Watershed health

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Upper Iowa River, Mississippi River-Reno, Mississippi River-La Crescent Watersheds Monitoring and Assessment Report

MINNESOTA POLLUTION CONTROL AGENCY

Authors

Mel Markert, Joe Hadash, Joel Chirhart, Mark Gernes, David Duffey, Mike Walerak, James Jahnz, Tiffany Schauls, Justin Watkins, David Christopherson, Bruce Monson, Shawn Nelson

Contributors/acknowledgements

Citizen Stream Monitoring Program Volunteers
Minnesota Department of Natural Resources
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Minnesota Pollution Control Agency

520 Lafayette Road North | Saint Paul, MN 55155-4194 |

651-296-6300 | 800-657-3864 | Or use your preferred relay service. | Info.pca@state.mn.us

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List of acronyms

CD County Ditch

CI Confidence Interval

CLMP Citizen Lake Monitoring Program

CR County Road

CSAH County State Aid Highway

CSMP Citizen Stream Monitoring Program

CWA Clean Water Act

CWLA Clean Water Legacy Act

DNR Minnesota Department of Natural Resources

DOP Dissolved Orthophosphate

E Eutrophic

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

FWMC Flow Weighted Mean Concentration

H Hypereutrophic

HUC Hydrologic Unit Code

IBI Index of Biotic Integrity

IF Insufficient Information

K Potassium

LRVW Limited Resource Value Water

M Mesotrophic

MCES Metropolitan Council Environmental Services

MDA Minnesota Department of Agriculture

MDH Minnesota Department of Health

MINLEAP Minnesota Lake Eutrophication Analysis Procedure

MPCA Minnesota Pollution Control Agency

MSHA Minnesota Stream Habitat Assessment

MTS Meets the Standard

N Nitrogen

Nitrate-N Nitrate Plus Nitrite Nitrogen

NA Not Assessed

NHD National Hydrologic Dataset

NH3 Ammonia

NT No Trend

OP Orthophosphate

P Phosphorous

PCB Poly Chlorinated Biphenyls

PWI Protected Waters Inventory

RNR River Nutrient Region

SWAG Surface Water Assessment Grant

SWCD Soil and Water Conservation District

SWUD State Water Use Database

TALU Tiered Aquatic Life Uses

TKN Total Kjeldahl Nitrogen

TMDL Total Maximum Daily Load

TP Total Phosphorous

TSS Total Suspended Solids

USGS United States Geological Survey

WID Waterbody Identification Number

WPLMN Watershed Pollutant Load Monitoring Network

Executive summary

The Upper Iowa River watershed is located along the Minnesota/Iowa border in southeast Minnesota. The watershed begins in southeast Mower County, and then flows through southern Fillmore County and southwest Houston County. The headwaters of the Upper Iowa River are in Minnesota, but most of the watershed is located in Iowa. The river is popular for fishing and canoeing. In Minnesota, Bee Creek is meeting exceptional use standards. Bee Creek, a popular trout fishing location drawing numerous angler to the area.

Louise Mill Pond is the only lake in the watershed, located in Lake Louise State Park. The park is a popular location for hiking and has a beach open for swimming. No assessment was conducted because residence time is too short for standards to apply.

Fish contaminants were sampled from the Upper Iowa River. Smallmouth bass and golden redhorse were tested. Tissue concentrations of mercury and Poly Chlorinated Biphenyls (PCBs) in both species were below the threshold for healthy consumption.

Assessments for biological life indicate 50% of the stream reaches sampled are impaired based on biological samples and water chemistry. Five stream reaches had data to assess for aquatic recreation. Assessment for aquatic recreation reveal 100% of stream reaches sampled are being listed as impaired due to elevated levels of Escherichia coli *(E. coli)*.

The Mississippi River-Reno is a small watershed located in eastern Houston County, in the Driftless Area. The area is characterized by rolling bluffs covered in thick woodlands and plunging valleys. Many of the streams are spring fed coldwater systems. Trout fishing is a popular recreation and draws anglers to the areas year round. Due to the size of the watershed, there was limited data available for assessment for this report

Two reaches were assessed and will be listed as impaired for aquatic recreation in the Mississippi River-Reno watershed for elevated *E. coli*. Ten stream reaches were assessed for aquatic life; 40% are being listed as impaired.

The Mississippi River-La Crescent is a very small watershed in southeast Minnesota. The watershed is located in southeast Winona County and Northeast Houston County. Due to the size of the watershed, limited data was available for assessment. The watershed is entirely in the Driftless Area of the state. Similar to the Mississippi River-Reno, the watershed is defined by wooded bluffs and spring fed streams. Trout fishing is a popular recreational activity. Streams are generally too small to canoe.

Four reaches were assessed for aquatic life. Of the reaches assessed, three of them are passing and not being listed for impairment. The fourth stream reach is being listed for impairment for TSS and fish assemblage. The same reach was the only one in the watershed assessed for aquatic recreation. It is being listed as impaired for aquatic recreation for *E. coli*.

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. 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 waterbody 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 Upper Iowa River, Mississippi River-Reno, Mississippi River-La Crescent Watersheds beginning in the summer of 2015. This report provides a summary of all water quality assessment results in these watersheds and incorporates all data available for the assessment process including watershed monitoring, volunteer monitoring and monitoring conducted by local government units.

The watershed monitoring approach

The watershed approach is a 10-year rotation for monitoring and assessing waters of the state on the level of Minnesota's 80 major watersheds. The major benefit of this approach is the integration of monitoring resources to provide a more complete and systematic assessment of water quality at a geographic scale useful for the development and implementation of effective TMDLs, project planning, effectiveness monitoring and protection strategies. The following paragraphs provide details on each of the four principal monitoring components of the watershed approach. For additional information see: Watershed Approach to Condition Monitoring and Assessment (MPCA, 2008) (http://www.pca.state.mn.us/publications/wq-s1-27.pdf).

Watershed pollutant load monitoring

The Watershed Pollutant Load Monitoring Network (WPLMN) is a long-term statewide river monitoring network initiated in 2007 and designed to obtain pollutant load information from 199 river monitoring sites throughout Minnesota. Monitoring sites span three ranges of scale:

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

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

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

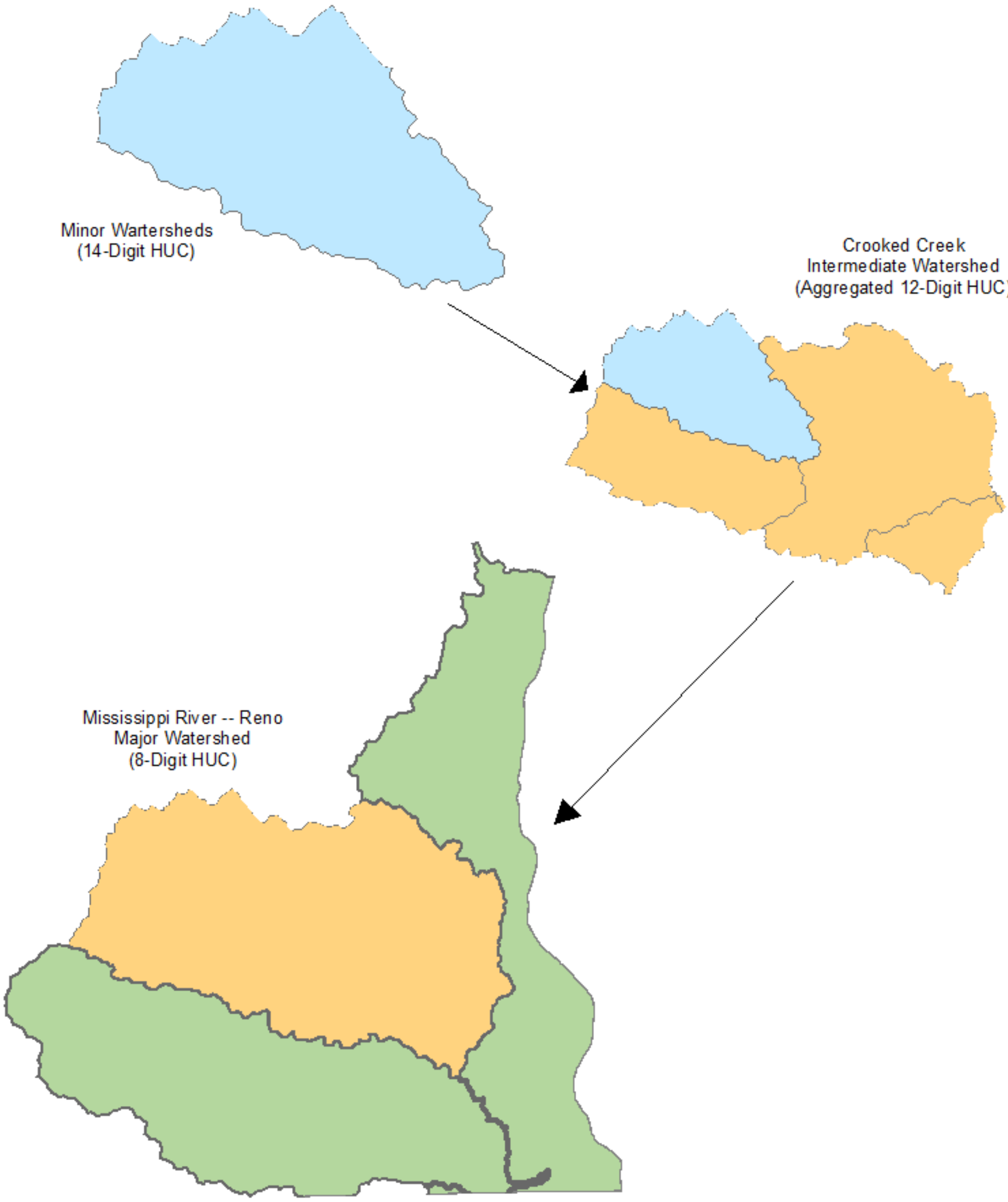
The program utilizes state and federal agencies, universities, local partners, and MPCA staff to collect water quality and flow data to calculate nitrogen, phosphorus, and sediment pollutant loads.

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 1). 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 80 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, aggregated 12-HUC and 14-HUC (Figure 1). 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 aggregated 12-HUC is the next smaller subwatershed scale, which generally consists of major tributary streams with drainage areas ranging from 75 to 150 mi^2. Each aggregated 12-HUC outlet (green dots in Figure 2) is sampled for biology and water chemistry for the assessment of aquatic life and aquatic recreation use support. Within each aggregated 12-HUC, smaller watersheds (14 HUCs, typically 10-20 mi^2), are sampled at each outlet that flows into the major aggregated 12-HUC tributaries. Each of these minor subwatershed outlets is sampled for biology to assess aquatic life use support (red dots in Figure 2).

Figure 1. The intensive watershed monitoring design.



Lake monitoring

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 and where applicable, where fish community health can be determined. Lakes are prioritized by size, accessibility (can the public access the lakes), and presence of recreational use.

Specific locations for sites sampled as part of the intensive monitoring effort in the Upper Iowa River, Mississippi River-Reno, Mississippi River-La Crescent watersheds are shown in Figure 2, Figure 3, Figure 4 and are listed in Appendices 2.1 and 2.2

Figure 2. Intensive watershed monitoring sites for streams in the Upper Iowa River watershed.

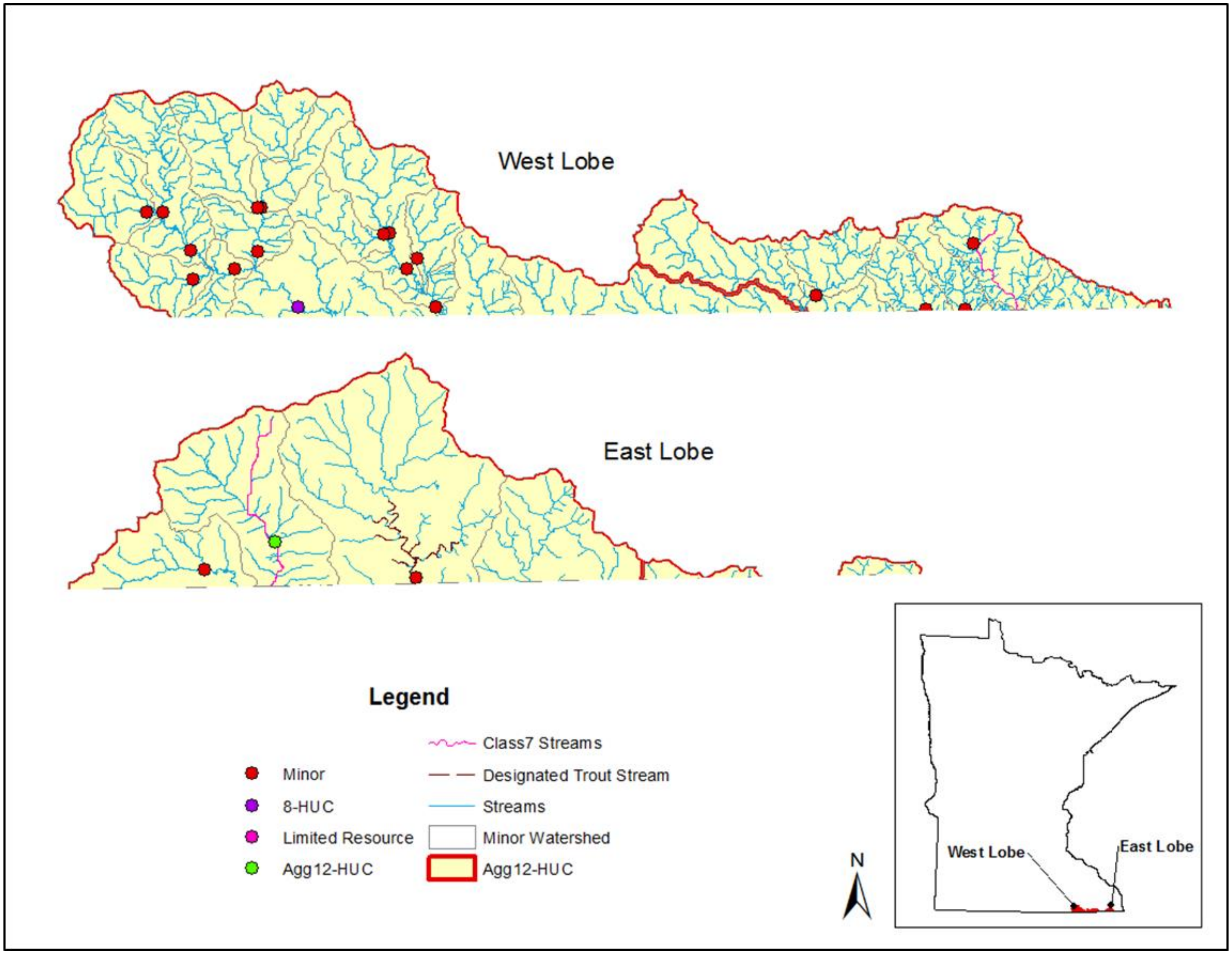


Figure 3. Intensive watershed monitoring sites for streams in the Mississippi River-Reno watershed.

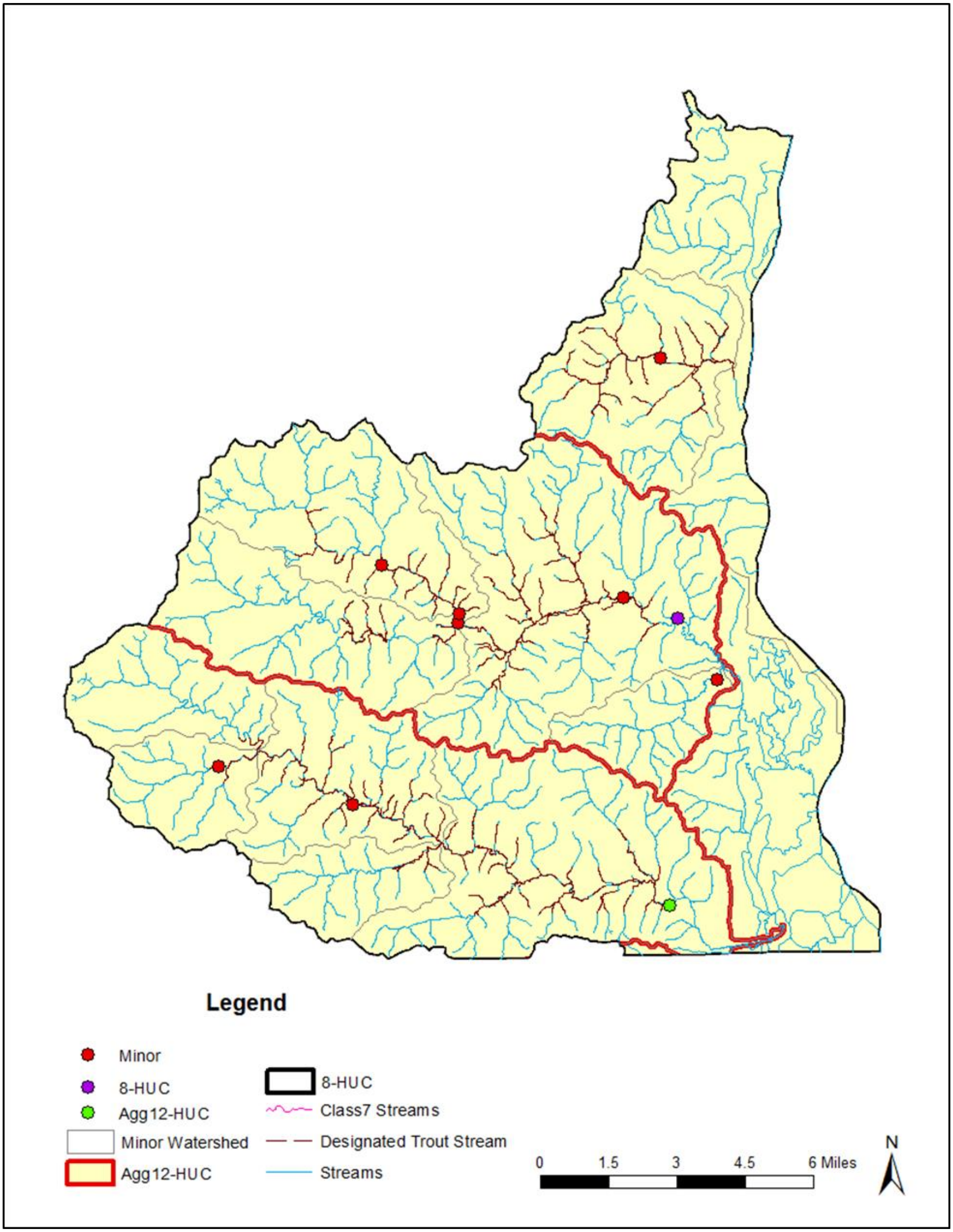
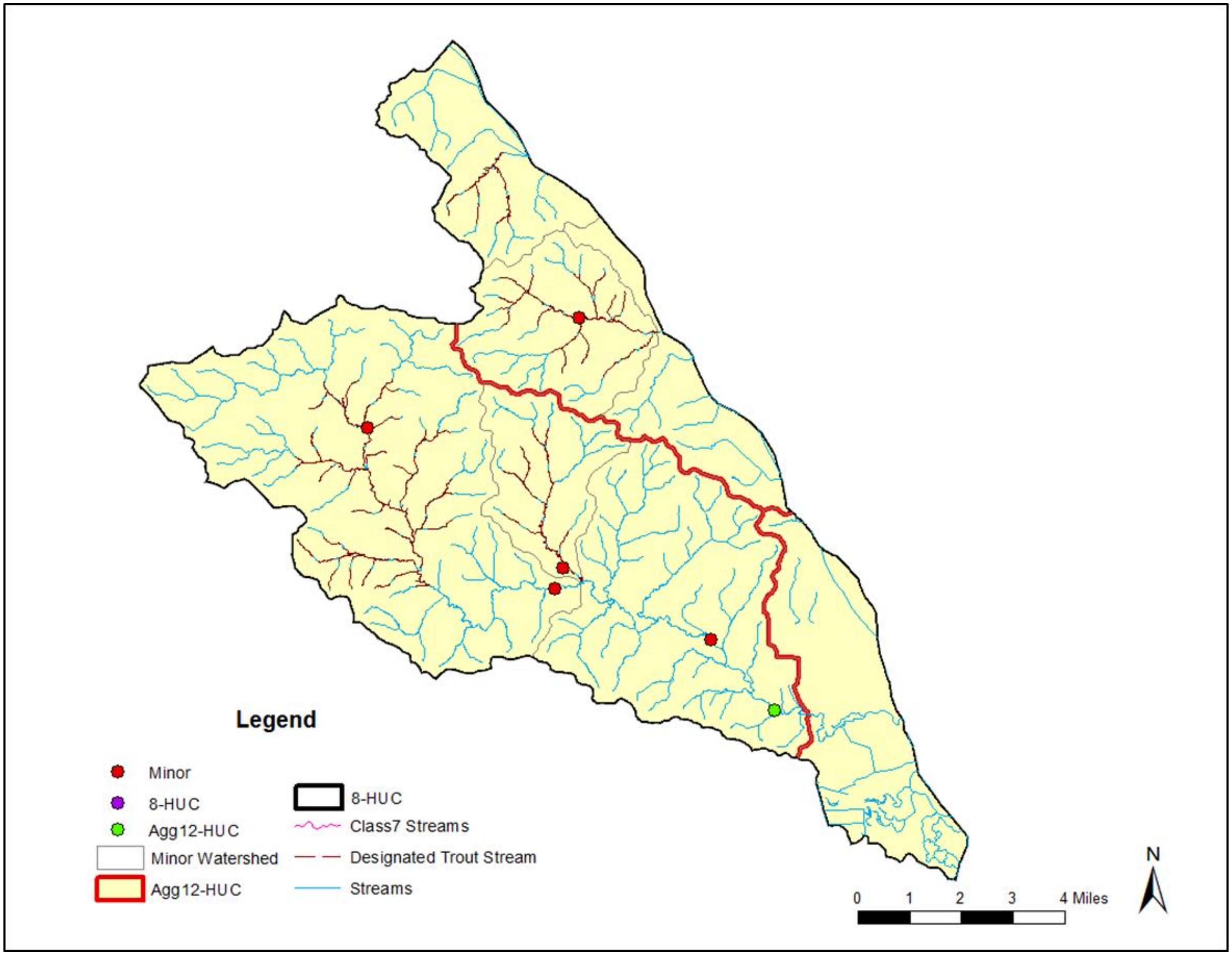


Figure 4. Intensive watershed monitoring sites for streams in the Mississippi River-La Crescent watershed.



Citizen and local monitoring

Citizen and local monitoring is an important component of the watershed approach. The MPCA and its local partners jointly select the stream sites and lakes to be included in the intensive watershed monitoring process. Funding passes from MPCA through Surface Water Assessment Grants (SWAGs) to local groups such as counties, soil and water conservation districts (SWCDs), watershed districts, nonprofits and educational institutions to support lake and stream water chemistry monitoring. Local partners use the same monitoring protocols as the MPCA, and all monitoring data from SWAG projects are combined with the MPCA'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. There are no citizen monitoring locations in the Upper Iowa River, Mississippi River-Reno, Mississippi River-La Crescent watersheds.

Assessment methodology

The CWA requires states to report on the condition of the waters of the state every two years. This biennial report to Congress contains an updated list of surface waters that are determined to be supporting or non-supporting of their designated uses as evaluated by the comparison of monitoring data to criteria specified by Minnesota Water Quality Standards (Minn. R. ch. 7050 2008; https://www.revisor.leg.state.mn.us/rules/?id=7050). The assessment and listing process involves dozens of MPCA staff, other state agencies and local partners. The goal of this effort is to use the best data and best science available to assess the condition of Minnesota's water resources. For a thorough review of the assessment methodologies see: *Guidance Manual for Assessing the Quality of Minnesota Surface Waters for the Determination of Impairment 305(b) Report and 303(d) List (MPCA, 2012)*. https://www.pca.state.mn.us/sites/default/files/wq-iw1-04.pdf.

Water quality standards

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

Protection of aquatic 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 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 waterbody 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.

Protection of aquatic life means the maintenance of a healthy aquatic community, including fish, macroinvertebrates and plants. Biological monitoring, the sampling of aquatic organisms, is a direct means to assess aquatic life use support, as the aquatic community tends to integrate the effects of all pollutants and stressors over time. To effectively use biological indicators, the MPCA employs the Index of Biotic Integrity (IBI). This index is a scientifically validated combination of measurements of the biological community (called metrics). An IBI is comprised of multiple metrics that measure different aspects of aquatic communities (e.g., dominance by pollution tolerant species, loss of habitat specialists). Metric scores are summed together and the resulting index score characterizes the biological integrity or "health" of a site. The MPCA has developed stream IBIs for (fish and macroinvertebrates) since these communities can respond differently to various types of pollution. The MPCA also uses a lake fish IBI developed by the Minnesota Department of Natural Resources (DNR) to determine if lakes are meeting aquatic life use. Because the lakes, rivers, and streams in Minnesota are physically, chemically, and biologically diverse, IBI's are developed separately for different stream classes and lake class groups to account for this natural variation. Further interpretation of biological community data is provided by an assessment threshold or biocriteria against which an IBI score can be compared within a given stream class. In general, an IBI score above this threshold is indicative of aquatic life use support, while a score below this threshold is indicative of non-support. Additionally, chemical parameters are measured and assessed against numeric standards developed to be protective of aquatic life. For streams these include pH, dissolved oxygen, un-ionized ammonia nitrogen, chloride, total suspended solids, pesticides, and river eutrophication. For lakes, pesticides and chlorides contribute to the overall aquatic life use assessment.

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

Table 1. Proposed tiered aquatic life use standards.

Proposed tiered aquatic life use	Acronym	Proposed use class code	Description
Warm water General	WWg	2Bg	Warm water Stream protected for aquatic life and recreation, capable of supporting and maintaining a balanced, integrated, adaptive community of warm or cool water aquatic organisms that meet or exceed the General Use biological criteria.
Warm water Modified	WWm	2Bm	Warm water Stream protected for aquatic life and recreation, physically altered watercourses (e.g., channelized streams) capable of supporting and maintaining a balanced, integrated, adaptive community of warm or cool water aquatic organisms that meet or exceed the Modified Use biological criteria, but are incapable of meeting the General Use biological criteria as determined by a Use Attainability Analysis
Warm water Exceptional	WWe	2Be	Warm water Stream protected for aquatic life and recreation, capable of supporting and maintaining an exceptional and balanced, integrated, adaptive community of warm or cool water aquatic organisms that meet or exceed the Exceptional Use biological criteria.
Coldwater General	CWg	2Ag	Coldwater Stream protected for aquatic life and recreation, capable of supporting and maintaining a balanced, integrated, adaptive community of coldwater aquatic organisms that meet or exceed the General Use biological criteria.
Coldwater Exceptional	CWe	2Ae	Coldwater Stream protected for aquatic life and recreation, capable of supporting and maintaining an exceptional and balanced, integrated, adaptive community of coldwater aquatic organisms that meet or exceed the Exceptional Use biological criteria.

A small percentage of stream miles in the state (~1% of 92,000 miles) have been individually evaluated and re-classified as a Class 7 Limited Resource Value Water (LRVW). These streams have previously demonstrated that the existing and potential aquatic community is severely limited and cannot achieve aquatic life standards either by: a) natural conditions as exhibited by poor water quality characteristics, lack of habitat or lack of water; b) the quality of the resource has been significantly altered by human activity and the effect is essentially irreversible; or c) there are limited recreational opportunities (such as fishing, swimming, wading or boating) in and on the water resource. While not being protective of aquatic life, LRVWs are still protected for industrial, agricultural, navigation and other uses. Class 7 waters are also protected for aesthetic qualities (e.g., odor), secondary body contact, and groundwater for use as a potable water supply. To protect these uses, Class 7 waters have standards for bacteria, pH, 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 WID), comprised of the United States Geological Survey (USGS) eight-digit hydrologic unit code (8-HUC) plus a three-character code that is unique within each HUC. Lake and wetland identifiers are assigned by the DNR. The Protected Waters Inventory provides the identification numbers for lake, reservoirs and wetlands. These identification numbers serve as the WID and are composed of an eight-digit number indicating county, lake and bay for each basin.

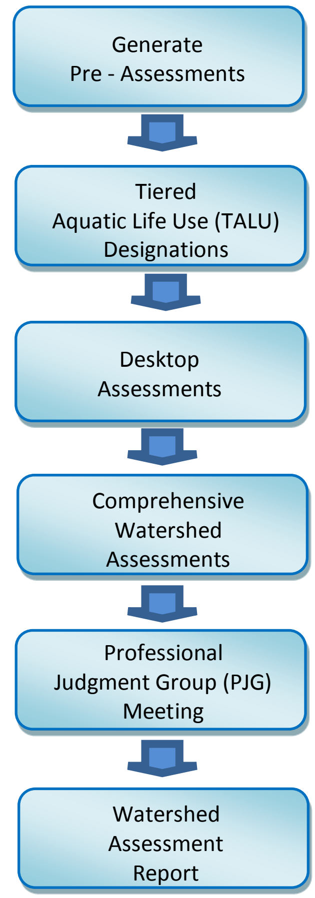
It is for these specific stream reaches or lakes that the data are evaluated for potential use impairment. Therefore, any assessment of use support would be limited to the individual assessment unit. The major exception to this is the listing of rivers for contaminants in fish tissue (aquatic consumption). Over the course of time it takes fish, particularly game fish, to grow to “catchable” size and accumulate unacceptable levels of pollutants, there is a good chance they have traveled a considerable distance. The impaired reach is defined by the location of significant barriers to fish movement such as dams upstream and downstream of the sampled reach and thus often includes several assessment units.

Determining use attainment

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

The first step in the aquatic life assessment process is largely an automated process performed by logic programmed into a database application where all data from the 10 year assessment window is gathered; the results are referred to as ‘Pre-Assessments’. Data filtered into the “Pre-Assessment” process is then reviewed to insure that data is valid and appropriate for assessment purposes. Tiered use designations are determined before data is assessed based on the attainment of the applicable biological criteria and/or an assessment of the habitat. Stream reaches are assigned the highest aquatic life use attained by both biological assemblages on or after November 28, 1975. Streams that do not attain the Exceptional or General Use for both assemblages undergo a Use Attainability Analysis (UAA) to determine if a lower use is appropriate. A Modified Use can be proposed if the UAA demonstrates that the General Use is not attainable as a result of legal human activities (e.g., drainage maintenance, channel stabilization) which are limiting the biological assemblages through altered habitat. Decisions to propose a new use are made through UAA workgroups, which include watershed project managers and biology leads. The final approval to change a designated use is through formal rulemaking.

Figure 5. Flowchart of aquatic life use assessment process.



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

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, 2016) https://www.pca.state.mn.us/sites/default/files/wq-iw1-04j.pdf for guidelines and factors considered when making such determinations.

The last step in the assessment process is the Professional Judgment Group meeting. At this meeting results are shared and discussed with entities outside of the MPCA that may have been involved in data collection or that might be responsible for local watershed reports and project planning. Information obtained during this meeting may be used to revise previous use attainment decisions (e.g., sampling events that may have been uncharacteristic due to annual climate or flow variation, local factors such as impoundments that do not represent the majority of conditions on the WID). 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.

Watershed overview

Upper Iowa River

The Upper Iowa River begins in Minnesota and crosses the Minnesota/Iowa border several times before ultimately flowing south into Iowa. The majority of the watershed is located in Iowa with the headwaters and several tributaries located in Minnesota. The watershed is found in Mower, Fillmore and Houston Counties. Drainage area for the Upper Iowa River is 217 square miles (DNR, 2015c). This is only 21.7% of the entire watershed. Before meeting the Mississippi River, the Upper Iowa River flows 134 miles (NRCS, 2007b).

The Upper Iowa River watershed is split between two ecoregions: the Driftless Area in the east and the Western Corn Belt Plains in the west. The NRCS further describes the watershed as spit between two resource areas: silty and loamy mantled firm till plain in the west and Driftless Loess hills and bedrock in the east. The till plains are described as having well drained soils often used for cropland and pastureland. The soils are often silty material over loamy till with bedrock underneath (NRCS, 2007b). The loess hills are characterized by silty soils over bedrock. They are well to medium well drained.

Fishing and canoeing are popular activities in the Upper Iowa River watershed. Many trout streams are stocked and managed for fishing, and estimates say 315,000 angling trips are taken annually in the watershed (Upper Iowa River Watershed Project). In Iowa, the Upper Iowa River is the only river eligible for designation as a National Wild and Scenic River.

Lake Louise State Park is located in the far west region of the watershed. There people can enjoy the Little Iowa River which flows through the park just before converging with the Upper Iowa River. Roughly, 29,000 visits are made to the park annually (DNR Lake Louise State Park).

The Iowa Department of Natural Resources is responsible for assessing the health of the waters of Iowa. Several of the reaches on the border have been assessed. Only one has a potential impairment for aquatic life. The reach (01-UIA-242: From confluence with Silver Cr to Winneshiek/Howard Co line) is partially supporting due to poor species diversity during mussel surveys. The other reaches on the Upper Iowa River were either supporting or did not have enough data to make an assessment decision. More information can be found on the Iowa DNR website (https://programs.iowadnr.gov/adbnet/).

Mississippi River-Reno

The Mississippi River-Reno watershed is located in eastern Houston County, along the Mississippi River. The watershed drains 184 square miles in Minnesota. There is no main river in the watershed, just a collection of tributaries that flow directly into the Mississippi River. Two of the larger streams are Crooked Creek and Winnebago Creek. Both flow from east to west in the watershed and have a complex system of springs, coldwater and warm water.

The Mississippi River-Reno watershed is found entirely in the Driftless Area ecoregion. An area of the state that was missed in the last glaciation. The area is known for its karst features, deep limestone lined valleys, and coldwater streams. The watershed contains a number of popular trout fisheries. Rainbow trout, brown trout and brook trout can all be found in Crooked Creek. Brook trout are the only native trout species in southern Minnesota. To support the fishing industry in the area, easements allow fishers access to streams on private property.

The NRCS further describes the watershed as being in the driftless loess hills and bedrock resource area. Soils are well to moderately well drained and consist of silty soils over bedrock. This area is also characterized by alternating hills and valleys. Steep slopes are often forested (NRCS, 2008).

Caledonia is the largest town in the watershed with a population of 2,868 (NRCS, 2008). Other cities include Brownsville, Eitzen and Jefferson. The overall population of the watershed is 5,372.

Mississippi River-La Crescent

The Mississippi River-La Crescent watershed is located in northeast Houston County and southeast Winona County. The watershed drains 95 square miles. There are no major rivers; rather, a collection of tributaries that flow directly to the Mississippi River. Pine Creek is the largest stream in the watershed. Beginning just south of Highway 90, the stream flows south then east before meeting the Mississippi River in La Crescent.

The Mississippi River-La Crescent is located entirely in the Driftless Area. An area of the state that was missed by the last glaciation. The area is known for its Karst features, deep limestone lined valet, and coldwater streams. This watershed consists largely of coldwater systems. Trout fishing is a common recreation. The DNR manages streams for fishing and fishing easements provide anglers with access to streams. The scenic natural setting and coldwater streams are a source of tourism in the area, providing income to a number of local businesses. La Crescent is the largest town in the watershed with a population of 4,830. Other towns in the watershed include New Hartford, Dresbach, and Dakota.

Similar to the Mississippi River-Reno watershed, the Mississippi River-La Crescent watershed is also defined as driftless loess hills and bedrock by the NRCS (2007a). This means the soils consist of silt well to moderately well drained soils over bedrock in a landscape dominated by dissected hills and valleys.

In 2007 a large flood devastated areas of southeast Minnesota. The Mississippi River-La Crescent watershed was in an area hit with the most rain, ranging from 8-14 inches in 24 hours. The floods washed out roads, buildings, and even railroad tracks. In some locations, streams were entirely changed or moved. Effects from the floods have diminished but can still be seen in parts of the watershed. Subsequent floods in 2009 and 2010 continued the damage done in 2007. Large sections of streams were washed away and people living near the downstream reaches were highly impacted (Winona County SWCD).

Figure 6. The Upper Iowa River watershed within the Driftless Area and Western Corn Belt Plains ecoregion of southeast Minnesota.

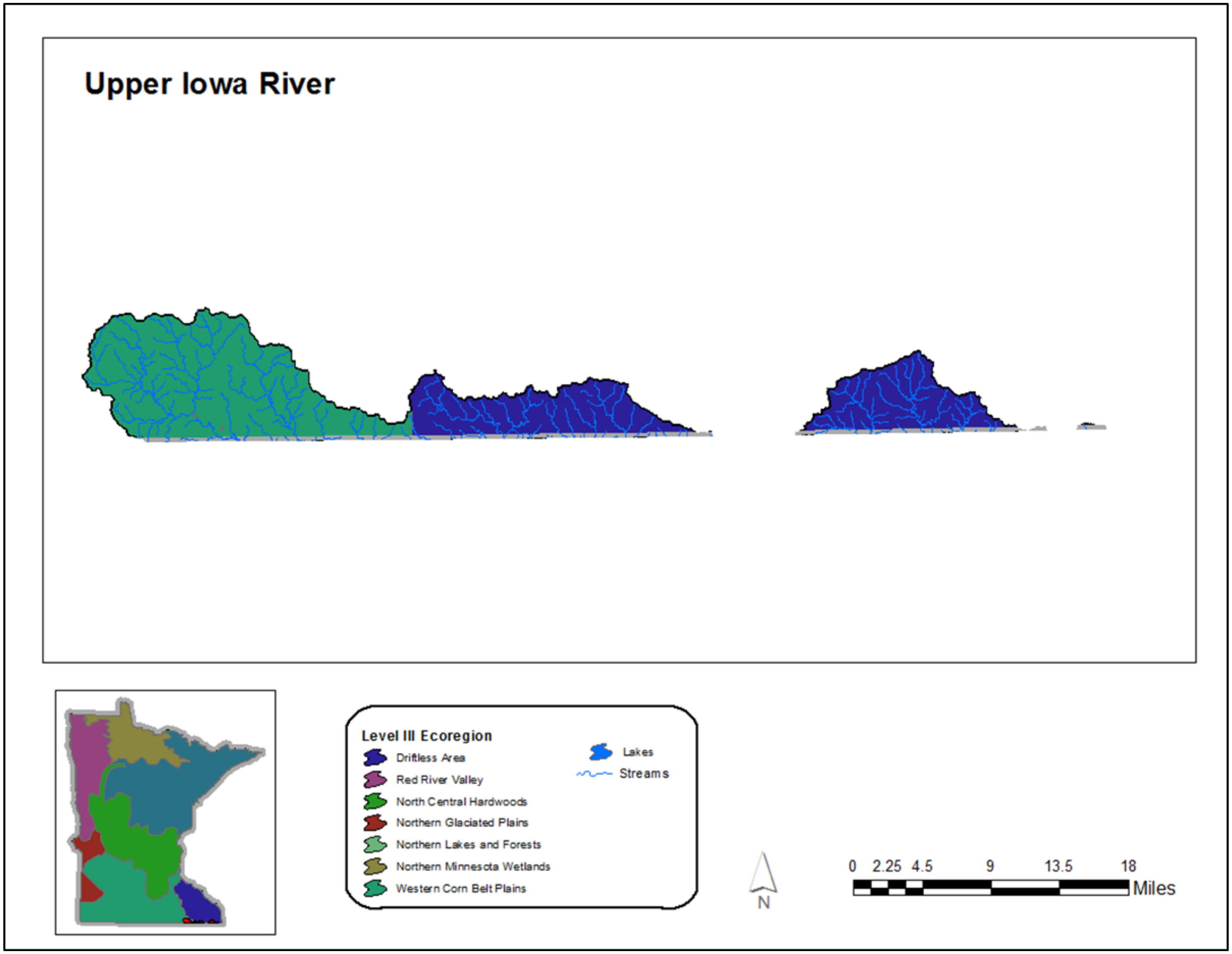


Figure 7. The Mississippi River-Reno watershed within the Driftless ecoregion of southeast Minnesota.

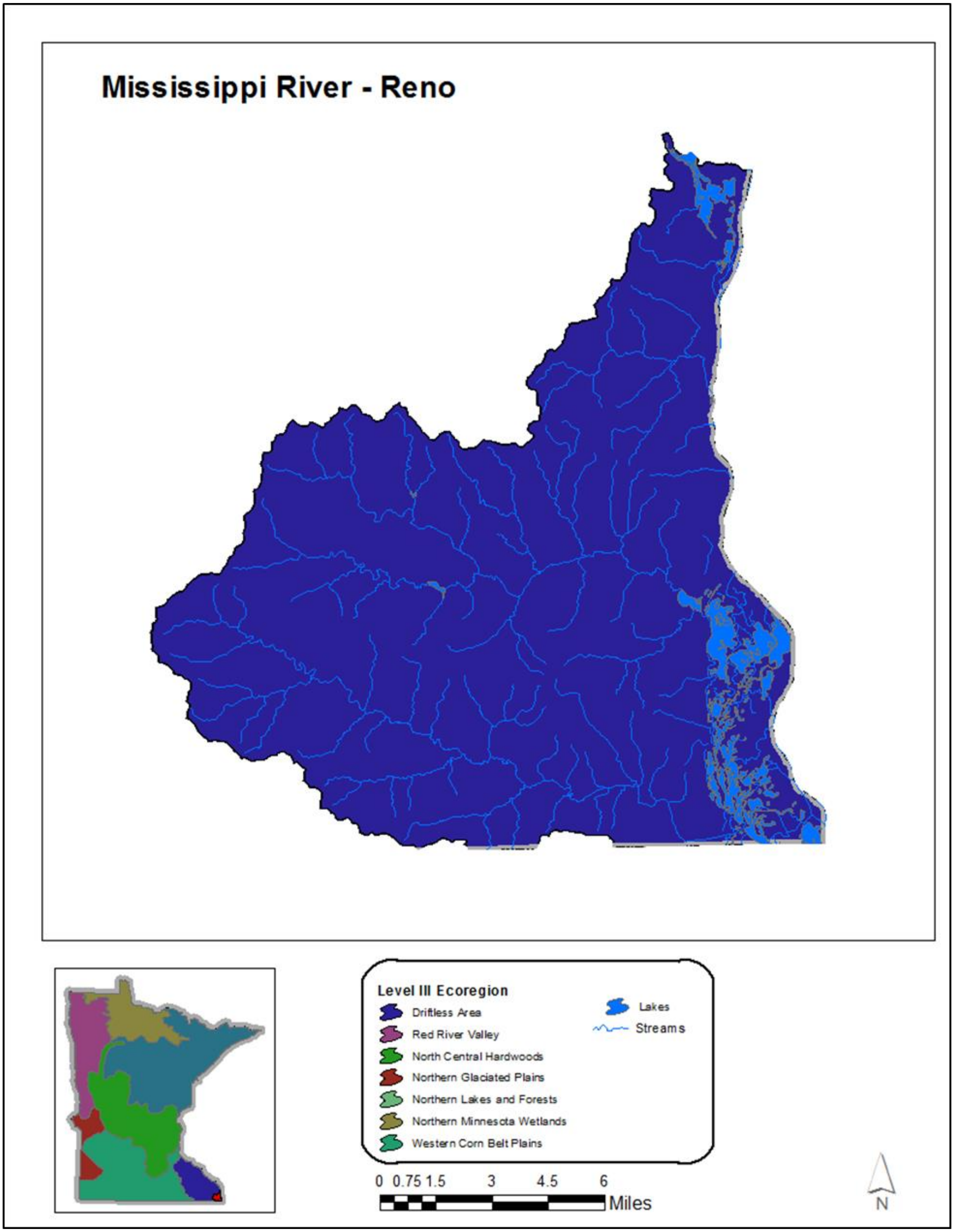


Figure 8. The Mississippi River-La Crescent watershed within the Driftless ecoregion of southeast Minnesota.

