stream reaches: Lake WInnibigoshish Subwatershed. Reaches are organized upstream to downstream in the table

AUID ***Reach Name***, *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 -NH_3	Pesticides ***	**Eutrophication** Phosphorous	Response Indicator	**Aquatic Life**	**Aquatic Rec. (Bacteria)**
07010101-549 ***Lydick Brook,*** *Headwaters to Mississippi R*	13UM125	4.14	WWg	MTS	--	IF	IF	IF	--	IF	--	--	IF	--	SUP	NA
07010101-590 ***Castle Creek,*** *Headwaters to Unnamed Cr*	13UM103	5.29	WWg	MTS	--	IF	IF	IF	--	IF	IF	--	IF	--	SUP	NA
07010101-606 ***Farley Creek,*** *Farley Lk to Unnamed lk (31-0895-00)*	13UM110	4.53	WWg	MTS	NA	IF	IF	IF	--	IF	IF	--	IF	--	SUP	NA
07010101-620 ***Pigeon River,*** *T147 R27W S18, west line to Unnamed Cr*	13UM132	0.66	WWg	MTS	--	IF	IF	IF	--	IF	IF	--	IF	--	SUP	NA

Abbreviations for Indicator Evaluations: **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,
LRVW = limited resource value water
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Table 36. Minnesota Stream Habitat Assessment (MSHA): Lake Winnibigoshish 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	13UM125	Lydick Brook	5	12	8	11	19	55	Fair
1	13UM103	Castle Creek	5	11	18	15	26	75	Good
2	13UM110	Farley Creek	5	11	9.8	14.5	15	55.3	Fair
1	13UM132	Pigeon River	5	11	14.3	14	25	69.3	Good
Average Habitat Results: *Lake Winnibigoshish Subwatershed*			**5**	**11.6**	**11.8**	**13.9**	**19.3**	**61.5**	**Fair**

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 37. Lake assessments: Lake Winnibigoshish Subwatershed.

Name	DNR Lake ID	Area (acres)	Trophic Status	Percent 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
Middle Pigeon	31-0892-00	178	E	77	7.6			43	23	1.7	NS	NA
Lower Pigeon	31-0893-00	285	E		6.1			60	32	1.9	NS	IF
Pigeon Dam	31-0894-00	523	E		2.9			38	4		IF	NA
Unnamed	31-0895-00	50	E		3.4					1.5	IF	NA
Upper Pigeon	31-0908-00	100	E		4.6			75	23	1.2	NS	NA
Sugar	31-0926-00	1,478	E		4.6			29	8	2.6	IF	NA
Kenogama	31-0928-00	565	E		1.5			37	10	1.1	NS	NA
Morph	31-0929-00	307	E		1.2					0.9	IF	NA
Winnibigoshish	11-0147-00	55,818	M		21.3	6.1	NT	21	6	3.0	FS	IF
Tibbett	31-0819-00	13	H							0.5	IF	NA
Unnamed	31-0820-00	20	E							1.1	NA	NA
Two Mile	31-0823-00	27	E		1.5					0.8	IF	NA
Little Cut Foot Sioux	31-0852-00	588	E	80	6.1			52	17	1.5	NS	NA
Goodwin	31-0855-00	39	M							4.0	NA	NA
Cut Foot Sioux(Main Bay)	31-0857-01	2,316	M		23.8		NT	20	6	2.8	FS	NA
Wart	31-0859-00	18	M		6.4					2.7	NA	NA
Biauswah	31-0862-00	133	E		4.6			34	12	1.6	NS	NA
Simpson	31-0867-00	32	E		1.2					0.9	IF	NA
Unnamed	31-0870-00	12	E							0.6	NA	NA
Unnamed	31-0871-00	11	E							0.9	NA	NA

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

Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use

Summary

Four stream segments, each with one biological monitoring station, were sampled within this subwatershed in 2013. All of these streams flow directly, or indirectly into Lake Winnibigoshish. The gradient, productivity, and DO concentrations in these streams are typically low. Fish samples collected from all four streams indicate that the streams are healthy and support aquatic life. Similar to other streams in this watershed, beaver activity and low flows during the fall of 2013 prevented the collection of macroinvertebrate samples at all four stations.

Aquatic recreation was assessed on eight lakes. A large portion of this watershed is covered by Lake Winnibigoshish. Kenogama and Biauswah are the only lakes with data that do not have direct flow conduits to Lake Winnibigoshish.

Lake Winnibigoshish and Cut Foot Sioux, a direct connector to Lake Winnibigoshish, both fully support aquatic recreation. These lakes have similar maximum depths, phosphorus, Chl-a and Secchi measurements. Lake Winnibigoshish is a vital resource to the local economy and should be protected in order to maintain its good water quality.

Five lakes; Upper, Middle, and Lower Pigeon, Kenogama, and Biauswah were found to be impaired for aquatic recreation due to natural background conditions. These lakes do not have any land use disturbances within their catchments that could conceivably contribute to a nutrient impairment. Little Cut Foot Sioux was the only lake in this watershed that did not support aquatic recreation and also had a significant amount of development along the lake shore.

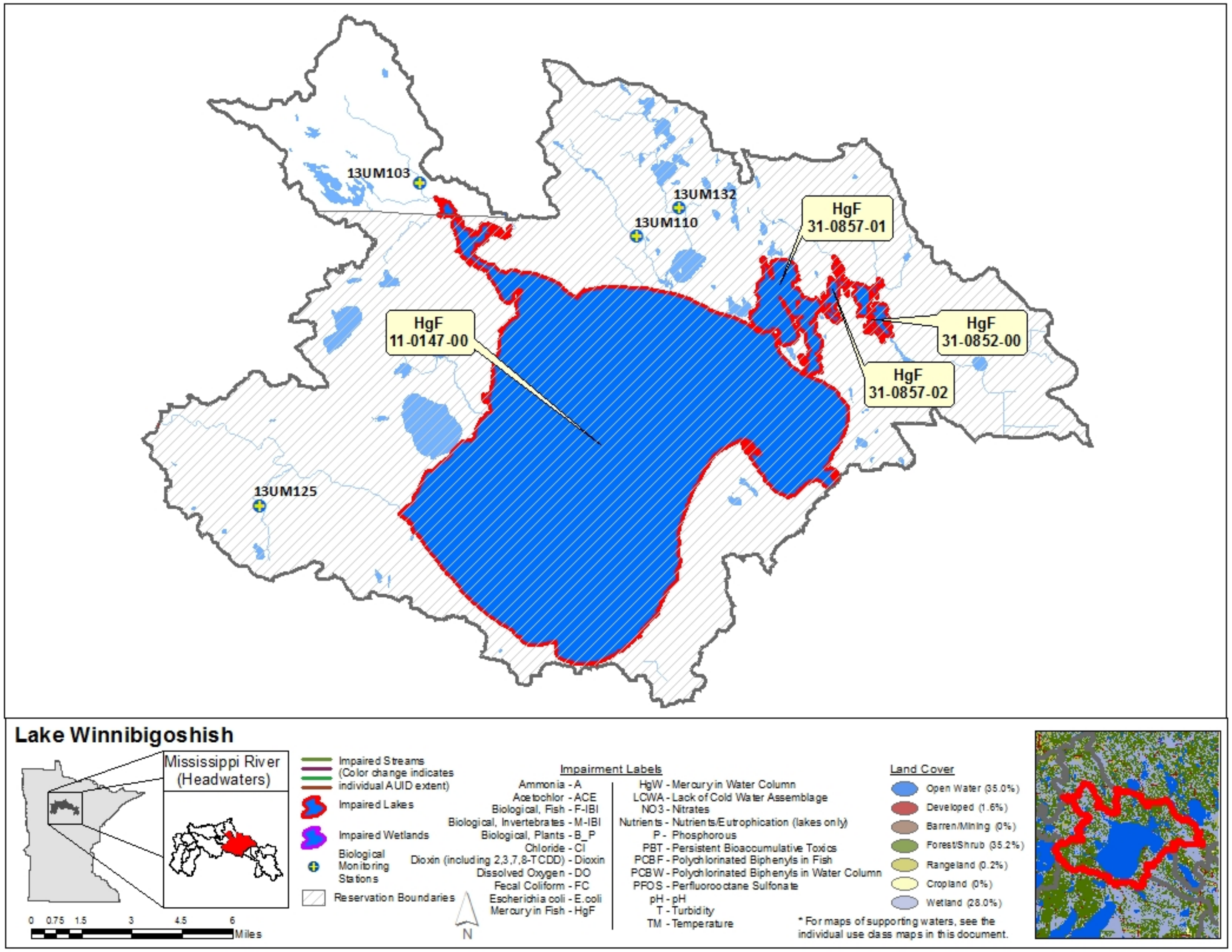

Figure 41. Currently listed impaired waters by parameter and land use characteristics in the Lake Winnibigoshish Subwatershed.

Deer River Subwatershed

HUC 0701010108-01

The Deer River Subwatershed is located in central Itasca County and drains approximately 87.3 square miles. Originating at Deer Lake, the Deer River flows southwesterly approximately 18 miles to its confluence with the Mississippi River, near the town of Deer River. Island Lake Creek, which drains 2.4 miles out of Hansen Lake, is the only named tributary to the Deer River. The subwatershed contains numerous lakes: Notable named lakes include Deer, Moose, Little Moose, Island, Johnson, and Pughole Lakes. The eastern portion of the subwatershed has a high density of lakes, most of which drain to the Deer River. The western portion of the watershed is void of lakes. The land use is primarily forest (45.3%), however wetlands (27%) and open water (17%) are mixed throughout. The water chemistry monitoring station for this subwatershed is represented by the outlet station 13UM105 on the Deer River at County Road 128, 0.5 mi. NE of Deer River.

Table 38. Aquatic life and recreation assessments on stream reaches: Deer River Subwatershed. Reaches are organized upstream to downstream in the table.

AUID *Reach Name*, *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 -NH_3	Pesticides ***	Eutrophication: Phosphorous	Eutrophication: Response Indicator	Aquatic Life	Aquatic Rec. (Bacteria)
07010101-619 ***Island Lake Creek,*** *Hansen Lk outlet to Deer R*	13UM119	2.36	WWg	MTS	--	IF	IF	IF	--	IF	--	--	IF	--	SUP	NA
07010101-505 ***Deer River,*** *Bay Lk to Mississippi R*	13UM106 13UM105	18.36	WWg	MTS	MTS	IF	IF	MTS	IF	MTS	MTS	--	IF	--	SUP	SUP

Abbreviations for Indicator Evaluations: **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, **LRVW** = limited resource value water
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Table 39. Minnesota Stream Habitat Assessment (MSHA): Deer 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	13UM105	Deer River	4	13.5	15.2	17	19	68.7	Good
1	13UM106	Deer River	2.5	12	9	14	25	62.5	Fair
1	13UM119	Island Lake Creek	4	10	9.2	17	16	56.2	Fair
1	13UM145	Unnamed Creek	4	8.5	11.6	16	15	55.1	Fair
		Average Habitat Results: *Deer River Subwatershed*	**3.9**	**10.6**	**10.5**	**14.4**	**18.6**	**58**	**Fair**

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: Deer River Subwatershed.

Station location:	Deer River, at CR 128, .5 miles East of Deer River, MN						
STORET/EQuIS ID:	S007-620						
Station #:	13UM105						
Parameter	Units	# of Samples	Minimum	Maximum	Mean	WQ Standard[1]	# of WQ Exceedances
Ammonia-nitrogen	ug/L	15	1.0	25.6	10.8	40	0
Chloride	mg/L	10	3	6	4	230	0
Dissolved Oxygen	mg/L	13	4.4	8.8	6.3	5	2
pH		13	7.2	7.8	7.5	6.5 - 9	0
Secchi Tube	100 cm	19	99	100	100	40	0
Total suspended solids	mg/L	10	1	6	3	15	0
Phosphorus	ug/L	10	31	70	46	50	4
Chlorophyll-a, Corrected	ug/L	-	-	-	-	7	-
Escherichia coli (geometric mean)	MPN/100ml	2	37	65	-	126	0
Escherichia coli	MPN/100ml	15	12	613	86	1260	0
Inorganic nitrogen (nitrate and nitrite)	mg/L	10	0.10	1.00	0.27	-	-
Kjeldahl nitrogen	mg/L	10	0.6	2.7	1.2	-	-
Orthophosphate	ug/L	-	-	-	-	-	-
Pheophytin-a	ug/L	-	-	-	-	-	-
Specific Conductance	uS/cm	13	179	279	248	-	-
Temperature, water	deg °C	13	7.3	24.4	17.2	-	-
Sulfate	mg/L	10	1	5	2	-	-
Hardness	mg/L	10	87	137	122	-	-

[1]Secchi Tube standards are surrogate standards derived from the total suspended solids standard.

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

Table 41. Lake assessments: Deer River Subwatershed.

Name	DNR Lake ID	Area (acres)	Trophic Status	Percent 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
Clarke	31-0578-00	32	M	72.9	10.4			13	2	3.6	FS	NA
McAvity	31-0585-00	138	O	74.5	8.8		NT	11	4	4.9	FS	NA
Johnson	31-0586-00	445	O	29.7	26.8		D	9	4	4.7	FS	FS
Orange	31-0587-00	98	O	56	9.1			10	2	3.3	FS	NA
Little Horn	31-0588-00	38	M	57	15.2					3.5	IF	NA
Beaver	31-0590-00	57	M	90	9.1			19	4	2.4	FS	NA
Cottonwood	31-0594-00	124	M	52	12.2			19	5	2.9	FS	FS
Amen	31-0597-00	213	O	53.5	22.9		NT	10	1	5.1	FS	NA
Big Horn	31-0598-00	33	M	65.9	6.1					2.3	IF	NA
Pughole	31-0602-00	149	M	93	7.0			15	5	3.1	FS	NA
Fawn	31-0609-00	181	M	47	12.2			14	2	3.1	FS	NA
Little Moose	31-0610-00	288	M	45.4	7.0		NT	15	4	2.4	FS	FS
Dead Horse	31-0611-00	11	E							0.8	IF	NA
Deer	31-0719-00	4,035	O	22	30.5	12.5	I	8	2	5.5	FS	FS
Moose	31-0722-00	1,269	M	27.3	18.6	5.8	NT	16	4	4.2	FS	FS
Chase	31-0749-00	200	O	54.1	28.7	11.0		8	1	8.1	FS	NA
Little Deer	31-0751-00	63	O	57.7	11.9			10	1	5.1	FS	NA
Island	31-0754-00	284	M	65	9.4			17	6	2.4	FS	FS
Alp	31-0761-00	36	M							2.1	IF	NA

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

H – Hypereutrophic
E – Eutrophic
M – Mesotrophic
O - Oligotrophic

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

Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use

Summary

The Deer River is one of the last major tributary streams to the Mississippi River within the Upper Mississippi River (Headwaters) Watershed. Tributaries to the Deer River include Island Lake Creek and a number of small unnamed streams. Aquatic life Indicators for this subwatershed consistently reflect good water quality with fish and macroinvertebrate communities meeting, or exceeding, their respective standards.

The Deer River (AUID - 505) flows 18.4 miles from Deer Lake to its outlet at the Mississippi River just south of the town of Deer River. The River exhibits numerous changes in land use along its course, consisting primarily of forest and wetland but also a fair amount of development; the development is primarily downstream of Chase Lake Rd. Two biological monitoring stations (13UM105, 13UM106) were sampled for fish and macroinvertebrates in 2013; both IBI's indicate support for aquatic life. The fish community at both stations consisted of two sensitive species (Horneyhead Chub, Burbot). Habitat ratings along the Deer River were fair to good. Both stations received very good MSHA metric scores for cover indicating that there is a healthy mixture of aquatic vegetation, bank habitat, wood, and deeper pool that supports a diverse biological community.

Island Lake Creek originates in Island Lake before flowing south 3.9 miles to its confluence with the Deer River. Island Lake Creek is split into two sections. The upper reach was not sampled due to its small drainage. One biological monitoring station (13UM119) was located on the downstream segment (-619). This station was sampled once for fish in 2013, and had an FIBI score far above the impairment threshold. Macroinvertebrates were not collected along this reach because the stream had insufficient flow during the time of sample.

Aquatic recreation and aquatic life were assessed in 15 and 6 lakes, respectively. All lakes assessed for aquatic recreation had excellent water quality and fully supported the use. The highest phosphorus and Chl-a concentrations observed in lakes within the watershed were well below the eutrophication standards. Protection should be the primary focus on lake within this watershed. Four additional lakes; Little Horn, Big Horn, Dead Horse, and Alp only had Secchi data available and were not able to be assessed. Six lakes were assessed for aquatic life use using the FIBI. Cottonwood, Little Moose, Deer, Moose, and Island are high quality lakes, with exceptional fish communities. None of the lakes in this subwatershed had fish species considered tolerant of pollution in their survey results. Cisco was found in Deer Lake and Moose Lake, and Iowa Darter was found in all the lakes noted above. Johnson Lake is the only lake to score below the impairment threshold. Johnson is a headwater lake with no surface water connection to other waters. Its watershed has little disturbance, with only 3% development overall and 40% of the lakeshore publically held (i.e. undisturbed shoreland). The dock density is also low, indicating that development/human disturbance is not a major contributor of stress to this lake. In addition, aquatic plant surveys conducted on Johnson Lake as well as all other FIBI lakes indicated that the assessed lakes in this subwatershed have healthy plant communities. Johnson's isolation appears to be the primary factor responsible for its low species diversity and IBI score. Due to all of these factors (i.e. healthy plant community, low watershed disturbance, isolation from other waterbodies), Johnson Lake was considered to fully support aquatic life.

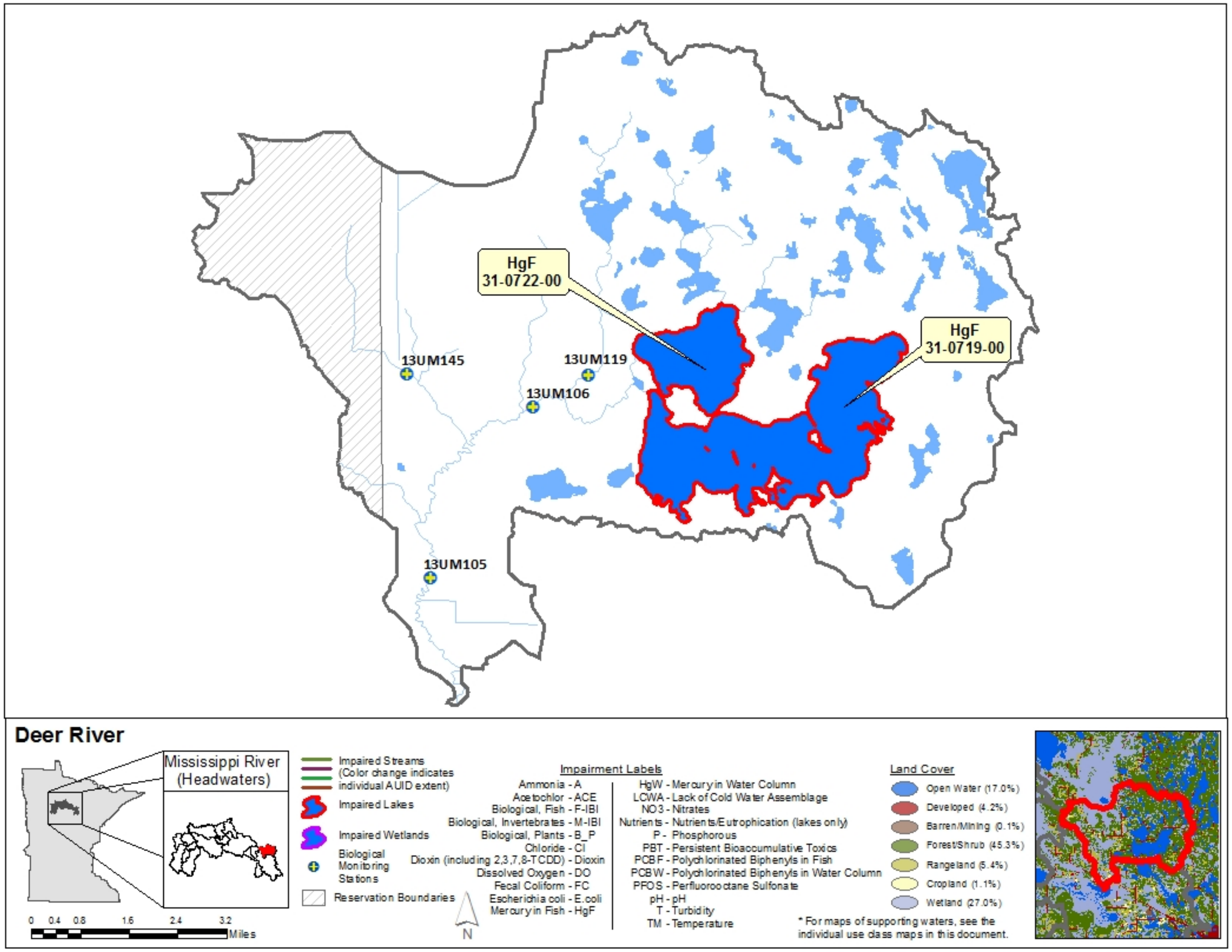

Figure 42. Currently listed impaired waters by parameter and land use characteristics in the Deer River Subwatershed.

Ball Club Lake Subwatershed HUC 0701010109-03

The Ball Club Lake Subwatershed drains 43.3 square miles within Itasca County, making it the smallest subwatershed within the Mississippi River (Headwaters) Watershed. The only named stream within the subwatershed is Fisherman's Brook, which originates approximately 5 miles east of Lake Winnibigoshish and flows 6.6 miles south to Ball Club Lake. Aside from Ball Club Lake, other named lakes include Little Ball Club and Tuttle Lake. This subwatershed lies entirely within the Leech Lake Indian Reservation and the landscape is primarily undeveloped (approximately 94%). Due to its small drainage size, no water chemistry monitoring station was established.

Table 42. Aquatic life and recreation assessments on stream reaches: Ball Club Lake Subwatershed. Reaches are organized upstream to downstream in the table.

				Aquatic Life Indicators:									Eutrophication			
AUID ***Reach Name***, *Reach Description*	**Biological Station ID**	**Reach Length (miles)**	**Use Class**	Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Phosphorous	Response Indicator	**Aquatic Life**	**Aquatic Rec. (Bacteria)**
07010101-741 ***Fisherman's Brook,*** *Headwaters to Ball Club Lk*	13UM111	6.66	WWg	EXS	MTS	IF	IF	IF	--	IF	IF	--	IF	--	IMP	NA

Abbreviations for Indicator Evaluations: **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, **LRVW** = limited resource value water
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Table 43. Minnesota Stream Habitat Assessment (MSHA): Ball Club Lake 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
3	13UM111	Fisherman's Brook	3.9	10.6	10.48	14.4	18.6	58	Fair
		Average Habitat Results: *Ball Club Lake Subwatershed*	**3.9**	**10.6**	**10.48**	**14.4**	**18.6**	**58**	**Fair**

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: Ball Club Lake Subwatershed.

Name	DNR Lake ID	Area (acres)	Trophic Status	Percent 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	31-0812-00	3,847	O		25.9	11.9		11	2	3.6	FS	IF
Little Ball Club	31-0822-00	181	M	45	8.8			17	7	2.3	FS	NA

Abbreviations:

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

H – Hypereutrophic
E – Eutrophic
M – Mesotrophic
O - Oligotrophic

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

Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use

Summary

Water quality indicators in the Ball Club Lake Subwatershed show mixed results. Fisherman's Brook is the only named stream within the subwatershed boundaries; this stream lies entirely within the Leech Lake Indian Reservation. One biological monitoring station (13UM111) was sampled once for fish in 2013 and 2014, and once for macroinvertebrates in 2014. The 2014 MIBI score was well above the impairment threshold and contained numerous sensitive and long lived taxa. The fish community was very poor in 2013 and 2014, with the FIBI scored near zero both times. Habitat data indicates that severe embeddedness and heavy bank erosion was noted throughout the reach. Fisherman's Brook drains a large tamarack swamp by a historically dredged drainage ditch. During high flows from spring snow melt and large precipitation events, Fisherman's Brook takes on a substantial amount of water, which in return appears to be incising the stream banks and blowing out habitat.

Aquatic recreation was assessed on two lakes. This subwatershed is relatively small and consists of the lake catchment area that drains directly to Ball Club Lake. Little Ball Club and Ball Club Lakes both support aquatic recreation. Little Ball Club is shallower and has higher phosphorus, Chl-a, and a lower Secchi transparency then Ball Club. Ball Club is much larger and has a greater maximum depth. In turn, phosphorus and Chl-a concentrations are lower and Secchi transparency is better. Both lakes have good water quality and future management should be based on protecting current water quality conditions.

