Chippewa River Watershed Biotic Stressor Identification Report

Minnesota Pollution Control Agency

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Key terms and abbreviations

AUID	Assessment Unit ID
CADDIS	Causal Analysis/Diagnosis Decision Information System
CD	County Ditch
cfs	cubic feet per second
CRWP	Chippewa River Watershed Project
DMR	discharge monitoring reports
DO	Dissolved Oxygen
DOMFiveCHPct	dominant five taxa
EPA	U.S. Environmental Protection Agency
EPT	Ephemeroptera, Plecoptera, and Trichoptera
FIBI	Page 81
GIS	Geographic Information System
HSPF	Hydrological Simulation Program–Fortran
HUC	Hydrologic Unit Code
IBI	Index of Biotic Integrity
LLVD	Taxa richness of long-lived fish species (Frimpong)
DNR	Minnesota Department of Natural Resources
mg/L	milligrams per Liter
MDA	Minnesota Department of Agriculture
MIBI	Macroinvertebrate Index of Biotic Integrity
MPCA	Minnesota Pollution Control Agency
MSHA	MPCA Stream Habitat Assessment
NAIP	National Agriculture Imagery Program
NCHF	North Central Hardwood Forest
NGP	Northern Glaciated Plains
NLCD	National Land Cover Dataset
NO2-3	Nitrate Nitrite Nitrogen
NTU	Nephelometric Turbidity Units
pH	Phosphates
ppm	Parts per Million/Minute
SID	Stressor Identification
SVAP	Stream Visual Assessment Protocol
TIV	Tolerance Indicator Value
TMDL	Total Maximum Daily Load
TP	Total Phosphorus
TSI	Trophic State Indexes
TSS	Total Suspended Solids
TSVS	Total Suspended Volatile Solids
USDA	United States Department of Agriculture
USGS	United States Geological Survey
VSS	Volatile Suspended Sediments
WA	weighted averages
WCBP	Western Corn Belt Plains
WWPT	Wastewater Treatment Plant
YSI	Yellow Springs Instrument Company now YSI Inc.

Table of contents

Table of Figures

1. Executive summary

This report summarizes stressor identification work in the Chippewa River watershed.

Stressor identification is a formal and rigorous process that identifies stressors causing biological impairment of aquatic ecosystems, and provides a structure for organizing the scientific evidence supporting the conclusions (EPA, 2000). In simpler terms, it is the process of identifying the major factors causing harm to fish and other river and stream life. Stressor identification is a key component of the major watershed restoration and protection projects being carried out under Minnesota's Clean Water Legacy Act.

In recent years, the Minnesota Pollution Control Agency (MPCA) has substantially increased the use of biological monitoring and assessment as a means to determine and report the condition of rivers and streams. The basic approach is to evaluate fish and aquatic invertebrates (mostly insects) and related habitat conditions at sites throughout a major watershed. The resulting information is used to produce an index of biological integrity (IBI). Index of biological integrity scores can then be compared to standards. Segments of streams and rivers with low IBI scores are deemed "impaired".

The purpose of stressor identification is to interpret the data collected during the biological monitoring and assessment process. This analysis may provide insight as to why one stream has a low IBI score, while another has a high score. It considers causal factors – negative ones harming fish and insects, and positive ones leading to healthy biology. Stressors may be physical, chemical, or biological. (MPCA Mississippi River- Lake Pepin SID 2013).

Located in western Minnesota, the Chippewa River watershed encompasses approximately 1.3 million acres. Much of the watershed is channelized and in poor biological condition. Sixteen streams in this watershed were found to be impaired for aquatic life due to their biological communities. These streams are listed below.

After examining many candidate causes for the biological impairments, the following stressors were identified for the impaired streams:

Chippewa River Dry Weather Creek to Watson Sag, 07020005-502
Nitrates, Phosphorus, Turbidity, Habitat, Altered Hydrology, Lack of Connectivity

Upper Chippewa River, 07020005-503
Nitrates, Phosphorus, Turbidity, Habitat, Altered Hydrology

Outlet Creek, 07020005-505
Phosphorus, Turbidity, Habitat, Altered Hydrology

Chippewa River, Shakopee Creek to Cottonwood Creek 07020005-507
Phosphorus, Turbidity, Habitat, Altered Hydrology

Chippewa River, Cottonwood Creek to Dry Weather Creek 07020005-508
Phosphorus, Turbidity, Altered Hydrology

Outlet Creek, 07020005-523
Low Dissolved Oxygen, Phosphorus, Turbidity, Habitat, Altered Hydrology

Judicial Ditch 8, 07020005-546
Habitat, Altered Hydrology

Mud Creek T123 R36WS28, 07020005-551
Low Dissolved Oxygen, Lack of Connectivity

Mud Creek, CD15 to East Branch Chippewa River, 07020005-523
Low Dissolved Oxygen, Lack of Connectivity

Shakopee Creek, 07020005-559
Phosphorus, Nitrates, Turbidity, Habitat, Altered Hydrology, Lack of Connectivity

Unnamed Creek (Lines Creek), Chippewa County, 07020005-584
Low Dissolved Oxygen, Phosphorus, Altered Hydrology

Shakopee Creek, 07020005-559
Low Dissolved Oxygen, Phosphorus, Nitrates, Turbidity, Habitat, Altered Hydrology, Lack of Connectivity

Headwaters to Lake Ben, 07020005-623
Low Dissolved Oxygen, Phosphorus, Turbidity, Habitat

Trappers Run, 07020005-628
Low Dissolved Oxygen, Phosphorus, Habitat, Altered Hydrology, Lack of Connectivity

Unnamed Creek, Douglas County, 07020005-638
Phosphorus, Nitrates, Turbidity, Altered Hydrology

Little Chippewa River (major), 07020005-713
Low Dissolved Oxygen, Phosphorus, Turbidity, Habitat, Altered Hydrology

Little Chippewa River (minor), 07020005-714
Low Dissolved Oxygen, Nitrates, Altered Hydrology

2. Introduction

Organization framework of Stressor Identification

The Stressor Identification (SID) process is used in this report to weigh evidence for or against various candidate causes of biological impairment (Cormier et al., 2000). The SID process is prompted by biological assessment data indicating that a biological impairment has occurred. Through a review of available data, stressor scenarios are developed that may accurately characterize the impairment, the cause, and the sources/pathways of the various stressors (Fig. 1). Confidence in the results often depends on the quality of data available to the SID process. In some cases, additional data collection may be necessary to accurately identify the stressor(s).

SID draws upon a broad variety of disciplines, such as aquatic ecology, geology, geomorphology, chemistry, land-use analysis, and toxicology. Weight of evidence analysis is used to develop cases in support of, or against, various candidate causes. Typically, the majority of the information used in the SID analysis is from the study watershed, although evidence from other case studies or scientific literature can also be drawn upon in the SID process.

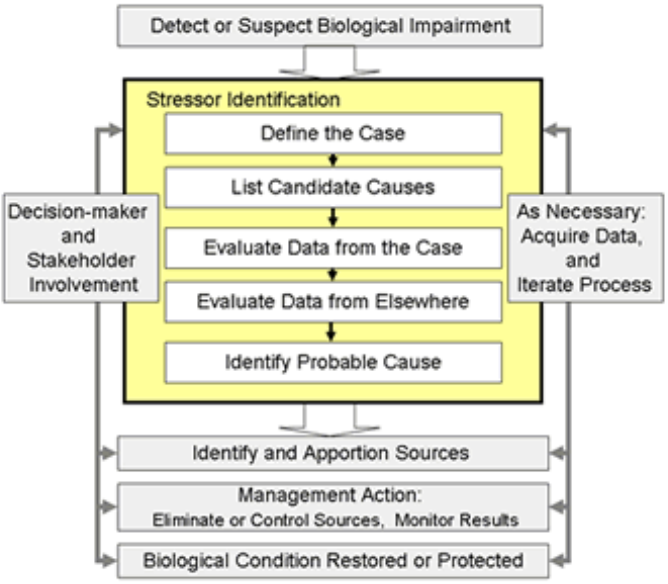

Figure E-1 Conceptual model of stressor identification (SID) process.

Completion of the SID process does not result in completed Total Maximum Daily Load (TMDL) allocations. The product of the SID process is the identification the stressor(s) for which the TMDL load allocation will be developed. For example, the SID process may help investigators identify excess fine sediment as the cause of biological impairment, but a separate effort is then required to determine the TMDL and implementation goals needed to address and correct the impaired condition.

Elements of Stream Health The elements of a healthy stream consist of five main components stream connections, hydrology, stream channel assessment, water chemistry, and stream biology. If one or more of the components are unbalanced the stream ecosystem fails to function properly and is listed as an impaired water body. Common stream stressors of fish and invertebrate communities are: too much sediment, low oxygen, temperature, lack or loss of habitat, and increased nutrients.

Report overview

The Chippewa River watershed consists of tributaries and sub-watersheds. For the purpose of this report Stressor Analysis was based on an impaired reach. This report describes the step-by-step analytical approach, based on the United States Environmental Protection Agency (US EPA)'s Stressor Identification process, for identifying probable causes of impairment in a particular system.

This report describes the connection between the biological community and the stressor(s) causing the impairments. Stressors are those factors that negatively impact the biological community. Stressors can interact with each other and can be additive to the stress on the biota. The Chippewa River Monitoring and Assessment Report is available and provides some background information about the watershed and the results of recent monitoring and assessment at the 11-HUC (Hydrologic Unit Code) scale.

This report includes a discussion of the data collected to support the determination of candidate stressors on a reach by reach basis. A comprehensive review of biological, chemical, and physical data was performed to select probable causes for the impairments. The initial list of candidate causes was reduced after additional data analysis leaving seven candidate causes for final analysis in this report. The candidate causes for the biologically impaired streams in the Chippewa River are listed below:

Low Dissolved Oxygen
High Phosphorus
High Nitrates
Altered Hydrology
High Turbidity/Total Suspended Solids
Lack of Habitat
Lack of Connectivity
Biological Assessment

Biological assessment

The Chippewa River watershed was assessed in 2012 for aquatic recreation, aquatic consumption and aquatic life beneficial uses (8-Digit HUC: 07020005). Based on this investigation, it was determined that sixteen stream reaches were impaired for fish and/or invertebrates, as part of the aquatic life use designation.

The Chippewa River watershed had many more instances where the fish and invertebrate IBI scores were below their respective threshold. However, many of these sampling stations are located on stream reaches that are more than 50% channelized. At the time this watershed was assessed, the MPCA was not assessing channelized streams. Beginning with streams sampled in 2012, the MPCA has begun assessing channelized streams using draft standards associated with Tiered Aquatic Life Use designations.

Summary of biological impairments

Fish and invertebrate community assemblages were assessed as part of the aquatic life use portion of the assessment. The fish and invertebrates within each Assessment Unit Identification (AUID) were compared to regionally developed, class specific thresholds and confidence intervals and utilized a weight of evidence approach. In the Chippewa River watershed, sixteen AUIDs are currently impaired for a lack of biological assemblage (Figure E-2). The data considered during the assessment process were collected from 2002-2012. Of the sixteen listed AUIDs, five are impaired for both fish and invertebrates.

Six AUIDs are impaired only for invertebrate communities. Five AUIDs are impaired only for fish communities.

Reach name	Reach Description	AUID #	Biological Impairments
Chippewa River	Dry Weather Cr to Watson Sag	07020005-502	Fishes Bioassessments and Aquatic Macroinvertebrate Bioassessments
Chippewa River	Stowe Lk to Little Chippewa R	07020005-503	Aquatic Macroinvertebrate Bioassessments
Chippewa River	Unnamed cr to E Br Chippewa R	07020005-505	Fishes Bioassessments
Chippewa River	Shakopee Cr to Cottonwood Cr	07020005-507	Aquatic Macroinvertebrate Bioassessments
Chippewa River	Cottonwood Cr to Dry Weather Cr	07020005-508	Aquatic Macroinvertebrate Bioassessments
Outlet Creek	Lk Minnewaska to Lk Emily	07020005-523	Aquatic Macroinvertebrate Bioassessments
Judicial Ditch 8	Unnamed cr to Unnamed ditch	07020005-546	Fishes Bioassessments
Mud Creek	T123 R36W S28, east line to T123 R36W S29, west line	07020005-551	Aquatic Macroinvertebrate Bioassessments
Mud Creek	CD 15 to E Br Chippewa R	07020005-554	Fishes Bioassessments and Aquatic Macroinvertebrate Bioassessments
Shakopee Creek	Shakopee Lk to Chippewa R	07020005-559	Fishes Bioassessments
Unnamed creek	Unnamed cr to Chippewa R	07020005-584	Aquatic Macroinvertebrate Bioassessments
Unnamed creek	Headwaters to Lk Ben	07020005-623	Fishes Bioassessments
Trapper Run Creek	Strandness Lk to Pelican Lk	07020005-628	Fishes Bioassessments and Aquatic Macroinvertebrate Bioassessments
Unnamed creek	Unnamed lk to Unnamed lk	07020005-638	Fishes Bioassessments and Aquatic Macroinvertebrate Bioassessments
Little Chippewa River	Unnamed cr to CD 2	07020005-713	Fishes Bioassessments
Little Chippewa River	Unnamed wetland (61-0527-00) to Chippewa R	07020005-714	Fishes Bioassessments and Aquatic Macroinvertebrate Bioassessments

Figure E-2 Biologically impaired AUIDs in the Chippewa River watershed.

The fish and invertebrate thresholds and confidence limits are shown by class for sites found in the Chippewa River watershed in Figure E-3. For a complete description of the Fish and Invertebrate classes, please see Appendices 1.1 and 1.2.

Each IBI is comprised of fish or invertebrate metrics based on community structure and function that produces a metric score scaled to 100 points. The number of metrics that make up an IBI determine the metric score range. For example, each metric in an IBI comprised of 8 metrics would have a range from 0-12.5, metrics in an IBI with 10 metrics would have a range from 0-10.

	Class Code	Region Desc	Threshold	Upper CL	Lower CL
Invertebrate IBI	2	Prairie Forest Rivers	30.7	41.5	19.9
	5	Southern Streams RR	35.9	48.5	23.3
	6	Southern Forest Streams GP	46.8	60.4	33.2
	7	Prairie Streams GP	38.3	51.9	24.7
	9	ColdSouth	46.1	59.9	32.3
Fish IBI	1	Southern Rivers	39	50	28
	2	Southern Streams	45	54	36
	3	Southern Headwaters	51	58	44
	7	Low Gradient	40	50	30
	10	Southern Coldwater	45	58	32

Figure E-3 Fish and Invert Classes found in the Chippewa River watershed with their respective Index of Biotic Integrity (IBI) thresholds and upper/lower confidence limits.

AUID #	Station	Year	Fish IBI Score	Fish Class	Invertebrate IBI Score	Invertebrate Class
07020005-502	09MN001	2009	45.5	1	33.5	2
07020005-503	09MN005	2009	79	2	35.9	5
	09MN070	2009	57.2	1	29.5	5
	09MN013	2009	79.8	1	38.5	5
07020005-505	03MN009	2003	58.5	1	35.5	2
	03MN010	2007	41.5	1	40.2	2
07020005-507	09MN068	2009	53	1	39.4	2
	09MN063	2009	50	1	34.4	2
07020005-508	09MN064	2009	49	1	35.8	2
07020005-523	09MN077	2009	49	2	No Data	No Data
	09MN065	2009	42	2	33.4	7
07020005-546	03MN014	2009	25	2	25	2
07020005-551	90MN009	2009	25	10	36.6	9
07020005-554	09MN014	2009	58	2	38.3	7
	03MN013	2009	35	2	53.3	7
07020005-559	09MN042	2009	26	2	13.4	7
	03MN015	2009	3	1	1.49	7
07020005-584	03MN056	2003	60	3	19.5	7
07020005-623	03MN005	2003	33	3	No Data	No Data
07020005-628	09MN007	2009	27	2	37.3	7
07020005-638	09MN018	2009	16	2	36.9	7
07020005-713	09MN004	2009	33	2	46.2	7
07020005-714	03MN004	2003, 2009	41	3	20.2	5

Figure E-4 shows the latest fish and invertebrate IBI scores for the sites studied further in this report.

3. Candidate causes

Source of data used for candidate causes

The data used in this report were taken from several sources:

— Minnesota Pollution Control Agency's Surface Water Data http://www.pca.state.mn.us/index.php/data/surface-water.html. The MPCA maintains data for five site types:

- **Lake** and **stream monitoring sites** typically offer water chemistry data collected by local or state government organizations. The data available for any given site vary based on the reasons for conducting the monitoring.
- **U.S. Geological Survey (USGS) sites** are monitoring stations on rivers or streams, and are maintained by the USGS. These collect water flow rates; some, also offer water chemistry data.
- **Biological monitoring sites** measure the number and species of fish and other aquatic creatures present. Some data on water chemistry is also collected.
- **Discharge sites** are not monitoring stations in the traditional sense. Instead, these are facilities that have an MPCA permit to discharge treated waste water into nearby water bodies. Data from these sites are summaries of discharge monitoring reports (DMRs) submitted by the permittees. The MPCA uses the DMRs to ensure that the facilities are complying with the terms of their permits.

— Chippewa River Site Surveys. In the fall of 2012 Chippewa River Bank Pin conducted site surveys at all of the biological sites that were within an impaired AUID.

— Chippewa River Bank Pin (CRWP) Surveys. Chippewa River Bank Pin collects and stores bank erosion data on 44 separate sites across the Chippewa watershed. These data were used in the relevant cases.

— Aerial Photographs. United States Department of Agriculture (USDA) Farm Service Agency. The National Agriculture Imagery Program (NAIP) acquires aerial imagery during the agricultural growing seasons in the continental US. These aerial photographs can be accessed at https://www.fsa.usda.gov/programs-and-services/aerial-photography/index. Other aerial photographs can be found through Google Earth.

Candidate cause: Dissolved oxygen

Dissolved oxygen (DO) refers to the concentration of oxygen gas within the water column. Low or highly fluctuating concentrations of DO can have detrimental effects on many fish and macroinvertebrate species (Davis, 1975; Nebeker et al., 1991). DO concentrations change seasonally and daily in response to shifts in ambient air and water temperature, along with various chemical, physical, and biological processes within the water column. If DO concentrations become limited or fluctuate dramatically, aquatic life can experience reduced growth or fatality (Allan, 1995). Some invertebrates that are intolerant to low levels of DO include mayflies, stoneflies and caddisflies (Marcy, 2007). Many species of fish avoid areas where dissolved oxygen concentrations are below 5mg/L (Kemker, 2013). Additionally, fish growth rates can be significantly affected by low DO levels (Doudoroff and Warren, 1965).

In most streams and rivers, the critical conditions for stream DO usually occur during the late summer season when water temperatures are high and stream flows are reduced to baseflow. As temperatures increase, the saturation levels of DO decrease. Increased water temperature also raises the DO needs

for many species of fish (Raleigh et al., 1986). Low DO can be an issue in streams with slow currents, excessive temperatures, high biological oxygen demand, and/or high groundwater seepage (Hansen, 1975).

Water quality standards

In Class 2B streams, the Minnesota standard for dissolved oxygen is 5.0mg/L as a daily minimum. Additional stipulations have been recently added to this standard. The following is from the Guidance Manual for Assessing the Quality of Minnesota Surface Waters (MPCA, 2009):

Under revised assessment criteria beginning with the 2010 assessment cycle, the DO standard must be met at least 90% of the time during both the 5-month period of May through September and the 7-month period of October through April. Accordingly, no more than 10% of DO measurements can violate the standard in either of the two periods.

Further, measurements taken after 9:00 in the morning during the 5-month period of May through September are no longer considered to represent daily minimums, and thus measurements of >5 DO later in the day are no longer considered to be indications that a stream is meeting the standard.

A stream is considered impaired if 1) more than 10% of the "suitable" (taken before 9:00) May through September measurements, or more than 10% of the total May through September measurements, or more than 10% of the October through April measurements violate the standard, and 2) there are at least three total violations.

Types of dissolved oxygen data

Point measurements

Instantaneous DO data is available throughout the watershed and can be used as an initial screening for low DO. These measurements represent discrete point samples, usually conducted in conjunction with surface water sample collection utilizing a YSI sonde. Because DO concentrations can vary significantly as a result of changing flow conditions and time of sampling, instantaneous measurements need to be used with caution and are not completely representative of the DO regime at a given site.

Longitudinal (Synoptic)

Longitudinal (synoptic) DO surveys were conducted throughout the Chippewa watershed seven times in 2009 and ten times in 2010. A synoptic monitoring approach aims to gather data across a large spatial scale and minimal temporal scale. In terms of DO, the objective was to sample a large number of sites from upstream to downstream under comparable ambient conditions. For the most part, the surveys took place in mid to late summer when low DO is most commonly observed.

Overview of dissolved oxygen in the Chippewa River watershed

Dissolved oxygen has been extensively measured throughout the watershed. Thirty-five percent of the sites documented DO to be below 5mg/L over 10% of the time (Figure 1-1). These low DO cases tended to cluster together suggesting regional issues. The upper reaches of Cottonwood Creek, Lines Creek, Pope CD15, and the Little Chippewa River deserve further attention to address their low DO levels. They also tended to be in the upstream/headwaters regions of the tributaries. None of the long term Chippewa River Watershed Project (CRWP) point measurement sites exceeded the 10% threshold from 2003-2010, though it should be noted that these point measurements rarely were taken before 9:00 AM.

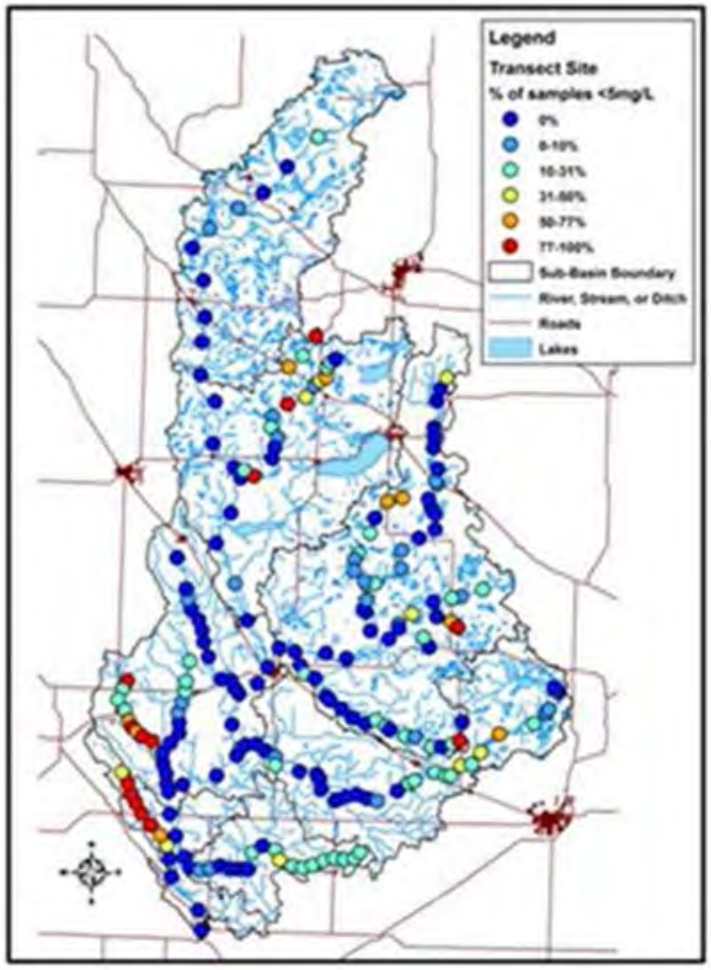

Figure 1-1 Percent of samples below 5 mg/L, 2009-2010.

Meador and Carlisle (2007) derived tolerance indicator values (TIVs) for common fish species of the U.S.). The species in the Chippewa River watershed were compared with the TIVs, and quartiled for comparison. The first quartile species are more sensitive to DO while the fourth quartile species are less sensitive to DO (some fish did not have tolerance data available. Figure 1-4 shows the fish quartiled by weighted averages for the impaired reaches in the Chippewa River watershed.

1st Quartile		2nd Quartile		3rd Quartile		4th Quartile	
bowfin	WA	Common Name	WA	Common Name	WA	Common Name	WA
orangespotted sunfis	4.9	mimic shiner	7.8	tadpole madtom	8.2	rock bass	8.7
white crappie	5.7	yellow bullhead	7.8	hornyhead chub	8.3	spotfin shiner	8.7
golden shiner	5.7	brown bullhead	7.9	quillback	8.3	fathead minnow	8.8
bluegill	6.4	white bass	7.9	blackside darter	8.4	bluntnose minnow	8.9
black crappie	7	black bullhead	8	creek chub	8.4	fantail darter	8.9
johnny darter	7.3	green sunfish	8	common carp	8.5	blacknose dace	9.1
largemouth bass	7.4	northern pike	8	spottail shiner	8.5	sand shiner	9.2
freshwater drum	7.4	silver redhorse	8	stonecat	8.5	bigmouth shiner	9.9
pumpkinseed	7.6	walleye	8	central stoneroller	8.6		
yellow perch	7.6	emerald shiner	8.1	common shiner	8.6		
	7.6			golden redhorse	8.6		
				shorthead redhorse	8.6		
				white sucker	8.6		

Sensitive → Less Sensitive

Tolerance Data Not Available		
Common Name		
banded killifish	carmine shiner	Gen: stonerollers
bigmouth buffalo	central mudminnow	hybrid sunfish
blackchin shiner	fantail darter	Iowa darter
blacknose shiner	fathead minnow	northern redbelly dace
brassy minnow	finescale dace	shorthead redhorse
brook stickleback	Gen: redhorses	slenderhead darter

Figure 1-2 Chippewa River watershed fish quartiles based on Weighted Averages (WA) for dissolved oxygen (Meador and Carlisle, 2007).

Sources and causal pathways model for low dissolved oxygen

Dissolved oxygen concentrations in lotic environments are often driven by a combination of natural and anthropogenic factors. Natural background characteristics of a watershed, such as topography, hydrology, climate, and biological productivity can influence the dissolved oxygen regime of a waterbody. Agricultural and urban land-uses, impoundments (dams), and point-source discharges are some of the anthropogenic factors that can cause unnaturally high, low, or volatile DO concentrations. The conceptual model for low DO as a candidate stressor in the Chippewa River watershed is modeled at EPA's CADDIS Dissolved Oxygen webpage.

Candidate cause: Nitrate - Nitrite

Exposure to elevated nitrite or nitrate concentrations can lead to the development of methemoglobinemia. The iron site of the hemoglobin molecule in red blood cells preferentially bonds with nitrite molecules over oxygen molecules. Methemoglobinemia ultimately limits the amount of oxygen which can be absorbed by fish and invertebrates (Grabda et al., 1974). Certain species of caddisflies, amphipods, and salmonid fishes seem to be the most sensitive to nitrate toxicity according to Camargo and Alonso (2006).

Water quality standards

Minnesota streams classified as Class 1 waters of the state, designated for domestic consumption, have a nitrate-N (nitrate plus nitrite) water quality standard of 10 mg/L. At this time, none of the AUIDs in the Chippewa watershed that are impaired for biota are classified as Class 1 streams. Minnesota currently does not have a nitrate standard for other waters of the state besides for class 1.

Ecoregion data

McCollor & Heiskary (1993) developed a guidance for stream water quality parameters by ecoregion for Minnesota streams. The Chippewa River watershed encompasses portions of three ecoregions: North Central Hardwood Forest (NCHF), Northern Glaciated Plains (NGP), and Western Corn Belt Plains (WCBP). The annual 75th percentile nitrate-N values where used for comparison (Table 4).

	75 Percentile value (mg/L)
North Central Hardwood Forest (NCHF)	0.28
Northern Glaciated Plains (NGP)	0.52
Western Corn Belt Plains (WCBP)	6.9

Figure 1-3 Ecoregions in the Chippewa River with the associated annual 75 percentile nitrate-nitrite level ecoregion.

Collection methods for nitrate and nitrite

Water samples analyzed for nitrate-N were collected throughout the watershed for purposes of assessment and stressor identification. Nitrate-N is comprised of both nitrate (NO3-) and nitrite (NO2-). Typically water samples contain a small proportion of nitrite relative to nitrate due to the instability of nitrite, which quickly oxidizes to nitrate. The water samples collected were analyzed for Nitrate+Nitrite (NO2-3) at a Minnesota State certified lab.

Nitrate and nitrite in the Chippewa River watershed

Calculations of the Chippewa River's nitrate plus nitrite-nitrogen loads indicate a variation of levels between sites and regions (see Chippewa River Watershed Monitoring and Assessment Report for more information). In general NO2-3 levels increase from north to south and upstream to downstream in the Chippewa watershed (see Figure 1-2). Areas where row cropping is dominant tend to have the highest NO2-3 levels but there are exceptions to this trend (Cottonwood Creek).

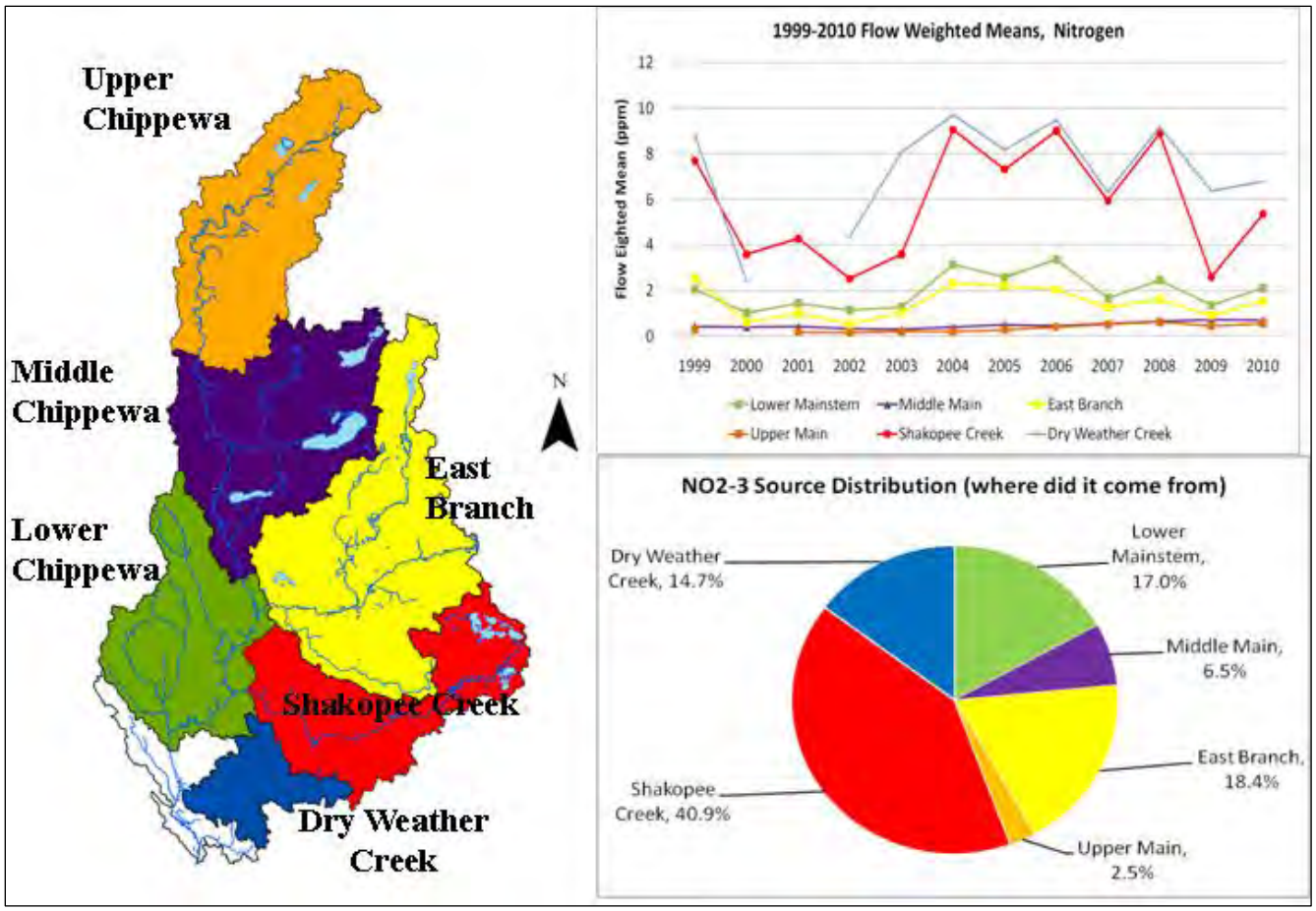

Figure 1-4 Nitrogen monitoring results (from Chippewa River Watershed Monitoring Summary 2009-2010).

Point measurements provide a useful picture of NO2-3 in the watershed. NO2-3 tends to leak out of watersheds with less perennial land uses in the Chippewa watershed. An example of this can be seen in Figure 1-3. The chart documents point measurements of NO2-3 in two sub-watershed of the Chippewa River Shakopee Creek and the Upper Chippewa. In Shakopee Creek NO2-3 levels are high starting during the spring melt period and generally drop in July when the row crops mature. NO2-3 levels rise again in late August when the row crops stop growing.

	Upper Chippewa	Shakopee Creek
Row Crop	60.30%	81.40%
Forest	9.10%	4.30%
Range	14.90%	6.70%
Urban	1.80%	1.70%
Water	9.60%	3.90%
Wetland	4.20%	1.90%
Other	0.10%	0.10%

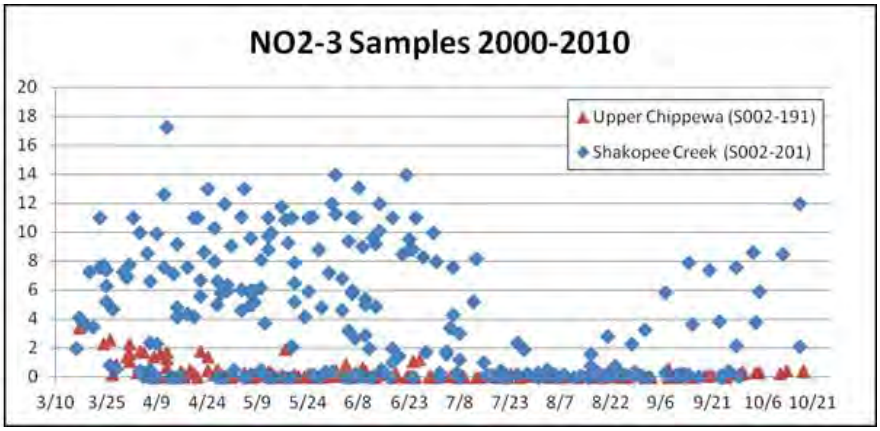

Figure 1-5 Land uses and NO2-3 point measurements for Upper Chippewa and Shakopee Creek 2000-10.

Meador and Carlisle (2007) derived TIVs for common fish species of the U.S.). The species in the Chippewa River watershed were compared with the TIVs, and quartiled for comparison. The first quartile species are more sensitive to nitrate while the fourth quartile species are less sensitive to

nitrate (some fish did not have tolerance data available. Figure 1-6 shows the fish quartiled by weighted averages for the impaired reaches in the Chippewa River watershed.

1st Quartile		2nd Quartile		3rd Quartile		4th Quartile	
Common Name	WA	Common Name	WA	Common Name	WA	Common Name	WA
bowfin	0.3	white crappie	0.91	pumpkinseed	1.3	yellow bullhead	1.8
golden shiner	0.44	black crappie	0.98	rock bass	1.3	spotfin shiner	1.8
mimic shiner	0.53	brown bullhead	0.99	green sunfish	1.4	bluntnose minnow	2
tadpole madtom	0.68	northern pike	1.03	white bass	1.4	blacknose dace	2.4
yellow perch	0.7	channel catfish	1.04	emerald shiner	1.5	common carp	2.5
silver redhorse	0.79	freshwater drum	1.04	stonecat	1.5	sand shiner	2.5
bluegill	0.8	johnny darter	1.04	golden redhorse	1.6	white sucker	2.6
walleye	0.81	largemouth bass	1.15	quillback	1.6	black bullhead	2.6
hornyhead chub	0.87	creek chub	1.21	blackside darter	1.7	orangespotted sunfis	2.7
central stoneroller	0.88	common shiner	1.28			bigmouth shiner	3.5

Sensitive → Less Sensitive

Tolerance Data Not Available		
Common Name		
banded killifish	carmine shiner	Gen: stonerollers
bigmouth buffalo	central mudminnow	hybrid sunfish
blackchin shiner	fantail darter	Iowa darter
blacknose shiner	fathead minnow	northern redbelly dace
brassy minnow	finescale dace	shorthead redhorse
brook stickleback	Gen: redhorses	slenderhead darter

Figure 1-6 Chippewa River watershed fish quartiles based on WA for nitrate+nitrite (ppm) (Meador and Carlisle, 2007).

Sources and causal pathways model for nitrate and nitrite

The causes and potential sources for nitrate-nitrite in the Chippewa River are modeled at EPA's Causal Analysis/Diagnosis Decision Information System (CADDIS) nutrients webpage. Helsel (1995) reported nitrate concentrations were the highest below agricultural or urban areas. Figure 1-3 also indicates that nitrate concentrations are elevated during snow melt events and rain events. Some of the highest measurements of nitrate were observed in the drainage systems of Shakopee Creek and Dry Weather Creek.

Nitrogen is commonly applied as a crop fertilizer. Over half of the Chippewa watershed is comprised of cropland (Figure 1-5); it is likely that various forms of nitrogen including nitrate and ammonia are being applied to the cropland throughout the watershed. The specific timing and rate of nitrogen fertilizer application is unknown, but nitrogen isotopes could assist in the source identification of excess nitrate in future monitoring.

Candidate cause: Phosphorus

Phosphorus is an essential nutrient for all aquatic life, but elevated phosphorus concentrations can result in an imbalance which can impact stream organisms. Excess phosphorus does not result in direct harm to fish and invertebrates. Rather, its detrimental effect occurs as it alters other factors in the water

environment. Dissolved oxygen, pH, water clarity, and changes in food resources and habitat are all stressors that can result when there is excess phosphorus.

Water quality standards and ecoregion norms

There is no current water quality standard for Total Phosphorus (TP) however there is a draft nutrient standard for rivers of Minnesota as well as ecoregion data to show if the data is within the expected norms. The current draft standard is a maximum concentration of 0.15mg/l with at least one response variable (pH, biological oxygen demand, DO flux, chlorophyll-a) for the Chippewa River. For more information, please reference the Chippewa River Watershed Monitoring and Assessment Report.

Phosphorus in the Chippewa River watershed

As stated in the *Chippewa River Watershed Monitoring Summary, 2009-2010*, Total Phosphorus (TP) concentrations have not changed much in the Chippewa River, the draft nutrient standard has been consistently exceeded over the past ten years. Measured phosphorus concentrations exceeding the standard have been identified throughout the watershed. Pelican Creek has elevated levels of phosphorus, but it is not described further in this document.

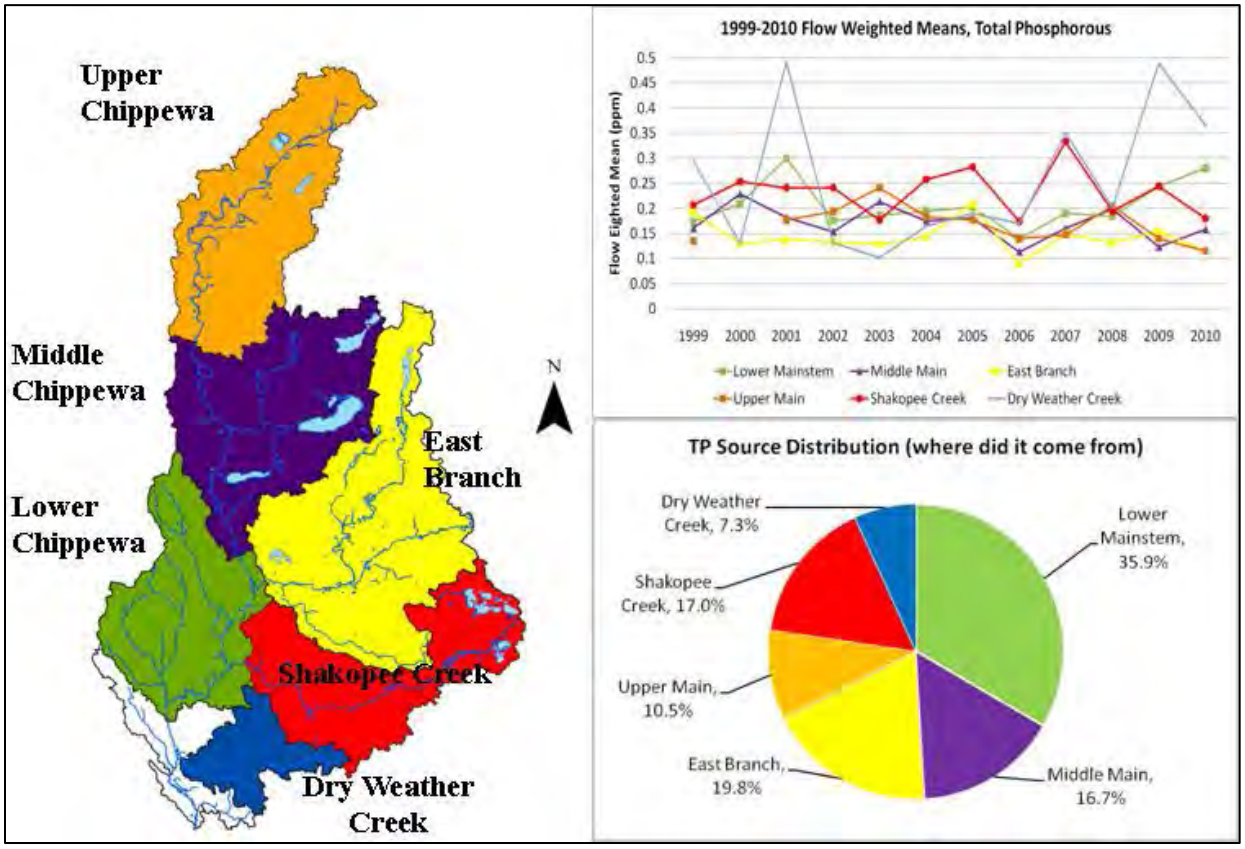

Figure 1-7 Phosphorous Monitoring Results (from Chippewa River Watershed Monitoring Summary 2009-2010).

Sources and causal pathways for excess phosphorus

Phosphorus is delivered to streams by wastewater treatment facilities, urban storm water, agriculture, and direct discharges of sewage. The causes and potential sources for excess phosphorus in the Chippewa River watershed are modeled at EPA's CADDIS Nutrients webpage. As stated previously, much of the watershed is agricultural, particularly in the lower sections where phosphorus concentrations are often elevated. In the southern third of the Chippewa watershed Ortho phosphorous is a significantly higher portion of the TP profile. This is particularly true in the early part of the season during the spring

snow melt. For this reason TP samples taken during this period in the areas with more row cropping tend to be higher than regions with less row crop land use (see Figure1-8).

	Upper Chippewa	Shakopee Creek
Row Crop	60.30%	81.40%
Forest	9.10%	4.30%
Range	14.90%	6.70%
Urban	1.80%	1.70%
Water	9.60%	3.90%
Wetland	4.20%	1.90%
Other	0.10%	0.10%

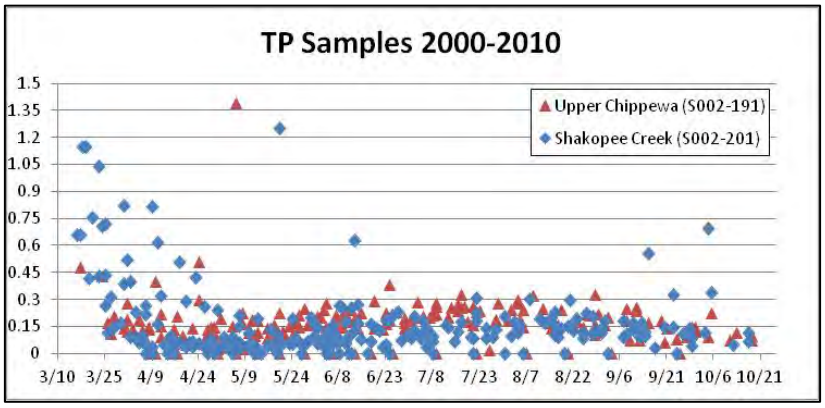

Figure 1-8 Land uses and TP point measurements for Upper Chippewa and Shakopee Creek 2000-10

Meador and Carlisle (2007) derived TIVs for common fish species of the U.S. The species in the Chippewa River watershed were compared with the TIVs, and quartiled for comparison. The first quartile species are more sensitive to phosphorous while the fourth quartile species are less sensitive to phosphorous (some fish did not have tolerance data available). Figure 1-9 shows the fish quartiles by weighted averages for the impaired reaches in the Chippewa River watershed.

1st Quartile		2nd Quartile		3rd Quartile		4th Quartile	
Common Name	WA	Common Name	WA	Common Name	WA	Common Name	WA
silver redhorse	20	tadpole madtom	34	green sunfish	62	bigmouth shiner	77
yellow perch	21	blacknose dace	36	white sucker	62	channel catfish	81
bowfin	24	bluegill	36	stonecat	63	emerald shiner	84
mimic shiner	24	golden redhorse	37	hornyhead chub	64	quillback	88
brown bullhead	26	common shiner	38	spotfin shiner	65	common carp	93
rock bass	28	walleye	45	blackside darter	67	sand shiner	111
central stoneroller	29	creek chub	46	yellow bullhead	73	freshwater drum	127
golden shiner	30	bluntnose minnow	48	black bullhead	76	white bass	137
pumpkinseed	30	northern pike	48			white crappie	138
largemouth bass	31	black crappie	56			orangespotted sunfish	174
		johnny darter	56				

Sensitive → Less Sensitive

Tolerance Data Not Available		
Common Name		
banded killifish	carmine shiner	Gen: stonerollers
bigmouth buffalo	central mudminnow	hybrid sunfish
blackchin shiner	fantail darter	Iowa darter
blacknose shiner	fathead minnow	northern redbelly dace
brassy minnow	finescale dace	shorthead redhorse
brook stickleback	Gen: redhorses	slenderhead darter

Figure 1-9 Chippewa River watershed fish quartiles based on WA for phosphorous (ppm) (Meador and Carlisle, 2007).

Candidate cause: Turbidity

Increases in total suspended sediment (TSS) and turbidity within aquatic systems are now considered one of the greatest causes of water quality and biological impairment in the United States (U.S. EPA, 2003). Although sediment delivery and transport are important natural processes for all stream systems, sediment imbalance (either excess sediment or lack of sediment) can result in the loss of habitat in addition to the direct harm to aquatic organisms. As described in a review by Waters (1995), excess total suspended sediments cause harm to aquatic life through two major pathways: (1) direct, physical effects on biota (i.e. abrasion of gills, suppression of photosynthesis, avoidance behaviors); and (2) indirect effects (i.e. loss of visibility, increase in sediment oxygen demand). Elevated turbidity levels and TSS concentrations can reduce the penetration of sunlight and thus impede photosynthetic activity and limit primary production (Munavar et al., 1991; Murphy et al., 1981).

Elevated Volatile Suspended Sediments (VSS) concentrations can impact aquatic life in a similar manner as TSS – with the suspended particles reducing water clarity – but unusually high concentrations of VSS can also be indicative of nutrient imbalance and an unstable DO regime.

Water quality standards

At the time the Chippewa River was assessed, the current standard for TSS was not yet in rule, and a standard of 25 Nephelometric Turbidity Units (NTUs) was used to assess the amount of suspended sediment in the water column. The water quality standard for turbidity was 25 NTUs for Class 2b waters. Total suspended solids and transparency tube measurements were used as surrogates for the standard. A regression of the TSS to turbidity indicated impairment at 60mg/L for waters within the Northern Glaciated Plains Ecoregion.

Turbidity is a measure of reduced transparency that can increase due to suspended particles such as sediment, algae and organic matter. At the time the Chippewa River was assessed Minnesota had a turbidity standard of 25 NTU for protection of aquatic life.

A strong correlation exists between the measurements of TSS concentration and turbidity. In 2010, MPCA released draft TSS standards for public comment (Markus). The new TSS criteria are stratified by geographic region and stream class due to differences in natural background conditions resulting from the varied geology of the state and biological sensitivity. The draft TSS standard for the Chippewa River has been set at 54 mg/L. For assessment, this concentration is not to be exceeded in more than 10% of samples within a 10-year data window.

As well as TSS, sestonic algae can lead to increases in turbidity and can be evaluated by tests which measure the percentage of the solids from a sample that are burned off – VSS and by TP. There are no current standards for either.

For the purposes of stressor identification, transparency tube measurements, TSS, VSS, and Hydrological Simulation Program–Fortran (HSPF) modeling results of TSS were relied upon to quantify the suspended material present from which inferences were made regarding the effects of suspended solids on fish and invertebrate populations.

Turbidity in the Chippewa River watershed

Much of the Chippewa River is impaired for Turbidity. In 2009 and 2010 most of the Chippewa's load monitoring sites exceeded the standard.

In 2009 and 2010 overall, 32% of the samples taken exceeded the standard for turbidity. Looking at both years separately, 2009 and 2010 saw about the same level of turbidity exceedances overall. The most significant exceedances occurred along the Chippewa Mainstem from Peterson Lake to the confluence

with the Minnesota River, the Little Chippewa River and from Shakopee Lake to Shakopee Creek. (Figure 1-10).

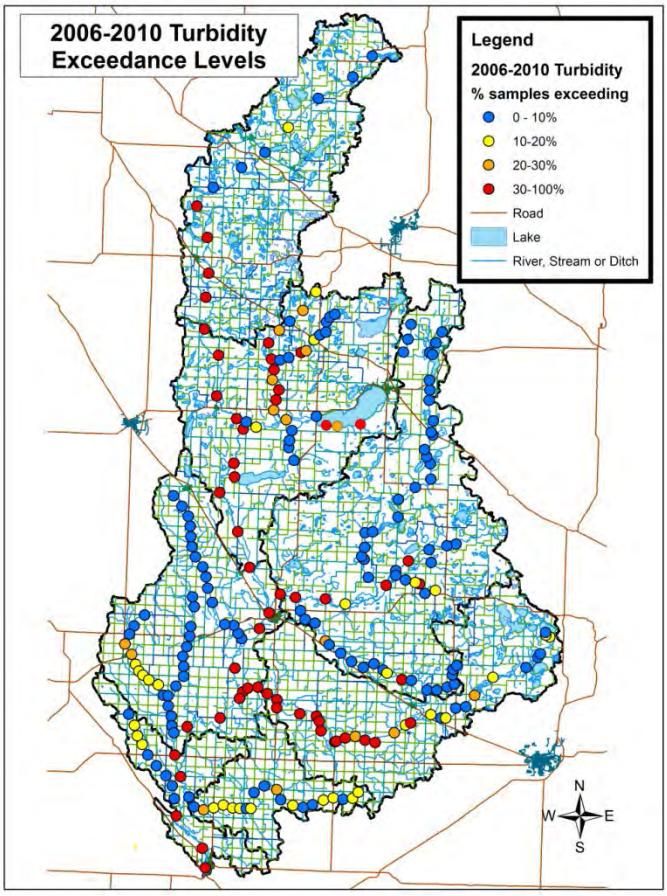

Figure 1-19 Turbidity exceedances of the Standard.

A TMDL report for turbidity was submitted to the EPA in 2011 for many reaches within the Chippewa River and as of this printing has not been approved. More information about the turbidity in the Chippewa River watershed can be found in the Chippewa River Monitoring and Assessment Report.

Meador and Carlisle (2007) derived TIVs for common fish species of the U.S.). The species in the Chippewa River watershed were compared with the TIVs, and quartered for comparison (Figure 1-11). The first quartile species are more sensitive to suspended sediment while the fourth quartile species are less sensitive to suspended sediment (some fish did not have tolerance data available).

1st Quartile		2nd Quartile		3rd Quartile		4th Quartile	
Common Name	WA	Common Name	WA	Common Name	WA	Common Name	WA
silver redhorse	20	tadpole madtom	34	green sunfish	62	bigmouth shiner	77
yellow perch	21	blacknose dace	36	white sucker	62	channel catfish	81
bowfin	24	bluegill	36	stonecat	63	emerald shiner	84
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pumpkinseed	30	northern pike	48			white crappie	138
largemouth bass	31	black crappie	56			orangespotted	174
		johnny darter	56			sunfish	

Sensitive → Less Sensitive

Tolerance Data Not Available		
Common Name		
banded killifish	carmine shiner	Gen: stonerollers
bigmouth buffalo	central mudminnow	hybrid sunfish
blackchin shiner	fantail darter	Iowa darter
blacknose shiner	fathead minnow	northern redbelly dace
brassy minnow	finescale dace	shorthead redhorse
brook stickleback	Gen: redhorses	slenderhead darter

Figure 1-11 Chippewa River watershed fish quartiles based on WA for suspended sediment (Meador and Carlisle, 2007).

Sources and causal pathways for turbidity

The causes and potential sources for increases in turbidity in the Chippewa River watershed are modeled at EPA's CADDIS Sediments webpage. High turbidity occurs when heavy rains fall on unprotected soils, dislodging the soil particles which are transported by surface runoff into the rivers and streams (MPCA and MSUM, 2009). The soil may be unprotected for a variety of reasons, such as construction, mining, agriculture, or insufficiently vegetated pastures. Decreases in bank stability may also lead to sediment loss from the stream banks, often caused by perturbations in the landscape such as channelization of waterways, riparian land cover alteration, and increases in impervious surfaces.

In the Chippewa, in areas where row cropping is more prevalent, there is a trend toward higher turbidity during the spring months when there is little canopy cover. In the Northern part of the Chippewa, where row cropping makes up a smaller portion of the overall land use, the turbidity profile is different. Turbidity tends to rise into June, July and August and then come down in September. This may be due to high levels of nutrients and warm water temperatures creating the ideal conditions for algal growth in the stream channel and connected lakes. High turbidity for long periods of time including during low flow periods is alarming. The consistently high turbidity levels seen throughout the watershed suggest that aquatic habitat and recreational enjoyment on the Chippewa is seriously degraded. (Figure 1-12).

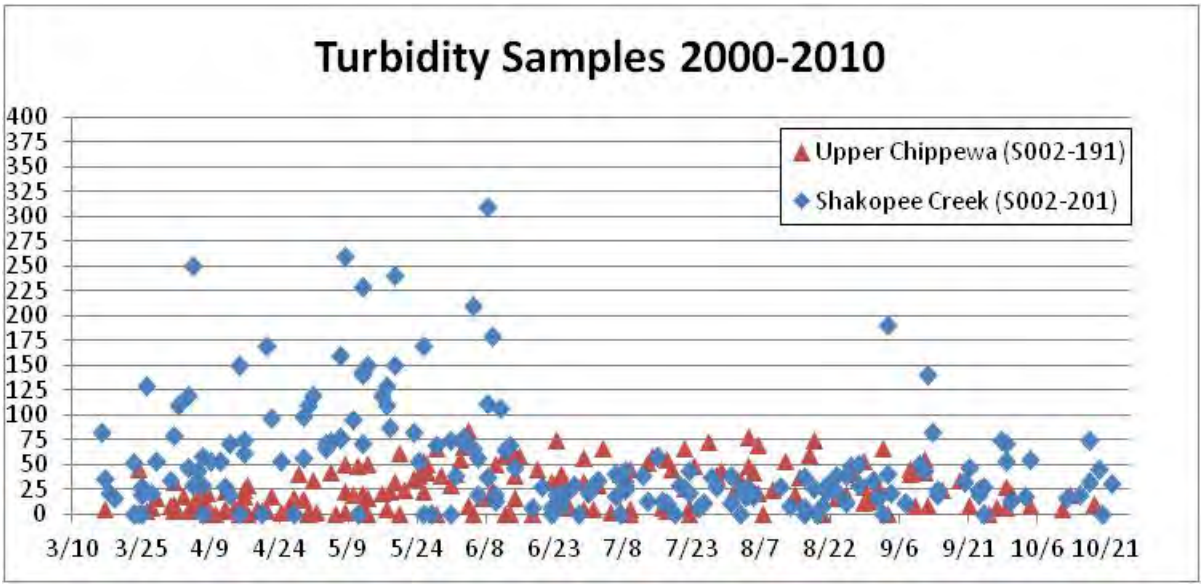


Figure 1-12 Turbidity point measurements for Upper Chippewa and Shakopee Creek 2000-10.

Candidate cause: Lack of habitat

Habitat is a broad term encompassing all aspects of the physical, chemical and biological conditions needed to support a biological community. This section will focus on the physical habitat structure including geomorphic characteristics and vegetative features (Griffith et al., 2010). Physical habitat is often interrelated to other stressors (e.g., sediment, flow, DO). Fish passage will also be addressed in a separate section.

Physical habitat diversity enables fish and invertebrate habitat specialists to prosper, allowing them to complete their life cycles. Some examples of the requirements needed by habitat specialists are: sufficient pool depth, cover or refuge from predators, and riffles that have clean gravel or cobble which are unimbedded by fine sediment (Griffith et al., 2010).

Specific habitats that are required by a healthy biotic community can be minimized or altered by practices on our landscape by way of resource extraction, agriculture, forestry, urbanization, and industry. These landscape alterations can lead to reduced habitat availability, such as decreased riffle habitat, or reduced habitat quality, such as embedded gravel substrates. Biotic population changes can result from decreases in availability or quality of habitat by way of altered behavior, increased mortality, or decreased reproductive success (Griffith et al. 2010).

Water quality standards

There currently is no applicable standard for lack of habitat for biotic communities.

Habitat characteristics in the Chippewa River

Habitat is variable throughout the Chippewa River watershed and is vital in understanding the biological communities. Throughout the Chippewa River watershed, qualitative habitat was measured with the Minnesota Stream Habitat Assessment (MSHA) along with the fish survey Figure 1-10. The MSHA is useful in describing the aspects of habitat needed to obtain an optimal biological community. It includes five subcategories: land use, riparian zone, substrate, cover, and channel morphology.

The IBI scores in the Chippewa River watershed do not seem to have a clear relationship with the total MSHA score (Figure 1-13). The IBI is comprised of numerous metrics that measure biotic response to

various stresses including, but not limited to, habitat. Therefore it is reasonable to conclude that habitat is not the prime stressor at many of the sites under consideration.

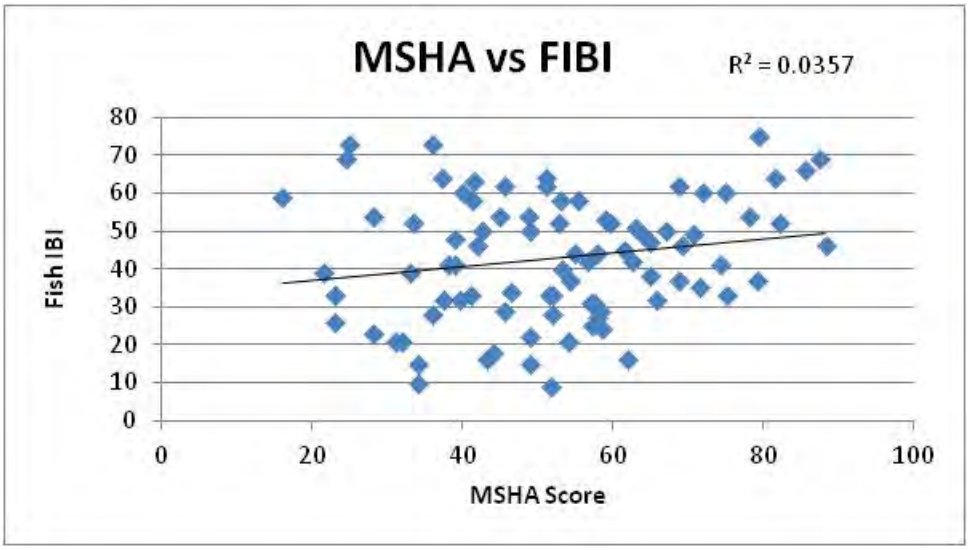


Figure 1-13 MSHA scores and points above or below fish IBI threshold for all natural channel sites in the Chippewa River watershed.

Stream visual assessment protocol

A modified version of the USDA's Stream Visual Assessment Protocol (SVAP) was used at all of the MPCA's biological monitoring sites in 2012.

The SVAP provides a basic level of stream health evaluation. This protocol provides an assessment based primarily on physical conditions within the assessment area. Stream Visual Assessment Protocol is intended to be a simple, comprehensive assessment of stream condition that maximizes ease of use. It is suitable as a basic first approximation of stream condition. It can also be used to identify the need for more accurate assessment methods that focus on a particular aspect of the aquatic system (National Water and Climate Center Technical Note 99–1).

Stream Visual Assessment Protocol scores stream health based on ten factors: channel condition, hydrologic alteration, riparian zone, bank stability, water appearance, nutrient enrichment, barriers to fish movement, in stream fish cover, pools, and invertebrate habitat. These scores are then used to generate an overall score of the sites stream health. Detailed notes are taken when in the field around these ten items and regarding the suspected causes of the observed problems and recommendations.

Sources and causal pathways model for habitat

The causes and potential sources for lack of habitat in the Chippewa River watershed are modeled at EPA's CADDIS Physical Habitat webpage. Many riparian areas along the Chippewa River and tributaries are influenced by cattle and row crop agriculture, this in turn decreases riparian and bank vegetation. Along with altered hydrology, the alteration of habitat caused by channelization and impoundments has numerous pathways of influence affecting the biological community.

Candidate cause: Connectivity

Connectivity in river ecosystems refers to how waterbodies and waterways are linked to each other on the landscape and how matter, energy, and organisms move throughout the system (Pringle, 2003).

There are many components of connectivity, but this section will only address the physical barriers of dams.

Dams, both human made and natural, can cause changes in flow, sediment, habitat and chemical characteristics of a waterbody. They can alter the hydrologic connectivity, which may obstruct the movement of migratory fish causing a change in the population and community structure. The stream environment is also altered by a dam to a predominately lentic surrounding (Mitchell and Cunjak, 2007).

Humans have placed dams on the landscape for many reasons including flood control, livestock watering, and irrigation. Beavers build dams to create impoundments with adequate water depth for a winter food cache (Collen and Gibson, 2001). Beaver dams, even though natural, can also be barriers to fish migration.

Water quality standards

There is no applicable water quality standard for connectivity impacts.

Connectivity in the Chippewa River

Connectivity to the Chippewa River watershed was altered in the 1930's when the dam on the Chippewa River at Watson was constructed. The impact of the dam and rerouting blocked fish movement between the Minnesota River and the Chippewa River.

Many other dams have been built on the Chippewa River. Many of them are low head dams and restrict some fish movement. There are some that currently are considered fish barriers. These dams are addressed in their respective AUID reports.

Sources and causal pathways model for connectivity

The causes and potential sources for connectivity in the Chippewa River watershed are modeled at EPA's CADDIS webpage. Impoundments placed on rivers and streams can create barriers to fish passage and can alter the aquatic community.

4. AUID: 07020005-502, Chippewa River, Dry Weather Creek to Watson Sag, Chippewa County

AUID: 07020005-502 was assessed in 2012 and determined to be impaired for fish communities and aquatic macroinvertebrates. The impaired reach is the Chippewa River in Tunsberg Township of Chippewa County in the Chippewa River watershed. There is one chemical monitoring site on this reach. There is also one biological monitoring site located within the reach that was monitored twice in 2009, once in July and once in September. Fish species documented in this region indicate potential issues with turbidity, phosphorous, nitrogen and low DO. Figure 502-1 is a map of the named drainage and monitoring sites.

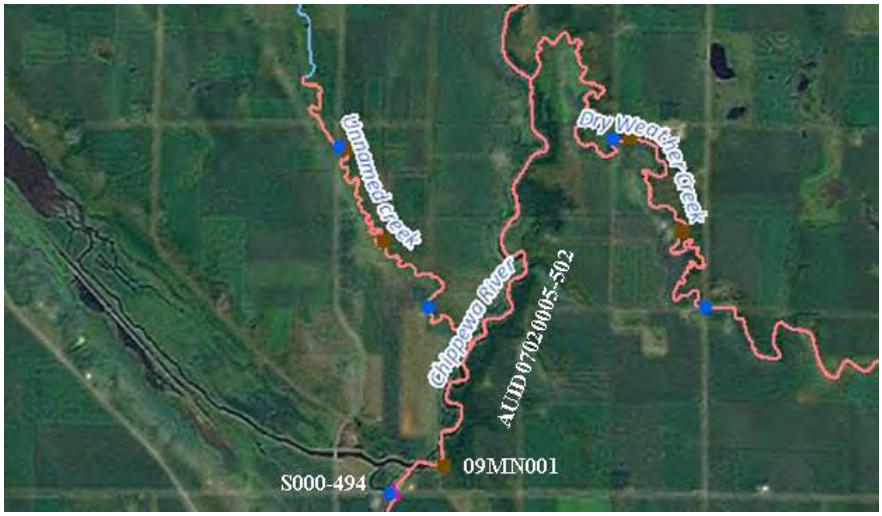


Figure 502-1 AUID: 07020005-502 monitoring sites.

The contributing watershed is 2,043 square miles in area. This watershed's area is occupied by 68% row crop agriculture, 11.1 % is range, 4.5 is forest, 6% is open water, 5.2 % wetlands, and 4.9% urban.

Biology:

The fish sampled in this drainage were sampled twice (July and September) in 2009 at site 09MN001 and reported 15 species. The majority of the fish reported were tolerant to pollution. Common carp, a species with high tolerance to most pollutants made up 47% of the fish observed. Consequently, fish metrics for this site were mostly poor. Even though the number of longer lived species was high as evidenced in the high score for the Taxa richness of long-lived fish species (LLvd) they were mostly comprised of carp. (Figure 502-2).

Invertebrates were sampled once in August 2009 and reported 51 genera. This site scored well for the number of Trichoptera taxa present, and total taxa richness, and was not overly dominated by the dominant five taxa (DomFiveCHPct) in the sample (Figure 502-2).

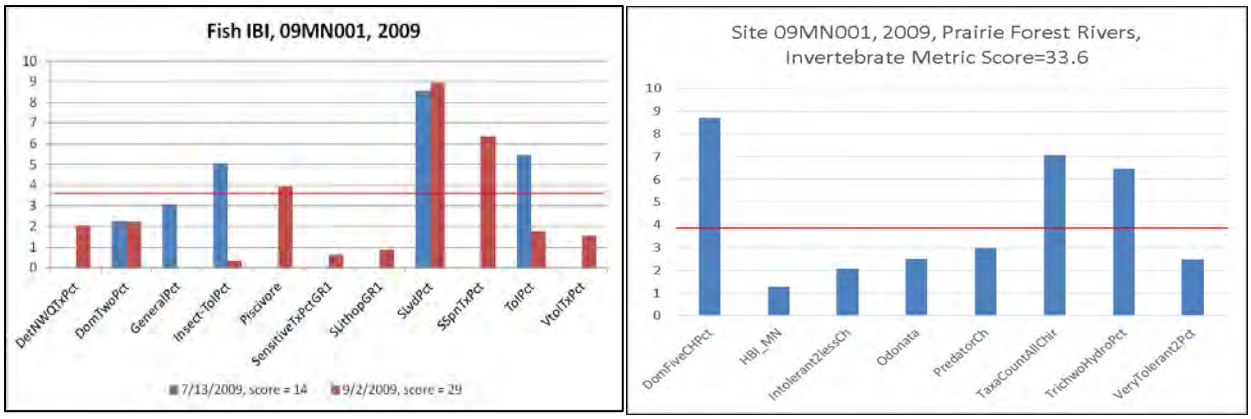


Figure 502-2 Fish and Invertebrate metric scores belonging to site 09MN001. The red line indicates the average metric score needed for the score to be at the threshold.

A survey of fish species tolerance levels to NO2-3, TP, TSS and DO revealed a high number of pollution tolerant individuals (Meador and Carlisle, 2006). These results suggest that low DO, turbidity, high phosphorous and high nitrogen are all possible stressors.

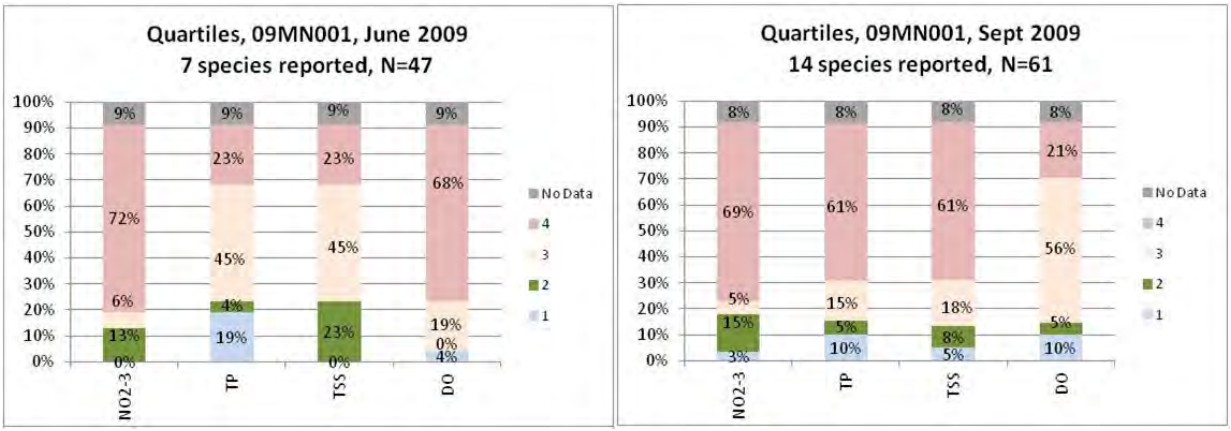


Figure 502-3 Fish quartile values for NO2-3, TP, TSS and DO.

Candidate cause: Dissolved oxygen

Dissolved Oxygen monitoring conducted in AUID 07020005-502 indicates that low DO is not a likely stressor within the reach. None of the 49 (0%) DO readings taken from 2006 through 2012 fell below the 5mg/L standard, though none of these samples were collected before 9:00 AM. The sample data do not support listing low DO as a primary stressor. Furthermore, the presence of some low DO intolerant fish species lends support to the monitoring data.

A review of the fish species and their numbers finds that the majority of species found were those that are tolerant to low DO (Figure 502-3). At site 09MN001, 87% in June and 78% in September of the fish recorded were either in the third or fourth quartile, tolerant or very tolerant of low DO. Serial spawning fish, in some cases an indicator of low DO, were in high numbers when sampled in July and then low in September of 2009. Macroinvertebrate populations did not give a clear sign of a low problem. EPT taxa were not low, in particular the number of nonhydropsychid Trichoptera scored well. These data suggest that low DO is a possible stressor for fish.

HSPF Modeling suggests that there is not a DO issue at this site. Figure 502-4 shows the modeled 10 year duration curve of daily minimum DO values. The model suggests that incidences below 5mg/L are fairly rare.

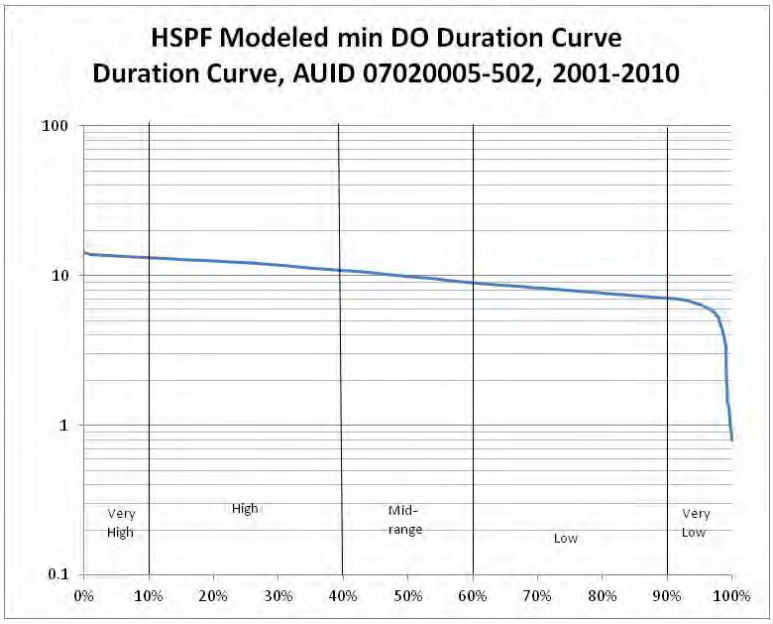


Figure 502-4 HSPF DO Modeling Predictions.

Stressor pathway: Impoundments

Dissolved Oxygen levels can be affected by impoundments by collecting nutrients and organic materials leading to less availability and by serving as areas for algae blooms. The site 09MN001 itself is an impoundment due to the dam on County Road 13. In the AUID 07020005-502 watershed, there are no immediate upstream natural impoundments.

Stressor pathway: Source-Water pollution

Site S002-203, located six miles upstream of AUID 07020005-502 was sampled 188 times between 2003 and 2012 for DO. None of the samples were below 5ppm. Site S002-204, located two miles upstream of AUID 07020005-502 on Dry Weather Creek was sampled 174 times between 2003 and 2012 for DO. Four of the Dry Weather Creek samples were below 5ppm. Sampled source waters do not appear to be passing a low DO condition into AUID 07020005-502.

Dissolved oxygen summary:

Dissolved oxygen is probably not a stressor in AUID 07020005-502. The absence of low DO samples, the agreement of the HSPF model and the presence of some low DO intolerant fish species are all factors that agree with this assessment.

Candidate cause: Phosphorus

Phosphorus samples were taken in AUID 07020005-502 at site S000-494 also known as 09MN001, nine times in 2009. The samples exceeded the 0.15ppm draft standard twice.

Looking at the fish data (Figure 502-3) 68% and 76% of the sample was made up of the phosphorous tolerant individuals (third and fourth quartile). There were individuals representing the first and second quartiles. These data suggest that while phosphorous may be the driving force of other stressors (turbidity) it in itself is not the most pressing stressor to fish populations.

Evidence of elevated phosphorous is apparent in the biological indicators observed in the site data. These indicators include: the high number of tolerant fish species and invertebrate taxa, a low EPT taxa (12), and a high number of scraper taxa (16.8%).

The HSPF model suggests that phosphorous concentrations above 0.15ppm occurred 52% of the time from 2001-2010 (Figure 502-5).