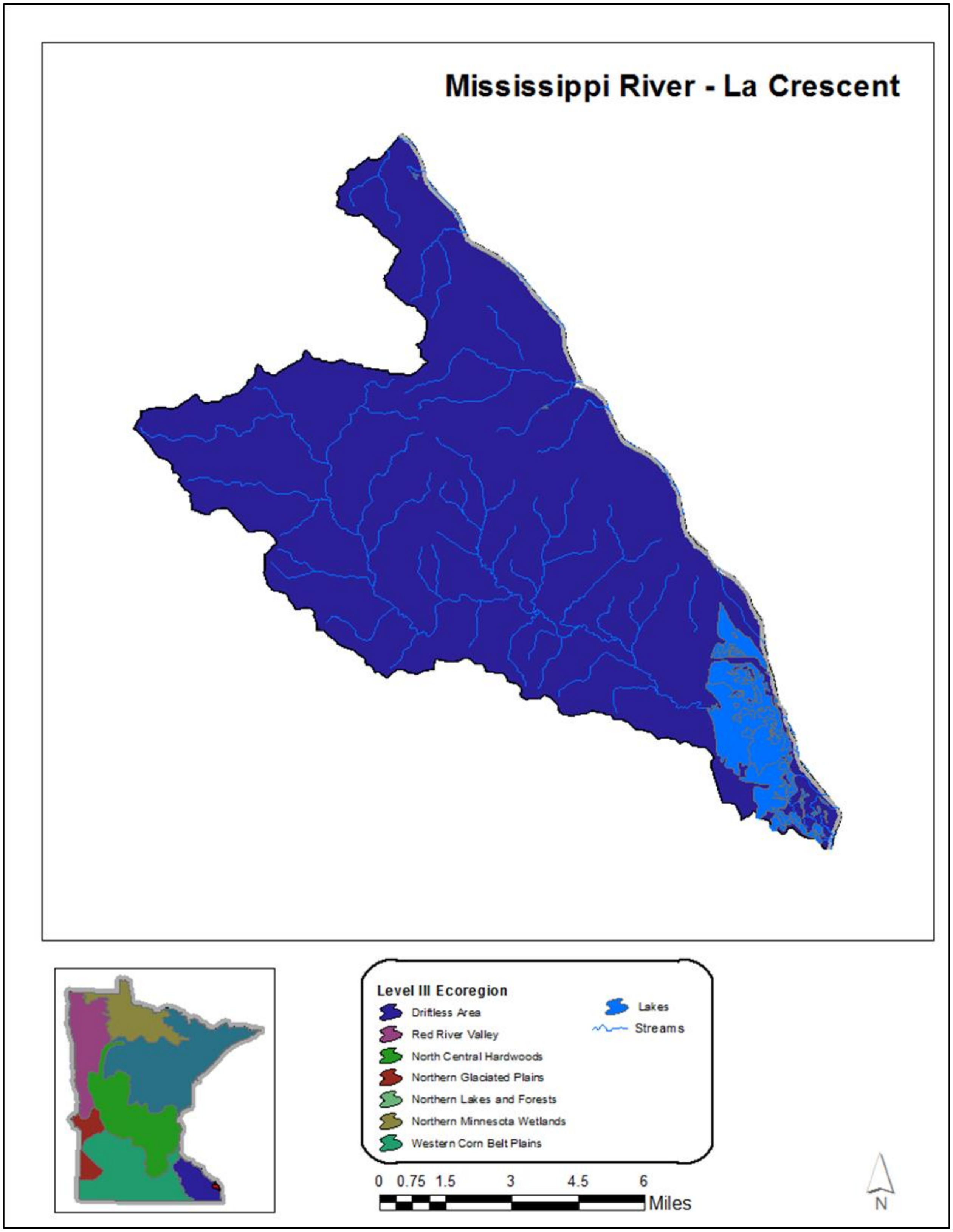


Figure 9. Major Land Resource Areas (MLRA) and springs in the Upper Iowa River watershed.

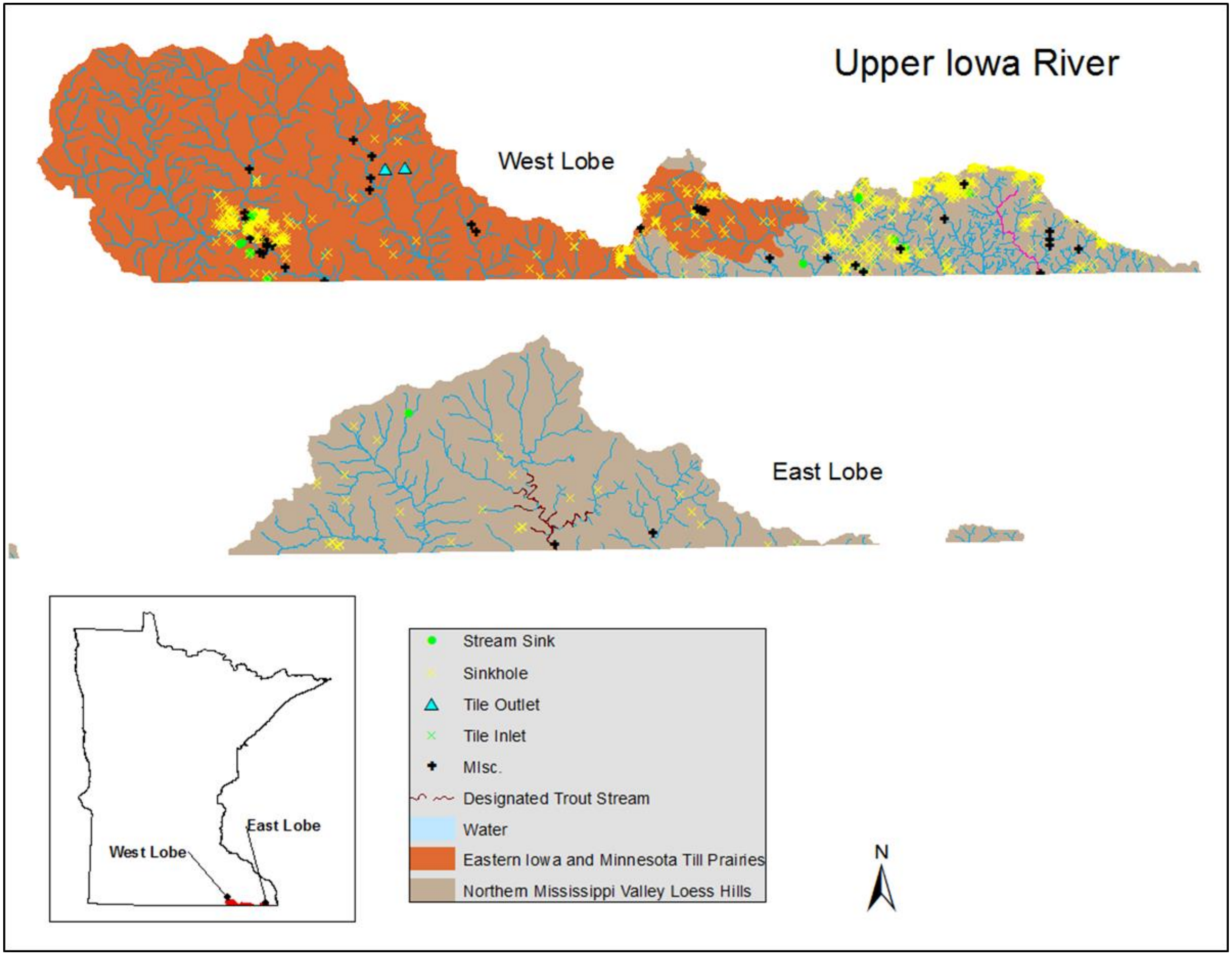


Figure 10. Major Land Resource Areas (MLRA) and springs in the Mississippi River-Reno watershed.

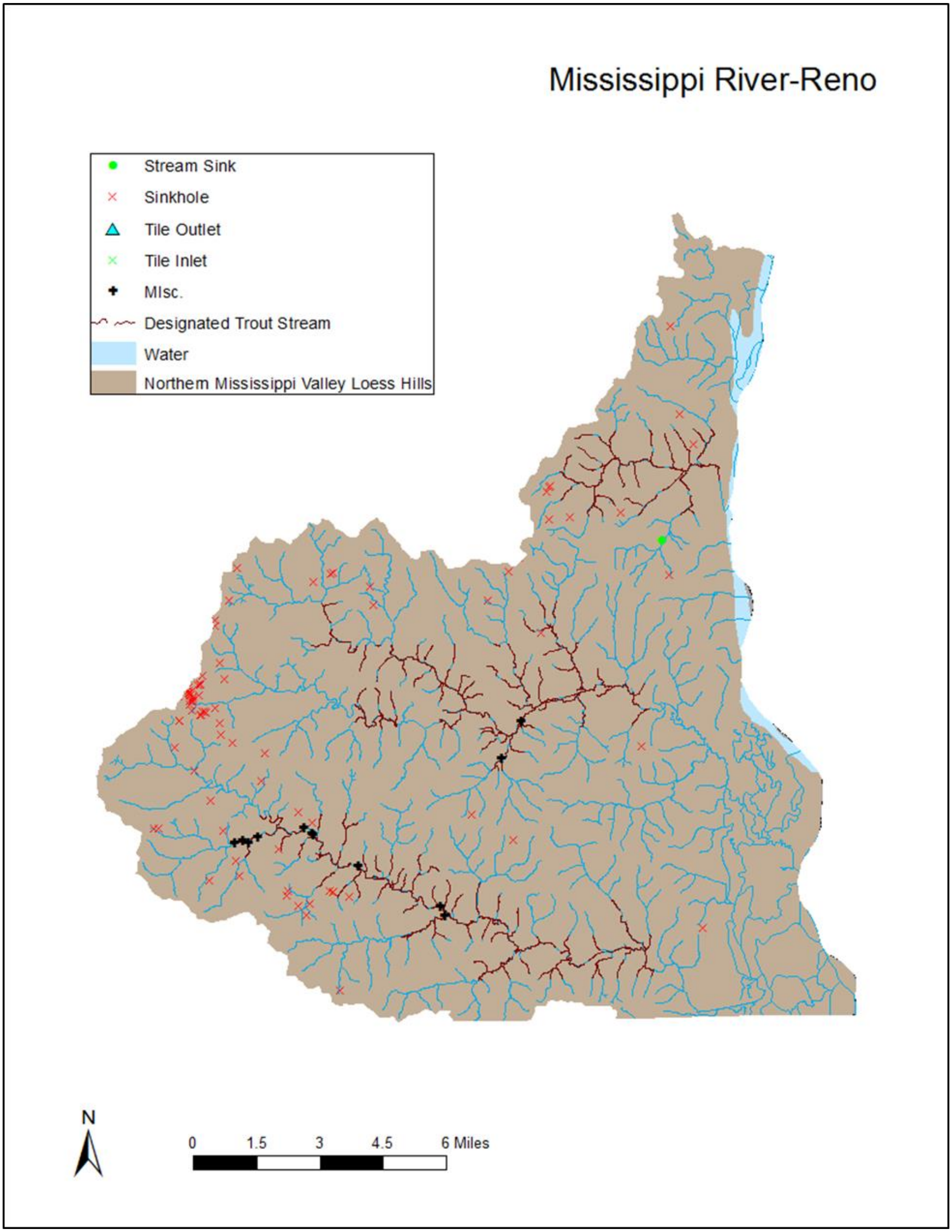
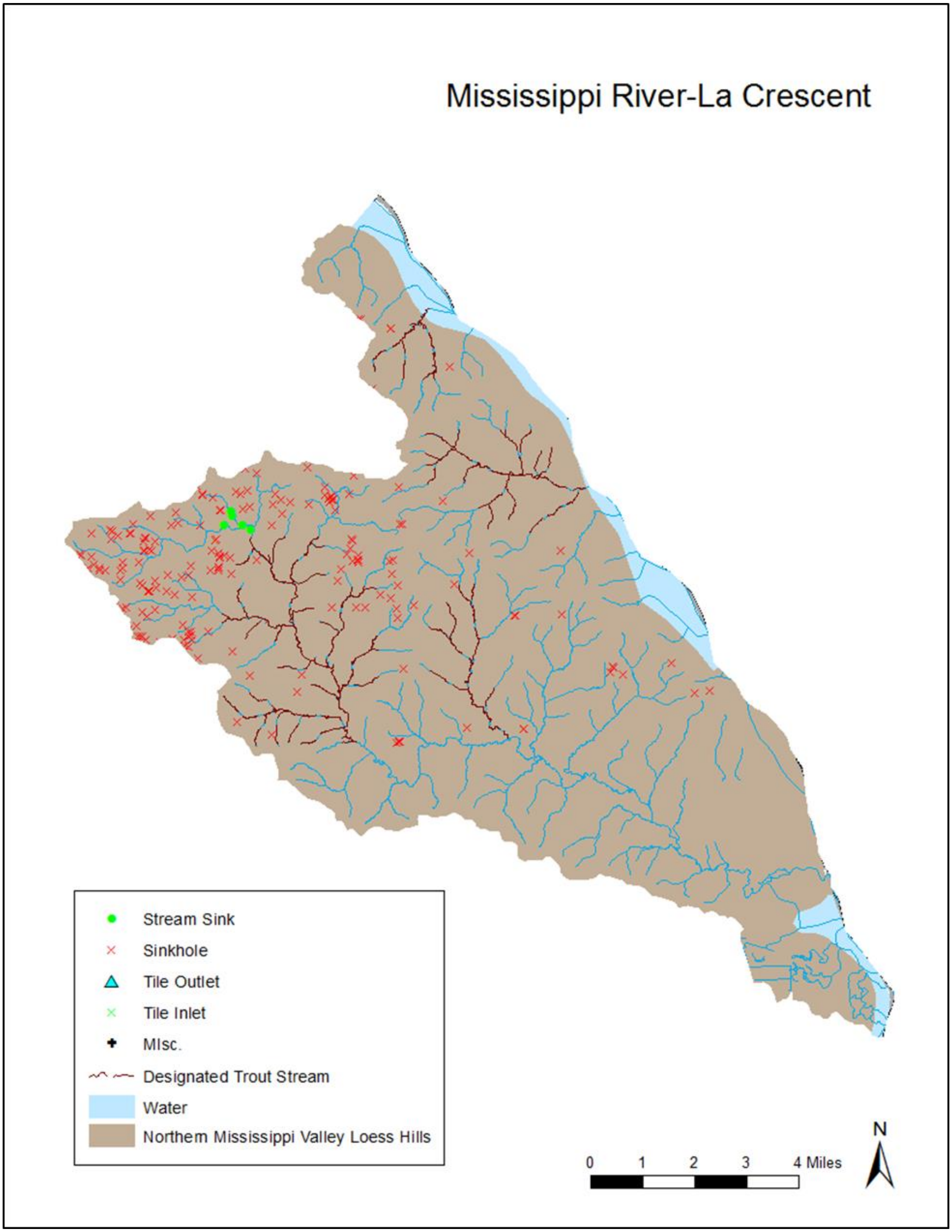


Figure 11. Major Land Resource Areas (MLRA) and springs in the Mississippi River-La Crescent watershed.



Land use summary

Upper Iowa River

Historically the Upper Iowa River watershed was a mixture of oak openings and barrens; prairie; brush prairie; big woods – hardwoods; wet prairie; and river bottom forests (DNR, 2017c). Now row crop accounts for 65% of landuse in the watershed (DNR, 2017c). The western area of the watershed has less sloping landscape and is more manageable as farmland. Pasture and hay land is the second largest land use type at 13.5%. There is still nearly 10% grassland and herbaceous land left in the watershed. Forest now accounts for nearly 6% of the watershed. The scale in the overall watershed differs for the entire watershed from what is located in just Minnesota.

Throughout the entire watershed, (Minnesota and Iowa) land is 98% owned privately and 1,943 farms are located in its boundaries (NRCS, 2007b). The Conservation Reserve Program has 52,534 acres enrolled in it across the entire Upper Iowa River watershed (NRCS, 2007b). An additional Environmental Quality Incentives Program has 35,485 acres using the program (NRCS, 2007b).

Mississippi River-Reno and Mississippi River-La Crescent

The Mississippi River-Reno and Mississippi River-La Crescent watersheds are a complex combination of different land use and land types. Because the watersheds are located in bluff country traditional row crop farming practices are not an effective way to farm. The Mississippi River-Reno watershed is 35% deciduous forest. Followed by 23.8% pasture and hay. The third most abundant landuse is cultivated crops with 17.7% (DNR, 2017b). The Mississippi River-La Crescent watershed is 46.3% deciduous forest. Pasture and hay land is 23.4% of the watershed, followed by 7% water and 5.1% grassland and herbaceous land (DNR, 2017b).

Pastureland is often found in the valleys where the land is too steep to access with farming equipment. Pasture leaves vegetation on the land, but over grazing and trampling of stream banks can contribute to poor water quality. Row crop farming is often seen at or near the bluff tops. Farming practices in such areas usually include contour stripping, contour farming, field terraces, diversions and grass waterways. These practices help to prevent erosion and keep fields stable.

A large portion of these watersheds is left wooded. Hunting, fishing, hiking and camping are popular recreational activities in southeast Minnesota. Parks are visited frequently in both summer and winter. Southeast Minnesota is well known for its trout fishing and many trout streams are managed by the DNR to support the fishing industry. Access to undisturbed forest and prairie land protects the water quality of the trout streams.

The Mississippi River-Reno and Mississippi River-La Crescent watersheds are part of larger watersheds located in Wisconsin and Iowa. The greater watersheds consist of rivers and streams that flow directly to the Mississippi River along the state borders. According to the NRCS (2007a; 2008) 25,701 acres are enrolled in the Conservation Reserve Program through both watersheds. 27,597 acres are part of the Environmental Quality Incentives Program. Many of the Minnesota SWCDs have educational materials and contacts for landowners interested in using cover crops and conservation tillage. These practices were seen throughout the watersheds during sampling and are an effective way to protect against soil loss.

Figure 12. Land use in the Upper Iowa River watershed.

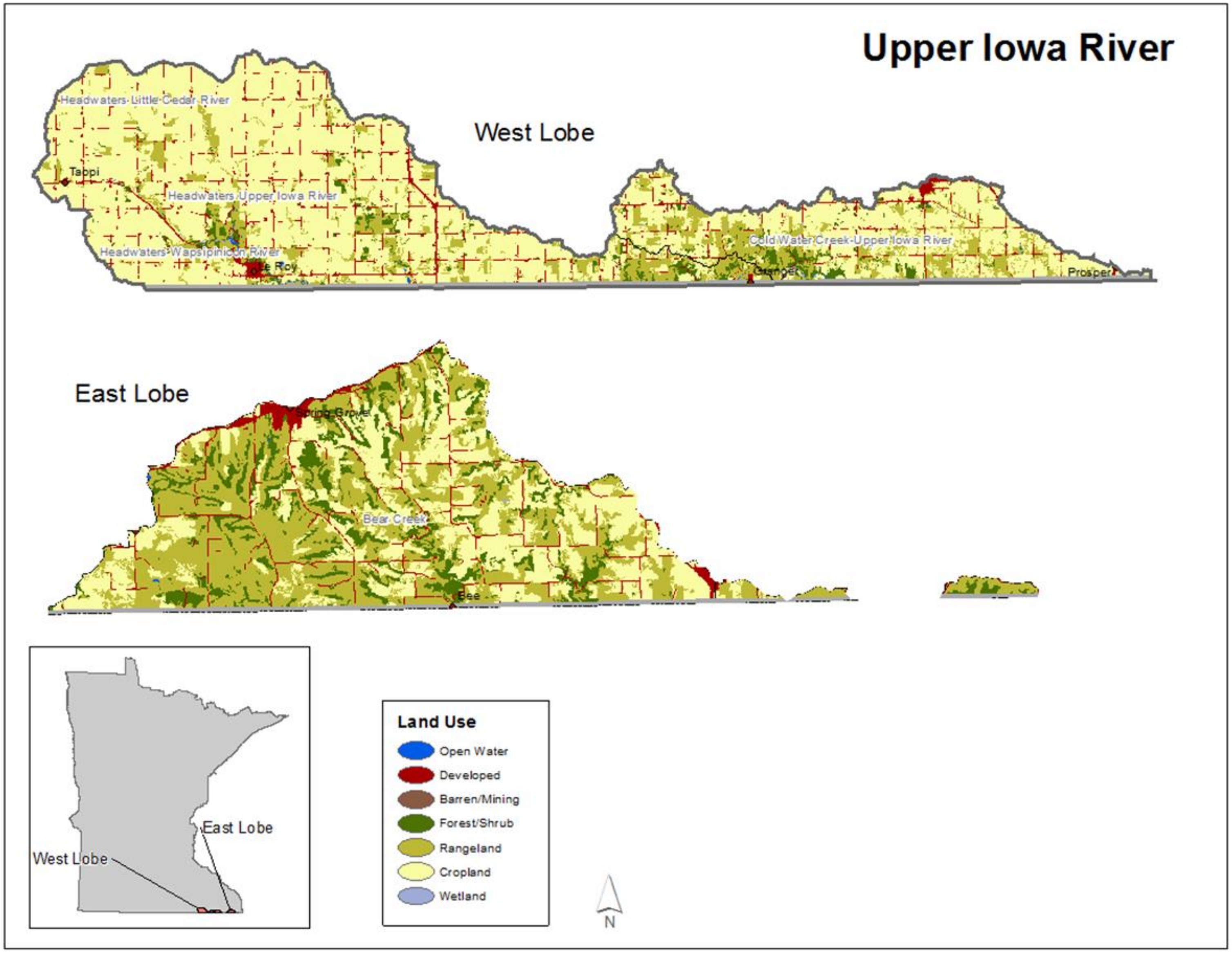


Figure 13. Land use in the Mississippi River-Reno watershed.

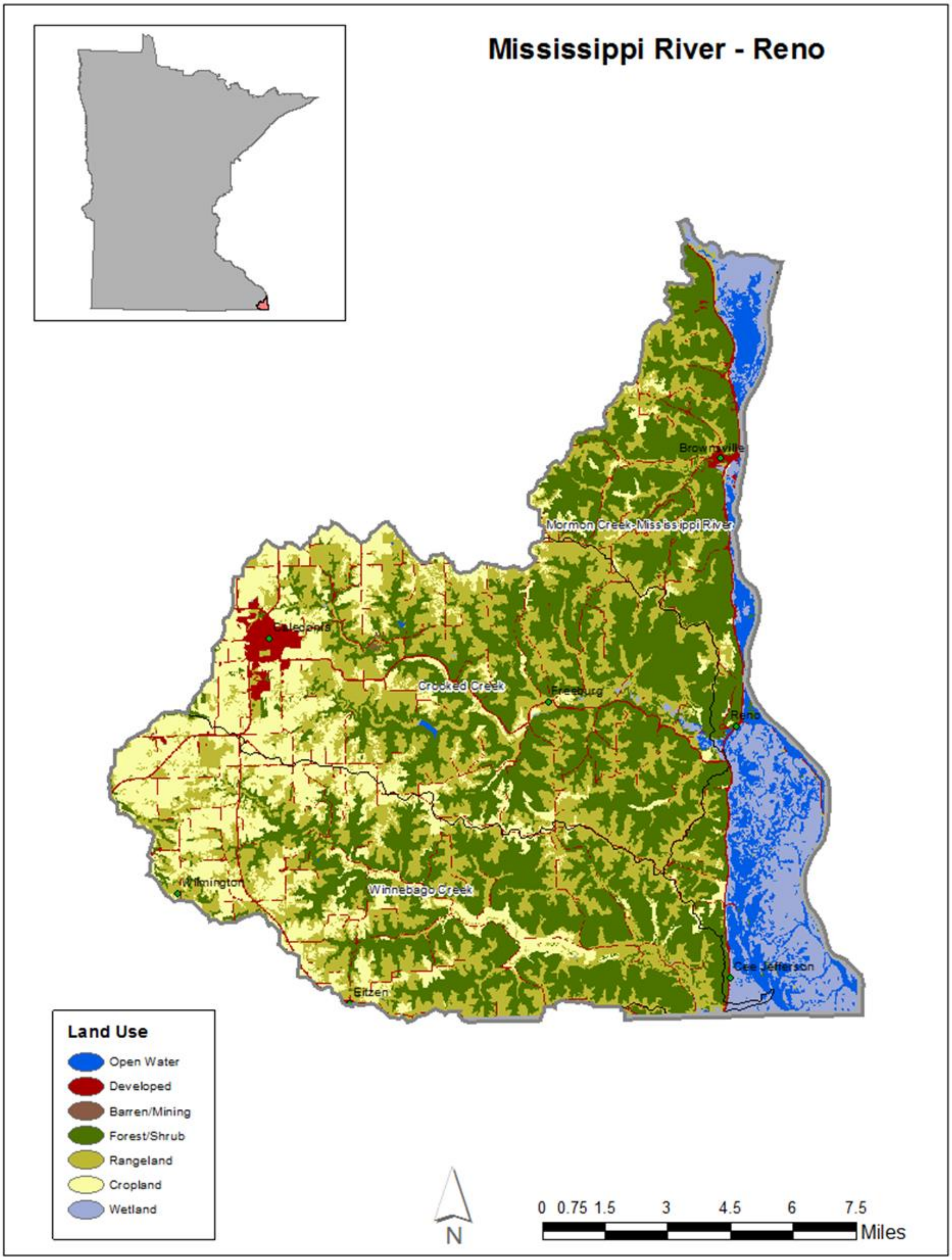
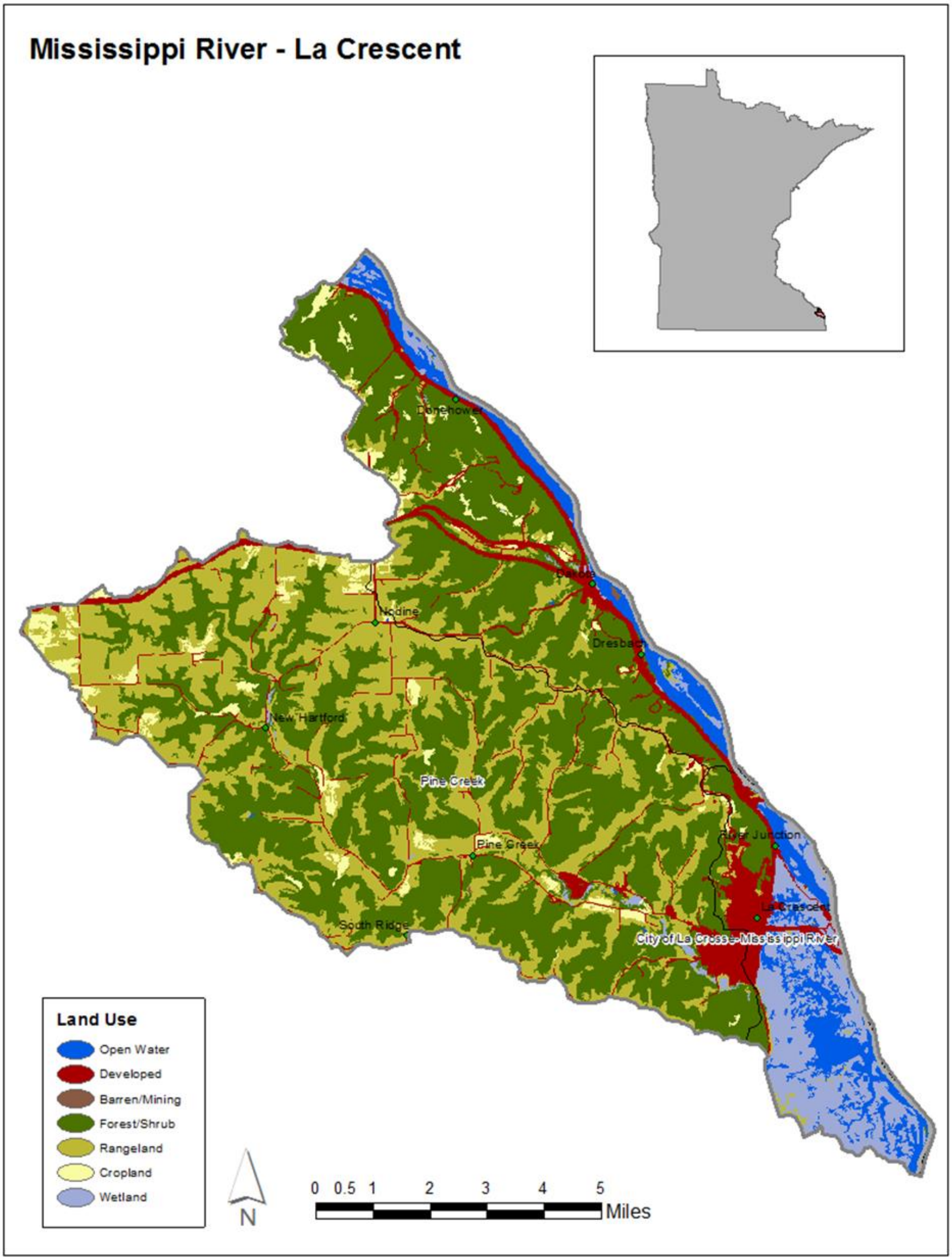


Figure 14. Land use in the Mississippi River-La Crescent watershed.



Surface water hydrology

Upper Iowa River

Alteration to hydrology has occurred in the Upper Iowa River. Derived from the Altered Water Course dataset, 65% of streams in the watershed have been altered. Altered streams are often the result of agricultural practices. Surveys done by DNR across the watershed show a range in channel stability and connectivity to flood plain. Erosion and sediment deposition were noted as being a problem in some locations. Often, altered streams have less access to flood plains. Crossing with roads can be problem areas for stream flow. If the bridge or culvert crossing is not sized appropriately, it can lead to erosion and sediment deposition. Ditched streams are highly altered and provide faster drainage. Ditches can recover over time, by forming small meanders, pools and even riffles. This happens when ditches are not cleaned out. Allowing the stream to adjust naturally in the ditch can help improve water quality and increase water storage. This natural process mimics two-stage ditches; a form of ditch improvement.

Draintile is normally paired with ditching in agricultural areas. Tile lines drain water quickly from the land. They eliminate the over land flow of water, that can filter out sediment and nutrients. Tile and ditching has been used to drain wetland areas for agricultural use. Impervious surfaces also limit ability to filter water before it reaches a stream. Impervious surfaces are more often found in urban areas. This watershed in not heavily populated and has limited impervious surface. The DNR scores much of the watershed as having little impervious surface (DNR, 2015c).

There is one lake located in the Upper Iowa River watershed. Located in Lake Louise State Park, the lake is a popular recreation area. The lake is a result of an impoundment on the river and has a short residence time.

The Upper Iowa River watershed is in an area of karst. There are many sink holes, springs, and even some disappearing streams. Sink holes allow direct access of surface water to ground water. When surface water enters a sinkhole and becomes ground water it may not stay in the same watershed it entered the ground. Dye traces have shown ground water is not limited by the same boundaries surface watersheds are. Springs normally feed coldwater systems and nitrate is often a concern in these streams.

One notable disappearing stream (or stream sink) is located in Spring Grove. There is a wastewater facility that discharges to an Unnamed Creek. This stream disappears underground shortly after the permitted discharges enters the stream. It is unknown at this time where the water reemerges. The channel holds water again downstream but it is unclear if it is the same water as was in the channel before. Groundwater is not bound by the same watershed boundaries as surface water. Water can enter the groundwater system and emerge in a different major watershed. Work is still being down to investigate this occurrence in Spring Grove.

Beavers are common in the watershed. They can have dramatic impacts on streams. In some instances, dams are removed to protect the integrity of roads and road crossings. By damming the streams, they change the hydrology and can limit flow. During sampling a number of beaver dams were observed, some even flooding into agricultural fields.

Most natural channels in the Upper Iowa River watershed are larger streams, not headwater streams. Natural channel accounts for 18% of streams in the watershed.

Mississippi River-Reno and Mississippi River-La Crescent

The majority of streams (56.4%) in the Mississippi River-Reno watershed are still natural streams. Altered streams make up 19.9% of the streams. Most of the altered hydrology is found in the headwaters of the watershed. Impounded streams account for 16.5% of the streams. Most of these are found in the

Mississippi River valley where the small streams flow into the river. These streams can act as backwaters and sometimes wetland areas and have different characteristics than streams farther away from the river.

The Mississippi River-La Crescent watershed is similar to the Mississippi River-Reno watershed. Natural channel accounts for 60% of streams found in the watershed. Only 14% are defined as altered. Similar to above, 20% of the channels are defined as impounded.

The watersheds are not heavily dominated by row crop agriculture, which is likely the reason for fewer altered streams and tile under fields. Flow in these watersheds can be of great concern due to the high gradient nature of many of the streams. During high intensity rain events water is quickly washed down the valleys and into the streams. Extensive damage have been done by heavy floods in the area, especially in the fall of 2007. Many of the watershed districts in the Driftless Area list flood and flow concerns as one of their top priorities to address. Lessening the potential for erosion along the streams to protect property and, in some cases, houses is a real concern.

Both of these watersheds have an abundance of karst features, which include springs, sinkholes and disappearing streams. These features are areas where groundwater changes from surface water or surface water changes to groundwater. Once water enters a sinkhole or a disappearing stream, that water is no longer bound by the major watershed boundaries defined for surface water. Water has been known to enter a sinkhole in one major watershed and emerge in an entirely different one. This makes managing groundwater and surface water as one watershed more complex.

Figure 15. Map of percent modified streams by major watershed (8-HUC).

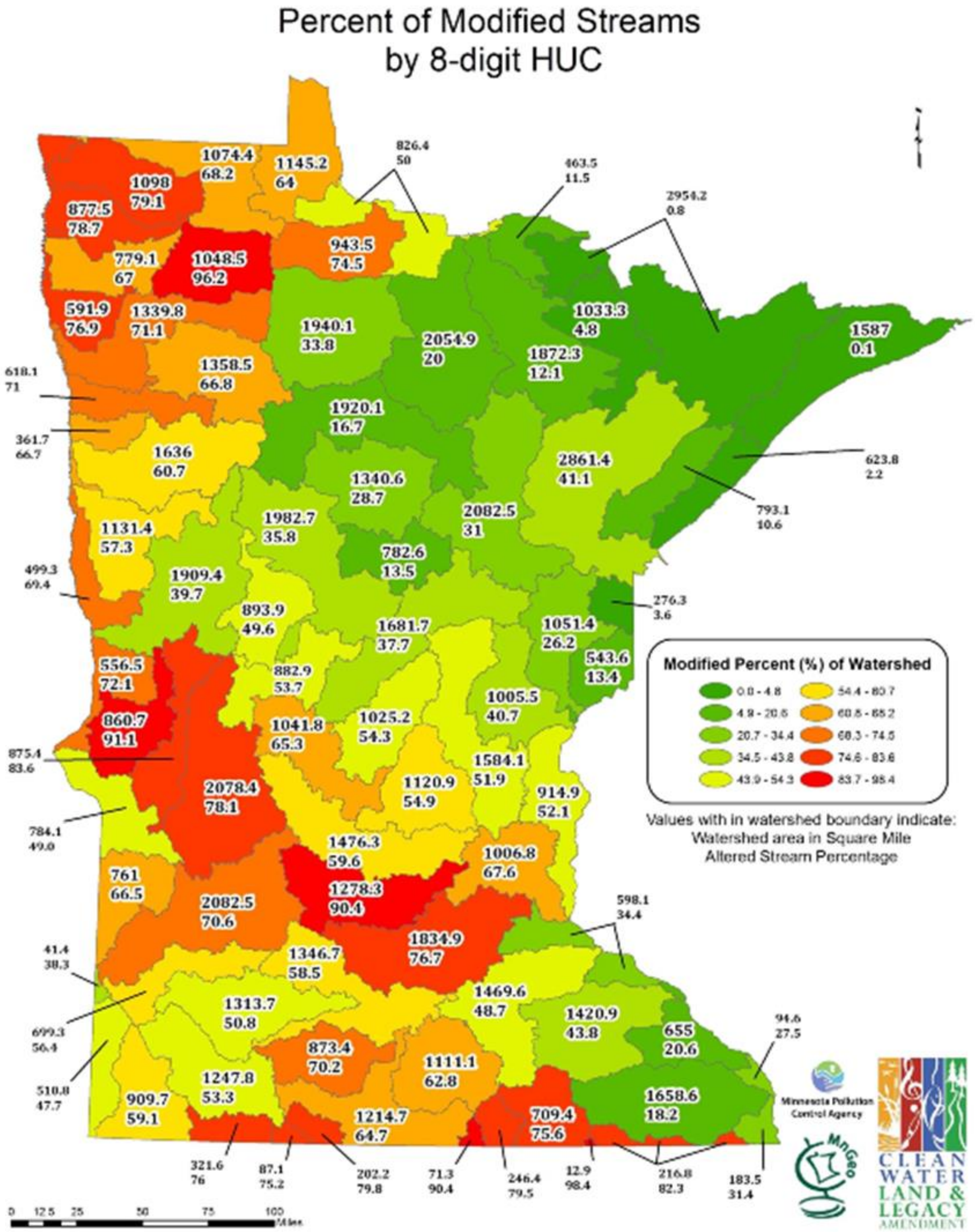


Figure 16. Comparison of natural to altered streams in the Upper Iowa River watershed (percentages derived from the Statewide Altered Water Course project).

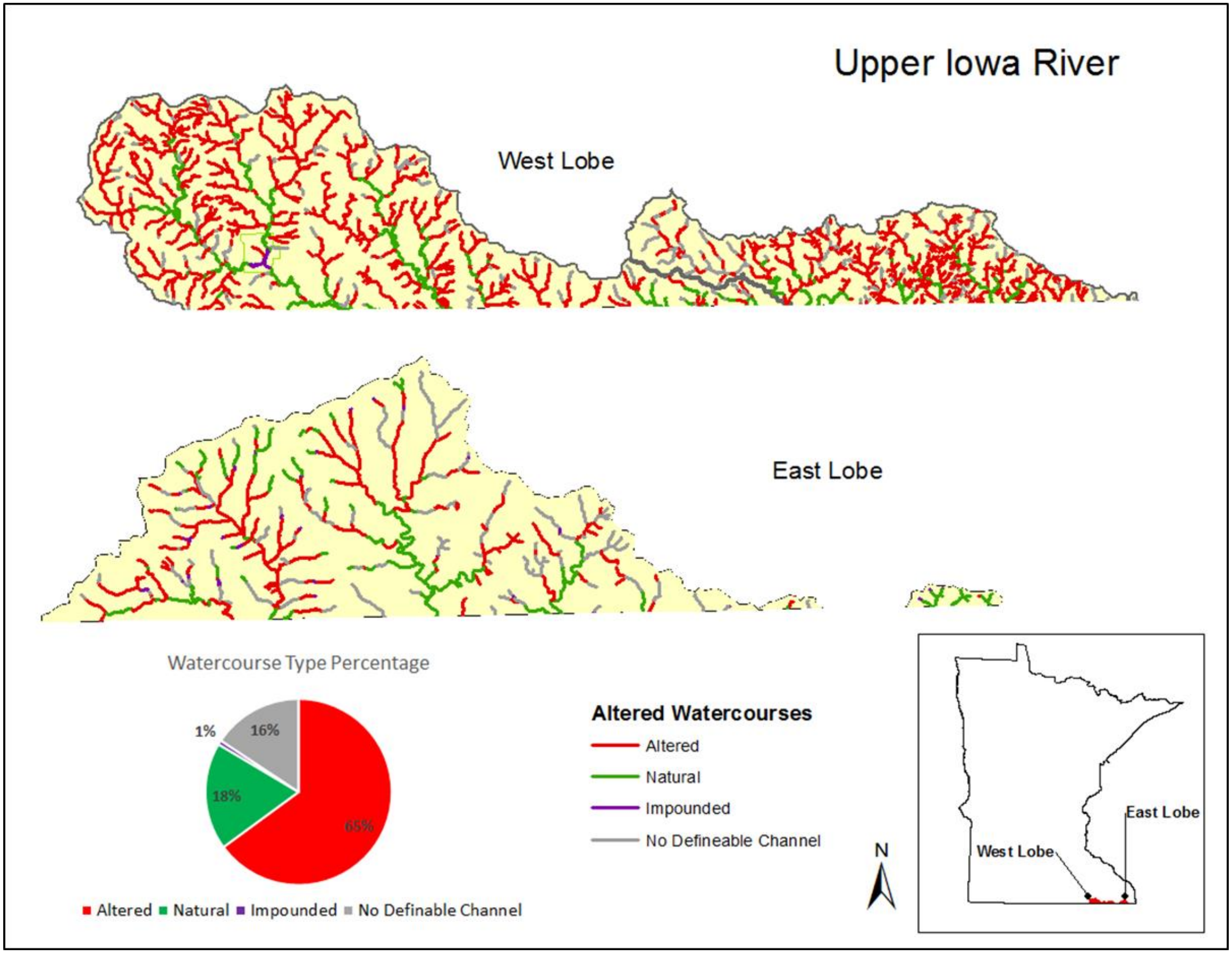


Figure 17. Comparison of natural to altered streams in the Mississippi River-Reno watershed (percentages derived from the Statewide Altered Water Course project).

