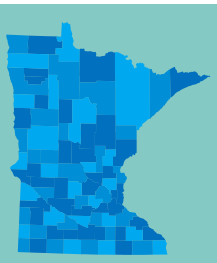
Stressor identification

December 2019

Minnesota River – Headwaters Watershed Stressor Identification Report

Stressor identification for biological impairments in the Minnesota River – Headwaters

MINNESOTA POLLUTION CONTROL AGENCY



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Executive summary

Over the past few 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 the state's rivers and streams. This basic approach is to examine fish and aquatic macroinvertebrate communities and related habitat conditions at multiple sites throughout a major watershed. From these data, an Index of Biological Integrity (IBI) score can be developed, which provides a measure of overall community health. If biological impairments are found, stressors to the aquatic community must be identified.

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 (Cormier et al. 2000). In simpler terms, it is the process of identifying the major factors causing harm to aquatic 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 (CWLA).

This report summarizes stressor identification work in the Minnesota River – Headwaters Watershed. There were 18 stream reaches identified with biological impairments within the watershed. Each stream reach (Assessment Unit Identification is described further in Section 2.

There are 18 stream reaches with fish or macroinvertebrate impairments in the Minnesota River – Headwaters Watershed. Of these 18 impairments, 10 are impaired for fish only and 2 are impaired for macroinvertebrates only. The remaining 6 reaches are impaired for both fish and macroinvertebrates. A summary of the stressors identified in each stream reach is found in Table 14.

After examining many candidate causes for the biological impairments, the following stressors were identified as probable causes of stress to aquatic life:

- Hydrologic alteration
- Connectivity
- Lack of physical habitat
- Dissolved oxygen
- Eutrophication
- Suspended solids
- Nitrates

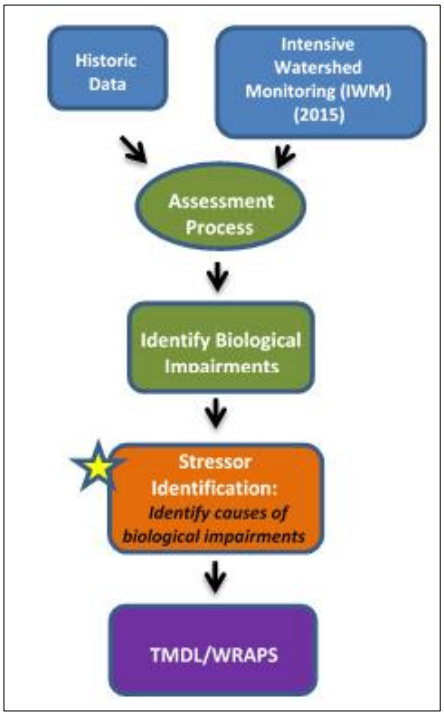
1 Introduction

1.1 Monitoring and assessment

Water quality and biological monitoring in the Minnesota River-Headwaters watershed have been ongoing. As part of the MPCA's Intensive Watershed Monitoring approach, monitoring activities increased in rigor and intensity in the Minnesota River – Headwaters Watershed during the years of 2015-2016 and focused more on biological monitoring (fish and macroinvertebrates) as a means of assessing stream health. The data collected during this period, as well as historic data dating back to 2005, was used to identify stream impairments (Figure 1).

Once a biological impairment is discovered, the next step is to identify the source(s) of stress to the biological community. A Stressor Identification (SID) analysis is a step-by-step approach for identifying probable causes of an impairment in a particular system. Completion of the SID process does not result in a finished Total Maximum Daily Load (TMDL) study. The product of the SID process is the identification of the stressor(s) for which the TMDL may be developed. For example, the SID process may help investigators nail down excess fine sediment as stressor to biological community, but a separate effort is then required to determine the TMDL and implementation goals needed to restore the impaired condition.

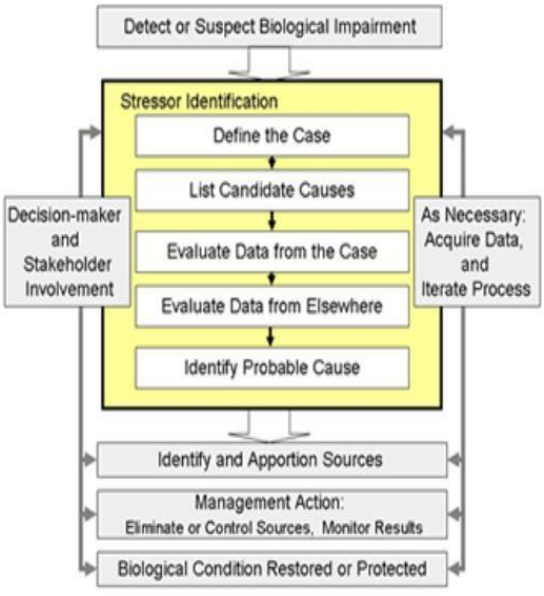
Figure 1. Process map of Intensive Watershed Monitoring.



1.2 Stressor identification process

The MPCA follows the U. S. Environmental Protection Agency (EPA)'s process of identifying stressors that cause a biological impairment, which has been used to develop the MPCA's guidance to stressor identification (Cormier et al. 2000; MPCA 2008). The EPA has also developed an updated, interactive web-based tool, the Causal Analysis/Diagnosis Decision Information System (CADDIS; EPA 2010). This system provides an enormous amount of information designed to guide and assist investigators through the process of Stressor Identification. Additional information on the Stressor Identification process using CADDIS can be found here: http://www.epa.gov/caddis/. Stressor Identification is a key component of the major watershed restoration and protection projects being carried out under Minnesota's CWLA. SID draws upon a broad variety of disciplines and applications, such as aquatic ecology, geology, geomorphology, chemistry, land-use analysis, and toxicology. A conceptual model showing the steps in the SID process is shown (Figure 2). Through a review of available data, stressor scenarios are developed that aim to characterize the biological impairment, the cause, and the sources/pathways of the various stressors.

Figure 2. Stressor identification process (Cormier et al. 2000).



Strength of evidence (SOE) analysis is used to evaluate the data for candidate causes of stress to biological communities. The relationship between stressor and biological response are evaluated by considering the degree to which the available

evidence supports or weakens the case for a candidate cause. Typically, much of the information used in the SOE analysis is from the study watershed (i.e., data from the case). However, evidence from other case studies and the scientific literature is also used in the SID process (i.e., data from elsewhere).

Developed by the EPA, a standard scoring system is used to tabulate the results of the SOE analysis for the available evidence. A narrative description of how the scores were obtained from the evidence should be discussed as well. The SOE table allows for organization of all of the evidence, provides a checklist to ensure each type has been carefully evaluated and offers transparency to the determination process.

The existence of multiple lines of evidence that support or weaken the case for a candidate cause generally increases confidence in the decision for a candidate cause. Additionally, confidence in the results depends on the quantity and quality of data available to the SID process. In some cases, additional data collection may be necessary to accurately identify the stressor(s) causing impairment. Additional detail on the various types of evidence and interpretation of findings can be found here: http://www.epa.gov/caddis.

1.3 Index of Biological Integrity Scores and Biological Classes

Aquatic biota are known to be responsive to a wide variety of anthropogenic impacts and, at the community level, reflect the integrated result of physical, chemical, and biological processes through time (Barbour et al. 1999). In this manner, aquatic communities provide a direct, comprehensive perspective on water quality, and lend themselves well to tools that utilize community-level parameters, such as the Index of Biological Integrity (IBI).

The IBI was originally developed as a tool for assessing the condition of rivers and streams in the Midwestern United States (Karr 1981, Karr et al. 1986). The concept has since been expanded to a wide variety of geographic regions and ecological systems, and has demonstrated its effectiveness in several applications (e.g., condition monitoring, stressor identification). At its core, the IBI provides a framework for translating biological community data into information regarding ecological integrity ("the capability of supporting and maintaining a balanced, integrated, functional organization comparable to that of the natural habitat of the region," Frey 1977). It utilizes a variety of attributes ("metrics") of the biological community, each of which responds in a predictable way to anthropogenic disturbance.

Biological metrics are based on ecological traits of species and represent different aspects of ecological structure and function. The metrics are scored numerically to quantify deviation from least-disturbed conditions, and summed together producing a composite IBI score that characterizes biological integrity (Karr et al.1986). Narrative language within Minnesota Administrative Rule identifies an IBI calculation as the primary determinant for evaluating impairment of aquatic biota (Minn. R. 7050.0150, subp. 6, Impairment of biological community and aquatic habitat). More information on Fish and Invertebrate IBI development can be found here: (MPCA, 2014a; MPCA, 2014b).

Recognizing that biological communities vary along natural gradients, an effort was undertaken to develop a stream classification framework for Minnesota's riverine fish and invertebrate communities. A classification framework was developed that divides Minnesota Rivers and streams into eleven "fish classes," and nine "invertebrate classes". These classes are differentiated by region, drainage area, gradient, thermal regime, types of habitat sampled, qualitative and quantitative habitat measurements, and observations of flow at the time of sampling (MPCA, 2017ab).

The biological classes have been further broken up into three Tiered Aquatic Life Uses (TALU). The aquatic life expectations we have for our streams, as expressed as IBI scores, form the basis for TALU. TALU divides streams into Exceptional, General, and Modified Uses. Exceptional use streams will be high quality waters with fish and invertebrate communities at or near undisturbed conditions. General use streams will be waters with good fish and invertebrate communities that meet minimum goals. Modified use streams will be waters with legally altered habitat that prevents fish and invertebrate communities from meeting minimum goals. Each of these classifications has specific biological threshold scores for both fish and invertebrates (Table 1). Stream reaches addressed in this report contain one or more biological sampling Bio sites that did not meet the threshold for their respective c lass.

The biologically impaired reaches addressed in this report within the Minnesota River – Headwaters Watershed consist of three fish classes and two invertebrate classes, as well as both general and modified uses (Table 1). The biological fish and invertebrate classes are as follows:

Fish Class 1 Southern Rivers

Large warm/coolwater rivers in southern Minnesota and the western portion of the Red River Basin

Sites in southern Minnesota and the Glacial Lake Agassiz Basin (GLAB) ecoregion, where watershed area exceeds 300 square miles.

Fish Class 2 Southern Streams

Large warm/coolwater streams and small rivers in southern Minnesota and the far-western portion of the Red River Basin

Sites in southern Minnesota and the GLAB ecoregion, where watershed area exceeds 30-square miles but is less than 300-square miles.

Fish Class 3 Southern Headwaters

Small, moderate to high-gradient warm/coolwater streams in southern Minnesota and the far-western portion of the Red River Basin

Sites in southern Minnesota and the GLAB ecoregion, where watershed area is less than 30-square miles and gradient is greater than 0.5 m/km.

Table 1. Fish and Invertebrate bio classes and their numeric thresholds addressed within the Minnesota River-Headwaters Stressor ID Report.

Fish

Bio Class	IBI Threshold General Use	IBI Threshold Modified Use
Class 1 – Southern Rivers	49	N/A
Class 2 – Southern Streams	50	35
Class 3 – Southern Headwaters	55	33

Invertebrates

Bio Class	IBI Threshold General Use	IBI Threshold Modified Use
Class 5 – Southern Streams Rock Riffle	37	24
Class 7 – Prairie Streams Glide Pool	41	22

1.4 Data used in Stressor Identification

The Strength of evidence (SOE) analysis in Stressor Identification uses several different types of data from various sources. A variety of published and non-published sources were used to assign trophic, reproductive, habitat, tolerance, and life history traits to different taxa known to inhabit Minnesota's rivers and streams (Balon 1975, Pflieger 1975, Becker 1983, Lyons 1992, Barbour et al. 1999, Etnier and Starnes 1999, Goldstein and Meador 2004, Frimpong and Angermeier 2009).

The biological metric, tolerance value, habitat, and chemical parameter data used in this report is summarized below:

1.4.1 Biological metrics

Biological metrics are simply different groupings of certain taxa combined into groups based off of commonalities related to their taxonomy, morphometry, behavior, habitat requirements, or life history traits. This type of trait-based approach

groups' species that experience their environment in a similar fashion, and emphasizes the functional structure of biological communities (Karr and Chu 1999).

1.4.2 Tolerance values- Taxa

Tolerance values were determined for various fish and invertebrate taxa using MPCA biological sampling data to refine existing tolerance attributes derived from literature. Taxa-specific tolerance values were calculated by using a weighted-averaging process (Meador and Carlisle 2007) (Sandberg, 2013) using the taxa abundance in a biological sample and the parameter/pollutant (e.g., phosphorus, total suspended solids (TSS), nitrate-nitrite, dissolved oxygen (DO), habitat/channel characteristics) concentration/value at the time of the sample. This assigns a tolerance value that indicates the most common concentration/value that each species was found during biological sampling by the MPCA within Minnesota.

1.4.3 Tolerance Index Values-Biological bio site

A Tolerance Index Value for bio sites for certain parameters/pollutants is calculated by using a weighted-averaging process of the taxa specific tolerance values of each taxon that is present at a biological Bio site. Each Bio site gets a tolerance index value based off of the tolerance values and number of fish of each species present at the Bio site.

1.4.4 MSHA-Habitat data

Habitat characteristics are recorded using a qualitative, observation based method modified from Rankin, 1989. The Ohio QHEI is a physical habitat index designed to provide an empirical evaluation of the lotic macro-habitat characteristics that are important to fish communities and which are generally important to other aquatic life. Although similar to the Ohio QHEI, the MSHA has been modified to more adequately assess important characteristics influencing Minnesota streams. The MSHA incorporates measures of watershed land use, riparian quality, bank erosion, substrate type and quality, instream cover, and characteristics of channel morphology, stability, and development.

1.4.5 Monitoring data

Water samples were collected and analyzed by several different public and private entities throughout Minnesota. This monitoring data is entered into the MPCAs EQuIS database and is used for a variety of purposes, including stressor identification. There are two main types of monitoring data collected in the Minnesota River Headwaters:

Grab samples

Water samples are collected and sent to a laboratory for analysis. Labs can test for a variety of different parameters and pollutants, such as total phosphorus, total suspended solids, nitrate-nitrite, Chlorophyll a, and many others. Results are usually given in the form of a concentration of total pollutant per unit of water.

Field measurements

Temperature, specific conductance, DO and pH measurements are recorded with a field meter using point measurements. These measurements indicate the concentration/value at the time of the reading and are usually taken while collecting grab samples. Measurements are typically taken using a YSI Sonde field meter or some equivalent meter.

Diurnal measurements

Under eutrophic conditions, excessive algae growth during the day produces relatively high concentrations of oxygen and can actually supersaturates the water. Overnight, as photosynthesis stops producing oxygen and bacteria consumes the dead algae, oxygen levels can drop significantly below 5 mg/L. Field meters are deployed for weeks at a time and usually record field measurements every 15 minutes. This allows overnight DO levels to be monitored in order to assess the amount of diurnal DO flux, or the difference between the highest and lowest DO levels in a cycle of approximately a 24-hour period, which recurs every 24 hours.

1.5 Stressors, biological metrics, and tolerance values

The elements of a healthy stream consist of five main components: stream connections, hydrology, stream channel assessment, water chemistry, and stream biology (Figure 3). The following flowchart shows the five components of a healthy stream. If one or more of the components are unbalanced, the stream ecosystem fails to function properly and may be listed as an impaired waterbody. These dynamics are important to understand when going through SID evaluation.

Common stressors to biological communities are specific aspects within one of the five stream elements. The stressors and biological metrics that are examined in this report are listed and explained below (MPCA, 2017c). Metrics are based on ecological traits of species and represent different aspects of ecological structure and function.

Figure 3. The five components of stream health and conditions that stress streams.

1.5.1 Hydrologic alteration

Hydrologic alteration describes any type of change to the way water moves within a watershed. Many types of alterations have occurred in the past and continue today; including channel alteration, re-routing and ditching of streams, water withdrawals, and land cover alteration, subsurface tile drainage, and impoundments or dams. Hydrologic Alteration and its follow-on effects of channel instability, bank erosion, excess sediment, and destruction or reduced habitat are all possible stressors.

Changes in landscape vegetation, pavement, and drainage can increase how fast rainfall runoff reaches stream channels. This creates a stronger pulse of flow, followed later by decreased baseflow levels. According to the authors of a review on flow effects (Poff, 1997), "Streamflow quantity and timing are critical components of water supply, water quality, and the ecological integrity of river systems. Indeed, streamflow, which is strongly correlated with many critical physicochemical characteristics of rivers, such as water temperature, channel geomorphology, and habitat diversity, can be considered a 'master variable'..." Increasing surface water runoff and seasonal variability in stream flows have the potential for both indirect and direct effects on fish populations (Schlosser, 1990).

The inverse effect to an increase of stream flow with artificial subsurface drainage and trapezoidal ditches is seen in the reduction of base flow conditions during periods of low precipitation. Within this watershed, there are times where base flows within upland tributaries drastically drop and dry up later in the summer. (Carlisle et al, 2011) found a strong correlation between diminished streamflow and impaired biological communities. Numerous studies have found conventional trapezoidal ditches to be inferior to natural streams in terms of sediment transport capacity and channel

stability over time (Urban and Rhoads, 2004; Landwehr and Roads, 2003). Conventional ditches are designed to handle low frequency, high-magnitude flood events. This design may not support adequate water depth and velocities for transporting sediment and maintaining stream features (e.g., glide, riffle, run, pool) during low to moderate flow periods. The common result is excess sedimentation of the streambed as particles become immobile and aggrade over time. In general, this design does not provide good habitat for aquatic species or provide stability of its streambed and stream banks.

Habitat availability can be scarce when flows are interrupted, low for a prolonged duration, or extremely low, leading to decreased wetted width, cross sectional area, and water depth. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and competition for resources increases.

Pollutant concentrations can increase when flows are lower than normal, increasing the exposure dosage to organisms. Tolerant organisms can out-compete others in such limiting situations and will thrive. Low flows of prolonged duration lead to macroinvertebrate and fish communities comprised of generalist species or that have preference for standing water (U.S.EPA, 2012). Drainage of wetlands within the Minnesota Headwaters Watershed has increased the speed at which water moves within the watershed. This has the effect of reducing water storage and the amount of water available during times of low precipitation, lowering groundwater tables, and reducing near channel storage that otherwise sustains lateral drainage during dry periods (Blann; et al 2009). Wetlands tend to slow water down and store it on the landscape, metering out the water over time.

Table 2. Hydrologic alteration related fish metric descriptions

Fish Metric	Metric Description	Response to Hydrologic Alteration Stress
General %	Generalized fish species are correlated with channelization and are adaptable to different habitats through generalized food preferences. Trophic generalists are able to utilize multiple food resources (e.g. macrophytes, plankton, detritus). They are more tolerant of degradation than trophic specialists, because they can survive even if sensitive food resources (e.g. benthic invertebrates) are reduced or eliminated, by switching to other, less sensitive, food resources.	**Increase**
Nesting Non Lithophilic Spawner %	Relative abundance of non-Lithophilic, nest-guarding individuals. The numbers of nest guarder species are positively correlated with low flow conditions. Non-lithophilic nest-builders include species that build and spawn in or over nests constructed from materials other than coarse substrate. Because these species invest time and energy in preparing nests, and frequently also invest time and energy in guarding the nests and/or caring for their eggs and offspring, they experience an advantage in degraded habitats and other stressful environmental conditions.	**Increase**

Table 3. Hydrologic alteration related invertebrate metric descriptions

Invertebrate Metric	Metric Description	Response to Hydrologic Alteration Stress
Clinger %	Relative abundance (%) of clinger invertebrates. High flows and the associated increased flow velocities can displace macroinvertebrates downstream, and move habitat features like woody debris out of the stream. Woody debris and other habitat features are important as living surfaces for clinging invertebrates.	**Decrease**
Collector-Filterer %	Relative abundance (%) of collector filterer. The number of collector-filterer taxa represents the number of different taxa that collect their food by filtering it out of the water column. The filtering is typically done one of two ways: 1) by using physical adaptation such as a filamentous antennal structure or 2) by constructing a net which filters the water, gathering filtered material from the net. Collector filterer macroinvertebrates that filter food particles from the water column have shown negative responses to low flows.	**Decrease**
Long-Lived %	Macroinvertebrate types may shift from those species having long life cycles to shorter ones, because these species can complete their life cycle within the bounds of the recurrence interval of the elevated flow conditions	**Decrease**

1.5.2 Connectivity

Connectivity in river ecosystems generally refers to how water features are linked to each other on the landscape or how locations within a stream are connected. Connectivity also pertains to locations adjacent to a stream, such as a stream's connectivity to its floodplain. These different types of connectivity affect biology differently, do not often produce the same effects, and often times are linked to other stressors like habitat

In Minnesota, there are more than 800 dams on streams and rivers for a variety of purposes. Dams usually directly block seasonal fish migration for reproduction and overwintering. Stream channel road crossings also have the potential to become physical barriers to fish movement. Crossings can either be culverts (metal corrugated tubes or concrete boxes) or bridges. The crossings can become barriers when they are not installed properly, either due to incorrect sizing for the stream or put at the wrong elevation and/or slope. Bridges generally do not become barriers because they are wider and the channel can naturally adjust. Culverts are more likely will become a migration barrier if not engineered or installed properly. If culverts are too small, the passing water will increase in velocity. The velocity can become too fast for smaller fish species to move through (Warren and Pardew, 1998). Improper slope of the culvert will also lead to high velocity. If culverts are installed at an incorrect elevation, they can be "perched" at the outlet end, meaning the base of the culvert is above the water level of the stream. Minnesota's native fish species are not capable of doing the leaping and surging required for migrating through these situations in the way that salmon for instance can navigate ledges in streams. The denser the road network, and the older the crossing constructions, the more opportunity there is for barriers to be found. Disrupted migration not only alters reproduction of fish; it also impacts mussel species that utilize fish movement to disperse their offspring. Structures, such as dams, have been shown to reduce species richness of systems, while also increasing the abundance of tolerant or undesirable species (Winston, 1991), (Santucci V.A., 2005).

Table 4. Connectivity related fish metric descriptions

Fish Metric	Metric / Tolerance Metric Description	Response to Connectivity Stress
Mature Age >3 minus Tolerant Taxa %	Relative abundance (%) of species with a female mature age >=3, excluding tolerant species. Late maturity is a trait adaptive to stable, well-connected environments that allow these species to access the habitats and resources necessary for their life history requirements, over many years of growth and development. Stable environmental conditions are typically associated with minimal human disturbance. Therefore, the presence of large numbers of late-maturing species and/or individuals is an indication of a high quality resource.	**Decrease**
Migrating Taxa %	Relative abundance (%) of migratory species.	**Decrease**

1.5.3 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, Rashleigh, & Schofield, 2010). Excess fine sediment deposition on benthic habitat has been proven to adversely impact fish and macroinvertebrate species that depend on clean, coarse stream substrates for feeding, refuge, and/or reproduction (Newcombe & MacDonald, 1991). Specific habitats needed by a healthy biotic community can be minimized or altered by practices on the 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, reduced habitat quality, and 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, Rashleigh, & Schofield, 2010).

Schlosser (1982) compared the trophic structure, reproductive success, and growth rate in fishes from a natural and modified (ditched) stream in central Illinois. The study found that the ditched stream experienced a loss of pool habitat, increased organic substrates, and a shift in trophic structure to omnivores and herbivores instead of insectivores and piscivores. In a study conducted in the east-central Indiana Cornbelt region, Lau et al (2006) found that channelized streams had lower quality fish assemblages when compared to natural streams, and that a reduction in riffle and pool habitats associated with channelization was the most significant factor affecting the fish assemblage. Fish communities are typically influenced through a reduction in spawning habitat or egg survival (Chapman 1988) and a reduction in prey items as a result of decreases in primary production and benthic productivity (Bruton 1985; Gray and Ward 1982).

Table 5. Habitat related fish metric descriptions

Fish Metric	Metric Description	Response to Habitat Stress
Benthic Insect minus Tolerant %	Relative abundance (%) of benthic insectivore individuals (excludes tolerant species). Benthic insectivore and invertivore species rely on undisturbed benthic habitats to feed and reproduce. Many benthic invertivores require clean coarse substrates and an ample supply of aquatic macrophytes or woody debris for cover. Benthic insectivore species occupied the same type of niche as darters. This allows a greater degree of sensitivity in evaluating streams that naturally had few darter species. An increase in benthic insectivore species was correlated with increased biotic integrity.	**Decrease**
Darter Sculpin Sucker %	Relative abundance (%) of darter, sculpin, and round-bodied sucker individuals. Darters and sculpins are commonly found in riffle habitats, and are considered sensitive to water quality degradation. Darters and sculpins are generally found in higher quality streams. These species are benthic insectivores; they rely on undisturbed benthic habitats to feed and reproduce. The degradation of benthic habitats will cause the species to decline. Because darters and sculpins require clean coarse substrate materials in order to thrive, they tend to disappear in streams that have been affected by siltation or channelization.	**Decrease**
Lithophilic Spawner %	Relative abundance (%) of lithophilic individuals. This metric uses species that have both guarding and non-guarding spawning behavior that require clean gravel or cobble for success. This metric detects changes in environmental disturbance, particularly siltation.	**Decrease**
Pioneer %	Relative abundance (%) of pioneer individuals. Pioneer species tend to colonize disturbed and degraded habitats.	**Increase**
Piscivore %	Relative abundance (%) of piscivorous individuals. The presence of a viable piscivore population indicates a healthy, tropically diverse fish community.	**Decrease**
Riffle %	Relative abundance (%) of individuals that predominately utilize riffle habitats. Riffle species are those that require riffle habitat as part of their life history either for feeding, reproduction, or both. Sedimentation can decrease this type of habitat thereby negatively impacting these species.	**Decrease**
Simple lithophilic Spawner %	Relative abundance (%) of simple lithophilic individuals. This metric uses species that have simple, non-guarding spawning behavior that require clean gravel or cobble for success. This metric detects changes in environmental disturbance, particularly siltation.	**Decrease**
tolerant %	Relative abundance (%) of tolerant individuals. Tolerant species are those that are known to persist in poor quality streams. They may become the dominant component in streams that have been chemically or physically altered.	**Increase**

Table 6. Habitat related invertebrate metric descriptions

Invert Metric	Metric Description	Response to Habitat Stress
Burrower %	Relative abundance (%) of burrowers in subsample. Burrowers "Burrow" into fine sediments or tunnel into plant stems, leaves or roots. Many chironomid midges (Diptera: Chironomidae) and segmented worms (Oligochaeta) are burrowers.	**Increase**
Climber %	Relative abundance (%) of climbers in subsample, climbers "Climb" up the stems and leaves of submerged plants, roots and woody debris.	**Decrease**
Clinger %	Relative abundance (%) of clingers in subsample. "Clinger" macroinvertebrate taxa have adaptations for attachment to surfaces in stream riffles. They typically dwell in swift water and attach themselves to the surfaces of coarse substrates or woody debris. They are particularly dependent on the interstitial spaces created by gaps in overlapping coarse material (large gravels, cobbles, boulders, etc.).	**Decrease**
Ephemeroptera Plecoptera Trichoptera %	Relative abundance (%) of Ephemeroptera, Plecoptera & Trichoptera individuals in subsample. Ephemeroptera, or mayflies, are benthic invertebrates that are sensitive to environmental disturbance. They occupy a variety of habitats including interstitial spaces between rocks, rock surfaces, sediment, and aquatic vegetation.	**Decrease**
Legless %	Relative abundance (%) of legless individuals in subsample. Legless species are tolerant of degraded habitat conditions.	**Increase**
Sprawler %	Relative abundance (%) of sprawler individuals in subsample. Sprawlers inhabit surfaces of floating leaves or on the surface of fine sediments.	**Decrease**

1.5.4 Dissolved oxygen

DO refers to the concentration of oxygen gas within the water column. Adequate DO is important to growth and reproduction of aquatic life. Oxygen diffuses into water from the atmosphere (turbulent flow enhances this diffusion) and from the release of oxygen by aquatic plants during photosynthesis.

If DO concentrations become limited or fluctuate dramatically, aerobic aquatic life can experience reduced growth or fatality (Allan, 1995). Low DO, or highly fluctuating concentrations of DO can have detrimental effects on many fish and macroinvertebrate species (Davis, 1975) (Nebeker, 1991). Fish and invertebrates require oxygen for respiration. Many species of fish avoid areas where DO concentrations are below 5 mg/L (Raleigh, 1986). Additionally, fish growth rates can be significantly affected by low DO levels (Doudoroff and Warren, 1965).

In most streams and rivers, the critical seasonal conditions for stream DO usually occur during late summer when water temperatures are at or near the annual high while stream flow volumes and rates are near base flow. The critical daily period for DO is early morning, when the daily DO flux is at its minimum. Human activities can alter many of these driving factors and change the DO concentrations of water resources. Increased nutrient content of surface waters is a common human influence, which can result in excess aquatic plant growth. This situation often leads to a decline in daily minimum oxygen concentrations and an increase in the magnitude of daily DO concentration fluctuations due to the decay of the excess organic material, increased usage of oxygen by plants at night, and their greater oxygen production during the daytime. Humans may directly add organic material by municipal or industrial effluents. These forms of pollution increase the risk of eutrophication, which can also lead to low DO.

Table 7. Dissolved oxygen related fish metric descriptions

Fish Metric	Metric Description	Response to Low Dissolved Oxygen Stress
DO Sensitive %	Relative abundance (%) of individuals that are sensitive to DO stress	**Decrease**
Mature Age >3 %	Relative abundance (%) of species with a female mature age > three years excluding tolerant species. Late maturity is a trait adaptive to stable, well-connected environments that allow these species to access the habitats and resources necessary for their life history requirements, over many years of growth and development. Stable environmental conditions are typically associated with minimal human disturbance. Therefore, the presence of large numbers of late-maturing species and/or individuals is an indication of a high quality resource.	**Decrease**
Sensitive %	Relative abundance (%) of sensitive individuals. An absence of sensitive species indicates an anthropogenic stress or loss of habitat. This metric distinguished between streams of the highest quality.	**Decrease**
Taxa Count	Total taxa richness of fish. The total number of species declines as environmental degradation increases. Hybrids, subspecies and exotics are not included in this metric.	**Decrease**
DO Index Score	DO Tolerance Index Value.	**Decrease**
DO Tolerant %	Relative abundance (%) of individuals that are tolerant to DO stress.	**Increase**

Table 8. Dissolved oxygen related invertebrate metric descriptions

Invert Metric	Metric Description	Response to Low Dissolved Oxygen Stress
Low DO Intolerant Taxa %	Relative abundance (%) of dissolved oxygen intolerant taxa.	**Decrease**
Low DO Tolerant Taxa %	Relative abundance (%) of dissolved oxygen tolerant taxa.	**Increase**
DO TIV	DO Tolerance Index Value.	**Decrease**
HBI_MN	A measure of pollution based on tolerance values assigned to each individual taxon developed by Chirhart.	**Increase**

1.5.5 Eutrophication

Phosphorus (P), an important plant nutrient, is typically in short supply in natural systems, but human activity on the landscape often exports phosphorus to waterways, which can impact stream organisms. Phosphorus exists in several forms, with the soluble form, orthophosphorus, readily available for plant and algal uptake. While phosphorus itself is not toxic to aquatic organisms, it can have detrimental effects via other associated chemistry when levels are elevated above natural concentrations. Increased nutrients can cause excessive aquatic plant and algal growth (eutrophication), which alters physical habitat, food resources, and oxygen levels in streams. Excess plant growth increases DO during daylight hours and saps oxygen from the water during the nighttime. As plant material dies, bacterial decomposition lowers DO through absorption. Streams dominated with submerged macrophytes experience the largest swings in DO and pH (Wilcox R. a., 2001). Suspended algae in the water column (often measured as chlorophyll-a) also produce these effects. In some cases, oxygen production leads to extremely high levels of oxygen in the water (supersaturation), which can cause gas bubble disease in fish. The wide daily fluctuations in DO caused by excess plant growth and algae are also correlated to degradation of aquatic communities (Heiskary, 2013).

Determining the type of suspended material within a stream (mineral vs organic) is important for proper conclusions about the stressor and source (erosion vs. nutrient enrichment vs. a wastewater discharge). Elevated total suspended volatile solids (TSVS) concentrations can impact aquatic life in a similar manner as suspended sediment, with the suspended particles reducing water clarity. Unusually high concentrations of TSVS can indicate excess nutrients (causing algal growth) and an unstable DO regime.

Table 9. Eutrophication related fish metric descriptions

Fish Metric	Metric Description	Response to Eutrophication Stress
Darter %	Relative abundance (%) of darter individuals. Many darters are considered sensitive to water quality degradation. They require clean coarse substrate material in order to thrive, and tend to disappear in stream affected by siltation, channelization, and eutrophication.	**Decrease**
Omnivore %	Relative abundance (%) of omnivorous individuals. Omnivores have the ability to utilize multiple food sources allows omnivore species to switch to another food source when one is depleted.	**Increase**
Sensitive %	Relative abundance (%) of sensitive individuals. An absence of sensitive species indicated an anthropogenic stress or loss of habitat. This metric distinguished between streams of the highest quality.	**Decrease**
Tolerant %	Relative abundance (%) of tolerant macroinvertebrate individuals in subsample. Tolerant species are those that are known to persist in poor quality streams. They may become the dominant component in streams that have been chemically or physically altered.	**Increase**

Table 10. Eutrophication related invertebrate metric descriptions

Invert Metric	Metric Description	Response to Eutrophication Stress
Taxa Count All #	Total taxa richness of macroinvertebrates. Taxa richness is considered a good indicator of environmental quality. In most types of aquatic ecosystems as environmental disturbance increases, taxa richness decreases.	**Decrease**
Collector – Filterer Taxa #	Taxa richness of collector-filterers. The number of collector-filterer taxa represents the number of different taxa that collect their food by filtering it out of the water column. The filtering is typically done one of two ways: 1) by using physical adaptation such as a filamentous antennal structure or 2) by constructing a net which filters the water, gathering filtered material from the net.	**Decrease**
Collector – Gatherer Taxa #	Taxa richness of collector-gatherers. The number of collector-gatherer taxa represents the number of different taxa that collect their food by gathering it from the substrate.	**Increase**
Ephemeroptera Plecoptera Trichoptera Taxa #	Taxa richness of Ephemeroptera, Plecoptera & Trichoptera. Ephemeroptera, or mayflies, are benthic invertebrates that are sensitive to environmental disturbance. They occupy a variety of habitats including interstitial spaces between rocks, rock surfaces, sediment, and aquatic vegetation. Plecoptera, or stoneflies, are among the most sensitive indicator organisms. They occupy the interstitial spaces between rocks, woody debris, and vegetation, and require a relatively high amount of DO in order to survive. Trichoptera, or caddisflies, are a diverse group of benthic insects that are considered good indicators of environmental disturbance. As a group, they are somewhat more tolerant to pollution than mayflies, but in the presence of significant impairment they do not persist as a diverse community. Because of their ability to exploit a variety of habitats, their diversity is a good indicator of habitat quality. Their ability to thrive in lentic conditions makes them excellent indicators for use in slow moving streams as well.	**Decrease**
Intolerant 2 Taxa #	Taxa richness of macroinvertebrates with tolerance values less than or equal to two, using MN Tolerance Values.	**Decrease**
Tolerant 2 Taxa %	Relative percentage of taxa with tolerance values equal to or greater than six, using MN Tolerance Values.	**Increase**

1.5.6 Suspended solids

Sediment and turbidity are among the leading pollutant issues affecting stream biological impairment in the United States (U.S.EPA, 2012). Recent studies in Minnesota have demonstrated that human activities on the landscape have dramatically increased the sediment entering streams and rivers since European settlement (Triplet, 2009) and (Engstrom, 2009). Sediment can come from land surfaces such as exposed soil or from unstable streambanks. The soil may be unprotected for a variety of reasons, such as construction, mining, agriculture, or insufficiently vegetated pastures. Human actions on the landscape, such as channelization of waterways, riparian land cover alteration, artificial drainage, and increased impervious surface area can cause stream bank instability leading to sediment input from bank sloughing. Fine sediment often is deposited on the stream bottom and can cover and embed coarser sediment. Although sediment delivery and transport are an important natural process for all stream systems, sediment imbalance (either

excess suspended sediment or lack of sediment) can be detrimental to aquatic organisms. Organic particles, including algae, can also contribute to TSS.

Excess deposited/bedded fine sediment (DBS) upon benthic habitat has been proven to negatively impact fish and macroinvertebrate species that depend on clean, coarse stream substrates for feeding, refugia, and/or reproduction. Highly embedded coarse substrates reduce spawning habitat and interstitial spaces for the fish and macroinvertebrate taxa which depend on these microhabitats.

Benthic insectivores are fish species that prey on insect life that occupy benthic (stream bottom) habitats. The abundance and richness of fish species with this trophic trait has been shown to decrease as the percentage of fine sediment increases (Berkman and Rabeni, 1987).

Table 11. Suspended solids related fish metric descriptions

Fish	Metric description	Response to suspended solids stress
Benthic feeder %	Relative abundance (%) of benthic feeding individuals. Relative abundance (%) of benthic insectivore individuals (excludes tolerant species). Benthic insectivore and invertivore species rely on undisturbed benthic habitats to feed and reproduce. Many benthic invertivores require clean coarse substrates and an ample supply of aquatic macrophytes or woody debris for cover. Benthic insectivore species occupied the same type of niche as darters. This allows a greater degree of sensitivity in evaluating streams that naturally had few darter species. An increase in benthic insectivore species was correlated with increased biotic integrity.	**Decrease**
Centrarchid-Tolerant %	Relative abundance (%) of Centrarchid individuals (excludes tolerant species). These species are sight feeders which can be negatively impacted by increased suspended solids.	**Decrease**
Herbivore %	Relative abundance (%) of herbivorous individuals. Fish species that utilize vegetation. These species are negatively impacted by the loss of vegetation which can be caused by sedimentation and hydromodification.	**Increase**
Long-Lived %	Relative abundance (%) of long-lived individuals. Long-lived species typically have long life histories and as a result require more time to recover from disturbance.	**Decrease**
Perciformes-Tolerant %	Relative abundance (%) of Perciformid individuals (excludes tolerant species). Fish species in the family Percidae includes walleye, perch, and darters. Species classified as tolerant are not included in this metric.	**Decrease**
Riffle %	Relative abundance (%) of individuals that predominately utilize riffle habitats. Riffle species are those that require riffle habitat as part of their life history either for feeding, reproduction, or both. Sedimentation can decrease this type of habitat thereby negatively impacting these species.	**Decrease**
Simple lithophilic spawner %	Relative abundance (%) of simple lithophilic individuals. Relative abundance (%) of simple lithophilic individuals. This metric uses species that have simple spawning behavior that requires clean gravel or cobble for success. This metric detects changes in environmental disturbance, particularly siltation.	**Decrease**
TSS TIV	Total Suspended Solids Tolerance Index Value.	**Increase**

Table 12. Suspended solids related invertebrate metric descriptions

Invert	Metric description	Response to suspended solids stress
Collector-Filterer %	Relative abundance (%) of collector-filterer individuals in subsample.	**Decrease**
Plecoptera %	Relative abundance (%) of Plecoptera individuals in subsample. Plecoptera, or stoneflies, are among the most sensitive indicator organisms. They occupy the interstitial spaces between rocks, woody debris, and vegetation, and as such, are sensitive to sedimentation.	**Decrease**
TSS Intolerant %	Relative abundance (%) of taxa intolerant suspended solids.	**Decrease**
TSS Tolerant %	Relative abundance (%) of taxa tolerant suspended solids.	**Increase**
TSS TIV	Total Suspended Solids Tolerance Index Value.	**Increase**

1.5.7 Nitrates

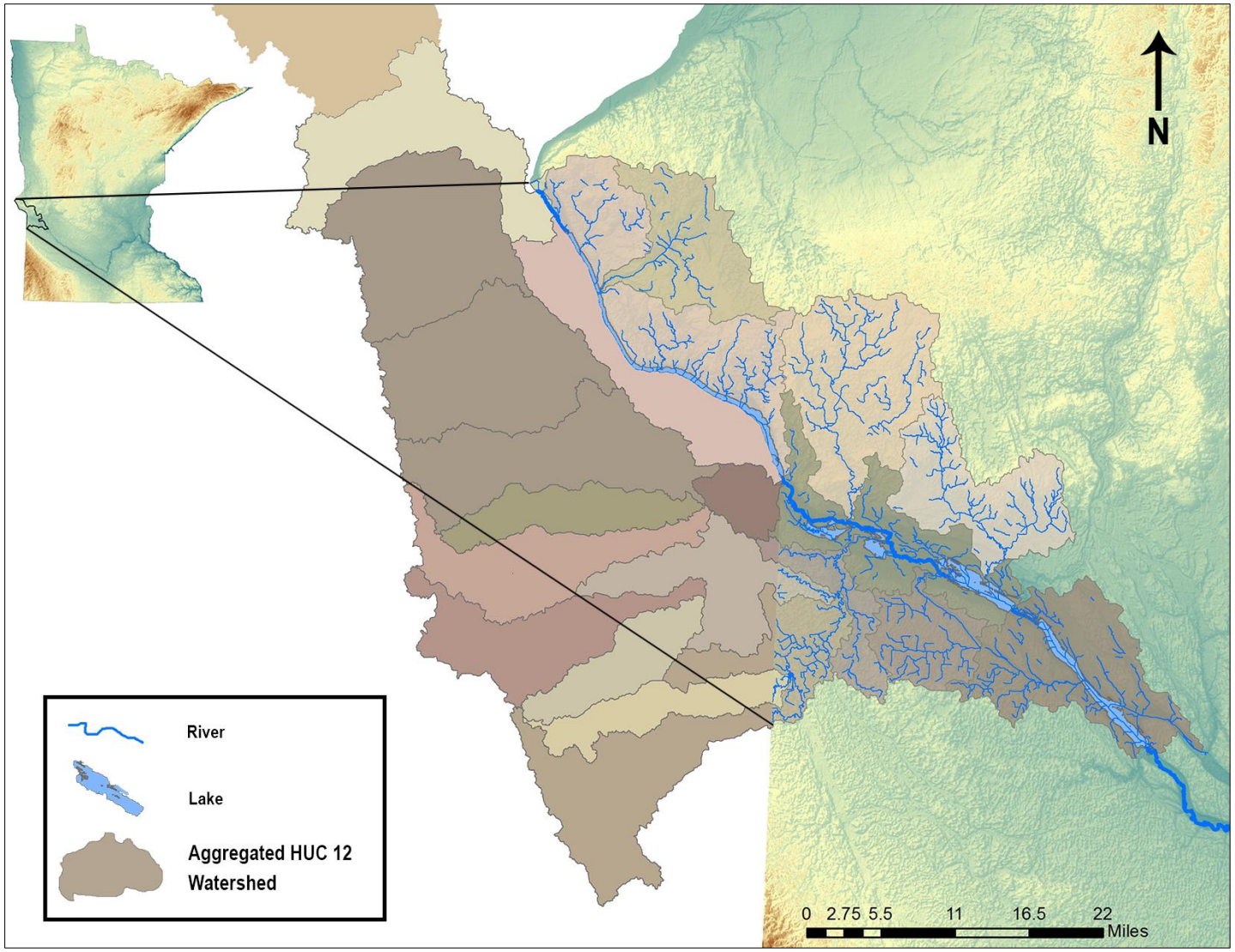
Nitrate (NO3) and nitrite (NO2) are components of the natural nitrogen cycle in aquatic ecosystems. NO2 anions are naturally present in soil and water, and are readily converted to NO3 by microorganisms as part of the nitrification process of the nitrogen cycle. As a result, nitrate is far more abundant than nitrite. Although the water test commonly used measures both nitrate and nitrite, because a large percentage is nitrate, this report will refer to these data as being nitrate. Nitrate is commonly applied as a crop fertilizer. Nitrate transport pathways can be different depending on the geology and hydrology of the watershed. When water moves quickly through the soil profile, as in the case of watersheds with karst geology or in heavily tiled watersheds, nitrate transport can become significant. Apart from its function as a biological nutrient, some levels of nitrate can become toxic to organisms. Nitrate toxicity depends on concentration and exposure time, as well as the sensitivity of the individual organisms. The intake of nitrate by aquatic organisms converts oxygen-carrying pigments into forms that are unable to carry oxygen, thus inducing a toxic effect on fish and macroinvertebrates (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), who cited a maximum level of 2.0 mg/L nitrate N as appropriate for protecting the most sensitive freshwater species and nitrate-N concentrations under 10.0 mg/L to protect several other sensitive fish and aquatic invertebrate taxa.

Table 13. Nitrate related invertebrate metric descriptions

Invert	Metric description	Response to nitrate stress
Nitrate intolerant taxa %	Relative abundance (%) of nitrate intolerant species.	**Decrease**
Nitrogen TIV	Nitrogen Tolerance Index Value.	**Increase**
Nitrate tolerant taxa %	Relative abundance (%) of nitrate tolerant species.	**Increase**
Trichoptera taxa %	Relative percentage of taxa belonging to Trichoptera.	**Decrease**

2 Watershed description

Figure 4. Map of the Minnesota River – Headwaters Watershed boundaries including area outside of Minnesota



The Minnesota River – Headwaters Watershed is comprised of the Little Minnesota River, the Yellow Bank River, and several smaller creels and ditches that flow directly into the Minnesota River from both the north and south sides (Figure 4). The combination of these watersheds together are identified as the Hydrologic Unit Code (HUC) 07020001. The Minnesota River – Headwaters Watershed drains approximately 761 square miles over parts of twelve different counties residing in three different states. Counties with lands within the watershed include Richland County in North Dakota; Marshall, Roberts, Grant, Codington, and Deuel counties in South Dakota; and Traverse, Big Stone, Stevens, Swift, Lac qui Parle, and Chippewa counties in Minnesota. For more information about the Minnesota River – Headwaters Watershed refer to the Minnesota River – Headwaters Watershed Characterization Report (DNR, 2019).

3 Biological impaired reaches and stressors

Figure 5. Map of biological impairments identified in the Minnesota River-Headwaters watershed

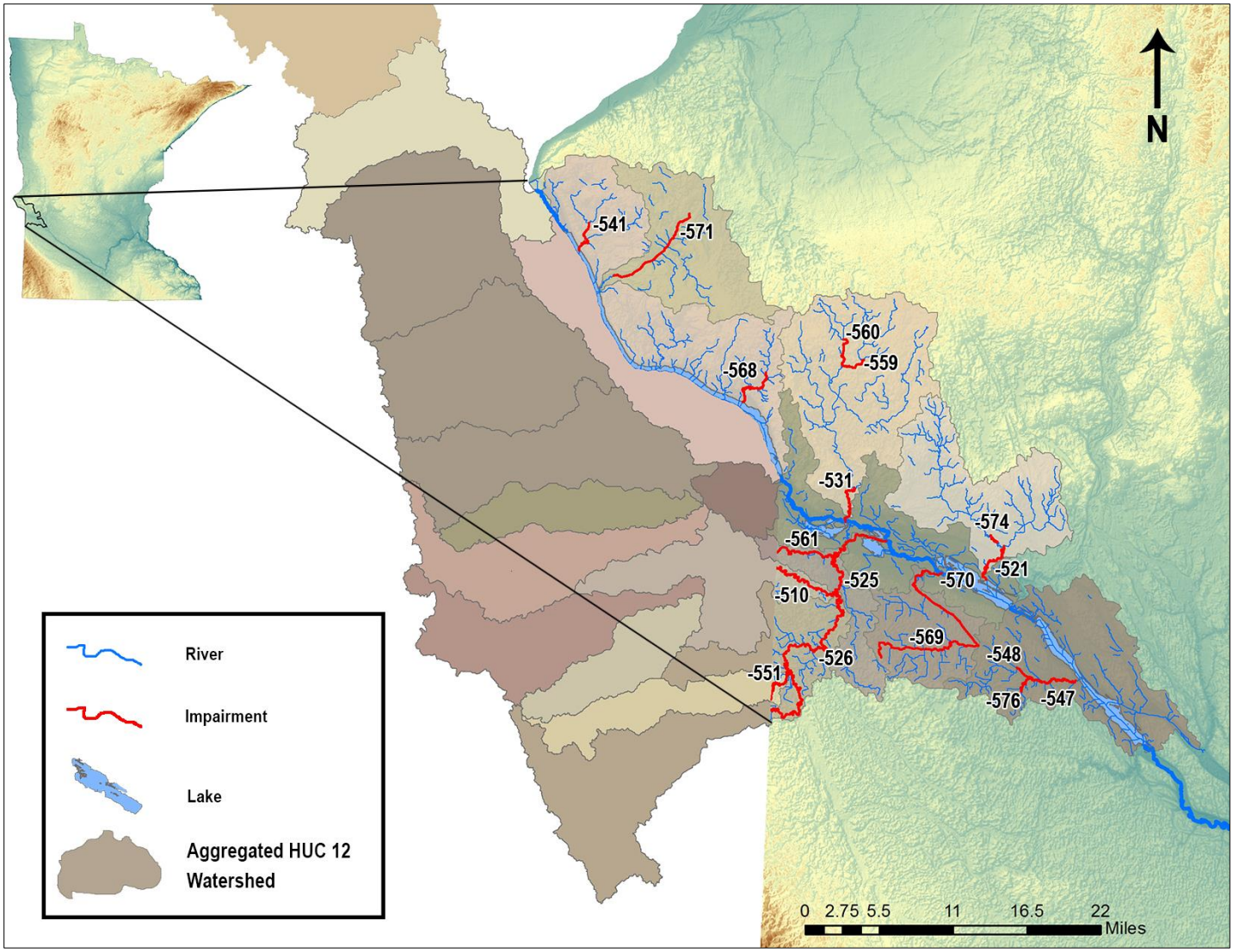


Table 14. Summary of biological impairments and stressors identified in this report

✓= Stressor ×= Not a Stressor **O** = Inconclusive	**Hydrologic Alteration**	**Connectivity**	**Habitat**	**Dissolved Oxygen**	**Eutrophication**	**Suspended Solids**	**Nitrate**
07020001-541	✓	×	**O**	✓	✓	**O**	✓
07020001-571	✓	✓	✓	✓	✓	**O**	✓
07020001-568	✓	×	**O**	✓	**O**	**O**	×
07020001-531	✓	✓	**O**	**O**	✓	✓	×
07020001-559	✓	✓	✓	✓	✓	**O**	**O**
07020001-560	✓	✓	✓	✓	✓	**O**	**O**
07020001-551	✓	×	✓	✓	✓	**O**	**O**
07020001-526	**O**	**O**	✓	×	×	×	**O**
07020001-510	✓	×	**O**	**O**	✓	×	×
07020001-525	✓	**O**	×	**O**	**O**	✓	✓
07020001-561	✓	✓	**O**	✓	**O**	**O**	**O**
07020001-569	✓	**O**	✓	✓	✓	**O**	**O**
07020001-570	✓	**O**	✓	**O**	✓	**O**	**O**
07020001-574	✓	**O**	✓	✓	**O**	**O**	×
07020001-521	✓	×	**O**	**O**	**O**	**O**	×
07020001-548	✓	**O**	✓	✓	✓	**O**	**O**
07020001-576	✓	**O**	✓	×	**O**	**O**	**O**
07020001-547	✓	**O**	✓	✓	✓	**O**	**O**

3.1 07020001-541 Unnamed Creek

Figure 6. Satellite image of reach 07020001-541 and its watershed

3.1.1 Biological community

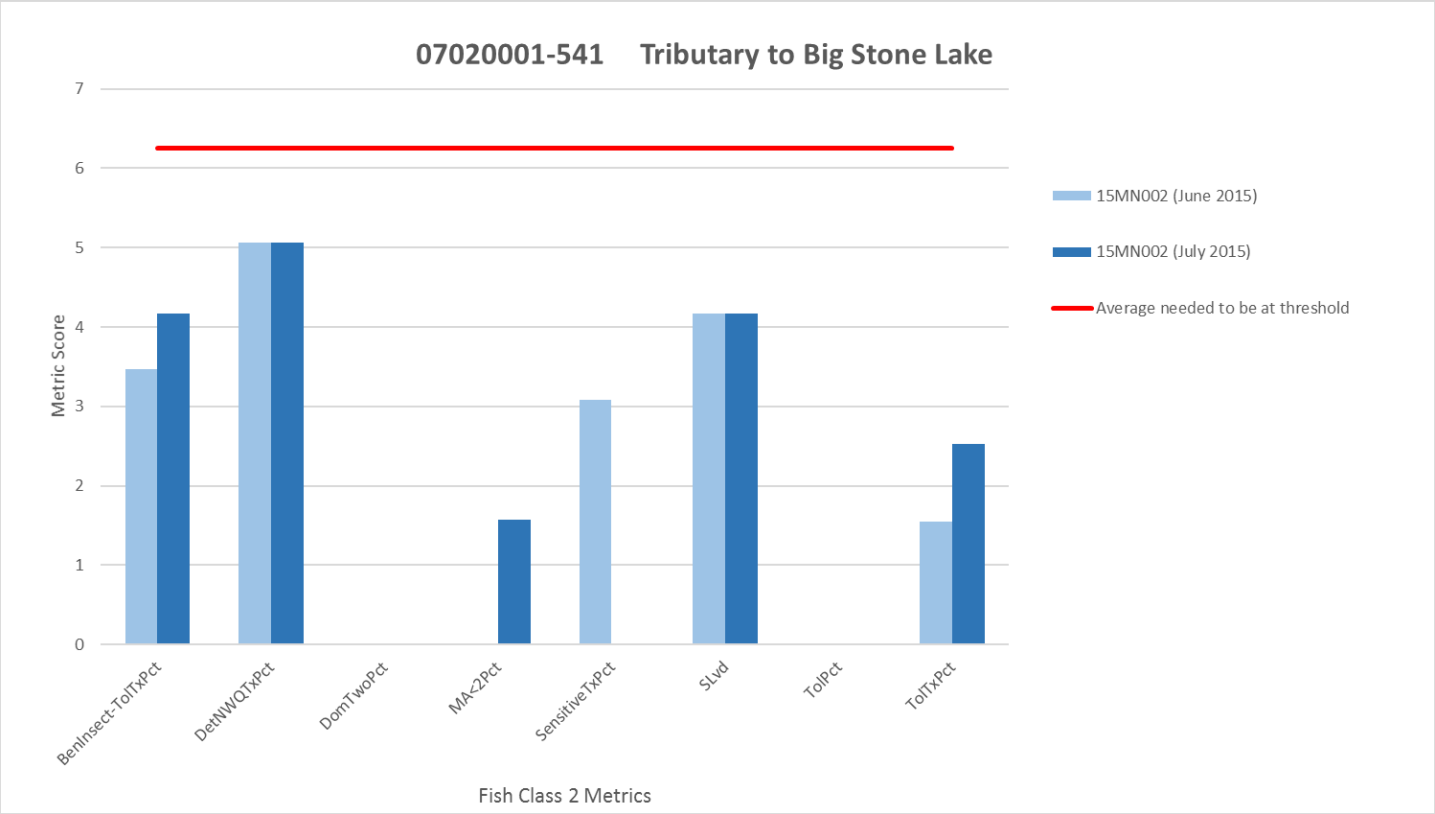
Bio site 15MN002 was sampled twice for fish in 2015. The FIBI scores of 17.3 and 17.5 are well below the Fish Class 2 Southern Streams general use threshold of 50 (Table 15). Fathead minnows and creek chubs dominated the fish community as well as other short lived and tolerant taxa resulting in poor metric scores. Metrics used to calculate the Fish IBI score are shown in a graph with the red line indicating the value each metric needed to score in order to meet the threshold (Figure 7).

Biological metric data

Table 15. Fish IBI score and threshold

07020001-541 Fish Class 2 General Use		Fish IBI Score	Class Threshold Score
15MN002	6/16/2015	17.3	50
15MN002	7/27/2015	17.5	

Figure 7. Fish Class 2 metric scores for bio site 15MN002



3.1.2 Hydrologic alteration

Hydrologic alteration biological metric data

Table 16. Hydrologic alteration related fish metrics

07020001-541 **Fish Class 2** **General Use**	General %	Nesting Non Lithophilic Spawner %
15MN002 6/16/2015	94.3	75
15MN002 7/27/2015	93.1	57.4
Statewide average for Class 2 southern stream bio sites that are meeting the FIBI general use threshold (50.0)	**42.4**	**19.1**
Expected response to **Hydrologic** stress	↑	↑

HSPF model flow data

Table 17. HSPF modeled flow data, 1994-2012

07020001-541 HSPF Reach 431 Min: 0.07 cfs Max: 618.51 cfs	**<5 cfs %** (# of values)	**<1 cfs %** (# of values)	**<0.5 cfs %** (# of values)
6,940 Total Daily Averages 1994–2012	**67.1%** (4,659)	**31.5%** (2,186)	**17.4%** (1,210)

Hydrologic alteration summary

The biological metrics all scored poorly when compared to the average of Class 2 streams bio sites that meet the IBI general use threshold. Generalized fish species are correlated with channelization and are adaptable to different habitats through generalized food preferences. Bio site 15MN002 had a population of generalist fish ranging from 93-94% of the population (Table 16).

Reach 07020001-541 is predominantly natural according to the MPCA Hydrologic Alteration layer (Figure 6); though its upper watershed has been channelized (Figure 8) and many wetlands have been drained and tiled (Figure 9)

Figure 8. Satellite image showing re-routing of a natural channel within the watershed

Figure 9. Satellite image showing tile lines draining agricultural fields within the watershed

The HSPF model (Table 17) shows that more than 30% of the daily average flows from 1994 – 2012 are below 1 cfs. Flows reduced beyond normal base flow will decrease habitat for aquatic organisms and increase competition for resources. Bio site 15MN002 has a drainage area of 32.8 square miles.

According to the original surveying data (Figure 10), it appears that the two main tributaries that drain the upper part of the watershed were created and channelized by ditching through wetlands and connecting them to the mainstream channel (Figure 11). Creating these ditches essentially added to the amount of land and water that drained into the creek and the timing of water runoff. This altered the natural flow regime of this stream that had developed over several millenniums by decreasing the time it takes for water to move through the system, moving more water through the system at a higher frequency, and increasing the impact to the stream channel of high flow events while also increasing the intensity of low flow periods during periods of little precipitation.

Figure 10. Original Plat map upstream of impaired reach showing the very upstream portion of reach 07020001-541

Figure 11. Original Plat map with altered ditches, green indicates altered/created stream channels

Based on the very poor scores of the biological metrics, extended low flow periods shown in the HSPF model, as well as historic surveying data, Hydrologic Alteration is a stressor in this reach. The primary impact in this reach from Hydrologic

Alteration is seen by the nutrient overloading of phosphorus, nitrogen, and the subsequent effects to eutrophication and DO levels, which is exasperated by low flows during periods of low precipitation.

3.1.3 Connectivity

Connectivity metric data

Table 18. Connectivity related fish metrics

07020001-541 Fish Class 2 General Use		Mature Age >3 minus Tolerant Taxa %	Migrating Taxa %
15MN002	6/16/2015	0.00	33.3
15MN002	7/27/2015	6.7	20.0
Statewide average for Class 2 southern stream bio sites that are meeting the FIBI general use threshold (50.0)		**21.8**	**24.3**
Expected response to **Connectivity** stress		↓	↓

Figure 12. Photo of culvert, a possible fish barrier, just upstream of Bio site 15MN002

Connectivity summary

Metrics for fish taxa whose females take greater than three years to mature were low and yellow perch was the only long-maturing species present. Migrating taxa were present and close to the average for southern streams that meet the standard, though the majority were white suckers, a tolerant species.

There are no know barriers or road crossings from the site downstream to Big Stone Lake. However, just upstream from Bio site 15MN002, there is a culvert that is a fish barrier at low flows due to it being set at a higher elevation than the channel. This culvert is also relatively long and completely smooth, likely creating velocities that are barriers to fish migration upstream into the upper and headwater areas during high flows. Due to the presence of migratory species, it appears that connectivity is not a stressor at the bio site at this time. It is likely a stressor upstream of the bio site.

3.1.4 Habitat

Habitat metric data

Table 19. Habitat related fish metrics

07020001-541 Fish Class 2 General Use	Benthic Insect minus Tolerant %	Darter Sculpin Sucker %	Lithophilic Spawner %	Pioneer %	Piscivore %	Riffle %	Simple Lithophilic Spawner %	Tolerant %
15MN002 6/16/2015	0.5	0.5	23.1	89.7	0.0	1.6	4.6	98.4
15MN002 7/27/2015	2.0	2.0	37.7	82.8	0.0	6.9	10.6	94.6
Statewide average for Class 2 southern stream bio sites that are meeting the FIBI general use threshold (50.0)	**20.4**	**18.2**	**58.3**	**19.0**	**5.2**	**32.5**	**39.4**	**44.9**
Expected response to Habitat stress	↓	↓	↓	↑	↓	↓	↓	↑

MPCA stream habitat assessment score

Table 20. Habitat assessment score

07020001-541	Land Use	Riparian	Substrate	Cover	Channel Morphology	Total Score
15MN002 6/16/2015	0	11	16	13	28	68
15MN002 7/27/2015	0	11	15.8	12	28	66.8
15MN002 8/4/2015	2.5	10.5	24.1	6	29	72.1
Maximum Attainable Habitat Score	**5**	**14**	**28**	**18**	**35**	**100**

Habitat summary

The fish community in reach 07020001-541 scored below average in all 8 habitat related fish metrics when compared to all other Class 2 southern stream bio sites that meet the FIBI general use threshold (Table 12).

Although the MSHA score was good, every fish habitat related fish metric scored well below the average for Class 2 streams. The lack of benthic insectivores as well as lower than average lithophilic spawners indicate habitat may be a stressor to the biological community in the reach due to lack of clean course substrate. Though it is inconclusive as a stressor at this time, it is likely that low flows are contributing to a limitations in habitat for fish, which in turn could be a stressor to the fish within the reach.

Figure 13. Photo of Bio site 15MN002 showing a cobble riffle and vegetation along banks

3.1.5 Dissolved oxygen

Dissolved oxygen biological metric data

Table 21. Dissolved oxygen related fish metrics

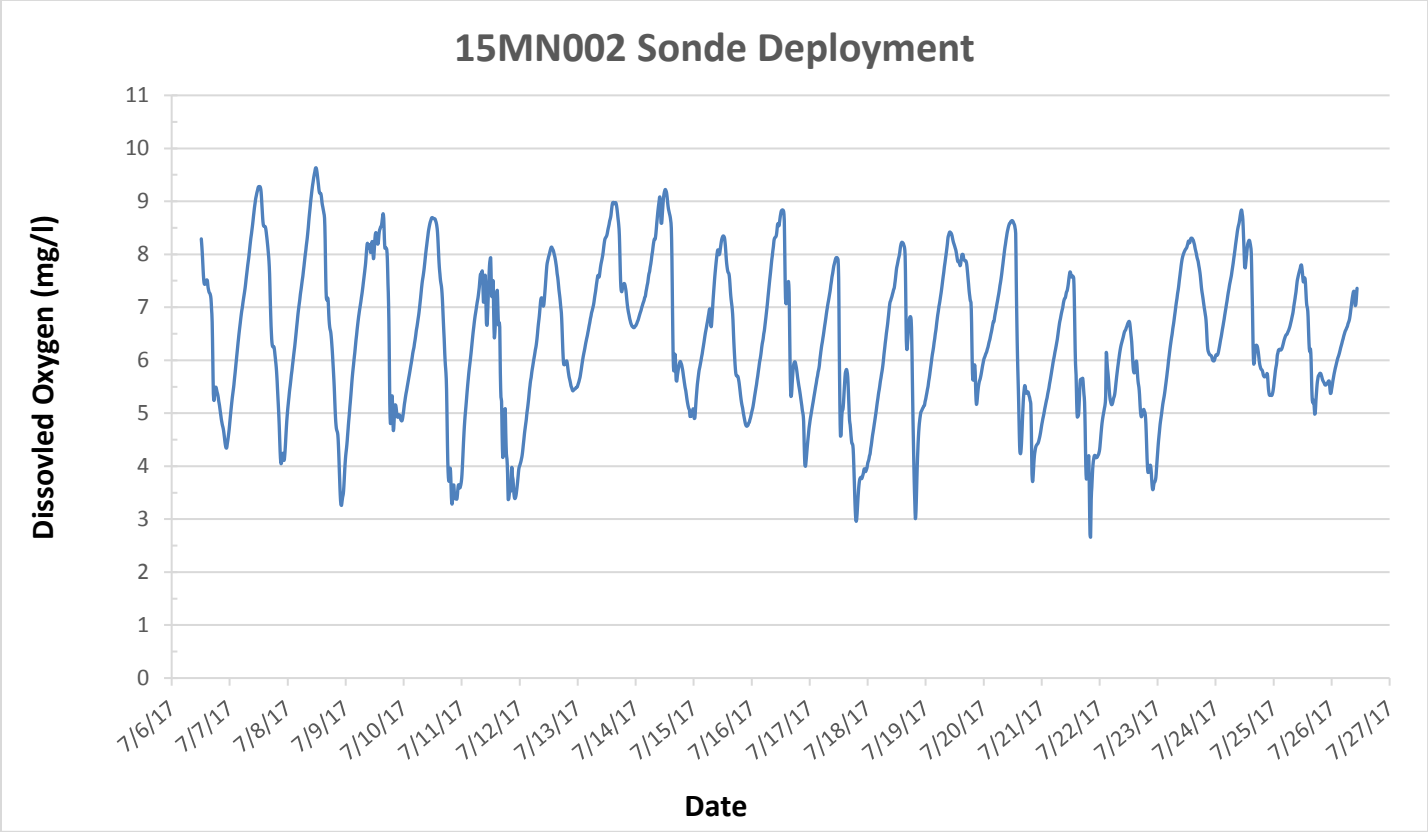
07020001-541 **Fish Class 2** **General Use**	Mature Age >3 %	Serial Spawner %	Taxa Count	DO TIV	DO Sensitive %	DO Tolerant %
15MN002 6/16/2015	1.4	71.5	9.0	6.4	0.0	76.9
15MN002 7/27/2015	8.7	55.2	15.0	6.6	0.0	61.8
Statewide average for Class 2 southern stream bio sites that are meeting the FIBI general use threshold (50.0)	**23.9**	**28.7**	**20.4**	**7.2**	**6.1**	**15.8**
Expected response to **DO** stress	↓	↑	↓	↓	↓	↑

Dissolved oxygen monitoring data

Table 22. Dissolved oxygen monitoring data

07020001-541 DO Data	Range of Data (mg/L)	% of Monthly Samples < 5 mg/L [# of Samples]							May-Sep <5 mg/L % [# of Samples]
		April	May	June	July	August	Sept	Oct	
S006-557 (2011-2017)	6.7-14.8	0% [4]	0% [7]	0% [10]	0% [14]	0% [11]	0% [6]	0% [4]	0% [56]

Figure 14. Continuous dissolved oxygen data at site 15MN002



Dissolved oxygen summary

The fish community at bio site 15MN002 scored below average in all four DO related fish metrics when compared to the average of all other Class 2 southern stream bio sites that meet the FIBI general use threshold (Table 21). There were no fish caught who are sensitive to low DO. Species with females that take more than three years to mature comprised 1.4% and 8.7%, both well below class averages. No DO sensitive fish were caught. DO tolerant species comprised about 76.9% and 61.8% of the fish population.

Although no DO measurements taken during sampling were below the warmwater standard of 5 mg/L, none of those measurements were taken before 8:00 am, when values are usually the lowest. When values are usually the lowest. A YSI Sonde water meter measured continuous DO data from July 6, 2017 to July 27, 2017. During this deployment, DO values were measured below the standard 14 out of 21 days.

Based on the related fish biological metric scores and the measured sonde values, DO is a stressor in this reach. It is likely being aggravated by low flow conditions.

3.1.6 Eutrophication

Eutrophication biological metric data

Table 23. Eutrophication related fish metrics

07020001-541 **Fish Class 2** **General Use**	Darter %	Omnivore %	Sensitive %	Tolerant %
15MN002 6/16/2015	0.5	72.8	0.5	98.4
15MN002 7/27/2015	2.0	63.1	0.0	94.6
Statewide average for Class 2 southern stream bio sites that are meeting the FIBI general use threshold (50.0)	**11.7**	**16.5**	**18.7**	**44.9**
Expected response to **Eutrophication** stress	↓	↑	↓	↑

Eutrophication monitoring data

Table 24. Phosphorus monitoring data

07020001-541 P Sample Data 0.15 mg/L target	Range of Data (mg/L)	Monthly Average of Samples (mg/L) [# of Samples]							June-Aug Average (mg/L) [# of Samples]
		April	May	June	July	August	Sept	Oct	
S006-557 (2011-2017)	0.1–1.0	n/a [0]	0.2 [7]	0.2 [6]	0.3 [10]	0.4 [7]	0.3 [6]	0.1 [2]	0.3 [38]

Eutrophication HSPF model data

Table 25. Phosphorus model data

	Total Phosphorus	
07020001-541 HSPF Reach 431	**June – September** **% values > 0.15 mg/l** (# Daily Values)	**June – September** **Multi-year Average**
2,318 Total Daily Averages *June–Sep 1994–2012*	**68.3%** (1582)	**0.23 mg/l**

Figure 15. Photo of bio site 15MN002 showing algae growth

Eutrophication summary

The fish community at bio site 15MN002 scored below average in all four eutrophication related fish metrics when compared to the average of all other Class 2 southern stream bio sites that meet the FIBI general use threshold. The abundance of darter individuals was very low and omnivorous fish comprised around 70% of the population. There were almost no sensitive species and nearly all individuals present were tolerant species (Table 23).

Thirty-eight samples were collected and analyzed for Phosphorus from 2011-2017. The summer average was twice the standard of 0.15 mg/L (Table 24). The HSPF model computed the summer average well above the standard at 0.23 mg/L.

A YSI Sonde water meter measured continuous DO data from July 6, 2017 to July 27, 2017. During this deployment, diel DO flux was measured at or above 5 mg/L several times.

The biological community is showing the effects of the elevated phosphorus, phosphorus sampling showed elevated concentrations, and DO flux was 5 mg/L or greater. Algae growth was observed at the station (Figure 15). Eutrophication is a stressor in this reach.

3.1.7 Suspended solids

Suspended solids biological metric data

Table 26. Suspended solids related metrics

07020001-541 **Fish Class 2** **General Use**	Benthic Feeder %	Centrarchid-Tolerant %	Herbivore %	Intolerant %	Long-Lived %	Perciformes-Tolerant %	Riffle %	Sensitive %	Simple Lithophilic Spawner %	TSS TIV
15MN002 6/16/2015	1.6	0.0	1.6	0.0	0.0	0.5	1.6	0.0	4.6	21.6
15MN002 7/27/2015	7.1	0.0	1.2	0.0	2.7	4.4	6.9	0.0	10.6	20.4
Statewide average for Class 2 Southern Stream stations that are meeting the FIBI general use threshold (50.0)	**37.4**	**4.9**	**9.6**	**5.0**	**11.7**	**18.7**	**32.5**	**18.6**	**39.4**	**17.6**
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

TSS monitoring data

Table 27. Total suspended solids monitoring data

07020001-541 TSS Sample Data	Range of Data (mg/L)	% of Monthly Samples > 65 mg/L [# of Samples]							% of Total Samples > 65 mg/L [# of Samples]
		April	May	June	July	August	Sept	Oct	
S006-557 (2011-2015)	2-45	0% [4]	0% [7]	0% [6]	0% [9]	0% [7]	0% [5]	0% [4]	0% [42]

Suspended solids summary

The fish community at bio site 15MN002 scored below average in all ten suspended solids related fish metrics when compared to the average of all other Class 2 southern stream bio sites that meet the FIBI general use threshold (Table26). There were some benthic feeders, perciformes, and simple lithophillic spawners present though they were below the class average.

Forty-two samples were collected and analyzed for total suspended solids from 2011-2015. No sample had a total suspended solid concentration above 65 mg/L (Table 27).

Suspended solids are inconclusive as a stressor to aquatic life at this time. It is likely that other factors, such as altered hydrology or habitat are causing poor scores in the fish biological metrics. It is recommended that more TSS data be collected during high flows in order to determine whether it is a biological stressor.

3.1.8 Nitrates

Nitrate biological metric data

Table 28. Nitrate related metrics

07020001-541 **Invert Class 5** **General Use**	Nitrate Intolerant Taxa %	Nitrogen TIV	Nitrogen Tolerant Taxa %	Trichoptera Taxa %
15MN002 August 4, 2015	0.0	3.5	39.2	19.5
Statewide average for Class 5 southern streams rock riffle bio sites that are meeting the MIBI general use threshold (37.0)	**2.9**	**3.0**	**47.6**	**13.6**
Expected response to nitrogen stress	↓	↑	↑	↓

Nitrate monitoring data

Table 29. Nitrate monitoring data for chemistry site S006-557

07020001-541 Nitrate/Nitrite Sample Data	Range of Data (mg/L)
S006-557 (2011-2017)	0.7–9.6

Summary

The macroinvertebrate assemblage at site 15MN002 scored below average in two of the four nitrate related metrics evaluated when compared to all other macroinvertebrate Class 5 streams bio sites that meet the MIBI general use threshold (Table 28). The biological bio site did show a healthy amount of Trichoptera taxa, which tend to decrease in streams with excessive nitrate values. There was a high amount of nitrate tolerant invertebrates as well as complete lack of nitrate intolerant invertebrate species. The nitrogen TIV score also indicates a macroinvertebrate community that is generally tolerant to high levels of nitrates.

Thirty-eight samples were collected in reach 07020001-541 and analyzed for nitrate/nitrite (Table 23). Seventy-nine percent of the total nitrate samples had concentrations greater than 4.9 mg/L. Due to the biological response and relatively high nitrate concentrations, nitrates are a stressor to aquatic life in reach 07020001-541.

3.1.9 Reach stressors

A high priority in this watershed should be to manage changes to the hydrology of both stream channels and contributing watersheds. The construction of ditches and the addition of tile drainage has altered the land area that that regularly contributes water to the stream. This increase in drainage area affects the amount and timing of water that reaches the stream. Phosphorus and nitrates quickly reach the stream via drain tiles, outlets, and field runoff. Increasing the storage

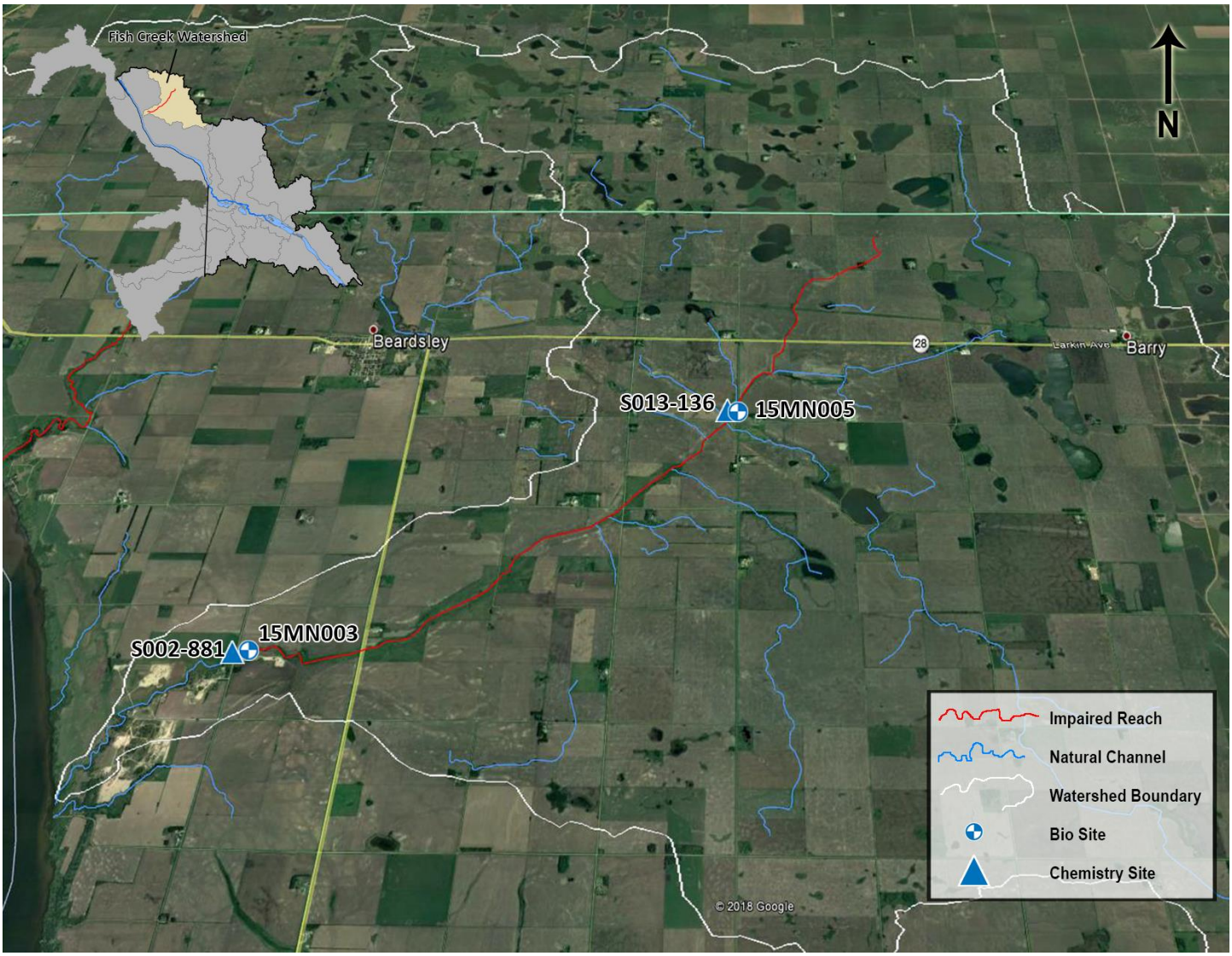
and infiltration of water can help reduce nutrient delivery to the stream, erosion and incision from high flows after large rain events, and can help mitigate periods of extremely low flows during times of low precipitation.

Table 30. Summary of stressors in reach 07020001-541

07020001-541	Hydrologic Alteration	Connectivity	Habitat	Dissolved Oxygen	Eutrophication	Suspended Solids	Nitrate
✓= Stressor ×= Not a Stressor **O** = Inconclusive	✓	×	**O**	✓	✓	**O**	✓

3.2 07020001-571 Fish Creek

Figure 16. Satellite image of reach 07020001-571 and its watershed



3.2.1 Biological community

Bio sites 15MN003 and 15MN005 were both sampled for fish on June 9, 2015. Fathead minnows, creek chubs, and a few other short lived and tolerant taxa dominated both bio sites, resulting in metric scores of zero for both bio sites (Table 31). Metrics used to calculate the Fish IBI score are shown in a graph with the red line indicating the value each metric needed to score in order to meet the threshold (Figure 17).

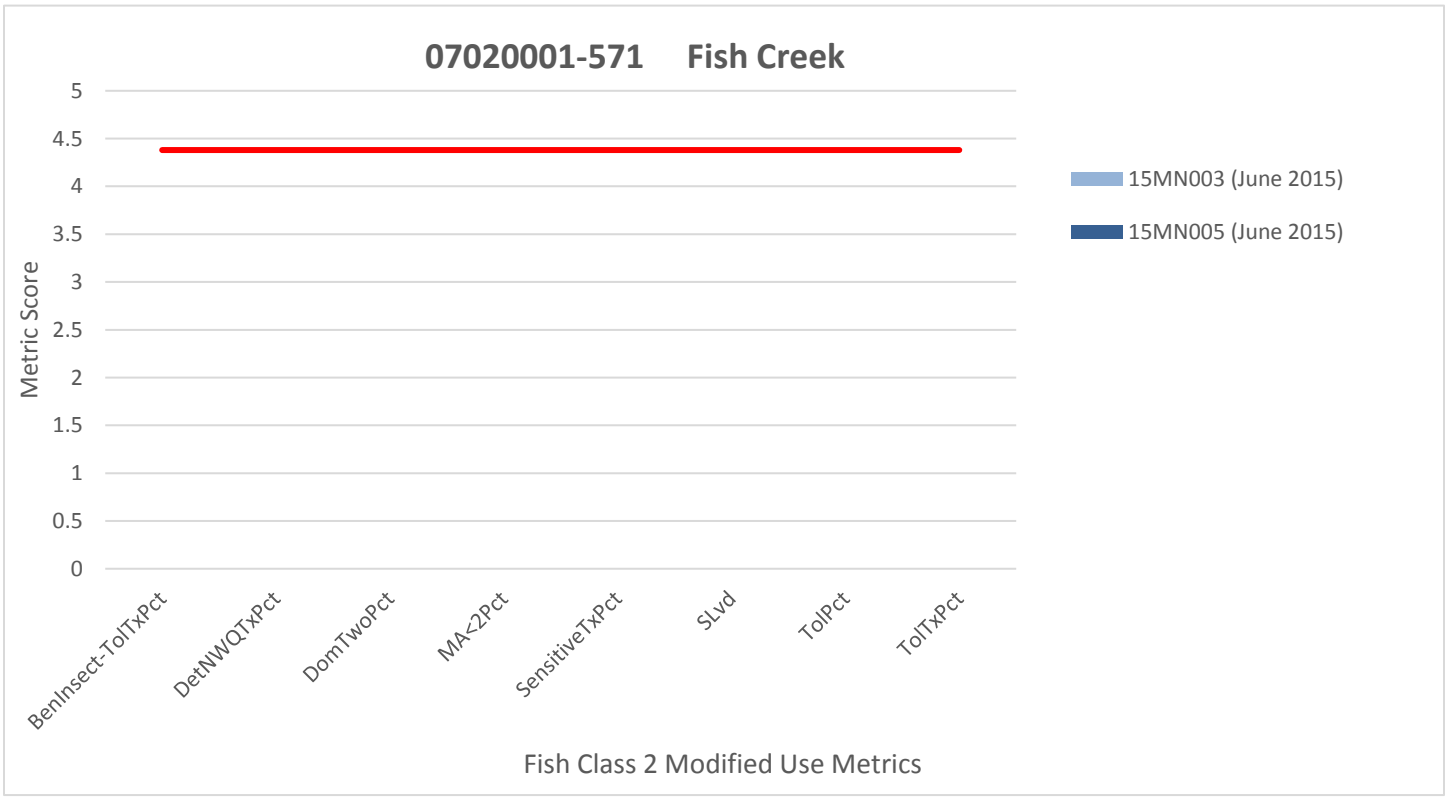
Bio site 15MN003 was sampled for invertebrates on August 4, 2015 and received a score of 21.1; just under the invert Class 7 modified use threshold of 22. Bio site 15MN005 was not sampled for fish or invertebrates on August 4, 2015 due to insufficient flow. Metrics used to calculate the invert IBI score are shown in a graph with the red line indicating the value each metric needed to score in order to meet the threshold (Figure 18).