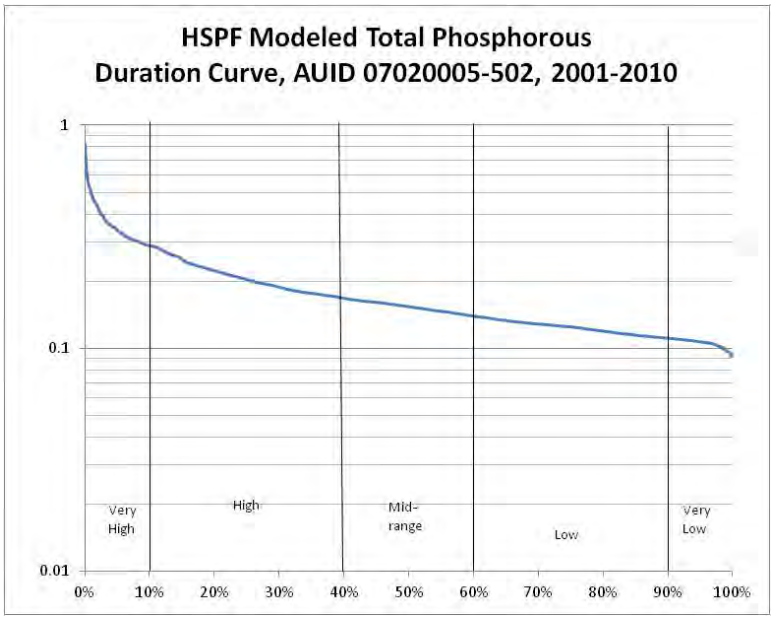


Figure 502-5 HSPF Phosphorous modeling projections.

Stressor pathway: Riparian condition

The riparian buffers along the main channel of AUID 07020005-502 are good on each side. The banks are eroding at a high rate according to CRWP surveys. Peak flows at USGS site 05304500 Chippewa River near Milan, Minnesota have seen a 252% increase since 1946. Flow conditions have been altered and bank erosion is on the rise which could be a possible source of in-stream phosphorous.

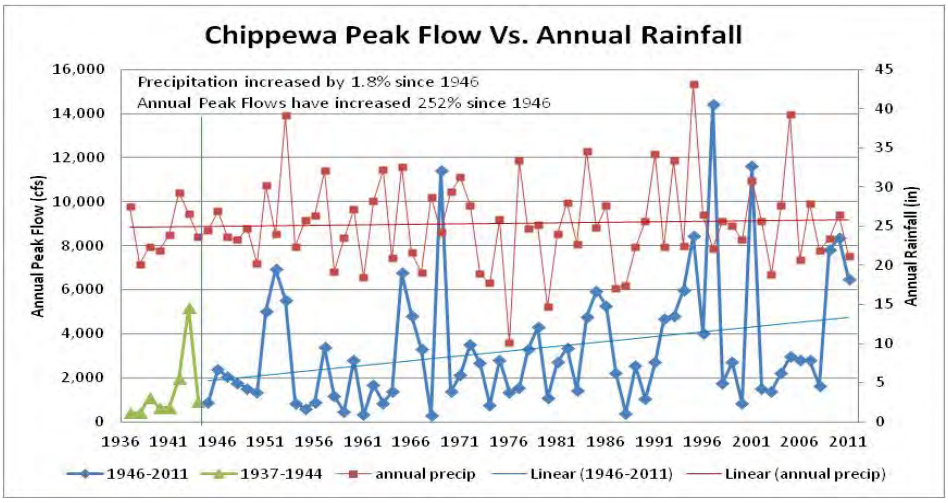


Figure 502-6, Peak flows at USGS site 05304500 Chippewa River near Milan, Minnesota.

Samples were collected at S002-203, located six miles upstream of this reach. A total of 340 samples were taken between 2001 and 2012. TP exceeded the standard 55.8% of the times it was sampled. At site S002-204, located two miles upstream of AUID 07020005-502 on Dry Weather Creek TP was sampled 174 times between 2001 and 2012, 37% of these samples exceeded the draft standard.

Phosphorous summary:

There is good data that shows the Chippewa River (AUID 07020005-502) has elevated levels of phosphorus. Data indicate that upstream sources on the Chippewa River and Dry Weather Creek are contributing phosphorous to this reach. Phosphorus from within the reach is likely coming from the stream banks and tributary streams in this reach's watershed.

Candidate cause: Nitrate

A limited number of NO2-3 samples (10 samples) were taken in 2009 in AUID 07020005-502 at site S000-494 also known as 09MN001. The average concentration of all the samples was 0.28ppm. The maximum sampled value was 0.58 mg/L.

Two upstream sites (S002-203 and S002-204) were sampled consistently and frequently enough to calculate flow weighted means for 2001-2010. The flow weighted means did not exceed the 10ppm drinking water standard. The larger site S002-203 (Chippewa River at Minnesota Hwy 40) did not exceed the 4.9mg/L aquatic life draft chronic standard nor the 75 percentile value of 6.9ppm for Western Corn Belt Plains ecoregion. S002-204 (Dry Weather Creek) did exceed the 4.9mg/L aquatic life draft chronic standard and the 75 percentile value of 6.9ppm for Western Corn Belt Plains ecoregion in most of the years sampled. (Figure 502-7).

HSPF modeling projects levels above the 75 percentile value of 6.9ppm for Western Corn Belt Plains ecoregion 2.5% of the time. The model suggests between 2001-2010 Nitrogen levels exceeded the 10ppm standard less than 1% of the time. These levels are below what is considered a stress to aquatic populations. (Figure 502-7).

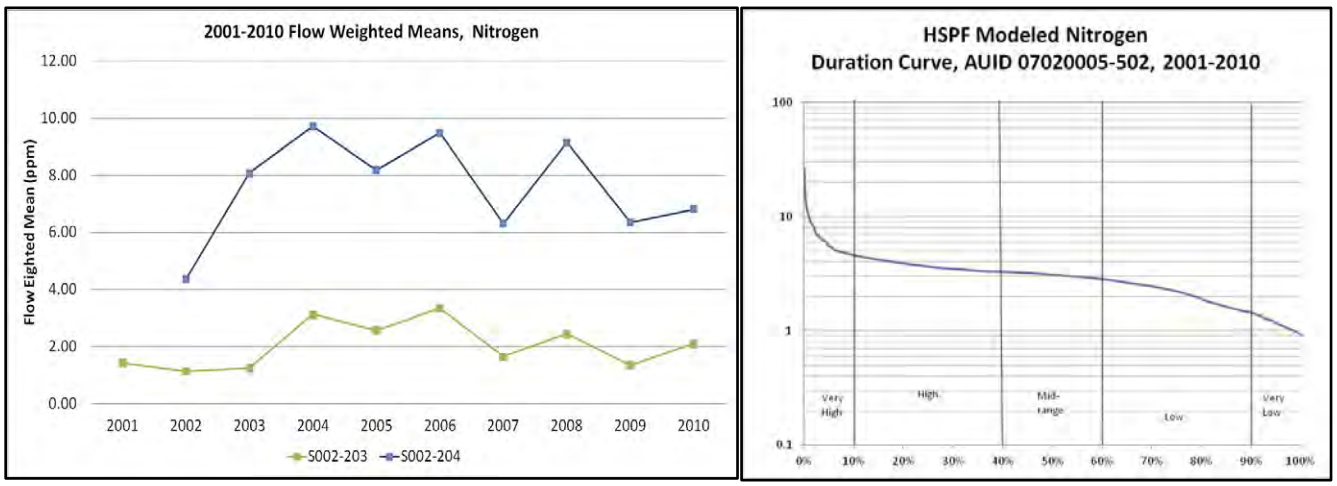


Figure 502-7 HSPF Nitrogen modeling projections and monitoring data derived flow weighted means.

In an examination of species' tolerance along physiochemical gradients in AUID 07020005-502 the first quartile was represented by 3% of the sample, the second quartile 15%, the third quartile 5% and the fourth quartile 69% (Figure 502-3). These results indicate that nitrogen is a possible stressor at site 09MN001.

The invertebrate sample collected in 2009 showed contradictory results. The site had a good representation of trichoptera taxa, while showing the presence of Physa (21 individuals) and Hyalella (18 individuals). Physa and Hyalella are commonly present in degraded water quality conditions consistent with elevated nutrient levels as they tend to feed on organic material and detritus.

Nitrogen summary:

Nitrate-Nitrite is a possible stressor to the stream biotic community. Sample data, biological data, and modeling all suggest that nitrogen may be having some effect on fish populations.

Candidate cause: Turbidity

Transparency (a surrogate for turbidity) was sampled at site S000-494 77 times between 2006 and 2009. Turbidity exceeded the standard in 55% of the samples. TSS was sampled 10 times at site S000-494 and exceeded the standard in 90% of the samples.

HSPF modeling of TSS projects levels in exceedance of the 54ppm surrogate standard 76% of the time (Figure 502-8).

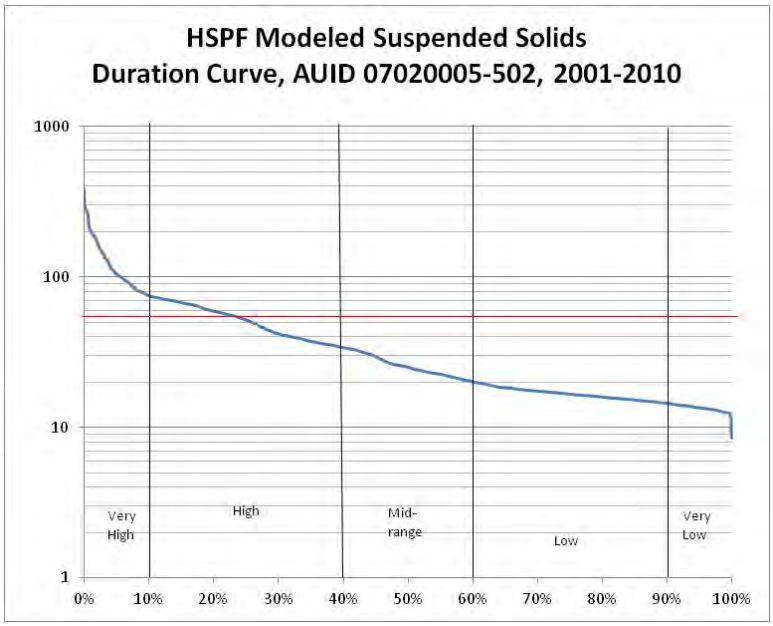


Figure 502-8 HSPF TSS modeling projections.

In 2009, the fish sampled at site 09MN001 were comprised of mostly fish that are tolerant to suspended solids (Figure 502-3). Sixty one percent of the invertebrates sampled at site 09MN001 were species tolerant to high TSS and collector-filterers made up only 5.97% of the sample.

Stressor pathway: Source-water pollution

The two main tributaries to this reach, the Chippewa River and Dry Weather Creek, are impaired for Turbidity. These tributaries have been monitored extensively from 1998-2012 and consistently are well above the 10% threshold for samples above 25 NTU turbidity, 20 cm transparency and 54ppm TSS.

Stressor pathway: Riparian condition

The riparian buffers along the main channel of AUID 07020005-502 are good. Upstream riparian buffers are not adequate especially on the tributary streams and ditches that feed into this AUID.

The banks are eroding at a high rate according to CRWP surveys. Peak flows at USGS site 05304500 Chippewa River near Milan, Minnesota have seen a 252% increase since 1946. Flow conditions have been altered and bank erosion is on the rise. Increased bank erosion could be responsible for some of the turbidity exceedances.

Stressor pathway: Channelization

The actual reach of AUID 07020005-502 is not channelized. Channelized flow to the reach from tributary sources dominates the flow pattern of this reach. Channelization is changing in-stream erosion rates that have led to an increase in turbidity (Figure 502-6).

Turbidity summary:

All factors considered support listing turbidity as a stressor in AUID 07020005-502.

Candidate cause: Habitat

At sites 09MN001 MSHA habitat conditions were sampled in July and September of 2009. Both visits gave Site 09MN001 a score of “Fair”. In 2012 these sites were visited again and a SVAP survey was completed at each site. During the 2012 visit, SVAP gave the site a score of "Poor".

Both of the 2009 MSHA's scored riparian conditions well. Substrate, cover and channel morph all pulled the overall score down. (Figure 502-9)

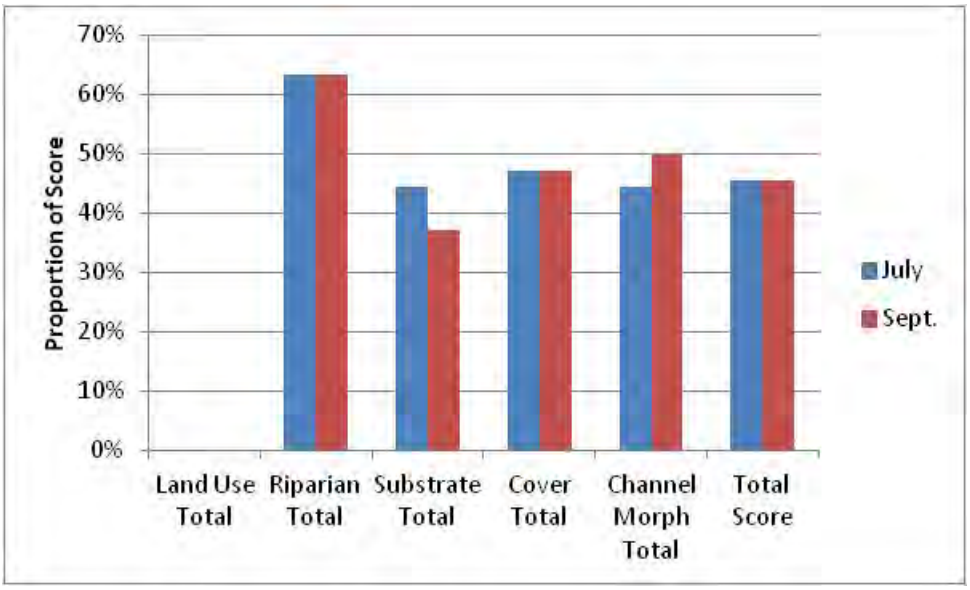


Figure 502-9 MSHA scores by category for 09MN001

The SVAP survey conducted in 9-2012 noted a number of negative factors for aquatic habitat. In general, the river is entrenched and suffers from poor channel condition and obvious hydrologic alteration. The banks are somewhat unstable. The water appearance was poor and there were multiple signs of nutrient enrichment. The presence of two dams immediately downstream of the reach creates serious barriers to fish movement. The survey team observed a moderate number of habitat types for fish but only two of eight types of invertebrate habitats. The condition of pools at the site was excellent.

Figure 502-10 Looking upstream toward 09MN001.

Figure 502-11 The two dams downstream of 09MN001.

The fish survey in September of 2009 found low numbers of simple lithophilic spawning species, benthic insectivores, darters/sculpins/round bodied suckers. These findings suggest poor habitat. The lack of plecoptera (invertebrate) taxa detected in August of 2009 suggests issues with embedded sediment. The low number of clinging invertebrates is also indicative of poor habitat.

Stressor pathway: Channel alteration

Channel alteration in reaches contributing to the river have led to changes in the hydrologic and geomorphologic condition. This has led to upstream changes in discharge patterns, changes in substrate, down cutting, entrenchment, and increases in erosion. The two dams downstream are also causing problems for the channel and river bottom at this site. Deposition of sediments is a common phenomenon upstream of dams. These sediments smother habitat and limit sensitive species.

Habitat summary:

The Chippewa River at site 09MN001 does not have many of the structural components for good habitat. Three factors are limiting factors to the natural function of the river and are negatively impacting fish and invertebrate habitat: upstream hydrologic alteration, the presence of downstream dams and, surrounding land use and buffer management. At this point habitat is a limiting stressor.

Candidate cause: Altered hydrology

This reach has 2,043 square miles of drainage delivered to it from upstream watershed. Sixty-eight percent of this watershed's area is occupied by row crop agriculture. Much of the agricultural regions of the Chippewa watershed are efficiently served by a system of ditches and underground tile drainage. This drainage has effectively altered the hydrological drainage pattern of the Chippewa River. Flow monitoring upstream of this reach has noted a 252% increase in the annual peak event from 1946 to 2011 (Figure 502-6).

The presence of downstream dams has also altered the local hydrology of the reach. Flows in the pool area of the dam allows for the settling of sediments covering aquatic habitats. The pooled waters also reduce turbulence over riffle areas.

The lack of sensitive fish and invertebrate taxa and the presence of many tolerant ones lends support to considering flow alteration a stressor.

Altered hydrology summary:

There is good evidence to support listing flow alteration as a stressor in the reach. The hydrologic alteration that has been ongoing over the last 50 years in row cropped areas has had an impact on this reach. Flow monitoring upstream clearly notes a change in flow pattern over the last several decades. The presence of the downstream dams and their known impact to hydrologic patterns is evident. Surveys at 09MN001 found physical evidence indicative of flow alteration. Flow alteration is a stressor.

Candidate cause: Lack of connectivity

Site visits to AUID 07020005-502 noted two barriers to fish passage. The dam on Chippewa County Road 13 blocks all upstream movement of fish species on the Chippewa River. The dam on the Chippewa diversion channel under Chippewa County Road 9 does the same. These barriers limit fish movement and isolate fish populations within the Chippewa River. These barriers prevent the movement of fish populations from stressful stream conditions.

Weight of evidence

The evidence for each potential stressor, the quantity and quality of each type of evidence is evaluated. The consistency and credibility of the evidence is evaluated. Each step for AUID 07020005-502 was scored and summarized in Figure 502-12. For more information on scoring please see EPA's CADDIS Summary Table of Scores.

Types of Evidence	Scores					
	High Phosphorus	High Nitrate	Lack of Connectivity	Lack of Habitat	High Turbidity	Altered Hydrology
Spatial/temporal co-occurrence	++	+	++	+	++	+
Temporal sequence	+	+	++	+	+	+
Field evidence of stressor-response	+	+	++	+	++	+
Causal pathway	+	+	++	+	++	+
Evidence of exposure, biological mechanism	+	+	++	+	+	+
Field experiments /manipulation of exposure	NA	NE	NE	NE	NE	NE
Laboratory analysis of site media	NA	NE	NE	NE	NE	NE
Verified or tested predictions	NE	NE	NE	NE	NE	NE
Symptoms	+	+	0	+	+	+
Mechanistically plausible cause	+	+	+	+	+	+
Stressor-response in other lab studies	+	+	+	+	+	+
Stressor-response in other field studies	+	+	+	+	+	+
Stressor-response in ecological models	NE	NE	NA	NE	NE	NE
Manipulation experiments at other sites	NE	NE	NA	NE	NE	NE
Analogous stressors	NA	NE	NA	NA	NE	NE
Consistency of evidence	+	+	++	++	++	++
Explanatory power of evidence	++	+	++	++	++	++

Figure 502-12 Weight of evidence table for potential stressors in AUID 07020005-502 Chippewa River.

Conclusions

In AUID: 07020005-502 there are good monitoring data, therefore a good assessment of possible stressors can be made by combining the relevant information that is available. This reach has a number of stressors impacting the biological monitoring site 09MN001.

A survey of fish species tolerance levels to NO2-3, TP, TSS and DO revealed a high number of pollution tolerant individuals (Meador and Carlisle, 2006). These results suggest that low DO, turbidity, high phosphorous and high nitrogen are all possible stressors.

Dissolved oxygen is probably not a stressor in AUID 07020005-502. The absence of low DO samples, the agreement of the HSPF model and the presence of some low DO intolerant fish species are all factors that point toward this assessment.

There is good data that shows the Chippewa River (AUID 07020005-502) has elevated levels of phosphorus. Data indicate that upstream sources on the Chippewa River and Dry Weather Creek are contributing phosphorous to this reach. Phosphorus from within the reach is likely coming from the

stream banks and tributary streams in this reach's watershed. Upstream sources are also a major contribution to the conditions of the reach.

Nitrate-Nitrite is a possible stressor to the stream biotic community. Sample data, biological data, and modeling all suggest that nitrogen may be having some effect on fish populations.

All factors considered support listing turbidity as a stressor in AUID 07020005-502.

The Chippewa River at site 09MN001 does not have many of the structural components for good habitat. Three factors are limiting factors to the natural function of the river and are negatively impacting fish and invertebrate habitat: upstream hydrologic alteration, the presence of downstream dams and, surrounding land use and buffer management. At this point habitat is a limiting stressor.

There is good evidence to support listing altered hydrology as a stressor in the reach. The hydrologic alteration that has been ongoing over the last 50 years in row cropped areas has had an impact on this reach. Flow monitoring upstream clearly notes a change in flow pattern over the last several decades. The presence of the downstream dams and their known impact to hydrologic patterns is evident. Surveys at 09MN001 found physical evidence indicative of flow alteration. Altered hydrology is a stressor.

The dam on Chippewa County Road 13 blocks all upstream movement of fish species on the Chippewa River. The dam on the Chippewa diversion channel under Chippewa County Road 9 does the same. These barriers limit fish movement and isolate fish populations within the Chippewa River. The barriers prevent the movement of fish populations from stressful stream conditions.

5. AUID: 07020005-503, Upper Chippewa River, Stowe Lake to Little Chippewa River

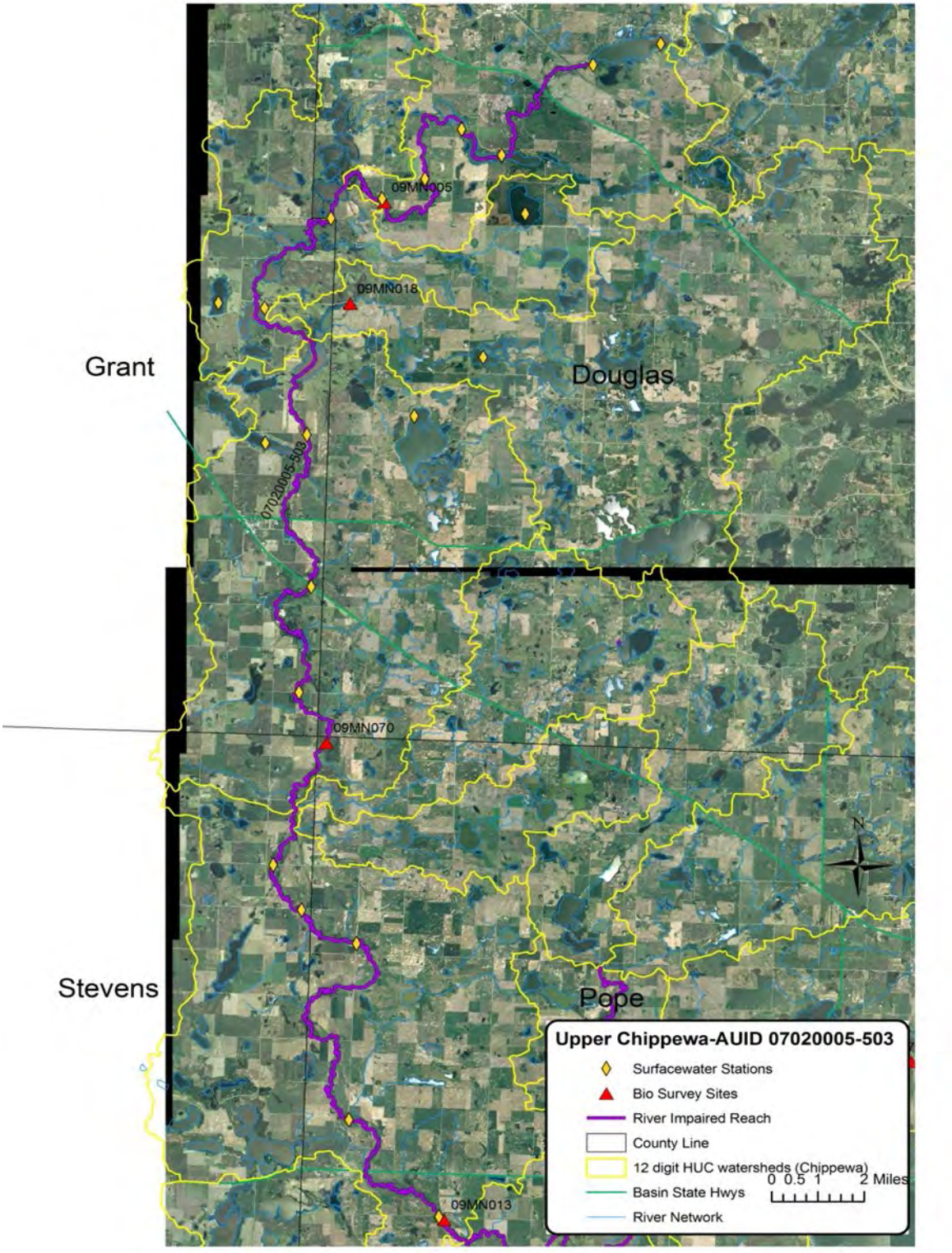


Figure 503-1 Upper Chippewa AUID 07020005-503.

Biology:

The Chippewa River from Stowe Lake to Little Chippewa River is impaired for invertebrates. Invertebrate metrics in this region indicate potential issues with disturbance, water born pollution and in some cases a lack of aquatic vegetative habitat (Figure 1).

At two of the sites, the relatively low mean metric score for ClimberCh, the abundance of climber taxa, suggest a lack of aquatic vegetation.

The lack of intolerant taxa as seen in the low metric score for HBI_MN, a measure of pollution based tolerance values assigned to each taxa, and the low value of Tolerant2CHTxPct, the relative percentage of taxa that are considered intolerant or less able to endure elevated levels of pollution indicate that water quality and disturbance are issues in this reach (Figure 1). In addition, the low numbers of pollution intolerant Plecoptera (stoneflies), and Trichoptera (caddisflies) taxa support this analysis.

The relatively low values for the Predator metric (taxa richness of predators), indicate that trophic complexity supported by this reach is poor. Less disturbed sites support a greater diversity of prey items and a variety of habitats in which to find them.

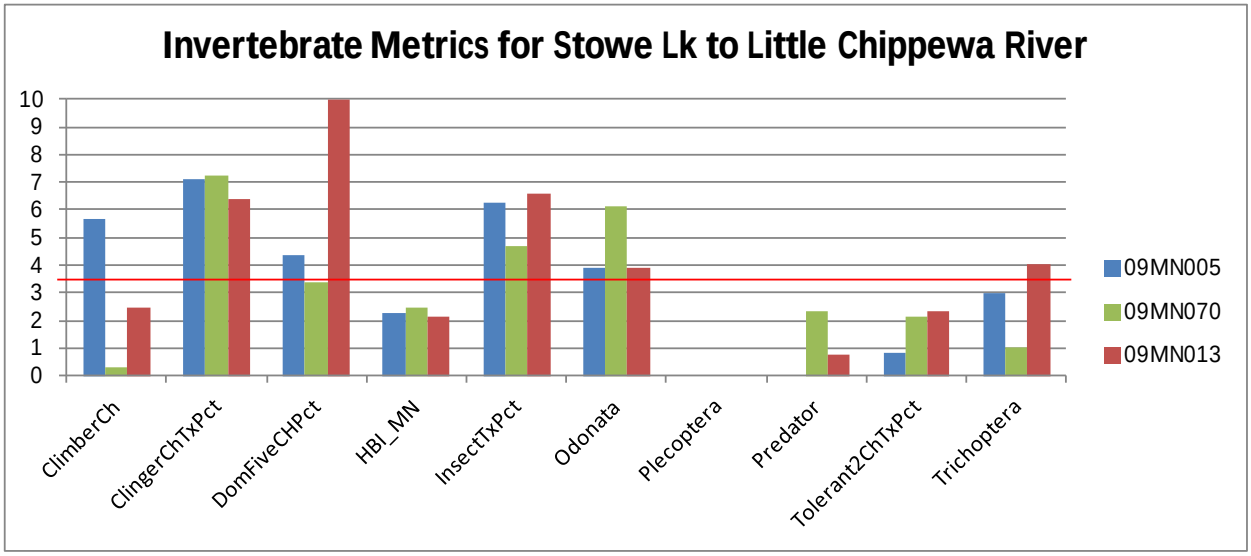


Figure 503-2 Invertebrate metric scores belonging to the Chippewa River, Stowe Lake to Little Chippewa River AUID: 07020005-503. Red line indicates the average metric score (3.6) needed for IBI score to be at the threshold.

Candidate cause: Dissolved oxygen

Dissolved Oxygen monitoring conducted in AUID 07020005-503 yielded minimal evidence for a DO cause to the impairment. Dissolved oxygen was monitored at four major sites and fourteen transect sites effectively covering the entirety of the reach. Readings taken between 2009 and 2012 numbered 388. Overall 3.4% of the readings were below the 5mg/L state standard.

One monitoring site (S002-190) did stand out as having the most exceedances of the standard (10% of 113 samples from 2009-2012). The majority of these exceedances (9 samples) occurred in 2011 during extended period of out of bank flows and flood plain inundation where extensive decay of the flood plain vegetation was noted.

Invertebrate metrics such as Plecoptera, Trichoptera and EPT tell a mixed story. The lack of plecoptera taxa while concerning could be due to poor habitat. The trichoptera and EPT scores varied from low to

adequate suggesting a possible range of poor to adequate DO levels. The number of DO tolerant invertebrates at the three sites ranged from 6-10% which suggests that low DO is not a persistent issue.

Stressor pathway: Impoundments

Dissolved oxygen levels can be affected by impoundments by collecting nutrients and organic materials leading less to availability and by serving as areas for algae blooms. In the AUID 07020005-503 watershed, there is one constructed impoundments and eight known natural impoundment. Figure 503-3 shows photos of one of the constructed impoundments, where the creek is held back by a 6-8 foot impoundment wall. The upstream impoundment conditions are difficult to discern from the road.

Figure 503-3 Impoundment on Upper Chippewa River, 9/26/ 2012 and aerial view 6/23/2010.

Three lakes within the AUID 07020005-503 watershed had DO data. None of these data documented unusually low DO levels.

Stressor pathway: Riparian condition

The riparian buffers along the Upper Chippewa mainstem are good in most areas with some notable exceptions. Some of the tributary streams are poorly buffered. Minimal buffers along lakeshores, and waterways could be failing to protect these areas from the impact of fertile lakeshore properties, farm fields and in some areas continuous livestock grazing. This can allow high amounts of nutrients, sediment and pesticides to enter adjacent streams and rivers. This nutrient enrichment can lead to an increased oxygen demand.

Stressor pathway: Source-water pollution

In AUID 07020005-503 monitoring has documented water nutrient levels above the draft standards and above the 75% value for the ecoregion. The documented eutrophic condition of many of the lakes within the watershed also suggests the widespread pervasiveness of elevated waterborne nutrients. The

sources of nutrients to the lakes are thus also contributing a high load of nutrients to the Upper Chippewa River.

Dissolved oxygen summary:

In AUID 07020005-503, DO appears to be an intermittent stressor to invertebrate communities throughout the stream. There were independent cases of measured low DO at some stations for short periods but most sites monitored did not register low DO.

Candidate cause: Phosphorus

Total phosphorus concentrations in AUID 07020005-503 are often above the Minnesota draft standard (0.15ppm). The flow weighted mean phosphorus levels from 2001 through 2010 were above the proposed standard and ecoregion expectations six out of the past ten years (Figure 503-4). Of the three sites monitored for phosphorous in this reach all of them reported levels above the draft standard at some point (09MN005 - 10% (N=10), S002-190 - 60% (N=106), 09MN013 - 40% (N=10)).

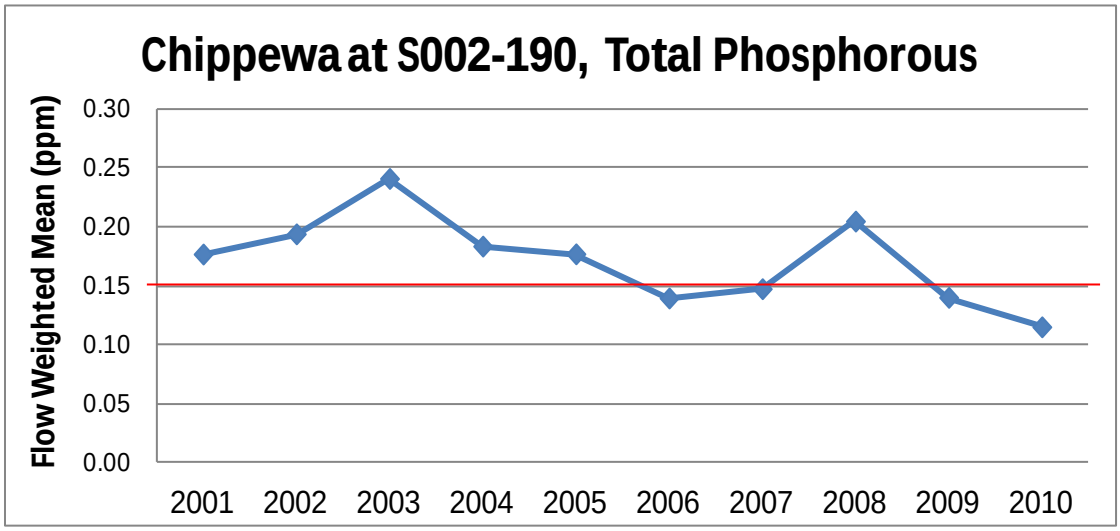


Figure 503-4 Flow Weighted Mean for Total Phosphorous at site S002-190

A significant amount of algae have been observed during monitoring season by CRWP staff. Algae are often related to high phosphorus concentrations. At Site S002-190 total suspended volatile solids (TSVS) have been monitored from 2009 through 2012. Total suspended volatile solids measures the fraction of total suspended solids that are organic in nature, such as algae cells, tiny pieces of plant material, and/or tiny animals (zooplankton) in the water column. High TSVS values indicate that a large portion of the suspended solids may be made up of algae cells. In the years when TSVS was measured at S002-190, 56% of the TSS was actually TSVS (34 samples).

The following invertebrate metrics support the case for listing phosphorous as a stressor. The Poor score for Tolerant2ChTxPct, the relative abundance (%) of macroinvertebrate individuals in subsample with tolerance values equal to or greater than 6. A low number of chironomid individuals in the tribe Tanytarsini observed at all three sites. The relative abundance (%) of macroinvertebrate individuals in subsample with tolerance values less than or equal to two, IntolerantPct, fits the profile of a system on the borderline of high phosphorous (Minnesota River Nutrient Criteria Development).

Stream Visual Assessments conducted in October of 2012 by CRWP staff provide a useful perspective. At the time of the survey the three sites 09MN005, 09MN070 and 09MN013 presented bright green water and channel substrates covered with algae (Figure 503-5). Since algae are often related to high phosphorus concentrations it seems reasonable that these sites experience high phosphorous.

Figure 503-5 Photos from the Upper Chippewa taken on 9/26/2012 showing algae saturated water algae covered substrates.

Stressor pathway: Riparian condition

The riparian buffers along the Upper Chippewa mainstem are good in many areas but there are serious exceptions. Some of the tributary streams are poorly buffered. Minimal buffers along lakeshores, and waterways could be failing to protect these areas from the impact of fertile lakeshore properties, farm fields and in some areas continuous livestock grazing. This can allow high amounts of nutrients, sediment and pesticides from adjacent area to enter adjacent streams and rivers.

Stressor pathway: Source-water pollution

In the AUID 07020005-503 watershed, there is one constructed impoundment and eight known natural impoundments that the Chippewa River passes through. Two of these natural impoundments are monitored (Stowe and Long Lake). Both Stowe and Long lake have several years worth of total phosphorous, chlorophyll-a and Secchi disk transparency data that indicate that both lakes are eutrophic. In addition, six other adjacent lakes that contribute to the impaired reach are monitored. All of the additional six lakes (Wicklund, Redrock, Jennie, Venus, Lower Elk and Thompson) are eutrophic or hypereutrophic. Two of these adjacent lakes had average total phosphorous levels above the draft standard, Wicklund (Ave. TP = 0.178) and Jennie (Ave. TP = 0.228). USDA Farm Service Agency aerial photos document the green color of these and other lakes in the surrounding watershed (Figure 6). The sources of nutrients to these lakes are also contributing a high load of nutrients to AUID 07020005-503.

Phosphorous levels observed at site S002-190 if taken from a lake would be considered high. According to the Carlson's Trophic State Index these levels in a lake would be considered hypereutrophic (Figure 503-6). Considering that there are two lakes (Reed and Wilson) on the Chippewa River immediately upstream (5 and 7 miles respectively) of site S002-190, it stands to reason that they are both hypereutrophic and sources of algae within the reach.

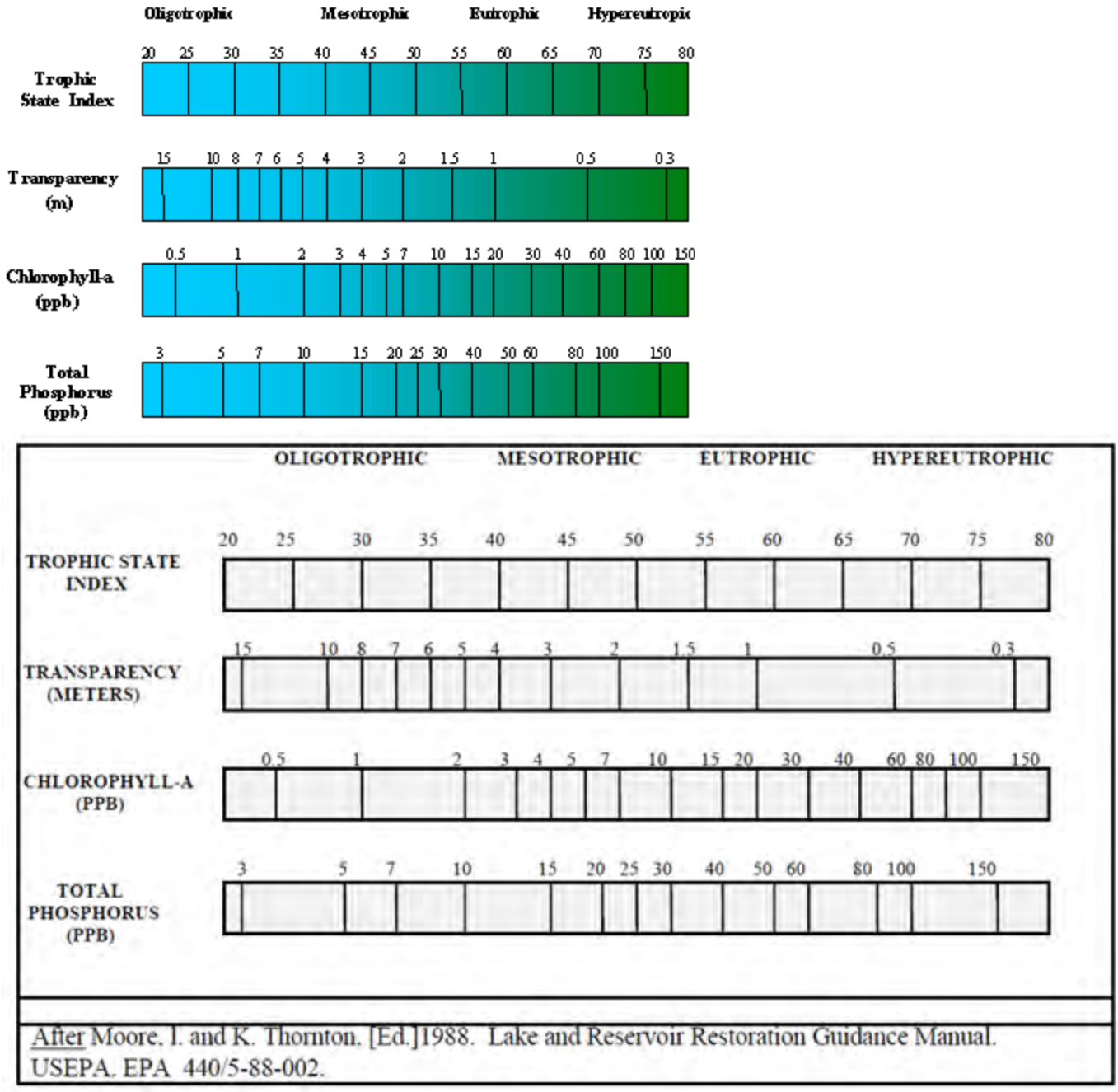


Figure 503-6 Carlson's Trophic State Index for Lakes.

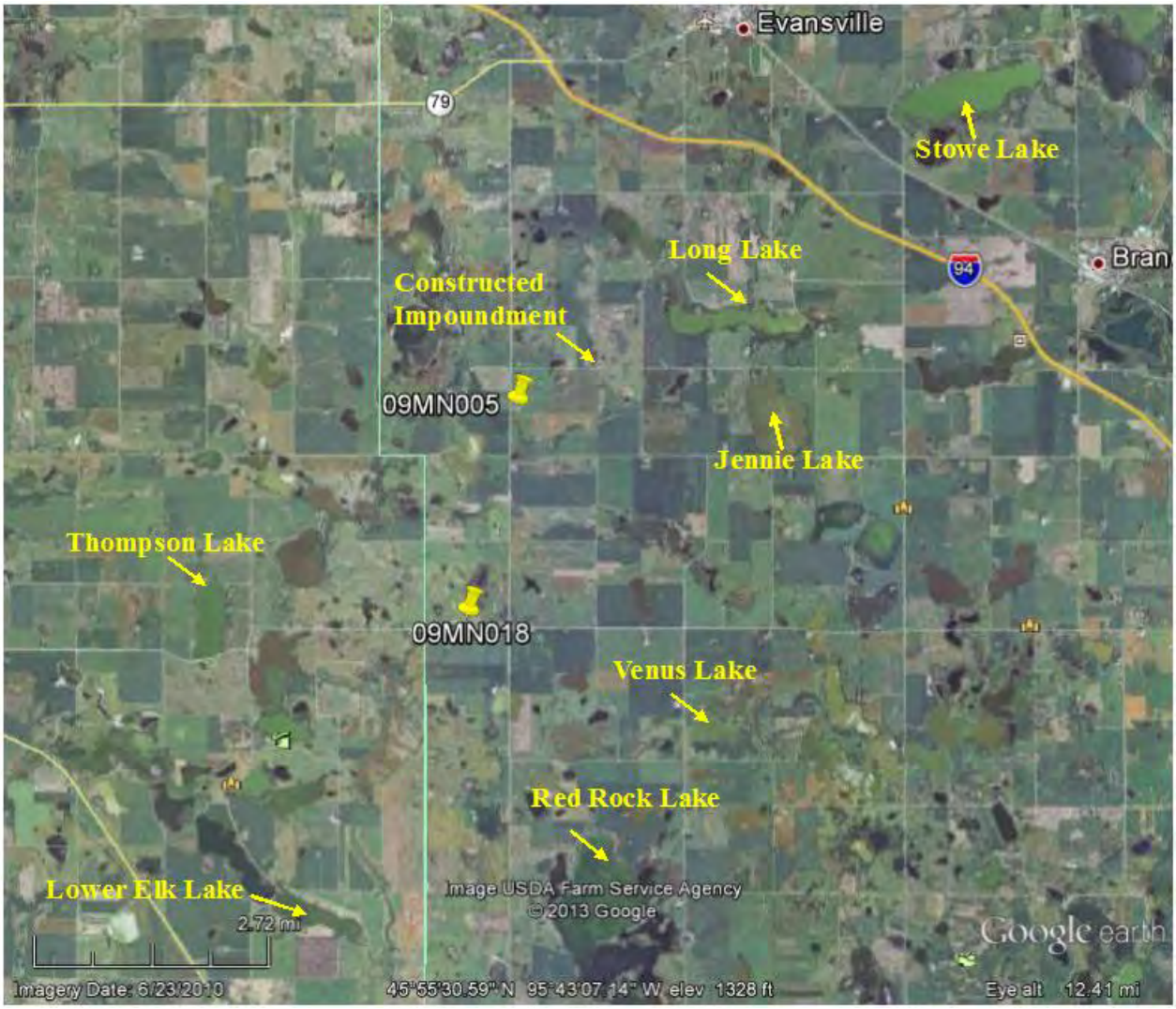


Figure 503-7 Aerial photo of green lakes in the Upper Chippewa River.

Phosphorous summary:

Considerable data shows the Upper Chippewa River AUID 07020005-503 to be extensively influenced by elevated levels of phosphorus. Phosphorus in this system is likely contributing to the dissolved oxygen and turbidity stressors also present in this system. Habitat and altered food resources for the biotic community are also likely influenced by excess phosphorus.

Candidate cause: Nitrate

Nitrate Nitrite (NO2-3) samples were gathered at two sites within AUID 07020005-503's reach. S002-190 has been monitored almost every year since 1999 (Figure 503-8). There appears to be an increasing trend in NO2-3 levels in the Upper Chippewa River. In 2007, 2008 and 2010 the calculated flow weighted means were above the Northern Glaciated Plains 75 percentile value of 0.52 mg/L. A total of 123 samples were taken from 2007 through 2012, 22% of these samples were above the Northern Glaciated Plains 75 percentile value of 0.52mg/L (Figure 503-9).

In 2009, ten samples were taken at site 09MN013, no other years were monitored. None of these samples measured values above the Northern Glaciated Plains 75 percentile value of 0.52 mg/L.

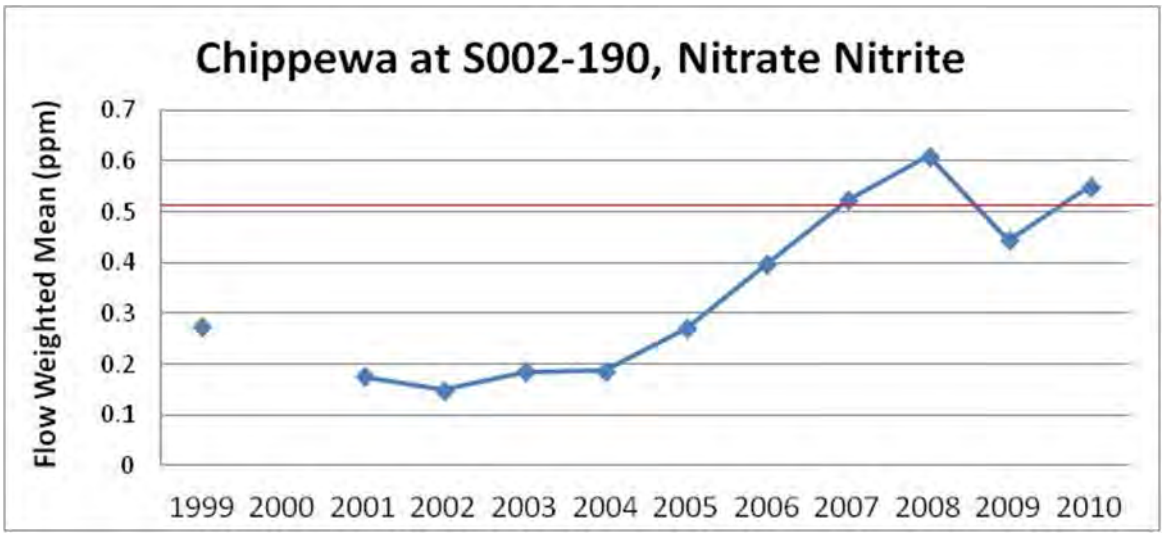


Figure 503-8 Flow weighted Means for S002-190, 1999-2010

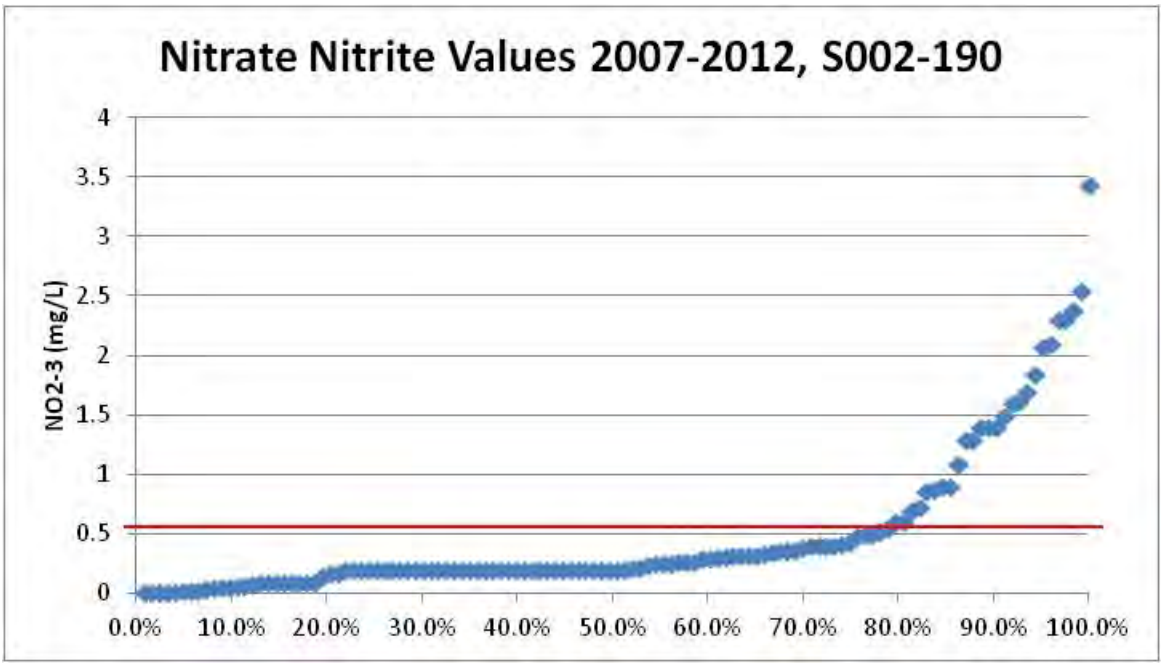


Figure 503-9 Proportional breakdown of NO2-3 samples taken at S002-190, 2007-2012, 123 samples.

While fish are not listed as impaired for this reach their response to nitrogen pollution can be used as an indicator and shed some light on the conditions of the reach. In an examination of species' tolerance along physiochemical gradients, four species in the Upper Chippewa River (in 2009-2010) had mean TIV in the first quartile, indicative of the greatest sensitivity to nitrate (Figure 503-10; Meador and Carlisle, 2007). Those species included yellow perch, golden shiner, bluegill, and walleye. Although these species were present, they were not present in great numbers. Starting at 09MN005 and going downstream, the nitrate sensitive species made up a minor portion of the sample size.

In 2009 and 2010, the fish samples in the Upper Chippewa were comprised of varied portions of nitrogen tolerant individuals (fourth Quartile) at each of the sites (Figure 503-10). At the Upstream site (09MN005) 44.97% of the sample was made up of nitrogen tolerant species, 36.77% at 09MN070 and then 83.1% at 09MN013. These fluctuating levels of Nitrogen tolerance and the drop-off of nitrogen intolerant species suggests that nitrogen may be more of an issue in the lower portion than it is in the upper portion of the reach.

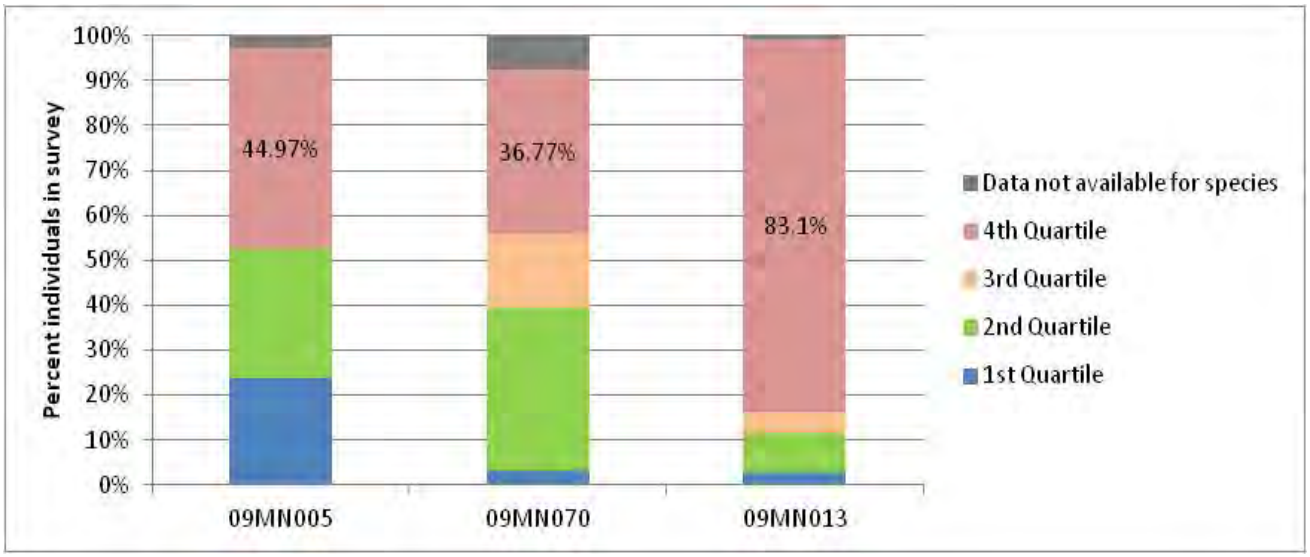


Figure 503-10 Percent fish individuals by biological site in the Upper Chippewa River, for each quartile based nitrate tolerance indicator values (Meador and Carlisle, 2007).

Stressor pathway: Riparian condition

The riparian buffers along the main channel of the Chippewa River are minimal in some areas and heavily grazed in others but are mostly buffered. On the other hand many of the contributing tributaries of the Upper Chippewa watershed are not adequately protected by buffers. This can allow high amounts of nutrients, sediment and pesticides from adjacent fields to enter adjacent streams and rivers.

Stressor pathway: Source-water pollution

Channelized and natural tributaries to the Chippewa River carry nitrates during snowmelt and rain events. It is assumed that nitrogen and forms of nitrogen, such as ammonia, are being applied to the cropland throughout the watershed as it is nearly 65% cropland. It is unknown how much groundwater contributes nitrate.

Nitrogen summary:

Nitrate-Nitrite is an identified stressor to the downstream biotic community of AUID 07020005-503. Fish data and chemical monitoring suggest that it has a lesser effect in upstream areas.

Candidate cause: Habitat

The Upper Chippewa River has Good to Fair habitat as scored by the MSHA during fish survey visits. The land use category scored the lowest for all three bio-sites. The 09MN005 and 09MN013 both scored well for the other categories. Site 09MN070 scored poorly in the categories of riparian zone and cover, the score for channel morphology was also less than the other two. The land use along the Upper Chippewa River is predominantly row crop and pasture, both of which contribute to the lack of decent riparian vegetation. Site 09MN070 is a continuously grazed cattle pasture evidenced in a 2012 site visit. The disturbance of perennial vegetation and intense hoof action to the bank at 09MN070 has unraveled that reach. The river at this site is currently a F4 stream type rather than a C stream type that is typical of a prairie stream with low slope such as the Upper Chippewa River. The F4 stream type is extremely sensitive to disturbance, has a very high potential for stream bank erosion and a poor recovery potential. The other two geomorphic sites on the creek were observed to have better riparian vegetation.

General observations of habitat at the twelve transect sites within the reach suggest that the reach is not a uniform reach nor a gradient of habitat conditions but rather a variable mix of conditions that degrade and improve dependent on the conditions of adjacent land use, management and geomorphic condition. The following detailed habitat descriptions of the SWAG bio-survey sites and site S002-190 are good examples of the variable conditions observed through AUID 07020005-503.

Station 09MN005

Station 09MN005 is the most upstream biological monitoring site on the Upper Chippewa. The contributing drainage area is approximately 149 square miles. The Chippewa River at station 09MN005 is classified as a C3 stream type, characterized by a gravel bed, low entrenchment ratio with good connectivity to the flood plain, moderate to low width depth ratio, moderate sinuosity, and low slope. The reach is protected from down-cutting by riffles with boulders and subpavement materials that are resistant to degradation. There is a dam 3.25 miles upstream from this site. In addition, the reach has a 1,500 foot straightened section about 2,000 foot upstream of the monitoring site. The dam and straightened portion of the creek are likely reasons for severe erosion on the outside of bends and the prevalence of undercut banks. The hydraulically controlling culvert, riffles and stable stream bed in this reach help resist down cutting. This leaves the stream banks as the weakest link in adjusting to the sediment free flows coming over the upstream dam and down the increased slope of the straightened section.

Figure 503-11 Station 09MN005 9/26/2012 (extreme drought, channel dewatered).

Station 09MN070

Station 09MN070 is the middle biological site located in the Upper Chippewa. The contributing drainage area is approximately 300 square miles. The land immediately adjacent to site 09MN070 is a continuously grazed cattle pasture evidenced by a 2012 site visit. The disturbance of perennial vegetation and intense hoof impact to the bank at 09MN070 has rendered the reach bare of vegetation. The river at this site is currently a F4 stream type rather than the E and C stream types that are typical of the Chippewa River in this reach. The F4 stream type is entrenched and extremely sensitive to disturbance, it has a very high potential for stream bank erosion and a poor recovery potential. The land surrounding this station is mostly engaged in the row crop agriculture (Figure 503-12). A simple geomorphic assessment and habitat survey was completed on September 26, 2012.

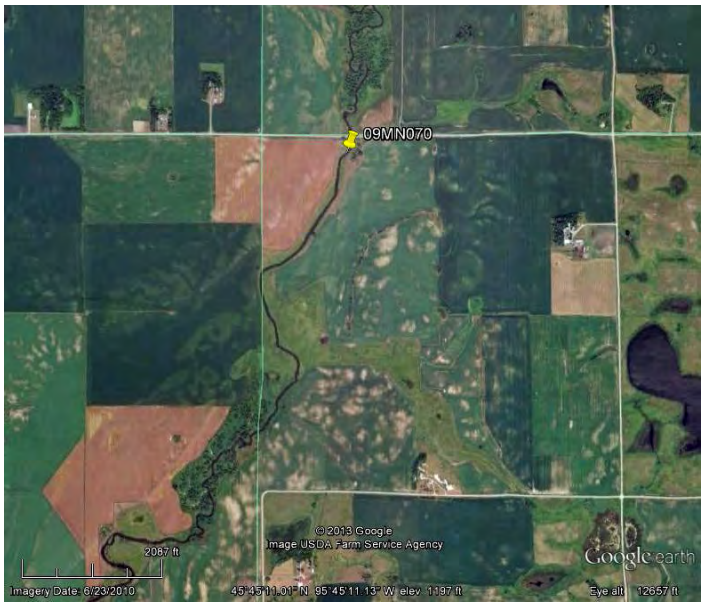


Figure 503-12 aerial photo of site 09MN070.

The September 26, 2012 survey of 09MN070 noted that the unrestricted, long term access of cattle to both banks of the river for the entirety of the survey site exposes the river channel and aggravates the impact of the stream entrenchment and upstream hydrologic alterations. Poor water quality was noted as was the pervasive presence of algae covered substrates (Figure 503-13).

Invertebrate habitats consisted of boulders, cobble, gravel, riffles and shallow pools. Of note was the lack of aquatic vegetation and overhanging bank vegetation. The water appeared too turbid to allow for aquatic vegetation and the channel bottom appeared to be disturbed by cattle crossing the river. Perennial grasses were closely cropped or non-existent due to the continuous grazing and frequent disturbance by hoof action. This may well be the reason that there were very few climber invertebrates found at this site. Climbers need either vascular hydrophytes or detrial debris of which none were observed in 2012.

Between the continuously grazed pasture and the adjacent row crop fields little of value was left for the function of the riparian zone. The land use adjacent to this site does not provide "natural riparian zone" benefits (as defined by NWCC Technical Note 99-1, Stream Visual Assessment Protocol, December 1998) for invertebrates, fish nor natural stream function.

Figure 503-13 Station 09MN070 9/26/2012, livestock impact and algae in water column and on substrate.

Station S002-190

Station S002-190 is a long term continuous flow and water chemistry monitoring site operated and maintained by CRWP. The contributing drainage area is approximately 355 square miles. The land immediately adjacent to site S002-190 is a combination of wild grass dominated flood plain, row crops and hayfields (2012). Mature perennial vegetation dominates the riparian zone. The river at this site is currently an E4 stream type, typical of the Chippewa River in this reach. The E4 stream type is characterized as being the least entrenched and has a very high sensitivity to disturbance, it has a high potential for stream bank erosion but E4's have a high potential for recovery. The controlling influence of vegetation on E4 channels is very high. This site was not surveyed for biology by the MPCA in 2009-2010. This site has been assessed for habitat and geomorphology, most recently on September 9, 2012.

S002-190 was scored overall as Fair by the SVAP. The SVAP gave Invertebrate habitat 10 out of 10 points, habitat types documented were: overhanging vegetation (draped in water), boulders, cobble, coarse grave, and undercut banks. The factors that brought this site down were water quality and geomorphology based. Scores for water appearance and nutrient enrichment were poor due to the documented pervasively bad turbidity levels and the high nutrient issues.

Figure 503-14 Aerial photo of site S002-190.

Figure 503-15 Photos of site S002-190, looking downstream and upstream.

While this site is fairly stable and well protected by perennial vegetation the geomorphology of this site is negatively impacted by the road and culverts. This brought down the scores for channel condition and hydrologic alteration. The road acts as a dike to the river during high flows and prevents access to the flood plain on one side. Even so, since the flood plain is so large this impact is minimal. The culverts restrict flow and focus the rivers power into the river channel during high flows. This has had the impact of creating a scour pool downstream of the culverts. In addition, the stream banks downstream of the culvert are noticeably worse than those upstream of the road.

Station 09MN013

Station 09MN013 is the downstream biological site on the Upper Chippewa. The contributing drainage area is approximately 401 square miles. The land immediately adjacent to site 09MN013 is a mix of mostly wild flood plain and some row crops (2012). The land surrounding this station is mostly engaged in the row crop agriculture (Figure 503-16). The river at this site is currently a C2 stream type which is typical of the Chippewa River in this reach. The C2 stream type has a low sensitivity to disturbance, it has a low potential for stream bank erosion and a very good recovery potential. A simple geomorphic assessment and habitat survey was completed on September 26, 2012.

Figure 503-16 Aerial photo of site 09MN013.

The MSHA scores this site as Good with a total of 81.6. Only six other sites of the 123 in the Chippewa that were surveyed scored higher than 09MN013. In fact, 09MN013 scored above the threshold for the Macroinvertebrate Index of Biotic Integrity (MIBI) but its score is within the confidence interval.

Figure 503-17 Site 09MN013 looking downstream and upstream.

The SVAP gave 09MN013 an overall score of Good. Invertebrate habitat scored 10 out of 10 points. Invertebrate habitat types documented were: overhanging vegetation (draped in water), boulders, cobble, coarse gravel, fine woody debris, root wads and undercut banks. Clearly this site has excellent habitat characteristics for invertebrates. The only factors that were negative for this were water quality based. Scores for water appearance and nutrient enrichment were poor due to the documented pervasively bad turbidity levels and the high nutrient issues.

Site 09MN013 appears to be maintaining its borderline status due to its strengths of good habitat and good hydrologic stability. The poor water quality coming from upstream sources is degrading what should be an otherwise thriving invertebrate population.

The fish surveys in 2009 found low numbers of simple lithophilic spawning species, benthic insectivores, and darters/sculpins/round bodied suckers at site 09MN005. These findings suggest poor habitat at 09MN005 but not the lower two downstream sites. The lack of plecoptera (invertebrate) taxa detected at all sites in 2009 suggests issues with embedded sediment. The high number of clinging invertebrates is indicative of good habitat. Habitat conditions appear to change dependent on local conditions.

Stressor pathway: Riparian condition

The riparian buffers along the main channel of the Chippewa River are mostly good and serving their function as natural habitat for the aquatic invertebrates. Riparian conditions are poor in identifiable areas where row cropping gets too close to the river and where pastures are grazed too far for too long. In both instances these impacted areas no longer serve a benefit to the invertebrates as natural habitat. In some cases when the physical conditions are right the lack of protective vegetation allows the river to shift to unstable riparian conditions.

Stressor pathway: Channel alteration

Channel alteration in distinct locations on the river and in reaches contributing to the river have led to changes in the hydrological and geomorphological condition. This has led to changes in discharge patterns, changes in substrate, changes in sinuosity, and increases in erosion.

Stressor pathway: Impoundments

Some impoundments in Upper Chippewa River have led to instability creating increased erosion below impoundments as well as channel alteration to regain stability.

Habitat summary:

In Upper Chippewa River, there is clear evidence that in distinct locations the lack of habitat afforded to the aquatic community is significant and that poor habitat is clearly a stressor causing biotic impairment in these distinct locations.

Observations suggest that the reach is not a uniform reach nor a gradient of habitat conditions but rather a shifting mix of conditions that degrade and improve dependent on culvert placement, upstream impoundments, conditions of adjacent land use, management and geomorphic condition.

Candidate cause: Turbidity

Turbidity, which is a measure of transparency, can be increased with sediment, algae and organic matter. In addition to turbidity, the State of Minnesota allows transparency (25NTU=20cm transparency) and total suspended solids (TSS) (25 NTU= 54ppm TSS) as surrogates for turbidity in the Chippewa River watershed. In AUID 07020005-503 there are 15 sites where turbidity, TSS or transparency has been measured.

At S002-190 the flow weighted mean levels for TSS from 2001 through 2010 were above 54ppm three out of the past ten years (Figure 503-18). 121 TSS samples were collected at this site from 2001 through 2010. Forty-one percent of the TSS Samples were above 54ppm.

Turbidity concentrations in AUID 07020005-503 are often above the Minnesota standard (25 NTU). In AUID 07020005-503 site S002-190 was the only site where turbidity was directly measured. At site S002-190 from 2007 through 2012 101 turbidity measurements were made, 45% of them exceeded the standard. At site 09MN005 11% of 19 transparency measurements taken over 2009 and 2010 exceeded the standard. At site 09MN013 85% of the 55 transparency measurements taken between 2006 and 2010 exceeded the standard.

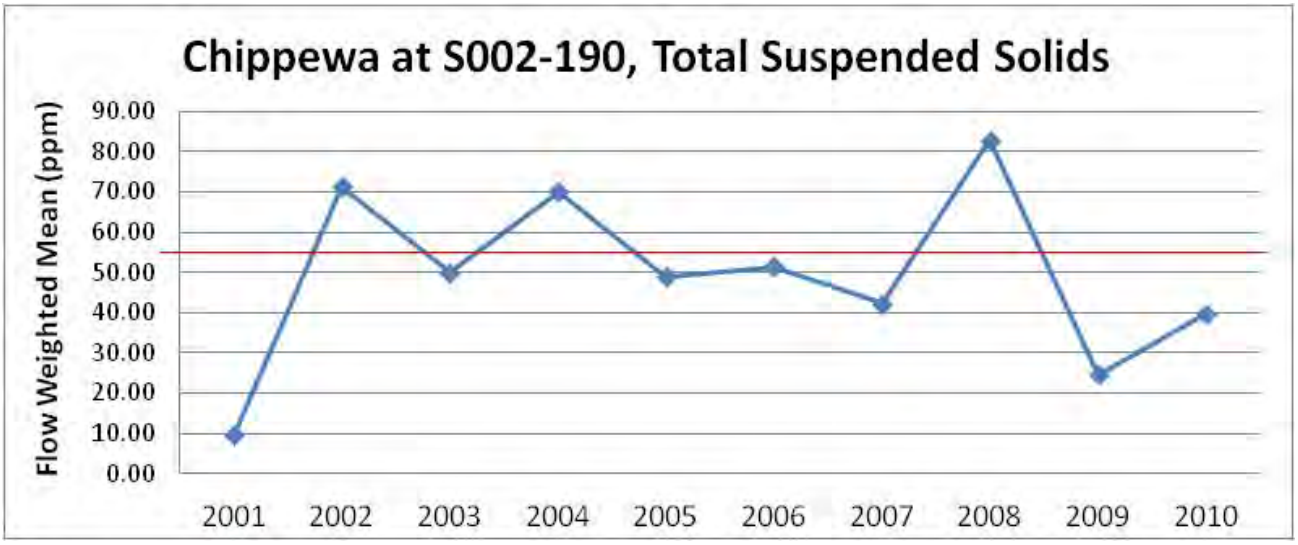


Figure 503-18 Flow Weighted Means for S002-190, 2001-2010.

Review of the transparency data from the transect sites from 2009 and 2010 reveals an interesting pattern. Overall the 12 sites were monitored for transparency 19 times each over this two year period and overall they exceeded the standard 58% of the time. When the sites are broken out we see that the first four sites upstream of Peterson Lake exceeded the standard 6% of the time. The next eight sites downstream of Peterson Lake exceeded the standard 80% of the time. Turbidity is a significant issue from Peterson Lake downstream till the end of the reach. Upstream of Peterson Lake, in-stream turbidity appears to not be an issue.

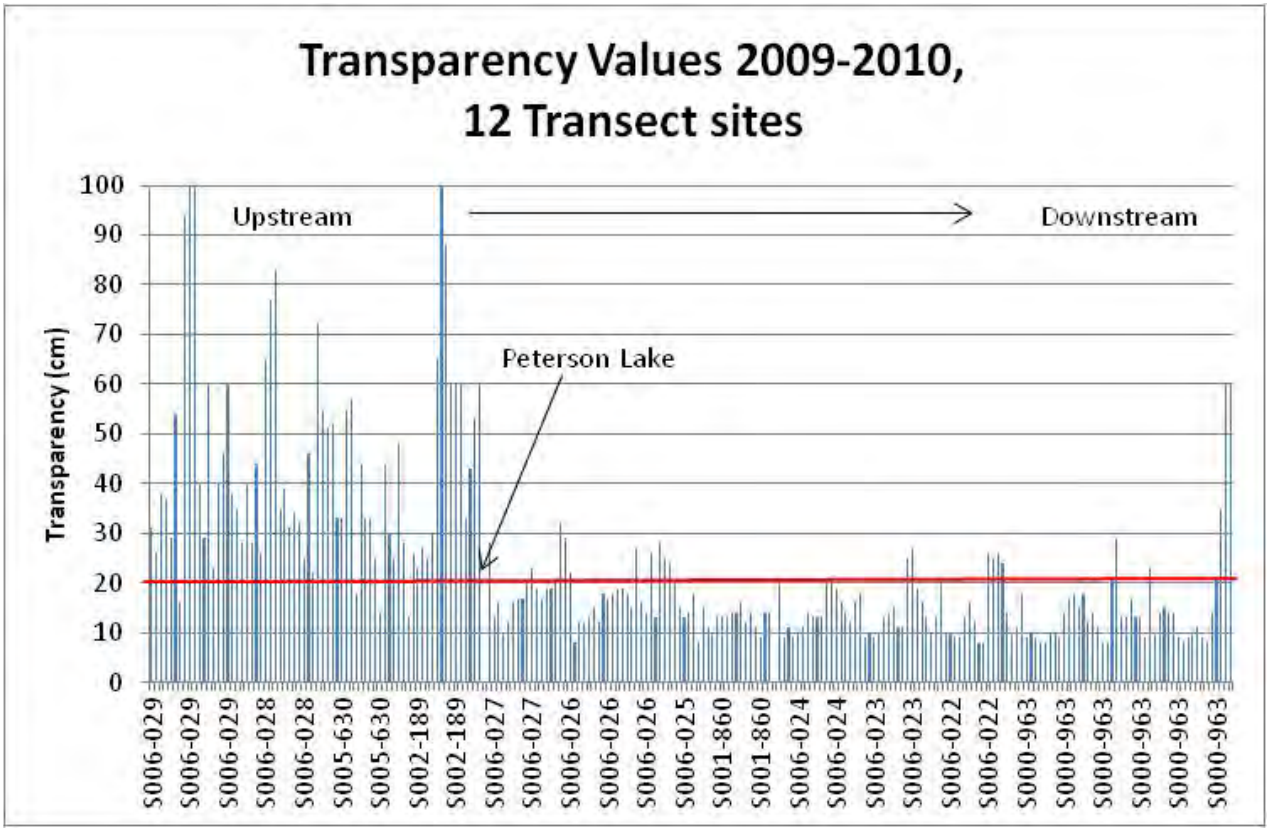


Figure 503-19 Transparency results showing the drop in transparency as the water moves downstream (note the red line, values below 20 cm are considered in exceedance of the standard).

The invertebrates sampled at site 09MN005, 09MN013 and 09MN070 were comprised of taxa tolerant to high TSS 43%, 49% and 58% respectively. The relative percentage of scraper taxa decreases from site to site as one moves downstream. Scrapers are known to be sensitive to turbidity.

Stressor pathway: Riparian condition

The riparian buffers along the main reach of AUID 07020005-503 are good in most areas. There are sections of the river where the stream banks have been exposed to continuous livestock disturbance. This has led to decreased riparian and bank vegetation, leading to increased erosion potential.

The riparian buffers along the tributary streams of AUID 07020005-503 are often not adequate. There are many field drainage ditches and small streams that flow into tributary waters that do not have adequate riparian buffers. These smaller tributaries have decreased riparian and bank vegetation, leading to increased erosion potential.

Stressor pathway: Channelization

Channelization of reaches within AUID 07020005-503 are minimal. Channelization of reaches contributing to the river are more frequent and have led to changes in the hydrological and geomorphological condition. This has led to changes in erosion rates that have led to an increase in turbidity.

Stressor pathway: Impoundments and source-water pollution

Impoundments in AUID 07020005-503 have led to instability creating increased erosion around impoundments as well as channel alteration to regain stability. In addition, they are rich in nutrients. The sources of nutrients to the lakes are thus also contributing a high load of nutrients to AUID 07020005-503 that manifests in an abundance of blue green algae at times which limits water transparency.

In the AUID 07020005-503 watershed, there is one constructed impoundment and eight known natural impoundments that the Chippewa River passes through. Two of these natural impoundments are monitored (Stowe and Long Lake). Both Stowe and Long Lake have several years worth of Chlorophyll-a and Secchi-disk transparency data that indicate both lakes are excessively turbid. In addition, six other adjacent lakes that contribute to the impaired reach are monitored. All of the additional six lakes (Wicklund, Redrock, Jennie, Venus, Lower Elk and Thompson) are eutrophic or hypereutrophic and exhibit turbid conditions. USDA Farm Service Agency aerial photos document the green color of these and other lakes in the surrounding watershed (Figure 503-7). These lakes are also contributing a high load of algae and turbidity to AUID 07020005-503.

Phosphorous levels observed at site S002-190 if taken from a lake would be considered high. According to the Carlson's Trophic State Index these levels in a lake would be considered hypereutrophic (Figure 503-6). Considering that Reed Lake and Wilson Lake are two lakes on the Chippewa River immediately upstream (5 and 7 miles) of site S002-190 it stands to reason that they are both hypereutrophic and sources of algae and turbidity to the site and within the downstream reach. USDA Farm Service Agency aerial photos corroborate this hypothesis by documenting the consistent green and brown color of these lakes.