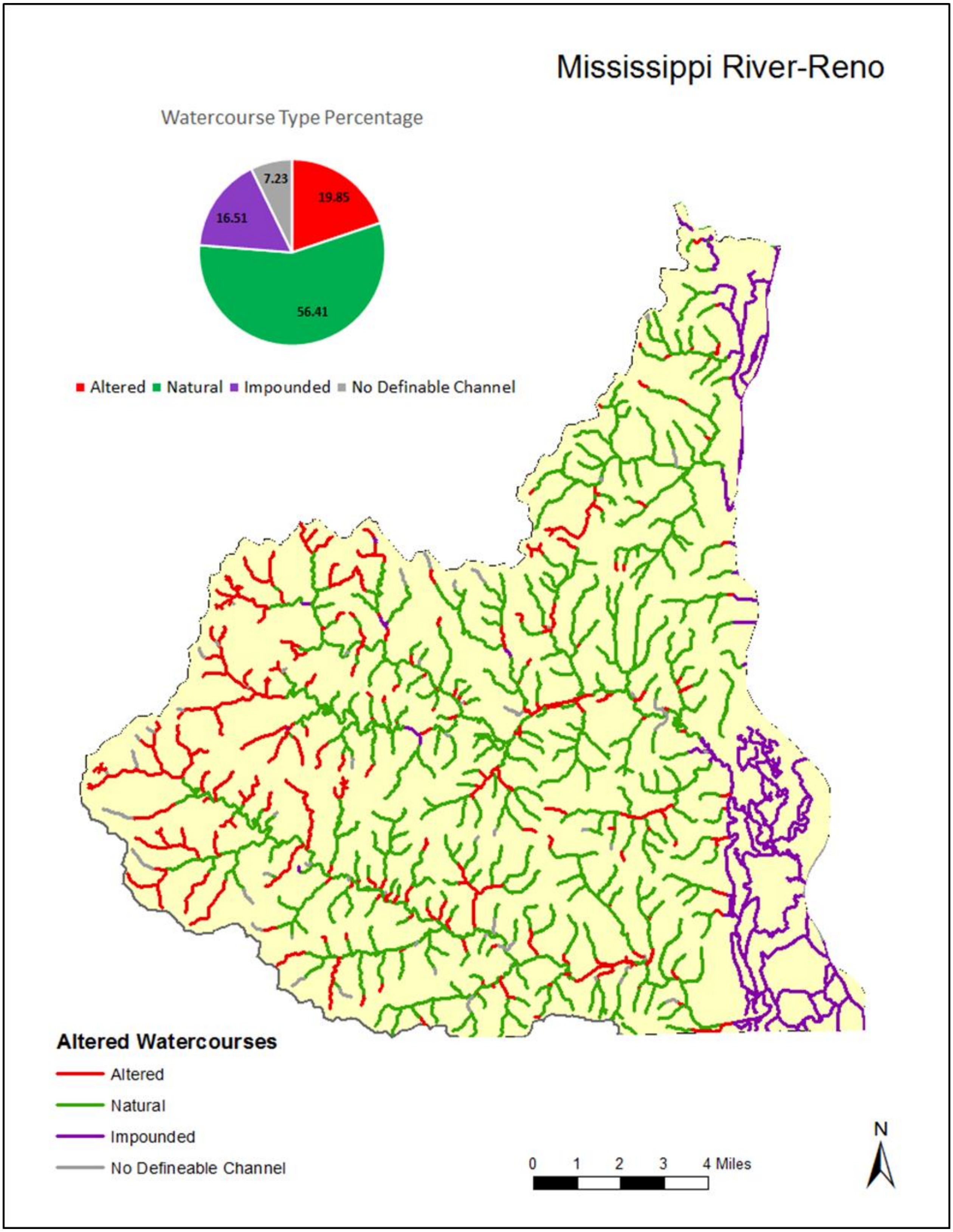
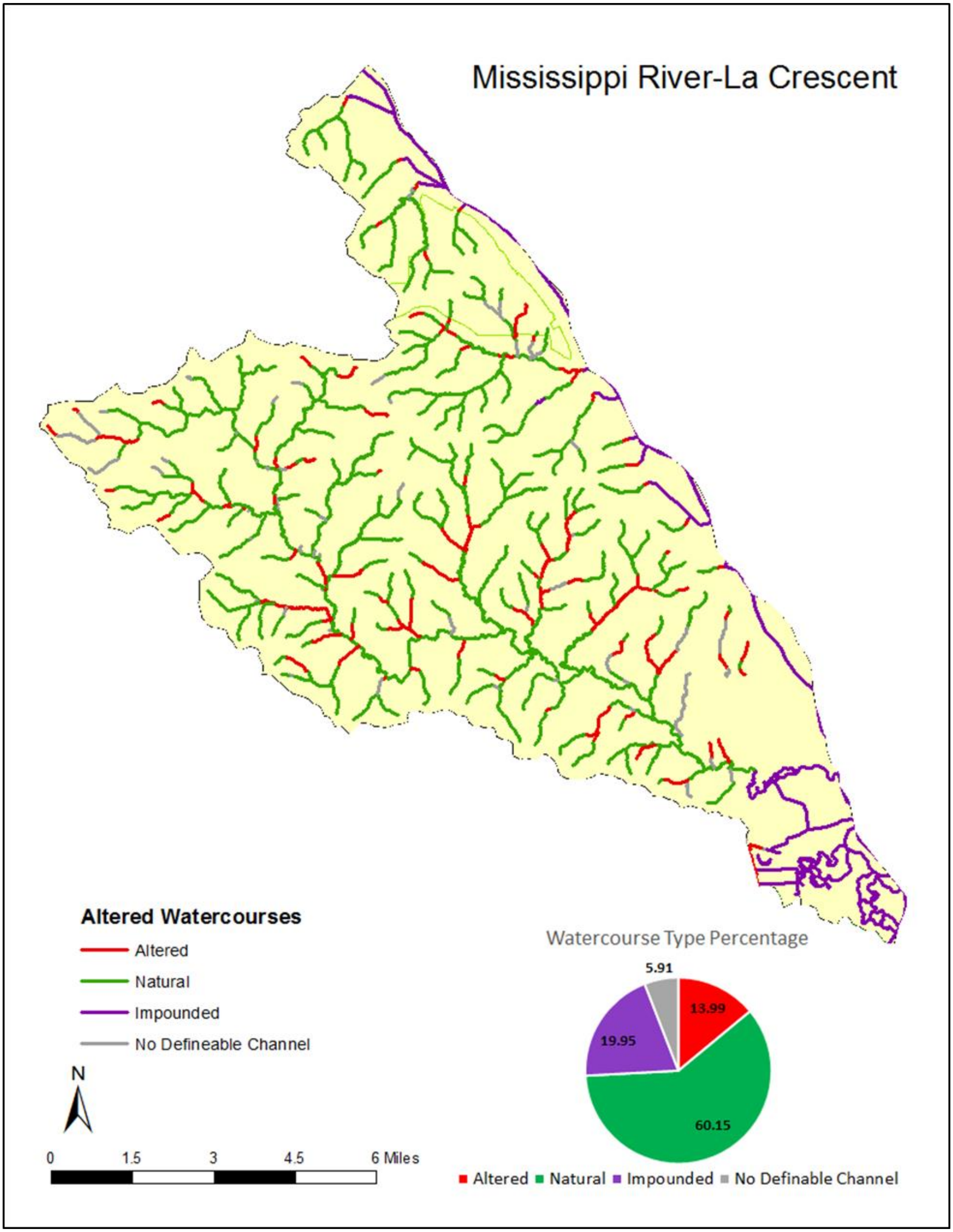


Figure 18. Comparison of natural to altered streams in the Mississippi River-La Crescent watershed (percentages derived from the Statewide Altered Water Course project)

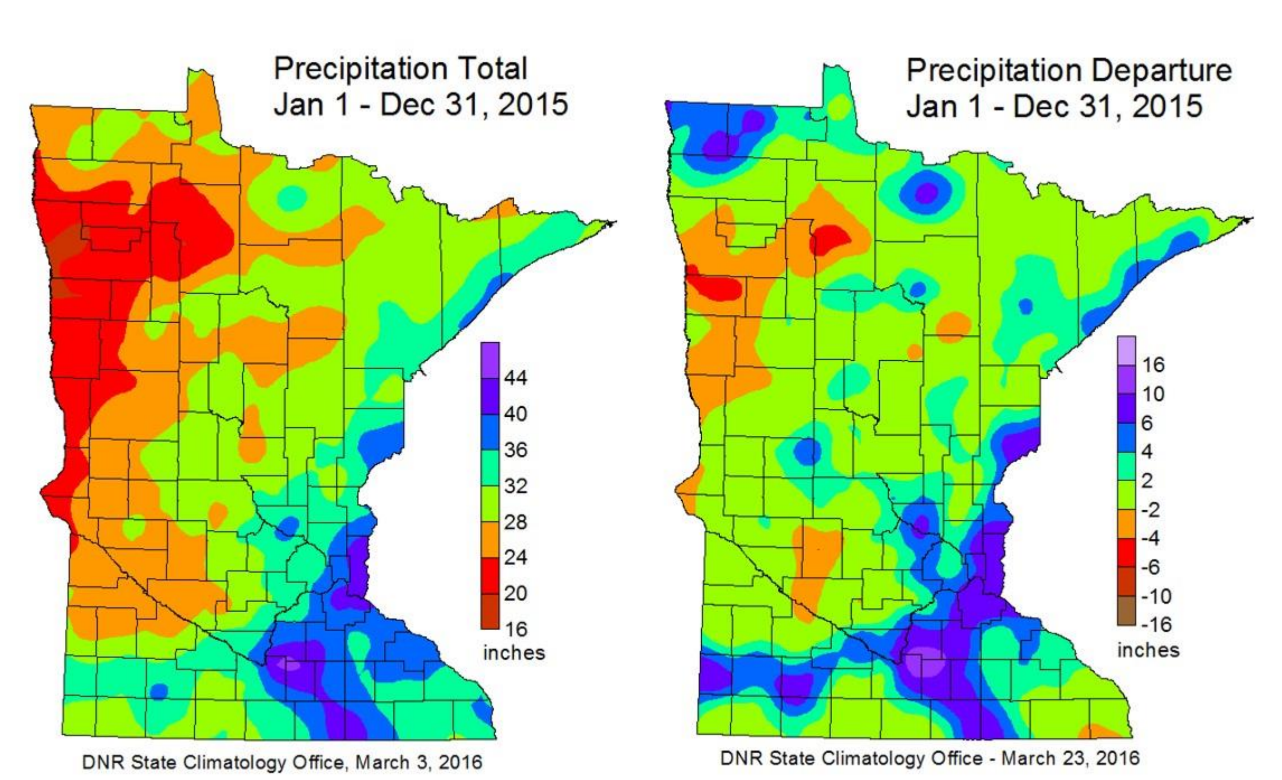


Climate and precipitation

Minnesota has a continental climate, marked by warm summers and cold winters. The mean annual temperature for Minnesota is 4.6˚C (NOAA, 2016); the mean (1981-2010) summer (June-August) temperature for southeast Minnesota around the Mississippi River-Reno and Mississippi River-La Crescent watersheds is 20.55˚C and the mean winter (December-February) temperature is -7.2˚ C (DNR: Minnesota State Climatology Office, 2017a).

Precipitation is an important source of water input to a watershed. Figure 19 displays two representations of precipitation for calendar year 2015. On the left is total precipitation, showing the typical pattern of increasing precipitation toward the eastern portion of the state. According to this figure, southeast Minnesota received 32-36 inches of precipitation in 2015. The display on the right shows the amount that precipitation levels departed from normal. The watershed area experienced precipitation that ranged from two inches below normal to two inches above normal in 2015.

Figure 19. Statewide precipitation total (*left*) and precipitation departure (*right*) during 2015 (DNR State Climatology Office, 2017b)



The Mississippi River-Reno, Mississippi River-La Crescent and Upper Iowa River watersheds are located within the southeast precipitation region. Figure 20 and Figure 21 display the areal average representation of precipitation in southeast Minnesota for 20 and 100 years, respectively. An aerial average is a spatial average of all the precipitation data collected within a certain area presented as a single dataset. Though rainfall can vary in intensity and time of year, rainfall totals in the Southeast region display no significant trend over the last 20 years. However, precipitation in southeast Minnesota exhibits a significant rising trend over the past 100 years ($p<0.01$). This is a strong trend and matches similar trends throughout Minnesota.

[Figure 20](#) displays the areal average representation of precipitation in southeast 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 the University of Minnesota Climate website: http://www.wrcc.dri.edu/spi/divplot1map.html.

Figure 20. Precipitation trends in southeast Minnesota (1996-2015) with five-year running average (WRCC, 2017)

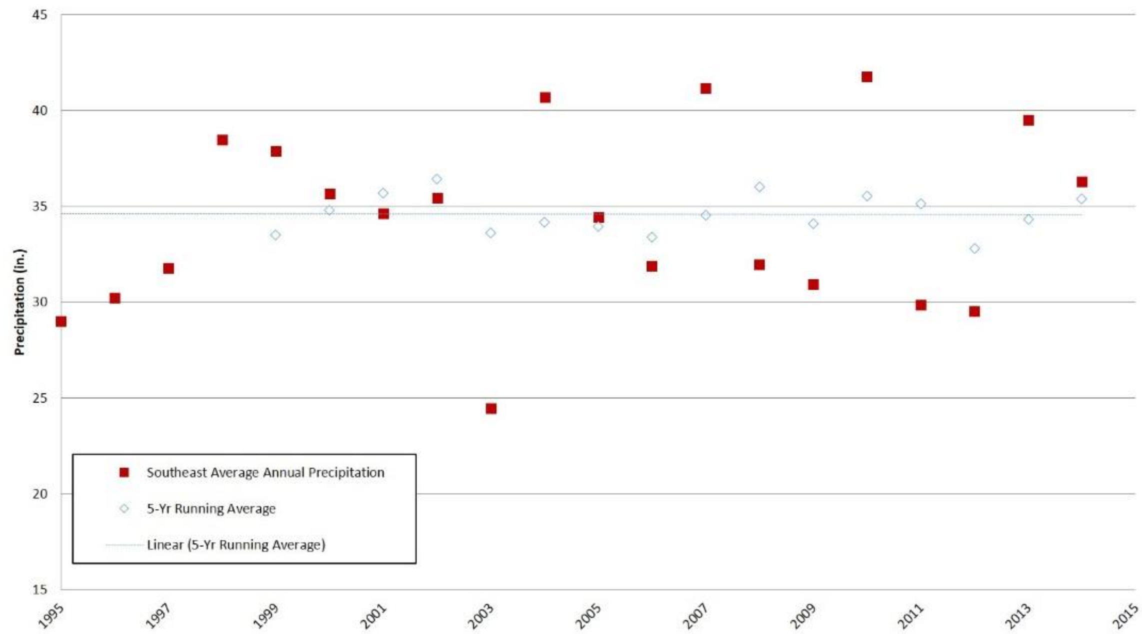
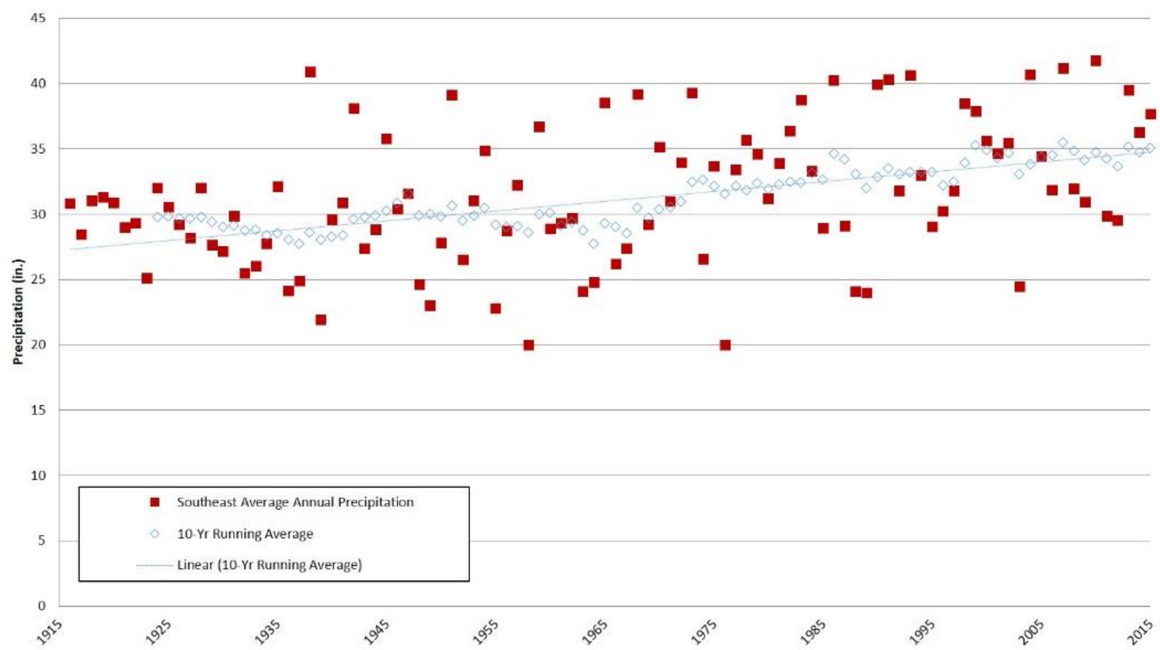


Figure 21. Precipitation trends in southeast Minnesota (1916-2015) with ten-year running average (WRCC, 2017)



Hydrogeology and groundwater quality

Hydrogeology

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

The watershed is found in the eastern area of the southeast hydrogeologic region (Region 5) and is dominated by glacial landforms and till. Due to the Paleozoic bedrock geology of the area, it is primarily limestone, dolomite and sandstone. The main aquifers include the Upper Carbonate Group (Galena and Cedar Valley carbonate aquifers), St. Peter sandstone, Prairie du Chien Group, Jordan sandstone, and Franconia-Ironton-Galesville aquifers, and the Mt. Simon aquifer (MPCA, 1999).

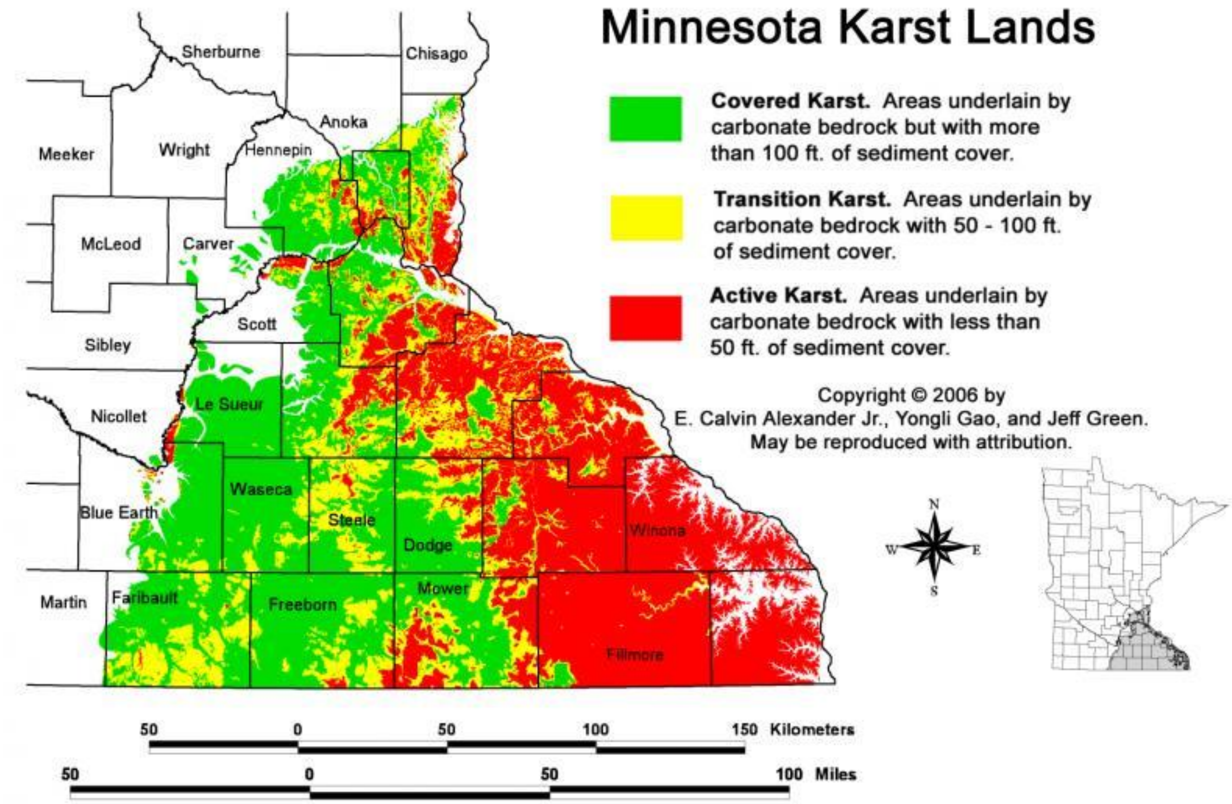
The Mississippi River-Reno, Mississippi River-La Crescent and the Upper Iowa River watersheds fall within the southeastern province of Minnesota's six groundwater provinces. The southeast province is characterized by "thin (less than 100 feet) clayey glacial drift overlying Paleozoic sandstone, limestone, and dolostone aquifers. Karst characteristics are common in limestone and dolostone bedrock" (DNR, 2017a).

Geology in Mississippi River – Reno, Mississippi River - La Crescent and the Upper Iowa River watersheds is characterized by karst features. These geologic features occur where limestone is slowly dissolved by infiltrating rainwater, sometimes forming hidden, rapid pathways from pollution release points to drinking water wells or surface water. Surface water and groundwater are so closely connected in karst areas that the distinction between the two is difficult to determine. Groundwater may emerge as a spring, flow a short distance above ground, only to vanish in a disappearing stream, returning to groundwater conduits and perhaps re-emerge farther downstream again as surface water.

Karst aquifers are very difficult to protect from activities at the ground surface because pollutants can be quickly transported to drinking water wells or surface water. Because of this, the best strategy to protect groundwater in this watershed is pollution prevention from common sources like row-crop agriculture, septic systems, abandoned wells, and animal feedlot operations.

Recharge of these aquifers is important and limited to areas located at topographic highs, those with surficial sand and gravel deposits, and those along the bedrock/surficial deposit interface. Typically, recharge rates in unconfined aquifers are estimated at 20 to 25% of precipitation received, but can be less than 10% of precipitation where glacial clays or till are present (USGS, 2007). For the watersheds in this report average annual recharge rate to surficial materials ranges from 2.6 to 11.5 inches per year with a mean of 7.64 inches per year. (USGS, 2015).

Figure 22. Locations of karst features in Southeast Minnesota (Alexander, Yao & Green, 2006)



High capacity withdrawals

The DNR permits all high capacity water withdrawals where the pumped volume exceeds 10,000 gallons per day or one million gallons per year. Permit holders are required to track water use and report back to the DNR annually. The changes in withdrawal volume detailed in this groundwater report are a representation of water use and demand in the watershed and are taken into consideration when the DNR issues permits for water withdrawals. Other factors not discussed in this report but considered when issuing permits include: interactions between individual withdrawal locations, cumulative effects of withdrawals from individual aquifers, and potential interactions between aquifers. This holistic approach to water allocations is necessary to ensure the sustainability of Minnesota's groundwater resources.

The three largest permitted consumers of water in the state for 2015 are (in order) power generation, public water supply (municipals), and irrigation (DNR, 2017b). According to the most recent DNR Permitting and Reporting System (MPARS), in 2015 the withdrawals within the Mississippi River-Reno, Mississippi River-La Crescent and Upper Iowa watersheds are primarily utilized for municipal water supply (46%) with livestock watering as the second most common use (20%).

Figure 21 displays total high capacity withdrawal locations within the watershed with active permit status in 2015. During 1996 to 2015, groundwater withdrawals within the Mississippi River-Reno and Mississippi River-La Crescent watersheds exhibit a significant decreasing trend ($p<0.01$) (Figure 24 top), while surface water withdrawals have increased more significantly ($p<0.001$) (Figure 24 *bottom*).

Figure 23. Locations of active status permitted high capacity withdrawals in 2015 within the Mississippi River-Reno, Mississippi River-La Crescent and Upper Iowa River watersheds

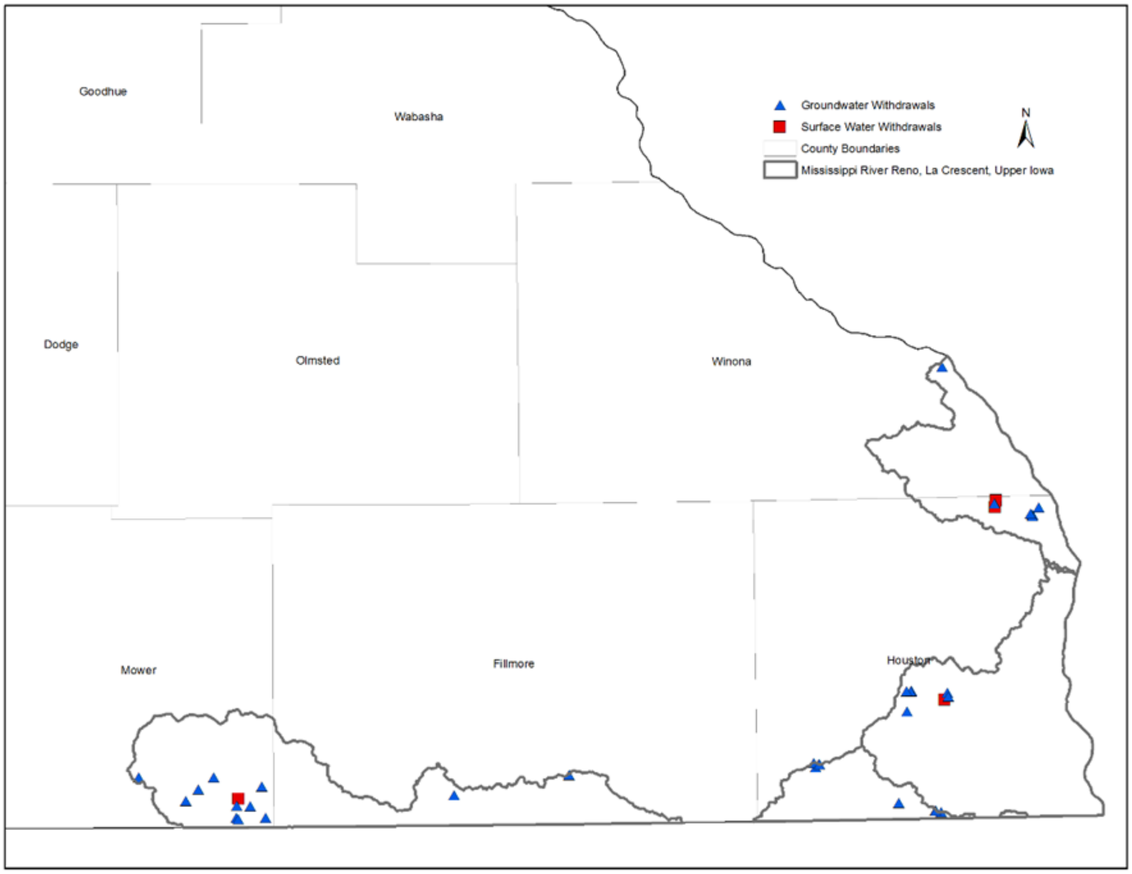
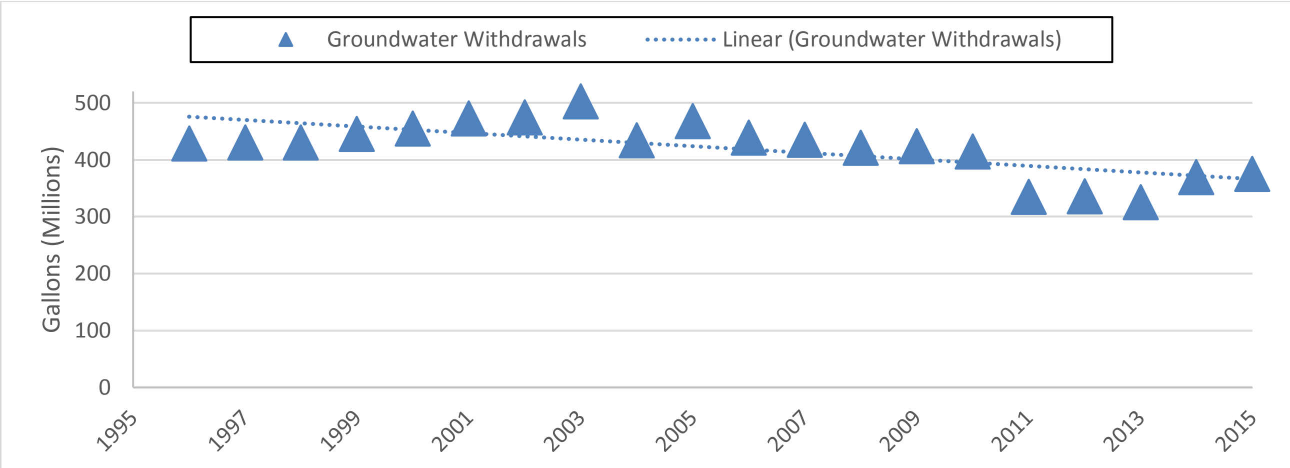
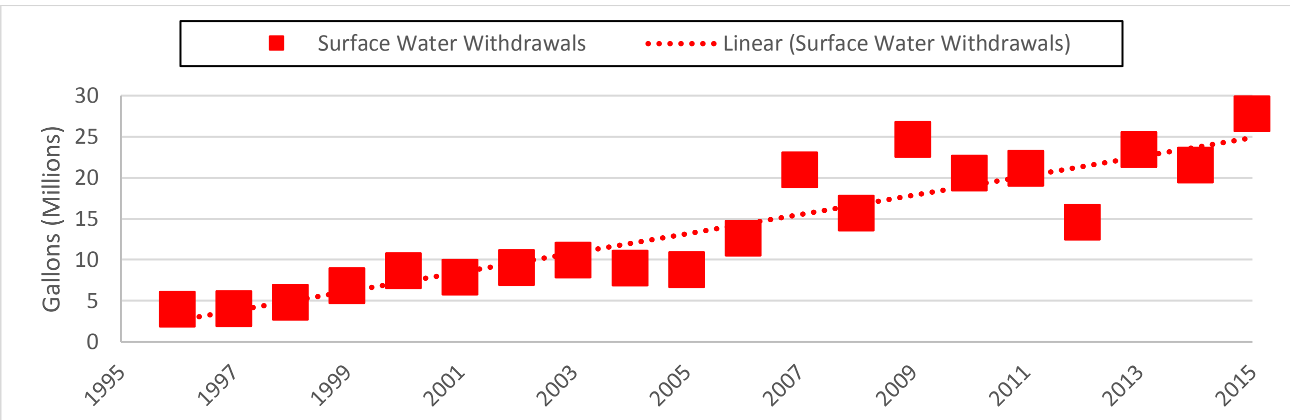


Figure 24. Total annual groundwater (top) and surface water (bottom) withdrawals in the Mississippi River-Reno, Mississippi River-La Crescent and Upper Iowa River watersheds (1996-2015).





Wetlands

Wetland background

Together, the Mississippi River Reno and Mississippi River La Crescent watersheds support an estimated 20,897 acres of wetland, or 11.7%. This estimate does not include open water portions of lakes, and rivers collectively classed as Deep Water Habitats, which comprised 48,930 acres or 27.5% (Figure 25). Wetlands with herbaceous emergent vegetation are the most common wetland type (5.5%) and forested wetlands are a close second (4.1%). Shrub dominated wetlands and shallow open water systems comprise (0.70% and 1.5% respectively). Most of the wetlands in these combined watersheds appear to be associated with the steam network, particularly in the Mississippi River backwater and floodplain complex.

An estimated 4,158 acres of wetland occur in the Upper Iowa River watershed, equaling 2.34% of the watershed area. These estimates do not include the 170 acres of permanent open water found in lakes and rivers and makeup 0.12% area of the watershed and are classed as deep-water habitats (Figure 26). Wetlands dominated by herbaceous emergent plants such as cattails, sedges or bulrushes cover 2.1% of the Upper Iowa watershed. Occurring mostly in floodplains, forested wetlands occupy 0.53% of the watershed area followed closely by 0.19% scrub-shrub and 0.15% shallow water wetlands.

Estimates in the Mississippi Reno and La Crescent watersheds and in the Upper Iowa watershed are based on 2011 spring imagery data with wetland mapping published as part of the updated southern Minnesota phase of the state NWI update that was released in 2015.

Figure 25. Distribution and types of wetlands according to the updated Minnesota updated National Wetland Inventory within the Mississippi River Reno and Mississippi River La Crescent watersheds.

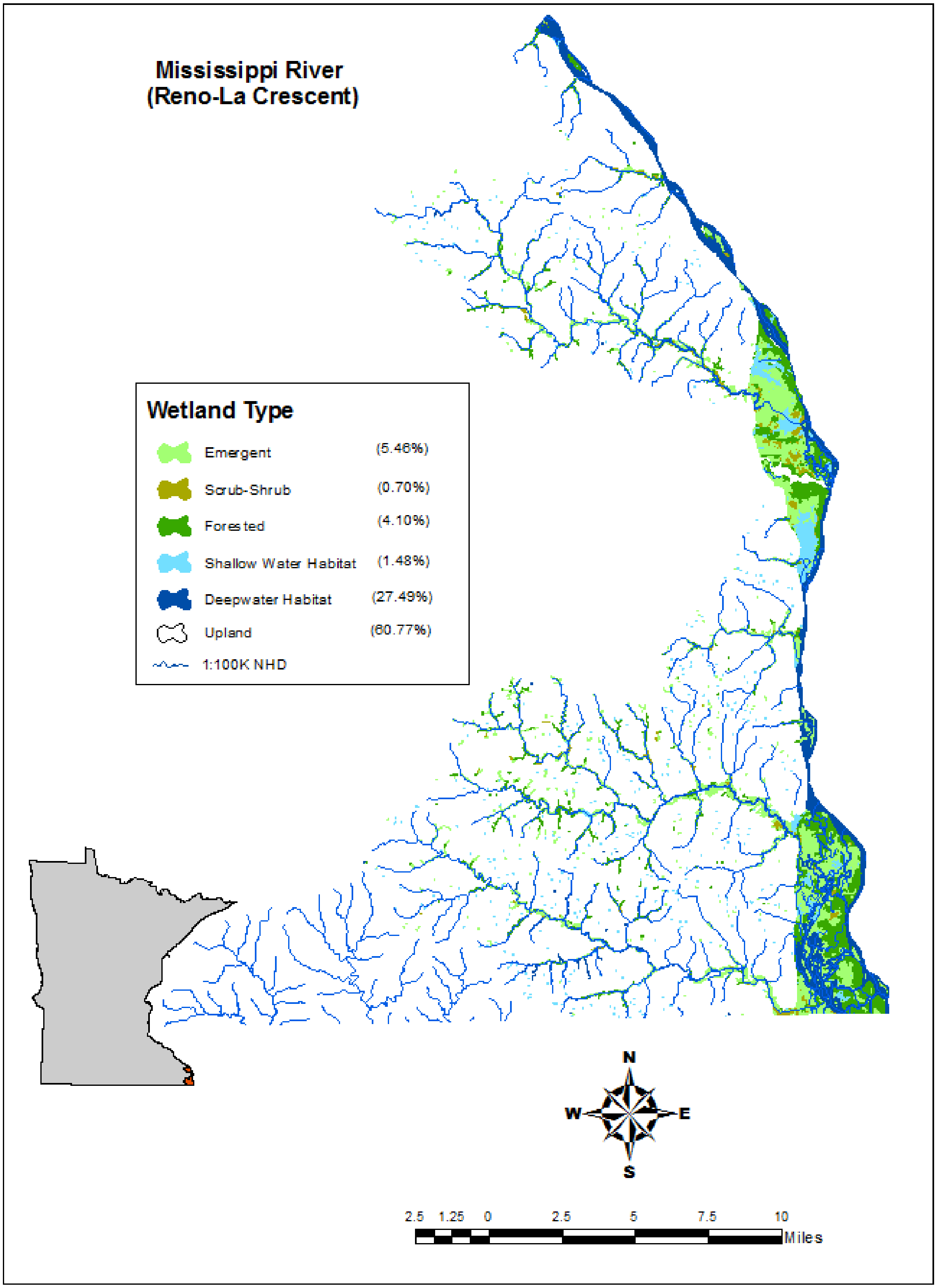
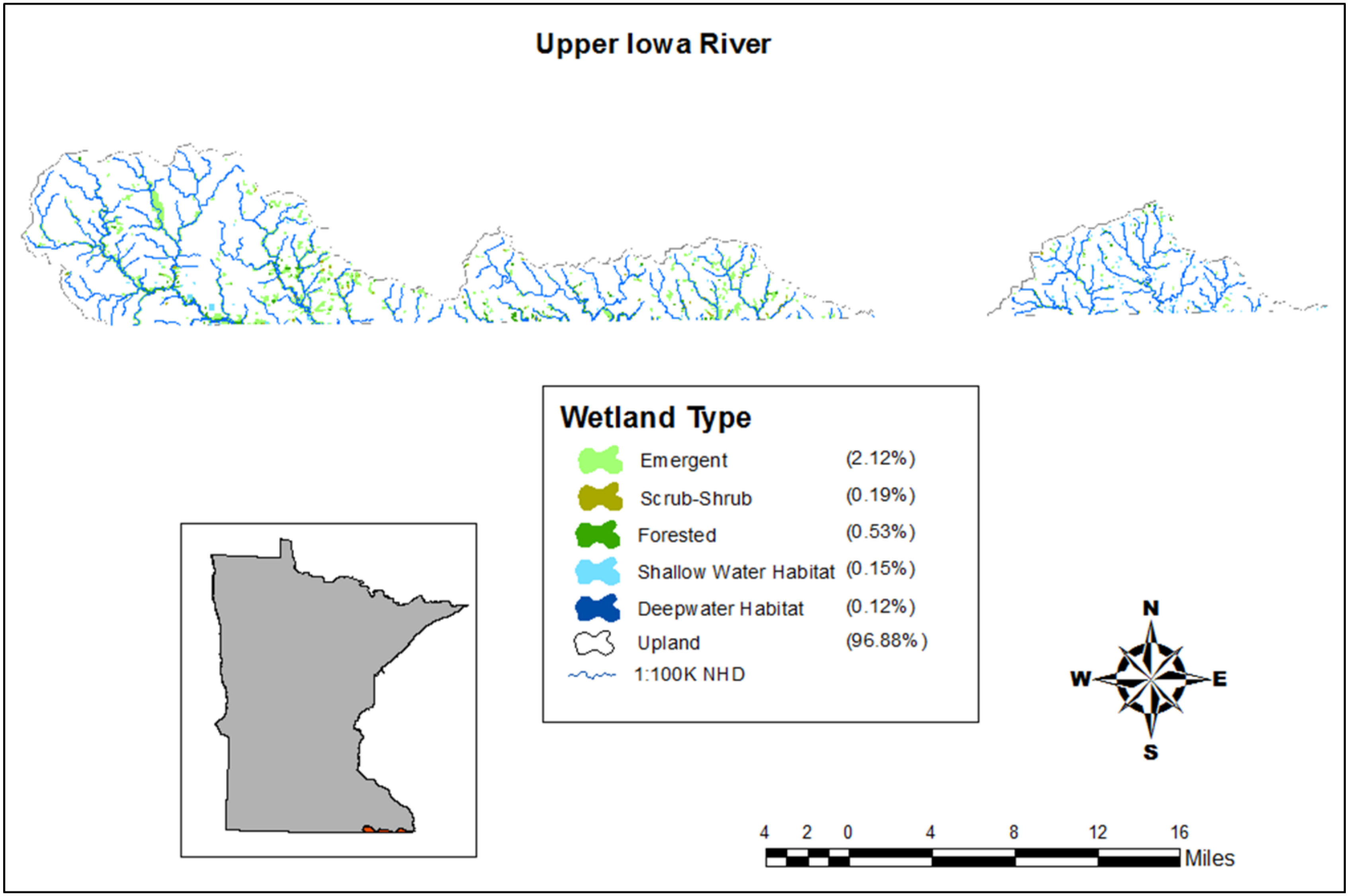


Figure 26. Distribution and types of wetlands according to the updated Minnesota updated National Wetland Inventory within the Mississippi River Reno and Mississippi River La Crescent watersheds.



Surficial geology in the combined Mississippi River-Reno and Mississippi River-La Crescent watershed is characterized by steep topography, underlain by weathered parent material residual over bedrock with some alluvial deposition in stream and river valleys. This geology is not necessarily conducive to formation of wetlands, in contrast with watersheds in other regions of Minnesota that are dominated by glacial geologic features. Rather wetland features in this combined watershed are more dependent on topographic drainage and stream influence.

Similar drift less surficial geology occurs in the eastern two-thirds of the Upper Iowa watershed within Cold Water Creek, Lower Upper Iowa and Bear Creek subwatersheds that exhibit similar steep topography with hill and valley features predominating. Wetlands in these subwatersheds are also associated with streams and hillside seeps. In the western third of the Upper Iowa watershed in the Headwaters of the Upper Iowa subwatershed the topography begins to flatten out and surficial geology is mostly characterized by older grey glacial drift (pre-Wisconsin period) and drift less residuum over bedrock toward the Mississippi River Valley. Wetlands are somewhat more common in this part of the Upper Iowa River watershed, though still predominantly associated with streams.

Wetland hydrogeomorphic classification

Not all wetlands provide the same functions, e.g. human benefits or services. Position in the watershed and hydrologic connectivity between the wetland and the associated stream network are major influences for many wetland functions. Plant community, water source, duration, frequency and magnitude of inundation or saturation and soil properties are also significant determinants of wetland function. Hydrogeomorphic (HGM) classification of wetlands characterizes the hydrologic regime and expected primary water flow paths of individual wetlands (Tiner, 2011). HGM is a hierarchical classification approach based on physical attributes including landscape (River, Stream; Lake and Inland [terrene]; major landform (Fringe, Island, Basin, Floodplain, Flat, Slope, Pond, Lake); water flow path (bi-directional, throughflow, outflow, inflow, isolated, paludified -- organic material deposition as in peatlands) and waterbody type. Several dozen possible combinations occur when the landscape, major landform, and flow path descriptors can be combined hierarchically.

Table 2. Predominant (> 2.0% total wetland area), wetland HGM classes present in the combined Mississippi River Reno and Mississippi River La Crescent Watersheds; simplified plant communities present in each respective HGM class; relative percent of the total wetland area (20,897 acres); number of polygons (5020 total) of each respective HGM class; and total summed area (ac) of each HGM wetland class.

HGM Class Code	Wetland HGM Landform Description	Simplified Wetland Plant Communities Present	% Total Wetland Area	Number of Wetland Polygons	HGM Class Area (ac)
LELKTH	Lentic Lake Throughflow	Shallow Open Water	7.83	23	1635.6
LRFPTH	Lotic River Floodplain Throughflow	Emergent, Forested, Scrub-Shrub, and Shallow Open Water	69.09	2193	14459.4
LRILTH	Lotic River Island Throughflow	Emergent, Forested, and Scrub-Shrub	5.49	318	1150.0
LRPDTH	Lotic River Pond Throughflow	Shallow Open Water	3.51	257	734.2
LSFLTH	Lotic Stream Flat Throughflow	Emergent, Forested, and Scrub-Shrub	2.10	133	450.2
TESLOU	Terrene Slope Outflow	Emergent, Forested, and Scrub-Shrub	7.87	606	1643.6

Twenty-one unique wetland HGM descriptor combinations (“classes”) occurred in the combined Mississippi River-Reno and Mississippi River-La Crescent watershed. Fifteen of the total

21 unique HGM classes each making up less than 2% of the total wetland area were deemed to be of minimal importance, and were not included in Table 2. The remaining six HGM classes each comprising at least 2% of the combined wetland area are presented in Table 2. The "Lentic Lake Throughflow" predominant wetland HGM class was attributed to 23 polygons, in which, all except one were backwater areas of the Mississippi River. One polygon in this class was a 37-acre impoundment on Crooked Creek. This HGM class, as well as the four lotic predominant HGM classes all had a "Throughflow" hydrologic flow path, demonstrating that the vast majority of wetlands in this watershed were well connected to the stream and river drainage network. These HGM classes typically have short water retention times and thus provide limited assimilative and storage capacities. The last predominant HGM class presented in Table 2 is the "Terrene Slope Outflow" wetlands that are essentially seepage wetlands that were expected to be common in this bluff and valley landscape. The majority, 80.1% of the 1353, wetland polygons found in all terrene classes excluding slope flow paths, were constructed by humans by either excavation or impoundment.

Applying the same threshold of greater than 2% wetland area in the Upper Iowa River watershed results in five predominant HGM classes out of the twenty unique classes found to occur in the watershed (Table 3). Two of the HGM classes are associated with flowing water (lotic) and comprise nearly 54% of the wetland area. Three wetland classes of inland landform (terrene) occur among greater than 2% of the wetland area. Two of these, terrene flat and pond classes have longer water retention times which contributes to improved water quality downstream. Based on area, just over one quarter of the Upper Iowa wetland resource was found to be associated with slopes and occur as seepage and other slope outflow wetland systems that maintain saturated soil habitats and ameliorate downstream water temperatures. Essentially all of the terrene slope wetland polygons were interpreted by the NWI data to occur naturally. In contrast, roughly 10% of the other terrene wetland polygons had a history of excavation or impoundment influence by humans.

Table 3. Predominant (> 2.0% total wetland area) wetland HGM classes present in the Upper Iowa River watershed; types of simplified plant communities present in each respective HGM class; relative percent of the total wetland area (4158 acres); number of polygons (2017 total) of each respective HGM class; and total summed area (ac) of each HGM wetland class.

HGM Class Code	Wetland HGM Landform Description	Simplified Wetland Plant Communities Present	% Total Wetland Area	Number of Wetland Polygons	HGM Class Area (ac)
LRFPTH	Lotic River Floodplain Throughflow	Emergent, Forested, and Scrub-Shrub	28.21	515	1182.41
LSFLTH	Lotic Stream Flat Throughflow	Emergent, Forested, and Scrub-Shrub	25.65	182	1066.71
TEFLOU	Terrene Flat Outflow	Emergent, Forested, and Scrub-Shrub	12.24	318	508.92
TEPDIS	Terrene Pond Isolated	Shallow Open Water	2.08	110	86.62
TESLOU	Terrene Slope Outflow	Emergent, Forested, and Scrub-Shrub	26.30	445	1093.58

Watershed-wide data collection methodology

Lake water sampling

MPCA sampled Louise Mill Pond in 2015 and 2016 to determine aquatic recreation use support. There are currently no volunteers enrolled in the MPCA's CLMP that are conducting lake monitoring within the watersheds. Sampling methods are similar among monitoring groups and are described in the document entitled "*MPCA Standard Operating Procedure for Lake Water Quality*" found at http://www.pca.state.mn.us/publications/wq-s1-16.pdf. The lake recreation use assessment requires eight observations/samples within a 10-year period (June to September) for phosphorus, chlorophyll-a and Secchi depth.

Stream water sampling

Six water chemistry stations among the three watersheds were sampled from May thru September in 2015, and again June thru August of 2016, to provide sufficient water chemistry data to assess all components of the aquatic life and recreation use standards. Following the IWM design, water chemistry stations were placed at the outlet of each aggregated 12 HUC subwatershed that was >40 square miles in area (blue circles in (Figure 2A, 2B, & 2C). A SWAG was awarded to the Root River SWCD. All of these stations collocated with the IWM design and water chemistry was collected by the SWCD. (See Appendix 2.1 for locations of stream water chemistry monitoring sites. See Appendix 1 for definitions of stream chemistry analytes monitored in this study).

Stream flow methodology

MPCA and the DNR joint stream water quantity and quality monitoring data for dozens of sites across the state on major rivers, at the mouths of most of the state's major watersheds, and at the mouths of some aggregated 12-HUC subwatersheds are available at the DNR/MPCA Cooperative Stream Gaging webpage at: http://www.dnr.state.mn.us/waters/csg/index.html.

