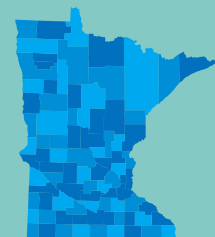


December 2018

Des Moines River Watershed Stressor Identification Report

A study of stressors limiting the biotic communities in the Des Moines River Watershed.



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Key terms & abbreviations

AUID	Assessment Unit Identification
CADDIS	Causal Analysis/Diagnosis Decision Information System
DNR	Minnesota Department of Natural Resources
DO	Dissolved Oxygen
EPA	U. S. Environmental Protection Agency
FIBI	Fish Index of Biotic Integrity
HSPF	Hydrological Simulation Program – FORTRAN
IBI	Index of Biotic Integrity
IWM	Intensive Watershed Monitoring
MIBI	Macroinvertebrate Index of Biotic Integrity
MPCA	Minnesota Pollution Control Agency
MRL	Method Reporting Limit
NPS	Non-Point Source
SID	Stressor Identification
SOE	Strength of Evidence
TIVS	Tolerance Indicator Values
TMDL	Total Maximum Daily Load
TSS	Total Suspended Solids
WRAPS	Watershed Restoration and Protection Strategy

Executive summary

The Minnesota Pollution Control Agency (MPCA) uses 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. Stream and river reaches are assigned an Assessment Unit Identification (AUID) number and will be referred to as the AUID in this report. AUIDs with low IBI scores are determined to have a biological impairment. 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). It looks at causal factors – negative ones harming fish and insects, and positive ones leading to healthy biology. Stressors may be physical, chemical, or biological. 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.

This report summarizes stressor identification work in the Des Moines River Watershed. There were 56 reaches identified with biological impairment in the watershed. The impairments in this report are organized by 10-digit Hydrologic Unit Code (HUC). There are ten HUCs discussed in this report.

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

- DO
- Eutrophication
- Nitrate
- Suspended Sediment
- Habitat
- Flow Alteration and Connectivity

1. Introduction

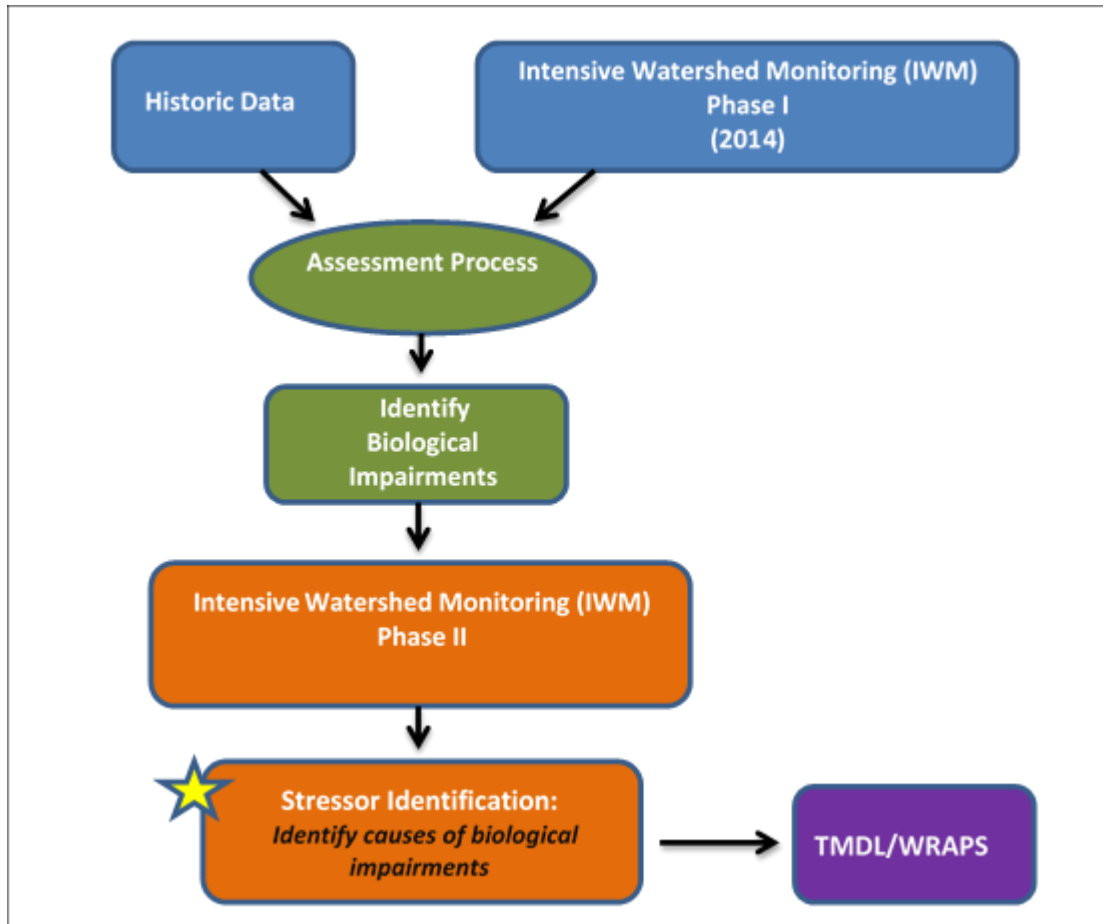
1.1. Monitoring and assessment

Water quality and biological monitoring in the Des Moines River Watersheds have been ongoing since 2004. As part of the MPCA's Intensive Watershed Monitoring (IWM) approach, monitoring activities increased in rigor and intensity in 2014, 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 within a 10-year window obtained prior to 2014 were used to identify stream reaches that were not supporting healthy fish and macroinvertebrate assemblages (Figure 1).

Once a biological impairment is discovered, the next step is to identify the source(s) of stress on the biological community. A Stressor Identification (SID) analysis is a step-by-step approach for identifying probable causes of 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. In other words, the SID process may help investigators nail down excess fine sediment as the cause of biological impairment, but a separate effort is then required to determine the TMDL and implementation goals needed to restore the impaired condition. Some stressors require TMDLs to be completed, while others do not.

Figure 1. Process maps of Intensive Watershed Monitoring, Assessment, Stressor Identification and TMDL processes.

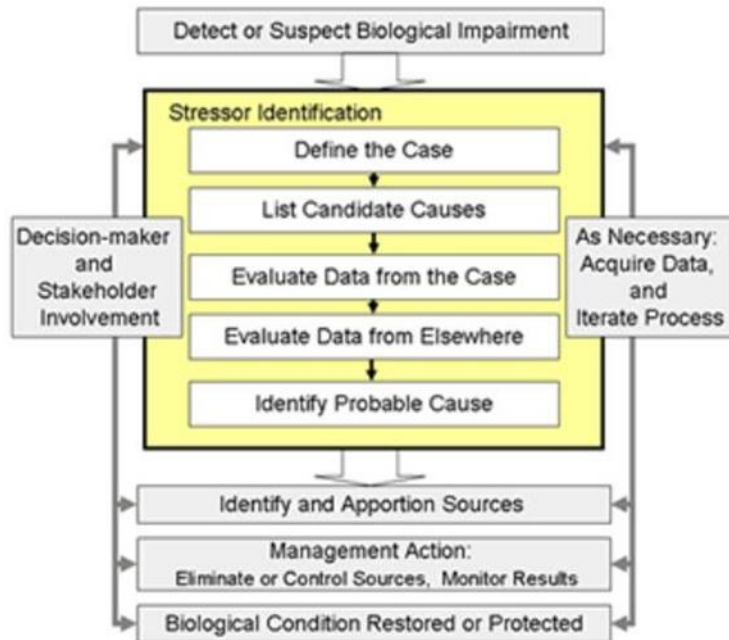


1.2. Stressor identification process

The MPCA follows the EPA’s process of identifying stressors that cause 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 Clean Water Legacy Act. 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 in 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. Conceptual model of 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).

1.3. Common stream stressors

The five major elements of a healthy stream system are stream connections, hydrology, stream channel assessment, water chemistry and stream biology. If one or more of the components are unbalanced, the stream ecosystem may fail to function properly and is listed as an impaired water body. Table 1 lists the common stream stressors to biology relative to each of the major stream health categories.

Table 1. Common streams stressors to biology (i.e., fish and macroinvertebrates).

Stream Health	Stressor(s)	Link to Biology
Stream Connections	Loss of Connectivity <ul style="list-style-type: none"> • Dams and culverts • Lack of Wooded riparian cover • Lack of naturally connected habitats/ causing fragmented habitats 	Fish and macroinvertebrates cannot freely move throughout system. Stream temperatures also become elevated due to lack of shade.
Hydrology	Altered Hydrology Loss of habitat due to channelization Elevated Levels of TSS <ul style="list-style-type: none"> • Channelization • Peak discharge (flashy) • Transport of chemicals 	Unstable flow regime within the stream can cause a lack of habitat, unstable stream banks, filling of pools and riffle habitat, and affect the fate and transport of chemicals.
Stream Channel Assessment	Loss of Habitat due to excess sediment Elevated levels of TSS <ul style="list-style-type: none"> • Loss of dimension/pattern/profile • Bank erosion from instability • Loss of riffles due to accumulation of fine sediment • Increased turbidity and or TSS 	Habitat is degraded due to excess sediment moving through system. There is a loss of clean rock substrate from embeddedness of fine material and a loss of intolerant species.
Water Chemistry	Low DO Concentrations Elevated levels of Nutrients <ul style="list-style-type: none"> • Increased nutrients from human influence • Widely variable DO levels during the daily cycle • Increased algal and or periphyton growth in stream • Increased nonpoint pollution from urban and agricultural practices • Increased point source pollution from urban treatment facilities 	There is a loss of intolerant species and a loss of diversity of species, which tends to favor species that can breathe air or survive under low DO conditions. Biology tends to be dominated by a few tolerant species.
Stream Biology	Fish and macroinvertebrate communities are affected by all of the above listed stressors	If one or more of the above stressors are affecting the fish and macroinvertebrate community, the IBI scores will not meet expectations and the stream will be listed as impaired.

2. Overview of Des Moines River Watersheds

2.1. Background

Located in southwestern Minnesota, the Des Moines River Watersheds consists of three 8-HUC watersheds: Des Moines River-Headwaters (07100001), Lower Des Moines River (07100002), and East Fork Des Moines River (07100003).

The Des Moines River-Headwaters is by far the largest of the three watersheds in the Minnesota portion of the Des Moines River basin. This watershed is 1248 mi² and flows in a southeasterly direction starting in Pipestone, Lyon, and Murray counties before also entering portions of Nobles, Cottonwood, and Jackson counties. Major tributaries to the Des Moines River in this watershed include: Beaver Creek, Lake Shetek, Lime Creek, Jack Creek, and Okabena Creek.

The next largest watershed in this group is the East Fork Des Moines River Watershed, which encompasses 202 mi². This watershed is located southeast of the Des Moines River Headwaters Watershed and is located in parts of Jackson and Martin counties. The East Fork Des Moines River is the major waterbody in this watershed, with County Ditch 11 being the primary tributary to the East Fork Des Moines River in this watershed.

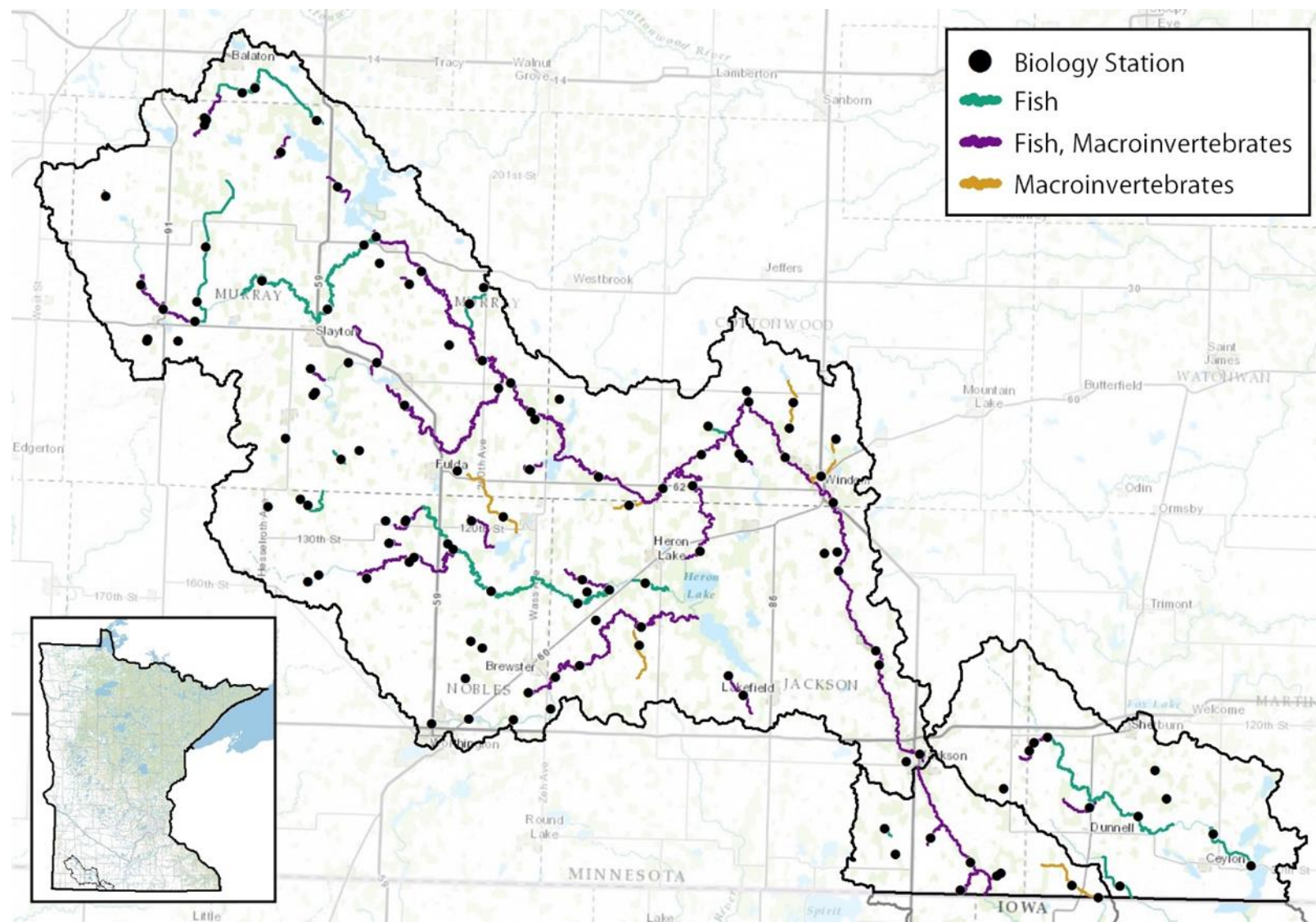
Lastly, the smallest watershed in this group is the Lower Des Moines River Watershed. This watershed covers an area of 87 mi² in parts of Jackson and Martin counties. This watershed is located southeast of the Des Moines River Headwaters Watershed and immediately west of the East Fork Des Moines River watershed. The Des Moines River is the major waterbody in this watershed, with Story Brook and Judicial Ditch 11 being tributaries to the Des Moines River.

