Des Moines River Basin in Minnesota Monitoring and Assessment Report

Minnesota Pollution Control Agency

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Contents

Tables

Figures

List of Acronyms

AUID Assessment Unit Identification Determination

CD County Ditch

CI Confidence Interval

CLMP Citizen Lake Monitoring Program

CR County Road

CSAH County State Aid Highway

CSMP Citizen Stream Monitoring Program

CWA Clean Water Act

CWLA Clean Water Legacy Act

DNR Minnesota Department of Natural Resources

DOP Dissolved Orthophosphate

E Eutrophic

EQuIS Environmental Quality Information System

EX Exceeds Criteria (Bacteria)

EXP Exceeds Criteria, Potential Impairment

EXS Exceeds Criteria, Potential Severe Impairment

FS Full Support

FWMC Flow Weighted Mean Concentration

H Hypereutrophic

HUC Hydrologic Unit Code

IBI Index of Biotic Integrity

IF Insufficient Information

K Potassium

LRVW Limited Resource Value Water

M Mesotrophic

MCES Metropolitan Council Environmental Services

MDA Minnesota Department of Agriculture

MDH Minnesota Department of Health

MINLEAP Minnesota Lake Eutrophication Analysis Procedure

MPCA Minnesota Pollution Control Agency

MSHA Minnesota Stream Habitat Assessment

MTS Meets the Standard

N Nitrogen

Nitrate-N Nitrate Plus Nitrite Nitrogen

NA Not Assessed

NHD National Hydrologic Dataset

NH3 Ammonia

NS Not Supporting

NT No Trend

OP Orthophosphate

P Phosphorous

PCB Poly Chlorinated Biphenyls

PWI Protected Waters Inventory

RNR River Nutrient Region

SWAG Surface Water Assessment Grant

SWCD Soil and Water Conservation District

SWUD State Water Use Database

TALU Tiered Aquatic Life Uses

TKN Total Kjeldahl Nitrogen

TMDL Total Maximum Daily Load

TP Total Phosphorous

TSS Total Suspended Solids

USGS United States Geological Survey

WPLMN Watershed Pollutant Load Monitoring Network

Executive summary

The monitoring and assessment report is the first in a series of reports for watershed work conducted in the three Minnesota watersheds of the Des Moines River Basin. The report shares information on monitoring conducted to further information about the watersheds through Intensive Watershed Monitoring (IWM), and assessments on aquatic life, aquatic recreation, and drinking water uses. Subsequent reports will address stressor identification biological impairments, total maximum daily loads (TMDLs), and Watershed Restoration and Protection Strategies (WRAPS) for these watersheds.

The three Des Moines River Watersheds are located in southwestern Minnesota, and include Headwaters of the Des Moines River (07100001), Lower Des Moines River (07100002), and East Fork Des Moines River (07100003). The Lower Des Moines and East Fork Des Moines Watersheds extend out of Minnesota into Iowa. This report will only focus on the portions of watersheds within Minnesota. In total, these watersheds drain 1559.6 mi^2 in seven Minnesota counties (Cottonwood, Jackson, Martin, Murray, Nobles, Lyon, and Pipestone). Intensive agricultural land use has drastically changed the landscape and the water quality of these watersheds. Only a small percentage of land is undeveloped forest and wetlands and only 1% is open water (lakes, rivers, streams, ditches).

The anthropogenic effects of the agricultural land use has greatly diminished the aquatic life and aquatic recreation of the lakes and streams. In the Des Moines River Basin 9% of streams are supporting of aquatic life use and 7% of streams are fully supporting aquatic recreation use. Sixty stream reaches do not support aquatic life use. There is widespread aquatic life impairments due to water chemistry. There are turbidity (19), dissolved oxygen (3), chloride (1), pH (1), eutrophication (3), and ammonia (1) spread throughout the three watersheds. All of the 12 lakes where aquatic life use was assessed were found to be non-supporting the use.

It is a rare occurrence to see a lake fully supporting the aquatic recreation standard in this region of Minnesota. Second Fulda Lake (51-0020-00) and First Fulda Lake (51-0021-00) are both meeting the aquatic recreation standard and both found in the Tributary to Jack Creek Watershed. These lakes and their associated watersheds went through a restoration effort in 2009 that was conducted by the local city and partners. Their efforts created a landscape to improve water quality that resulted in the delisting First Fulda.

Twenty-two stream reaches do not support aquatic recreation use. Only two of the stream reaches sampled for bacteria supports aquatic recreation use. Fifty-six of the 134 lakes greater than 10 acres in the Des Moines Basin were assessed for aquatic life and recreation. The widespread impairments point toward nonpoint sources as a major problem throughout the basin.

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 TMDLs. A TMDL is a comprehensive study determining the assimilative capacity of a waterbody, identifying all pollution sources causing or contributing to impairment, and an estimation of the reductions needed to restore a water body so that it can once again support its designated use.

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

The passage of Minnesota's Clean Water Legacy Act (CWLA) in 2006 provided a policy framework and the initial resources for state and local governments to accelerate efforts to monitor, assess, restore and protect surface waters. This work is implemented on an on-going basis with funding from the Clean Water Fund created by the passage of the Clean Water Land, and Legacy Amendment to the state constitution. To facilitate the best use of agency and local resources, the MPCA has developed a watershed monitoring strategy that 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 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 Des Moines Rivers Watersheds in Minnesota beginning in the summer of 2014. This report provides a summary of all water quality assessment results in the three Des Moines Rivers Watersheds (Headwaters of the West Fork, Lower West Fork, and East Fork) 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).

Intensive watershed monitoring

The IWM 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 that 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).

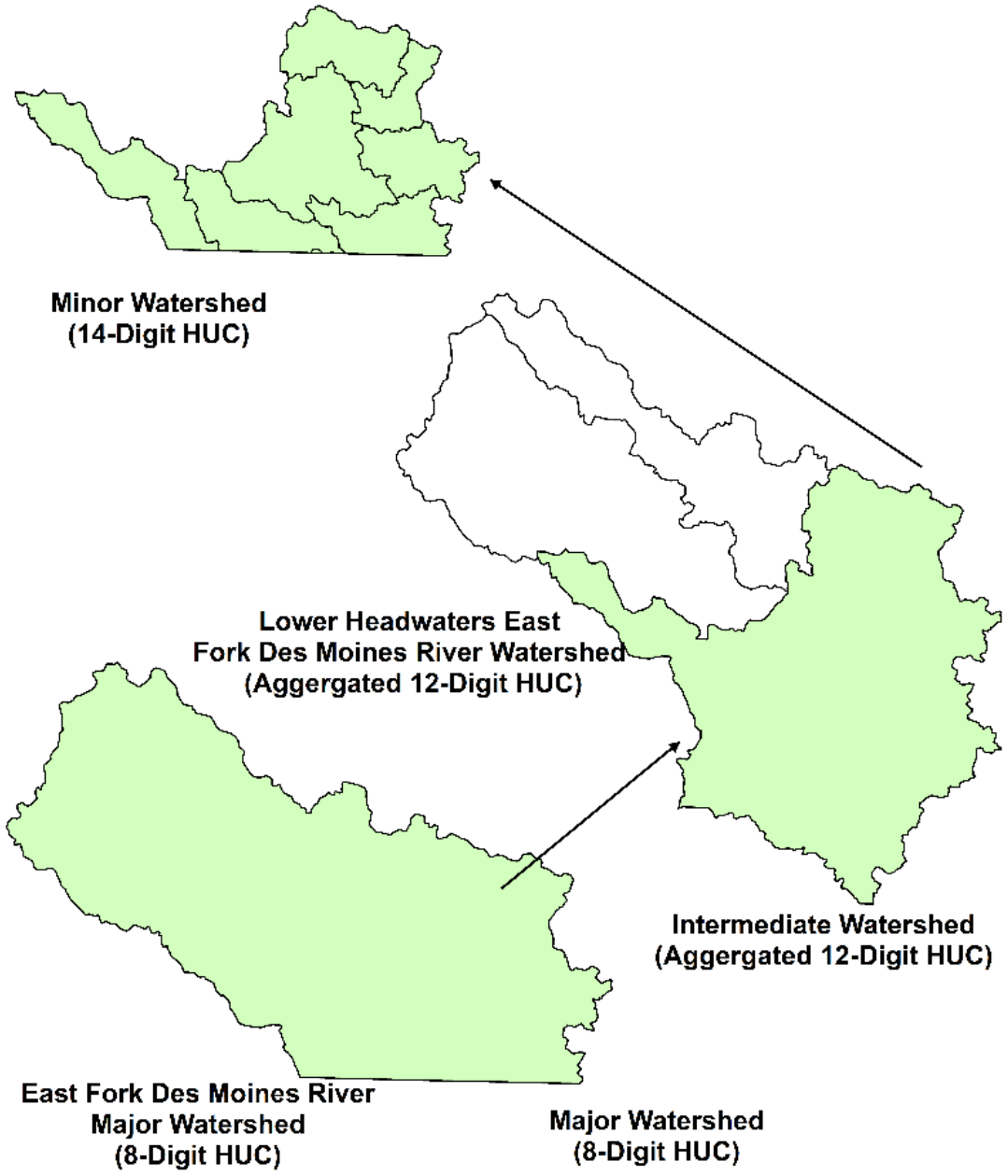

Figure 1. The Intensive Watershed Monitoring Design.

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 Des Moines River Watersheds are shown in Figure 2, Figure 3, and Figure 4 and are listed in Appendices 2.1 and 2.2.

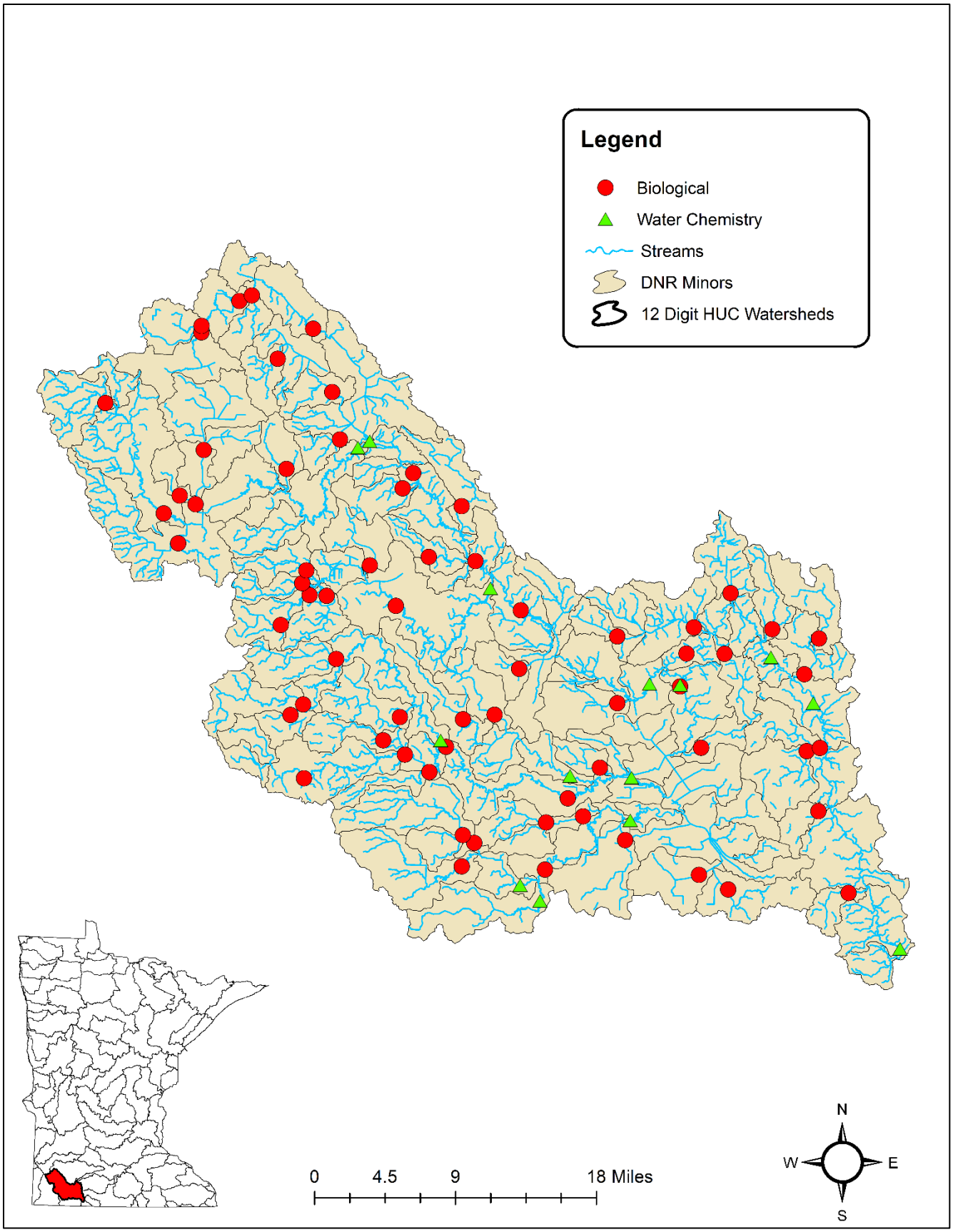

Figure 2. Intensive watershed monitoring sites for streams in the Des Moines River Headwaters Watershed.

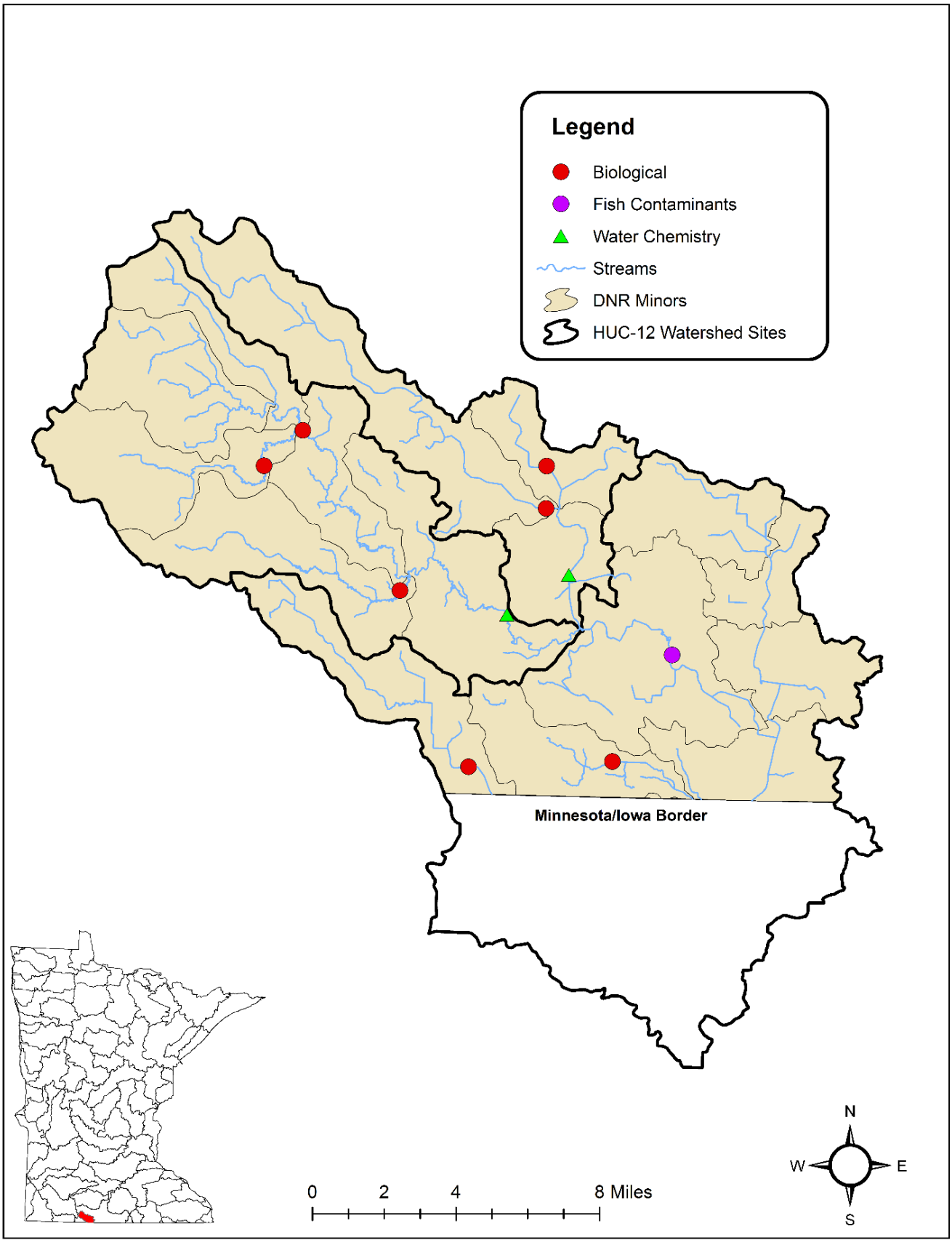

Figure 3. Intensive watershed monitoring sites for streams in the East Fork Des Moines River Watershed.

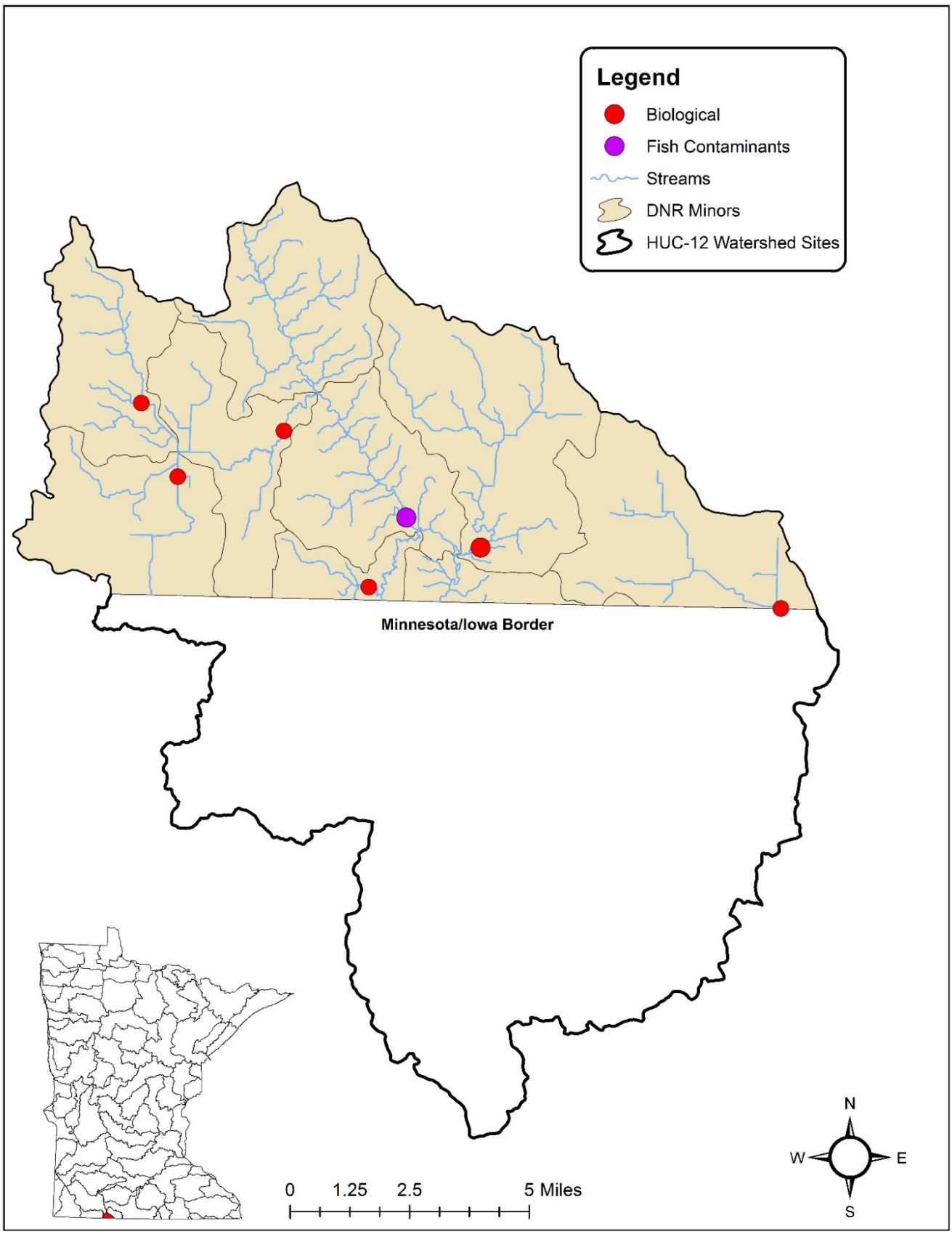

Figure 4. Intensive watershed monitoring sites for streams in the Lower Des Moines River Watershed.

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 IWM process. Funding passes from MPCA through Surface Water Assessment Grants (SWAGs) to local groups such as counties, soil and water conservation districts (SWCDs), watershed districts, nonprofits and educational institutions to support lake and stream water chemistry monitoring. Local partners use the same monitoring protocols as the MPCA, and all monitoring data from SWAG projects are combined with the MPCA's to assess the condition of Minnesota lakes and streams. Preplanning and coordination of sampling with local citizens and governments helps focus monitoring where it will be most effective for assessment and observing long-term trends. This allows citizens/governments 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. Like the permanent load monitoring network, having citizen volunteers monitor a given lake or stream site monthly and from year to year can provide the long-term picture needed to help evaluate current status and trends. Citizen monitoring is especially effective at helping to track water quality changes that occur in the years between intensive monitoring years. Figure 5 provides an illustration of the locations where citizen monitoring data were used for assessment in the Des Moines River Watersheds in Minnesota.

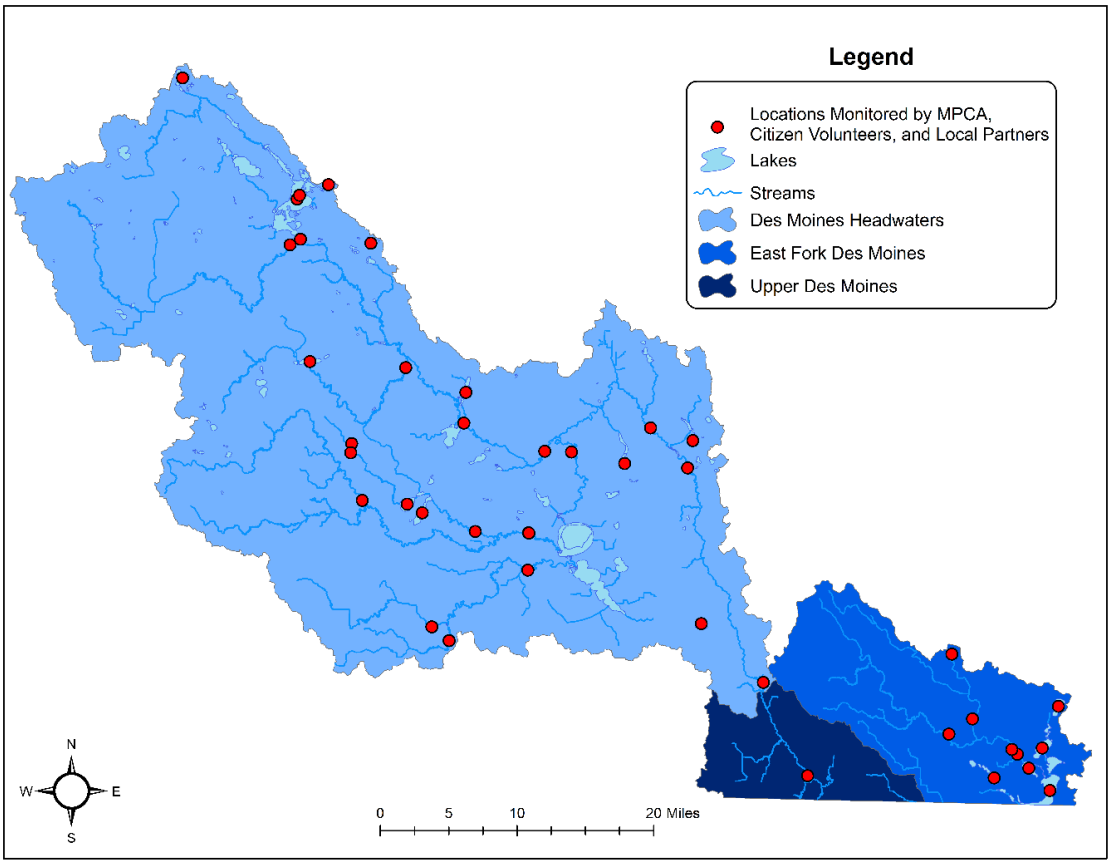

Figure 5. Monitoring locations of local groups, citizens and the MPCA lake monitoring staff in the three watersheds of the Des Moines River Basin in Minnesota.

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

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

Protection of aquatic life means the maintenance of a healthy aquatic community, including fish, invertebrates 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 (DO), un-ionized ammonia nitrogen, chloride, total suspended solids (TSS), 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 that 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 (Table 1). 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. Table of 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 cold water aquatic organisms that meet or exceed the General Use biological criteria.

Proposed Tiered Aquatic Life Use	Acronym	Proposed Use Class Code	Description
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 cold water 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, DO and toxic pollutants.

Assessment units

Assessments of use support in Minnesota are made for individual waterbodies. The waterbody unit used for river systems, lakes and wetlands is called the "assessment unit". A stream or river assessment unit usually extends from one significant tributary stream to another or from the headwaters to the first tributary. A stream "reach" may be further divided into two or more assessment reaches when there is a change in use classification (as defined in Minn. R., Ch. 7050) or when there is a significant morphological feature, such as a dam or lake, within the reach. Therefore, a stream or river is often segmented into multiple assessment units that are variable in length. The MPCA is using the 1:24,000 scale high resolution National Hydrologic Dataset (NHD) to define and index stream, lake and wetland assessment units. Each river or stream reach is identified by a unique waterbody identifier (known as its AUID), comprised of the 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 AUID and are composed of an eight-digit number indicating county, lake and bay for each basin.

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

Determining use attainment

For beneficial uses related to human health, such as drinking water or aquatic recreation, the relationship is well understood and thus the assessment process is a relatively simple comparison of monitoring data to numeric standards. In contrast, assessing whether a waterbody supports a healthy

aquatic community is not as straightforward and often requires multiple lines of evidence to make use attainment decisions with a high degree of certainty. Incorporating a multiple lines of evidence approach into MPCA's assessment process has been evolving over the past few years. The current process used to assess the aquatic life use of rivers and streams is outlined below and in.

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 that include watershed project managers and biology leads. The final approval to change a designated use is through formal rulemaking.

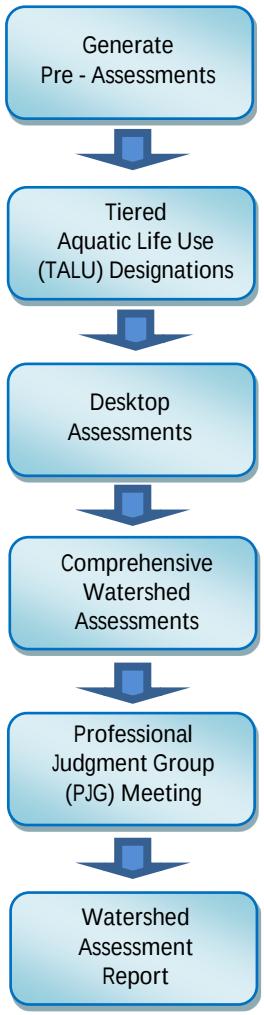

Figure 6. Flowchart of aquatic life use assessment process.

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. Iimplementing a comprehensive approach to water quality assessment requires a means of organizing and evaluating information to formulate a conclusion utilizing multiple lines of evidence. Occasionally, the evidence stemming from individual parameters 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-iw1-04i.pdf for guidelines and factors considered when making such determinations.

The last step in the assessment process is the Professional Judgment Group meeting. At this meeting, results are shared and discussed with entities outside of the MPCA that may have been involved in data collection or that might be responsible for local watershed reports and project planning. Information obtained during this meeting may be used to revise previous use attainment decisions (e.g., sampling

events that may have been uncharacteristic due to annual climate or flow variation, local factors such as impoundments that do not represent the majority of conditions on the AUID). Waterbodies that do not meet standards and therefore do not attain one or more of their designated uses are considered impaired waters and are placed on the draft 303(d) Impaired Waters List. Assessment results are also included in watershed monitoring and assessment reports.

Watershed overview

Historically, this portion of the Des Moines River Basin was home to Native American villages that used the land and rivers for hunting, fishing, and navigation. Fur trading, logging, and rich tillable soil brought European settlers to the region. Cities grew along the rivers and railroad corridors. Since immigrants arrived in the 1850s, the area has undergone considerable land use modification, including the plowing of its native prairies, harvesting of its hardwood forests, draining of its wetlands and lakes, and modifications to its natural stream courses. Many dams were placed along the Des Moines River and tributaries to harvest the energy of flowing water for operating flourmills. Additionally, many smaller dams were placed to maintain lake levels and control flooding.

Today, land is predominantly used for growing crops such as corn and soybeans, with some urban and forested land. State, county, and city parks associated with lakes, rivers, and streams provide recreational opportunities for fishing, swimming, canoeing, camping, hiking, bicycling, and bird watching. Drinking water quality and the recreational enjoyment of lakes and streams are valuable assets to the health of its citizens and the wealth of local economies throughout the watershed.

Three major watersheds in Minnesota are included in the Des Moines River Basin monitoring and assessment report. These three watersheds are located in southwestern Minnesota near the Iowa border. The Des Moines River - Headwaters (07100001) flows into the Lower Des Moines River (07100002) (also referred to as the West Fork of the Des Moines River), and East Fork Des Moines River (07100003) which flows into the Lower Des Moines River (West Fork) across the Minnesota border in Iowa. From there, the Des Moines River travels southeast before eventually entering the Mississippi River at Keokuk, Iowa. In total, the West and East Forks drain 1,635,152 acres of seven counties in Minnesota (Cottonwood, Jackson, Martin, Murray, Nobles, Lyon, and Pipestone). The Des Moines River is used for recreational activities such as fishing, tubing, snowmobiling, and canoeing. It is also a valuable fisheries resource with game fish such as northern pike, buffalo, carp, walleye, channel catfish, crappie, and bullhead. A brief description of each individual watershed is included below.

Headwaters of the Des Moines River Watershed (07100001)

This watershed drains approximately 801,772 acres of seven counties (Lyon, Pipestone, Murray, Cottonwood, Nobles, Jackson, and Martin). There are 14 communities in the watershed, the largest of which are the cities of Worthington, Slayton, Windom, Lakefield, Heron Lake, and Fulda. Heron, Shetek, and Sarah lakes are in this watershed. Larger streams and rivers include Okabena Creek, Elk Creek, Jack Creek, Beaver Creek, Lime Creek, and the West Fork Des Moines River. The outlet of the Des Moines River headwaters (07100001) flows into the Lower Des Moines River (07100002) in Jackson, Minnesota.

Lower Des Moines River Watershed (07100002)

The Lower Des Moines River Watershed is located in southwestern Minnesota and drains approximately 703,000 acres in Jackson and Martin Counties. This portion of the Des Moines River Basin flows out of the Headwaters of the Des Moines River Watershed (07100001) from south of Jackson and then travels to the Minnesota border into Iowa.

The East Fork Des Moines River Watershed (07100003)

Located in Martin and Jackson Counties, this portion of the East Fork Des Moines River Watershed in Minnesota drains 130,380 acres. Communities in the watershed include Alpha, Sherburn, Dunnell, Ceylon and Wilbert. The East Fork Des Moines River flows southeast for about 30 miles before coming into Okamanpeedan Lake on the Minnesota-Iowa border. Other lakes include Bright and Pierce. Several shallow waterfowl lakes are also located in the southern part of the watershed.

Water Use and Recreation

The waters in the watershed provide drinking water for households and industry, habitat for aquatic life, riparian corridors for wildlife, and many recreational opportunities. The West Fork and East Fork Des Moines Rivers pass through scenic landscapes of variable terrain, from flat fertile farmlands in the headwaters to the high bluff wooded valleys on the lower reaches of the Des Moines River. The Des Moines River from the Talcott Lake Dam to the border with Iowa is designated as a DNR as state water course that is navigable by canoe and kayak. At the start of the watercourse, the Des Moines River meanders through wildlife management areas (Talcott Lake, Winkler) and county parks (Pat's Grove and Dynamite) until it reaches Windom. Here the Des Moines travels swiftly as a Class 1 rapids at Island Park. The river then travels through the Des Moines River Prairie, Holthe, and Prairie Brush Clover Scenic and Natural Areas and Kilen Woods State Park. The Des Moines River Watersheds in Minnesota are dotted with lakes that are managed for game fish recreation. There is one trout stream, Sheldorf Creek, which has brown trout that brings residents to the area for fly fishing. Other natural areas for recreational enjoyment include state parks, scenic and natural areas, county parks, city parks, and bike trails which provide recreational opportunities for fishing, canoeing, hiking, biking, birdwatching, and snowmobiling.

Ecoregions and land use

The Des Moines River Watersheds in Minnesota falls entirely in the Western Cornbelt Plains and Northern Glaciated Plains Level III ecoregion (Omernik and Gallant 1988) (Figure 7). The ecosystem framework attempts to characterize broad regional differences in geology, physiography, vegetation, climate, soils, land use, wildlife, and hydrology (Omernik 1995). This framework helps to better understand ecosystem responses to disturbance (Bryce et al. 1999) and assists with the implementation of effective management strategies (Omernik et al. 2000).

The Level III ecoregions were recently further subdivided into Level IV ecoregions (EPA 2007). These watersheds are located within the Loess Prairies and Des Moines Lobe Level IV ecoregions. The Loess Prairies ecoregion is described as a "Loess covered undulating plain with dissecting rivers and predominantly row crop agriculture" and the Des Moines Lobe is described as a "Vast fertile plain of deep soils dominated by row crops" (EPA 2007).

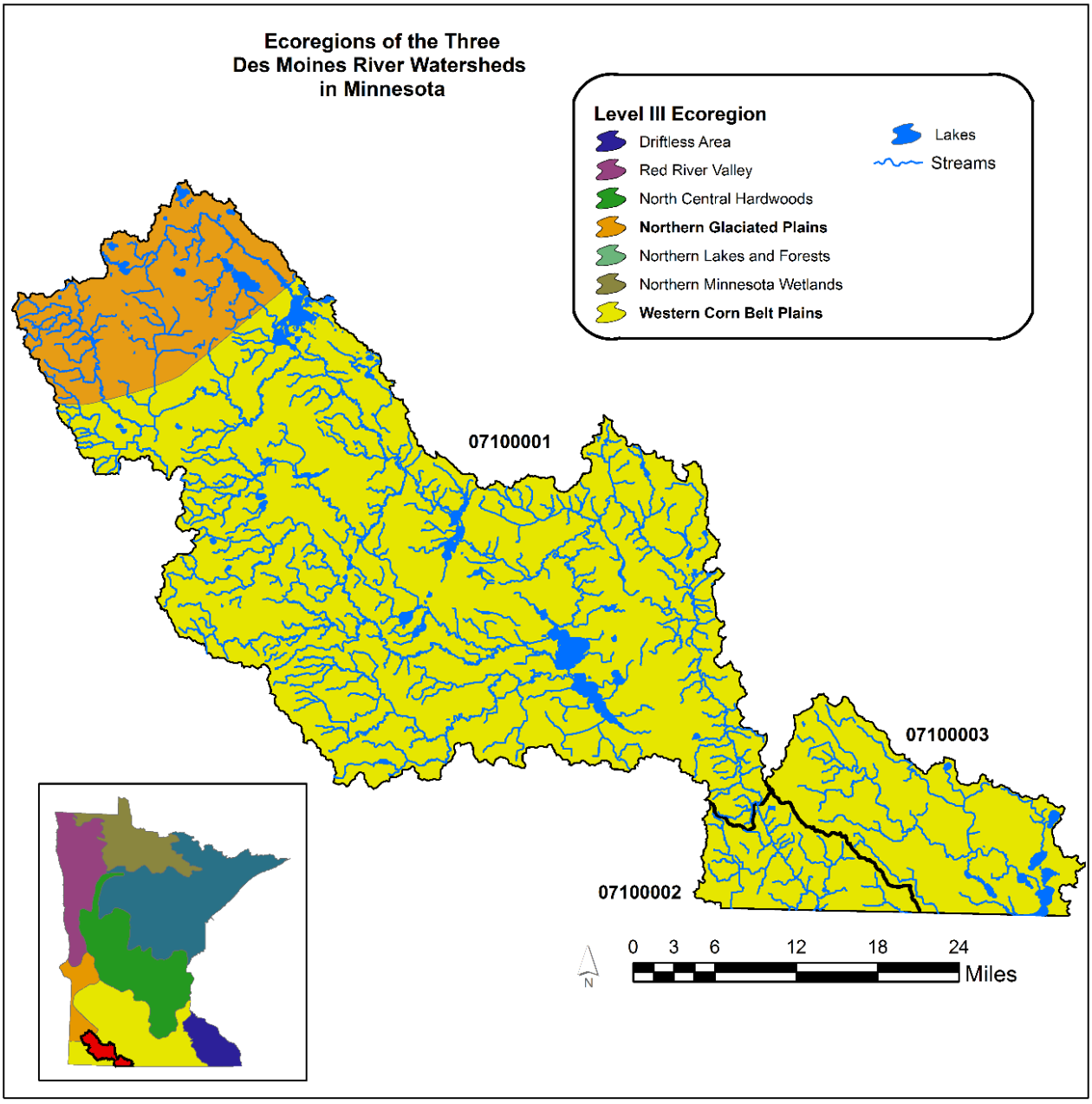

Figure 7. The three Des Moines River Watersheds within the Northern Glaciated Plains and Western Corn Belt Plains ecoregions of southwest Minnesota.

Land use summary

Land use within the Des Moines River Watersheds in Minnesota is uniform across the three watersheds (Figure 8). The three watersheds mainly drain agricultural land (~90%) with limited development (e.g., industrial land use, urban and rural housing, roads) comprising ~6%. Agricultural land is used predominantly for growing corn and soybeans (~85%) with small pockets rangeland (4.5%). A very small percentage of land is undeveloped forest and wetlands account for ~9% and open water (lakes, rivers, streams, ditches) only 1%.

The total watershed population is over 200,000. The largest cities in the Des Moines River Watersheds in Minnesota include: Jackson, Windom, Slayton, Fulda, and the eastern side of Worthington. Additionally, there are 26 smaller communities across the three watersheds.

As of 2008, there were 10 small communities identified as needing wastewater management improvements. The wastewater treatment concerns ranged from outdated septic systems to individual and community straight pipe connections to lakes and streams.

According to the Natural Resources Conservation Service (NRCS) (2007) reports, the top resource concerns in the Des Moines River Basin are sediment and erosion control, drinking water and source water protection, excessive wind erosion, excessive sheet and rill erosion, feedlot and animal waste management, nutrient management, and wetland management. The report indicates that there has been improvement in soil from wind and water erosion, as demonstrated by the 15 - year record (1982 to 1997). Newer data was not found at this time to indicate whether this trend is continuing. Excess sediment derived from overland erosion on unprotected cropland, urban lands, and increased stormwater volume can exacerbate eroding stream banks and stream bottoms thereby reducing water quality and limiting suitable habitat conditions for aquatic organisms. Animal waste has the potential to enter streams and lakes when placed near waterbodies without adequate containment or run-off control. Parts of the region are especially susceptible to groundwater and drinking water contamination due to: geology and soil characteristics that allow ease of water infiltration, open and abandoned wells, aging septic systems, and historical tiling practices (NRCS 2007). Excess nutrients (e.g., phosphorus, nitrogen) derived from fertilizer for lawns and cropland, undermanaged waste (e.g., aging or non-compliant septic systems, basic water treatment technology, and unsewered communities) and manure runoff from feedlots and cropland can contribute to unsightly and sometimes toxic algae conditions in lakes and rivers. Loss of wetlands and plowing in periodically flooded riparian areas has led to increases in stormwater volume and nutrients entering lakes and streams. A number of best management practices can be undertaken to reduce these concerns.

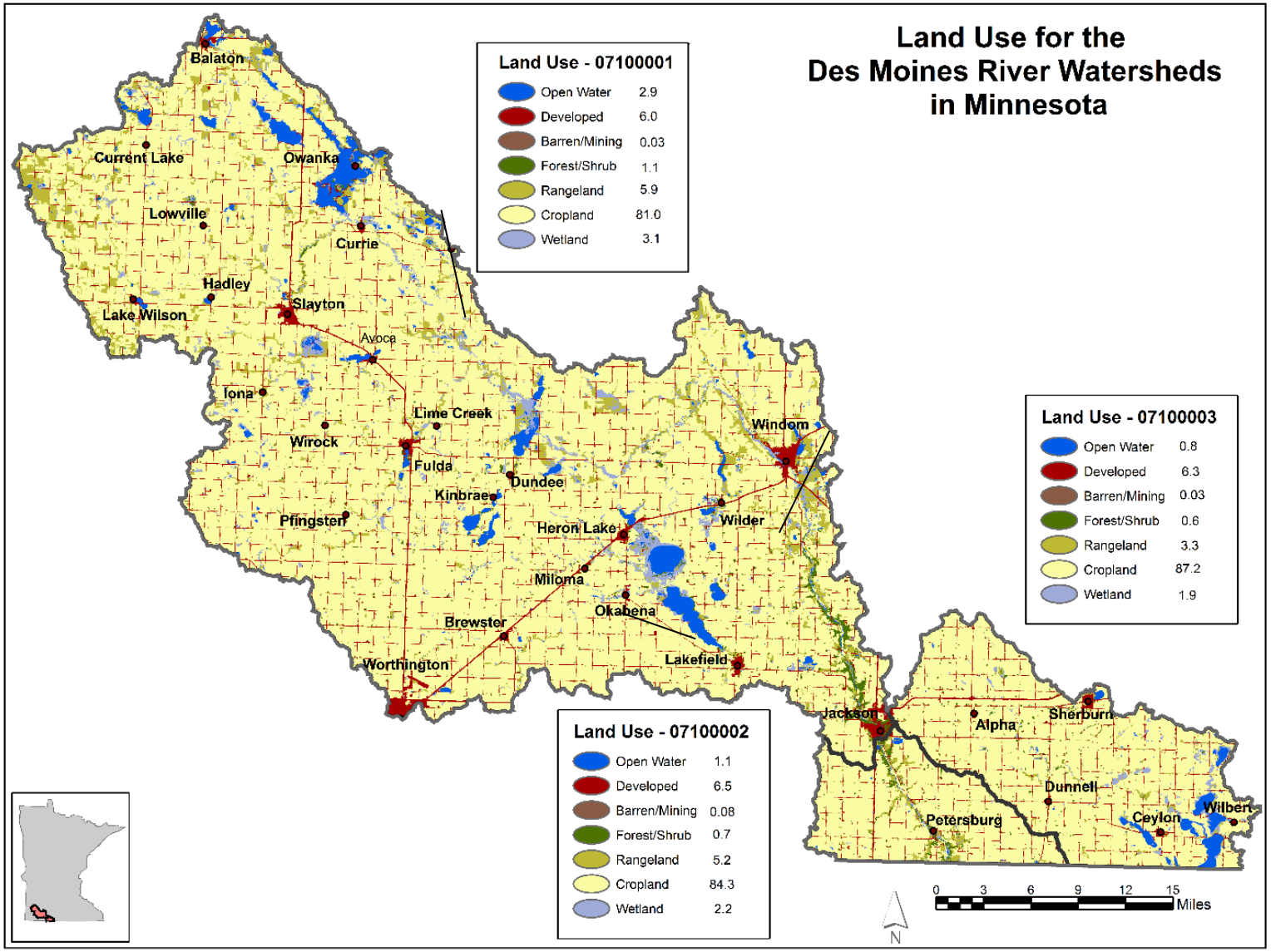

Figure 8. Land use and communities within the three Des Moines River Watersheds in Minnesota.

Surface water hydrology

The portion of the Des Moines River Basin in Minnesota is comprised of two river systems: the West Fork (main branch) and the East Fork. (Figure 9). The West Fork begins it journey as it first flows out of Lake Shetek in Murray County. It flows southeast into Cottonwood County, through the Talcot Lake State Wildlife Management Area until it flows along the border of Jackson County. From here, the River takes a sharp turn and zigzags back to the northeast and then southeast before flowing through the City of Windom. Along its way, it connects with Beaver Creek, Lime Creek, and the Heron Lake Outlet. The West Fork of the Des Moines River then heads south into Jackson County and through Kilen Woods State Park before reaching the City of Jackson. The West Fork skirts the city, and then heads south, to the border with Iowa. The East Fork begins as a fan of ditches on the border of Jackson and Martin Counties, east of the City of Jackson. The East Fork then flows southeast, eventually flowing into Turtle Lake and Okamanpeedan Lake on the Iowa border.

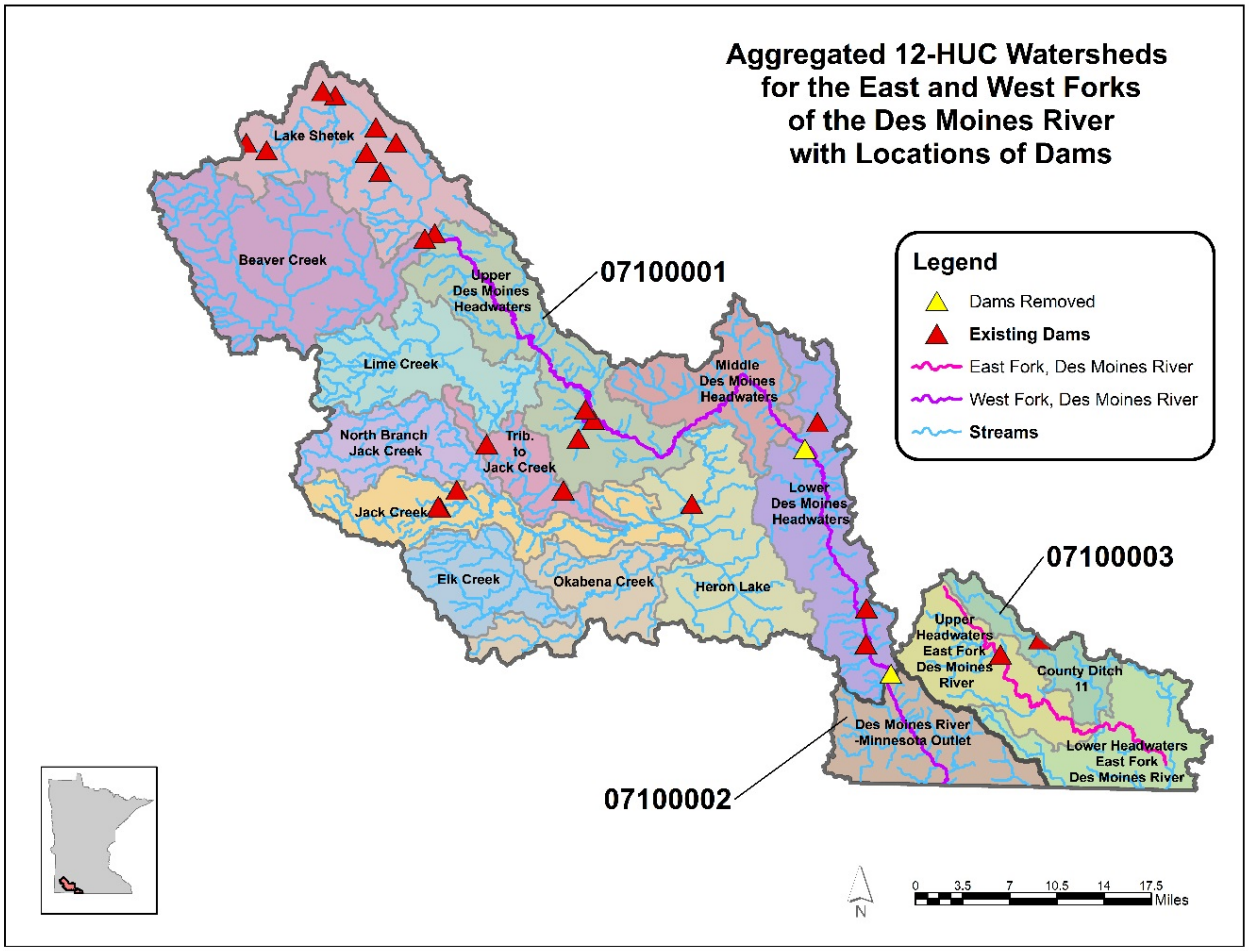

Figure 9. Aggregated 12-HUC watersheds of the East and West Forks of the Des Moines River with locations of dams.

Historically, a number of dams were built along the East and West Forks and tributary streams in order to harness the energy of flowing water for operating mills, control flooding, and manage water levels of recreational lakes and reservoirs. Many of these dams act as fish barriers, preventing fish migration between spring spawning areas and refuge during winter months and large flooding events. In addition,

many species of mussels have disappeared or have had numbers greatly reduced in association with land use changes, over extraction, and dams that limit mussel dispersal since certain species of migratory fish are hosts for mussel larvae. Within the last 10 years, two dams have been removed.

The dams were located on the West Fork of the Des Moines River in the City of Windom and on the Des Moines River in Jackson. Both dams were removed and replaced with a rock riffle to alleviate safety concerns. The rock riffles that replaced both dams allow fish passage and are considered an amenity of the parks and the cities.

Agriculture has altered the streams in the basin by channelizing the streams to allow for more tillable land and faster movement of water out of tillable areas. These altered streams make up for the majority of the flowing water within the Des Moines Basin (Figure 10). This type of stream channelization is very common in the agricultural regions of Minnesota (Figure 11).

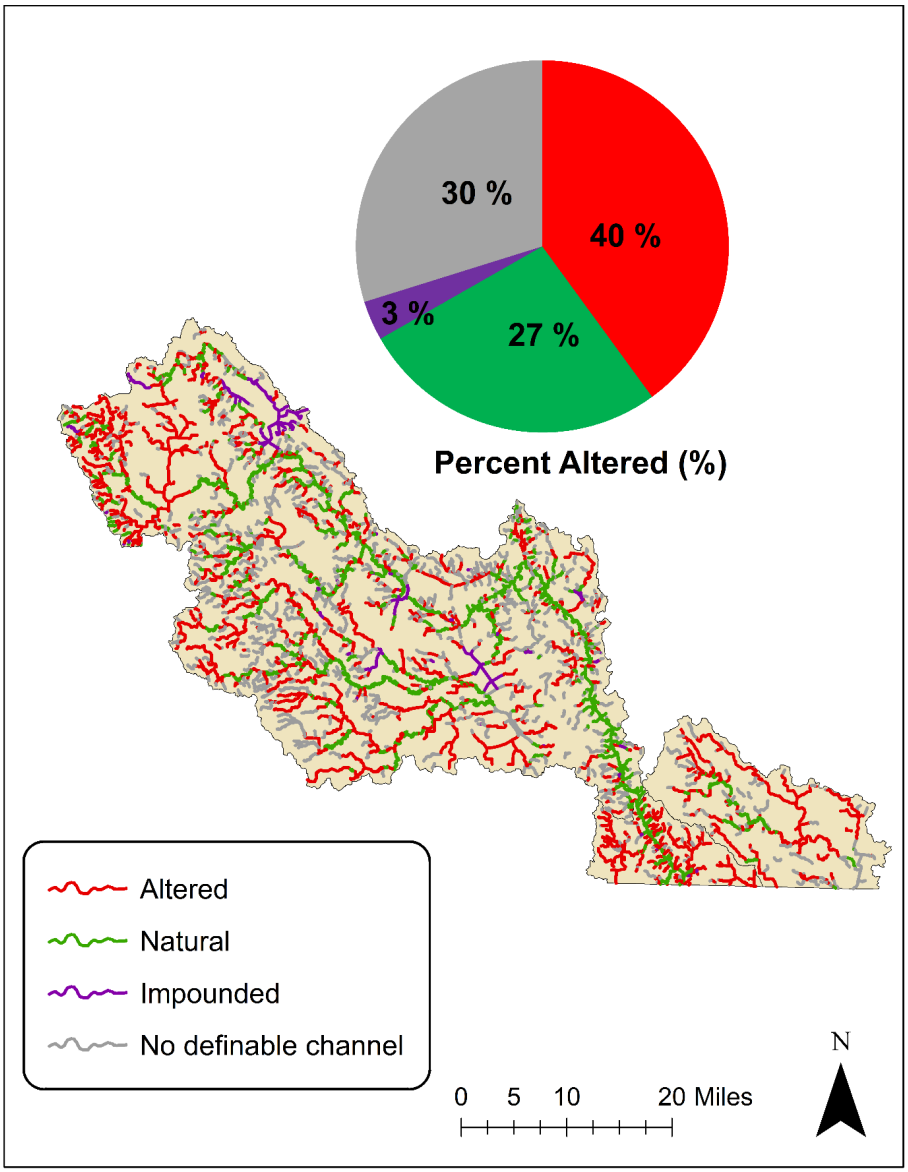

Figure 10. Comparison of natural to altered streams in the Des Moines River Watersheds (percentages derived from the Statewide Altered Water Course project).