Stream biological sampling

The biological monitoring component of the intensive watershed monitoring in the Upper Iowa River, Mississippi River-Reno, Mississippi River- La Crescent watersheds was completed during the summer of 2015. A total of 38 sites were newly established across the watershed and sampled. These sites were located near the outlets of most minor HUC-14 watersheds. In addition, two existing biological monitoring stations within the watershed were revisited in 2015. While data from the last 10 years contributed to the watershed assessments, the majority of data utilized for the 2017 assessment was collected in 2015. A total of 18 WIDs in the Upper Iowa River watershed; 10 WIDs in the Mississippi River-Reno watershed; 5 WIDs in the Mississippi River-La Crescent watershed were sampled for biology. Waterbody assessments to determine aquatic life use support were conducted for 27 WIDs. Biological information that was not used in the assessment process will be crucial to the stressor identification process and will also be used as a basis for long term trend results in subsequent reporting cycles.

To measure the health of aquatic life at each biological monitoring station, indices of biological integrity (IBIs), specifically fish and macroinvertebrate IBIs, were calculated based on monitoring data collected for each of these communities. A fish and macroinvertebrate classification framework was developed to account for natural variation in community structure which is attributed to geographic region, watershed drainage area, water temperature and stream gradient. As a result, Minnesota's streams and rivers were divided into seven distinct warm water classes and two coldwater classes, with each class having its own unique fish IBI and macroinvertebrate IBI. Each IBI class uses a unique suite of metrics, scoring functions, impairment thresholds, and confidence intervals (CIs) (For IBI classes, thresholds and CIs, see Appendix 3.1). 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 Appendices 4.1 and 4.2.

Fish contaminants

The DNR fisheries staff collect most of the fish for the Fish Contaminant Monitoring Program. In addition, MPCA's biomonitoring staff collect up to five piscivorous (top predator) fish and five forage fish near the HUC8 pour point, as part of the Intensive Watershed Monitoring. All fish collected by the MPCA are analyzed for mercury and the two largest individual fish of each species are analyzed for PCBs.

Captured fish were wrapped in aluminum foil and frozen until they were thawed, scaled (or skinned), filleted, and ground to a homogenized tissue sample. Homogenized fillets were placed in 60 mL glass jars with Teflon™ lids and frozen until thawed for lab analysis. The Minnesota Department of Agriculture Laboratory analyzed the samples for mercury and PCBs. If fish were tested for perfluorochemicals (PFCs), whole fish were shipped to AXYS Analytical Laboratory, which analyzed the homogenized fish fillets for 13 PFCs. Of the measured PFCs, only perfluorooctane sulfonate (PFOS) is reported because it bioaccumulates in fish to levels that are potentially toxic and a reference dose has been developed.

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

Monitoring of fish contaminants in the 1970s and 1980s showed high concentrations of PCBs were primarily a concern downstream of large urban areas in large rivers, such as the Mississippi River, and in Lake Superior. Therefore, PCBs are now tested where high concentrations in fish were measured in the past and the major watersheds are screened for PCBs in the watershed monitoring collections.

Before 2006, mercury in fish tissue was assessed for water quality impairment based on MDH's fish consumption advisory, the same as PCBs. With the adoption of a water quality standard for mercury in edible fish tissue, a waterbody has been classified as impaired for mercury in fish tissue if 10% of the fish samples (measured as the 90th percentile) exceed 0.2 mg/kg of mercury. At least five fish samples of the same species are required to make this assessment and only the last 10 years of data are used for the assessment. MPCA's Impaired Waters List includes waterways that were assessed as impaired prior to 2006 as well as more recent impairments.

Pollutant load monitoring

Intensive water quality sampling occurs at all WPLMN sites. Thirty-five samples per year are allocated for basin and major watershed sites and 25 samples per season (ice out through October 31) for subwatershed sites. Because concentrations typically rise with streamflow for many of the monitored pollutants, and because of the added influence elevated flows have on pollutant load estimates, sampling frequency is greatest during periods of moderate to high flow. All major snowmelt and rainfall events are sampled. Low flow periods are also sampled although sampling frequency is reduced as pollutant concentrations are generally more stable when compared to periods of elevated flow.

Water sample results and daily average flow data are coupled in the $FLUX_{32}$ pollutant load model to estimate the transport (load) of nutrients and other water quality constituents past a sampling station over a given period of time. Loads and flow weighted mean concentrations (FWMCs) are calculated for total suspended solids (TSS), total phosphorus (TP), dissolved orthophosphate, nitrate plus nitrite nitrogen (NO_3+NO_2-N), and total Kjeldahl nitrogen (TKN).

More information can be found at the WPLMN website.

Groundwater monitoring

Groundwater quality

The MPCA's Ambient Groundwater Monitoring Program monitors trends in statewide groundwater quality by sampling for a comprehensive suite of chemicals including nutrients, metals, and volatile organic compounds. These Ambient wells represent a mix of deeper domestic wells and shallow monitoring wells. The shallow wells interact with surface waters and exhibit impacts from human activities more rapidly. Available data from federal, state and local partners are used to supplement reviews of groundwater quality in the region.

Groundwater quantity

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

Groundwater/Surface water withdrawals

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

Stream flow

MPCA and the DNR jointly monitor stream water quantity and quality at dozens of sites across the state on major rivers, at the mouths of most of the state's major watersheds, and at the mouths of some aggregated 12-HUC subwatersheds. Information and data on these sites are available at the DNR/MPCA Cooperative Stream Gaging webpage at: http://www.dnr.state.mn.us/waters/csg/index.html.

Wetland monitoring

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

The MPCA currently does not monitor wetlands systematically by watershed. Alternatively, the overall status and trends of wetland quality in the state and by major ecoregion is being tracked through probabilistic monitoring. Probabilistic monitoring refers to the process of randomly selecting sites to monitor; from which, an unbiased estimate of the resource can be made. Regional probabilistic survey results can provide a reasonable approximation of the current wetland quality in the watershed.

As few open water depressional wetlands exist in the watershed, the focus will be on vegetation quality results of all wetland types.

Individual aggregated 12-HUC subwatershed results

Aggregated 12-HUC subwatersheds

Assessment results for aquatic life and recreation use are presented for each Aggregated HUC-12 subwatershed within the Upper Iowa River, Mississippi-Reno, Mississippi-La Crescent Watersheds. The primary objective is to portray all the full support and impairment listings within an aggregated 12-HUC subwatershed resulting from the complex and multi-step assessment and listing process. This scale provides a robust assessment of water quality condition at a practical size for the development, management, and implementation of effective TMDLs and protection strategies. The graphics presented for each of the aggregated HUC-12 subwatersheds contain the assessment results from the 2017 Assessment Cycle as well as any impairment listings from previous assessment cycles. Discussion of assessment results focuses primarily on the 2015-2016 intensive watershed monitoring effort, but also considers available data from the last 10 years.

The proceeding pages provide an account of each aggregated HUC-12 subwatershed. Each account includes a brief description of the aggregated HUC-12 subwatershed and summary tables of the results for each of the following: a) stream aquatic life and aquatic recreation assessments, and b) lake aquatic life and recreation assessments. Following the tables is a narrative summary of the assessment results and pertinent water quality projects completed or planned for the aggregated HUC-12 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 aggregated HUC-12 subwatershed (i.e., where sufficient information was available to make an assessment). Primarily, these tables reflect the results of the 2017 assessment process (2018 EPA reporting cycle); however, impairments from previous assessment cycles are also included and are distinguished from new impairments via cell shading (see footnote section of each table). These tables also denote the results of comparing each individual aquatic life and aquatic recreation indicator to their respective criteria (i.e., standards); determinations made during the desktop phase of the assessment process (see Figure 5). Assessment of aquatic life is derived from the analysis of biological (fish and macroinvertebrate IBIs), dissolved oxygen, total suspended solids, chloride, pH, total phosphorus, chlorophyll-a, biochemical oxygen demand and un-ionized ammonia (NH3) data, while the assessment of aquatic recreation in streams is based solely on bacteria (Escherichia coli) data. Included in each table is the specific aquatic life use classification for each stream reach: coldwater community (2A); cool or warm water community (2B); or indigenous aquatic community (2C). Where applicable and sufficient data exists, assessments of other designated uses (e.g., class 7, drinking water, aquatic consumption) are discussed in the summary section of each aggregated HUC-12 subwatershed as well as in the watershed-wide results and discussion section.

Lake assessments

A summary of lake water quality is provided in the aggregated HUC-12 subwatershed sections where available data exists. This includes aquatic recreation (phosphorus, chlorophyll-a, and Secchi) and aquatic life, where available (chloride and fish IBI). Similar to streams, parameter level and over all use decisions are included in the table.

Headwaters Upper Iowa River Aggregated 12-HUC   HUC 0706000201-01

Located on the far west side of the Upper Iowa River watershed, this is the headwaters to the Upper Iowa River watershed. There are several small unnamed tributaries throughout the subwatershed. Beaver Creek, Little Iowa River, and North Branch Upper Iowa River are larger tributaries to the headwaters of the Upper Iowa River. The subwatershed is located in the southeast corner of Mower County and the southwest corner of Fillmore County. The town of Tapoi is on the far west border of the subwatershed and Le Roy is in the south central region, just south of Lake Louise State Park. The Little Iowa River flows south through the park and meets the Upper Iowa River just south of the park. The Upper Iowa River crosses into Iowa from this subwatershed before flowing back into Minnesota. Generally, flow is directed south in all streams.

Table 4. Aquatic life and recreation assessments on stream reaches: Headwaters Upper Iowa River Aggregated 12-HUC.

				Aquatic life indicators:												
WID ***Reach name,*** *Reach description*	**Biological Station ID**	**Reach length (miles)**	**Use class***	**Fish IBI**	**Invert IBI**	**Dissolved oxygen**	**TSS**	**Secchi Tube**	**Chloride**	**pH**	**Ammonia -NH_3**	**Pesticides**	**Eutrophication**	**Aquatic life**	**Aquatic rec. (Bacteria)**
07060002-509 **Upper Iowa River,** Little Iowa River to Beaver Creek (MN)	15LM019	5.92	WWg	MTS	MTS	MTS	IF	MTS	MTS	MTS	MTS	--	IF	SUP	IMP
07060002-526 **North Branch Upper Iowa River,** Unnamed creek to Unnamed creek	15LM023	2.31	WWg	MTS	MTS	IF	IF	IF	IF	MTS	IF	--	IF	SUP	--
07060002-536 **Unnamed creek,** Unnamed cr to MN/IA border	--	1.59	WWg	--	--	IF	--	IF	--	IF	--	--	--	IF	--
07060002-537 **Unnamed creek,** Unnamed creek to Beaver Creek	15LM015	3.07	WWg	MTS	EXS	IF	IF	IF	--	MTS	IF	--	IF	IMP	--
07060002-539 **Unnamed creek,** Unnamed creek to Little Iowa River	--	1.44	WWg	--	--	IF	--	IF	--	IF	--	--	--	IF	--

07060002-540 **Unnamed creek,** Unnamed creek to Little Iowa River	15LM026	1.28	WWg	MTS	EXS	IF	IF	IF	--	MTS	IF	--	IF	IMP	--
07060002-541 **Unnamed creek,** Unnamed creek to Unnamed creek	--	2.46	WWg	--	--	IF	--	IF	--	IF	--	--	--	IF	--
07060002-542 **Unnamed creek,** Unnamed creek to Upper Iowa River	--	2.10	WWg	--	--	IF	--	--	--	IF	--	--	--	IF	--
07060002-543 **Unnamed creek,** Headwaters to North Branch Upper Iowa River	--	3.29	WWg	--	--	IF	--	IF	--	IF	--	--	--	IF	--
07060002-544 **Unnamed creek,** Unnamed creek to Upper Iowa River	15LM021	2.70	WWg	MTS	EXS	IF	IF	IF	--	MTS	IF	--	IF	IMP	--
07060002-545 **Beaver Creek,** Headwaters to Mower-Fillmore Rd	--	2.15	WWg	--	--	IF	IF	IF	--	IF	--	--	IF	IF	--
07060002-546 **Beaver Creek,** Mower-Fillmore Rd to Upper Iowa River	04LM018 15LM014 15LM016 15LM017	9.43	WWg	MTS	EXS	IF	IF	IF	--	MTS	IF	--	IF	IMP	IMP
07060002-547 **Little Iowa River,** Headwaters to 770th Ave	--	4.78	WWg	--	--	IF	--	IF	--	MTS	--	--	--	IF	--
07060002-548 **Little Iowa River,** 770th Ave to Upper Iowa River	04LM106 15LM025 15LM045	4.57	WWg	MTS	MTS	IF	IF	MTS	--	MTS	MTS	--	IF	SUP	IMP
07060002-549 **Upper Iowa River,** Headwaters to -92.5901, 43.5985	--	2.57	WWg	--	--	IF	--	IF	--	IF	--	--	--	IF	--

07060002-550 **Upper Iowa River,** -92.5901, 43.5985 to Little Iowa River	15LM020 15LM022 15LM024	12.91	WWg	MTS	EXS	IF	IF	IF	--	MTS	IF	--	IF	IMP	IMP
07060002-552 **Unnamed creek,** -92.4338, 43.5416 to Beaver Creek	15LM018	1.49	WWg	MTS	MTS	IF	IF	IF	--	MTS	IF	--	IF	SUP	--

Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: -- = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: ☐ = existing impairment, listed prior to 2016 reporting cycle; ☐ = new impairment; ☐ = full support of designated use; ☐ = insufficient information.
Abbreviations for Use Class: **WWg** = warmwater general, **WWm** = Warmwater modified, **WWe** = Warmwater exceptional, **CWg** = Coldwater general, **CWe** = Coldwater exceptional, **LRVW** = limited resource value water
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Table 5. Lake assessments: Headwaters Upper Iowa River Aggregated 12-HUC.

Lake name	DNR ID	Area (acres)	Max depth (ft)	Assessment method	Ecoregion	Secchi trend	Aquatic life indicators:			Aquatic recreation indicators:			Aquatic life use	Aquatic recreation use
							Fish IBI	Chloride	Pesticides	Total phosphorus	Chlorophyll-a	Secchi		
Louise Mill Pond	50-0001-00	36	8	Shallow	WCBP	NT	--	MTS	--	NA	NA	NA	--	NA

Abbreviations for Ecoregion: **DA** = Driftless Area, **NCHF** = North Central Hardwood Forest, **NGP** = Northern Glaciated Plains, **NLF** = Northern Lakes and Forests, **NMW** = Northern Minnesota Wetlands, **RRV** = Red River Valley, **WCBP** = Western Corn Belt Plains
Abbreviations for Secchi Trend: **D** = decreasing/declining trend, **I** = increasing/improving trend, **NT** = no detectable trend, **--** = not enough data
Abbreviations for Indicator Evaluations: -- = No Data, **MTS** = Meets Standard; **EX** = Exceeds Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: -- = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **FS** = Full Support (Meets Criteria); **NS** = Not Support (Impaired, exceeds standard)
Key for Cell Shading: ☐ = existing impairment, listed prior to 2016 reporting cycle; ☐ = new impairment; ☐ = full support of designated use; ☐= insufficient information.

Summary

Biological assessment

The Headwaters Upper Iowa River subwatershed has nine stream reaches with assessable fish data. All data was assessed using the general use thresholds. Several tributaries to the Upper Iowa River, including the North Branch Upper Iowa River, Little Iowa River, and Beaver Creek are found in this subwatershed.

In this subwatershed, four WIDs unnamed creeks (-544, -540, -552, -537) were sampled at four different stations between 2015-2016. All fish samples scored above the threshold for general use standards; some even scoring near or above the exceptional use thresholds. Macroinvertebrate samples at three of the unnamed creeks (-537, -540, and -544) all scored below the general use threshold, while the sample collected on reach -552 agreed with the fish assessment. Low water levels, some habitat stressors and very high nitrogen values seems to have a larger impact on macroinvertebrates than fish. All four reaches are recommended for full support for aquatic life for fish, while only -552 is recommend for full support for macroinvertebrates.

Beaver Creek (-546) has four sample locations (04LM018, 15LM014, 15LM016, 15LM017). Station 04LM018 was sampled in 2004 but the data was expired during this assessment. The other three stations were each sampled once in 2015. Station 15LM014, scored above the exceptional use threshold for fish. All current fish data scored above the general use threshold and CI. Assessable macroinvertebrate data scored above the general use threshold at 15LM014 and 15LM015, and fell below the general use threshold at 15LM017.

The North Branch Upper Iowa River (-526) flows into the mainstem Upper Iowa River east of Taopi. The reach has one station (15LM023) which was twice from 2015-2016. The fish and macroinvertebrate samples collected in August 2015 scored below the general use threshold. Seventeen species of fish were found during that sample, but only 11% of the taxa collected were sensitive. The second fish sample from 2015 was above the general use threshold but within the CI. It was noted in 2015 there was suspected beaver activity downstream of the station location, which could limit both flow and fish movement. When sampled in 2016 both fish and macroinvertebrate scores were above the general use threshold and CI. Water levels were lower in 2016, which allowed better access to coarse substrates for macroinvertebrate sampling. Considering all the data, the WID is recommended full support for both fish and macroinvertebrates.

There are two reaches on the Little Iowa River with assessable biological data. The upstream reach (-548), was sample at three locations: 04LM106, 15LM025, 15LM045. Station 04LM106 had expired biological data from a 2004 sample. The fish IBI score was above the exceptional use threshold while the macroinvertebrate score was below the general use threshold. The other two stations were each sampled once in 2015. Both sites had fish IBI scores well above the general use threshold and even above the exceptional use threshold. Station 15LM045 is located in Lake Louise State Park, a popular outdoor recreation area. In the park, 27 species were identified with 33% of the taxa being sensitive species. The macroinvertebrate scores from both stations scored just above the general use threshold. While several of the samples scored above the exceptional use threshold, because not all of them did and the macroinvertebrate scores did not, the reach remained general use. Using all data available, the reach is recommended for full support for both fish and macroinvertebrate.

The downstream reach on the Upper Iowa River (-509) had one sample location, 15LM019, that was sample once in 2015. The fish scored above the general use threshold and the CI, while the macroinvertebrates scored just above the general use threshold. The fish sample showed great diversity. The stream had diverse habitat types for fish and macroinvertebrates, but some accumulation of sediment was noted, especially in pools. Based on the fish and macroinvertebrate data collected this reach is recommended for full support for aquatic life.

The headwaters of the Upper Iowa River begins in this subwatershed. One reach (-550) was assessed for biological data. Three stations (15LM020, 15LM022, 15LM024) were sampled for fish between 2015 and 2016. Stations 15LM020 and 15LM024 scored above the general use threshold and CI for fish in 2015. Due to a beaver dam in the reach of 15LM022, it was not sampled until 2016. The fish IBI score was above exceptional use threshold. Because only one of the three IBI scores was above the exceptional use, the reach will remain general use, and recommended for full support for fish. Three biological invert visits were conducted in 2015. Sites 15LM022 and 15LM024 both scored below the general use threshold. Station 15LM020 scored three points above the general use threshold. All sites had high numbers of invertebrates tolerant of nitrogen, corroborating the high nitrogen values. Unstable banks were common at all sites, as were high nitrogen values. Recommend non-support of aquatic life based on macroinvertebrate assessment.

Water chemistry

The most data-intensive stream reach for chemical parameters was the Upper Iowa River from the Little Iowa River to Beaver Creek. It was determined to be meeting aquatic life use standards for DO, TSS, pH, un-ionized ammonia, and chloride. Bacteria data indicated an impairment for aquatic recreation as *E. coli* concentrations were elevated over the summer months.

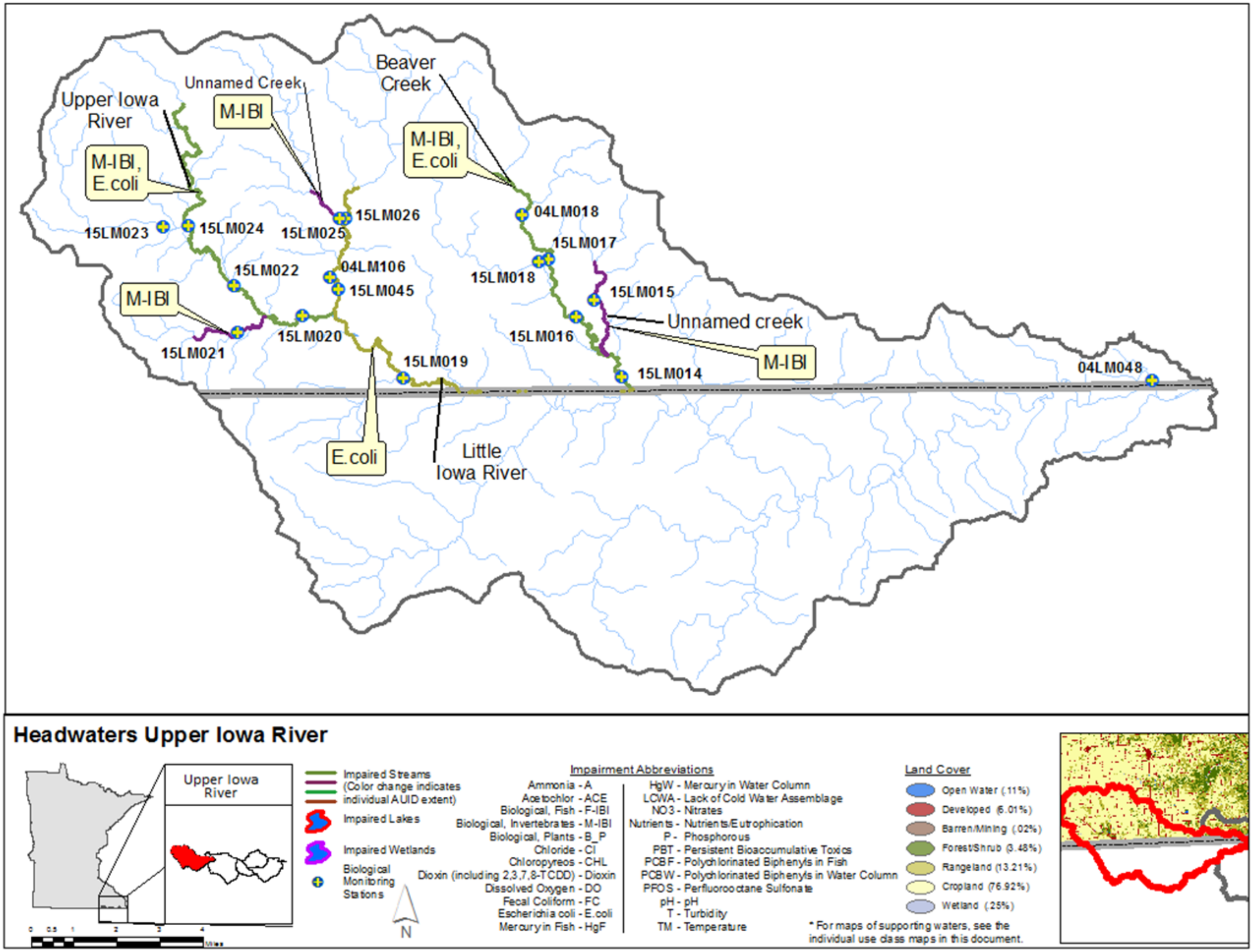
The Little Iowa River reach from 770th Avenue to the Upper Iowa River was meeting for TSS, pH, and un-ionized ammonia. Bacteria data indicated an impairment for aquatic recreation, the *E. coli* concentrations were elevated over the summer months.

Beaver Creek from the Mower-Fillmore Road to Upper Iowa River and Upper Iowa River downstream of 170th Street to the Little Iowa River both were found to be impaired for aquatic recreation, bacteria levels were elevated throughout the summer months over the assessment period.

Additional reaches of the Upper Iowa River, Little Iowa River, Beaver Creek, and several unnamed creeks had few chemistry samples taken and were insufficient to assess for aquatic life use. Though there were limited datasets on the North Branch Upper Iowa River and unnamed creeks (-540, -544, and -552), data indicates that pH is not impaired on these reaches.

Louise Mill Pond, a reservoir in Lake Louise State Park, was sampled to help determine if aquatic recreation use was met. The State Park does provide swimming opportunities on the basin. During assessments, analysis was completed to determine if the basin held water long enough to meet the definition of a lake. During low flow, the lake would completely cycle through water in 5 days. A 14 day minimum is required for our standards to apply. The available data shows that chlorophyll-a (algae) concentrations are low across the summer, and the phosphorus contributions to the reservoir are low enough to be supporting recreation use on the basin.

Figure 27. Currently listed impaired waters by parameter and land use characteristics in the Headwaters Upper Iowa River Aggregated 12-HUC.



Coldwater Creek Aggregated 12-HUC — HUC 0706000202-01

Located east of Headwaters Upper Iowa River, this subwatershed is the central region of the major watershed. There are three notable tributaries: Elliot Creek, Deer Creek and Pine Creek. The Upper Iowa River also flows back into Minnesota from Iowa in several locations, before flowing back into Iowa. Coldwater Creek subwatershed is found in South Central Fillmore County. The town of Harmony is located on the northern border of the subwatershed. No other towns are found in the subwatershed.

Table 6. Aquatic life and recreation assessments on stream reaches: Coldwater Creek Aggregated 12-HUC.

WID *Reach name,* Reach description	Biological station ID	Reach length (miles)	Use class	Aquatic life indicators: Fish IBI	Invert IBI	Dissolved oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides	Eutrophication	Aquatic life	Aquatic rec. (Bacteria)
07060002-505 **Unnamed Creek,** Headwaters to Pine Creek	15LM008	1.53	WWg	NA	NA	IF	IF	IF	--	MTS	IF	--	IF	NA	--
07060002-506 **Upper Iowa River,** Beaver Creek (IA) to Pine Creek	02LM010 04LM048	4.21	WWg	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	SUP	--
07060002-512 **Pine Creek,** T101 R10W S24, north line to MN/IA border	--	4.57	LRVW	--	--	MTS	--	--	--	MTS	MTS	--	--	--	IMP
07060002-520 **Deer Creek,** Headwaters to MN/IA border	15LM009	0.83	WWg	EXS	MTS	IF	IF	IF	--	MTS	IF	--	IF	IMP	--
07060002-521 **Elliot Creek,** Headwaters to MN/IA border	15LM010	2.32	WWg	NA	NA	IF	IF	IF	--	MTS	IF	--	IF	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.

Summary

Biological assessment

Deer Creek (-520) showed a supporting macroinvertebrate assemblage. The fish samples were mixed with one result above the general use threshold, and one below. This reach had instream habitat dominated by fine substrates, and a riparian corridor consisting of pasture, and row crop in the upstream watershed. Stream bank erosion was prevalent in this reach, and was noted as being a potential stressor for both fish and macroinvertebrates. No sensitive fish taxa were found during either sample. The water temperatures were cold, but the fish assemblage did not support changing the stream from warm water to coldwater. Recommend non-support for aquatic life based on fish.

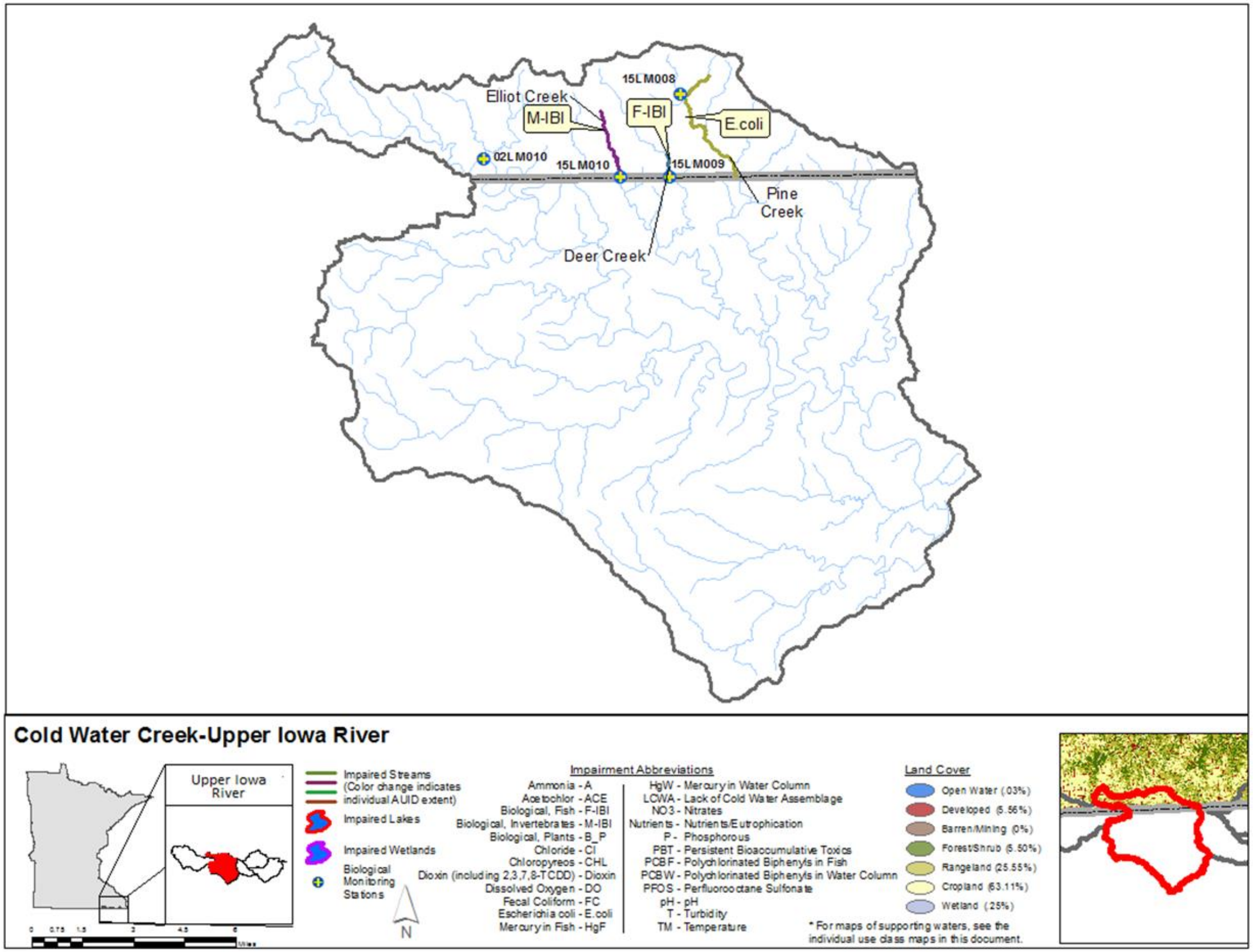
One reach on the Upper Iowa River (-506) has two stations: 02LM010, 04LM048. The reach within this subwatershed and the Headwaters Upper Iowa River subwatershed. Station 04LM048 is located in the headwaters subwatershed, but all the biological data was expired at the time of assessment. In 2004, the fish scored above the exceptional use threshold, but the macroinvertebrate scored just below the exceptional use threshold. The second station, 02LM010, was sampled once in 2002 for fish, and once in 2015 for both fish and macroinvertebrates. The sample from 2002 was only used as supporting evidence and was not assessed. The 2015 fish sample scored above the general use threshold and CI, while the macroinvertebrate score fell one point below the general use threshold. The fish IBI score was high enough to be above the exceptional use threshold. Because the macroinvertebrate scores were not above the exceptional use threshold, the reach remains general use. The reach is recommended for full support for fish and macroinvertebrates. Heavy erosion was noted as a possible stressor along the reach.

Water chemistry

The Upper Iowa River, Deer Creek, Elliot Creek, and an unnamed creek (-505) had chemistry data available over the assessment period to compare to aquatic life use standards. Unnamed creek (-505) was meeting for pH. However, light pH datasets were available on Deer Creek and Elliot Creek the data suggests there are no pH issues on these reaches. All other parameters had insufficient numbers of samples to assess.

Pine Creek is classified as a limited resource value water. DO, pH, and unionized ammonia were meeting Class 7 standards. However, bacteria data was elevated throughout the summer months, which indicates an impairment.

Figure 28. Currently listed impaired waters by parameter and land use characteristics in the Coldwater Creek Aggregated 12-HUC.



Bear Creek Aggregated 12-HUC — HUC 0706000205-01

Bear Creek subwatershed is located on the far eastern side. The town of Spring Grove is located on the north border and Emmons on the far southwest border. The subwatershed is located in the southeast corner of Houston County. Bear Creek and Bee Creek are the two notable tributaries to the Upper Iowa River. The Upper Iowa River crosses into Minnesota for the final time before continuing into Iowa where the majority of the major watershed is found.

Table 7. Aquatic life and recreation assessments on stream reaches: Bear Creek Aggregated 12-HUC.

WID *Reach name,* Reach description	Biological station ID	Reach length (miles)	Use class	Aquatic life indicators: Fish IBI	Invert IBI	Dissolved oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides	Eutrophication	Aquatic life	Aquatic rec. (Bacteria)
07060002-503 **Bear Creek,** Unnamed creek to MN/IA border	--	2.67	LRVW	--	--	MTS	--	--	--	MTS	MTS	--	--	--	IMP
07060002-515 **Bee Creek (Waterloo Creek),** T101 R6W S29, north line to MN/IA border	15LM004	3.45	CWe	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	SUP	IMP
07060002-535 **Unnamed creek,** Unnamed creek to MN/IA border	15LM005	2.44	CWg	MTS	EXS	IF	IF	IF	--	MTS	IF	--	IF	IMP	--

Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: ☐ = existing impairment, listed prior to 2016 reporting cycle; ☐ = new impairment; ☐ = full support of designated use; ☐ = insufficient information.
Abbreviations for Use Class: **WWg** = warmwater general, **WWm** = Warmwater modified, **WWe** = Warmwater exceptional, **CWg** = Coldwater general, **CWe** = Coldwater exceptional, **LRVW** = limited resource value water

Summary

Biological assessment

Bee Creek (Waterloo Creek) has one reach (-515) with one station (15LM004) that was sampled once in 2015. The reach is coldwater and managed by DNR. The stream is a popular location for trout fishing. Trout are abundant in both Minnesota and Iowa. Both the macroinvertebrate and fish IBI scores were above the exceptional use threshold. Bee Creek met the exceptional use criteria and assessments were made using this new classification. Nearly 800 slimy sculpin and 106 brown trout, both indicators of a healthy coldwater stream, were found during the fish sample. Good habitat supported a healthy coldwater macroinvertebrate community. Monitored temperatures from the summer support the existing coldwater designation. The reach has passing scores for fish and macroinvertebrates and is fully supporting for aquatic life.

Unnamed Creek (-535) had one sample location (15LM005) in an active pasture. Despite being in an active pasture, in-stream habitat was good. This reach was previously considered warm water, but is being changed to coldwater based on stream temperature readings, and fish assemblage**.** Average summer water temperatures in 2015 were 15.8°C, and both mottled sculpin and brook trout were sampled. Of the total number of fish collected, 45% were considered sensitive. The coldwater fish community is supporting of the general use standard, while the macroinvertebrate community does not show a supporting condition. A lack of strong numbers of coldwater obligate macroinvertebrate taxa, as well as high numbers of nitrogen and TSS tolerant taxa (90^{th} percentile for southern coldwater streams), suggest the stream is being stressed, and corroborates high nitrogen and TSS data collected during the fish survey.

Water chemistry

Bee Creek and an unnamed creek (follows along east side of Houston County Road 4, begins at its confluence with an unnamed creek near the intersection of Newhouse Drive to the Minnesota-Iowa border) had chemistry data available to compare to aquatic life use standards over the assessment period. The pH dataset, though limited in samples, indicates pH is not adversely affecting aquatic life on the unnamed creek. All other chemical datasets on these two streams were insufficient as the number of samples were lacking. A new aquatic recreation impairment is suggested for Bee Creek, *E. coli* concentrations were high during the summer months over the assessment period.

Bear Creek is a limited resource value water and was meeting standards for DO, pH, and un-ionized ammonia. Bacteria data over the assessment period was elevated over the summer months, this indicates an impairment.

Winnebago Creek Aggregated 12-HUC

HUC 0706000104-01

Located in Houston County, the Winnebago Creek subwatershed is located in the southwest region of the Mississippi River-Reno watershed. There are no towns entirely within the subwatershed, but Eitzen is on the southwest border. Winnebago Creek begins in the north region of the subwatershed and flows southeast to the Mississippi River. Several small tributaries flow into Winnebago Creek throughout the subwatershed.

Table 8. Aquatic life and recreation assessments on stream reaches: Winnebago Creek Aggregated 12-HUC.

WID ***Reach name***, *Reach description*	Biological station ID	Reach length (miles)	Use class	Aquatic life indicators: Fish IBI	Invert IBI	Dissolved oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides	Eutrophication	Aquatic life	Aquatic rec. (Bacteria)
07060001-508 **Winnebago Creek,** Unnamed creek to T101 R4W S28, east line	15LM030	13.62	CWg	MTS	MTS	IF	IF	IF	--	IF	IF	--	MTS	SUP	--
07060001-685 **Unnamed creek,** T101 R6W S12, west line to Unnamed creek	15LM031	0.43	CWg	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	SUP	--
07060001-687 **Unnamed creek,** T101 R5W S14, north line to Unnamed creek	04LM030	0.84	CWg	NA	NA	--	--	--	--	--	--	--	--	NA	--
07060001-693 **Winnebago Creek,** T101 R4W S27, west line to south line	15LM028	0.92	CWg	MTS	EXS	IF	EXS	EXS	MTS	IF	MTS	--	MTS	IMP	IMP

Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: = existing impairment, listed prior to 2016 reporting cycle; = new impairment; = full support of designated use; = insufficient information.
Abbreviations for Use Class: **WWg** = warmwater general, **WWm** = Warmwater modified, **WWe** = Warmwater exceptional, **CWg** = Coldwater general, **CWe** = Coldwater exceptional, **LRVW** = limited resource value water
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Summary

The three coldwater reaches within the Winnebago Creek Watershed, showed high quality fish communities throughout, while the macroinvertebrate communities showed variable results. Unnamed creek (-685) had very different results between the two years it was sampled for macroinvertebrates. In 2015, the stream was completely covered with a dense mat of watercress; thick enough that it limited access to coarse substrates. The corresponding macroinvertebrate sample showed a non-supporting condition. The fish community scored above the exceptional use threshold. In the fish sample, 89 brook trout were found, with roughly 30 of those considered young of the year; indicating naturally occurring reproduction. Slimy sculpin, brown trout and a rare tiger trout were also found during the survey (a tiger trout is a hybrid of the brown trout and brook trout). This reach had very high nutrient vales. Dense watercress growth throughout the stream could be an indication of a nutrient problem. A macroinvertebrate sample was also collected in 2016, after a high flow event had scoured out the majority of watercress, leaving quality coarse substrates exposed. Access to these more typical coldwater habitats resulted in a macroinvertebrate sample that was supporting of the general use threshold.

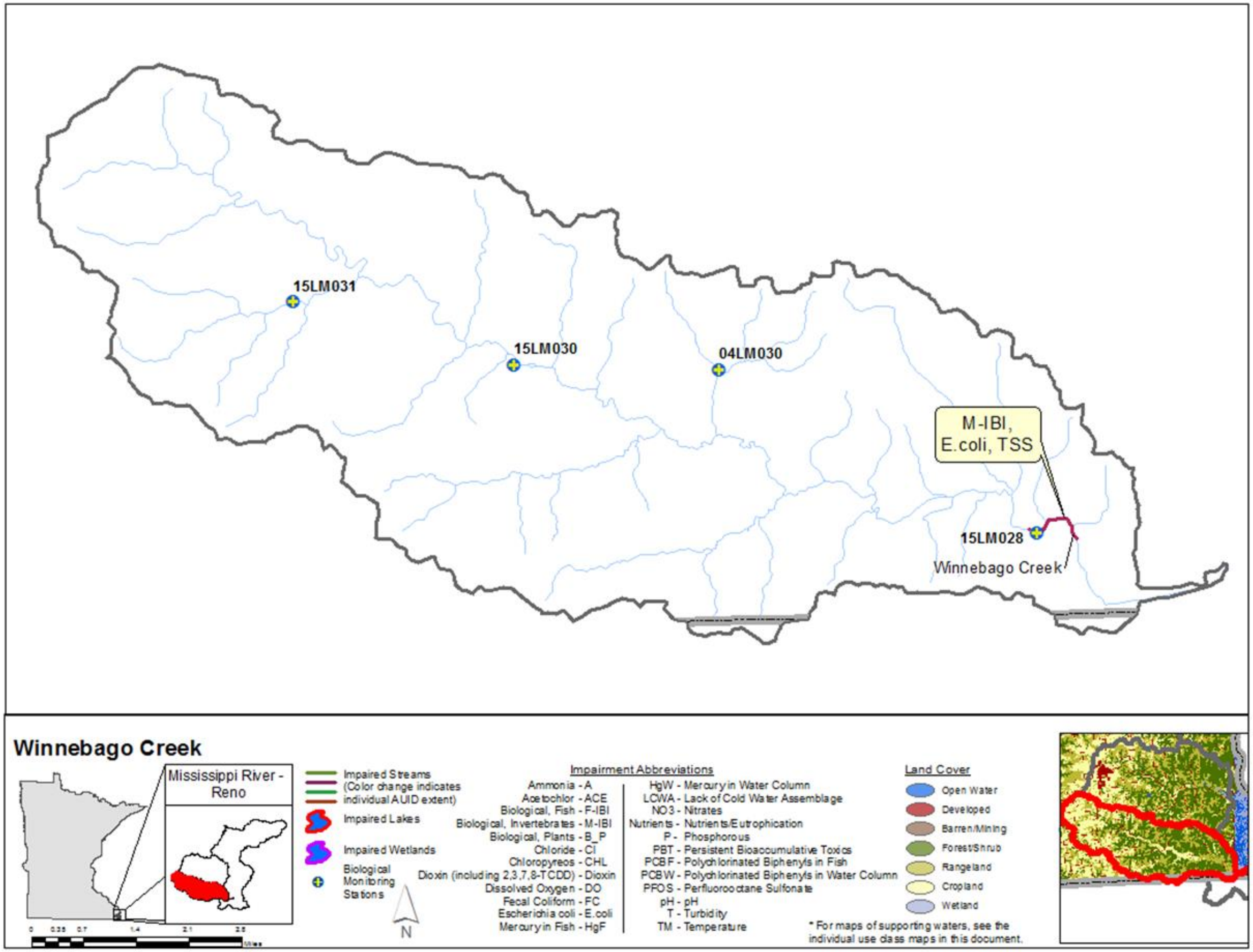
The most upstream assessable reach on Winnebago Creek (-508) was sampled once for fish and macroinvertebrates in 2015 at one location, 15LM030. This section of Winnebago Creek is designated as coldwater and managed by the DNR as a trout fishery. Winnebago Creek is stocked for trout and has several fishing easements. During the fish sample over 600 slimy sculpin and over 250 brown trout were collected. Sculpin are an indicator of coldwater and a sensitive species. The fish IBI was above the general use threshold and above the exceptional use threshold. The macroinvertebrate score below the general use threshold, but within the confidence interval (CI). Despite the score being below the threshold numerous coldwater taxa were collected. Habitat was good and supported a healthy macroinvertebrate community. The macroinvertebrate score is still within the CI and is suggested for full support for aquatic life.

The most downstream reach on Winnebago Creek (-693) showed a significant departure from the uppermost reach in stream characteristics, and correspondingly, a macroinvertebrate community not supportive of the general use standard. In contrast, the fish sampled scored above the general use threshold. This lowermost assessable reach had much different habitat characteristics from the uppermost reaches, and consisted of primarily shifting sand substrates, with limited coarse substrate that are preferred by macroinvertebrates.

Water chemistry

Winnebago Creek (from its confluence with an unnamed creek east of Minnesota Highway 76 to just upstream of Houston County Rd 5) was meeting river eutrophication standards as the mean total phosphorus concentration over the assessment period was below the regional standard. All other chemical parameters on this reach were insufficient to assess for aquatic life use. The 0.92-mile reach just downstream was found to be meeting river eutrophication standards, but was deemed impaired due to elevated suspended sediment: TSS and S-tube data both are over aquatic life use standards. This reach of the Winnebago Creek also had high concentrations of *E. coli* over the assessment period in the months of June, July, and August indicating an aquatic recreation impairment. Other unnamed creeks with chemistry data lacked the sufficient number of samples to assess for aquatic life in this subwatershed.

Figure 29. Currently listed impaired waters by parameter and land use characteristics in the Winnebago Creek Aggregated 12-HUC.