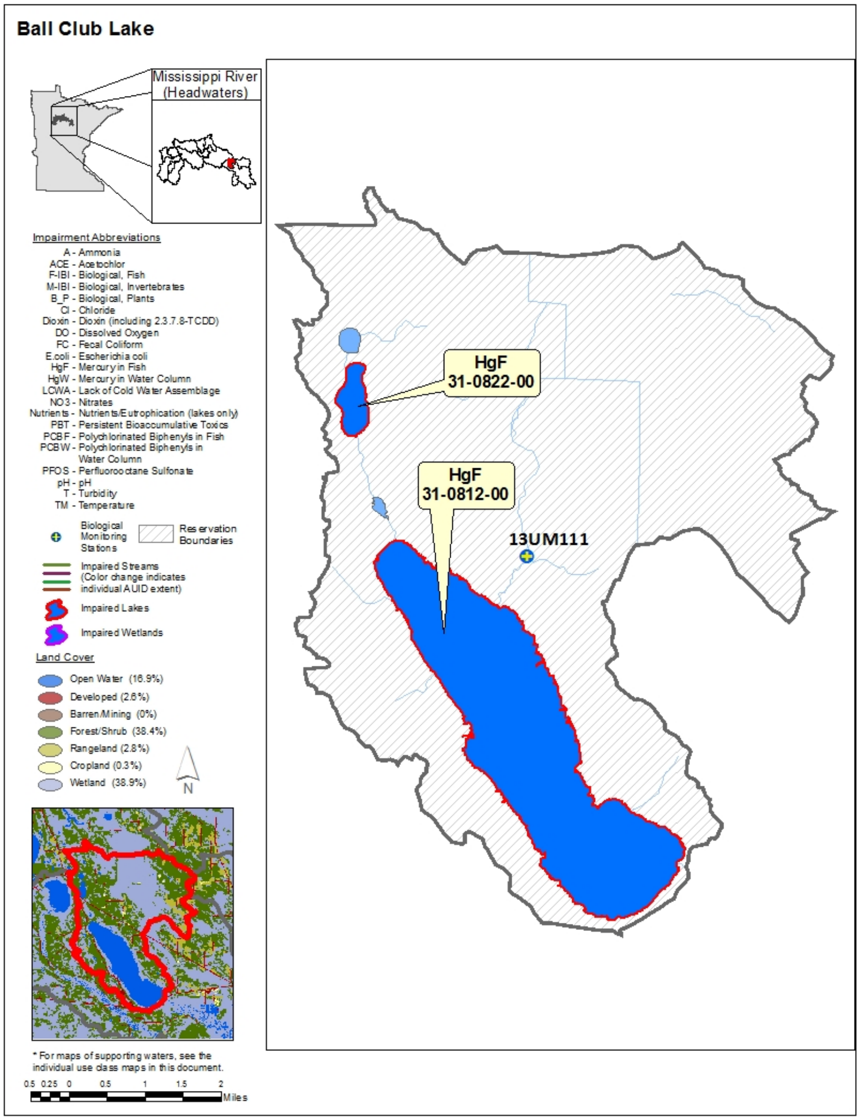

Figure 43. Currently listed impaired waters by parameter and land use characteristics in the Ball Club Lake Subwatershed

Vermillion River Subwatershed HUC 0701010109-02

The Vermillion River Subwatershed drains 45 square miles of northeastern Cass County. From its headwaters, the Vermillion River flows approximately 16 miles to its confluence with the Mississippi River, 7.5 miles west of Cohasset. A number of lakes reside within the subwatershed boundaries, most notably Lake Vermillion, Little Vermillion, Sugar, Spring, and Long Lake. Land use within the watershed is primarily forest (59.1%) and wetlands (29.4%). The water chemistry monitoring station for this subwatershed was established on the Vermillion River at CSAH 74, 8.5 miles South of Deer River.

Table 45. Aquatic life and recreation assessments on stream reaches: Vermillion Subwatershed. Reaches are organized upstream to downstream in the table.

				Aquatic Life Indicators:									Eutrophication			
AUID ***Reach Name,*** *Reach Description*	**Biological Station ID**	**Reach Length (miles)**	**Use Class**	Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Phosphorous	Response Indicator	**Aquatic Life**	**Aquatic Rec. (Bacteria)**
07010101-521 ***Vermillion River,*** *Headwaters to Mississippi R*	13UM161	15.69	WWg	NA	MTS	NA	MTS	MTS	MTS	MTS	MTS	--	IF	--	SUP	SUP

Abbreviations for Indicator Evaluations: **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, **LRVW** = limited resource value water
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Table 46. Minnesota Stream Habitat Assessment (MSHA): Vermillion 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	13UM161	Vermillion River	5	13	14.8	14	27	73.8	Good
		Average Habitat Results: *Vermillion River Subwatershed*	**5**	**13**	**14.8**	**14**	**27**	**73.8**	**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 47. Outlet water chemistry results: Vermillion River Subwatershed.

Station location:	Vermillion River, at 88th Avenue / CSAH 74, 8.5 miles South of Deer River, MN						
STORET/EQuIS ID:	S006-258						
Station #:	N/A						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**WQ Standard[1]**	**# of WQ Exceedances**
Ammonia-nitrogen	ug/L	12	0.3	4.8	1.3	40	0
Chloride	mg/L	10	1	6	3	230	0
Dissolved Oxygen	mg/L	13	0.6	7.6	3.3	5	9
pH		13	7.2	7.5	7.4	6.5 - 9	0
Secchi Tube	100 cm	19	100	100	100	40	0
Total suspended solids	mg/L	10	1	5	3	15	0
Phosphorus	ug/L	10	27	84	44	50	2
Chlorophyll-a, Corrected	ug/L	-	-	-	-	7	-
Escherichia coli (geometric mean)	MPN/100ml	3	34	46	-	126	0
Escherichia coli	MPN/100ml	15	18	157	50	1260	0
Inorganic nitrogen (nitrate and nitrite)	mg/L	10	0.10	1.00	0.29	-	-
Kjeldahl nitrogen	mg/L	10	1.0	4.0	2.0	-	-
Orthophosphate	ug/L	-	-	-	-	-	-
Pheophytin-a	ug/L	-	-	-	-	-	-
Specific Conductance	uS/cm	13	206	484	315	-	-
Temperature, water	deg °C	13	5.6	22.6	16.9	-	-
Sulfate	mg/L	10	1	3	2	-	-
Hardness	mg/L	10	120	235	165	-	-

[1]Secchi Tube standards are surrogate standards derived from the total suspended solids standard.

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

Table 48. Lake assessments: Vermillion River Subwatershed.

Name	DNR Lake ID	Area (acres)	Trophic Status	Percent 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
Spring	11-0022-00	85	O	33.9	13.7					5.0	IF	NA
Long	11-0023-00	113	M	64.7	7.3			19	6	2.6	FS	NA
Sugar	11-0026-00	689	M	49	13.4	4.6		24	10	3.7	IF	FS
Vermillion	11-0029-00	408	E	58	8.2		NT	31	11	1.9	IF	FS
Little Vermillion	11-0030-00	148	M	56	15.2			18	4	3.5	FS	NA

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

Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use

Summary

Water quality in the Vermillion River Subwatershed is good. Aquatic life and aquatic recreation indicators easily met standards. The Vermillion River is the only river within the subwatershed boundaries, flowing 15.6 miles from its headwaters to the Mississippi River. The headwaters of the watershed are almost entirely natural, consisting of dense forest and wetlands. Biological monitoring was limited to one site (16UM161) on the upper portion of the Vermillion River. The macroinvertebrate IBI score was good; the community included a number of sensitive taxa. However, the F-IBI score was low in spite of excellent habitat within the reach. The reach sampled had excellent channel morphology and suitable substrates for sensitive organisms. The surrounding land use shows little to no human disturbance, and water chemistry parameters are all meeting standards. While conducting follow up monitoring to determine the cause of the poor F-IBI score, extensive beaver activity was found upstream and downstream of the reach. These very large beaver dams (Figure 44) appear to be significant barriers and likely prohibit fish passage. Therefore, based primarily on the water quality and macroinvertebrate indicators, the reach was determined to fully support aquatic life.

Figure 44. Beaver dam upstream of 16UM161 in the spring of 2014

There were data to assess five lakes for aquatic recreation; Long, Spring, Sugar, Vermillion, and Little Vermillion. Long Lake, located in the headwaters portion of this watershed, fully supports aquatic recreation. Spring Lake, just downstream via a small tributary and wetland drainage had only one Secchi measurement so an aquatic recreation assessment was not possible. Vermillion Lake, still further downstream, had phosphorus concentrations that were near the eutrophication standard. Vermillion drains a large forested and wetland area and has significant development along it shoreline. Vermillion should be considered vulnerable because additional phosphorus inputs would likely lead to exceedances of the eutrophication standard. Sugar Lake is the largest lake in this subwatershed. Phosphorus, Chl-a, and Secchi data collected in 2004 and 2014 indicate that Sugar Lake supports aquatic recreation. However, one additional year of monitoring would be beneficial. Little Vermillion is the last lake on the Vermillion River before the pour point of this sub watershed. It is also the deepest lake in the sub watershed and likely has the ability to assimilate phosphorus as it has a lower concentration than the two lakes immediately upstream; Vermillion and Sugar. Vermillion Lake's large watershed catchment combined with the relatively high phosphorus concentrations in the upstream lakes make it particularly vulnerable to further phosphorus loading.

Fish IBI's surveys were conducted on Vermillion lake in 2010 and Sugar Lake in 2014. Both surveys resulted in IBI scores that easily met their respective standards. Bluegill were well represented in samples collected from near shore areas in both lakes. Also, the seine halls from both lakes included two sensitive cyprinids; Blackchin and Blacknose Shiners. Tolerant species were nearly absent from both lakes; the samples collected from Vermillion lake contained a few Black Bullheads while only one fathead minnow was collected from Sugar Lake. Aquatic plant surveys indicated that species richness and floristic quality were good in both lakes.

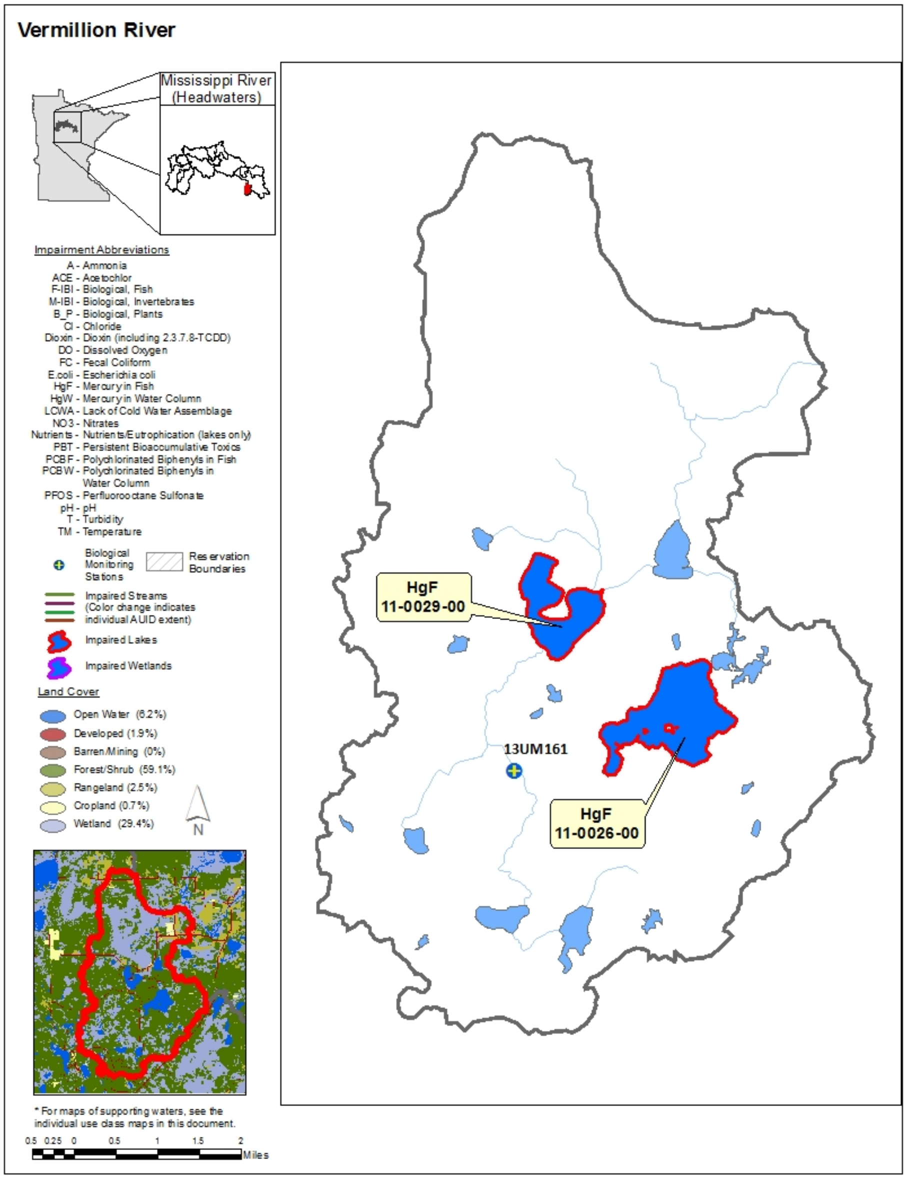

Figure 45. Currently listed impaired waters by parameter and land use characteristics in the Vermillion River Subwatershed.

Pokegama Lake-Mississippi River Subwatershed HUC 0701010109-01

The Pokegama Lake-Mississippi River Subwatershed drains 274 square miles of land in Cass and Itasca counties. Major tributaries within this subwatershed include Sugar Brook and Smith Creek. Sugar Brook flows from Sugar lake approximately two miles to Lake Pokegama. Smith Creek flows approximately six miles from its headwaters to Smith Lake; Smith Creek is one of the few coldwater streams within the Mississippi River (Headwaters) Watershed. The landscape within this subwatershed is almost entirely natural, with forest and wetlands making up approximately 90% of the land use. This is a flow-through subwatershed along the Mississippi River, therefore no water chemistry station was established.

Table 49. Aquatic life and recreation assessments on stream reaches: Pokegama Lake-Mississippi RIver Subwatershed. Reaches are organized upstream to downstream in the table.

				Aquatic Life Indicators:									Eutrophication			
AUID ***Reach Name,*** *Reach Description*	**Biological Station ID**	**Reach Length (miles)**	**Use Class**	Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Phosphorous	Response Indicator	**Aquatic Life**	**Aquatic Rec. (Bacteria)**
07010101-692 ***Sugar Brook,*** *Unnamed Lk (31-0553-00) to Pokegama Lk*	13UM141	2.04	WWg	MTS	MTS	IF	MTS	IF	IF	MTS	IF	--	IF	--	SUP	NA
07010101-732 ***Unnamed Creek,*** *Headwaters to Pokegama Lk*		2.17	WWg	--	--	IF	MTS	--	IF	MTS	IF	--	IF	--	IF	NA
07010101-659, ***Unnamed Creek (Pokegama Creek),*** *Headwaters to Sherry Lk*		2.73	CWg	--	--	IF	IF	--	IF	MTS	--	--	IF	--	IF	NA
07010101-644 ***Smith Creek,*** *Headwaters to Smith Lk*	13UM137 14UM101	6.23	CWg	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	--	SUP	NA
07010101-645 ***Smith Creek,*** *Smith Lk to Little Pokegama Lk*		1.65	CWg	--	--	IF	IF	--	--	MTS	IF	--	IF	--	IF	NA

Table 49 cont.

Abbreviations for Indicator Evaluations: **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, **LRVW** = limited resource value water
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Table 50. Minnesota Stream Habitat Assessment (MSHA): Pokegama Lake-Mississippi 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
4	13UM141	Sugar Brook	4.17	11.30	19.67	15	25.67	75.83	Good
1	13UM137	Smith Creek	5	13	19	13	23	73	Good
2	14UM101	Smith Creek	5	12.75	19.6	10.5	24	71.85	Good
Average Habitat Results: *Pokegama Lake-Mississippi River Subwatershed*			4.61	12.17	19.26	13.22	24	73.26	**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 51. Lake assessments: Pokegama Lake-Mississippi River subwatershed.

Name	DNR Lake ID	Area (acres)	Trophic Status	Percent 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
Tioga Mine Pit	31-0946-00	48	O	1	68.6					12.7	IF	NA
Stokey	31-0358-00	12	M							3.7	IF	NA
Unnamed	31-0359-00	13	E							0.8	IF	NA
Munzer	31-0360-00	101	M		5.2			21	8	2.0	FS	NA
POKEGAMA (MAIN BAY)	31-0532-01	1,107	O		33.5	10.4	NT	12	4	4.7	FS	IF
POKEGAMA (WENDIGO)	31-0532-02	5,527	O		33.5	11.0	NT	8	3	4.3	FS	IF
Smith	31-0547-00	43	M	78.9	7.6		NT			2.7	IF	NA
Unnamed	31-0549-00	22	E							0.8	IF	NA
Siseebakwet	31-0554-00	1,205	O	22	32.0	12.8	I	5	1	5.3	FS	FS
South Sugar	31-0555-00	87	O		11.0	4.9	NT	11	3	4.6	FS	NA
Unnamed	31-0557-00	19	M							2.4	IF	NA
Unnamed	31-0559-00	11	M							3.4	IF	NA
Warburg	31-0563-00	43	E							1.7	IF	NA
Unnamed	31-0564-00	76	E							1.8	IF	NA
Jay Gould	31-0565-00	532	M	68	10.1		NT	13	6	3.4	FS	FS
Little Jay Gould	31-0566-00	147	O	52	17.1	4.6		10	4	4.0	FS	FS
Guile	31-0569-00	90	M		15.2		NT			3.8	IF	NA
Long	31-0570-00	125	O	60	22.9			8	2	5.8	FS	IF
Loon	31-0571-00	223	O	48	21.0		NT	8	3	4.3	FS	FS
Salter Pond	31-0573-00	24	E							1.8	NA	NA
Little Bass	31-0575-00	158	O	35.4	18.9	7.0		9	2	4.1	FS	FS
Bass	31-0576-00	2,662	M		12.2	6.1	I	17	5	4.4	FS	NA
Mallard	31-0583-00	12	M							3.1	NA	NA
Little Rice	31-0716-00	141	M	43.8	10.4			13	4	3.4	FS	NA
Rice	31-0717-00	841	O	229	20.7		NT	9	2	3.8	FS	FS
Stevens	31-0718-00	229	E		2.4			26	4	1.5	FS	NA

Little Siseebakwet	31-0733-00	326	M	100	2.7			20	4	1.2	FS	NA
Spring	31-0735-00	19	E							1.2	IF	NA
Skelly	31-0736-00	66	M		10.7					2.7	IF	NA
Leighton	31-0739-00	234	O	10	19.2			8	2	4.0	FS	NA
Little White Oak	31-0740-00	522	E					25	3	2.3	IF	NA
Little Drum	31-0741-00	86	E		0.9					0.9	NA	NA
Miller	31-0748-00	63	M		6.7					2.3	NA	NA
White Oak	31-0776-00	942	E					32	9	1.3	IF	NA
Little Winnibigoshish	31-0850-00	823	M	22.3	7.9	4.9		17	4	3.2	FS	NA

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

H – Hypereutrophic
E – Eutrophic
M – Mesotrophic
O - Oligotrophic

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

Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use

Summary

The Pokegama Lake – Mississippi River Subwatershed represents the outlet of the Mississippi River (Headwaters) Watershed at the Lake Pokegama Dam in Grand Rapids. Biological Data was collected at stations on Sugar Brook (-692) and Smith Creek (-644). Aquatic life indicators for this subwatershed reflect good water quality with fish and macroinvertebrate communities meeting, or exceeding, their respective standards.

From its headwaters at Sugar Lake, Sugar Brook flows 3.5 miles to Lake Pokegama. Biological data was collected from one station (13UM141) on Sugar Brook. Macroinvertebrate samples were collected in 2013 and 2014. The 2013 sample scored above the general use threshold but the 2014 sample was just below the general use threshold. The lower MIBI score in 2014 was likely caused be a hyperdominance of blackfly larva in the sample. Both samples had both sensitive and coldwater obligate taxa present, suggesting some groundwater influence within this system. The fish data collected in 2013 failed to meet aquatic life standards. After reviewing aerial imagery, extensive beaver activity was noticed upstream and downstream of the biological monitoring station. According to local residents, Sugar Brook experiences extensive beaver activity. In the 1970's and 80's beaver dams were often removed by DNR or the County but in recent times beaver dam removal has been more sporadic. One local resident indicated that dams were removed between 2014 and 2015. A second fish sample taken from Sugar Brook in 2015 met the aquatic life standards. Walleye were captured in the second sample suggesting that fish migration through the system has improved. Walleye are likely coming into the stream from Sugar Lake, or Lake Pokegama. The improved F-IBI scores along with good MIBI and water chemistry results led to a decision to assess the stream as fully supporting for aquatic life.

Smith Creek is one of the few coldwater trout streams in the Mississippi River (Headwaters) Watershed. The creek begins in a large wetland complex 8.5 miles southwest of Grand Rapids. From there, the river flows 6.2 miles to Smith Lake. Downstream of Smith Lake the creek flows 1.7 miles to its outlet at Lake Pokegama. The creek has very good flow, clean course substrates, good shade, and cold water suitable for coldwater organisms. The riparian corridor is generally natural, and primarily dense forest. Two biological monitoring stations were established on the upper 6.2 miles of Smith Creek (- 644). Biological communities at all stations indicate full support. Brook trout were collected at two of the three stations (13UM137, 14UM101). Both stations were sampled for macroinvertebrates; both scored well above the general use thresholds with several stenothermic taxa present. Habitat conditions are very good all along Smith Creek (Table 50) and are likely contributing to the robust biological communities.

The Mississippi River flows through Little Winnibigoshish and Jay Gould Lake before exiting this sub watershed. Jay Gould receives water from many lakes in the southern portion of the watershed. Long and Loon contribute to Jay Gould as well as water from Pokegama which receives water from Little Siseebakwet, Siseebakwet, South Sugar, and Munzer. Lakes throughout the watershed also drain through small tributaries to the Mississippi River. Rice, Little Rice, and Leighton drain from the south while North Stevens, Bass, and Little Bass drain from the north.

Aquatic recreation and aquatic life were assessed in 17 and 6 lakes, respectively. All of the assessed lakes support aquatic recreation.

White Oak was the only lake that had a concentration of phosphorus, Chl-a, and Secchi transparency that were at the eutrophication standards. White Oak appears to be a shallow lake with a large wetland influence as the Deer River enters the lake. Water then drains through a series of channels and diffusely through wetlands until its confluence with Mississippi River. Land use along the Deer River should be managed to promote good water quality entering White Oak and ultimately the Mississippi River.

Six lakes were assessed for aquatic life using the FIBI: Siseebakwet, Jay Gould, Little Jay Gould, Loon, Little Bass, and Rice. These are high quality lakes, with exceptional fish communities observed in all the lakes, with the exception of Little Jay Gould which scored just below the exceptional threshold. Only Little Bass Lake had a pollution tolerant species, the Green Sunfish. Banded Killifish, Rock Bass and Iowa Darter were found in all the lakes. Ciscoes, a pelagic fish requiring well oxygenated cold water were found in Siseebakwet, Loon, Little Bass, and Rice which are all oligotrophic, deep lakes. Aquatic plant surveys were used to assess aquatic life on all the lakes with FIBI; the results indicated that all assessed lakes had healthy aquatic plant communities.

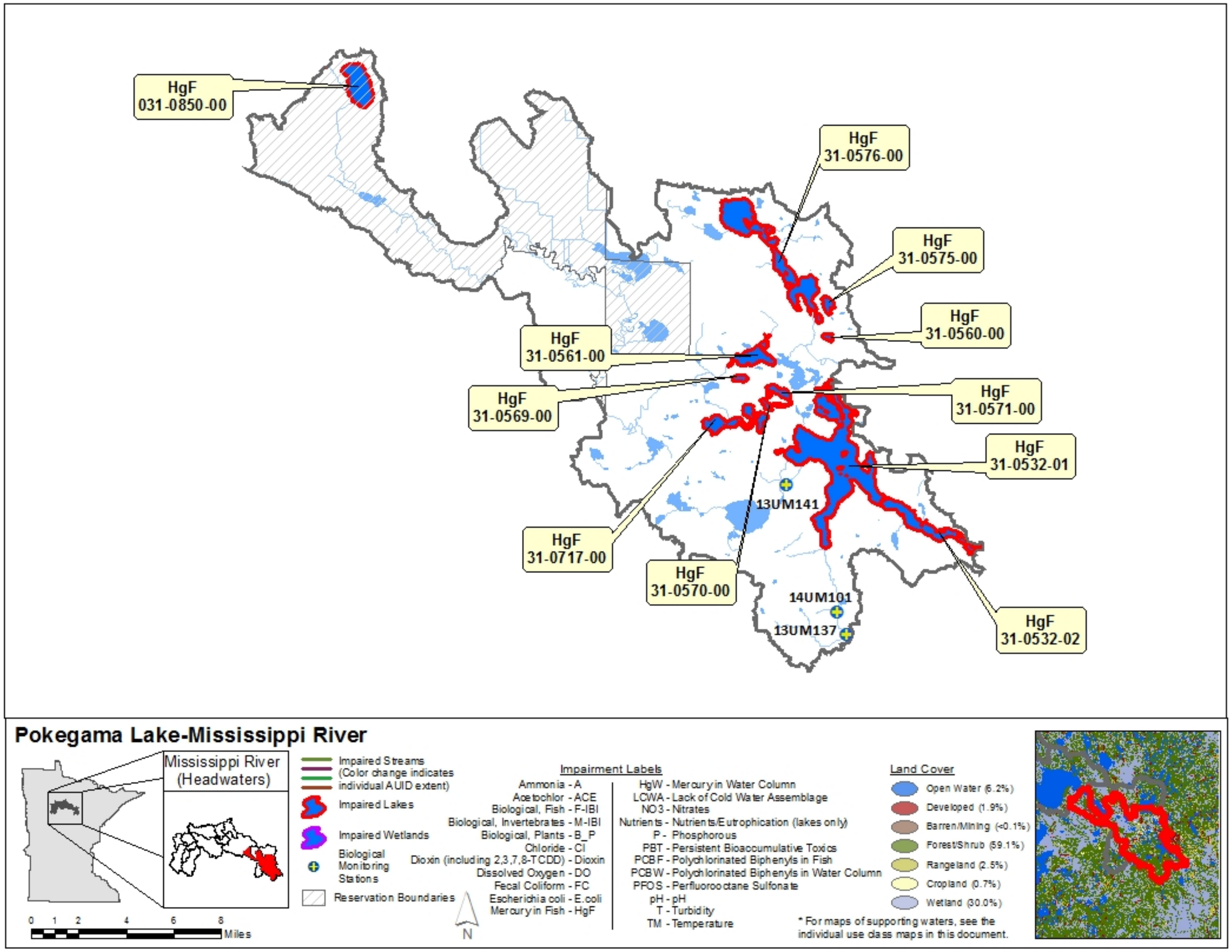

Figure 46. Currently listed impaired waters by parameter and land use characteristics in the Pokegama Lake-Mississippi River Subwatershed.

