Lake Superior—North Watershed Restoration and Protection Strategy Report

August 2018

MINNESOTA POLLUTION CONTROL AGENCY

TETRA TECH

CLEAN WATER LAND & LEGACY AMENDMENT

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Project Partners

This WRAPS builds on the collaboration and stakeholder input processes that supported the Lake Superior North One Watershed, One Plan that was completed in 2016. This was led by Dan Schutte from the Lake County Soil and Water Conservation District and Ilena Hansel from the Cook County Soil and Water Conservation District. Support was provided to the plan process by a significant group of stakeholders and natural resource collaborators.

In addition, a Core Team supported WRAPS development and included representatives from various state and federal agencies, local governments, non-profit groups and local land owners.

Board of Water and Soil Resources

Cook County Soil and Water Conservation District

Cook County Zoning and Environmental Services

Cook County Coalition of Lake Associations

FluteReed River Watershed Partnership

Grand Portage Band of Lake Superior Chippewa

Lake County Soil and Water Conservation District

Minnesota Department of Agriculture

Minnesota Department of Health

Minnesota Department of Natural Resources

Minnesota Pollution Control Agency

St Croix River Watershed Research Station

Tetra Tech

U.S. Department of Agriculture Natural Resources Conservation Service

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Key Terms

Assessment Unit Identifier (AUID): The unique water body identifier for each river reach comprised of the USGS eight-digit Hydrologic Unit Code (HUC) plus a three-character code unique within each HUC.

Aquatic life impairment: The presence and vitality of aquatic life is indicative of the overall water quality of a stream. A stream is considered impaired for impacts to aquatic life if the fish Index of Biotic Integrity (IBI), macroinvertebrate IBI, dissolved oxygen, turbidity, total suspended solids, or certain chemical standards are not met.

Aquatic recreation impairment: Streams are considered impaired for impacts to aquatic recreation if fecal bacteria standards are not met. Lakes are considered impaired for impacts to aquatic recreation if total phosphorus, chlorophyll-a, or Secchi disc depth standards are not met.

Hydrologic Unit Code (HUC): A HUC is assigned by the USGS for each watershed. HUCs are organized in a nested hierarchy by size. For example, the Lake Superior basin is assigned a HUC4 of 0401 and the Lake Superior-North Watershed is assigned a HUC8 of 04010101.

Impairment: Water bodies are listed as impaired if water quality standards are not met for designated uses including: aquatic life, aquatic recreation, and aquatic consumption.

Index of Biotic integrity (IBI): A method for describing water quality using characteristics of aquatic communities, such as the types of fish and invertebrates found in the waterbody. It is expressed as a numerical value between 0 (lowest quality) to 100 (highest quality).

Protection: This term is used to characterize actions taken in watersheds of waters not known to be impaired to maintain conditions and beneficial uses of the waterbodies.

Restoration: This term is used to characterize actions taken in watersheds of impaired waters to improve conditions, eventually to meet water quality standards and achieve beneficial uses of the waterbodies.

Source (or Pollutant Source): This term is distinguished from 'stressor' to mean only those actions, places or entities that deliver/discharge pollutants (e.g., sediment, phosphorus, nitrogen, pathogens).

Stressor (or Biological Stressor): This is a broad term that includes both pollutant sources and non-pollutant sources or factors (e.g., altered hydrology, dams preventing fish passage) that adversely impact aquatic life.

Total Maximum Daily Load (TMDL): A calculation of the maximum amount of a pollutant that may be introduced into a surface water and still ensure that applicable water quality standards for that water are met. A TMDL is the sum of the wasteload allocation for point sources, a load allocation for nonpoint sources and natural background, an allocation for future growth (i.e., reserve capacity), and a margin of safety as defined in the Code of Federal Regulations.

Abbreviations and Acronyms

1W1P	One Watershed, One Plan
AIS	aquatic invasive species
AUID	Assessment Unit Identifier
Beach Act	Beaches Environmental Assessment and Coastal Health Act
BOD	biochemical oxygen demand
BWCAW	Boundary Waters Canoe Area Wilderness
BWSR	Board of Water and Soil Resources
CCCoLA	Cook County Coalition of Lakes Association
CWLA	Clean Water Legacy Act
DNR	Department of Natural Resources
E. coli	*Escherichia coli*
EPA	U.S. Environmental Protection Agency
EQuIS	Environmental Quality Information System
FIBI	fish index of biotic integrity
GIS	geographic information system
HUC	hydrologic unit code
IBI	index of biotic integrity
LSN	Lake Superior North
MDA	Minnesota Department of Agriculture
MDH	Minnesota Department of Health
MIBI	macroinvertebrate index of biotic integrity
MOS	margin of safety
MPCA	Minnesota Pollution Control Agency
NRCS	Natural Resource Conservation Service

SE	standard error
SWCD	soil and water conservation district
TALU	Tiered Aquatic Life Use
TMDL	Total Maximum Daily Load
TP	total phosphorus
TSS	total suspended solids
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
WPLMN	Watershed Pollutant Load Monitoring Network
WRAPS	Watershed Restoration and Protection Strategy

Executive Summary

The state of Minnesota has adopted a watershed approach to address the state's 80 major watersheds (denoted by 8-digit hydrologic unit code or HUC). This watershed approach incorporates water quality assessment, watershed analysis, civic engagement, planning, implementation, and measurement of results into a 10-year cycle that addresses both restoration and protection as part of a Watershed Restoration and Protection Strategy (WRAPS) report. This WRAPS report addresses a portion of the waterbodies within the Lake Superior North (LSN) Watershed (HUC 04010101), located in the most northeastern portion of Minnesota along Lake Superior. Lake Superior's shoreline forms the eastern border of the LSN Watershed. The watershed constitutes 1,570 square miles and lies within the Northern Lakes and Forest ecoregion. The dominant land cover is forest and wetland, and the majority of the watershed is undeveloped.

Water quality in the LSN Watershed is exceptionally high. The Minnesota Pollution Control Agency (MPCA) assessed lakes and streams in the watershed to identify impaired waters and waters in need of protection. Of these, two streams and no lakes were identified as impaired for aquatic life use, demonstrating the high overall water quality in the watershed. The Poplar River was previously identified as impaired due to high levels of sediment, but was recently recommended for delisting in the 2018 draft impairment list. This success is a testament to restoration efforts that have taken place in the watershed. The Flute Reed River was also identified as impaired due to high levels of sediment and requires restoration efforts. The remaining unimpaired streams and lakes are identified for protection efforts.

Restoration and protection strategies for implementation aim to preserve and enhance water quality in unimpaired streams and lakes and improve water quality in the Flute Reed River. Protection efforts in the LSN Watershed are of the highest importance, and, to that end, a series of indicators are provided to inform implementation activities and focus initial efforts on at-risk waters and those that are of exceptional quality. Indicators are provided that represent potential human-caused risk, geomorphology, and biology. These indicators, along with the results of a statewide prioritization of lakes, including lakes in the watershed, were used to select appropriate protection strategies. Restoration and protection strategies include: reducing industrial/municipal wastewater discharges, nutrient management/ addressing subsurface septic systems, fisheries management (streams), increasing stream connectivity, streambank stabilization and riparian management, lake management and shoreland stabilization, invasive species control, land use planning and ordinances, stormwater management, forest management, education and outreach activities, wetland management, groundwater/drinking water management, and aggregate mining management.

During the timeframe of the WRAPS effort, the Lake Superior North One Watershed One Plan (1W1P) local water management planning process was initiated as a pilot project, and was completed prior to the final WRAPS components being available for incorporation into the 1W1P plan. Findings of the final WRAPS study, which may improve the targeted, prioritized and measured goals of the 1W1P plan will be reviewed at the 1W1P five year update interval. WRAPS deliverables, which may benefit the 1W1P include: a detailed review of stressors in the one impaired watershed in need of a TMDL, the Flute Reed River, and a companion detailed report, stressor reviews for waters in need of protection and a

companion summary report, trend analysis for lakes and streams, LSN Hydrologic Simulation Program Fortran watershed model outputs, a specific Flute Reed River Watershed model and outputs, the Flute Reed River TMDL Report, and a collaborative review of stressors by HUC 12 subwatersheds to better define future watershed work, organized as a series of individual subwatershed strategy tables.

Targeted geographic areas for implementation were identified based on a detailed prioritization and ranking process conducted as part of the 1W1P process in Lake and Cook counties and include: Poplar River, Flute Reed River, Devil Track Lake, nearshore Lake Superior, city of Grand Marais, Baptism River Subwatershed, the Mid-Gunflint Trail Lakesheds (Poplar, Hungry Jack, West and East Bearskin), Cascade River, Mcfarland Lakeshed, Cross River Subwatershed, and Greenwood Lake. These geographic areas are targeted for the first 10 years of implementation and were selected to leverage local interest and momentum.

A Core Team of local, state, and federal resource management agency staff, along with other interested stakeholders, supported the WRAPS process and provided valuable input. The WRAPS study summarizes and is supported by previous work including the Lake Superior – North: 1W1P (Cook and Lake Counties, Cook and Lake County Soil and Water Conservation Districts [SWCD] 2016), Lake Superior – North Monitoring and Assessment Report (MPCA 2017), the Lake Superior – North Watershed Stressor Identification Report (MPCA 2018), the Lake Superior North and Lake Superior South Basins–Watershed Model Development Report (Tetra Tech 2016), the Poplar River Total Maximum Daily Load (TMDL) Study (MPCA 2013) and the Flute Reed River TMDL Study (MPCA n.d.).

What is the WRAPS Report?

Minnesota has adopted a watershed approach to address the state's 80 major watersheds. The Minnesota watershed approach incorporates **water quality assessment, watershed analysis, public participation, planning, implementation, and measurement of results** into a 10-year cycle that addresses both restoration and protection. (Figure 1).

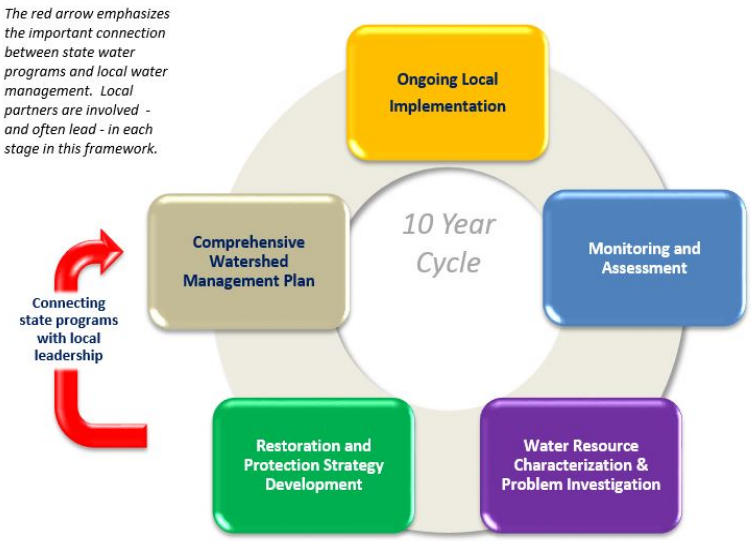

Figure 1. WRAPS 10-year cycle.

As part of the watershed approach, the MPCA developed a process to identify and address threats to water quality in each of these major watersheds. This process is called WRAPS development. WRAPS reports have two parts: impaired waters have strategies for restoration, and waters that are not impaired have strategies for protection.

As part of the watershed approach, waters not meeting state water quality standards are listed as impaired and TMDL studies are developed for them. TMDLs are incorporated into WRAPS. In addition, the watershed approach process facilitates a more cost-effective and comprehensive characterization of multiple water bodies and overall watershed health, including both protection and restoration efforts. A key aspect of this effort is to develop and utilize watershed-scale data and other tools to identify strategies and actions for point and nonpoint source pollution that will cumulatively achieve water quality targets. For nonpoint source pollution, this report informs local planning efforts, and ultimately the local partners decide what work will be included in their local plans. This report also serves as the basis for addressing the U.S. Environmental Protection Agency's (EPA's) Nine Minimum Elements of watershed plans, to help qualify applicants for Clean Water Act Section 319 implementation funds.

The watershed approach for the LSN Watershed is unique as Lake and Cook counties and their respective SWCDs recently completed a watershed-based local water plan through the 1W1P process. As part of the 1W1P planning process, partner and public engagement and input was conducted. This WRAPS document summarizes and incorporates the valuable information from the 1W1P and maintains the same targeted areas for implementation over the next 10 years. Additionally, this WRAPS document also:

- Identifies at-risk waters and unique and high value water resources for protection
- Incorporates information from the recently completed Flute Reed River TMDL
- Incorporates new data, including those from the MPCA's Monitoring and Assessment Report and Stressor Identification Report, and captures public responses to that information

- Provides a somewhat smaller scale analysis of priorities, trends, and pollution sources as the report covers the smaller MPCA-defined LSN Watershed
- Adapts implementation activities identified in the 1W1P due to the above additions

Purpose	•Support local working groups and jointly develop scientifically-supported restoration and protection strategies to be used for implementation planning •Summarize Watershed Approach work done to date, including the following reports: •*LSN: One Watershed, One Plan* •*LSN Watershed Monitoring and Assessment* •*LSN Watershed Stressor Identification* •*Poplar River Total Maximum Daily Load* •*Flute Reed River Total Maximum Daily Load*
Scope	•Impacts to aquatic life in streams •Protection of uses for at-risk and high quality water resources
Audiences	•Non-profits (watershed groups, Trout Unlimited, etc.) •Local governments and soil and water conservation districts •State agencies (MPCA, DNR, BWSR, etc.) •Federal agencies (USDA, USGS, EPA, etc.) •Tribal authorities •Citizen and land owners in the watershed

1. Watershed Background and Description

The LSN Watershed is in the most northeastern portion of Minnesota in the Northern Lakes and Forests ecoregion, and lies adjacent to Lake Superior (Figure 2). The Pigeon River creates a divide between the U.S. and Canada and forms the northern border of the watershed. The Lake Superior shoreline delineates the entirety of the eastern border. As such, Lake Superior has cultural, social, and economic value for its communities. Additionally, Lake Superior's shoreline beauty and vastness help maintain a strong tourism and recreational presence in the region and provide access to the chain of Great Lakes for shipping and industry, supporting the local economy.

The U.S. portion of the LSN Watershed, which is the focus of this report, covers approximately 1,570 square miles and contains portions of Cook and Lake Counties and is part of the larger Lake Superior Basin. The LSN Watershed contains several exceptional water resources. Two segments of one stream, the Flute Reed River, do not meet water quality standards for aquatic life use. A second stream, the Poplar River, also did not meet water quality standards for aquatic life use, but has been restored and now meets water quality standards (Figure 2).

Northeastern Minnesota is blessed with many of the state's highest quality natural resources. These resources are important to both the native people and the more recent settlers in this area. The ultimate natural resource is Lake Superior itself, or Anishinaabewi-gichigami in Ojibwe. The LSN Watershed contains: more than 600 lakes; numerous cascades, rapids, and waterfalls; several state parks; and part of the Boundary Waters Canoe Area Wilderness (BWCAW). The watershed also includes several lake trout and wild rice lakes, which have high cultural and social importance to local residents. Predominant wetlands include coniferous swamps (black spruce, tamarack, and/or white cedar), bogs, and hardwood swamps (e.g., black ash).

The watershed is mostly undeveloped and has historically been used for logging, trapping, and commercial fishing, with these uses continuing today. The watershed is a popular destination for tourists and recreational users, with several state parks and a wide variety of dispersed camp sites and campgrounds. Land cover in the watershed is, in large part, forest and wetlands, with relatively small areas of development (Figure 3 and Table 1). Land use is a combination of small towns, commercial (timber production), resorts, recreational and rural residential. The major developed areas include Finland, Schroeder, Tofte, Lutsen, Grand Marais, Hovland, and Grand Portage, as well as areas along the Lake Superior shoreline. The Grand Portage Reservation, governed by the Grand Portage Band of Lake Superior Chippewa, comprises approximately 5% of the watershed in the northeast corner.

Table 1. Percent land cover in the LSN Watershed

Land Cover	Percent of Watershed [a]
Forest (Total)	**62%**
Deciduous Forest	23%
Evergreen Forest	21%
Mixed Forest	18%
Wetlands (Total)	**21%**
Woody Wetlands	20%
Emergent Herbaceous Wetlands	1%
Shrub/Scrub	**8%**
Herbaceous	**1%**
Open Water	**6%**
Developed (Total)	**2%**
Developed, Open Space	2%
Developed, Low Intensity	<1%
Developed, Medium Intensity	<1%
Developed, High Intensity	<1%
Barren Land	**<1%**
Hay/Pasture	**<1%**
Cultivated Crops	**<1%**

a. Percentages rounded to the nearest whole number.

Additional LSN Watershed Resources

LSN: One Watershed, One Plan

Many LSN Watershed documents referenced in this report are available at:
https://www.pca.state.mn.us/water/watersheds/lake-superior-north

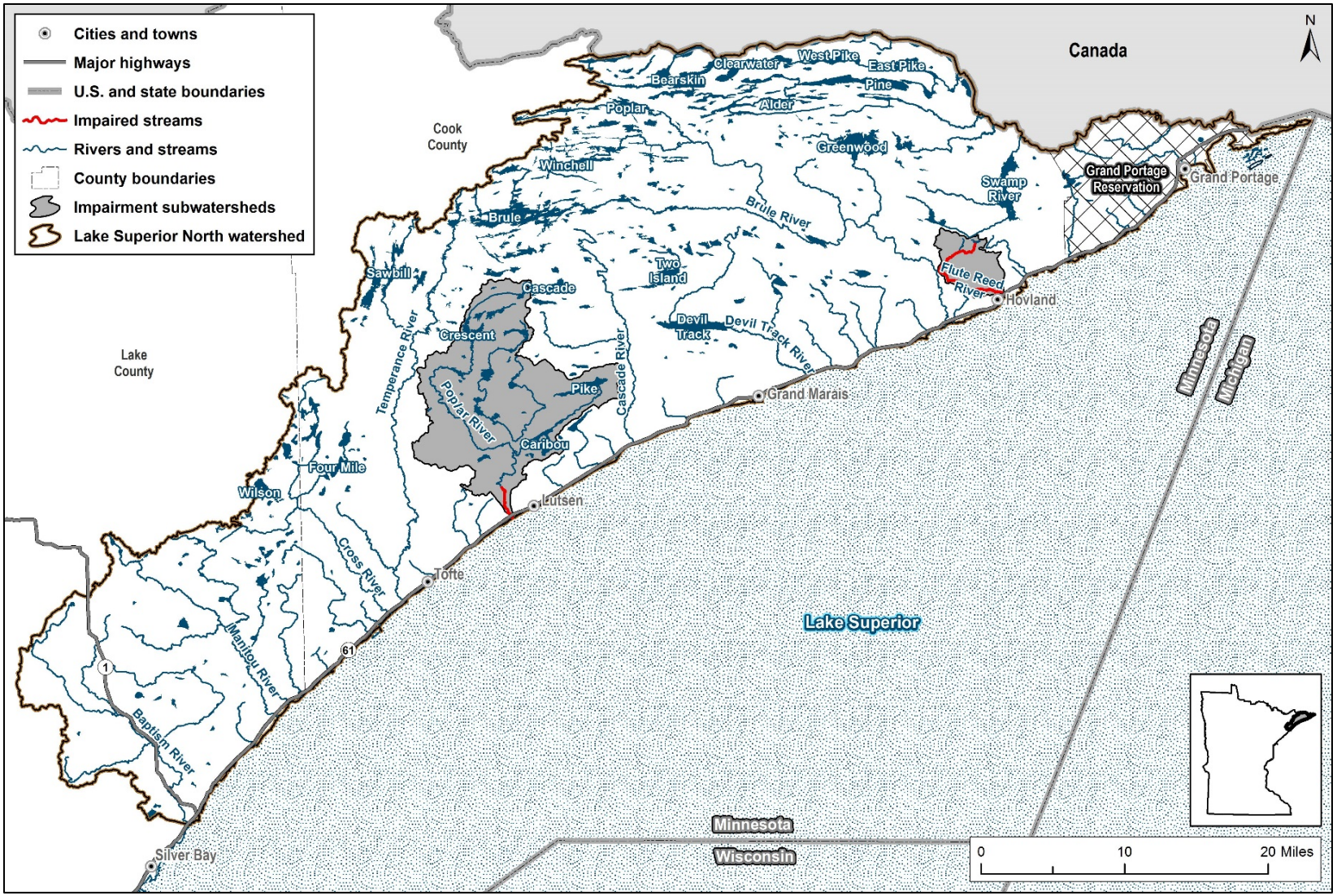

Figure 2. LSN Watershed project area. Note: Poplar River remains listed as impaired until officially approved for removal by EPA. The most recent draft list submitted to EPA proposes it for removal as an impaired water.

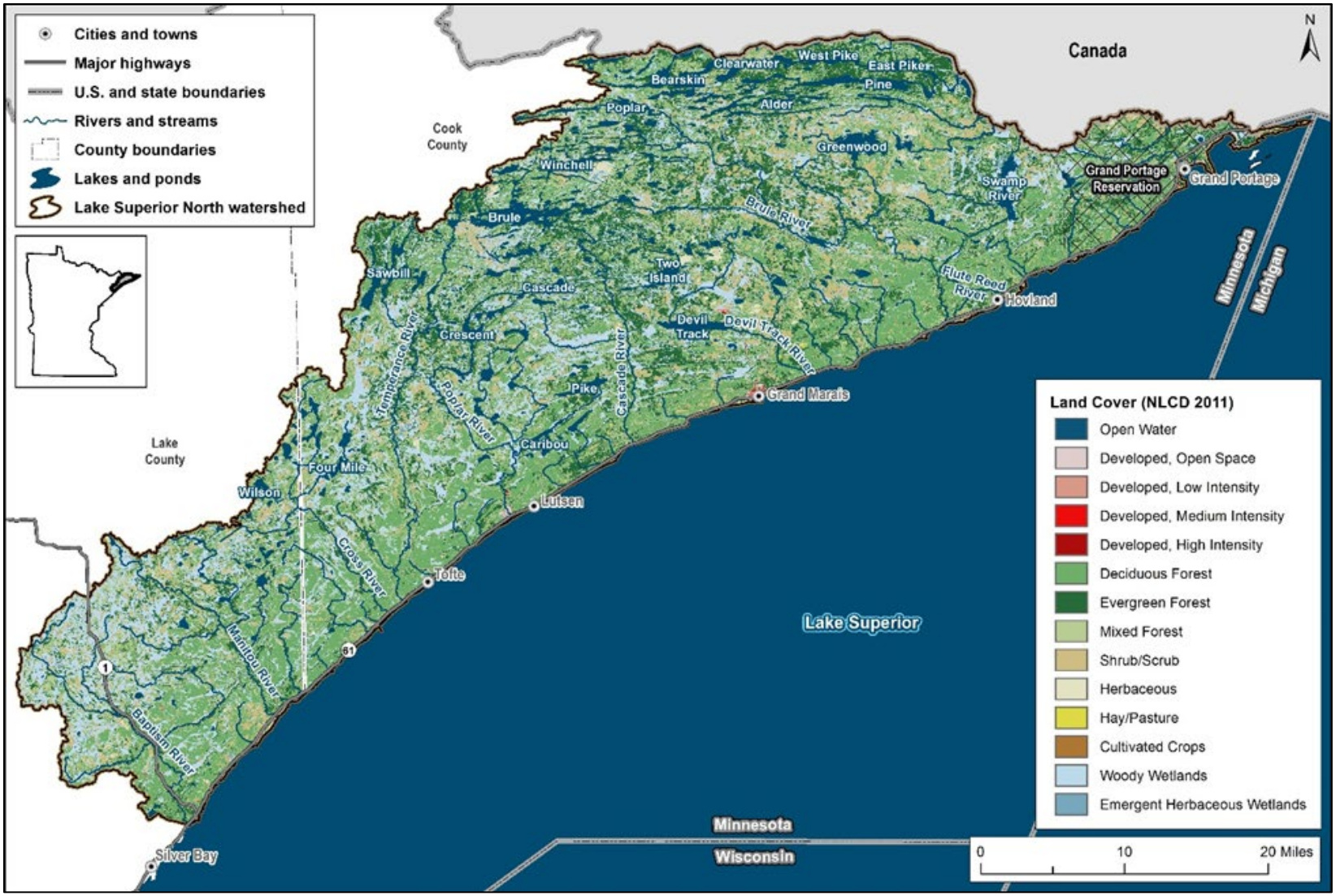

Figure 3. Land cover in the LSN Watershed.

2. Watershed Conditions

The LSN Watershed is defined by a series of streams that transition from slower moving, meandering gravel bed streams through wetland complexes upstream of the Lake Superior bluff line, to high gradient, fast moving bedrock-controlled streams near their outlets to Lake Superior. The watershed consists of several small- to medium-sized catchments, each of which drains to the western shore of Lake Superior. The watershed contains over 600 lakes, several of which have wild rice and lake trout populations, both highly valued to people in the area and beyond.

2.1 Condition Status

The MPCA assesses the water quality of streams and lakes based on each waterbody's ability to support aquatic life (e.g., fish and macroinvertebrates) and aquatic recreation (e.g., wading and swimming). Data from waterbodies are compared to state standards and targets. Waterbodies that meet the targets are considered to be fully supporting and require protection; waterbodies that do not meet the targets are considered to be impaired and are the focus of restoration efforts. Waters that are not yet assessed, contingent on availability of resources and priorities, continue through a process of data collection and evaluation and can be candidates for protection work or future restoration work if they are later found to be impaired.