2.2. Monitoring overview

A total of 190 stream AUIDs were assessed for aquatic life use, aquatic recreational use or both in the Des Moines River Watersheds. Of these assessed streams, only nine were considered to be fully supporting of aquatic life and two streams were fully supporting of aquatic recreation (MPCA 2017).

Throughout the watersheds, 82 AUIDs are non-supporting for aquatic life and/or recreation. Of those AUIDs, 56 are non-supporting for aquatic life due to their biological assemblages. For a map of the biological impairments and the sampling sites in the Des Moines River Watersheds, see Figure 3.

Figure 3. Biological impairment map of the Des Moines River Watershed with colors to reflect the type of impairment (fish, macroinvertebrates, or both).



2.3. Summary of biological impairments

The approach used to identify biological impairments includes assessment of fish and aquatic macroinvertebrates communities and related habitat conditions at sites throughout a watershed. The resulting information is used to develop an index of biological integrity (IBI). The IBI scores can then be compared to range of thresholds.

The fish and macroinvertebrates within each Assessment Unit Identification (AUID) were compared to a regionally developed threshold and confidence interval and utilized a weight of evidence approach. The water quality standards call for the maintenance of a healthy community of aquatic life. IBI scores provide a measurement tool to assess the health of the aquatic communities. IBI scores higher than the impairment threshold indicate that the stream reach supports aquatic life. Conversely, scores below the impairment threshold indicate that the stream reach does not support aquatic life. Confidence limits around the impairment threshold help to ascertain where additional information may be considered to help inform the impairment decision. When IBI scores fall within the confidence interval, interpretation and assessment of the waterbody condition involves consideration of potential stressors and draws upon additional information regarding water chemistry, physical habitat, and land use, etc.

In the Des Moines River Watersheds, 56 AUIDs are currently impaired for poor biological assemblage (Table 2). The majority of the biological impairments (45) are located in the Des Moines River-Headwaters Watershed (07100001), while the Lower Des Moines River Watershed (07100002) has six impairments, and the East Fork Des Moines River Watershed (07100003) has five impairments.

Table 2. Biologically impaired AUIDs in the Des Moines River Watersheds and corresponding water quality impairments.

Stream Name	AUID #	Impairments	
		Biological	Water Quality
Des Moines River	07100001-501	Fish and Macroinvertebrates	Un-ionized ammonia, DO, Turbidity and Fecal Coliform
County Ditch 20	07100001-504	Fish	-
Lower Lake Sarah Outlet	07100001-508	Fish and Macroinvertebrates	Fecal Coliform
Jack Creek	07100001-514	Fish	Fecal Coliform
Unnamed creek	07100001-518	Fish and Macroinvertebrates	-
Judicial Ditch 26	07100001-523	Macroinvertebrates	-
Des Moines River	07100001-524	Fish and Macroinvertebrates	Turbidity and Fecal Coliform
Heron Lake Outlet	07100001-527	Fish and Macroinvertebrates	pH, Turbidity, River Eutrophication, Fecal Coliform
Des Moines River	07100001-533	Fish and Macroinvertebrates	Turbidity, River Eutrophication, Fecal Coliform
Lime Creek	07100001-535	Fish and Macroinvertebrates	Turbidity and Fecal Coliform
Perkins Creek	07100001-544	Macroinvertebrates	-
Des Moines River	07100001-545	Fish and Macroinvertebrates	Turbidity
Des Moines River	07100001-546	Fish and Macroinvertebrates	Turbidity and Fecal Coliform
Jack Creek	07100001-549	Fish and Macroinvertebrates	-

Stream Name	AUID #	Impairments	
		Biological	Water Quality
Unnamed creek	07100001-551	Fish and Macroinvertebrates	Turbidity
County Ditch 43 (Scheldorf Creek)	07100001-552	Fish and Macroinvertebrates	-
Unnamed creek	07100001-563	Macroinvertebrates	-
Unnamed creek	07100001-564	Fish and Macroinvertebrates	Fecal Coliform
Okabena Creek	07100001-602	Fish and Macroinvertebrates	Turbidity, Chloride, Fecal Coliform
Unnamed creek	07100001-613	Fish	-
Unnamed creek	07100001-614	Macroinvertebrates	-
Unnamed creek	07100001-618	Fish and Macroinvertebrates	-
Unnamed creek	07100001-619	Fish	-
Unnamed creek	07100001-621	Macroinvertebrates	-
Unnamed creek	07100001-624	Fish and Macroinvertebrates	-
Unnamed creek	07100001-625	Fish and Macroinvertebrates	-
Unnamed creek	07100001-626	Fish and Macroinvertebrates	-
Unnamed creek	07100001-628	Fish and Macroinvertebrates	-
Unnamed creek	07100001-632	Fish and Macroinvertebrates	-
Unnamed creek	07100001-637	Macroinvertebrates	-
Lake Shetek Inlet	07100001-641	Fish and Macroinvertebrates	-
Lake Shetek Inlet	07100001-642	Fish	-
Lake Shetek Inlet	07100001-643	Fish	Fecal Coliform
Beaver Creek	07100001-646	Fish	Turbidity and Fecal Coliform
Jack Creek, North Branch	07100001-649	Fish	-
Jack Creek, North Branch	07100001-652	Fish	Fecal Coliform
Elk Creek	07100001-656	Fish and Macroinvertebrates	Turbidity and Fecal Coliform
Jack Creek	07100001-658	Fish	Turbidity and Fecal Coliform
Unnamed creek	07100001-661	Fish and Macroinvertebrates	-
Beaver Creek	07100001-663	Fish and Macroinvertebrates	-
Beaver Creek	07100001-664	Fish	-
Judicial Ditch 12	07100001-666	Fish and Macroinvertebrates	-
Devils Run Creek	07100001-668	Fish	-
Unnamed creek	07100001-670	Macroinvertebrates	-
Unnamed creek	07100001-672	Fish and Macroinvertebrates	-
Des Moines River	07100002-501	Fish and Macroinvertebrates	Turbidity, River Eutrophication, Fecal Coliform
Brown Creek (Judicial Ditch 10)	07100002-502	Macroinvertebrates	-

Stream Name	AUID #	Impairments	
		Biological	Water Quality
Unnamed creek	07100002-504	Fish and Macroinvertebrates	-
Judicial Ditch 56	07100002-505	Fish and Macroinvertebrates	-
Story Brook	07100002-507	Fish and Macroinvertebrates	-
Unnamed ditch	07100002-510	Fish	-
County Ditch 53	07100003-506	Fish	-
Fourmile Creek	07100003-510	Fish and Macroinvertebrates	Fecal Coliform
Des Moines River, East Branch	07100003-525	Fish	Fecal Coliform
Des Moines River, East Branch	07100003-527	Fish	DO, Turbidity, River Eutrophication, Fecal Coliform
Unnamed creek	07100003-529	Fish and Macroinvertebrates	-

The purpose of stressor identification is to interpret the data collected during the biological monitoring and assessment process. Trends in the IBI scores can help to identify causal factors for biological impairments.

2.4. Hydrological Simulation Program – FORTRAN (HSPF) Model

The Hydrological Simulation Program - Fortran (HSPF) is a comprehensive package for simulation of watershed hydrology and water quality for both conventional and toxic organic pollutants. HSPF was developed from the watershed-scale Agricultural Runoff Management (ARM) and Non-Point Source (NPS) models into a basin-scale analysis framework that includes fate and transport in one dimensional stream channels. It is the only comprehensive model of watershed hydrology and water quality that allows the integrated simulation of land and soil contaminant runoff processes with in-stream hydraulic and sediment-chemical interactions. The result of this simulation is a time history of the runoff flow rate, sediment load, and nutrient and pesticide concentrations, along with a time history of water quantity and quality at the outlet of any subwatershed. HSPF simulates three sediment types (sand, silt, and clay) in addition to a single organic chemical and transformation product of that chemical.

The HSPF watershed model contains components to address runoff and constituent loading from pervious land surfaces, runoff and constituent loading from impervious land surfaces, and flow of water and transport/transformation of chemical constituents in stream reaches. Primary external forcing is provided by the specification of meteorological time series. The model operates on a lumped basis within subwatersheds. Upland responses within a subwatershed are simulated on a per-acre basis and converted to net loads on linkage to stream reaches within each subwatershed and the upland areas are separated into multiple land use categories.

An HSPF watershed model was run for the Des Moines River Watershed to predict water quality conditions throughout the watershed on an hourly basis from 1994-2014. Streams with biological impairments used the model output to supplement water quality analyses.

2.5. Lake stressor identification

The majority of this document examines the biotic stressors in streams of the Des Moines River Watersheds, the Minnesota Department of Natural Resources (DNR) with cooperation from the MPCA, also sampled and assessed the lakes in the Des Moines River Watershed for biological impairments. Stressor identification was then evaluated in these biologically impaired lakes. The lakes impaired biologically and underwent stressor identification are listed in Table 3.

Table 3: Biologically impaired Lakes in the Des Moines River Watersheds and corresponding water quality impairments.

Lake Name	AUID (DOW #)	Impairments	
		Biological	Water Quality
Cottonwood	17002200	Not Supporting-FIBI	Aquatic Recreation: Insufficient Information
Talcot	17006000	Not Supporting-FIBI	Aquatic Recreation: Not Supporting-nutrient/eutrophication biological indicators
Yankton	42004700	Not Supporting-FIBI	Aquatic Recreation: Not Supporting-nutrient/eutrophication biological indicators
Bright	46005200	Not Supporting-FIBI	Aquatic Recreation: Insufficient Information
Temperance	46010300	Not Supporting-FIBI	Aquatic Recreation: Not Supporting-nutrient/eutrophication biological indicators
Lime	51002400	Not Supporting-FIBI	Aquatic Recreation: Not Supporting-nutrient/eutrophication biological indicators
Fox	51004300	Not Supporting-FIBI	Aquatic Recreation: Not Supporting-nutrient/eutrophication biological indicators
Shetek	51004600	Not Supporting-FIBI	Aquatic Recreation: Not Supporting-nutrient/eutrophication biological indicators
Corabelle	51005400	Not Supporting-FIBI	Aquatic Recreation: Not Supporting-nutrient/eutrophication biological indicators
Sarah	51006300	Not Supporting-FIBI	Aquatic Recreation: Not Supporting-nutrient/eutrophication biological indicators
Currant	51008200	Not Supporting-FIBI	Aquatic Recreation: Not Supporting-nutrient/eutrophication biological indicators
East Graham	53002000	Not Supporting-FIBI	Aquatic Recreation: Not Supporting-nutrient/eutrophication biological indicators
West Graham	53002100	Not Supporting-FIBI	Aquatic Recreation: Not Supporting-nutrient/eutrophication biological indicators

The lake stressor identification process primarily focused on the candidate causes of Excess Nutrients and Sedimentation, as well as Physical Habitat Alteration and Shoreline Development. For the complete report detailing lake stressor identification work in this watershed, please see the document located in the Appendix.

3. Possible stressors to biological communities

There is a comprehensive list of potential stressors to aquatic biological communities compiled by the EPA (<https://www.epa.gov/caddis-vol1/aquatic-stressors-can-potentially-cause-biological-impairment>). This comprehensive list serves two purposes. First, it can serve as a checklist for investigators to consider all possible options for impairment in the watershed of interest. Second, it can be used to identify potential stressors that can be eliminated from further evaluation. In some cases, the data may be inconclusive and limit the ability to confidently determine if a stressor is causing impairment to aquatic life. It is imperative to document if a candidate cause was suspected, but there was not enough information to make a scientific determination. In this case, management decisions can include modification of sampling plans and future evaluation of the inconclusive case. Alternatively, there may be enough information to conclude that a candidate cause is not causing biological impairment and therefore can be eliminated. The inconclusive or eliminated causes will be discussed in more detail in the following section.