Fish biological metric data

Table 31. Fish IBI scores and threshold

07020001-571 Fish Class 2 Modified Use		Fish IBI Score	Class Threshold Score
15MN003	6/9/2015	0.0	35
15MN005	6/9/2015	0.0	
15MN005	8/4/2015	No Flow	

Figure 17. Fish Class 2 metric scores for bio sites 15MN003 and 15MN005

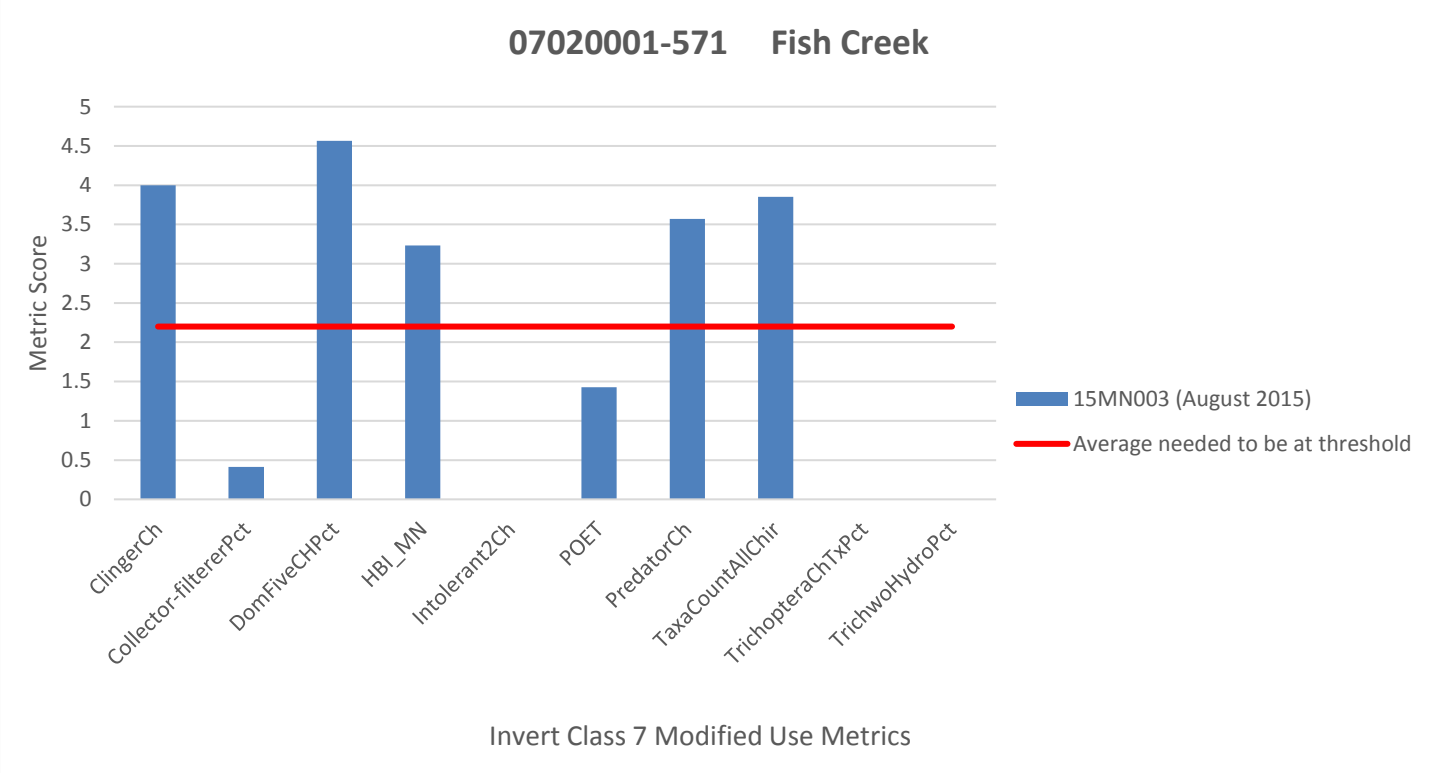


Invertebrate biological metric data

Table 32. Invert IBI scores and threshold

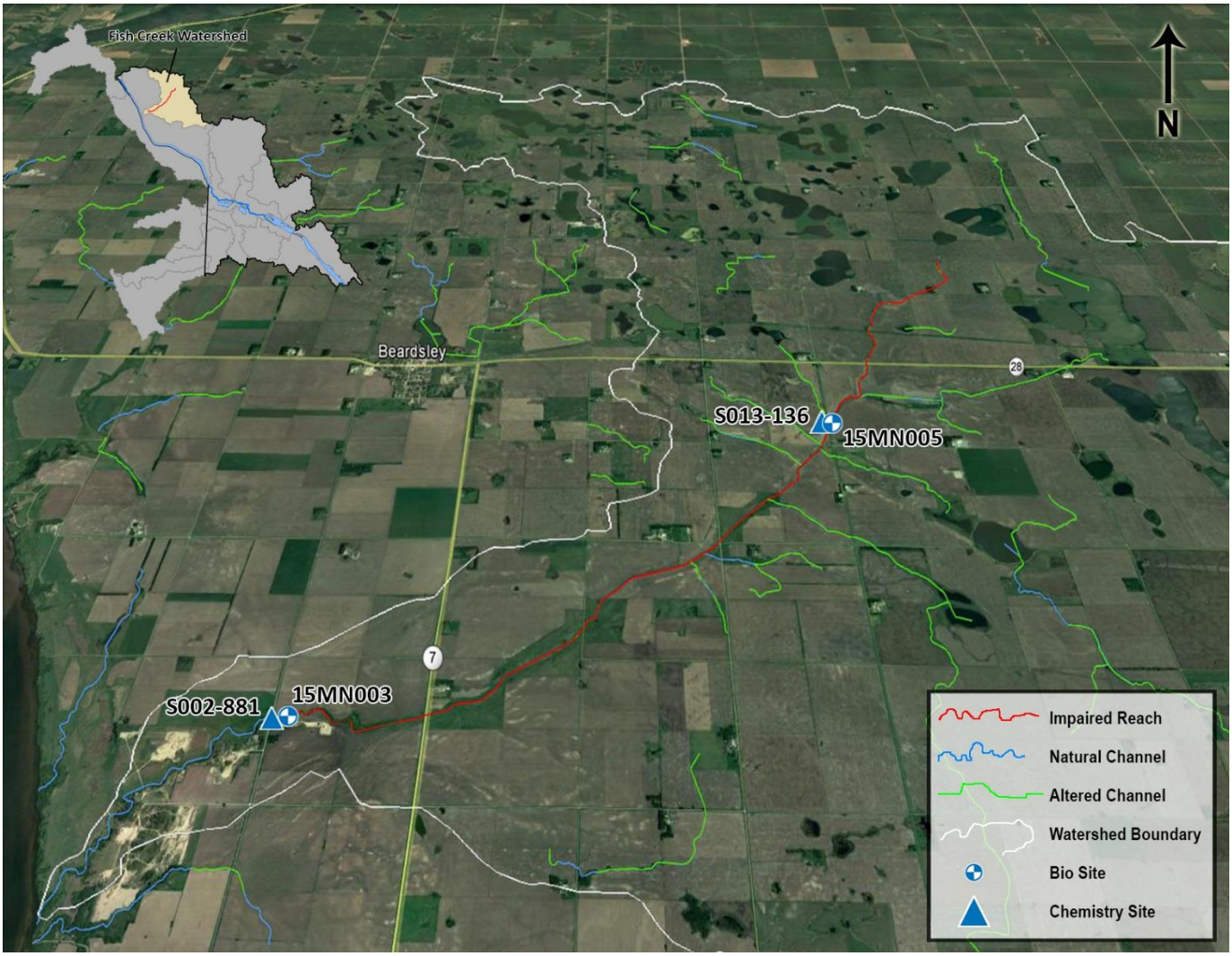
07020001-571 Invert Class 7 Modified Use		Invert IBI Score	Class Threshold Score
15MN003	8/4/2015	21.1	22
15MN005	8/4/2015	Insufficient Flow	

Figure 18. Invert Class 2 modified use metric scores for bio site 15MN003



3.2.2 Hydrologic alteration

Figure 19. Satellite image showing reach 0702001-571 and altered streams within its watershed



Hydrologic alteration biological metric data

Table 33. Hydrologic alteration related fish metrics

07020001-571 Fish Class 2 Modified Use		General %	Nesting Non Lithophilic Spawner %
15MN003	6/9/2015	96.5	95.0
15MN005	6/9/2015	96.8	96.8
Statewide average for Class 2 southern stream bio sites that are meeting the FIBI modified use threshold (35.0)		**43.9**	**30.6**
Expected response to **Hydrologic** stress		↑	↑

Table 34. Hydrologic alteration related invert metrics

07020001-571 **Invert Class 7** **Modified Use**	Clinger %	Collector-Filterer %	Long-Lived %
15MN003 8/4/2015	17.2	1.9	8.8
15MN005 8/4/2015	Insufficient Flow		
Statewide average for Class 7 Prairie Streams Glide Pool bio sites that are meeting the MIBI modified use threshold (22.0)	**23.1**	**9.9**	**5.6**
Expected response to hydrologic stress	↓	↓	↓

HSPF model flow data

Table 35. HSPF modeled flow data, 1994-2012

07020001-571 HSPF Reach 428 Min: 0.11 cfs Max: 1283 cfs	**<5 cfs %** (# of values)	**<1 cfs %** (# of values)	**<0.5 cfs %** (# of values)
6,940 Total Daily Averages 1994–2012	**50.7%** (4,659)	**16.1%** (2,186)	**5.0%** (1,210)

Hydrologic alteration summary

Both of the hydrologic alteration related fish biological metrics scored poorly when compared to the average of Fish Class 2 stream bio sites that meet the IBI modified use threshold (Table 33). Bio sites 15MN003 and 15MN005 both had generalist fish population of 97%. The percent of nesting fish were also very high as the fish assemblage was dominated by fathead minnows at both bio sites.

Two out of three hydrologic alteration related invertebrate metrics at bio site 15MN003 scored below the Invert Class 7 average compared to stream bio sites that meet the IBI modified use threshold (Table 34). Clinger and filterer invertebrate percentages both scored poorly; with filterers scoring very poorly, indicating low flows are stressing the invertebrate community. Long-Lived percentage scored above the average of Class 2 stream bio sites that meet the IBI modified use threshold. Inverts were not sampled at bio site 15MN005 due to insufficient flow at the time of sampling.

The HSPF model (Table 35) shows that 16.1% of the daily average flows from 1994 – 2012 are below 1 cfs. Flows reduced beyond normal base flow will decrease habitat for aquatic organisms and increase competition for resources.

According to the original plat information, it appears that the majority of this reach was historically more of a flowing wetland (Figure 20) (Figure 21). Its watershed has been extensively altered to drain upland wetlands (Figure 22). Creating ditches added to the amount of land and water that drained into the creek and the timing of water runoff. This altered the natural flow regime of this stream that had developed over several millenniums by decreasing the time it takes for water to move through the system, moving more water through the system at a higher frequency, and increasing the impact to the stream channel of high flow events during periods of high precipitation. Both the frequency and intensity of low flow periods are increased during periods of low precipitation.

Figure 20. Original Plat map close-up of reach 07020001-571

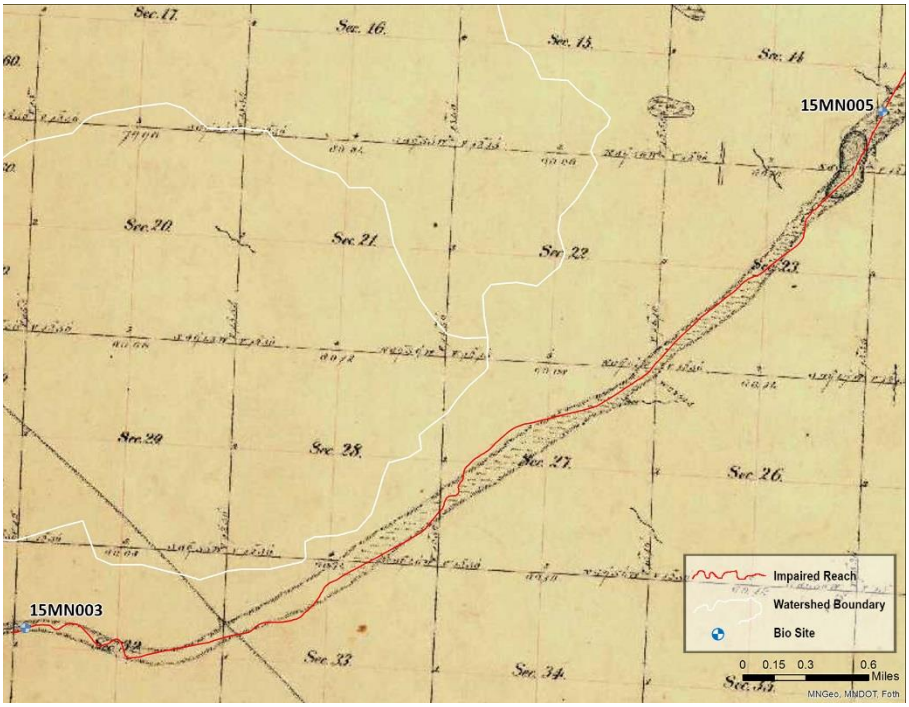


Figure 21. Original Plat map of the watershed of reach 07020001-571

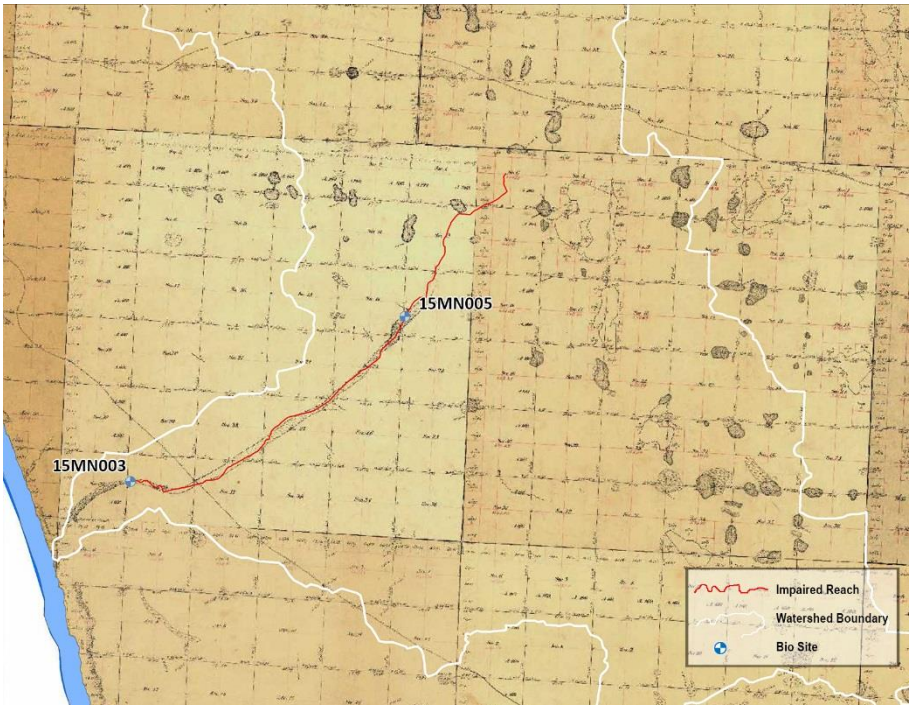
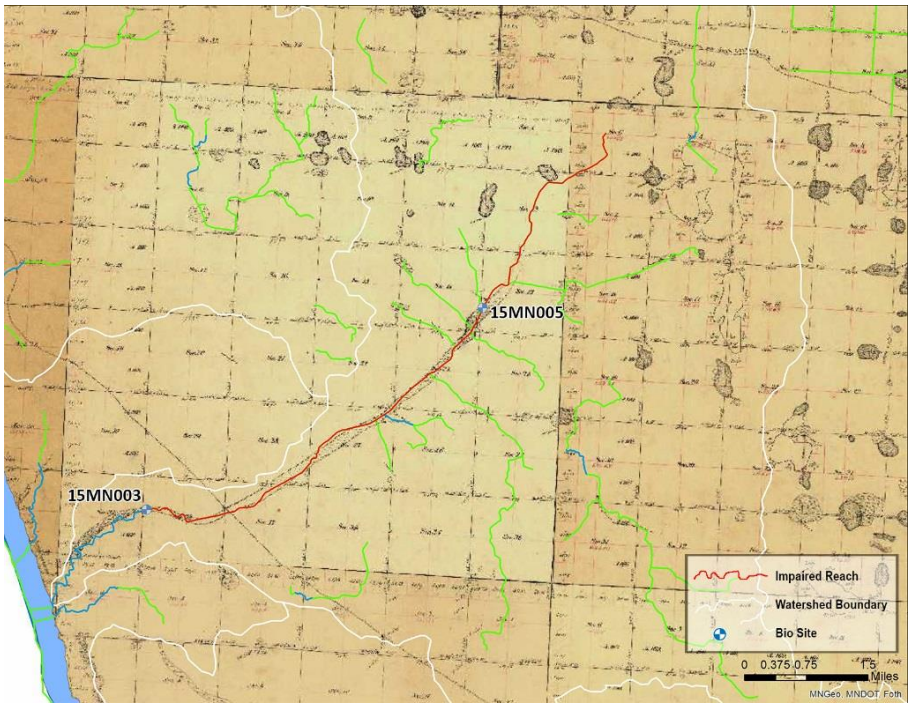


Figure 22. Original Plat map of the watershed of reach 07020001-571 with altered streams/ditches



According to the Minnesota River–Headwaters Watershed Characteristic Report (DNR, 2019) reach 571 is a type E5 stream. The E5 stream types are channels with slight to moderately steep gradients, very low width/depth ratios, where the dominant channel materials are composed of finer materials (Rosgen 1996)]. Channel slopes are typically less than 2% while the bed and banks are inherently stable (Rosgen 1996). Riparian vegetative influence is very important in E5 channels (Rosgen 1994; Appendix III) as root mats help the relatively deep channels to maintain high resistance to adjustment (Rosgen 1996). The E5 stream type is very stable unless streambanks are disturbed and/or significant changes in sediment or streamflow occur (Rosgen 1996). The bank height ratio of this channel indicates the reach is deeply incised (DNR, 2019), likely adjusting to increased flow magnitudes.

Based on the poor scores of most of the biological metrics, low flow periods shown in the HSPF model, insufficient flow at bio site 15MN005, DNR geomorphology data indicating incision, as well as historic surveying data, Hydrologic Alteration is a stressor in Fish Creek. The primary impact in this reach from Hydrologic Alteration is seen by the changes in nutrient overloading of phosphorus and the subsequent effects to eutrophication and DO levels, which is exasperated by low flows during periods of low precipitation.

3.2.3 Connectivity

Connectivity metric data

Table 36. Connectivity related fish metrics

07020001-571 **Fish Class 2** **Modified Use**	Mature Age >3 minus Tolerant Taxa %	Migrating Taxa %
15MN003 6/9/2015	0.0	20.0
15MN005 6/9/2015	0.0	0.0
Statewide average for Class 2 southern stream bio sites that are meeting the FIBI modified use threshold (35.0)	**21.8**	**24.3**
Expected response to connectivity stress	↓	↓

Figure 23. Culvert just downstream from bio site 15MN003

Connectivity summary

There were no species of fish whose females take greater than three years to mature. Migrating taxa at bio site 15MN003 was close to the average for Class 2 southern streams that met the standard, though this was because of only one Iowa Darter that was caught out of only four other unique species. Bio site 15MN005 had no migrating taxa at all (Table 36).

A culvert just downstream from the bio site was identified as a potential barrier under low flows (Figure 23). Due to the lack of migrating taxa and a culvert downstream of both bio sites that could prevent fish passage, connectivity is a stressor to the biological community in Fish Creek.

3.2.4 Habitat

Habitat metric data

Table 37. Habitat related fish metrics

07020001-571 Fish Class 2 Modified Use	Benthic Insect minus Tolerant %	Darter Sculpin Sucker %	Lithophilic Spawner %	Pioneer %	Piscivore %	Riffle %	Simple Lithophilic Spawner %	Tolerant %
15MN003 6/9/2015	0.5	0.5	2.5	96.5	0.0	0.0	0.0	99.5
15MN005 6/9/2015	0.0	0.0	3.2	96.8	0.0	0.0	0.0	100.0
Statewide average for Class 2 southern stream bio sites that are meeting the FIBI modified use threshold (35.0)	**20.4**	**18.2**	**58.3**	**19.0**	**5.2**	**32.5**	**39.4**	**44.9**
Expected response to habitat stress	↓	↓	↓	↑	↓	↓	↓	↑

Table 38. Habitat related invert metrics

07020001-571 Invert Class 7 Modified Use	Burrower %	Climber %	Clinger %	Ephemeroptera Plecoptera Trichoptera %	Legless %	Sprawler %
15MN003 8/4/2015	11.9	14.4	17. 2	5.9	32.8	56.3
15MN005 8/4/2015	Insufficient Flow					
Statewide average for Class 7 Prairie Streams Glide Pool bio sites that are meeting the MIBI modified use threshold (22.0)	**14.1**	**27.5**	**23.1**	**20.6**	**55.8**	**27.0**
Expected response to habitat stress	↑	↓	↓	↓	↑	↑

MPCA stream habitat assessment score

Table 39. Habitat assessment score

07020001-571		Land Use	Riparian	Substrate	Cover	Channel Morphology	Total Score
15MN003	6/09/2015	0	8	9.8	12	11	40.8
15MN005	6/09/2015	0	7	1	10	4	22
Maximum Attainable Habitat Score		**5**	**14**	**28**	**18**	**35**	**100**

Figure 24. Photo of bio site 15MN005 taken in-stream (left) and from up on the bank (right)

Figure 25. Photo of bio site 15MN003 taken in-stream (left) and photo of scour pool downstream of bio site (right)

Habitat summary

The fish community at bio sites 15MN003 and 15MN005 scored below average in all eight habitat related fish metrics when compared to all other Class 2 southern stream bio sites that meet the FIBI general use threshold (Table 37).

The invert community at bio site 15MN003 scored below the class average in three out of five habitat related metrics. Inverts were not sampled at bio site 15MN005 due to insufficient flow (Table 38).

The MSHA scores for bio sites 15MN003 and 15MN005 were both poor (Table 39). The downstream bio site 15MN003 scored better than upstream bio site 15MN005.

The stream at bio site 15MN005 has been altered from a wetland and shallow lake (Figure 20) into a channelized stream (Figure 24). Channelization reduces stream length, increases slope, and leaves the channel devoid of habitat, such as glide/riffle/run/pools sequences. This section is mostly muck and fine silt, any coarse sediment that was observed was embedded or covered due to heavy siltation. Bio site 15MN003 is downstream of 15MN005. This section of the reach has been altered but appears to be less channelized with higher channel stability and a wide, highly vegetated flood plain. This reach also had better depth variability but still lacked visible riffles. Several road crossings appear to be altering the channel by being improperly aligned, causing the dimension, pattern, and profile of the river to adjust and causing plunge pools just downstream of the crossing (Figure 25) (DNR, 2109).

It appears that surrounding land use, poor substrate, channelization, and low flows are contributing to limitations in habitat for fish and invertebrates. The lack of benthic insectivores, lower than average lithophilic spawners, as well as the lack of Ephemeroptera, Plecoptera, and Trichoptera indicate habitat is a stressor to the biological community in Fish Creek.

3.2.5 Dissolved oxygen

DO biological metric data

Table 40. Dissolved oxygen related fish metrics

07020001-571 **Fish Class 2** **Modified Use**	Mature Age >3 %	Serial Spawner %	Taxa Count	DO TIV	DO Sensitive %	DO Tolerant %
15MN003 6/9/2015	0.0	0.5	5.0	6.2	0.0	97.5
15MN005 6/9/2015	0.0	0.0	3.0	6.2	0.0	96.8
Statewide average for Class 2 southern stream bio sites that are meeting the FIBI modified use threshold (35.0)	**28.0**	**25.3**	**20.4**	**6.8**	**0.9**	**42.6**
Expected response to DO stress	↓	↑	↓	↓	↓	↑

Table 41. Dissolved oxygen related invert metrics

07020001-571 **Invert Class 7** **Modified Use**	Low DO Intolerant Taxa %	Low DO Tolerant Taxa %	DO TIV	HBI_MN
15MN003 8/4/2015	3.1	70.6	6.2	7.9
Statewide average for Class 7 Prairie Streams Glide Pool bio sites that are meeting the MIBI modified use threshold (22.0)	**3.1**	**31.4**	**6.2**	**8.0**
Expected response to DO stress	↓	↑	↓	↑

DO monitoring data

Table 42. Dissolved oxygen monitoring data

07020001-571 DO Data 5 mg/L	Range of Data (mg/L)	% of Monthly Samples < 5 mg/L [# of Samples]							% of Total Samples < 5 mg/L [# of Samples]
		April	May	June	July	August	Sept	Oct	
S002-881 (2011-2016)	3.3–14.0	0% [4]	0% [7]	0% [10]	33% [12]	9% [11]	0% [6]	0% [4]	9.3% [54]
S013-136 (2017)	0.4–3.6	N/A [0]	N/A [0]	N/A [0]	100% [2]	N/A [0]	N/A [0]	N/A [0]	100% [2]

Figure 26. Continuous dissolved oxygen data at site 15MN005

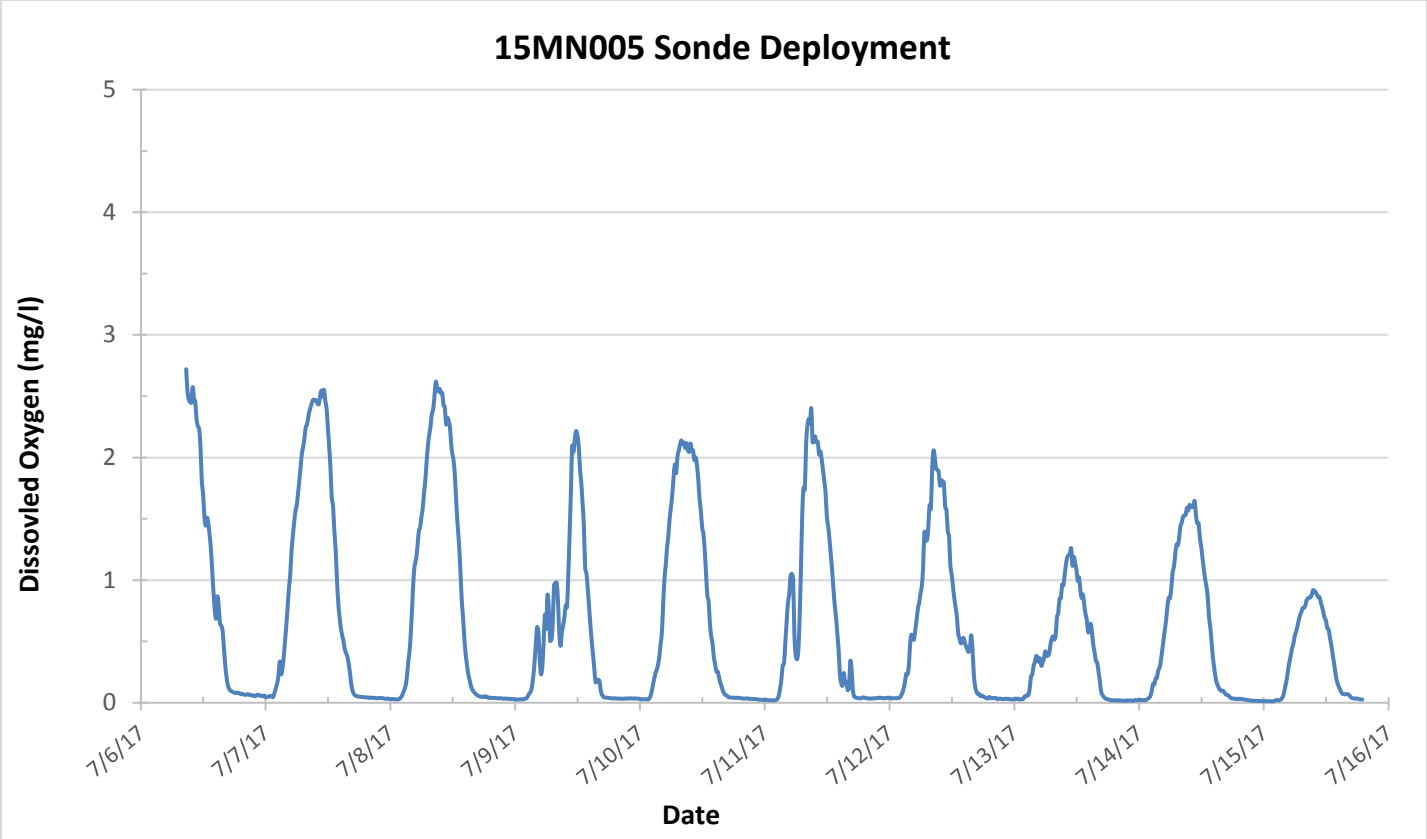
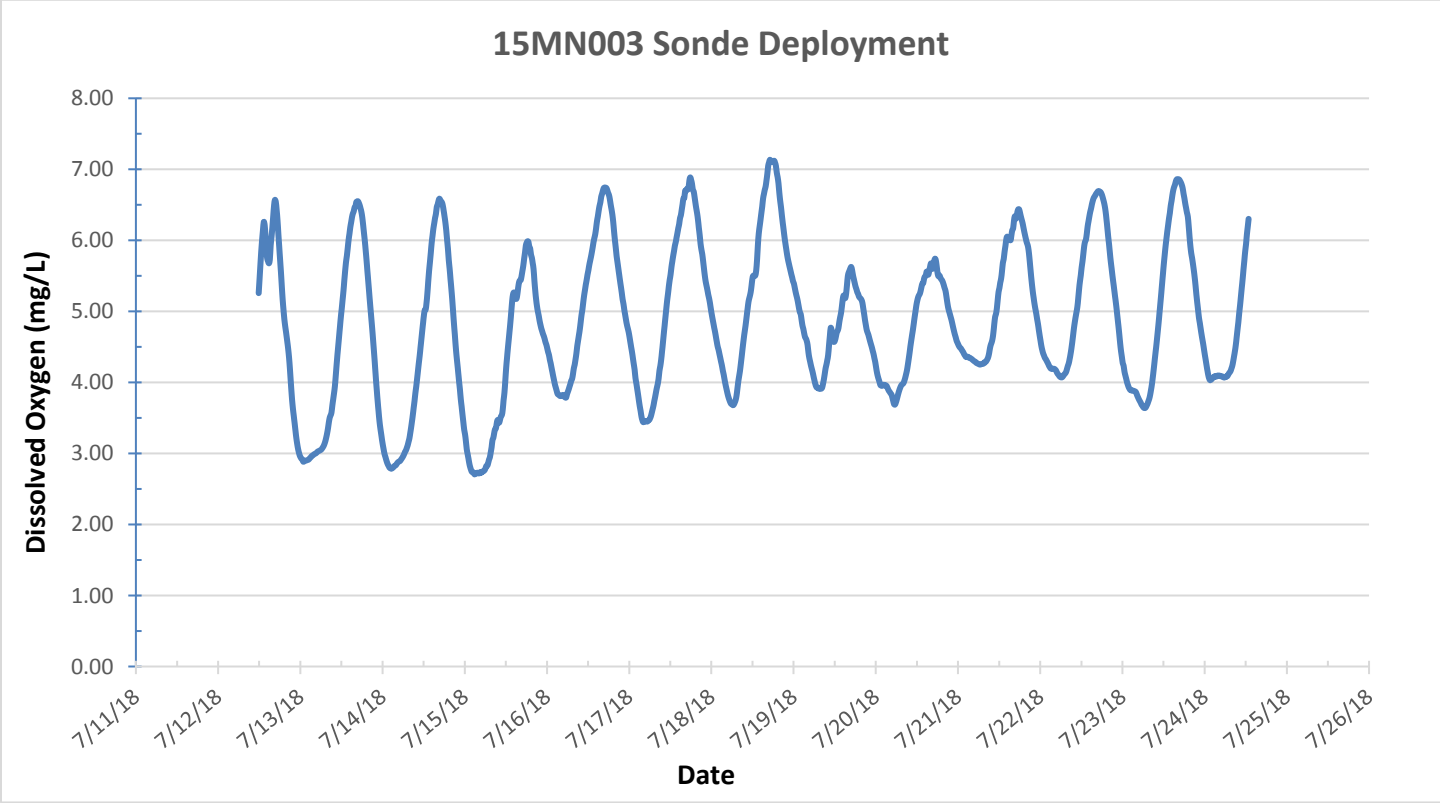


Figure 27. Continuous dissolved oxygen data at site 15MN003



Dissolved oxygen summary

The fish community at bio sites 15MN003 and 15MN005 scored below average in all six DO related fish metrics when compared to the average of all other Class 2 southern stream bio sites that meet the FIBI general use threshold. Species with females that take more than three years to mature comprised 0% at both bio sites. The percentage of serial spawning fish was also very high when compared the class average (Table 40). There were no species sensitive to low dissolved oxygen (DO).

Invert metrics scored better than the fish metrics, though there were still a high percentage of species that are tolerant of low DO (Table 41).

Although no DO measurements taken before 8:00 am, several were below the warmwater standard of 5 mg/L (Table 42). A YSI Sonde water meter was deployed and measured continuous DO data from July 6, 2017 to July 16, 2017 at bio site 15MN005. During this deployment, dissolved oxygen values were measured below the standard every day and got very close to 0 mg/L (Figure 26). Downstream at bio site 15MN003 a sonde was deployed from July 12, 2018 to July 24, 2018. The DO levels dropped below 5mg/L every day as well, though they did not drop quite as low as at bio site 15MN005 (Figure 27).

Based on the related biological metric scores and the measured values, DO is a stressor in this reach. It is likely being aggravated by low flow conditions, especially upstream at bio site 15MN005.

3.2.6 Eutrophication

Eutrophication biological metric data

Table 43. Eutrophication related fish metrics

07020001-571 **Fish Class 2** **Modified Use**	Darter %	Omnivore %	Sensitive %	Tolerant %
15MN003 6/9/2015	0.5	94.0	0.5	99.5
15MN005 6/9/2015	0.0	93.6	0.0	100.0
Statewide average for Class 2 southern stream bio sites that are meeting the FIBI modified use threshold (35.0)	**13.6**	**25.5**	**8.4**	**46.4**
Expected response to eutrophication stress	↓	↑	↓	↑

Table 44. Eutrophication related invert metrics

07020001-571 **Invert Class 7** **Modified Use**	Taxa Count All #	Collector–Filterer Taxa #	Collector–Gatherer Taxa #	Ephemeroptera Plecoptera Trichoptera Taxa #	Intolerant Taxa #	Tolerant Taxa %
15MN003 8/4/2015	32	2	15	1	0	87.5
15MN005 8/4/2015	Insufficient Flow					
Statewide average for Class 7 Prairie Stream Glide Pool bio sites that are meeting the FIBI modified use threshold (22.0)	**33.6**	**3.2**	**11.6**	**4.8**	**0.1**	**86.6**
Expected response to eutrophication stress	↓	↓	↑	↓	↓	↑

Eutrophication monitoring data

Table 45. Phosphorus monitoring data

07020001-571 P Sample Data 0.15 mg/L target	Range of Data (mg/L)	Monthly Average of Samples (mg/L) [# of Samples]							June-Aug Average (mg/L) [# of Samples]
		April	May	June	July	August	Sept	Oct	
S002-881 (2011-2015)	0.06-0.67	n/a [0]	0.28 [7]	0.26 [6]	0.38 [9]	0.29 [7]	0.14 [6]	0.08 [2]	0.32 [22]
S013-136 (2017)	1.14	n/a [0]	n/a [0]	n/a [0]	1.14 [1]	n/a [0]	n/a [0]	n/a [0]	1.14 [1]

Table 46. Chlorophyll a monitoring data

07020001-571 Chlorophyll a Sample Data 40 ug/L target	Range of Data (ug/L)	Monthly Average of Samples (ug/L) [# of Samples]							June-Aug Average (ug/L) [# of Samples]
		April	May	June	July	August	Sept	Oct	
S013-136 (2017)	15.2	n/a [0]	n/a [0]	n/a [0]	15.2 [1]	n/a [0]	n/a [0]	n/a [0]	15.2 [1]

Eutrophication HSPF model data

Table 47. HSPF model phosphorus data

	Total Phosphorus	
07020001-571 HSPF Reach 428	**June–September** **% values > 0.15 mg/l** (# Daily Values)	**June–September** **Multi-year Average**
2,318 Total Daily Averages *June–Sep 1994–2012*	**65%** (1511)	**0.23 mg/l**

Figure 28. Photo of dead and decaying algae at bio site 15MN005

Eutrophication summary

The fish community at bio sites 15MN003 and 15MN005 scored below average in all four eutrophication related fish metrics when compared to the average of all other Class 2 southern stream bio sites that meet the FIBI modified use threshold. The abundance of darter individuals was very low and omnivorous fish comprised over 90% of the population. There were almost no sensitive species and nearly all individuals present were tolerant species (Table 43).

The invert community at bio sites 15MN003 scored below average in all six eutrophication related invert metrics when compared to the average of all other Invert Class 7 Prairie Stream Glide Pool bio sites that meet the MIBI modified use threshold (Table 44). However, the metrics that scored poorly were not too far from the class averages indicating eutrophication is having less of an effect on the invert communities. Total taxa count and collector – filterer taxa count both scored poorly and were just below the class average. Collector – gatherer taxa, EPT taxa, intolerant two taxa, and tolerant two taxa all scored poorly.

Twenty-two samples were collected and analyzed for Phosphorus from 2011-2015. The summer average was 0.32 mg/L, over twice the standard of 0.15 mg/L (Table 45). The HSPF model computed the summer average well above the standard at 0.23 mg/L.

Both the fish and invert biological communities are showing the effects of the elevated phosphorus. High levels of phosphorus were also measured during sampling. Dead and decaying algae covered the entire stream channel (Figure 28). Although DO flux did not reach 5 mg/L values were close to zero during the night and did not get above 5 mg/L during the day (Figure 26). Eutrophication is a stressor in Fish Creek, especially at the upstream bio station 15MN005.

3.2.7 Suspended solids

Suspended solids biological metric data

Table 48. Suspended solids related fish metrics

07020001-571 Fish Class 2 Modified Use	Benthic Feeder %	Centrarchid-Tolerant %	Herbivore %	Intolerant %	Long-Lived %	Perciformes-Tolerant %	Riffle %	Sensitive %	Simple Lithophilic Spawner %	TSS TIV
15MN003 6/9/2015	0.0	0.0	2.0	0.0	0.0	0.5	0.0	0.0	0.0	23.6
15MN005 6/9/2015	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	23.3
Statewide average for Class 2 Southern Stream stations that are meeting the FIBI modified use threshold (35.0)	**30.1**	**6.2**	**2.9**	**0.9**	**21.3**	**28.7**	**19.5**	**8.4**	**26.2**	**20.5**
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Table 49. Suspended solids related invert metrics

07020001-571 Invert Class 7 Modified Use	Collector-Filterer %	Plecoptera %	TSS Intolerant %	TSS Tolerant %	TSS TIV
15MN003 8/4/2015	1.9	0.0	0.0	8.0	15.6
Statewide average for Class 7 Prairie Streams Glide Pool bio sites that are meeting the MIBI Modified Use Threshold (22.0)	**9.9**	**0.02**	**1.3**	**35.6**	**16.3**
Expected response to TSS stress	↓	↓	↓	↑	↑

TSS monitoring data

Table 50. Total suspended solids monitoring data

07020001-571 TSS Sample Data 65 mg/L	Range of Data (mg/L)	% of Monthly Samples > 65 mg/L [# of Samples]							% of Total Samples > 65 mg/L [# of Samples]
		April	May	June	July	August	Sept	Oct	
S002-881 (2011-2015)	3-44	0% [4]	0% [7]	0% [6]	0% [9]	0% [7]	0% [6]	0% [5]	0% [44]

Suspended solids summary

The fish community at bio sites 15MN003 and 15MN005 scored below average in all ten suspended solids related fish metrics when compared to the average of all other Class 2 southern stream bio sites that meet the FIBI modified use threshold (Table 48).

The invert community at bio site 15MN003 scored poorly in three out of five related metrics though species tolerant to TSS was low (Table 49). There were some TSS tolerant species and the TSS TIV score indicated that the invertebrate community was not unusually tolerant of sediment.

Forty-four samples were collected and analyzed for total suspended solids from 2011-2015. No sample had a total suspended solid concentration above 65 mg/L (Table 50).

Suspended solids are inconclusive as a stressor to aquatic life at this time. It is likely that other factors, such as altered hydrology and habitat are causing poor scores in the fish biological metrics. It is recommended that more TSS data be collected during high flows in order to determine whether it is a biological stressor.

3.2.8 Nitrates

Nitrate biological metric data

Table 51. Nitrate related invert metrics

07020001-571 Invert Class 7 Modified Use	Nitrate Intolerant Taxa %	Nitrogen TIV	N Tolerant Taxa %	Trichoptera Taxa %
15MN003 8/4/2015	0.0	2.9	40.3	0.0
15MN005 8/4/2015	Insufficient Flow			
Statewide average for Class 7 Prairie Streams Glide Pool bio sites that are meeting the MIBI modified use threshold (22.0)	**2.0**	**3.3**	**59.4**	**5.9**
Expected response to nitrogen stress	↓	↑	↑	↓

Nitrate monitoring data

Table 52. Nitrate monitoring data for chemistry site S002-881

07020001-571 Nitrate/Nitrite Sample Data 4.9 mg/L	Range of Data (mg/L)
S002-881 (2011-2018)	1.1–9.8

The macroinvertebrate assemblage at site 15MN003 scored below average in two of the four nitrate related metrics when compared to all other macroinvertebrate Class 7 streams bio sites that meet the MIBI modified use threshold (Table 22). The biological bio site did show a healthy amount of Trichoptera taxa, which tend to decrease in streams with excessive nitrate values. There was a high amount of nitrate tolerant invertebrates as well as complete lack of nitrate intolerant invertebrate and fish species. The nitrogen TIV score also indicates a macroinvertebrate community that is generally tolerant to high levels of nitrates.

Thirty-eight samples were collected in reach 07020001-541 and analyzed for nitrate/nitrite (Table 52). Twenty-nine percent of the total nitrate concentrations were above 4.9 mg/L. Due to the mostly poor biological metrics and relatively high nitrate values, nitrates appear to be a stressor to the aquatic life in Fish Creek.

3.2.9 Reach stressors

This stream is being stressed by changes to the hydrology of the stream channel and contributing watershed. The stream itself has been ditched, which has eliminated in-stream habitat and has caused heavy siltation and very little depth variability. Phosphorus and nitrates quickly reach the stream via drain tiles, outlets, and field runoff. High nutrient levels affect algae growth, DO concentrations, and DO flux, causing eutrophic conditions. The construction of ditches and the addition of tile drainage has altered the land area that that regularly contributes water to the stream as well as the amount and timing of water that reaches the stream. Increasing the storage and infiltration of water can help reduce nutrient delivery to the stream, erosion and incision from high flows after large rain events, and can help mitigate periods of extremely low flows during times of low precipitation.

Table 53. Summary of stressors in reach 07020001-571

07020001-571	**Hydrologic Alteration**	**Connectivity**	**Habitat**	**Dissolved Oxygen**	**Eutrophication**	**Suspended Solids**	**Nitrate**
✓= Stressor ×= Not a Stressor **O** = Inconclusive	✓	✓	✓	✓	✓	**O**	✓

3.3 07020001-568 Meadowbrook Creek

Figure 29. Satellite image of reach 07020001-568 and its watershed

3.3.1 Biological community

Bio site 15MN009 was sampled for fish in June of 2015. Creek chubs, fathead minnows, and a few other short lived and tolerant taxa dominated the fish community. Even so, the overall number of fish caught, along with several Iowa darters and central stonerollers contributed to a FIBI score of 51.7, just under the Fish Class 3 General Use threshold of 55 (Figure 30). Metrics used to calculate the Fish IBI score are shown in a graph with the red line indicating the value each metric needed to score in order to meet the threshold (Figure 30).

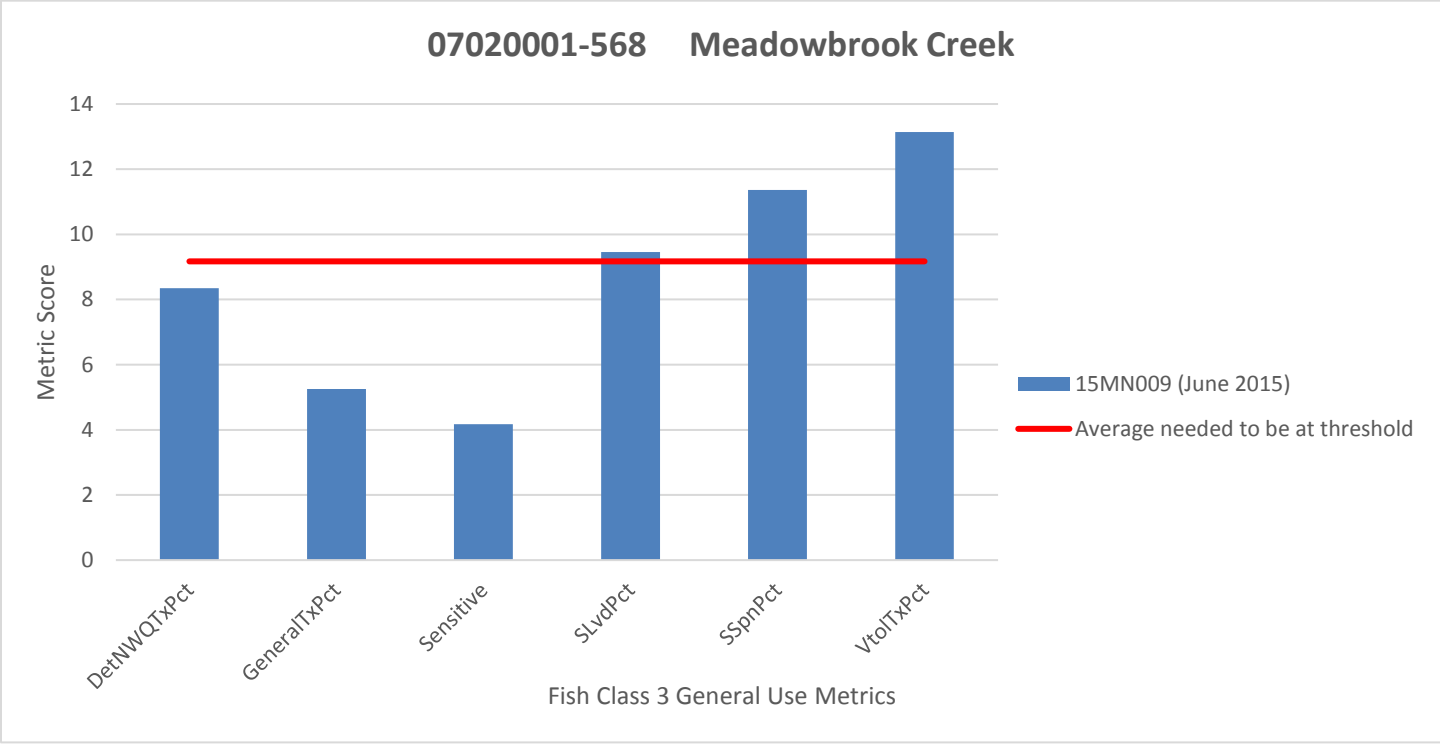
Bio site 15MN009 was sampled for invertebrates in August of 2015 and received a score of 25.8 compared to the Invert Class 5 modified use threshold of 37 (Table 55). Metrics used to calculate the invert IBI score are shown in a graph with the red line indicating the value each metric needed to score in order to meet the threshold (Figure 31).

Fish biological metric data

Table 54. Fish IBI score and threshold

07020001-568 Fish Class 3 General Use		Fish IBI Score	Class Threshold Score
15MN009	6/11/2015	51.7	55

Figure 30. Fish Class 3 metric scores for bio site 15MN009

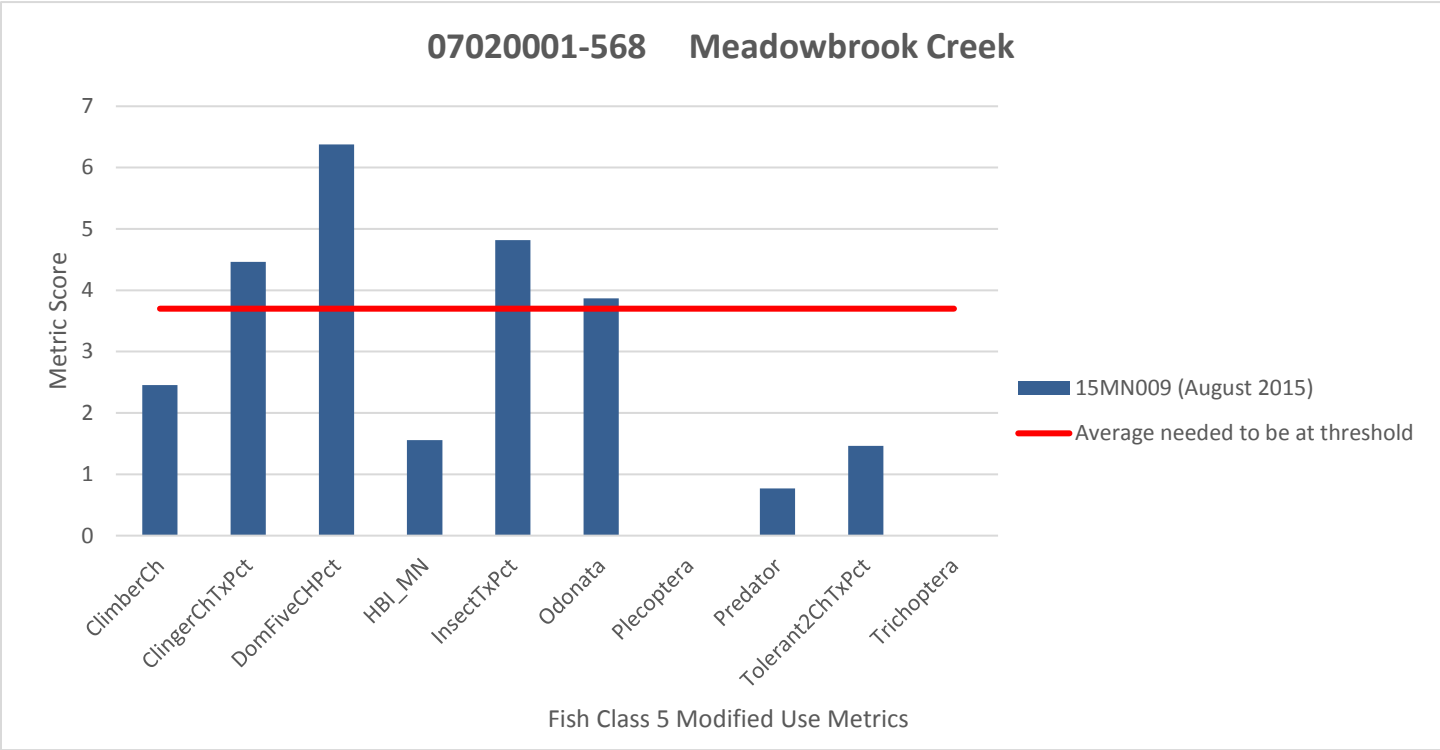


Invertebrate biological metric data

Table 55. Invert IBI score and threshold

07020001-568 Invert Class 5 General Use		Invert IBI Score	Class Threshold Score
15MN009	8/05/2015	25.8	37
15MN009	8/05/2015	31.1	37

Figure 31. Invertebrate Class 5 metric scores for bio sites 15MN009



3.3.2 Hydrologic alteration

Hydrologic alteration biological metric data

Table 56. Hydrologic alteration related fish metrics

07020001-568 **Fish Class 3** **General Use**	General %	Nesting Non Lithophilic Spawner %
15MN009 6/11/2015	93.3	26.7
Statewide average for Class 3 southern headwaters bio sites that are meeting the FIBI general use threshold (55.0)	**59.1**	**19.2**
Expected response to **Hydrologic** stress	↑	↑

Table 57. Hydrologic alteration related invertebrate metrics

07020001-568 **Invert Class 5** **General Use**	Clinger %	Collector-Filterer %	Long-Lived %
15MN009 8/5/2015	53.4	16.1	3.0
15MN009 8/5/2015	35.3	11.3	3.0
Statewide average for Class 5 southern stream rock riffle bio sites that are meeting the MIBI general use threshold (37.0)	**50**	**26.9**	**9.0**
Expected response to hydrologic stress	↓	↓	↓

HSPF model flow data

Table 58. HSPF modeled flow data, 1994-2012

07020001-568 HSPF Reach 424 Min: 0.02 cfs Max: 321.6 cfs	**<5 cfs %** (# of values)	**<1 cfs %** (# of values)	**<0.5 cfs %** (# of values)
6,940 Total Daily Averages 1994–2012	**79.0%** (5,485)	**46.7%** (3,243)	**32.3%** (2,240)

Hydrologic alteration summary

Both of the fish biological metrics scored poorly when compared to the Fish Class 3 stream bio sites that meet the IBI general use threshold (Table 56). Bio site 15MN009 had generalist fish population of 93.3%. The fish assemblage was dominated by fathead minnows and creek chubs and they comprised over 60% of the total number of fish caught.

Invertebrates were sampled twice at bio site 15MN009 in August 2015 (Table 57). All but one invertebrate metric scored poorly when compared to the average of Invert Class 5 general use streams that met the IBI threshold. Clinger invertebrates scored just above the class average but was below it during the other visit. Collector filterers and long-lived invertebrates both scored poorly indicating stress from both high and low flows.

The HSPF model (Table 58) shows that 46.7% of the daily average flows from 1994–2012 are below 1 cfs. Flows reduced beyond normal base flow will decrease habitat for aquatic organisms and increase competition for resources.

Reach 07020001-541 is predominantly natural according to the MPCA Hydrologic Alteration layer (Figure 29), though its upper watershed has been channelized and drained.

According to the original plat information, it appears that this reach had very few and relatively small tributaries with wetlands and shallow lakes throughout the watershed. Its watershed has been extensively altered to drain upland wetlands (Figure 32). Creating ditches added to the amount of land and water that drained into the creek and the timing of water runoff. This altered the natural flow regime of this stream that had developed over several millenniums by decreasing the time it takes for water to move through the system, moving more water through the system at a higher frequency, and increasing the impact to the stream channel of high flow events during periods of high precipitation. Both the frequency and intensity of low flow periods are increased during periods of low precipitation.

Figure 32. Original Plat map with impaired reach 07020001-568 and Original Plat map with altered streams/ditches

Based on the poor scores of most of the biological metrics, low flow periods shown in the HSPF model, as well as historic surveying data, Hydrologic alteration is a stressor in Meadowbrook Creek. The primary impact in this reach from Hydrologic Alteration is seen by the changes in nutrient overloading of phosphorus and the subsequent effects to eutrophication and DO levels, which is exasperated by low flows during periods of low precipitation.

3.3.3 Connectivity

Connectivity metric data

Table 59. Connectivity related fish metrics

07020001-568 **Fish Class 3** **General Use**	Mature Age >3 minus Tolerant Taxa %	Migrating Taxa %
15MN009 6/11/2015	0.0	37.5
Statewide average for Class 3 southern headwaters bio sites that are meeting the FIBI general use threshold (55.0)	**5.3**	**19.5**
Expected response to connectivity stress	↓	↓

Connectivity summary

Although there were no species of fish whose females take greater than three years to mature, migrating taxa comprised 37.5%, well above the Fish Class 3 average of 19.5%. No downstream culverts were identified as fish barriers. Due to the presence of migratory species, it appears that connectivity is not a stressor at this time.

3.3.4 Habitat

Habitat metric data

Table 60. Habitat related fish metrics

07020001-568 Fish Class 3 General Use	Benthic Insect minus Tolerant %	Darter Sculpin Sucker %	Lithophilic Spawner %	Pioneer %	Piscivore %	Riffle %	Simple Lithophilic Spawner %	Tolerant %
15MN009 6/11/2015	3.3	3.3	70.0	62.1	0.0	7.9	31.3	85.0
Statewide average for Class 3 Southern Headwater bio sites that are meeting the FIBI general use threshold (55.0)	**14.2**	**12.6**	**69.2**	**37.8**	**1.6**	**28.3**	**33.7**	**70.6**
Expected response to habitat stress	↓	↓	↓	↑	↓	↓	↓	↑

Table 61. Habitat related invertebrate metrics

07020001-568 Invert Class 5 General Use	Burrower %	Climber %	Clinger %	Ephemeroptera Plecoptera Trichoptera %	Legless %	Sprawler %
15MN009 8/5/2015	15.3	31.3	35.3	2.7	85.7	17.7
15MN009 8/5/2015	10.8	21.6	53.4	6.2	82.3	14.1
Statewide average for Class 5 southern streams rock riffle bio sites that are meeting the MIBI general use threshold (37.0)	**7.5**	**14.7**	**49.5**	**43.9**	**36.0**	**16.8**
Expected response to habitat stress	↑	↓	↓	↓	↑	↑

MPCA stream habitat assessment score

Table 62. Habitat assessment score

07020001-568	Land Use	Riparian	Substrate	Cover	Channel Morphology	Total Score
15MN009 6/11/2015	1.3	10	19.4	15	29	74.7
Maximum Attainable Habitat Score	**5**	**14**	**28**	**18**	**35**	**100**

Figure 33. Photo of Meadowbrook Creek and bio site 15MN009 taken from the stream bank (left) and a photo of gravel substrate at bio site 15MN009 (right)

Habitat summary

The fish community at bio site 15MN009 scored below average in seven out of eight habitat related fish metrics when compared to all other Class 3 Southern Headwater bio sites that met the FIBI general use threshold. Benthic insectivores, Darter, sculpin, and suckers, Pioneer species, and riffle species scored poorly. Lithophilic spawners scored above the average and simple Lithophilic spawners scored just below the average (Table 60).

Invertebrate metrics were mixed. Climber and Sprawler species scored above or just below the average. Ephemeroptera, Plecoptera, and Trichoptera scored very poorly and legless percentage was very high (Table 61).

The MSHA habitat assessment score was good, though substrate and land use brought the score down. Sedimentation of silt seems to be affecting the substrate habitat, resulting in a high number of legless invertebrates. There was some gravel observed within the reach near the bio site. A large grass buffer is providing good cover and the stream appears to be able to access its flood plain (Figure 33).

The lack of benthic insectivores, lower than average riffle dwelling fish, and the high number of legless invertebrates indicate habitat may be a stressor to the biological community in the reach. Climber, clinger, and sprawler invertebrates scored decent however. Due to the mixed bio metrics and decent MSHA habitat scores it is inconclusive as a stressor at this time.

3.3.5 Dissolved oxygen

DO biological metric data

Table 63. Dissolved oxygen related fish metrics

07020001-568 **Fish Class 3** **General Use**	Mature Age >3 %	Serial Spawner %	Taxa Count	DO TIV	DO Sensitive %	DO Tolerant %
15MN009 6/11/2015	0.0	24.6	8.0	6.9	0.0	30.0
Statewide average for Class 3 southern headwaters bio sites that are meeting the FIBI general use threshold (55.0)	**13.3**	**17.1**	**12.2**	**7.2**	**3.7**	**18.6**
Expected response to DO stress	↓	↑	↓	↓	↓	↑

Table 64. Dissolved oxygen related invert metrics

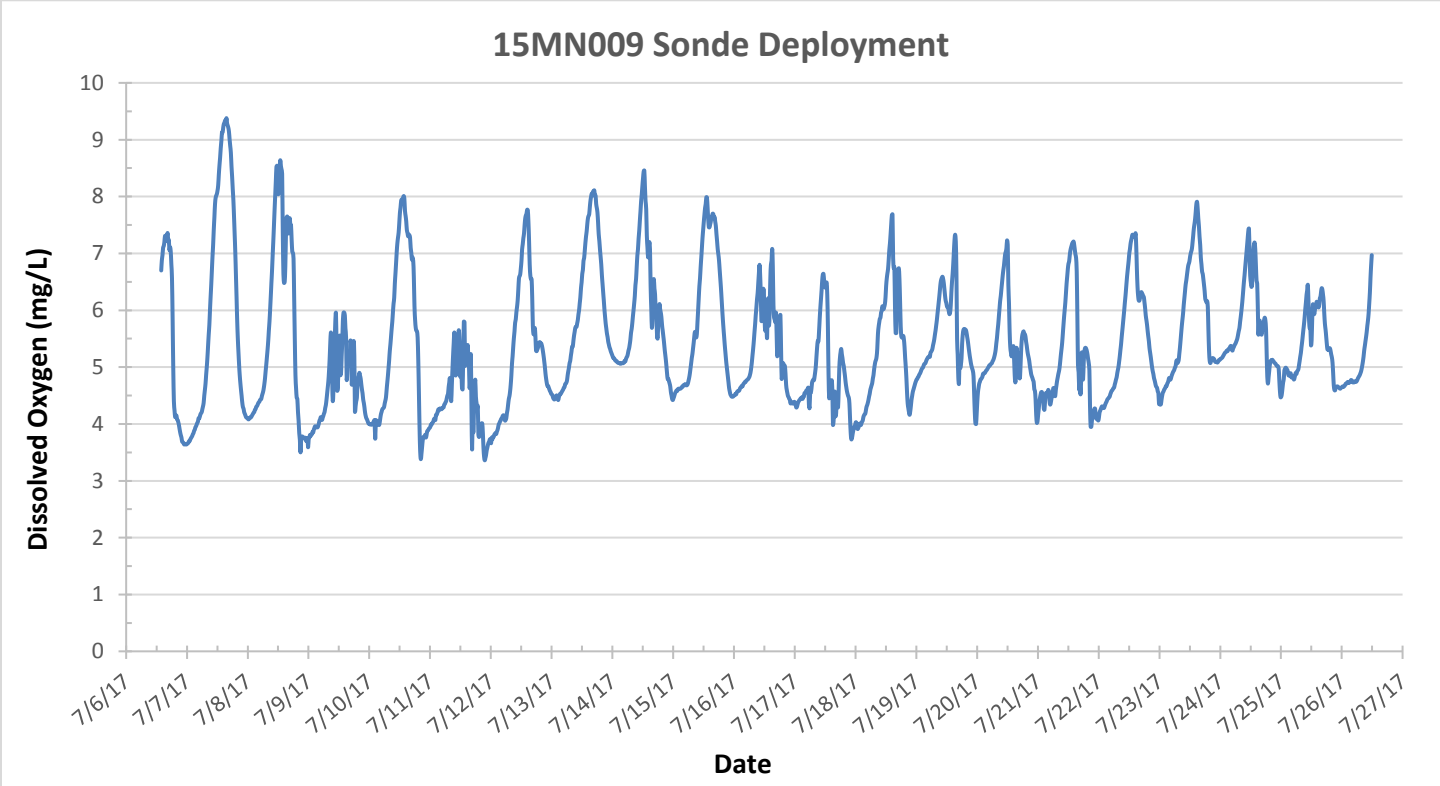
07020001-568 **Invert Class 5** **General Use**	Low DO Intolerant Taxa %	Low DO Tolerant Taxa %	DO TIV	HBI_MN
15MN009 6/11/2015	1.3	17.7	6.6	7.8
15MN009 6/11/2015	3.3	17.5	6.9	8.0
Statewide average for Class 5 southern streams rock riffle bio sites that are meeting the MIBI general use threshold (37.0)	**24.6**	**8.6**	**7.1**	**7.0**
Expected response to DO stress	↓	↑	↓	↑

DO monitoring data

Table 65. Dissolved oxygen monitoring data

07020001-568 DO Data 5 mg/L	Range of Data (mg/L)	% of Monthly Samples < 5 mg/L [# of Samples]							% of Total Samples < 5 mg/L [# of Samples]
		April	May	June	July	August	Sept	Oct	
S008-470 (2015-2017)	4.5–15.2	n/a [0]	0% [2]	40% [5]	0% [8]	0% [5]	0% [2]	n/a [0]	10% [22]
S002-877 (2011-2012)	6.6–14.7	0% [4]	0% [5]	0% [5]	0% [6]	0% [6]	0% [4]	0% [4]	0% [34]

Figure 34. Dissolved oxygen continuous data at site 15MN009



DO HSPF model data

Table 66. Dissolved oxygen HSPF model data

07020001-568 HSPF Reach 424	**June – September** **% Daily Averages** **<5 mg/l** (# of values)
2,318 Total Daily Averages	**8%** (197)

Dissolved oxygen summary

The fish community at bio site 15MN009 scored below average in all six DO related fish metrics when compared to the average of all other Class 3 Southern Headwater bio sites that meet the FIBI general use threshold (Table 63). No species with females that take more than three years to mature were caught. Serial spawning fish were high and overall taxa count scored poorly.

All four DO related invertebrate metrics scored poorly than the Class 5 average. Invertebrate taxa intolerant of low DO scored very poorly and DO tolerant scored well above the Class 5 average.

Forty percent of the June DO measurements taken during sampling were below the warmwater standard of 5 mg/L, none of those measurements were taken before 8:00 am, when values are usually the lowest, when values are usually the lowest. A YSI Sonde water meter measured continuous DO data from July 6 2017 to July 27 2017. During this deployment, DO values were measured below the standard 19 out of 21 days.

Based on the related biological metric scores and the measured values, DO is a stressor in this reach. It is likely being aggravated by low flow conditions.

3.3.6 Eutrophication

Eutrophication biological metric data

Table 67. Eutrophication related fish metrics

07020001-568 **Fish Class 3** **General Use**	Darter %	Omnivore %	Sensitive %	Tolerant %
15MN009 6/11/2015	3.3	31.3	3.3	85.0
Statewide average for Class 3 southern headwaters bio sites that are meeting the FIBI general use threshold (55.0)	**12.1**	**14.6**	**8.6**	**70.6**
Expected response to eutrophication stress	↓	↑	↓	↑

Table 68. Eutrophication related invertebrate metrics

07020001-568 **Invert Class 5** **General Use**	Taxa Count All #	Collector–Filterer Taxa #	Collector–Gatherer Taxa #	Ephemeroptera Plecoptera Trichoptera Taxa #	Intolerant Two Taxa #	Tolerant Two Taxa %
15MN009 8/5/2015	38	4	15	3	0	86.8
15MN009 8/5/2015	33	6	10	4	0	94.0
Statewide average for Class 5 southern streams rock riffle bio sites that are meeting the MIBI general use threshold (37.0)	**41.9**	**6.5**	**15.0**	**10.9**	**0.8**	**71.9**
Expected response to eutrophication stress	↓	↓	↑	↓	↓	↑

Eutrophication monitoring data

Table 69. Phosphorus monitoring data

07020001-568 P Sample Data 0.15 mg/L	Range of Data (mg/L)	Monthly Average of Samples (mg/L) [# of Samples]							June-Aug Average (mg/L) [# of Samples]
		April	May	June	July	August	Sept	Oct	
S008-470 (2015-2017)	0.1–0.3	n/a [0]	0.22 [2]	0.10 [2]	0.15 [4]	0.11 [2]	0.10 [2]	n/a [0]	0.13 [8]
S002-877 (2011-2012)	0.03–0.8	n/a [0]	0.11 [5]	0.17 [5]	0.34 [5]	0.23 [5]	0.09 [5]	0.05 [2]	0.18 [27]

Eutrophication HSPF model data

Table 70. HSPF model phosphorus data

	Total Phosphorus	
07020001-568 HSPF Reach 424	**June–September % values > 0.15 mg/l** (# Daily Values)	**June–September Multi-year Average**
2,318 Total Daily Averages June–Sep 1994–2012	**66.4%** (1,540)	**0.2 mg/l**

Figure 35. Photo of bio site 15MN009 showing cloudy green water

Eutrophication summary

The fish community at bio site 15MN009 scored below average in all four eutrophication related fish metrics when compared to the average of all other Class 3 Southern Headwater bio sites that meet the FIBI general use threshold (Table 67). The abundance of darter individuals was very low and omnivorous fish comprised 31.3% of the population. There were almost no sensitive species and tolerant species comprised 85% of the population.

The invert community at bio sites 15MN009 was sampled twice on August 5, 2015 in order to do a duplicate sample (Table 68). It scored below average in five out of six eutrophication related invert metrics in both samples compared to the average of all other Class 5 Southern Stream rock riffle bio sites that meet the MIBI General Use threshold. Total taxa count and collector filterer taxa count both scored poorly and were just below the class average. Collector – gatherer taxa scored right at the class average in the first sample and below it in the second. EPT taxa, intolerant two taxa, and tolerant two taxa percentage all scored poorly.

Thirty-five samples were collected and analyzed for Phosphorus from 2011-2017. The summer average was below the standard of 0.15 mg/L at S008-470 but was above the standard at site S002-877 (Table 69). The HSPF model computed the summer average well above the standard at 0.2 mg/L (Table 70).

A YSI Sonde water meter measured continuous DO data from July 6, 2017 to July 26, 2017 (Figure 34). During this deployment, DO diurnal flux, or the difference between the daily high and low DO concentrations was mostly below the eutrophication DO flux standard, though it did reach 5 mg/l on July 7, 2017.

High levels of phosphorus were measured during sampling and both the fish and invert biological communities appear to be showing the effects of eutrophication. More overnight measurements or chlorophyll-a sampling is recommended in order to determine whether eutrophication is a stressor. Due to a lack of a response variable, eutrophication is inconclusive as a stressor in Meadowbrook Creek.

3.3.7 Suspended solids

Suspended solids biological metric data

Table 71. Suspended solid related fish metrics

07020001-568 Fish Class 3 General Use	Benthic Feeder %	Centrarchid-Tolerant %	Herbivore %	Intolerant %	Long-Lived %	Perciformes-Tolerant %	Riffle %	Sensitive %	Simple Lithophilic Spawner %	TSS TIV
15MN009 6/11/2015	7.9	0.0	1.3	0.0	0.0	3.3	7.9	3.3	31.3	16.8
Statewide average for Class 3 Southern Headwater stations that are meeting the FIBI general use threshold (55.0)	**37.8**	**0.9**	**13.3**	**1.9**	**3.6**	**13.9**	**28.3**	**8.6**	**33.7**	**15.2**
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Table 72. Suspended solid related invertebrate metrics

07020001-568 Invert Class 5 General Use	Collector-Filterer %	Plecoptera %	TSS Intolerant %	TSS Tolerant %	TSS TIV
15MN009 8/5/2015	11.3	0.0	0.0	13.0	14.7
15MN009 8/5/2015	16.1	0.0	0.0	15.0	15.1
Statewide average for Class 5 southern streams rock riffle bio sites that are meeting the MIBI general use threshold (37.0)	**26.9**	**0.5**	**5.1**	**35.2**	**15.9**
Expected response to TSS stress	↓	↓	↓	↑	↑

TSS monitoring data

Table 73. Total suspended solids monitoring data

07020001-568 TSS Sample Data 65 mg/L	Range of Data (mg/L)	% of Monthly Samples > 65 mg/L [# of Samples]							% of Total Samples > 65 mg/L [# of Samples]
		April	May	June	July	August	Sept	Oct	
S008-470 (2015-2016)	2-10	n/a [0]	0% [2]	0% [2]	0% [3]	0% [2]	0% [2]	n/a [0]	0% [11]
S002-877 (2011-2012)	1-24	0% [4]	0% [5]	0% [5]	0% [5]	0% [5]	0% [5]	0% [4]	0% [33]

Suspended solids summary

The fish community at bio site 15MN009 scored below average in all 10 suspended solids related fish metrics when compared to the average of all other Class 2 southern stream bio sites that meet the FIBI general use threshold (Table 71). However, simple lithophillic spawners scored just below the class average at 31.3% of the population. The TSS TIVC score was just above the class average.

The invert community at bio site 15MN009 scored poorly in three out of five related metrics. Species tolerant to TSS were low however and the invert TIV scores were below the class average (Table 72).

Forty-four samples were collected and analyzed for total suspended solids from 2011-2016. No sample had a total suspended solid concentration above 65 mg/L (Table 73).

Suspended solids are inconclusive as a stressor to aquatic life at this time. It is likely that other factors, such as altered hydrology and habitat are causing poor scores in the fish biological metrics. It is recommended that more TSS data be collected during high flows in order to determine whether it is a biological stressor.

3.3.8 Nitrates

Nitrate biological metric data

Table 74. Nitrate related invert metrics

07020001-568 **Invert Class 5** **General Use**	Nitrate Intolerant Taxa %	Nitrogen TIV	N Tolerant Taxa %	Trichoptera Taxa %
15MN009 8/5/2015	0.0	4.0	80.3	5.3
15MN009 8/5/2015	0.0	4.0	82.8	12.1
Statewide average for Class 5 southern streams rock riffle bio sites that are meeting the MIBI general use threshold (37.0)	**2.9**	**3.0**	**47.6**	**13.6**
Expected response to nitrogen stress	↓	↑	↑	↓

Nitrate monitoring data

Table 75. Nitrate monitoring data for chemistry site S008-470 and S002-877

07020001-568 Nitrate/Nitrite Sample Data	Range of Data (mg/L)
S008-470 (2015-2017)	0.03–3.2
S002-877 (2011-2012)	0. 03–1.5

Nitrate summary

The macroinvertebrate assemblage at site 15MN009 scored below average in all four nitrate related metrics when compared to all other macroinvertebrate Class 5 southern stream rock riffle bio sites that meet the MIBI general use threshold (Table 74). Trichoptera taxa was close to the average on the second visit, which tend to decrease in streams with excessive nitrate values. There was a high amount of nitrate tolerant invertebrates as well as complete lack of nitrate intolerant invertebrate and fish species. The nitrogen TIV score also indicates a macroinvertebrate community that is generally tolerant to high levels of nitrates.

Thirty-nine samples were collected in reach 07020001-568 and analyzed for nitrate/nitrite (Table 75). Nitrate concentrations were all relatively low and do not appear to be a stressor to aquatic life in Meadowbrook Creek.

3.3.9 Reach stressors

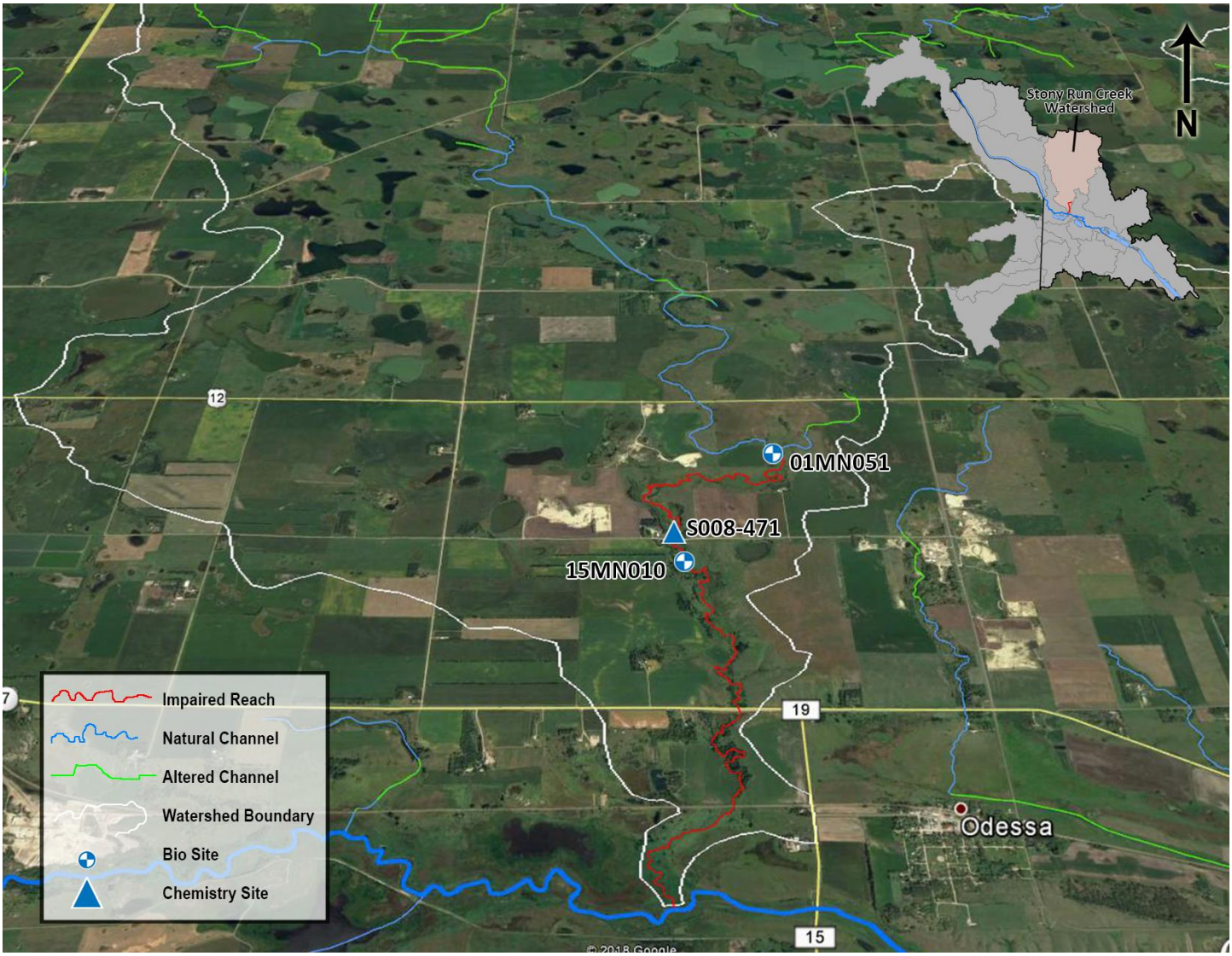
This stream is being stressed by changes to the hydrology of the stream channel and contributing watershed. The construction of ditches and the addition of tile drainage has altered the land area that that regularly contributes water to the stream as well as the amount and timing of water that reaches the stream. This stream is stressed by low DO, likely from low flows during the hot, summer months when precipitation is low. Increasing the storage and infiltration of water can help reduce nutrient delivery to the stream, erosion and incision from high flows after large rain events, and can help mitigate periods of extremely low flows during times of low precipitation.

Table 76. Summary of stressors in reach 07020001-568

07020001-568	Hydrologic Alteration	Connectivity	Habitat	Dissolved Oxygen	Eutrophication	Suspended Solids	Nitrate
= Stressor × = Not a Stressor **O** = Inconclusive		×	**O**		**O**	**O**	×

3.4 07020001-531 Stony Run Creek

Figure 36. Satellite image of reach 07020001-568 and its watershed



3.4.1 Biological community

Bio sites 01MN051 and 15MN010 were sampled for fish in 2001 and in 2015. Fathead minnows, common shiners, creek chubs, and a few other short lived and tolerant taxa dominated both bio sites resulting in metric scores of 19.4 and 39 (Table 77). Metrics used to calculate the Fish IBI score are shown in a graph with the red line indicating the value each metric needed to score in order to meet the threshold (Figure 37).

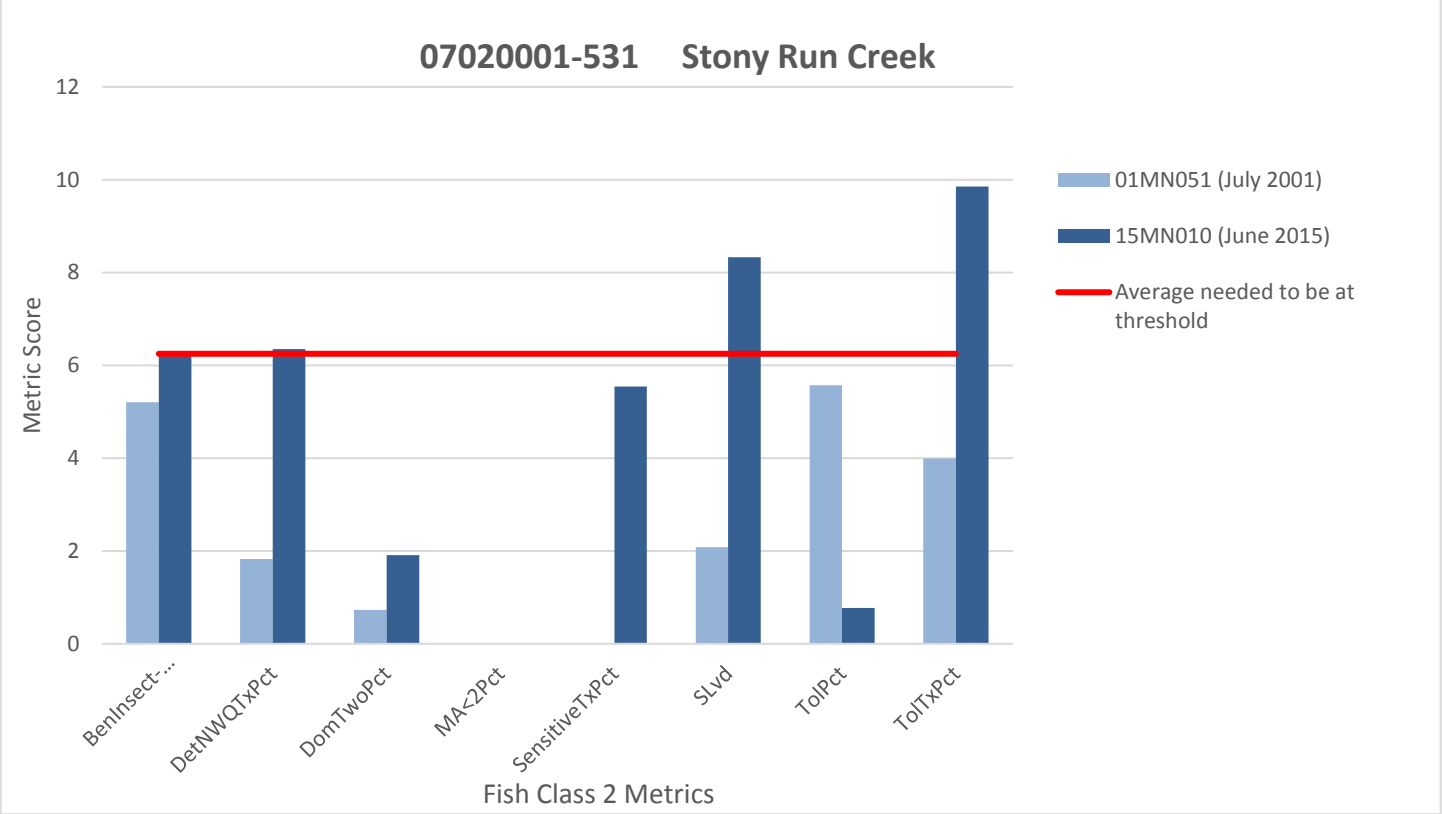
Bio sites 01MN051 and 15MN010 were sampled for invertebrates in 2001 and 2015. Macroinvertebrate scores were 33.3 and 23.3, under the Invert Class 5 general use threshold of 37 (Table 78). Although a fair number of caddisflies and mayflies were found, only one of the species of caddisfly is considered sensitive and only a single individual was observed. The midge *Polypedilum*, comprising over 35% of the total number of invertebrates caught, dominated the invertebrate community. Midges are typically tolerant of silt embedded substrates and indicate an impaired biological community, especially in a rock/riffle bio site. Metrics used to calculate the invert IBI score are shown in a graph with the red line indicating the value each metric needed to score in order to meet the threshold (Figure 38).