Streams

Sixty-seven assessment units in the LSN Watershed were assessed by the MPCA to identify impaired waters and waters in need of protection (Table 2). Most stream segments were found to either fully support aquatic life and/or fully support aquatic recreation. Of the assessed waters, only three stream reaches along the Poplar River and Flute Reed River were found to be impaired. The Poplar River has seen dramatic improvements in water quality (see Section 2.2) and was subsequently proposed for delisting in Minnesota's draft 303(d) list for 2018. Overwhelmingly, the LSN Watershed streams have exceptional water quality and are at or above standards for fish and macroinvertebrate communities.

Table 2. Assessment status of stream reaches in the LSN Watershed

Note: Sup = found to meet the water quality standard, Imp = does not meet the water quality standard and therefore is impaired, IF = the data collected were insufficient to make a finding, – = No data

AUID = Assessment Unit Identifier, IBI = Index of Biotic Integrity

HUC-10 Subwatershed	AUID (Last 3 digits)	Stream	Reach Description	Aquatic Life										Aquatic Recreation
				Fish IBI	Macroinvertebrate IBI	Dissolved Oxygen	Turbidity/Total Suspended Solids	Secchi Tube	Chloride	pH	Ammonia	Pesticides	Phosphorus	Pathogenic Bacteria
Pigeon River (0401010102)	542	Stump River	T64 R3E S8, west line to Pigeon R	Sup	Sup	IF	IF	IF	–	IF	IF	–	IF	–
	D54	Portage Brook	Headwaters (unnamed lk 16-0864-00) to CSAH 16	Sup	Sup	IF	IF	IF	–	IF	IF	–	IF	–
	D55	Portage Brook	CSAH 16 to Pigeon R	Sup	Sup	IF	IF	IF	–	IF	IF	–	IF	–
	531	Irish Creek	Headwaters to Swamp River Reservoir	Sup	Sup	IF	IF	IF	–	IF	IF	–	IF	–
	543	Swamp River	Swamp River Reservoir to Pigeon Creek	Sup	Sup	IF	IF	IF	–	IF	IF	–	IF	–
	B66	Swamp River	Stevens Lk to T63 R4E S20, east line	Sup	Sup	IF	IF	Sup	–	IF	IF	–	IF	–
	501	Pigeon River	South Fowl Lk to Pigeon Bay	–	–	IF	IF	IF	Sup	Sup	Sup	–	Sup	Sup
Flute Reed River (0401010103)	D31	Flute Reed River	Headwaters (Moosehorn Lk 16-0015-00) to Unnamed Cr	Sup	Sup	Sup	Imp	Imp	–	Sup	IF	–	Sup	–
	D32	Flute Reed River	Unnamed Cr to Lk Superior	Sup	Sup	Sup	Imp	Imp	Sup	Sup	Sup	–	Sup	Sup

HUC-10 Subwatershed	AUID (Last 3 digits)	Stream	Reach Description	Aquatic Life										Aquatic Recreation
				Fish IBI	Macroinvertebrate IBI	Dissolved Oxygen	Turbidity/Total Suspended Solids	Secchi Tube	Chloride	pH	Ammonia	Pesticides	Phosphorus	Pathogenic Bacteria
Brule River (0401010104)	502	Brule River	Greenwood R to Lk Superior	Sup	Sup	Sup	Sup	Sup	Sup	Sup	Sup	–	Sup	Sup
	528	Greenwood River	Greenwood Lk to Brule R	Sup	Sup	IF	IF	IF	–	IF	IF	–	IF	–
	541	South Brule River	Headwaters (Lower Trout Lk 16-0175-00) to Brule R	Sup	Sup	Sup	Sup	Sup	Sup	Sup	Sup	–	Sup	Sup
	546	Timber Creek	Headwaters to Brule R	Sup	Sup	IF	IF	IF	–	IF	IF	–	IF	–
	594	Assinika Creek	Assinika Lk to Brule R	Sup	Sup	IF	IF	IF	–	IF	IF	–	IF	–
	596	Brule River	South Brule R to Northern Light Lk	Sup	Sup	IF	IF	IF	–	IF	IF	–	IF	–
	646	Bluff Creek	East Twin Lk (16-0145-00) to South Brule R	Sup	Sup	IF	IF	IF	–	IF	IF	–	IF	–
	737	Fiddle Creek	Unnamed Cr to South Brule R	Sup	Sup	IF	IF	IF	–	IF	IF	–	IF	–
	814	Lullaby Creek	Headwaters to Brule R	Sup	Sup	IF	IF	IF	–	IF	IF	–	IF	–
	D30	Brule River	BWCA boundary to South Brule R	Sup	Sup	Sup	–	–	Sup	Sup	Sup	–	Sup	Sup
Devil Track River (0401010105)	D80	Devil Track River	Unnamed Cr to Lk Superior	Sup	Sup	Sup	IF	IF	Sup	Sup	Sup	–	Sup	Sup
	D79	Devil Track River	Devil Track Lk to Unnamed Cr	Sup	Sup	IF	IF	IF	–	–	IF	–	IF	IF

HUC-10 Subwatershed	AUID (Last 3 digits)	Stream	Reach Description	Aquatic Life										Aquatic Recreation
				Fish IBI	Macroinvertebrate IBI	Dissolved Oxygen	Turbidity/Total Suspended Solids	Secchi Tube	Chloride	pH	Ammonia	Pesticides	Phosphorus	Pathogenic Bacteria
Devil Track River (0401010105) (cont.)	532	Kimball Creek	Headwaters to Lk Superior	Sup	Sup	Sup	Sup	Sup	Sup	Sup	Sup	–	Sup	Sup
	566	Little Devil Track River	Unnamed Cr to Devil Track R	Sup	Sup	IF	IF	IF	–	IF	IF	–	IF	–
	601	Junco Creek	Junco Lk to Devil Track R	Sup	Sup	IF	IF	IF	–	IF	IF	–	IF	–
	D61	Woods Creek	(90.1484) 47.861 to Lk Superior	Sup	Sup	IF	IF	–	–	IF	IF	–	IF	–
	717	Elbow Creek	Unnamed Cr to Devil Track R	Sup	Sup	IF	IF	IF	–	IF	IF	–	IF	–
	D53	Kadunce River (Kadunce Creek)	(90.1484) 47.8261 to Lk Superior	Sup	Sup	IF	Sup	Sup	Sup	Sup	Sup	–	Sup	Sup
Cascade River (0401010106)	590	Cascade River	N Br Cascade R to Lk Superior	Sup	Sup	Sup	Sup	Sup	Sup	Sup	Sup	–	Sup	Sup
	615	Spruce Creek (Deer Yard Creek)	Unnamed Cr (Ward Lk outlet) to Lk Superior	Sup	Sup	IF	IF	IF	–	IF	IF	–	IF	–
	682	Nester Creek	Headwaters to Cascade R	Sup	Sup	IF	IF	IF	–	IF	–	–	IF	–
	841	Mississippi Creek	Unnamed cr to Little Mississippi Cr	Sup	Sup	IF	IF	IF	–	IF	IF	–	IF	–
	535	Onion River	Headwaters to Lk Superior	Sup	Sup	Sup	Sup	Sup	Sup	Sup	Sup	–	Sup	Sup

HUC-10 Subwatershed	AUID (Last 3 digits)	Stream	Reach Description	Aquatic Life										Aquatic Recreation
				Fish IBI	Macroinvertebrate IBI	Dissolved Oxygen	Turbidity/Total Suspended Solids	Secchi Tube	Chloride	pH	Ammonia	Pesticides	Phosphorus	Pathogenic Bacteria
Poplar River (0401010107)	536	Mistletoe Creek	Halls Pond to Poplar R	Sup	Sup	IF	IF	IF	–	IF	IF	–	IF	–
	567	Tait River	Christine Lk to Mistletoe Cr	Sup	Sup	IF	IF	IF	–	IF	IF	–	IF	–
	592	Poplar River	T61 R4W S10, north line to Mistletoe Cr	Sup	Sup	IF	IF	IF	–	IF	IF	–	IF	–
	612	Poplar River	Mistletoe Cr to Superior Hiking Tail bridge	–	Sup	Sup	Sup	Sup	Sup	Sup	–	–	Sup	Sup
	613	Poplar River	Superior Hiking Trail bridge to Lk Superior	Sup	Sup	Sup	Imp [a]	Imp [a]	Sup	Sup	Sup	–	Sup	Sup
	614	Caribou Creek	Caribou Lk to Poplar R	Sup	Sup	IF	IF	IF	–	IF	–	–	IF	–
a. The Poplar River impairment was proposed for delisting in the draft 2018 impaired waters list because it is meeting the applicable water quality standards due to restoration activities														
Temperance River (0401010108)	568	Plouff Creek	Paoli Lk to Temperance R	Sup	Sup	IF	IF	IF	–	IF	IF	–	IF	–
	569	Heartbeat Creek	Unnamed Cr to Temperance R	Sup	Sup	IF	IF	IF	–	IF	–	–	IF	–
	B35	Sixmile Creek	Unnamed Cr to Temperance R	Sup	Sup	IF	IF	IF	–	IF	–	–	IF	–
	D56	Temperance River	T61 R4W S4, north line to Sixmile	Sup	Sup	IF	IF	IF	–	IF	–	–	IF	–
	D57	Temperance River	Sixmile Cr to Lk Superior	Sup	Sup	Sup	Sup	Sup	IF	Sup	Sup	–	Sup	Sup

HUC-10 Subwatershed	AUID (Last 3 digits)	Stream	Reach Description	Aquatic Life										Aquatic Recreation
				Fish IBI	Macroinvertebrate IBI	Dissolved Oxygen	Turbidity/Total Suspended Solids	Secchi Tube	Chloride	pH	Ammonia	Pesticides	Phosphorus	Pathogenic Bacteria
Cross River (0401010109)	518	Cross River	Fourmile Cr to Lk Superior	Sup	Sup	Sup	IF	Sup	–	Sup	Sup	–	IF	Sup
	519	Cross River	Cross River Lk to Fourmile Cr	Sup	Sup	IF	IF	IF	–	IF	IF	–	IF	–
	525	Fourmile Creek	Headwaters (Fourmile Lk 16-0639-00) to Cross R	Sup	Sup	IF	IF	IF	–	IF	IF	–	IF	–
	547	Two Island River	Unnamed Cr to Lk Superior	Sup	Sup	IF	IF	IF	–	IF	IF	–	IF	–
	570	Houghtaling Creek	Headwaters to Unnamed Cr	Sup	Sup	IF	IF	IF	–	IF	IF	–	IF	–
	571	Houghtaling Creek	Unnamed Cr to Unnamed Cr	Sup	Sup	IF	IF	IF	–	IF	IF	–	IF	–
	692	Wilson Creek (Cross River Tributary)	T60 R6W S24, west line to Cross R	Sup	Sup	IF	–	–	–	IF	IF	–	IF	–
	783	Wanless Creek	Headwaters (Dam Fiver Lk 38-0053-00) to Houghtaling Cr	Sup	Sup	IF	IF	IF	–	IF	IF	–	IF	–
Manitou River (0401010110)	534	Manitou River	S Br Manitou R to Lk Superior	Sup	Sup	Sup	Sup	Sup	Sup	Sup	Sup	–	Sup	Sup
	575	Caribou River	Unnamed Cr to Unnamed Cr	Sup	Sup	IF	IF	IF	–	IF	IF	–	IF	IF
	576	Caribou River	Unnamed Cr to Lk Superior	–	–	Sup	IF	IF	Sup	Sup	Sup	–	Sup	Sup
Manitou River (0401010110)	661	Cabin Creek	Cabin Lk to T59 R6W S20, south line	Sup	Sup	IF	IF	IF	–	IF	IF	–	Sup	–

HUC-10 Subwatershed	AUID (Last 3 digits)	Stream	Reach Description	Aquatic Life										Aquatic Recreation
				Fish IBI	Macroinvertebrate IBI	Dissolved Oxygen	Turbidity/Total Suspended Solids	Secchi Tube	Chloride	pH	Ammonia	Pesticides	Phosphorus	Pathogenic Bacteria
(cont.)	819	Manitou River (North Branch Manitou River)	T59 R7W S19, northline to S Br Manitou	Sup	Sup	IF	IF	IF	–	IF	IF	–	IF	–
	827	Manitou River, South Branch	Junction Cr to Manitou	Sup	Sup	IF	IF	IF	–	IF	IF	–	IF	–
	829	Manitou River, South Branch	Unnamed Creek to Unnamed Cr	Sup	Sup	IF	IF	IF	–	–	–	–	IF	–
	835	Junction Creek	Unnamed Cr to S Br Manitou	Sup	Sup	IF	IF	IF	–	–	–	–	IF	–
	862	Ninemile Creek	Unnamed Cr to Cramer Lk	Sup	Sup	IF	IF	IF	–	IF	IF	–	IF	–
Baptism River (0401010111)	508	Baptism River	W Br to Baptism R to Lk Superior	Sup	Sup	Sup	Sup	Sup	Sup	Sup	Sup	–	Sup	Sup
	581	Crown Creek	Fry Cr to Unnamed Cr	Sup	Sup	IF	IF	IF	–	IF	IF	–	IF	–
	587	Hockamin Creek	Unnamed Cr to W Br Baptism R	Sup	Sup	IF	IF	IF	–	IF	IF	–	IF	–
	B24	Sawmill Creek	Unnamed Cr to Baptism R	Sup	Sup	IF	IF	IF	–	IF	IF	–	IF	–
Baptism River (0401010111) (cont.)	D49	Baptism River, West Branch	Crown Cr to E Br Baptism R	Sup	Sup	Sup	Sup	Sup	Sup	Sup	Sup	–	Sup	Sup
	D50	Baptism River, West Branch	(91.3381) 47.4702 to Crown Cr	Sup	Sup	IF	IF	IF	–	IF	IF	–	IF	–

HUC-10 Subwatershed	AUID (Last 3 digits)	Stream	Reach Description	Aquatic Life										Aquatic Recreation
				Fish IBI	Macroinvertebrate IBI	Dissolved Oxygen	Turbidity/Total Suspended Solids	Secchi Tube	Chloride	pH	Ammonia	Pesticides	Phosphorus	Pathogenic Bacteria
	D58	Baptism River, East Branch	Lk Twenty-three to Blesner Cr	Sup	Sup	IF	IF	IF	–	IF	IF	–	IF	–
	D59	Baptism River, East Branch	Blesner Cr to Baptism R	Sup	Sup	Sup	Sup		Sup	Sup	Sup	–	Sup	Sup

Sup = found to meet the water quality standard, Imp = does not meet the water quality standard and therefore is impaired, IF = the data collected were insufficient to make a finding, – = No data

.

Lakes

Lakes are assessed for their ability to support aquatic recreation, based on the level of eutrophication. Water transparency and levels of phosphorus and chlorophyll are used to evaluate eutrophication. Phosphorus is a nutrient that plants and algae need to grow, and chlorophyll is a measure of the amount of algae in the water column. One hundred fifty-two lakes in the LSN Watershed were assessed for their ability to support aquatic recreation (Table 3). Of those, there are no nutrient impaired lakes. Ninety-one lakes were found to meet the eutrophication standards, and 61 lakes do not have sufficient data or were not assessed in the 10-year monitoring cycle.

Table 3. Assessment status of lakes in the LSN Watershed

Sup = fully supporting aquatic recreation, *=based on remotely-sensed data, IF =insufficient information, NA=not assessed

HUC10 Subwatershed	Lake ID	Lake	Aquatic Recreation
Arrow River (0401010101)	16-0228-00	Bearskin	Sup
	16-0247-00	Birch	Sup
	16-0150-00	Daniels	Sup*
	16-0232-00	Duncan	Sup*
	16-0227-00	Hungry Jack	Sup
	16-0198-00	Leo	Sup
	16-0230-00	Rose	Sup
	16-0137-00	Rove	NA
	16-0244-00	South	Sup*
	16-0138-00	Watap	Sup*
Baptism River (0401010111)	38-0242-00	Johnson	IF
	38-0232-00	Nipisiquit	Sup*
Brule River (0401010104)	16-0320-00	Allen	IF
	16-0350-00	Banadad	Sup*
	16-0348-00	Brule	Sup*
	16-0397-00	Cam	Sup
	16-0240-00	Caribou	Sup*
	16-0435-00	Davis	Sup*
	16-0145-00	East Twin	Sup
	16-0023-00	Esther	Sup
	16-0909-00	Gasket	IF
	16-0319-00	Gaskin	Sup*
	16-0077-00	Greenwood	Sup
	16-0314-00	Henson	IF
	16-0241-00	Horseshoe	IF
	16-0222-00	Jackal	NA
	16-0910-00	Jump	IF
	16-0168-00	Kroft	NA
	16-0170-00	Little Trout	NA

HUC10 Subwatershed	Lake ID	Lake	Aquatic Recreation
Brule River (0401010104) (cont.)	16-0199-00	Lizz	Sup
	16-0022-00	Lost	Sup*
	16-0393-00	Lower Cone	IF
	16-0175-00	Lower Trout	NA
	16-0223-00	Lux	NA
	16-0307-00	Meeds	Sup*
	16-0391-00	Mid Cone	Sup*
	16-0225-00	Misquah	IF
	16-0220-00	Morgan	NA
	16-0389-00	Mulligan	Sup*
	16-0089-00	Northern Light	IF
	16-0353-00	Omega	Sup*
	16-0298-00	One Island	Sup*
	16-0318-00	Pillsbery	IF
	16-0108-00	Pine Mountain	Sup
	16-0239-00	Poplar	Sup
	16-0174-00	Ram	Sup*
	16-0200-00	Road	IF
	16-0169-00	Rum	NA
	16-0299-00	Rush	IF
	16-0457-00	South Temperance	IF
	16-0405-00	Star	Sup
	16-0663-00	Sunhugh	IF
	16-0409-00	Vern	IF
	16-0520-00	Weird	IF
	16-0202-00	Squint	Sup*
	16-0268-00	Swan	Sup*
	16-0412-00	Upper Cone	Sup*
	16-0224-00	Vista	Sup*
	16-0349-00	Wanihigan	Sup*
	16-0398-00	Wench	Sup*
	16-0186-00	West Twin	Sup
	16-0354-00	Winchell	Sup*
Cascade River (0401010106)	16-0182-00	Ball Club	Sup
	16-0346-00	Cascade	Sup
	16-0253-00	Deer Yard	Sup
	16-0347-00	Little Cascade	Sup
	16-0205-00	Mark	IF
Cascade River (0401010106) (cont.)	16-0235-00	McDonald	IF
	16-0256-00	Swamp	NA

HUC10 Subwatershed	Lake ID	Lake	Aquatic Recreation
	16-0345-00	Tomash	IF
	16-0156-00	Two Island	Sup
	16-0248-00	Ward	Sup
Cross River (0401010108)	38-0024-00	Crooked	IF
	38-0024-01	Crooked (East Bay)	Sup
	16-0634-00	Dyers	IF
	16-0805-01	Elbow (Main Basin)	Sup
	16-0639-00	Four mile	Sup
	38-0051-00	Little Wilson	Sup
	16-0643-00	Richey	Sup
	16-0654-00	Timber	IF
	16-0645-00	Toohey	Sup
	38-0060-00	Whitefish	Sup
	38-0047-00	Wilson	Sup
Devil Track River (0401010105)	16-0098-00	Binagami	Sup
	16-0044-00	Boys	Sup
	16-0143-00	Devil Track	Sup
	16-0096-00	Elbow	Sup
	16-0188-00	Kemo	Sup
	16-0045-00	Kimball	Sup
	16-0046-00	Mink	Sup
	16-0104-00	Musquash	Sup
	16-0194-00	Pine	Sup
	16-0049-00	Trout	Sup
Manitou River (0401010110)	38-0260-00	Cabin	NA
	38-0415-00	Delay	Sup
	38-0256-00	Divide	IF
	38-0251-00	Hoist	IF
	38-0033-00	Ninemile	Sup
Pigeon River (0401010102)	16-0204-00	Aspen	Sup
	16-0141-00	Caribou	Sup*
	16-0033-00	Chester	IF
	16-0139-00	Clearwater	Sup
	16-0136-00	Deer	NA
	16-0029-00	Devil Fish	Sup
	16-0146-00	East Bearskin	Sup
Pigeon River (0401010102) (cont.)	16-0042-00	East Pike	Sup*
	16-0147-00	Flour	IF

HUC10 Subwatershed	Lake ID	Lake	Aquatic Recreation
	16-0060-00	Gadwell	NA
	16-0035-00	John	IF
	16-0142-00	Little Caribou	IF
	16-0026-00	Little John	IF
	16-0027-00	McFarland	IF
	16-0117-00	Moon	NA
	16-0043-00	Moose	Sup*
	16-0093-00	Mountain	Sup*
	16-0036-00	North Fowl	IF
	16-0032-00	Otter	IF
	16-0041-00	Pine	Sup*
	16-0025-00	Royal	NA
	16-0019-00	Tom	Sup
	16-0061-00	Vale	NA
	16-0086-00	West Pike	Sup
Poplar River (0401010107)	16-0359-00	Agnes	IF
	16-0358-00	Barker	Sup
	16-0344-00	Bigsby	IF
	16-0383-00	Bouder	Sup
	16-0360-00	Caribou	Sup
	16-0373-00	Christine	Sup
	16-0365-00	Clara	Sup
	16-0454-00	Crescent	Sup
	16-0380-00	Gust	Sup
	16-0366-00	Holly	IF
	16-0382-00	Lichen	Sup
	16-0368-00	Mistletoe	Sup
	16-0252-00	Pike	Sup
	16-0384-00	Tait	Sup
	16-0369-00	White Pine	Sup
Temperance River (0401010108)	16-0515-00	Ada	IF
	16-622-00	Alton	Sup
	16-0486-00	Baker	IF
	16-0477-00	Burnt	IF
	16-0406-00	Homer	Sup
	16-0521-00	Jack	NA
	16-0402-00	Juno	IF
Temperance River (0401010108) (cont.)	16-0476-00	Kelly	IF
	16-0706-00	Kelso	IF
	16-0705-00	Lujenida	IF

HUC10 Subwatershed	Lake ID	Lake	Aquatic Recreation
	16-0489-00	Moore	NA
	16-0456-00	North Temperance	Sup*
	16-0478-00	Peterson	IF
	16-0496-00	Sawbill	IF
	16-0495-00	Smoke	IF
	16-0410-00	Whack	Sup*
	16-0664-00	Wonder	IF
Sup = fully supporting aquatic recreation, *=based on remotely-sensed data, IF =insufficient information, NA=not assessed			

Beaches

Elevated bacteria levels pose a human health threat, and beaches closed due to contamination negatively impact the local economy. Routine beach monitoring to quantify bacteria levels is conducted by the Minnesota Department of Health (MDH) and partners at various locations as part of the Beaches Environmental Assessment and Coastal Health (Beach) Act. This includes monitoring sites along the Lake Superior shoreline. The *Escherichia coli* (*E. coli)* water quality standards are applicable to recreational uses of beaches between April 1 and October 31; they are documented in Beaches Environmental Assessment and Coastal Health Act (Beach Act) Rule and include:

- 126 organisms per 100mL of water not to be exceeded as the geometric mean of not less than five samples in a calendar month
- 235 organisms per 100mL of water not to be exceeded by 10% of all samples taken in a calendar month, individually

Beaches are assessed according to the following summarized procedure documented in greater detail by the MPCA (2016):

> There is a considerable amount of *E. coli* data collected as part of the beach monitoring program in Minnesota. Most beaches are monitored weekly from Memorial Day to Labor Day, while some are monitored twice weekly. To ensure use of the most recent data, data for the most recent five-year period are used and assessments are made every other (odd numbered) year.
>
> Data from adjacent sampling sites on the same beach are combined. For sites with both tributary mouth stations and beach stations, data from each station are assessed separately and the results considered using best professional judgment to make an assessment decision. For sites with only tributary mouth samples, the data are assessed against the coastal recreation water standards. Streams tributary to Lake Superior with bacteria data at stations upstream of the mouth are assessed as stream assessment unit identifiers (AUIDs) using the statewide water quality standards and methodology in part A of the procedures document.

A summary of beach *E. coli* exceedances in the LSN Watershed is provided in Figure 4.