VI. Watershed-wide results and discussion

Assessment results and data summaries are included below for the entire Mississippi River (Headwaters) Watershed, grouped by sample type. Summaries are provided for load monitoring data results near the mouth of the river, aquatic life and recreation uses in streams and lakes throughout the watershed, and for aquatic consumption results at select river and lake locations along the watershed. Additionally, groundwater monitoring results and long-term monitoring trends are included where applicable.

Following the results are a series of graphics that provide an overall summary of assessment results by designated use, impaired waters, and fully supporting waters within the entire Mississippi River (Headwaters) Watershed.

Watershed pollutant load monitoring

The Mississippi River is monitored just east of Highway 169 in downtown Grand Rapids. Many years of water quality data from throughout Minnesota combined with previous analysis of Minnesota's ecoregion patterns, resulted in the development of three "River Nutrient Regions" (RNR) (MPCA 2010a), each with unique nutrient standards. Of the state's three RNR's (North, Central, South), the Mississippi River's load monitoring station is located within the North RNR. Annual FWMCs were calculated and compared for years 2008-2013 (Figure 47, Figure 48, Figure 49 and Figure 50) and compared to the RNR standards (only TP and TSS draft standards are available for the North RNR). It should be noted that while a FWMC exceeding given water quality standard is generally a good indicator the water body is out of compliance with the River Nutrient Region standard, the rule does 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 (MPCA 2010a), over the most recent 10-year period 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 were above the standard.

Pollutant sources affecting rivers are often diverse and can be quite variable from one watershed to the next depending on land use, climate, soils, slopes, and other watershed factors. However, as a general rule, elevated levels of TSS and nitrate plus nitrite-nitrogen (nitrate-N) are generally regarded as "non-point" source derived pollutants originating from many small diffuse sources such as urban or agricultural runoff. Excess TP and DOP can be attributed to either "non-point" as well as "point", or end of pipe, sources such as industrial or wastewater treatment plants. Major "non-point" sources of phosphorus include dissolved phosphorus from fertilizers and phosphorus adsorbed to and transported with sediment during runoff.

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 canopy development, soil saturation level, and precipitation type and intensity. Surface erosion and in-stream sediment concentrations, for example, will typically be much higher following high intensity rain events prior to canopy development, rather than after low intensity post-canopy events where less surface runoff and more infiltration occur. Precipitation type and intensity influence the major course of storm runoff, routing water through several potential pathways including overland, shallow and deep groundwater, and/or tile flow. 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 FWMCs and loads, barring differences in total runoff volume. During years when high intensity rain events provide the greatest proportion of total annual runoff, concentrations of TSS and TP tend to be higher with DOP and nitrate-N concentrations tending to be lower. In contrast, during years with high snow melt runoff and less intense rainfall events, TSS levels tend to be lower while TP, DOP, and nitrate-N levels tend to be elevated. In many cases, it is a combination of climatic factors from which the pollutant loads are derived.

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.

Analysis has shown a strong correlation to exist between the measures of 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 (MPCA and MSUM 2009). An overabundance of algae can 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 (MPCA and MSUM 2009).

Currently, the State of Minnesota's TSS standards are moving from the "development phase" into the "approval phase" and must be considered to be draft standards until complete approval. Within the South RNR, the TSS draft standard is 15 mg/L (MPCA 2010c), when greater than 10% of the individual samples exceed the draft standard, the river is out of compliance. Calculations from 2008 through 2013 show 0, 0, 0,0, 4 and 0% of the individual TSS samples exceeded the 15 mg/L draft standard, respectively. In addition, none of the computed FWMCs for the five sampling years exceeded the 15 mg/L draft standard (Figure 47). The only sample exceeding the 15 mg/L standard was collected in March, 2012 during low flow conditions. Although the data may not reflect long term trends, both TSS FWMCs and annual loads did not show consistent trends from 2008 through 2013. (**Figure 47** and Because of the strong correlation that often exists between pollutant loads and annual runoff volume, variations in loads may be due strictly to differences in annual runoff volume.

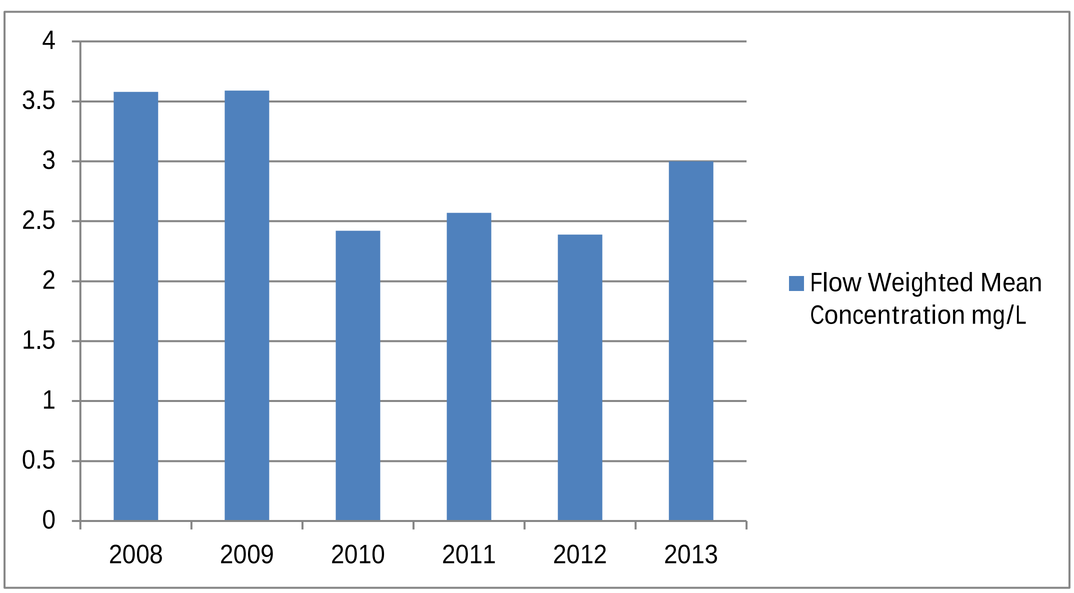

Figure 47. Total Suspended Solids Flow Weighted Mean Concentrations for the Mississippi (Headwaters) Watershed.

Table 52. Annual pollutant loads in kilograms per year by parameter calculated for the Mississippi (Headwaters) Watershed.

Year	Total Suspended Solids	Total Phosphorus	Nitrate Nitrite N	Total Kjeldahl N	Ortho Phosphorus
2008	3394773	29325	30097	711863	6251
2009	4082462	30830	38506	796196	7392
2010	2752215	25371	28374	831322	5480
2011	3846574	38804	37486	1126992	9615
2012	2053148		24978	632738	6777
2013	3564696		38573	878074	7017

Total phosphorus

Nitrogen (N), phosphorus (P), and potassium (K) are essential macronutrients and are required for growth by all animals and plants. Lack of sufficient nutrient levels in surface water often restricts the growth of aquatic plant species (University of Missouri Extension 1999). In freshwaters such as lakes and streams, phosphorus is typically the nutrient limiting growth; increasing the amount of phosphorus entering a stream or lake will increase the growth of aquatic plants and other organisms. Although phosphorus is a necessary nutrient, excessive levels overstimulate aquatic growth in lakes and streams resulting in reduced water quality. The progressive deterioration of water quality from overstimulation of nutrients is called eutrophication where, as nutrient concentrations increase, the surface water quality is degraded (University of Missouri Extension 1999). 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 (University of Missouri Extension 1999). In “non-point” source dominated watersheds, TP concentrations are strongly correlated with stream flow. During years of above average precipitation, TP loads are generally highest.

TP standards for Minnesota’s rivers are also in the final approval phase and must be considered draft standards until approved. Within the North RNR, the TP draft standard is 50 ug/L as a summer average. Summer average violations of one or more “response” variables (pH, biological oxygen demand (BOD), DO flux, chlorophyll-a) must also occur along with the numeric TP violation for the water to be listed. Concentrations from 2008 through 2011, show that 3.6, 0, 0 and 0% of the individual TP samples exceeded the 50 ug/L draft standard, respectively. Observation of Figure 13 shows that all of the FWMCs from 2009 to 2011 are less than the draft standard at 30, 40,22 and 25 ug/L, respectively. At this site, TP concentrations are low at all flows throughout the year.

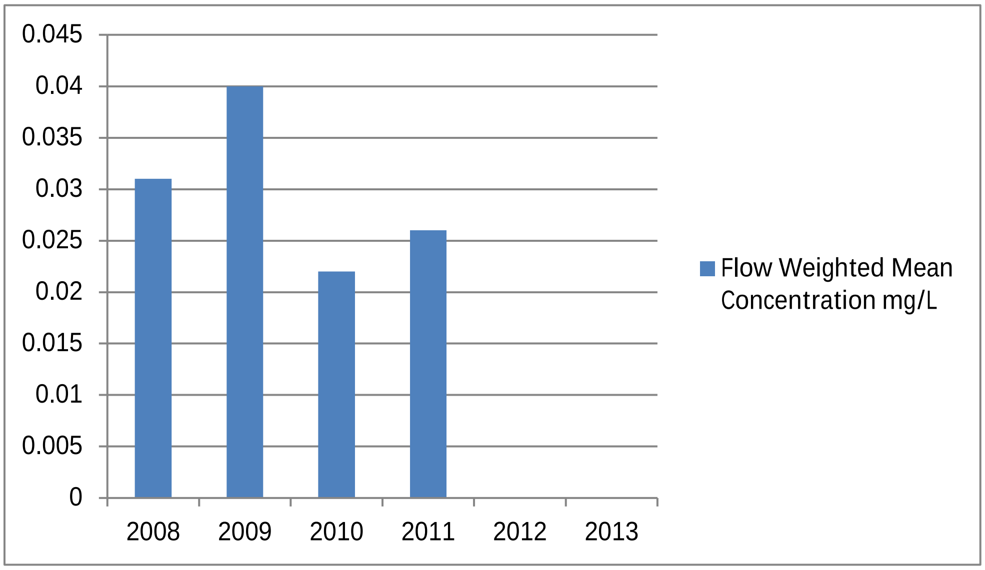

Figure 48. Total Phosphorus (TP) flow weighted mean concentrations for the Mississippi River at Grand Rapids.

Dissolved orthophosphate

DOP is a water-soluble form of phosphorus that is readily available to algae (bioavailable) (MPCA and MSUM 2009). While orthophosphates occur naturally in the environment, river and stream concentrations may become elevated with additional inputs from wastewater treatment plants, noncompliant septic systems, and fertilizers in urban and agricultural runoff. The 2009 through 2011 FWMC ratio of DOP to TP shows that 20 to 25% of TP is in the orthophosphate form. Figure 49 indicates DOP FWMC showed little variation from year to year.

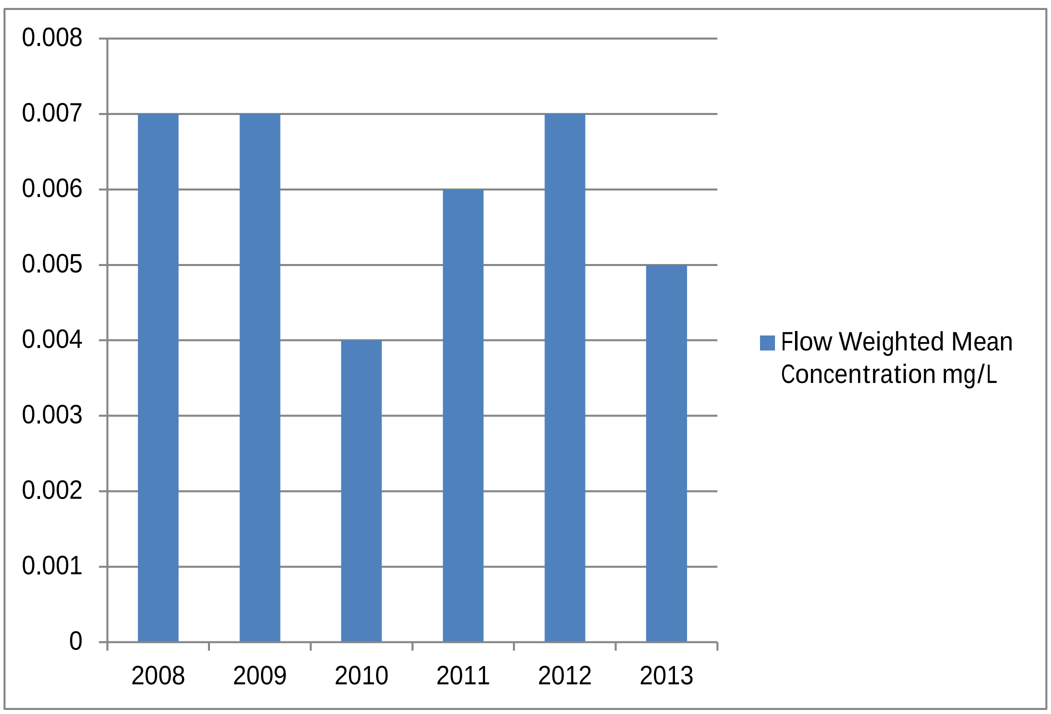

Figure 49. Dissolved Orthophosphate (DOP) flow weighted mean concentrations for the Mississippi River at Grand Rapids.

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 (MPCA 2010b). 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.

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 (2012) for the protection of aquatic life in lakes and streams. The draft acute value (maximum standard) for all Class 2 surface waters is 41 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, Aquatic Life Water Quality Standards Technical Support Document for Nitrate, Nov 2010).

Nitrate-N FWMCs from [2009] through [2013] for the Mississippi Headwaters] Watershed were .034, .025, .025, .029 and .032 mg/L, respectively (**Figure 50**). Calculations of the Mississippi River at Grand Rapid's annual nitrate-N loads show little relationship to the annual runoff volume over the five-year sampling period (Figure 50).

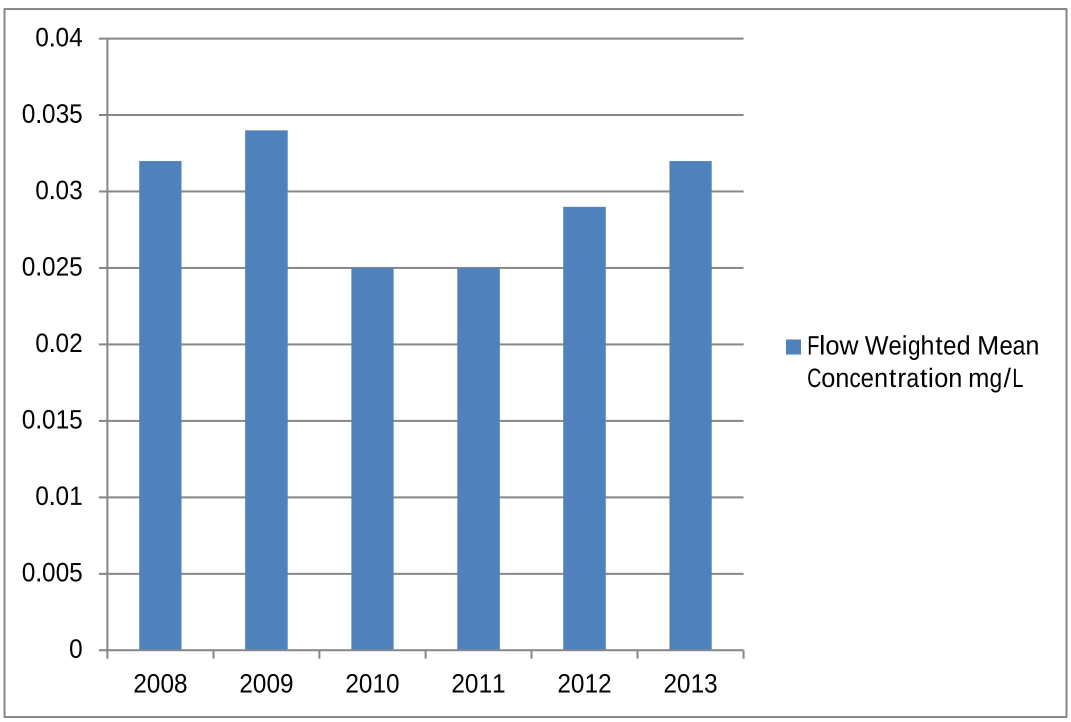

Figure 50. Nitrate-N flow weighted mean concentrations for the Mississippi River at Grand Rapids.

Stream water quality

Within the Upper Mississippi River (Headwaters) Watershed, 30 of the 73 stream reaches were assessed for aquatic life and/or aquatic recreation (Table 53). Assessment summary for stream water quality in the Mississippi River (Headwaters) Watershed. Of the assessed stream reaches, 28 fully supported aquatic life and one did not. All nine of the streams that were assessed for aquatic recreation were fully supporting.

Table 53. Assessment summary for stream water quality in the Mississippi River (Headwaters) River Watershed.

				Supporting		Non-supporting			
Watershed	**Area (acres)**	**# Total AUIDs**	**# Assessed AUIDs**	**# Aquatic Life**	**# Aquatic Recreation**	**# Aquatic Life**	**# Aquatic Recreation**	**Insufficient Data**	**# of Delisting's**
07010101 **HUC 8**	**1,229,432**	**73**	**30**	**28**	**9**	**1**	**0**	**4**	**0**
0701010101 -01-	42,710	2	2	2	1	0	0	0	0
0701010101 -02-	45,960	6	3	2	1	0	0	1	0
0701010102 -01-	119,915	6	2	2	0	0	0	0	0
0701010102 -02-	28,313	1	1	1	1	0	0	0	0
0701010103 -01-	109,656	5	5	5	1	0	0	0	0
0701010104 -01-	140,566	3	2	2	1	0	0	0	0
0701010104 -02-	47,811	2	2	2	1	0	0	0	0
0701010105 -01-	158,332	10	1	1	0	0	0	0	0
0701010106 -01-	56,843	2	2	2	1	0	0	0	0
0701010107 -01-	191,001	12	4	4	0	0	0	0	0
0701010108 -01-	55,894	7	2	2	1	0	0	0	0
0701010109 -03-	27,777	1	1	0	0	1	0	0	0
0701010109 -02-	28,913	1	1	1	1	0	0	0	0
0701010109 -01-	175,741	15	2	2	0	0	0	3	0

Lake water quality

One hundred and thirty-three lakes greater than ten acres were assessed; 110 fully supported aquatic recreation and 28 supported aquatic life (Table 54). Fifteen lakes did not support aquatic recreation. Additionally, 57 lakes did not have sufficient data to make an assessment.

Table 54. Assessment summary for lake water chemistry in the Mississippi River (Headwaters) River Watershed.

				Supporting		Non-supporting			
Watershed	**Area (acres)**	**# Lakes > 10 acres**	**# Assessed AUIDs**	**# Aquatic Life**	**# Aquatic Recreation**	**# Aquatic Life**	**# Aquatic Recreation**	**Insufficient Data**	**# of Delisting's**
07010101 **HUC 8**	**1,229,432**	**355**	**133**	**28**	**110**	**1**	**15**	**57**	**0**
0701010101 -01-	42,710	5	4	1	2	0	1	1	0
0701010101 -02-	45,960	10	2	1	2	0	0	0	0
0701010102 -01-	119,915	55	14	5	7	0	0	6	0
0701010102 -02-	28,313	3	1	1	0	0	0	1	0
0701010103 -01-	109,656	39	8	6	5	0	1	7	0
0701010104 -01-	140,566	52	25	11	21	0	3	7	0
0701010104 -02-	47,811	19	9	2	8	0	1	0	0
0701010105 -01-	158,332	39	22	4	18	0	1	4	0
0701010106 -01-	56,843	12	2	0	0	0	2	1	0
0701010107 -01-	191,001	44	8	0	2	0	6	8	0
0701010108 -01-	55,894	36	15	6	15	0	0	6	0
0701010109 -03-	27,777	2	2	0	2	0	0	0	0
0701010109 -02-	28,913	6	4	2	2	0	0	3	0
0701010109 -01-	175,741	33	17	6	17	0	0	13	0

Fish contaminant results

Mercury was analyzed in fish tissue samples collected from Mississippi River and 66 lakes in the watershed. Polychlorinated biphenyls (PCBs) were measured in fish from the river and 32 lakes. Nineteen fish species were tested for contaminants. Fish species are identified by codes that are defined by their common and scientific names (Table 55). A total of 3,196 fish were collected for contaminant analysis between 1969 and 2014.

Contaminant concentrations are summarized by waterway, fish species, and year (Appendix 8). "Total Fish" indicates the total number of fish analyzed and "N" indicates 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 (BGS) and yellow perch (YP). "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.

The Mississippi River Headwaters and 53 lakes are listed as impaired for mercury in fish tissue (MPCA's 2014 draft Impaired Waters List). They are identified in Table (Appendix 8) with a red asterisk (*). None of the waters in this watershed are listed as impaired for PCBs in fish tissue. Forty-five of the impaired lakes (and the Headwaters reach of the river) are covered under the Statewide Mercury TMDL and do not need additional TMDLs for mercury in fish tissue. The eight lakes that had mercury levels too high to be included in the Statewide Mercury TMDL are identified with a double red asterisk.

Most of the PCB concentrations in fish tissue were near or below the reporting limit (0.01 - 0.05 mg/kg). The highest PCB concentration was 0.069 mg/kg in a white sucker (WSU) collected from Stump Lake (04013001) in 1988. The next highest PCB concentration was 0.059 mg/kg in a walleye (WE) from George Lake in 1992. The most recent PCBs concentrations in fish from the Mississippi River Headwaters were less than the 0.025 mg/kg reporting limit.

Perfluorooctane sulfonate (PFOS) concentration was measured in µg/kg (ppb), which is 1000 times lower units than mercury and PCBs. The impairment threshold is the threshold for a meal per month fish consumption advisory: 200 µg/kg. All measured PFOS concentrations in fish from the two large lakes were below the reporting limit (~ 5 µg/kg).

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.

Table 55. Fish species codes, common names, and scientific names

Species	Common name	*Scientific name*
BGS	Bluegill sunfish	*Lepomis macrochirus*
BKB	Black bullhead	*Ameiurus melas*
BKS	Black crappie	*Pomoxis nigromaculatis*
BRB	Brown bullhead	*Ictalurus nebulosus*
BT	Brown trout	*Salmo trutta*
CIS	Cisco (Lake herring)	*Coregonus artedi*
LMB	Largemouth bass	*Micropterus salmoides*
LWH	Lake whitefish	*Coregonus clupeaformis*
NP	Northern pike	*Esox lucius*
RBT	Rainbow trout	*Salmo gairdneri*
RKB	Rock bass	*Ambloplites rupestris*
SF	Pumpkinseed sunfish	*Lepomis gibbosus*
SMB	Smallmouth bass	*Micropterus dolomieue*
SRD	Shorthead redhorse	*Moxostoma macrolepidotum*
SUF	Sunfish family	*Centrarchidae*
WE	Walleye	*Sander vitreus*
WSU	White sucker	*Catostomus commersoni*
YEB	Yellow bullhead	*Ameiurus natalis*
YP	Yellow perch	*Perca flavescens*

Wetland condition

The majority of the Mississippi River (Headwaters) Watershed lies within the Mixed Wood Shield (MWS) level II ecoregion. The second iteration of the Depressional Wetland Quality Assessment did not include this ecoregion, focusing instead on the Mixed Wood Plains and Temperate Prairies ecoregions (Genet 2015). Therefore, results from the baseline depressional wetland assessment will be discussed here. Based on a random sample of sites that were monitored in 2009, macroinvertebrate IBI results indicated that MWS depressional wetlands were primarily (69%) in good condition, while 19% were in fair condition, and 11% were in poor condition (Genet 2012). Similarly, vegetation community data indicated that approximately 54% of depressional wetlands in the MWS ecoregion were in good condition, while 29% were in fair condition and 17% were in poor condition. It is reasonable to assume that these estimates provide a good approximation of depressional wetland quality in the Mississippi River (Headwaters) Watershed.

A more recent and comprehensive assessment of wetland quality in the MWS ecoregion is provided by the Minnesota Wetland Condition Assessment (MWCA). Using FQA to assess the condition of wetland plant communities, the MWCA found that approximately 84% of the wetland area in the MWS ecoregion was in exceptional-good condition (MPCA 2015). Wetlands in exceptional-good condition have had few (if any) changes in expected native vegetation composition or abundance distribution. The high rate of wetlands in exceptional-good condition was largely driven by the extent and condition of forested and scrub-shrub wetlands in this ecoregion. Both account for a large percentage of the wetland area in the MWS ecoregion and both communities were predominantly in exceptional condition (MPCA 2015). Given the proportion of forested and scrub-shrub wetlands in the watershed (Figure 19), it is likely that wetlands in the Mississippi River (Headwaters) Watershed also have high rates of exceptional-good vegetation condition.