Turbidity summary:

The data and consistency of the evidence supports turbidity as a stressor in AUID 07020005-503. There are plausible sources and pathways as well as a observed biological responses expected in a stream with elevated turbidity levels.

Candidate cause: Altered hydrology

Flow monitoring in this reach was limited to site S002-190. This site's hydrology is characterized by slow rising water levels following rain events and an adequate base flow.

Chippewa River Bank Pin monitoring of daily flows in AUID 07020005-503 ranged from 2 to 789 cubic feet per second (cfs) at site S002-190 from 2001 through 2011 (Figure 503-20). Bankfull discharge was determined by geomorphic surveys at the monitoring station and was calculated to be 187cfs. Bankfull flows have a recurrence interval of 1.369. Bankfull flow is the 27.02 percentile flow at site S002-190. Flows at bankfull flow or greater were tallied from 2001 to 2011, of these events 28% occurred in April, 19% in May, 17% in June and 15% in July. August, September and October together accounted for 16%. The measured velocities in this reach range from 0.16 to 3.88ft/s. The ranges of velocities endured are most important to biota rather than an average. Overall the higher flow hydrological condition of this reach appears to be in good shape.

Low flow events are a natural part of a river's cycle, but flows that are too low or low too often could result in a negative biological impact. Extended low flow events which were below the estimated 90th percentile flows of 10.0cfs (Figure 88) occurred in the fall of 2007, 2008, 2009 and 2012. The 7Q10 for this site is 2.8cfs and the 1Q10 is 2cfs. The upstream site 09MN005 was completely dewatered in the 2012 drought.

There is physical evidence to support listing altered hydrology as a candidate cause in the upper portion of the reach. Surveys a site 09MN005 noted channel erosion, scouring and dry stream conditions. These are all evidence of flow alteration. The presence of a dam and channelized section of stream immediately upstream of site 09MN005 are likely contributing factors to these observed conditions. In the case of 09MN070 the channel erosion appeared to be the result of extensive over grazing and the resulting destruction of the riparian corridor. Surveys at 09N013 did not find physical evidence indicative of flow alteration. Further evidence against flow alteration as a candidate cause in the lower region of the reach comes from bank pins placed at site S002-190. They have not documented high rates of bank erosion.

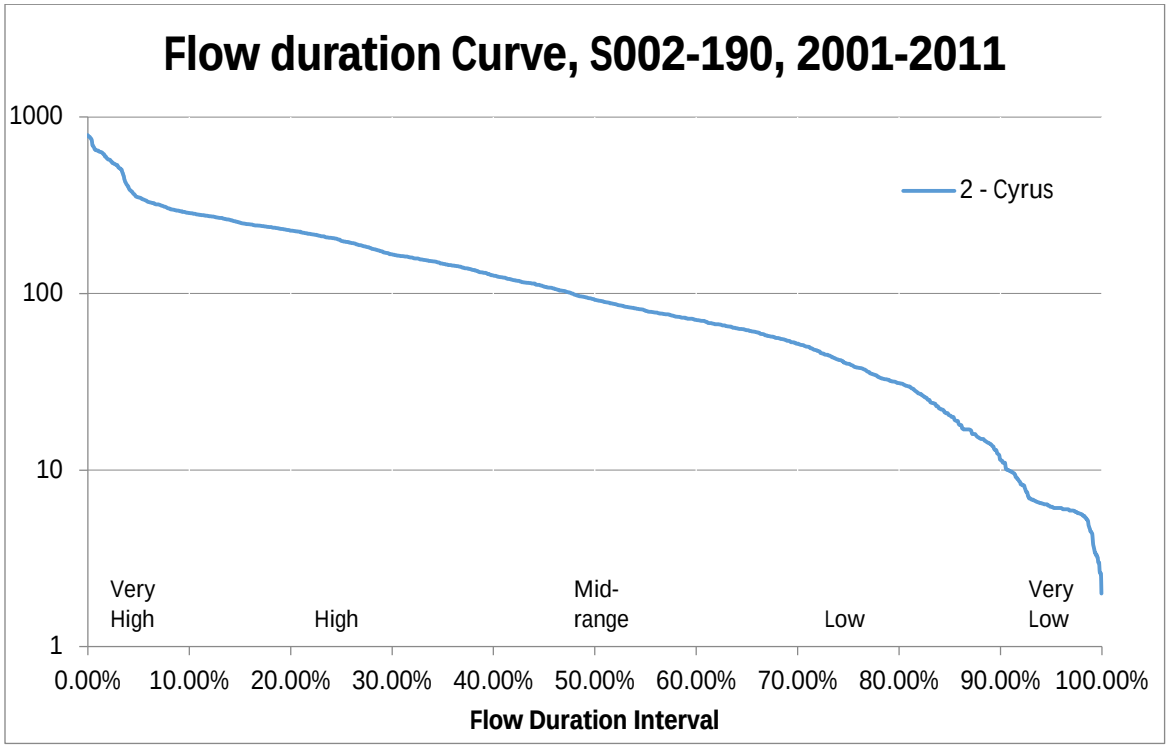


Figure 503-20 Flow duration curves for S002-190.

Stressor pathway: Channelization

The channelization of intermittent flow pathways and tile drainage has led to changes in flow dynamics and changes in substrate. The changes in the hydrological and geomorphological condition have direct impact to the biology of the reach.

Stressor pathway: Impoundments

Active impoundments change the discharge of a system creating changes in water slope leading to changes in scouring and deposition as well as changes to water velocity and depth. They can hold back water which increases discontinuity and potential stranding.

Altered hydrology summary:

The data and consistency of the evidence supports altered hydrology as a candidate cause in AUID 07020005-503 at site 09MN005 but not at locations further downstream. There are plausible sources and pathways as well as a documented biological response at site 09MN005.

Weight of evidence:

The evidence for each potential stressor, the quantity and quality of each type of evidence is evaluated. The consistency and credibility of the evidence is evaluated. Each step for AUID 07020005-503 was scored and summarized in Figure 503-21. For more information on scoring please see EPA's CADDIS Summary Table of Scores.

Figure 503-21. Weight of evidence table for potential stressors in AUID 07020005-503 Upper Chippewa River evidence using data from Chippewa River watershed

Types of Evidence	Scores						
	Low Dissolved Oxygen	High Phosphorus	High Nitrate	Lack of Connectivity	Lack of Habitat	High Turbidity	Altered Hydrology
Spatial/temporal co-occurrence	+	+	+	0	+	++	+
Temporal sequence	+	+	+	+	+	++	+
Field evidence of stressor-response	+	+	+	0	++	++	++
Causal pathway	++	++	+	+	++	++	++
Evidence of exposure, biological mechanism	+	++	+	0	++	++	++
Field experiments /manipulation of exposure	NE	NA	NE	NE	NE	NE	NE
Laboratory analysis of site media	NE	NA	NE	NE	NE	NE	NE
Verified or tested predictions	NE	NE	NE	NE	NE	NE	NE
Symptoms	+	+	+	0	+	+	+

Evidence using data from other systems

	Low Dissolved Oxygen	High Phosphorus	High Nitrate	Lack of Connectivity	Lack of Habitat	High Turbidity	Altered Hydrology
Mechanistically plausible cause	+	+	+	+	+	+	+
Stressor-response in other lab studies	++	NE	+	NA	NE	NE	NE
Stressor-response in other field studies	++	+	+	-	+	+	+
Stressor-response in ecological models	NE	NE	NE	NA	NE	NE	NE
Manipulation experiments at other sites	NE	NE	NE	NA	NE	NE	NE
Analogous stressors	NE	NA	NE	NA	NA	NE	NE

Multiple lines of evidence

	Low Dissolved Oxygen	High Phosphorus	High Nitrate	Lack of Connectivity	Lack of Habitat	High Turbidity	Altered Hydrology
Consistency of evidence	+	+	+++	-	+++	+++	+
Explanatory power of evidence	+	++	++	-	+	++	+

Conclusions

This reach, the Chippewa River from Stowe Lake to Little Chippewa River (AUID 07020005-503), should have been broken into several reaches. The reach consists of 70.3 river miles and drains 256,832 acres. It crosses four HUC12's and the conditions observed change as one moves downstream.

In this reach low DO, elevated levels of phosphorus, Nitrate-Nitrite, turbidity, lack of connectivity, lack of habitat and altered hydrology are the stressors identified as contributing to the impairment of the invertebrate community. These stressors are not uniform throughout this reach.

Dissolved oxygen appears to be an intermittent stressor to invertebrate communities throughout the creek. There were independent cases of measured low DO at some stations for short periods but most sites monitored did not register low DO.

Considerable data shows the Upper Chippewa River AUID 07020005-503 to be extensively influenced by elevated levels of phosphorus. Phosphorus in this system is likely to be directly contributing to the DO and turbidity stressors also present in this system. Habitat and altered food resources for the biotic community are also likely influenced by excess phosphorus.

Nitrate-Nitrite is an identified stressor to the downstream biotic community of AUID 07020005-503. Fish data and chemical monitoring suggest that it has a lesser effect in upstream areas.

In Upper Chippewa River, there is overwhelming evidence that in distinct locations the lack of habitat afforded to the aquatic community is significant and that poor habitat is clearly a stressor causing biotic impairment in these distinct locations.

Observations suggest that the reach is not a uniform reach nor a gradient of habitat conditions but rather a shifting mix of conditions that degrade and improve dependent on culvert placement, upstream impoundments, conditions of adjacent land use, management and geomorphic condition.

Turbidity as a stressor in this reach is supported by data and the consistency of the evidence is excellent. There are plausible sources and pathways as well as a documented biological response expected in a stream with elevated turbidity levels. Elevated levels of Turbidity have been widely and consistently documented for many years in this reach.

The evidence supports altered hydrology as a candidate cause in this reach at site 09MN005 but not at locations further downstream. There are plausible sources and pathways as well as a documented biological response expected in a stream with altered hydrology.

6. AUID: 07020005-505, Outlet Creek to East Branch Chippewa River

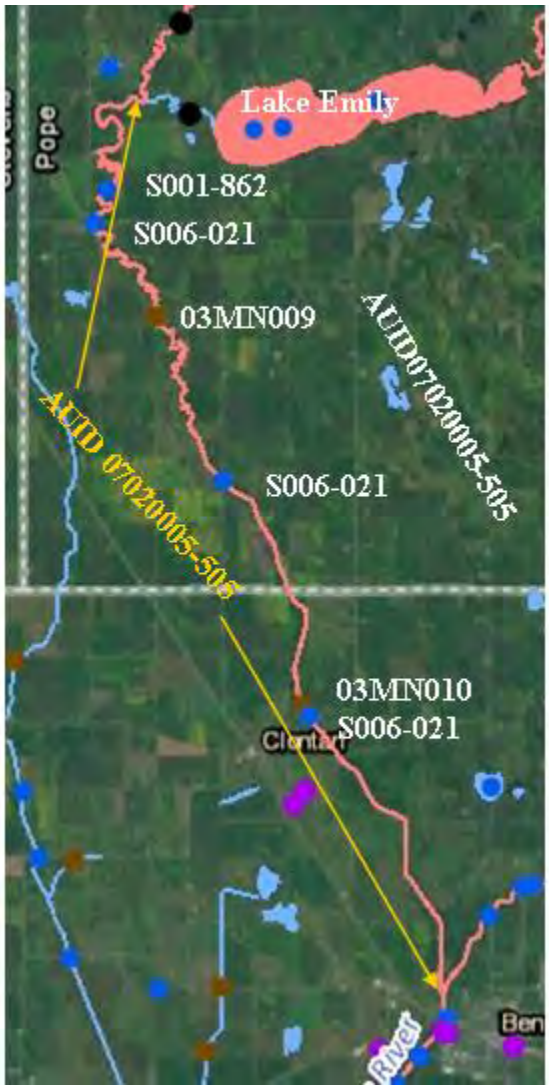


Figure 505-1 AUID 07020005-505, Outlet Creek to East Branch Chippewa River.

Biology:

The Chippewa River from Outlet Creek to East Branch Chippewa River is impaired for fish communities. Site 03MN009, visited in 2003, was deemed assessable and the fish IBI score of 24 was below the threshold and below the confidence interval. The other site in this AUID (03MN010, FIBI score: 49) was sampled in 2003, 2007 and 2009 but was deemed not assessable due to its channelized condition.

Site 03MN009, the basis for this impairment listing, was only visited once, in 2003. A follow up visit should have been conducted in 2009 but was not. This weakens the case for this impairment especially since the downstream channelized site 03MN010 scored well on the FIBI and was surveyed three times (2003, 2007, and 2009).

At site 03MN009 the dominant two species made up 74% of the sample and were both pollution tolerant species (fathead minnow 56% and central mudminnow 18%). The sample identified a lack of generalist feeders, insectivore species, sensitive taxa and simple lithophilic spawners. The results

indicate potential issues with disturbance, water born pollution and a lack of adequate aquatic habitat (Figure 505-2). Sevenhundred twenty-four fish were caught representing 23 different species.

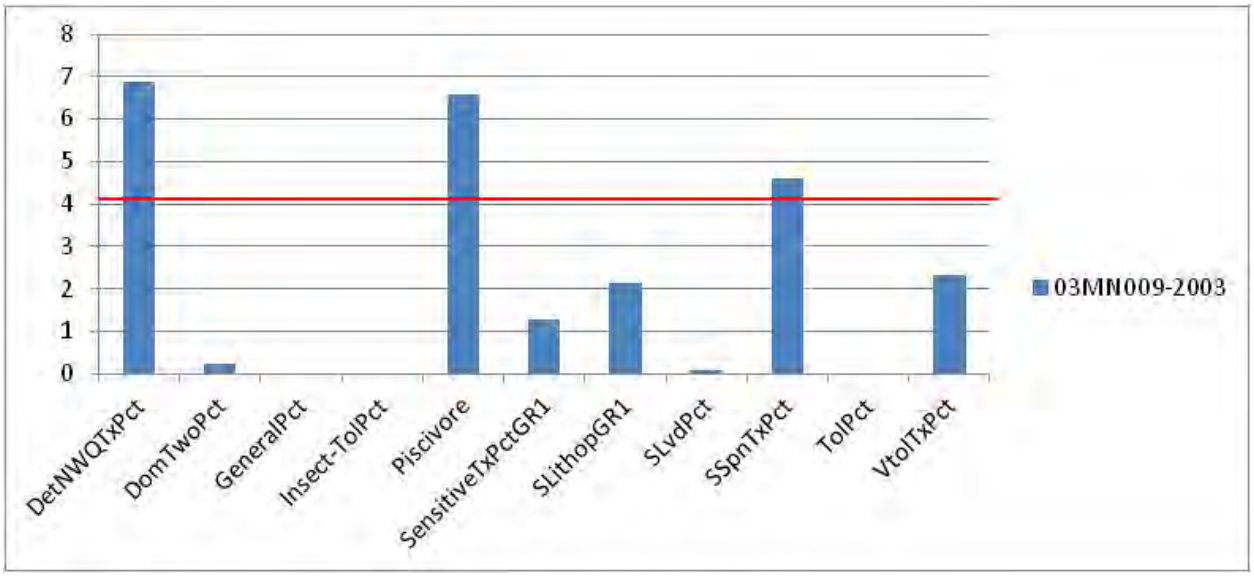


Figure 505-2 Fish metric scores belonging to site 03MN009 from the Chippewa River, Outlet Creek to East Branch Chippewa River AUID: 07020005-505. Red line indicates the average metric score (4.18) needed for IBI score to be at the threshold.

At the downstream channelized site 03MN010 in all three years sampled there were a lack of piscivorous species and simple lithophilic spawners (Figure 505-3). In addition the relative abundance of taxa that are sensitive was low while tolerant taxa made up the majority of the samples. Overall this site had fewer numbers of fish (average per sample 124) but represented more species, thirty species were noted.

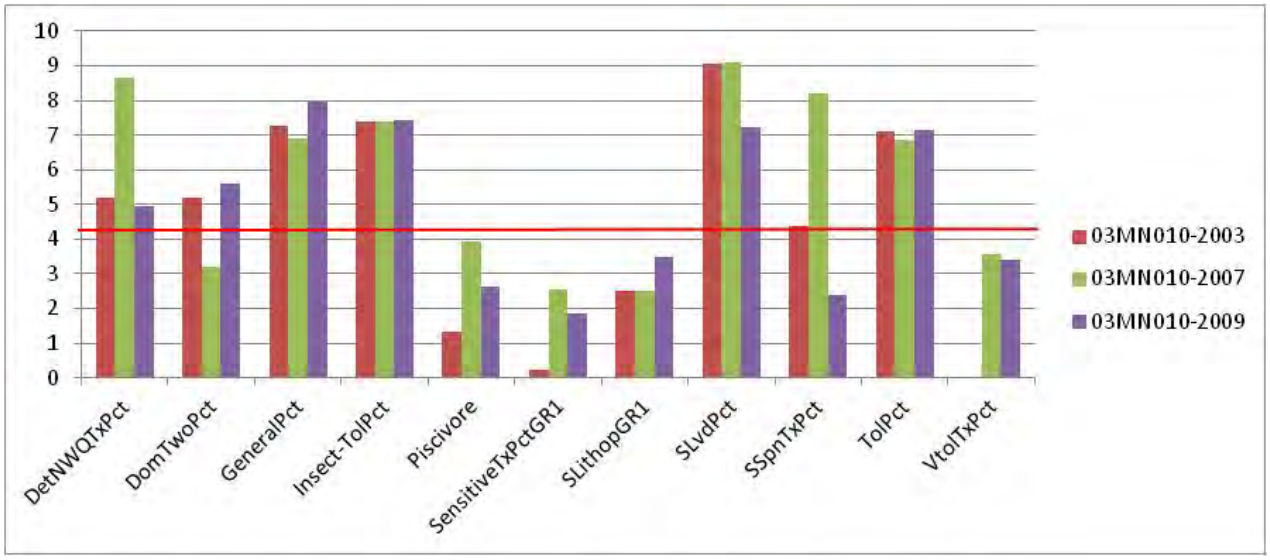


Figure 505-3 Fish metric scores belonging to non-assessable site 03MN010 (2003, 2007, 2009) from the Chippewa River, Outlet Creek to East Branch Chippewa River AUID: 07020005-505. Red line indicates the average metric score (4.18) needed for IBI score to be at the threshold.

Candidate cause: Dissolved oxygen

Dissolved oxygen monitoring conducted in AUID 07020005-505 yielded minimal evidence for a DO cause to the impairment. None of the samples were collected before 9:00 AM. Dissolved oxygen was monitored at three sites effectively covering the entirety of the reach. Readings taken between 2003

and 2010 numbered 235. Over seven years only 5% of the 235 readings were below the 5mg/L state standard. Conditions below 5mg/L can be detrimental to biological communities.

HSPF modeling agrees with the monitoring results. The HSPF model predicts that DO exceeded the standard less than 0.2% of the time from 2001-2010.

Fathead minnows are known for their tolerance of low DO. The fish samples documented the dominance of fathead minnows at site 03MN009 and the lack of them at site 03MN010. This leaves the possibility open that there may be low DO at site 03MN009.

Serial spawning fish, in some cases an indicator of low DO, were in high numbers when sampled in 2003 and 2007 but then low in 2009. At site 03MN009, fathead minnows and central mudminnows made up 56% and 18% of the sample respectively. Macroinvertebrate populations did not give a clear sign of a low problem. EPT taxa were not low, plecoptera counts were low, invertebrate taxa counts were average. Furthermore DO tolerant invertebrates did not make up a significant portion of the population (03MN009 9.5%, 03MN010 0.67% and 2.27%). These data suggest that low DO is a stressor for fish communities.

Stressor pathway: Impoundments

Dissolved oxygen levels can be affected by impoundments by collecting nutrients and organic materials leading less to availability and by serving as areas for algae blooms. In the AUID 07020005-505 watershed there is one constructed impoundment. Figure 505-4 shows a photo of the constructed impoundments, where the creek is held back by a low head impoundment wall.

Figure 505-4 Impoundment on Upper Chippewa River, August 14, 2012.

Lake Emily, immediately upstream of AUID 07020005-505 is a major impoundment that could have a significant impact on the AUID. Lake Emily is currently listed as impaired for nutrient/eutrophication biological indicators. Lake Emily contributes a large volume of flow to the Chippewa River. Over 161,000 acres drain to the lake, and the water that passes through the lake pick up a large quantity of algae and volatile solids.

Stressor pathway: Riparian condition

The riparian buffers along the main channel of the Chippewa River in this area are good (twice the river channel width) in most areas with some exceptions. Many of the tributary streams are poorly buffered. Minimal buffers along waterways could be failing to protect these areas from the impact of farm fields and in some areas continuous livestock grazing. This can allow high amounts of nutrients, sediment and pesticides from adjacent area to enter adjacent streams and rivers. This nutrient enrichment can lead to an increased oxygen demand.

Dissolved oxygen summary:

Dissolved oxygen is a possible stressor to fish communities. Even though low values and high flux were not present, and the data suggests that DO is not a stressor to the fish community in AUID 07020005-505 at this time. Nevertheless, since none of the readings were taken before 9:00 PM, it cannot be ruled out. Also given the dominance of fathead minnows at site 03MN009 and the lack of them at site 03MN010 it seems plausible that low DO may be an issue in the upper portion of this AUID.

Candidate cause: Phosphorus

Total phosphorus concentrations in AUID 07020005-505 are often above the Minnesota draft standard (0.15ppm). The flow weighted mean phosphorus levels from 2001 through 2012 were above the proposed standard and ecoregion expectations ten out of the past twelve years (Figure 505-5). At site S002-193 from 2001-2013 56% of the 271 samples collected were above the draft standard.

The elevated levels of phosphorus can be attributed to the minimal amount of riparian buffer present in tributary ditches and streams of the River. In addition, upstream phosphorous loading coming from the mainstem of the Chippewa River, Outlet creek, and Lake Emily are compounding contributors. These high inputs of phosphorus cause increased algal growth within the stream leading to an increase in turbidity.

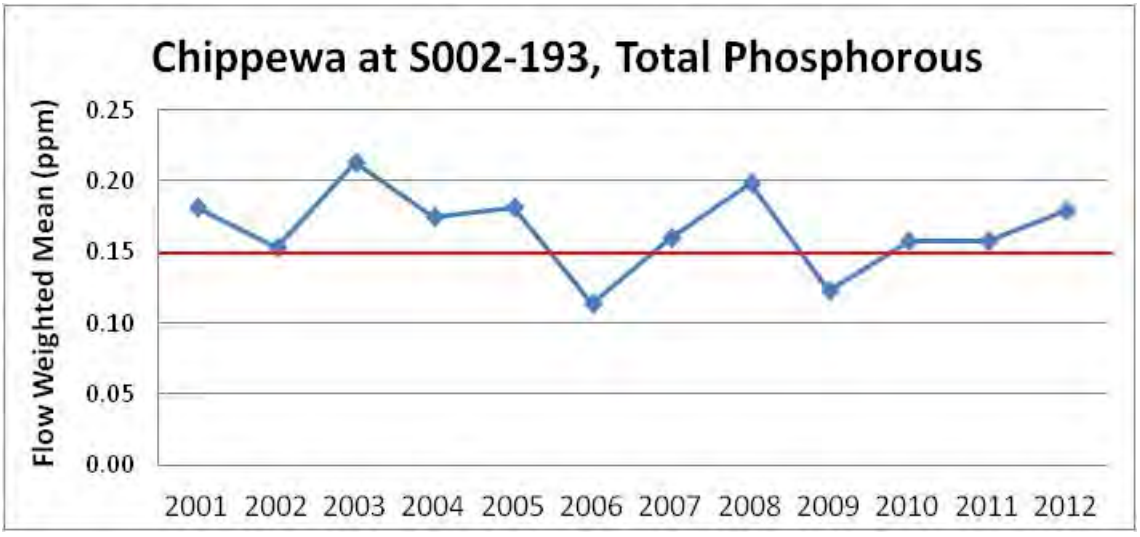


Figure 505-5 Flow weighted means for TP at site S002-190, the red line is the Minnesota draft standard (0.15ppm).

Algae have been observed during warm parts of the monitoring season by CRWP staff. Algae are often related to high phosphorus concentrations. At Site S002-193, TSVS have been monitored from 2009 through 2013. TSVS measures the fraction of TSS that are organic in nature, such as algae cells, tiny pieces of plant material, and/or tiny animals (zooplankton) in the water column. High TSVS values indicate that a large portion of the suspended solids may be made up of algae cells. In the years when TSVS was measured at S002-190 of the 37% of the TSS was actually TSVS (67 samples).

The majority of the invertebrates sampled were high tolerance taxa an indicator of excess phosphorous, but the other indicators do not strongly indicate that phosphorous is a stressor to aquatic populations. High phosphorous contributes to algae blooms which then adversely affect aquatic populations through low DO levels and altering benthic macro-invertebrate population assemblages and raising turbidity levels. These factors are common in this reach.

Phosphorous summary:

There is strong evidence that shows the Chippewa River AUID 07020005-505 to be influenced by elevated levels of phosphorus. Phosphorus in this system is likely to be directly contributing to the turbidity levels and possibly low DO.

Candidate cause: Nitrate

Nitrate Nitrite (NO2-3) samples were gathered at site S002-193 every year since 1999. There appears to be an increasing trend in NO2-3 levels in the Chippewa River. From 2007 to 2011 the calculated flow weighted means were above the Northern Glaciated Plains 75 Percentile value of 0.52 mg/L (Figure 505-6). A total of 275 samples were taken from 1999 through 2012, 37% of these samples were above the Northern Glaciated Plains 75 Percentile value of 0.52 mg/L.

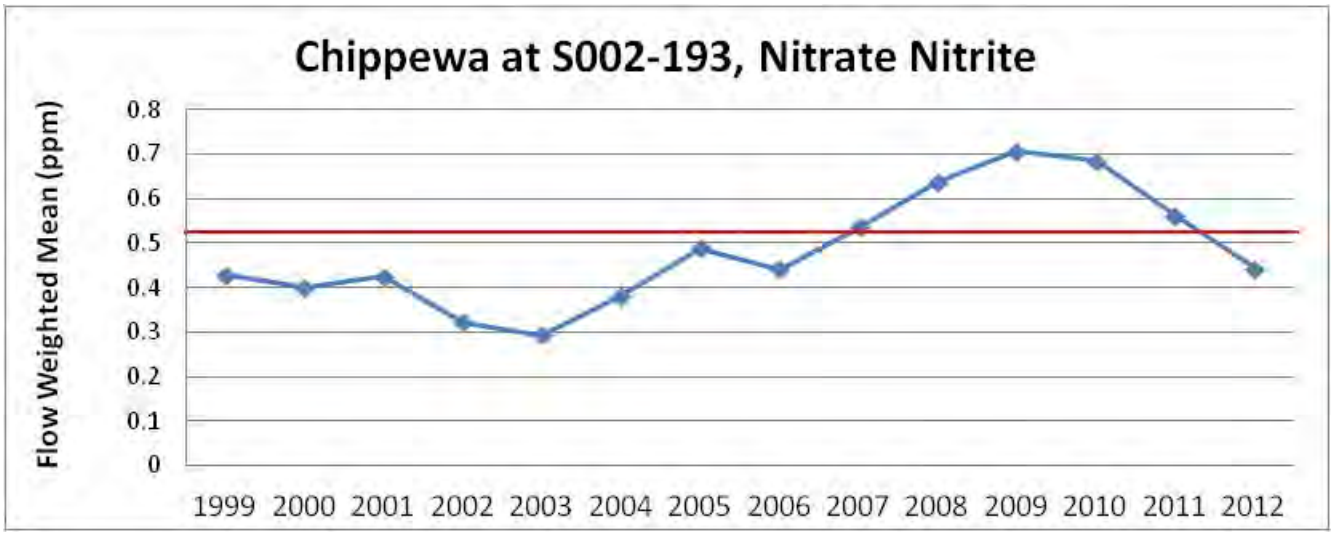


Figure 505-6 Flow weighted means for S002-193, 1999-2010. The red line represents the Northern Glaciated Plains 75 percentile value of 0.52 mg/L.

Fish response to nitrogen can yield some light on the conditions of the reach. In an examination of species' tolerance along physiochemical gradients, two species in the upstream site 03MN009 had mean TIV in the first quartile, indicative of the greatest sensitivity to nitrate (Figure 505-7; Meador and Carlisle, 2007). Those species were bluegill, and walleye. Although these species were present, they were not present in great numbers (3 bluegill and 2 walleye) and they made up less than 1% of the sample. At the downstream site 03MN010 the nitrate sensitive species made up 8% of the sample (5 bluegill, 14 walleye, 1 mimic shiner, 5 silver redhorse, 2 yellow perch).

The fish samples in the Chippewa River were comprised of varied portions of nitrogen tolerant individuals (fourth quartile) at each of the sites (Figure 505-7). At the upstream site (03MN009) 69% of the sample was made up of nitrogen tolerant species and then 43% at 03MN010. These different levels of nitrogen tolerance and the drop-off of nitrogen intolerant species suggests that nitrogen may be more of an issue in the upper portion than it is in the lower portion of the reach.

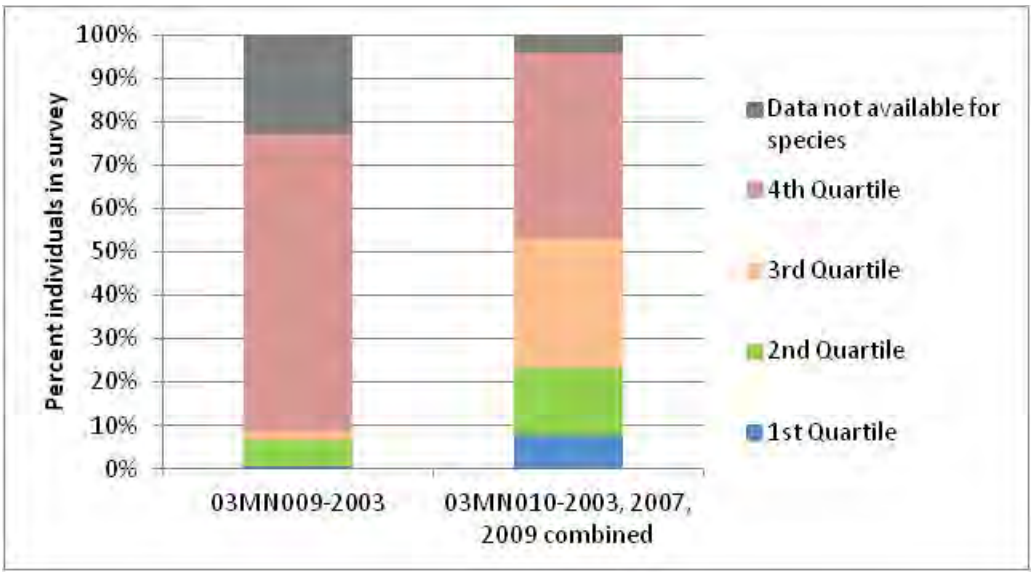


Figure 505-7 Percent fish individuals by biological site in the Upper Chippewa River, for each quartile based nitrate tolerance indicator values (Meador and Carlisle, 2007).

Stressor pathway: Riparian condition

The riparian buffers along the main channel of the Chippewa River are minimal in some areas and heavily grazed in others but are mostly buffered. On the other hand many of the contributing tributaries of the Upper Chippewa watershed are not adequately protected by buffers. This can allow high amounts of nutrients from adjacent fields to enter adjacent streams and rivers.

Stressor pathway: Source-water pollution

Channelized and natural tributaries to the Chippewa River carry nitrates during snowmelt and rain events. It is known that nitrogen and forms of nitrogen, such as ammonia, are being applied to the cropland throughout the watershed and that cropland makes up nearly 65% of the contributing watershed. It is unknown how much groundwater contributes nitrate.

Nitrogen summary:

Fish data suggest Nitrate-Nitrite is a possible stressor to the biotic community of upstream portions of AUID 07020005-505. Fish data and chemical monitoring indicate that it has a lesser effect in downstream areas.

Candidate cause: Turbidity

This reach has been separately listed as impaired for turbidity. In addition, AUID 07020005-504, the upstream reach, is listed as impaired for turbidity.

Turbidity, which is a measure of transparency, can be increased with sediment, algae and organic matter. In addition to turbidity, the state of Minnesota allows transparency (25NTU=20cm transparency) and TSS (25 NTU= 54ppm TSS) as surrogates for turbidity in the Chippewa River watershed. In AUID 07020005-505 there are three sites where turbidity, TSS or transparency has been measured.

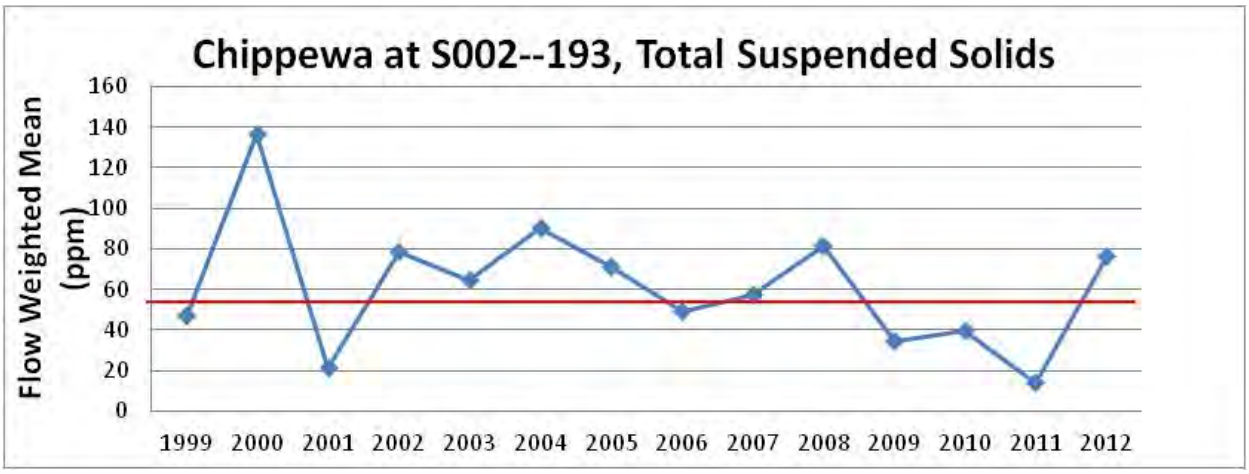


Figure 505-8 Flow weighted means for S002-190, 1999-2012, the red line represents the 54ppm surrogate standard for the Chippewa River.

At S002-193 the flow weighted mean levels for TSS from 1999 through 2012 were above 54ppm eight out of the past fourteen years (Figure 505-8). One hundred twenty-one TSS samples were collected at this site from 2001 through 2013. Forty-five percent of the TSS Samples were above 54ppm.

Turbidity levels in AUID 07020005-505 are often above the Minnesota standard (25 NTU). In AUID 07020005-505 site S002-193 was the only site where turbidity was directly measured. At site S002-193 from 2001 through 2013, 246 turbidity measurements were made, 57% of them exceeded the standard. At site S006-020 85% of 27 transparency measurements taken over 2006 and 2010 exceeded the standard. At site S006-021 85% of the 26 transparency measurements taken between 2006 and 2010 exceeded the standard.

Stressor pathway: Riparian condition

The riparian buffers along the main reach of AUID 07020005-505 are good in many areas. There are sections of the river where the stream banks have been exposed to continuous livestock disturbance this has led to decreased riparian and bank vegetation, leading to increased erosion potential.

The riparian buffers along the tributary streams of AUID 07020005-505 are often not adequate. There are many field drainage ditches and small streams that flow into tributary waters that do not have adequate riparian buffers. These smaller tributaries have decreased riparian and bank vegetation, leading to increased erosion potential.

Stressor pathway: Channelization

Channelization of reaches within AUID 07020005-505 are minimal in the upstream one third of the reach. A third of the way down the channel has been straightened and extensive stream bank erosion is evident. Channelization of reaches contributing to the river are also extensive. These alterations have impacted the hydrological and geomorphological conditions. These have led to changes in erosion rates and an increase in turbidity.

Stressor pathway: Impoundments and source-water pollution

Immediately upstream of the AUID is the impaired Lake Emily currently listed as impaired for nutrient/eutrophication biological indicators and a rich source of algae and nutrients. Transparency from the outlet of Lake Emily was measured 289 times from 2005-2012, 34% of the readings exceeded the surrogate standard. The nutrients in Lake Emily are also contributing a high load of nutrients to AUID

07020005-505 these manifest themselves in an abundance of algae which at times increases water turbidity.

In the AUID 07020005-505 watershed there is one constructed impoundment. Figure 505-9 shows a photo of the constructed impoundments, where the creek is held back by a low head impoundment wall.

Figure 505-9 Impoundment on Upper Chippewa River, 8/14/ 2012 and aerial view 6/23/2010, note the water color difference at the confluence of Lake Emily Outlet and the Chippewa River.

Turbidity summary:

The majority of the fish individuals sampled at both sites were species with high tolerance to turbid water. Simple lithophilic spawners were absent from the sites, also an indicator of high turbidity. The monitoring data and consistency of the evidence supports turbidity as a stressor in AUID 07020005-505. There are plausible sources and pathways as well as a documented biological response expected in a stream with elevated turbidity levels.

Candidate cause: Habitat

The Chippewa River at reach 07020005-505 has Fair to Poor habitat as scored by the MSHA during fish survey visits (Figure 505-10). The subjective nature of the MSHA is clearly evident in its description of site 03MN010. Channel stability of this straight ditch section varied from moderate to moderate/high and then to low in the three years it was surveyed. A study of CRWP bank pin and cross section survey data puts this site at low for all three survey years.

The land use category scored the lowest for both bio-sites. The land use along the Upper Chippewa River is predominantly row crop and pasture, both of which contribute to the lack of decent riparian vegetation. The 03MN009 scored Well for channel morphology and Fair for substrate and cover categories. 03MN010 scored poorly for channel morphology and cover categories while getting a Fair score for substrate. Site 03MN009 scored poorly in the categories of riparian zone and cover.

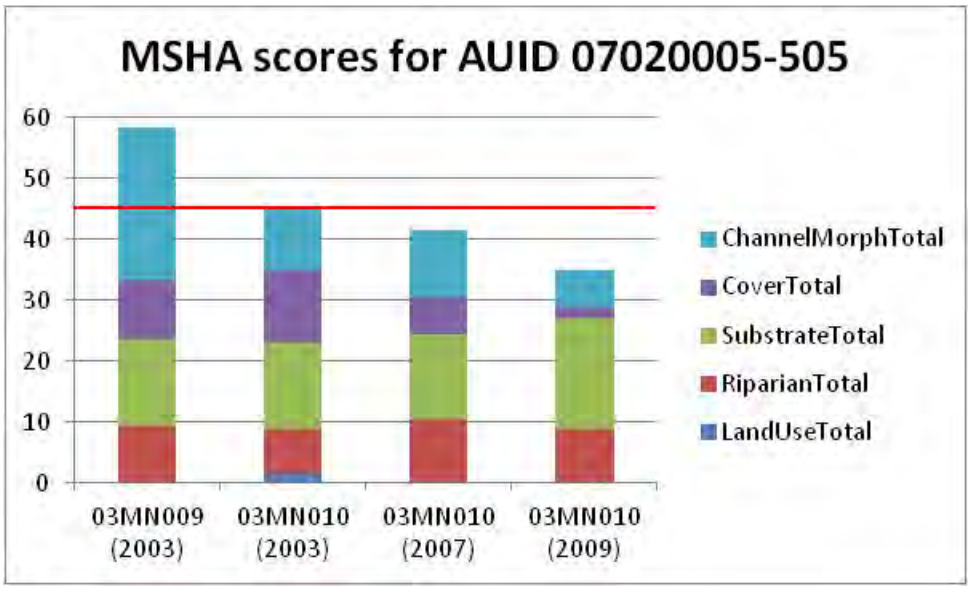


Figure 505-10 MSHA score for sites 03MN009 and 03MN010, red line delineates the break between a Fair and a Poor score.

General observations of habitat at the three transect sites within the reach suggest that the reach is not a uniform reach nor a gradient of habitat conditions but rather a variable mix of conditions that degrade and improve dependent on the conditions of adjacent land use, management and geomorphic condition.

The following detailed habitat descriptions of the SWAG bio-survey sites and site S002-190 are good examples of the variable conditions observed through AUID 07020005-505.

Station 03MN009 is the most upstream biological monitoring site in the reach. The contributing drainage area is approximately 716 square miles. The Chippewa River at station 03MN009 is classified as a C5 stream type, characterized by a sand bed, low entrenchment ratio with good connectivity to the flood plain, moderate width depth ratio, high sinuosity, and low slope. The reach is not protected from down-cutting the riffles are mostly composed of twigs and gravel with a distinct absence of boulders and sub-pavement materials that are resistant to degradation.

The site presented a number of habitat types for fish and invertebrates. Though due to the water's appearance, high level of nutrients and poor bank stability the SVAP protocol score this site as only Fair.

There is a low head dam about five miles upstream from this site. In addition, the reach becomes channelized about two miles downstream from site 03MN009 and remains so through the rest of the reach. A visual survey of the area where channelization begins shows that there is a migrating effect moving up the channel. The dam and straightened portion of the river are likely reasons for severe erosion and the prevalence of undercut banks. It appears that the river is down cutting as the nick point caused by the increased slope of the downstream straightened section river move upstream. The sand and gravel bed materials are poorly suited to resist these pressures.

Figure 505-11 Photos of site 03MN009, note unstable banks and sandy substrate.

Station 03MN010

Station 03MN010 is located just east of Clontarf on the Chippewa River. The contributing drainage area is approximately 741 square miles. The land immediately adjacent to site 09MN070 is wooded (2012). The channel itself has been straightened at this location. The vertical banks are bare and free of protective vegetation. The river at this site is currently a F5 stream type rather than the E and C stream types that are typical of the Chippewa River further up and downstream. The F5 stream type is entrenched and extremely sensitive to disturbance, it has a very high potential for stream bank erosion and a poor recovery potential. Beyond the buffering woodland the land surrounding this station is mostly engaged in row crop agriculture (Figure 505-12). A simple geomorphic assessment and SVAP habitat survey was completed on September 18, 2012.

Figure 505-12, aerial photo of site 03MN010.

The SVAP gave 03MN010 an overall score of Poor. The survey noted that the altered channel and hydrology cause poor habitat quality for fish and bugs. These issues have caused the river to become entrenched and the river's banks and bottom to be unstable. (Figure 505-13).

The altered hydrology and channel entrenchment are causing habitat disturbance in the straightened portion of the reach. A complicating factor is the soil structure of the river banks. The banks are made up of horizontal layers of clay and sand. As the river comes up it easily entrains the sand. As sand is

removed, the layers of clay collapse. This has led to channel down cutting and widening. Bank pins at site 03MN010 have documented 0.75ft/year of bank loss in some years.

Instream fish cover at 03MN010 was poor and consisted of some boulders, overhanging vegetation and fine woody debris. The river bed was a matrix of loose shifting sand. The channel structure does not allow a riffle to pool pattern. There was no aquatic vegetation. Given these characteristics the fish found at this site could be mostly migrating through. This might account for the fish sample population numbers being about 1/3 of those found at sight 03MN009.

Figure 505-13 Station 03MN010 September 18, 2012, entrenched ditch with significant bank erosion.

Stressor pathway: Riparian condition

The riparian buffers along the main channel of the Chippewa River are mostly good and serving their function as natural habitat. Riparian conditions along the tributary streams are poor in many areas. The majority of these tributaries have little to no buffer and the row cropping gets too close to the stream or ditch. These areas provide little in the way of habitat or refuge for fish species.

Stressor pathway: Channel alteration

Channel alteration dominates the lower ten miles of this reach and its impact extends upstream into areas that were not altered. The changes caused by straightening the channel are migrating upstream altering the hydrological and geomorphological condition. On the tributary streams extensive ditching, straightening and tiling have altered the rivers hydrology. This has led to changes in discharge patterns, changes in substrate, changes in sinuosity, and increases in erosion. These are all disturbing river stability and degrading habitat conditions in the reach.

Stressor pathway: Impoundments

The upstream impoundment may have led to instability creating increased erosion below the impoundment as well as channel alteration to regain stability.

Biological metric connections:

The Poor scores for the taxa richness of simple lithophilic spawning species, the dominance of two main fish species, the high number of taxa that are very tolerant, and the high number of tolerant insectivores are all biological indicators that point to habitat being impaired.

Habitat summary:

In the Chippewa River, there is legitimate evidence that the poor habitat is a significant stressor causing biotic impairment. The altered hydrology and channel entrenchment are causing habitat disturbance throughout the reach.

Candidate cause: Altered hydrology

Flow monitoring in this reach has been conducted at site S002-193 from 1998-2013. This site's hydrology is characterized by slow rising water levels following rain events and good base flow. CRWP monitoring of daily flows ranged from 10 to 1643cfs at site S002-193 from 2000 through 2012 (Figure 505-14). Bankfull discharge was determined by geomorphic surveys at the monitoring station and was calculated to be 187cfs. Bankfull flows have a recurrence interval of 1.369. Bankfull flow is the 27.02 percentile flow at site S002-190. Flows at bankfull flow or greater were tallied from 2001 to 2011, of these events 28% occurred in April, 19% in May, 17% in June and 15% in July. August, September and October together accounted for 16%. The measured velocities in this reach range from 0.16 to 3.88ft/s. The ranges of velocities endured are most important to biota rather than an average. Overall the higher flow hydrological condition of this reach appears to be in good shape.

Low flow events are a natural part of a river's cycle, but flows that are too low or low too often could result in a negative biological impact. Extended low flow events which were below the estimated 90th percentile flows of 10.0cfs (Figure 505-14) occurred in the fall of 2007, 2008, 2009 and 2012. The 7Q10 for this site is 2.8cfs and the 1Q10 is 2cfs. The upstream site 09MN005 was completely dewatered in the 2012 drought.

There is physical evidence to support listing flow alteration as a candidate cause in the upper portion of the reach. Surveys at site 09MN005 noted channel erosion, scouring and dry stream conditions. These are all evidence of flow alteration. The presence of a dam and channelized section of stream immediately upstream of site 09MN005 are likely contributing factors to these observed conditions. In the case of 09MN070 the channel erosion appeared to be the result of extensive over grazing and the resulting destruction of the riparian corridor. Surveys at 09N013 did not find physical evidence indicative of flow alteration. Further evidence against flow alteration as a candidate cause in the lower region of the reach comes from bank pins placed at site S002-190. They have not documented high rates of bank erosion.

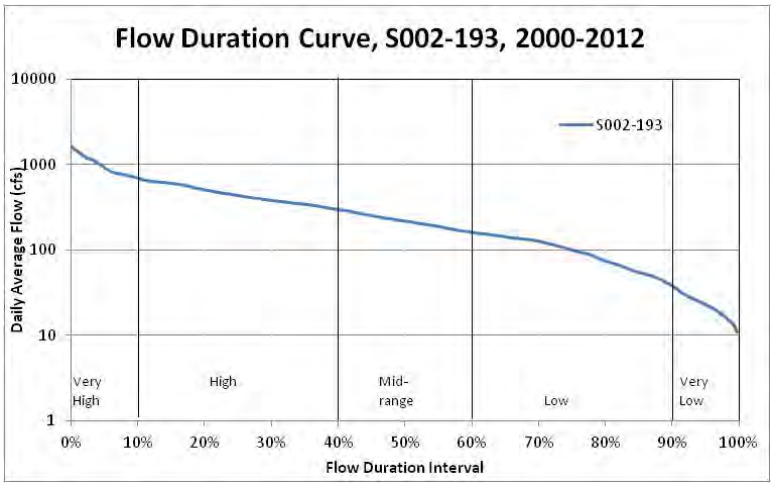


Figure 505-14 Flow duration curve for S002-193.

Stressor pathway: Channelization

Channelization dominates the lower ten miles of this reach and its impact extends upstream into areas that were not altered. The changes caused by straightening the channel are migrating upstream altering the hydrological and geomorphological condition. On the tributary streams extensive ditching, straightening and tiling have altered the rivers hydrology. This has led to changes in discharge patterns, changes in substrate, changes in sinuosity, and increases in erosion. These changes in the hydrological and geomorphological condition have direct impact to the biology of the reach.

Altered hydrology summary:

The data and consistency of the evidence supports altered hydrology as a candidate cause in AUID 07020005-505. There are plausible sources and pathways as well as a documented biological response at sites 03MN009 and 03MN010.

Weight of evidence

The evidence for each potential stressor, the quantity and quality of each type of evidence is evaluated. The consistency and credibility of the evidence is evaluated. Each step for AUID 07020005-505 was scored and summarized in Figure 505-15. For more information on scoring please see EPA's CADDIS Summary Table of Scores.

Types of Evidence	Scores				
	High Phosphorus	High Nitrate	Lack of Habitat	High Turbidity	Altered Hydrology
Spatial/temporal co-occurrence	0	0	++	++	+
Temporal sequence	+	+	+	+	+
Field evidence of stressor-response	+	+	+	++	+
Causal pathway	+	+	+	++	+
Evidence of exposure, biological mechanism	+	+	+	+	+
Field experiments /manipulation of exposure	NA	NE	NE	NE	NE
Laboratory analysis of site media	NA	NE	NE	NE	NE
Verified or tested predictions	NE	NE	NE	NE	NE
Symptoms	+	+	+	+	+
Mechanistically plausible cause	+	+	+	+	+
Stressor-response in other lab studies	+	+	+	+	+
Stressor-response in other field studies	+	+	+	+	+
Stressor-response in ecological models	NE	NE	NE	NE	NE
Manipulation experiments at other sites	NE	NE	NE	NE	NE
Analogous stressors	NA	NE	NA	NE	NE
Consistency of evidence	+	+	++	++	++
Explanatory power of evidence	+	+	++	++	++

Figure 505-15. Weight of evidence table for potential stressors in AUID 07020005-505 Chippewa River, Outlet Creek to East Branch Chippewa River, Evidence using data from Chippewa River watershed.

Conclusions

In the Chippewa River from Lake Emily outlet to the East Branch Chippewa River (AUID 07020005-505) low DO, elevated levels of phosphorus, nitrate-nitrite, turbidity, lack of habitat and altered hydrology are the stressors identified as contributing to the impairment of the invertebrate community.

Dissolved oxygen is a possible stressor to fish communities. Low values and high flux were not present, and the data suggests that DO is not a stressor to the fish community in AUID 07020005-505 at this time. Nevertheless, since none of the readings were taken before 9:00 AM, it cannot be ruled out. Also given the dominance of fathead minnows at site 03MN009 and the lack of them at site 03MN010 it seems plausible that low DO may be an issue in the upper portion of this AUID.

There is strong evidence that shows the Chippewa River AUID 07020005-505 to be influenced by elevated levels of phosphorus. Phosphorus in this system is likely to be directly contributing to the turbidity stressor and possibly low DO.

Fish data suggest nitrate-nitrite is a possible stressor to the biotic community of upstream portions of AUID 07020005-505. Fish data and chemical monitoring indicate that it has a lesser effect in downstream areas.

Turbidity is a stressor in AUID 07020005-505. There are plausible sources and pathways as well as a documented biological response expected in a stream with elevated turbidity levels.

In the Chippewa River, there is overwhelming evidence that the poor habitat is a significant stressor causing biotic impairment. The altered hydrology and channel entrenchment are causing habitat disturbance throughout the reach.

The data and consistency of the evidence supports altered hydrology as a candidate cause in AUID 07020005-505. There are plausible sources and pathways as well as a documented biological response at sites 03MN009 and 03MN010.

7. AUID: 07020005-507, Chippewa River, Shakopee Creek to Cottonwood Creek, Swift and Chippewa Counties

AUID: 07020005-507 was assessed in 2012 and determined to be impaired for aquatic invertebrate communities. The impaired reach is the Chippewa River in Swift and Chippewa Counties in the Chippewa River watershed. There are four chemical monitoring sites on this reach. There are also two biological monitoring sites located within the reach that were monitored in 2009. Fish species documented in this region indicate potential issues with turbidity, phosphorous, nitrogen and low DO. Figure 507-1 is a map of the named reach and monitoring sites.

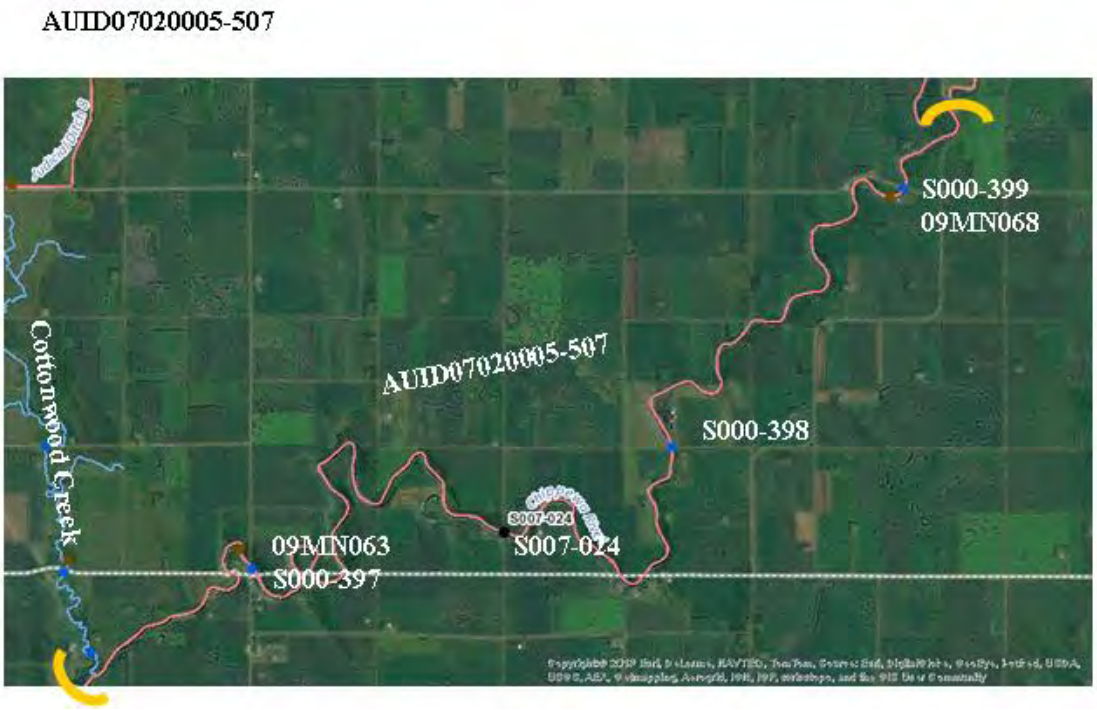


Figure 507-1 AUID: 07020005-507 monitoring sites.

The contributing watershed is 1,741 square miles in area. This watershed's area is occupied by 65% row crop agriculture, 13% is range, 5% is forest, 7% is open water, 5% wetlands, and 5% urban.

Biology:

Invertebrates were sampled only in August 2009 and reported 44 and 43 genera. The sites score well for overall number of taxa, number of predator taxa and sensitive trichoptera individuals. The score for pollution tolerance of the samples overall (HBI_MN) was poor, as was the frequency of pollution sensitive species and the richness of Odonata taxa (Figure 507-2).

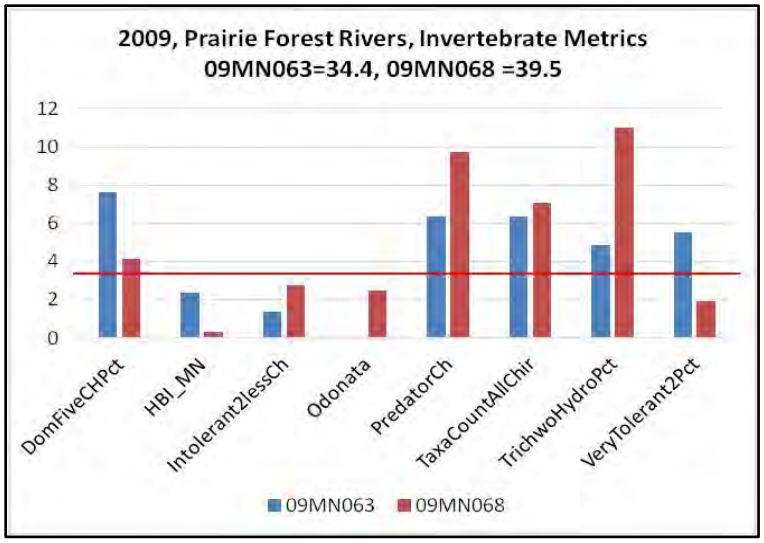


Figure 507-2 Invertebrate metric scores belonging to site 09MN063 and 09MN068. The red line indicates the average metric score needed (3.8) for the score to meet the MIBI threshold.

A survey of fish species tolerance levels may shed some light on the pollution levels impacting invertebrates in this reach. Fish tolerance to NO2-3, TP, TSS and DO revealed a high number of pollution tolerant individuals (Meador and Carlisle, 2006). These results suggest that low DO, turbidity, high phosphorous and high nitrogen are all possible stressors.

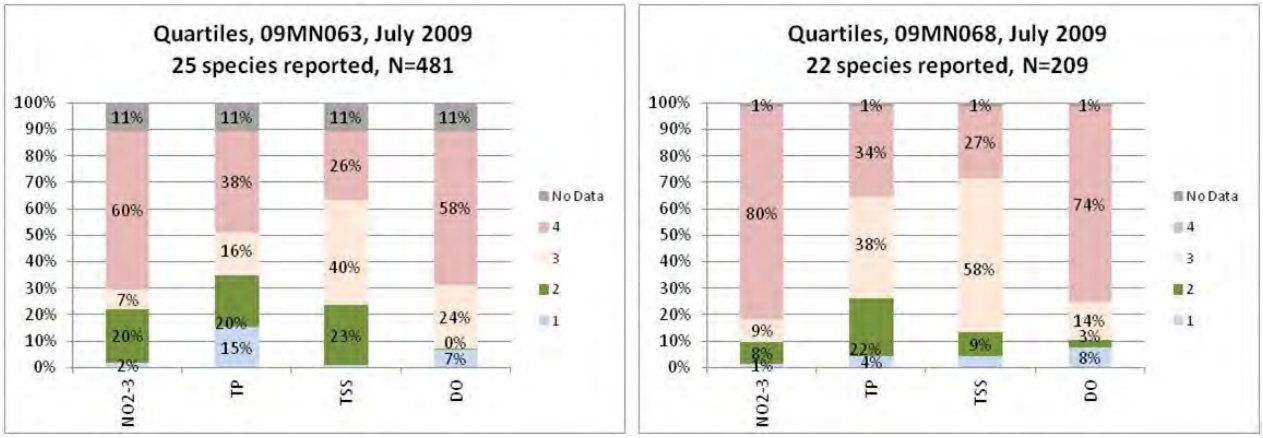


Figure 507-3 Fish quartile values for NO2-3, TP, TSS and DO.

Candidate cause: Dissolved oxygen

Dissolved oxygen monitoring conducted in AUID 07020005-507 indicates that low DO is not a likely stressor within the reach. Only one of the 78 (1%) DO readings taken from 2006 through 2011 did not meet the 5mg/L standard though none of these samples were collected before 9:00 AM. Six of the samples were below 6mg/L. The sample data do not support listing low DO as a primary stressor. Furthermore, the presence of three species of low DO intolerant fish lends support to the disregarding this stressor.

HSPF modeling suggests that there is not a DO issue at this site. Figure 507-4 shows the modeled 10 year duration curve of daily minimum DO values. The model suggests that incidences below 5mg/L are rare.

The percent of low DO tolerant invertebrates was only 3% and 9% for sites 09MN063 and 09MN068, suggesting that low DO is not a driving force in invertebrate survival. In addition, the presence of both

low DO sensitive fish and invertebrates and the high relative abundance of fish taxa with a female mature age greater than or equal to three years (MA>3TXPct) indicate that low DO is not a stressor.

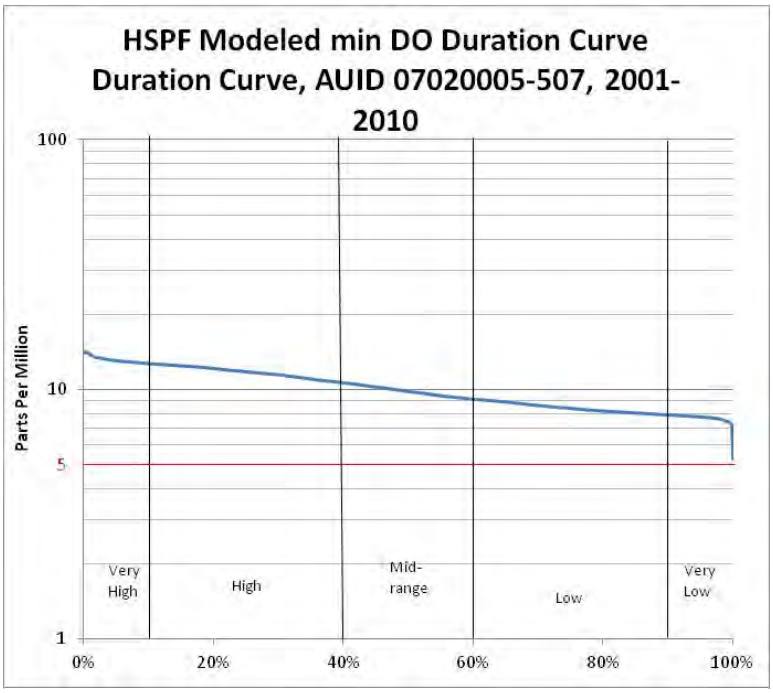


Figure 507-4 HSPF DO modeling projections.

Dissolved oxygen summary:

Dissolved oxygen is probably not a stressor in AUID 07020005-507. The absence of low DO samples, the agreement of the HSPF model and the presence of low DO intolerant fish and invertebrate taxa are all factors that support this conclusion.

Candidate cause: Phosphorus

No Phosphorus samples were taken in AUID 07020005-507.

Looking at the fish data (Figure507-3) 50% - 70% of the sample was made up of the phosphorous tolerant individuals (third and fourth quartile). There were individuals representing the first and second quartiles. These data suggest that while phosphorous may be the driving force of other stressors (turbidity) it in itself is not the most pressing stressor to aquatic populations.

Evidence of high phosphorous is apparent in the biological indicators observed in the site data. These indicators include: the high number of tolerant fish and invertebrate taxa, a low EPT taxa (10), and a high number of scraper taxa (14.5%).

The HSPF model suggests that phosphorous concentrations above 0.15ppm occurred 66% of the time from 2001-2010 (Figure 507-5).

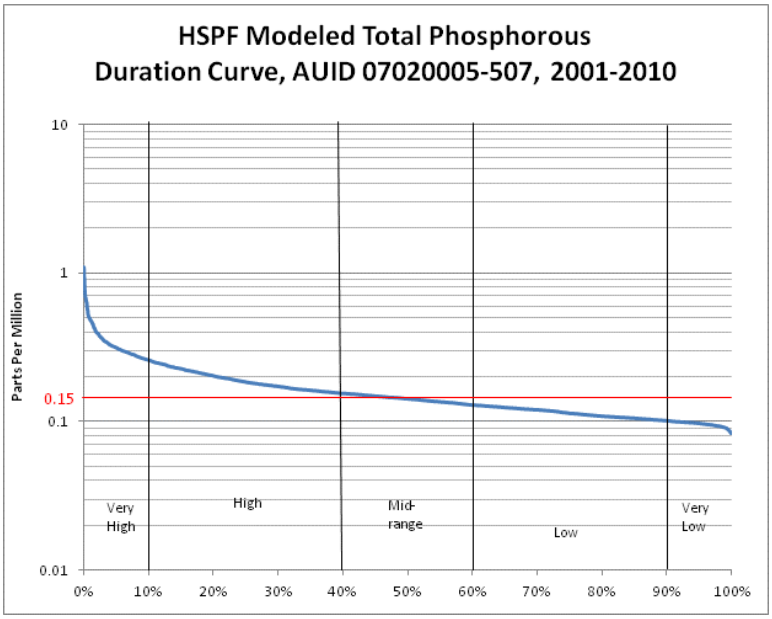


Figure 507-5 HSPF Phosphorous modeling projections.

Stressor pathway: Riparian condition

The riparian buffers along the main channel of AUID 07020005-507 are good on each side. The banks are eroding at a high rate according to CRWP surveys. Peak flows at USGS site 05304500 Chippewa River near Milan, Minnesota have seen a 252% increase since 1946. Flow conditions have been altered and bank erosion is on the rise which could be a possible source of in stream phosphorous.

Upstream sources of phosphorous are likely derived from non-point sources. High phosphorous measurements have been documented by the CRWP especially from areas with higher levels of row crop land use. Flow weighted means for waters contributing to this reach regularly exceed the draft standard.

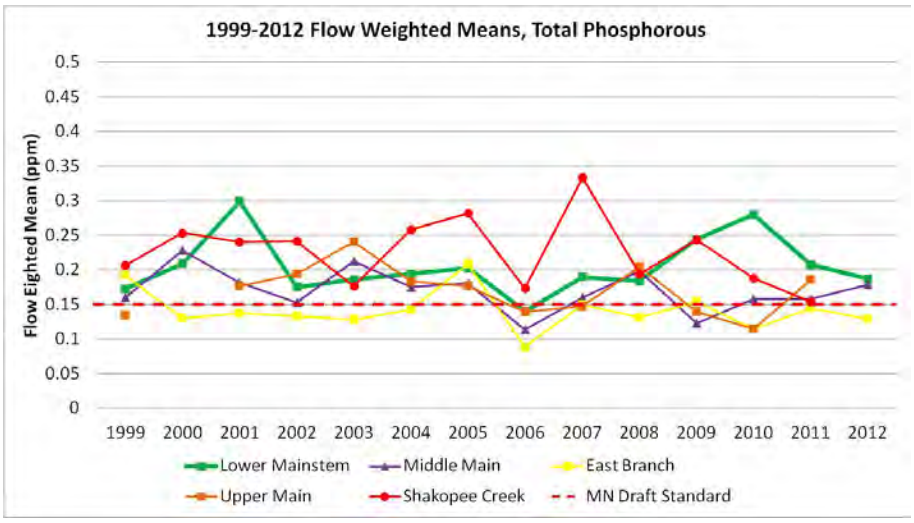


Figure 507-6 Flow weighted means for phosphorous, sites contributing to AUID 07020005-507.

Samples at S002-203, two miles downstream of this reach, a total of 340 samples were taken between 2001 and 2012. Total phosphorus exceeded the standard 55.8% of the times it was sampled.

Phosphorous summary:

There is good data that shows the Chippewa River (AUID 07020005-507) has levels of phosphorus in excess of what is acceptable for aquatic populations. Data indicate that upstream sources on the Chippewa River are contributing phosphorous to this reach. Phosphorus from within the reach is likely coming from the stream banks and tributary streams in this reach's watershed.

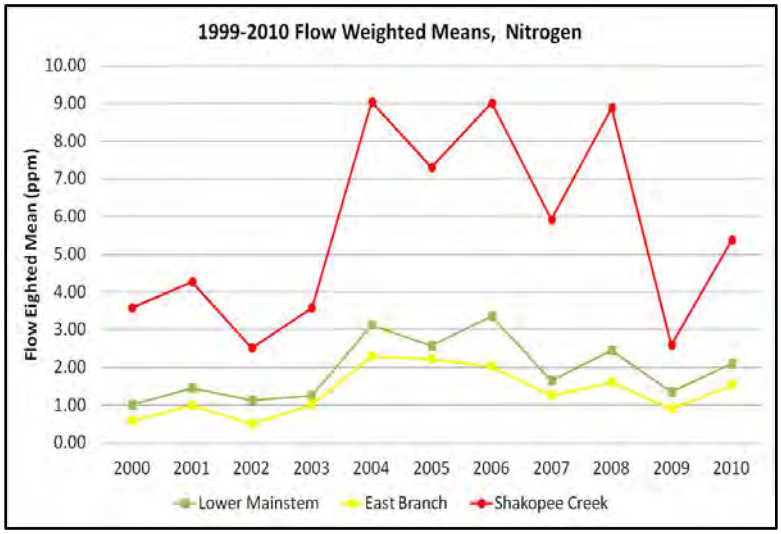
Candidate cause: Nitrate

No NO2-3 samples were taken from AUID 07020005-507.

Upstream sources of nitrogen are likely derived from non-point sources. High nitrogen measurements have been documented by the CRWP especially from areas with higher levels of row crop land use. Flow weighted means for waters contributing to this reach regularly exceed the draft standard (Figure 507-7).

Two upstream sites (S002-201 Shakopee Creek and S005-634 Chippewa East Branch) and one downstream site (S002-203, Chippewa River at Hwy 40) were sampled consistently and frequently enough to calculate flow weighted means for 2001-2010. The flow weighted means did not exceed the 10ppm drinking water standard. The S002-203 (Chippewa River at Minnesota Hwy 40) and S005-634 (Chippewa East Branch) did not exceed the 4.9mg/L aquatic life draft chronic standard nor the 75 percentile value of 6.9ppm for Western Corn Belt Plains ecoregion. S002-201 (Shakopee Creek) did exceed the 4.9mg/L aquatic life draft chronic standard and the 75 percentile value of 6.9ppm for Western Corn Belt Plains ecoregion in many of the years sampled (Figure 507-7).

HSPF modeling projects levels above the 75 percentile value of 6.9ppm for Western Corn Belt Plains ecoregion 2.8% of the time. The model suggests between 2001-2010 nitrogen levels exceeded the 10ppm standard less than 1% of the time. These levels are below what is considered a stress to aquatic populations. (Figure 507-7)



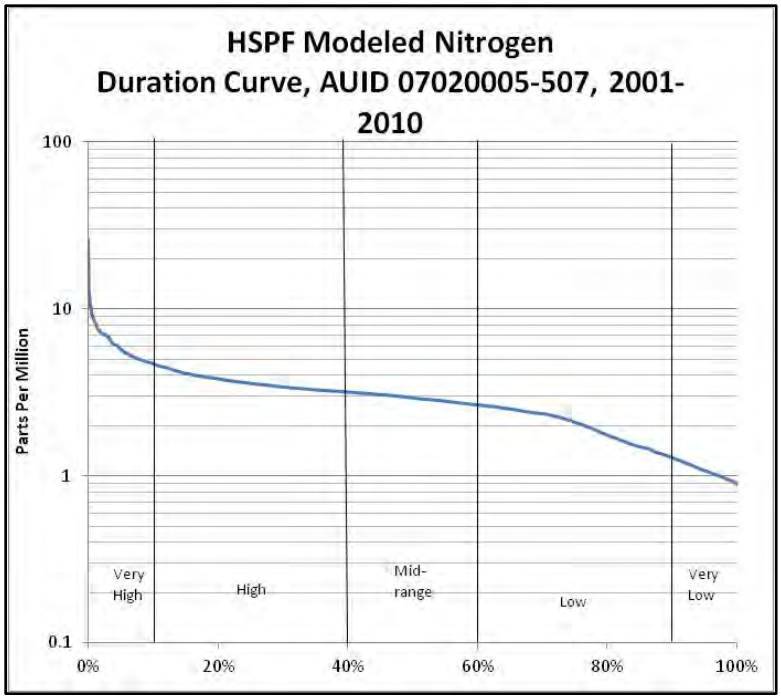


Figure 507-7 HSPF nitrogen modeling projections and monitoring data derived Flow Weighted Means. The invertebrate sample collected in 2009 had a good representation of Trichoptera taxa suggesting that nitrogen samples were not stressing the invertebrate population.

Nitrogen summary:

Sample data indicate that the level of nitrogen in this reach is not at a high enough level known to cause damage to invertebrate communities.

Candidate cause: Turbidity

Transparency (a surrogate for turbidity) was sampled at four sites 130 times between 2006 and 2012. Transparency exceeded the standard in 80% of the samples.

HSPF modeling of TSS projects levels in exceedance of the 54ppm surrogate standard 78% of the time (Figure 507-8).

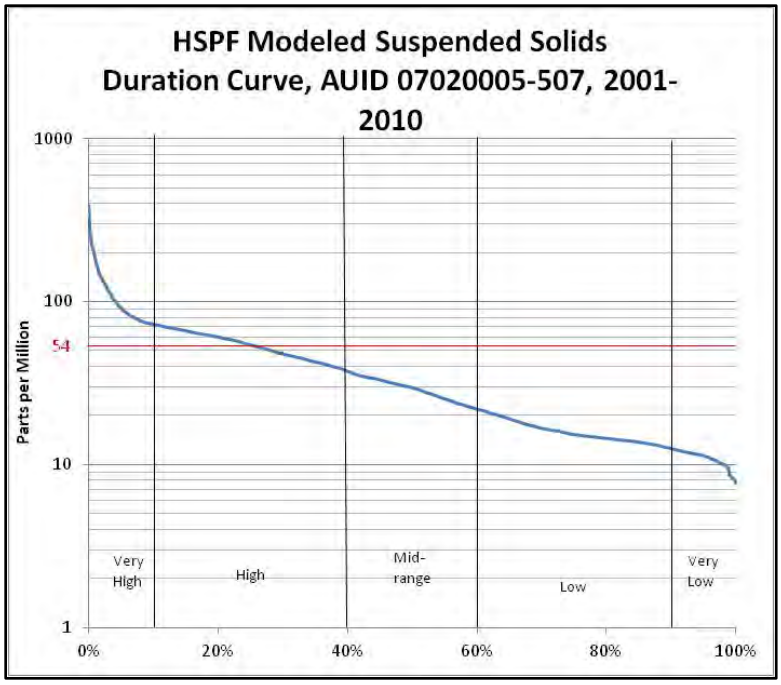


Figure 507-8 HSPF TSS modeling projections.

The high number of Chironomidae individuals (34%) are indicative of high turbidity. The fish sampled at sites 09MN063 and 09MN068 were comprised of mostly fish that are tolerant to suspended solids (See Figure 507-3).

The two main tributaries to this reach, the Chippewa River and Shakopee Creek, are impaired for turbidity. These tributaries have been monitored extensively from 1998-2012 and consistently are well above the 10% threshold for samples above 25 NTU turbidity, 20 cm transparency and 54ppm TSS.

The riparian buffers along the main channel of AUID 07020005-507 are good on each side. Upstream riparian buffers are not adequate especially on the smaller streams and ditches that feed into this AUID.

The banks are eroding at a high rate according to CRWP surveys. Peak flows at USGS site 05304500 Chippewa River near Milan, Minnesota have seen a 252% increase since 1946. Flow conditions have been altered and bank erosion is on the rise. Increased bank erosion could be responsible for some of the turbidity exceedances. Channelized flow to the reach from tributary sources dominates the flow pattern of this reach. Channelization is changing in-stream erosion rates that have led to an increase in turbidity.

