Crow Wing River Watershed Monitoring and Assessment Report

Minnesota Pollution Control Agency

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List of acronyms

AUID Assessment Unit Identification Determination

BMP Best Management Practices

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

DO Dissolved Oxygen

DOP Dissolved Orthophosphate

E Eutrophic

EPA U.S. Environmental Protection Agency

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

HGM hydrogeomorphic

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

MDNR Minnesota Department of Natural Resources

MINLEAP Minnesota Lake Eutrophication Analysis Procedure

MLRA Major Land Resource Areas

MPCA Minnesota Pollution Control Agency

MSHA Minnesota Stream Habitat Assessment

MTS Meets the Standard

MWS Mixed Wood Shield

MWP Mixed Wood Plains

N Nitrogen

Nitrate-N Nitrate Plus Nitrite Nitrogen

NA Not Assessed

NHD National Hydrologic Dataset

NH3 Ammonia

NLF Northern Lakes and Forests

NS Not Supporting

NT No Trend

OP Orthophosphate

P Phosphorous

PCB Poly Chlorinated Biphenyls

PFC Perfluorochemicals

PFO Perfluorooctane

PFOS perfluorooctane sulfonate

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

TSVS Total Suspended Volatile Solids

USDA United States Department of Agriculture

USGS United States Geological Survey

WPLMN Water Pollutant Load Monitoring Network

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Executive summary

The Crow Wing River Watershed (HUC 07010106) lies in the north central portion of Minnesota and originates through a series of 11 lakes which were formed by the melting of blocks of ice that occurred following the glaciations period (Waters, 1977). These lakes, comprising a combined surface area of 5,000 acres (Waters, 1977), are named sequentially from the First Crow Wing Lake through the Eleventh Crow Wing Lake, with the uppermost headwater lake being the Eleventh. The Crow Wing River begins in this uppermost lake, and flows through the entire chain in a southward direction for approximately 20 miles (Waters, 1977). After the lake chain it continues for approximately 80 more miles before entering into the Mississippi River south of Brainerd.

In 2010, the Minnesota Pollution Control Agency (MPCA) began an intensive watershed monitoring effort of the Crow Wing River Watershed's surface waters. Sixty-eight sites on rivers and streams were sampled for biology, habitat and water chemistry at the outlets of variable sized sub-watersheds within the Crow Wing River Watershed. Subsets (15) of these locations were selected for more intensive water chemistry monitoring. In addition, 111 lakes were sampled for water chemistry.

Of the 379 protected lakes and basins greater than four hectares (ten acres) within the Crow Wing Watershed, the trophic status of 111 lakes were assessed to determine if the lakes supported aquatic recreation. One hundred four of the assessed lakes supported aquatic recreation and seven lakes did not support aquatic recreation and are considered impaired. The impaired lakes are small to moderately sized lakes with large watershed catchment areas making them susceptible to high levels of external nutrient contributions. Most notably, First Crow Wing, Lower Twin and Blueberry Lakes each have catchment areas greater than 100,000 acres. In addition to external nutrient contribution, several of the impaired lakes were shallow and likely receive additional nutrients from suspended bottom sediments. Internal loading of nutrients is most likely in Margaret, Portage, Lower Twin, Blueberry and First Crow Wing Lakes. Assessment data were available on an additional nine wetlands and reservoirs; however, the basin characteristics and/or residence times did not qualify them to be assessed as lakes.

Rivers and streams were assessed for aquatic life and aquatic recreation. Throughout the Crow Wing Watershed, 32 stream Assessment Unit Identification Determination (AUIDs) were fully supporting for aquatic life and 13 streams are fully supporting for aquatic recreation. Eighteen AUIDs were non-supporting of aquatic life and/or recreation. Of those AUIDs, nine were non-supporting of aquatic life and ten were non-supporting of aquatic recreation. The aquatic life impairments were due to low fish and macroinvertebrate Index of Biotic Integrity (IBI) scores and or low dissolved oxygen (DO). None of the assessed streams within the Crow Wing Watershed were impaired for turbidity. Notable impairments include the Straight River and Shell River for DO while the Upper Crow Wing River, Cat River, Farnham Creek, Partridge River and Swan Creek were impaired for aquatic recreational use due to high bacteria levels.

Introduction

Water is one of Minnesota's most abundant and precious resources. The Minnesota Pollution Control Agency (MPCA) is charged under both federal and state law with the responsibility of protecting the water quality of Minnesota's water resources. The 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 Crow Wing River Watershed beginning in the summer of 2010. This report provides a summary of all water quality assessment results in the Crow Wing River 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).

Pollutant load monitoring network

The Watershed Pollutant Load Monitoring Network (WPLMN) is a long-term monitoring-approach designed to measure levels of key pollutants in the state's watersheds, 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. Since the network'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 (MDNR) flow gaging stations with water quality data collected by the Metropolitan Council Environmental Services (MCES), local monitoring organizations, and Minnesota Pollution Control Agency MWLM staff to compute annual pollutant loads at 79 river monitoring sites across Minnesota. Data will also be used to assist with: "Total Maximum Daily Load" studies and implementation plans; watershed modeling efforts and watershed research projects.

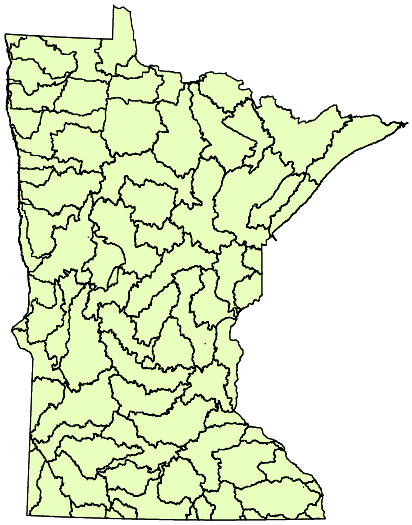

Figure 1. Major watersheds within Minnesota (8-Digit HUC).

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, 11-HUC and 14-HUC. 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 2)) 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 11-HUC is the next smaller watershed scale which generally consists of major tributary streams with drainage areas ranging from 75 to 150 mi^2. Each 11-HUC outlet (green triangles in Figure 2) is sampled for biology and water chemistry for the assessment of aquatic life and aquatic recreation use support.

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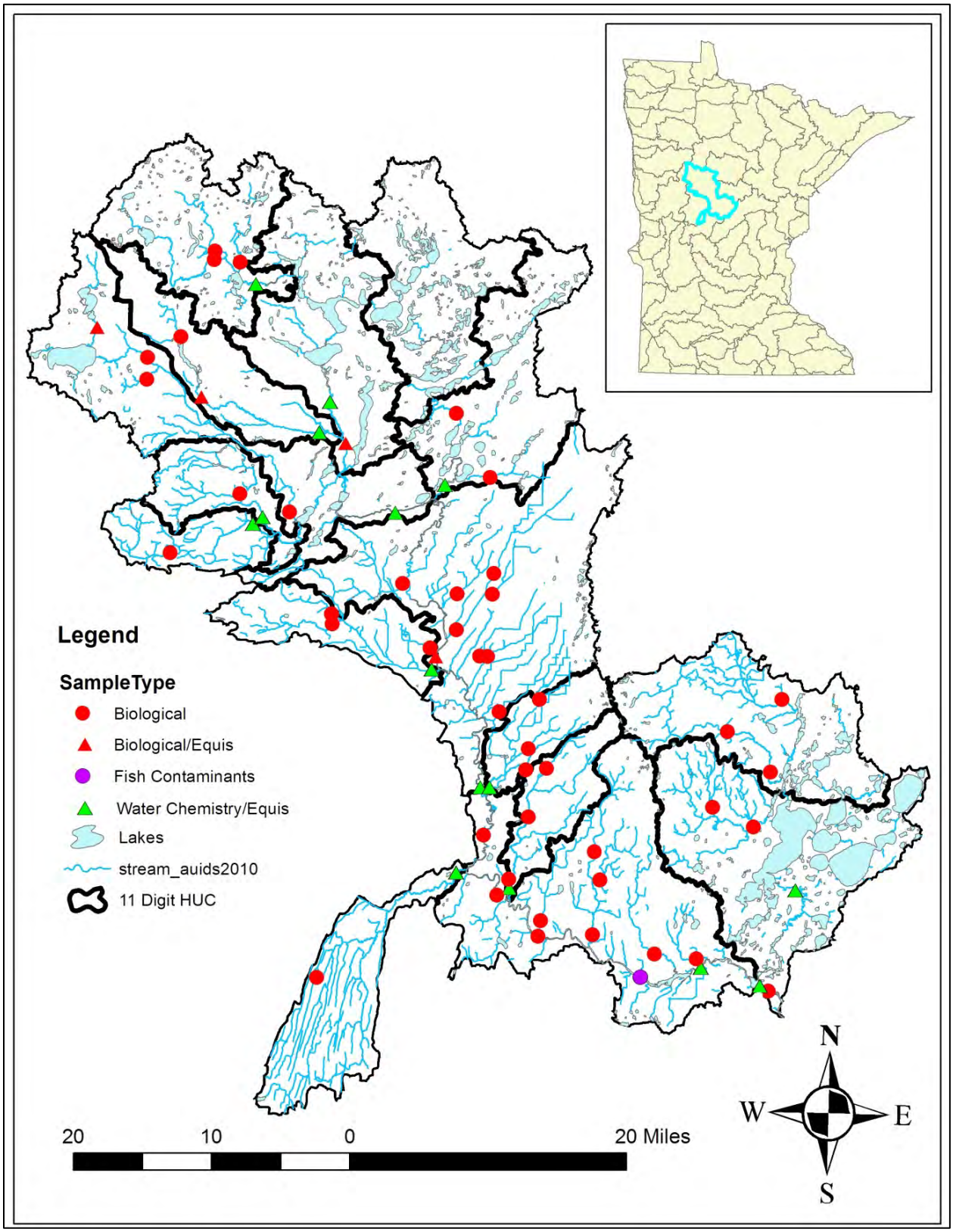

Figure 2. Intensive watershed monitoring sites for streams in the Crow Wing River Watershed.

Within each 11-HUC, 14-HUC, smaller watersheds (typically 10-20 mi^2), are sampled at each outlet that flows into the major 11-HUC tributaries. Each of these minor watershed outlets is sampled for biology to assess aquatic life use support (red dots in Figure 2).

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. There is currently no tool that allows us to determine if lakes are supporting aquatic life; however, a method that includes monitoring fish and aquatic plant communities is in development in cooperation with the MDNR.

Specific locations for sites sampled as part of the intensive monitoring effort in the Crow Wing River watershed are shown in Figure 2 and are listed in Appendix 3, Appendix 4.2, Appendix 4.3, Appendix 5.2 and Appendix 5.3.

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's to assess the condition of Minnesota lakes and streams. Preplanning and coordination of sampling with local citizens and governments helps focus monitoring where it will be most effective for assessment and observing long-term trends. This allows citizens/governments 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 current 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 3 provides an illustration of the locations where citizen monitoring data were used for assessment in the Crow Wing River Watershed.

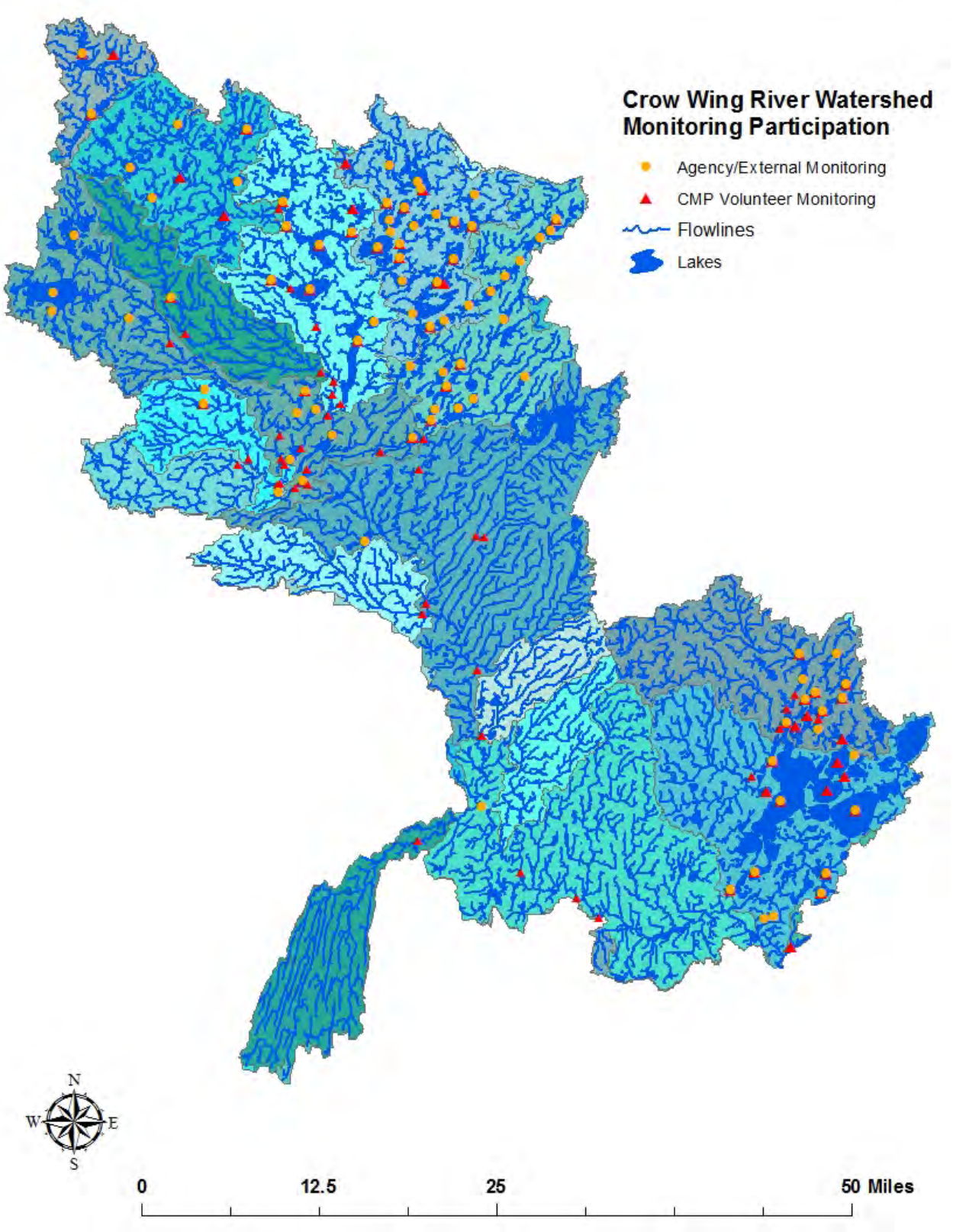

Figure 3. Monitoring locations of local groups, citizens and the MPCA lake monitoring staff within the Crow Wing River Watershed.

Assessment methodology

The Clean Water Act 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). http://www.pca.state.mn.us/index.php/view-document.html?gid=16988.

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. Interpretations of narrative criteria for aquatic life in streams are based on multi-metric biological indices including the Fish Index of Biological Integrity (Fish IBI), which evaluates the health of the fish community, and the Macroinvertebrate Index of Biological Integrity (Invert IBI), which evaluates the health of the aquatic invertebrate community. Additionally, chemical parameters are measured and assessed against numeric standards developed to be protective of aquatic life, including pH, dissolved oxygen, un-ionized ammonia nitrogen, chloride and turbidity.

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, secchi depth and chlorophyll-a as indicators. Lakes that are enriched with nutrients and have abundant algal growth are eutrophic and do not support aquatic recreation.

Protection of consumption means protecting citizens who eat fish from Minnesota waters or receive their drinking water from waterbodies protected for this beneficial use. 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 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, dissolved oxygen 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 MDNR. 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 4.

The first step in the aquatic life assessment process is a comparison of the monitoring data to water quality standards. This is largely an automated process performed by logic programmed into a database application and the results are referred to as 'Pre-Assessments'. 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 attenuating circumstances that should be considered (e.g., flow, time/date of data collection, or habitat).

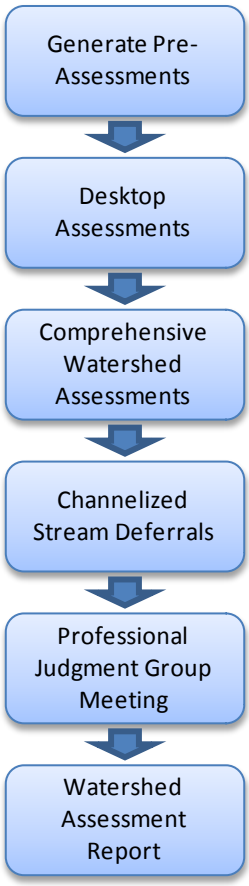

Figure 4. Flowchart of aquatic life use assessment process.

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. Implementing 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 are not in agreement 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 2014): http://www.pca.state.mn.us/index.php/view-document.html?gid=16988 for guidelines and factors considered when making such determinations.

Any new impairment (i.e., waterbody not attaining its beneficial use) is first reviewed using GIS to determine if greater than 50 percent of the assessment unit is channelized. Currently, the MPCA is deferring any new impairments on channelized reaches until new aquatic life use standards have been developed as part of the Tiered Aquatic Life Use (TALU) framework. For additional information see: http://www.pca.state.mn.us/index.php/view-document.html?gid=18309. However, in this report, channelized reaches with biological data are evaluated on a "good-fair-poor" system to help evaluate their condition (see Appendix 5.1).

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 also uploaded to the US Environmental Protection Agency's (EPAs) data warehouse. Data for monitoring projects with federal or state funding are required to be stored in EQuIS (e.g., Clean Water Partnership, CWLA Surface Water Assessment Grants and TMDL program). Many local projects not funded by MPCA also choose to submit their data to the MPCA in an EQuIS - ready format so that 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.

Watershed overview

From its source in the Crow Wing Chain of Lakes, the Crow Wing River flows over 100 miles to its confluence with the Mississippi River at Crow Wing State Park south of Brainerd, Minnesota. The Crow Wing River Watershed covers approximately 1,946 square miles (1,245,755 acres). It is located in the north central portion of the Upper Mississippi River Basin and includes parts of Becker, Cass, Clearwater, Crow Wing, Hubbard, Morrison, Otter Tail, Todd and Wadena Counties. Major cities within the Crow Wing River Watershed include Park Rapids, Staples and Nisswa.

The name "Crow Wing" was derived from the island that splits the mouth of the Crow Wing at its confluence with the Mississippi River. Native Americans believed the island resembled a raven's wing and this was later translated to Crow Wing. Historically, this confluence served as an important trading and bartering location and eventually a village named Old Crow Wing developed there. The village also played a vital role in the logging industry due to its location at the junction of two major log transport rivers. The Chippewa land cession of 1837, stimulated the earliest logging activity within the area and although the treaty included only the land on the east side of the Mississippi River, illegal cutting began along both of the rivers. The treaties of 1847 and 1855, allowed for legal logging practices upstream and the village of Old Crow Wing prospered as a result. Trade and bartering flourished and eventually an oxcart trail came into Old Crow Wing which increased the development of the village even more. Years later, when the railroad and steamboat were becoming the main mode of merchandise transport, the Northern Pacific Railroad company chose to cross the Mississippi at the town of Brainerd. This re-route of goods led to the quick demise of the village, and Old Crow Wing became a part of history (Waters 1977). This location is currently preserved as part of Crow Wing State Park.

Shell City was another historical location of interest within the Crow Wing River Watershed. Located along the Shell River in northern Wadena County, it was initially established as a village and served as the region post office. A button production factory was developed which manufactured buttons from the numerous mussel shells present within the Shell River, and the town flourished. This was short lived however, as the development of plastics along with the re-route of the railroad led to the rapid demise of the city.

Today, the Crow Wing River is a major canoeist destination and provides for several other forms of aquatic recreation, including fishing which is considered excellent within certain parts of the watershed. The river is known for its relatively stable water levels and pristine clarity; visually it appears relatively untouched along much of its path. Although the river no longer serves as a major transporter of huge quantities of pine and goods, the Crow Wing River to this day remains a valued resource.

There are 16 contributing sub-watersheds (HUC 11's) to the Crow Wing River Watershed with some of the tributaries still being able to support cold-water assemblages such as trout. Aside from providing excellent aquatic recreation opportunity, the watershed serves as home to a many people and also provides refuge to diverse fish, wildlife, and vegetative communities.

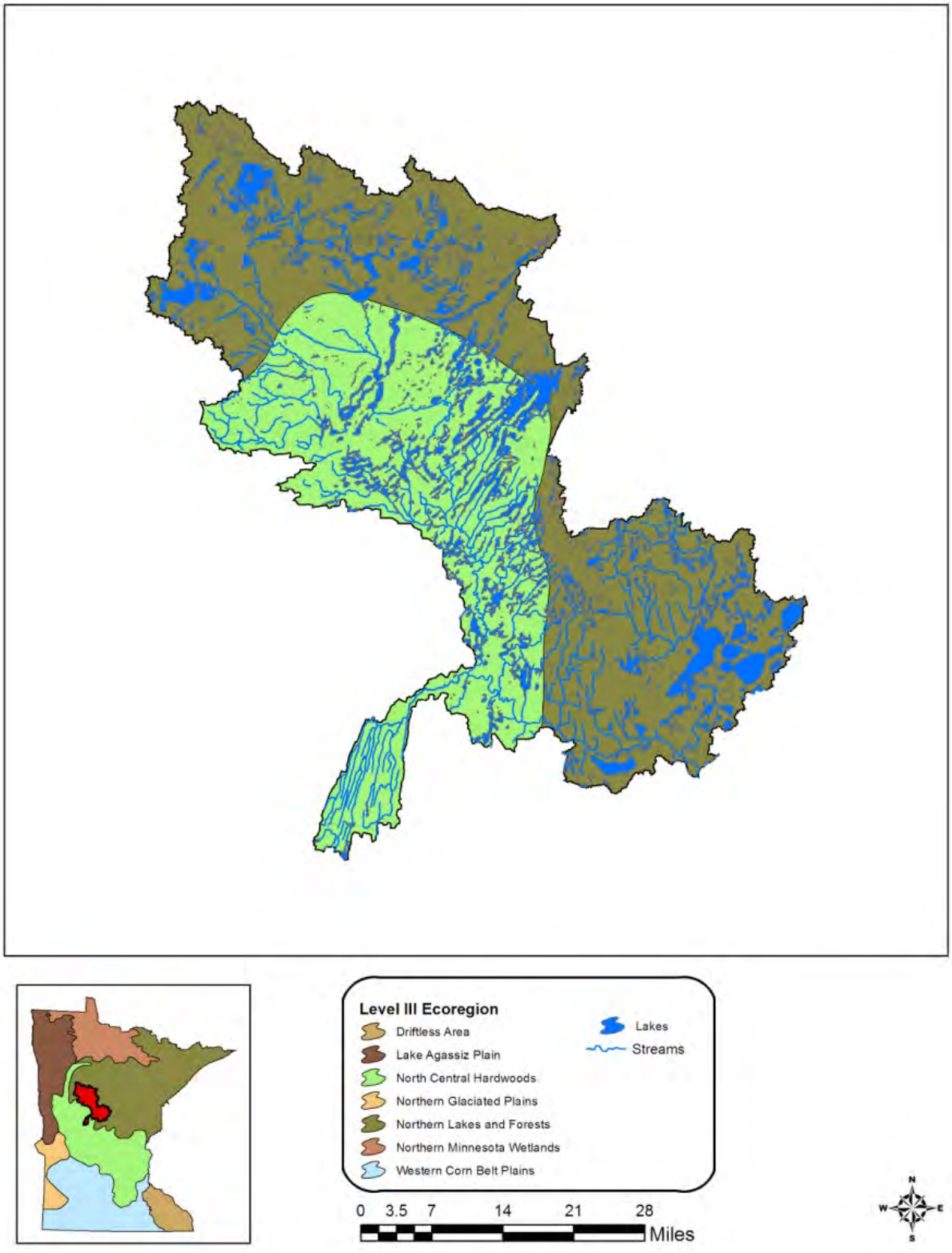

Figure 5. The Crow Wing River Watershed within the Northern Lakes/Forests and North Central Hardwoods ecoregions of Central Minnesota.

The Crow Wing River Watershed lies within two of Minnesota's level III (Omernik and Gallant, 1988) ecoregions (Figure 5). The northwest (headwaters) and southeast portions lie within the Northern Lakes and Forests (NLF) ecoregion. A transition occurs near the middle of the watershed where the Northern Central Hardwoods ecoregion forms a boundary with the NLF ecoregion. The Crow Wing River Watershed is also comprised of two United States Department of Agriculture (USDA) Major Land Resource Areas (MLRA), which include the Northern Minnesota Gray Drift and also the Central Minnesota Sandy Outwash (Figure 6). The Northern Minnesota Gray Drift is described as a rolling glacial moraine with complex slopes. The soils in this MLRA are generally composed of loam; however some clay and sandy areas are also present. Numerous lakes exist in this particular region. Resource concerns within this MLRA region mainly regard improving drainage for production of crops as well as grazing management, erosion, and the effect on water quality as a result (NRCS 2007). The Central Minnesota Sandy Outwash MLRA is more level with less gradient changes. This region also is comprised of many areas of poorly drained organic soils which are conducive to anaerobic (low oxygen) soil conditions. Due to these conditions, irrigated cropland, pasture, and hay-land are the main land uses in this area. Forests are very patchy in this region. The primary resource concerns within this MLRA are erosion, nutrient management, grazing land management, and minimizing the impacts of these practices on water quality. There are four major types of soils within the Crow Wing River Watershed which include Alfisols, Entisols, Mollisols and some Histosols which occur in the wetland areas. The bedrock geology consists of mainly of Precambrian crystalline and Cretaceous era rocks (Sims and Morey, 1972, Stark et al, 1996). The bedrock and hydrogeology and groundwater within the watershed is mainly comprised of Precambrian igneous and metamorphic rocks, as well as pockets of Cretacious aquifers which occur in Becker and Ottertail Counties. The glacial till consists of calcareous and siliceous deposits. In some areas of the watershed these deposits are up to over 600 feet deep (NRCS 2007).

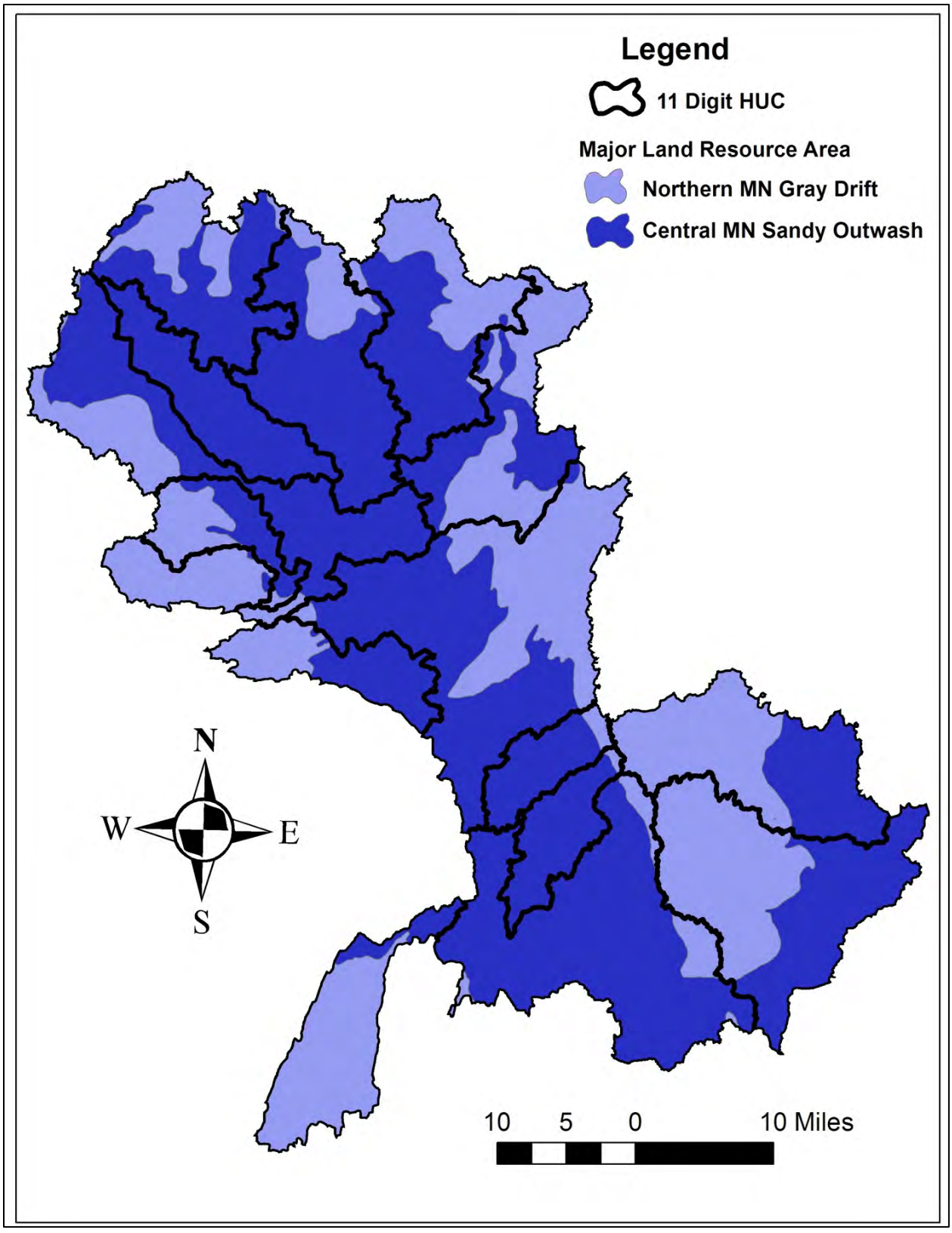

Figure 6. Major Land Resource Areas (MLRA) in the Crow Wing River Watershed.

Land use summary

The Crow Wing River Watershed was at one time nearly all comprised of oak savannah, prairie, forests and wetland habitat. After western settlement, land quickly gave way to the plow, railroad and development. Current assessment estimates indicate that there are 1,434 active farms within the watershed. Over half (approximately 57%) of these farms are less than 180 acres in size (NRCS 2007). A majority of the lands within the Crow Wing River Watershed are not highly erodible, and are therefore moderately suited to agricultural usage. Today, agricultural use accounts for approximately 25% of the available acres (Figure 7). The remaining land area is still dominated by Forest/Shrub lands, comprising nearly 51 percent of the total watershed acres (MDNR 2003). A relatively small percentage (3%) of the watershed is developed (e.g. residential, urban) with an even smaller portion (.04%) classified as barren/mining. Row crops and wetland uses occupy the same percentage of area (roughly 10%) and rangeland (pasture) comprises approximately 14 percent of the total watershed area. The remaining (7%) is open water. Development is becoming significant in some locations as lakeshore is being parceled out for lake homes or recreational purposes (NRCS 2007).

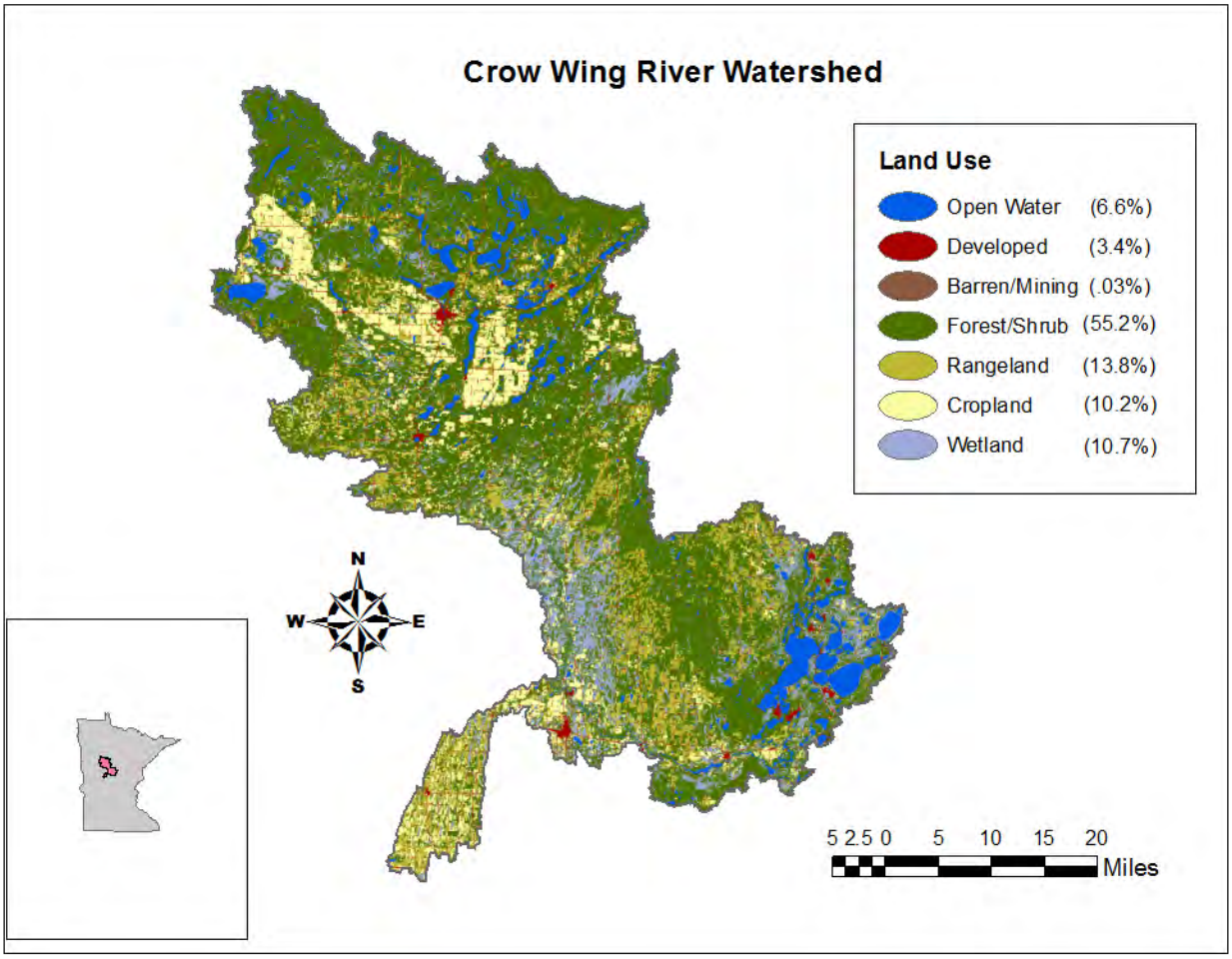

Figure 7. Land use in the Crow Wing River Watershed.

Surface water hydrology

The Crow Wing Rivers Watershed is comprised of 16 HUC 11 sub-watersheds: Upper Crow Wing, Mantrap Lake, Fishhook River, Two Inlets, Straight River, Shell River, Kettle Creek, Blueberry River, Middle Crow Wing River, Cat River, Farnham Creek, Partridge River, Swan Creek, Lower Crow Wing, Upper Gull Lake and Gull Lake. The average elevation of the watershed basin is estimated at approximately 1,357 feet above sea level (NRCS 2007).

The Crow Wing River runs through a chain of 11 lakes known as the Crow Wing Lakes that are named First thru Eleventh with the Eleventh being the most upstream. From its origins in the northern part of the watershed to its confluence with the Mississippi River the Crow Wing River grows from a small headwater stream to a rather large fifth order stream. As the river forms and begins to meander to the southwest it receives water from several major tributaries including the Straight, Fishhook, Shell, Kettle, Blueberry and Cat Rivers as well as Farnham Creek. The tributaries that contribute to the Crow Wing River have different sources, from wetlands to underground springs such as with Hell Camp Creek. There are also 34 dams within the Crow Wing River Watershed (See appendix 6.3 at end of report), which range from small privately owned control dams to some larger structures which are used to generate hydroelectric power.

Climate and precipitation

Precipitation is the source of almost all water inputs to a watershed, and therefore is a good hydrologic dataset to begin this study. Figure 8 shows two representations of precipitation for water year 2012 (October – September). On the left is total precipitation, which shows that the watershed received a wide range of precipitation that varied from 18 to 34 inches. The display on the right shows the amount that precipitation levels in water year 2012 departed from normal. For the Crow Wing River Watershed precipitation departures varied from six inches below normal, to four inches above normal. Most of Minnesota shows the effect of persistent drought.

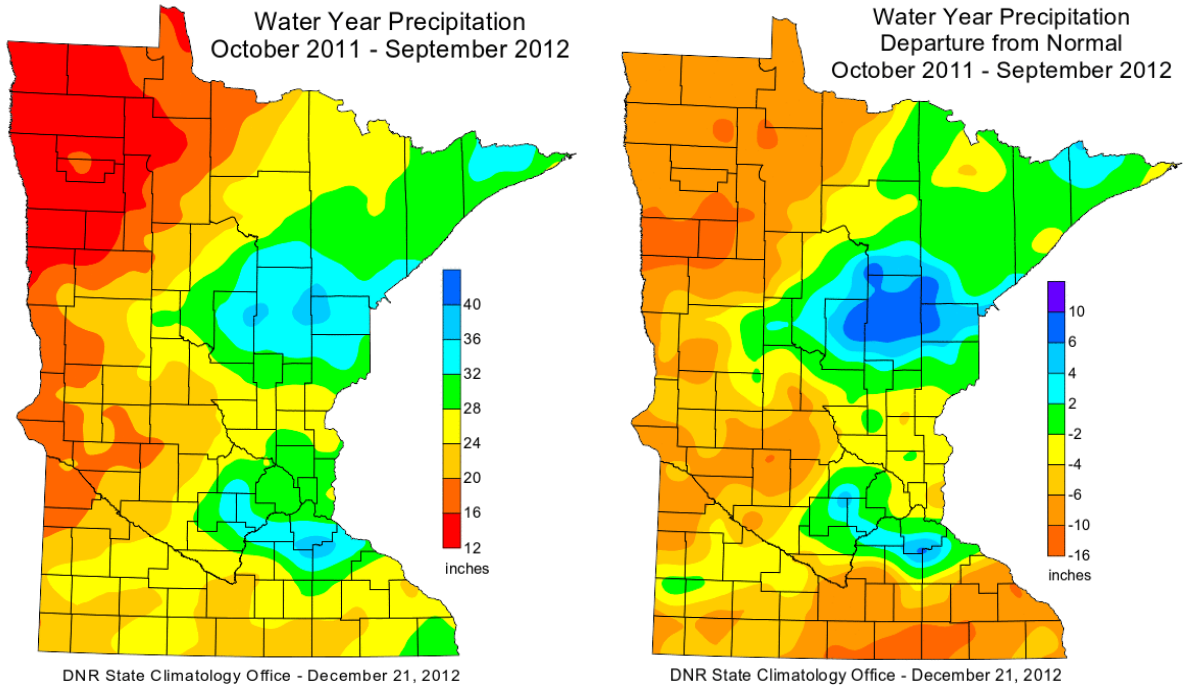

Figure 8. State-wide precipitation levels during the 2012 water year.

Figure 9 displays the areal average representation of precipitation in Central Minnesota. An aerial average is a spatial average of all the precipitation data collected within a certain area presented as a

single dataset. This data is taken from the Western Regional Climate Center, available as a link off of the University of Minnesota Climate website: http://www.wrcc.dri.edu/spi/divplot1map.html.

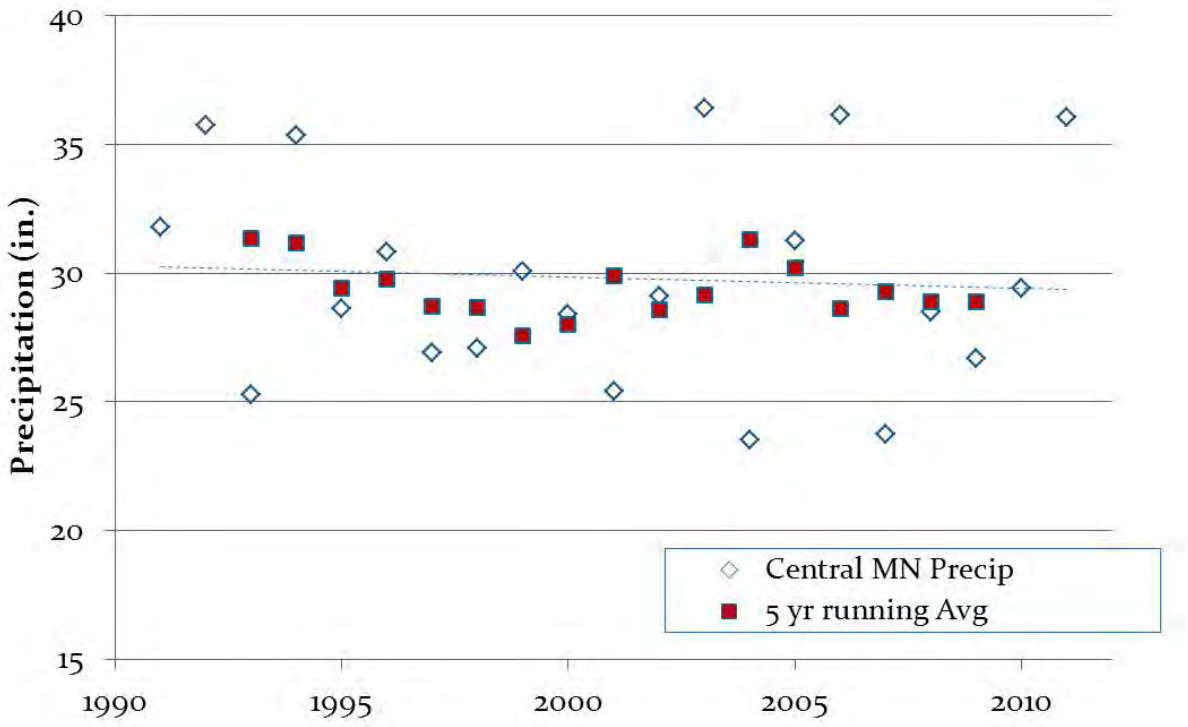

Figure 9. Precipitation trends in Central Minnesota (1990-2011) with five year running average.

Rainfall in the Central region displays no statistically significant trend over the last 20 years. Though rainfall can vary in intensity and time of year, it would appear that Central Minnesota precipitation has not changed dramatically over this time period.

However, precipitation in Central Minnesota does exhibit a statistically significant rising trend over the past 100 years, $p = 0.001$ (Figure 10). This is a strong trend and matches similar trends throughout Minnesota for this time period.

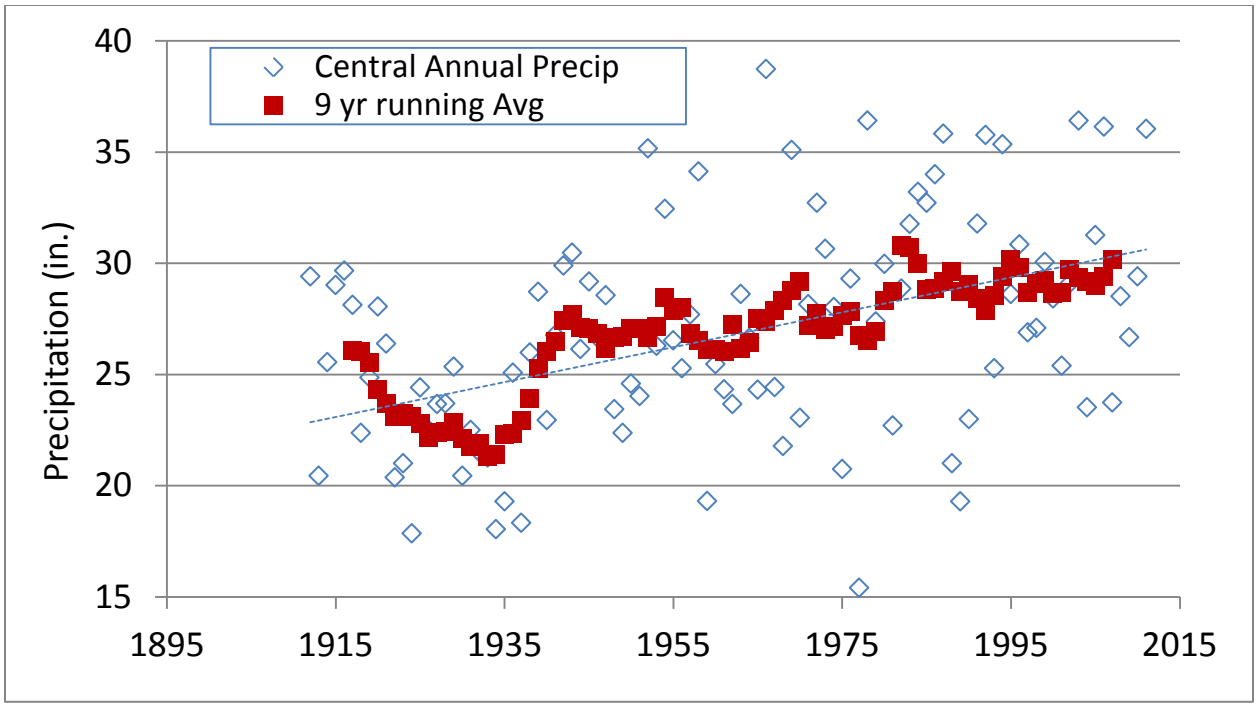

Figure 10. Precipitation trends in Central Minnesota (1895-2015) with nine year running average.

Hydrogeology and groundwater quality

Hydrogeology encompasses the movement and distribution of groundwater in the subsurface, incorporating both the geology and its influence on the storage or movement of groundwater.

High capacity withdrawals

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

Displayed below are the locations of these permitted groundwater and surface water withdrawals in and near the Crow Wing River Watershed (Figure 11). Blue symbols are groundwater withdrawals and red are surface water, taken from lake, stream or other surface water feature. Wells that are included in an analysis of groundwater withdrawals in the upper watershed (next Figure) are identified with a blue oval. This highlighted region is dominated by the Straight and Shell rivers, tributaries to the Crow Wing. This is the area in the watershed most affected by groundwater pumping.

The three largest permitted consumers of water in the state (in order) are irrigation, municipalities and industry. The Crow Wing River Watershed withdrawals are mostly irrigation and municipal use.

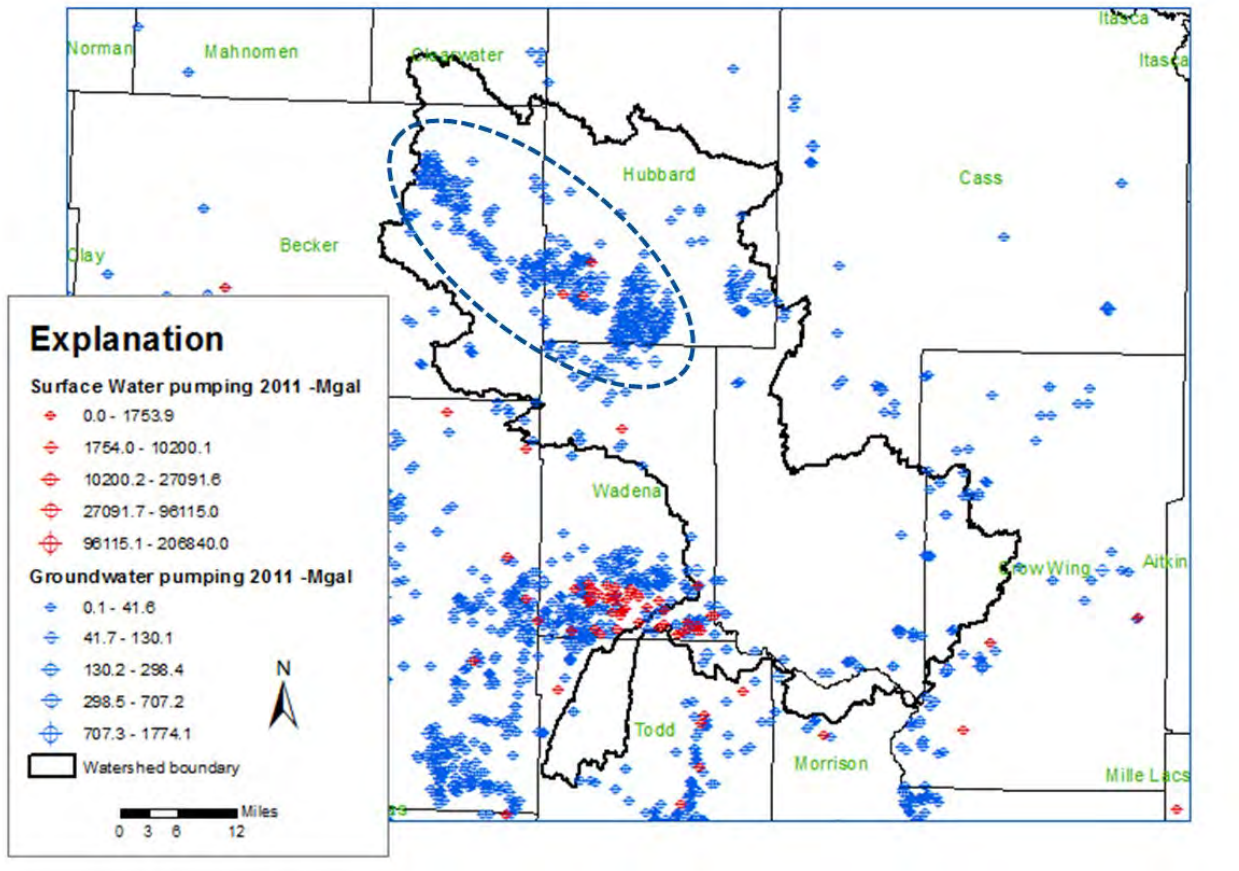

Figure 11. Locations of permitted groundwater withdrawals in the Crow Wing River Watershed.

Total groundwater withdrawals for the upper watershed (Straight River) from 1991-2011 are displayed in Figure 12 as blue diamonds. The data is taken from the DNR SWUDS database. The strong rising trend

in groundwater withdrawals is similar to what has been found throughout the state for this time period, though the high volumes and the sharp trend rise put this watershed in a special category. The trend is statistically significant at p=0.001. Surface water withdrawals are several orders of magnitude lower in this area.

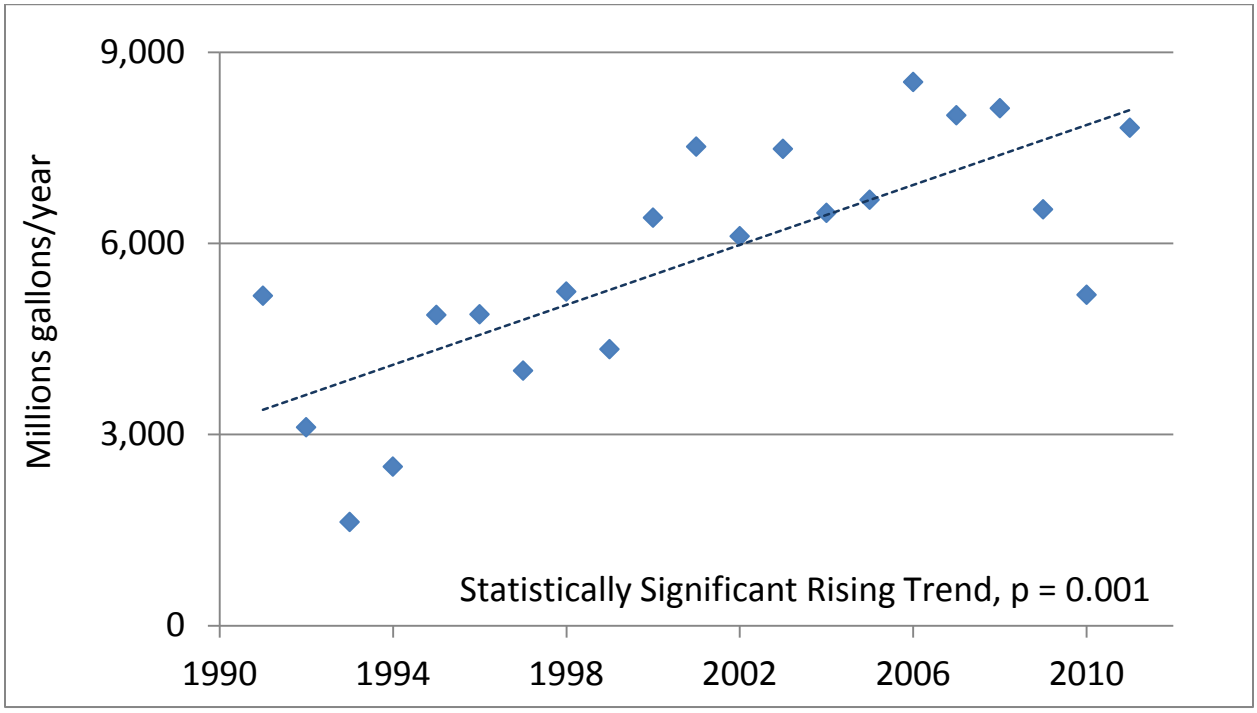

Figure 12. Total groundwater withdrawals for the Straight River Watershed (1991-2011).

Watershed-wide data collection methodology

Pollutant load monitoring

Intensive water quality sampling occurs year round at all WPLMP sites. Twenty to thirty grab samples were collected at the Crow Wing River near Pillager per year with sampling frequency greatest during periods of moderate to high flow (Figure 13). Because correlations between concentration and flow exist for many of the monitored analytes, and because these relationships can 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.