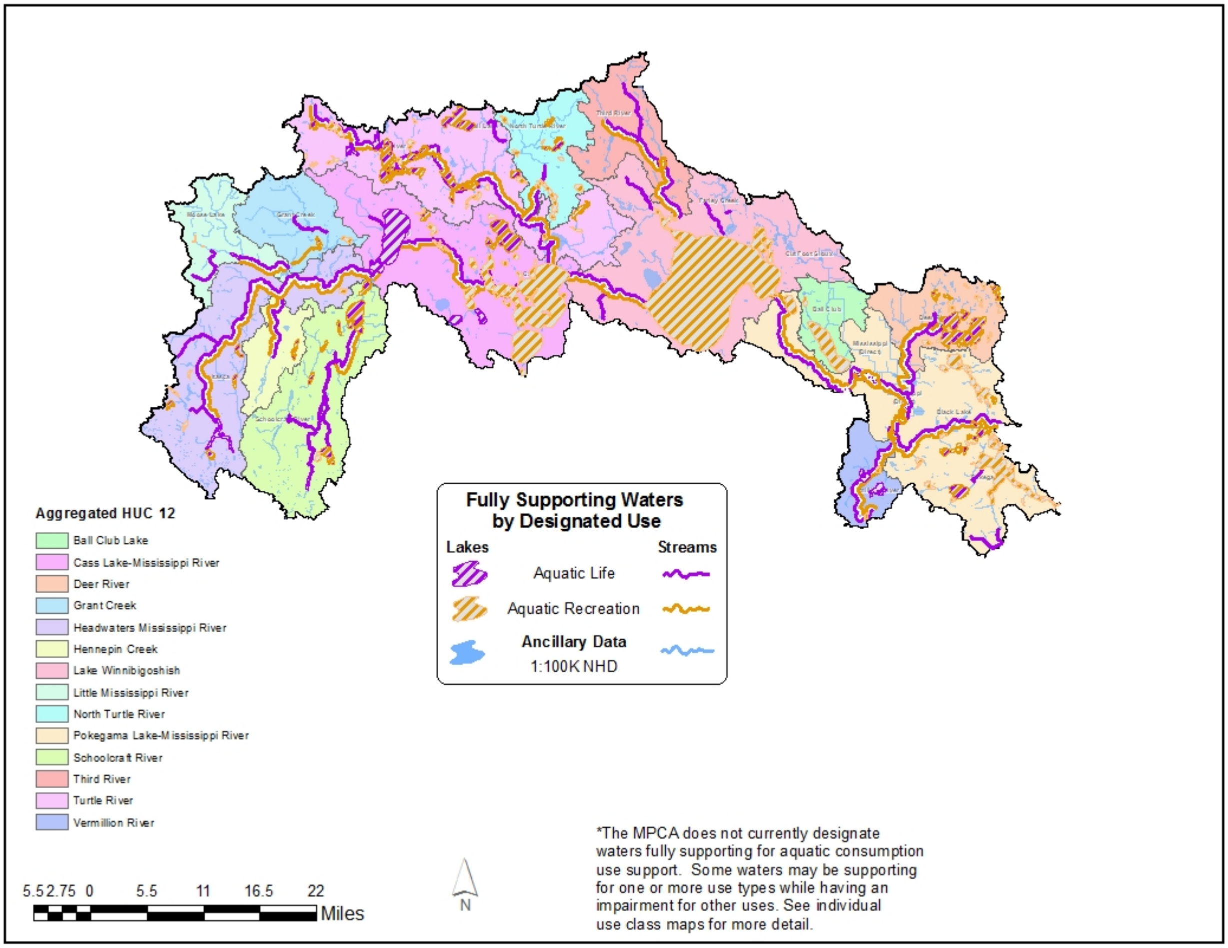

Figure 51. Fully supporting waters by designated use in the Mississippi River (Headwaters) River Watershed.

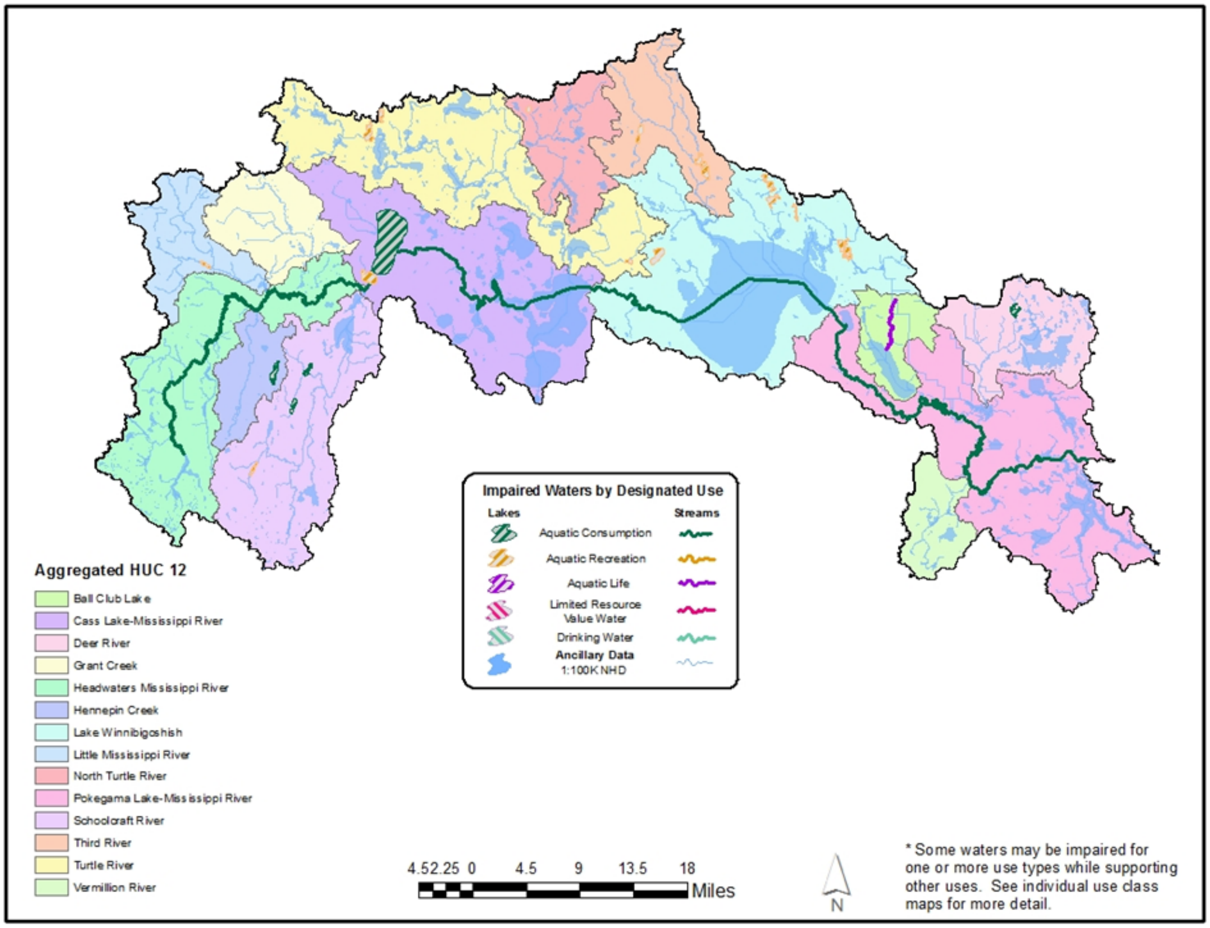

Figure 52. Impaired waters by designated use in the Mississippi River (Headwaters) River.

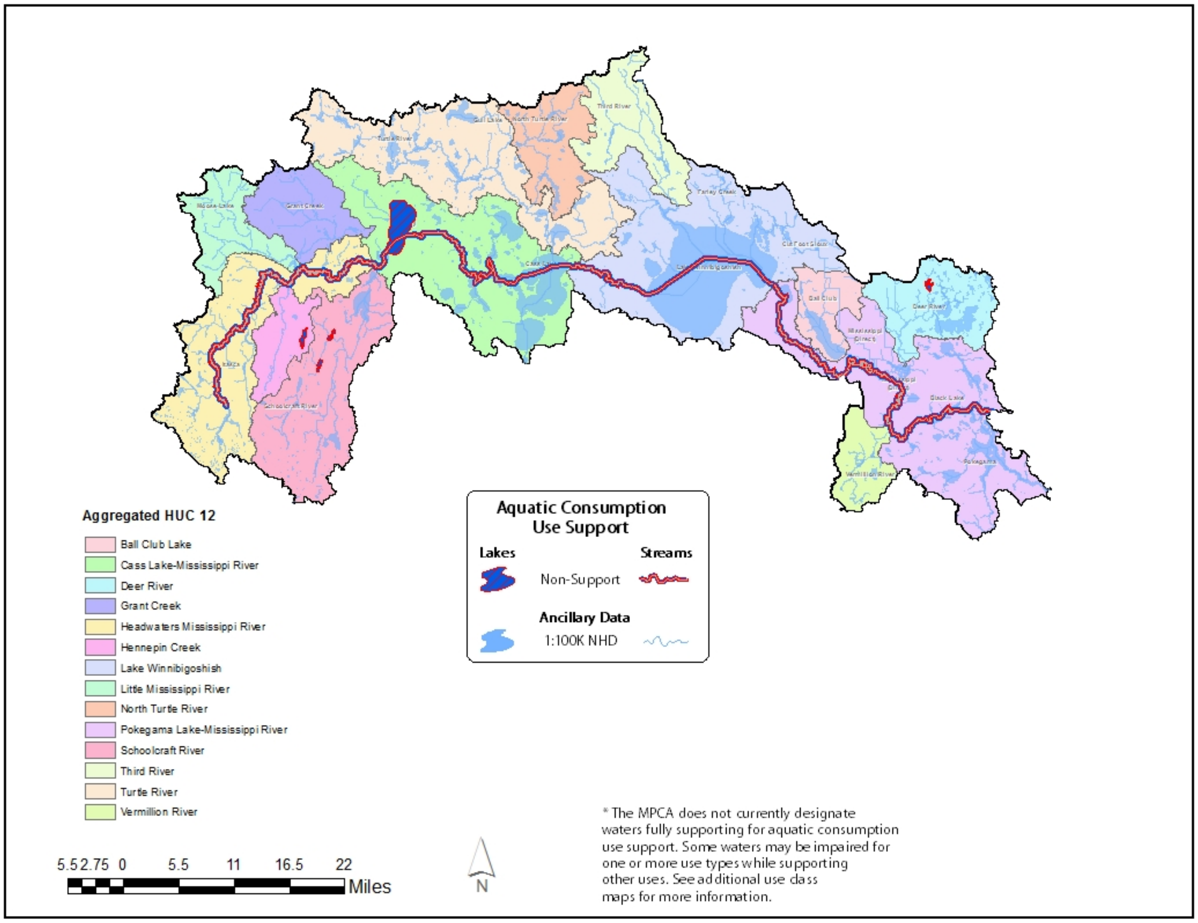

Figure 53. Aquatic consumption use support in the Mississippi River (Headwaters) Watershed.

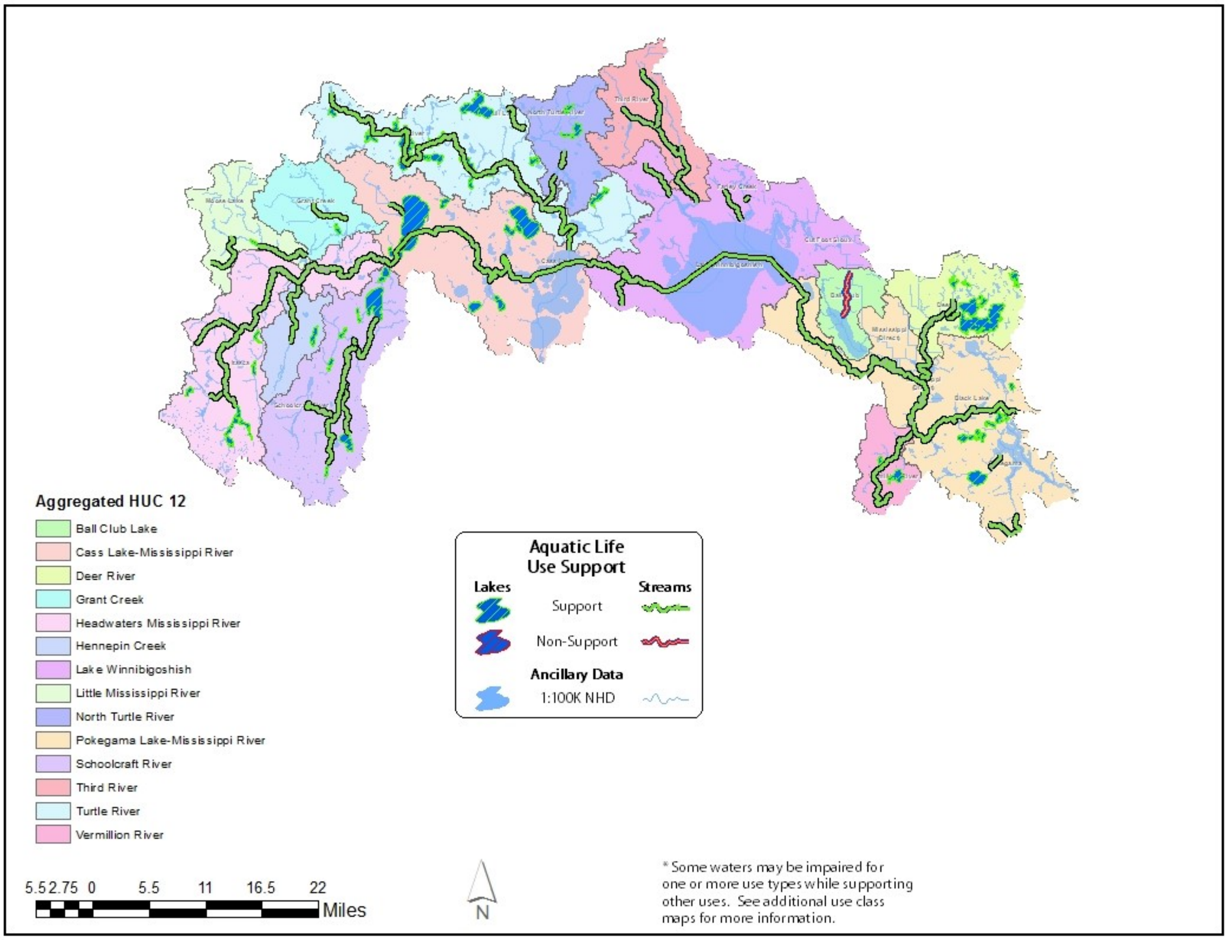

Figure 54. Aquatic life use support in the Mississippi River (Headwaters) Watershed.

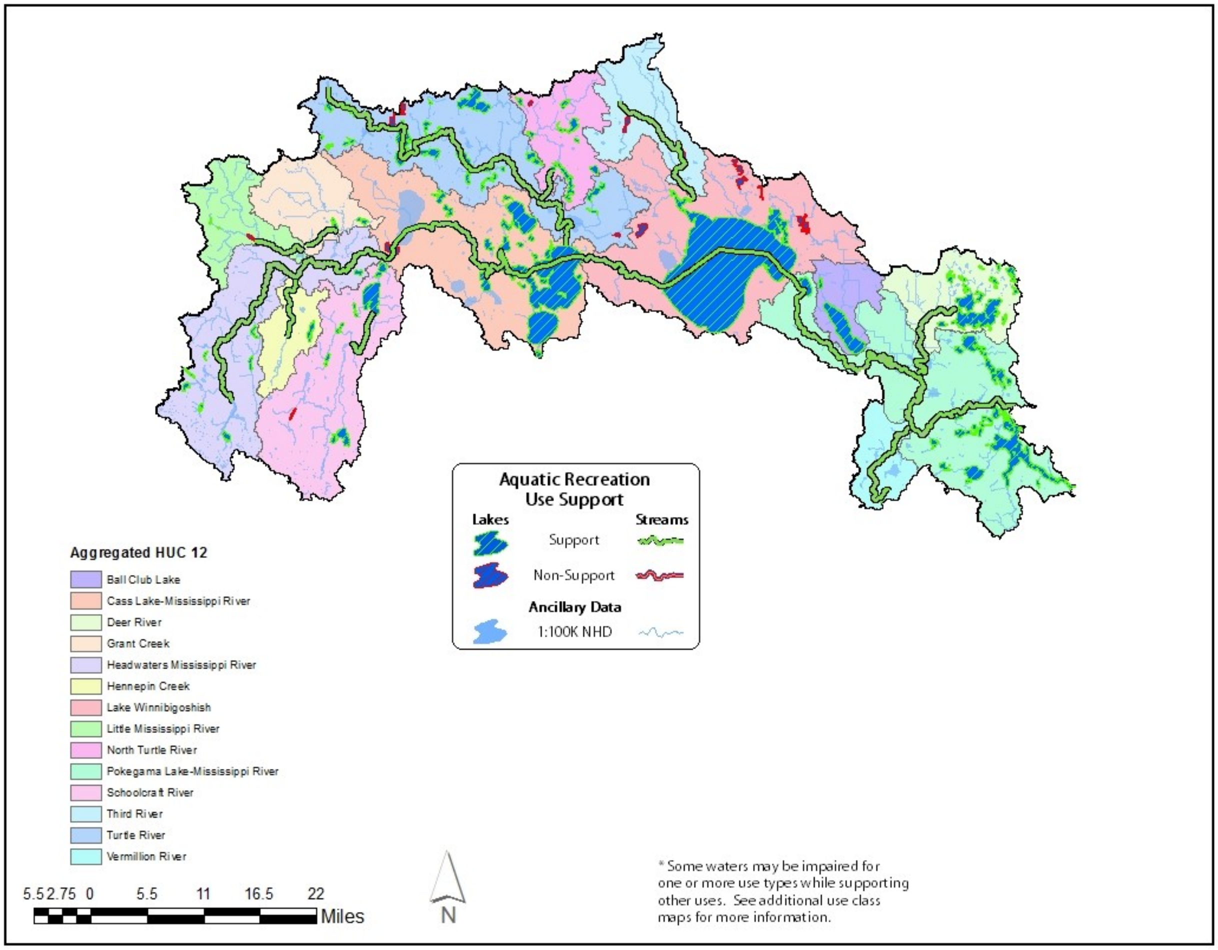

Figure 55. Aquatic recreation use support in the aquatic life use support in the Mississippi River (Headwaters) Watershed.

Pollutant trends for the Mississippi River (Headwaters) Watershed

Water quality trends at long-term monitoring stations

Water Chemistry data were analyzed for trends (Table 56) for the long-term period of record (1965-2010) and near term period of record (1995-2010). The only significant increase was in TP during the short-term period at the MN-200 station. Conversely, there were significant decreases in TSS, TP, ammonia, and biological oxygen demand for the long-term period of record at the CSAH-8 and MN-6 stations. The MN-200 station also had decreases for TSS, TP, and biological oxygen demand but did not show a trend for ammonia.

Table 56. Trends in the Mississippi River (Headwaters) Watershed.

	Total Suspended Solids	Total Phosphorus	Nitrite/ Nitrate	Ammonia	Biochemical Oxygen Demand	Chloride
At MN-200 Bridge 0.5 mi W of Lake Itasca						
overall trend (1965-2010)	**decrease**	**decrease**	**no trend**	**no trend**	**decrease**	**no trend**
Estimated average annual change	-1.9%	-1.4%			-2.2%	
Estimated total change	**-59%**	**-47%**			**-64%**	
recent trend (1995 – 2010)	**no trend**	**increase**	**no trend**	**no trend**	**no trend**	**little data**
Estimated average annual change		2.0%				
Estimated total change		40%				
median concentrations first 10 years	4	0.06	<0.01	0.06	2	3
median concentrations most recent 10 years	2	0.05	<0.05	<0.05	1	2
At CSAH-8 Bridge 7 mi E of Bemidji						
overall trend (1967–2010)	**decrease**	**decrease**	**no trend**	**decrease**	**decrease**	**Increase**
average annual change	-2.7%	-4.8%		-2.6%	-2.2%	0.0%
total change	-70%	-88%		-56%	-62%	0.0%
Recent trend (1995 – 2010)	**no trend**	**no trend**	**no trend**	**no trend**	**no trend**	**little data**
average annual change						
total change						
median concentrations first 10 years	5	0.09	0301	0.07	3	4
median concentrations most recent 10 years	1	0.03	<0.05	<0.05	1	7
At MN-6 Bridge 8 mi SW of Cohasset						
overall trend (1967–2010)	**decrease**	**decrease**	**no trend**	**decrease**	**decrease**	**Increase**
average annual change	-2.1%	-1.6%		-4.1%	-2.7%	0.0%
total change	-59%	-51%		-74%	-69%	0.0%
Recent trend (1995 – 2010)	**no trend**	**no trend**	**no trend**	**no trend**	**no trend**	**little data**
average annual change						
total change						
median concentrations first 10 years	7	0.05	<0.01	0.10	2	3
median concentrations most recent 10 years	2	0.03	<0.05	<0.05	1	3

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.

Water clarity trends at citizen monitoring sites

Citizen volunteer monitoring occurs at 24 stream and 216 lake stations throughout the Mississippi River (Headwaters) Watershed. At this time, only one stream has sufficient data to calculate a long-term trend, indicating no significant trend over the dataset. Eleven lakes show an increasing trend in water clarity while five appear to be declining in water clarity (Table 57). Maintaining citizen data collection at these locations is vital to strengthen long-term datasets. Local advocacy is necessary for recruiting new volunteer monitors within the watershed. Citizen monitoring data can be used to fill in data gaps between intensive watershed monitoring years and other local ongoing projects.

Table 57. Water Clarity Trends at Citizen Stream Monitoring Sites.

Mississippi River (Headwaters) HUC 07010101	Citizen Stream Monitoring Program	Citizen Lake Monitoring Program
number of sites w/ increasing trend	0	11
number of sites w/ decreasing trend	0	5
number of sites w/ no trend	1	44

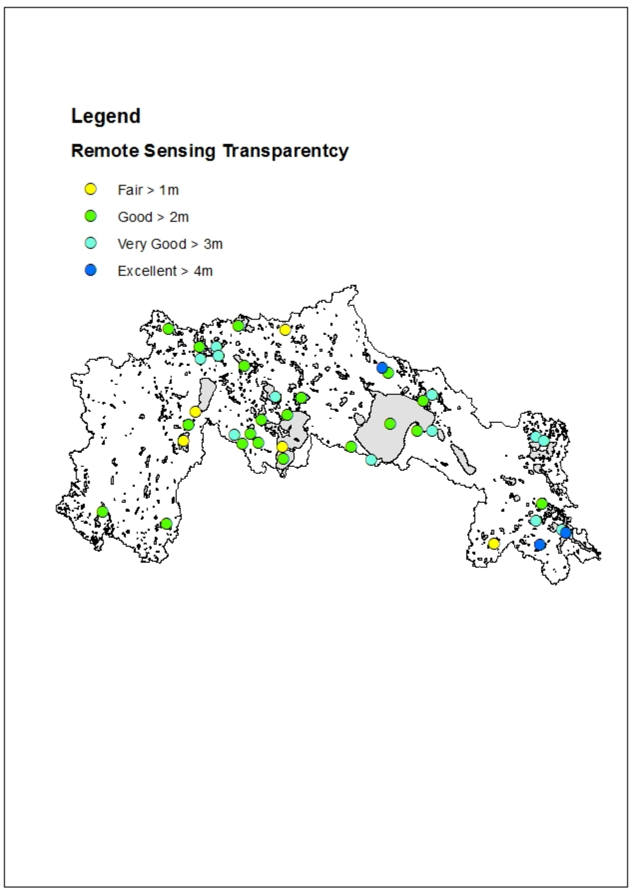

Figure 56. Remote Sensing Transparency Data on lakes without Observed Water Chemistry Data within the Mississippi River (Headwaters) Watershed.

VII. Summaries and recommendations

The Mississippi River (Headwaters) Watershed contains some of the most pristine water resources in the state. With almost 50% of its land being publically owned, the watershed offers a wide array of recreational opportunities. The abundance of publically owned land also provides the benefit of managing the landscape for water quality protection along with increased fish and wildlife habitat. Overall, biological communities found throughout the watershed are very good, with only one stream segment failing to meet its aquatic life standards. The Schoolcraft River from Frontenac Creek to Lake Plantagenet had very good fish and macroinvertebrate communities, resulting in it being classified as an exceptional aquatic life use. The Schoolcraft River along this reach also has exceptional habitat, and should be addressed by WRAPs to protect its natural riparian corridor.

Seventy-five species of fish have been documented within the Upper Mississippi River Basin. In 2013 and 2014, MPCA staff collected 50 (this number only includes fish collected from tributaries to the Mississippi River). Two fish species (Longear Sunfish and Pugnose Shiner) were captured at only one station in the watershed (13UM153). The Longear Sunfish is listed as a species of greatest conservation need in Minnesota and is a species of concern in Wisconsin. Their distribution is extremely spotty, and currently there are only 37 known lakes/streams where they are documented in Minnesota. The Pugnose Shiner is listed as a species of special concern in Minnesota, and is highly intolerant of turbidity, eutrophication, and vegetation removal (Becker 1983). The most commonly sampled species in the watershed was Central Mudminnow, which was captured at 36 of the 42 sites. The Central Mudminnow is tolerant of a wide variety of habitats, including being highly tolerant to low DO, and their abundance is likely due in part to the high proportion of low gradient, naturally low DO streams across the watershed.

The macroinvertebrate community in the Upper Mississippi (Headwaters) Watershed is diverse and healthy. Over 12000 individual organisms representing 218 unique taxa were collected and identified from the samples. This diversity is the result of the good quality and variety of streams throughout the watershed. The majority of the watershed is characterized by low gradient streams with little anthropogenic disturbance. Some of the notable sensitive taxa in these streams were the caddisflies *Oxyethira* and *Neureclipsi*s, and the midge *Stempellinella*. There are also several coldwater streams in the watershed: notable taxa in these streams were the dragonfly *Cordulegaster*, and the caddisflies *Glossosoma and Rhyacophila*. In the 1990's, a new caddisfly species was discovered in the Upper Mississippi (Headwaters) Watershed - *Oxyethira itascae, and named after Itasca State Park, where it was found in spring seeps. It is a* species of special concern due to its small known range of distribution. . MPCA staff did not identify any of these organisms likely due to its favored habitat of springs, which were not sampled. No endangered, threatened or species of special concern were collected in the Upper Mississippi (Headwaters) Watershed during this study, however, the majority of the biological monitoring sites had strong macroinvertebrate IBI scores and robust macroinvertebrate communities.