Turbidity summary:

The monitoring data from within this reach plus that from up and downstream all support listing turbidity as a stressor in AUID 07020005-507. The biological indicators point to the same conclusion. Turbidity is a stressor in this reach.

Candidate cause: Habitat

At sites 09MN063 and 09MN068 MSHA habitat conditions were sampled in 2009. Site 09MN063 received a score of "Poor" and 09MN068 a score of “Fair”. In 2012 these sites were visited again and a SVAP survey was completed at each site. During 2012 the SVAP gave site 09MN063 a score of "Fair" and 09MN068 a score of “Poor”.

The 2009 MSHA's scored both sites fairly well for substrate conditions and both scored poorly for surrounding land use due to the prevalence of row crop agriculture. (Figure 507-9)

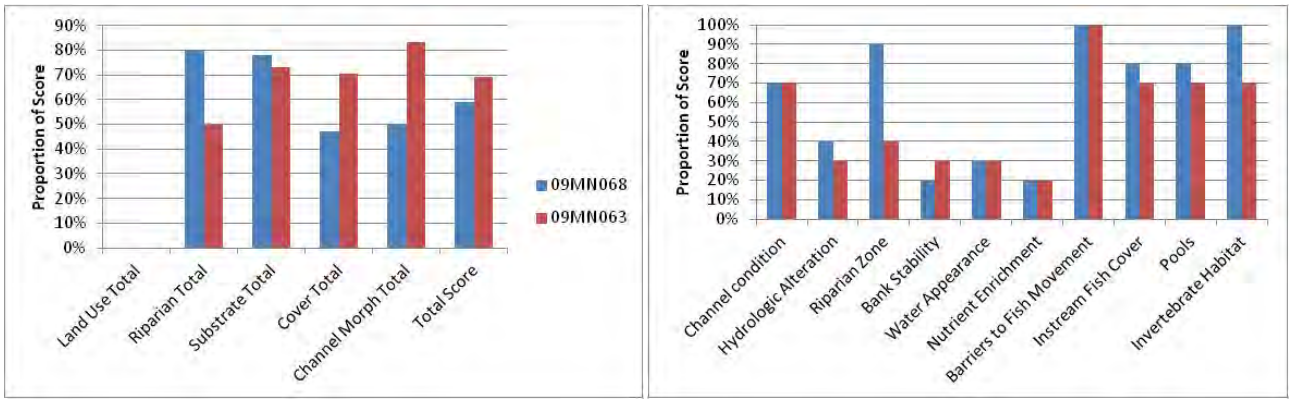


Figure 507-9 MSHA and SVAP scores by category for 09MN063 and 09MN068

The SVAP surveys conducted in 9-2012 noted a number of negative factors for aquatic habitat. In general, the river is entrenched and suffers from poor channel conditions and obvious hydrologic alteration. The banks are unstable. The water is turbid and there are multiple signs of nutrient enrichment. Both sites have the elements for good habitat.

Figure 507-10 Station 09MN063

Figure 507-11 Station 09MN068

Channel alteration in reaches contributing to the river are changing the hydrologic and geomorphologic condition. This has led to upstream changes in discharge patterns, changes in substrate, down cutting, entrenchment, and increased erosion.

A decrease in benthic insectivore fish taxa, clinger invertebrates, taxa richness of riffle-dwelling taxa are expected when poor habitat is a stressor. In all three cases these metrics were above average for the region. Neither sample was dominated by tolerant or sensitive fish or invertebrate taxa. Habitat as judged by habitat based bio-metrics appears not to be a stressor in at the two bio-monitoring sites.

Habitat summary:

The Chippewa River at site 09MN063 and 09MN068 has many of the structural components for good habitat. Turbid, nutrient rich waters further exasperated by hydrologic alteration and bank instability create conditions unfavorable for aquatic life and recreation.

Candidate cause: Altered hydrology

This reach has 1,741 square miles of drainage delivered to it from upstream watershed. Sixty-five percent of this watershed is occupied by row crop agriculture. Much of the agricultural regions of the Chippewa watershed are efficiently served by a system of ditches and underground tile drainage. This drainage has effectively altered the hydrological drainage pattern of the Chippewa River. Flow monitoring downstream of this reach has noted a 252% increase in the annual peak event from 1946 to 2011.

Flow alteration is altering and degrading habitat for invertebrate taxa in this reach. High levels of bank and stream instability make it difficult for populations to thrive. This is especially noticeable through the dominance of tolerant taxa.

Altered hydrology summary:

There is good evidence to support listing flow alteration as a stressor in the reach. The hydrologic alteration that has been ongoing over the last 50 years in row cropped areas has had an impact on this reach. Flow monitoring downstream clearly notes a change in flow patterns over the last several decades. Surveys at 09MN063 and 09MN068 found physical evidence indicative of flow alteration. Altered hydrology is a stressor.

Weight of evidence

The evidence for each potential stressor, the quantity and quality of each type of evidence is evaluated. The consistency and credibility of the evidence is evaluated. Each step for AUID 07020005-507 was scored and summarized in Figure 507-12. For more information on scoring please see EPA's CADDIS Summary Table of Scores.

Types of Evidence	Scores			
	High Phosphorus	Lack of Habitat	High Turbidity	Altered Hydrology
Spatial/temporal co-occurrence	++	+	+	+
Temporal sequence	+	-	+	+
Field evidence of stressor-response	++	+	++	++
Causal pathway	++	+	++	++
Evidence of exposure, biological mechanism	++	+	+	++
Field experiments /manipulation of exposure	NA	NE	NE	NE
Laboratory analysis of site media	NA	NE	NE	NE
Verified or tested predictions	NE	NE	NE	NE
Symptoms	+	+	+	+
Mechanistically plausible cause	+	+	+	+
Stressor-response in other lab studies	+	NE	NE	NE
Stressor-response in other field studies	+	+	+	+
Stressor-response in ecological models	NE	NE	NE	NE
Manipulation experiments at other sites	NE	NE	NE	NE
Analogous stressors	NA	NA	NE	NE
Consistency of evidence	+	+++	+++	+++

Figure 507-12. Weight of evidence table for potential stressors in AUID 07020005-507 Chippewa River, evidence using data from Chippewa River watershed

Conclusions

In AUID: 07020005-507 the data is sufficient and clear, a good assessment of possible stressors has been made by combining the relevant information. This reach has a number of stressors impacting the biological monitoring site 09MN063 and 09MN068.

Invertebrates were sampled only in August 2009 and reported 44 and 43 genera. The sites score well for overall number of taxa, number of predator taxa and sensitive trichoptera individuals. The score for pollution tolerance of the samples overall (HBI_MN) was Poor, as was the frequency of pollution sensitive taxa and the richness of Odonata taxa. A survey of fish species tolerance levels may shed some light on the pollution levels impacting invertebrates in this reach. Fish tolerance to NO2-3, TP, TSS and DO revealed a high number of pollution tolerant individuals (Meador and Carlisle, 2006). These results suggest that low DO, turbidity, high phosphorous and high nitrogen are all possible stressors.

Dissolved oxygen is probably not a stressor in AUID 07020005-507. The absence of low DO samples, the agreement of the HSPF model and the presence of some low DO intolerant fish species are all factors that support this conclusion.

There is good data that shows the Chippewa River (AUID 07020005-507) has levels of phosphorus in excess of what is acceptable for aquatic populations. Data indicate that upstream sources on the Chippewa River are contributing phosphorous to this reach. Phosphorus from within the reach is likely coming from the stream banks and tributary streams in this reach's watershed.

Sample data indicate that the level of nitrogen in this reach is not at a high enough level known to cause damage to invertebrate communities.

The monitoring data from within this reach plus that from up and downstream all support listing turbidity as a stressor in AUID 07020005-507. The biological indicators point to the same conclusion. Turbidity is a stressor in this reach.

The Chippewa River at site 09MN063 and 09MN068 has many of the structural components for good habitat. Turbid, nutrient rich waters further exasperated by hydrologic alteration and bank instability create conditions unfavorable for aquatic life and recreation.

There is good evidence to support listing altered hydrology as a stressor in the reach. The hydrologic alteration that has been ongoing over the last 50 years in row cropped areas has had an impact on this reach. Flow monitoring downstream clearly notes a change in flow patterns over the last several decades. Surveys at 09MN063 and 09MN068 found physical evidence indicative of altered hydrology. Altered hydrology is a stressor.

8. AUID: 07020005-508, Chippewa River, Cottonwood Creek to Dry Weather Creek, Chippewa County

AUID: 07020005-508 was assessed in 2012 and determined to be impaired for aquatic invertebrate communities. The impaired reach is the Chippewa River in Big Bend and Tunsberg Townships of Chippewa County in the Chippewa River watershed. There are two chemical monitoring sites on this reach. There is one biological monitoring site located within the reach that was monitored once in July of 2009. Fish species documented in this region indicate potential issues with turbidity and low dissolved oxygen. Figure 508-1 is a map of the named drainage and monitoring sites.

Figure 508-1 AUID: 07020005-508 monitoring sites.

The contributing watershed is 1,872 square miles in area. This watershed's area is occupied by 66% row crop agriculture, 12% is range, 5% is forest, 7% is open water, 5% wetlands, and 5% urban.

Biology:

Invertebrates were sampled at site 09MN064 in August 2009 and reported 42 genera. This site scored well for the number of sensitive Trichoptera taxa present and the overall taxa richness. The site also was not overly dominated by the most dominant five species (DomFiveCHPct) in the sample. There was not a

big number of the most tolerant taxa either (VeryTolerant2Pct). 09MN064 scored poorly on metrics that measured sensitive taxa (HBI_MN and Intolerant2lessCH). The score was brought down further by a complete lack of Odonata taxa (Figure 508-2).

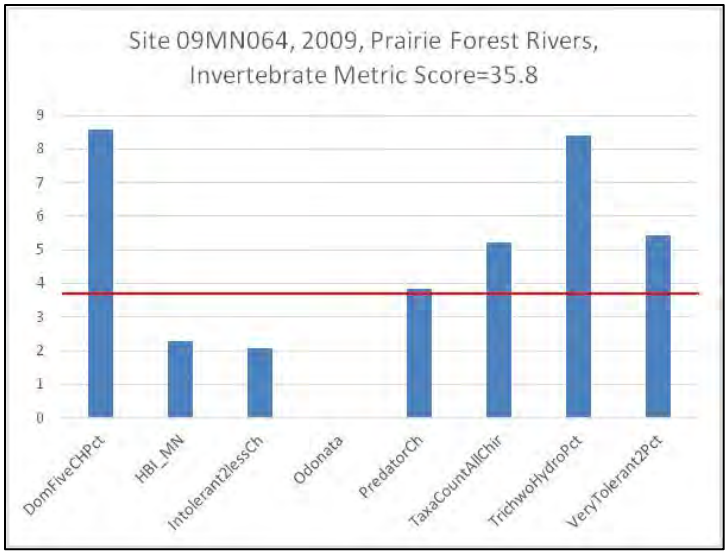


Figure 508-2 Invertebrate metric scores belonging to site 09MN064. The red line indicates the average metric score needed for the score to be at the threshold (3.8).

A survey of fish species tolerance levels sheds some light on the pollution levels impacting invertebrates in this reach. Fish tolerance to NO2-3, TP, TSS and DO revealed a high number of pollution tolerant individuals (Meador and Carlisle, 2006). These results suggest that low DO, turbidity, high phosphorous and high nitrogen are all possible stressors.

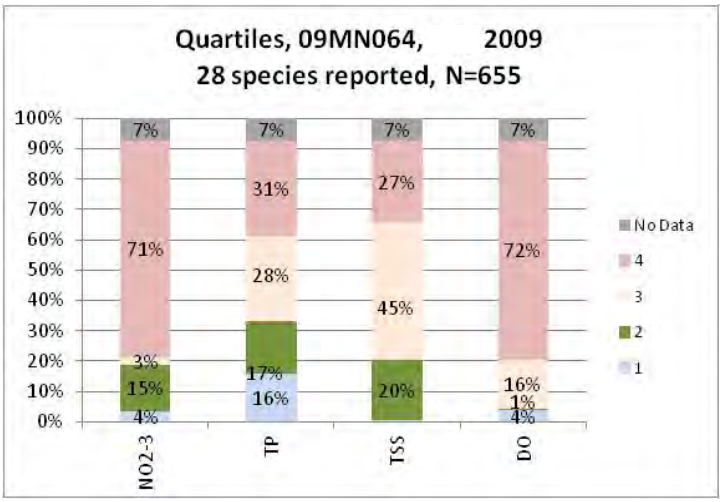


Figure 508-3 Fish quartile values for NO2-3, TP, TSS and DO.

Candidate cause: Dissolved oxygen

Dissolved oxygen monitoring conducted in AUID 07020005-508 indicates that low DO is not a likely stressor within the reach. One of the 241 (0%) DO readings taken from 2003 through 2012 did not meet the 5mg/L standard though it is uncertain how many of these samples were collected before 9:00 AM. The sample data do not support listing low DO as a primary stressor.

A survey of DO tolerance levels found that 11% of the invertebrate sample was made up of individuals deemed intolerant to low DO. Additionally, the Good score for taxa richness and the lack of very tolerant taxa (3.1% of invertebrate individuals were tolerant to low DO) suggests that low DO may not be a stressor for the invertebrate community.

HSPF Modeling indicates that there is not a DO issue at this site. Figure 508-4 shows the modeled 10 year duration curve of daily minimum DO values. The model suggests that incidences below 5mg/L did not occur.

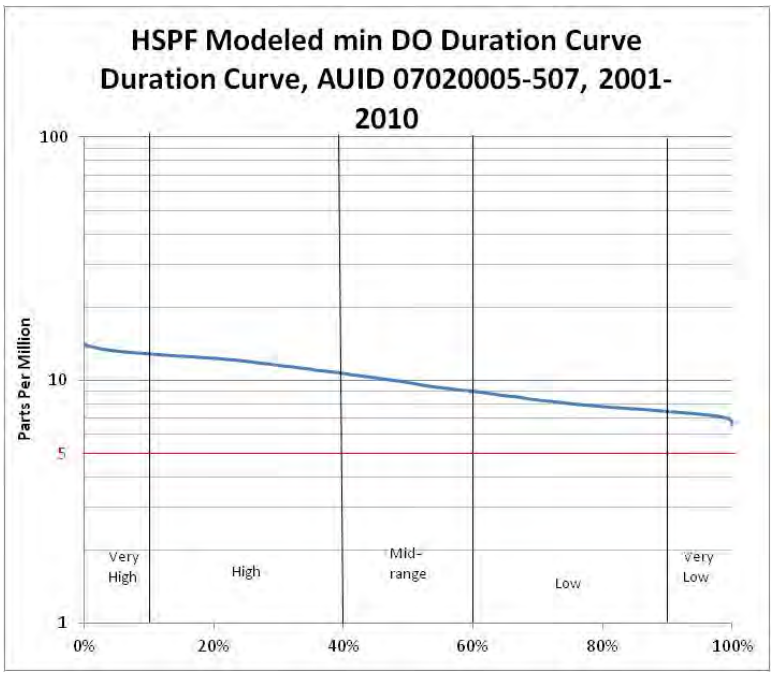


Figure 508-4 HSPF DO modeling projections.

Dissolved oxygen summary:

Dissolved oxygen is not a stressor in AUID 07020005-508. The absence of low DO samples, the agreement of the HSPF model and macro-invertebrate metrics all point toward this conclusion.

Candidate cause: Phosphorus

Phosphorus samples were taken in AUID 07020005-508 at site S002-203 (also known as 09MN064) 281 times from 2001 to 2011. The samples exceeded the 0.15ppm draft standard 56% of the time. Given that this AUID was already listed as impaired for turbidity these monitoring results alone are sufficient to list excessive phosphorous as a stressor.

Looking at the fish data (Figure508-3) 31% and 28% of the sample was made up of the phosphorous tolerant individuals (third and fourth quartile). There were individuals representing the first and second quartiles. These data suggest that while phosphorous may be the driving force of other stressors (turbidity) it in itself is not the most pressing stressor to aquatic populations.

Evidence of high phosphorous is also mixed when looking at invertebrate metrics. The indicators that support the listing phosphorous as a stressor include: the high number of tolerant fish and invertebrate taxa, a low EPT taxa (12). A high number of scraper taxa is often indicative of high phosphorous levels yet in this case only 3.1% of the sample consisted of scrapers.

The HSPF model suggests that phosphorous concentrations above 0.15ppm occurred 51% of the time from 2001-2010 (Figure 508-5).

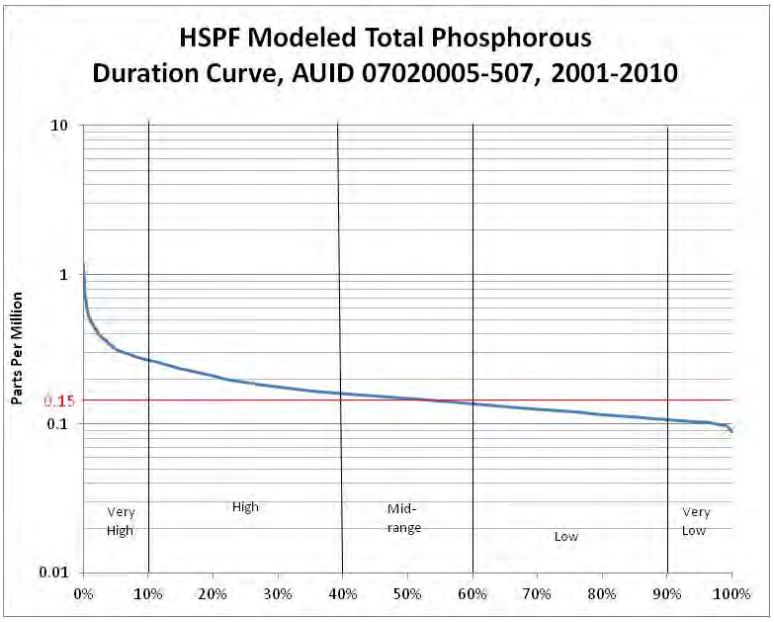


Figure 508-5 HSPF Phosphorous modeling projections.

The riparian buffers along the main channel of AUID 07020005-508 are Good on each side. The banks are eroding at a high rate according to CRWP surveys. Peak flows at USGS site 05304500 Chippewa River near Milan, Minnesota have seen a 252% increase since 1946. Flow conditions have been altered and bank erosion is on the rise which could be a possible source of in stream phosphorous.

Upstream sources of phosphorous are likely derived from non-point sources. High phosphorous measurements have been documented by the CRWP especially from areas with higher levels of row crop land use. Flow weighted means for waters contributing to this reach regularly exceed the draft standard.

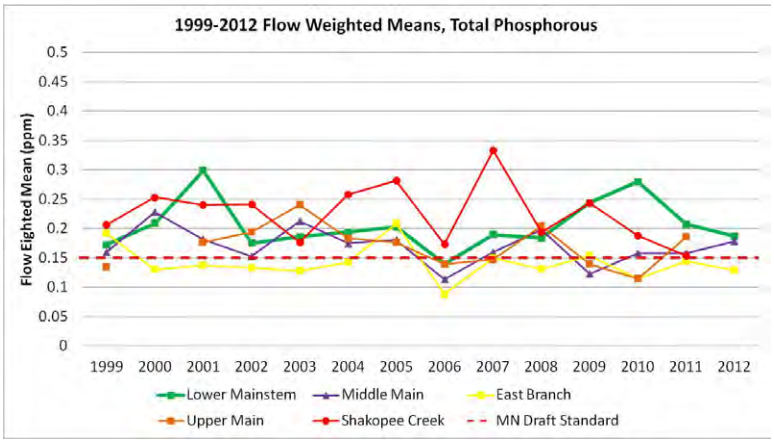


Figure 508-6 Flow weighted means for phosphorous, Site S002-203 is labeled as "Lower Mainstem" the other data are taken from tributaries contributing to AUID 07020005-508.

Phosphorous summary:

There is indisputable monitoring data that shows the Chippewa River (AUID 07020005-508) has elevated levels of phosphorus. Data indicate that upstream sources on the Chippewa River are contributing

phosphorous to this reach. Phosphorus from within the reach is likely coming from the stream banks and phosphorous yielding land uses via the tributary streams in this reach's watershed.

Candidate cause: Nitrate

A total of 274 NO2-3 samples were taken between 2001 and 2011 in AUID 07020005-508 at site S002-203. None of the samples exceeded the 10ppm drinking water standard. S002-203 did not exceed the 4.9mg/L aquatic life draft chronic standard nor the 75 percentile value of 6.9ppm for Western Corn Belt Plains ecoregion. (Figure 508-7).

HSPF modeling projects levels above the 75 percentile value of 6.9ppm for Western Corn Belt Plains ecoregion 2.5% of the time. The model suggests between 2001-2010 nitrogen levels exceeded the 10ppm standard less than 1% of the time. These levels are below what is considered a stress to aquatic populations. (Figure 508-7).

Metrics responses suggestive of a nitrogen issue did not indicate a strong nitrogen issue. The metric trichopteraPct should be low but was measured at 22.3%, taxaCount was 29 a Good score and the taxa richness of macroinvertebrates with tolerance values less than or equal to two (excluding intolerant chironomid and baetid taxa) scored an eight, also very good.

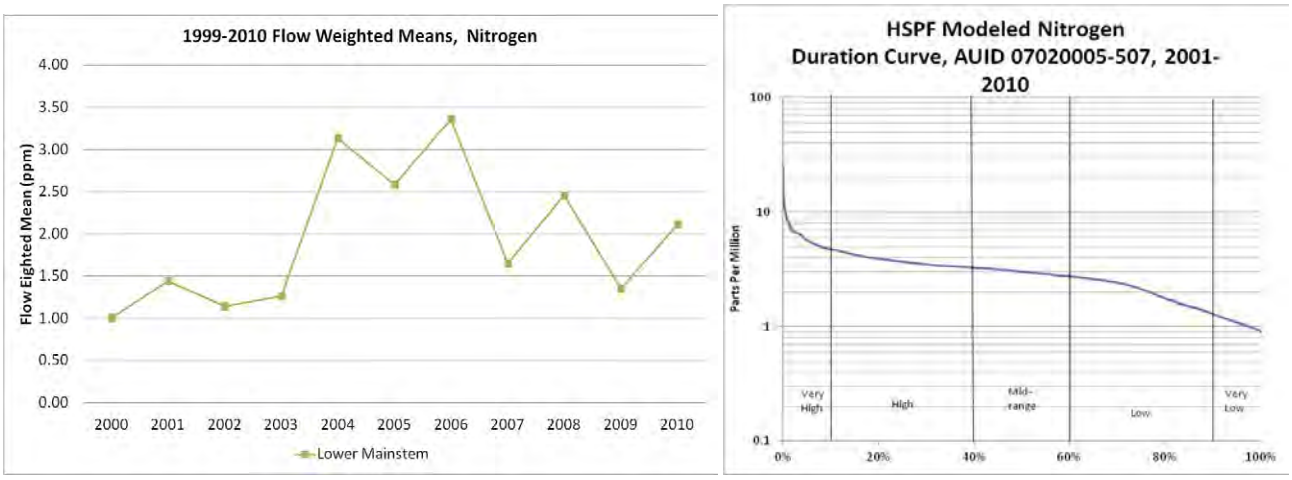


Figure 508-7 HSPF nitrogen modeling projections and monitoring data derived flow weighted means.

Nitrogen summary:

Nitrogen levels are below what is known to cause damage to invertebrate communities. Robust chemical sampling and analysis of bio-metrics in this AUID rule out nitrogen as a stressor to invertebrate communities.

Candidate cause: Turbidity

Turbidity exceeded the standard in 58% of the 243 times it was sampled in this AUID. Transparency (a surrogate for turbidity) exceeded the standard 59% of the 310 times it was sampled between 2001 and 2011. TSS was sampled 273 times at site S002-203 and exceeded the standard in 47% of the samples.

A survey of TSS tolerance index scores found that 50.3% of the invertebrate sample was made up of individuals deemed tolerant to high TSS. Only 1% of invertebrates were in the intolerant category. Furthermore, a survey of fish TSS tolerance scores found that 72% of the individuals sampled were in either the third or fourth quartile (TSS tolerant).

HSPF modeling of TSS projects levels in exceedance of the 54ppm surrogate standard 69% of the time (Figure 508-8).

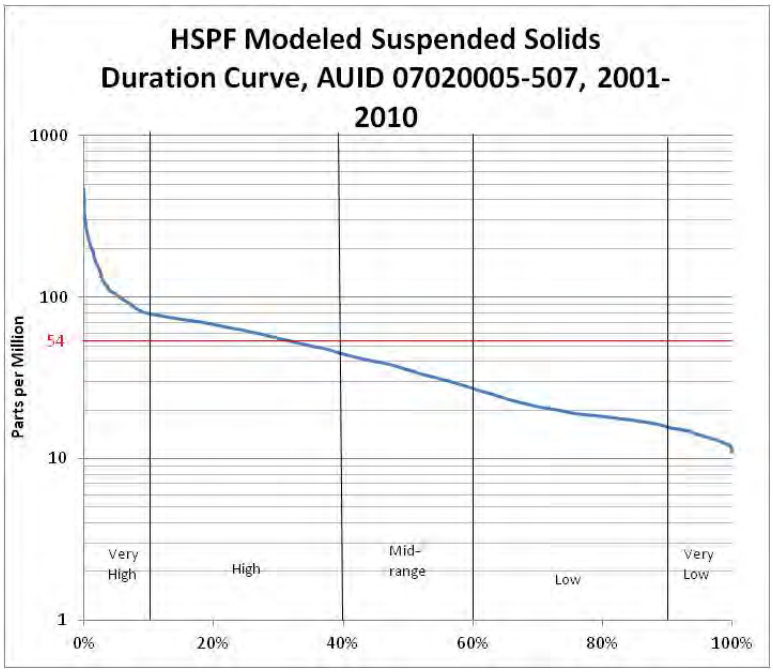


Figure 508-8 HSPF TSS modeling projections.

Much of the Chippewa River upstream of this reach is impaired for turbidity. Many of these tributaries have been monitored extensively from 1998-2012 and consistently are well above the 10% threshold for turbidity samples. Additionally most of these regions also have excessive levels of phosphorous which contributes to turbidity through increased algal production in the water column.

The riparian buffers along the main channel of AUID 07020005-508 are good. Upstream riparian buffers are not adequate especially on the tributary streams and ditches that feed into this AUID.

The banks are eroding at a high rate according to CRWP surveys. Peak flows at USGS site 05304500 Chippewa River near Milan, Minnesota (S002-203) have seen a 252% increase since 1946. Flow conditions have been altered and bank erosion is on the rise. Increased bank erosion is responsible for some of the turbidity exceedances.

The main reach of AUID 07020005-508 is not channelized. Channelized flow to the reach from tributary sources dominates the flow pattern of this reach. Channelization is changing in-stream erosion rates that have led to an increase in turbidity (Figure 508-6).

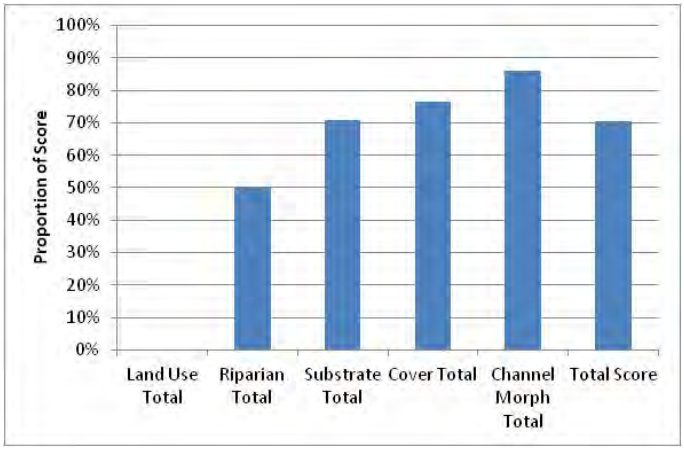
Turbidity summary:

Extensive water quality monitoring of this reach and contributing tributaries support listing turbidity as a stressor in AUID 07020005-508. HSPF modeling and biological sampling also support this conclusion. Likely sources of turbidity are bank erosion caused by upstream hydrologic alteration and upstream non-point source pollution dominated by the prevalent land uses. In addition to these the excessive levels of phosphorous are likely causing significant algal growth in the water column which in turn contribute to turbidity levels.

Candidate cause: Habitat

At sites 09MN064 habitat conditions were sampled in July of 2009. Both visits gave Site 09MN064 a MSHA habitat score of “Good”. In 2012 the site was visited again and a SVAP survey was completed. The SVAP gave the site a score of "Fair".

The 2009 MSHA's gave the surrounding land use category 0% of the possible points due to the dominance of row crop land use surrounding the land immediately adjacent to the reach. Riparian conditions also score poorly. Substrate, cover and channel morph all pulled the overall score up. (Figure 508-9).



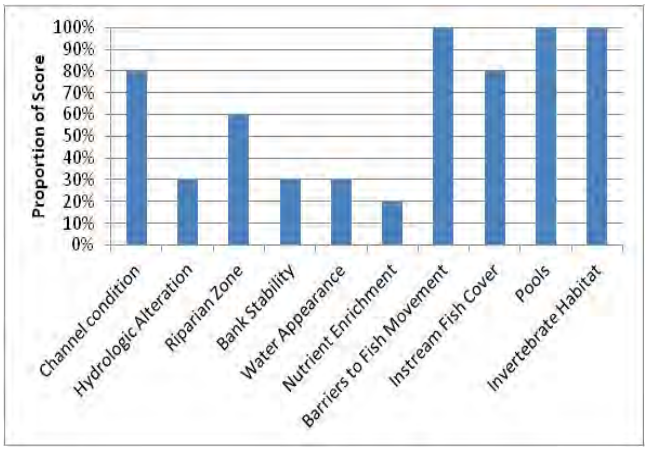


Figure 508-9 MSHA scores and SVAP rankings by category for 09MN064

The SVAP survey conducted in 9-2012 noted a number of negative factors and positive factors. In general, the river is entrenched and suffers from hydrologic alteration. The banks are unstable. The water appearance was poor and there were obvious signs of nutrient enrichment. On the positive side there are no dams in the reach. The survey team observed a good number of habitat types for fish and an excellent diversity of habitat types for invertebrates and the condition of pools at the site was excellent.

Figure 508-10 Station 09MN064

The fish survey in 2009 found good numbers of simple lithophilic spawning species, riffle dwelling species, benthic insectivores, and darters/sculpins/round bodied suckers at site 09MN064. These findings suggest good habitat at 09MN064. The fair number of plecoptera (invertebrate) taxa the good number of clinging invertebrates is indicative of good habitat.

Candidate cause: Altered hydrology

This reach has 1,872 square miles of drainage delivered to it from the upstream watershed. Sixty-six percent of this watershed's area is occupied by row crop agriculture. Much of the agricultural regions of the Chippewa watershed are efficiently served by a system of ditches and underground tile drainage. This drainage has effectively altered the hydrological drainage pattern of the Chippewa River. In addition, flood protection projects around many of the municipalities in the Chippewa watershed have altered flow and decreased holding times of flood waters. Flow monitoring upstream of this reach has noted a 252% increase in the annual peak event from 1946 to 2011 (Figure 508-6).

The lack of sensitive fish and invertebrate taxa and the presence of many tolerant ones lend support to considering flow alteration a stressor.

Altered hydrology summary:

There is good evidence to support listing flow alteration as a stressor in the reach. The hydrologic alteration that has been ongoing over the last 50 years has had an impact on this reach. Flow monitoring upstream clearly notes a change in flow pattern over the last several decades. Surveys at 09MN064 found physical evidence indicative of flow alteration. Altered hydrology is a stressor.

Candidate cause: Lack of connectivity

There are no barriers to fish passage in AUID 07020005-508. The dam on Chippewa County Road 13 blocks all upstream movement of fish species on the Chippewa River. The dam on the Chippewa diversion channel under Chippewa County Road 9 does the same. These barriers limit fish movement and isolate fish populations within AUID 07020005-508 but are not in this reach.

Weight of evidence

The evidence for each potential stressor, the quantity and quality of each type of evidence is evaluated. The consistency and credibility of the evidence is evaluated. Each step for AUID 07020005-508 was scored and summarized in Figure 508-11. For more information on scoring please see EPA's CADDIS Summary Table of Scores.

Types of Evidence	Scores		
	High Phosphorus	High Turbidity	Altered Hydrology
Spatial/temporal co-occurrence	++	++	++
Temporal sequence	+	+	+
Field evidence of stressor-response	++	++	++
Causal pathway	++	++	++
Evidence of exposure, biological mechanism	++	++	++
Field experiments /manipulation of exposure	NA	NE	NE
Laboratory analysis of site media	NA	NE	NE
Verified or tested predictions	NE	NE	NE
Symptoms	+	+	+
Mechanistically plausible cause	+	+	+
Stressor-response in other lab studies	+	+	+
Stressor-response in other field studies	+	+	+
Stressor-response in ecological models	NE	NE	NE
Manipulation experiments at other sites	NE	NE	NE
Analogous stressors	NA	NE	NE
Consistency of evidence	+	++	++
Explanatory power of evidence	++	++	++

Figure 508-11 Weight of evidence table for potential stressors in AUID 07020005-508 Chippewa River

Conclusions

The Chippewa River at site 09MN064 has many of the structural components for good habitat. Three factors are limiting factors to the natural function of the river: upstream hydrologic alteration, unstable stream channel and high nutrient levels. At this point habitat is not a limiting stressor.

In AUID: 07020005-508 a good assessment of possible stressors can be made because the reach has an incredibly robust dataset covering the last 11 years. This reach has a number of stressors impacting the biological monitoring site 09MN064.

Dissolved oxygen is not a stressor in AUID 07020005-508. The absence of low DO samples, the agreement of the HSPF model and macroinvertebrate metrics all point toward this conclusion.

There is indisputable evidence that shows the Chippewa River (AUID 07020005-508) has elevated levels of phosphorus. Data indicate that upstream sources on the Chippewa River are contributing phosphorous to this reach. Phosphorus from within the reach is likely coming from the stream banks and phosphorous yielding land uses via the tributary streams in this reach's watershed.

Nitrogen levels are below what is known to cause damage to invertebrate communities. Robust sampling in this AUID rules out nitrogen as a stressor to invertebrate communities.

Extensive water quality monitoring of this reach and contributing tributaries support listing turbidity as a stressor in AUID 07020005-508. HSPF modeling and biological sampling also support this conclusion. Likely sources are bank erosion caused by upstream hydrologic alteration and upstream non-point source pollution dominated by the prevalent land uses. In addition to these the excessive levels of phosphorous are likely causing significant algal growth in the water column which in turn contribute to turbidity levels.

The Chippewa River at site 09MN064 has many of the structural components for good habitat. At this point habitat is not a limiting stressor.

There is good evidence to support listing altered hydrology as a stressor in the reach. The hydrologic alteration that has been ongoing over the last 50 years has had an impact on this reach. Flow monitoring upstream clearly notes a change in flow pattern over the last several decades. Surveys at 09MN064 found physical evidence indicative of flow alteration. Altered hydrology is a stressor.

There are no barriers to fish passage in AUID 07020005-508. The dam on Chippewa County Road 13 blocks all upstream movement of fish species on the Chippewa River. The dam on the Chippewa diversion channel under Chippewa County Road 9 does the same. These barriers limit fish movement and isolate fish populations within AUID 07020005-508 but are not in this reach.

9. AUID: 07020005-523, Outlet Creek, Lake Minnewaska to Lake Emily, Pope County

AUID: 07020005-523 was assessed in 2012 and determined to be impaired for fish communities and aquatic macroinvertebrates. The impaired reach is Outlet Creek in White Bear Lake and Blue Mounds Townships of Pope County in the Chippewa River watershed. There are six chemical monitoring sites on this reach. There are also two biological monitoring sites located within the reach that were monitored each once in 2009. Fish data indicate potential issues with low DO, water borne pollution and unstable habitat. Figure 523-1 is a detailed map of the named drainage and monitoring sites.

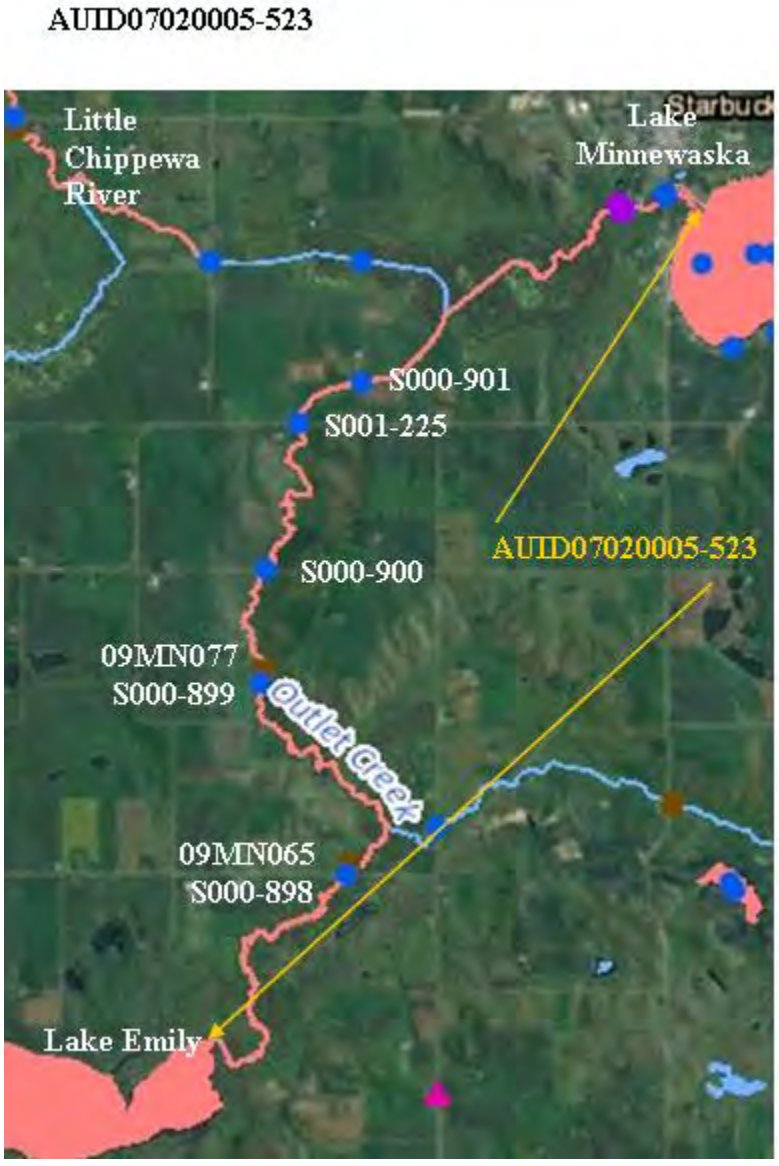


Figure 523-1 AUID: 07020005-523 monitoring sites.

Biology:

The fish sampled in this drainage at site 09MN065 and 09MN077 in 2009 reported 19 species. There were a number of tolerant and sensitive species reported. Common Shiners, a species with high tolerance to low DO but intolerances to high phosphorous made up 40% of the fish observed.

Consequently, fish metrics for this site were mixed. There was not a predominance of tolerant species as seen in the good metric score for TolTXPct, a measure of the relative abundance (%) of taxa that are tolerant species. In the description of quartiles below the data indicate that water quality and disturbance are issues in this reach. There were a good number of non-tolerant benthic insectivore species (BenInsect-TolTxPct) and taxa that are detrivores (DetNWQTXPct) at both sites. The number of sensitive taxa (SensitiveTxPct) was borderline. The taxa present were mostly tolerant of low DO but sensitive to other pollutants (Figure 523-2).

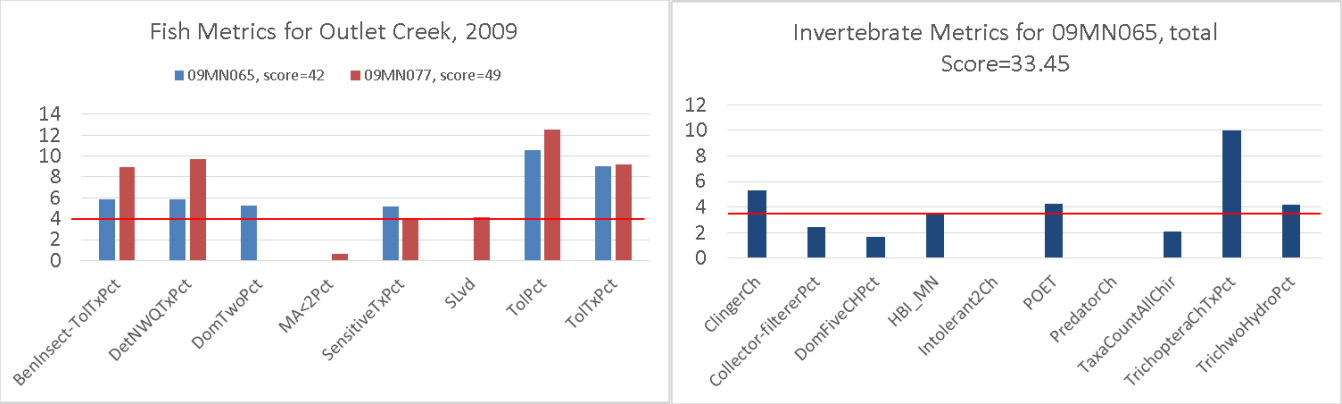


Figure 523-2. Fish and Invertebrate metric scores belonging to site 09MN065 and 09MN077, Outlet Creek, AUID: 07020005-523. The red line indicates the average metric score needed for the score to be at the threshold.

A survey of fish species tolerance levels to NO2-3, TP, TSS and DO revealed a high number of pollution sensitive individuals (Meador and Carlisle, 2006). Results indicate a high number of low DO tolerant species and the absence of the most intolerant species to TSS. These results suggest that low DO is a possible stressor.

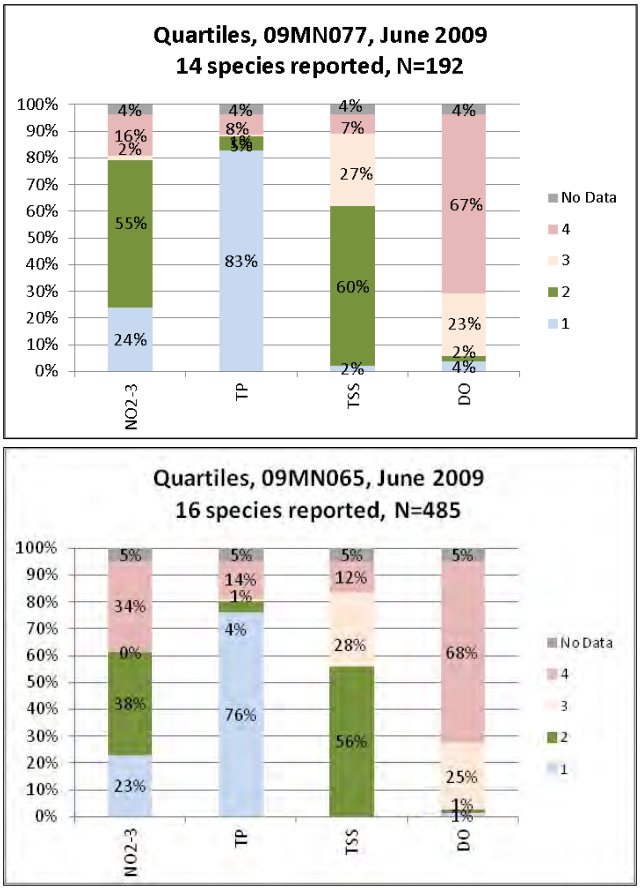


Figure 523-3 Fish quartile values for NO2-3, TP, TSS and DO.

Candidate cause: Dissolved oxygen

Dissolved oxygen monitoring conducted in AUID 07020005-523 indicates that low DO is not a likely stressor within the reach. None of the 87 (0%) DO readings taken from 2006 through 2010 did not meet the 5mg/L standard though none of these samples were collected before 9:00 AM. Two of the samples (2%) were below 6mg/L. Given that DO levels are known to rise over the course of the day these two samples were likely below 5mg/L during the night. The sample data do not support listing low DO as a primary stressor.

A review of the fish species and their numbers finds that the majority of species found were those that are tolerant to low DO (Figure 523-3). At sites 09MN077 and 09MN065, 91% of the fish recorded were either in the third or fourth quartile, tolerant or very tolerant of low DO. The number of fish that were late maturing species was low which is expected with low DO. Serial Spawning fish taxa normally decrease in low DO, this metric was above average at both sites. These data paint a mixed picture but suggest that low DO is a possible stressor for fish.

Macroinvertebrate populations did not give a clear sign of a low DO problem. Invertebrate metrics such as Plecoptera, Trichoptera and EPT tell a mixed story. The lack of plecoptera taxa while concerning could be due to poor habitat. The number of trichoptera was not particularly poor and the EPT score was quite good. The low number of low DO tolerant invertebrates corroborates the EPT data suggesting that low DO is not a persistent issue for macroinvertebrate populations.

HSPF modeling suggests that there is not a DO issue at this site. Figure 523-4 shows the modeled 10 year duration curve of daily minimum DO values. The model suggests that incidences below 5mg/L are rare.

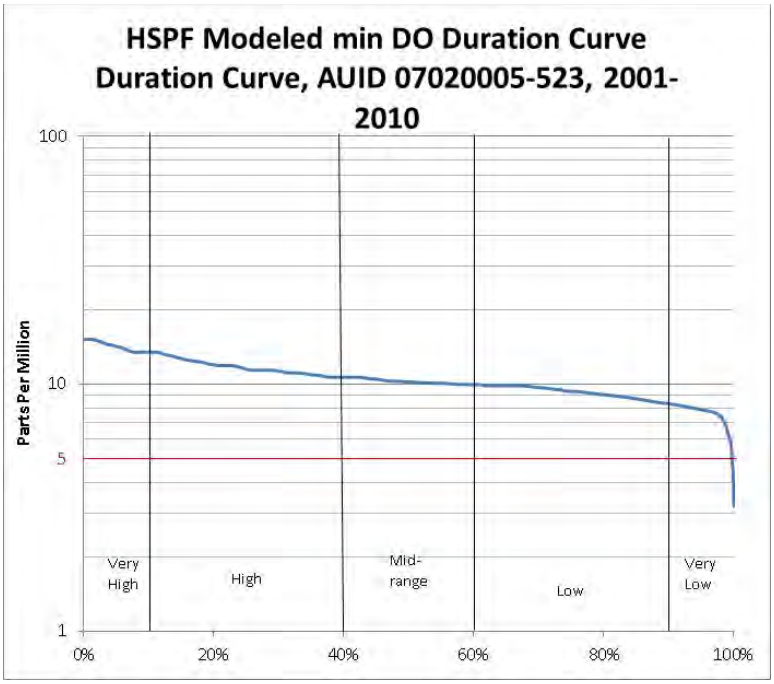


Figure 523-4 HSPF DO modeling projections

Stressor pathway: Impoundments

Dissolved oxygen levels can be affected by impoundments by collecting nutrients and organic materials leading to less availability and by serving as areas for algae blooms. In the AUID 07020005-523 watershed, there are upstream natural impoundments. These natural impoundments, Lake Minnewaska and the shallow Starbuck wetland are not known to be impaired for Nutrient/Eutrophication on low DO.

Outlet Creek empties into Lake Emily. While not a part of the reach, this 2261 acre lake with a maximum depth of 4.5 feet, is classified as hyper-eutrophic by the MPCA. Monitoring at the outlet of Lake Emily from 2007-2009 found that low DO was a recurrent factor in the water exiting the lake.

Given these lake conditions and the presence of a fish passage barrier into Lake Minnewaska, it is reasonable to conclude that fish populations have been forced to endure the conditions in Lake Emily during periods of low flow since passage into Minnewaska is blocked. Therefore low DO is a stressor to fish populations in Outlet Creek even though low DO conditions may not be observed in the reach.

Stressor pathway: Source-water pollution

The two main sampled source waters to Outlet Creek are Lake Minnewaska and the Little Chippewa River. The Little Chippewa River (AUID 07020005-713) has a borderline low DO stressor. Lake Minnewaska is not known to be impaired for nutrient/eutrophication or low DO.

Dissolved oxygen summary:

Dissolved oxygen is probably not a stressor for fish in AUID 07020005-523 but it is a possible stressor to fish populations in the reach. The HSPF model and monitoring data do not find low DO in the reach. The fish survey data point toward low DO as a stressor to fish communities. It is highly likely that fish populations have been forced to endure the low DO conditions in Lake Emily during periods of low flow since passage into Minnewaska is blocked by a fish barrier and low flow.

Candidate cause: Phosphorus

Phosphorus samples were taken in AUID 07020005-523 at site S000-898 also known as 09MN065, 58 times from 2007-2009. The samples exceeded the 0.15ppm draft standard 29% of the time and the flow weighted means for the three years averaged 0.178ppm. These levels when found in lakes resulting in frequent algae blooms and fish kills in low flow warm periods.

Looking at the fish data (Figure 523-3) 8% and 14% of the samples were made up of the most phosphorous tolerant individuals (fourth quartile) while 83% and 76% of the individuals were the most sensitive (first quartile). There were few individuals representing the second and third quartiles. These data suggest that while phosphorous may be a driving force of other stressors (low DO and turbidity) in itself is not the most toxic stressor to fish populations.

Invertebrate data support this conclusion. Every metric used to understand the impact of phosphorous on invertebrate populations (EPT, % intolerant, % Tanytarsini, % dominant, % scrapers, % tolerant) pointed toward phosphorous not being a stressor to invertebrates.

The HSPF model suggests that phosphorous concentrations above 0.15ppm occurred 77% of the time from 2001-2010 (Figure 523-5).

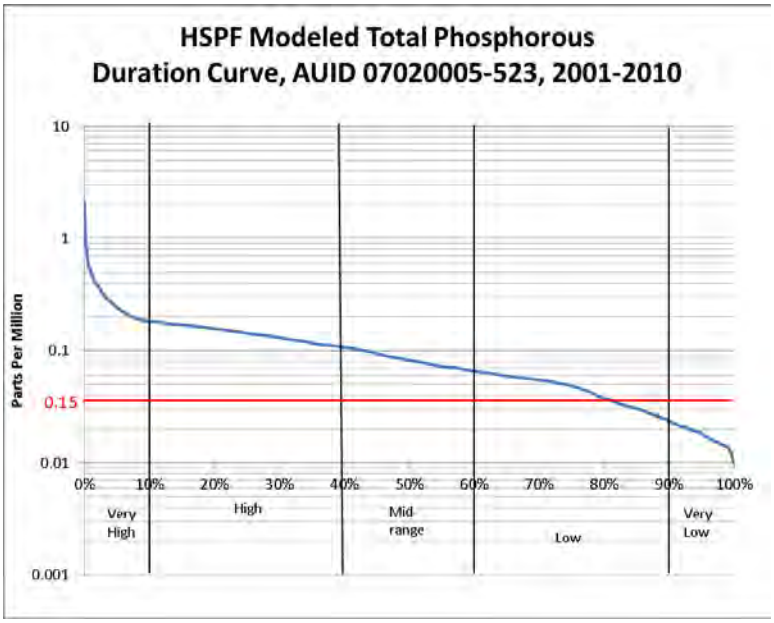


Figure 523-5 HSPF phosphorous modeling projections

Stressor pathway: Riparian condition

The riparian buffers along the main channel of AUID 07020005-523 are good, often four to five stream widths on each side. There are some exceptions where overland flow appears to be an issue. In addition, the smaller tributary ditches and streams that feed into Outlet Creek frequently have inadequate buffers. Lack of a riparian zone providing some form of "natural" benefit can allow high amounts of nutrients and sediment from adjacent fields and mowed yards to enter the adjacent stream.

Bank erosion was noted in the field surveys of both 09MN065 and 09MN077. If flows have been altered and bank erosion is on the rise then this could be a possible source of in stream phosphorous.

Stressor pathway: Source-water pollution

There are three likely source water pollution sources; Lake Minnewaska, the Little Chippewa River and the Starbuck wastewater treatment facility. Lake Minnewaska phosphorous data collected between 2003-2012 averaged 0.027 with a maximum value of 0.047. Lake Minnewaska is not a significant source of phosphorous. The Little Chippewa River flows into reach 07020005-523 via Pope County Ditch 2. Monitoring from 2006-2009 documented high phosphorous levels, with the average flow weighted mean for the three years being 0.182 with 45% of the samples exceeding the draft standard. The Starbuck wastewater treatment plant (MN0021415-SD-3) discharges into Outlet Creek. The wastewater treatment effluent flow averaged 0.42cfs at a concentration of 1.46mg/L from 2003-2012. These data indicate that the Little Chippewa River is a source of phosphorous particularly during higher flows and that the Starbuck wastewater treatment plant is a concern during low flows. (Figure 523-6)

Figure 523-6 Source Water Map

Phosphorous summary:

There is good chemical monitoring data that shows Outlet Creek (AUID 07020005-523) is stressed by elevated levels of phosphorus. Data indicate that the Little Chippewa River is a source of phosphorous particularly during higher flows and that the Starbuck wastewater treatment plant is a concern during low flows. Phosphorus in this system is likely to be directly contributing to the turbidity stressor in this reach and the eutrophic conditions in Lake Emily downstream.

Candidate cause: Nitrate

NO2-3 samples were taken in AUID 07020005-523 at site S000-898 also known as 09MN065, 58 times from 2007-2009. The average concentration of all the samples was 0.54ppm and the flow weighted means for 2007-2009 ranged between 0.50 and 0.71mg/L (Figure 523-7). The maximum sampled value was 4.2 mg/L. The samples, averages and flow weighted means did not exceed the 10ppm drinking water standard nor the 4.9mg/L aquatic life draft chronic standard.

HSPF modeling projects levels in exceedance of the 75 percentile value of 0.28ppm for North Central Hardwood Forest ecoregion 100% of the time. The model suggests between 2001-2010 nitrogen levels never exceeded the 10ppm standard. These are levels below what is considered a stress to aquatic populations. (Figure 523-7)

Invertebrate metrics indicate that nitrogen is not an issue. Trichoptera taxa were more numerous than average, nitrogen tolerant individuals made up only 17% of the sample, taxa count was average. Fish metrics followed a similar pattern. Number of fish taxa were slightly above average, nitrogen tolerant fish were present but not dominant and there were a fair number of sensitive individuals.

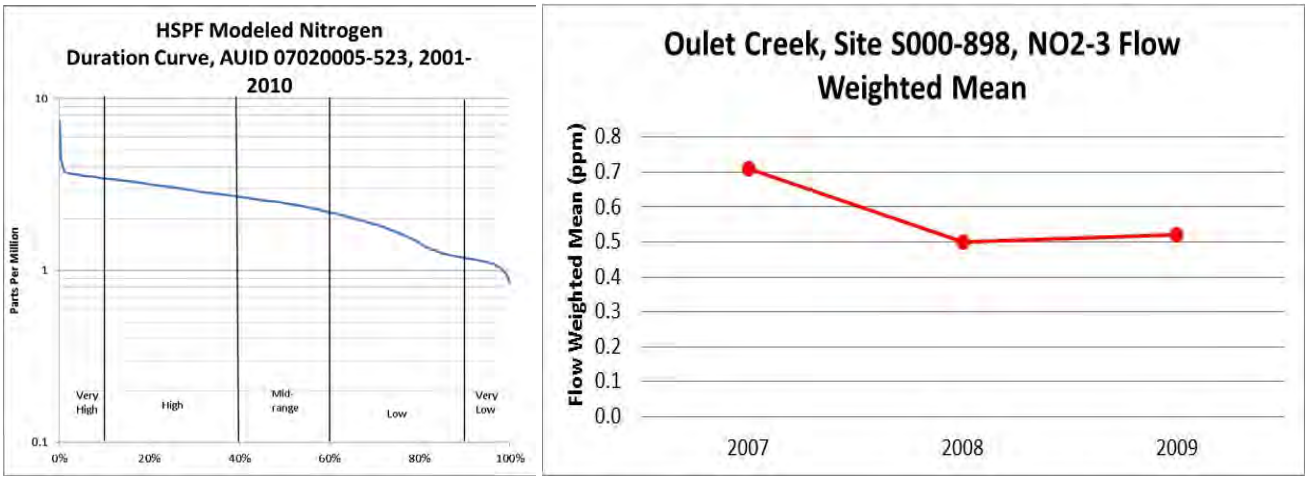


Figure 523-7 HSPF nitrogen modeling projections and monitoring data derived flow weighted means.

In an examination of species' tolerance along physiochemical gradients species in the Outlet Creek (in 2009-2010) the first quartile was represented by 24% of the sample, the second quartile 55%, the third quartile 2% and the fourth quartile 16% (Figure 523-3). These results indicate that nitrogen is not a likely stressor at site 09MN065 and 09MN077.

Nitrogen summary:

Nitrate-nitrite is an unlikely stressor to the stream biotic community. Sample data, bio-metrics and modeling all suggest that it nitrogen is having little effect on fish populations.

Candidate cause: Turbidity

Turbidity, which is a measure of transparency, can be increased with sediment, algae and organic matter. In addition to turbidity, the state of Minnesota allows transparency (25NTU=20cm transparency) and TSS (25 NTU= 54ppm TSS) as surrogates for turbidity in the Chippewa River watershed. In AUID 07020005-523 there are six sites where turbidity, TSS or transparency has been measured.

The monitoring data indicates a low level stressor. Turbidity was sampled at site S000-898 55 times between 2007 and 2009. Turbidity exceeded the standard in 10.9% of the samples. Transparency was sampled 135 times at six sites from 2006-2010. Transparency exceeded the surrogate standard in 0.04% of the samples. Total suspended solids was sampled 58 times at site S000-898 and exceeded the standard in 8.6% of the samples.

In 2009, the fish sampled at sites 09MN065 and 09MN077 were comprised of mostly fish that are somewhat sensitive to suspended solids (55% second quartile). Tolerant species in the third and fourth quartiles made up 40% of the samples (Figure 523-3). The relative abundance (%) of individuals that are herbivore species at both sites was low, this is often indicative of a turbidity stressor.

The percent of TSS tolerant invertebrates at site 09MN065 was high (65%) and there were no TSS intolerant taxa found. The relative percentage of taxa belonging to EPT was high, contrary to what one would expect in a high turbidity situation. Most of the other invertebrate metrics were inconclusive.

HSPF modeling of TSS projects levels in exceedance of the 54ppm surrogate standard 16% of the time (Figure 523-8).

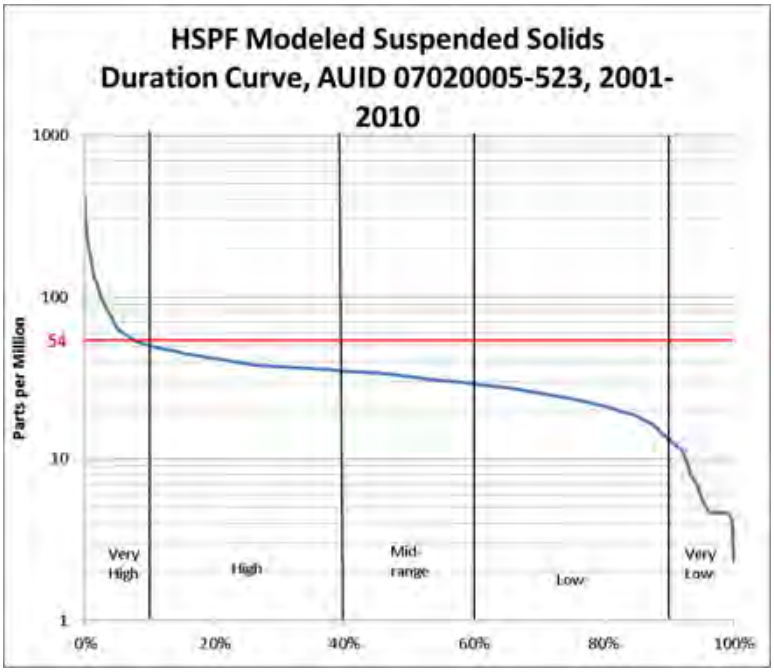


Figure 523-8: HSPF TSS modeling projections.

Stressor pathway: Riparian condition

The riparian buffers along the main channel of AUID 07020005-523 are good. There are some exceptions where overland flow appears to be an issue (Figure 523-6). In addition the smaller tributary ditches and streams that feed into Outlet Creek sometimes have inadequate buffers. The stream banks show signs of increased erosion possibly due to hydrologic alteration. Increased bank erosion could be responsible for some of the turbidity exceedances.

Stressor pathway: Source-water pollution

Lake monitoring data upstream of the Reach indicate that turbidity is not a stressor in Lake Minnewaska. The Little Chippewa River that flows into Outlet Creek is impaired for turbidity.

The reach is impaired for turbidity as more than 10% of the turbidity samples were more than 25 NTU. Figure 523-6 shows all of the monitoring sites on Outlet Creek. It is notable that transparency is worse in the western tributary ditch. This is likely due to outflow from the Little Chippewa River.

Stressor pathway: Channelization

Channelization on the actual reach of AUID 07020005-523 represents about 30% of the reach. County Ditch 2 is a major tributary of Outlet Creek and contributes its channelized flow to the reach. Channelization could be changing in-stream erosion rates that have led to an increase in turbidity.

Turbidity summary:

Stream chemical monitoring data, the HSPF model and an assessment of stressor pathways all support listing turbidity as a stressor in AUID 07020005-523. The fish and invertebrate data are mixed and show some indication that turbidity may be a stressor to fish and invertebrate populations. More biological samples would be useful in making a better assessment.

Candidate cause: Habitat

At sites 09MN065 and 09MN077 fish populations, macroinvertebrate populations and habitat were sampled in the summer of 2009. Site 09MN065 received a score of "Good" and site 09MN077 received a score of "Fair". In 2012 these sites were visited again and a SVAP survey was completed at each site.

Site 09MN065 and 09MN077 has fair habitat as scored by the MSHA in 2009. Both sites scored poorly in the category of surrounding land use.

The SVAP surveys conducted in 9-2012 gave 09MN065 an overall assessment score of Good and 09MN077 an overall assessment score of Fair. They observed a good number of habitat types for invertebrates and slightly less for fish species. Channel condition and hydrologic stability were Fair with lateral erosion evident. There was bank erosion evident and a beaver dam in the culvert at site 09MN065. At sight 09MN077 thick mats of floating algae were noted. They are likely the result of excessive nutrients.

Figure 523-9 Station 09MN065 (Note beaver dam and undercut banks).

Figure 523-10 Station 09MN077, Note thick mats of floating algae.

Biometrics for the two sites provided mixed results. The number of riffle dwelling fish and benthic insectivores were indicative of good habitat. The number of lithophilic spawners, darter, sculpin and round bodied suckers and invertebrate clingers were above average. These metrics suggest Fair habitat. The number of tolerant fish and invertebrates plus the dominance of the dominant two taxa are indicative of poor habitat quality. The metrics are not decisive in making a clear determination.

Stressor pathway: Channel alteration

Channel Alteration in reaches contributing to the river have likely led to changes in the hydrologic and geomorphologic condition. This has likely led to changes in discharge patterns, changes in substrate, change in sinuosity, and increases in erosion. Given the poor stability of sand and silt as bed and bank material, areas where the river has lost its bank cover and channel stability are particularly susceptible to habitat destruction.

Habitat summary:

Outlet Creek has many of the structural components for good habitat. Surrounding land use and buffer management are limiting factors to the natural function of the river. At this point habitat is not a limiting stressor.

Candidate cause: Altered hydrology

Flow monitoring in this reach was limited to site S000-898. This site's hydrology is characterized by quick rising and falling water levels following rain events and not much base flow. These are characteristics of a stream undergoing a change in hydrology.

CRWP monitoring of daily flows in AUID 07020005-503 ranged from 2.2 to 182cfs at site S000-898 from 2007 through 2009 (Figure 523-11). The channel is classified as an E channel with an easily accessed floodplain. It has a very low entrenchment ratio and is quite sinuous. The measured velocities in this reach range from 0.2 to 2.5ft/s. The ranges of velocities endured are most important to biota rather than an average. Overall the higher flow hydrological condition of this reach appears to be in good shape but the trend appears to be toward higher peak flows which have a tendency to destabilize stream banks and aquatic habitat.

Low flow events are a natural part of a river's cycle, but flows that are too low or low too often could result in a negative biological impact. According to the HSPF model, extended low flow events which were below the estimated 90th percentile flows of 2.88cfs occurred in the spring of 2003, 2006 and the fall of 2003, 2006, 2007, 2008 and 2009.

Lower flows may reduce surface area and turbulence, which can decrease DO and stress organisms. In this case, DO is considered the proximate stressor, while flow alteration is a step in the causal pathway. It is possible that during the early spring and late fall DO levels follow the falling flow levels. Very few samples of DO were taken during these times.

Low flows can also force fish to move to upstream and downstream locations where conditions are more favorable. In the case of Outlet Creek the two most likely destinations are Lake Minnewaska and Lake Emily. Lake Minnewaska has a man-made fish barrier and has been observed to stop flowing out during low flows. Lake Emily is hyper-eutrophic and less than ideal habitat.

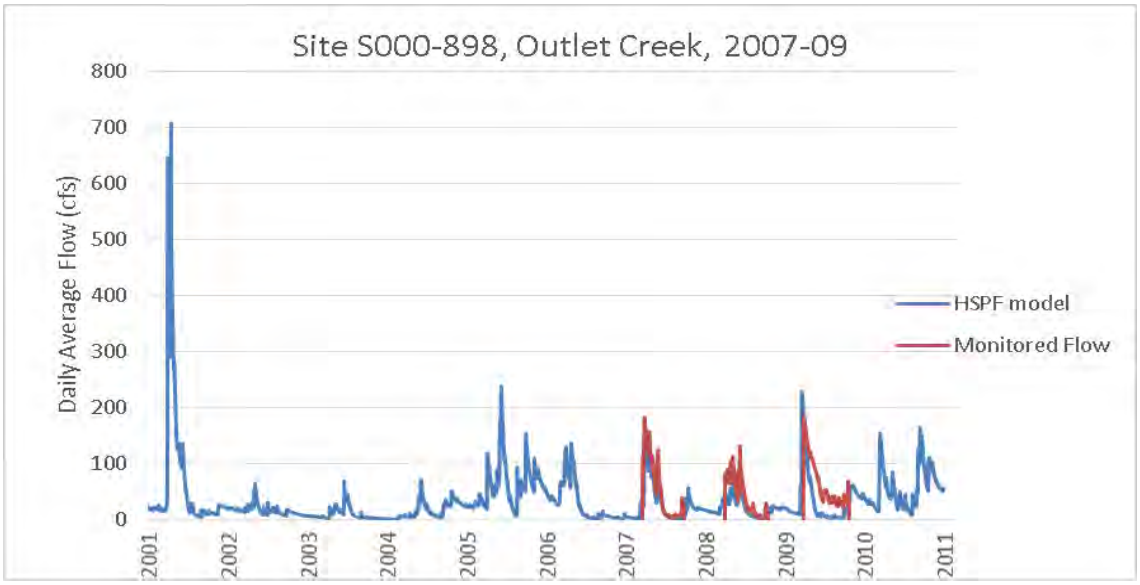


Figure 523-11 Site S000-898, Outlet Creek, 2007-09, Monitored and Modeled Flow

Stressor pathway: Channelization

Channelization and tile drainage can lead to changes in flow dynamic. Changes to upstream hydrology have an impact on the discharge of the river system creating changes in water slope leading to changes in scouring and deposition as well as changes to water velocity and depth. The changes in the hydrological and geomorphological condition have a direct impact on stream habitat and stream stability; these in turn negatively impact the biology in the reach.

Altered hydrology summary:

There is evidence to support listing altered hydrology as a stressor in the reach. Surveys at 09MN065 and 09MN077 did find physical evidence indicative of flow alteration. This is evidence of low flow conditions. Lower flows may reduce surface area and turbulence, which can decrease DO and stress organisms. Low flows may also create a fish passage issue and force fish into Lake Emily, a hyper-eutrophic lake known for its periodically low DO levels. In this case, DO and fish passage barriers would be considered the proximate stressor, while altered hydrology is a step in the causal pathway.

Candidate cause: Lack of connectivity

Site visits to AUID 07020005-523 noted several barriers to fish passage. The outlet of Lake Emily, immediately downstream of AUID 07020005-523 is a dam that impedes the movement of fish. The culvert at site 09MN065 had a beaver dam within the culvert in 2012 that would limit fish movement, and the outlet of Lake Minnewaska has a constructed fish barrier. These barriers limit fish movement and may isolate fish populations within Outlet Creek. These barriers may make the low level stressors of Outlet Creek more harmful, especially when flows are low and stream chemistry is poor, as the barriers prevent the movement of fish populations from stressful stream conditions.

Weight of evidence

The evidence for each potential stressor, the quantity and quality of each type of evidence is evaluated. The consistency and credibility of the evidence is evaluated. Each step for AUID 07020005-523 was scored and summarized in Figure 523-12. For more information on scoring please see EPA's CADDIS Summary Table of Scores.

Types of Evidence	Scores						
	Low Dissolved Oxygen	High Phosphorus	High Nitrate	Lack of Connectivity	Lack of Habitat	High Turbidity	Altered Hydrology
Spatial/temporal co-occurrence	+	++	--	++	+	+	+
Temporal sequence	+	+	+	0	-	+	+
Field evidence of stressor-response	0	++	--	-	+	++	-
Causal pathway	++	++	-	++	-	++	++
Evidence of exposure, biological mechanism	+	++	-	-	-	+	++
Field experiments /manipulation of exposure	NE	NA	NE	NE	NE	NE	NE
Laboratory analysis of site media	NE	NA	NE	NE	NE	NE	NE

Verified or tested predictions	NE	NE	NE	NE	NE	NE	NE
Symptoms	+	+	+	0	+	+	+
Evidence using data from other systems							
Mechanistically plausible cause	+	+	+	+	+	+	+
Stressor-response in other lab studies	++	+	+	NA	NE	NE	NE
Stressor-response in other field studies	++	+	+	-	+	+	+
Stressor-response in ecological models	NE	NE	NE	NA	NE	NE	NE
Manipulation experiments at other sites	NE	NE	NE	NA	NE	NE	NE
Analogous stressors	NE	NA	NE	NA	NA	NE	NE
Multiple lines of evidence							
Consistency of evidence	+	+	+	-	+++	+++	+++
Explanatory power of evidence	++	++	++	-	++	++	++

Figure 523-12 Weight of evidence table for potential stressors in AUID 07020005-503 Outlet Creek Evidence using data from Chippewa River watershed.

Conclusions

In AUID: 07020005-523 there is good monitoring data, therefore a good assessment of possible stressors can be made by combining the relevant information that is available. This reach has a number of stressors impacting the biological monitoring sites 09MN065 and 09MN077.

A survey of species tolerance levels to NO2-3, TP, TSS and DO revealed a predominance of tolerant individuals (Meador and Carlisle, 2006). In addition it appears that TSS (turbidity) and DO may be the stressors.

In AUID 07020005-523, there is sufficient data to conclude DO is a possible stressor to fish communities throughout the reach.

There is ample chemical monitoring data that shows the Outlet Creek (AUID 07020005-523) to be influenced by elevated levels of phosphorus. Phosphorus in this system is likely to be directly contributing to the DO and turbidity stressors also present in this system.

Nitrate-nitrite is an unlikely stressor to the stream biotic community. Sample data, fish data, and modeling all suggest that it nitrogen is having little effect on fish populations.

Stream chemical monitoring data, the HSPF model and an assessment of stressor pathways all support listing turbidity as a stressor in AUID 07020005-523. The fish and invertebrate data are mixed and show some indication that turbidity may be a stressor to fish and invertebrate populations. More biological samples would be useful in making a better assessment.

Outlet Creek has many of the structural components for good habitat. Surrounding land use and buffer management are limiting factors to the natural function of the river. Due to natural limitations in soil types available for channel substrate this reach may be uniquely susceptible to habitat degradation.

Human management decisions regarding livestock impact, buffer width and actions that impact habitat availability are causing biotic impairment in distinct locations.

There is little evidence to support listing altered hydrology as a primary stressor in the reach. Surveys at 09MN065 and 09MN077 did find physical evidence indicative of flow alteration. This is evidence of low flow conditions. Lower flows may reduce surface area and turbulence, which can decrease DO and stress organisms. In this case, DO is considered the proximate stressor, while altered hydrology is a step in the causal pathway.

10. AUID: 07020005-546, Judicial Ditch 8, Unnamed creek to Unnamed ditch, Swift County

AUID: 07020005-546 was assessed in 2012 and determined to be impaired for fish communities. The impaired reach is the Chippewa River in Marysland and Westbank Townships of Swift County in the Chippewa River watershed. There are six chemical monitoring sites on this reach. There are three biological monitoring sites located within the reach and one 03MN014 was monitored once in July of 2009. Fish species documented in this region indicate potential issues with turbidity and low DO.

AUID07020005-546

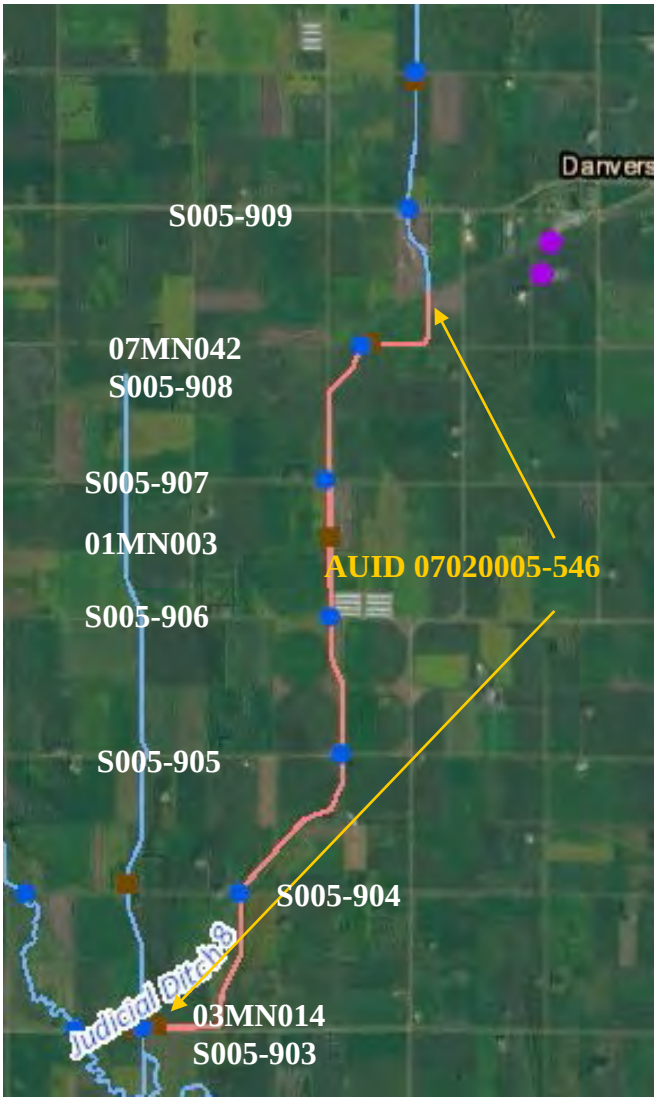


Figure 546-1 AUID: 07020005-546 monitoring sites.