Fish biological metric data

Table 77. Fish IBI scores and threshold

07020001-531 Fish Class 2 General Use		Fish IBI Score	Class Threshold Score
01MN051	9/13/2001	19.4	50
15MN010	8/5/2015	39.0	

Figure 37. Fish Class 2 metric scores for bio sites 01MN051 and 15MN010

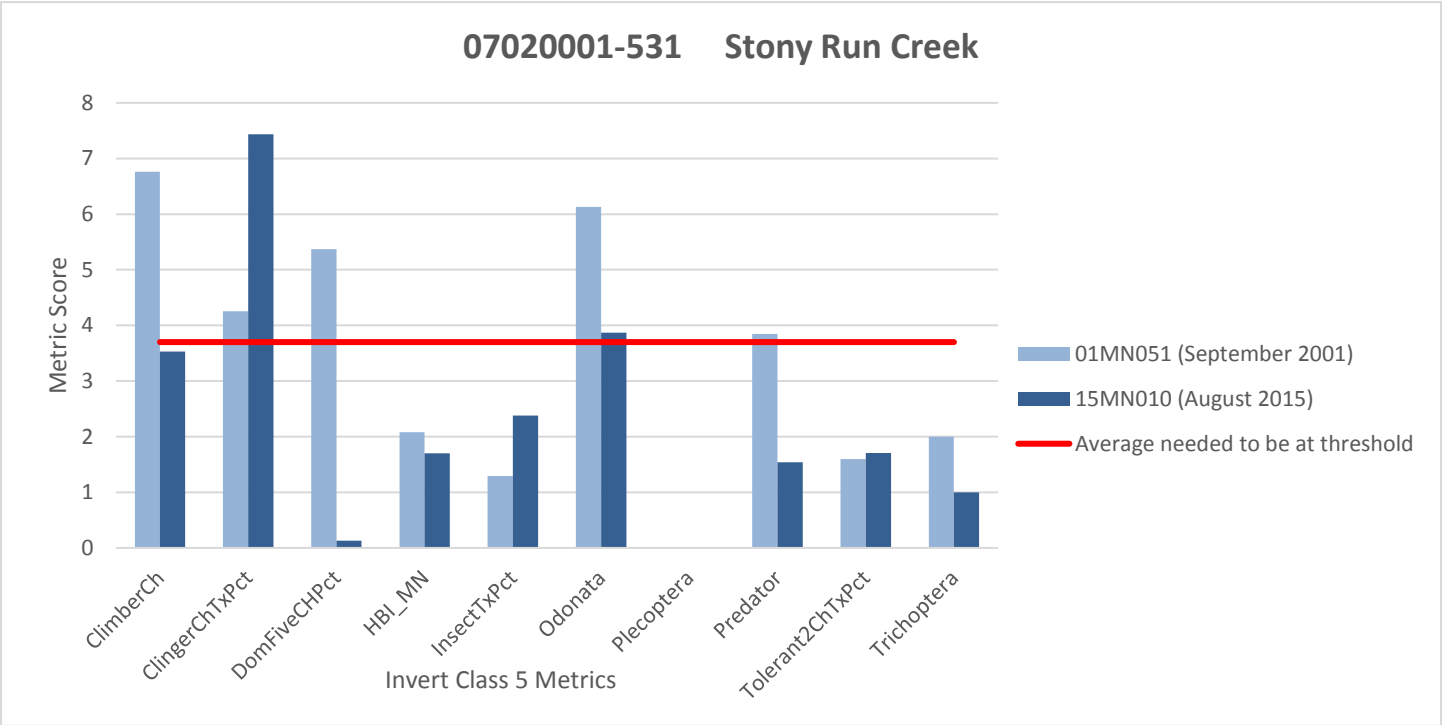


Invert biological metric data

Table 78. Invert IBI scores and threshold

07020001-531 Invert Class 5 General Use		Fish IBI Score	Class Threshold Score
01MN051	9/13/2001	33.3	37
15MN010	8/5/2015	23.3	

Figure 38. Invert Class 5 metric scores for bio sites 01MN051 and 15MN010



3.4.2 Hydrologic alteration

Hydrologic alteration biological metric data

Table 79. Hydrologic alteration related fish metrics

07020001-531 **Fish Class 2** **General Use**		General %	Nesting Non Lithophilic Spawner %
01MN051	7/16/2001	57.0	52.0
15MN010	6/18/2015	93.5	48.1
Statewide average for Class 2 southern stream bio sites that are meeting the FIBI general use threshold (50.0)		**42.4**	**19.1**
Expected response to **Hydrologic** stress		↑	↑

Table 80. Hydrologic alteration related invertebrate metrics

07020001-531 **Invert Class 5** **General Use**	Clinger %	Collector-Filterer %	Long-Lived %
01MN051 9/13/2001	49.1	26.8	0.0
15MN010 8/5/2015	39.5	28.4	3.7
Statewide average for Class 5 southern streams rock riffle bio sites that are meeting the MIBI general use threshold (37.0)	**50**	**26.9**	**9.0**
Expected response to hydrologic stress	↓	↓	↓

HSPF model flow data

Table 81. HSPF modeled flow data, 1994-2012

07020001-531 HSPF Reach 417 Min: 0.0003 cfs Max: 1,596.5 cfs	**<5 cfs %** (# of values)	**<1 cfs %** (# of values)	**<0.5 cfs %** (# of values)
6,940 Total Daily Averages 1994–2012	**47.6%** (3,301)	**22.2%** (1,538)	**17.5%** (1,212)

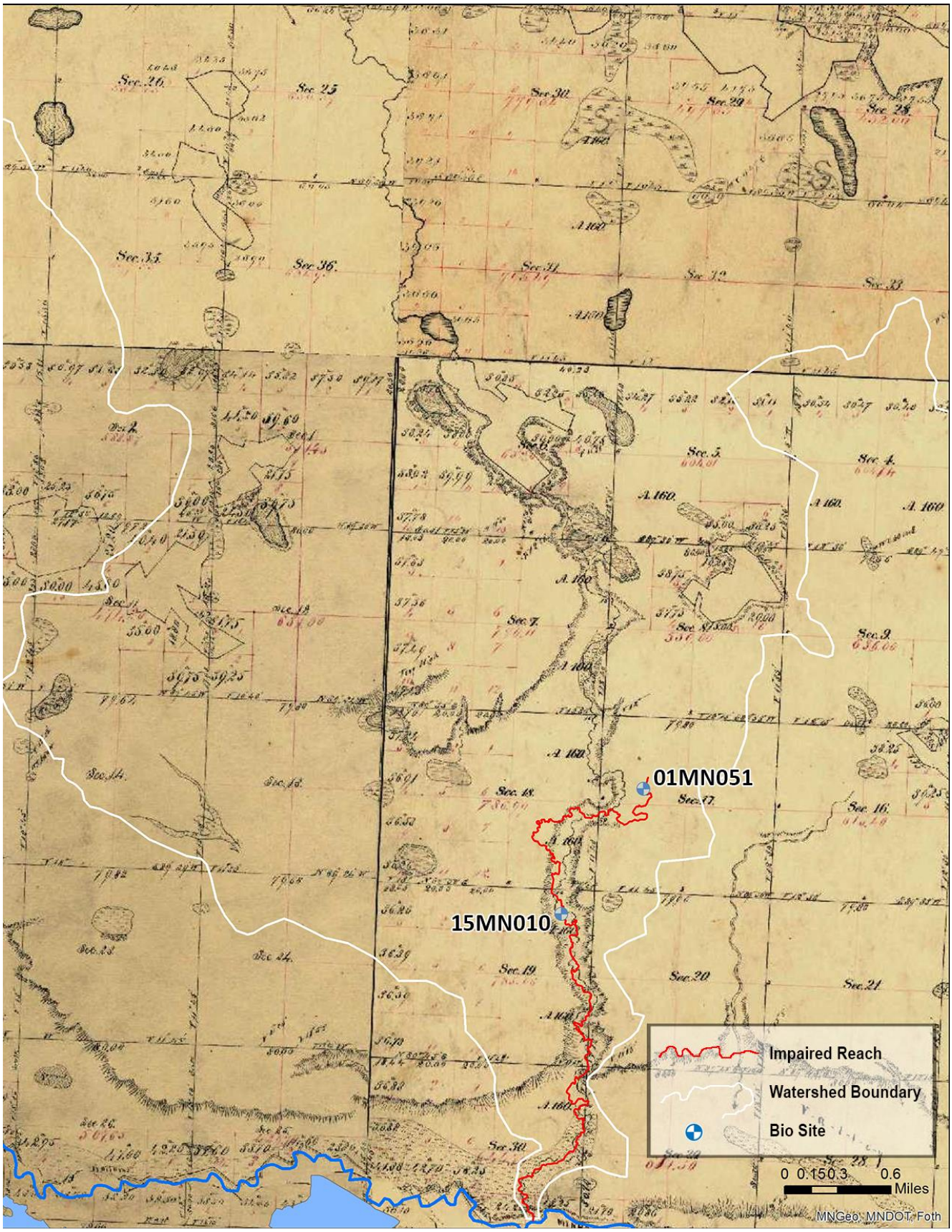
Hydrologic alteration summary

Both of the fish biological metrics scored poorly when compared to the Fish Class 2 southern stream bio sites that meet the IBI general use threshold (Table 79). The fish assemblage was dominated by fathead minnows, common shiners, and creek chubs and those three species comprised over 87% of the total number of fish caught. Bio site 15MN010 had a generalist fish population of 93.5%, which is significantly higher than the class average and higher than bio site 01MN051 sampled in 2001. Nesting fish scored poorly at over 48% of the total number of fish caught, well above the class average.

Two out of three invertebrate metrics scored poorly when compared to the average of Invert Class 5 general use streams that met the IBI threshold (Table 80). Clinger invertebrates were below the class average, collector filterers were just above and long-lived inverts made up 3.7% of the total number of fish caught.

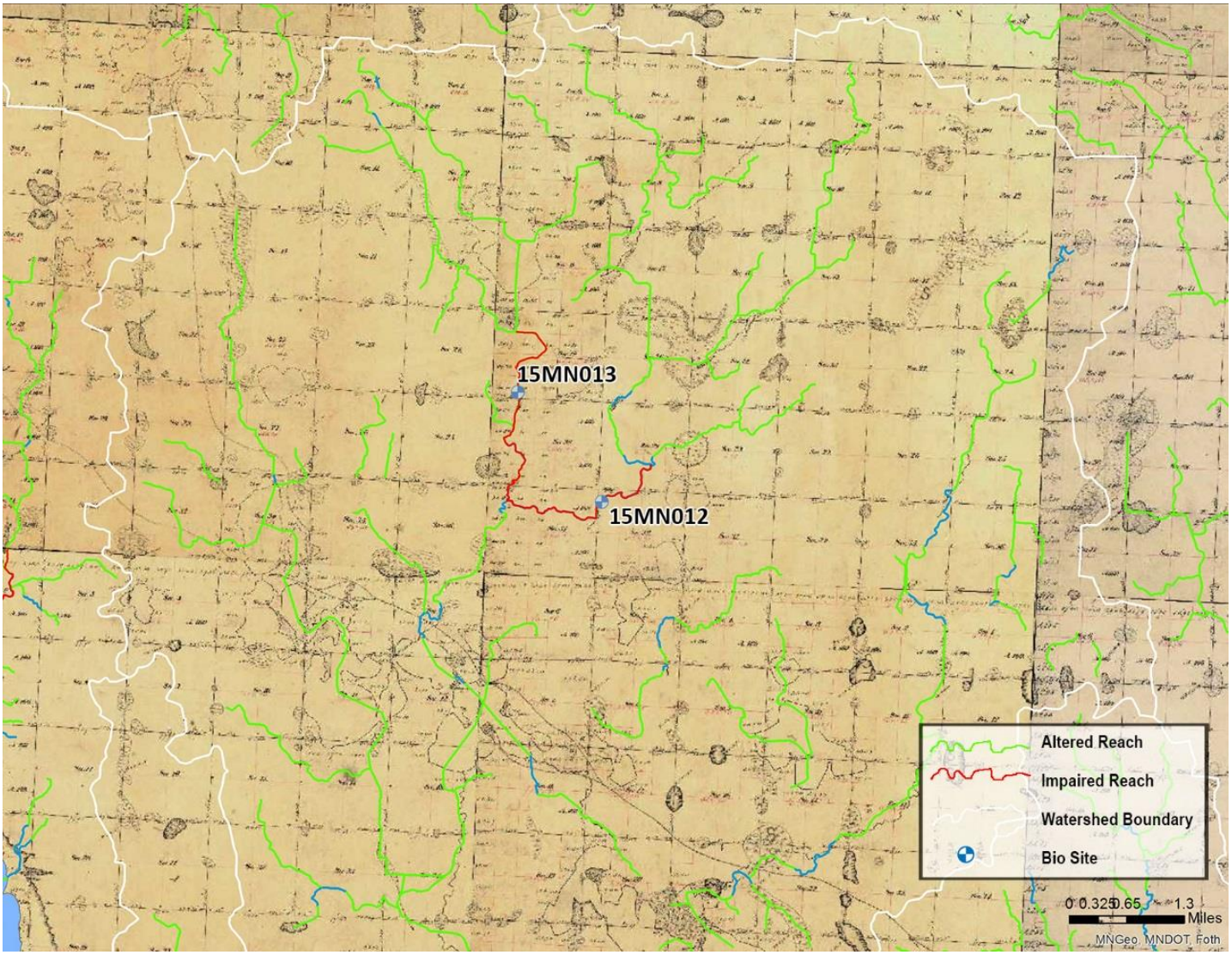
The HSPF model (Table 81) shows that 22.2% of the daily average flows from 1994 – 2012 are below 1 cfs. Flows reduced beyond normal base flow will decrease habitat for aquatic organisms and increase competition for resources.

Figure 39. Zoomed in original survey plat map of the watershed of reach 07020001-531 showing Long Tom Lake and some other shallow lakes



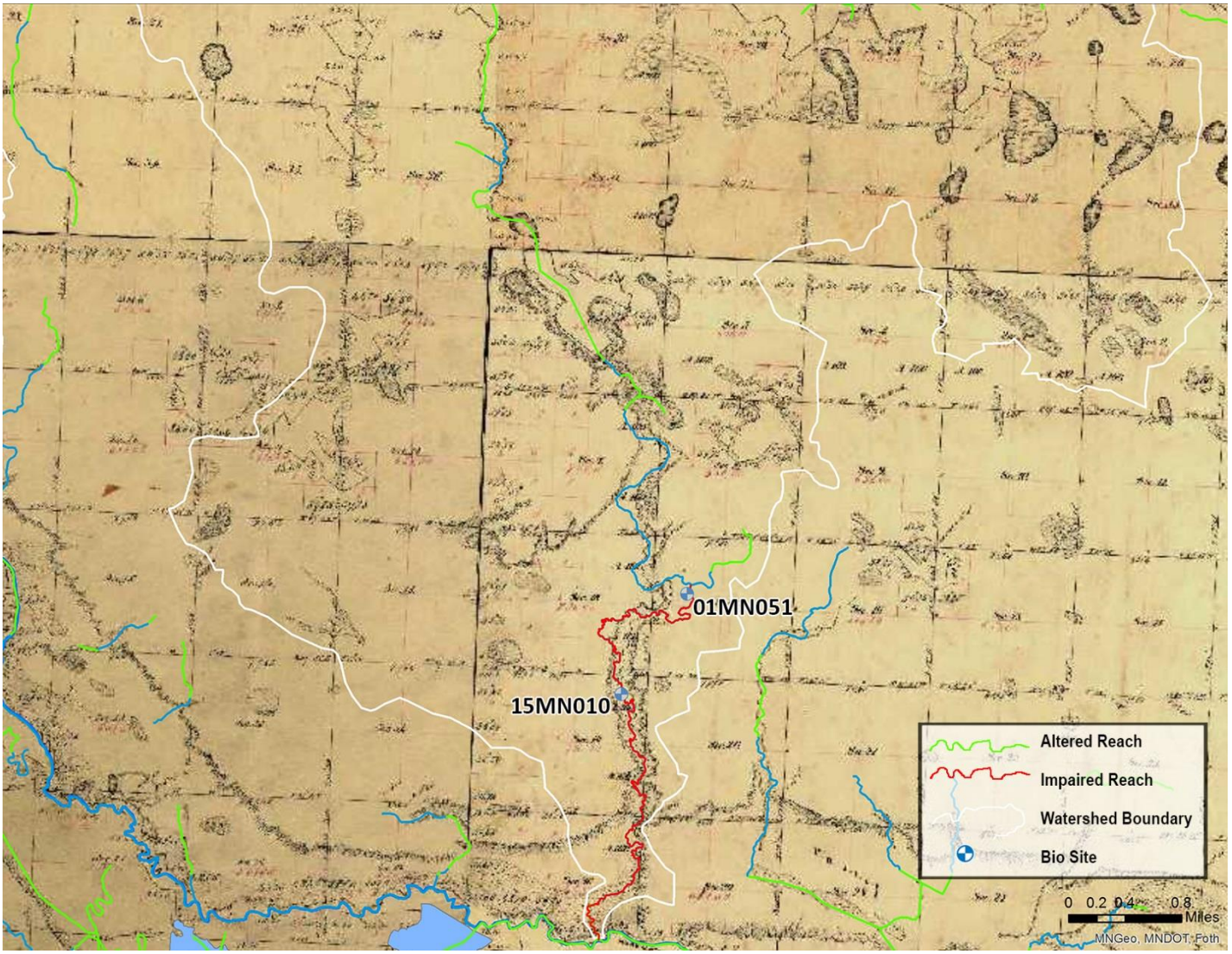
According to the original plat information, the watershed of reach 07020001-531 had many shallow lakes and wetlands in its mid to upper watershed (Figure 39), (Figure 40) and (Figure 41). At the lower end of the watershed the creek is confined within a roughly 1/10 of a mile wide valley until the very end where it flows out on the flood plain of the Minnesota River. There are two main areas of shallow lakes and wetlands approximately halfway up the watershed, many of which still exist today. Several of the larger, shallow lakes have been impounded to control water levels.

Figure 40. Original survey map Upper Stony Run Watershed with altered streams/ditches



The Upper Stony Run watershed contains the impaired reaches 07020001-559 and 07020001-560 (Figure 40), both are impaired for their fish IBI scores. The very upper watershed has been ditched to drain the large wetland complex that existed, many of the stream channels probably did not exist or were more of a wetland in this area with some shallow lakes mixed in (Figure 39). Most of the lakes have been at least partially drained and connected by ditches in order to move water and grow crops. Creating these ditches essentially added to the amount of land and water that drains into the creek and the timing of water runoff. This altered the natural flow regime of this stream that had developed over several millenniums by decreasing the time it takes for water to move through the system, moving more water through the system at a higher frequency, and increasing the impact to the stream channel of high flow events while also increasing the intensity of low flow periods.

Figure 41. Original survey map Lower Stony Run Watershed with altered streams/ditches



The Minnesota River – Headwaters Watershed Characteristic Report classified reach 07020001-531 as a C5c (DNR, 2019). This stream type is described as a slightly entrenched, meandering, sand-dominated, riffle/pool channel with a well-developed floodplain (Rosgen 1996). C5 stream types have a very high sensitivity to disturbance, sediment supply, and streambank erosion potential (DNR, 2019). The bank height ratio was calculated as stable at 1.1 and the entrenchment ratio is only slightly entrenched at 11.9. The stream channel appears to be relatively stable in lower Stony Run Creek. This stability is likely being helped by the grade control that the lakes and reservoirs provide by slowing down and regulating the water flowing downstream. The last lake in the chain, Long Tom Lake, has a concrete structure that controls the lake level (Figure 42).

Figure 42. Google Earth image of the outlet structure that controls water levels on Long Tom Lake

Based on the poor scores of most of the biological metrics, low flow periods shown in the HSPF model, the historic surveying data, and the DNR geomorphology analysis, Hydrologic Alteration is a stressor in Stony Run Creek. The primary impact in this reach from Hydrologic Alteration is the pollutant overloading of nutrients. The lakes within the watershed although helping the stability of the stream channel, also collect and act as sources of nutrients, contributing to the high phosphorus and chlorophyll-a values that were sampled within both the lakes and stream. It appears to be affecting the fish community more than the invertebrate.

3.4.3 Connectivity

Connectivity metric data

Table 82. Connectivity related fish metrics

07020001-531 **Fish Class 2** **General Use**		Mature Age >3 minus Tolerant Taxa %	Migrating Taxa %
01MN051	7/16/2001	8.3	25.0
15MN010	6/18/2015	10.0	20.0
Statewide average for Class 2 southern stream bio sites that are meeting the FIBI general use threshold (50.0)		**21.8**	**24.3**
Expected response to connectivity stress		↓	↓

Connectivity summary

Fish whose females take greater than three years to mature and migrating taxa were below the average of bio sites that met the Class 2 Southern Stream threshold (Table 82). These consisted of four white suckers, a tolerant species, and one shorthead redhorse. No downstream culverts were identified as fish barriers. Due to the several lake impoundments in the watershed and the below average percentage of long-lived and migratory species, it appears that connectivity is a stressor to the biological community.

3.4.4 Habitat

Habitat metric data

Table 83. Habitat related fish metrics

07020001-531 Fish Class 2 General Use	Benthic Insect minus Tolerant %	Darter Sculpin Sucker %	Lithophilic Spawner %	Pioneer %	Piscivore %	Riffle %	Simple Lithophilic Spawner %	Tolerant %
01MN051 7/16/2001	41.7	41.7	46.7	82.9	0.0	0.6	15.6	54.0
15MN010 6/18/2015	0.5	0.5	52.0	66.4	0.0	5.9	28.7	72.1
Statewide average for Class 2 southern stream bio sites that are meeting the FIBI general use threshold (50.0)	**20.4**	**18.2**	**58.3**	**19.0**	**5.2**	**32.5**	**39.4**	**44.9**
Expected response to habitat stress	↓	↓	↓	↑	↓	↓	↓	↑

Table 84. Habitat related invertebrate metrics

07020001-531 Invert Class 5 General Use	Burrower %	Climber %	Clinger %	Ephemeroptera Plecoptera Trichoptera %	Legless %	Sprawler %
01MN051 9/13/2001	11.3	11.3	46.1	41.2	37.3	21.5
15MN010 8/5/2015	2.7	39.5	39.5	45.3	48.0	6.8
Statewide average for Class 5 southern streams rock riffle bio sites that are meeting the MIBI general use threshold (37.0)	**7.5**	**14.7**	**49.5**	**43.9**	**36.0**	**16.8**
Expected response to habitat stress	↑	↓	↓	↓	↑	↑

MPCA stream habitat assessment score

Table 85. Habitat assessment score

07020001-531	Land Use	Riparian	Substrate	Cover	Channel Morphology	Total Score
01MN051 7/16/2001	1.5	8	19.5	3	21	53
15MN010 6/18/2015	5	8	16	14	23	66
Maximum Attainable Habitat Score	**5**	**14**	**28**	**18**	**35**	**100**

Figure 43. Photos of reach 07020001-531 at bio site 15MN010 (left) and bio site 01MN051 (right)

Habitat summary

The fish community at bio site 15MN010 scored below average in all eight habitat related fish metrics when compared to all other Class 2 southern stream bio sites that met the FIBI general use threshold (Table 83). Benthic insectivores minus tolerant taxa and Darter, sculpin, sucker metrics scored very poorly. There were some lithophilic and simple lithophilic spawners, though they were both below the class averages. Pioneer and tolerant species were both very high.

Invertebrate metrics were mixed. Clinger and legless taxa scored poorly. Burrower taxa were low and climber and EPT taxa scored above average (Table 84).

The MSHA habitat assessment scored 66 out of 100 (Table 85). Substrate and channel morphology brought the score down. Sedimentation of silt seems to be affecting the substrate habitat, resulting in a high number of legless invertebrates.

Some bank erosion was also observed at bio site 15MN010 though the reach overall has decent stream morphology with several substrate types (Table 85) and good depth variability, riffle, and pool habitat (Figure 43) were observed during habitat assessment.

The lack of benthic insectivores, lower than average riffle dwelling fish, and the high number of legless invertebrates indicate habitat may be a stressor to the biological community in the reach. Climber, clinger, and sprawler invertebrates scored decent however. It would appear that limitations in habitat may be having some impact on invertebrate populations, but the reach is still able to support taxa that are sensitive to habitat degradation. Though it is inconclusive as a stressor at this time, it is likely that sedimentation is contributing to limitations in habitat for fish and invertebrates.

3.4.5 Dissolved oxygen

DO biological metric data

Table 86. Dissolved oxygen related fish metrics

07020001-531 **Fish Class 2** **General Use**	Mature Age >3 %	Serial Spawner %	Taxa Count	DO TIV	DO Sensitive %	DO Tolerant %
01MN051 7/16/2001	0.8	11.3	12.0	7.1	0.0	10.5
15MN010 6/18/2015	1.29	52.5	10.0	6.8	0.0	47.8
Statewide average for Class 2 southern stream bio sites that are meeting the FIBI general use threshold (50.0)	**23.9**	**28.7**	**20.4**	**7.2**	**6.1**	**15.8**
Expected response to DO stress	↓	↑	↓	↓	↓	↑

Table 87. Dissolved oxygen related invertebrate metrics

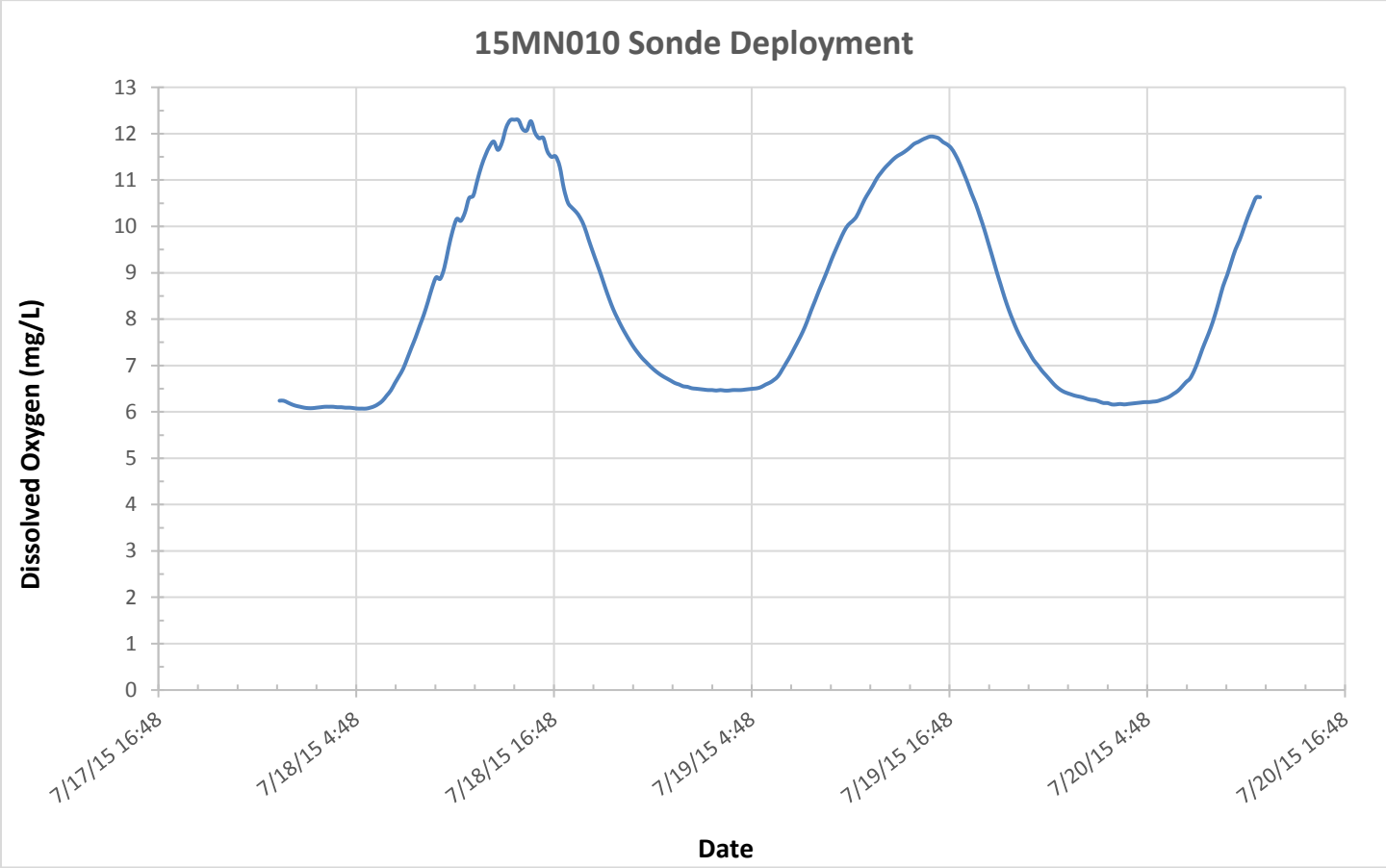
07020001-531 **Invert Class 5** **General Use**	Low DO Intolerant Taxa %	Low DO Tolerant Taxa %	DO TIV	HBI_MN
01MN051 9/13/2001	14.5	40.3	6.7	7.6
15MN010 8/5/2015	29.0	2.0	7.4	7.8
Statewide average for Class 5 southern streams rock riffle bio sites that are meeting the MIBI general use threshold (37.0)	**24.6**	**8.6**	**7.1**	**7.0**
Expected response to DO stress	↓	↑	↓	↑

DO monitoring data

Table 88. Dissolved oxygen monitoring data

07020001-531 DO Data	Range of Data (mg/L)	% of Monthly Samples < 5 mg/L [# of Samples]							% of Total Samples < 5 mg/L [# of Samples]
		April	May	June	July	August	Sept	Oct	
S008-471 (2015-2017)	5.8–13.0	0% [7]	0% [6]	0% [8]	0% [12]	0% [10]	0% [9]	0% [8]	0% [60]

Figure 44. Dissolved oxygen continuous data at site 15MN021



Dissolved oxygen summary

The fish community at bio site 15MN010 scored below average in all six DO related fish metrics when compared to the average of all other Class 2 southern stream bio sites that meet the FIBI general use threshold (Table 86). The other bio site was sampled in 2001 and represents expired data. Only one individual shorthead redhorse, a species whose females take more than three years to mature, was caught. Serial spawning fish numbers were high and overall taxa count scored poorly compared to the average.

Invertebrate metrics were mixed. Two out of four DO related invertebrate metrics scored poorly. However, taxa that are intolerant of low DO scored better than average and DO tolerant taxa were low. The other bio site was sampled in 2001 and represents expired data.

No DO measurements taken during sampling were below the warmwater standard of 5 mg/L, only one of those measurements were taken before 8:00 am, when values are usually the lowest. A YSI Sonde water meter measured continuous DO data from July 18, 2015 to July 20, 2015. During this deployment, DO values were not measured below the standard of 5 mg/L.

Based on the mixed related biological metric scores and no measured values below the standard, DO is inconclusive as a stressor in this reach.

3.4.6 Eutrophication

Eutrophication biological metric data

Table 89. Eutrophication related fish metrics

07020001-531 **Fish Class 2** **General Use**	Darter %	Omnivore %	Sensitive %	Tolerant %
01MN051 7/16/2001	41.7	10.9	0.0	54.0
15MN010 6/18/2015	0.3	48.8	5.9	72.1
Statewide average for Class 2 southern stream bio sites that are meeting the FIBI general use threshold (50.0)	**11.7**	**16.5**	**18.7**	**44.9**
Expected response to eutrophication stress	↓	↑	↓	↑

Table 90. Eutrophication related invertebrate metrics

07020001-531 **Invert Class 5** **General Use**	Taxa Count All #	Collector – Filterer Taxa #	Collector – Gatherer Taxa #	Ephemeroptera Plecoptera Trichoptera Taxa #	Intolerant Two Taxa #	Tolerant Two Taxa %
01MN051 9/13/2001	29	6	8	7	0	86.2
15MN010 8/5/2015	28	5	9	7	0	85.7
Statewide average for Class 5 southern stream rock riffle bio sites that are meeting the MIBI general use threshold (37.0)	**41.9**	**6.5**	**15.0**	**10.9**	**0.8**	**71.9**
Expected response to eutrophication stress	↓	↓	↑	↓	↓	↑

Eutrophication monitoring data

Table 91. Phosphorus monitoring data

07020001-531 P Sample Data	Range of Data (mg/L)	Monthly Average of Samples (mg/L) [# of Samples]							June-Aug Average (mg/L) [# of Samples]
		April	May	June	July	August	Sept	Oct	
S008-471 (2015-2017)	0.19–0.89	0.33 [7]	0.30 [6]	0.40 [5]	0.38 [10]	0.58 [8]	0.36 [11]	0.49 [8]	0.45 [55]

Eutrophication HSPF model data

Table 92. HSPF model phosphorus data

	Total Phosphorus	
07020001-531 HSPF Reach 417	**June–September** **% values > 0.15 mg/l** (# Daily Values)	**June–September** **Multi-year Average**
2,318 Total Daily Averages *June–Sep 1994–2012*	**55.1%** (1260)	**0.28 mg/l**

Eutrophication summary

The fish community at bio site 15MN010 scored below average in all four eutrophication related fish metrics when compared to the average of all other Class 2 southern stream bio sites that meet the FIBI general use threshold (Table 89). Bio site 10MN051 was sampled in 2001 and is considered expired data. The abundance of darter individuals was very low and omnivorous fish comprised 48.8% of the population. There were very few sensitive species and tolerant species comprised 72% of the population. All of the metrics in from the 2015 visit scored worse than at the 2001 visit, indicating that some degradation has occurred in that time period.

The invert community at bio site 15MN010 scored poorly in five out of six eutrophication related invert metrics when compared to the average of all other Invert Class 5 southern stream rock riffle bio sites that meet the MIBI general use threshold (Table 90). Bio site 10MN051 was sampled in 2001 and is considered expired data. Total taxa count scored poorly and was well below the class average. Collector filterer taxa count scored poorly and was just below the class average. Collector – gatherer taxa was below the class average. EPT taxa, intolerant two taxa, and tolerant two taxa percentage all scored poorly.

Fifty-five samples were collected and analyzed for Phosphorus from 2015-2017. The summer average was well above the standard of 0.15 mg/L (Table 91). The HSPF model computed the summer average well above the standard at 0.28 mg/L (Table 92).

A YSI Sonde water meter measured continuous DO data from July 18, 2015 to July 20, 2015 (Figure 44). During this deployment, DO diurnal flux, or the difference between the daily high and low DO concentrations was above the eutrophication DO flux standard of 5 mg/l all three days.

High levels of phosphorus were measured during sampling and the fish community seems to be showing the effects of eutrophication and DO flux appears to be an issue. Eutrophication is a stressor to the biological community in Stony Run Creek.

3.4.7 Suspended solids

Suspended solids biological metric data

Table 93. Suspended solids related fish metrics for bio sites 01MN051 and 15MN010

07020001-531 Fish Class 2 General Use		Benthic Feeder %	Centrarchid-Tolerant %	Herbivore %	Intolerant %	Long-Lived %	Perciformes-Tolerant %	Riffle %	Sensitive %	Simple Lithophilic Spawner %	TSS TIV
01MN051	7/16/2001	42.2	0.0	0.2	0.0	0.2	41.7	0.6	0.0	15.6	14.6
15MN010	6/18/2015	1.6	0.0	0.0	0.0	0.3	0.3	6.0	5.9	28.7	18.7
Statewide average for Class 2 Southern Stream stations that are meeting the FIBI general use threshold (50.0)		**37.4**	**5.0**	**9.6**	**5.0**	**11.7**	**18.7**	**32.5**	**18.7**	**39.4**	**17.6**
Expected response to TSS stress		↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Table 94. Suspended solids related invertebrate metrics for bio sites 01MN051 and 15MN010

07020001-531 Invert Class 5 General Use		Collector-Filterer %	Plecoptera %	TSS Intolerant %	TSS Tolerant %	TSS TIV
01MN051	9/13/2001	26.8	0.0	1.0	18.0	16.2
15MN010	8/5/2015	28.4	0.0	2.0	13.0	17.9
Statewide average for Class 5 southern streams rock riffle bio sites that are meeting the MIBI general use threshold (37.0)		**26.9**	**0.5**	**5.1**	**35.2**	**15.9**
Expected response to TSS stress		↓	↓	↓	↑	↑

TSS monitoring data

Table 95. Total suspended solids monitoring data for chemistry site S008-471

07020001-531 TSS Sample Data	Range of Data (mg/L)	% of Monthly Samples > 65 mg/L [# of Samples]							% of Total Samples > 65 mg/L [# of Samples]
		April	May	June	July	August	Sept	Oct	
S008-471 (2015-2017)	4-165	0% [7]	17% [6]	20% [5]	0% [10]	12.5% [8]	0% [11]	12.5% [8]	7.2% [55]

Suspended solids summary

The fish community at bio site 15MN010 scored below average in all ten suspended solids related fish metrics when compared to the average of all other Class 2 southern stream bio sites that meet the FIBI general use threshold (Table 93). Eight out of the ten scored very poorly with no Centrarchids, herbivores, or intolerant taxa. Benthic feeders, long-lived species, and perciformes were close to 0%. There was a good percentage of simple Lithophilic spawners, though they still were below the class average.

The invert community at bio site 15MN010 scored poorly in three out of five related metrics (Table 94). Species tolerant to TSS were low and collector-filterers were above the class average. There were no Plecoptera taxa and very few taxa intolerant of high-suspended solids. The TSS tolerance index value was relatively high. Collector filterer invertebrates scored above the average and TSS tolerant taxa were well below the class average.

Fifty-five samples were collected and analyzed for total suspended solids from 2015-2017 (Table 95). Several samples had a total suspended solid concentration above 65 mg/L, though the number of exceedances did not get above the 10% threshold for the TSS standard.

With all of the fish metrics and the majority of invert metrics related to suspended solid scoring poorly as well as chemistry data showing high concentrations of TSS, suspended solids are a stressor to aquatic life in Stony Run Creek.

3.4.8 Nitrates

Nitrate biological metric data

Table 96. Nitrate related invertebrate metrics

07020001-531 **Invert Class 5** **General Use**	Nitrate Intolerant Taxa %	Nitrogen TIV	Nitrate Tolerant Taxa %	Trichoptera Taxa %
01MN051 9/13/2001	0.3	3.0	44.1	13.8
15MN010 8/5/2015	0.3	3.5	66.7	10.7
Statewide average for Class 5 southern streams rock riffle bio sites that are meeting the MIBI general use threshold (37.0)	**2.9**	**3.0**	**47.6**	**13.6**
Expected response to nitrogen stress	↓	↑	↑	↓

Nitrate monitoring data

Table 97. Nitrate monitoring data for chemistry site S008-471

07020001-531 Nitrate/Nitrite Sample Data	Range of Data (mg/L)
S008-471 (2015-2017)	0.03 – 1.4

Nitrate summary

The macroinvertebrate assemblage at site 15MN010 scored below average in all four nitrate related metrics when compared to all other macroinvertebrate Class 5 southern stream rock riffle bio sites that meet the MIBI general use threshold (Table 96). Trichoptera taxa was close to the average, which tend to decrease in streams with excessive nitrate values. There was a high amount of nitrate tolerant invertebrates as well as very few nitrate intolerant invertebrates. The nitrogen TIV score also indicates a macroinvertebrate community that is generally tolerant to high levels of nitrates.

Fifty-five samples were collected in reach 07020001-531 and analyzed for nitrate/nitrite (Table 97). Nitrate concentrations were all relatively low and do not appear to be a stressor to aquatic life in Stony Run Creek.

3.4.9 Reach stressors

This stream is being stressed by changes to the hydrology of the stream channel and contributing watershed. Most of its watershed has been ditched, which has eliminated in-stream habitat and has caused heavy siltation and very little depth variability. Phosphorus and nitrates quickly reach the stream via drain tiles, outlets, and field runoff. Many of the lakes and impoundments in the watershed are eutrophic themselves, which then act as sources of nutrients to the stream channel. High nutrient levels affect algae growth, DO concentrations, and DO flux, which in turn causes eutrophic conditions. The construction of ditches and the addition of tile drainage has altered the land area that that regularly contributes water to the stream as well as the amount and timing of water that reaches the stream. Increasing the storage and infiltration of water can help reduce nutrient delivery to the lakes within the watershed as well as the stream itself.

Table 98. Summary of stressors in reach 07020001-531

07020001-531	Hydrologic Alteration	Connectivity	Habitat	Dissolved Oxygen	Eutrophication	Suspended Solids	Nitrate
✓= Stressor ×= Not a Stressor **O** = Inconclusive	✓	×	**O**	**O**	✓	✓	×

3.5 07020001-559 Unnamed Creek

Figure 45. Satellite image of reach 07020001-559 and its watershed

3.5.1 Biological community

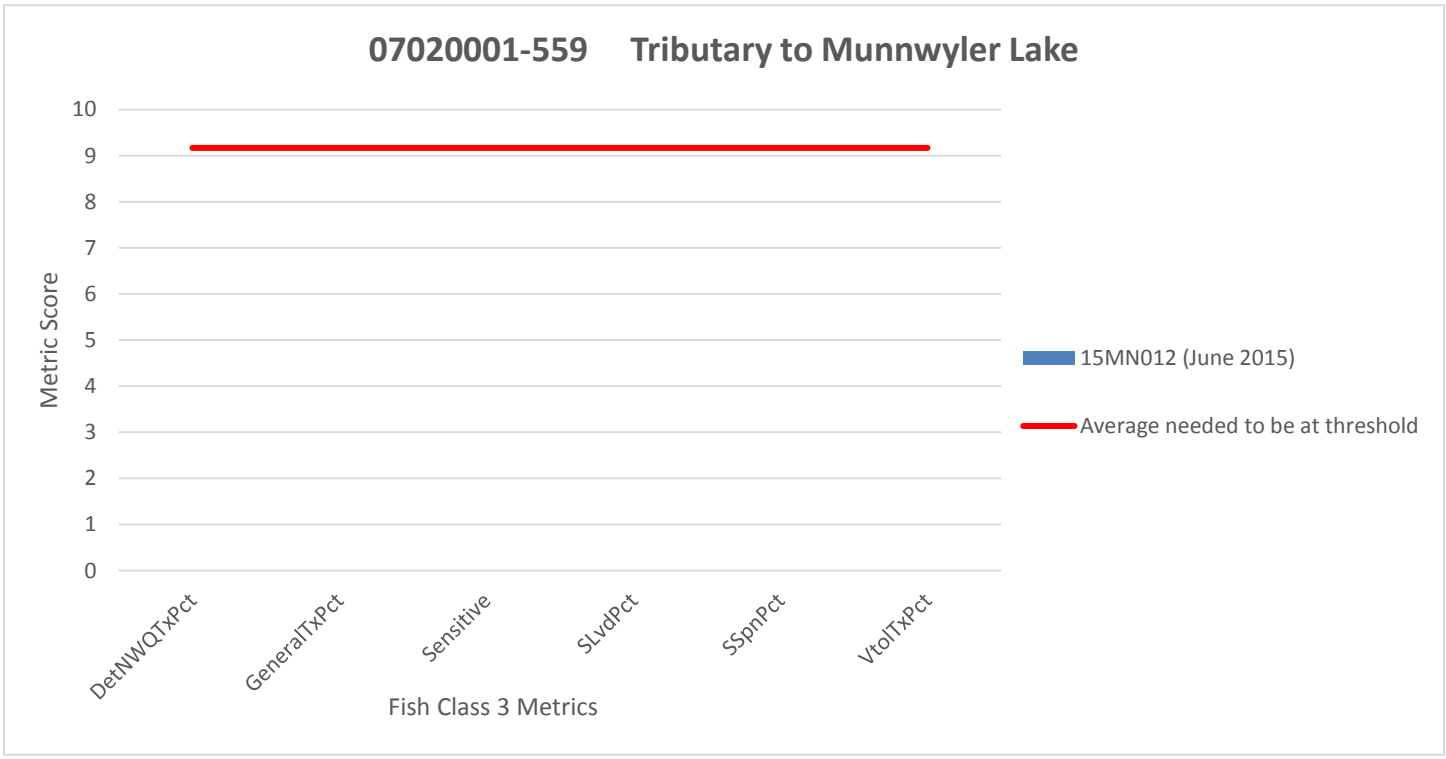
Bio site 15MN012 was sampled for fish in June of 2015. Only fathead minnows and a few sticklebacks were caught resulting in an IBI score of zero (Table 99). Metrics used to calculate the Fish IBI score are shown in a graph with the red line indicating the value each metric needed to score in order to meet the threshold (Figure 46). In August of 2015, fish and invertebrates were not sampled due to insufficient flow.

Fish biological metric data

Table 99. Fish IBI score and threshold for bio site 15MN012

07020001-559 Fish Class 3 General Use		Fish IBI Score	Class Threshold Score
15MN012	6/17/2015	0	55
15MN012	8/4/2015	Insufficient Flow	

Figure 46. Fish Class 3 metric scores for bio site 15MN012



3.5.2 Hydrologic alteration

Hydrologic alteration biological metric data

Table 100. Hydrologic alteration related fish metrics

07020001-559 **Fish Class 3** **General Use**	General %	Nesting Non Lithophilic Spawner %
15MN012 6/17/2015	90.5	100.0
Statewide average for Class 3 Southern Headwater bio sites that are meeting the FIBI general use threshold (55.0)	**59.1**	**19.1**
Expected response to **Hydrologic** stress	↑	↑

HSPF model flow data

Table 101. HSPF modeled flow data, 1994-2012

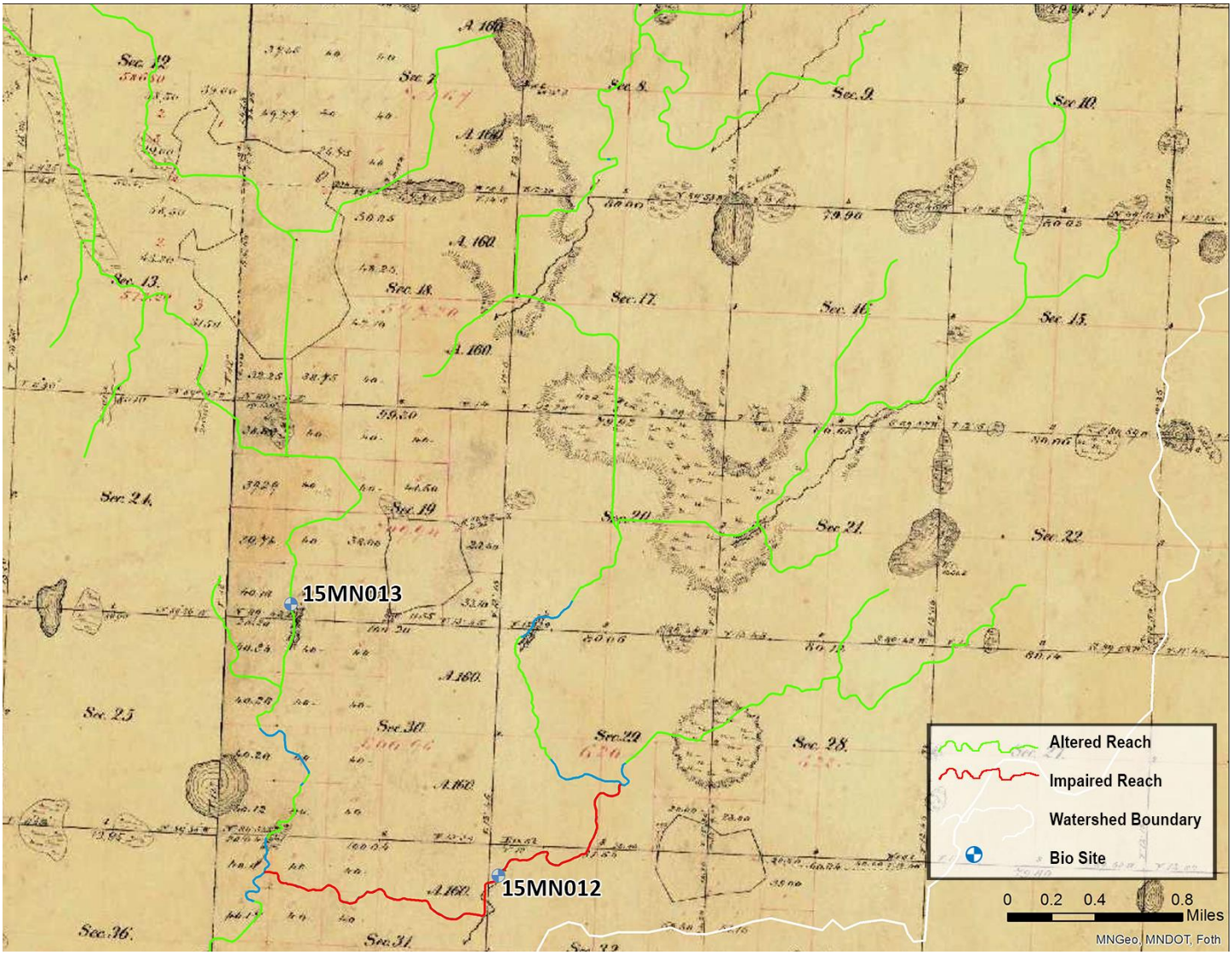
07020001-559 HSPF Reach 422 Min: 0.04 cfs Max: 1070.5 cfs	**<5 cfs %** (# of values)	**<1 cfs %** (# of values)	**<0.5 cfs %** (# of values)
6,940 Total Daily Averages 1994–2012	**57.9%** (4,018)	**25.6%** (1,779)	**15.2%** (1,054)

Hydrologic alteration summary

Both of the fish biological metrics scored very poorly when compared to the Fish Class 3 Southern Headwater bio sites that meet the IBI general use threshold (Table 100). The fish assemblage was dominated by fathead minnows, a nesting and generalized fish species. Bio site 15MN012 had generalist fish population of 90.5%. All fish caught were nesting species.

The HSPF model (Table 35) shows that 25.6% of the daily average flows from 1994–2012 are below 1 cfs. Flows reduced beyond normal base flow will decrease habitat for aquatic organisms and increase competition for resources.

Figure 47. Original survey plat map of the watershed of reach 07020001-559 including altered watercourses



According to the original plat information, it appears that this reach had many wetlands within its watershed. These have been extensively altered and drained (Figure 47). Creating these ditches essentially added to the amount of land and water that drained into the creek and the timing of water runoff. This altered the natural flow regime of this stream that had developed over several millenniums by decreasing the time it takes for water to move through the system, moving more water through the system at a higher frequency, and increasing the impact to the stream channel of high flow events while also increasing the intensity of low flow periods.

The Minnesota River – Headwaters Watershed Characteristic Report classified reach 07020001-559 as a E5. The entrenchment ratio was calculated at 3.87, which is considered slightly entrenched as the stream can still access it is relatively wide flood plain. The bank height ratio was calculated as deeply incised at 1.57, meaning the lowest bank is relatively high when compared to the streams bank full elevation. Further analysis of the riffle cross section identifies that the river can still access its floodplain, but any further incision will begin to significantly decrease the flood-prone width and thus the entrenchment ratio (DNR, 2019).

Figure 48. Photo of reach 07020001-559 showing channelization of the stream looking downstream from bio site 15MN012

Based on the poor scores of all of the biological metrics, low flow periods shown in the HSPF model, the historic surveying data, and the DNR geomorphology analysis, Hydrologic Alteration is a stressor in reach 07020001-559. The primary impact in this reach from Hydrologic Alteration is the ditching and channelization of the stream channel and its tributaries, subsurface tile drainage of the surrounding uplands and tributaries, and the pollutant overloading of nutrients.

3.5.3 Connectivity

Connectivity metric data

Table 102. Connectivity related fish metrics

07020001-559 **Fish Class 3** **General Use**	Mature Age >3 minus Tolerant Taxa %	Migrating Taxa %
15MN012 6/17/2015	0.0	0.0
Statewide average for Class 3 southern headwaters bio sites that are meeting the FIBI general use threshold (55.0)	**5.3**	**19.5**
Expected response to connectivity stress	↓	↓

Connectivity summary

The fish community at bio site 15MN012 scored below average in both connectivity related fish metrics when compared to the average of all other Class 3 Southern Headwater bio sites that meet the FIBI general use threshold (Table 102). No migrating fish or fish whose females take more than three years to mature were caught.

Based on the biological metric scores, the fish barrier downstream at Long Tom Lake, and several road crossings that could potentially limit fish migration, connectivity appears to be a stressor in reach 07020001-559.

3.5.4 Habitat

Habitat metric data

Table 103. Habitat related fish metrics

07020001-559 **Fish Class 3** **General Use**	Benthic Insect minus Tolerant %	Darter Sculpin Sucker %	Lithophilic Spawner %	Pioneer %	Piscivore %	Riffle %	Simple Lithophilic Spawner %	Tolerant %
15MN012 6/17/2015	0.0	0.0	0.0	90.5	0.0	0.0	0.0	100.0
Statewide average for Class 3 Southern Headwater bio sites that are meeting the FIBI general use threshold (55.0)	**14.2**	**12.6**	**69.2**	**37.8**	**1.6**	**28.3**	**33.7**	**70.6**
Expected response to habitat stress	↓	↓	↓	↑	↓	↓	↓	↑

MPCA stream habitat assessment score

Table 104. Habitat assessment score

07020001-559	Land Use	Riparian	Substrate	Cover	Channel Morphology	Total Score
15MN012 6/17/2015	0	9	15.3	12	18	54.3
Maximum Attainable Habitat Score	**5**	**14**	**28**	**18**	**35**	**100**

Figure 49. Photos of reach 07020001-559 at bio site 15MN012 showing incision in the stream channel and exposed stream bank (left) (right)

Habitat summary

The fish community at bio site 15MN012 scored below average in all eight habitat related fish metrics when compared to all other Class 3 Southern Headwater bio sites that met the FIBI general use threshold (Table 103). Benthic insectivores minus tolerant taxa and Darter, sculpin, sucker metrics scored very poorly. Pioneer and tolerant species were both very high because the only two fish species collected were fathead minnows and brook sticklebacks.

The MSHA habitat assessment scored fair with a 54.3 out of 100 (Table 104). The surrounding land use scored zero, as it was entirely row crop agriculture. The substrate score was also poor as a lot of silt was present and very little riffles were observed. Channel morphology was also poor as the channel development was listed as fair; there was only moderate depth variability and channel stability.

Photos within the stream (Figure 49) show an incised stream channel that appears to be adjusting to the increased drainage and channelization in the upstream watershed. Although the stream has access to its flood plain, the incision within the channel has left a relatively featureless stream channel that lacks quality habitat.

The very poor fish metrics and MSHA scores indicate habitat is a stressor to the biological community in the reach.

3.5.5 Dissolved oxygen

DO biological metric data

Table 105. Dissolved Oxygen related fish metrics

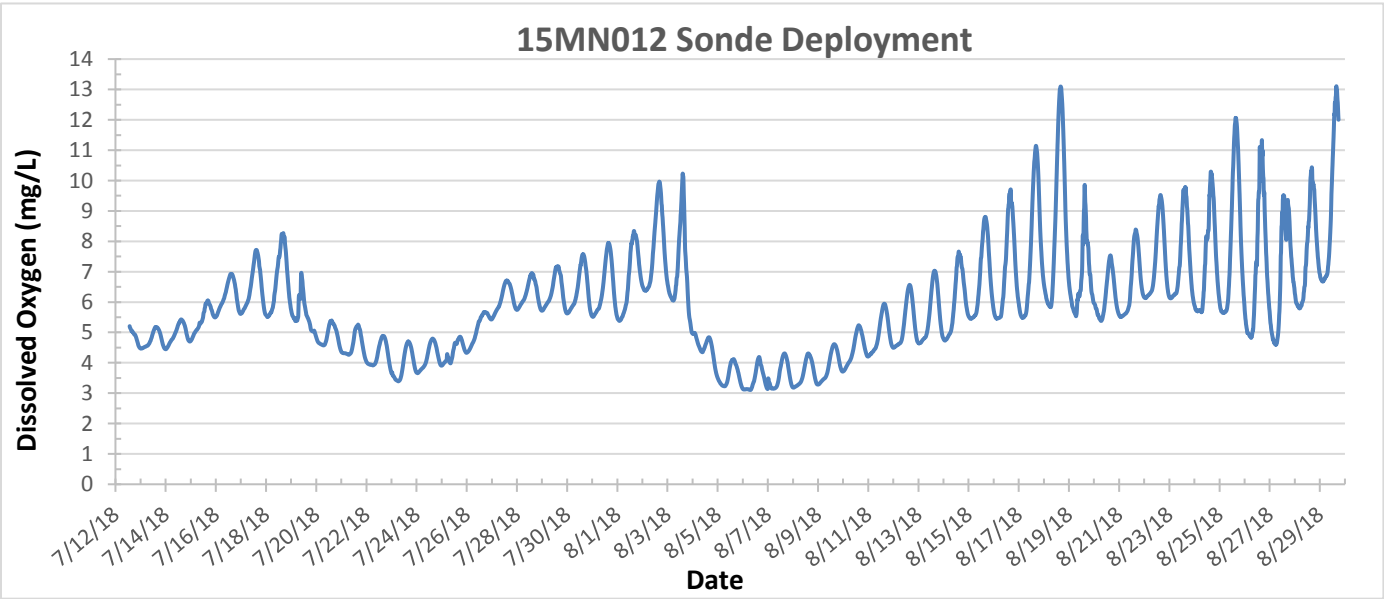
07020001-559 **Fish Class 3** **General Use**	Mature Age >3 %	Serial Spawner %	Taxa Count	DO TIV	DO Sensitive %	DO Tolerant %
15MN012 6/17/2015	0.0	90.5	2.0	6.2	0.0	100.0
Statewide average for Class 3 southern headwaters bio sites that are meeting the FIBI general use threshold (55.0)	**13.3**	**17.1**	**12.2**	**7.2**	**3.7**	**18.6**
Expected response to DO stress	↓	↑	↓	↓	↓	↑

DO monitoring data

Table 106. Dissolved oxygen monitoring data

07020001-559 DO Data	Range of Data (mg/L)	% of Monthly Samples < 5 mg/L [# of Samples]							% of Total Samples < 5 mg/L [# of Samples]
		April	May	June	July	August	Sept	Oct	
S013-139 (2017)	3.5–16.3	N/A [0]	0% [1]	0% [1]	33% [3]	0% [1]	N/A [0]	N/A [0]	17% [6]

Figure 50. Dissolved oxygen continuous data at site 15MN012



Dissolved oxygen summary

The fish community at bio site 15MN012 scored poorly in all six DO related fish metrics when compared to the average of all other Class 3 Southern Headwater bio sites that meet the FIBI general use threshold (Table 105). There were no species whose females take more than three years to mature. Fathead minnows, a serial spawning fish dominated the fish community.

Six dissolved oxygen (DO) measurements were taken in reach 07020001-559. One measurement fell below 5 mg/L (Table 106). A YSI Sonde water meter measured continuous dissolved oxygen data from July 12, 2018 to August 29, 2018 (Figure 50). During this deployment, DO values were measured below the standard of 5 mg/L 22 out of 48 days.

Based on the very poor related biological metric scores and many measured values below the standard, DO is a stressor in this reach.

3.5.6 Eutrophication

Eutrophication biological metric data

Table 107. Eutrophication related fish metrics

07020001-559 **Fish Class 3** **General Use**	Darter %	Omnivore %	Sensitive %	Tolerant %
15MN012 6/17/2015	0.0	90.5	0.0	100.0
Statewide average for Class 3 southern headwaters bio sites that are meeting the FIBI general use threshold (55.0)	**12.1**	**14.6**	**8.6**	**70.6**
Expected response to eutrophication stress	↓	↑	↓	↑

Eutrophication monitoring data

Table 108. Phosphorus monitoring data

07020001-559 P Sample Data	Range of Data (mg/L)	Monthly Average of Samples (mg/L) [# of Samples]							June-Aug Average (mg/L) [# of Samples]
		April	May	June	July	August	Sept	Oct	
S013-139 (2015-2017)	0.24–1.34	N/A [0]	0.61 [1]	0.24 [1]	1.10 [2]	N/A [0]	N/A [0]	N/A [0]	0.80 [4]

Eutrophication HSPF model data

Table 109. HSPF model phosphorus data

	Total Phosphorus	
07020001-559 HSPF Reach 422	**June–September** **% values > 0.15 mg/l** (# Daily Values)	**June–September** **Multi-year Average**
2,318 Total Daily Averages *June–Sep 1994–2012*	**82.7%** (1,918)	**0.31 mg/l**

Figure 51. Photographs of bio site 15MN012 showing floating algae mats

Eutrophication summary

The fish community at bio site 15MN012 scored poorly in all four eutrophication related fish metrics when compared to the average of all other Class 3 Southern Headwater bio sites that meet the FIBI general use threshold (Table 107). There were no darter taxa and omnivorous fish comprised 90.5% of the fish population. There were no sensitive taxa and tolerant fish comprised 100% of the population.

Four samples were collected and analyzed for Phosphorus from 2015-2017. The summer average was 0.80mg/L, well above the standard of 0.15 mg/L (Table 108). The HSPF model computed the summer average well above the standard at 0.31 mg/L (Table 109).

A YSI Sonde water meter measured continuous DO data from July 12, 2018 to July 29, 2018 (Figure 50). During this deployment, DO diurnal flux, or the difference between the daily high and low DO concentrations was above the eutrophication DO flux standard of 5 mg/l for several days.

High levels of phosphorus were measured during sampling and the fish community seems to be showing the effects of eutrophication. Large algae mats were present during bio sampling (Figure 51) and DO flux appears to be an issue. Eutrophication is a stressor to the fish community in reach 07020001-559.

3.5.7 Suspended solids

Suspended solids biological metric data

Table 110. Suspended solids related fish metrics

07020001-559 **Fish Class 3** **General Use**	Benthic Feeder %	Centrarchid-Tolerant %	Herbivore %	Intolerant %	Long-Lived %	Perciformes-Tolerant %	Riffle %	Sensitive %	Simple Lithophilic Spawner %	TSS TIV
15MN012 6/17/2015	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22.9
Statewide average for Class 3 Southern Headwater stations that are meeting the FIBI general use threshold (55.0)	**37.8**	**0.9**	**13.3**	**2.0**	**3.6**	**13.9**	**28.3**	**8.6**	**33.7**	**15.2**
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

TSS monitoring data

Table 111. Total suspended solids monitoring data

07020001-559 TSS Sample Data	Range of Data (mg/L)	% of Monthly Samples > 65 mg/L [# of Samples]							% of Total Samples > 65 mg/L [# of Samples]
		April	May	June	July	August	Sept	Oct	
S013-139 (2015-2018)	6	N/A [0]	0% [1]	0% [1]	0% [2]	N/A [0]	N/A [0]	N/A [0]	0% [4]

Suspended solids summary

The fish community at bio site 15MN012 scored very poorly in all nine suspended solids related fish metrics when compared to the average of all other Class 3 Southern Headwater bio sites that meet the FIBI general use threshold (Table 110). All the metrics scored zero and the TSS TIV score indicated a biological community tolerant of suspended solids.

Four samples were collected and analyzed for TSS from 2015-2017 (Table 111). No samples had a TSS concentration above 65 mg/L.

At this time, suspended solids are inconclusive as a stressor. The lowered metrics are due to the lack of fish diversity captured, but could be due to other stressors. More samples would be helpful. Since the metrics, all scored zero it is likely that other factors, such as altered hydrology, connectivity, and habitat are causing poor scores in the fish biological metrics. It is recommended that more TSS data be collected during high flows in order to determine whether it is a biological stressor.

3.5.8 Nitrates

Nitrate monitoring data

Table 112. Nitrate monitoring data for chemistry site S013-139

07020001-559 Nitrate/Nitrite Sample Data	Range of Data (mg/L)
S013-139 (2017-2018)	0.1–8

Nitrate summary

Macroinvertebrates were not sampled at site 15MN012 due to insufficient flow.

Three samples were collected in reach 07020001-559 and analyzed for nitrate/nitrite (Table 112). One sample had a relatively high nitrate concentration of 8 mg/L. Nitrates are inconclusive at this time. Collecting more chemistry data within this reach is recommended in order to determine if nitrates are a stressor to the biological community.

3.5.9 Reach stressors

This stream is being stressed by changes to the hydrology of the stream channel and contributing watershed. The stream itself appears to have been ditched, often times right through wetlands in order to drain them, which has eliminated in-stream habitat and has caused siltation and very little depth variability. This stream reach could benefit from allowing the channel to re-meander and form pools, riffles, and runs, which forms the habitat that aquatic life needs to live. The stream is also disconnected from its flood plain in areas due to both ditching of the stream as well as incision.

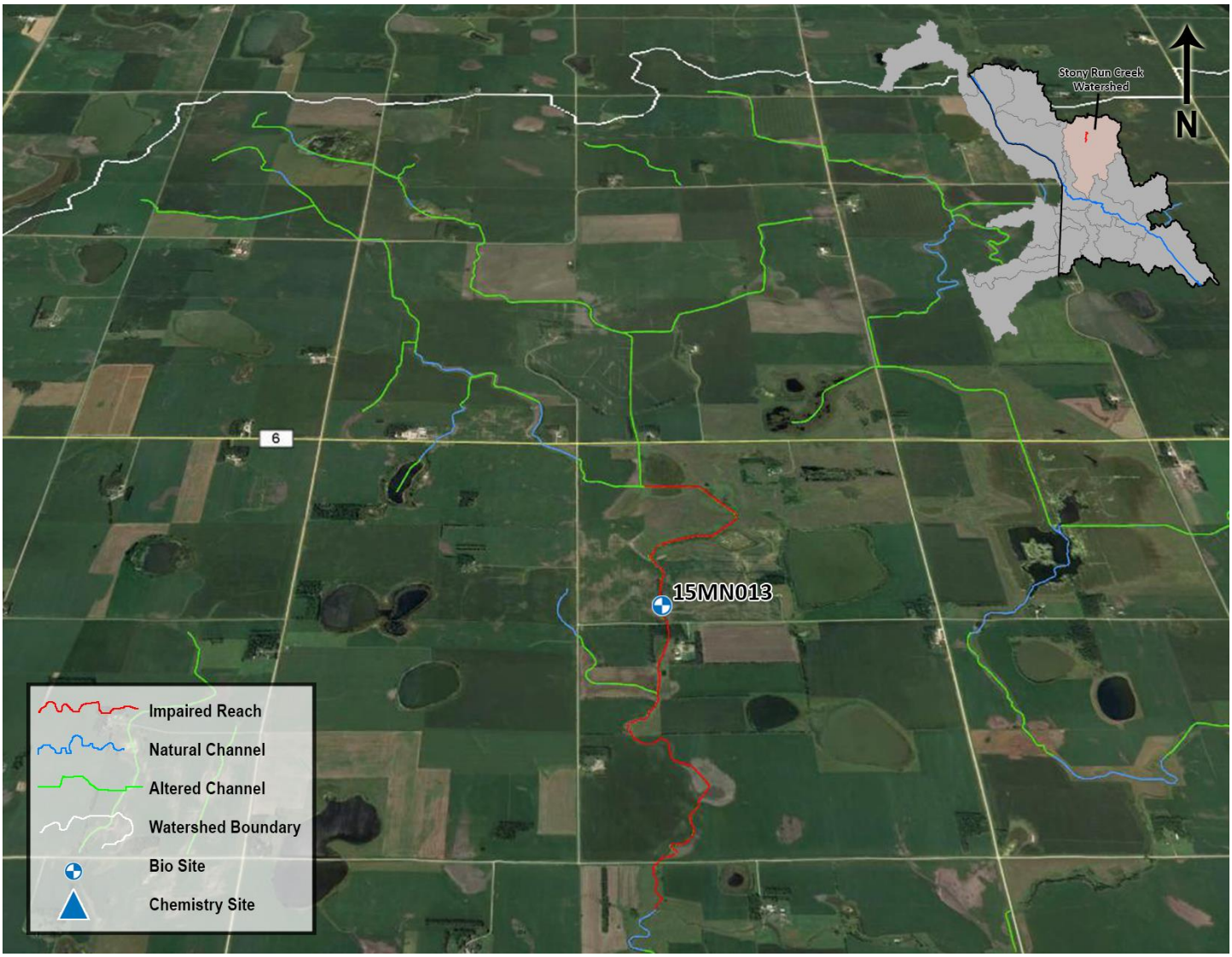
The construction of ditches and the addition of tile drainage has altered the land area that that regularly contributes water to the stream as well as the amount and timing of water that reaches the stream. Increasing the storage and infiltration of water can help reduce nutrient delivery to the stream, erosion and incision from high flows after large rain events, and can help mitigate periods of extremely low flows during times of low precipitation.

Table 113. Summary of stressors in reach 07020001-559

07020001-559	**Hydrologic Alteration**	**Connectivity**	**Habitat**	**Dissolved Oxygen**	**Eutrophication**	**Suspended Solids**	**Nitrate**
✓= Stressor ×= Not a Stressor **O** = Inconclusive	✓	✓	✓	✓	✓	**O**	**O**

3.6 07020001-560 Unnamed Creek

Figure 52. Satellite image of reach 07020001-560 and its watershed



3.6.1 Biological community

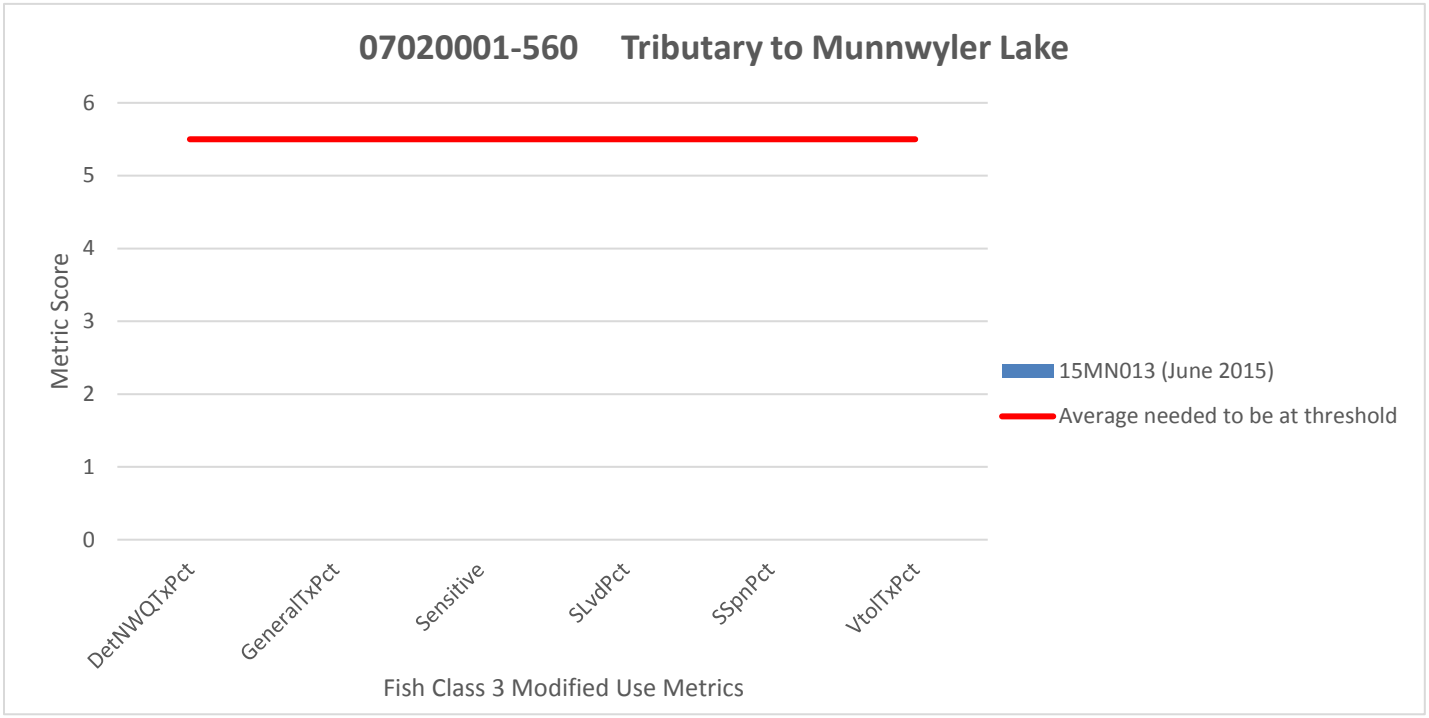
Bio site 15MN013 was sampled for fish in June of 2015. Only fathead minnows and a few sticklebacks were caught resulting in an IBI score of zero (Table 114). Metrics used to calculate the Fish IBI score are shown in a graph with the red line indicating the value each metric needed to score in order to meet the threshold (Figure 52). Invertebrates were sampled in August of 2015 and scored above the invert Class 7 modified use threshold.

Biological metric data

Table 114. Fish IBI score and threshold for bio site 15MN013

07020001-560 Fish Class 3 Modified Use		Fish IBI Score	Class Threshold Score
15MN013	6/17/2015	0	33

Figure 52. Fish Class 3 modified use metric scores for bio site 15MN013



3.6.2 Hydrologic alteration

Hydrologic alteration biological metric data

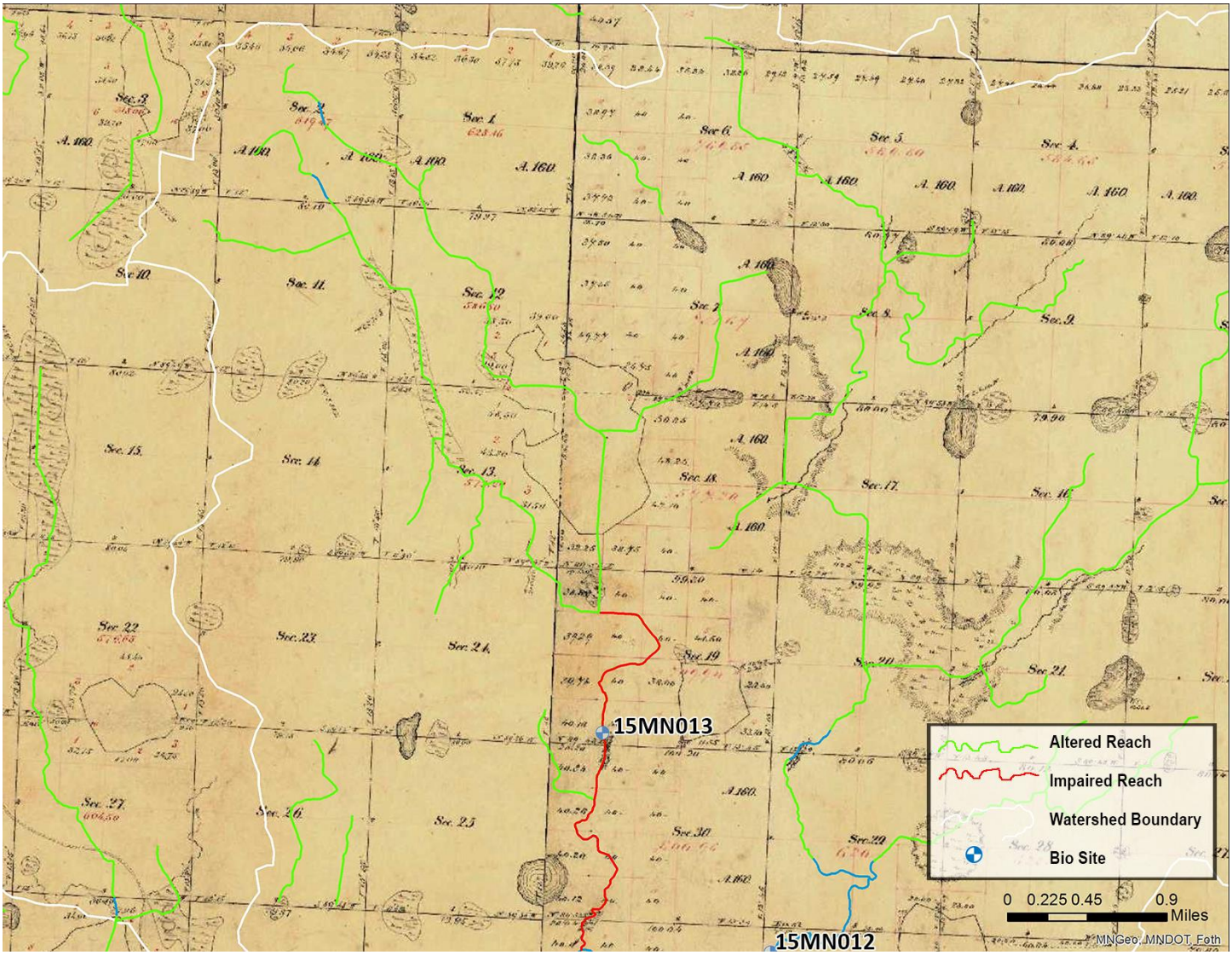
Table 115. Hydrologic alteration related fish metrics for bio site 15MN013

07020001-560 Fish Class 3 Modified Use		General %	Nesting Non Lithophilic Spawner %
15MN013	6/17/2015	83.6	100.0
Statewide average for Class 3 southern headwaters bio sites that are meeting the FIBI modified use threshold (33.0)		**56.3**	**24.0**
Expected response to **Hydrologic** stress		↑	↑

Table 116. HSPF modeled flow data, 1994-2012

07020001-560 HSPF Reach 422 Min: 0.04 cfs Max: 1070.5 cfs	**<5 cfs %** (# of values)	**<1 cfs %** (# of values)	**<0.5 cfs %** (# of values)
6,940 Total Daily Averages *1994–2012*	**57.9%** (4,018)	**25.6%** (1,779)	**15.2%** (1,054)

Figure 53. Original survey plat map of the watershed of reach 07020001-560 including altered watercourses



Hydrologic alteration summary

Both of the fish biological metrics scored very poorly when compared to the Fish Class 3 Southern Headwater bio sites that meet the IBI modified use threshold (Table 115). The fish assemblage was dominated by fathead minnows, a generalized and nesting fish species. Bio site 15MN013 had generalist fish population of 83.6%. All fish caught were nesting species.

The HSPF model (Table 116) shows that 25.6% of the daily average flows from 1994 – 2012 are below 1 cfs. Flows reduced beyond normal base flow will decrease habitat for aquatic organisms and increase competition for resources.

According to the original plat information, it appears that this reach had many wetlands and a few shallow lakes in it is the watershed. These have been extensively drained and altered (Figure 53). Creating these ditches essentially added to the amount of land and water that drained into the creek and the timing of water runoff. This altered the natural flow regime of this stream that had developed over several millenniums by decreasing the time it takes for water to move through the system, moving more water through the system at a higher frequency, and increasing the impact to the stream channel of high flow events while also increasing the intensity of low flow periods.

Based on the poor scores of all of the biological metrics, low flow periods shown in the HSPF model, and the historic surveying data, Hydrologic Alteration is a stressor in reach 07020001-560. The primary impact in this reach from Hydrologic Alteration is the ditching and channelization of the stream channel and its tributaries, subsurface tile drainage of the surrounding wetlands and lakes, as well as the pollutant overloading of nutrients.

3.6.1 Connectivity

Connectivity metric data

Table 117. Connectivity related fish metrics

07020001-560 Fish Class 3 Modified Use	Mature Age >3 minus Tolerant Taxa %	Migrating Taxa %
15MN013 6/17/2015	0.00	0.00
Statewide average for Class 3 southern headwaters bio sites that are meeting the FIBI general use threshold (55.0)	**5.27**	**19.48**
Expected response to connectivity stress	↓	↓

Figure 54. Satellite image of Long Tom Lake Outlet

The fish community at bio site 15MN013 scored below average in both connectivity related fish metrics when compared to the average of all other Class 3 Southern Headwater bio sites that meet the FIBI general use threshold (Table 102). No migrating fish or fish whose females take more than three years to mature were caught.

There is a fish barrier downstream at the outlet of Long Tom Lake (Figure 54). A dam controls the water level of the lake and is likely a fish barrier to upstream migration.

Based on the biological metric scores, the fish barrier at Long Tom Lake, and several road crossings that could potentially limit fish migration, connectivity appears to be a stressor in reach 07020001-560.

3.6.3 Habitat

Habitat metric data

Table 118. Habitat related fish metrics

07020001-560 Fish Class 3 Modified Use	Benthic Insect minus Tolerant %	Darter Sculpin Sucker %	Lithophilic Spawner %	Pioneer %	Piscivore %	Riffle %	Simple Lithophilic Spawner %	Tolerant %
15MN013 6/17/2015	0.0	0.0	0.0	83.6	0.0	0.0	0.0	100.0
Statewide average for Class 3 southern headwaters bio sites that are meeting the FIBI modified use threshold (33.0)	**14.2**	**12.6**	**69.2**	**37.8**	**1.6**	**28.3**	**33.7**	**70.6**
Expected response to habitat stress	↓	↓	↓	↑	↓	↓	↓	↑

MPCA stream habitat assessment score

Table 119. Habitat assessment score for bio site 15MN013

07020001-560	Land Use	Riparian	Substrate	Cover	Channel Morphology	Total Score
15MN013 6/17/2015	0	8	5.7	11	10	34.7
Maximum Attainable Habitat Score	**5**	**14**	**28**	**18**	**35**	**100**

Figure 55. Photo of reach 07020001-560 at bio site 15MN013 showing a channelized section (left) and an unnatural bend running alongside a agricultural field (right)

The fish community at bio site 15MN013 scored very poorly in all eight habitat related fish metrics when compared to all other Class 3 Southern Headwater bio sites that met the FIBI modified use threshold (Table 118). Fathead minnows are both a pioneer and tolerant taxa and comprised 83.6% of the total number of fish caught.

The MSHA habitat assessment scored poor with a 34.7 out of 100 (Table 119). The surrounding land use, as well as the streams riparian condition, substrate, and channel morphology all brought the score down. The surrounding land use scored zero, as it was entirely row crop agriculture. The substrate score was also poor as only silt and clay were listed, no coarse substrates were observed. Channel morphology was also poor as the channel development was listed as fair; there was no sinuosity, no depth variability, and no riffles present. This reach is classified as modified use and as such, has a lower threshold to meet compared to a general use stream of the same class. This reach appears to have been created by ditching in between or through several wetlands and shallow lakes. Ditched streams tend to have lower quality habitat as well as less overall habitat for fish and invertebrates.

Photos within the stream show channelization and an altered stream pattern (Figure 55). Land around ditched streams tend to be monocropped and plowed up for long periods, often right up next to the bank of the ditch. They are typically deep, narrow, and have uniform depths to help accommodate and move large amounts of water quickly. Substrate in most ditches tend to be fine silt, poor habitat for most fish and invertebrates. Ditches have less riffle, run, pool sequences due to the lack of a meander. Meandering sets up the hydrologic conditions necessary to scour out pools while keeping fine sediments from covering rocks and gravel on the streambed.

The very poor fish metrics and MSHA scores indicate habitat is a stressor to the biological community in the reach.

3.6.4 Dissolved oxygen

DO biological metric data

Table 120. Dissolved oxygen related fish metrics

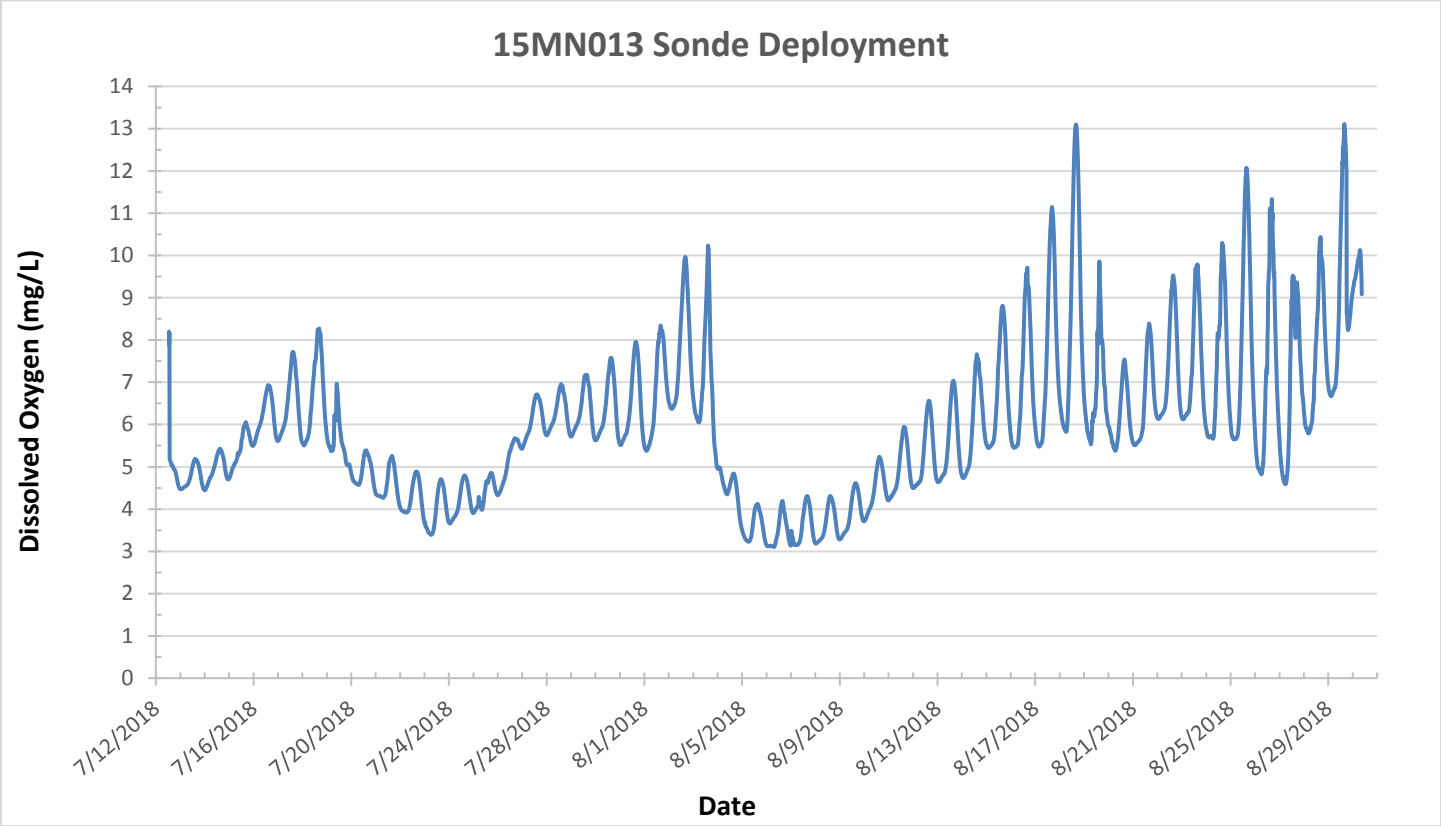
07020001-560 **Fish Class 3** **Modified Use**	Mature Age >3 %	Serial Spawner %	Taxa Count	DO TIV	DO Sensitive %	DO Tolerant %
15MN013 6/17/2015	0.0	83.6	2.0	6.2	0.0	100.0
Statewide average for Class 3 southern headwaters bio sites that are meeting the FIBI general use threshold (55.0)	**13.3**	**17.1**	**12.2**	**7.2**	**3.7**	**18.6**
Expected response to DO stress	↓	↑	↓	↓	↓	↑

DO monitoring data

Table 121. Dissolved oxygen monitoring data

07020001-560 DO Data	Range of Data (mg/L)	% of Monthly Samples < 5 mg/L [# of Samples]							% of Total Samples < 5 mg/L [# of Samples]
		April	May	June	July	August	Sept	Oct	
S013-140 (2017-2018)	4.9-7.1	N/A [0]	0% [1]	N/A [0]	100% [1]	N/A [0]	N/A [0]	N/A [0]	50% [2]

Figure 56. Dissolved oxygen continuous data at site 15MN013



Dissolved oxygen summary

The fish community at bio site 15MN013 scored poorly in all six DO related fish metrics when compared to the average of all other Class 3 Southern Headwater bio sites that meet the FIBI general use threshold (Table 120). There were no species whose females take more than three years to mature. Fathead minnows, a serial spawning fish dominated the fish community.

Only one DO measurement was taken in reach 07020001-560 (Table 121). One measurement fell below 5 mg/L. A YSI Sonde water meter measured continuous DO data from July 12, 2018 to August 29, 2018 (Figure 56). During this deployment, DO values were measured below the standard of 5 mg/L 22 out of 49 days.

Based on the very poor related biological metric scores and the many measured values below the standard, DO is a stressor in this reach.