Beaver dams prevented the collection of fish and macroinvertebrates in several streams, and appear to be a natural stressor, particularly to the fish communities. Dams create a loss of stream connectivity, which can limit fish migration. This can prevent fish from accessing prime spawning habitats in smaller headwater streams. Beaver management should be addressed across the watershed, but most notably along the Vermillion where beavers are creating extensive damage to the rivers riparian buffer; therefore, the morphology of the stream channel is being altered.

The most widespread impairment found in the watersheds lakes is high levels of mercury in fish tissue; The Mississippi River and 53 lakes are currently listed as impaired. Most of the PCB concentrations in fish tissue were near or below the reporting limit (0.01 - 0.05 mg/kg). The highest PCB concentration was 0.069 mg/kg in a white sucker (WSU) collected from Stump Lake (04013001) in 1988. The next highest PCB concentration was 0.059 mg/kg in a walleye (WE) from George Lake in 1992. The most recent PCBs concentrations in fish from the Mississippi River Headwaters were less than the 0.025 mg/kg reporting limit. Similarly, all measured Perfluorooctane sulfonate (PFOS) concentrations in fish from the two large lakes (Lake Winnibigoshish and Cass Lake) were below the reporting limit (~ 5 µg/kg).

The Mississippi River (Headwaters) Watershed has a high density of lakes with good water quality. One hundred and seventy-eight, lake basins had at least one water quality measurement available. Of these lake basins, one hundred and sixteen had enough water quality information to conduct a formal aquatic recreation use assessment and forty-five had enough information to conduct aquatic life use assessments. One hundred and one, lakes were found to be fully supporting for aquatic recreation use and fifteen were found to be nonsupport for aquatic recreation use. Forty-five lakes were found to be full support for aquatic life use. No lakes were found to be nonsupport for aquatic life use.

The hydrology of the Mississippi River (Headwaters) Watershed has high connectivity between its water bodies. Water flows from lake to lake through a network of streams and wetlands from the headwaters of smaller aggregated HUC-12 watersheds eventually entering the Mississippi River. Many prominent lakes; Bemidji, Cass, and Winnibigoshish receive water from the Mississippi River as it flows through the watershed.

The Mississippi River (Headwaters) Watershed has a mixture of deep and shallow lakes. Deep lakes have the ability to assimilate phosphorus within lake bed sediments. This not only limits internal nutrient loading within deep lakes but also removes phosphorus from being transferred to lakes further downstream. Typically, shallow lakes have higher phosphorus concentrations because they do not have the ability to assimilate phosphorus. Most of the lakes that are nonsupport for aquatic recreation use are relatively shallow and likely mix during large wind events. In this case, aquatic vegetation with in these lakes and stream channels become important and should be protected in order to aid in phosphorus removal and nutrient up take. Highly connected watersheds can also be at increased risk for eutrophication if nutrient loads from land use or human, activities increase causing water quality to degrade.

Groundwater protection should be considered for both quantity and quality. Quantity is based on the amount of water withdrawn versus the amount of water being recharged to the aquifer. Groundwater withdrawals in the watershed have decreased by nearly 10% from 1994 to 2013. However, water table elevations in DNR observation wells show decreasing trends over the most recent 20 years of data collected. Moderate increases in development have occurred in some parts of the watershed. More land has been converted from farms and timberland to recreation and country homes (USDA NRCS). There has also been a slight increase in non-crop irrigation (golf course, athletic field and landscape irrigation) and water supply ($p=0.05$). Therefore, although overall groundwater withdrawals have been decreasing, the watershed's water table may be responding to these changing land use patterns. While fluctuations due to seasonal variations are normal, long-term changes in elevations should not be ignored. The potential groundwater recharge to surficial materials throughout the watershed ranges from very low to very high, with an average of 5.2 inches per year. However, many permitted groundwater withdrawals are located in areas of medium to low potential recharge.

The groundwater quality of the watershed appears to be good. The MPCA monitors 19 well within the watershed; 18 monitoring wells and one domestic well. Arsenic, nitrate and chloride detection frequency for 2010 to 2015 was 59.8, 70.6 and 92.2% of wells, respectively. Only one well had consistent high levels of arsenic, which is likely due to the presence of a clay layer and low DO levels. Nitrate exceeded the MCL, and chloride exceeded the secondary MCL only once, both in the same well near Bemidji at different times. Other sources of groundwater quality data were limited due to the high forested/low agricultural land use for this watershed. Due to the higher levels of groundwater contamination susceptibility throughout the watershed, it is important to continue to monitor potentially harmful sites in order to inhibit possible water pollution.

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 best management practices will benefit both surface and groundwater.

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Overall, rivers and streams in the Upper Mississippi River (Headwaters) Watershed appear to be in good condition. Biological communities are generally good, low levels of bacteria were found throughout most of the watershed. With only one impairment within the watershed, protection strategies should be the focus moving forward. Some examples of actions that could help maintain the current conditions and prevent further degradation for surface waters include:

- Protect natural vegetative buffers along riparian zones.
- Limit the alteration and/or removal of wetlands
- Continue civic engagement within the watershed to educate on the benefits of clean water
- Promote shoreline restoration as development along lakes increases

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Appendix 1. Water chemistry definitions

(DO) - Oxygen dissolved in water required by aquatic life for metabolism. DO enters into water from the atmosphere by diffusion and from algae and aquatic plants when they photosynthesize. DO 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 wastewater 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 Phosphorus (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.’’

Unnionized 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 encounters 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 watershed monitoring water chemistry stations in the Mississippi River (Headwaters) Watershed

Biological Station ID	STORET/ EQuIS ID	Waterbody Name	Location	12-digit HUC
13UM122	S002-621	Little Mississippi River	Little Mississippi River, Moose Lake to Grant Creek	0701010102-01
13UM114	S002-620	Grant Creek	Grant Lake outlet to Unnamed Creek	0701010101-02
13UM117	S007-549	Hennepin Creek	Hennepin Creek, T145 R35W S35, West line to Mississippi River	0701010102-02
13UM134	S007-5501	Schoolcraft River	Schoolcraft River, Frontenac Creek to Plantagenet Lake	0701010103-01
13UM153	S007-621	Turtle River	Turtle River, at Mission Road North East .5 miles of Sugar Bush, MN	0701010104-01
13UM130	S003-921	North Turtle River	North Turtle River, at CSAH 20, 15 miles East North East of Bemidji, MN	0701010104-02
00UM007	S002-290	Third River	Third River, Skimmerhorn Lake to Lake Winnibigoshish	0701010106-01
13UM105	S007-620	Deer River	Deer River, at CR 128, .5 miles East of Deer River, MN	0701010108-01
--	S006-258	Vermillion River	Vermillion River, at 88th Avenue / CSAH 74, 8.5 miles South of Deer River, MN	0701010109-01

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

AUID DESCRIPTIONS				USES						BIOLOGICAL CRITERIA		WATER QUALITY STANDARDS						
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 2012	Fish	Macroinvertebrates	Dissolved Oxygen	Turbidity	Chloride	pH	NH3	Pesticides	Bacteria (Aquatic Recreation)
HUC 12: 0701010101-01 (Little Mississippi River)																		
07010101-517	Little Mississippi River	Moose Lk to Grant Cr	8.73	2Bg, 3C	FS	FS				MTS	MTS	NA	MTS	MTS	MTS	MTS	IF	MTS
07010101-738	Unnamed Creek	Headwaters to Duncan Lk	5.94	2Bg, 3C	FS	--				MTS		IF	IF		IF	IF	IF	
HUC 12: 070101010101-02 (Grant Creek)																		
07010101-546	Grant Creek	Grant Lk outlet to Unnamed cr	4.25	2Bg, 3C	NA	FS						NA	MTS	MTS	MTS	MTS	IF	MTS
07010101-666	Grant Creek	Unnamed lk (04-0225-00) to Unnamed lk (04-0202-00)	1.97	2Bg, 3C	NA													
07010101-670	Grant Creek	Unnamed ditch to Unnamed cr	2.64	2Bg, 3C	FS					MTS		IF	IF		IF	IF	IF	
07010101-739	Unnamed Creek	Headwaters to Unnamed ditch	4.39	2Bg, 3C	IF							IF	IF		IF	IF	IF	
07010101-747	Unnamed Creek	Headwaters to T147 R35W S24, south line	6.08	2Bg, 3C	NA													
07010101-748	Unnamed Creek	T147 R35W S25, north line to Grant Cr	2.62	2Bg, 3C	FS					MTS		IF	IF		IF	IF	IF	
HUC 12: 0701010102-01 (Headwaters Little Mississippi River)																		
07010101-574	Nicollet Creek	Headwaters to Lk Itasca	1.29	2Bg, 3C	NA													
07010101-631	Bear Creek	south line to Mississippi R	6.64	2Bg, 3C	FS					MTS	MTS	IF	IF		IF	IF	IF	
07010101-663	Sucker Creek	Gould Cr to Mississippi R	2.39	1B, 2Ag, 3B	FS					MTS	MTS	IF	IF		IF	IF	IF	
HUC 12: 0701010102-02 (Hennepin Creek)																		
07010101-637	Hennepin Creek	T145 R35W S35, west line to Mississippi R	8.06	2Bg, 3C	FS	FS				MTS	MTS	IF	MTS	MTS	MTS	MTS	IF	MTS
HUC 12: 0701010103-01 (Schoolcraft River)																		
07010101-573	Birch Creek	Lk Hattie outlet to Schoolcraft R	5.04	2Bg, 3C	FS					MTS	MTS	IF	IF		IF	IF	IF	
07010101-638	Alcohol Creek	Lk George to Schoolcraft R	6.51	2Bg, 3C	FS					MTS	MTS	IF	IF		IF	IF	IF	

07010101-651	Fontenac Creek	Unnamed lk (29-0497-00) to T145 R34W S34, south line	1.12	2Bg, 3C	FS						MTS		IF	IF		IF	IF	IF	
07010101-751	Schoolcraft River	Frontenac Cr to Plantagenet Lk	7.78	2Be, 3C	FS	FS					MTS	MTS	IF	MTS	MTS	MTS	MTS	MTS	MTS
07010101-752	Schoolcraft River	Schoolcraft Lk to Frontenac Cr	19.49	2Bg, 3C	FS						MTS	MTS	IF	IF		IF	IF	IF	
HUC 12: 0701010104-01(Turtle River)																			
07010101-510	Turtle River	Headwaters (Stray Horse Lk 04-0246-00) to Cass Lk	53.95	2Bg, 3C	FS	FS					MTS	MTS	IF	MTS	MTS	MTS	MTS	IF	MTS
07010101-551	Gull River	Erickson Lk to Nelson Lk outlet	4.44	2Bg, 3C	FS						NA	MTS	IF	IF		IF	IF	IF	
07010101-577	Kitchi Creek	Burns Lk to Sucker Cr	5.81	2Bg, 3C															
HUC 12: 0701010104-02 (North Turtle River)																			
07010101-548	North Turtle River	Pimushe Lk to Turtle R	4.66	2Bg, 3C	FS	FS					MTS	MTS	IF	MTS	MTS	IF	MTS	IF	MTS
07010101-570	North Turtle River	Little Rice Pond outlet to Pimushe Lk	2.45	2Bg, 3C	FS						MTS		IF	IF		IF	IF	IF	
HUC 12: 0701010105-01(Cass lake-Mississippi River Subwatershed)																			
07010101-624	Pike Bay Creek	Pike Bay to Cass Lk	0.52	2Bg, 3C	NA									NA				NA	
07010101-627	Big Lake Creek	Lk Andrusia to Big Lk	1.20	2Bg, 3C	NA	IF							NA	NA	NA	NA	NA	NA	NA
07010101-750	Unnamed Creek	Unnamed cr to Lk Bemidji	1.94	2Bg, 3C	FS						MTS	MTS	IF	IF		IF	IF	IF	
07010101-749	Unnamed Creek	Alice Lk to Unnamed cr	1.66	2Bg, 3C										NA				NA	
HUC 12: 0701010106-01 (Third River)																			
07010101-526	Third River	Skimmerhorn Lk to Lk Winnibigoshish	24.82	2Bg, 3C	FS	FS					MTS	MTS	IF	MTS	MTS	IF	MTS	IF	MTS
07010101-581	Moose Creek	Unnamed cr to Third R	9.33	2Bg, 3C	FS						NA	MTS	IF	IF		IF	IF	IF	
HUC 12: 0701010107-01 (Lake Winibigoshish)																			
07010101-549	Lydick Brook	Headwaters to Mississippi R	4.14	2Bg, 3C	FS						MTS		IF	IF		IF		IF	
07010101-590	Castle Creek	Headwaters to Unnamed cr	5.29	2Bg, 3C	FS						MTS		IF	IF		IF	IF	IF	
07010101-592	Unnamed Creek	Headwaters to Upper Pigeon Lk	1.96	2Bg, 3C	NA														
07010101-606	Farley Creek	Farley Lk to Unnamed lk (31-0895-00)	4.53	2Bg, 3C	FS						MTS	NA	IF	IF		IF	IF	IF	MTS

07010101-609	Simpson Creek	Headwaters to Little Cut Foot Sioux Lk	3.99	2Bg, 3C	IF									IF				IF	
07010101-620	Pigeon River	T147 R27W S18, west line to Unnamed cr	0.66	2Bg, 3C	FS						MTS		IF	IF		IF	IF	IF	
07010101-628	Island Lake Creek	Wetland to Lk Winnibigoshish (Third River Flowage)	3.07	2Bg, 3C	IF									IF				IF	
07010101-629	Cut Foot Sioux Creek	Little Cut Foot Sioux Lk to Cut Foot Sioux Lk (Bay)	2.37	2Bg, 3C	NA									NA				NA	
07010101-630	Raven Creek	Wetland to Lk Winnibigoshish	4.54	2Bg, 3C	NA									NA				NA	
07010101-698	Pigeon River	Pigeon Dam Lk to Pigeon Dam	0.25	2Bg, 3C	NA									NA				NA	
HUC 12: 0701010108-01 (Deer River)																			
07010101-505	Deer River	Bay Lk to Mississippi R	18.36	2Bg, 3C	FS	FS					MTS	MTS	IF	MTS		MTS	MTS	IF	MTS
07010101-618	Island lake Creek	Island Lk to Hansen Lk outlet	1.56	2Bg, 3C	NA							NA						IF	
07010101-619	Island lake Creek	Hansen Lk outlet to Deer R	2.36	2Bg, 3C	FS						MTS		IF	IF		IF	IF		
07010101-734	Deer River	Deer Lk to Bay Lk	0.16	2Bg, 3C	NA								NA			NA		IF	
07010101-736	Unnamed Creek	Moose Lk (31-0722-00) to Bay Lk	0.48	2Bg, 3C	NA								NA			NA		IF	
07010101-737	Unnamed Creek	Little Deer Lk to Deer Lk	0.05	2Bg, 3C	NA								NA			NA		IF	
07010101-740	Unnamed Creek	Headwaters to Deer R	3.63	2Bg, 3C	IF						IF		IF	IF		IF	IF	IF	
HUC 12: 0701010109-01 (Pokegama Lake-Mississippi River)																			
07010101-505	Deer River	Bay Lk to Mississippi R	18.36	2Bg, 3C	FS	FS					MTS	MTS	IF	MTS		MTS	MTS	IF	MTS
07010101-618	Island lake Creek	Island Lk to Hansen Lk outlet	1.56	2Bg, 3C	NA							NA						IF	
07010101-619	Island lake Creek	Hansen Lk outlet to Deer R	2.36	2Bg, 3C	FS						MTS		IF	IF		IF	IF		
07010101-734	Deer River	Deer Lk to Bay Lk	0.16	2Bg, 3C	NA								NA			NA		IF	
07010101-736	Unnamed Creek	Moose Lk (31-0722-00) to Bay Lk	0.48	2Bg, 3C	NA								NA			NA		IF	
07010101-737	Unnamed Creek	Little Deer Lk to Deer Lk	0.05	2Bg, 3C	NA								NA			NA		IF	
07010101-740	Unnamed Creek	Headwaters to Deer R	3.63	2Bg, 3C	IF						IF		IF	IF		IF	IF	IF	
HUC 12: 0701010109-03 (Ball Club)																			
07010101-741	Fisherman's Brook	Headwaters to Ball Club Lake	6.66	2Bg, 3C	NS				FIBI		EXS	MTS	IF	IF	IF		IF		
HUC 12: 0701010109-03 (Vermillion River)																			
07010101	Vermillion River	Headwaters to Mississippi River	6.66	2Bg, 3C	FS	FS			FIBI		EXS	MTS	IF	IF	IF		IF		

AUID DESCRIPTIONS				USES							BIOLOGICAL CRITERIA		WATER QUALITY STANDARDS						
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 2015		Fish	Macroinvertebrates	Dissolved Oxygen	Turbidity	Chloride	pH	NH3	Pesticides	Bacteria (Aquatic Recreation)
HUC 12: 0701010109-01 (Pokegama Lake-Mississippi River)																			
07010101-644	Smith Creek	Headwaters to Smith Lk	6.23	1B, 2Ag, 3B	FS						MTS	MTS	IF	IF		IF	IF	IF	
07010101-645	Smith Creek	Smith lake to Little Pokegama Lk	1.65	1B, 2Ag, 3B	IF								IF	IF		MTS		IF	
07010101-659	Unnamed Creek (Pokegama Creek)	Headwaters to Sherry Lk	2.73	1B, 2Ag, 3B	IF								IF	IF	IF	MTS		IF	
07010101-692	Sugar Brook	Unnamed lk (31-0553-00) to Pokegama Lk	2.04	2Bg, 3C	FS						MTS	MTS	IF	MTS	IF	MTS	IF	IF	
07010101-732	Unnamed Creek	Headwaters to Pokegama Lk	2.17	2Bg, 3C	IF								IF	MTS	IF	MTS		IF	
07010101-733	Unnamed Creek	Munzer Lk to Pokegama Lk	0.57	2Bg, 3C	NA								NA	NA		NA		NA	
07010101-742	Unnamed Creek	Lk Winnibigoshish (11-0147-00) to Cohasset Dam	10.39	2Bg, 3C	FS														
HUC 12: 0701010109-03 (Ball Club Lake)																			
07010101-741	Fisherman's Brook	Headwaters to Ball Club Lake	6.66	2Bg, 3C	NS				FIBI		EXS	MTS	IF	IF	IF		IF		
HUC 12: 0701010109-02 (Vermillion River)																			
07010101-521	Vermillion River	Headwaters to Mississippi River	15.59	2Bg, 3C	FS	FS					NA	MTS	NA	MTS	MTS	MTS	MTS	IF	MTS

Appendix 3.2 Assessment results for lakes in the Upper Mississippi River (Headwaters) Watershed

Lake ID	Lake Name	County	HUC-12	Ecoregion	Lake Area (acres)	AQR Support Status	AQL Support Status
04-0001-00	Burns	Beltrami	0701010104-01	NLF	115	NS	
04-0005-00	Schram	Beltrami	0701010105-01	NLF	130	FS	
04-0007-00	Kitchi	Beltrami	0701010104-01	NLF	1815	IF	
04-0008-00	Little Moose	Beltrami	0701010104-02	NLF	230	FS	
04-0011-00	Moose	Beltrami	0701010104-01	NLF	593	FS	FS
04-0014-00	Popple	Beltrami	0701010104-01	NLF	94	FS	IF
04-0015-00	Little Rice	Beltrami	0701010104-01	NLF	116	FS	
04-0019-00	Anderson	Beltrami	0701010104-02	NLF	87	FS	
04-0024-00	Gilstad	Beltrami	0701010104-02	NLF	251	FS	FS
04-0030-00	Cass	Beltrami	0701010105-01	NLF	15948	FS	IF
04-0031-00	Big Rice	Beltrami	0701010104-01	NLF	628	IF	
04-0032-00	Pimushe	Beltrami	0701010104-02	NLF	1214	FS	IF
04-0033-00	Benjamin	Beltrami	0701010104-02	NLF	32	FS	IF
04-0034-00	Rabideau	Beltrami	0701010104-02	NLF	654	FS	FS
04-0036-00	Drewery	Beltrami	0701010105-01	NLF	155	FS	
04-0038-00	Andrusia	Beltrami	0701010105-01	NLF	1579	FS	
04-0039-00	Silver	Beltrami	0701010105-01	NLF	127	FS	
04-0041-00	Ten	Beltrami	0701010105-01	NLF	163	FS	
04-0042-00	Buck	Beltrami	0701010105-01	NLF	352	FS	
04-0043-00	Lost	Beltrami	0701010105-01	NLF	129	FS	
04-0048-00	Windigo	Beltrami	0701010105-01	NLF	193	FS	
04-0049-00	Big	Beltrami	0701010105-01	NLF	3558	FS	FS
04-0050-00	Meadow	Beltrami	0701010104-01	NLF	101	FS	
04-0051-00	Flora	Beltrami	0701010105-01	NLF	178	FS	
04-0053-00	South Twin	Beltrami	0701010104-01	NLF	217	FS	IF
04-0059-00	Rice Pond	Beltrami	0701010104-02	NLF	154	FS	

Lake ID	Lake Name	County	HUC-12	Ecoregion	Lake Area (acres)	AQR Support Status	AQL Support Status
04-0063-00	North Twin	Beltrami	0701010104-01	NLF	317	FS	FS
04-0064-00	Gull	Beltrami	0701010104-01	NLF	140	IF	IF
04-0066-00	Hanson	Beltrami	0701010104-02	NLF	94	NS	
04-0067-00	Dutchman	Beltrami	0701010104-02	NLF	176	FS	
04-0076-00	Long	Beltrami	0701010104-01	NLF	400	FS	
04-0079-00	Wolf	Beltrami	0701010105-01	NLF	1072	FS	
04-0085-00	Swenson	Beltrami	0701010105-01	NLF	410	FS	
04-0097-00	Buck	Beltrami	0701010104-01	NLF	42	IF	
04-0099-00	Unnamed	Beltrami	0701010105-01	NLF	36	FS	
04-0110-00	Little Bass	Beltrami	0701010105-01	NLF	363	FS	
04-0111-00	Turtle River	Beltrami	0701010104-01	NLF	1744	FS	FS
04-0114-00	School	Beltrami	0701010104-01	NLF	185	IF	
04-0120-00	Gull	Beltrami	0701010104-01	NLF	2252	FS	FS
04-0130-01	Stump	Beltrami	0701010105-01	NLF	324	FS	IF
04-0130-02	Bemidji (main lake)	Beltrami	0701010105-01	NLF	6573	IF	FS
04-0132-01	Big Bass (west basin)	Beltrami	0701010105-01	NLF	51	FS	
04-0132-02	Big Bass (east basin)	Beltrami	0701010105-01	NLF	334	FS	FS
04-0134-00	Three Island	Beltrami	0701010104-01	NLF	733	FS	FS
04-0135-00	Beltrami	Beltrami	0701010104-01	NLF	714	FS	FS
04-0140-00	Irving	Beltrami	0701010105-01	NLF	661	NS	FS
04-0141-00	Carr	Beltrami	0701010105-01	NLF	42	IF	
04-0142-00	Marquette	Beltrami	0701010103-01	NLF	509	FS	FS
04-0152-00	Movil	Beltrami	0701010104-01	NLF	851	FS	FS
04-0153-00	Lindgren	Beltrami	0701010104-01	NLF	69	FS	
04-0154-00	Larson	Beltrami	0701010104-01	NLF	200	NS	
04-0155-00	Little Turtle	Beltrami	0701010104-01	NLF	461	NS	FS
04-0157-00	Black	Beltrami	0701010104-01	NLF	267	FS	

Lake ID	Lake Name	County	HUC-12	Ecoregion	Lake Area (acres)	AQR Support Status	AQL Support Status
04-0159-00	Turtle	Beltrami	0701010104-01	NLF	1591	FS	FS
04-0162-00	Fox	Beltrami	0701010104-01	NLF	166	FS	IF
04-0196-00	Campbell	Beltrami	0701010104-01	NLF	449	IF	FS
04-0211-00	Bootleg	Beltrami	0701010102-01	NLF	297	IF	
04-0212-00	Steinbrook	Beltrami	0701010102-01	NLF	25	IF	
04-0215-00	Fern	Beltrami	0701010102-01	NLF	194	FS	
04-0216-00	Grass	Beltrami	0701010101-02	NLF	233	FS	
04-0217-00	Grant	Beltrami	0701010101-02	NLF	199	FS	FS
04-0227-00	Long	Beltrami	0701010104-01	NLF	665	FS	
04-0230-00	Deer	Beltrami	0701010104-01	NLF	293	FS	FS
04-0234-00	Wolf	Beltrami	0701010104-01	NLF	88	FS	
04-0235-00	Peterson	Beltrami	0701010104-01	NLF	252	FS	
04-0237-00	Pony	Beltrami	0701010104-01	NLF	109	FS	
04-0286-00	Manomin	Beltrami	0701010101-01	NLF	255	IF	
04-0342-00	Moose	Beltrami	0701010101-01	NLF	129	NS	FS
11-0415-00	Pike Bay	Cass	0701010105-01	NLF	4729	FS	IF
11-0485-00	Moss	Cass	0701010105-01	NLF	202	FS	
11-0022-00	Spring	Cass	0701010109-02	NLF	85	IF	IF
11-0023-00	Long	Cass	0701010109-02	NLF	113	FS	
11-0026-00	Sugar	Cass	0701010109-02	NLF	689	IF	FS
11-0029-00	Vermillion	Cass	0701010109-02	NLF	408	IF	FS
11-0030-00	Little Vermillion	Cass	0701010109-02	NLF	148	FS	
11-0147-00	Winnibigoshish	Cass	0701010107-01	NLF	55818	FS	IF
11-0505-00	Little Wolf	Cass	0701010105-01	NLF	526	IF	FS
15-0001-00	Big LaSalle	Clearwater	0701010102-01	NLF	234	FS	FS
15-0005-00	Ozawindib	Clearwater	0701010102-01	NLF	158	FS	
15-0010-00	Elk	Clearwater	0701010102-01	NLF	292	FS	FS