The contributing watershed is 46.4 square miles in area. This watershed's area is occupied by 88% row crop agriculture, 1.2% is range, 0.5% is forest, 0.1% is open water, 3.4% wetlands, and 6.8% urban.

Biology:

Fish were sampled at site 07MN042 in July 2007. 01MN003 was sampled once in 2001. 03MN014 was sampled twice in 2003 and then once in 2009. This site scored well for the number of sensitive Trichoptera taxa present and the overall taxa richness. The site also was not overly dominated by the most dominant five species (DomFiveCHPct) in the sample. There was not a big number of the most tolerant species either (VeryTolerant2Pct). 03MN014 scored poorly on metrics that measured sensitive species (HBI_MN and Intolerant2lessCH). The score was brought down further by a complete lack of Odonata taxa (Figure 546-2).

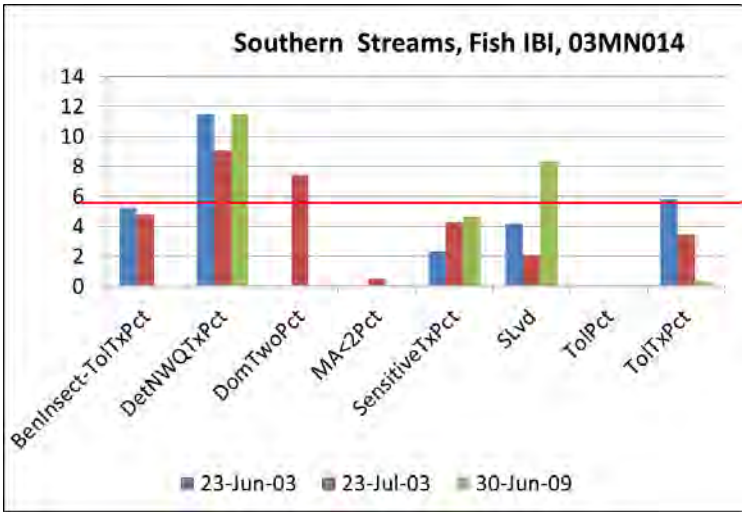


Figure 546-2 Fish metric scores belonging to site 09MN014. The red line indicates the average metric score needed for the score to be at the threshold (5.6).

A survey of fish species tolerance levels is useful in understanding pollution levels impacting fish in this reach. Fish tolerance to NO2-3, TP, TSS and DO revealed a high number of pollution tolerant individuals (Meador and Carlisle, 2006). These results suggest that high nitrogen and low DO are possible stressors.

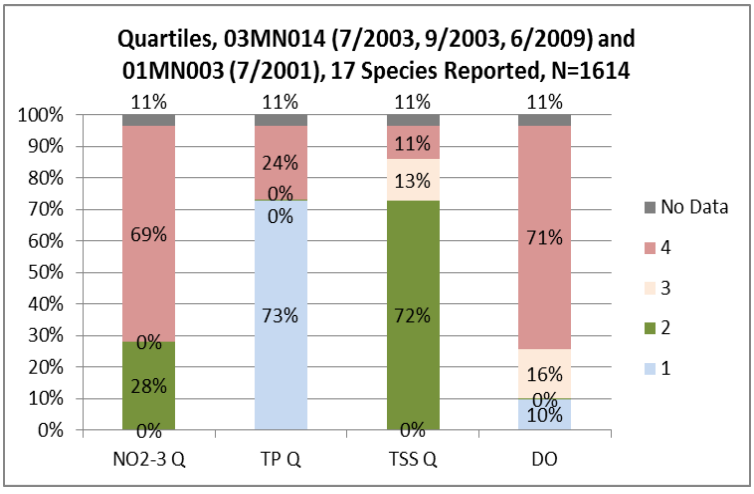


Figure 546-3 Fish quartile values for NO2-3, TP, TSS and DO.

Candidate cause: Dissolved oxygen

Dissolved oxygen monitoring conducted in AUID 07020005-546 indicates that low DO is not a likely stressor within the reach. Five of the 154 (3%) DO readings taken from 2009 through 2013 did not meet

the 5mg/L standard though most of these samples were not collected before 9:00 AM. The sample data do not support listing low DO as a primary stressor.

The majority of fish individuals (71%) at 03MN014 and 01MN003 were tolerant of low DO conditions. The Poor score for tolerant species and the lack of sensitive fish species suggests that low DO may be a stressor for the fish community. Four bio surveys were conducted for two sites over a ten year period. The number of late maturing fish (MA<3) was below average, and the relative abundance of individuals with a female mature age less than or equal to two years was high (Poor).

Invertebrate numbers showed few low DO tolerant taxa, average taxa richness and average WPT numbers. The invertebrate data do not suggest a low DO issue though there were considerable differences between visit dates.

HSPF modeling suggests that there is not a DO issue at this site. Figure 546-4 shows the modeled 10 year duration curve of daily minimum DO values. The model suggests that incidences below 5mg/L occurred very infrequently.

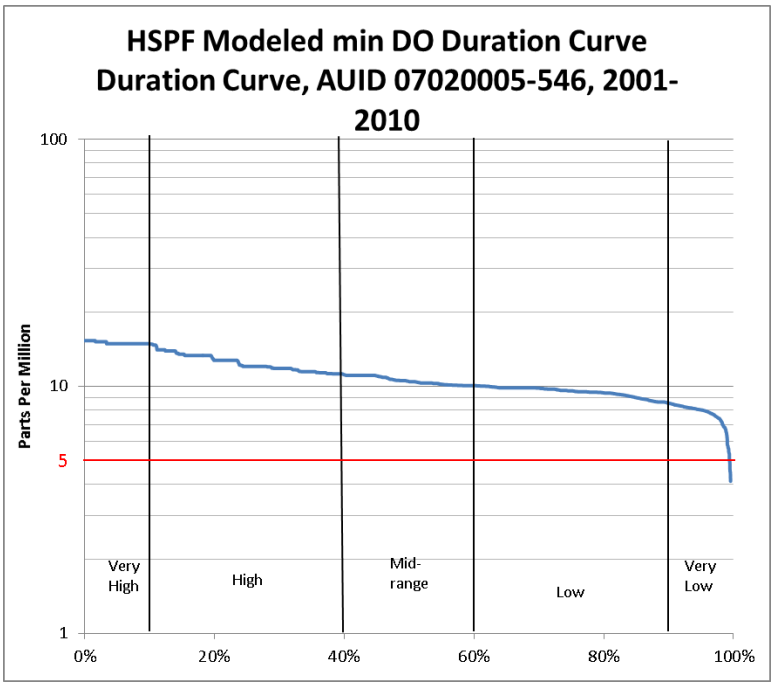


Figure 546-4 HSPF DO modeling projections.

Dissolved oxygen summary:

Dissolved oxygen is a possible stressor. Fish data suggest that low DO is a stressor, invertebrate data point in the opposite direction The HSPF model and daytime DO samples point toward the opposite conclusion. The absence of night time DO samples raises questions about ruling out DO as a stressor. More DO samples need to be taken before 9:00 AM. Dissolved oxygen is probably not a stressor in this AUID.

Candidate cause: Phosphorus

One phosphorus sample was taken at site 03MN014 in 2009 (0.057ppm).

At site S002-202 3 miles downstream of site 03MN014, TP was sampled 35 times between 2004 and 2006, it exceeded the draft standard 2 times (6%).

Looking at the fish data (Figure546-3) 73% of the samples were made up of the phosphorous sensitive (intolerant) individuals (first quartile). These data suggest that phosphorous is not a stressor to aquatic populations. The main invertebrate metric values were all average values. None of the invertebrate metrics were indicative of high phosphorous levels.

The HSPF model suggests that phosphorous concentrations above 0.15ppm occurred 52% of the time from 2001-2010 (Figure 546-5).

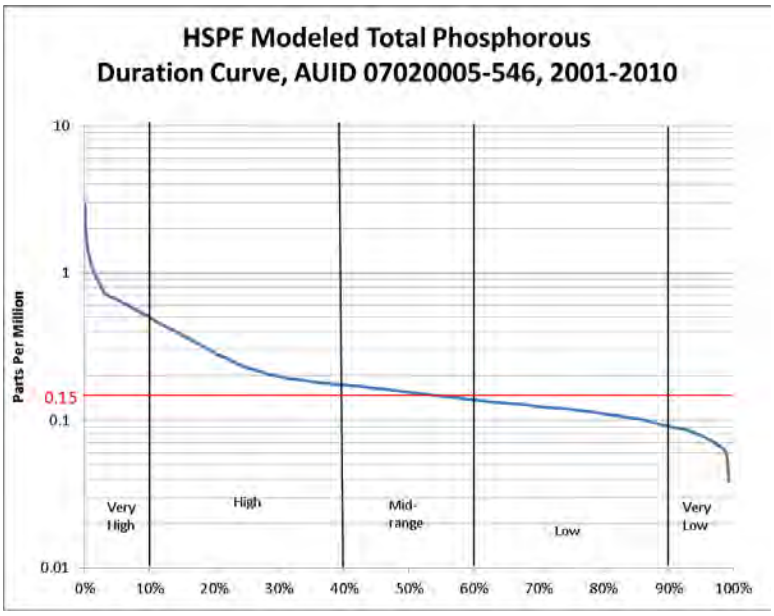


Figure 546-5 HSPF Phosphorous modeling projections.

The riparian buffers along the main channel of AUID 07020005-546 are poor on each side. The banks are eroding at a high rate according to CRWP surveys. A CRWP 2013 survey of buffer widths found that 25% of the banks had no buffer in this region. This reach has been straightened and entrenched through ditching. Flow conditions have been altered and bank erosion is on the rise which could be a possible source for in stream phosphorous.

Phosphorous summary:

Monitoring data from downstream of AUID 07020005-546 has low levels of phosphorus. Fish and invertebrate data also suggest that phosphorous levels are low. The HSPF model disagrees and the channel conditions in the reach support the mechanism for phosphorous to enter the reach. Given the field based numbers, the data do not lie, phosphorous is not a stressor in this reach.

Candidate cause: Nitrogen

One NO2-3 sample was taken in 2009 at site 03MN014 (0.88ppm).

At site S002-202 three miles downstream of site 03MN014, NO2-3 was sampled 57 times between 2004 and 2006. NO2-3 levels at S002-202 went above the 75 percentile value of 6.9ppm for Western Corn Belt Plains ecoregion 3% of the time and never exceeded the 10ppm drinking water standard. These levels are below what is considered a stress to aquatic populations (Minnesota River Nutrient Criteria Development, 2010).

HSPF modeling projects levels above the 75 percentile value of 6.9ppm for Western Corn Belt Plains ecoregion 18.2% of the time. The model suggests between 2001-2010 nitrogen levels exceeded the

10ppm standard less than 5.3% of the time. These levels are below what is considered a stress to aquatic populations. (Figure 546-6)

A survey of invertebrate tolerance found a high number of nitrogen tolerant invertebrate taxa (71-96%). No nitrogen sensitive fish were found and 69% of the four bio-samples were made up of nitrogen tolerant individuals. There were average numbers of trichoptera individuals, invertebrate taxa were average to slightly above average, these suggest that nitrogen may not be a stressor.

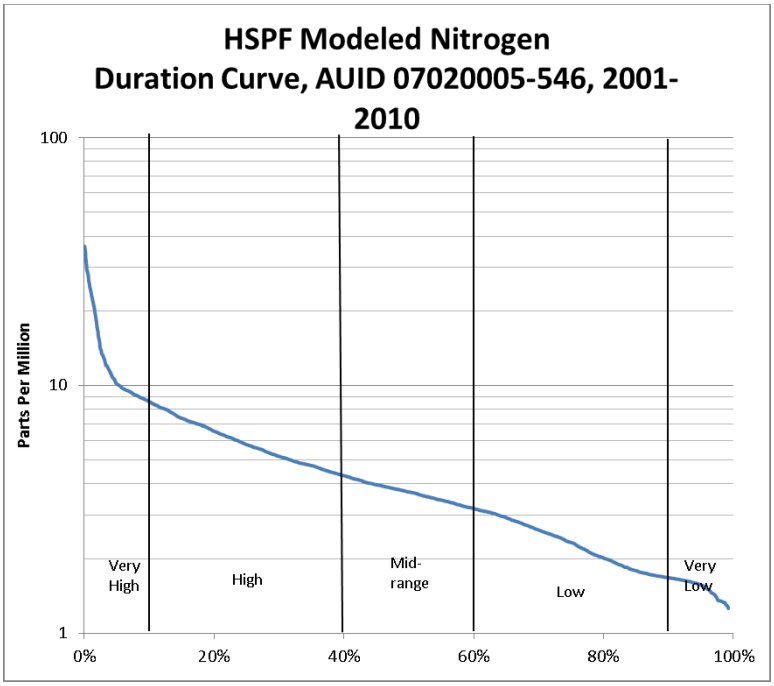


Figure 546-6 HSPF Nitrogen modeling projections.

Nitrogen summary:

Nitrogen levels are below what is known to cause damage to invertebrate communities. Sampling from downstream of this AUID and HSPF modeling indicate that nitrogen is not a likely stressor to fish communities.

Candidate cause: Turbidity

Transparency never exceeded the standard in the 207 times it was sampled from 2006 through 2013 in this AUID.

These results are supported by the downstream result taken from S002-202. TSS, turbidity and transparency were all sampled there from 2004-2006 and never exceeded the standard in more than 4% of the samples.

Fish tolerance data (Figure 546-3) found that 72% of the sample was made up of individuals that are phosphorous intolerant (second quartile). Invertebrates with tolerance to TSS made up between 7% and 19% of the samples. Invertebrate % scrapers and % dominant metrics were average to slightly above average. These data suggest that phosphorous is not a stressor to aquatic populations.

HSPF modeling of TSS projects levels in exceedance of the 54ppm surrogate standard 28.5% of the time (Figure 546-7). The model indicates that turbidity levels should be higher than what the monitoring measured.

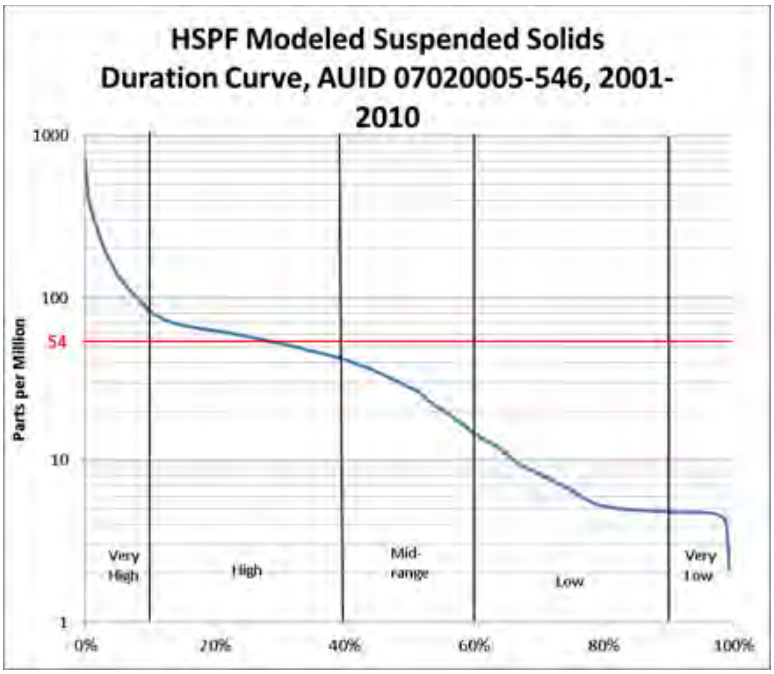


Figure 546-7 HSPF TSS modeling projections.

Turbidity summary:

Water quality monitoring from this reach and a close downstream site and biological analysis of fish tolerances to turbidity do not support listing turbidity as a stressor in AUID 07020005-546. HSPF modeling does not support this conclusion.

Candidate Cause: Habitat

At site 03MN014 habitat conditions were sampled twice in 2003 and once in 2009. Both 2003 visits gave Site 03MN014 a MSHA habitat score of “Fair” and the 2009 visit received a score of “Poor”. The Chippewa River at site 03MN014 is a ditch.

The 2009 MSHA's gave the Surrounding Land Use category 0% of the possible points due to the dominance of row crop land use surrounding the land immediately adjacent to the reach. All of the elements scored poorly in 2009. Particularly bad were the scores for Cover and Channel Morphology (Figure 546-8).

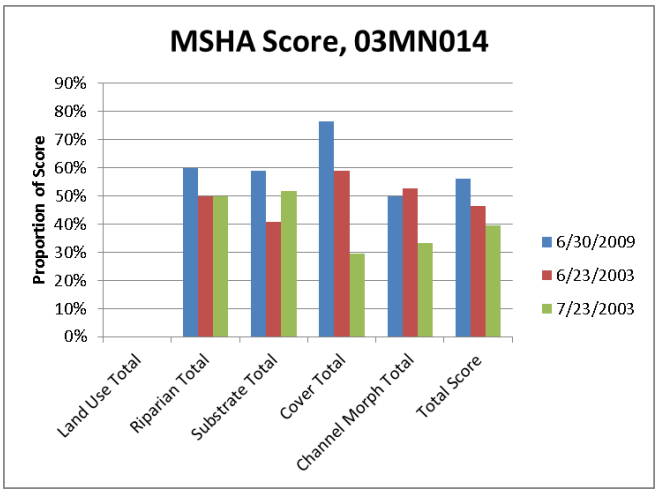


Figure 546-8, MSHA scores for 03MN014.

Fish bio-metrics identify poor habitat as a stressor. Bio-metrics that support this conclusion are: the low number of riffle dwelling fish, the high percentage of fish from tolerant taxa, in 2009 the absence of benthic insectivore fish, and the low percentage of darter, sculpin and round bodied suckers. Invertebrate bio-metrics also agree with the fish bio-metrics. The abundance (%) of dominant two taxa in subsample was high and the number of clingers dropped dramatically in 2009.

Habitat summary:

Judicial Ditch 8 at site 03MN014 is a ditch. The channel is made up of shifting sand and silt and does not foster fish species. The channel morphology has been dramatically altered and the physical structures of habitat are not stable. Poor habitat is a limiting stressor.

Candidate cause: Altered hydrology

This reach has 46.4 square miles of ditched drainage delivered to it from the upstream watershed. Eighty eight percent of this watershed's area is occupied by row crop agriculture. These lands are efficiently served by a system of ditches and underground tile drainage. This drainage has effectively altered the hydrological drainage pattern of the AUID. Flow monitoring downstream of this reach at site S002-202 has all the hallmarks of a stream that is undergoing high levels of hydrologic alteration via ditching.

The lack of fish in general, the presence of dominance of tolerant species and the abundance of early maturing species supports considering flow alteration a stressor.

Altered hydrology summary:

The evidence is clear, Judicial Ditch 8 is a ditch and as is the nature of ditches altered hydrology is a stressor. Hydrologic alteration has been ongoing over the last 50 years in the AUID and is evident in the fish populations and in the shape of the channel (a ditch). Surveys at 03MN014 found physical evidence indicative of flow alteration.

Candidate cause: Lack of connectivity

There are no barriers to fish passage in AUID 07020005-546. Lack of connectivity is not a stressor in the reach.

Weight of evidence

The evidence for each potential stressor, the quantity and quality of each type of evidence is evaluated. The consistency and credibility of the evidence is evaluated. Each step for AUID 07020005-546 was scored and summarized in Figure 546-9. For more information on scoring please see EPA's CADDIS Summary Table of Scores.

Evidence using data from Chippewa River watershed

Types of Evidence	Scores	
	Poor Habitat	Altered Hydrology
Spatial/temporal co-occurrence	++	++
Temporal sequence	++	++
Field evidence of stressor-response	++	++
Causal pathway	++	++
Evidence of exposure, biological mechanism	++	++
Field experiments /manipulation of exposure	NE	NE
Laboratory analysis of site media	NE	NE
Verified or tested predictions	NE	NE
Symptoms	+	+
Mechanistically plausible cause	+	+
Stressor-response in other lab studies	+	+
Stressor-response in other field studies	+	+
Stressor-response in ecological models	NE	NE
Manipulation experiments at other sites	NE	NE
Analogous stressors	NE	NE
Consistency of evidence	++	++
Explanatory power of evidence	++	++

Figure 546-9 Weight of evidence table for potential stressors in AUID: 07020005-546, Judicial Ditch 8, Unnamed creek to Unnamed ditch, Swift County.

Conclusions

AUID: 07020005-546, Judicial Ditch 8, Unnamed creek to Unnamed ditch, Swift County was assessed in 2012 and determined to be impaired for fish communities. This reach has a number of stressors impacting the biological monitoring site 03MN014.

Dissolved oxygen is a possible stressor. Fish data suggest that low DO is a stressor. The HSPF model and daytime DO samples point toward the opposite conclusion. The absence of night time DO samples raises questions about ruling out DO as a stressor. More DO samples need to be taken before 9:00 AM.

Monitoring data from downstream of AUID 07020005-546 has low levels of phosphorus. Fish data also suggest that phosphorous levels are low. The HSPF model disagrees and the channel conditions in the reach support the mechanism for phosphorous to enter the reach. Given the field based numbers, the data do not lie, phosphorous is not a stressor in this reach.

Nitrogen levels are below what is known to cause damage to invertebrate communities. Sampling from downstream of this AUID rules out nitrogen as a stressor to fish communities.

Water quality monitoring from this reach and a close downstream site and biological analysis of fish tolerances to turbidity do not support listing turbidity as a stressor in AUID 07020005-546. HSPF modeling does not support this conclusion.

Judicial Ditch 8 at site 03MN014 is a ditch. The channel is made up of shifting sand and silt and does not foster fish species. The channel morphology has been wrecked and the physical structures of habitat are not stable. Poor habitat is a limiting stressor.

The evidence is clear, Judicial Ditch 8 is a ditch and as is the nature of ditches altered hydrology is a stressor. Hydrologic alteration has been ongoing for the last 50 years. In this AUID it is evident in the fish populations and in the shape of the channel (a ditch). Surveys at 03MN014 found physical evidence indicative of flow alteration.

There are no barriers to fish passage in AUID 07020005-546. Lack of connectivity is not a stressor in the reach.

11. AUID: 07020005-551, Mud Creek, T123 R36W S28, East line to T123 R36W S29, West line, Pope County

AUID: 07020005-551 was assessed in 2012 and determined to be impaired for invertebrate communities. The impaired reach is the Chippewa River in Lake Johanna Township of Pope County in the Chippewa River watershed. There are two chemical monitoring sites on this reach. There is one biological monitoring site (90MN009) located within the reach that was monitored once in 2001, 2009 and 2010.

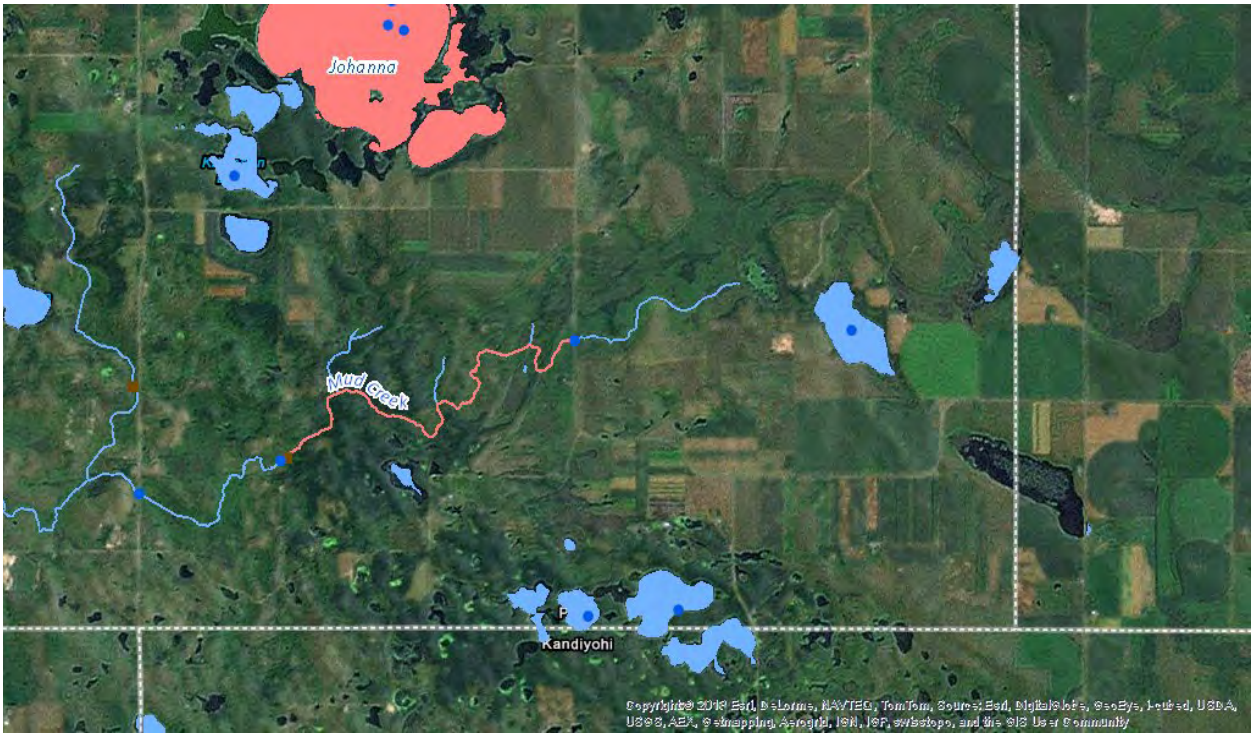


Figure 551-1 AUID: 07020005-551 monitoring sites.

The contributing watershed is 27.5 square miles in area. This watershed's area is occupied by 51% row crop agriculture, 13.5 % is range, 10.1% is forest, 14% is open water, 7.8% wetlands, and 3.8% urban.

Biology:

Invertebrates were sampled at site 90MN009 in 2001, 2009 and 2010 and reported 34, 40 and 51 taxa respectively. 90MN009 was sampled once in 2001. This site has scored a worse MIBI every time it has been sampled. In 2010, EPT taxa and Trichoptera families were low, Chironomidae taxa made up 44% of the sample and the top two dominant taxa made up 60.5% of the sample.

A survey of fish species tolerance levels sheds some light on the pollution levels impacting invertebrates in this reach. Fish tolerance to NO2-3, and DO revealed a high number of pollution tolerant individuals (Meador and Carlisle, 2006). These results suggest that low DO, and high nitrogen are possible stressors.

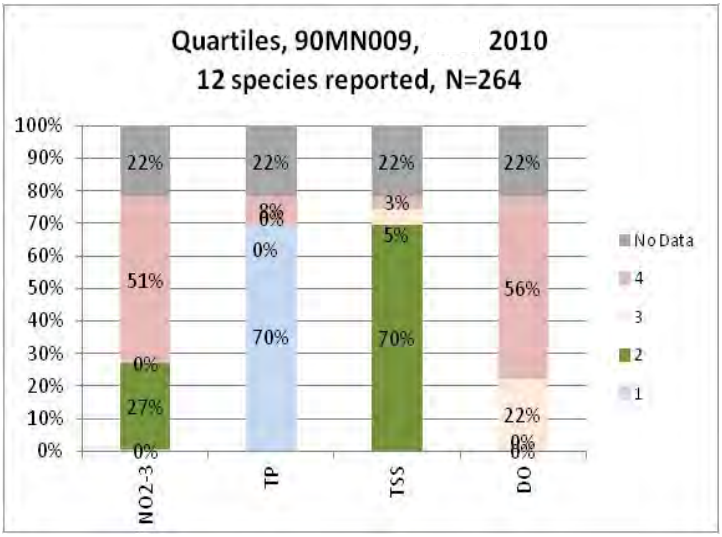


Figure 551-2 Fish quartile values for NO2-3, TP, TSS and DO.

Candidate cause: Dissolved oxygen

Dissolved oxygen monitoring conducted in AUID 07020005-551 indicates that low DO is a likely stressor within the reach. Seven of the 39 (17%) DO readings taken from 2006 through 2012 did not meet the 5mg/L standard. It is uncertain how many of these samples were collected before 9:00 AM. This sample data does support listing Low D.O. as a stressor.

The Poor score MN_HBI, the lack of taxa richness, the high number of serial spawning fish and the low number of late maturing fish all indicate a low DO stressor to fish populations. Also the abundance of chironominid invertebrate taxa suggests that low DO may be a stressor for the invertebrate community.

HSPF Modeling suggests that there is not a DO issue at this site. Figure 551-3 shows the modeled 10 year duration curve of daily minimum DO values. The model suggests that incidences below 5mg/L did not occur.

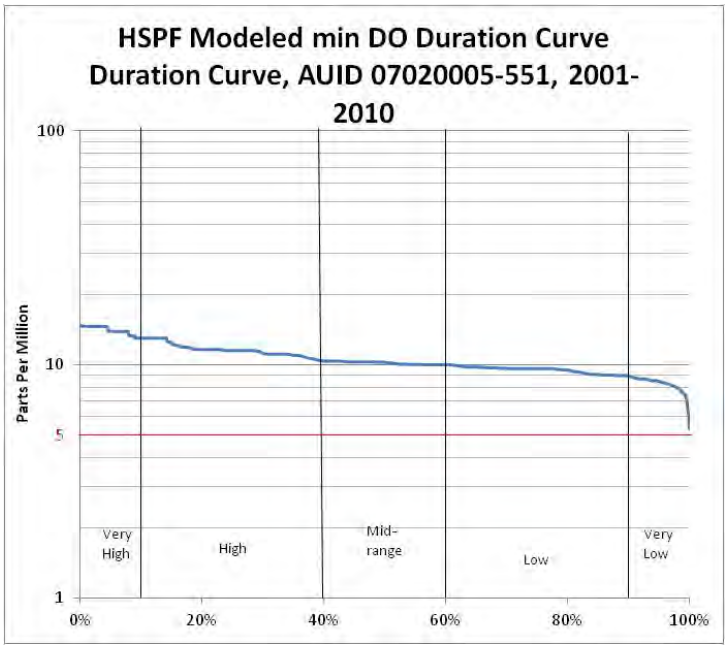


Figure 551-3 HSPF DO modeling projections.

Dissolved oxygen summary:

Dissolved oxygen appears to be a stressor in AUID 07020005-551. The presence of low DO samples (17%) and the agreement macroinvertebrate data point toward this conclusions.

Candidate cause: Phosphorus

No phosphorus samples were taken in AUID 07020005-551. There is not sufficient data to judge whether excessive phosphorous is a stressor.

Looking at the fish data (Figure551-2) 70% of the sample was made up of the phosphorous sensitive individuals (first quartile). Only 8 % of the individuals represented the fourth quartile. These data suggest that phosphorous is not a stressor to aquatic populations.

Invertebrate metric data suggest that phosphorous may be an issue. The abundance of Ephemeroptera, Plecoptera and Trichoptera individuals went from average to low from 2001 to 2009 and then back to average. The percent intolerant individuals went from high to low and the number of tolerant invertebrates was high in all years.

Site visits to site 90MN009 noted large mats of fibrous algae coating the stream bed.

The HSPF model suggests that phosphorous concentrations above 0.15ppm occurred 98% of the time from 2001-2010 (Figure 551-4).

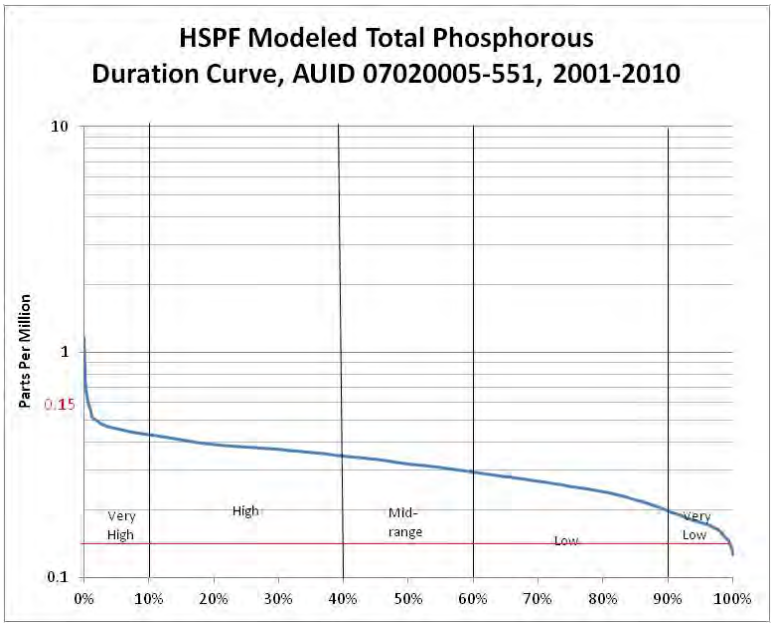


Figure 551-4 HSPF Phosphorous modeling projections, the red line indicates the draft standard 0.15ppm.

The riparian buffers along the main channel of AUID 07020005-551 are good. The banks are stable and the creek has good access to the flood plain.

Upstream sources of phosphorous are likely derived from non-point sources, livestock in the riparian corridor, and possibly failing septic systems.

Phosphorous summary:

Further monitoring data is needed before phosphorous can be ruled out as a stressor. The presence of sensitive species and mats of algae are contradictory. Upstream sources of phosphorous on Mud Creek may be contributing phosphorous to this reach.

Candidate cause: Nitrate

No nitrogen samples were taken between 2001 and 2011 in AUID 07020005-551.

Fish species tolerant to high nitrogen levels (fourth quartile) made up 51% of the sample in 2010. There were no sensitive species (first quartile). These data suggest nitrogen is a stressor.

HSPF modeling projects levels above the 75 percentile value of 0.28ppm for North Central Hardwood Forest ecoregion 100% of the time. The model suggests between 2001-2010 nitrogen levels exceeded the 10ppm standard less than 1% of the time. These levels are still below what is considered a stressor to aquatic populations. (Figure 551-5)

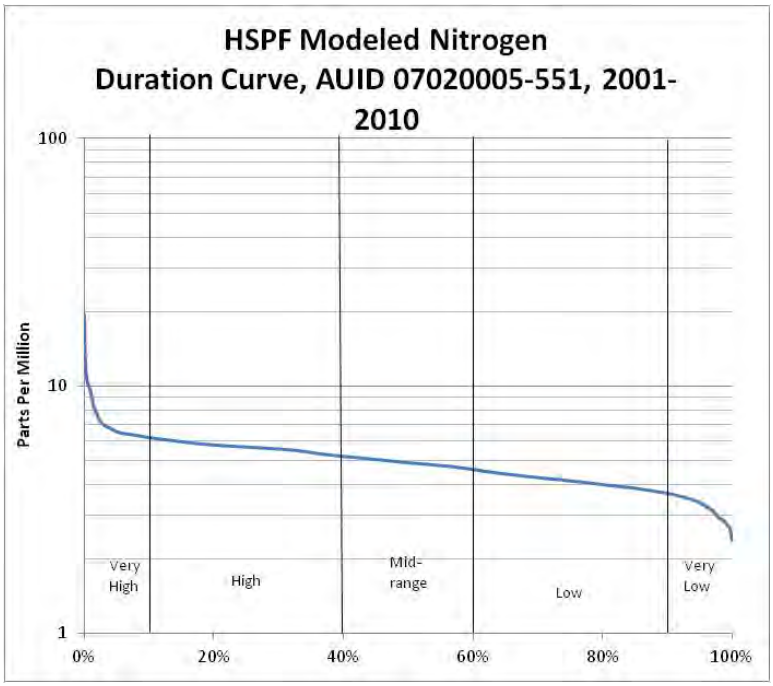


Figure 551-5 HSPF Nitrogen modeling projections.

Nitrogen summary:

Further monitoring data is needed before nitrogen can be ruled out as a stressor. Model nitrogen levels are below what is known to cause damage to invertebrate communities. Fish data suggest there may be a nitrogen stressor.

Candidate cause: turbidity

Transparency (a surrogate for Turbidity) exceeded the standard 7.6% of the 59 times it was sampled between 2006 and 2012.

The fish surveys at 90MN009 found populations with many moderately intolerant individuals. There were more than average simple lithophilic spawners and the abundance of herbivore species was within the standard deviation of average. Invertebrate surveys did not flag turbidity as a possible stressor, tolerant individuals made up between 6 and 9% of the populations surveyed. The number of scrapper and filterers was normal in 2001 but then low in 2009 and 2010 suggesting the possibility of a turbidity issue. Invertebrate collector-gatherers was normal in 2001, low in 2009 and then normal again in 2010. The number of taxa belonging to Chironomidae was normal. More metrics point against turbidity being a stressor than point to it.

HSPF modeling of TSS projects levels in exceedance of the 54ppm surrogate standard 15.5% of the time (Figure 551-6).

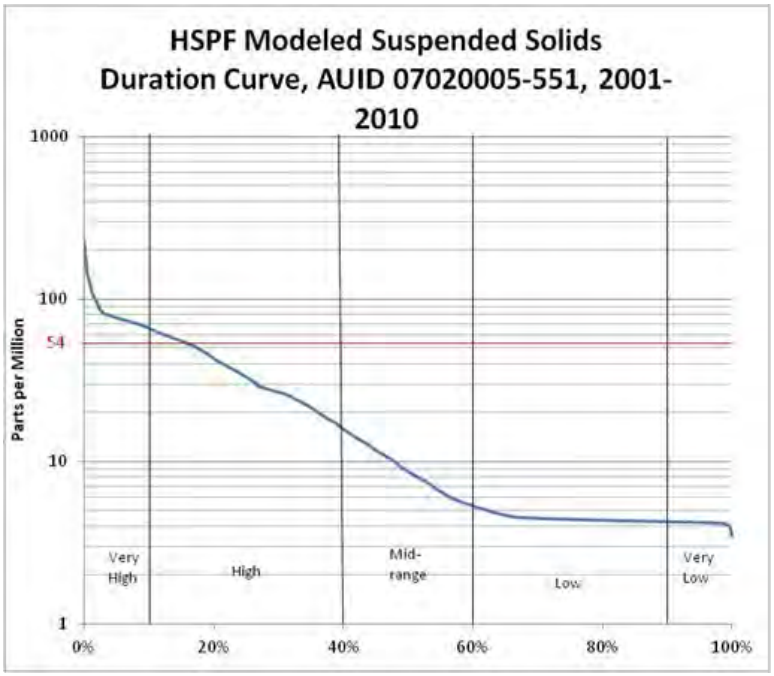


Figure 551-6 HSPF TSS modeling projections.

Analysis of fish tolerance to turbidity shows that 70% of the fish individuals are sensitive (second quartile) to TSS.

The riparian buffers along the main channel of AUID 07020005-551 are good. The banks are stable and the geomorphologic condition of the stream at site 90MN009 was a C4 and deemed to be fairly stable. This suggests that flow conditions are stable as well. Increased bank erosion is probably not responsible for some of the turbidity exceedances.

Turbidity summary:

Water quality monitoring of this reach and site surveys suggest that turbidity is not a stressor in AUID 07020005-551. Analysis of biological indicators also supports this conclusion.

Candidate cause: Habitat

At sites 90MN009 habitat conditions were sampled in August of 2001 and in 2009 in June and July. All three visits gave Site 90MN009 a MSHA habitat score of “Good”. In 2012 the site was visited again and a SVAP survey was completed. The SVAP protocol also gave the site a score of "Good".

The 2009 MSHA's gave the Surrounding Land Use category 100% of the possible points due to the good mix of perennial land uses surrounding the land immediately adjacent to the reach. Riparian conditions did not score as well in 2009. Substrate, cover and channel morph all pulled the overall score up (Figure 551-7).

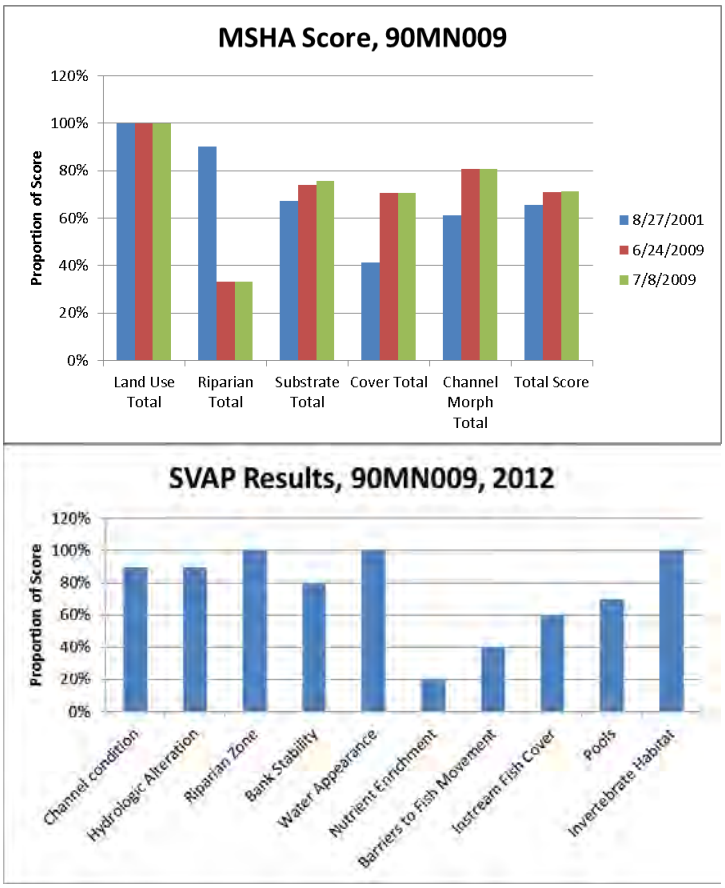


Figure 551-7 MSHA scores and SVAP rankings by category for 90MN009

The SVAP survey conducted in 9-2012 noted algae mats and that the downstream culvert may serve as a fish barrier. Both the SVAP and the MSHA note the stable conditions and good habitat conditions.

Figure 551-9 Station 09MN065 (Note perched culvert, algal mats and livestock grazing in riparian zone).

Invertebrate surveys do not support listing habitat as a stressor. The taxa richness of clingers was statistically higher than average. The relative abundance (%) of the dominant two taxa in the samples was average to low in all three sample dates. The taxa richness of climbers while low was within one standard deviation of the average.

Habitat summary:

Mud Creek at site 90MN009 has many of the structural components for good habitat. Channel condition is good and hydrologic alteration appears to be minimal so the stream channel and habitat should be fairly stable. Lack of habitat does not appear to be a stressor.

Candidate cause: Altered hydrology

This reach has 27.5 square miles of drainage delivered to it from the upstream watershed. Fifty point eight percent of this watershed's area is occupied by row crop agriculture. Almost 22% of the watershed is made up of open water and wetlands. The stream at 90MN009 was classified as a C4 (Rosgen) with a well-developed easy to access flood plain.

Flow alteration summary:

The field evidence is good; flow alteration is not a stressor in AUID 07020005-551.

Candidate cause: Lack of connectivity

There are barriers to fish passage in AUID 07020005-551. The culvert directly downstream of 90MN009 blocks movement of fish species in Mud Creek. This barrier limits fish movement and isolates fish populations within AUID 07020005-551.

Weight of evidence

The evidence for each potential stressor, the quantity and quality of each type of evidence is evaluated. The consistency and credibility of the evidence is evaluated. Each step for AUID 07020005-551 was scored and summarized in Figure 551-10. For more information on scoring please see EPA's CADDIS Summary Table of Scores.

Types of Evidence	Scores	
	Low Dissolved Oxygen	Lack of Connectivity
Spatial/temporal co-occurrence	++	++
Temporal sequence	+	++
Field evidence of stressor-response	++	++
Causal pathway	++	+ +
Evidence of exposure, biological mechanism	+	+
Field experiments /manipulation of exposure	NA	NE
Laboratory analysis of site media	NA	NE
Verified or tested predictions	NE	NE
Symptoms	+	+
Mechanistically plausible cause	+	+
Stressor-response in other lab studies	+	+
Stressor-response in other field studies	+	+
Stressor-response in ecological models	NE	NE
Manipulation experiments at other sites	NE	NE
Analogous stressors	NA	NE
Consistency of evidence	+	++
Explanatory power of evidence	++	++

Figure 551-10: Weight of evidence table for potential stressors in AUID 07020005-551 Mud Creek

Conclusions

AUID: 07020005-551 was assessed in 2012 and determined to be impaired for invertebrate communities. The impaired reach is the Chippewa River in Lake Johanna Township of Pope County in the Chippewa River watershed. There are two chemical monitoring sites on this reach. There is one biological monitoring site (90MN009) located within the reach that was monitored once in 2001, 2009 and 2010.

Dissolved oxygen appears to be a stressor in AUID 07020005-551. The presence of low DO samples (17%) and the agreement macro-invertebrate data point toward this conclusions.

Further monitoring data is needed before Phosphorous can be ruled out as a stressor. The presence of sensitive species and mats of algae are contradictory. Upstream sources of phosphorous on Mud Creek may be contributing phosphorous to this reach.

Further monitoring data is needed before nitrogen can be ruled out as a stressor. Model nitrogen levels are below what is known to cause damage to invertebrate communities. Fish data suggest there may be a nitrogen stressor.

Water quality monitoring of this reach and site surveys suggest that turbidity is not a stressor in AUID 07020005-551. Analysis of biological indicators also supports this conclusion.

Mud Creek at site 90MN009 has many of the structural components for good habitat. Channel condition is good and hydrologic alteration appears to be minimal so the stream channel and habitat should be fairly stable. Lack of habitat does not appear to be a stressor.

The field evidence is good; flow alteration is not a stressor in AUID 07020005-551.

There are barriers to fish passage in AUID 07020005-551. The culvert directly downstream of 90MN009 blocks movement of fish species in Mud Creek. This barrier limits fish movement and isolates fish populations within AUID 07020005-551.

12. AUID: 07020005-554, Mud Creek, County Ditch 15 to East Branch Chippewa River, Swift County

AUID: 07020005-554 was assessed in 2012 and determined to be impaired for both fish and invertebrate communities. The impaired reach is Mud Creek in Camp Lake and Kerkhoven Townships of Swift County in the Chippewa River watershed. There are four chemical monitoring sites on this reach. There are two biological monitoring sites located within the reach that were monitored once in 2003 and 2009.

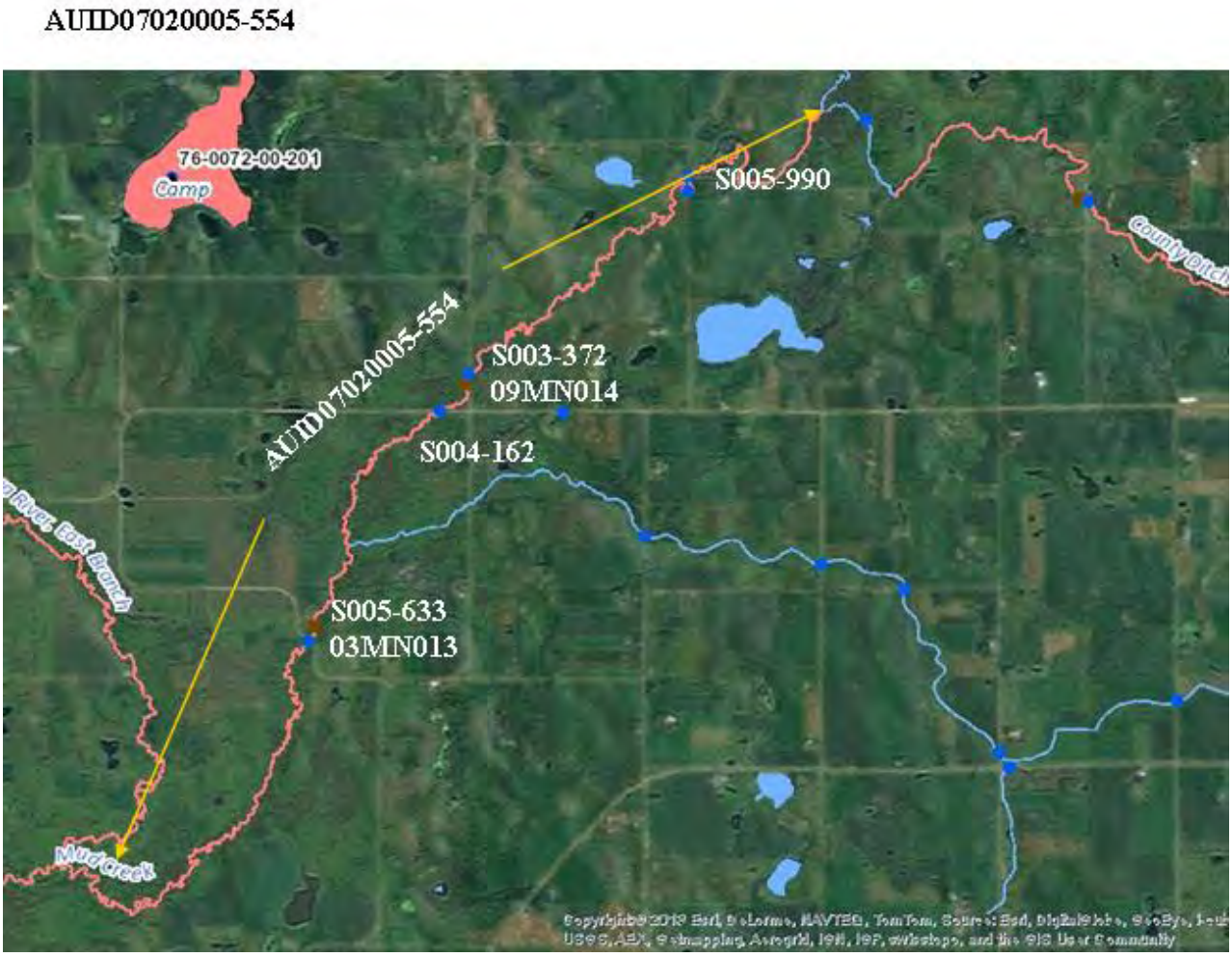


Figure 554-1 AUID: 07020005-554 monitoring sites.

The contributing watershed is 114 square miles in area. This watershed's area is occupied by 47% row crop agriculture, 21% is range, 12% is forest, 11% is open water, 6% wetlands, and 4% urban.

Biology:

Invertebrates were sampled at site 03MN013 in 2003 and 2009 and reported 39 and 41 taxa respectively and at 09MN014 in 2009 reporting 36 taxa. These sites scored below the MIBI threshold every time they have been sampled. In 2009, at site 09MN014 low trichoptera, predator and POET numbers kept the score down. Results for site 03MN013 in 2009 were depressed due to low trichoptera numbers, a high overall pollution tolerance (HBI_MN) and low numbers of collector-filterers. (Figure 554-2).

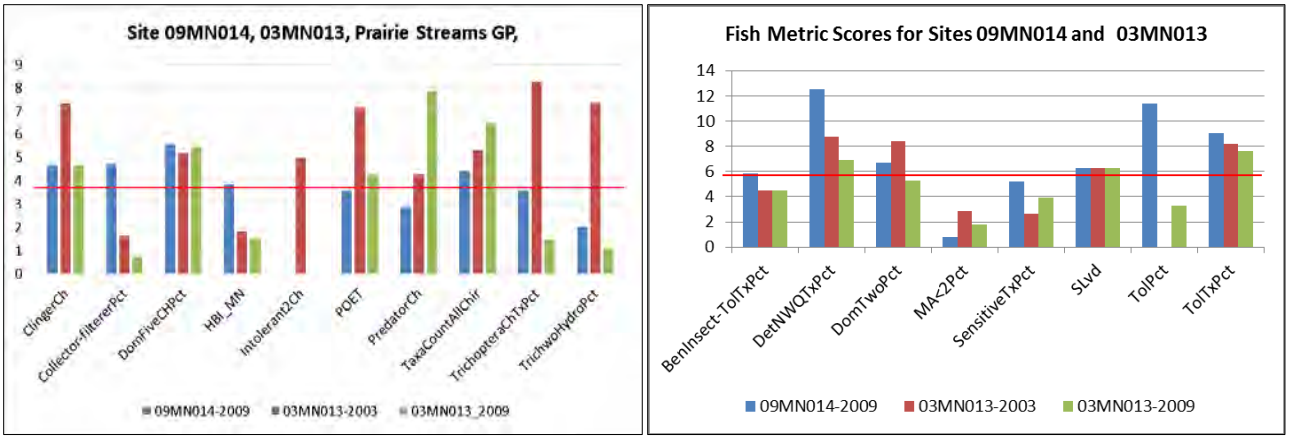


Figure 554-2 MIBI and FIBI results for 03MN013 and 09MN014, red line indicates the average IBI score needed to meet the minimum threshold (3.8 and 5.6).

A survey of fish species tolerance levels sheds some light on the pollution levels impacting both fish and invertebrates in this reach. Fish tolerance to DO revealed the highest number of pollution tolerant individuals (Meador and Carlisle, 2006). These results suggest that low DO is the most likely stressor.

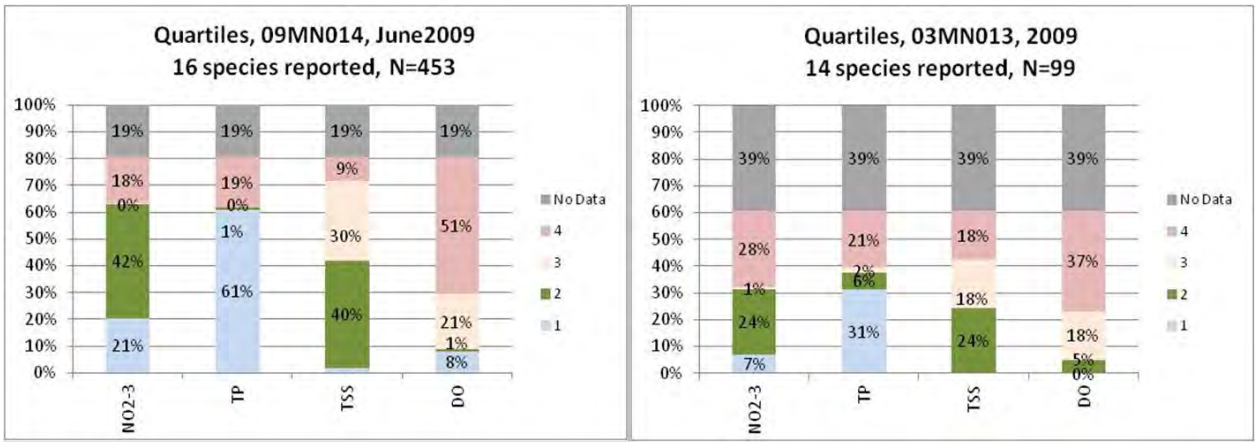


Figure 554-3 Fish quartile values for NO2-3, TP, TSS and DO.

Candidate cause: Dissolved oxygen

Dissolved oxygen monitoring conducted in AUID 07020005-554 indicates that low DO is a likely stressor within the reach. Fifteen of the 135 (11%) DO readings taken from 2006 through 2010 did not meet the 5mg/L standard. Most of these samples were collected after 9:00 AM so the monitoring data probably is underestimating the problem. The sample data supports listing low DO as a stressor.

The invertebrate data indicate that low DO is a stressor for the invertebrate community. Mud Creek invertebrate indicators of low DO include: low Trichpoptera taxa richness, the lack of any Plecoptera taxa, and the high number of low DO tolerant individuals in 03mn013 in 2009.

Fish tolerance analysis found that the majority of fish species identified in Mud Creek were the species most tolerant to low DO (Figure 554-3). The relative abundance of fish taxa with a female mature age greater than or equal to three was low, an indicator of low DO conditions.

HSPF Modeling suggests that there is not a DO issue at this site. Figure 554-4 shows the modeled 10 year duration curve of daily minimum DO values. The model suggests that incidences below 5mg/L did not occur.

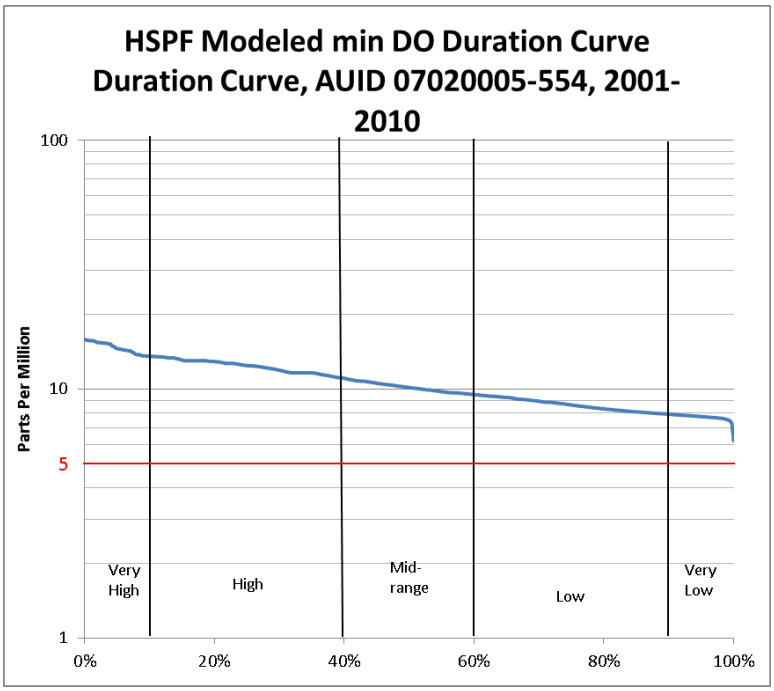


Figure 554-4 HSPF DO modeling projections.

Dissolved oxygen summary:

The weight of evidence suggests that DO is a stressor in AUID 07020005-554. The presence of low DO samples (11%) and the agreement of invertebrate and fish data override the contrary statement from the HSPF model.

Candidate cause: Phosphorus

Eighteen samples were taken in AUID 07020005-554 one sample or 6% exceeded the draft standard. The presence of many sensitive individuals (61 and 31% first quartile) is noted in the fish samples. These data suggest that phosphorous is not a stressor to aquatic populations.

The HSPF model suggests that phosphorous concentrations above 0.15ppm occurred 89% of the time from 2001-2010 (Figure 554-5).

Invertebrate metrics do not clearly point toward a phosphorous stressor. The percentage of taxa belonging to Crustacea/Mollusca was average in all three samples. The relative abundance (%) of macro-invertebrate individuals in subsample with tolerance values equal to or greater than six was in the upper 90% range. The relative abundance (%) of collector-gatherer individuals in subsample was low at site 09MN014 but not at 03MN013. The relative abundance (%) of chironomid individuals in subsamples was high at site 09MN014 (8/12/2009) but not at 03MN013.

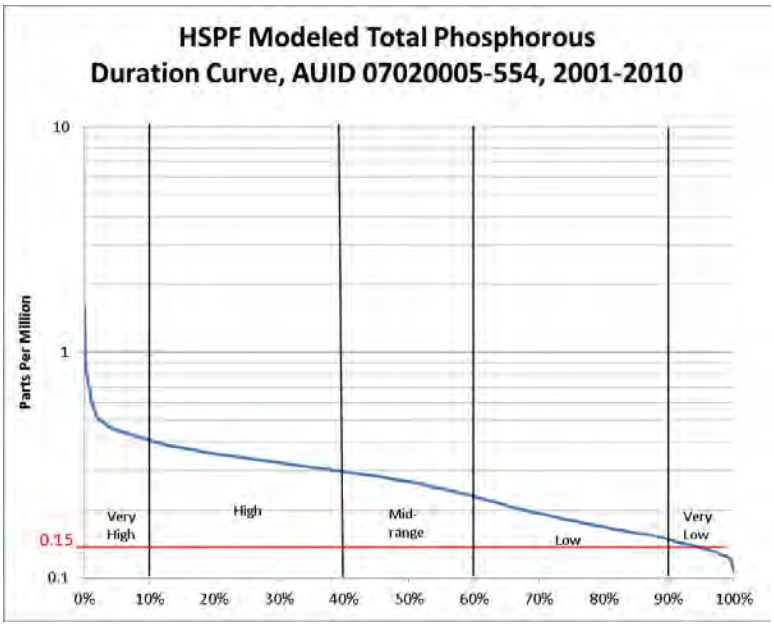


Figure 554-5 HSPF Phosphorous modeling projections, the red line indicates the draft standard 0.15ppm.

The riparian buffers along the main channel of AUID 07020005-554 are good. The banks are stable and the creek has good access to the flood plain. Upstream sources of phosphorous are likely derived from non-point sources, livestock in the riparian corridor, and possibly failing septic systems.

Phosphorous summary:

Phosphorous is possibly a stressor to invertebrate populations in this reach. The monitoring data is not very robust and the bio-data points toward an issue at site 09MN014 but not at 03MN013. Further monitoring would be useful to definitively rule it out as a stressor. The HSPF model suggests that phosphorous is a problem at this site.

Candidate cause: Nitrate

No nitrogen samples were taken between 2001 and 2011 in AUID 07020005-554.

Fish species nitrogen tolerances ranged widely at both of the Mud Creek biological survey sites in 2009. These data suggest nitrogen is not a stressor.

HSPF modeling projects levels above the 75 percentile value of 0.28ppm for North Central Hardwood Forest ecoregion 100% of the time. The model suggests between 2001-2010 nitrogen levels exceeded the 10ppm standard less than 1% of the time. These levels are below what is considered a stressor to aquatic populations. (Figure 554-6)

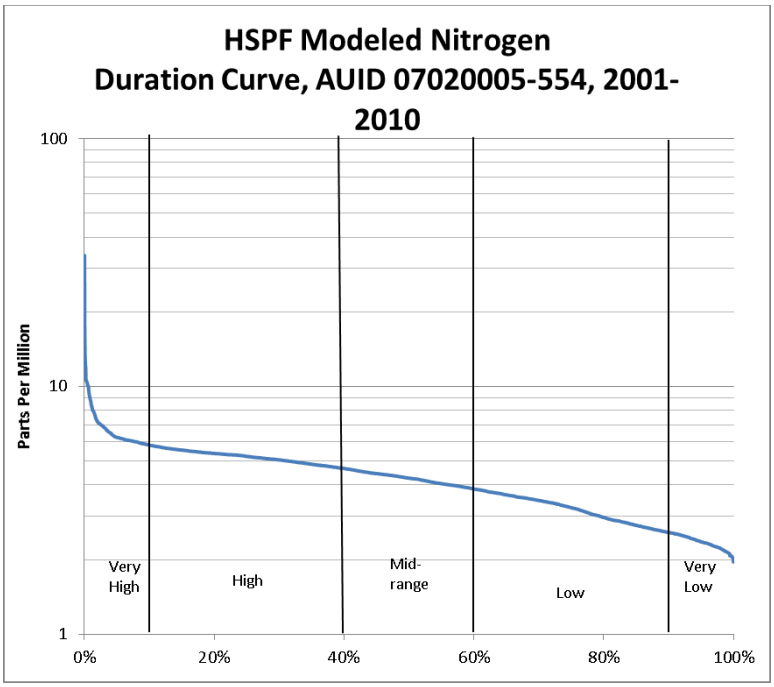


Figure 554-6 HSPF Nitrogen modeling projections.

Nitrogen summary:

Further monitoring data is needed before nitrogen can be ruled out definitively as a stressor. Model nitrogen levels are higher than ecoregion norms but below what is known to cause damage to invertebrate communities. Fish data suggest there is not a nitrogen stressor.

Candidate cause: Turbidity

Transparency (a surrogate for turbidity) exceeded the standard 7% of the 326 times it was sampled between 2006 and 2012.

HSPF modeling of TSS projects levels in exceedance of the 54ppm surrogate standard 20% of the time (Figure 554-7).

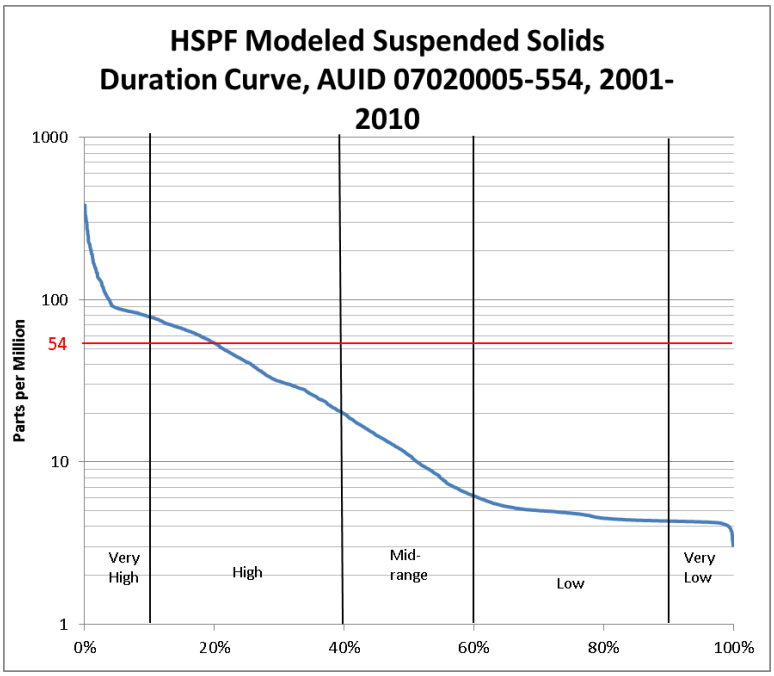


Figure 554-7 HSPF TSS modeling projections.

Analysis of fish tolerance to turbidity shows that a low number (9-18%, in 2009) of the fish individuals are the most tolerant (fourth quartile) to TSS.

The riparian buffers along the main channel of AUID 07020005-554 are good. The banks are stable and the geomorphologic condition of the stream is fairly stable. This suggests that flow conditions are stable as well. Increased bank erosion is probably not responsible for some of the turbidity exceedances.

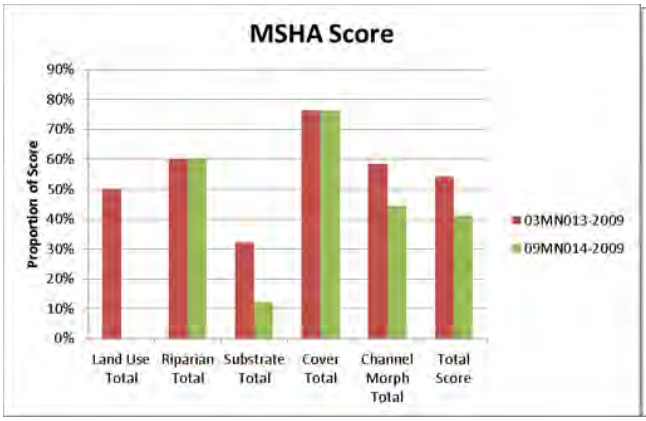
Turbidity summary:

Extensive water quality monitoring of this reach, fish surveys and site surveys suggest that turbidity is not a stressor in AUID 07020005-554.

Candidate cause: Habitat

MSHA habitat conditions were surveyed in 2009 and site 09MN014 received score of “Poor” and 03MN013 a score of “Fair”. In 2012 the sites were visited again and SVAP surveys were completed. The SVAP gave both sites a score of "Good".

The MSHA noted poor substrate condition at both sites and problems with the channel morphology. The SVAP survey noted that there were potential barriers to fish movement and poor fish cover in 03MN013 (Figure 554-8).



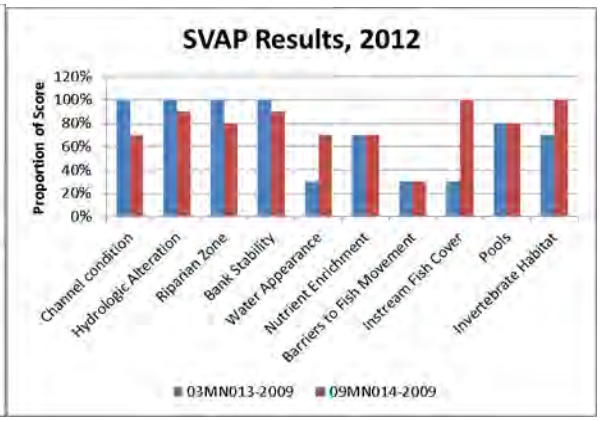


Figure 554-8 MSHA scores and SVAP rankings by category

Figure 554-9 Station 03MN013.

Figure 554-10 Station 09MN014.

Invertebrate metrics do not point to a problem with lack of invertebrate habitat. The abundance of Climbers, Clingers and Spawlers was high to average. The total taxa richness of macroinvertebrates was high to average. While the number of Plecoptera taxa was zero, the previously mentioned metrics all point in the other directions.

Habitat summary:

Mud Creek at site 09MN014 and 03MN013 have good structural components for invertebrate habitat. Channel condition is good and hydrologic alteration appears to be minimal so the stream channel and habitat should be fairly stable. Lack of habitat does not appear to be a stressor.

Candidate cause: Altered hydrology

This reach has 114 square miles of drainage delivered to it from the upstream watershed. Most of this watershed's area is occupied by perennial land uses. Almost 17% of the watershed is made up of open water and wetlands both of which support healthy stream hydrology. The stream at both sites were classified as a E type channels (Rosgen) with a well-developed easy to access flood plain.

Flow alteration summary:

The field evidence is good, flow alteration is not a stressor in AUID 07020005-554.

Candidate cause: Lack of connectivity

There are barriers to fish passage in AUID 07020005-554. Both sites had the presence of beaver dams. Site 09MN014 also had a bridge with a steep rock weir that could be serving as a barrier to fish movement. These barriers limit fish movement and isolate fish populations within AUID 07020005-554 but should have minimal impact on the invertebrate community.

Weight of evidence

The evidence for each potential stressor, the quantity and quality of each type of evidence is evaluated. The consistency and credibility of the evidence is evaluated. Each step for AUID 07020005-554 was scored and summarized in Figure 554-11. For more information on scoring please see EPA's CADDIS Summary Table of Scores.

Types of Evidence	Scores	
	Low Dissolved Oxygen	Lack of Connectivity
Spatial/temporal co-occurrence	++	++
Temporal sequence	+	++
Field evidence of stressor-response	++	++
Causal pathway	++	+ +
Evidence of exposure, biological mechanism	+	+
Field experiments /manipulation of exposure	NA	NE
Laboratory analysis of site media	NA	NE
Verified or tested predictions	NE	NE
Symptoms	+	+
Mechanistically plausible cause	+	+
Stressor-response in other lab studies	+	+
Stressor-response in other field studies	+	+
Stressor-response in ecological models	NE	NE
Manipulation experiments at other sites	NE	NE
Analogous stressors	NA	NE
Consistency of evidence	+	++
Explanatory power of evidence	++	++

Figure 554-11 Weight of evidence table for potential stressors in AUID 07020005-554 Mud Creek

Conclusions

AUID: 07020005-554 was assessed in 2012 and determined to be impaired for invertebrate communities. The impaired reach is Mud Creek in Camp Lake and Kerkhoven Townships of Swift County

in the Chippewa River watershed. There are four chemical monitoring sites on this reach. There are two biological monitoring sites located within the reach that were monitored once in 2003 and 2009.

The weight of evidence suggests that DO is a stressor in AUID 07020005-554. The presence of low DO samples (11%) and the agreement of macroinvertebrate and fish data override the contrary statement from the HSPF model.

Phosphorous is probably not a stressor to invertebrate populations in this reach. The monitoring data is not very robust and the bio-data could be interpreted differently. Further monitoring would be useful to definitively rule it out as a stressor. The HSPF model suggests that phosphorous is a problem at this site.

Further monitoring data is needed before nitrogen can be ruled out definitively as a stressor. Model nitrogen levels are higher than ecoregion norms but below what are known to cause damage to invertebrate communities. Fish data suggest there is not a nitrogen stressor.

Extensive water quality monitoring of this reach, fish surveys and site surveys suggest that turbidity is not a stressor in AUID 07020005-554.

Mud Creek at site 09MN014 and 03MN013 have good structural components for good invertebrate habitat. Channel condition is good and hydrologic alteration appears to be minimal so the stream channel and habitat should be fairly stable. Lack of habitat does not appear to be a stressor.

The field evidence is good, flow alteration is not a stressor in AUID 07020005-554.

There are barriers to fish passage in AUID 07020005-554. Both sites had the presence of beaver dams. Site 09MN014 also had a bridge with a steep rock weir that could be serving as a barrier to fish movement. These barriers limit fish movement and isolate fish populations within AUID 07020005-554 but should have minimal impact on the invertebrate community.

13. AUID: 07020005-559, Shakopee Creek Shakopee Lake to Chippewa River, Swift and Chippewa Counties

AUID: 07020005-559 was assessed in 2012 and determined to be impaired for fish communities. The impaired reach is in Swift and Chippewa Counties in the Shakopee Creek watershed a tributary of the Chippewa River. There are eleven chemical monitoring sites on this reach. There are also two biological monitoring sites located within the reach that were monitored in 2009. Fish species documented in this region indicate potential issues with turbidity, phosphorous, nitrogen and low dissolved oxygen. Figure 559-1 is a map of the named reach and monitoring sites.