A candidate cause is defined as a “hypothesized cause of an environmental impairment that is sufficiently credible to be analyzed” (EPA, 2012). Identification of a set of candidate causes is an important early step in the SID process and provides the framework for gathering key data for causal analysis. A more detailed description of possible candidate causes or stressors is provided in the document [Stressors to Biological Communities in Minnesota’s Rivers and Streams](#) (MPCA, 2017). This information provides an overview of the pathway and effects of each candidate stressor considered in the biological stressor identification process with relevant data and water quality standards specific to Minnesota. The EPA has additional information, conceptual diagrams of sources and causal pathways, and publication references for numerous stressors on its [CADDIS website](#). This information provides an overview of the pathway and effects of each candidate stressor considered in the biological stressor identification process with relevant data and water quality standards specific to Minnesota.

3.1. Inconclusive causes

- Ammonia
- Toxics
- Predation and interspecies competition
- Physical trampling
- Parasitism

4. Evaluation of Candidate Causes

The list of candidate causes was narrowed down after initial data evaluation resulting in six candidate causes for final analysis in this report. The six remaining candidate causes are:

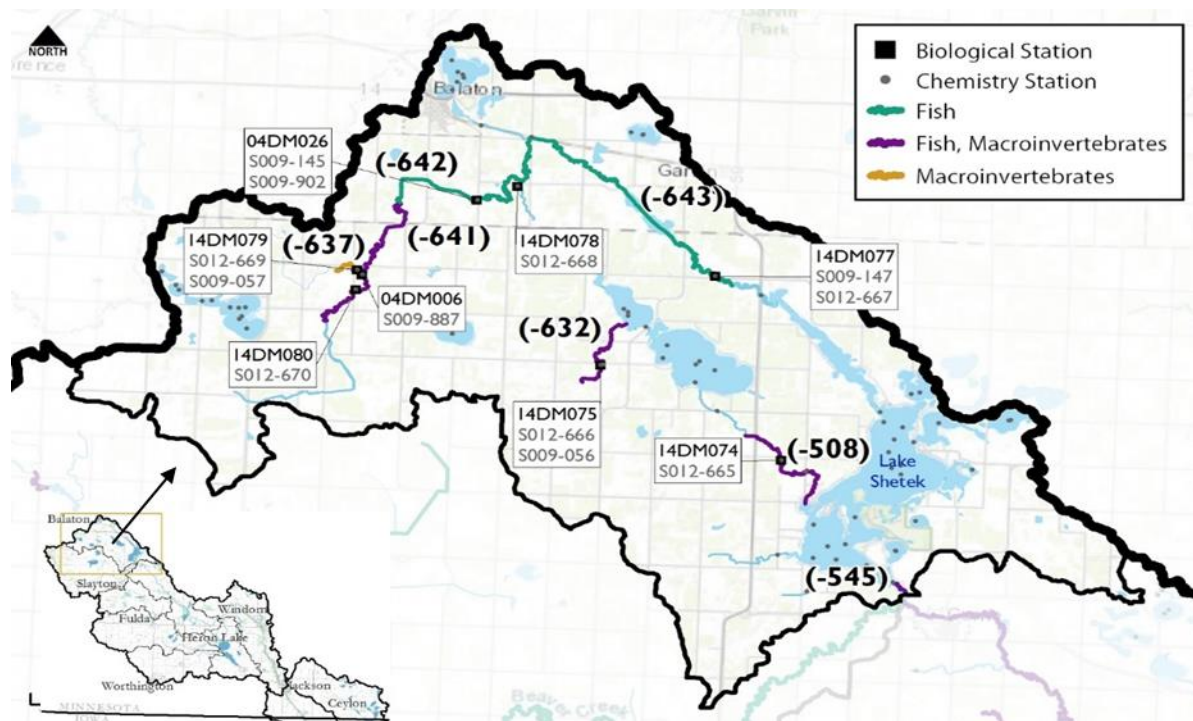
- DO (DO)
- Eutrophication
- Nitrate
- Suspended Sediment (TSS)
- Habitat
- Flow Alteration and Connectivity

5. Evaluation of Candidate Causes by Watershed Area

5.1. Lake Shetek Watershed (0710000102)

The Lake Shetek HUC-10 watershed (0710000102) is a 129.87 mi² watershed (Figure 4) located in the far northwestern portion of the Des Moines River-Headwaters Watershed. This watershed contains six biologically impaired reaches. The primary land use within this watershed is row crop agriculture.

Figure 4. Lake Shetek Watershed with monitoring stations and biological impairments.



Lower Lake Sarah Outlet (07100001-508)

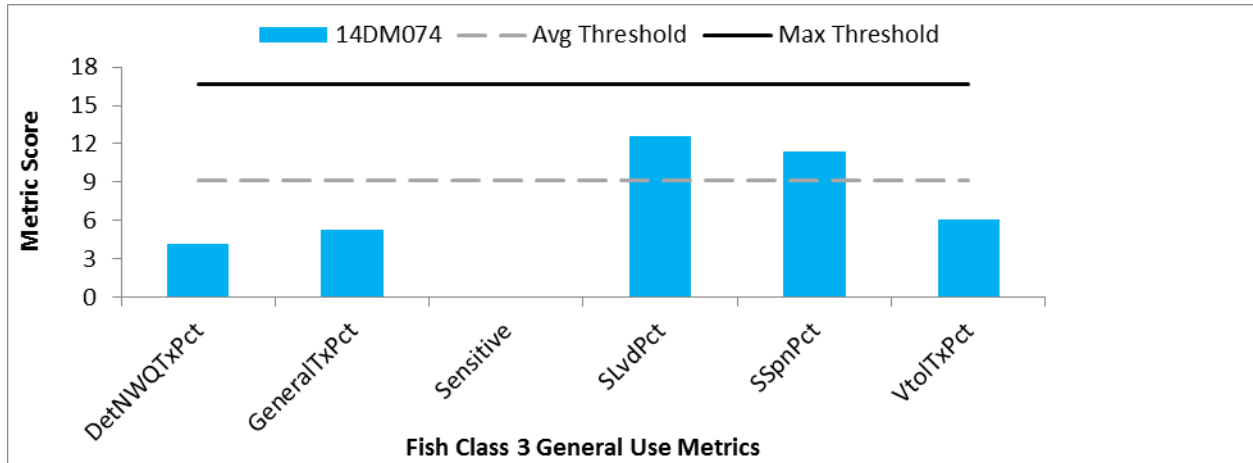
Located in north central Murray County, Lower Lake Sarah Outlet is a 3.38-mile reach that is impaired for aquatic life due to both the fish and macroinvertebrate assemblages. This stream reach extends from the first unnamed creek on Lake Sarah outlet stream to Lake Shetek inlet. Along this stream section there is one biological monitoring station, 14DM074.

Biology

Fish

The fish community in Lower Lake Sarah Outlet (-508) was sampled for fish in July of 2014 at its biological monitoring station 14DM074. The FIBI score at this reach was 39.5, which is below the Fish Class 3 Southern Headwaters General Use Threshold of 55. This site had two metrics (SLvdPct, SSpnPct) reach the average metric score needed to meet the threshold (Figure 5), however, the remaining four metrics comprising this FIBI scored well below average with one metric scoring zero (Sensitive).

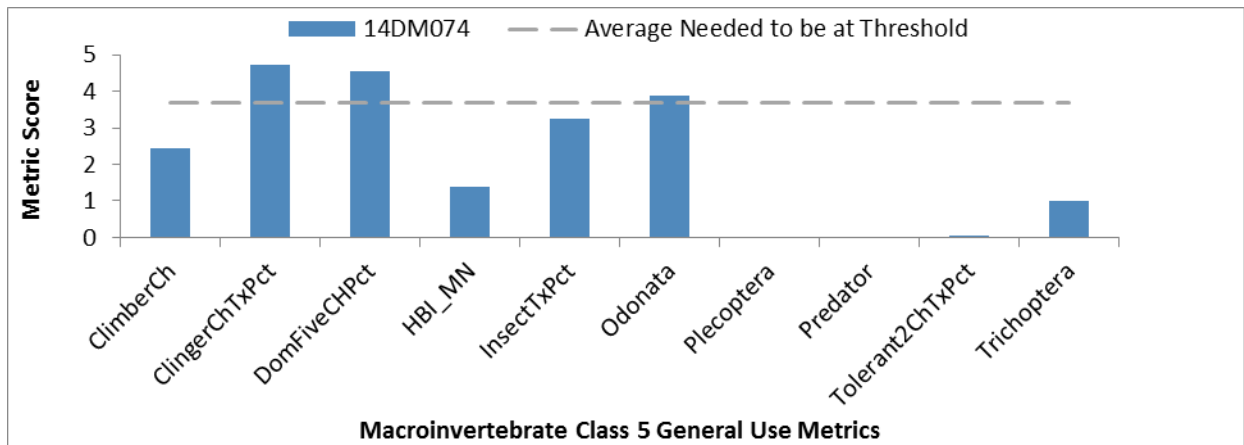
Figure 5. Lower Lake Sarah Outlet (-508) Fish IBI metric scores.



Macroinvertebrates

The macroinvertebrate assemblage at site 14DM074 was sampled in August of 2014. This visit had a MIBI score of 21.2, which is below the Macroinvertebrate Class 5 Southern Streams RR General Use Threshold of 37. This site had three metrics scoring above the average needed to reach the threshold. However, the remaining seven metrics scored below average or poorly resulting in the impairment designation. See Figure 6 for a complete breakdown of the metric scores at this site.

Figure 6. Lower Lake Sarah Outlet (-508) Macroinvertebrate IBI metric scores.



DO

A total of 11 DO (DO) measurements were taken from one chemistry site (S001-547) and one biological monitoring station (14DM074) in 2016. The average of all the values is 9.37 mg/L with a low of 4.91 mg/L and a high of 11.07 mg/L. The summer average (June-Aug) is 9.09 mg/L. The DO values fell below 5 mg/L one time.

The HSPF model calculated daily minimum DO values for this subwatershed from 1994-2014. Of these calculations, 1749 (22.80%) of the days had a daily minimum DO level below the daily minimum standard of 5 mg/L. This is a high exceedance rate for DO.

Table 4. DO related fish metrics in Lower Lake Sarah Outlet (-508). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-508 Fish Class 3 – General Use	MA>3 Avg	SspnPct Avg	Taxa Count Avg	DO TIV Avg
14DM074	62.12	24.24	8.00	8.20
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	13.32	17.09	12.16	8.44
Expected response to DO stress	↓	↑	↓	↓

The fish community in Lower Lake Sarah Outlet (-508) at site 14DM074 scored below average in three of the four DO related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 4). This reach had a lower overall taxa count, an increased number of serial spawning individuals, and a poor DO TIV score. These results are often found in streams with low DO. This reach did however have an increased amount of mature individuals, which is not common in streams with poor DO conditions.

Table 5. DO related macroinvertebrate metrics in Lower Lake Sarah Outlet (-508). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-508 Macroinvertebrate Class 5 – General Use	HBI_MN Value	% DO Tolerant Taxa	# DO Tolerant Taxa	ChemTV_DO
14DM074	7.88	18.03	8.00	6.89
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	7.04	8.62	4.33	7.10
Expected response to DO stress	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in all four of the DO related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 5). This reach had a high amount and percentage of DO tolerant taxa, while also having a poor HBI_MN and DO TIV scores. These results are common in communities stressed by DO.

The DO conditions fell below 5 mg/L as evidenced by the observed data, while the modeled data also calculated a very high standard exceedance rate. The majority of the fish and all of the macroinvertebrate metrics related to DO scored below average. Additionally, this reach had large amounts of algae present, which can signal issues with daily flux of DO. Based on this information, DO is a stressor to aquatic life in Lower Lake Sarah Outlet (-508) at this time.

Eutrophication

A total of 11 phosphorus samples from one chemistry site (S001-547) and one biological monitoring station (14DM074) in 2016 were analyzed for phosphorus. The average of all the values is 0.090 mg/L with a low of 0.03 mg/L and a high of 0.14 mg/L. The summer average (June-Aug) is 0.086 mg/L. No samples exceeded the 0.15 mg/L standard for phosphorus. Large amounts of algae were also observed while visiting site 14DM074 (Figure 7).

Figure 7. Algae at site 14DM074.



Additionally, the HSPF model calculated daily phosphorus values for this subwatershed from 1994-2014. These values ranged from 0.05-13.30 mg/L with an average phosphorus concentration of 0.34 mg/L. Of these calculations, 6268 (95.48%) were above the 0.15 mg/L standard for phosphorus.

Table 6. Eutrophication related fish metrics in Lower Lake Sarah Outlet (-508). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-508 Fish Class 3 – General Use	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct
14DM074	0.00	0.00	34.85	33.33
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	8.9	12.11	70.79	14.71
Expected response to Eutrophication stress	↓	↓	↑	↑

The fish community in Lower Lake Sarah Outlet (-508) at site 14DM074 scored below average in three of the four eutrophication related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 6). This reach did have a lower amount of tolerant individuals present, which can be a good sign; however, there was a lack of sensitive and darter individuals and an increased amount of omnivorous individuals. These results are more common in streams with eutrophic conditions.