Lake ID	Lake Name	County	HUC-12	Ecoregion	Lake Area (acres)	AQR Support Status	AQL Support Status
15-0016-00	Itasca	Clearwater	0701010102-01	NLF	1058	IF	FS
15-0018-00	Mallard	Clearwater	0701010102-01	NLF	107	FS	
15-0020-00	Sucker	Clearwater	0701010102-01	NLF	79	IF	
15-0022-00	Daniel	Clearwater	0701010101-01	NLF	50	FS	
15-0023-00	Dahlberg	Clearwater	0701010101-01	NLF	21	FS	
15-0057-00	Long	Clearwater	0701010102-01	NLF	150	FS	IF
15-0058-00	Heart	Clearwater	0701010102-01	NLF	212	FS	FS
29-0066-00	Midge	Hubbard	0701010105-01	NLF	538	IF	FS
29-0071-00	Grace	Beltrami	0701010105-01	NLF	867	IF	IF
29-0156-00	Plantagenet	Hubbard	0701010103-01	NLF	2511	FS	FS
29-0215-00	Schoolcraft	Hubbard	0701010103-01	NLF	162	IF	FS
29-0216-00	George	Hubbard	0701010103-01	NLF	816	FS	FS
29-0217-00	Paine	Hubbard	0701010103-01	NLF	239	FS	IF
29-0227-00	Evergreen	Hubbard	0701010103-01	NLF	203	FS	FS
29-0234-00	Minnie	Hubbard	0701010103-01	NLF	74		IF
29-0238-00	Little Spearhead	Hubbard	0701010103-01	NLF	14	IF	
29-0239-00	Spearhead	Hubbard	0701010103-01	NLF	171	FS	FS
29-0241-00	Frontenac	Hubbard	0701010103-01	NLF	204	FS	FS
29-0246-00	Hennepin	Hubbard	0701010102-02	NLF	410	FS	FS
29-0286-00	Alice	Hubbard	0701010103-01	NLF	127	NS	
29-0292-00	Beauty	Hubbard	0701010103-01	NLF	54	IF	
29-0303-00	Lost	Hubbard	0701010103-01	NLF	113	IF	IF
29-0309-00	LaSalle	Hubbard	0701010102-01	NLF	231	FS	FS
31-0358-00	Stokey	Itasca	0701010109-01	NLF	12	IF	
31-0359-00	Unnamed	Itasca	0701010109-01	NLF	13	IF	
31-0360-00	Munzer	Itasca	0701010109-01	NLF	101	FS	
31-0716-00	Little Rice	Itasca	0701010109-01	NLF	141	FS	

Lake ID	Lake Name	County	HUC-12	Ecoregion	Lake Area (acres)	AQR Support Status	AQL Support Status
31-0717-00	Rice	Itasca	0701010109-01	NLF	841	FS	FS
31-0718-00	Stevens	Itasca	0701010109-01	NLF	229	FS	
31-0719-00	Deer	Itasca	0701010108-01	NLF	4035	FS	FS
31-0722-00	Moose	Itasca	0701010108-01	NLF	1269	FS	FS
31-0733-00	Little Siseebakwet	Itasca	0701010109-01	NLF	326	FS	
31-0735-00	Spring	Itasca	0701010109-01	NLF	19	IF	
31-0736-00	Skelly	Itasca	0701010109-01	NLF	66	IF	
31-0739-00	Leighton	Itasca	0701010109-01	NLF	234	FS	
31-0740-00	Little White Oak	Itasca	0701010109-01	NLF	522	IF	
31-0749-00	Chase	Itasca	0701010108-01	NLF	200	FS	
31-0751-00	Little Deer	Itasca	0701010108-01	NLF	63	FS	
31-0754-00	Island	Itasca	0701010108-01	NLF	284	FS	FS
31-0761-00	Alp	Itasca	0701010108-01	NLF	36	IF	
31-0776-00	White Oak	Itasca	0701010109-01	NLF	939	IF	
31-0812-00	Ball Club	Itasca	0701010109-03	NLF	3847	FS	IF
31-0819-00	Tibbett	Itasca	0701010107-01	NLF	13	IF	
31-0822-00	Little Ball Club	Itasca	0701010109-03	NLF	181	FS	
31-0823-00	Two Mile	Itasca	0701010107-01	NLF	27	IF	
31-0850-00	Little Winnibigoshish	Itasca	0701010109-01	NLF	823	FS	
31-0532-01	POKEGAMA (MAIN BAY)	Itasca	0701010109-01	NLF	5565	FS	IF
31-0532-02	POKEGAMA (WENDIGO)	Itasca	0701010109-01	NLF	1107	FS	IF
31-0547-00	Smith	Itasca	0701010109-01	NLF	43	IF	
31-0549-00	Unnamed	Itasca	0701010109-01	NLF	22	IF	
31-0554-00	Siseebakwet	Itasca	0701010109-01	NLF	1205	FS	FS
31-0555-00	South Sugar	Itasca	0701010109-01	NLF	87	FS	
31-0557-00	Unnamed	Itasca	0701010109-01	NLF	19	IF	
31-0559-00	Unnamed	Itasca	0701010109-01	NLF	11	IF	

Lake ID	Lake Name	County	HUC-12	Ecoregion	Lake Area (acres)	AQR Support Status	AQL Support Status
31-0563-00	Warburg	Itasca	0701010109-01	NLF	43	IF	
31-0564-00	Unnamed	Itasca	0701010109-01	NLF	76	IF	
31-0565-00	Jay Gould	Itasca	0701010109-01	NLF	420	FS	FS
31-0566-00	Little Jay Gould	Itasca	0701010109-01	NLF	147	FS	FS
31-0569-00	Guile	Itasca	0701010109-01	NLF	90	IF	
31-0570-00	Long	Itasca	0701010109-01	NLF	125	FS	IF
31-0571-00	Loon	Itasca	0701010109-01	NLF	223	FS	FS
31-0575-00	Little Bass	Itasca	0701010109-01	NLF	158	FS	FS
31-0576-00	Bass	Itasca	0701010109-01	NLF	2662	FS	
31-0578-00	Clarke	Itasca	0701010108-01	NLF	32	FS	
31-0585-00	McAvity	Itasca	0701010108-01	NLF	138	FS	
31-0586-00	Johnson	Itasca	0701010108-01	NLF	445	FS	FS
31-0587-00	Orange	Itasca	0701010108-01	NLF	98	FS	
31-0588-00	Little Horn	Itasca	0701010108-01	NLF	38	IF	
31-0590-00	Beaver	Itasca	0701010108-01	NLF	57	FS	
31-0594-00	Cottonwood	Itasca	0701010108-01	NLF	124	FS	FS
31-0597-00	Amen	Itasca	0701010108-01	NLF	213	FS	
31-0598-00	Big Horn	Itasca	0701010108-01	NLF	33	IF	
31-0602-00	Pughole	Itasca	0701010108-01	NLF	149	FS	
31-0609-00	Fawn	Itasca	0701010108-01	NLF	181	FS	
31-0610-00	Little Moose	Itasca	0701010108-01	NLF	288	FS	FS
31-0611-00	Dead Horse	Itasca	0701010108-01	NLF	11	IF	
31-1311-00	LaPlant Pond	Itasca	0701010109-01	NLF	2	IF	
31-1347-00	Unnamed	Itasca	0701010109-01	NLF	3	IF	
31-1348-00	Unnamed	Itasca	0701010109-01	NLF	4	IF	
31-0852-00	Little Cut Foot Sioux	Itasca	0701010107-01	NLF	588	NS	
31-0857-01	Cut Foot Sioux(Main Bay)	Itasca	0701010107-01	NLF	2316	FS	

Lake ID	Lake Name	County	HUC-12	Ecoregion	Lake Area (acres)	AQR Support Status	AQL Support Status
31-0862-00	Biauswah	Itasca	0701010107-01	NLF	133	NS	
31-0867-00	Simpson	Itasca	0701010107-01	NLF	32	IF	
31-0892-00	Middle Pigeon	Itasca	0701010107-01	NLF	178	NS	
31-0893-00	Lower Pigeon	Itasca	0701010107-01	NLF	285	NS	IF
31-0894-00	Pigeon Dam	Itasca	0701010107-01	NLF	523	IF	
31-0895-00	Unnamed	Itasca	0701010107-01	NLF	50	IF	
31-0908-00	Upper Pigeon	Itasca	0701010107-01	NLF	100	NS	
31-0921-00	Dixon	Itasca	0701010106-01	NLF	550	NS	IF
31-0926-00	Sugar	Itasca	0701010107-01	NLF	1478	IF	
31-0928-00	Kenogama	Itasca	0701010107-01	NLF	565	NS	
31-0929-00	Morph	Itasca	0701010107-01	NLF	307	IF	
31-0934-00	Decker	Itasca	0701010106-01	NLF	236	NS	IF
31-0942-00	Rice	Itasca	0701010104-01	NLF	35	IF	
31-0943-00	Coleman	Itasca	0701010106-01	NLF	50	IF	
31-0946-00	Tioga Mine Pit	Itasca	0701010109-01	NLF	48	IF	
31-0971-00	Unnamed	Itasca	0701010108-01	NLF	9	IF	
31-1146-00	Unnamed	Itasca	0701010108-01	NLF	4	IF	
31-1223-00	Unnamed	Itasca	0701010107-01	NLF	73	IF	
15-0491-00	Unnamed	Clearwater	0701010102-01	NLF	5	IF	IF

Abbreviations: **FS** – Full Support **NA** – Not Assessed
NS – Non-Support
IF – Insufficient Information

Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use.

*These depths were created by MPCA Staff.

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 (assessable reaches)

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Fish Class	Threshold	FIBI	Visit Date
HUC 12: 0701010101-01 (Little Mississippi River)							
07010101-517	13UM122	Little Mississippi River	58.42	5	47	32.79	10-Jul-13
07010101-517	13UM122	Little Mississippi River	58.42	5	47	53.95	14-Jul-14
07010101-738	13UM149	Unnamed creek	10.58	6	42	49.79	15-Jul-14
HUC 12:0701010101-02 (Grant Creek)							
07010101-739	13UM147	Unnamed creek	5.97	7	42	0.00	11-Jun-13
07010101-739	13UM147	Unnamed creek	5.97	7	42	0.00	15-Jul-14
07010101-747	00UM001	Unnamed ditch	5.84	6	42	38.48	12-Jul-00
07010101-748	13UM146	Unnamed ditch	14.07	6	42	37.87	14-Jul-14
07010101-670	10EM165	Grant Creek	40.31	7	42	52.08	08-Jul-10
07010101-546	13UM114	Grant Creek	64.44	5	47	0.00	23-Jul-13
HUC 12: 0701010102-01 (Headwaters Mississippi River)							
07010101-663	09UM083	Sucker Creek	19.78	11	35	55.61	20-Jul-10
07010101-663	09UM083	Sucker Creek	19.78	11	35	58.78	03-Sep-10
07010101-663	09UM083	Sucker Creek	19.78	11	35	73.09	10-Jun-13
07010101-631	13UM102	Bear Creek	13.28	6	42	45.08	11-Jun-13
07010101-663	09UM083	Sucker Creek	19.78	11	35	55.61	20-Jul-10
07010101-663	09UM083	Sucker Creek	19.78	11	35	58.78	03-Sep-10
HUC 12: 0701010102-02 (Hennepin Creek)							
07010101-637	13UM117	Hennepin Creek	41.59	6	42	55.77	31-Jul-13
HUC 12: 0701010103-01 (Schoolcraft River)							
07010101-573	00UM011	Birch Creek	43.12	6	42	37.32	12-Jul-00
07010101-573	00UM011	Birch Creek	43.12	6	42	81.49	17-Jun-13
07010101-752	13UM135	Schoolcraft River	80.92	5	47	43.99	11-Jul-13
07010101-752	13UM135	Schoolcraft River	80.92	5	47	61.49	19-Jun-13
07010101-752	13UM136	Schoolcraft River	33.01	6	42	46.54	17-Jun-13
07010101-638	13UM100	Alcohol Creek	17.26	6	42	57.17	10-Jun-13
07010101-651	13UM112	Frontenac Creek	17.82	7	42	62.80	18-Jun-13

07010101-751	13UM134	Schoolcraft River	134.02	5	47	59.51	08-Jul-13
07010101-751	13UM134	Schoolcraft River	134.02	5	47	65.55	14-Jul-14
HUC 12: 0701010104-01 (Turtle River)							
07010101-551	13UM116	Gull River	16.36	6	42	31.73	06-Aug-14
07010101-551	13UM116	Gull River	16.36	6	42	37.21	12-Jun-13
07010101-510	13UM153	Turtle River	166.14	5	47	56.81	20-Jun-13
07010101-510	13UM154	Turtle River	122.63	5	47	49.91	24-Jul-13
07010101-510	13UM155	Turtle River	86.95	5	47	66.72	18-Jun-13
07010101-510	13UM156	Turtle River	38.14	7	42	48.72	09-Jul-13
HUC 12: 0701010104-02 (North Turtle River)							
07010101-570	13UM131	North Turtle River	48.96	7	42	49.88	23-Jul-13
07010101-548	13UM130	North Turtle River	74.56	5	47	47.65	10-Jul-13
HUC 12: 0701010105-01 (Cass Lake-Mississippi River)							
07010101-750	13UM148	Unnamed creek	20.25	7	42	41.97	10-Jul-13
07010101-750	13UM148	Unnamed creek	20.25	7	42	49.23	12-Jun-13
HUC 12: 0701010106-01 (Third River)							
07010101-581	13UM129	Moose Creek	17.72	7	42	0.34	11-Sep-13
07010101-526	00UM007	Third River	88.77	5	47	50.81	06-Aug-14
07010101-526	00UM007	Third River	88.77	5	47	44.05	12-Jul-00
07010101-526	13UM142	Third River	36.86	7	42	49.34	10-Jul-13
07010101-526	13UM160	Third River	9.49	7	42	47.33	13-Jun-13
HUC 12: 0701010107-01 (Lake Winnibigoshish)							
07010101-549	13UM125	Lydick Brook	6.50	7	42	56.12	19-Jun-13
07010101-590	13UM103	Castle Creek	12.71	6	42	54.69	13-Jun-13
07010101-606	13UM110	Farley Creek	6.22	7	42	43.30	19-Jun-13
07010101-620	13UM132	Pigeon River	11.66	6	42	43.02	19-Jun-13
HUC 12: 0701010108-01 (Deer River)							
07010101-505	*13UM105*	Deer River	83.92	5	47	69.15	25-Jul-13
07010101-505	*13UM106*	Deer River	55.39	5	47	54.99	25-Jul-13
07010101-619	13UM119	Island Lake Creek	8.35	6	42	55.84	13-Jun-13
07010101-740	13UM145	Unnamed creek	12.10	6	42	0.00	12-Jun-13

HUC 12: 0701010109-01 (Pokegama Lake-Mississippi River)							
07010101-692	13UM141	Sugar Brook	16.52	6	42	21.34	15-Jul-14
07010101-692	13UM141	Sugar Brook	16.52	6	42	33.44	12-Jun-13
07010101-692	13UM141	Sugar Brook	16.52	6	42	45.89	09-Jun-15
07010101-692	15UM400	Sugar Brook	16.82	6	42	24.39	09-Jun-15
07010101-692	15UM401	Sugar Brook	17.26	6	42	18.26	09-Jun-15
07010101-644	14UM101	Smith Creek	9.00	6	42	41.91	15-Jul-14
HUC 12: 0701010109-02 (Vermillion River)							
07010101-521	13UM161	Vermillion River	9.57	6	42	34.26	11-Jul-13
HUC 12: 0701010109-03 (Ball Club)							
07010101-741	13UM111	Fisherman's Brook	18.39	6	42	0.81	15-Jul-14
07010101-741	13UM111	Fisherman's Brook	18.39	6	42	1.36	11-Jul-13

Appendix 4.3 Biological monitoring results – macroinvertebrate IBI (assessable reaches)

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Invert Class	Threshold	MIBI	Visit Date
HUC 12: 0701010101-01 (Little Mississippi River)							
07010101-517	13UM122	Little Mississippi River	58.42	4	51	68.02	27-Aug-13
HUC 12: 0701010102-01 (Headwaters Mississippi River)							
07010101-663	09UM083	Sucker Creek	19.78	8	32	16.11	27-Aug-13
07010101-663	09UM083	Sucker Creek	19.78	8	32	25.98	15-Sep-09
07010101-663	09UM083	Sucker Creek	19.78	8	32	32.46	03-Sep-14
07010101-631	13UM102	Bear Creek	13.28	3	53	65.70	27-Aug-13
HUC 12: 0701010102-02 (Hennepin Creek)							
07010101-637	13UM117	Hennepin Creek	41.59	3	53	50.90	28-Aug-14
07010101-637	13UM117	Hennepin Creek	41.59	3	53	55.84	31-Jul-13
HUC 12: 0701010103-01 (Schoolcraft River)							
07010101-573	00UM011	Birch Creek	43.12	3	53	66.03	26-Aug-13
07010101-752	13UM135	Schoolcraft River	80.92	4	51	51.14	27-Aug-13
07010101-752	13UM135	Schoolcraft River	80.92	4	51	56.38	28-Aug-13
07010101-752	13UM136	Schoolcraft River	33.01	3	53	56.25	26-Aug-13
07010101-752	15EM002	Schoolcraft River	105.65	4	51	40.00	17-Aug-15
07010101-752	15EM002	Schoolcraft River	105.65	4	51	60.00	17-Aug-15
07010101-638	13UM188	Alcohol Creek	17.20	4	51	75.01	26-Aug-13
07010101-751	00UM011	Birch Creek	43.12	3	53	66.03	26-Aug-13
07010101-751	13UM135	Schoolcraft River	80.92	4	51	51.14	27-Aug-13
HUC 12: 0701010104-01 (Turtle River)							
07010101-551	13UM116	Gull River	16.36	3	53	59.25	28-Aug-13
07010101-510	13UM153	Turtle River	166.14	4	51	73.76	27-Aug-13
07010101-510	13UM156	Turtle River	38.14	4	51	58.12	27-Aug-13
07010101-510	15EM050	Turtle River	56.42	4	51	69.00	06-Aug-15
HUC 12: 0701010104-02 (North Turtle River)							
07010101-548	13UM130	North Turtle River	74.56	4	51	61.10	27-Aug-13
HUC 12: 0701010105-01 (Cass Lake-Mississippi River)							

07010101-750	13UM148	Unnamed creek	20.25	4	51	66.10	27-Aug-13
HUC 12: 0701010106-01 (Third River)							
07010101-581	13UM129	Moose Creek	17.72	4	51	74.15	11-Sep-13
07010101-526	00UM007	Third River	88.77	4	51	46.19	16-Sep-04
07010101-526	00UM007	Third River	88.77	4	51	57.74	02-Sep-14
07010101-526	13UM160	Third River	9.49	4	51	67.96	11-Sep-13
HUC 12: 0701010107-01 (Lake Winnibigoshish)							
07010101-606	13UM110	Farley Creek	6.22	4	51	38.75	02-Sep-14
HUC 12: 0701010108-01 (Deer River)							
07010101-505	13UM105	Deer River	83.92	4	51	56.98	28-Aug-13
07010101-505	13UM106	Deer River	55.39	4	51	66.99	28-Aug-13
HUC 12: 0701010109-01 (Pokegama Lake-Mississippi River)							
07010101-692	13UM141	Sugar Brook	16.52	3	53	50.21	02-Sep-14
07010101-692	13UM141	Sugar Brook	16.52	3	53	59.31	28-Aug-13
07010101-644	13UM137	Smith Creek	8.06	8	32	42.89	29-Aug-13
07010101-644	14UM101	Smith Creek	9.00	8	32	57.19	02-Sep-14
HUC 12: 0701010109-02 (Vermillion River)							
07010101-521	13UM161	Vermillion River	9.57	3	53	58.69	28-Aug-13
HUC 12: 0701010109-03 (Ball Club)							
07010101-741	13UM111	Fisherman's Brook	18.39	4	51	59.09	02-Sep-14

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 6. Fish species found during biological monitoring surveys

Common Name	Quantity of Stations Where Present	Quantity of Individuals Collected
banded killifish	1	2
bigmouth shiner	3	55
black bullhead	14	108
black crappie	5	30
blackchin shiner	8	69
blacknose dace	14	619
blacknose shiner	13	60
bluegill	18	407
bluntnose minnow	4	48
brassy minnow	1	6
brook stickleback	8	55
brook trout	2	145
brown bullhead	7	11
burbot	3	6
central mudminnow	36	1080
common shiner	17	1172
creek chub	19	229
fathead minnow	9	36
finescale dace	3	6
Gen: common sunfishes	1	10
golden shiner	14	52
greater redhorse	3	4
green sunfish	7	15
hornyhead chub	10	414
hybrid sunfish	3	10
Iowa darter	14	55
johnny darter	16	477

Common Name	Quantity of Stations Where Present	Quantity of Individuals Collected
largemouth bass	14	235
logperch	3	32
longear sunfish	2	32
mimic shiner	3	36
mottled sculpin	4	85
muskellunge	1	1
northern pike	29	260
northern redbelly dace	7	94
pearl dace	2	4
pugnose shiner	1	51
pumpkinseed	12	79
rock bass	14	169
sand shiner	2	1
shorthead redhorse	1	8
silver redhorse	2	12
smallmouth bass	2	3
spotfin shiner	1	1
tadpole madtom	10	71
walleye	4	6
weed shiner	1	2
white sucker	21	242
yellow bullhead	16	64
yellow perch	34	3167

Appendix 7. Macroinvertebrate species found during biological monitoring surveys

Taxonomic Name	Number of Stations Where Present	Quantity of Individuals Collected
Amphipoda		
Gammarus	5	30
Hyalella	32	1377
Coleoptera		
Anacaena	3	6
Desmopachria convexa	1	1
Dubiraphia	26	104
Dytiscidae	2	2
Enochrus	1	1
Gymnochthebius	1	2
Gyrinus	3	4
Haliplus	7	11
Helichus	1	2
Hydraena	9	21
Hydrobius	1	1
Hydrochus	1	1
Hydrophilidae	4	122
Liodessus	6	12
Macronychus glabratus	14	49
Optioservus	14	90
Peltodytes	1	1
Scirtidae	1	1
Stenelmis	15	66
Decapoda		
Cambaridae	1	1
Decapoda	1	1
Orconectes	10	11

Diptera		
Ablabesmyia	18	51
Acricotopus	1	3
Anopheles	8	52
Antocha	3	5
Atrichopogon	1	1
Bezzia	1	3
Bezzia/Palpomyia	1	1
Brillia	7	25
Cardiocladius	1	1
Ceratopogonidae	1	1
Ceratopogoninae	9	11
Chironomini	3	13
Chironomus	1	1
Cladotanytarsus	2	4
Clinocera	1	1
Clinotanypus	2	2
Conchapelopia	6	7
Corynoneura	12	21
Cricotopus	21	106
Culicidae	4	10
Dicranota	5	6
Dicrotendipes	5	8
Diplocladius cultriger	2	22
Dixa	2	4
Dixella	8	17
Dixidae	1	3
Doncricotopus bicaudatus	1	1
Empididae	3	11
Endochironomus	1	1
Ephydridae	6	11
Eukiefferiella	8	25

Hemerodromia	19	78
Hexatoma	1	2
Labrundinia	15	27
Larsia	1	1
Limnophila	1	1
Limnophyes	4	4
Micropsectra	14	36
Microtendipes	19	85
Nanocladius	4	16
Natarsia	1	3
Neoplasta	1	2
Nilotanypus	5	7
Nilothauma	2	2
Odontomesa	3	5
Orthocladiinae	7	8
Orthocladius	12	19
Orthocladius (Symposiocladius)	3	4
Paracladopelma	1	1
Parakiefferiella	5	12
Paramerina	8	33
Parametriocnemus	14	81
Paratanytarsus	4	5
Paratendipes	3	4
Pentaneura	8	20
Phaenopsectra	9	13
Polypedilum	33	306
Procladius	11	28
Psectrocladius	11	46
Psychoda	1	1
Rheocricotopus	10	22
Rheotanytarsus	26	249
Roederiodes	1	3

Simuliidae	1	1
Simulium	31	1215
Sphaeromias	1	1
Stempellina	1	1
Stempellinella	22	49
Stenochironomus	10	36
Stictochironomus	1	1
Stratiomyidae	1	1
Synorthocladius	1	1
Tabanidae	3	5
Tanypodinae	11	26
Tanytarsini	15	42
Tanytarsus	26	161
Thienemanniella	10	34
Thienemannimyia	4	9
Thienemannimyia Gr.	25	134
Tipula	11	32
Tribelos	3	3
Trissopelopia ogemawi	1	2
Tvetenia	20	175
Xenochironomus xenolabis	1	1
Xylotopus par	1	3
Zavrelimyia	2	2
Ephemeroptera		
Acentrella	5	31
Acentrella parvula	3	5
Acentrella turbida	2	60
Acerpenna	12	92
Acerpenna pygmaea	12	155
Anafroptilum	1	1
Baetidae	12	52
Baetis	9	77

Baetis brunneicolor	16	279
Baetis flavistriga	12	147
Baetis intercalaris	1	9
Baetisca	7	11
Caenis	7	41
Caenis diminuta	6	48
Caenis hilaris	6	33
Caenis tardata	1	3
Callibaetis	2	3
Ephemerella	1	2
Ephemerellidae	5	31
Eurylophella	3	13
Heptagenia	3	7
Heptageniidae	11	34
Hexagenia	1	1
Hexagenia limbata	1	1
Isonychia	2	11
Iswaeon	13	359
Labiobaetis	1	24
Labiobaetis dardanus	1	18
Labiobaetis propinquus	16	378
Leptophlebia	1	1
Leptophlebiidae	15	211
Leucrocuta	4	4
Maccaffertium	17	184
Maccaffertium exiguum	2	2
Maccaffertium mediopunctatum	2	4
Maccaffertium modestum	2	4
Maccaffertium terminatum	1	1
Maccaffertium vicarium	8	44
Metretopodidae	1	1
Paraleptophlebia	14	268