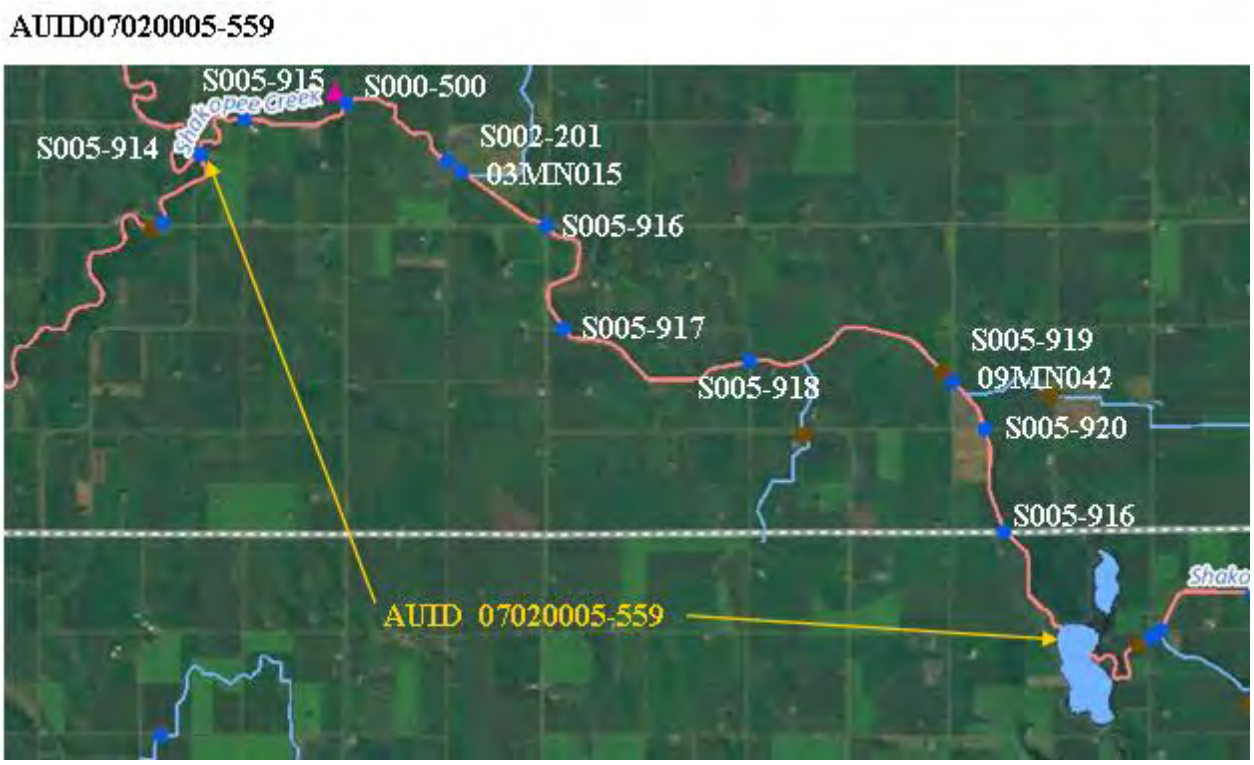


Figure 559-1 AUID: 07020005-559 monitoring sites.

The contributing watershed is 305 square miles in area. This watershed's area is comprised of 76% row crop agriculture, 7% range, 4% forest, 4.8% open water, 3% wetlands, and 4.6% urban.

Biology:

Fish were sampled twice in 2003 at site 03MN015 and then one time again in 2009 at sites 09MN042. Site 03MN015 scored a FIBI of 3 in 2009 and site 09MN042 scored a FIBI of 26. At 03MN015 nothing scored well. At 09MN042 the site scored well for abundance of generalist species, insectivore species, short lived taxa and sensitive taxa (Figure 559-2).

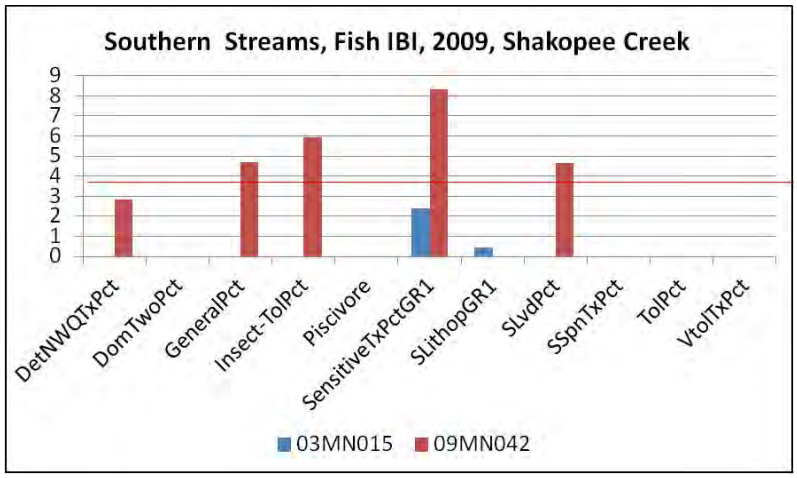


Figure 559-2 Invertebrate metric scores belonging to site 03MN015 and 09MN042. The red line indicates the average metric score needed (3.8) for the score to meet the MIBI threshold.

A survey of fish species tolerance levels to pollution levels impacting biology in this reach shows that the conditions are fairly poor. Fish tolerance to NO2-3, TP, TSS and DO revealed a high number of pollution tolerant individuals (Meador and Carlisle, 2006). These results suggest that low DO, turbidity, high phosphorous and high nitrogen are all stressors.

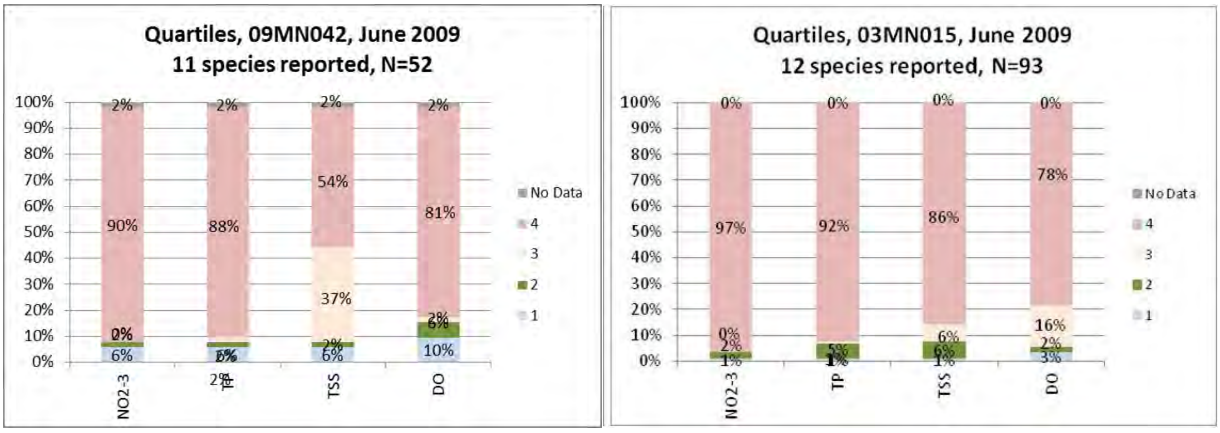


Figure 559-3 Fish quartile values for NO2-3, TP, TSS and DO.

Candidate cause: Dissolved oxygen

Dissolved oxygen monitoring conducted in AUID 07020005-559 indicates that low DO is not a likely stressor within the reach. Fourteen of the 492 (3%) DO readings taken from 2003 through 2010 did not meet the 5mg/L standard though few of these samples were collected before 9:00 AM. Fifty-five of the samples were below 6 mg/L. The sample data do not support listing low DO as a primary stressor. Furthermore, the presence of several species of low DO intolerant fish lends support to disregarding this stressor.

HSPF modeling suggests that there is not a DO issue at this site. Figure 559-4 shows the modeled 10 year duration curve of daily minimum DO values. The model suggests that incidences below 5mg/L are rare.

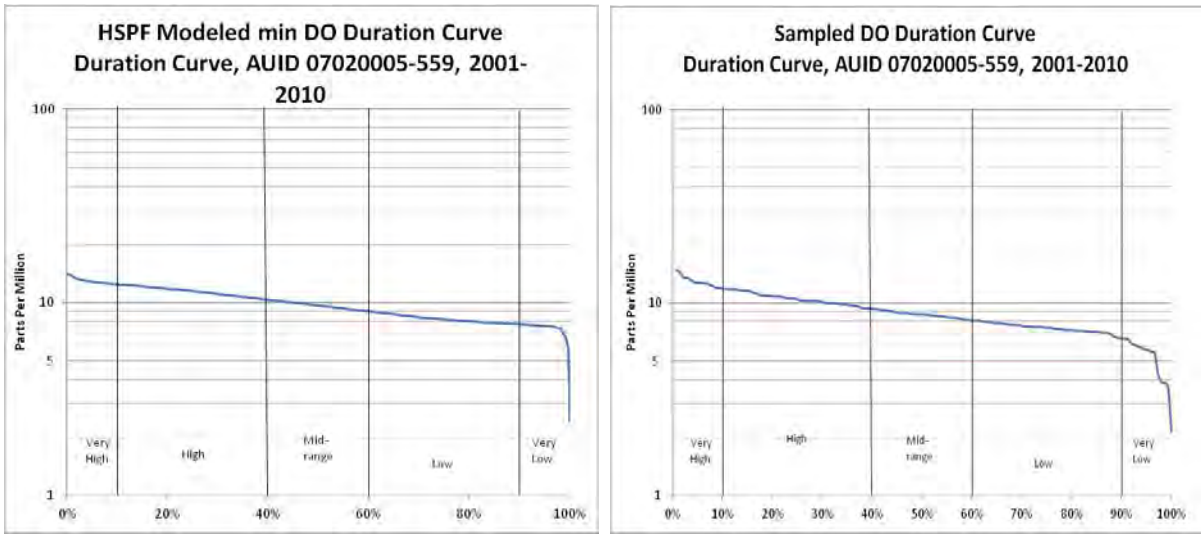


Figure 559-4 HSPF DO modeling projections compared to the sampled data duration curve

Invertebrate numbers suggest low DO is an unlikely stressor at site 03MN015 where only 10-19% of the taxa were low DO tolerant. At site 09MN042, a side branch to the main AUID, invertebrates sampled twice in 2009 found 29% and 51% of the taxa were low DO tolerant.

Fish metrics from this AUID suggest an issue with low DO is present. All sites and visits had a high relative abundance (%) of individuals that are serial spawning species. The relative abundance of individuals with a female mature age greater than or equal to three was low at both sites in 2009. Low DO intolerant taxa were found but the majority of the species found were Low DO tolerant.

Dissolved oxygen summary:

Dissolved oxygen may be a stressor in AUID 07020005-559. Fish metrics and a lack of conclusive before 9:00 AM DO samples support the listing of low DO as a stressor. The absence of low DO samples, the agreement of the HSPF model and the presence of some low DO intolerant fish species are all factors that refute this conclusion.

Candidate cause: Phosphorus

There were 296 phosphorus samples taken in AUID 07020005-559, 78 % of them were over the 0.15ppm draft standard.

Looking at the fish data (Figure559-3) 82%-92% of the sample was made up of the phosphorous tolerant individuals (fourth quartile). These data suggest that while phosphorous may be the driving force of other stressors (turbidity) it in itself is not the most pressing stressor to aquatic populations.

Evidence of high phosphorous is apparent in the biological indicators observed in the site data. The high number of tolerant fish and the lack of sensitive species are both indicative of high phosphorous levels.

The HSPF model suggests that phosphorous concentrations above 0.15ppm occurred 90% of the time from 2001-2010 (Figure 559-5).

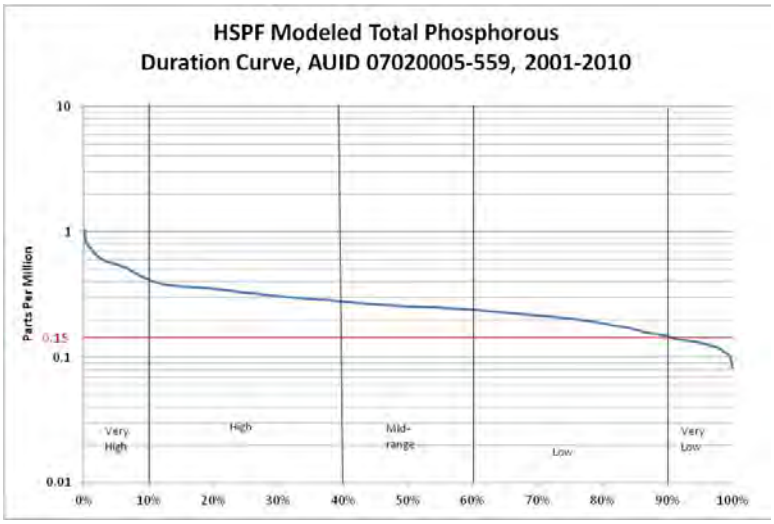


Figure 559-5 HSPF Phosphorous modeling projections

The riparian buffers along the main channel of AUID 07020005-559 are often missing. The banks, according to CRWP surveys, are eroding at a high rate. The main channel is widening at a rate of 0.5 feet a year. Flow conditions have been altered and bank erosion is on the rise which could be a possible source of in stream phosphorous.

Upstream sources of phosphorous are likely derived from non-point sources and Shakopee Lake. The lake has been observed to be hyper-eutrophic. Shakopee Lake has been noted to release more phosphorous than it takes in. High phosphorous measurements have been documented upstream of the reach as well. Total phosphorous readings from waters contributing to this reach regularly exceed the draft standard.

The following invertebrate matrices support the hypothesis that phosphorous is a stressor in this reach: Intolerant 2Pct = 0%, the relative abundance (%) of macroinvertebrate individuals in subsample with tolerance values less than or equal to two was too low, %EPT = 0.63%, the taxa richness of ephemeroptera, plecoptera and trichoptera was too low, %Mollusca= 56%, the relative abundance (%) of Mollusca individuals in subsample was too high, %Crustacea = 23%, the relative abundance (%) of crustacean individuals in subsample was high, % Scrapers= 52%, the % of scraper individuals in subsample was high. These results are all documented known responses to excess phosphorous on invertebrate communities.

Phosphorous summary:

There is significant data that shows that Shakopee Creek (AUID 07020005-559) has levels of phosphorus in excess of what is acceptable for aquatic populations. Data indicate that upstream sources on Shakopee Creek are contributing phosphorous to this reach.

Candidate cause: Nitrogen

NO2-3 samples were sampled 292 times from 2001-2010 in AUID 07020005-559. Samples exceeded the 75 percentile value of 6.9ppm for Western Corn Belt Plains ecoregion 30% of the time. The model suggests between 2001-2010 nitrogen levels exceeded the 10ppm standard less than 13.5% of the time. These chronic levels are a stress to aquatic species. (Figure 559-6)

Fish populations show a clear relationship to the high levels of NO2-3. The most tolerant species (fourth quartile) make up 37-85% of the fish sampled in 2009.

Upstream sources of nitrogen are likely derived from the non-point sources of the agriculturally dominant land use. High nitrogen measurements have been documented by the CRWP especially from areas with higher levels of row crop land use. Waters contributing to this reach regularly exceed the draft standard.

HSPF modeling projects levels above the 75 percentile value of 6.9ppm for Western Corn Belt Plains ecoregion 2.8% of the time. The model suggests between 2001-2010 nitrogen levels exceeded the 10ppm standard less than 1% of the time. These levels are below what is considered a stress to aquatic populations. (Figure 559-6)

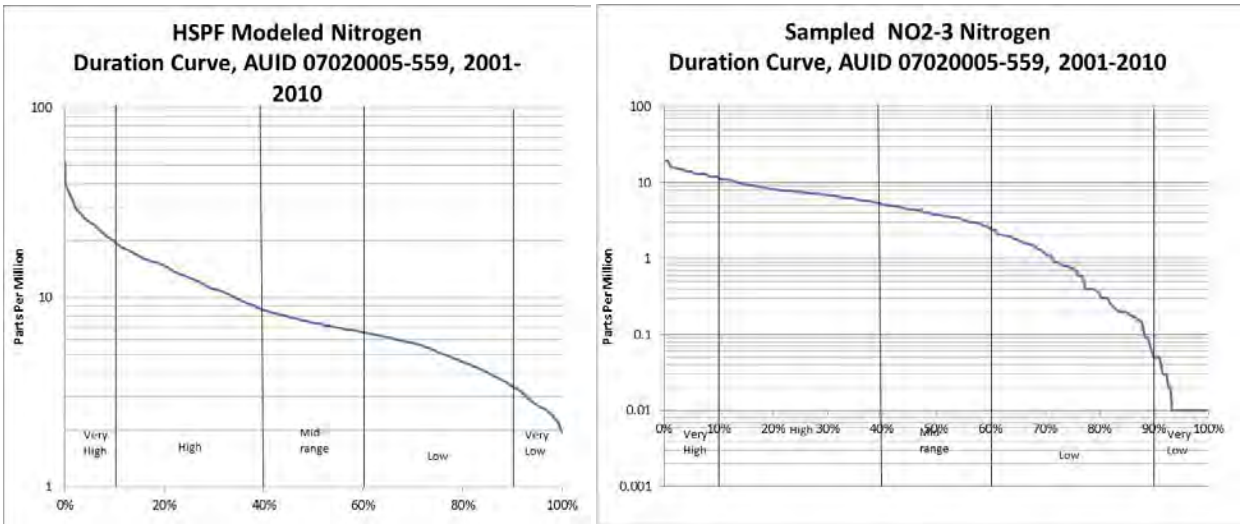


Figure 559-6 HSPF nitrogen modeling projections and sampled levels

Nitrogen summary:

Sample data, fish surveys and modeling all indicate that the level of nitrogen in this reach is at a high enough level to impact fish communities. Nitrogen is a stressor to fish communities in Shakopee Creek.

Candidate cause: Turbidity

Turbidity was measured 198 times from 2003 to 2010 in the reach. Turbidity exceeded the standard in 73% of the samples. Transparency was sampled at four sites 709 times between 2006 and 2010. Transparency exceeded the standard in 80% of the samples. TSS was sampled 286 times and exceeded the standard in 60.8% of the samples.

Fish metrics support the conclusion that turbidity is one of the stressors in this AUID. Tolerant fish species from the fourth quartile dominated fish species collected at both of these biological monitoring sites. Both the relative abundance (%) of individuals that are simple lithophilic spawners and riffle-dwelling species were low. The taxa richness of herbivore species was very low.

HSPF modeling of TSS projects levels in exceedance of the 54ppm surrogate standard 78% of the time (Figure 559-7).

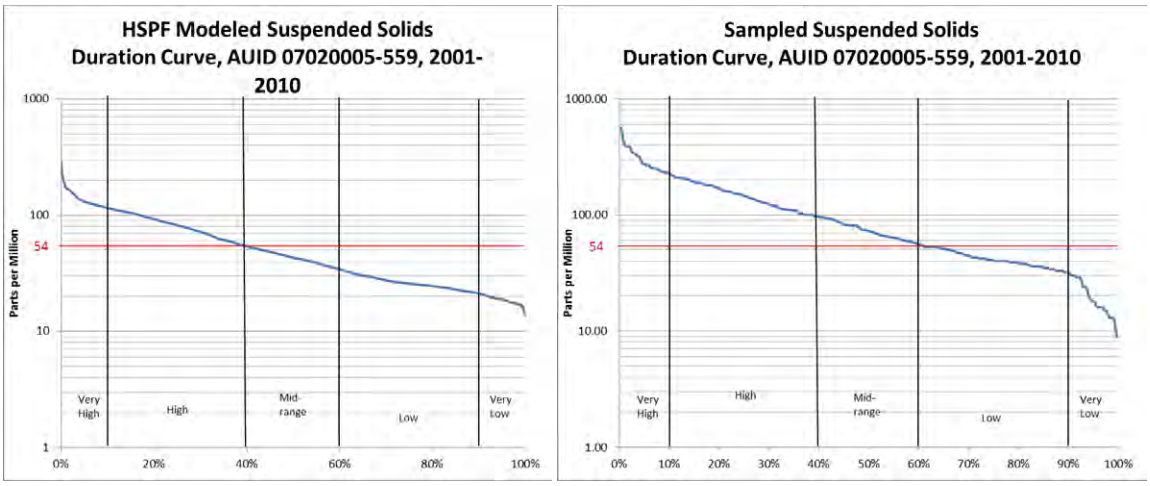


Figure 559-7 HSPF TSS modeling projections and sampled levels.

Turbidity is coming from upstream sources and within the reach. Shakopee Lake upstream of the reach is a turbid settling pond full of carp and prone to algae blooms. The dam at its outlet is responsible for intense and extensive channel widening and bank erosion throughout the impaired reach. The surrounding waterways have a low rate of adopting buffers and contribute sizable amounts of turbidity as well. Beyond the impact of the dam, flow conditions have been altered and bank erosion is on the rise. Channelized flow to the reach from tributary sources dominates the flow pattern of this reach. Channelization is changing in-stream erosion rates and has led to an increase in turbidity.

Turbidity summary:

Sample data, pathways and modeling all indicate that the level of turbidity in this reach is at a high enough level to impact fish communities. The fish surveys and subsequent metrics support this conclusion. Turbidity is a stressor to fish communities in Shakopee Creek.

Candidate cause: Habitat

At sites 03MN015 and 09MN042 MSHA habitat conditions were sampled in 2009. Both sites received a score of "Poor". The score were so bad that there is no doubt that poor habitat is a stressor. In 2012 these sites were visited again and a SVAP survey was completed at each site. The SVAP surveys gave both sites a score of “Poor”. SVAP found very few structural elements of habitat for fish or invertebrates to use. Rocks placed to protect culverts and roads were the sole structural elements in much of this muck bottomed drainage ditch. (Figure 559-8)

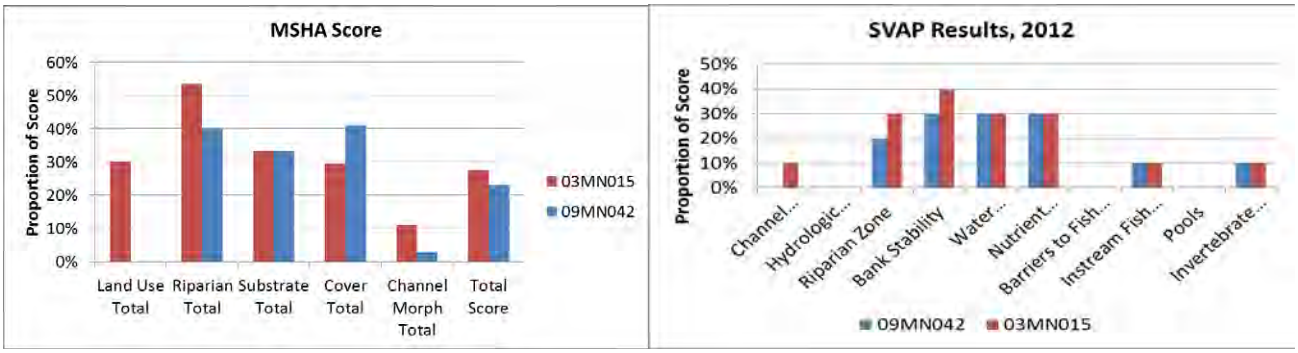


Figure 559-8 MSHA and SVAP scores by category for 03MN015 and 09MN042

The SVAP surveys conducted in 9-2012 noted a number of negative factors for aquatic habitat. In general, Shakopee Creek is a ditch. It suffers from poor channel conditions and massive hydrologic

alteration. The banks are unstable, the water is turbid and there are multiple signs of nutrient enrichment. Neither site have the elements for good habitat.

Bio-data support the conclusion that lack of habitat is a stressor to fish populations. Both the taxa richness of riffle-dwelling species and the relative abundance (%) of individuals that are riffle-dwelling species were low. The only reason this group even scored in the metrics was due to the fact that very few actual fish were found in the surveys. The taxa richness of and number of individuals that are darter, sculpin, and round bodied sucker species were both low as well.

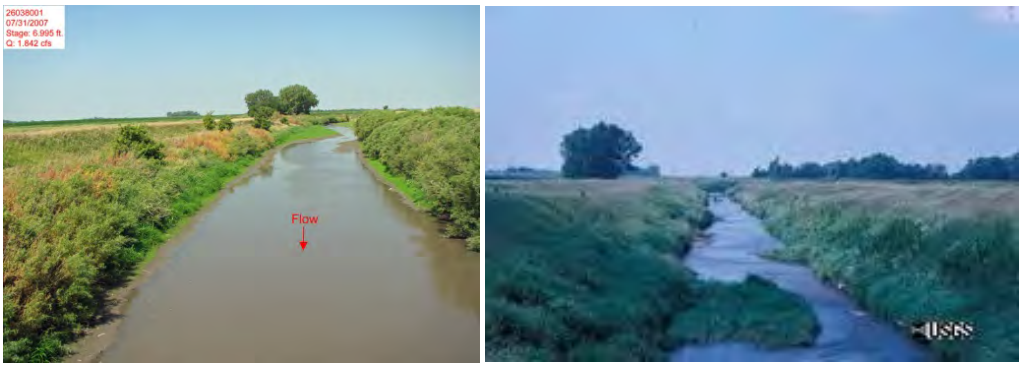


Figure 559-9 Shakopee Creek at S002-201

Habitat summary:

Shakopee Creek at sites 03MN015 and 09MN042 does not have the elements for good habitat. Shakopee Creek at AUID 07020005-559 is a shifting muck bottomed ditch. Turbid, nutrient rich waters further exasperated by hydrologic alteration and bank instability create conditions unfavorable for aquatic life and recreation. Poor habitat is indisputably a stressor to fish populations in AUID 07020005-559.

Candidate cause: Altered hydrology

This reach has 304 square miles of drainage delivered to it from upstream watershed. Seventy-six point three percent of this watershed is occupied by row crop agriculture. Much of Shakopee is a part of an old glacial lake bed and consequently does not move water quickly without artificial drainage. Shakopee Creek watershed is efficiently served by a system of ditches and underground tile drainage. This drainage has effectively altered the hydrological drainage pattern of Shakopee Creek. In addition, the dam at Shakopee Lake is directly responsible for an impressive amount of downstream bank erosion due to its hydrological impact on bed flow and downstream stream widening. These two factors make AUID 07020005-559 the most hydrologically altered reach in the Chippewa River watershed.

Hydrologic alteration is destabilizing and degrading habitat for fish species in this reach. High levels of bank, bed and stream instability make it difficult for populations to survive. Even tolerant species are having a hard go at it.

Altered hydrology summary:

There is good evidence to support listing altered hydrology as a stressor in this reach, Shakopee Creek is a ditch with a big dam. Flow monitoring clearly notes a change in flow patterns over the last several decades. Field surveys have documented that hydrologic alteration is destabilizing and degrading habitat for fish species in this reach. High levels of bank, bed and stream instability make it difficult for populations to survive.

Candidate cause: Lack of connectivity

Lack of connectivity is negatively impacting fish populations. The large dam at the outlet of Shakopee Lake is an effective barrier to all fish movement upstream.

Weight of evidence

The evidence for each potential stressor, the quantity and quality of each type of evidence is evaluated. The consistency and credibility of the evidence is evaluated. Each step for AUID 07020005-559 was scored and summarized in Figure 559-10. For more information on scoring please see EPA's CADDIS Summary Table of Scores.

Types of Evidence	Scores					
	High Phosphorus	High Nitrates	High Turbidity	Lack of Habitat	Altered Hydrology	Lack of Connectivity
Spatial/temporal co-occurrence	++	++	++	++	++	++
Temporal sequence	+	++	++	+	+	+
Field evidence of stressor-response	++	++	++	++	++	++
Causal pathway	++	++	++	++	++	++
Evidence of exposure, biological mechanism	++	++	++	++	++	++
Field experiments /manipulation of exposure	NA	NA	NE	NE	NE	NA
Laboratory analysis of site media	NA	NA	NE	NE	NE	NA
Verified or tested predictions	NE	NE	NE	NE	NE	NE
Symptoms	+		+	+	+	
Mechanistically plausible cause	+		+	+	+	
Stressor-response in other lab studies	+	NE	NE	NE	NE	NE
Stressor-response in other field studies	+	+	+	+	+	+
Stressor-response in ecological models	NE	NE	NE	NE	NE	NE
Manipulation experiments at other sites	NE	NE	NE	NE	NE	NE
Analogous stressors	NA	NE	NA	NE	NE	NE
Consistency of evidence	+	+	++	++	++	+
Explanatory power of evidence	+	+	++	++	++	++

Figure 559-10 Weight of evidence table for potential stressors in AUID 07020005-559 Shakopee Creek. Evidence using data from Chippewa River watershed.

Conclusions

In AUID: 07020005-559 fish were sampled twice in 2003 at site 03MN015 and one time in 2009 at site 09MN042. Site 03MN015 scored a FIBI of 3 in 2009 and site 09MN042 scored a FIBI of 26. At 03MN015 nothing was good. At 09MN042 the site scored well for abundance of generalist species, insectivore species, short lived taxa and sensitive taxa.

Dissolved oxygen is probably not a stressor in AUID 07020005-559. The absence of low DO samples, the agreement of the HSPF model and the presence of some low DO intolerant fish species are all factors that support this conclusion.

There is overwhelming data that shows that Shakopee Creek (AUID 07020005-559) has levels of phosphorus in excess of what is acceptable for aquatic populations. Data indicate that upstream sources on Shakopee Creek are contributing phosphorous to this reach.

Sample data, fish surveys and modeling all indicate that the level of nitrogen in this reach is at a high enough level to impact fish communities. Nitrogen is a stressor to fish communities in Shakopee Creek.

Sample data, fish surveys, pathways and modeling all indicate that the level of turbidity in this reach is at a high enough level to impact fish communities. Turbidity is a stressor to fish communities in Shakopee Creek.

Shakopee Creek at sites 03MN015 and 09MN042 do not have the elements for good habitat. Shakopee Creek at AUID 07020005-559 is a shifting muck bottomed ditch. Turbid, nutrient rich waters further exasperated by hydrologic alteration and bank instability create conditions unfavorable for aquatic life and recreation. Poor habitat is indisputably a stressor to fish populations in AUID 07020005-559.

There is good evidence to support listing altered hydrology as a stressor in this reach, Shakopee Creek is a ditch with a big dam. Flow monitoring clearly notes a change in flow patterns over the last several decades. Field surveys have documented that hydrologic alteration is destabilizing and degrading habitat for fish species in this reach. High levels of bank, bed and stream instability make it difficult for populations to survive.

Lack of connectivity is negatively impacting fish populations. The large dam at the outlet of Shakopee Lake is an effective barrier to all fish movement upstream.

14. AUID: 07020005-584, Unnamed Creek (Lines Creek), Unnamed Creek to Chippewa River, Chippewa County

AUID: 07020005-584 was assessed in 2012 and determined to be impaired for aquatic invertebrate communities. The impaired reach is a tributary of the Chippewa River that enters the Chippewa just North of Watson in Chippewa County. There are two chemical monitoring sites on this reach. There are two biological monitoring sites located within the reach (03MN056 and 09MN002). Fish species documented in this region indicate potential issues with turbidity and low DO. Figure 584-1 is a map of the named drainage and monitoring sites.

AUID07020005-584

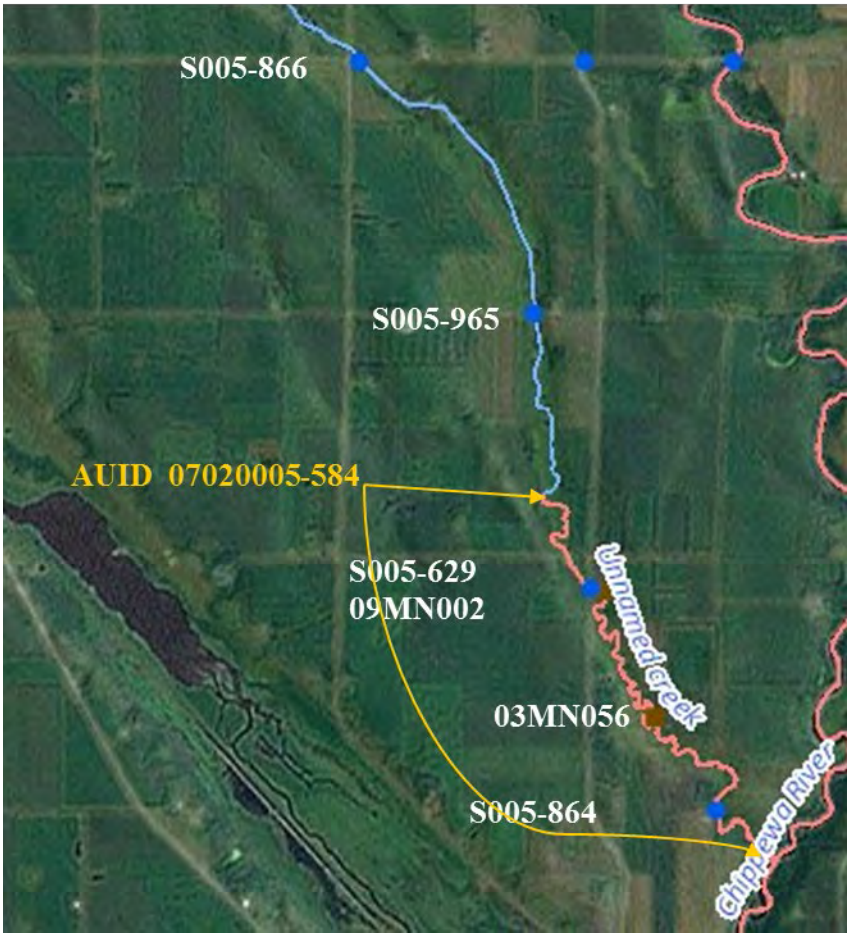


Figure 584-1 AUID: 07020005-584 monitoring sites.

The contributing watershed is 30 square miles in area. This watershed's area is occupied by 77.7% row crop agriculture, 4.4% is range, 0.4% is forest, 0.3% is open water, 12.7% wetlands, and 4.3% urban.

Biology:

Invertebrates were sampled at site 09MN002 in 2009. This site did not score that well for most of the metrics (Figure 584-2).

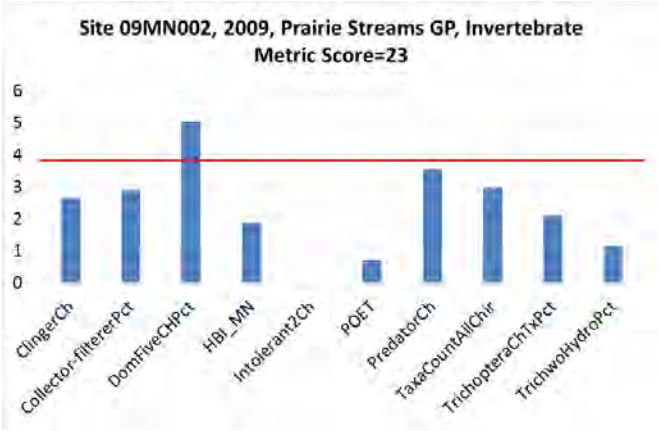


Figure 584-2 Invertebrate metric scores belonging to site 09MN002. The red line indicates the average metric score needed for the score to be at the threshold (3.8).

A survey of fish species tolerance levels sheds some light on the pollution levels impacting invertebrates in this reach. It turns out that the "no data" species are brook sticklebacks and central mud minnows, both known to be tolerant of low DO in Minnesota. Fish tolerance to NO2-3, TP, TSS and DO revealed some pollution tolerant individuals (Meador and Carlisle, 2006). These results suggest that low DO is a possible stressor.

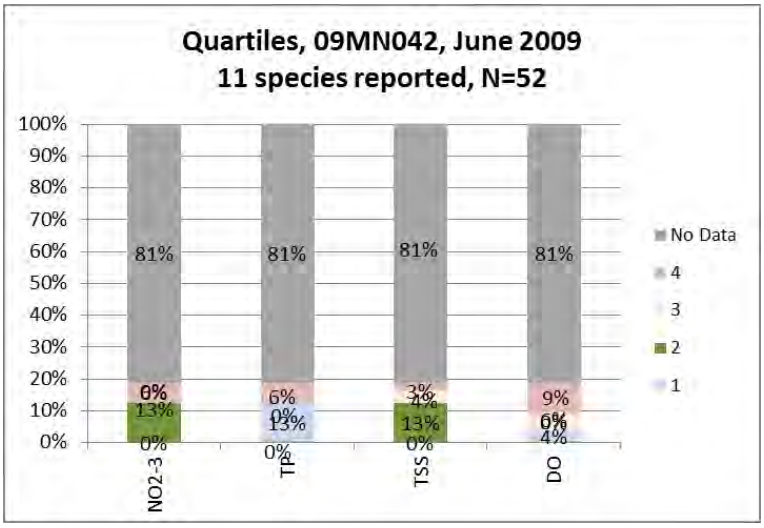


Figure 584-3 Fish quartile values for NO2-3, TP, TSS and DO, unknown species are brook sticklebacks and central mud minnows

Candidate cause: Dissolved oxygen

Dissolved oxygen monitoring conducted in AUID 07020005-584 indicates that low DO is a likely stressor within the reach. Seventy-two of the 122 (59%) DO readings taken from 2006 through 2011 did not meet the 5mg/L standard though it is uncertain how many of these samples were collected before 9:00 AM. The sample data support listing low DO as a primary stressor.

The low score for HBI_MN and the lack of very intolerant species suggests that low DO is a likely stressor for the invertebrate community. In addition, there were not any plecoptera taxa, and the relative abundance (%) of non-hydropsychid trichoptera individuals in subsamples was low.

Fish metrics indicate that low DO is a concern in this AUID. The relative abundance (%) of individuals that are serial spawning species was low. Also low was the relative abundance of individuals with a female mature age greater than or equal to three years. The count of taxa was below average.

HSPF modeling suggests that there is not a DO issue at this site. Figure 584-4 shows the modeled 10 year duration curve of daily minimum DO values. The model suggests that incidences below 5mg/L did not occur.

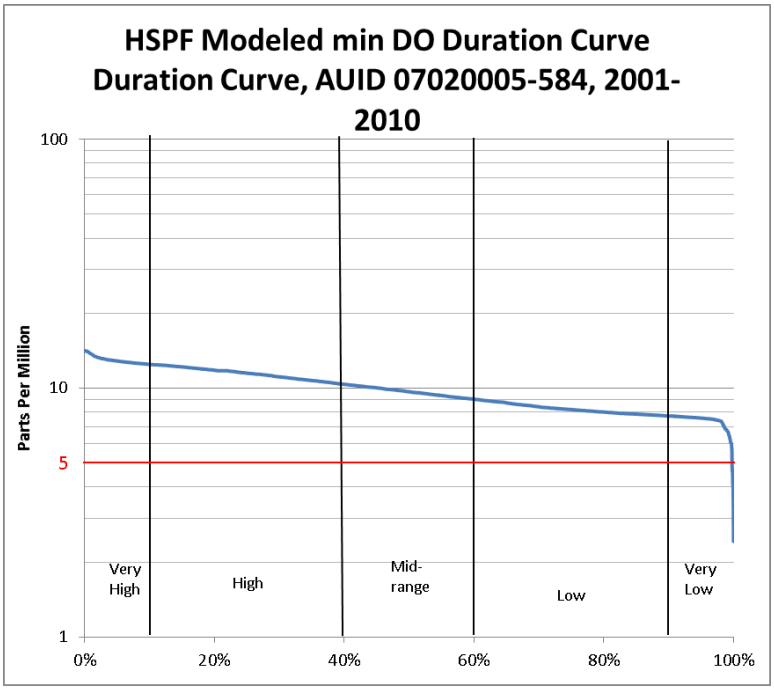


Figure 584-4 HSPF DO modeling projections.

Upstream of site 09MN002 the main channel of Lines Creek disappears through many miles of cattail wetlands. In these locations the stream flow slows dramatically and DO levels have been observed to drop dramatically. This essentially natural condition is the probable cause for the low DO expressed downstream.

Dissolved oxygen summary:

Dissolved oxygen is a stressor in AUID 07020005-584. The excessive number of low DO samples, the agreement of the fish data and macro-invertebrate metrics all point toward this conclusion.

Candidate cause: Phosphorus

Phosphorus samples were taken in AUID 07020005-584 at site S005-629 13 times in 2009. The samples exceeded the 0.15ppm draft standard 61% of the time.

The fish data (Figure 584-3) are not the most conclusive but considering the dominance of brook sticklebacks and central mud minnows, these data suggest that phosphorous may be a stressor to aquatic populations.

Evidence of high phosphorous is present when looking at invertebrate metrics. The indicators that support listing phosphorous as a stressor include: the high number of tolerant invertebrate taxa, a low EPT taxa (2) and a high number of scraper taxa (15%). All present at 09MN002.

The HSPF model suggests that phosphorous concentrations above 0.15ppm occurred 51% of the time from 2001-2010 (Figure 584-5).

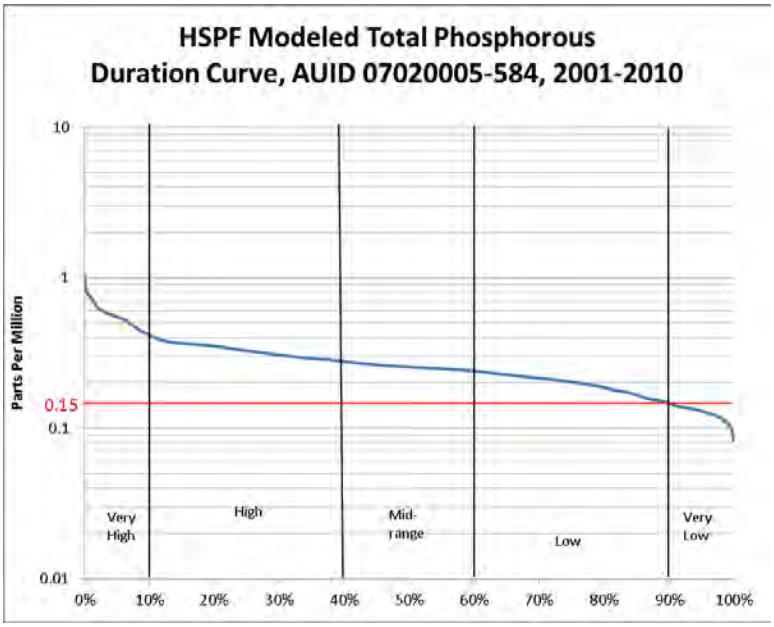


Figure 584-5 HSPF Phosphorous modeling projections.

Phosphorous summary:

There is a case for listing phosphorus as a stressor in Lines Creek. Lines of evidence include monitoring data from 2009, fish data, invertebrate data and the HSPF model.

Candidate cause: Nitrate

A total of four NO2-3 samples were taken in 2011 in AUID 07020005-584 at site S002-203. None of the samples exceeded the 10ppm drinking water standard. S002-203 did not exceed the 4.9mg/L aquatic life draft chronic standard nor the 75 percentile value of 6.9ppm for Western Corn Belt Plains ecoregion.

Fish tolerance indicator data is inconclusive. The low HBI and the low number of trichoptera taxa lend some support to considering nitrogen a stressor.

HSPF modeling projects levels above the 75 percentile value of 6.9ppm 55% of the time for the Western Corn Belt Plains ecoregion. The model suggests that between 2001 and 2010, nitrogen levels exceeded the 10ppm standard less than 34% of the time. These levels are below what is considered a stress to aquatic populations. (Figure 584-6)

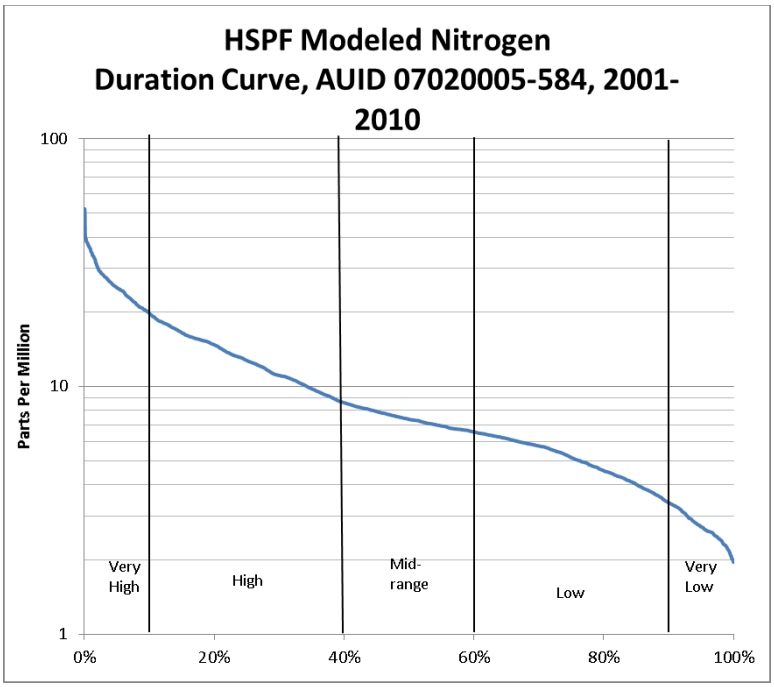


Figure 584-6 HSPF Nitrogen modeling projections and monitoring data derived flow weighted means.

Nitrogen summary:

Sampled nitrogen levels are below what is known to cause damage to invertebrate communities. HSPF modeled nitrogen levels are borderline as well. The biological data suggest there might be issues. More sampling is needed to definitively conclude the state of a nitrogen stressor in Lines Creek.

Candidate cause: Turbidity

Transparency (a surrogate for turbidity) exceeded the standard 3% of the 197 times it was sampled between 2006 and 2010. TSS was sampled 10 times at site S002-203 and did not exceed the standard.

HSPF modeling of TSS projects levels in exceedance of the 54ppm surrogate standard 40% of the time (Figure 584-7).

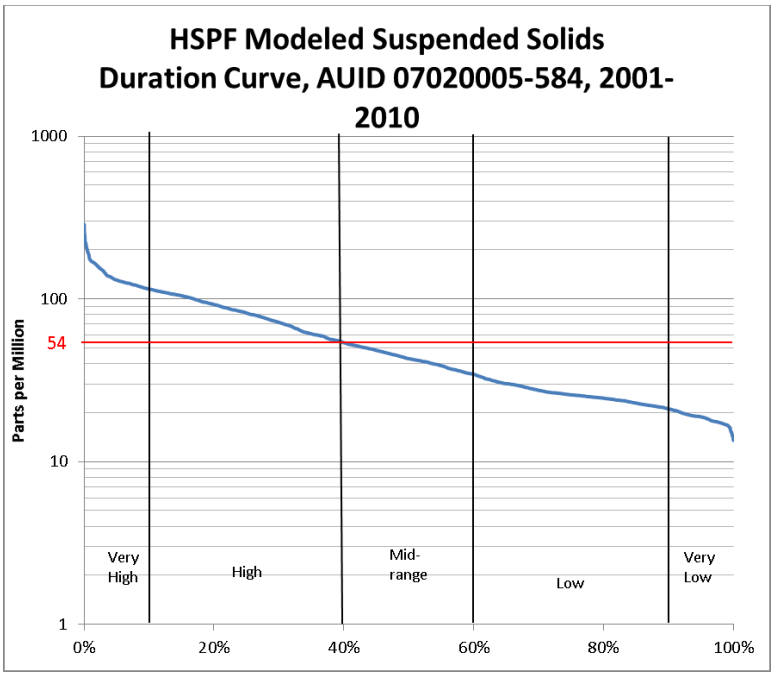


Figure 584-7 HSPF TSS modeling projections.

Fish metrics suggest that turbidity is not much of an issue in AUID 07020005-584. The relative abundance (%) of taxa that are simple lithophilic spawners at both 09MN002 and 03MN056 were slightly above average. The relative abundance (%) of taxa that are herbivores at site 09MN002 (2009) was high while at 03MN056 (2003) it was low.

The riparian buffers along the main channel of AUID 07020005-584 are very good. Upstream riparian buffers are not adequate especially on the tributary streams and ditches that feed into this AUID.

Upstream of site 09MN002, the main channel of Lines Creek disappears through many miles of cattail wetlands. In these locations the stream flow slows dramatically and sediments drop out of the water column. This essentially natural condition prevents much of upstream suspended solids from reaching the monitoring location downstream. It is also a condition that HSPF has a hard time modeling.

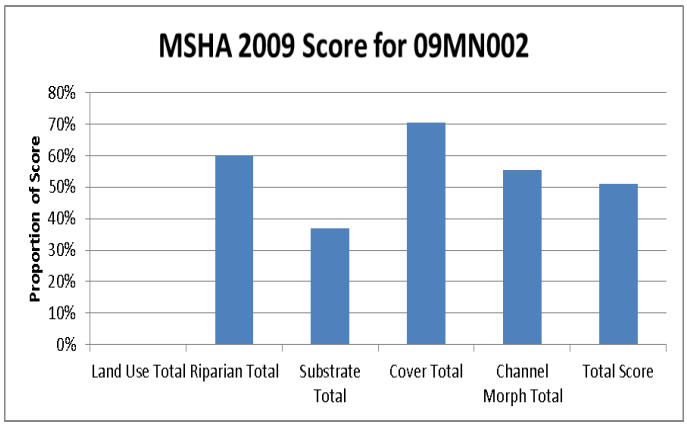
Turbidity summary:

Extensive water quality monitoring of this reach and contributing tributaries do not support listing turbidity as a stressor in AUID 07020005-584. HSPF modeling is inadequate in this case due to the complex conditions of the AUID. Turbidity is not a stressor at this location.

Candidate cause: Habitat

At sites 09MN002 MSHA habitat conditions were sampled in 2009. MSHA gave Site 09MN002 a MSHA habitat score of “Fair”. In 2012 the site was visited again and a SVAP survey was completed. The SVAP gave the site a score of "Fair".

The 2009 MSHA's gave the Surrounding Land Use category 0% of the possible points due to the dominance of row crop land use surrounding the land immediately adjacent to the reach. Substrate conditions also score poorly. Riparian, cover and channel morph all pulled the overall score up. (Figure 584-8)



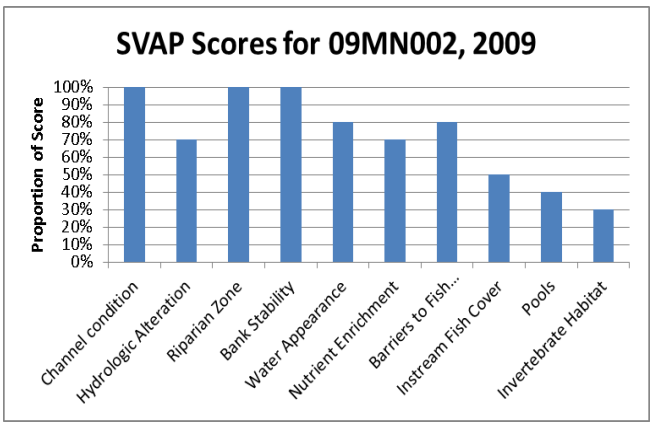


Figure 584-8 MSHA scores and SVAP rankings by category for 09MN002

In general, the creek is in good shape at 09MN002. The banks are stable. The water appearance was good and there were no obvious signs of nutrient enrichment. The survey team observed a fair number of habitat types for fish and invertebrates and the condition of pools at the site was fair.

Invertebrate metrics taken from both sites 03MN056 and 09MN002 reinforce the hypothesis that habitat is not a major stressor. The taxa richness of climbers and clingers were both at the average to good level. Also the relative abundance (%) of dominant two taxa in subsample (chironomids grouped at family level) metric scored slightly below and slightly above average for the two sites sampled suggesting fair to good habitat.

Habitat summary:

Habitat is not a stressor at site 09MN002 in AUID 07020005-584. Several site visits give this location a fair assessment.

Figure 584-9 Station 09MN002 9-2012 extreme low flow

Candidate cause: Altered hydrology

This reach has 30 square miles of drainage delivered to it from the upstream watershed. Upstream of AUID 07020005-584 in Swift County Lines Creek is a ditch. Seventy-eight percent of the Lines Creek watershed's area is occupied by row crop agriculture. This drainage has likely altered the hydrological drainage pattern of the Lines Creek.

To its benefit, the Lines Creek watershed has 12.7% wetlands and a large portion of these are along the main channel of the reach. These wetlands most likely buffer hydrologic alteration from the upstream

drained regions of the watershed and provide an easily accessible flood plain for flashy drainage from upstream agricultural areas.

Both MSHA and SVAP noted the good stream channel characteristics of AUID 07020005-584. High flows are probably not the hydrologic constraint. Rather it is the low flows that are the problem. Low flows caused by efficient drainage and changes to the hydrology structure of upstream areas are the issue. They cause low DO and a lack of water. No water is a stressor to invertebrates as they cannot swim away to other parts of the river.

The lack of sensitive invertebrate taxa, the presence of many tolerant ones and the low HBI_MN score lends support to considering altered hydrology a stressor.

Altered hydrology summary:

There is good evidence to support listing altered hydrology as a stressor in the reach. Low flows are the problem. Low flows caused by efficient drainage and changes to the hydrology structure of upstream areas are the issue. They cause low DO and a lack of water. No water is a stressor to invertebrates as they cannot swim away to other parts of the river. Surveys at 09MN002 found physical evidence indicative of flow alteration. Altered hydrology is a stressor.

Candidate cause: Lack of connectivity

There are barriers to fish passage in AUID 07020005-584. There are several beaver dams and the SVAP survey conducted in 9-2012 noted that low flow conditions restricted fish passage and probably resulted in low DO. SVAP surveys upstream concluded the same, upstream cattail regions and beaver dams blocked fish passage during low flow periods. These natural barriers limit fish movement and isolate fish populations within AUID 07020005-584 but are not in this reach. It is possible that low flows are the result of hydrologic alteration upstream.

Weight of evidence

The evidence for each potential stressor, the quantity and quality of each type of evidence is evaluated. The consistency and credibility of the evidence is evaluated. Each step for AUID 07020005-584 was scored and summarized in Figure 584-10. For more information on scoring please see EPA's CADDIS Summary Table of Scores.

Types of Evidence	Scores			
	Low DO	High Phosphorus	Altered Hydrology	Lack of Connectivity
Spatial/temporal co-occurrence	++	+	+	++
Temporal sequence	+	+	+	+
Field evidence of stressor-response	++	+	+	++
Causal pathway	++	+	+	++
Evidence of exposure, biological mechanism	++	+	+	++
Field experiments /manipulation of exposure	NA	NA	NA	NA
Laboratory analysis of site media	NA	NA	NA	NA
Verified or tested predictions	NE	NE	NE	NE
Symptoms	+	+	+	+
Mechanistically plausible cause	+	+	+	+
Stressor-response in other lab studies	+	+	+	+
Stressor-response in other field studies	+	+	+	+
Stressor-response in ecological models	NE	NE	NE	NE
Manipulation experiments at other sites	NE	NE	NE	NE
Analogous stressors	NA	NE	NE	NE
Consistency of evidence	+	+	+	++
Explanatory power of evidence	++	+	+	++

Figured 584-10 Weight of evidence table for potential stressors in AUID 07020005-584 Unnamed Creek (Lines Creek)

Conclusions

The Chippewa River at site 09MN002 has many of the structural components for good habitat. Three factors are limiting factors to the natural function of the river: low DO, high phosphorous and low flows. At this point habitat is not a limiting stressor.

In AUID: 07020005-584 a good assessment of possible stressors can be made because the reach has an incredibly robust dataset covering the last 11 years. This reach has a number of stressors impacting the biological monitoring site 09MN002.

Dissolved oxygen is a stressor in AUID 07020005-584. The excessive number of low DO samples, the agreement of the fish data and macro-invertebrate metrics all point toward this conclusion.

There is a case for listing phosphorus as a stressor in Lines Creek. Lines of evidence include monitoring data from 2009, fish data, invertebrate data and the HSPF model.

Sampled nitrogen levels are below what is known to cause damage to invertebrate communities. HSPF modeled nitrogen levels are borderline as well. The biological data suggest there might be issues. More sampling is needed to definitively conclude the state of a nitrogen stressor in Lines Creek.

Extensive water quality monitoring of this reach and contributing tributaries do not support listing turbidity as a stressor in AUID 07020005-584. HSPF modeling is inadequate in this case due to the complex conditions of the AUID. Turbidity is not a stressor at this location.

Habitat is not a stressor at site 09MN002 in AUID 07020005-584. Several site visits give this location a fair assessment.

There is good evidence to support listing altered hydrology as a stressor in the reach. Low flows are the problem. Low flows caused by efficient drainage and changes to the hydrology structure of upstream areas are the issue. They cause low DO and a lack of water. No water is a stressor to invertebrates as they cannot swim away to other parts of the river. Surveys at 09MN002 found physical evidence indicative of flow alteration. Altered hydrology is a stressor.

There are barriers to fish passage in AUID 07020005-584. There are several beaver dams and the SVAP survey conducted in 9-2012 noted that low flow conditions restricted fish passage and probably resulted in low DO. SVAP surveys upstream concluded the same, upstream cattail regions and beaver dams blocked fish passage during low flow periods. These natural barriers limit fish movement and isolate fish populations within AUID 07020005-584 but are not in this reach. It is possible that low flows are the result of hydrologic alteration upstream.

15. AUID: 07020005-623, Headwaters to Lake Ben, Chippewa Falls and Barsness Townships, Pope County

AUID: 07020005-623 was assessed in 2003 and determined to be impaired for fish communities. The impaired reach is an ephemeral tributary of Lake Ben and County Ditch 15 in Chippewa Falls and Barsness Townships of Pope County in the Chippewa River watershed. The Fish metrics in this region indicate potential issues with disturbance, low DO and unstable habitat. Figure 623-1 is a detailed map of the unnamed drainage and it's watershed.

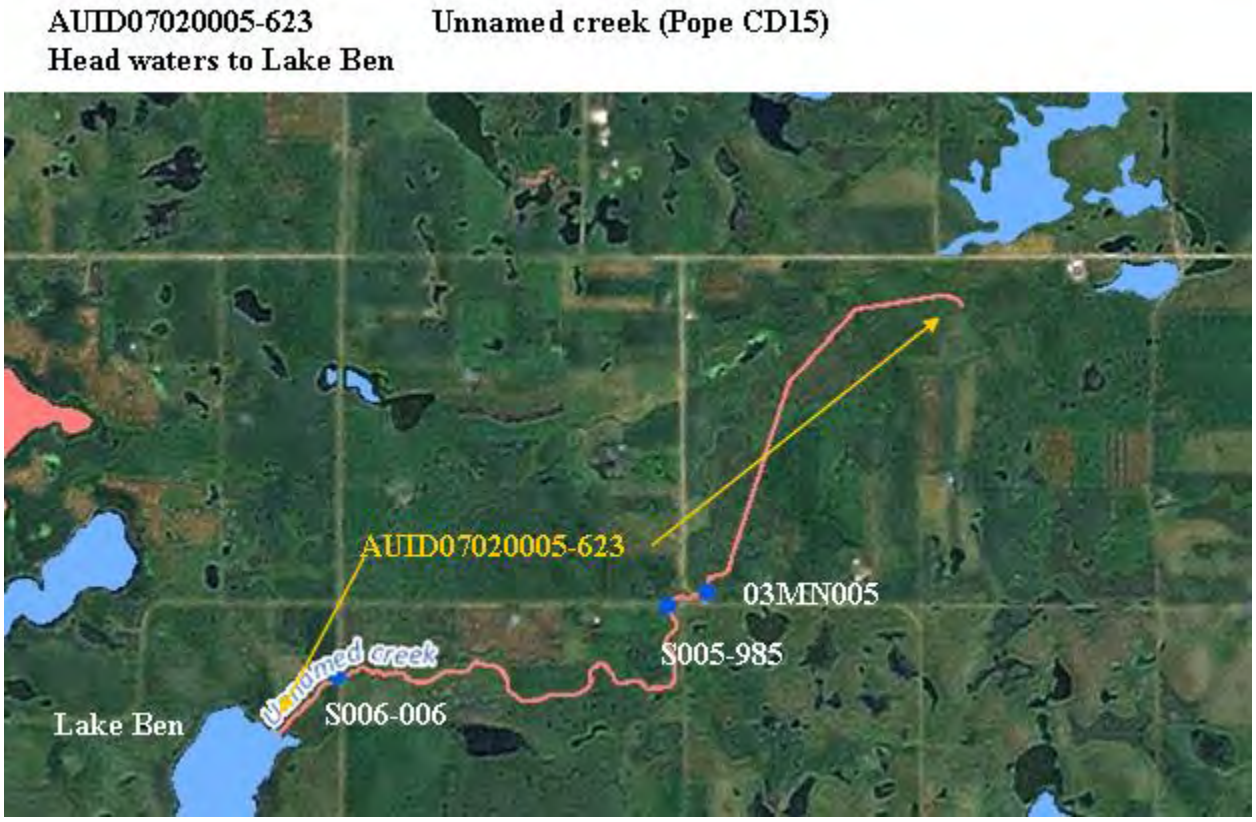


Figure 623-1 AUID: 07020005-623 monitoring sites and contributing watershed.

Biology:

The fish sample in this drainage at site 03MN005 in 2003 reported 13 fish caught representing seven species. Due to the small sample size and low numbers a biological analysis of the sample may not provide an accurate picture.

The majority of the individual fish counted were pollution tolerant species. Fathead minnows and white suckers, both pollution tolerant species, made up 60% of the sample. Consequently, fish metrics for this site were poor with the exception of GeneralTxPct (the percentage of taxa that are generalist species) and VtolTXPct (the percent of taxa that are very tolerant) (Figure 623-2). The limited sample size makes these population statistics of questionable value. The small sample size and low numbers of types of species in general supports the conclusion that this site is stressed.

The predominance of tolerant species as seen in the moderate metric score for TolTXPct, a measure of the relative abundance (%) of taxa that are tolerant species and in the description of quartiles below indicate that water quality and disturbance are issues in this reach (Figure 623-2). There were no non-tolerant benthic insectivore species (BenInsect-TolTxPct), no taxa that are detrivores (DetNWQTXPct), nor where there any sensitive taxa (SensitiveTxPct). The species present were mostly pollution tolerant.

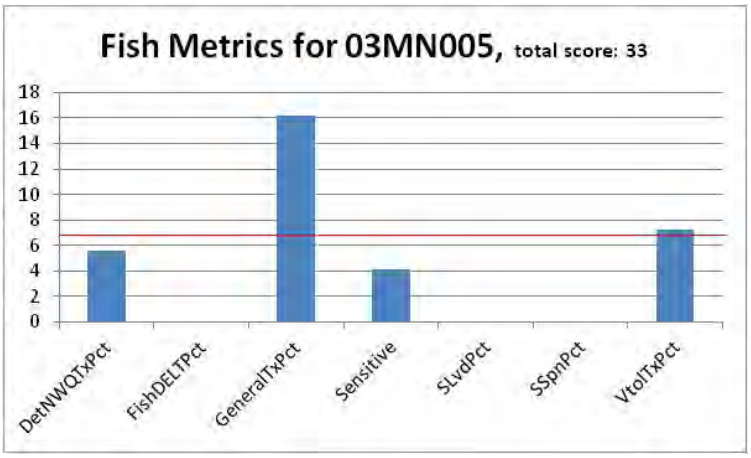


Figure 623-2 Fish metric scores belonging to site 03MN005, AUID: 07020005-623. The red line indicates the average metric score (5.6) needed for IBI score to be at the threshold.

A survey of species tolerance levels to NO2-3, TP, TSS and DO revealed a predominance of tolerant individuals (Meador and Carlisle, 2006). In addition it appears that TSS (turbidity) and DO may be the main stressors. Though, due to the small sample size and low numbers this analysis may not provide an accurate picture.

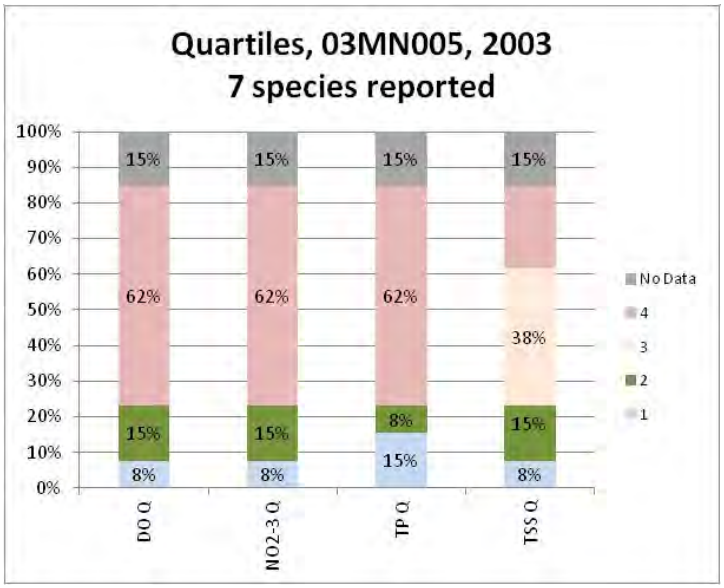


Figure 623-3 Fish quartile values for NO2-3, TP, TSS and DO. Seven species reported out of 13 individuals.

Candidate cause: Dissolved oxygen

Dissolved oxygen monitoring conducted in AUID 07020005-623 indicates that low DO is an issue. Dissolved oxygen was sampled 38 times from 2009-2012. 17 of 38 DO readings (44.7%) were in exceedance of the 5mg/L standard none of these samples were collected before 9:00 AM.

A review of the fish species and their numbers present suggests that DO is a driving force in their makeup (Figure 623-3). At site 03MN005, 62% of the fish recorded were either in the fourth quartile, very tolerant of low DO. The relative abundance (%) of taxa that are serial spawners scored poorly indicating low DO issues. Eight out of thirteen fish found were fathead minnows and white suckers, both highly tolerant to low DO. These data constitute a biological response.

HSPF modeling suggests that there is not a DO issue at this site. Figure 623-3 shows the modeled 10 year duration curve of daily minimum DO values. The model suggests that incidences below 5mg/L are rare. Given that 44% of samples taken from 2009-2012 exceeded the standard, it is likely that the model is wrong in this case.

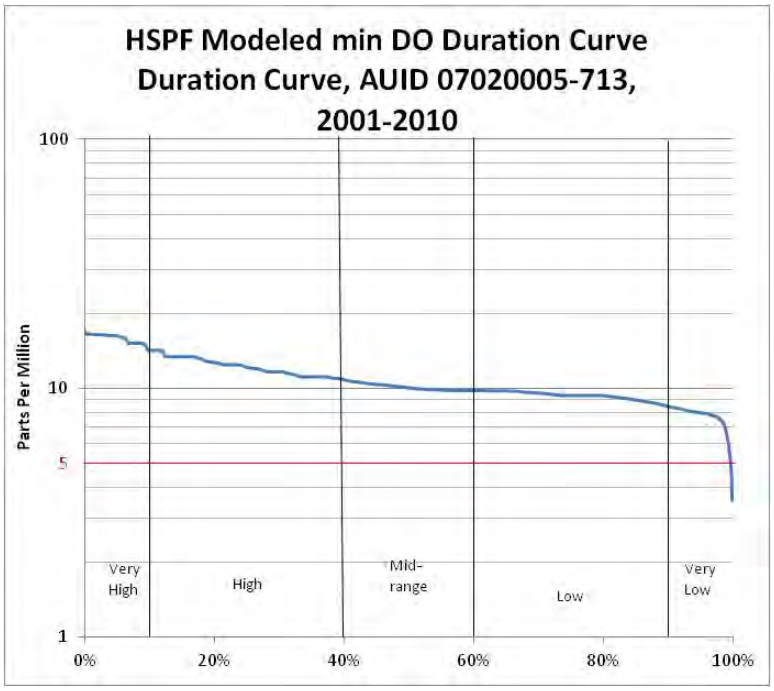


Figure 623-4 HSPF DO modeling projections.

Stressor pathway: Impoundments

Dissolved oxygen levels can be affected by impoundments by collecting nutrients and organic materials leading to less availability and by serving as areas for algae blooms. In the AUID 07020005-623 watershed, there are known natural impoundments both immediately up and downstream of the site 03MN005. Figure 623-1 shows the unnamed impoundment upstream of the monitoring site as well as the downstream Lake Ben.

Lake Ben has water quality data from 2009 and 2010. The data did not measure DO levels but they do document eutrophic conditions. Eutrophic conditions indicate widespread pervasiveness of elevated waterborne nutrients. The sources of nutrients to the lake are thus also contributing a high load of nutrients to the stream. This nutrient enrichment can lead to an increased oxygen demand.

Stressor Pathway: decreased aeration via low flow

Site visits data observed many low flow periods. Oxygen enters streams in various ways including atmospheric diffusion and entrainment from riffles and waves. Changes to flow may reduce surface area and turbulence, which can decrease DO and stress organisms. Site visits to site 03MN005 noted stagnant or no water in July and August of 2006, 2007, 2009, 2010 and 2012.

Dissolved oxygen summary:

In AUID 07020005-623, there is sufficient data to conclude DO is a stressor to fish communities throughout the reach.

Candidate cause: Phosphorus

No phosphorus samples have been taken in AUID 07020005-623 at any of the monitoring sites.

Lake Ben was tested for total phosphorous 12 times in 2009 and 2010. These samples averaged 0.036ppm and the highest reading was 0.49ppm.

The HSPF model suggests that phosphorous concentrations above 0.15ppm occurred 24.7% of the time from 2001-2010 (Figure 623-5).

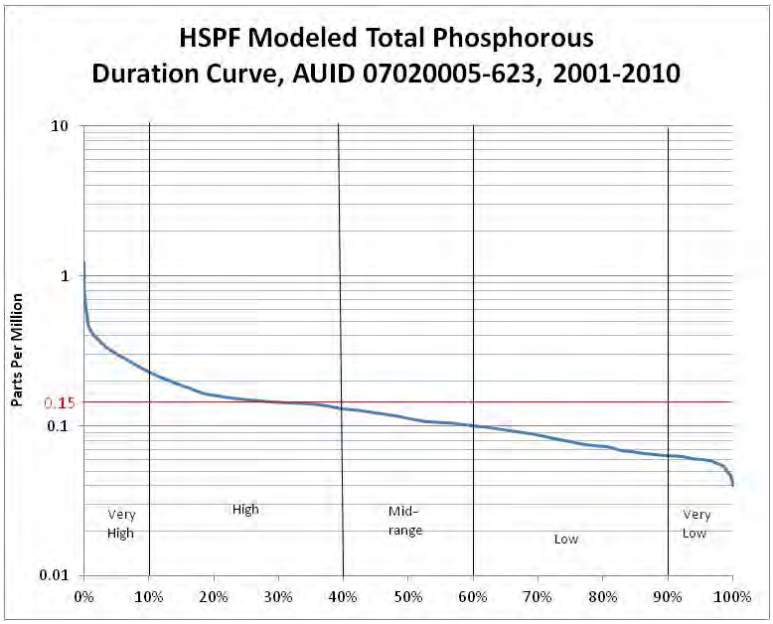


Figure 623-5 HSPF Phosphorous modeling simulation.

In 2003, the fish sample at site 03MN005 was comprised of mostly fish that are very tolerant to phosphorous (62% fourth quartiles).

Stressor pathway: Riparian condition

The riparian buffers along the main channel of AUID 07020005-623 are fair to poor. There are some notable locations where overland flow appears to be an issue (Figure 623-6). The smaller tributary field ditches and streams that feed into this stream often have inadequate buffers. Lack of a riparian zone providing some form of "natural" benefit can allow high amounts of nutrients and sediment from adjacent fields and mowed yards to enter the adjacent stream.

Figure 623-6 Example of good buffers (blue) and inadequate buffers (red) between cropland and water (2012).

Stressor pathway: Source-water pollution

Over 70% of the contributing watershed is used for row crop agriculture. The terrain in this region is notable for its hills and slopes. Given the minimal state of the riparian buffers there is a clear pathway for overland runoff from row crop fields to impact water pollution. Some of this is clearly evident in the aerial photos seen in Figure 623-6.

Phosphorous summary:

Phosphorous is a likely secondary stressor to fish populations in the tributary to Lake Ben (AUID 07020005-623, though the weight of evidence is not high. There is little lab data that shows the tributary to Lake Ben to be influenced by elevated levels of phosphorus. The evidence for phosphorous in this system can only be inferred from field observations of phosphorus pathways and has been modeled in the HSPF model. Phosphorous in this system is likely contributing to the DO stressor also present in this system.

Candidate cause: Nitrate

No NO2-3 samples were taken in AUID 07020005-623 at site 03MN005.

HSPF modeling projects levels in exceedance of the 75 percentile value of 0.28ppm for North Central Hardwood Forest ecoregion 100% of the time. It also predicts that nitrogen levels exceeded the 10ppm standard only 0.05% of the time between 2001-2010. Given that 90% of the time nitrogen was simulated below 1.5ppm, the model suggests that nitrogen is not a stressor.

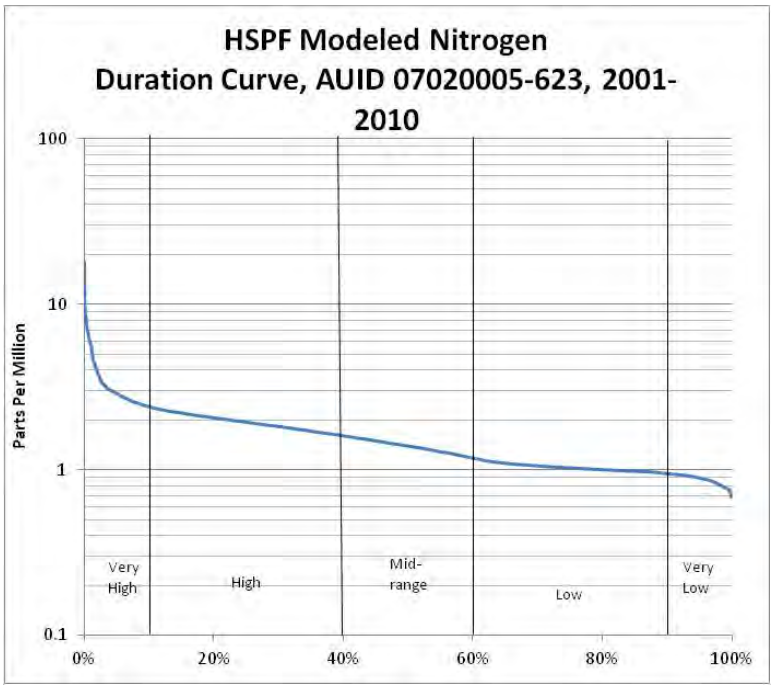


Figure 623-7 HSPF Nitrogen modeling simulation.

In an examination of species' tolerance along physiochemical gradients species (in 2009-2010) in the first quartile represented 14% of the sample, the second quartile 25% and the fourth quartile 59% (Figure 623-3). These results indicate that nitrogen may not be a limiting factor at site 03MN005.

Stressor pathway: Riparian condition

The riparian buffer along the main channel of AUID 07020005-623 is fair to poor. There are some notable locations where overland flow appears to be an issue (Figure 623-6). The smaller tributary field ditches and streams that feed into this reach often have inadequate buffers. Lack of a riparian zone providing some form of "natural" benefit can allow high amounts of nutrients from adjacent fields and mowed yards to enter the adjacent stream.