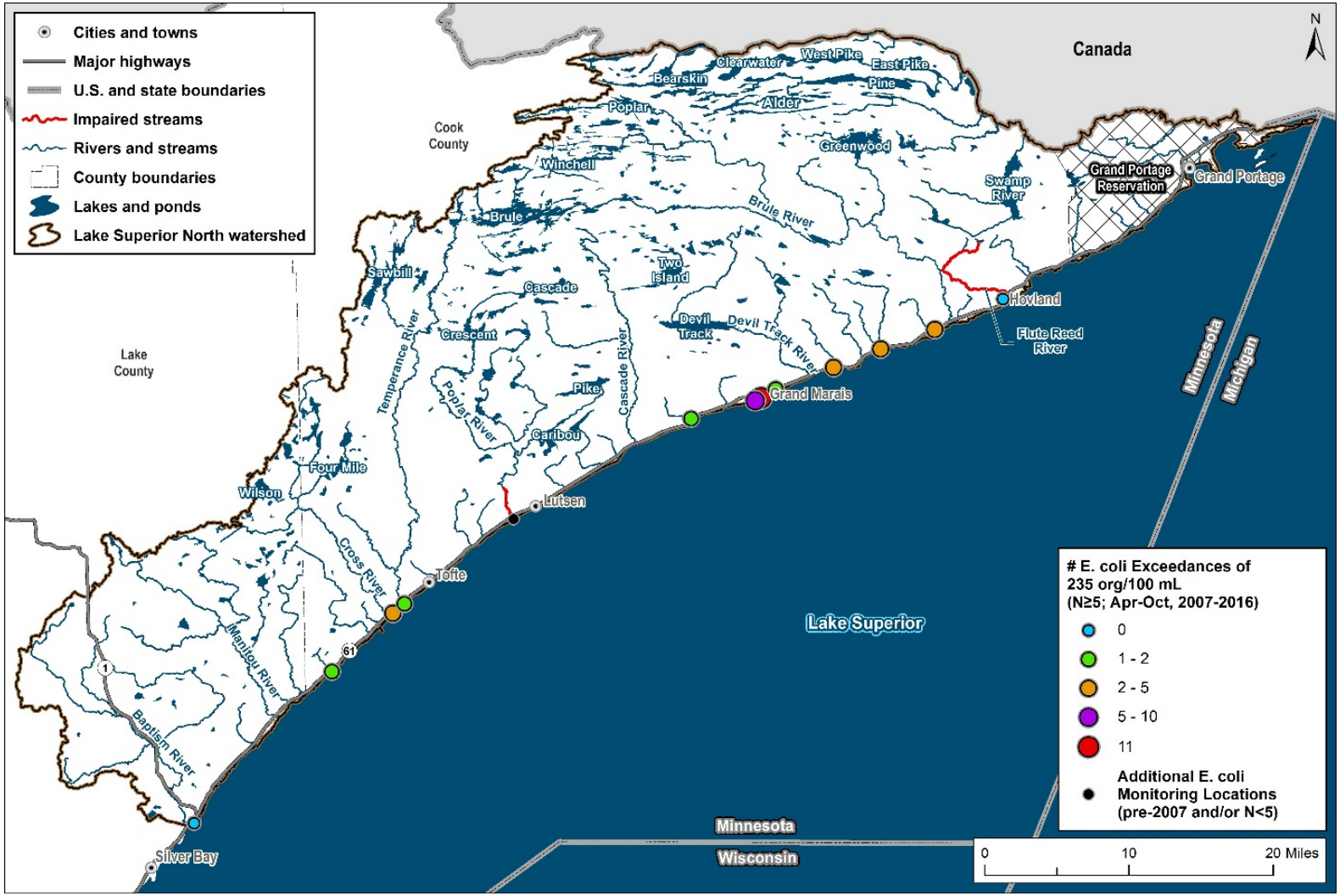

Figure 4. *E. coli* exceedances of the maximum criterion (235 org/100 mL) in nearshore Lake Superior.

2.2 Water Quality Trends

Streams

Long-term water quality data were evaluated in the *Lake Superior–North Watershed Monitoring and Assessment Report* (MPCA 2017) at two long-term stream water chemistry monitoring stations. Near-term (1995 through 2010) and long-term (1973 through 2010) trends were evaluated for the Brule River and Poplar River. Decreasing trends in total phosphorus (TP) concentration (i.e., improved water quality) were found in the Brule River over the near-term and long-term, and in the Poplar River over the long-term (Table 4). Trends were not observed for the other water quality indicators.

Total suspended solids (TSS) concentrations on the Poplar River decreased between 2001 and 2005 (Figure 4) as a result of the efforts of the Poplar River Management Board, the Cook SWCD, and landowners in the watershed, who worked together to restore water quality in the river.

Table 4. Stream water quality trends

↓: decreasing trend N: no evidence for a trend
NT: near-term (1995–2010) LT: long-term (1973–2010)
TSS = total suspended solids, TP = total phosphorus, BOD = Biochemical oxygen demand

Site	TSS		TP		Nitrite/ nitrate		Ammonia		BOD		Chloride	
	NT	LT	NT	LT	NT	LT	NT	LT	NT	LT	NT	LT
Brule River (upstream of US-61 at Judge C.R. Magney State Park, S000-251, BRU-0.4, period of record 1973–2010)	N	N	↓	↓	N	N	N	N	N	N	N	N
Poplar River (between foot bridges at Lutsen Lodge (S000-261, POP-0, period of record 1973–2010)	N	N	N	↓	N	N	N	N	N	N	N	N

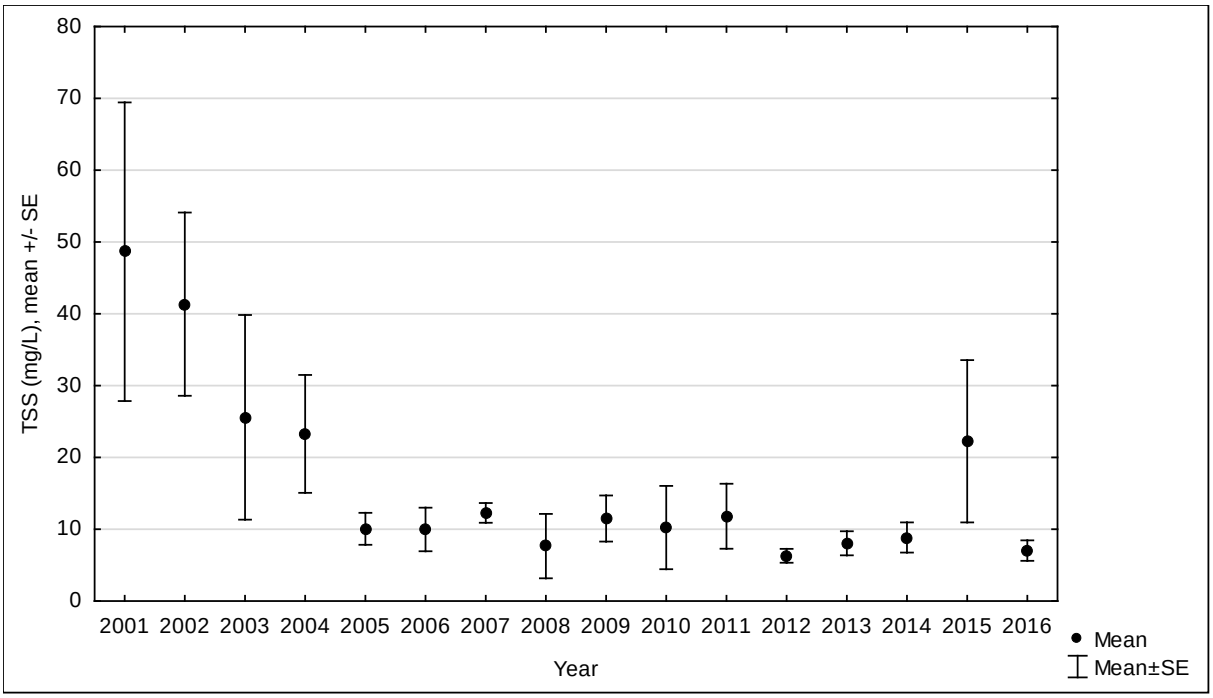

Figure 5. Total suspended solids concentrations (Apr–Sep) by year on the downstream reach of the Poplar River (AUID 04010101-613)

Data from the monitoring stations on the most downstream assessment unit of the Poplar River were aggregated to be able to evaluate water quality over a longer period of time. Standard error (SE) is a measure of variability in the data.

Lakes

Lake water quality is very good across the watershed. A water clarity trend analysis was conducted as part of an interagency lake prioritization effort conducted by staff from the MPCA, Department of Natural Resources (DNR), Board of Water and Soil Resources (BWSR), Minnesota Department of Agriculture (MDA), and MDH. Only lakes with eight or more years of data were analyzed. Section 2.5 contains further information on the lake prioritization effort. Of the 26 lakes for which there are enough data to evaluate trends in water clarity, four lakes (Deer Yard, Devil Track, Poplar, and Tom) show evidence of a worsening trend (i.e., lower clarity, or poorer water quality), and 22 lakes show no evidence of a trend. The remaining lakes did not have sufficient data for a trend analysis (Table 5).

Table 5. Lake water quality trends

Lake Name	Lake ID	Impaired	Average Total Phosphorus (µg/L)	Average Transparency (m)	Trend in Clarity [a]
Agnes	16035900	N	31.3	0.6	–
Alton	16062200	N	4.9	3.96	N
Aspen	16020400	N	16.1	2.89	–
Babble	16025700	N	31	NA	NA
Ball Club	16018200	N	16.1	3.49	N
Barker	16035800	N	20.5	1.19	–
Bearskin	16022800	N	12.8	6.61	N
Benson	38001800	N	9.3	NA	NA

Lake Name	Lake ID	Impaired	Average Total Phosphorus (µg/L)	Average Transparency (m)	Trend in Clarity [a]
Bigsby	16034400	N	19.3	1.17	–
Binagami	16009800	N	15.6	2.24	–
Birch	16024700	N	8.1	5.51	N
Bouder	16038300	N	24.3	1.56	–
Bower Trout	16017500	N	11	1.7	–
Boys	16004400	N	11.6	2.36	–
Brule	16034800	N	9.5	4.98	N
Cabin	38026000	N	17	0.8	–
Caribou	16024000	N	7.5	2.2	–
Caribou	16036000	N	21	2.1	N
Carrot	16036000	N	13	NA	NA
Cascade	16034600	N	13	2.52	–
Chester	16003300	N	13.3	3.96	N
Christine	16037300	N	16.3	1.57	–
Clara	16036500	N	15.3	2.25	–
Clearwater	16013900	N	4.7	8.99	N
Cramer	38001400	N	16.6	NA	NA
Crescent	16045400	N	16.5	2.36	–
Crooked	38002400	N	9.9	3.73	–
Daniels	16015000	N	–	–	–
Davis	16043500	N	19	3.83	–
Deer Yard	16025300	N	16.3	2.9	↓
Delay	38042500	N	14.9	2.36	–
Devil Track	16014300	N	12.1	2.96	↓
Devilfish	16002900	N	12	2.94	–
Divide	38025600	N	15	3.67	N
Dyers	16163400	N	22.8	2.05	–
East Bearskin	16014600	N	10.3	3.61	–
East Twin	16014500	N	19.8	2.39	–
Echo	38002800	N	11	8	–
Elbow (Main Basin)	16080501	N	13.1	2.47	–
Elbow	16009600	N	19.2	1.25	–
Esther	16002300	N	10.3	2.76	N
Flour	16014700	N	10.8	5.46	N
Four Mile	16063900	N	21.8	1.76	–
Goldeneye	38002900	N	12	–	–
Greenwood	16007700	N	8.7	5.21	N
Gust	16038000	N	19.9	1.44	–

Lake Name	Lake ID	Impaired	Average Total Phosphorus (µg/L)	Average Transparency (m)	Trend in Clarity [a]
Hare	38002600	N	24	3	–
Homer	16040600	N	14.6	2.03	N
Hungry Jack	16022700	N	7.8	5.31	N
Jock Mock	16038100	N	14	3.8	–
Johnson	38024200	N	23	3.66	N
Kemo	16018800	N	7.8	4.36	N
Kimball	16004500	N	11.8	3.72	–
Leo	16019800	N	9.9	4.4	N
Lichen	16038200	N	17.9	1.08	–
Little Cascade	16034700	N	14.1	1.42	–
Little Wilson	38005100	N	9.6	2.17	–
Loft	16003100	N	14	–	–
Lost	16002200	N	12.8	1.61	–
Mark	16025000	N	31	–	–
McFarland	16002700	N	9.4	5.03	N
Micmic	38023300	N	17.5	–	–
Mink	16004600	N	13.6	3.11	–
Mistletoe	16036800	N	15.3	1.11	–
Mit	16019300	N	9	3	–
Moore	16048900	N	12	1.1	–
Moose	16004300	N	8	5.26	–
Musquash	16020400	N	7	3.77	–
Ninemile	38003300	N	11.5	2.69	–
Nipisquit	38023200	N	17.7	4	–
Northern Light	16008900	N	13.5	1.29	–
Pancore	16047500	N	6.7	–	–
Peanut	16013300	N	141	0.3	–
Peterson	16047800	N	14	2.14	–
Pike	16025200	N	8.6	5.55	N
Pine	16019400	N	6.8	3.67	–
Pine Mountain	16010800	N	8.9	2.48	–
Pipe	16037500	N	24	–	–
Poplar	16023900	N	9.6	3.67	↓
Richey	16064300	N	28.9	1.35	–
Sonju	38024800	N	18.2	–	–
Squint	16020200	N	35	3	–
Star	16040500	N	18.9	1.68	–
Swamp	16025600	N	16	1.5	–

Lake Name	Lake ID	Impaired	Average Total Phosphorus (µg/L)	Average Transparency (m)	Trend in Clarity [a]
Tait	16038400	N	11.2	2.21	N
Thompson	16016000	N	14	–	–
Thrush	16019100	N	5.5	6.5	–
Tom	16001900	N	12.1	2.99	↓
Toohey	16064500	N	23.4	1.02	–
Trout	16004900	N	8.4	6.4	N
Two Island	16015600	N	11.9	2.66	–
Upper Cone	16041200	N	11	3.03	–
Ward	16024800	N	17.7	2.1	–
Wench	16039800	N	10.5	4.3	–
West Twin	16018600	N	10.2	3.18	–
White Pine	16036900	N	18.7	1.6	–
Whitefish	38006000	N	10.5	4.31	–
Wilson	38004700	N	14.8	4.59	N

a. ↑: increasing trend ↓: decreasing trend N: no evidence for a trend –: insufficient data
NA: not assessed

Beaches

E. coli concentrations along the shoreline and beach closures were a concern brought up through public participation efforts in the 1W1P and the WRAPS planning processes. Concentrations of *E. coli* at Lake Superior beaches are typically low, with mean concentrations at the monitoring sites ranging from 9 to 77 organisms per 100 milliliters (org/100 mL; Figure 6). Exceedances of the *E. coli* beach standard (235 org/100 mL) were observed at all sites, except for Tettegouche State Park (B024) and Chicago Bay Boat Landing (B078); however, the numbers of exceedances were low and not enough to designate the beaches as impaired (Table 6). The exceedances varied seasonally, with the majority of exceedances in July. Beaches with the most exceedances of the standard were the Grand Marais Campground (B029) and Grand Marais Downtown/Marina (B030). Although there was no significant statistical trend in the annual *E. coli* geometric means at these two sites (based on a Kendall-Tau correlation analysis), the number of samples that exceeded the standard has increased over the years (Figure 7).

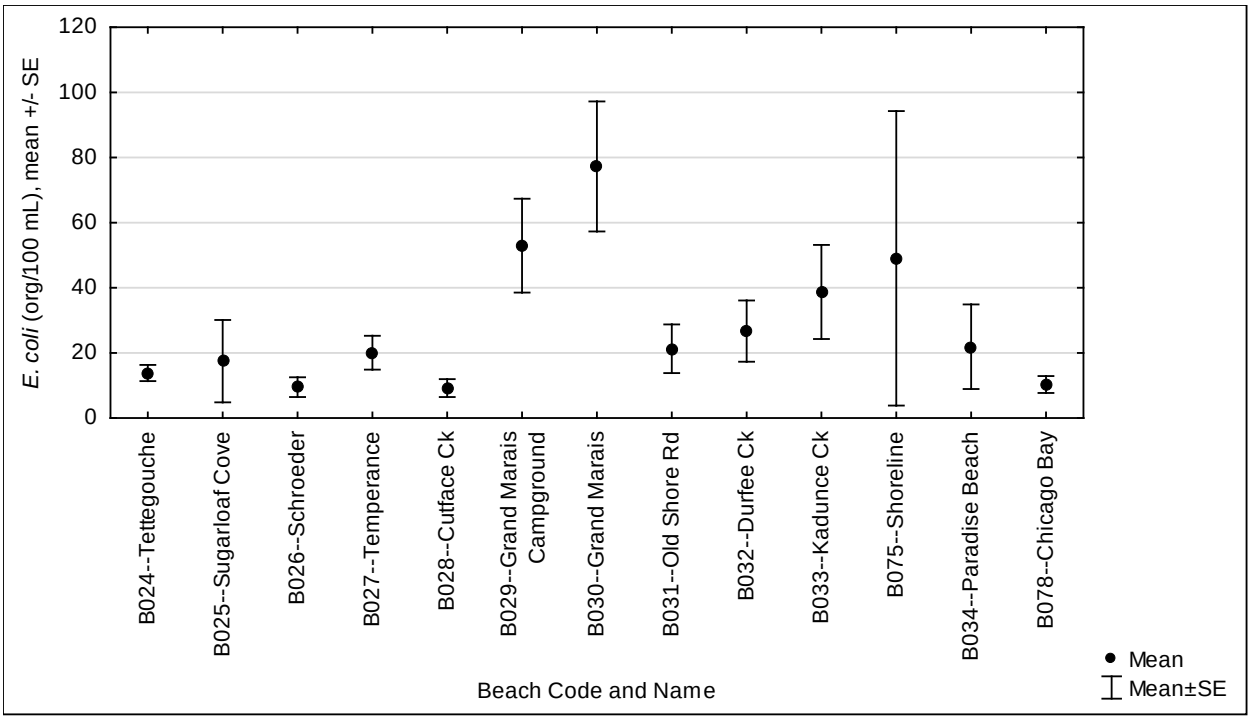

Figure 6. *E. coli* average concentrations at beaches, ordered from southwest to northeast (2003–2016).

Table 6. Number of exceedances by month across all monitored beaches (2003–2016)

Site Name (Number)	Number of Exceedances of *E. coli* Standard (Number of Samples)							
	Apr	May	Jun	Jul	Aug	Sep	Oct	Total
Tettegouche St Pk 4.5 mi NE of Silver Bay (B024)	–	0 (10)	0 (44)	0 (45)	0 (42)	0 (15)	–	0 (156)
Sugarloaf Cove 4.5 mi SW of Schroeder (B025)	–	0 (10)	0 (53)	1 (53)	0 (55)	0 (19)	–	1 (190)
Schroeder Town Park in Schroeder (B026)	–	0 (10)	0 (56)	2 (55)	1 (58)	0 (19)	–	3 (198)
Temperance R St Pk 1 mi NE of Schroeder (B027)	0 (1)	0 (10)	0 (55)	2 (55)	0 (57)	0 (19)	–	2 (197)
Cutface Ck Wayside 5 mi SW of Grand Marais (B028)	0 (1)	0 (10)	0 (56)	1 (55)	0 (57)	0 (21)	–	1 (200)
Grand Marais Campground in Grand Marais (B029)	0 (1)	0 (16)	0 (56)	4 (55)	7 (63)	1 (28)	0 (6)	12 (225)
Grand Marais Downtown/Marina in Grand Marais (B030)	–	0 (16)	0 (54)	9 (62)	5 (61)	0 (26)	0 (6)	14 (225)
Old Shore Road NE of Grand Marais (B031)	–	0 (10)	0 (53)	2 (53)	0 (56)	1 (22)	–	3 (194)
Durfee Ck Mouth NE of Grand Marais (B032)	0 (1)	0 (9)	2 (53)	1 (52)	1 (58)	1 (22)	–	5 (195)
Kadunce Ck Mouth 8 mi NE of Grand Marais (B033)	0 (1)	0 (9)	1 (51)	2 (51)	0 (57)	1 (22)	–	4 (191)
Paradise Beach NE of Grand Marais (B034)	–	0 (9)	1 (50)	1 (51)	0 (57)	1 (21)	–	3 (188)
Shoreline at MNTH-61 NE of Grand Marais (B075)	–	–	0 (17)	1 (19)	0 (17)	–	–	1 (53)
Chicago Bay Boat Landing (B078)	–	0 (3)	0 (30)	0 (32)	0 (37)	0 (11)	–	0 (113)
Total	*0 (5)*	*0 (122)*	*4 (628)*	*26 (638)*	*14 (675)*	*5 (245)*	*0 (12)*	*49 (2,325)*

–: no data

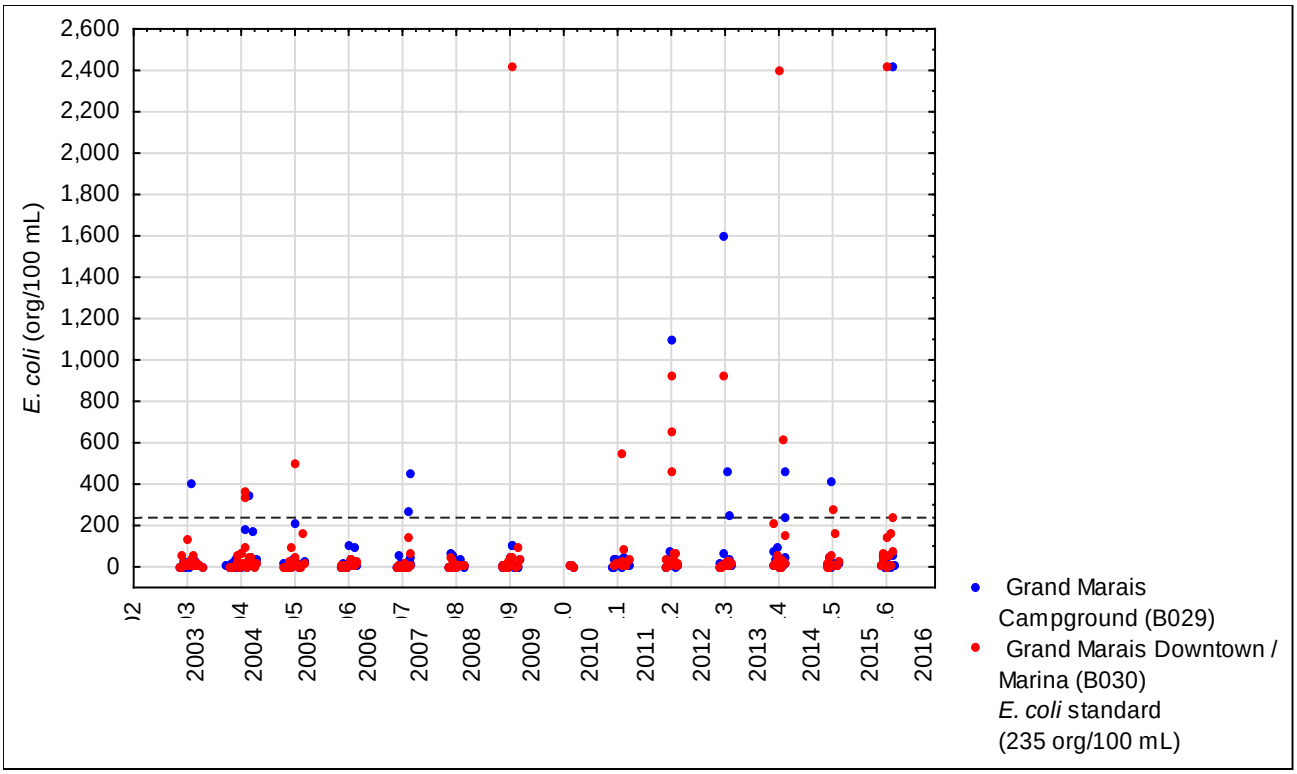

Figure 7. *E. coli* concentrations at Grand Marais beaches.

Due to water quality concerns along the shore of Lake Superior, Cook SWCD began sampling Lake Superior near shore sites in 2014 (Figure 8). Sediment plumes had been observed in the lake at tributary inputs, in addition to increased levels of attached algae. Samples were collected at five sites near Grand Marais. Transparency varied among the sites, with the best (highest) transparency at the most south-western site (site 204) and the poorest (lowest) transparency at the site closest to the shore (site 212; Figure 9). Phosphorus concentrations varied slightly among the sites, with no clear spatial patterns (Figure 10). TSS concentrations were low—the majority of the samples were below the detection limit, with the remaining samples at or less than 2 mg/L TSS.

Figure 8. Near shore monitoring sites near Grand Marais.

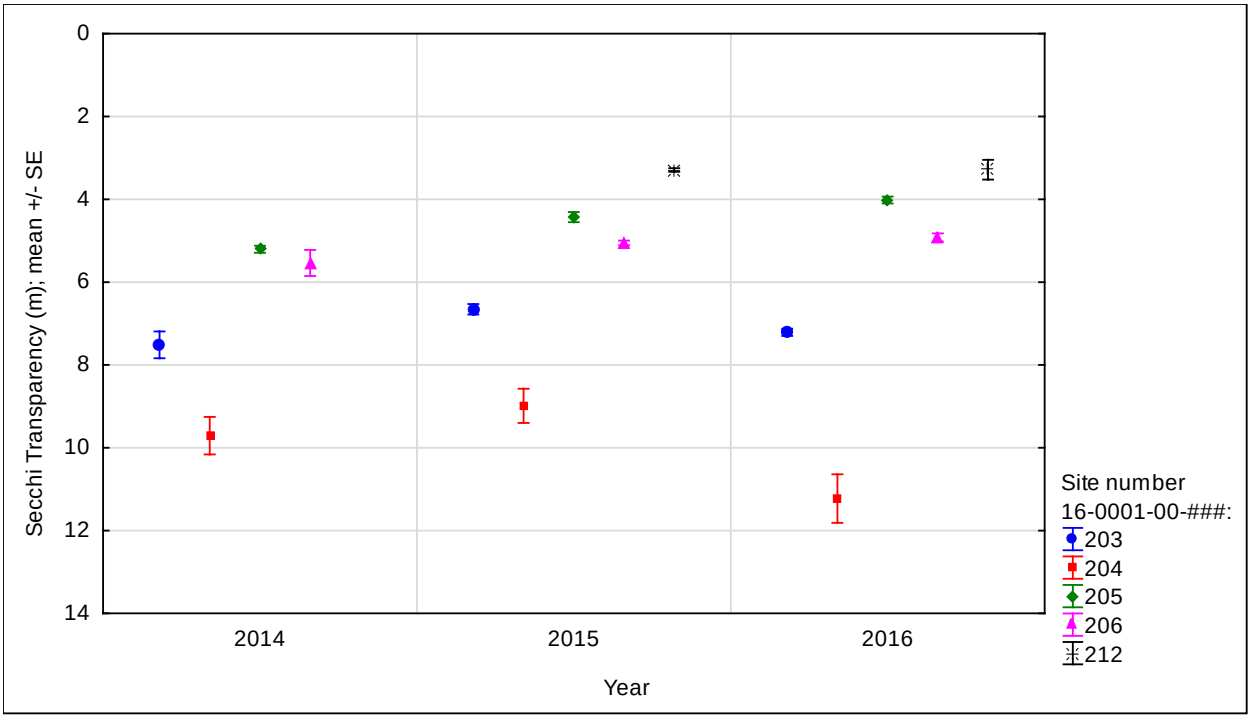

Figure 9. Secchi transparency by year at Lake Superior near shore monitoring sites near Grand Marais.