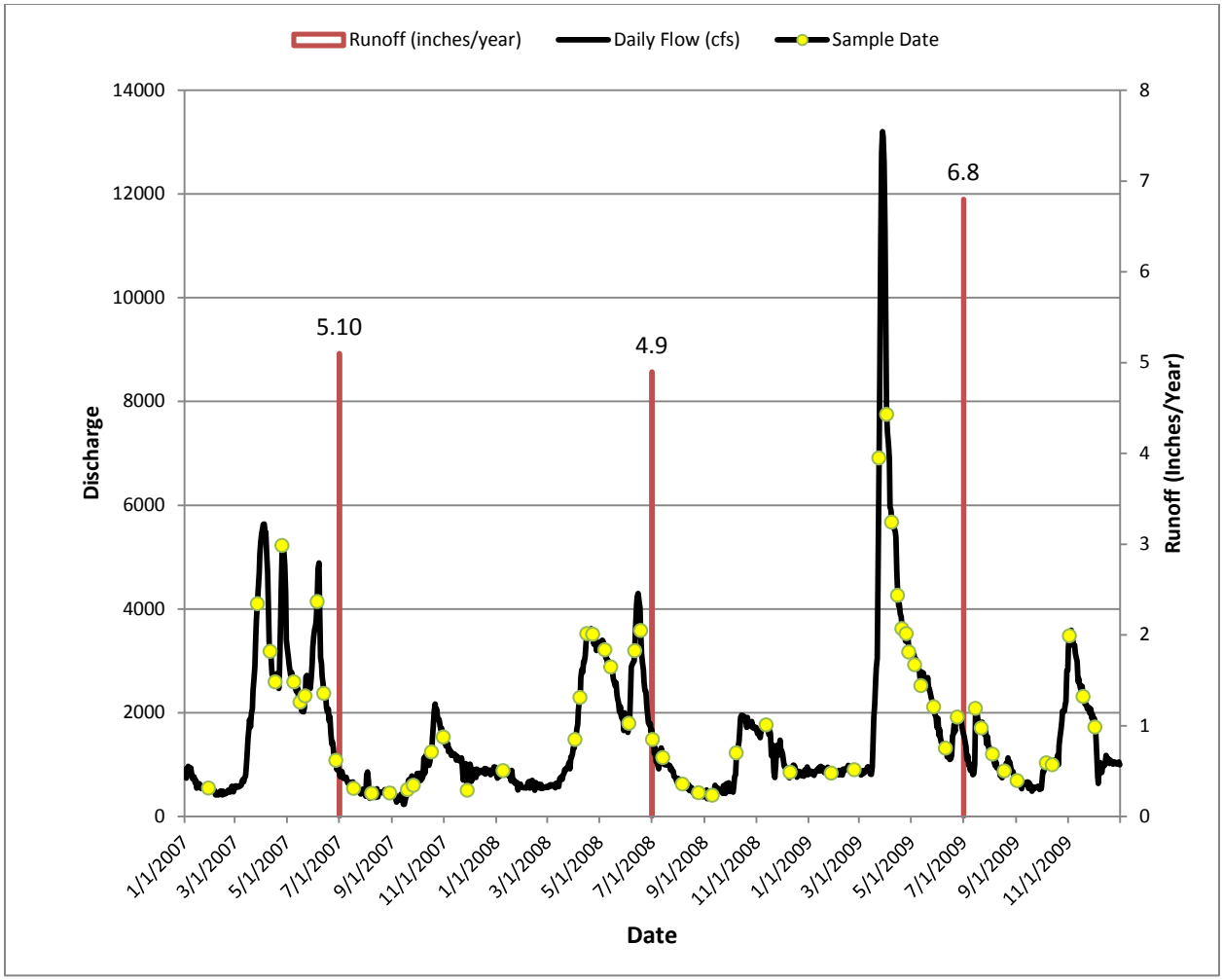

Figure 13. 2007 – 2009 Hydrograph and Annual Runoff for the Crow Wing River near Pillager, Minnesota.

Annual water quality and daily average discharge data are coupled in the "Flux32," pollutant load model, originally developed by Dr. Bill Walker and upgraded in 2010 by the U.S. Army Corp of Engineers and MPCA. FLUX32 allows the user to create concentration/flow regression equations to estimate pollutant concentrations and loads on days when samples were not collected. Primary outputs include annual and

daily pollutant loads and flow weighted mean concentrations (pollutant load/total flow volume). Loads and flow weighted mean concentrations are calculated for total suspended solids (TSS), total phosphorus (TP), dissolved orthophosphate (DOP), and nitrate plus nitrite nitrogen (nitrate-N).

Stream water sampling

Six water chemistry stations were sampled from May through September in 2009, and again June through August of 2010. An additional nine water chemistry stations were sampled from May through September 2010, and again June through August of 2011. Samples were collected to provide sufficient water chemistry data to aquatic life and recreation. Following the IWM design, water chemistry stations were placed at the outlet of each 11 digit HUC subwatershed that was >40 square miles in area (purple circles and green circles/triangles in Figure 2). Surface Water Assessment Grants (SWAG's) were awarded to Cass County Environmental Services Department (ESD), Crow Wing County SWCD, and Wadena County SWCD, who sampled water chemistry. (See Appendix 1 for definitions of stream chemistry analytes monitored).

Stream biological sampling

The biological monitoring component of the intensive watershed monitoring in the Crow Wing River watershed was completed during the summer of 2010. A total of 62 sites were newly established across the watershed and sampled. These sites were located near the outlets of most minor HUC-14 watersheds. In addition, six existing biological monitoring stations within the watershed were revisited in 2010. These pre-existing monitoring stations were initially established as part of a random Upper Mississippi River basin wide survey in 1999 and 2000, or as part of a survey which investigated the quality of channelized streams with intact riparian zones. While data from the last 10 years contributed to the watershed assessments, the majority of data utilized for the 2012 assessment was collected in 2010. A total of 58 AUIDs were sampled for biology in the Crow Wing River Watershed resulting in assessments on 48 AUIDs. Waterbody assessments were not conducted for 10 AUIDs because they were channelized and the criteria for channelized reaches had not been developed prior to the assessments. Nonetheless, the biological information that was not used in the assessment process was given a qualitative rating to provide an indication of the stream segments' condition for stressor identification. Also, the information on non-assessed channelized streams will also be important for long term trend results in subsequent reporting cycles. Qualitative ratings for non-assessed reaches area included in Appendix 5.1.

To measure the health of aquatic life at each biological monitoring station, fish and invertebrate indices of biological integrity (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 invertebrate IBI. Fish and macroinvertebrate classes are similar but do differ slightly in respect to the regional and physical features that are used to differentiate one class from another. 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 4.2, 4.3, 5.2 and Appendix 5.3.

Fish contaminants

Mercury was analyzed in fish tissue samples collected from the Crow Wing River and 46 lakes in the watershed. Polychlorinated biphenyls (PCBs) were measured in fish from the Crow Wing River and 21 lakes. MPCA biomonitoring staff collected the fish from the river in 2010 and MDNR fisheries staff collected all other fish.

Select fish species from six lakes in the watershed were tested for perfluorochemicals (PFCs). The PFC that bio-accumulates in fish and is a known health concern for human consumption is perfluorooctane sulfonate (PFOS). Therefore, it is the only PFC concentration reported here for fish tissue. PFCs became a contaminant of emerging concern in 2004 when high concentrations of PFOS were measured in fish from the Mississippi River, Pool 2. Extensive statewide monitoring of lakes and rivers for PFCs in fish was continued through 2010. More focused monitoring for PFCs will continue in known contaminated waters, such as the Mississippi River, Fish Lake Flowage near Duluth, and Twin Lake in this watershed.

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.

For PFCs, the MPCA shipped whole fish to AXYS Analytical Services Ltd in Sidney, British Columbia, Canada. AXYS did the fish measurements and processing before analyzing the tissue samples for 13 PFCs. Four of the lakes have PFOS results for one bluegill sunfish (BGS) or one black crappie (BKS) that were analyzed by U.S. EPA Research Triangle Park Laboratory. The detection limit from AXYS was approximately 4.8 nanograms per gram PFOS, whereas the detection limit reported by the USEPA RTP lab was 0.92 ng/g PFOS.

The MPCA has included waters impaired for contaminants in fish on the 303d Impaired Waters List since 1998. Impairment assessment for PCBs and PFCs in fish tissue is based on the fish consumption advisories prepared by the Minnesota Department of Health (MDH). If the consumption advice is to restrict consumption of a particular fish species to less than a meal per week because of PCBs or PFCs, the MPCA considers the lake or river impaired. The threshold concentration for impairment (consumption advice of one meal per month) is 0.22 mg/kg for PCBs and 0.200 mg/kg (200 ppb) for PFOS.

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

PCBs in fish have not been monitored as intensively as mercury in the last three decades because of results of monitoring completed in the 1970s and 1980s. These studies identified that high concentrations of PCBs were only a concern downstream of large urban areas in large rivers, such as the Mississippi River and in Lake Superior. Therefore, continued widespread frequent monitoring of smaller river systems was not necessary. However, limited PCB monitoring of forage fish was included in the watershed sampling design to confirm PCBs are not appearing in the smaller streams.

Lake water sampling

MPCA sampled 14 of the assessed lakes in this watershed in 2009-10. The MPCA also previously sampled two additional lakes in this watershed as part of the Sentinel Lakes monitoring program, a long-term monitoring program coordinated by MDNR to comprehend the effects of land use climate change on Minnesota lakes. SWAGs were awarded to Becker County SWCD, Cass County ESD, Clearwater County SWCD, Crow Wing County SWCD, Hubbard County SWCD and , Morrison County SWCD. Through these grants, 69 lakes were monitored by RMB Laboratories, local governmental organizations or volunteers. There were 59 lakes within the watershed where data were collected by volunteers enrolled in the MPCA's Citizens Lake Monitoring Program (CLMP). Sampling methods are the same among all groups involved with data collection 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.

Groundwater monitoring

Groundwater quantity is monitored by the MDNR through a network of observation wells. Figure 14 shows the locations of wells in the watershed and neighboring counties.

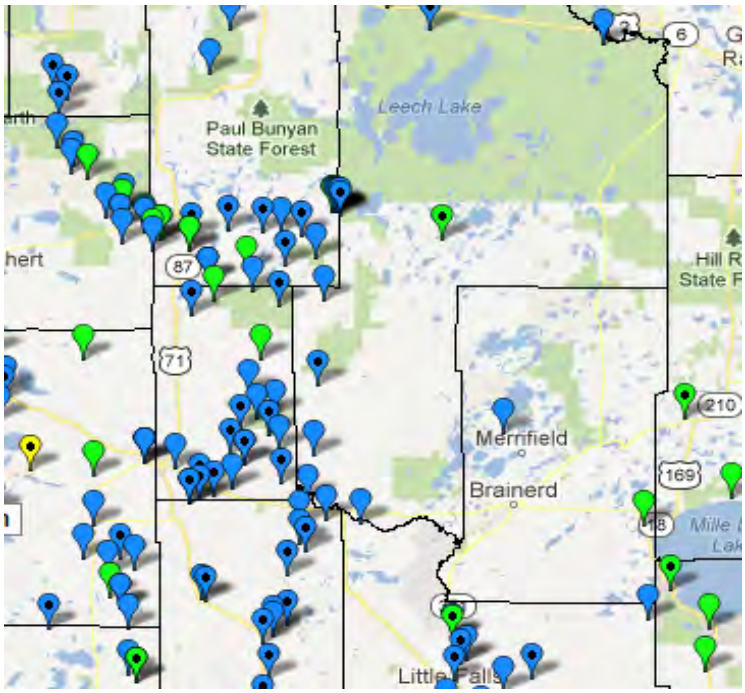

Figure 14. Locations of area MDNR Observation Wells.

= water table aquifer
= bedrock aquifer
= bedrock aquifer
= buried artesian aquifer
indicates measurements are no longer made

Figure 15 is an example of the hydrograph generated by readings from a well in the watershed. Well 3133 is an observation well in Becker County. There is no trend to the readings from this well, nor from any of the other wells in the watershed.

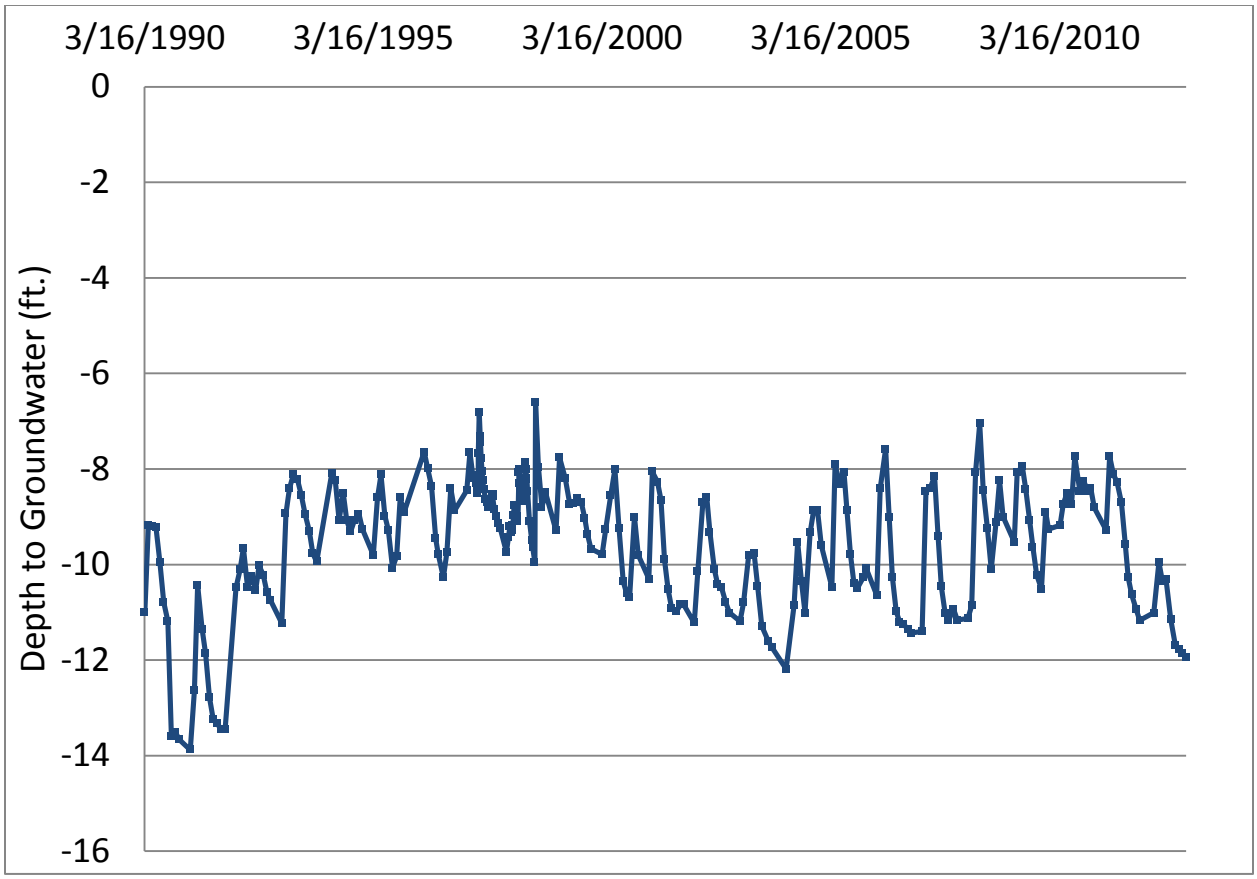

Figure 15. Groundwater elevation as measured at MDNR observation well 3133 in Becker County.

Groundwater quality is monitored by the MPCA through a similar though smaller network of observation wells. Figure 16 shows the locations of the Ambient Groundwater Monitoring Program wells in the watershed and neighboring counties.

The MPCA Ambient Groundwater Network monitors trends in statewide groundwater quality by sampling a comprehensive suite of chemicals including nutrients, metals, and volatile organic compounds.

Data collected from these wells indicates the presence of naturally-occurring constituents like iron, sulfate and manganese. Some of these may impact water aesthetically, creating need for treatment prior to household use. Chloride is also commonly detected and its' source can either be from natural conditions or be an indicator of human impacts to groundwater.

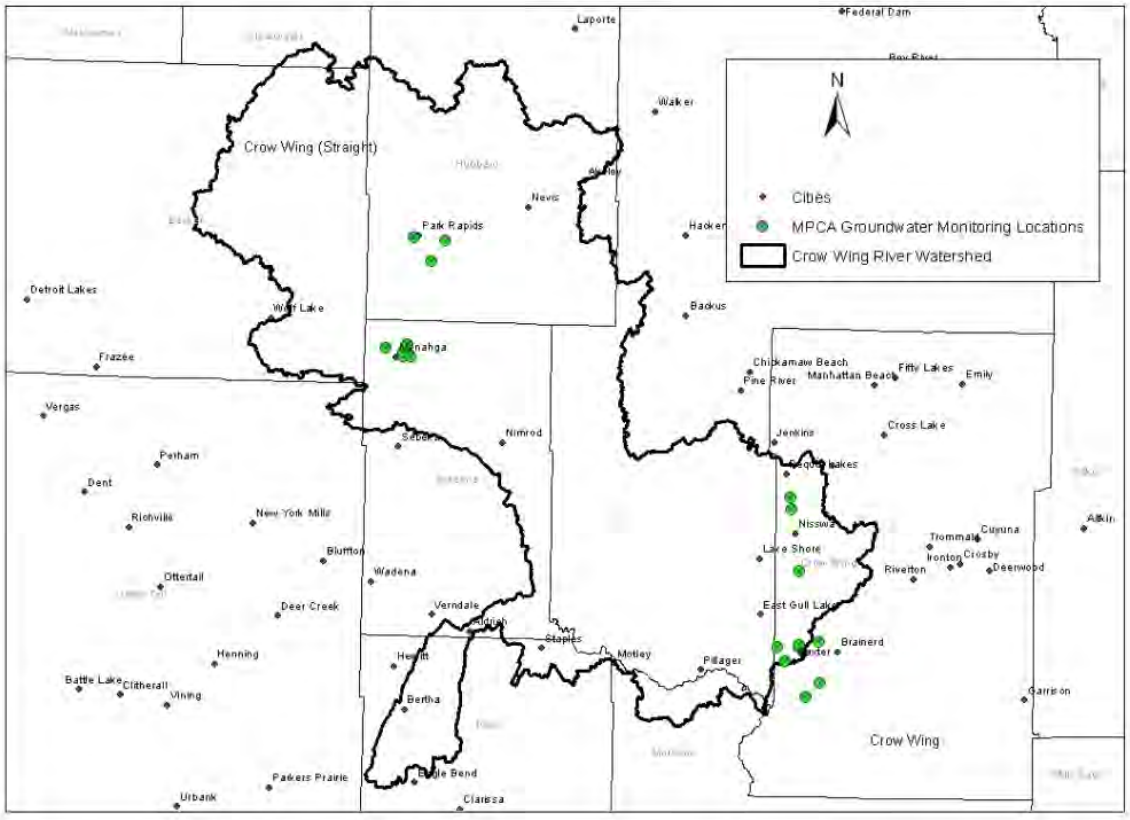

Figure 16. Locations of area MPCA Ambient groundwater observation Wells.

The MDA is responsible for monitoring groundwater quality in agricultural areas of the state. The geographic area known as the central sands (which encompasses the Crow Wing Watershed) is particularly vulnerable with respect to agricultural chemical movement due to the hydrogeologic conditions that include the presence of shallow groundwater beneath highly conductive, coarse, sandy-textured soils.

The MDA detected nitrate in 97% of samples collected from 2000-2010 in this area (Figure 17). Of those samples, 14% were at or below background level of three milligrams per liter (mg/L) and 62% were above the Health Risk Limit of 10 mg/L.

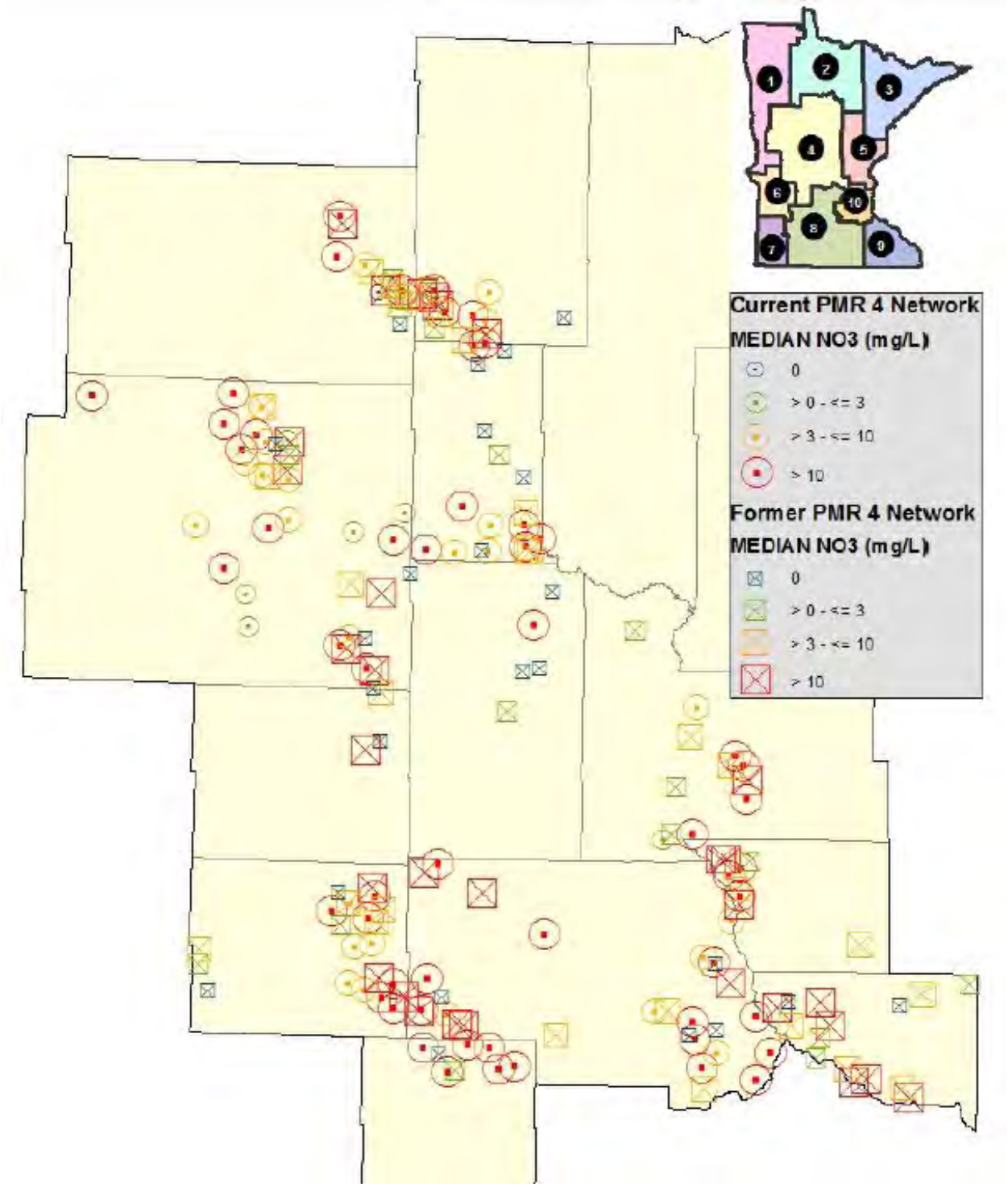

Figure 17. Locations and results of the sampling of area MDA observation wells.

Wetland monitoring

Wetlands are a prominent feature in the Crow Wing River Watershed. National Wetlands Inventory (NWI) data estimate 302,288 acres of wetlands present in the Crow Wing - about 24% of the watershed area (Figure 18). This is higher than the state wetland coverage rate of 19% (Kloiber 2010). The predominant wetland cover types are scrub-shrub (i.e., shrub dominated) and emergent (i.e., grass and sedge dominated) which occupy approximately 8% and 6% of the watershed respectively.

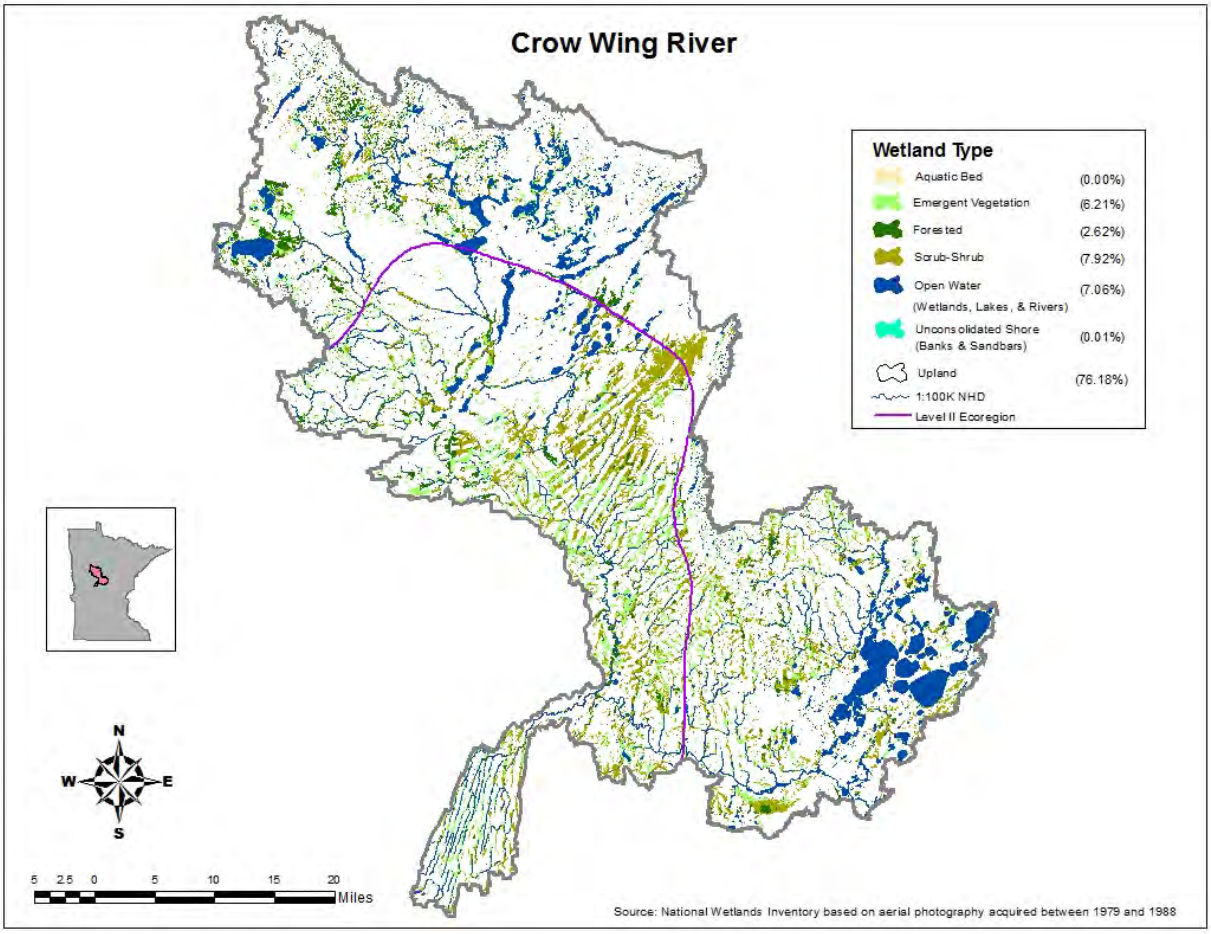

Figure 18. Wetlands and surface water in the Crow Wing River Watershed. Wetland data is from the National Wetlands Inventory. The level II ecoregion boundary has been included.

The glacial landforms are varied in the watershed—leading to contrasting hydrogeomorphic (HGM) wetland patterns. Stagnation moraines (formed along the outer edge of a glacial advance) occur in the northern and eastern lobes of the watershed (MNGS 1997, Figure 18). The stagnation moraine landscape has numerous hills and basins—producing many lakes and depressional wetlands. Depressional wetland hydrology may be dominated by surface flow, precipitation, and/or groundwater depending on the local setting and whether a basin has a surface water connection (Brinson 1993). Many of the depressional basins occurring in stagnation moraines are topographically isolated from other surface water bodies—retaining precipitation inflows from their small catchments with water either infiltrating or being removed from the watershed through evapotranspiration. The remainder of the watershed landform is predominantly glacial outwash plains (outflow delta deposits from melting glaciers) and the Wadena drumlins (streamlined hills and swales aligned parallel to ice flow). This landscape is generally flat. With little landscape gradient for water to drain—extensive wetlands are

formed that accumulate organic peat (i.e., organic flat wetlands; Brinson 1993). Precipitation is the predominant water source of organic flats—which may then form low gradient headwater/low order streams as water slowly drains from the wetlands. This can be seen in the central portion of the watershed where extensive linear wetland features occur in parallel in the Wadena drumlin field Low gradient stream drainage has formed on many of these linear organic flats flowing towards the mainstem of the Crow Wing. In many cases drainage has been established or augmented by ditching and channelization.

The MPCA is actively developing methods and building capacity to conduct wetland quality monitoring and assessment. Our primary approach is biological monitoring, where changes in biological communities may be indicating a response to human-caused stressors. The MPCA has developed macroinvertebrate and vegetation IBIs for depressional wetlands (i.e., wetlands occurring within a depression in the landscape that has marsh vegetation and semi-permanent to permanent open water) for each Level II ecoregion (White and Omernik 2007) in the state: the Temperate Prairies (former prairie region represented as TP in Table 1); the Mixed Wood Plains (MWP; central hardwood forest region); and the Mixed Wood Shield (MWS; northern forest region). For more information about the depressional wetland IBIs (including sampling procedures) please visit the MPCA Wetland monitoring and assessment webpage: http://www.pca.state.mn.us/index.php/water/water-types-and-programs/surface-water/wetlands/wetland-monitoring-and-assessment.html.

The MPCA currently does not monitor wetlands systematically by watershed. Alternatively, the overall status and trends of wetland quality in the state (and by ecoregion) is being tracked through probabilistic monitoring. Probabilistic monitoring refers to the process of randomly selecting sites to monitor, from which an unbiased estimate of the resource can be made. Sites are assessed as Good/Fair/Poor according to the vegetation and invertebrate IBIs independently and results are extrapolated to the estimated population of depressional wetlands. The MPCA has completed an initial baseline of depressional wetland quality (MPCA 2012; http://www.pca.state.mn.us/index.php/view-document.html?gid=17741) that may be related to the Crow Wing River Watershed.

Statewide there are relatively high proportions of depressional wetlands in Good and Fair quality when measured by the invertebrate IBI, but a more even distribution of quality—with a majority (45%) being in Poor condition—when measured by the vegetation IBI (Table 1). Geographically, depressional quality is greatest in the northern MWS ecoregion and has the lowest ratings in the agriculturally dominated TP ecoregion for both invertebrates and vegetation (Table 1). The central MWP ecoregion had generally Good/Fair invertebrate depressional wetland condition but generally Poor (61%) vegetation condition.

Table 1. The relative proportions of depressional wetland condition categories (Good/Fair/Poor) statewide and by Level II ecoregion (TP/MWP/MWS). Proportions are based on the estimated number of wetland basins with results reported separately for vegetation and invertebrates.

Condition Category	Vegetation					Invertebrates			
	Statewide	TP	MWP	MWS		Statewide	TP	MWP	MWS
Good	30%	17%	18%	54%		57%	33%	44%	60%
Fair	25%	28%	21%	29%		32%	20%	40%	29%
Poor	45%	54%	61%	17%		11%	47%	15%	12%

The boundary separating the central MWP and northern MWS ecoregions crosses through the Crow Wing River Watershed—roughly dividing it in equal parts (Figure 19). The MWS ecoregion portion of the watershed includes most of the areas dominated by the stagnation moraine landform where depressional wetlands are very common. Given the probabilistic IBI results for the ecoregion and the fact that depressional wetlands are common—general wetland condition for both vegetation and invertebrates is expected to be high in this part of the watershed. The MWP ecoregion portion of the watershed is predominantly outwash plains and drumlins where there are relatively few depressional wetlands (Figure 19). The depressional wetland conditions are mixed between invertebrates and vegetation in the MWP ecoregion — with vegetation being generally in Poor condition (Table 1). The ability to relate depressional wetland conditions from this ecoregion to the watershed, however, are more limited due to the relative scarcity of depressional wetlands in this part of the watershed. Monitoring results from organic flat HGM wetland sites would be more appropriate in this context.

Between depressional wetland IBI development projects and the probabilistic monitoring—a total of eight sites have been sampled by the MPCA in the watershed from 2004-09 (Figure 19). Only a single site was located in the generally flat MWP ecoregion. It was an isolated man-made dugout (most likely created for wildlife habitat) and—as with many dugouts—the habitat was limiting to both vegetation and invertebrates. The site was rated as a Poor/Fair respectively. As expected—the seven sites located in the MWS ecoregion area of the watershed (which +/- corresponds to the depressional wetland rich stagnation moraine) generally had predominantly Good quality—with four sites being rated Good for both invertebrates and vegetation (Figure 19). All of these sites were (+/-) hydrologically isolated from other surface waters. When gauged by the invertebrate community—the sites break down as four Good/two Fair/one Poor. The Poor rated site is probably better characterized as a Fair, as the 2009 IBI score (47) was very close the threshold score for a Fair rating (49.4) and the site had been rated as Fair in previous samples (2004 and 2005). When gauged by the vegetation community—the MWS sites in the watershed break down as five being rated as Good and two being Fair. All of these sites (including the two sites rated as Fair) had native vegetation composition and structure with little to no evidence of human caused stressors—giving no reason to believe any measurable impacts are occurring that affect vegetation quality at these sites.

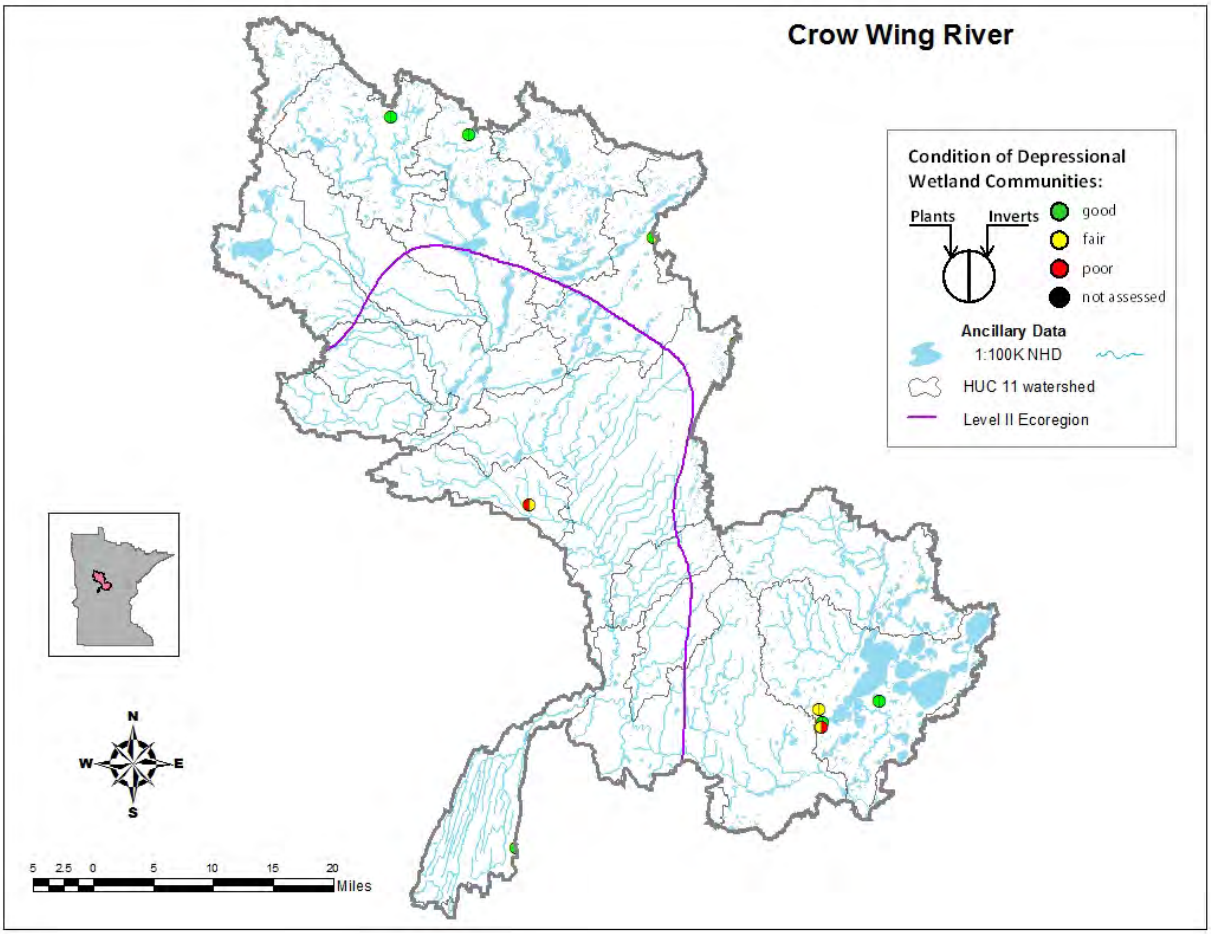

Figure 19. MPCA depressional wetland monitoring sites and condition categories in the Crow Wing River Watershed. The level II ecoregion boundary has been included. The Mixed Wood Plains (MWP) ecoregion lies to the west and south of the boundary and the Mixed Wood Shield ecoregion to the north and east.

Individual watershed results

HUC-11 Watershed units

Assessment results for aquatic life and recreation use are presented for each HUC-11 watershed unit within the Crow Wing River Watershed. The primary objective is to portray all the full support and impairment listings within an 11-HUC watershed unit resulting from the complex and multi-step assessment and listing process. (A summary table of assessment results for the entire 8-HUC watershed including aquatic consumption, and drinking water assessments (where applicable) is included in Appendix 3). The HUC 11 scale provides an assessment of water quality conditions at a practical size for the development, management, and implementation of effective TMDLs and protection strategies. The graphics presented for each of the HUC-11 watershed units contain the assessment results from the 2012 Assessment Cycle as well as any impairment listings from previous assessment cycles. Discussion of assessment results focuses primarily on the 2010 intensive watershed monitoring effort, but also considers available data from the last ten years.

The following pages provide an account of each HUC-11 watershed unit. 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) biological condition of channelized streams and ditches, a) stream habitat quality d) channel stability, and where applicable e) water chemistry for the

HUC-11 outlet, and g) lake aquatic recreation assessments. Following the tables is a narrative summary of the assessment results including where applicable any 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 watershed (i.e., where sufficient information was available to make an assessment). Primarily, these tables reflect the results of the 2012 assessment process 2014 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 were made during the desktop phase of the assessment process (see Figure 4). Assessment of aquatic life is derived from the analysis of biological (fish and invertebrate IBIs), dissolved oxygen, turbidity, chloride, pH and un-ionized ammonia (NH3) 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: cold water 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 5.2 and Appendix 5.3. 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-11 as well as in the Watershed-Wide Results and Discussion section.

Channelized stream evaluations

Biological criteria have not been developed yet for channelized streams and ditches, therefore, assessment of fish and macroinvertebrate community data for aquatic life use support was not possible at some monitoring stations. A separate table provides a narrative rating of the condition of fish and macroinvertebrate communities at such stations based on IBI results. Evaluation criteria are based on aquatic life use assessment thresholds for each individual IBI class (see Appendix 5.1). IBI scores above this threshold are given a “good” rating, scores falling below this threshold by less than ~15 points (i.e., value varies slightly by IBI class) are given a “Fair” rating, and scores falling below the threshold by more than ~15 points are given a “poor” rating. For more information regarding channelized stream evaluation criteria refer to Appendix 5.1.

Stream habitat results

Habitat information documented during each fish sampling visit is provided in each HUC-11 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-11 watershed.

Stream stability results

Stream channel stability information evaluated during each macroinvertebrate sampling visit is provided in each HUC-11 section. These tables display the results of the Channel Condition and Stability Index

(CCSI) which rates the geomorphic stability of the stream reach sampled for biology. The CCSI rates three regions of the stream channel (upper banks, lower banks, and bottom) indicating stream channel geomorphic changes and loss of habitat quality which may be related to changes in watershed hydrology, stream gradient, sediment supply, or sediment transport capacity. The CCSI was recently implemented in 2008, and is collected once at each biological station. Consequently, the CCSI ratings are only available for biological visits sampled in 2010 or later.

Watershed outlet water chemistry results

These summary tables display the water chemistry results for the monitoring station representing the outlet of the HUC-11 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 subwatershed. 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 Crow Wing River 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-11 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 6.2.

Upper Crow Wing River Watershed Unit HUC 07010106010

The Upper Crow Wing River Watershed is located in the northeastern portion of the Crow Wing River Watershed and is the eighth largest sub-watershed draining approximately 123 square miles of land surface. Roughly 16% of the watershed is comprised of crop/pasture land with most of this use occurring in the eastern most and western portions of the watershed. Forest land makes up a large percentage (almost 60%) of the unit and dominates the south central to north central portions of the watershed. It is within this unit that the headwaters of the Crow Wing River exist. Located in Hubbard County, this sub-watershed contains several lakes including Big Bass, Ninth Crow Wing, Eleventh Crow Wing (East), Tenth Crow Wing and Eighth Crow Wing. Forest/shrub land dominates this watershed with some agriculture also occurring. The major tributary to the Crow Wing River within this sub-watershed is Bender Creek. Smaller tributaries within this unit include Wallingford and Mucky Creek. Water chemistry data was collected at the outlet of the subwatershed upstream of CR 109, approximately three miles north of Huntersville. This data is represented by MPCA's EQuIS station S004-789 and biological station 10UM046. The water chemistry data at this location was collected by the Cass County Soil and Water Conservation District and the biological data was collected by MPCA staff.

Table 2. Aquatic life and recreation assessments on stream reaches: Upper Crow Wing River Watershed Unit. Reaches are organized upstream to downstream in the table.

AUID Reach Name Reach Description	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators									Aquatic Life	Aquatic Rec.
					Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides	Bacteria		
07010106-523 , Crow Wing River, Headwaters (Eleventh Crow Wing Lk 29-0036-00) to Shell R	28.79	2B,3C	10UM045 10UM046	Upstream of CR 13, 4 mi. S of Nevis Downstream of CR 109, 3 mi. N of Huntersville	MTS	MTS	IF	MTS	MTS	MTS	MTS	_	MTS	FS	FS
07010106-691, Bender Creek, Unnamed Lk (29-0608-00) to First Crow Wing Lk	4.74	2B,3C	10UM070	Downstream of Bender Creek Rd, 3 mi. SW of Badoura	EXS	EXP	IF	IF	_	IF	_		_	NS**	NA

Abbreviations for Indicator Evaluations: -- = No Data, NA = Not Assessed, IF = Insufficient Information, MTS = Meets criteria; EXP = Exceeds criteria, potential impairment; EXS = Exceeds criteria, potential severe impairment; EX = Exceeds criteria (Bacteria).

Abbreviations for Use Support Determinations: NA = Not Assessed, IF = Insufficient Information, NS = Non-Support, FS = Full Support

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

Double asterisk (**) = Placed in 4E category with additional monitoring recommended to determine if impairment is due to Natural Background factors.

Aquatic life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50 percent) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

Table 3. Minnesota Stream Habitat Assessment (MSHA): Upper Crow Wing River 11-HUC.

# 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	10UM070	Bender Creek	5	11	14	11	9	50	Fair
1	10UM046	Crow Wing River	5	11	9	14	18	57	Fair
1	10UM045	Crow Wing River	4	15	13	11	20	63	Fair
Average Habitat Results: *Upper Crow Wing River 11 HUC*			**4.7**	**12.3**	**12**	**12**	**15.7**	**56.7**	**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 4. Outlet water chemistry results: Upper Crow Wing River 11-HUC.

Station location:	**Crow Wing River upstream of CR 109, three miles North of Huntersville**							
STORET/EQuIS ID:	**S004-789**							
Station #:	**10UM046**							
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**Median**	**WQ Standard1**	**# of WQ Exceedances2**
Ammonia-nitrogen	mg/L	10	<0.04	2	0.3	0.06		
Chloride	mg/L	10	2	4	3	3	230	
Chlorophyll-a, Corrected	ug/L							
Dissolved Oxygen (DO)	mg/L	19	2.7	10.4	5.5	4.6	5	11
Escherichia coli	MPN/100ml	15	1	19	7	7	126/1260	
Inorganic nitrogen (nitrate and nitrite)	mg/L	10	<0.03	0.09	0.04	0.03		
Kjeldahl nitrogen	mg/L	10	0.4	0.7	0.5	0.5		
Orthophosphate	ug/L							
pH		19	7.5	8.7	7.9	7.9	6.5-9.0	
Pheophytin-a	ug/L							
Phosphorus	ug/L	10	0.02	0.04	0.03	0.03		
Specific Conductance	uS/cm	19	248	303	277	276		
Temperature, water	deg °C	19	11.1	26.8	20.4	20.7		
Total suspended solids	mg/L	10	1	6	3	4	100	
Total volatile solids	mg/L	10	1	5	3	3		
Transparency tube	100 cm	19	98	>100	100	100	20	
Transparency tube	60 cm						>20	
Turbidity	FNU						25	
Sulfate	mg/L	10	<3	<3				
Hardness	mg/L							

[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 Upper Crow Wing River 11 HUC, a component of the IWM work conducted between May and September in 2010 and 2011. This specific data does not necessarily reflect all data that was used to assess the AUID.

Table 5. Lake water aquatic recreation assessments: Upper Crow Wing River 11-HUC.

Name	DOW#	Area (ha)	Trophic Status	Percent Littoral	Max. Depth (M)	Avg. Depth (M)	CLMP Trend	Mean TP (µg/L)	Mean chl-a (µg/L)	Secchi Mean (M)	Support Status
Mow	29-0002-00	45	M	60	10.4	3.9	IF	11	4	4.5	FS
Tripp	29-0005-00	61	M	43	19.8	5.8	IF	16	5	3.2	FS
Oelschlager Slough	29-0006-00	63	M	100			IF	21	4	1.4	NA
Ham	29-0017-00	76	M	98	6.4	2.1	IF	13	4	2.8	FS
Loon	29-0020-00	50	M	100	1.8		IF	17	5	1.7	FS
Ninth Crow Wing	29-0025-00	93	M	42	19.8	6.1	↓	19	7	3.1	FS
Big Bass	29-0032-00	53	M	42	18.3	6.1	↑	9	2	6.4	FS
Upper Bass	29-0034-00	13	M	77						3.4	IF
Eleventh Crow Wing	29-0036-01	193	M		24.4	10.2	IF	12	4	4.3	FS
Eleventh Crow Wing (East)	29-0036-02	108	M		16.8	7.1	IF	14	5	4.2	IF
Tenth Crow Wing	29-0045-00	70	M	62	12.2	4.0	IF	20	5	2.9	FS
Eighth Crow Wing	29-0072-00	200	E	31	9.1	5.6	NT	30	14	2.7	NS
Indian	29-0074-00	37	M	42	11.0	5.0	IF	9	3	5.7	FS
Third Crow Wing	29-0077-00	260	E	62	10.7	3.5	NT	27	12	1.4	IF
Fourth Crow Wing	29-0078-00	184	E	100	3.0	1.5	NT	26	8	2.3	FS
Wolf	29-0081-00	112	M	100	3.7	1.8	IF	18	3	3.2	FS
Bladder	29-0083-00	90	M	100	1.2		IF	17	2	2.0	FS
Second Crow Wing	29-0085-00	92	E	54	10.7	4.4	NT	22	11	2.1	FS
First Crow Wing	29-0086-00	211	E	100	4.6	1.6	↓	59	32	1.1	NS
Palmer	29-0087-00	59	M	62	6.4	2.6	NT	12	4	3.9	FS
Island	29-0088-00	90	M	65	9.8	3.0	NT	14	5	3.7	FS
Big Stony	29-0143-00	139	M	70	7.3	3.1	↓	14	5	2.9	FS

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

Summary

As a whole, the Upper Crow Wing River Subwatershed had good biological communities. Minimal impairments were identified based on biological condition, and most observed are plausibly the result of natural background factors and not anthropogenic stressors. The watershed has a relatively large amount of open water (roughly 8%) due to a strip of lakes that runs all the way from the southwestern portion to the northeastern portion of this sub-watershed. Due to the large preponderance of lakes, there were few biological stream stations. All of the stations where biological samples (fish and macroinvertebrates) were collected are located in the downstream portion of this drainage. Of the three biological stations within the Upper Crow Wing River Watershed, two of them (10UM045 and 10UM046) produced F-IBI scores that were above their respective thresholds. Both of these sampling locations occurred on the main-stem Crow Wing River (07010106-523) where good habitat scores were also noted. A series of lakes (Fourth, Third, First and Second Crow Wing Lakes) separate biological stations 10UM045 and 10UM046. As a result, many fish species that are typically associated with lakes were sampled at these biological stations such as largemouth bass, spotfin shiners, weed shiners and yellow perch. Least darters were also sampled, and are a Minnesota Species of Special Concern. M-IBI scores for this stream segment were close to the impairment threshold, but the invertebrate as well as the overall assessment was fully supporting for aquatic life.

Bender Creek enters from the east of the First Crow Wing Lake. The F-IBI score at the biological monitoring site (10UM070) was extremely poor. Only three taxa were collected and no sensitive species were observed. The site was also sampled for macroinvertebrates, where despite three habitat types being sampled, the M-IBI score was low. Subsequent monitoring and analysis suggests that the low scores on Bender Creek are due to natural background factors. The five lakes in the upstream portion of Bender Creek (Tripp, Nagel, Mud, Kettle and Mow) contain negligible levels of TP and there are no known nutrient issues despite row crop agriculture occurring in the upstream portions of the subwatershed. The stream banks and channel are very stable and there is no known evidence of extensive algae/periphyton on hard surfaces within the stream. The lack of anthropogenic disturbance downstream of the lakes and upstream of the biological monitoring station suggests no impacts. Of the five upstream lakes, Mow and Tripp were assessed for aquatic recreational use support and both were determined to be fully supporting. The three remaining lakes did not have adequate data to make an aquatic recreational assessment, but the nutrient levels appear to be within the standards. The natural lack of coarse substrate and presence of upstream wetlands and beaver induced impoundments were determined as the plausible explanation for the poor biological communities observed. The Bender Creek AUID (07010106-691) was placed in the 4E natural background category with additional monitoring recommendations suggested as follows:

1. Deploy data sondes to collect continuous dissolved oxygen at the biological station and possibly one to two additional locations within the watershed.
2. Characterization of the wetland downstream of Tripp Lake.
3. Investigate the potential perched culvert upstream of the First Crow Wing Lake as a barrier to fish migration.
4. Re-sample 10UM070 for both Fish and Macroinvertebrates (Biology)
5. Add an additional biological monitoring station within the subwatershed (as needed).

Stressor ID staff collected the additional monitoring data for Bender Creek in 2012. The additional information was used by the Natural Background Review Team to recommend that the aquatic life impairment on Bender Creek was due to natural background (category 4D).

Assessable stream water quality data represented a 28 mile reach of the Crow Wing River from the headwaters and extending to Eleventh Crow Wing Lake. No chloride impairments were observed. DO data were determined to be insufficient to make an assessment; however, the low DO levels observed

on a number of sampling visits were attributed to the presence of wetlands. Additionally, DO and turbidity data were collected from a five mile reach of Bender Creek but the amount of data was also insufficient to complete an assessment.

The Upper Crow Wing River Subwatershed consists of 45 lakes greater than four hectares (ten acres) of which, 21 were assessed for aquatic recreational use (Appendix A). A majority of the lakes in this subwatershed are small to moderately sized deep lakes that often form chains. The Crow Wing chain of lakes is an example. Lakes are evenly distributed throughout the Upper Crow Wing Subwatershed with several wetlands often separating the chains. With the exception of First Crow Wing, a majority of the assessed lakes within the subwatershed were fully supporting for aquatic recreational use. First Crow Wing Lake and Eighth Crow Wing Lakes were previously listed in 2006 for exceeding the nutrient criteria. Recent data for First Crow Wing Lake suggests a continued decline in water clarity. While land use within the catchment area is comprised mostly of natural forests, First Crow Wing Lake lies at the bottom of the subwatershed. This is likely resulting in high levels of external nutrient contribution from a large catchment area. Additionally, First Crow Wing Lake is shallow making it susceptible to internal nutrient release from disturbed lake sediment. Data collected since 2006 for Eighth Crow Wing Lake did indicate reduced nutrient levels with a coinciding reduction in chl-a. Additional TP, chl-a, and Secchi data indicate improving conditions within the lake and that further watershed improvements will be necessary to initiate a delisting.

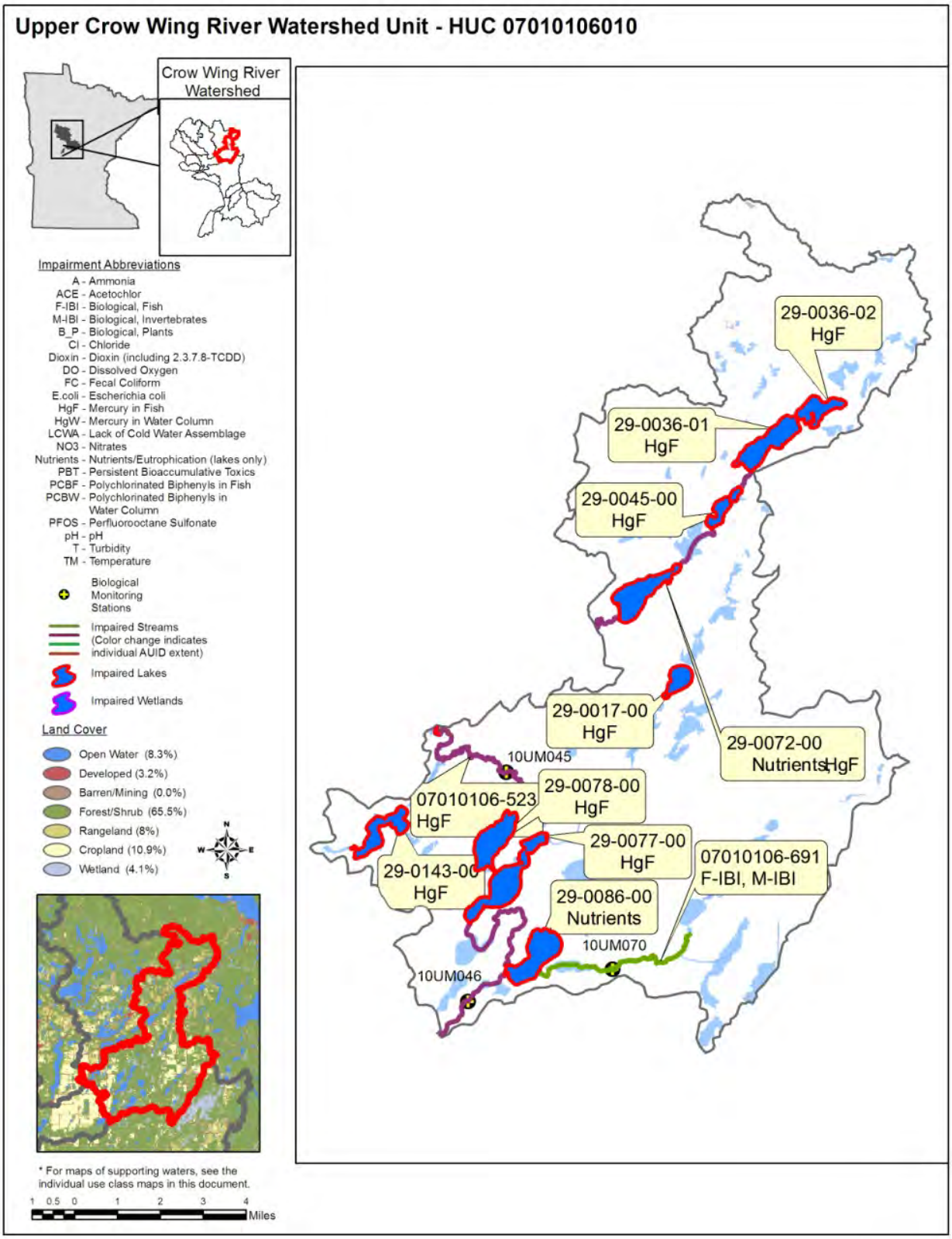

Figure 20. Currently listed impaired waters by parameter and land use characteristics in the Upper Crow Wing River Watershed Unit.