Stressor pathway: Source-water pollution

Channelized and natural tributaries to the reach carry nitrates during snowmelt and rain events. It is known that nitrogen and forms of nitrogen, such as ammonia, are being applied to the cropland throughout the watershed as it is nearly 70% cropland (2009 NLCD). It is unknown how much groundwater contributes nitrate.

Nitrogen summary:

Nitrate-Nitrite is an unlikely stressor to the stream biotic community. There are logical pathways open for nitrogen to enter the stream. The lack of sample data makes the case weak. Fish data is inconclusive. HSPF modeling suggests little impact from nitrogen on fish populations.

Candidate cause: Turbidity

Turbidity, which is a measure of transparency, can be increased with sediment, algae and organic matter. In addition to turbidity, the state of Minnesota allows Transparency (25NTU=20cm Transparency) and TSS (25 NTU= 54ppm TSS) as surrogates for turbidity in the Chippewa River

watershed. In AUID 07020005-623 there are two sites where turbidity, TSS or transparency has been measured.

Transparency was sampled 48 times between 2006 and 2012. Transparency never exceeded the standard.

HSPF modeling projects levels in exceedance of the 54ppm surrogate standard 3.5% of the time (Figure 623-8). These exceedances were predicted to occur only during the highest flows. These levels are not high enough over sufficient time to be considered a stressor.

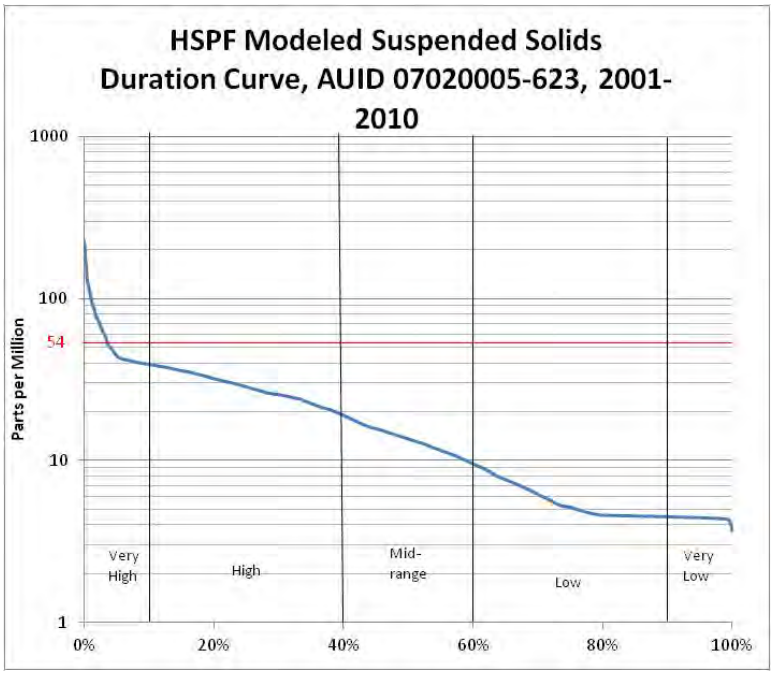


Figure 623-8 HSPF TSS modeling projections.

In 2003, the fish sample at site 03MN005 was comprised of mostly fish that are tolerant or very tolerant to suspended solids (62% third and fourth quartiles). There were sensitive species present as well (15% second quartile and 8% first quartile). The metrics for taxa richness of simple lithophilic spawning species and for riffle-dwelling species both had average scores. These data indicate imply turbidity is not a stressor. The small sample size makes a determination highly questionable. See Figure 623-3.

Stressor pathway: Riparian condition

The riparian buffer along the main channel of AUID 07020005-623 is fair to poor. There are some notable locations where overland flow appears to be an issue (Figure 623-6). The smaller tributary field ditches and streams that feed into this stream often have inadequate buffers. Lack of a riparian zone providing some form of "natural" benefit can allow high amounts of nutrients from adjacent fields and mowed yards to enter the adjacent stream.

Stressor pathway: Source-water pollution

Over 70% of the contributing watershed is used for row crop agriculture. The terrain in this region is notable for its hills and slopes. Given the minimal state of the riparian buffers there is a clear pathway for overland runoff from row crop fields to impact water pollution. Some of this is clearly evident in the aerial photos seen in Figure 623-6.

Stressor pathway: Channelization

Channelization on the actual reach of AUID 07020005-623 is minimal. Channelization has occurred on the tributary ditches and streams that feed into this reach (Figure 623-6). These changes could be changing in-stream erosion rates that have led to an increase in turbidity. A 2012 survey of the stream channel classified it as a fairly stable E4 channel.

Turbidity summary:

Stream monitoring data, fish data and the HSPF model all refute turbidity as a stressor in AUID 07020005-623. There are plausible sources and pathways but elevated turbidity levels do not appear to be a significant issue.

Candidate cause: Habitat

Fish populations and habitat were sampled in the summer of 2003. In 2012 the site was visited again and a SVAP survey was completed. During the 2012 site visit the channel was observed to be completely dry, a condition that has been noted at this site in the late summer five out of the last seven years it has been monitored for transparency. This site is clearly an ephemeral stream that should not be assessed in the same manner as a stream with a perennial source of water.

Figure 623-9 Station 03MN005 upstream.

Site 03MN005 has fair habitat as scored by the MSHA in 2003. The site scored poorly in the category of surrounding land use, the riparian zone was listed as narrow and the instream zone was not very diverse and much of the rock habitat was severely embedded. Channel morphology and instream cover types were somewhat better and brought the overall score up enough to give the site a score of fair. The survey noted a good depth variability, no riffles, good sinuosity and fair channel development.

Figure 623-10 Station 03MN005 note dry channel and long dry culvert.

The SVAP survey conducted on 10-4-2012 noted a complete lack of water. No water makes any further assessment of fish habitat pointless. Even so the SVAP survey gave the site an overall assessment score of Fair. They observed a decent number of habitat types for fish. The pools were good and there were plenty of macroinvertebrate habitat types. Channel condition and hydrologic stability were Poor. The channel had a good pool riffle structure but the impact of three roads and the surrounding land use was noted as having a negative impact on the sites habitat. Related to this, the outside bends were somewhat scoured and undercut indicating an unstable condition.

At the same time as the SVAP survey a Rosgen type assessment was made of the stream channel. The channel was found to be an E4 type channel. E4 channels are noted for their high sensitivity to disturbance but good recovery potential. E4 channels are also highly controlled by their surrounding vegetation.

Stressor pathway: Riparian condition

The riparian buffer along the main channel of AUID 07020005-623 is fair to poor. There are some notable locations where overland flow appears to be an issue (Figure 623-6). The smaller tributary field ditches and streams that feed into this stream often have inadequate buffers. Lack of a riparian zone providing some form of "natural" benefit can allow high amounts of nutrients from adjacent fields and mowed yards to enter the adjacent stream.

Stressor pathway: Channel alteration

Upstream channel alteration is evident and maybe leading to changes in the hydrologic and geomorphologic condition. These may have led to changes in discharge patterns, changes in substrate, changes in sinuosity and increases in erosion. The stream still has a good vegetative bank cover which should help maintain channel stability and habitat structure.

Habitat summary:

This site is clearly an ephemeral stream that should not be assessed in the same manner as a stream with a perennial source of water. The primary requirement of aquatic species is water, no water equals a major stressor to fish populations. Without perennial water this stream reach will never serve as good habitat for fish. The reach has many of the structural components for good habitat. Surrounding land use and buffer management could be limiting factors to the natural function of the river.

Candidate cause: Altered hydrology

No intensive flow monitoring was conducted at this site. Water levels are noted in the monitoring data at the two monitoring sites located within the reach. The channel has been observed to be completely dry or with standing water in the late summer five out of the last seven years it has been monitored. This suggests that the site's hydrology is characterized by quick rising water levels following rain events and minimal base flow. There is no data that suggests that these conditions are new or anything different from what has been the condition on this reach previously.

In consideration of higher flows, the channel is an E channel with an easily accessed floodplain. It has a very low entrenchment ratio and is quite sinuous. Overall the higher flow hydrological condition of this reach appears to be in good shape.

Analysis of HSPF simulated flow for 2001-2010 did not show any incidents of no flow. Field visits clearly refute this. The model does suggest that 10% of the flows fell below a level of 5cfs (Figure 623-11).

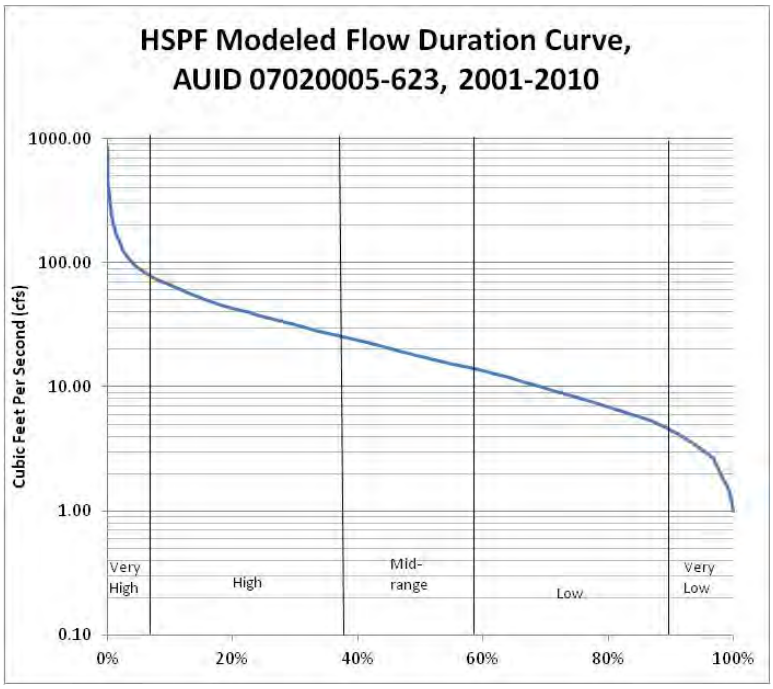


Figure 623-11 Simulated flow from HSPF model.

Stressor pathway: Channelization

The channelization of intermittent flow pathways and tile drainage has likely led to changes in flow dynamic. The changes in the hydrological and geomorphological condition would have direct impact to the biology of the reach.

Stressor pathway: Impoundments

Active impoundments exist upstream. Any changes to these upstream could have impact on the discharge of the river system creating changes in water slope leading to changes in scouring and deposition as well as changes to water velocity and depth. They can hold back water which increases discontinuity and potential stranding.

Flow alteration summary:

There is little evidence to support listing flow alteration as a primary stressor in the reach. Surveys at 03MN005 did find physical evidence indicating no water in the channel. There is no evidence that this condition is different than what it has always been. The reach is most likely an ephemeral stream that runs dry in most years.

Weight of evidence:

The evidence for each potential stressor, the quantity and quality of each type of evidence is evaluated. The consistency and credibility of the evidence is evaluated. Each step for AUID 07020005-623 was scored and summarized in Figure 623-12. For more information on scoring please see EPA's CADDIS Summary Table of Scores.

Types of Evidence	Scores						
	Low Dissolved Oxygen	High Phosphorus	High Nitrate	Lack of Connectivity	Lack of Habitat	High Turbidity	Altered Hydrology
Spatial/temporal co-occurrence	+	++	--	-	+	++	-
Temporal sequence	+	+	+	0	-	+	+
Field evidence of stressor-response	+	++	--	-	+	++	-
Causal pathway	++	++	-	++	-	++	++
Evidence of exposure, biological mechanism	++	++	-	-	-	+	++
Field experiments /manipulation of exposure	NE	NA	NE	NE	NE	NE	NE
Laboratory analysis of site media	NE	NA	NE	NE	NE	NE	NE
Verified or tested predictions	NE	NE	NE	NE	NE	NE	NE
Symptoms	+	+	+	0	+	+	+
Evidence using data from other systems							
Mechanistically plausible cause	+	+	+	+	+	+	+
Stressor-response in other lab studies	++	+	+	NA	NE	NE	NE
Stressor-response in other field studies	++	+	+	-	+	+	+
Stressor-response in ecological models	NE	NE	NE	NA	NE	NE	NE
Manipulation experiments at other sites	NE	NE	NE	NA	NE	NE	NE
Analogous stressors	NE	NA	NE	NA	NA	NE	NE
Multiple lines of evidence							
Consistency of evidence	+	+	+	-	+++	+++	+++
Explanatory power of evidence	++	++	++	-	++	++	++

Figure 623-12 Weight of evidence table for potential stressors in AUID: 07020005-623, headwaters to Lake Ben, Chippewa Falls and Barsness Townships, Pope County.

Conclusions

In AUID: 07020005-623 there is good monitoring data, therefore a good assessment of possible stressors can be made by combining the relevant information that is available. This reach has a number of stressors impacting the biological monitoring site 03MN005.

A survey of species tolerance levels to NO2-3, TP, TSS and DO revealed a predominance of tolerant individuals (Meador and Carlisle, 2006). In addition it appears that TSS (turbidity) and DO may be the main stressors.

In AUID 07020005-623, there is sufficient data to conclude DO is a stressor to fish communities throughout the reach.

There is ample data that shows AUID 07020005-623 to be influenced by elevated levels of phosphorus. Phosphorus in this system is likely to be directly contributing to the DO and turbidity stressors also present in this system.

Nitrate-Nitrite is an unlikely stressor to the stream biotic community. Sample data, fish data, and modeling all suggest that it nitrogen is having little effect on fish populations.

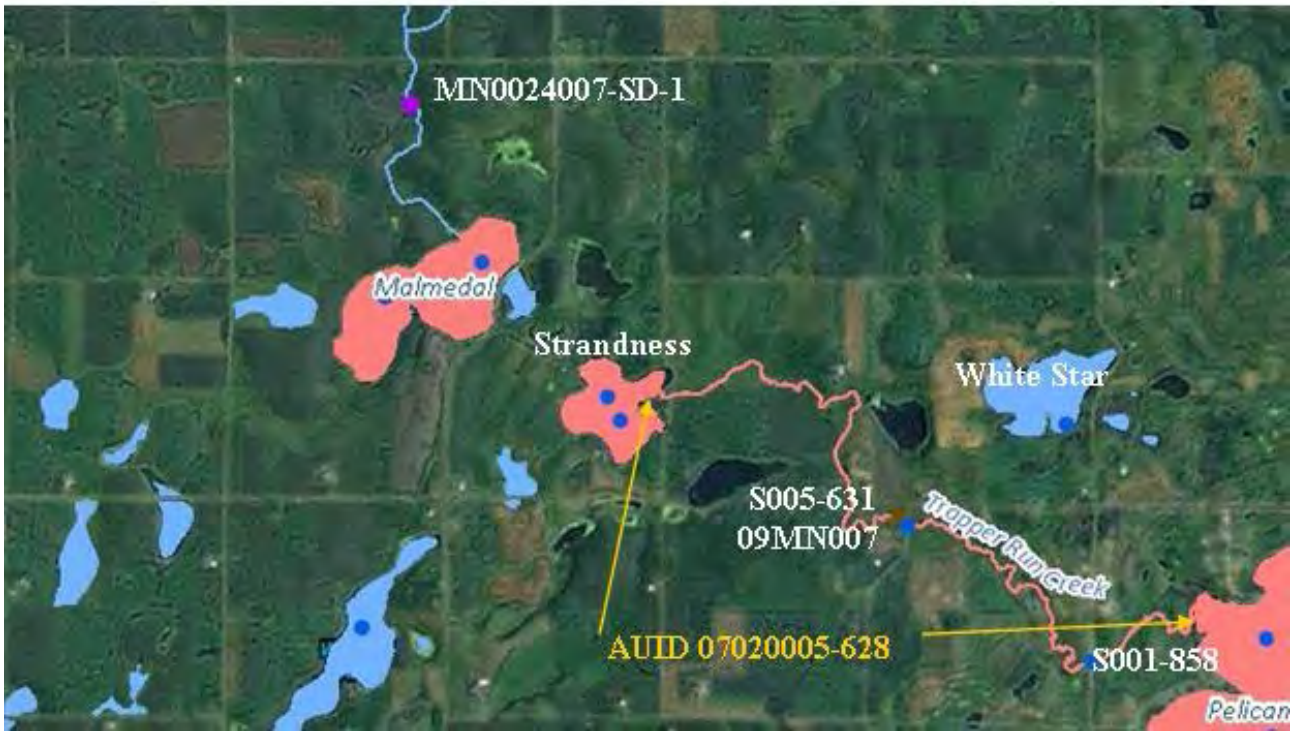
Lake and stream monitoring data, fish data and the HSPF model all support listing turbidity as a stressor in AUID 07020005-623. There are plausible sources and pathways as well as a documented biological response expected in a stream with elevated turbidity levels.

This AUID 07020005-623 Unnamed creek (Pope CD15), headwaters to Lake Ben, has many of the structural components for good habitat. Surrounding land use and buffer management are limiting factors to the natural function of the river. Due to natural limitations in soil types available for channel substrate this reach may be uniquely susceptible to habitat degradation. Human management decisions regarding livestock impact, buffer width and actions that impact habitat availability are causing biotic impairment in distinct locations.

There is little evidence to support listing flow alteration as a primary stressor in the reach. Surveys at 03MN005 did find physical evidence indicative of flow alteration. There is evidence of low flow conditions. Lower flows may reduce surface area and turbulence, which can decrease DO and stress organisms. In this case, DO would be considered the proximate stressor, while flow alteration is a step in the causal pathway.

16. AUID: 07020005-628, Trappers Run from Strandness Lake to Pelican Lake, Pope County

AUID: 07020005-628 was assessed in 2012 and determined to be impaired for fish and aquatic macroinvertebrate communities. The impaired reach is part of Trappers Run in Ben Wade, Reno and Minnewaska Townships in Pope County. Bio-metrics in this region indicate potential issues with disturbance, water born pollution and DO. Figure 628-1 is a map of the AUID drainage and it's immediate watershed.



	Drainage Area	32.14 square miles
Land Use	Agricultural	69.70%
	Forest	4.60%
	Range	11.10%
	Urban	5.10%
	Water	7.20%
	Wetland	2.20%
	Other	0.00%

Figure 628-1 AUID 07020005-628 Map, drainage area and contributing land use.

Biology:

The fish sample in this drainage at site 09MN007 in 2009 found very few fish (14 total individuals) and those found were mostly tolerant species. Consequently, fish metrics for this site were poor and of questionable validity due to such a small sample size (Figure 628-2). For example the good score for SLvd, the taxa richness of short-lived species and TolTXPct measure of the relative abundance (%) of taxa that are tolerant were probably more a result of the small sample size than it is a true depiction of taxa

richness. The metrics do provide some insight. The predominance of tolerant species as seen in the Poor metric score for TolPct, a measure of the relative abundance (%) of individuals that are tolerant species suggests that water quality and disturbance are issues in this reach. There were no non-tolerant benthic insectivore species (BenInsect-TolTxPct), no taxa that are detrivores (DetNWQTXPct), nor where there any sensitive taxa (SensitiveTxPct). The species present were mostly pollution tolerant. The low numbers of individuals and species alone supports the analysis that this site is stressed.

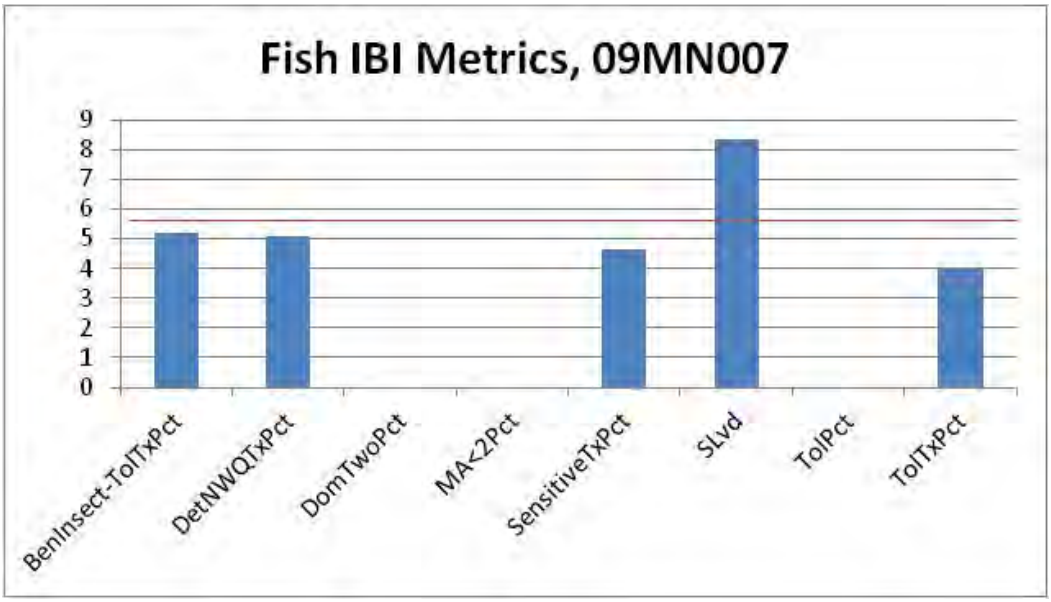


Figure 628-2 Fish metric scores belonging to Trappers Run, AUID: 07020005-628. The red line indicates the average metric score (5.6) needed for IBI score to be at the threshold.

The Minnesota Department of Natural Resources (DNR) undertook game fish surveys in 2010 at Strandness Lake and then in 2012 at Pelican Lake (the lakes upstream and downstream of the AUID reach). At the time of the fish surveys many more fish were found in the lakes than what was found in the MPCA's 2009 survey of site 09MN007.

These DNR data suggest that there are fish to stock the AUID reach and that the conditions exist to support fish populations at least in the downstream Pelican Lake.

2012 DNR Lake Fish survey	Pelican (2012)	Strandness (2010)
Species	# of fish	# of fish
black bullhead	1	151
black crappie	519	
bluegill	107	
brown bullhead	77	7
golden shiner	5	
largemouth bass	18	
northern pike	135	35
pumpkinseed	18	
rock bass	11	
smallmouth bass	10	
walleye	42	22
white sucker	2	11
yellow perch	376	113
common carp		43
Total Number of Fish	**1321**	**382**

Trapper's Run is also impaired for invertebrates. While there were some indicators of stress many of the indicator metrics were Fair to Good. The good numbers for *ClingerCh* suggest that habitat is decent. *Collector-filtererPct* also scored well suggesting that the trophic base of the invertebrate community is intact. The relative abundance (%) of dominant five taxa in subsample, represented by *DomFiveChPct*, was well balanced indicating that no one or two taxa dominated the community. The measure of pollution based on tolerance values assigned to each individual taxon (*HBI_MN*) scored reasonably well suggesting that there are a number of sensitive taxa present. The total taxa richness indicator (*TaxaCountAllChir*) also scored above the average indicating that there were plenty of invertebrate taxa represented (Figure 628-3). These metrics suggest that pollutants and habitat are not necessarily an issue at this site.

There were three invertebrate metrics that indicate problems in this region. A low score for *Intolerant2C* indicated that there were very few of the most sensitive taxa present. *PredatorCh, a* trophic indicator, noted a lack of predators. Finally, the low score for *TrichwoHydroPct* indicated a lack of non-hydropsychid Trichopteras in the sample. These metrics point to potential issues with the trophic composition of the invertebrate population and possibly a low level pollution issue. Also the low predatorCh score hints that there is a possibility of disturbance, less disturbed sites support a greater diversity of prey items and a variety of habitats in which to find them.

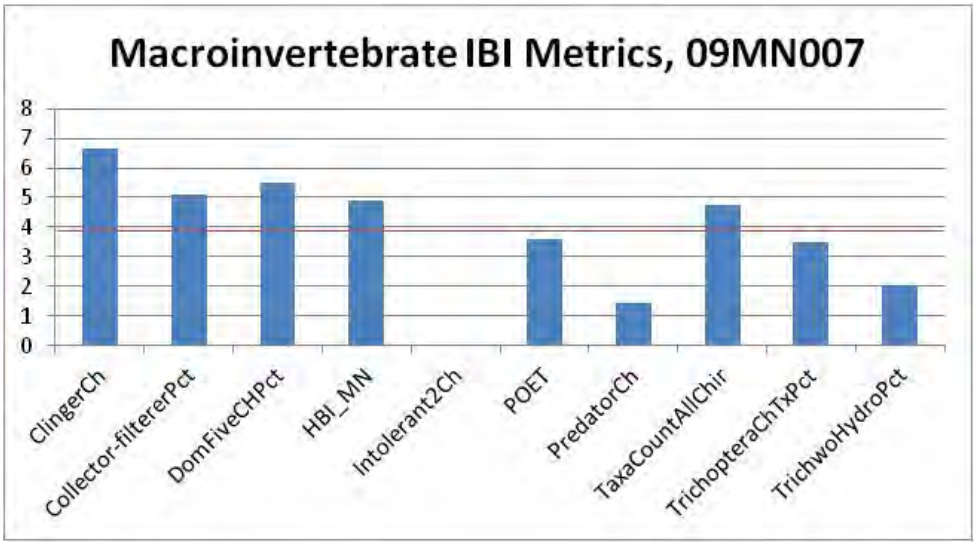


Figure 628-3 Macroinvertebrate metric scores belonging to Trappers Run, AUID: 07020005-628. The red line indicates the average metric score (5.6) needed for IBI score to be at the threshold.

Candidate cause: Dissolved oxygen

There were 21 DO spot checks conducted at site 09MN007 from 2009 through 2011, 24% of them were under 5 mg/L. None of the samples were gathered before 9:00 AM suggesting that DO levels were likely lower. The average DO level for the 21 samples was 7.03 mg/L, not exceptionally high. This data is sufficient to list this reach as impaired for DO according to standards.

Stressor pathway: Impoundments

Dissolved oxygen levels can be affected by impoundments collecting nutrients and organic materials which leads to less availability and by serving as areas for algae blooms. Trapper's Run flows between three lakes that are impaired for nutrients (Malmedal > Strandness > Pelican), which could be a reason for the DO impairment.

In the 2010 DNR Lake Information Report on Strandness Lake it stated that:

"Strandness Lake is a shallow basin located in the flowage of Trapper's Run Creek. It lies between Malmedal and Pelican Lakes, each of which is listed as impaired waters. Maximum depth of Strandness Lake is 5.0 feet. Undoubtedly, Strandness Lake holds little DO during winter months. Partial and severe winterkill events have likely occurred, but such events have been poorly documented." http://www.dnr.state.mn.us/lakefind/showreport.html?downum=61012800.

Dissolved oxygen summary:

In AUID 07020005-628, there is sufficient data pathways to conclude DO is a stressor to fish and invertebrate communities throughout the reach.

Candidate cause: Phosphorus

There were 12 phosphorus samples taken at site 09MN007 in 2009. None of the samples were above 0.15ppm and the average was 0.10ppm.

Phosphorous samples have been extensively collected from the three impaired lakes between 2003 - 2012 above and below the reach. Malmedal Lake exceeded the 0.15ppm draft standard in 50% of the samples. Strandness Lake exceeded the standard 29% of the samples. Pelican Lake did not exceed the

standard. Lake samples in 2009 reported no exceedances of the standard, but there were many in 2010 - 2012 (see Figure 628-4).

Lake data clearly suggests that elevated phosphorous levels are an issue. Citizen Monitoring Data extensively documents cloudy green water during mid to late summer. Low readings in mid to late summer are often the result of sestonic algae growth resulting from high phosphorous concentrations in the water. Additionally, low transparency readings in the lakes also document algae and phosphorous issues.

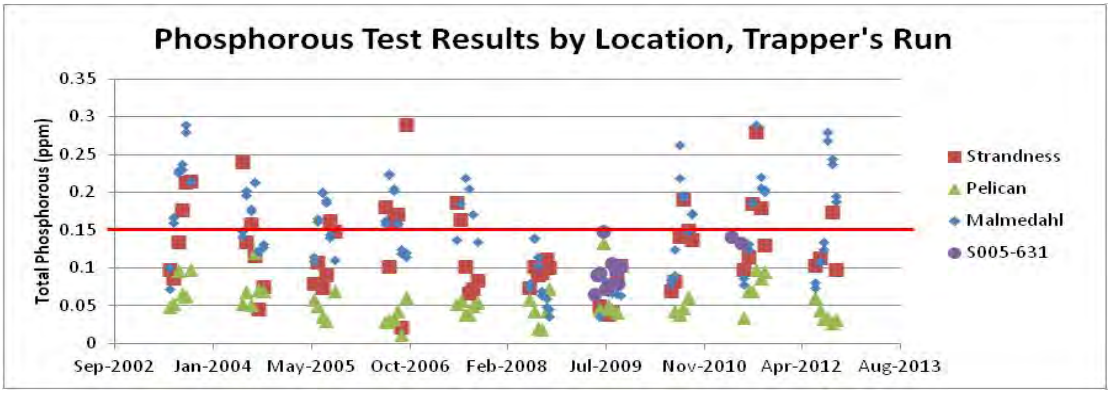


Figure 628-4 Phosphorous test results by location, Trapper's Run, note S005-631 was sampled during a period of low phosphorous levels.

Stressor pathway: Riparian condition

The riparian buffers along the impaired reach are at least twice the width of the stream channel in most areas. A lack of buffers can be seen on the many tributary streams and ditches that feed into Trapper's Run and the upstream impaired lakes. These unbuffered tributaries may allow high amounts of nutrients and sediment from adjacent fields and mowed yards to enter the waterway (Figure 628-5).

Figure 628-5 Example of good buffers (green) and lack of buffer (red arrows) between cropland and waterways along tributaries of Trapper's Run (2013).

Stressor pathway: Source-water pollution

In the AUID 07020005-628 watershed, there are many natural impoundments that Trappers Run passes through or feeds from. Many of the monitored lakes are eutrophic with documented Trophic State Indexes (TSI) in the 60-80 range. Aerial photographs from the USDA Farm Service Agency show numerous wetlands, ponds and lakes in various shades of green. Eutrophic conditions indicate widespread pervasiveness of elevated waterborne nutrients. The nutrients in these impoundments are contributing nutrients to the stream that pass through them.

Phosphorous summary:

Considerable data shows Trapper's Run to be influenced by elevated levels of phosphorus. Phosphorus in this system is likely contributing to the DO stressor also present in this reach.

Candidate cause: Nitrate

Twelve nitrate nitrite (NO2-3) samples were taken at site 09MN007. Three of them were above 1ppm and the average was 0.74ppm. HSPF modeling projects levels in exceedance of the 75 percentile value of 0.28ppm for North Central Hardwood Forest ecoregion. A MPCA quantile regression showed with 75% confidence that a stream of the same invertebrate class as Smith Creek will score below the designated MIBI threshold when values are over 18mg/L (W. Bouchard, 2014). Of the 12 samples taken at Trappers Run, no values were at or above 18.1mg/L. This suggests that nitrogen is not a stressor to fish assemblages within the AUID.

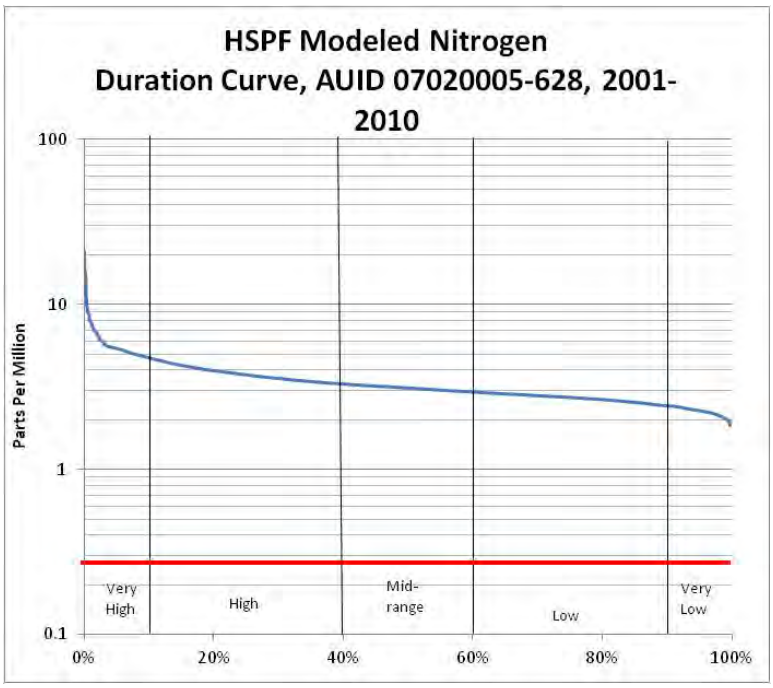


Figure 628-6 HSPF Nitrogen modeling projections, red line indicates the 75 percentile value of 0.28ppm for North Central Hardwood Forest ecoregion.

Stressor pathway: Riparian condition

The riparian buffers along AUID 07020005-628 are poor in upstream areas (see Figure 628-5) where row cropping gets too close to the stream. Lack of buffers can allow high amounts of nutrients from adjacent fields and mowed yards to enter the adjacent stream.

Stressor pathway: Source-water pollution

Channelized and natural tributaries to the Trappers Run carry nitrates during snowmelt and rain events. It is assumed that nitrogen and forms of nitrogen, such as ammonia, are being applied to the cropland throughout the watershed as it is nearly 70% cropland. It is unknown how much groundwater contributes nitrate.

Nitrogen summary:

Nitrate-Nitrite is not a likely stressor to the stream biotic community. Monitoring data, fish data, modeling and a survey of physical landscape conditions suggest that it has minimal effect on fish populations.

Candidate cause: Turbidity

Turbidity, which is a measure of transparency, can be increased with sediment, algae and organic matter. In addition to turbidity, the state of Minnesota uses Transparency (25NTU=20cm Transparency) and TSS (25 NTU= 54ppm TSS) as surrogates for turbidity in the Chippewa River watershed. In AUID 07020005-628 there are two sites where Turbidity, TSS or Transparency has been measured.

At sites S001-858 and S005-631 (also referred to as 09MN007) between 2003 and 2010 284 transparency tube measurements were taken. Transparency tube measurements in exceedance of the standard accounted for only 4% of the measurements. The average transparency reading for these 284 readings was 54 cm which is considered a good reading.

Due to the small sample size analyzing the fish sample based on TSS tolerance quartiles is not useful.

Turbidity summary:

Stream monitoring rule out turbidity as a stressor in AUID 07020005-628. There is no evidence of elevated turbidity levels in this stream reach.

Candidate cause: Connectivity

According to the MN DNR, *"A permanent fish barrier was installed on Trapper's Run Creek (downstream of Strandness Lake) in 1993 to prevent re-infestation of undesirable fish species in Strandness and Malmedal Lakes following severe winterkill."*
http://www.dnr.state.mn.us/lakefind/showreport.html?downum=61012800.

At site 09MN007 the culvert under the township road would also restrict fish passage during low flows.

Connectivity summary:

A fish barrier at Lake Strandness and the culvert at site 09MN007 are barriers to fish passage at times of the year where flow is low. These conditions represent a partial stressor to the local fish population.

Candidate cause: Habitat

Site 09MN007 has fair habitat as scored by the MSHA during the fish survey visit in 2009. The site scored well in the riparian zone category. The site scored low to average in the substrate and cover categories suggesting that there are habitat issues. The survey noted a lack of pools, moderate bank stability, an abundance of silt and sparse vegetative cover. It also noted good sinuosity and good channel development.

The SVAP survey conducted on September 19, 2012, observed a wide range of habitat types for macro invertebrates and less for fish. The overall assessment score was Good. There was some bank erosion and a fair amount of silty muck on the stream bed. There was no gravel or cobble habitat. Low flow also appeared to be a possible barrier for fish passage as there was barely any water in the stream. This is a small creek that could potentially dry up on a regular basis, it is probably not well suited for many species of fish.

Figure 628-8: Station 09MN007 (Note soft soil stream bottom and bank erosion).

Stressor pathway: Riparian condition

The riparian buffers along the main channel of the reach are mostly good and serving their function as natural habitat. Riparian conditions are poor in upstream tributary areas (see Figure 628-5) where row cropping gets too close to the river. These impacted areas no longer serve a benefit as natural habitat. In some cases, when the physical conditions are right, the lack of protective vegetation the river could shift to unstable riparian conditions.

Stressor pathway: Channel alteration

Channel alteration in distinct locations on the stream and in reaches contributing to the river have likely led to changes in the hydrological and geomorphological condition. This has led to changes in discharge patterns, changes in substrate, changes in sinuosity, and increases in erosion (see candidate cause: altered hydrology below).

Figure 628-9 Channel Alteration 09MN07

Habitat summary:

At site 09MN007, the structural (physical) components of good habitat are present for macro-invertebrates but the hydrology makes it unstable particularly for fish. This is a small creek that potentially dries up on a regular basis; it is probably not well suited for many species of fish. In addition there were a limited number of habitat types for fish documented in the habitat surveys at this site. Poor habitat is a stressor causing biotic impairment in these distinct locations. The ability of macro-invertebrates to survive in lower flows and recolonize the reach makes them less subject to this impairment.

Candidate cause: Altered hydrology

No flow monitoring was conducted in this reach. This site's hydrology has been determined through modeling and field surveys.

A September 2012, survey of this reach found that the extreme low flows at that point in time were limiting fish passage. There were also signs of bank slumping, bare roots and trees down in the stream indicating that the stream channel was not in a stable state with the higher flows.

HSPF modeling of daily flows in AUID 07020005-628 ranged from 0.18 to 126cfs from 2001 through 2010 (Figure 628-10) The HSPF model predicts that 70% of the flows are under 10.2cfs. The persistence of lower flows are not good for fish communities. Lower flows in the mid to late summer are typically associated with higher pollution levels in the Chippewa River watershed. These combine to create a higher stress level than just low flows.

Low flow events are a natural part of a river's cycle, but flows that are too low or low too often could result in a negative biological impact. According to the HSPF model extended low flow events which were below the estimated 90th percentile flows of 1.71cfs (Figure 628-10), occurred in every winter except for 2005 and 2010. The HSPF low 7Q10 for this site is 0.21cfs and the low 1Q10 is 0.18cfs. These model statistics suggest that there are regular significant periods in the winter where the stream has extreme low flow. Given that this reach is in Minnesota, the stream freezes solid. Solid ice would prevent this reach from serving as habitat. Therefore low flow is a significant stressor to aquatic populations.

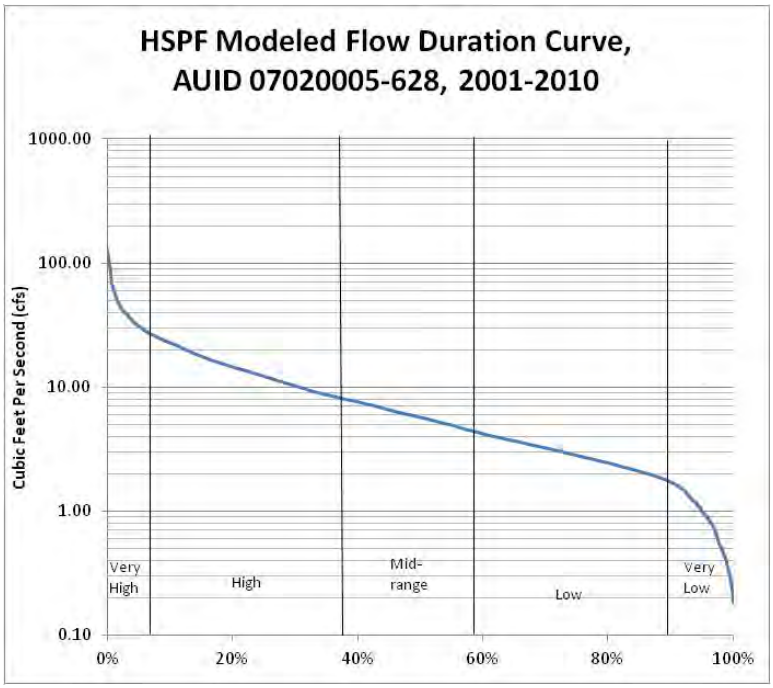


Figure 628-10 HSPF Modeled flow.

Stressor pathway: Altered hydrology

The upstream channelization of intermittent flow pathways and tile drainage have possibly led to changes in flow dynamics. Changes in the hydrological and geomorphologic condition could have direct impacts to the biology of the reach. The geomorphologic survey of site 09MN007 revealed to be an E6 stream type. The reach is not entrenched; it is highly sinuous with a very low width to depth ratio. The E6 stream type with good perennial vegetation can be very stable.

There was some evidence of bank instability, suggesting upstream conditions were possibly changing. Upstream land use, cropping, and drainage patterns have been changing in recent years due to high grain prices. These changes could be revealing themselves as changes to hydrologic output which would cause increased bank instability.

There is no evidence of rainfall pattern change. The period of 1991-2000 differed by 2.5 inches less rainfall than the period of 2001-2010 a difference of 0.25 inches/year (Climate.mn.edu). Changes in the hydrological and geomorphologic condition due to changes in precipitation seem rather unlikely.

Altered hydrology summary:

Altered hydrology is a candidate cause in AUID 07020005-628 at site 09MN007. The strength of the evidence is fair but not high since it is based on modeling and field observations. There are plausible sources and pathways as well as a documented response to the habitat conditions at site 09MN007.

Weight of evidence

Each step of the evidence based approach for AUID 07020005-628 was scored and summarized in Figure 628-11. The evidence for each potential stressor, the quantity and quality of each type of evidence, the consistency and credibility of the evidence are evaluated. For more information on scoring please see EPA's CADDIS Summary Table of Scores.

Types of Evidence	Scores						
	Low Dissolved Oxygen	High Phosphorus	High Nitrate	High Turbidity	Lack of Connectivity	Lack of Habitat	Altered Hydrology
Spatial/temporal co-occurrence	++	+	-	-	+	++	+
Temporal sequence	+	+	-	-	+	++	+
Field evidence of stressor-response	++	+	-	R	+	+	+
Causal pathway	+	+	+	-	+	+	+
Evidence of exposure, biological mechanism	+	+	-	-	+	+	+
Field experiments /manipulation of exposure	NA	NA	NA	NA	NA	NA	NA
Laboratory analysis of site media	NA	NA	NA	NA	NA	NA	NA
Verified or tested predictions							
Symptoms	+	+	-	-	+	+	+
Mechanistically plausible cause	+	+	+	+	+	+	+
Stressor-response in other lab studies	NE	NE	NE	NE	NE	NE	NE
Stressor-response in other field studies	+	+	+	+	+	+	+
Stressor-response in ecological models	+						
Manipulation experiments at other sites	NE	NE	NE	NE	NE	NE	NE
Analogous stressors	NA	NA	NA	NA	NA	NA	NA
Consistency of evidence	+	+	+	+	+	+	+
Explanatory power of evidence	+	+	+	+	+	+	+

Figure 628-11 Weight of evidence table for potential stressors in AUID 07020005-628 Trappers Run from Strandness Lake to Pelican Lake evidence using data from Chippewa River watershed.

Conclusions

In AUID: 07020005-628 a good assessment has been made. The primary stressor to this site is poor habitat caused by low water in the winter and low DO most likely the result of the impaired upstream Lakes. This reach has a number of secondary stressors impacting the reach. All stressors considered are summarized below.

In AUID 07020005-628, there is sufficient data to conclude DO is a stressor to fish and invertebrate communities throughout the reach.

Considerable data shows Trapper's Run to be influenced by elevated levels of phosphorus. Phosphorus in this system is likely contributing to the DO stressor also present in this reach.

Nitrate-Nitrite is not a likely stressor to the streams biotic community. Monitoring data, fish data, modeling and a survey of physical landscape conditions suggest that it has minimal effect on fish populations.

Stream monitoring rules out turbidity as a stressor in AUID 07020005-628. There is no evidence of elevated turbidity levels in this stream reach.

At site 09MN007, the structural (physical) components of good habitat are present for macro-invertebrates but the hydrology makes it unstable, particularly for fish. This is a small creek that potentially dries up on a regular basis, it is probably not well suited for many species of fish. In addition there were a limited number of habitat types for fish documented in the habitat surveys at this site. Poor habitat is a stressor causing biotic impairment in these distinct locations. The ability of macro-invertebrates to survive in lower flows and recolonize the reach makes them less subject to this impairment.

A fish barrier at Lake Strandness and the culvert at site 09MN007 are barriers to fish passage at certain times of the year. These conditions represent a partial stressor to the local fish population.

Altered hydrology is a candidate cause in AUID 07020005-628 at site 09MN007. The strength of the evidence is fair but not high, since it is based on modeling and field observations. There are plausible sources and pathways as well as a documented response to the habitat conditions at site 09MN007.

17. AUID: 07020005-638, Unnamed lake to Unnamed lake, Upper Chippewa River, Douglas County, Urness Township

AUID: 07020005-638 was assessed in 2012 and determined to be impaired for fish communities. The impaired reach is an unnamed drainage in Urness Township, Douglas County of the Chippewa River watershed. Fish metrics in this region indicate potential issues with disturbance, water born pollution and unstable habitat. Figure 638-1 is a detailed map of the unnamed drainage and it's watershed.

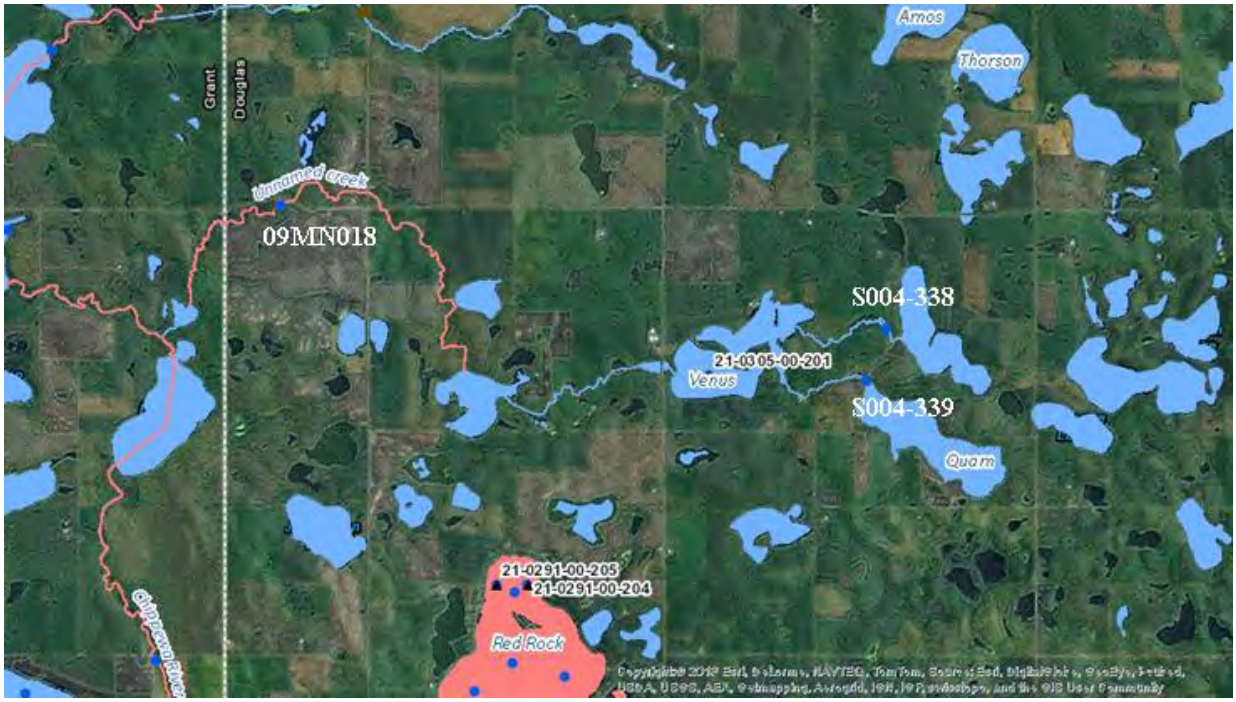


Figure 638-1 AUID 07020005-638 Contributing drainage area and monitoring sites

Biology:

The fish sample in this drainage at site 09MN018 in 2009 documented a relatively limited number of pollution tolerant species. Fathead minnows, a shortlived species, made up 93% of the sample. Consequently, fish metrics for this site were poor with the exception of SLvd (the taxa richness of short-lived species). The predominance of tolerant species as seen in the moderate metric score for TolTXPct, a measure of the relative abundance (%) of taxa that are tolerant species and in the description of quartiles below indicate that water quality and disturbance are issues in this reach (Figure 638-2). There were no non-tolerant benthic insectivore species (BenInsect-TolTxPct), no taxa that are detrivores (DetNWQTXPct), nor where there any sensitive taxa (SensitiveTxPct). The species present were mostly pollution tolerant. The low numbers of types of species in general supports the conclusion that this site is stressed.

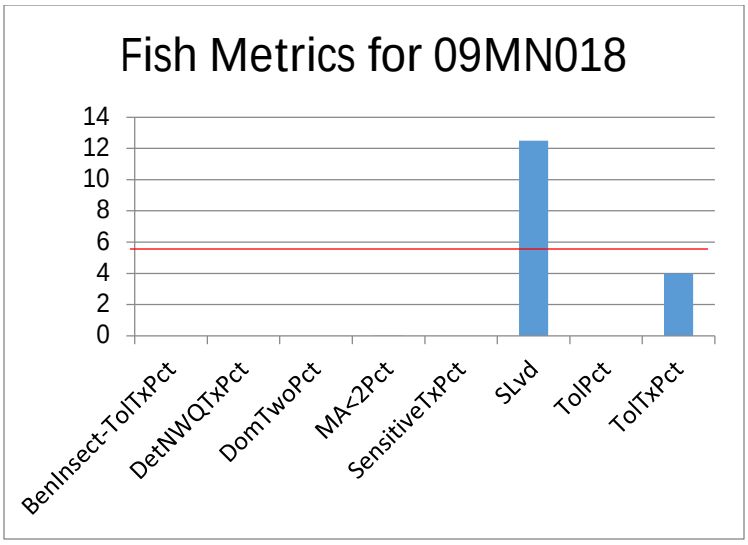


Figure 638-2 Fish metric scores belonging to the unnamed drainage in Urness Township, AUID: 07020005-638. The red line indicates the average metric score (5.6) needed for IBI score to be at the threshold.

Candidate cause: Dissolved oxygen

There was no substantial DO monitoring conducted in AUID 07020005-638.

HSPF modeling suggests that there is not a DO issue at this site. Figure 638-3 shows the modeled 10 year duration curve of daily minimum DO values. The model suggests that incidences below 5mg/L are extremely rare.

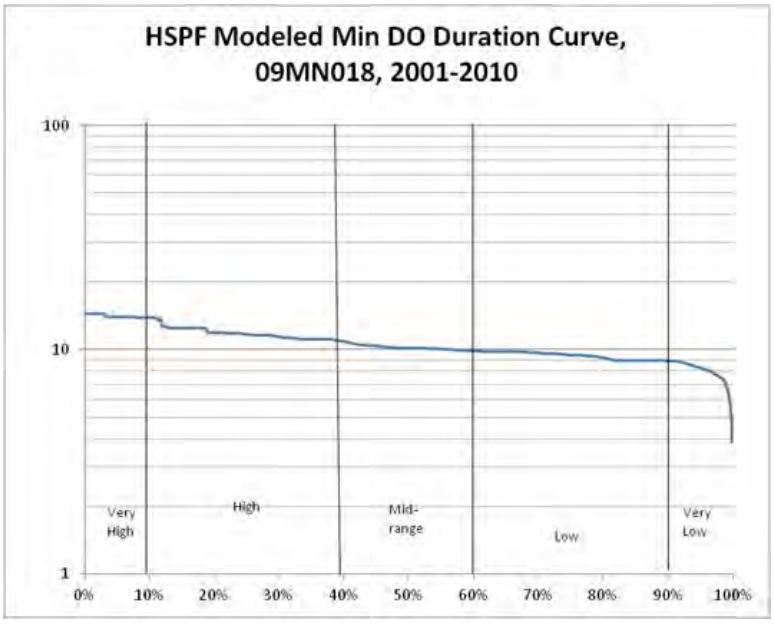


Figure 638-3 HSPF DO modeling projections.

Stressor pathway: Impoundments

Fish metrics were complicated. The relative abundance (%) of individuals that are serial spawning species was high but the taxa richness of serial spawning species was normal meaning that there were many low DO indicating individuals present but there were many other taxa in lower numbers. The

relative abundance of taxa with a female mature age greater than or equal to three was good but the number of individuals was low.

Invertebrate tolerance data found only 6% of the invertebrates were tolerant to low DO.

Dissolved oxygen levels can be affected by impoundments by collecting nutrients and organic materials leading to less availability and by serving as areas for algae blooms. In the AUID 07020005-638 watershed, there is one constructed impoundments and at least seven known natural impoundments. Figure 638-4 shows the unnamed drainage and the impoundments upstream of the monitoring site.

Venus Lake is the only lake upstream of AUID 07020005-638 that has data. The data did not measure DO levels but it does document eutrophic conditions from 2010 to 2012 (27 samples). Eutrophic conditions indicate widespread pervasiveness of elevated waterborne nutrients. The sources of nutrients to the lake are thus also contributing a high load of nutrients to the stream. This nutrient enrichment can lead to an increased oxygen demand.

Dissolved oxygen summary:

In AUID 07020005-638, there is insufficient data to conclude DO as a stressor to fish communities throughout the reach. Modeling and the limited data suggest that DO is not a stressor.

Candidate cause: Phosphorus

There were no phosphorus samples taken in AUID 07020005-638. Secondary data suggests that elevated phosphorous levels are an issue. A site visit in September 2012 documented cloudy green water during the relatively low flow period. Upstream data at the outlets of Quam and Holleque Lakes document low transparency readings in mid to late summer. Low readings in mid to late summer are often the result of sestonic algae growth resulting from high phosphorous concentrations in the water. Additionally, low transparency readings in Venus Lake also document algae and phosphorous issues.

The relative abundance (%) of individuals that are sensitive species and the taxa richness of sensitive species were zero. These results are the expected response to high phosphorous for these two fish metrics. In addition, 99% of the fish sample was comprised of phosphorous tolerant individuals in 2009. Invertebrate metrics that indicate phosphorous as a stressor were: a high percentage of taxa belonging to Crustacea and Mollusca, a low percentage of taxa with tolerance values less than or equal to two, using Minnesota TVs.

Stressor pathway: Riparian condition

The riparian buffers along AUID 07020005-638 are minimal to non-existent in many areas. Lack of buffers can allow high amounts of nutrients and sediment from adjacent fields and mowed yards to enter the adjacent stream.

Figure 638-4 Example of lack of buffer between cropland and water along unnamed creek (2012).

Stressor pathway: Source-water pollution

In the AUID 07020005-638 watershed, there is one constructed impoundment and many natural impoundments that the unnamed creek passes through. Venus Lake is the only lake upstream of AUID 07020005-638 that has water quality data. The data did not monitor phosphorous levels but rather lake transparency. This data documents an overall Trophic State Index (TSI) for Lake Venus of 67 indicating eutrophic conditions from 2010 to 2012 (27 samples). Eutrophic conditions indicate widespread pervasiveness of elevated waterborne nutrients. The nutrients in the lake are also contributing nutrients to the stream that passes through it.

Observations from the 9-26-2009 SVAP survey documented possible impacts from high phosphorous levels in the water. The rocks and stream bottom were coated with algae and the water itself was green, indicating poor water quality.

The HSPF model suggests that phosphorous concentrations above 0.15ppm occurred 92% of the time from 2001-2010 (Figure 638-5).

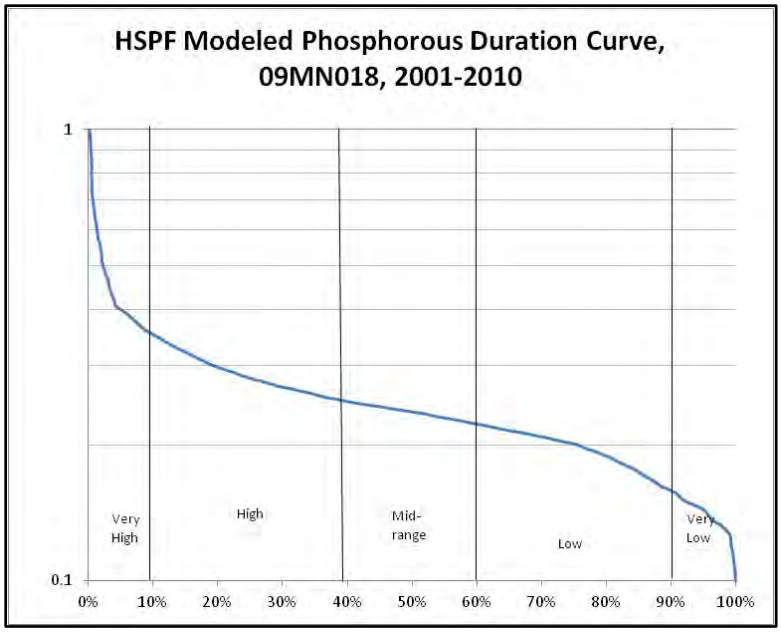


Figure 638-5 HSPF Phosphorous modeling projections.

Phosphorous summary:

Considerable surrogate data shows the unnamed drainage (AUID 07020005-638) to be influenced by elevated levels of phosphorus. Biological data also indicates the likelihood of phosphorous being a stressor. Phosphorus in this system is likely to be directly contributing to the turbidity stressor also present in this system.

Candidate cause: Nitrate

There are no documented sample data for NO2-3 from this AUID. HSPF modeling projects levels in exceedance of the 75 percentile value of 0.28ppm for North Central Hardwood Forest ecoregion. This suggests that nitrogen is a possible stressor to fish assemblages within the AUID.

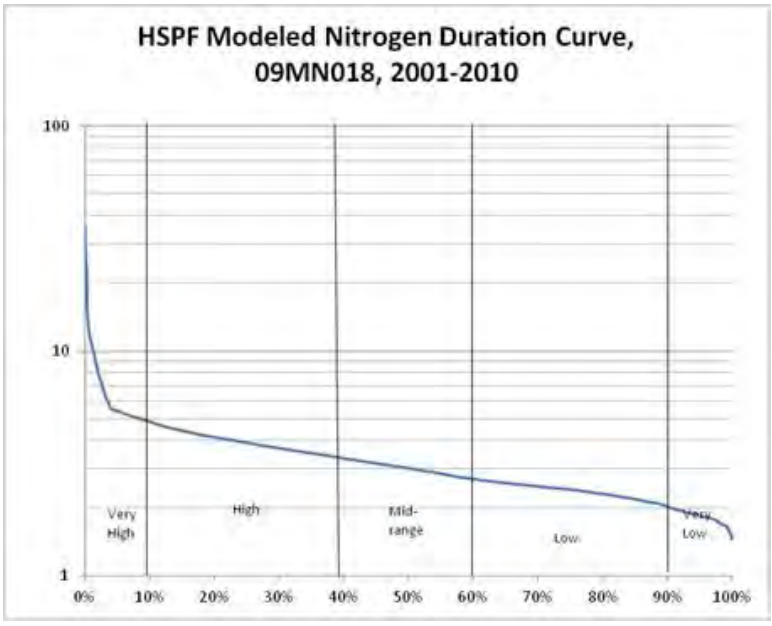


Figure 638-6 HSPF Nitrogen modeling projections.

In an examination of species' tolerance along physiochemical gradients, four species in the Upper Chippewa River (in 2009-2010) had mean TIV in the first quartile, indicative of the greatest sensitivity to nitrate (Figure 638-7; Meador and Carlisle, 2007). Those species included yellow perch, golden shiner, bluegill, and walleye. Although these species were present, they were not present in great numbers. Starting at 09MN005 and going downstream, the nitrate sensitive species made up a minor portion of the sample size.

In 2009 the fish sample at site 09MN018 was comprised of mostly fish for which there is limited data on how they respond to Nitrogen. Of the species where there is data, Nitrogen tolerant individuals (fourth Quartile) comprised 78% of the sample.

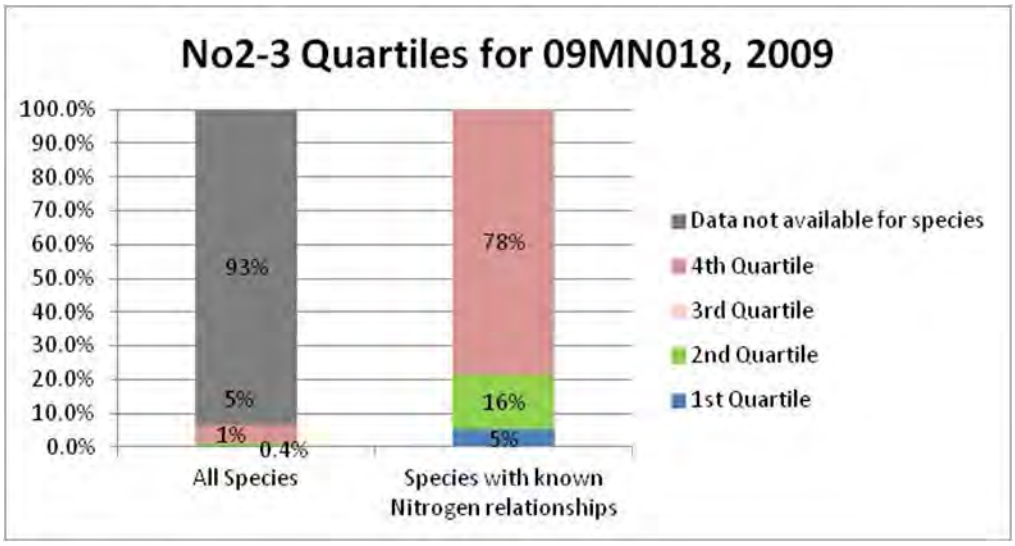


Figure 638-7 Percent fish individuals for each quartile based nitrate tolerance indicator values (Meador and Carlisle, 2007)

Stressor pathway: Riparian condition

The riparian buffers along AUID 07020005-638 are poor in certain areas (see Figure 638-4) where row cropping gets too close to the stream. Lack of buffers can allow high amounts of nutrients from adjacent fields and mowed yards to enter the adjacent stream.

Stressor pathway: Source-water pollution

Channelized and natural tributaries to the Chippewa River carry nitrates during snowmelt and rain events. It is assumed that nitrogen and forms of nitrogen, such as ammonia, are being applied to the cropland throughout the watershed as it is nearly 51% cropland. It is unknown how much groundwater contributes nitrate.

Nitrogen summary:

Nitrate-Nitrite is a likely stressor to the stream biotic community. Fish data, modeling and a survey of physical landscape conditions suggest that it has an effect on fish populations.

Candidate cause: Habitat

Site 09MN018 is located at a slope change. The site sits at the end of a lower slope meandering stream and the top of the stream's 43ft plunge down into the Chippewa River valley in 1.5 miles. The stream at this site is currently a B4 stream type. This is a stream channel type typical to narrow steep valleys, which aptly describes site 09MN018 The B4 stream type is defined as relatively stable to disturbance.

The culvert immediately upstream of the site is acting as an elevation control structure and a barrier to bed load movement. Consequently the reach below the culvert is down cutting as a result of the high slope and lack of bedload.

Site 09MN018 has fair habitat as scored by the MSHA during the fish survey visit in 2009. The site scored well in most of the categories. The site scored low to average in the channel morphology category suggesting that there are geomorphological issues. The survey noted a lack of depth variability, no riffles, limited sinuosity and inadequate channel development.

The SVAP survey conducted on September 26, 2012, observed a wide range of habitat types present including riffles. Despite the presence of good habitat components the overall assessment score was poor. The upstream ditching and a poorly placed culvert were causing downstream scouring issues. This in turn had led to heavy bank erosion. The rocks and stream bottom were coated with algae and the water itself was green indicating poor water quality.

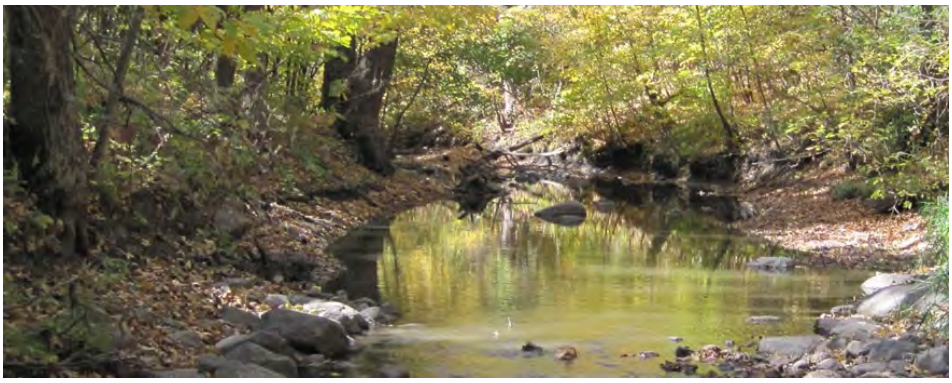


Figure 638-8: Station 09MN018 (Note entrenched channel and bank erosion).

Fish bio-metrics clearly point to habitat stress. The taxa richness of simple lithophilic spawning species was normal but the relative abundance (%) of individuals that are simple lithophilic spawners was low. The same was true of riffle-dwelling species, normal number of taxa but low number of individuals. No individuals or taxa that are benthic insectivores were found in 2009. This was also true of darter, sculpin, and round bodied suckers. These metrics are a clear sign of habitat stress.

Stressor pathway: Riparian condition

The riparian buffers along the main channel of reach are mostly good and serving their function as natural habitat. Riparian conditions are poor in identifiable areas (see Figure 638-4) where row cropping gets too close to the river. These impacted areas no longer serve a benefit as natural habitat. In some cases when the physical conditions are right the lack of protective vegetation allows the river to shift to unstable riparian conditions.

Stressor pathway: Channel alteration

Channel alteration in distinct locations on the stream and in reaches contributing to the river have likely led to changes in the hydrological and geomorphological condition. This has led to changes in discharge patterns, changes in substrate, changes in sinuosity, and increases in erosion.

Figure 638-9: Upstream ditching and meander cutoffs

Habitat summary:

At site 09MN018, the structural components of good habitat are present but the hydrology and geomorphology are making them unstable. Bio-metrics and field surveys identified poor habitat as a stressor causing biotic impairment.

Observations suggest that the reach where the fish were sampled is not representative of the entire reach. Site 09MN018 is located in a wooded, high energy, steep, entrenched stream with low sinuosity. Much of AUID 07020005-638 passes through a highly sinuous lower slope stream in a landscape dominated by grass and cropland.

Candidate cause: Turbidity

Turbidity, which is a measure of transparency, can be increased with sediment, algae and organic matter. In addition to turbidity, the state of Minnesota allows Transparency (25NTU=20cm Transparency) and TSS (25 NTU= 54ppm TSS) as surrogates for turbidity in the Chippewa River watershed. In AUID 07020005-638 there are two sites where turbidity, TSS or transparency has been measured.

In 2009, the fish sample at site 09MN018 was comprised of mostly fish for which there is limited data on how they respond to suspended solids. Of the species where there is data, suspended solids tolerant individuals (fourth Quartile) comprised 78% of the sample.

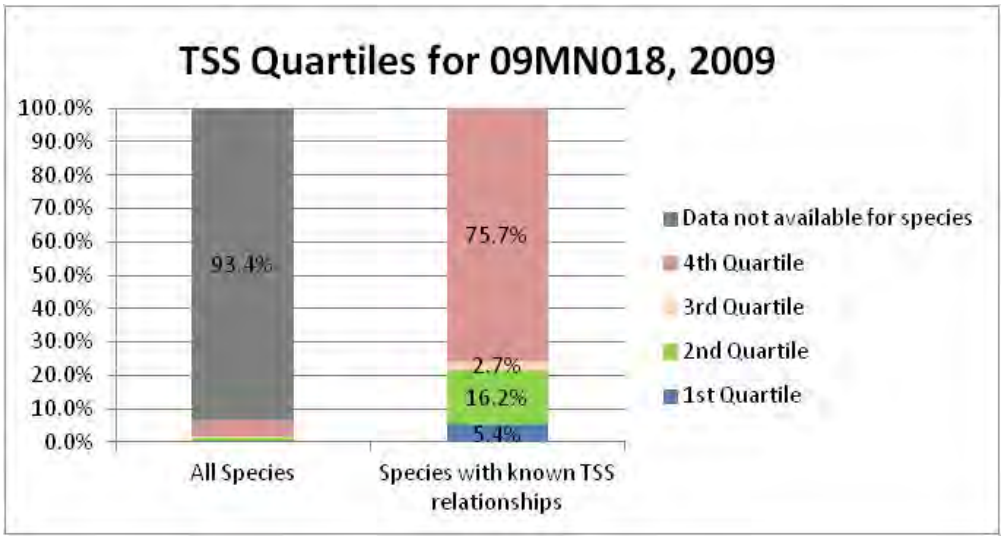


Figure 638-10 TSS quartiles for site 09MN018

Physical monitoring data suggests that turbidity may play a role as a stressor in AUID 07020005-638. Monitoring upstream of the AUID at site S004-338 (Holleque Lake Outlet) shows the stream is possibly impaired for turbidity as more than 10% of the transparency samples were 20cm or less (13% of 70 samples exceeded the standard). At S004-339 (Quam Lake Outlet) only 2% of the 54 samples exceeded the standard (see Figures 638-10 and 638-11). It is notable that transparency tends to get worse as the summer advances. This is likely due to growth of sestonic algae as the water temperature rises and the algae makes use of available water borne nutrients.

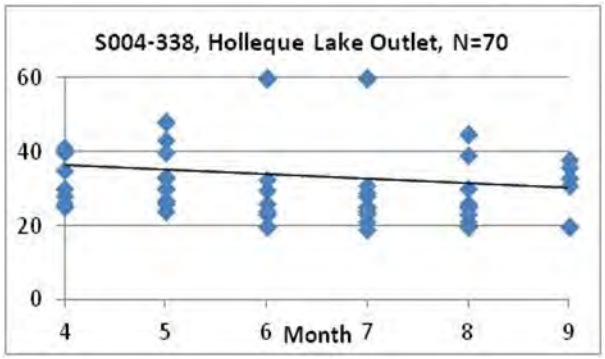


Figure 638-11 Holleque Lake Outlet Transparency (cm)

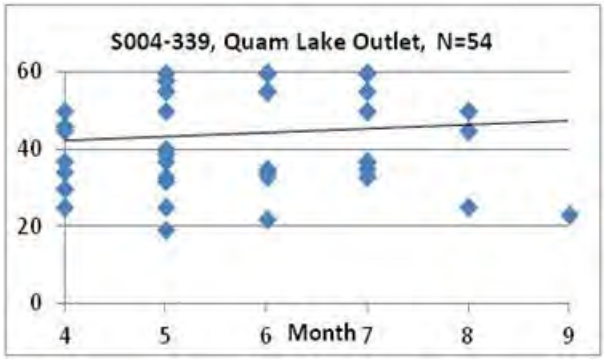


Figure 638-12 Quam Lake outlet transparency (cm)

Venus Lake is immediately upstream of the reach. It too has turbidity data in the form of Secchi depth measurements (Figure 638-12). Venus Lake also exhibits the same summer decreasing pattern seen in

the stream transparency data. This pattern is significant as it occurs during the low flow period of late summer. The combination of low flow, higher water temperatures and higher turbidity is more stressful on fish populations.

The unnamed lake immediately downstream of Lake Venus and the last lake body before the stream reach begins is prone to turbid water and algae blooms. This can be seen easily in USDA Farm Service Agency aerial photos (Figure 638-14).

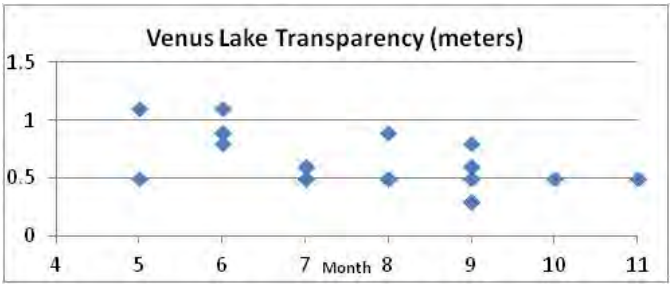


Figure 638-13 Venus Lake Secchi disk Transparency (meters)

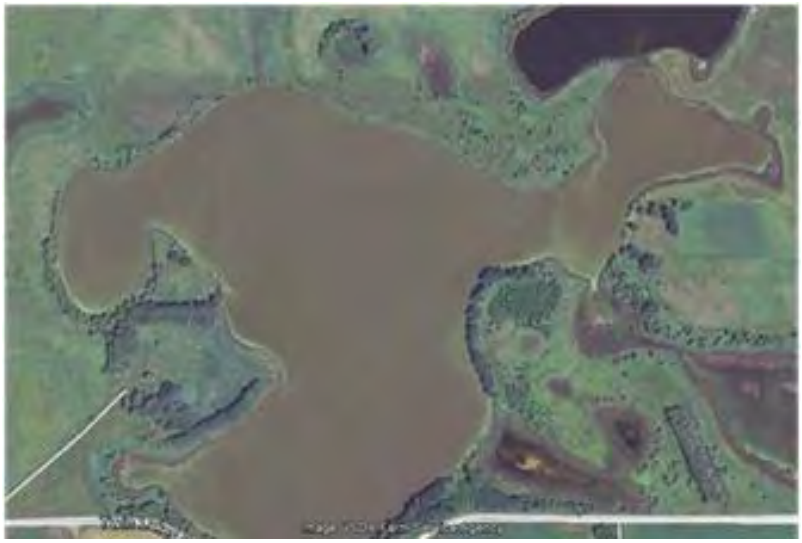


Figure 638-14 Unnamed Lake at beginning of impaired reach, note green algae along the shoreline.

Fish bio-metrics indicate turbidity as a stressor. The taxa richness of simple lithophilic spawning species (need clean gravel substrate for reproduction) was normal but the relative abundance (%) of individuals that are simple lithophilic spawners was low. The lack of taxa and individuals that are herbivore species also is a clear indicator of turbidity stress.

Invertebrate bio-metrics are also a useful indicator of stress. Invertebrates tolerant to turbidity made up 66% of the sample. The relative percentage of scraper taxa was normal but the relative abundance (%) of individuals in the subsample was low. These metrics indicate that turbidity is an issue in this AUID and is having a biological impact.

Stressor pathway: Riparian condition

The riparian buffers along the main reach of AUID 07020005-638 are mostly good and serving their function as natural habitat. Riparian conditions are poor in certain areas (see Figure 638-4) where row cropping gets too close to the stream. These impacted areas no longer serve as a buffer limiting runoff and increased stream turbidity.

Stressor pathway: Channelization

Channelization of reaches within AUID 07020005-638 are minimal. Hydrological changes appear to have impacted the geomorphological condition of the stream. It appears that the stream is in the process of cutting off meanders and decreasing its sinuosity. This has led to changes in erosion rates that have led to an increase in turbidity (Figure 638-9).