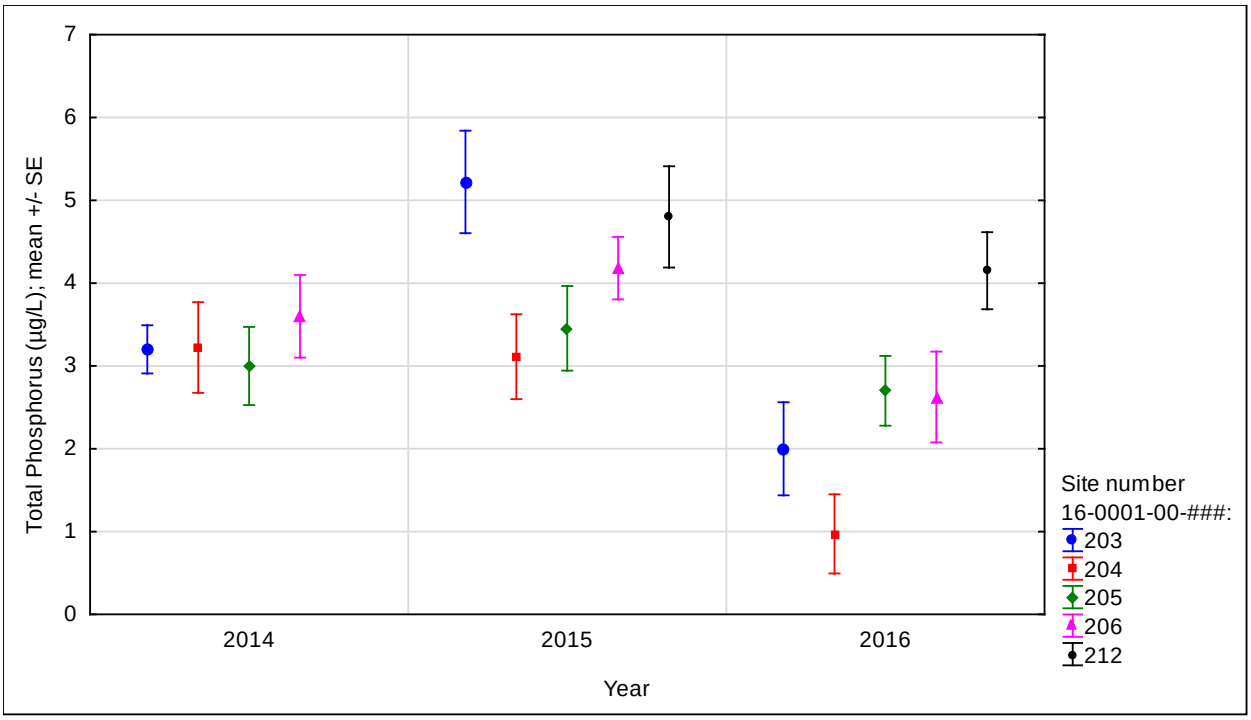

Figure 10. Total phosphorus concentrations by year at Lake Superior near shore monitoring sites near Grand Marais.

2.3 Stressors and Sources

In order to develop appropriate strategies for restoring or protecting waterbodies, the stressors and/or sources impacting or threatening them must be identified and evaluated. The *Lake Superior North Watershed Stressor Identification* (MPCA 2018) report provides results of stressor identification monitoring completed in select LSN Subwatersheds. Additionally, investigations into loss of connectivity were completed for several subwatersheds in which localized impacts can be addressed with feasible strategies. The Core Team also provided additional input on stressors and sources that were present in the watershed. The primary stressors and pollutant sources impacting the LSN Watershed include the following:

- **High water temperatures** that do not support sensitive coldwater species such as brook trout. Causes of high water temperatures may include beaver dams, turbid water, loss of riparian vegetation and shade, low flows, low groundwater input, and climate change.
- **Physical habitat degradation and loss of habitat diversity** that reduces spawning areas, cover or pools for fish, and critical habitat for aquatic macroinvertebrates. Habitat loss can be due to bank erosion (caused by channel incision and widening), sediment deposition, beaver dams, road and ditch runoff, major flooding events, sediment transport issues related to road culverts, and invasive species (e.g., Emerald Ash Borer) that have the potential to affect watershed hydrology and aquatic organisms.
- **Aquatic organism passage barriers** created by road culverts or natural barriers, both of which can reduce or eliminate fish passage and serve as a migratory barrier to other aquatic life. Road culverts can be undersized, perched, and/or improperly set. Natural barriers include bedrock

and boulder waterfalls that are usually permanent barriers, and beaver dams that create temporary or periodic barriers. Barriers contribute to spawning stress since fish may need to migrate to find suitable spawning habitat. Fish also need to seek temperature refuge during periods of thermal stress (summer heat, winter ice).

- **High sediment and associated nutrient concentrations** that are a result of high magnitude, low frequency snowmelt and precipitation events. Sediment and nutrient sources are varied:
  - Streambank and valley wall erosion
  - Watershed runoff from open lands, gravel or dirt roads, and development and impervious surfaces (e.g., roads and driveways, ditches/conveyances, culvert crossings, other land management activities)
  - Beaver activities (e.g., failed dams, ponds)
  - Historic and current land clearing and timber harvest in the watershed and riparian areas
  - Septic systems (non-compliant/non-functional systems under all conditions)
- **Altered hydrology associated with flashy, high stream power and low flows associated with lack of groundwater influence.** Flashy hydrology combined with erodible soils contributes to high sediment loads during snowmelt and rain events, and can cause excess sediment transport and deposition further degrading physical habitat (e.g., in the Woods Creek Watershed). Ditched channels and deforested land increase the hydrologic flashiness of the system, leading to stream bed and bank erosion. Impoundments, including private dams and beaver dams, can also alter streamflow. Finally, groundwater discharge to some streams is low during the summer, leading to low baseflow conditions.
- **Altered food webs** affect fish assemblages. Climate change, aquatic invasive species (AIS), and fisheries management can alter a species' food base and predation pressures, and therefore affect growth and survival rates.

2.4 TMDL Summary

The Clean Water Act and EPA regulations require that TMDLs be developed for waters that do not support their designated uses (fishable, swimmable, consumable). A TMDL is a plan to restore and maintain water quality standards in waters that are not currently meeting them. TSS TMDLs have been developed for the Poplar River (MPCA 2013) and Flute Reed River Watersheds (MPCA n.d.). Appendix A provides the current loading, load reductions needed, and load and wasteload allocations from the TMDLs. The Poplar River was proposed for delisting in the 2018 draft 303(d) list because it meets the applicable water quality standard due to restoration activities. Some of the waterbodies in the LSN Watershed are also impaired due to mercury; however, this report does not cover toxic pollutants. Mercury impaired lakes are addressed by a statewide TMDL study approved in 2007, and supporting

updates approved in 2010, 2013, and 2014. For more information on mercury impairments see the statewide mercury TMDL.

Table 7. Completed TMDLs in the LSN Watershed

HUC10 Subwater-shed	Stream/Reach (AUID)	Affected Designated Use	Cause/Indicator of Impairment	TMDL Pollutant
Poplar River* (0401010107)	Poplar River: Superior Hiking Trail Bridge to Lake Superior (613)	Aquatic Life	Turbidity	TSS
Flute Reed River (0401010103)	Flute Reed River: Headwaters to Unnamed Creek (D31)	Aquatic Life	TSS	TSS
	Flute Reed River: Unnamed Creek to Lake Superior (D32)	Aquatic Life	Turbidity	TSS

* The Poplar River was proposed for delisting in the 2018 draft 303(d) list.

2.5 Protection Considerations

All waters in the LSN Watershed require protection in some capacity, including those with insufficient data. It is important to prioritize areas for protection, however, to better focus implementation of the WRAPS. For example, waters that are particularly threatened or vulnerable are considered at risk for further degradation and impairment and should be protected. In addition, unique and high value resources that exhibit the highest biological, cultural, and social significance in the region, should also be protected to ensure their continued quality. The following sections provide an overview of indicators to consider when prioritizing areas for overall protection in the LSN Watershed, as well as a detailed prioritization of specific streams based on biological monitoring, and specific lakes based on a statewide prioritization effort and local input.

Watershed Protection

Several different indicators with known impacts to water quality or water use and readily available data were considered in determining a reasonable sub-set of waters in need of protection (Table 8). Indicators were divided into three larger categories: human-caused, geomorphic based or biologic based.

During WRAPS development, stakeholders reviewed a series of maps (Figure 11 through Figure 26) depicting indicators that influence watershed health. During the review, discussion centered on the indicator, the data collected across the watershed describing lake and stream conditions, and the potential degree of impact. This review and analytical conversation generated the protection strategies listed in Section 3.3. Table 8 summarizes each indicator, provides information on why the indicator should be included in a protection strategies framework, and how the indicator is applicable to protection considerations for both at-risk and unique and high value water resources. While each specific indicator is listed separately for ease of readability, it is important to recognize the interaction between all indicators when considering protection strategies. For example, wetlands in public lands have several layers of protection and may not need as much protection as wetlands in privately held lands. Maps of each indicator are provided in Figure 11 through Figure 26.

Table 8. Indicators for protection considerations in the LSN Watershed

Type	Indicator	Protection Consideration
Human-caused	Impervious Cover Figure 11	Impervious cover in a watershed may increase temperatures, stormwater runoff, and flashiness of streams, and decrease infiltration of stormwater.
	Population Density Figure 12	Population density can be used as an indicator of human-caused stressors. Population may also help inform targeted areas for education and outreach to citizens and landowners on best management practices.
	Road Density Figure 13	Road density may indicate areas with less infiltration and water retention, as well as areas of potential pollutant loading. It may also indicate the level of watershed development and potential altered hydrology via culverts and ditch networks intercepting flow.
	Road/Stream Crossings Figure 14	Road crossings may indicate areas susceptible to erosion and sediment loading, in addition to potential areas of fish passage barriers.
Human-caused	Location of Aggregate Mining Sources Figure 15	Aggregate mining management was identified as a priority concern by local stakeholders. Relative location of aggregate mining operations can help prioritize areas for aggregate mining management strategies.
	Percent Private Land Ownership Figure 16	Private land ownership may be indicative of areas in need of further protection and/or indicate human-caused impacts to water resources. Protection strategies may vary between publicly owned and privately owned land. Areas with high private landownership and population may also present potential areas to target landowner education and outreach.
	Recreational Areas Figure 17	Recreational areas can represent areas to target education and outreach efforts.
Geomorphic	Erosion Vulnerability Figure 18	Bluffs with high risk of erosion indicate areas of potential sediment loading.
	Clay Soils Stability Figure 19	Clay soils, their location and their relative stability can be used as indicators of potential areas vulnerable to erosion. In addition, areas with clay soil have lower infiltration rates potentially leading to larger runoff events and failing septic systems.
	Ground Water Pollution Sensitivity Figure 20	Different types of aquifers are more or less susceptible to pollution. Aquifers near the surface that are not covered with a layer of thick till are more likely to be vulnerable to contamination, have direct hydrologic connections to local surface waters, and influence the quality and quantity of local surface waters.
Biologic	Aquatic Invasive Species Figure 21	Locations of known AIS may be used to target efforts to prevent the spread of the species, and also indicate at-risk waters that are near and/or have a known connection to AIS waters.
	Lakes of Biological Importance Figure 22 and Table 9	Lake Trout, Cisco, and wild rice lakes have been identified by stakeholders as unique and important resources in the LSN Watershed. The preservation of their populations can be a consideration in planning efforts for unique and high value resources.
	Exceptional Use Streams Table 10	Exceptional use streams are those that support biological communities at or near natural conditions. Maintaining conditions in these streams can be a consideration in planning efforts for unique and high value resources. Exceptional use streams were determined from Tiered Aquatic Life Uses (TALU) effective as of October 2017. Note that this varies from the LSN Monitoring and Assessment Report that was published prior.

Type	Indicator	Protection Consideration
	Fish Index of Biological Integrity (FIBI) and Macroinvertebrate IBI (MIBI) Figure 23 and Figure 24	Indices of biotic integrity are a tool used to identify impaired segments of streams for supporting aquatic life. They provide a quantitative assessment of the composition of a community. A higher IBI score indicates a more diverse and abundant community. Although no streams are impaired for aquatic life relative to fish or macroinvertebrate evaluations in the LSN Watershed, lower IBIs may be an indicator of at-risk waters, and high IBIs of unique and high value waters. FIBIs may provide an indication of passage blocked along a stream if abrupt changes are seen. The type of IBI may indicate lack of specific habitat. MIBIs may be indicative of the quality of micro habitats in the sediment or other localized places, while FIBIs may be indicative of the stream ecosystem at a broader scale as fish are much more mobile.
Biologic	Wetlands Figure 25	Quantity, quality and location of wetlands may indicate areas of unique and high value waters. Watersheds with a high percentage of wetlands likely rely on wetlands to provide flood storage and water quality functions. Areas with a low percentage of wetlands could be vulnerable to changes in baseflow conditions and should also be protected.
	Future Forest Cover Prediction Figure 26	Warming temperatures from climate change are predicted to drastically influence forest cover in the LSN Watershed. Future forest predictions of various forest types can be used to identify areas with at-risk land cover for forestry management protection efforts.

Human-Caused Indicators

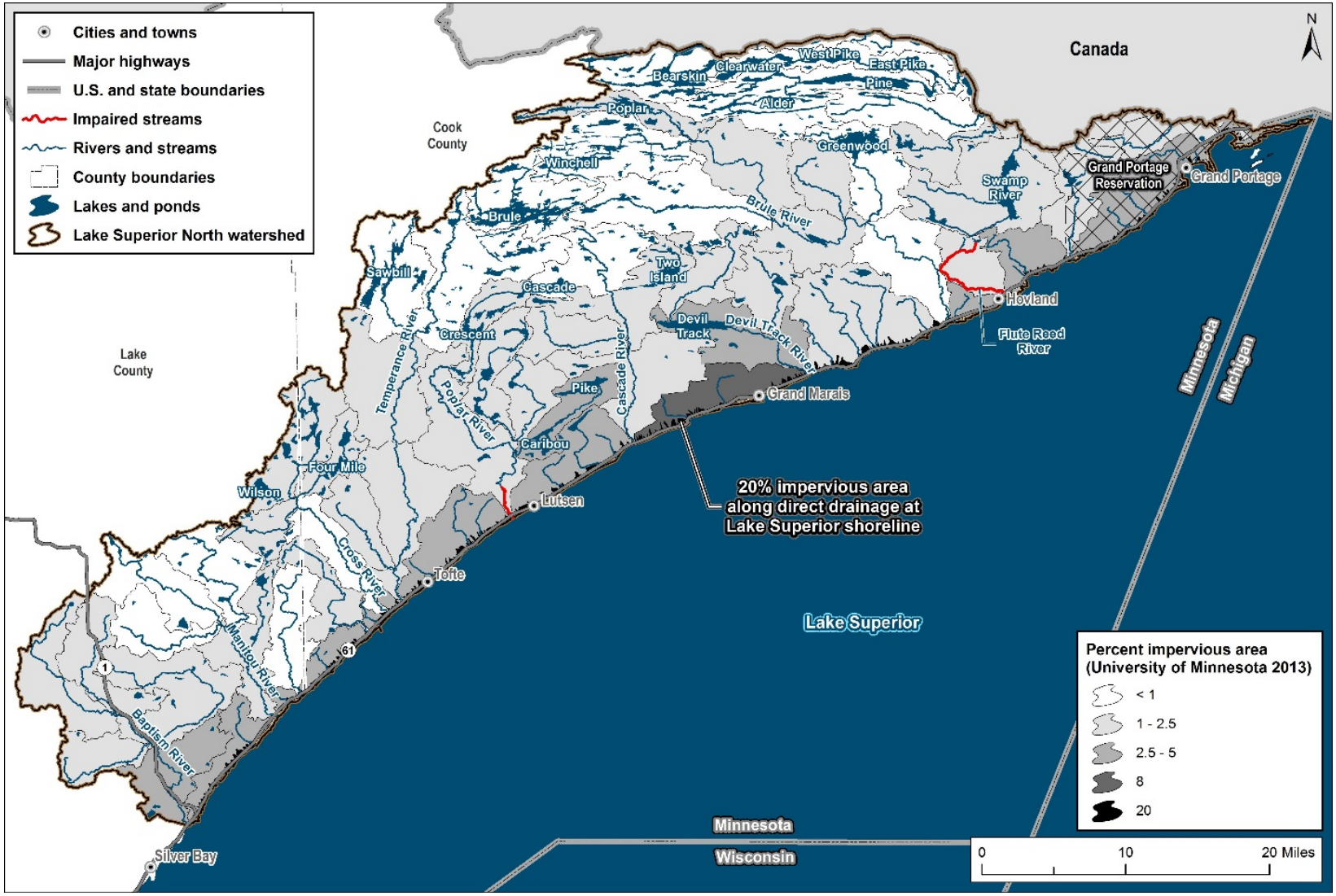

Figure 11. Percent impervious area by HUC12.

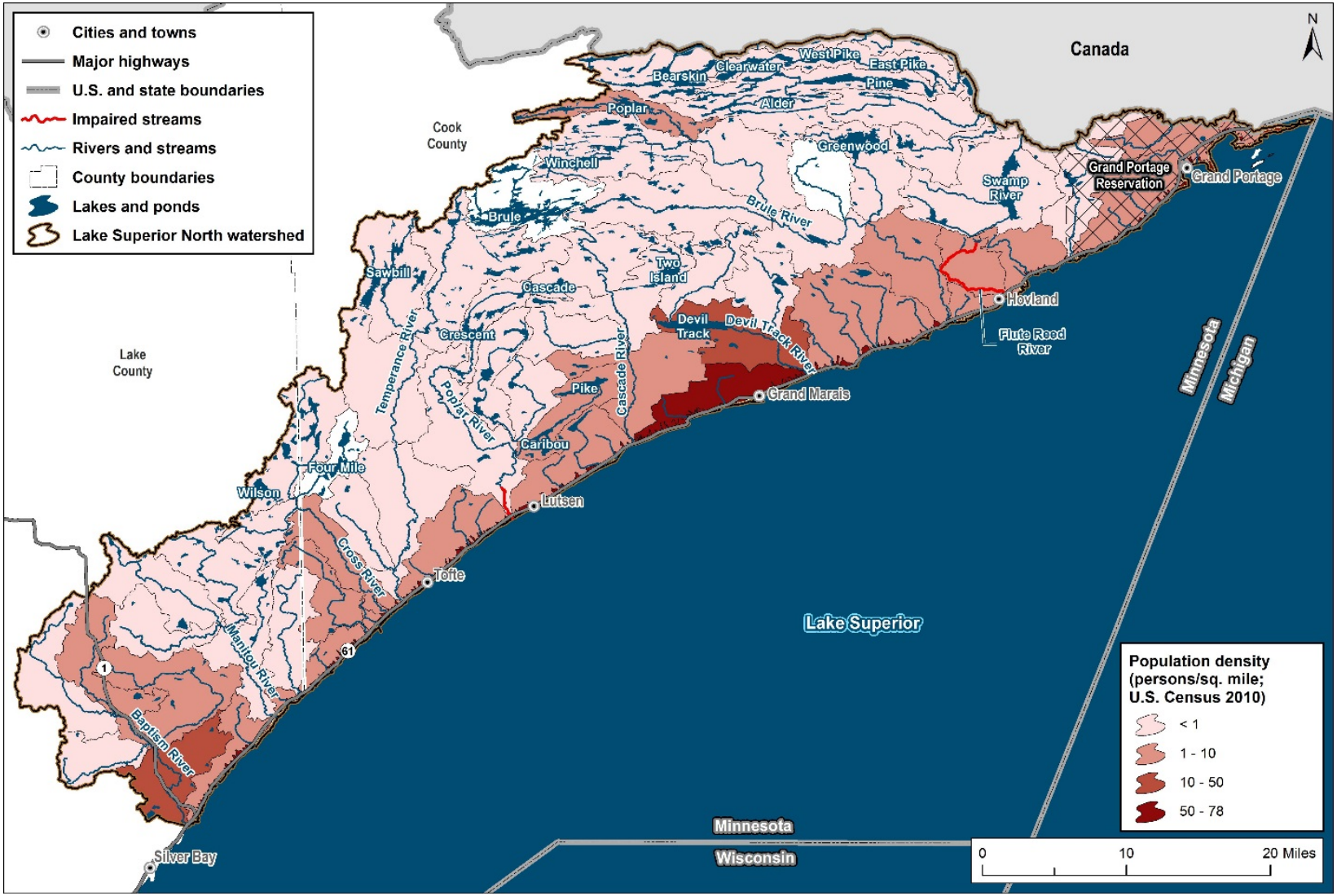

Figure 12. Population densities by HUC12.

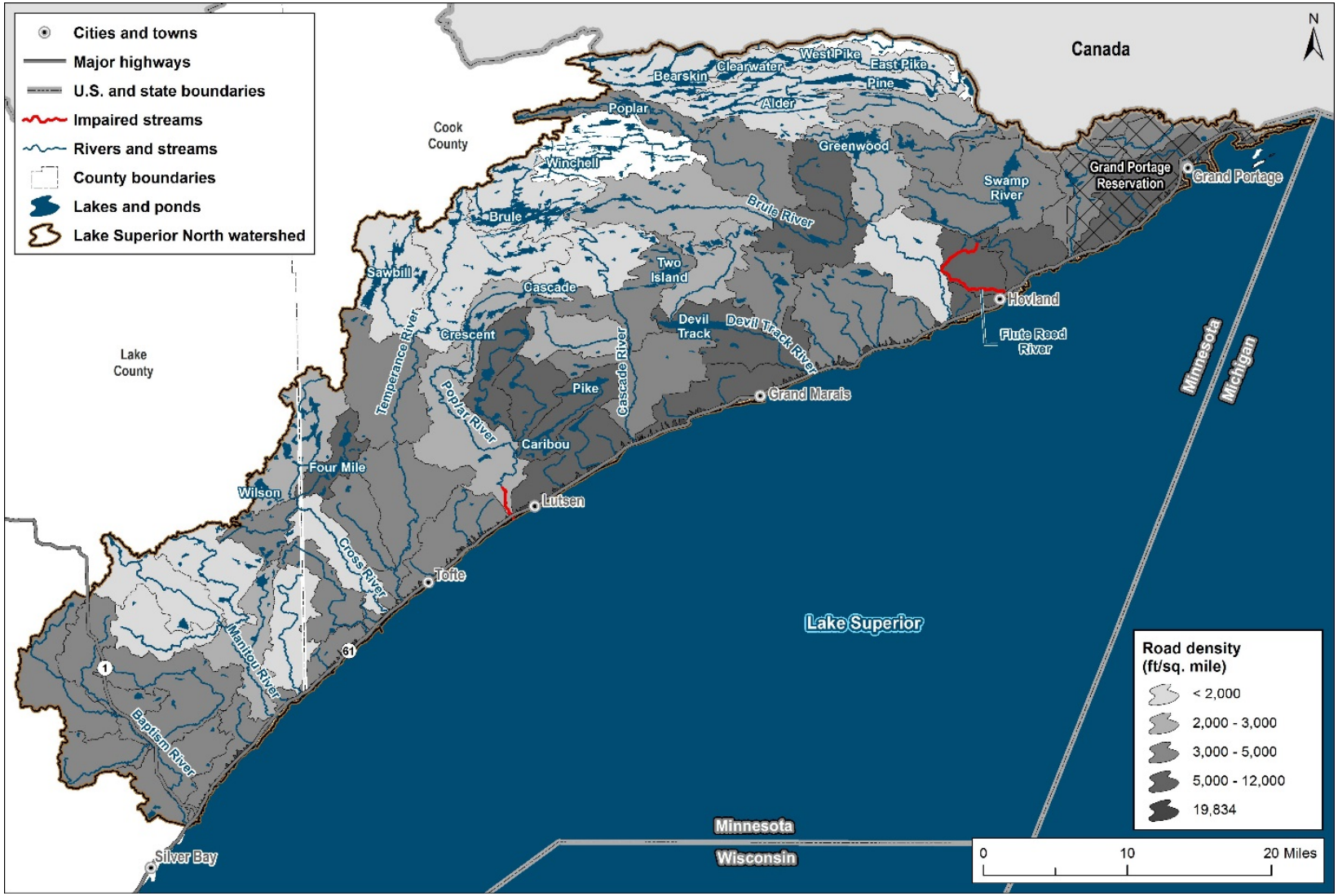

Figure 13. Road density by HUC12.