Crooked Creek Aggregated 12-HUC HUC 0706000102-01

Located in Houston County, the Crooked Creek Watershed is located on the west side of the subwatershed. The town of Caledonia is located on the west side of the subwatershed. The North fork and South fork of Crooked Creek converge to join Crooked Creek, which flows east to the Mississippi River. Pleasant Valley Creek begins in the northern part of the subwatershed and flows south to join Crooked Creek. Clear Creek is another notable tributary, which is located at the very eastern region of the subwatershed.

Table 9. Aquatic life and recreation assessments on stream reaches: Crooked Creek Aggregated 12-HUC.

WID *Reach name,* *Reach Description*	Biological station ID	Reach length (miles)	Use class	Aquatic life indicators: Fish IBI	Invert IBI	Dissolved oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides	Eutrophication	Aquatic life	Aquatic rec. (Bacteria)
07060001-507 **Crooked Creek,** South Fork Crooked Creek to T102 R4W S28, east line	15LM027	5.92	CWg	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	SUP	--
07060001-518 **Unnamed creek,** Unnamed creek to Crooked Creek	10EM162	2.10	CWg	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	SUP	--
07060001-519 **Crooked Creek,** T102 R4W S27, west line to Bluff Slough	15LM037	2.80	WWg	MTS	EXS	IF	MTS	MTS	MTS	MTS	MTS	--	IF	IMP	IMP
07060001-520 **North Fork Crooked Creek,** T102 R5W S21, north line to Crooked Creek	15LM034 15LM035	2.75	CWg	MTS	MTS	IF	IF	IF	--	IF	MTS	--	IF	SUP	--
07060001-524 **Clear Creek,** T102 R4W S34, south line to Bluff Slough	15LM036	0.82	WWg	NA	EXS	IF	IF	IF	--	IF	IF	--	IF	IMP	--

07060001-574 **South Fork Crooked Creek,** T102 R5W S26, west line to Crooked Creek	15LM033	1.07	CWg	EXS	EXS	IF	IF	IF	--	IF	IF	--	IF	IMP	--

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

Summary

Biological assessment

Unnamed Creek (-518) was sampled once for fish and macroinvertebrates in 2010 as part of the EMAP project. This reach is coldwater. The fish score above the coldwater general use threshold but within the CI. Only two species of fish were collected: brown trout and brook stickleback. The brown trout support the existing coldwater designation, but the large number brook stickleback (a very tolerant species) could indicate the stream is stressed. The macroinvertebrate sample scored above the general use threshold and CI, and even above the exceptional use threshold. Despite having unstable banks, the bed was primarily coarse substrate with noted embeddedness; the macroinvertebrate community was dominated by coldwater obligate macroinvertebrates. Particularly Brachycentrus, which made up nearly half of the community. The reach is suggested full support for fish and macroinvertebrates.

Clear Creek (-524) was sampled for fish and macroinvertebrates once in 2015. The fish sample was not assessed due to proximity to the Mississippi River. The macroinvertebrate sample scored below the general use threshold. Both in-stream habitat, as well as riparian conditions were relatively poor – streambed was primarily sand and silt. The presence of a few coldwater taxa suggests the influence of springs on this station. This WID is being recommend non-support for aquatic life based on low macroinvertebrate scores.

One reach on North Fork Crooked Creek (-520) has two stations (15LM034, 15LM035) that were sampled in 2015 and 2016. This is a designated trout stream and managed by the DNR. There are several fishing easements along the stream for trout fishers. Station 15LM034 was sampled twice for fish and once for macroinvertebrates in 2015. All samples for both assemblages scored above the general use threshold and upper CI. All three trout species found in southeast Minnesota were collected, and coldwater obligate macroinvertebrate taxa were diverse and abundant. Station 15LM035 was sampled for fish twice in 2015 and once in 2016, and once in each year for macroinvertebrates. The three fish samples scored above the general use threshold, but one was within the CI. All samples from 15LM035 were dominated by brown trout. During the second sample from 2015, all three trout species were collected. Brook trout are more sensitive to temperature changes and their presence often indicates a healthy coldwater stream. Both macroinvertebrate samples scored just below the impairment threshold, despite the presence of coldwater obligates. Temperatures in both reaches were consistent with coldwater systems. Considering all of the data, this reach is recommended full support for fish and macroinvertebrates.

South Fork Crooked Creek (-574) was sampled for fish and macroinvertebrates twice at one station (15LM033), once in 2015 and once in 2016. This reach is designated as coldwater and is accessible for fishing through easements. Upstream from the sample location there is an impoundment on the stream, which forms a warm water lake. The lake is stocked by DNR with warm water fish species, including largemouth bass, channel catfish and bluegill. Where the impoundment occurs the stream designation change from coldwater to warm water. Water released from the impoundment warms the downstream reaches to temperatures that are marginal for coldwater designation. During this assessment, it was decided that the assessable reach with station 15LM033 would remain designated as coldwater, despite marginal water temperatures and fish assemblage. Before the installation of the impoundment it is likely the stream had colder water. There are several small tributaries flowing into South Fork Crooked Creek between the confluence with North Fork Crooked Creek and the impoundment. These tributaries should be investigated as a source of refuge for coldwater fish and macroinvertebrates that cannot survive the warm temperatures found in the reach. It is likely fish are using Crooked Creek when water temperatures become too high to survive in this section of South Fork Crooked Creek. The fish and macroinvertebrates IBIs from 2015 were both below their respective coldwater thresholds. Rainbow and brown trout were collected during this sample however, a number of white sucker and yellow bullhead were found. Very low numbers of obligate coldwater macroinvertebrates were found. The fish and macroinvertebrates samples from 2016 both scored above their respective general use thresholds, but within the CI. Ten brown trout and a single brook trout were collected during this sample. It is possible the brook trout moved into the stream from the confluence directly downstream. White sucker and young of the year largemouth bass were the most abundant fish found during sampling. Based on the fish and macroinvertebrate IBIs scores this reach is recommended non-support for aquatic life. It is likely the upstream impoundment, which is considered warm water, is a stressor contributing to the degraded coldwater system.

The furthest upstream reach on Crooked Creek with assessable data (-507) was sampled once for fish in 2015 at station 15LM027. This reach is designated as coldwater and managed by the DNR as a trout fishery. There are several easements along the stream for angler access. This station might have some influence from the Mississippi River. Golden shiners, walleye, and common shiner were all collected during the sample. Brown trout and rainbow trout were both collected during sampling. The fish IBI score was above the general use threshold. Water temperatures were constant with coldwater systems. There were two macroinvertebrate visits on one station (15LM027), collected in 2015. One sample scored above the general use threshold above the upper CI, the other scored above the general use threshold, at the top of the CI. Despite poor bank and bed conditions, coldwater taxa were abundant (Brachycentrus, Gammarus, Tvetenia), which drove the high IBI scores. This assessment recommends full support for aquatic life.

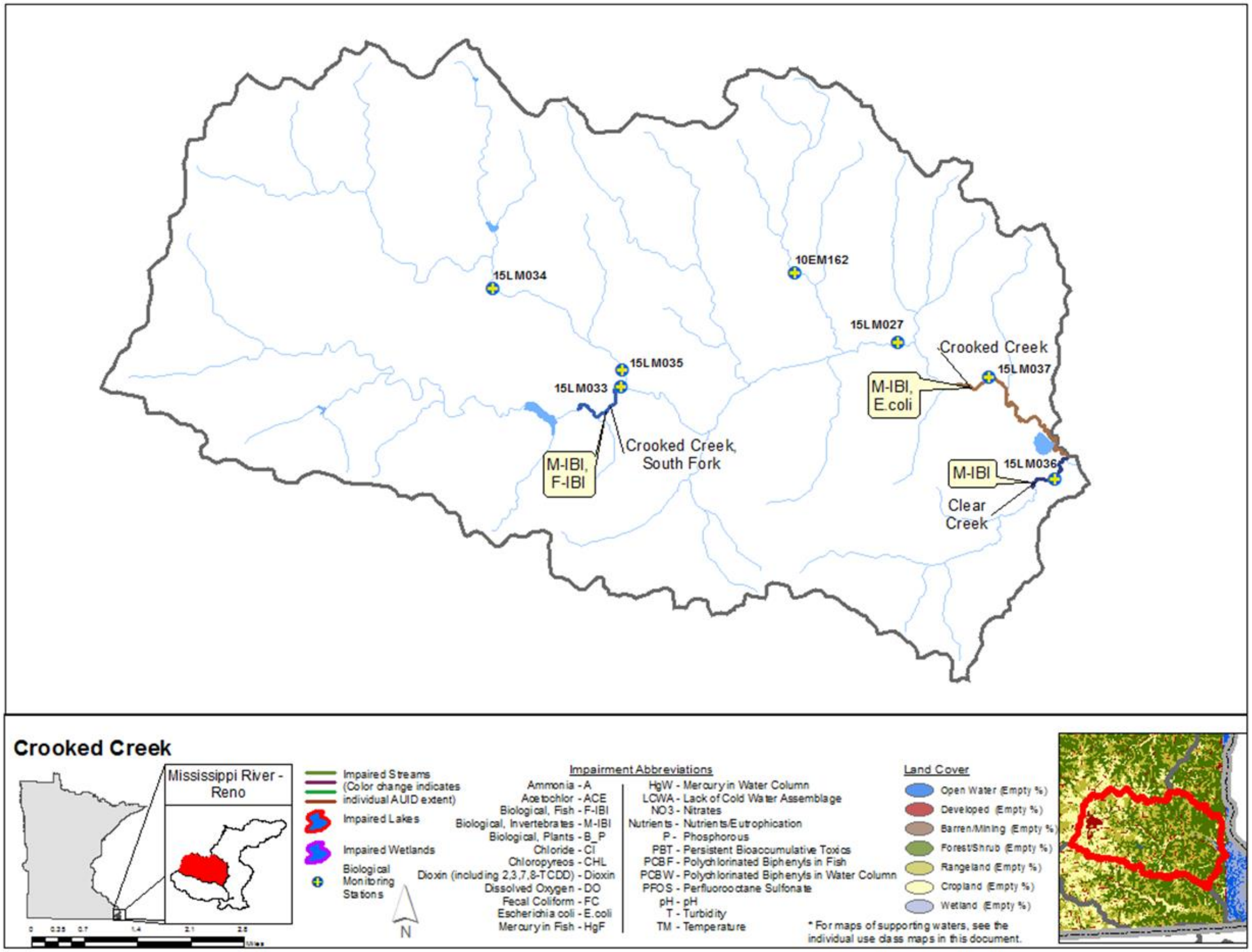
The downstream assessable reach on Crooked Creek (-519) was sampled at one station (15LM037) once for fish in 2015 and once in 2016. The reach was reviewed for changes from warm water to coldwater, but there was not enough evidence to make the change. Proximity to the Mississippi River is likely influencing the fish assemblage at this station, but not enough to impair it. A larger number of river species were collect here than in other streams including emerald shiner, mimic shiner, weed shiner, pumpkinseed, warmouth, and walleye. The fish sample from 2015 scored above the general use threshold and CI. The 2016 sample scored above the general use threshold but within the CI. Sand was the dominant substrate throughout the sample reach, with little change in depth or flow. The sample reach is in an active pasture where some bank erosion is present. Three macroinvertebrate samples were taken between 2015 and 2016. All scores were below the general use threshold. Samples had abundant coldwater obligate individuals, suggesting the possibility of a stream that is transitional between warm and coldwater. The reach is being listed as impaired for aquatic life based on the macroinvertebrate samples.

Water chemistry

The 2.8 mile reach of Crooked Creek that ends at Bluff Slough is meeting standards for aquatic life use for TSS, chloride, pH, and un-ionized ammonia. To note, a few TSS and Secchi tube exceedances were observed, but the samples were taken during or immediately after a significant rainfall. Bacteria data taken over the summer months indicate elevated levels of *E. coli*, so the reach will be listed for aquatic recreation.

For the exception of pH data meeting standards on the North Fork of Crooked Creek, other branches of Crooked Creek, Clear Creek, and unnamed creek (just northeast of Freeburg) with chemistry samples taken were insufficient to assess for aquatic life.

Figure 30. Currently listed impaired waters by parameter and land use characteristics in the Crooked Creek Aggregated 12-HUC.



Mormon Creek-Mississippi River (Wildcat Creek) Aggregated 12-HUC HUC 0706000105-01

Located in Houston County this subwatershed run the length of the eastern side of the major watershed. A section of the subwatershed is found in Wisconsin. The town of Brownsville is located in the northern region. Most of the streams are small tributaries the flow directly to the Mississippi River. Wildcate Creek flows from west to east and is one of the larger streams in the subwatershed.

Table 10. Aquatic life and recreation assessments on stream reaches: Mormon Creek-Mississippi River Aggregated 12-HUC.

WID ***Reach name, Reach description***	**Biological station ID**	**Reach length (miles)**	**Use class**	**Aquatic life indicators:** Fish IBI	Invert IBI	Dissolved oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides	Eutrophication	**Aquatic life**	**Aquatic rec. (Bacteria)**
07060001-516 **Wildcat Creek,** Unnamed creek to Mississippi River	15LM038	4.02	CWg	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	SUP	--

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

Summary

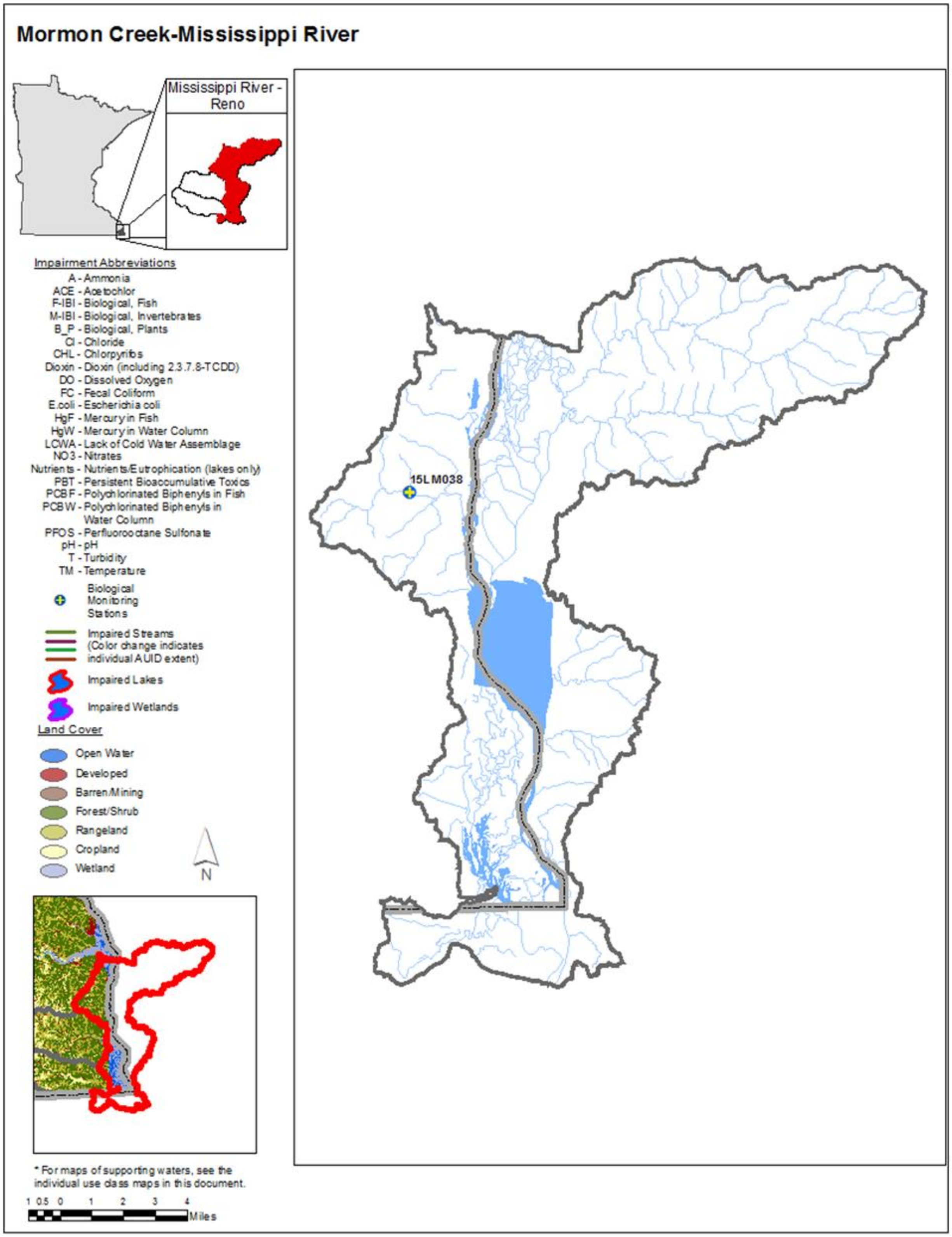
Biological assessment

Station 15LM038 on Wildcat Creek (-516) was sampled for fish and macroinvertebrates once in 2015 and once for fish in 2016. All IBI scores for both assemblages scored above the general use threshold, but not above the CI. The 2016 fish sample showed a higher score due to a much larger portion of the sample consisting of sensitive individuals 27% in 2015 vs 73% in 2016. The majority of sensitive individuals in 2016 were brown trout being the more dominant taxon in the 2016 sample. Brook trout were also collected during each sample, but in smaller numbers than brown trout. The stream is coldwater and managed by the DNR for trout. Water temperatures collected from the stream fell within the normal range for a coldwater system. In 2016 there was a large beaver dam roughly 5m upstream of the sampling reach. Beaver dams were seen in 2015, but were farther upstream. In fall of 2016, a large rain event led to high flows, which knocked out the beaver dam. Beaver dams are a stressor and can lead to impairment by limiting fish movement and raising water temperatures in coldwater streams. This stream reach is recommended full support for aquatic life for fish and macroinvertebrates.

Water chemistry

Chemistry data on Wildcat Creek was limited and as such there was insufficient information to assess chemical parameters for aquatic life.

Figure 31. Currently listed impaired waters by parameter and land use characteristics in the Mormon Creek-Mississippi River Aggregated 12-HUC.



Pine Creek Aggregated 12-HUC

HUC 0704000605-02

Located in the northeast part of Houston County and the southeast part Winona County, the Pine Creek subwatershed is located in the southern part of the major watershed. The town of La Crescent is located on the east side of the subwatershed, on the Mississippi River. Rose Valley Creek, Bobcat Creek, Burns Valley, and Lanes Valley are tributaries to Pine Creek. The watershed flows from west to east with several streams flowing directly into the Mississippi River. Pine Creek begins in the west side of the subwatershed flowing south and then east to the Mississippi River.

Table 11. Aquatic life and recreation assessments on stream reaches: Pine Creek Aggregated 12-HUC.

WID ***Reach name,*** *Reach description*	Biological station ID	Reach length (miles)	Use class	Aquatic life indicators: Fish IBI	Invert IBI	Dissolved oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides	Eutrophication	Aquatic life	Aquatic rec. (Bacteria)
07040006-507 **Pine Creek,** T105 R6W S13, north line to T105 R5W S32, south line	15LM041	5.79	CWg	MTS	MTS	IF	IF	IF	--	MTS	IF	--	IF	SUP	--
07040006-511 **Rose Valley Creek,** T105 R5W S22, north line to Pine Creek	04LM093	4.60	CWg	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	SUP	--
07040006-576 **Pine Creek,** T104 R5W S4, north line to Hwy 16	04LM034 04LM061 15LM039 15LM040 15LM043	13.14	CWg	EXS	MTS	IF	EXS	EXS	MTS	IF	MTS	--	IF	IMP	IMP

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

Summary

Biological assessment

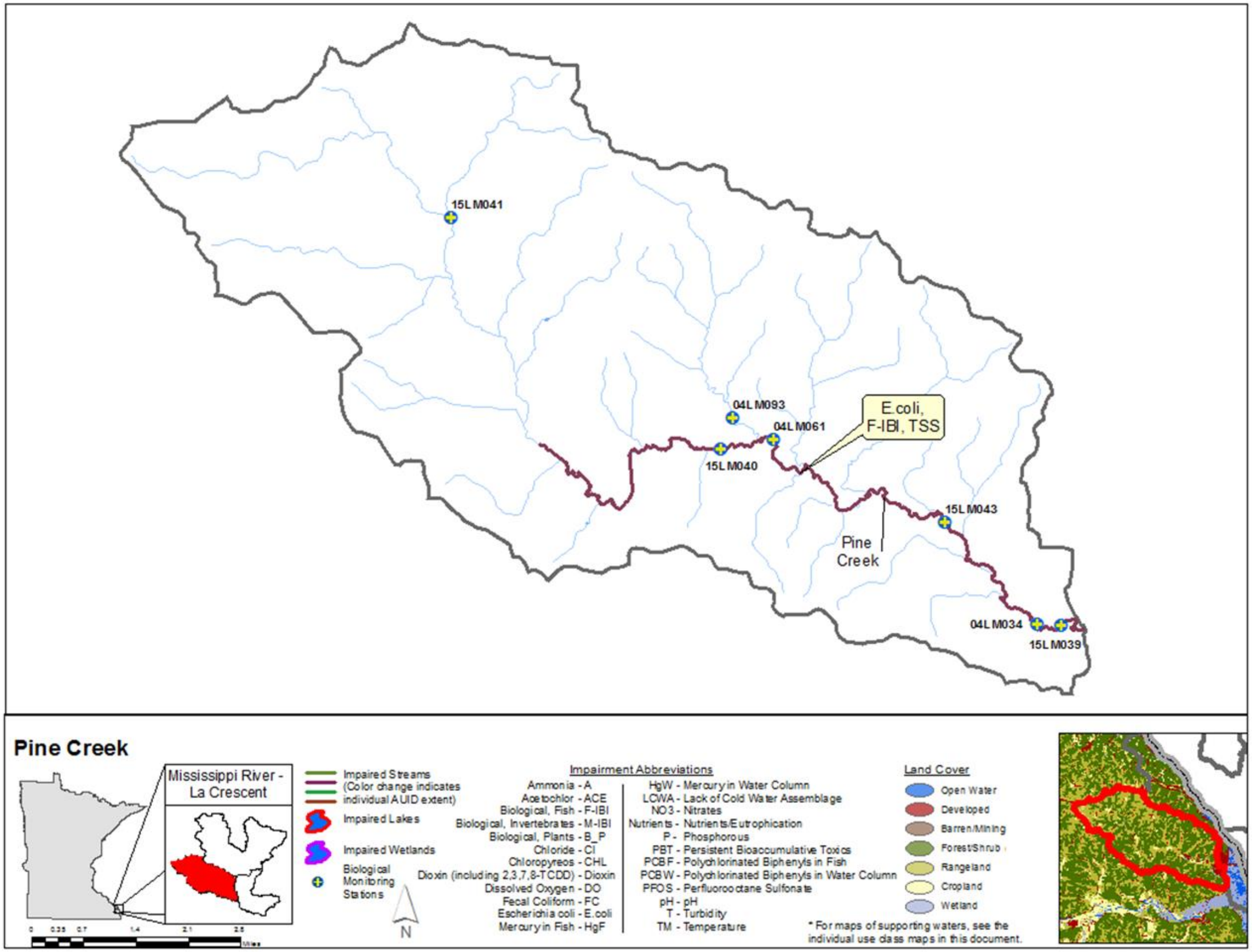
The uppermost reach on Pine Creek (-507), along with the tributary Rose Valley Creek (-511), both had very healthy macroinvertebrate and fish communities, with both stream reaches scored above the general use threshold for both assemblages. A historic record from Rose Valley Creek showed a non-supportive fish community, dominated by white suckers. The more recent fish sample shows positive change, with the community dominated by brown trout and brook trout.

The downstream reach on Pine Creek (-576) was previously designated as warm water. Fish, macroinvertebrate and water temperature data support a coldwater designation. The DNR have recognized that the stream supports coldwater species, but the reach was never changed to coldwater. Previously the coldwater designation ended at the county line. This downstream shows a significant change in stream characteristics from the upper part of the watershed, with the in-stream habitat dominated by sandy substrates, and riparian zones ranging from forested to pasture and row-crop. All of the stations sampled in this reach showed macroinvertebrate communities supporting of the coldwater general use. The fish communities showed a consistent non-supportive condition. The abundance and diversity of coldwater obligate macroinvertebrate taxa decreased throughout the lower reach, but were present in adequate numbers to show a supportive condition. While the presence of coldwater fish species was also reduced in this reach, they were present throughout, even at the lowermost station. The three lower stations show a significant increase in suspended sediments, which was evident in samples collected in both 2004 and 2015. The lowermost station (15LM039) was not assessed for fish due to its proximity to the Mississippi River. The reach is being listed as impaired for aquatic life based on the fish assemblage.

Water chemistry

Pine Creek from the Winona-Houston County line to Minnesota Highway 16 was meeting aquatic life use standards for chloride and un-ionized ammonia. TSS and Secchi tube data both greatly exceeded the 10% exceedance threshold, suggesting the reach should be listed for TSS. Bacteria was elevated over the summer months during the assessment period, suggesting a new aquatic recreation impairment. Pine Creek upstream of the Winona-Houston County line was meeting aquatic life standards for pH, but all other chemical parameters were limited. Rose Valley Creek had an insufficient number of samples to assess for aquatic life use.

Figure 32. Currently listed impaired waters by parameter and land use characteristics in the Pine Creek Aggregated 12-HUC.



Halfway Creek-Mississippi River Aggregated 12-HUC — HUC 0704000601-01

Located in southeast Winona County this subwatershed is the most northern in the major watershed. A large portion of it is located in Wisconsin. There are no towns in the subwatershed in Minnesota. Flow in the watershed is generally west to east, ultimately flowing into the Mississippi River. Dakota Creek is the largest stream; beginning in the southeast region of the subwatershed and flowing east to the Mississippi River.

Table 12. Aquatic life and recreation assessments on stream reaches: Halfway Creek-Mississippi River Aggregated 12-HUC.

WID ***Reach name,*** *Reach description*	Biological station ID	Reach length (miles)	Use class	Aquatic life indicators: Fish IBI	Invert IBI	Dissolved oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides	Eutrophication	Aquatic life	Aquatic rec. (Bacteria)
07040006-512 **Dakota Creek,** T105 R5W S3, south line to Mississippi River	15LM042	4.26	CWg	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	SUP	--
07040003-594 **Miller Valley Creek,** T106 R5W S28, south line to Mississippi River	--	1.82	CWg	--	--	--	--	IF	--	--	--	--	--	IF	--

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

Summary

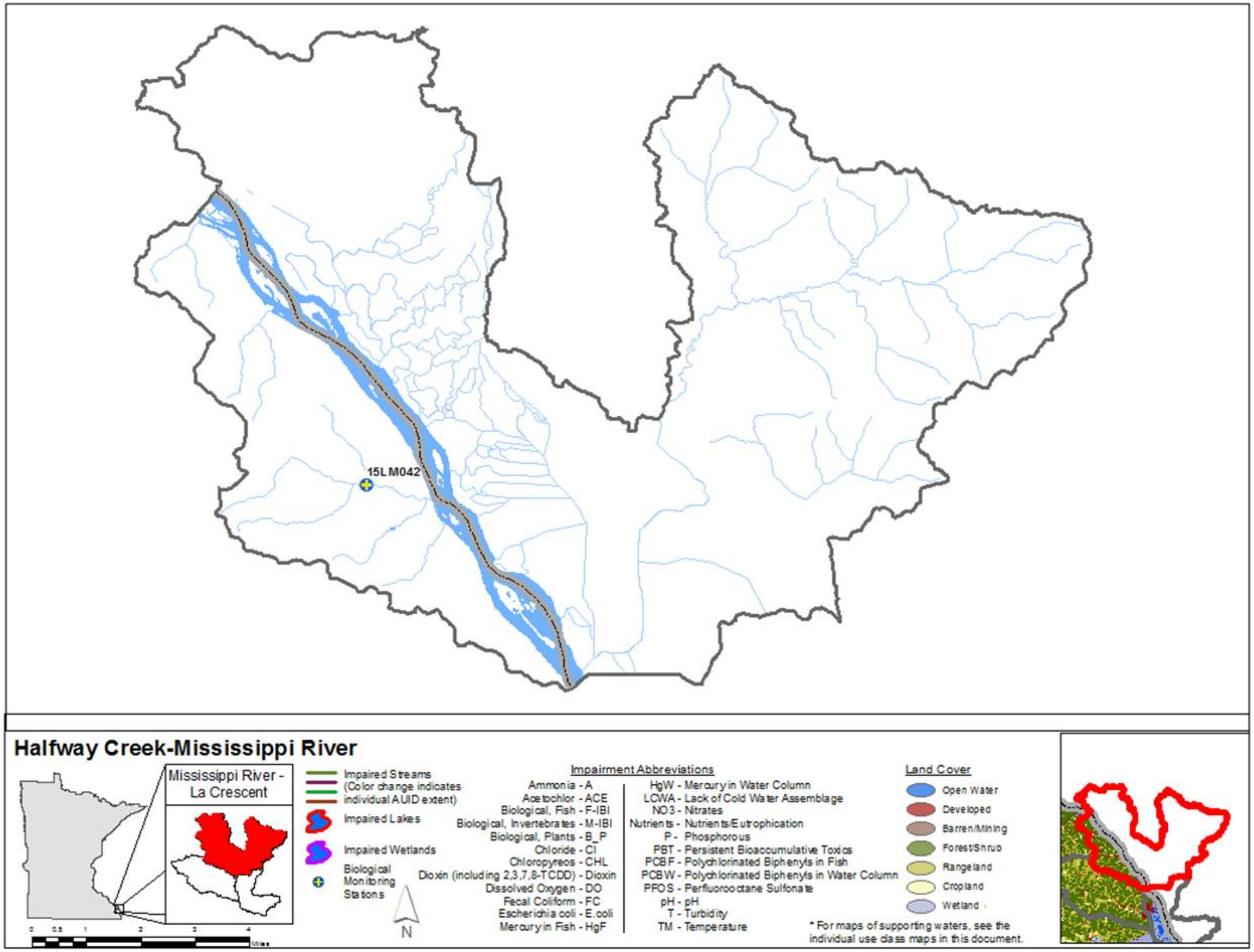
Biological assessment

Dakota Creek (-512), was sampled for macroinvertebrates in 2015 and fish in 2016. It was the only stream sampled for biology in this watershed and showed very healthy fish and macroinvertebrate communities. The stream is designated as coldwater, and both temperature and biological data support this. Both assemblages scored above the general use threshold, and upper CI. Despite being in a pasture, this site had excellent in-stream habitat, and a healthy riparian zone. Coldwater obligate macroinvertebrate taxa were diverse and abundant, and brook trout were the most abundant fish species sampled. There was a large beaver dam downstream of the station, which might limit fish movement, but the sample collected shows a healthy coldwater community. Both brook and brown trout were collected during sampling. Nearly half the brook trout collected were young of the year; indicated natural reproduction and a healthy trout fishery. This reach is fully supporting for aquatic life for biology.

Water chemistry

Chemistry data was limited on Dakota and Miller Valley Creeks over the assessment period – insufficient information to assess for aquatic life use.

Figure 33. Currently listed impaired waters by parameter and land use characteristics in the Halfway Creek-Mississippi River Aggregated 12-HUC.



Watershed-wide results and discussion

Assessment results and data summaries are included below for the entire HUC-8 watershed unit of the Upper Iowa River, Mississippi-Reno, Mississippi-La Crescent watersheds grouped by sample type. Summaries are provided for lakes, streams, and rivers in the watershed for the following: aquatic life and recreation uses, aquatic consumption results, load monitoring data results, transparency trends, and remote sensed lake transparency. Waters identified as priorities for protection or restoration work were also identified. Additionally, groundwater and wetland monitoring results 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 Upper Iowa River, Mississippi-Reno, Mississippi-La Crescent watersheds.

Stream water quality

Forty-one of the 313 stream WIDs were assessed (Table 13) Of the assessed streams, only 15 streams were considered to be fully supporting of aquatic life and no streams were fully supporting of aquatic recreation. Two WIDs were classified as limited resource waters and assessed accordingly.

Throughout the watersheds, 15 WIDs are non-supporting for aquatic life and/or recreation. Of those WIDs, 13 are non-supporting for aquatic life and 8 are non-supporting for aquatic recreation.

Table 13. Assessment summary for stream water quality in the Upper Iowa River, Mississippi-Reno, Mississippi-La Crescent watersheds.

				Supporting		Non-supporting				
Watershed	Area (acres)	# Total WIDs	# Assessed WIDs	# Aquatic life	# Aquatic recreation	# Aquatic life	# Aquatic recreation	Insufficient data	# Delistings	# Assessed LRV Water
07060001 07060002 07040006	**466926**	**313**	**41**	**15**	**0**	**13**	**8**	**8, 3 NA**	**0**	**2**
0706000201-01	150285	22	17	4	0	5	4	8	0	0
0706000202-01	57988	12	5	1	0	1	0	2 (NA)	0	1
0706000205-01	52650	14	3	1	0	1	1	0	0	1
0706000104-01	39610	76	4	2	0	1	1	1 (NA)	0	0
0706000102-01	44516	73	6	3	0	3	1	0	0	0
0706000105-01	59266	29	1	1	0	0	0	0	0	0
0704000605-02	37403	49	3	2	0	1	1	0	0	0
0704000601-01	25208	38	2	1	0	0	0	1	0	0

Lake water quality

Louise Mill Pond is the only basin within these watersheds. No assessment was made as the residence time is too short for the standards to apply; however, concentrations of nutrients and algae were low.

Table 14. Assessment summary for lake water chemistry in the Upper Iowa River, Mississippi-Reno, and Mississippi La Crescent Watersheds.

			Supporting		Non-supporting			
Watershed	Area (acres)	Lakes >10 acres	# Aquatic life	# Aquatic recreation	# Aquatic life	# Aquatic recreation	Insufficient data	# Delistings
07060001 07060002 07040006	**466926**	0	0	0	0	0	1 (NA)	0
0706000201-01	150285	0	0	0	0	0	1 (NA)	0

Fish contaminant results

Mercury and polychlorinated biphenyls (PCBs) were analyzed in fish tissue samples collected from the Upper Iowa River in 2015, by the MPCA biomonitoring staff. Samples had previously been collected by DNR fisheries staff in 2007. The only lake sampled for fish contaminants in the watershed was Louise Mill Pond (50-0001).

Fish collected from the Upper Iowa River in 2015—Golden redhorse and Smallmouth bass—were tested for mercury and PCBs. Mercury levels were below the threshold for listing as impaired (0.2 mg/kg) and the PCBs were less than the 0.025 mg/kg reporting limit (Table 15). Louise Mill Pond samples were collected in 1987. The concentrations of mercury in common carp and northern pike were low, except for a composite sample of two carp, which had a mercury concentration of 0.45 mg/kg. This two-fish composite does not meet the five fish minimum for impairment assessment; therefore, Louise Mill Pond was not listed as impaired for mercury.

Table 15. Fish contaminants: summary of fish length, mercury and PCBs by waterway-species-year

HUC8	WID / RIVER	Waterway / Location	Species	Year	Anatomy[1]	Total Fish	Number Samples	Length (in) Mean	Length (in) Min	Length (in) Max	Mercury (mg/kg) Mean	Mercury (mg/kg) Min	Mercury (mg/kg) Max	PCBs (mg/kg) N	PCBs (mg/kg) Mean	PCBs (mg/kg) Max	PCBs (mg/kg) < RL
07060002	UPPER IOWA R.	HWY 56/MAIN ST, 0.5 MILE OF LEROY	Golden redhorse	2015	FILSK	5	5	13.1	10.9	15.8	0.115	0.051	0.182	2	0.025	0.025	Y
			Smallmouth bass	2015	FILSK	5	5	9.5	7.9	11.0	0.145	0.093	0.188	2	0.025	0.025	Y
		UNNAMED GRAVEL PIT 1 MI NW OF LE ROY	Black crappie	2007	FILSK	4	2	11.8	10.4	13.3	0.482	0.343	0.620				
			Bluegill sunfish	2007	FILSK	2	1	6.6	6.6	6.6	0.134	0.134	0.134				
07060002	50000100	LOUISE MILL POND	Common Carp	1987	FILSK	5	2	24.4	20.0	28.8	0.320	0.190	0.450	2	0.05	0.05	Y
			Largemouth bass	1987	FILSK	5	1	14.3	14.3	14.3	0.200	0.200	0.200	1	0.05	0.05	Y

1 Anatomy codes: FILSK – edible fillet, skin-on.

Pollutant load monitoring

Due to the small proportion of total watershed drainage area contained within Minnesota, the Upper Iowa, Mississippi River-Reno, Mississippi River-La Crescent watersheds are not monitored by the WPLMN. However, neighboring watersheds of similar land cover and land use should have water quality characteristics not unlike those of the ungaged watersheds.

Average annual FWMCs of TSS, TP, and NO_3+NO_2-N by major watershed are presented below, with the Upper Wapsipinicon, Upper Iowa and Winnebago watersheds highlighted. Water runoff, a significant factor in pollutant loading, is also shown. Water runoff is the portion of annual precipitation that makes it to a river or stream and can be expressed in inches.

As a general rule, elevated levels of TSS and NO_3+NO_2-N are regarded as “non-point” source derived pollutants originating from many small diffuse sources such as urban or agricultural runoff. Excess TP can be attributed to both non-point as well as point sources such as industrial or wastewater treatment plants. Major “non-point” sources of phosphorus include dissolved phosphorus from fertilizers and phosphorus adsorbed to and transported with sediment during runoff.

Excessive TSS, TP, and NO_3+NO_2-N in surface waters impacts fish and other aquatic life, as well as fishing, swimming and other recreational uses. High levels of NO_3+NO_2-N is a concern for drinking water.

When compared with watersheds throughout the state Figure 34 , Figure 35, Figure 36 and Figure 37 show average annual TSS, TP, and NO_3+NO_2-N FWMCs to be several times higher for southeastern watersheds than those of north central and northeast Minnesota but in line with the agriculturally rich watersheds found in the northwest and southern regions of the state.

More information, including results for subwatershed stations, can be found at the WPLMN website.

Substantial year-to-year variability in water quality occurs for most rivers and streams, these rivers are no exception and pollutant concentrations often follow closely to water runoff and river discharge.

Figure 34. 2007-2015 Average annual NO3+NO2-N FWMCs flow weighted mean concentrations by major watershed.