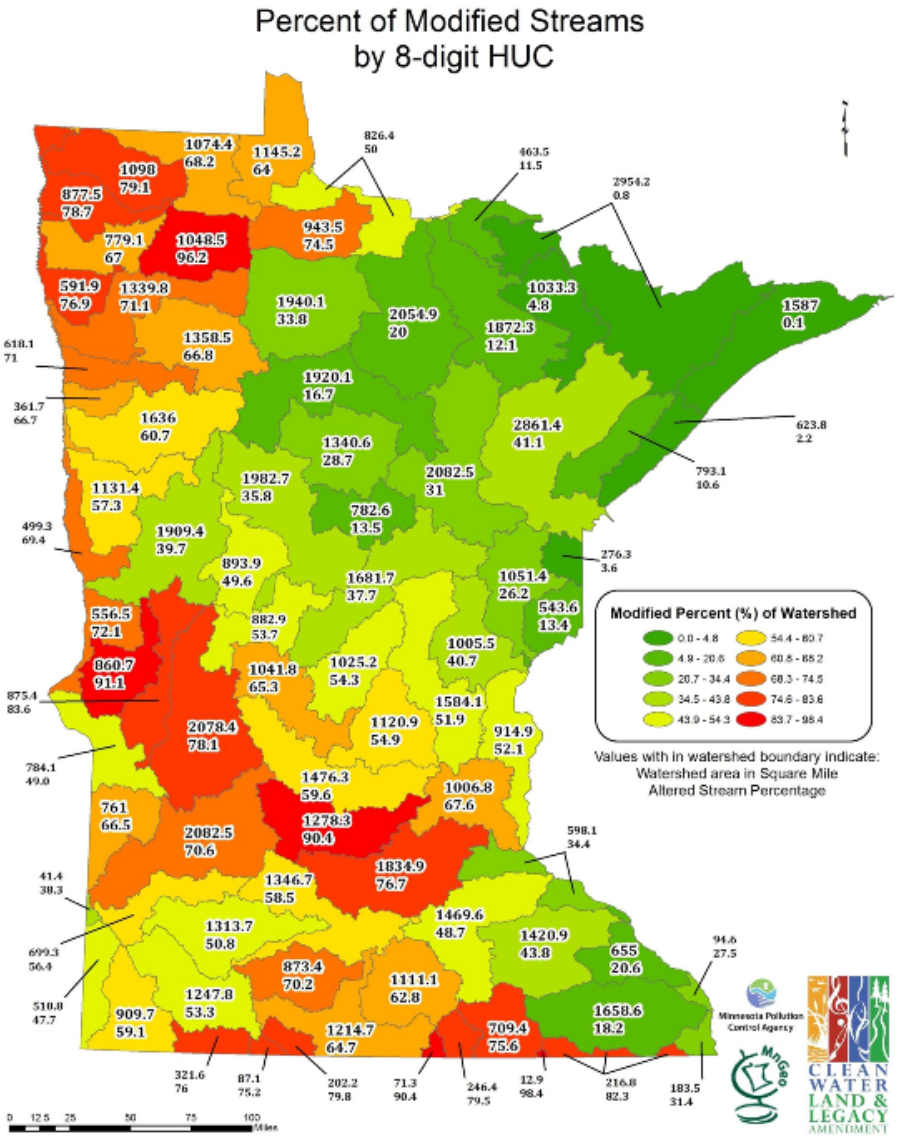

Figure 11. Map of percent modified streams by major watershed (8-HUC).

Climate and precipitation

Minnesota has a continental climate, marked by warm summers and cold winters. The mean annual temperature for Minnesota is 40.1˚F. The mean summer (June-August) temperature for southwest Minnesota and the Des Moines River Watersheds is 69.2˚F and the mean winter (December-February) temperature is 15.4˚ F. (NOAA, 2017)

Precipitation is an important source of water input to a watershed. Figure 12 and Figure 13 shows two representations of precipitation for the water year 2014-2015. Total precipitation is displayed on the left and on the right, how that total differed from normal amounts. Precipitation in the Des Moines River Watersheds ranged from 24 to 32 inches in water year 2014 which was close to normal for most of the watersheds. In water year 2015, total precipitation ranged from 24 to 28 inches, which was normal in the western portion of the watersheds, and slightly less than normal in the eastern portion (DNR, 2016a).

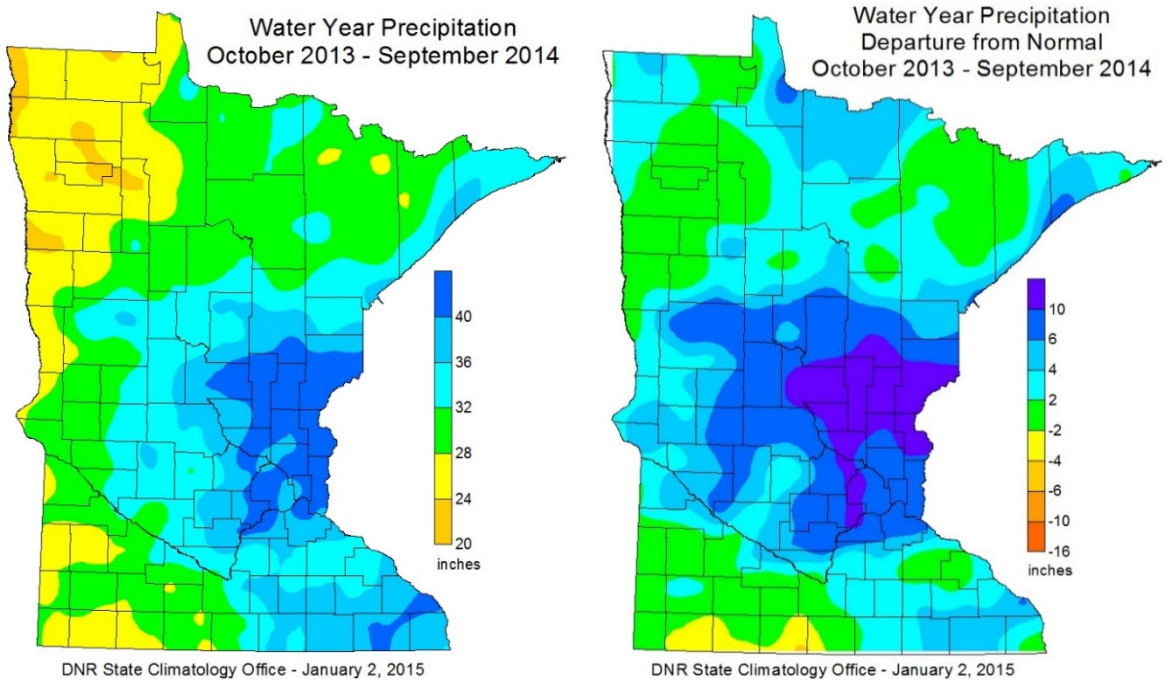

Figure 12. Statewide precipitation levels during the 2014 water year.

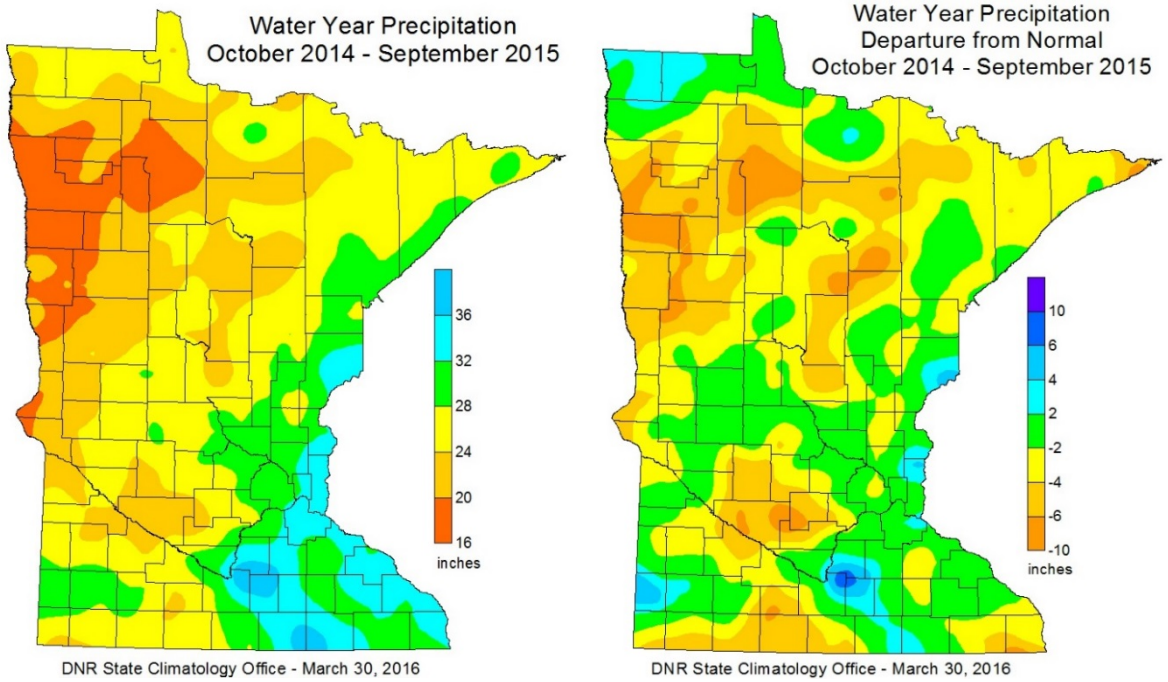

Figure 13. Statewide precipitation levels during the 2015 water year.

Figure 14 and Figure 15 displays the areal average representation of precipitation in southwest 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 southwest region display no significant trend over the last 20 years. However, precipitation in southwest Minnesota exhibits a significant rising trend over the past 100 years (p=0.001). This is a strong trend and matches similar trends throughout Minnesota (WRCC 2016).

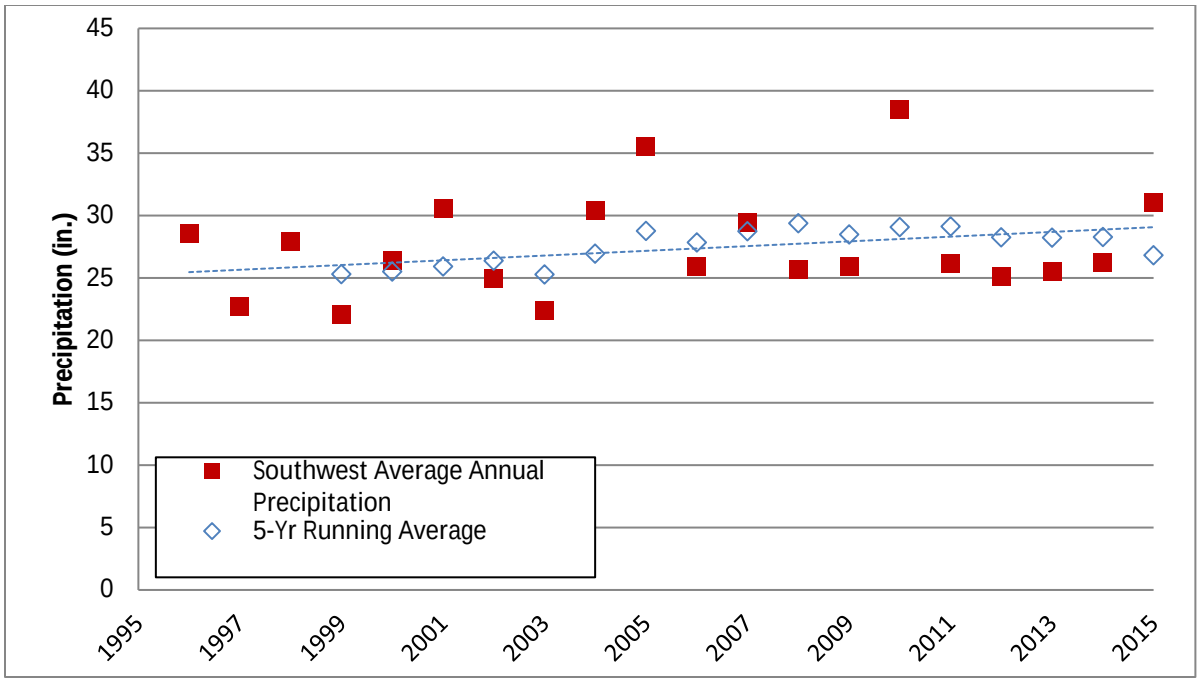

Figure 14. Average annual precipitation in southwest Minnesota 1996-2015 with five-year running average.

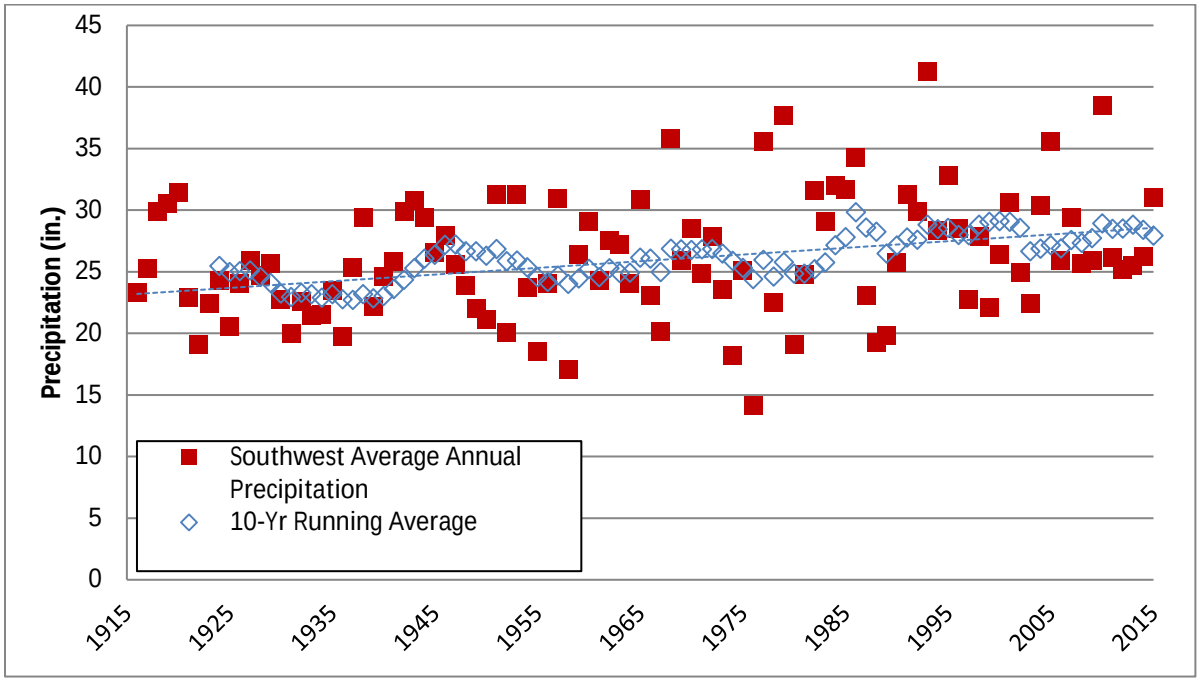

Figure 15. Average annual precipitation in southwest Minnesota 1916-2015 with ten-year running average.

Hydrogeology and groundwater quality

The Des Moines River Watersheds are underlain by nearly impermeable Precambrian bedrock that is occasionally exposed, but largely covered by Cretaceous bedrock. Quaternary deposits cover nearly all of the area and serve as the primary source of groundwater (MPCA, 1999; DNR, 2001). Recharge of these aquifers is limited to areas located at topographic highs, those with surficial sand and gravel deposits, and those along the bedrock/surficial deposit interface. In the Des Moines River Watersheds, the average annual recharge rate to surficial materials can range from two to four inches per year in the western portions, to six to eight in the far eastern portions (Figure 16).

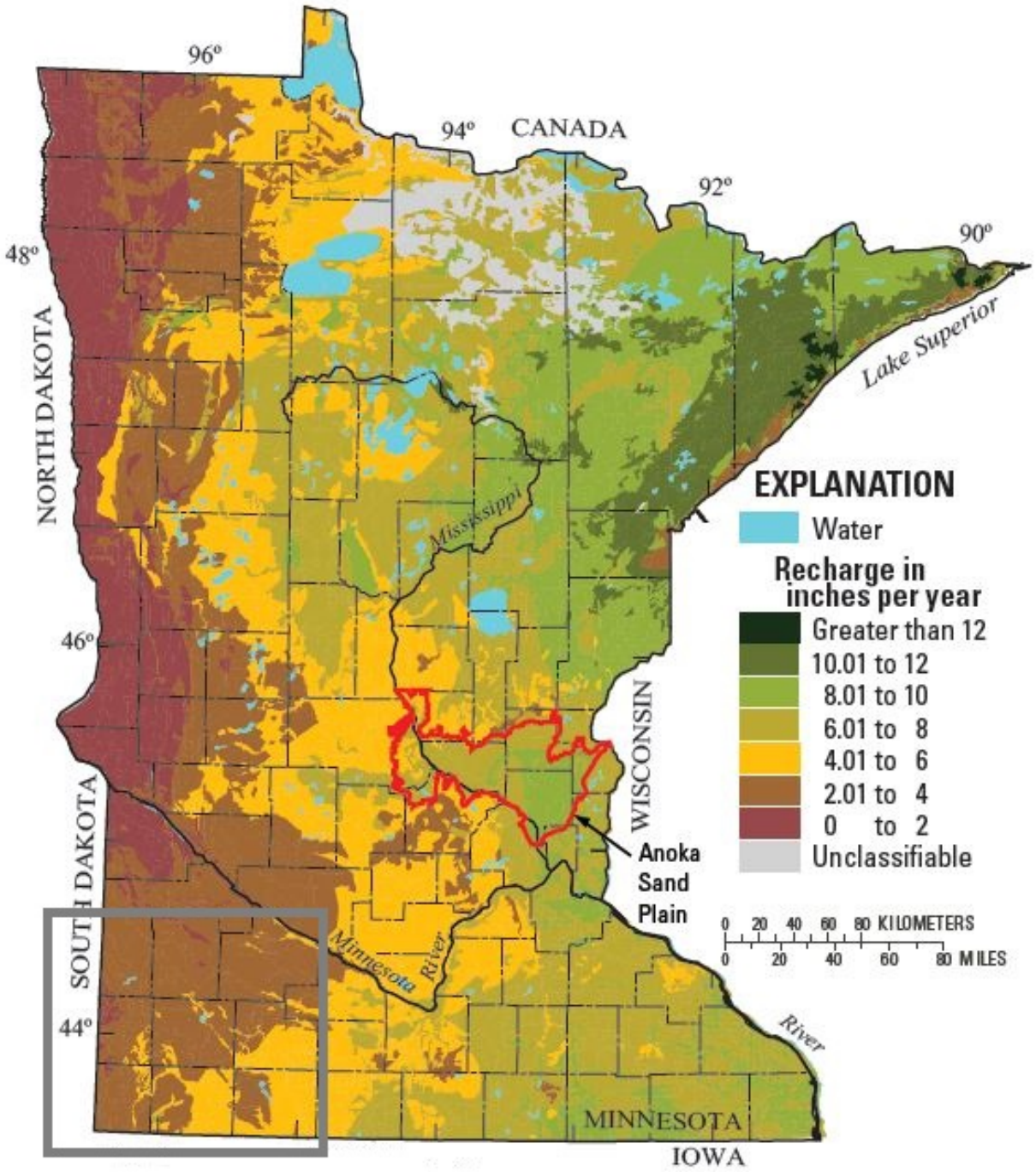

Figure 16. Average annual recharge rate to surficial materials in Minnesota (1971-2000) (USGS, 2007).

Wetlands

Currently there are approximately 55,000 acres of wetlands in the Des Moines River Watersheds, roughly equivalent to 5.6% of their total area. Emergent vegetation wetlands comprise the majority of this area and are well distributed across watershed (Figure 17). Scrub-shrub wetlands and forested wetlands account for a minor component (< 1%) of the watershed's wetland profile as would be expected given its location within the Temperate Prairies (Level II) ecoregion. The topography and soil types – and thus the type and distribution of wetlands – in the Des Moines River Watershed was

largely determined by the region's glacial history. The last glacial advance through this region, the Des Moines lobe, reached it southernmost point in Des Moines, Iowa about 14,000 years ago. The watershed lies entirely within the Bemis moraine, in an area representing the westernmost extent of the Des Moines lobe (MNGS 1997). The hill and basin topography typical of a moraine landform produces numerous lakes and depressional wetlands following glacial retreat. Historically, the majority of the watershed's emergent wetland vegetation would have been associated with such depressions (e.g., prairie potholes). Drainage of these basins for agricultural production has led to a disproportionate amount of emergent vegetation in association with riparian corridors and lake fringes (Figure 17).

Prior to European settlement, wetlands were much more prevalent throughout the watershed. As wetland soil features typically persist after artificial drainage, soil survey data can provide an estimate of historical wetland extent and serve as a baseline for comparisons with current wetland acreage. The NRCS Soil Survey Geographic (SSURGO) database, based on a summation of map units classified as "poorly drained" or "very poorly drained", yields an estimate of approximately 422,000 acres of wetlands (~43% of watershed area) occurring in the Des Moines River Watershed prior to European settlement (Soil Survey Staff, NRCS 2013). The current wetland area estimate for the watershed, based on the 2011 National Wetlands Inventory update, is about 55,000 acres. A comparison of these two periods (i.e., pre-settlement vs. 2011) shows an overall estimate of 87% wetland loss for the watershed. Wetland loss is relatively uniform across the watershed with all subwatersheds exhibiting >75% wetland loss (Figure 18).

The Des Moines River Watershed supports some notable wetland features. Calcareous fens, which receive an upwelling of groundwater rich in calcium carbonate, support a unique community of plant species (many are rare) and receive additional protections as state Outstanding Resource Value Waters (ORVW; Minn. R. Ch. 7050; https://www.revisor.leg.state.mn.us/rules/?id=7050). The DNR has identified nine calcareous fens in the watershed, three of which are designated ORVWs.

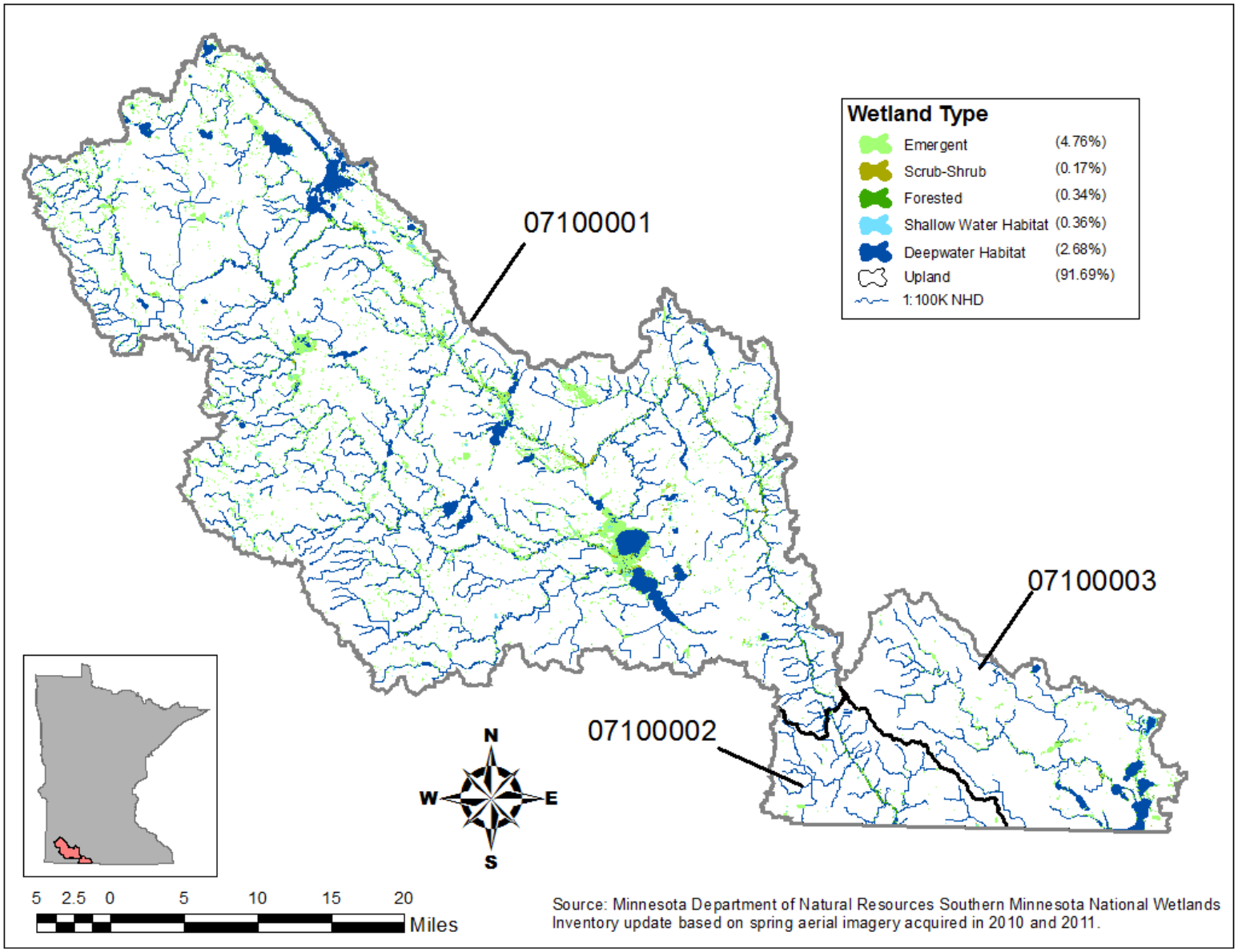

Figure 17. Wetland types and their distribution across the Des Moines River Watershed.

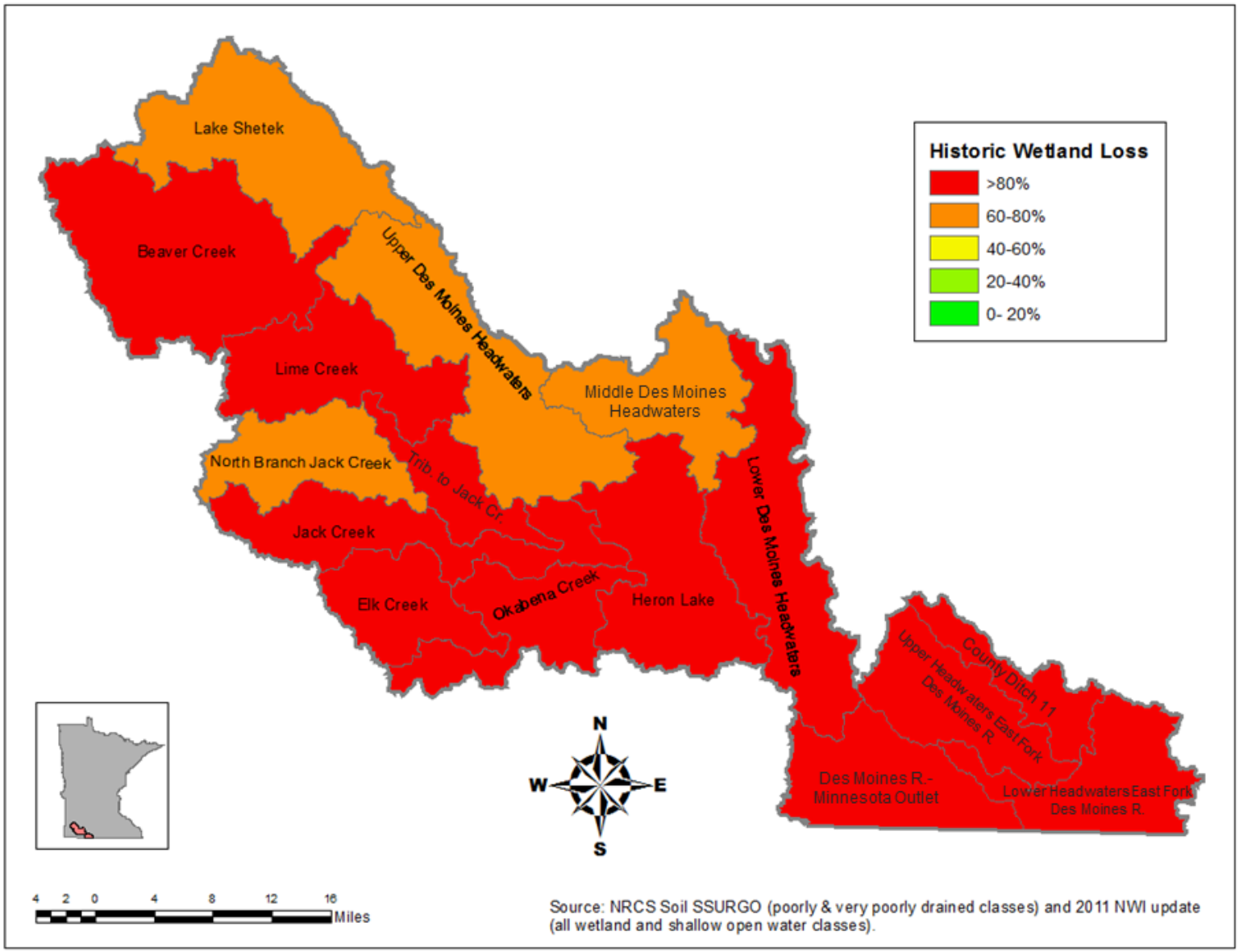

Figure 18. Estimated historic wetland loss in each subwatershed based on a comparison of "poorly drained" and "very poorly drained" soil types (SSURGO database) to wetland extent in 2011 (NWI update).

Watershed-wide data collection methodology

Lake water sampling

MPCA sampled 14 lakes in 2014 and 2015, as part of the Clean Water Legacy Surface Water Monitoring project for the purpose of enhancing the dataset for lake assessment of aquatic recreation. There is currently one volunteer enrolled in the MPCA's CLMP that is conducting lake monitoring within the watershed. This volunteer collects transparency measurements from Lake Shetek (51-0046-00). A SWAG was awarded to the Heron Lake Watershed District and Martin County SWCD for the purpose of collecting and submitting lake chemistry data. Four lakes were selected as targets for the groups to sample. The data that was collected and submitted to the MPCA for lake assessments of aquatic recreation. Sampling methods are similar among monitoring groups and are described in the document entitled "MPCA Standard Operating Procedure for Lake Water Quality" found at http://www.pca.state.mn.us/publications/wq-s1-16.pdf. The lake water quality assessment standard requires eight observations/samples within a 10-year period (June to September) for phosphorus, chlorophyll-a and Secchi depth.

Stream water sampling

Eighteen water chemistry stations were sampled from May through September in 2014, and again June through August of 2015, to provide sufficient water chemistry data to assess all components of the aquatic life and recreation use standards. Following the IWM design, water chemistry stations were placed at the outlet of each aggregated 12-HUC subwatershed that was >40 square miles in area (purple circles and green circles/triangles in (Figure 2, Figure 3, Figure 4). A SWAG was awarded to the Heron Lake Watershed District (HLWD), Martin County SWCD, and Murray County to collect water chemistry data from the eighteen water chemistry sties. (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). The Upper Des Moines Watershed is small with only one site on the Des Moines River, monitored by the HLWD. Martin County SWCD collected water chemistry data from three streams (Des Moines River, East Branch [2 locations] and County Ditch Number 11) in the East Fork Des Moines Watershed. The remaining (14) water chemistry sites were sampled by HLWD and Murray County in the Des Moines Headwaters.

Lake biological sampling

Seventeen lakes were monitored for fish community health in the Des Moines Basin. While data from the last 10 years contributed to the watershed assessments, the majority of data utilized for the 2016 assessment was collected in 2011 to 2015 for lakes. Waterbody assessments to determine aquatic life use support were completed for 17 AUIDs.

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

Stream biological sampling

The biological monitoring component of the IWM in the three Des Moines River Watersheds in Minnesota was completed during the summer of 2014. Seventy-one sites were newly established across the watershed and sampled. These sites were located near the outlets of most minor HUC-14 watersheds. In addition, five existing biological monitoring stations within the watershed were revisited in 2014. These monitoring stations were initially established as part of a random Des Moines River Basin wide survey in 2004, or as part of a 2007 survey which investigated the quality of channelized streams with intact riparian zones. While data from the last 10 years contributed to the watershed assessments, the majority of data utilized for the 2016 assessment was collected in 2014. Sixty-six AUIDs were sampled for biology in the Des Moines River Basin. Waterbody assessments to determine aquatic life use support were conducted for 58 AUIDs. Biological information that was not used in the assessment process will be crucial to the stressor identification process and will be used as a basis for long term trend results in subsequent reporting cycles.

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

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 as part of the IWM. 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 (MDA) 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. 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 ten percent 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 impairments that are more recent.

Pollutant load monitoring

The Watershed Pollutant Load Monitoring Network (WPLMN) is a long-term program designed to measure and compare regional differences and long-term trends in water quality among Minnesota's major rivers including the Red, Rainy, St. Croix, Mississippi, and Minnesota; at the outlets of the major tributaries (8 digit HUC scale) draining to these rivers; and for subwatersheds of the major watersheds. 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. 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 TSS, TP, dissolved orthophosphate (DOP), nitrate plus nitrite nitrogen (NO_3+NO_2-N), and total Kjeldahl nitrogen (TKN).

More information can be found at the WPLMN website:
http://www.pca.state.mn.us/index.php/water/water-types-and-programs/surface-water/streams-and-rivers/watershed-pollutant-load-monitoring-network.html

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 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.

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 three 8-HUC watersheds of the Des Moines River Basin in Minnesota. 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 2016 Assessment Cycle as well as any impairment listings from previous assessment cycles. Discussion of assessment results focuses primarily on the 2014 IWM effort, but also considers available data from the last ten 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 2016 assessment process (2016 EPA reporting cycle); however, impairments from previous assessment cycles are also included and are distinguished from new impairments via cell shading (see footnote section of each table). These tables also denote the results of comparing each individual aquatic life and aquatic recreation indicator to their respective criteria (i.e., standards); determinations made during the desktop phase of the assessment process. Assessment of aquatic life is derived from the analysis of biological (fish and invert 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: cold water community (2A); cool or warm water community (2B); or indigenous aquatic community (2C). Where applicable and sufficient data exists, assessments of other designated uses (e.g., class 7, drinking water, aquatic consumption) are discussed in the summary section of each aggregated 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.

Beaver Creek Aggregated 12-HUC HUC 0710000101-01

Located within the Headwaters of the Des Moines River Watershed, Beaver Creek is the largest subwatershed at 177 mi^2 and lies within parts of Pipestone and Murray counties. Larger cities in the watershed include Lake Wilson, Hadley, Lowville, and the eastern side of Slayton. Land use is dominated by row crop agriculture (82%) and rangeland (10%) for 92% total agricultural land use. Developed land is minimal at 5% with very limited cover as forest (0.5%), wetland (1.8%), and open water (0.5%). The largest stream reach is Beaver Creek which flows 28 miles until joining the mainstem Des Moines River, near Currie, Minnesota. Summit Lake and Wilson Lake are two major lakes that serve as a resource for public recreation. In total, there are 16 stream reaches and 18 lakes. Of those, seven stream reaches were assessed for aquatic life and recreation (Table 2) while no lakes could to be assessed, due to limited data (Table 3). Impairments are widespread throughout the watershed (Figure 20).

Table 2. Aquatic life and recreation assessments on stream reaches: Beaver Creek Aggregated 12-HUC.

AUID *Reach Name*, *Reach Description*	Biological Station ID	Reach Length (miles)	Use Class*	Aquatic Life Indicators:										Aquatic Life	Aquatic Rec. (Bacteria)
				Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Eutrophication		
07100001-504 **County Ditch 20,** Headwaters to Beaver Cr	14DM066, 14DM067	10.2	WWm	EXS	MTS	IF	IF	IF	--	IF	IF	--	IF	IMP	IMP
07100001-589 **Judicial Ditch 14,** Unnamed ditch to Unnamed cr	14DM101	1.5	WWm	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	SUP	--
07100001-594 **Unnamed ditch,** Unnamed ditch to Unnamed ditch	07DM006	0.6	WWm	MTS	MTS	IF	IF	IF	--	IF	IF	--	IF	SUP	--
07100001-628 **Unnamed creek,** Unnamed cr to Unnamed cr	14DM071	1.0	WWg	EXS	EXS	IF	IF	IF	--	IF	IF	--	IF	IMP	--
07100001-663 **Beaver Creek,** 131st St to JD 14	14DM070	8.9	WWg	EXS	EXS	IF	IF	IF	--	IF	IF	--	IF	IMP	--

AUID *Reach Name*, *Reach Description*	Biological Station ID	Reach Length (miles)	Use Class*	Aquatic Life Indicators:										Aquatic Life	Aquatic Rec. (Bacteria)
				Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Eutrophication		
07100001-664 **Beaver Creek,** JD 14 to CD 20	07DM002	1.8	WWm	EXS	MTS	IF	IF	IF	--	IF	--	--	IF	IMP	--
07100001-646 **Beaver Creek,** 121st Ave to Des Moines R	14DM014	28.1	WWg	EXS	MTS	IF	EXS	MTS	MTS	MTS	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 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 3. Lake water aquatic recreation assessments: Beaver Creek 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		
Summit	51-0068-00	74	5	Shallow Lake	WCBP	No Evidence of Trend	--	IF	--	IF	IF	IF	IF	IF
Wilson	51-0081-00	159	--	Shallow Lake	WCBP	--	NA	--	--	IF	--	IF	NA	IF

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

Across the subwatershed, pollution tolerant species dominated the fish and macroinvertebrates communities sampled. At all impaired stream reaches, DO measured in the afternoon was high (11-15 mg/L) and supersaturated (>100%), indicating a potential for low DO at night, with an abundance of filamentous algae and instream macrophytes. This condition can be stressful for pollution sensitive fish and macroinvertebrate species and allow only the most pollution tolerant species to persist.

The proportion of simple lithophils (fish that require clean coarse substrates to spawn) was also very low at most stations sampled which could also indicate potential habitat limitations. Macroinvertebrates diversity of the community as well as other community attributes were able to somewhat compensate for the dominance of tolerant taxa, yielding IBI scores that met criteria in modified use streams but were not enough to meet the higher expectations of the general use. For a majority of impaired reaches, habitat quality was moderate to very poor, with severe bank erosion (Figure 19) and moderate to severe degree of embeddedness observed which may be a main cause for the degraded fish and macroinvertebrate communities.

In 2008, a TMDL was completed and approved by EPA to address the existing fecal coliform and turbidity impairments on Beaver Creek (previously -503, now -646) and County Ditch 20 (-504). The TMDL is available online and titled: The *West Fork Des Moines River Watershed Total Maximum Daily Load Final Report: Excess Nutrients (North and South Heron Lake), Turbidity, and Fecal Coliform Bacteria Impairments.* The stream reach, in some spots, has some good buffer areas but overall the land use is dominated by agriculture and feedlots, which could be a contributor to the TSS and bacteria impairments.

In addition to the water quality data that was collected on lakes, the DNR completed three plant surveys. The plant IBI data from the most recent survey from Wilson Lake indicates the plant community is healthy but this is conflicting from the older surveys.

Figure 19. Severe bank erosion and excess sedimentation at Beaver Creek station 14DM014.

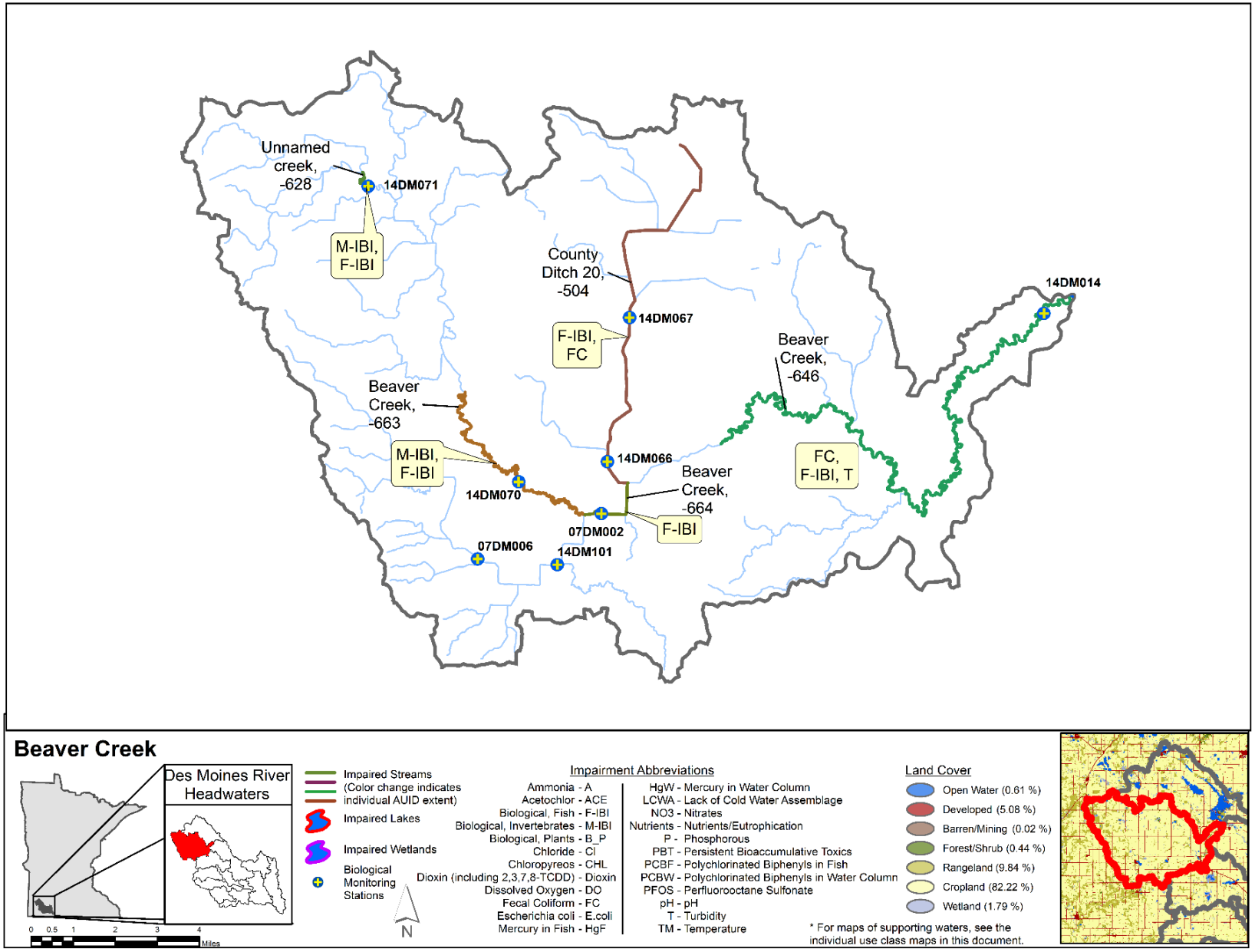

Figure 20. Currently listed impaired waters by parameter and land use characteristics in the Beaver Creek Subwatershed.

Lake Shetek Aggregated 12-HUC HUC 0710000102-01

The Lake Shetek subwatershed is located in the northern tip of the Headwaters of the Des Moines River Watershed. Watershed area is 130 mi.^{2} and encompasses parts of Lyon and Murray Counties. The three largest cities are Balaton, Current Lake, and Owanka. Land use is dominated by row crop agriculture (72%) and rangeland is at 9%. Developed land as cities and roads is at 5%. Forest and wetland comprise only 4% of the watershed. Major lakes that are used for recreation include Yankton, Fox, Shetek, Sarah, and Currant. These lakes together with streams comprise 10% open water, which is the largest percentage of open water land use for all of the Des Moines Subwatersheds. In total, there are 20 stream reaches and 29 lakes in the Lake Shetek Watershed. During the 2016 assessments, 12 stream reaches and 6 lakes were assessed for aquatic life and aquatic recreation (Table 4 and Table 5). Impairments are widespread throughout the watershed (Figure 21).

Table 4. Aquatic life and recreation assessments on stream reaches: Lake Shetek Aggregated 12-HUC.

AUID *Reach Name*, *Reach Description*	Biological Station ID	Reach Length (miles)	Use Class*	Aquatic Life Indicators:										Aquatic Life	Aquatic Rec. (Bacteria)
				Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Eutrophication		
07100001-508 **Lower Lake Sarah Outlet,** First Unnamed cr on Lk Sarah outlet str to Lk Shetek inlet	14DM074	3.4	WWg	EXS	EXS	IF	IF	IF	-	IF	IF	--	IF	IMP	IMP
07100001-545 **Des Moines River,** Lk Shetek to Beaver Cr	14DM007	0.6	WWg	EXS	EXS	IF	EXS	EXS	MTS	MTS	MTS	--	IF	IMP	SUP
07100001-632 **Unnamed creek,** Unnamed cr to Lk Maria	14DM075	2.5	WWg	EXS	EXS	IF	IF	IF	--	IF	IF	--	IF	IMP	--
07100001-637 **Unnamed creek,** Unnamed cr to Lk Shetek inlet	14DM079	1.0	WWg	NA	EXS	IF	IF	IF	-	IF	IF	--	IF	IMP	--
07100001-641 **Lake Shetek Inlet,** -95.9137 44.1640 to -95.8869 44.2032	14DM080	5.6	WWg	EXS	EXS	IF	IF	IF	-	IF	IF	--	IF	IMP	--

AUID *Reach Name*, *Reach Description*	Biological Station ID	Reach Length (miles)	Use Class*	Aquatic Life Indicators:										Aquatic Life	Aquatic Rec. (Bacteria)
				Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Eutrophication		
07100001-642 **Lake Shetek Inlet,** -95.8869 44.2032 to -95.8495 44.2061	04DM026	2.9	WWm	EXS	MTS	IF	IF	IF	-	IF	IF	--	IF	IMP	--
07100001-643 **Lake Shetek Inlet,** -95.8495 44.2061 to -95.7553 44.1793	14DM077	10.6	WWg	EXS	IF	IF	IF	IF	-	IF	IF	--	IF	IMP	IMP
07100001-644 **Lake Shetek Inlet,** -95.7553 44.1793 to Lk Shetek	--	4.8	WWg	--	--	--	--	--	--	--	--	--	--	--	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.

Table 5. Lake water aquatic recreation assessments: Lake Shetek 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		
Lake of the Hill	42-0032-00	111	--	Shallow Lake	NGP	Insufficient Data	--	--	--	IF	--	IF	NA	IF
Yankton	42-0047-00	396	8	Shallow Lake	NGP	No Evidence of Trend	EX	MTS	--	EX	EX	EX	NS	NS
Fremont	51-0039-00	219	6	Shallow Lake	WCBP	Insufficient Data	--	--	--	IF	--	IF	NA	IF

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		
Bloody	51-0040-00	257	11	Shallow Lake	WCBP	No Evidence of Trend	--	MTS	--	EX	EX	IF	IF	NS
Fox	51-0043-00	180	9	Shallow Lake	WCBP	Insufficient Data	EX	MTS	--	EX	EX	EX	NS	NS
Shetek	51-0046-00	3477	10	Shallow Lake	WCBP	Decreasing Trend	EX	MTS	--	EX	EX	EX	NS	NS
Maria	51-0062-00	320	3	Shallow Lake	NGP	Insufficient Data	--	--	--	EX	IF	IF	NA	IF
Sarah	51-0063-00	1164	4	Shallow Lake	NGP	No Evidence of Trend	EX	--	--	EX	EX	EX	NS	NS
Iron	51-0079-00	253	2	Shallow Lake	NGP	Insufficient Data	--	IF	--	IF	IF	IF	IF	IF
Currant	51-0082-00	391	8	Shallow Lake	NGP	No Evidence of Trend	EX	--	--	EX	--	EX	NS	NS
North Marsh	51-0089-01	43	--	Shallow Lake	NGP	Insufficient Data	--	--	--	IF	--	IF	NA	IF
Hjermstad Slough	51-0089-02	68	--	Shallow Lake	NGP	Insufficient Data	--	--	--	EX	IF	IF	NA	IF
Current Lake Marsh	51-0090-00	47	--	Shallow Lake	NGP	Insufficient Data	--	--	--	IF	IF	IF	NA	IF

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 2014 reporting cycle; = new impairment; = full support of designated use; = insufficient information.

Summary

Every stream segment sampled for biology is impaired for aquatic life. All of the fish IBI scores were well below the threshold and only one macroinvertebrate sample was passing because it was scored against a modified use threshold. The biological monitoring stations had Minnesota Stream Habitat Assessment (MSHA) scores that ranged between 40 and 65, indicating fair stream habitat conditions and possibly suggesting that poor water quality (e.g., nutrients) are causing the aquatic life impairments. Tolerant taxa dominated most of the macroinvertebrate and fish samples collected in this subwatershed and the Biological Condition Gradient model placed most sites in tier 5 (major changes in structure of biotic community).

As you move downstream in the watershed the compounding effects of the surface water runoff only increases which results in high levels of phosphorus and bacteria being distributed in waterbodies. Every assessable lake in the watershed has excess nutrient problems. Bacteria and nutrients are a major concern within the watershed. There are six lakes and three streams that have bacteria impairments (Table 5). Approximately 81% of the watersheds land use is used for agricultural purposes and overland transport of animal waste and fertilizer is finding its way into the streams and lakes. Buffers along the waterways and lakes should help these ongoing problems.

Water chemistry was collected on Des Moines River (-545) which helped determine aquatic life and aquatic recreation assessments. A 0.6 miles stretch that exits Shetek Lake is currently impaired for turbidity. There are two inlets to Lake Shetek that are both listed as impaired for bacteria. Downstream of Lake Shetek the Des Moines River has very low bacteria concentrations. The Lake Shetek inlet is split into five stream reaches that drain in to Lake Shetek. The Lake Shetek Inlet contains high levels of phosphorus that appears to be coming from Yankton Lake and contributing surface water runoff. The above stream reaches have a few phosphorus samples but they are all relatively low compared to the watershed.

Six lakes had enough data for an assessment to be completed. All of the lakes are shallow and located in the NGP or the WCBP ecoregion. Currant Lake is located in the headwaters of the Lake Shetek Watershed. It was previously listed as impaired for aquatic recreation in 2008 and the current data confirms that listing. As you move downstream in the watershed the compounding effects of the surface water runoff only increases which results in high levels of phosphorus being distributed in waterbodies. Yankton Lake is located near the town of Balaton, Minnesota and was previously as impaired for aquatic recreation in 2010 and the current data confirms that listing. Sarah Lake is located upstream of Lake Shetek. Sarah Lake was previously listed as impaired for aquatic recreation in 2006. Fox Lake is a small lake, only 180 acres in size. This lake drains west into Bloody Lake that then drains into Lake Shetek. Both Fox Lake and Bloody Lake have phosphorus and chlorophyll-a concentrations that are very high. Lake Shetek is the major lake in the Lake Shetek Watershed. It was previously listed as impaired for aquatic recreation in 2006. Lake Shetek covers 3,462 acres and receives all of the upstream surface water. It is shallow (10 feet) and has a large fetch that results in internal loading. The overall landuse of the Lake Shetek Watershed is dominated by agriculture. There are minimal forested areas and surface runoff is a concern as many of the lakes contain high levels of phosphorus.

Five lakes were assessed for aquatic life use using fish IBI: Yankton Lake, Fox Lake, Lake Shetek, Sarah Lake, and Currant Lake. All of the lakes have a low diversity fish population. Bigmouth Buffalo and Common Carp were found in every lake but they were sampled in large numbers in Yankton Lake, Fox Lake, and Lake Shetek. Fathead Minnows dominated the nearshore samples in Fox Lake and Lake Shetek. Sarah Lake and Currant Lake both contain higher percentages of Walleye, Black Bullhead, and Yellow Perch than the other lakes in the watershed. The potential

stressor for these lakes would include watershed landuse disturbance, poor shoreline habitat, and high phosphorus levels. All five of these lakes are impaired based on their applied fish IBI scores. A review of the available plant data indicated degraded conditions on Currant Lake and heathy plant communities on Yankton Lake, Fox Lake, and Shetek Lake. Sarah Lake's data was inconclusive.