Note: There is only one watershed with a density greater than 12,000; this watershed has a density of 19,834.

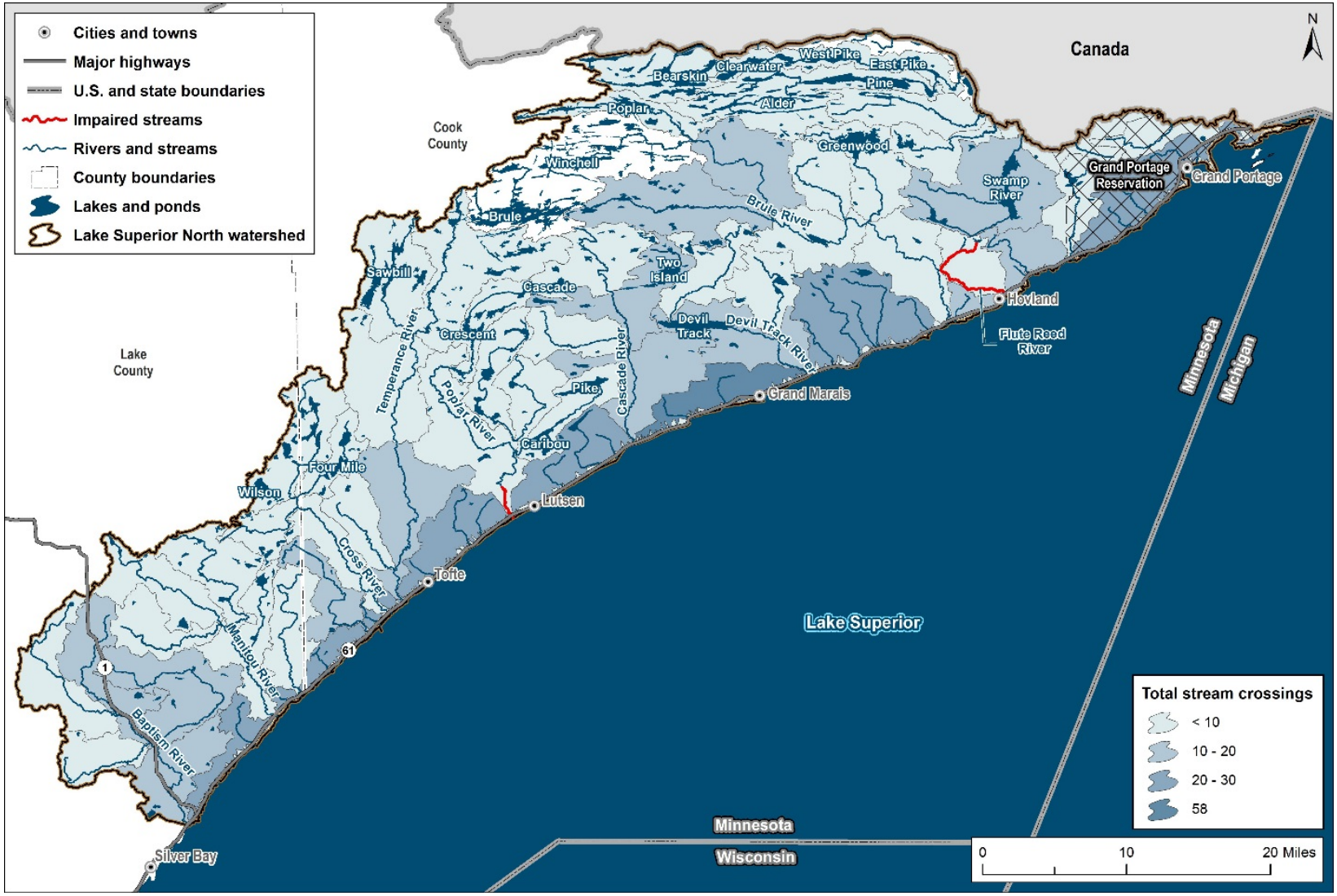

Figure 14. Total stream crossings by HUC12.

Note: There is only one watershed with more than 30 stream crossings; this watershed has 58 crossings. These typically are culverts and bridges.

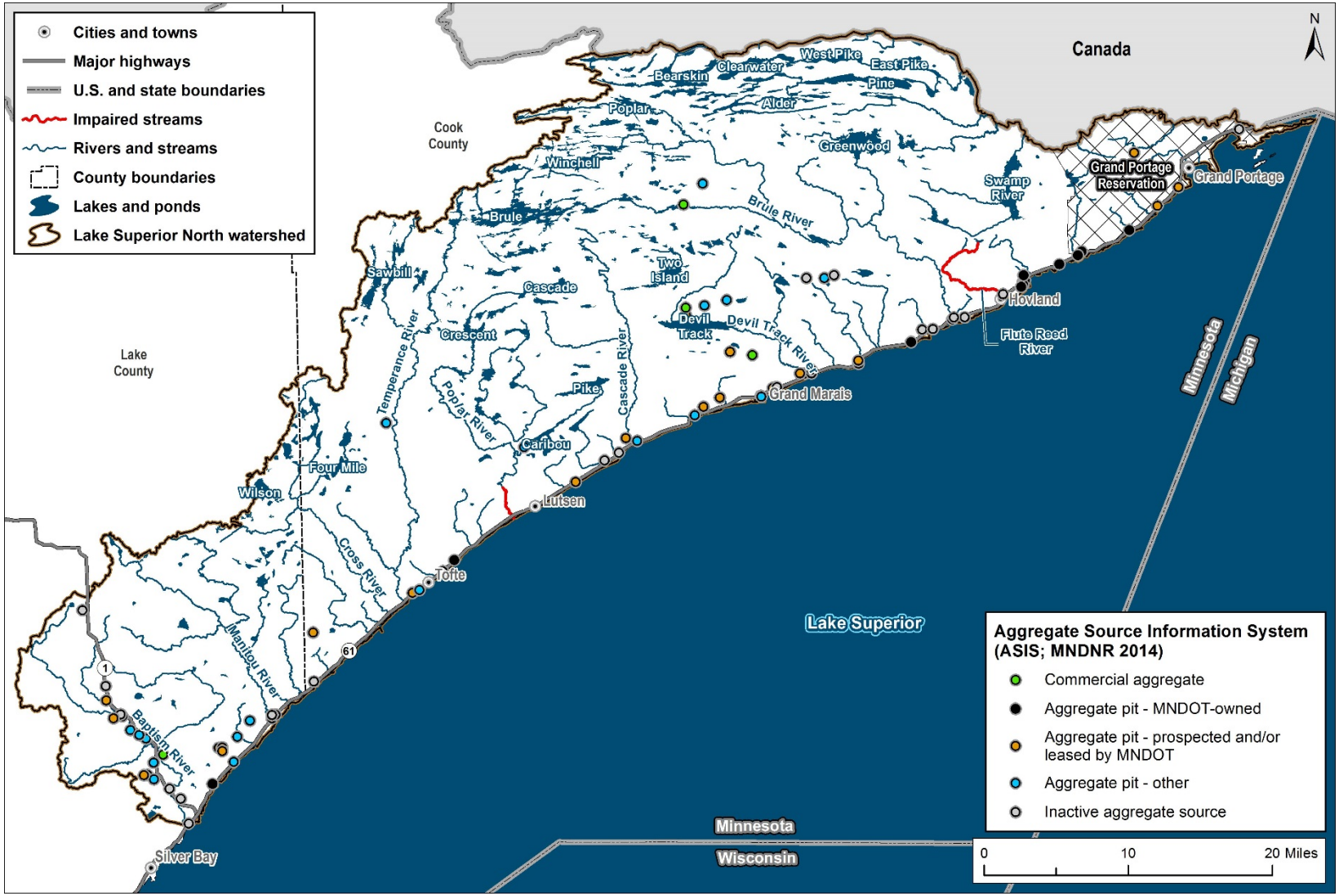

Figure 15. Aggregate sources.

Note: This is a partial representation of pits. Other known locations include Portage Brook, Thompson Creek, Cascade River, Irish Creek, and Esther Lake Road.

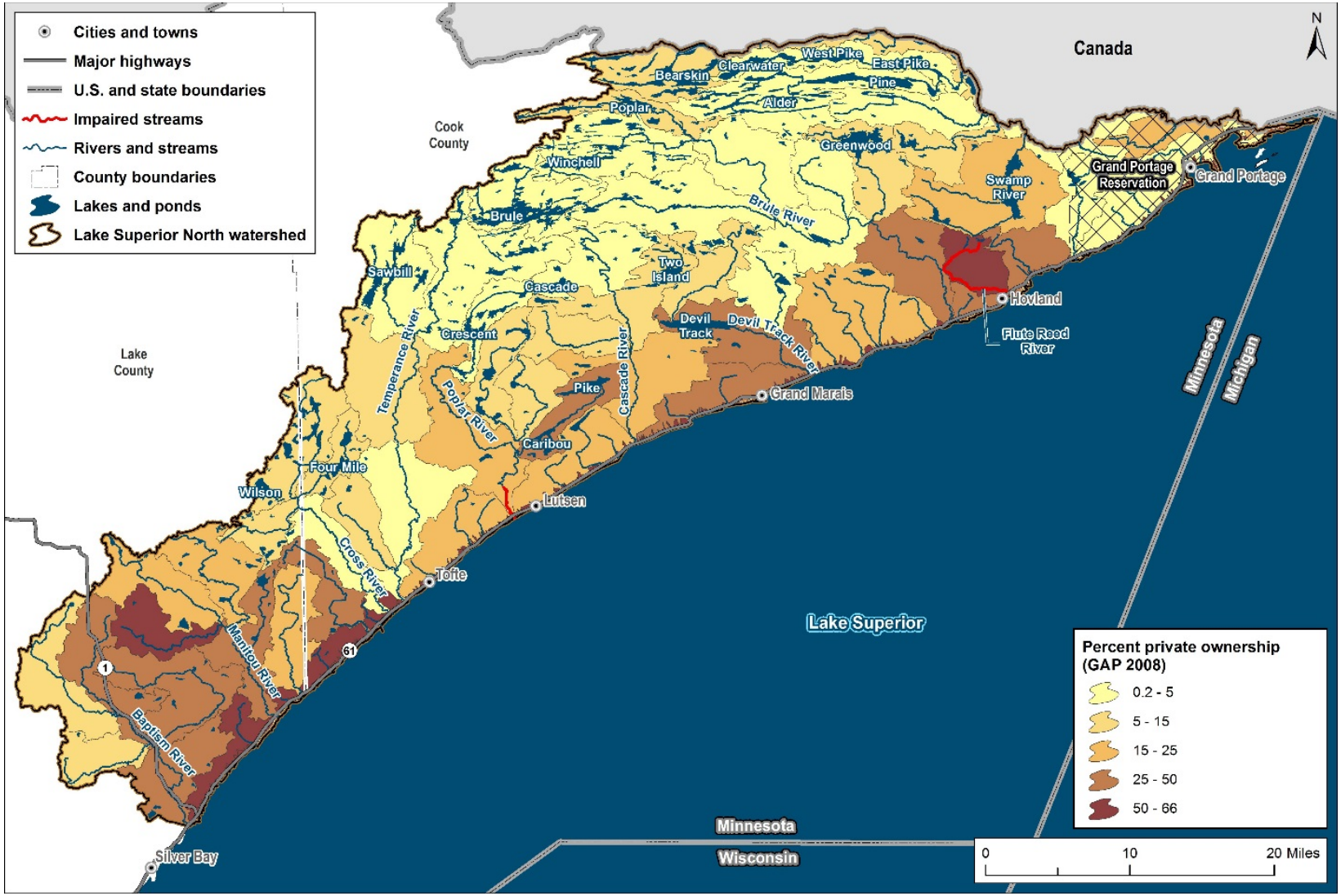

Figure 16. Percent private land ownership by HUC12.

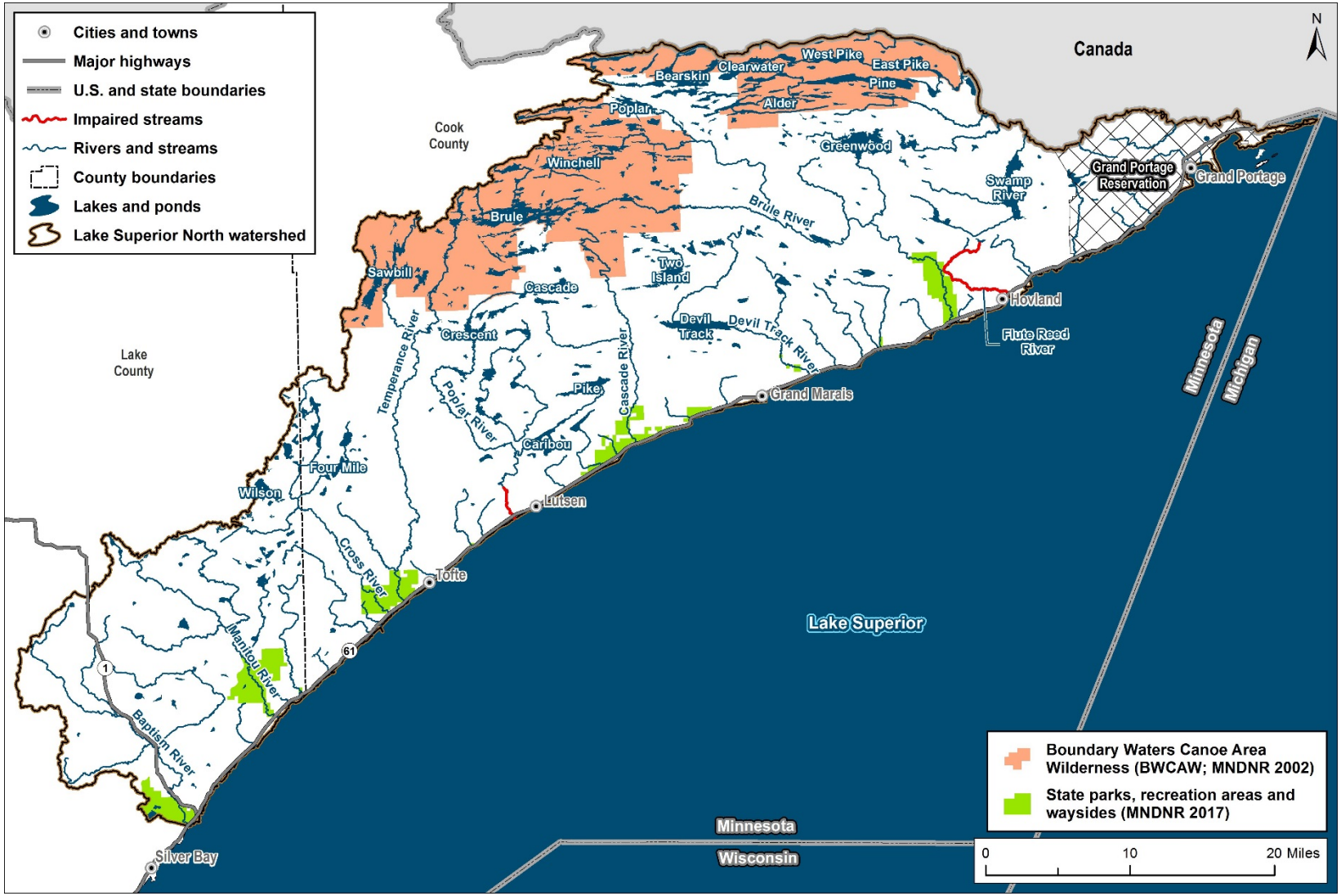

Figure 17. State parks, recreation areas and waysides.

Geomorphic Indicators

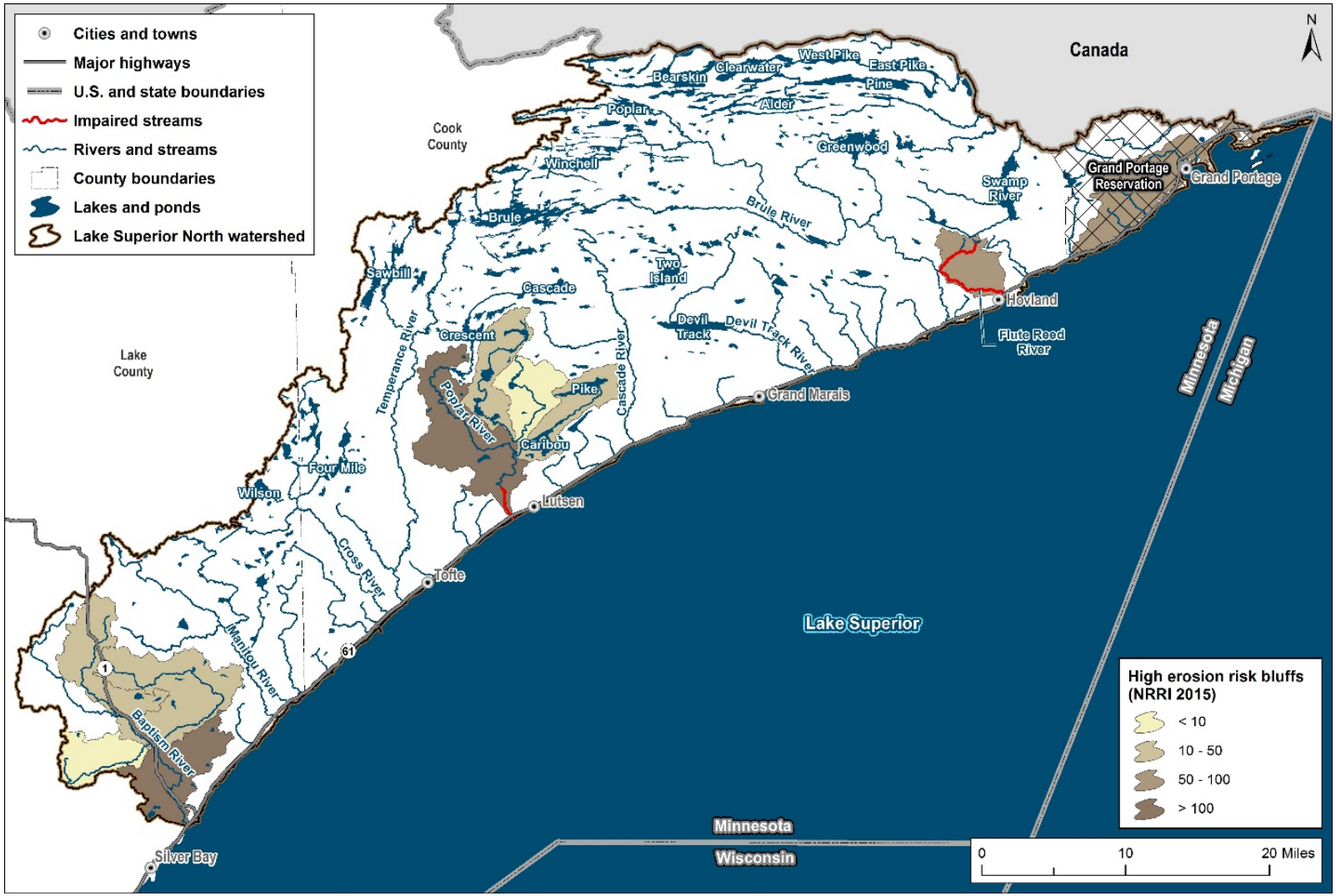

Figure 18. Number of high erosion risk bluffs by HUC12.

Note: Only the identified watersheds were evaluated for high erosion risk bluffs.

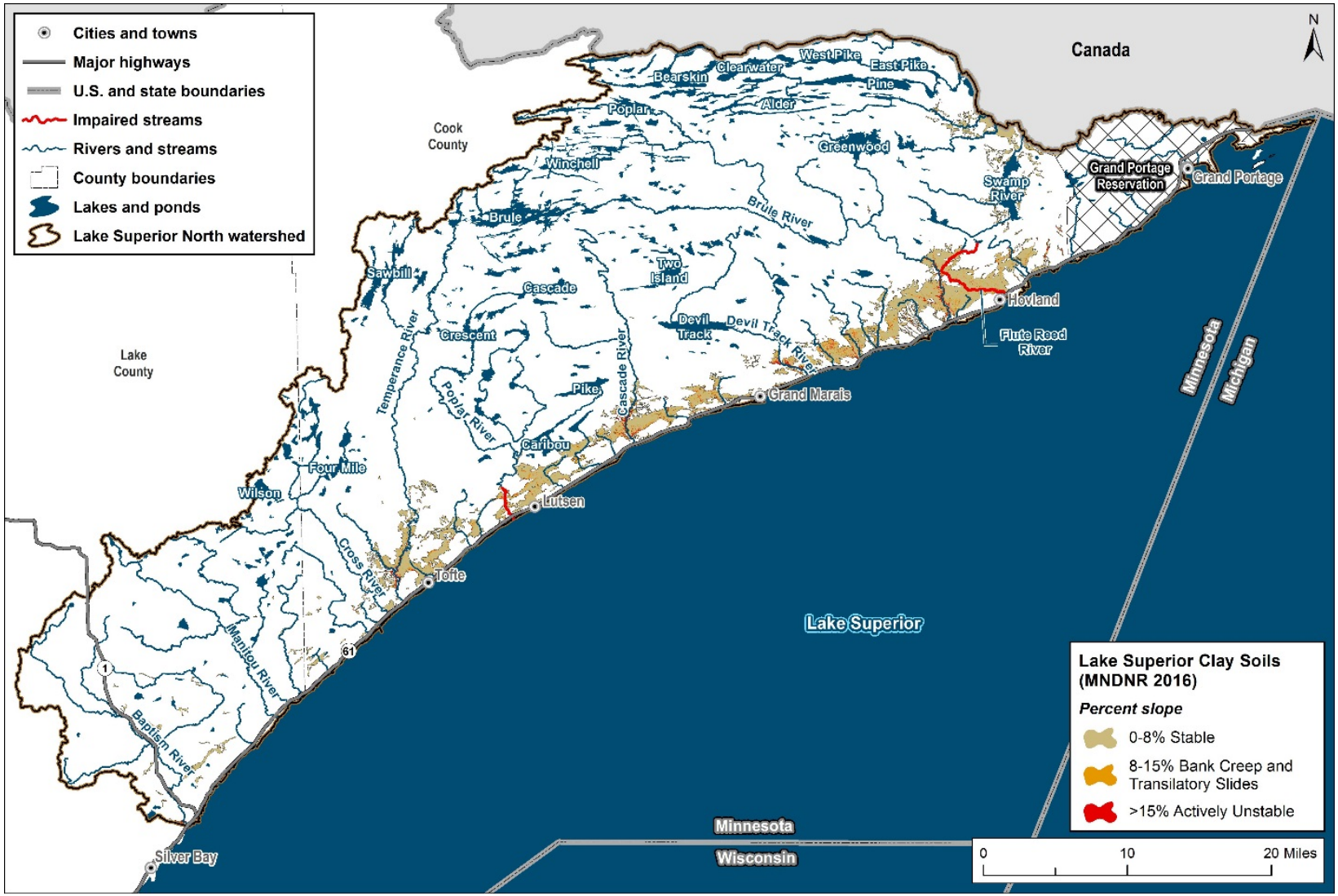

Figure 19. Stability of clay soils.

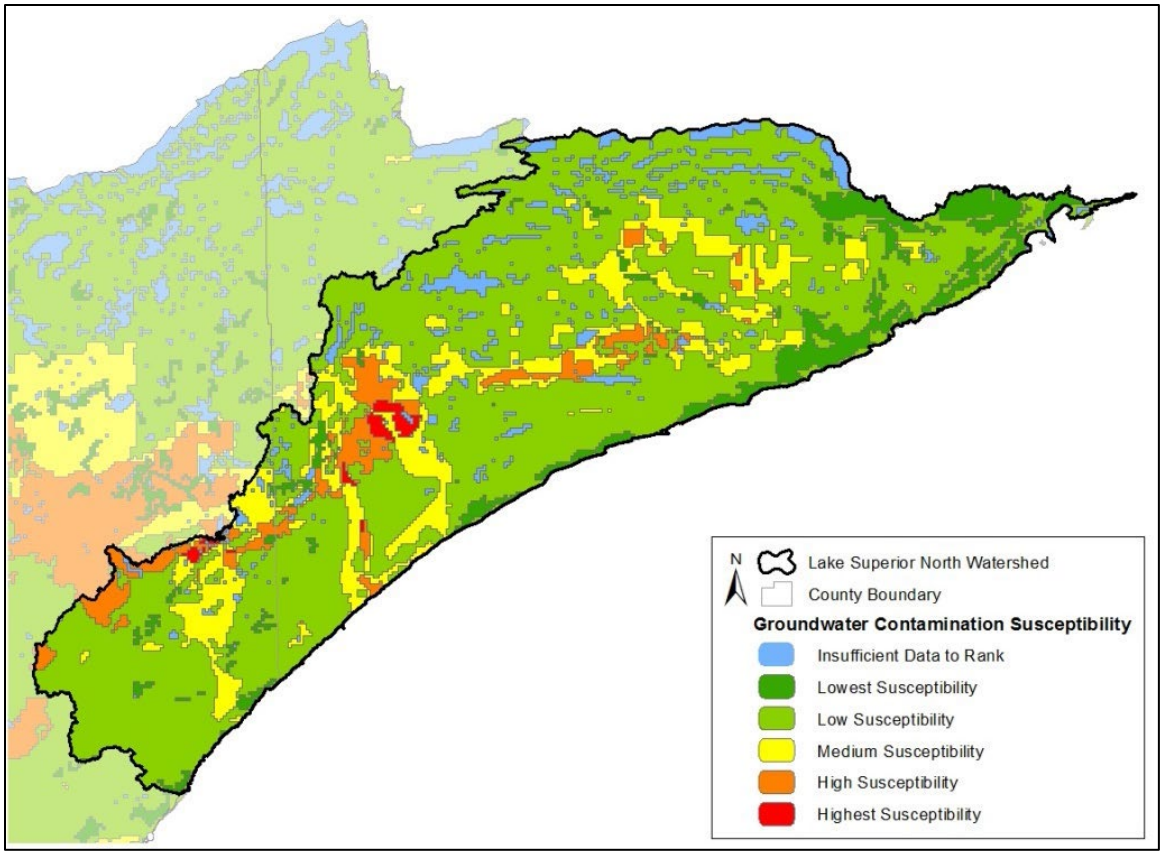

Figure 20. Groundwater susceptibility in the LSN Watershed.