Plauditus	1	1
Procloeon	1	5
Pseudocloeon	1	2
Pseudocloeon propinquum	1	120
Stenacron	15	46
Tricorythodes	4	8
Gastropoda		
Amnicola	1	3
Ferrissia	13	93
Fossaria	3	11
Gyraulus	2	9
Helisoma anceps	3	3
Hydrobiidae	10	381
Lymnaea stagnalis	2	3
Lymnaeidae	3	8
Physa	18	257
Physella	7	23
Planorbella	5	6
Planorbidae	5	6
Promenetus exacuous	1	1
Stagnicola	1	1
Valvata	4	36
Viviparus	1	13
Hemiptera		
Belostoma flumineum	16	30
Corixidae	3	25
Gerridae	1	1
Lethocerus	2	2
Mesovelia	1	1
Neoplea striola	3	3
Ranatra	2	2
Sigara	4	6

Trichocorixa	1	1
Lepidoptera		
Crambidae	4	6
Parapoynx	6	12
Petrophila	1	5
Megaloptera		
Sialis	4	10
Nematoda		
Nemata	6	9
Nematoda	2	2
Odonata		
Aeshna	4	4
Aeshna umbrosa	1	1
Aeshnidae	4	5
Anisoptera	1	1
Basiaeschna janata	1	1
Boyeria	1	1
Boyeria vinosa	5	7
Calopterygidae	7	15
Calopteryx	11	42
Calopteryx aequabilis	13	42
Coenagrionidae	8	36
Cordulegaster	2	2
Cordulegaster maculata	1	1
Corduliidae	3	7
Enallagma	1	1
Epitheca canis	1	1
Gomphidae	2	4
Hetaerina	1	1
Ophiogomphus	3	3
Somatochlora minor	2	2

Oligochaeta		
Lumbriculidae	1	1
Oligochaeta	16	57
Stylaria	1	1
Plecoptera		
Acroneuria	2	2
Acroneuria lycorias	3	4
Amphinemura	3	13
Isoperla	8	65
Nemouridae	1	1
Paragnetina media	3	6
Perlesta	3	8
Perlidae	1	2
Perlodidae	3	14
Pteronarcys	5	16
Trichoptera		
Agraylea	1	1
Brachycentrus numerosus	9	36
Ceraclea	6	19
Ceratopsyche	14	142
Ceratopsyche bronta	4	21
Ceratopsyche morosa	1	6
Ceratopsyche slossonae	9	179
Ceratopsyche sparna	2	9
Cheumatopsyche	31	358
Chimarra	7	128
Glossosoma	2	4
Glossosoma intermedium	1	2
Glossosomatidae	1	2
Helicopsyche borealis	13	127
Hydatophylax argus	1	1
Hydropsyche	7	52

Hydropsyche betteni	19	192
Hydropsychidae	21	275
Hydroptila	11	32
Hydroptilidae	5	47
Lepidostoma	9	76
Leptoceridae	7	17
Leptocerus americanus	1	3
Limnephilidae	17	49
Limnephilus	2	3
Lype diversa	3	7
Micrasema	1	1
Micrasema rusticum	2	5
Molanna	1	1
Nectopsyche	4	6
Nectopsyche diarina	6	15
Neophylax oligius	1	1
Neureclipsis	12	149
Nyctiophylax	3	10
Oecetis	3	4
Oecetis avara	11	80
Oecetis furva	1	1
Oecetis testacea	6	28
Oxyethira	13	137
Philopotamidae	1	1
Phryganeidae	9	20
Polycentropodidae	6	7
Polycentropus	8	25
Protoptila	4	90
Psychomyia	1	1
Psychomyia flavida	1	3
Psychomyiidae	1	1
Ptilostomis	11	27

Pycnopsyche	3	4
Rhyacophila	1	1
Triaenodes	4	11
Uenoidae	3	13
Unclassified		
Acari	30	184
Helobdella stagnalis	1	1
Hirudinea	10	54
Hydrozoa	1	1
Ostracoda	1	16
Prostoma	1	1
Trepaxonemata	2	3
Turbellaria	7	43
Veneroida		
Pisidiidae	20	178

Appendix 8. Summary statistics of fish length, mercury, and PCBs, by waterway-species-year

									Length (in)			Mercury (mg/kg)			PCBs (mg/kg)				PFOS (µg/kg)		
Major Watershed	HUC8	AUID	Waterway	Species	Year	Anat.	No. Fish	N	Mean	Min	Max	Mean	Min	Max	N	Mean	Max	< RL	N	Mean	Max
Mississippi R - Headwaters	07010101	07010101-725*	RM 1190, UPSTREAM OF POKEGAMA LAKE DAM IN COHASSET	LMB	2013	FILSK	8	8	15.6	14.0	17.2	0.395	0.287	0.588	2	0.025	0.025	Y			
				SRD	2013	FILSK	2	2	19.1	18.5	19.7	0.212	0.211	0.212	2	0.025	0.025	Y			
				YP	2013	FILSK	7	3	10.9	9.2	11.8	0.184	0.158	0.198							
		04000700	KITCHI*	BGS	1993	FILSK	6	1	8.0	8.0	8.0	0.015	0.015	0.015							
				CIS	1993	FILSK	8	1	15.6	15.6	15.6	0.075	0.075	0.075	1	0.01	0.01	Y			
				NP	1993	FILSK	21	5	25.9	18.5	34.2	0.292	0.180	0.570	2	0.026	0.042	Y			
				WE	1993	FILSK	24	4	16.9	11.6	22.2	0.214	0.095	0.360	1	0.01	0.01	Y			
		04001100	MOOSE**	BGS	2006	FILSK	10	1	6.8	6.8	6.8	0.059	0.059	0.059							
				NP	2006	FILSK	5	5	22.2	18.5	30.6	0.247	0.140	0.345							
				WE	2006	FILSK	6	6	22.1	18.0	26.8	0.474	0.188	0.835							
		04002400	GILSTAD**	NP	2010	FILSK	15	15	24.0	16.5	30.4	0.459	0.232	0.653							
		04003000	CASS*	CIS	1983	FILSK	5	1	13.3	13.3	13.3	0.080	0.080	0.080	1	0.06	0.06				
					1996	FILSK	7	1	12.6	12.6	12.6	0.070	0.070	0.070	1	0.01	0.01	Y			
					2002	FILSK	4	1	13.8	13.8	13.8	0.097	0.097	0.097							
				NP	1983	FILSK	5	1	21.9	21.9	21.9	0.270	0.270	0.270	1	0.05	0.05	Y			
					1984	FILSK	5	1	23.2	23.2	23.2	0.340	0.340	0.340	1	0.05	0.05	Y			
					1985	FILSK	5	1	20.9	20.9	20.9	0.200	0.200	0.200	1	0.05	0.05	Y			
					1996	FILSK	24	5	24.6	19.2	30.5	0.256	0.180	0.340							
					2006	FILSK	5	5	24.5	19.2	28.2	0.274	0.146	0.410							
					2009	FILSK	14	14	24.8	21.3	31.2	0.214	0.096	0.434							
				WE	1983	FILSK	7	1	17.0	17.0	17.0	0.340	0.340	0.340	1	0.05	0.05	Y			
					1984	FILSK	5	1	17.0	17.0	17.0	0.220	0.220	0.220	1	0.05	0.05	Y			
					1985	FILSK	6	1	17.4	17.4	17.4	0.220	0.220	0.220	1	0.05	0.05	Y			
					1990	FILSK	23	4	19.7	13.6	25.4	0.420	0.140	0.730	4	0.013	0.018	Y			
					1996	FILSK	23	5	20.9	12.8	28.9	0.326	0.060	0.650	1	0.01	0.01				
					2002	FILSK	5	5	17.6	14.0	23.2	0.266	0.170	0.480							

Major Watershed	HUC8	AUID	Waterway	Species	Year	Anat.	No. Fish	N	Length (in) Mean	Length (in) Min	Length (in) Max	Mercury (mg/kg) Mean	Mercury (mg/kg) Min	Mercury (mg/kg) Max	PCBs (mg/kg) N	PCBs (mg/kg) Mean	PCBs (mg/kg) Max	PCBs (mg/kg) < RL	PFOS (µg/kg) N	PFOS (µg/kg) Mean	PFOS (µg/kg) Max
					2006	FILSK	24	24	15.7	12.7	20.2	0.242	0.142	0.775							
					2010	FILSK	5	5	15.3	13.4	16.3								5	4.9	Y
					2012	FILSK	6	6	17.1	14.8	19.7	0.190	0.169	0.231							
				WSU	1983	FILSK	5	1	18.6	18.6	18.6	0.060	0.060	0.060	1	0.05	0.05	Y			
					1984	FILSK	5	1	16.2	16.2	16.2	0.070	0.070	0.070	1	0.05	0.05	Y			
					1985	FILSK	5	1	17.5	17.5	17.5	0.030	0.030	0.030	1	0.05	0.05	Y			
					1990	FILSK	17	3	16.1	11.0	20.4	0.048	0.025	0.072	3	0.012	0.017	Y			
				YP	1990	FILSK	10	1	6.7	6.7	6.7	0.068	0.068	0.068	1	0.01	0.01	Y			
					1996	FILSK	10	1	9.4	9.4	9.4	0.080	0.080	0.080							
					2002	FILSK	8	1	9.8	9.8	9.8	0.153	0.153	0.153							
					2010	FILSK	5	5	9.7	8.3	10.4								5	4.8	Y
					2012	FILSK	6	1	9.9	9.9	9.9	0.135	0.135	0.135							
		04003200	PIMUSHE*	BGS	2008	FILSK	9	2	7.4	6.8	8.0	0.032	0.028	0.036							
				BKB	2008	FILET	10	1	12.2	12.2	12.2	0.019	0.019	0.019							
				NP	2008	FILSK	8	8	18.6	16.4	22.3	0.191	0.104	0.323							
		04003400	RABIDEAU*	BGS	2008	FILSK	9	2	8.2	8.0	8.3	0.065	0.065	0.065							
				NP	2008	FILSK	5	5	21.3	16.3	30.2	0.254	0.154	0.467							
				WE	2008	FILSK	2	2	23.5	20.5	26.4	0.628	0.577	0.678							
				WSU	2008	FILSK	4	1	17.2	17.2	17.2	0.049	0.049	0.049							
		04003800	ANDRUSIA*	BGS	1992	FILSK	1	1	8.0	8.0	8.0	0.047	0.047	0.047							
				CIS	1992	FILSK	10	3	13.6	12.0	14.6	0.043	0.036	0.056	2	0.014	0.014				
				NP	1992	FILSK	17	6	22.7	19.1	26.4	0.218	0.100	0.380	2	0.013	0.015	Y			
					2009	FILSK	15	15	20.8	17.3	28.5	0.217	0.113	0.466							
				RKB	1992	FILSK	1	1	10.7	10.7	10.7	0.150	0.150	0.150							
				WE	1992	FILSK	24	8	18.1	13.6	23.1	0.236	0.110	0.410	2	0.029	0.037				
				WSU	1992	FILSK	17	6	18.2	13.5	22.6	0.057	0.010	0.120	1	0.01	0.01	Y			
				YP	1992	FILSK	8	1	8.3	8.3	8.3	0.078	0.078	0.078							

									Length (in)			Mercury (mg/kg)			PCBs (mg/kg)				PFOS (µg/kg)		
Major Watershed	HUC8	AUID	Waterway	Species	Year	Anat.	No. Fish	N	Mean	Min	Max	Mean	Min	Max	N	Mean	Max	< RL	N	Mean	Max
		04004800	WINDIGO*	BGS	2005	FILSK	9	1	7.9	7.9	7.9	0.036	0.036	0.036							
				LMB	2005	FILSK	1	1	13.5	13.5	13.5	0.108	0.108	0.108							
				NP	2005	FILSK	5	5	23.2	20.0	26.2	0.225	0.147	0.332							
				WE	2005	FILSK	5	5	21.1	20.6	22.2	0.429	0.369	0.563							
		04004900	BIG*	NP	1995	FILSK	30	5	25.0	18.0	32.5	0.332	0.110	0.600	1	0.01	0.01				
					2011	FILSK	8	8	21.4	17.8	28.7	0.197	0.121	0.500							
				WE	1995	FILSK	22	5	17.3	11.4	22.9	0.230	0.082	0.530							
					2011	FILSK	8	8	17.6	13.9	19.9	0.133	0.098	0.172							
				WSU	1995	FILSK	8	1	19.6	19.6	19.6	0.026	0.026	0.026							
				YP	1995	FILSK	10	1	9.1	9.1	9.1	0.120	0.120	0.120							
					2011	FILSK	8	2	10.4	9.8	10.9	0.085	0.068	0.102							
		04005300	SOUTH TWIN*	BGS	1995	FILSK	10	1	7.3	7.3	7.3	0.049	0.049	0.049							
				NP	1995	FILSK	34	6	21.8	13.6	31.1	0.126	0.078	0.160	1	0.01	0.01	Y			
				WE	1995	FILSK	13	4	16.6	11.1	20.8	0.143	0.055	0.310							
				WSU	1995	FILSK	8	1	21.1	21.1	21.1	0.050	0.050	0.050							
		04007900	WOLF*	CIS	1996	FILSK	7	2	14.1	12.3	15.8	0.090	0.069	0.110	2	0.03	0.04				
				NP	1996	FILSK	21	5	25.6	17.7	36.9	0.322	0.180	0.640	1	0.01	0.01	Y			
					2009	FILSK	15	15	20.1	14.2	27.3	0.229	0.093	0.555							
				WE	1996	FILSK	14	5	17.8	13.2	23.6	0.372	0.160	0.680	1	0.01	0.01	Y			
				YP	1996	FILSK	10	1	8.8	8.8	8.8	0.120	0.120	0.120							
		04008500	SWENSON*	BGS	1993	FILSK	8	1	7.9	7.9	7.9	0.120	0.120	0.120							
				NP	1993	FILSK	21	4	25.7	18.3	32.9	0.345	0.150	0.480	1	0.01	0.01	Y			
				WE	1993	FILSK	19	4	20.0	15.3	24.6	0.370	0.250	0.500	1	0.01	0.01	Y			
				WSU	1993	FILSK	5	1	20.7	20.7	20.7	0.120	0.120	0.120	1	0.01	0.01	Y			
		04011100	TURTLE RIVER*	BGS	1993	FILSK	9	1	7.2	7.2	7.2	0.037	0.037	0.037							
				BKS	2011	FILSK	8	2	10.5	9.6	11.3	0.061	0.046	0.075							
				CIS	1993	FILSK	5	1	15.1	15.1	15.1	0.064	0.064	0.064	1	0.01	0.01	Y			

Major Watershed	HUC8	AUID	Waterway	Species	Year	Anat.	No. Fish	N	Length (in)			Mercury (mg/kg)			PCBs (mg/kg)				PFOS (µg/kg)		
									Mean	Min	Max	Mean	Min	Max	N	Mean	Max	< RL	N	Mean	Max
				NP	1993	FILSK	7	2	25.9	22.7	29.1	0.270	0.220	0.320	1	0.01	0.01	Y			
					2011	FILSK	8	8	21.6	17.6	28.5	0.257	0.172	0.474							
				WE	1993	FILSK	17	3	18.5	13.4	22.7	0.377	0.190	0.590	1	0.01	0.01	Y			
					2011	FILSK	9	9	15.1	11.6	18.2	0.206	0.173	0.253							
				WSU	2011	FILSK	6	1	16.9	16.9	16.9	0.068	0.068	0.068							
		04012000	GULL*	BGS	2014	FILSK	10	1	8.0	8.0	8.0	0.029	0.029	0.029							
				NP	1986	FILSK	15	3	22.0	18.2	26.3	0.247	0.110	0.450							
					2007	FILSK	6	6	18.6	17.0	20.6	0.156	0.040	0.315							
					2014	FILSK	9	9	18.8	17.4	20.3	0.225	0.135	0.357							
				WE	1986	FILSK	12	3	17.2	13.6	21.3	0.240	0.150	0.370							
					2007	FILSK	5	5	16.6	13.0	21.1	0.113	0.015	0.317							
				YEB	2014	FILSK	5	1	12.9	12.9	12.9	0.062	0.062	0.062							
		04013000	BEMIDJI*	CIS	1998	FILSK	8	1	12.9	12.9	12.9	0.039	0.039	0.039							
				NP	1986	FILSK	13	3	22.2	16.5	26.4	0.233	0.100	0.310	3	0.05	0.05	Y			
					1998	FILSK	7	7	23.9	19.7	29.3	0.169	0.078	0.340							
				WE	1986	FILSK	14	3	17.7	14.1	21.6	0.247	0.200	0.290	3	0.05	0.05	Y			
					1998	FILSK	8	8	17.8	12.2	27.6	0.204	0.056	0.790							
					2012	FILSK	8	8	15.7	13.5	20.2	0.165	0.100	0.273							
				WSU	1986	FILSK	5	1	17.8	17.8	17.8	0.080	0.080	0.080	1	0.05	0.05	Y			
					2012	FILSK	5	1	18.5	18.5	18.5	0.048	0.048	0.048							
				YP	1998	FILSK	10	1	9.6	9.6	9.6	0.049	0.049	0.049							
					2012	FILSK	10	2	8.6	7.8	9.3	0.029	0.027	0.030							
		04013001	STUMP*	BGS	1996	FILSK	10	1	7.8	7.8	7.8	0.074	0.074	0.074							
				BKB	1988	FILET	5	1	10.8	10.8	10.8	0.270	0.270	0.270	1	0.05	0.05	Y			
				NP	1988	FILSK	5	1	22.5	22.5	22.5	1.000	1.000	1.000	1	0.05	0.05	Y			
					1996	FILSK	25	6	24.0	17.4	32.5	0.365	0.100	0.700	1	0.01	0.01				
				WE	1988	FILSK	3	1	15.6	15.6	15.6	0.620	0.620	0.620	1	0.05	0.05	Y			

Major Watershed	HUC8	AUID	Waterway	Species	Year	Anat.	No. Fish	N	Length (in) Mean	Min	Max	Mercury (mg/kg) Mean	Min	Max	PCBs (mg/kg) N	Mean	Max	< RL	PFOS (µg/kg) N	Mean	Max
				WSU	1988	FILSK	1	1	19.6	19.6	19.6	0.250	0.250	0.250	1	0.069	0.069				
				YP	1988	FILSK	3	1	11.0	11.0	11.0	0.290	0.290	0.290	1	0.05	0.05	Y			
		04013200	BIG BASS	BGS	2002	FILSK	10	1	6.2	6.2	6.2	0.041	0.041	0.041							
				BRB	2002	FILET	1	1	14.7	14.7	14.7	0.192	0.192	0.192							
				NP	2002	FILSK	3	3	19.9	14.1	30.0	0.341	0.053	0.888							
				WE	2002	FILSK	4	4	15.7	12.4	23.7	0.189	0.098	0.436							
				WSU	2002	FILSK	1	1	20.3	20.3	20.3	0.101	0.101	0.101							
		04013400	THREE ISLAND**	BGS	2007	FILSK	10	1	7.9	7.9	7.9	0.072	0.072	0.072							
				BRB	2007	FILET	5	1	10.8	10.8	10.8	0.114	0.114	0.114							
				NP	2007	FILSK	6	6	24.0	16.8	28.6	0.295	0.106	0.608							
				YEB	2007	FILET	3	1	11.9	11.9	11.9	0.044	0.044	0.044							
		04013500	BELTRAMI*	BGS	2011	FILSK	5	1	7.6	7.6	7.6	0.072	0.072	0.072							
				CIS	2004	FILSK	4	1	15.4	15.4	15.4	0.067	0.067	0.067							
				NP	2004	FILSK	6	6	22.7	16.4	31.4	0.251	0.104	0.571							
					2011	FILSK	5	5	22.5	21.3	25.0	0.260	0.162	0.354							
				RKB	2004	FILSK	10	1	8.7	8.7	8.7	0.137	0.137	0.137							
				WSU	2011	FILSK	3	1	19.0	19.0	19.0	0.064	0.064	0.064							
		04014000	IRVING*	NP	2012	FILSK	7	7	24.3	19.1	28.5	0.248	0.122	0.339							
				WE	2012	FILSK	8	8	15.9	10.4	18.8	0.239	0.133	0.393							
				WSU	2012	FILSK	5	1	15.7	15.7	15.7	0.123	0.123	0.123							
				YP	2012	FILSK	10	2	9.0	8.7	9.3	0.081	0.071	0.091							
		04014100	CARR**	NP	1987	FILSK	5	1	22.1	22.1	22.1	0.330	0.330	0.330							
				WE	2007	FILSK	5	5	19.5	16.3	26.0	0.445	0.117	0.671							
				WSU	1987	FILSK	5	1	17.1	17.1	17.1	0.130	0.130	0.130	1	0.01	0.01	Y			
		04014200	MARQUETTE*	NP	1987	FILSK	5	1	21.9	21.9	21.9	0.330	0.330	0.330							
				WE	1987	FILSK	5	1	16.7	16.7	16.7	0.260	0.260	0.260							
					2007	FILSK	5	5	19.1	15.9	22.7	0.273	0.120	0.445							

Major Watershed	HUC8	AUID	Waterway	Species	Year	Anat.	No. Fish	N	Length (in)			Mercury (mg/kg)			PCBs (mg/kg)				PFOS (µg/kg)		
									Mean	Min	Max	Mean	Min	Max	N	Mean	Max	< RL	N	Mean	Max
				WSU	1987	FILSK	5	1	17.1	17.1	17.1	0.100	0.100	0.100	1	0.01	0.01	Y			
		04015200	MOVIL*	BGS	2007	FILSK	10	1	7.0	7.0	7.0	0.052	0.052	0.052							
				NP	2007	FILSK	6	6	20.8	19.6	22.4	0.331	0.244	0.458							
				WE	2007	FILSK	6	6	20.3	17.4	22.7	0.349	0.240	0.493							
				WSU	2007	FILSK	2	1	18.3	18.3	18.3	0.062	0.062	0.062							
		04015900	TURTLE*	BGS	2003	FILSK	9	1	7.8	7.8	7.8	0.047	0.047	0.047							
				CIS	2003	FILSK	4	1	17.0	17.0	17.0	0.102	0.102	0.102							
				NP	2003	FILSK	5	5	24.1	16.9	31.5	0.401	0.128	0.741							
				WE	2003	FILSK	6	6	17.2	12.7	23.3	0.301	0.163	0.567							
		04023000	DEER*	BKS	2004	FILSK	4	1	8.7	8.7	8.7	0.079	0.079	0.079							
				CIS	2004	FILSK	5	1	13.8	13.8	13.8	0.078	0.078	0.078							
				NP	2004	FILSK	5	5	25.6	19.7	31.7	0.444	0.339	0.563							
		11002600	SUGAR*	BGS	2009	FILSK	10	2	7.3	6.8	7.8	0.056	0.054	0.058							
				BKS	2009	FILSK	10	2	8.7	8.2	9.2	0.045	0.037	0.052							
				LMB	2009	FILSK	8	8	13.4	10.8	16.2	0.203	0.129	0.412							
				NP	2009	FILSK	7	7	23.8	18.2	34.4	0.207	0.184	0.231							
				WE	2009	FILSK	8	8	21.9	18.8	24.6	0.396	0.286	0.492							
		11002900	VERMILLION**	BGS	2010	FILSK	9	2	7.4	7.1	7.6	0.040	0.037	0.042							
				BKS	2010	FILSK	10	2	8.2	7.9	8.5	0.026	0.025	0.026							
				LMB	2010	FILSK	4	4	13.8	12.8	14.6	0.263	0.218	0.305							
				NP	2010	FILSK	7	7	19.7	16.7	23.5	0.210	0.126	0.289							
				WE	2010	FILSK	8	8	18.0	14.3	21.6	0.327	0.211	0.588							
				WSU	2010	FILSK	5	1	16.3	16.3	16.3	0.026	0.026	0.026							
		11014700	WINNIBIGOSHISH*	BRB	1991	FILET	1	1	13.1	13.1	13.1	0.076	0.076	0.076	1	0.01	0.01	Y			
				CIS	1991	FILSK	8	1	7.8	7.8	7.8	0.040	0.040	0.040							
					1997	FILSK	3	1	10.3	10.3	10.3	0.040	0.040	0.040							
					2002	FILSK	5	1	11.5	11.5	11.5	0.054	0.054	0.054							