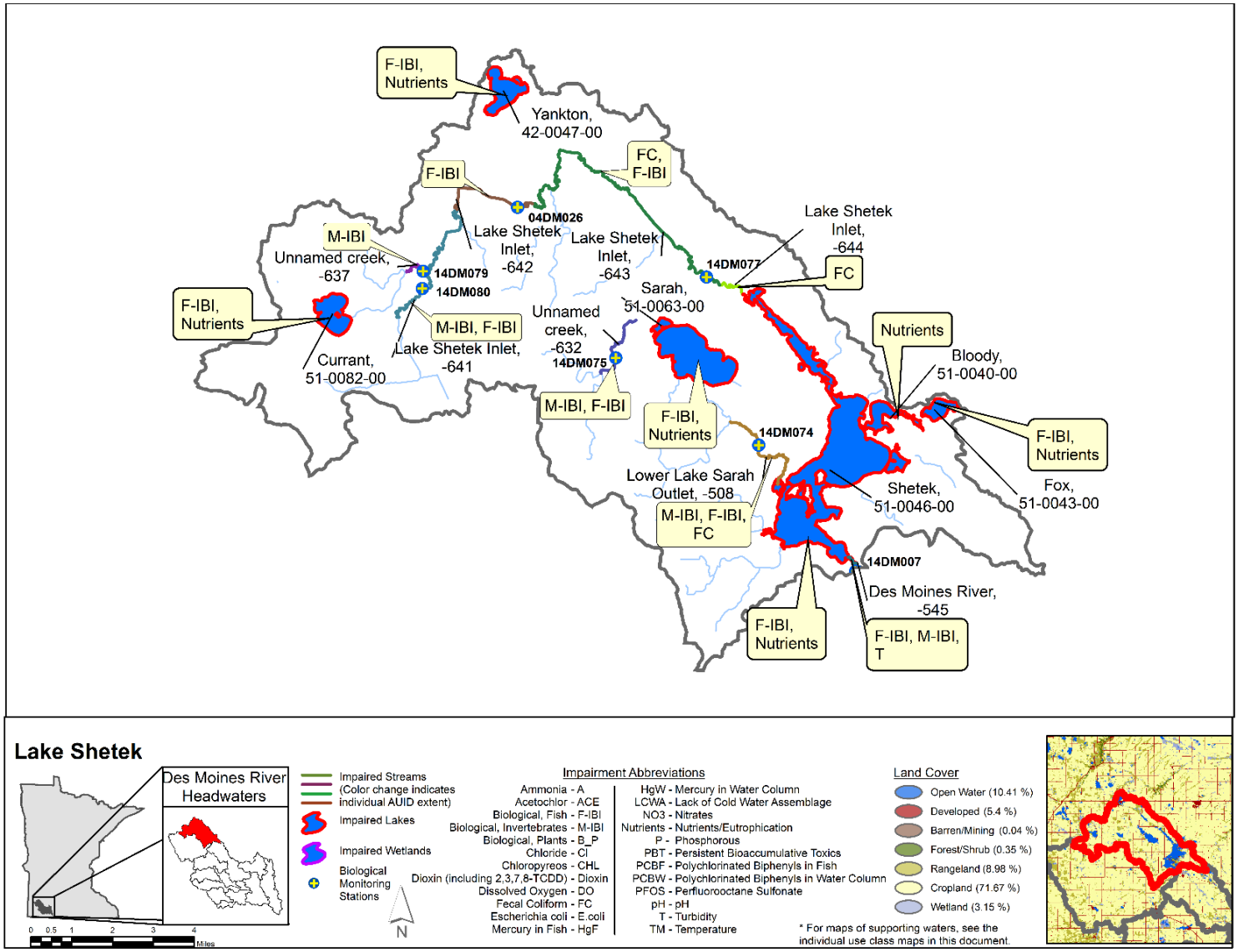

Figure 21. Currently listed impaired waters by parameter and land use characteristics in the Lake Shetek Aggregated 12-HUC.

Lime Creek Aggregated 12-HUC HUC 0710000103-01

The Lime Creek Watershed is located in the west-central portion of the Headwaters of the Des Moines River Watershed. The 97.7 mi^2 watershed is entirely within Murray County. Larger cities in the watershed include Iona, Avoca, and Fulda. Land use is dominated by row crop agriculture (83.5%) and rangeland (4.5%) for 87.9% total agricultural land use. Developed land is minimal at 6.5% with very limited natural land cover with forest (0.5%), wetland (3.6%), and open water (1.5%) making up less than 6% of the watershed. The largest stream reach is Lime Creek, which flows southeast out of Lime Lake to the city of Fulda where it turns northeast ending in the mainstem Des Moines River. In total, there are four stream reaches with data assessed for aquatic life and recreation (Table 6). Only Lime Lake had enough data to be assessed for aquatic life use and aquatic recreation (Table 7). Impairments are widespread throughout the watershed (Figure 23).

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

AUID *Reach Name*, *Reach Description*	Biological Station ID	Reach Length (miles)	Use Class*	Aquatic Life Indicators:										Aquatic Life	Aquatic Rec. (Bacteria)
				Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Eutrophication		
07100001-535 Lime Creek, Lime Lk to Des Moines R	14DM013, 14DM054	26.8	WWg	EXS	EXS	EXS	IF	IF	MTS	MTS	MTS		IF	IMP	IMP
07100001-624 Unnamed creek, Headwaters to Unnamed creek	14DM055	4.6	WWm	EXS	EXS	IF	IF	IF	--	IF	IF		IF	IMP	NA
07100001-625 Unnamed creek, Unnamed cr to unnamed cr	14DM057	2.3	WWg	EXS	EXS	IF	IF	IF	--	IF	IF		IF	IMP	NA

Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: = existing impairment, listed prior to 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 7. Lake water aquatic recreation assessments: Lime Creek 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		
Unnamed	51-0023-00	48	--	Shallow Lake	WCBP	Insufficient Data	--	--	--	IF	--	IF	NA	IF
Lime	51-0024-00	318	6	Shallow Lake	WCBP	Insufficient Data	EX	MTS	--	EX	EX	EX	NS	NS
Big Slough	51-0105-00	380	--	Shallow Lake	WCBP	Insufficient Data	--	--	--	IF	--	--	NA	IF

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

All reaches where fish and macroinvertebrates that were sampled in 2014 were assessed in this subwatershed have impaired biological communities. A repeat sample for fish in 2015 at 14DM055 confirmed the extremely high abundance (>90%) of tolerant macroinvertebrate taxa and fish species, dense filamentous algae, and large diurnal fluxes in DO. This suggests that nutrient enrichment is likely the cause of these observed impairments. Lime Creek was previously listed as impaired for turbidity mainly from sloughing stream banks (Figure 22. Photograph at biological monitoring site 14DM057) and bacteria in 2004 and the current data confirms those listings. Further evidence of elevated nutrient concentrations in this subwatershed is provided by the aquatic recreation impairment on Lime Lake (51-0024-00) which is the source of Lime Creek. Biological data in Lime Lake also follows the same pattern of extremely high abundance of tolerant fish species. Common Carp and Bigmouth Buffalo were the most common fish species that were sampled in the Lime Lake. Lime Lake is a shallow basin located in the WCBP. The shallow nature of the basin combined with the large fetch creates an ideal scenario for internal loading to occur. The surrounding landuse is mainly agriculture with little forested area. There is a larger wetland that is upstream of Lime Lake but historical photos show that this wetland has been drained and tilled into row crops. This lake is prone to winterkill and the potential stressors include watershed disturbance and high

amounts of phosphorus. In addition to the water quality data and Fish FIBI the DNR completed a plant survey. The plant IBI data indicates the plant community is degraded.

A carp barrier at Big Slough could potentially be a problem for recolonization of fishes to the headwater streams. The lack of intolerant species at Lime Lake and the two stream biological sampling locations downstream of the fish barrier make it highly unlikely as the cause for the impaired biological community. The evidence of drained and farmed wetlands, historically high bacteria and TSS levels, large diurnal dissolved flux, and habitat loss due to channelization (Table 7) point towards agriculture being the largest contributor to the very low fish and macroinvertebrate IBI scores and high nutrient and sediment loads throughout the subwatershed.

Figure 22. Photograph at biological monitoring site 14DM057.

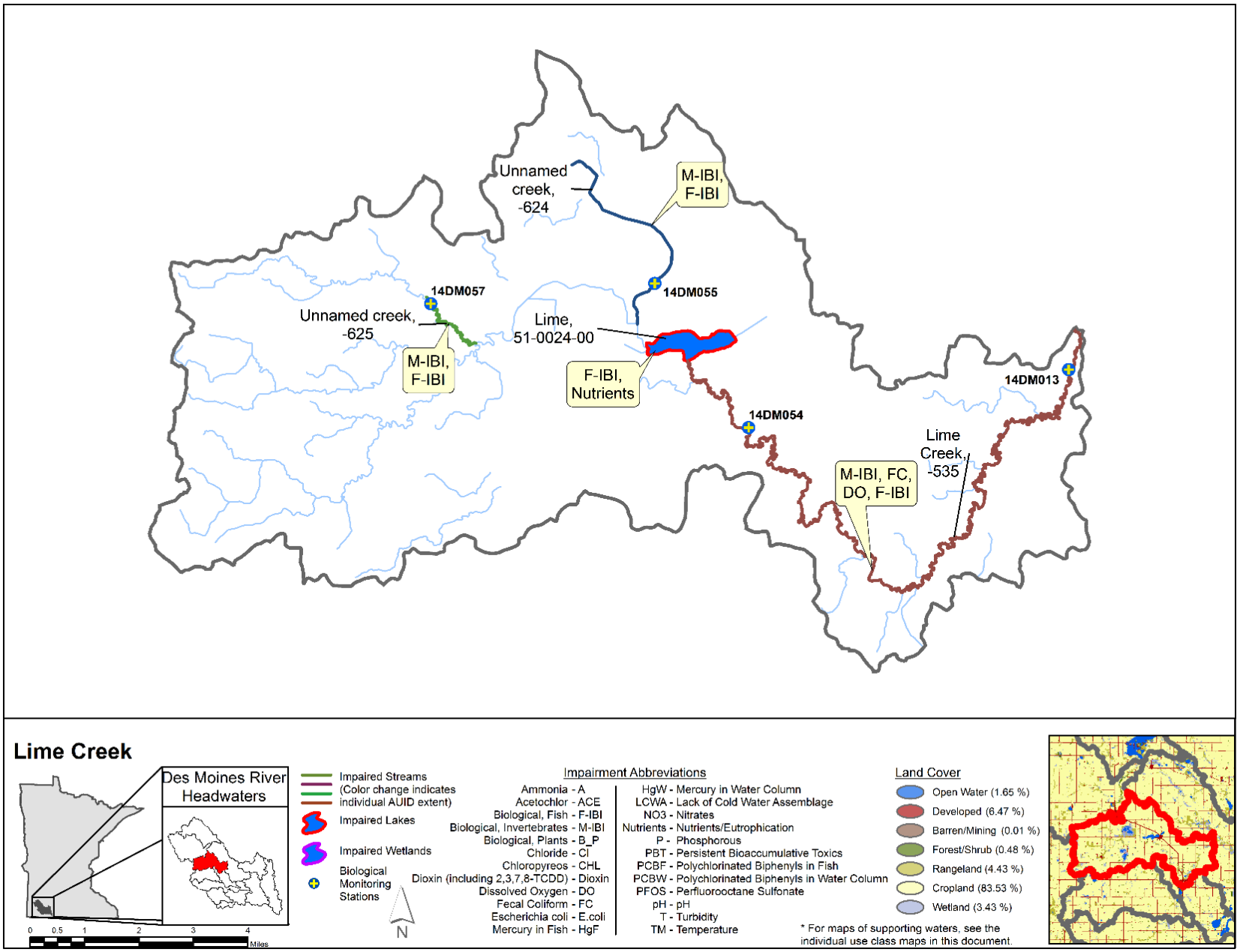

Figure 23. Currently listed impaired waters by parameter and land use characteristics in the Lime Creek Aggregated 12-HUC.

Upper Des Moines Headwaters Aggregated 12-HUC HUC 0710000104-01

Located within the headwaters of the Upper Des Moines Headwaters Watershed, the Upper Des Moines Headwater Watershed drains 151 mi.^{2} and lies within parts of Murray, Cottonwood, Jackson, and Nobles Counties. Cities in this watershed include Currie, Dundee, and Cottonwood. Land use is dominated by row crop agriculture (80.1%) and rangeland (6.4%) for 86.5% total agricultural land use. Developed land is minimal at 4.7% with very limited cover as forest (0.5%), wetland (5.6%), and open water (2.6%). The Des Moines River flows from Lake Shetek to the Heron Lake Outlet. In total, there are 17 stream reaches and 21 lakes. Of those, six stream reaches had data to be assessed for aquatic life and recreation (Table 8) while only North Oaks and Talcot could be assessed for lakes (Table 9). Impairments are widespread throughout the watershed (Figure 24).

Table 8. Aquatic life and recreation assessments on stream reaches: Upper Des Moines Headwaters Aggregated 12-HUC.

AUID *Reach Name*, *Reach Description*	Biological Station ID	Reach Length (miles)	Use Class*	Aquatic Life Indicators:										Aquatic Life	Aquatic Rec. (Bacteria)
				Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Eutrophication		
07100001-533 Des Moines River, Lime Cr to Heron Lk outlet	14DM006, 14DM017, 15DM200	28.3	WWg	EXS	EXS	IF	EXS	EXS	MTS	MTS	MTS		EXS	IMP	IMP
07100001-546 Des Moines River, Beaver Cr to Lime Cr	14DM018, 14DM019	24.8	WWg	EXS	EXS	IF	IF	IF	--	IF	IF		IF	IMP	IMP
07100001-621 Unnamed creek, Unnamed lk to Des Moines R	14DM052	2.3	WWm	MTS	EXS	IF	IF	IF	--	IF	IF		IF	IMP	NA
07100001-626 Unnamed creek, Unnamed cr to Unnamed cr	14DM063	1.3	WWg	EXS	EXS	IF	IF	IF	--	IF	IF		IF	IMP	NA
07100001-668 Devils Run Creek, Unnamed cr to Des Moines R	14DM062	4.0	WWg	EXS	MTS	IF	IF	IF	--	IF	IF		IF	IMP	NA
07100001-672 Unnamed creek, 21st St to Talcot Lk	14DM053	1.9	WWm	EXS	EXS	IF	IF	IF		IF	IF		IF	IMP	NA

Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: = existing impairment, listed prior to 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 9. Lake water aquatic recreation assessments: Upper Des Moines Headwaters 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		
South Clear	17-0041-00	230	2	Shallow Lake	WCBP	--	--	--	--	IF	IF	--	NA	IF
North Oaks	17-0044-00	333	6	Shallow Lake	WCBP	Insufficient Data	--	MTS	--	EX	EX	EX	IF	NS
Talcot	17-0060-00	844	6	Shallow Lake	WCBP	Insufficient Data	IF	MTS	--	EX	EX	EX	IF	NS
Buffalo Marsh	51-0011-00	70	--	Shallow Lake	--	--	--	--	--	IF	--	--	NA	IF
Buffalo	51-0018-00	124	8	Shallow Lake	WCBP	Insufficient Data	IF	MTS	--	MTS	EX	EX	IF	IF
Hanson Marsh	51-0031-00	78	--	Shallow Lake	--	--	--	--	--	IF	--	--	NA	IF
Unnamed	51-0111-00	29	--	Shallow Lake	--	--	--	--	--	IF	--	--	NA	IF
Unnamed	51-0112-00	8	--	Shallow Lake	--	--	--	--	--	IF	--	--	NA	IF

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

All reaches in the watershed where fish and macroinvertebrates were sampled and assessed have impaired biological communities. An extremely high abundance (>90%) of tolerant macroinvertebrate taxa and fish species, dense filamentous algae, and large diurnal fluxes in DO suggests that nutrient enrichment is likely the cause of these observed impairments. Habitat scores ranged from 18 to 59(fair), but extensive bank erosion across the watershed is creating over-widened streams with the course substrates covered by sediment.

The lakes in the watershed are all shallow and in the WCBP ecoregion. North Oaks Lake and Talcot Lake contain very high levels of phosphorus, which could be a direct result from the extreme prevalence (86.5%) of agricultural land use in the watershed. Talcot Lake receives the majority of the surface water from the watershed via the Des Moines River (-546 and -533). Both reaches of the Des Moines River are impaired for turbidity and fecal coliform, since 2004, and contain high levels of phosphorus. Stream and lake buffers could help the overland transport of nutrients and sedimentation of the streams and lakes.

Two lakes were assessed for aquatic life use using fish IBI: Talcot Lake and Buffalo Lake. Talcot Lake was sampled in 2014 and contained a high amount of black bullhead, fathead minnows, common carp, and white suckers. Buffalo Lake was sampled in 2015 and contained a high amount of black bullhead, northern pike, and iowa darter. It is a lake that has the potential for winterkill to occur which would affect the fish population and ability to sample it with a high level of accuracy. Potential stressors include an altered hydrologic regime because of outlet manipulations and watershed disturbance for both lakes. In addition to the water quality data, the DNR completed a plant survey on Talcot Lake and Buffalo Lake. The plant survey on Talcot Lake resulted in the plant IBI data indicating the plant community is degraded. The Buffalo Lake plant surveys indicated two conflicting surveys. There is not enough information to assess the plant community on Buffalo Lake.

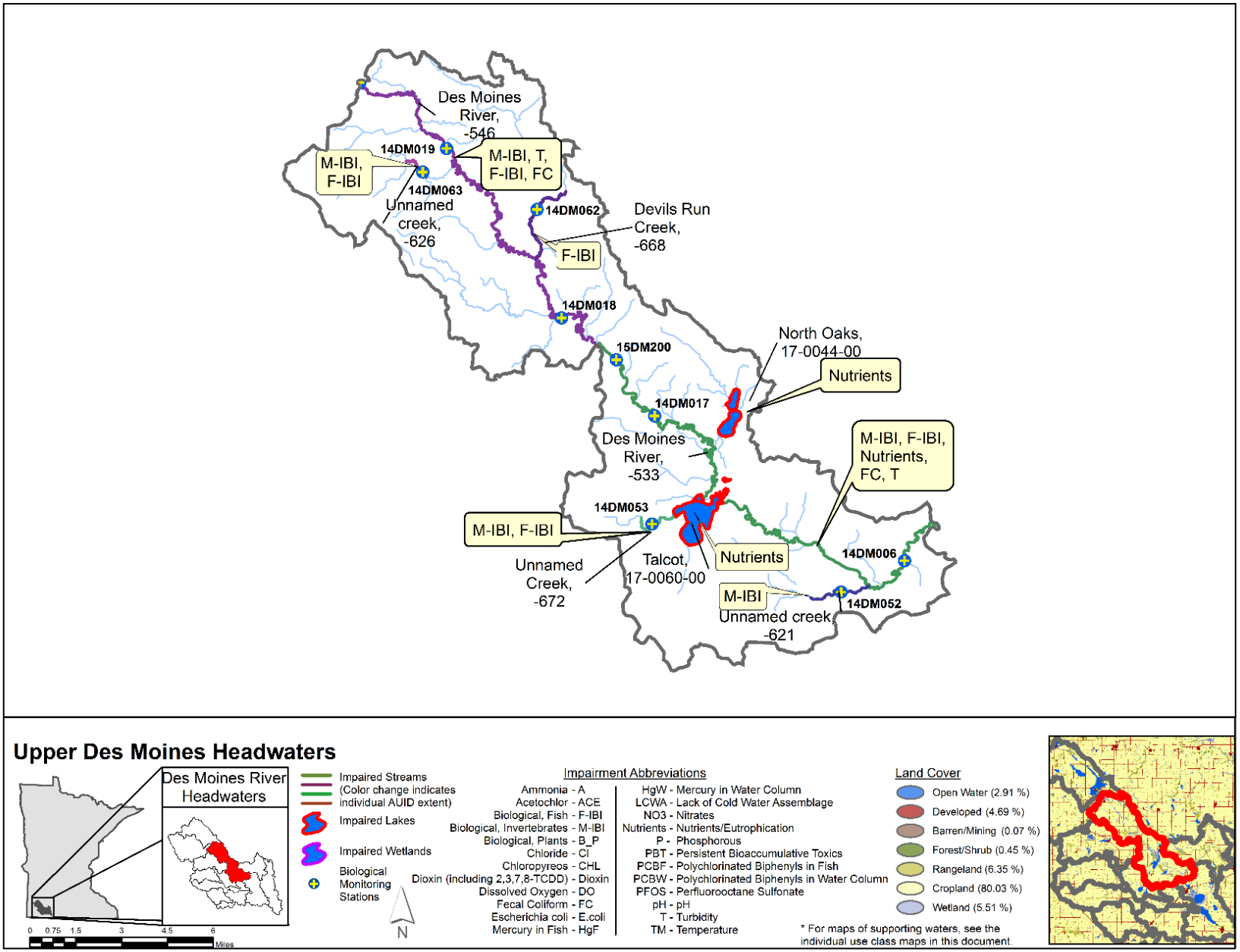

Figure 24. Currently listed impaired waters by parameter and land use characteristics in the Upper Des Moines Headwaters Aggregated 12-HUC.

Okabena Creek Aggregated 12-HUC HUC 0710000105-01

The Okabena Creek Watershed is located in the southcentral portion of the Headwaters of the Des Moines River Watershed. The watershed falls on the border between Nobles and Jackson counties. The two largest cities are Brewster and Okabena. Land use is dominated by row crop agriculture (85.6%) and rangeland (1.7%) for 87.3% total agricultural land use. This is the most developed (10.1%) watershed in Headwaters of the Des Moines River Watershed. There are 11 stream reaches and five lakes in the Okabena Creek Watershed. Okabena Creek (-602) is a 24-mile long reach that receives surface water from the Elk Creek subwatershed (0710000105-02). There are six stream reaches with data that was assessed for aquatic life and recreation (Table 10). Impairments are widespread throughout the watershed (Figure 25).

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

AUID *Reach Name*, *Reach Description*	Biological Station ID	Reach Length (miles)	Use Class*	Aquatic Life Indicators:										Aquatic Life	Aquatic Rec. (Bacteria)
				Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Eutrophication		
07100001-614 Unnamed creek, Unnamed cr to JD 84	14DM032	3.8	WWm	MTS	EXS	IF	IF	IF		IF	IF		IF	IMP	NA
07100001-515 Judicial Ditch 76, Unnamed cr to Okabena Cr	07DM004	6.7	WWm	MTS	MTS	IF	IF	IF		IF	IF		IF	SUP	NA
07100001-512 Okabena Creek, Unnamed cr to T102 R38W S6, north line	04DM040, 07DM003	8.0	LRVW	--	--	IF	--	--	--	MTS	MTS		--	NA	IMP
07100001-602 Okabena Creek, Elk Cr to Division Cr	04DM041, 14DM010	24.7	WWg	EXS	EXS	MTS	EXS	EXS	EXS	MTS	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 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

Water chemistry and biology were collected on Okabena Creek (-602) which helped determine both aquatic life and aquatic recreation assessments. Okabena Creek was previously listed as impaired for Fecal Coliform in 2006 (-602) and in 2010 (-512). The current data confirms both listings, as excess bacteria continues to be an issue. This reach has a previous turbidity listing from (2006) and recent data confirm the turbidity impairment. In addition, high levels of chloride were measured and this reach will now be listed for chloride. The elevated chloride concentrations could be attributed to wastewater discharges and road salt as well as water softening and industrial processing.

Two stations were sampled for fish and macroinvertebrates at the upstream end (04DM041) and downstream end (14DM010) of Okabena Creek. At both stations, few pollution sensitive species were collected. Fish sampled were dominated by pollution tolerant fish at both stations (96% and 99%, respectively) but differed in the proportion gravel spawning fish (i.e., simple lithophils) 3% and 14%, respectively. Habitat quality observations indicate that there is severe bank erosion and instream embeddedness at the downstream station, which may be a cause of this difference. Potential stressors at the upstream station include DO which was very high (13 mg/L) and supersaturated (169%) during fish sampling in the afternoon of August 20, 2014. Grab sample phosphorus (0.305 mg/L) and nitrogen (25 mg/L) were also high, and conductivity elevated (1103 umhos). These conditions may be potential stressors to both the fish and macroinvertebrate communities at this station as well as along this reach. The overall landuse of the watershed is row crops. The extensive area used for row crop could be contributing to the high levels of phosphorus that are being deposited into the streams.

Two additional reaches of Okabena Creek (-540 & -512), encompassing its headwaters as it flows out of Worthington, are designated as LRVWs that are assessed using different standards than those used to assess aquatic life. Upstream of these LRVW sections (-539), the creek is considered intermittent and the stream is managed for flood control where the majority of the stream's discharge is diverted to Okabena Lake except during high flow events. This unique situation, where water can be diverted between watersheds, may represent an opportunity to manage stream flow in a manner that addresses impairments on Okabena Lake as well as the downstream section of Okabena Creek (-602). At this point, the aquatic life assessment decision on the artificially intermittent section of Okabena Creek (-539) was insufficient information (IF) as it is not currently understood whether societal benefits of flood control and a healthy aquatic community in this section of the creek can simultaneously be achieved.

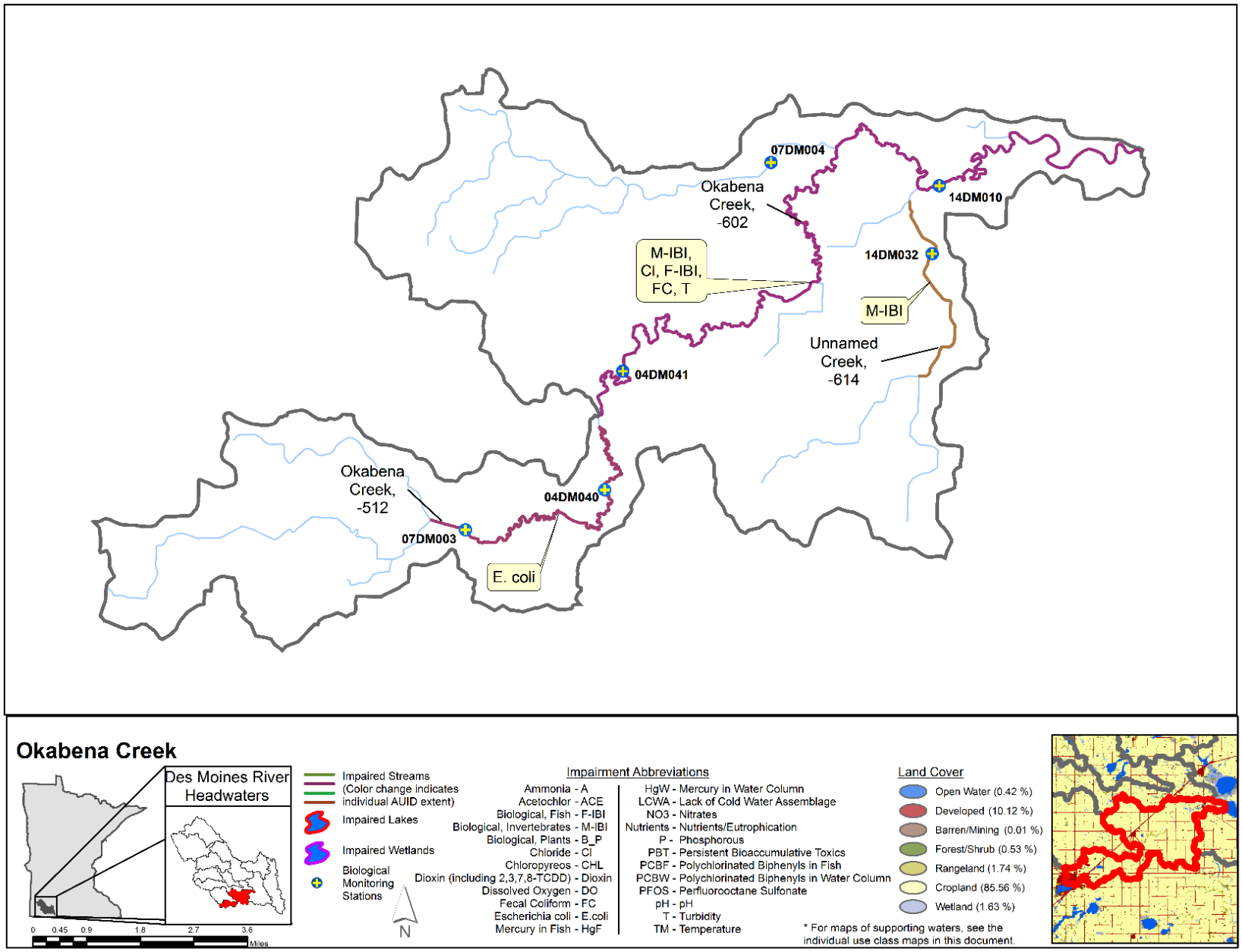

Figure 25. Currently listed impaired waters by parameter and land use characteristics in the Okabena Creek Aggregated 12-HUC.

Elk Creek Aggregated 12-HUC HUC 0710000105-02

The Elk Creek Watershed is located on the southcentral border of the Headwaters of the Des Moines River Watershed. Almost the entire subwatershed falls within Nobles County and borders Jackson County. The subwatershed is smaller compared to others in the Des Moines Basin with 6.22 mi^2 surface area. Land use is dominated by row crop agriculture (91.2%) and rangeland (1.7%) for 92.9% total agricultural land use. Developed land is minimal at 5.8% with very limited cover as forest (0.7%), wetland (10.6%), and open water (0%) are present.

There are six stream reaches and two lakes in the Elk Creek Watershed. There are three stream reaches with data assessed for aquatic life and recreation (Table 11). Impairments are only at the pour point of the watershed (Figure 27).

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

AUID *Reach Name*, *Reach Description*	Biological Station ID	Reach Length (miles)	Use Class*	Aquatic Life Indicators:										Aquatic Life	Aquatic Rec. (Bacteria)
				Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Eutrophication		
07100001-615 Unnamed creek, Unnamed cr to Elk Cr	14DM036	2.0	WWm	MTS	MTS	IF	IF	IF	--	IF	IF		IF	SUP	NA
07100001-654 Elk Creek, T- 41 to CSAH 3	14DM034	7.0	WWg	MTS	MTS	IF	IF	IF	--	IF	IF		IF	SUP	NA
07100001-656 Elk Creek, -95.4791 43.6750 to Okabena Cr	14DM011	2.3	WWg	EXS	EXS	IF	IF	MTS	MTS	MTS	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 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

Elk Creek Subwatershed had three stream reaches assessed for aquatic life and one reach assessed for aquatic recreation. Of the three stream reaches that were assessed for aquatic life, only one reach is not supporting (Elk Creek, -656) with a paired fish and macroinvertebrate community impairments and a confirmed turbidity impairment. Conversely, two reaches were assessed as fully supporting aquatic life (one for General Use and one for proposed Modified Use), while one reach did not have enough information with which to make an aquatic life assessment.

Water chemistry and biology were collected on Elk Creek (-656) which helped determine both aquatic life and aquatic recreation assessments. Past assessments and impairments for aquatic recreation (fecal coliform) and aquatic life (turbidity) will remain on this section of Elk Creek, a child stream reach from a parent stream reach (-507) . Additionally, this reach is not supporting aquatic life for its fish and macroinvertebrate communities. The fish community at the outlet biological station (14DM011) was largely comprised of pollution tolerant fish (90%) with 45% considered very tolerant. Of the 15 fish species that were collected, there were no sensitive fish and only 14% simple lithophilic spawners (fish that utilize clean, coarse gravel to spawn). Afternoon DO was high (>12 mg/L) during both fish and macroinvertebrate visits suggesting a potential DO issue. Some young white suckers (~2 inches) were observed dead or dying in the stream at time of fish sampling. Habitat quality was rated fair to good between the fish and macroinvertebrate visits. However, channel stability was rated moderately unstable with some bank erosion observed (Figure 26). Riffle, pool, and run features were comprised of sand and gravel with light to moderate embeddedness. The reach is listed for turbidity and may potentially be a biological stressor.

In contrast, the upstream Elk Creek reach (-654) was found to be supporting for aquatic life. At station 13DM034, the FIBI (55.4) was only slightly above the impairment threshold (55). While the fish community was still dominated by tolerant fish (89%) and no sensitive fish, only 4% were considered very tolerant, with a higher proportion of simple lithophils (34%). Habitat quality was rated fair-good with little bank erosion. The station had riffle, pool, and run features of sand and gravel along with light embeddedness. Additionally, channel stability was rated moderate/high. While habitat quality was better at this Elk Creek station, afternoon DO measured during both the fish and macroinvertebrate visits was high (>13 mg/L) and supersaturated (>150%) indicating a potential longitudinal DO issue. Sampling observations indicate that filamentous algae and macrophytes were dense (Figure 26) which may be the cause of the DO conditions observed. Diel oxygen measurements may uncover low values in the nighttime, which would be an additional stress to the aquatic communities within Elk Creek. These biological stressors, if not managed, could potentially lead to aquatic life impairments in the future.

Results from this first iteration of IWM in the Des Moines River Watershed suggest that the Elk Creek Subwatershed may be in the best condition with two of four stream reaches attaining their respective aquatic life use goals. Both supporting reaches had nine EPT taxa and their macroinvertebrate community compositions placed them into a Biological Condition Gadient (BCG) tier 4 (moderate changes in biotic structure with minimal changes in ecosystem function). Stoneflies (Perlesta) were also collected in both supporting streams. The macroinvertebrate community in Elk Creek (-654) was assessed as potentially impaired (EXP) due to the IBI score falling just below the impairment threshold, however, was not listed as impaired due to the presumed impacts of recent drought (2013) and flooding (2014) on these results. Additional monitoring under more normal precipitation patterns would clarify the impairment status of this reach. Also supporting the notion that Elk Creek may be an area of the watershed that is in relatively good condition are MSHA scores ranging between 44 and 64, with an average score of 54 for the subwatershed.

Figure 26. Bank erosion at biological station 14DM011 (left) and filamentous algae at biological station 14DM034 (right).

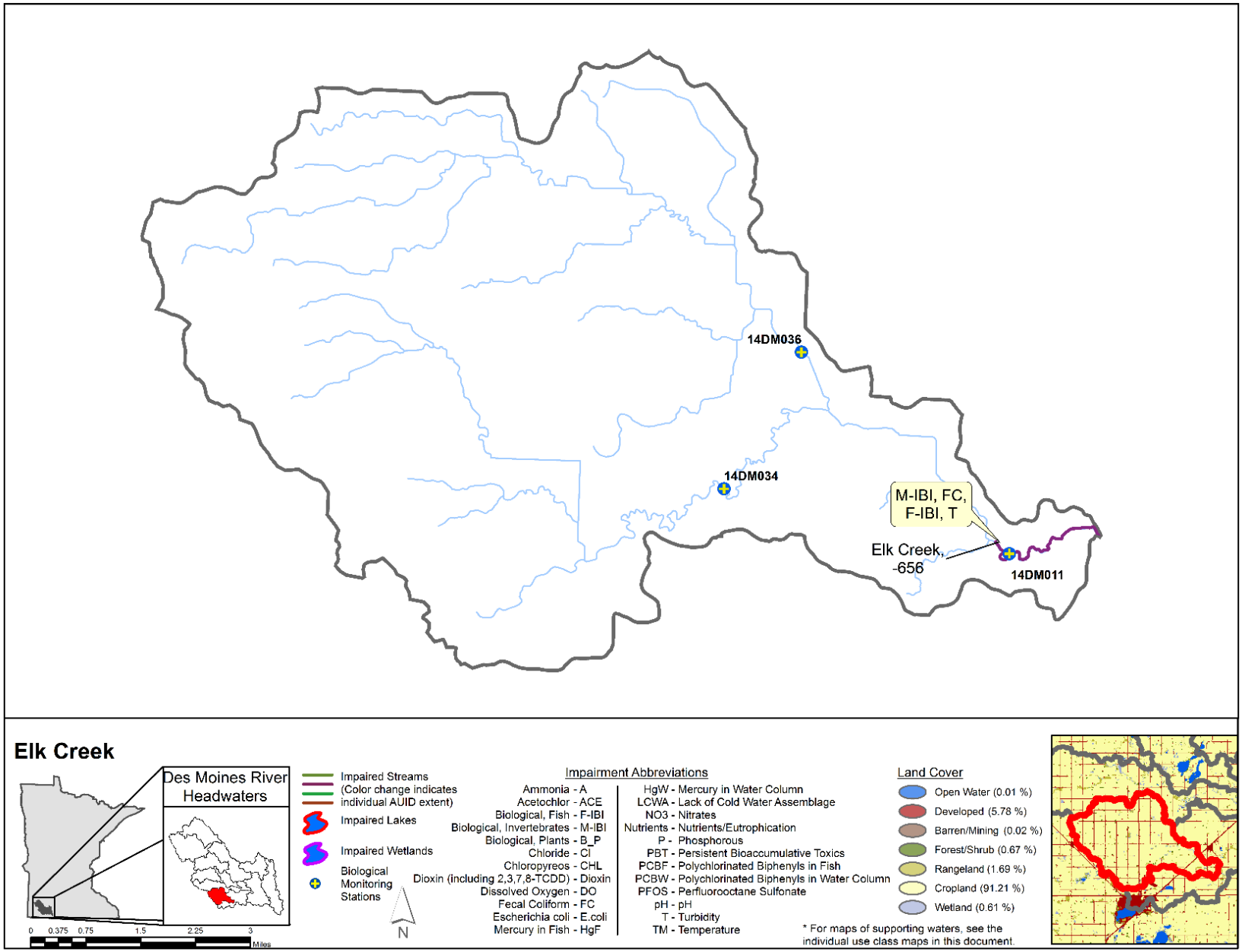

Figure 27. Currently listed impaired waters by parameter and land use characteristics in the Elk Creek Aggregated 12-HUC.

Jack Creek Aggregated 12-HUC HUC 0710000106-01

The Jack Creek Watershed is located in the west-central portion of the Headwaters of the Des Moines River Watershed. The watershed cuts through the middle of Nobles and Jackson Counties. Land use is dominated by agriculture (91.1%) with 88.6% row crop and 2.5% rangeland. Developed land is 5.3% of the land cover with only cities of Pfingsten and Miloma. Very little forest (0.8%) and wetland (2.6%) cover remains in the watershed. Jack Creek (-514) is the longest stream reach at 26 miles and flow straight west across the watershed into Heron Lake. There are 18 stream reaches and three lakes. During the 2016 assessment, five stream reaches were assessed for aquatic life and recreation (Table 12). Impairments are widespread throughout the watershed (Figure 29).

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

AUID, *Reach Name*, *Reach Description*	Biological Station ID	Reach Length (miles)	Use Class*	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Eutrophication	Aquatic Life	Aquatic Rec. (Bacteria)
07100001-618 Unnamed creek, Unnamed cr to Unnamed lk	14DM040	2.0	WWg	EXS	EXS	IF	IF	IF	--	IF	IF		IF	IMP	NA
07100001-549 Jack Creek, T104 R40W S31, west line to N Br Jack Cr	14DM039, 14DM081	15.5	WWg	EXS	EXS	IF	IF	MTS	--	IF	IF		IF	IMP	NA
07100001-658 Jack Creek, MN Hwy 60 to -93.3062 43.7685	14DM009	3.7	WWm	EXS	MTS	MTS	EXS	EXS	MTS	MTS	MTS		IF	IMP	IMP
07100001-659 Jack Creek, -93.3062 43.7685 to Heron Lk	--	2.3	WWg	--	--	--	--	IF	--	--	--		--	IMP	IF
07100001-514 Jack Creek, N Br Jack Cr to JD 26	14DM037	26.1	WWg	EXS	IF	IF	IF	IF	--	IF	IF		IF	IMP	NA

Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: = existing impairment, listed prior to 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

Jack Creek (-509) had an existing turbidity impairment. This reach was split into two, so the existing turbidity impairment is now being carried forward to both reaches -658 and -659. Elevated sediment in the water column (TSS) is still an issue on Jack Creek. Fish communities were sampled on three reaches of Jack Creek and all found to be poor leading to aquatic life impairments. For fish communities, all IBI scores were well below impairment thresholds leading to four new fish impairments on all reaches sampled. Nutrient concentrations may be affecting aquatic life in this watershed. High amounts of phosphorus were collected from Jack Creek, which could have a direct connection to the 91.1% agricultural land use.

The invert IBI assessment for Jack Creek (-514) was insufficient information (Table 12) due to the lack of habitat making it impossible to collect a macroinvertebrate sample using the MPCA qualitative multi-habitat (QMH) protocol. Steep, non-cohesive banks (Figure 28) and lack of coarse substrates precluded sample collection, a condition that can at least partially be ascribed to watershed disturbance. Therefore, while not officially listed on the impaired waters list, the macroinvertebrate community in this reach should be considered as not supporting Warmwater General Use criteria for stressor ID purposes as well as watershed planning and prioritization. Just upstream of this reach, the macroinvertebrate data for Jack Creek (-549) was assessed and clearly demonstrated an impaired aquatic community. The stream channel at both biological monitoring stations (14DM039 & 14DM081) showed obvious signs of over widening and bed aggradation that is likely affecting stability and quality of habitat in this stream. Both samples were dominated by pollution tolerant taxa, had relatively low taxa richness, and was categorized as a BCG tier 5 macroinvertebrate community.

Figure 28. High cut banks on Jack Creek at biological station (14DM037).

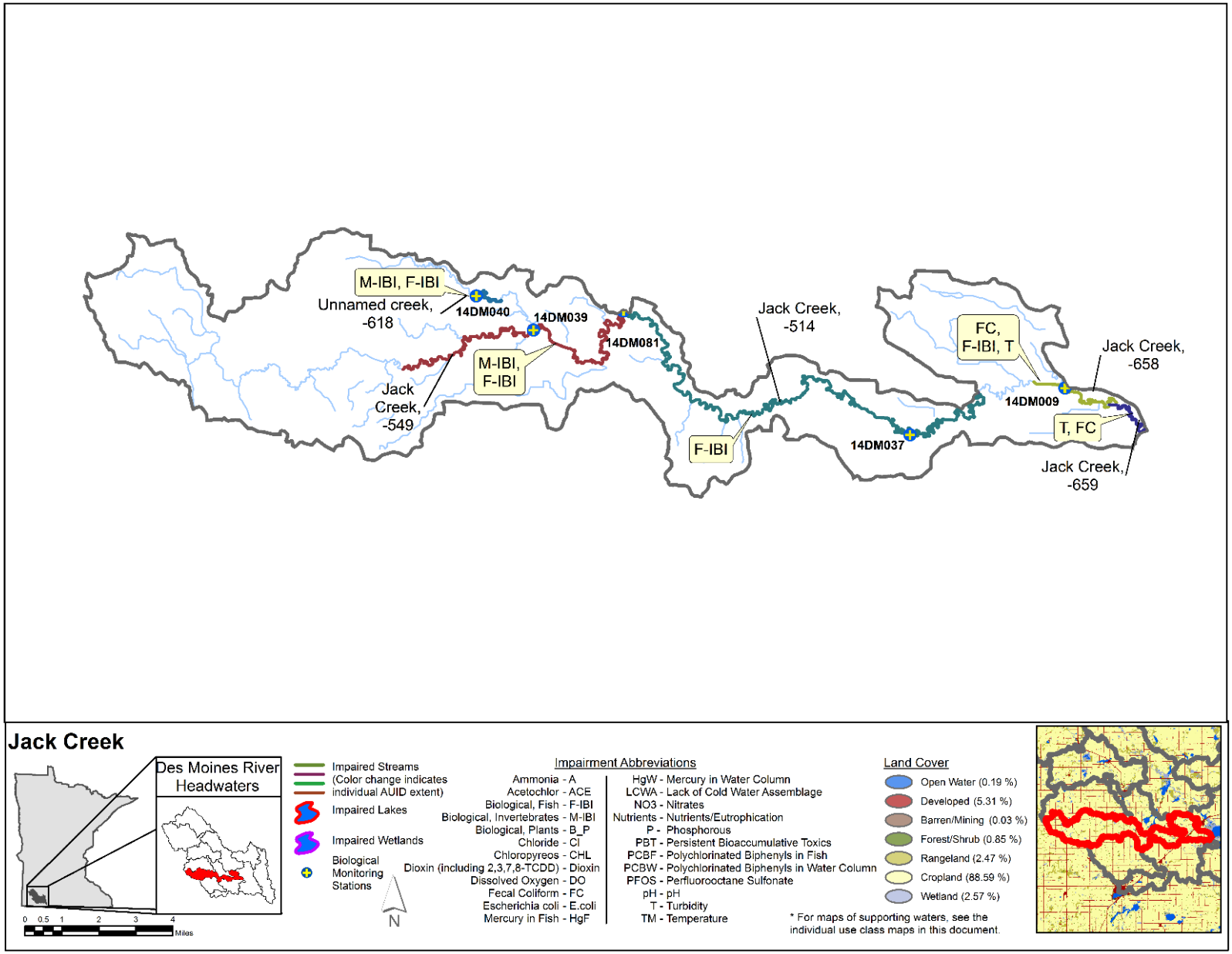

Figure 29. Currently listed impaired waters by parameter and land use characteristics in the Jack Creek Aggregated 12-HUC.

Tributary to Jack Creek Aggregated 12-HUC HUC 0710000106-02

The tributary to Jack Creek Watershed is a 43.9 mi^2 watershed located in the center of the hHeadwaters of the Des Moines River Watershed and falls across three counties: Murray, Nobles, and Jackson. The watershed flows southwest from near the city of Fulda to Jack Creek. Land use is dominated by row crop agriculture (84.5%) and rangeland (1.8%) for 86.3 % total agricultural land use. Developed land is minimal at 5.3% with very limited natural land cover forest (1.1%), wetland (2.3%), and open water (5.06). There are four major lakes in the Jack Creek Watershed. First Fulda Lake, Second Fulda Lake, East Graham Lake, and West Graham Lake are shallow and serve as a resource for public recreation. There are nine stream reaches and six lakes in the tributary to Jack Creek Watershed. There were three stream reaches assessed for aquatic life and recreation (Table 13) and four lakes (Table 14) with data that were assessed. Impairments are widespread throughout the watershed (Figure 30).

Table 13. Aquatic life and recreation assessments on stream reaches: Trib. to Jack Creek Aggregated 12-HUC.

AUID *Reach Name*, *Reach Description*	Biological Station ID	Reach Length (miles)	Use Class*	Aquatic Life Indicators:										Aquatic Life	Aquatic Rec. (Bacteria)
				Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Eutrophication		
07100001-661, Unnamed creek, -95.5572 43.8293 to West Graham Lk	14DM050	4.9	WWg	EXS	EXS	IF	IF	IF	--	IF	IF	--	IF	IMP	NA
07100001-523 Judicial Ditch 26, Unnamed cr to Jack Lk	14DM049	6.5	WWm	NA	EXS	IF	IF	IF	--	IF	IF	--	IF	IMP	NA
07100001-564 Unnamed creek, Unnamed ditch to Jack Cr	14DM012	4.3	WWg	EXS	EXS	IF	IF	IF	MTS	MTS	MTS	--	IF	IMP	IMP

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*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Table 14. Lake water aquatic recreation assessments: Trib. to Jack Creek 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		
Second Fulda	51-0020-00	62	7	Shallow Lake	WCBP	Insufficient Data	--	MTS	--	MTS	MTS	MTS	IF	FS
First Fulda	51-0021-00	119	9	Shallow Lake	WCBP	No Evidence of Trend	NA	MTS	--	MTS	MTS	MTS	IF	FS
East Graham	53-0020-00	469	8	Shallow Lake	WCBP	Insufficient Data	EX	MTS	--	EX	EX	EX	NS	NS
West Graham	53-0021-00	519	8	Shallow Lake	WCBP	Insufficient Data	EX	MTS	--	EX	EX	EX	NS	NS

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

According to assessments of the macroinvertebrate and fish data, this subwatershed is in relatively poor condition compared to other subwatersheds in the Des Moines River Basin. Judicial Ditch 26 (-523), a modified use stream, was in particularly poor condition with MIBI scores approaching zero. The macroinvertebrate community at this location has been severely degraded as exhibited by low taxa richness (14), a high percentage of tolerant taxa (>90%), no EPT taxa, and a dominance of midge larvae. A fish sample of less than 25 fish was collected but was determined that after a severe drought the station did not have time to recolonize be before the fish sampling had occurred. A BCG rating of six demonstrates that this channelized stream has experienced extreme changes in community composition and ecosystem function. Extremely high DO measurements (> 15 mg/L) during both fish and invert sampling indicate large diurnal fluxes and probable anoxic conditions present during nighttime and early morning hours. During the August invert visit the channel was choked with filamentous algae and submerged aquatic vegetation.

In the Des Moines Basin, it is a rare occurrence to see a lake as fully supporting the aquatic recreation standard. In the tributary to Jack Creek Watershed Second Fulda Lake and First Fulda Lake are both meeting the aquatic recreation standard. Second Fulda Lake is located on the south side of Fulda, Minnesota and is connected to the basin of First Fulda Lake. Second Fulda Lake was first listed as impaired for aquatic recreation in 2008 but a closer look at the data revealed an outlier that skewed the dataset. After consideration of this new information, a correction was made to the impaired waters list and now Second Fulda Lake is meeting the standard. First Fulda Lake was also listed as impaired for aquatic recreation in 2008 but again a closer look at the data revealed a different outcome. In both lakes, the data after 2009 showed very improved water quality. This can be explained by the significant alteration and restoration in this lakeshed, which resulted in water quality improvement. The following is an overview of some of the improvements that were completed. In March of 2006, DNR and local units of government decided to temporarily drawdown First and Second Fulda, which occurred in 2008. An awarded 319 grant in 2007 was used to develop a plan and install critical area planting, shoreline restoration, and provide incentives to operators who practices conservation tillage on their farmland. There were three highly erodible channels that feed directly into the lakes and these channels were reshaped, widened, and seeded with permanent vegetation. Some farmers were asked to contain 55 percent residue cover for corn and 30 percent residue cover for soybean fields. Local units of government established and implemented three shoreline restorations projects. A settling pond was established sometime between the fall of 2009 and spring of 2010. In 2011, the stormwater outlet from the City of Fulda was rerouted from straight pipe access to the lake to a rock outwash area to prevent erosion. The above efforts resulted in reduction of phosphorus and improvement of water quality. West Graham Lake and East Graham Lake were both previously listed as impaired for aquatic recreation in 2008, but will now come off the impaired water list. A recent failure of a fish barrier has reintroduced carp into the lake and could cause a significant resuspension of phosphorus from the sediment. The landuse of the watershed is mostly row crop that could be major contributor to the high levels of phosphorus. There were a few wetlands in the watershed but those have been drained and cultivated.

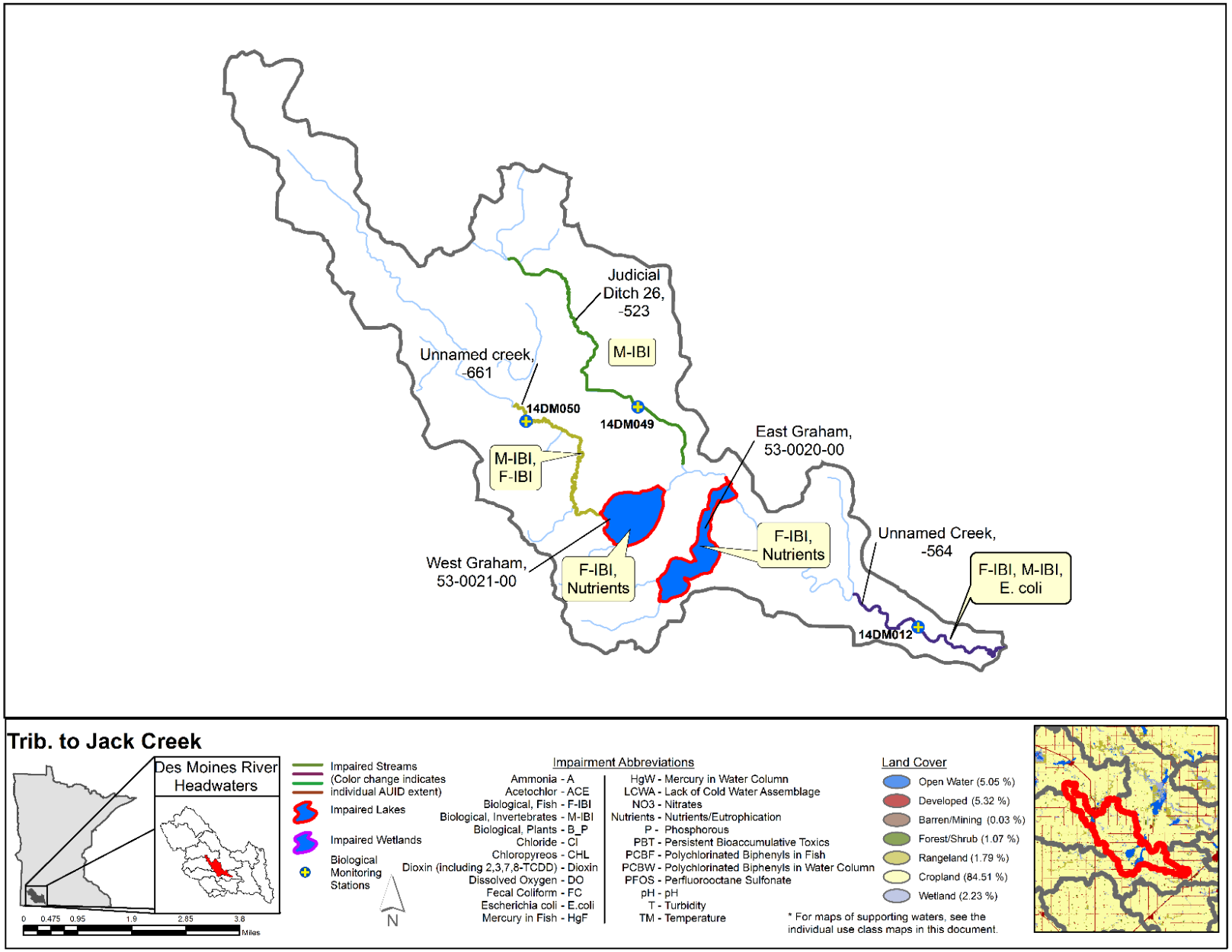

Figure 30. Currently listed impaired waters by parameter and land use characteristics in the Trib. to Jack Creek Aggregated 12-HUC.