3.6.5 Eutrophication

Eutrophication biological metric data

Table 122. Eutrophication related fish metrics at bio site 15MN013

07020001-560 **Fish Class 3** **Modified Use**	Darter %	Omnivore %	Sensitive %	Tolerant %
15MN013 6/17/2015	0.0	83.6	0.0	100.0
Statewide average for Class 3 southern headwaters bio sites that are meeting the FIBI modified use threshold (33.0)	**1.5**	**19.8**	**6.0**	**76.7**
Expected response to eutrophication stress	↓	↑	↓	↑

Table 123. Phosphorus monitoring data for chemistry site S013-140

07020001-560 P Sample Data	Range of Data (mg/L)	Monthly Average of Samples (mg/L) [# of Samples]							June-Aug Average (mg/L) [# of Samples]
		April	May	June	July	August	Sept	Oct	
S013-140 (2015-2018)	0.45–1.0	N/A [0]	0.45 [1]	0.65 [1]	1.10 [1]	N/A [0]	N/A [0]	N/A [0]	0.82 [4]

Eutrophication HSPF model data

Table 124. HSPF model phosphorus data

	Total Phosphorus	
07020001-559 HSPF Reach 422	**June–September** **% values > 0.15 mg/l** (# Daily Values)	**June–September** **Multi-year Average**
2,318 Total Daily Averages *June–Sep 1994–2012*	**82.7%** (1,918)	**0.31 mg/l**

Figure 57. Photo of floating algae mats at bio site 15MN013

Eutrophication summary

The fish community at bio site 15MN013 scored poorly in all four eutrophication related fish metrics when compared to the average of all other Class 3 Southern Headwater bio sites that meet the FIBI modified use threshold (Table 122). There were no darter taxa and omnivorous fish comprised 83.6% of the fish population. There were no sensitive taxa and tolerant fish comprised 100% of the population.

Four samples were collected and analyzed for Phosphorus from 2015-2018. The summer average was 0.82 mg/L, well above the standard of 0.15 mg/L (Table 108). The HSPF model computed the summer average well above the standard at 0.31 mg/L (Table 124).

A YSI Sonde water meter measured continuous DO data from July 12, 2018 to July 29, 2018 (Figure 56). During this deployment, DO diurnal flux, or the difference between the daily high and low DO concentrations was above the eutrophication DO flux standard of 5 mg/l several days.

High levels of phosphorus were measured during sampling and the fish community seems to be showing the effects of eutrophication. Large algae mats were present during bio sampling (Figure 57) and DO flux appears to be an issue. Eutrophication is a stressor to the fish community in reach 07020001-560.

3.6.6 Suspended solids

Suspended solids biological metric data

Table 125. Suspended solids related fish metrics at bio site 15MN013

07020001-560 Fish Class 3 Modified Use	Benthic Feeder %	Centrarchid-Tolerant %	Herbivore %	Intolerant %	Long-Lived %	Perciformes-Tolerant %	Riffle %	Sensitive %	Simple Lithophilic Spawner %	TSS TIV
15MN013 6/17/2015	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22.3
Statewide average for Class 3 southern headwaters stations that are meeting the FIBI modified use threshold (33.0)	**31.4**	**1.0**	**10.8**	**0.5**	**4.9**	**12.4**	**22.6**	**6.0**	**30.1**	**16.7**
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Suspended solids summary

The fish community at bio site 15MN013 scored very poorly in all ten suspended solids related fish metrics when compared to the average of all other Class 3 Southern Headwater bio sites that meet the FIBI modified use threshold (Table 125). All the metrics scored zero and the TSS TIV score indicated a biological community tolerant of suspended solids.

At this time, suspended solids are inconclusive as a stressor. The lowered metrics are due to the lack of fish diversity captured, but could be due to other stressors. Since the metrics, all scored zero it is likely that other factors, such as altered hydrology, connectivity, and habitat are causing poor scores in the fish biological metrics. More samples would be helpful. It is recommended that more TSS data be collected during high flows in order to determine whether it is a biological stressor.

3.6.7 Nitrates

Nitrate biological metric data

Table 126. Nitrate related invertebrate metrics at bio site 15MN013

07020001-560 Invert Class 7 Modified Use	Nitrate Intolerant Taxa %	Nitrogen TIV	Nitrate Tolerant Taxa %	Trichoptera Taxa %
15MN013 8/4/2015	0.3	4.2	54.1	0.0
Statewide average for Class 7 Prairie Streams Glide Pool bio sites that are meeting the MIBI modified use threshold (22.0)	**2.0**	**3.3**	**59.4**	**5.9**
Expected response to nitrogen stress	↓	↑	↑	↓

Nitrate monitoring data

Table 127. Nitrate monitoring data for chemistry site S013-140

07020001-560 Nitrate/Nitrite Sample Data	Range of Data (mg/L)
S013-140 (2017-2018)	0.25–11

Nitrate summary

The macroinvertebrate assemblage at site 15MN010 scored below average in all four nitrate related metrics when compared to all other macroinvertebrate Class 5 southern stream rock riffle bio sites that meet the MIBI general use threshold (Table 126). Trichoptera taxa was close to zero, which tend to decrease in streams with excessive nitrate values. There were very few nitrate intolerant invertebrates. Nitrate tolerant taxa was 54.1%, just below the class average. The nitrogen TIV score also indicates a macroinvertebrate community that is generally tolerant to higher levels of nitrates.

Only two samples were collected and analyzed for nitrate/nitrite in reach 07020001-560 (Table 127). One of the two samples had nitrate concentrations above 10 mg/L. Three out of four metrics scored poorly and a relatively high percentage of nitrate tolerant inverts were present. It would appear that nitrates are a stressor to biological community but due to insufficient data, are inconclusive at this time. Collecting more chemistry data within this reach is recommended in order to determine if nitrates are a stressor to the biological community.

3.6.8 Reach stressors

This stream is being stressed by changes to the hydrology of the stream channel and contributing watershed. The stream itself appears to have been ditched, often times right through wetlands in order to drain them, which has eliminated in-stream habitat and has caused siltation and very little depth variability. This stream reach could benefit from allowing the channel to re-meander and form pools, riffles, and runs, which forms the habitat that aquatic life needs to live. The stream is also disconnected from its flood plain in areas due to both ditching of the stream as well as incision.

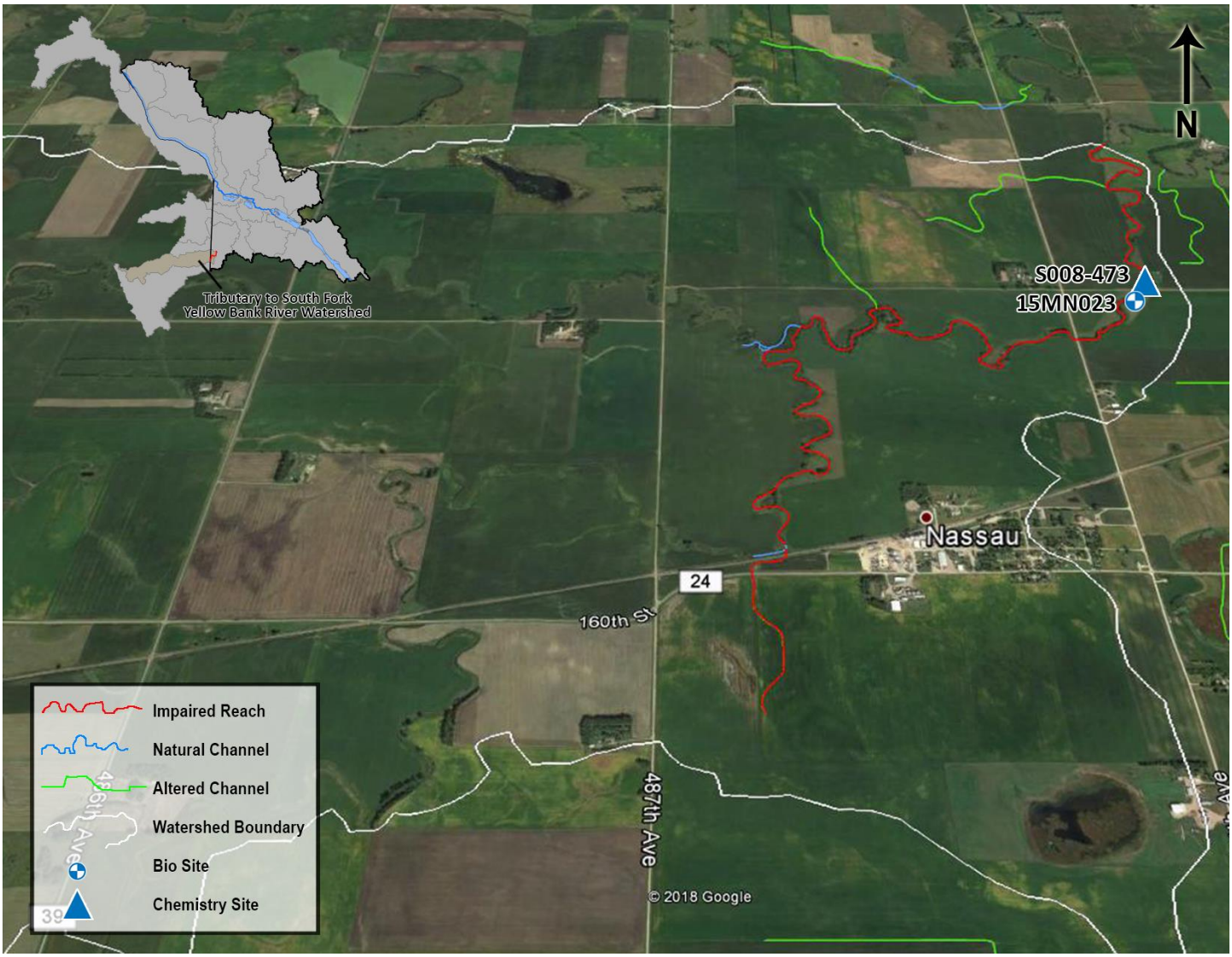
The construction of ditches and the addition of tile drainage has altered the land area that that regularly contributes water to the stream as well as the amount and timing of water that reaches the stream. Increasing the storage and infiltration of water can help reduce nutrient delivery to the stream, erosion and incision from high flows after large rain events, and can help mitigate periods of extremely low flows during times of low precipitation.

Table 128. Summary of stressors in reach 07020001-560

07020001-560	**Hydrologic Alteration**	**Connectivity**	**Habitat**	**Dissolved Oxygen**	**Eutrophication**	**Suspended Solids**	**Nitrate**
✓= Stressor ×= Not a Stressor **O** = Inconclusive	✓	✓	✓	✓	✓	**O**	**O**

3.7 07020001-551 Unnamed Tributary to South Branch Yellow Bank

Figure 58. Satellite image of reach 07020001-551 and its watershed



3.7.1 Biological community

Bio site 15MN023 was sampled for fish in June of 2015. Creek chubs and common shiners comprised over 58% of the total number of fish caught resulting in an IBI score of 20.9 (Table 129). Metrics used to calculate the Fish IBI score are shown in a graph with the red line indicating the value each metric needed to score in order to meet the threshold (Figure 59).

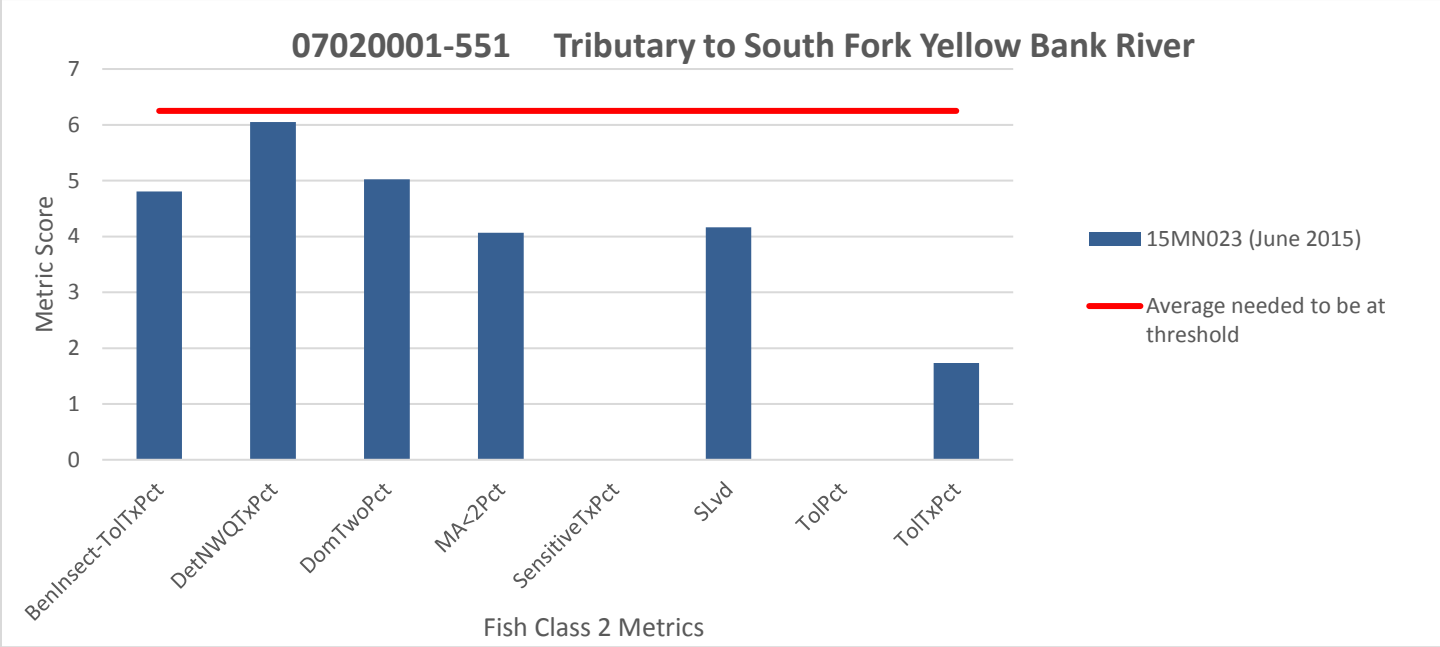
Invertebrates were sampled in August of 2015 and scored 32.6, below the threshold of 41 for the invertebrate Class 7 general use threshold (Table 130). Metrics used to calculate the Invert IBI score are shown in a graph with the red line indicating the value each metric needed to score in order to meet the threshold (Figure 60).

Fish biological metric data

Table 129. Fish IBI score and threshold for bio site 15MN023

07020001-551 Fish Class 2 General Use		Fish IBI Score	Class Threshold Score
15MN023	6/10/2015	20.9	35

Figure 59. Fish Class 2 general use metric scores for bio site 15MN023

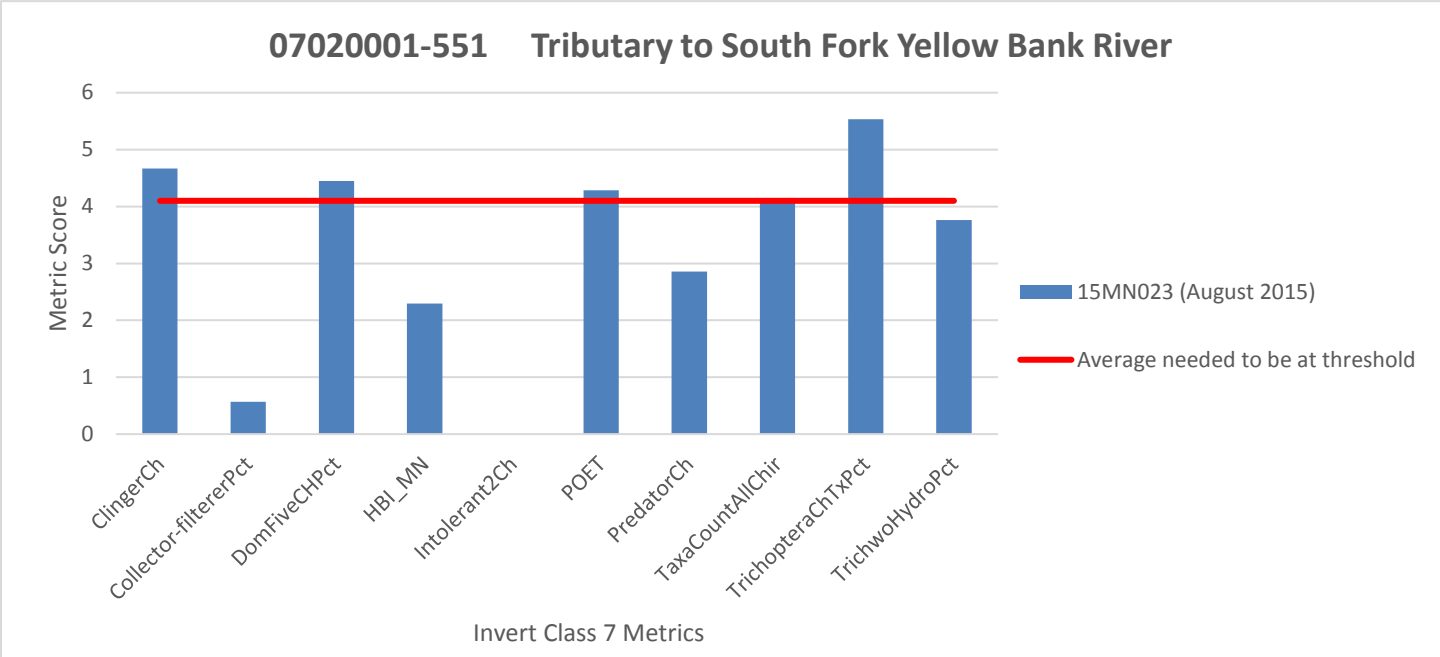


Invertebrate biological metric data

Table 130. Invertebrate IBI score and threshold for bio site 15MN023

07020001-551 Invert Class 7 General Use		Invertebrate IBI Score	Class Threshold Score
15MN023	8/6/2015	32.6	41

Figure 60. Invert Class 7 general use metric scores for bio site 15MN023



3.7.2 Hydrologic alteration

Hydrologic alteration biological metric data

Table 131. Hydrologic alteration related fish metrics for bio site 15MN023

07020001-551 **Fish Class 2** **General Use**	General %	Nesting Non Lithophilic Spawner %
15MN023 6/10/2015	76.3	8.9
Statewide average for Class 2 southern stream bio sites that are meeting the FIBI general use threshold (50.0)	**42.4**	**19.1**
Expected response to **Hydrologic** stress	↑	↑

Table 132. Hydrologic alteration related invertebrate metrics for bio site 15MN023

07020001-551 **Invert Class 7** **General Use**	Clinger %	Collector-Filterer %	Long-Lived %
15MN023 8/6/2015	13.5	2.5	0.3
Statewide average for Class 7 Prairie Streams Glide Pool bio sites that are meeting the MIBI general use threshold (41.0)	**23.1**	**9.9**	**5.6**
Expected response to hydrologic stress	↓	↓	↓

HSPF model flow data

Table 133. HSPF modeled flow data, 1994-2012

07020001-551 HSPF Reach 504 Min: 0.1 cfs Max: 556.5 cfs	**<5 cfs %** (# of values)	**<1 cfs %** (# of values)	**<0.5 cfs %** (# of values)
6,940 Total Daily Averages 1994–2012	**59.7%** (4,140)	**24.0%** (1,668)	**10.7%** (740)

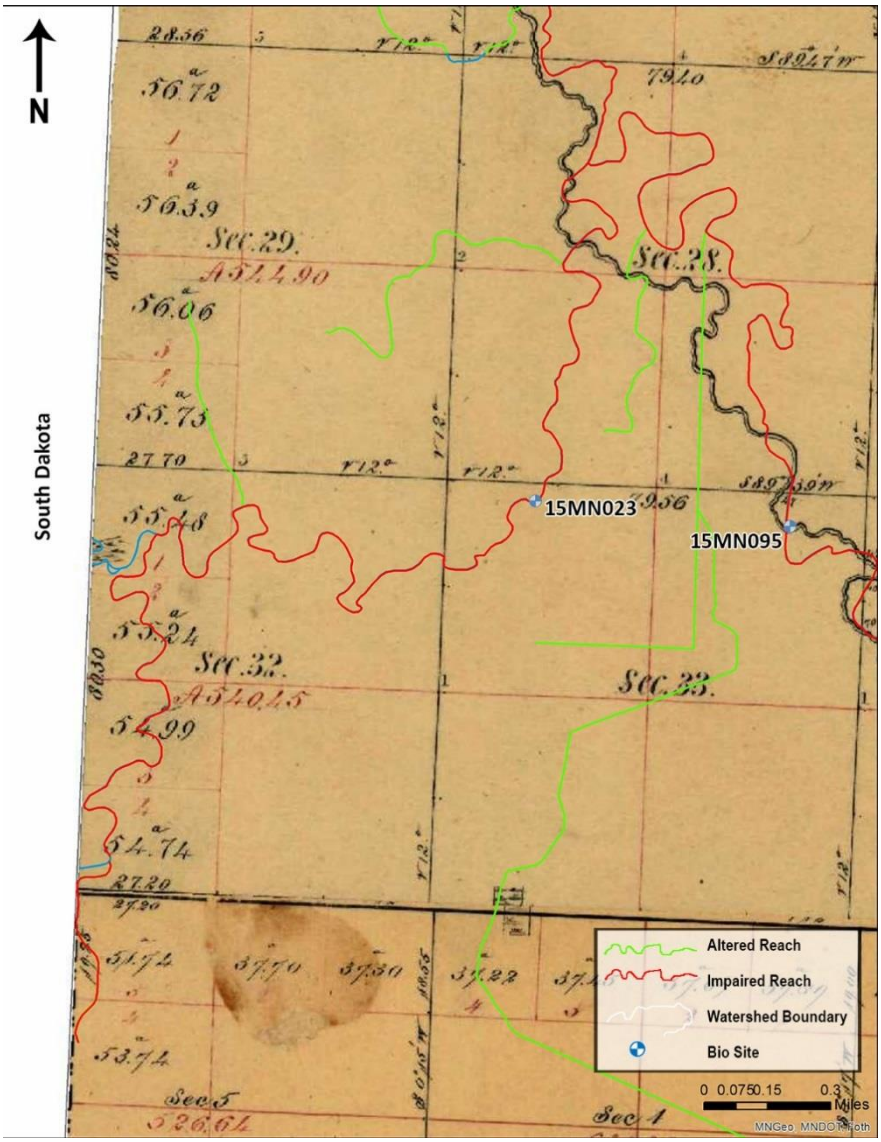
Hydrologic alteration summary

One out of the two fish biological metrics scored poorly when compared to the average of Fish Class 2 southern stream bio sites that meet the IBI general use threshold (Table 131). The fish assemblage was dominated by creek chubs and common shiners, and those two species comprised over 58.5% of the total number of fish caught. Bio site 15MN023 had generalist fish population of 76.3%. Nesting fish species scored well, comprising of only 8.9%.

All three invertebrate metrics scored poorly when compared to the average of Invert Class 7 general use streams that met the IBI threshold (Table 132), indicating stress from both low and high flows.

The HSPF model (Table 133) shows that 24.0% of the daily average flows from 1994 – 2012 are below 1 cfs. Flows reduced beyond normal base flow decreases habitat for aquatic organisms and increases competition for resources.

Figure 61. Original survey plat map of the watershed of reach 07020001-551 including altered watercourses



It appears that reach 07020001-551 was small enough that it was not identified in the original plat information (Figure 61). Most of the watershed of this reach is in South Dakota. Several of its tributaries have been channelized and a large portion of its watershed appears to have been drained and cultivated.

Based on the poor scores of most of the biological metrics, low flow periods shown in the HSPF model, as well as historic surveying data, Hydrologic Alteration is a stressor in reach 07020001-551. The primary impact in this reach from Hydrologic Alteration is from subsurface tile drainage and channelization of its watershed, as well as the pollutant overloading of nutrients.

3.7.3 Connectivity

Connectivity metric data

Table 134. Connectivity related fish metrics for bio site 15MN023

07020001-551 **Fish Class 2** **General Use**	Mature Age >3 minus Tolerant Taxa %	Migrating Taxa %
15MN023 6/10/2015	0.0	23.1
Statewide average for Class 2 southern stream bio sites that are meeting the FIBI general use threshold (50.0)	**21.8**	**24.3**
Expected response to connectivity stress	↓	↓

Connectivity summary

There were no fish whose females take greater than three years to mature. Migrating taxa scored just below the average of bio sites that met the Class 2 Southern Stream threshold (Table 134). These consisted of 19 central stonerollers and 13 white suckers, both tolerant species, and 1 blackside darter. No downstream culverts were identified as fish barriers. Due to the presence of some migratory species, it appears that connectivity is not a stressor at this time.

3.7.4 Habitat

Habitat metric data

Table 135. Habitat related fish metrics for bio site 15MN023

07020001-551 **Fish Class 2** **General Use**	Benthic Insect minus Tolerant %	Darter Sculpin Sucker %	Lithophilic Spawner %	Pioneer %	Piscivore %	Riffle %	Simple Lithophilic Spawner %	Tolerant %
15MN023 6/10/2015	3.7	3.7	85.2	47.4	0.0	23.7	31.9	77.0
Statewide average for Class 2 southern stream bio sites that are meeting the FIBI general use threshold (50.0)	**20.4**	**18.2**	**58.3**	**19.0**	**5.2**	**32.5**	**39.4**	**44.9**
Expected response to habitat stress	↓	↓	↓	↑	↓	↓	↓	↑

Table 136. Habitat related fish metrics for bio site 15MN023

07020001-551 **Invert Class 7** **General Use**	Burrower %	Climber %	Clinger %	Ephemeroptera Plecoptera Trichoptera %	Legless %	Sprawler %
15MN023 8/6/2015	13.5	55.5	13.5	7.1	90.8	16.9
Statewide average for Class 7 Prairie Streams Glide Pool bio sites that are meeting the MIBI general use threshold (41.0)	**7.5**	**21.6**	**38.5**	**38.5**	**39.8**	**20.9**
Expected response to habitat stress	↑	↓	↓	↓	↑	↑

MPCA stream habitat assessment score

Table 137. Habitat assessment score for bio site 15MN023

07020001-551	Land Use	Riparian	Substrate	Cover	Channel Morphology	Total Score
15MN023 6/10/2015	0	9	8.8	14	17	48.8
Maximum Attainable Habitat Score	**5**	**14**	**28**	**18**	**35**	**100**

Figure 62. Photo of reach 07020005-551 showing gravel on the stream bottom (left) and stream channel (right)

Habitat summary

The fish community at bio site 15MN023 scored below average in seven out of eight habitat related fish metrics when compared to all other Class 2 southern stream bio sites that met the FIBI general use threshold (Table 135). Benthic insectivores minus tolerant taxa and Darter, sculpin, sucker metrics scored very poorly. Pioneer and tolerant species were both high and there were no piscivores caught. There were some lithophilic and simple lithophilic spawners.

The invertebrate community at bio site 15MN023 scored below average in four out of six habitat related invertebrate metrics when compared to all other Class 7 Prairie Streams Glide Pool bio sites that met the MIBI general use threshold (Table 136). Burrower, Clinger, legless, and sprawler taxa all scored poorly.

The MSHA habitat assessment was fair and scored 48.8 out of 100 (Table 137). Substrate and channel morphology brought the score down. Moderate embeddedness of coarse substrates from silt deposition has degraded the habitat, resulting in a high number of legless invertebrates. There was low depth variability, no riffles observed, and fair channel development.

Photos of reach 07020001-551 shows that there is some gravel substrate within the reach near bio site 15MN023 and that there is some channel instability causing bank erosion ().

The lack of benthic insectivores, darters, and piscivores indicate habitat may be a stressor to the biological community in reach 07020001-551. However, there is a better than average percent of lithophilic spawners and a decent number of central stonerollers, a riffle fish. The high number of legless invertebrates indicate habitat may be a stressor to the biological community in the reach. Clinger and EPT scored very poorly. Climber invertebrates scored decent however. Though the gravel substrate appears adequate to support some fish and invertebrate species that rely on coarse stream bottom sediment, it would appear that limitations in habitat is having some impact on fish and invertebrate populations and is a stressor, likely being exasperated by low flows.

3.7.5 Dissolved oxygen

DO biological metric data

Table 138. Dissolved oxygen related fish metrics

07020001-551 **Fish Class 2** **General Use**	Mature Age >3 %	Serial Spawner %	Taxa Count	DO TIV	DO Sensitive %	DO Tolerant %
15MN023 6/10/2015	9.6	3.7	13.0	7.2	0.0	11.1
Statewide average for Class 2 southern stream bio sites that are meeting the FIBI general use threshold (50.0)	**23.9**	**28.7**	**20.4**	**7.2**	**6.1**	**15.8**
Expected response to DO stress	↓	↑	↓	↓	↓	↑

Table 139. Dissolved oxygen related invertebrate metrics

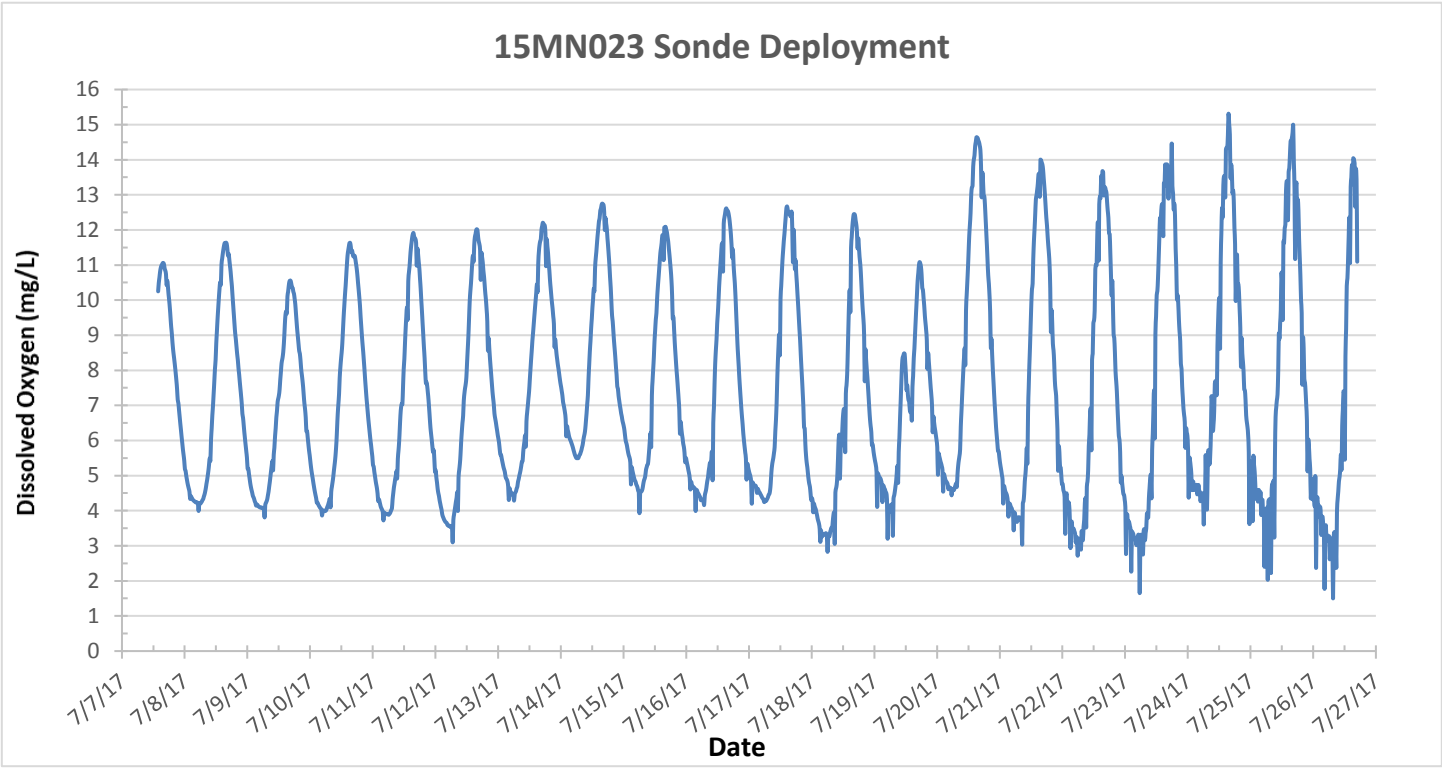
07020001-551 **Invert Class 7** **General Use**	Low DO Intolerant Taxa %	Low DO Tolerant Taxa %	DO TIV	HBI_MN
15MN023 8/6/2015	0.0	23.9	6.7	8.2
Statewide average for Class 7 Prairie Streams Glide Pool bio sites that are meeting the MIBI general use threshold (41.0)	**4.5**	**8.4**	**6.4**	**7.9**
Expected response to DO stress	↓	↑	↓	↑

DO monitoring data

Table 140. Dissolved oxygen monitoring data

07020001-551 DO Data	Range of Data (mg/L)	% of Monthly Samples < 5 mg/L [# of Samples]							% of Total Samples < 5 mg/L [# of Samples]
		April	May	June	July	August	Sept	Oct	
S008-473 (2015-2016)	2.1–10.1	N/A [0]	0% [2]	0% [5]	22% [9]	40% [5]	100% [2]	N/A [0]	26% [23]

Figure 63. Dissolved oxygen continuous data at site 15MN023



Dissolved oxygen summary

The fish community at bio site 15MN023 scored poorly in three out of four DO related fish metrics when compared to the average of all other Class 2 southern stream bio sites that meet the FIBI general use threshold (Table 138). Few species whose females that take more than three years to mature were caught and overall taxa count was poor. No species that are sensitive to low DO were present.

Three out of four DO related invertebrate metrics scored poorly (Table 139). There were no low DO intolerant taxa and low DO tolerant taxa comprised 23.9% of the total number of taxa present.

Twenty-six percent out of 23 DO measurements taken during sampling from 2015-2016 were below the warmwater standard of 5 mg/L (Table 140). A YSI Sonde water meter measured continuous DO data from July 7, 2017 to July 26, 2017. During this deployment, DO values were not measured below the standard of 5 mg/L (Figure 63).

Based on the poor related biological metric scores, a high percentage of measured values below the standard, as well as the measured values from the sonde deployment that fall below the standard, DO is a stressor in this reach.

3.7.6 Eutrophication

Eutrophication biological metric data

Table 141. Eutrophication related fish metrics for bio site 15MN023

07020001-551 **Fish Class 2** **General Use**	Darter %	Omnivore %	Sensitive %	Tolerant %
15MN023 6/10/2015	3.7	13.3	0.0	77.0
Statewide average for Class 2 southern stream bio sites that are meeting the FIBI general use threshold (50.0)	**11.9**	**16.5**	**18.7**	**44.9**
Expected response to eutrophication stress	↓	↑	↓	↑

Table 142. Eutrophication related invertebrate metrics for bio site 15MN023

07020001-551 **Invert Class 7** **General Use**	Taxa Count All #	Collector–Filterer Taxa #	Collector–Gatherer Taxa #	Ephemeroptera Plecoptera Trichoptera Taxa #	Intolerant Taxa #	Tolerant Taxa %
15MN023 8/6/2015	33	2	12	7	0	90.9
Statewide average for Class 7 Prairie Streams Glide Pool bio sites that are meeting the MIBI general use threshold (41.0)	**41.9**	**6.5**	**15.0**	**10.9**	**0.8**	**71.9**
Expected response to eutrophication stress	↓	↓	↑	↓	↓	↑

Eutrophication monitoring data

Table 143. Phosphorus monitoring data for chemistry site S008-473

07020001-551 P Sample Data	Range of Data (mg/L)	Monthly Average of Samples (mg/L) [# of Samples]							June-Aug Average (mg/L) [# of Samples]
		April	May	June	July	August	Sept	Oct	
S008-473 (2015-2017)	0.08–0.31	N/A [0]	0.11 [2]	0.14 [2]	0.28 [4]	0.23 [2]	0.22 [2]	N/A [0]	0.21 [12]

Eutrophication HSPF model data

Table 144. HSPF model phosphorus data

	Total Phosphorus	
07020001-551 HSPF Reach 504	**June–September** **% values > 0.15 mg/l** (# Daily Values)	**June–September** **Multi-year Average**
2,318 Total Daily Averages *June–Sep 1994–2012*	**50.9%** (1181)	**0.20 mg/l**

Figure 64. Photo of algae and aquatic macrophytes at bio site 15MN023

Eutrophication summary

The fish community at bio site 15MN023 scored poorly in all four eutrophication related fish metrics when compared to the average of all other Class 2 southern stream bio sites that meet the FIBI general use threshold (Table 141). Only a few Johnny Darters, a tolerant fish, were caught. Omnivorous fish comprised 13.3% of the fish population. There were no sensitive taxa and tolerant fish comprised 77% of the population.

The invert community at bio site 15MN023 scored poorly in all six invert eutrophication related metrics compared to the average of all other Invert Class 7 Prairie Streams Glide Pool bio sites that meet the MIBI general use threshold (Table 142). Total taxa count scored poorly as did collector – filterer taxa numbers, collector–gatherer, and EPT taxa. There were no intolerant taxa and over 90% of the species are considered tolerant.

Twelve samples were collected and analyzed for Phosphorus from 2015-2017. The summer average was 0.21 mg/L, above the standard of 0.15 mg/L (Table 143).

The HSPF model computed the summer average was above the standard at 0.20 mg/L (Table 144).

A YSI Sonde water meter measured continuous DO data from July 7, 2017 to July 26, 2017 (Figure 63). During this deployment, DO diurnal flux, or the difference between the daily high and low DO concentrations was consistently over 9 mg/L, well above the eutrophication DO flux standard of 5 mg/L.

High levels of phosphorus were measured during sampling and algae was observed covering the stream bottom (Figure 64). Both the fish and invertebrate community seem to be showing the effects of eutrophication and high levels of DO flux indicate eutrophication is a stressor to the biological community in reach 07020001-551.

3.7.7 Suspended solids

Suspended solids biological metric data

Table 145. Suspended solids related fish metrics for bio site 15MN023

07020001-551 Fish Class 2 General Use	Benthic Feeder %	Centrarchid-Tolerant %	Herbivore %	Intolerant %	Long-Lived %	Perciformes-Tolerant %	Riffle %	Sensitive %	Simple Lithophilic Spawner %	TSS TIV
15MN023 6/10/2015	26.7	0.0	19.3	0.0	0.0	3.7	23.7	0.0	31.9	16.2
Statewide average for Class 2 Southern Stream stations that are meeting the FIBI general use threshold (50.0)	**36.0**	**5.4**	**25.70**	**5.0**	**11.7**	**18.7**	**32.5**	**18.7**	**39.4**	**17.6**
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Table 146. Suspended solids related invertebrate metrics for bio site 15MN023

07020001-551 **Invert Class 7** **General Use**	Collector-Filterer %	Plecoptera %	TSS Intolerant %	TSS Tolerant %	TSS TIV
15MN023 8/6/2015	2.5	0.0	1.0	12.0	21.5
Statewide average for Class 7 Prairie Streams Glide Pool bio sites that are meeting the MIBI general use threshold (41.0)	**19.1**	**0.2**	**2.7**	**48.3**	**17.8**
Expected response to TSS stress	↓	↓	↓	↑	↑

TSS monitoring data

Table 147. Total suspended solids monitoring data for chemistry site S008-473

07020001-551 TSS Sample Data	Range of Data (mg/L)	% of Monthly Samples > 65 mg/L [# of Samples]							% of Total Samples > 65 mg/L [# of Samples]
		April	May	June	July	August	Sept	Oct	
S008-473 (2015)	6 – 33	N/A [0]	0% [2]	0% [2]	0% [3]	0% [2]	0% [2]	N/A [0]	0% [11]

Suspended solids summary

The fish community at bio site 15MN023 scored below average in nine out of ten suspended solids related fish metrics when compared to the average of all other Class 2 southern stream bio sites that meet the FIBI general use threshold (Table 145). Benthic feeders, simple lithophilic spawners, herbivores, and riffle fish all scored fair but were below the class averages. There were no Centrarchids, intolerant taxa, long-lived taxa, or sensitive species.

The invert community at bio site 15MN023 scored poorly in four out of five related metrics though species tolerant to TSS were low (Table 146). There were no Plecoptera taxa and very few taxa intolerant of high-suspended solids. The TSS tolerance index value was relatively high. Collector filterer invertebrates scored poorly. TSS tolerant taxa were present but scored well compared to the class average.

Eleven samples were collected and analyzed for total suspended solids from 2015-2017 (Table 147). No samples had a total suspended solid concentration above 65 mg/L.

Even though all of the fish metrics related to suspended solids scored below the class average, there were a fair amount of benthic feeders, herbivores, and riffle fish, which tend to indicate that there are enough coarse substrates and riffles to support those fish. Invert suspended solids related metrics seemed more impacted than the fish metrics. Chemistry data showed low concentrations of TSS. Right now suspended solids are inconclusive as a stressor to aquatic life in reach 07020001-551. It is likely that other factors, such as altered hydrology and habitat are causing poor scores in the fish and invert biological metrics. It is recommended that more TSS data be collected during high flows in order to determine whether it is a biological stressor.

3.7.8 Nitrates

Nitrate biological metric data

Table 148. Nitrate related invertebrate metrics for bio site 15MN023

07020001-551 **Invert Class 7** **General Use**	Nitrate Intolerant Taxa %	Nitrogen TIV	Nitrate Tolerant Taxa %	Trichoptera Taxa %
15MN023 8/6/2015	0.3	5.4	76.1	9.1
Statewide average for Class 7 Prairie Streams Glide Pool bio sites that are meeting the MIBI general use threshold (41.0)	**3.2**	**3.2**	**54.9**	**10.9**
Expected response to nitrogen stress	↓	↑	↑	↓

Nitrate monitoring data

Table 149. Nitrate monitoring data for chemistry site S008-473

07020001-551 Nitrate/Nitrite Sample Data	Range of Data (mg/L)
S008-473 (2015)	0.1–1.9

Nitrate summary

The macroinvertebrate assemblage at site 15MN023 scored poorly in all four nitrate related metrics when compared to all other macroinvertebrate Class 7 Prairie Stream Glide pool bio sites that meet the MIBI general use threshold (Table 148). Trichoptera taxa percentage was close to the average, which tend to decrease in streams with excessive nitrate values. However, two of the three Trichoptera taxa are tolerant of nitrates. The one taxa observed that is intolerant of high nitrates, Phryganeidae, consisted of only one individual. Nitrate tolerant invertebrates scored poorly at 76.1%. The nitrogen TIV score also indicates a macroinvertebrate community that is generally tolerant to high levels of nitrates.

Twelve samples were collected in reach 07020001-551 and analyzed for nitrate/nitrite (Table 149). All of the samples collected had relatively low nitrate concentrations, though none of the samples were collected before May. Although the four metrics scored very poorly, there was no chemical data corroborating it and nitrates are inconclusive as a stressor at this time. Collecting more chemistry data within this reach is recommended in order to determine if nitrates are a stressor to the biological community.

3.7.9 Reach stressors

This stream is being stressed by changes to the hydrology of the stream channel and contributing watershed. The construction of ditches and the addition of tile drainage has altered the land area that that regularly contributes water to

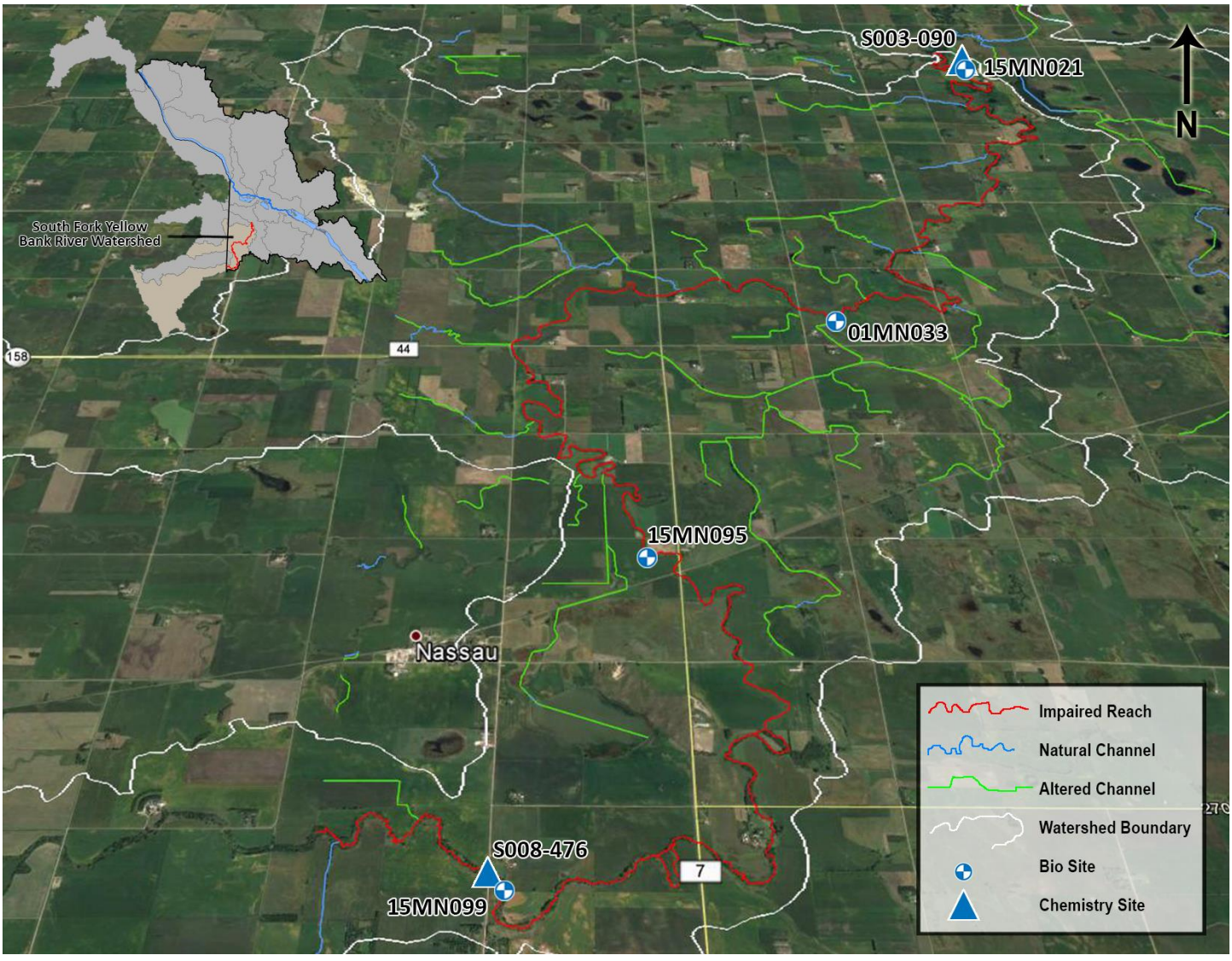
the stream as well as the amount and timing of water that reaches the stream. This stream is stressed by low DO, and DO flux. This is likely from excessive nutrients and low flows during the hot, summer months when precipitation is low. Increasing the storage and infiltration of water can help reduce nutrient delivery to the stream, erosion and incision from high flows after large rain events, and can help mitigate periods of extremely low flows during times of low precipitation.

Table 150. Summary of stressors in reach 07020001-551

07020001-551	Hydrologic Alteration	Connectivity	Habitat	Dissolved Oxygen	Eutrophication	Suspended Solids	Nitrate
✓= Stressor ×= Not a Stressor **O** = Inconclusive	✓	×	✓	✓	✓	**O**	**O**

3.8 07020001-526 South Fork Yellow Bank River

Figure 65. Satellite image of reach 07020001-526 and its watershed



3.8.1 Biological community

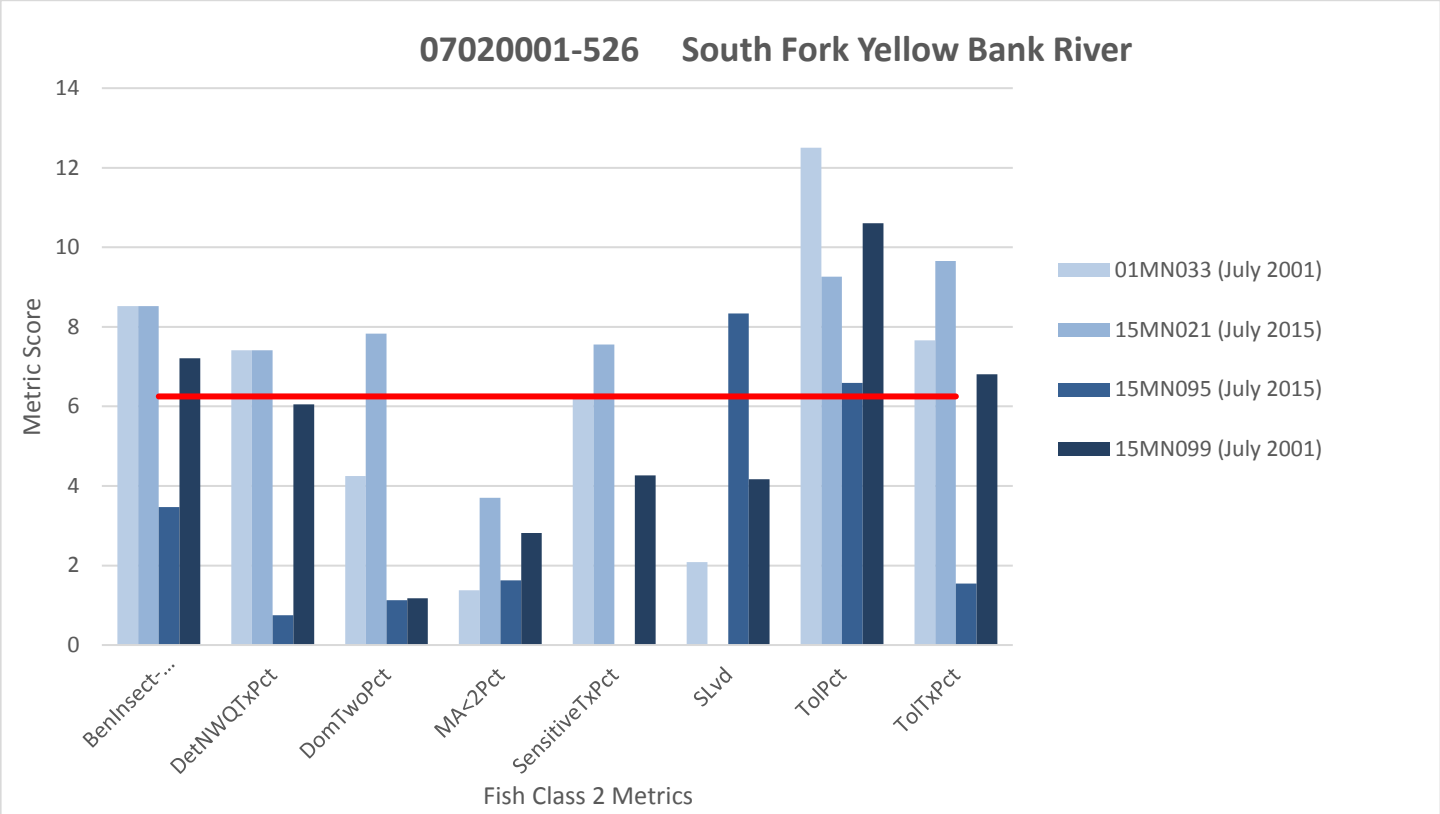
The South Branch Yellow Bank River, reach 07020001-526 is a 27-mile long reach and contains four bio sites. 01MN033 was sampled for fish on July 17, 2001. The rest of the bio sites were sampled more recently in 2015. Fathead minnows, creek chubs, and a few other short lived and tolerant taxa dominated the bio sites resulting in metric scores of two out of the three-bio sites (Table 151). Lowest taxa richness was found in the upstream portion of the reach (15MN099 and 15MN095) with only 3-13 taxa collected in those samples compared to the 22 taxa collected at the downstream bio sites (01MN033 and 15MN021). Tolerant species were found to be most abundant at 15MN095 (50.2% of the individuals) followed by the downstream most bio site 15MN021 with 40% of the individuals in the sample. 15MN099 had 35% of the individuals in the sample considered tolerant. Metrics used to calculate the Fish IBI score are shown in a graph with the red line indicating the value each metric needed to score in order to meet the threshold (Figure 66).

Biological metric data

Table 151. Fish IBI score and threshold for bio sites 01MN033, 15MN021, 15MN095, and 15MN099

07020001-526 **Fish Class 2** **General Use**		Fish IBI Score	Class Threshold Score
15MN099	6/16/2015	43.1	50
15MN095	7/8/2015	23.4	50
01MN033	7/17/2001	20.9	50
15MN021	7/8/2015	53.9	50

Figure 66. Fish Class 2 general use metric scores for bio sites 01MN033, 15MN021, 15MN095, and 15MN099



3.8.2 Hydrologic alteration

Hydrologic alteration biological metric data

Table 152. Hydrologic alteration related fish metrics for bio sites 01MN033, 15MN021, 15MN095, and 15MN099

07020001-531 Fish Class 2 General Use		General %	Nesting Non Lithophilic Spawner %
15MN099	6/16/2015	83.6	3.6
15MN095	7/8/2015	86.5	4.8
01MN033	7/17/2001	62.4	13.7
15MN021	7/8/2015	54.3	2.5
Statewide average for Class 2 southern stream bio sites that are meeting the FIBI general use threshold (50.0)		**42.4**	**19.1**
Expected response to **Hydrologic** stress		↑	↑

HSPF model flow data

Table 153. HSPF modeled flow data, 1994-2012

07020001-526 HSPF Reach 501 Min: 0.2 cfs Max: 2424.6 cfs	**<5 cfs %** (# of values)	**<1 cfs %** (# of values)	**<0.5 cfs %** (# of values)
6,940 Total Daily Averages *1994–2012*	**28.3%** (1,964)	**4.5%** (311)	**1.3%** (93)

Figure 67. Photo showing cut bank and erosion at Bio site 15MN021

Hydrologic alteration summary

The hydrologic alteration related metrics were mixed compared to the average of Fish Class 2 southern stream bio sites that meet the IBI general use threshold (Table 152). Generalist species were well above the class average and had poor scores. Nesting fish at all, bio sites scored well compared to the class average. In general, the downstream sites scored better than the upstream sites.

The fish assemblage at the farthest upstream bio site 15MN099 was dominated by common shiners and creek chubs. Those two species comprised over 71% of the total number of fish caught. Site 15MN099 had a generalist fish population of 83.6%. Blackside darters and golden redhorses, two sensitive species, were caught at this bio site.

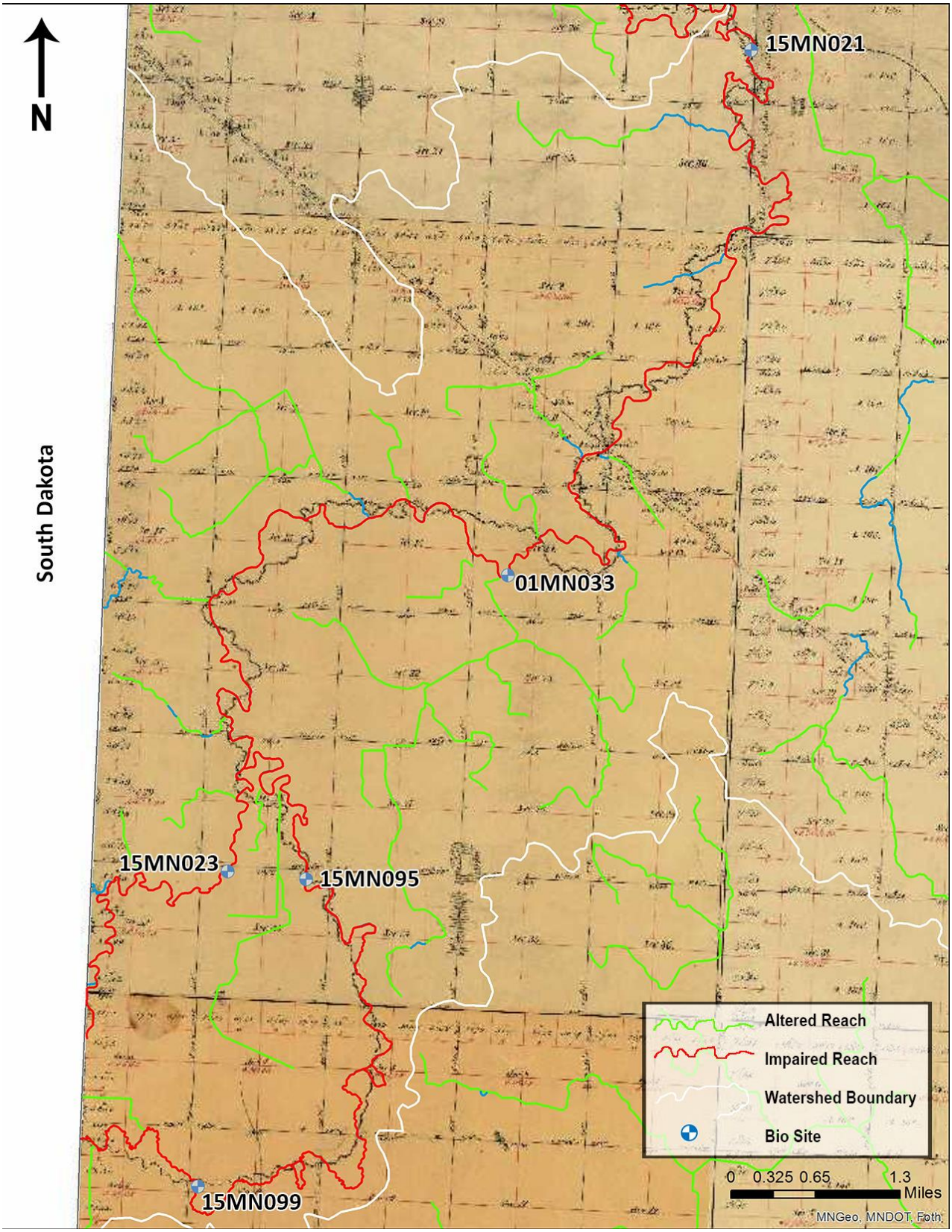
The fish assemblage at the next bio site 15MN095 was also dominated by common shiners and creek chubs. Those two species comprised over 61% of the total number of fish caught. Bio site 15MN095 had generalist fish population of 86.5%.

bio site 01MN033 was sampled back in 2001 and the data collected is expired for assessment purposes. The fish assemblage at the bio site was dominated by common shiners and hornyhead chubs; the latter is considered a sensitive fish. Those two species comprised over 71% of the total number of fish caught. Bio site 01MN033 had generalist fish population of 62.4%.

The fish assemblage at the farthest downstream bio site 15MN021 was dominated by common shiners and central stonerollers. Those two species comprised over 49% of the total number of fish caught. Site 15MN021 had a generalist fish population of 54.3%. Sensitive fish scored higher than average as carmine shiners, hornyhead chubs, Stonecats, Slenderhead Darters, and Iowa Darters were all caught at this bio site.

The HSPF model (Table 153) shows that 4.5% of the daily average flows from 1994–2012 are below 1 cfs. Flows reduced beyond normal base flow decreases habitat for aquatic organisms and increases competition for resources.

Figure 68. Original survey plat map of the watershed of reach 07020001-526 including altered watercourses



Reach 07020001-526 is a rather long stream reach and most of its tributaries have been altered into ditches in order to move water and grow crops (Figure 68). Creating these ditches essentially added to the amount of land and water that drains into the creek and the timing of that water. This altered the natural flow regime of this stream that had developed over several millenniums by decreasing the time it takes for water to move through the system, moving more water through the system at a higher frequency, and increasing the impact to the stream channel of high flow events while also increasing the intensity of low flow periods.

The Minnesota River – Headwaters Watershed Characteristic Report classified reach 07020001-526 as a C4 (DNR, 2019). The C4c- stream type is very similar to the previously described C5c- stream type; however, instead of being a sand dominated stream, the C4c- stream type has a gravel-dominated streambed (Rosgen 1996). Overall, C4c- streams have a very high sensitivity to disturbance, good recovery potential, high sediment supply, very high stream bank erosion potential where riparian vegetative influence is very high (Rosgen 1994). The bank height ratio was calculated as moderately incised at 1.37. Though the channel is moderately incised, the river still currently has adequate lateral floodplain connectivity. With an entrenchment ratio of 2.88, the channel is currently considered to only be slightly entrenched. An additional half foot of incision, however, would greatly reduce the entrenchment ratio and floodplain connectivity (DNR, 2019).

Based on the mixed metric scores, relatively small low flow periods shown in the HSPF model, the several sensitive species found within the reach, and the geomorphology data, Hydrologic Alteration inconclusive as a stressor to the biology in the South Branch Yellow Bank River. It does appear to be contributing to severe bank erosion, down cutting, and incision within the stream channel, which in turn affects habitat, especially in the downstream section of the reach.

3.8.3 Connectivity

Connectivity metric data

Table 154. Connectivity related fish metrics for bio sites 01MN033, 15MN021, 15MN095, and 15MN099

07020001-526 **Fish Class 2** **General Use**		Mature Age >3 minus Tolerant Taxa %	Migrating Taxa %
15MN099	6/16/2015	7.7	30.8
15MN095	7/8/2015	0	22.2
01MN033	7/17/2001	18.2	27.3
15MN021	7/8/2015	13.6	27.3
Statewide average for Class 2 southern stream bio sites that are meeting the FIBI general use threshold (50.0)		**21.8**	**24.3**
Expected response to connectivity stress		↓	↓

Connectivity summary

Throughout reach 07020001-526 there were some fish whose females take greater than three years to mature, however, all sites scored poorly compared to the average of Fish Class 2 southern stream bio sites that meet the IBI general use threshold (Table 154). Three out of four bio sites within the reach scored above the class average for migrating taxa. 15MN099, the furthest upstream bio site, had the most diverse migrating taxa, with white suckers, central stonerollers, blackside darters, and golden redhorses all caught during sampling. No downstream culverts were identified as fish barriers and most of the road crossings along this reach have large bridges across them that does not affect fish migration. Due to the presence of long-lived and migratory species, it appears that connectivity is inconclusive at this time. Lateral floodplain connectivity is appears to be a stressor in the downstream section of this reach.

3.8.4 Habitat

Habitat metric data

Table 155. Habitat related metrics for bio sites 01MN033, 15MN021, 15MN095, and 15MN099

07020001-526 Fish Class 2 General Use		Benthic Insect minus Tolerant %	Darter Sculpin Sucker %	Lithophilic Spawner %	Pioneer %	Piscivore %	Riffle %	Simple Lithophilic Spawner %	Tolerant %
15MN099	6/16/2015	4.6	4.6	90.8	14.0	0.0	18.8	76.0	35.07
15MN095	7/8/2015	0.4	0.4	82.5	26.7	0.0	11.2	60.2	50.2
01MN033	7/17/2001	12.2	12.1	83.0	13.6	2.2	15.8	67.2	17.4
15MN021	7/8/2015	12.5	11.9	91.0	13.2	0.6	26.1	60.7	40.1
Statewide average for Class 2 southern stream bio sites that are meeting the FIBI general use threshold (50.0)		**20.4**	**18.2**	**58.3**	**19.0**	**5.2**	**32.5**	**39.4**	**44.9**
Expected response to habitat stress		↓	↓	↓	↑	↓	↓	↓	↑

MPCA stream habitat assessment score

Table 156. Habitat assessment score for bio sites 01MN033, 15MN021, 15MN095, and 15MN099

07020001-526		Land Use	Riparian	Substrate	Cover	Channel Morphology	Total Score
15MN099	6/16/2015	0	12	9	12	16	49
15MN099	8/6/2015	0	9	8.9	9	9	35.9
15MN095	7/8/2015	0	8.5	5.3	12	15	40.8
15MN095	8/6/2015	0	8.5	6	5	9	28.5
01MN033	7/17/2001	0	7	16.8	8	27	58.8
15MN021	6/10/2015	2.5	9	13.9	15	22	62.4
15MN021	8/5/2015	0	7	18.4	12	15	52.4
Reach Average		0.4	8.7	11.2	10.4	16.1	46.8
Maximum Attainable Habitat Score		**5**	**14**	**28**	**18**	**35**	**100**

Figure 69. Photos of reach 07020001-526 at bio site 15MN099 (left) and at bio site 15MN095 (right)

Figure 70. Photos of reach 07020001-526 at bio site 01MN033 (left) and riffle at bio site 15MN021 (right)

Habitat summary

The fish community in reach 07020001-526 were pretty similar in scores at the four-bio sites compared to all other Class 2 southern stream bio sites that met the FIBI general use threshold (Table 155). The metric responses were mixed as benthic insectivores minus tolerant fish, darter, sculpin, sucker, piscivore, and riffle fish metrics all scored poorly. There were high numbers of lithophilic and simple lithophilic spawners. With the exception of bio site 15MN095, pioneer and tolerant fish were below average.

There were seven MSHA habitat assessments done within reach 07020001-526 (Table 156). Land use, substrate, and channel morphology brought the score down. Bank erosion gets worse the further downstream in the reach. Embeddedness from silt deposition is worse at the upstream bio sites. Cover and substrate tend to improve going downstream.

07020001-526 is a 27-mile long reach that varies from upstream to down. A photo taken at 15MN099 shows that the adjacent riparian is well vegetated with trees, shrubs, and grass (Figure 70). Moving downstream to bio site 15MN095 there is more incision and bank erosion, as well as less tree cover (Figure 70). The stream at the furthest downstream bio sites, 01MN033 and 15MN021, is a different stream type and has much better morphology and substrate for habitat (Figure 71).

The lack of benthic insectivores, darters, piscivores, and riffle fish indicate habitat may be a stressor to the biological community in reach 07020001-526. However, there is a better than average percent of lithophilic spawners and simple lithophilic spawners. It would appear that habitat is likely having some impact on fish populations and is a stressor in the South Fork Yellow Bank River, especially in the upper sections of the reach. Habitat is less of a stressor in the downstream section.

3.8.5 Dissolved oxygen

DO biological metric data

Table 157. Dissolved oxygen related fish metrics for bio sites 01MN033, 15MN021, 15MN095, and 15MN099

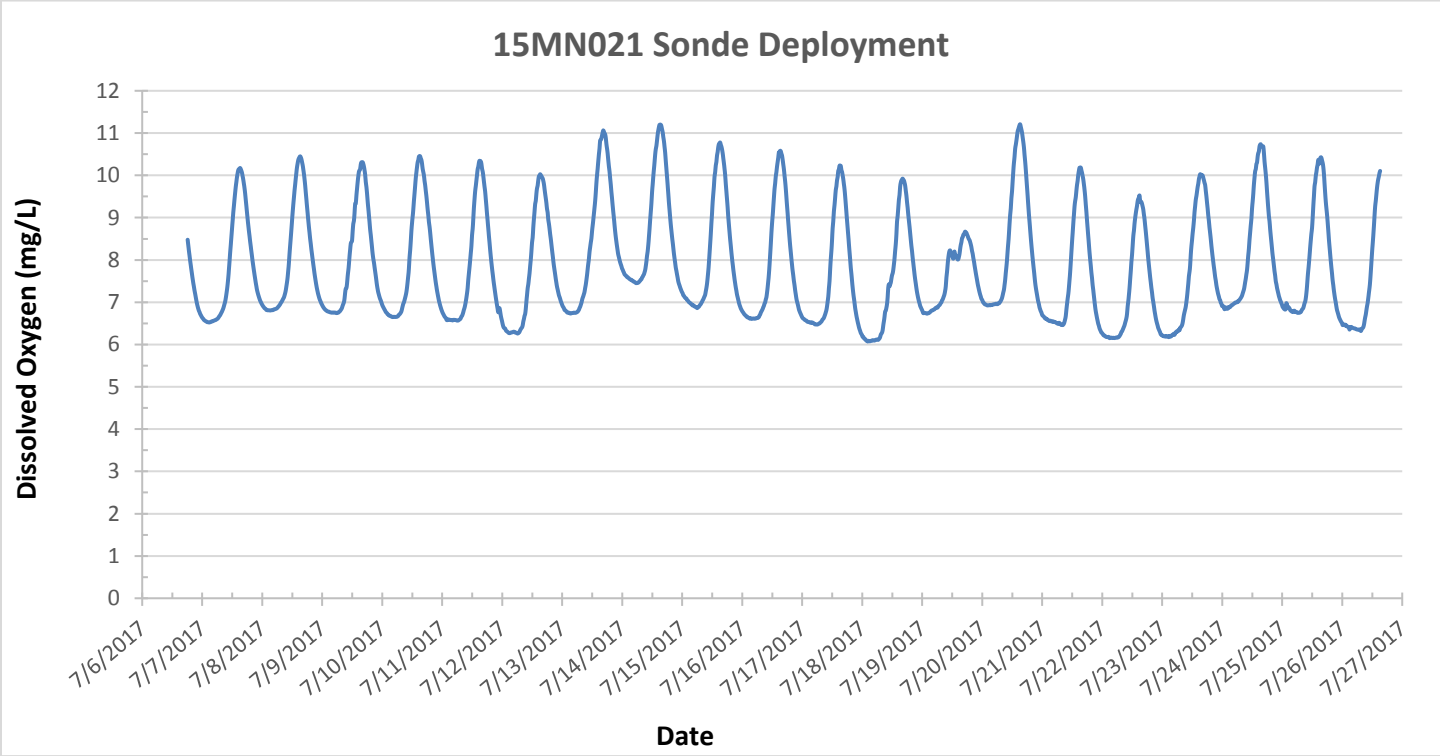
07020001-526 Fish Class 2 General Use		Mature Age >3 %	Serial Spawner %	Taxa Count	DO TIV	DO Sensitive %	DO Tolerant %
15MN099	6/16/2015	15.0	3.8	13.0	7.2	0.0	4.0
15MN095	7/8/2015	10.8	4.0	9.0	7.1	0.0	15.5
01MN033	7/17/2001	3.5	17.5	22.0	7.3	0.0	2.5
15MN021	7/8/2015	7.1	6.7	22.0	7.2	0.0	5.0
Statewide average for Class 2 southern stream bio sites that are meeting the FIBI general use threshold (50.0)		**23.9**	**28.7**	**20.4**	**7.2**	**6.1**	**15.8**
Expected response to DO stress		↓	↑	↓	↓	↓	↑

DO monitoring data

Table 158. Dissolved oxygen monitoring data for chemistry sites S008-476 and S003-090

07020001-526 DO Data	Range of Data (mg/L)	% of Monthly Samples < 5 mg/L [# of Samples]							% of Total Samples < 5 mg/L [# of Samples]
		April	May	June	July	August	Sept	Oct	
S008-476 (2015-2016)	4.5–10.1	N/A [0]	0% [2]	0% [5]	17% [6]	0% [5]	0% [2]	N/A [0]	5% [20]
S003-090 (2002-2016)	5.7–18.2	0% [11]	0% [19]	0% [27]	0% [23]	0% [24]	0% [23]	0% [9]	0% [136]

Figure 71. Dissolved oxygen continuous data at site 15MN021



Dissolved oxygen summary

Dissolved oxygen (DO) related metrics for the two upstream bio sites, 15MN099 and 15MN095, scored similarly to the two downstream bio sites, 01MN033 and 15MN021 with the exception of taxa count in the downstream bio sites scoring above the average of Class 2 southern stream bio sites that meet the FIBI general use threshold (Table 157).

The fish community at bio sites 15MN099 and 15MN095 scored poorly in three out of four DO related fish metrics when compared to the average of all other Class 2 southern stream bio sites that meet the FIBI general use threshold. Although there were species whose females that take more than three years to mature caught at all of the bio sites.

Only one DO measurement taken during sampling from 2015-2016 was below the warmwater standard of 5 mg/L. This was at the upstream chemistry site S008-476. None of the 136 DO measurements taken at the downstream chemistry site S003-090 were below 5 mg/L. A YSI Sonde water meter measured continuous DO data from July 6, 2017 to July 26, 2017. During this deployment, DO values were not measured below the standard of 5 mg/L.

Based on the mixed related biological metric scores, the low percentage of measured values below the standard, as well as the measured values above the standard from the sonde deployment, DO does not appear to be a stressor in the South Fork Yellow Bank River.

3.8.6 Eutrophication

Eutrophication biological metric data

Table 159. Eutrophication related fish metrics at bio sites 15MN099, 15MN095, 01MN033, 15MN021

07020001-526 Fish Class 2 General Use		Darter %	Omnivore %	Sensitive %	Tolerant %
15MN099	6/16/2015	4.0	14.4	3.6	35.1
15MN095	7/8/2015	0.4	13.2	0.0	50.2
01MN033	7/17/2001	10.8	1.8	17.6	17.4
15MN021	7/8/2015	11.7	6.3	13.6	40.1
Statewide average for Class 2 southern stream bio sites that are meeting the FIBI general use threshold (50.0)		**11.7**	**16.5**	**18.7**	**44.9**
Expected response to eutrophication stress		↓	↑	↓	↑

Eutrophication monitoring data

Table 160. Phosphorus monitoring data for chemistry sites S008-476 and S003-090

07020001-526 P Sample Data	Range of Data (mg/L)	Monthly Average of Samples (mg/L) [# of Samples]							June-Aug Average (mg/L) [# of Samples]
		April	May	June	July	August	Sept	Oct	
S008-476 (2015-2016)	0.04–0.14	N/A [0]	0.07 [2]	0.11 [2]	0.11 [3]	0.10 [2]	0.05 [2]	N/A [0]	0.09 [11]
S003-090 (2002-2016)	0.04–0.60	0.11 [9]	0.07 [15]	0.17 [11]	0.27 [10]	0.11 [14]	0.07 [10]	0.07 [6]	0.13 [75]

Eutrophication HSPF model data

Table 161. HSPF model phosphorus data

07020001-526 HSPF Reach 501	**Total Phosphorus**	
	June–September % values > 0.15 mg/l (# Daily Values)	**June–September Multi-year Average**
2,318 Total Daily Averages June–Sep 1994–2012	**38.4%** (889)	**0.16 mg/l**

Eutrophication summary

The eutrophication related fish metrics were mixed within reach 07020001-526. Bio site 15MN021 scored at the average of all other Class 2 southern stream bio sites that meet the FIBI general use threshold. The two upstream bio sites seemed to show more of a negative response than the two downstream reaches (Table 159). Darters were low throughout the reach. Generally, omnivorous fish scored below the average, though they were more prevelant at the two upstream bio sites. Sensitive fish were the opposite with the downstream sites having a higher percentage than the upstream bio sites, though they were all below the class average.

Eleven samples were collected and analyzed for phosphorus from 2015-2016 at chemistry site S008-476. The summer average was 0.09 mg/L, well below the standard of 0.15 mg/L. 75 samples were collected and analyzed for phosphorus from 2002-2016 at chemistry site S003-090. The summer average was 0.13 mg/L, also below the standard of 0.15 mg/L (Table 160). The HSPF model computed the summer average was above the standard at 0.16 mg/L, just above the standard (Table 161).

A YSI Sonde water meter measured continuous DO data from July 6, 2017 to July 27, 2017 (Figure 71). During this deployment, DO diurnal flux, or the difference between the daily high and low DO concentrations was consistently under the eutrophication DO flux standard of 5 mg/L.

Fish metrics related to eutrophication are mixed and low phosphorus concentrations were measured during sampling. The sonde deployment also showed DO flux was low (Figure 71). Eutrophication is not a stressor to the biological community in the South Fork Yellow Bank River.

3.8.7 Suspended solids

Suspended solids biological metric data

Table 162. Suspended solids related fish metrics for bio sites 15MN099, 15MN095, 01MN033, and 15MN021

07020001-526 Fish Class 2 General Use		Benthic Feeder %	Centrarchid-Tolerant %	Herbivore %	Intolerant %	Long-Lived %	Perciformes-Tolerant %	Riffle %	Sensitive %	Simple Lithophilic Spawner %	TSS TIV
15MN099	6/16/2015	20.8	0.0	6.6	0.0	0.0	4.0	18.8	3.6	76.0	14.2
15MN095	7/8/2015	11.6	0.0	13.2	0.0	0.0	0.4	11.2	0.0	60.2	15.8
01MN033	7/17/2001	13.1	1.2	5.8	0.0	1.2	12.0	15.8	17.6	67.2	14.9
15MN021	7/8/2015	22.8	0.4	19.2	0.0	0.4	12.1	26.1	13.6	60.7	15.7
Statewide average for Class 2 Southern Stream stations that are meeting the FIBI general use threshold (50.0)		**37.4**	**5.0**	**9.6**	**5.0**	**11.7**	**18.7**	**32.5**	**18.7**	**39.4**	**17.6**
Expected response to TSS stress		↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

TSS monitoring data

Table 163. Total suspended solids monitoring data for chemistry sites S008-476 and S003-090

07020001-526 TSS Sample Data	Range of Data (mg/L)	% of Monthly Samples > 65 mg/L [# of Samples]							% of Total Samples > 65 mg/L [# of Samples]
		April	May	June	July	August	Sept	Oct	
S008-476 (2015-2016)	4-61	N/A [0]	0% [2]	0% [2]	0% [3]	0% [2]	0% [2]	N/A [0]	0% [11]
S003-090 (2001-2015)	1-120	0% [10]	0% [17]	6% [16]	20% [15]	0% [20]	0% [16]	0% [7]	4% [101]

Suspended solids summary

The suspended solids related fish metrics were mostly poor within reach 07020001-526 (Table 162). Benthic feeders, Centrarchids, riffle, and sensitive fish were all low throughout the reach compared to the average of all other Class 2 southern stream bio sites that meet the FIBI general use threshold. Herbivore metrics were mixed and there were above average simple lithophilic spawning fish throughout the reach.

Eleven samples were collected and analyzed for total suspended solids from 2015-2016 at chemistry site S008-476 (Table 163). None of the samples were above the standard of 65 mg/L. 101 samples were collected and analyzed from 2015-2016 at chemistry site S003-090 with 4% of the samples exceeding 65 mg/L.

Fish metrics related to suspended solids are mixed and low total suspended solid concentrations were measured during sampling. There were enough benthic feeders, herbivores, riffle fish, and simple lithophilic spawning fish to indicate that there is enough course substrate to support the various fish that rely on it. Suspended solids are not a stressor to the biological community in the South Fork Yellow Bank River.

3.8.8 Nitrates

Nitrate biological metric data

Table 164. Nitrate related invertebrate metrics for bio sites 15MN099, 15MN095, 01MN033, and 15MN021

07020001-526 Invert Class 5 General Use		Nitrate Intolerant Taxa %	Nitrogen TIV	Nitrate Tolerant Taxa %	Trichoptera Taxa %
15MN099	6/16/2015	0.3	4.0	85.0	46.5
15MN095	7/8/2015	0	4.4	84.5	13.7
01MN033	9/14/2001	1.9	3.1	48.4	9.3
15MN021	8/5/2015	1.9	3.0	50.9	21.4
Statewide average for Class 5 southern streams rock riffle bio sites that are meeting the MIBI general use threshold (37.0)		**48.1**	**3.0**	**47.6**	**13.6**
Expected response to nitrogen stress		↓	↑	↑	↓

Nitrate monitoring data

Table 165. Nitrate monitoring data for chemistry sites S008-476 and S003-090

07020001-526 Nitrate/Nitrite Sample Data	Range of Data (mg/L)
S008-476 (2015-2016)	0.03 – 0.6
S003-090 (2015-2017)	0.01 – 8.5

Nitrate summary

The macroinvertebrate assemblage at sites 15MN099, 15MN095, and 15MN021 scored poorly in three out of four nitrate related metrics when compared to all other macroinvertebrate Class 5 southern stream rock riffle bio sites that meet the MIBI general use threshold (Table 164). Trichoptera taxa percentage at the three sites that were sampled in 2015 was close to the average, which tend to decrease in streams with excessive nitrate values. Nitrate tolerant invertebrates scored poorly at 76.1%. The nitrogen TIV score also indicates a macroinvertebrate community that is generally tolerant to high levels of nitrates.

Eleven samples were collected at chemistry site S008-476 and 76 samples at S003-090 and analyzed for nitrate/nitrite (Table 165). Only one sample had an elevated nitrate concentration above 8 mg/L, the rest were close to or below

1 mg/L. Although most of the metrics scored poorly, only one chemical sample showed a high concentration. Nitrates are inconclusive as a stressor at this time. Collecting more chemistry data within this reach is recommended in order to determine if nitrates are a stressor to the biological community.

3.8.9 Reach stressors

The main stressor in the South Fork Yellow Bank River, habitat, appears to be limiting the biology of the stream in the upper reach more than the lower. This reach is over 27 miles long and drains more than 200 square miles of land. It varies considerably from the upstream bio site at 15MN099 downstream to bio site 15MN021. In-stream habitat, substrate, and channel morphology appear to be stressing the biology in the upper section of this reach. The downstream section has evidence of down cutting, incision, and stream bank erosion, likely due to hydrologic alteration in the upstream watershed.

Table 166. Summary of stressors in reach 07020001-526

07020001-526	Hydrologic Alteration	Connectivity	Habitat	Dissolved Oxygen	Eutrophication	Suspended Solids	Nitrate
✓= Stressor ×= Not a Stressor **O** = Inconclusive	**O**	**O**	✓	×	×	×	**O**

3.9 07020001-510 North Fork Yellow Bank River

Figure 72. Satellite image of reach 07020001-510 and its watershed

3.9.1 Biological community

Biological metric data

Bio sites 03MN053 and 15MN400 were sampled for fish in June 2003 and in July 2015. Bio site 15MN400 had an IBI score of 43 compared to a threshold of 50 (Table 167). Overall, a large number of fish and 25 different taxa were caught. Out of the 25 fish taxa present, 8 are considered tolerant, 6 very tolerant, 3 sensitive and 8 neither sensitive nor tolerant. Common shiners, central stonerollers, brassy minnows, and white suckers dominated the fish community with over 60% of the total fish population. Stonerollers, brassy minnows, and white suckers are considered tolerant fish. Only 1.5% of the total number of fish caught were a sensitive species. Metrics used to calculate the Fish IBI score are shown in a graph with the red line indicating the value each metric needed to score in order to meet the threshold (Figure 73).

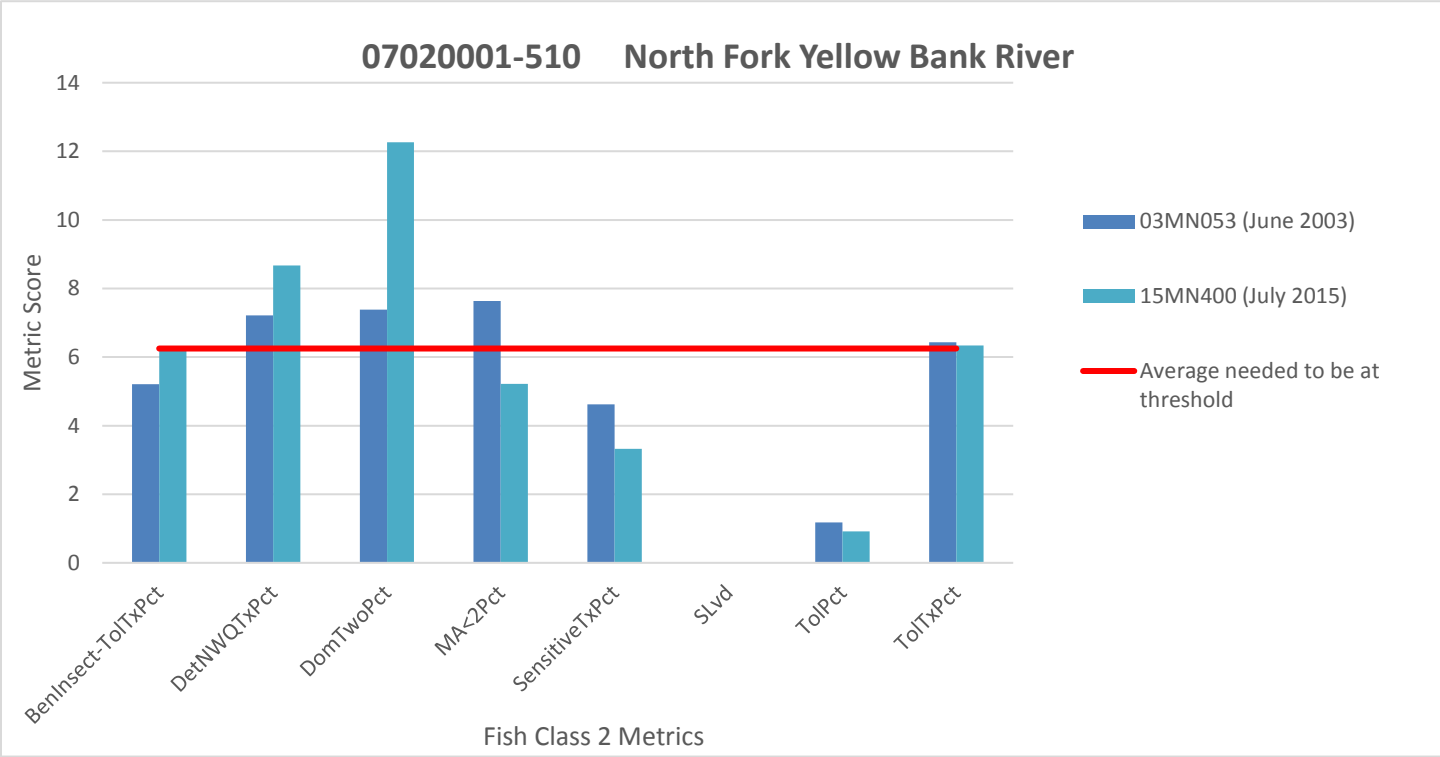
Bio site 15MN400 was not listed as impaired for invertebrates. It was sampled in August 2015 and scored a 38.2, just over the invert Class 5 threshold of 37.