Table 7. Eutrophication related macroinvertebrate metrics in Lower Lake Sarah Outlet (-508). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-508 Macroinvertebrate Class 5 – General Use	EPT Pct	Tanytarsini Pct	CrustMoll Pct	Scraper Pct	% Tolerant Taxa	% Intolerant Taxa
14DM074	43.56	16.96	15.18	8.58	22.30	0.33
<i>Statewide average for Class 5 Southern Streams Rock Riffle stations that are meeting the MIBI General Use Threshold (37)</i>	43.90	27.84	9.23	15.78	17.17	5.79
Expected response to Eutrophication stress	↓	↓	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in five of the six eutrophication related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 7). This reach did have a decreased amount of scraper individuals, which can be a sign that eutrophication is not a stressor, however, this reach had a below average amount of EPT and tanytarsini individuals, very few phosphorus intolerant taxa, while also having an increased amount of crustacean/mollusca individuals and phosphorus tolerant taxa.

Although the observed data set did not have a phosphorus standard exceedance, the presence of algae, the high exceedance rate predicted by the model, and the majority of the eutrophication related metrics in both the fish and macroinvertebrate communities scoring below average concluded that eutrophication is a stressor to aquatic life in Lower Lake Sarah Outlet (-508). Furthermore, Lake Sarah is located immediately upstream of this reach and is impaired for nutrients as well.

Nitrates

Eleven samples taken from one chemistry site (S001-547) and one biological monitoring station (14DM074) in 2014-2016 were analyzed for Inorganic Nitrogen (NO₂-NO₃). The average of all the values is 4.19 mg/L with a low of 1.20 mg/L and a high of 7.60 mg/L. The spring average (March-May) is 5.55 mg/L. The summer average (June-Aug) is 3.67 mg/L. Nitrate values exceeded 4 mg/L five times.

The HSPF model also calculated daily nitrate concentrations for this subwatershed from 1994-2014. These values ranged from 0.03-158.93 mg/L with an average nitrate concentration of 4.76 mg/L. A quantile regression analysis showed that when nitrate levels exceed 18.1 mg/L at a Class 5 site, the macroinvertebrate community has a 75% probability of being impaired. The nitrate concentration in this stream reach has exceeded this level. Of these calculations, 12 (0.18%) were above 18.1 mg/L. This is a very low level of exceedance.

Table 8. Nitrate related macroinvertebrate metrics in Lower Lake Sarah Outlet (-508). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-508 Macroinvertebrate Class 5 – General Use	TrichopteraChTx Pct	N Index Score	% N Tolerant	% N Intolerant
14DM074	9.68	3.73	72.46	0.00
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	13.16	3.00	48.68	0.96
Expected response to N stress	↓	↑	↑	↓

The macroinvertebrate community in Lower Lake Sarah Outlet (-508) scored below average in all four nitrate related metrics evaluated when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 8). The site, 14DM074, had a high amount of nitrate tolerant individuals, while also having a lower number of trichoptera taxa and zero nitrate intolerant species. The nitrate index score had a score indicating nitrate stress.

While the macroinvertebrate metrics related to nitrates score below average, the observed nitrate concentrations were fairly low, while the calculated values were generally low as well, therefore, nitrates are not a stressor to aquatic life at this time. It is likely that other stressors are causing the poor scoring biological metrics.

Suspended Solids

Ten samples taken from one chemistry site (S001-547) in 2016 were analyzed for Total Suspended Solids (TSS). The average of all the values is 33 mg/L with a low of 11 mg/L and a high of 78 mg/L. The TSS concentrations exceeded the 65 mg/L standard mg/L two times.

Additionally, 10 secchi tube measurements were taken from this reach. These values ranged from 20-73 cm, with no values falling below the 10 cm minimum standard for secchi tube.

The HSPF model calculated daily TSS values for this subwatershed from 1994-2014. These concentrations ranged from 2.68-582.28 mg/L with an average TSS value of 34.46 mg/L. Of these calculations, 764 (11.64%) were above the TSS standard of 65 mg/L.

Table 9. TSS related fish metrics in Lower Lake Sarah Outlet (-508). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-508 Fish Class 3 – General Use	BenFrdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RifflePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14DM074	1.52	0.00	0.00	60.6 1	1.52	0.0 0	1.52	0.0 0	63.6 4	15.8 4
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	37.8 3	0.90	13.3 3	13.9 3	28.3 3	8.5 5	33.7 1	1.9 5	3.56	15.27
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

The fish community in Lower Lake Sarah Outlet (-508) at site 14DM074 scored below average in eight of the ten TSS related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 9). This reach did have higher amounts of long-lived and perciforms (perch-like) individuals, however, the remaining metrics scored poorly. These results are common in streams potentially stressed by the TSS conditions.

Table 10. TSS related macroinvertebrate metrics in Lower Lake Sarah Outlet (-508). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-508 Macroinvertebrate Class 5 – General Use	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
14DM074	16.52	0.00	10.00	27.54	9.57	0.00
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)</i>	15.87	3.02	11.59	35.23	26.89	0.54
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

The macroinvertebrate assemblage in this reach scored below average in four of the six metrics related to TSS when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 10). Site 14DM074 did have a lower percentage and amount of TSS tolerant taxa, but did have zero TSS intolerant taxa, few collector filterer individuals, no plecoptera taxa, while also having a poor TSS Index score. These scores are common in streams with likely TSS issues.

The TSS concentrations in this stream do become elevated at times according to both the observed and modeled data sets. In addition, the majority of the TSS related metrics scored below average in both the fish and macroinvertebrate communities. Therefore, TSS is a stressor to aquatic life in Lower Lake Sarah Outlet (-508).

Habitat

Lower Lake Sarah Outlet (-508) had a qualitative habitat assessment take place at its biological monitoring site, 14DM074 during the fish and macroinvertebrate sampling events in 2014. The average MSHA score from these visits was 54.95 (Fair). Limiting the habitat at this site was the row crop agriculture as the dominant land use, no stream riparian buffer, light embeddedness, and moderate channel development. Further MSHA analysis can be seen in Figure 8.

Figure 8. MSHA Metric Scores at site 14DM074 in Lower Lake Sarah Outlet (-508).

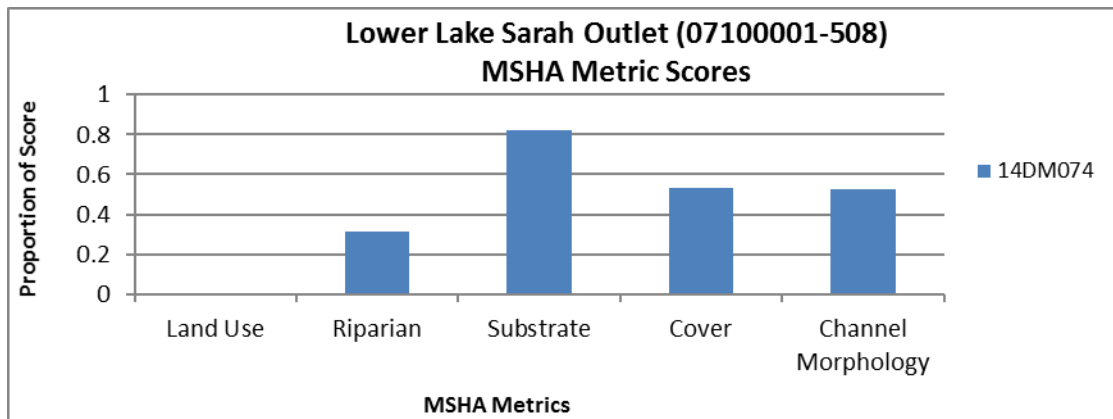


Table 11. Habitat related fish metrics in Lower Lake Sarah Outlet (-508). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-508 Fish Class 3 – General Use	BenInsect-TolPct	SLithopPct	DarterSculpSu cPct	RifflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14DM074	0.00	1.52	0.00	1.52	3.03	1.52	34.85	22.73
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	14.22	33.71	12.55	28.33	1.62	69.21	70.64	37.79
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

The fish community in Lower Lake Sarah Outlet at site 14DM074 scored below average in five of the eight habitat related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 11). The fish assemblage did contain some species tolerant of degraded habitat conditions including fathead minnows, white suckers, and brook sticklebacks. However, the most abundant fish species was yellow perch (40), the stream also contained northern pike. This fish community, while not having an abundance of tolerant individuals, it also lacked many species requiring specialized habitat conditions.

Table 12. Habitat related macroinvertebrate metrics in Lower Lake Sarah Outle (-508). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-508 Macroinvertebrate Class 5 – General Use	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14DM074	2.64	19.80	54.13	43.56	44.55	13.20
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)</i>	5.66	12.52	49.77	42.46	34.53	13.99
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate assemblage at site 14DM074 scored below average in two of the six habitat related metrics when compared to all other Class Southern Streams RR stations that meet the MIBI General Use Threshold (Table 12). The macroinvertebrate community contained a high amount of legless individuals, while having fewer sprawler individuals. These results can be indicators of habitat stress. However, this site did have an above average amount of EPT, clinger, and climber individuals, while having few burrowers. These results are indicative of an assemblage not affected by the habitat conditions.

While the habitat conditions in Lower Lake Sarah Outlet (-508) could certainly be improved, the macroinvertebrate community scored pretty well in the habitat related metrics. The fish community is likely being more negatively affected by other stressors, therefore, the habitat conditions in this reach are not a stressor at this time.

Connectivity and Altered Hydrology

Monitoring station 14DM074 is located along reach 07100001-508, which receives water from the Lake Sarah subwatershed. The subwatershed is a relatively small drainage area that includes Lake Sarah, a locally important walleye fishery, and Lake Maria, which is part of a State Wildlife Management Area. Both lakes are impoundments that have structures that artificially raise the level of the water. Although these structures create deeper and more recreationally suitable waterbodies, they also create barriers for fish migration. Upstream of station 14DM074 there is a barrier at the Lake Sarah outlet that would prohibit fish migration from the stream reach to the lake. Site 14DM074 has connectivity barriers both upstream and downstream from the station. Although hydrologically connected to Lake Shetek, a dam at the outlet of the lake would limit fish migration further downstream. The loss of wetlands and water retention along with drainage tile present can lead to low flow conditions at times (Figure 9).

Figure 9. Low flow conditions present at site 14DM074.



Hydrologically, a large percentage of the streams within the subwatershed have been altered and channelized. These channelized streams have limited floodplain connectivity and are often incorrectly sized (e.g., cross sectional area to drainage area, width/depth ratio), not allowing the channel to effectively transport the sediment of its watershed. Tiling is also common in the subwatershed in the

form of drained wetlands and field outlets to the ditches. Both these forms of alterations are influencing the downstream station, 14DM074's, water volume as well as water quality. As channels take on extra water, they change their dimension, pattern, and profile to adjust; resulting in high sediment loads, loss of habitat, and water quality impairments. Therefore, Flow Alteration/Connectivity is a stressor to aquatic life in Lower Lake Sarah Outlet (-508).

Conclusions and recommendations

The impaired fish and macroinvertebrate communities in Lower Lake Sarah Outlet (-508) are being stressed by DO, Eutrophication, Suspended Sediment, and Flow Alteration/Connectivity (Table 13). Nitrates and Habitat were ruled out as stressors to aquatic life. For further information on the stressors and recommendations to fixing the stressors in the Lake Shetek HUC 10 watershed, please see Page 59.

Table 13. Summary of stressor determinations for Lower Lake Sarah Outlet (-508).

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Lower Lake Sarah Outlet	07100001-508	●	●	---	●	---	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Unnamed Creek (07100001-632)

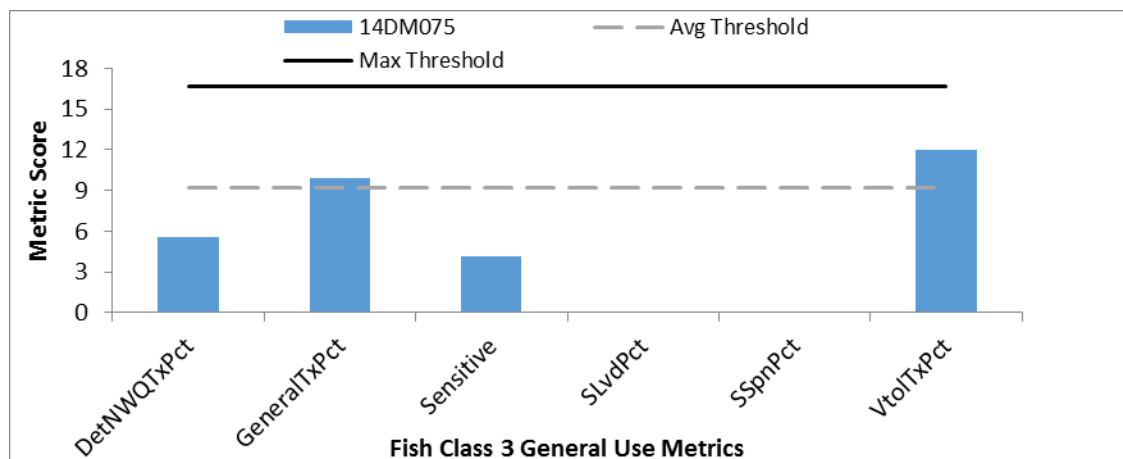
Located in north central Murray County, Unnamed Creek (-632) is a 2.46-mile reach that is impaired for aquatic life due to both the fish and macroinvertebrate assemblages. This stream reach extends from Unnamed Creek to the confluence with Lake Maria. Along this stream section there is one biological monitoring station, 14DM075.