North Branch Jack Creek Aggregated 12-HUC HUC 0710000106-03

The North Branch Jack Creek Watershed is located in the west-central side of the Headwaters of the Des Moines River Watershed. The 70.2 mi^2 watershed lies on the border in Murray and Nobles Counties. Land use is dominated by row crop agriculture (89%) and rangeland (2.4%) for 91.4% total agricultural land use. Developed land is minimal at 5.1% with very limited natural cover as forest (0.7%), wetland (2%), and open water (0.7%). There is one major lake in the North Branch Jack Creek Watershed. Corabelle Lake is shallow and serves as a resource for public recreation. In total, there are 11 stream reaches and six lakes in the North Branch Jack Creek Watershed. There are six stream reaches that were assessed for aquatic life and recreation (Table 15) and one lake with assessable data (Table 16). Impairments are widespread throughout the watershed (Figure 31).

Table 15. Aquatic life and recreation assessments on stream reaches: North Branch Jack Creek Aggregated 12-HUC.

AUID *Reach Name*, *Reach Description*	Biological Station ID	Reach Length (miles)	Use Class	Aquatic Life Indicators:										Aquatic Life	Aquatic Rec. (Bacteria)
				Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Eutrophication		
07100001-619 Unnamed creek, Unnamed cr to JD 20	14DM046	1.7	WWg	EXS		IF	IF	IF	--	IF	IF		IF	IMP	NA
07100001-649 Jack Creek, North Branch, T-148 to 1st St	14DM047	3.8	WWm	EXS		IF	IF	IF		IF	IF		IF	IMP	NA
07100001-651 Jack Creek, North Branch, 31st St to JD 12	--	10.4	WWg	--	--	--	IF	IF	--	--	--		--	IMP	NA
07100001-652 Jack Creek, North Branch, JD 12 to Jack Cr	04DM033	7.1	WWg	EXS	IF	IF	IF	IF	MTS	MTS	MTS		IF	IMP	IMP
07100001-665 Judicial Ditch 12, Unnamed cr to CSAH 18	15EM023	2.0	WWm	MTS	MTS	IF	IF	IF	--	IF	IF		IF	SUP	NA
07100001-666 Judicial Ditch 12, CSAH 18 to N Br Jack Cr	14DM045	4.0	WWg	EXS	EXS	IF	IF	IF	--	IF	IF		IF	IMP	NA

Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: = existing impairment, listed prior to 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 16. Lake water aquatic recreation assessments: North Branch Jack Creek 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		
Willow	51-0048-00	63	--	Shallow Lake	WCBP	--	--	--	--	IF	--	--	NA	IF
Corabelle	51-0054-00	104	--	Shallow Lake	WCBP	Insufficient Data	EX	--	--	EX	EX	EX	NS	NS
Unnamed	51-0104-00	13	--	Shallow Lake	WCBP	Insufficient Data	--	--	--	IF	--	IF	NA	IF
Sieverding Marsh	53-0031-00	100	--	Shallow Lake	--	--	--	--	--	IF	--	--	NA	IF

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

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Key for Cell Shading: = existing impairment, listed prior to 2016 reporting cycle; = new impairment; = full support of designated use; = insufficient information.

Summary

All reaches on Jack Creek, North Branch where fish were sampled in 2014, were assessed with degraded biological communities with an aquatic life use impairment. Between 90 and 93% of the fish sampled in Jack Creek, North Branch are considered pollution tolerant species while only one sensitive species (1 Iowa Darter) was collected at the two sampling locations on Jack Creek, North Branch. The macroinvertebrates within North Branch Jack Creek (-649) could not be sampled with MPCA's QMH protocol. Once again, it appears that anthropogenic disturbance was the cause of the absence of macroinvertebrate habitat within the sample reach. Lack of habitat and severe over-widening of the stream channel that appears to be the result of unrestricted cattle access to the stream and lack of deep-rooted riparian vegetation. Therefore, while not officially listed on the impaired waters list, the macroinvertebrate community in this reach should be considered as not supporting Warmwater Modified Use criteria for stressor ID purposes as well as watershed planning and prioritization.

There are 26 active feedlots within a quarter mile of Jack Creek, North Branch and the bacteria levels collected at the pour point are very high especially June through August. Agricultural land use (91.4%) is most likely the main contributor to the poor water quality within the watershed contributing the turbidity and bacteria impairments in Jack Creek, North Branch.

Although Judicial Ditch 12(-665) is the only stream reach that was supporting for aquatic life it still has issues that should be addressed. The MSHA habitat quality was rated poor with mostly run and pool habitat, with severe embeddedness and moderate siltation. Channel stability was rated moderately unstable with little to moderate bank erosion noted between the fish and macroinvertebrate visits. Tolerance Indicator Values developed by the MPCA suggest that DO may be potential stressor to the fish community that scores just 0.4 above the Warmwater Modified Use criteria. Invertebrates did much better, the macroinvertebrate community sample had good EPT (6) and total taxa richness (42) for a modified use low gradient prairie stream and scored above the modified threshold and upper confidence interval.

Corabelle Lake is located southwest of Iona, Minnesota and is somewhat isolated in the watershed which means there are no direct inflow or outflows. The characteristics of the lake creates a prime example of internal loading. The depth of the lake is only 1.8 meters (6 feet) and is surrounded by agriculture. There is no protection from the wind that results in resuspension of sediments throughout the water column. Phosphorus, Chlorophyll-a, and Secchi were collected in 2009 and 2010 and all exceed their applied standard. Phosphorus was two times higher than the standard and Chlorophyll-a was three times the standard. Watershed inputs of phosphorus and internal loading will need to be addressed to see water quality improvements.

Corabelle Lake was assessed for aquatic life use using the fish IBI. There is significantly large amount of tolerant fish species that were sampled. White sucker, bigmouth buffalo, bluntnose minnow, and fathead minnow were the majority of what was surveyed. Potential stressors include watershed disturbance, loss of connectivity, and high average total phosphorous. Aquatic life is impaired in Corabelle Lake. In addition to the water quality data and fish IBI the DNR completed a plant survey. The plant IBI data collected from Corabelle Lake indicates a healthy aquatic plant community.

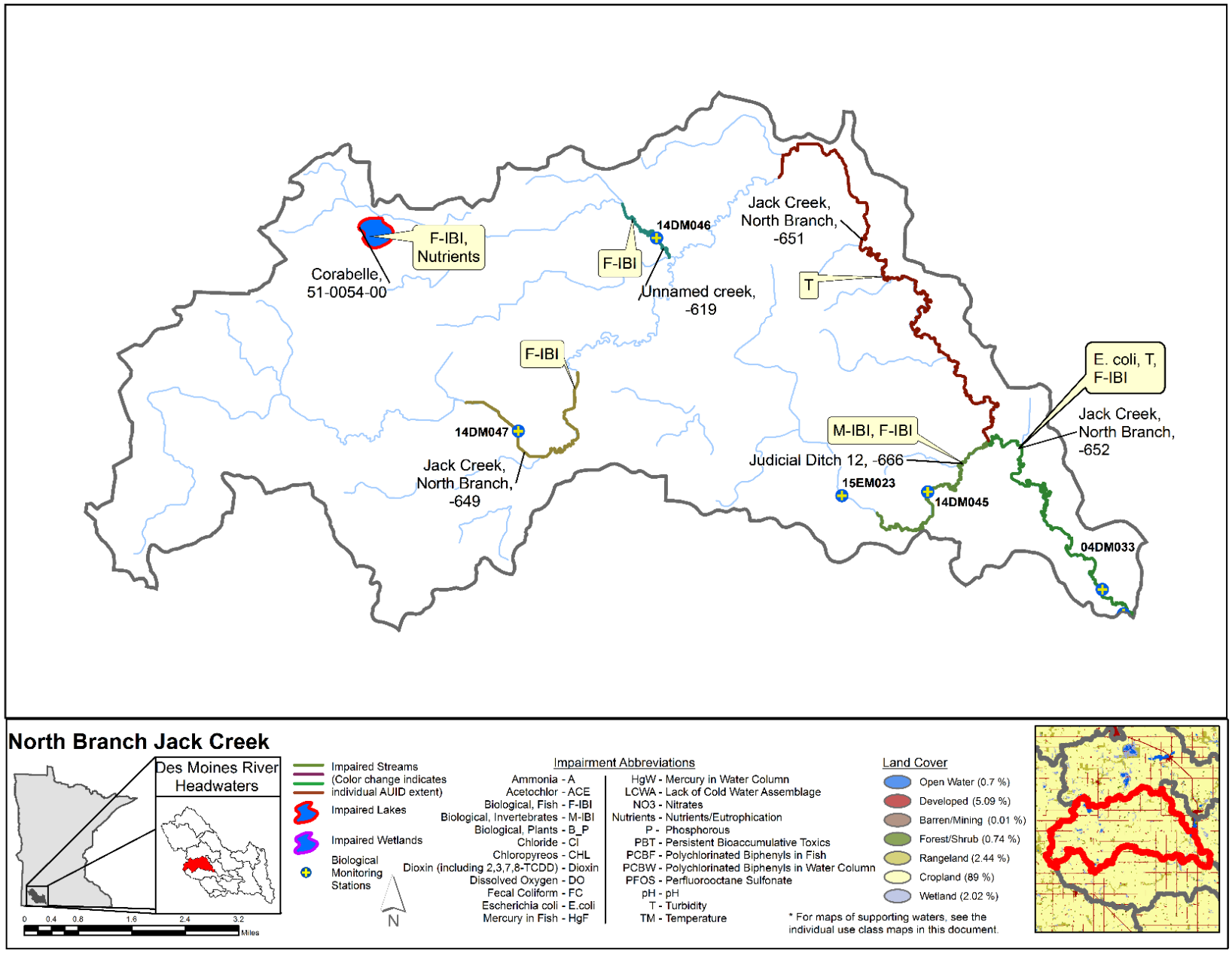

Figure 31. Currently listed impaired waters by parameter and land use characteristics in the North Branch Jack Creek Aggregated 12-HUC.

Heron Lake Aggregated 12-HUC HUC 0710000107-01

The Heron Lake Watershed is located in the southcentral part of the Headwaters of the Des Moines River Watershed. The 120 mi^2 watersheds outlet is in Cottonwood County but the majority of the watershed falls within Jackson County. Land use is dominated by row crop agriculture (77%) and rangeland (2%) for 79% total agricultural land use. Developed land is minimal at 6.1% with very limited natural cover as forest (1.7%), wetland (5.6%), and open water (7.7%). There are three major lakes in the Heron Lake Watershed. Flahtery Lake, Heron Lake, and Timber Lake are shallow and serve as a resource for public recreation. In total, there are 15 stream reaches and 10 lakes in the Heron Lake Watershed. There are three stream reaches that were assessed for aquatic life and recreation (Table 17) and six lakes with assessable data (Table 18). Impairments are widespread throughout the watershed (Figure 32).

Table 17. Aquatic life and recreation assessments on stream reaches: Heron Lake Aggregated 12-HUC.

AUID *Reach Name*, *Reach Description*	Biological Station ID	Reach Length (miles)	Use Class*	Aquatic Life Indicators:										Aquatic Life	Aquatic Rec. (Bacteria)
				Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Eutrophication		
07100001-518 Unnamed creek, Unnamed cr to JD 3	14DM030	3.1	WWm	EXS	EXS	IF	IF	IF		IF	IF		IF	IMP	NA
07100001-527 Heron Lake Outlet, Heron Lk (32-0057-01) to Des Moines R	14DM008	13.6	WWg	EXS	EXS	IF	EXS	EXS	MTS	EXS	IF		EXS	IMP	IMP
07100001-529 Division Creek, Okabena Cr to Heron Lk (32-0057-06)	--	1.6	WWg	--	--	--	--	IF	--	--	--		--	IMP	NA

Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information
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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 18. Lake water aquatic recreation assessments: Heron Lake 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		
Flahtery	32-0045-00	417	6	Shallow Lake	WCBP	Insufficient Data	--	--	--	EX	EX	EX	NA	NS
Teal	32-0053-00	90	--	Shallow Lake	WCBP	Insufficient Data	--	--	--	EX	EX	EX	NA	NS
Heron (Duck)	32-0057-02	307	--	Shallow Lake	WCBP	Insufficient Data	--	--	--	EX	EX	EX	NA	NS
Heron (North Heron)	32-0057-05	3204	--	Shallow Lake	WCBP	Insufficient Data	--	--	--	EX	EX	EX	NA	NS
Heron (South Heron)	32-0057-07	2670	--	Shallow Lake	WCBP	Insufficient Data	--	--	--	EX	EX	EX	NA	NS
Timber	32-0058-00	194	8	Shallow Lake	WCBP	Insufficient Data	--	--	--	EX	EX	EX	NA	NS

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
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Key for Cell Shading: = existing impairment, listed prior to 2016 reporting cycle; = new impairment; = full support of designated use; = insufficient information.

Summary

Heron Lake Outlet and Unnamed Creek, both had degraded biological communities leading to impairment of the aquatic life use. Both streams had relatively good habitat scores (> 50), suggesting that poor water quality and/or altered hydrology may be responsible. The 2014 macroinvertebrate sample from Heron Lake Outlet (-527) had very low taxa richness (21), low EPT taxa richness (9), and a high percentage of pollution tolerant taxa (95%) for macroinvertebrates. Fish sampled at the same site only had one sensitive species (slenderhead darter), while 63% considered very tolerant, and only 10% simple lithophilic spawners. It is likely that nutrient-enrichment, as demonstrated in the nutrient-impaired lakes and streams in this watershed, is having a detrimental impact on the stream aquatic communities and is a leading candidate for the cause of these biological impairments. The Heron Lake Waste Water Treatment Facility is located on the west side of Heron Lake (32-0057-01) which is very shallow and inundated with macrophytes. The lake is dammed before flowing into the Heron Lake Outlet stream. This stream reach is currently impaired for aquatic life based on turbidity and pH impairments which were established in 2006. There was no data collected upstream to determine if the dam or Heron Lake Waste Water Treatment Facility is possibly a point source for the impairment. There is a bacteria impairment that is present in the Heron Lake Outlet stream reach.

Heron Lake is split into four separate basins and we were able to sample three of them. Heron Lake (all three basins) were listed as impaired for aquatic recreation in 2002. The current data confirms those previous listings. The large basins and minimal wind cover makes these basins susceptible to internal loading. As noted in other watersheds all the lakes in this watershed have high land disturbance, minimal cover, and shallow lake depth result in the need to manage watershed loading of phosphorus and internal loading for water quality improvement.

Flahtery Lake is located east of Heron Lake and is connected through an Unnamed Creek (-560). Flahtery Lake is a shallow lake surrounded by some forest but mainly agriculture. This lake was previously listed as impaired for aquatic recreation in 2010 and the current data confirms that listing. Heron Lake is split into four separate basins and we were able to sample three of them. Heron Lake (all three basins) were listed as impaired for aquatic recreation in 2002. The current data confirms those previous listings. The large basins and minimal wind cover makes these basins susceptible to internal loading. As noted in other watersheds, high land disturbance, minimal cover and shallow lake depth result in the need to manage watershed loading of phosphorus and internal loading for water quality improvement. Timber Lake is located near the town of Wilder, Minnesota. The immediate landuse around the lake is a mix of wetland and row crop. There doesn't appear to be any direct stream channels into or out of the lake but the overall water quality is poor. The data collected in recent years consisted of phosphorus samples that are 2.5 times the standard and chlorophyll-a concentrations that are 3 times the standard.

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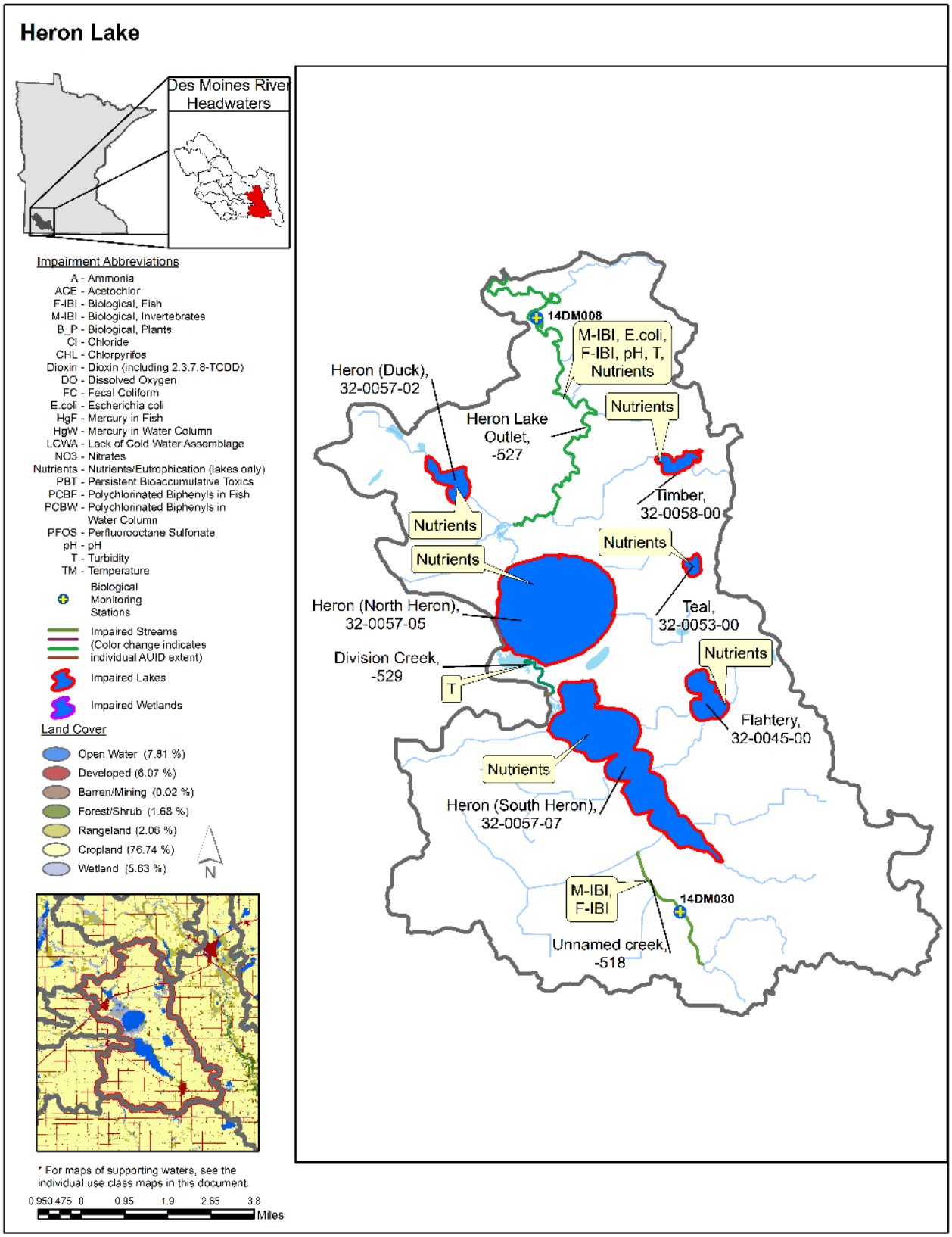

Figure 32. Currently listed impaired waters by parameter and land use characteristics in the Heron Lake Aggregated 12-HUC.

Lower Des Moines Headwaters Aggregated 12-HUC HUC 0710000108-01

Lying across both Cottonwood and Jackson Counties, the Lower Des Moines Headwaters Subwatershed covers 138 mi^2 of the southeastern side of the Headwaters of the Des Moines River Watershed. Land use is dominated by row crop agriculture. There are two major lakes in this subwatershed: Cottonwood Lake and Boot Lake. Both are shallow and serve as a resource for public recreation. The longest stream reach is the Des Moines River (-501) which is 25 miles in long. It travels throughout the whole watershed from the Windom dam to the City of Jackson and supports many popular fishing places, including below the former Talcott dam in Windom and the Currie dam in the City of Jackson. In total, there are 14 stream reaches and 13 lakes in this subwatershed. Of those, five stream reaches (Table 19) and two lakes (Table 20) were assessed for aquatic life and recreation. Impairments are widespread throughout the watershed (Figure 33).

Table 19. Aquatic life and recreation assessments on stream reaches: Lower Des Moines Headwaters Aggregated 12-HUC.

AUID *Reach Name*, *Reach Description*	Biological Station ID	Reach Length (miles)	Use Class*	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Eutrophication	Aquatic Life	Aquatic Rec. (Bacteria)
07100001-544 Perkins Creek, Warren Lk to Des Moines R	14DM024	2.5	WWm	NA	EXS	IF	IF	IF	--	IF	IF		IF	IMP	NA
07100001-608 Unnamed creek, Unnamed cr to Unnamed cr	14DM022	1.2	WWm	MTS	MTS	IF	IF	IF	--	IF	IF		IF	SUP	NA
07100001-670, Unnamed creek, 490th Ave to Warren Lk	14DM025	1.2	WWg	NA	EXS	IF	IF	IF	--	IF	IF		IF	IMP	NA
07100001-541 Des Moines River, Jackson Dam to JD 66	--	0.6	WWg	--	--	IF	EXS	EXS	MTS	MTS	MTS		IF	IMP	NA
07100001-501 Des Moines River, Windom Dam to Jackson Dam	10EM179, 14DM003, 14DM004	24.9	WWg	EXS	EXS	IF	EXS	EXS	MTS	MTS	MTS		EXS	IMP	IMP

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*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Table 20. Lake water aquatic recreation assessments: Lower Des Moines Headwaters 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		
Boot	32-0015-00	151	6	Shallow Lake	WCBP	Insufficient Data	--	--	--	EX	MTS	MTS	NA	NS
Wolf	17-0013-00	120	--	Shallow Lake	WCBP	Insufficient Data	--	--	--	IF	IF	IF	NA	IF
Cottonwood	17-0022-00	154	9	Shallow Lake	WCBP	Insufficient Data	EX	MTS	--	MTS	EX	EX	NS	IF
Summit	17-0073-00	65	10	Shallow Lake	WCBP	Insufficient Data	--	IF	--	IF	IF	IF	IF	IF

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
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Key for Cell Shading: = existing impairment, listed prior to 2016 reporting cycle; = new impairment; = full support of designated use; = insufficient information.

Summary

During the 2016 assessment, one stream reach was confirmed not supporting for both aquatic life and recreation (Des Moines River, -501), three stream reaches were found to not be supporting for aquatic life, while one reach (Unnamed creek, -608) is supporting aquatic life for its proposed Modified Use. One additional stream reach was not assessed due to expired data (older than 10 years). For lakes, two lakes were found to be impaired: one for aquatic life (Cottonwood) and one for aquatic recreation (Boot), while two additional lakes did not have enough data to assess (Summit and Wolf).

For streams, water chemistry and biological community surveys were collected on the Des Moines River (-501) which helped determine both aquatic life and aquatic recreation assessments. Due to its long length, water chemistry data were collected from the northern and southern portion of the reach. The Des Moines River has been the focus of a number of stream assessments in the past. In 1994, this reach was listed as impaired for aquatic life for dissolved oxygen and un-ionized ammonia, and additionally, in 1998 for turbidity. For aquatic recreation, this reach

was listed in 2004 for fecal coliform bacteria. Some potential improvements have been observed in recent years for dissolved oxygen and unionized ammonia, likely due to the Windom dam being replaced with a rock riffle (2011-2012) and the Windom Wastewater Treatments Plant (WWTP) facility upgrade (1996). However, recent data were collected mostly during high flows, so the dissolved oxygen and unionized ammonia listings will remain until additional data is collected that shows that this reach can now meet those standards under normal flow conditions. Additionally, three new aquatic life impairments will now be added to this reach: fish, macroinvertebrates, and river eutrophication. Fish and macroinvertebrate communities were collected at three stations upstream and downstream along this 25 mile reach with all fish and macroinvertebrate IBI scores well below impairment thresholds. Samples were dominated by mostly pollution tolerant species. Habitat quality was only rated fair with moderately unstable channel conditions, excess embeddedness of coarse substrates, and a lack of depth variability. Filamentous and sestonic algae was also observed, suggesting potential nutrient issues. Sediment, excess nutrients, and algal growth are likely still impacting water quality conditions and aquatic life on this reach of the Des Moines River (-501). Recreation use is also limited by excess bacteria levels as well. Practices to reduced watershed runoff such as perennial buffers along the streams and lakes would benefit the river.

Cottonwood Lake and Boot Lake were both assessed for aquatic recreation while only Cottonwood Lake was assessed for aquatic life. Cottonwood Lake is located on the east side of Windom, Minnesota. Overall, the water quality on Cottonwood Lake is poor but not impaired for aquatic recreation per the standards. There is a wetland and grasslands on the north and east sides of the lake. The west side of the lake is developed with some forested areas. The stream that flows into the lake is coming from a wetland, which can capture and filter out pollutants. The phosphorus concentrations in Cottonwood Lake are relatively low compared to the rest of the waterbodies in the watershed. Intact land use (wetlands and non-agricultural land) in the lakeshed reduce runoff. Chlorophyll-a is elevated and some algal blooms will occur. While Boot Lake is in a similar geographical situation as Cottonwood Lake, it has a smaller lakeshed and has wetlands in the surrounding area. The difference with Boot Lake is that there is no direct stream flow from a wetland to filter any pollutants and some row cropping on the northern and eastern sides of the lake. Phosphorus concentrations are high and transparency is low. Boot Lake is impaired for aquatic recreation.

Cottonwood Lake was assessed for aquatic life use using the fish IBI. Significantly large amount of tolerant fish species were sampled. Black bullhead, common carp, and walleye were the majority of the fish species surveyed. Potential stressors include watershed disturbance, water level fluctuations due to water control structures and water use. Aquatic life is impaired in Cottonwood Lake. In addition to the water quality data and fish IBI the DNR completed a plant survey. The plant IBI data from Boot Lake indicates the plant community is degraded. Plant IBI data collected from Cottonwood Lake indicates a healthy aquatic plant community.

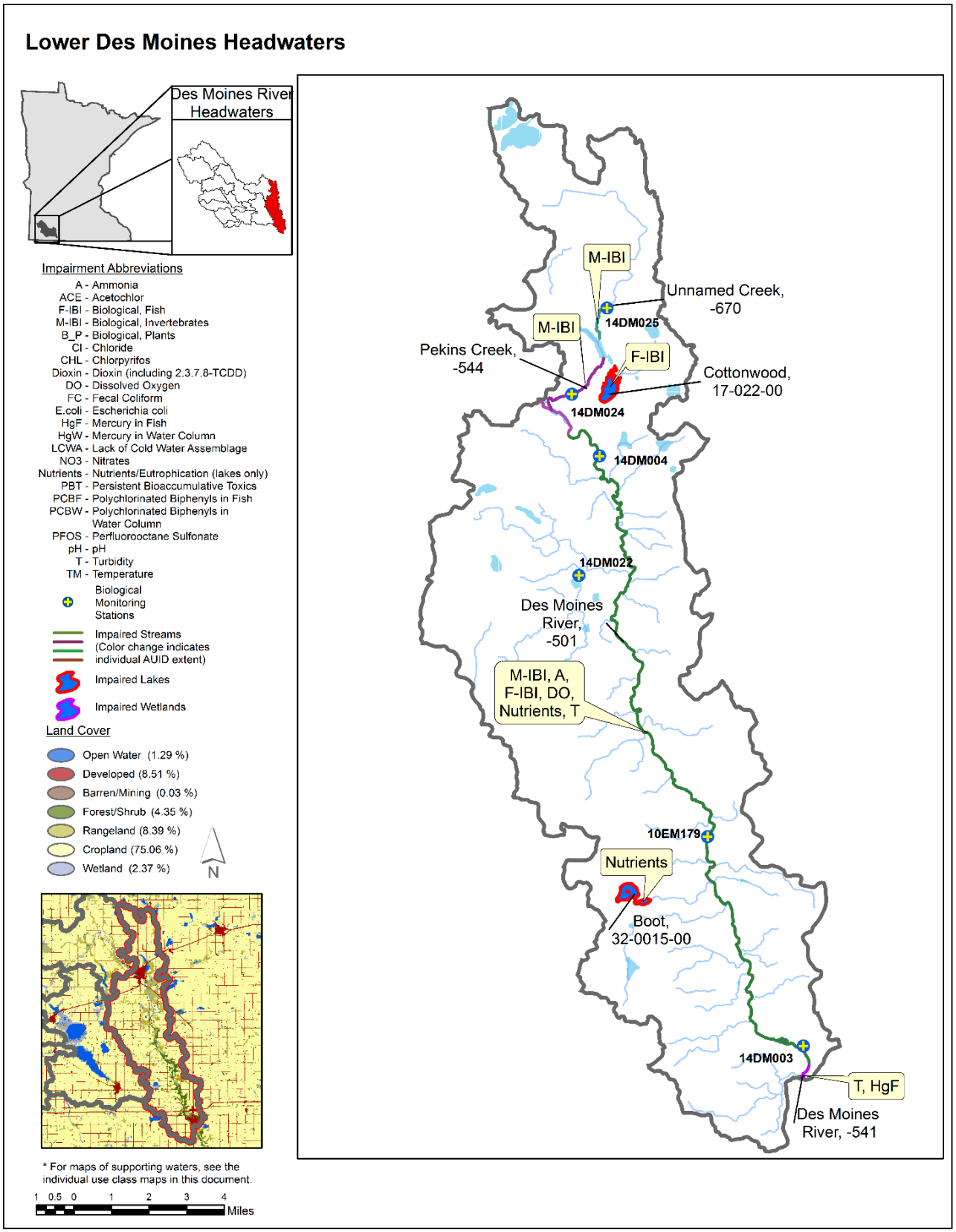

Figure 33. Currently listed impaired waters by parameter and land use characteristics in the Lower Des Moines Headwaters Aggregated 12-HUC.

Middle Des Moines Headwaters Aggregated 12-HUC HUC 0710000108-02

The Middle Des Moines Headwaters Watershed is located in the north central tip of the Headwaters of the Des Moines River Watershed. This 86.3 mi^2 watershed falls mostly within Cottonwood County with a small section that extends into Jackson County. Land use is dominated by row crop agriculture (75.1%) and rangeland (4.4%) for 79.5% total agricultural land use. Developed land is minimal at 8.3% with very limited natural cover as forest (4.4%), wetland (2.4%), and open water (1.2%). There is one major lake in the Middle Des Moines Headwaters Watershed. String Lake is shallow and serves as a resource for public recreation. In total, there are 14 stream reaches and eight lakes in the watershed. There are five stream reaches with data assessed for aquatic life and recreation (Table 21) and no lake were assessable (Table 22). Impairments are widespread throughout the watershed (Figure 34).

Table 21. Aquatic life and recreation assessments on stream reaches: Middle Des Moines River Headwaters Aggregated 12-HUC.

AUID *Reach Name*, *Reach Description*	Biological Station ID	Reach Length (miles)	Use Class*	Aquatic Life Indicators:										Aquatic Life	Aquatic Rec. (Bacteria)
				Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Eutrophication		
07100001-524 Des Moines River, Heron Lk outlet to Windom Dam	04DM020, 14DM005	18.1	WWg	EXS	EXS	IF	EXS	EXS	MTS	MTS	MTS		IF	IMP	IMP
07100001-551 Unnamed creek, String Lk to Des Moines R	14DM027	2.6	WWg	EXS	EXS	IF	IF	IF	--	IF	IF		IF	IMP	NA
07100001-552 County Ditch 43 (Scheldorf Creek), Unnamed cr to Des Moines R	09DM001, 14DM099	1.3	CWg	EXS	EXS	IF	IF	IF	--	IF	IF		IF	IMP	NA
07100001-563 Unnamed creek, Harder Lk to Unnamed cr	14DM026	3.9	WWg	NA	EXS	IF	IF	IF	--	IF	IF		IF	IMP	NA
07100001-613 Unnamed creek, Unnamed cr to Des Moines R	14DM028	1.8	WWg	EXS	MTS	IF	IF	IF	--	IF	IF		IF	IMP	NA

Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: = existing impairment, listed prior to 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 22. Lake water aquatic recreation assessments: Middle Des Moines Headwaters 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		
String	17-0024-00	336	6	Shallow Lake	WCBP	Insufficient Data	--	MTS	--	MTS	EX	EX	IF	IF
Unnamed	17-0030-00	43	--	Shallow Lake	WCBP	Insufficient Data	--	--	--	IF	--	IF	NA	IF
Harder	17-0031-00	192	4	Shallow Lake	WCBP	Insufficient Data	--	--	--	IF	--	IF	NA	IF

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

Stream macroinvertebrate and fish communities failed to attain aquatic life use goals in three out of four Warmwater General stream reaches assessed in this subwatershed. MSHA scores in the failing streams were generally between 40 and 50, suggesting that habitat degradation in conjunction with water quality issues may be causing the observed impairments. Macroinvertebrate samples from these streams had low taxa richness, a high percentage of pollution tolerant taxa, and very few mayfly/caddisfly/stonefly taxa (i.e., EPT). Fish sampled at the three reaches (-524, -551, -613) had very high percentage tolerant species 75, 85, and 83% respectively and very few if any sensitive species 7, 0, and 0.5% respectively. The first 9 miles of the Des Moines River flow north east across an agricultural landscape with little to no buffers then the stream turns southeast towards the town of Windom, Minnesota. The last nine miles of the stream appears to have some buffers along the banks that can help reduce pollutant loads that runoff into the stream. There is a previous impairment for turbidity on the stream dating back to 2006. The current data collected represents a stream that has higher levels of TSS and low transparency that confirms the previous turbidity listing. Bacteria levels in the stream are high enough in June to warrant an impaired listing.

The one coldwater stream was assessed in this subwatershed, the only one in the Des Moines Watersheds, was determined to be not supporting aquatic life according to the macroinvertebrate community and fish community data. County Ditch 43 (a.k.a. Scheldorf Creek) was sampled for fish and macroinvertebrates in 2009 and 2014. Neither resulting macroinvertebrate IBI score attained coldwater aquatic life criteria and both samples had very few taxa that are indicative of a coldwater stream. Scheldorf Creek is a coldwater prairie stream annually stocked with trout that takes its flow from small cool springs, and seepages in creek bed. It is a borderline trout stream due to lack of flow, depth, cover, pools riffles and shade. Previously flow had been greater and temperatures cooler. However, since ditching the creek, it has become shallower and flow has lessened. Trout spawning conditions are poor and likely unfit for natural reproduction. Riffles are lacking and much of the streambed is composed of fine materials (silt or clay-loam sand). Quality of the trout stream appear to be growing progressively worse. This stream was reviewed for a possible reclassification to a warmwater aquatic life designated use, but after meeting with DNR, it was decided to leave as coldwater (CWg) due to their continued management of trout in this stream.

String Lake is located 3.8 miles west of Windom, Minnesota and consist of three basins stretching south to north. These basins are connected through culverts underneath roadways. The landuse surrounding the lake is mainly agriculture. The southern portion of the landscape is a large wetland that flows into the lake basin. The phosphorus levels are below the standard and low compared to the other lakes in the watershed. Chlorophyll-a concentrations are high and transparency is low and blooms will occur in String Lake. This basin would be high priority for protection activities that would limit watershed sources of phosphorus. In addition to the water quality data the DNR completed a plant survey which resulted in the plant IBI data indicating the plant community is degraded.

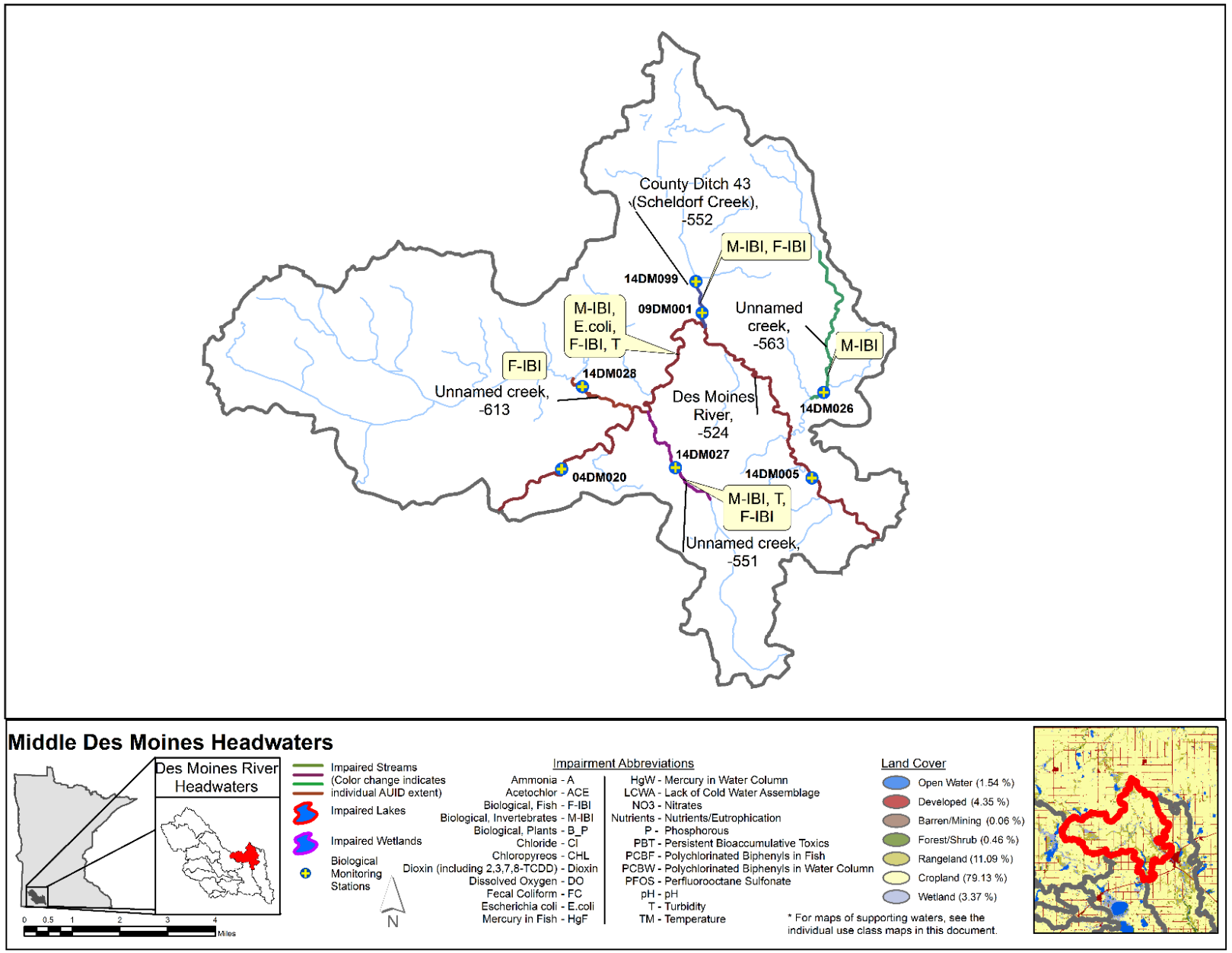

Figure 34. Currently listed impaired waters by parameter and land use characteristics in the Middle Des Moines Headwaters Aggregated 12-HUC.

Des Moines River-Minnesota Outlet Aggregated 12-HUC HUC 0710000201-01

The Des Moines River-Minnesota Outlet Subwatershed is located in the Lower Des Moines River Watershed (07100002). The watershed falls mostly within Jackson County with a small section draining Martin County. There is only one aggregated 12-HUC within the Lower Des Moines River Watershed 8-HUC. Half of the Des Moines River-Minnesota Outlet 12-HUC is south of Minnesota border in Iowa. The largest stream reach is the Des Moines River, which flows 11.7 miles from Judicial Ditch 66 to the Minnesota/Iowa border. In total, there are 14 stream reaches and no lakes in this watershed. There were seven stream reaches assessed for aquatic life and recreation (Table 23). Impairments are widespread throughout the watershed (Figure 36).

Table 23. Aquatic life and recreation assessments on stream reaches: Des Moines River-Minnesota Outlet Aggregated 12-HUC.

AUID *Reach Name*, *Reach Description*	Biological Station ID	Reach Length (miles)	Use Class*	Aquatic Life Indicators:										Aquatic Life	Aquatic Rec. (Bacteria)
				Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Eutrophication		
07100002-501 Des Moines River, JD 66 to MN/IA border	14DM001	11.6	WWg	EXS	EXS	IF	EXS	EXS	MTS	MTS	MTS	--	EX	IMP	IMP
07100002-502 Brown Creek (Judicial Ditch 10), Headwaters to MN/IA border	14DM088	5.2	WWm	MTS	EXS	IF	IF	IF	--	IF	IF	--	IF	IMP	NA
07100002-504 Unnamed creek, JD 11 to Des Moines R	14DM089	1.2	WWg	EXS	EXS	IF	IF	IF	--	IF	IF	--	IF	IMP	NA
07100002-505 Judicial Ditch 56, Unnamed cr to Des Moines R	14DM087	3.7	WWg	EXS	EXS	IF	IF	IF	--	IF	IF		IF	IMP	NA
07100002-507 Story Brook, JD 56 to Des Moines R	14DM084	2.5	WWg	EXS	EXS	IF	IF	IF	--	IF	IF		IF	IMP	NA
07100002-510 Unnamed ditch, Unnamed ditch to Unnamed ditch	07DM005	0.9	WWg	EXS	IF	IF	IF	IF	--	IF	IF		IF	IMP	NA

AUID *Reach Name*, *Reach Description*	Biological Station ID	Reach Length (miles)	Use Class*	Aquatic Life Indicators:										Aquatic Life	Aquatic Rec. (Bacteria)
				Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Eutrophication		
07100002-513 Judicial Ditch 6, Unnamed ditch to Unnamed ditch	14DM085	2.5	WWm	MTS	MTS	IF	IF	IF	--	IF	IF		IF	SUP	NA

Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: = existing impairment, listed prior to 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

Water chemistry and biological surveys were collected on the Des Moines River (-501) which helped determine both aquatic life and aquatic recreation assessments. This section of the Des Moines River was previously listed as impaired for turbidity (2002), fecal coliform (2004). In addition to the previous impairments, the Des Moines River is also impaired for river eutrophication. There are high levels of phosphorus, chlorophyll-a, and BOD that flow through this watershed.

The majority of the monitoring data collected in this subwatershed indicates that the aquatic life designated use (general or modified) are not being supported. Macroinvertebrate communities did not attain Warmwater General Use criteria in all but one stream reaches where there was sufficient data to assess aquatic life. Fish also did not attain Warmwater General Use criteria in five out of seven reaches. Communities in these streams were comprised of a high percentage of pollution tolerant taxa, low numbers of EPT taxa, and no intolerant taxa. Fish communities ranged from 67 to 98% tolerant species with many having little or no sensitive species. Streams such as Brown Creek (-502) and Judicial Ditch 56 (-505) exhibited signs of excess nutrients with dense aquatic macrophyte and filamentous algae growth (Figure 35). Increased productivity in the stream results in highly fluctuating daily DO concentrations, reduced habitat quality, and shifts in the trophic composition of the community, all of which are detrimental to biological integrity. Similarly, MSHA habitat scores in Unnamed Creek (-504) were very high (73 & 76), suggesting that the impaired biological community in this stream is primarily due to poor water quality as opposed to habitat degradation at the monitoring station.

Figure 35. Extensive filaments algae located in Brown Creek (-502).

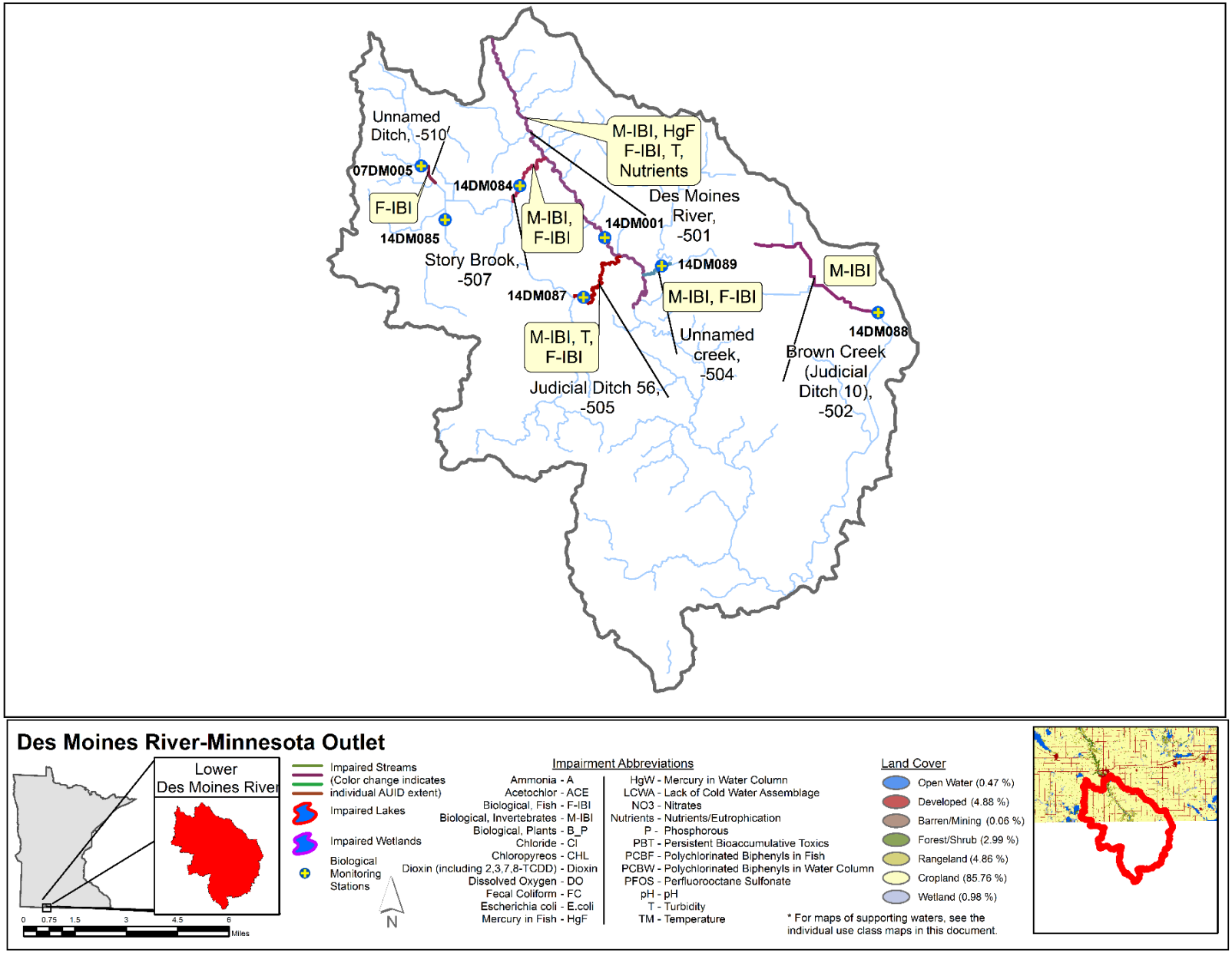

Figure 36. Currently listed impaired waters by parameter and land use characteristics in the Des Moines River-Minnesota Outlet Aggregated 12-HUC.

Lower Headwaters East Fork Des Moines River Aggregated 12-HUC HUC 0710000301-01

The Lower Headwaters East Fork Des Moines River Watershed is within the lower end of the East Fork Des Moines River Watershed. The 138.4 mi^2 watershed falls mostly within Martin County with a small headwater portion in Jackson County. Over half of the watershed falls south of the Minnesota border in Iowa. Land use is dominated by row crop agriculture (80.1%) and rangeland (2.6%) for 82.7% total agricultural land use. Developed land is minimal at 5.5% with very limited natural cover as forest (0.4%), wetland (3.82%), and open water (7.62%). There are four major lakes in the Lower Headwaters East Fork Des Moines River Watershed. Okamanpeedan, Bright, Pierce, and Little Turtle are all used for recreational activity. In total, there are 13 stream reaches and 15 lakes in this watershed. There are four stream reaches with data that were assess for aquatic life and recreation (Table 24) and three lakes with assessable data (Table 25). Impairments are widespread throughout the watershed (Figure 37).

Table 24. Aquatic life and recreation assessments on stream reaches: Lower Headwaters East Fork Des Moines River Aggregated 12-HUC.

AUID *Reach Name*, *Reach Description*	Biological Station ID	Reach Length (miles)	Use Class*	Aquatic Life Indicators:										Aquatic Life	Aquatic Rec. (Bacteria)
				Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Eutrophication		
07100003-506 County Ditch 53, Unnamed cr to MN/IA border	14DM097	4.0	WWm	EXS	MTS	IF	IF	IF	--	IF	IF		IF	IMP	NA
07100003-516 Mud Slough, Unnamed ditch to Bright Lk	--	2.1	WWg	--	--	IF	IF	IF	--	IF	MTS		IF	IF	SUP
07100003-527 Des Moines River, East Branch, -94.6258 43.5659 to Okamanpeedan Lk	14DM002	5.1	WWg	EXS	MTS	IF	EXS	EXS	MTS	MTS	MTS		EX	IMP	IMP

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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 25. Lake water aquatic recreation assessments: Lower Headwaters East Fork Des Moines 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		
Okamanpeedan	46-0051-00	2233	7	Shallow Lake	WCBP	Insufficient Data	NA	MTS		EX	EX	EX	IF	NS
Bright	46-0052-00	639	5	Shallow Lake	WCBP	Insufficient Data	EX	MTS		EX	EX	MTS	NS	NS
Clayton	46-0061-00	513	5	Shallow Lake	WCBP	Insufficient Data						IF		IF
Pierce	46-0076-00	429		Shallow Lake	WCBP	Insufficient Data				EX	EX	EX		NS
Little Tuttle	46-0088-00	391	6	Shallow Lake	WCBP	Insufficient Data				EX	MTS	MTS		IF
Susan	46-0094-00	113		Shallow Lake	WCBP	Insufficient Data						IF		IF
Fish	46-0095-00	142	6	Shallow Lake	WCBP	Insufficient Data						IF		IF
Clear	46-0096-00	261	10	Shallow Lake	WCBP	No Evidence of Trend		MTS		MTS	EX	EX	IF	IF
Dutton Slough	46-0098-00	37		Shallow Lake	WCBP	Insufficient Data		IF		IF	IF	IF	IF	IF

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

Both fish reaches sampled are below their respective thresholds for aquatic life. The County Ditch 53 sample is just below the Warmwater Modified Use threshold but is still dominated by 95% tolerant species. Filamentous algae and row crop encroachment into riparian were noted as problems. Afternoon dissolved oxygen during fish collection on August 5, 2014 show dissolved oxygen was high (13.5 mg/L) and supersaturated (156%) suggesting a potential issue.

Macroinvertebrates were assessed in two stream reaches in this subwatershed, the East Branch Des Moines River and County Ditch 53, and both exhibited attainment of their respective aquatic life use macroinvertebrate criteria. However, the MIBI scores from both streams were only marginally meeting their criteria, and County Ditch 53 showed obvious signs of nutrient enrichment during sample collection in June and August. This nutrient enrichment may be the cause of an afternoon dissolved oxygen measured during invert sampling on August 4, 2014 that was very high dissolved oxygen (18.1 mg/L) and supersaturated condition (240%), suggesting a potential dissolved oxygen issue. Restoration efforts to address other aquatic life impairments in these streams will also benefit the fish and macroinvertebrate community found therein.

The section of the Des Moines River that flows five miles through Turtle Lake and into Okamanpeedan Lake. It is a child stream reach of the parent stream reach (-501). Two previous impairments (dissolved oxygen and turbidity) are going to carry forward to this section of the Des Moines River. There are very high levels phosphorus and BOD that warrants a river eutrophication impairment. The Des Moines River also has high levels of bacteria affecting recreation use.

All of the lakes in the Lower Headwaters East Fork Des Moines River Watershed are shallow basins and located in the Western Corn Belt Plain ecoregion. Nine lakes have enough data for an assessment. Okamanpeedan Lake was previously listed as impaired in 2010 and current data confirms this listing. Bright Lake and Pierce Lake will be joining the impaired waters list based on the high amounts of phosphorus, chlorophyll-a, and low Secchi. Watershed inputs of phosphorus and internal loading will need to be address for water quality to improve.

There were four lakes with data for aquatic life using the fish IBI: Okamanpeedan, Bright, Clear, and Dutton Slough. Bight Lake was the only lake with enough data to make a defining assessment decision. It is impaired for aquatic life and is dominated by white crappie, carp, and yellow perch. There could be potential stressors in the watershed such as agriculture and high levels of phosphorus, which would affect the F-IBI. In addition to the water quality data and fish IBI the DNR completed a plant survey. Plant IBI data collected from Okamanpedan Lake and Clear Lake indicates a healthy aquatic plant community.