Map from the LSN Monitoring and Assessment Report (MPCA 2017).

Biologic Indicators

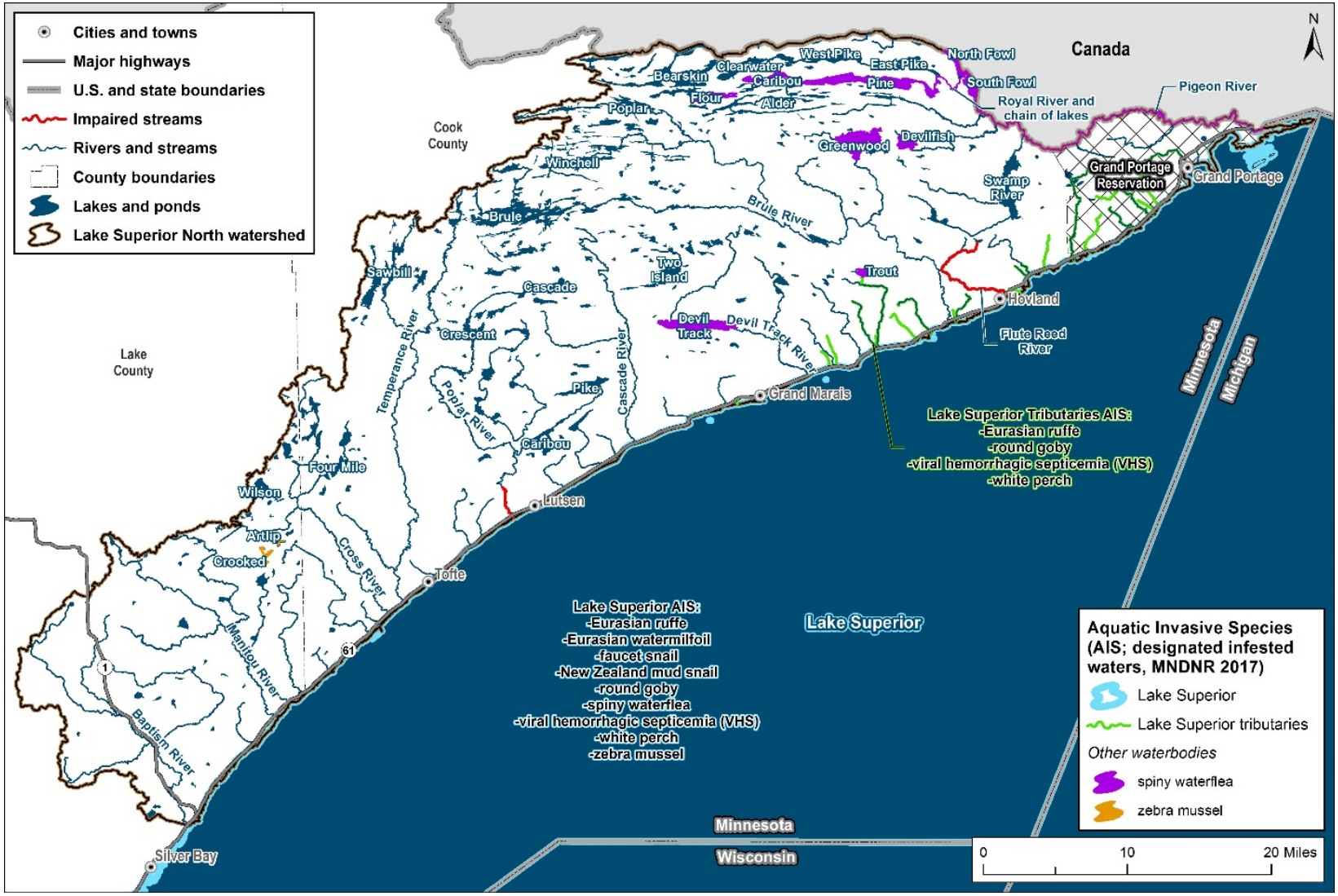

Figure 21. Designated aquatic invasive species infested waters.

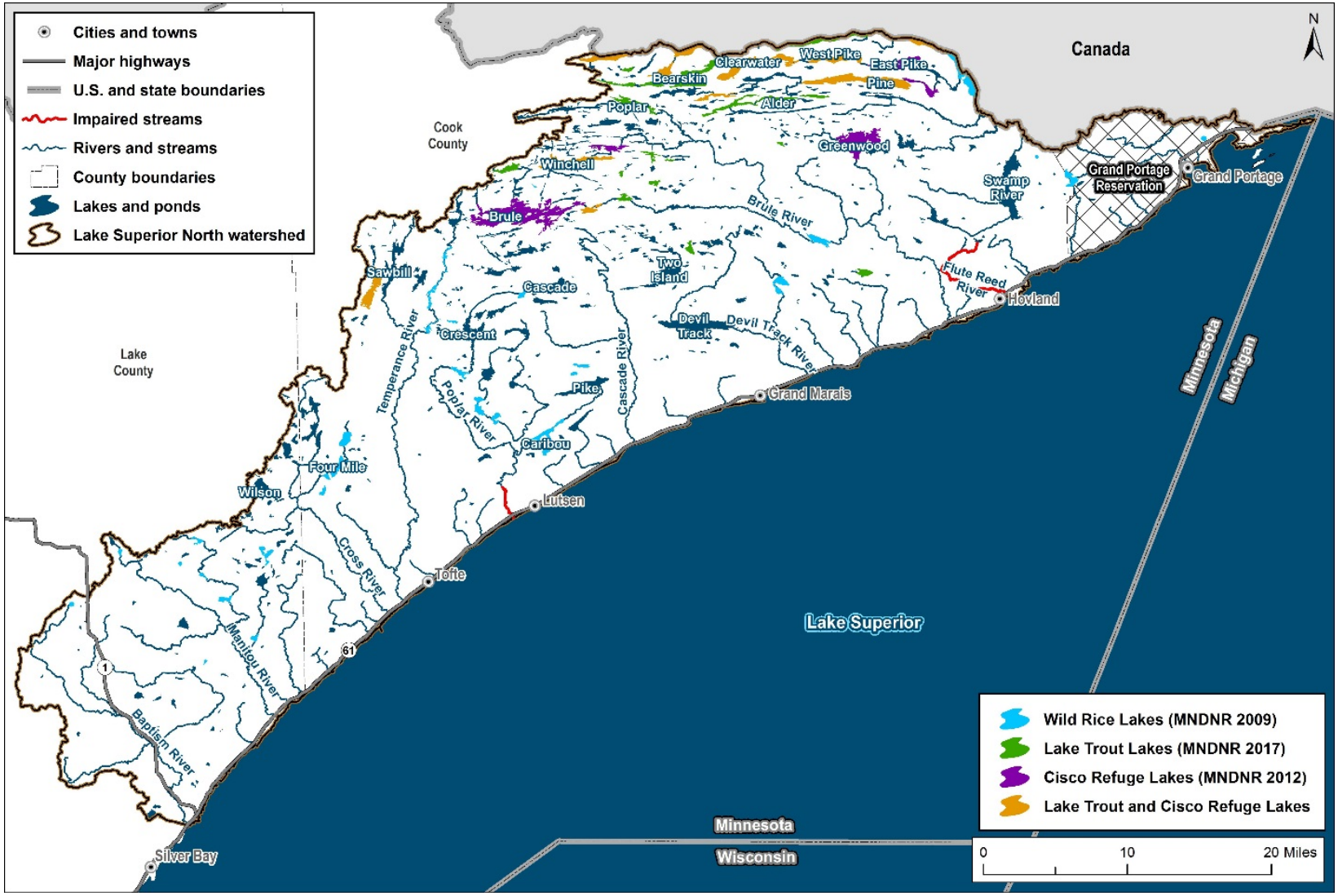

Figure 22. Lakes of biological significance.
See Table 9 for a complete listing of lakes of biological significance.

Table 9. Lakes of biological significance

Note, not all lakes included in the Monitoring and Assessment Report.

HUC 10	Lake ID	Lake Name	Lake Type
Arrow River	16023000	Rose	LT/C
	16023200	Duncan	LT/C
	16024400	South	LT/C
	16015000	Daniels	LT
	16022800	Bearskin	LT
	16024700	Birch	LT
	16024500	Dunn	LT
	16023400	Moss	LT
Brule River	16008900	Northern Light	WR
	16036000	Caribou	WR
	16035400	Winchell	LT/C
	16022300	Lux	LT [a]
	16022400	Vista	LT [a]
	16026800	Swan	LT [a]
	16023900	Poplar	LT [a]
	16007700	Greenwood	C, LT [b]
	16031900	Gaskin	C
	16034800	Brule	C
	16043500	Davis	LT [a]
	16029300	State	LT
	16039000	Grassy	WR
	16026700	Vernon	LT [a]/C
	16013500	Jim	LT
	16017000	Little Trout	LT
Pigeon River	16003600	North Fowl	WR
	38003600	Moose	WR [a]
	16004300	Moose	LT/C
	16008600	West Pike	LT/C
	16013900	Clearwater	LT/C
	16002700	McFarland	C
	16004200	East Pike	C
	16009300	Mountain	LT
	16014600	East Bearskin	LT
	16003400	South Fowl	WR
	16090100	Swamp River Reservoir	WR [b]
	16000300	Teal	WR
	16001300	Prout	WR
	16014700	Flour	LT/C
	16011400	Alder	LT
	16009000	Crystal	LT
Poplar River	16034400	Bigsby	WR
	16036900	White Pine	WR
	16037300	Christine	WR
	16038000	Gust	WR
	16045300	Rice	WR
Devil Track River	16009600	Elbow	WR
	16004100	Pine	LT/C
	16018800	Kemo	LT
	16004900	Trout	LT
Nearshore Lake Superior	16048800	Marsh	WR
Cross River	38002402	Crooked (West Bay)	WR
	16063900	Four Mile	WR
	16064300	Richey	WR

HUC 10	Lake ID	Lake Name	Lake Type
	16064500	Toohey	WR
	38002401	Crooked (East Bay)	WR
Cascade River	16025000	Mark	WR
	16000900	Swamp	WR
	16025100	Turtle	WR
Temperance River	16047600	Kelly	WR
	16047800	Peterson	WR
	16048900	Moore	WR
	16052100	Jack	WR
	16062200	Alton	LT/C
Manitou River	38025100	Hoist	WR
	38026000	Cabin	WR
	38001400	Cramer	WR
	38026100	Bluebill	WR
	38041700	Round Island	WR
Baptism River	38024600	Cramer Homestead	WR
	38041900	Crown	WR
Flute Reed River	16000600	Cuffs	WR

a: Could be removed from list based on DNR Area Fisheries review
b: Could be added to list based on DNR Area Fisheries Review
C: Cisco Refuge Lake (DNR 2012)
LT: Lake Trout Lake (DNR 2017)
WR: Wild Rice Lake (DNR 2009)

Table 10. Exceptional Use streams

Based on the most recent and final 2018 TALU classifications. Some streams were not listed in the Monitoring and Assessment Report (MPCA 2017) since their final reviews occurred after publication.

HUC 10	Name	AUID
Pigeon River (0401010102)	Irish Creek	04010101-531
	Swamp River	04010101-B66
	Portage Brook	04010101-D55
Brule River (0401010104)	Greenwood River	04010101-528
	Bluff Creek	04010101-646
	Lullaby Creek	04010101-814
	North Brule River	04010101-D30
Devil Track River (0401010105)	Devil Track River	04010101-D79
	Kimball Creek	04010101-532
	Little Devil Track River	04010101-566
	Elbow Creek	04010101-717
	Woods Creek	04010101-D61
	Kadunce River	04010101-D53
Cascade River (0401010106)	Cascade River	04010101-590
	Spruce Creek	04010101-615
Poplar River (0401010107)	Mistletoe Creek	04010101-536
Temperance River (0401010108)	Heartbreak Creek	04010101-569
	Sixmile Creek	04010101-B35
	Temperance River	04010101-D56
Cross River (0401010109)	Cross River	04010101-518
	Two Island River	04010101-547
	Houghtaling Creek	04010101-571
	Wanless Creek	04010101-783
Manitou River (0401010110)	Manitou River	04010101-534
	Manitou River, South Branch	04010101-827
	Caribou River	04010101-573
	Caribou River	04010101-575

HUC 10	Name	AUID
Baptism River (0401010111)	Baptism River, West Branch	04010101-D50
	Baptism River, East Branch	04010101-D58
	Crown Creek	04010101-581

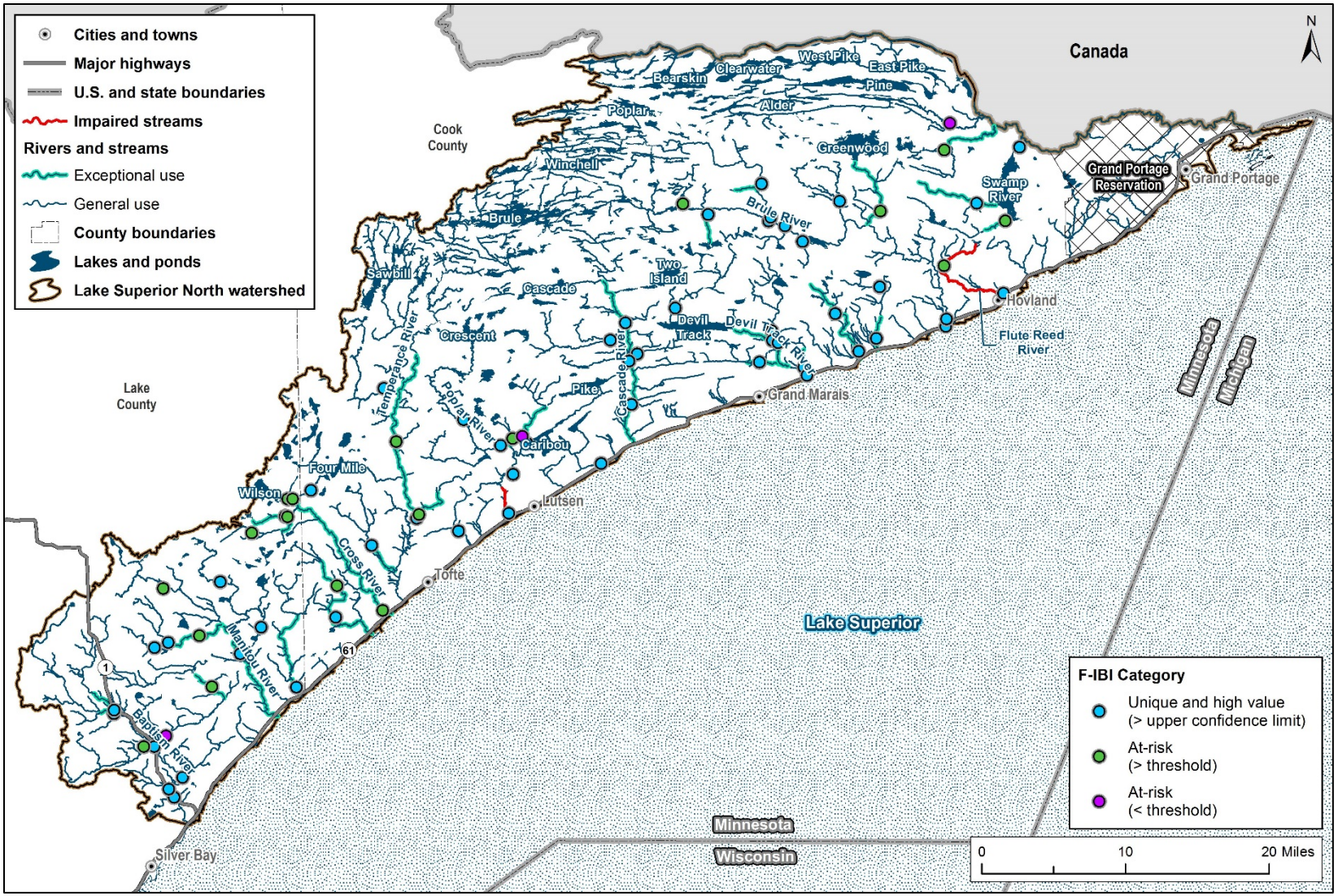

Figure 23. Categorized Fish Index of Biological Integrity (FIBI) by monitoring location. See Table 8 for more information on FIBI.

Notes: See section below entitled "Streams Identified for Protection" for a detailed description of the thresholds used in the map. See Table 10 for a complete listing of streams with exceptional use classifications.

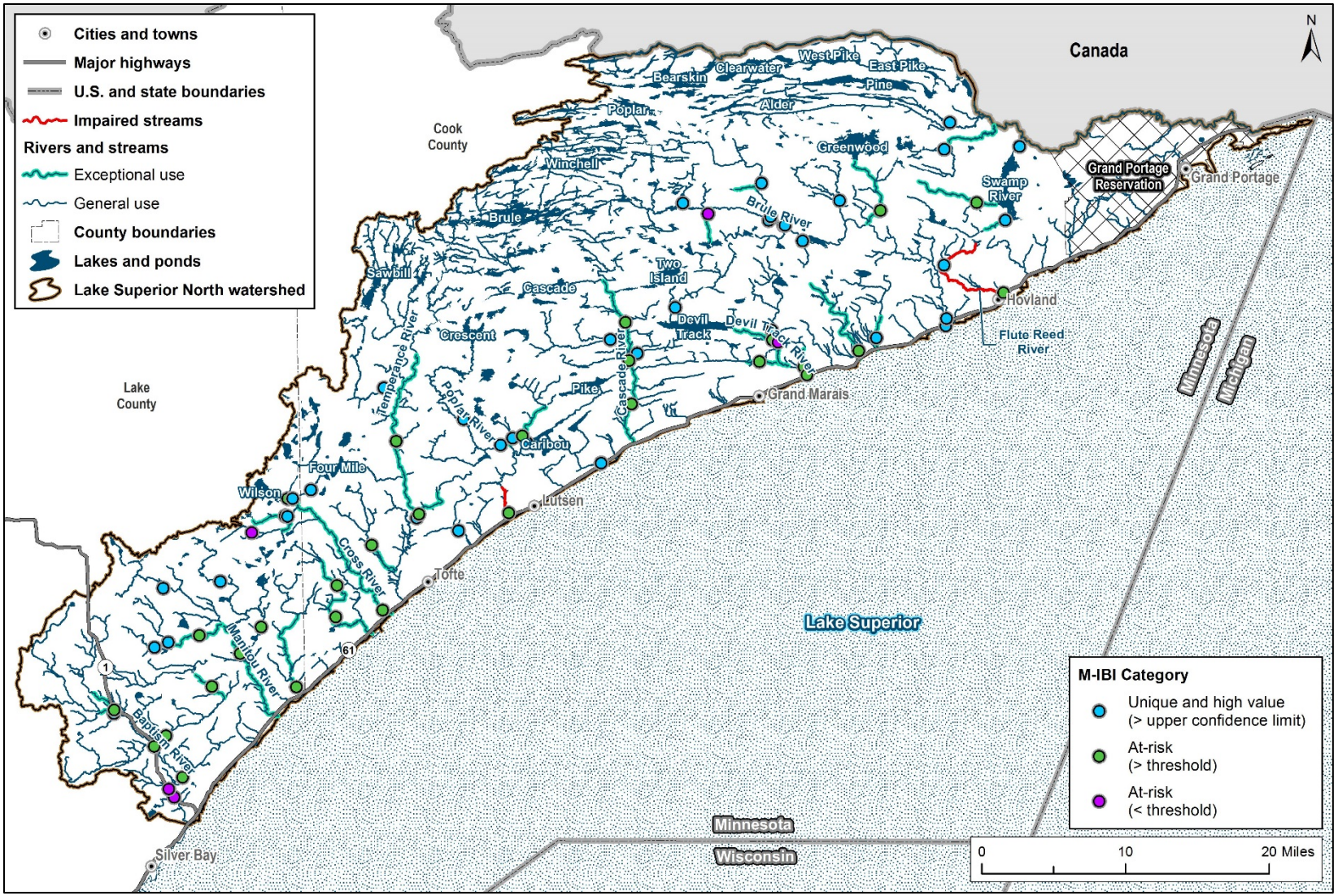

Figure 24. Categorized Macroinvertebrate Index of Biological Integrity (MIBI) by monitoring location. See Table 8 for more information on MIBI.

Notes: See section below entitled "Streams Identified for Protection" for a detailed description of the thresholds used in the map. See Table 10 for a complete listing of streams with exceptional use classifications.

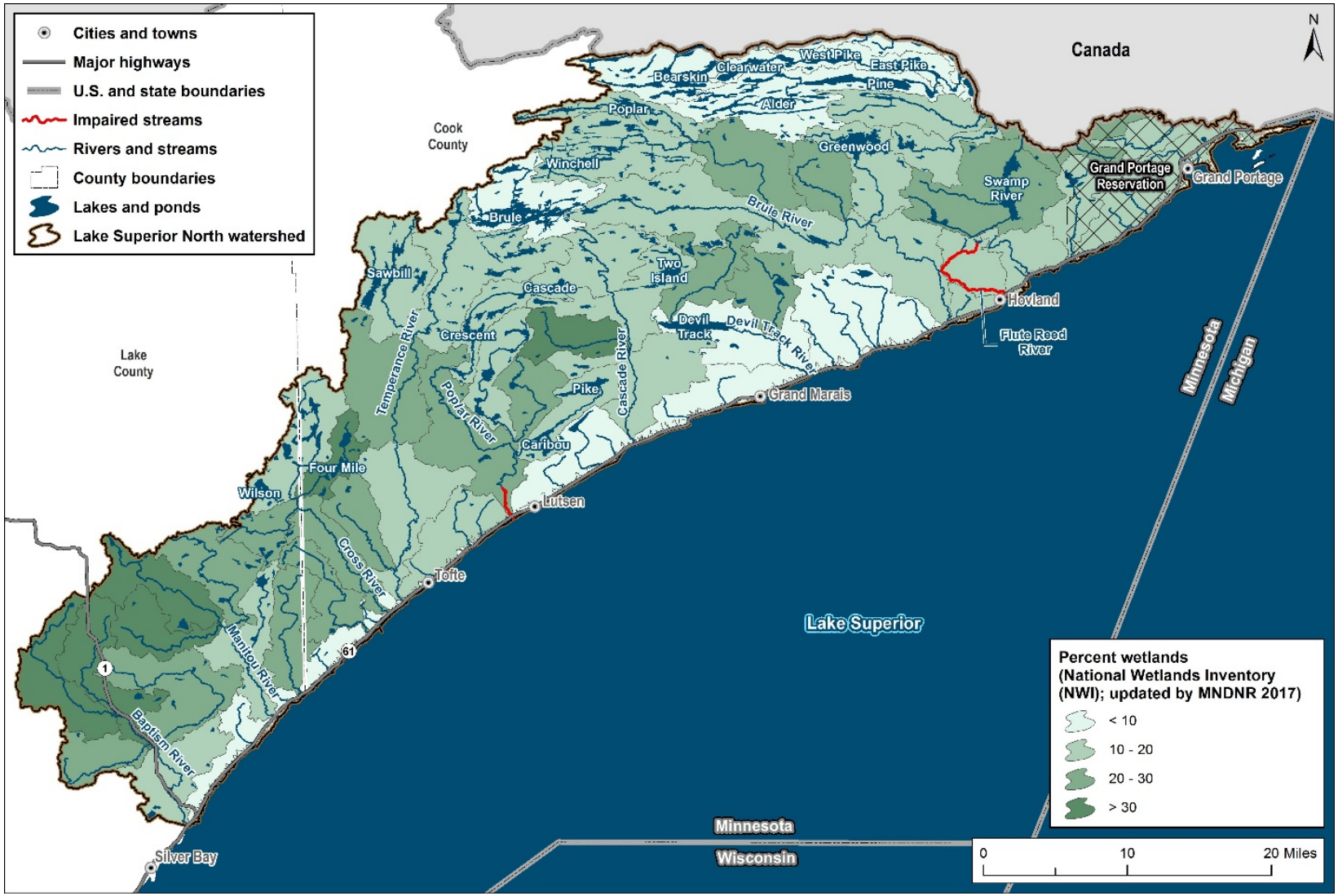

Figure 25. Percent wetlands by HUC12.