Biology

Fish

The fish community in Unnamed Creek (-632) was sampled for fish in June and August of 2014 at its biological monitoring station 14DM075. The average FIBI score at this site was 31.65, which is below the Fish Class 3 Southern Headwaters General Use Threshold of 55. This site did have two metrics (GeneralTxPct, VtolTxPct) reach the average metric score needed to meet the threshold (Figure 10), however, the remaining four metrics comprising this FIBI scored well below average with one metric scoring zero (SSpnPct). This site was also dominated by the presence of fathead minnows (90.34% average of sampled individuals between both visits). Fathead minnows are a very tolerant fish species often found in large numbers in degraded stream systems.

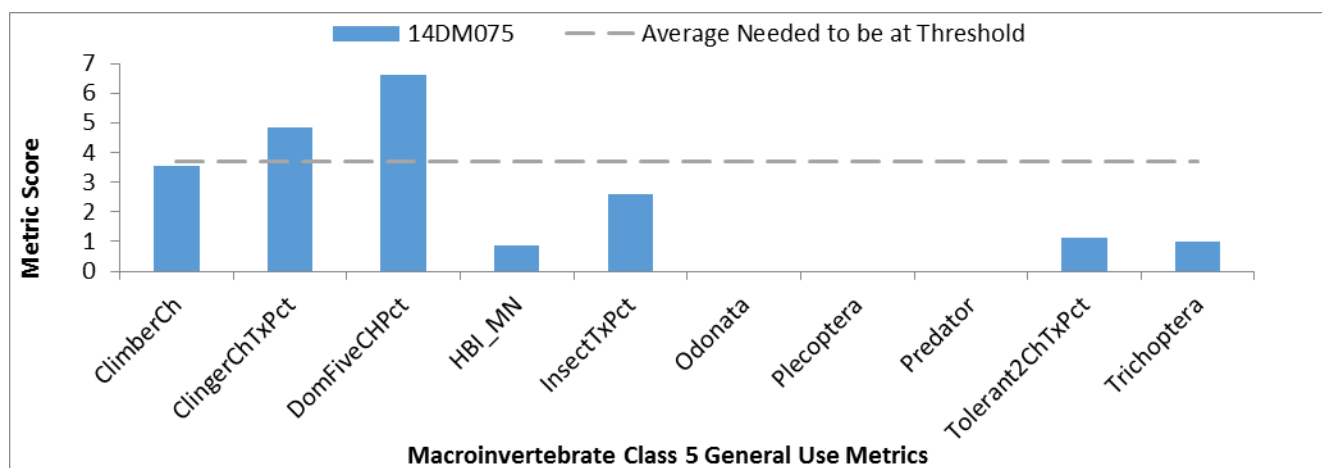
Figure 10. Unnamed Creek (-632) Fish IBI metric scores.



Macroinvertebrates:

The macroinvertebrate assemblage at site 14DM075 was sampled in August of 2014. This visit had a MIBI score of 20.6, which is below the Macroinvertebrate Class 5 Southern Streams RR General Use Threshold of 37. This site had two metrics scoring above the average needed to reach the threshold (ClingerChTxPct, DomFiveCHPct). However, the remaining eight metrics scored below average and three of those metrics had a score of zero. See Figure 11 for a complete breakdown of the metric scores at this site.

Figure 11. Unnamed Creek (-632) Macroinvertebrate IBI metrics scores.



DO

Twelve samples were taken from one chemistry site (S009-056) and one biological monitoring station (14DM075) from 2014-2016. The average of all the values is 9.91 mg/L with a low of 7.63 mg/L and a high of 11.50 mg/L. The summer average (June-Aug) is 9.74 mg/L. The DO values never fell below 5 mg/L.

The HSPF model calculated daily minimum DO values for this subwatershed from 1994-2014. Of these calculations, 1757 (22.91%) of the days had a daily minimum DO level below the daily minimum standard of 5 mg/L. This is a high exceedance rate for DO.

Table 14. DO related fish metrics in Unnamed Creek (-632). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-632 Fish Class 3 – General Use	MA>3 Avg	SspnPct Avg	Taxa Count Avg	DO TIV Avg
14DM075	0.00	90.34	6.00	8.34
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	13.32	17.09	12.16	8.44
Expected response to DO stress	↓	↑	↓	↓

The fish community in Unnamed Creek (-632) at site 14DM075 scored below average in all four of the DO related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 14). This reach had a very high amount of serial spawning individuals, specifically fathead minnows as 3,268 and 1,994 individuals were sampled during the visits. This is a very high amount and these species tend to be most present in degraded stream conditions. This site also had few mature fish, a low overall taxa count and a poor DO TIV score.

Table 15. DO related macroinvertebrate metrics in Unnamed Creek (-632). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-632 Macroinvertebrate Class 5 – General Use	HBI_MN Value	% DO Tolerant Taxa	# DO Tolerant Taxa	ChemTV _DO
14DM075	8.05	12.15	8.00	6.08
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	7.04	8.62	4.33	7.10
Expected response to DO stress	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in all four of the DO related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 15). This reach had a high percentage and amount of DO tolerant taxa, while also having a poor HBI_MN and DO TIV score. These results are often found in streams with DO issues.

The model calculated a high standard exceedance rate and the biological metrics in both fish and macroinvertebrate communities related to DO scored poorly. However, the observed data set does not indicate an issue with DO. Based on this conflicting information, DO is inconclusive as a stressor. Continuous DO monitoring with a sonde is recommended to better determine the DO conditions and its impacts on aquatic life in Unnamed Creek (-632).

Eutrophication

Twelve phosphorus samples were taken from one chemistry site (S009-056) and one biological monitoring station (14DM075) from 2014-2016. The average of all the values is 0.078 mg/L with a low of 0.03 mg/L and a high of 0.17 mg/L. The summer average (June-Aug) is 0.077 mg/L. The phosphorus values exceeded the standard of 0.150 mg/L once.

Table 16. Eutrophication related fish metrics in Unnamed Creek (-632). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-632 Fish Class 3 – General Use	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct
14DM075 (2014)	0.69	0.69	99.31	98.58
14DM075 (2015)	6.30	6.30	93.70	82.09
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	8.9	12.11	70.79	14.71
Expected response to Eutrophication stress	↓	↓	↑	↑

The fish community in Unnamed Creek (-632) scored below average in all four metrics related to eutrophication at both visits to site 14DM075 when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 16). These visits had especially high numbers of tolerant and omnivorous fish individuals resulting in poor metric scores. This reach was dominated by fathead minnows, which are a very tolerant species capable of living in most conditions.

Table 17. Eutrophication related macroinvertebrate metrics in Unnamed Creek (-632). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-632 Macroinvertebrate Class 5 – General Use	EPT Pct	Tanytarsini Pct	CrustMoll Pct	Scraper Pct	% Tolerant Taxa	% Intolerant Taxa
14DM075	18.38	24.59	5.30	5.92	15.89	0.31
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	43.90	27.84	9.23	15.78	17.17	5.79
Expected response to Eutrophication stress	↓	↓	↑	↑	↑	↓

The macroinvertebrate community in this reach scored below average in three of the six metrics related to eutrophication when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 17). Site 14DM075 showed low numbers of EPT and tanytarsini individuals, while also having a lower amount of intolerant taxa. This site did have a lower amount of crustacean/mollusk and scraper individuals, as well as a lower amount of tolerant taxa. These results are not typical in streams being negatively impacted by high levels of phosphorus.

The observed data set shows that phosphorus levels rarely exceed 0.15 mg/L. Phosphorus levels do not appear to be negatively impacting the macroinvertebrate community as evidenced by the low numbers of tolerant taxa, and few crustacean/mollusk and scraper individuals. Streams with high levels of phosphorus would likely see more of those species. Therefore, eutrophication is not a stressor to aquatic life in Unnamed Creek (-632) at this time. It is likely that other stressors are impacting the fish community resulting in lower metric scores.

Nitrates

Twelve samples taken from one chemistry site (S009-056) and one biological monitoring station (14DM075) from 2014-2016 were analyzed for Inorganic Nitrogen (NO₂-NO₃). The average of all the

values is 11.68 mg/L with a low of 4.50 mg/L and a high of 20.00 mg/L. The spring average (March-May) is 19.50 mg/L. The summer average (June-Aug) is 10.21 mg/L. Nitrate values exceeded 4 mg/L 12 times. A quantile regression analysis showed that when nitrate levels exceed 18.1 mg/L at a Class 5 site, the macroinvertebrate community has a 75% probability of being impaired. The nitrate concentration in this stream reach has exceeded this level.

The HSPF model also calculated daily nitrate concentrations for this subwatershed from 1994-2014. These values ranged from 1.0-267.15 mg/L with an average nitrate concentration of 7.8 mg/L. Of these calculations, 29 (0.46%) were above 18.1 mg/L.

Table 18. Nitrate related macroinvertebrate metrics in Unnamed Creek (-632). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-632 Macroinvertebrate Class 5 – General Use	TrichopteraChTx Pct	N Index Score	% N Tolerant	% N Intolerant
14DM075	6.98	3.62	76.64	0.00
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	13.16	3.00	48.68	0.96
Expected response to N stress	↓	↑	↑	↓

The macroinvertebrate community in Unnamed Creek (-632) scored below average in all four of the nitrate related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 18). The site, 14DM075, lacked nitrate intolerant species, while also having few trichoptera taxa. Additionally, there was an exceptionally high number of nitrate tolerant individuals, and the nitrate index score was also poor.

Based on the high observed nitrate values, the very poor scoring nitrate related metrics in the macroinvertebrate community, as well as the quantile regression analysis, nitrates are a stressor to aquatic life in Unnamed Creek (-632) at this time.

Suspended Solids

Ten samples taken from one chemistry site (S009-056) in 2016 were analyzed for TSS. The average of all the values is 7.48 mg/L with a low of 2 mg/L and a high of 26 mg/L. The TSS concentrations exceeded the 65 mg/L standard mg/L zero times.

Additionally, ten secchi tube measurements were taken from this reach. These values ranged from 37-100 cm, with an average secchi tube value of 90.8 cm. No measurements fell below the 10 cm minimum standard for secchi tube.

The HSPF model calculated daily TSS values for this subwatershed from 1994-2014. These concentrations ranged from 2.27-1021.19 mg/L with an average TSS value of 29.52 mg/L. Of these calculations, 311 (4.90%) were above the TSS standard of 65 mg/L.

Table 19. TSS related fish metrics in Unnamed Creek (-632). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-632 Fish Class 3 – General Use	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RifflePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14DM075	0.00	0.00	2.86	3.50	0.00	3.50	1.32	0.00	0.00	23.24
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	37.83	0.90	13.33	13.93	28.33	8.55	33.71	1.95	3.56	15.27
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

The fish community in Unnamed Creek (-632) at site 14DM075 scored below average in all ten of the TSS related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 19). Again, this reach was dominated by the presence of fathead minnows, which are a very tolerant fish species often found in high numbers in degraded stream systems.

Table 20. TSS related macroinvertebrate metrics in Unnamed Creek (-632). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-632 Macroinvertebrate Class 5 – General Use	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
14DM075	15.16	0.00	14.00	39.88	13.71	0.00
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)</i>	15.87	3.02	11.59	35.23	26.89	0.54
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

The macroinvertebrate assemblage in this reach scored below average in five of the six metrics related to TSS when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 20). Site 14DM075 did have a good TSS Index Score; however, the remaining metrics scored poorly with many TSS tolerant species present.

The observed and modeling data sets both indicate that the TSS concentrations in this reach are low and remain low. It is likely that other stressors are causing the fish and macroinvertebrate communities to score poorly as the chemical and model data give no indication of potential stress. Therefore, TSS is not a stressor to aquatic life in Unnamed Creek (-632) at this time.

Habitat

Unnamed Creek (-632) had a qualitative habitat assessment take place at its biological monitoring site, 14DM075, during the fish and macroinvertebrate sampling events in 2014 and 2015. The average MSHA score from these visits was 57.87 (Fair). Limiting the habitat at this site was the row crop agriculture and open pasture as the dominant nearby land uses (Figure 12), no stream riparian buffer, light embeddedness, sand substrates, and fair sinuosity. Further MSHA analysis can be seen in Figure 13.

Figure 12. Surrounding land use at site 14DM075.



Figure 13. MSHA Metric scores in Unnamed Creek (-632).

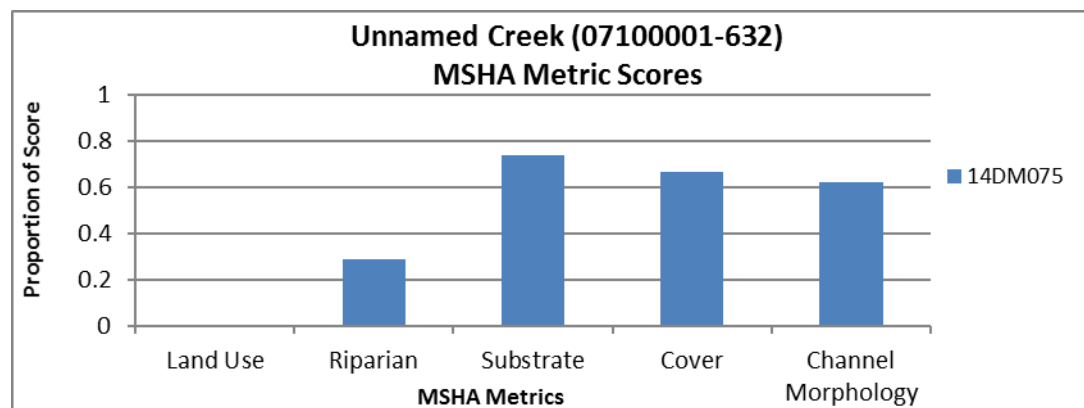


Table 21. Habitat related fish metrics in Unnamed Creek (-632). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-632 Fish Class 3 – General Use	BenInsect- ToIPct	SLithopPct	DarterSculps ucPct	RifflePct	PiscivorePct	LithFrimPct	ToIPct	PioneerPct
14DM075	3.50	1.32	3.50	0.00	0.00	2.19	96.50	91.20
Statewide average for Class 3 Southern Headwaters stations that are meeting the FBI General Use Threshold (55.0)	14.22	33.71	12.55	28.33	1.62	69.21	70.64	37.79
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

The fish community in Unnamed Creek (-632) at site 14DM075 scored below average in all eight of the habitat related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FBI General Use Threshold (Table 21). The fish assemblage was dominated by fathead minnows, which are very tolerant to poor habitat conditions. One fish sample contained 3,268 fathead minnows, while only 47 individuals of other species were caught. This high dominance of one species, a very habitat tolerant one at that, is a strong signal that the habitat conditions are potentially a stressor.