Major Watershed	HUC8	AUID	Waterway	Species	Year	Anat.	No. Fish	N	Length (in)			Mercury (mg/kg)			PCBs (mg/kg)				PFOS (µg/kg)		
									Mean	Min	Max	Mean	Min	Max	N	Mean	Max	< RL	N	Mean	Max
				NP	1984	FILSK	10	1	22.7	22.7	22.7	0.120	0.120	0.120							
					1991	FILSK	10	4	24.8	17.3	31.3	0.203	0.100	0.370	3	0.01	0.01	Y			
					1997	FILSK	6	6	22.9	16.1	33.0	0.172	0.090	0.320	2	0.01	0.01	Y			
					2002	FILSK	5	5	24.1	18.5	29.5	0.186	0.095	0.306							
					2006	FILSK	23	23	22.9	16.3	33.0	0.196	0.091	0.463							
					2010	FILSK	16	16	22.6	16.5	29.3	0.140	0.061	0.185					7	4.8	Y
				WE	1984	FILSK	25	5	16.0	13.0	21.0	0.100	0.060	0.170	1	0.05	0.05	Y			
					1991	FILSK	11	2	14.8	12.2	17.3	0.080	0.059	0.100	1	0.01	0.01	Y			
					1997	FILSK	8	8	14.3	11.9	17.8	0.110	0.080	0.150	2	0.01	0.01	Y			
					2002	FILSK	5	5	18.9	15.0	22.3	0.167	0.105	0.215							
					2006	FILSK	11	11	16.3	11.0	24.4	0.111	0.063	0.243							
					2012	FILSK	6	6	18.7	14.1	25.3	0.151	0.076	0.224							
				YP	1991	FILSK	15	1	6.3	6.3	6.3	0.022	0.022	0.022							
					1997	FILSK	6	1	10.2	10.2	10.2	0.110	0.110	0.110	1	0.01	0.01	Y			
					2002	FILSK	8	1	10.0	10.0	10.0	0.082	0.082	0.082							
					2010	FILSK	7	7	9.1	8.1	10.6								7	4.7	Y
					2012	FILSK	10	2	7.6	6.7	8.5	0.053	0.046	0.059							
		11041500	PIKE BAY*	CIS	1983	FILSK	5	1	13.3	13.3	13.3	0.080	0.080	0.080	1	0.06	0.06				
					1996	FILSK	7	2	10.9	8.8	12.9	0.031	0.024	0.038	1	0.01	0.01				
				LWH	1996	FILSK	13	3	17.0	14.4	19.7	0.036	0.027	0.052	1	0.01	0.01				
				NP	1983	FILSK	5	1	21.9	21.9	21.9	0.270	0.270	0.270	1	0.05	0.05	Y			
					1984	FILSK	5	1	23.2	23.2	23.2	0.340	0.340	0.340	1	0.05	0.05	Y			
					1996	FILSK	26	6	25.6	18.0	34.8	0.245	0.110	0.520	1	0.01	0.01				
					2009	FILSK	15	15	24.4	16.8	34.5	0.218	0.100	0.494							
				WE	1983	FILSK	7	1	17.0	17.0	17.0	0.340	0.340	0.340	1	0.05	0.05	Y			
					1984	FILSK	5	1	17.0	17.0	17.0	0.220	0.220	0.220	1	0.05	0.05	Y			
					1996	FILSK	29	5	19.8	13.4	26.1	0.214	0.068	0.400	1	0.01	0.01	Y			

									Length (in)			Mercury (mg/kg)			PCBs (mg/kg)				PFOS (µg/kg)		
Major Watershed	HUC8	AUID	Waterway	Species	Year	Anat.	No. Fish	N	Mean	Min	Max	Mean	Min	Max	N	Mean	Max	< RL	N	Mean	Max
				WSU	1983	FILSK	5	1	18.6	18.6	18.6	0.060	0.060	0.060	1	0.05	0.05	Y			
					1984	FILSK	5	1	16.2	16.2	16.2	0.070	0.070	0.070	1	0.05	0.05	Y			
					1996	FILSK	10	3	15.0	13.0	16.7	0.019	0.015	0.022	1	0.01	0.01	Y			
				YP	1996	FILSK	10	1	8.5	8.5	8.5	0.110	0.110	0.110							
		11050500	LITTLE WOLF*	BGS	1991	FILSK	7	2	7.2	6.5	7.8	0.041	0.031	0.050	1	0.01	0.01	Y			
				BKS	1991	FILSK	2	2	12.4	12.1	12.7	0.084	0.081	0.087	2	0.01	0.01	Y			
				NP	1991	FILSK	3	2	21.5	19.9	23.0	0.102	0.074	0.130	2	0.01	0.01	Y			
					2009	FILSK	14	14	25.0	17.0	32.1	0.242	0.082	0.435							
				WE	1985	FILSK	1	1	22.6	22.6	22.6				1	0.05	0.05	Y			
					1991	FILSK	25	11	18.7	12.6	26.1	0.308	0.088	1.200	10	0.01	0.01	Y			
					2014	FILSK	15	15	14.6	10.5	21.7	0.226	0.088	0.477							
				WSU	1991	FILSK	1	1	15.9	15.9	15.9	0.020	0.020	0.020	1	0.01	0.01	Y			
		15001000	ELK*	BGS	2008	FILSK	4	1	6.4	6.4	6.4	0.010	0.010	0.010							
				CIS	1995	FILSK	14	2	14.0	13.1	14.9	0.075	0.060	0.090	1	0.01	0.01	Y			
					2000	FILSK	4	1	14.8	14.8	14.8	0.100	0.100	0.100							
					2008	FILSK	5	1	12.6	12.6	12.6	0.104	0.104	0.104							
				LMB	2008	FILSK	3	3	11.5	10.5	12.2	0.113	0.089	0.132							
				NP	1995	FILSK	19	5	25.1	18.8	33.4	0.268	0.120	0.430	1	0.01	0.01				
					2000	FILSK	12	12	18.5	15.0	26.4	0.198	0.120	0.400							
					2005	FILSK	14	14	24.2	14.4	34.3	0.252	0.094	0.703							
					2008	FILSK	18	18	22.9	19.5	34.8	0.174	0.104	0.326							
				RKB	2008	FILSK	4	1	9.4	9.4	9.4	0.223	0.223	0.223							
				SF	2008	FILSK	3	1	6.2	6.2	6.2	0.016	0.016	0.016							
				WE	1995	FILSK	17	5	15.7	11.8	20.4	0.226	0.140	0.340							
					2000	FILSK	9	9	20.6	13.0	27.6	0.346	0.170	0.600							
					2005	FILSK	7	7	18.3	12.1	24.7	0.236	0.108	0.350							
					2008	FILSK	11	11	16.4	13.5	21.1	0.154	0.128	0.204							

									Length (in)			Mercury (mg/kg)			PCBs (mg/kg)				PFOS (µg/kg)		
Major Watershed	HUC8	AUID	Waterway	Species	Year	Anat.	No. Fish	N	Mean	Min	Max	Mean	Min	Max	N	Mean	Max	< RL	N	Mean	Max
				YP	2008	FILSK	8	2	9.1	7.5	10.6	0.084	0.077	0.090							
		15001600	ITASCA*	BGS	2005	FILSK	8	1	7.9	7.9	7.9	0.027	0.027	0.027							
				NP	1995	FILSK	20	3	21.9	18.8	25.0	0.167	0.150	0.190							
					2005	FILSK	5	5	21.3	18.2	25.3	0.105	0.072	0.117							
					2010	FILSK	12	12	20.9	16.4	34.6	0.138	0.075	0.456							
				WE	1995	FILSK	24	5	19.6	13.8	29.6	0.246	0.110	0.690	1	0.01	0.01				
					2005	FILSK	5	5	18.9	14.6	24.1	0.113	0.061	0.192							
				WSU	1969	FILET	1	1							1	0.001	0.001	Y			
					1995	FILSK	4	1	17.3	17.3	17.3	0.026	0.026	0.026							
				YP	1995	FILSK	8	1	8.1	8.1	8.1	0.120	0.120	0.120							
		15005700	LONG	BGS	2006	FILSK	10	1	6.8	6.8	6.8	0.093	0.093	0.093							
				RBT	2006	FILSK	6	6	16.4	14.5	18.8	0.066	0.061	0.077							
		29006600	MIDGE*	NP	1985	FILSK	15	4	25.6	19.1	32.9	0.508	0.220	0.750	1	0.05	0.05	Y			
					2010	FILSK	8	8	25.2	21.3	29.5	0.225	0.158	0.358							
				WE	1985	FILSK	5	1	18.7	18.7	18.7	0.490	0.490	0.490	1	0.05	0.05	Y			
				WSU	2010	FILSK	5	1	18.7	18.7	18.7	0.049	0.049	0.049							
				YP	2010	FILSK	5	1	7.6	7.6	7.6	0.081	0.081	0.081							
		29007100	GRACE*	BGS	2010	FILSK	5	1	8.5	8.5	8.5	0.025	0.025	0.025							
				NP	1995	FILSK	24	6	23.2	15.3	32.4	0.122	0.064	0.250	1	0.01	0.01				
					2010	FILSK	8	8	23.9	20.9	29.6	0.171	0.113	0.257							
				SF	1995	FILSK	10	1	7.2	7.2	7.2	0.030	0.030	0.030							
				WE	1995	FILSK	25	5	17.6	12.8	23.2	0.150	0.037	0.310	1	0.01	0.01	Y			
					2010	FILSK	8	8	19.5	12.2	27.5	0.147	0.041	0.400							
				WSU	1995	FILSK	5	1	18.6	18.6	18.6	0.070	0.070	0.070							
					2010	FILSK	3	1	21.4	21.4	21.4	0.044	0.044	0.044							
		29015600	PLANTAGENET*	CIS	1999	FILSK	8	1	15.1	15.1	15.1	0.080	0.080	0.080	1	0.01	0.01	Y			
				NP	1999	FILSK	7	7	20.5	18.8	22.5	0.213	0.160	0.330							

									Length (in)			Mercury (mg/kg)			PCBs (mg/kg)				PFOS (µg/kg)		
Major Watershed	HUC8	AUID	Waterway	Species	Year	Anat.	No. Fish	N	Mean	Min	Max	Mean	Min	Max	N	Mean	Max	< RL	N	Mean	Max
				WE	1999	FILSK	8	8	18.5	14.5	25.4	0.305	0.190	0.490	1	0.01	0.01	Y			
					2012	FILSK	8	8	14.3	12.3	18.6	0.142	0.112	0.185							
				WSU	2012	FILSK	5	1	18.2	18.2	18.2	0.034	0.034	0.034							
				YP	1999	FILSK	10	1	8.1	8.1	8.1	0.120	0.120	0.120							
					2012	FILSK	5	1	9.0	9.0	9.0	0.070	0.070	0.070							
		29021500	SCHOOLCRAFT*	BKS	2010	FILSK	3	1	11.8	11.8	11.8	0.044	0.044	0.044							
				NP	2010	FILSK	6	6	18.3	15.5	20.8	0.077	0.036	0.109							
				WE	2010	FILSK	6	6	21.0	18.4	25.8	0.127	0.054	0.238							
				WSU	2010	FILSK	3	1	19.5	19.5	19.5	0.073	0.073	0.073							
		29021600	GEORGE*	BGS	1992	FILSK	10	1	6.7	6.7	6.7	0.036	0.036	0.036							
					2014	FILSK	7	1	7.6	7.6	7.6	0.083	0.083	0.083							
				BKS	2014	FILSK	5	1	9.7	9.7	9.7	0.057	0.057	0.057							
				BRB	1992	FILET	2	1	14.8	14.8	14.8	0.043	0.043	0.043	1	0.011	0.011				
				LMB	1992	FILSK	6	1	13.4	13.4	13.4	0.230	0.230	0.230							
					2014	FILSK	5	5	14.1	12.2	16.2	0.269	0.148	0.463							
				NP	1992	FILSK	17	3	24.6	18.2	33.6	0.170	0.140	0.210	1	0.01	0.01	Y			
					2014	FILSK	8	8	25.9	20.3	34.6	0.286	0.112	0.607							
				WE	1992	FILSK	23	3	17.5	13.6	20.6	0.253	0.140	0.420	1	0.059	0.059				
					2014	FILSK	9	9	20.5	17.1	27.0	0.307	0.177	0.435							
				WSU	2014	FILSK	5	1	16.7	16.7	16.7	0.046	0.046	0.046							
		29022700	EVERGREEN	BGS	2013	FILSK	5	1	8.6	8.6	8.6	0.067	0.067	0.067							
				LMB	2013	FILSK	1	1	17.3	17.3	17.3	0.367	0.367	0.367							
				NP	2013	FILSK	8	8	22.8	18.3	30.8	0.286	0.183	0.413							
				WE	2013	FILSK	4	4	20.7	18.5	21.8	0.297	0.148	0.488							
				YEB	2013	FILET	5	1	12.5	12.5	12.5	0.263	0.263	0.263							
		29023700	NEWMAN	RBT	1995	FILSK	8	2	13.3	10.4	16.2	0.118	0.076	0.160	1	0.01	0.01	Y			
		29024100	FRONTENAC	NP	2013	FILSK	5	5	21.1	18.0	25.2	0.334	0.201	0.633							

Major Watershed	HUC8	AUID	Waterway	Species	Year	Anat.	No. Fish	N	Length (in) Mean	Min	Max	Mercury (mg/kg) Mean	Min	Max	PCBs (mg/kg) N	Mean	Max	< RL	PFOS (µg/kg) N	Mean	Max
				SF	2013	FILSK	1	1	7.8	7.8	7.8	0.082	0.082	0.082							
				SUF	2013	FILSK	1	1	8.8	8.8	8.8	0.056	0.056	0.056							
				WE	2013	FILSK	2	2	18.6	15.5	21.6	0.450	0.249	0.651							
		29024600	HENNEPIN	BGS	2013	FILSK	9	2	6.8	6.5	7.1	0.059	0.058	0.059							
				BKS	2013	FILSK	9	2	8.6	7.8	9.4	0.106	0.104	0.108							
				BRB	2013	FILET	4	1	10.0	10.0	10.0	0.036	0.036	0.036							
				NP	2013	FILSK	8	8	24.2	19.3	28.2	0.224	0.153	0.314							
				WE	2013	FILSK	3	3	21.6	21.5	21.8	0.179	0.159	0.217							
		29029200	BEAUTY**	BGS	2001	FILSK	9	1	5.9	5.9	5.9	0.136	0.136	0.136							
					2011	FILSK	5	1	7.4	7.4	7.4	0.081	0.081	0.081							
				LMB	2001	FILSK	4	4	13.4	11.2	15.2	0.323	0.226	0.472							
					2011	FILSK	5	5	12.4	11.2	13.1	0.241	0.226	0.262							
				NP	2001	FILSK	7	7	20.7	16.0	29.2	0.440	0.231	1.000							
					2011	FILSK	6	6	20.6	16.8	30.0	0.230	0.178	0.283							
				WE	2001	FILSK	1	1	25.4	25.4	25.4	1.187	1.187	1.187							
					2011	FILSK	2	2	22.0	21.8	22.2	0.496	0.494	0.498							
		31053200	POKEGAMA	BGS	2005	FILSK	10	1	6.4	6.4	6.4	0.097	0.097	0.097							
				NP	1984	FILSK	5	1	22.2	22.2	22.2	0.330	0.330	0.330							
					2010	FILSK	12	12	21.4	15.7	28.9	0.231	0.125	0.461							
				WE	1984	FILSK	5	1	17.7	17.7	17.7	0.330	0.330	0.330							
					2005	FILSK	11	11	20.9	17.1	25.8	0.502	0.253	1.133							
				WSU	1984	FILSK	5	1	16.7	16.7	16.7	0.070	0.070	0.070							
					2005	FILSK	4	1	18.6	18.6	18.6	0.077	0.077	0.077							
		31055400	SISSEEBAKWET	BGS	2012	FILSK	8	1	7.0	7.0	7.0	0.092	0.092	0.092							
				WE	2012	FILSK	6	6	14.9	13.2	16.7	0.122	0.081	0.155							
				WSU	2012	FILSK	4	1	17.2	17.2	17.2	0.040	0.040	0.040							
		31056000	FORSYTHE*	BGS	1999	FILSK	6	1	7.4	7.4	7.4	0.100	0.100	0.100							

Major Watershed	HUC8	AUID	Waterway	Species	Year	Anat.	No. Fish	N	Length (in)			Mercury (mg/kg)			PCBs (mg/kg)				PFOS (µg/kg)		
									Mean	Min	Max	Mean	Min	Max	N	Mean	Max	< RL	N	Mean	Max
				NP	1999	FILSK	11	11	17.1	12.1	32.1	0.374	0.170	1.020	1	0.01	0.01	Y			
		31056100	BLACKWATER*	LMB	2007	FILSK	9	9	13.8	11.1	16.1	0.216	0.113	0.409							
				NP	1987	FILSK	5	1	22.2	22.2	22.2	0.430	0.430	0.430	1	0.01	0.01	Y			
				WSU	1987	FILSK	5	1	17.1	17.1	17.1	0.130	0.130	0.130	1	0.01	0.01	Y			
		31056500	JAY GOULD	BGS	2010	FILSK	4	1	7.4	7.4	7.4	0.035	0.035	0.035							
				NP	2010	FILSK	8	8	17.8	13.3	21.4	0.165	0.120	0.194							
				SF	2010	FILSK	4	1	7.0	7.0	7.0	0.040	0.040	0.040							
		31056600	LITTLE JAY GOULD	BGS	2010	FILSK	3	1	7.0	7.0	7.0	0.033	0.033	0.033							
				NP	2010	FILSK	5	5	17.8	15.5	19.7	0.157	0.132	0.188							
				WE	2010	FILSK	1	1	11.0	11.0	11.0	0.122	0.122	0.122							
				YP	2010	FILSK	3	1	8.2	8.2	8.2	0.110	0.110	0.110							
		31056900	GUILE*	NP	1999	FILSK	24	24	23.6	19.5	32.7	0.433	0.150	0.940	1	0.01	0.01	Y			
		31057000	LONG**	BGS	1999	FILSK	10	1	6.9	6.9	6.9	0.070	0.070	0.070							
				NP	1999	FILSK	24	24	19.1	14.0	32.1	0.440	0.110	1.500	1	0.01	0.01	Y			
		31057100	LOON*	NP	1999	FILSK	24	24	21.4	16.0	31.8	0.372	0.190	0.670	1	0.01	0.01	Y			
					2006	FILSK	24	24	21.8	16.8	28.6	0.405	0.108	0.696							
		31057500	LITTLE BASS	BGS	1997	FILSK	10	1	7.5	7.5	7.5	0.080	0.080	0.080							
				CIS	1997	FILSK	4	1	15.6	15.6	15.6	0.090	0.090	0.090							
				NP	1997	FILSK	23	23	22.1	18.5	32.5	0.259	0.120	0.510	3	0.01	0.01	Y			
				WE	1997	FILSK	5	5	18.9	13.5	24.6	0.484	0.250	0.690	1	0.01	0.01	Y			
		31057600	BASS*	BGS	2014	FILSK	9	2	7.9	7.1	8.8	0.084	0.061	0.107							
				CIS	2014	FILSK	2	2	17.1	15.7	18.5	0.059	0.030	0.088							
				NP	1988	FILSK	5	1	21.9	21.9	21.9	0.240	0.240	0.240	1	0.01	0.01	Y			
					2007	FILSK	7	7	18.3	15.2	27.3	0.245	0.140	0.342							
					2014	FILSK	9	9	20.3	15.1	24.7	0.305	0.189	0.376							
				WE	2014	FILSK	10	10	18.3	11.3	25.5	0.236	0.051	0.393							
				WSU	1988	FILSK	4	1	17.8	17.8	17.8	0.035	0.035	0.035	1	0.01	0.01	Y			

									Length (in)			Mercury (mg/kg)			PCBs (mg/kg)				PFOS (µg/kg)		
Major Watershed	HUC8	AUID	Waterway	Species	Year	Anat.	No. Fish	N	Mean	Min	Max	Mean	Min	Max	N	Mean	Max	< RL	N	Mean	Max
		31060300	LUCKY	BT	1988	FILSK	9	3	13.5	10.4	16.2	0.217	0.170	0.250	3	0.02	0.02	Y			
		31071700	RICE**	BGS	2011	FILSK	6	2	8.7	8.5	8.9	0.045	0.043	0.047							
				BKS	2002	FILSK	8	1	8.7	8.7	8.7	0.056	0.056	0.056							
					2011	FILSK	7	2	9.2	8.5	9.8	0.026	0.020	0.031							
				CIS	2002	FILSK	5	1	11.1	11.1	11.1	0.078	0.078	0.078							
					2011	FILSK	5	1	13.8	13.8	13.8	0.072	0.072	0.072							
				LMB	1985	FILSK	5	1	13.2	13.2	13.2	0.380	0.380	0.380							
				NP	1985	FILSK	15	3	21.6	16.9	25.6	0.373	0.220	0.460							
					2002	FILSK	5	5	24.9	19.3	31.3	0.442	0.287	0.646							
					2011	FILSK	8	8	25.4	19.7	31.1	0.340	0.109	0.560							
				WE	1985	FILSK	1	1	22.0	22.0	22.0	1.130	1.130	1.130							
		31071900	DEER*	LMB	2007	FILSK	6	6	12.6	10.8	13.8	0.155	0.101	0.239							
				NP	1984	FILSK	13	3	22.6	18.4	27.5	0.270	0.220	0.310							
				SMB	2007	FILSK	2	2	15.0	13.8	16.2	0.158	0.115	0.201							
				WE	1984	FILSK	5	1	17.6	17.6	17.6	0.240	0.240	0.240							
		31072200	MOOSE*	BGS	2010	FILSK	8	2	7.3	6.7	7.9	0.021	0.015	0.027							
				CIS	2010	FILSK	3	1	13.7	13.7	13.7	0.069	0.069	0.069							
				NP	1990	FILSK	5	2	19.8	17.5	22.1	0.230	0.150	0.310	2	0.01	0.01	Y			
					2010	FILSK	4	4	24.1	21.6	25.8	0.184	0.099	0.257							
				WE	1990	FILSK	5	2	19.4	17.2	21.6	0.365	0.240	0.490	2	0.01	0.01	Y			
					2010	FILSK	8	8	16.0	12.8	25.5	0.129	0.073	0.414							
				WSU	1990	FILSK	5	2	19.1	17.0	21.1	0.043	0.020	0.066	2	0.01	0.01	Y			
		31075400	ISLAND	BKS	2014	FILSK	9	1	9.6	9.6	9.6	0.043	0.043	0.043							
				BRB	2014	FILSK	5	1	13.3	13.3	13.3	0.042	0.042	0.042							
				NP	2014	FILSK	9	9	21.5	17.5	25.3	0.243	0.138	0.382							
		31081200	BALL CLUB*	BKS	1998	FILSK	10	1	9.4	9.4	9.4	0.060	0.060	0.060							
				CIS	1998	FILSK	8	1	11.3	11.3	11.3	0.040	0.040	0.040							

Major Watershed	HUC8	AUID	Waterway	Species	Year	Anat.	No. Fish	N	Length (in)			Mercury (mg/kg)			PCBs (mg/kg)				PFOS (µg/kg)		
									Mean	Min	Max	Mean	Min	Max	N	Mean	Max	< RL	N	Mean	Max
				LMB	1983	FILSK	1	1	16.5	16.5	16.5	0.470	0.470	0.470							
				NP	1983	FILSK	16	3	22.6	18.3	27.5	0.340	0.220	0.500							
					1998	FILSK	10	10	22.0	19.0	26.7	0.281	0.140	0.480							
					2007	FILSK	24	24	21.2	17.1	27.7	0.261	0.153	0.441							
					2014	FILSK	15	15	21.1	15.8	28.8	0.351	0.110	0.647							
				WE	1983	FILSK	6	1	19.2	19.2	19.2	0.410	0.410	0.410							
					1998	FILSK	10	10	15.5	11.2	22.8	0.209	0.140	0.490							
		31081300	BOWSTRING*	NP	1988	FILSK	6	2	20.7	19.7	21.6	0.270	0.260	0.280							
					2007	FILSK	7	7	18.9	17.0	21.3	0.121	0.078	0.190							
					2014	FILSK	15	15	19.3	14.6	24.1	0.193	0.087	0.325							
				WE	1988	FILSK	13	5	19.0	12.5	24.3	0.260	0.150	0.450	1	0.01	0.01	Y			
					2007	FILSK	7	7	15.8	12.8	23.0	0.117	0.051	0.341							
		31082200	LITTLE BALL CLUB*	BKS	2009	FILSK	4	1	8.9	8.9	8.9	0.101	0.101	0.101							
				NP	2009	FILSK	8	8	22.3	19.1	27.7	0.308	0.228	0.409							
		31085000	LITTLE WINNIBIGOSHISH*	NP	2007	FILSK	6	6	20.9	19.3	24.9	0.226	0.155	0.339							
				WE	2007	FILSK	7	7	15.2	11.9	18.9	0.168	0.065	0.266							
				YP	2007	FILSK	10	1	6.7	6.7	6.7	0.050	0.050	0.050							
		31085200	LITTLE CUT FOOT SIOUX*	BRB	2012	FILET	5	1	13.4	13.4	13.4	0.071	0.071	0.071							
				NP	2012	FILSK	6	6	20.2	12.7	29.3	0.216	0.142	0.344							
				WE	2012	FILSK	1	1	18.8	18.8	18.8	0.244	0.244	0.244							
				YP	2012	FILSK	5	1	9.4	9.4	9.4	0.095	0.095	0.095							
		31085700	CUT FOOT SIOUX	NP	1984	FILSK	7	2	24.1	22.2	25.9	0.230	0.220	0.240							
					2007	FILSK	24	24	20.3	13.4	32.5	0.157	0.055	0.441							
				WE	1984	FILSK	14	3	17.1	12.6	21.0	0.120	0.070	0.190							
					2007	FILSK	6	6	19.0	16.5	21.5	0.212	0.110	0.344							
		31092100	DIXON*	BKS	2009	FILSK	10	2	9.4	8.6	10.1	0.067	0.060	0.073							

Major Watershed	HUC8	AUID	Waterway	Species	Year	Anat.	No. Fish	N	Length (in) Mean	Length (in) Min	Length (in) Max	Mercury (mg/kg) Mean	Mercury (mg/kg) Min	Mercury (mg/kg) Max	PCBs (mg/kg) N	PCBs (mg/kg) Mean	PCBs (mg/kg) Max	PCBs (mg/kg) < RL	PFOS (µg/kg) N	PFOS (µg/kg) Mean	PFOS (µg/kg) Max
				NP	2009	FILSK	5	5	20.3	17.1	22.4	0.235	0.116	0.419							
				WE	2009	FILSK	8	8	17.4	11.2	21.3	0.265	0.124	0.492							

*** 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.**

1. Species codes are defined in Table FC1
2. Anatomy codes: FILSK – edible fillet, skin-on; FILET—edible fillet, skin-off; PLUG—dorsal muscle piece, without skin; WHORG—whole organism