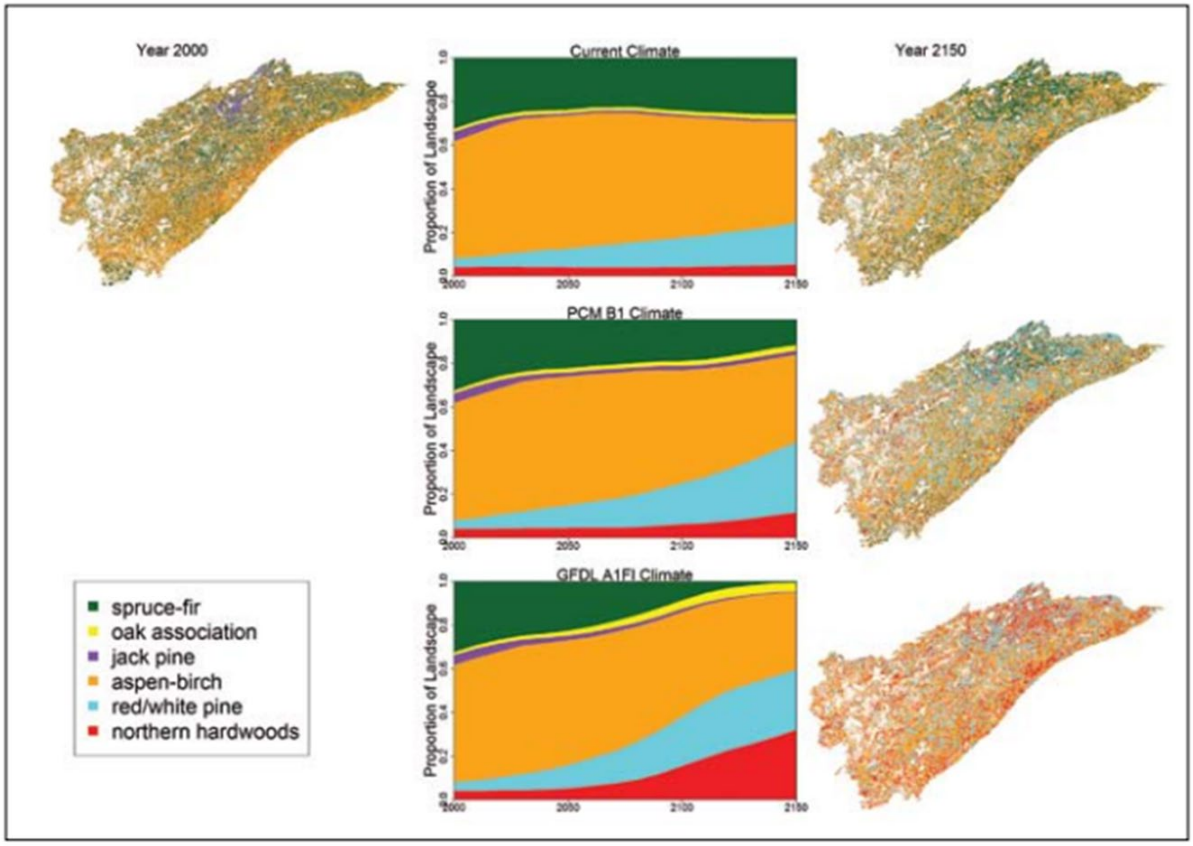

Figure 26. Projected changes in land cover from 2000 to 2150 for six forest types under three future climate scenarios in the LANDIS-II model. (Handler et al. 2014).

Larger percentages of red pine and white pine and smaller percentages of spruce-fir and aspen-birch forests are observed in the PCM B1 scenario in 2150 when compared to the current climate scenario. A more dramatic shift is seen in the GFDL A1F1 scenario in all forest types in 2150 when spruce-fir forests no longer exist and northern hardwood dominates the forest composition.

Prioritizing Lakes and Streams for Protection

In addition to the indicators listed above for protection of the LSN Watershed as a whole, specific lakes and streams were prioritized for protection. Lakes were prioritized using the results of a statewide lake prioritization effort and Core Team input, and streams were prioritized using biological (fish and macroinvertebrate) scores. The following sections discuss the methods for prioritizing and selecting candidate locations to employ protection strategies.

Lakes Identified for Protection

The LSN Watershed is unique in that it contains over 600 lakes, none of which are impaired for aquatic life or recreational use. Several of the lakes serve as exceptional water quality examples in the state, hold cultural and social significance, and/or help to support the region's tourism economy. While all lakes in the watershed should be considered for some level of protection, a level of prioritization is needed. In order to develop a reasonable list of lakes to prioritize for protection over the next 10 years, a series of questions were applied to a statewide data set as depicted in Figure 27.

1. *Is the lake in the watershed?*

   For the purposes of the LSN WRAPS document, it is important to ensure that all lakes contained in the watershed were included in the prioritization effort and compared on a watershed level. An inclusive statewide list of lakes was clipped to only those contained within the LSN Watershed. Overall, the watershed contains 631 lakes.

2. *Is the lake within the Boundary Waters Canoe Access Area?*

   Waters within the BWCA have extensive protection and restrictions already in place on fishing, forestry, development and other potential stressors in the LSN Watershed. Based on this, and with support from stakeholder groups, lakes within the BWCA were determined to have sufficient protection and were filtered from the lake prioritization list. Of the 631 lakes within the LSN watershed, 334 were outside of the BWCA.

3. *Does the lake have sufficient* Environmental Quality Information System *(EQuIS) data for analysis?*

   Sufficient data is necessary for prioritization efforts and trend analysis. For the purposes of the WRAPS document, sufficient data means five or more sample dates for multiple parameters, and had samples taken within the last 10 years. Out of the 334 lakes in the watershed and outside the BWCA, 58 lakes were determined to have sufficient EQuIS data.

4. *Was the lake evaluated in the statewide lake prioritization effort?*

   The statewide lake prioritization effort was conducted by an interagency group consisting of staff from MPCA, DNR, BWSR, MDA, and MDH. The effort developed goals for lakes that meet water quality standards, identified unimpaired lakes that are at greatest risk, and developed a preliminary priority ranking for protection efforts. Water quality risk is determined by each lake's sensitivity to increased phosphorus loading, proximity to the water quality standard, the percent of disturbed land use in the watershed, lake size, existing phosphorus levels, and whether the lake shows a declining trend in water clarity (MPCA et al. 2017). Of the 58 lakes with sufficient EQuIS data, a total of 54 lakes were also included in the state prioritization effort.

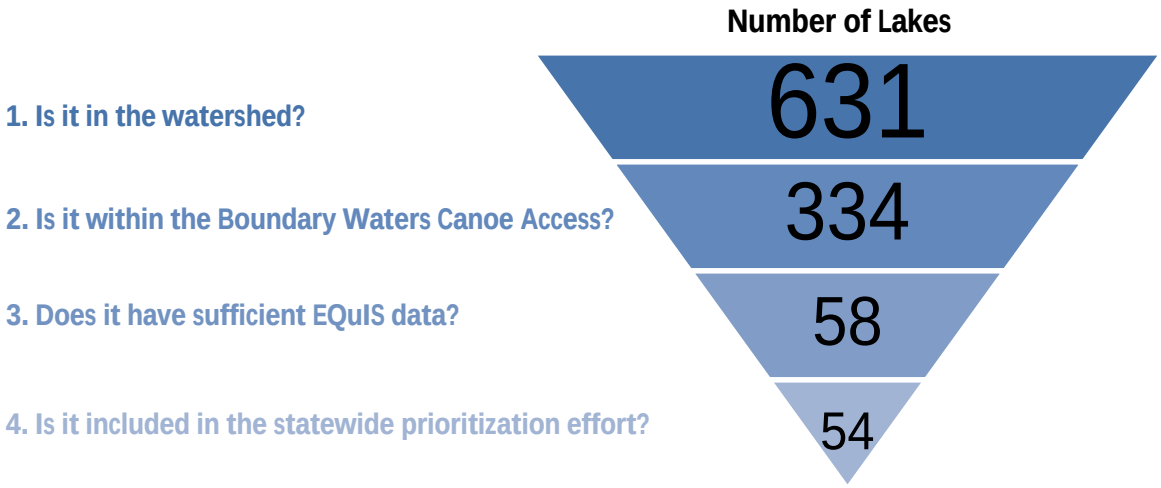

Figure 27. Lake Prioritization Process for the LSN Watershed.

A final check was also conducted to ensure all 54 lakes were mentioned in the Monitoring and Assessment Report for LSN (MPCA 2017). Of the 54 lakes, Johnson Lake was not included in the Monitoring and Assessment Report, but was still included in the final list.

Remaining lakes were then prioritized for protection based on the ranks provided in the statewide prioritization effort and local stakeholder input. Lakes of biological significance (lake trout lakes or designated trout lakes), especially those with phosphorus levels nearing the standard, and lakes with existing and active lake associations were given higher prioritization based on stakeholder input (Table 11). Lake Superior is also identified for protection consideration, as it has experienced some change in trophic status in nearshore areas with increasing levels of attached algae and turbidity. In addition, Lake Superior has been identified by the U.S./Canada International Joint Commission as a demonstration lake and is recognized nationally and internationally as one of world's most important freshwater lakes. Appendix B provides the full list of lakes that were analyzed.

Table 11. At-risk lakes identified for protection

Lake Name	Lake ID	Lake Type	Secchi Depth (m)[a]	Average Total Phosphorus (µg/L) [a]	P Sensitivity Score [a]	% Disturbed [a]	Lake Association [b]	HUC 10
Tom	16001900		3	12.1	22.4	2.6%		401010102
Devil Track	16014300		3	12.1	4.7	1.9%	√	401010105
Hungry Jack	16022700		5.3	7.8	50.5	2.6%	√	401010101
Birch	16024700	LT [c]	5.5	8.1	73.2	3.8%		401010101
Deer Yard	16025300		2.9	16.3	31.8	1.2%	√	401010106
Divide [d]	38025600	T	3.7	15.0	8.9	0.7%		401010110
Poplar	16023900	LT	3.7	9.6	18	2.5%	√	401010104

Lake Name	Lake ID	Lake Type	Secchi Depth (m)[a]	Average Total Phosphorus (µg/L) [a]	P Sensitivity Score [a]	% Disturbed [a]	Lake Association [b]	HUC 10
Superior	Not assessed as part of statewide prioritization effort							Multiple

LT: lake trout lake (DNR 2017). T: designated trout lake (DNR 2017)

a: Number from statewide prioritization effort

b: Lake Association list provided by CCCoLA members

c: Lake Trout are still present but in low numbers (DNR correspondence)

d: Average total phosphorus is nearing the standard for designated trout lakes (20 µg/L)

Streams Identified for Protection

As noted in Section 2.1, most streams meet water quality standards and, in many cases, are significantly better than the standards. Although all rivers and streams require some level of protection, select streams within the LSN Watershed were identified as potential at-risk waters, or unique and high value waters. These streams are identified based on their index of biotic integrity (IBI) scores paired with the stream's TALU designation that assigns biological goals to a stream. The current TALU process defines three potential categories: exceptional use, general use and modified use. Once the highest use for a stream has been established, it should remain at that use. Two TALU designations for streams exist in the LSN Watershed – general and exceptional use. Exceptional use streams are those that support biological communities at or near natural conditions. General use streams support good or healthy aquatic communities (MPCA 2015).

Figure 23 and Figure 24 summarize the IBI data and TALU designations. Biological monitoring sites on exceptional use streams are indicated with a star. The blue markers ("> upper confidence limit") indicate streams that are comfortably meeting IBI targets for their use (general or exceptional). The green and purple markers ("> or < threshold") indicate streams with IBI scores that are close to the targets and are considered threatened of becoming impaired. No streams were below the lower confidence limits for either use. The streams that are near the expected target score for either fish or macroinvertebrate IBI (green and purple markers) are unimpaired, but at risk of becoming so. These streams are considered for protection because they are potentially vulnerable to impairment in the future. It is possible that some of the lower scoring monitoring sites are due to poor monitoring site selection, physical barriers downstream, or application of a target that is not reflective of the stream condition. Using this review process, the streams identified as potentially threatened based on fish and macroinvertebrate IBI data include:

- Baptism River
- East Branch Baptism
- West Branch Baptism
- Hockamin Creek
- Manitou River
- South Branch Manitou River
- Houghtaling Creek
- Two Island River
- Cross River
- Wilson Creek
- Six Mile Creek
- Temperance River

- Mistletoe Creek
- Greenwood River
- Flute Reed

The MPCA has recently completed a process for stream prioritization, similar to lake prioritization, which provides a ranked list of streams for each watershed. Once the MPCA process is finalized and available for WRAPS use, the LSN stakeholders and resource professionals may choose to review and revise the list as defined above.

Local concerns can also be factored into a final selection of prioritized streams. For example, Devil Track River is identified as a priority in the LSN 1W1P. Devil Track River is a system classified for the most part as exceptional use, but its watershed lies within a developing corridor located between Grand Marais and Devil Track Lake, a lake with significant shoreline and lakeshed development. The river watershed includes industrial operations such as aggregate mining, a large sawmill operation and commercial airport, as well as semi-urban, lakeshore, and rural residential developments. The potential for future change in the watershed should be factored into future management of the watershed. As a result of local concerns, the 1W1P plan highlighted the area as a priority target for future work and, in addition to the other high priority areas in the 1W1P, was therefore identified as a targeted geographic area for the LSN WRAPS. Targeted geographic areas are described in greater detail in Section 3.1.

3. Prioritizing and Implementing Restoration and Protection

The LSN Watershed contains several exceptional streams, lakes, and natural areas that require protection efforts to maintain their current conditions. Two streams are listed as impaired in the watershed. One has undergone significant restoration work to date and is proposed for removal from the impairment list. This leaves one, the FluteReed River, in need of restoration efforts. There are also several water resources that are threatened and vulnerable to land use changes and management activities.

Sediment, nutrients, high water temperatures, physical habitat degradation, barriers to aquatic organism passage, altered food webs, stream power, flashiness, and altered hydrology contribute to these challenges. Protection and restoration strategies to address these concerns are provided by stream in Section 3.3. Additional activities that promote protection include land use planning and conservation.

The Clean Water Legacy Act (CWLA) requires that WRAPS reports summarize priority areas for targeting actions to improve water quality, and identify point sources and nonpoint sources of pollution with sufficient specificity to prioritize and geographically locate watershed restoration and protection actions. In addition, the CWLA requires an implementation table of strategies and actions that are capable of cumulatively achieving needed pollution load reductions for point and nonpoint sources. As noted in the Executive Summary, a 1W1P pilot project was completed in LSN. Development of WRAPS strategies endeavored to be consistent with the 1W1P effort, avoid redundancy, minimize meeting fatigue, and allow for new strategy recommendations to be explored from tools and data associated with WRAPS analysis.

This section of the report provides the results of prioritization and strategy development. Because many of the nonpoint source strategies outlined in this section rely on voluntary implementation by landowners, land users, and residents of the watershed, it is imperative to create social capital (trust, networks, and positive relationships) with those who will be needed to voluntarily implement best management practices. Thus, effective ongoing civic engagement is fully a part of the overall plan for moving forward.

The implementation strategies, including associated scales of adoption and timelines, provided in this section are the result of technical input from agency staff and professional judgment based on what is known at this time and, thus, should be considered approximate. Furthermore, many strategies are predicated on needed funding being secured. As such, the proposed actions outlined are subject to adaptive management—an iterative approach of implementation, evaluation, and course correction.

3.1 Targeting of Geographic Areas

The primary purpose of this section is to identify targeted or critical areas in which to focus implementation activities during the first 10 years of implementation. While the previous section identifies specific waterbodies to prioritize for protection and provides protection strategies to consider in management decisions, this section contains the geographic areas within the watershed in which to focus implementation activities and to leverage local interest and momentum in the watershed.

In order to align with local planning efforts and priorities, targeted geographic areas for the LSN WRAPS are identified based on a prioritization and ranking process that was conducted during development of the LSN 1W1P. The 1W1P process reflects local priorities in the watershed and involved numerous public meetings with stakeholders, integration of local and regional management plans, expertise from regional partnering agencies and organizations, and the output of the Zonation model. Zonation is a value-based model that uses a combination of individual landscape features and analyzed spatial information about these criteria to prioritize areas for conservation and restoration. Some of the spatial input used in Zonation reflects the indicators in Figure 11 through Figure 26; however, stakeholders were limited in what indicators they could input to the model. The highest priority areas that were identified in the 1W1P are also identified as targeted geographic areas in the LSN WRAPS, and the focus of the first 10 years of watershed project implementation (Table 12 and Figure 28). During the WRAPS process, review of all subwatersheds occurred using the geographic information system (GIS) discovery tools highlighted by the maps in this document. This generated additional conversation on targets not captured in the 1W1P process.

Table 12. Targeted areas for protection and restoration

Name (from 1W1P)	Description (from 1W1P)
Poplar River	· 303(d) list of impaired waterbodies [a] · Includes designated trout streams · Identified as catchments of rivers vulnerable to pollution · Includes areas of biological significance · Susceptible to groundwater contamination
Flute Reed River	· 303(d) list of impaired waterbodies · Includes designated trout streams · Identified as catchments of rivers vulnerable to pollution · Includes areas of biological significance; susceptible to groundwater contamination
Devil Track Lake	· Highly developed watershed · Historical alteration from logging and development within watershed · Potential mining impact on water resources · Shoreland development on lakes
Near Shore Lake Superior	· Strong potential for future land development · Known septic system issues · Significant shoreline management issues, including the presence of a number of erosion hazard zones · Trout catchments · Includes a significant number of rare features and sites of biological significance
City of Grand Marais	· One of the two largest municipalities in the watershed · Increased land development pressure · Includes area within the Lake Superior shoreline erosion hazard zone · Includes areas of biological significance · Susceptible to groundwater contamination · Source Water Assessment Area for four Community Public Water Suppliers identified as a high priority by MDH
Baptism River Watershed	· Includes high-quality natural areas · Areas of high biological significance

Name (from 1W1P)	Description (from 1W1P)
	· Tettegouche State Park · Susceptible to groundwater contamination · Includes vulnerable catchments
Mid (Gunflint) Trail Lakesheds Poplar and Hungry Jack	· Shoreland development on Poplar and Hungry Jack lakes · Boundary Waters Canoe Area Wilderness entry access · Superfund site within watershed · Some lakes within watershed have up to 90% privately owned lakeshed and possibility of increased developmental impact
Cascade Lower River	· Includes high-quality natural areas · Areas of high biological significance · Cascade State Park · Susceptible to groundwater contamination · Includes vulnerable catchments
McFarland Lakeshed	· Shoreland development on McFarland Lake · Boundary Waters Canoe Area Wilderness entry access · Historical lots have land use practices that are a source of possible impact to water quality
Cross River Watershed	· Moderate potential for groundwater contamination
Cascade River Upper and Middle	· Moderate potential for groundwater contamination; significant degrees of shoreland development
Mid (Gunflint) Trail Lakesheds West/East Bearskin	· Strong development pressure · Evidence of nutrient loading · Includes sites of biological significance within the lakesheds
Greenwood Lake	· Strong development pressure · Evidence of nutrient loading · Includes sites of biological significance within the lakesheds

a: The Poplar River was proposed for delisting in the 2018 draft 303(d) list.

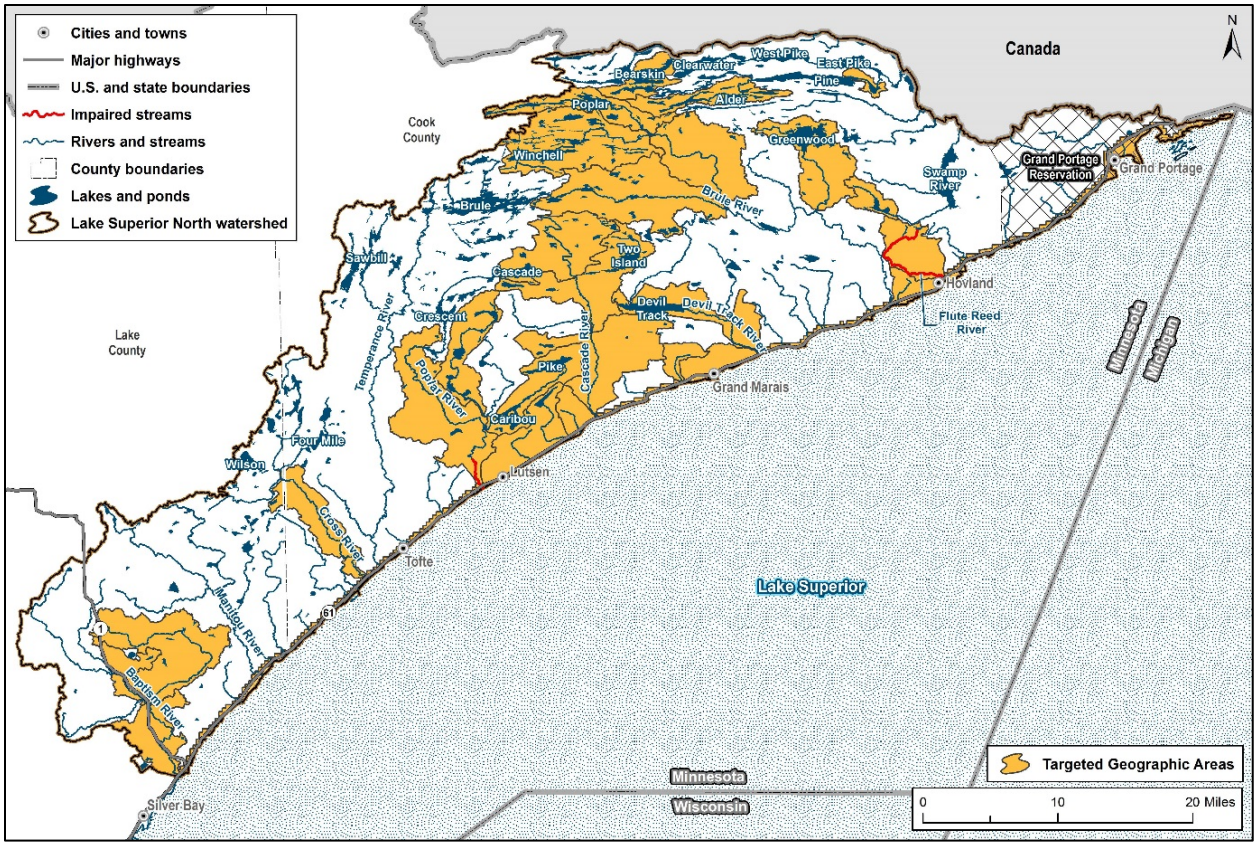

Figure 28. Targeted geographic areas for restoration and protection.

3.2 Civic Engagement

A key prerequisite for successful strategy development and on-the-ground implementation is meaningful civic engagement. This is distinguished from the broader term 'public participation' in that civic engagement encompasses a higher, more interactive level of involvement. The MPCA has coordinated with the University of Minnesota Extension Service for years on developing and implementing civic engagement approaches and efforts for the watershed approach. Specifically, the University of Minnesota Extension's definition of civic engagement is "Making 'resourceFULL' decisions and taking collective action on public issues through processes that involve public discussion, reflection, and collaboration" (Figure 29). Extension defines a resourceFULL decision as one based on diverse sources of information and supported with buy-in, resources (including human), and competence. Further information on civic engagement is available at: http://www1.extension.umn.edu/community/civic-engagement/.

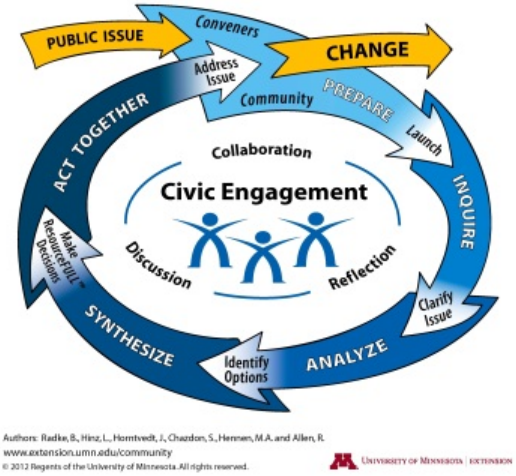

Figure 29. Resourcefull decision making process.

Accomplishments and Future Plans

The LSN Watershed has several entities that conduct civic engagement related to water quality protection and restoration. Key examples are listed below.

Cook and Lake County Soil and Water Conservation Districts

Cook and Lake County SWCDs actively participate in water resources civic engagement efforts in their respective counties. In 2012, the two SWCDs conducted a multi-year civic engagement project in preparation for and during the WRAPS effort referred to as the Cook County SWCD Civic Engagement & Project Support Watershed Restoration and Protection Project. The project aimed to build:

- Knowledge about the watershed approach among watershed residents
- A communication network to exchange knowledge
- A sense of shared concern about watershed related issues through events, workshops, forums or other organized activities
- A trusted foundation for future water related work among a group of new collaborators

Activities conducted under the project included the development of the LSN Watershed Team in 2013, and several outreach products such as radio spots, workshops, website updated, water monitoring workshops, newspaper insert and articles, and monthly radio interviews. Examples of activities include:

- Cook County SWCD's citizen lake and stream monitoring program https://www.youtube.com/watch?time_continue=280&v=D2tJcnDXu8c
- Lake County Radio Spot: "Conservation Corner" on Two Harbors Community Radio. http://www.co.lake.mn.us/departments/soil_and_water_conservation_district/radio.php#geSgJU847wXYeZqI.9

Both SWCDs will continue to lead education and outreach activities in the LSN Watershed.