Table 22. Habitat related macroinvertebrate metrics in Unnamed Creek (-632). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-632 Macroinvertebrate Class 5 – General Use	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14DM075	9.03	30.84	44.55	18.38	68.22	6.85
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)</i>	5.66	12.52	49.77	42.46	34.53	13.99
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate assemblage at site 14DM075 scored below average in five of the six habitat related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 22). The site did contain an above average amount of climber individuals, which can be a good sign. However, the site also contained higher numbers of burrower and legless individuals, while also having lower amounts of EPT and sprawler species which can signal degraded habitat conditions.

Based on the vast majority of the habitat related metrics for the fish and macroinvertebrate communities scoring below average, as well as the fair MSHA score, habitat is a stressor to aquatic life in Unnamed Creek (-632) at this time.

Altered Hydrology and Connectivity

Altered Hydrology is prevalent in most of the watershed, as ditching and tiling are common practices in these sections. Both of these forms of alterations are influencing the downstream station, 14DM075's water volume as well as water quality. As channels take on extra water, they change their dimension, pattern, and profile to adjust; resulting in high sediment loads, loss of habitat, and water quality impairments. This section of stream also has fish migration limitations as there are multiple lake outlets with barriers between this stream and the mainstem.

This reach is on an unnamed creek and is roughly half altered, however, the majority of its entire upstream watershed is altered according to the MPCA altered watercourse layer. The reach flows directly into Lake Maria, which has an impoundment at the lake outlet that creates a fish barrier.

Extreme weather events affect high flow events as well as also low flows during drought. HSPF models show this section of Unnamed Creek (-632) experiencing low flow at less than five cfs 72.7% of the time and less than one cfs 38.7% of the time.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The average percentage for generalist fish within the reach was 92.5% compared to the average in Class 3 general use waters meeting the standard of 59.1%. General fish populations ranged from 86.2-98.9%.

The numbers of nest guarder species are also positively correlated with increased low flows. The average percentage for nest guarder fish within the reach was 91.5% compared to the average in Class 3 general use waters meeting the standard of 19.2%. Nest guarder fish species ranged from 83.9-99.0%.

Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The average percentage for long-lived macroinvertebrates within the reach was 6.2%

compared to the average in Class 5 general use waters meeting the standard of 9%. Long-lived macroinvertebrates ranged from 6.2-6.2%.

Based on this information, Flow Alteration/Connectivity is a stressor to aquatic life in Unnamed Creek (-632).

Summary

The impaired fish and macroinvertebrate communities in Unnamed Creek (-632) are being stressed by Nitrates, Habitat, and Flow Alteration/Connectivity (Table 23). DO was inconclusive as a stressor, while Eutrophication and Suspended Sediment were ruled out as stressors to aquatic life. For further information on the stressors and recommendations to fixing the stressors in the Lake Shetek HUC 10 watershed, please see Page 59.

Table 23. Summary of stressor determinations for Unnamed Creek (-632).

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Unnamed Creek	07100001-632	o	---	●	---	●	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Lake Shetek Inlet (07100001-643)

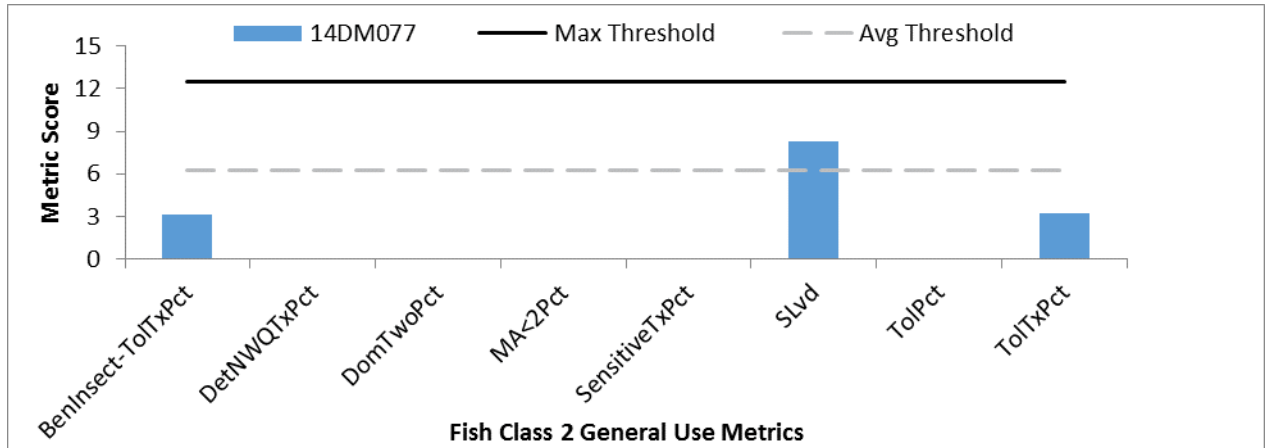
Located in north central Murray County and south central Lyon County, Lake Shetek Inlet (-643) is a 10.55-mile reach that is impaired for aquatic life due to the fish assemblage. This stream reach extends from approximately 0.5 miles downstream of County Road 63 to just downstream of County Road 21. Along this stream section there is one biological monitoring station, 14DM077.

Biology

Fish

The fish community in Lake Shetek Inlet (-643) was sampled for fish in August of 2014 at its biological monitoring station 14DM077. The FBI score at this reach was 14.8, which is far below the Fish Class 2 Southern Streams General Use Threshold of 50. This site did have one metric (SLvd) reach the average metric score needed to meet the threshold (Figure 14), however, the remaining seven metrics comprising this FBI scored well below average with five of those metrics scoring zero. This site was also dominated by the presence of fathead minnows (82.1% of sampled individuals). Fathead minnows are often found in large numbers in degraded stream systems.

Figure 14. Lake Shetek Inlet (-643) Fish IBI metric scores.

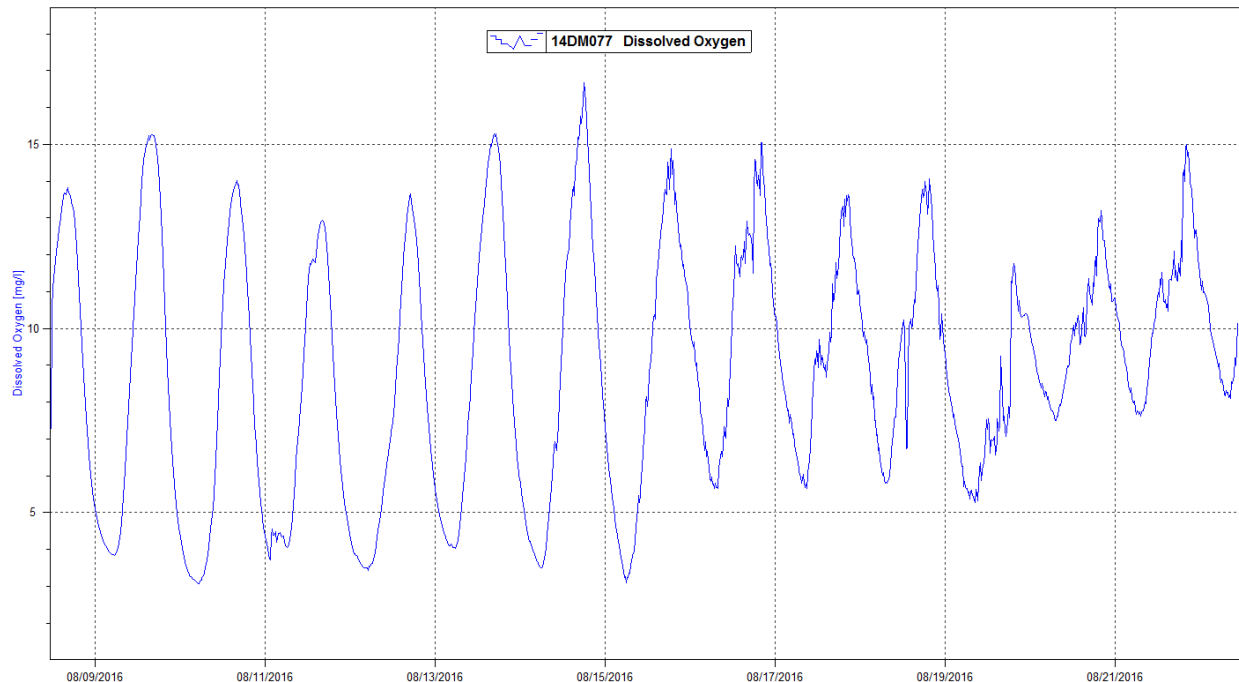


DO

A total of 11 DO measurements were taken from two chemistry sites (S001-552, S009-147) from 2016. The average of all the values is 7.93 mg/L with a low of 4.11 mg/L and a high of 9.80 mg/L. The summer average (June-Aug) is 7.16 mg/L. The DO values fell below the 5 mg/L daily minimum standard once.

Continuous DO monitoring took place at site 14DM077 in 2016 (Figure 15). This monitoring showed that the DO levels in this reach frequently fell below 5 mg/L. The daily flux in this reach was also very high and easily exceeded the 4.5 mg/L daily standard for the southern region of the state. These results are indicative of a reach with DO and possibly eutrophication issues.

Figure 15. Continuous DO monitoring results in Lake Shetek Inlet (-643).



The HSPF model calculated daily minimum DO values for this subwatershed from 1994-2014. Of these calculations, 493 (6.43%) of the days had a daily minimum DO level below the daily minimum standard of 5 mg/L.

Table 24. DO related fish metrics in Lake Shetek Inlet (-643). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-643 Fish Class 2 – General Use	MA>3 Avg	SspnPct Avg	Taxa Count Avg	DO TIV Avg
14DM077	2.49	82.14	10.00	8.38
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FBI General Use Threshold (50.0)</i>	23.89	28.72	20.38	8.56
Expected response to DO stress	↓	↑	↓	↓

The fish assemblage in Lake Shetek Inlet (-643) at site 14DM077 scored below average in all four of the DO related metrics when compared to all other Class 2 Southern Streams stations that meet the FBI General Use Threshold (Table 24). This reach had a very high amount of serial spawning individuals, while also having few mature fish greater than three years, a low overall taxa count and a below average DO TIV score. These results commonly occur in streams with DO issues.

Table 25. DO related macroinvertebrate metrics in Lake Shetek Inlet (-643). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-643 Macroinvertebrate Class 5 – General Use	HBI_MN Value	% DO Tolerant Taxa	# DO Tolerant Taxa	ChemTV_DO
14DM077	7.78	19.69	10.00	6.67
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	7.04	8.62	4.33	7.10
Expected response to DO stress	↑	↑	↑	↓

The macroinvertebrate community in this reach scored below average in all four of the DO related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 25). Site 14DM077 had poor HBI_MN and DO TIV scores, while also having an increased amount and percentage of DO tolerant taxa. These results frequently occur in streams being negatively impacted by the DO conditions.

Based on the frequency that the DO values fall below 5 mg/L according to the continuous monitoring, the very high daily flux of DO that exceeds the standard, as well as the poor scoring DO related metrics in both the fish and macroinvertebrate communities, DO is a stressor to aquatic life in Lake Shetek Inlet (-643).

Eutrophication

A total of 12 phosphorus samples were taken from two chemistry sites (S001-552, S009-147) from 2016. The average of all the values is 0.190 mg/L with a low of 0.05 mg/L and a high of 0.39 mg/L. The summer

average (June-Aug) is 0.233 mg/L. Phosphorus values exceeded the standard of 0.150 mg/L eight times. Filamentous algae was also present, which can signal issues related to eutrophication (Figure 16).

Figure 16. Station 14DM077 taken at the time of biological monitoring on August 06, 2014. Photo displays filamentous algae within the riffle feature of the stream.



Table 26. Eutrophication related fish metrics in Lake Shetek Inlet (-643). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-643 Fish Class 2 – General Use	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct
14DM077	0.00	0.87	99.06	96.57
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)</i>	19	11.47	45.1	17
Expected response to Eutrophication stress	↓	↓	↑	↑

The fish community in Lake Shetek Inlet (-643) at site 14DM077 scored below average in all four of the DO related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 26). The fish community was dominated by tolerant fish individuals, while having zero sensitive and few darter individuals. These results are common in streams with eutrophic conditions.