Turbidity summary:

Upstream lake and stream monitoring data support turbidity as a stressor in AUID 07020005-638. There are plausible sources and pathways as well as a documented biological response expected in a stream with elevated turbidity levels.

Candidate cause: Altered hydrology

No flow monitoring was conducted in this reach. This site's hydrology has been inferred through modeling and field surveys.

A September 2012 survey of this reach found that it has fairly good low flow hydrology. During the fall drought of 2012 when many other sites of similar size had no flow this stream had a fair volume of flow. There were clear signs of bank scour, bare roots and trees down in the stream indicating that the stream channel was not in a stable state with the higher flows.

HSPF modeling of daily flows in AUID 07020005-638 ranged from 0.20 to 778cfs from 2001 through 2011 (Figure 638-15) The HSPF model predicts that most of the flows are under 20cfs with 40% less than 5.7cfs. The persistence of lower flows is not good for fish communities. Lower flows in the mid to late summer are typically associated with higher pollution levels in the Chippewa watershed. These combine to create a higher stress level than just low flows.

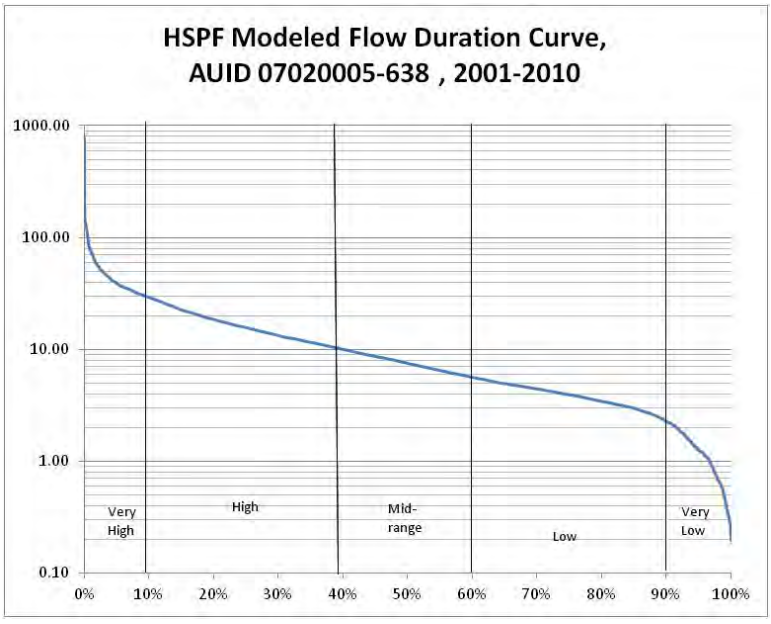


Figure 638-15 HSPF flow duration curve for AUID 07020005-638

Low flow events are a natural part of a river's cycle, but flows that are too low or low too often could result in a negative biological impact. Extended low flow events which were below the estimated 90th percentile flows of 2.0cfs (Figure 638-15) occurred in the winters of 2003, 2004, and 2007 and in the falls of 2006, 2007 and 2012. The low 7Q10 for this site is 0.25cfs and the low 1Q10 is 0.2cfs.

Figure 638-16 Upstream ditching **Bank erosion downstream of culvert**

There is physical evidence to support listing flow alteration as a candidate cause directly upstream of the 09MN018 monitoring site. Surveys at site 09MN018 noted channel scour directly downstream of the upstream culvert. Scouring and dry stream conditions are also evidence of flow alteration. The presence of a channelized section of stream immediately upstream of site 09MN018 is likely a contributing factor to these conditions.

Model points toward flow alteration as seen in the decrease in flow from the 1994-2000 period to the 2000-2010 period depicted in Figure 638-17.

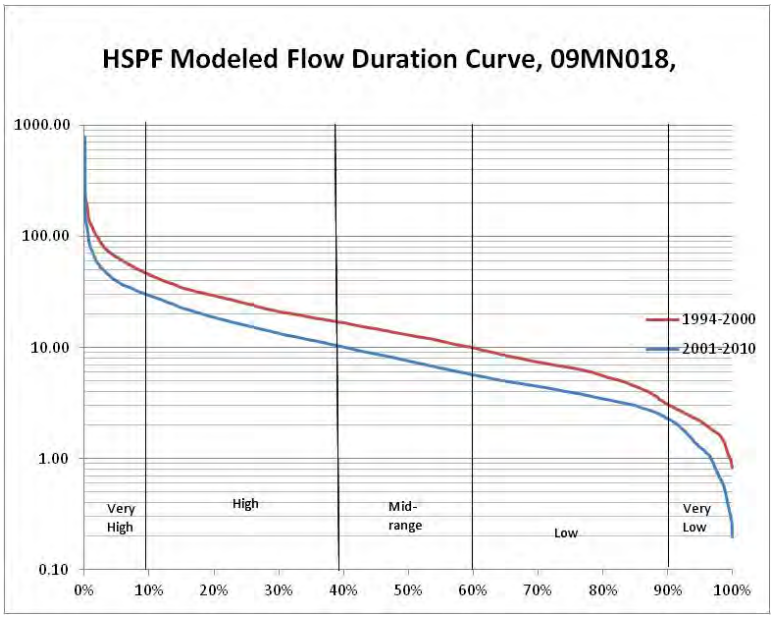


Figure 638-17: HSPF modeled flow duration curve, 09MN018.

Stressor pathway: Channelization

The channelization of intermittent flow pathways and tile drainage has possibly led to changes in flow dynamics. The changes in the hydrological and geomorphological condition have direct impact to the biology of the reach.

Flow alteration summary:

Flow alteration as a candidate cause in AUID 07020005-638 at site 09MN018. The strength of the evidence is fair but not high since it is based on modeling and field observations. There are plausible sources and pathways as well as a documented response to the habitat conditions at site 09MN018.

Weight of evidence

The evidence for each potential stressor, the quantity and quality of each type of evidence is evaluated. The consistency and credibility of the evidence is evaluated. Each step for AUID 07020005-638 was scored and summarized in Figure 638-18. For more information on scoring please see EPA's CADDIS Summary Table of Scores.

Types of Evidence	Scores						
	Low Dissolved Oxygen	High Phosphorus	High Nitrate	Lack of Connectivity	Lack of Habitat	High Turbidity	Altered Hydrology
Spatial/temporal co-occurrence	NE	+	+	R	-	+	+
Temporal sequence	+	+	+	0	-	+	+
Field evidence of stressor-response	-	+	++	0	--	++	+
Causal pathway	+	++	++	++	-	++	++
Evidence of exposure, biological mechanism	+	++	++	0	-	+	++
Field experiments /manipulation of exposure	NE	NA	NE	NE	NE	NE	NE
Laboratory analysis of site media	NE	NA	NE	NE	NE	NE	NE
Verified or tested predictions	NE	NE	NE	NE	NE	NE	NE
Symptoms	+	+	+	0	+	+	+
Evidence using data from other systems							
Mechanistically plausible cause	+	+	+	+	+	+	+
Stressor-response in other lab studies	++	+	+	NA	NE	NE	NE
Stressor-response in other field studies	++	+	+	-	+	+	+
Stressor-response in ecological models	NE	NE	NE	NA	NE	NE	NE
Manipulation experiments at other sites	NE	NE	NE	NA	NE	NE	NE
Analogous stressors	NE	NA	NE	NA	NA	NE	NE
Multiple lines of evidence							
Consistency of evidence	+	+	+	-	+++	+++	+++
Explanatory power of evidence	++	++	++	-	++	++	++

Figure 638-18 Weight of evidence table for potential stressors in AUID: 07020005-638, Unnamed lake to Unnamed lake, Upper Chippewa River, Douglas County, Urness Township.

Conclusions

In AUID: 07020005-638 there is limited monitoring data, nonetheless a relatively good assessment can be made by combining the relevant information that is available. This reach has a number of stressors impacting the biological monitoring site 09MN018.

Observations suggest that the location where the fish were sampled is not representative of the entire reach. Site 09MN018 is located in a wooded high energy steep valley stream with lower sinuosity. Much of AUID 07020005-638 passes through a highly sinuous lower slope stream in a landscape dominated by grass and cropland.

Considerable data shows the drainage to be influenced by elevated levels of phosphorus. Phosphorus in this system is likely to be directly contributing to the turbidity stressor also present in this system.

Nitrate-Nitrite is a likely stressor to the stream biotic community. Fish data, modeling and the presence of the necessary physical pathways suggest that it has an effect on fish populations.

At site 09MN018, poor habitat is a lesser stressor causing biotic impairment in this location. The structural components of good habitat are all there but the hydrology and geomorphology are making them unstable.

Upstream lake and stream monitoring data support turbidity as a stressor in AUID 07020005-638. There are plausible sources and pathways as well as a documented biological response expected in a stream with elevated turbidity levels.

Flow alteration as a candidate cause in AUID 07020005-638 at site 09MN018. The strength of the evidence is good for the monitoring site as a culvert is causing significant scour and impacting downstream habitat. Upstream of the site the evidence is not as good since it is based on modeling and field observations. Overall, there are plausible sources and pathways as well as a documented response to the habitat conditions at site 09MN018 suggesting that flow alteration is a stressor.

18. AUID: 07020005-713, Little Chippewa River, Unamed Creek to County Ditch 2, Pope County

AUID: 07020005-713 was assessed in 2012 and determined to be impaired for fish communities. The impaired reach is the Little Chippewa River in Ben Wade and White Bear Lake Townships of Pope County in the Chippewa River watershed. Fish metrics in this region indicate potential issues with disturbance, water born pollution and unstable habitat. Figure 713-1 is a detailed map of the unnamed drainage and it's watershed.

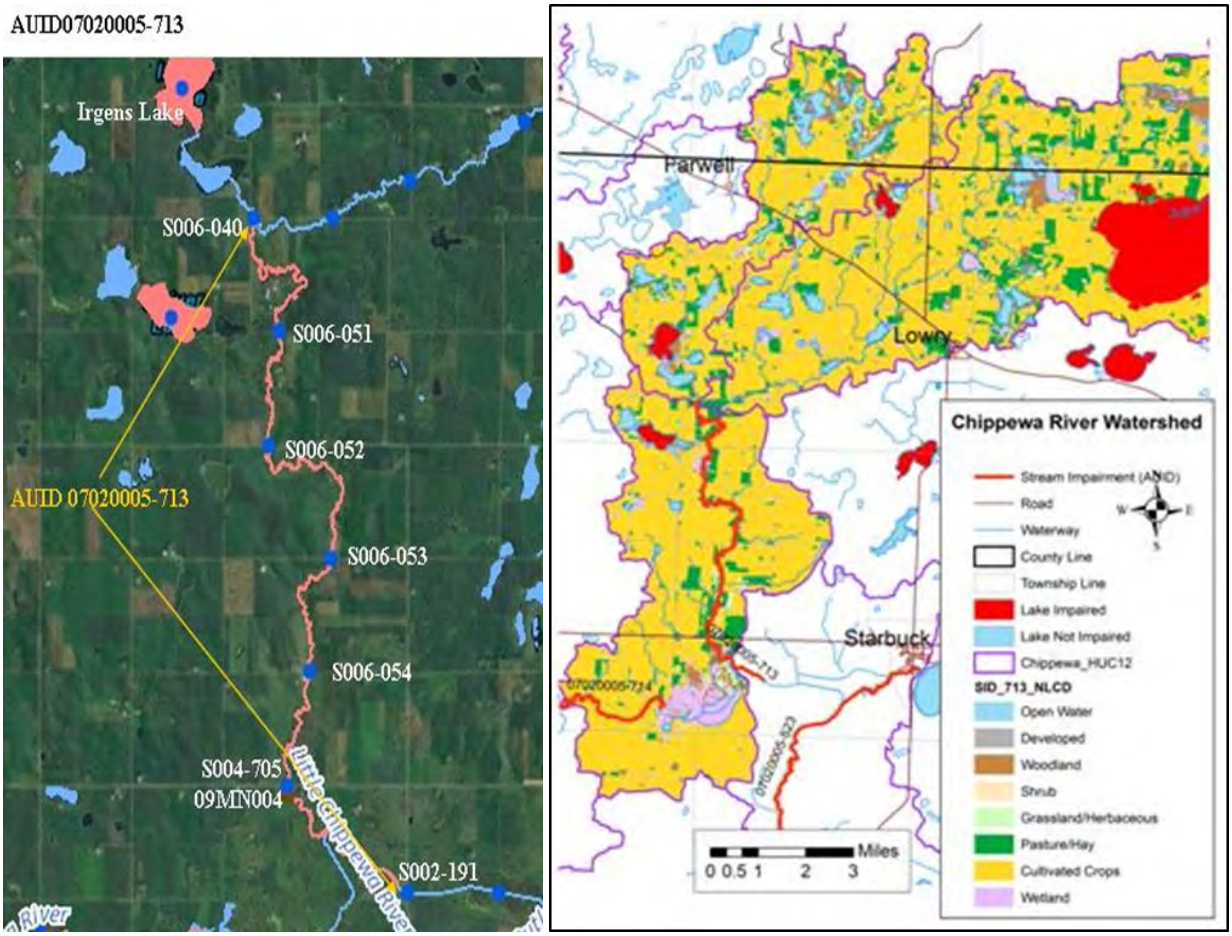


Figure 713-1 AUID: 07020005-713 monitoring sites and contributing watershed.

Biology:

The fish sample in this drainage at site 09MN004 in 2009 reported 16 species. The majority of the individual fish counted were pollution tolerant species. Fathead minnows, a short lived, pollution tolerant species made up 58% of the sample. Consequently, fish metrics for this site were poor with the exception of SLvd (the taxa richness of short-lived species). The predominance of tolerant species as seen in the moderate metric score for TolTXPct, a measure of the relative abundance (%) of taxa that are tolerant species and in the description of quartiles below indicate that water quality and disturbance are issues in this reach (Figure 713-2). There were no non-tolerant benthic insectivore species (BenInsect-TolTxPct), no taxa that are detrivores (DetNWQTXPct), nor were there any sensitive taxa (SensitiveTxPct). The species present were mostly pollution tolerant. The low numbers of types of species in general supports the conclusion that this site is stressed.

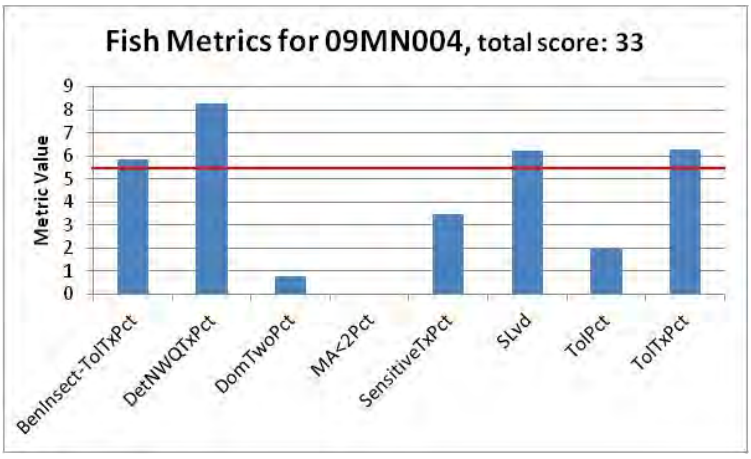


Figure 713-2. Fish metric scores belonging to site 09MN004, Little Chippewa River, AUID: 07020005-713. The red line indicates the average metric score (5.6) needed for IBI score to be at the threshold

A survey of species tolerance levels to NO2-3, TP, TSS and DO revealed a predominance of tolerant individuals (Meador and Carlisle, 2006). In addition it appears that TSS (turbidity) and DO may be the main stressors.

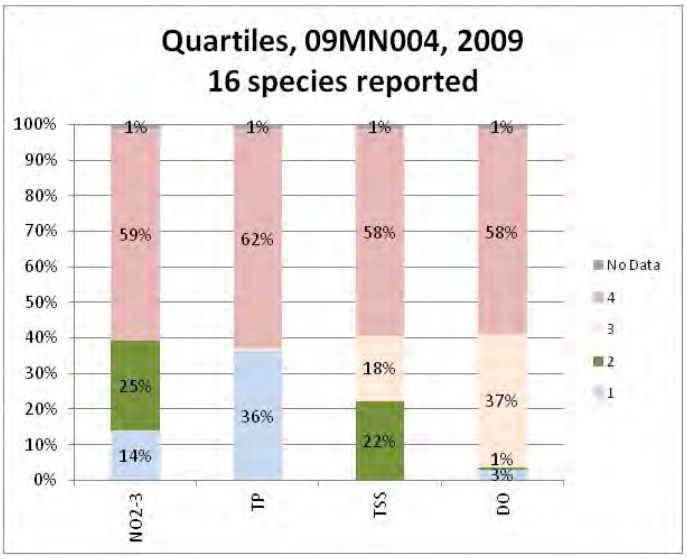


Figure 713-3. Fish quartile values for NO2-3, TP, TSS and DO

Candidate cause: Dissolved oxygen

Dissolved oxygen monitoring conducted in AUID 07020005-713 indicates that DO might be an issue. While only 17 of 317 (5%) DO readings were in exceedance of the 5mg/L standard none of these samples were collected before 9:00 AM. Forty-one of the samples (13%) were below 6mg/L. Given that DO levels are known to rise over the course of the day these samples were likely below 5mg/L during the night.

A review of the fish species, their numbers and metrics present suggests that DO is a driving force in their makeup (Figure 713-3). At site 09MN004, 95% of the fish recorded were either in the third or fourth quartile, tolerant or very tolerant of low DO. The relative abundance (%) of fish individuals that are serial spawners was quite high (71%). In addition, both the taxa richness and the relative abundance (%) of species with a female mature age greater than or equal to three years were low. These metrics and quartile results all indicate that low DO is a stressor to fish populations in the Little Chippewa River.

HSPF modeling suggests that there is not a DO issue at this site. Figure 713-4 shows the modeled 10 year duration curve of daily minimum DO values. The model suggests that incidences below 5mg/L are extremely rare. It is possible that the model is wrong in this case.

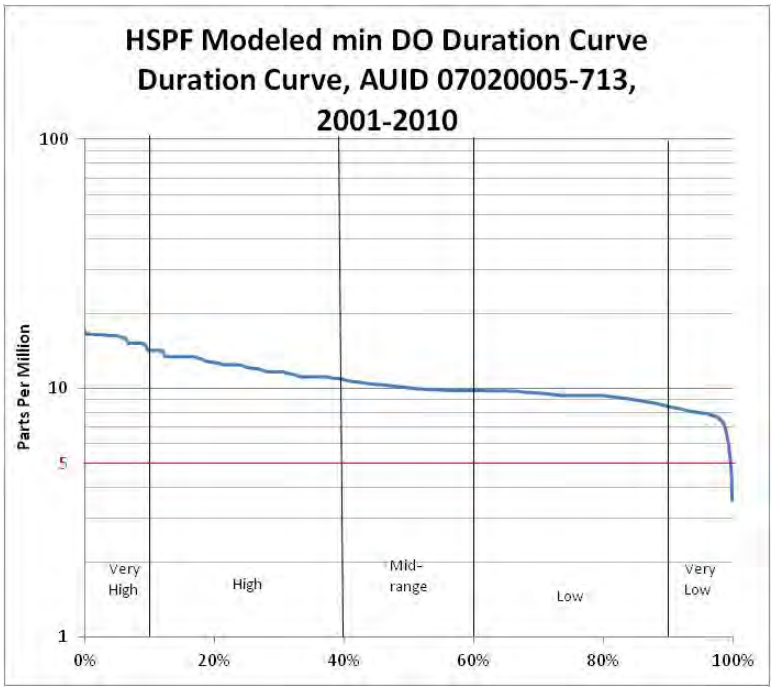


Figure 713-4, HSPF DO modeling projections

Stressor pathway: Impoundments

Dissolved oxygen levels can be affected by impoundments by collecting nutrients and organic materials leading to less availability and by serving as areas for algae blooms. In the AUID 07020005-713 watershed, there are at least ten known natural impoundments. Three of these natural impoundments, Irgens, McIver and Jorgenson Lakes are listed as impaired (Nutrient/Eutrophication Biological Indicators). Figure 713-1 shows the unnamed drainage and the impoundments upstream of the monitoring site.

Irgens, McIver and Jorgenson Lakes all have water quality data. The data did not measure DO levels but they do document eutrophic conditions. Eutrophic conditions indicate widespread pervasiveness of elevated waterborne nutrients. The sources of nutrients to the lake are thus also contributing a high load of nutrients to the stream. This nutrient enrichment can lead to an increased oxygen demand.

Stressor pathway:

Flow monitoring data observed many low flow periods. Oxygen enters streams in various ways including atmospheric diffusion and entrainment from riffles and waves. Changes to flow may reduce surface area and turbulence, which can decrease DO and stress organisms. Site visits to site 09MN004 noted a distinct lack of turbulent water.

Dissolved oxygen summary:

In AUID 07020005-713, there is sufficient data to conclude DO is a stressor to fish communities throughout the reach.

Candidate cause: Phosphorus

Phosphorus samples were taken in AUID 07020005-713 at site 09MN004 also known as S004-705, 65 times from 2006-2009. The samples exceeded the 0.15ppm draft standard 45% of the time and averaged 0.163ppm.

The three impaired lakes, Irgens, McIver and Jorgenson, all have TP water quality data. These data indicate high levels of TP in all three lakes. The sources of nutrients to the lake are thus also contributing a high load of nutrients to the stream.

Looking at the fish data (Figure713-3) 62% of the sample was made up of the most phosphorous tolerant individuals (fourth quartile) while 36% of the individuals were the most sensitive (first quartile). There were no individuals representing the second and third quartiles. These data suggest that while phosphorous may be the driving force of other stressors (low DO and turbidity) it in itself is not the most toxic stressor to fish populations.

The HSPF model suggests that phosphorous concentrations above 0.15ppm occurred 91% of the time from 2001-2010 (Figure 713-5).

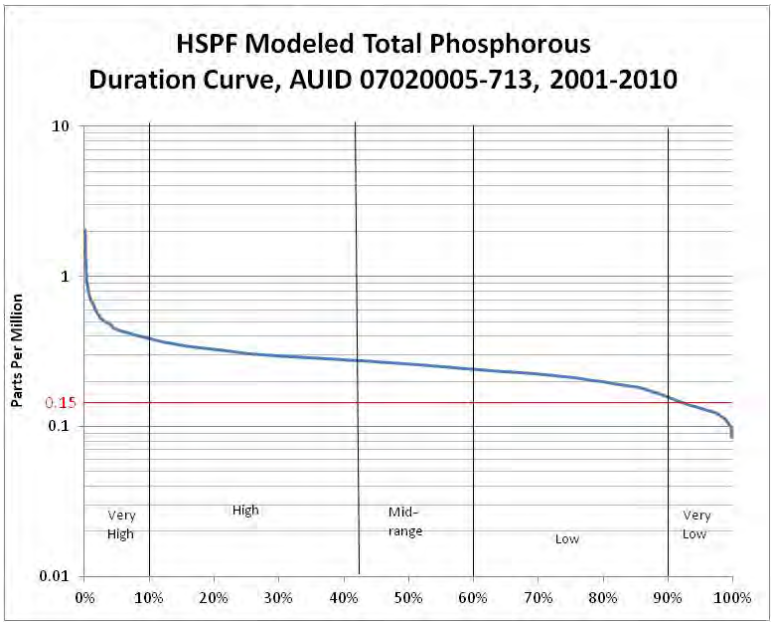


Figure 713-5 HSPF Phosphorous modeling projections

Stressor pathway: Riparian condition

The riparian buffers along the main channel of AUID 07020005-713 are good, often four to five stream widths on each side. There are some notable exceptions where overland flow appears to be an issue (Figure 713-6) and where continuous grazing of livestock is compromising the natural function of the riparian zone (see Stressor: Habitat below). In addition the smaller tributary ditches and streams that feed into the Little Chippewa often have inadequate buffers. Lack of a riparian zone providing some form of "natural" benefit can allow high amounts of nutrients and sediment from adjacent fields and mowed yards to enter the adjacent stream.

Figure 713-6 Example of good buffers (blue) and inadequate buffers (red) between cropland and water along the Little Chippewa River (2012)

Stressor pathway: Source-water pollution

The three impaired lakes, Irgens, McIver and Jorgenson, all have TP water quality data. These data indicate high levels of TP in all three lakes. The sources of nutrients to the lake and the lakes are contributing a high load of nutrients to the stream.

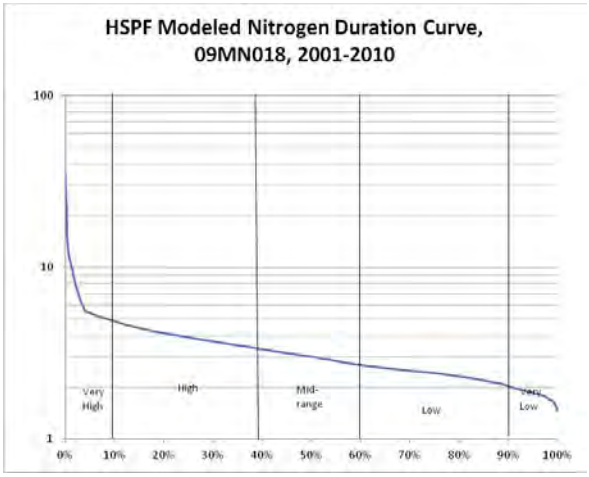
Phosphorous summary:

There is ample data that shows the Little Chippewa River (AUID 07020005-713) to be influenced by elevated levels of phosphorus. Phosphorus in this system is likely to be directly contributing to the DO and turbidity stressors also present in this system.

Candidate cause: Nitrate

NO2-3 samples were taken in AUID 07020005-713 at site 09MN004 also known as S004-705, 63 times from 2006-2009. The average concentration of all the samples was 1ppm and the flow weighted means for 2007-2009 ranged between 1.12 and 1.75mg/L (Figure 713-7). The maximum sampled value was 4.2mg/L. The samples, averages and flow weighted means did not exceed the 10ppm drinking water standard nor the 4.9mg/L aquatic life draft chronic standard.

HSPF modeling projects levels in exceedance of the 75 percentile value of 0.28ppm for North Central Hardwood Forest ecoregion 100% of the time. It also predicts that nitrogen levels exceeded the 10ppm standard only 1% of the time between 2001 and 2010.



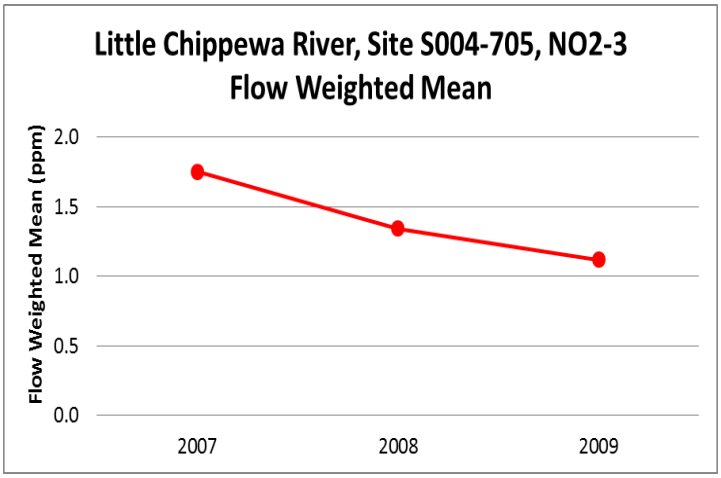


Figure 713-7 HSPF Nitrogen modeling projections and monitoring data derived flow weighted means.

In an examination of species' tolerance along physiochemical gradients species in the Little Chippewa River (in 2009-2010) the first quartile was represented by 14% of the sample, the second quartile 25% and the fourth quartile 59% (Figure 713-3). These results indicate that nitrogen may not be a limiting factor at site 09MN004.

Stressor pathway: Riparian condition

The riparian buffers along the main channel of AUID 07020005-713 are good, often four to five stream widths on each side. There are some notable exceptions where overland flow appears to be an issue (Figure 713-6) and were continuous grazing of livestock is compromising the natural function of the riparian zone (see Stressor: Habitat). In addition the smaller tributary ditches and streams that feed into the Little Chippewa often have inadequate buffers. Lack of a riparian zone providing some form of "natural" benefit can allow high amounts of nutrients and sediment from adjacent fields and mowed yards to enter the adjacent stream.

Stressor pathway: Source-water pollution

Channelized and natural tributaries to the Chippewa River carry nitrates during snowmelt and rain events. It is assumed that nitrogen and forms of nitrogen, such as ammonia, are being applied to the cropland throughout the watershed as it is nearly 73% cropland (2009NLCD). It is unknown how much groundwater contributes nitrate.

Nitrogen summary:

Nitrate-Nitrite is an unlikely stressor to the stream biotic community. Sample data, fish data, and modeling all suggest that it nitrogen is having little effect on fish populations.

Candidate cause: turbidity

Turbidity, which is a measure of transparency, can be increased with sediment, algae and organic matter. In addition to turbidity, the state of Minnesota allows transparency (25NTU=20cm transparency) and TSS (25 NTU= 54ppm TSS) as surrogates for turbidity in the Chippewa River watershed. In AUID 07020005-713 there are six sites where turbidity, TSS or transparency has been measured.

Turbidity was sampled at site S004-705 53 times between 2006 and 2009. Turbidity exceeded the standard in 25% of the samples. Transparency was sampled 139 times at six sites from 2006-2010.

Transparency exceeded the surrogate standard in 42% of the samples. TSS was sampled 64 times at site S004-705. TSS exceeded the standard in 17% of the samples.

HSPF modeling projects levels in exceedance of the 54ppm surrogate standard 16% of the time (Figure 713-8).

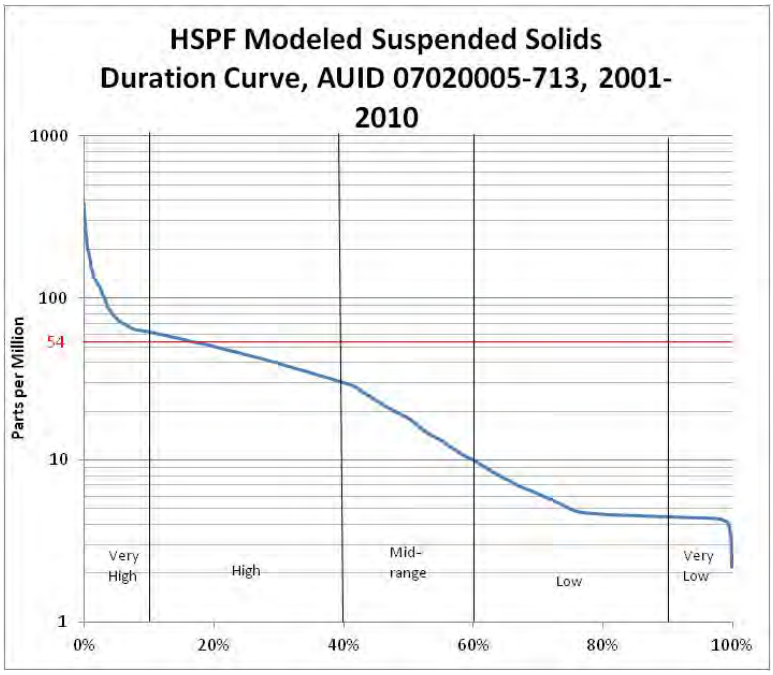


Figure 713-8 HSPF TSS modeling projections

A review of the fish species, their numbers and metrics present suggests that turbidity does have a negative impact in their makeup. In 2009, the fish sample at site 09MN004 was comprised of mostly fish that are tolerant or very tolerant to suspended solids (76% third and fourth quartiles). See Figure 713-3. The relative abundance (%) of individuals that are simple lithophilic spawners was somewhat lower than the average but the number of taxa was normal. The relative abundance (%) of individuals that are herbivore species was quite low (0.05%) even though the number of taxa represented in the sample was high.

Invertebrate metrics did not yield evidence that indicated turbidity is a stressor to invertebrates.

Stressor pathway: Riparian condition

The riparian buffers along the main channel of AUID 07020005-713 are good, often four to five stream widths on each side. There are some notable exceptions where overland flow appears to be an issue (Figure 713-6) and where continuous grazing of livestock is compromising the natural function of the riparian zone (see stressor: habitat below). In addition the smaller tributary ditches and streams that feed into the Little Chippewa often have inadequate buffers. Lack of a riparian zone providing some form of "natural" benefit can allow high amounts of nutrients and sediment from adjacent fields and mowed yards to enter the adjacent stream.

Stressor pathway: Source-water pollution

Lake monitoring data upstream of the reach indicate that turbidity is a stressor in the Little Chippewa River's Lakes. Secchi disk monitoring results from the upstream lakes of the Little Chippewa River document poor lake transparency (Irgens, McIver and Jorgenson Lakes).

The reach is impaired for turbidity as more than 10% of the transparency samples were 20cm or less. The same is true of the two branches of the little Chippewa River upstream of the AUID reach. Figure 713-9 shows all of the monitoring sites on the Little Chippewa River. It is notable that transparency tends to get worse around several upstream lakes. This is likely due to growth of algae that make use of available water borne nutrients.

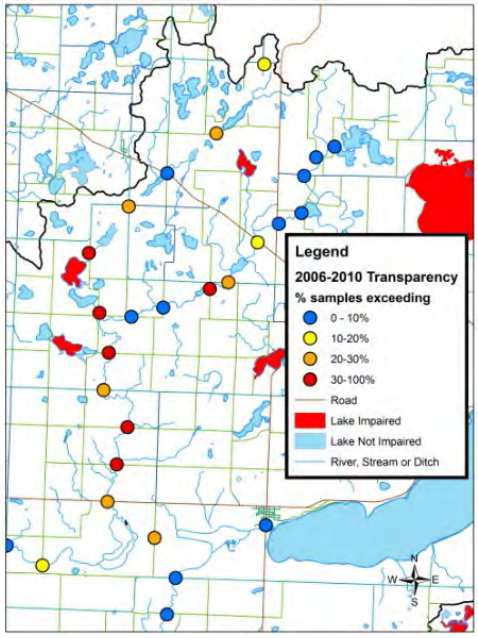


Figure 713-9: Transparency exceedances 2006-10

Stressor pathway: Channelization

Channelization on the actual reach of AUID 07020005-713 is minimal. Channelization has occurred on the tributary ditches and streams that feed into the Little Chippewa River (Figure 713-6). These changes could be changing in-stream erosion rates that have led to an increase in turbidity.

Turbidity summary:

Lake and stream monitoring data, fish data and the HSPF model all support listing turbidity as a stressor in AUID 07020005-713. There are plausible sources and pathways as well as a documented biological response to fish populations expected in a stream with elevated turbidity levels.

Candidate cause: Habitat

Site 09MN004 is located on the upstream side of Minnesota State Highway 28. Fish populations, macroinvertebrate populations and habitat were sampled in the summer of 2009. In 2012 the site was visited again and a SVAP survey was completed. During the 2012 site visit it was noted that immediately downstream of site 09MN004 an overgrazed pasture straddled the river. Consequently a SVAP assessment was taken of the downstream site.

Site 09MN004 has fair habitat as scored by the MSHA in 2009. The site scored poorly in the categories of surrounding land use, riparian zone characteristics and channel substrate. The scores for channel morphology and instream cover Types brought the score up enough to give the site an overall score of Fair. The survey noted a good depth variability, no riffles, good sinuosity and good channel development. It also noted only two substrate types, sand and silt.

The upstream SVAP survey conducted on September 12, 2012, gave the site an overall assessment score of good. They observed a good number of habitat types for fish and slightly less for invertebrates. Channel condition and hydrologic stability were good. The channel bed and banks were made up of mostly silt and some sand. The riffles had little more than sand and shells to work with. The water was slow and slightly turbid. The survey crew did not find any points of water turbulence where air was being mixed into the water.

Figure 713-10 Station 09MN004 upstream (Note undercut bank and fine bed substrate).

The downstream SVAP survey conducted on September 19, 2012, gave the site a poor overall assessment score. Cattle are being continuously grazed at this site. Channel condition and bank stability were unstable due to the constant trampling. Instream fish cover was limited to a few large woody debris. Invertebrate habitat scored slightly better but was poor overall. Overhanging vegetation and macrophytes were nonexistent. There were no deep pools and the riparian zone did not provide a natural function. Here too the channel bed and banks were made up of mostly silt and some sand.

Figure 713-11 Station 09MN004 downstream (Note overgrazed bank and bank erosion).

Fish metrics varied, some of the habitat related metrics indicated stress but not all of them. The relative abundance (%) of individuals that are darter, sculpin, and round bodied sucker species was low (2.65%) indicating stress. The number of darter, sculpin, and round bodied sucker taxa was normal. The relative abundance (%) of individuals that are simple lithophilic spawners was lower than average. Whereas the number of simple lithophilic spawner taxa was normal. The relative abundance (%) of individuals that are benthic insectivore species was below average while the taxa were well represented.

Stressor pathway: Riparian condition

The riparian buffers along the main channel of AUID 07020005-713 are good, often four to five stream widths on each side. There are some notable exceptions where overland flow appears to be an issue (Figure 713-6) and where continuous grazing of livestock is compromising the natural function of the riparian zone. In addition the smaller tributary ditches and streams that feed into the Little Chippewa often have inadequate buffers. These impacted areas no longer serve a benefit as natural habitat. In cases when the physical conditions are right the lack of protective vegetation allows the river to shift to unstable riparian conditions.

Stressor pathway: Channel alteration

Channel alteration in reaches contributing to the river have likely led to changes in the hydrologic and geomorphologic condition. This has likely led to changes in discharge patterns, changes in substrate, changes in sinuosity, and increases in erosion. Given the poor stability of sand and silt as bed and bank material, areas where the river has lost its bank cover and channel stability are particularly susceptible to habitat destruction.

Habitat summary:

The Little Chippewa River has many of the structural components for good habitat. Surrounding land use and buffer management are limiting factors to the natural function of the river. Due to natural limitations in soil types available for channel substrate this reach may be uniquely susceptible to habitat degradation. Human management decisions regarding livestock impact, buffer width and actions that impact habitat availability are causing biotic impairment in distinct locations.

Candidate cause: Altered hydrology

Flow monitoring in this reach was limited to site S004-705. This site's hydrology is characterized by quick rising water levels following rain events and a fair amount of base flow.

CRWP monitoring of daily flows in AUID 07020005-503 ranged from 0.68 to 125cfs at site S004-705 from 2007 through 2009 (Figure 713-12). The channel is an E channel with an easily accessed floodplain. It has a very low entrenchment ratio and is quite sinuous. The measured velocities in this reach range from 0.2 to 2.5ft/s. The ranges of velocities endured are most important to biota rather than an average. Overall, the higher flow conditions of this reach appear to be in good shape.

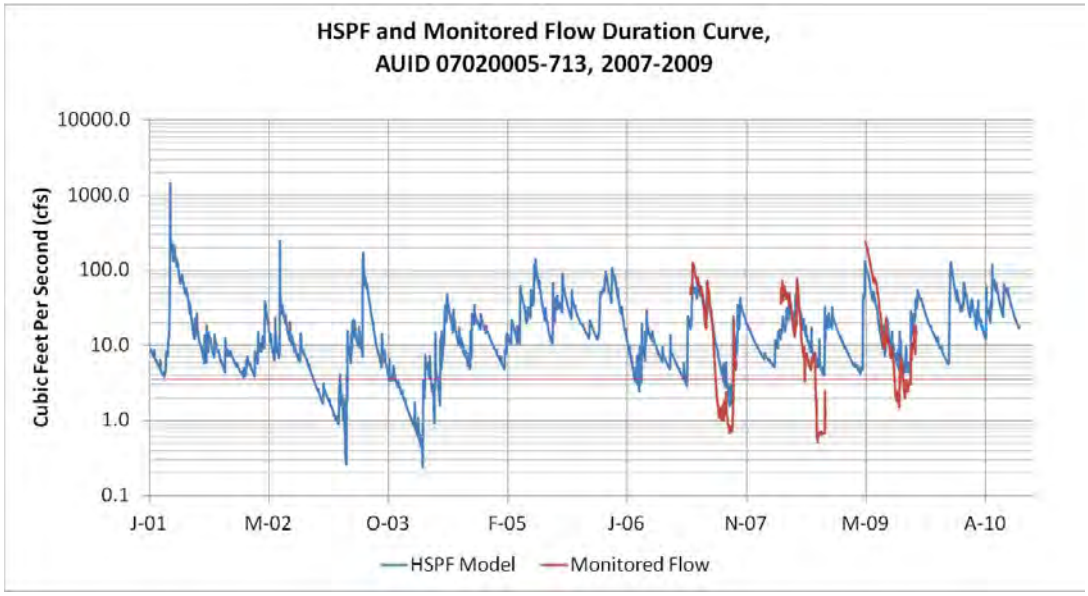


Figure 713-12 Daily flows for site S004-705 from 2007 through 2009

Low flow events are a natural part of a river's cycle, but flows that are too low or low too often could result in a negative biological impact. Extended low flow events which were below the estimated 90th percentile flows of 3.7cfs (Figure 713-13) occurred in the fall of 2002, 2003, 2004, 2006, 2007, 2008 and 2009. The 7Q10 for this site is 0.35cfs and the 1Q10 is 0.24cfs.

Lower flows may reduce surface area and turbulence, which can decrease DO and stress organisms. In this case DO is considered the proximate stressor, while altered hydrology is a step in the causal pathway.

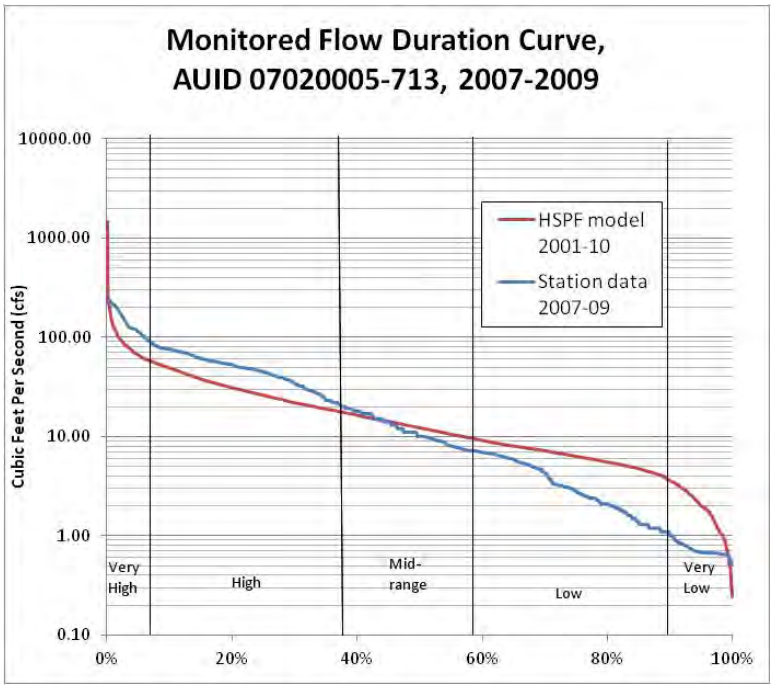


Figure 713-13: Flow duration curves for S004-705

Stressor pathway: Channelization

The channelization of intermittent flow pathways and tile drainage has probably led to changes in flow dynamic. The changes in the hydrological and geomorphological condition have direct impact to the biology of the reach.

Stressor pathway: Impoundments

Active impoundments exist upstream. Any changes to these upstream could have an impact on the discharge of the river system creating changes in water slope leading to changes in scouring and deposition as well as changes to water velocity and depth. They can hold back water which increases discontinuity and potential stranding.

Altered hydrology summary:

There is little evidence to support listing altered hydrology as a primary stressor in this reach. Surveys at 09MN004 did find physical evidence indicative of flow alteration. This is evident of low flow conditions. Lower flows may reduce surface area and turbulence, which can decrease DO and stress organisms. In this case, DO would be considered the proximate stressor, while altered hydrology is a step in the causal pathway.

Weight of evidence

The evidence for each potential stressor, the quantity and quality of each type of evidence is evaluated. The consistency and credibility of the evidence is evaluated. Each step for AUID 07020005-713 was scored and summarized in Figure 713-14. For more information on scoring please see EPA's CADDIS Summary Table of Scores.

Types of Evidence	Scores						
	Low Dissolved Oxygen	High Phosphorus	High Nitrate	Lack of Connectivity	Lack of Habitat	High Turbidity	Altered Hydrology
Spatial/temporal co-occurrence	+	++	--	-	+	++	-
Temporal sequence	+	+	+	0	-	+	+
Field evidence of stressor-response	+	++	--	-	+	++	-
Causal pathway	++	++	-	++	-	++	++
Evidence of exposure, biological mechanism	++	++	-	-	-	+	++
Field experiments /manipulation of exposure	NE	NA	NE	NE	NE	NE	NE
Laboratory analysis of site media	NE	NA	NE	NE	NE	NE	NE
Verified or tested predictions	NE	NE	NE	NE	NE	NE	NE
Symptoms	+	+	+	0	+	+	+
Evidence using data from other systems							
Mechanistically plausible cause	+	+	+	+	+	+	+
Stressor-response in other lab studies	++	+	+	NA	NE	NE	NE
Stressor-response in other field studies	++	+	+	-	+	+	+
Stressor-response in ecological models	NE	NE	NE	NA	NE	NE	NE
Manipulation experiments at other sites	NE	NE	NE	NA	NE	NE	NE
Analogous stressors	NE	NA	NE	NA	NA	NE	NE
Multiple lines of evidence							
Consistency of evidence	+	+	+	-	+++	+++	+++
Explanatory power of evidence	++	++	++	-	++	++	++

Figure 713-14. Weight of evidence table for potential stressors in AUID 07020005-713 Little Chippewa River.

Conclusions

In AUID: 07020005-713 there is good monitoring data, therefore a good assessment of possible stressors can be made by combining the relevant information that is available. This reach has a number of stressors impacting the biological monitoring site 09MN004.

A survey of species tolerance levels to NO2-3, TP, TSS and DO revealed a predominance of tolerant individuals (Meador and Carlisle, 2006). In addition it appears that TSS (turbidity) and DO may be the main stressors.

In AUID 07020005-713, there is sufficient data to conclude DO is a stressor to fish communities throughout the reach.

There is ample data that shows the Little Chippewa River (AUID 07020005-713) to be influenced by elevated levels of phosphorus. Phosphorus in this system is likely to be directly contributing to the DO and turbidity stressors also present in this system.

Nitrate-Nitrite is an unlikely stressor to the stream biotic community. Sample data, fish data, and modeling all suggest that it nitrogen is having little effect on fish populations.

Lake and stream monitoring data, fish data and the HSPF model all support listing turbidity as a stressor in AUID 07020005-713. There are plausible sources and pathways as well as a documented biological response expected in a stream with elevated turbidity levels.

The Little Chippewa River has many of the structural components for good habitat. Surrounding land use and buffer management are limiting factors to the natural function of the river. Due to natural limitations in soil types available for channel substrate this reach may be uniquely susceptible to habitat degradation. Human management decisions regarding livestock impact, buffer width and actions that impact habitat availability are causing biotic impairment in distinct locations.

There is little evidence to support listing altered hydrology as a primary stressor in the reach. Surveys at 09MN004 did find physical evidence indicative of flow alteration. These are evidence of low flow conditions. Lower flows may reduce surface area and turbulence, which can decrease DO and stress organisms. In this case, DO is considered the proximate stressor, while altered hydrology is a step in the causal pathway.

19. AUID: 07020005-714, Little Chippewa River, Unnamed wetland (61-0527-00) to Chippewa River, Pope County

AUID: 07020005-714 was assessed in 2012 and determined to be impaired for aquatic invertebrate communities. The impaired reach is the Little Chippewa River in New Prairie and White Bear Lake Townships of Pope County in the Chippewa River watershed. Bio-metrics in this region indicate potential issues with DO and altered hydrology. Figure 714-1 is a detailed map of the unnamed drainage.

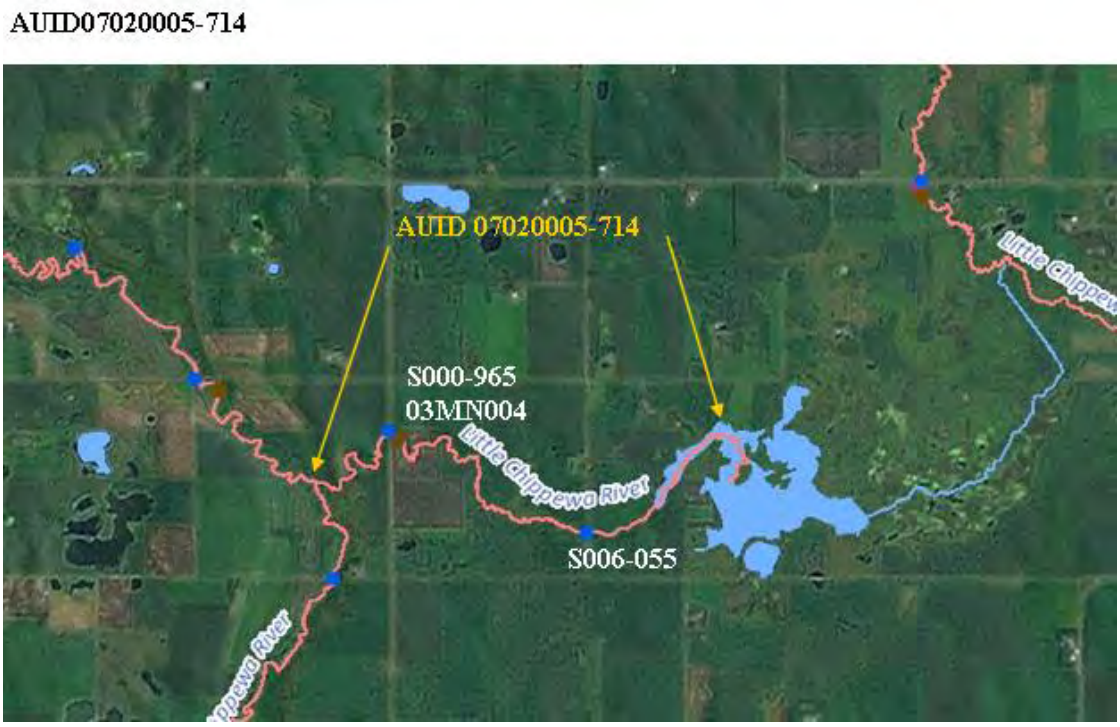


Figure 714-1 AUID 07020005-714 monitoring sites and contributing watershed.

The contributing watershed is 12.6 square miles in area. This watershed's area is occupied by 61.7% row crop agriculture, 13.9 % range, 5.6% forest, 10.9% open water, 3.8% wetlands, and 4.1% urban.

Biology:

The invertebrates were sampled in this drainage at site 03MN004 in 2003 and reported 28 genera. The low scores for Clingers, HBI_MN, Plecoptera taxa, Trichoptera taxa and the dominance of tolerant species all point toward strong stressors at this site.

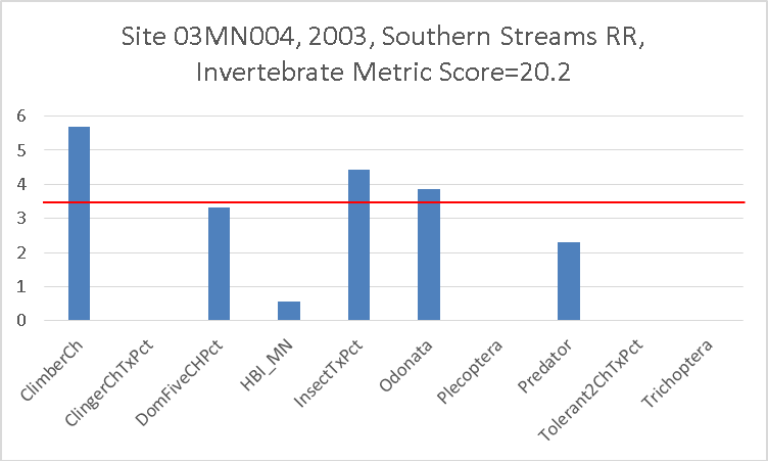


Figure 714-2 Invertebrate metric scores belonging to site 03MN004, Little Chippewa River, AUID: 07020005-714. The red line indicates the average metric score (3.59) needed for Southern Streams MIBI score to be at the threshold

A survey of fish species tolerance levels to NO2-3, TP, TSS and DO can reveal something of the nature of the stressors that the invertebrates are facing in this AUID. There is a dominance of pollution tolerant individuals (Meador and Carlisle, 2006). It appears that TSS (turbidity) and DO may be the main stressors.

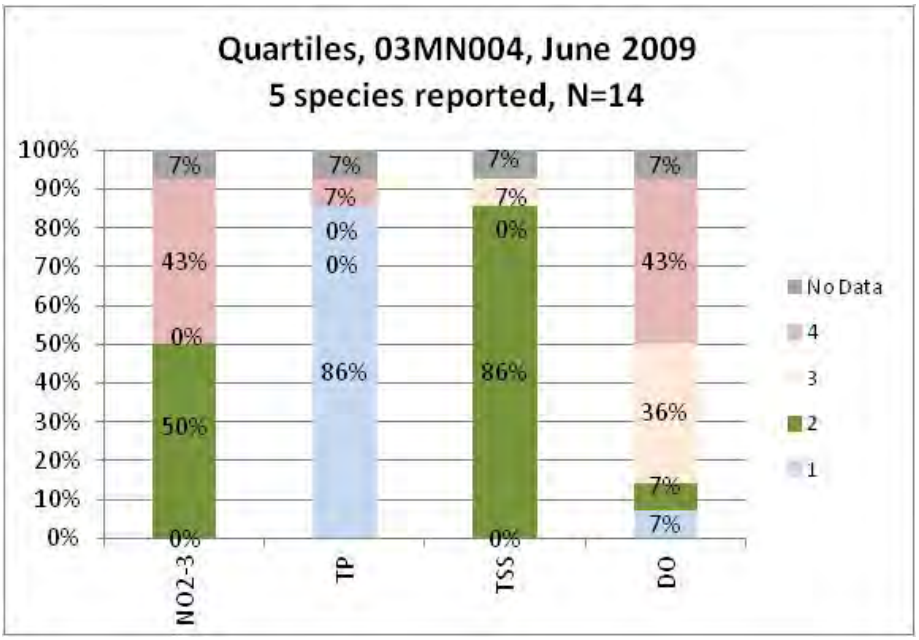


Figure 714-3 Fish quartile values for NO2-3, TP, TSS and DO

Candidate cause: Dissolved oxygen

Dissolved oxygen monitoring conducted in AUID 07020005-714 indicates that DO might be an issue. Thirteen of 28 (46%) DO readings were in exceedance of the 5mg/L standard. These samples may not be getting at the true level of the problem as none of these samples were collected before 9:00 AM. Dissolved oxygen levels are known to rise over the course of the day. These samples were likely below 5mg/L during the night.

A review of the fish species and their numbers present suggests that DO is a driving force in their makeup (Figure 714-3). At site 03MN004, 79% of the fish recorded were either in the third or fourth quartile, tolerant or very tolerant of low DO.

HSPF Modeling suggests that there is not a DO issue at this site. Figure 714-4 shows the modeled 10 year duration curve of daily minimum DO values. The model suggests that incidences below 5mg/L are extremely rare. It is possible that the model is wrong in this case.

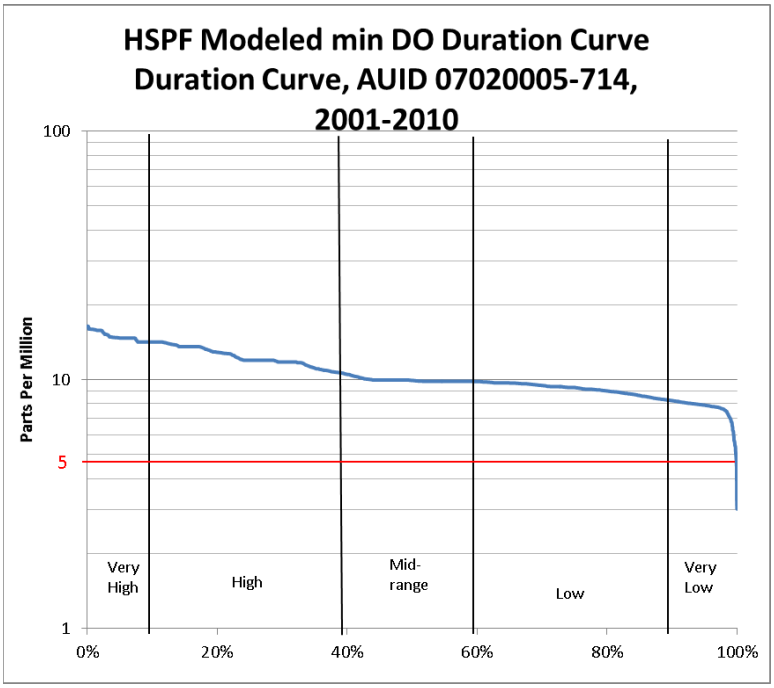


Figure 714-4 HSPF DO modeling projections

Stressor Pathway: Impoundments

Dissolved oxygen levels can be affected by impoundments by collecting nutrients and organic materials leading to less availability and by serving as areas for algae blooms. In the AUID 07020005-714 watershed, the reach begins in a wetland. Figure 714-1 shows the unnamed drainage and the impoundments upstream of the AUID.

Field surveys during 2006-2012 observed periods low flow. Oxygen enters streams in various ways including atmospheric diffusion and entrainment from riffles and waves. Low flow may reduce surface area and turbulence, which can decrease DO and stress organisms. Site visits to site 03MN004 noted a distinct lack of turbulent water.

Dissolved oxygen summary:

In AUID 07020005-714, there is sufficient data to conclude DO is a stressor to fish communities throughout the reach.

Candidate cause: Phosphorus

No phosphorus samples were taken in AUID 07020005-714.

Looking at the fish tolerance data (Figure714-3) 86% of the sample was made up of the most phosphorous in tolerant individuals (first quartile). These data suggest that phosphorous is not a stressor.

Invertebrate metrics were inconclusive. Relative percentage of individuals belonging to Tanytarsini was slightly below average but within one standard deviation. The relative abundance (%) of Mollusca individuals in subsample was low not high which would be the predicted response to high phosphorous. The % dominant metric were all normal as well, not indicating high phosphorous.

The HSPF model suggests that phosphorous concentrations above 0.15ppm occurred 91% of the time from 2001-2010 (Figure 714-5).

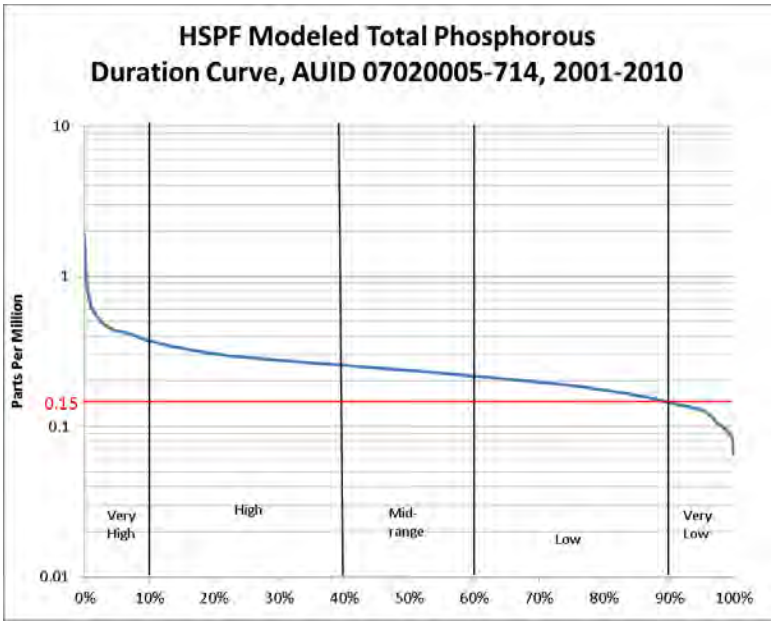


Figure 714-5 HSPF Phosphorous modeling projections

Phosphorous summary:

There is not enough monitoring data to be definitive about the impact of phosphorous on invertebrate populations. Fish tolerance data is fairly clear that phosphorous is not an issue. HSPF modeling argues that phosphorous is a stressor. Phosphorus in this system is not likely stressing the invertebrates. These results are inconclusive until more samples are collected.

Candidate cause: Nitrate

No NO2-3 samples were taken in AUID 07020005-714. Fish tolerance data are inconclusive. Invertebrate indicators are revealing. The numbers for Physa (24) and Hyalella (49) were high. Inversely, there were no Trichoptera taxa and there was only one EPT Taxa. These invertebrate indicators suggest nitrogen is a stressor.

HSPF modeling projects levels in exceedance of the 75 percentile value of 0.28ppm for North Central Hardwood Forest ecoregion 100% of the time. It also predicts that nitrogen levels exceeded the 10ppm standard only 1% of the time between 2001 and 2010.

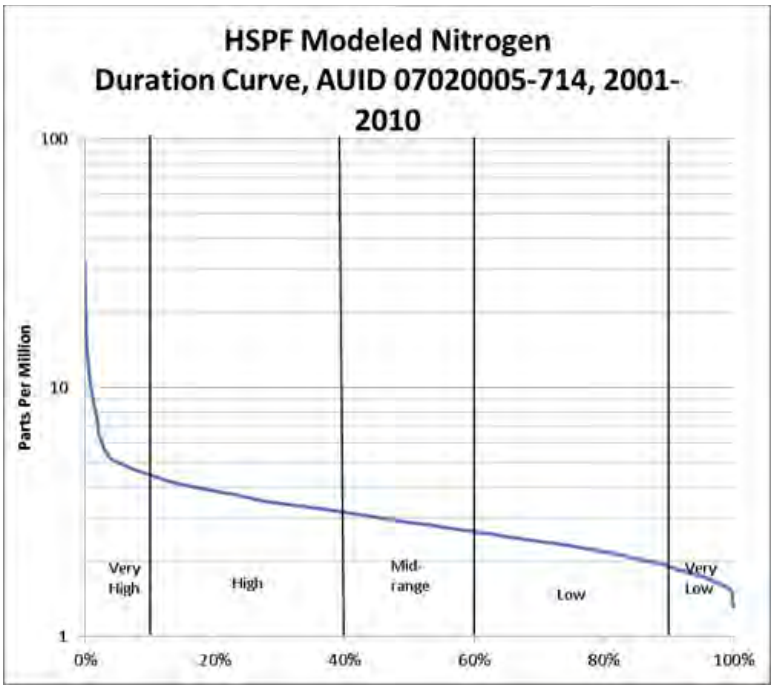


Figure 714-7 HSPF Nitrogen modeling projections and monitoring data derived flow weighted means.

Nitrogen summary:

Nitrate-Nitrite is a likely stressor to the stream biotic community. Invertebrate and HSPF modeling suggest that nitrogen has an effect on invertebrate populations. More samples would be useful.

Candidate cause: Turbidity

Transparency was sampled 108 times in AUID 07020005-714 in 2006-2010. Transparency exceeded the surrogate standard in 3.7% of the samples. HSPF modeling projects levels in exceedance of the 54ppm surrogate standard 14% of the time (Figure 714-8). Given the difficulties HSPF has with modeling small systems heavily influenced by in-stream wetlands these results suggest that turbidity is not an issue.

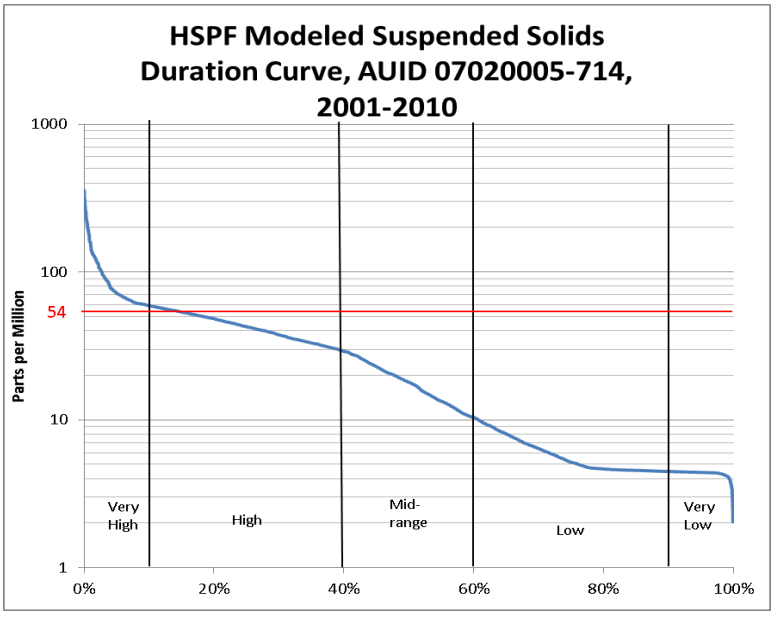


Figure 714-8 HSPF TSS modeling projections

Invertebrate matric data do not support listing turbidity as a stressor. Both the relative abundance (%) of individuals and the richness of taxa of collector-filterers in subsample were normal. Taxa richness and relative abundance (%) of individuals of scrapers were normal. Total taxa richness of macro-invertebrates (chironomid and baetid taxa each treated as one taxon) was also normal. In a survey of invertebrate tolerance to TSS 26% of the sample was found to be made up of invertebrate individuals tolerant to TSS.

Further evidence in agreement with the invertebrate data is the fish tolerance data. In 2009, the fish sample at site 03MN004 was comprised mostly of individuals (86%) that are from the second quartile, intolerant to suspended solids (Figure 714-3).

The riparian buffers along the main channel of AUID 07020005-714 are fair.

Turbidity summary:

Stream monitoring data, bio data and the HSPF model all support the conclusion that turbidity is not a stressor in AUID 07020005-714.

Candidate cause: Habitat

Habitat at Site 03MN004 was scored as good by MSHA protocols in 2003 and 2009. The SVAP protocol also gave the site a "Good" score in 2012.

A survey of invertebrate habitat metrics found only one possible indicator of habitat stress. The absence of plecoptera taxa suggests problems with embedded sediments. Clinger and climber metrics were normal, and dominant species metrics were all normal.

Habitat summary:

The Little Chippewa River has many of the structural components for good habitat. Surrounding land use and buffer management are limiting factors to the natural function of the river. Invertebrate habitat metrics did not identify significant issues. At this time habitat is not a limiting stressor.

Candidate cause: Altered hydrology

AUID 07020005-714 has good high flow characteristics. Surveys of the channel found that overall the higher flow hydrological condition of this reach appears to be in good shape as can be seen in the good meander patterns in Figure 714-9.

Figure 714-9 Little Chippewa River healthy meander pattern

Low flow events on the other hand may be causing the low DO stressor. Site visits in 2012 noted that road culverts were disrupting connectivity and causing water to pool. These low flows are probably due to the unnatural hydrology caused by the dominant surrounding agricultural land use.

Lower flows may reduce surface area and turbulence, which can decrease DO and stress organisms. In this case, DO is considered the proximate stressor, while altered hydrology is a step in the causal pathway.

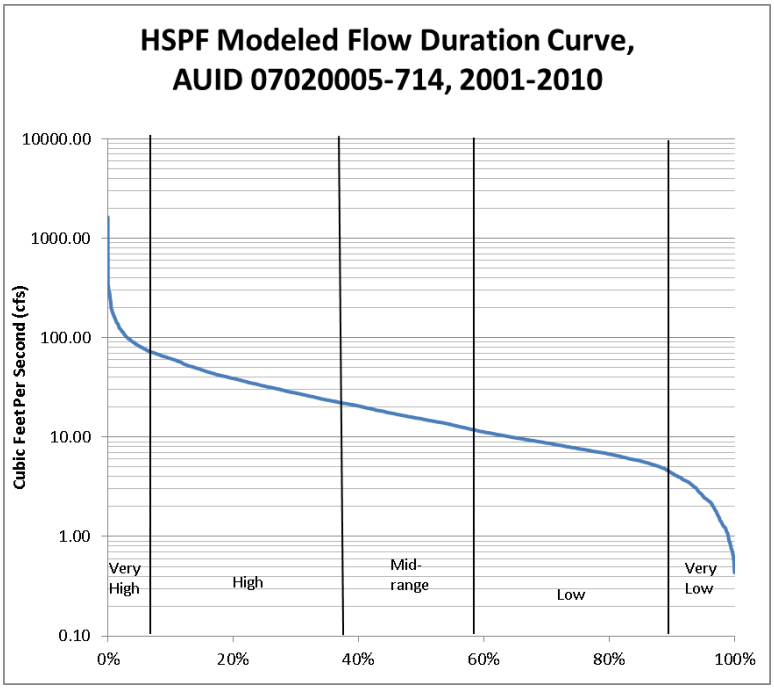


Figure 714-12 Flow duration curves for AUID 07020005-714

Altered hydrology summary:

There is some evidence to support listing altered hydrology as a stressor in this reach. Surveys at 03MN004 did find physical evidence indicative of flow alteration. There is evidence of low flow conditions. Lower flows may reduce surface area and turbulence, which can decrease DO and stress

organisms. In this case, DO would be considered the proximate stressor, while altered hydrology is a step in the causal pathway.

Weight of evidence

The evidence for each potential stressor, the quantity and quality of each type of evidence is evaluated. The consistency and credibility of the evidence is evaluated. Each step for AUID 07020005-714 was scored and summarized in Figure 714-13. For more information on scoring please see EPA's CADDIS Summary Table of Scores.

Types of Evidence	Scores		
	Low Dissolved Oxygen	High Nitrate	Altered Hydrology
Spatial/temporal co-occurrence	++	+	+
Temporal sequence	++	+	+
Field evidence of stressor-response	+	+	+
Causal pathway	++	+	++
Evidence of exposure, biological mechanism	++	+	++
Field experiments /manipulation of exposure	NE	NE	NE
Laboratory analysis of site media	NE	NE	NE
Verified or tested predictions	NE	NE	NE
Symptoms	+	+	+
Mechanistically plausible cause	+	+	+
Stressor-response in other lab studies	++	+	NE
Stressor-response in other field studies	++	+	+
Stressor-response in ecological models	NE	NE	NE
Manipulation experiments at other sites	NE	NE	NE
Analogous stressors	NE	NE	NE
Consistency of evidence	+	+	+
Explanatory power of evidence	++	+	+

Figure 714-13 Weight of evidence table for potential stressors in AUID 07020005-714 Little Chippewa River

Conclusions

AUID: 07020005-714 was assessed in 2012 and determined to be impaired for aquatic invertebrate communities. The main stressors to the invertebrate community are low DO, high nitrogen and altered hydrology.

In AUID 07020005-714, there is sufficient data to conclude DO is a stressor to fish communities throughout the reach.

There is not enough monitoring data to be definitive about the impact of phosphorous on invertebrate populations. Fish tolerance data is fairly clear that phosphorous is not an issue. HSPF modeling argues that phosphorous is a stressor. Phosphorus in this system is not likely stressing the invertebrates. These results are inconclusive until more samples are collected.

Nitrate-Nitrite is a likely stressor to the stream biotic community. Invertebrate and HSPF modeling suggest that nitrogen is an effect on invertebrate populations. More samples would be useful.

Stream monitoring data, bio data and the HSPF model all support the conclusion that turbidity is not a stressor in AUID 07020005-714.

AUID 07020005-714 has good high flow characteristics. Surveys of the channel found that overall the higher flow hydrological condition of this reach appears to be in good shape as can be seen in the good meander patterns in Figure 714-9.

There is some evidence to support listing altered hydrology as a stressor in this reach. Surveys at 03MN004 did find physical evidence indicative of flow alteration. There is evidence of low flow conditions. Lower flows may reduce surface area and turbulence, which can decrease DO and stress organisms. In this case, DO would be considered the proximate stressor, while altered hydrology is a step in the causal pathway.

20. Summary and Recommendations

The Chippewa River watershed is impaired for biology at sixteen different stream reaches. Multiple stressors were found at all streams studied.

Dissolved oxygen is a widespread stressor as seen in the CRWP's monitoring reports (Figure 1-1). Stressor in County Ditch 119 as evidenced by the continuous diurnal monitoring using a sonde. Many parts of the Chippewa River are stressed by low DO. More monitoring is needed watershed wide (particularly 24 hour measurements) to better understand the stress this parameter has on the biological communities.

High phosphorus readings were fairly common throughout the Chippewa watershed. A watershed scale plan to reduce phosphorus amounts is needed. Given the dominance of agricultural land uses in the watershed, plans focusing on managing fertilizers and manure application would help reduce the amount of phosphorus in the system. Additionally, demanding that wastewater and septic systems are up to code and maintained of should be a part of any phosphorous plan. Phosphorous reductions would also aid in the turbidity and dissolved oxygen problems present in the watershed.

Elevated levels of nitrates are stressing the invertebrate communities in many parts of the southern watershed. High nitrate coincides with cropland during snowmelt and rainfall events. Fertilizer application is the likely source of the nitrates in these waterways. Reducing the amounts of nitrates in the system can be achieved by lowering fertilizer application rates, better application times, using cover crops, wetland restorations and increasing the stream buffer width.

Turbidity was a prevalent stressor. Extensive turbidity measuring by the CRWP has revealed that poor turbidity is a prevalent condition in many Chippewa River reach sections. This information suggests that turbidity needs to be addressed on a wider scale than the reach or HUC12 basis. Practices like decreasing algae bloom on in-stream lakes, decreasing nutrient delivery to waterways, increasing stream buffer widths, improving hydrology, as well as improving riparian conditions are activities that need to be considered to reduce turbidity values. Without an increase in effort further impairments to biological communities can be expected.

Habitat throughout the studied reaches had MSHA scores that fell mostly in the Fair category. In general, increases in riparian buffer width, and stabilizing stream banks would greatly help the in-stream habitat that many of these impaired streams lack. Further restoration practices and techniques would also help alleviate the stress on the biological communities in this watershed and could eventually aid in the removal of these streams from the impaired waters list.

Altered hydrology is a major stressor to the fish and invertebrate communities in many parts of the Chippewa River. Drain tiles and channelized streams designed to remove water quickly from the landscape have had a significant impact on the Chippewa Rivers hydrology. Peak flows have become higher resulting in higher energies destabilizing habitat and channel morphology in many parts of the river. Base flows have become lower during dry periods. Practices that reduce the volume, rates and timing of runoff as well as increase the base flows will be needed to prevent continued and further impairments to biological assemblages not only in the studied stream reaches, but throughout the Chippewa River watershed.

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