One Watershed, One Plan for the LSN Watershed

During the development of 1W1P for the LSN Watershed, public meetings were held to create opportunities for local constituents to participate in identifying water quality concerns in the watershed, and to provide the public with background information and an overview of the 1W1P process. Broad natural resource issues were discussed to gain local insight to water quality problems. The following topics were discussed:

- Reducing erosion and runoff
- Protecting/improving waters of concern
- Protecting/improving fish and wildlife habitat
- Protecting/focusing on lands of concern

Citizen input was gathered and incorporated into the Zonation planning process. For more information, see Appendix A of the Lake Superior North 1W1P.

WRAPS Development

During the development of the WRAPS, three stakeholder meetings were held for technical advice and strategy prioritization: May 24, 2017; July 27, 2017; and February 26, 2018. An additional meeting concerning development of the Flute Reed River TMDL was held on July 17, 2017, in Hovland with the Flute Reed Stream Partnership.

Also, throughout the WRAPS process, the MPCA staff participated in a variety of local meetings to provide updates on the purpose and development of the LSN WRAPS document, outcomes of data collection, condition of the lakes and streams in the watershed and request feedback from interested stakeholders.

Public Notice for Comments

An opportunity for public comment on the draft WRAPS and TMDL reports were provided via a public notice in the State Register from June 18, 2018 through July 18, 2018. No comments were received.

3.3 Restoration & Protection Strategies

The LSN Watershed is unique as it contains many exceptional water resources, few impairments, and relatively low population density. As such, watershed strategies are able to focus predominantly on protection efforts, with less emphasis on restoration efforts. During the development of the WRAPS, existing watershed plans and assessments provided meaningful, local knowledge to the selection of strategies. This section provides a summary of implementation strategies and actions for both restoration and protection. During the development of the WRAPS, existing plans, assessments, and priorities were referenced and provided meaningful, local knowledge to the selection of the restoration and protection strategies, including:

- LSN 1W1P
- LSN Stressor Identification Report
- Flute Reed River TMDL
- Poplar River TMDL
- Sustaining Minnesota's Lake Superior Tributaries in a Changing Climate
- USDA Forest Adaptation Resources: Climate Change Tools and Approaches for Land Managers
- Climate Change Field Guide for Northern Minnesota Forests
- Minnesota Forest ecosystem vulnerability assessment and synthesis: a report from the Northwoods Climate Change Response Framework Project
- Cook County Coalition of Lake Associations list of priorities for the 25 by 2025 effort

There are several strategies that apply across the entire watershed; these are provided in a watershed-wide summary table. See Table 14a. In addition, many strategies apply to the near-shore Lake Superior area. These strategies are presented in Table 14b. Lastly, strategies are also summarized at a HUC10 subwatershed scale (Tables 14c-14m). In an effort to coordinate and align the WRAPS document with

the 1W1P for the area, specific goals from the 1W1P that are applicable to the WRAPS document were included as restoration and protection strategies and are delineated by *italics* when applicable. The summary tables include the following information:

- ***Water Quality – Current Conditions:*** "Current" condition is interpreted as the baseline condition over the evaluation period for the pollutant or non-pollutant stressor identified in the previous column. Current loads represent available data sources.
- ***Water Quality – Goals / Targets and Estimated % and Load Reduction by Flow Regime:*** Includes the reductions needed to meet water quality standards, and are referenced to Appendix A that includes the TMDL summaries. Percent reductions are typically included as a range that covers the different flow regimes (e.g., reductions under high flow and dry conditions) when a TMDL is provided for multiple flow regimes (see Appendix A). The range represents the highest and lowest reduction needed across all flow regimes.
- ***Strategy and Strategy Type:*** These columns provide the strategies to be used for both protection and restoration. Strategies outline the method, approach, or combination of approaches that could be taken to achieve or maintain water quality goals.
- ***Estimated Adoption Rates:*** These columns tie to the strategies column and generally describe the magnitude of effort that it will take to achieve the 10-year milestones and ultimate implementation goal. These estimates are meant to describe approximately "what needs to happen" but does not detail precisely "how" goal attainment will be achieved (the latter is left to subsequent planning steps). These estimates are an approximation only and subject to adaptive management. Note that some water bodies do not have any planned activity during the first 10 years. These water bodies are lower priority and activities are expected to take place in the future.
- ***Governmental Units with Primary Responsibility:*** Identifies the governmental unit with primary responsibility. Other government entities as well as stakeholders, non-profits, and non-governmental organizations will likely support these strategies.
- ***Estimated Year to Achieve Water Quality Targets:*** This applies to the water body, specifically the year it is reasonably estimated that applicable water quality targets will be achieved. These dates are based on the level of implementation needed to achieve standards, watershed priorities, and best professional judgement. Activities related to protection efforts are ongoing.

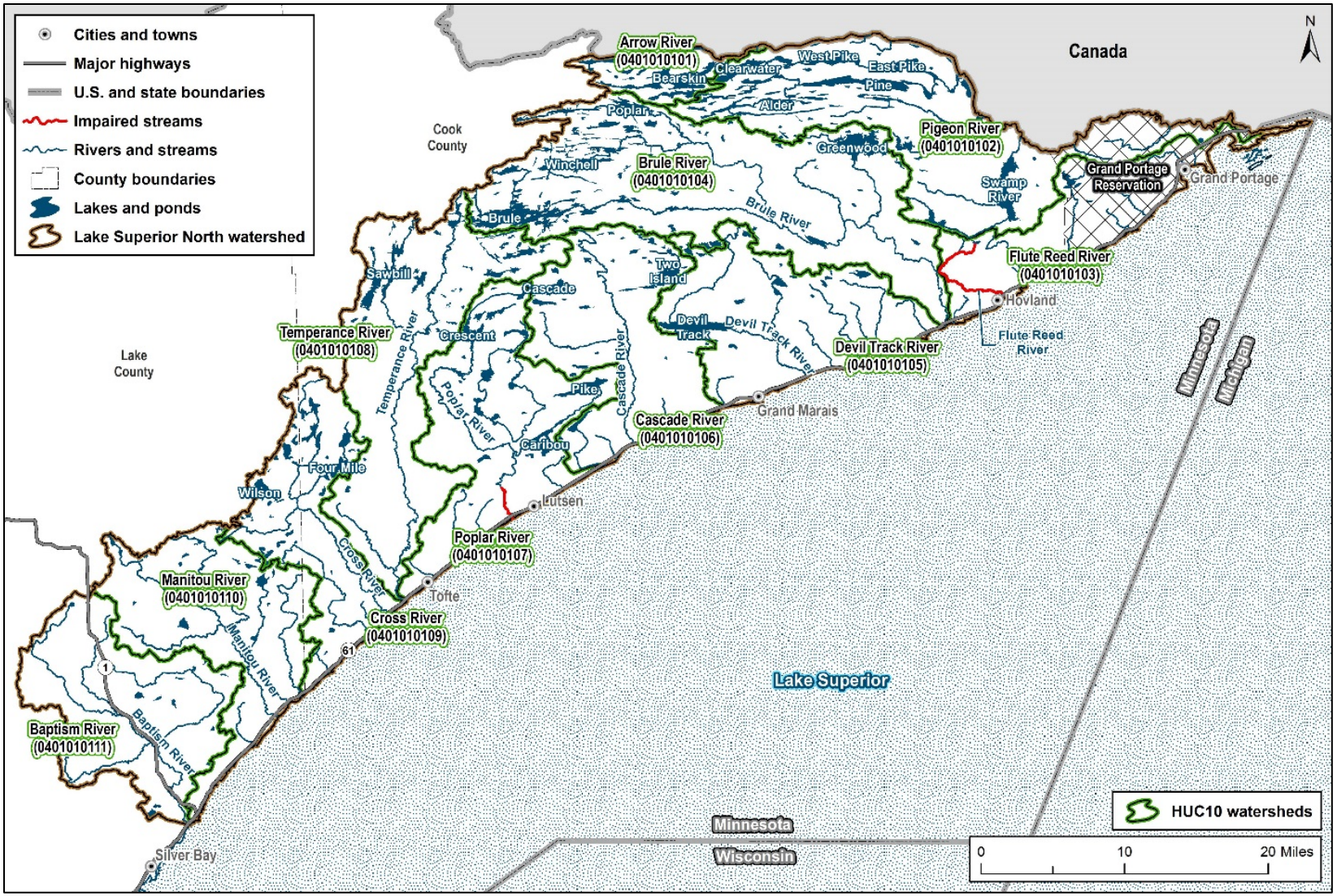

Figure 30. LSN HUC10 watersheds.

Achieving the goals of this WRAPS will require partnerships and collaboration, in addition to financial resources. Governmental units with primary implementation responsibility include the following entities:

- Counties (Cook and Lake)
- SWCDs (Cook and Lake)
- Municipalities
- MPCA
- DNR
- MDH
- BWSR
- USDA Forest Service

Government agencies with secondary responsibilities include the MDA, USDA Natural Resource Conservation Service (NRCS), and Fish and Wildlife Service. These and other agencies will work with private landowners and other agencies and project partners to support implementation of this WRAPS. In addition, many other partners are anticipated to participate, with implementation including:

- Grand Portage Band of Chippewa Indians
- Mining and forestry interests
- State and local non-profits (e.g., Trout Unlimited, Flute Reed Partnership)
- Universities
- Business owners

Local lake and river associations can provide the grassroots energy and organization to help support WRAPS implementation, and can play an integral part in civic engagement activities. The following local associations are active in the LSN Watershed:

- Flute Reed River Watershed Partnership
- Poplar River Management Board
- Cook County Coalition of Lake Associations (CCCoLA) (Table 13)

Table 13. Lakes Associations within CCCoLA

Cook County Coalition of Lake Associations		
· Caribou-Lutsen · Clearwater · Deer Yard · Devil Track · Friends of Tait Lake · Gunflint Lakes (Loon and Tucker within LSN)	· Hungry Jack · Lace · Leo · Mid-Trail Property Owners · North Tom · Pike	· Poplar · Seagull/Saganaga · Trout · Voyageurs Point/Poplar · West Bearskin

The proposed strategies will rely on available funding sources to fund projects and programs. The level of implementation proposed for the first 10 years is significantly higher than current efforts, and will require new sources of funding for local capacity and capital improvement projects.

Potential funding sources for implementation activities in the LSN Watershed include:

- Clean Water Fund, part of the Clean Water, Land, and Legacy Amendment
- Outdoor Heritage Fund, part of the Clean Water, Land, and Legacy Amendment
- Legislative-Citizen Commission on Minnesota Resources
- Local government cost-share and loan programs
- Minnesota Lake Superior Coastal Program
- Minnesota Clean Water Partnership Loan Program
- Conservation Reserve Program and NRCS cost-share programs
- Federal Section 319 program for watershed improvements
- Great Lakes Restoration Initiative
- National Fish and Wildlife Foundation
- Great Lakes Protection Fund
- Great Lakes Commission
- Other federal grants and technical assistance programs

Table 14. Watershed Strategy Tables are in separate files

- Table 14a Watershed Wide Table: strategies that apply across the LSN Watershed
- Table 14b Nearshore Table: strategies that apply to only nearshore Lake Superior. Includes references to watershed wide strategy table.
- Table's 14c-m HUC10 specific tables: One table for each HUC10 watershed arranged alphabetically. Contains strategies specific to HUC 10 and references to the watershed wide table

4. Monitoring Plan

Monitoring of flow and water quality are needed to refine source assessments, further focus implementation activities identified as part of the WRAPS process, inform protection efforts for all unimpaired uses, and evaluate the effect of improvements for those resources that show declining trends in water quality or are currently impaired. New data can also be used to further improve watershed modeling efforts. Monitoring is also a critical component of an adaptive management approach and can be used to help determine when a change in management is needed. This section describes recommended monitoring activities in the watershed, contingent on available resources and priorities.

It is the intent of the implementing organizations in this watershed to make steady progress in terms of pollutant reduction in both impaired and non-impaired streams, as needed. Accordingly, as a very general guideline, progress benchmarks are established for the Flute Reed River, a currently impaired stream, that assume improvements will occur resulting in a water quality pollutant concentration decline each year equivalent to approximately 5% of the starting (i.e., long-term) pollutant concentration. Overall watershed progress benchmarks (for non-impaired waters in need of some pollutant reduction) suggest, at a minimum, reductions at approximately 1% to 2% with more specific targets decided on for each water body in future planning efforts.

Factors that may mean slower progress include: limits in funding or landowner acceptance, challenging fixes (e.g., unstable bluffs and ravines, invasive species), and unfavorable climatic factors. Conversely, there may be faster progress for some waters, especially where high-impact fixes are slated to occur. Monitoring efforts will be used to evaluate water quality trends and ensure protection efforts are being effectively implemented.

Existing Monitoring Efforts

The MPCA conducted intensive monitoring throughout the watershed during 2013 and 2014. These and past monitoring efforts by the MPCA are summarized in the monitoring and assessment report (MPCA 2017). It is anticipated that the next round of intensive monitoring will begin in 2023. In addition, the MPCA and partners have established several sites in the watershed as part of the state's Watershed Pollutant Load Monitoring Network (WPLMN) program including:

- Poplar River near Lutsen 0.2 miles upstream of MN61
- Brule River near Hovland, MN61
- Baptism River near Beaver Bay, MN61

The long-term WPLMN measures and compares data on pollutant loads from Minnesota's rivers and streams and tracks water quality trends. WPLMN data will be used to assist with assessing impaired waters, watershed modeling, determining pollutant source contributions, developing watershed and water quality reports, targeting restoration and protection activities, and measuring the effectiveness of water quality restoration and protection efforts.

The Long-Term Biological Monitoring program, managed by the MPCA staff, includes 60 monitoring stations, 4 of which are part of EPA's regional monitoring network. Data collected includes water chemistry, fish and invertebrates, temperature, discharge, habitat condition and channel stability assessments, watershed characteristics and site photos. LSN sites include Manitou River, Heartbreak Creek, Irish Creek, Temperance River, and Elbow Creek. The program is designed to enhance overall understanding of aquatic community variability, document and help to better inform climate change impacts to the biomonitoring program, and evaluate site level and regional trends.

There are three sentinel lakes –Trout, Tait and, Greenwood– in the watershed. These lakes are the focus of a long-term, collaborative monitoring effort led by the DNR's Sustaining Lakes in a Changing Environment (SLICE) program. The program is designed to understand and predict the consequences of land use and climate change on lake habitats.

DNR Fisheries staff also collect various data in support of fishery management and monitoring. It is anticipated that these data will be collected into the future. DNR, with oversight by the Minnesota Forest Resources Council, also monitors forest BMP implementation in the LSN Watershed. Both the Cook and Lake SWCDs perform physical, chemical and limited biological sampling (e.g., AIS) and are working to develop more comprehensive monitoring programs that address numerous other surface and groundwater resources. There are many other project-specific monitoring efforts throughout the watershed.

Lastly, routine beach monitoring to quantify bacteria levels is conducted by the MDH and partners at various locations as part of the Beach Act. This includes monitoring sites along the Lake Superior shoreline. Due to water quality concerns along the shore of Lake Superior, Cook SWCD also began sampling Lake Superior near shore sites in 2014.

Monitoring Needs

- Monitor lake clarity and food web dynamics related to invasive species (i.e., spiny water flea, rusty crayfish)
- Collect additional in-lake water quality data (e.g., phosphorus, chlorophyll-a); collect water quality and flow data on tributaries to priority lakes
- Bacterial source tracking for beaches with *E. coli* concerns
- Additional flow monitoring at more sites
- Improve hydrologic modeling in the watershed, which will in turn improve pollutant loading estimates as recommended in the *Sustaining Minnesota's Lake Superior Tributaries in a Changing Climate* report (DNR et al. 2016)
    - Expand continuous flow monitoring to more tributaries and during winter time periods
    - Enhance current biodiversity survey (aquatic and terrestrial) to better establish baseline conditions

- Complete culvert inventory in Cook County to better understand infrastructure and conditions that may impede or restrict flow and biological connectivity, or conversely serve as grade control structures in streams that may benefit stream stability
- Better understand the effect of timber harvesting on watershed hydrology, wildlife and water resources
- Expand citizen monitoring networks for both lakes and streams (e.g., increase water clarity monitoring)
- Standardize method for monitoring wild rice in the region
- Conduct additional biological monitoring to determine if wild brook trout still inhabit Woods Creek and a major tributary upstream of County Road 60
- Investigate effects of private impoundments on water temperature, streamflow, and physical habitat conditions, in Woods Creek and other streams
- Riparian logging study on Poplar, Caribou and Durfee Creeks
- Ensure MIBI monitoring where FIBI monitoring is conducted to better understand habitat conditions

As implementation activities are conducted in the watershed, an evaluation of the before and after conditions can be useful to aid in future project planning. In addition to flow and water quality monitoring, a broader assessment of ecological function and restoration could be used to assess various components of the stream system and overall effectiveness of the implementation activity.

5. References and Further Information

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LSN Watershed Reports

Many of the LSN Watershed documents referenced in this watershed report are available at: https://www.pca.state.mn.us/water/watersheds/lake-superior-north

Appendix A. TMDL Summaries

The tables below summarize the TSS pollutant load allocations, wasteload allocations, current loading, and load reductions needed to meet water quality standards.

Table 15. TSS TMDL Summary, Flute Reed River (04010101-D31)

TMDL Parameter		Flow Regime				
		Very High	High	Mid-Range	Low	Very Low
		TSS Load (lbs/day)				
Wasteload Allocation	Construction Stormwater (MNR100001)	0.113	0.019	0.006	0.002	0.0004
	Industrial Stormwater (MNR050000)	0.225	0.038	0.011	0.003	0.001
Load Allocation		4,110	702	202	62	13
MOS		457	78	22	7	1
Loading Capacity		**4,567**	**780**	**224**	**69**	**14**
Existing Load		59,416	3,623	330	100	-
Percent Load Reduction		92%	78%	32%	31%	-

-: No data

Table 16. TSS TMDL Summary, Flute Reed River (04010101-D32)

TMDL Parameter		Flow Regime				
		Very High	High	Mid-Range	Low	Very Low
		TSS Load (lbs/day)				
Wasteload Allocation	Construction Stormwater (MNR100001)	0.132	0.021	0.006	0.002	0.0004
	Industrial Stormwater (MNR050000)	0.264	0.043	0.012	0.004	0.001
Load Allocation		4,811	779	222	68	14
MOS		535	87	25	8	2
Loading Capacity		**5,346**	**866**	**247**	**76**	**16**
Existing Load		137,752	2,569	403	94	10
Percent Load Reduction		96%	66%	39%	19%	0%

Table 17. TSS TMDL Summary, Poplar River (04010101-613) EPA approved 2013.

TMDL Parameter		Flow Regime				
		Very High	High	Mid-Range	Low	Very Low
Flow Interval (cfs)		> 260	260 – 68	68 – 41	41 – 18	< 18
Flow Interval (%)		0 – 10%	10 – 40%	40 – 60%	60 – 90%	90 – 100%
TMDL Capacity (lbs/day)		25,297	7,532	3,281	1,904	736
MOS (lbs/day)		2,530	753	328	190	74
Wasteload Allocation	Caribou Highlands WW	106	106	106	106	106
	Construction stormwater	227	67	28	16	6
Load Allocation (lbs/day)		22,434	6,606	2,819	1,592	550
Existing Load (lbs/day)		240,623	23,853	28,607	1,956	207
Percent Load Reduction		89%	68%	89%	3%	none

Appendix B. Lake Prioritization Ranks

Lake ID	Lake Name	Area basin (acres)	Lake Type	State Prioritization Rank	Secchi Depth (m)	Average TP (ug/L)	P sensitivity	% Disturbed	HUC 10	Additional Notes from Core Team Input
16001900	Tom	418.7		A	3.0	12.1	22.4	2.6%	401010102	
16002200	Lost	78.3		C	1.6	12.8	2.7	1.3%	401010104	Privately managed for trout Stream trout present
16002300	Esther	84.6	T	C	2.8	10.3	13.9	1.1%	401010104	Stream trout present
16002900	Devilfish	427.3		C	2.9	12.0	29.9	1.3%	401010102	
16003300	Chester	53.4	T	C	4.0	13.3	14.7	2.0%	401010102	Stream trout present
16004400	Boys	25.7	T	C	2.4	11.6	29.3	2.0%	401010112	Stream trout present
16004500	Kimball	80.6	T	C	3.7	11.8	19.7	2.0%	401010112	Stream trout present
16004600	Mink	59.7	T	C	3.1	13.6	16.4	2.0%	401010112	Stream trout present
16004900	Trout	263.1	LT	B	6.4	8.4	73.0	1.0%	401010112	Stream trout present
16007700	Greenwood	2109.9	LT, C	C	5.2	8.7	17.1	0.4%	401010104	
16008900	Northern Light	390.2	WR	C	1.3	13.5	2.2	1.3%	401010104	
16009600	Elbow	420.5	WR	C	1.3	19.2	10.3	1.1%	401010105	
16009800	Binagami	120.6		C	2.2	15.6	63.2	1.2%	401010105	
16010400	Musquash	136.2	T	B	3.8	7.0	128.3	1.7%	401010105	Stream trout present
16010800	Pine Mountain	110.1	T	C	2.5	8.9	89.7	0.9%	401010104	Stream trout present
16014300	Devil Track	1895.6		A	3.0	12.1	4.7	1.9%	401010105	
16014500	East Twin	178.6		C	2.4	19.8	30.6	0.7%	401010104	
16015600	Two Island	815.4		C	2.7	11.9	17.0	1.3%	401010106	
16018600	West Twin	140.9		C	3.2	10.2	86.1	0.8%	401010104	
16018800	Kemo	195.6	LT	C	4.4	7.8	78.1	0.0%	401010105	
16019400	Pine	101.3	T	C	3.7	6.8	29.1	0.5%	401010105	Stream trout present
16019800	Leo	104.9	T	C	4.4	9.9	90.2	1.0%	401010101	Stream trout present
16020400	Aspen	150.3		C	2.9	16.6	31.2	2.3%	401010102	
16022700	Hungry Jack	477.8		A	5.3	7.8	50.5	2.6%	401010101	

Lake ID	Lake Name	Area basin (acres)	Lake Type	State Prioritization Rank	Secchi Depth (m)	Average TP (ug/L)	P sensitivity	% Disturbed	HUC 10	Additional Notes from Core Team Input
16024700	Birch	254	LT	A	5.5	8.1	73.2	3.8%	401010101	Lake trout still present but in low numbers Stream trout present
16024800	Ward	41.6		C	2.1	17.7	17.6	1.1%	401010113	
16025200	Pike	836.4		B	5.5	8.6	30.8	1.5%	401010107	
16025300	Deer Yard	348.4		A	2.9	16.3	31.8	1.2%	401010113	
16034400	Bigsby	101.2	WR	C	1.2	19.3	7.1	2.3%	401010107	
16034600	Cascade	484.1		B	2.5	13.0	23.1	2.0%	401010106	
16034700	Little Cascade	270.5		C	1.4	14.1	45.1	0.7%	401010106	
16035800	Barker	154.6		C	1.2	20.5	10.2	2.0%	401010107	
16035900	Agnes	73.9		C	0.6	31.3	3.9	2.3%	401010107	
16036000	Caribou	741.4	WR	C	2.1	21.0	4.5	2.3%	401010107	
16036500	Clara	400.9		C	2.2	15.3	11.2	0.9%	401010107	
16036800	Mistletoe	151.1		C	1.1	15.3	29.3	1.6%	401010107	
16036900	White Pine	350.6	WR	C	1.6	18.7	7.3	1.4%	401010107	
16037300	Christine	191.9	WR	C	1.6	16.3	9.8	1.7%	401010107	
16038000	Gust	148.2	WR	C	1.4	19.9	38.1	2.3%	401010107	
16038200	Lichen	269.7		C	1.1	17.9	26.4	2.2%	401010107	
16038300	Bouder	133.9		C	1.6	24.3	22.4	3.0%	401010107	
16038400	Tait	371.9		C	2.2	11.2	34.4	1.1%	401010107	
16045400	Crescent	793.2		C	2.4	16.5	8.5	1.3%	401010107	
16063400	Dyers	69.9		C	2.1	22.8	5.8	2.2%	401010113	
16063900	Four Mile	607.3	WR	C	1.8	21.8	6.9	1.7%	401010109	
16064300	Richey	104.8	WR	C	1.3	28.9	29.8	1.9%	401010109	
16064500	Toohey	371.5	WR	C	1.0	23.4	13.1	1.2%	401010109	
38003300	Ninemile	333.7		B	2.7	11.5	53.9	4.0%	401010110	
38004700	Wilson	708.1		C	4.6	14.8	17.6	0.3%	401010109	
38005100	Little Wilson	57.3		C	2.2	9.6	48.8	0.3%	401010109	

Lake ID	Lake Name	Area basin (acres)	Lake Type	State Prioritization Rank	Secchi Depth (m)	Average TP (ug/L)	P sensitivity	% Disturbed	HUC 10	Additional Notes from Core Team Input
38006000	Whitefish	363.3		B	4.3	10.5	45.6	1.6%	401010109	
38024200	Johnson	35.8		C	3.7	23.0	1.5	2.1%	401010111	
38025600	Divide	63.2		C	3.7	15.0	8.9	0.7%	401010110	Stream trout present
38041500	Delay	105.8		C	2.4	14.9	62.7	0.4%	401010110	

Lake Type: C= Cisco Lake (DNR 2012), LT= Lake Trout Lake (DNR 2017), WR= Wild Rice Lake (DNR 2009), T: Designated Trout Lake (DNR 2017).