Biological fish metric data

Table 167. Fish IBI score and threshold for bio sites 03MN053, 15MN400

07020001-510 Fish Class 2 General Use		Fish IBI Score	Class Threshold Score
03MN053	6/25/2003	39.7	50
15MN400	7/8/2015	43.0	50

Figure 73. Fish Class 2 general use metric scores for bio sites 03MN053, 15MN400



3.9.2 Hydrologic alteration

Hydrologic alteration biological metric data

Table 168. Hydrologic alteration related fish metrics for bio sites 03MN053 and 15MN400

07020001-510 **Fish Class 2** **General Use**		General %	Nesting Non Lithophilic Spawner %
03MN053	6/25/2003	24.2	10.9
15MN400	7/8/2015	50.3	9.1
Statewide average for Class 2 southern stream bio sites that are meeting the FIBI general use threshold (50.0)		**42.4**	**19.1**
Expected response to **Hydrologic** stress		↑	↑

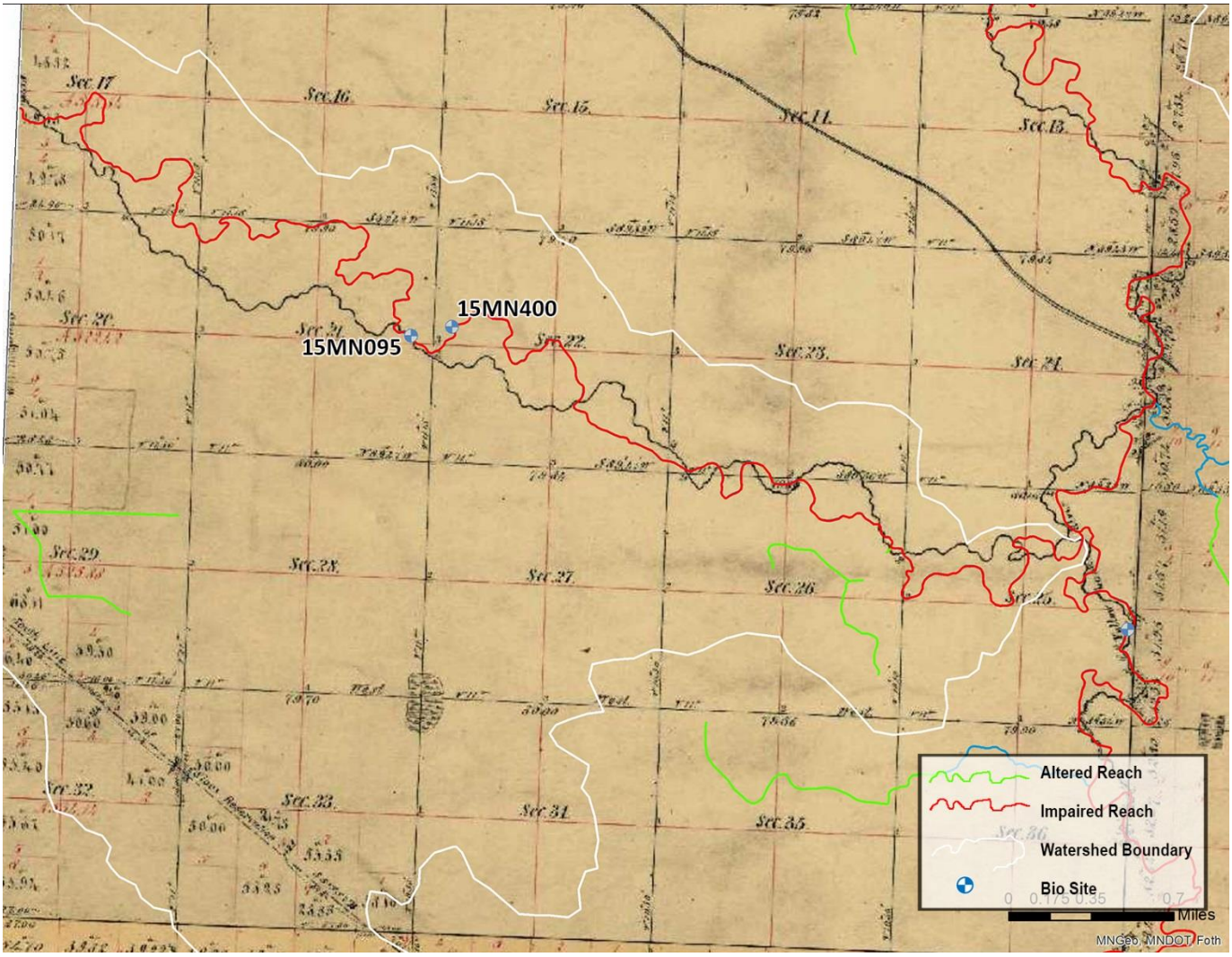
HSPF model flow data

Table 169. HSPF modeled flow data, 1994-2012

07020001-510 HSPF Reach 600 Min: 0.2 cfs Max: 2433.4 cfs	**<5 cfs %** (# of values)	**<1 cfs %** (# of values)	**<0.5 cfs %** (# of values)
6,940 Total Daily Averages 1994 – 2012	**29.9%** (2,074)	**4.3%** (298)	**0.9%** (62)

Figure 74. Photo showing severe bank erosion (left) and instream photo upstream of bio site 15MN400 showing deep incision of the stream channel

Figure 75. Original survey plat map of the watershed of reach 07020001-510 including altered watercourses



Hydrologic alteration summary

Only one out of two fish biological metrics related to Hydrologic Alteration at bio site 15MN400 scored poorly when compared to the average of Fish Class 2 southern stream bio sites that meet the IBI general use threshold (Table 168). General fish percentage was just above the class average and nesting fish were low. Bio site 03MN053 was sampled in 2003 and scored well in both metrics.

The HSPF model (Table 169) shows that 4.3% of the daily average flows from 1994 – 2012 are below 1 cfs. Flows of less than 5 cfs were higher at 29.9%. Flows reduced beyond normal base flow decreases habitat for aquatic organisms and increases competition for resources.

Severe bank erosion was documented during habitat assessments and the river has been deeply incised, likely adjusting to increased high flows after precipitation events.

This reach was identified in the original plat information (Figure 75). Most of the watershed of this reach is in South Dakota. Several of its tributaries have been channelized and a large portion of its watershed appears to have been drained and cultivated.

According to the Minnesota Headwaters Watershed Report (DNR, 2019), this reach has a bank height ratio of 3.1 and a entrenchment ratio of 1.51, which indicates this reach is deeply incised and moderately entrenched. This severely limits the streams ability to access its flood plain during high flow events and can cause stream bank erosion and high velocities in the stream.

The biological metrics were mixed and impacts to this reach from hydrologic alteration appear to be from high, rather than low flows. Due to the observed stream bank erosion and deep channel incision, hydrologic alteration is a stressor to the biology in the North Branch Yellow Bank River.

3.9.3 Connectivity

Connectivity metric data

Table 170. Connectivity related fish metrics for bio sites 03MN053 and 15MN400

07020001-510 **North Fork Yellow Bank River** **Fish Class 2** **General Use**		Mature Age >3 minus Tolerant Taxa %	Migrating Taxa %
03MN053	6/25/2003	11.1	27.8
15MN400	7/8/2015	12.0	20.0
Statewide average for Class 2 southern stream bio sites that are meeting the FIBI general use threshold (50.0)		**21.8**	**24.3**
Expected response to connectivity stress		↓	↓

Connectivity summary

Bio site 15MN400 scored poorly in both connectivity related metrics compared to the average of Fish Class 2 southern stream bio sites that meet the IBI general use threshold (Table 170). No downstream road crossings were identified as fish barriers and most of the road crossings along this reach have a large bridge across them that does not appear to be affecting fish migration. Due to the presence of long-lived and migratory species, it appears that connectivity is not a stressor at this time.

3.9.4 Habitat

Habitat metric data

Table 171. Habitat related fish metrics for bio sites 03MN053 and 15MN400

07020001-510 Fish Class 2 General Use	Benthic Insect minus Tolerant %	Darter Sculpin Sucker %	Lithophilic Spawner %	Pioneer %	Piscivore %	Riffle %	Simple Lithophilic Spawner %	Tolerant %
03MN053 6/25/2003	6.2	6.2	77.5	18.3	0.3	54.6	16.4	70.6
15MN400 7/8/2015	3.5	3.5	67.1	17.4	0.1	32.7	39.9	71.6
Statewide average for Class 2 southern stream bio sites that are meeting the FIBI general use threshold (50.0)	**20.4**	**18.2**	**58.3**	**19.0**	**5.2**	**32.5**	**39.4**	**44.9**
Expected response to habitat stress	↓	↓	↓	↑	↓	↓	↓	↑

MPCA stream habitat assessment score

Table 172. Habitat assessment score for bio sites 03MN053 and 15MN400

07020001-510	Land Use	Riparian	Substrate	Cover	Channel Morphology	Total Score
03MN053 6/25/2003	0	8.5	18.3	13	33	72.8
15MN400 7/8/2015	0	8	12.4	16	23	59.4
15MN400 8/5/2015	0	6	9.3	14	11	40.3
Maximum Attainable Habitat Score	**5**	**14**	**28**	**18**	**35**	**100**

Figure 76. Photos of reach 07020001-510 at bio site 15MN400 showing gravel substrate on stream bottom (left) and stream morphology showing some pools and riffles (right)

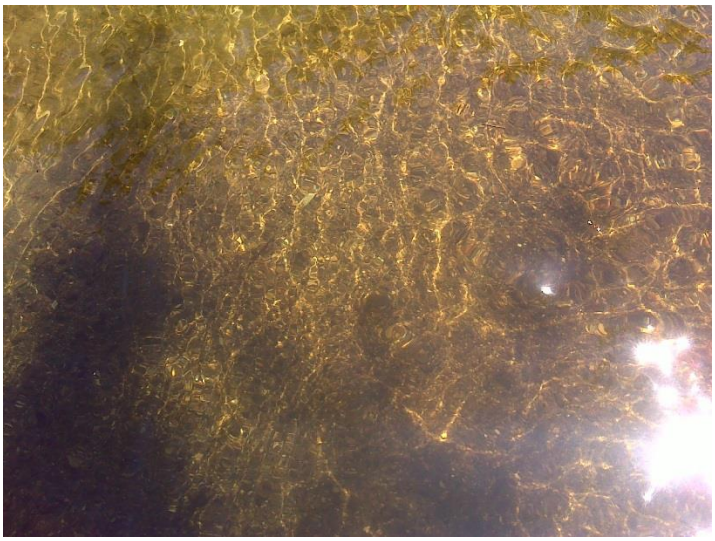


Figure 77. Photos of reach 07020001-510 at bio site 03MN053 shows diverse habitat for both fish and invertebrates

Habitat summary

The fish community at bio site 15MN400 scored below average in only four out of eight habitat related fish metrics when compared to all other Class 2 southern stream bio sites that met the FIBI general use threshold (Table 171). Benthic insectivores minus tolerant taxa, Darter/sculpin/sucker, and tolerant metrics scored very poorly. Pioneer and tolerant species were both high and no piscivores were caught. There were a decent amount of lithophilic spawning fish and even though the majority were tolerant taxa, there were two sensitive lithophilic spawning species that were caught in decent numbers.

The MSHA habitat assessments were fair with 59.4 out of 100 in July of 2015 and poor with 40.3 out of 100 in August of 2015. Bio site 03MN053 scored markedly better with 72.8 out of 100 back in June of 2003 (Table 172). Substrate and channel morphology brought the score down in August, though the water levels were lower which had an effect on the channel morphology score. Embeddedness from silt deposition was also worse in August, likely from deposition of silt.

Photos of reach 07020001-510 shows a natural channel with a variety of habitat. (Figure 76) (Figure 77). There were a several types and sizes of substrate observed at the bio site. Along with riffles and gravel there was woody debris and riffle, run, pool, and glide sequences that provide good habitat for both fish and invertebrates.

The lack of benthic insectivores, darters, and piscivores indicate habitat may be a stressor too. However, there is a better than average percent of lithophilic spawning fish, including a high number of central stonerollers, and decent numbers of carmine shiners and hornyhead chubs. It would appear that habitat is inconclusive as a stressor to the biological fish community in reach 07020001-510.

3.9.5 Dissolved oxygen

DO biological metric data

Table 173. Dissolved oxygen related fish metrics for bio sites 03MN053 and 15MN400

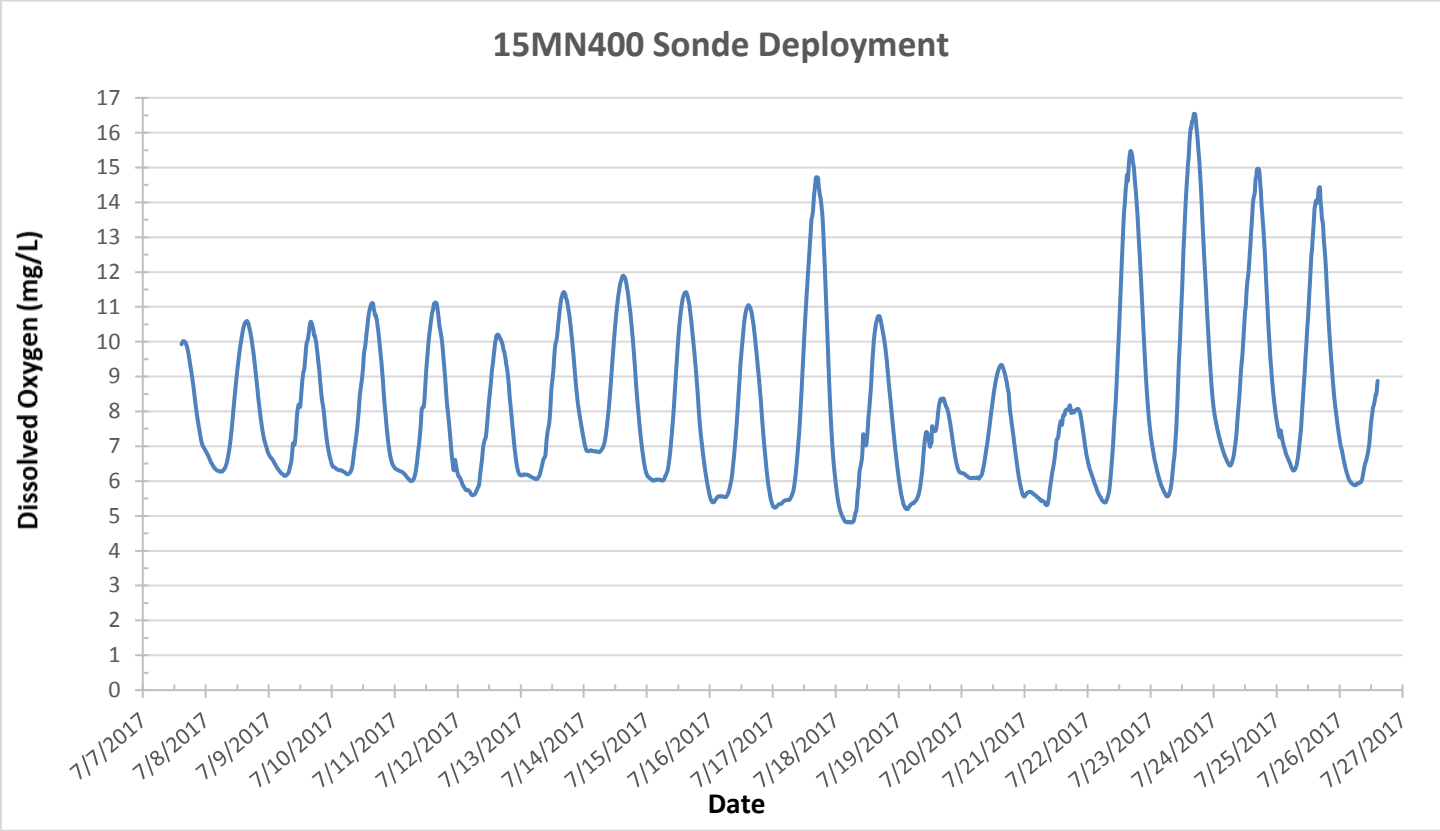
07020001-510		Land Use	Riparian	Substrate	Cover	Channel Morphology	Total Score
03MN053	6/25/2003	0	8.5	18.3	13	33	72.8
15MN400	7/8/2015	0	8	12.4	16	23	59.4
15MN400	8/5/2015	0	6	9.3	14	11	40.3
Maximum Attainable Habitat Score		**5**	**14**	**28**	**18**	**35**	**100**

DO monitoring data

Table 174. Dissolved oxygen data from chemistry sites S000-158, S003-083, and S013-209

07020001-510 DO Data	Range of Data (mg/L)	% of Monthly Samples < 5 mg/L [# of Samples]							% of Total Samples < 5 mg/L [# of Samples]
		April	May	June	July	August	Sept	Oct	
S000-158 (2015-2016)	3.7 – 16.0	N/A [0]	0% [2]	20% [5]	0% [6]	20% [5]	0% [2]	N/A [0]	10% [20]
S003-083 (2002)	3.6 – 12.2	0% [3]	0% [5]	0% [4]	100% [2]	66% [6]	50% [2]	0% [1]	30% [23]
S013-209 (2015-2017)	8.6 – 10.0	N/A [0]	N/A [0]	N/A [0]	0% [3]	0% [1]	N/A [0]	N/A [0]	0% [4]

Figure 78. Dissolved oxygen continuous data at bio site 15MN400



Dissolved oxygen summary

The fish community at bio site 15MN400 scored poorly in two out of four DO related fish metrics when compared to the average of all other Class 2 southern stream bio sites that meet the FIBI general use threshold (Table 173). The fish community was dominated by species whose females take less than two years to mature. Only 11 individual fish from three species whose females take more than three years to mature were caught. Overall taxa count was high at 25, though six are considered very tolerant and eight taxa tolerant. No species that are sensitive to low DO were present.

8.3% out of 24 DO measurements at chemistry sites S000-158 and S013-209 taken during sampling from 2015-2016 were below the warmwater standard of 5 mg/L (Table 174). DO data from S003-083 taken in 2002 was worse with 30% out of 23 samples below the standard. A YSI Sonde water meter measured continuous DO data from July 7 2017 to July 26 2017. During this deployment, DO values were measured below the standard of 5 mg/L just once as it dipped just below 5 mg/L on the morning of July 18 2017 (Figure 78), while eight other values were below 6 mg/L.

Based on the mixed biological metric scores, a low percentage of recently measured values below the standard, as well as most of the measured values from the sonde deployment falling above the standard, DO is inconclusive as a stressor in this reach.

3.9.6 Eutrophication

Eutrophication biological metric data

Table 175. Eutrophication related fish metrics for bio sites 03MN053 and 15MN400

07020001-510 **Fish Class 2** **General Use**	Darter %	Omnivore %	Sensitive %	Tolerant %
03MN053 6/25/2003	6.1	2.1	11.0	70.6
15MN400 7/8/2015	2.9	20.9	6.1	71.6
Statewide average for Class 2 southern stream bio sites that are meeting the FIBI general use threshold (50.0)	**11.7**	**16.5**	**18.7**	**44.9**
Expected response to eutrophication stress	↓	↑	↓	↑

Eutrophication monitoring data

Table 176. Phosphorus monitoring data for chemistry sites S000-158, S003-083, and S013-209

07020001-510 P Sample Data	Range of Data (mg/L)	Monthly Average of Samples (mg/L) [# of Samples]							June-Aug Average (mg/L) [# of Samples]
		April	May	June	July	August	Sept	Oct	
S000-158 (2015)	0.07 – 0.31	N/A [0]	0.12 [2]	0.14 [2]	0.21 [3]	0.26 [2]	0.14 [2]	N/A [0]	0.21 [11]
S003-083 (2001-2003)	0.04 – 0.56	0.10 [6]	0.05 [8]	0.21 [12]	0.15 [5]	0.13 [13]	0.08 [9]	0.06 [3]	0.17 [30]
S013-209 (2017)	0.38	N/A [0]	N/A [0]	N/A [0]	0.38 [1]	0.38 [1]	N/A [0]	N/A [0]	0.38 [2]

Eutrophication HSPF model data

Table 177. HSPF model phosphorus data

07020001-510 HSPF Reach 600	**Total Phosphorus**	
	June – September **% values > 0.15 mg/l** (# Daily Values)	**June – September** **Multi-year Average**
2,318 Total Daily Averages *June – Sep 1994 – 2012*	**34.4%** (797)	**0.15 mg/l**

Eutrophication summary

The fish community at bio site 15MN400 scored poorly in all four eutrophication related fish metrics when compared to the average of all other Class 2 southern stream bio sites that meet the FIBI general use threshold (Table 175). Only a few Johnny Darters, a tolerant fish, were caught. Omnivorous fish comprised only 20.9% of the fish population, just over the average of 16.5%. There were no sensitive taxa and tolerant fish comprised over 71% of the population.

Eleven samples were collected and analyzed for Phosphorus from chemistry site S000-158 in 2015. The summer average was 0.21 mg/L, above the standard of 0.15 mg/L (Table 176). The two samples taken in 2017 at bio site S013-209 were also high at 0.38 mg/L.

The HSPF model computed the summer average was at the standard of 0.15 mg/L (Table 177).

A YSI Sonde water meter measured continuous DO data from July 7 2017 to July 26 2017 (Figure 78). During this deployment, DO diurnal flux, or the difference between the daily high and low DO concentrations was consistently over 5 mg/L, well above the eutrophication DO flux standard of 5 mg/L.

High levels of phosphorus were measured during sampling, the fish community seems to be showing the effects of eutrophication, and high levels of DO flux were measured. Eutrophication is a stressor to the biological community in reach 07020001-510.

3.9.7 Suspended solids

Suspended solids biological metric data

Table 178. Suspended solids related fish metrics for bio sites 03MN053 and 15MN400

07020001-510 Fish Class 2 General Use	Benthic Feeder %	Centrarchid-Tolerant %	Herbivore %	Intolerant %	Long-Lived %	Perciformes-Tolerant %	Riffle %	Sensitive %	Simple Lithophilic Spawner %	TSS TIV
03MN053 6/25/2003	52.3	0.3	46.1	0.0	0.0	6.4	54.6	11.0	16.4	18.5
15MN400 7/8/2015	31.7	0.1	29.7	0.0	0.3	2.9	32.7	6.1	39.9	18.6
Statewide average for Class 2 Southern Stream s stations that are meeting the FIBI general use threshold (50.0)	**37.4**	**4.9**	**9.6**	**5.0**	**11.7**	**18.7**	**32.5**	**18.6**	**39.4**	**17.6**
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

TSS monitoring data

Table 179. Total suspended solids monitoring data for chemistry sites S000-158 and S003-083

07020001-510 TSS Sample Data	Range of Data (mg/L)	% of Monthly Samples > 65 mg/L [# of Samples]							% of Total Samples > 65 mg/L [# of Samples]
		April	May	June	July	August	Sept	Oct	
S000-158 (2015)	2-36	N/A [0]	0% [2]	0% [2]	0% [3]	0% [2]	0% [2]	N/A [0]	4% [11]
S003-083 (2001-2003)	4-160	0% [6]	0% [8]	25% [12]	0% [5]	0% [13]	0% [9]	0% [3]	5.4% [56]

Transparency Tube Monitoring Data

Table 180. Transparency tube monitoring data for chemistry sites S000-158 and S003-083

07020001-510 Transparency Data	Range of Data (cm)	% of Monthly Samples > 10 cm [# of Samples]							% of Total Samples > 10 cm [# of Samples]
		April	May	June	July	August	Sept	Oct	
S000-158 (2002-2018)	4->100	0% [8]	0% [27]	10% [39]	6.3% [32]	0% [31]	0% [23]	0% [10]	3.5% [170]
S003-083 (2002-2018)	9.2->60	0% [6]	0% [9]	10% [10]	0% [5]	0% [10]	0% [9]	0% [3]	1.9% [52]

Suspended solids summary

The fish community at bio site 15MN400 scored below average in seven out of ten suspended solids related fish metrics when compared to the average of all other Class 2 southern stream bio sites that meet the FIBI general use threshold (Table 178). Benthic feeders, Centrarchids, intolerant species, long-lived species, perciformes, and sensitive species all scored poorly. The percentage of herbivores, riffle fish, and simple lithophilic spawners all scored above the class averages although those numbers were mostly from tolerant taxa.

Eleven samples were collected from bio site S000-158 and analyzed for total suspended solids in 2015 (Table 179). No samples had a total suspended solid concentration above 65 mg/L. Older data at bio site S003-083 had a few exceedances in June. There is a robust Transparency Tube data set from 2002-2018 (Table 180) all showing some exceedances in June as well but overall TSS and transparency data area all meeting water quality standards.

Right now suspended solids do not appear to be a stressor to aquatic life in reach 07020001-510.

3.9.8 Nitrates

Nitrate biological metric data

Table 181. Nitrate related invertebrate metrics for bio sites 15MN400

07020001-510 **Invert Class 5** **General Use**	Nitrate Intolerant Taxa %	Nitrogen TIV	Nitrate Tolerant Taxa %	Trichoptera Taxa %
15MN400 8/5/2015	0.6	3.4	67.5	14.0
Statewide average for Class 5 southern streams rock riffle bio sites that are meeting the MIBI general use threshold (37.0)	**2.91**	**3.0**	**47.6**	**13.6**
Expected response to nitrogen stress	↓	↑	↑	↓

Nitrate monitoring data

Table 182. Nitrate monitoring data for chemistry sites S000-158 and S003-083

07020001-510 Nitrate/Nitrite Sample Data	Range of Data (mg/L)
S000-158 (2015-2017)	0.01 – 4.7
S003-083 (2001-2003)	0.04 – 4.1

Nitrate summary

The macroinvertebrate assemblage at sites 15MN400 scored poorly in three out of four nitrate related metrics when compared to all other macroinvertebrate Class 5 southern stream rock riffle bio sites that meet the MIBI general use threshold (Table 181). Trichoptera taxa percentage was the only metric to score above the average, which tend to decrease in streams with excessive nitrate values. However, the dominant Trichoptera taxa, Cheumatopsyche, is a tolerant species. Nitrate tolerant invertebrates scored poorly at 67.5%. The nitrogen TIV score also indicates a macroinvertebrate community that is generally tolerant to high levels of nitrates.

Sixty-eight samples were collected at chemistry sites S000-158 and S003-083 and analyzed for nitrate/nitrite (Table 182). No samples had nitrate concentrations above 4.9 mg/L. Nitrates do not appear to be a stressor at this time.

3.9.9 Reach stressors

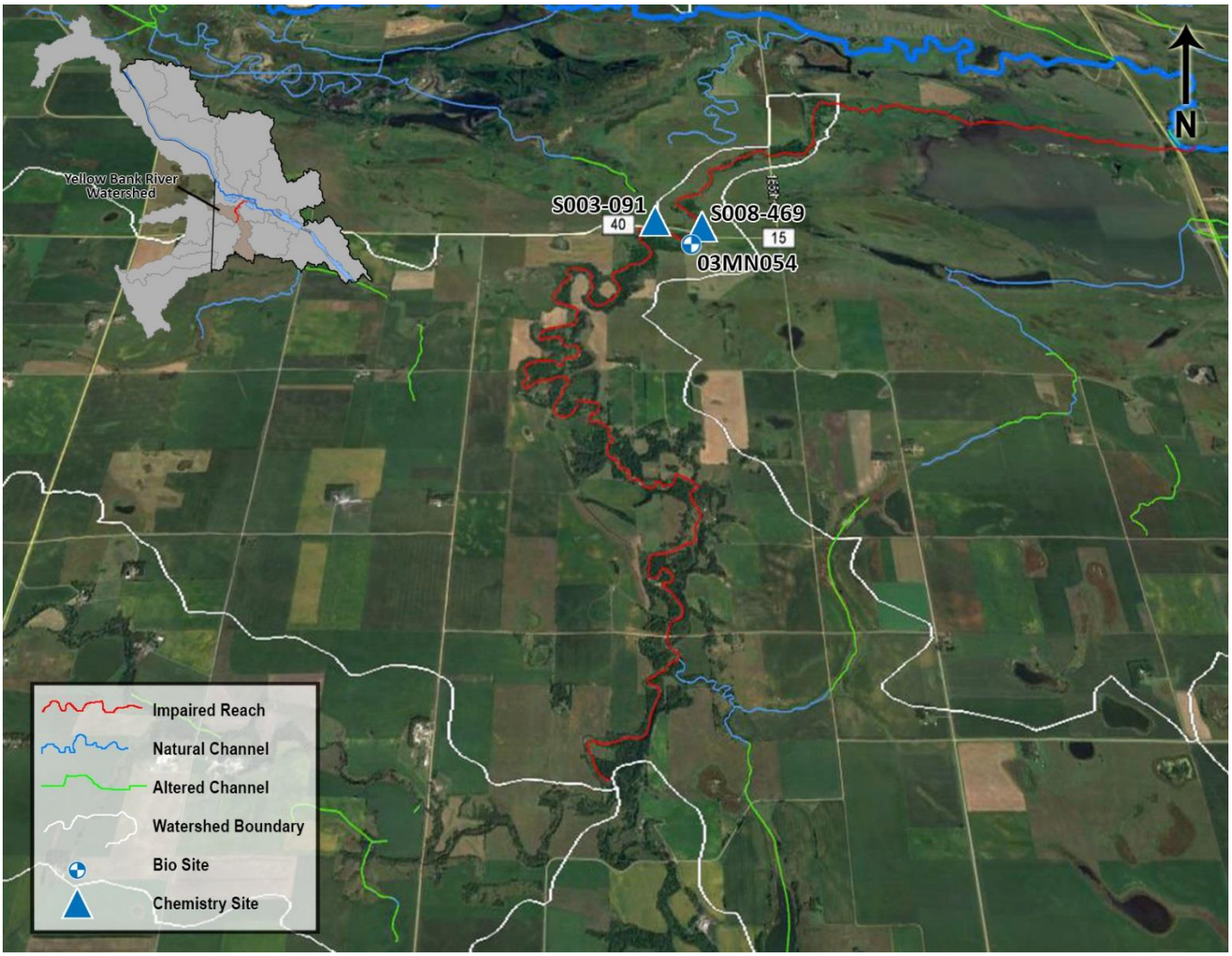
The main stressor in the North Fork Yellow Bank River, habitat, appears to be limiting the biology of the stream in the upper reach more than the lower. This reach drains more than 200 square miles of land. In-stream habitat, substrate, and channel morphology appear to be stressing the biology in the upper section of this reach. The downstream section has evidence of down cutting, incision, and stream bank erosion, likely due to hydrologic alteration upstream.

Table 183. Summary of stressors in reach 07020001-526

07020001-510	Hydrologic Alteration	Connectivity	Habitat	Dissolved Oxygen	Eutrophication	Suspended Solids	Nitrate
✓= Stressor ×= Not a Stressor **O** = Inconclusive	✓	×	**O**	**O**	✓	×	×

3.10 07020001-525 Yellow Bank River

Figure 79. Satellite image of reach 07020001-525 and its watershed



3.10.1 Biological community

Bio site 03MN054 was sampled for fish in June 2003 and twice in July 2015 and scored a 46.8 and 47.2 respectively, just under the Fish Class 1 threshold of 49 (Table 184). On July 27, 2015 an in season repeat fish sampling visit was done with a result of 20.5. Metrics used to calculate the Fish IBI score are shown in a graph with the red line indicating the value each metric needed to score in order to meet the threshold (Figure 80). Common shiners, brassy minnows, and white suckers dominated the fish community in all of the visits. Brassy minnows and white suckers are considered tolerant fish. The fish community had several sensitive taxa represented with 224 individuals from those sensitive taxa caught in 2003. The July 7, 2015 visit actually had a few more sensitive species but in far fewer numbers with only 28 individual considered sensitive fish. The July 27, 2015 visit had a lot less fish overall, had less sensitive species, and a lot less numbers of those sensitive species with only 19 individual fish considered sensitive.

Bio site 03MN054 was sampled for invertebrates in August and September of 2003 and scored a 35.5 and 39.8 respectively, compared to the Invert Class 5 threshold of 37. It was sampled in August 2015 and scored a 34.1 (Table 185).

Metrics used to calculate the Invert IBI score are shown in a graph with the red line indicating the value each metric needed to score in order to meet the threshold (Figure 81).

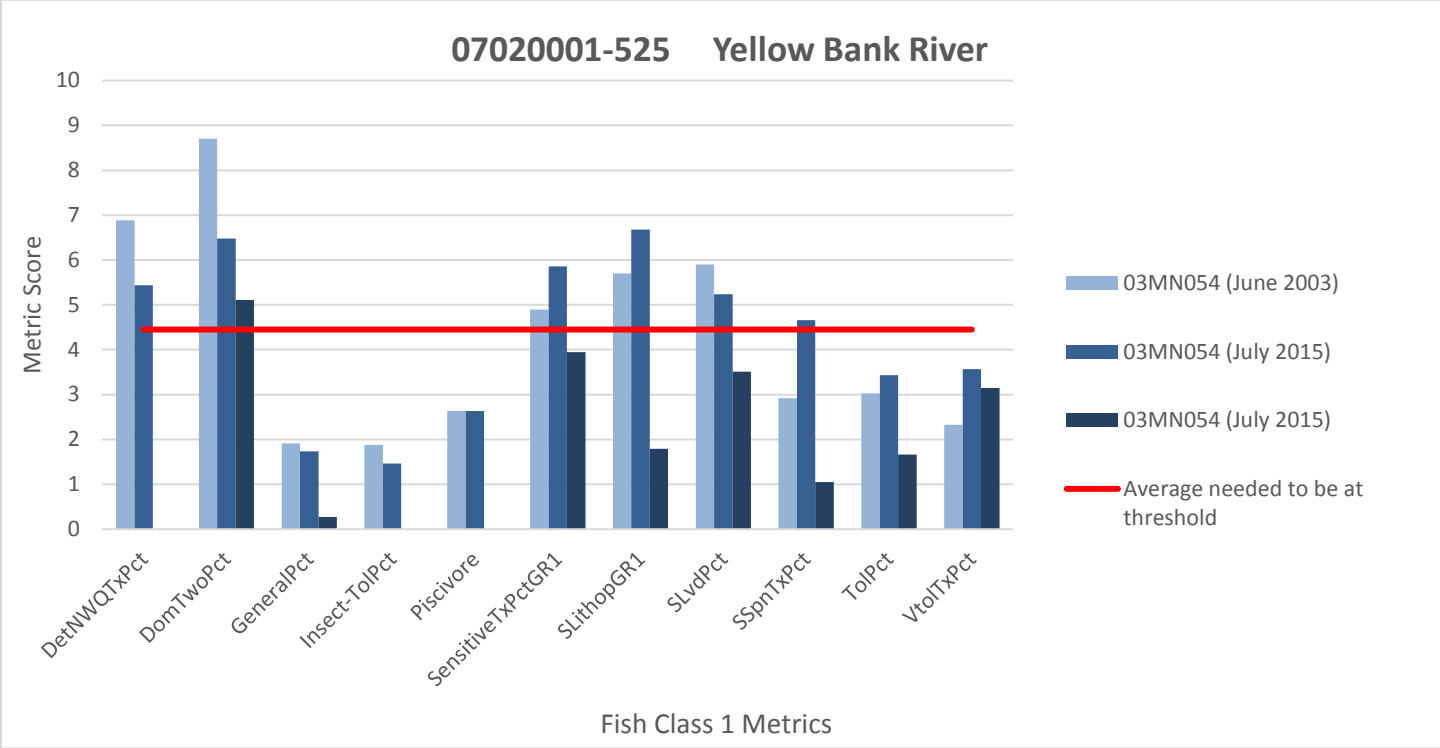
Although a fair number of caddisflies and mayflies were found, only one of the species of caddisfly is considered sensitive and only a single individual was observed. The midge Polypedilum, comprising over 35% of the total number of invertebrates caught, dominated the invertebrate community.

Fish biological metric data

Table 184. Fish IBI score and threshold for bio sites 03MN053, 15MN400

07020001-525 **Fish Class 1** **General Use**		Fish IBI Score	Class Threshold Score
03MN054	6/24/2003	46.8	49
03MN054	7/7/2015	47.2	
03MN054	7/27/2015	20.5	

Figure 80. Fish Class 1 general use metric scores for bio site 03MN054

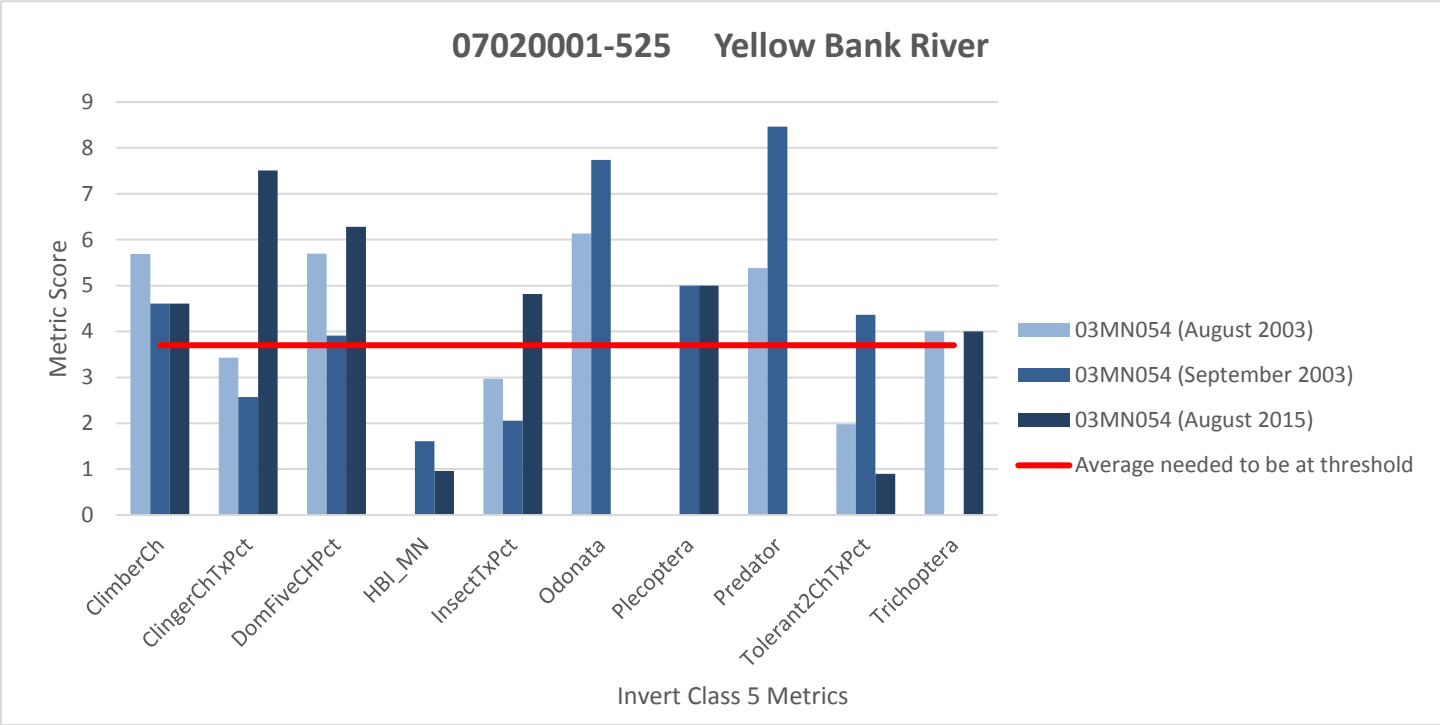


Invertebrate biological metric data

Table 185. Invertebrate IBI scores and threshold for bio site 03MN054

07020001-525 **Invert Class 5** **General Use**		Invert IBI Score	Class Threshold Score
03MN054	8/19/2003	35.3	
03MN054	9/9/2003	39.8	37
03MN054	8/6/2015	34.1	

Figure 81. Invert Class 5 general use metric scores for bio site 03MN054



3.10.2 Hydrologic alteration

Hydrologic alteration biological metric data

Table 186. Hydrologic alteration related fish metrics for bio site 03MN054

07020001-510 Fish Class 1 General Use		General %	Nesting Non Lithophilic Spawner %
03MN054	6/24/2003	52.3	14.5
03MN054	7/7/2015	53.4	10.2
03MN054	7/27/2015	63.0	7.63
Statewide average for Class 1 Southern River bio sites that are meeting the FIBI general use threshold (49.0)		**20.7**	**16.0**
Expected response to **Hydrologic** stress		↑	↑

Table 187. Hydrologic alteration related invertebrate metrics

07020001-525 **Invert Class 5** **General Use**		Clinger %	Collector-Filterer %	Long-Lived %
03MN054	8/19/2003	17.1	7.9	3.9
03MN054	9/9/2003	20.2	6.2	9.8
03MN054	8/6/2015	48.9	30.2	4.2
Statewide average for Class 5 southern streams rock riffle bio sites that are meeting the MIBI general use threshold (37.0)		**49.5**	**26.9**	**9.0**
Expected response to **Hydrologic** stress		↓	↓	↓

HSPF model flow data

Table 188. HSPF modeled flow data, 1994-2012

07020001-525 HSPF Reach 500 Min: 0.4 cfs Max: 4,442.7 cfs	**<5 cfs %** (# of values)	**<1 cfs %** (# of values)	**<0.5 cfs %** (# of values)
6,940 Total Daily Averages *1994 – 2012*	**15.2%** (1,052)	**1.2%** (80)	**0.1%** (8)

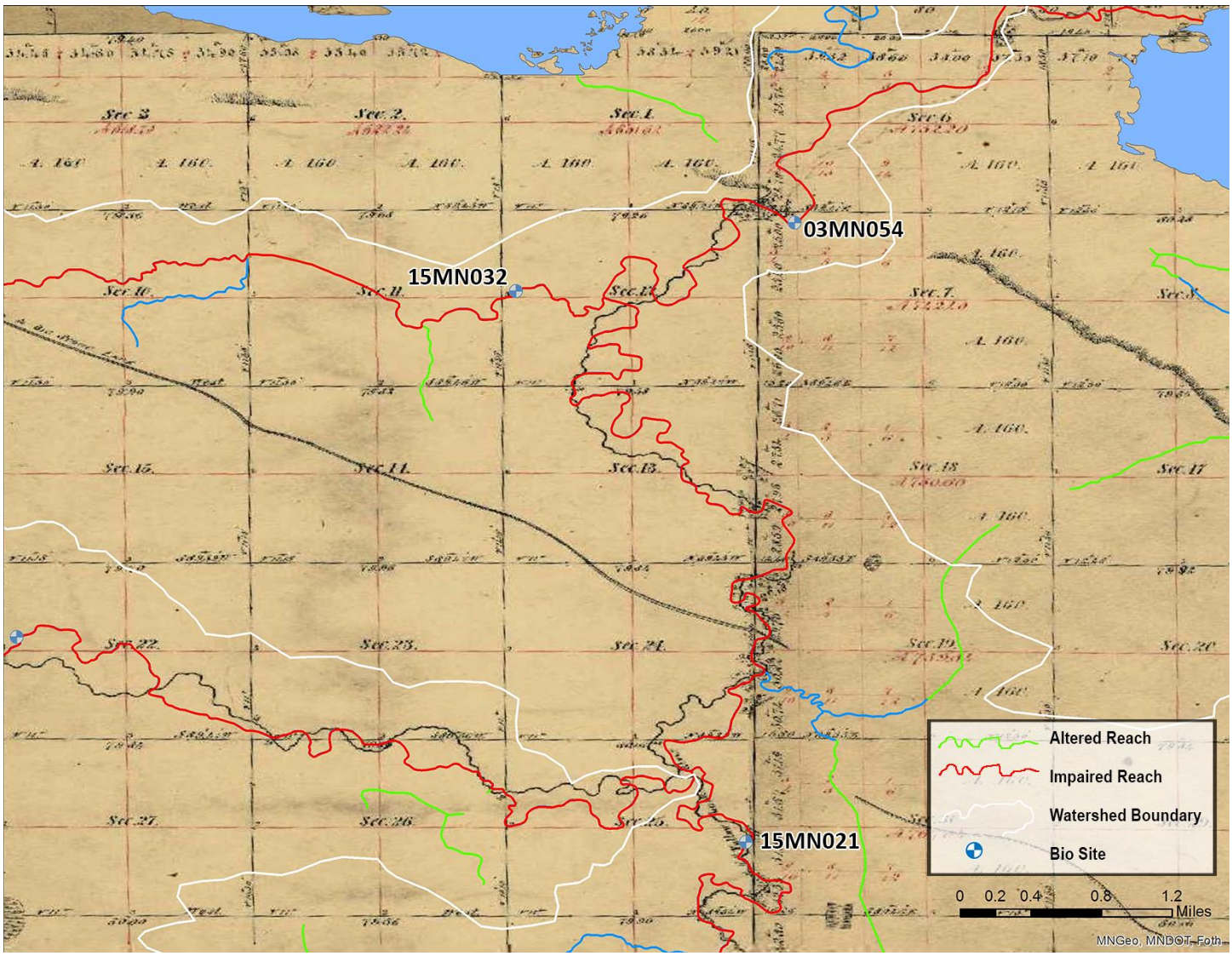
Hydrologic alteration summary

The hydrologic alteration related fish biological metrics were mixed when compared to the Fish Class 1 Southern River bio sites that meet the IBI general use threshold (Table 186). The bio site was sampled twice in 2015 and once in 2003. The bio site was dominated by common shiners, brassy minnows, and white suckers. Bio site 03MN054 had generalist fish population of 53.4% and 63%, well above the class average. The percentage of nesting fish was low as most of the fish caught, with the exception of the carmine shiner, are tolerant lithophilic spawners.

Looking at the only bio site visit from 2015 four out of five invertebrate metrics scored poorly when compared to the average of Invert Class 5 general use streams that met the IBI threshold (Table 187). Clingers were just below and filterers were just above the class average. Long lived scored poorly. There were no taxa that are flow intolerant. The percentage of flow tolerant taxa was 66%.

The HSPF model (Table 35) shows that only 1.2% of the daily average flows from 1994 – 2012 are below 1 cfs.

Figure 82. Original survey plat map of the watershed of reach 07020001-525 including altered watercourses



Reach 07020001-525 is the small, furthest downstream section of the Yellow Bank River after both the north and south converge into the main channel (Figure 82). The reach itself is mostly natural although its watershed has been extensively altered, channelized and ditched. Creating these ditches essentially added to the amount of land and water that drains into the creek and the timing of water runoff. This altered the natural flow regime of this stream that had developed over several millenniums by decreasing the time it takes for water to move through the system, moving more water through the system at a higher frequency. This can both increase the impact to the stream channel from high flow events while also increasing the intensity of low flow periods.

The Minnesota River – Headwaters Watershed Characteristic Report classified reach 07020001-525 as a C4c- (DNR, 2019). The C4c- stream type is very similar to the previously described C5c- stream type; however, instead of being a sand dominated stream, the C4c- stream type has a gravel dominated streambed (Rosgen 1996). Overall, C4c- streams have a very high sensitivity to disturbance, good recovery potential, high sediment supply, very high stream bank erosion potential where riparian vegetative influence is very high (Rosgen 1994). The bank height ratio was calculated as deeply incised at 1.53. Though the channel is deeply incised, the channel currently maintains the capacity to access its floodplain over its left bank. The entrenchment ratio was measured to be 2.21 identifying that the channel is only slightly

entrenched. However, as little as three quarters of a foot of additional incision will begin to dramatically reduced the entrenchment ratio thus indicating a reduction in floodplain access. (DNR, 2019).

Based on the mixed the fish and the mostly poor invertebrate biological metrics, very few low flow periods shown in the HSPF model, as well as historic surveying data, Hydrologic Alteration, especially in the form of high flows, is a stressor in the Yellow Bank River.

3.10.3 Connectivity

Connectivity metric data

Table 189. Connectivity related fish metrics for bio site 03MN054

07020001-525 **Fish Class 1** **General Use**		Mature Age >3 minus Tolerant Taxa %	Migrating Taxa %
03MN054	6/24/2003	21.7	30.4
03MN054	7/7/2015	22.2	37.0
03MN054	7/27/2015	11.8	29.4
Statewide average for Class 1 Southern Rivers bio sites that are meeting the FIBI general use threshold (49.0)		**41.5**	**30.7**
Expected response to connectivity stress		↓	↓

Connectivity summary

Fish whose females take greater than three years to mature were well below the average of bio sites that met the Class 1 Southern River threshold (Table 189). Migrating taxa were just below the class average and consisted of white suckers, a fair amount of central stonerollers, and a few darter species. Although no downstream culverts or road crossings were identified as fish barriers, there is an impoundment of the Minnesota River just upstream of Marsh Lake. Due to the fact that species that reproduce at a mature age can be affected by other stressors and migratory species are close to the class average, it appears that connectivity is inconclusive at this time.

3.10.4 Habitat

Habitat metric data

Table 190. Habitat related fish metrics for bio site 03MN054

07020001-525 **Fish Class 1** **General Use**	Benthic Insect minus Tolerant %	Darter Sculpin Sucker %	Lithophilic Spawner %	Pioneer %	Piscivore %	Riffle %	Simple Lithophilic Spawner %	Tolerant %
03MN054 6/24/2003	13.0	12.9	77.8	23.4	2.4	36.9	49.1	56.7
03MN054 7/7/2015	20.3	20.1	67.3	13.6	1.8	26.1	60.5	53.3
03MN054 7/27/2015	3.2	1.9	59.5	18.9	0.0	20.5	44.2	68.2
Statewide average for Class 1 Southern River bio sites that are meeting the FIBI general use threshold (49.0)	**20.6**	**18.5**	**29.2**	**5.2**	**15.2**	**13.9**	**25.0**	**22.1**
Expected response to habitat stress	↓	↓	↓	↑	↓	↓	↓	↑

Table 191. Habitat related invertebrate metrics

07020001-525 **Invert Class 5** **General Use**	Burrower %	Climber %	Clinger %	Ephemeroptera Plecoptera Trichoptera %	Legless %	Sprawler %
03MN054 8/19/2003	12.5	39.7	17.0	29.8	46.2	28.5
03MN054 9/9/2003	15.3	9.8	20.2	45.0	36.5	56.4
03MN054 8/6/2015	2.3	16.1	48.9	64.6	26.7	29.9
Statewide average for Class 5 southern streams rock riffle bio sites that are meeting the MIBI general use threshold (37.0)	**7.5**	**14.7**	**49.5**	**43.9**	**36.0**	**16.8**
Expected response to habitat stress	↑	↓	↓	↓	↑	↓

MPCA stream habitat assessment score

Table 192. Habitat assessment score for bio site 03MN054

07020001-525		Land Use	Riparian	Substrate	Cover	Channel Morphology	Total Score
03MN054	6/24/2003	5	11	17	13	30	76
03MN054	7/7/2015	2.5	9.5	17.9	9	26	64.9
03MN054	7/27/2015	2.5	9.5	16.5	8	25	61.5
03MN054	8/6/2015	2.5	9	8.6	7	9	36.1
Maximum Attainable Habitat Score		**5**	**14**	**28**	**18**	**35**	**100**

Figure 83. Photos of reach 07020001-525 at bio site 03MN054 showing riffle and cobbles (left) and an view of the reaches riparian zone showing dense vegetation (right)

Habitat summary

The fish community at bio site 03MN054 scored below average in several of the habitat related fish metrics when compared to all other Class 1 Southern River bio sites that met the FIBI general use threshold (Table 190). Benthic insectivores minus tolerant taxa, Pioneer, and tolerant species metrics scored very poorly. Darter and suckers were scored well on the July 7 visit but was poor on the July 27 visit. Both visits scored well in Lithophilic spawners, riffle dwelling fish, and simple lithophilic spawners.

Invertebrate metrics scored well in six out of eight habitat related metrics (Table 191). Clinger scored just below the class average.

The MSHA habitat assessment scored good in 2003 and fair for the first three assessments in 2015 but scored poorly in the August 2015 (Table 192). The Riparian zone, substrate, and channel morphology brought the score down, especially the August 2015 score. Erosion and embeddedness were listed as severe in the August assessment.

Photos of reach 07020001-525 shows a natural channel with a variety of habitat. (Figure 83). There were a several types and sizes of substrate observed at the bio site. Along with gravel and cobble substrates, there were several riffle, run, pool, and glide sequences that provide good habitat for both fish and invertebrates.

The lack of benthic insectivores, lower than average darters, and the high number of clinger invertebrates indicate habitat may be a stressor to the biological community in the reach. Burrower, Climber, EPT, legless, and sprawler invertebrates scored well. Due to the mixed metrics, higher than average lithophilic spawning fish, and higher than average EPT inverts, habitat is not a stressor in the Yellow Bank River.

3.10.5 Dissolved oxygen

DO biological metric data

Table 193. Dissolved oxygen related fish metrics for bio site 03MN054

07020001-525 **Fish Class 1** **General Use**		Mature Age >3 %	Serial Spawner %	Taxa Count	DO TIV	DO Sensitive %	DO Tolerant %
03MN054	6/24/2003	22.2	17.8	23.0	7.3	0.0	2.2
03MN054	7/7/2015	35.9	13.7	27.0	7.2	0.0	14.4
03MN054	7/27/2015	17.3	13.4	17.0	7.0	0.0	31.6
Statewide average for Class 1 Southern Rivers bio sites that are meeting the FIBI general use threshold (49.0)		**40.4**	**35.6**	**22.4**	**7.6**	**14.2**	**10.9**
Expected response to DO stress		↓	↑	↓	↓	↓	↑

Table 194. Dissolved oxygen related invertebrate metrics

07020001-525 **Invert Class 5** **General Use**		Low DO Intolerant Taxa %	Low DO Tolerant Taxa %	DO TIV	HBI_MN
03MN054	8/19/2003	2.6	40.1	6.3	8.5
03MN054	9/9/2003	3.2	24.9	6.1	7.8
03MN054	8/6/2015	8.9	2.2	7.3	8.0
Statewide average for Class 5 southern streams rock riffle bio sites that are meeting the MIBI general use threshold (37.0)		**24.6**	**8.6**	**7.1**	**7.0**
Expected response to DO stress		↓	↑	↓	↑

DO monitoring data

Table 195. Dissolved oxygen data from chemistry sites S003-091 and S008-469

07020001-525 DO Data	Range of Data (mg/L)	% of Monthly Samples < 5 mg/L [# of Samples]							% of Total Samples < 5 mg/L [# of Samples]
		April	May	June	July	August	Sept	Oct	
S003-091 (2007-2017)	4.13 – 18.4	0% [47]	0% [39]	0% [62]	2.4% [35]	0% [29]	0% [29]	0% [19]	0.4% [260]
S008-469 (2015-2016)	5.2 – 11.8	N/A [0]	0% [2]	0% [5]	0% [6]	0% [5]	0% [2]	0% [0]	0% [20]

Dissolved oxygen summary

The fish community at bio site 03MN054 scored below average in two of the DO related fish metrics when compared to the average of all other Class 1 Southern River bio sites that meet the FIBI general use threshold (Table 193). The other bio site was sampled in 2001 and represents expired data. Females that take more than three years to mature and overall taxa count scored poorly. Overall taxa count scored poorly compared to the average during one visit.

Invertebrate metrics were mostly poor with three out of four DO related invertebrate metrics scored poorly. However, taxa that are tolerant of low DO scored better than average.

Only one DO measurement taken during sampling was below the warmwater standard of 5 mg/L.

Based on the mixed DO related biological metric scores, especially the fish metrics and only one measured value below the standard, DO is inconclusive as a stressor in this reach.

3.10.6 Eutrophication

Eutrophication biological metric data

Table 196. Eutrophication related fish metrics for bio site 03MN054

07020001-525 Fish Class 1 General Use		Darter %	Omnivore %	Sensitive %	Tolerant %
03MN054	6/24/2003	10.9	19.8	15.6	56.7
03MN054	7/7/2015	8.4	25.1	6.2	53.3
03MN054	7/27/2015	1.9	23.9	3.0	68.2
Statewide average for Class 1 Southern Rivers bio sites that are meeting the FIBI general use threshold (49.0)		**4.4**	**15.5**	**13.5**	**22.1**
Expected response to eutrophication stress		↓	↑	↓	↑

Table 197. Eutrophication related invertebrate metrics

07020001-525 Invert Class 5 General Use		Taxa Count All #	Collector – Filterer Taxa #	Collector – Gatherer Taxa #	Ephemeroptera Plecoptera Trichoptera Taxa #	Intolerant Taxa #	Tolerant Taxa %
03MN054	6/24/2003	45	6	17	11	0	84.4
03MN054	7/7/2015	38	7	15	14	0	89.5
03MN054	7/27/2015	45	4	13	10	0	73.3
Statewide average for Class 5 southern stream rock riffle bio sites that are meeting the MIBI general use threshold (37.0)		**41.9**	**6.5**	**15.0**	**10.9**	**0.8**	**71.9**
Expected response to eutrophication stress		↓	↓	↑	↓	↓	↑

Eutrophication monitoring data

Table 198. Phosphorus monitoring data for chemistry sites S003-091 and S008-469

07020001-525 P Sample Data	Range of Data (mg/L) [# of Samples]	Monthly Average of Samples (mg/L) [# of Samples]							June-Aug Average (mg/L) [# of Samples]
		April	May	June	July	August	Sept	Oct	
S003-091 (2001-2017)	0.01 – 1.19 [283]	0.16 [50]	0.14 [51]	0.31 [62]	0.20 [29]	0.19 [43]	0.13 [29]	0.15 [19]	0.25 [134]
S008-469 (2015-2016)	0.05 – 0.26 [17]	N/A [0]	0.11 [2]	0.12 [4]	0.19 [5]	0.19 [4]	0.08 [2]	N/A [0]	0.17 [13]

Eutrophication HSPF model data

Table 199. HSPF model phosphorus data

	Total Phosphorus	
07020001-525 HSPF Reach 500	**June – September % values > 0.15 mg/l** (# Daily Values)	**June – September Multi-year Average**
2,318 Total Daily Averages June – Sep 1994 – 2012	**33.4%** (775)	**0.16 mg/l**

Eutrophication summary

During two visits in July 2015, the fish community at bio site 03MN054 scored below average in three out of four and all four eutrophication related fish metrics when compared to the average of all other Class 1 Southern River bio sites that meet the FIBI general use threshold (Table 196). Darters were above the class average on July 7 but were well below during the July 27 visit. Omnivorous fish percentage, sensitive percentage, and tolerant percentage all scored poorly during both visits.

During two visits in July 2015, the invertebrate community scored below average in three out of six and five out of six eutrophication related metrics compared to the average of all other Invert Class 5 southern stream rock riffle bio sites that meet the MIBI general use threshold (Table 197). The 2003 data represents expired data. Taxa count and collector – filterer metrics were just below and just above the class averages on the two separate visits. During the July 7 visit collector – gatherer metrics were at the class average and during the July 27 visit is was just below the class average. EPT taxa scored above the class average on the seven and just below on the 27. There were no intolerant taxa and a high percentage of tolerant taxa.

One hundred and thirty-four samples were collected and analyzed for Phosphorus at chemistry site S003-091 from 2001-2017. The summer average was well above the standard of 0.15 mg/L (Table 198). Seventeen samples were collected and analyzed for Phosphorus from 2015-2016 at chemistry site S008-469 with a summer average of 0.17 mg/L.

The HSPF model computed the summer average just above the standard at 0.16 mg/L (Table 199).

High levels of phosphorus were measured during sampling and both the fish and invert community seem to be showing the effects of eutrophication. At this time eutrophication is inconclusive and it is recommended that more response variable data be collected in order to determine whether eutrophication is a biological stressor.

3.10.7 Suspended solids

Suspended solids biological metric data

Table 200. Suspended solids related fish metrics for bio site 03MN054

07020001-525 Fish Class 1 General Use	Benthic Feeder %	Centrarchid-Tolerant %	Herbivore %	Tolerant %	Long-Lived %	Perciformes-Tolerant %	Riffle %	Sensitive %	Simple Lithophilic Spawner %	TSS TIV
03MN054 6/24/2003	38.6	1.8	13.3	58.8	1.3	13.0	36.9	1.8	49.1	17.4
03MN054 7/7/2015	41.4	1.0	11.9	35.7	3.7	9.6	26.1	1.0	60.5	18.5
03MN054 7/27/2015	21.8	0.0	27.3	36.7	2.7	1.9	20.5	0.0	44.2	19.4
Statewide average for Class 1 Southern River stations that are meeting the FIBI general use threshold (49.0)	**21.4**	**4.1**	**1.0**	**58.8**	**43.6**	**18.0**	**13.9**	**3.8**	**25.0**	**34.1**
Expected response to TSS stress	↓	↓	↓	↑	↓	↓	↓	↓	↓	↑

Table 201. Suspended solids related invert metrics for bio site 03MN054

07020001-525 Invert Class 7 General Use	Collector-Filterer %	Plecoptera %	TSS Intolerant %	TSS Tolerant %	TSS TIV
03MN054 8/19/2003	7.9	0.0	0.3	49.5	17.4
03MN054 9/9/2003	6.2	0.0	0.6	51.8	18.9
03MN054 8/6/2015	30.2	0.0	0.6	66.9	21.3
Statewide average for Class 5 southern streams rock riffle bio sites that are meeting the MIBI general use threshold (37.0)	**26.9**	**0.5**	**5.1**	**35.2**	**15.9**
Expected response to TSS stress	↓	↓	↓	↑	↑

TSS monitoring data

Table 202. Total suspended solids monitoring data for chemistry sites S003-091 and S008-469

07020001-525 TSS Sample Data	Range of Data (mg/L)	% of Monthly Samples > 65 mg/L [# of Samples]							% of Total Samples > 65 mg/L [# of Samples]
		April	May	June	July	August	Sept	Oct	
S003-091 (2001-2018)	1 – 610	36% [64]	20% [66]	46% [87]	22% [41]	20% [54]	5% [39]	11% [27]	25% [378]
S008-469 (2015)	2 – 78	N/A [0]	0% [2]	0% [2]	33% [3]	0% [2]	0% [2]	N/A [0]	9% [11]

Suspended solids summary

The fish community at bio site 03MN054 scored below average in four out of ten suspended solids related fish metrics and five out of ten metrics when compared to the average of all other Class 1 Southern River bio sites that meet the FIBI general use threshold (Table 200). There were a fair amount of benthic feeders, herbivores, and lithophilic-spawning fish caught to indicate enough course substrate to support those fish species. Centrarchids, long-lived species, Perciformes, and sensitive metrics all scored poorly. Tolerant species were below the class average.

The invert community at bio site 03MN054 scored poorly in four out of five related metrics when sampled in 2015 (Table 201). There were no Plecoptera taxa and very few taxa intolerant of high-suspended solids. The TSS tolerance index value was relatively high. Collector filterer invertebrates, which tend to decrease in streams with high TSS, scored well and were actually above the class average.

Three hundred and seventy-eight samples were collected and analyzed for total suspended solids from 2015-2017 (Table 202). Several samples throughout had a total suspended solid concentration above 65 mg/L and the number of exceedances was 25%, well above the 10% threshold for the TSS standard.

From 2001-2015 there were 240 paired TSS and TSVS samples taken between the months of April-October. Out of all those samples, 73 (28%) were above the TSS standard of 65 mg/L. Of the 73 that were above the standard, the summer average percentage of TSVS to TSS was only 14.1%, which indicates that the majority of the suspended solids in the water is probably sediment and not algae.

With the half of fish the metrics and the majority of invert metrics related to suspended solids scoring very poorly as well as chemistry data showing some elevated concentrations of TSS, suspended solids are a stressor to aquatic life in the Yellow Bank River.

3.10.8 Nitrates

Nitrate biological metric data

Table 203. Nitrate related invertebrate metrics for bio site 03MN054

07020001-525 Invert Class 5 General Use		Nitrate Intolerant Taxa %	Nitrogen TIV	Nitrate Tolerant Taxa %	Trichoptera Taxa %
03MN054	8/19/2003	0.3	3.3	60.5	13.3
03MN054	9/9/2003	1.6	2.8	56.6	4.4
03MN054	8/6/2015	0.6	3.6	70.7	15.8
Statewide average for Class 5 southern streams rock riffle bio sites that are meeting the MIBI general use threshold (37.0)		**2.9**	**2.9**	**47.6**	**13.6**
Expected response to nitrogen stress		↓	↑	↑	↓

Nitrate monitoring data

Table 204. Nitrate monitoring data for chemistry sites S003-091 and S008-469

07020001-525 Nitrate/Nitrite Sample Data	Range of Data (mg/L)
S003-091 (2007-2018)	0.01 – 14.0
S008-469 (2015-2016)	0.03 – 2.7

Nitrate summary

The macroinvertebrate assemblage at sites 03MN054 scored poorly in three out of four nitrate related metrics when compared to all other macroinvertebrate Class 5 southern stream rock riffle bio sites that meet the MIBI general use threshold (Table 203). Trichoptera taxa percentage was the only metric to score above the average, which tend to decrease in streams with excessive nitrate values. However, the dominant Trichoptera taxa were mostly nitrate tolerant species. There were almost no nitrate intolerant species present and nitrate tolerant species were well above the class average. The nitrogen TIV score also indicates a macroinvertebrate community that is generally tolerant to high levels of nitrates.

Three hundred and forty-eight samples were collected at chemistry sites S003-091 and analyzed for nitrate/nitrite (Table 204). Five percent of the samples had nitrate concentrations above 4.9 mg/L and 2% had concentrations above the drinking water standard of 10 mg/L.

Due to the poor nitrate related biological metrics and corroborating chemistry data, nitrates appear to be stressing the biological community in the Yellow Bank River.

3.10.9 Reach stressors

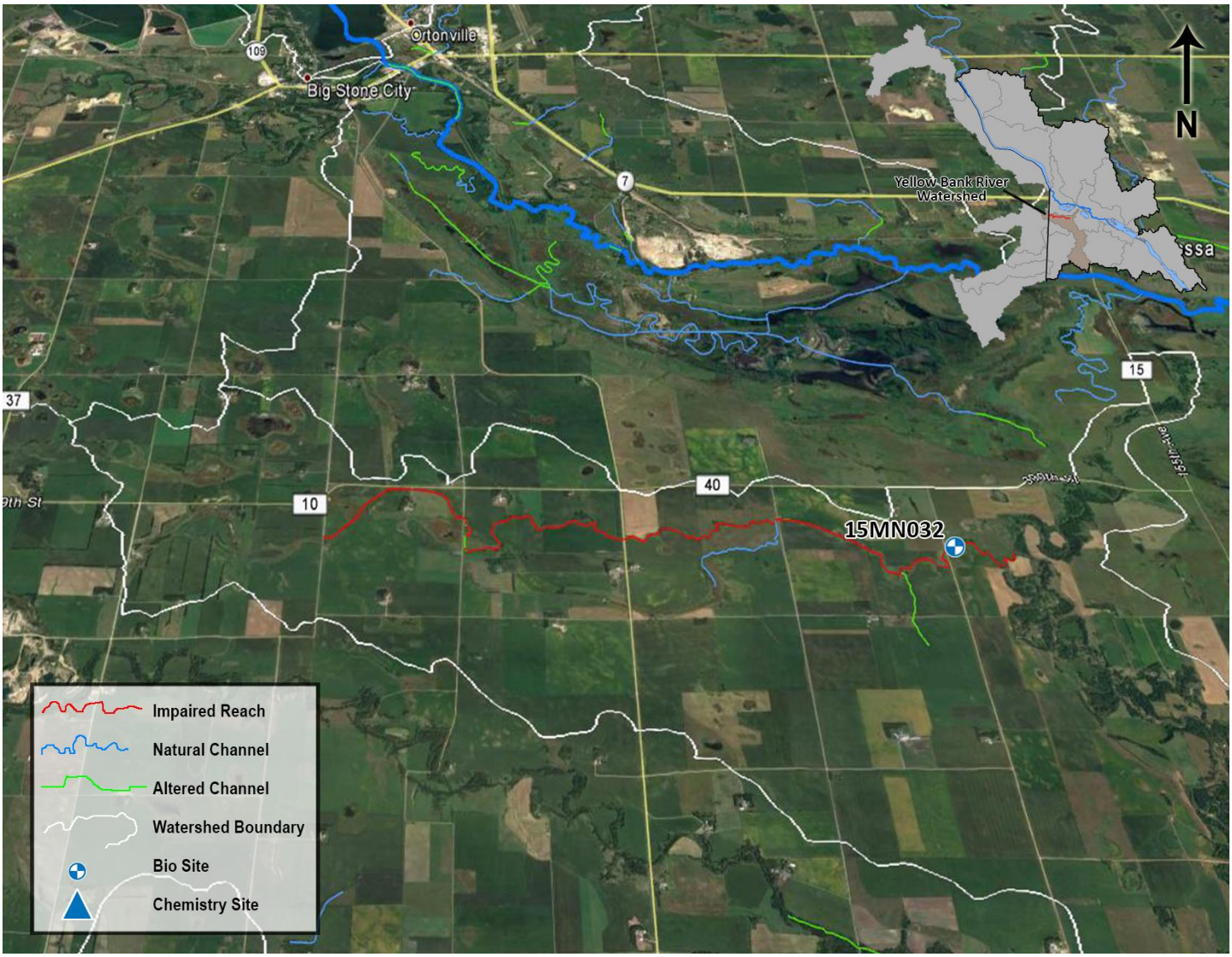
Reach 07020001-525 is the main stem Yellow Bank River after the North and South Forks come together. The stressors identified within those two reaches would apply to this reach as well. The Yellow Bank River itself is at the end of a relatively large watershed, draining more than 450 square miles of mostly agricultural land. This stream reach has evidence of down cutting, incision, and stream bank erosion, likely due to hydrologic alteration in the upstream watershed. A high priority in this watershed should be to manage changes to the hydrology of both its tributaries and contributing watersheds. The construction of ditches and the addition of tile drainage has altered the land area that that regularly contributes water to the stream. This increase in drainage area affects the amount and timing of water that reaches the stream. Increasing the storage and infiltration of water can help reduce nutrient delivery to the stream as well as erosion and incision from high flows after large rain events.

Table 205. Summary of stressors in reach 07020001-525

07020001-525	Hydrologic Alteration	Connectivity	Habitat	Dissolved Oxygen	Eutrophication	Suspended Solids	Nitrate
✓= Stressor ×= Not a Stressor **O** = Inconclusive	✓	**O**	×	**O**	**O**	✓	✓

3.11 07020001-561 Unnamed Creek

Figure 84. Satellite image of reach 07020001-561 and its watershed



3.11.1 Biological community

Bio site 15MN032 was sampled for fish in June of 2015 and scored a 24.5, under the Fish Class 3 general use threshold of 55 (Table 206). Fathead minnows and creek chubs dominated the fish community. All fish species caught were tolerant fish.

On August 6, 2015, the biological sampling crew visited the bio site and were unable to sample fish or invertebrates due to insufficient flow.

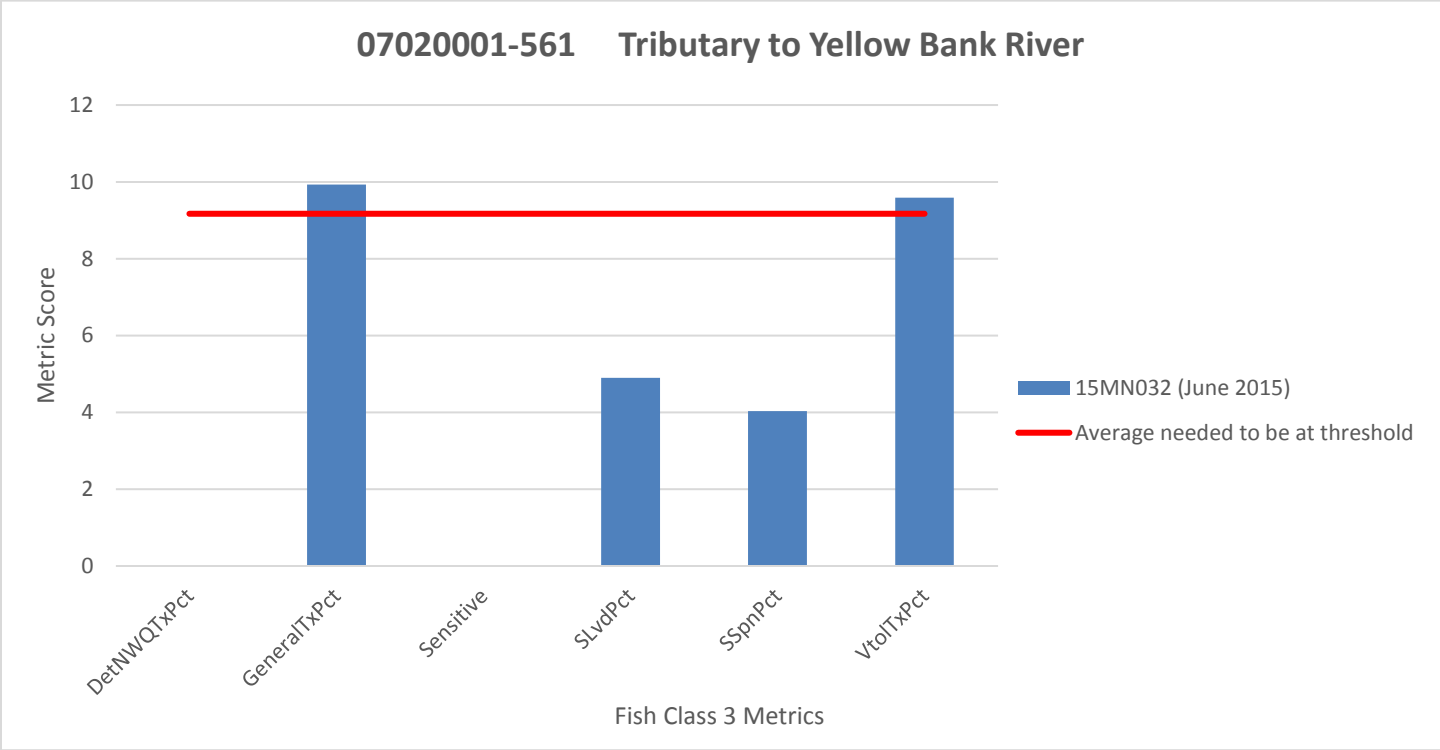
Metrics used to calculate the Fish IBI score are shown in a graph with the red line indicating the value each metric needed to score in order to meet the threshold (Figure 85).

Biological metric data

Table 206. Fish IBI score and threshold for bio sites 15MN032

07020001-561 **Fish Class 3** **General Use**		Fish IBI Score	Class Threshold Score
15MN032	6/10/2015	24.5	55

Figure 85. Fish Class 3 general use metric scores for bio site 15MN032



3.11.2 Hydrologic alteration

Hydrologic alteration biological metric data

Table 207. Hydrologic alteration related fish metrics for bio site 15MN032

07020001-561 Fish Class 3 General Use		General %	Nesting Non Lithophilic Spawner %
15MN032	6/10/2015	88.5	60.4
15MN032	8/6/2015	Insufficient Flow	
Statewide average for Class 3 Southern Headwater bio sites that are meeting the FIBI general use threshold (55.0)		**59.1**	**19.2**
Expected response to **Hydrologic** stress		↑	↑

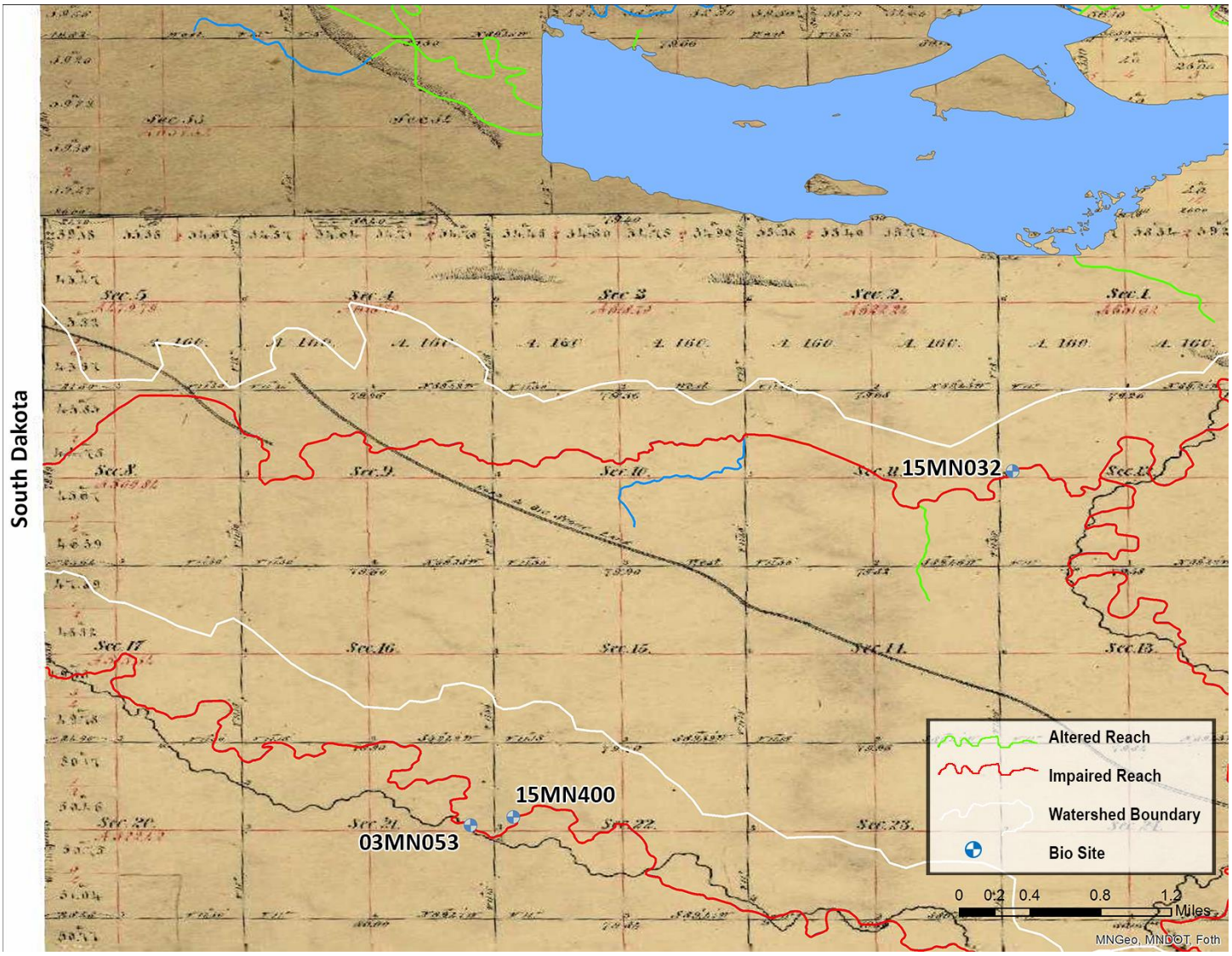
Hydrologic alteration summary

Both of the hydrologic alteration related fish biological metrics scored poorly when compared to the Fish Class 3 Southern headwaters bio sites that meet the IBI general use threshold (Table 207). Bio site 03MN054 had generalist fish population of 88.5% and Fathead minnows were 58% of the total fish caught. Nesting fish scored well above the class average.

On August 6, 2015, the biological sampling crew visited the bio site and were unable to sample due to insufficient flow.

This drainage area of this bio site is only 9.2 square miles. There are several drained wetlands in its upper watershed which starts only a few miles across the border in South Dakota. In a creek with such a small watershed, upland drainage is likely contributing low flow conditions in a stream that would naturally would be prone to low flows during dry periods.

Figure 86. Original survey plat map of the watershed of reach 07020001-561 including altered watercourses



It appears that reach 07020001-561 was small enough that it was not identified in the original plat information (Figure 86). A small portion of the watershed of this reach is in South Dakota. Several of its tributaries have been channelized and some of its watershed appears to have been drained and cultivated.

Based on the very poor scores of the fish biological metrics and the evidence of drainage in its upper watershed Hydrologic Alteration is a stressor in reach 07020001-561. The primary impact in this reach from Hydrologic Alteration is the ditching and channelization of the stream channel and its tributaries, subsurface tile drainage of the surrounding wetlands, as well as low flows during periods of low precipitation.

3.11.3 Connectivity

Connectivity metric data

Table 208. HSPF modeled flow data, 1994-2012

07020001-561 Fish Class 3 General Use	Mature Age >3 minus Tolerant Taxa %	Migrating Taxa %
15MN032 6/10/2015	0.0	0.0
Statewide average for Class 3 southern headwaters bio sites that are meeting the FIBI general use threshold (55.0)	**5.3**	**19.5**
Expected response to connectivity stress	↓	↓

Connectivity summary

No fish whose females take greater than three years to mature or migrating fish were caught at bio site 15MN032 (Table 208). A=No downstream culverts or road crossings were identified as fish barriers. Due to the lack of species that reproduce at a mature age and migratory species, it appears that connectivity is a likely stressor at this time. These metric scores may be a result of the fact that this stream is prone to very low flows, which is in itself a connectivity issue. Connectivity is a stressor to the biological community. It is recommended that road crossings could be checked and inventoried to rule out any possible fish barriers both up and downstream.

3.11.4 Habitat

Habitat metric data

Table 209. Habitat related fish metrics for bio site 15MN032

07020001-561 Fish Class 3 General Use	Benthic Insect minus Tolerant %	Darter Sculpin Sucker %	Lithophilic Spawner %	Pioneer %	Piscivore %	Riffle %	Simple Lithophilic Spawner %	Tolerant %
15MN032 6/10/2015	0.0	0.0	30.2	88.5	0.0	0.0	0.0	100.0
Statewide average for Class 3 Southern Headwater bio sites that are meeting the FIBI general use threshold (55.0)	**14.2**	**12.6**	**69.2**	**37.8**	**1.6**	**28.3**	**33.7**	**70.6**
Expected response to habitat stress	↓	↓	↓	↑	↓	↓	↓	↑

MPCA stream habitat assessment score

Table 210. Habitat assessment score for bio site 15MN032

07020001-561	Land Use	Riparian	Substrate	Cover	Channel Morphology	Total Score
15MN032 6/10/2015	5	14	12.5	9	21	61.5
Maximum Attainable Habitat Score	**5**	**14**	**28**	**18**	**35**	**100**

Figure 87. Photos of reach 07020001-561 showing the thick vegetation adjacent to (left) and within the reach (right) at bio site 15MN032

Habitat summary

The fish community at bio site 15MN032 scored below average in all eight of the habitat related fish metrics when compared to all other Class 3 Southern Headwater bio sites that met the FIBI general use threshold (Table 209). There were no benthic insectivores, Darters, piscivores, riffle fish, or simple lithophilic spawning fish. Pioneer and tolerant species metrics scored very poorly. There were some lithophilic spawners, but no simple lithophilic spawners.

The MSHA habitat assessment scored fair in June 2015 (Table 210). The land use and riparian zone scored very well as the stream channel around the bio site is natural and surrounded by grass. There was no erosion observed during habitat surveying and embeddedness was listed as light. This section of reach 07020001-561 scored fair in channel morphology with good channel stability and sinuosity but was brought down due to depth variability and channel development. Pools, riffles, and runs were all observed at bio site 15MN032 and gravel was observed in the riffle.

Photos within reach 07020001-561 show a very robust riparian buffer and a lot of cover for fish habitat (Figure 87).

Though it is inconclusive as a stressor at this time, it is likely that low flows are contributing to limitations in habitat for fish, which in turn could be a stressor to the fish within the reach.