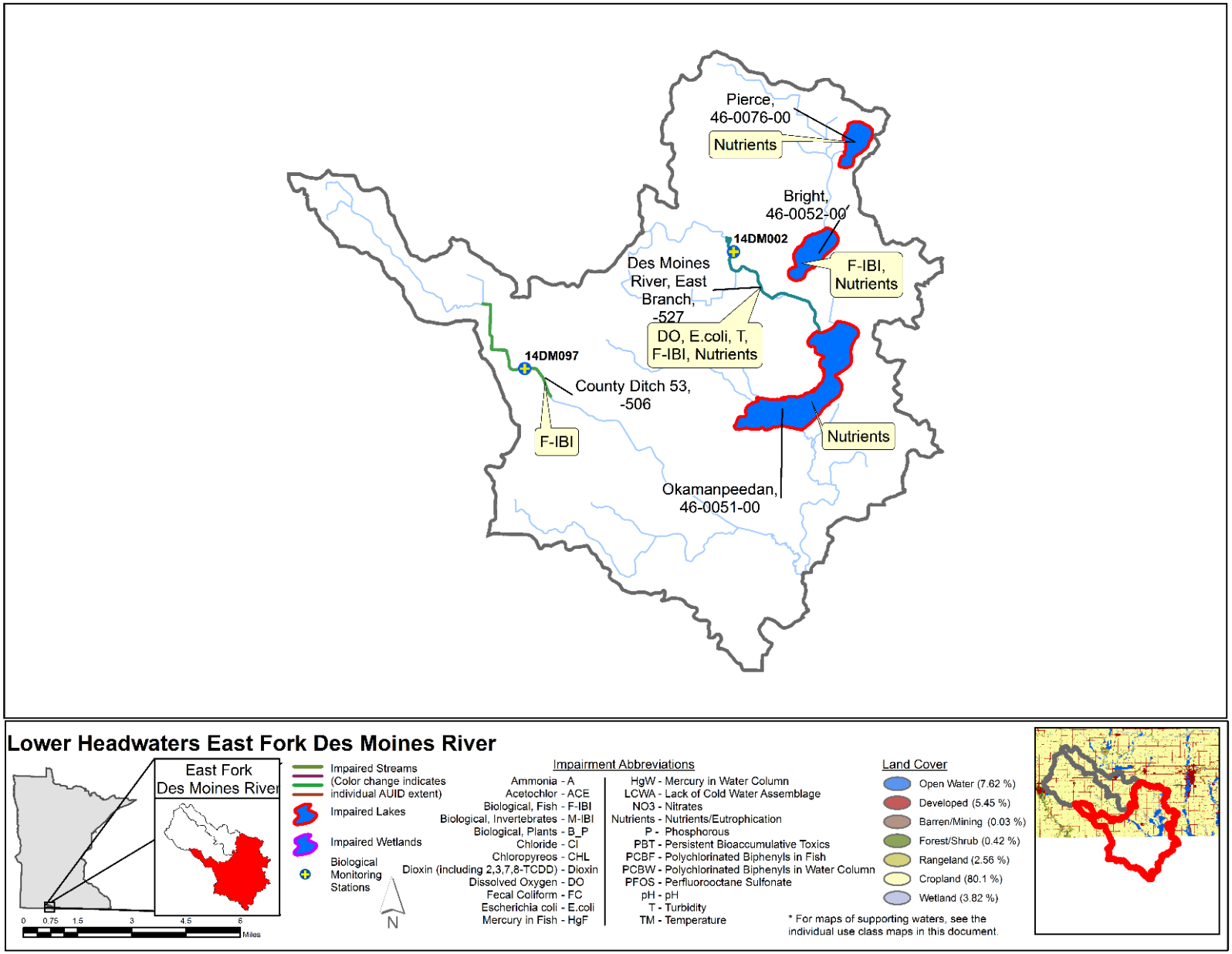

Figure 37. Currently listed impaired waters by parameter and land use characteristics in the Lower Headwaters East Fork Des Moines River Aggregated 12-HUC.

Upper Headwaters East Fork Des Moines River Aggregated 12-HUC HUC 0710000301-02

The Upper Headwaters East Fork Des Moines River Watershed is located in the upper portion of the East Fork Des Moines River Watershed. This 78.6 mi^2 watershed falls across both Jackson and Martin Counties. Land use is dominated by row crop agriculture (89.8%) and rangeland (1.1%) for 90.9% total agricultural land use. Developed land is minimal at 6.4% with very limited natural cover as forest (1.6%), wetland (1.1%), and open water (0.1%). There are two very small lakes in the Upper Headwaters East Fork Des Moines River Watershed: Fox Lake Gravel Pit and Willard Peters Pond. The lakes are small, shallow, and no data was collected on them. In total, there are seven stream reaches and two lakes in the Upper Headwaters East Fork Des Moines River Watershed. There are three stream reaches assessed for aquatic life and recreation (Table 26). Impairments are widespread throughout the watershed (Figure 38).

Table 26. Aquatic life and recreation assessments on stream reaches: Upper Headwaters East Fork Des Moines River Aggregated 12-HUC.

AUID *Reach Name*, *Reach Description*	Biological Station ID	Reach Length (miles)	Use Class*	Aquatic Life Indicators:										Aquatic Life	Aquatic Rec. (Bacteria)
				Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Eutrophication		
07100003-510 Fourmile Creek, JD 105 to Des Moines R	14DM096	4.1	WWg	EXS	MTS	IF	MTS	MTS	--	MTS	MTS		IF	IMP	IMP
07100003-525 Des Moines River, East Branch, Unnamed cr to CD 11	14DM015 14DM093	19.5	WWg	EXS	IF	IF	IF	MTS	MTS	MTS	MTS		IF	IMP	IMP
07100003-529 Unnamed creek, -94.8641 43.6264 to Des Moines R	14DM095	5.1	WWg	EXS	EXS	IF	IF	IF	--	IF	IF		IF	IMP	NA

Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: = existing impairment, listed prior to 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

Despite a failing IBI score, macroinvertebrates were determined to be meeting Warmwater General Use expectations in Fourmile Creek (-510) during the 2016 assessment process. This decision took into consideration the magnitude of the deviation from the impairment threshold (~1 pt), the extreme flooding that occurred several weeks prior to macroinvertebrate monitoring, and the habitat quality of the station (MSHA scores 63-68). There were similar concerns regarding the impact of flooding on the fish community that was present in the stream when it was sampled (July 17, 2014); however, an analysis of the fish community data in this stream resulted in an impairment determination. Therefore, additional biological monitoring was requested during the assessment process to address these concerns. Since there were concerns regarding the assessment decisions of both assemblages, each one was re-sampled in 2016. Preliminary IBI scores from the 2016 samples confirm the original fish impairment decision and suggest that macroinvertebrates should also be listed as impaired in Fourmile Creek (-510). Four Mile Creek (-510) is a contributor to the Des Moines River from the west. The bacteria levels that were sampled in Four Mile Creek are overwhelming high. Both stream reaches had sustained elevated bacteria levels affecting swimming and wading activities. In addition, nutrients were also very high. High concentrations can lead to algal blooms and stressed aquatic life. Large feedlots near the stream and intensive agricultural land use are likely the contributing to both issues.

Macroinvertebrate data was collected at two stations on the East Branch Des Moines River (-525). One station (14DM093) is located near the upstream end of the reach, while the other station (14DM015) is near the downstream end of the assessment unit. According to the Prairie Streams Glide-Pool IBI, both stations fall just below the Warmwater General Use threshold. At the upstream station, the sampler noted very questionable sampling conditions due to low flow and limited habitat, yet the IBI score was only a few points below threshold. The sample indicated that a BCG 4 macroinvertebrate community (i.e., moderate changes in biological community with minimal changes in ecosystem function) was present with seven EPT taxa, one intolerant taxa, and 32 total taxa in this low gradient, glide-pool stream. At the downstream station, the monitoring crew noted a beaver dam, but they determined that an invert sample was still obtainable and could be used for assessment. Also a BCG 4 community, this sample had 9 EPT taxa and 36 total taxa, but was comprised entirely of tolerant taxa. During the assessment of this reach, additional monitoring was requested due to the uncertainty regarding conditions at the time of sampling and a determination of insufficient information (IF) was made for the macroinvertebrate IBI assessment. Unfortunately, additional monitoring could not be conducted on this stream in 2016 and therefore the IF determination remains for the invert IBI. No fish IBI scores were meeting for Warmwater General Use criteria. High abundance of tolerant fish brought the IBI scores down. MSHA habitat scores rated fair to good with bank erosion and some riffle/run/pool with coarse substrates and moderate embeddedness. Fish cover was diverse, suggesting that the impaired biological community in this stream is primarily due to poor water quality as opposed to habitat degradation at the monitoring station. This section of the Des Moines River contains high levels of bacteria and phosphorus that could be explained by the extensive amounts of agriculture that dominates the landscape.

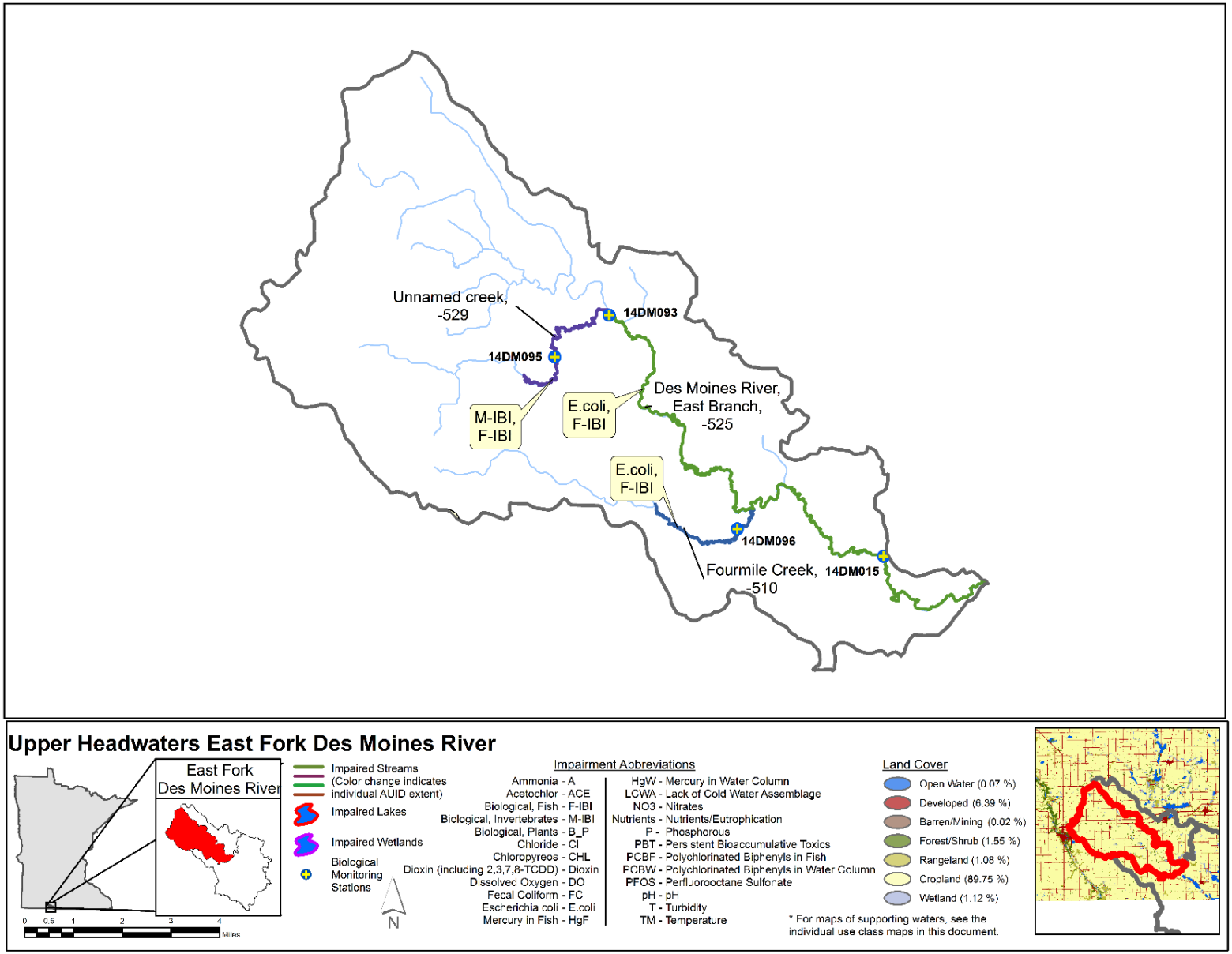

Figure 38. Currently listed impaired waters by parameter and land use characteristics in the Upper Headwaters East Fork Des Moines River Aggregated 12-HUC.

County Ditch 11 Aggregated 12-HUC HUC 0710000301-03

The smallest of the subwatersheds, the County Ditch 11 Watershed is located in the Northern headwaters of the East Fork Des Moines River Watershed. This subwatershed begins in Jackson County while most of its land it drains falls within Martin County. Land use is dominated by row crop agriculture (87%) with limited rangeland (2%). Sherburn is the largest city with all developed land at 6.8% of the subwatershed. Undeveloped land as forest, wetland, and open water is at 4.5%. There are seven stream reaches and one remaining lake (Temperance), as three other lakes (Munger, Prairie, and Smith) appear to have been drained with the land now used for agriculture. The largest stream reach, County Ditch 11, is an eight mile stretch of stream that begins in the town of Sherburn, Minnesota at Temperance Lake and then flows south passing through and then exiting into the Des Moines River, East Branch (-526) in the Lower Headwaters, East Fork Des Moines River 8-HUC Watershed (07100003). During the 2016 assessment, two stream reaches (Table 27) and one lake (Table 28) were assessed for aquatic life and aquatic recreation. The aquatic recreation impairments are all located in the lower half of the watershed (Figure 40).

Table 27. Aquatic life and recreation assessments on stream reaches: County Ditch 11 Aggregated 12-HUC.

AUID *Reach Name*, *Reach Description*	Biological Station ID	Reach Length (miles)	Use Class	Aquatic Life Indicators:										Aquatic Life	Aquatic Rec. (Bacteria)
				Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Eutrophication		
07100003-515 County Ditch 1/Judicial Ditch 50, Unnamed cr to CD 11	14DM091	4.4	WWm	MTS	MTS	IF	IF	MTS	--	IF	MTS		IF	SUP	IMP
07100003-503 County Ditch 11, Headwaters to E Fk Des Moines R	14DM016	8.0	LRVW	NA	NA	IF	--	--	--	MTS	MTS		--	NA	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.

Table 28. Lake water aquatic recreation assessments: County Ditch 11 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		
Temperance	46-0103-00	153	5	Shallow Lake	WCBP	Insufficient Data	EX	--	--	EX	EX	EX	NS	NS

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

For streams, County Ditch 1/Judicial Ditch 50 (-515), has an elevated bacteria level which is high enough to list as impaired for aquatic recreation. The stream reach flows 4.4 miles through Manyaska south to County Ditch 11 (-503). Manyaska is a lake basin that has been drained and converted into row crop. There are four active feedlots with 0.25 miles of the stream reach with 2000 goat/sheep, 1700 pigs, and 240 cows that could be a possible contributor to the high levels of bacteria. For aquatic life, County Ditch 1/Judicial Ditch 50 is fully supporting for its proposed modified use, with both fish and macroinvertebrate communities scoring above their respective impairment thresholds. This reach appears to have not been redredged for some time as some remeandering within the channel is now present (Figure 39) which is assisting some diversity of good habitat features, such as well sorted gravel riffle areas and some deeper pools. However, habitat quality is still limiting on this reach due to historical ditching practices and so while it is not meeting general use standards, it is meeting is proposed modified use standards.

For lakes, Temperance Lake (46-0103-00) is impaired for aquatic life and aquatic recreation. This lake is a shallow basin and located in the Western Corn Belt Plain ecoregion on the east side of Sherburn, Minnesota. The lake is surrounded by row crop and some development which could be a possible contributor to the high levels of phosphorus and chlorophyll-a. The Secchi average is 0.2m that is far less than the 0.7m standard. Temperance Lake was also part of a 2013 fish IBI survey and assessed in 2016. Overall, common carp, bigmouth buffalo, and fathead minnows dominated the lake. Potential stressors include high watershed disturbance (49% agriculture and 24% urban). Based on the high

number of tolerant species, high relative biomass of tolerant and low relative biomass of (non-stocked) top carnivores in the fish community, making Temperance Lake impaired for aquatic life. In addition to the water quality data the plant IBI data indicates the plant community is degraded.

Figure 39. Meandering within the channelized reach at biological station 14DM091.

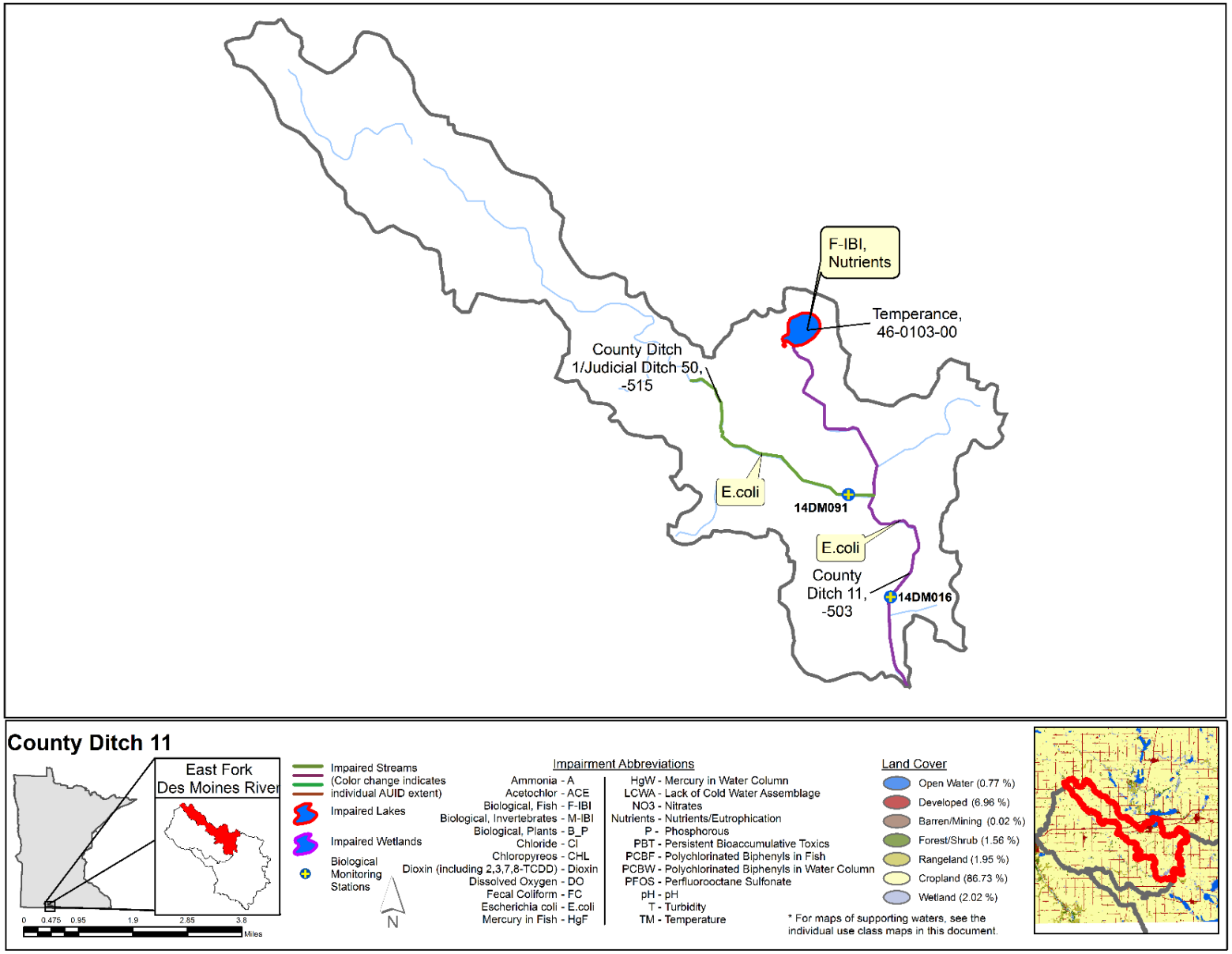

Figure 40. Currently listed impaired waters by parameter and land use characteristics in the County Ditch 11 Aggregated 12-HUC.

Watershed-wide results and discussion

Assessment results and data summaries are included below for the three 8-HUC watersheds for the entire Des Moines River Basin in Minnesota, 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. 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 portion of the Des Moines River Basin in Minnesota.

Stream water quality

In the three Des Moines River Watersheds in Minnesota, 82 of the 190 stream AUIDs were assessed (Table 29). Of the assessed streams, only nine streams were considered supporting of aquatic life and two streams was fully supporting of aquatic recreation. Two AUIDs were classified as limited resource waters and assessed accordingly.

Throughout the watersheds, there are a total of 82 impairments for aquatic life and recreation. Of those AUIDs, 60 are non-supporting for aquatic life and 22 are non-supporting for aquatic recreation.

Table 29. Assessment summary for stream water quality in the three watersheds of the Des Moines River Basin in Minnesota.

				Supporting		Non-supporting			
Watershed	**Area (acres)**	**# Total AUIDs**	**# Assessed AUIDs**	**# Aquatic Life**	**# Aquatic Recreation**	**# Aquatic Life**	**# Aquatic Recreation**	**Insufficient Data**	**# Delistings**
Des Moines Headwaters HUC 8	**798598**	**152**	**66**	**7**	**1**	**49**	**17**	**7**	
Beaver Creek	113698	16	7	2		5	2		
Lake Shetek	83115	20	12		1	7	3	1	
Lime Creek	62518	9	4			3	1	1	
Upper Des Moines Headwaters	96861	19	6			6	2		
Okabena Creek	48934	11	6	1		2	2	2	
Elk Creek	39172	6	4	2		1	1	1	
Jack Creek	60921	18	7			5	2	2	
Trib. to Jack Creek	28077	13	5			3	1	3	

				Supporting		Non-supporting			
Watershed	**Area (acres)**	**# Total AUIDs**	**# Assessed AUIDs**	**# Aquatic Life**	**# Aquatic Recreation**	**# Aquatic Life**	**# Aquatic Recreation**	**Insufficient Data**	**# Delistings**
North Branch Jack Creek	44910	11	6	1		5	1		
Heron Lake	76785	15	3			3	1		
Lower Des Moines Headwaters	88344	14	5	1		4	1		
Middle Des Moines Headwaters	55262	14	5			5	1		
Upper Des Moines HUC 8	**118884**	**14**	**7**	**1**		**6**	**1**		
Des Moines River-Minnesota Outlet	118884	14	7	1		6	1		
East Fork Des Moines HUC 8	**164959**	**24**	**8**	**1**	**1**	**5**	**4**	**2**	
Lower Headwaters East Fork Des Moines	88589	13	4		1	2	1	2	
Upper Headwaters East Fork Des Moines	50313	7	3			3	2		
County Ditch 11	26057	7	2	1			1		

Fish and macroinvertebrate IBI results were plotted along the mainstem Des Moines River for a longitudinal evaluation of the watershed (Figure 41). Evaluating the Des Moines River using biological indicators required multiple IBI classes to represent the various stream types found in this river. Thus, IBI scores were standardized by calculating their deviation from the general use impairment threshold. In general, fish and macroinvertebrate condition follows a similar longitudinal pattern along the river and indicates that the Des Moines River is biologically impaired throughout the majority of its length in Minnesota (i.e., below GU threshold). Both assemblages show a dramatic decrease in condition at stations just downstream of Talcot Lake, and then begin to rebound as you continue downstream (Figure 41). In addition to the biological indicators, the river assessment unit that spans Talcot Lake (07100001-533) is also impaired for turbidity, nutrient enrichment, and fecal coliform; however, signs of impairment are clearly evident upstream of Talcot Lake as well. Examining the pattern of condition relative to the location of WWTPs along the river, there was no obvious impacts on fish or macroinvertebrate communities immediately downstream of the three facilities (Figure 41). While fish and macroinvertebrate community condition decreased downstream of the Currie WWTP, the impact of this facility cannot be distinguished from the influence of Beaver Creek, which drains into the Des Moines River between Lake Shetek Dam and the WWTP.

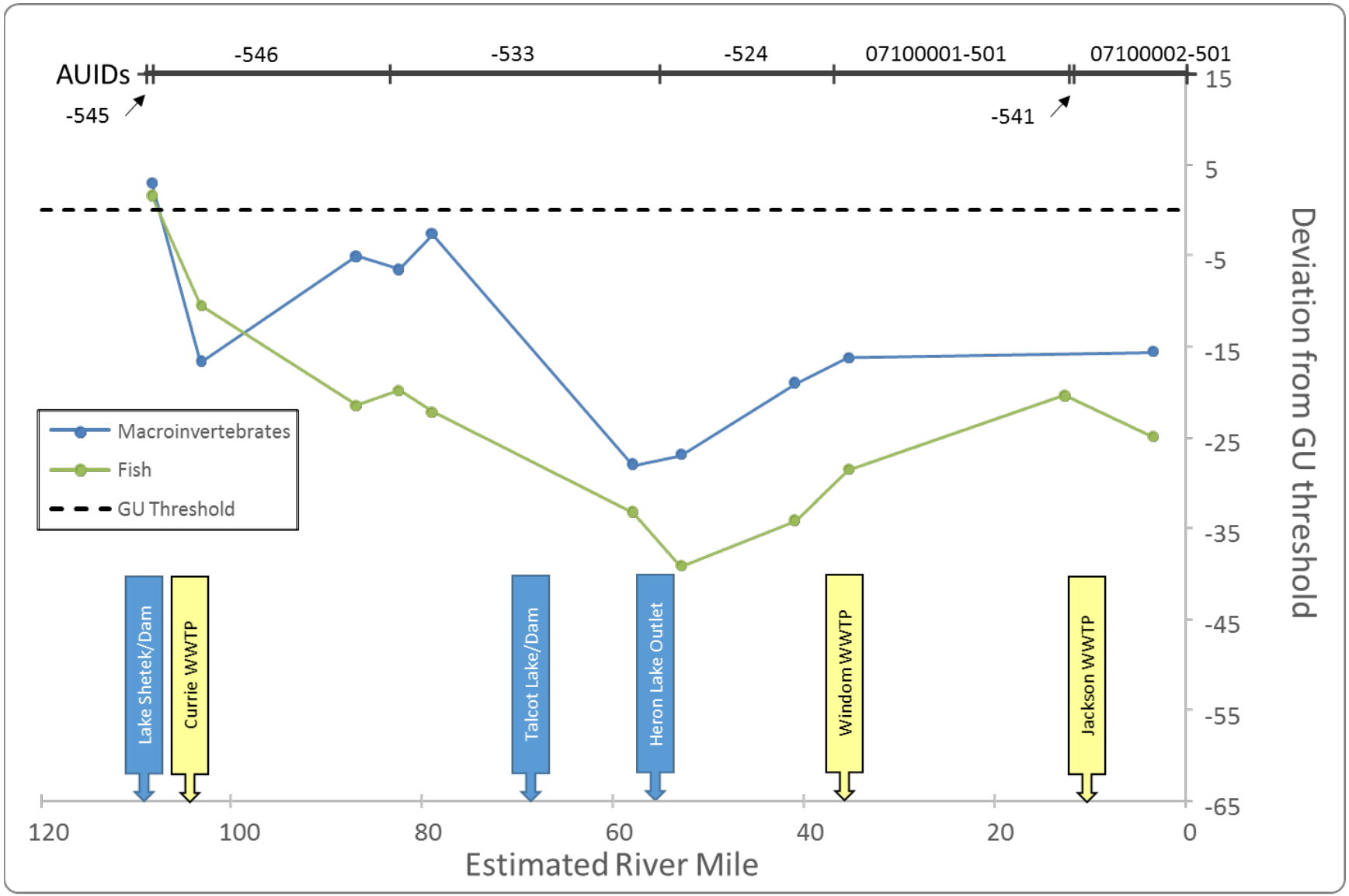

Figure 41. Fish and macroinvertebrate IBI score deviations from general use criteria longitudinally along the Des Moines River. Multiple IBI classes are represented within each assemblage requiring IBI scores to be presented as deviations from their respective GU criteria in order to standardize across IBI classes.

Biological monitoring: Macroinvertebrates

The condition of macroinvertebrate stream communities in the Des Moines River Watershed reflects the land use, hydrologic modification, and discharge of pollutants (point and non-point) upstream of each monitoring location. Out of the 61 stream and river assessment units where macroinvertebrate data was assessed, 39 (64%) were determined to have impaired aquatic macroinvertebrate communities (7 modified use, 32 general use). Of the 18 assessment units that exhibited healthy macroinvertebrate communities, six were on Warmwater General Use streams and 12 were on Warmwater Modified Use streams. Four macroinvertebrate assessments in the watershed were deemed insufficient information or IF due to a variety of circumstances. The assessment of macroinvertebrate community data in the Des Moines River Watershed required the application of four distinct macroinvertebrate IBIs: Prairie Streams (Glide/Pool Habitat) IBI; Southern Streams (Riffle/Run Habitat) IBI; Southern Coldwater Streams IBI; and Prairie Forest Rivers IBI. Having options in terms of which IBI to use for assessing macroinvertebrate communities, depending on characteristics of the monitoring station, allows natural variability to be somewhat accounted for and therefore increases the resolution of the anthropogenic or human disturbance "signal" provided by IBI results.

A total of 194 genera in 75 families of macroinvertebrates were collected in the Des Moines River Watershed based on 129 qualitative multi-habitat samples taken primarily in 2014 (Appendix 4.2). The most commonly collected macroinvertebrates in watershed included: midges in the genera Polypedilum, Cricotopus, Thienemannimyia, and Paratanytarsus; mayflies in the genus Caenis; crayfish in the genus Orconectes; and caddisflies in the genus Cheumatopsyche. A total of 161 macroinvertebrate genera were collected from low gradient (i.e., glide/pool) streams, the most common of which were: midges in the genera Polypedilum, Paratanytarsus, and Cricotopus; Caenis; Orconectes; and the amphipod Hyalella. In high gradient (i.e., riffle/run habitat) streams 133 macroinvertebrate genera were collected, the most common of which were: mayflies in the genera Baetis and Caenis; caddisflies in the genus Cheumatopsyche; midges Polypedilum and Thienemannimyia; and Orconectes. A total of 63 genera were collected from the Des Moines River mainstem where the drainage area was large enough (> 500 mi^2) to be evaluated using the Prairie Forest Rivers IBI. Caddisflies in the genera Ceratopsyche, Hydropsyche and Cheumatopsyche; riffle beetle genus Stenelmis; Polypedilum; mayflies in the genera Caenis and Acentrella; and blackflies in the genus Simulium were collected most frequently at the biological monitoring stations.

Biological monitoring: Fish

The condition of fish stream communities in the Des Moines River Watershed reflects the land use, hydrologic modification, and discharge of pollutants (point and non-point) upstream of each monitoring location. Out of the 60 stream and river assessment units where fish data was assessed, 50 (83%) were determined to have impaired fish communities (10 modified use, 40 general use). Of the 10 assessment units that exhibited healthy fish communities, three were on Warmwater General Use streams and seven were on Warmwater Modified Use streams. The assessment of fish community data in the Des Moines River Watersheds required the application of four distinct fish IBIs: Southern Rivers, Southern Streams, Southern Headwaters, and Southern Coldwater. Having options in terms of which IBI to use for assessing fish communities, depending on characteristics of the monitoring station, allows natural variability to be somewhat accounted for and therefore increases the resolution of the anthropogenic or human disturbance "signal" provided by IBI results.

A total of 44 species of fish were collected in the Des Moines River Watershed based on 194 qualitative samples taken primarily in 2014 (Appendix 3.2, Appendix 3.22, Appendix 3.23). The most commonly collected fish in watershed included: fathead minnow, sand shiner, creek chub, and bluntnose minnow. All of these species are tolerant of human disturbance.

Lake water quality

The Des Moines Basin consists of three watersheds: Des Moines Headwaters, Des Moines River – Minnesota Outlet, and East Fork Des Moines. A total 134 lakes are greater than 10 acres. The assessable lakes were limited to 31 lakes (Table 30). None of the biological data was able to show supporting information for aquatic life and 10 lakes were not supporting the aquatic life. For aquatic recreation, 2 out of 118 lakes were meeting the standard. First Fulda Lake (51-0021-00) is being requested to be delisted due to improvements in the watershed that improved water quality. The other lake that is full supporting the aquatic recreation standard is Second Fulda Lake (51-0020-00) which is connected to First Fulda Lake (51-0021-00). There were 23 lakes that did not meeting the aquatic recreation standard and are either new additions (9 lakes) to the impaired waters list or supporting previous listings (14 lakes). There was insufficient information on 35 lakes for aquatic life or aquatic recreation.

Table 30. Assessment summary for lake water chemistry in the Des Moines River Watershed Basin.

			Supporting		**Non-supporting**			
Watershed	**Area (acres)**	**Lakes >10 Acres**	**# Aquatic Life**	**# Aquatic Recreation**	**# Aquatic Life**	**# Aquatic Recreation**	**Insufficient Data**	**# Delistings**
Des Moines Headwaters **HUC 8**	**798598**	**118**	**0**	**2**	**10**	**19**	**35**	**1**
Beaver Creek	113698	14	0	0	0	0	3	0
Lake Shetek	83115	25	0	0	5	6	8	0
Lime Creek	62518	8	0	0	1	1	2	0
Upper Des Moines Headwaters	96861	18	0	0	0	2	9	0
Okabena Creek	48934	5	0	0	0	0	0	0
Elk Creek	39172	2	0	0	0	0	0	0
Jack Creek	60921	3	0	0	0	0	0	0
Trib. to Jack Creek	28077	7	0	2	2	2	2	1
North Branch Jack Creek	44910	5	0	0	1	1	3	0
Heron Lake	76785	11	0	0	0	6	0	0
Lower Des Moines Headwaters	88344	12	0	0	1	1	4	0
Middle Des Moines Headwaters	*55262*	*8*	*0*	*0*	*0*	*0*	*4*	*0*

			Supporting		Non-supporting			
Watershed	**Area (acres)**	**Lakes >10 Acres**	**# Aquatic Life**	**# Aquatic Recreation**	**# Aquatic Life**	**# Aquatic Recreation**	**Insufficient Data**	**# Delistings**
Lower Des Moines **HUC 8**	**118884**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Des Moines River-Minnesota Outlet	118884	0	0	0	0	0	0	0
East Fork Des Moines **HUC 8**	**164959**	**16**	**0**	**0**	**2**	**4**	**9**	**0**
Lower Headwaters East Fork Des Moines	88589	13	0	0	1	3	9	0
Upper Headwaters East Fork Des Moines	50313	2	0	0	0	0	0	0
County Ditch 11	26057	1	0	0	1	1	0	0

Fish contaminant results

Mercury was analyzed in fish tissue samples collected from two Des Moines River Watersheds (Headwaters and Lower) and ten lakes in the watersheds. PCBs were measured in fish from the river and three lakes (Heron, Second Fulda, and Shetek). Thirteen fish species were tested for contaminants. A total of 392 fish were collected for contaminant analysis between 1985 and 2015.

Contaminant concentrations are summarized by waterway, fish species, and year (Table 31). "Total Fish" indicates the total number of fish analyzed and "N" indicates the number of samples. The number of fish exceeds the number of samples when fish are combined into a composite sample. This was typically done for panfish, such as bluegill sunfish and yellow perch. "Anatomy" refers to the type of sample; since 1989, most of the samples have been skin-on fillets (FILSK) or for fish without scales (catfish and bullheads), skin-off fillets (FILET). Occasionally whole fish (WHORG) are analyzed.

The Headwaters and Lower Des Moines River Watersheds were listed as impaired for mercury in fish tissue in MPCA's 2016 Draft Impaired Waters List. They are identified in Table 31 with a red asterisk (*). None of the waters in this watershed is listed as impaired for PCBs in fish tissue. The two impairments were added to the Statewide Mercury TMDL.

All of the PCB concentrations in fish tissue were near or below the reporting limit (0.01 - 0.05 mg/kg). The highest PCB concentration was 0.05 mg/kg in a three fish species collected from Shetek Lake in 1985. They were all composites of five or six fish; therefore, the concentrations

represent an average of the fish within each sample. Fish consumption advice, developed by the Minnesota Department of Health, has meal advice of "unrestricted" for PCBs in fish less than or equal to 0.05 mg/kg.

Overall, mercury and PCBs in fish in the Des Moines River Watersheds are very low compared to other waters of the state. The Fish Contaminant Monitoring Program will continue to retest the fish from impaired waters to assess if mercury levels are changing.

Table 31. Summary of fish length, mercury, and PCBs, by waterway-species-year.

									Length (in)			Mercury (mg/kg)			PCBs (mg/kg)			
Major Watershed	HUC8	DOWID	Waterway	Species	Year	Anatomy[1]	Total Fish	No. Samples	Mean	Min	Max	Mean	Min	Max	N	Mean	Max	< RL
Des Moines Headwaters	07100001	07100001-541*	Des Moines R., W Fork	Bigmouth buffalo	2012	FILSK	2	1	18.3	18.3	18.3	0.029	0.029	0.029	1	0.025	0.025	Y
				Black crappie	2012	FILSK	5	1	8.9	8.9	8.9	0.121	0.121	0.121				
				Common Carp	2012	FILSK	2	1	18.9	18.9	18.9	0.111	0.111	0.111	1	0.025	0.025	Y
				Channel catfish	2012	FILET	4	4	19.4	15.4	21.7	0.163	0.119	0.186	1	0.025	0.025	Y
				Walleye	2012	FILSK	4	4	14.9	10.0	19.4	0.213	0.154	0.350				
		17006000	Talcot	Common Carp	2010	FILSK	4	1	22.5	22.5	22.5	0.019	0.019	0.019				
				Walleye	2010	FILSK	8	8	14.2	12.4	17.5	0.059	0.031	0.096				
				Yellow perch	2010	FILSK	5	1	10.4	10.4	10.4	0.026	0.026	0.026				
		32005700	Heron	Bigmouth buffalo	1991	FILSK	1	1	22.5	22.5	22.5	0.023	0.023	0.023	1	0.016	0.016	
				Black crappie	1991	FILSK	10	1	6.8	6.8	6.8	0.130	0.130	0.130				
				Common Carp	1991	FILSK	19	4	19.2	11.0	25.9	0.020	0.020	0.020	3	0.01	0.01	Y
					1996	FILSK	20	5	19.7	13.8	27.3	0.012	0.011	0.015	1	0.01	0.01	Y
					2006	FILSK	8	2	24.0	21.7	26.2	0.011	0.010	0.011	1	0.01	0.01	Y
				Northern pike	1991	FILSK	4	2	26.8	23.3	30.2	0.040	0.023	0.056	2	0.01	0.01	Y
					1996	FILSK	20	5	21.8	16.9	27.8	0.028	0.020	0.050	1	0.01	0.01	Y
				Walleye	2006	FILSK	7	7	14.9	12.7	16.2	0.070	0.045	0.082				
				Yellow perch	1996	FILSK	10	1	9.0	9.0	9.0	0.020	0.020	0.020				
					2006	FILSK	1	1	11.9	11.9	11.9	0.029	0.029	0.029				
		42004700	Yankton	Walleye	2014	FILSK	3	3	15.6	13.7	17.3	0.035	0.029	0.040				
				White sucker	2014	FILSK	5	1	17.1	17.1	17.1	0.019	0.019	0.019				
		51001800	Buffalo	Black bullhead	2015	FILET	5	1	8.7	8.7	8.7	0.027	0.027	0.027				
				Northern pike	2015	FILSK	4	4	22.3	17.2	24.8	0.069	0.036	0.095				
				Yellow perch	2015	FILSK	4	1	6.6	6.6	6.6	0.051	0.051	0.051				

Major Watershed	HUC8	DOWID	Waterway	Species	Year	Anatomy[1]	Total Fish	No. Samples	Length (in)			Mercury (mg/kg)			PCBs (mg/kg)			
									Mean	Min	Max	Mean	Min	Max	N	Mean	Max	< RL
		51002000	Second Fulda	Bluegill sunfish	1992	FILSK	10	1	5.9	5.9	5.9	0.010	0.010	0.010				
				Common Carp	1992	FILSK	13	3	16.9	11.8	23.0	0.021	0.010	0.035	2	0.0165	0.023	
				Walleye	1992	FILSK	8	1	14.3	14.3	14.3	0.051	0.051	0.051	1	0.01	0.01	Y
		51004600	Shetek	Black crappie	1992	FILSK	10	1	8.5	8.5	8.5	0.010	0.010	0.010				
				Common Carp	1985	FILSK	6	1	16.0	16.0	16.0	0.020	0.020	0.020	1	0.05	0.05	Y
					1992	FILSK	23	4	18.8	10.6	25.1	0.017	0.010	0.026	2	0.01	0.01	Y
				Channel catfish	2007	FILET	7	7	17.4	15.5	19.5	0.045	0.036	0.057	1	0.01	0.01	Y
				Smallmouth buffalo	1985	FILSK	5	1	15.6	15.6	15.6	0.020	0.020	0.020	1	0.05	0.05	Y
				Walleye	1992	FILSK	23	3	17.0	10.8	21.9	0.033	0.010	0.066	1	0.01	0.01	Y
				White sucker	1985	FILSK	5	1	13.0	13.0	13.0	0.050	0.050	0.050	1	0.05	0.05	Y
		51006300	Sarah	Common Carp	2010	FILSK	2	1	27.0	27.0	27.0	0.010	0.010	0.010				
				Walleye	2010	FILSK	8	8	15.9	14.1	19.3	0.017	0.010	0.027				
				Yellow perch	2010	FILSK	10	2	10.0	8.6	11.4	0.014	0.010	0.017				
		53002000	East Graham	Bigmouth buffalo	2003	FILSK	5	1	10.3	10.3	10.3	0.010	0.010	0.010				
					2015	FILSK	5	1	11.9	11.9	11.9	0.010	0.010	0.010				
				Black crappie	2003	FILSK	11	1	7.1	7.1	7.1	0.010	0.010	0.010				
				Channel catfish	2015	FILET	8	8	16.7	14.1	19.0	0.026	0.020	0.035				
				Northern pike	2015	FILSK	8	8	20.6	14.5	26.0	0.027	0.018	0.033				
				Walleye	2003	FILSK	6	6	16.3	11.9	21.5	0.071	0.022	0.116				
		53002100	West Graham	Common Carp	2010	FILSK	4	1	22.2	22.2	22.2	0.010	0.010	0.010				
				Walleye	2010	FILSK	8	8	16.6	13.6	21.0	0.018	0.013	0.030				
				Yellow perch	2010	FILSK	10	2	10.2	9.4	10.9	0.010	0.010	0.010				
East Fork Des Moines	07100003	46005200	Bright	Black crappie	2007	FILSK	10	1	9.7	9.7	9.7	0.032	0.032	0.032				
				Common Carp	2007	FILSK	4	1	20.0	20.0	20.0	0.046	0.046	0.046				
				Northern pike	2007	FILSK	6	6	23.0	19.6	28.1	0.060	0.028	0.101				
				White crappie	2007	FILSK	10	1	9.5	9.5	9.5	0.041	0.041	0.041				

Major Watershed	HUC8	DOWID	Waterway	Species	Year	Anatomy[1]	Total Fish	No. Samples	Length (in)			Mercury (mg/kg)			PCBs (mg/kg)			< RL
									Mean	Min	Max	Mean	Min	Max	N	Mean	Max	
Lower Des Moines	07100002	07100002-501*	Des Moines R.	Shorthead redhorse	2014	FILSK	5	5	16.2	15.8	17.0	0.185	0.150	0.221	2	0.03	0.03	Y
				Walleye	2014	FILSK	7	7	16.7	11.7	21.3	0.265	0.162	0.373	2	0.033	0.035	Y

* Impaired for mercury in fish tissue as of 2016 Draft Impaired Waters List; categorized as EPA Class 4a for waters covered by the Statewide Mercury TMDL.

1 Anatomy codes: FILSK – edible fillet, skin-on; FILET—edible fillet, skin-off; PLUG—dorsal muscle piece, without skin; WHORG—whole organism

Pollutant load monitoring

The WPLMN has two sites within the Des Moines River – Headwaters (07100001) Watershed as shown in Table 32.

Table 32. WPLMN Stream Monitoring Sites for the Des Moines River – Headwaters Watershed

Site type	Stream name	USGS ID	DNR/MPCA ID	EQuIS ID
Major Watershed	West Fork Des Moines River at Jackson, River St	05476000	E51107001	S005-936
Subwatershed	West Fork Des Moines River nr Avoca, CSAH6	NA	H51026001	S004-528

Average annual FWMCs of TSS, TP, and NO_3+NO_2-N for major watershed stations statewide are presented below, with the Des Moines River Watershed 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; this it 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. Many lakes in the Des Moines River Watershed suffer from excessive algal blooms on an annual basis.

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. Although the Des Moines River is not used directly as a drinking water source, there are several communities and one rural water system which utilize shallow drinking water wells. In the early 1990's, the USGS developed a report described this important interaction of surface to groundwater in the Des Moines aquifer.

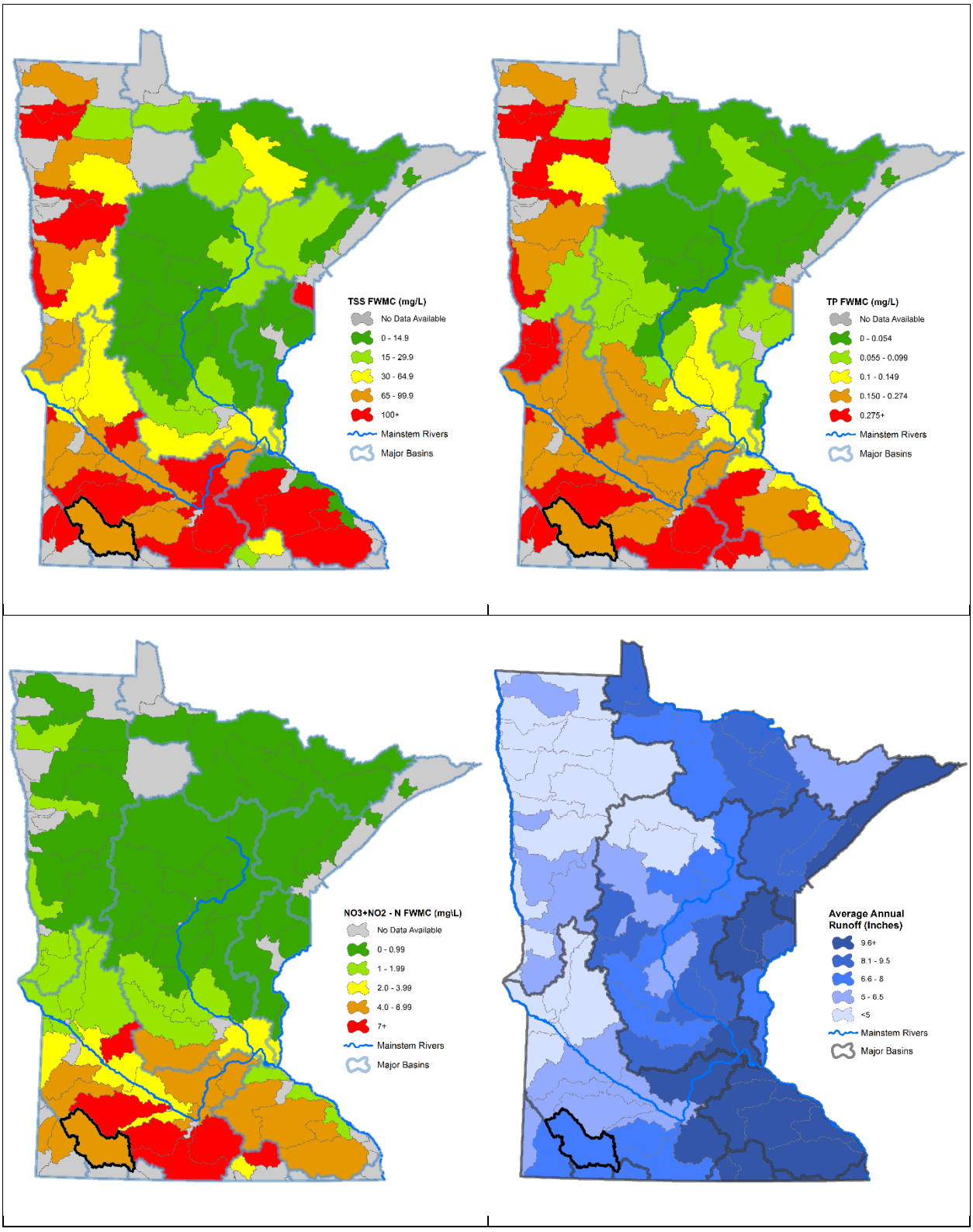

Figure 42. 2007-2014 Average annual TSS, TP, and NO3-NO2-N FWMCs, and runoff by major watershed.

When compared with other major watersheds throughout the state, Figure 42 shows the average annual TSS, TP, and NO_3+NO_2-N FWMCs to be at higher levels for the Des Moines River – Headwaters Watershed than watersheds in 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 and pollutant loading occurs for most rivers and streams, including the Des Moines River. Barring large differences in pollutant concentrations, annual differences in pollutant loads are largely a function of differences in total flow volume. Results for individual years are shown in the charts below (Figure 43).

TSS mass was highest in 2010 because of an extreme rain event in September. The high FWMC in 2012 was a result of the several rain events in May and June where concentrations ranged from 65-640 mg/L. The remainder of the year had concentrations below the TSS standard of 65 mg/L.

From 2007-2011, there was only one sample during the summer months where TP concentrations were less than the TP standard of 0.150 mg/L. The Des Moines River has unique watershed features, which results in higher phosphorus impacts. The river begins at the outlet of Lake Shetek and travels through Talcot Lake, of which both have low head dams and are hypereutrophic lakes. In addition, the Heron Lake Watershed is a major tributary to the Des Moines River and brings additional phosphorus loading. Similar to TSS, the increased mass in 2010 was related to the higher flow volume in the system.

The NO_3+NO_2-N FMWC range was relatively minor between years (3.1-5.5 mg/L). But seasonally, individual NO_3+NO_2-N concentrations are typically highest after rain events in May and June and also during January, February and March (before snowmelt). Interestingly, in 2010 and 2011, there were higher concentrations during snowmelt, resulting in the higher FWMCs.

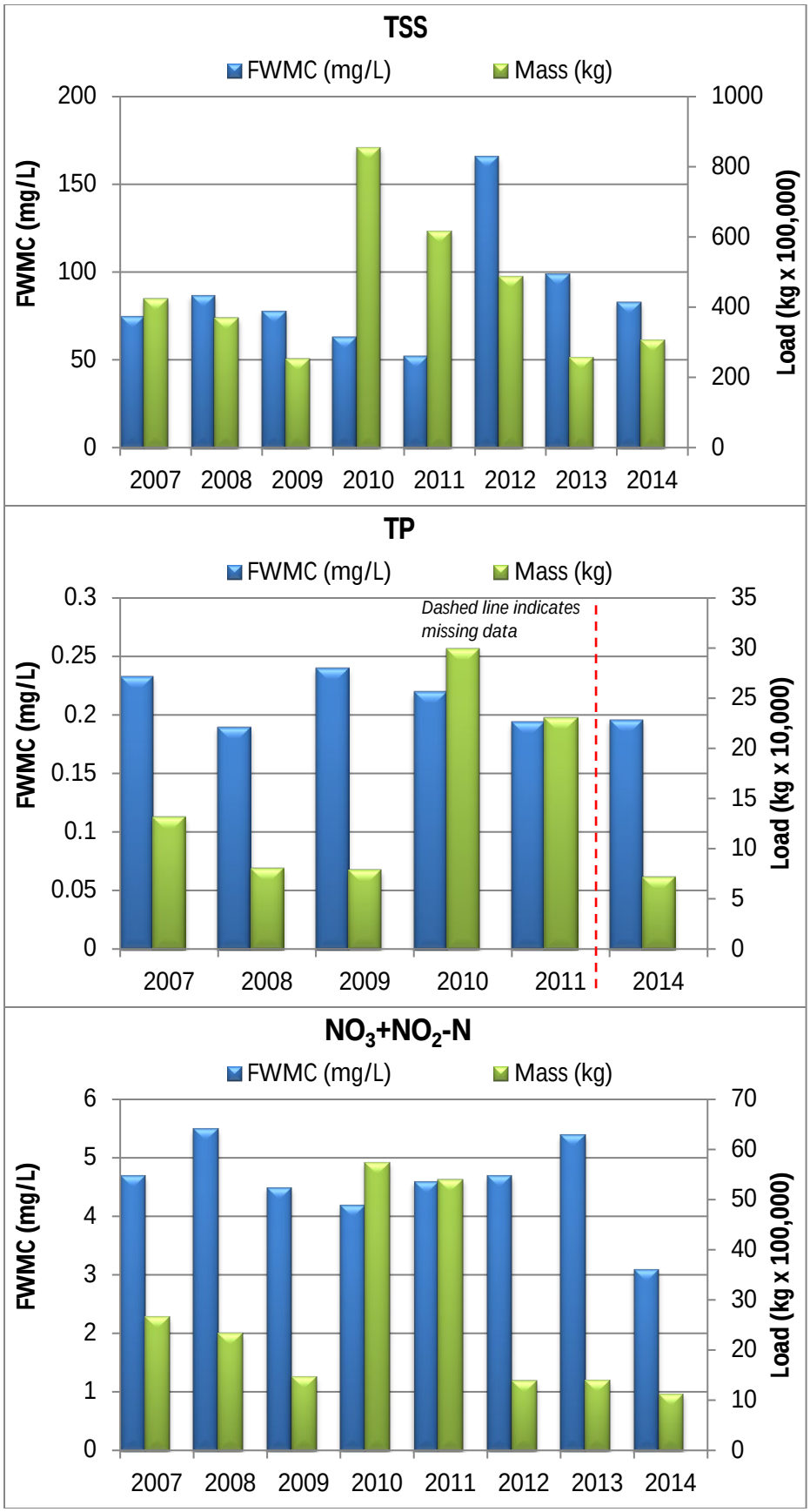

Figure 43. TSS, TP, and NO_3+NO_2-N FWMCs and loads for the West Fork Des Moines River at Jackson, Minnesota.