Table 27. Eutrophication related macroinvertebrate metrics in Lake Shetek Inlet (-643). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-514 Macroinvertebrate Class 5– General Use	EPT Pct	Tanytarsini Pct	CrustMoll Pct	Scrapper Pct	% Tolerant Taxa	% Intolerant Taxa
14DM077	27.59	6.48	2.19	5.96	27.81	0.00
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	43.90	27.84	9.23	15.78	17.17	5.79
Expected response to Eutrophication stress	↓	↓	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in four of the six eutrophication related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 27). Site 14DM077 did have lower amounts of crustacea/mollusca and scraper individuals, which can be a good sign, however, the remaining metrics scored poorly and reflect a community likely stressed by the eutrophic conditions.

Based on the high rate of frequency that the phosphorus standard was exceeded, the pictures of filamentous algae, the very high DO flux values likely signaling eutrophication, and the majority of the fish and macroinvertebrate metrics related to eutrophication scoring poorly all conclude that eutrophication is a stressor to aquatic life in Lake Shetek Inlet (-643).

Nitrates

Due to the location of Lake Shetek in the middle of the stream reach, Inorganic Nitrogen (NO₂-NO₃) samples taken upstream of the lake may not be indicative of the conditions downstream of the lake. Therefore, only nitrate data collected below the lake will be analyzed.

Biological monitoring station 14DM077 and water chemistry site S009-147 had two Inorganic Nitrogen (NO₂-NO₃) samples taken from 2014-2016. These sample values were 0.87 mg/L and 3.9 mg/L. Furthermore, immediately downstream of this reach, chemistry site S001-546 had 13 Inorganic Nitrogen (NO₂-NO₃) samples taken. These values ranged from 0.05-19 mg/L with an average nitrate concentration of 4.50 mg/L. A quantile regression analysis for Class 5 streams showed that with 75% probability that sites at or exceeding this value would be impaired. Site S001-546 had one sample exceed this level.

The HSPF model also calculated daily nitrate concentrations for this subwatershed from 1994-2014. These values ranged from 0.182-33.51 mg/L with an average nitrate concentration of 6.13 mg/L. Of these calculations, 1 (0.04%) was above 18.1 mg/L.

Table 28. Nitrate related macroinvertebrate metrics at Lake Shetek Inlet (-643). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

007100001-643 Macroinvertebrate Class 5 – General Use	TrichopteraChTx Pct	N Index Score	% N Tolerant	% N Intolerant
14DM077	8.57	3.23	50.31	0.00
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	13.16	3.00	48.68	0.96
Expected response to N stress	↓	↑	↑	↓

The macroinvertebrate community at site 14DM077 in Lake Shetek Inlet (-643) scored below average in all four of the nitrate related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 28). This reach had a lower amount of trichoptera and nitrate intolerant taxa, while also scoring just below average for nitrate index score and having a slightly above average amount of nitrate tolerant individuals resulting in a lower metric score.

The nitrate related macroinvertebrate metrics score very near the averages of similar sites that did reach the MIBI threshold. The observed and calculated nitrate concentrations do get elevated at times, but generally have a lower average nitrate concentration. Further nitrate monitoring is recommended

downstream of Lake Shetek to better understand the nitrate concentrations in this stream reach. Therefore, nitrates are inconclusive as a stressor to aquatic life in Lake Shetek Inlet (-643) at this time.

Suspended Solids

Eleven samples taken from two chemistry sites (S001-552, S009-147) in 2016 were analyzed for TSS. The average of all the values is 76.45 mg/L with a low of 14 mg/L and a high of 260 mg/L. The TSS concentrations were at or exceeded the 65 mg/L standard mg/L four times.

Additionally, eleven secchi tube measurements were taken from this reach. These values ranged from 8-52 cm, with two values falling below the 10 cm minimum standard for secchi tube.

The HSPF model calculated daily TSS values for this subwatershed from 1994-2014. These concentrations ranged from 2.97-715.07 mg/L with an average TSS value of 12.21 mg/L. Of these calculations, 73 (1.03%) were above the TSS standard of 65 mg/L.

Table 29. TSS related fish metrics in Lake Shetek Inlet (-643). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-643 Fish Class 2 – General Use	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RifflePct	SensitivePct	SlithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14DM077	3.35	0.00	0.11	0.87	2.49	0.00	2.49	0.00	11.83	25.08
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)</i>	37.38	4.89	9.61	18.66	32.49	18.65	39.38	4.97	11.68	19.19
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

The fish community in Lake Shetek Inlet (-643) at site 14DM077 scored below average in nine of the ten metrics related to TSS when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 29). This reach did have a slightly above average amount of long-lived individuals, however, the remaining metrics scored poorly and indicate potential stress from the present TSS conditions.

Table 30. TSS related macroinvertebrate metrics in Lake Shetek Inlet (-643). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

007100001-643 Macroinvertebrate Class 5 – General Use	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plectoptera Pct
14DM077	18.38	1.00	15.00	42.50	35.74	0.00
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)</i>	15.87	3.02	11.59	35.23	26.89	0.54
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

The macroinvertebrate assemblage in this reach scored below average in five of the six TSS related metrics at site 14DM077 when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 30). This reach had an above average amount of collector-filterer

individuals, which is not common in streams negatively impacted by high TSS concentrations, however, the rest of the metrics scored poorly and this reach had many TSS tolerant individuals and taxa, while having fewer TSS intolerant taxa.

Based on the high rate of standard exceedances from the observed data set, as well as the majority of both the fish and macroinvertebrate metrics related to TSS scoring poorly, TSS is a stressor to aquatic life in Lake Shetek Inlet (-643) at this time.

Habitat

Lake Shetek Inlet (-643) had a qualitative habitat assessment take place at its biological monitoring site, 14DM077, during the fish and macroinvertebrate sampling events in 2014. The average MSHA score from these visits was 46.28 (Fair). Limiting the habitat at this site was the row crop agriculture and open pasture as the dominant nearby land uses, moderate bank erosion, no stream shading, the presence of silt and clay substrates, sparse fish cover, and fair channel development. Further MSHA analysis can be seen in Figure 17.

Figure 17. MSHA metric scores in Lake Shetek Inlet (-643).

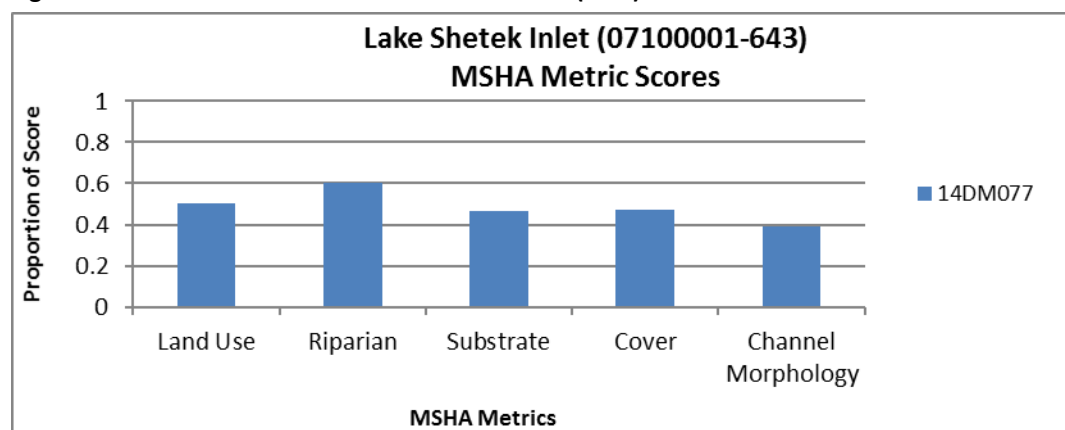


Table 31. Habitat related fish metrics in Lake Shetek Inlet (-643). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-643 Fish Class 2 – General Use	BenInsect-TolPct	SLithopPct	DarterSculpSu cPct	RifflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14DM077	0.87	2.49	0.87	2.49	0.04	2.60	99.06	83.08
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	20.4	39.38	18.18	32.49	5.24	58.26	44.85	19.02
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

The fish community in Lake Shetek Inlet (-643) at site 14DM077 scored below average in all eight of the habitat related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 31). The fish sample was dominated by fathead minnows, which comprised 82.1% of the sample with 2179 individuals caught. Common carp were also abundant in this reach with 313 individuals present. These two species are very tolerant of poor habitat conditions.

Table 32. Habitat related macroinvertebrate metrics in Lake Shetek Inlet (-643). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

007100001-643 Macroinvertebrate Class 5 – General Use	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14DM077	18.18	13.79	55.17	27.59	41.38	5.33
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)</i>	5.66	12.52	49.77	42.46	34.53	13.99
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate assemblage in this reach scored below average in four of the six habitat related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 32). The site, 14DM077, had a high number of both Burrower and Legless individuals, while also having lower amounts of EPT and sprawler individuals. While the macroinvertebrate community is not impaired these results are indicate that the assemblage could be much better with improved habitat conditions.

Based on all of the fish habitat related metrics scoring poorly, as well as the majority of the macroinvertebrate habitat related metrics scoring below average, and the fair MSHA score, habitat is a stressor to aquatic life in Lake Shetek Inlet (-643).

Altered Hydrology

This reach is on a natural channel according to the MPCA altered watercourse layer. Station 14DM077 is located within a stretch of stream that falls between two lake outlet fish barriers. Upstream from the site is Long Lake outlet, downstream is Shetek Lake Inlet (-644). There are no known side tributaries that would allow access to these water bodies for fish to seek refuge during times of drought or deep freeze.

Extreme weather events affect high flow events as well as also low flows during drought. HSPF models show this section of Lake Shetek Inlet (-643) experiencing low flow at less than five cfs 28.7% of the time and less than one cfs 4.0% of the time.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The percentage for generalist fish within the reach was 96.7% compared to the average in Class 2 general use waters meeting the standard of 42.4%.

The numbers of nest guarder species are also positively correlated with increased low flows. The percentage for nest guarder fish within the reach was 85.2% compared to the average in Class 2 general use waters meeting the standard of 19%.

Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The percentage for long-lived macroinvertebrates within the reach was 0.3% compared to the average in Class 5 general use waters meeting the standard of 9%.

This natural reach does experience times of low flow conditions as calculated by the HSPF model, but much of the time base flow conditions exist, while the majority of the flow related biological metrics do score poorly. The presence of two fish barriers on this reach appears to be negatively impacting the presence of many fish species as well. Therefore, Flow Alteration/Connectivity is a stressor in Lake Shetek Inlet (-643).

Summary

The impaired fish community in Lake Shetek Inlet (-643) is being stressed by DO, Eutrophication, Suspended Sediment, Habitat, and Flow Alteration/Connectivity (Table 33). Nitrates were inconclusive as a stressor to aquatic life at this point. For further information on the stressors and recommendations to fixing the stressors in the Lake Shetek HUC 10 Watershed, please see Page 59.

Table 33. Summary of stressor determinations for Lake Shetek Inlet (-643).

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Lake Shetek Inlet	07100001-643	●	●	o	●	●	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Unnamed Creek (07100001-637)

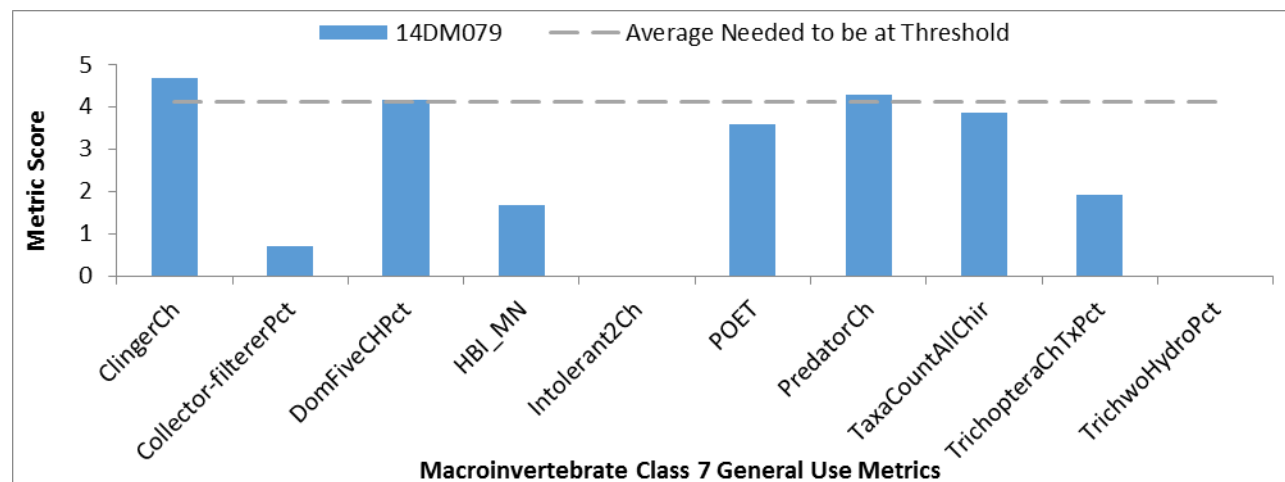
Located in north central Murray County, Unnamed Creek (-637) is a 1.00-mile reach that is impaired for aquatic life due to the macroinvertebrate assemblage. This stream reach extends from the Unnamed Creek to the confluence with Lake Shetek Inlet. Along this stream section there is one biological monitoring station, 14DM079.

Biology

Macroinvertebrates:

The macroinvertebrate assemblage at site 14DM079 was sampled in August of 2014. This visit had a MIBI score of 24.8, which is below the Macroinvertebrate Class 7 Prairie Streams GP General Use Threshold of 41. This site had three metrics scoring above the average needed to reach the threshold (ClingerCh, DomFiveChPct, PredatorCh). However, the remaining seven metrics scored below average and two of those metrics had a score of zero. See Figure 18 for a complete breakdown of the metric scores at this site.