3.11.5 Dissolved oxygen

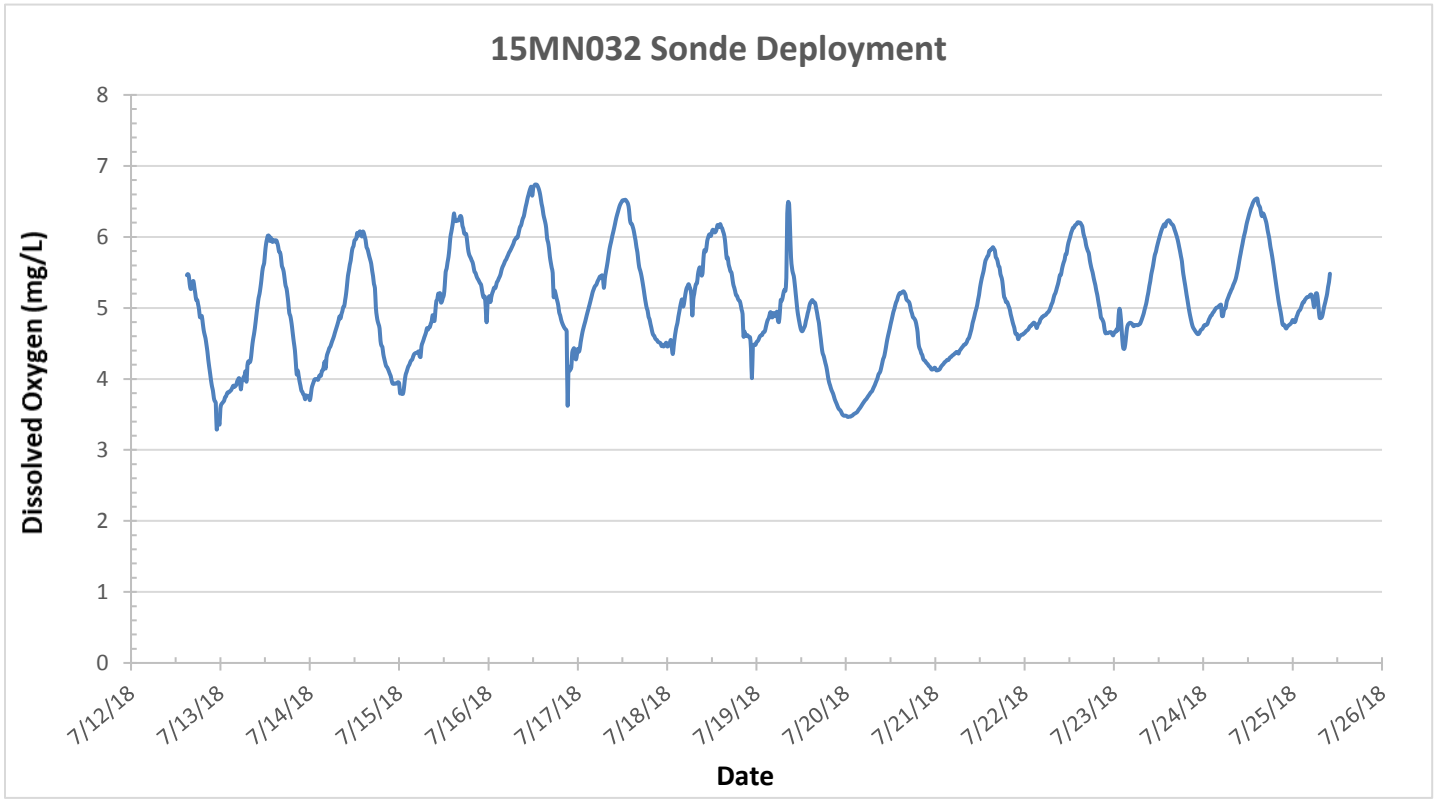
DO biological metric data

Table 211. Dissolved oxygen related fish metrics for bio site 15MN032

07020001-561 **Fish Class 3** **General Use**	Mature Age >3 %	Serial Spawner %	Taxa Count	DO TIV	DO Sensitive %	DO Tolerant %
15MN032 6/10/2015	0.0	58.3	4.0	6.5	0.0	69.8
Statewide average for Class 3 southern headwaters bio sites that are meeting the FIBI general use threshold (55.0)	**13.3**	**17.1**	**12.2**	**7.2**	**3.7**	**18.6**
Expected response to DO stress	↓	↑	↓	↓	↓	↑

DO monitoring data

Figure 88. Continuous dissolved oxygen data at bio site 15MN032



Dissolved oxygen summary

The fish community at bio site 15MN032 scored below average in all four DO related fish metrics when compared to the average of all other Class 3 Southern Headwater bio sites that meet the FIBI general use threshold (Table 211). There were no species with females that take more than three years to mature. There were no fish who are intolerant of low dissolved oxygen (DO) and no sensitive fish caught. Three out of the four species caught are tolerant to low DO.

A YSI Sonde water meter measured continuous DO data from July 12 2017 to July 25 2017 (Figure 88). During this deployment, DO values were measured below the standard all 13 days the sonde was deployed.

Based on the related fish biological metric scores and the measured sonde values below 5 mg/L, DO is a stressor in this reach. It is likely being aggravated by low flow conditions.

3.11.6 Eutrophication

Eutrophication biological metric data

Table 212. Eutrophication related fish metrics for bio site 15MN032

07020001-561 **Fish Class 3** **General Use**	Darter %	Omnivore %	Sensitive %	Tolerant %
15MN032 6/10/2015	0.0	58.3	0.0	100.0
Statewide average for Class 3 southern headwaters bio sites that are meeting the FIBI general use threshold (55.0)	**12.1**	**14.6**	**8.6**	**70.6**
Expected response to eutrophication stress	↓	↑	↓	↑

Eutrophication monitoring data

Table 213. Phosphorus monitoring data for chemistry sites S003-091 and S008-469

07020001-561 P Sample Data	Range of Data (mg/L) [# of Samples]	Monthly Average of Samples (mg/L) [# of Samples]							June-Aug Average (mg/L) [# of Samples]
		April	May	June	July	August	Sept	Oct	
S013-149 (2015-2018)	0.11 – 0.65 [4]	N/A [0]	0.11 [1]	0.26 [2]	0.65 [1]	N/A [0]	N/A [0]	N/A [0]	0.39 [3]

Eutrophication summary

The fish community at bio site 15MN032 scored extremely poorly in all four eutrophication related fish metrics when compared to the average of all other Class 3 Southern Headwater bio sites that meet the FIBI general use threshold (Table 212). No darters or sensitive fish were caught. Fathead minnows, and omnivorous fish, comprised 58.3% of the fish population. Tolerant fish comprised 100% of the population.

During both bio and stressor ID sampling within reach 07020001-561 at chemistry site S013-149 there were four samples collected and analyzed for Phosphorus from 2015-2018. The summer average was 0.39 mg/L, well above the standard of 0.15 mg/L (Table 213).

A YSI Sonde water meter measured continuous DO data from July 7 2017 to July 26 2017 (Figure 88). During this deployment, DO diurnal flux, or the difference between the daily high and low DO concentrations was consistently between 1 and 3 mg/L, below the eutrophication DO flux standard of 5 mg/L.

High levels of phosphorus were measured during sampling and the fish community seems to be showing the effects of eutrophication. However, measured DO flux values did not get above 5 mg/L. Eutrophication is inconclusive as a stressor to the biological community in reach 07020001-561. It is recommended that more diurnal DO measurements are taken to determine if eutrophication is a stressor to the bio community.

3.11.7 Suspended solids

Suspended solids biological metric data

Table 214. Suspended solids related fish metrics for bio site 15MN032

07020001-561 Fish Class 3 General Use	Benthic Feeder %	Centrarchid-Tolerant %	Herbivore %	Intolerant %	Long-Lived %	Perciformes-Tolerant %	Riffle %	Sensitive %	Simple Lithophilic Spawner %	TSS TIV
15MN032 6/10/2015	0.0	0.0	9.4	0.0	0.0	0.0	0.0	0.0	0.0	21.7
Statewide average for Class 3 Southern Headwater stations that are meeting the FIBI general use threshold (55.0)	**37.83**	**0.90**	**13.33**	**1.95**	**3.56**	**13.93**	**28.33**	**8.55**	**33.71**	**15.2**
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Suspended solids summary

The fish community at bio site 15MN032 scored very poorly in TSS related fish metrics when compared to the average of all other Class 3 Southern Headwater bio sites that meet the FIBI general use threshold (Table 214). There were no benthic feeders, Centrarchids, intolerant fish, long-lived fish, perciformes, riffle dwelling fish, sensitive fish, or simple lithophilic spawning fish caught. Herbivore fish were 9.4% and consisted of nine brassy minnows, a tolerant and short-lived species.

During both bio and stressor ID sampling within reach 07020001-561 at chemistry site S013-149 there were two samples collected and analyzed for TSS in 2015 with a value of 4.8 mg/L and in 2017 with a value of 2.4 mg/L. Both of these samples were well below the standard of 65 mg/L.

The majority of fish metrics related to suspended solids scored very poorly, though chemistry data was very limited. Because of this, suspended solids are inconclusive as a stressor to aquatic life in the Yellow Bank River. It is likely that other factors, such as altered hydrology and habitat are causing poor scores in the fish biological metrics. It is recommended that more TSS data be collected during high flows in order to determine whether it is a biological stressor.

3.11.8 Nitrates

Table 215. Nitrate monitoring data for chemistry site S013-149

07020001-561 Nitrate/Nitrite Sample Data	Range of Data (mg/L)
S013-149 (2017-2018)	0.33 – 0.36

Nitrate summary

On August 6 2015, the biological sampling crew visited bio site 15MN032 and were unable to sample fish or invertebrates due to insufficient flow. Only two samples were collected and analyzed for nitrates and were not above 4.9 mg/L. Nitrates are inconclusive as a stressor at this time. Collecting more chemistry data within this reach is recommended in order to determine if nitrates are a stressor to the biological community.

3.11.9 Reach stressors

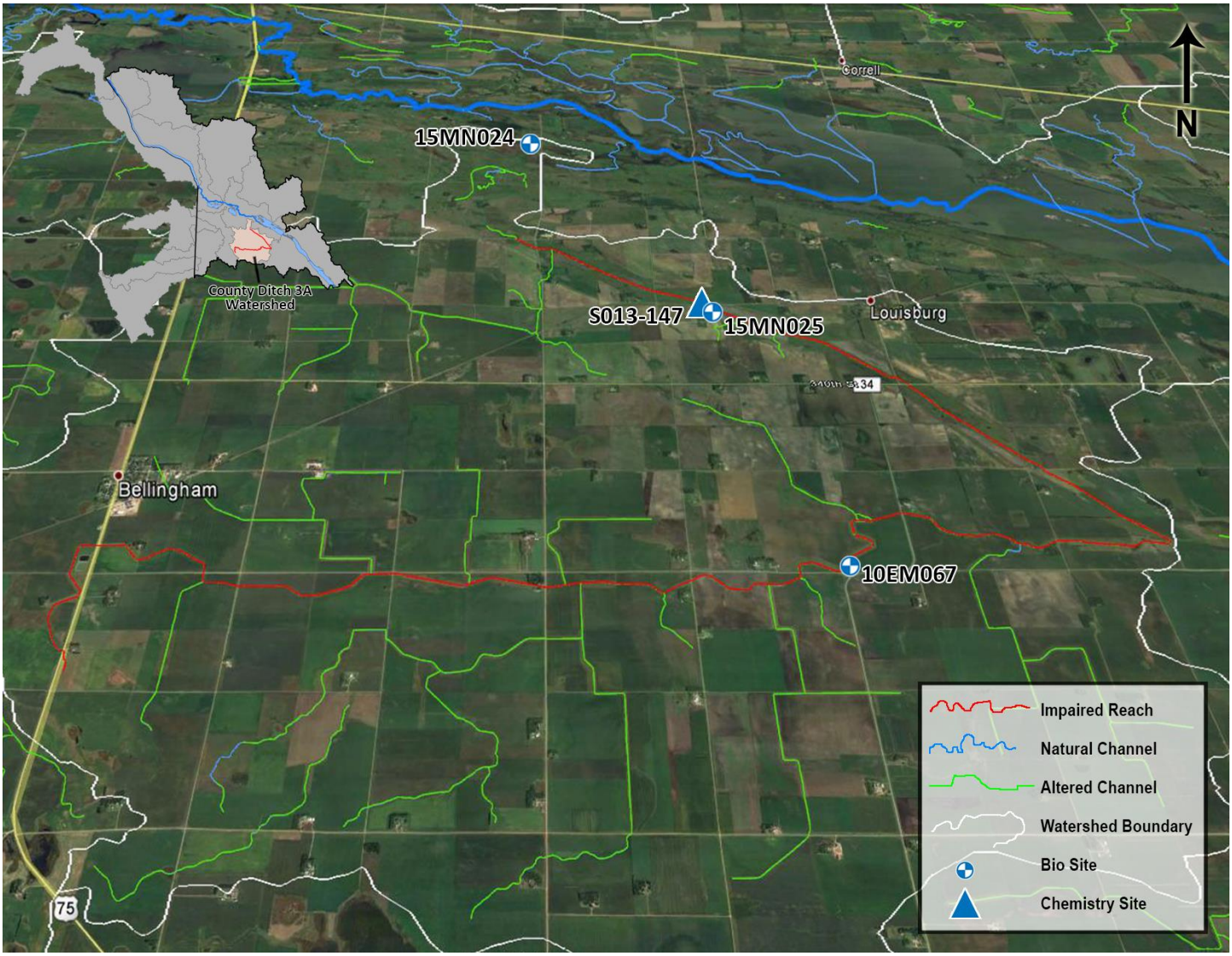
A high priority in this watershed should be to manage changes to the hydrology of both stream channels and contributing watersheds. The construction of ditches and the addition of tile drainage has altered the land area that that regularly contributes water to the stream. This increase in drainage area affects the amount and timing of water that reaches the stream. Phosphorus and nitrates quickly reach the stream via drain tiles, outlets, and field runoff. Increasing the storage and infiltration of water can help reduce nutrient delivery to the stream, erosion and incision from high flows after large rain events, and can help mitigate periods of extremely low flows during times of low precipitation.

Table 216. Summary of stressors in reach 07020001-561

07020001-561	**Hydrologic Alteration**	**Connectivity**	**Habitat**	**Dissolved Oxygen**	**Eutrophication**	**Suspended Solids**	**Nitrate**
✓= Stressor ×= Not a Stressor **O** = Inconclusive	✓	✓	**O**	✓	**O**	**O**	**O**

3.12 07020001-569 Unnamed Creek

Figure 89. Satellite image of reach 07020001-569 and its watershed



3.12.1 Biological community

Bio site 15MN025 was sampled for fish in June of 2015. A total of only 3 species and 18 fish were caught resulting in an IBI score of zero (Table 217).

Bio site 10MN067 was sampled for fish in August of 2010 and June of 2015. Creek chubs and blacknose dace dominated the fish community resulting in an IBI score of 0 (Table 218). Metrics used to calculate the Fish IBI score are shown in a graph with the red line indicating the value each metric needed to score in order to meet the threshold (Figure 90).

Biological metric data

Table 217. Fish IBI score and threshold for bio site 15MN025

07020001-561 Fish Class 2 Modified Use		Fish IBI Score	Class Threshold Score
15MN025	6/17/2015	0	35
15MN025	8/5/2015	Insufficient Flow	

Figure 90. Fish Class 2 modified use metric scores for bio site 15MN025

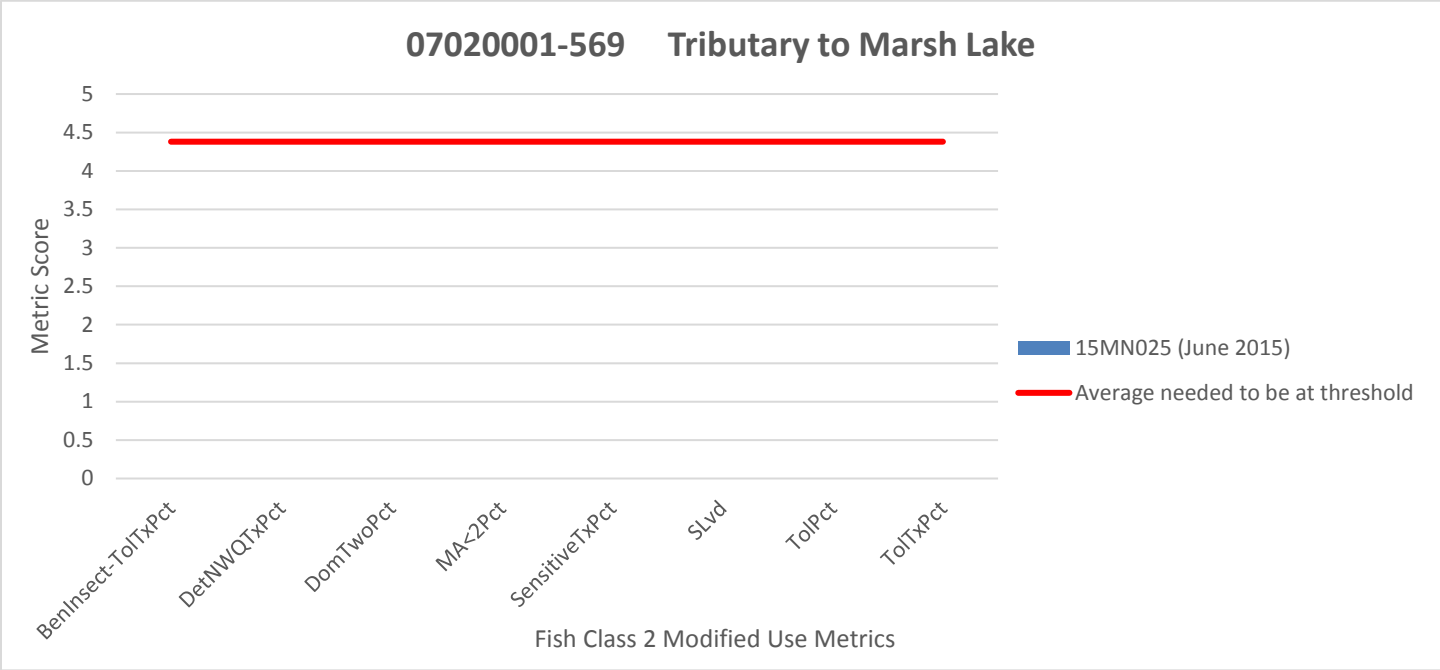
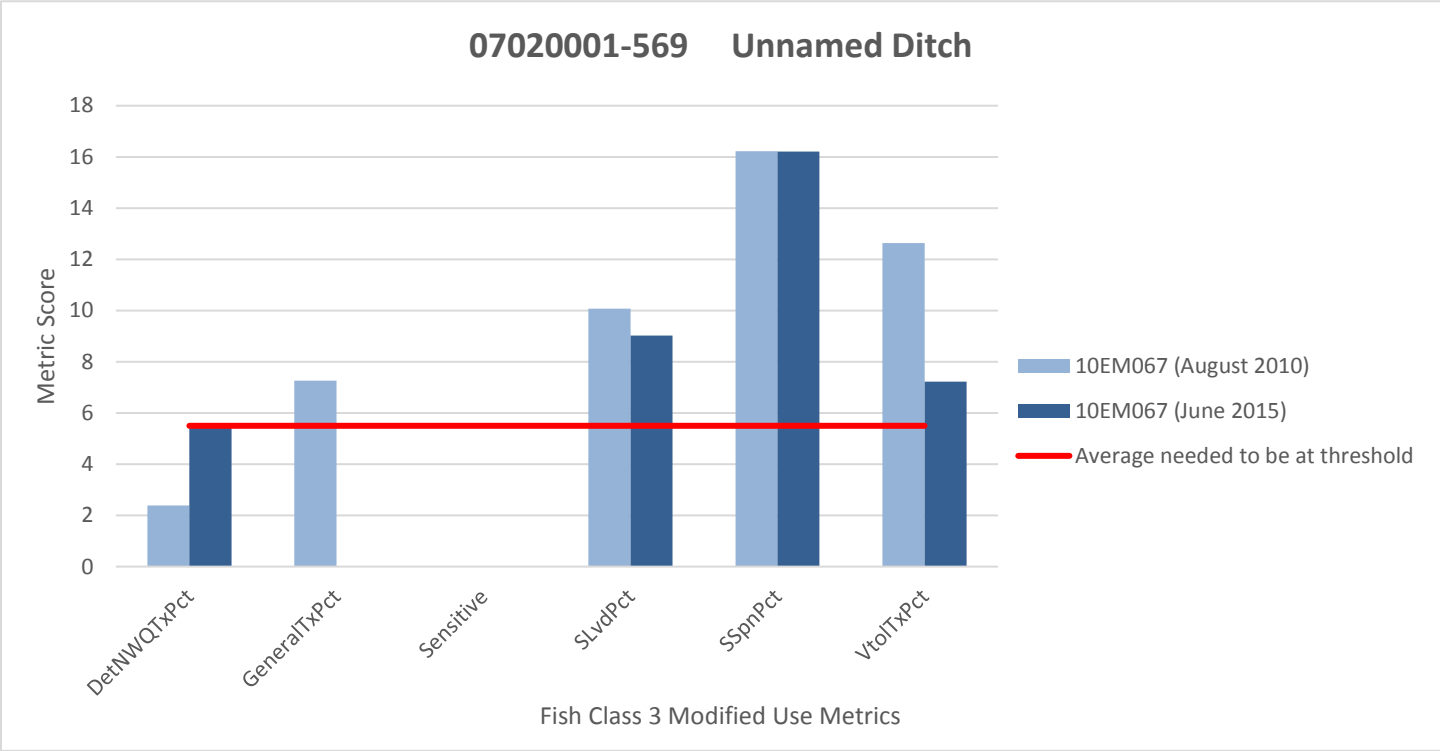


Table 218. Fish IBI score and threshold for bio site 10EM067

07020001-561 Fish Class 3 Modified Use		Fish IBI Score	Class Threshold Score
10EM067	8/24/2010	48.6	33
10EM067	6/9/2015	38.0	33

Figure 91. Fish Class 3 modified use metric scores for bio site 10EM067



3.12.2 Hydrologic alteration

Hydrologic alteration biological metric data

Table 219. Hydrologic alteration related fish metrics for bio site 15MN025

07020001-569 Fish Class 2 Modified Use		General %	Nesting Non Lithophilic Spawner %
15MN025	6/17/2015	83.3	16.7
15MN025	8/5/2015	Insufficient Flow	
Statewide average for Class 2 southern stream bio sites that are meeting the FIBI modified use threshold (35.0)		**42.4**	**19.1**
Expected response to **Hydrologic** stress		↑	↑

Table 220. Hydrologic alteration related fish metrics for bio site 10EM067

07020001-569 **Fish Class 3** **Modified Use**		General %	Nesting Non Lithophilic Spawner %
10EM067	8/24/2010	85.2	8.9
10EM067	6/9/2015	90.9	11.4
Statewide average for Class 3 southern stream bio sites that are meeting the FIBI modified use threshold (33.0)		**56.3**	**23.9**
Expected response to **Hydrologic** stress		↑	↑

HSPF model flow data

Table 221. HSPF modeled flow data, 1994-2012

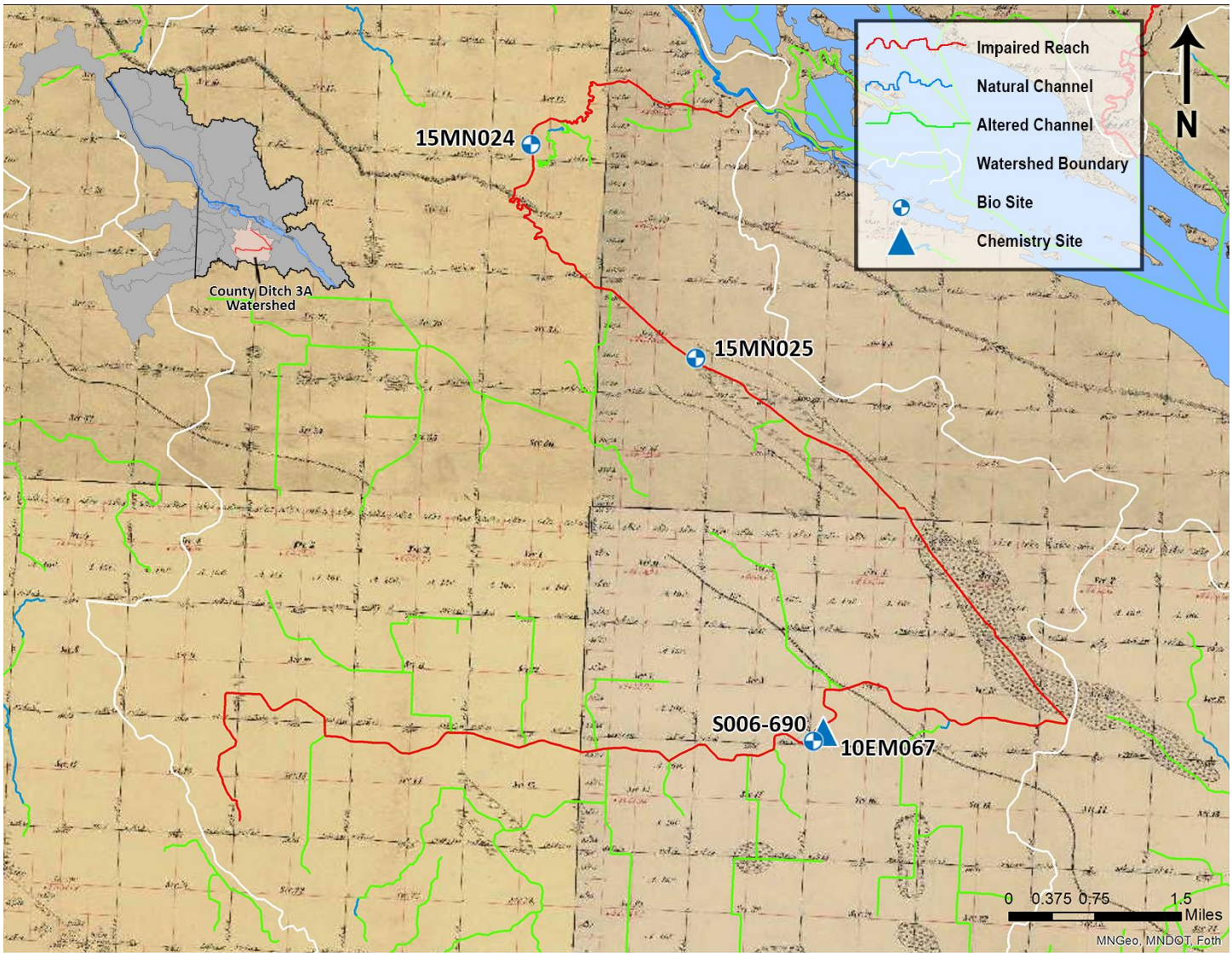
07020001-569 HSPF Reach 408 Min: 0 cfs Max: 772.5 cfs	**<5 cfs %** (# of values)	**<1 cfs %** (# of values)	**<0.5 cfs %** (# of values)
6,940 Total Daily Averages 1994 – 2012	**70.9%** (4,921)	**43%** (2,985)	**31.5%** (2,185)

Hydrologic alteration summary

One of the two hydrologic alteration related fish biological metrics scored poorly in all visits when compared to the averages of Fish Class 2 (Table 219) and Fish Class 3 (Table 220) bio sites that meet the IBI modified use threshold. Generalist fish scored very poorly and nesting non-lithophilic fish scored well at both bio sites. Only 18 total fish were caught at bio site 15MN025 and 44 total fish were caught at bio site 10EM067.

On August 6 2015, the biological sampling crew visited bio site 15MN025 and were unable to sample due to insufficient flow.

Figure 92. Original survey plat map of the watershed of reach 07020001-569 including altered watercourses



Both the channel and contributing watershed of reach 07020001-569 is altered. Almost all streams in the watershed that drain into the reach are ditches, likely created to drain wetlands in the very flat and low-lying area. The watershed is also extensively drained in order to grow crops. According to original surveying data, a large wetland existed where the reach makes a sharp turn to the northwest (Figure 92). Drainage is likely contributing to high flow conditions during wet periods and low flow conditions during dry periods.

Based on the low numbers of fish caught, poor generalist fish scores of the fish biological metrics, the insufficient flow at bio site 15MN025 and the evidence of ditching and drainage in its upper watershed, Hydrologic Alteration is a stressor in reach 07020001-569. The primary impact in this reach from Hydrologic Alteration is the ditching and channelization of the stream channel and its tributaries, subsurface tile drainage of the surrounding wetlands, as well as the pollutant overloading of nutrients.

3.12.3 Connectivity

Connectivity metric data

Table 222. Connectivity related fish metrics for bio site 15MN025

07020001-569 **Fish Class 2** **Modified Use**	Mature Age >3 minus Tolerant Taxa %	Migrating Taxa %
15MN025 6/17/2015	0.0	0.0
Statewide average for Class 2 southern stream bio sites that are meeting the FIBI modified use threshold (35.0)	**2.7**	**20.6**
Expected response to connectivity stress	↓	↓

Table 223. Connectivity related fish metrics for bio site 10EM067

07020001-569 **Fish Class 3** **Modified Use**	Mature Age >3 minus Tolerant Taxa %	Migrating Taxa %
10EM067 8/24/2010	0.0	14.3
10EM067 6/9/2015	0.0	0.0
Statewide average for Class 3 Southern Stream bio sites that are meeting the FIBI modified use threshold (33)	**1.4**	**20.1**
Expected response to connectivity stress	↓	↓

Connectivity summary

No fish whose females take greater than three years to mature or migrating fish were caught at either bio site (Table 222 and Table 223). Although no downstream culverts or road crossings were identified as fish barriers there are several road crossing and culverts that could be limiting fish migration. This reach could also be affected by the impoundment downstream that controls water levels in Marsh Lake. Due to the lack of long-lived species and migratory species it appears that connectivity is a stressor, but is inconclusive at this time.

3.12.4 Habitat

Habitat metric data

Table 224. Habitat related fish metrics for bio site 15MN025

07020001-569 Fish Class 2 Modified Use	Benthic Insect minus Tolerant %	Darter Sculpin Sucker %	Lithophilic Spawner %	Pioneer %	Piscivore %	Riffle %	Simple Lithophilic Spawner %	Tolerant %
15MN025 6/17/2015	0.0	0.0	83.3	66.7	0.0	0.0	16.7	100.0
Statewide average for Class 2 southern stream bio sites that are meeting the FIBI modified use threshold (35.0)	**3.6**	**16.5**	**35.6**	**23.6**	**8.0**	**19.5**	**16.1**	**46.4**
Expected response to habitat stress	↓	↓	↓	↑	↓	↓	↓	↑

Table 225. Habitat related fish metrics for bio site 10EM067

07020001-569 Fish Class 3 Modified Use	Benthic Insect minus Tolerant %	Darter Sculpin Sucker %	Lithophilic Spawner %	Pioneer %	Piscivore %	Riffle %	Simple Lithophilic Spawner %	Tolerant %
10EM067 8/24/2010	4.4	4.4	83.0	60.7	0.0	2.2	28.9	95.6
10EM067 6/9/2015	0.0	0.0	86.4	52.3	0.0	0.0	36.4	97.7
Statewide average for Class 3 Southern Stream bio sites that are meeting the FIBI modified use threshold (33.0)	**10.9**	**10.6**	**58.0**	**32.5**	**2.0**	**22.6**	**30.1**	**76.7**
Expected response to habitat stress	↓	↓	↓	↑	↓	↓	↓	↑

MPCA stream habitat assessment score

Table 226. Habitat assessment score for bio sites 10EM067 and 15MN025

07020001-569		Land Use	Riparian	Substrate	Cover	Channel Morphology	Total Score
10EM067	8/24/2010	0	11	14	5	4	34
10EM067	6/9/2015	0	9	12	5	9	35
10EM067	8/6/2015	0	8	11.5	1	13	33.5
15MN025	6/17/2015	0	10	2	1	4	17
Maximum Attainable Habitat Score		**5**	**14**	**28**	**18**	**35**	**100**

Figure 93. Photos of reach 07020001-569 showing channelization (left) as well as bank erosion and muck deposition (right)

Habitat summary

The fish community at bio site 15MN025 scored poorly in six out of eight of the habitat related fish metrics when compared to all other Class 2 southern stream bio sites that met the FIBI modified Use Threshold (Table 224). The fish community at bio site 10EM067 scored poorly in six out of eight of the habitat related fish metrics when compared to all other Class 3 Southern Headwater bio sites that met the FIBI modified Use Threshold (Table 225). There were no benthic insectivores, darters, piscivores, riffle fish, or simple lithophilic spawning fish. Pioneer and tolerant species metrics scored very poorly. Lithophilic and simple lithophilic spawner percentage was higher than the class averages but those numbers were inflated from the 12 creek chubs and 3 blacknose daces that were caught out of only 18 total fish.

The MSHA habitat assessment scored poorly in every visit at both bio sites (Table 226). The downstream bio site, 15MN025, scored lower than the upstream bio site, 10EM067. Site 15MN025 is a modified bio site and the stream

channel is a ditch. 10EM067 is located in a less channelized section of the stream reach, though it is still considered modified. The riparian zone scored well as did the stream channel width. At bio site 10EM067 the channel appears to be stable enough that erosion was listed a light. Embeddedness of coarse substrates was a problem at bio site 10EM067 and no coarse substrate was observed at 15MN025.

Photos of reach 07020001-569 show a channelized ditch (Figure 93). Channelization reduces stream length, increases slope, and leaves the channel devoid of habitat, such as glide/riffle/run/pools sequences. This section is mostly muck and fine silt, most of the coarse sediment that was observed was embedded or covered due to heavy siltation.

It is likely that Hydrologic Alteration and ditching the channel are contributing to limitations in habitat for fish, which in turn is a stressor to the fish within the reach. Lack of habitat is affecting the biology and is a stressor to reach 07020001-569.

3.12.5 Dissolved oxygen

DO biological metric data

Table 227. Dissolved oxygen related fish metrics for bio site 15MN025

07020001-569 **Fish Class 2** **Modified Use**	Mature Age >3 %	Serial Spawner %	Taxa Count	DO TIV	DO Sensitive %	DO Tolerant %
15MN025 6/17/2015	0.0	0.0	3.0	7.1	0.0	16.7
Statewide average for Class 2 southern stream bio sites that are meeting the FIBI modified use threshold (35.0)	**23.9**	**28.7**	**20.4**	**6.8**	**0.9**	**42.6**
Expected response to DO stress	↓	↑	↓	↓	↓	↑

Table 228. Dissolved oxygen related fish metrics for bio site 10EM067

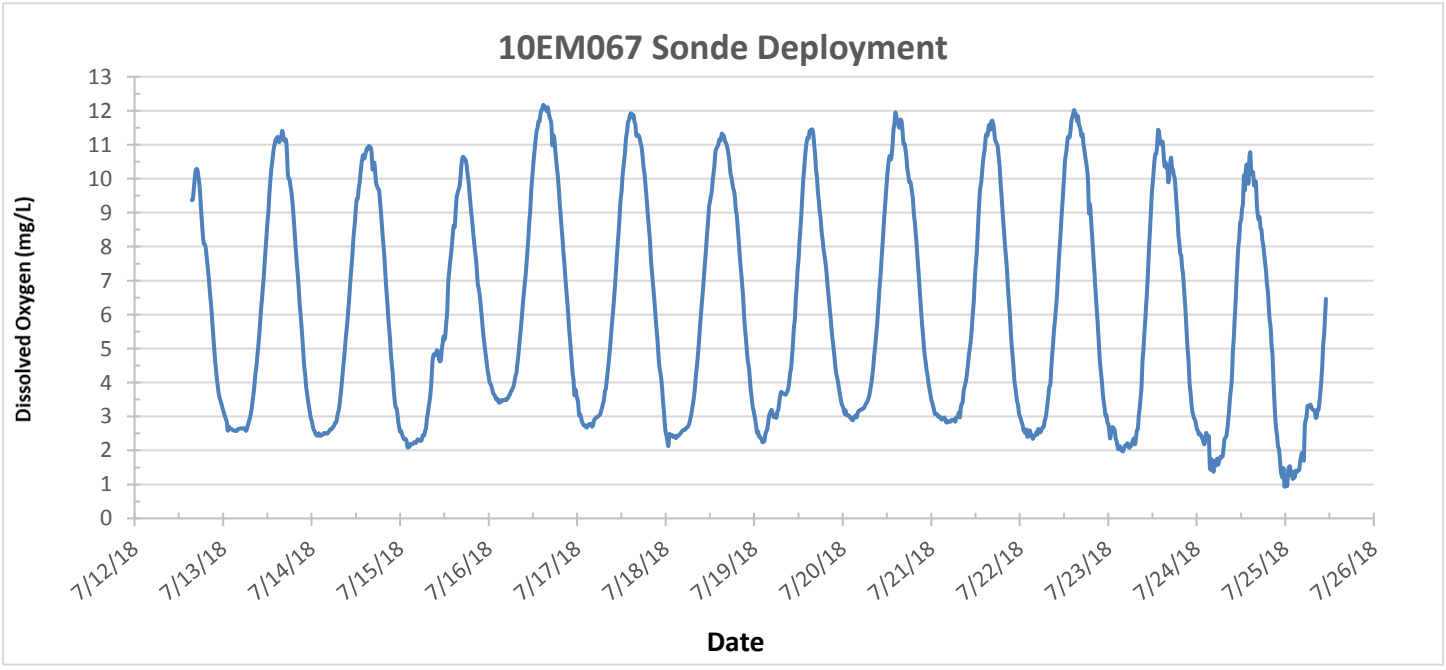
07020001-569 **Fish Class 2** **Modified Use**	Mature Age >3 % %	Serial Spawner %	Taxa Count	DO TIV	DO Sensitive %	DO Tolerant %
10EM067 8/24/2010	2.2	2.2	7.0	7.3	0.0	12.6
10EM067 6/9/2015	0.0	2.3	6.0	7.3	0.0	13.6
Statewide average for Class 3 Southern Stream bio sites that are meeting the FIBI modified use threshold (33.0)	**23.9**	**28.7**	**20.4**	**6.9**	**0.2**	**32.1**
Expected response to DO stress	↓	↑	↓	↓	↓	↑

DO monitoring data

Table 229. Dissolved oxygen data from chemistry site S013-147

07020001-569 DO Data	Range of Data (mg/L)	% of Monthly Samples < 5 mg/L [# of Samples]							% of Total Samples < 5 mg/L [# of Samples]
		April	May	June	July	August	Sept	Oct	
S013-147 (2017)	7.9 – 9.7	N/A [0]	N/A [0]	0% [2]	0% [1]	N/A [0]	N/A [0]	N/A [0]	0% [3]

Figure 94. Continuous dissolved oxygen data at bio site 10EM067



DO HSPF model data

Table 230. Dissolved oxygen HSPF model data

07020001-569 HSPF Reach 408	**June – September** **% Daily Averages** **<5 mg/l** (# of values)
2,318 Total Daily Averages	**11%** (266)

Dissolved oxygen summary

The fish community at bio site 15MN025 scored below average in three out of six DO related fish metrics when compared to the average of all other Class 2 southern stream bio sites that meet the FIBI modified use threshold (Table 227). There were no species whose females take more than three years to mature and there were no fish caught who are sensitive to low DO. The fish community at bio site 10EM067 was a bit better with a few more species caught and 44 total fish caught. There were no species whose females take more than three years to mature and there were no fish caught who are sensitive to low DO.

A YSI Sonde water meter measured continuous dissolved oxygen data from July 12 2017 to July 25 2017 (Figure 88). During this deployment, DO values were measured below the standard all 13 days the sonde was deployed, with the lowest value below 1 mg/L.

Based on the related fish biological metric scores and the measured sonde values, DO is a stressor in this reach.

3.12.6 Eutrophication

Eutrophication biological metric data

Table 231. Eutrophication related fish metrics for bio site 10EM067

07020001-569 **Fish Class 2** **Modified Use**	Darter %	Omnivore %	Sensitive %	Tolerant %
15MN025 6/17/2015	0.0	0.0	0.0	100.0
Statewide average for Class 2 southern stream bio sites that are meeting the FIBI modified use threshold (35.0)	**13.6**	**25.5**	**8.4**	**46.4**
Expected response to eutrophication stress	↓	↑	↓	↑

Table 232. Eutrophication related fish metrics for bio site 10EM067

07020001-569 **Fish Class 3** **Modified Use**	Darter %	Omnivore %	Sensitive %	Tolerant %
10EM067 8/24/2010	4.4	4.4	0.0	95.6
10EM067 6/9/2015	0.0	4.6	0.0	97.7
Statewide average for Class 3 Southern Stream bio sites that are meeting the FIBI modified use threshold (33.0)	**1.5**	**19.8**	**6.0**	**76.7**
Expected response to eutrophication stress	↓	↑	↓	↑

Eutrophication monitoring data

Table 233. Phosphorus monitoring data for chemistry sites S013-147

07020001-569 P Sample Data	Range of Data (mg/L) [# of Samples]	Monthly Average of Samples (mg/L) [# of Samples]							June-Aug Average (mg/L) [# of Samples]
		April	May	June	July	August	Sept	Oct	
S013-147 (2010-2017)	0.02 – 0.50 [6]	N/A [0]	N/A [0]	0.04 [4]	0.315 [1]	0.502 [1]	N/A [0]	N/A [0]	0.16 [6]

Eutrophication HSPF model data

Table 234. HSPF model phosphorus data

	Total Phosphorus	
07020001-569 HSPF Reach 408	**June – September** **% values > 0.15 mg/l** (# Daily Values)	**June – September** **Multi-year Average**
2,318 Total Daily Averages *June – Sep 1994 – 2012*	**98.2%** (2,241)	**0.62 mg/l**

Figure 95. Photo taken of reach 07020001-569 showing algae caught up on rocks directly downstream of a culvert near bio site 10EM067

Eutrophication summary

The fish community at bio site 15MN025 scored poorly in three out of four eutrophication related fish metrics when compared to the average of all other Class 2 southern stream bio sites that meet the FIBI modified use threshold (Table 231). No darters or sensitive fish were caught and tolerant fish comprised 100% of the population. Although there were no omnivorous fish caught, there were only 3 species and 18 total fish caught. The fish community at bio site 10EM067 scored poorly in three out of four eutrophication related fish metrics when compared to the average of all other Class 3 Southern Headwater bio sites that meet the FIBI modified use threshold (Table 232). No darters were caught in the latest visit and no sensitive fish were caught. Tolerant fish comprised 97.7% of the population. However, omnivorous fish were below the class average.

Only six samples were collected and analyzed for Phosphorus from 2015-2018 within reach 07020001-569. The summer average was 0.157 mg/L, just above the standard of 0.15 mg/L (Table 233).

A YSI Sonde water meter measured continuous DO data from July 12 2018 to July 25 2018 (Figure 94). During this deployment, DO diurnal flux, or the difference between the daily high and low DO concentrations was close to 9 mg/L, well above the eutrophication DO flux standard of 5 mg/L.

High levels of phosphorus were measured during sampling and the fish community seems to be showing the effects of eutrophication. DO flux values were well above 5 mg/L and consistently dropped below 5 mg/L. Algae was observed at the site during stressor identification fieldwork (Figure 95). Eutrophication is a stressor to the biological community in reach 07020001-569. It is likely being aggravated by low flow conditions.

3.12.7 Suspended solids

Suspended solids biological metric data

Table 235. Suspended solids related fish metrics for bio site 15MN025

07020001-569 Fish Class 2 Modified Use	Benthic Feeder %	Centrarchid-Tolerant %	Herbivore %	Intolerant %	Long-Lived %	Perciformes-Tolerant %	Riffle %	Sensitive %	Simple Lithophilic Spawner %	TSS TIV
15MN025 6/17/2015	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.0
Statewide average for Class 2 Southern Stream stations that are meeting the FIBI modified use threshold (35.0)	**30.1**	**6.2**	**2.9**	**0.9**	**21.3**	**28.7**	**19.5**	**8.4**	**16.1**	**20.5**
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Table 236. Suspended solids related fish metrics for bio site 10EM067

07020001-569 Fish Class 3 Modified Use	Benthic Feeder %	Centrarchid-Tolerant %	Herbivore %	Intolerant %	Long-Lived %	Perciformes-Tolerant %	Riffle %	Sensitive %	Simple Lithophilic Spawner %	TSS TIV
10EM067 8/24/2010	6.7	0.0	8.2	0.0	0.0	4.4	2.2	0.0	2.2	15.6
10EM067 6/9/2015	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	14.8
Statewide average for Class 3 southern stream bio sites that are meeting the FIBI modified use threshold (33.0)	**31.4**	**1.0**	**10.8**	**0.5**	**4.9**	**12.4**	**22.6**	**6.0**	**15.7**	**16.7**
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

TSS monitoring data

Table 237. Total suspended solids monitoring data for chemistry sites S013-091

07020001-569 TSS Sample Data	Range of Data (mg/L)	% of Monthly Samples > 65 mg/L [# of Samples]							% of Total Samples > 65 mg/L [# of Samples]
		April	May	June	July	August	Sept	Oct	
S013-147 (2015-2017)	1.6 – 2.4	N/A [0]	N/A [0]	0% [6]	N/A [0]	0% [1]	N/A [0]	N/A [0]	0% [7]

Suspended solids summary

The fish community at bio site 15MN025 scored very poorly in TSS related fish metrics when compared to the average of all other Class 2 southern stream bio sites that meet the FIBI modified use threshold (Table 235). There were no benthic feeders, Centrarchids, herbivores, intolerant fish, long-lived fish, perciformes, riffle dwelling fish, sensitive fish, or simple lithophilic spawning fish caught. The TSS TIV score was not elevated above the class average. The fish community at bio site 10EM067 scored very poorly in TSS related fish metrics when compared to the average of all other Class 3 Southern Headwater bio sites that meet the FIBI modified use threshold (Table 235). There were no benthic feeders, Centrarchids, herbivores, intolerant fish, long-lived fish, perciformes, riffle dwelling fish, sensitive fish, or simple lithophilic spawning fish caught. The TSS TIV score was below the class average.

Only seven samples were collected within reach 07020001-569 and all were well below 65 mg/L.

Although the majority of fish metrics related to suspended solids scored poorly, other stressors could be having an effect on these metrics. The TSS specific TIV scores were all below the class averages and the chemistry data, though limited, all showed low concentrations of TSS. It is likely that other factors, such as altered hydrology and habitat are causing poor scores in the fish biological metrics. It is recommended that more TSS data be collected during high flows in order to determine whether it is a biological stressor. Suspended solids are inconclusive as a stressor to aquatic life in reach 07020001-569.

3.12.8 Nitrates

Nitrate biological metric data

Table 238. Nitrate related invertebrate metrics for bio site 10EM067

07020001-569 Invert Class 7 Modified Use		Nitrate Intolerant Taxa %	Nitrogen TIV	Nitrate Tolerant Taxa %	Trichoptera Taxa %
10EM067	8/19/2010	0.0	3.1	61.7	6.7
10EM067	8/19/2010	0.0	3.7	81.6	7.1
10EM067	8/6/2015	0.0	2.6	19.9	9.1
Statewide average for Class 7 Prairie Streams Glide Pool bio sites that are meeting the MIBI modified use threshold (22.0)		**1.9**	**3.3**	**59.4**	**5.9**
Expected response to nitrogen stress		↓	↑	↑	↓

Nitrate monitoring data

Table 239. Nitrate monitoring data for chemistry sites S013-147

07020001-569 Nitrate/Nitrite Sample Data	Range of Data (mg/L)
S013-147 (2010-2018)	0.4 – 8.9

Nitrate summary

The macroinvertebrate assemblage at sites 10EM067 scored poorly in one of the four nitrate related metrics when compared to all other macroinvertebrate Class 7 Prairie Stream Glide Pool bio sites that meet the MIBI modified use threshold (Table 238). Trichoptera taxa percentage scored above the average, which tend to decrease in streams with excessive nitrate values. The nitrogen TIV was below the class average.

Five samples were collected at chemistry sites S013-147 and analyzed for nitrate/nitrite (Table 239). Nitrate concentrations were relatively high as three of the five samples had nitrate concentrations above 8 mg/L.

Due to the low number of chemistry samples as well as the biological metrics not showing a response, nitrates are inconclusive as a stressor at this time. Collecting more chemistry data within this reach is recommended in order to determine if nitrates are a stressor to the biological community.

3.12.9 Reach stressors

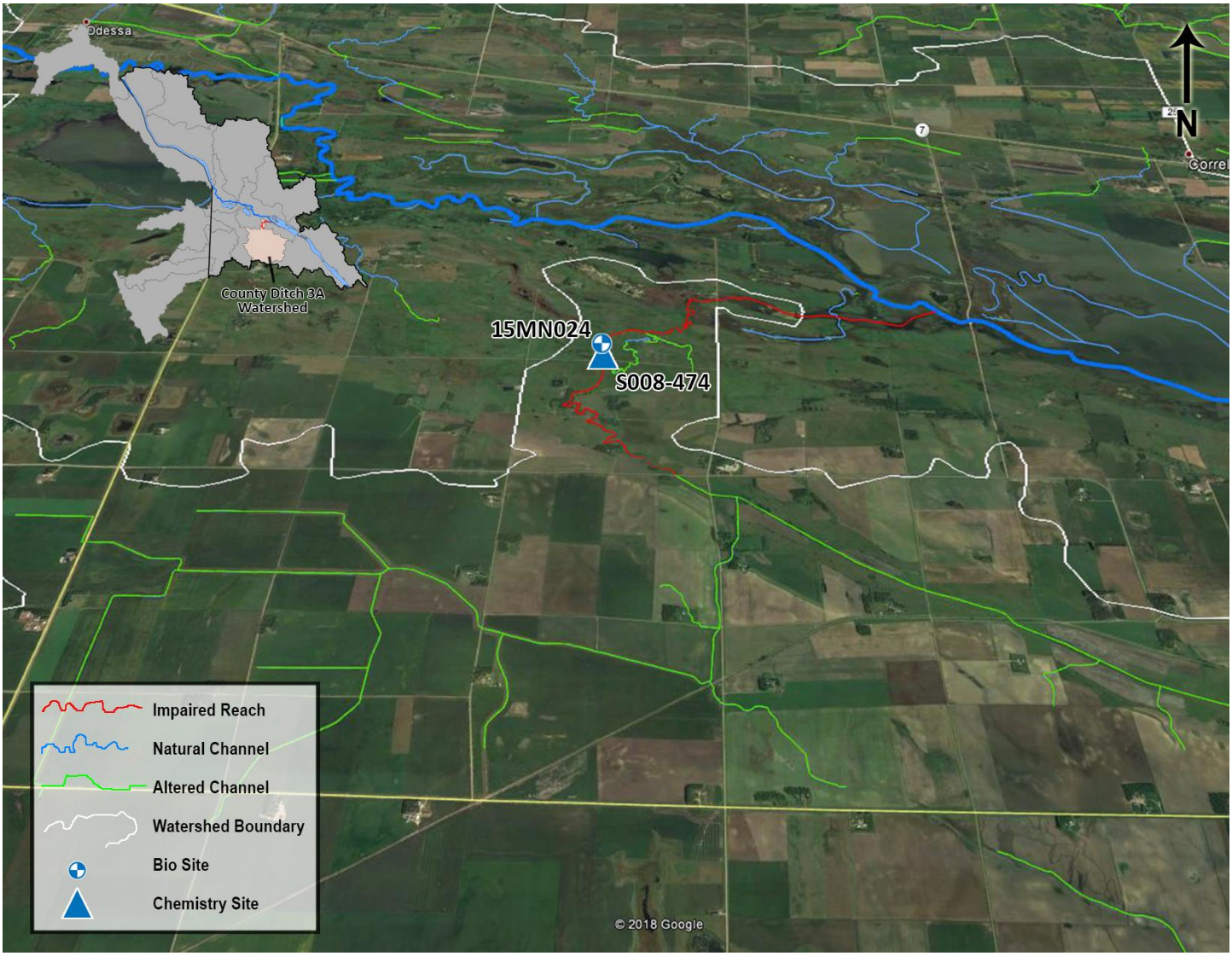
This stream is being stressed by changes to the hydrology of the stream channel and contributing watershed. Most of the reach itself was ditched, as well as the tributaries that flow into this reach, which has eliminated in-stream habitat and has caused heavy siltation and very little depth variability. Historically this reach appeared to be more of a series of wetlands, its flow was redirected, and the wetlands were ditched through. Phosphorus and nitrates quickly reach the stream via drain tiles, outlets, and field runoff. High nutrient levels affects algae growth, DO concentrations, and DO flux causing eutrophic conditions within the reach. The construction of ditches and the addition of tile drainage has altered the land area that that regularly contributes water to the stream as well as the amount and timing of water that reaches the stream.

Table 240. Summary of stressors in reach 07020001-561

07020001-569	Hydrologic Alteration	Connectivity	Habitat	Dissolved Oxygen	Eutrophication	Suspended Solids	Nitrate
✓= Stressor ×= Not a Stressor **O** = Inconclusive	✓	**O**	✓	✓	✓	**O**	**O**

3.13 07020001-570 Unnamed Creek

Figure 96. Satellite image of reach 07020001-570 and its watershed



3.13.1 Biological community

Bio site 15MN024 was sampled for fish in twice in 2015. On June 10 2015 only two tolerant species, creek chubs and blacknose dace, and a total of 49 fish were caught resulting in an IBI score of zero (Table 241). The visit on August 3 2015 scored better with eight different species and 65 total fish caught resulting in an IBI score of 34.4. Six out of the eight species are considered tolerant or very tolerant. The only sensitive species caught were two Iowa darters.

Metrics used to calculate the Fish IBI score are shown in a graph with the red line indicating the value each metric needed to score in order to meet the threshold (Figure 97).

Bio site 15MN024 was sampled for invertebrates on August 5 2015 and received a score of 16.1; well under the invert Class 7 general use threshold of 41 (Table 242). The invertebrate community was dominated by the amphipod Hyalella, a generally tolerant species. Two hundred and twelve Hyalla's were caught, comprising almost 65% of the total invertebrate population. The next abundant invertebrate caught was Caenis diminuta, a somewhat tolerant small,

square-gilled Mayfly. Snails, beetles, and midges made up most of the rest of the invert community with a few Odonata species as well.

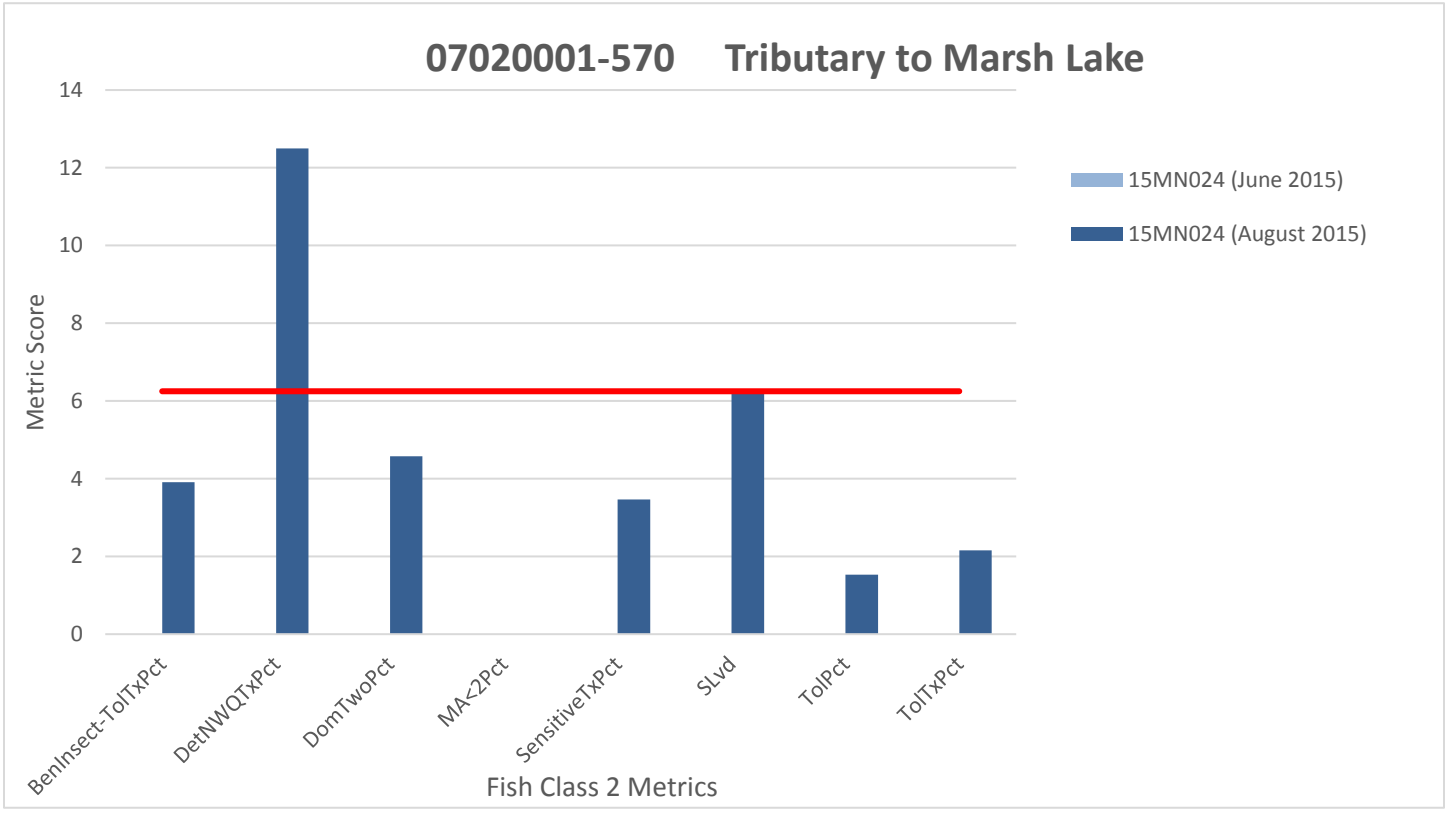
Metrics used to calculate the invert IBI score are shown in a graph with the red line indicating the value each metric needed to score in order to meet the threshold (Figure 97).

Fish biological metric data

Table 241. Fish IBI score and threshold for bio site 15MN024

07020001-570 **Fish Class 2** **General Use**		Fish IBI Score	Class Threshold Score
15MN024	6/10/2015	0	50
15MN024	8/3/2015	34.4	50

Figure 97. Fish Class 2 general use metric scores for bio site 15MN024

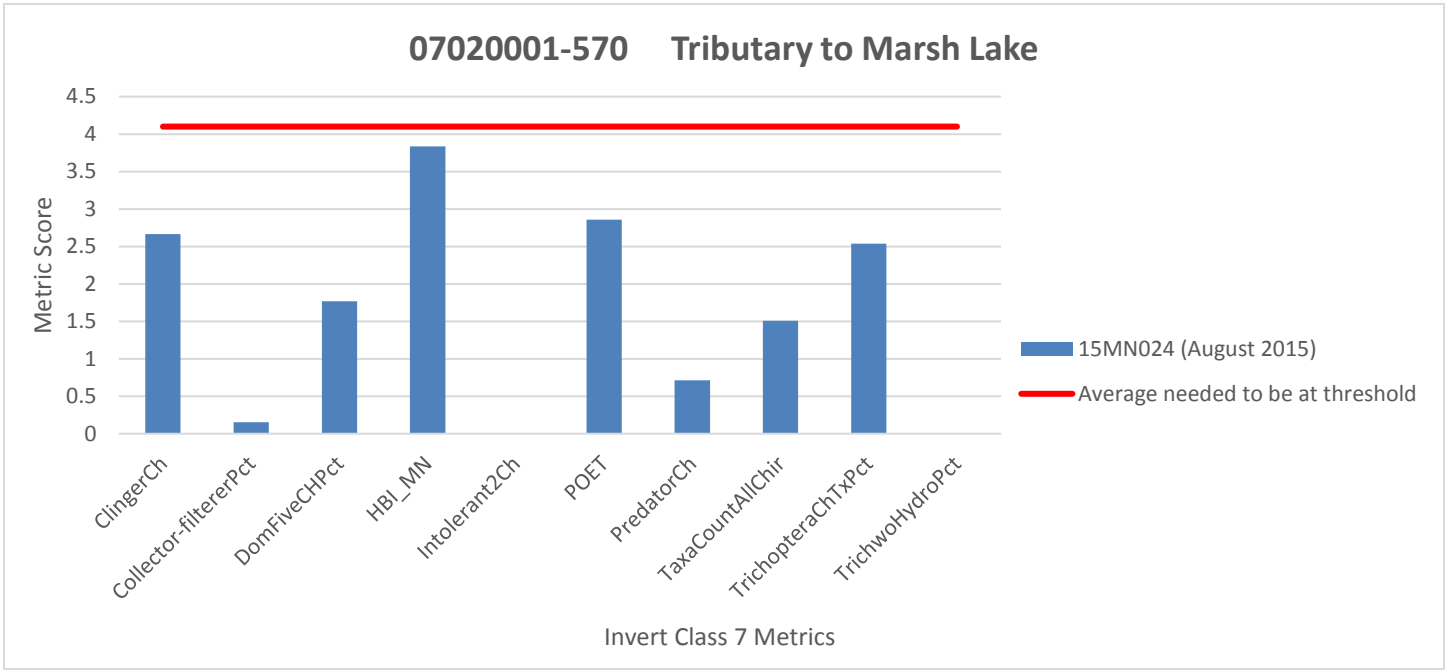


Invertebrate biological metric data

Table 242. Invertebrate IBI score and threshold for bio site 15MN024

07020001-570 **Invert Class 7** **General Use**		Invertebrate IBI Score	Class Threshold Score
15MN024	8/5/2015	16.0	41

Figure 98. Invert Class 2 general use metric scores for bio site 15MN024



3.13.2 Hydrologic alteration

Hydrologic alteration biological metric data

Table 243. Hydrologic alteration related fish metrics for bio site 15MN024

07020001-570 **Fish Class 2** **General Use**	General %	Nesting Non Lithophilic Spawner %
15MN024 6/10/2015	100.0	0.00
15MN024 8/3/2015	72.3	20.0
Statewide average for Class 2 southern stream bio sites that are meeting the FIBI general use threshold (50.0)	**42.4**	**19.1**
Expected response to **Hydrologic** stress	↑	↑

Table 244. Hydrologic alteration related invertebrate metrics for bio site 15MN024

07020001-570 **Invert Class 7** **General Use**	Clinger %	Collector-Filterer %	Long-Lived %
15MN024 8/5/2015	8.8	0.9	9.7
Statewide average for Class 7 Prairie Streams Glide Pool bio sites that are meeting the MIBI general use threshold (41.0)	**38.5**	**19.1**	**8.0**
Expected response to **Hydrologic** stress	↓	↓	↓

HSPF model flow data

Table 245. HSPF modeled flow data, 1994-2012

07020001-570 HSPF Reach 452 Min: 0 cfs Max: 324.8 cfs	**<5 cfs %** (# of values)	**<1 cfs %** (# of values)	**<0.5 cfs %** (# of values)
6,940 Total Daily Averages *1994 – 2012*	**82.7%** (5,738)	**59.3%** (4,113)	**43.4%** (3,015)

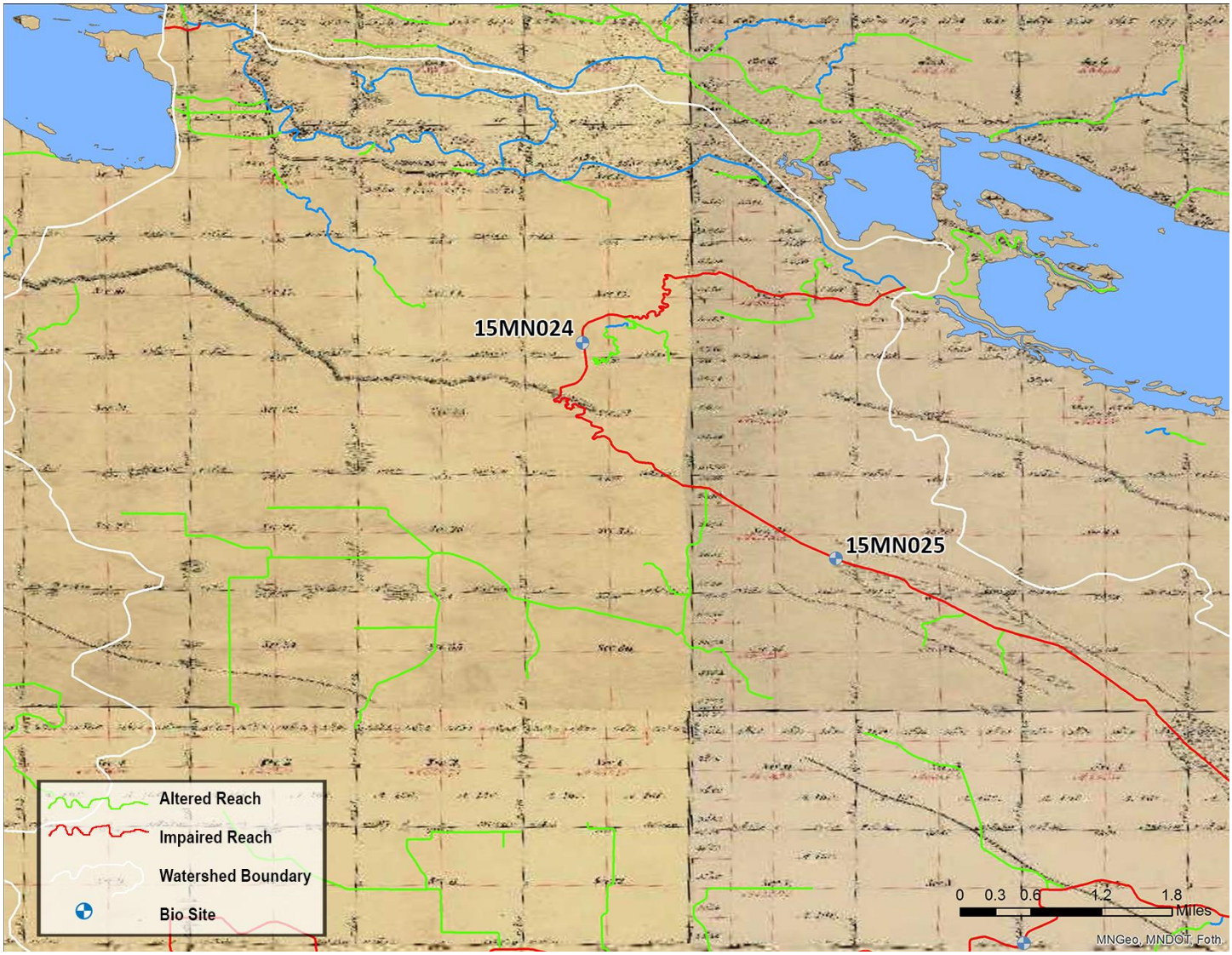
Hydrologic alteration summary

Most of the hydrologic alteration related fish biological metrics scored poorly when compared to the Fish Class 2 (Table 243) bio sites that meet the IBI general use threshold. The only two species caught were creek chubs and blacknose dace, both are a tolerant species. During the June 10 visit, there were no nesting non-lithophilic fish but generalist fish comprised 100% of the population. In August, generalist fish were lower but still well above the class average and nesting fish scored just above the average.

Two out of three of the invertebrate biological metrics scored poorly. Long-lived invertebrates scored just above the Invert Class 7 average.

The HSPF model (Table 245) shows that 59.3% of the daily average flows from 1994 – 2012 are below 1 cfs. Flows of less than 5 cfs were higher at 82.7%. Flows reduced beyond normal base flow decreases habitat for aquatic organisms and increases competition for resources.

Figure 99. Original survey plat map of the watershed of reach 07020001-570 including altered watercourses



The upstream reach 07020001-569 and the contributing watershed of reach 07020001-570 is highly altered. Almost all streams in the watershed that drain into the reach are ditches, likely created to drain wetlands in the very flat and low lying area (Figure 99). The watershed is also extensively drained in order to grow crops. Drainage and land cover changes are likely contributing to high flow conditions during wet periods and low flow conditions during dry periods.

Based on the very poor scores of the fish biological metrics, the channelization upstream, the very high percentage of low flows, and the evidence of drainage in its upper watershed, Hydrologic Alteration is a stressor in reach 07020001-570. The primary impact in this reach from Hydrologic Alteration is the ditching and channelization of the stream channel and its tributaries, subsurface tile drainage of the surrounding wetlands, as well as the pollutant overloading of nutrients.

3.13.3 Connectivity

Connectivity metric data

Table 246. Connectivity related fish metrics for bio site 15MN024

07020001-570 Fish Class 2 General Use		Mature Age >3 minus Tolerant Taxa %	Migrating Taxa %
15MN024	6/10/2015	0.0	0.0
15MN024	8/3/2015	0.0	12.5
Statewide average for Class 2 southern stream bio sites that are meeting the FIBI general use threshold (50.0)		**21.8**	**24.3**
Expected response to connectivity stress		↓	↓

Connectivity summary

Both fish metrics scored poorly at bio site 15MN024 (Table 246). No fish whose females take greater than three years to mature were caught at either visit. There were no migrating fish caught in June and few caught in August. Although no downstream culverts or road crossings were identified as fish barriers, there are several road crossing and culverts that could be limiting fish migration. Due to the lack of long-lived species and migratory species it appears that connectivity is a stressor at this time though with no identified fish barriers it is inconclusive.

3.13.4 Habitat

Habitat metric data

Table 247. Habitat related fish metrics for bio site 15MN024

07020001-570 Fish Class 2 General Use		Benthic Insect minus Tolerant %	Darter Sculpin Sucker %	Lithophilic Spawner %	Pioneer %	Piscivore %	Riffle %	Simple Lithophilic Spawner %	Tolerant %
15MN024	6/10/2015	0.0	0.0	100.0	89.8	0.0	0.0	10.2	100.0
15MN024	8/3/2015	3.1	3.1	66.2	32.3	0.0	0.0	33.9	69.2
Statewide average for Class 2 southern stream bio sites that are meeting the FIBI general use threshold (50.0)		**20.4**	**18.2**	**58.3**	**19.0**	**5.2**	**32.5**	**39.4**	**44.9**
Expected response to habitat stress		↓	↓	↓	↑	↓	↓	↓	↑

Table 248. Habitat related invert metrics for bio site 15MN024

07020001-570 Invert Class 7 General Use	Burrower %	Climber %	Clinger %	Ephemeroptera Plecoptera Trichoptera %	Legless %	Sprawler %
15MN024 8/5/2015	2.4	11.0	8.8	7.9	17.0	77.5
Statewide average for Class 7 Prairie Streams Glide Pool bio sites that are meeting the MIBI general use threshold (41.0)	**7.5**	**21.6**	**38.5**	**38.5**	**39.8**	**20.9**
Expected response to habitat stress	↑	↓	↓	↓	↑	↑

MPCA stream habitat assessment score

Table 249. Habitat assessment score for bio site 15MN024

07020001-570	Land Use	Riparian	Substrate	Cover	Channel Morphology	Total Score
15MN024 6/10/2015	2.5	10	19	8	6	45.5
15MN024 8/3/2015	2.5	9	17	7	4	39.5
15MN024 8/5/2015	1.5	10	13	5	7	36.5
Maximum Attainable Habitat Score	**5**	**14**	**28**	**18**	**35**	**100**

Figure 100. Photos of reach 07020001-570 showing some channelization and down cutting (left) as well as some embedded coarse sediment observed at the bio site (right)

Habitat summary

The fish community at bio site 15MN024 scored poorly on both visits in seven out of eight of the habitat related fish metrics when compared to all other Class 2 southern stream bio sites that met the FIBI general Use Threshold (Table 247). There were very few benthic insectivores, darters, and simple lithophilic spawning fish. There were no piscivores or riffle fish. Pioneer and tolerant species metrics scored very poorly. Lithophilic spawner percentage was higher than the class averages but those numbers were high from the percentage of creek chubs and blacknose daces compared to the total number of fish that were caught.

The invertebrate metrics at bio site 15MN024 are mixed (Table 248). The bio site scored poorly in four out of six habitat related metrics. There were low numbers of burrowers and legless species. Sprawler invertebrates scored poorly at 77% due to the overabundance of Hyallela, a tolerant freshwater amphipod, as well as the tolerant mayfly Caenis diminuta, which is tolerant of silt. There were low numbers of climbers likely due to the lack of woody debris and low numbers of clingers from siltation and embeddedness of coarse substrates.

The MSHA habitat assessment scored poorly in the three assessments at bio site 15MN024 (Table 249). The riparian zone and substrate scored decently as there was a decent riparian width and only moderate bank erosion. The stream substrate was listed as gravel, sand, and silt present with severe embeddedness of coarse substrates. Cover scored poorly as well as channel morphology, as there were no riffle or pools present. Evidence of both channel alteration and down cutting indicates the stream was altered at this bio site and is adjusting to Hydrologic Alteration upstream.

The ditching of the channel at the bio site and further upstream as well as other forms of Hydrologic Alteration upstream in the watershed has created a fairly wide, flat streambed devoid of depth variability, sinuosity, riffles, or channel development (Figure 100). These alterations of the hydrology of the reach is contributing to limitations in habitat for both fish and invertebrates and is a stressor to the biology within the reach.

3.13.5 Dissolved oxygen

DO biological metric data

Table 250. Dissolved oxygen related fish metrics for bio site 15MN024

07020001-570 **Fish Class 2** **General Use**	Mature Age >3 %	Serial Spawner %	Taxa Count	DO TIV	DO Sensitive %	DO Tolerant %
15MN024 6/10/2015	0.0	0.0	2.0	7.3	0.0	0.0
15MN024 8/3/2015	0.0	1.5	8.0	6.8	0.0	32.3
Statewide average for Class 2 southern stream bio sites that are meeting the FIBI general use threshold (50.0)	**23.9**	**28.7**	**20.4**	**7.2**	**6.1**	**15.8**
Expected response to DO stress	↓	↑	↓	↓	↓	↑

Table 251. Dissolved oxygen related invertebrate metrics for bio site 15MN024

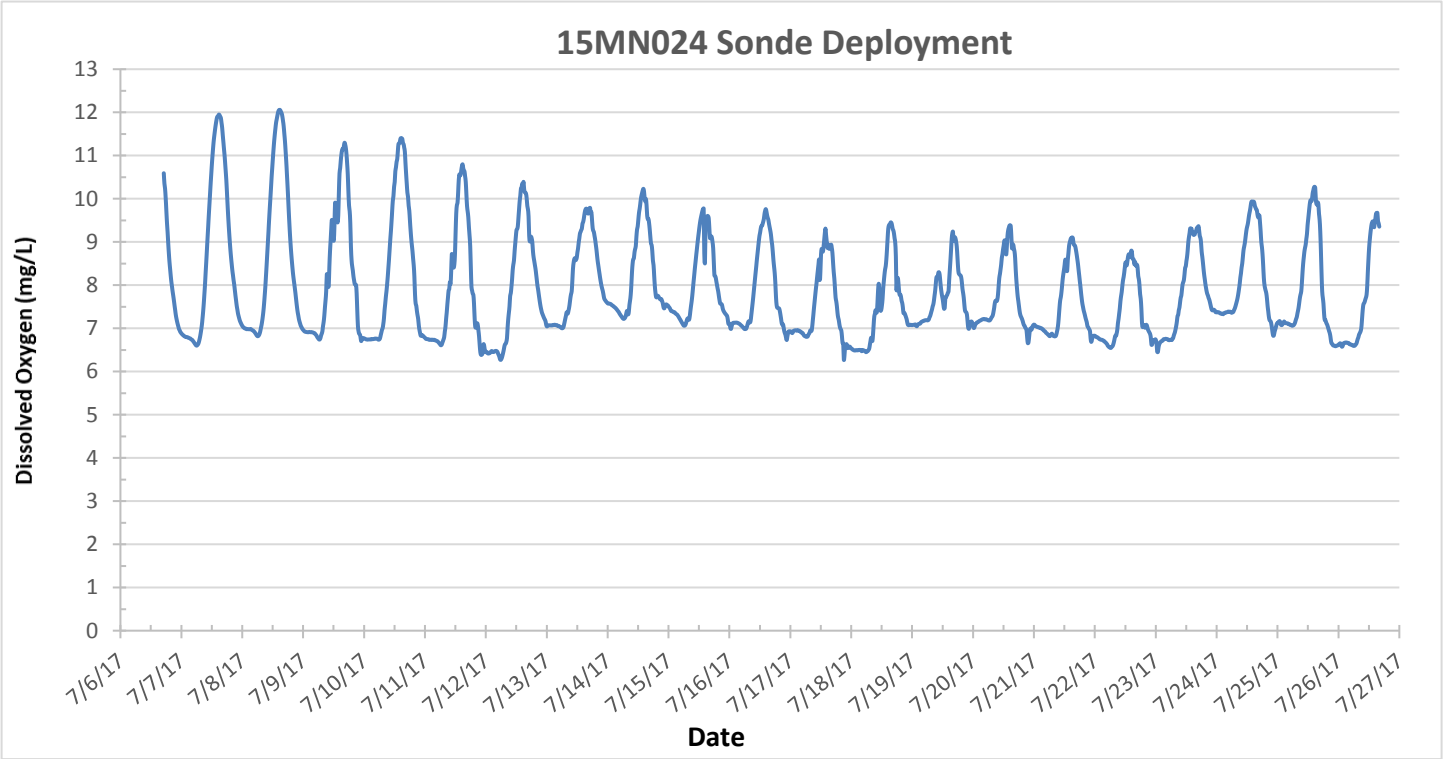
07020001-570 **Invert Class 7** **General Use**	Low DO Intolerant Taxa %	Low DO Tolerant Taxa %	DO TIV	HBI_MN
15MN024 8/5/2015	0.9	74.8	6.2	7.7
Statewide average for Class 7 Prairie Streams Glide Pool bio sites that are meeting the MIBI general use threshold (41.0)	**6.4**	**13.0**	**6.9**	**7.6**
Expected response to DO stress	↓	↑	↓	↑

DO monitoring data

Table 252. Dissolved oxygen data from chemistry site S008-474

07020001-570 DO Data	Range of Data (mg/L)	% of Monthly Samples < 5 mg/L [# of Samples]							% of Total Samples < 5 mg/L [# of Samples]
		April	May	June	July	August	Sept	Oct	
S008-474 (2014-2016)	5.9 – 13.5	N/A [0]	0% [2]	0% [5]	0% [9]	0% [5]	0% [2]	N/A [0]	0% [23]

Figure 101. Continuous dissolved oxygen data at bio site 15MN024



DO HSPF model data

Table 253. Dissolved oxygen HSPF model data

07020001-570 HSPF Reach 452	**June – September** **% Daily Averages** **<5 mg/l** (# of values)
2,318 Total Daily Averages	**21%** (476)

Dissolved oxygen summary

The fish community at bio site 15MN024 scored below average during the June visit in four out of six DO related fish metrics when compared to the average of all other Class 2 southern stream bio sites that meet the FIBI general use threshold (Table 250). There were no species whose females take more than three years to mature and there were no fish caught who are sensitive to low DO. The fish community at bio site 15MN024 again scored poorly in four out of six DO related metrics during the August visit with a few more species and 65 total fish caught. Again, there were no species whose females take more than three years to mature and there were no fish caught who are sensitive to low DO.

A YSI Sonde water meter measured continuous DO data from July 6 2017 to July 26 2017 (Figure 101). During this deployment, DO values were not measured below the standard any of the days the sonde was deployed.

The HSPF model estimates that 21% of the DO daily average values fell below 5 mg/l.

Based on the mixed related fish biological metric scores and the measured sonde values, DO is inconclusive as a stressor in this reach.

3.13.6 Eutrophication

Eutrophication biological metric data

Table 254. Eutrophication related fish metrics for bio site 15MN024

07020001-570 **Fish Class 2** **General Use**	Darter %	Omnivore %	Sensitive %	Tolerant %
15MN024 6/10/2015	0.0	0.0	0.0	100.0
15MN024 8/3/2015	3.1	6.2	3.1	69.2
Statewide average for Class 2 southern stream bio sites that are meeting the FIBI general use threshold (50.0)	**11.7**	**16.5**	**18.7**	**44.9**
Expected response to eutrophication stress	↓	↑	↓	↑

Table 255. Eutrophication related invertebrate metrics for bio site 15MN024

07020001-570 **Invert Class 7** **General Use**	Taxa Count All #	Collector – Filterer Taxa #	Collector – Gatherer Taxa #	Ephemeroptera Plecoptera Trichoptera Taxa #	Intolerant Taxa #	Tolerant Taxa %
15MN024 8/5/2015	24	2	9	3	0	91.7
Statewide average for Class 7 Prairie Stream Glide Pool bio sites that are meeting the MIBI general use threshold (41.0)	**37**	**5**	**13.2**	**8.9**	**0.2**	**81.9**
Expected response to eutrophication stress	↓	↓	↑	↓	↓	↑

Eutrophication monitoring data

Table 256. Phosphorus monitoring data for chemistry sites S008-474

07020001-570 P Sample Data	Range of Data (mg/L)	Monthly Average of Samples (mg/L) [# of Samples]							June-Aug Average (mg/L) [# of Samples]
		April	May	June	July	August	Sept	Oct	
S008-474 (2015-2017)	0.03 – 0.26	N/A [0]	0.11 [2]	0.04 [4]	0.13 [4]	0.16 [2]	0.06 [2]	N/A [0]	0.10 [14]

Eutrophication HSPF model data

Table 257. HSPF model phosphorus data

	Total Phosphorus	
07020001-570 HSPF Reach 452	**June – September % values > 0.15 mg/l** (# Daily Values)	**June – September Multi-year Average**
2,318 Total Daily Averages June – Sep 1994 – 2012	**79.9%** (1,851)	**0.67 mg/l**

Eutrophication summary

The fish community at bio site 15MN024 scored very poorly during both 2015 visits in three out of four eutrophication related fish metrics when compared to the average of all other Class 2 southern stream bio sites that meet the FIBI general use threshold (Table 254). In June, no darters or sensitive fish were caught and tolerant fish comprised 100% of the population. There were only 2 tolerant species and 49 total fish caught. In August, the fish population looked better as there were more species of fish caught but only two Iowa darters, which accounted for the only darter and sensitive fish. Tolerant fish comprised 69.2% of the population. Omnivorous fish were below the class average during both visits

During the August 2015 visit, the invertebrate community at bio site 15MN024 scored very poorly in all six eutrophication related invertebrate metrics when compared to the average of all other Class 7 Prairie Stream Glide Pool bio sites that meet the MIBI general use threshold (Table 255). Total taxa count scored poorly, as did the collector – Filterer taxa metrics. EPT taxa were below the class average and no intolerant taxa were caught. Tolerant fish made up over 91% of the total population.

Only fourteen samples were collected and analyzed for phosphorus from 2015-2017 within reach 07020001-570. The summer average was 0.10 mg/L, below the standard of 0.15 mg/L (Table 256).

A YSI Sonde water meter measured continuous DO data from July 6 2017 to July 26 2017 (Figure 101). During this deployment, DO diurnal flux, or the difference between the daily high and low DO concentrations was close to the eutrophication DO flux standard of 5 mg/L.

High levels of phosphorus were measured during the limited water chemistry sampling. Both the fish and invert community seems to be showing the effects of eutrophication. DO flux values were close to or above 5 mg/L. Eutrophication is a stressor to the biological community in reach 07020001-570.

3.13.7 Suspended solids

Suspended solids biological metric data

Table 258. Suspended solids related fish metrics for bio site 15MN024

07020001-570 Fish Class 2 General Use	Benthic Feeder %	Centrarchid-Tolerant %	Herbivore %	Intolerant %	Long-Lived %	Perciformes-Tolerant %	Riffle %	Sensitive %	Simple Lithophilic Spawner %	TSS TIV
15MN024 6/10/2015	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.2	15.7
15MN024 8/3/2015	0.0	0.0	0.0	0.0	6.2	3.1	0.0	3.1	33.9	15.6
Statewide average for Class 2 Southern Stream stations that are meeting the FIBI general use threshold (50.0)	**37.4**	**4.9**	**9.6**	**5.0**	**11.7**	**18.7**	**32.5**	**18.7**	**39.4**	**17.6**
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Table 259. Suspended solids related invertebrate metrics for bio site 15MN024

07020001-570 Invert Class 7 General Use	Collector-Filterer %	Plecoptera %	TSS Intolerant %	TSS Tolerant %	TSS TIV
15MN024 8/5/2015	0.9	0.0	1.0	10.0	16.5
Statewide average for Class 7 Prairie Streams Glide Pool bio sites that are meeting the MIBI general use threshold (41.0)	**19.1**	**0.2**	**2.7**	**48.3**	**17.8**
Expected response to TSS stress	↓	↓	↓	↑	↑

TSS Monitoring data

Table 260. Total suspended solids monitoring data for chemistry site S008-474

07020001-570 TSS Sample Data	Range of Data (mg/L)	% of Monthly Samples > 65 mg/L [# of Samples]							% of Total Samples > 65 mg/L [# of Samples]
		April	May	June	July	August	Sept	Oct	
S008-474 (2015)	4 – 84	N/A [0]	0% [2]	0% [4]	0% [3]	50% [2]	0% [2]	N/A [0]	8% [13]

Suspended solids summary

The fish community at bio site 15MN024 scored very poorly in most TSS related fish metrics when compared to the average of all other Class 2 southern stream bio sites that meet the FIBI general use threshold (Table 258). There were no benthic feeders, Centrarchids, herbivores, intolerant fish, riffle dwelling fish, and very few, long-lived fish, perciformes, sensitive fish, or simple lithophilic spawning fish caught. The TSS TIV score was below the class average and scored decent.

The invertebrate community at bio site 15MN024 scored very poorly in three out of five TSS related invertebrate metrics when compared to the average of all other Class 2 southern stream bio sites that meet the FIBI general use threshold (Table 259). There were almost no collector-filterers, plecoptera, sensitive, or intolerant species. The TSS TIV score was just below the class average.