Mantrap Lake Watershed Unit HUC 07010106020

The Mantrap Lake Watershed Unit is in the northeast corner of the Crow Wing River Watershed. Located in Hubbard County, it drains approximately 131 square miles. Within this unit, an interesting phenomenon exists. The Sand River connects Mantrap, Upper and Lower Bottle, Big and Little Sand and Belle Taine Lake. Although the river is up to 200 feet wide in some locations, and eventually empties into Belle Taine Lake, the lake displays no surface outlet. The soils within this area are quite porous, and evidence suggests that the outlet exists underground and contributes to the several springs which are the source of Hell Camp Creek which eventually empties to the Fifth Crow Wing Lake (Waters 1977).

Table 6. Lake water aquatic recreation assessments: Mantrap Lake 11-HUC.

Name	DOW #	Area (ha)	Trophic Status	Percent Littoral	Max. Depth (F)	Avg. Depth (F)	CLMP Trend	Mean TP (µg/L)	Mean chl-a (µg/L)	Secchi Mean (F)	Support Status
Shallow	29-0089-00	115	M	100	3.0	1.3	IF	13	3	2.3	FS
Deer	29-0090-00	67	M	100	2.7	0.8	IF	13	4	4.2	FS
Seventh Crow Wing	29-0091-00	102	E	47	12.2	5.3	↑	26	13	2.3	FS
Fifth Crow Wing	29-0092-00	161	M	50	10.7	4.4	NT	23	10	2.8	FS
Sixth Crow Wing	29-0093-00	136	M	50	12.2	4.9	↓	22	10	2.6	FS
Waboose	29-0098-00	68	M	83	9.8	1.7	IF	15	5	4.4	FS
East Crooked	29-0101-01	146	M	33	15.2	11.3	NT	8	1	6.5	IF
Middle Crooked	29-0101-02	116	M	51	10.1	1.6	NT	15	4	3.5	FS
West Crooked	29-0101-03	99	M	88	29.3	5.4	IF	12	2	4.8	FS
Dead	29-0110-00	54	M	59	10.4	5.1	NT	16	4	6.2	IF
Spider (NE/SW Bay)	29-0117-01	193	M	74	29.3	3.3	NT	11	4	5.5	FS
Spider (East Bay)	29-0117-02	42	M		20.1	7.5	↑			5.5	IF
Belle Taine	29-0146-00	601	M	61	19.2	3.8	↑	11	3	5.7	FS
Upper Bottle	29-0148-00	132	M	37	16.8	6.2	↓	15	4	4.5	FS
Ojibway	29-0149-00	72	M	59	6.7	2.8	IF	17	4	5.3	FS
Little Sand	29-0150-00	163	M	39	24.4	7.6	↑	9	2	6.4	FS
Mantrap (East Basin)	29-0151-01	210	M		20.7	5.7	NT	19	5	4.1	FS
Mantrap (Middle Basin)	29-0151-02	221	M		10.7	3.4	NT	22	5	3.2	FS
Mantrap (West Arm)	29-0151-04	63	M		18.0	5.6	NT			4.3	IF
Mantrap (Home Bay)	29-0151-05	23	M		16.2	4.6	↓			4.7	IF
Boulder	29-0162-00	131	M	50	8.5	4.7	NT	13	5	3.9	FS
Ida	29-0170-00	27	M	64	12.2	3.9	IF	9	2	7.2	FS
Stocking	29-0172-00	39	M	51	7.6	3.7	↑	25	9	3.1	FS
Lower Bottle	29-0180-00	163	M	49	33.5	8.2	↓	12	3	4.6	FS
Big Sand	29-0185-00	658	M		41.2	13.4	↑	9	2	7.0	FS
Emma	29-0186-00	27	M	40	15.2	6.3	NT	16	4	4.2	FS
Gilmore	29-0188-00	37	M	39	16.5	6.3	NT	10	3	4.4	FS
Bad Axe	29-0208-00	107	M	46	11.9	5.8	NT	14	4	4.9	FS
Skunk	29-0212-00	81	M	62	16.8	3.0	IF	12	3	6.1	FS

Abbreviations: ↘ -- Decreasing/Declining Trend **H** – Hypereutrophic **FS** – Full Support

↗ -- Increasing/Improving Trends **E** – Eutrophic **NS** – Non-Support

NT – No Trend **M** – Mesotrophic **IF** – Insufficient Information

Summary

There were no sampleable streams within the Mantrap Lake Subwatershed because stream segments that exist within this sub-watershed were not long enough in between lakes to locate a biological station. However, 24 lakes within this watershed were assessed for aquatic recreation and all were fully supporting.

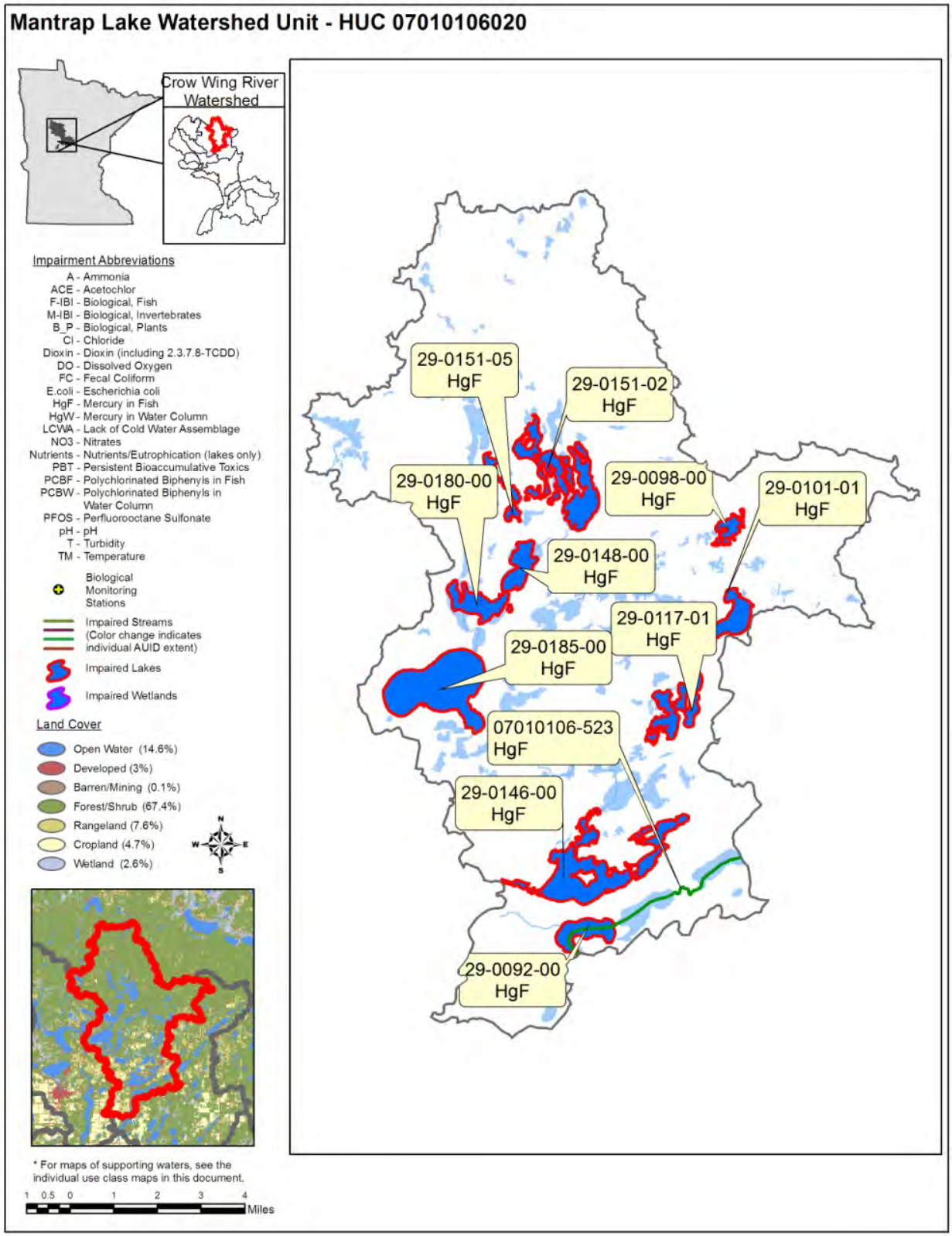

Figure 21. Currently listed impaired waters by parameter and land use characteristics in the Mantrap Lake Watershed

Fish Hook River Watershed Unit HUC 07010106030

The Fish Hook River Watershed is the fifth largest sub-watershed within the Crow Wing River Watershed and drains approximately 140 square miles. Located within portions of Becker and Hubbard Counties, it includes several lakes including Portage, Island, Potato and Fish Hook as well as two major tributaries to the Crow Wing River, the Fish Hook and Portage Rivers. Forest/Shrub land is predominant throughout most of the watershed with some cropland also being present. The outlet monitoring site of the watershed is represented by MPCA's biological/EQuIS station S006-251 and biological station 10UM043. They are located at CR 15, 0.5 miles SE of Park Rapids. The water chemistry data for this location was collected by the Cass County Soil and Water Conservation District with the biological data being collected by MPCA staff.

Table 7. Aquatic life and recreation assessments on stream reaches: Fish Hook River Watershed Unit.

AUID Reach Name, Reach Description	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators:									Aquatic Life	Aquatic Rec.
					Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides	Bacteria		
07010106-543 Fishhook River Park Rapids Dam to Straight R	6.08	2B,3C	99UM031 10UM043	Park Rapids DNR, S. of Hwy. 34 and W. of Hwy. 71 Upstream of CR 15, 0.5 mi. SE of Park Rapids	MTS	MTS	IF	MTS	MTS	MTS	MTS	_	MTS	FS	FS
07010106-542 Fishhook River Straight R to Shell R	3.52	2B,3C	10UM113	Upstream of Hwy 87, 4 mi. SE of Park Rapids	MTS	MTS	IF	MTS	_	IF	MTS	_	IF	FS	IF

Abbreviations for Indicator Evaluations: -- = No Data, NA = Not Assessed, IF = Insufficient Information, MTS = Meets criteria; EXP = Exceeds criteria, potential impairment; EXS = Exceeds criteria, potential severe impairment; EX = Exceeds criteria (Bacteria).

Abbreviations for Use Support Determinations: NA = Not Assessed, IF = Insufficient Information, NS = Non-Support, FS = Full Support

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

Aquatic life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50 percent) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

Table 8. Minnesota Stream Habitat Assessment (MSHA): Fish Hook River 11-HUC.

# 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	10UM113	Fish Hook River	4.5	9.5	18	16	18	66	Good
1	10UM043	Fish Hook River	1	12	16	13	25	67	Good
Average Habitat Results: *Fish Hook River 11 HUC*			**2.8**	**10.8**	**17**	**14.5**	**21.5**	**66.5**	**Good**

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

Table 9. Outlet water chemistry results: Fish Hook River 11-HUC.

Station location:	**Fish Hook River at CR 15, 0.5 miles SE of Park Rapids**							
STORET/EQuIS ID:	**S006-251**							
Station #:	**10UM043**							
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**Median**	**WQ Standard[1]**	**# of WQ Exceedances[2]**
Ammonia-nitrogen	mg/L	10	<0.04	<0.04				
Chloride	mg/L	10	4	7	5	5		
Chlorophyll-a, Corrected	ug/L							
Dissolved Oxygen (DO)	mg/L	19	7.5	11.1	8.9	8.8	5	
Escherichia coli	MPN/100ml	15	11	130	36	26	126/1260	1
Inorganic nitrogen (nitrate and nitrite)	mg/L	10	<0.03	0.08	0.04	0.03		3
Kjeldahl nitrogen	mg/L	10	0.3	0.7	0.5	0.5		
Orthophosphate	ug/L							
pH		19	8	8.7	8.3	8.2	6.5-9.0	
Pheophytin-a	ug/L							
Phosphorus	ug/L	10	0.01	0.02	0.02	0.02		
Specific Conductance	uS/cm	19	264	323	293	294		
Temperature, water	deg °C	19	10.6	25.7	20	21		
Total suspended solids	mg/L	10	1	6	3	2	100	
Total volatile solids	mg/L	10	1	5	2	2		
Transparency tube	100 cm	19	>100	>100			20	
Transparency tube	60 cm						>20	
Turbidity	FNU						25	
Sulfate	mg/L	10	<3	<3				
Hardness	mg/L							

[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 Fish Hook River 11 HUC, a component of the IWM work conducted between May and September in 2010 and 2011. This specific data does not necessarily reflect all data that was used to assess the AUID.

Table 10. Lake water aquatic recreation assessments: Fish Hook River 11-HUC.

Name	DOW#	Area (ha)	Trophic Status	Percent Littoral	Max. Depth (M)	Avg. Depth (M)	CLMP Trend	Mean TP (µg/L)	Mean chl-a (µg/L)	Secchi Mean (M)	Support Status
Long	29-0161-00	785	M	24	41.2	11.3	↓	13	5	3.2	FS
Sweitzer	29-0164-00	44	M	100	3.0	0.9	IF	19	4	2.5	FS
Peysenske (Main Bay)	29-0169-01	81	M	100	4.3		IF	16	4	2.8	FS
Peysenske (E. Bay)	29-0169-02	8	M	100			IF	16	4	1.6	IF
Rice	29-0177-00	62	E	94	5.5	1.5	IF	25	9	1.9	FS
Pickerel	29-0178-00	118	M	87	7.9	2.0	IF	16	5	4.0	FS
Blue	29-0184-00	129	M	26	25.6	11.0	NT	10	2	5.1	FS
Fish Hook	29-0242-00	660	M	41	23.2	8.1	NT	17	5	3.5	FS
Potato	29-0243-00	839	M	20	26.5	8.3	↑	14	5	3.4	FS
Portage	29-0250-00	170	E	100	4.6	2.5	NT	51	22	1.2	NS
Island	29-0254-00	215	M	27	19.8	6.8	IF	22	9	2.5	FS
Eagle	29-0256-00	170	M	40	23.5	6.6	↑	19	7	3.1	FS
Fish Hook River Dam	29-0504-00	54	M				IF	15	4	3.3	NA

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

Summary

Results of the fish and macroinvertebrate surveys within the Fish Hook River Subwatershed indicated that aquatic communities were in good condition. Macroinvertebrate scores in particular were very high and were in fact among the highest for the Crow Wing River. No impairments were indicated downstream of Park Rapids, which for this watershed would have otherwise been the most likely stress contributor. Of the macroinvertebrates collected, several sensitive species and moderately intolerant species were identified. Cold/cool water dependent macroinvertebrate species such as Hemerodromia, Isoperla, and Atherix were also found in 07010106-542. The presence of brown trout, mottled sculpin, and several species of redhorse, along with several other intolerant taxa (i.e. longnose dace and hornyhead chub), all indicate good to excellent water quality. Fish and macroinvertebrate IBI scores were well above the thresholds and near or above the upper confidence limits. Good buffering occurs in the upstream portions of the subwatershed. Large tracts of deciduous and evergreen forest are still present and no doubt help to maintain the exceptional biological communities that were observed. Near the middle of this sub-watershed, south of Fish Hook Lake, high intensity development is more common with much of the southern portion of the unit dominated by pasture/hay land and/or row crop agriculture.

Assessable stream water quality data were available for two AUIDs on the Fish Hook River. These AUIDs extended from the Park Rapids dam to the Shell River. DO data for the Shell River were determined to be insufficient whereas the E. coli results from these two AUIDs were supporting of aquatic recreational use and turbidity data was supporting of aquatic life. DO and E. coli data were also collected from two additional tributaries to the Fish Hook River. Due to the lake influence at these locations, they were not assessed.

The Fish Hook River Subwatershed consists of 46 lakes greater than four hectares (ten acres) of which 12 were assessed for aquatic recreational use (Appendix A). Lake morphology within the subwatershed varies with large, deep basins (Potato, Long and Fish Hook) and small, deep basins (Island and Eagle). Lakes are evenly distributed throughout the subwatershed with several wetlands throughout. A majority of the assessed lakes within the Fish Hook River Subwatershed are supporting for aquatic recreation. However, Portage Lake was determined to be non-supporting of aquatic recreation. Portage Lake has a small catchment area but it lies near the NCHF and NLF ecoregional transition area where the percentage of rangeland and pasture is high. Consequently, the nutrient contribution from the watershed may be greater for Portage than for other local lakes. Additionally, the lake's large fetch and shallow basin likely result in internal nutrient release as the lake sediment is disturbed by lake mixing.

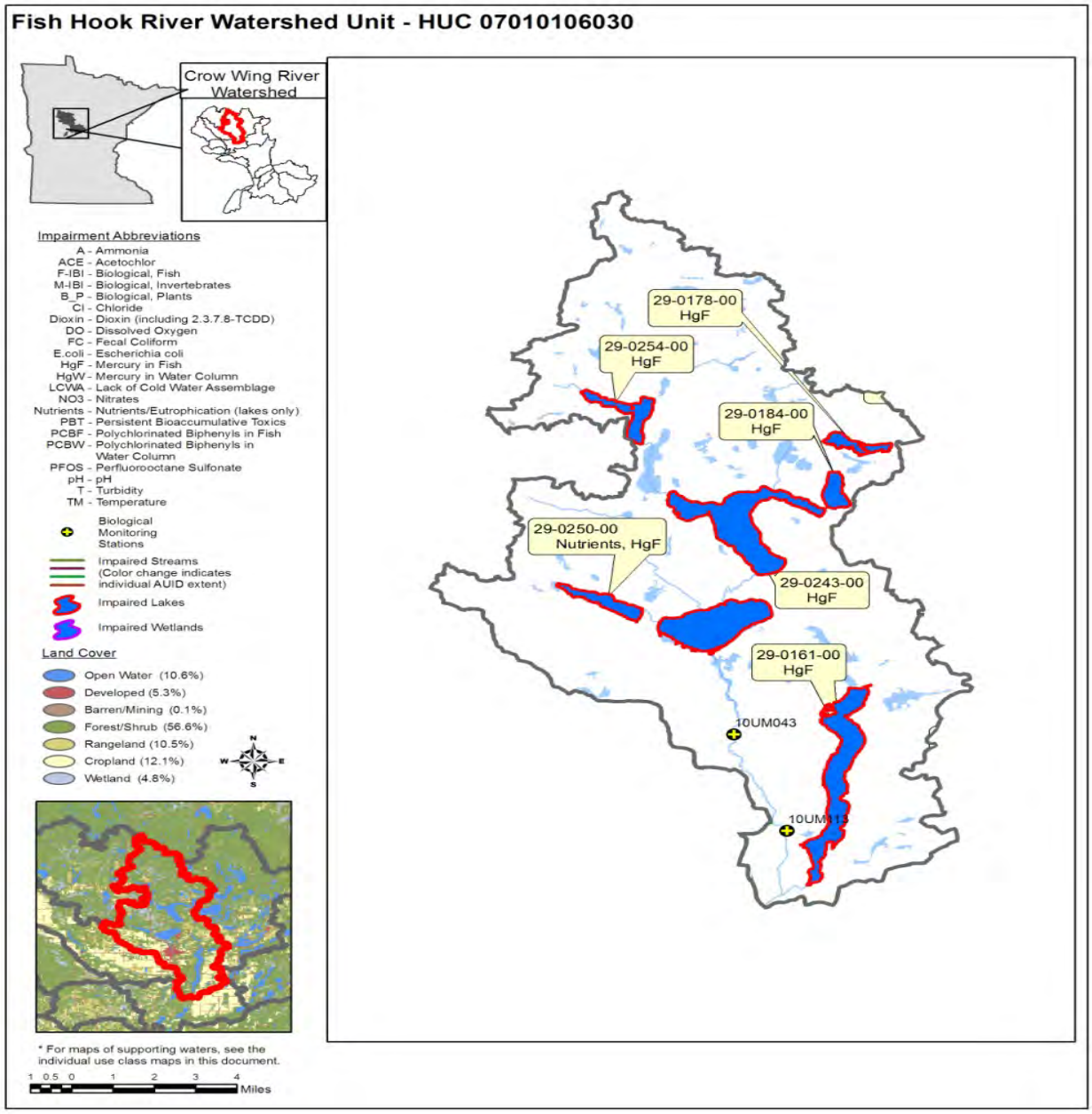

Figure 22. Currently listed impaired waters by parameter and land use characteristics in the Fish Hook River Watershed Unit.

Two Inlets Watershed Unit HUC 07010106040

The Two Inlets Subwatershed is located in the northern portion of the Crow Wing River Watershed and drains approximately 119 square miles. Located in Becker and Hubbard Counties, it includes several lakes such as Hungry Man, Boot, Big Basswood, Two Inlets and Island. Forest/shrub dominates this sub-watershed with a large percentage being classified as open water due to the many occurring lakes. Major tributaries to the Crow Wing River that are within this subwatershed include Basswood Creek, Indian Creek, Hay Creek and Dinner Creek. The outlet monitoring site of this subwatershed is represented by MPCA's Water Chemistry site S006-252 and Biological station 10UM044 located at CR 152, approximately two miles southeast of Two Inlets. The water chemistry data at this location were collected by the Cass County Soil and Water Conservation District and the Biological data were collected by MPCA staff.

Table 11. Aquatic life and recreation assessments on stream reaches: Two Inlets Watershed Unit.

AUID Reach Name, Reach Description	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators:									Aquatic Life	Aquatic Rec.
					Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides	Bacteria		
07010106-568 Basswood Creek Unnamed Lk (03-0665-00) to Indian Cr	7.66	2C	10UM064	Upstream of CR 127, 1 mi. NW of Two Inlets	MTS	MTS	IF	IF		IF	_	_	_	FS	NA
07010106-569 Indian Creek Big Basswood Lk to Basswood Cr	13.88	2C	10UM065	Downstream of CR 127, 1 mi. W of Two Inlets	IF	MTS	IF	IF		IF	_	_	_	FS	NA
07010106-690 Dinner Creek Little Dinner Lk to Two Inlets Lk	3.76	2B,3C	10UM063	Downstream CR 44, 1 mi. E of Two Inlets	MTS	_	IF	IF		IF	_	_	_	FS	NA
07010106-617 Hay Creek Two Inlets Lk to Unnamed Lk (29-0554-00)	2.5	2B,3C	10UM044	Upstream of CR 152, 2 mi. SE of Two Inlets	MTS	MTS	IF	MTS	MTS	MTS	MTS	_	MTS	FS	FS

Abbreviations for Indicator Evaluations: -- = No Data, NA = Not Assessed, IF = Insufficient Information, MTS = Meets criteria; EXP = Exceeds criteria, potential impairment; EXS = Exceeds criteria, potential severe impairment; EX = Exceeds criteria (Bacteria).

Abbreviations for Use Support Determinations: NA = Not Assessed, IF = Insufficient Information, NS = Non-Support, FS = Full Support

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

Aquatic life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50 percent) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

Table 12. Minnesota Stream Habitat Assessment (MSHA): Two Inlets 11-HUC.

# 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	10UM065	Indian Creek	2.5	7	20.5	13	25	68	good
1	10UM064	Basswood Creek	5	13.5	21	13	24	76.5	good
1	10UM063	Dinner Creek	5	10.5	8	14	19	56.5	Fair
2	10UM044	Hay Creek	4	10.5	16	8	19.5	58	Fair
Average Habitat Results: *Two Inlets 11 HUC*			**4.1**	**10.2**	**16.3**	**11.2**	**21.4**	**63.4**	**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 13. Outlet water chemistry results: Two Inlets 11-HUC.

Station location:	**Hay Creek at CR 152, 2 mi SE of Two Inlets**							
STORET/EQuIS ID:	**S006-252**							
Station #:	**10UM044**							
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**Median**	**WQ Standard[1]**	**# of WQ Exceedances[2]**
Ammonia-nitrogen	mg/L	10	<0.04	0.06	0.05	0.04		
Chloride	mg/L	10	2	3	2	2		
Chlorophyll-a, Corrected	ug/L							
Dissolved Oxygen (DO)	mg/L	19	7.2	10.4	8.3	8.2	5	
Escherichia coli	MPN/100ml	15	10	228	46	23	126/1260	2
Inorganic nitrogen (nitrate and nitrite)	mg/L	10	<0.03	<0.03				
Kjeldahl nitrogen	mg/L	10	0.4	0.6	0.5	0.6		
Orthophosphate	ug/L							
pH		19	7.9	8.7	8.2	8.2	6.5-9.0	
Pheophytin-a	ug/L							
Phosphorus	ug/L	10	0.02	0.03	0.02	0.02		
Specific Conductance	uS/cm	19	168	370	328	336		
Temperature, water	deg °C	19	10.2	25.5	19.8	20.5		
Total suspended solids	mg/L	10	2	5	4	4	100	
Total volatile solids	mg/L	10	1	4	3	3		
Transparency tube	100 cm	19	>100	>100			20	
Transparency tube	60 cm						>20	
Turbidity	FNU						25	
Sulfate	mg/L	10	<3	<3				
Hardness	mg/L							

[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 Two Inlets 11 HUC, a component of the IWM work conducted between May and September in 2010 and 2011. This specific data does not necessarily reflect all data that was used to assess the AUID.

Table 14. Lake water aquatic recreation assessments: Two Inlets 11-HUC.

Name	DOW #	Area (ha)	Trophic Status	Percent Littoral	Max.Depth (M)	Avg. Depth (M)	CLMP Trend	Mean TP (µg/L)	Mean chl-a (µg/L)	Secchi Mean (M)	Support Status
Two Inlets	03-0017-00	228	M	29	18.3	6.3	NT	21.7	8.5	2.4	FS
Hungry Man	03-0029-00	55	M	96	6.4	0.6	IF	12.1	2.0	4.0	FS
Boot	03-0030-00	153	M	25	30.5	12.3	↑	8.2	1.2	6.8	FS
Abners	03-0039-00	31	E					41.0			IF
Wahbegon	03-0082-00	42	M	100	0.6	0.3	IF	11.8	2.3	2.7	FS
Bad Medicine	03-0085-00	295	M	36	24.4	9.8	NT	8.3	2.1	7.2	FS
Bass	03-0088-00	78	M	65	10.7	3.4	IF	19.6	5.6	3.5	FS
Big Basswood	03-0096-00	237	M	100	2.4	2.2	IF	18.1	3.7	1.8	FS
Unnamed	03-0786-00	65	E				IF	46.1	10.0	1.7	NA
Little Mantrap	29-0313-00	144	M	57	16.5	4.2	NT	11.4	3.4	5.4	FS

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

Summary

As a whole, the Two Inlets Subwatershed is in good condition. Much of the Two Inlets Subwatershed is comprised of forest lands (>65%) with some pasture/hay land use being noted throughout the subwatershed mostly occurring in the east and west central portions of this unit. Some development is occurring; however throughout the majority of this subwatershed good riparian conditions are noted.

Sampling that occurred at Basswood Creek (07010106-568), Hay Creek (07010106-617) and Dinner Creek (07010106-690) showed high taxa richness and sensitive species presence of both fish and macroinvertebrates which led to a status fully supporting for aquatic life. Good habitat (MSHA) scores were also noted at these locations which more than likely were reflected by the good IBI scores. Although a good biological community was observed, a perched culvert was identified downstream of the Basswood Creek biological station which is potentially acting as a fish blockage. A poor F-IBI score in conjunction with low dissolved oxygen (<4mg/l) on Indian Creek (07010106-569) initially led to an impairment listing for this reach. A large wetland area upstream of the biological station 10UM065 may have been a factor in the poor F-IBI score. As a result, this segment was recommended as a natural background stressor candidate. The natural background committee placed this segment into category 4E and determined that more information was needed before anthropogenic stressors could be ruled out as a source of the impairment. Further data collected from Indian Creek confirmed that the upstream wetland contributed to the poor F-IBI scores and ruled out anthropogenic stressors. However, because the site (10UM065) was located in a transition zone between two different habitat types (low and high gradient), the fish results were deemed to be insufficient and the stream was determined to be fully supporting for aquatic life based on the macroinvertebrate sample.

Assessable water chemistry information was available for a segment of Hay Creek extending from Two Inlets Lake to an unnamed lake. No water chemistry impairments were observed on this segment, further corroborating the biological monitoring results (10UM044). However, the presence of riparian wetland areas combined with some low DO readings on Hay Creek and Indian Creek suggest that further DO monitoring may be necessary.

Relative to its area, the Two Inlets unit has a high number of lakes greater than four hectares (ten acres). A total of 58 lakes are within the subwatershed eight of which were assessed. All of the assessed lakes were determined to be supporting aquatic recreational use. The assessed lake basins were typically small and deep with natural land use within their catchment areas. Two Inlets and Big Basswood Lakes were among the larger lakes in the subwatershed. Both lakes have large catchment areas, but their large basins give them a greater ability to absorb external nutrients. Two Inlets is one of the deeper lakes while Big Basswood is a shallow lake with a maximum depth of 2.4 meters (8 feet).

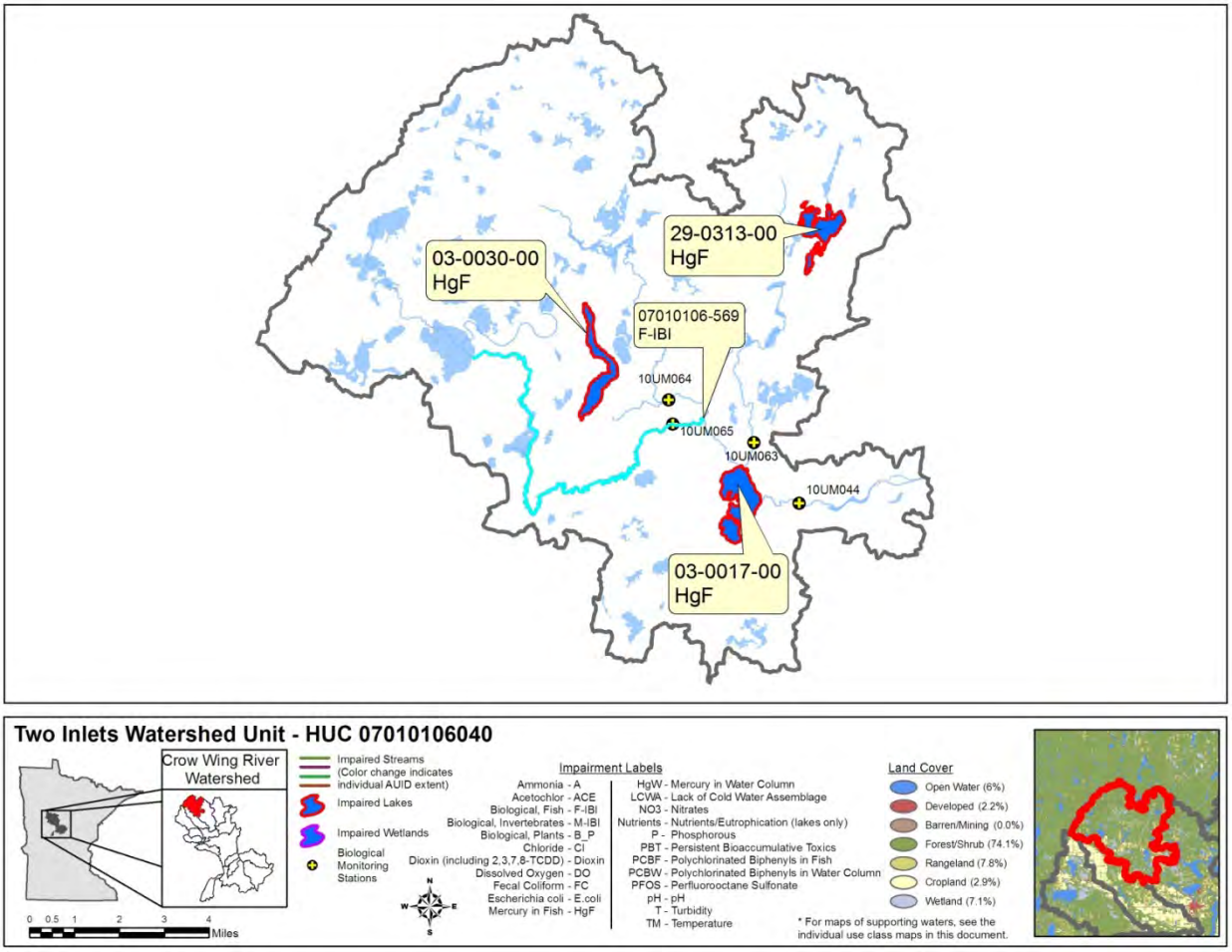

Figure 23. Currently listed impaired waters by parameter and land use characteristics in the Two Inlets Watershed Unit.

Straight River Watershed Unit HUC 07010106050

The Straight River Subwatershed is in the northwest central portion of the Crow Wing River Watershed. Located primarily in Becker and Hubbard Counties and draining approximately 79 square miles, it is one of the smallest subwatersheds within the Crow Wing Watershed. The Straight River is a coldwater system that has long been known by sportsman for its trophy class brown trout fishery which draws many anglers to this area year after year. Land use is predominantly cropland. The MDNR actively manages the Straight River for trout, employing available protection and habitat enhancement strategies to prevent degradation of the resource from surrounding watershed development, which is primarily row crop agriculture. The outlet monitoring site is represented by MPCA's Water Chemistry/EQuIS station S002-960 and Biological station 10UM041 located at US Highway 71, approximately three miles south of Park Rapids. The water chemistry data at this location was collected by the Cass County Soil and Water Conservation District with the biological data collected by MPCA staff. Data from Biological/EquIS station S004-793 (biological station 10UM061) located further upstream on the Straight River was also used during the assessment process of this unit.

Table 15. Aquatic life and recreation assessments on stream reaches: Straight River Watershed Unit.

AUID Reach Name, Reach Description	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators:									Aquatic Life	Aquatic Rec.
					Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides	Bacteria		
07010106-517 Straight River Headwaters to Straight Lk	4.6	1B,2A,3B	10UM060	Upstream of Minimum Maintenance Rd off of Bass Bay Ave, 5 mi. NW of Osage	MTS	MTS	IF	IF	_	IF	_	_	_	FS	NA
07010106-558 Straight River Straight Lk to Fish Hook R	17	1B,2A,3B	10UM061 10UM041	Upstream of CR 123, 1 mi. S of Osage Upstream of Hwy 71, 3 mi. S of Park Rapids	MTS	MTS	EXS	MTS	MTS	EXP	MTS	_	MTS	NS	FS

Abbreviations for Indicator Evaluations: -- = No Data, NA = Not Assessed, IF = Insufficient Information, MTS = Meets criteria; EXP = Exceeds criteria, potential impairment; EXS = Exceeds criteria, potential severe impairment; EX = Exceeds criteria (Bacteria).

Abbreviations for Use Support Determinations: NA = Not Assessed, IF = Insufficient Information, NS = Non-Support, FS = Full Support

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

Aquatic life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50 percent) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

Table 16. Minnesota Stream Habitat Assessment (MSHA): Straight River 11-HUC.

# 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	10UM061	Straight River	3.8	13.5	18.8	16	21	73.1	Good
1	10UM041	Straight River	0	13.5	18.1	12	26	69.6	Good
1	10UM060	Straight River	3.3	11	16	11	12	53.3	Fair
Average Habitat Results: *Straight River 11 HUC*			**2.4**	**12.7**	**17.6**	**13**	**20**	**65.3**	**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 17. Outlet water chemistry results: Straight River 11-HUC.

Station location:	**At US Hwy 71, three miles south of Park Rapids**							
STORET/EQuIS ID:	**S002-960**							
Station #:	**10UM041**							
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**Median**	**WQ Standard[1]**	**# of WQ Exceedances[2]**
Ammonia-nitrogen	mg/L	10	<0.04	0.09	0.04	0.04		
Chloride	mg/L	10	8	12	11	11		
Chlorophyll-a, Corrected	ug/L							
Dissolved Oxygen (DO)	mg/L	19	6.2	10.6	8.3	8.2	7	4
Escherichia coli	MPN/100ml	15	23	387	114	99	126/1260	4
Inorganic nitrogen (nitrate and nitrite)	mg/L	10	0.3	2.7	1.6	1.3		
Kjeldahl nitrogen	mg/L	10	0.4	0.8	0.5	0.4		
Orthophosphate	ug/L							
pH		19	7.5	8.5	7.9	7.9	6.5-9.0	
Pheophytin-a	ug/L							
Phosphorus	ug/L	10	0.02	0.09	0.04	3		
Specific Conductance	uS/cm	19	369	486	443	457		
Temperature, water	deg °C	19	9.6	22.1	16.7	17		
Total suspended solids	mg/L	10	2	23	9	6	100	
Total volatile solids	mg/L	10	1	11	5	3		
Transparency tube	100 cm	19	75	>100	97	100	20	
Transparency tube	60 cm							
Turbidity	FNU						25	
Sulfate	mg/L	10	9	15	12	12		
Hardness	mg/L							
Parameter	mg/L	10	<0.04	0.09	0.04	0.04		
Ammonia-nitrogen	mg/L	10	8	12	11	11		
Chloride	ug/L							

[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 Straight River 11 HUC, a component of the IWM work conducted between May and September in 2010 and 2011. This specific data does not necessarily reflect all data that was used to assess the AUID.

Table 18. Lake water aquatic recreation assessments: Straight River 11-HUC.

Name	DOW#	Area (ha)	Trophic Status	Percent Littoral	Max. Depth (M)	Avg. Depth (M)	CLMP Trend	Mean TP (µg/L)	Mean chl-a (µg/L)	Secchi Mean (M)	Support Status
Straight	03-0010-00	193	M	42	19.2	7	NT	22	11	3	FS

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

Summary

All of the biological stations established within the subwatershed were located on the Straight River, which is divided into two AUIDs (07010106-517 and 07010106-558) with 517 being the uppermost headwater portion. F-IBI scores from the Straight River were excellent. The Straight River is classified as a Northern Coldwater stream and aside from its ability to support and sustain a cold-water fish assemblage, it has long been known as one of the best trout fisheries in the state. Though it is has an excellent fishery, the subwatershed itself has been developed. Row crop and pasture/hay land make up approximately 50% of the land use in the Straight River Subwatershed and most of this is located near the central and lower portions near Straight Lake. The sampling that occurred in the headwater portion was represented by biological station 10UM060. Numerous (14) fish species were captured including sensitive species such as mottled sculpin and brook trout. However, the habitat noted at this station was only Fair with the most obvious negative aspect of the habitat being a lack of coarse substrate and poorer stream morphological characteristics. M-IBI scores were not as high as the F-IBI, falling below or near the threshold yet remaining above the lower confidence limit. The lower M-IBI scores were attributed to the more homogenous habitat, reflecting a macroinvertebrate assemblage that lacked coldwater taxa and a diversity of functional feeding groups. Further downstream (07010106-558), sampling that occurred at biological stations 10UM061 and 10UM041 were similar with several sensitive fish (brown trout, mottled sculpin, and hornyhead chub) and macroinvertebrate (Baetisca and Acerpenna) species identified.

Water quality data were available on two segments of the Straight River. Segments extending from the headwaters to Straight Lake and then onto the Fish Hook River were assessed. The reach of the Straight River extending from the lake to the Fish Hook River was previously listed in 2010 for a DO impairment. Data collected since the listing supports this assessment. This portion of the Straight River flows through an agricultural area with high groundwater withdrawals. Further investigation is needed to determine if groundwater withdrawals are influencing the dissolved oxygen levels within the Straight River. Although DO is an obvious point of concern, the biology and particularly the fish communities are exceptional and indicative of the good habitat and water chemistry that generally occurs throughout the Straight River. Finally, the Straight River was determined to be supporting recreational activities with no bacterial exceedances.

Only one of three lakes greater than four hectares (ten acres) within the Straight River Subwatershed was assessed for aquatic recreation. Straight Lake was determined to be supporting aquatic recreational use. Chl-a levels exceeded the ecoregional standard and TP levels were elevated yet still within the standard. Despite these high levels the water transparency of Straight Lake was good. Straight Lake lies in an area containing both agricultural activity and undisturbed forested areas. The area and depth of the lake combined with a potential short residence time may be preventing more extensive eutrophication.

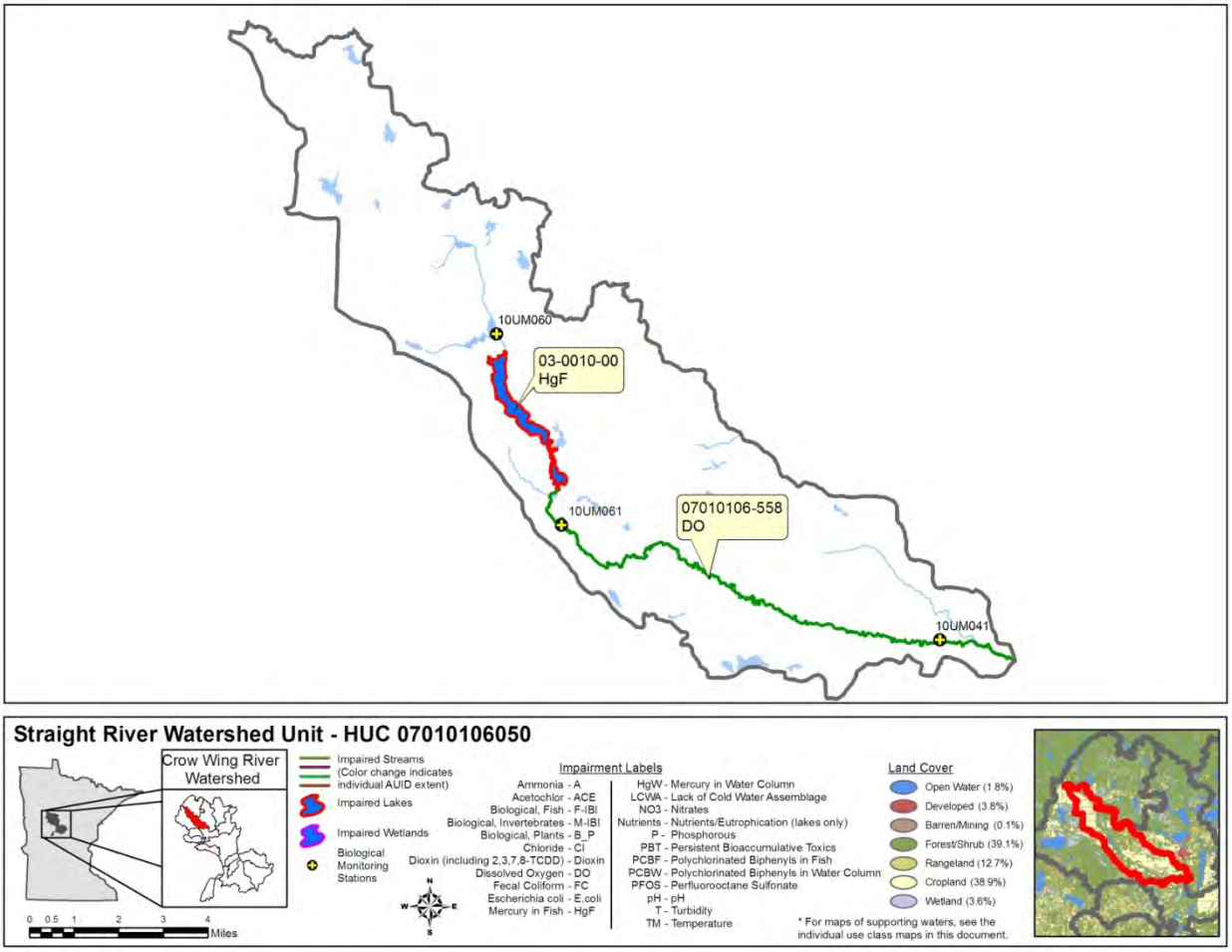

Figure 24. Currently listed impaired waters by parameter and land use characteristics in the Straight River Watershed Unit.

Shell River Watershed Unit HUC 07010106060

The Shell River Subwatershed is located in the northwest portion of the Crow Wing River Watershed. It is the fourth largest contributing subwatershed to the Crow Wing River and drains approximately 172 square miles. Located in portions of Becker, Hubbard and Wadena Counties, this subwatershed includes several tributaries including Stocking Creek and Fish Creek. Several lakes also exist within this unit including Duck, Upper Twin, Lower Twin, Blueberry and Morgan Lakes. The outlet monitoring site of the Shell River Subwatershed is represented by MPCA's water chemistry/EQuIS station S003-442 and biological station 00UM027 which is located downstream of CR 24, approximately seven miles northeast of Menahga. The water chemistry data at this location was collected by staff from the Wadena County Soil and Water Conservation District and the biological data was collected by MPCA staff.

Table 19. Aquatic life and recreation assessments on stream reaches: Shell River Watershed Unit.

AUID Reach Name, Reach Description	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators:									Aquatic Life	Aquatic Rec.
					Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides	Bacteria		
07010106-597 Fish Creek Aspinwall Lk to Shell Lk	2.9	2B,3C	99UM011	At CR 129 & CR 44, 2.0 mi. W of Pine Point	MTS	MTS	_	_	_	_	_	_	_	FS	NA
07010106-553 Unnamed creek Headwaters to Shell R	4.4	2B,3C	10UM054	1.8 mi. W of Hwy 225, ~ 1.2 mi. N of Hwy 34, 0.2 mi. NE of hunter walking trail stream cross	_	EXP	_	_	_	_	_	_	_	NS***	NA
07010106-681 Shell River Lower Twin Lk to Crow Wing R	9.2	2B,3C	00UM027	At Shell City Landing	MTS	MTS	EXP	MTS	_	MTS	MTS	_	MTS	NS	FS
07010106-537 Shell River Shell Lk to Blueberry Lk	30	2B,3C	10UM053 10EM133 10UM055	Upstream of Guyles Rd, 3.5 mi. NW of Osage Adjacent to CR 47, 10 mi. E of Park Rapids Upstream of 390th St, 2.5 mi. N of Menahga	EXS	MTS	MTS	MTS	_	MTS	MTS	_	_	NS	_

Abbreviations for Indicator Evaluations: -- = No Data, NA = Not Assessed, IF = Insufficient Information, MTS = Meets criteria; EXP = Exceeds criteria, potential impairment; EXS = Exceeds criteria, potential severe impairment; EX = Exceeds criteria (Bacteria).

Abbreviations for Use Support Determinations: NA = Not Assessed, IF = Insufficient Information, NS = Non-Support, FS = Full Support

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

Triple asterisk (***) = Placed in 4D Category/Natural Background Review Team has determined impairment is due to Natural Background factors and no TMDL is recommended to occur

Aquatic life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50 percent) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

Table 20. Minnesota Stream Habitat Assessment (MSHA): Shell River 11-HUC.

# 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	10EM133	Shell River	3.8	10	16	12	26	67.8	good
1	99UM011	Fish Creek	4.5	11	9	11	11	46	Fair
1	10UM055	Shell River	3	7	18	9	15	52	Fair
1	10UM053	Shell River	2.5	10	18	8	14	52.5	Fair
1	00UM027	Shell River	2.5	12	9	7	19	49	Fair
Average Habitat Results: *Shell River 11 HUC*			**3.3**	**10**	**14**	**9.4**	**17**	**53.5**	**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 21. Outlet water chemistry results: Shell River11-HUC.

Station location:	**Shell River Downstream of CR 24, 7 miles NE of Menahga**							
STORET/EQuIS ID:	**S003-442**							
Station #:	**00UM027**							
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**Median**	**WQ Standard[1]**	**# of WQ Exceedances[2]**
Ammonia-nitrogen	mg/L	20	<0.04	0.12	0.08	0.07		
Chloride	mg/L						230	
Chlorophyll-a, Corrected	ug/L							
Dissolved Oxygen (DO)	mg/L	20	3.9	12.2	7.4	7.3	5	3
Escherichia coli	MPN/100ml	20	1	38	12	11	126/1260	
Inorganic nitrogen (nitrate and nitrite)	mg/L	20	0.07	0.6	0.3	0.3		
Kjeldahl nitrogen	mg/L	13	0.4	0.8	0.6	0.6		
Orthophosphate	ug/L							
pH		20	7.2	8.3	7.8	7.9	6.5-9.0	
Pheophytin-a	ug/L							
Phosphorus	ug/L	20	0.02	0.05	0.03	0.02		
Specific Conductance	uS/cm	19	309	448	363	370		
Temperature, water	deg °C	70	6.1	26.1	18.9	20		
Total suspended solids	mg/L	20	1	11	2	1	100	
Transparency tube	mg/L							
Transparency tube	100 cm	70	80	>100	98	100	20	
Turbidity	60 cm						>20	
Sulfate	FNU						25	
Hardness	mg/L							

[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 Shell River 11 HUC, a component of the IWM work conducted between May and September in 2010 and 2011. This specific data does not necessarily reflect all data that was used to assess the AUID.

Table 22. Lake water aquatic recreation assessments: Shell River 11-HUC.

Name	DOW#	Area (ha)	Trophic Status	Percent Littoral	Max. Depth (M)	Avg. Depth (M)	CLMP Trend	Mean TP (µg/L)	Mean chl-a (µg/L)	Secchi Mean (M)	Support Status
Gyles	03-0066-00	7	E				IF	12		1.1	IF
Shell	03-0102-00	1,256	E	98	4.9	2.2	NT	27	10	1.7	IF
Big Rush	03-0103-00	375	M	100	2.6	1.2	IF	15		1.6	IF
Aspinwall	03-0104-00	56	M	100	1.5	1.5	IF	14	2	1.4	FS
Mud	03-0120-00	62	M	100	2.4	0.9	IF	17	4	2.5	FS
Dumbbell	03-0124-00	54	E	100	4.6	1.2	IF	33		1.2	IF
Bass	03-0127-00	51	M	61	14.6	3.9	IF	16	7	3.4	FS
Duck	29-0142-00	133	M	48	7.0	4.2	NT	20	8	2.3	FS
Upper Twin	29-0157-00	95	E	75	3.7	1.3	NT	41	4	2.2	FS
Moran	29-0247-00	43	M	100	4.6	0.8	↑	15	5	3.7	FS
Lord	29-0248-00	24	M	90	9.8	1.5	↑	14	6	4.1	FS
Hinds	29-0249-00	124	M	75	4.9	4.9	NT	15	4	4.3	FS
Lower Twin	80-0030-00	103	E	75	7.9	3.2	NT	40	15	1.9	NS
Blueberry	80-0034-00	222	E	100	4.6	2.1	NT	93	52	0.9	NS
Stocking	80-0037-00	142	E	82	6.7	2.1	NT	45	21	1.8	FS
Morgan	80-0038-00	8	M	46	17.7	5.5	NT	11	2	6.3	FS

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

Summary

Streams within this unit are wide, shallow and lack coarse substrate. Roughly 41% of this subwatershed is forest and wetland with a majority located in the northwestern portions of the subwatershed. Some agricultural use occurs (approximately 20%), primarily in the northeastern portions of this subwatershed. Four AUIDs were assessed and three of them were determined to have impaired aquatic life (07010106-681, 07010106-553, and 07010106-537). The macroinverbrate community was impaired at unnamed creek (553) where poor taxa richness was observed and low dissolved oxygen was noted at the time of sampling (1.3 mg/L). A review of the natural stream characteristics and land use practices within the subwatershed suggested that the impairments were due to natural factors. There are numerous upstream wetlands and associated beaver dams that may limit the DO and aquatic macroinvertebrate community at unnamed creek (553). The third aquatic life impairment is on the Shell River (537), where poor fish communities that lacked intolerant taxa were observed at the two assessable biological stations (10UM053 and 10EM133) associated with this segment. All three of these segments display similar levels of biological impairment. Follow up monitoring by stressor ID staff indicated that poor stream habitat and a number of improperly sized culverts may be contributing to the poor IBI scores, and based on these findings this reach was placed in the 4C category requiring no TMDL development. Faucet Snails which are an invasive species were identified within the Shell River during the biological monitoring sampling activities and reported to the MDNR.

Stream water quality data were available from four segments within the Shell River. All water chemistry parameters indicated support of aquatic life, with the exception of dissolved oxygen. Numerous exceedances of the DO standard occurred throughout the subwatershed. However, only the lower segment of the Shell River from Lower Twin Lake to the Crow Wing River had sufficient data for assessment and was identified as impaired due to low DO. Further monitoring should be conducted to determine the source of the low dissolved oxygen levels throughout the subwatershed and whether or not there is any association with the aquatic macroinvertebrate impairment. E. coli samples collected from the watershed suggest support of aquatic recreation.

The Shell River Subwatershed contains 25 lakes greater than four hectares (ten acres) of which 16 were assessed. Additionally, four wetlands with basin characteristics more similar to lakes were also assessed. Lakes within the Shell River Watershed are split between the NLF and North Central Hardwoods ecoregions. Of the assessed lakes, Blueberry and Lower Twin lakes were determined to be non-supporting for aquatic recreation. Blueberry Lake lies directly below the pour point of the Blueberry River with water flowing directly from both the Blueberry River and the Kettle River Watersheds. Total Phosphorous results from both of these watersheds were among the highest in the Crow Wing River Watershed. Additionally, the catchment area for Lower Twin Lake is 143,982 hectares (356,391 acres), making it the largest catchment area of the assessed lakes within the Crow Wing Watershed. The large catchment areas for both Lower Twin and Blueberry Lakes make them more susceptible to external nutrient contributions. High nutrient values were also observed within Upper Twin Lake, however it remained within the standard for aquatic recreational use for shallow lakes within the Streams within this unit are wide, shallow and lack coarse substrate. Roughly 41% of this subwatershed is forest and wetland with a majority located in the northwestern portions of the subwatershed. Some agricultural use occurs (approximately 20%), primarily in the northeastern portions of this subwatershed. Four AUIDs were assessed and three of them were determined to have impaired aquatic life (07010106-681, 07010106-553, and 07010106-537). The macroinverbrate community was impaired at unnamed creek (553) where poor taxa richness was observed and low DO was noted at the time of sampling (1.3 mg/L). A review of the natural stream characteristics and land use practices within the subwatershed suggested that the

impairments were due to natural factors. There are numerous upstream wetlands and associated beaver dams that may limit the DO and aquatic macroinvertebrate community at unnamed creek (553). The third aquatic life impairment is on the Shell River (537), where poor fish communities that lacked intolerant taxa were observed at the two assessable biological stations (10UM053 and 10EM133) associated with this segment. All three of these segments display similar levels of biological impairment. Follow up monitoring by stressor ID staff indicated that poor stream habitat and a number of improperly sized culverts may be contributing to the poor IBI scores, and based on these findings this reach was placed in the 4C category requiring no TMDL development. Faucet Snails which are an invasive species were identified within the Shell River during the biological monitoring sampling activities and reported to the MDNR.

Stream water quality data were available from four segments within the Shell River. All water chemistry parameters indicated support of aquatic life, with the exception of dissolved oxygen. Numerous exceedances of the DO standard occurred throughout the subwatershed. However, only the lower segment of the Shell River from Lower Twin Lake NCHF ecoregion. Due to the rapid flushing of these lakes, a MNLEAP model was used to estimate residence time for Upper and Lower Twin. It was determined that both basins be assessed as lakes and not reservoirs based on the minimal residence time of 14 days.