Groundwater monitoring

There are currently no MPCA groundwater monitoring wells in the Des Moines Watersheds. A MPCA statewide baseline study determined that concentrations of most chemicals were higher in the surficial and buried drift aquifers of southwest Minnesota than in similar aquifers statewide. The reasons for the higher concentrations vary; surficial aquifers are influenced by precipitation and oxidation/reduction reactions whereas deeper aquifer are influenced more by parent material. Nitrate, though, is the primary chemical of concern in all aquifers (MPCA, 1998).

The MDA annually monitors pesticides in groundwater through a network of monitoring wells statewide. The Des Moines River Watersheds are split between two of the MDA's Pesticide Monitoring Regions (PMRs); the western portions being in Region 7 and the eastern in Region 8. Trend analysis of median concentrations of four pesticides in regions 7 and 8 concluded there was a statistically significant increase for one pesticide degredate (Acetochlor ESA) and a decreasing trend for another degredate (Metolachlor ESA). Median concentrations of all other pesticides and degredates exhibited no trend. (MDA, 2015)

The MDA also analyzed these samples for nitrate. The federal drinking water standard for nitrate is 10.00 milligrams per liter (mg/L). Nitrate was frequently detected in both PMRs at levels from below the method reporting limit (MRL) to above 10.00 mg/L. Results from the sampling are summarized in Table 33.

Table 33. Summary of selected nitrate sampling results for MDA PMRs 7 and 8 (MDA, 2015)

PMR	Detection Frequency (%)	Median (mg/L)	<MRL (%)	MRL to 3.00 mg/L (%)	3.01 to 10.00 mg/L (%)	>10.00 mg/L (%)
7	71	8.79	29	7	21	43
8	68	2.95	32	18	25	25

Mandatory MDH testing of new drinking water wells for arsenic, a naturally occurring but potentially harmful contaminant for humans, found that this part of the state is more likely to have arsenic concentrations above the maximum contaminant level (MCL) of 10 µg/L. The percentages of wells identified with concentrations exceeding the MCL by county in the Des Moines River Watersheds are as follows: Murray (23.7%) Jackson (17.2%) Nobles (14.3%) Cottonwood (13.5%) and Martin (13.2%) (MDH, 2017).

Groundwater quantity

The DNR monitors groundwater levels to track trends and aid in managing the resource. Water levels from two DNR observation wells in the Des Moines River Watershed are displayed below in Figure 44 and Figure 45. Monthly data show seasonal fluctuations in groundwater levels. Annual averages of water levels in each well exhibit no significant trend.

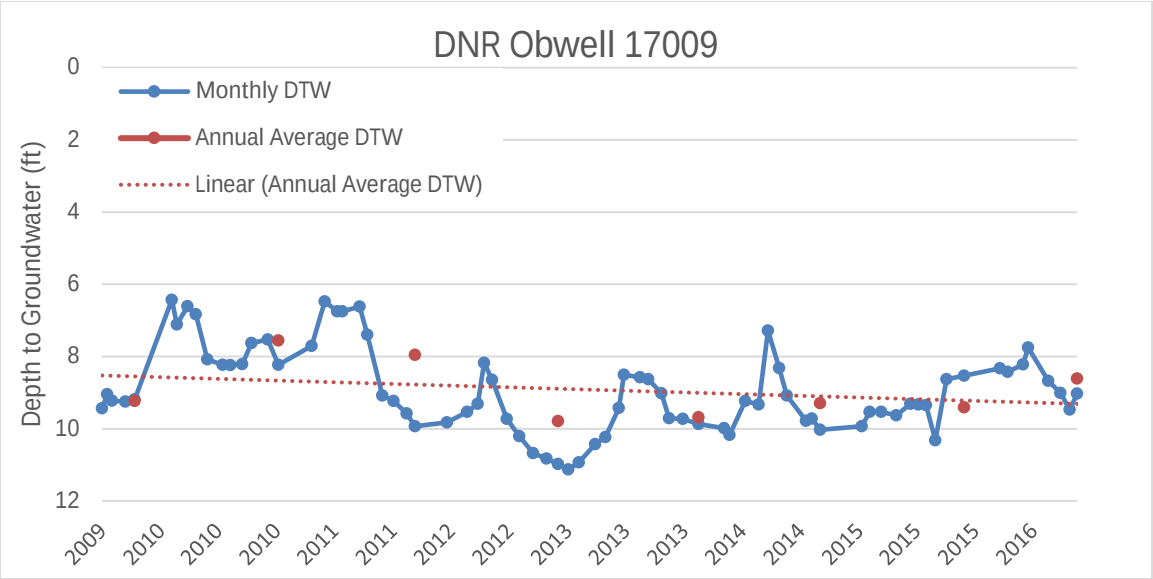

Figure 44. Groundwater level measurements – DNR observation wells 17009

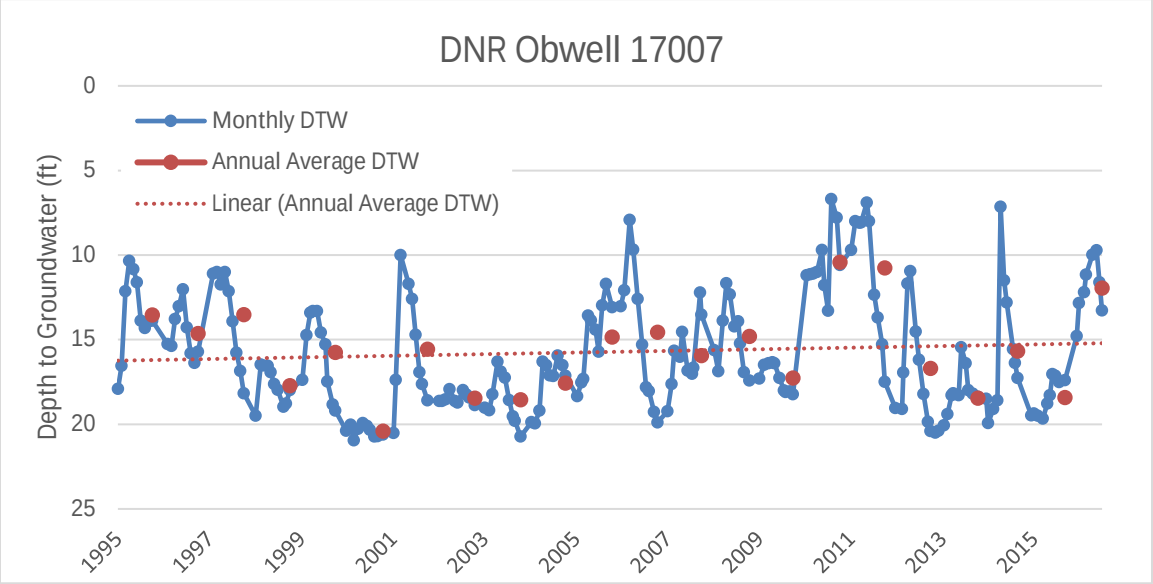

Figure 45. Groundwater level measurements – DNR observation wells 17007

Groundwater/Surface water withdrawals

The Minnesota DNR requires permits for users withdrawing more than 10,000 gallons of water per day or 1 million gallons/year. Annual reports are entered into and stored in the DNR Permitting and Reporting System. Figure 46 and Figure 47 display, respectively, total active permitted groundwater and surface water withdrawals within the watershed for the past 20 years (DNR, 2016b). Over this time period, surface water withdrawals have not developed any trend while groundwater withdrawals have increased at a statistically significant rate (p=0.001).

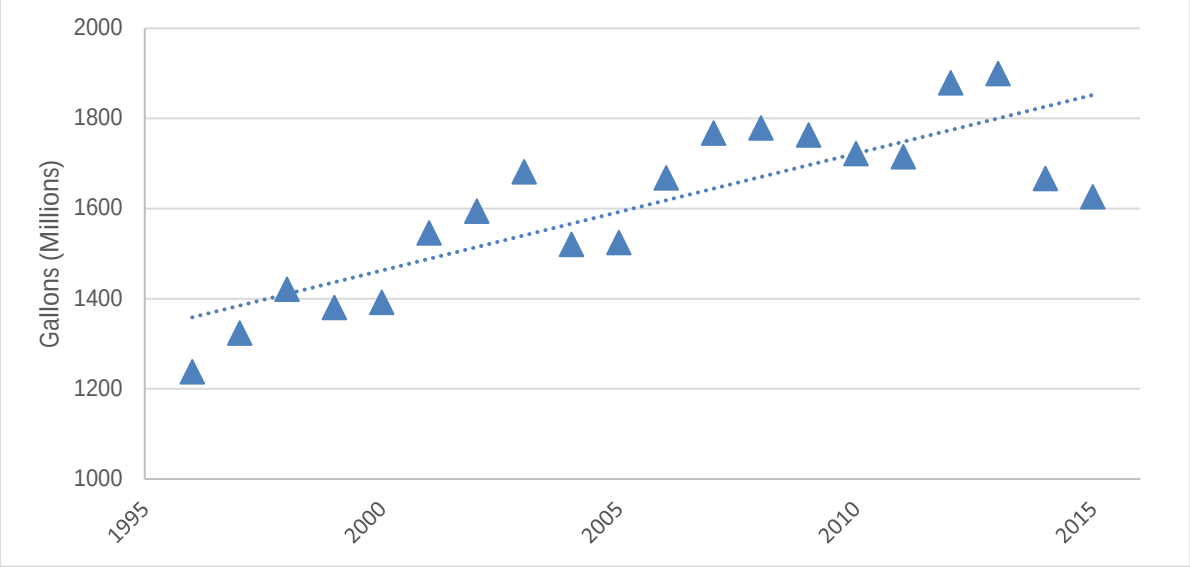

Figure 46. Total annual permitted groundwater withdrawals, Des Moines River Watersheds (1996-2015).

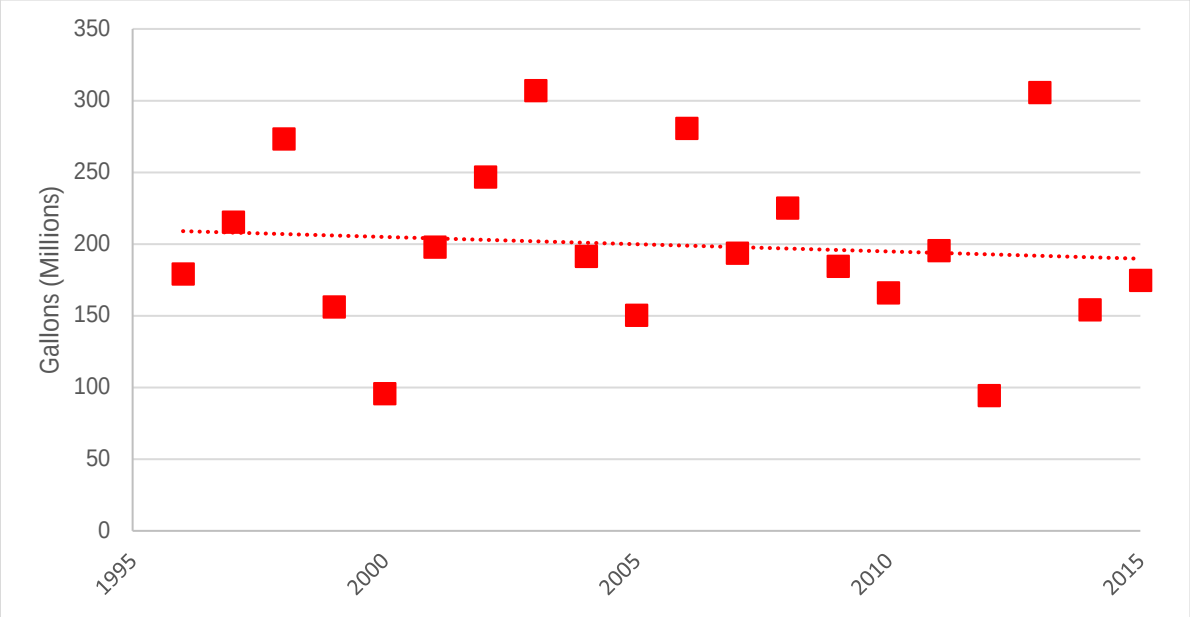

Figure 47. Total annual permitted surface water withdrawals, Des Moines River Watersheds (1996-2015).

Stream flow

Groundwater/surface water interactions are common and the impacts of groundwater use on surface water quantity have been documented in places like Little Rock Creek and White Bear Lake. Discharge is one measure of the volume of water in a stream. Figure 48 and Figure 49 includes two graphs depicting mean annual and mean summer monthly discharge on the Des Moines River for the time period 1996-2015. The data appear to indicate an increasing flow trend, but the increase is not at a statistically significant rate. (USGS, 2016)

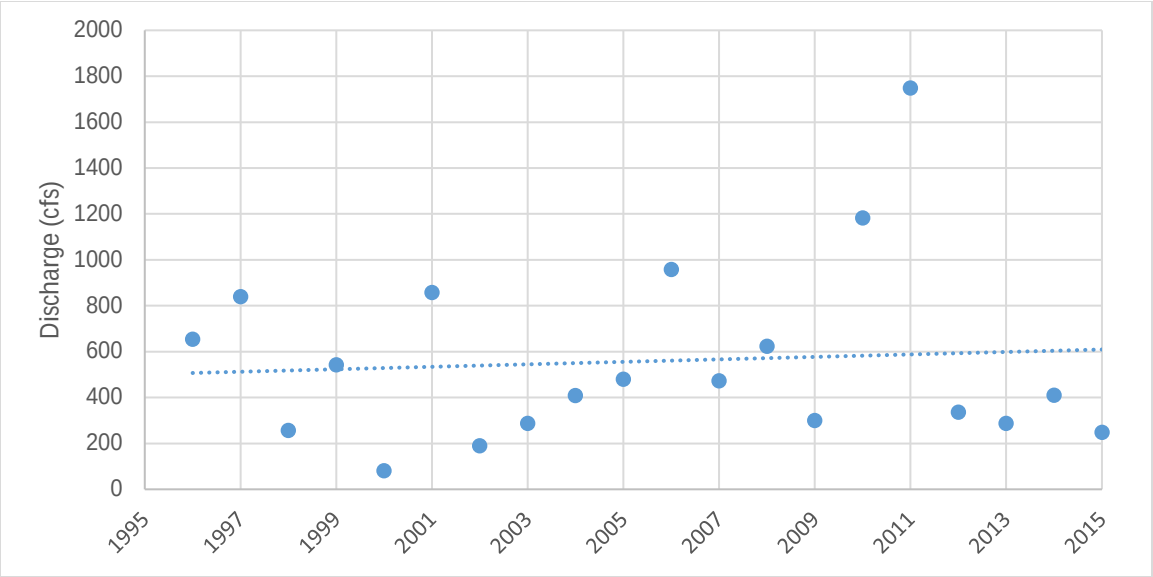

Figure 48. Mean annual discharge measurements for the Des Moines River (2004-2015).

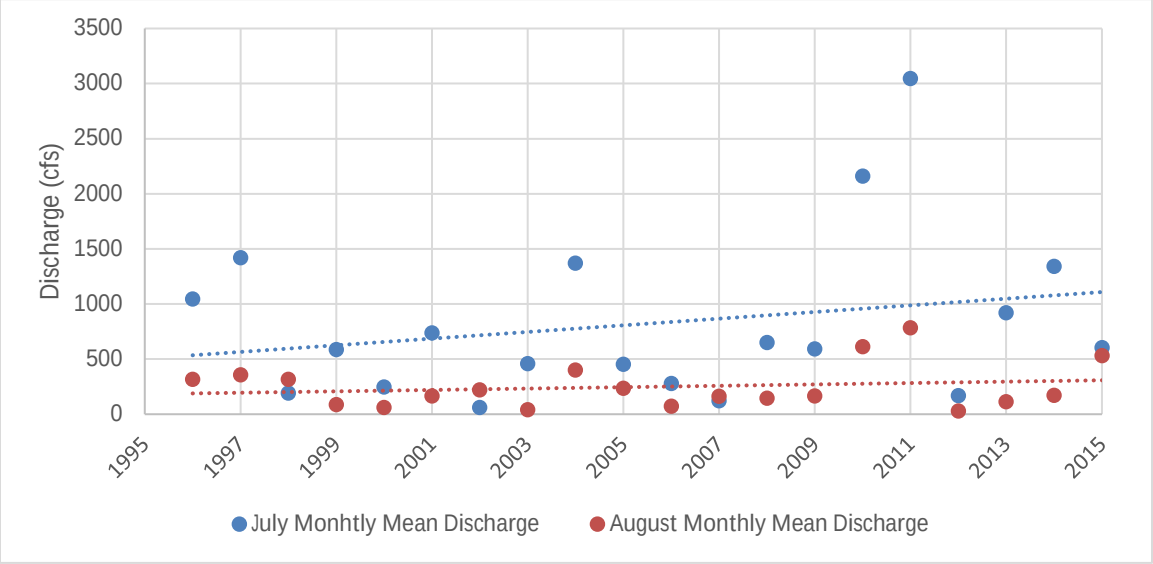

Figure 49. Mean July/August discharge measurements for the Des Moines River (2004-2015).

Wetland condition

Statewide wetland surveys have revealed that biological condition, based on floristic quality and aquatic macroinvertebrate indicators, in the Temperate Prairies ecoregion is relatively poor (Table 34). Since the Des Moines River Watershed lies entirely within the Temperate Prairies ecoregion, it is expected that ~80% of wetlands (i.e., all wetland types) in this watershed have fair-poor vegetation condition. Depressional wetlands are a prominent feature in the Des Moines River Watershed as it coincides with a terminal moraine. Based on results from naturally formed basins in the Temperate Prairies ecoregion, it is likely that macroinvertebrate community condition is better, with an estimated 41% good (Table 34), in depressional wetlands that remain in the Des Moines River Watershed. The predominance of invasive

wetland plants such as narrow-leaf cattail (Typha angustifolia), hybrid cattail (Typha X glauca), and reed canary grass (Phalaris arundinacea) is believed to contribute to the difference between macroinvertebrate and vegetation condition results. Invasive plant species are likely to have a more direct impact on the composition and structure of the native plant community due to their tolerance of nutrient enrichment, hydrologic alterations and toxic pollutants (Galatowisch 2012). However, it should also be noted that comparison of the vegetation and macroinvertebrate results is somewhat of an apples-to-oranges comparison due to macroinvertebrate condition results being limited to depressional wetlands.

Table 34. Biological wetland condition statewide and by major ecoregions according to vegetation and macroinvertebrate indicators. Vegetation results are expressed by extent (i.e., percentage of wetland acres) and include virtually 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%

Macroinvertebrate condition in depressional wetlands

Condition Category	Mixed Wood Plains	Temperate Prairies
Good	46%	41%
Fair	34%	30%
Poor	20%	27%

Transparency trends for the Des Moines River Basin

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 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 (Jack Creek: 07100001-658 and Des Moines River, East Branch: 07100003-527) and in Shetek Lake (51-0046-00) in the watershed. Water clarity has shown no trend in streams and a decreasing trend in Shetek Lake (51-0046-00) (Table 35).

Table 35. Water clarity trends at Citizen Stream Monitoring Sites

Des Moines Headwaters HUC 07100001	Citizen Stream Monitoring Program	Citizen Lake Monitoring Program
number of sites w/increasing trend		
number of sites w/decreasing trend		1
number of sites w/no trend	2	

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.

Remote sensing for lakes in the Des Moines River Watersheds

The University of Minnesota, in partnership with MPCA, conducts remote sensing of lake clarity. The information provides a snapshot of water transparency during late summer over a span of 30 years. Secchi disk transparency data is paired with satellite imagery to come up with estimates of water clarity across the state. While there are limitations to the data, such as cloud cover, vegetation, or stained water altering the estimated Secchi transparency, it does provide information to help prioritize monitoring and protection efforts on lakes which do not have water quality data.

Remote sensing data was used to describe lake transparencies on eight lakes in the Des Moines Basin. The Des Moines Basin crosses over two ecoregions; Western Corn Belt Plains and Northern Glaciated Plains. There are 121 lakes within the Western Corn Belt Plains and 30 lakes within the Northern Glaciated Plains. All of the lakes in both ecoregions are considered shallow. The standard for the Western Corn Belt Plains and Northern Glaciated Plains shallow basin is >0.7 m. All of the eight lakes were below this standard. The remoting sensing data collected on these lakes confirms the water quality data that was collected. The poor water quality conditions of the lakes in the Des Moines Basin should be addressed in a restoration plan to improve water quality.

Watershed maps

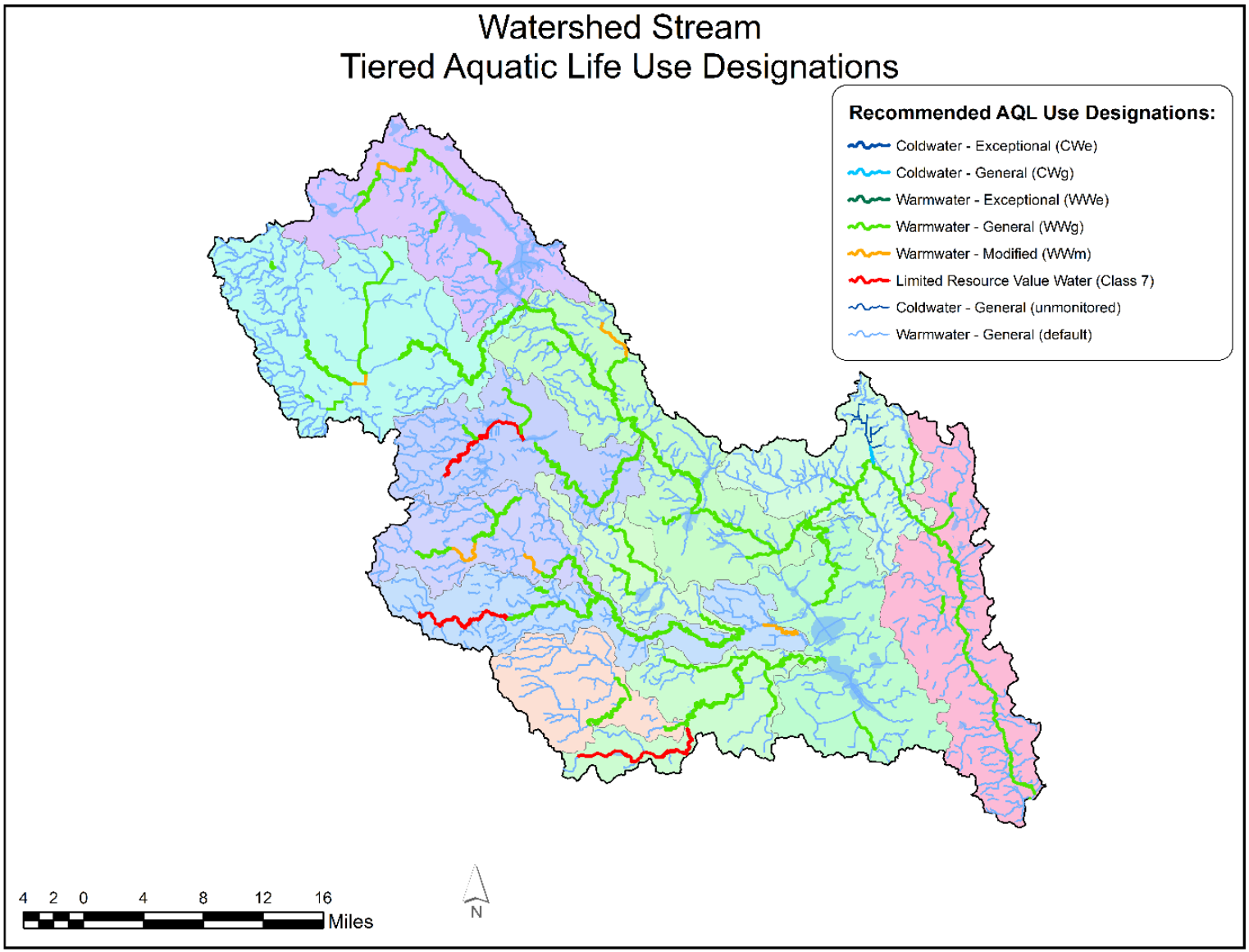

Figure 50. Stream tiered aquatic life use designations in the Headwaters Des Moines River Watershed.

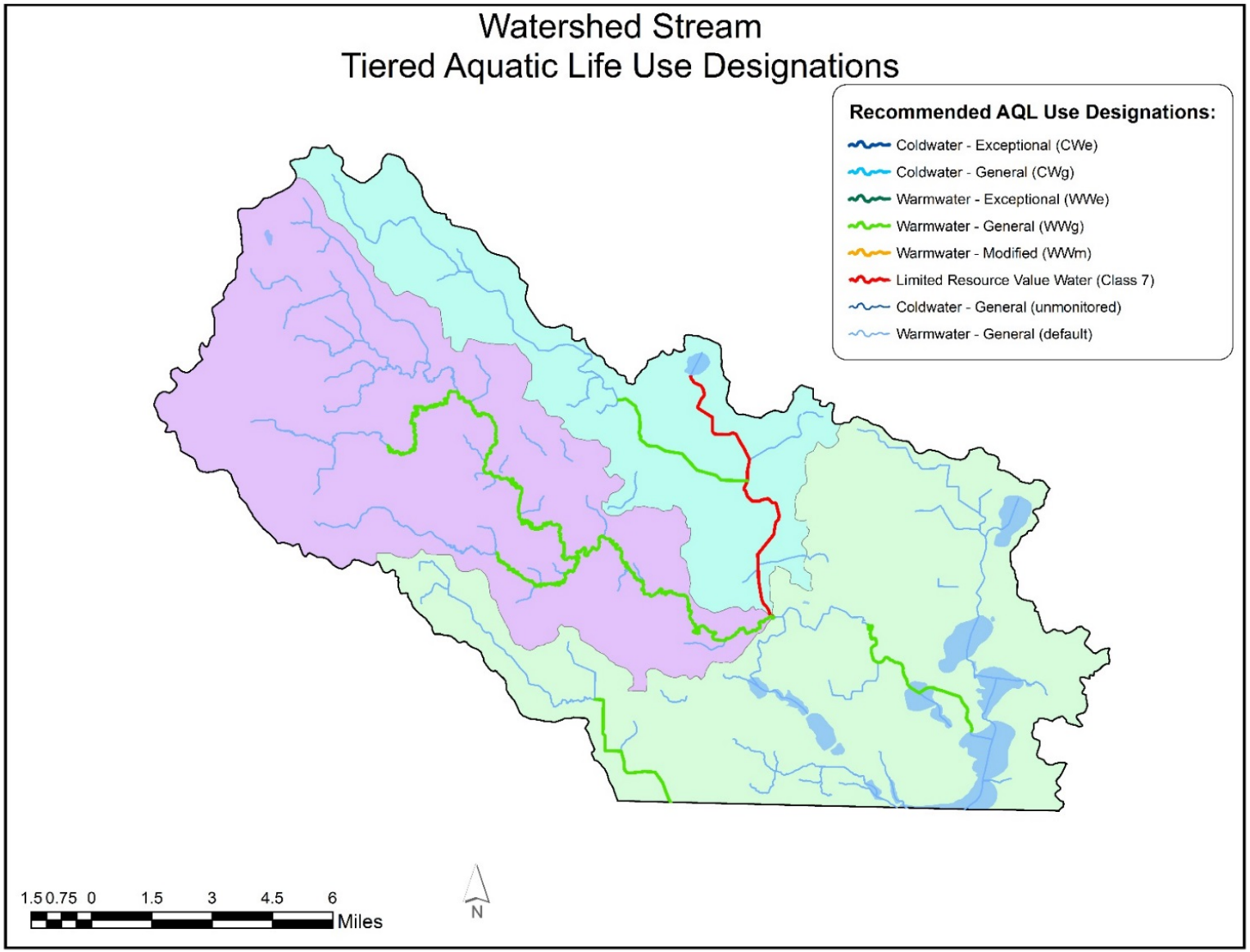

Figure 51. Stream tiered aquatic life use designations in the East Fork Des Moines River Watershed.

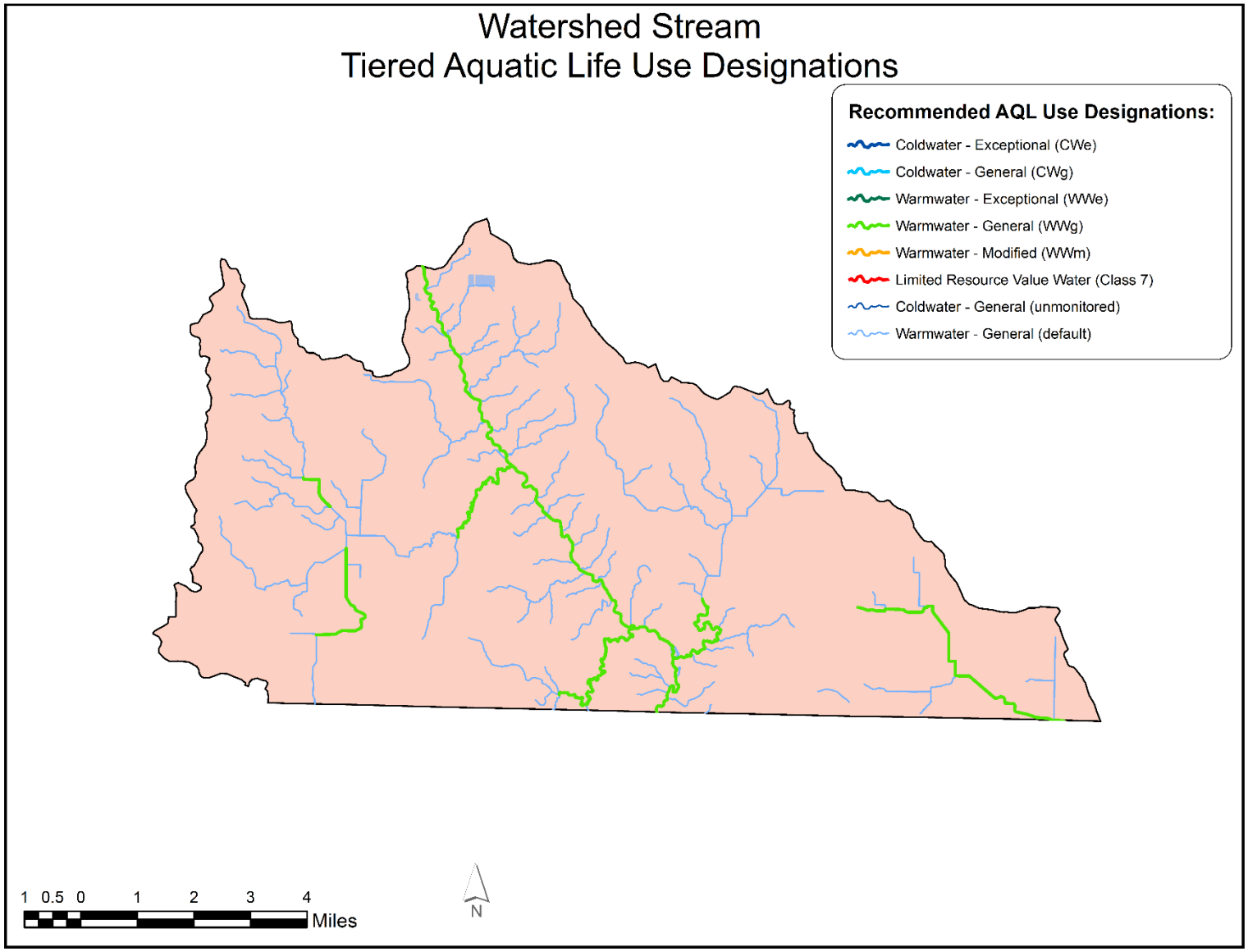

Figure 52. Stream tiered aquatic fife use designations in the Lower Des Moines River Watershed.

Figure 53. Fully supporting waters by designated use in the Des Moines River Headwaters Watershed.

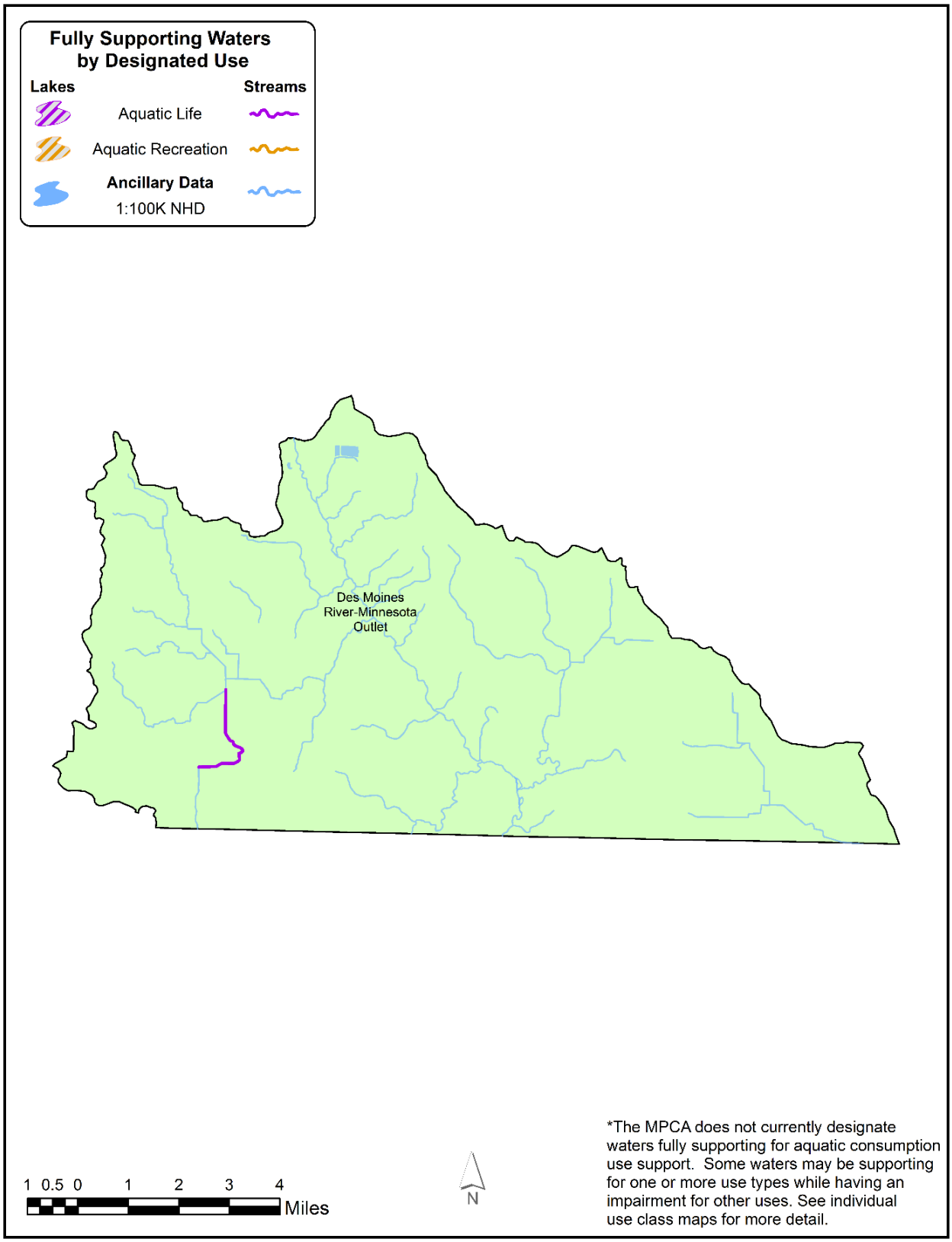

Figure 54. Fully supporting waters by designated use in the Lower Des Moines River Watershed.

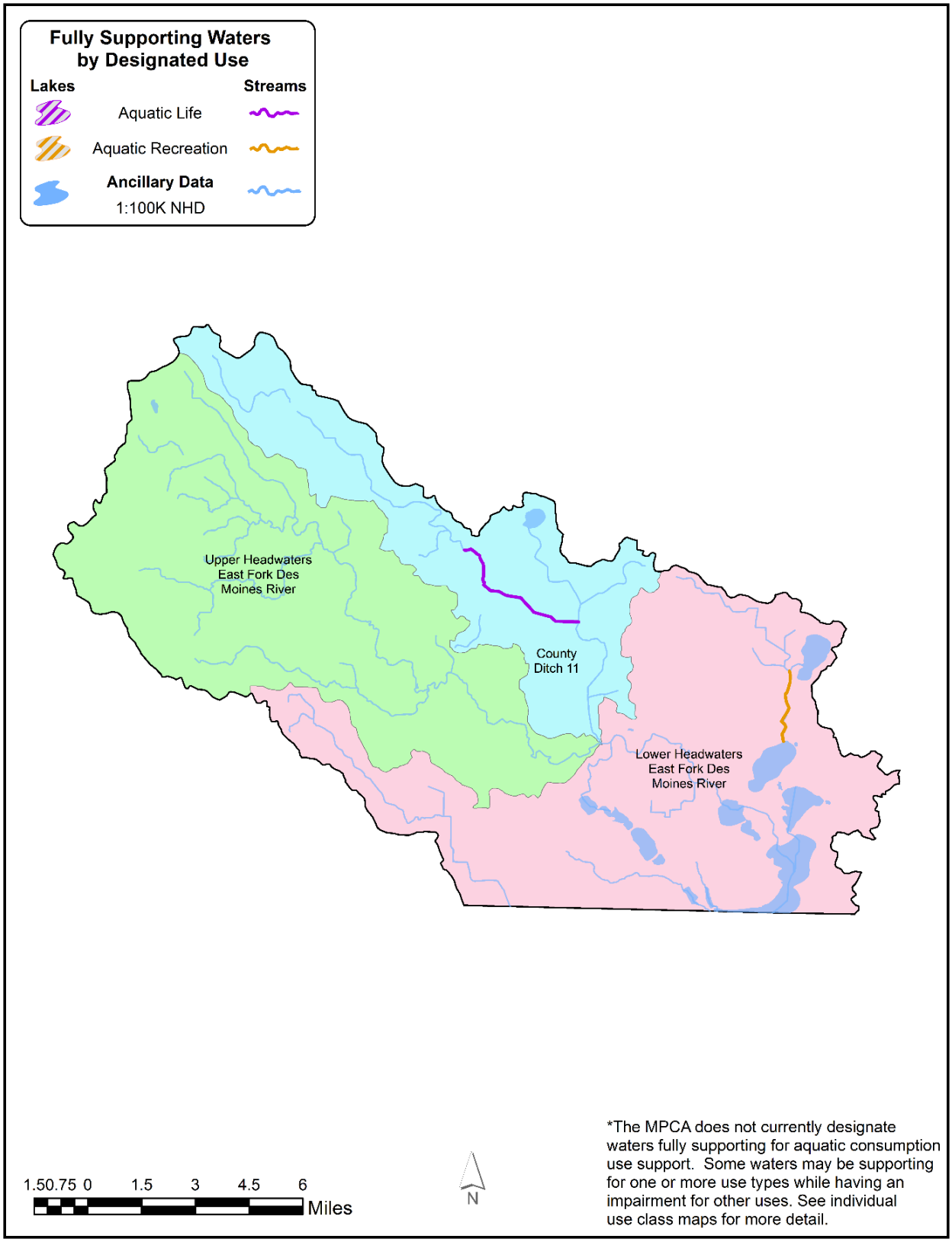

Figure 55. Fully supporting waters by designated use in the East Fork Des Moines River Watershed.

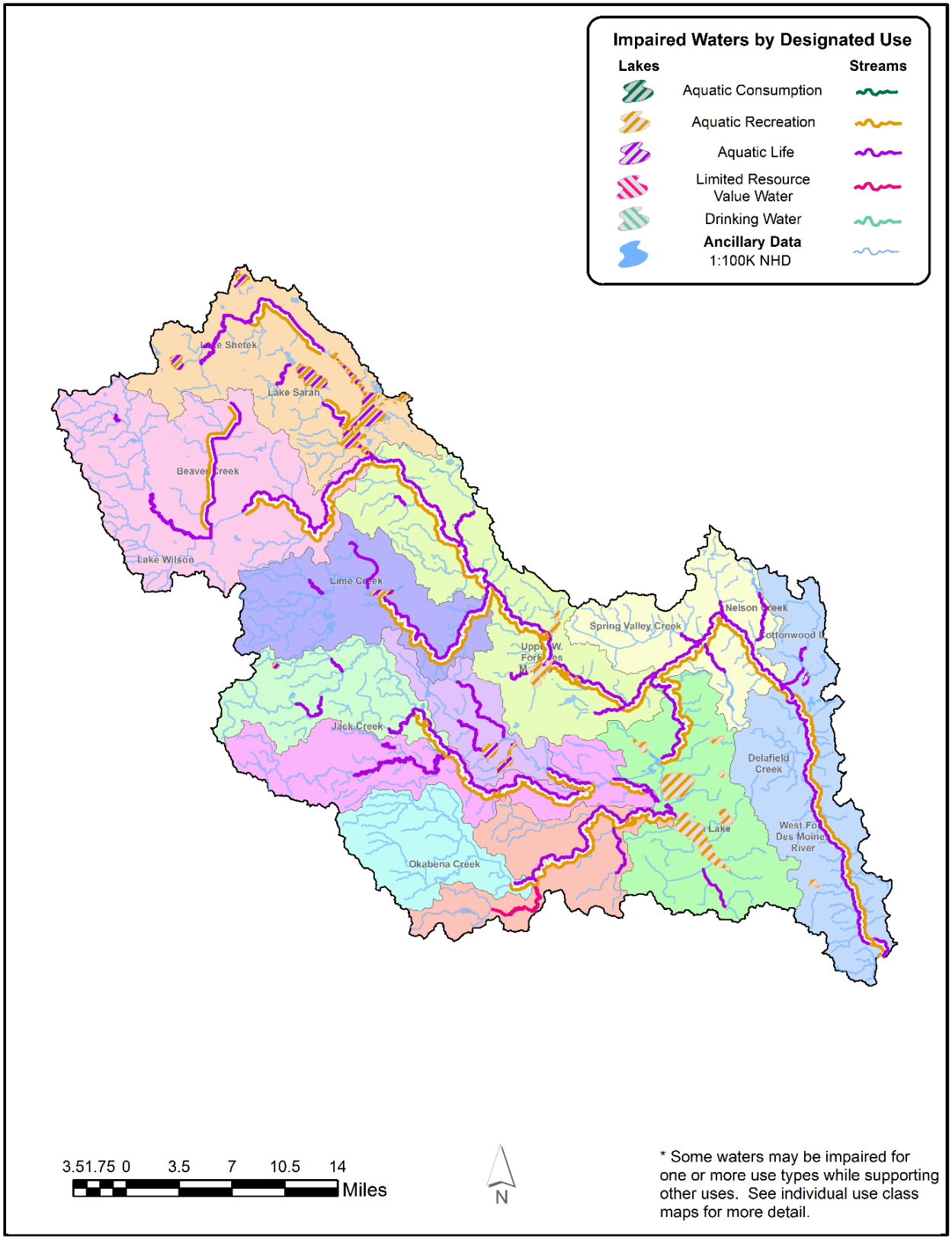

Figure 56. Impaired waters by designated use in the Des Moines River Headwaters.

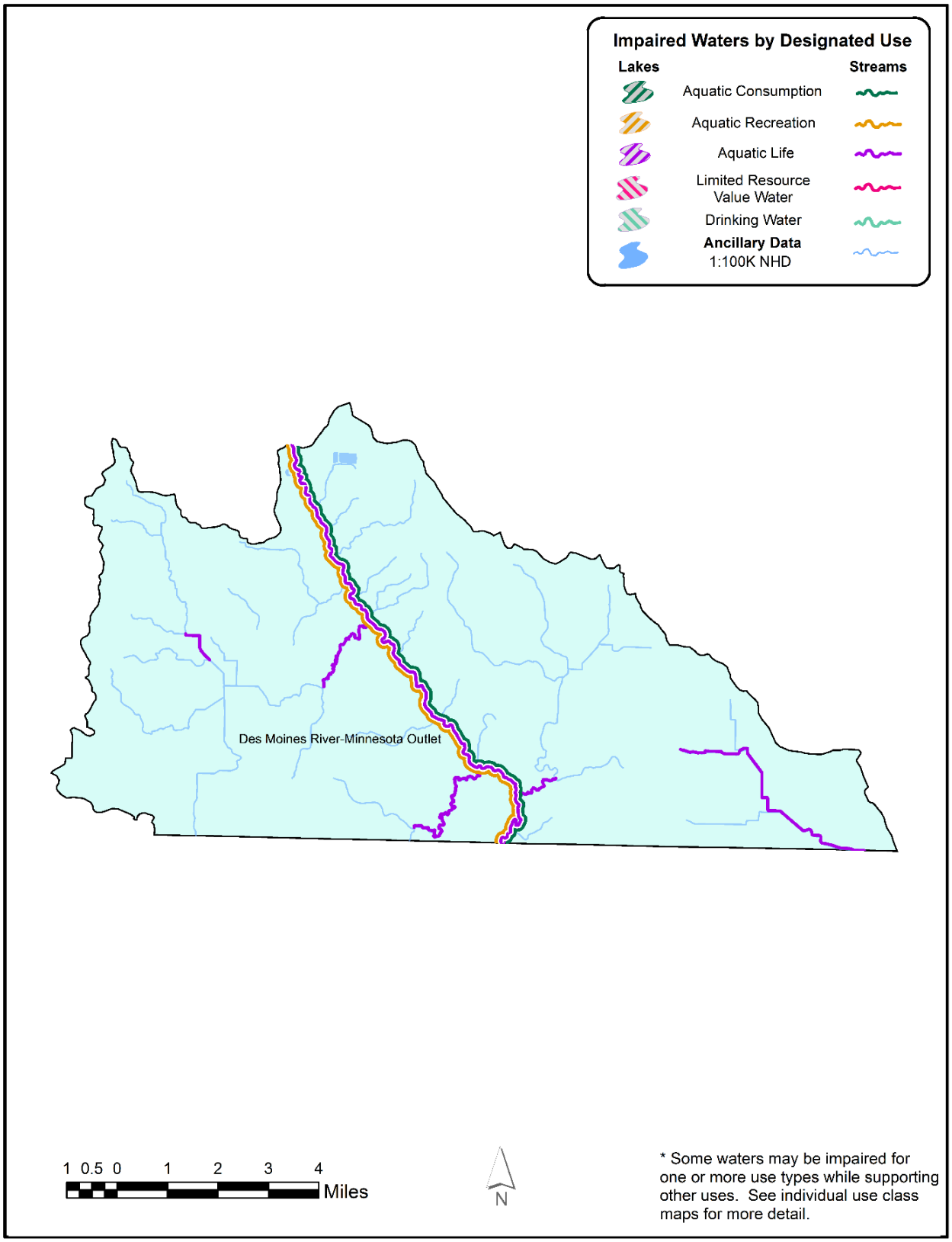

Figure 57. Impaired waters by designated use in the Lower Des Moines River.

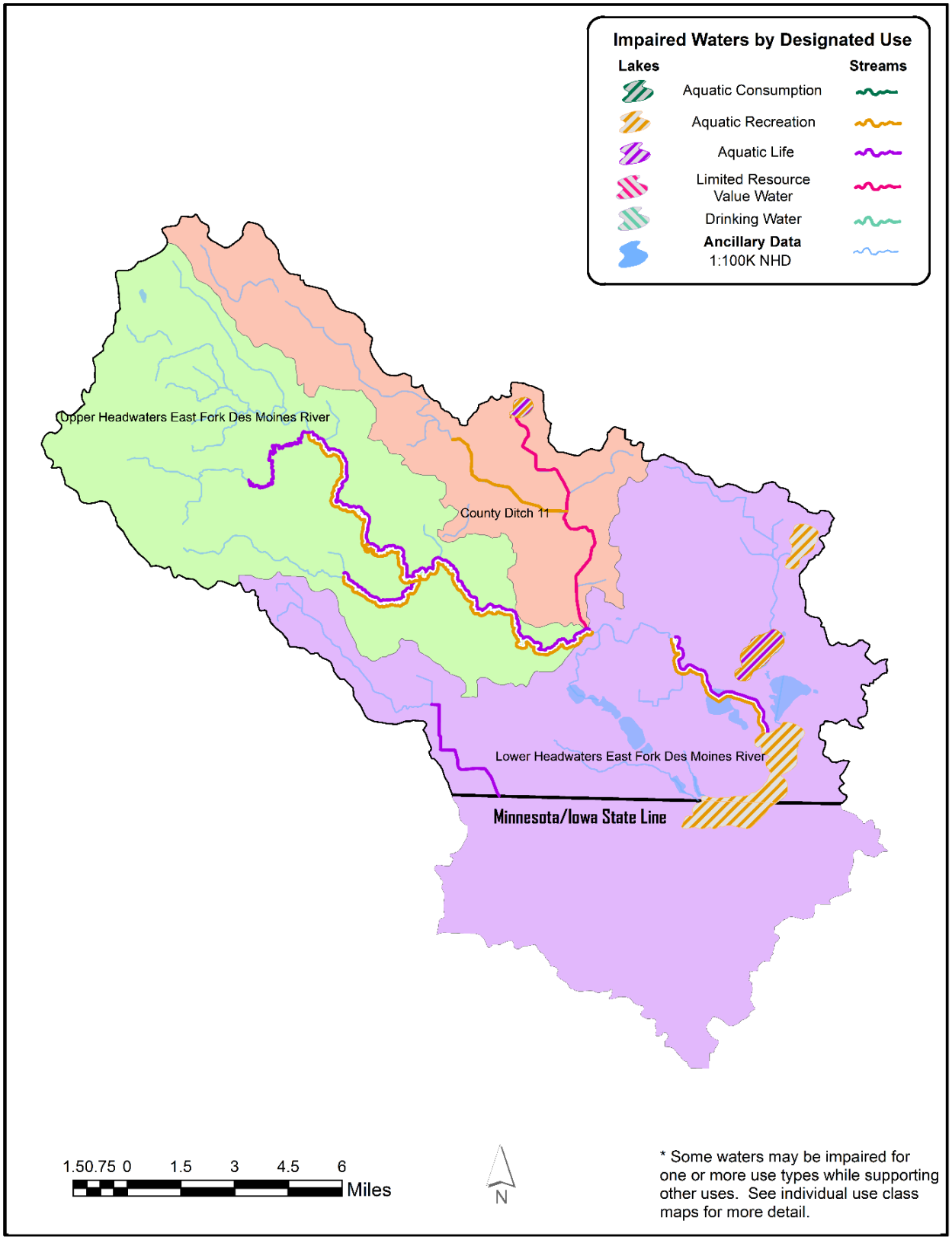

Figure 58. Impaired waters by designated use in the East Fork Des Moines River.

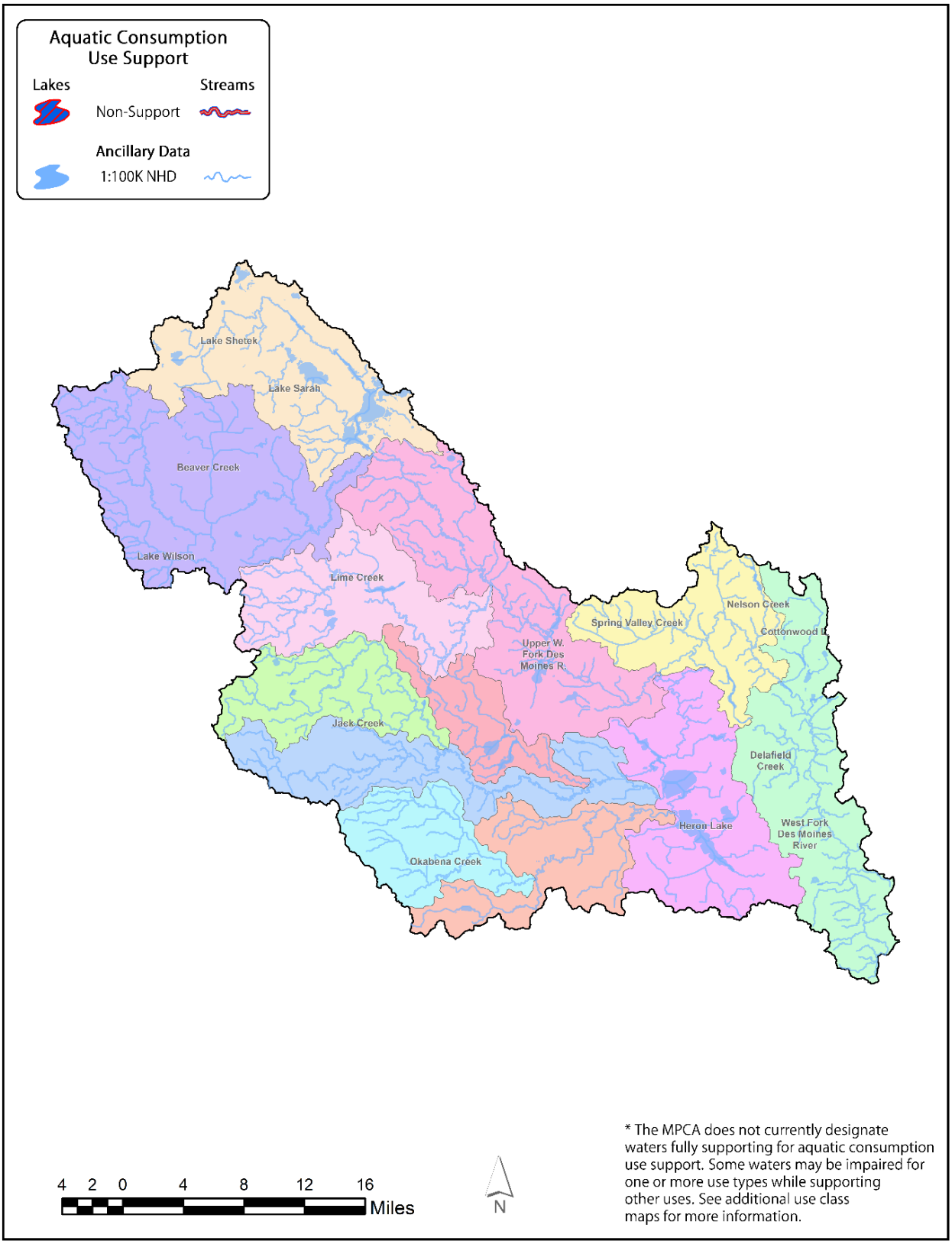

Figure 59. Aquatic consumption use support in the Des Moines River Headwaters Watershed.