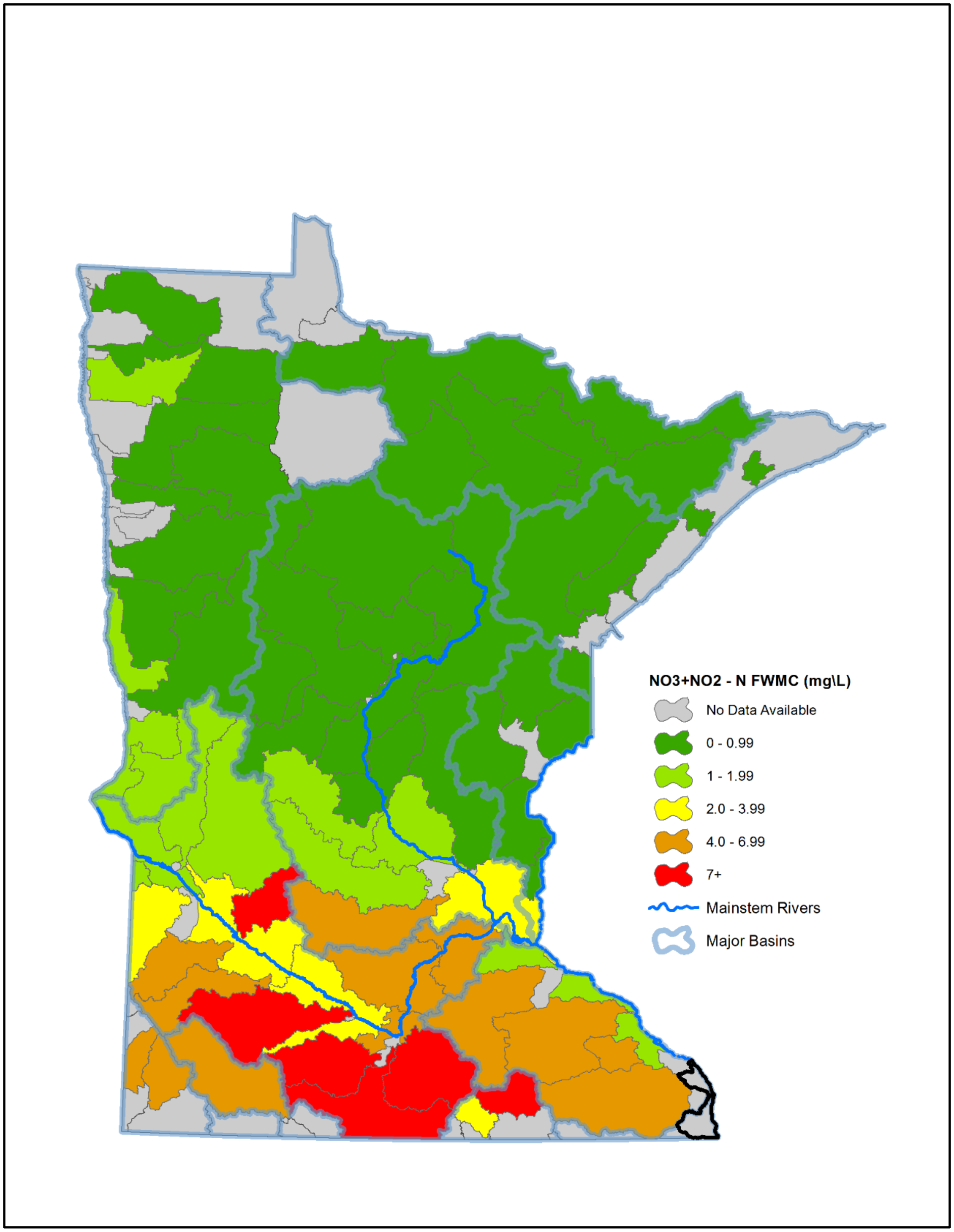


Figure 35. 2007-2015 Average annual TP flow weighted mean concentrations by major watershed

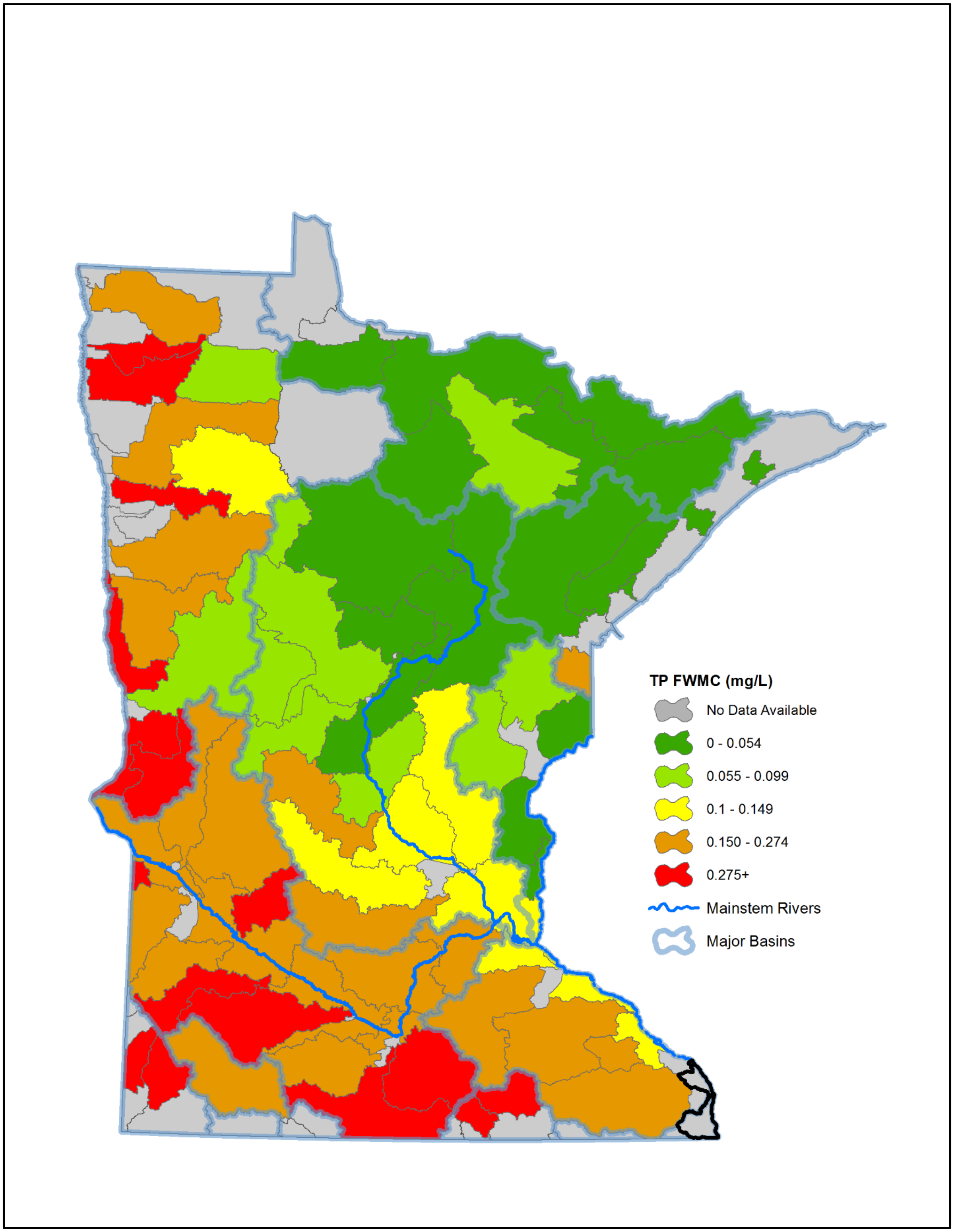


Figure 36. 2007-2015 Average annual TP flow weighted mean concentrations by major watershed

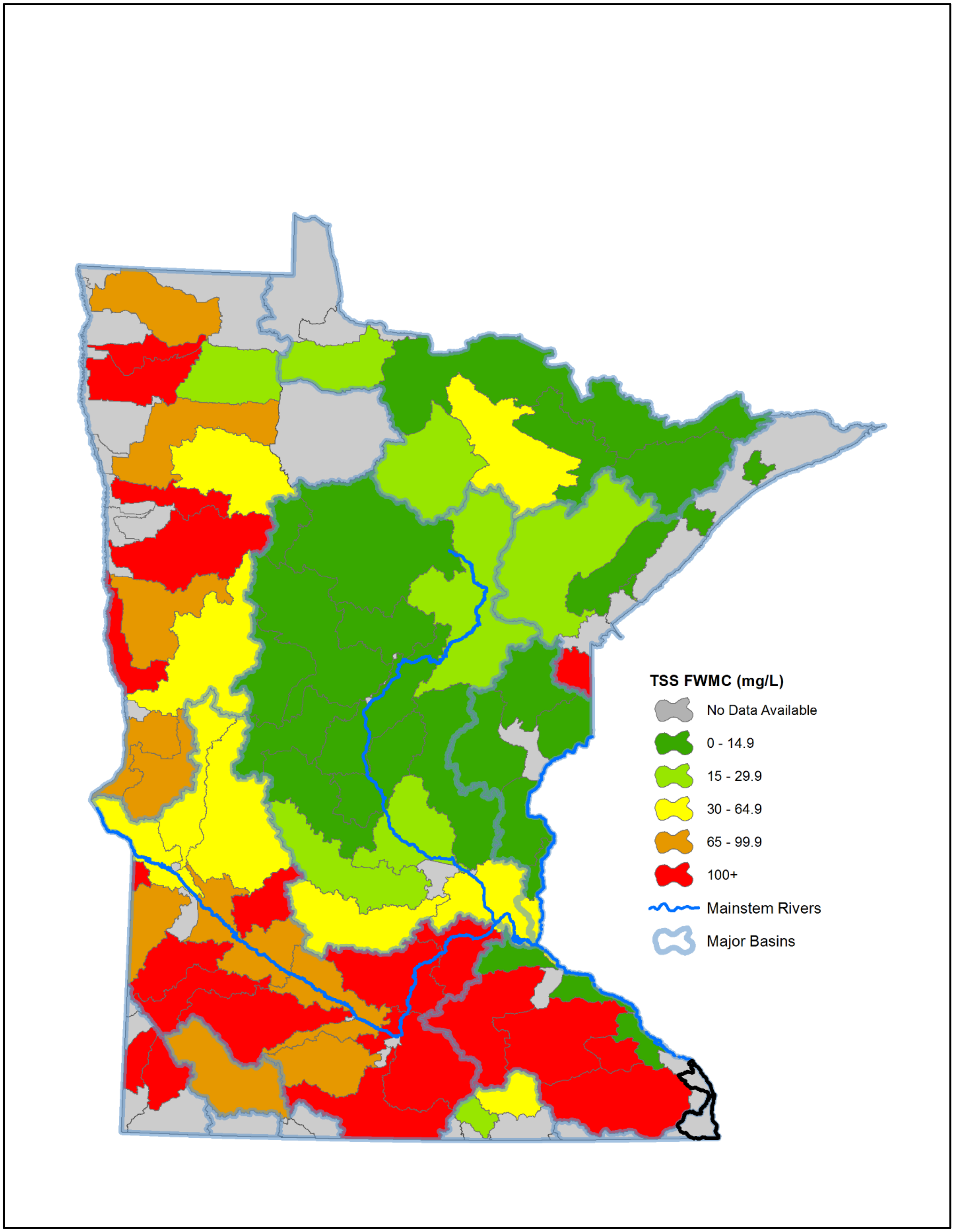
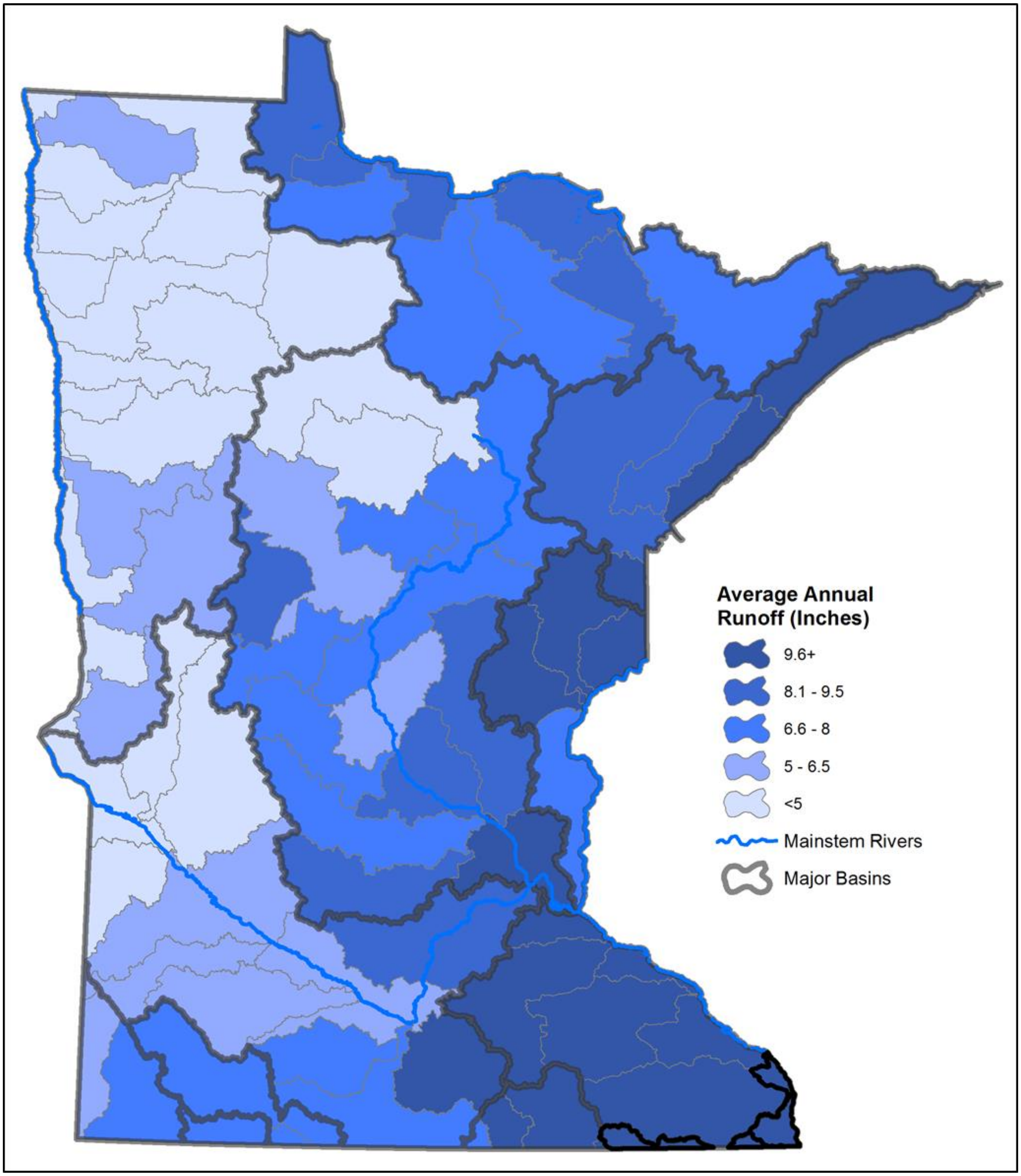


Figure 37. 2007-2015 Average annual runoff by major watershed.



Groundwater monitoring

Groundwater quality

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

There no MPCA Ambient Groundwater Monitoring wells within the watersheds. However, from 1992 to 1996, the Minnesota Pollution Control Agency conducted baseline water quality sampling and analysis of Minnesota's principal aquifers. The Mississippi River-Reno, Mississippi River-La Crescent and Upper Iowa watersheds lay entirely within the southeast region, where groundwater quality is considered good when compared to other areas with similar aquifers, but with, due to the geology, some high concentrations of trace elements like cadmium, lead and arsenic (MPCA, 1999). Concentrations of chemicals within the Precambrian aquifers were comparable to similar aquifers throughout the state and concentrations of major cations and anions were lower in the surficial and buried drift aquifers when compared to similar aquifers statewide (MPCA, 1999).

Another source of information on groundwater quality comes from the Minnesota Department of Health (MDH). Mandatory testing for arsenic, a naturally occurring but potentially harmful contaminant for humans, of all newly constructed wells has found that 10.7% of all wells installed from 2008 to 2016 have arsenic levels above the maximum contaminant level (MCL) for drinking water of 10 micrograms per liter. All three watersheds in this report include portions of Houston County where no new wells were identified with concentrations exceeding the MCL and only 5.4% exceeded 2 ug/L. The Mississippi River-La Crescent Watershed also includes Winona County, where, again, no new wells exceeded the MCL. The Upper Iowa River Watershed in Minnesota includes portions of Southern Fillmore and Mower County where 0.5% and 3.4%, respectively, had concentrations exceeding the MCL. (MDH, 2018a)

Stream flow

There are no DNR or USGS gages monitoring continuous flow in the Minnesota portions the Mississippi River-Reno, Mississippi River-La Crescent and Upper Iowa watersheds

Wetland condition

The combined Mississippi River Reno and Mississippi River La Crescent watershed occurs entirely within the Mixed Wood Plains Ecoregion. Wetland condition, in this ecoregion is mostly rated as fair to poor (Table 16). Based on plant community floristic quality, 42% of the wetlands in the Mixed Wood Plains Ecoregion were estimated to be in fair condition and an estimated 40% were in poor condition, while 6% were estimated to be exceptional condition.

The Upper Iowa River watershed is split across two ecoregions. To the east, the Lower Upper Iowa River, Cold Water Creek, and Bear Creek subwatersheds are in the Mixed Wood Plains Ecoregion. Whereas the Headwaters of Upper Iowa River subwatershed is located in the Temperate Prairies Ecoregion.

Wetland condition in the Mixed Wood Plains Ecoregion is similar to wetland condition in the Temperate Prairies Ecoregion. In both of these ecoregions significant extents of wetland area are dominated by invasive plants, particularly narrow-leaf cattail (Typha angustifolia), hybrid cattail (Typha X glauca), and reed canary grass (Phalaris arundinacea). These invasive plants often outcompete native species due to their tolerance of nutrient enrichment, hydrologic alterations and toxic pollutants such as chlorides (Galatowisch, 2012) and thus strongly influence the composition and structure of the wetland plant community. Restoring wetlands in these two watersheds will increase the amount of water retained on the landscape and contribute to improved water quality within lakes streams as well as in the remaining wetlands in these watersheds.

Table 16. Wetland biological condition by major ecoregions based on floristic quality. Results are expressed as an extent (i.e., percentage of wetland acres) and include essentially all wetland types (MPCA, 2015).

Vegetation Condition in All Wetlands

Condition Category	**Mixed Wood Shield**	**Mixed Wood Plains**	**Temperate Prairies**
Exceptional	64%	6%	7%
Good	20%	12%	11%
Fair	16%	42%	40%
Poor		40%	42%

Figure 38. Stream Tiered Aquatic Life Use Designations in the Upper Iowa River watershed.

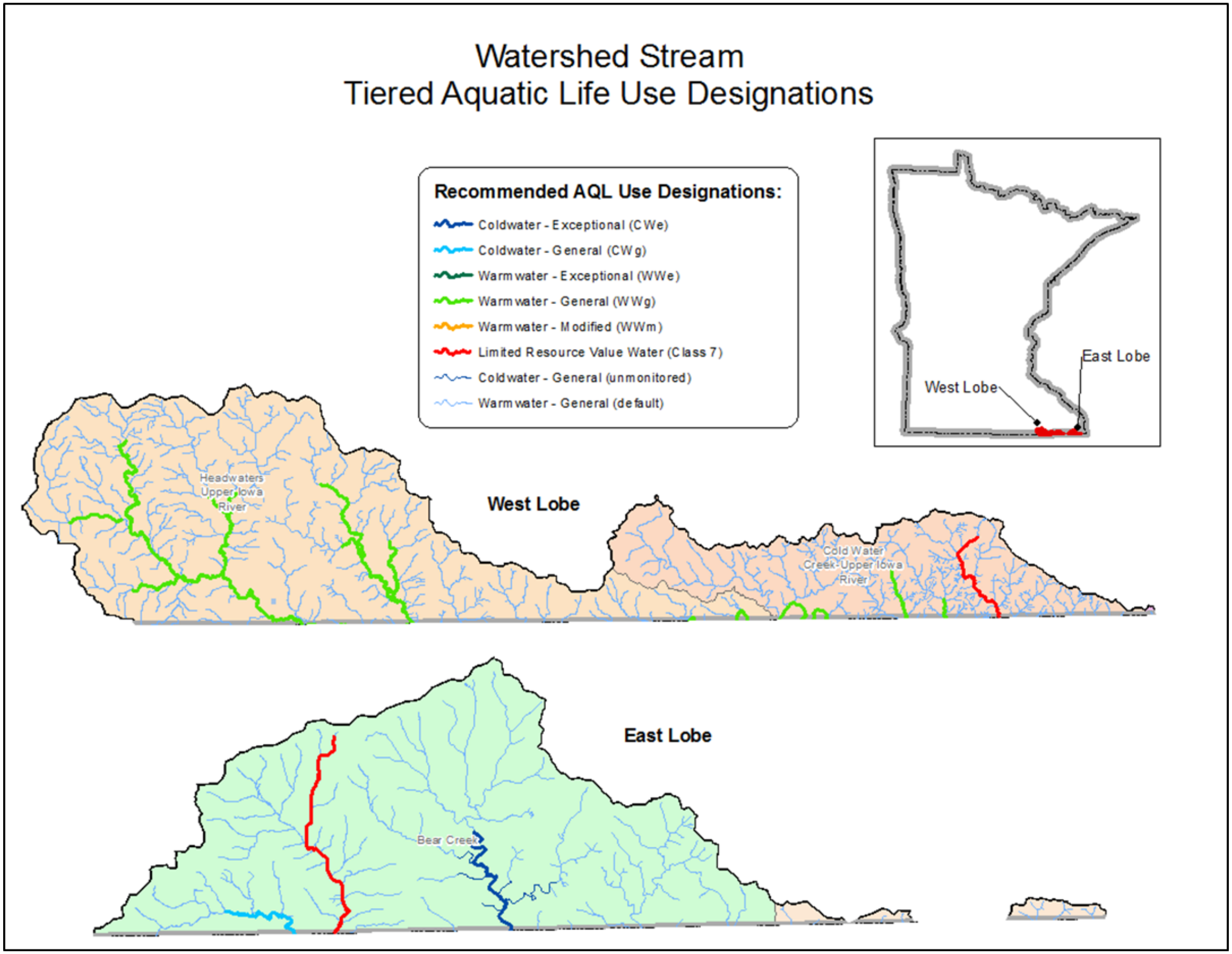


Figure 39. Stream Tiered Aquatic Life Use Designations in the Mississippi River-Reno watershed.

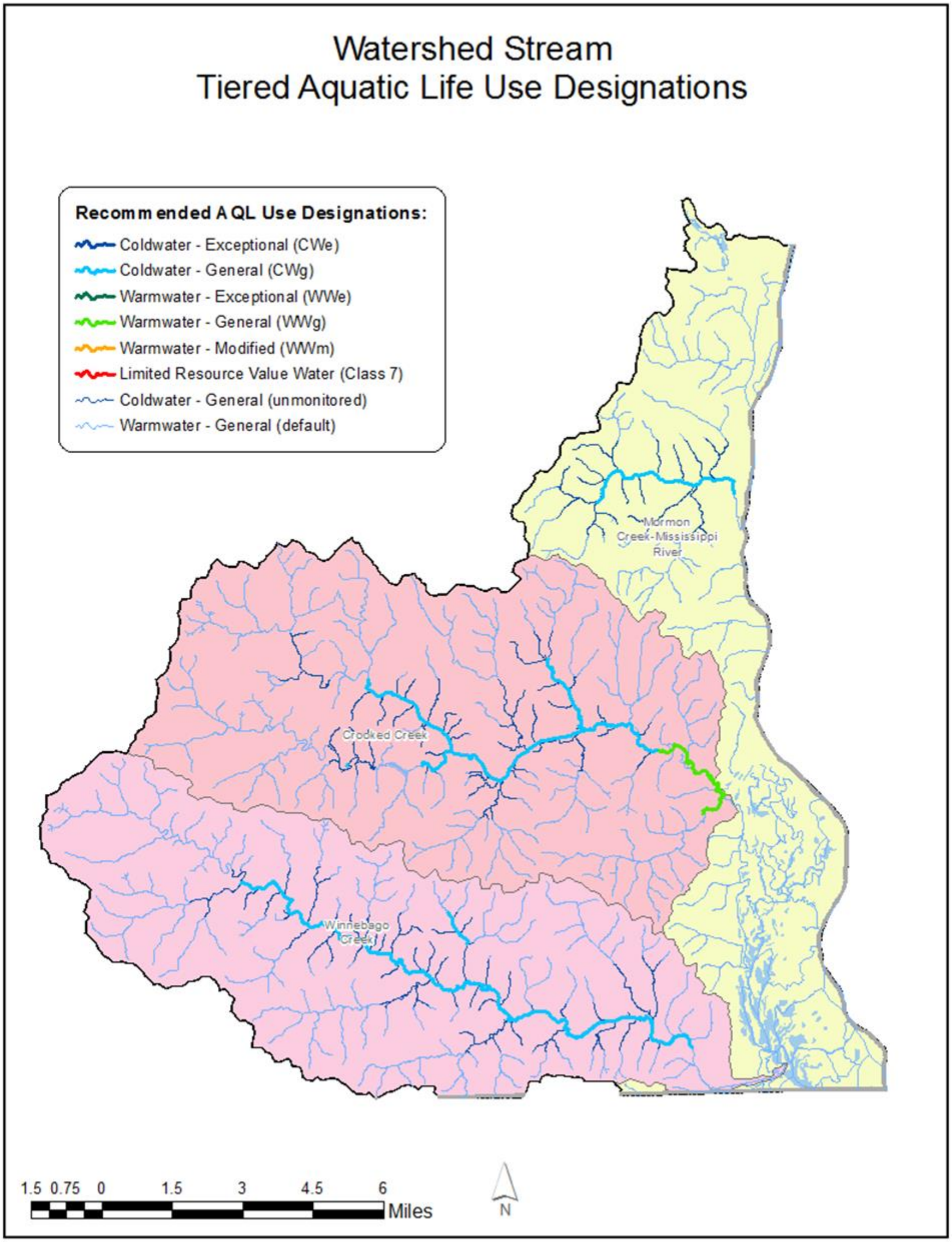


Figure 40. Stream Tiered Aquatic Life Use Designations in the Mississippi River-La Crescent watershed.

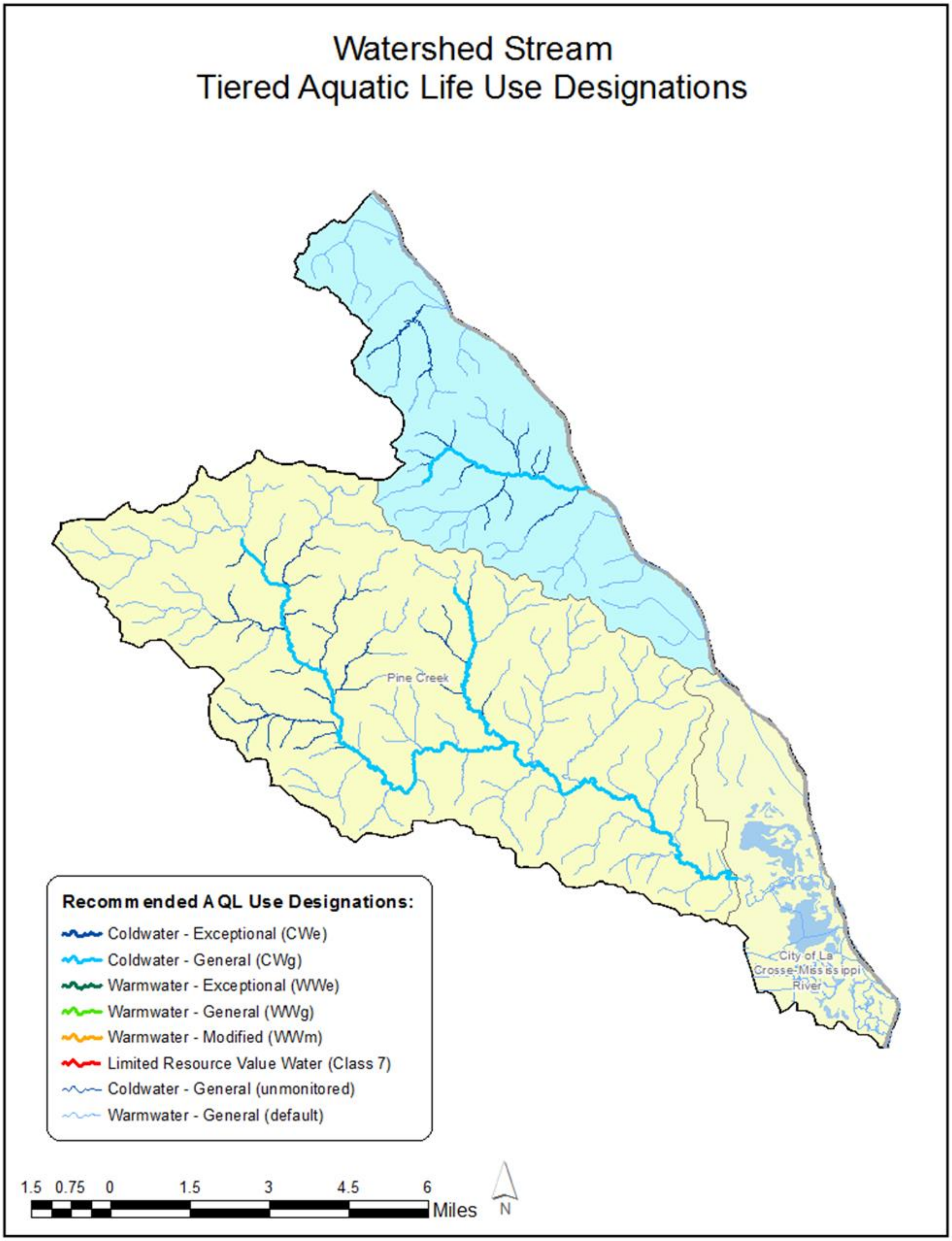


Figure 41. Fully supporting waters by designated use in the Upper Iowa River watershed.

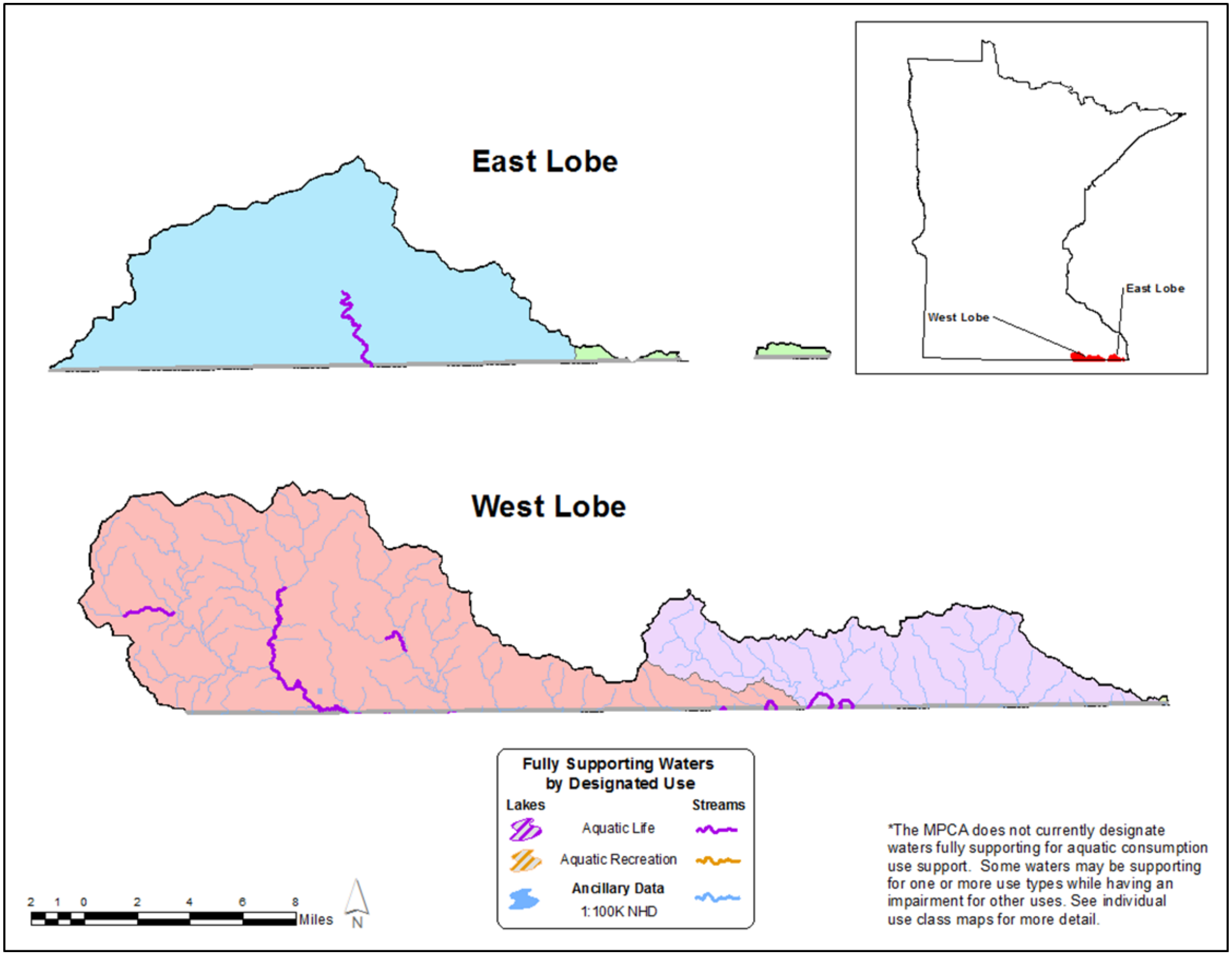


Figure 42. Fully supporting waters by designated use in the Mississippi River-Reno watershed.

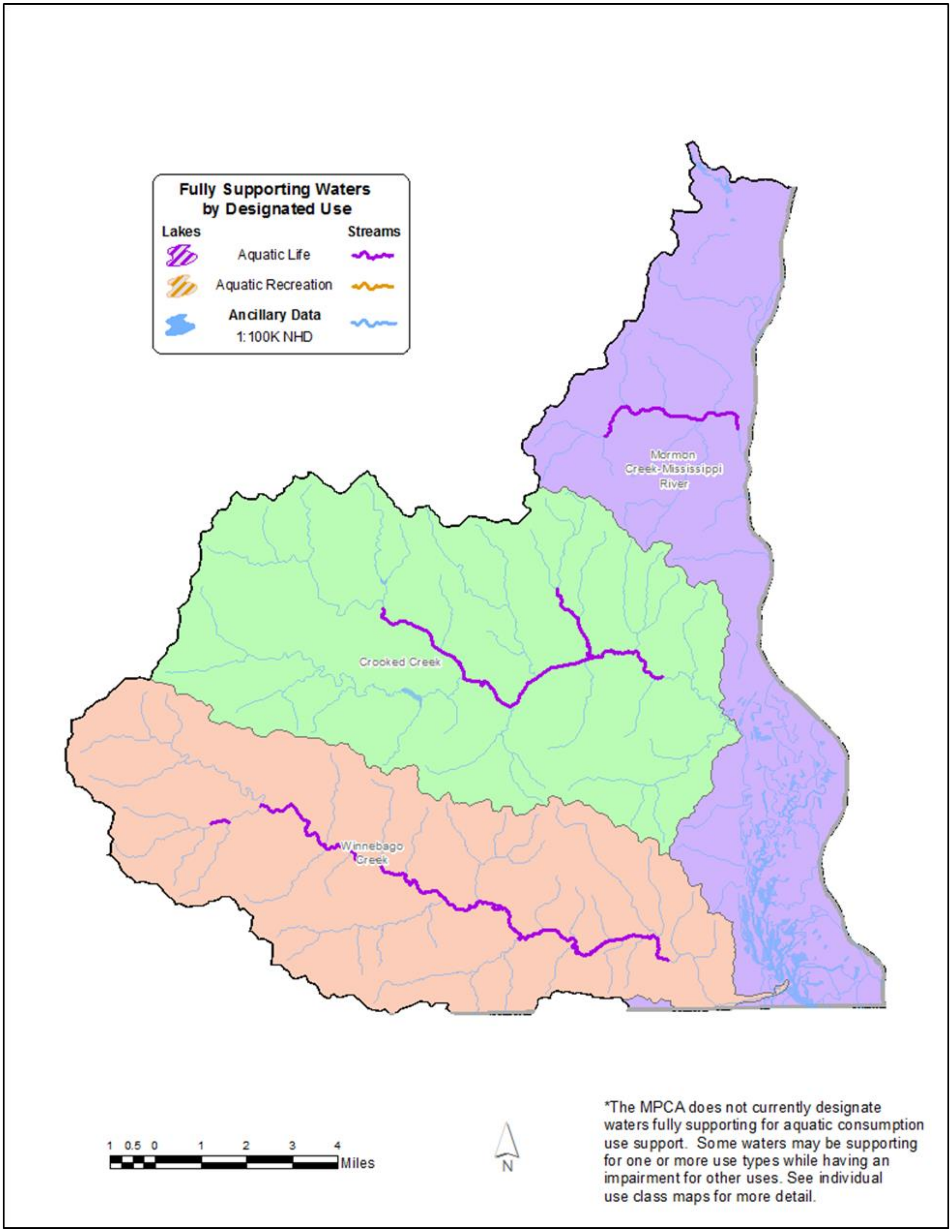


Figure 43. Fully supporting waters by designated use in the Mississippi River-La Crescent watershed.

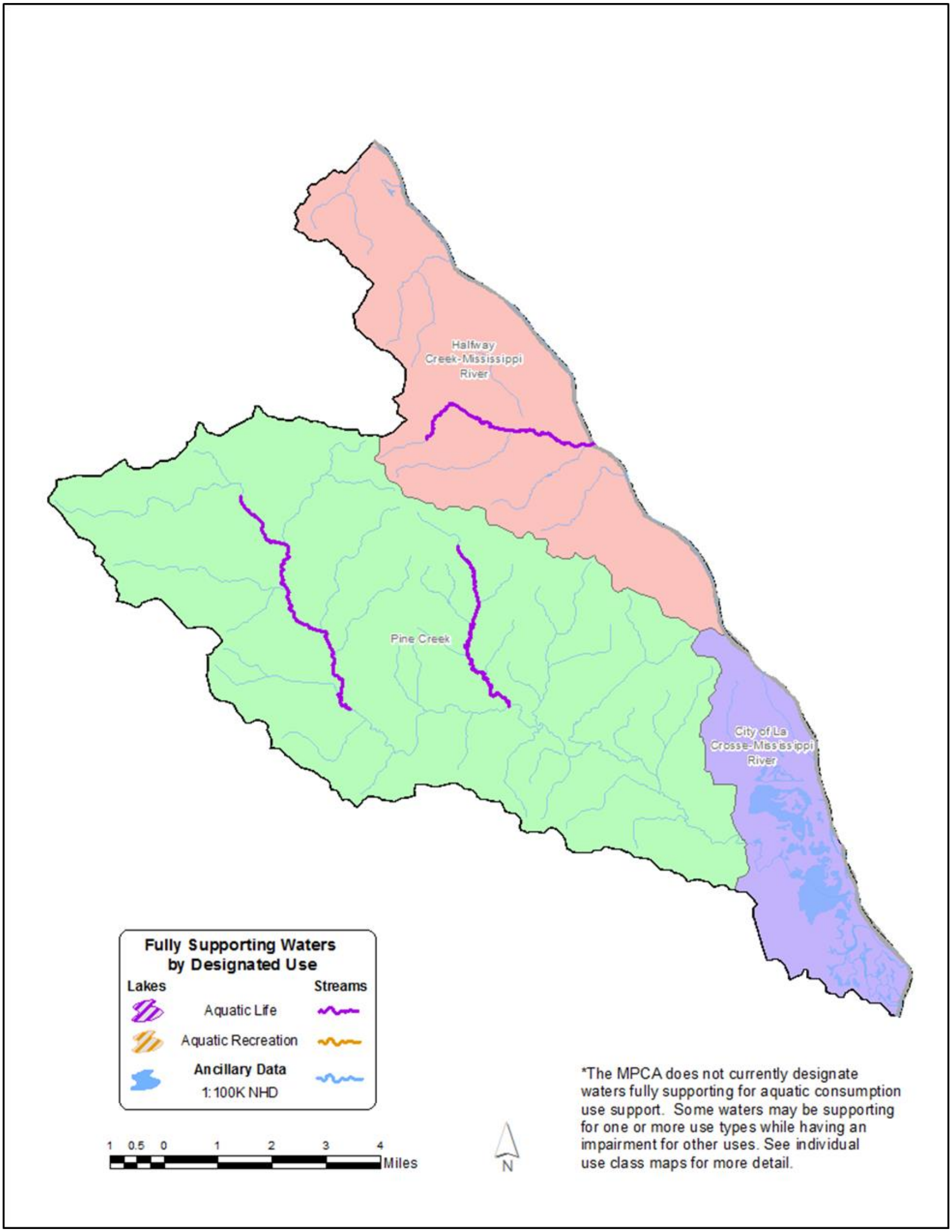


Figure 44. Impaired waters by designated use in the Upper Iowa River watershed.

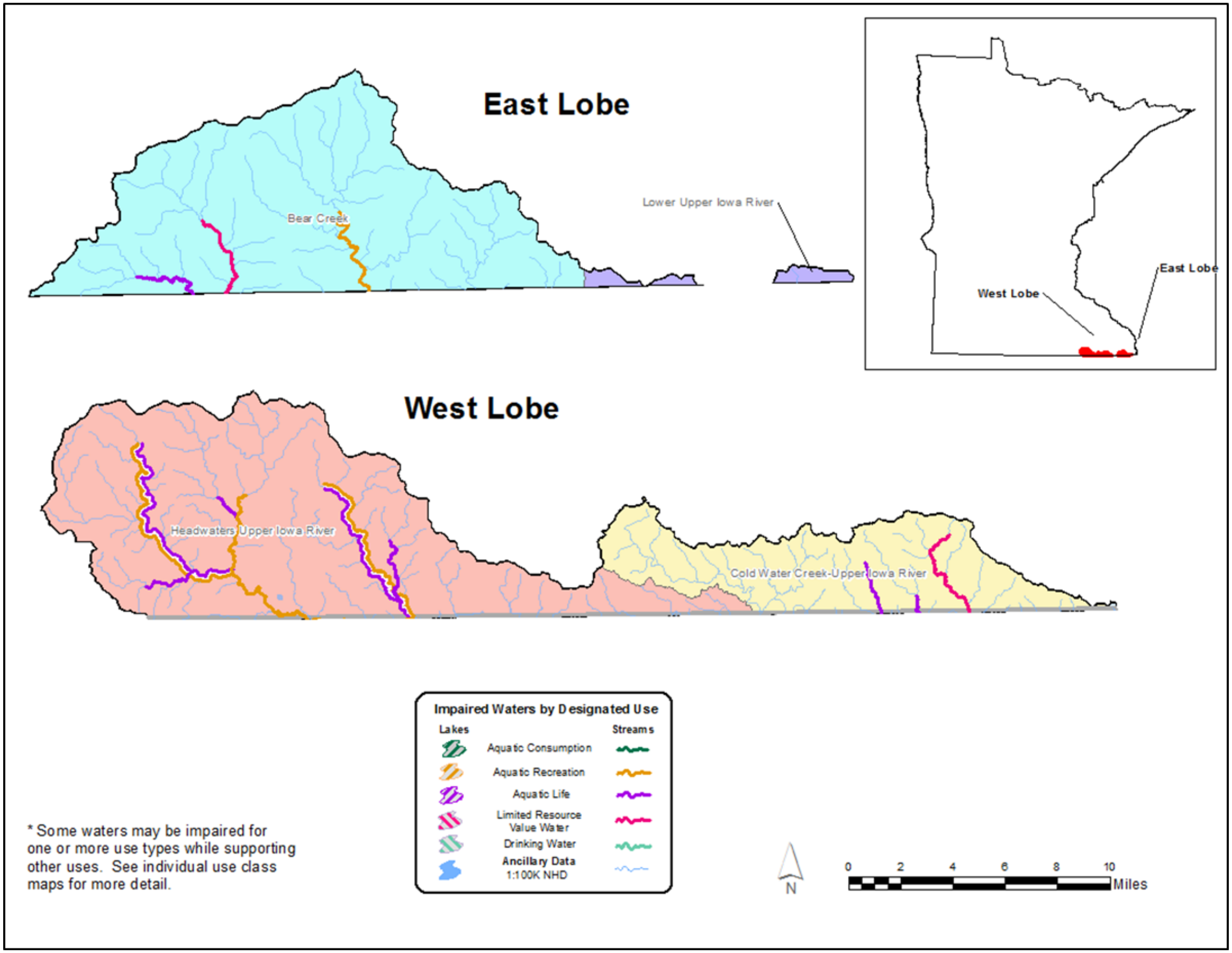


Figure 45. Impaired waters by designated use in the Mississippi River-Reno watershed

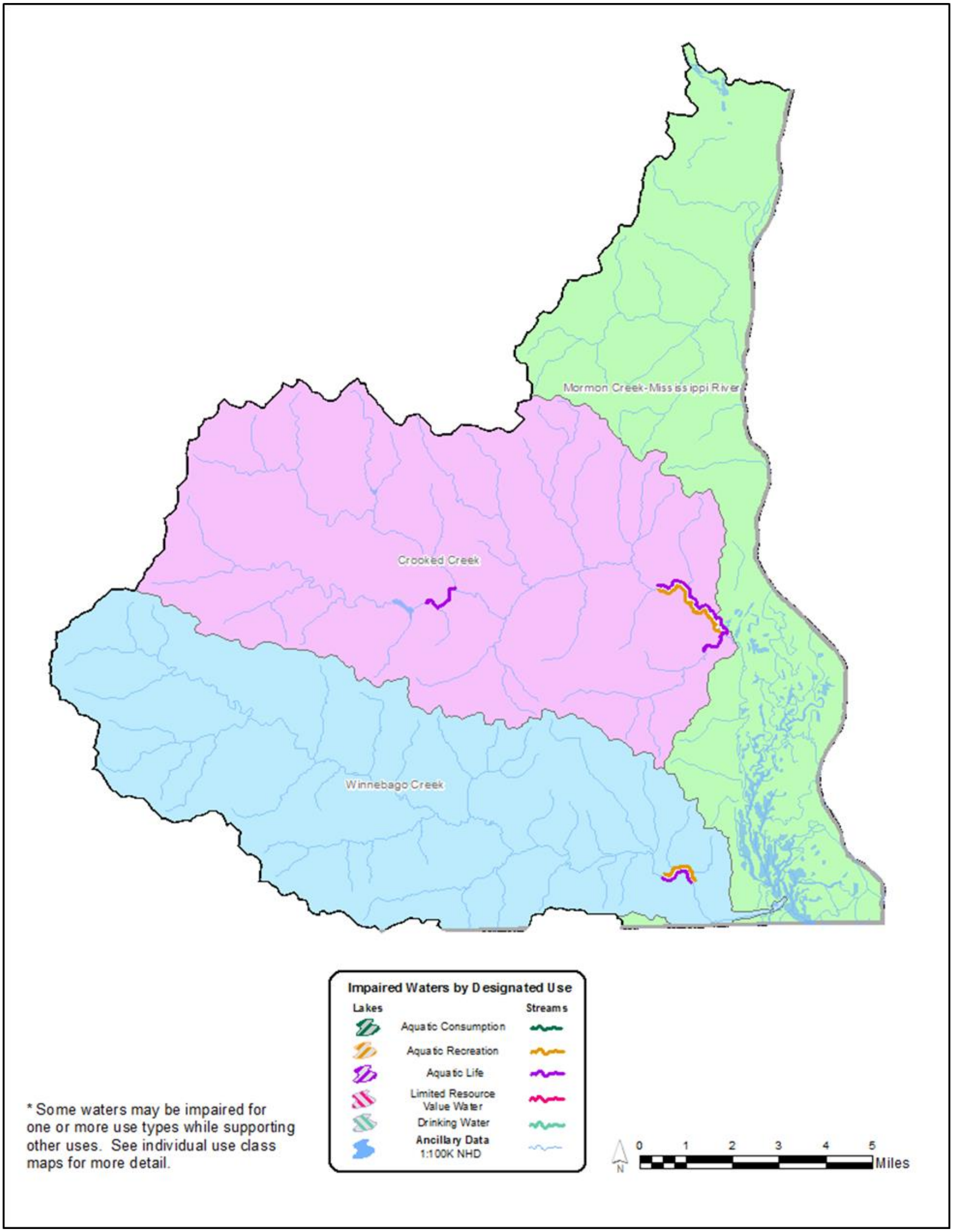


Figure 46. Impaired waters by designated use in the Mississippi River-La Crescent watershed.