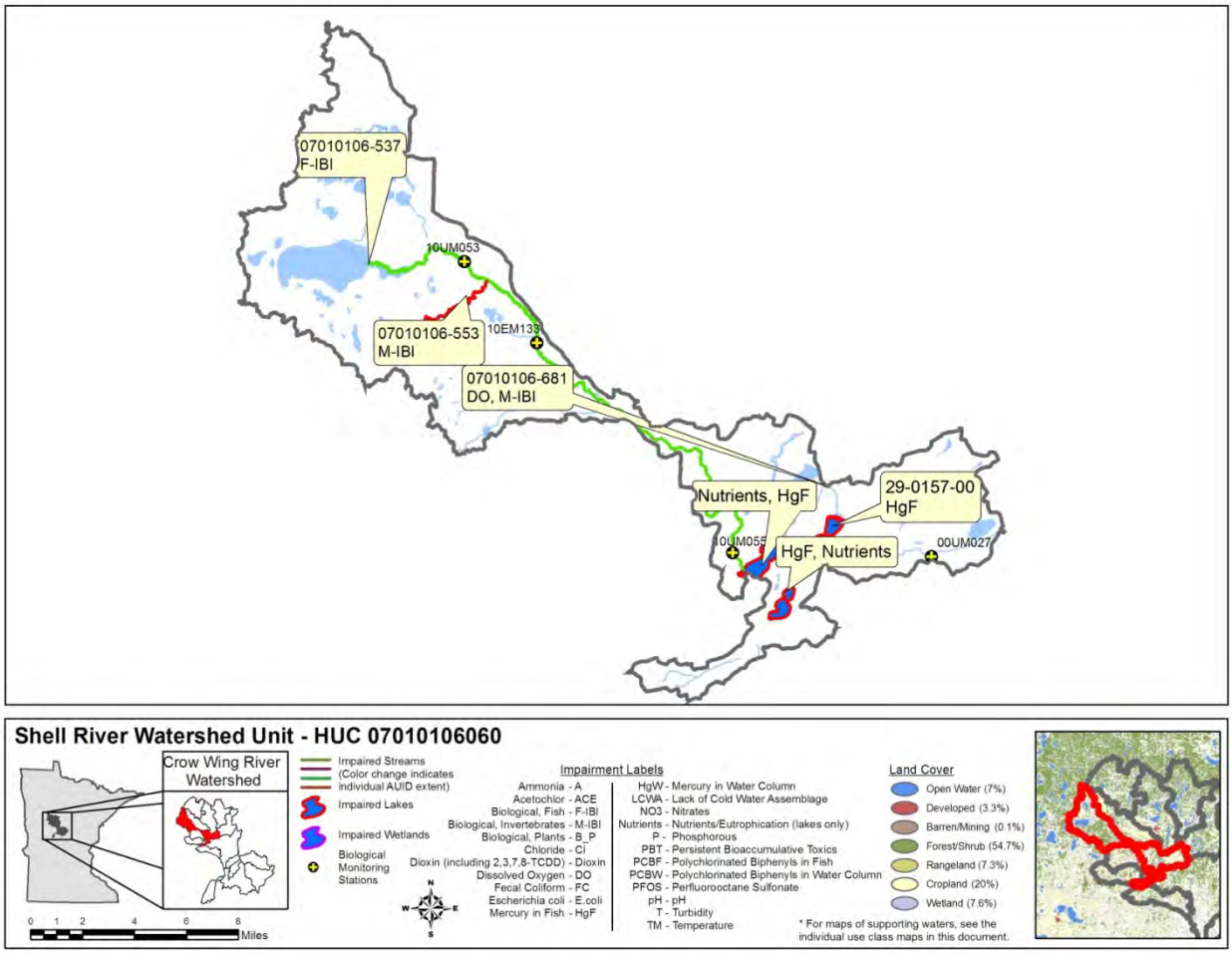

Figure 25. Currently listed impaired waters by parameter and land use characteristics in the Shell River Watershed Unit.

Kettle Creek Watershed Unit HUC 07010106070

The Kettle Creek Subwatershed is located in Becker and Wadena Counties, in the western portion of the Crow Wing River Watershed. Draining 47 square miles, it is one of the smallest subwatersheds to the Crow Wing River. Mud and Katie Lake are within this subwatershed. There are many small tributaries that enter into Kettle Creek as it flows east towards the Crow Wing River. The outlet monitoring site of this subwatershed is represented by MPCA's water chemistry/EQuIS station S003-502 and biological station 10UM040 located at CR 156 approximately three miles NW of Menahga. The water chemistry data was collected by the Cass County Soil and Water Conservation District and the biological data was collected by MPCA staff.

Table 23. Aquatic life and recreation assessments on stream reaches: Kettle Creek Watershed.

AUID Reach Name, Reach Description	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators:									Aquatic Life	Aquatic Rec.
					Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides	Bacteria		
07010106-541 Kettle Creek Unnamed cr to Blueberry R	20.45	2C	10UM057 10UM040	Upstream of 530th St, 3 mi. SW of Midway Upstream of CR 156, 3 mi. NW of Menagha	MTS	MTS	_	MTS	MTS	_	MTS	-	MTS	FS	FS

Abbreviations for Indicator Evaluations: -- = No Data, NA = Not Assessed, IF = Insufficient Information, MTS = Meets criteria; EXP = Exceeds criteria, potential impairment; EXS = Exceeds criteria, potential severe impairment; EX = Exceeds criteria (Bacteria).

Abbreviations for Use Support Determinations: NA = Not Assessed, IF = Insufficient Information, NS = Non-Support, FS = Full Support

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

Aquatic life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50 percent) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

Table 24. Minnesota Stream Habitat Assessment (MSHA): Kettle Creek 11-HUC.

# 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	10UM057	Kettle Creek	4	12	16	15	23	70	good
1	10UM040	Kettle Creek	4	12.5	19.1	13	25	73.6	good
Average Habitat Results: *Kettle Creek 11 HUC*			**4**	**12.3**	**17.6**	**14**	**24**	**71.8**	**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 25. Outlet water chemistry results: Kettle Creek11-HUC.

Station location:	**Kettle Creek at CR 156, 3 mi NW of Menagha**							
STORET/EQuIS ID:	**S003-502**							
Station #:	**10UM040**							
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**Median**	**WQ Standard[1]**	**# of WQ Exceedances[2]**
Ammonia-nitrogen	mg/L	10	<0.04	0.07	0.05	0.04		
Chloride	mg/L	10	3	5	4	4		
Chlorophyll-a, Corrected	ug/L							
Dissolved Oxygen (DO)	mg/L	63	5	11.8	8.5	8.5	5	
Escherichia coli	MPN/100ml	15	34	1986	247	82	126/1260	4
Inorganic nitrogen (nitrate and nitrite)	mg/L	10	<0.03	<0.03				
Kjeldahl nitrogen	mg/L	10	0.3	1.1	0.7	0.7		
Orthophosphate	ug/L							
pH		19	7.7	8.9	8.2	8.1	6.5-9.0	
Pheophytin-a	ug/L							
Phosphorus	ug/L	10	0.07	0.2	0.1	0.09		
Specific Conductance	uS/cm	19	287	593	498	515		
Temperature, water	deg °C	63	7.8	27.4	17.8	18		
Total suspended solids	mg/L	10	1	10	4.7	5	100	
Transparency tube	mg/L	10	1	6	2.4	2		
Transparency tube	100 cm	63	47	>100	93	100	20	
Turbidity	60 cm						>20	
Sulfate	FNU						25	
Hardness	mg/L	10	<3	<3				

[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 Kettle Creek 11 HUC, a component of the IWM work conducted between May and September in 2010 and 2011. This specific data does not necessarily reflect all data that was used to assess the AUID.

Summary

The Kettle Creek Subwatershed is dominated by forest land (approximately 50%), with roughly 30% being agricultural (pasture/row crop). Exceptional biological communities and habitat scores were observed within the Kettle Creek Subwatershed. Two biological stations (10UM040 and 10UM057) were sampled on Kettle Creek (AUID 07010106-541). Fish sampling at both locations yielded several species as well as sensitive taxa which led to superb fish IBI scores. Least darters, which are a Minnesota Species of Special Concern, and central stonerollers were also collected at 10UM040. Both of these species are believed to be rare for this area. They require good water quality and coarse substrate for spawning. Macroinvertebrate IBI scores at Kettle Creek (10UM040) were also excellent with samples composed of high taxa richness and several sensitive species. The macroinvertebrate IBI score for 10UM057 was just below the threshold yet above the lower confidence limit. Forty-one taxa were collected with a dominance of moderate/fairly tolerant species. The slightly lower macroinvertebrate IBI score reflects a lack of diversity within the macroinvertebrate functional feeding groups. Overall this subwatershed appears to be in good condition in terms of biology and habitat.

Assessable stream water quality data were available for a 21 mile reach of Kettle Creek. The segment fully supported aquatic recreation and aquatic life; however TP results from this segment were the highest among the Crow Wing River Watershed. The excess flow of nutrients may contribute to downstream lake impairments within Blueberry and Lower Twin Lakes.

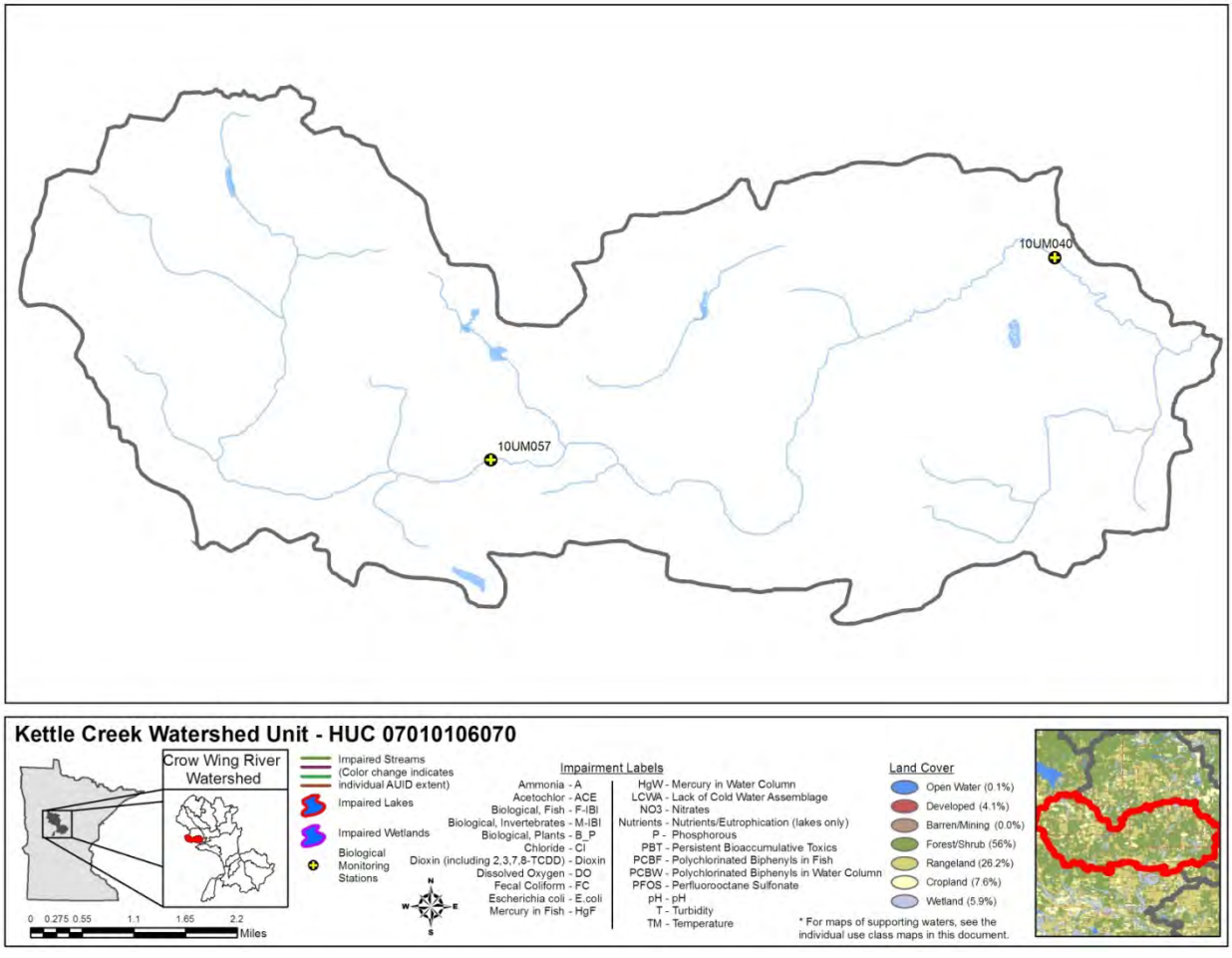

Figure 26. Currently listed impaired waters by parameter and land use characteristics in the Kettle Creek Watershed Unit.

Blueberry River Watershed Unit HUC 07010106080

The Blueberry River Subwatershed is located in the western portion of the Crow Wing River Watershed. Located in Becker and Wadena Counties and draining approximately 51 square miles, it is one of the smallest subwatersheds to the Crow Wing River. Some of the lakes included in this subwatershed are Spirit, Star, North Menahga, Knutson, Shipman and Blueberry. As the Blueberry River flows east to the Crow Wing River, it is joined by numerous unnamed tributaries. The outlet monitoring location is represented by MPCA's water chemistry/EQuIS station S003-501 and biological station 00UM025. The water chemistry data was collected at this location by the Crow Wing County Soil and Water Conservation District and the biological data was collected by MPCA staff.

Table 26. Aquatic life and recreation assessments on stream reaches: Blueberry River Subwatershed.

AUID Reach Name, Reach Description	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators:									Aquatic Life	Aquatic Rec.
					Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides	Bacteria		
07010106-554 Blueberry River Unnamed cr to Kettle R	7.4	2C	10UM121	Downstream of CR 16, 3 mi. NW of Menahga	MTS	MTS	IF	MTS	_	MTS	MTS	-	MTS	FS	FS

Abbreviations for Indicator Evaluations: -- = No Data, NA = Not Assessed, IF = Insufficient Information, MTS = Meets criteria; EXP = Exceeds criteria, potential impairment; EXS = Exceeds criteria, potential severe impairment; EX = Exceeds criteria (Bacteria).

Abbreviations for Use Support Determinations: NA = Not Assessed, IF = Insufficient Information, NS = Non-Support, FS = Full Support

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

Aquatic life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50 percent) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

Table 27. Non-assessed biological stations on channelized AUIDs: Blueberry River 11-HUC.

AUID Reach Name, Reach Description	Reach length (miles)	Use Class	Biological Station ID	Location of Biological Station	Fish IBI	Invert IBI
07010106-586 Blueberry River Unnamed cr to Unnamed cr	4.43	2C	10UM059	Downstream of CR 136, 5 mi. NW of Menahga	Good	Good

See Appendix 5.1 for clarification on the Good/Fair/Poor thresholds and Appendix 5.2 and Appendix 5.3 for IBI results.

Table 28. Minnesota Stream Habitat Assessment (MSHA): Blueberry River 11-HUC.

# 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	10UM121	Blueberry River	3.8	11.5	17.1	14	17	63.4	Fair
1	10UM059	Blueberry River	4.5	10.5	8	14	26	63	Fair
Average Habitat Results: *Blueberry River 11 HUC*			**4.2**	**11**	**12.6**	**14**	**21.5**	**63.2**	**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 29. Outlet water chemistry results: Blueberry River 11-HUC.

Station location:	**Blueberry River Upstream of CR 16, 3 mi NW of Menahga**							
STORET/EQuIS ID:	**S003-501**							
Station #:	**00UM025**							
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**Median**	**WQ Standard[1]**	**# of WQ Exceedances[2]**
Ammonia-nitrogen	mg/L	15	<0.04	0.08	0.05	0.04		
Chloride	mg/L	4	4	4	4	4		
Chlorophyll-a, Corrected	ug/L							
Dissolved Oxygen (DO)	mg/L	66	4.4	12.1	8.5	8.8	5	2
Escherichia coli	MPN/100ml	24	9	517	120	86	126/1260	5
Inorganic nitrogen (nitrate and nitrite)	mg/L	14	0.03	0.4	0.1	0.04		
Kjeldahl nitrogen	mg/L	15	0.4	1.1	0.7	0.6		
Orthophosphate	ug/L							
pH		26	7.3	8.3	7.9	8	6.5-9.0	
Pheophytin-a	ug/L							
Phosphorus	ug/L	15	0.03	0.2	0.06	0.06		
Specific Conductance	uS/cm	26	322	522	449	460		
Temperature, water	deg °C	66	9	26.5	18.1	18.5		
Total suspended solids	mg/L	15	1	11	5	4	100	
Total volatile solids	mg/L	15	1	6	3	2		
Transparency tube	100 cm	66	42	>100	93	100	20	
Transparency tube	60 cm						>20	
Turbidity	FNU						25	
Sulfate	mg/L	15	<3	<3				
Hardness	mg/L							

[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 Blueberry 11 HUC, a component of the IWM work conducted between May and September in 2010and 2011. This specific data does not necessarily reflect all data that was used to assess the AUID.

Table 30. Lake water aquatic recreation assessments: Blueberry River 11-HUC.

Name	DOW#	Area (ha)	Trophic Status	Percent Littoral	Max. Depth (M)	Avg. Depth (M)	CLMP Trend	Mean TP (µg/L)	Mean chl-a (µg/L)	Secchi Mean (M)	Support Status
Shipman	03-0005-00	25	M	44	16.8	5.9	IF	19	7	3	IF
Blueberry	03-0007-00	34	E	49	14.3	5	IF	31	17	2.5	IF
Spirit	80-0039-00	46	M	57	14.6	4.4	NT	20	5	3.8	FS

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

Summary

One 13 mile stream segment (Blueberry River 07010106-554) represented by biological station 10UM121 was assessed. This reach had the highest macroinvertebrate IBI scores in the Crow Wing River Watershed. Invertebrate taxa richness (59) was high and dominated by sensitive individuals, with some coldwater indicator taxa also being observed in the sample. The fish IBI score was also very good. The assemblage consisted of 13 taxa including two sensitive taxa (hornyhead chub and pearl dace). Even the non- assessed channelized segment (Blueberry River 07010106-586) displayed good biological condition.

Assessable stream water quality data were available for one segment of the Blueberry River extending from CR 136 and 580th Avenue to Blueberry Lake. Approximately 13 miles of the Blueberry River were assessed. All water chemistry parameters indicated full support for aquatic life and aquatic recreation. There were several DO exceedances; however, nearly all of these occurred within an area heavily influenced by wetlands so the Blueberry River was not listed as impaired.

The Blueberry River Subwatershed contains seven lakes greater than four hectares (ten acres), of which three were assessed. These lakes are all classified as small, deep lakes, each within small catchment areas. Sufficient data were available to complete the assessment of only one lake, Spirit, which was determined to be fully supporting aquatic recreation. Assessment data for Blueberry and Shipman Lake were insufficient; however, existing data indicated aquatic recreation use support.

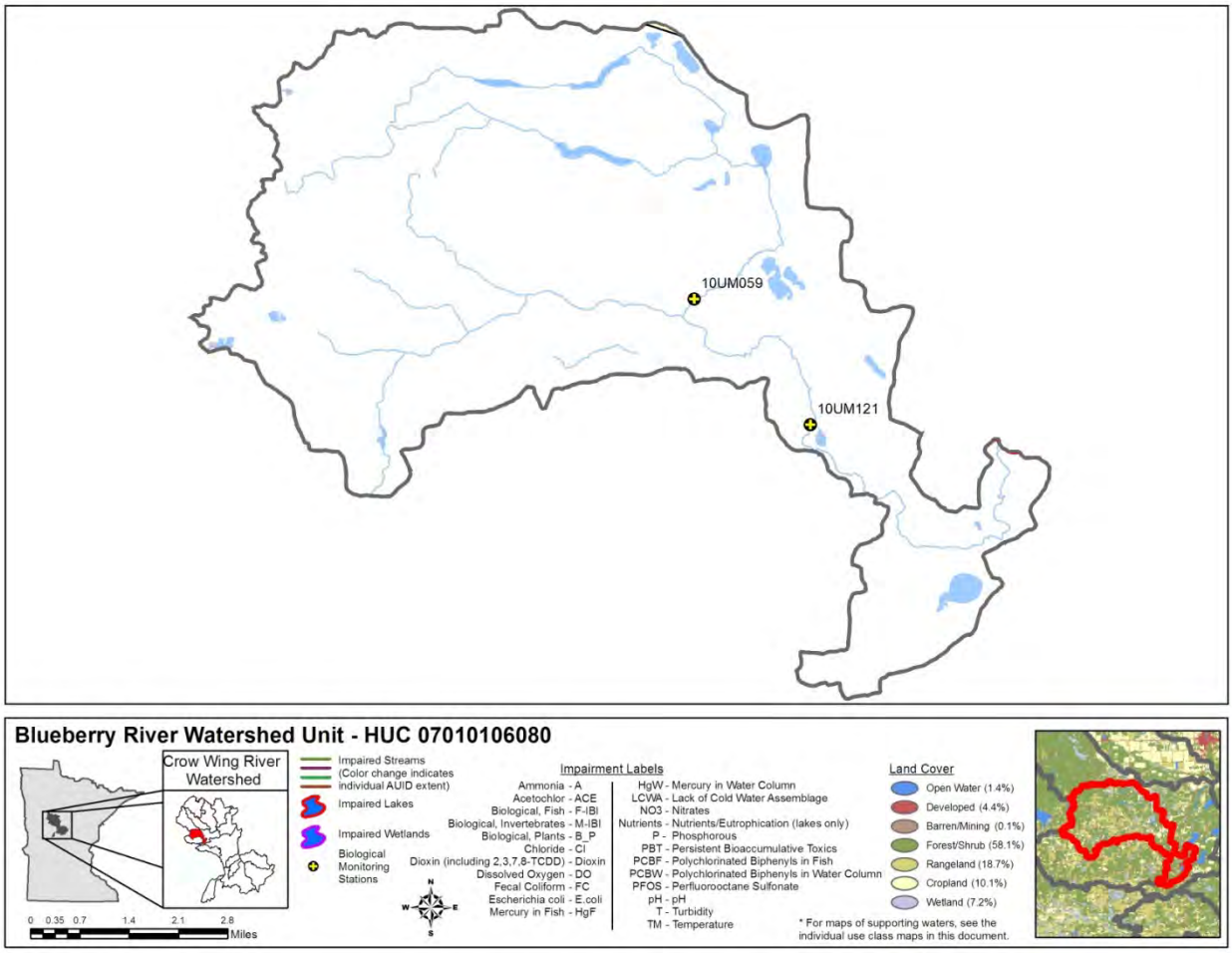

Figure 27. Currently listed impaired waters by parameter and land use characteristics in the Blueberry River Watershed.

Middle Crow Wing River Watershed Unit HUC 07010106090

The Middle Crow Wing River Subwatershed lies within the central portion of the Crow Wing River Watershed. Located in portions of Cass, Hubbard and Wadena Counties and draining approximately 269 square miles, it is the largest contributing subwatershed to the Crow Wing River Watershed. Several lakes are within this unit including Jim Cook, Finn, Strike, Spider and Bergkeller. Major tributaries within this watershed unit include Beaver Creek and Big Swamp Creek, along with several other unnamed tributaries. The outlet monitoring location of this unit is represented by MPCA's biological/EQuIS station S005-731 (biological station 10UM048).

Table 31. Aquatic life and recreation assessments on stream reaches: Middle Crow Wing River Watershed Unit.

AUID Reach Name, Reach Description	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators:									Aquatic Life	Aquatic Rec.
					Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides	Bacteria		
07010106-516 Crow Wing River Shell R to Big Swamp Cr	20.5	2B,3C	10UM110	Upstream of CR 15, 8 mi. SE of Menahga	MTS	_	IF	MTS	_	IF	_	_	_	FS	NA
07010106-515 Crow Wing River Big Swamp Cr to Cat R	2.64	2B,3C	00UM026	Upstream of bridge at county park in Nimrod	MTS	MTS	MTS	MTS	MTS	MTS	MTS		IF	FS	IF
07010106-513 Crow Wing River Beaver Cr to Farnham Cr	12.4	2B,3C	10UM048	Downstream of CR 7, 10 mi. N of Staples	MTS	MTS	IF	MTS	_	MTS	MTS	_	MTS	FS	FS

Abbreviations for Indicator Evaluations: -- = No Data, NA = Not Assessed, IF = Insufficient Information, MTS = Meets criteria; EXP = Exceeds criteria, potential impairment; EXS = Exceeds criteria, potential severe impairment; EX = Exceeds criteria (Bacteria).

Abbreviations for Use Support Determinations: NA = Not Assessed, IF = Insufficient Information, NS = Non-Support, FS = Full Support

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

Aquatic life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50 percent) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

Table 32. Non-assessed biological stations on channelized AUIDs: Middle Crow Wing River 11-HUC.

AUID Reach Name, Reach Description	Reach length (miles)	Use Class	Biological Station ID	Location of Biological Station	Fish IBI	Invert IBI
07010106-555 Unnamed ditch Unnamed cr to Unnamed cr	2.31	2B,3C	10UM076	Downstream of CR 18, 5 mi. NE of Nimrod	Good	Poor
07010106-683 Unnamed ditch Unnamed cr to Big Swamp cr	1.87	2B,3C	10UM102	Downstream of 336th St, 6 mi. NE of Nimrod	Good	Poor
07010106-531 Big Swamp Creek Headwaters to Crow Wing R	15.48	2C	10UM101 10UM077	Upstream of CR 154, 6 mi. SE of Huntersville Upstream of CR 18, 2.5 mi. NE of Nimrod	Good	Good
07010106-688 Unnamed creek Headwaters to Beaver cr	8.05	2B,3C	10UM106	Downstream of CR 12, 3 mi. E of Nimrod	Good	Poor
07010106-530 Beaver Creek Unnamed ditch to Crow Wing R	6.9	2C	10UM107	Downstream of CR 12, 3.5 mi. E of Nimrod	Good	Fair
07010106-689 Unnamed creek	5.03	2B,3C	10UM099	Downstream of CR 7, 1 mi. NE of Oylen	Good	Good

See Appendix 5.1 for clarification on the Good/Fair/Poor thresholds and Appendix 5.2 and Appendix 5.3 for IBI results.

Table 33. Minnesota Stream Habitat Assessment (MSHA): Middle Crow Wing River 11-HUC.

# 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	10UM076	Trib. To Crow Wing River	4.8	12	6.2	7	9.5	39.5	Poor
1	10UM099	Trib. To Crow Wing River	4	14	15.2	10	7	50.2	Fair
1	10UM077	Big Swamp Creek	3.25	7	17.1	7	3	37.3	Poor
1	10UM107	Beaver Creek	4	10.5	9	12	9	44.5	Poor
1	10UM048	Crow Wing River	4	13.5	17.7	6	20	61.2	Fair
1	10UM106	Trib. To Beaver Creek	2.5	3	17.1	11	13	46.6	Fair
1	10UM110	Crow Wing River	5	11	9	7	21	53	Fair
1	00UM026	Crow Wing River	4.5	13.5	18.8	12	21	69.8	Good
1	10UM102	Trib. To Big Swamp Creek	4	13	12.5	11	10	50.5	Fair
2	10UM101	Big Swamp Creek	4.8	9.3	17.3	8	9.5	48.8	Fair
Average Habitat Results: *Middle Crow Wing River 11 HUC*			**4.1**	**11.1**	**14**	**9.1**	**12.3**	**50.1**	**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 34. Outlet water chemistry results: Middle Crow Wing River 11-HUC.

Station location:	**Crow Wing River at CR 7, 10 mi N of Staples**							
STORET/EQuIS ID:	**S005-731**							
Station #:	**10UM048**							
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**Median**	**WQ Standard1**	**# of WQ Exceedances2**
Ammonia-nitrogen	mg/L	20	<0.04	0.06	0.04	0.04		
Chloride	mg/L						230	
Chlorophyll-a, Corrected	ug/L							
Dissolved Oxygen (DO)	mg/L	22	5.2	11.8	8.1	7.6	5	
Escherichia coli	MPN/100ml	20	4	138	35	23	126/1260	1
Inorganic nitrogen (nitrate and nitrite)	mg/L	20	0.02	0.03	0.1	0.1		
Kjeldahl nitrogen	mg/L	13	<0.3	0.8	0.6	0.6		
Orthophosphate	ug/L							
pH		20	7.2	8.4	7.9	7.9	6.5-9.0	
Pheophytin-a	ug/L							
Phosphorus	ug/L	20	0.02	0.05	0.04	0.03		
Specific Conductance	uS/cm	19	205	416	334	347		
Temperature, water	deg °C	22	8.2	24.4	19.2	20.2		
Total suspended solids	mg/L	20	1	8	3	3	100	
Total volatile solids	mg/L							
Transparency tube	100 cm	22	87	>100	98	100	20	
Transparency tube	60 cm						>20	
Turbidity	FNU						25	
Sulfate	mg/L							
Hardness	mg/L							

[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 Middle Crow Wing River 11 HUC, a component of the IWM work conducted between May and September in 2010 and 2011. This specific data does not necessarily reflect all data that was used to assess the AUID.

Table 35. Lake water aquatic recreation assessments: Middle Crow Wing River 11-HUC.

Name	DOW#	Area (ha)	Trophic Status	Percent Littoral	Max. Depth (M)	Avg. Depth (M)	CLMP Trend	Mean TP (µg/L)	Mean chl-a (µg/L)	Secchi Mean (M)	Support Status
Spider	11-0500-00	55	M	88	5.2	1.6	IF	16	6	3.5	FS
Yaeger	80-0022-00	38	E	100	1.1			46			IF
Jim Cook (West)	80-0027-01	23	M	100	1.1		IF	14	2	1.1	IF

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

Summary

The Middle Crow Wing River Watershed is the largest contributing subwatershed to the Crow Wing River, draining approximately 269 square miles. The land use is dominated by forested land (approximately 55%) with some agricultural practices occurring throughout. Three segments on the main stem Crow Wing River (07010106-513, 07010106-516, and 07010106-515) were assessed for aquatic life and all were fully supporting. Overall, these main-stem sites appear to be doing very well for biology in terms of fish and macroinvertebrates, as taxa richness was generally high and sensitive species were abundant. Six AUIDs were not assessed because they were channelized. The poor macroinvertebrate biology (M-IBI) within the channelized reaches was associated with lower habitat (MSHA) scores. Substrate seems to be the driving force behind the poor habitat. Without coarse substrate many of lithophilic spawning species that require coarse substrates will not be present.

There were no E. coli exceedances on the one segment assessed for aquatic recreation (07010106-513). Additional data were available upstream of Beaver Creek; however, there was not enough data to conduct an assessment. All other water chemistry parameters used to assess aquatic life indicated full support.

The Middle Crow Wing Subwatershed contains 48 lakes greater than four hectares (ten acres) of which three were assessed. All three lakes are small and shallow. Spider and Jim Cook Lakes each had small catchment areas while Yaeger Lake has a much larger area. Sufficient data were available to complete the assessment of only one lake, Spider Lake, which was determined to be fully supporting aquatic recreation.

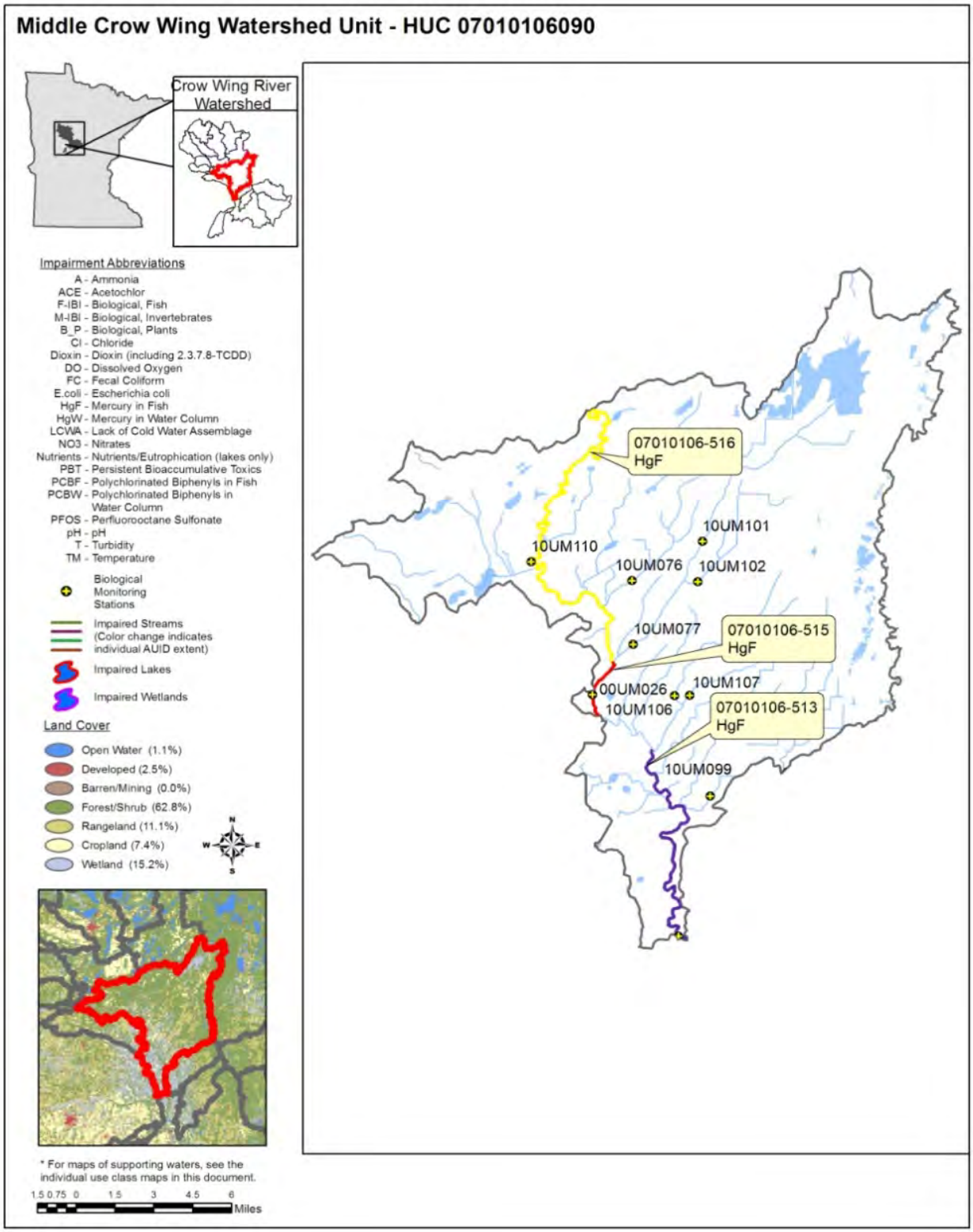

Figure 28. Currently listed impaired waters by parameter and land use characteristics in the Middle Crow Wing River.

Cat River Watershed Unit HUC07010106100

The Cat River Subwatershed lies on the western-most edge of the Crow Wing River Watershed. Located in portions of Wadena and Becker Counties and draining approximately 63 square miles, it is one of the smallest subwatersheds in the Crow Wing River Watershed. Major tributaries within this watershed include Kitten Creek, Cat River and several unnamed reaches. A portion of the Cat River from its headwaters to the east line of Section 13 (T137 R35 W) is classified as 2A (coldwater), meaning that it has the ability to sustain and support a coldwater assemblage. Over the last half century however, several beaver impoundments have decreased flow and allowed sunlight to warm water temperatures, reducing the ability of the Cat River to support a coldwater fish and macroinvertebrate assemblage. Also, for many years perched culverts occurred on the Cat River. These culverts were barriers to migration of fish species, so in 2010 levelers were put in at some of these locations. The outlet monitoring of the Cat River Subwatershed is represented by MPCA's water chemistry/EQuIS station S002-408 (biological station 10UM047), located upstream of CR 12 which is approximately one mile south of Nimrod. Water chemistry data at this station was collected by the Wadena County Soil and Water Conservation District whereas the biological data was collected by MPCA staff.

Table 36. Aquatic life and recreation assessments on stream reaches: Cat River Watershed.

AUID Reach Name, Reach Description	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators:									Aquatic Life	Aquatic Rec.
					Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides	Bacteria		
07010106-546 Kitten Creek Headwaters to Cat R	10.1	2C	10UM072	Off of 159th Ave, 5 mi. SE of Menagha	MTS	_	IF	IF	_	IF	_	_	_	FS	NA
07010106-687 Unnamed creek Unnamed ditch to Crow Wing R	3.12	2B,3C	10UM103	Upstream of 294th St, 0.5 mi. NW of Nimrod	IF	MTS	IF	IF	_	IF	_	_	_	IF	NA
07010106-544 Cat River Kitten Cr to Crow Wing R	9.31	2C	10UM047	Downstream of CR 12, 1 mi. S of Nimrod	MTS	MTS	IF	MTS	_	MTS	MTS	_	EX	FS	NS

Abbreviations for Indicator Evaluations: -- = No Data, NA = Not Assessed, IF = Insufficient Information, MTS = Meets criteria; EXP = Exceeds criteria, potential impairment; EXS = Exceeds criteria, potential severe impairment; EX = Exceeds criteria (Bacteria).

Abbreviations for Use Support Determinations: NA = Not Assessed, IF = Insufficient Information, NS = Non-Support, FS = Full Support

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

Aquatic life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50 percent) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

Table 37. Non-assessed biological stations on channelized AUIDs: Cat River 11-HUC.

AUID Reach Name, Reach Description	Reach length (miles)	Use Class	Biological Station ID	Location of Biological Station	Fish IBI	Invert IBI
07010106-545 Cat River Headwaters to T137 R35W S13, east line	6.21	1B,2A,3B	10UM071	Upstream of 318th St, 4.5 mi. SE of Menagha	Good	Good

See Appendix 5.1 for clarification on the Good/Fair/Poor thresholds and Appendix 5.2 and Appendix 5.3 for IBI results.

Table 38. Minnesota Stream Habitat Assessment (MSHA): Cat River 11-HUC.

# 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)	MSH Rating
1	10UM072	Kitten Creek	3.3	10	3	13	11	40.3	Poor
1	10UM047	Cat River	5	13.5	19.3	12	20	69.8	Good
1	10UM103	Trib. To Crow Wing River	4	12.5	14	13	10	53.5	Fair
Average Habitat Results: *Cat River 11 HUC*			**4.1**	**12**	**12.1**	**12.7**	**13.7**	**54.5**	**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 39. Outlet water chemistry results: Cat River 11-HUC.

Station location:	**Cat River Upstream of CR 12, 1 mi S of Nimrod**							
STORET/EQuIS ID:	**S002-408**							
Station #:	**10UM047**							
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**Median**	**WQ Standard[1]**	**# of WQ Exceedances[2]**
Ammonia-nitrogen	mg/L	20	<0.04	0.17	0.07	0.06		
Chloride	mg/L						230	
Chlorophyll-a, Corrected	ug/L							
Dissolved Oxygen (DO)	mg/L	20	6.4	11.3	8.5	8.4	5	
Escherichia coli	MPN/100ml	20	29	649	224	147	126/1260	11
Inorganic nitrogen (nitrate and nitrite)	mg/L	20	0.1	0.3	0.1	0.1		
Kjeldahl nitrogen	mg/L	13	0.5	1.1	0.9	0.8		
Orthophosphate	ug/L							
pH		19	6.8	7.9	7.7	7.8	6.5-9.0	
Pheophytin-a	ug/L							
Phosphorus	ug/L	20	0.03	0.1	0.06	0.06		
Specific Conductance	uS/cm	19	278	566	425	433		
Temperature, water	deg °C	21	7.3	20.1	14.7	15.1		
Total suspended solids	mg/L	20	1	16	5	3	100	
Total volatile solids	mg/L							
Transparency tube	100 cm	21	63	>100	89	90	20	
Transparency tube	60 cm						>20	
Turbidity	FNU						25	
Sulfate	mg/L							
Hardness	mg/L							

[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.
[3]Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993).

**Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Cat River 11 HUC, a component of the IWM work conducted between May and September in 2010 and 2011. This specific data does not necessarily reflect all data that was used to assess the AUID.

Summary

The Cat River Subwatershed is dominated by forest land which makes up roughly 40% of the land usage, with some agricultural practices occurring in some locations. Two stream segments (07010106-546 and 07010106-544) were assessed for aquatic life from biological stations 10UM072 (Kitten Creek) and 10UM047 (Cat River), and both were determined to be fully supporting. The fish IBI score for Kitten Creek was well above the upper confidence limit with 12 fish taxa, which included sensitive species such as pearl dace, northern red belly dace, finescale dace and burbot. Seventeen fish species were found on the Cat River (10UM047, downstream of CR 12 and 1 mile south of Nimrod). Sensitive taxa included mottled sculpin and hornyhead chub, which signify good water quality and are also indicative of a cool water regime. The macroinvertebrate sample on the Cat River included 31 species and was dominated by sensitive taxa that were also indicative of a coldwater system. Although this reach is not classified as coldwater, the biology suggests otherwise and supports the idea that this segment may be capable of supporting coldwater species on a long term basis. However, after consultation with MDNR it was concluded that this segment of the Cat River should remain in the warm-water class. The MDNR designated coldwater segment of the Cat River (07010106-545) had good biology but it was not assessed due to channelization. An unnamed creek (07010106-687) is currently being petitioned as a 4C candidate (which means the stressor is non-pollutant based and therefore would require no TMDL); however additional data will be collected in 2013 to confirm this.

Assessable stream water quality data were available from the nine mile reach of the Cat River from Kitten Creek to the Crow Wing River (07010106-544). The Cat River was determined to be non-supporting of aquatic recreation use due to a geometric mean bacterial exceedance. Dissolved oxygen data were insufficient to make an assessment, however there were no indications of impairment. Turbidity results were supporting for aquatic life use.

No lakes were assessed within the Cat River Watershed.

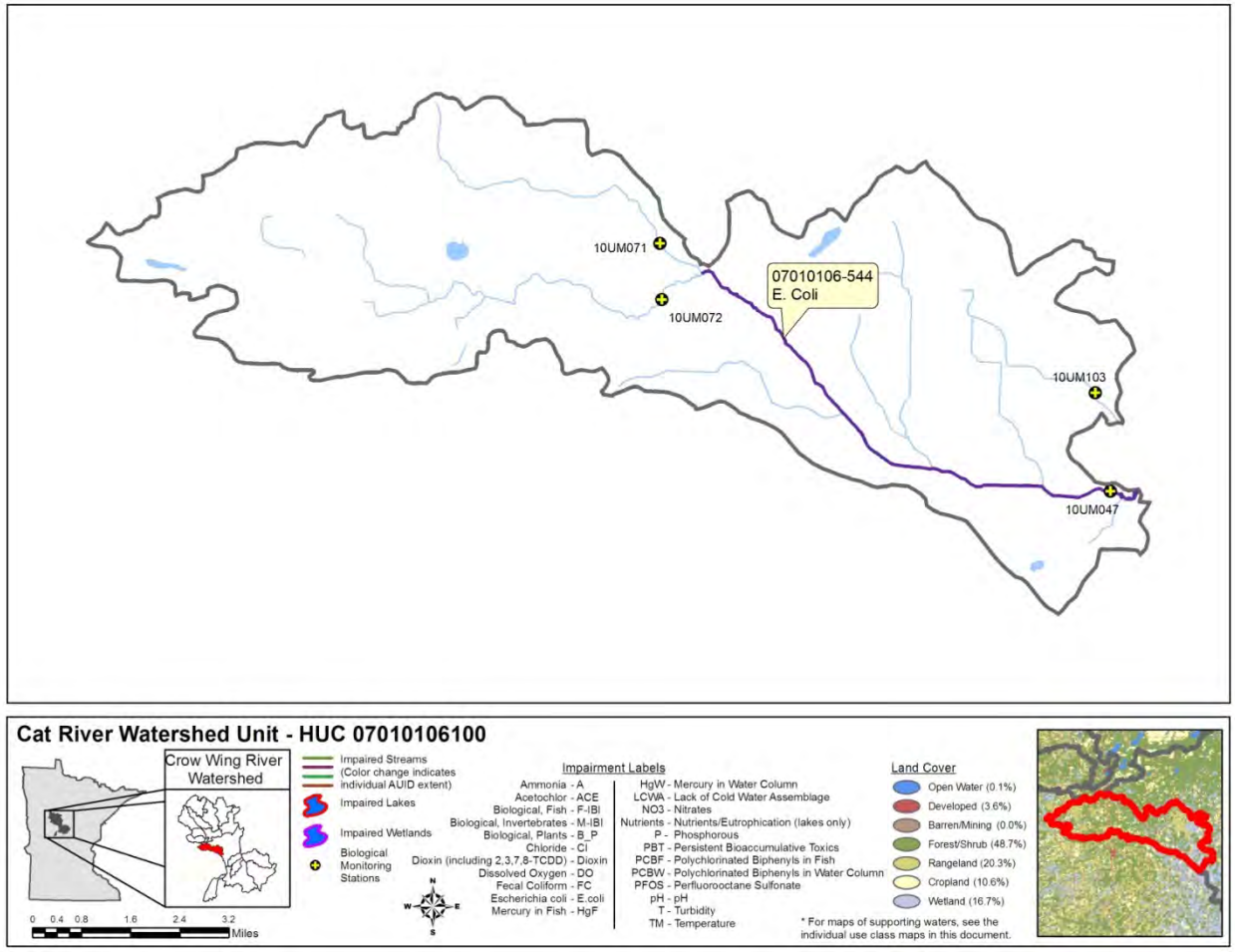

Figure 29. Currently listed impaired waters by parameter and land use characteristics in the Cat River Watershed Unit

Farnham Creek Watershed Unit HUC 07010106110

The Farnham Creek Subwatershed is located in the south central portion of the Crow Wing River Watershed. Draining approximately 42 miles^2 in portions of Cass and Wadena Counties, it is the smallest contributing subwatershed to the Crow Wing River Watershed. Major tributaries within this watershed include Tower Creek, Martin Creek, Farnham Creek and several other smaller unnamed streams. Portions of Martin Creek and Farnham Creek are classified as 2A waters for their ability to support a coldwater assemblage. Martin Creek was stocked with trout from 1954 until 1971. In 1964 it was classified by MDNR as a Type 1B trout stream meaning that it could sustain an existing or introduced population of trout. Farnham Creek was stocked with trout until 1994. The MDNR indicates that natural reproduction of trout within Farnham Creek is also questionable (per con Owen Baird , MDNR-Brainerd), but it is classified as a coldwater stream because evidence suggests that it is able to support a coldwater assemblage. The outlet monitoring location of the Farnham Creek subwatershed is represented by MPCA's water chemistry/EQuIS station S004-065 and biological station 10UM122 which are located downstream of CR 30, approximately ten miles north of Staples.

Table 40. Aquatic life and recreation assessments on stream reaches: Farnham Creek Watershed.

AUID Reach Name, Reach Description	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators:									Aquatic Life	Aquatic Rec.
					Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides	Bacteria		
07010106-702* Farnham Creek Unnamed ditch to T136 R32W S21, west line	2.96	1B,2A,3B	10UM080	Downstream of 56th St SW, 1 mi. NW of Poplar	_	_	EXP	MTS	MTS	MTS	_	_	EX	IF	NS
07010106-588 Martin Creek (Poplar Brook) * T136 R32W S22, east line to Farnham cr	5.44	2B	10UM079	Downstream of 87th Ave SW, 3 mi. NW of Ellis	MTS	MTS	IF	MTS	MTS	MTS	_	_	MTS	FS	FS
07010106-528 Tower Creek T135 R32W S4,north line to	3.57	2C	10UM078	Upstream of 87th Ave SW, 2 mi. NW of Ellis	MTS	EXS	IF	IF	_	IF	_	_	_	NS**	NA
07010106-522 Farnham Creek Unnamed cr to Crow Wing R	0.56	2B,3C	99UM022	At CR 30, ~10.0 mi. N. of Staples	_	_	IF	_	_	MTS	MTS	_	MTS	IF	FS

Abbreviations for Indicator Evaluations: -- = No Data, NA = Not Assessed, IF = Insufficient Information, MTS = Meets criteria; EXP = Exceeds criteria, potential impairment; EXS = Exceeds criteria, potential severe impairment; EX = Exceeds criteria (Bacteria).

Abbreviations for Use Support Determinations: NA = Not Assessed, IF = Insufficient Information, NS = Non-Support, FS = Full Support

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

Singe asterisk (*) = A use class change has taken place regarding the AUID

Double asterisk (**) = Natural Background Review Team has determined impairment is due to Natural Background factors

Aquatic life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50 percent) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

Table 41. Non-assessed biological stations on channelized AUIDs: Farnham Creek 11-HUC.

AUID Reach Name, Reach Description	Reach length (miles)	Use Class	Biological Station ID	Location of Biological Station	Fish IBI	Invert IBI
07010106-702 Farnham Creek Unnamed ditch to T136 R32W S21, west line	2.95	1B,2A,3B	10UM080	Downstream of 56th St SW, 1 mi. NW of Poplar	Fair	Fair

See Appendix 5.1 for clarification on the Good/Fair/Poor thresholds and Appendix 5.2 and Appendix 5.3 for IBI results.

Table 42. Minnesota Stream Habitat Assessment (MSHA): Farnham Creek 11-HUC.

# 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	10UM078	Tower Creek	5	15	9	10	22	61	Fair
1	10UM079	Martin Creek	5	12	9	10	18	54	Fair
1	99UM022	Farnham Creek	4.5	11	9	14	18	56.5	Fair
1	10UM080	Farnham Creek	4	13	9	8	13	47	Fair
Average Habitat Results: *Farnham Creek 11 HUC*			**4.6**	**12.8**	**9**	**10.5**	**17.8**	**54.6**	**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 43. Outlet water chemistry results: Farnham Creek 11-HUC.

Station location:	**Farnham Creek Downstream of CR 30, 10 mi N of Staples**							
STORET/EQuIS ID:	**S004-065**							
Station #:	**10UM122**							
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**Median**	**WQ Standard[1]**	**# of WQ Exceedances[2]**
Ammonia-nitrogen	mg/L	20	<0.04	0.14	0.07	0.05		
Chloride	mg/L						230	
Chlorophyll-a, Corrected	ug/L							
Dissolved Oxygen (DO)	mg/L	20	0.4	10.2	4.5	4.1	7	16
Escherichia coli	MPN/100ml	20	18	1203	140	63	126/1260	4
Inorganic nitrogen (nitrate and nitrite)	mg/L	20	0.02	0.05	0.03	0.03		
Kjeldahl nitrogen	mg/L	13	0.6	1.6	0.9	0.9		
Orthophosphate	ug/L							
pH		20	6.8	7.9	7.4	7.4	6.5-9.0	
Pheophytin-a	ug/L							
Phosphorus	ug/L	20	0.01	0.45	0.09	0.05		
Specific Conductance	uS/cm	18	146	511	365	368		
Temperature, water	deg °C	20	7.4	24.2	17.9	18.6		
Total suspended solids	mg/L	20	1	1	3.8	1.5	100	
Total volatile solids	mg/L							
Transparency tube	100 cm	20	22.5	>100	81	100	20	
Transparency tube	60 cm						>20	
Turbidity	FNU						25	
Sulfate	mg/L							
Hardness	mg/L							

[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 Farnham Creek 11 HUC, a component of the IWM work conducted between May and September in 2010 and 2011. This specific data does not necessarily reflect all data that was used to assess the AUID.

Summary

A large percentage of the Farnham Creek Subwatershed is composed of forested lands (approximately 40%); however a majority of this is in the easternmost portions of the watershed. Martin Creek (07010106-588) fully supported aquatic life based on the biological samples. Consultation with MDNR led this segment of Martin Creek to be reclassified as a warmwater stream because no coldwater species were found in the sample and no evidence of successful coldwater species reproduction or survival has ever been reported. The fish sample (10UM079) consisted of eight species including sensitive taxa. The IBI score was above the upper confidence limit. Macroinvertebrate sampling at this location indicated similar indicators of good water quality as 41 species were identified with a good percentage of sensitive taxa. Fish sampling associated with the biological station 10UM078 (Tower Creek) produced seven species and included three sensitive taxa. The IBI scored well and was above that of the upper confidence limit. Macroinvertebrate sampling associated with this reach contradicted what the fish data suggested. Poor taxa richness along with dominance of tolerant taxa led to a decision of non-support of macroinvertebrates. The impairment may possibly be due to natural factors (low dissolved oxygen associated with wetlands) and not anthropogenic stressors and therefore this reach is in the 4E category until further data is collected. Upstream wetlands and associated beaver dams are the plausible causes for the impairment. The fact that fish are more mobile and are able to seek out refuge areas during times of stress such as low dissolved oxygen and high flows is a plausible cause as to why the fish displayed a much higher IBI score. Farnham Creek (07010106-522) was found to be impaired for both fish and macroinvertebrates based on 1999 sampling. Biological sampling conducted in 2010 supported the existing impairment designation for Farnham Creek, particularly for macroinvertebrates (MIBI=9.75). The Farnham Creek Subwatershed presents several challenges for biologists and managers as it is a very complex watershed with a variety of land use types and stream classes (e.g. warm and coldwater streams).

Low DO results were observed at the Farnham Creek outlet (07010106-110) into the Crow Wing River. The presence of upstream wetlands suggests that these low DO results may be in part due to natural factors. Additional monitoring may be necessary to determine the source of the low DO concentrations, and the potential impact on biological communities. The upstream reach of Farnham Creek did not support aquatic recreation due to high bacteria levels. The presence of beaver impoundments within this reach may be an influence. There were no assessed lakes in this watershed.