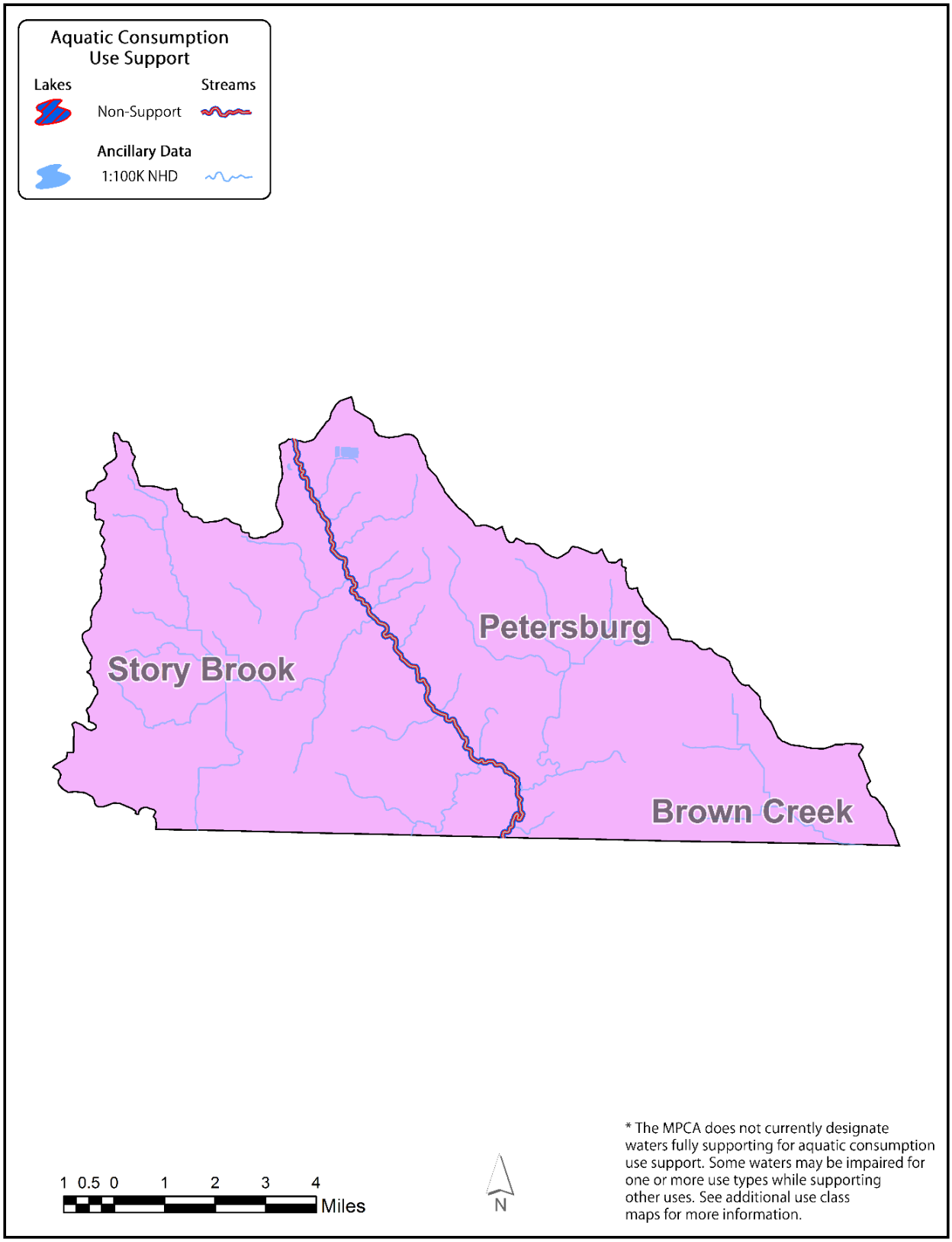

Figure 60. Aquatic consumption use support in the Lower Des Moines River Watershed.

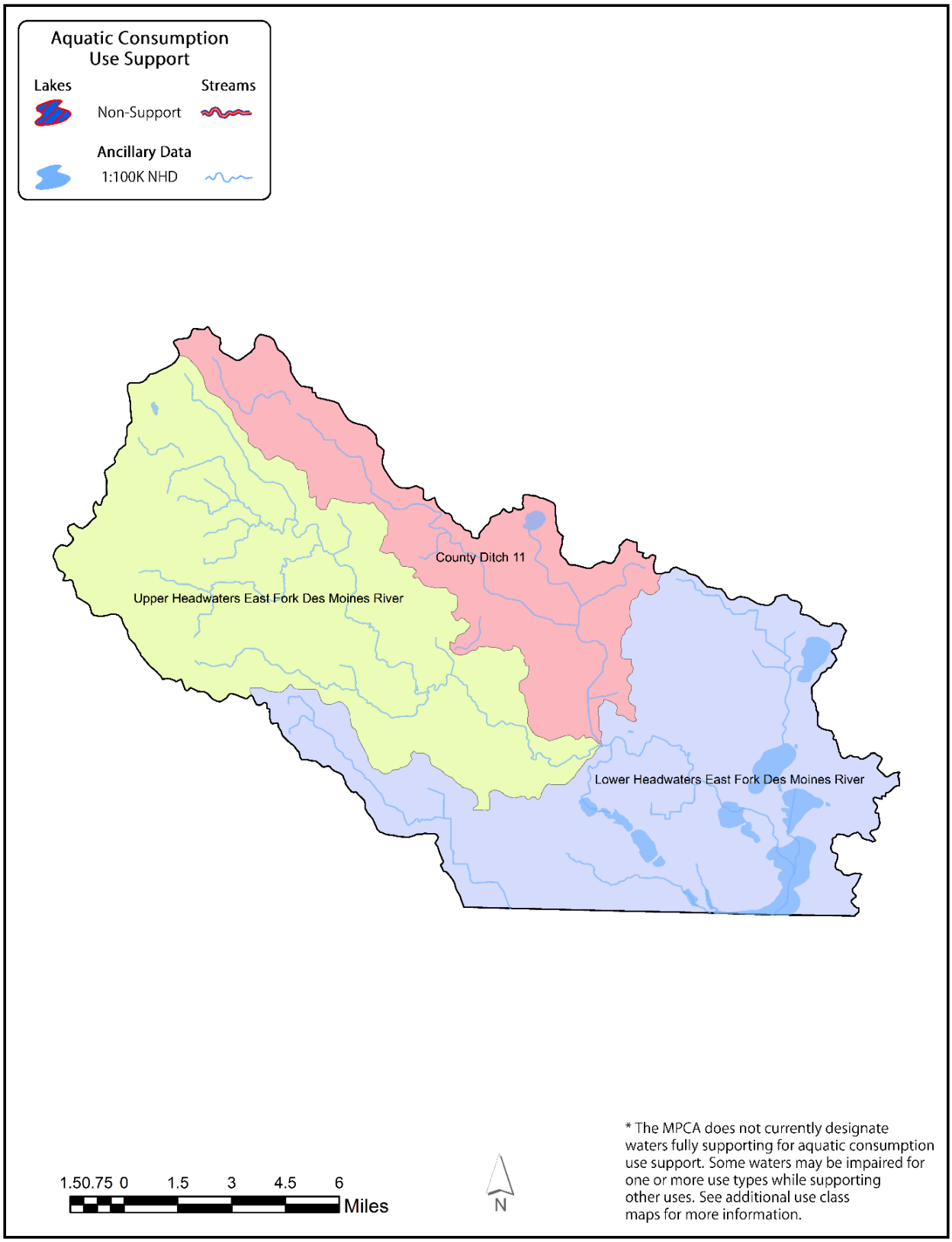

Figure 61. Aquatic consumption use support in the East Fork Des Moines River Watershed.

Figure 62. Aquatic life use support in the Des Moines River Headwaters Watershed.

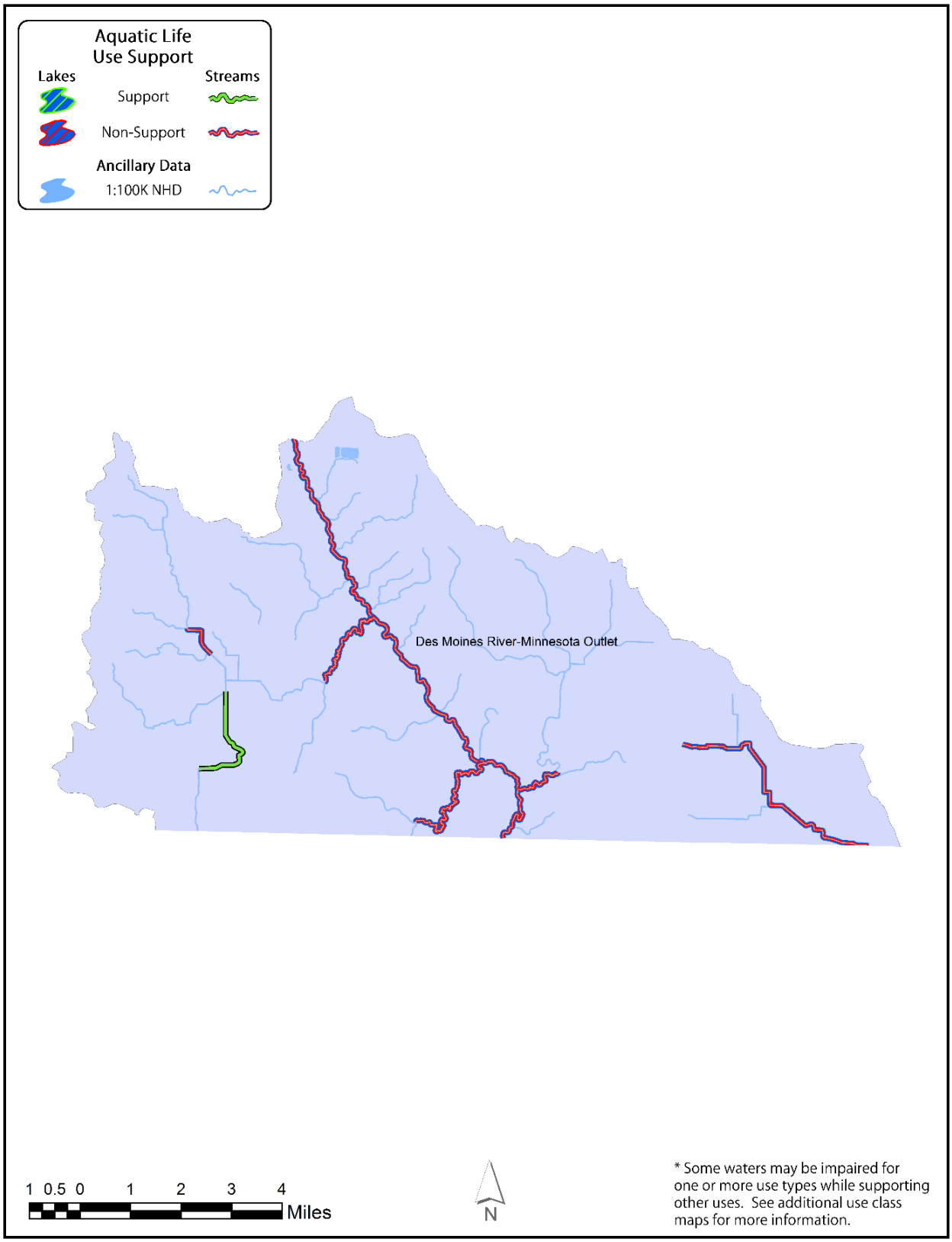

Figure 63. Aquatic life use support in the Lower Des Moines River Watershed.

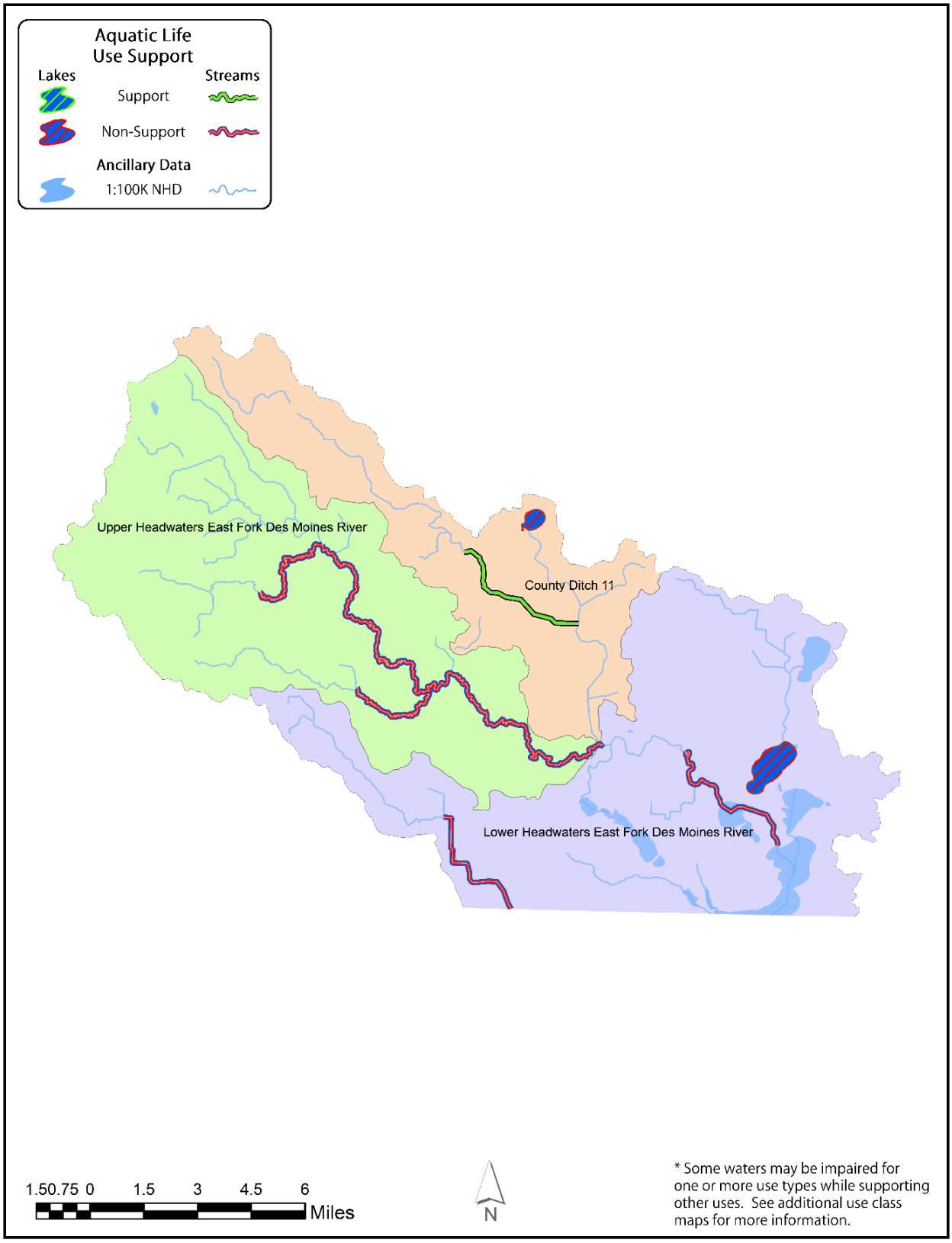

Figure 64. Aquatic life use support in the East Fork Des Moines River Watershed.

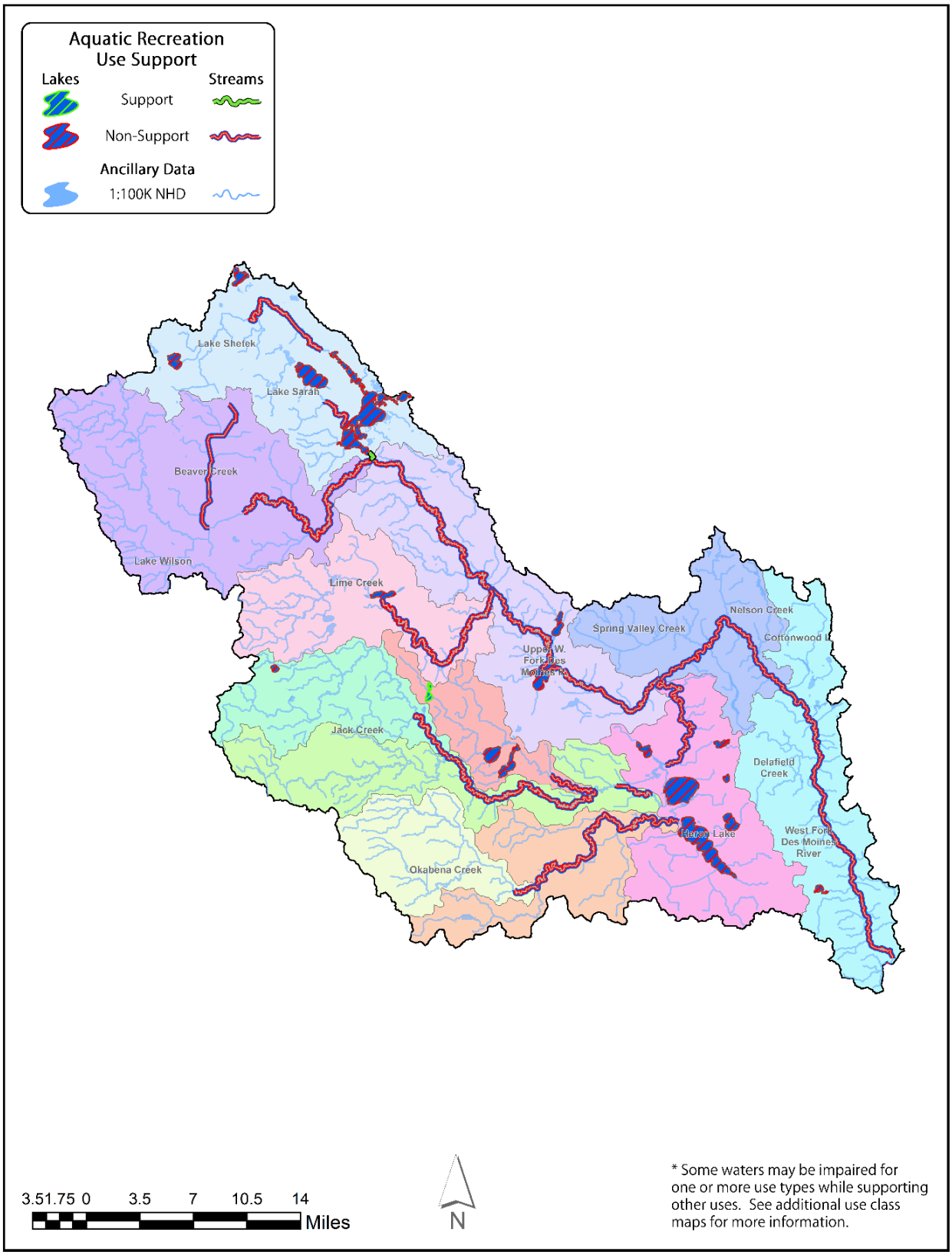

Figure 65. Aquatic recreation use support in the Des Moines River Headwaters Watershed.

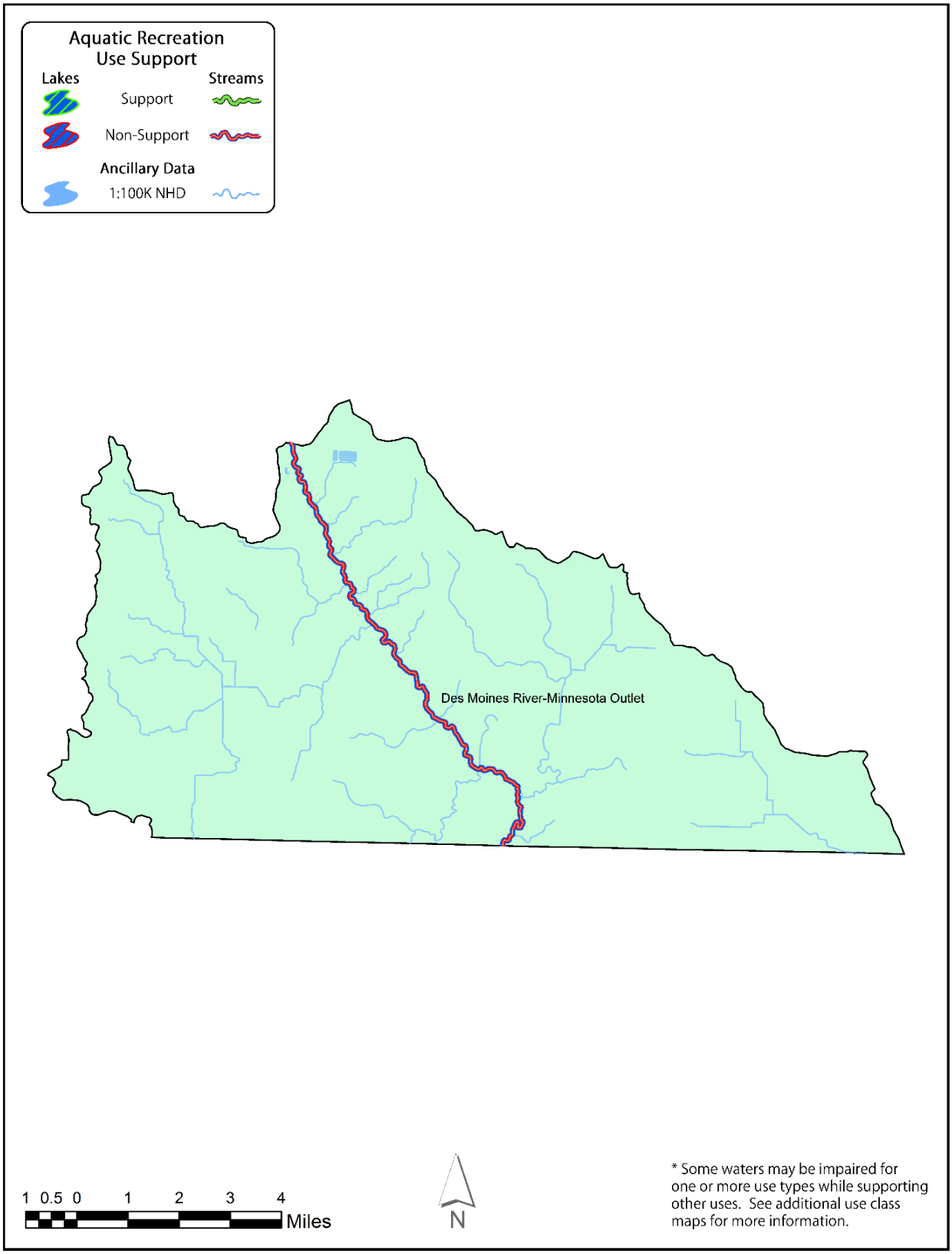

Figure 66. Aquatic recreation use support in the Lower Des Moines River Watershed.

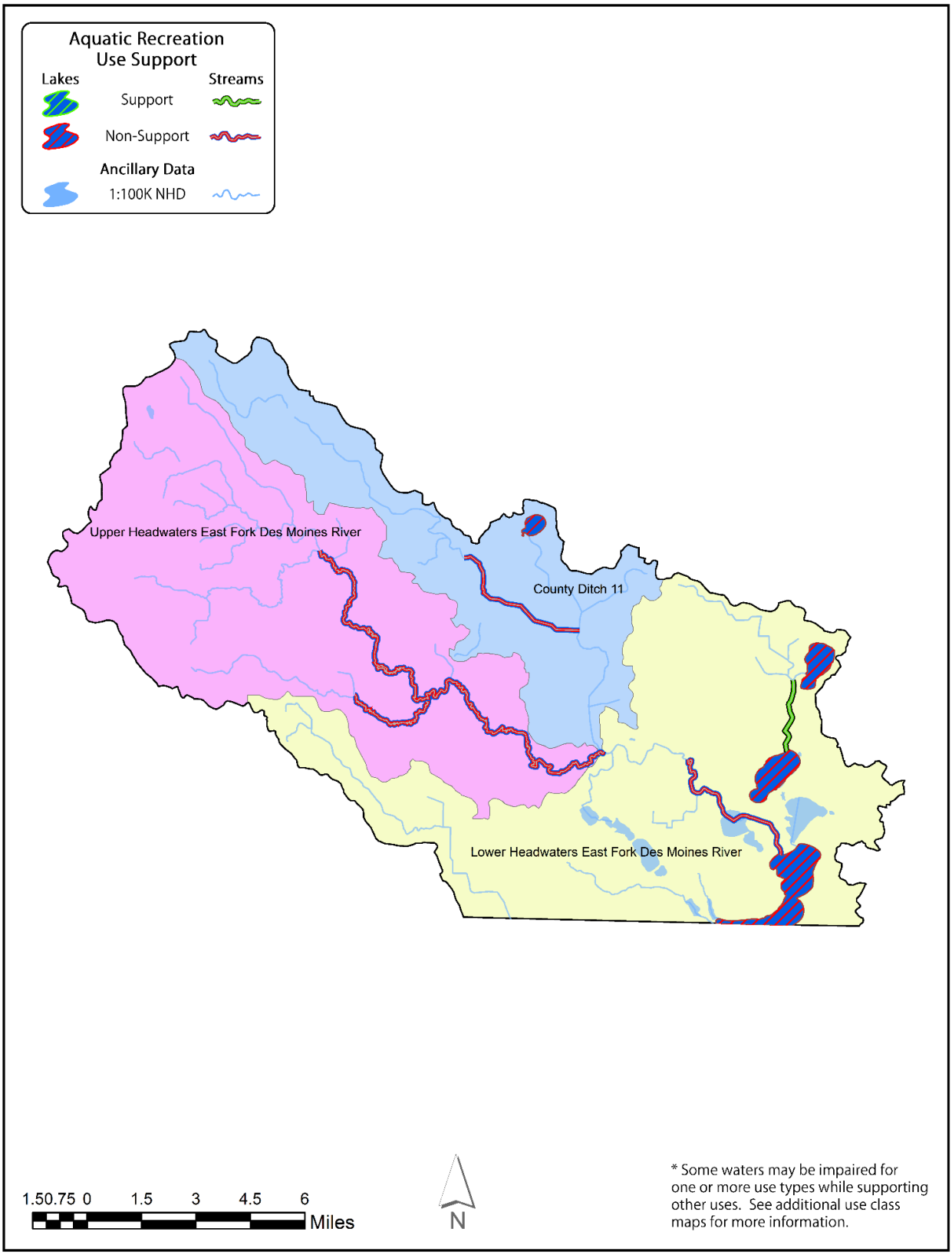

Figure 67. Aquatic recreation use support in the Lower Des Moines River Watershed.

Summaries and recommendations

Measures need to be taken to reduce land use impacts on water resources in the Des Moines River Basin. Nonpoint source pollution from the agricultural practices is negatively affecting immediate and downstream designated uses of aquatic life, recreation, consumption, and drinking water. Eighty-two of the 190 stream AUIDs were assessed for aquatic life and/or aquatic recreation. Of the assessed streams, only nine AUIDs were considered supporting of aquatic life and two stream is fully supporting of aquatic recreation. There are a combined total of eighty-two stream reaches that are non-supporting for aquatic life or recreation uses.

Impairment for aquatic recreation due to elevated bacteria levels, including sometimes incredibly high levels, is widespread across the basin, affecting all the assessed streams in the Des Moines River Basin, except one AUID where sufficient data was available to make an assessment of full support. The large number of active feedlots (975) in the Minnesota portion of the Des Moines Basin is likely contributing to these widespread impairments. In fact, it is common practice to fence livestock in the river or stream corridor as it provides a source of water for the animals. One of the two sampling reaches that are supporting for aquatic recreation was sampled just below Lake Shetek in the very headwaters of the watershed. The closest active feedlot is more than five miles away from the sampling location. Lake Shetek and a dam are in between the sampling location and the closest feedlot or closed pasture. The other reach on Mud Slough is also near the headwaters with only two feedlots upstream and only one of them is near the sampling location. The lack of sufficient rangeland and 537 feedlots within a quarter mile of streams in the basin makes it more likely the bacteria impairments are more widespread than Figure 65, Figure 66, and Figure 67 suggest. High bacteria levels could also be attributed to failing septic systems, which are not well quantified across the watersheds.

Turbidity issues and are as universal as impairments due to bacteria in the Des Moines River Basin. Improvements are needed in the watersheds to significantly reduce overland soil loss and stream erosion by implementing soil conservation efforts and restoring natural vegetation along riparian zones. High levels of turbidity are likely stemming from stream bank erosion as streams cut into banks. Drain tile in fields has dramatically cut down the time it takes rainwater to reach the rivers and streams. The streams as they exist now cannot handle the dramatic surge of water and the banks are eroding as they try to increase the capacity of the stream channel. Poor habitat conditions observed across many biological stations is likely linked to turbidity and sedimentation issues, as well as poor riparian land use.

Aquatic life use impairments within the Des Moines River Basin are widespread. Macroinvertebrate and fish communities are equally poor throughout the basin except for Beaver Creek Watershed where macroinvertebrates are much healthier. Biotic impairments are likely a result of nonpoint source pollution and localized stress linked to unstable channel conditions and poor in-stream habitat, both of which can be associated with high suspended sediment and embedded substrates. High nutrient levels are also likely to be influencing biotic communities, as seen in other watersheds across southern Minnesota.

Two of the 25 lakes in the Des Moines River Basin are meeting the aquatic recreation standard. The Lower Des Moines River Watershed is the only watershed that did not have lakes for assessment. All of these lakes are very shallow and are susceptible to mixing from wind throughout the open water season. The Des Moines River Basin is dominated by vast open areas, mainly cropland, which can lead to increased sediment flowing into lakes. The increase nutrients paired with shallow basins can lead to large internal loading issues. Most lakes in this basin will have the potential for severe algal blooms throughout the summer. Runoff and internal loading are the major contributors of phosphorus leading

to the impairment of lakes in this basin. The use of buffer strips, shoreline management and other BMPs are going to be important to implement to restore the water quality for lakes in this basin.

Due to the geology, groundwater concentrations of naturally occurring elements like boron, iron, manganese and phosphorous are, in general, higher in southwest Minnesota and the Des Moines River Watersheds. Also in this region, arsenic is a naturally occurring concern for drinking water and nitrate is a concern for shallow groundwater quality. Recharge to the surficial aquifers is dependent on precipitation and surficial geology. In recent years, periods of seasonal drought in southwest Minnesota have made it particularly difficult for citizens to obtain water for consumptive use. Low recharge rates coupled with increasing groundwater withdrawals heighten the need for water conservation and a more complete understanding of groundwater in the region.

The Des Moines River Watersheds are very similar in land use and water quality to the other watersheds in southwestern Minnesota. Efforts are necessary to improve the water quality in areas affected by human disturbance and intensive agriculture. Improvements in water quality should target nonpoint sources of pollution. Implementation of BMPs should target sensitive features on the landscape that are known to impact water quality, to insure a high return on investment for valuable restoration dollars. Reductions in sediment loading needs to be made by taking efforts to limit erosion and soil loss from agricultural sources using buffer strips and limiting cattle access to streams in the watersheds. The reduction of natural wetlands allows for less water retention on the landscape and filtering the excess nutrients within the watershed. Great care needs to be taken to protect and even replace these natural filters. Extensive use of drain tile has increased the impacts of high flows on stream bank erosion and instream sediment loading. Areas of extensive agriculture have higher potential for impaired stream reaches for aquatic life due to severe land modifications and excess nutrients entering he waterways. Stream restoration efforts could include perennial vegetation buffers to stabilize stream banks and reduce erosion. Plans to reduce bacteria in the watersheds and nitrate levels should include measures to better control livestock waste, fertilizer management, and fix failing septic systems. Surface water quality improvements will be dependent on local cooperation as using regulatory authority to reduce nonpoint source pollution is currently limited.

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

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

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 Des Moines River Watersheds in Minnesota

EQuIS ID	Biological station ID	AUID	Waterbody name	Location	Aggregated 12-digit HUC
S000-027	14DM003	07100001-501	Des Moines River, West Fork	At North Hwy, in Jackson	0710000108-01
S000-156	14DM001	07100002-501	Des Moines River, West Fork	At Co. Hwy. 23(Petersburg Rd.), 10.5 mi. SE of Jackson	0710000201-01
S000-269	04DM040	07100001-512	Okabena Creek	Upsteam of 810th St., 3 mi. S of Brewster	0710000105-01
S000-481	14DM004	07100001-501	Des Moines River, West Fork	At US Hwy. 71, 0.5 S of Windom	0710000108-01
S001-000	14DM002	07100003-527	Des Moines River, East Fork	At 50th St., 1.5 mi. N of Ceylon	0710000301-01
S001-363	14DM006	07100001-533	Des Moines River, West Fork	At Hwy. 62, 10 mi. W of Windom	0710000104-01
S001-557	14DM009	07100001-658	Jack Creek	Downstream of 370th Ave., 1 mi. SW of Heron Lake	0710000106-01
S001-568	14DM010	07100001-602	Okabena Creek	At 370th Ave., 1 mi. W of Okabena	0710000105-01
S002-005	14DM014	07100001-646	Beaver Creek	Upstream of Hwy. 30, 1.5 mi. W of Currie	0710000101-01
S002-006	14DM007	07100001-545	Des Moines River, West Fork	West of 161st St., 1 mi. NW of Currie	0710000104-01
S002-007	14DM013	07100001-535	Lime Creek	Upstream of Hwy. 91(270th Ave), 6 mi. E of Acova	0710000103-01
S005-027	14DM016	07100003-503	County Ditch 11	At 70th St., 5 mi. SE of Sherburne	0710000301-03
S007-813	14DM015	07100003-525	Des Moines River, East Fork	At 60th St., 5 mi. NW of Ceylon	0710000301-02
S007-890	04DM033	07100001-652	Jack Creek, North Branch	At 130th St., 5 mi. S of Fulda	0710000106-03
S007-891	14DM012	07100001-564	Unnamed Creek(Trib. to Jack Creek)	Unn Str (Trib To Jack Creek) At 890th St, 2 Mi W Of Miloma, Mn. T104n/R38w/S33	0710000106-02
S007-892	14DM011	07100001-656	Elk Creek	Upstream of Wass Ave., 1.8 mi. S of Brewster	0710000105-02
S007-893	14DM008	07100001-527	Heron Lake Outlet	Downstream of CR 62, 6 mi. NE of Heron Lake	0710000107-01
S007-894	14DM005	07100001-524	Des Moines River, West Fork	At CR 15(Country Club Dr.), 2.5 NW of Windom	0710000108-02

Appendix 2.2 – Intensive watershed monitoring biological monitoring stations in the Des Moines River Watersheds

AUID	Biological station ID	Waterbody name	Biological station location	County	Aggregated 12-digit HUC
Headwater of the Des Moines River (07100001)					
07100001-663	04DM015	Beaver Creek	0.9 mi. upstream of 131st St, 1.5 mi. NW of Lake Wilson	Murray	071000010101
07100001-663	14DM070	Beaver Creek	Upstream of CR 91, 1 mi. NE of Lake Wilson	Murray	071000010101
07100001-628	14DM071	Unnamed creek	Downstream of CR 25 (20th Ave), 8 mi. NW of Lake Wilson	Murray	071000010101
07100001-586	04DM023	Unnamed ditch	Upstream of Hwy 27, 1 mi. S of Lake Wilson	Murray	071000010102
07100001-664	07DM002	Beaver Creek	Upstream of CSAH 28 (80th Ave), 2.5 mi. W of Hadley	Murray	071000010102
07100001-594	07DM006	Unnamed ditch	Upstream of 91st St, 1 mi. SW of Lake Wilson	Murray	071000010102
07100001-589	14DM101	Judicial Ditch 14	Upstream of 70th Ave, 1.5 SE of Lake Wilson	Murray	071000010102
07100001-504	14DM066	County Ditch 20	Adjacent to CR 28 (80th Ave), 2 mi. NE of Lake Wilson	Murray	071000010103
07100001-504	14DM067	County Ditch 20	Downstream of 151st St, 6 mi. NE of Lake Wilson	Murray	071000010103
07100001-646	04DM001	Beaver Creek	0.4 mi. upstream of 116th St, 1.5 mi. N of Slayton	Murray	071000010104
07100001-646	04DM012	Beaver Creek	At end of CR 87 (120th Ave), 4 mi. NW of Slayton	Murray	071000010104
07100001-646	14DM014	Beaver Creek	Upstream of Hwy 30 (155th St), 1.5 mi. W of Currie	Murray	071000010104
07100001-641	04DM006	County Ditch 26	0.6 mi. downstream of 80th Ave, 4 mi. SW of Balaton	Murray	071000010201
07100001-642	04DM026	Lake Shetek Inlet	Upstream of CSAH 63 (220th Ave), 2 mi. S of Balaton	Lyon	071000010201
07100001-637	14DM079	Unnamed creeek	Downstream of 80th Ave, 4.5 mi. S of Balaton	Murray	071000010201
07100001-641	14DM080	Lake Shetek Inlet	Downstream of 80th Ave, 4.5 mi. S of Balaton	Murray	071000010201
07100001-643	14DM077	Lake Shetek Inlet	Upstream of CR 21 (231st St), 2 mi. S of Garvin	Murray	071000010202
07100001-636	14DM078	Unnamed creek	Upstream of 110th St, 1 mi. SE of Balaton	Lyon	071000010202
07100001-508	14DM074	Lower Lake Sarah Outlet	Downstream of 191st St, 6 mi. NW of Currie	Murray	071000010203
07100001-632	14DM075	Unnamed creek	Upstream of CR 73 (211th St), 5 mi. SW of Garvin	Murray	071000010203
07100001-583	04DM014	Trib. to unnamed stream	Downstream of Hwy 3, 1 mi. S of Iona	Murray	071000010301
07100001-624	14DM055	Unnamed creek	Upstream of Hwy 59, 4 mi. SE of Slayton	Murray	071000010302
07100001-625	14DM057	Unnamed creek	Downstream of CSAH 32 (150th Ave), 2 mi. S of Slayton	Murray	071000010302
07100001-535	14DM013	Lime Creek	Upstream of 270th Ave, 6 mi. E of Avoca	Murray	071000010303
07100001-535	14DM054	Lime Creek	Downstream of 210th Ave, 1.5 mi. S of Avoca	Murray	071000010303

AUID	Biological station ID	Waterbody name	Biological station location	County	Aggregated 12-digit HUC
07100001-667	04DM030	Devil's Run Creek (County Ditch 4)	Downstream of 131st St, S of Dovray	Murray	071000010401
07100001-668	14DM062	Devils Run Creek (County Ditch 4)	Downstream of 121st St, 2 mi. SW of Dovray	Murray	071000010401
07100001-580	04DM007	Trib. to Des Moines River	Upstream of Hwy 40, 3 mi. SW of Avoca	Murray	071000010402
07100001-545	14DM007	Des Moines River	West of 161st St, 1 mi. NW of Currie	Murray	071000010402
07100001-546	14DM018	Des Moines River	Upstream of CR 42 (260th Ave), 5.5 mi. E of Avoca	Murray	071000010402
07100001-546	14DM019	Des Moines River	Downstream of 141st St, 4 mi. W of Dovray	Murray	071000010402
07100001-626	14DM063	Unnamed creek	Upstream of CR 9 (131st St), 4 mi. W of Dovray	Murray	071000010402
07100001-533	04DM027	Des Moines River	0.8 mi. downstream of 290th Ave, 5 mi. NE of Fulda	Murray	071000010403
07100001-604	10EM158	Unnamed ditch	Adjacent to CR 7, 6.5 mi. N of Dundee	Cottonwood	071000010403
07100001-533	14DM017	Des Moines River	Downstream of 290th Ave, 8 mi. E of Avoca	Murray	071000010403
07100001-672	14DM053	Unnamed creek	Downstream of 290th Ave, 5.5 mi. E of Fulda	Murray	071000010403
07100001-533	15DM200	Des Moines River	Upstream of CR 6, 7 mi. E of Avoca	Murray	071000010403
07100001-533	04DM013	Des Moines River	1.1 mi. upstream of CSAH 6, 3 mi. NE of Dundee	Cottonwood	071000010404
07100001-533	14DM006	Des Moines River	Upstream of Hwy 62, 10 mi. W of Windom	Cottonwood	071000010404
07100001-621	14DM052	Unnamed creek	Upstream of 360th Ave, 4 mi. NW of Heron Lake	Jackson	071000010404
07100001-656	14DM011	Elk Creek	Upstream of Wass Ave, 1.8 mi. S of Brewster	Nobles	071000010501
07100001-654	14DM034	Elk Creek	Upstream of Roberts Ave, 3.5 mi. W of Brewster	Nobles	071000010501
07100001-616	14DM035	Unnamed creek	Upstream of 190th St, 4 mi. W of Brewster	Nobles	071000010501
07100001-615	14DM036	Unnamed creek	Upstream of CR 3, 3 mi. W of Brewster	Nobles	071000010501
07100001-539	11DM001	Okabena Creek	Upstream of Hwy 59 (Humistan Ave), 0.5 mi. N of Worthington	Nobles	071000010502
07100001-515	07DM004	Judicial Ditch 76	Downstream of 340th Ave, 3.5 mi. NE of Brewster	Jackson	071000010503
07100001-614	14DM032	Unnamed creek	Downstream of 850th St, 2 mi. SW of Okabena	Jackson	071000010504
07100001-602	04DM041	Okabena Creek	Upstream of 830th St, 2 mi. SE of Brewster	Jackson	071000010505
07100001-602	04DM046	Okabena Creek	Downstream of 330th Ave, 3 mi. E of Brewster	Jackson	071000010505
07100001-602	14DM010	Okabena Creek	Upstream of 370th Ave, 1 mi. W of Okabena	Jackson	071000010505
07100001-649	04DM032	Jack Creek, North Branch	0.7 mi. upstream of 110th St, 4 mi. SE of Iona	Nobles	071000010601

AUID	Biological station ID	Waterbody name	Biological station location	County	Aggregated 12-digit HUC
07100001-648	04DM035	Jack Creek, North Branch	0.6 mi. upstream of CR 70 (110th St), 4.3 mi. N of Wilmont	Nobles	071000010601
07100001-619	14DM046	Unnamed creek	Upstream of CR 2 (21st St), 7 mi. W of Fulda	Murray	071000010601
07100001-649	14DM047	Jack Creek, North Branch	Upstream of CR 70 (110th St), 5 mi. NE of Wilmont	Nobles	071000010601
07100001-666	04DM003	Judicial Ditch 12	Downstream of Palm Ave, 3 mi. SW of Fulda	Nobles	071000010602
07100001-650	04DM022	Jack Creek, North Branch	0.7 mi. downstream of CSAH 2 (21st St), 3 mi. W of Fulda	Murray	071000010602
07100001-652	04DM033	Jack Creek, North Branch	Upstream of T-175, 4 m. SE of Fulda	Nobles	071000010602
07100001-666	14DM045	Judicial Ditch 12	Upstream of Palm Ave, 3.5 mi. S of Fulda	Nobles	071000010602
07100001-665	15EM023	Judicial Ditch 12	0.25 mi. upstream of Oliver Ave, 4 mi. SW of Fulda	Nobles	071000010602
07100001-557	04DM008	Unnamed creek	0.6 mi. downstream of Palm Ave, 2 mi. SE of Pfingsten	Nobles	071000010603
07100001-591	04DM028	Trib. to Jack Creek	Upstream of Hwy 18/7, 5 mi. NE of Reading	Nobles	071000010603
07100001-549	14DM039	Jack Creek	0.14 mi. downstream of 140th St, 5 mi. S of Fulda	Nobles	071000010603
07100001-618	14DM040	Unnamed creek	Upstream of Oliver Ave, 1 mi. E of Pfingsten	Nobles	071000010603
07100001-549	14DM081	Jack Creek	Upstream of Read Ave, 2.5 mi. S of Fulda	Nobles	071000010603
07100001-592	04DM031	Trib. to Lime Creek	Downstream of Hwy 40, 1 mile E of Fulda	Murray	071000010604
07100001-564	14DM012	Unnamed creek	Upstream of 890th St, 2 mi. W of Miloma	Jackson	071000010604
07100001-523	14DM049	Judicial Ditch 26	Upstream of Town Ave, 1 mi. W of Kinbrae	Nobles	071000010604
07100001-661	14DM050	Unnamed creek	Upstream of Roberts Ave, 3 mi. W of Kinbrae	Nobles	071000010604
07100001-514	04DM004	Jack Creek	Upstream of Hwy 16, 4 mi. NW of Brewster	Nobles	071000010605
07100001-585	04DM016	unconnected channel	N of CR 63, 1.5 mi. W of Miloma	Jackson	071000010605
07100001-514	04DM025	Jack Creek	Adjacent to private drive, W of CR 7 (350th Ave), 0.5 mi. NW of Miloma	Jackson	071000010605
07100001-658	14DM009	Jack Creek	Downstream of 370th Ave, 1 mi. SW of Heron Lake	Jackson	071000010605
07100001-514	14DM037	Jack Creek	Upstream of 330th Ave, 4.5 mi. NE of Brewster	Jackson	071000010605
07100001-518	04DM011	Unnamed creek	Upstream of CSAH 20 (Okebena Rd), just upstream of confluence with Judicial Ditch 3, 2 mi. NW of Lakefield	Jackson	071000010701
07100001-518	14DM030	Unnamed creek	Downstream of CR 14 (830th Ave), 1.5 mi. W of Lakefield	Jackson	071000010701
07100001-527	04DM018	Heron Lake Outlet	Dowstream of CSAH 24 (910th St), 1.5 mi. NE of Heron Lake	Jackson	071000010704

AUID	Biological station ID	Waterbody name	Biological station location	County	Aggregated 12-digit HUC
07100001-527	14DM008	Heron Lake Outlet	Downstream of CSAH 62, 6 mi. NE of Heron Lake	Cottonwood	071000010704
07100001-613	14DM028	Unnamed creek	Upstream of CR 14 (410st St), 8 mi. NW of Windom	Cottonwood	071000010801
07100001-551	04DM002	Unnamed creek	Upstream of CSAH 15, 5 mi. NW of Windom	Cottonwood	071000010802
07100001-524	04DM020	Des Moines River	0.5 mi. upstream of CSAH 40 (410th Ave), 6 mi. W of Windom	Cottonwood	071000010802
07100001-551	14DM027	Unnamed creek	Downstream of 430th Ave, 4 mi. W of Windom	Cottonwood	071000010802
07100001-563	04DM019	Trib. to Des Moines River	0.5 mi. upstream of 380th St, 4 mi. NW of Windom	Cottonwood	071000010803
07100001-552	09DM001	County Ditch 43 (Scheldorf Creek)	Downstream of 375th St, 6 mi. NW of Windom	Cottonwood	071000010803
07100001-524	14DM005	Des Moines River	Upstream of CR 15 (Country Club Dr), 2 mi. NW of Windom	Cottonwood	071000010803
07100001-563	14DM026	Unnamed creek	Upsteam of 460th Ave, 3 mi. NW of Windom	Cottonwood	071000010803
07100001-552	14DM099	County Ditch 43 (Scheldorf Creek)	Upstream of CSAH 13 (370th St), 6.5 mi. NW of Windom	Cottonwood	071000010803
07100001-544	14DM024	Perkins Creek	Downstream of 4th Ave, in Windom	Cottonwood	071000010804
07100001-670	14DM025	Unnamed creek	Downstream of 490th Ave, 2 mi. NE of Windom	Cottonwood	071000010804
07100001-501	04DM024	Des Moines River	0.2 mi. downstream of CSAH 30 (900th St), 4 mi. S. of Windom	Jackson	071000010805
07100001-501	14DM004	Des Moines River	Upstream of Hwy 71, 0.5 mi. S of Windom	Cottonwood	071000010805
07100001-608	14DM022	Unnamed creek	Downstream of CR 82 (910th St), 4 mi. S of Windom	Jackson	071000010805
07100001-610	14DM023	Unnamed creek	Upstream of CR 17 (490th Ave), 3 mi. S of Windom	Jackson	071000010805
07100001-569	04DM010	Judicial Ditch 66	0.3 mi. upstream of CSAH 34, just W of Jackson	Jackson	071000010806
07100001-501	04DM043	Des Moines River	0.6 mi. downstream of CSAH 19 (510th Ave), 6 mi. NW of Jackson	Jackson	071000010806
07100001-501	10EM179	Des Moines River	1 mi. Upstream of CSAH 16 (830th St), 6 mi. NE of Lakefield	Jackson	071000010806
07100001-501	14DM003	Des Moines River	Downstream of Hwy 71, just NE of Jackson	Jackson	071000010806

Appendix 2.22 – Intensive watershed monitoring biological monitoring stations in the Des Moines River Watersheds

AUID	Biological station ID	Waterbody name	Biological station location	County	Aggregated 12-digit HUC
07100002-510	**07DM005**	**Unnamed ditch**	**Downstream of 740th Ave, 4.5 mi. SW of Jackson**	**Jackson**	**071000020101**
07100002-507	14DM084	Story Brook	Upstream of 735th St, 5 mi. SE of Jackson	Jackson	071000020101
07100002-513	14DM085	Judicial Ditch 6	Upstream of 725th St, 6 mi. SW of Jackson	Jackson	071000020101
07100002-505	14DM087	Judicial Ditch 56	Downstream of 570th Ave, 2 mi. SW of Petersburg	Jackson	071000020102
07100002-501	14DM001	Des Moines River	Upstream of Petersburg Rd (578th Ave), 10.5 mi. SE of Jackson	Jackson	071000020103
07100002-515	04DM005	Judicial Ditch 11	0.5 mi. upstream of 590th Ave, 1.5 mi. SE of Petersburg	Jackson	071000020104
07100002-504	14DM089	Unnamed creek	Upstream of 590th Ave, 10 mi. SE of Jackson	Jackson	071000020104
07100002-502	04DM021	Brown Creek (Judicial Ditch 10)	Upstream of 40th Ave, 3 mi. SW of Dunnell	Martin	071000020105
07100002-502	14DM088	Brown Creek (Judicial Ditch 10)	Upstream of 10th St (Iowa Border), 3.5 mi. S of Dunnell	Martin	071000020105

Appendix 2.23 – Intensive watershed monitoring biological monitoring stations in the East Fork Des Moines River Watershed

AUID	Biological station ID	Waterbody name	Biological station location	County	Aggregated 12-digit HUC
07100003-529	**04DM042**	**Unnamed creek**	**0.5 mi. upstream of 110st, 1.5 mi. E of Alpha**	**Martin**	**071000030101**
07100003-529	14DM095	Unnamed creek	Downstream of 100th St, 1 mi. E of Alpha	Martin	071000030101
07100003-508	04DM017	Fourmile Creek	Upstream of Hwy 29, 1.5 mi. S of Alpha	Jackson	071000030102
07100003-525	14DM015	Des Moines River, East Branch	Upstream of 60th St, 5 mi. NW of Ceylon	Martin	071000030102
07100003-510	14DM096	Fourmile Creek	Upstream of CSAH 4, 1.5 mi. N of Dunnell	Martin	071000030102
07100003-515	14DM091	County Ditch 1/ Judicial Ditch 50	Upstream of CR 119 (90th Ave), 2 mi. SE of Sherburn	Martin	071000030103
07100003-527	04DM034	The Inlet	~0.5 mi. upstream of county route 8, 3 miles east of Ceylon, MN	Martin	071000030104
07100003-527	14DM002	Des Moines River, East Branch	Upstream of 50th St, 1.5 mi. N of Ceylon	Martin	071000030104
07100003-506	14DM097	County Ditch 53	Upstream of CR 13 (70th Ave), 5 mi. SW of Ceylon	Martin	071000030107