Only 13 samples were collected within reach 07020001-570. All but one were well below 65 mg/L (Table 260).

Although the majority of fish metrics and the majority of invert metrics related to suspended solids scored poorly, the TSS TIV scores were all below the class averages. The chemistry data, though limited, showed low concentrations of TSS. Suspended solids are inconclusive as a stressor to aquatic life in reach 07020001-570. It is likely that other factors, such as altered hydrology and habitat are causing poor scores in the fish biological metrics. It is recommended that more TSS data be collected during high flows in order to determine whether it is a biological stressor.

3.13.8 Nitrates

Nitrate biological metric data

Table 261. Nitrate related invertebrate metrics for bio site 15MN024

07020001-570 **Invert Class 7** **General Use**	N Intolerant Taxa %	Nitrogen TIV	Nitrate Tolerant Taxa %	Trichoptera Taxa %
15MN024 8/5/2015	0.0	2.9	31.3	4.2
Statewide average for Class 7 Prairie Streams Glide Pool bio sites that are meeting the MIBI general use threshold (41.0)	**3.2**	**3.2**	**54.9**	**10.9**
Expected response to nitrogen stress	↓	↑	↑	↓

Nitrate monitoring data

Table 262. Nitrate monitoring data for chemistry sites S008-474

07020001-570 Nitrate/Nitrite Sample Data	Range of Data (mg/L)
S008-474 (2015-2017)	0.5 – 10.8

Nitrate summary

The macroinvertebrate assemblage at sites 15MN024 scored poorly in half of the four nitrate related metrics when compared to all other macroinvertebrate Class 7 Prairie Stream Glide Pool bio sites that meet the MIBI general use threshold (Table 261). There were no nitrogen tolerant taxa. Trichoptera taxa percentage scored below the average, which tend to decrease in streams with excessive nitrate values. Nitrogen tolerant taxa scored below the class average but still made up over 30% of the total invertebrates. The nitrogen TIV scored decent and was below the class average.

Fourteen samples were collected at chemistry site S008-474 and analyzed for nitrate/nitrite (Table 262). Four of the samples had nitrate concentrations above 7 mg/L and one of the samples had nitrate concentrations above 10 mg/L. Nitrates are inconclusive as a stressor to the biological community in reach 07020001-570. Collecting more chemistry data within this reach is recommended in order to determine if nitrates are a stressor to the biological community.

3.13.9 Reach stressors

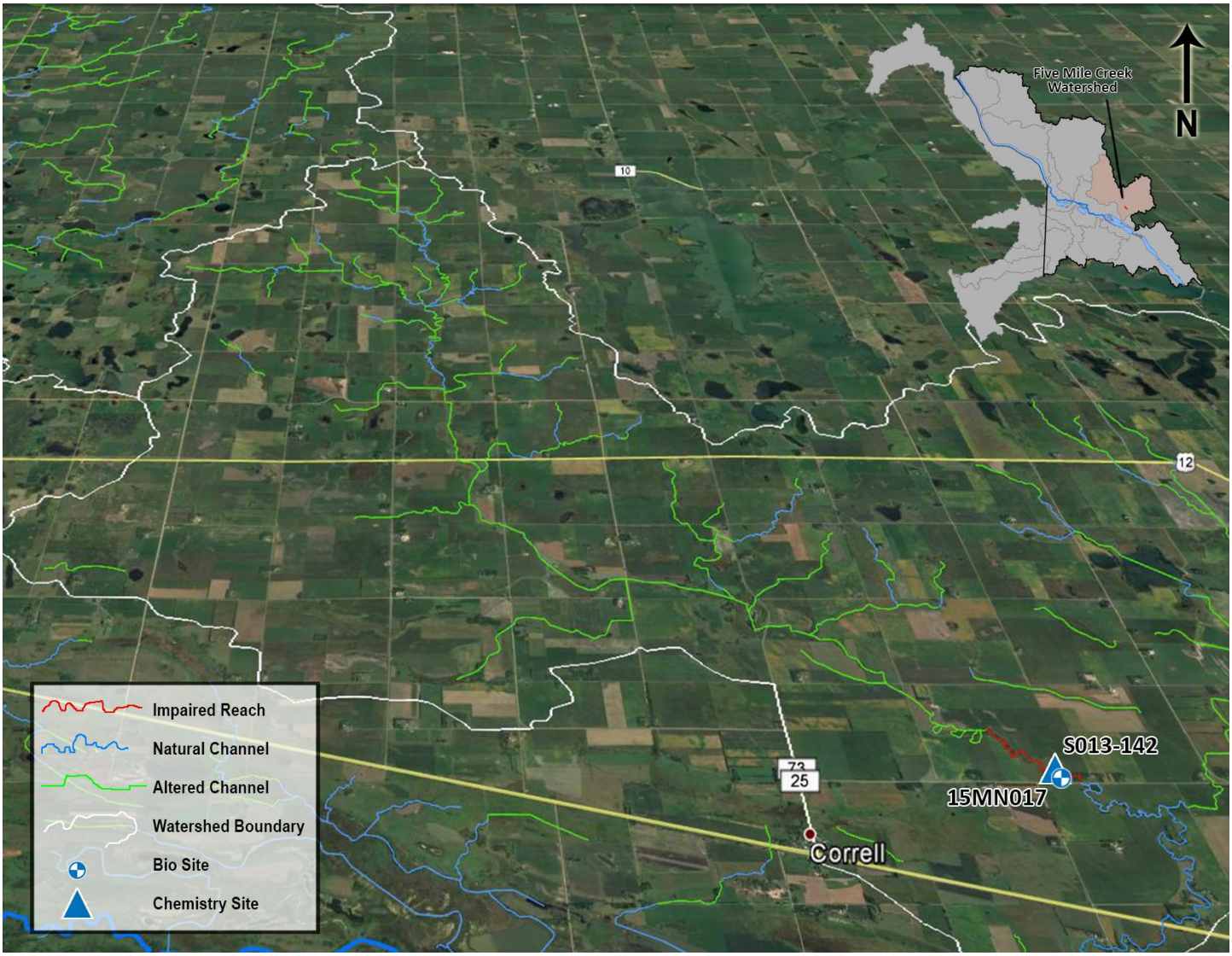
This reach is just the furthest downstream section of reach 07020001-569. This stream is being stressed by changes to the hydrology of the stream channel and contributing watershed. Most of the reach itself was ditched, as well as the tributaries that flow into this reach, which has eliminated in-stream habitat and has caused heavy siltation and very little depth variability. Historically this reach appeared to be more of a series of wetlands, its flow was redirected, and the wetlands were ditched through. Phosphorus and nitrates quickly reach the stream via drain tiles, outlets, and field runoff. High nutrient levels affects algae growth, DO concentrations and flux causing eutrophic conditions within the reach. The construction of ditches and the addition of tile drainage has altered the land area that that regularly contributes water to the stream as well as the amount and timing of water that reaches the stream.

Table 263. Summary of stressors in reach 07020001-570

07020001-570	Hydrologic Alteration	Connectivity	Habitat	Dissolved Oxygen	Eutrophication	Suspended Solids	Nitrate
✓= Stressor ×= Not a Stressor **O** = Inconclusive	✓	**O**	✓	**O**	✓	**O**	**O**

3.141.107020001-574County Ditch 2

Figure 102. Satellite image of reach 07020001-574 and its watershed



3.14.1 Biological community

Bio site 15MN017 was sampled for fish once in 2015. Seven total species and 65 individual fish were caught, with fathead minnows and creek chubs comprising over 84% of the population, resulting in an IBI score of 15.2 (Table 264). No sensitive species were caught.

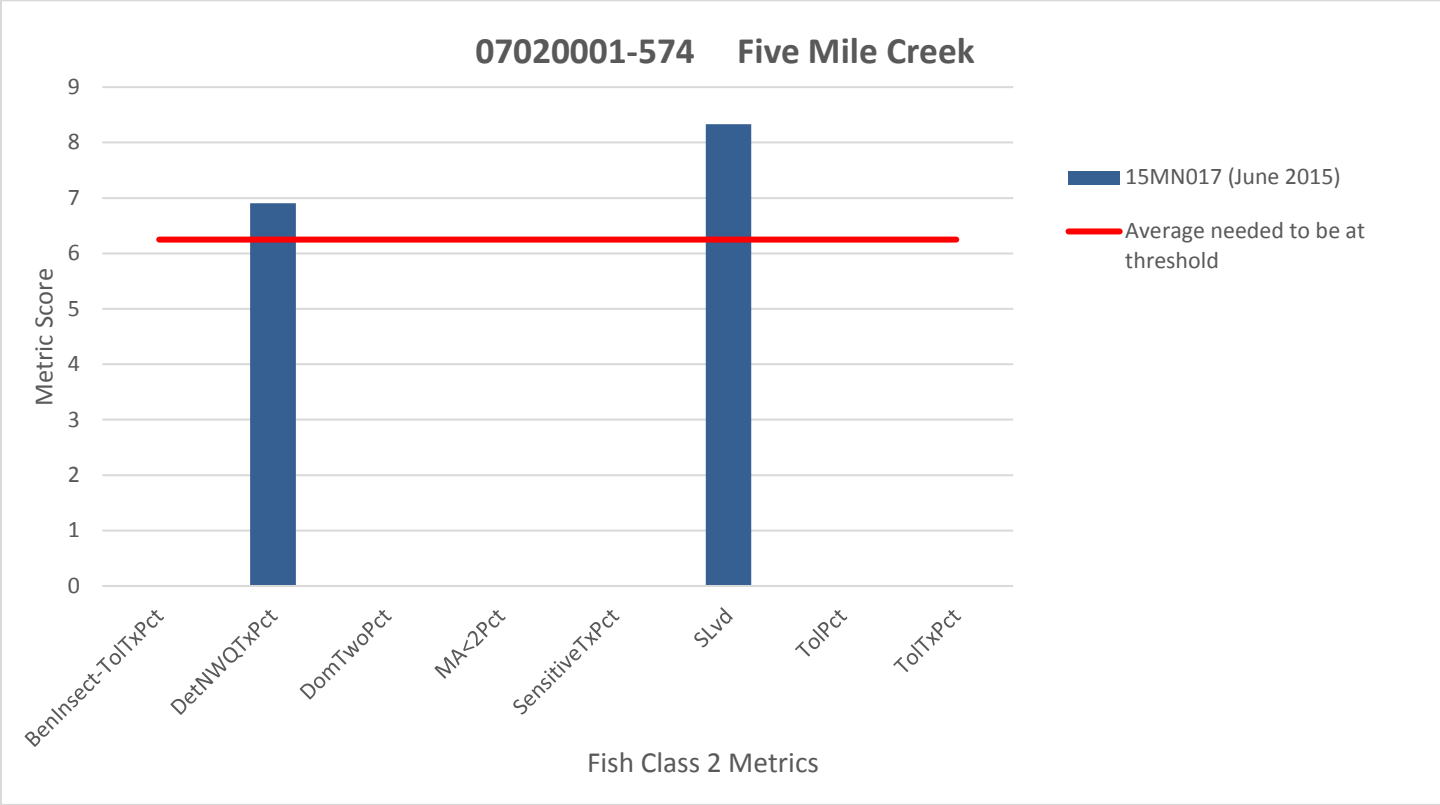
Metrics used to calculate the Fish IBI score are shown in a graph with the red line indicating the value each metric needed to score in order to meet the threshold (Figure 103).

Table 264. Fish IBI score and threshold for bio site 15MN017

07020001-574 Fish Class 2 General Use		Fish IBI Score	Class Threshold Score
15MN017	6/10/2015	15.2	50

Biological metric data

Figure 103. Fish Class 2 general use metric scores for bio site 15MN017



3.14.2 Hydrologic alteration

Hydrologic alteration biological metric data

Table 265. Hydrologic alteration related fish metrics for bio site 15MN017

07020001-574 **Fish Class 2** **General Use**	General %	Nesting Non Lithophilic Spawner %
15MN017 6/9/2015	95.4	73.9
Statewide average for Class 2 southern stream bio sites that are meeting the FIBI general use threshold (50.0)	**42.4**	**19.1**
Expected response to **Hydrologic** stress	↑	↑

HSPF model flow data

Table 266. HSPF modeled flow data, 1994-2012

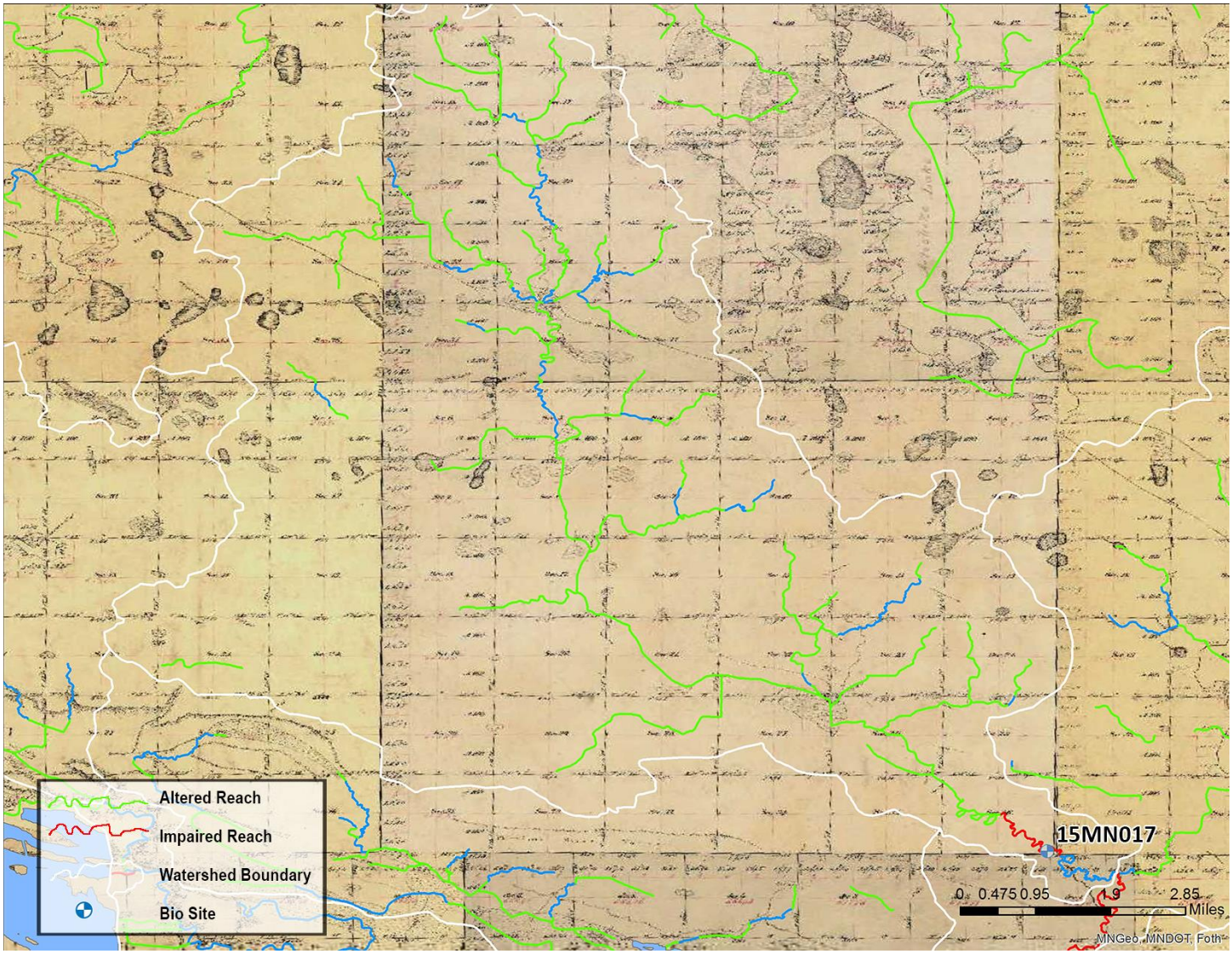
07020001-574 HSPF Reach 411 Min: 0 cfs Max: 828.6 cfs	**<5 cfs %** (# of values)	**<1 cfs %** (# of values)	**<0.5 cfs %** (# of values)
6,940 Total Daily Averages 1994 – 2012	**66.5%** (4,614)	**38.1%** (2,642)	**26.6%** (1,848)

Hydrologic alteration summary

Both of the hydrologic alteration related fish biological metrics scored poorly when compared to the Fish Class 2 bio sites that meet the IBI general use threshold (Table 265). At 95.4%, generalists scored very poorly and over 73% of the fish caught are nesting species. The two dominant species, fathead minnows and creek chubs, made up over 84% of the total number of fish. All of the species caught were short maturing and over 75% were short-lived species. None of the species caught are considered sensitive.

The HSPF model (Table 266) shows that 38.1% of the daily average flows from 1994 – 2012 are below 1 cfs. Flows of less than 5 cfs were higher at 66.5%. Flows reduced beyond normal base flow decreases habitat for aquatic organisms and increases competition for resources.

Figure 104. Original survey plat map of the watershed of reach 07020001-574 including altered watercourses



Reach 07020001-574 is a relatively small stream reach at the end of a large and highly altered watershed. Most of the stream's tributaries have been altered into ditches in order to move water (Figure 104). Creating these ditches essentially added to the amount of land and water that drains into the creek and also the timing of water runoff. This altered the natural flow regime of this stream that had developed over several millenniums by decreasing the time it takes for water to move through the system, moving more water through the system at a higher frequency, and increasing the impact to the stream channel of high flow events while also increasing the intensity of low flow periods.

Based on the very poor scores of the fish biological metrics, high percentage of channelization and altered stream channels upstream (Figure 102), the high percentage of modeled low flows, and the evidence of drainage in its upper watershed, Hydrologic Alteration is a stressor in reach 07020001-574. The primary impact in this reach from Hydrologic Alteration is the extensive low flows resulting from the ditching and channelization of the tributaries in the watershed and subsurface tile drainage of the surrounding wetlands, as well as the pollutant overloading of nutrients.

3.14.3 Connectivity

Connectivity metric data

Table 267. Connectivity related fish metrics for bio site 15MN017

07020001-574 **Fish Class 2** **General Use**	Mature Age >3 minus Tolerant Taxa %	Migrating Taxa %
15MN017 6/9/2015	0.0	0.0
Statewide average for Class 2 southern stream bio sites that are meeting the FIBI general use threshold (50.0)	**21.8**	**24.3**
Expected response to connectivity stress	↓	↓

Connectivity summary

No fish whose females take greater than three years to mature or migrating fish were caught at either bio site (Table 267). Although no downstream culverts or road crossings were identified as fish barriers, there are several that could be limiting fish migration. Due to the lack of long-lived and migratory species, it appears that connectivity could be a stressor but at this time is inconclusive. It is recommended that road crossings be checked and inventoried to rule out any possible fish barriers both up and downstream of reach 07020001-574.

3.14.4 Habitat

Habitat metric data

Table 268. Habitat related fish metrics for bio site 15MN017

07020001-574 **Fish Class 2** **General Use**	Benthic Insect minus Tolerant %	Darter Sculpin Sucker %	Lithophilic Spawner %	Pioneer %	Piscivore %	Riffle %	Simple Lithophilic Spawner %	Tolerant %
15MN017 6/9/2015	0.0	0.0	16.9	84.6	0.0	0.0	3.1	98.5
Statewide average for Class 2 southern stream bio sites that are meeting the FIBI general use threshold (50.0)	**20.4**	**18.2**	**58.3**	**19.0**	**5.2**	**32.5**	**39.4**	**44.5**
Expected response to habitat stress	↓	↓	↓	↑	↓	↓	↓	↑

MPCA stream habitat assessment score

Table 269. Habitat assessment score for bio site 15MN017

07020001-574		Land Use	Riparian	Substrate	Cover	Channel Morphology	Total Score
15MN017	6/9/2015	0	7.5	12	12	18	49.5
15MN017	8/5/2015	0	9.5	8	3	9	29.5
Maximum Attainable Habitat Score		**5**	**14**	**28**	**18**	**35**	**100**

Figure 105. Photo just upstream of Bio site 15MN017 showing incision (left) and a photo showing severe bank erosion within reach 07020001-574 (right).

Habitat summary

The fish community at bio site 15MN017 scored poorly in all eight of the habitat related fish metrics when compared to all other Class 2 southern stream bio sites that met the FIBI general use threshold (Table 268). There were no benthic insectivores, darters, and very few lithophilic spawning fish. There no piscivores or riffle dwelling fish. Pioneer and tolerant species metrics scored very poorly at 84.6% and 98.5% respectively.

The MSHA habitat assessment scored poorly in the three assessments at bio site 15MN017 (Table 269). The riparian zone and substrate scored decently as there was a decent riparian width and little to moderate bank erosion at the bio site (Figure 105). The stream substrate was listed as mostly sand with some silt present with severe embeddedness of coarse substrates in June and no coarse substrates identified during the August visit. Cover scored poorly as did channel morphology, as there were no riffles present. Evidence of both channel alteration and down cutting indicates the stream is adjusting to Hydrologic Alteration upstream.

Photos within the stream (Figure 105) show an incised stream channel that appears to be adjusting to the increased drainage and channelization in the upstream watershed. The incision within the channel has left a relatively featureless

stream channel that lacks quality habitat. Hydrologic Alteration both at the bio site and upstream in the watershed are contributing to a limitations in habitat for fish which in turn is a stressor to the fish within the reach. Habitat is a stressor to the biology of this reach.

3.14.5 Dissolved oxygen

DO biological metric data

Table 270. Dissolved oxygen related fish metrics for bio site 15MN017

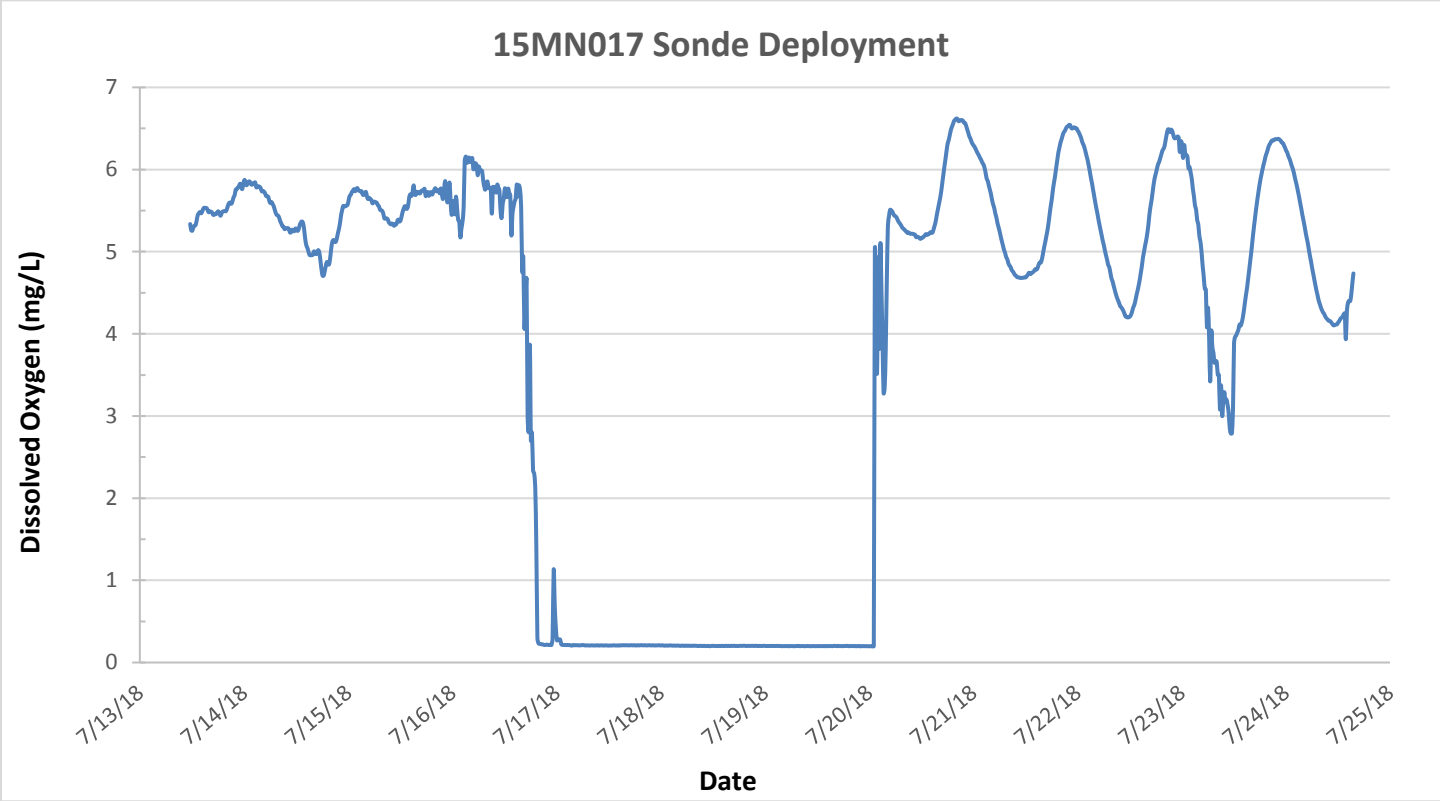
07020001-574 **Fish Class 2** **General Use**	Mature Age >3 %	Serial Spawner %	Taxa Count	DO TIV	DO Sensitive %	DO Tolerant %
15MN017 6/9/2015	0.0	70.8	7.0	6.4	0.0	83.1
Statewide average for Class 2 southern stream bio sites that are meeting the FIBI general use threshold (50.0)	**23.9**	**28.7**	**20.4**	**7.2**	**6.1**	**15.8**
Expected response to DO stress	↓	↑	↓	↓	↓	↑

DO monitoring data

Table 271. Dissolved oxygen data from chemistry site S013-142

07020001-574 DO Data	Range of Data (mg/L)	% of Monthly Samples < 5 mg/L [# of Samples]							% of Total Samples < 5 mg/L [# of Samples]
		April	May	June	July	August	Sept	Oct	
S013-142 (2015-2018)	4.9 – 8.6	N/A [0]	0% [1]	0% [1]	100% [1]	0% [1]	N/A [0]	N/A [0]	25% [4]

Figure 106. Continuous dissolved oxygen data at bio site 15MN017



DO HSPF model data

Table 272. Dissolved oxygen HSPF model data

07020001-574 HSPF Reach 411	**June – September** **% Daily Averages** **<5 mg/l** (# of values)
2,318 Total Daily Averages	**11%** (244)

Dissolved oxygen summary

The fish community at bio site 15MN017 scored below average in all six DO related fish metrics when compared to the average of all other Class 2 southern stream bio sites that meet the FIBI general use threshold (Table 270). There were no species whose females take more than three years to mature, a high percentage of serial spawners, a low total taxa count, and there were no fish caught who are sensitive to low DO.

A YSI Sonde water meter measured continuous DO data from July 13 2018 to July 24 2018 (Figure 106). During this deployment, DO values were measured below the standard of 5 mg/L several of the days the sonde was deployed It appears the probe was buried for approximately three days as the DO concentration fell to almost zero and then resumed a diurnal swing.

The HSPF model estimates that 11% of the DO daily average values fell below 5 mg/l.

Based on the very poor related fish biological metric scores and the measured sonde values, DO is a stressor in reach 07020001-574.

3.14.6 Eutrophication

Eutrophication biological metric data

Table 273. Eutrophication related fish metrics for bio site 15MN017

07020001-574 **Fish Class 2** **General Use**	Darter %	Omnivore %	Sensitive %	Tolerant %
15MN017 6/9/2015	0.0	78.5	0.0	98.5
Statewide average for Class 2 southern stream bio sites that are meeting the FIBI general use threshold (50.0)	**11.7**	**16.5**	**18.7**	**44.9**
Expected response to eutrophication stress	↓	↑	↓	↑

Eutrophication monitoring data

Table 274. Phosphorus monitoring data for chemistry sites S013-142

07020001-574 P Sample Data	Range of Data (mg/L)	Monthly Average of Samples (mg/L) [# of Samples]							June-Aug Average (mg/L) [# of Samples]
		April	May	June	July	August	Sept	Oct	
S013-142 (2015-2017)	0.07 – 0.32	N/A [0]	0.11 [1]	0.07 [1]	0.32 [1]	N/A [0]	N/A [0]	N/A [0]	0.20 [14]

Eutrophication HSPF model data

Table 275. HSPF model phosphorus data

07020001-574 HSPF Reach 411	**Total Phosphorus**	
	June – September **% values > 0.15 mg/l** (# Daily Values)	**June – September** **Multi-year Average**
2,318 Total Daily Averages *June – Sep 1994 – 2012*	**87.9%** (2,101)	**0.52 mg/l**

Eutrophication summary

The fish community at bio site 15MN017 scored very poorly in all four eutrophication related fish metrics when compared to the average of all other Class 2 southern stream bio sites that meet the FIBI general use threshold (Table 273). No darters or sensitive fish were caught and tolerant fish comprised 98.5% of the population. Over 78.5% of the total number of fish caught were omnivorous fish, well above the class average.

Fourteen samples were collected and analyzed for Phosphorus at chemistry site S013-142 from 2015-2017. The summer average was 0.20 mg/l, above the standard of 0.15 mg/L (Table 274).

The HSPF model computed the summer average well above the standard at 0.52 mg/L (Table 275).

A YSI Sonde water meter measured continuous DO data from July 13 2017 to July 24 2017 (Figure 106). During this deployment, DO diurnal flux, or the difference between the daily high and low DO concentrations was below the eutrophication DO flux standard of 5 mg/L.

The fish community seems to be showing the effects of eutrophication, although DO flux values were below 5 mg/L. Eutrophication is likely a stressor to the biological community in reach 07020001-574, but at this time, it is inconclusive. It is recommended that more response variable data be collected in order to determine whether eutrophication is a biological stressor.

3.14.7 Suspended solids

Suspended solids biological metric data

Table 276. Suspended solids related fish metrics for bio site 15MN017

07020001-574 Fish Class 2 General Use	Benthic Feeder %	Centrarchid-Tolerant %	Herbivore %	Intolerant %	Long-Lived %	Perciformes-Tolerant %	Riffle %	Sensitive %	Simple Lithophilic Spawner %	TSS TIV
15MN017 6/9/2015	0.0	0.0	0.0	0.0	7.7	0.0	0.0	0.0	3.1	23.1
Statewide average for Class 2 Southern Stream stations that are meeting the FIBI general use threshold (50.0)	**37.4**	**4.9**	**9.6**	**5.0**	**11.7**	**18.7**	**32.5**	**18.7**	**39.4**	**17.6**
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

TSS monitoring data

Table 277. Total suspended solids monitoring data for chemistry site S008-474

07020001-574 TSS Sample Data	Range of Data (mg/L)	% of Monthly Samples > 65 mg/L [# of Samples]							% of Total Samples > 65 mg/L [# of Samples]
		April	May	June	July	August	Sept	Oct	
S013-474 (2015)	2.8 – 9.2	N/A [0]	0% [1]	0% [1]	N/A [0]	N/A [0]	N/A [0]	N/A [0]	0% [2]

Suspended solids summary

The fish community at bio site 15MN017 scored very poorly in all TSS related fish metrics when compared to the average of all other Class 2 southern stream bio sites that meet the FIBI general use threshold (Table 276). There were no benthic feeders, Centrarchids, herbivores, intolerant fish, perciformes, riffle dwelling fish, sensitive fish. There were very few simple lithophilic spawning or long-lived fish caught. The TSS TIV scored poorly.

Only two samples were collected within reach 07020001-574. All were well below 65 mg/L (Table 277).

All of the fish metrics related to suspended solids scored poorly. The chemistry data, though limited, showed low concentrations of TSS. Suspended solids are inconclusive as a stressor to aquatic life in reach 07020001-574. It is likely that other factors, such as altered hydrology, habitat, or connectivity are causing poor scores in the fish biological metrics. It is recommended that more TSS data be collected during high flows in order to determine whether it is a biological stressor.

3.14.8 Nitrates

Nitrate biological metric data

Table 278. Nitrate related invertebrate metrics for bio site 15MN017

07020001-574 **Invert Class 7** **General Use**	Nitrate Intolerant Taxa %	Nitrogen TIV	Tolerant Taxa %	Trichoptera Taxa %
15MN017 8/5/2015	0.3	3.0	51.9	10.3
Statewide average for Class 7 Prairie Streams Glide Pool bio sites that are meeting the MIBI general use threshold (41.0)	**3.2**	**3.2**	**59.4**	**10.9**
Expected response to nitrogen stress	↓	↑	↑	↓

Nitrate monitoring data

Table 279. Nitrate monitoring data for chemistry sites S013-142

07020001-574 Nitrate/Nitrite Sample Data	Range of Data (mg/L)
S013-142 (2015-2017)	0.5 – 2.2

Nitrate summary

The macroinvertebrate assemblage at sites 15MN017 scored poorly in two of the four nitrate related metrics when compared to all other macroinvertebrate Class 7 Prairie Stream Glide Pool bio sites that meet the MIBI general use threshold (Table 278). There were very few nitrogen tolerant taxa and Trichoptera taxa percentage scored just below the average. Nitrogen tolerant taxa scored just below the class average but still made up over 51.9% of the total invertebrate species. The nitrogen TIV just below the class average.

Four samples were collected at chemistry site S013-142 and analyzed for nitrate/nitrite (Table 279). None of the samples had nitrate concentrations above 4.9 mg/L. Nitrates do not appear to be a stressor to the biological community in reach 07020001-574. Collecting more chemistry data within this reach is recommended in order to determine if nitrates are a stressor to the biological community.

3.14.9 Reach stressors

This stream is being stressed by changes to the hydrology of the stream channel and contributing watershed. Many of its tributaries have been ditched, often times right through wetlands in order to drain them, which has eliminated in-stream habitat and has caused siltation and very little depth variability. This stream reach could benefit from allowing its tributaries to re-meander and form pools, riffles, and runs, which forms the habitat that aquatic life needs to live.

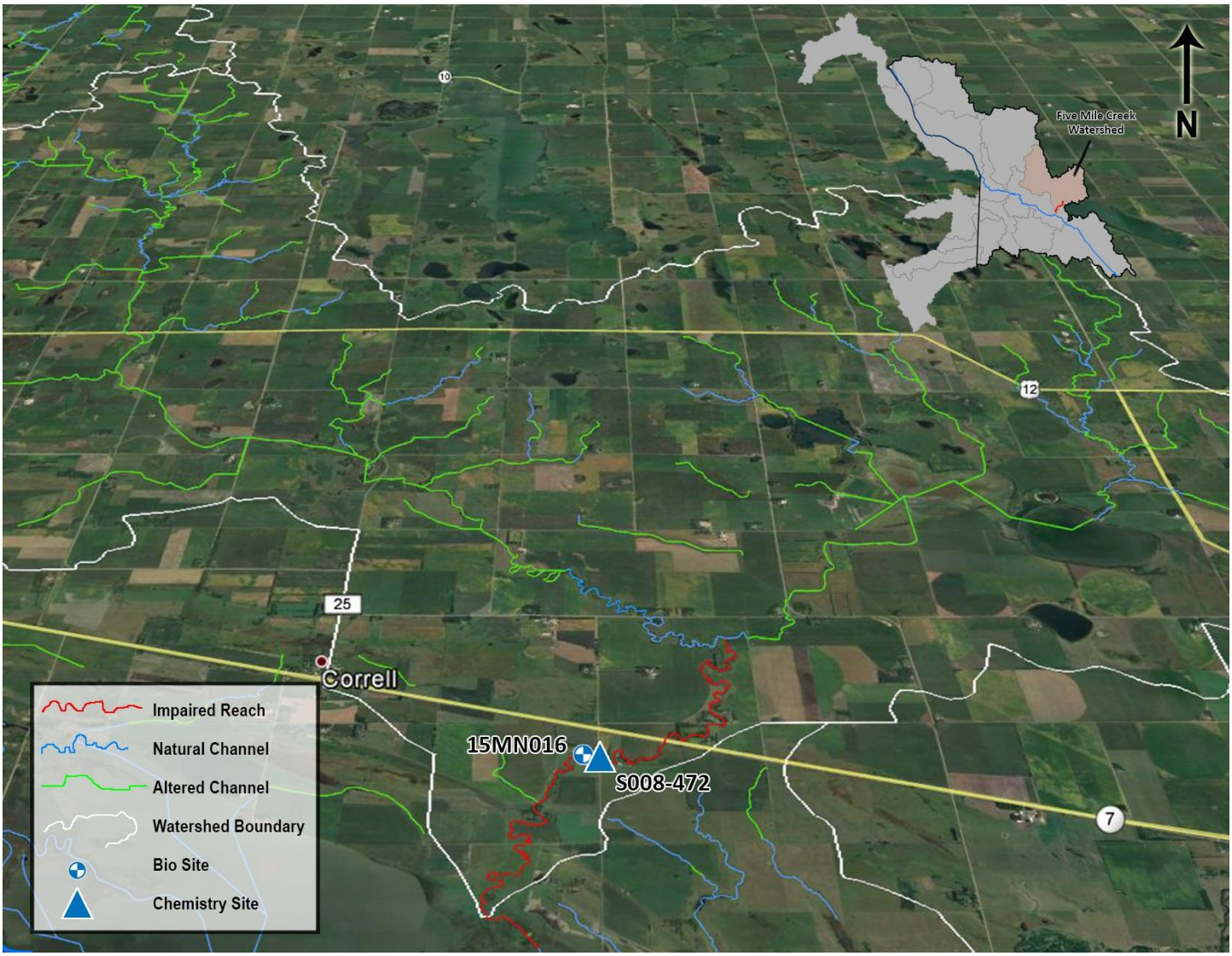
The stream is also disconnected from its flood plain in areas due to incision. The construction of ditches and the addition of tile drainage has altered the land area that that regularly contributes water to the stream as well as the amount and timing of water that reaches the stream. Increasing the storage and infiltration of water can help reduce nutrient delivery to the stream, erosion and incision from high flows after large rain events, and can help mitigate periods of extremely low flows during times of low precipitation.

Table 280. Summary of stressors in reach 07020001-574

07020001-574	**Hydrologic Alteration**	**Connectivity**	**Habitat**	**Dissolved Oxygen**	**Eutrophication**	**Suspended Solids**	**Nitrate**
✓= Stressor ×= Not a Stressor **O** = Inconclusive	✓	**O**	✓	✓	**O**	**O**	×

3.15 07020001-521 County Ditch 2 (Five Mile Creek)

Figure 107. Satellite image of reach 07020001-521 and its watershed



3.15.1 Biological community

Bio site 15MN016 was sampled for fish once in 2015. Twenty-two total species and 862 individual fish were caught, with fathead minnows and creek chubs comprising over 54% of the population, resulting in a IBI score of 32.5 (Table 264). Three sensitive species were caught including 35 Iowa darters, 5 slenderhead darters, and 1 carmine shiner.

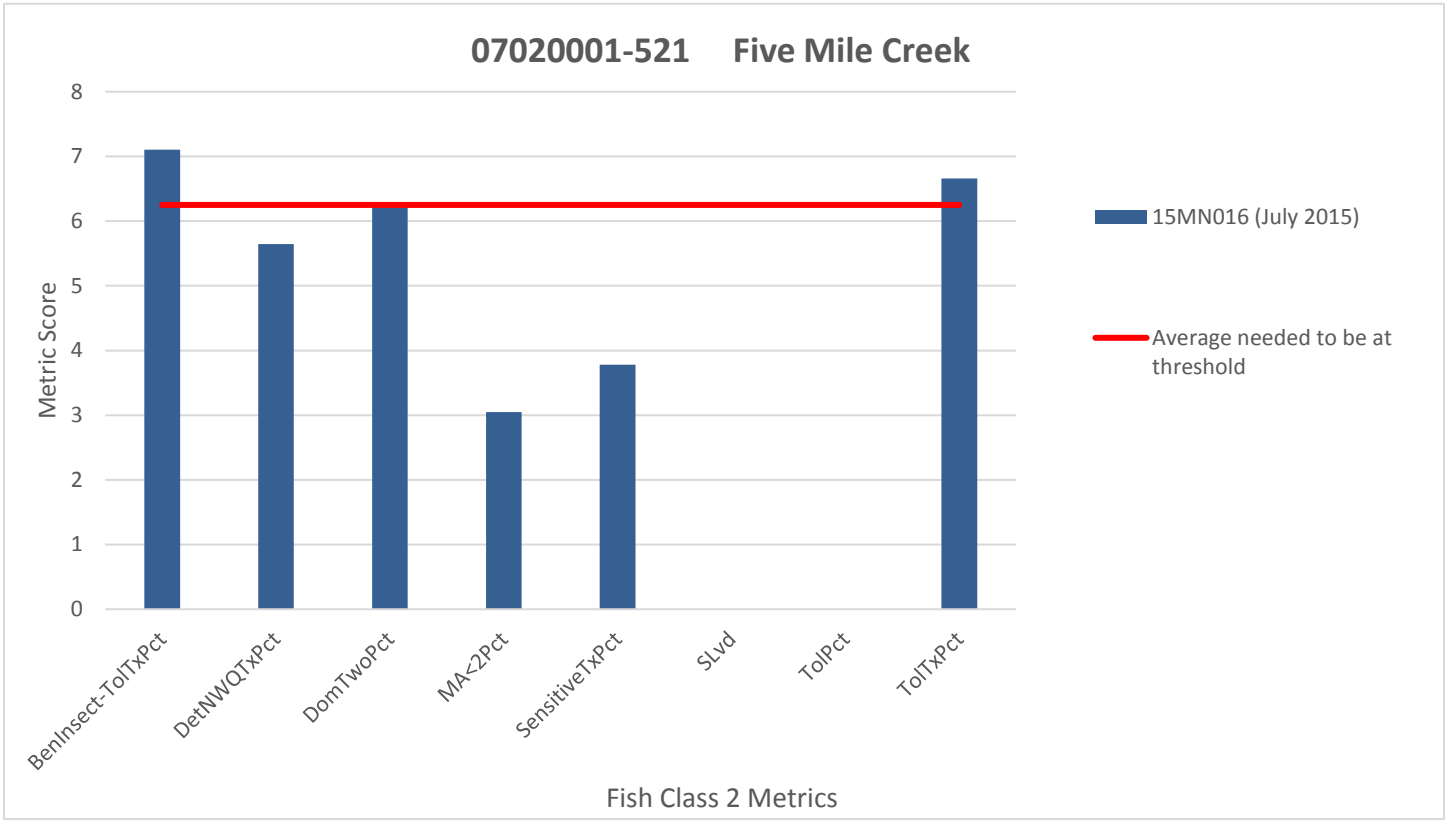
Metrics used to calculate the Fish IBI score are shown in a graph with the red line indicating the value each metric needed to score in order to meet the threshold (Figure 108).

Table 281. Fish IBI score and threshold for bio site 15MN017

07020001-521 Fish Class 2 General Use		Fish IBI Score	Class Threshold Score
15MN016	7/9/2015	32.5	50

Biological metric data

Figure 108. Fish Class 2 general use metric scores for bio site 15MN016



3.15.2 Hydrologic alteration

Hydrologic alteration biological metric data

Table 282. Hydrologic alteration related fish metrics for bio site 15MN016

07020001-521 **Fish Class 2** **General Use**	General %	Nesting Non Lithophilic Spawner %
15MN016 7/9/2015	79.6	47.1
Statewide average for Class 2 southern stream bio sites that are meeting the FIBI general use threshold (50.0)	**42.4**	**19.1**
Expected response to **Hydrologic** stress	↑	↑

HSPF model flow data

Table 283. HSPF modeled flow data, 1994-2012

07020001-521 HSPF Reach 410 Min: 0 cfs Max: 1,264.2 cfs	**<5 cfs %** (# of values)	**<1 cfs %** (# of values)	**<0.5 cfs %** (# of values)
6,940 Total Daily Averages 1994 – 2012	**58.5%** (4,063)	**28.9%** (2,005)	**18.9%** (1,311)

Hydrologic alteration summary

Both of the hydrologic alteration related fish biological metrics scored poorly when compared to the Fish Class 2 bio sites that meet the IBI general use threshold (Table 282). Generalist fish scored very poorly at 79.6% and over 47% of the fish caught are nesting species, both well above the class averages. The two dominant species, fathead minnows and creek chubs, made up over 84% of the total number of fish. All of the species caught were short maturing and over 75% were short-lived species. None of the species caught are considered sensitive.

The HSPF model (Table 283) shows that 28.9% of the daily average flows from 1994 – 2012 are below 1 cfs. Flows of less than 5 cfs were higher at 58.5.5percentage. Flows reduced beyond normal base flow decreases habitat for aquatic organisms and increases competition for resources.

Figure 109. Original survey plat map of the watershed of reach 07020001-521 including altered watercourses

Reach 07020001-521 is just downstream from reach 574 and is located after the confluence of reach 574 and the large watershed to the east. The eastern watershed contained a large wetland complex that has been extensively drained. Most of its tributaries have been altered into ditches in order to move water and grow crops (Figure 109). Creating these ditches essentially added to the amount of land and water that drains into the creek and the timing of water runoff. This altered the natural flow regime of this stream that had developed over several millenniums by decreasing the time it takes for water to move through the system, moving more water through the system at a higher frequency, and increasing the impact to the stream channel of high flow events while also increasing the intensity of low flow periods.

The Minnesota River – Headwaters Watershed Characteristic Report classified reach 07020001-521 as an E5 (DNR, 2019). The BHR was the lowest of all sites surveyed within the Minnesota River – Headwaters Watershed at 1.1. A BHR of 1.1 is considered to be stable and very minimally incised in comparison to other rivers and sites surveyed. A survey of a representative riffle cross section also identified that the channel has adequate lateral access to its floodplain with an entrenchment ratio of 35.93. An entrenchment ratio of 35.93 is just below the average entrenchment ratio of E5 channels (i.e. 39.5) as outlined by Rosgen (DNR, 2019).

Based on the very poor scores of the fish biological metrics, high percentage of channelization and altered stream channels upstream (Figure 109), the high percentage of modeled low flows, and the evidence of drainage in its upper

watershed, Hydrologic Alteration is a stressor in reach 07020001-521. The primary impact in this reach from Hydrologic Alteration is the low base flows from ditching and channelization of the stream channel and its tributaries, subsurface tile drainage of the surrounding wetlands, as well as the pollutant overloading of nutrients.

3.15.3 Connectivity

Connectivity metric data

Table 284. Connectivity related fish metrics for bio site 15MN016

07020001-521 **Fish Class 2** **General Use**	Mature Age >3 minus Tolerant Taxa %	Migrating Taxa %
15MN016 7/9/2015	9.1	31.8
Statewide average for Class 2 southern stream bio sites that are meeting the FIBI general use threshold (50.0)	**21.8**	**24.3**
Expected response to connectivity stress	↓	↓

Connectivity summary

Fish whose females take greater than three years to mature scored poorly as only two species were caught (Table 284). No downstream culverts or road crossings were identified as fish barriers and migrating fish scored above the Class 2 Average. Due to the presence of late maturing and migratory species it appears that connectivity is not a stressor at this time.

3.15.4 Habitat

Habitat metric data

Table 285. Habitat related fish metrics for bio site 15MN016

07020001-521 Fish Class 2 General Use	Benthic Insect minus Tolerant %	Darter Sculpin Sucker %	Lithophilic Spawner %	Pioneer %	Piscivore %	Riffle %	Simple Lithophilic Spawner %	Tolerant %
15MN016 7/9/2015	6.3	6.3	30.6	57.7	0.2	15.2	15.3	92.3
Statewide average for Class 2 southern stream bio sites that are meeting the FIBI general use threshold (50.0)	**20.4**	**18.2**	**58.3**	**19.0**	**5.2**	**32.5**	**39.4**	**44.9**
Expected response to habitat stress	↓	↓	↓	↑	↓	↓	↓	↑

MPCA stream habitat assessment score

Table 286. Habitat assessment score for bio site 15MN016

07020001-521	Land Use	Riparian	Substrate	Cover	Channel Morphology	Total Score
15MN016 7/9/2015	0	7.5	15.7	16	25	64.2
15MN016 8/5/2015	0	6.5	18.5	12	17	54
Maximum Attainable Habitat Score	**5**	**14**	**28**	**18**	**35**	**100**

Figure 110. Photo of bio site 15MN016 showing tree cover (left) and a riffle with boulders in it (right)

Habitat summary

The fish community at bio site 15MN016 scored poorly in all eight of the habitat related fish metrics when compared to all other Class 2 southern stream bio sites that met the FIBI general Use Threshold (Table 285).

The MSHA habitat assessment scored fairly in the two assessments at bio site 15MN016 (Table 286). The riparian zone and substrate scored decently as there was a decent riparian width and little to moderate bank erosion. The stream substrate was listed as cobble, gravel, and sand with some silt present with moderate embeddedness of coarse substrates. Cover scored fair as well as channel morphology, as there were both riffles and pools present.

Photos from field visits (Figure 110) show good cover (left) as well as diverse habitats, substrates, and depth variability, such as riffles (right).

Although all biological metrics scored poorly, there were decent numbers of lithophilic and simple lithophilic spawners as well as riffle dwelling fish. Habitat scores were also decent. Habitat is inconclusive as a stressor to the biology of reach 07020001-521.

3.15.5 Dissolved oxygen

DO biological metric data

Table 287. Dissolved oxygen related fish metrics for bio site 15MN016

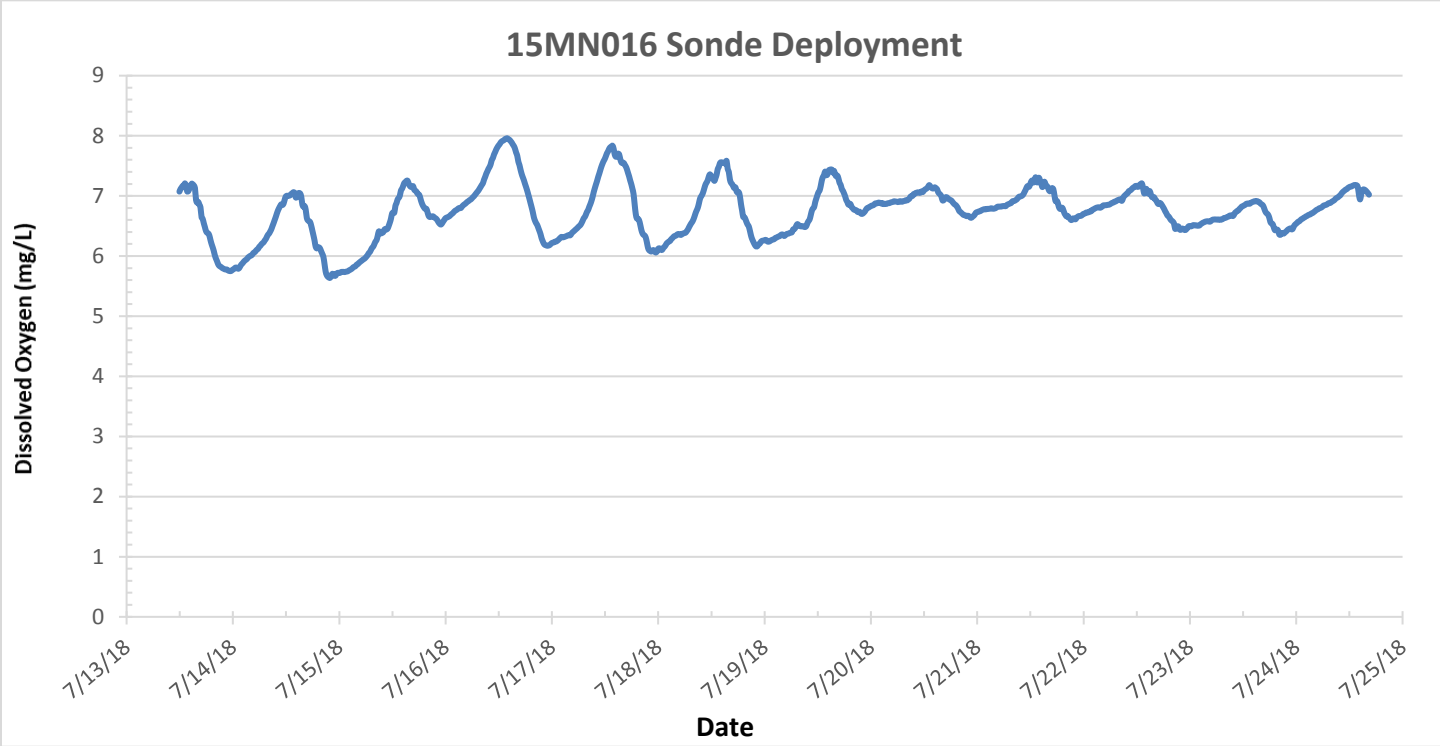
07020001-521 **Fish Class 2** **General Use**	Mature Age >3 %	Serial Spawner %	Taxa Count	DO TIV	DO Sensitive %	DO Tolerant %
15MN016 7/9/2015	15.4	43.4	22.0	6.3	0.0	63.3
Statewide average for Class 2 southern stream bio sites that are meeting the FIBI general use threshold (50.0)	**23.9**	**28.7**	**20.4**	**7.2**	**6.1**	**15.8**
Expected response to DO stress	↓	↑	↓	↓	↓	↑

DO monitoring data

Table 288. Dissolved oxygen data from chemistry site S008-472

07020001-521 DO Data	Range of Data (mg/L)	% of Monthly Samples < 5 mg/L [# of Samples]							% of Total Samples < 5 mg/L [# of Samples]
		April	May	June	July	August	Sept	Oct	
S008-472 (2015 – 2016)	5.9 – 12.9	N/A [0]	0% [2]	0% [5]	0% [7]	0% [5]	0% [2]	N/A [0]	0% [21]

Figure 111. Continuous dissolved oxygen data at bio site 15MN016



Dissolved oxygen summary

The fish community at bio site 15MN016 scored below average in five out of six DO related fish metrics when compared to the average of all other Class 2 southern stream bio sites that meet the FIBI general use threshold (Table 287). There were some species whose females take more than three years to mature, a high percentage of serial spawners, a good number of total taxa, a below average DO TIV, and no low DO sensitive fish caught. Low DO tolerant species comprised over 63% of the total number of fish caught.

A total of 21 dissolved oxygen (DO) measurements were made during sampling from 2015-2016 with none falling below the standard of 5 mg/L.

A YSI Sonde water meter measured continuous DO data from July 13 2018 to July 24 2018 (Figure 111). During this deployment, DO values were not measured below the standard of 5 mg/L. The lowest value recorded was 5.64 mg/L.

Based on the DO related fish biological metric scores and the decent measured sonde values, DO is inconclusive as a stressor in reach 07020001-521.

3.15.6 Eutrophication

Eutrophication biological metric data

Table 289. Eutrophication related fish metrics for bio site 15MN016

07020001-521 **Fish Class 2** **General Use**	Darter %	Omnivore %	Sensitive %	Tolerant %
15MN016 7/9/2015	6.2	62.8	4.8	92.3
Statewide average for Class 2 southern stream bio sites that are meeting the FIBI general use threshold (50.0)	**11.7**	**16.5**	**18.7**	**44.9**
Expected response to eutrophication stress	↓	↑	↓	↑

Eutrophication monitoring data

Table 290. Phosphorus monitoring data for chemistry sites S008-472

07020001-521 P Sample Data	Range of Data (mg/L)	Monthly Average of Samples (mg/L) [# of Samples]							June-Aug Average (mg/L) [# of Samples]
		April	May	June	July	August	Sept	Oct	
S008-472 (2015)	0.04 – 0.26	N/A [0]	0.18 [2]	0.11 [2]	0.22 [4]	0.14 [2]	0.06 [2]	N/A [0]	0.17 [12]

Eutrophication HSPF model data

Table 291. HSPF model phosphorus data

	Total Phosphorus	
07020001-521 HSPF Reach 410	**June – September** **% values > 0.15 mg/l** (# Daily Values)	**June – September** **Multi-year Average**
2,318 Total Daily Averages *June – Sep 1994 – 2012*	**89%** (2,063)	**0.52 mg/l**

Eutrophication summary

The fish community at bio site 15MN016 scored poorly in all four eutrophication related fish metrics when compared to the average of all other Class 2 southern stream bio sites that meet the FIBI general use threshold (Table 289). 6.2% of

the total number of fish caught were darters and only 4.8% were sensitive fish. Tolerant fish comprised 92.3% of the population. Over 62% of the total number of fish caught were omnivorous fish, well above the class average.

Twelve samples were collected and analyzed for phosphorus at chemistry site S008-472 in 2015. The summer average was 0.17 mg/l, just above the standard of 0.15 mg/L (Table 290).

The HSPF model computed the summer average well above the standard at 0.52 mg/L (Table 291).

A YSI Sonde water meter measured continuous DO data from July 13 2017 to July 24 2017 (Figure 106). During this deployment, DO diurnal flux, or the difference between the daily high and low DO concentrations was below the eutrophication DO flux standard of 5 mg/L.

The fish community seems to be showing the effects of eutrophication and phosphorus concentrations were high, although DO flux values were below 5 mg/L. Eutrophication is likely a stressor to the biological community in reach 07020001-521, but at this time, it is inconclusive. It is recommended that more response variable data be collected in order to determine whether eutrophication is a biological stressor.

3.15.7 Suspended solids

Suspended solids biological metric data

Table 292. Suspended solids related fish metrics for bio site 15MN016

07020001-521 Fish Class 2 General Use	Benthic Feeder %	Centrarchid-Tolerant %	Herbivore %	Intolerant %	Long-Lived %	Perciformes-Tolerant %	Riffle %	Sensitive %	Simple Lithophilic Spawner %	TSS TIV
15MN016 7/9/2015	15.8	0.0	12.0	0.0	9.4	6.3	15.2	4.8	15.3	22.3
Statewide average for Class 2 Southern Stream s stations that are meeting the FIBI general use threshold (50.0)	**37.4**	**4.9**	**9.6**	**5.0**	**11.7**	**18.7**	**32.5**	**18.7**	**39.4**	**17.6**
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

TSS monitoring data

Table 293. Total suspended solids monitoring data for chemistry sites S008-472

07020001-521 TSS Sample Data	Range of Data (mg/L)	% of Monthly Samples > 65 mg/L [# of Samples]							% of Total Samples > 65 mg/L [# of Samples]
		April	May	June	July	August	Sept	Oct	
S008-472 (2015)	3 – 27	N/A [0]	0% [2]	0% [2]	0% [3]	0% [2]	0% [2]	N/A [0]	0% [11]

Transparency monitoring data

Table 294. Transparency monitoring data for chemistry site S008-472

07020001-521 Transparency Tube Sample Data	Range of Data (cm)	% of Monthly Samples < 10 cm [# of Samples]							% of Total Samples < 10 cm [# of Samples]
		April	May	June	July	August	Sept	Oct	
S008-472 (2015-2018)	23.5 – 100	N/A [0]	0% [2]	0% [5]	0% [8]	0% [5]	0% [2]	N/A [0]	0% [22]

Suspended solids summary

The fish community at bio site 15MN016 scored very poorly in all but one TSS related fish metric when compared to the average of all other Class 2 southern stream bio sites that meet the FIBI general use threshold (Table 292). There were no Centrarchids or intolerant fish. Few benthic feeders, perciformes, riffle dwelling fish, sensitive fish, simple lithophilic spawning, or long-lived fish were caught. The TSS TIV scored poorly.

Eleven samples were collected within reach 07020001-521. All were well below 65 mg/L (Table 293).

All of the fish metrics related to suspended solids scored poorly. The chemistry data, though limited, showed low concentrations of TSS. Suspended solids are inconclusive as a stressor to aquatic life in reach 07020001-521. It is likely that other factors, such as altered hydrology and habitat are causing poor scores in the fish biological metrics. It is recommended that more TSS data be collected during high flows in order to determine whether it is a biological stressor.

3.15.8 Nitrates

Nitrate biological metric data

Table 295. Nitrate related invertebrate metrics for bio site 15MN016

07020001-521 Invert Class 5 General Use	Nitrate Intolerant Taxa %	Nitrogen TIV	Tolerant Taxa %	Trichoptera Taxa %
15MN016 8/5/2015	0.3	3.3	48.6	20.0
Statewide average for Class 5 southern stream rock riffle bio sites that are meeting the MIBI general use threshold (37.0)	**2.9**	**2.6**	**47.6**	**13.6**
Expected response to nitrogen stress	↓	↑	↑	↓

Nitrate monitoring data

Table 296. Nitrate monitoring data for chemistry sites S008-472

07020001-521 Nitrate/Nitrite Sample Data	Range of Data (mg/L)
S008-472 (2007-2017)	0.23 – 2.24

Nitrate summary

The macroinvertebrate assemblage at sites 15MN016 scored poorly in three of the four nitrate related metrics when compared to all other macroinvertebrate Class 5 southern stream rock riffle bio sites that meet the MIBI general use threshold (Table 295). There were very few nitrogen intolerant taxa, the nitrogen TIV scored poorly, and tolerant taxa was just above the average of Class 5 bio sites that were not impaired. Trichoptera taxa percentage scored well and was above the class average.

Twelve samples were collected at chemistry site S008-472 and analyzed for nitrate/nitrite (Table 296). All of the samples had relatively low nitrate concentrations. Nitrates do not appear to be a stressor to the biological community in reach 07020001-521. Collecting more chemistry data within this reach is recommended in order to determine if nitrates are a stressor to the biological community.

3.15.9 Reach stressors

Reach 07020001-521 is the furthest downstream section of Five Mile Creek. The stressors identified within the upper reach would apply to this one as well. This stream is being stressed by changes to the hydrology of the stream channel and contributing watershed. Many of its tributaries have been ditched, often times right through wetlands in order to drain them, which has eliminated in-stream habitat and has caused siltation and very little depth variability. This stream reach could benefit from allowing its tributaries to re-meander and form pools, riffles, and runs, which forms the habitat that aquatic life needs.

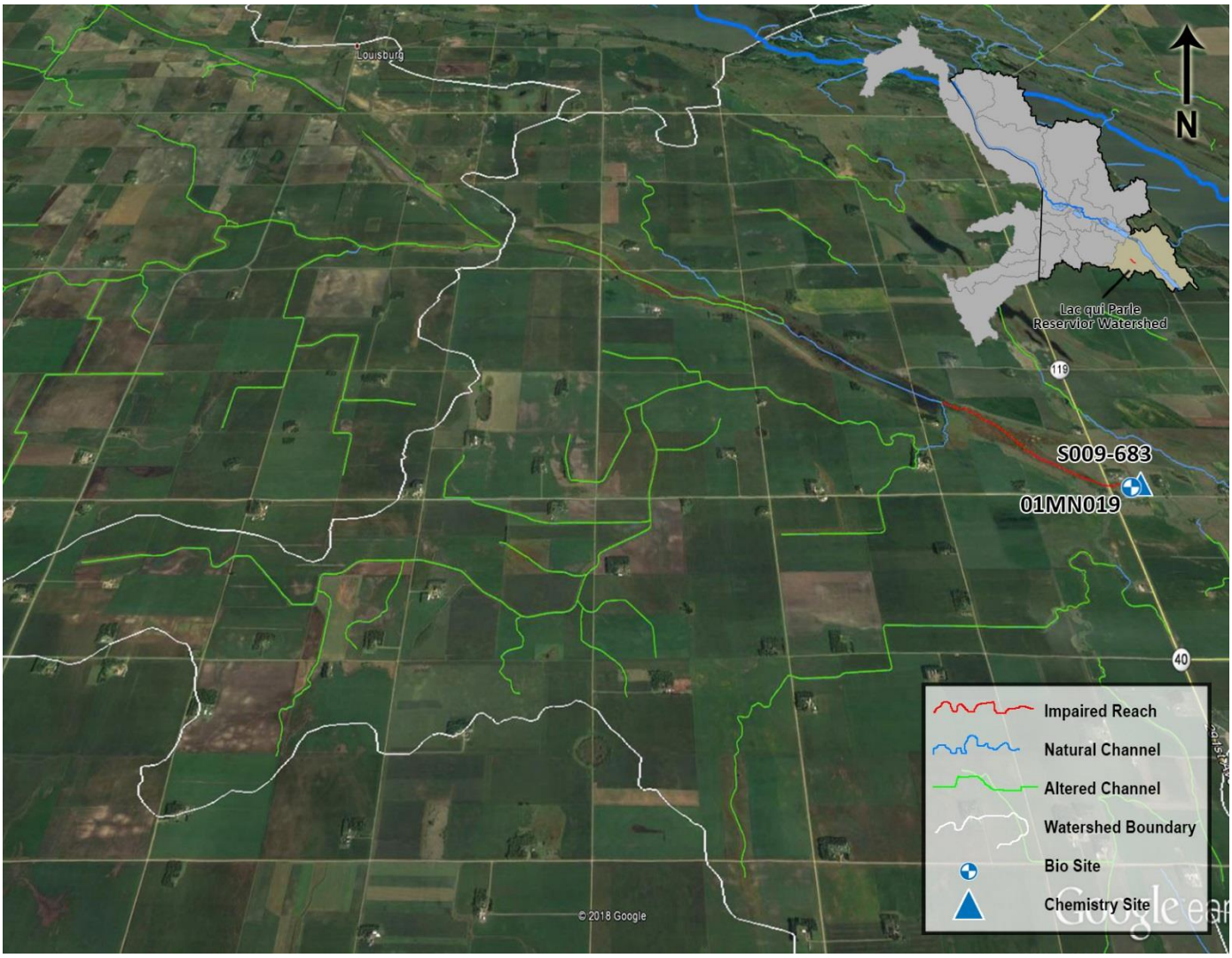
The stream is also disconnected from its flood plain in areas due to incision. The construction of ditches and the addition of tile drainage has altered the land area that that regularly contributes water to the stream as well as the amount and timing of water that reaches the stream. Increasing the storage and infiltration of water can help reduce nutrient delivery to the stream and can help mitigate periods of extremely low flows during times of low precipitation.

Table 297. Summary of stressors in reach 07020001-521

07020001-521	**Hydrologic Alteration**	**Connectivity**	**Habitat**	**Dissolved Oxygen**	**Eutrophication**	**Suspended Solids**	**Nitrate**
✓= Stressor ×= Not a Stressor **O** = Inconclusive	✓	×	**O**	**O**	**O**	**O**	×

3.16 07020001-548 Unnamed Creek

Figure 112. Satellite image of reach 07020001-548 and its watershed



3.16.1 Biological community

Bio site 01MN019 was sampled for fish once in 2015. Only four total species and 17 individual fish were caught, with fathead minnows and central mud minnows comprising over 76% of the population, resulting in a IBI score of 2.4 (Table 298). No sensitive species were caught.

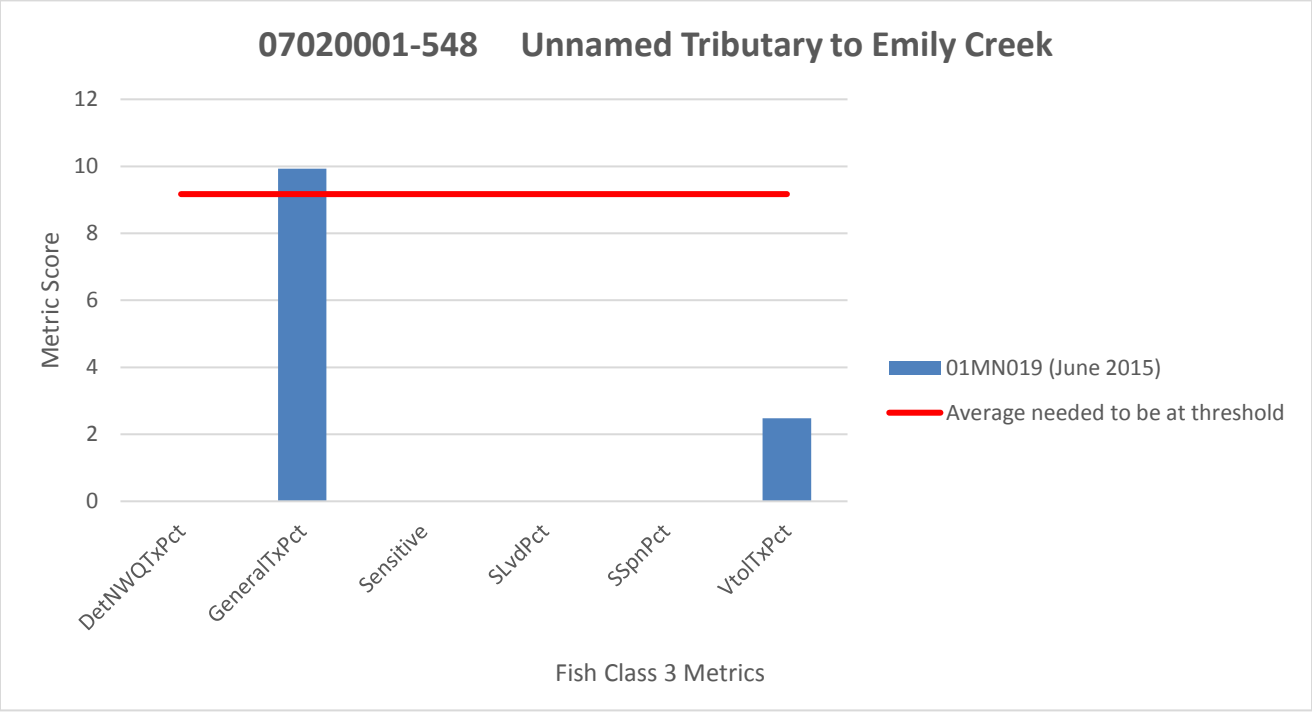
Metrics used to calculate the Fish IBI score are shown in a graph with the red line indicating the value each metric needed to score in order to meet the threshold (Figure 108).

Table 298. Fish IBI score and threshold for bio site 01MN019

07020001-548 Fish Class 3 General Use		Fish IBI Score	Class Threshold Score
1MN019	6/15/2015	2.4	55

Biological metric data

Figure 113. Fish Class 3 general use metric scores for bio site 15MN019



3.16.2 Hydrologic alteration

Hydrologic alteration biological metric data

Table 299. Hydrologic alteration related fish metrics for bio site 01MN019

07020001-561 **Fish Class 3** **General Use**	General %	Nesting Non Lithophilic Spawner %
01MN019 6/15/2015	64.7	64.7
Statewide average for Class 3 Southern Headwater bio sites that are meeting the FIBI general use threshold (55.0)	**59.1**	**19.2**
Expected response to **Hydrologic** stress	↑	↑

HSPF model flow data

Table 300. HSPF modeled flow data, 1994-2012

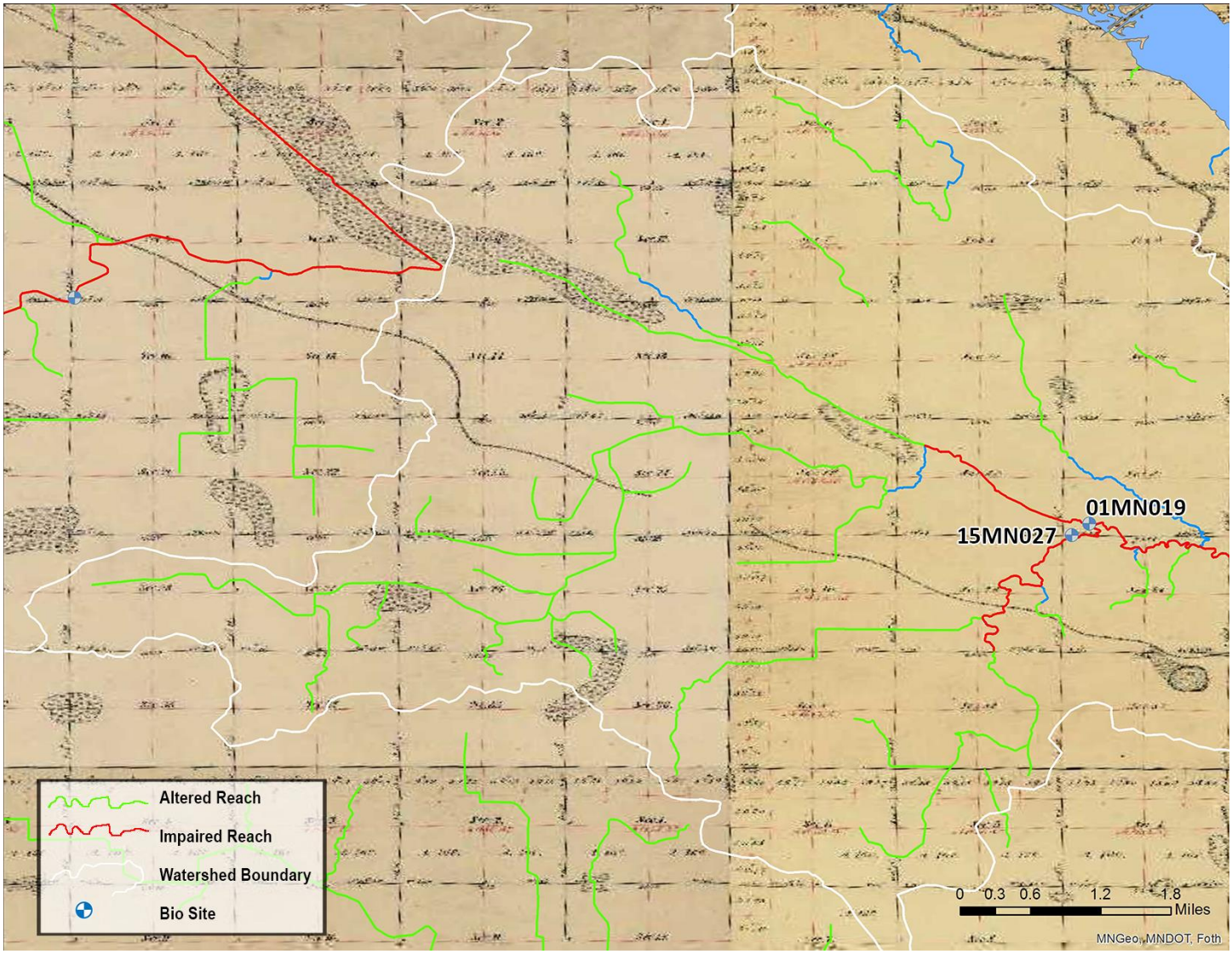
07020001-548 HSPF Reach 407 Min: 0 cfs Max: 1,079.1 cfs	**<5 cfs %** (# of values)	**<1 cfs %** (# of values)	**<0.5 cfs %** (# of values)
6,940 Total Daily Averages 1994 – 2012	**66.2%** (4,591)	**37.3%** (2,587)	**25.5%** (1,769)

Hydrologic alteration summary

Both of the hydrologic alteration related fish biological metrics scored poorly when compared to the Fish Class 2 bio sites that meet the IBI general use threshold (Table 299). Generalist fish and nesting fish both scored poorly at 64.7%. The two dominant species, fathead minnows and creek chubs, made up over 76% of the total number of fish. None of the species caught are considered sensitive.

The HSPF model (Table 300) shows that 37.3% of the daily average flows from 1994 – 2012 are below 1 cfs. 66.2% of the modeled flows were less than 5 cfs. Flows reduced beyond normal base flow decreases habitat for aquatic organisms and increases competition for resources.

Figure 114. Original survey plat map of the watershed of reach 07020001-548 including altered watercourses



Reach 07020001-548 is the northern tributary of Emily Creek before the confluence with reach 0702001-576. According to the original survey data and the MPCAs altered watercourse data, its upland tributaries have been extensively altered and ditched in order to move water and grow crops (Figure 114). There also appears to have been a re direction of the wetland that existed in the very North West area of the watershed that crossed the modern watershed boundary. Creating these ditches essentially added to the amount of land and water that drains into the creek and the timing of water runoff. This altered the natural flow regime of this stream that had developed over several millenniums by decreasing the time it takes for water to move through the system, moving more water through the system at a higher frequency, and increasing the impact to the stream channel of high flow events while also increasing the intensity of low flow periods.

Based on the poor scores of the fish biological metrics, the high percentage of channelization and altered stream channels upstream (Figure 114), and the high percentage of modeled low flows, Hydrologic Alteration is a stressor in reach 07020001-548.

3.16.3 Connectivity

Connectivity metric data

Table 301. Connectivity related fish metrics for bio site 01MN019

07020001-548 Fish Class 3 General Use	Mature Age >3 minus Tolerant Taxa %	Migrating Taxa %
01MN019 6/15/2015	0.0	25.0
Statewide average for Class 3 southern headwaters bio sites that are meeting the FIBI general use threshold (55.0)	**5.3**	**19.5**
Expected response to connectivity stress	↓	↓

Connectivity summary

There were no fish caught whose females take greater than three years to mature (Table 301). There was an above average percentage of migrating species, though it was only two white suckers out of four total species caught. No downstream culverts or road crossings were identified as fish barriers, though there are several small road crossings that could have undersized or be placed at the wrong elevation. Due to the above average percentage of migratory species, connectivity is inconclusive as a stressor at this time. It is recommended that road crossings could be checked and inventoried to rule out any possible fish barriers both up and downstream.

3.16.4 Habitat

Habitat metric data

Table 302. Habitat related fish metrics for bio site 01MN019

07020001-548 Fish Class 3 General Use	Benthic Insect minus Tolerant %	Darter Sculpin Sucker %	Lithophilic Spawner %	Pioneer %	Piscivore %	Riffle %	Simple Lithophilic Spawner %	Tolerant %
01MN019 6/15/2015	0.0	0.0	11.8	52.9	0.0	11.8	11.8	100.0
Statewide average for Class 3 Southern Headwater bio sites that are meeting the FIBI general use threshold (55.0)	**14.2**	**12.6**	**69.2**	**37.8**	**1.6**	**28.3**	**33.7**	**70.6**
Expected response to habitat stress	↓	↓	↓	↑	↓	↓	↓	↑

MPCA stream habitat assessment score

Table 303. Habitat assessment score for bio site 01MN019

07020001-548		Land Use	Riparian	Substrate	Cover	Channel Morphology	Total Score
01MN019	6/27/2001	1.3	6	3	12	21	43.3
01MN019	6/15/2015	0	8	2	12	11	33
Maximum Attainable Habitat Score		**5**	**14**	**28**	**18**	**35**	**100**

Figure 115. Photo of bio site 01MN019 showing cattails adjacent to stream channel (left) and a pasture (right)

Habitat summary

The fish community at bio site 01MN019 scored poorly in all eight of the habitat related fish metrics when compared to all other Class 3 Southern Headwater bio sites that met the FIBI general Use Threshold (Table 302).

The MSHA habitat assessment scored poorly in the two assessments at bio site 01MN019 (Table 303). The Riparian zone and substrate scored decently as there was a decent riparian width and little to moderate bank erosion. The stream substrate was listed as silt and detritus with no coarse substrates. Cover scored fair as well as there were cattails and grasses on the stream bank. Channel morphology was poor as there were no riffles present and very little depth variability.

Photos from field visits (Figure 115) show cattails and submerged vegetation indicative of a wetland environment (left) as well as pastureland surrounding the stream channel (right).

Due to the poor habitat related metrics, poor stream habitat assessment score, silt and embeddedness of coarse substrates, and wetland indicators, poor habitat is a stressor to the biology of reach 07020001-548.

3.16.5 Dissolved oxygen

DO biological metric data

Table 304. Dissolved oxygen related fish metrics for bio site 01MN019

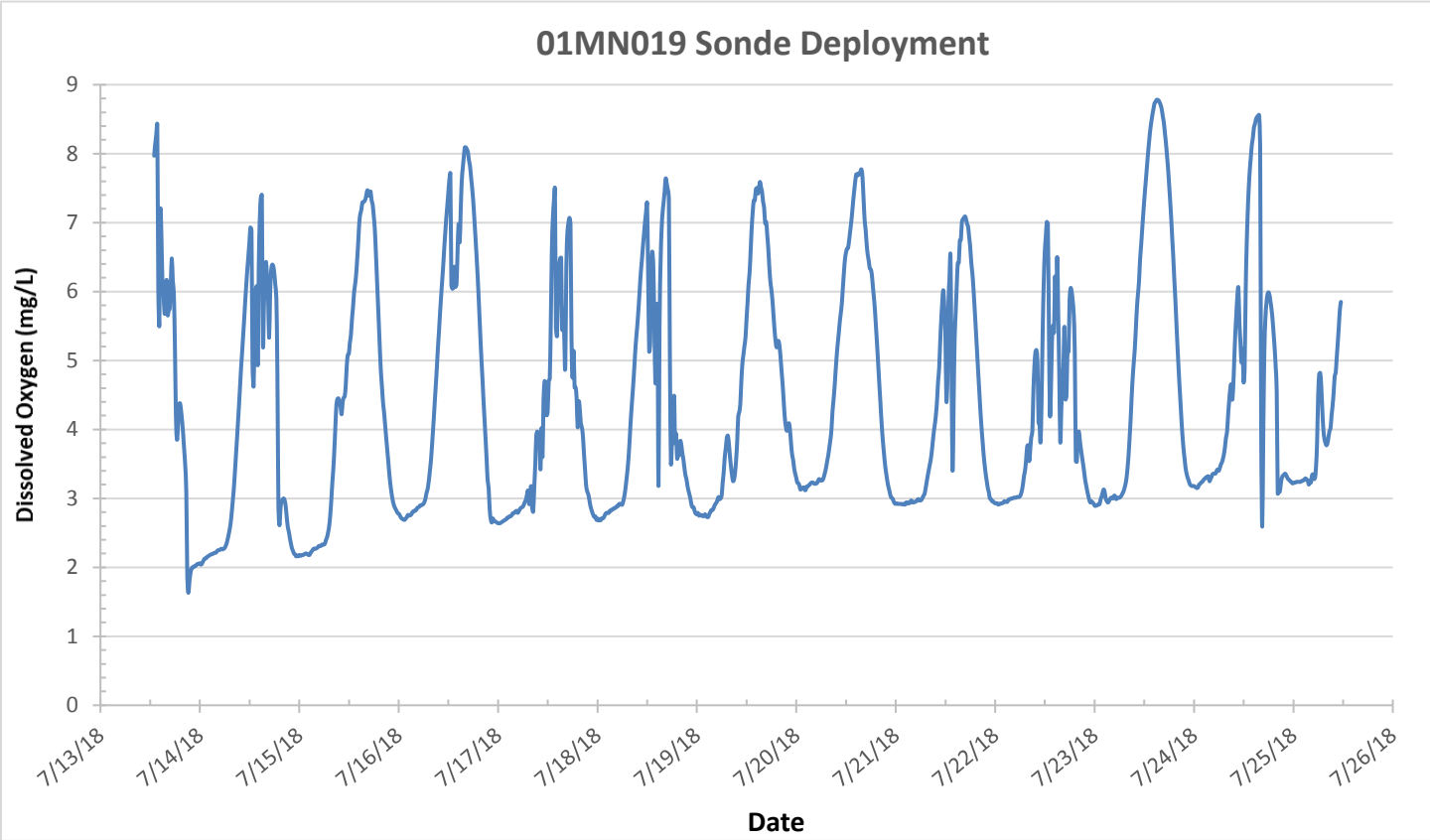
07020001-548 **Fish Class 3** **General Use**	Mature Age >3 %	Serial Spawner %	Taxa Count	DO TIV	DO Sensitive %	DO Tolerant %
01MN019 6/15/2015	11.8	52.9	4.0	6.1	0.0	88.2
Statewide average for Class 3 southern headwaters bio sites that are meeting the FIBI general use threshold (55.0)	**13.3**	**17.1**	**12.2**	**7.0**	**3.7**	**18.6**
Expected response to DO stress	↓	↑	↓	↓	↓	↑

DO monitoring data

Table 305. Dissolved oxygen data from chemistry site S009-683

07020001-548 DO Data	Range of Data (mg/L)	% of Monthly Samples < 5 mg/L [# of Samples]							% of Total Samples < 5 mg/L [# of Samples]
		April	May	June	July	August	Sept	Oct	
S009-683 (2001-2018)	3.8 – 11.1	N/A [0]	0% [1]	50% [2]	0% [1]	N/A [0]	N/A [0]	N/A [0]	33% [4]

Figure 116. Continuous dissolved oxygen data at bio site 01MN019



DO HSPF model data

Table 306. Dissolved oxygen HSPF model data

07020001-548 HSPF Reach 407	**June – September** **% Daily Averages** **<5 mg/l** (# of values)
2,318 Total Daily Averages	**7%** (154)

Dissolved oxygen summary

The fish community at bio site 01MN019 scored below average in all of the DO related fish metrics when compared to the average of all other Class 3 Southern Headwater bio sites that meet the FIBI general use threshold (Table 304). There were some species whose females take more than three years to mature, a high percentage of serial spawners, a low number of total taxa, a below average DO TIV, and no low DO sensitive fish caught. Low DO tolerant species comprised over 88% of the total number of fish caught.

A total of four DO measurements were made during sampling from 2001-2018 with one falling below the standard of 5 mg/L.

A YSI Sonde water meter measured continuous DO data from July 13 2018 to July 25 2018 (Figure 116). During this deployment, dDO values were measured below the standard of 5 mg/L every day.

Based on the poor DO related fish biological metric scores and the measured sonde values, DO is a stressor in reach 07020001-548.