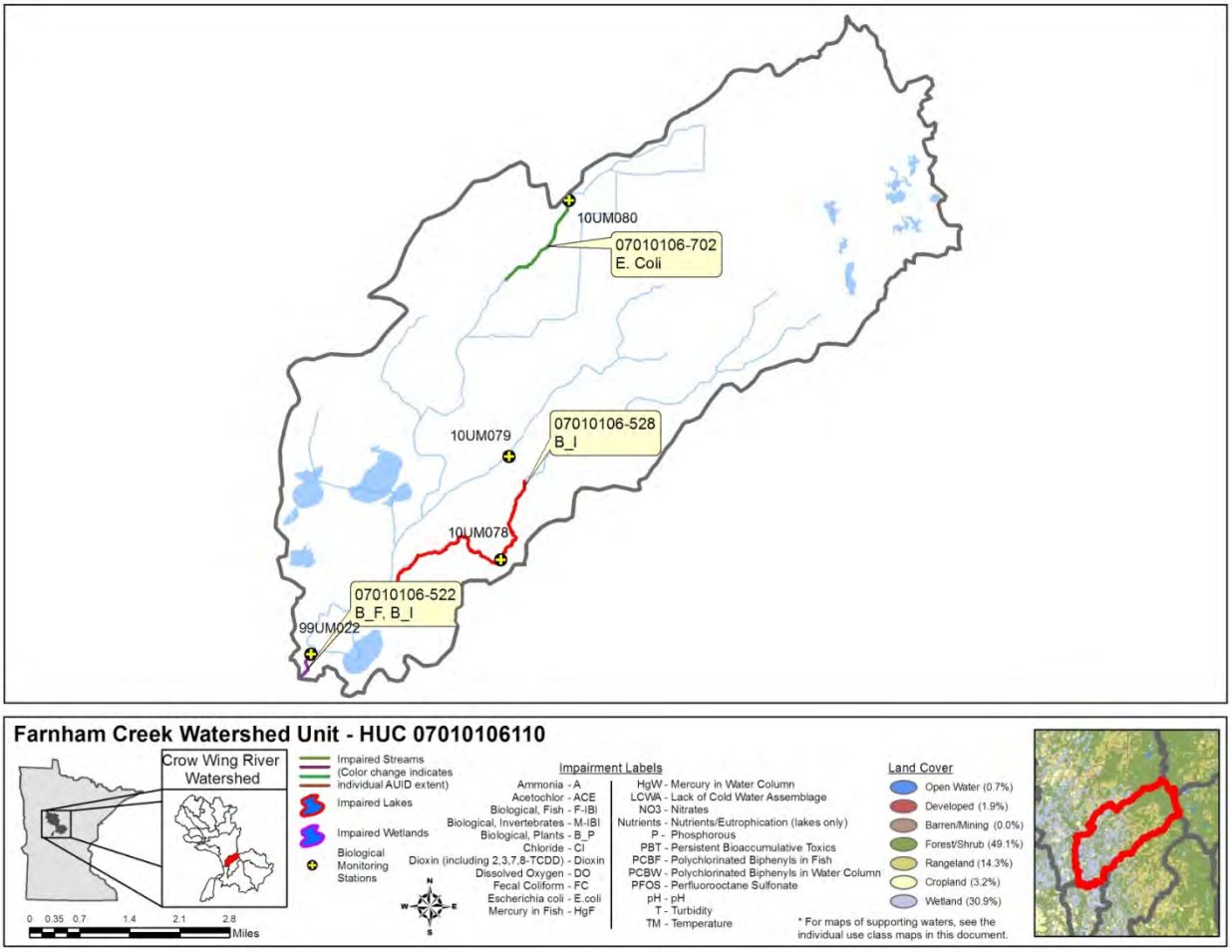

Figure 30. Currently listed impaired waters by parameter and land use characteristics in the Farnham Creek Subwatershed

Partridge River Watershed Unit HUC 07010106190

The Partridge River Subwatershed is in the southwest corner of the Crow Wing River Watershed. Draining approximately 94 square miles, it is located within portions of Morrison and Wadena Counties. Major tributaries include Little Partridge Creek, County Ditch 15, Bear Creek, and the Partridge River. Major lakes within the Partridge River Subwatershed include Lovejoy and Pendergast. From its headwaters, the Partridge River flows north to the Crow Wing River. Forest/shrub and cropland are the major land uses within this unit. The outlet monitoring location of the Partridge River is represented by MPCA's water chemistry/EquIS station S002-961 and biological station 10UM050. The water chemistry data associated with this station was collected by the Wadena County Soil and Water Conservation District whereas the biological data was collected by MPCA staff.

Table 44. Aquatic life and recreation assessments on stream reaches: Partridge River Watershed.

AUID Reach Name, Reach Description	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators:									Aquatic Life	Aquatic Rec.
					Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides	Bacteria		
07010106-551 Little Partridge Creek Little Partridge R to Partridge R	3.77	2B,3C	10UM085	Downstream of CR 113 St, 4 mi. SW of Aldrich	MTS	MTS	IF	IF	_	IF	_	_	_	FS	NA
07010106-518 Partridge River Headwaters to Crow Wing R	33.2	2B,3C	10UM050	Downstream of CR 29, 4.5 mi. NW of Staples	MTS	MTS	MTS	MTS	_	MTS	MTS	_	EX	FS	NS

Abbreviations for Indicator Evaluations: -- = No Data, NA = Not Assessed, IF = Insufficient Information, MTS = Meets criteria; EXP = Exceeds criteria, potential impairment; EXS = Exceeds criteria, potential severe impairment; EX = Exceeds criteria (Bacteria).

Abbreviations for Use Support Determinations: NA = Not Assessed, IF = Insufficient Information, NS = Non-Support, FS = Full Support

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

Aquatic life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50 percent) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

Table 45. Non-assessed biological stations on channelized AUIDs: Partridge River 11-HUC.

AUID Reach Name, Reach Description	Reach length (miles)	Use Class	Biological Station ID	Location of Biological Station	Fish IBI	Invert IBI
07010106-552 County Ditch 15 T132 R35W S2 west line to Bear Cr	3.33	7	10UM086	Downstream of CR 113 St, 4 mi. SW of Aldrich	Good	Poor

See Appendix 5.1 for clarification on the Good/Fair/Poor thresholds and Appendix 5.2 and Appendix 5.3 for IBI results.

Table 46. Minnesota Stream Habitat Assessment (MSHA): Partridge River 11-HUC.

# 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	10UM050	Partridge River	3.5	5	18	13	30	69.5	Good
1	10UM086	County Ditch 15	2.5	12	10.9	11	17	53.4	Fair
1	10EM150	Little Partridge	3.8	11	11	13	20	58.8	Fair
Average Habitat Results: *Partridge River 11 HUC*			**3.3**	**9.3**	**13.3**	**12.3**	**22.3**	**60.6**	**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 47. Outlet water chemistry results Partridge River 11-HUC.

Station location:	**Partridge River at CR 29, 4.5 mi NW of Staples**							
STORET/EQuIS ID:	**S002-961**							
Station #:	**10UM050**							
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**Median**	**WQ Standard[1]**	**# of WQ Exceedances[2]**
Ammonia-nitrogen	mg/L	20	<0.04	0.1	0.05	0.04		
Chloride	mg/L						230	
Chlorophyll-a, Corrected	ug/L							
Dissolved Oxygen (DO)	mg/L	20	6.9	12.6	9.3	8.9	5	
Escherichia coli	MPN/100ml	20	22	866	288	222	126/1260	16
Inorganic nitrogen (nitrate and nitrite)	mg/L	20	0.3	3.1	1.2	0.9		
Kjeldahl nitrogen	mg/L	13	0.8	1.4	1	1		
Orthophosphate	ug/L							
pH		20	7.2	8.3	7.9	8	6.5-9.0	
Pheophytin-a	ug/L							
Phosphorus	ug/L	20	0.01	0.1	0.04	0.04		
Specific Conductance	uS/cm	19	449	614	533	528		
Temperature, water	deg °C	20	7.3	22.4	17.3	17.9		
Total suspended solids	mg/L	20	1	9	3	3	100	
Total volatile solids	mg/L							
Transparency tube	100 cm	20	88	>100	99	100	20	
Transparency tube	60 cm						>20	
Turbidity	FNU						25	
Sulfate	mg/L							
Hardness	mg/L							

[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 Partridge River 11 HUC, a component of the IWM work conducted between May and September in 2010 and 2011. This specific data does not necessarily reflect all data that was used to assess the AUID.

Summary

With the exception of high bacteria levels, the Partridge River Watershed appears to be in fairly good condition. Two AUIDs (07010106-518 and 07010106-551) were assessed in this watershed with one (07010106-552) being non-assessable due to channelization. Fish samples collected from Little Partridge Creek (07010106-551) had relatively high taxa richness and a good presence of sensitive species including various dace, greater redhorse, rock bass, and blacknose shiner. The macroinvertebrate community was also in good condition with several sensitive taxa, and relatively high taxa richness. The good biological communities indicated that the stream fully supported aquatic life. Biological and water chemistry samples from the Partridge River (07010106-518) indicated full support of aquatic life. However, nitrate levels are high and may be associated with the significant (>60%) amount of agricultural usage throughout the watershed that includes both cultivated crops and feedlots. The Partridge River Watershed has a significant feedlot presence with approximately 125 actively registered units, and livestock were often observed within the river during monitoring events. Consequently, the Partridge River was determined to be non-supporting of aquatic recreation due to bacterial exceedances.

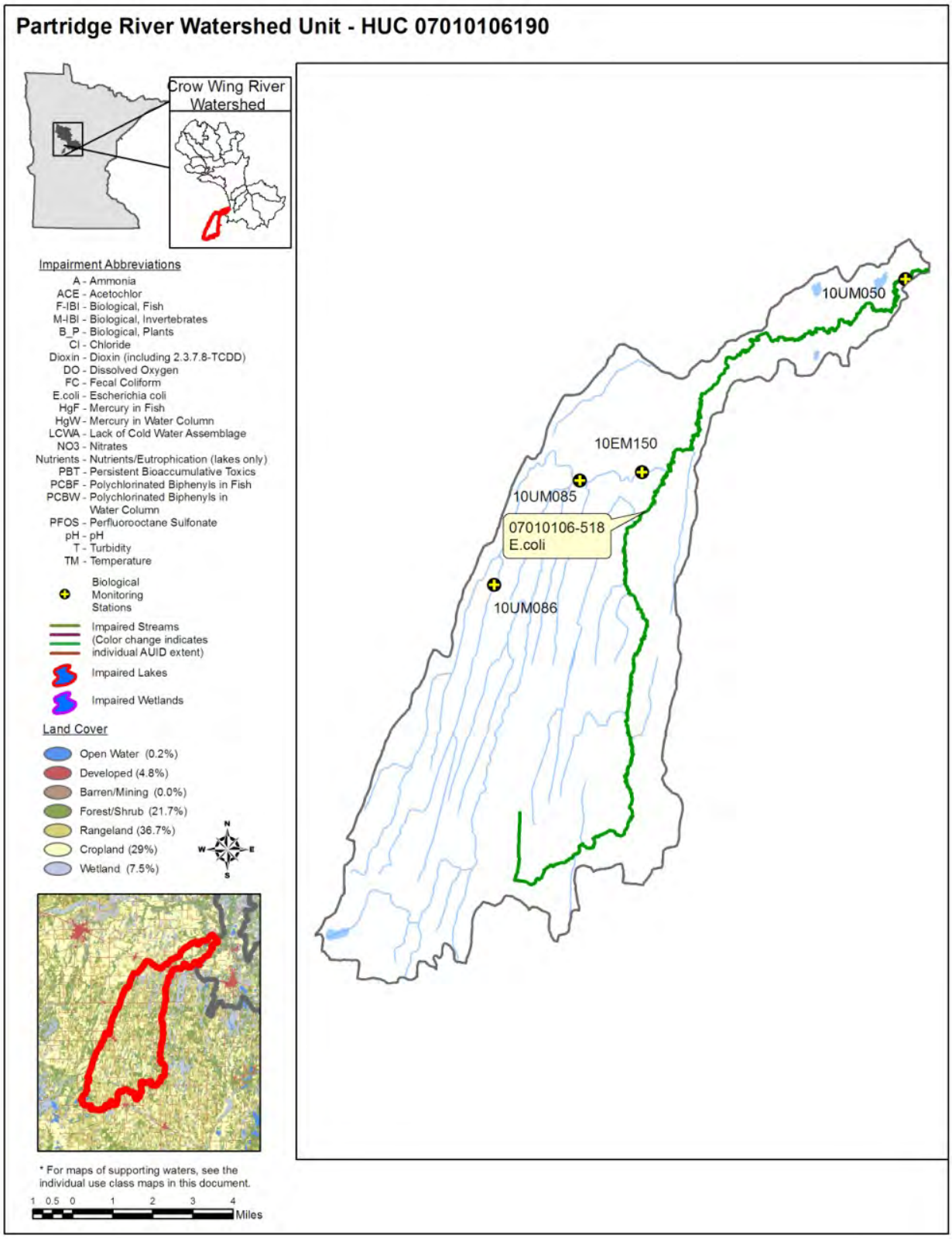

Figure 31. Currently listed impaired waters by parameter and land use characteristics in the Partridge River Subwatershed.

Swan Creek Watershed Unit HUC 07010106200

The Swan Creek Subwatershed is located in the south-central portion of the Crow Wing River Watershed. The watershed drains approximately 49 square miles, primarily in Cass County. From its headwaters in the northwest, Swan Creek flows in a southwesterly direction towards the Crow Wing River. Along its course, it is joined by numerous tributaries including Little Swan Creek, Iron Creek, and a few other unnamed streams. The land-use is dominated by forest/shrub, rangeland, and wetlands. A water chemistry station was located at County Road 32, approximately three miles north of Staples, and is represented By MPCA's EQuIS station S006-293. The water chemistry data was collected by the Crow Wing County Soil and Water Conservation District.

Table 48. Aquatic life and recreation assessments on stream reaches: Swan Creek Watershed Unit.

AUID Reach Name, Reach Description	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators:									Aquatic Life	Aquatic Rec.
					Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides	Bacteria		
07010106-527 Swan Creek T135 R32W S2, north line to Crow Wing R	19.51	2C	10UM108 10UM081 10EM086	Downstream of 76th St SW, 2.5 mi. W of Leader Upstream of CR 30, 1.5 mi. NW of Esterday 0.25 mi. E of CR 32, 4 mi. N of Staples	MTS	EXS	EXP	MTS	MTS	MTS	MTS	_	EX	NS	NS

Abbreviations for Indicator Evaluations: -- = No Data, NA = Not Assessed, IF = Insufficient Information, MTS = Meets criteria; EXP = Exceeds criteria, potential impairment; EXS = Exceeds criteria, potential severe impairment; EX = Exceeds criteria (Bacteria).

Abbreviations for Use Support Determinations: NA = Not Assessed, IF = Insufficient Information, NS = Non-Support, FS = Full Support

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

Aquatic life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50 percent) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

Table 49. Minnesota Stream Habitat Assessment (MSHA): Swan Creek 11-HUC.

# 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	10UM081	Swan Creek	5	13.5	18.9	16	29	82.4	Good
1	10UM108	Swan Creek	1.5	4	9	14	13	41.5	Poor
1	10EM086	Swan Creek	2.5	9.5	9	8	11	40	Poor
Average Habitat Results: *Swan Creek 11 HUC*			**3**	**9**	**12.3**	**12.7**	**17.7**	**54.6**	**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 50. Outlet water chemistry results: Swan Creek 11-HUC.

Station location:	**Swan Creek at CR 32, 3 mi N of Staples**							
STORET/EQuIS ID:	**S006-293**							
Station #:								
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**Median**	**WQ Standard[1]**	**# of WQ Exceedances[2]**
Ammonia-nitrogen	mg/L	11	<0.04	0.08	0.05	0.05		
Chloride	mg/L	9	2	4	3	3		
Chlorophyll-a, Corrected	ug/L							
Dissolved Oxygen (DO)	mg/L	18	2.4	7.9	5.5	5.4	5	5
Escherichia coli	MPN/100ml	13	133	2420	706	359	126/1260	13
Inorganic nitrogen (nitrate and nitrite)	mg/L	10	<0.03	0.1	0.05	0.03		
Kjeldahl nitrogen	mg/L	11	0.7	1	0.9	0.9		
Orthophosphate	ug/L							
pH		18	7.2	7.8	7.5	7.5	6.5-9.0	
Pheophytin-a	ug/L							
Phosphorus	ug/L	11	0.03	0.1	0.07	0.09		
Specific Conductance	uS/cm	18	201	427	324	327		
Temperature, water	deg °C	18	8.1	23.5	17.4	18.9		
Total suspended solids	mg/L	10	3	20	6	4	100	
Total volatile solids	mg/L	10	2	11	4	3		
Transparency tube	100 cm	20	76	>100	97	100	20	
Transparency tube	60 cm						>20	
Turbidity	FNU						25	
Sulfate	mg/L	11	<3	<3				
Hardness	mg/L							

[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 Swan Creek 11 HUC, a component of the IWM work conducted between May and September in 2010 and 2011. This specific data does not necessarily reflect all data that was used to assess the AUID.

Summary

One AUID (07010106-527) in the Swan Creek Subwatershed was assessed. Three biological stations were sampled within the reach. The fish community at each site had fairly good taxa richness including sensitive species such as mottled sculpin, burbot, rock bass, and sensitive dace species (pearl, finescale, and northern red-belly). F-IBI scores for all three sites indicated full support. Conversely, the macroinvertebrate scores were well below the impairment thresholds at the upper and lowermost stations (10UM108 and 10UM086). Poor taxa richness and a low sensitive species counts typified these communities. The low macroinvertebrate IBI scores appear to be driven by poor habitat conditions. Poor stream morphology (i.e. lack of pools and riffles) and a lack of coarse substrates were found at both of these locations. Land around these sites is being pastured with some wetland influence being noted at the most downstream station. The biological station (10UM081) located in between these stations had an M-IBI score that was very good. The assemblage had a high number of taxa that included both stonefly and caddisfly species. Somewhat predictably, the habitat at this site was much better with coarse substrate and deep pools being present. This station had one of the highest MSHA scores (82) in the entire Crow Wing River Watershed.

The 20 mile reach of Swan Creek was listed as impaired due to low DO. Upstream wetlands may be a factor; however, the amount of influence is likely marginal. Turbidity in the Swan Creek Subwatershed does not appear to be a problem as all transparency samples indicated good water clarity. However, all of the bacterial samples exceeded the standard, indicating non -support of aquatic recreation. Additional monitoring is recommended for Iron Creek (07010106-593) where the existing data was not sufficient for assessment but demonstrated that E. coli levels were high at times. The presence of extensive wetlands around Iron Creek suggests that low DO conditions may be occurring naturally.

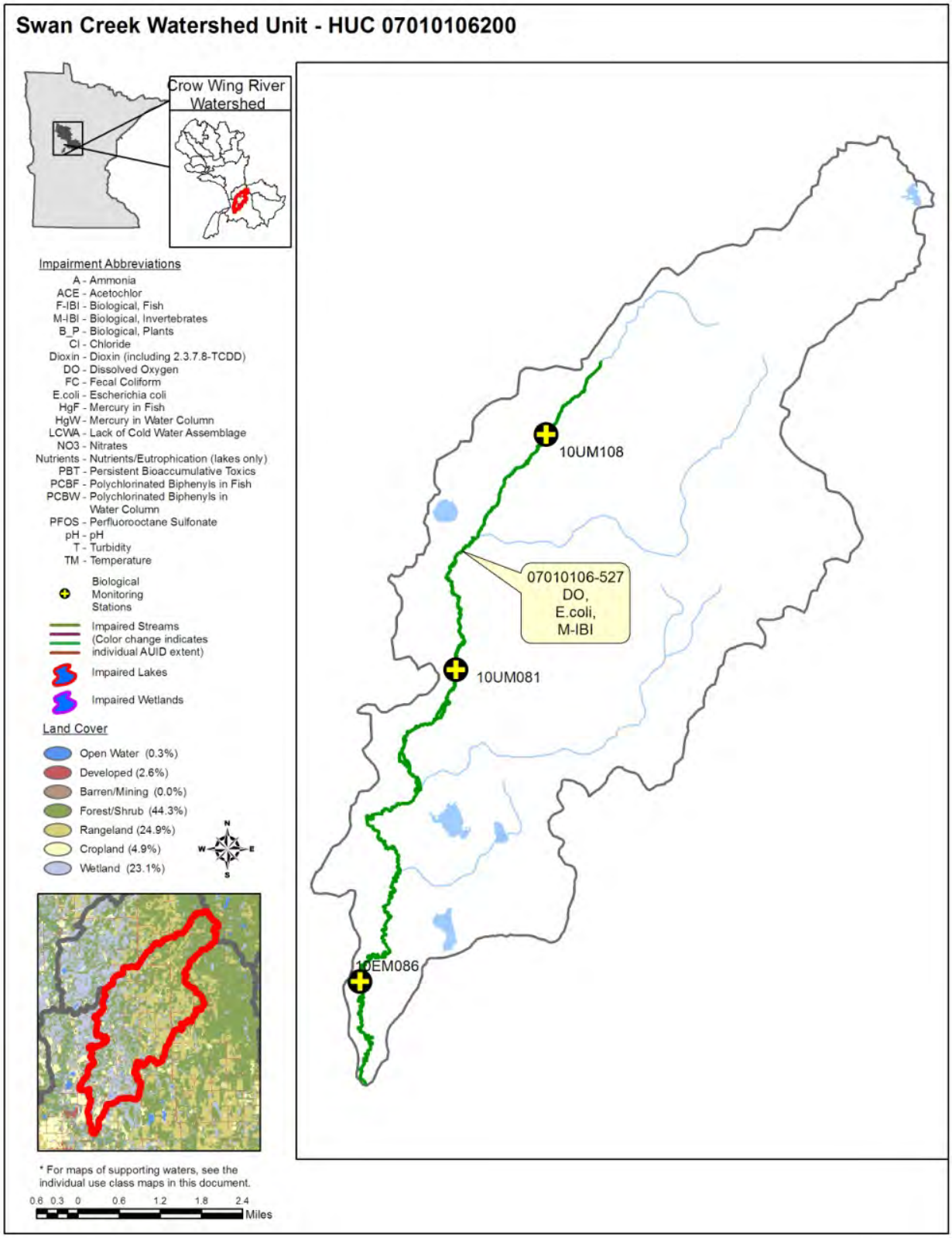

Figure 32. Currently listed impaired waters by parameter and land use characteristics in the Swan Creek Subwatershed.

Lower Crow Wing Watershed Unit HUC 07010106210

The Lower Crow Wing Subwatershed is in the southern most portion of the Crow Wing River Watershed and drains approximately 232 square miles, making it one of the largest contributing subwatersheds to the Crow Wing River. The subwatershed is located in portions of Morrison and Cass Counties. Major rivers and streams include the mainstem of the Crow Wing River, Mosquito Creek, East Branch Mosquito Creek, Pillager Creek, and Seven Mile Creek.

Table 51. Aquatic life and recreation assessments on stream reaches: Lower Crow Wing Watershed.

AUID Reach Name, Reach Description	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators:									Aquatic Life	Aquatic Rec.
					Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides	Bacteria		
07010106-506 Crow Wing River Seven Mile Cr to Gull R	7	2B,3C	10UM049	Downstream of CR 1, in Pillager	MTS	_	IF	MTS	MTS	MTS	MTS	_	IF	FS	IF
07010106-512 Crow Wing River Farnham Cr to Leaf R	11.1	2B,3C	10UM112	At boat launch in Bullard's Bluff Campground, 7 mi. N of Staples	MTS	_	IF	IF	_	IF	_	_	_	FS	NA
07010106-510 Crow Wing River Partridge R to Swan Cr	6.81	2B,3C	10UM111	Off of Orvs Landing Rd, 2 mi. N of Staples	MTS	MTS	IF	IF	_	IF	_	_	_	FS	NA
07010106-684 Unnamed Creek Unnamed Cr to Crow Wing R	5.51	2B,3C	10UM087	Upstream of CR 33, 3 mi. NW of Motley	_	_	IF	IF	IF	IF			EX	IF	NS
07010106-509 Crow Wing River Swan Cr to Mosquito Cr	10.5	2B,3C	10UM117	At Green Oak Boat Landing off of Trapper Ln, 3.5 mi. E	MTS	MTS	IF	MTS	_	MTS	MTS	_	_	FS	NA
07010106-591 Mosquito Creek (Hay Creek) T135 R31W S20,north line to Crow Wing R	17.9	2B,3C	10UM089	Off of 124th St SW, 1.5 mi. NE of Motley	MTS	MTS	IF	IF	_	IF	_	_	_	FS	NA
07010106-693 East Branch Mosquito Creek Unnamed cr to Mosquito Cr	1.44	2B,3C	10UM119	Off of 65th Ave SW, 5 mi. N of Motley	MTS	MTS	IF	IF	_	IF	_	_	_	FS	NA
07010106-507 Crow Wing River Long Prairie R to Seven Mile Cr	6.93	2B,3C	10UM120	Upstream of Crystal Rd boat launch, 4 mi. SW of Pillager	MTS	MTS	IF	_	_	IF	_	_	_	FS	NA
07010106-525 Sevenmile Creek T134 R31W S2, north line to Crow Wing R	16.3	2C	10UM090	Upstream of 51st Ave SW, 3 mi. W of Pillager	MTS	MTS	IF	IF	_	IF	_	_	_	FS	NA
07010106-577 Pillager Creek T133 R30W S5, north line to Crow Wing R	6.07	2C	10UM091	Upstream of CR 1, in Pillager	MTS	MTS	IF	MTS	MTS	MTS	_	_	EX	FS	NS
07010106-591 Mosquito Creek (Hay Creek) T135 R31W S20,north line to Crow Wing R	17.9	2B,3C	10UM109 10UM089	Upstream of 100th St SW, 6.5 mi. N of Motley Off of 124th St SW, 1.5 mi. NE of Motley	MTS	MTS	IF	IF	_	IF	_	_	_	FS	NA

Abbreviations for Indicator Evaluations: -- = No Data, NA = Not Assessed, IF = Insufficient Information, MTS = Meets criteria; EXP = Exceeds criteria, potential impairment; EXS = Exceeds criteria, potential severe impairment; EX = Exceeds criteria (Bacteria).

Abbreviations for Use Support Determinations: NA = Not Assessed, IF = Insufficient Information, NS = Non-Support, FS = Full Support

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

Aquatic life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50 percent) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

Table 52. Minnesota Stream Habitat Assessment (MSHA): Lower Crow Wing 11-HUC.

# 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	10UM089	Mosquito Creek	4	11	11.8	14	32	72.8	Good
1	10UM109	Mosquito Creek	2.5	9	16.6	11	18	57.1	Fair
1	10UM049	Crow Wing River	3.25	11	18	11	20	63.3	Fair
1	10UM120	Crow Wing River	4.5	12.5	18	7	20	62	Fair
1	10UM119	Trib. To Mosquito Creek	4	11.5	15.7	16	28	75.2	Good
1	10UM112	Crow Wing River	4.5	14.5	16.8	12	22	69.8	Good
2	10UM091	Pillager Creek	2.4	10.5	19.2	15.5	24	71.6	Good
2	10UM090	Sevenmile Creek	0	11.5	17.8	11	19	59.3	Fair
1	10UM111	Crow Wing River	2.8	14	17.1	6	20	59.9	Fair
1	10UM117	Crow Wing River	4	13.5	21.9	12	28	79.4	Good
1	10UM087	Trib. To Crow Wing River	0	1.5	13.1	12	14	40.6	Poor
Average Habitat Results: *Lower Crow Wing 11 HUC*			**3**	**11**	**17**	**11.6**	**22.3**	**64.6**	**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 53. Outlet water chemistry results: Lower Crow Wing 11-HUC.

Station location:	**Crow Wing River at CR 1, at Pillager**							
STORET/EQuIS ID:	**S000-176**							
Station #:	**10UM049**							
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**Median**	**WQ Standard[1]**	**# of WQ Exceedances[2]**
Ammonia-nitrogen	mg/L	11	<0.04	0.08	0.05	0.06		
Chloride	mg/L	7	9	12	10	11		
Chlorophyll-a, Corrected	ug/L							
Dissolved Oxygen (DO)	mg/L	21	5	12	8	8	5	
Escherichia coli	MPN/100ml	14	3	1733	142	13	126/1260	1
Inorganic nitrogen (nitrate and nitrite)	mg/L	10	0.1	0.4	0.2	0.2		
Kjeldahl nitrogen	mg/L	11	0.5	1	0.8	0.8		
Orthophosphate	ug/L							
pH		21	7.2	8.4	8	8	6.5-9.0	
Pheophytin-a	ug/L							
Phosphorus	ug/L	11	0.04	0.1	0.07	0.07		
Specific Conductance	uS/cm	21	176	477	417	436		
Temperature, water	deg °C	21	10.3	25.6	19.7	21.4		
Total suspended solids	mg/L	10	2	11	5	5	100	
Total volatile solids	mg/L	10	2	4	3	3		
Transparency tube	100 cm	24	78	>100	92	93	20	
Transparency tube	60 cm						>20	
Turbidity	FNU						25	
Sulfate	mg/L	11	3	7	4	3		
Hardness	mg/L							

[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.
[3]Based on 1970-1992 summer data; see Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions (McCollor and Heiskary 1993).

**Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Lower Crow Wing 11 HUC, a component of the IWM work conducted between May and September in 2010 and 2011. This specific data does not necessarily reflect all data that was used to assess the AUID.

Table 54. Lake water aquatic recreation assessments: Lower Crow Wing 11-HUC.

Name	DOW#	Area (ha)	Trophic Status	Percent Littoral	Max. Depth (M)	Avg. Depth (M)	CLMP Trend	Mean TP (µg/L)	Mean chl-a (µg/L)	Secchi Mean (M)	Support Status
Pillager	11-0320-00	80	M	35	13.4	6	IF	11	2	5.3	FS
Sylvan (Main)	49-0036-01	101	E	81	9.5	3.6	IF	60	12	2.0	NA
Simon	80-0003-00	43	M				IF	12		1.4	IF

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

Summary

The Lower Crow Wing Subwatershed seems to be maintaining good biological integrity despite the fact that many anthropogenic stressors are present within this drainage. All ten of the stream segments that were assessed for aquatic life were found to be fully supporting. Fish communities displayed high taxa richness and good presence of sensitive species such as pearl, finescale, and northern red-belly dace. Sensitive macroinvertebrates included both stoneflies and caddisflies. An unnamed creek (07010106-684) was not assessed for aquatic life because it was channelized. In general, the water chemistry data supported the good biological monitoring results. All water chemistry data collected in the watershed indicated support for aquatic life. However two streams, Pillager Creek (07010106-577) and an unnamed tributary to the Crow Wing River (07010106-684), had elevated E. coli levels exceeding the standard and did not support aquatic recreation.

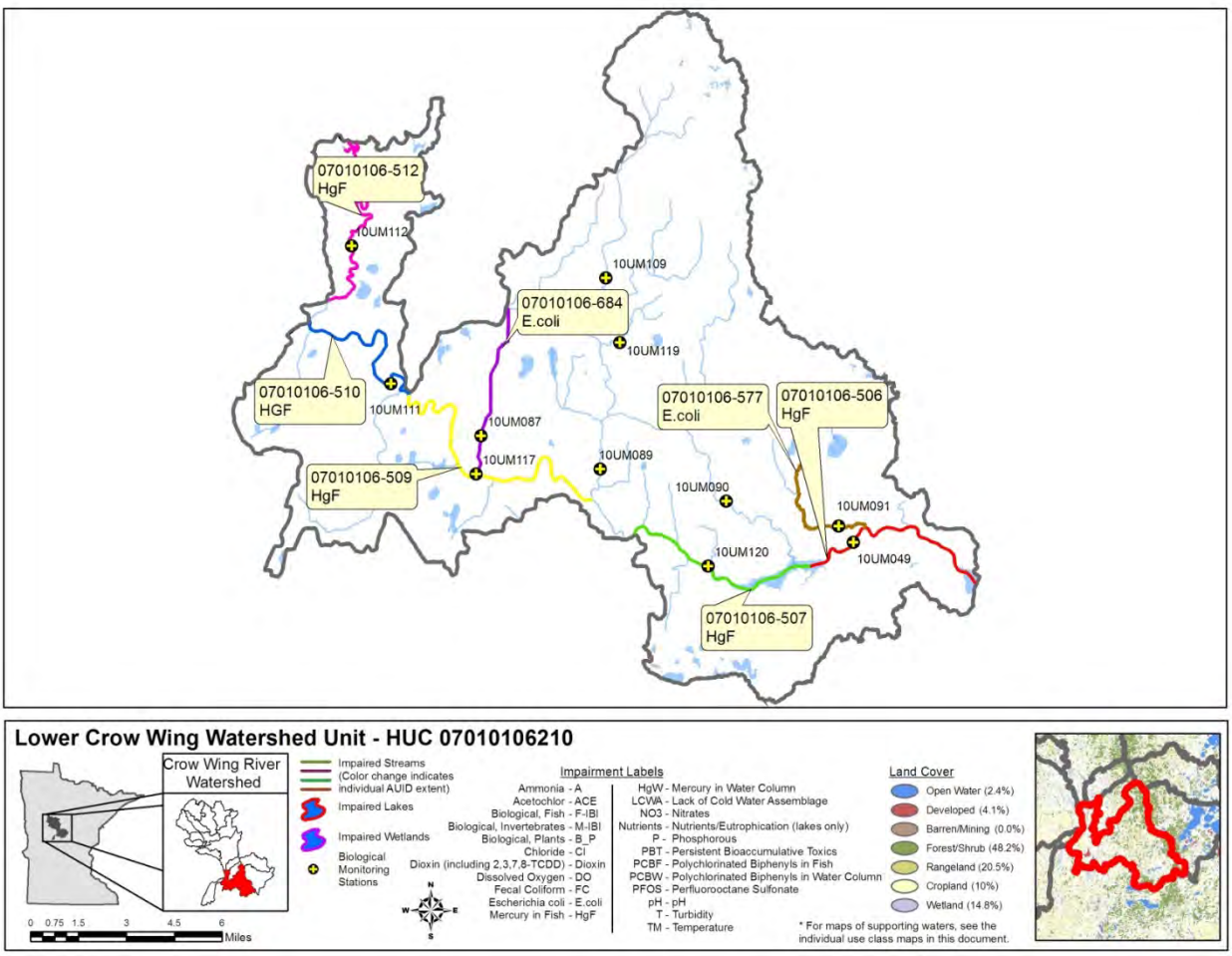

Figure 33. Currently listed impaired waters by parameter and land use characteristics in the Lower Crow Wing Watershed

The Lower Crow Wing Watershed contains 32 lakes greater than four hectares (ten acres) of which two were assessed. Lake assessment data was collected from the main basin of Sylvan Lake; however, the lake was not assessed because the residence time was less than one day. Assessment data were available for Pillager and Simon Lakes. Pillager was determined to be supporting aquatic recreation use. Available data were insufficient to assess Simon Lake, but the available data do indicate supporting conditions.

Upper Gull Lake Watershed Unit HUC 07010106220

The Upper Gull Lake River Subwatershed is located in the southeastern portion of the Crow Wing River Watershed and drains approximately 139 square miles of land. Located in portions of Crow Wing and Cass Counties, the drainage includes the main stem of the Crow Wing River and several tributaries; Mayo Creek, Stoney Brook, and several unnamed reaches. This sub-watershed of the Crow Wing River also includes many lakes such as Upper Gull, Margaret, Gull, Mud, Rice, Clark, Upper and Middle Cullen, Edna, Fawn, Roy, Sibley, East Twin and Mayo. Several of these lakes are noted for providing exceptional aquatic recreation. Gull Lake in particular draws thousands of anglers every year which are lured by the possibility of catching trophy class walleye, northern pike, and largemouth bass. Many of the smaller lakes within this watershed also provide excellent fishing, with the black crappie and walleye being two of the key sought- after species. Stoney Brook has been influenced by human induced and natural stressors throughout the years which have raised water temperatures in the stream. However, thanks to management practices in certain locations it still supports a coldwater fish assemblage and can provide for exceptional trout angling as well.

Table 55. Aquatic life and recreation assessments on stream reaches: Upper Gull Lake Subwatershed.

AUID Reach Name, Reach Description	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators:										Aquatic Life	Aquatic Rec.
					Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides	Bacteria			
07010106-604 Mayo Creek Unnamed cr to Unnamed cr	6.08	2B,3C	10UM093	Upstream of 13th Ave SW, 2 mi. W of Pequot Lakes	MTS	MTS	IF	MTS	MTS	MTS	_	_	EX		FS	NS
07010106-699 Stoney Brook * T136 R31W S26, south line to T136 R29W S31, east line	12.9	1B,2B,3B	10UM098	Downstream of 29th Ave SW, 2 mi. N of Stoneybrook	MTS	MTS	IF	IF	_	IF	_	_	_		FS	NA
07010106-698 Stoney Brook T136 R29W S32, west line to Upper Gull	4.63	1B,2A,3B	10UM092	Off of CR 78, 3 mi. W of Nisswa	MTS	MTS	IF	MTS	MTS	MTS	_	_	EX		FS	NS

Abbreviations for Indicator Evaluations: -- = No Data, NA = Not Assessed, IF = Insufficient Information, MTS = Meets criteria; EXP = Exceeds criteria, potential impairment; EXS = Exceeds criteria, potential severe impairment; EX = Exceeds criteria (Bacteria).

Abbreviations for Use Support Determinations: NA = Not Assessed, IF = Insufficient Information, NS = Non-Support, FS = Full Support

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

Aquatic life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50 percent) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

Table 56.Minnesota Stream Habitat Assessment (MSHA): Upper Gull Lake 11-HUC.

# 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	10UM093	Mayo Creek	2.9	13.3	18.5	15.5	27.5	77.6	Good
1	10UM098	Stoney Brook	4	13	19.9	15	21	72.9	Good
1	10UM092	Stoney Brook	5	14	22	16	31	88	Good
Average Habitat Results: *Upper Gull Lake 11 HUC*			**4**	**13.4**	**20.1**	**15.5**	**26.5**	**79.5**	**Good**

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

Table 57. Lake water aquatic recreation assessments: Upper Gull Lake 11-HUC.

Name	DOW#	Area (ha)	Trophic Status	Percent Littoral	Max. Depth (M)	Avg. Depth (M)	CLMP Trend	Mean TP (µg/L)	Mean chl-a (µg/L)	Secchi Mean (M)	Support Status
Upper Gull	11-0218-00	169	E	42	16.5	6.6	NT	24	10	2.7	FS
Lost	11-0219-00	5	M				IF			2.6	IF
Ray	11-0220-00	57	M	82	8.2	2.1	↓	13	7	2.9	IF
Spider	11-0221-00	13	M				IF	16	10	2.6	FS
Upper Loon	11-0225-00	48	E				IF	32	12	2.3	IF
Loon	11-0226-00	91	M	91	7.6	1.0	↑	18	4	3.7	FS
Mud	18-0326-00	11	E					32	43		NA
Rice	18-0327-00	40	E	100	0.9		IF	29	4	1.0	IF
Garden	18-0329-00	104	M	100	2.4		IF	17	4	1.4	FS
Unnamed	18-0330-00	10	M				IF	27	7	5.5	IF
Upper Cullen	18-0376-00	169	M	69	12.2	4.1	NT	25	9	2.9	FS
Middle Cullen	18-0377-00	158	M	33	14.0	6.3	↑	19	5	4.0	FS
Edna	18-0396-00	61	M	60	19.2	4.5	↓	11	3	4.6	FS
Fawn	18-0397-00	26	M	48	12.2	3.1	IF	11	4	3.8	FS
Roy	18-0398-00	127	M	41	7.9	3.5	NT	20	7	2.8	FS
Nisswa	18-0399-00	88	M	58	7.0	3.3	NT	20	9	2.3	FS
Lower Cullen	18-0403-00	227	M	35	11.9	5.8	NT	21	7	3.7	FS
Sibley	18-0404-00	169	E	61	12.2	3.8	↓	33	20	1.5	NS
Rice	18-0405-00	23	E				IF	144		1.3	NA
East Twin	18-0407-00	63	M	61	13.7	4.4	↑	10	3	5.2	FS
Mayo	18-0408-00	66	E	95	6.7	1.9	NT	36	18	2.0	NS
West Twin	18-0409-00	50	M	63	14.3	3.6	NT	9	2	5.7	IF

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

Summary

The Upper Gull Lake Subwatershed is well known for the great recreational opportunities, particularly angling. The biological communities of both fish and macroinvertebrates displayed excellent biological integrity and signify good overall condition for aquatic life. High taxa richness along with several sensitive taxa were observed at the biological stations associated with the three assessable AUIDs. Mayo Creek (07010106-604) had the highest macroinvertebrate IBI score in the entire Crow Wing River Watershed. The fish sample also was excellent at this biological station (10UM093). This station had high taxa richness that included northern red-belly and pearl dace , and mottled sculpin, species that are all indicative of good water quality. Stoney Brook which is well known as a coldwater (2A) resource produced a fish sample that was numerically dominated by mottled sculpin and brook trout, with some brown trout also being observed. The macroinvertebrate collection at the biological station (10UM092) associated with this reach had low taxa richness, however it was dominated by hypersensitive species. Low numbers of coldwater fish species (1%) from another station on Stoney Brook (10UM098) caused agency staff to question the potential of this reach to support coldwater aquatic communities . Further discussion between MPCA and DNR staff led to the decision to change the use designation to 2B from 2A for the upper portions of Stoney Brook (07010106-699). The Upper Gull Lake Subwatershed had some of the highest habitat (MSHA) and IBI scores in the Crow Wing River Watershed. Based on the fact that Stoney Brook is one of Central Minnesota's premiere trout streams, protective measures such as BMPs (Best Management Practices) should be implemented to protect this resource from anthropogenic stressors. As more people move into the subwatershed, shoreline management and protection will become more important. The exceptional fishing that this subwatershed provides can only continue if the fish have access to suitable spawning habitats, which include both vegetative shoreline and areas of coarse substrate. Without these areas, the natural reproduction of many if not all of the fish species mentioned are at risk. Feedlot usage of stream resources is relatively heavy in this subwatershed and aquatic recreational standards are beginning to display the impacts.

Water chemistry data were available from two reaches of Stoney Brook and Mayo Creek. Both reaches were determined to be non-supporting for aquatic recreation due to high bacteria levels. All other water chemistry parameters were within standards.

The Upper Gull Lake Subwatershed contains 42 lakes greater than four hectares (ten acres) of which 20 were assessed. Data were collected on two additional lakes; however, the basin characteristics of Mud and Rice (18-0405) were more similar to a wetland. These two lakes were not assessed. Spider Lake, listed as a wetland by MDNR, was determined to be supporting for aquatic recreational use using aquatic recreational standards for lakes based on the basin characteristics. A majority of the lakes within the Upper Gull Lake Subwatershed are located in the eastern and southeastern portion and typically have high water clarity. Land use in this area is commonly undisturbed and the lakes catchment areas are typically small. Two lakes, Sibley and Mayo, were determined to be non-supporting for aquatic recreational use. Sibley and Mayo Lakes receive inputs from a large catchment area a higher amount of rangeland use than other areas of the subwatershed. Both lakes are moderately deep, but have shallow mean depths. Despite being classified as deep lakes this may allow for sediment re-suspension allowing for additional internal nutrient release within the water column.

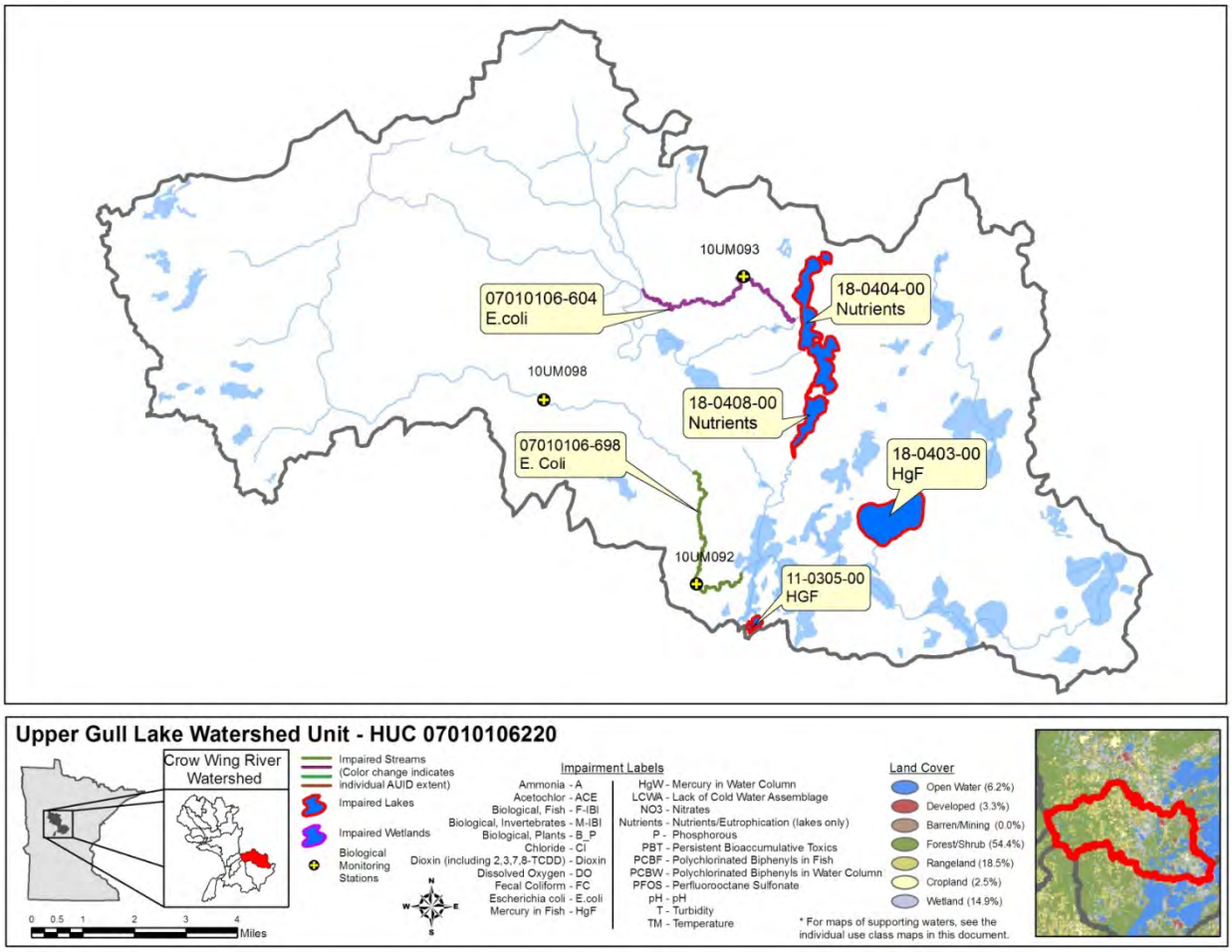

Figure 34. Currently listed impaired waters by parameter and land use characteristics in the Upper Gull Lake Watershed.

Gull Lake Watershed Unit HUC 07010106230

The Gull Lake Subwatershed, located in the south-central portion of the Crow Wing River Watershed is the last subwatershed to contribute to the Crow Wing River. Encompassing portions of Crow Wing and Cass Counties, it drains approximately 193 square miles. Major tributaries include the Gull River, Home Brook and Corey Brook. Several lakes are also within this unit including Upper Gull, Sylvan, Gull, Edward, North Long, Round, Red Sand, Hubert and Margaret Lakes as well as many others. Much like the Upper Gull Lake Subwatershed, lakes, rivers and streams in this subwatershed provide exceptional angling opportunity as well as other forms of aquatic recreation. The water monitoring station at the outlet of the watershed is represented by MPCA's EquIS Station S001-926. An additional water chemistry/biology station on the Gull River was also established (station S005- 799, Biological station 10UM051). The water chemistry data at both stations was collected by the Crow Wing County Soil and Water Conservation District.

Table 58. Aquatic life and recreation assessments on stream reaches: Gull Lake Watershed.

AUID Reach Name, Reach Description	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators:									Aquatic Life	Aquatic Rec.
					Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides	Bacteria		
07010106-700 Corey Brook * T135 T30W S16, north line to Home Bk	2.89	1B,2B,3B	10UM096	Upstream of CSAH 1, 8 mi. SW of Nisswa	MTS	MTS	IF	MTS	MTS	MTS	_	_	EX	FS	NS
07010106-524 Home Brook Headwaters (Omen Lk 11-0336-00) to Lk Margaret	16.1	2B,3C	10UM097	Upstream of CR 107, 6 mi. SW of Nisswa	MTS	MTS	IF	MTS	MTS	MTS	_	_	EX	FS	NS
07010106-502 Gull River Gull Lk to Crow Wing R	15.3	2B,3C	10UM051	Upstream of Great River Rd, 5 mi. NW of Baxter	MTS	MTS	IF	MTS	MTS	MTS	MTS	_	MTS	FS	FS
07010106-501 Crow Wing River (Gull R. to Miss R)	4.12	2B,3C	10UM052	Downstream of Fisherman's Bank Landing off of Sylvan	MTS	MTS	MTS	MTS	MTS	MTS	MTS	_	MTS	FS	FS

Abbreviations for Indicator Evaluations: -- = No Data, NA = Not Assessed, IF = Insufficient Information, MTS = Meets criteria; EXP = Exceeds criteria, potential impairment; EXS = Exceeds criteria, potential severe impairment; EX = Exceeds criteria (Bacteria).

Abbreviations for Use Support Determinations: NA = Not Assessed, IF = Insufficient Information, NS = Non-Support, FS = Full Support

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

Aquatic life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50 percent) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

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Table 59. Minnesota Stream Habitat Assessment (MSHA): Gull Lake 11-HUC.

# 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	10UM051	Gull River	3.5	14	21.4	12	31	81.9	Good
1	10UM097	Home Brook	4.5	13	21.8	12	28	79.3	Good
1	10UM052	Crow Wing River	5	14.5	21.8	8	27	76.3	Good
1	10UM096	Corey Brook	4.5	14	17.2	15	22	72.7	Good
Average Habitat Results: *Gull Lake 11 HUC*			**4.4**	**13.9**	**20.6**	**11.8**	**27**	**77.6**	**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 60. Outlet water chemistry results: Gull Lake 11-HUC.

Station location:	**Gull River at Great River Rd, 5 mi NW of Baxter**							
STORET/EQuIS ID:	**S005-799**							
Station #:	**10UM051**							
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**Median**	**WQ Standard[1]**	**# of WQ Exceedances[2]**
Ammonia-nitrogen	mg/L	10	<0.04	0.1	0.05	0.05		
Chloride	mg/L						230	
Chlorophyll-a, Corrected	ug/L							
Dissolved Oxygen (DO)	mg/L	21	1.8	9.4	5.6	5.1	5	9
Escherichia coli	MPN/100ml	16	10	770	199	58	126/1260	
Inorganic nitrogen (nitrate and nitrite)	mg/L	10	<0.02	<0.02				
Kjeldahl nitrogen	mg/L	10	<0.05	1.5	1	1		
Orthophosphate	ug/L							
pH		21	7.2	8.5	7.5	7.5	6.5-9.0	
Pheophytin-a	ug/L							
Phosphorus	ug/L	10	0.03	0.09	0.04	0.04		
Specific Conductance	uS/cm	21	222	290	245	242		
Temperature, water	deg °C	21	10.8	25.8	18.7	20.1		
Total suspended solids	mg/L	10	1	3	2	2	100	
Total volatile solids	mg/L	10	<1	<1				
Transparency tube	100 cm	22	80	>100	99	100	20	
Transparency tube	60 cm						>20	
Turbidity	FNU						25	
Sulfate	mg/L							
Hardness	mg/L							

[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 Gull Lake 11 HUC, a component of the IWM work conducted between May and September in 2010 and 2011. This specific data does not necessarily reflect all data that was used to assess the AUID.

Table 61. Outlet water chemistry results: Gull Lake 11-HUC.

Station location:	**Crow Wing River at CR 36 at Sylvan Dam, 9 mi SW of Brainerd**							
STORET/EQuIS ID:	**S001-926**							
Station #:	**S001-926**							
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**Median**	**WQ Standard[1]**	**# of WQ Exceedances[2]**
Ammonia-nitrogen	mg/L	11	<0.04	0.08	0.05	0.05		
Chloride	mg/L	10	9	14	11	11		
Chlorophyll-a, Corrected	ug/L							
Dissolved Oxygen (DO)	mg/L	43	6.9	11.2	8.3	7.9	5	
Escherichia coli	MPN/100ml	12	6	1046	117	17	126/1260	
Inorganic nitrogen (nitrate and nitrite)	mg/L	32	0.05	0.4	0.8	0.8		
Kjeldahl nitrogen	mg/L	33	0.5	1.9	0.8	0.8		
Orthophosphate	ug/L	25	0.01	0.06	0.03	0.03		
pH		43	7.9	8.8	8.1	8.1	6.5-9.0	
Pheophytin-a	ug/L							
Phosphorus	ug/L	33	0.03	0.1	0.06	0.06		
Specific Conductance	uS/cm	43	292	481	414	422		
Temperature, water	deg °C	43	7.4	25.5	19.1	20.6		
Total suspended solids	mg/L	33	1.6	8.4	4	4	100	
Total volatile solids	mg/L	33	1	4	2.3	2		
Transparency tube	100 cm	46	85	>100	98	100	20	
Transparency tube	60 cm						>20	
Turbidity	FNU						25	
Sulfate	mg/L	12	3	7	4	3		
Hardness	mg/L							

[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 Gull Lake 11 HUC, a component of the IWM work conducted between May and September in 2010 and 2011. This specific data does not necessarily reflect all data that was used to assess the AUID.

Table 62. Lake water aquatic recreation assessments: Gull Lake 11-HUC.

Name	DOW#	Area (ha)	Trophic Status	Percent Littoral	Max. Depth (M)	Avg. Depth (M)	CLMP Trend	Mean TP (µg/L)	Mean chl-a (µg/L)	Secchi Mean (M)	Support Status
Agate	11-0216-00	62	M	100	3.7	1.1	NT	14	2	3.3	FS
Margaret	11-0222-00	98	E	29	7.9	3.3	NT	77	26	1.4	NS
Sylvan (SW Bay)	11-0304-01	176	M	100	13.4	3.0	NT	14	3	5.1	FS
Sylvan (NE Bay)	11-0304-02	180	M		17.4	7.7	NT	9	1	6.0	FS
Gull	11-0305-00	3,994	M	30	21.3	9.8	NT	22	9	3.2	FS
Rock	11-0324-00	102	M	98	5.2	1.8	IF	21	6	2.2	FS
Unnamed	11-0777-00	16	E				IF	31		0.8	IF
Unnamed	11-0780-00	5	E				IF	30		2.0	NA
Perch	18-0304-00	66	E	100	2.0		NT	25	5	1.5	FS
Unnamed	18-0333-00	9	M					18			IF
Mollie	18-0335-00	133	E	100	2.0		NT	20	8	1.7	FS
Twin	18-0336-00	26	E				IF	112	21	1.4	NA
Unnamed	18-0337-00	11	E					27	7		IF
Gladstone	18-0338-00	175	M	60	11.0	3.5	NT	17	5	3.5	FS
Moody	18-0339-00	17	M				IF	14	4	3.6	IF
Little Hubert	18-0340-00	76	M	78	12.5	2.7	↑	17	3	4.3	FS
Crystal	18-0341-00	36	E				IF	35	11	1.2	IF
North Long	18-0372-00	2,476	M	65	29.6	4.7	↑	18	5	4.5	FS
Round	18-0373-00	667	E	38	15.5	5.6	NT	25	12	3.2	FS
Clark	18-0374-00	122	M	77	7.6	2.7	NT	21	5	3.0	FS
Hubert	18-0375-00	520	M	36	12.6	7.7	NT	16	3	4.6	FS
White Sand	18-0379-00	172	M	70	7.9	3.0	NT	20	6	3.3	FS
Red Sand	18-0386-00	212	M		4.6	1.1	NT	24	4	3.2	FS
Middle Whipple	18-0387-02	63	M		7.6	2.7	IF	15	4	3.3	FS

Name	DOW#	Area (ha)	Trophic Status	Percent Littoral	Max. Depth (M)	Avg. Depth (M)	CLMP Trend	Mean TP (µg/L)	Mean chl-a (µg/L)	Secchi Mean (M)	Support Status
Love	18-0388-00	30	M	81	8.2	2.3	IF	20	6	2.9	FS
Moburg	18-0389-00	16	M				IF	22	3		IF
Hartley	18-0392-00	54	M				↑	18	2	4.6	FS
Bass	18-0402-00	15	M	89	5.5	2.1	IF	23	4	4.0	FS
Unnamed	18-0544-00	6	H				IF	144		0.3	IF
Sylvan (N. Basin)	49-0036-02	25	E			3.2	IF	32	8	2.8	NA

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

Summary

The Gull Lake Subwatershed has a large number of lakes and streams that are well known for the recreational opportunities they provide. Four streams were assessed within this unit and all received a fully supporting status in terms of aquatic life. Corey Brook (AUID 07010106-700) is designated by the MDNR as a coldwater stream but was assessed as a warmwater stream after discussions with MDNR concluded that the assessed reach lacks the ability to support a viable coldwater fish assemblage. Large beaver impoundments throughout the reach increase water temperatures to levels that are unsuitable for coldwater species. While the stream is not coldwater, it does have a quality warmwater fish assemblage consisting of eight fish species including two sensitive species, pearl and northern red-belly dace. Fish and macroinvertebrate IBI scores as well as habitat scores from all the other streams were excellent.