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
Invertebrates						
1	Northern Forest Rivers	2B, 2C	77	49	NA	±10.8
2	Prairie Forest Rivers	2B, 2C	63	31	NA	±10.8
3	Northern Forest Streams RR	2B, 2C	82	53	NA	±12.6
4	Northern Forest Streams GP	2B, 2C	76	51	37	±13.6
5	Southern Streams RR	2B, 2C	62	37	24	±12.6
6	Southern Forest Streams GP	2B, 2C	66	43	30	±13.6
7	Prairie Streams GP	2B, 2C	69	41	22	±13.6
8	Northern Coldwater	2A	52	32	NA	±12.4
9	Southern Coldwater	2A	72	43	NA	±13.8

Appendix 3.2 – Biological monitoring results Headwaters Des Moines River – fish IBI (assessable reaches)

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological station ID	Stream segment name	Drainage area Mi^2	Fish class	Use class	Threshold	FIBI	Visit date
0710000101-01 (Beaver Creek Subwatershed)								
07100001-594	07DM006	Unnamed ditch	12.5	3	WWm	33	40	04-Sep-07
07100001-628	14DM071	Unnamed creek	13.1	3	WWg	55	29	19-Aug-14
07100001-589	14DM101	Judicial Ditch 14	21.4	3	WWm	33	45	16-Jul-14
07100001-504	14DM067	County Ditch 20	29.4	7	WWm	15	12	17-Sep-15
07100001-504	14DM066	County Ditch 20	39.8	2	WWm	35	25	16-Jul-14
07100001-663	14DM070	Beaver Creek	50.7	2	WWg	50	22	19-Aug-14
07100001-664	07DM002	Beaver Creek	82.0	2	WWm	35	20	06-Sep-07
07100001-646	04DM012	Beaver Creek	137.7	2	WWg	50	18	14-Jul-04
07100001-646	04DM012	Beaver Creek	137.7	2	WWg	50	27	07-Sep-04
07100001-646	04DM001	Beaver Creek	169.9	2	WWg	50	10	15-Jul-04
07100001-646	14DM014	Beaver Creek	177.0	2	WWg	50	23	20-Aug-14
07100001-646	14DM014	Beaver Creek	177.0	2	WWg	50	27	06-Aug-14
0710000102-01 (Lake Shetek Subwatershed)								
07100001-508	14DM074	Lower Lake Sarah Outlet	26.1	3	WWg	55	40	17-Jul-14
07100001-545	14DM007	Des Moines River	129.9	2	WWg	50	44	05-Aug-14
07100001-632	14DM075	Unnamed creek	7.8	3	WWg	55	32	10-Jun-14
07100001-632	14DM075	Unnamed creek	7.8	3	WWg	55	32	05-Aug-15
07100001-641	14DM080	Lake Shetek Inlet	16.2	3	WWg	55	52	19-Aug-14
07100001-642	04DM026	Lake Shetek Inlet	34.5	2	WWm	35	11	07-Jul-04
07100001-642	04DM026	Lake Shetek Inlet	34.5	2	WWm	35	25	19-Aug-14
07100001-643	14DM077	Lake Shetek Inlet	60.6	2	WWg	50	15	06-Aug-14
0710000103-01 (Lime Creek Subwatershed)								
07100001-625	14DM057	Unnamed creek	8.5	3	WWg	55	27	16-Jul-14
07100001-624	14DM055	Unnamed creek	10.7	3	WWm	33	16	17-Sep-15
07100001-535	14DM054	Lime Creek	67.5	2	WWg	50	30	04-Aug-14
07100001-535	14DM013	Lime Creek	97.3	2	WWg	50	29	04-Aug-14

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological station ID	Stream segment name	Drainage area Mi^2	Fish class	Use class	Threshold	FIBI	Visit date
0710000104-01 (Upper Des Moines River Headwaters Subwatershed)								
07100001-672	14DM053	Unnamed creek	6.5	3	WWg	55	54	28-Jul-15
07100001-626	14DM063	Unnamed creek	8.1	3	WWg	55	41	01-Sep-15
07100001-667	04DM030	County Ditch 4	9.6	3	WWm	33	59	04-Aug-04
07100001-668	14DM062	Devils Run Creek	12.2	3	WWg	55	39	05-Aug-15
07100001-621	14DM052	Unnamed creek	14.3	7	WWm	15	29	16-Jul-14
07100001-546	14DM019	Des Moines River	319.0	1	WWg	49	37	11-Aug-14
07100001-546	14DM018	Des Moines River	368.4	1	WWg	49	26	07-Aug-14
07100001-533	14DM017	Des Moines River	480.2	1	WWg	49	21	06-Aug-14
07100001-533	14DM017	Des Moines River	480.2	1	WWg	49	29	27-Aug-14
07100001-533	04DM027	Des Moines River	480.3	1	WWg	49	23	10-Aug-04
07100001-533	04DM013	Des Moines River	522.9	1	WWg	49	13	29-Jul-04
07100001-533	14DM006	Des Moines River	554.2	1	WWg	49	17	12-Aug-14
0710000105-01 (Okabena Creek Subwatershed)								
07100001-614	14DM032	Unnamed creek	12.3	3	WWm	33	46	11-Jun-14
07100001-515	07DM004	Judicial Ditch 76	16.0	3	WWm	33	33	10-Jun-14
07100001-515	07DM004	Judicial Ditch 76	16.0	3	WWm	33	49	05-Sep-07
07100001-602	04DM041	Okabena Creek	85.3	2	WWg	50	27	20-Aug-14
07100001-602	04DM041	Okabena Creek	85.3	2	WWg	50	29	28-Jul-04
07100001-602	14DM010	Okabena Creek	132.7	2	WWg	50	14	12-Aug-14
0710000105-02 (Elk Creek Subwatershed)								
07100001-654	14DM034	Elk Creek	21.0	3	WWg	55	55	26-Aug-14
07100001-615	14DM036	Unnamed creek	29.1	3	WWm	33	33	11-Jun-14
07100001-656	14DM011	Elk Creek	59.8	2	WWg	50	24	20-Aug-14
0710000106-01 (Jack Creek Subwatershed)								
07100001-618	14DM040	Unnamed creek	8.1	3	WWg	55	16	29-Jul-15
07100001-549	14DM039	Jack Creek	33.2	2	WWg	50	15	15-Jul-14
07100001-549	14DM081	Jack Creek	55.6	2	WWg	50	22	13-Aug-14
07100001-514	04DM004	Jack Creek	131.4	2	WWg	50	23	19-Jul-04
07100001-514	14DM037	Jack Creek	142.1	2	WWg	50	14	05-Aug-14

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological station ID	Stream segment name	Drainage area Mi^2	Fish class	Use class	Threshold	FIBI	Visit date
07100001-514	04DM025	Jack Creek	148.1	2	WWg	50	24	20-Jul-04
07100001-658	14DM009	Jack Creek	204.2	2	WWm	35	9	05-Aug-14
0710000106-02 (Trib. to Jack Creek Subwatershed)								
07100001-661	14DM050	Unnamed creek	11.0	3	WWg	55	49	29-Jul-15
07100001-564	14DM012	Unnamed creek	42.9	2	WWg	50	9	13-Aug-14
0710000106-03 (North Branch Jack Creek Subwatershed)								
07100001-619	14DM046	Unnamed creek	8.5	3	WWg	55	29	16-Jul-14
07100001-648	04DM035	Jack Creek, North Branch	10.6	3	WWg	55	42	05-Aug-04
07100001-665	15EM023	Judicial Ditch 12	10.7	3	WWm	33	33	21-Jul-15
07100001-666	04DM003	Judicial Ditch 12	12.1	3	WWg	55	50	20-Jul-04
07100001-666	04DM003	Judicial Ditch 12	12.1	3	WWg	55	52	05-Aug-04
07100001-666	14DM045	Judicial Ditch 12	12.3	3	WWg	55	51	29-Jul-15
07100001-649	04DM032	Jack Creek, North Branch	13.9	3	WWm	33	11	14-Jul-04
07100001-649	14DM047	Jack Creek, North Branch	14.1	3	WWm	33	28	14-Jul-14
07100001-650	04DM022	Jack Creek, North Branch	39.1	2	WWg	50	23	20-Jul-04
07100001-652	04DM033	Jack Creek, North Branch	69.8	2	WWg	50	29	03-Aug-04
07100001-652	04DM033	Jack Creek, North Branch	69.8	2	WWg	50	32	07-Aug-14
0710000107-01 (Heron Lake Subwatershed)								
07100001-518	14DM030	Unnamed creek	11.9	3	WWm	33	12	30-Jul-15
07100001-518	04DM011	Unnamed creek	16.3	7	WWm	15	11	02-Aug-04
07100001-527	04DM018	Heron Lake Outlet	450.0	1	WWg	49	2	10-Sep-04
07100001-527	14DM008	Heron Lake Outlet	462.0	1	WWg	49	23	13-Aug-14
0710000108-01 (Lower Des Moines River Headwaters Subwatershed)								
07100001-608	14DM022	Unnamed creek	13.0	3	WWm	33	56	11-Jun-14
07100001-501	14DM004	Des Moines River	1137.8	1	WWg	49	21	14-Aug-14
07100001-501	04DM024	Des Moines River	1182.0	1	WWg	49	17	18-Aug-04
07100001-501	04DM043	Des Moines River	1205.2	1	WWg	49	19	18-Aug-04
07100001-501	10EM179	Des Moines River	1211.5	1	WWg	49	23	01-Sep-11
07100001-501	14DM003	Des Moines River	1240.1	1	WWg	49	30	19-Aug-14

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological station ID	Stream segment name	Drainage area Mi^2	Fish class	Use class	Threshold	FIBI	Visit date
0710000108-02 (Middle Des Moines River Headwaters Subwatershed)								
07100001-563	04DM019	Unnamed creek	4.5	3	WWg	55	33	07-Jul-04
07100001-551	04DM002	Unnamed creek	8.1	3	WWg	55	1	02-Aug-04
07100001-551	14DM027	Unnamed creek	8.4	3	WWg	55	34	10-Jun-14
07100001-552	14DM099	County Ditch 43 (Scheldorf Creek)	12.3	10	CWg	50	18	09-Jun-14
07100001-552	09DM001	County Ditch 43 (Scheldorf Creek)	12.7	10	CWg	50	17	12-Aug-10
07100001-613	14DM028	Unnamed creek	31.8	2	WWg	50	31	14-Jul-14
07100001-524	04DM020	Des Moines River	1024.7	1	WWg	49	7	19-Aug-04
07100001-524	04DM020	Des Moines River	1024.7	1	WWg	49	11	13-Aug-14
07100001-524	14DM005	Des Moines River	1104.7	1	WWg	49	16	19-Aug-14

Appendix 3.22 – Biological monitoring results Lower Des Moines River– fish IBI (assessable reaches)

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological station ID	Stream segment name	Drainage area Mi^2	Fish class	Use class	Threshold	FIBI	Visit date
0710000201-01 (Des Moines River – Minnesota Outlet Subwatershed)								
07100002-510	07DM005	Unnamed ditch	6.2	3	WWg	55	64	05-Sep-07
07100002-510	07DM005	Unnamed ditch	6.2	3	WWg	55	30	30-Jun-15
07100002-515	04DM005	Judicial Ditch 11	13.9	3	WWg	55	51	30-Aug-04
07100002-504	14DM089	Unnamed creek	16.5	3	WWg	55	36	11-Jun-14
07100002-505	14DM087	Judicial Ditch 56	22.6	3	WWg	55	0	11-Jun-14
07100002-507	14DM084	Story Brook	29.9	3	WWg	55	53	26-Aug-14
07100002-501	14DM001	Des Moines River	1297.7	1	WWg	55	25	26-Aug-14

Appendix 3.23 – Biological monitoring results East Fork Des Moines River– fish IBI (assessable reaches)

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological station ID	Stream segment name	Drainage area Mi^2	Fish class	Use class	Threshold	FIBI	Visit date
0710000301-01 (Lower Headwaters East Fork Des Moines River Subwatershed)								
07100003-506	14DM097	County Ditch 53	13.1	3	WWm	33	30	30-Jun-15
07100003-527	14DM002	Des Moines River, East Branch	131.5	2	WWg	50	18	21-Aug-14
0710000301-02 (Upper Headwaters East Fork Des Moines River Subwatershed)								
07100003-529	14DM095	Unnamed creek	12.5	3	WWg	55	25	01-Sep-15
07100003-510	14DM096	Fourmile Creek	15.4	3	WWg	55	35	01-Aug-16
07100003-510	14DM096	Fourmile Creek	15.4	3	WWg	55	50	17-Jul-14
0710000301-03 (County Ditch 11 Subwatershed)								
07100003-515	14DM091	County Ditch 1/Judicial Ditch 50	24.4	3	WWm	33	65	16-Jul-14

Appendix 3.3 – Biological monitoring results Headwaters Des Moines River -macroinvertebrate IBI (assessable reaches)

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological station ID	Stream segment name	Drainage area Mi^2	Invert class	Use class	Threshold	MIBI	Visit date
0710000101-01 (Beaver Creek Subwatershed)								
07100001-594	07DM006	Unnamed ditch	12.5	7	WWm	22	51.6	11-Sep-07
07100001-628	14DM071	Unnamed creek	13.1	7	WWg	41	23.9	05-Aug-14
07100001-589	14DM101	Judicial Ditch 14	21.4	7	WWm	22	40.5	04-Aug-15
07100001-589	14DM101	Judicial Ditch 14	21.4	7	WWm	22	42.5	06-Aug-14
07100001-589	14DM101	Judicial Ditch 14	21.4	7	WWm	22	46.0	06-Aug-14
07100001-504	14DM067	County Ditch 20	29.4	7	WWm	22	15.4	05-Aug-14
07100001-504	14DM066	County Ditch 20	39.8	5	WWm	22	26.6	05-Aug-14
07100001-663	14DM070	Beaver Creek	50.7	5	WWg	37	13.5	05-Aug-14
07100001-664	07DM002	Beaver Creek	82.0	7	WWm	22	23.7	11-Sep-07
07100001-646	04DM012	Beaver Creek	137.7	5	WWg	37	24.4	25-Aug-04
07100001-646	04DM001	Beaver Creek	169.9	5	WWg	37	28.1	25-Aug-04
07100001-646	14DM014	Beaver Creek	177.0	5	WWg	37	44.3	06-Aug-14
0710000102-01 (Lake Shetek Subwatershed)								
07100001-632	14DM075	Unnamed creek	7.8	5	WWg	37	20.6	05-Aug-14
07100001-637	14DM079	Unnamed creek	9.7	7	WWg	41	24.8	04-Aug-14
07100001-641	14DM080	Lake Shetek Inlet	16.2	5	WWg	37	23.5	04-Aug-14
07100001-641	04DM006	Lake Shetek Inlet	16.6	5	WWg	37	33.1	01-Sep-04
07100001-508	14DM074	Lower Lake Sarah Outlet	26.1	5	WWg	37	21.2	05-Aug-14
07100001-642	04DM026	Lake Shetek Inlet	34.5	7	WWm	22	45.0	01-Sep-04
07100001-642	04DM026	Lake Shetek Inlet	34.5	7	WWm	22	54.4	04-Aug-14
07100001-643	14DM077	Lake Shetek Inlet	60.6	5	WWg	37	16.0	04-Aug-14
07100001-545	14DM007	Des Moines River	129.9	7	WWg	41	44.0	06-Aug-14
0710000103-01 (Lime Creek Subwatershed)								
07100001-625	14DM057	Unnamed creek	8.5	7	WWg	41	22.8	07-Aug-14
07100001-624	14DM055	Unnamed creek	10.7	7	WWm	22	17.8	07-Aug-14
07100001-535	14DM054	Lime Creek	67.5	7	WWg	41	25.5	07-Aug-14

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological station ID	Stream segment name	Drainage area Mi^2	Invert class	Use class	Threshold	MIBI	Visit date
07100001-535	14DM013	Lime Creek	97.3	5	WWg	37	18.6	07-Aug-14
0710000104-01 (Upper Des Moines Headwaters Subwatershed)								
07100001-672	14DM053	Unnamed creek	6.5	7	WWg	41	32.5	07-Aug-14
07100001-626	14DM063	Unnamed creek	8.1	7	WWg	41	28.8	06-Aug-14
07100001-667	04DM030	County Ditch 4	9.6	7	WWm	22	10.5	25-Aug-04
07100001-668	14DM062	Devils Run Creek	12.2	7	WWg	41	39.2	06-Aug-14
07100001-621	14DM052	Unnamed creek	14.3	7	WWm	22	17.2	07-Aug-14
07100001-546	14DM019	Des Moines River	319.0	5	WWg	37	20.4	06-Aug-14
07100001-546	14DM018	Des Moines River	368.4	5	WWg	37	31.9	11-Aug-14
07100001-533	15DM200	Des Moines River	476.1	5	WWg	37	30.5	04-Aug-15
07100001-533	14DM017	Des Moines River	480.2	5	WWg	37	34.4	07-Aug-14
07100001-533	04DM027	Des Moines River	480.3	5	WWg	37	25.1	02-Sep-04
07100001-533	04DM013	Des Moines River	522.9	2	WWg	31	19.7	08-Sep-04
07100001-533	04DM013	Des Moines River	522.9	2	WWg	31	20.6	02-Sep-04
07100001-533	14DM006	Des Moines River	554.2	2	WWg	31	3.0	07-Aug-14
07100001-533	14DM006	Des Moines River	554.2	2	WWg	31	16.3	03-Aug-15
0710000105-01 (Okabena Creek Subwatershed)								
07100001-614	14DM032	Unnamed creek	12.3	7	WWm	22	10.3	07-Aug-14
07100001-614	14DM032	Unnamed creek	12.3	7	WWm	22	18.4	07-Aug-14
07100001-515	07DM004	Judicial Ditch 76	16.0	7	WWm	22	4.2	10-Sep-07
07100001-515	07DM004	Judicial Ditch 76	16.0	7	WWm	22	27.0	07-Aug-14
07100001-602	04DM041	Okabena Creek	85.3	5	WWg	37	6.6	07-Aug-14
07100001-602	04DM041	Okabena Creek	85.3	5	WWg	37	22.5	07-Sep-04
07100001-602	04DM041	Okabena Creek	85.3	5	WWg	37	27.1	24-Aug-04
07100001-602	04DM046	Okabena Creek	87.0	5	WWg	37	28.5	30-Aug-04
07100001-602	14DM010	Okabena Creek	132.7	7	WWg	41	22.1	07-Aug-14
0710000105-02 (Elk Creek Subwatershed)								
07100001-654	14DM034	Elk Creek	21.0	5	WWg	37	36.0	06-Aug-14
07100001-615	14DM036	Unnamed creek	29.1	5	WWm	22	35.9	07-Aug-14
07100001-656	14DM011	Elk Creek	59.8	5	WWg	37	22.9	06-Aug-14

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological station ID	Stream segment name	Drainage area Mi^2	Invert class	Use class	Threshold	MIBI	Visit date
0710000106-01 (Jack Creek Subwatershed)								
07100001-618	14DM040	Unnamed creek	8.1	7	WWg	41	6.0	06-Aug-14
07100001-549	14DM039	Jack Creek	33.2	7	WWg	41	22.9	06-Aug-14
07100001-549	14DM081	Jack Creek	55.6	5	WWg	37	12.0	06-Aug-14
07100001-514	04DM004	Jack Creek	131.4	7	WWg	41	40.3	24-Aug-04
07100001-514	04DM025	Jack Creek	148.1	5	WWg	37	16.1	09-Sep-04
07100001-514	04DM025	Jack Creek	148.1	5	WWg	37	38.3	24-Aug-04
07100001-658	14DM009	Jack Creek	204.2	7	WWm	22	27.7	07-Aug-14
0710000106-02 (Trib. to Jack Creek Subwatershed)								
07100001-661	14DM050	Unnamed creek	11.0	5	WWg	37	11.8	04-Aug-15
07100001-661	14DM050	Unnamed creek	11.0	5	WWg	37	32.3	06-Aug-14
07100001-523	14DM049	Judicial Ditch 26	11.7	7	WWm	22	2.4	06-Aug-14
07100001-523	14DM049	Judicial Ditch 26	11.7	7	WWm	22	3.4	06-Aug-14
07100001-564	14DM012	Unnamed creek	42.9	7	WWg	41	11.3	07-Aug-14
0710000106-03 (North Branch Jack Creek Subwatershed)								
07100001-648	04DM035	Jack Creek, North Branch	10.6	7	WWg	41	23.7	25-Aug-04
07100001-665	15EM023	Judicial Ditch 12	10.7	7	WWm	22	43.4	04-Aug-15
07100001-666	04DM003	Judicial Ditch 12	12.1	7	WWg	41	26.3	08-Sep-04
07100001-666	04DM003	Judicial Ditch 12	12.1	7	WWg	41	28.1	26-Aug-04
07100001-666	14DM045	Judicial Ditch 12	12.3	7	WWg	41	17.8	06-Aug-14
07100001-649	04DM032	Jack Creek, North Branch	13.9	7	WWm	22	24.1	25-Aug-04
07100001-649	04DM032	Jack Creek, North Branch	13.9	7	WWm	22	32.8	08-Sep-04
07100001-650	04DM022	Jack Creek, North Branch	39.1	7	WWg	41	37.5	25-Aug-04
07100001-652	04DM033	Jack Creek, North Branch	69.8	7	WWg	41	29.0	06-Aug-14
07100001-652	04DM033	Jack Creek, North Branch	69.8	7	WWg	41	44.6	26-Aug-04
0710000107-01 (Heron Lake Subwatershed)								
07100001-518	14DM030	Unnamed creek	11.9	7	WWm	22	15.5	06-Aug-14
07100001-518	04DM011	Unnamed creek	16.3	7	WWm	22	27.3	30-Aug-04
07100001-527	04DM018	Heron Lake Outlet	450.0	7	WWg	41	27.0	02-Sep-04
07100001-527	14DM008	Heron Lake Outlet	462.0	5	WWg	37	8.6	12-Aug-14

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological station ID	Stream segment name	Drainage area Mi^2	Invert class	Use class	Threshold	MIBI	Visit date
0710000108-01 (Lower Des Moines Headwaters Subwatershed)								
07100001-608	14DM022	Unnamed creek	13.0	7	WWm	22	34.8	05-Aug-14
07100001-670	14DM025	Unnamed creek	13.8	5	WWg	37	27.8	05-Aug-14
07100001-544	14DM024	Perkins Creek	25.8	5	WWm	22	14.8	05-Aug-14
07100001-501	14DM004	Des Moines River	1137.8	2	WWg	31	14.8	05-Aug-14
07100001-501	04DM024	Des Moines River	1182.0	2	WWg	31	28.9	09-Sep-04
07100001-501	04DM043	Des Moines River	1205.2	2	WWg	31	20.9	09-Sep-04
07100001-501	10EM179	Des Moines River	1211.5	2	WWg	31	9.8	19-Aug-10
0710000108-02 (Middle Des Moines Headwaters Subwatershed)								
07100001-563	04DM019	Unnamed creek	4.5	7	WWg	41	19.1	26-Aug-04
07100001-563	14DM026	Unnamed creek	7.3	7	WWg	41	22.6	03-Aug-15
07100001-551	04DM002	Unnamed creek	8.1	7	WWg	41	27.5	02-Sep-04
07100001-551	14DM027	Unnamed creek	8.4	5	WWg	37	12.3	11-Aug-14
07100001-552	14DM099	County Ditch 43 (Scheldorf Creek)	12.3	9	CWg	43	1.7	11-Aug-14
07100001-552	14DM099	County Ditch 43 (Scheldorf Creek)	12.3	9	CWg	43	10.0	11-Aug-14
07100001-552	09DM001	County Ditch 43 (Scheldorf Creek)	12.7	9	CWg	43	3.7	22-Sep-09
07100001-613	14DM028	Unnamed creek	31.8	7	WWg	41	47.0	11-Aug-14
07100001-524	04DM020	Des Moines River	1024.7	2	WWg	31	4.1	07-Aug-14
07100001-524	04DM020	Des Moines River	1024.7	2	WWg	31	17.1	02-Sep-04
07100001-524	14DM005	Des Moines River	1104.7	2	WWg	31	12.0	05-Aug-14

Appendix 3.32 – Biological monitoring results Lower Des Moines River-macroinvertebrate IBI (assessable reaches)

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological station ID	Stream segment name	Drainage area Mi^2	Invert class	Use class	Threshold	MIBI	Visit date
0710000201-01 (Des Moines River-Minnesota Outlet Subwatershed)								
07100002-510	07DM005	Unnamed ditch	6.2	7	WWg	41	30.7	10-Sep-07
07100002-513	14DM085	Judicial Ditch 6	7.4	7	WWm	22	37.9	06-Aug-14
07100002-502	04DM021	Brown Creek (Judicial Ditch 10)	9.9	7	WWm	22	20.6	23-Aug-04

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological station ID	Stream segment name	Drainage area Mi^2	Invert class	Use class	Threshold	MIBI	Visit date
07100002-515	04DM005	Judicial Ditch 11	13.9	5	WWg	37	34.3	23-Aug-04
07100002-502	14DM088	Brown Creek (Judicial Ditch 10)	14.3	7	WWm	22	12.0	05-Aug-14
07100002-504	14DM089	Unnamed creek	16.5	5	WWg	37	19.5	05-Aug-14
07100002-505	14DM087	Judicial Ditch 56	22.6	5	WWg	37	18.0	05-Aug-14
07100002-507	14DM084	Story Brook	29.9	5	WWg	37	21.3	06-Aug-14
07100002-507	14DM084	Story Brook	29.9	5	WWg	37	34.8	06-Aug-14
07100002-501	14DM001	Des Moines River	1297.7	2	WWg	31	15.4	05-Aug-14

Appendix 3.33 – Biological monitoring results East Fork Des Moines River-macroinvertebrate IBI (assessable reaches)

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological station ID	Stream segment name	Drainage area Mi^2	Invert class	Use class	Threshold	MIBI	Visit date
0710000301-01 (Lower Headwaters East Fork Des Moines River Subwatershed)								
07100003-527	14DM002	Des Moines River, East Branch	131.4	7	WWg	41	41.6	04-Aug-14
0710000302-02 (Upper Headwaters East Fork Des Moines River Subwatershed)								
07100003-529	14DM095	Unnamed creek	12.5	7	WWg	41	33.5	06-Aug-14
07100003-529	04DM042	Unnamed creek	13.7	7	WWg	41	23.2	23-Aug-04
07100003-510	14DM096	Fourmile Creek	15.4	5	WWg	37	36.1	05-Aug-14
07100003-525	14DM015	Des Moines River, East Branch	74.2	7	WWg	41	32.3	05-Aug-14
0710000302-03 (County Ditch 11 Subwatershed)								
NONE								

Appendix 4.1 – Fish species found during biological monitoring surveys

Fish species found in the headwaters of the Des Moines River Watershed (07100001)

Common name	Quantity of stations where present	Quantity of individuals collected
Bigmouth buffalo	24	228
Bigmouth shiner	54	2800
Black bullhead	63	715
Black crappie	15	120
Blacknose dace	51	2204
Blackside darter	39	351
Bluegill	6	21
Bluntnose minnow	63	4856
Brassy minnow	61	2866
Brook stickleback	57	1217
Brown trout	2	3
Central stoneroller	49	1525
Channel catfish	19	277
Common carp	68	1946
Common shiner	32	527
Creek chub	97	4647
Fantail darter	6	40
Fathead minnow	101	27885
Gen: common sunfishes	1	3
Gen: redhorses	1	4
Golden redhorse	1	2
Green sunfish	32	424
Hornyhead chub	2	11
Hybrid sunfish	4	100
Iowa darter	24	269
Johnny darter	78	2689
Largemouth bass	8	44
Northern pike	31	75
Orangespotted sunfish	31	923
Pumpkinseed	3	7
Quillback	15	120
Rainbow trout	1	1
Sand shiner	54	8908
Shorthead redhorse	9	64
Slenderhead darter	3	10
Smallmouth buffalo	2	3
Spotfin shiner	42	2522
Stonecat	3	4
Tadpole madtom	25	115

Common name	Quantity of stations where present	Quantity of individuals collected
Walleye	29	592
White sucker	85	2114
Yellow bullhead	20	62
Yellow perch	29	455

Fish Species Found in the Lower Des Moines River Watershed (07100002)

Common name	Quantity of stations where present	Quantity of individuals collected
Bigmouth buffalo	1	7
Bigmouth shiner	7	285
Black bullhead	6	18
Black crappie	1	1
Blacknose dace	8	324
Blackside darter	1	4
Bluntnose minnow	6	521
Brassy minnow	6	54
Brook stickleback	6	43
Central stoneroller	4	571
Channel catfish	1	16
Common carp	2	22
Common shiner	1	22
Creek chub	9	776
Fantail darter	6	211
Fathead minnow	9	227
Green sunfish	4	19
Johnny darter	8	149
Largemouth bass	3	9
Northern pike	2	3
Pumpkinseed	1	3
Quillback	1	5
Sand shiner	3	500
Shorthead redhorse	1	11
Slenderhead darter	1	2
Spotfin shiner	4	242
Stonecat	2	2
Walleye	2	16
White sucker	9	148

The East Fork Des Moines River Watershed (07100003)

Common name	Quantity of stations where present	Quantity of individuals collected
Bigmouth buffalo	2	7
Bigmouth shiner	4	67
Black bullhead	5	176
Black crappie	1	1
Blacknose dace	1	13
Bluegill	2	16
Bluntnose minnow	4	53
Brassy minnow	1	47
Brook stickleback	5	30
Common carp	3	8
Creek chub	6	99
Fathead minnow	8	7621
Johnny darter	7	73
Largemouth bass	1	1
Northern pike	3	23
Orangespotted sunfish	2	5
Sand shiner	2	68
Smallmouth buffalo	1	1
Spotfin shiner	1	3
Walleye	1	1
White crappie	1	5
White sucker	8	458
Yellow bullhead	2	2
Yellow perch	7	175

Appendix 4.2 – Macroinvertebrate species found during biological monitoring surveys

Taxonomic name	Quantity of stations where present	Quantity of individuals collected
Ablabesmyia	56	136
Acari	63	255
Acentrella	20	111
Acentrella parvula	27	120
Acricotopus	1	2
Acroneuria	1	present
Acroneuria abnormis	3	2
Aeshna	29	51
Aeshna umbrosa	18	13
Aeshnidae	11	21
Agabus	1	1
Agraylea	2	2
Amphipoda	1	1

Taxonomic name	Quantity of stations where present	Quantity of individuals collected
Anabolia	1	1
Anafroptilum	6	11
Anax	6	1
Anax junius	9	3
Anisoptera	2	2
Anopheles	12	22
Anthopotamus	7	22
Argia	2	9
Atherix	1	present
Atrichopogon	4	4
Baetidae	23	53
Baetis	33	131
Baetis brunneicolor	3	19
Baetis flavistriga	7	31
Baetis intercalaris	24	133
Baetisca	1	1
Belostoma	10	present
Belostoma flumineum	10	6
Berosus	4	6
Bezzia	1	1
Bezzia/Palpomyia	4	4
Boyeria	1	1
Branchiobdellida	26	380
Branchiobdellidae	1	1
Brillia	33	131
Caecidotea	8	42
Caenidae	1	32
Caenis	50	838
Caenis diminuta	38	376
Caenis hilaris	23	210
Caenis tardata	1	1
Callibaetis	17	39
Calopterygidae	4	6
Calopteryx	3	11
Calopteryx aequabilis	2	1
Cambaridae	3	124
Cambarus	4	3
Ceratopogonidae	2	2
Ceratopogoninae	6	6
Ceratopsyche	37	892
Ceratopsyche morosa	15	149
Ceratopsyche slossonae	1	1
Cercobrachys	1	3

Taxonomic name	Quantity of stations where present	Quantity of individuals collected
Cheumatopsyche	85	2316
Chironomini	46	216
Chironomus	33	112
Chrysops	1	present
Cladopelma	1	2
Cladotanytarsus	42	141
Coenagrionidae	40	120
Conchapelopia	8	10
Corduliidae	2	2
Corixidae	49	210
Corynoneura	27	68
Cricotopus	95	1355
Cricotopus (Isocladius)	1	16
Cricotopus bicinctus	1	13
Cryptochironomus	49	96
Cryptotendipes	15	17
Culex	1	2
Culicidae	7	9
Desmopachria	3	3
Dicranota	1	1
Dicrotendipes	79	1167
Dineutus	5	8
Diplocladius	1	1
Dixella	1	present
Dolichopodidae	1	1
Dromogomphus	1	present
Dubiraphia	57	640
Dytiscidae	11	11
Dytiscus	1	1
Elmidae	3	3
Empididae	5	5
Enallagma	12	114
Enchytraeus	2	3
Endochironomus	23	95
Enochrus	5	4
Ephemerellidae	1	1
Ephemeridae	2	4
Ephoron	5	11
Ephydridae	51	115
Erioptera	1	1
Eukiefferiella	3	3
Fallceon	11	179
Ferrissia	20	190

Taxonomic name	Quantity of stations where present	Quantity of individuals collected
Forcipomyia	2	3
Forcipomyiinae	1	1
Fossaria	18	69
Fridericia	1	1
Gammarus	6	283
Gastropoda	1	5
Gerridae	2	2
Glyptotendipes	61	348
Gomphus	1	present
Gyraulus	12	53
Gyrinus	2	5
Haliplus	6	8
Helichus	4	6
Helicopsyche borealis	1	1
Helisoma	1	present
Helobdella	1	1
Helophorus	1	1
Hemerodromia	6	6
Heptagenia	77	1213
Heptageniidae	38	323
Hesperocorixa	1	2
Hetaerina	1	2
Hexagenia	10	34
Hirudinea	82	221
Hyalella	83	3656
Hydridae	2	7
Hydrobaenus	1	13
Hydrochara	2	present
Hydrochus	4	4
Hydrophilidae	5	6
Hydropsyche	14	83
Hydropsyche betteni	3	5
Hydropsyche bidens	1	6
Hydropsyche incommoda	5	40
Hydropsyche placoda	2	3
Hydropsyche simulans	2	9
Hydropsychidae	46	696
Hydroptila	55	293
Hydroptilidae	18	56
Hydrozoa	2	5
Hygrotus	1	1
Ilybius	1	present
Ischnura	1	2

Taxonomic name	Quantity of stations where present	Quantity of individuals collected
Ischnura posita	1	present
Isonychia	22	193
Kloosia	1	1
Labiobaetis	6	8
Labiobaetis dardanus	36	297
Labiobaetis frondalis	23	118
Labiobaetis propinquus	16	52
Labrundinia	64	306
Laccophilus	2	2
Lampyridae	1	1
Larsia	1	1
Leptoceridae	20	34
Leptophlebiidae	5	5
Lestes	1	1
Lethocerus	1	present
Leucorrhinia	2	present
Leucrocuta	30	178
Libellula	1	2
Libellulidae	3	3
Limnephilidae	3	24
Limnodrilus	2	8
Limnophyes	26	54
Limonia	1	1
Liodessus	8	10
Lopescladius	2	2
Lymnaeidae	23	66
Maccaffertium	10	69
Maccaffertium exiguum	1	3
Maccaffertium terminatum	2	6
Mallochohelea	2	3
Mayatrichia	2	5
Mayatrichia ayama	2	10
Merragata	1	1
Mesovelia	2	2
Micropsectra	41	346
Microtendipes	14	20
Microvelia	1	1
Muscidae	2	2
Naididae	4	4
Nais	3	4
Nanocladius	48	81
Nectopsyche	23	60
Nectopsyche candida	3	5

Taxonomic name	Quantity of stations where present	Quantity of individuals collected
Nectopsyche diarina	52	515
Nemata	16	46
Nematoda	8	30
Nematomorpha	2	4
Neoplea	4	5
Neoplea striola	5	6
Neoporus	6	6
Neurocordulia	2	1
Nilotanypus	3	3
Nixe	2	2
Notonecta	7	9
Notonectidae	1	1
Ochthebius	1	1
Odontomyia /Hedriodiscus	3	4
Oecetis	1	1
Oecetis furva	6	7
Oligochaeta	83	1748
Optioservus	9	41
Orconectes	97	456
Orthocladiinae	46	234
Orthocladius	20	128
Orthotrichia	1	1
Ostracoda	9	30
Oxyethira	1	1
Palmacorixa	7	9
Parachironomus	21	113
Paracladopelma	1	1
Paracymus	2	2
Paragnetina	2	1
Parakiefferiella	30	320
Paralauterborniella	2	2
Paraleptophlebia	2	4
Paramerina	26	93
Parametriocnemus	6	5
Paraphaenocladius	6	11
Paratanytarsus	94	1324
Paratendipes	40	301
Peltodytes	4	4
Pentaneura	1	1
Pericoma / Telmatoscopus	1	1
Perithemis	5	10
Perlesta	14	27
Phaenopsectra	32	72

Taxonomic name	Quantity of stations where present	Quantity of individuals collected
Phryganeidae	2	2
Physa	38	840
Physella	67	1732
Physidae	2	47
Pisidiidae	70	349
Planorbella	10	154
Planorbidae	5	12
Plauditus	11	27
Polycentropus	2	3
Polypedilum	121	3603
Potamyia	4	40
Potamyia flava	7	18
Procladius	29	79
Procloeon	2	3
Promenetus exacuous	1	1
Pseudochironomus	2	2
Pseudocloeon	26	863
Pseudosuccinea	11	15
Pseudosuccinea columella	9	80
Psychodidae	2	2
Pteronarcys	5	1
Ptilostomis	1	present
Ranatra	1	1
Rheocricotopus	5	9
Rheotanytarsus	61	538
Rheumatobates	2	2
Saetheria	12	20
Sciomyzidae	12	19
Scirtidae	1	1
Sigara	17	40
Simulium	72	1010
Sisyra	1	1
Somatochlora	1	present
Somatochlora walshii	1	6
Stagnicola	24	65
Stempellinella	1	1
Stenacron	21	114
Stenelmis	35	243
Stenochironomus	8	17
Stenonema	7	79
Stictochironomus	16	77
Stratiomyidae	2	2
Sublettea	1	3

Taxonomic name	Quantity of stations where present	Quantity of individuals collected
Sublettea coffmani	2	4
Tabanidae	1	1
Tanypodinae	48	146
Tanypus	1	1
Tanytarsini	48	332
Tanytarsus	47	212
Telopelopia okoboji	1	3
Thienemanniella	59	249
Thienemannimyia	3	82
Thienemannimyia Gr.	90	717
Tipula	2	3
Trepaxonemata	4	6
Trichocorixa	13	35
Tricorythodes	48	1194
Tropisternus	7	14
Tubificinae	6	86
Turbellaria	1	1
Tvetenia	1	1
Xenochironomus xenolabis	3	7
Zavreliella	1	1
Zavrelimyia	8	74

Appendix 5 – Minnesota Stream Habitat Assessment results Headwater Des Moines River

Habitat information documented during each fish sampling visit is provided. This table convey the results of the Minnesota Stream Habitat Assessment (MSHA) survey, which evaluates the section of stream sampled for biology and can provide an indication of potential stressors (e.g., siltation, eutrophication) impacting fish and macroinvertebrate communities. The MSHA score is comprised of five scoring categories including adjacent land use, riparian zone, substrate, fish cover and channel morphology, which are summed for a total possible score of 100 points. Scores for each category, a summation of the total MSHA score, and a narrative habitat condition rating are provided in the tables for each biological monitoring station. Where multiple visits occur at the same station, the scores from each visit have been averaged. The final row in each table displays average MSHA scores and a rating for the 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	04DM001	Beaver Creek	1.25	7.5	18.58	6.5	19	52.83	Fair
2	04DM012	Beaver Creek	0	6	18.6	10	18.5	53.1	Fair
1	04DM015	Beaver Creek	0	5	8.8	5	9	27.8	Poor
1	07DM002	Beaver Creek	0	10	16	7	16	49	Fair
1	07DM006	Unnamed ditch	0	8	16	7	18	49	Fair
3	14DM014	Beaver Creek	0.83	6.83	16.27	14.67	21	59.6	Fair
2	14DM066	County Ditch 20	0	6.5	18.5	10.5	16	51.5	Fair
3	14DM067	County Ditch 20	0	6	4	5	4.67	19.67	Poor
2	14DM070	Beaver Creek	0.5	1	16.4	5.5	15	38.4	Poor
2	14DM071	Unnamed creek	0.5	3.5	10.33	8.5	18.5	41.33	Poor
3	14DM101	Judicial Ditch 14	0	6.17	12.33	4.33	6	28.83	Poor
Average Habitat Results: *Beaver Creek Aggregated 12 HUC*			**0.28**	**6.05**	**14.16**	**7.64**	**14.7**	**42.82**	**Poor**
3	04DM026	Lake Shetek Inlet	0	7.5	15.73	8.33	14.33	45.88	Fair
2	14DM007	Des Moines River	2.5	9	12.23	5	14.5	43.23	Poor
2	14DM074	Lower Lake Sarah Outlet	0	4.75	22.2	9	19	54.95	Fair
3	14DM075	Unnamed creek	0	4.33	19.88	11.33	22.33	57.88	Fair
2	14DM077	Lake Shetek Inlet	1.25	8	12.53	7.5	17	46.28	Fair
1	14DM078	Unnamed creek	0	8.5	10.5	7	16	42	Poor
2	14DM079	Unnamed creek	0	12.75	5.95	13	20	51.7	Fair
2	14DM080	Lake Shetek Inlet	0	10.25	15.98	12	21	59.23	Fair
Average Habitat Results: *Lake Shetek Aggregated 12 HUC*			**0.47**	**8.14**	**14.38**	**9.15**	**18.02**	**50.14**	**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
1	04DM009	Unnamed creek	0	9.5	17.4	11	30	67.9	Good
1	04DM029	Unnamed creek	2.5	8.5	18	11	10	50	Fair
2	14DM013	Lime Creek	0	7	16.78	8	18.5	50.28	Fair
2	14DM054	Lime Creek	0	6.5	12.5	6.5	7	32.5	Poor
3	14DM055	Unnamed creek	0	7.67	8.07	6.67	12.67	35.07	Poor
2	14DM057	Unnamed creek	0	5.25	14.65	5	12	36.9	Poor
2	14DM058	Unnamed creek	1.25	6.5	14.18	7	17	45.93	Fair
Average Habitat Results: *Lime Creek Aggregated 12 HUC*			**0.54**	**7.27**	**14.51**	**7.88**	**15.31**	**45.51**	**Fair**
1	04DM013	Des Moines River	0	6.5	18.65	2	24	51.15	Fair
1	04DM027	Des Moines River	0	8.5	18.1	3	18	47.6	Fair
1	04DM030	County Ditch 4	0	9	11	14	15	49	Fair
3	14DM006	Des Moines River	1.25	8.83	19.72	11.67	18	59.47	Fair
3	14DM017	Des Moines River	1.25	6	17.6	11.67	20	56.52	Fair
2	14DM018	Des Moines River	1.25	7	11.7	13	17	49.95	Fair
2	14DM019	Des Moines River	0	6.75	18.88	7	17	49.63	Fair
2	14DM052	Unnamed creek	0	2.5	4	7.5	3.5	17.5	Poor
3	14DM053	Unnamed creek	0.5	9	12.02	9.33	19.67	50.52	Fair
3	14DM062	Devils Run Creek	0	9.17	8.13	7	9.67	33.97	Poor
3	14DM063	Unnamed creek	0	5.33	14.23	9.67	17.33	46.57	Fair
2	15DM200	Des Moines River	0.63	6.25	18.88	6.5	19.5	51.75	Fair
Average Habitat Results: *Upper Des Moines Headwaters Aggregated 12 HUC*			**0.41**	**7.07**	**14.417**	**8.533**	**16.56**	**46.97**	**Fair**
3	04DM040	Okabena Creek	0.67	4.67	19.08	10.67	21	56.08	Fair
3	04DM041	Okabena Creek	0	4.33	20.87	10.33	22	57.53	Fair
1	04DM045	Okabena Creek	0	7.5	14.1	8	9	38.6	Poor
1	07DM003	Okabena Creek	0	8.5	16	6	12	42.5	Poor
3	07DM004	Judicial Ditch 76	0	8.5	14.23	11.33	13.67	47.73	Fair
1	11DM001	Okabena Creek	1	9	8	8	15	41	Poor

# 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	14DM010	Okabena Creek	1.25	7	16.38	7	9.5	41.13	Poor
2	14DM032	Unnamed creek	0	8.5	7.65	11	8	35.15	Poor
Average Habitat Results: *Okabena Creek Aggregated 12 HUC*			**0.37**	**7.25**	**14.54**	**9.04**	**13.77**	**44.97**	**Poor**
2	14DM011	Elk Creek	0	9.5	14.15	9.5	19.5	52.65	Fair
3	14DM034	Elk Creek	0	8	18.33	13.33	22.67	62.33	Fair
1	14DM035	Unnamed creek	0	6	15.25	12	15	48.25	Fair
2	14DM036	Unnamed creek	0	7.25	16.05	10.5	14	47.8	Fair
Average Habitat Results: *Elk Creek Aggregated 12 HUC*			**0**	**7.69**	**15.95**	**11.33**	**17.79**	**52.76**	**Fair**
1	04DM004	Jack Creek	0	1	16	4	7	28	Poor
1	04DM008	Unnamed creek	0	12.5	9	15	17	53.5	Fair
1	04DM025	Jack Creek	0	8.5	18.15	8	15	49.65	Fair
2	10EM078	Jack Creek	0	4	12.55	5.5	17	39.05	Poor
2	14DM009	Jack Creek	2.5	8	8.78	5.5	6	30.78	Poor
1	14DM037	Jack Creek	0	5.5	5	6	10	26.5	Poor
2	14DM039	Jack Creek	0	5	14.2	9.5	21	49.7	Fair
3	14DM040	Unnamed creek	1.67	10.33	9.65	7.67	13.67	42.98	Poor
2	14DM042	Jack Creek	0	4.5	8	4.5	6	23	Poor
2	14DM081	Jack Creek	0	5	14.3	7	17	43.3	Poor
Average Habitat Results: *Jack Creek Aggregated 12 HUC*			**0.42**	**6.43**	**11.56**	**7.27**	**12.97**	**38.65**	**Poor**
2	14DM012	Unnamed creek	1.25	10	4.5	5.5	8	29.25	Poor
2	14DM049	Judicial Ditch 26	0	9.25	6	6	4	25.25	Poor
4	14DM050	Unnamed creek	0.63	8.13	10.51	10.75	12	42.01	Poor
Average Habitat Results: *Trib. to Jack Creek Aggregated 12 HUC*			**0.63**	**9.13**	**7.00**	**7.42**	**8**	**32.17**	**Poor**
2	04DM003	Judicial Ditch 12	0	11.25	9.5	12	11.5	44.25	Poor
1	04DM022	Jack Creek, North Branch	2	2	6	2	9	21	Poor
1	04DM032	Jack Creek, North Branch	0	9	18	7	18	52	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	04DM033	Jack Creek, North Branch	0	7.33	14.97	11	15.67	48.97	Fair
1	04DM035	Jack Creek, North Branch	0	7.5	14	14	22	57.5	Fair
3	14DM045	Judicial Ditch 12	0	7.33	8.78	10	11.33	37.45	Poor
1	14DM046	Unnamed creek	0	1	10.45	0	11	22.45	Poor
1	14DM047	Jack Creek, North Branch	0	0	14	0	4	18	Poor
2	15EM023	Judicial Ditch 12	0	11	8.25	10.5	12.5	42.25	Poor
Average Habitat Results: *North Branch Jack Creek Aggregated 12 HUC*			**0.22**	**6.27**	**11.55**	**7.39**	**12.78**	**38.21**	**Poor**
1	04DM011	Unnamed creek	0	9	14	9	13	45	Fair
1	04DM018	Heron Lake Outlet	0	8	10	2	7	27	Poor
1	14DM008	Heron Lake Outlet	0	8.5	22.3	16	25	71.8	**Good**
3	14DM030	Unnamed creek	1.17	9.33	18.08	7.33	17.67	53.58	Fair
Average Habitat Results: *Heron Lake Aggregated 12 HUC*			**0.29**	**8.71**	**16.1**	**8.58**	**15.67**	**49.35**	**Fair**
1	04DM010	Judicial Ditch 66	2.5	9	17.6	7	18	54.1	Fair
1	04DM024	Des Moines River	0	7.5	16.8	7	20	51.3	Fair
1	04DM043	Des Moines River	0	5.5	13.2	7	20	45.7	Fair
1	10EM179	Des Moines River	2.5	9.5	16	6	11	45	Fair
1	14DM003	Des Moines River	2.75	8.5	10	14	8	43.25	Poor
2	14DM004	Des Moines River	2.5	9.75	14	7.5	13	46.75	Fair
2	14DM022	Unnamed creek	1.25	5	16.7	6.5	12	41.45	Poor
2	14DM024	Perkins Creek	0.5	7	16.45	13	14	50.95	Fair
2	14DM025	Unnamed creek	2	10.75	19.7	13.5	26.5	72.45	Good
Average Habitat Results: *Lower Des Moines Headwaters Aggregated 12 HUC*			**1.56**	**8.08**	**15.96**	**9.39**	**16**	**50.97**	**Fair**
1	04DM002	Unnamed creek	0	1	9	13	12	35	Poor
1	04DM019	Unnamed creek	0	8	6	10	14	38	Poor
3	04DM020	Des Moines River	0	1.33	17.97	7.33	16.67	43.3	Poor

# Visits	Biological station ID	Reach name	Land use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish cover (0-17)	Channel morph (0-36)	MSHA score (0-100)	MSHA rating
1	09DM001	County Ditch 43 (Scheldorf Creek)	0	9.5	11.6	12	29	62.1	Fair
2	14DM005	Des Moines River	3.63	8.25	13.2	7.5	15	47.58	Fair
2	14DM026	Unnamed creek	1.25	10.25	6.25	11	10.5	39.25	Poor
2	14DM027	Unnamed creek	1.25	10.75	16.63	8	18	54.63	Fair
2	14DM028	Unnamed creek	0	8.5	16.6	10.5	20.5	56.1	Fair
2	14DM099	County Ditch 43 (Scheldorf Creek)	0	10	12.5	12.5	9	44	Poor
Average Habitat Results: *Middle Des Moines Headwaters*			**0.68**	**7.51**	**12.19**	**10.23**	**16.07**	**46.66**	**Fair**

Qualitative habitat ratings

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

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

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

Appendix 5.1 – Minnesota Stream Habitat Assessment results Lower Des Moines River

# Visits	Biological station ID	Reach name	Land use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish cover (0-17)	Channel morph (0-36)	MSHA score (0-100)	MSHA rating
1	04DM005	Judicial Ditch 11	5	10	15.1	9	25	64.1	Fair
1	04DM021	Brown Creek (Judicial Ditch 10)	0	11	6.05	10	9	36.05	Poor
3	07DM005	Unnamed ditch	0	6.33	16.327	11	13.33	46.98	Fair
2	14DM001	Des Moines River	1.25	6.75	15.78	12	15.5	51.28	Fair
2	14DM084	Story Brook	1.25	9.5	17.33	14	23.5	65.58	Fair
3	14DM085	Judicial Ditch 6	0	7.5	6.233	8	6	27.73	Poor
2	14DM087	Judicial Ditch 56	0	4.75	13.55	10.5	23	51.8	Fair
2	14DM088	Brown Creek (Judicial Ditch 10)	0	7.5	4.6	6	7.5	25.6	Poor
2	14DM089	Unnamed creek	5	10.75	20.18	13	26	74.93	Good
Average Habitat Results: *Des Moines River- Minnesota Outlet Aggregated 12 HUC*			**1.39**	**8.23**	**12.79**	**10.39**	**16.54**	**49.34**	**Fair**

Qualitative habitat ratings

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

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

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

Appendix 5.2 – Minnesota Stream Habitat Assessment results East Fork Des Moines River

# 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	14DM002	Des Moines River, East Branch	2.5	8	10.55	9	11	41.05	Poor
3	14DM097	County Ditch 53	0	8.17	8.33	10	12.67	39.17	Poor
Average Habitat Results: *Lower Headwaters East Fork Des Moines River Agg. 12 HUC*			**1.25**	**8.09**	**9.44**	**9.5**	**11.84**	**40.11**	**Poor**
1	14DM015	Des Moines River, East Branch	0	9.5	13	9	11	42.5	Poor
3	14DM095	Unnamed creek	0.5	6.33	12.47	10.33	14	43.63	Poor
5	14DM096	Fourmile Creek	0	9.8	19.86	11.8	22.6	64.06	Fair
Average Habitat Results: *Upper Headwaters East Fork Des Moines River Agg. 12 HUC*			**0.17**	**8.54**	**15.11**	**10.38**	**15.87**	**50.06**	**Fair**
2	14DM016	County Ditch 11	0	7.5	8.35	4	4.5	24.35	Poor
2	14DM091	County Ditch 1/Judicial Ditch 50	0	8.25	11.75	10.5	18	48.5	Fair
Average Habitat Results: *County Ditch 11 Aggregated 12 HUC*			**0**	**7.88**	**10.05**	**7.25**	**11.25**	**36.43**	**Poor**

Qualitative habitat ratings

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

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

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