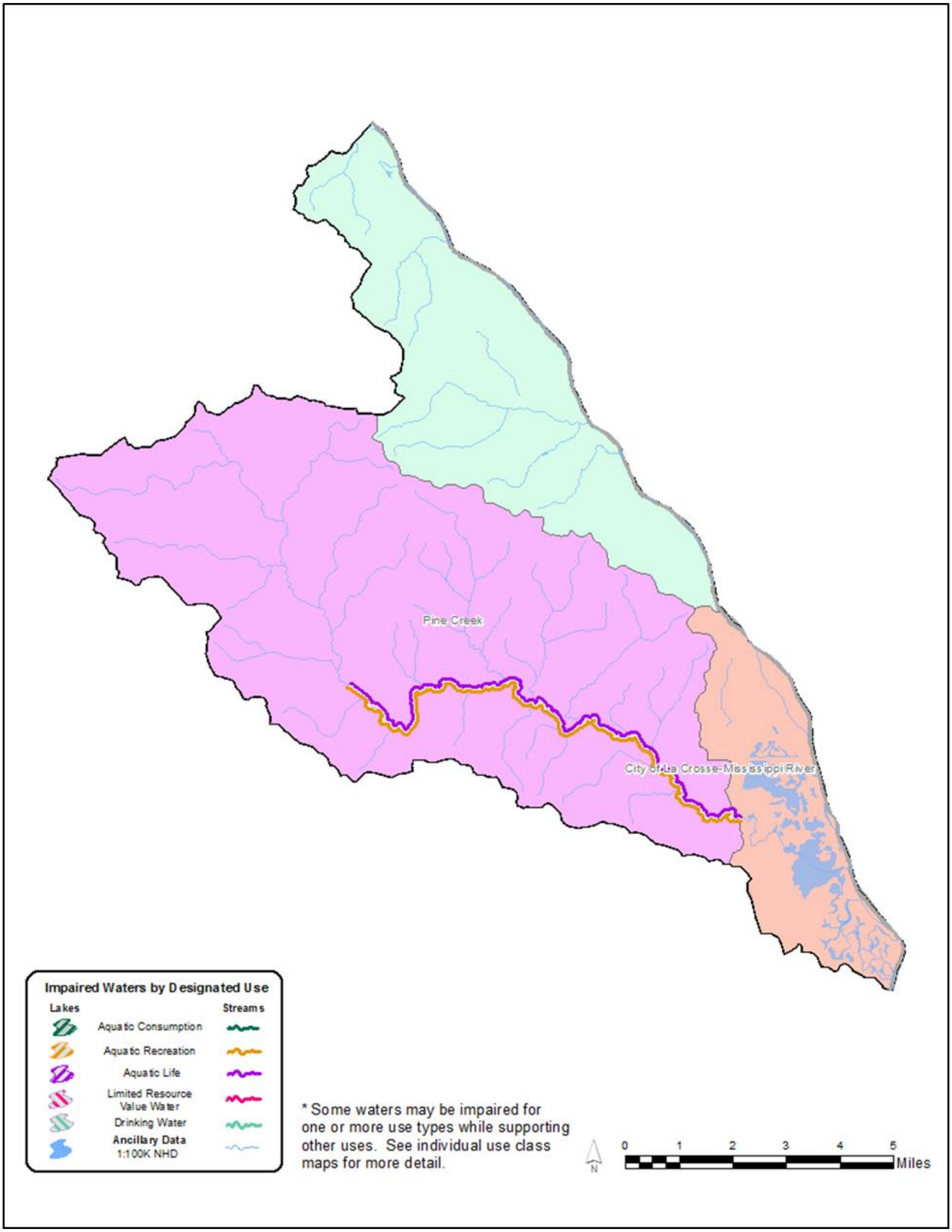


Figure 47. Aquatic consumption use support in the Upper Iowa River watershed.

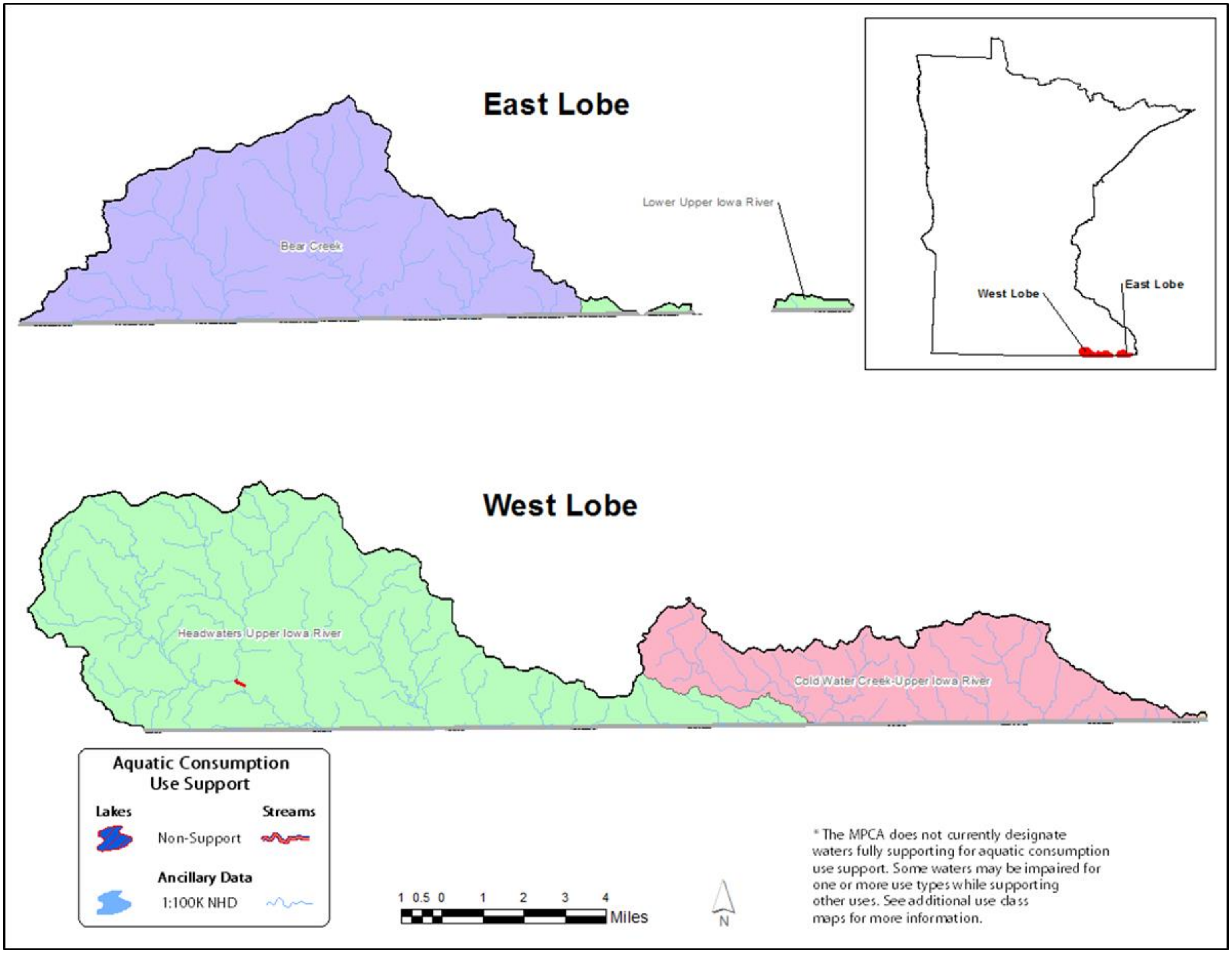


Figure 48. Aquatic consumption use support in the Mississippi River-Reno watershed.

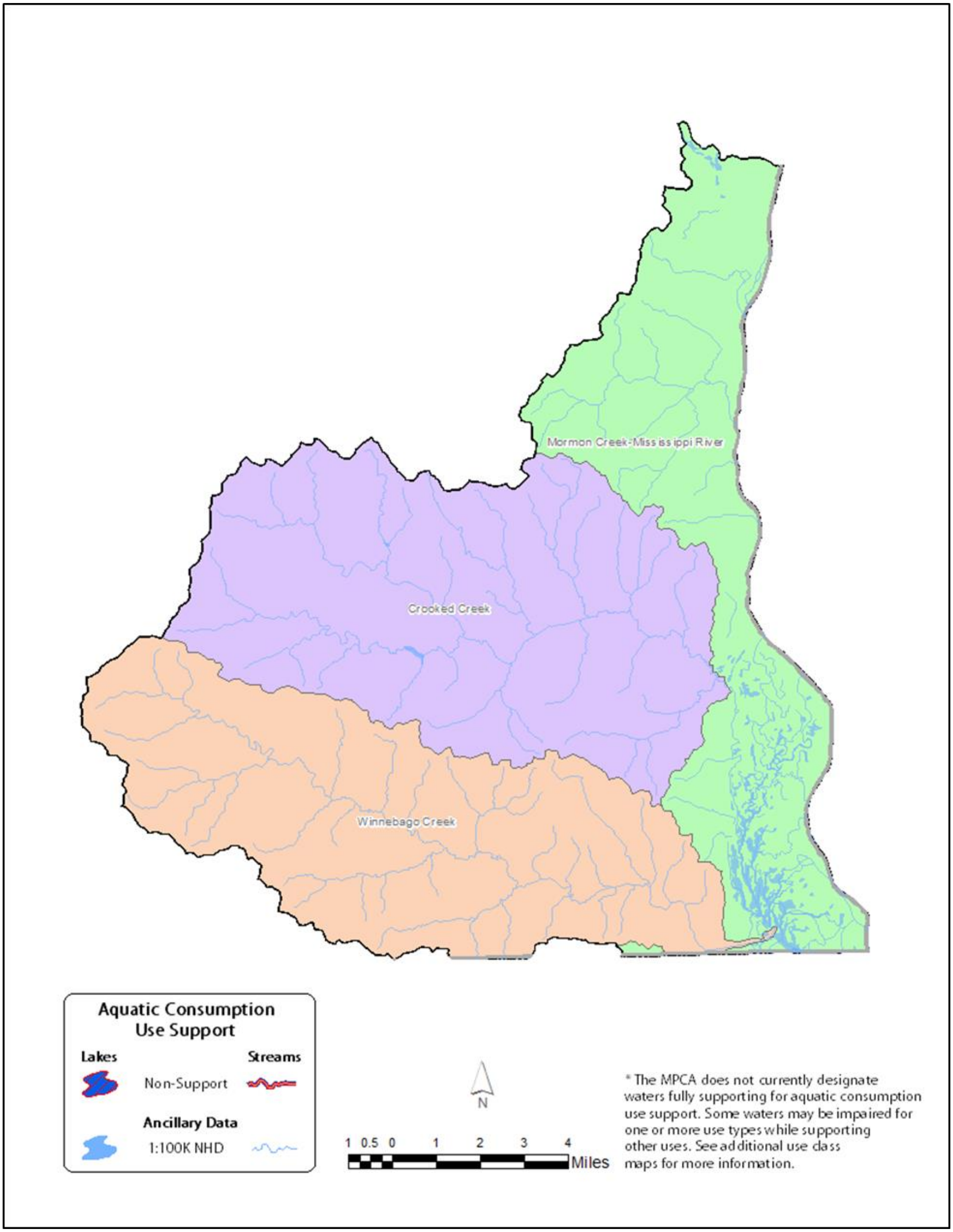


Figure 49. Aquatic consumption use support in the Mississippi River-La Crescent watershed.

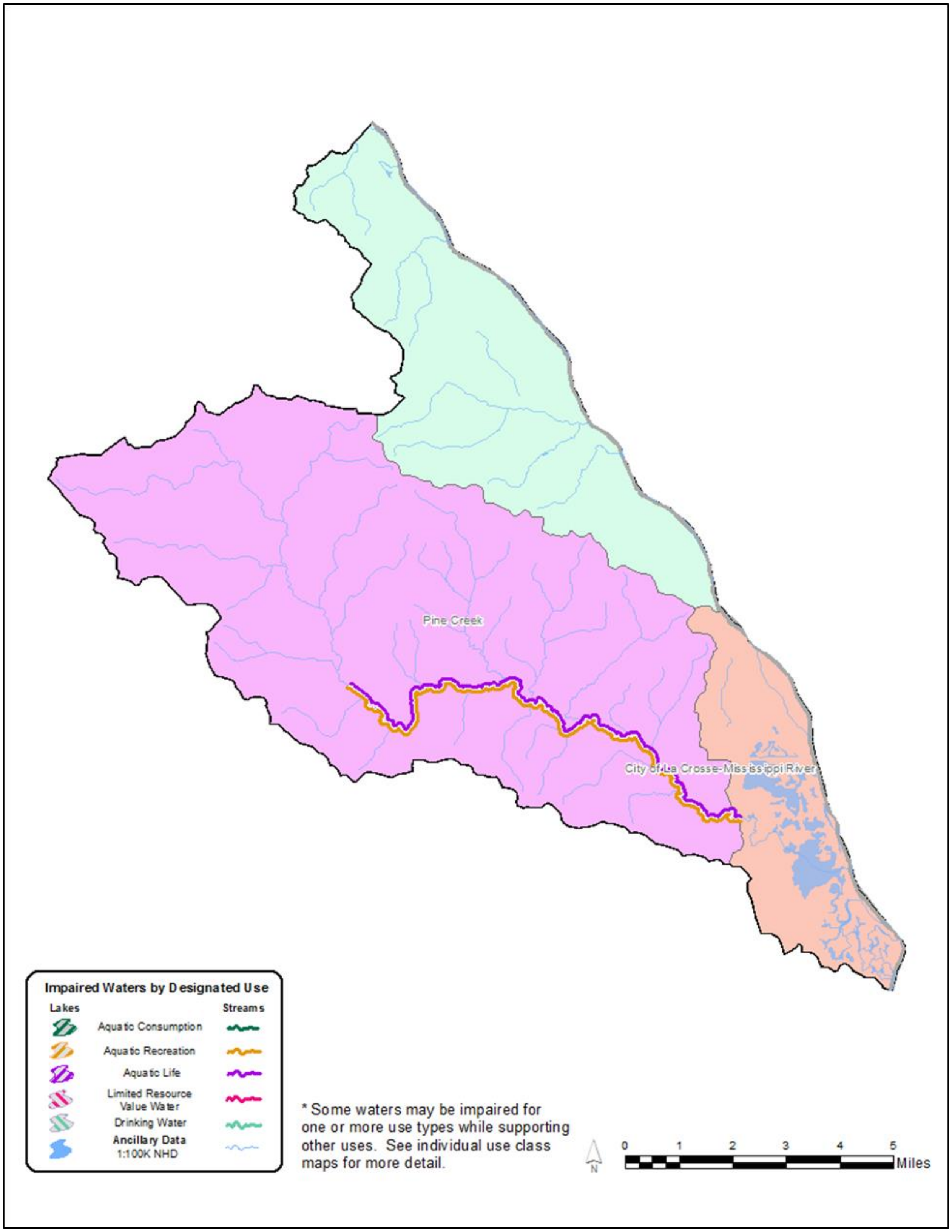


Figure 50. Aquatic life use support in the Upper Iowa River watershed.

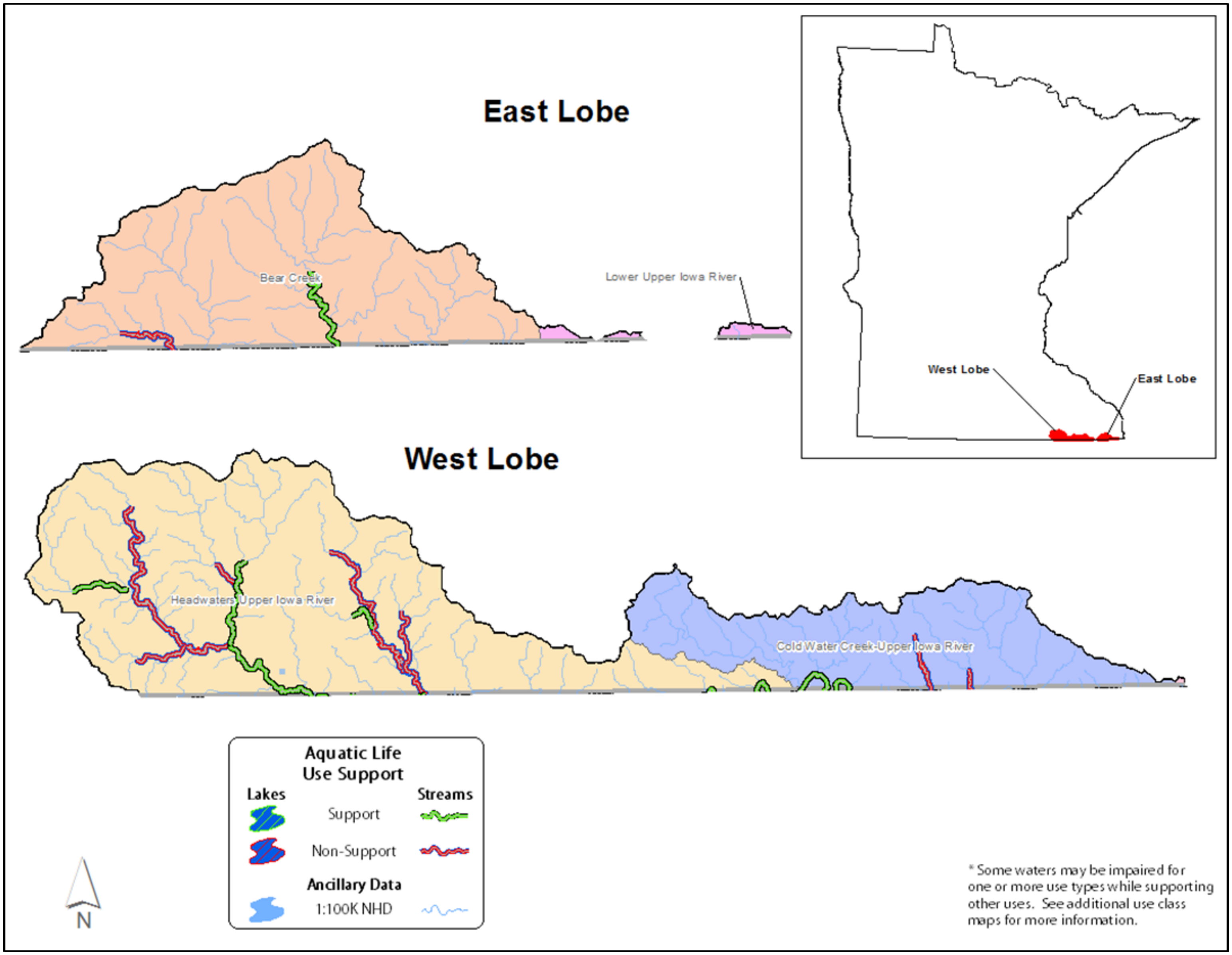


Figure 51. Aquatic life use support in the Mississippi River-Reno watershed.

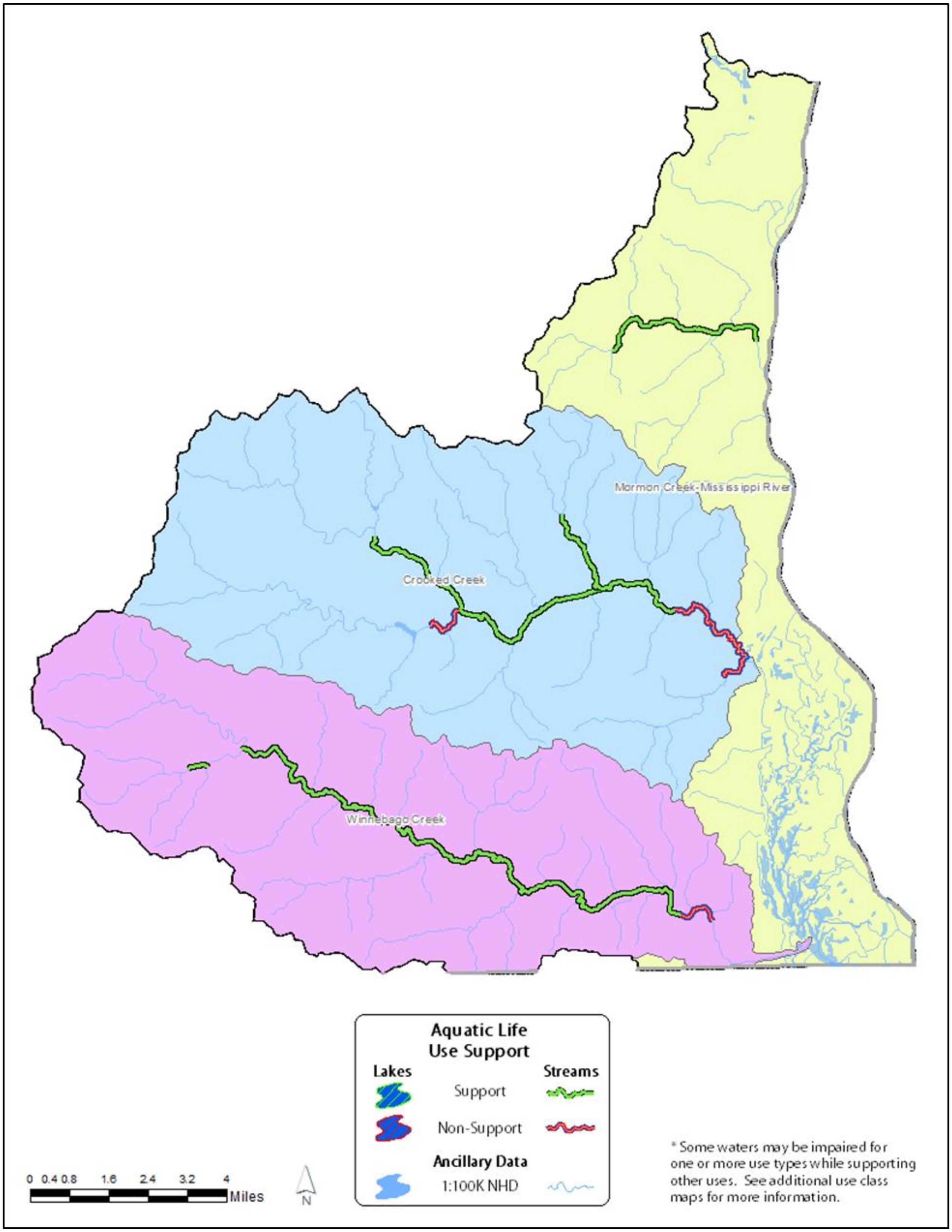


Figure 52. Aquatic life use support in the Mississippi River-La Crescent watershed.

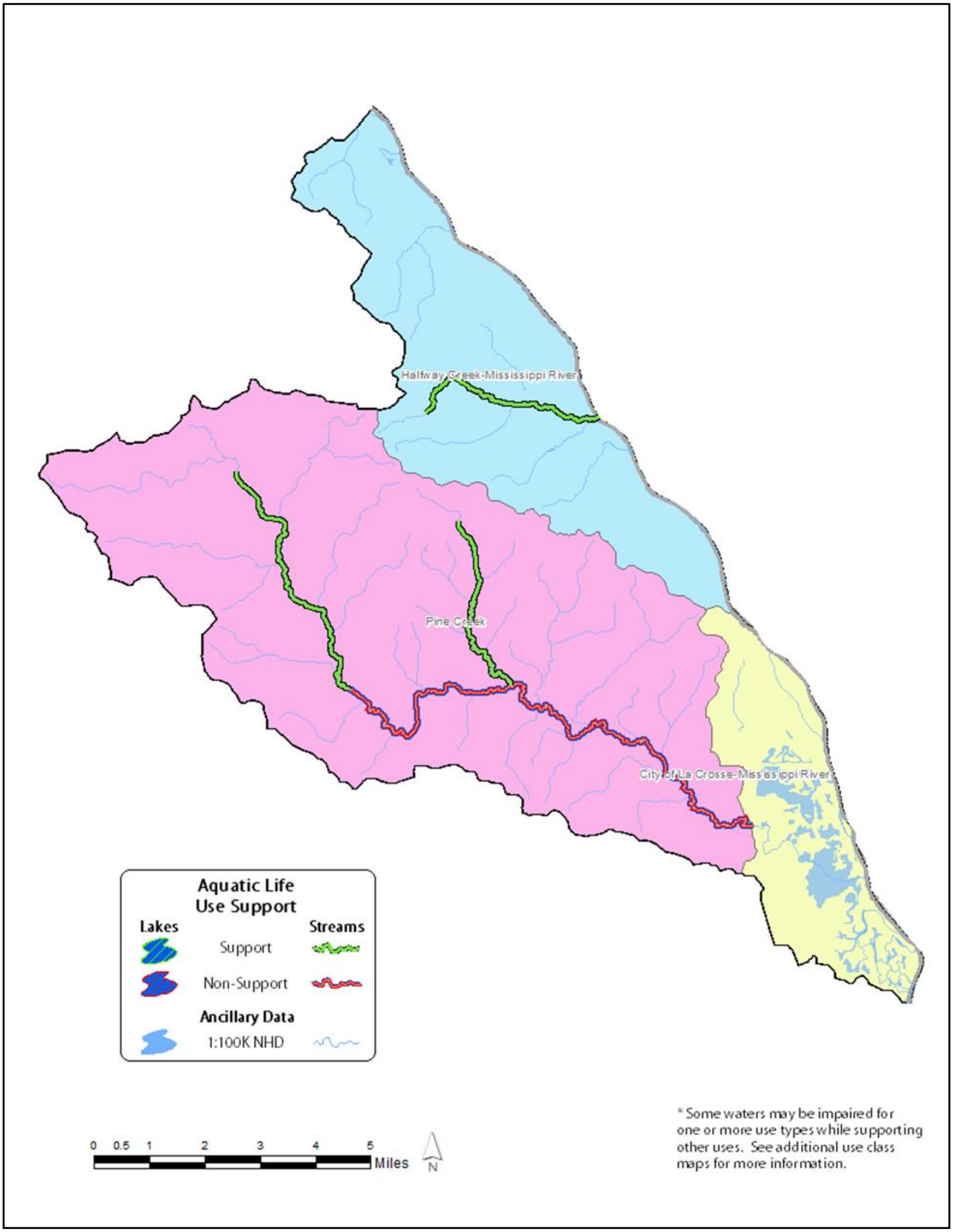


Figure 53. Aquatic recreation use support in the Upper Iowa River watershed.

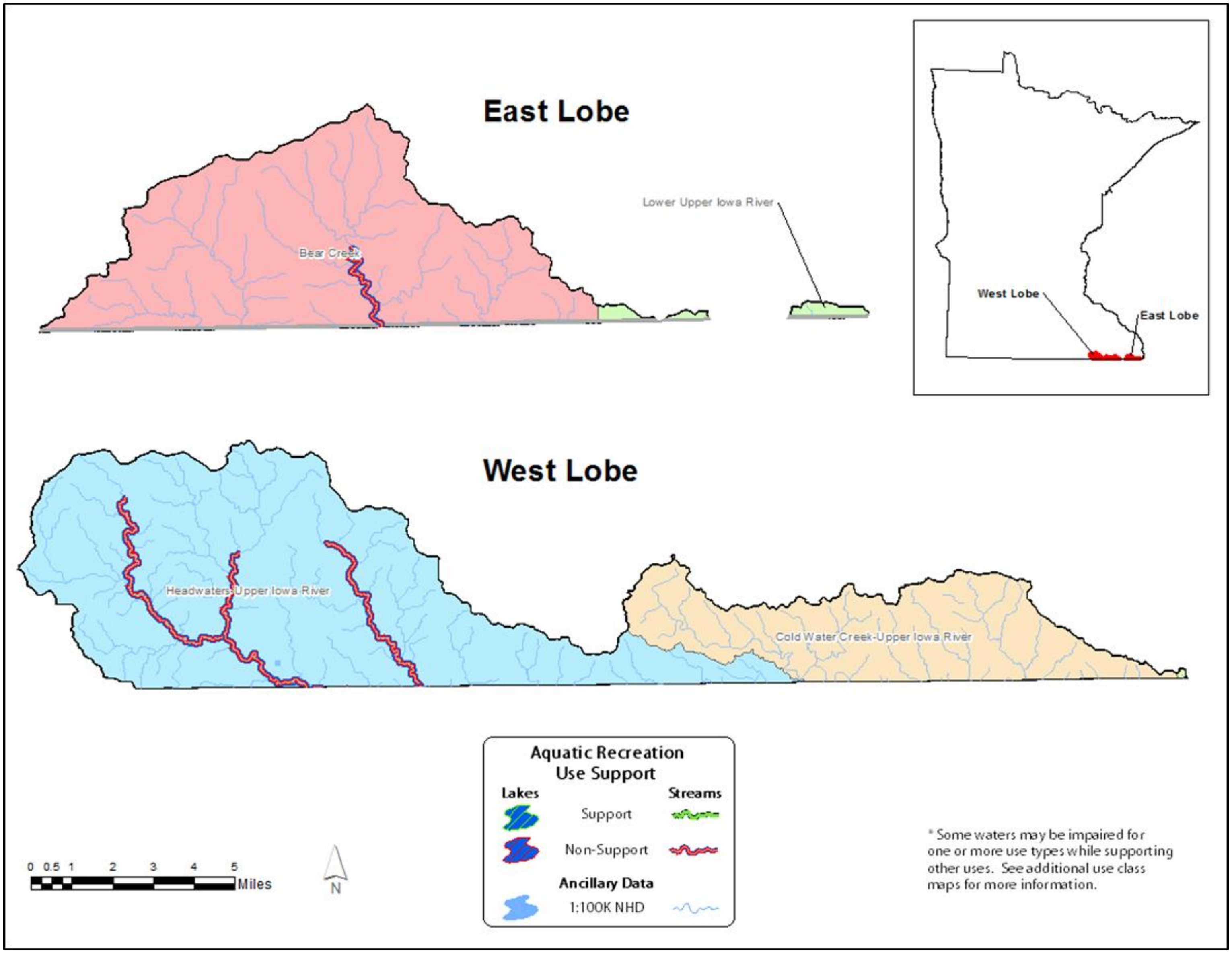


Figure 54. Aquatic recreation use support in the Mississippi River-Reno watershed.

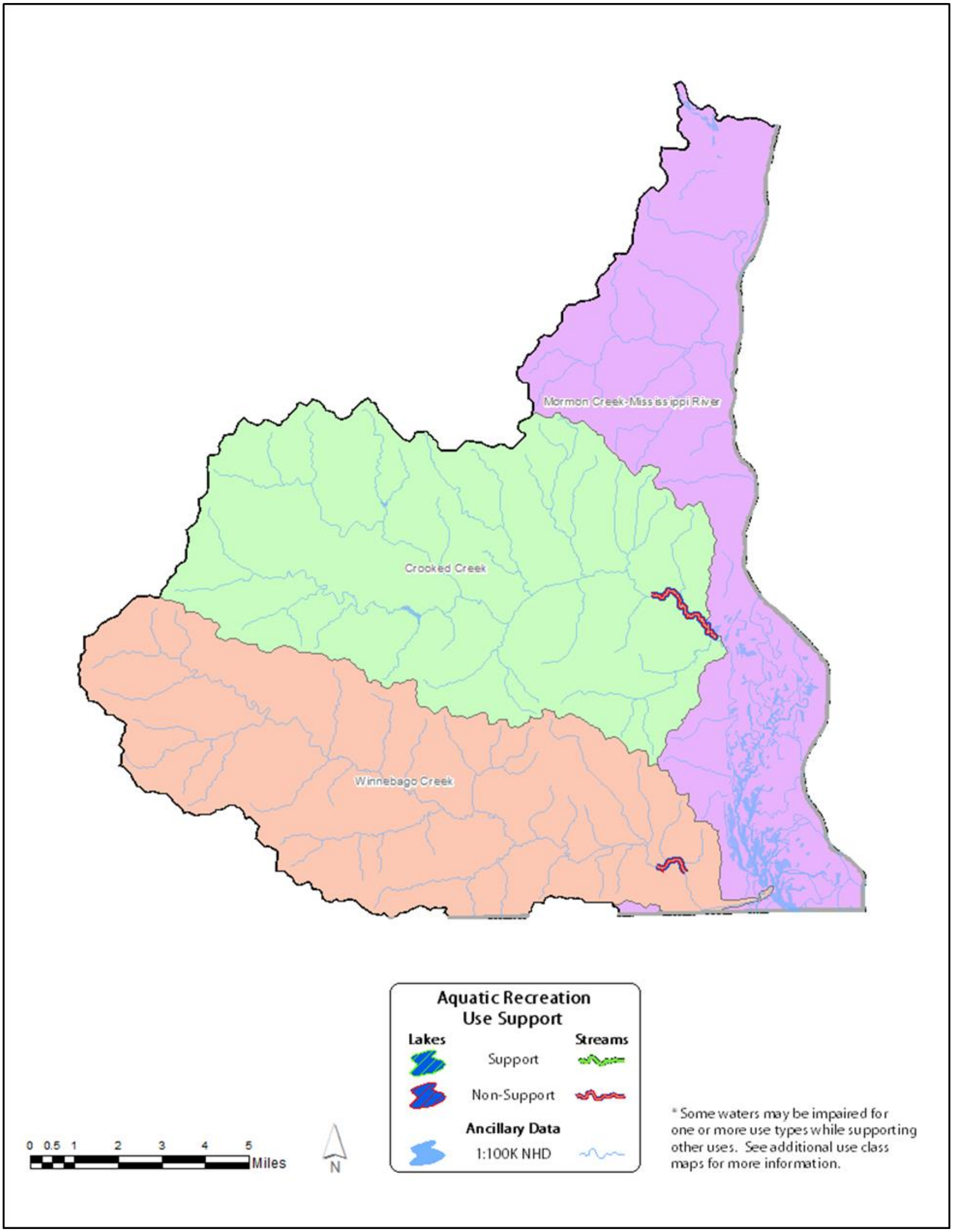
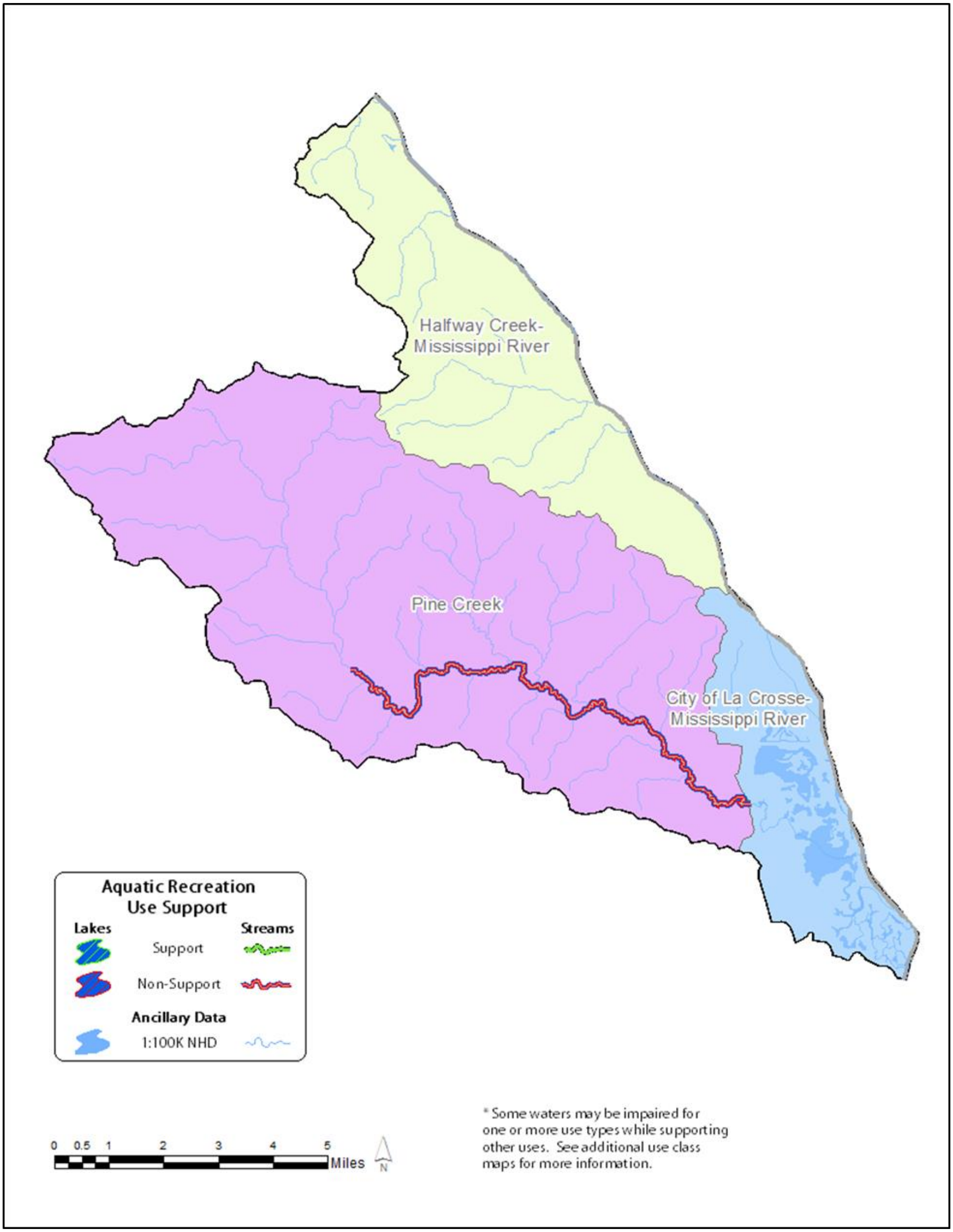


Figure 55. Aquatic recreation use support in the Mississippi River-La Crescent watershed.



Transparency trends for the Upper Iowa River, Mississippi River-Reno, and Mississippi River-La Crescent watersheds

MPCA completes annual trend analysis on lakes and streams across the state based on long-term transparency measurements. The data collection for this work relies heavily on volunteers across the state and also incorporates any agency and partner data submitted to EQuIS.

The trends are calculated using a Seasonal Kendall statistical test for waters with a minimum of eight years of transparency data; Secchi disk measurements in lakes and Secchi Tube measurements in streams.

Citizen volunteer monitoring occurs at two streams in the watersheds. No trend was detected at either location.

Table 17. Water clarity trends.

Upper Iowa River, Mississippi-Reno, and Mississippi LaCrescent Watersheds	Streams	Lakes
Number of sites w/increasing trend	0	0
Number of sites w/decreasing trend	0	0
Number of sites w/no trend	2	0

In June 2014, the MPCA published its final trend analysis of river monitoring data located statewide based on the historical Milestones Network. The network is a collection of 80 monitoring locations on rivers and streams across the state with good, long-term water quality data. The period of record is generally more than 30 years, through 2010, with monitoring at some sites going back to the 1950s. While the network of sites is not necessarily representative of Minnesota's rivers and streams as a whole, they do provide a valuable and widespread historical record for many of the state's waters. Starting in 2017, the MPCA will be switching to the Pollutant Load Monitoring Network for long term trend analysis on rivers and streams. Data from this program has much more robust sampling and will cover over 100 sites across the state.

Priority waters for protection and restoration in the Upper Iowa River, Mississippi River-Reno, and Mississippi River-La Crescent watersheds

The MPCA and DNR have been developing methods to help identify waters that are high priority for protection and restoration activities. Protecting lakes and streams from degradation requires consideration of how human activities impact the lands draining to the water. In addition, helping to determine the risk for degradation allows for prioritization to occur; so limited resources can be directed to waters that would benefit most from implementation efforts.

The results of the analysis are provided to watershed project teams for use during WRAPS and One Watershed One Plan or other local water plan development. The results of the analysis are considered a preliminary sorting of possible protection priorities and should be followed by a discussion and evaluation with other resource agencies, project partners and stakeholders. Other factors that are typically considered during the protection prioritization process include whether a water has an active lake or river association, is publically accessible, presence of wild rice, presence of invasive, rare or endangered species, as well as land use information and/or threats from proposed development.

Opportunities to gain or enhance multiple natural resource benefits ("benefit stacking") is another consideration during the final protection analysis. Waterbodies identified during the assessment process as vulnerable to impairment are also included in the summary below.

Pine Creek, from the Winona-Houston County line to MN Highway 16, was identified as impaired for fish and had elevated TSS concentrations. Excess sediment could be having a negative influence on the biology on these reaches; efforts should be made to reduce erosion and sedimentation to improve aquatic life.

Bee Creek is recommended to change from a general use stream to an exceptional use stream. There are very few streams in the state that achieve such high IBI scores for both macroinvertebrates and fish to be considered exceptional. The stream is a popular fishing location in both Minnesota and Iowa and is actively managed by DNR. Anglers have access to the stream through fishing easements. Fishing activity and landuse within the subwatershed could impact the pristine condition of Bee Creek.

Summaries and recommendations

The Upper Iowa River watershed is located along the Minnesota/Iowa border in southeast Minnesota. The watershed begins in southeast Mower County, runs along southern Fillmore County and southwest Houston County. The watershed had no wetland monitoring but data from similar watersheds suggest wetlands are generally in good to fair condition. The watershed has a number of karst features and protecting groundwater is especially important in such areas. Groundwater does not follow the same boundaries as surface water and can complicate the process to identify stream stressors.

Louise Mill Pond is the only lake in the watershed, but no assessment was conducted. The lake is a popular recreation area and nutrient and algae levels are low enough to support swimming uses.

Fish contaminants were sampled from the Upper Iowa River. Smallmouth bass and golden redhorse were tested. Tissue concentrations of mercury and PCBs in both species were below the threshold for healthy consumption. Data collected in 1987 from Louise Mill Pond was insufficient for an assessment as only two carp were collected and five are needed for assessment.

There are no existing impairments from previous assessments in the Upper Iowa River watershed. In this assessment, 14 stream reaches had data to assess for aquatic life. Seven of the reaches are being listed as impaired for aquatic life based on biological samples and water chemistry. Five reaches were impaired for aquatic recreation use with elevated bacteria concentrations present.

Animal access to streams is common throughout the watershed and may be contributing to the aquatic recreation impairments. Limiting animal access and manure access to streams could contribute to water quality improvements. Fine sediment in streams were notes in many of the streams in the watershed. Too much fine sediment changes stream habitat, especially for macroinvertebrates. Erosion control and conservation practices implemented in farming both limit the amount of sediment entering streams and can help improve water quality.

The Mississippi River-Reno watershed is a small watershed located in eastern Houston County. Groundwater is an important resource in southeast Minnesota. Much of drinking water in this part of the state comes from groundwater. It is important to protect these resources.

Two stream reaches were assessed as impaired for aquatic recreation in the Mississippi River-Reno watershed. Ten stream reaches had data to assess for aquatic life; four of the reaches did not meet standards and are being listed as impaired.

Four new impairments for aquatic life were identified during this assessment. One new macroinvertebrate impairment was among the new aquatic life impairments. Macroinvertebrates are sensitive to nitrogen. Many of the streams in the Mississippi River-Reno watershed are coldwater streams and susceptible to high levels of nitrogen. The new fish assemblage impairment is on the South Fork Crooked Creek below the impoundment that is managed by DNR as a warm water fishery. The impoundment is likely contributing to the impairment. There are no plans to remove the impoundment or change how it is managed. As a result, conditions will likely remain the same in the stream. The impoundment is a popular fishing location, allowing anglers access to different games species not found in the coldwater dominated watershed. Animal access to streams is common in the watershed and could be contributing to impairments. Beavers sign was seen throughout the watershed and could also be contributing to impairments by limiting fish movement and raising water temperatures in coldwater streams. Stream road crossings can also limit fish movement can be a stressor to fish communities.

The Mississippi River-La Crescent watershed is a very small watershed in southeast Minnesota. The watershed is located in southeast Winona County and northeast Houston County. Groundwater is of particular concern in this watershed. Most communities in southeast Minnesota rely on groundwater for drinking water, as well as individual residents. Protecting groundwater is karst areas protects drinking water and human health.

Four stream reaches were assessed for aquatic life; a fifth stream reach did not have enough information for assessment. Of the reaches assessed, three of them are meeting water quality standards. The fourth reach (07040006-576) is being listed as impaired for TSS and fish assemblage, and excess bacteria. More information is needed about the causes of the new impairments. Cattle access to streams is common in the Pine Creek watershed, where the *E.coli* impairment occurs. This could be contributing to the new aquatic recreation listing. Sources for the fish assemblage impairment should be investigated. Especially investigating sources of sediment in the water and higher water temperatures.

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Appendix 1 – Water chemistry definitions

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

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

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

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

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

Total Kjeldahl 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.