3.16.6 Eutrophication

Eutrophication biological metric data

Table 307. Eutrophication related fish metrics for bio site 01MN019

07020001-548 **Fish Class 3** **General Use**	Darter %	Omnivore %	Sensitive %	Tolerant %
01MN019 6/15/2015	0.0	64.7	0	100
Statewide average for Class 3 southern headwaters bio sites that are meeting the FIBI general use threshold (55.0)	**12.1**	**14.6**	**70.6**	**8.6**
Expected response to eutrophication stress	↓	↑	↓	↑

Eutrophication monitoring data

Table 308. Phosphorus monitoring data for chemistry sites S009-683

07020001-548 P Sample Data	Range of Data (mg/L)	Monthly Average of Samples (mg/L) [# of Samples]							June-Aug Average (mg/L) [# of Samples]
		April	May	June	July	August	Sept	Oct	
S009-683 (2015-2018)	0.10 – 0.12	N/A [0]	N/A [0]	0.16 [3]	0.20 [1]	N/A [0]	N/A [0]	N/A [0]	0.18 [3]

Eutrophication HSPF model data

Table 309. HSPF model phosphorus data

	Total Phosphorus	
07020001-548 HSPF Reach 407	**June – September** **% values > 0.15 mg/l** (# Daily Values)	**June – September** **Multi-year Average**
2,318 Total Daily Averages *June – Sep 1994 – 2012*	**96.9%** (2,247)	**0.63 mg/l**

Figure 117. Photo of algae growing around aquatic macrophytes at bio site 01MN019

Eutrophication summary

The fish community at bio site 01MN019 scored poorly in all four eutrophication related fish metrics when compared to the average of all other Class 3 Southern Headwater bio sites that meet the FIBI general use threshold (Table 307). There were no darters or any sensitive fish caught. Tolerant fish comprised 100% of the population and over 64% of the total number of fish caught were omnivorous fish, well above the class average.

Only three samples were collected and analyzed for phosphorus at chemistry site S009-683 from 2015-2018. The summer average was 0.18 mg/l, above the standard of 0.15 mg/L (Table 308).

The HSPF model computed the summer average well above the standard at 0.63 mg/L (Table 309).

A YSI Sonde water meter measured continuous DO data from July 13 2017 to July 25 2017 (Figure 116). During this deployment, DO diurnal flux, or the difference between the daily high and low DO concentrations was above the eutrophication DO flux standard of 5 mg/L every day of the deployment.

The fish community seems to be showing the effects of eutrophication, phosphorus concentrations were high, DO flux values were 5 mg/L or above, and algae was observed covering the stream bottom (Figure 117). Eutrophication is a stressor to the biological community in reach 07020001-548.

3.16.7 Suspended solids

Suspended solids biological metric data

Table 310. Suspended solids related fish metrics for bio site 01MN019

07020001-548 **Fish Class 3** **General Use**	Benthic Feeder %	Centrarchid-Tolerant %	Herbivore %	Intolerant %	Long-Lived %	Perciformes-Tolerant %	Riffle %	Sensitive %	Simple Lithophilic Spawner %	TSS TIV
01MN019 6/15/2015	11.8	0.0	0.0	0.0	0.0	0.0	11.8	0.0	11.8	19.9
Statewide average for Class 3 Southern Headwater stations that are meeting the FIBI general use threshold (55.0)	**37.8**	**0.9**	**13.3**	**2.0**	**3.6**	**13.9**	**28.3**	**8.6**	**33.7**	**18.9**
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

TSS monitoring data

Table 311. Total suspended solids monitoring data for chemistry sites S009-683

07020001-548 TSS Sample Data	Range of Data (mg/L)	% of Monthly Samples > 65 mg/L [# of Samples]							% of Total Samples > 65 mg/L [# of Samples]
		April	May	June	July	August	Sept	Oct	
S009-683 (2001-2017)	1.2 – 30	N/A [0]	0% [1]	0% [3]	N/A [0]	N/A [0]	N/A [0]	N/A [0]	0% [4]

Suspended solids summary

The fish community at bio site 01MN019 scored very poorly in all of the TSS related fish metrics when compared to the average of all other Class 3 Southern Headwater bio sites that meet the FIBI general use threshold (Table 310). There were some benthic feeders, simple lithophilic spawning fish, and riffle dwelling fish. There were no Centrarchids, herbivores, intolerant fish, long-lived fish, perciformes, or sensitive fish caught. The TSS TIV scored poorly.

Four samples were collected within reach 07020001-548. All were well below 65 mg/L (Table 311).

All of the fish metrics related to suspended solids scored poorly, however this could be due to the effect of other stressors and a generally poor fish community. The chemistry data, though limited, showed low concentrations of TSS. Suspended solids are inconclusive as a stressor to aquatic life in reach 07020001-548. It is likely that other factors, such as altered hydrology and habitat are causing poor scores in the fish biological metrics. It is recommended that more TSS data be collected during high flows in order to determine whether it is a biological stressor.

3.16.8 Nitrates

Nitrate biological metric data

Nitrate Monitoring Data

Table 312. Nitrate related invertebrate metrics for bio site 01MN019

07020001-548 Nitrate/Nitrite Sample Data	Range of Data (mg/L)
S009-683 (2001-2015)	0.1 – 5.6

Nitrate summary

Macroinvertebrates were not sampled in reach 07020001-548.

Only four samples were collected at chemistry site S009-683 and analyzed for nitrate/nitrite (Table 312). Two samples had nitrate concentrations above 4.9 mg/L.

Nitrates are inconclusive as a stressor to the biological community in reach 07020001-548. Collecting more chemistry and biological data within this reach is recommended in order to determine if nitrates are a stressor to the biological community.

3.16.9 Reach stressors

This stream is being stressed by changes to the hydrology of the stream channel and contributing watershed. The stream itself appears to have been ditched, often times right through wetlands in order to drain them, which has eliminated in-stream habitat and has caused siltation and very little depth variability. This stream reach could benefit from allowing its tributaries to re-meander and form pools, riffles, and runs, which forms the habitat that aquatic life needs to live. The stream is also disconnected from its flood plain in areas due to both ditching of the stream as well as incision. Trampled banks from cattle have also caused the stream to over widen, decreasing mean depth.

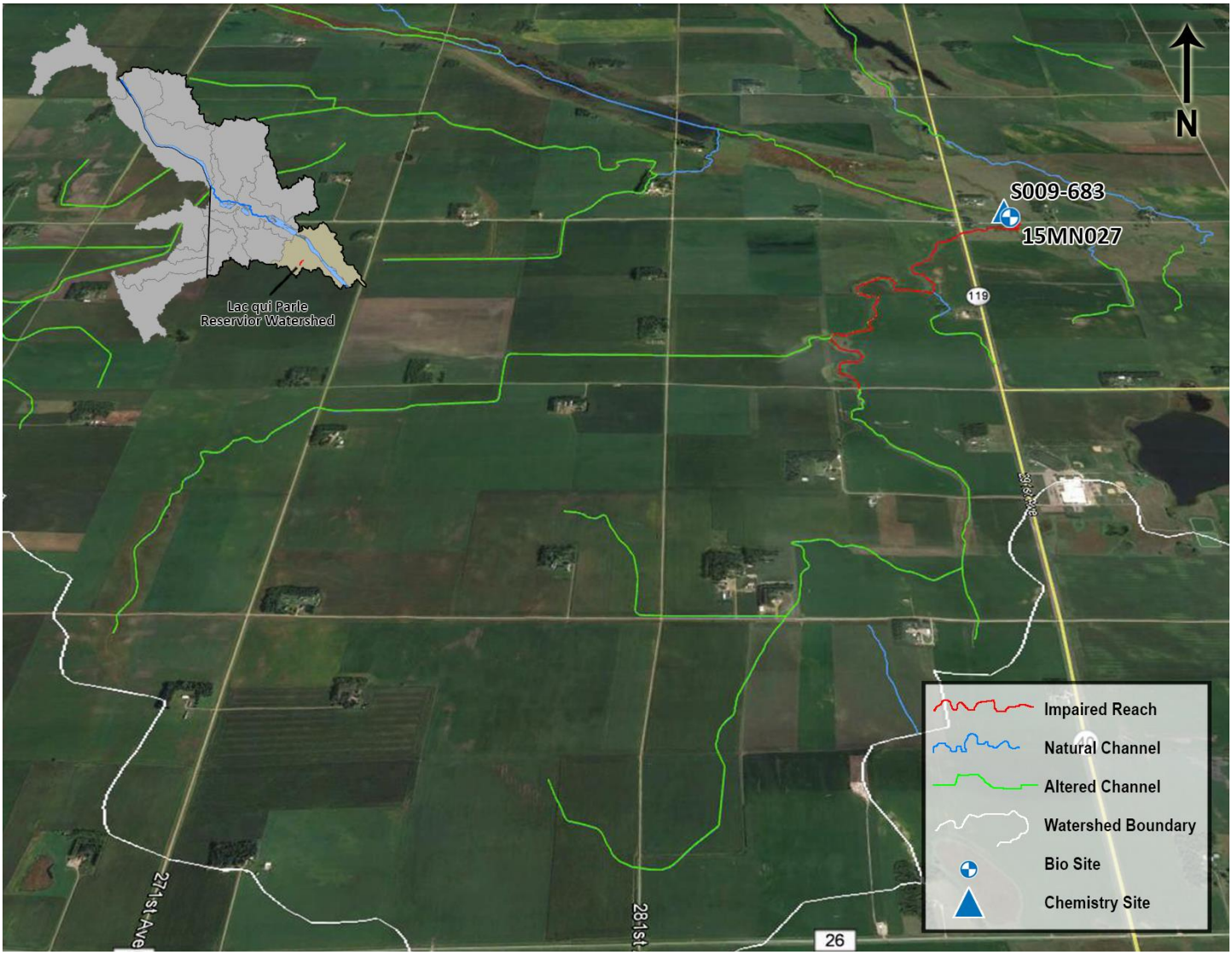
The construction of ditches and the addition of tile drainage has altered the land area that that regularly contributes water to the stream as well as the amount and timing of water that reaches the stream. Increasing the storage and infiltration of water can help reduce nutrient delivery to the stream, erosion and incision from high flows after large rain events, and can help mitigate periods of extremely low flows during times of low precipitation.

Table 313. Summary of stressors in reach 07020001-548

07020001-548	**Hydrologic Alteration**	**Connectivity**	**Habitat**	**Dissolved Oxygen**	**Eutrophication**	**Suspended Solids**	**Nitrate**
✓= Stressor ×= Not a Stressor **O** = Inconclusive	✓	**O**	✓	✓	✓	**O**	**O**

3.17 07020001-576 Emily Creek

Figure 118. Satellite image of reach 07020001-576 and its watershed



3.17.1 Biological community

Bio site 15MN027 was sampled for fish once in 2015. Five total species and 88 individual fish were caught, with brook sticklebacks comprising over 82% of the population, resulting in a IBI score of 46.2 (Table 314). Metrics used to calculate the fish IBI score are shown in a graph with the red line indicating the value each metric needed to score in order to meet the threshold (Figure 119).

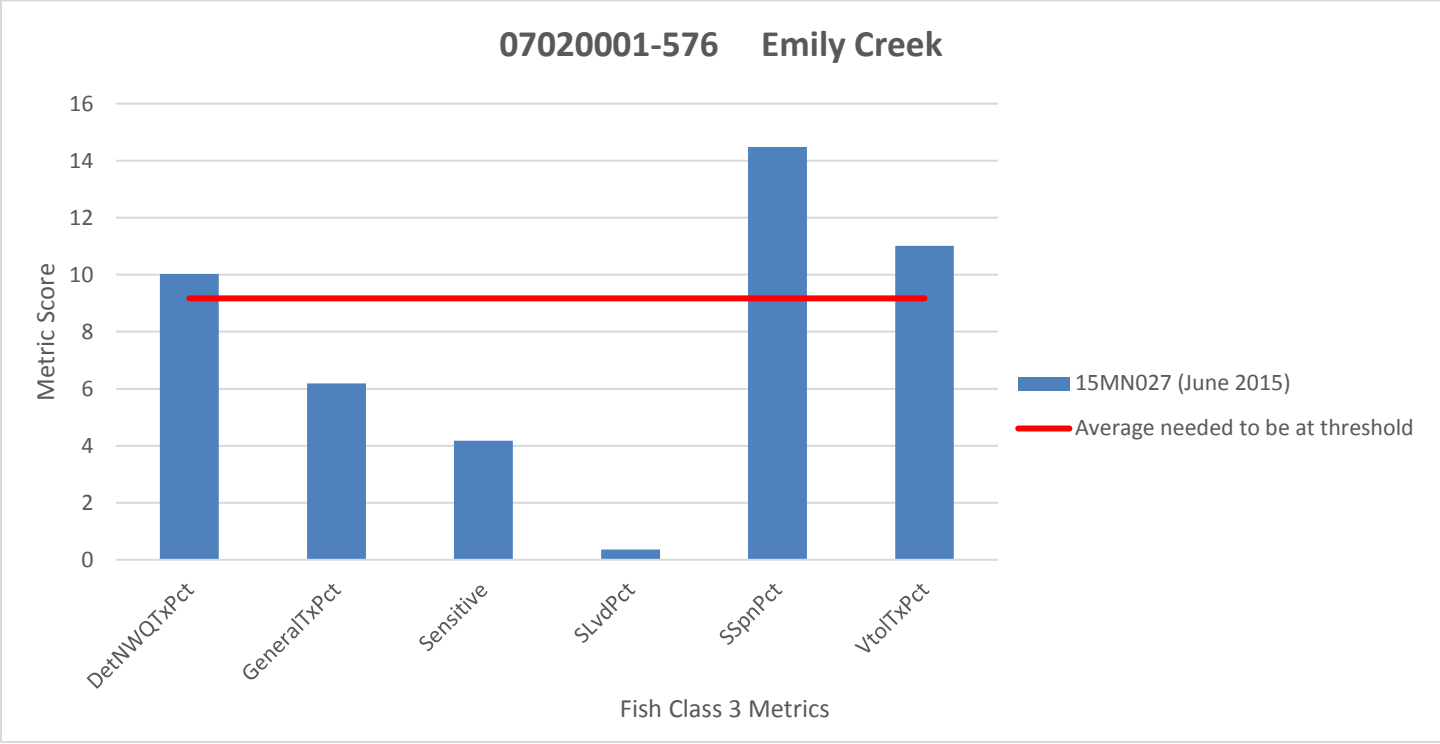
Bio site 15MN027 was sampled for invertebrates once in 2015. Macroinvertebrate scores were 34.1 and 23.3, under the Invert Class 7 general use threshold of 41 (Table 315). Midges comprised over 72% of the total number of invertebrates caught, dominating the invertebrate community. Midges are typically tolerant of silt-embedded substrates and often indicate an impaired biological community. Five different mayfly, two caddisfly, and one stonefly species were found. Metrics used to calculate the invert IBI score are shown in a graph with the red line indicating the value each metric needed to score in order to meet the threshold (Figure 120).

Fish biological metric data

Table 314. Fish IBI score and threshold for bio site 15MN027

07020001-576 Fish Class 3 General Use		Fish IBI Score	Class Threshold Score
15MN027	6/15/2015	46.2	55

Figure 119. Fish Class 3 general use metric scores for bio site 15MN027

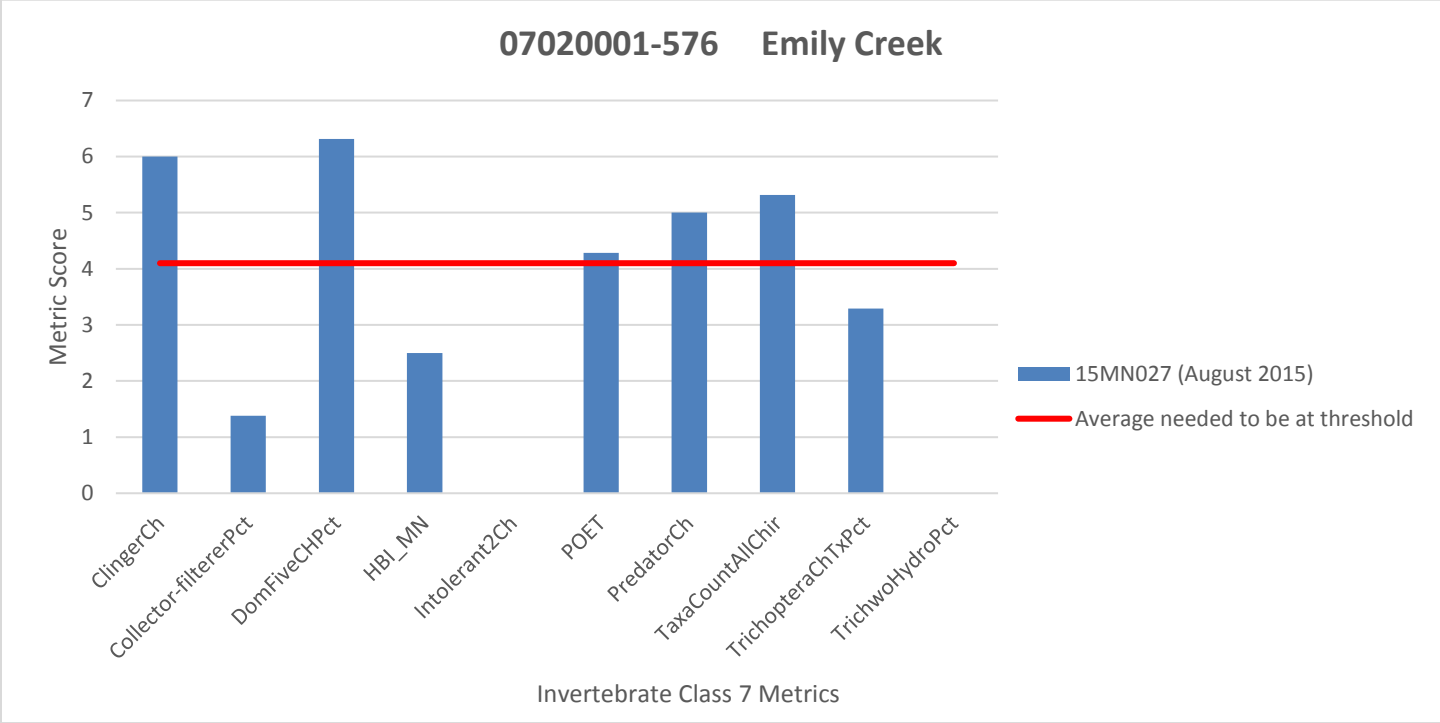


Invertebrate biological metric data

Table 315. Invert IBI score and threshold for bio site 15MN027

07020001-576 Invert Class 7 General Use		Invert IBI Score	Class Threshold Score
15MN027	8/06/2015	34.1	41

Figure 120. Invert Class 7 general use metric scores for bio site 15MN027



3.18.8 Nitrates

Nitrate biological metric data

Table 316. Nitrate related invertebrate metrics for bio site 15MN401

07020001-547 Invert Class 7 General Use	Nitrate Intolerant Taxa %	Nitrogen TIV	Tolerant Taxa %	Trichoptera Taxa %
15MN401 8/10/2015	0.0	4.8	73.2	11.1
Statewide average for Class 7 Prairie Streams Glide Pool bio sites that are meeting the MIBI general use threshold (41.0)	**3.2**	**3.2**	**54.9**	**10.9**
Expected response to nitrogen stress	↓	↑	↑	↓

Nitrate monitoring data

Table 317. Nitrate monitoring data for chemistry sites S008-475

07020001-547 Nitrate/Nitrite Sample Data	Range of Data (mg/L)
S008-475 (2015)	0.5 – 4.7

Nitrate summary

The macroinvertebrate assemblage at sites 15MN401 scored poorly in three out of four nitrate related metrics when compared to all other macroinvertebrate Class 7 Prairie Stream Glide Pool bio sites that meet the MIBI general use threshold (Table 316). There were no nitrogen intolerant taxa, the nitrogen TIV scored poorly, and tolerant taxa were well above the Class 7 average of bio sites that met the IBI threshold. Trichoptera taxa percentage scored decent and was just above the class average.

Twelve samples were collected and analyzed for nitrate/nitrite at chemistry site S008-475 (Table 317). None of the samples had nitrate concentrations above 4.9 mg/L.

Although the nitrate related invert metrics were, mostly poor none of the twelve samples was above 4.9 mg/l, inconclusive as a stressor to the biological community in reach 07020001-547. It is recommended more data be collected within this reach to determine if nitrates are a stressor to the biological community.

3.17.2 Hydrologic alteration

Hydrologic alteration biological metric data

Table 318. Hydrologic alteration related fish metrics for bio site 15MN027

07020001-576 **Fish Class 3** **General Use**	General %	Nesting Non Lithophilic Spawner %
15MN027 6/15/2015	15.9	93.2
Statewide average for Class 3 Southern Headwater bio sites that are meeting the FIBI general use threshold (55.0)	**59.1**	**19.2**
Expected response to **Hydrologic** stress	↑	↑

Table 319. Hydrologic alteration related invert metrics for bio site 15MN027

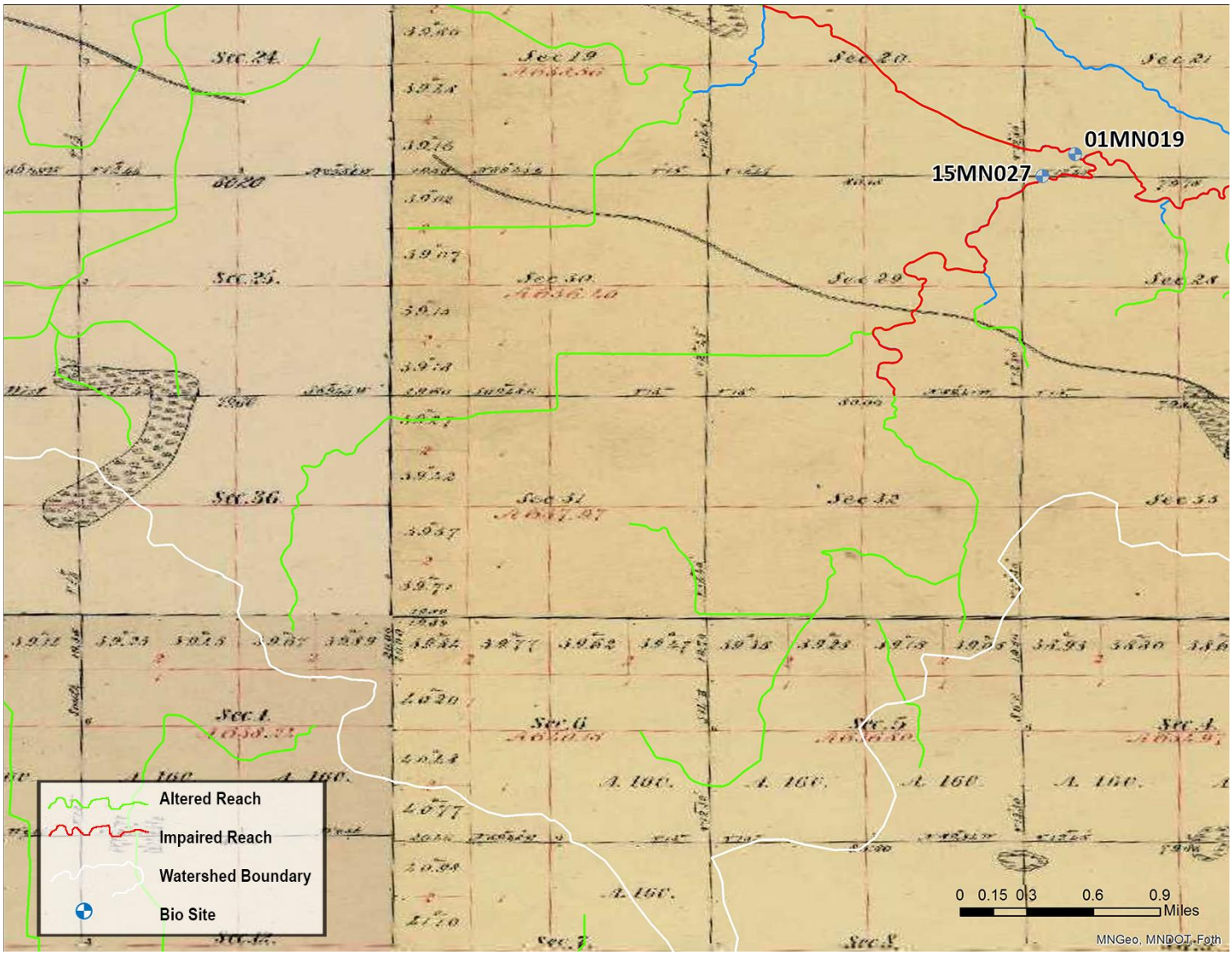
07020001-576 **Invert Class 7** **General Use**	Clinger %	Collector-Filterer %	Long-Lived %
15MN027 8/6/2015	15.3	5.5	2.8
Statewide average for Class 7 Prairie Streams Glide Pool bio sites that are meeting the MIBI general use threshold (41.0)	**38.5**	**19.1**	**8.0**
Expected response to **Hydrologic** stress	↓	↓	↓

Hydrologic alteration summary

One out of two hydrologic alteration related fish biological metrics scored poorly when compared to the Fish Class 3 bio sites that meet the IBI general use threshold (Table 318). Generalist fish scored well; however, brook sticklebacks made up over 82% of the total number of fish caught and is not considered a generalist species. Over 93% of the fish caught are nesting species. 100% of the species caught were short maturing and over 96% were short-lived species. One of the species, the Iowa darter, is considered sensitive though there was only a single individual caught.

All three of the invertebrate metrics scored poorly when compared to the average of Invert Class 7 general use streams that met the IBI threshold (Table 319). Clinger, collector-filterer, and long-lived invertebrates were all well below the class averages.

Figure 121. Original survey plat map of the watershed of reach 07020001-576 including altered watercourses



Reach 07020001-576 is the southern branch of Emily Creek before the confluence with reach 0702001-548. According to the original survey data and the MPCAs altered watercourse data, its upland tributaries have been extensively altered and ditched in order to move water and grow crops (Figure 121). Creating these ditches essentially added to the amount of land and water that drains into the creek and the timing of water runoff. This altered the natural flow regime of this stream that had developed over several millenniums by decreasing the time it takes for water to move through the system, moving more water through the system at a higher frequency, and increasing the impact to the stream channel of high flow events while also increasing the intensity of low flow periods.

The Minnesota River – Headwaters Watershed Characteristic Report classified reach 07020001-521 as an E4 (DNR, 2019). Characteristics of E4 channels are identical to E5 channels with the exception that E4 channels have predominantly gravel sized substrates in contrast to the finer substrates of an E5 channel (Rosgen 1996). Two representative riffle cross sections were surveyed at the upper Emily Creek survey site. Both cross sections indicated that the channel is deeply incised with a BHR of 1.85. The first of the riffle cross sections (i.e. cross section utilized for classification purposes) showed that the channel was only slightly entrenched, but was within several tenths of a foot of incision from being severely entrenched. Dimensions documented at the second riffle cross section showed that the channel was severely entrenched at that location (DNR, 2019).

Based on the very poor scores of most of the fish and invertebrate biological metrics, the high percentage of channelization and altered stream channels upstream (Figure 121), Hydrologic Alteration in the form of both low and high flows is a stressor in reach 07020001-576. The primary impact in this reach from Hydrologic Alteration is the incision of the stream channel from the ditching and channelization of the stream channel and its tributaries, subsurface tile drainage of the surrounding wetlands, as well as the pollutant overloading of nutrients.

3.17.3 Connectivity

Connectivity metric data

Table 320. Connectivity related fish metrics for bio site 15MN027

07020001-576 **Fish Class 3** **General Use**	Mature Age >3 minus Tolerant Taxa %	Migrating Taxa %
15MN027 6/15/2015	0.0	20.0
Statewide average for Class 3 southern headwaters bio sites that are meeting the FIBI general use threshold (55.0)	**5.3**	**19.5**
Expected response to connectivity stress	↓	↓

Connectivity summary

There were no fish caught whose females take greater than three years to mature (Table 320). There was an above average percentage of migrating species, though it was only one Iowa darter out of five total species caught. No downstream culverts or road crossings were identified as fish barriers, though there are several small road crossings that could have undersized or be placed at the wrong elevation. This reach could also be affected by the impoundment downstream that controls water levels in Lac qui Parle Lake. Due to the presence of only one migratory species, connectivity is inconclusive as a stressor at this time. It is recommended that road crossings could be checked and inventoried to rule out any possible fish barriers both up and downstream.

3.17.4 Habitat

Habitat metric data

Table 321. Habitat related fish metrics for bio site 15MN027

07020001-576 Fish Class 3 General Use	Benthic Insect minus Tolerant %	Darter Sculpin Sucker %	Lithophilic Spawner %	Pioneer %	Piscivore %	Riffle %	Simple Lithophilic Spawner %	Tolerant %
15MN027 6/15/2015	1.1	1.1	5.7	13.6	0.0	0.0	2.3	98.8
Statewide average for Class 3 Southern Headwater bio sites that are meeting the FIBI general use threshold (55.0)	**14.2**	**12.6**	**69.2**	**37.8**	**1.6**	**28.3**	**33.7**	**70.6**
Expected response to habitat stress	↓	↓	↓	↑	↓	↓	↓	↑

Table 322. Habitat related invert metrics for bio site 15MN027

07020001-576 Invert Class 7 General Use	Burrower %	Climber %	Clinger %	Ephemeroptera Plecoptera Trichoptera %	Legless %	Sprawler %
15MN027 8/6/2015	12.3	30.1	15.3	15.3	75.2	39.6
Statewide average for Class 7 Prairie Streams Glide Pool bio sites that are meeting the MIBI general use threshold (41.0)	**7.5**	**21.6**	**38.5**	**38.5**	**39.8**	**20.9**
Expected response to habitat stress	↑	↓	↓	↓	↑	↑

MPCA stream habitat assessment score

Table 323. Habitat assessment score for bio site 15MN027

07020001-576		Land Use	Riparian	Substrate	Cover	Channel Morphology	Total Score
15MN027	6/15/2015	0	7	10.6	14	23	54.6
15MN027	8/6/2015	0	9	13.9	10	13	45.9
Maximum Attainable Habitat Score		**5**	**14**	**28**	**18**	**35**	**100**

Figure 122. Photo of bio site 15MN027 showing land adjacent to stream channel (left) and an instream photo showing vegetative cover on both sides of the stream (right)

Habitat summary

The fish community at bio site 15MN027 scored very poorly in seven out of eight of the habitat related fish metrics when compared to all other Class 3 Southern Headwater bio sites that met the FIBI general Use Threshold (Table 321). There were almost no benthic insectivores, darters, lithophillic spawners, or simple lithophillic spawners. There were no piscivores or riffle dwelling fish and tolerant fish comprised over 98% of the population.

Invertebrate metrics were mixed (Table 322). Burrower, clinger, EPT, and legless taxa scored poorly, indicating the presence of fine sediment and embeddedness of coarse sediment. There were a fair number of climber taxa, which would use the large amount of vegetation adjacent and within the stream channel. Sprawlers scored well above average, though the majority of sprawler taxa was the mayfly Caenis diminuta, which is very tolerant to fine sediment.

The MSHA habitat assessment scored fair in June of 2015 and poor in August of 2015 at bio site 15MN027 (Table 323). The riparian zone scored decently as there was a decent riparian width and little to moderate bank erosion. The stream substrate was listed as boulders, cobble, gravel, and sand with some silt present, though there was severe embeddedness of coarse substrates. Cover scored decent and channel morphology scored better in the June assessment, likely due to higher flows affecting the depth ratios of pools and riffles.

Photos from field visits (Figure 122) shows agricultural land use adjacent to the stream channel (left) and an instream photo with a large amount of vegetation adjacent to the stream (right).

Due to the poor habitat related metrics and poor and just barely fair stream habitat assessment score poor habitat is a stressor to the biology of reach 07020001-576.

3.17.5 Dissolved oxygen

DO biological metric data

Table 324. Dissolved oxygen related fish metrics for bio site 15MN027

07020001-576 **Fish Class 3** **General Use**	Mature Age >3 %	Serial Spawner %	Taxa Count	DO TIV	DO Sensitive %	DO Tolerant %
15MN027 6/15/2015	0.0	10.2	5.0	5.8	0.0	94.3
Statewide average for Class 3 southern headwaters bio sites that are meeting the FIBI general use threshold (55.0)	**13.3**	**17.1**	**12.2**	**7.0**	**3.7**	**18.6**
Expected response to DO stress	↓	↑	↓	↓	↓	↑

Table 325. Dissolved oxygen related fish metrics for bio site 15MN027

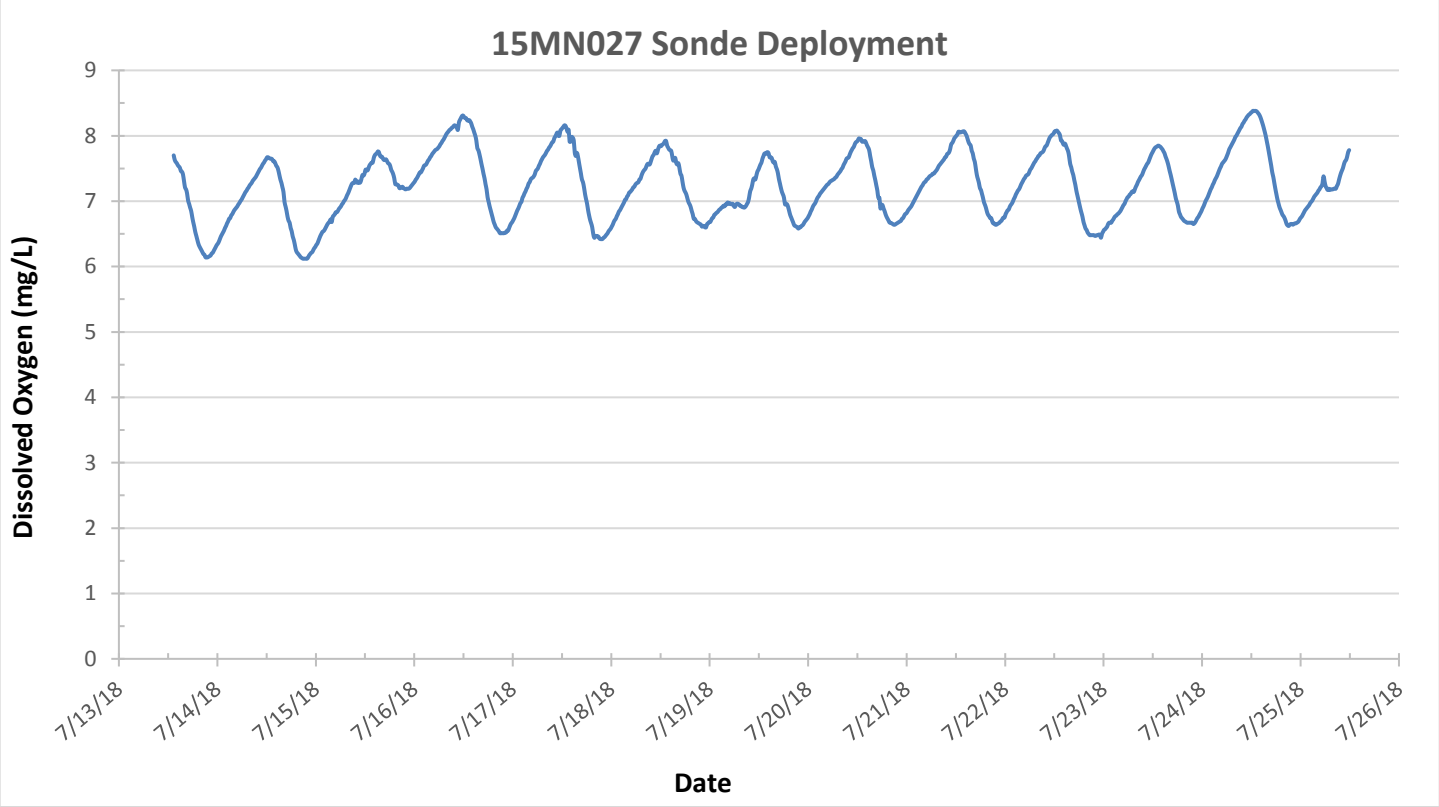
07020001-576 **Invert Class 7** **General Use**	Low DO Intolerant Taxa %	Low DO Tolerant Taxa %	DO TIV	HBI_MN
15MN027 6/15/2015	11.0	14.9	6.9	8.1
Statewide average for Class 7 Prairie Streams Glide Pool bio sites that are meeting the MIBI general use threshold (41.0)	**9.3**	**13.0**	**6.9**	**7.6**
Expected response to DO stress	↓	↑	↓	↑

DO monitoring data

Table 326. Dissolved oxygen data from chemistry site S013-148

07020001-576 DO Data	Range of Data (mg/L)	% of Monthly Samples < 5 mg/L [# of Samples]							% of Total Samples < 5 mg/L [# of Samples]
		April	May	June	July	August	Sept	Oct	
S013-148 (2017-2018)	7.5 – 9.6	N/A [0]	0% [1]	N/A [0]	0% [1]	N/A [0]	N/A [0]	N/A [0]	0% [2]

Figure 123. Continuous dissolved oxygen data at bio site 15MN027



Dissolved oxygen summary

The fish community at bio site 15MN027 scored below average in five out of six DO related fish metrics when compared to the average of all other Class 3 Southern Headwater bio sites that meet the FIBI general use threshold (Table 324). There were no species whose females take more than three years to mature, a low number of total taxa, a below average DO TIV, and no low DO sensitive fish caught. Low DO tolerant species comprised over 94% of the total number of fish caught.

Invertebrate metrics were mixed. Two out of four DO related invertebrate metrics scored poorly. However, taxa that are intolerant of low DO scored better than average and low DO tolerant taxa were just above the class average.

A total of two DO measurements were made during sampling from 2017-2018 with none falling below the standard of 5 mg/L (Table 326).

A YSI Sonde water meter measured continuous DO data from July 13 2018 to July 25 2018 (Figure 123). During this deployment, no DO values were measured below the standard of 5 mg/L, with a low value of 6.12 mg/L.

Based on the mixed DO related biological metric scores, the chemistry data, and the measured sonde values, DO is not a stressor in reach 07020001-576.

3.17.6 Eutrophication

Eutrophication biological metric data

Table 327. Eutrophication related fish metrics for bio site 15MN027

07020001-576 **Fish Class 3** **General Use**	Darter %	Omnivore %	Sensitive %	Tolerant %
15MN027 6/15/2015	1.1	10.2	1.1	98.9
Statewide average for Class 3 southern headwaters bio sites that are meeting the FIBI general use threshold (55.0)	**12.1**	**14.6**	**8.6**	**70.6**
Expected response to eutrophication stress	↓	↑	↓	↑

Table 328. Eutrophication related invert metrics for bio site 15MN027

07020001-576 **Invert Class 7** **General Use**	Taxa Count All #	Collector – Filterer Taxa #	Collector – Gatherer Taxa #	Ephemeroptera Plecoptera Trichoptera Taxa #	Intolerant Taxa #	Tolerant Taxa %
15MN027 8/6/2015	37	5	16	8	0	91.9
Statewide average for Class 7 Prairie Stream Glide Pool bio sites that are meeting the MIBI general use threshold (41.0)	**37**	**5**	**13.2**	**8.9**	**0.2**	**81.9**
Expected response to eutrophication stress	↓	↓	↑	↓	↓	↑

Eutrophication monitoring data

Table 329. Phosphorus monitoring data for chemistry site S013-148

07020001-576 P Sample Data	Range of Data (mg/L)	Monthly Average of Samples (mg/L) [# of Samples]							June-Aug Average (mg/L) [# of Samples]
		April	May	June	July	August	Sept	Oct	
S013-148 (2017 – 2018)	0.11 – 0.34	N/A [0]	0.18 [1]	N/A [0]	0.22 [1]	N/A [0]	N/A [0]	N/A [0]	0.22 [1]

Eutrophication summary

The fish community at bio site 15MN027 scored poorly in three out of four eutrophication related fish metrics when compared to the average of all other Class 3 Southern Headwater bio sites that meet the FIBI general use threshold (Table 327). There were almost no darters or any sensitive fish caught. Tolerant fish comprised 98.9% of the population. The omnivorous fish percentage was below the class average though the fish community was dominated by one species, the brook stickleback, which is not considered and omnivorous fish.

The invert community at bio site 15MN027 was mixed. Four out of six eutrophication related invert metrics scored poorly when compared to the average of all other Invert Class 7 Prairie Streams Glide Pool bio sites that meet the MIBI general use threshold (Table 328). Both Taxa count and collector – filterer metrics scored right at the class average. Collector – gatherer # scored above the class average. EPT taxa scored just below the class average, there were no intolerant taxa caught and over 91% of the taxa present are tolerant.

Only two samples were collected and analyzed for Phosphorus at chemistry site S013-148 from 2017-2018. The summer average was 0.22 mg/l, above the standard of 0.15 mg/L (Table 329).

A YSI Sonde water meter measured continuous DO data from July 13 2017 to July 25 2017 (Figure 123). During this deployment, DO diurnal flux, or the difference between the daily high and low DO concentrations was below the eutrophication DO flux standard of 5 mg/L.

The fish community seems to be showing the effects of eutrophication, the invert metrics were mixed. Phosphorus data was limited, and DO flux values were below 5 mg/L. Eutrophication is inconclusive as a stressor to the biological community in reach 07020001-576.

3.17.7 Suspended solids

Suspended solids biological metric data

Table 330. Suspended solids related fish metrics for bio site 15MN027

07020001-576 **Fish Class 3** **General Use**	Benthic Feeder %	Centrarchid-Tolerant %	Herbivore %	Intolerant %	Long-Lived %	Perciformes-Tolerant %	Riffle %	Sensitive %	Simple Lithophilic Spawner %	TSS TIV
15MN027 6/15/2015	0.0	0.0	0.0	0.0	0.0	1.1	0.0	1.1	2.3	15.3
Statewide average for Class 3 Southern Headwater stations that are meeting the FIBI general use threshold (55.0)	**37.8**	**0.9**	**13.3**	**2.0**	**3.6**	**13.9**	**28.3**	**8.6**	**33.7**	**15.2**
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Table 331. Suspended solids related invert metrics for bio site 15MN027

07020001-576 **Invert Class 7** **General Use**	Collector-Filterer %	Plecoptera %	TSS Intolerant %	TSS Tolerant %	TSS TIV
15MN027 8/6/2015	5.5	1.2	0.0	36.3	16.7
Statewide average for Class 7 Prairie Streams Glide Pool bio sites that are meeting the MIBI general use threshold (41.0)	**19.1**	**0.2**	**2.7**	**48.3**	**17.8**
Expected response to TSS stress	↓	↓	↓	↑	↑

TSS monitoring data

Table 332. Total suspended solids monitoring data for chemistry sites S013-148

07020001-576 TSS Sample Data	Range of Data (mg/L)	% of Monthly Samples > 65 mg/L [# of Samples]							% of Total Samples > 65 mg/L [# of Samples]
		April	May	June	July	August	Sept	Oct	
S013-148 (2017)	7.6	N/A [0]	0% [1]	N/A [0]	N/A [0]	N/A [0]	N/A [0]	N/A [0]	0% [1]

Suspended solids summary

The fish community at bio site 15MN027 scored very poorly in all of the TSS related fish metrics when compared to the average of all other Class 3 Southern Headwater bio sites that meet the FIBI general use threshold (Table 330). There were no benthic feeders, Centrarchids, herbivores, intolerant, long-lived, or riffle dwelling fish. There were almost no perciformes, sensitive fish, or simple lithophillic spawning fish caught. The TSS TIV scored just above the class average.

The bio site scored poorly in two of five invert suspended solids related metrics. There were low numbers of collector-filterers and no TSS intolerant species were found (Table 331). Plecoptera was above the class average, TSS tolerant percentage scored well, and the TSS tolerance index value was below the class average.

Only one sample was collected within reach 07020001-576. It was well below 65 mg/L (Table 332).

All of the fish metrics related to suspended solids scored poorly though the inverts mostly scored well. The chemistry data, though limited, showed low concentrations of TSS. Suspended solids are inconclusive as a stressor to aquatic life in reach 07020001-576. It is likely that other factors, such as altered hydrology and habitat are causing poor scores in the fish biological metrics. It is recommended that more TSS data be collected during high flows in order to determine whether it is a biological stressor.

3.17.8 Nitrates

Nitrate biological metric data

Table 333. Nitrate related invertebrate metrics for bio site 15MN027

07020001-576 Invert Class 7 General Use	Nitrate Intolerant Taxa %	Nitrogen TIV	Tolerant Taxa %	Trichoptera Taxa %
15MN027 6/15/2015	0.0	4.1	85.4	5.4
Statewide average for Class 7 Prairie Streams Glide Pool bio sites that are meeting the MIBI general use threshold (41.0)	**3.2**	**3.2**	**54.9**	**10.9**
Expected response to nitrogen stress	↓	↑	↑	↓

Nitrate monitoring data

Table 334. Nitrate monitoring data for chemistry sites S013-148

07020001-576 Nitrate/Nitrite Sample Data	Range of Data (mg/L)
S013-148 (2017-2018)	1.6 – 12.0

Nitrate summary

The macroinvertebrate assemblage at sites 15MN027 scored poorly in all four nitrate related metrics when compared to all other macroinvertebrate Class 7 Prairie Stream Glide Pool bio sites that meet the MIBI general use threshold (Table 333). There were no nitrogen intolerant taxa, the nitrogen TIV scored poorly, tolerant taxa was well above the average of Class 7 bio sites that were not impaired, and Trichoptera taxa percentage below the class average.

Only three samples were collected and analyzed for nitrate/nitrite at chemistry site S013-148 (Table 334). Two out of the three samples had relatively high nitrate concentrations at 8.6 and 12 mg/L.

The poor nitrate related invert metrics and the fact that two out of only three samples collected were high is concerning. Nitrates are inconclusive as a stressor to the biological community in reach 07020001-576. Collecting more chemistry and biological data within this reach is recommended in order to determine if nitrates are a stressor to the biological community.

3.17.9 Reach stressors

This stream is being stressed by changes to the hydrology of the stream channel and contributing watershed. The stream itself appears to have been ditched, often times right through wetlands in order to drain them, which has eliminated in-stream habitat and has caused siltation and very little depth variability. This stream reach could benefit from allowing its tributaries to re-meander and form pools, riffles, and runs, which forms the habitat that aquatic life needs to live. The stream is also disconnected from its flood plain in areas due to both ditching of the stream as well as incision.

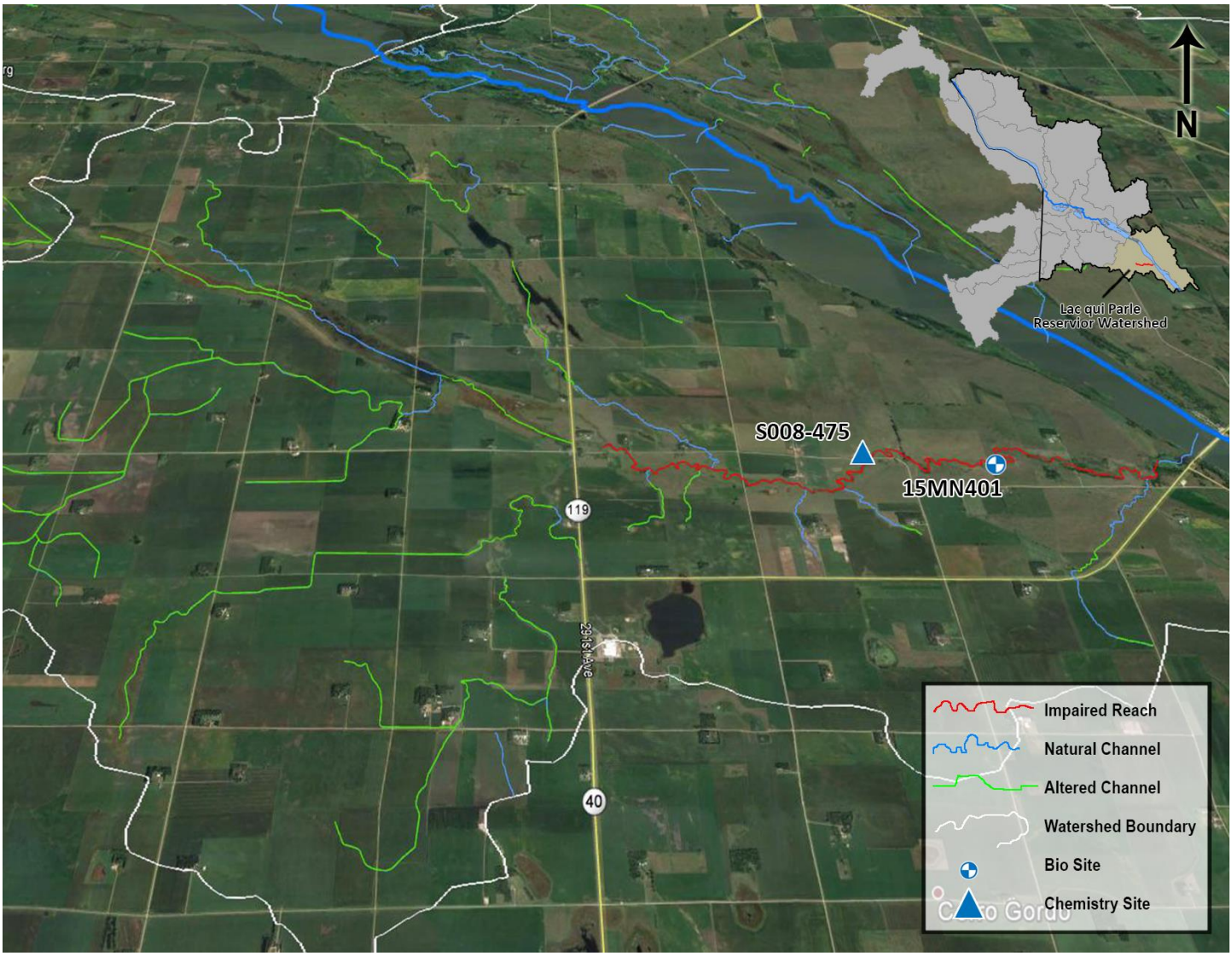
The construction of ditches and the addition of tile drainage has altered the land area that that regularly contributes water to the stream as well as the amount and timing of water that reaches the stream. Increasing the storage and infiltration of water can help reduce nutrient delivery to the stream, erosion and incision from high flows after large rain events, and can help mitigate periods of extremely low flows during times of low precipitation.

Table 335. Summary of stressors in reach 07020001-576

07020001-576	**Hydrologic Alteration**	**Connectivity**	**Habitat**	**Dissolved Oxygen**	**Eutrophication**	**Suspended Solids**	**Nitrate**
✓= Stressor ×= Not a Stressor **O** = Inconclusive	✓	**O**	✓	×	**O**	**O**	**O**

3.18 07020001-547 Emily Creek

Figure 124. Satellite image of reach 07020001-547 and its watershed



3.18.1 Biological community

Bio site 15MN401 was sampled for fish once in 2015. Eight total species and 87 individual fish were caught, with white suckers and fathead minnows comprising over 71% of the population, resulting in an IBI score of 33.5 (Table 336). Metrics used to calculate the fish IBI score are shown in a graph with the red line indicating the value each metric needed to score in order to meet the threshold (Figure 125).

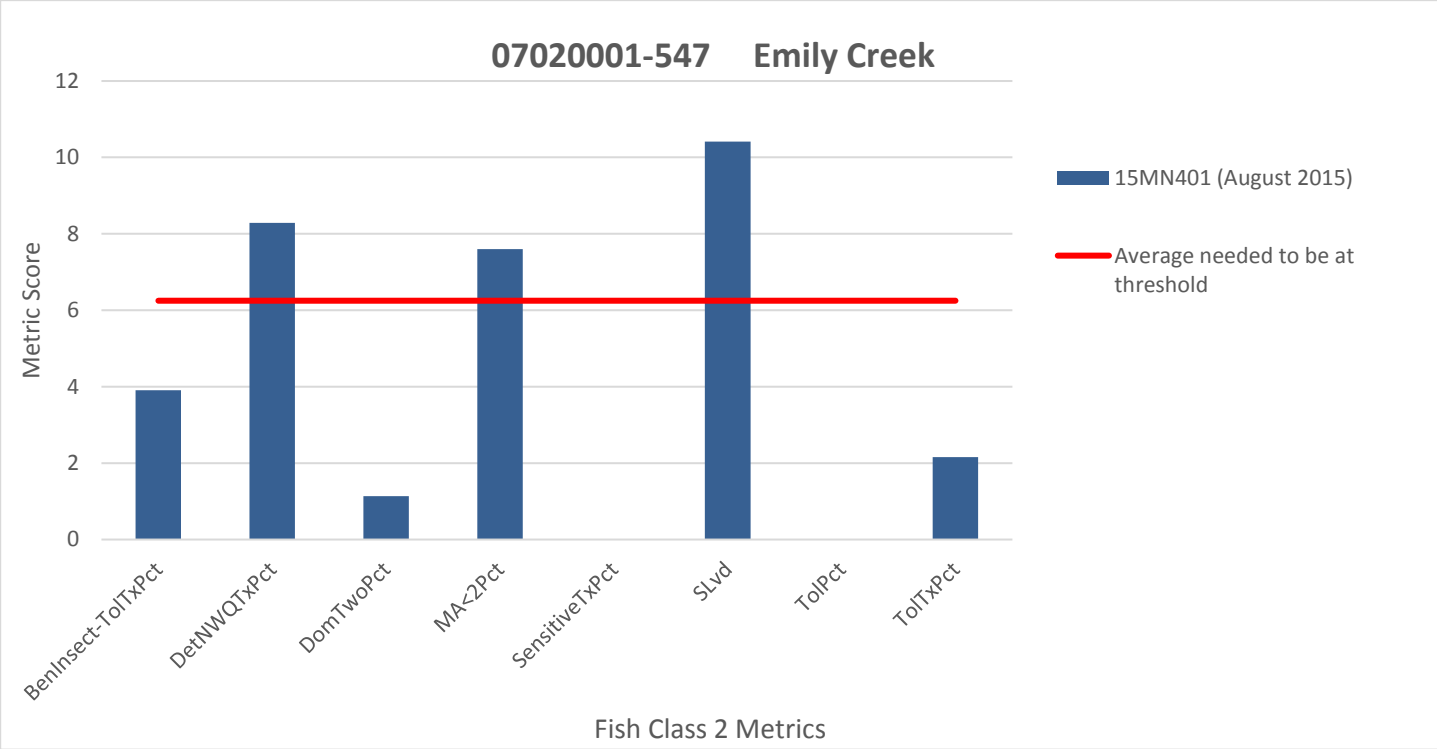
Bio site 15MN401 was sampled for invertebrates once in 2015. 28 total species and 305 individual invertebrates were caught, with Physella snails, midges, and amphipods comprising over 82% of the invert community resulting in a IBI score of 33.5 (Table 337). Metrics used to calculate the invert IBI score are shown in a graph with the red line indicating the value each metric needed to score in order to meet the threshold (Figure 126).

Fish biological metric data

Table 336. Fish IBI score and threshold for bio site 15MN401

07020001-547 Fish Class 2 General Use		Fish IBI Score	Class Threshold Score
15MN401	8/03/2015	33.5	55

Figure 125. Fish Class 2 general use metric scores for bio site 15MN401

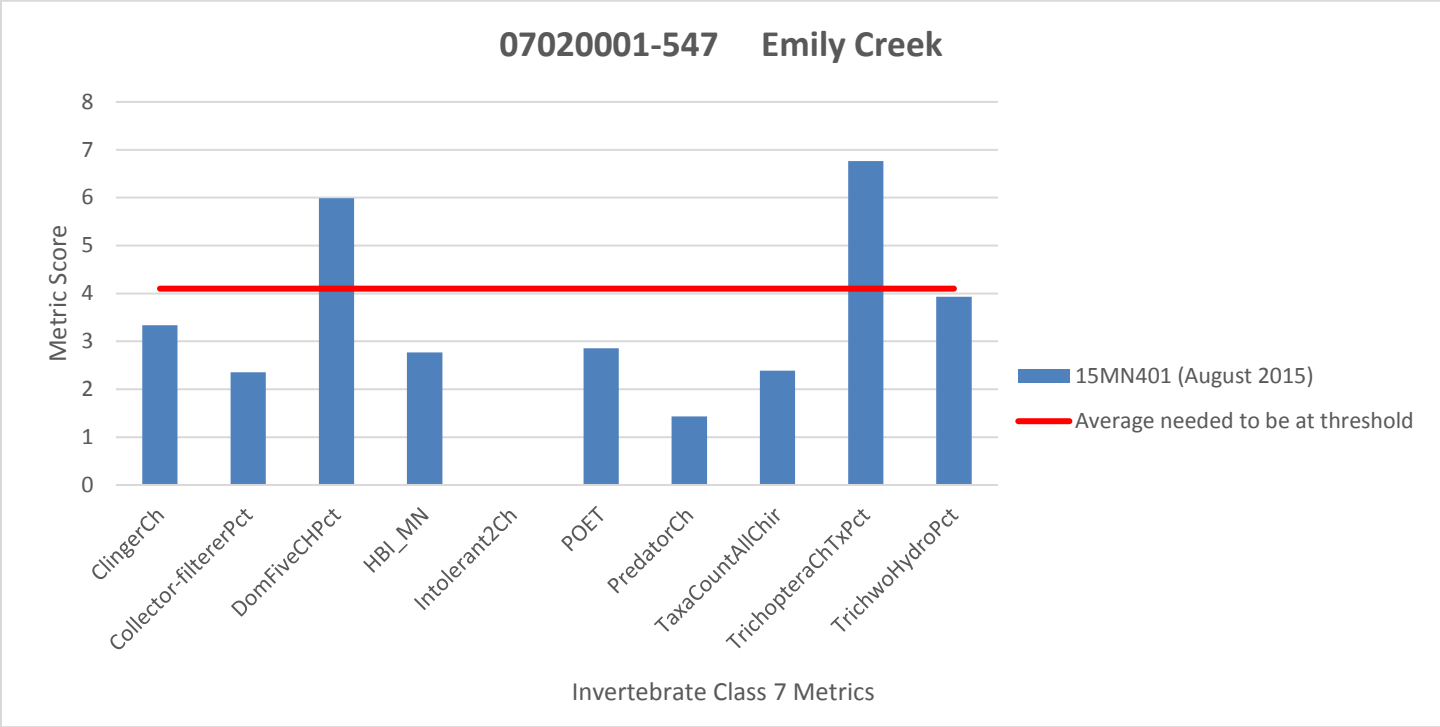


Invertebrate biological metric data

Table 337. Invert IBI score and threshold for bio site 15MN401

07020001-547 Invert Class 7 General Use		Invert IBI Score	Class Threshold Score
15MN401	8/10/2015	31.8	41

Figure 126. Invert Class 7 general use metric scores for bio site 15MN401



3.18.2 Hydrologic alteration

Hydrologic alteration biological metric data

Table 338. Hydrologic alteration related fish metrics for bio site 15MN401

07020001-547 **Fish Class 2** **General Use**	General %	Nesting Non Lithophilic Spawner %
15MN401 8/03/2015	85.1	46.0
Statewide average for Class 2 southern stream bio sites that are meeting the FIBI general use threshold (50.0)	**42.4**	**19.1**
Expected response to **Hydrologic** stress	↑	↑

Table 339. Hydrologic alteration related invert metrics for bio site 15MN401

07020001-547 **Invert Class 7** **General Use**	Clinger %	Collector-Filterer %	Long-Lived %
15MN401 8/10/2015	28.5	9.2	1.3
Statewide average for Class 7 Prairie Streams Glide Pool bio sites that are meeting the MIBI general use threshold (41.0)	**38.5**	**19.1**	**8.0**
Expected response to **Hydrologic** stress	↓	↓	↓

HSPF model flow data

Table 340. HSPF modeled flow data, 1994-2012

07020001-547 HSPF Reach 405 Min: 0 cfs Max: 1,503.5 cfs	**<5 cfs %** (# of values)	**<1 cfs %** (# of values)	**<0.5 cfs %** (# of values)
6,940 Total Daily Averages 1994 – 2012	**67.1%** (4,659)	**31.5%** (2,186)	**17.4%** (1,210)

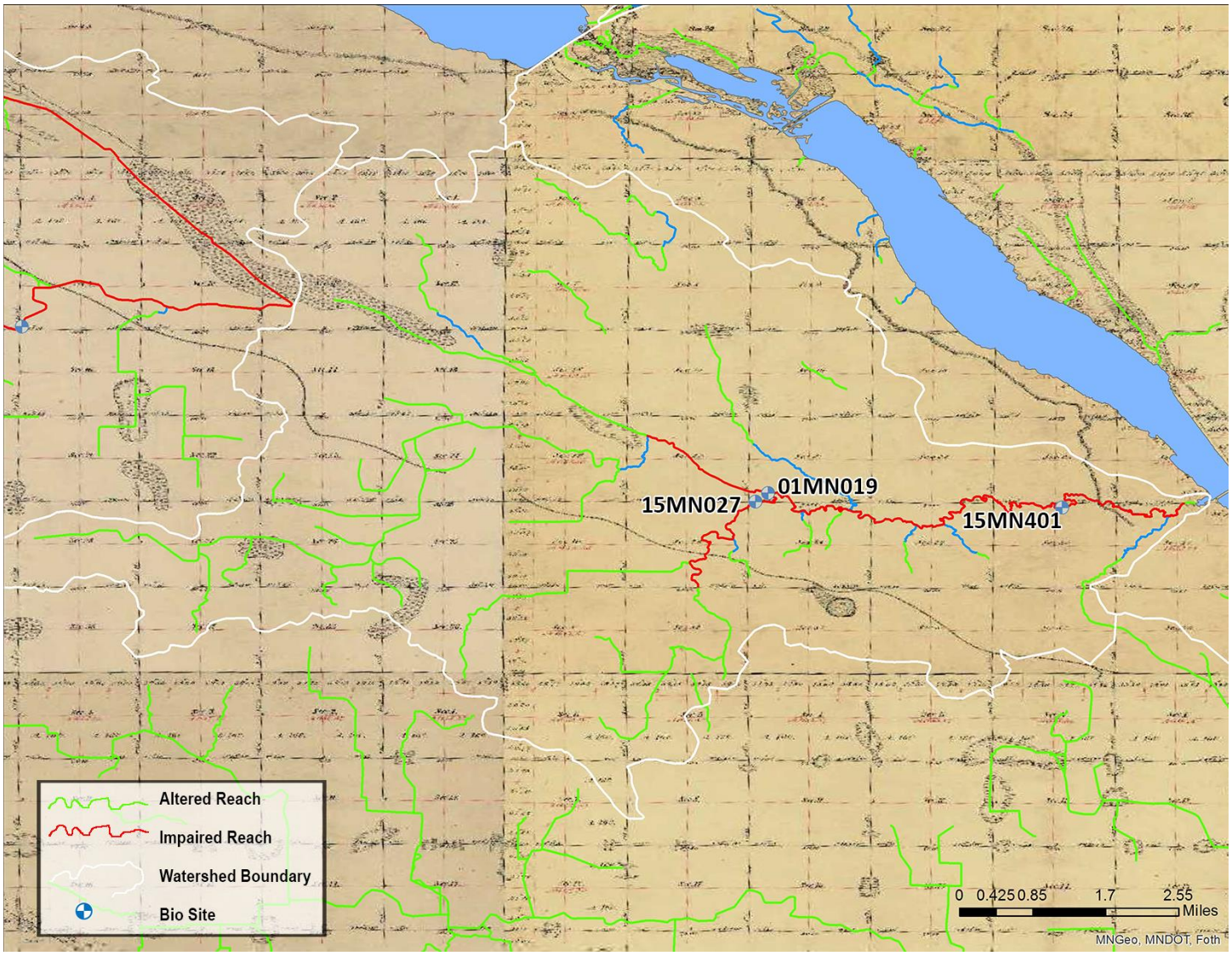
Hydrologic alteration summary

Both of the hydrologic alteration related fish biological metrics scored poorly when compared to the Fish Class 2 bio sites that meet the IBI general use threshold (Table 338). Generalist species were high at about 85% and there were a high percentage of nest building species. The two dominant species, white suckers and fathead minnows, made up over 71% of the total number of fish. There were no sensitive species caught.

All three of the invertebrate metrics scored poorly when compared to the average of Invert Class 7 general use streams that met the IBI threshold (Table 339). Clinger, collector-filterer, and long-lived invertebrates were below the class averages.

The HSPF model (Table 340) shows that 31.5% of the daily average flows from 1994 – 2012 are below 1 cfs. Flows of less than 5 cfs were higher at 67.1%. Flows reduced beyond normal base flow decreases habitat for aquatic organisms and increases competition for resources.

Figure 127. Original survey plat map of the watershed of reach 07020001-547 including altered watercourses



Reach 07020001-547 is the furthest downstream reach of Emily Creek. According to the original survey data the eastern watershed contained wetlands that have been extensively drained. Most of its tributaries have been altered into ditches in order to move water and grow crops (Figure 127). Creating these ditches essentially added to the amount of land and water that drains into the creek and the timing of water runoff. This altered the natural flow regime of this stream that had developed over several millenniums by decreasing the time it takes for water to move through the system, moving more water through the system at a higher frequency, and increasing the impact to the stream channel of high flow events while also increasing the intensity of low flow periods.

The channel at the study location was classified as an E6 stream type. E6 stream types have moderate to high sinuosity, moderately steep channel gradients, and very low width/depth ratios (Rosgen 1996). Channel types such as this have a very high sensitivity to disturbance, moderate streambank erosion potential, but low sediment supply (Rosgen 1994, Appendix III). E channels are typically controlled by the vegetation of their riparian corridor and have a good recovery potential (Rosgen 1994). The measured bank height ratio at the riffle cross section was 1.41 indicating that the channel is moderately incised. The channel has adequate floodplain access even though the channel is moderately incised. When analyzing flood-prone width in relation to bankfull width at the riffle cross section we find that the channel is only slightly entrenched, further indicating adequate floodplain access (DNR, 2019).

Based on the poor scores of the fish and invert biological metrics, the high percentage of channelization and altered stream channels upstream (Figure 124), and the high percentage of modeled low flows, Hydrologic Alteration in the form of both low and high flows is a stressor in reach 07020001-547. The primary impact in this reach from Hydrologic Alteration is extensive low flows from the ditching and channelization of the stream channel and its tributaries, subsurface tile drainage of the surrounding wetlands, as well as the pollutant overloading of nutrients.

3.18.3 Connectivity

Connectivity metric data

Table 341. Connectivity related fish metrics for bio site 15MN027

07020001-547 **Fish Class 2** **General Use**	Mature Age >3 minus Tolerant Taxa %	Migrating Taxa %
15MN401 8/03/2015	0.0	12.5
Statewide average for Class 2 southern stream bio sites that are meeting the FIBI general use threshold (50.0)	**21.8**	**24.3**
Expected response to connectivity stress	↓	↓

Connectivity summary

There were no fish caught whose females take greater than three years to mature (Table 341). There was only one migrating species present, the white sucker. No downstream culverts or road crossings were identified as fish barriers, though there are several small road crossings that could be undersized or placed at the wrong elevation. Due to the presence of one migratory species, connectivity is inconclusive as a stressor at this time. It is recommended that road crossings be checked and inventoried to rule out any possible fish barriers both up and downstream of reach 07020001-547.

3.18.4 Habitat

Habitat metric data

Table 342. Habitat related fish metrics for bio site 15MN401

07020001-547 **Fish Class 2** **General Use**	Benthic Insect minus Tolerant	Darter Sculpin Sucker %	Lithophilic Spawner %	Pioneer %	Piscivore %	Riffle %	Simple Lithophilic Spawner %	Tolerant %
15MN401 8/03/2015	1.2	1.2	50.57	40.2	0.0	40.2	42.5	96.6
Statewide average for Class 2 southern stream bio sites that are meeting the FIBI general use threshold (50.0)	**20.4**	**18.2**	**58.3**	**19.0**	**5.2**	**32.5**	**39.4**	**44.9**
Expected response to habitat stress	↓	↓	↓	↑	↓	↓	↓	↑

Table 343. Habitat related invert metrics for bio site 15MN401

07020001-547 **Invert Class 7** **General Use**	Burrower %	Climber %	Clinger %	Ephemeroptera Plecoptera Trichoptera %	Legless %	Sprawler %
15MN401 8/10/2015	4.3	38.7	28.5	6.9	77.1	27.9
Statewide average for Class 7 Prairie Streams Glide Pool bio sites that are meeting the MIBI general use threshold (41.0)	**7.5**	**21.6**	**38.5**	**38.5**	**39.8**	**20.9**
Expected response to habitat stress	↑	↓	↓	↓	↑	↑

MPCA stream habitat assessment score

Table 344. Habitat assessment score for bio site 15MN401

07020001-547	Land Use	Riparian	Substrate	Cover	Channel Morphology	Total Score
15MN401 8/03/2015	2.5	11	6.8	10	1	31.3
Maximum Attainable Habitat Score	**5**	**14**	**28**	**18**	**35**	**100**

Figure 128. Photo of bio site 15MN401 showing bulrush, a wetland plant (left) and an instream photo showing submerged vegetative cover on both sides of the stream (right)

Habitat summary

The fish community at bio site 15MN401 scored very poorly in six out of eight of the habitat related fish metrics when compared to all other Class 2 southern stream bio sites that met the FIBI general Use Threshold (Table 342). There were almost no benthic insectivores or darters. There were no piscivores and tolerant fish comprised over 96% of the population. Riffle fish and simple lithophilic spawning fish scored fairly as they were both above the class average.

Invertebrate metrics were mixed (Table 343). Clinger, EPT, and legless taxa scored poorly. Burrower taxa scored well and climber and sprawler taxa scored above the class average. Burrower taxa was low and there were a fair number of climber taxa, which would use the large amount of vegetation adjacent and within the stream channel. Sprawlers scored well above average, though the majority of sprawler taxa was the mayfly Caenis diminuta, which is very tolerant to fine sediment.

The MSHA habitat assessment scored poorly at bio site 15MN401 in August of 2015 (Table 344). The riparian zone scored decently as there was a decent riparian width and little to moderate bank erosion present. The stream substrate was very poor and was listed as mostly silt and muck with moderate embeddedness of coarse substrates. Cover scored decent and was listed as moderate. Channel morphology was very poor with a score of only one; there was no depth variability, poor sinuosity, no riffles, and slow water velocities.

Photos from field visits (Figure 128) shows bulrush growing along the stream bank (left) and submerged vegetation at the bio site (right).

Due to the majority of the habitat related metrics scoring poorly and the poor stream habitat assessment score habitat is a stressor to the biology of reach 07020001-547.

3.18.5 Dissolved oxygen

DO biological metric dta

Table 345. Dissolved oxygen related fish metrics for bio site 15MN401

07020001-547 **Fish Class 2** **General Use**	Mature Age >3 %	Serial Spawner %	Taxa Count	DO TIV	DO Sensitive %	DO Tolerant %
15MN401 8/03/2015	42.5	31.0	8.0	6.7	0.0	46.0
Statewide average for Class 2 southern stream bio sites that are meeting the FIBI general use threshold (50.0)	**23.9**	**28.7**	**20.4**	**7.2**	**6.1**	**15.8**
Expected response to DO stress	↓	↑	↓	↓	↓	↑

Table 346. Dissolved oxygen related invert metrics for bio site 15MN401

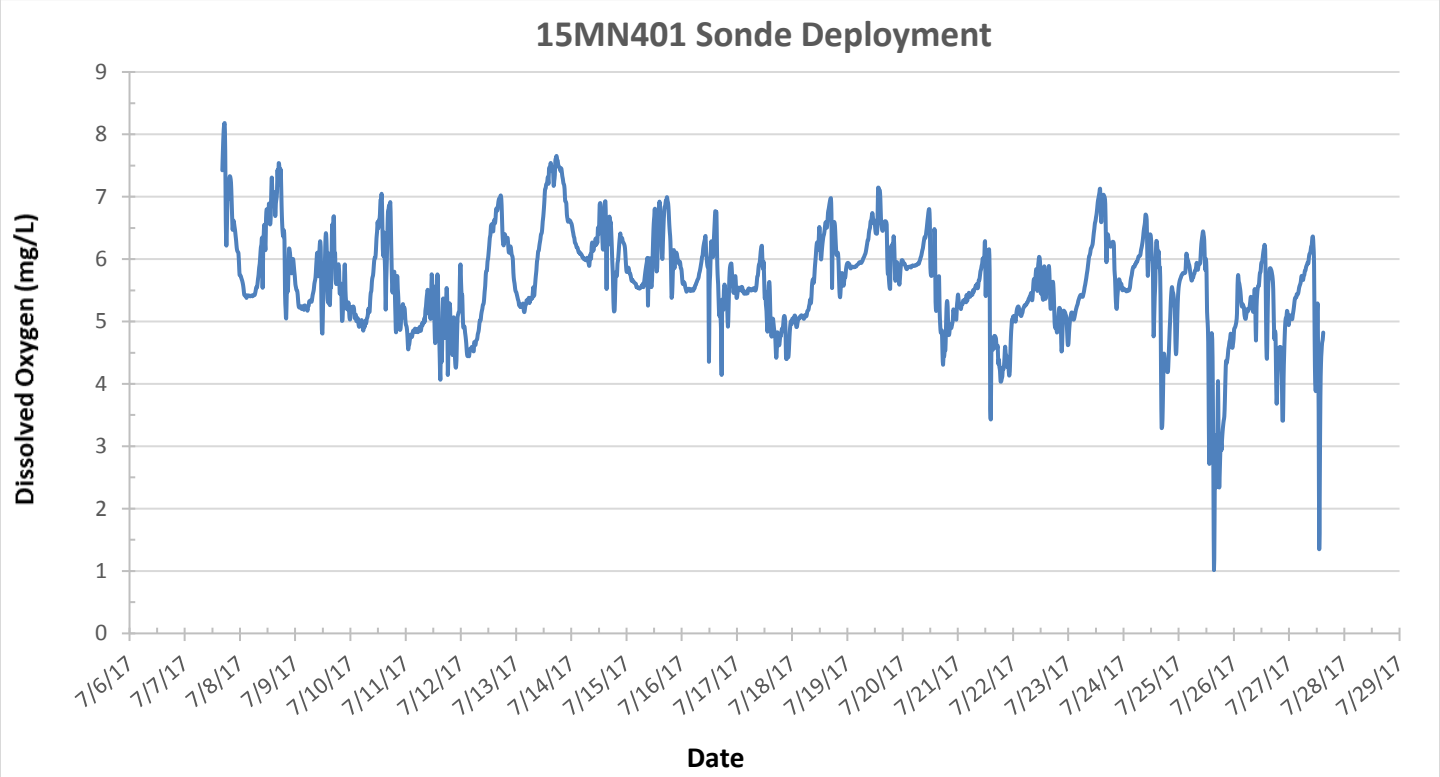
07020001-547 **Invert Class 7** **General Use**	Low DO Intolerant Taxa %	Low DO Tolerant Taxa %	DO TIV	HBI_MN
15MN401 8/10/2015	0.7	36.0	6.6	8.0
Statewide average for Class 7 Prairie Streams Glide Pool bio sites that are meeting the MIBI general use threshold (41.0)	**9.3**	**13.0**	**6.9**	**7.6**
Expected response to DO stress	↓	↑	↓	↑

DO monitoring data

Table 347. Dissolved oxygen data from chemistry site S008-475

07020001-547 DO Data	Range of Data (mg/L)	% of Monthly Samples < 5 mg/L [# of Samples]							% of Total Samples < 5 mg/L [# of Samples]
		April	May	June	July	August	Sept	Oct	
S008-475 (2015-2017)	4.2 – 12.5	N/A [0]	0% [2]	0% [6]	14.3% [7]	0% [5]	0% [2]	N/A [0]	4.5% [22]

Figure 129. Continuous dissolved oxygen data at bio site 15MN401



DO HSPF model data

Table 348. Dissolved oxygen HSPF model data

07020001-547 HSPF Reach 405	**June – September % Daily Averages <5 mg/l** (# of values)
2,318 Total Daily Averages	**22%** (521)

Dissolved oxygen summary

The fish community at bio site 15MN401 scored below average in five out of six DO related fish metrics when compared to the average of all other Class 2 southern stream bio sites that meet the FIBI general use threshold (Table 345). Females that take more than three years to mature scored well, though this was due to the fact that white suckers, a tolerant species, was the most numerous species present. Serial spawning fish percent scored poorly, though it was only slightly above the class average. Taxa count was very poor, the DO TIV scored relatively low, and both DO sensitive and DO tolerant metrics were very poor.

All four Invertebrate metrics scored poorly. Taxa that are intolerant of low DO scored very poorly compared to the class average (Table 346). DO tolerant taxa were relatively high and the HBI value indicates a fish population generally tolerant of pollution.

Fourteen percent of the DO measurements taken in July and 4.5% of the total measurements taken were below the warmwater standard of 5 mg/L (Table 347). A YSI Sonde water meter measured continuous DO data from July 7 2017 to July 27 2017. During this deployment, DO values were measured below the standard of 5 mg/L 12 out of 20 days (Figure 129).

Based on the poor related biological metric scores, several measured values below the standard, and the low deployed sonde DO values, DO is a stressor in reach 07020001-547.

3.18.6 Eutrophication

Eutrophication biological metric data

Table 349. Eutrophication related fish metrics for bio site 15MN401

07020001-547 **Fish Class 2** **General Use**	Darter %	Omnivore %	Sensitive %	Tolerant %
15MN401 8/03/2015	1.2	74.7	0.0	96.6
Statewide average for Class 2 southern stream bio sites that are meeting the FIBI general use threshold (50.0)	**11.7**	**16.5**	**44.9**	**18.7**
Expected response to eutrophication stress	↓	↑	↓	↑

Table 350. Eutrophication related invert metrics for bio site 15MN401

07020001-547 **Invert Class 7** **General Use**	Taxa Count All #	Collector – Filterer Taxa #	Collector – Gatherer Taxa #	Ephemeroptera Plecoptera Trichoptera Taxa #	Intolerant Taxa #	Tolerant Taxa %
15MN401 8/10/2015	27	5	10	4	0	81.5
Statewide average for Class 7 Prairie Stream Glide Pool bio sites that are meeting the MIBI general use threshold (41.0)	**37**	**5**	**13.2**	**8.9**	**0.2**	**81.9**
Expected response to eutrophication stress	↓	↓	↑	↓	↓	↑

Eutrophication monitoring data

Table 351. Phosphorus monitoring data for chemistry sites S008-475

07020001-547 P Sample Data	Range of Data (mg/L)	Monthly Average of Samples (mg/L) [# of Samples]							June-Aug Average (mg/L) [# of Samples]
		April	May	June	July	August	Sept	Oct	
S008-475 (2015)	0.08 – 0.29	N/A [0]	0.09 [2]	0.16 [2]	0.25 [4]	0.22 [2]	0.25 [2]	N/A [0]	0.22 [12]

Eutrophication HSPF model data

Table 352. HSPF model phosphorus data

07020001-547 HSPF Reach 405	**Total Phosphorus**	
	June – September **% values > 0.15 mg/l** (# Daily Values)	**June – September** **Multi-year Average**
2,318 Total Daily Averages *June – Sep 1994 – 2012*	**98.1%** (1,994)	**0.83 mg/l**

Eutrophication summary

The fish community at bio site 15MN401 scored poorly in all four eutrophication related fish metrics when compared to the average of all other Class 2 southern stream bio sites that meet the FIBI general use threshold (Table 349). There

were almost no darters caught. Omnivorous fish scored very poorly at over 74%. No sensitive fish were caught and tolerant fish comprised over 96.6% of the population.

The invert metrics were mixed at bio site 15MN401 (Table 350). Four out of six eutrophication related invert metrics scored poorly when compared to the average of all other Invert Class 7 Prairie Stream Glide Pool bio sites that meet the MIBI general use threshold. Taxa count was low. Collector – filterer scored right at the class average. EPT taxa scored poorly and there were no intolerant taxa caught. Collector – gatherer scored well and tolerant taxa percentage barely scored well as it was just below the class average.

Twelve samples were collected and analyzed for phosphorus at chemistry site S008-475 in 2015. The summer average was 0.22 mg/l, above the standard of 0.15 mg/L (Table 351).

The HSPF model computed the summer average just above the standard at 0.83 mg/L (Table 352).

A YSI Sonde water meter measured continuous DO data from July 7 2017 to July 27 2017 (Figure 129). During this deployment, DO diurnal flux, or the difference between the daily high and low DO concentrations was below the eutrophication DO flux standard of 5 mg/L for most of the deployment although they did reach 5 mg/L on two nights towards the end of the deployment.

The fish and invert community seems to be showing the effects of eutrophication, phosphorus concentrations were high, and DO flux values reached 5 mg/L. Eutrophication is a stressor to the biological community in reach 07020001-547.

3.18.7 Suspended solids

Suspended solids biological metric data

Table 353. Suspended solids related fish metrics for bio site 15MN401

07020001-547 Fish Class 2 General Use	Benthic Feeder %	Centrarchid-Tolerant %	Herbivore %	Intolerant %	Long-Lived %	Perciformes-Tolerant %	Riffle %	Sensitive %	Simple Lithophilic Spawner %	TSS TIV
15MN401 8/03/2015	41.4	0.0	0.0	0.0	2.3	1.2	40.2	0.0	42.5	18.4
Statewide average for Class 2 Southern Stream stations that are meeting the FIBI general use threshold (50.0)	**37.4**	**4.9**	**9.6**	**5.0**	**11.7**	**18.7**	**32.5**	**18.7**	**39.4**	**17.6**
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Table 354. Suspended solids related invert metrics for bio site 15MN401

07020001-547 **Invert Class 7** **General Use**	Collector-Filterer %	Plecoptera %	TSS Intolerant %	TSS Tolerant %	TSS TIV
15MN401 8/10/2015	9.2	0.0	0.0	10.0	17.1
Statewide average for Class 7 Prairie Streams Glide Pool bio sites that are meeting the MIBI general use threshold (41.0)	**19.1**	**0.2**	**2.7**	**48.3**	**17.8**
Expected response to TSS stress	↓	↓	↓	↑	↑

TSS monitoring data

Table 355. Total suspended solids monitoring data for chemistry sites S008-475

07020001-547 TSS Sample Data	Range of Data (mg/L)	% of Monthly Samples > 65 mg/L [# of Samples]							% of Total Samples > 65 mg/L [# of Samples]
		April	May	June	July	August	Sept	Oct	
S008-475 (2015)	6 – 57	N/A [0]	0% [2]	0% [2]	0% [3]	0% [2]	0% [2]	N/A [0]	0% [11]

Suspended solids summary

The fish community at bio site 15MN401 scored very poorly in seven out of ten TSS related fish metrics when compared to the average of all other Class 2 southern stream bio sites that meet the FIBI general use threshold (Table 353). There were no centrarchids, herbivores, intolerant, or sensitive fish. There were almost no long-lived fish or perciformes present. The TSS TIV scored poorly and was above the class average. Benthic feeders, riffle dwelling fish, and simple lithophilic spawning fish all scored decent and were above the class average.

The bio site scored poorly in three out of five invert suspended solids related metrics (Table 354). Collector-filterer invertebrates, Plecoptera, and TSS intolerant percentage all scored poorly. TSS Tolerant species scored decent and were well below the class average. The TSS tolerance index value was decent too and was below the class average.

Eleven samples were collected within reach 07020001-547. They were all below the TSS standard of 65 mg/L (Table 355).

The majority of fish metrics and over half of the invert metrics scored poorly. The chemistry data, though limited, showed some higher concentrations of TSS. Suspended solids are inconclusive as a stressor to aquatic life in reach 07020001-547. It is likely that other factors, such as altered hydrology and habitat are causing poor scores in the fish biological metrics. It is recommended that more TSS data be collected during high flows in order to determine whether it is a biological stressor.

3.18.9 Reach stressors

This stream is being stressed by changes to the hydrology of the stream channel and contributing watershed. The stream itself appears to have been ditched, often times right through wetlands in order to drain them, which has eliminated in-stream habitat and has caused siltation and very little depth variability. This stream reach could benefit from allowing its tributaries to re-meander and form pools, riffles, and runs, which forms the habitat that aquatic life needs to live. The stream is also disconnected from its flood plain in areas due to both ditching of the stream as well as incision.

The construction of ditches and the addition of tile drainage has altered the land area that that regularly contributes water to the stream as well as the amount and timing of water that reaches the stream. Increasing the storage and infiltration of water can help reduce nutrient delivery to the stream, erosion and incision from high flows after large rain events, and can help mitigate periods of extremely low flows during times of low precipitation.

Table 356. Summary of stressors in reach 07020001-547

07020001-547	Hydrologic Alteration	Connectivity	Habitat	Dissolved Oxygen	Eutrophication	Suspended Solids	Nitrate
✓= Stressor ×= Not a Stressor **O** = Inconclusive	✓	**O**	✓	✓	✓	**O**	**O**

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