Assessable water quality data were available for Corey Brook, Home Brook, Gull River and the lower four mile reach of the Crow Wing River. All assessed water chemistry parameters met the standards for aquatic life. However, a limited amount of DO readings from the lower gradient wetland dominated systems like Corey Brook and the Gull River indicate that the standard may be exceeded at times. Corey Brook did not support aquatic recreation due to high bacteria levels; however, the presence of several beaver impoundments may be an influence and should be investigated. An additional bacterial impairment was observed downstream in Home Brook and there is evidence that E. coli levels may be high upstream and downstream from the Corey Brook confluence. The Gull River and Crow Wing River AUIDs were both supporting of aquatic recreational use.

The Gull Lake Subwatershed contains 72 lakes greater than four hectares (ten acres), of which 27 were assessed. The lakes are distributed unevenly throughout the watershed, being more concentrated in the eastern half with several large deep lakes. These include Gull Lake, North Long and Round Lake, all of which have extensive residential and resort shoreline development. Additionally, these lakes are popular year round recreational locations. Of the 27 lakes that were assessed only one, Margaret Lake, was determined to be non-supporting of aquatic recreational use. Margaret Lake receives input from a catchment area that is more than one third of the total subwatershed area. Relative to nearby larger lakes with large catchment areas, Margaret Lake lacks the ability to absorb external nutrients. Additionally, profile results indicate that Margaret Lake mixes intermittently during the summer months. This increases the potential for the release of nutrients from re-suspended lake sediment. In addition to the nutrient loads that originate from the wider catchment and internal lake re-suspension, Margaret Lake may receive additional inputs from leaky septic systems.

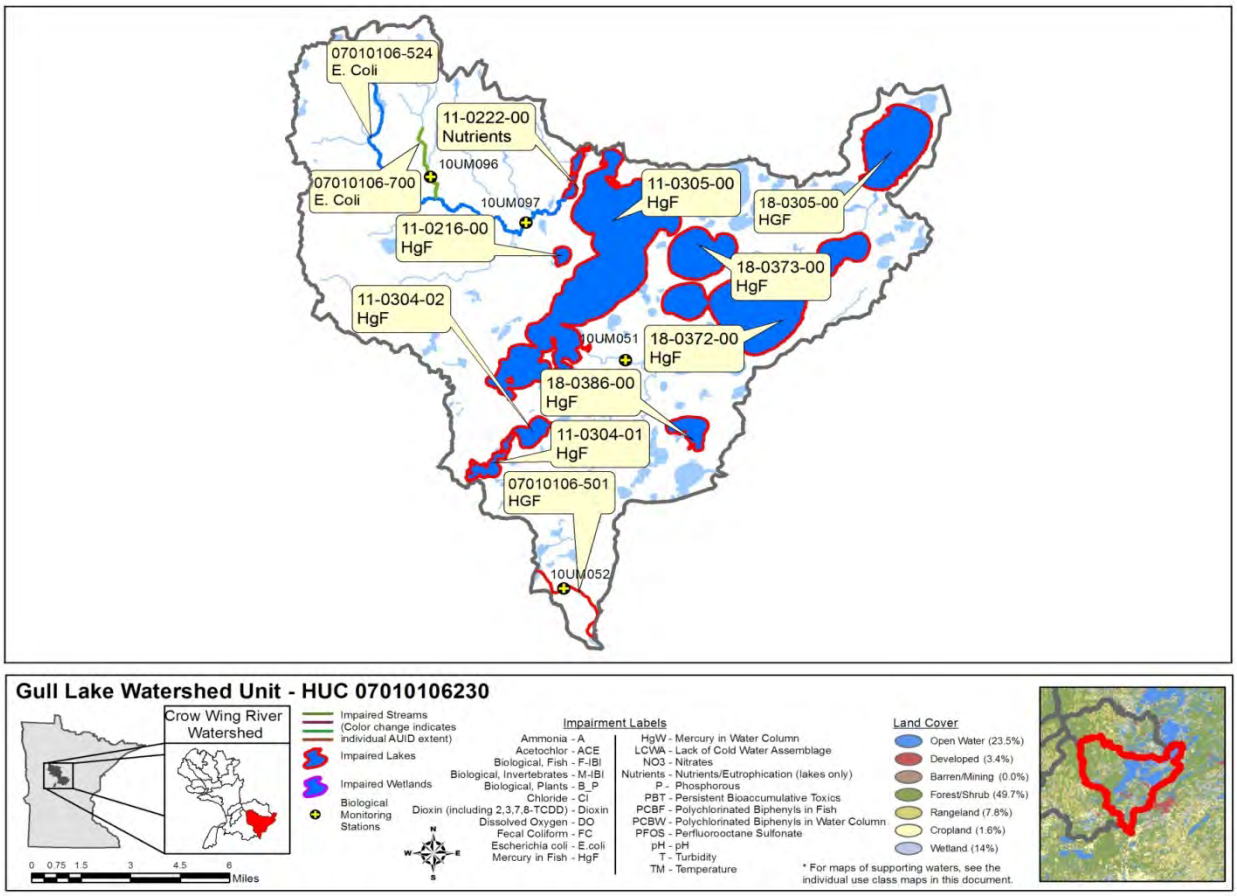

Figure 35. Currently listed impaired waters by parameter and land use characteristics in the Gull Lake Watershed.

Watershed-wide results and discussion

Assessment results and data summaries are included below for the entire HUC-8 watershed of the Crow Wing River, 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 within 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 Crow Wing River Watershed.

Pollutant load monitoring

The Crow Wing River is monitored below the Sylvan Dam east of Pillager, approximately two miles above its confluence with the Mississippi River. 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), each with unique nutrient standards (MPCA 2008). Of the state's three RNR's (North, Central, South), the Crow Wing River's load monitoring station is located within the North RNR. Since the Crow Wing River has tributaries in both the North and Central RNRs, it is listed as a stream for which a Reach Specific Criteria is proposed. This proposed standard will be between the North and Central RNR standard.

Annual FWMCs were calculated and compared for years 2007-2009 (Figures 37-40) and compared to the RNR standards (only TP and TSS draft standards are available for the North and Central 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 ten 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 ten percent 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 dissolved orthophosphate (DOP) can be attributed to both "non-point" as well as "point", or end of pipe, sources such as industrial or waste water treatment plants. Major "non-point" sources of phosphorus include dissolved phosphorus from fertilizers and phosphorus adsorbed to and transported with sediment during runoff.

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 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 and DOP and nitrate-N

concentrations tend 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.

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 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 in development and must be considered to be draft standards until approved. Within the North RNR, the river would be considered impaired when greater than 10% of the individual samples exceed the TSS draft standard of 15 mg/L (MPCA 2011); in the Central RNR the river would be considered impaired when greater that 10% of the individual samples exceed the TSS draft standard of 30 mg/L (MPCA 2011). None of the individual TSS samples from 2007 through 2009 exceeded the draft standards. In addition, none of the computed FWMC's for the three sampling years exceeded the 15 mg/L or 30ug/L draft standards, (Figure 37). The highest concentrations occurred in spring and late summer. Table 63 displays the total annual loads which indicate TSS FWMC's were higher in 2009, as were the annual loads. Because of the strong correlation that often exists between pollutant loads and annual runoff volume, annual load variations may be due to differences in annual runoff volume (Figure 2) or to timing of high flow events. The annual runoff volume was highest in 2009.

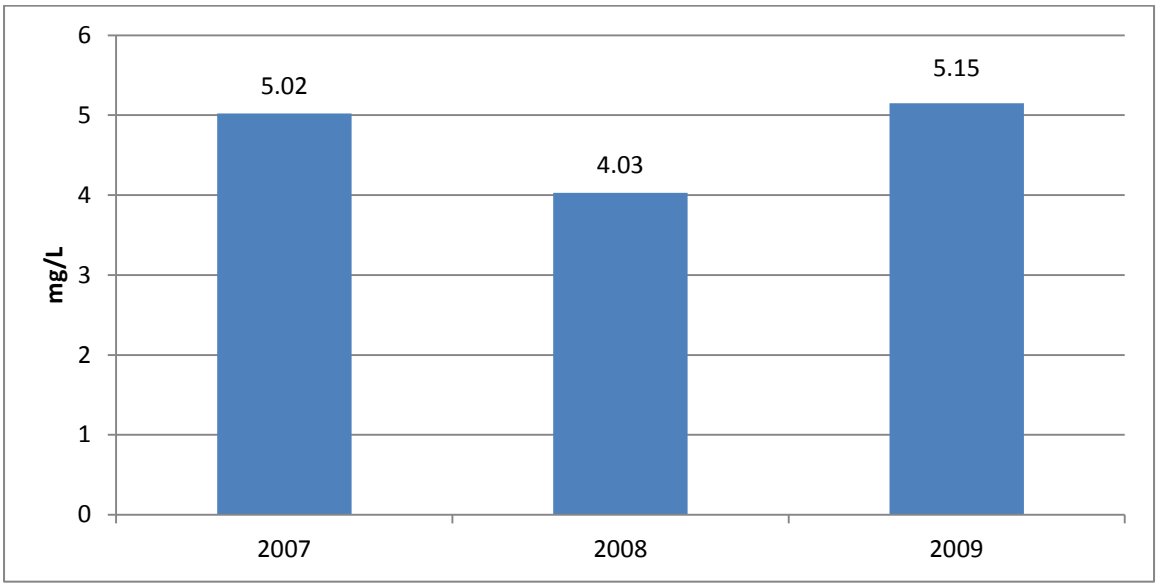

Figure 36. Total suspended solids flow weighted mean concentrations in the Crow Wing River.

Table 63. Annual pollutant loads calculated for the Crow Wing River.

	2007	2008	2009
Parameter	Mass (kg)	Mass (kg)	Mass (kg)
Total Suspended Solids	6,343,800	4,889,851	8,732,596
Total Phosphorus	117,593	67,405	105,812
Ortho Phosphorus	47,244	23,991	34,705
Nitrate + Nitrite Nitrogen	436,267	565,010	589,512

Total phosphorus

Nitrogen, phosphorus, and potassium 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.

Total phosphorus standards for Minnesota's rivers are also in development and must be considered draft standards until approved. Within the North RNR, the TP draft standard is .055 mg/L as a summer average. Within the Central RNR, the TP draft standard is .100 mg/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 as impaired. Thirty eight percent of the individual TP samples from 2007 through 2009 exceeded the .055 mg/L draft standard for the North NR while only 1.7 percent exceeded the Central RNR draft standard. Observation of Figure 38 shows that the FWMCs from 2007 and 2009 exceed the North RNR draft standard but do not exceed the Central RNR draft standard at .093 and .062 mg/L, respectively. The 2008 FWMC does not exceed the draft standard for either RNR at .52 mg/L.

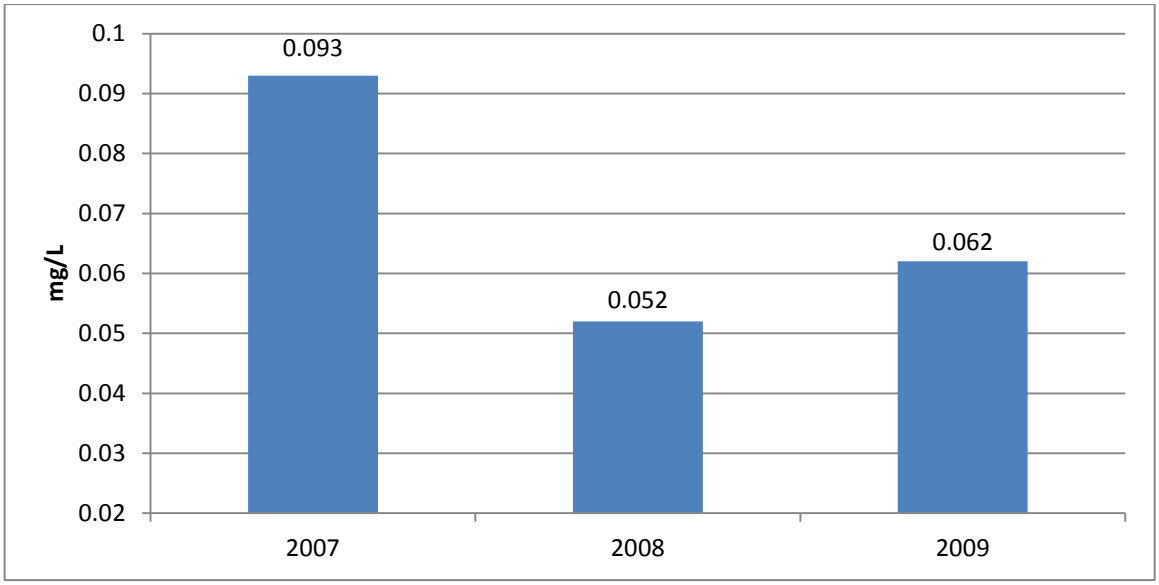

Figure 37. Total phosphorus (TP) flow weighted mean concentrations for the Crow Wing River.

Dissolved orthophosphate

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 waste water treatment plants, noncompliant septic systems, and fertilizers in urban and agricultural runoff. The DOP: TP ratio of FWMCs over the three year period of 2007 through 2009 was 35%. Dissolved Orthophosphate does not appear to be related to annual runoff volume as it is higher in 2007 and about the same in 2008 and 2009. Dissolved Orthophosphate and TP show similar trends over the three year period.

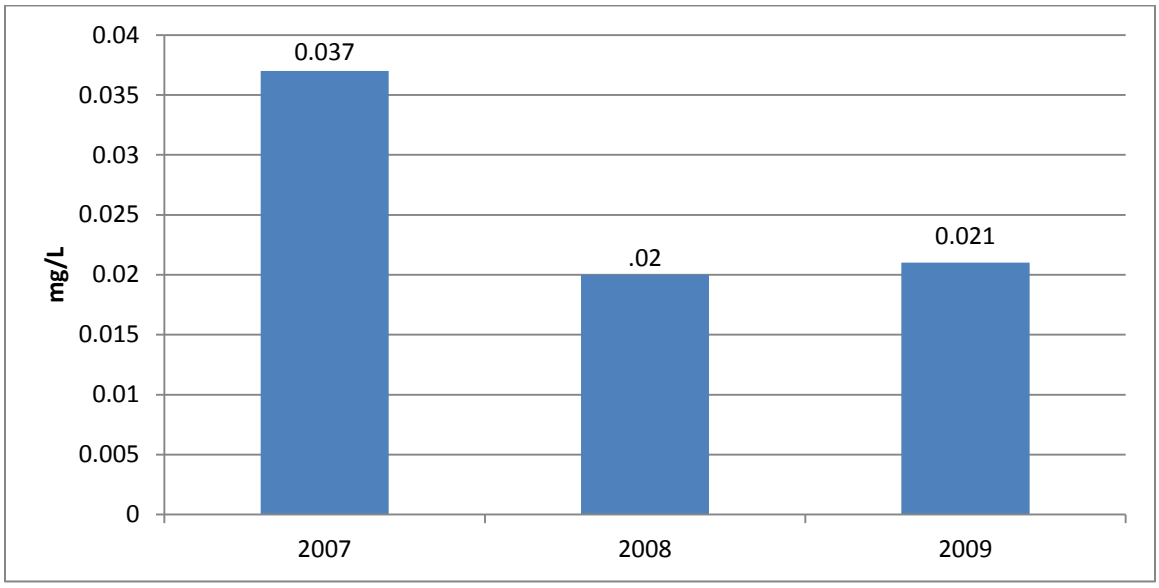

Figure 38. Dissolved orthophosphate (DOP) flow weighted mean concentrations for the Crow Wing River.

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 2008). 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 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 2010).

Figure 40 shows the nitrate-N FWMC's over the three-year period for the Crow Wing River site. The FWMC for all three years were below the draft acute and chronic nitrate-N standards. These values are all well below the proposed standards. Table 4 displays the annual loads which increased over the three years. The annual nitrate-N loads do not show a consistent relationship to the annual runoff volume over the three year sampling period.

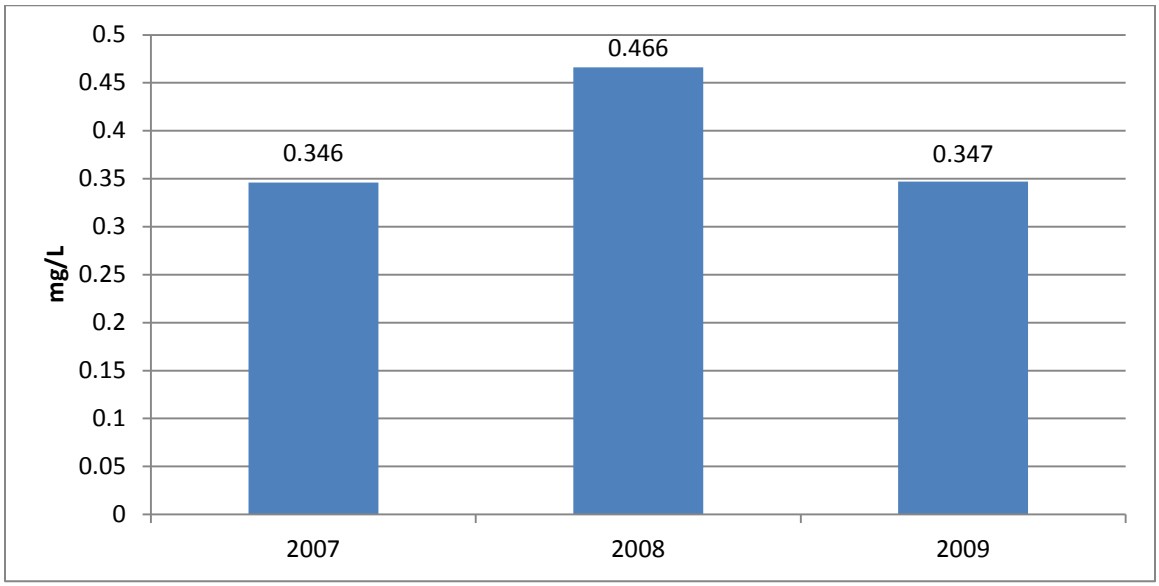

Figure 39. Nitrate +nitrite nitrogen (nitrate-N) flow weighted mean concentrations for the Crow Wing River

Stream water quality

Eighteen stream segments in the Crow Wing River Watershed were found to not support aquatic life and/or recreation. Of those stream segments, nine are non-supporting of aquatic life and ten are non-supporting of aquatic recreation. One stream, Swan Creek, was non-supporting of both aquatic life and aquatic recreation. No turbidity impairments were identified within the Crow Wing Watershed. Two streams, Shell River and Straight River, were impaired due to DO levels. The Straight River was previously listed and recent data supports the previous assessment. High bacteria levels were more common and more prevalent in the southern half of the watershed. In particular Swan Creek, Cat River, Home Brook and the Partridge River had several E. coli exceedences.

Table 64. Assessment summary for stream water quality in the Crow Wing River Watershed.

				Supporting		Non-supporting		
Watershed	Area (acres)	# Total AUIDs	# Assessed AUIDs	# Aquatic Life	# Aquatic Recreation	# Aquatic Life	# Aquatic Recreation	Insufficient Data
07010106 HUC 8	**1,245,241**	**202**	**45**	**32**	**12**	**9**	**10**	**8**
07010106010	78,770	11	2	1	1	1	0	0
07010106020	84,240	4	0	0	0	0	0	0
07010106030	89,769	16	2	2	1	0	0	1-AR
07010106040	76,793	11	4	3	1	1	0	0
07010106050	51,033	11	2	1	1	1	0	0
07010106060	110,384	17	4	1	1	3	0	0
07010106070	29,808	7	1	1	1	0	0	0
07010106080	32,646	7	1	1	1	0	0	0
07010106090	172,447	27	3	3	1	0	0	1-AR
07010106100	40,425	10	3	2	0	0	1	1-AL
07010106110	26,829	23	4	1	2	1	1	2-AL
07010106190	60,430	10	2	1	0	0	1	1-AL
07010106200	31,330	6	1	0	0	1	1	0
07010106210	148,239	34	10	8	0	1	2	1-AR,1-AL
07010106220	88,682	29	3	3	0	0	2	0
07010106230	123,416	17	4	4	2	0	2	0

Lake water quality

Of the 379 lakes greater than four hectares (ten acres), 111 lakes had sufficient data to complete an assessment. Seven of these lakes were determined to be impaired for aquatic recreation due to high nutrient levels. The basin characteristics varied among the impaired lakes with the majority being small and shallow. Profile results from several of the shallow lakes indicated intermittent mixing throughout the open water season re-suspending bottom sediments. This process, when combined with high temperatures and pH, can result in continued internal release of phosphorus into the water column. Additionally, a majority of the impaired lakes lie within large catchment areas with the potential for higher amounts of external nutrient contribution. In contrast, a majority of the supporting lakes were larger with the ability to absorb external nutrients. The deeper basins also limit the amount of internal nutrient release through lake mixing.

Table 65. Assessment summary for lake water chemistry in the Crow Wing River Watershed.

Watershed	Area (acres)	Total Lakes or Reservoirs	Lakes >10 Acres	Lake <10 Acres	Full Support	Non-support	Insufficient Data
Crow Wing River HUC 8	**1,245,755**	**492**	**379**	**4**	**103**	**8**	**31**
Upper Crow Wing	78,737	45	45		16	2	4
Mantrap Lake	84,205	61	61		24		5
Fish Hook River	89,732	46	46		10	1	1
Two Inlets	76,761	58	58		8		1
Straight River	51,012	3	3		1		
Shell River	110,338	26	25	1	10	2	2
Blueberry River	32,633	7	7		1		2
Middle Crow Wing	172,374	48	48		1		2
Lower Crow Wing	148,177	33	32	1	1		1
Upper Gull Lake	88,645	42	42		12	2	6
Gull Lake	123,364	73	72	1	19	1	7

Fish contaminant results

Fish species are identified by codes that are defined by their common and scientific names in Appendix 6.4. In this watershed, mercury has been measured in 21 fish species, PCBs in 14 species, and PFCs in five species.

Appendix 6.5 shows which waterways are impaired for aquatic consumption (i.e., fish contaminants). The contaminants analyzed to determine impairment are mercury (Hg), PCBs, and PFOS. The Crow Wing River is listed as impaired due to mercury in fish tissue, as are 41 of the 46 lakes (89%). Appendix 6.5 also shows the number of fish tested by species. Northern pike (NP) was the most commonly tested fish, followed by walleye (WE), bluegill sunfish (BGS), white sucker (WSU), black crappie (BKS), and largemouth bass (LMB). Northern Pike were tested in all but two of the lakes. Only one lake (Ham) had neither NP nor WE.

Appendix 6.6 is a summary of contaminant concentrations by waterway, fish species, and year. The table shows which contaminants, species, and years were sampled within a given lake. “Total Fish” and “Samples” are shown because many of the panfish, such as bluegill sunfish (BGS) and yellow perch (YP) were composite samples—multiple fish homogenized into a single sample. Sample years ranged from 1983 to 2011. Most of the samples were skin-on fillets (FILSK) or for fish without scales (catfish and bullheads) skin-off fillets (FILET). In 1979, many whole fish (WHORG) were sampled. Since then, many yellow perch were homogenized as whole fish because of their small size.

Mercury was measured in 2,464 fish in 1,024 samples from the Crow Wing River and the 46 lakes. Boot Lake (0300300) had fish with the highest mercury concentrations. A large NP captured in 2011 had a mercury concentration of 2.049 mg/kg. Northern Pike and WE collected from Boot Lake in 2001 had maximum mercury concentrations of 1.4 mg/kg. The grand mean mercury concentration for all fish in the Crow Wing River watershed is 0.165 mg/kg.

PCBs were measured in 85 fish samples from the Crow Wing River and 21 lakes. Total PCB concentrations were generally below the detection limit. The maximum total PCBs concentration was 0.062 mg/kg in a NP from Fish Hook Lake (290244200), collected in 1992. The impairment threshold for PCBs is 0.22 mg/kg.

PFOS was measured in 16 fish from six lakes. All PFOS concentrations were below the detection limit.

Overall, mercury in fish tissue remains a major concern in this watershed, with 89% of the monitored lakes impaired due to mercury in fish. Particularly, NP from some of the lakes had high mercury concentrations. PCBs and PFOS concentrations were mostly below the detection limits or at very low concentrations, therefore they are not a concern for the Crow Wing River Watershed.

Water clarity trends at citizen monitoring sites

Citizen lake monitoring has been performed at 81 sites in the watershed, with most lakes not displaying a trend. Of the lakes displaying a trend, more are improving than declining.

Citizen volunteer monitoring occurs at only one stream in the watershed. Water clarity has shown no trend.

Table 66. Water clarity trends at citizen stream monitoring sites.

Crow Wing River HUC 07010106	Citizen Stream Monitoring Program	Citizen Lake Monitoring Program
Number of sites w/ increasing trend	-	18
Number of sites w/ decreasing trend	-	11
Number of sites w/ no trend	1	52

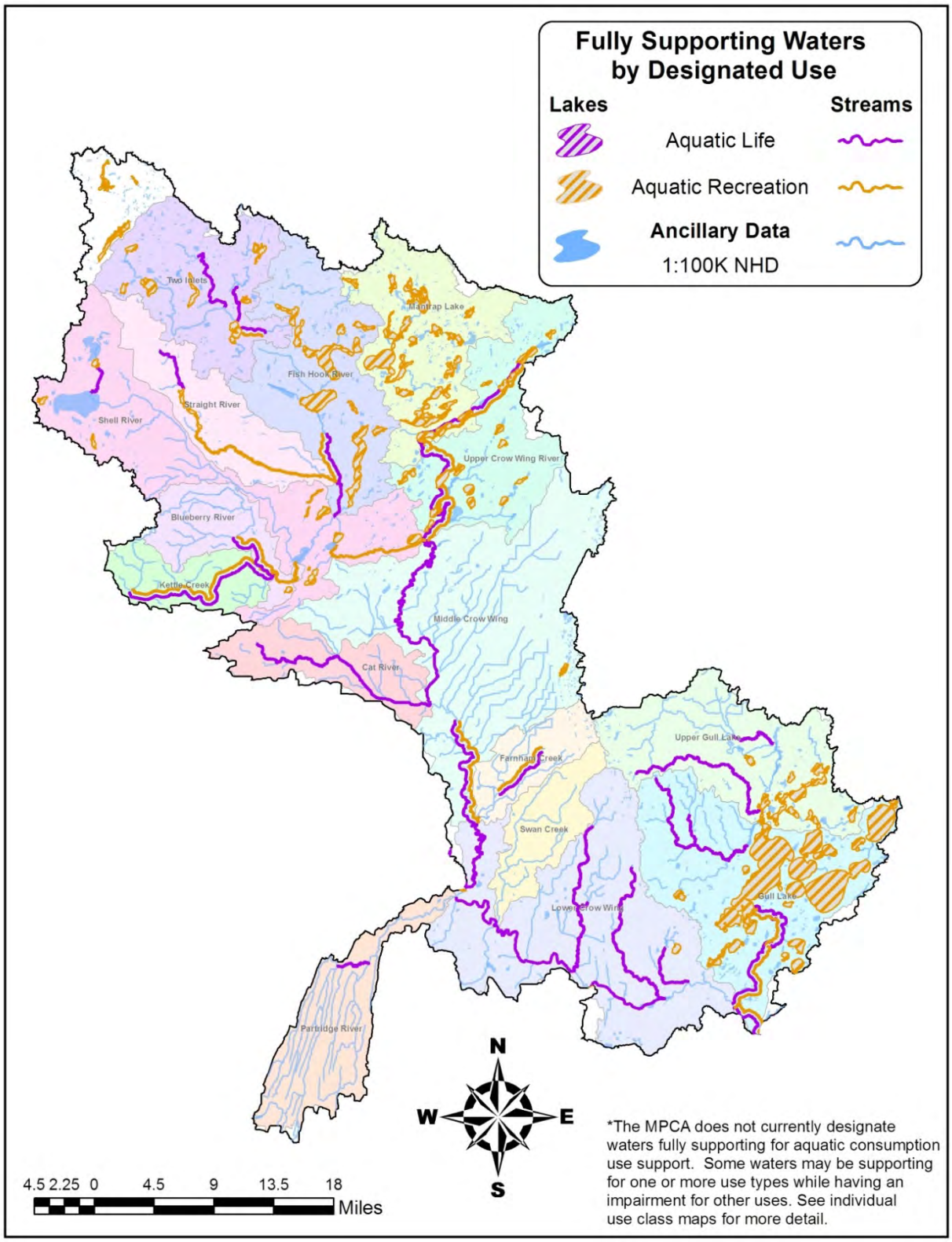

Figure 40. Fully supporting waters by designated use in the Crow Wing River Watershed.

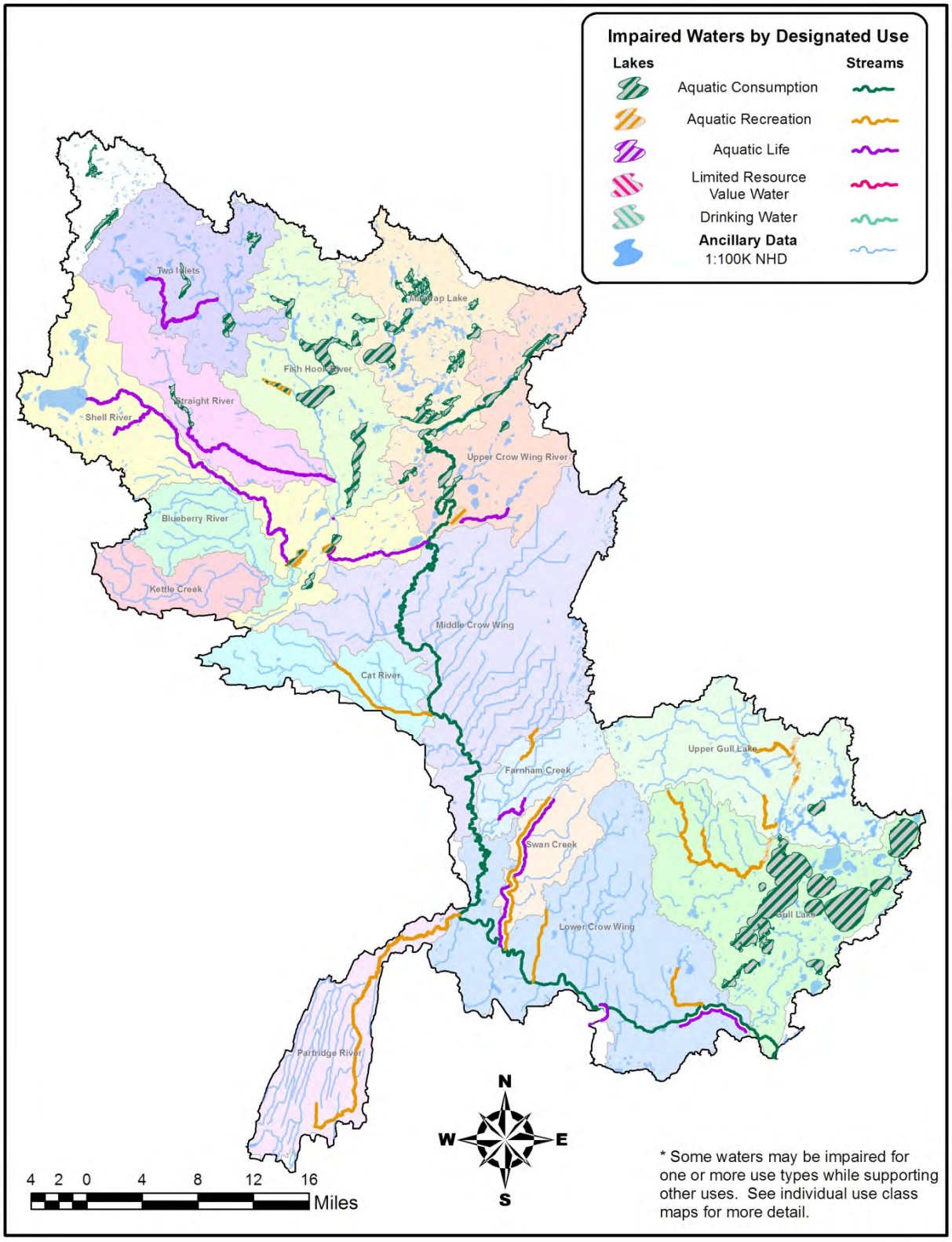

Figure 41. Impaired waters by designated use in the Crow Wing River Watershed

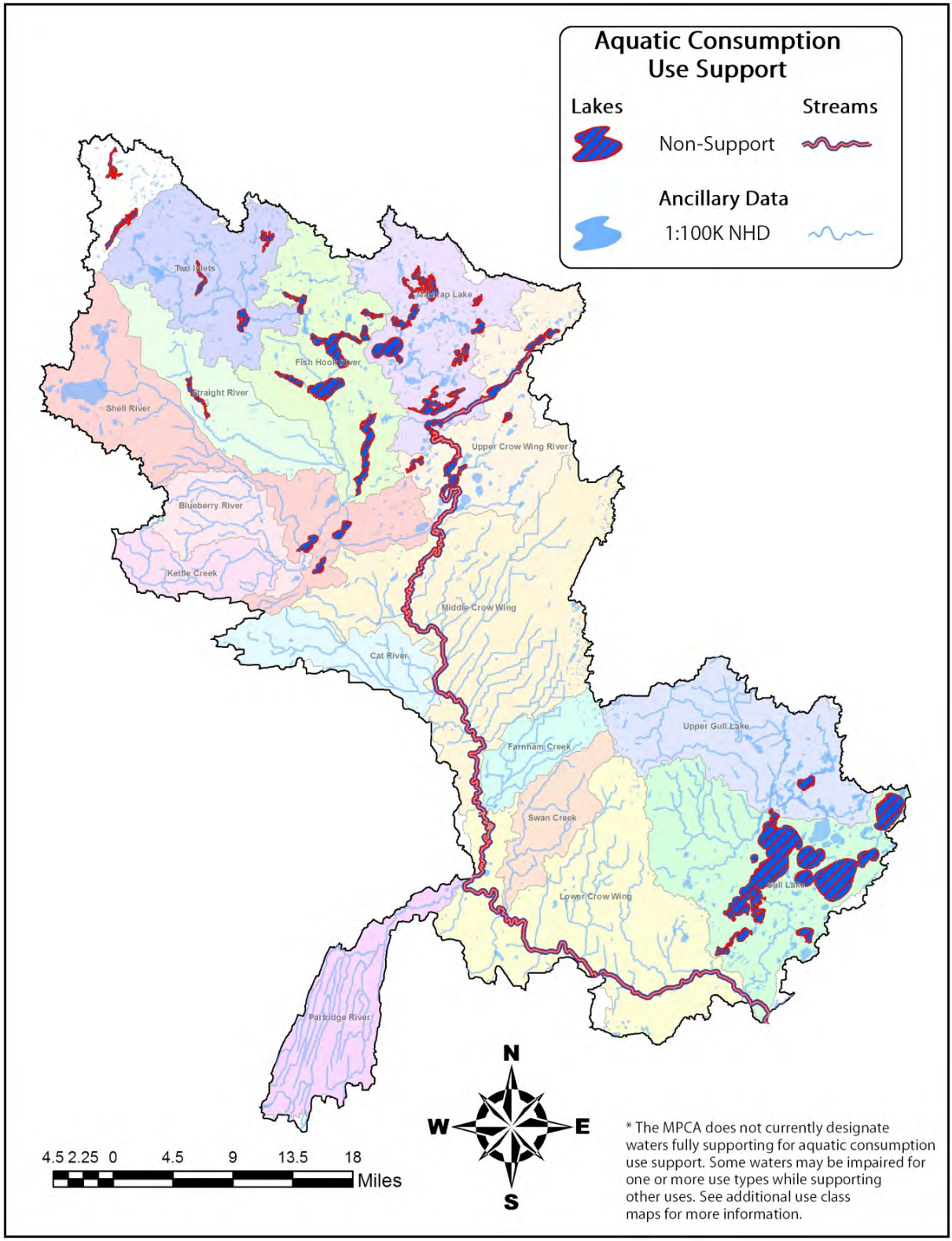

Figure 42. Aquatic consumption use support in the Crow Wing River Watershed.

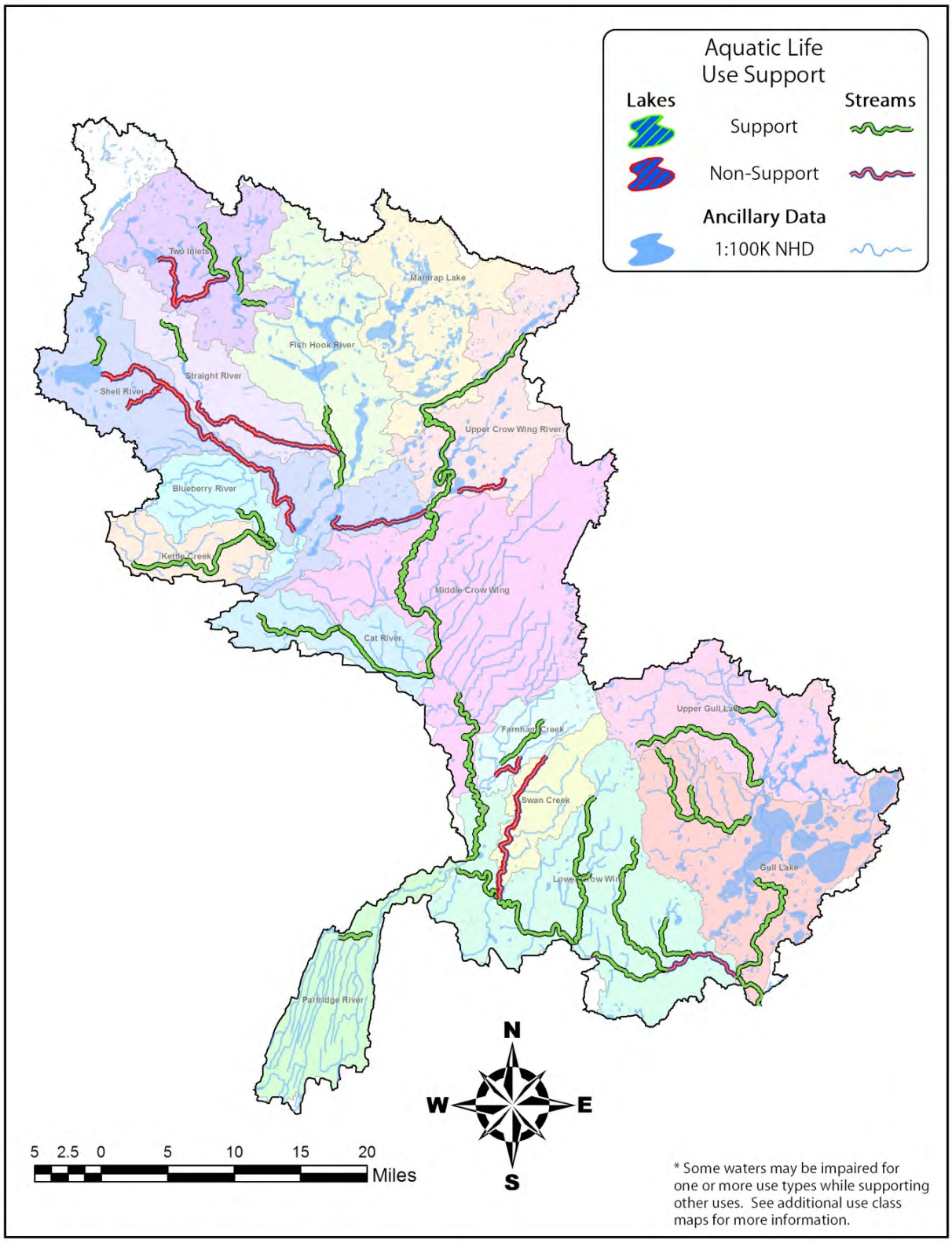

Figure 43. Aquatic life use support in the Crow Wing River Watershed.

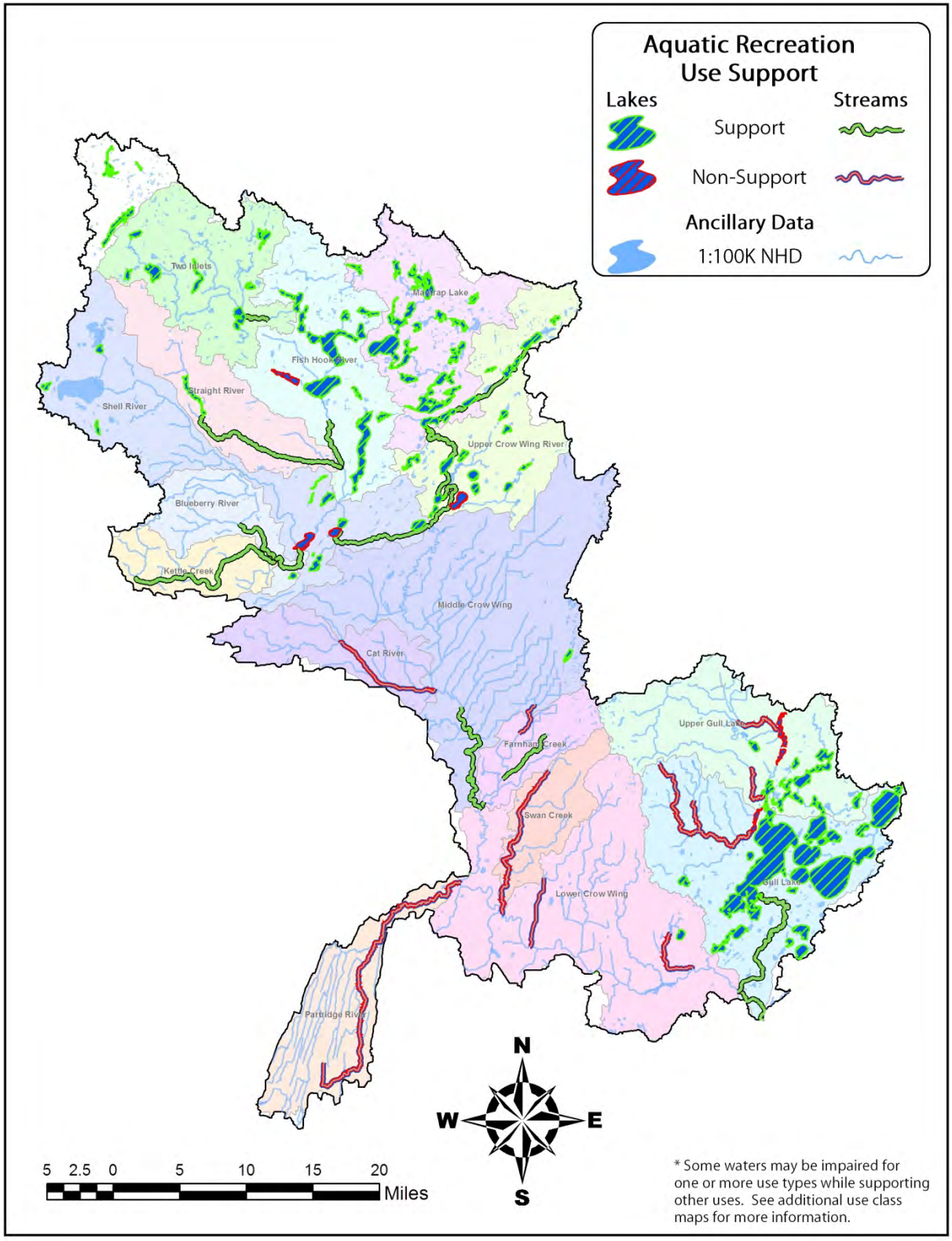

Figure 44. Aquatic recreation use support in the Crow Wing River Watershed.

Summaries and Recommendations

Fish

As a whole, fish assemblages within the Crow Wing River Watershed were in good biological condition. There have been 76 fish species documented historically within the entire Upper Mississippi River Basin and the Crow Wing River Watershed survey in 2010 yielded 56 of those species (Appendix 1). The white sucker was the most common species, identified at 60 sampling locations. Other more commonly sampled species included the central mudminnow, blacknose dace, common shiner, creek chub, hornyhead chub, and johnny darter. In terms of game fish, northern pike, largemouth and smallmouth bass, black crappie, bluegill, and walleye were identified at several stations. Cold/cool water species such as brook and brown trout, and mottled sculpin were identified in a majority of reaches that were previously known to support such assemblages. Certain species occurred at a limited number of sites such as the banded killifish, blacknose and blackchin shiner, and hybridized dace. These species are relatively intolerant to stressors and some like the banded killifish are known as a more lake dwelling species. The presence of this species within the sample is not surprising given the high preponderance of lakes within the Crow Wing River Watershed.

Coldwater streams in this region of Minnesota are particularly susceptible to disturbances that warm the water temperature (e.g. riparian disturbance, flow disruption). Historically, several of the reaches within the watershed were managed and stocked as trout fisheries (Stoney Brook, Martin Creek, Cat River, Corey Brook, Farnham Creek and the Straight River). Although much of the trout stocking efforts have ceased within the watershed, several of the reaches maintain healthy, naturally reproducing populations. The Straight River in particular remains one of the best trout fisheries in central Minnesota and Stoney Brook provides an excellent coldwater fishery as well. The capability of some of these reaches to support a coldwater assemblage appears to be compromised by beaver impoundments that slow flow and warm water temperatures to a level that exceeds the thermal tolerance level of these species. Management practices to control and minimize the impact of beavers would help to extend some of the coldwater reaches. However, these management strategies are costly and would need to be maintained long term to remain effective.

The least darter (*Ethiostoma microperca*), which is a Minnesota species of special concern, was identified within fish samples collected at biological stations located on Hay Creek, Dinner Creek, Gull River, Kettle Creek, Fishhook River, as well as the Crow Wing River. This relatively rare fish species is intolerant of pollution and therefore a good indicator of the overall health of the watershed.

Macroinvertebrates

The Crow Wing River Watershed contains a diverse group of aquatic macroinvertebrates. During the 2010 intensive watershed monitoring effort a total of 272 unique macroinvertebrate taxa were encountered. Macroinvertebrates were sampled from many habitats including; undercut banks/overhanging vegetation, aquatic macrophytes, riffle/rock and woody debris. The most frequently observed macroinvertebrate taxa within this watershed are: *Simulium* (Diptera), *Hyalella* (Amphipoda), *Polypedilum* (Diptera), *Physa* (Gastropoda) and *Cheumatopsyche* (Trichoptera). Twenty-four taxa were common to fifty% of sites sampled. The most abundant taxa (total number of organisms) are: *Hyallela* (2625), *Simulium (*1238), *Iswaeon* (938), *Rheotanytarsus* (742), *Hydrobiidae* (547), *Baetis brunneicolor* (452), *Leptophlebiida*e (416), *Pseudocloeon propinquum* (396), *Helocopsyche borealis* (367), *Chematopsyche* (362) and *Polypedilum* (352). Many of these taxa are ubiquitously distributed throughout lentic ecosystems across Minnesota. *Helicopsyche borealis*, *Iswaeon* and *Leptophlebiidae* are sensitive macroinvertebrate species, found in good numbers throughout this watershed. Several other intolerant/sensitive taxa were observed throughout the watershed and were often encountered in single digit numbers.

Faucet snails (*Bithynia tentaculata*) were found in high abundance on the Crow Wing River (10UM110). These snails are an invasive species that were brought into the Great Lakes in the 1870's plausibly via ballast water. The faucet snail is the intermediate host of two trematode parasites (*Cyathocotyle bushiensis* and *Sphaeridiotrema globulus*) which cause mortality in waterfowl and other waterbirds when ingested. Mass waterfowl die offs have been attributed to ingestion of these trematodes, and with the range of the intermediate host (faucet snails) of these flukes now spreading west throughout the major waterfowl flyway, the rate and severity of these kills are likely to increase. Steps to control this invasive species are being taken very seriously at a multi-agency level.

Recommendations

The Crow Wing River Watershed is in overall good condition, suggesting that efforts that focus on protection strategies will be an important ongoing consideration for water managers. Protecting the many high quality lakes and diverse biological assemblages found in streams throughout the watershed by emphasizing maintenance of good habitat and water quality characteristics that enable these organisms to carry out various life functions (i.e. reproduction, feeding etc.), will help ensure that the region's environment and tourism economy remain healthy. Fish species like the walleye and northern pike are a highly prized recreational resource in many of the region's lakes and streams and therefore very important to the local economy. These fish populations will be fostered if spawning habitat for natural reproduction is adequately protected. Important spawning habitat for many game and forage fish species includes both emergent lake vegetation and coarse substrates in streams (which is required by lithophilic spawners). Preventative measures and practices such as buffering stream and or lake shorelines and not removing in-water vegetation can help provide habitat and prevent erosion and sedimentation that embeds coarse substrates.

Exotic species are of particular concern in the Crow Wing River Watershed. Species such as the faucet snail as well as Eurasian water milfoil have been reported in the watershed and will have a deleterious effect on the ecosystem if allowed to expand unchecked. Once an invasive species makes its way into another body of water, it is nearly impossible to completely eradicate it without decimating all the other species present, so preventing the spread becomes the key. Practices that prevent the spreading of exotic species need to be employed such as draining boat live-wells and removing all vegetation from boats and trailers. It is also beneficial to let equipment (i.e docks, boats, etc.) that has been in a body of water dry for several days after it has been cleaned prior to transferring it into another body of water. State agencies such as the MNDNR provide information regarding the identification and known location of invasive species throughout Minnesota.

The Crow Wing River Watershed remains a valuable resource to this day, and by taking certain steps to maintain the overall health and integrity of these waters, we can help ensure that this resource will remain healthy for years to come.

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Appendix 1. Fish species identified during biological monitoring efforts within the Crow Wing River Watershed in 2010

Species	Site Presence
Banded Killifish	1
Bigmouth Shiner	18
Black Bullhead	6
Black Crappie	5
Blackchin Shiner	1
Blacknose Dace	47
Blacknose Shiner	20
Bluegill	13
Bluntnose Minnow	18
Bowfin	1
Brassy Minnow	21
Brook Stickleback	45
Brook Trout	2
Brown Bullhead	1
Brown Trout	5
Burbot	22
Central Mudminnow	57
Central Stoneroller	3
Common Carp	8
Common Shiner	51
Creek Chub	49
Fathead Minnow	28
Finescale Dace	10
Gen. Redhorses	1
Golden Shiner	5
Greater Redhorse	9
Green Sunfish	6
Hornyhead Chub	36
Hybrid Dace	1
Hybrid Sunfish	4
Iowa Darter	8
Johnny Darter	59
Largemouth Bass	25
Least Darter	7
Logperch	20
Longnose Dace	11
Mimic Shiner	3
Mottled Sculpin	28
Northern Pike	28
Northern Redbelly Dace	39
Pearl Dace	28
Pugnose Shiner	4
Pumpkinseed	8
Rock Bass	24
Shorthead Redhorse	13
Silver Redhorse	7
Smallmouth Bass	12
Spotfin Shiner	13
Spottail Shiner	2
Tadpole Madtom	14
Trout Perch	2
Walleye	16
Weed Shiner	2
White Sucker	60
Yellow Bullhead	7
Yellow Perch	23
Mottled Sculpin	28
Northern Pike	28
Northern Redbelly Dace	39
Pearl Dace	28
Pugnose Shiner	4
Pumpkinseed	8
Rock Bass	24
Shorthead Redhorse	13
Silver Redhorse	7
Smallmouth Bass	12
Spotfin Shiner	13
Spottail Shiner	2
Tadpole Madtom	14
Trout Perch	2
Walleye	16
Weed Shiner	2

Appendix 2 - Water chemistry definitions

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

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

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

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

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

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

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

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

Total 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 comes in contact with water, ammonia dissociates into $NH4^{+}$ ions and ^{-}OH ions (ammonium hydroxide). If pH levels increase, the ammonium hydroxide becomes toxic to both plants and animals.