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

Appendix 2.1 – Intensive watershed monitoring water chemistry stations in the Upper Iowa River, Mississippi-Reno, Mississippi-La Crescent watersheds

EQuIS ID	Biological station ID	WID	Waterbody name	Location	Aggregated 12-digit HUC
S008-437	15LM006	07060002-512	Pine Creek	State Line Rd, E of CR 115, 6 mi. SE of Harmony	0706000202-01
S008-438	15LM019	07060002-509	Upper Iowa River	Hwy 56/Main St, 0.5 mi. E of Le Roy	0706000201-01
S008-439	15LM001	07060002-503	Bear Creek	Four Corners Dr, 2 mi. S of Spring Grove	0706000205-01
S005-495	15LM028	07060001-693	Winnebago Creek	At CR5, 8 mi E of Eitzen	0706000104-01
S008-436	15LM037	07060001-519	Crooked Creek	At Twp Rd 108, 5 mi. S of Brownsville	0706000102-01
S008-435	15LM039	07040006-576	Pine Creek	At Skunk Hollow Rd, .5 mi. S of La Crescent	0704000605-02

Appendix 2.2 – Intensive watershed monitoring biological monitoring stations in the Upper Iowa River, Mississippi River-Reno, Mississippi River-La Crescent watersheds

WID	Biological station ID	Waterbody name	Biological station location	County	Aggregated 12-digit HUC
Mississippi River - La Crescent					
07040006-576	04LM034	Pine Creek	Upstream of Hwy 16 in La Crescent	Houston	Pine Creek
07040006-576	04LM061	Pine Creek	1 mile E. of Pine Creek on Winona/Houston Co. line	Winona	Pine Creek
07040006-511	04LM093	Rose Valley Creek	just upstream of road crossing, 0.5 mi. NE of Pine Creek	Winona	Pine Creek
07040006-576	15LM039	Pine Creek	Downstream of Skunk Hollow Rd, 0.5 mi. S of La Crescent	Houston	Pine Creek
07040006-576	15LM040	Pine Creek	Downstream of CSAH 30, 4.5 mi. W of La Crescent	Houston	Pine Creek
07040006-507	15LM041	Pine Creek	Upstream of CSAH 5, 2 mi. SW of Nodine	Winona	Pine Creek
07040006-512	15LM042	Dakota Creek	Adjacent to Cattail Dr, 1.5 mi. NW of Dakota	Winona	Halfway Creek
07040006-576	15LM043	Pine Creek	Upstream of CR 6, 1.5 mi. W of LaCrescent	Houston	Pine Creek
Mississippi River - Reno					
07060001-687	04LM030	Unnamed creek	5 miles SE of Caledonia	Houston	Winnebago Creek
07060001-518	10EM162	Unnamed creek	0.25 mi. upstream of CSAH 24, 5 mi. SW of Brownsville	Houston	Crooked Creek
07060001-507	15LM027	Crooked Creek	Downstream of Elsheimer Rd, 1.5 mi. NE of Freeburg	Houston	Crooked Creek
07060001-693	15LM028	Winnebago Creek	Upstream of CR 5, 8 mi. E of Eitzen	Houston	Winnebago Creek
07060001-508	15LM030	Winnebago Creek	Downstream of Quarry Rd, 6 mi. SE of Caledonia	Houston	Winnebago Creek
07060001-685	15LM031	Unnamed creek	Adjacent to Dunromin Dr, 5 mi. S of Caledonia	Houston	Winnebago Creek
07060001-574	15LM033	South Fork Crooked Creek	Upstream of private road off of CR 249, 2 mi. SE of Caledonia	Houston	Crooked Creek
07060001-520	15LM034	North Fork Crooked Creek	Upstream of CR 249, 3 mi. E of Caledonia	Houston	Crooked Creek
07060001-520	15LM035	North Fork Crooked Creek	Downstream of private rd off of CR 249, 5 mi. SE of Caledonia	Houston	Crooked Creek
07060001-524	15LM036	Clear Creek	Upstream of CR 249, 6 mi. S of Brownsville	Houston	Crooked Creek
07060001-519	15LM037	Crooked Creek	Upstream of Twp Rd 108, 5 mi. S of Brownsville	Houston	Crooked Creek
07060001-516	15LM038	Wildcat Creek	Adjacent to Cork Hollow Dr, 1.5 mi. W of Brownsville	Houston	Mormon Creek
Upper Iowa River					
07060002-506	02LM010	Upper Iowa River	Adjacent to CR 30, 1.5 mi. NE of Granger	Fillmore	Coldwater Creek

07060002-546	04LM018	Beaver Creek	Upstream of Hwy 1, 3 mi. S of Ostrander	Fillmore	Headwaters Upper Iowa River
07060002-506	04LM048	Upper Iowa River	Upstream of MN/IA border @ Granger	Fillmore	Coldwater Creek
07060002-548	04LM106	Little Iowa River	along 765 Ave, 2 mi. N of Le Roy	Mower	Headwaters Upper Iowa River
07060002-515	15LM004	Bee Creek (Waterloo Creek)	Upstream of Twp Rd 7, 6 mi. SE of Spring Grove	Houston	Bear Creek
07060002-535	15LM005	Unnamed creek	Upstream of Jesse James Rd, 6 mi. SW of Spring Grove	Houston	Bear Creek
07060002-505	15LM008	Unnamed Creek	Upstream of 331st Ave, S of Garden Rd, 1mi. SE of Harmony	Fillmore	Coldwater Creek
07060002-520	15LM009	Deer Creek	Upstream of State Line Rd, 3.5 mi. SE of Harmony	Fillmore	Coldwater Creek
07060002-521	15LM010	Elliot Creek	Upstream of State Line Rd, 6 mi. E of Granger	Fillmore	Coldwater Creek
07060002-546	15LM014	Beaver Creek	Downstream of Hwy 56, 5 mi. E of Le Roy	Fillmore	Headwaters Upper Iowa River
07060002-537	15LM015	Unnamed creek	Upstream of 120th St, 3.5 mi. NW of Chester	Fillmore	Headwaters Upper Iowa River
07060002-546	15LM016	Beaver Creek	Downstream of Twp Rd 143, S of TR 112, 6 mi. E of Le Roy	Fillmore	Headwaters Upper Iowa River
07060002-546	15LM017	Beaver Creek	Upstream of CR 26, W of Hwy 63, 6 mi. NE of Le Roy	Fillmore	Headwaters Upper Iowa River
07060002-552	15LM018	Unnamed creek	Upstream of CSAH 26, 4 mi. NE of LeRoy	Fillmore	Headwaters Upper Iowa River
07060002-509	15LM019	Upper Iowa River	Downstream of Hwy 56 (Main St), 0.5 mi. E of Le Roy	Mower	Headwaters Upper Iowa River
07060002-550	15LM020	Upper Iowa River	Downstream of 755th Ave, N of Hwy 56, 2 mi. NW of Le Roy	Mower	Headwaters Upper Iowa River
07060002-544	15LM021	Unnamed creek	Upstream of 120th St, W of Hwy 56, 2 mi. W of Leroy	Mower	Headwaters Upper Iowa River
07060002-550	15LM022	Upper Iowa River	Downstream of CR 8, N of Hwy 56, 3 mi. NW of LeRoy	Mower	Headwaters Upper Iowa River
07060002-526	15LM023	North Branch Upper Iowa River	Downstream of CR 11, W of CR 8, 6.5 mi. NW of Le Roy	Mower	Headwaters Upper Iowa River
07060002-550	15LM024	Upper Iowa River	Downstream of CR 11, W of CR 8, 6 mi. NW of Le Roy	Mower	Headwaters Upper Iowa River
07060002-548	15LM025	Little Iowa River	Upstream of CR 11, W of CR 14, 3 mi. NW of Le Roy	Mower	Headwaters Upper Iowa River

07060002-540	15LM026	Unnamed creek	Upstream of CR 11, 4 mi. N of Le Roy	Mower	Headwaters Upper Iowa River
07060002-548	15LM045	Little Iowa River	Upstream of bridge in Lake Louise State Park (down road from visitor center) 2.5mi N of LeRoy	Mower	Headwaters Upper Iowa River
07040006-576	04LM034	Pine Creek	Upstream of Hwy 16 in La Crescent	Houston	Pine Creek
07040006-576	04LM061	Pine Creek	1 mile E. of Pine Creek on Winona/Houston Co. line	Winona	Pine Creek
07040006-511	04LM093	Rose Valley Creek	just upstream of road crossing, 0.5 mi. NE of Pine Creek	Winona	Pine Creek

Appendix 3.1 – Minnesota statewide IBI thresholds and confidence limits

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

Appendix 3.2 – Biological monitoring results – fish IBI (assessable reaches)

National Hydrography Dataset (NHD) Assessment Segment WID	Biological station ID	Stream segment name	Drainage area Mi^2	Fish class	Threshold	FIBI	Visit date
Halfway Creek: 0704000601-01							
07040006-512	15LM042	Dakota Creek	6.57	Southern Coldwater	50	77.50	27-Jun-16
Pine Creek: 0704000605-02							
07040006-507	15LM041	Pine Creek	10.14	Southern Coldwater	50	83.36	19-Aug-15
07040006-507	15LM041	Pine Creek	10.14	Southern Coldwater	50	72.09	23-Jul-15
07040006-511	04LM093	Rose Valley Creek	6.26	Southern Coldwater	50	64.45	08-Jul-15
07040006-511	04LM093	Rose Valley Creek	6.26	Southern Coldwater	50	36.67	24-Jun-04
07040006-576	04LM034	Pine Creek	57.57	Southern Coldwater	50	38.33	30-Jun-04
07040006-576	04LM061	Pine Creek	38.85	Southern Coldwater	50	47.53	30-Jun-04
07040006-576	04LM061	Pine Creek	38.85	Southern Coldwater	50	50.51	24-Aug-04
07040006-576	15LM039	Pine Creek	56.80	Southern Coldwater	50	38.40	21-Jul-15
07040006-576	15LM040	Pine Creek	31.99	Southern Coldwater	50	36.24	27-Aug-15
07040006-576	15LM040	Pine Creek	31.99	Southern Coldwater	50	30.03	22-Jun-16
07040006-576	15LM043	Pine Creek	50.90	Southern Coldwater	50	42.24	22-Jul-15
07040006-576	15LM043	Pine Creek	50.90	Southern Coldwater	50	12.16	21-Jun-16
Crooked Creek: 0706000102-01							
07060001-507	15LM027	Crooked Creek	54.59	Southern Coldwater	50	66.02	29-Jun-15
07060001-518	10EM162	Unnamed creek	3.57	Southern Coldwater	50	51.83	07-Jun-10
07060001-519	15LM037	Crooked Creek	60.30	Southern Streams	50	59.24	21-Jul-15
07060001-519	15LM037	Crooked Creek	60.30	Southern Streams	50	55.04	10-Aug-16
07060001-520	15LM034	North Fork Crooked Creek	12.75	Southern Coldwater	50	68.10	25-Jun-15
07060001-520	15LM034	North Fork Crooked Creek	12.75	Southern Coldwater	50	70.25	22-Jul-15
07060001-520	15LM035	North Fork Crooked Creek	16.11	Southern Coldwater	50	67.03	23-Jul-15
07060001-520	15LM035	North Fork Crooked Creek	16.11	Southern Coldwater	50	53.12	14-Jul-16
07060001-520	15LM035	North Fork Crooked Creek	16.11	Southern Coldwater	50	56.67	10-Jun-15
07060001-524	15LM036	Clear Creek	5.74	Southern Headwaters	55	33.40	08-Jun-15
07060001-574	15LM033	South Fork Crooked Creek	15.89	Southern Coldwater	50	54.24	28-Jun-16

National Hydrography Dataset (NHD) Assessment Segment WID	Biological station ID	Stream segment name	Drainage area Mi^2	Fish class	Threshold	FIBI	Visit date
07060001-574	15LM033	South Fork Crooked Creek	15.89	Southern Coldwater	50	47.86	10-Jun-15
Winnebago Creek: 0706000102-01							
07060001-508	15LM030	Winnebago Creek	24.01	Southern Coldwater	50	85.27	30-Jun-15
07060001-685	15LM031	Unnamed creek	4.22	Southern Coldwater	50	86.96	19-Aug-15
07060001-687	04LM030	Unnamed creek	1.42	Southern Coldwater	50	77.79	29-Jun-04
07060001-693	15LM028	Winnebago Creek	58.09	Southern Coldwater	50	58.20	21-Jul-15
Mormon Creek: 0706000105-01							
07060001-516	15LM038	Wildcat Creek	7.40	Southern Coldwater	50	53.71	22-Jul-15
07060001-516	15LM038	Wildcat Creek	7.40	Southern Coldwater	50	61.42	28-Jun-16
Headwaters Upper Iowa River: 0706000201-01							
07060002-509	15LM019	Upper Iowa River	72.73	Southern Streams	50	60.40	20-Jul-15
07060002-526	15LM023	North Branch Upper Iowa River	7.73	Southern Headwaters	55	58.06	01-Jul-15
07060002-526	15LM023	North Branch Upper Iowa River	7.73	Southern Headwaters	55	69.85	12-Jul-16
07060002-526	15LM023	North Branch Upper Iowa River	7.73	Southern Headwaters	55	53.48	20-Aug-15
07060002-537	15LM015	Unnamed creek	4.24	Southern Headwaters	55	67.18	13-Jul-16
07060002-537	15LM015	Unnamed creek	4.24	Southern Headwaters	55	61.69	10-Jun-15
07060002-540	15LM026	Unnamed creek	9.54	Southern Headwaters	55	82.51	11-Jun-15
07060002-544	15LM021	Unnamed creek	5.53	Southern Headwaters	55	64.89	10-Jun-15
07060002-546	04LM018	Beaver Creek	8.45	Southern Headwaters	55	52.99	23-Jun-04
07060002-546	15LM014	Beaver Creek	26.60	Southern Headwaters	55	78.61	19-Aug-15
07060002-546	15LM016	Beaver Creek	18.18	Southern Headwaters	55	66.42	10-Jun-15
07060002-546	15LM017	Beaver Creek	10.46	Southern Headwaters	55	65.73	01-Jul-15
07060002-548	04LM106	Little Iowa River	26.26	Southern Headwaters	55	71.82	08-Sep-04
07060002-548	15LM025	Little Iowa River	12.10	Southern Headwaters	55	77.11	26-Aug-15
07060002-548	15LM045	Little Iowa River	26.44	Southern Headwaters	55	76.75	02-Jul-15
07060002-550	15LM020	Upper Iowa River	36.04	Southern Streams	50	61.81	22-Jul-15
07060002-550	15LM022	Upper Iowa River	23.58	Southern Headwaters	55	78.61	12-Jul-16
07060002-550	15LM024	Upper Iowa River	8.57	Southern Headwaters	55	62.80	09-Jun-15
07060002-552	15LM018	Unnamed creek	5.71	Southern Headwaters	55	56.14	10-Jun-15

National Hydrography Dataset (NHD) Assessment Segment WID	Biological station ID	Stream segment name	Drainage area Mi^2	Fish class	Threshold	FIBI	Visit date
07060002-552	15LM018	Unnamed creek	5.71	Southern Headwaters	55	59.33	13-Jul-16
Coldwater Creek: 0706000202-01							
07060002-505	15LM008	Unnamed Creek	2.31	Southern Headwaters	55	12.88	09-Jun-15
07060002-506	02LM010	Upper Iowa River	243.01	Southern Streams	50	74.54	23-Jul-15
07060002-506	02LM010	Upper Iowa River	243.01	Southern Streams	50	69.24	02-Jul-02
07060002-506	04LM048	Upper Iowa River	218.92	Southern Streams	50	82.98	11-Aug-04
07060002-520	15LM009	Deer Creek	4.91	Southern Headwaters	55	72.93	28-Jun-16
07060002-520	15LM009	Deer Creek	4.91	Southern Headwaters	55	50.76	09-Jun-15
07060002-521	15LM010	Elliot Creek	1.73	Southern Headwaters	55	57.62	09-Jun-15
Bear Creek:0706000205-01							
07060002-515	15LM004	Bee Creek (Waterloo Creek)	18.52	Southern Coldwater	50	92.39	09-Jul-15
07060002-535	15LM005	Unnamed creek	5.34	Southern Coldwater	50	57.44	23-Jul-15

Appendix 3.3 – Biological monitoring results-macromacroinvertebrate IBI (assessable reaches)

National Hydrography Dataset (NHD) Assessment Segment WID	Biological station ID	Stream segment name	Drainage area Mi²	Invert class	Threshold	MIBI	Visit date
Halfway Creek: 0704000601-01							
07040006-512	15LM042	Dakota Creek	6.57	Southern Coldwater	43	73.22	01-Sep-16
Pine Creek: 0704000605-02							
07040006-511	04LM093	Rose Valley Creek	6.26	Southern Coldwater	43	48.28	06-Aug-15
07040006-511	04LM093	Rose Valley Creek	6.26	Southern Coldwater	43	49.66	06-Aug-15
07040006-507	15LM041	Pine Creek	10.14	Southern Coldwater	43	86.02	06-Aug-15
07040006-576	04LM061	Pine Creek	38.85	Southern Coldwater	43	35.01	18-Aug-04
07040006-576	04LM034	Pine Creek	57.57	Southern Coldwater	43	62.84	31-Aug-04
07040006-576	15LM043	Pine Creek	50.90	Southern Coldwater	43	56.71	05-Aug-15
07040006-576	15LM043	Pine Creek	50.90	Southern Coldwater	43	49.10	01-Sep-16
07040006-576	15LM040	Pine Creek	31.99	Southern Coldwater	43	52.35	27-Aug-15
07040006-576	15LM040	Pine Creek	31.99	Southern Coldwater	43	42.20	01-Sep-16
07040006-576	15LM039	Pine Creek	56.80	Southern Coldwater	43	56.67	05-Aug-15
07040006-511	04LM093	Rose Valley Creek	6.26	Southern Coldwater	43	30.92	01-Sep-04
Crooked Creek: 0706000102-01							
07060001-519	15LM037	Crooked Creek	60.30	Southern Forest Streams GP	43	22.02	31-Aug-16
07060001-524	15LM036	Clear Creek	5.74	Southern Forest Streams GP	43	30.12	04-Aug-15
07060001-519	15LM037	Crooked Creek	60.30	Southern Forest Streams GP	43	24.09	05-Aug-15
07060001-519	15LM037	Crooked Creek	60.30	Southern Forest Streams GP	43	15.01	31-Aug-16
07060001-507	15LM027	Crooked Creek	54.59	Southern Coldwater	43	76.44	05-Aug-15
07060001-507	15LM027	Crooked Creek	54.59	Southern Coldwater	43	56.77	05-Aug-15
07060001-518	10EM162	Unnamed creek	3.57	Southern Coldwater	43	78.41	12-Aug-10
07060001-574	15LM033	South Fork Crooked Creek	15.89	Southern Coldwater	43	43.62	31-Aug-16
07060001-520	15LM034	North Fork Crooked Creek	12.75	Southern Coldwater	43	56.71	04-Aug-15
07060001-520	15LM035	North Fork Crooked Creek	16.11	Southern Coldwater	43	39.77	05-Aug-15
07060001-520	15LM035	North Fork Crooked Creek	16.11	Southern Coldwater	43	42.09	31-Aug-16
07060001-574	15LM033	South Fork Crooked Creek	15.89	Southern Coldwater	43	34.81	05-Aug-15

National Hydrography Dataset (NHD) Assessment Segment WID	Biological station ID	Stream segment name	Drainage area Mi^2	Invert class	Threshold	MIBI	Visit date
Winnebago Creek: 0706000104-01							
07060001-685	15LM031	Unnamed creek	4.22	Southern Coldwater	43	60.49	31-Aug-16
07060001-508	15LM030	Winnebago Creek	24.01	Southern Coldwater	43	35.50	04-Aug-15
07060001-685	15LM031	Unnamed creek	4.22	Southern Coldwater	43	29.14	04-Aug-15
07060001-687	04LM030	Unnamed creek	1.42	Southern Coldwater	43	52.80	31-Aug-04
07060001-693	15LM028	Winnebago Creek	58.09	Southern Coldwater	43	30.12	04-Aug-15
Mormon Creek: 0706000105-01							
07060001-516	15LM038	Wildcat Creek	7.40	Southern Coldwater	43	46.48	05-Aug-15
Headwaters Upper Iowa River: 0706000201-01							
07060002-546	15LM017	Beaver Creek	10.46	Southern Streams RR	37	26.51	13-Aug-15
07060002-548	15LM045	Little Iowa River	26.44	Southern Streams RR	37	37.93	12-Aug-15
07060002-548	15LM025	Little Iowa River	12.10	Southern Streams RR	37	37.89	13-Aug-15
07060002-540	15LM026	Unnamed creek	9.54	Southern Streams RR	37	31.81	13-Aug-15
07060002-550	15LM024	Upper Iowa River	8.57	Southern Streams RR	37	29.35	13-Aug-15
07060002-509	15LM019	Upper Iowa River	72.73	Southern Streams RR	37	39.00	13-Aug-15
07060002-548	04LM106	Little Iowa River	26.26	Southern Forest Streams GP	43	39.87	31-Aug-04
07060002-546	15LM016	Beaver Creek	18.18	Southern Streams RR	37	43.62	14-Aug-15
07060002-546	15LM014	Beaver Creek	26.60	Southern Streams RR	37	42.28	14-Aug-15
07060002-546	04LM018	Beaver Creek	8.45	Southern Streams RR	37	29.59	24-Aug-04
07060002-550	15LM020	Upper Iowa River	36.04	Southern Streams RR	37	40.49	12-Aug-15
07060002-537	15LM015	Unnamed creek	4.24	Southern Forest Streams GP	43	24.77	14-Aug-15
07060002-544	15LM021	Unnamed creek	5.53	Southern Forest Streams GP	43	33.33	12-Aug-15
07060002-526	15LM023	North Branch Upper Iowa River	7.73	Southern Forest Streams GP	43	41.32	13-Aug-15
07060002-526	15LM023	North Branch Upper Iowa River	7.73	Southern Forest Streams GP	43	59.55	04-Aug-16
07060002-552	15LM018	Unnamed creek	5.71	Southern Forest Streams GP	43	46.72	13-Aug-15
07060002-550	15LM022	Upper Iowa River	23.58	Southern Streams RR	37	29.52	13-Aug-15
Coldwater Creek: 0706000202-01							
07060002-520	15LM009	Deer Creek	4.91	Southern Forest Streams GP	43	56.79	18-Aug-15
07060002-506	02LM010	Upper Iowa River	243.01	Southern Streams RR	37	35.91	14-Aug-15

National Hydrography Dataset (NHD) Assessment Segment WID	Biological station ID	Stream segment name	Drainage area Mi^2	Invert class	Threshold	MIBI	Visit date
07060002-521	15LM010	Elliot Creek	1.73	Southern Streams RR	37	31.26	18-Aug-15
07060002-506	04LM048	Upper Iowa River	218.92	Southern Streams RR	37	56.14	24-Aug-04
07060002-505	15LM008	Unnamed Creek	2.31	Southern Forest Streams GP	43	26.40	18-Aug-15
Bear Creek: 0706000205-01							
07060002-535	15LM005	Unnamed creek	5.34	Southern Coldwater	43	34.23	11-Aug-16
07060002-515	15LM004	Bee Creek (Waterloo Creek)	18.52	Southern Coldwater	43	79.33	04-Aug-15
07060002-535	15LM005	Unnamed creek	5.34	Southern Coldwater	43	36.74	04-Aug-15

Appendix 4.1 – Fish species found during biological monitoring surveys

Common name	Quantity of stations where present	Quantity of individuals collected
Upper Iowa River		
American brook lamprey	6	74
banded darter	4	74
bigmouth shiner	17	1084
black bullhead	7	14
black redhorse	2	144
blacknose dace	4	80
blackside darter	8	72
bluegill	1	1
bluntnose minnow	20	3226
brassy minnow	4	46
brook stickleback	19	616
brook trout	1	1
brown trout	1	106
carmine shiner	11	304
central mudminnow	3	4
central stoneroller	18	4250
common carp	3	8
common shiner	19	5210
creek chub	23	2173
fantail darter	17	722
fathead minnow	18	323
Gen: redhorses	2	3
golden redhorse	12	195
gravel chub	2	24
green sunfish	14	171
hornyhead chub	17	1329
hybrid minnow	1	1
hybrid sunfish	1	1
Iowa darter	2	10
johnny darter	22	1961
lamprey ammocoete	1	9
largemouth bass	3	3
longnose dace	2	62
mottled sculpin	1	73
northern hogsucker	10	256
orangespotted sunfish	6	122
quillback	2	56
rainbow darter	15	1043

Common name	Quantity of stations where present	Quantity of individuals collected
rainbow trout	1	1
redfin shiner	1	3
rock bass	11	113
sand shiner	3	221
shorthead redhorse	2	47
slenderhead darter	1	1
slimy sculpin	1	770
smallmouth bass	8	86
southern redbelly dace	17	3305
spotfin shiner	2	22
stonecat	4	9
suckermouth minnow	8	77
white sucker	22	2144
yellow bullhead	4	6
Mississippi River - Reno		
American brook lamprey	1	2
black crappie	1	1
blacknose dace	1	42
bluegill	2	5
brook stickleback	6	143
brook trout	6	111
brown trout	10	1082
burbot	1	1
central mudminnow	4	21
chestnut lamprey	1	1
common carp	1	1
common shiner	1	1
creek chub	2	29
emerald shiner	1	24
fantail darter	1	10
golden shiner	1	3
green sunfish	1	1
lamprey ammocoete	1	1
largemouth bass	2	47
logperch	1	1
longnose dace	3	33
mimic shiner	1	6
northern pike	2	14
pumpkinseed	1	5
rainbow trout	6	9
shorthead redhorse	1	3
slimy sculpin	3	678

Common name	Quantity of stations where present	Quantity of individuals collected
spotfin shiner	1	52
spottail shiner	1	81
tiger trout	1	1
walleye	2	3
warmouth	1	1
weed shiner	2	212
white sucker	8	664
yellow bullhead	3	13
yellow perch	2	15
Mississippi River - LaCrescent		
black bullhead	1	1
blacknose dace	3	170
bluntnose minnow	2	4
brook stickleback	7	66
brook trout	2	66
brown trout	6	335
burbot	1	1
central mudminnow	2	5
common shiner	1	1
creek chub	5	87
emerald shiner	1	1
fathead minnow	6	25
golden shiner	1	1
green sunfish	4	242
Iowa darter	4	17
largemouth bass	3	39
longnose dace	2	53
mud darter	1	7
northern pike	2	3
shorthead redhorse	1	1
spottail shiner	2	5
weed shiner	3	145
white sucker	7	328
yellow perch	2	3

Appendix 4.2 – Macroinvertebrate species found during biological monitoring surveys

Taxonomic name	Quantity of stations where present	Quantity of individuals collected
Upper Iowa River		
Ablabesmyia	11	24
Acari	16	183
Acentrella	8	64
Acroneuria	1	1
Aeshna	6	9
Aeshnidae	2	2
Agabinae	1	1
Anacaena	1	1
Anafroptilum	1	2
Ancyronyx	1	3
Anopheles	2	28
Antocha	4	10
Atherix	6	6
Atrichopogon	1	1
Aulodrilus	1	1
Baetidae	3	15
Baetis	24	676
Baetisca	4	14
Belostoma	1	
Berosus	1	1
Boyeria	6	6
Brachycentrus	5	123
Branchiobdellida	4	19
Bratislavia	1	1
Brillia	18	107
Caecidotea	3	58
Caenis	9	40
Callibaetis	1	
Calopterygidae	6	32
Calopteryx	8	43
Cambaridae	6	11
Cambarus	1	1
Cardiocladius	1	7
Ceraclea	1	
Ceratopogoninae	2	2
Ceratopsyche	22	467
Cheumatopsyche	22	498
Chironomidae	1	1

Taxonomic name	Quantity of stations where present	Quantity of individuals collected
Chironomini	10	53
Chironomus	1	1
Cladotanytarsus	13	31
Coenagrionidae	8	74
Conchapelopia	3	3
Corixidae	7	13
Corynoneura	9	15
Cricotopus	19	247
Cryptochironomus	8	15
Cryptotendipes	9	15
Culicidae	2	10
Dero	1	1
Dicranota	3	6
Dicrotendipes	15	65
Dixa	1	1
Dixella	5	13
Dixidae	2	2
Dubiraphia	13	75
Dytiscidae	3	5
Ectopria	2	2
Empididae	4	9
Enallagma	2	6
Enchytraeus	8	11
Endochironomus	2	2
Ephoron	1	1
Ephydridae	8	23
Erioptera	1	2
Eukiefferiella	12	28
Ferrissia	14	96
Forcipomyiinae	2	4
Fossaria	1	1
Gammarus	6	55
Glyptotendipes	3	11
Gyraulus	3	11
Gyrinus	1	1
Helichus	6	29
Helicopsyche	6	56
Hemerodromia	4	6
Heptageniidae	4	6
Hetaerina	1	2
Heterotrissocladius	2	12

Taxonomic name	Quantity of stations where present	Quantity of individuals collected
Hirudinea	6	6
Hyalella	5	42
Hydatophylax	1	1
Hydrochus	1	1
Hydrophilidae	2	2
Hydropsyche	12	109
Hydropsychidae	13	111
Hydroptila	13	52
Hydroptilidae	6	20
Hydrozoa	1	2
Isonychia	2	3
Iswaeon	1	1
Labiobaetis	6	47
Labrundinia	18	154
Laccobius	1	1
Larsia	1	4
Lepidostoma	1	1
Leptoceridae	1	1
Leptophlebiidae	1	1
Limnephilidae	4	5
Limnephilus	3	6
Limnodrilus	2	2
Limnophyes	5	23
Liodessus	1	2
Lymnaeidae	6	9
Maccaffertium	2	7
Macronychus	5	10
Merragata	1	1
Metriocnemus	1	1
Micropsectra	15	117
Microtendipes	16	47
Microvelia	1	1
Muscidae	1	4
Naididae	2	2
Nais	17	43
Nanocladius	6	10
Nectopsyche	5	18
Nemata	4	10
Neoplasta	3	5
Neoplea	1	2
Neoporus	1	1

Taxonomic name	Quantity of stations where present	Quantity of individuals collected
Nigronia	1	1
Nilotanypus	3	3
Odontomesa	1	2
Oligochaeta	2	18
Ophidonais	1	8
Ophiogomphus	1	
Optioservus	8	23
Orconectes	12	7
Orthocladiinae	9	48
Orthocladius	8	21
Pagastia	2	4
Palmacorixa	1	2
Paracladopelma	1	1
Paracymus	1	1
Paragnetina	2	2
Parakiefferiella	4	12
Paralauterborniella	1	1
Paramerina	1	3
Parametriocnemus	11	32
Paratanytarsus	20	181
Paratendipes	11	33
Peltodytes	1	1
Pericoma / Telmatoscopus	1	1
Petrophila	1	4
Phaenopsectra	14	45
Phryganeidae	1	1
Physa	2	85
Physella	19	640
Pisidiidae	20	98
Planorbella	1	8
Plauditus	4	7
Polycentropodidae	1	2
Polypedilum	23	1165
Procladius	3	6
Procloeon	3	8
Prodiamesa	2	6
Protoptila	1	1
Psectrocladius	1	1
Pseudocloeon	2	3
Pseudosuccinea	1	1
Psychoda	1	1

Taxonomic name	Quantity of stations where present	Quantity of individuals collected
Pteronarcys	1	1
Ptilostomis	3	11
Pycnopsyche	1	1
Quistadrilus	1	1
Radotanypus	2	8
Rheocricotopus	4	6
Rheotanytarsus	19	354
Saetheria	8	16
Sanfilippodytes	1	1
Sciomyzidae	2	9
Scirtidae	1	1
Sigara	3	5
Simulium	21	485
Stagnicola	4	4
Stempellinella	1	1
Stenacron	4	7
Stenelmis	17	97
Stenochironomus	4	6
Stenonema	4	6
Stictochironomus	2	5
Tabanidae	1	1
Tanypodinae	12	18
Tanytarsini	12	40
Tanytarsus	17	70
Thienemanniella	11	18
Thienemannimyia Gr.	23	133
Tipula	4	8
Tipulidae	1	1
Trepaxonemata	3	3
Tribelos	3	3
Trichocorixa	1	1
Tricorythodes	3	19
Tubificinae	11	52
Tvetenia	22	250
Valvata	1	1
Zavrelimyia	12	43
Mississippi River - Reno		
Acari	11	313
Acentrella	1	4
Amphipoda	2	3
Anopheles	3	7

Taxonomic name	Quantity of stations where present	Quantity of individuals collected
Antocha	1	5
Argia	1	1
Baetidae	5	34
Baetis	12	917
Belostoma	2	2
Brachycentridae	1	1
Brachycentrus	9	484
Brillia	1	1
Caecidotea	4	573
Caenis	2	6
Callibaetis	1	1
Callicorixa	1	1
Caloparyphus	1	1
Cambaridae	2	1
Cambarus	2	2
Ceratopogonidae	1	2
Ceratopsyche	9	206
Cheumatopsyche	8	35
Chimarra	1	2
Chrysops	1	1
Cladotanytarsus	2	2
Coenagrionidae	3	46
Conchapelopia	1	1
Corixidae	4	9
Corynoneura	2	4
Cricotopus	8	76
Cryptochironomus	2	3
Dicranota	2	6
Dicrotendipes	2	2
Dixa	3	5
Dubiraphia	1	1
Dytiscidae	3	4
Enchytraeus	1	1
Ephemerella	2	8
Ephemerellidae	1	4
Ephydridae	2	4
Eukiefferiella	6	43
Gammarus	11	541
Glossosoma	3	28
Glossosomatidae	4	8
Gyraulus	2	2

Taxonomic name	Quantity of stations where present	Quantity of individuals collected
Haliplus	1	3
Helichus	1	1
Helopelopia	1	1
Hemerodromia	1	1
Heptagenia	3	21
Heptageniidae	3	8
Hesperophylax	1	1
Hetaerina	1	10
Heterotrissocladius	1	1
Hirudinea	3	2
Hyalella	4	26
Hydropsyche	6	27
Hydropsychidae	7	52
Hydroptila	6	50
Hydroptilidae	4	27
Iswaeon	4	54
Labiobaetis	1	29
Lepidostoma	2	10
Leptoceridae	1	1
Leptophlebiidae	3	22
Limnephilidae	1	2
Limnephilus	1	1
Limnodrilus	1	1
Limnophyes	1	1
Limonia	1	1
Lymnaeidae	1	1
Maccaffertium	3	4
Metriocnemus	1	3
Micrasema	2	2
Micropsectra	5	19
Microtendipes	3	7
Microvelia	2	2
Nais	1	1
Nanocladius	2	2
Nemata	4	4
Neophylax	1	1
Neoplasta	2	2
Odontomyia /Hedriodiscus	1	1
Oecetis	3	43
Oligochaeta	2	26
Optioservus	7	85

Taxonomic name	Quantity of stations where present	Quantity of individuals collected
Orconectes	2	1
Orthocladiinae	3	5
Orthocladius	3	10
Pagastia	5	10
Parachironomus	1	1
Paralauterborniella	1	1
Parametriocnemus	6	26
Paratanytarsus	4	70
Paratendipes	1	1
Pelocoris	1	1
Pentaneura	1	27
Pericoma	1	1
Pericoma / Telmatoscopus	1	2
Physa	2	53
Physella	9	535
Pisidiidae	8	20
Polypedilum	8	136
Potthastia	1	1
Protoptila	1	2
Pseudocloeon	1	1
Pseudosuccinea	1	1
Psilometriocnemus	1	2
Radotanypus	1	1
Rheocricotopus	3	8
Rheotanytarsus	7	206
Sialis	1	1
Sigara	4	4
Simulium	12	306
Stenacron	2	9
Stenelmis	1	29
Tanypodinae	4	5
Tanytarsini	3	15
Tanytarsus	4	39
Teloganopsis	2	11
Thienemanniella	6	12
Thienemannimyia Gr.	9	26
Tipula	1	1
Tipulidae	1	1
Trepaxonemata	7	76
Trichoclinocera	1	2
Tricorythodes	4	8

Taxonomic name	Quantity of stations where present	Quantity of individuals collected
Tubificinae	6	20
Tvetenia	10	87
Uenoidae	1	4
Zavrelimyia	5	9
Mississippi River – La Crescent		
Ablabesmyia	1	1
Acari	6	109
Acentrella	1	1
Aeshna	2	1
Agabus	1	1
Amphipoda	1	19
Antocha	1	1
Atherix	2	9
Baetidae	1	2
Baetis	8	891
Belostoma	4	3
Boyeria	1	1
Brachycentrus	7	180
Branchiobdellida	1	31
Brillia	2	11
Caecidotea	5	64
Caenis	4	32
Ceratopogonidae	1	1
Ceratopogoninae	1	1
Ceratopsyche	7	59
Cheumatopsyche	4	33
Chimarra	1	1
Chironomini	1	4
Clinocerinae	1	1
Coenagrionidae	1	1
Conchapelopia	1	1
Corixidae	1	1
Corynoneura	2	4
Cricotopus	7	34
Culicidae	1	1
Dicranota	2	4
Dixidae	2	2
Dubiraphia	1	2
Dytiscidae	1	1
Elmidae	1	1
Enchytraeus	2	3

Taxonomic name	Quantity of stations where present	Quantity of individuals collected
Ephemerella	2	5
Ephemerellidae	1	1
Ephydridae	5	15
Eukiefferiella	4	15
Ferrissia	1	1
Fridericia	1	1
Gammaridae	1	12
Gammarus	8	342
Glossosoma	2	16
Gyrinus	1	1
Hemerodromia	5	6
Heptagenia	4	42
Heptageniidae	4	12
Hesperophylax	1	1
Heterotrissocladius	2	3
Hexagenia	1	1
Hirudinea	2	3
Hyalella	2	16
Hydropsyche	4	91
Hydropsychidae	6	71
Hydroptila	4	24
Hydroptilidae	3	9
Iswaeon	2	19
Labiobaetis	2	48
Lepidostoma	2	63
Leptoceridae	1	1
Leptophlebiidae	1	1
Limnephilidae	1	2
Limnephilus	2	35
Limnophila	1	1
Limnophyes	4	9
Liodessus	1	1
Lumbriculidae	1	1
Lymnaeidae	3	3
Maccaffertium	2	8
Macronychus	3	13
Micropsectra	5	77
Microtendipes	1	4
Microvelia	1	1
Naididae	1	2
Nais	3	9

Taxonomic name	Quantity of stations where present	Quantity of individuals collected
Nanocladius	5	10
Nectopsyche	3	7
Nemata	4	9
Neoplasta	1	1
Notonecta	1	1
Oecetis	1	6
Oligochaeta	2	21
Ophidonais	1	1
Optioservus	2	11
Orconectes	5	2
Orthocladiinae	4	9
Pagastia	1	1
Paracladopelma	1	1
Parakiefferiella	1	1
Paraleptophlebia	1	1
Parametriocnemus	8	51
Paraphaenocladius	2	2
Paratanytarsus	3	13
Paratendipes	1	10
Pelocoris	2	8
Phaenopsectra	1	1
Physa	3	39
Physella	1	2
Pisidiidae	2	7
Polypedilum	8	154
Procambarus	1	1
Procladius	1	1
Pseudocloeon	2	14
Pseudosuccinea	3	4
Ptilostomis	1	2
Radotanypus	1	6
Rheotanytarsus	7	177
Simulium	8	535
Stagnicola	1	1
Tanypodinae	2	3
Tanytarsini	4	26
Tanytarsus	3	7
Thienemanniella	6	18
Thienemannimyia Gr.	6	25
Tipula	1	1
Tipulidae	1	1

Taxonomic name	Quantity of stations where present	Quantity of individuals collected
Trepaxonemata	3	22
Tricorythodes	4	12
Tubificinae	4	21
Tvetenia	7	65
Xenochironomus	1	1
Zavrelimyia	2	4

Appendix 5 – Minnesota Stream Habitat Assessment results

Habitat information documented during each fish sampling visit is provided. This table conveys 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 aggregated HUC-12 subwatershed.

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
2	15LM042	Dakota Creek	2.5	9.0	20.1	12.5	27.0	71.1	Good
Average Habitat Results: *Halfway Creek Aggregated 12 HUC*			2.5	9.0	20.1	12.5	27.0	71.1	Good

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
3	15LM041	Pine Creek	2.2	10.5	19.7	13.0	25.0	70.3	Good
3	04LM093	Rose Valley Creek	1.9	5.3	14.6	8.7	15.7	46.2	Fair
1	04LM034	Pine Creek	5.0	10.5	9.0	6.0	9.0	39.5	Poor
2	04LM061	Pine Creek	1.1	4.8	10.0	7.0	14.5	37.4	Poor
2	15LM039	Pine Creek	3.8	10.0	11.4	7.0	14.0	46.2	Fair
3	15LM040	Pine Creek	2.1	2.0	14.4	10.7	19.7	48.9	Fair
3	15LM043	Pine Creek	3.3	10.8	10.2	10.0	15.0	49.4	Fair
Average Habitat Results: *Pine Creek Aggregated 12 HUC*			2.8	7.7	12.8	8.9	16.1	48.3	Fair

# 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	15LM027	Crooked Creek	2.5	8.8	7.5	7.5	12.0	38.3	Poor
1	10EM162	Unnamed creek	5.0	5.0	16.0	8.0	24.0	58.0	Fair
4	15LM037	Crooked Creek	3.2	5.0	8.8	10.5	8.8	36.2	Poor
3	15LM034	Crooked Creek, North Fork	1.7	8.3	21.4	12.7	28.0	72.1	Good

# 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
5	15LM035	Crooked Creek, North Fork	2.2	7.6	21.2	13.8	21.6	66.4	Good
2	15LM036	Clear Creek	3.8	6.5	4.5	12.0	14.5	41.3	Poor
4	15LM033	Crooked Creek, South Fork	2.5	6.4	20.0	12.5	25.3	66.7	Good
Average Habitat Results: *Crooked Creek Aggregated 12 HUC*			3.0	6.8	14.2	11.0	19.2	54.1	Fair

# 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	15LM030	Winnebago Creek	2.5	10.3	19.8	12.0	24.0	68.5	Good
3	15LM031	Unnamed creek	1.7	9.5	18.8	10.3	16.0	56.3	Fair
1	04LM030	Trib. to Winnebago Creek	2.0	6.0	15.6	11.0	24.0	58.6	Fair
2	15LM028	Winnebago Creek	3.3	11.0	11.0	9.0	16.5	50.7	Fair
Average Habitat Results: *Winnebago Creek Aggregated 12 HUC*			2.4	9.2	16.3	10.6	20.1	58.5	Fair

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
3	15LM038	Wildcat Creek	2.5	10.2	17.3	11.7	21.7	63.3	Fair
Average Habitat Results: *Mormon Creek Aggregated 12 HUC*			2.5	10.2	17.3	11.7	21.7	63.3	Fair

# 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	15LM019	Upper Iowa River	1.3	8.0	12.6	11.0	19.0	51.9	Fair
5	15LM023	Upper Iowa River, North Branch	0.5	8.9	16.0	8.8	17.6	51.8	Fair
3	15LM015	Unnamed creek	1.7	11.2	15.5	9.3	18.7	56.3	Fair
2	15LM026	Trib. to Little Iowa River	0.0	7.3	18.6	10.0	21.5	57.4	Fair
2	15LM021	Trib. to Upper Iowa River	0.0	9.8	10.5	8.5	17.0	45.8	Fair
1	04LM018	Beaver Creek	1.0	7.0	16.6	10.0	26.0	60.6	Fair
2	15LM014	Beaver Creek	1.3	8.8	15.2	10.5	24.5	60.2	Fair
2	15LM016	Beaver Creek	0.0	11.5	14.6	10.0	24.0	60.1	Fair

# 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	15LM017	Beaver Creek	0.8	8.0	8.0	8.0	10.0	34.7	Poor
1	04LM106	Little Iowa River	0.0	9.5	19.0	8.0	14.0	50.5	Fair
2	15LM025	Little Iowa River	0.0	6.8	19.0	12.0	19.5	57.3	Fair
2	15LM045	Little Iowa River	3.8	13.0	22.3	13.5	23.0	75.6	Good
2	15LM020	Upper Iowa River	3.8	10.8	13.3	10.5	21.5	59.8	Fair
2	15LM022	Upper Iowa River	1.3	6.3	12.3	9.5	18.5	47.8	Fair
2	15LM024	Upper Iowa River	1.3	9.3	12.6	8.5	21.0	52.6	Fair
3	15LM018	Unnamed creek	0.5	9.2	15.5	9.3	18.3	52.8	Fair
Average Habitat Results: *Headwaters Upper Iowa River Aggregated 12 HUC*			1.1	9.1	15.1	9.8	19.6	54.7	Fair

# 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	15LM008	Unnamed creek	0.0	11.3	10.9	10.5	14.0	46.7	Fair
2	02LM010	Upper Iowa River	2.5	8.0	16.3	9.5	19.0	55.3	Fair
1	04LM048	Upper Iowa River	1.0	7.0	20.0	9.0	18.0	55.0	Fair
3	15LM009	Deer Creek	0.0	4.8	5.7	11.7	12.3	34.5	Poor
2	15LM010	Elliot Creek	0.0	6.8	15.8	12.0	20.5	55.1	Fair
Average Habitat Results: *Coldwater Creek Aggregated 12 HUC*			0.7	7.6	13.7	10.5	16.8	49.3	Fair

# 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	15LM004	Bee Creek (Waterloo Creek)	1.8	11.5	22.0	14.5	28.0	77.8	Good
3	15LM005	Unnamed creek	0.8	4.3	17.5	12.3	25.0	60.0	Fair
Average Habitat Results: *Bear Creek Aggregated 12 HUC*			1.3	7.9	19.8	13.4	26.5	68.9	Good

Qualitative habitat ratings

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

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

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