Appendix 3 - Intensive watershed monitoring water chemistry stations in the Crow Wing River Watershed

Biological Station ID	STORET/ EQuIS ID	Waterbody Name	Location	11-digit HUC
10UM041	S002-960	Straight River	At US Hwy 71, 3 m. S of Park Rapids	07010106050
10UM040	S003-502	Kettle Creek	At CR 156, 3 mi. NW of Menagha	07010106070
10UM046	S004-789	Crow Wing River	Upstream of CR 109, 3 mi. N of Huntersville	07010106010
10UM043	S006-251	Fish Hook River	At CR 15, .5 mi. SE of Park Rapids	07010106030
10UM044	S006-252	Hay Creek	At CR 152, 2 mi. SE of Two Inlets	07010106040
10UM049	S000-176	Crow Wing River	At CR 1, at Pillager	07010106210
00UM025	S003-501	Blueberry River	Upstream of CR 16, 3 mi. NW of Menahga	07010106080
10UM051	S005-799	Gull River	At Great River Rd, 5 mi. NW of Baxter	07010106230
10UM047	S002-408	Cat River	Upstream of CR 12, 1 mi. S of Nimrod	07010106100
10UM050	S002-961	Partridge River	At CR 29, 4.5 mi. NW of Staples	07010106190
00UM027	S003-442	Shell River	Downstream of CR 24, 7 mi. NE of Menahga	07010106060
10UM122	S004-065	Farnham Creek	Downstream of CR 30, 10 mi. N of Staples	07010106110
10UM048	S005-731	Crow Wing River	At CR 7, 10 mi. N of Staples	07010106090
	S001-926	Crow Wing River	At CR 36 at Sylvan Dam, 9 mi. SW of Brainerd	07010106230
	S006-293	Swan Creek	At CR 32, 3 mi. N of Staples	07010106200

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

AUID DESCRIPTIONS				USES					BIOLOGICAL CRITERIA		WATER QUALITY STANDARDS										ECOREGION EXPECTATIONS			
National Hydrography Dataset (NHD) Assessment Segment AUID	Stream Segment Name	Segment Description	NHD Length (Miles)	Use Class	Aquatic Life	Aquatic Recreation	Aquatic Consumption	Class 7	Fish	Macroinvertebrates	Acetochlor	Alachlor	Atrazine	Chloride	Bacteria (Aquatic ecreation)	Metolachlor	Dissolved Oxygen	pH	Turbidity	Un-ionized ammonia	Oxygen Demand (BOD)	Nitrite/Nitrate	Total Phosphorous	Suspended Solids
HUC 11: 07010106-010 Upper Crow Wing River																								
07010106-523	Crow Wing River	Headwaters (Eleventh Crow Wing Lk 29-0036-00) to Shell R	27.79	2B,3C	FS	FS	-		MTS	MTS				MTS	MT	-	IF	MTS	MT	MT				
07010106-691	Bender Creek	Unnamed lk (29-0608-00) to First Crow Wing Lk	4.74	2B,3C	NS**	NA	-		EXS	EXP				-	-	-	IF	IF	IF	MT				
HUC 11: 07010106-030 Fish Hook River																								
07010106-542	Fish Hook River	Straight R to Shell R	3.52	2B,3C	FS	IF	-		MTS	MTS				-	IF	-	IF	IF	MT	MT				
07010106-543	Fish Hook River	Park Rapids Dam to Straight R	6.08	2B,3C	FS	FS	-		MTS	MTS				MTS	MT	-	IF	MTS	MT	MT				
HUC 11: 07010106-040 Two Inlets																								
07010106-568	Basswood Creek	Unnamed lk (03-0665-00) to Indian Cr	7.66	2C	FS	NA	-		MTS	MTS				-	-	-	IF	IF	IF	-				
07010106-569	Indian Creek	Big Basswood Lk to Basswood Cr	13.88	2C	FS	NA	-		IF	MTS				-	-	-	IF	IF	IF	-				
07010106-690	Dinner Creek	Little Dinner Lk to Two Inlets Lk	3.76	2B,3C	FS	NA	-		MTS	-				-	-	-	IF	IF	IF	-				
07010106-617	Hay Creek	Two Inlets Lk to Unnamed lk (29-0554-00)	2.5	2B,3C	FS	FS	-		MTS	MTS				MTS	MT	-	IF	MTS	MT	MT				

Full Support (FS); Not Supporting (NS); Insufficient Data (IF); Not Assessed (NA); Meets standards or ecoregion expectations (MT/MTS), Potential Exceedence (EXP), Exceeds standards or ecoregion expectations (EX/EXS).
Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use. *
Aquatic life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50%) channelized or having biological data limited to a station occurring on a channelized portion of the stream.
† Double asterisk (**) = Placed in 4E category with additional monitoring recommended to determine if impairment is due to Natural Background factors.

AUID DESCRIPTIONS				USES					BIOLOGICAL CRITERIA		WATER QUALITY STANDARDS										ECOREGION EXPECTATIONS		
National Hydrography Dataset (NHD) Assessment Segment AUID	Stream Segment Name	Segment Description	NHD Length (Miles)	Use Class	Aquatic Life	Aquatic Recreation	Aquatic Consumption	Class 7	Fish	Macroinvertebrates	Acetochlor	Alachlor	Atrazine	Chloride	Bacteria (Aquatic Recreation)	Metolachlor	Dissolved Oxygen	pH	Turbidity	Un-ionized ammonia	Nitrite/Nitrate	Total Phosphorous	Suspended Solids
HUC 11: 07010106-050 Straight River																							
07010106-517	Straight River	Headwaters to Straight Lk	4.61	1B,2A,3B	FS	NA	-		MTS	-	-	-	-	-	-	-	IF	IF	IF	-			
07010106-558	Straight River	Straight Lk to Fish Hook R	16.98	1B,2A,3B	NS	FS	IF		MTS	MTS	-	-	-	MTS	MT	-	EXS	EXP	MTS	MT			
HUC 11: 07010106-060 Shell River																							
07010106-597	Fish Creek	Aspinwall Lk to Shell Lk	2.89	2B,3C	FS	NA	-		MTS	MTS	-	-	-	-	-	-	IF	-	-	-			
07010106-553	Unnamed creek	Headwaters to Shell R	4.38	2B,3C	NS*	NA	-		-	EXP	-	-	-	-	-	-	-	-	-	-			
07010106-681	Shell River	Lower Twin Lk to Crow Wing R	9.16	2B,3C	NS	FS	-		MTS	MTS	-	-	-	-	MT	-	EXP	MT	MTS	MT			
07010106-537	Shell River	Shell Lk to Blueberry Lk	30.49	2B,3C	NS	-	-		EXS	MTS	-	-	-	-	-	-	MTS	MT	MTS	MT			
HUC 11: 07010106-070 Kettle River																							
07010106-541	Kettle River	Unnamed cr to Blueberry R	20.45	2C	FS	FS	-		MTS	MTS	-	-	-	MTS	MT	-	-	-	MTS	MT			
HUC 11: 07010106-080 Blueberry River																							
07010106-586	Blueberry River	Unnamed cr to Unnamed cr	4.43	2C	NA	-	-		-	-	-	-	-	-	-	-	-	-	-	-			
07010106-554	Blueberry River	Unnamed cr to Kettle R	7.43	2C	FS	FS	-		MTS	MTS	-	-	-	-	MT	-	IF	MT	MTS	MT			

AUID DESCRIPTIONS				USES					BIOLOGICAL CRITERIA		WATER QUALITY STANDARDS										ECOREGION EXPECTATIONS		
National Hydrography Dataset (NHD) Assessment Segment AUID	Stream Segment Name	Segment Description	NHD Length (Miles)	Use Class	Aquatic Life	Aquatic Recreation	Aquatic Consumption	Class 7	Fish	Macroinvertebrates	Acetochlor	Alachlor	Atrazine	Chloride	Bacteria (Aquatic Recreation)	Metolachlor	Dissolved Oxygen	pH	Turbidity	Un-ionized ammonia	Nitrite/Nitrate	Total Phosphorous	Suspended Solids
HUC 11: 07010106-090 Middle Crow Wing River																							
07010106-516	Crow Wing River	Shell R to Big Swamp Cr	20.5	2B,3C	FS	FS	-		MTS	-	-	-	-	-	-	-	IF	IF	MTS	-			
07010106-555	Unnamed ditch	Unnamed cr to Unnamed cr	2.31	2B,3C	NA	NA	-		-	-	-	-	-	-	-	-	-	-	-	-			
07010106-683	Unnamed ditch	Unnamed cr to Big Swamp cr	1.87	2B,3C	NA	NA	-		-	-	-	-	-	-	-	-	IF	IF	MTS	-			
07010106-531	Big Swamp Creek	Headwaters to Crow Wing R	15.48	2C	NA	NA	-		-	-	-	-	-	-	-	-	-	IF	MTS	-			
07010106-515	Crow Wing River	Big Swamp Cr to Cat R	2.64	2B,3C	FS	IF	-		MTS	MTS	-	-	-	-	-	-	MTS	MT	MTS	MT			
07010106-688	Unnamed creek	Headwaters to Beaver cr	8.05	2B,3C	NA	NA	-		NA	NA	-	-	-	-	-	-	-	-	-	-			
07010106-530	Beaver Creek	Unnamed ditch to Crow Wing R	6.9	2C	NA	NA	-		-	-	-	--	-	-	-	-	-	-	-	-			
07010106-689	Unnamed creek	Unnamed ditch to Crow Wing R	5.03	2B,3C	NA	NA	-		-	-	-	-	-	-	-	-	-	-	-	-			
07010106-513	Crow Wing River	Beaver Cr to Farnham Cr	12.36	2B,3C	FS	FS	-		MTS	MTS	-	-	-	-	MT	-	IF	MT	MTS	MT			

AUID DESCRIPTIONS				USES						BIOLOGICAL CRITERIA		WATER QUALITY STANDARDS											ECOREGION EXPECTATIONS		
National Hydrography Dataset (NHD) Assessment Segment AUID	Stream Segment Name	Segment Description	NHD Length (Miles)	Use Class	Aquatic Life	Aquatic Recreation	Aquatic Consumption	Class 7		Fish	Macroinvertebrates	Acetochlor	Alachlor	Atrazine	Chloride	Bacteria (Aquatic Recreation)	Metolachlor	Dissolved Oxygen	pH	Turbidity	Un-ionized ammonia		Nitrite/Nitrate	Total Phosphorous	Suspended Solids
HUC 11: 07010106-100 Cat River																									
07010106-545	Cat River	Headwaters to T137 R35W S13, east line	6.21	1B,2A,3B	NA	NA	-			-	-	-	-	-	-	-	-	-	-	-	-				
07010106-546	Kitten Creek	Headwaters to Cat R	10.11	2C	FS	NA	-			MTS	-							IF	IF	IF	-				
07010106-687	Unnamed creek	Unnamed ditch to Crow Wing R	3.12	2B,3C	IF	NA	-			IF	MTS	-	-	-	-	-	-	IF	IF	IF	-				
07010106-544	Cat River	Kitten Cr to Crow Wing R	9.31	2C	FS	NS				MTS	MTS	-	-	-	-	EX	-	IF	MT	MTS	MT				
HUC 11: 07010106-110 Farnham Creek																									
07010106-702	Farnham Creek	Unnamed ditch to T136 R32W S21, west line	2.96	1B,2A,3B	IF	NS	IF			-	-	-	-	-	MT	EX	-	EXP	MT	MT	-				
07010106-588	Martin Creek (Poplar Brook)	T136 R32W S22, east line to Farnham cr	5.44	1B,2A,3B	FS	FS	-			MTS	MTS	-	-	-	MT	MT	-	IF	MT	MT	-				
07010106-528	Tower Creek	T135 R32W S4,north line to Farnham cr	3.57	2C	NS**	NA	-			MTS	EXS	-	-	-	-	-	-	IF	IF	IF	-				
07010106-522	Farnham Creek	Unnamed cr to Crow Wing R	0.56	2B,3C	IF	FS	-		-	-	-	-	-	-	-	MT	-	IF	MT	-	MT				

AUID DESCRIPTIONS				USES					BIOLOGICAL CRITERIA		WATER QUALITY STANDARDS										ECOREGION EXPECTATIONS		
National Hydrography Dataset (NHD) Assessment Segment AUID	Stream Segment Name	Segment Description	NHD Length (Miles)	Use Class	Aquatic Life	Aquatic Recreation	Aquatic Consumption	Class 7	Fish	Macroinvertebrates	Acetochlor	Alachlor	Atrazine	Chloride	Bacteria (Aquatic Recreation)	Metolachlor	Dissolved Oxygen	pH	Turbidity	Un-ionized ammonia	Nitrite/Nitrate	Total Phosphorous	Suspended Solids
HUC 11: 07010106-190 Partridge River																							
07010106-552	County Ditch 15	T132 R35W S2 west line to Bear Cr	3.33	7	NA	-	-	x	-	-	-	-	-	-	-	-	-	-					
07010106-551	Little Partridge Creek	Little Partridge R to Partridge R	3.77	2B,3C	FS	NA	-		MTS	MTS	-	-	-	-	-	-	IF	IF	IF	-			
07010106-518	Partridge River	Headwaters to Crow Wing R	33.2	2B,3C	FS	NS	-		MTS	MTS	-	-	-	-	EX	-	MT	MT	MT	MT			
HUC 11: 07010106-200 Swan Creek																							
07010106-527	Swan Creek	T135 R32W S2, north line to Crow Wing R	19.51	2C	NS	NS	-		MTS	EXS	-	-	-	MT	EX	-	EXP	MT	MT	MT			
HUC 11: 07010106-210 Lower Crow Wing River																							
07010106-512	Crow Wing River	Farnham Cr to Leaf R	11.14	2B,3C	FS	NA	-		MTS	-	-	-	-	-	-	-	IF	IF	IF	-			
07010106-510	Crow Wing River	Partridge R to Swan Cr	6.81	2B,3C	FS	NA	-		MTS	MTS	-	-	-	-	-	-	-IF	IF	IF	-			
07010106-684	Unnamed Creek	Unnamed Cr to Crow Wing R	5.51	2B,3C	IF	NS	-		-	-	-	-	-	MT	EX	-	EPS	MT	MT	-			
07010106-509	Crow Wing River	Swan Cr to Mosquito Cr	10.53	2B,3C	FS	NA	-		MTS	MTS	-	-	-	-	-	-	IF	MT	MT	MT			
07010106-591	Mosquito Creek (Hay Creek)	T135 R31W S20,north line to Crow Wing R	17.85	2B,3C	FS	NA	-		MTS	MTS	-	-	-	-	-	-	IF	IF	IF	-			

AUID DESCRIPTIONS				USES					BIOLOGICAL CRITERIA		WATER QUALITY STANDARDS										ECOREGION EXPECTATIONS		
National Hydrography Dataset (NHD) Assessment Segment AUID	Stream Segment Name	Segment Description	NHD Length (Miles)	Use Class	Aquatic Life	Aquatic Recreation	Aquatic Consumption	Class 7	Fish	Macroinvertebrates	Acetochlor	Alachlor	Atrazine	Chloride	Bacteria (Aquatic Recreation)	Metolachlor	Dissolved Oxygen	pH	Turbidity	Un-ionized ammonia	Nitrite/Nitrate	Total Phosphorous	Suspended Solids
07010106-693	East Branch Mosquito Creek	Unnamed cr to Mosquito Cr	1.44	2B,3C	FS	NA	-		MTS	MTS	-	-	-	-	-	-	IF	IF	IF	-			
07010106-507	Crow Wing River	Long Prairie R to Seven Mile Cr	6.93	2B,3C	FS	NA	-		MTS	MTS	-	-	-	-	-	-	IF	IF	-	-			
07010106-525	Sevenmile Creek	T134 R31W S2, north line to Crow Wing R	16.28	2C	FS	NA	-		MTS	MTS	-	-	-	-	-	-	IF	IF	IF	-			
07010106-577	Pillager Creek	T133 R30W S5, north line to Crow Wing R	6.07	2C	FS	NS	-		MTS	MTS	-	-	-	MT	EX	-	IF	MT	MT				
07010106-506	Crow Wing River	Seven Mile Cr to Gull R	7	2B,3C	NS	IF	-		MTS	-	-	-	-	MT	IF	-	IF	MT	MT	MT			
HUC 11: 07010106-220 Upper Gull Lake																							
07010106-604	Mayo Creek	Unnamed cr to Unnamed cr	6.08	2B,3C	FS	NS	-		MTS	MTS	-	-	-	MT	EX	-	IF	MT	MT	-			
07010106-699	Stoney Brook	T136 R31W S26, south line to T136 R29W S31, east line	12.85	1B,2A,3B	FS	NA	-		MTS	MTS	-	-	-	-	-	-	IF	IF	IF	-			
07010106-698	Stoney Brook	T136 R29W S32, west line to Upper Gull Lk	4.63	1B,2A,3B	FS	NS	-		MTS	MTS	-	-	-	MT	EX	-	IF	MT	MT	-			

AUID DESCRIPTIONS				USES						BIOLOGICAL CRITERIA		WATER QUALITY STANDARDS												ECOREGION EXPECTATIONS		
National Hydrography Dataset (NHD) Assessment Segment AUID	Stream Segment Name	Segment Description	NHD Length (Miles)	Use Class	Aquatic Life	Aquatic Recreation	Aquatic Consumption	Class 7		Fish	Macroinvertebrates	Acetochlor	Alachlor	Atrazine	Chloride	Bacteria (Aquatic Recreation)	Metolachlor	Dissolved Oxygen	pH	Turbidity	Un-ionized ammonia		Nitrite/Nitrate	Total Phosphorous	Suspended Solids
HUC 11: 07010106-230 Gull Lake																									
07010106-700	Corey Brook	T135 T30W S16, north line to Home Bk	2.89	1B,2A,3B	FS	NS	-			MTS	MTS	-	-	-	MT	EX	-	IF	MT	MT	-				
07010106-524	Home Brook	Headwaters (Omen Lk 11-0336-00) to Lk Margaret	16.13	2B,3C	FS	NS	-			MTS	MTS	-	-	-	MT	EX	-	IF	MT	MT	-				
07010106-502	Gull River	Gull Lk to Crow Wing R	15.32	2B,3C	FS	FS	-			MTS	MTS	-	-	-	MT	MT	-	IF	MT	MT	MT				
07010106-501	Crow Wing River	Gull R to Mississippi R	4.12	2B,3C	FS	FS	-			MTS	MTS	-	-	-	MT	MT	-	MT	MT	MT	MT				

Full Support (FS); Not Supporting (NS); Insufficient Data (IF); Not Assessed (NA); Meets standards or ecoregion expectations (MT/MTS), Potential Exceedence (EXP), Exceeds standards or ecoregion expectations (EX/EXS).

Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use. *Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50%) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

† Single asterisk (*) = Placed in 4D category /Natural Background Review Team has determined impairment is due to Natural Background factors and no TMDL is recommended to occur.

† AUID 07080201-503 is listed in the table twice since the 29 mile AUID spanned the length of two different HUCs (07080201010 and 07080201030)

Double asterisk (**) = Placed in 4E category with additional monitoring recommended to determine if impairment is due to Natural Background factors.

Appendix 3.2 - Assessment results for lakes in the Crow Wing River Watershed

Lake ID	Lake Name	County	HUC-11	Ecoregion	Lake Area (ha)	Max Depth (m)	Watershed Area (ha)	% Littoral	Mean depth (m)	Support Status
29-0002-00	Mow	Hubbard	07010106010	NLF	45	10	1277	59.8	3.9	FS
29-0005-00	Tripp	Hubbard	07010106010	NCHF	61	20	1754	43.1	5.8	FS
29-0017-00	Ham	Hubbard	07010106010	NLF	76	6	1825	98.3	2.1	FS
29-0020-00	Loon	Hubbard	07010106010	NLF	50	2	1497	100		FS
29-0025-00	Ninth Crow Wing	Hubbard	07010106010	NLF	93	20	9286	41.8	6.1	FS
29-0032-00	Big Bass	Hubbard	07010106010	NLF	53	19	344	41.9	6.1	FS
29-0034-00	Upper Bass	Hubbard	07010106010	NLF	13		42	77.3		IF
29-0036-01	Eleventh Crow Wing	Hubbard	07010106010	NLF	193	24	6604		10.2	FS
29-0036-02	*Eleventh Crow Wing (East)	Hubbard	07010106010	NLF	108	17	4888		7.1	IF
29-0045-00	Tenth Crow Wing	Hubbard	07010106010	NLF	70	12	7051	61.6	4	FS
29-0072-00	Eighth Crow Wing	Hubbard	07010106010	NLF	200	9	10134	31	5.6	NS
29-0074-00	*Indian	Hubbard	07010106010	NLF	37	11	138	41.8	5	FS
29-0077-00	Third Crow Wing	Hubbard	07010106010	NLF	260	11	57551	62.3	3.5	IF
29-0078-00	Fourth Crow Wing	Hubbard	07010106010	NCHF	184	3	50035	100	1.5	FS
29-0081-00	Wolf	Hubbard	07010106010	NCHF	112	4	297	100	1.8	FS
29-0083-00	Bladder	Hubbard	07010106010	NCHF	90	1	177	100		FS
29-0085-00	Second Crow Wing	Hubbard	07010106010	NCHF	92	11	58384	53.7	4.4	FS
29-0086-00	First Crow Wing	Hubbard	07010106010	NCHF	211	5	67249	100	1.6	NS
29-0087-00	Palmer	Hubbard	07010106010	NCHF	59	6	532	62	2.6	FS
29-0088-00	Island	Hubbard	07010106010	NCHF	90	10	522	64.6	3	FS
29-0143-00	Big Stony	Hubbard	07010106010	NCHF	139	7	2631	69.9	3.1	FS
29-0089-00	Shallow	Hubbard	07010106020	NLF	115	3	26843	100	1.3	FS
29-0090-00	Deer	Hubbard	07010106020	NLF	67	3	348	100	0.8	FS

Lake ID	Lake Name	County	HUC-11	Ecoregion	Lake Area (ha)	Max Depth (m)	Watershed Area (ha)	% Littoral	Mean depth (m)	Support Status
29-0091-00	Seventh Crow Wing	Hubbard	07010106020	NLF	102	12	11318	46.9	5.3	FS
29-0092-00	Fifth Crow Wing	Hubbard	07010106020	NLF	161	11	43518	50	4.4	FS
29-0093-00	Sixth Crow Wing	Hubbard	07010106020	NLF	136	12	12427	50	4.9	FS
29-0098-00	Waboose	Hubbard	07010106020	NLF	68	10	1885	82.6	1.7	FS
29-0101-01	East Crooked	Hubbard	07010106020	NLF	146	15	5324	33	11.3	IF
29-0101-02	*Middle Crooked	Hubbard	07010106020	NLF	116	10	2833	50.9	1.6	FS
29-0101-03	*West Crooked	Hubbard	07010106020	NLF	99	29	5207	88.4	5.4	FS
29-0110-00	*Dead	Hubbard	07010106020	NLF	54	10	5561	58.9	5.1	IF
29-0117-01	Spider (NE/SW Bay)	Hubbard	07010106020	NLF	193	29	1197	74.4	3.3	FS
29-0117-02	Spider (East Bay)	Hubbard	07010106020	NLF	42	20			7.5	IF
29-0146-00	Belle Taine	Hubbard	07010106020	NLF	601	19	29069	61.3	3.8	FS
29-0148-00	Upper Bottle	Hubbard	07010106020	NLF	132	17	8538	36.5	6.2	FS
29-0149-00	Ojibway	Hubbard	07010106020	NLF	72	7	5853	58.9	2.8	FS
29-0150-00	Little Sand	Hubbard	07010106020	NLF	163	24	22794	38.6	7.6	FS
29-0151-01	Mantrap (East)	Hubbard	07010106020	NLF	210	21	8021		5.7	FS
29-0151-02	*Mantrap (Middle Basin)	Hubbard	07010106020	NLF	221	11	3804		3.4	FS
29-0151-04	Mantrap (West Arm)	Hubbard	07010106020	NLF	63	18			5.6	IF
29-0151-05	Mantrap (Home Bay)	Hubbard	07010106020	NLF	23	16			4.6	IF
29-0101-01	East Crooked	Hubbard	07010106020	NLF	146	15	5324	33	11.3	IF
29-0101-02	*Middle Crooked	Hubbard	07010106020	NLF	116	10	2833	50.9	1.6	FS
29-0101-03	*West Crooked	Hubbard	07010106020	NLF	99	29	5207	88.4	5.4	FS
29-0110-00	*Dead	Hubbard	07010106020	NLF	54	10	5561	58.9	5.1	IF
29-0117-01	Spider (NE/SW Bay)	Hubbard	07010106020	NLF	193	29	1197	74.4	3.3	FS
29-0117-02	Spider (East Bay)	Hubbard	07010106020	NLF	42	20			7.5	IF

Lake ID	Lake Name	County	HUC-11	Ecoregion	Lake Area (ha)	Max Depth (m)	Watershed Area (ha)	% Littoral	Mean depth (m)	Support Status
29-0146-00	Belle Taine	Hubbard	07010106020	NLF	601	19	29069	61.3	3.8	FS
29-0148-00	Upper Bottle	Hubbard	07010106020	NLF	132	17	8538	36.5	6.2	FS
29-0149-00	Ojibway	Hubbard	07010106020	NLF	72	7	5853	58.9	2.8	FS
29-0150-00	Little Sand	Hubbard	07010106020	NLF	163	24	22794	38.6	7.6	FS
29-0151-01	Mantrap (East)	Hubbard	07010106020	NLF	210	21	8021		5.7	FS
29-0151-02	*Mantrap (Middle Basin)	Hubbard	07010106020	NLF	221	11	3804		3.4	FS
29-0151-04	Mantrap (West Arm)	Hubbard	07010106020	NLF	63	18			5.6	IF
29-0151-05	Mantrap (Home Bay)	Hubbard	07010106020	NLF	23	16			4.6	IF
29-0101-01	East Crooked	Hubbard	07010106020	NLF	146	15	5324	33	11.3	IF
29-0101-02	*Middle Crooked	Hubbard	07010106020	NLF	116	10	2833	50.9	1.6	FS
29-0101-03	*West Crooked	Hubbard	07010106020	NLF	99	29	5207	88.4	5.4	FS
29-0110-00	*Dead	Hubbard	07010106020	NLF	54	10	5561	58.9	5.1	IF
29-0117-01	Spider (NE/SW Bay)	Hubbard	07010106020	NLF	193	29	1197	74.4	3.3	FS
29-0117-02	Spider (East Bay)	Hubbard	07010106020	NLF	42	20			7.5	IF
29-0146-00	Belle Taine	Hubbard	07010106020	NLF	601	19	29069	61.3	3.8	FS
29-0148-00	Upper Bottle	Hubbard	07010106020	NLF	132	17	8538	36.5	6.2	FS
29-0149-00	Ojibway	Hubbard	07010106020	NLF	72	7	5853	58.9	2.8	FS
29-0150-00	Little Sand	Hubbard	07010106020	NLF	163	24	22794	38.6	7.6	FS
29-0151-01	Mantrap (East)	Hubbard	07010106020	NLF	210	21	8021		5.7	FS
29-0151-02	*Mantrap (Middle Basin)	Hubbard	07010106020	NLF	221	11	3804		3.4	FS
29-0151-04	Mantrap (West Arm)	Hubbard	07010106020	NLF	63	18			5.6	IF
29-0151-05	Mantrap (Home Bay)	Hubbard	07010106020	NLF	23	16			4.6	IF
29-0162-00	Boulder	Hubbard	07010106020	NLF	131	9	995	50	4.7	FS
29-0170-00	*Ida	Hubbard	07010106020	NLF	27	12	15089	63.9	3.9	FS

Lake ID	Lake Name	County	HUC-11	Ecoregion	Lake Area (ha)	Max Depth (m)	Watershed Area (ha)	% Littoral	Mean depth (m)	Support Status
29-0172-00	*Stocking	Hubbard	07010106020	NLF	39	8	3245	51.1	3.7	FS
29-0180-00	Lower Bottle	Hubbard	07010106020	NLF	163	34	12535	48.5	8.2	FS
29-0185-00	Big Sand	Hubbard	07010106020	NLF	658	41	14418		13.4	FS
29-0186-00	*Emma	Hubbard	07010106020	NLF	27	15	12603	40	6.3	FS
29-0188-00	Gilmore	Hubbard	07010106020	NLF	37	16	7173	39	6.3	FS
29-0208-00	Bad Axe	Hubbard	07010106020	NLF	107	12	931	46.1	5.8	FS
29-0212-00	Skunk	Hubbard	07010106020	NLF	81	17	1668	62.1	3	FS
29-0161-00	Long	Hubbard	07010106030	NCHF	785	41	6092	23.8	11.3	FS
29-0164-00	Sweitzer	Hubbard	07010106030	NLF	44	3	1033	100	0.9	FS
29-0169-01	Peysenske (Main Bay)	Hubbard	07010106030	NCHF	81	4	593	100		FS
29-0169-02	*Peysenske (East Bay)	Hubbard	07010106030	NLF	8		124			IF
29-0177-00	Rice	Hubbard	07010106030	NLF	62	5	1958	94	1.5	FS
29-0178-00	Pickerel	Hubbard	07010106030	NLF	118	8	1188	86.8	2	FS
29-0184-00	Blue	Hubbard	07010106030	NLF	129	26	384	25.5	11	FS
29-0242-00	Fish Hook	Hubbard	07010106030	NLF	660	23	52283	40.5	8.1	FS
29-0243-00	Potato	Hubbard	07010106030	NLF	839	27	44994	20.3	8.3	FS
29-0250-00	Portage	Hubbard	07010106030	NLF	170	5	1210	99.5	2.5	NS
29-0254-00	Island	Hubbard	07010106030	NLF	215	20	37874	27.2	6.8	FS
29-0256-00	Eagle	Hubbard	07010106030	NLF	170	23	39102	40	6.6	FS
03-0017-00	Two Inlets	Becker	07010106040	NLF	228	18	27859	29	6.3	FS
03-0029-00	Hungry Man	Becker	07010106040	NLF	55	6	501	95.7	0.6	FS
03-0030-00	Boot	Becker	07010106040	NLF	153	30	633	25	12.3	FS
03-0039-00	Abners	Becker	07010106040	NLF	31		179			IF
03-0082-00	Wahbegon	Becker	07010106040	NLF	42	0.6	1232	100	0.3	FS

Lake ID	Lake Name	County	HUC-11	Ecoregion	Lake Area (ha)	Max Depth (m)	Watershed Area (ha)	% Littoral	Mean depth (m)	Support Status
03-0085-00	Bad Medicine	Becker	07010106040	NLF	295	24	11007	36.2	9.8	FS
03-0088-00	Bass	Becker	07010106040	NLF	78	11	1050	64.6	3.4	FS
03-0096-00	Big Basswood	Becker	07010106040	NLF	237	2	5288	100	2.2	FS
29-0313-00	Little Mantrap	Hubbard	07010106040	NLF	144	16	1516	56.6	4.2	FS
03-0010-00	Straight	Becker	07010106050	NLF	193	19	9300	42.1	7	FS
03-0066-00	Gyles	Becker	07010106060	NLF	7					IF
03-0102-00	Shell	Becker	07010106060	NLF	1256	5	11694	97.8	2.2	IF
03-0103-00	Big Rush	Becker	07010106060	NLF	375	3	4373	100	1.2	IF
03-0104-00	Aspinwall	Becker	07010106060	NLF	56	2	4532	100	1.5	FS
03-0120-00	Mud	Becker	07010106060	NLF	62	2	564	100	0.9	FS
03-0124-00	Dumbbell	Becker	07010106060	NLF	54	5	905	100	1.2	IF
03-0127-00	Bass	Becker	07010106060	NLF	51	15	636	60.7	3.9	FS
29-0142-00	Duck	Hubbard	07010106060	NCHF	133	7	2232	48	4.2	FS
29-0157-00	Upper Twin	Hubbard	07010106060	NCHF	95	4	143227	75	1.3	FS
29-0247-00	Moran	Hubbard	07010106060	NCHF	43	5	1610	100	0.8	FS
29-0248-00	*Lord	Hubbard	07010106060	NCHF	24	10	1610	90.3	1.5	FS
29-0249-00	Hinds	Hubbard	07010106060	NCHF	124	5	2567	75	4.9	FS
80-0030-00	Lower Twin	Wadena	07010106060	NCHF	103	8	143982	75	3.2	NS
80-0034-00	Blueberry	Wadena	07010106060	NCHF	222	5	55077	100	2.1	NS
80-0037-00	Stocking	Wadena	07010106060	NCHF	142	7	3650	81.7	2.1	FS
80-0038-00	*Morgan	Wadena	07010106060	NCHF	8	18	106	46.2	5.5	FS
03-0005-00	*Shipman	Becker	07010106080	NCHF	25	17	1496	43.9	5.9	IF
03-0007-00	Blueberry	Becker	07010106080	NCHF	34	14	1248	49.3	5	IF
80-0039-00	Spirit	Wadena	07010106080	NCHF	46	15	791	56.5	4.4	FS

Lake ID	Lake Name	County	HUC-11	Ecoregion	Lake Area (ha)	Max Depth (m)	Watershed Area (ha)	% Littoral	Mean depth (m)	Support Status
11-0500-00	Spider	Cass	07010106090	NLF	55	5	688	88.4	1.6	FS
80-0022-00	Yaeger	Wadena	07010106090	NCHF	38	1	6441	100		IF
80-0027-01	Jim Cook (West)	Wadena	07010106090	NCHF	23	1	270	100		IF
11-0320-00	Pillager	Cass	07010106210	NLF	80	13	999	35	6	FS
80-0003-00	Simon	Wadena	07010106210	NCHF	43		110			IF
11-0218-00	Upper Gull	Cass	07010106220	NLF	169	16	55661	42	6.6	FS
11-0219-00	Lost	Cass	07010106220	NLF	5					IF
11-0220-00	Ray	Cass	07010106220	NLF	57	8	11526	81.6	2.1	IF
11-0221-00	*Spider	Cass	07010106220	NLF	13		11386			FS
11-0225-00	Upper Loon	Cass	07010106220	NLF	48		494			IF
11-0226-00	Loon	Cass	07010106220	NLF	91	8	321	91.1	1	FS
18-0327-00	Rice	Crow Wing	07010106220	NLF	40	1	2590	100		IF
18-0329-00	Garden	Crow Wing	07010106220	NLF	104	2	1014	100		FS
18-0330-00	Unnamed	Crow Wing	07010106220	NLF	10					IF
18-0376-00	Upper Cullen	Crow Wing	07010106220	NLF	169	12	3541	69	4.1	FS
18-0377-00	Middle Cullen	Crow Wing	07010106220	NLF	158	14	4142	33	6.1	FS
18-0396-00	Edna	Crow Wing	07010106220	NLF	61	19	643	59.5	4.5	FS
18-0397-00	*Fawn	Crow Wing	07010106220	NLF	26	12	643	47.5	3.1	FS
18-0398-00	Roy	Crow Wing	07010106220	NLF	127	8	11326	41	3.5	FS
18-0399-00	Nisswa	Crow Wing	07010106220	NLF	88	7	10964	58.2	3.3	FS
18-0403-00	Lower Cullen	Crow Wing	07010106220	NLF	227	12	4952	35	5.8	FS
18-0404-00	Sibley	Crow Wing	07010106220	NLF	169	12	14205	61	3.8	NS
18-0407-00	East Twin	Crow Wing	07010106220	NLF	63	14	205	60.8	4.4	FS
18-0408-00	Mayo	Crow Wing	07010106220	NLF	66	7	14521	94.8	1.9	NS

Lake ID	Lake Name	County	HUC-11	Ecoregion	Lake Area (ha)	Max Depth (m)	Watershed Area (ha)	% Littoral	Mean depth (m)	Support Status
18-0409-00	West Twin	Crow Wing	07010106220	NLF	50	14	326	63.2	3.6	IF
11-0216-00	Agate	Cass	07010106230	NLF	62	4	392	100	1.1	FS
11-0222-00	Margaret	Cass	07010106230	NLF	98	8	18263	29	3.3	NS
11-0304-01	*Sylvan (SW Bay)	Cass	07010106230	NLF	176	13	987		3	FS
11-0304-02	Sylvan (NE Bay)	Cass	07010106230	NLF	180	17	1466		7.7	FS
11-0305-00	Gull	Cass	07010106230	NLF	3994	21	75923	30	9.8	FS
11-0324-00	Rock	Cass	07010106230	NLF	102	5	850	98.3	1.8	FS
11-0777-00	Unnamed	Cass	07010106230	NLF	16					IF
18-0304-00	Perch	Crow Wing	07010106230	NLF	66	2	297	100		FS
18-0333-00	Unnamed	Crow Wing	07010106230	NLF	9					IF
18-0335-00	Mollie	Crow Wing	07010106230	NLF	133	2	458			FS
18-0337-00	Unnamed	Crow Wing	07010106230	NLF	11					IF
18-0338-00	Gladstone	Crow Wing	07010106230	NLF	175	11	746	60	3.5	FS
18-0339-00	Moody	Crow Wing	07010106230	NLF	17					IF
18-0340-00	Little Hubert	Crow Wing	07010106230	NLF	76	13	888	78.1	2.7	FS
18-0341-00	*Crystal	Crow Wing	07010106230	NLF	36		97			IF
18-0372-00	North Long	Crow Wing	07010106230	NLF	2476	30	8492	65	4.7	FS
18-0373-00	Round	Crow Wing	07010106230	NLF	667	16	9791	38	5.6	FS
18-0374-00	Clark	Crow Wing	07010106230	NLF	122	8	5122	76.9	2.7	FS
18-0375-00	Hubert	Crow Wing	07010106230	NLF	520	22	1721	36	7.7	FS
18-0379-00	White Sand	Crow Wing	07010106230	NLF	172	8	508	69.6	3	FS
18-0386-00	Red Sand	Crow Wing	07010106230	NLF	212	5	1840		1.1	FS
18-0387-02	Middle Whipple	Crow Wing	07010106230	NLF	63	8	467		2.7	FS
18-0388-00	*Love	Crow Wing	07010106230	NLF	30	8	134	80.5	2.3	FS

Lake ID	Lake Name	County	HUC-11	Ecoregion	Lake Area (ha)	Max Depth (m)	Watershed Area (ha)	% Littoral	Mean depth (m)	Support Status
18-0389-00	Moburg	Crow Wing	07010106230	NLF	16					IF
18-0392-00	Hartley	Crow Wing	07010106230	NLF	54		160			FS
18-0402-00	*Bass	Crow Wing	07010106230	NLF	15	5	31	88.9	2.1	FS
18-0544-00	Unnamed	Crow Wing	07010106230	NLF	6					IF

Abbreviations: **FS** – Full Support **N/A** – 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	Threshold	Confidence Limit	Upper	Lower
Fish						
1	Southern Rivers	2B, 2C	39	±11	50	28
2	Southern Streams	2B, 2C	45	±9	54	36
3	Southern Headwaters	2B, 2C	51	±7	58	44
10	Southern Coldwater	2A	45	±9	58	32
4	Northern Rivers	2B, 2C	35	±9	44	26
5	Northern Streams	2B, 2C	50	±9	59	41
6	Northern Headwaters	2B, 2C	40	±16	56	24
7	Low Gradient	2B, 2C	40	±10	50	30
11	Northern Coldwater	2A	37	±10	47	27
Invertebrates						
1	Northern Forest Rivers	2B, 2C	51.3	±10.8	62.1	40.5
2	Prairie Forest Rivers	2B, 2C	30.7	±10.8	41.5	19.9
3	Northern Forest Streams RR	2B, 2C	50.3	±12.6	62.9	37.7
4	Northern Forest Streams GP	2B, 2C	52.4	±13.6	66	38.8
5	Southern Streams RR	2B, 2C	35.9	±12.6	48.5	23.3
6	Southern Forest Streams GP	2B, 2C	46.8	±13.6	60.4	33.2
7	Prairie Streams GP	2B, 2C	38.3	±13.6	51.9	24.7
8	Northern Coldwater	2A	26	±12.4	38.4	13.6
9	Southern Coldwater	2A	46.1	±13.8	59.9	32.3

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 11:Upper Crow Wing River (07010106010)							
07010106-523	10UM046	Crow Wing River	260.3	5	50	58	18-Aug-10
07010106-523	10UM045	Crow Wing River	184.2	5	50	57	07-Jul-10
07010106-691	10UM070	Bender Creek	26.7	7	40	0	16-Jun-10
HUC 11: Fish Hook River(07010106030)							
07010106-542	10UM113	Fishhook River	339.9	5	50	59	09-Jun-10
07010106-543	10UM043	Fishhook River	245.6	5	50	60	08-Jun-10
HUC 11: Two Inlets (07010106040)							
07010106-617	10UM044	Hay Creek	150.8	5	50	43	08-Jun-10
07010106-569	10UM065	Indian Creek	75.6	5	50	41	08-Jun-10
07010106-568	10UM064	Basswood Creek	30.6	6	40	42	14-Jun-10
07010106-690	10UM063	Dinner Creek	24.2	7	40	44	22-Sep-10
07010106-617	10UM044	Hay Creek	150.8	5	50	57	27-Jul-10
HUC 11: Straight River(07010106050)							
07010106-558	10UM061	Straight River	40	11	37	52	23-Aug-10
07010106-558	10UM041	Straight River	58.9	11	37	60	18-Aug-10
07010106-517	10UM060	Straight River	26.4	11	37	50	14-Jun-10
HUC 11: Shell River (07010106060)							
07010106-597	99UM011	Fish Creek	17.9	7	40	41	15-Jun-10
07010106-681	00UM027	Shell River	628.1	4	35	51	19-Aug-10
07010106-553	99UM047	Unnamed creek	5.9	7	40	79	14-Jul-99
07010106-537	10UM053	Shell River	59.8	5	50	34	09-Jun-10
07010106-537	10UM055	Shell River	111.1	5	50	43	09-Jun-10
07010106-537	10EM133	Shell River	80.7	5	50	42	26-Aug-10

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Fish Class	Threshold	FIBI	Visit Date
HUC 11: Kettle Creek (07010106070)							
07010106-541	10UM040	Kettle River	40.2	6	56	64	15-Jun-10
07010106-541	10UM057	Kettle River	40.2	6	56	79	26-Jul-10
HUC 11: Blueberry River (07010106080)							
07010106-554	10UM121	Blueberry River	41.7	6	56	56	16-Jun-10
HUC 11: Middle Crow Wing River (07010106090)							
07010106-513	10UM048	Crow Wing River	1218.6	4	35	58	20-Jul-10
07010106-516	10UM110	Crow Wing River	919.7	4	35	42	19-Jul-10
07010106-515	00UM026	Crow Wing River	1070	4	35	60	06-Jul-10
HUC 11: Cat River (07010106100)							
07010106-546	10UM072	Kitten Creek	22	7	40	79	10-Jun-10
07010106-687	10UM103	Unnamed creek	9.9	6	56	0	28-Jun-10
07010106-544	10UM047	Cat River	52.8	5	50	56	10-Jun-10
HUC 11: Farnham Creek (07010106110)							
07010106-522	99UM022	Farnham Creek	52.7	5	50	50	07-Jun-10
07010106-528	10UM078	Tower Creek	8	7	40	62	17-Jun-10
07010106-588	10UM079	Martin Creek (Poplar Brook) *	5.4	7	40	65	17-Jun-10
HUC 11: Partridge River(07010106190)							
07010106-518	10UM050	Partridge River	90.8	5	50	56	15-Jul-10
07010106-551	10EM150	Little Partridge Creek	42.2	7	40	57	07-Jul-10
07010106-551	10UM085	Little Partridge Creek	38.3	6	56	68	29-Sep-11
HUC 11: Swan Creek (07010106200)							
07010106-527	10UM081	Swan Creek	25.9	6	56	72	17-Aug-10
07010106-527	10EM086	Swan Creek	47	7	40	66	07-Jul-10
07010106-527	10UM108	Swan Creek	4.1	6	56	60	30-Jun-10

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Fish Class	Threshold	FIBI	Visit Date
HUC 11: Lower Crow Wing (07010106210)							
07010106-506	10UM049	Crow Wing River	3395.6	4	35	43	01-Jul-10
07010106-507	10UM120	Crow Wing River	3344.7	4	35	64	30-Jun-10
07010106-509	10UM117	Crow Wing River	2361.9	4	35	62	30-Jun-10
07010106-510	10UM111	Crow Wing River	2289.4	4	35	50	21-Jul-10
07010106-512	10UM112	Crow Wing River	1283.8	4	35	57	20-Jul-10
07010106-525	10UM090	Sevenmile Creek	19.4	6	56	73	04-Jun-10
07010106-525	10UM090	Sevenmile Creek	19.4	6	56	57	07-Jul-10
07010106-577	10UM091	Pillager Creek	17.8	6	56	54	16-Jun-10
07010106-591	10UM089	Mosquito Creek (Hay Creek)	51.4	5	50	39	15-Jul-10
07010106-591	10UM109	Mosquito Creek (Hay Creek)	19.9	6	56	54	16-Jun-10
07010106-693	10UM119	East Branch Mosquito Creek	17	6	56	57	16-Jun-10
HUC 11: Upper Gull Lake(07010106220)							
07010106-604	10UM093	Mayo Creek	42.2	6	56	60	22-Jul-10
07010106-604	10UM093	Mayo Creek	42.2	6	56	58	04-Jun-10
07010106-698	10UM092	Stoney Brook	36.1	11	37	77	31-Aug-10
07010106-699	10UM098	Stoney Brook *	24.0	6	56	61	30-Jun-10
HUC 11: Gull Lake(07010106230)							
07010106-501	10UM052	Crow Wing River	3752.3	4	35	56	29-Jun-10
07010106-502	10UM051	Gull River	294	5	50	57	28-Jul-10
07010106-524	10UM097	Home Brook	57.8	5	50	52	07-Jun-10
07010106-700	10UM096	Corey Brook *	9.4	6	56	46	14-Jun-10

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 11: Upper Crow Wing River(07010106010)							
07010106-523	10UM046	Crow Wing River	260.3	4	52.4	42.94	04-Aug-10
07010106-523	10UM045	Crow Wing River	184.2	4	52.4	76.32	01-Sep-10
07010106-523	10UM045	Crow Wing River	184.2	4	52.4	50.55	01-Sep-10
07010106-691	10UM070	Bender Creek	26.7	4	52.4	41.65	01-Sep-10
HUC 11: Fish Hook River(07010106030)							
07010106-542	10UM113	Fish Hook River	339.9	4	52.4	77.24	01-Sep-10
07010106-543	10UM043	Fish Hook River	245.6	3	50.3	58.17	31-Aug-10
HUC 11: Two Inlets(07010106040)							
07010106-617	10UM044	Hay Creek	150.8	4	52.4	53.30	31-Aug-10
07010106-569	10UM065	Indian Creek	75.6	3	50.3	63.07	31-Aug-10
07010106-690	10UM063	Dinner Creek	24.2	4	52.4	51.50	27-Sep-10
07010106-558	10UM061	Straight River	40	8	26	33.27	31-Aug-10
07010106-558	10UM061	Straight River	40	8	26	24.77	31-Aug-10
07010106-558	10UM041	Straight River	58.9	8	26	53.65	15-Sep-10
07010106-558	10UM041	Straight River	58.9	8	26	43.90	23-Sep-10
07010106-517	10UM060	Straight River	26.4	8	26	16.73	31-Aug-10
HUC 11: Shell River(07010106060)							
07010106-597	99UM011	Fish Creek	17.9	4	52.4	57.92	04-Aug-11
07010106-537	10UM053	Shell River	59.8	4	52.4	48.77	31-Aug-10
07010106-537	10UM055	Shell River	111.1	4	52.4	72.50	30-Aug-10
07010106-537	10EM133	Shell River	80.7	4	52.4	57.46	11-Aug-11
HUC 11: Kettle Creek(07010106070)							
07010106-541	10UM040	Kettle Creek	40.2	3	50.3	75.10	01-Sep-10

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Invert Class	Threshold	MIBI	Visit Date
07010106-541	10UM057	Kettle Creek	19.9	4	52.4	51.85	01-Sep-10
HUC 11: Blueberry River(07010106080)							
07010106-554	10UM121	Blueberry River	41.7	3	50.3	77.09	01-Sep-10
HUC 11: Middle Crow Wing River (07010106090)							
07010106-513	10UM048	Crow Wing River	1218.6	1	51.3	49.95	22-Sep-10
07010106-516	10UM110	Crow Wing River	919.7	1	51.3	36.27	23-Sep-10
07010106-515	00UM026	Crow Wing River	1070	1	51.3	67.46	14-Sep-10
HUC 11:Cat River (07010106100)							
07010106-546	10UM072	Kitten Creek	22	4	52.4	44.89	04-Aug-11
07010106-687	10UM103	Unnamed creek	9.9	3	50.3	46.66	14-Sep-10
07010106-544	10UM047	Cat River	52.8	3	50.3	57.88	21-Sep-10
HUC 11: Farnham Creek (07010106110)							
07010106-522	99UM022	Farnham Creek	52.7	4	52.4	9.75	22-Sep-10
07010106-528	10UM078	Tower Creek	8	4	52.4	30.27	21-Sep-10
07010106-588	10UM079	Martin Creek (Poplar Brook) *	5.4	4	52.4	69.23	21-Sep-10
07010106-702	10UM080	Farnham Creek	19.2	8	26	13.88	14-Sep-10
HUC 11: Partridge River (07010106190)							
07010106-518	10UM050	Partridge River	90.8	3	50.3	39.93	14-Sep-10
07010106-551	10EM150	Little Partridge Creek	42.2	6	46.8	58.55	22-Sep-10
07010106-551	10UM085	Little Partridge Creek	38.3	6	46.8	35.12	24-Aug-11
HUC 11: Swan Creek (07010106200)							
07010106-527	10UM081	Swan Creek	25.9	4	52.4	72.03	16-Sep-10
07010106-527	10EM086	Swan Creek	47	4	52.4	27.18	10-Aug-11
07010106-527	10UM108	Swan Creek	4.1	4	52.4	23.45	16-Sep-10

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Invert Class	Threshold	MIBI	Visit Date
HUC 11: Lower Crow Wing (07010106210)							
07010106-506	10UM049	Crow Wing River	3395.6	1	51.3	34.69	25-Aug-11
07010106-507	10UM120	Crow Wing River	3344.7	1	51.3	48.73	25-Aug-11
07010106-509	10UM117	Crow Wing River	2361.9	1	51.3	60.80	24-Aug-11
07010106-510	10UM111	Crow Wing River	2289.4	1	51.3	57	24-Aug-11
07010106-512	10UM112	Crow Wing River	1283.8	1	51.3	32.92	22-Sep-10
07010106-525	10UM090	Sevenmile Creek	19.4	4	52.4	82.2	20-Sep-10
07010106-577	10UM091	Pillager Creek	17.8	3	50.3	46.94	16-Sep-10
07010106-591	10UM089	Mosquito Creek (Hay Creek)	51.4	4	52.4	51.44	16-Sep-10
07010106-591	10UM109	Mosquito Creek (Hay Creek)	19.9	3	50.3	53.06	15-Sep-10
07010106-684	10UM087	Unnamed Creek	13.7	4	52.4	52.03	20-Sep-10
07010106-693	10UM119	East Branch Mosquito Creek	17	4	52.4	60	15-Sep-10
HUC 11: Upper Gull Lake (07010106220)							
07010106-604	10UM093	Mayo Creek	42.2	3	50.3	64.59	15-Sep-10
07010106-698	10UM092	Stoney Brook	36.1	8	26	46.13	15-Sep-10
07010106-699	10UM098	Stoney Brook *	24.0	3	50.3	55.10	15-Sep-10
HUC 11:Gull Lake (07010106230)							
07010106-501	10UM052	Crow Wing River	3752.3	1	51.3	61.80	25-Aug-11
07010106-502	10UM051	Gull River	294.9	3	50.3	43.66	16-Sep-10
07010106-524	10UM097	Home Brook	57.8	3	50.3	68.63	16-Sep-10
07010106-700	10UM096	Corey Brook *	9.4	4	52.4	72.50	15-Sep-10

Ratings of **Good** for channelized streams are based on Minnesota's general use threshold for aquatic life (Appendix 4.1). Stations with IBIs that score above this general use threshold would be given a rating of **Good**. The **Fair** rating is calculated as a 15 point drop from the general use threshold. Stations with IBI scores below the general use threshold, but above the **Fair** threshold would be given a rating of **Fair**. Stations scoring below the Fair threshold would be considered **Poor**.

Appendix 5.1 - Good/Fair/Poor thresholds for biological stations on non-assessed channelized AUIDs

Class #	Class Name	Good	Fair	Poor
Fish				
1	Southern Rivers	>38	38-24	<24
2	Southern Streams	>44	44-30	<30
3	Southern Headwaters	>50	50-36	<36
4	Northern Rivers	>34	34-20	<20
5	Northern Streams	>49	49-35	<35
6	Northern Headwaters	>39	39-25	<25
7	Low Gradient Streams	>39	39-25	<25
Invertebrates				
1	Northern Forest Rivers	>51	52-36	<36
2	Prairie Forest Rivers	>31	31-16	<16
3	Northern Forest Streams RR	>50	50-35	<35
4	Northern Forest Streams GP	>52	52-37	<37
5	Southern Streams RR	>36	36-21	<21
6	Southern Forest Streams GP	>47	47-32	<32
7	Prairie Streams GP	>38	38-23	<23
8	Northern Coldwater	>26	26-11	<11

Appendix 5.2 - Channelized stream reach and AUID IBI scores-FISH (non-assessed)

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Fish Class	Good	Fair	Poor	FIBI	Visit Date
HUC 11: Blueberry River (07010106080)									
07010106-586	10UM059	Blueberry River	19.1	7	>39	39-25	<25	48	22-Sep-10
HUC 11: Middle Crow Wing River (07010106090)									
07010106-530	10UM107	Beaver Creek	7.9	6	>39	39-25	<25	49	29-Jun-10
07010106-531	10UM077	Big Swamp Creek	63.1	5	>49	49-35	<35	62	28-Jun-10
07010106-531	10UM101	Big Swamp Creek	46.8	6	>39	39-25	<25	61	22-Jul-10
07010106-531	10UM101	Big Swamp Creek	46.8	6	>39	39-25	<25	68	16-Jun-10
07010106-555	10UM076	Unnamed ditch	9.9	6	>39	39-25	<25	36	28-Jun-10
07010106-683	10UM102	Unnamed ditch	12.7	6	>39	39-25	<25	47	16-Jun-10
07010106-688	10UM106	Unnamed creek	9.3	6	>39	39-25	<25	77	17-Jun-10
07010106-689	10UM099	Unnamed creek	19.2	6	>39	39-25	<25	53	29-Jun-10
HUC 11: Cat River (07010106100)									
07010106-545	10UM071	Cat River	7.2	11	>37	37-22	<22	38	25-Aug-11
HUC 11: Partridge River (07010106190)									
07010106-552	10UM086	County Ditch 15	5.8	6	>39	39-25	<25	39	04-Jun-10

Appendix 5.3 - Channelized stream reach and AUID IBI scores- Macroinvertebrates (non-assessed)

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Invert Class	Good	Fair	Poor	MIBI	Visit Date
HUC 11: Blueberry River (07010106080)									
07010106-586	10UM059	Blueberry River	19.1	4	>52	52-37	<37	52.09	21-Sep-10
HUC 11: Middle Crow Wing River (07010106090)									
07010106-530	10UM107	Beaver Creek	7.9	4	>52	52-37	<37	41.11	02-Sep-10
07010106-531	10UM077	Big Swamp Creek	63.1	3	>52	52-37	<37	61.35	02-Sep-10
07010106-531	10UM101	Big Swamp Creek	46.8	4	>52	52-37	<37	51.58	02-Sep-10
07010106-555	10UM076	Unnamed ditch	9.9	4	>52	52-37	<37	22.80	02-Sep-10
07010106-683	10UM102	Unnamed ditch	12.7	4	>52	52-37	<37	35.74	02-Sep-10
07010106-688	10UM106	Unnamed creek	9.3	4	>52	52-37	<37	29.31	02-Sep-10
07010106-689	10UM099	Unnamed creek	19.2	4	>52	52-37	<37	59.91	24-Aug-11
HUC 11: Cat River (07010106100)									
07010106-545	10UM071	Cat River	7.2	8	>26	26-11	<11	26.87	01-Sep-10
HUC 11: Partridge River (07010106190)									
07010106-552	10UM086	County Ditch 15	5.8	6	>47	47-32	<32	12.56	20-Sep-10

Appendix 6.1 - 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 6.2 - MINLEAP model estimates of phosphorus loads for lakes in the Crow Wing River Watershed

Lake ID	Lake Name	Obs TP (µg/L)	MINLEAP TP (µg/L)	Obs Chl-a (µg/L)	MINLEAP Chl-a (µg/L)	Obs Secchi (m)	MINLEAP Secchi (m)	Avg. TP Inflow (µg/L)	TP Load (kg/yr)	%P Retention	Outflow (hm3/yr)	Residence Time (yrs)	Areal Load (m/yr)	Trophic Status
03-0005-00	*Shipman	19	42	7	15	3.0	1.6	151	295	72	2	2.5	8	M
03-0007-00	Blueberry	31	58	17	25	2.5	1.2	153	250	62	2	1	5	E
03-0010-00	Straight	22	30	11	9	3.0	2.1	53	1,141	44	22	0.6	11	M
03-0017-00	Two Inlets	22	36	8	13	2.4	1.7	52	3,366	31	64	0.2	28	M
03-0029-00	Hungry Man	12	37	2	13	4.0	1.7	56	68	33	1	0.3	2	M
03-0030-00	Boot	8	12	1	3	6.8	4.5	60	99	80	2	11.4	1	M
03-0082-00	Wahbegon	12	45	2	17	2.7	1.5	53	154	15	3	<0.1	7	M
03-0085-00	Bad Medicine	8	26	2	8	7.2	2.4	53	1,361	52	26	1.1	9	M
03-0088-00	Bass	20	27	6	8	3.5	2.3	55	137	51	3	1.1	3	M
03-0096-00	Big Basswood	18	33	4	11	1.8	1.9	54	668	38	13	0.4	5	M
03-0102-00	Shell	27	28	10	8	1.7	2.2	56	1,587	50	29	1	2	E
03-0104-00	Aspinwall	14	42	2	15	1.4	1.6	52	550	20	11	0.1	19	M
03-0120-00	Mud	17	34	4	12	2.5	1.8	56	77	38	1	0.4	2	M
03-0127-00	Bass	16	25	7	7	3.4	2.4	55	84	54	2	1.3	3	M
11-0216-00	Agate	14	31	2	10	3.3	2	57	56	46	1	0.7	2	M
11-0218-00	Upper Gull	24	41	10	15	2.7	1.6	52	6,682	21	128	0.1	76	E
11-0220-00	Ray	13	44	7	17	2.9	1.5	52	1,387	16	27	<0.1	47	M
11-0221-00	***Spider	16	49	10	20	2.6	1.3	52	1,364	1	26	<0.1	202	M
11-0222-00	Margaret	77	42	26	15	1.4	1.5	52	2,199	20	42	0.1	43	E
11-0225-00	**Upper Loon	32	34	12	11	2.3	1.8	55	66	38	1	0.4	3	E
11-0226-00	Loon	18	29	4	9	3.7	2.1	61	52	52	1	1.1	1	M
11-0304-01	*Sylvan (SW Bay)	14	23	3	6	5.1	2.6	58	144	61	3	2.1	1	M

Lake ID	Lake Name	Obs TP (µg/L)	MINLEAP TP (µg/L)	Obs Chl-a (µg/L)	MINLEAP Chl-a (µg/L)	Obs Secchi (m)	MINLEAP Secchi (m)	Avg. TP Inflow (µg/L)	TP Load (kg/yr)	%P Retention	Outflow (hm3/yr)	Residence Time (yrs)	Areal Load (m/yr)	Trophic Status
11-0304-02	Sylvan (NE Bay)	9	18	1	4	6.0	3.2	56	202	68	4	3.8	2	M
11-0305-00	Gull	22	21	9	6	3.2	2.8	54	9,679	61	180	2.2	5	M
11-0320-00	Pillager	11	22	2	6	5.3	2.7	55	131	60	2	2	3	M
11-0324-00	Rock	21	29	6	9	2.2	2.1	56	117	49	2	0.9	2	M
11-0500-00	Spider	16	32	6	10	3.5	2	55	91	42	2	0.5	3	M
18-0304-00	**Perch	25	30	5	10	1.5	2.1	59	45	49	1	0.9	1	E
18-0327-00	**Rice	29	43	4	16	1.0	1.5	53	316	19	6	0.1	15	E
18-0329-00	**Garden	17	34	4	11	1.4	1.9	55	137	39	3	0.4	2	M
18-0335-00	**Mollie	20	29	8	9	1.7	2.1	61	75	53	1	1.1	1	E
18-0338-00	Gladstone	17	20	5	5	3.5	2.9	59	115	66	2	3.2	1	M
18-0340-00	Little Hubert	17	28	3	8	4.3	2.2	55	118	50	2	1	3	M
18-0341-00	***Crystal	35	28	11	8	1.2	2.2	63	17	56	0	1.3	1	E
18-0372-00	North Long	18	17	5	4	4.5	3.4	61	1,387	72	23	5.1	1	M
18-0373-00	Round	25	24	12	7	3.2	2.5	54	1,271	57	23	1.6	4	E
18-0374-00	Clark	21	35	5	12	3.0	1.8	53	631	33	12	0.3	10	M
18-0375-00	Hubert	16	14	3	3	4.6	4	61	284	77	5	8.6	1	M
18-0376-00	Upper Cullen	25	28	9	9	2.9	2.2	54	449	48	8	0.8	5	M
18-0377-00	Middle Cullen	19	27	5	8	4.0	2.3	53	519	50	10	1	6	M
18-0379-00	White Sand	20	20	6	5	3.3	3	62	87	69	1	3.7	1	M
18-0386-00	Red Sand	24	33	4	11	3.2	1.9	56	252	42	5	0.5	2	M
18-0387-02	Middle Whipple	15	25	4	7	3.3	2.4	56	65	56	1	1.5	2	M
18-0388-00	*Love	20	23	6	7	2.9	2.5	59	21	60	0	2	1	M
18-0392-00	**Hartley	18	28	2	9	4.6	2.2	62	27	55	0	1.2	1	M

Lake ID	Lake Name	Obs TP (µg/L)	MINLEAP TP (µg/L)	Obs Chl-a (µg/L)	MINLEAP Chl-a (µg/L)	Obs Secchi (m)	MINLEAP Secchi (m)	Avg. TP Inflow (µg/L)	TP Load (kg/yr)	%P Retention	Outflow (hm3/yr)	Residence Time (yrs)	Areal Load (m/yr)	Trophic Status
18-0396-00	Edna	11	23	3	7	4.6	2.6	55	86	58	2	1.8	3	M
18-0397-00	*Fawn	11	31	4	10	3.8	2	53	81	42	2	0.5	6	M
18-0398-00	Roy	20	38	7	13	2.8	1.7	52	1,374	28	26	0.2	11	M
18-0399-00	Nisswa	20	40	9	14	2.3	1.6	52	1,324	23	25	0.1	29	M
18-0402-00	*Bass	23	21	4	6	4.0	2.8	66	6	68	0	3.5	1	M
18-0403-00	Lower Cullen	21	26	7	8	3.7	2.3	54	626	52	12	1.1	5	M
18-0404-00	Sibley	33	37	20	13	1.5	1.7	52	1,724	29	33	0.2	20	E
18-0407-00	East Twin	10	17	3	4	5.2	3.3	61	34	72	1	5	1	M
18-0408-00	Mayo	36	45	18	17	2.0	1.5	52	1,747	14	34	<0.1	51	E
18-0409-00	West Twin	9	22	2	6	5.7	2.7	57	46	61	1	2.2	2	M
29-0002-00	Mow	11	30	4	10	4.5	2	53	159	43	3	0.6	7	M
29-0005-00	Tripp	16	51	5	20	3.2	1.3	154	356	67	2	1.5	4	M
29-0017-00	Ham	13	34	4	11	2.8	1.9	53	230	37	4	0.4	6	M
29-0020-00	**Loon	17	39	5	14	1.7	1.6	53	187	26	4	0.1	7	M
29-0025-00	Ninth Crow Wing	19	35	7	12	3.1	1.8	52	1,125	33	22	0.3	23	M
29-0032-00	Big Bass	9	18	2	5	6.4	3.1	57	49	68	1	3.8	2	M
29-0036-01	11 Crow Wing (Fish Composite)	12	25	4	7	4.3	2.4	53	819	53	15	1.3	8	M
29-0036-02	*11 Crowing (East)	14	29	5	9	4.2	2.1	53	601	45	11	0.7	11	M
29-0045-00	Tenth Crow Wing	20	38	5	13	2.9	1.7	52	854	28	16	0.2	23	M
29-0072-00	Eighth Crow Wing	30	32	14	10	2.7	2	53	1,242	40	24	0.5	12	E
29-0074-00	*Indian	9	17	3	4	5.7	3.4	60	22	72	0	5.1	1	M
29-0077-00	Third Crow Wing	27	42	12	16	1.4	1.5	52	6,922	19	133	0.1	51	E
29-0078-00	[1]Fourth Crow Wing	26	46	8	18	2.3	1.4	52	6,012	12	115	<0.1	63	E

Lake ID	Lake Name	Obs TP (µg/L)	MINLEAP TP (µg/L)	Obs Chl-a (µg/L)	MINLEAP Chl-a (µg/L)	Obs Secchi (m)	MINLEAP Secchi (m)	Avg. TP Inflow (µg/L)	TP Load (kg/yr)	%P Retention	Outflow (hm3/yr)	Residence Time (yrs)	Areal Load (m/yr)	Trophic Status
29-0081-00	Wolf	18	39	3	14	3.2	1.6	211	91	81	0	4.7	0	M
29-0083-00	**Bladder	17	48	2	19	2.0	1.4	229	61	79	0	3.4	0	M
29-0085-00	[1]Second Crow Wing	22	45	11	17	2.1	1.4	52	6,997	13	134	<0.1	146	E
29-0086-00	[1]First Crow Wing	59	46	32	18	1.1	1.4	52	8,075	11	155	<0.1	73	E
29-0087-00	Palmer	12	47	4	18	3.9	1.4	168	120	72	2	1.2		M
29-0088-00	Island	14	39	5	14	3.7	1.6	178	127	78	1	3.8	1	M
29-0089-00	Shallow	13	46	3	18	2.3	1.4	52	3,228	12	62	<0.1	54	M
29-0090-00	Deer	13	32	4	11	4.2	1.9	58	52	44	1	0.6	1	M
29-0091-00	Seventh Crow Wing	26	37	13	13	2.3	1.7	52	1,369	30	26	0.2	26	E
29-0092-00	Fifth Crow Wing	23	42	10	16	2.8	1.5	52	5,229	19	100	0.1	62	M
29-0093-00	Sixth Crow Wing	22	36	10	12	2.6	1.8	52	1,507	31	29	0.2	21	M
29-0098-00	Waboose	15	36	5	12	4.4	1.8	53	236	33	4	0.3	7	M
29-0101-01	East Crooked	8	24	1	7	6.5	2.5	53	659	54	12	1.3	9	M
29-0101-02	*Middle Crooked	15	36	4	12	3.5	1.8	53	356	33	7	0.3	6	M
29-0101-03	*West Crooked	12	32	2	10	4.8	1.9	53	638	39	12	0.4	12	M
29-0110-00	*Dead	16	37	4	13	6.2	1.7	52	673	30	13	0.2	24	M
29-0117-01	Spider (NE/SW Bay)	11	22	4	6	5.5	2.6	57	172	61	3	2.1	2	M
29-0142-00	Duck	20	48	8	19	2.3	1.4	159	469	70	3	1.9	2	M
29-0143-00	Big Stony	14	55	5	23	2.9	1.2	158	548	65	4	1.2	3	M
29-0146-00	Belle Taine	11	34	3	11	5.7	1.9	53	3,567	36	68	0.3	11	M
29-0148-00	Upper Bottle	15	33	4	11	4.5	1.9	53	1,041	38	20	0.4	15	M
29-0149-00	Ojibway	17	39	4	14	5.3	1.7	52	711	26	14	0.1	19	M
29-0150-00	Little Sand	9	36	2	12	6.4	1.8	52	2,751	31	53	0.2	32	M

Lake ID	Lake Name	Obs TP (µg/L)	MINLEAP TP (µg/L)	Obs Chl-a (µg/L)	MINLEAP Chl-a (µg/L)	Obs Secchi (m)	MINLEAP Secchi (m)	Avg. TP Inflow (µg/L)	TP Load (kg/yr)	%P Retention	Outflow (hm3/yr)	Residence Time (yrs)	Areal Load (m/yr)	Trophic Status
29-0151-01	Mantrap (East Basin)	19	30	5	9	4.1	2.1	53	991	44	19	0.6	9	M
29-0151-02	*Mantrap (Middle Basin)	22	28	5	9	3.2	2.2	54	488	48	9	0.8	4	M
29-0157-00	[1]Upper Twin	41	50	4	20	2.2	1.3	52	17,144	36	330	<0.1	347	E
29-0161-00	Long	13	24	5	7	3.2	2.5	171	1,408	86	8	10.8	1	M
29-0162-00	Boulder	13	21	5	6	3.9	2.8	56	139	63	3	2.5	2	M
29-0164-00	Sweitzer	19	39	4	14	2.5	1.6	53	130	27	2	0.2	6	M
29-0169-01	**Peysenske (Main Bay)	16	63	4	28	2.8	1.1	172	138	63	1	1	1	M
29-0169-02	***Peysenske (E. BayK)	16	36	4	12	1.6	1.7	54	16	33	0	0.3	4	M
29-0170-00	*Ida	9	45	2	17	7.2	1.4	52	1,809	13	35	<0.1	129	M
29-0172-00	*Stocking	25	37	9	13	3.1	1.7	52	394	29	8	0.2	19	M
29-0177-00	Rice	25	37	9	13	1.9	1.7	53	243	30	5	0.2	7	E
29-0178-00	Pickerel	16	29	5	9	4.0	2.1	55	160	48	3	0.8	3	M
29-0180-00	Lower Bottle	12	32	3	10	4.6	2	52	1,524	39	29	0.5	18	M
29-0184-00	Blue	10	12	2	2	5.1	4.7	62	65	81	1	13.5	1	M
29-0185-00	Big Sand	9	20	2	5	7.0	2.9	54	1,823	63	34	2.6	5	M
29-0186-00	*Emma	16	43	4	16	4.2	1.5	52	1,511	18	29	0.1	108	M
29-0188-00	Gilmore	10	39	3	14	4.4	1.6	52	863	26	17	0.1	45	M
29-0208-00	Bad Axe	14	20	4	5	4.9	2.9	56	127	64	2	2.7	2	M
29-0212-00	Skunk	12	30	3	10	6.1	2	54	212	44	4	0.6	5	M
29-0242-00	Fish Hook	17	32	5	10	3.5	1.9	52	6,352	39	121	0.4	18	M
29-0243-00	Potato	14	29	5	9	3.4	2.1	53	5,507	44	105	0.7	13	M
29-0247-00	Moran	15	95	5	51	3.7	0.8	153	323	38	2	0.2	5	M

Lake ID	Lake Name	Obs TP (µg/L)	MINLEAP TP (µg/L)	Obs Chl-a (µg/L)	MINLEAP Chl-a (µg/L)	Obs Secchi (m)	MINLEAP Secchi (m)	Avg. TP Inflow (µg/L)	TP Load (kg/yr)	%P Retention	Outflow (hm3/yr)	Residence Time (yrs)	Areal Load (m/yr)	Trophic Status
29-0248-00	*Lord	14	93	6	50	4.1	0.8	151	317	38	2	0.2	9	M
29-0249-00	Hinds	15	48	4	19	4.3	1.4	157	531	69	3	1.8	3	M
29-0250-00	Portage	51	25	22	7	1.2	2.4	57	170	55	3	1.4	2	E
29-0254-00	Island	22	38	9	13	2.5	1.7	52	4,562	27	87	0.2	41	M
29-0256-00	Eagle	19	40	7	14	3.1	1.6	52	4,702	24	90	0.1	53	M
29-0313-00	Little Mantrap	11	24	3	7	5.4	2.5	55	203	57	4	1.6	3	M
80-0030-00	[1]Lower Twin	40	48	15	19	1.9	1.4	52	17,236	27	331	<0.1	322	E
80-0034-00	Blueberry	93	109	52	62	0.9	0.7	149	10,663	27	72	0.1	32	E
80-0037-00	Stocking	45	69	21	32	1.8	1	155	745	56	5	0.6	3	E
80-0038-00	*Morgan	11	40	2	14	6.3	1.6	162	23	76	0	3.1	2	M
80-0039-00	Spirit	20	47	5	18	3.8	1.4	159	166	70	1	1.9	2	M

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

* Catchment areas estimated from topographic coverage layer

** Depth information not available. Default to 1 m depth for model application.

*** Depth and catchment info estimated

[1]Lake located in NCHF ecoregion yet a majority of the input flows from the NLF ecoregion. NLF values utilized for the model application.

Appendix 6.3 – Dams within the Crow Wing River Watershed

Dam Name	Water Body	Owner	Purpose	County
Two Inlets Lake	Hay Creek	MNDNR	Other	Becker
Bass Lake	Indian Creek	MNDNR	Other	Becker
Straight Lake	Straight River	MNDNR-Waters	Flood control/storm water	Becker
Shell Lake	Shell River	MNDNR-Forestry	Recreation	Becker
Red Eye River	Red Eye River	Nelmark, Tadd		Becker
Sylvan	Crow Wing River	Mn Power and Light	Hydroelectric	Cass
Crackel Pond	Beaver Creek -Trib	Crackle, Warren	Other	Cass
Gull Lake	Gull River	USCOE	Flood control/storm water and recreation	Cass
Loon Lake Twp	Mayo Creek	MNDNR-Fisheries	Other	Cass
Mayo Lake	Stony Brook - Trib	MNDNR	Other	Cass
Sibley Lake	Mayo Creek - Trib	MNDNR	Other	Crow wing
Clark Lake		MNDNR-Trails	Recreation	Crow wing
Hubert Lake		MNDNR-Trails	Recreation	Crow wing
Little Hubert Lake		MNDNR		Crow wing
Crow Wing 8th Lake	Crow Wing River	MNDNR	Other	Hubbard
Crow Wing 11th Lake		MNDNR-Trails	Recreation	Hubbard
Potato Lake	Fish Hook River	County of Hubbard Highway Department	Other	Hubbard
Crow Wing 5th Lake	Crow Wing River	MNDNR-Forestry	Other	Hubbard
Long Lake	Shell River	MNDNR	Other	Hubbard
Portage Lake	Portage River	MNDNR	Other	Hubbard
Fish Hook River	Fish Hook River	City of Park Rapids	Other	Hubbard
Park Rapids Hatchery	Fish Hook River	MNDNR-Fisheries		Hubbard
Stanchfield Lake	Unnamed Creek	MNDNR-Fisheries	Flood control/storm water	Morrison
Pillager	Crow Wing River	MN Power and Light	Hydroelectric	Morrison
West Leaf Lake		MNDNR-Trails	Recreation	Otter tail
Gourd Lake		MNDNR	Recreation	Otter tail
Kramer Pond		Kramer, Ray	Fire Protection	Todd
Wing River	Wing River	MNDNR	R	Todd
Twin Lakes	Shell River	MNDNR		Wadena
Stocking Lake	Stocking Creek	MNDNR	R	Wadena
Aldrich	Partridge River	City of Aldrich	SR	Wadena
Huntersville No. 3	Crow Wing River - Trib	County of Wadena	DR	Wadena
Huntersville No. 4	Crow Wing River - Trib	County of Wadena	DR	Wadena
Yaeger Lake	State Ditch No. 30	County of Wadena	C	Wadena

Appendix 6.4 Fish species codes, common names and scientific names.

SPEC	Common Name	Scientific Name
BGS	Bluegill sunfish	Lepomis macrochirus
BKB	Black bullhead	Ictalurus melus
BKS	Black crappie	Pomoxis nigromaculatis
BRB	Brown bullhead	Ictalurus nebulosus
C	Common Carp	Cyprinus carpio
CIS	Cisco (Lake Herring)	Coregonus artedii
GRR	Greater Redhorse	Moxostoma valenciennesi
HSF	Hybrid sunfish	Lepomis sp.
LMB	Largemouth bass	Micropterus salmoides
ML	Muskellunge	Esox masquinongy
NP	Northern pike	Esox lucius
RBT	Rainbow trout	Salmo sairdneri
RKB	Rock bass	Ambloplites rupestris
SF	Pumpkinseed sunfish	Lepomis gibbosus
SMB	Smallmouth bass	Micropterus dolomieu
SRD	Shorthead redhorse	Moxostoma macrolepidotum
SRH	Silver redhorse	Moxostoma anisurum
WE	Walleye	Sander vitreus
WSU	White sucker	Catostomus commersoni
YEB	Yellow bullhead	Ictalurus natalis
YP	Yellow perch	Perca flavescens

Appendix 6.5 Waterways having fish contaminant data, showing impairments caused by contaminants in fish tissue and number of fish tested by species.

Waterway	AUID	Impaired	BGS	BKS	C	CIS	LMB	ML	NP	SF	SMB	SRD	SRH	WE	WSU	YEB	YP	Other
Crow Wing River	07010106	Hg	20		19				15		9							5 GRR
Agate	11021600	Hg					8		10					4				
Bad Medicine	03008500	Hg							12					18	8		8	12 RBT
Belle Taine	29014600	Hg	14	9			2		28		2			26	13			
Big Sand	29018500	Hg	15						20					33	16			
Big Stony	29014300	Hg	9				5		5					5	5			
Blue	29018400	Hg					2							8	5			4 RBT
Blueberry	80003400	Hg	9	8	8				6					6				
Boot	03003000	Hg	10				4		76					36	1		14	
Duck	29014200		10						8					20	8			
East Crooked	29010101	Hg		10			1		5		2			6	6			
Edward	18030500	Hg	8			6			18					22				
Eighth Crow Wing	29007200	Hg	8				5							5	3			
Eleventh Crow Wing	29003600	Hg	6			8	9		13	10				23	15	5	10	10 RKB
Fifth Crow Wing	29009200	Hg	9	6		2	6		6					5	4			
First Crow Wing	29008600		7	8		4	4		8					4	8			
Fish Hook	29024200	Hg	10						22					24	12			
Fourth Crow Wing	29007800	Hg	11	8	1		5		8						9			
Gull	11030500	Hg	18	16		8	9		54					41	8		21	2 HSF
Ham	29001700	Hg	10	10			6											
Island	29025400	Hg	10						25					29	9			
Little Mantrap	29031300	Hg	10	9			6		6					6		8		
Long	29016100	Hg	10				5		25					10	5			
Long Lost	15006800	Hg		7			1		5		5			5				

Waterway	AUID	Impaired	BGS	BKS	C	CIS	LMB	ML	NP	SF	SMB	SRD	SRH	WE	WSU	YEB	YP	Other
Lower Bottle	29018000	Hg							10	7				10	6			
Lower Cullen	18040300	Hg	19			15	7		15					13				
Lower Twin	80003000	Hg	10	10					5			3		5				
Mantrap	29015100	Hg	6	8				2	15	5				1	10	2	5	2 ML
Mayo	18040800								3								1	
North Long	18037200	Hg	10		3				16					25				
Palmer	29008700		10	4			5		3					7	5			
Pickerel	29017800	Hg	10	10			5		8					6	4			
Portage	29025000	Hg	8				8		5					5	12			
Potato	29024300	Hg	10				1		18		7			18	10			2 RKB
Red Sand	18038600	Hg	13	8					6	7							2	
Round	18037300	Hg		10		16			7					21				
Shell	03010200		9						8					8				5 BRB
Spider	29011700	Hg	10						18					16	7			
Stocking	80003700	Hg	6	5					24					19	5			
Straight	03001000	Hg	9						27					20	8			
Sylvan	11030400	Hg	8						18					11	2			
Tenth Crow Wing	29004500	Hg	20				8	1	27					11	16			8 BKB; 1 ML
Third Crow Wing	29007700	Hg	10	9			2		17				3	8				3 SRH
Two Inlets	03001700	Hg	20	10					15			4		15	10			
Upper Bottle	29014800	Hg	9	6					7					10	4		5	
Upper Twin	29015700	Hg	10						6		1	3		2				
Waboose	29009800	Hg	6	10			7		8					7				

Appendix 6.6 Summary statistics of mercury, PCBs, and

							Waterway				AUID				Species				Year	
Waterway	AUID	Species	Year	Anat	Total Fish	Samples	Mean	Min	Max	N	Mean	Min	Max	N	Mean	Min	Max	N	Mean	Max
CROW WING RIVER	07010106 -523 -516 -515 -514 -513 -512 -511 -510 -509 -508 -507 -506 -501	BGS	1990	FILSK	10	1	6.4			1	0.110			1	< 0.01					
			2002	FILSK	10	1	6.4			1	0.062									
		C	1990	FILSK	15	2	24.5	22.6	26.4	2	0.155	0.120	0.190	2	0.01	0.01	0.011			
			2002	FILSK	4	1	27.6			1	0.282			1	< 0.01					
		GRR	2010	FILSK	5	5	17.3	15.3	19.7	5	0.056	0.042	0.076	2		< 0.025	< 0.025			
		NP	1990	FILSK	14	3	20.0	13.0	29.8	3	0.182	0.095	0.300	3	< 0.01	< 0.01	< 0.01			
			2002	FILSK	1	1	14.1			1	0.086									
		SMB	2010	FILSK	9	9	15.7	12.0	17.4	9	0.236	0.096	0.360	2		< 0.025	< 0.025			
AGATE	11021600	LMB	2007	FILSK	8	8	14.1	10.7	20.1	8	0.274	0.114	1.099							
		NP	1983	FILSK	5	1	21.4			1	0.760			1	< 0.05					
		WE	1983	FILSK	2	1	17.7			1	0.890			1	0.06					
BAD MEDICINE	03008500	NP	1996	FILSK	12	3	19.4	17.0	22.0	3	0.147	0.130	0.160							
		RBT	1996	FILSK	12	3	15.6	12.2	18.8	3	0.063	0.031	0.099	1	< 0.01					
		WE	1996	FILSK	18	4	17.8	14.2	21.2	4	0.215	0.130	0.320	1	< 0.01					
		WSU	1996	FILSK	8	1	20.5			1	0.320									
		YP	1996	FILSK	8	1	11.7			1	0.190									
BELLE TAINE	29014600	BGS	1996	FILSK	10	1	5.9			1	0.040									
			2011	FILSK	4	1	8.0			1	0.042									
		BKS	2011	FILSK	9	2	9.4	8.7	10.0	2	0.062	0.059	0.065							
		LMB	1996	FILSK	2	1	13.6			1	0.130	0.130	0.130							
		NP	1996	FILSK	21	4	21.5	17.8	25.9	4	0.115	0.080	0.170	1	< 0.01					
			2011	FILSK	7	7	23.3	19.6	28.2	7	0.183	0.118	0.314							
		SMB	1996	FILSK	2	2	16.4	14.8	17.9	2	0.230	0.140	0.320	1	< 0.01					

							Waterway				AUID				Species				Year	
Waterway	AUID	Species	Year	Anat	Total Fish	Samples	Mean	Min	Max	N	Mean	Min	Max	N	Mean	Min	Max	N	Mean	Max
		WE	1996	FILSK	19	4	19.0	13.7	23.4	4	0.258	0.070	0.470							
			2011	FILSK	7	7	19.0	14.9	21.3	7	0.270	0.095	0.636							
		WSU	1996	FILSK	8	1	20.5			1	0.110									
			2011	FILSK	5	1	19.8			1	0.062									
BIG SAND	29018500	BGS	1992	FILSK	7	1	6.4			1	0.069									
			2011	FILSK	8	2	7.7	7.4	7.9	2	0.055	0.054	0.055							
		NP	1992	FILSK	12	4	26.2	19.1	35.8	4	0.161	0.062	0.280	1	0.056					
			2011	FILSK	8	8	27.8	20.5	35.3	8	0.316	0.158	0.615							
		WE	1992	FILSK	25	4	20.4	11.4	30.0	4	0.299	0.084	0.660	1	0.058					
			2011	FILSK	8	8	19.4	15.8	24.5	8	0.317	0.192	0.718							
		WSU	1992	FILSK	10	2	19.7	18.4	21.0	2	0.069	0.060	0.077	1	0.018					
			2011	FILSK	6	1	18.1			1	0.085									
BIG STONY	29014300	BGS	2002	FILSK	9	1	7.1			1	0.101									
		LMB	2002	FILSK	5	5	11.4	10.0	13.4	5	0.186	0.142	0.234							
		NP	2002	FILSK	5	5	21.6	18.0	27.8	5	0.264	0.112	0.540							
		WE	2002	FILSK	5	5	16.5	11.7	25.4	5	0.249	0.104	0.543							
		WSU	2002	FILSK	5	1	18.2			1	0.049									
BLUE	29018400	LMB	1999	FILSK	2	2	10.7	10.6	10.8	2	0.060	0.060	0.060							
		RBT	1999	FILSK	4	4	15.5	12.4	22.6	4	0.065	0.040	0.100	1	0.017					
		WE	1999	FILSK	8	8	20.3	16.1	27.8	8	0.318	0.090	0.960	1	0.014					
		WSU	1999	FILSK	5	1	14.7			1	0.060									
BLUEBERRY	80003400	BGS	2007	FILSK	9	1	7.8			1	0.039									
		BKS	2007	FILSK	8	1	9.9			1	0.046									

							Waterway				AUID				Species				Year	
Waterway	AUID	Species	Year	Anat	Total Fish	Samples	Mean	Min	Max	N	Mean	Min	Max	N	Mean	Min	Max	N	Mean	Max
		C	2007	FILSK	8	2	26.0	24.4	27.5	2	0.073	0.067	0.079							
		NP	2007	FILSK	6	6	21.9	17.2	31.2	6	0.067	0.033	0.157							
		WE	2007	FILSK	6	6	20.2	12.2	26.5	6	0.169	0.034	0.340							
BOOT	03003000	BGS	1996	FILSK	10	1	6.0			1	0.083									
		LMB	1996	FILSK	4	3	11.8	9.1	14.7	3	0.333	0.210	0.510							
		NP	1996	FILSK	26	5	21.2	14.5	28.1	5	0.348	0.230	0.530	1	< 0.01					
			2001	FILSK	19	19	20.3	13.8	28.0	19	0.492	0.216	1.423							
			2006	FILSK	16	16	19.9	12.1	24.5	16	0.406	0.172	0.700							
			2011	FILSK	15	15	21.2	15.3	34.5	15	0.433	0.195	2.049							
		WE	1996	FILSK	19	4	17.6	12.3	21.9	4	0.365	0.220	0.580							
			2001	FILSK	17	17	17.8	10.5	26.1	17	0.574	0.164	1.391							
		WSU	1996	FILSK	1	1	18.5			1	0.099									
		YP	2001	WHORG	4	1	5.8			1	0.114									
			2006	WHORG	10	4	6.2	6.1	6.3	4	0.109	0.101	0.118							
DUCK	29014200	BGS	1995	FILSK	10	1	6.4			1	0.019									
		NP	1995	FILSK	8	4	26.9	20.2	35.4	4	0.081	0.038	0.130							
		WE	1995	FILSK	20	6	20.7	13.7	27.8	6	0.131	0.063	0.180	1	< 0.01					
		WSU	1995	FILSK	8	1	16.7			1	0.042									
EAST CROOKED	29010101	BKS	2007	FILSK	10	1	9.2			1	0.052							1	< 0.92	
		LMB	2007	FILSK	1	1	17.3			1	0.724									
		NP	2007	FILSK	5	5	24.0	19.5	27.3	5	0.307	0.172	0.446							

							Waterway				AUID				Species				Year	
Waterway	AUID	Species	Year	Anat	Total Fish	Samples	Mean	Min	Max	N	Mean	Min	Max	N	Mean	Min	Max	N	Mean	Max
		SMB	2007	FILSK	2	2	14.9	12.8	17.0	2	0.118	0.112	0.124							
		WE	2007	FILSK	6	6	21.2	15.9	27.7	6	0.348	0.117	0.633							
		WSU	2007	FILSK	6	1	17.8			1	0.078									
EDWARD	18030500	BGS	1992	FILSK	8	1	6.3			1	0.047									
		CIS	1992	FILSK	6	2	14.1	12.1	16.0	2	0.127	0.083	0.170	1	< 0.01					
		NP	1992	FILSK	18	4	25.1	18.9	31.9	4	0.260	0.098	0.350	1	< 0.01					
		WE	1992	FILSK	22	3	17.4	13.5	20.4	3	0.207	0.120	0.280	1	0.012					
EIGHTH CROW WING	29007200	BGS	2008	FILSK	8	1	6.9	6.9	6.9	1	0.031									
		LMB	2008	FILSK	5	5	15.5	14.2	17.2	5	0.185	0.142	0.253							
		WE	2008	FILSK	5	5	19.1	16.6	21.5	5	0.138	0.105	0.183							
		WSU	2008	FILSK	3	1	18.4			1	0.043									
ELEVENTH CROW WING	29003600	BGS	1991	FILSK	6	1	6.7			1	0.041									
		CIS	1991	FILSK	8	1	11.5			1	0.066									
		LMB	1991	FILSK	7	1	11.8			1	0.160									
			2011	FILSK	2	2	16.2	14.0	18.3	2	0.303	0.113	0.492							
		NP	1991	FILSK	5	2	23.8	22.3	25.2	2	0.235	0.180	0.290							
			2011	FILSK	8	8	28.6	22.1	35.1	8	0.277	0.136	0.701							
		RKB	1991	FILSK	10	1	7.0			1	0.130									
		SF	1991	FILSK	10	1	6.0			1	0.053									
		WE	1991	FILSK	15	3	16.5	10.6	21.5	3	0.241	0.082	0.450	1	< 0.01					
			2011	FILSK	8	8	23.8	14.5	30.2	8	0.564	0.082	1.261							
		WSU	1991	FILSK	11	2	15.0	12.9	17.0	2	0.027	0.020	0.033	1	< 0.01					

							Waterway				AUID				Species				Year	
Waterway	AUID	Species	Year	Anat	Total Fish	Samples	Mean	Min	Max	N	Mean	Min	Max	N	Mean	Min	Max	N	Mean	Max
			2011	FILSK	4	1	18.8			1	0.021									
		YEB	1991	FILET	5	1	10.6			1	0.220									
		YP	1991	FILSK	10	1	6.8			1	0.092									
FIFTH CROW WING	29009200	BGS	2004	FILSK	9	1	7.4			1	0.039									
		BKS	2004	FILSK	6	1	8.8			1	0.031									
		CIS	2004	FILSK	2	1	16.7			1	0.051									
		LMB	2004	FILSK	6	6	12.3	9.5	15.6	6	0.154	0.066	0.397							
		NP	2004	FILSK	6	6	27.4	21.7	36.0	6	0.161	0.074	0.261							
		WE	2004	FILSK	5	5	18.0	14.4	21.5	5	0.188	0.077	0.304							
		WSU	2004	FILSK	4	1	18.0			1	0.045									
FIRST CROW WING	29008600	BGS	2009	FILSK	7	2	7.7	7.5	7.9	2	0.044	0.035	0.053							
		BKS	2009	FILSK	8	2	9.9	9.4	10.4	2	0.046	0.044	0.048							
		CIS	2009	FILSK	4	1	14.7			1	0.051									
		LMB	2009	FILSK	4	4	14.7	12.0	17.5	4	0.177	0.118	0.245							
		NP	2009	FILSK	8	8	23.6	17.5	32.4	8	0.117	0.072	0.185							
		WE	2009	FILSK	4	4	20.0	18.1	21.4	4	0.163	0.114	0.210							
		WSU	2009	FILSK	8	1	18.0			1	0.046									
FISH HOOK	29024200	BGS	1992	FILSK	10	1	6.6			1	0.045									
		NP	1992	FILSK	22	4	25.1	18.7	32.3	4	0.197	0.098	0.310	1	0.062					
		WE	1992	FILSK	24	3	17.7	12.1	22.5	3	0.216	0.067	0.380	1	0.023					
		WSU	1992	FILSK	12	2	15.2	12.4	17.9	2	0.025	0.010	0.039	1	< 0.012					
FOURTH CROW WING	29007800	BGS	2009	FILSK	11	2	7.9	7.8	7.9	2	0.073	0.063	0.083							

							Waterway				AUID				Species				Year	
Waterway	AUID	Species	Year	Anat	Total Fish	Samples	Mean	Min	Max	N	Mean	Min	Max	N	Mean	Min	Max	N	Mean	Max
		BKS	2009	FILSK	8	2	10.8	10.6	11.0	2	0.114	0.087	0.141							
		C	2009	FILSK	1	1	21.6			1	0.036									
		LMB	2009	FILSK	5	5	15.6	13.1	17.1	5	0.274	0.163	0.466							
		NP	2009	FILSK	8	8	25.2	17.6	30.2	8	0.145	0.083	0.224							
		WSU	2009	FILSK	9	2	18.3	17.8	18.8	2	0.089	0.068	0.109							
GULL	11030500	BGS	2001	FILSK	10	1	6.3			1	0.056									
			2007	FILSK	8	1	6.9			1	0.045							1	< 0.92	
		BKS	1991	FILSK	10	1	8.3			1	0.055									
			2007	FILSK	6	1	8.3			1	0.061									
		CIS	1991	FILSK	8	1	12.2			1	0.060			1	0.03					
		HSF	2007	FILSK	2	1	7.9			1	0.050									
		LMB	1991	FILSK	4	2	13.9	12.2	15.6	2	0.265	0.250	0.280	1	< 0.01					
			2007	FILSK	5	5	12.3	9.8	15.6	5	0.236	0.119	0.368							
		NP	1983	FILSK	5	1	23.0			1	0.180			1	< 0.05					
			1991	FILSK	18	4	24.9	16.7	32.9	4	0.233	0.080	0.340	1	0.044					
			2001	FILSK	6	6	22.5	17.1	27.0	6	0.324	0.101	0.561							
			2004	FILSK	25	25	25.7	19.5	34.7	25	0.303	0.125	0.751							
		WE	1983	FILSK	6	2	19.7	16.8	22.6	1	0.230			2	< 0.05					
			1991	FILSK	29	4	19.5	11.8	27.1	4	0.373	0.110	0.680	1	0.023					
			2001	FILSK	6	6	16.8	11.9	19.9	6	0.216	0.112	0.316							
		WSU	1991	FILSK	8	1	16.9			1	0.030									
		YP	1991	WHORG	10	1	5.9			1	0.050									
			2004	WHORG	11	2	5.3	5.0	5.5	2	0.030	0.029	0.030							

							Waterway				AUID				Species				Year	
Waterway	AUID	Species	Year	Anat	Total Fish	Samples	Mean	Min	Max	N	Mean	Min	Max	N	Mean	Min	Max	N	Mean	Max
HAM	29001700	BGS	2007	FILSK	10	1	7.2			1	0.031							1	< 0.92	
		BKS	2007	FILSK	10	1	9.2			1	0.048									
		LMB	2007	FILSK	6	6	13.2	11.7	14.3	6	0.170	0.076	0.240							
ISLAND	29025400	BGS	1995	FILSK	5	1	6.9			1	0.058									
			2010	FILSK	5	1	8.5			1	0.028									
		NP	1995	FILSK	17	6	21.1	14.6	29.4	6	0.218	0.130	0.300							
			2010	FILSK	8	8	19.5	17.1	22.5	8	0.121	0.069	0.165							
		WE	1995	FILSK	21	6	18.6	12.2	26.7	6	0.333	0.220	0.490	1	< 0.01					
			2010	FILSK	8	8	18.5	14.2	24.4	8	0.284	0.091	0.665							
		WSU	1995	FILSK	4	1	19.3			1	0.078									
			2010	FILSK	5	1	15.5			1	0.033									
LITTLE MANTRAP	29031300	BGS	2007	FILSK	10	1	6.8			1	0.089							1	< 0.92	
		BKS	2007	FILSK	9	1	9.7			1	0.094									
		LMB	2007	FILSK	6	6	14.1	11.4	18.3	6	0.361	0.186	0.616							
		NP	2007	FILSK	6	6	23.0	17.5	29.6	6	0.303	0.217	0.483							
		WE	2007	FILSK	6	6	18.6	12.4	24.4	6	0.298	0.147	0.514							
		YEB	2007	FILET	8	1	11.9			1	0.246									
LONG	29016100	BGS	1998	FILSK	10	1	5.9			1	0.050									
		LMB	1998	FILSK	5	5	12.3	10.4	14.0	5	0.124	0.100	0.180							
		NP	1998	FILSK	10	10	24.0	21.6	28.0	10	0.233	0.130	0.300							
			2009	FILSK	15	15	25.8	18.8	32.0	15	0.286	0.108	0.522							
		WE	1998	FILSK	10	10	22.2	18.0	27.2	10	0.689	0.310	1.150							
		WSU	1998	FILSK	5	1	19.4			1	0.040									

							Waterway				AUID				Species				Year	
Waterway	AUID	Species	Year	Anat	Total Fish	Samples	Mean	Min	Max	N	Mean	Min	Max	N	Mean	Min	Max	N	Mean	Max
LONG LOST	15006800	BKS	2005	FILSK	7	1	9.3			1	0.261									
		LMB	2005	FILSK	1	1	13.6			1	0.460									
		NP	2005	FILSK	5	5	21.4	19.7	23.3	5	0.331	0.269	0.371							
		SMB	2005	FILSK	5	5	14.8	13.6	16.2	5	0.332	0.266	0.391							
		WE	2005	FILSK	5	5	23.6	20.6	25.3	5	0.761	0.583	0.977							
LOWER BOTTLE	29018000	NP	1998	FILSK	10	10	22.2	16.6	31.0	10	0.135	0.070	0.280							
		SF	1998	FILSK	7	1	6.0	6.0	6.0	1	0.030									
		WE	1998	FILSK	10	10	15.2	12.2	20.3	10	0.122	0.090	0.190							
		WSU	1998	FILSK	6	1	17.6			1	0.030									
LOWER CULLEN	18040300	BGS	1998	FILSK	10	1	6.5			1	0.018									
			2009	FILSK	9	2	6.9	6.8	6.9	1	0.024							1	< 4.9	
		CIS	1998	FILSK	7	1	14.1			1	0.020									
			2009	FILSK	8	2	15.7	14.6	16.8	2	0.062	0.062	0.062							
		LMB	2009	FILSK	7	7	13.4	10.4	15.1	4	0.150	0.070	0.192					3	< 4.89	< 5.00
		NP	1998	FILSK	8	8	27.1	21.7	34.1	8	0.119	0.052	0.210							
			2009	FILSK	7	7	21.7	19.3	26.1	4	0.088	0.060	0.155					3	< 4.76	< 4.85
		WE	1998	FILSK	6	6	20.3	18.3	21.5	6	0.293	0.089	0.570							
			2009	FILSK	7	7	22.1	14.6	26.5	4	0.418	0.243	0.574					3	< 4.74	< 4.88
LOWER TWIN	80003000	BGS	2008	FILSK	10	1	7.2			1	0.079									
		BKS	2008	FILSK	10	1	10.0			1	0.065									
		NP	2008	FILSK	5	5	22.0	19.5	26.7	5	0.226	0.156	0.355							
		SRD	2008	FILSK	3	1	20.9			1	0.162									

							Waterway				AUID				Species				Year	
Waterway	AUID	Species	Year	Anat	Total Fish	Samples	Mean	Min	Max	N	Mean	Min	Max	N	Mean	Min	Max	N	Mean	Max
		WE	2008	FILSK	5	5	18.0	14.5	24.0	5	0.402	0.175	0.859							
MANTRAP	29015100	BGS	1991	FILSK	6	1	6.5			1	0.047									
		BKS	1991	FILSK	8	2	7.5	7.5	7.5	2	0.044	0.028	0.059	1	< 0.01					
		ML	1991	FILSK	2	2	26.5	21.5	31.4	2	0.294	0.087	0.500	1	0.02					
		NP	1991	FILSK	15	6	23.4	19.2	27.3	6	0.189	0.083	0.330	6	< 0.01					
		SF	1991	FILSK	5	1	6.2			1	0.039									
		WE	1991	FILSK	1	1	23.0			1	0.680			1	0.017					
		WSU	1991	FILSK	10	3	16.6	16.4	16.8	3	0.020	0.020	0.020	3	< 0.01					
		YEB	1991	FILET	2	2	10.0	9.6	10.3	2	0.165	0.160	0.170	2	< 0.01					
		YP	1991	FILSK	5	2	7.8	7.6	8.0	2	0.093	0.085	0.100	1	< 0.01					
MAYO	18040800	NP	2007	FILSK	3	3	22.5	18.6	28.7	3	0.532	0.483	0.567							
		YP	2007	WHO RG	1	1	6.1			1	0.114									
NORTH LONG	18037200	BGS	1993	FILSK	10	1	7.3			1	0.052									
		C	1993	FILSK	3	1	21.8			1	0.066			1	0.012					
		NP	1993	FILSK	16	3	28.2	23.2	32.1	3	0.260	0.190	0.360	1	< 0.01					
		WE	1993	FILSK	25	4	19.0	13.2	26.2	4	0.240	0.150	0.320	1	0.013					
PALMER	29008700	BGS	2011	FILSK	10	2	7.7	7.1	8.3	2	0.066	0.045	0.086							
		BKS	2011	FILSK	4	1	8.9			1	0.056									
		LMB	2011	FILSK	5	5	13.2	12.1	14.1	5	0.241	0.200	0.274							
		NP	2011	FILSK	3	3	28.0	16.2	41.2	3	0.424	0.137	0.692							
		WE	2011	FILSK	7	7	15.5	13.2	22.8	7	0.292	0.181	0.598							
		WSU	2011	FILSK	5	1	17.4			1	0.015									

							Waterway				AUID				Species				Year	
Waterway	AUID	Species	Year	Anat	Total Fish	Samples	Mean	Min	Max	N	Mean	Min	Max	N	Mean	Min	Max	N	Mean	Max
PICKEREL	29017800	BGS	2006	FILSK	10	1	6.3			1	0.044									
		BKS	2006	FILSK	10	1	8.7			1	0.099									
		LMB	2006	FILSK	5	5	13.2	10.4	16.8	5	0.180	0.096	0.308							
		NP	2006	FILSK	8	8	25.1	19.5	38.0	8	0.146	0.068	0.394							
		WE	2006	FILSK	6	6	21.1	17.0	23.5	6	0.331	0.259	0.394							
		WSU	2006	FILSK	4	1	17.4			1	0.049									
PORTAGE	29025000	BGS	2002	FILSK	8	1	6.6			1	0.056									
		LMB	2008	FILSK	8	8	13.4	12.3	14.5	8	0.163	0.112	0.298							
		NP	2002	FILSK	5	5	19.4	17.4	21.4	5	0.125	0.071	0.192							
		WE	2002	FILSK	5	5	16.6	13.4	22.1	5	0.157	0.086	0.258							
		WSU	2002	FILSK	4	1	18.2			1	0.044									
			2008	FILSK	8	1	20.5			1	0.053									
POTATO	29024300	BGS	2010	FILSK	10	2	7.3	6.9	7.7	2	0.032	0.027	0.037							
		LMB	2010	FILSK	1	1	14.8			1	0.206									
		NP	1998	FILSK	10	10	21.4	15.9	28.4	10	0.131	0.040	0.280							
			2010	FILSK	8	8	23.6	16.1	31.8	8	0.137	0.052	0.247							
		RKB	1998	FILSK	2	1	9.6			1	0.110									
		SMB	2010	FILSK	7	7	14.9	12.4	19.0	7	0.224	0.111	0.342							
		WE	1998	FILSK	10	10	18.7	15.0	21.7	10	0.258	0.140	0.480							
			2010	FILSK	8	8	19.9	16.8	24.8	8	0.172	0.135	0.214							
		WSU	1998	FILSK	6	1	18.1			1	0.039									
			2010	FILSK	4	1	19.9			1	0.036									

							Waterway				AUID				Species				Year	
Waterway	AUID	Species	Year	Anat	Total Fish	Samples	Mean	Min	Max	N	Mean	Min	Max	N	Mean	Min	Max	N	Mean	Max
RED SAND	18038600	BGS	2008	FILSK	3	1	6.9			1	0.129									
			2009	FILSK	10	1	6.8											1	< 4.61	
		BKS	2009	FILSK	8	1	6.2			1	0.038							1	< 4.95	
		NP	2008	FILSK	6	6	21.3	14.2	28.8	6	0.140	0.051	0.235							
		SF	2008	FILSK	7	1	6.4			1	0.047									
		YP	2008	FILSK	2	1	8.6			1	0.109									
ROUND	18037300	BKS	1991	FILSK	10	1	9.8			1	0.040									
		CIS	1991	FILSK	16	2	14.2	12.9	15.4	2	0.022	0.020	0.023	1	< 0.01					
		NP	1991	FILSK	7	3	27.9	23.4	32.0	3	0.180	0.110	0.250	3	< 0.01					
		WE	1991	FILSK	21	3	17.0	13.0	21.1	3	0.196	0.068	0.390	2	< 0.01					
SHELL	03010200	BGS	2010	FILSK	9	2	7.2	6.8	7.5	2	0.030	0.026	0.033							
		BRB	2010	FILET	5	1	10.0			1	0.025									
		NP	2010	FILSK	8	8	21.0	13.1	27.0	8	0.124	0.072	0.201							
		WE	2010	FILSK	8	8	14.8	12.0	16.4	8	0.055	0.033	0.100							
SPIDER	29011700	BGS	1993	FILSK	10	1	6.9			1	0.097									
		NP	1993	FILSK	18	4	25.1	17.8	34.0	4	0.505	0.310	0.840	1	< 0.01					
		WE	1993	FILSK	16	4	19.6	13.8	27.5	4	0.368	0.210	0.570	1	< 0.01					
		WSU	1993	FILSK	7	1	18.6			1	0.072			1	< 0.01					
STOCKING	80003700	BGS	1996	FILSK	3	1	8.5			1	0.040									
			2011	FILSK	3	1	8.3			1	0.023									
		BKS	2011	FILSK	5	1	11.6			1	0.034									
		NP	1996	FILSK	19	5	23.6	18.2	30.5	5	0.092	0.060	0.140	1	< 0.01					
		WE	1996	FILSK	17	5	19.7	14.2	25.0	5	0.248	0.090	0.430							

							Waterway				AUID				Species				Year	
Waterway	AUID	Species	Year	Anat	Total Fish	Samples	Mean	Min	Max	N	Mean	Min	Max	N	Mean	Min	Max	N	Mean	Max
			2011	FILSK	2	2	15.1	14.8	15.3	2	0.057	0.044	0.069							
		WSU	1996	FILSK	5	1	17.2			1	0.090									
STRAIGHT	03001000	BGS	1995	FILSK	9	1	6.7			1	0.048									
		NP	1995	FILSK	27	5	23.3	18.1	28.9	5	0.156	0.110	0.180							
		WE	1995	FILSK	20	4	19.3	12.9	24.3	4	0.353	0.120	0.520	1	< 0.01					
		WSU	1995	FILSK	8	1	18.5			1	0.040									
SYLVAN	11030400	BGS	1993	FILSK	8	1	7.4			1	0.038									
		NP	1993	FILSK	18	5	24.1	14.1	35.0	5	0.588	0.090	1.600	1	< 0.01					
		WE	1993	FILSK	11	3	22.3	19.0	25.9	3	0.420	0.290	0.580	1	< 0.01					
		WSU	1993	FILSK	2	1	18.5			1	0.051			1	< 0.01					
TENTH CROW WING	29004500	BGS	1990	FILSK	10	1	6.5			1	0.062			1	< 0.01					
			1995	FILSK	10	1	6.6			1	0.079									
		BKB	1990	FILET	8	1	11.2			1	0.130			1	< 0.01					
		LMB	1990	FILSK	6	1	12.0			1	0.200			1	< 0.01					
			1995	FILSK	2	1	13.5			1	0.270									
		ML	1995	FILSK	1	1	21.4			1	0.120									
		NP	1990	FILSK	6	3	22.7	18.3	27.0	3	0.090	0.057	0.150	3	< 0.01					
			1995	FILSK	21	7	23.9	15.5	35.6	7	0.343	0.160	0.630	1	< 0.01					
		WE	1990	FILSK	4	2	19.0	17.7	20.2	2	0.280	0.220	0.340	2	< 0.01					
			1995	FILSK	7	3	16.0	12.1	19.7	3	0.329	0.028	0.790							
		WSU	1990	FILSK	8	2	13.9	12.3	15.5	2	0.030	0.025	0.034	2	< 0.01					
			1995	FILSK	8	1	17.2			1	0.032									

							Waterway				AUID				Species				Year	
Waterway	AUID	Species	Year	Anat	Total Fish	Samples	Mean	Min	Max	N	Mean	Min	Max	N	Mean	Min	Max	N	Mean	Max
THIRD CROW WING	29007700	BGS	1999	FILSK	10	1	7.0			1	0.040									
		BKS	1999	FILSK	9	1	8.1			1	0.040									
		LMB	1999	FILSK	2	2	14.1	10.0	18.2	2	0.170	0.080	0.260							
		NP	1999	FILSK	8	8	23.8	19.5	33.1	8	0.155	0.070	0.280	1	< 0.01					
			2009	FILSK	9	9	26.4	20.1	35.1	9	0.137	0.061	0.218							
		SRH	1999	FILSK	3	1	21.2			1	0.050									
		WE	1999	FILSK	8	8	20.2	18.6	23.1	8	0.271	0.180	0.320	1	< 0.01					
TWO INLETS	03001700	BGS	2001	FILSK	10	1	7.2			1	0.033									
			2011	FILSK	10	2	7.0	6.5	7.4	2	0.022	0.021	0.023							
		BKS	2001	FILSK	10	1	9.0			1	0.030									
		NP	2001	FILSK	8	8	21.4	17.4	26.0	8	0.163	0.119	0.216							
			2011	FILSK	7	7	23.6	14.8	33.2	7	0.144	0.084	0.342							
		SRD	2001	FILSK	4	1	16.9	16.9	16.9	1	0.079									
		WE	2001	FILSK	7	7	21.6	15.5	28.2	7	0.365	0.203	0.587							
			2011	FILSK	8	8	25.3	21.2	29.2	8	0.422	0.253	0.758							
		WSU	2001	FILSK	5	1	17.4			1	0.036									
			2011	FILSK	5	1	18.7			1	0.040									
UPPER BOTTLE	29014800	BGS	2008	FILSK	9	2	8.3	7.6	8.9	2	0.041	0.036	0.046							
		BKS	2008	FILSK	6	2	9.7	9.1	10.2	2	0.030	0.028	0.031							
		NP	2008	FILSK	7	7	21.7	18.6	27.2	7	0.124	0.047	0.335							
		WE	2008	FILSK	10	10	20.2	13.5	25.2	10	0.152	0.051	0.332							
		WSU	2008	FILSK	4	1	17.6			1	0.016									

							Waterway				AUID				Species				Year	
Waterway	AUID	Species	Year	Anat	Total Fish	Samples	Mean	Min	Max	N	Mean	Min	Max	N	Mean	Min	Max	N	Mean	Max
		YP	2008	FILSK	5	1	9.9			1	0.070									
UPPER TWIN	29015700	BGS	2008	FILSK	10	2	8.3	7.7	8.8	2	0.078	0.069	0.086							
		NP	2008	FILSK	6	6	23.7	18.1	28.6	6	0.232	0.109	0.320							
		SMB	2008	FILSK	1	1	20.3			1	0.555									
		SRD	2008	FILSK	3	1	22.6			1	0.275									
		WE	2008	FILSK	2	2	19.4	18.2	20.6	2	0.601	0.255	0.946							
WABOOSE	29009800	BGS	2009	FILSK	6	1	7.0			1	0.026									
		BKS	2009	FILSK	10	2	8.0	7.6	8.4	2	0.026	0.025	0.026							
		LMB	2009	FILSK	7	7	15.1	10.5	17.4	7	0.202	0.051	0.461							
		NP	2009	FILSK	8	8	23.5	20.2	26.4	8	0.105	0.068	0.202							