Figure 18. Unnamed Creek (-637) macroinvertebrate IBI metric scores.



DO

Twelve DO measurements were taken from one chemistry site (S009-057) and one biological monitoring station (14DM079) from 2014-2016. The average of all the values is 7.73 mg/L with a low of 5.21 mg/L and a high of 10.13 mg/L. The summer average (June-Aug) is 7.53 mg/L. The DO values did not fall below 5 mg/L.

The HSPF model also calculated daily minimum DO levels for this subwatershed from 1994-2014. Of these calculations, 1880 (24.51%) fell below the 5 mg/L daily minimum standard. This is a relatively high number of instances in which the DO levels exceeded the standard.

Table 34. DO related macroinvertebrate metrics in Unnamed Creek (-637). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-637 Macroinvertebrate Class 7 – General Use	HBI_MN Value	% DO Tolerant Taxa	# DO Tolerant Taxa	ChemTV DO
14DM079	8.36	20.07	8.00	6.72
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	7.55	12.98	5.74	6.91
Expected response to DO stress	↑	↑	↑	↓

The macroinvertebrate community in Unnamed Creek (-637) at site 14DM079 scored below average in all four of the DO related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 34). This site had both increased numbers and percentage of DO tolerant taxa while also having a below average DO TIV score. These results do signal potential stress from the DO conditions.

The observed DO levels in a limited data set do get rather close to the daily minimum standard, while the HSPF calculated a rather high amount of exceedances of the standard. Additionally, all of the macroinvertebrate metrics related to DO scored below average when compared to a similarly classified stream that did meet the MIBI threshold. Based on this information, DO is a stressor to aquatic life in Unnamed Creek (-637).

Eutrophication

Eleven phosphorus samples were taken from one chemistry site (S009-057) and one biological monitoring station (14DM079) from 2014-2016. The average of all the values is 0.146 mg/L with a low of 0.05 mg/L and a high of 0.35 mg/L. The summer average (June-Aug) is 0.177 mg/L. Phosphorus values exceeded the standard of 0.150 mg/L three times.

The HSPF model also calculated daily phosphorus concentrations for this subwatershed from 1994-2014. These values ranged from 0.03-2.88 mg/L with an average value of 0.34 mg/L. Of these calculations, 6432 (92.32%) were above the 0.15 mg/L standard. This is a very high exceedance rate.

Table 35. Eutrophication related macroinvertebrate metrics in Unnamed Creek (-637). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-637 Macroinvertebrate Class 7 – General Use	EPT Pct	Tanytarsini Pct	CrustMoll Pct	Scraper Pct	% Tolerant Taxa	% Intolerant Taxa

14DM079	15.13	20.37	6.25	13.82	34.21	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	38.45	18.46	11.78	16.11	26.84	4.03
Expected response to Eutrophication stress	↓	↓	↑	↑	↑	↓

The macroinvertebrate community in Unnamed Creek (-637) scored below average in three of the six eutrophication related metrics at site 14DM079 when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 35). This reach had low numbers of both EPT and intolerant taxa, while also having a higher amount of tolerant taxa.

Based on the high standard exceedance rate of both the observed and modeled data, as well as half of the macroinvertebrate metrics related to phosphorus scoring below average, eutrophication is a stressor to aquatic life in Unnamed Creek (-637) at this time.

Nitrates

There were 11 samples taken from one chemistry site (S009-057) and one biological monitoring station (14DM079) from 2014-2016 were analyzed for Inorganic Nitrogen (NO₂-NO₃). The average of all the values is 6.72 mg/L with a low of 2.5 mg/L and a high of 14.00 mg/L. The spring average (March-May) is 6.60 mg/L. The summer average (June-Aug) is 7.46 mg/L. Nitrate values exceeded 4 mg/L 10 times. A quantile regression analysis of Class 7 stream stations showed that when nitrate concentrations exceeded 11.5 mg/L, there was a 90% probability for impairment. The nitrate concentrations in the limited sampling in this reach exceeded this level.

The HSPF model calculated daily nitrate concentrations for this subwatershed from 1994-2014. These values ranged from 0.06-44.95 mg/L, with an average value of 5.58 mg/L. Of the nitrate calculations, 794 (11.4%) were above 11.5 mg/L.

Table 36. Nitrate related macroinvertebrate metrics in Unnamed Creek (-637). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-637 Macroinvertebrate Class 7 – General Use	TrichopteraChTx Pct	N Index Score	% N Tolerant	% N Intolerant
14DM079	3.13	4.55	90.46	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	10.00	3.30	57.57	0.91
Expected response to N stress	↓	↑	↑	↓

The macroinvertebrate community in Unnamed Creek (-637) scored below average in all four of the nitrate related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 36). This stream reach completely lacked nitrate intolerant species, while also having few trichoptera taxa. Additionally, the Nitrate Index Score was poor and there was a very high amount of nitrate tolerant individuals present in this reach.

The nitrate concentrations in Unnamed Creek (-637) reach elevated levels as shown by both the observed results as well as the HSPF calculations. Based on these results as well as the poor nitrate related metrics in the macroinvertebrate community, nitrates are a stressor to aquatic life in this reach.

Suspended Solids

Ten samples taken from one chemistry site (S009-057) in 2016 were analyzed for TSS. The average of all the values is 16.86 mg/L with a low of 5.6 mg/L and a high of 60 mg/L. The TSS concentrations did not exceed the 65 mg/L standard.

Additionally, ten secchi tube measurements were taken from this reach. These values ranged from 15-100 cm, with an average value of 67.8 cm. None of the measurements fell below the 10 cm minimum standard for transparency.

The HSPF model calculated daily TSS values for this subwatershed from 1994-2014. These concentrations ranged from 2.86-401.20 mg/L with an average TSS value of 12.50 mg/L. Of these calculations, 105 (1.51%) were above the TSS standard of 65 mg/L.

Table 37. TSS related macroinvertebrate metrics in Unnamed Creek (-637). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-637 Macroinvertebrate Class 7 – General Use	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plectoptera Pct
14DM079	19.68	0.00	10.00	59.54	2.96	0.99
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (22.0)</i>	17.35	1.33	13.20	48.28	19.13	0.22
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

The macroinvertebrate assemblage in Unnamed Creek (-637) at site 14DM079 scored below average in four of the six TSS related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 37). This site did have a slightly above average number of plecoptera individuals and a lower amount of TSS tolerant taxa, however, this reach also had an increased number of TSS tolerant individuals, few collector-filterer individuals, zero TSS intolerant taxa, and a poor TSS Index Score. These results often occur in streams with increased concentrations of TSS.

Despite the majority of the macroinvertebrate metrics related to TSS scoring below average, both the observed and modeled data show very few indications that TSS concentrations reach levels that negatively impact aquatic life. Other stressors are likely causing the poor metric scores in this reach. Therefore, TSS is not a stressor to aquatic life in Unnamed Creek (-637) at this time.

Habitat

Unnamed Creek (-637) had a qualitative habitat assessment take place at its biological monitoring site, 14DM079, during the fish and macroinvertebrate sampling events in 2014. The average MSHA score from these visits was 51.7 (Fair). Limiting the habitat at this site was the row crop agriculture dominant nearby land use, no stream riparian buffer, moderate embeddedness, silt and detritus substrates, moderate channel stability and fair channel development. Further MSHA analysis can be seen in Figure 19.

Figure 19. MSHA metric scores in Unnamed Creek (-637).

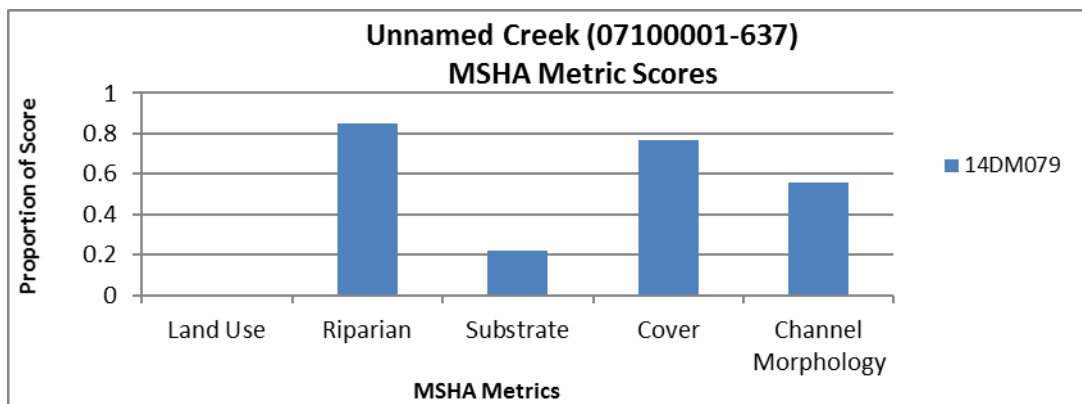


Table 38. Habitat related macroinvertebrate metrics in Unnamed Creek (-637). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-637 Macroinvertebrate Class 7 – General Use	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14DM079	10.86	40.79	30.26	15.13	77.63	11.51
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	5.40	20.35	36.94	37.77	37.96	19.49
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate assemblage in Unnamed Creek (-637) scored below average in five of the six habitat related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 38). The reach did have an above average amount of climber

individuals, however, the site also had a higher amount of burrower and legless individuals as well which correlates to the silt, clay, and detritus substrates found during the habitat assessment.

The habitat in Unnamed Creek (-637) was considered fair, however, the macroinvertebrate community metrics related to habitat scored rather poorly, therefore habitat is a stressor to the macroinvertebrate community in this reach. An assessable fish sample is needed to better determine the impact that the habitat conditions are having on that community.

Altered Hydrology

Monitoring station 14DM079 has barriers both upstream and downstream from the bio station. The reach is a small tributary that flows into the Lake Shetek Inlet stream, which flows approximately 9 miles downstream where a dam would limit fish migration. Upstream of the reach is another barrier from Currant Lake Outlet that would prohibit fish migration from the stream to the lake. Altered Hydrology is prevalent in most of the watershed, as ditching and tiling are common practices in these sections. Both these forms of alterations are influencing the downstream station, 14DM079's, water volume as well as water quality. As channels take on extra water, they change their dimension, pattern, and profile to adjust; resulting in high sediment loads, loss of habitat, and water quality impairments.

Extreme weather events affect high flow events as well as also low flows during drought. HSPF models show this section of Unnamed Creek (-637) experiencing low flow at less than five cfs 75.8% of the time and less than one cfs 37.5% of the time. Figure 20 shows site 14DM079 dry.

Figure 20. Dry portion of Unnamed Creek (-637).



Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The percentage for generalist fish within the reach was 100% compared to the average in Class 3 general use waters meeting the standard of 59.1%.

The numbers of nest guarder species are also positively correlated with increased low flows. The percentage for nest guarder fish within the reach was 9.5% compared to the average in Class 3 general use waters meeting the standard of 19.2%.

Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The percentage for long-lived macroinvertebrates within the reach was 6.9% compared to the average in Class 7 general use waters meeting the standard of 8%.

Based on this information, Flow Alteration/Connectivity is a stressor to aquatic life in Unnamed Creek (-637).

Summary

The impaired macroinvertebrate community in Unnamed Creek (-637) is being stressed by DO, Eutrophication, Nitrates, Habitat, and Flow Alteration/Connectivity (Table 39). Suspended Sediment was ruled out as a stressor to aquatic life. For further information on the stressors and recommendations to fixing the stressors in the Lake Shetek HUC 10 Watershed, please see Page 59.

Table 39. Stressor determinations for Unnamed Creek (-637).

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Unnamed Creek	07100001-637	●	●	●	---	●	●

● = stressor; ○ = inconclusive stressor; --- = not an identified stressor

Lake Shetek Inlet (07100001-641)

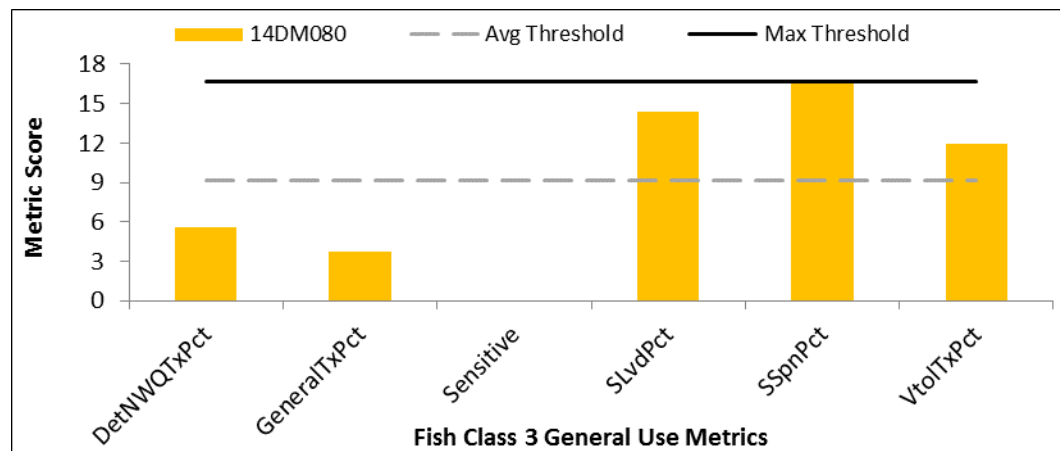
Located mainly in north central Murray County and slightly in south central Lyon County, Lake Shetek Inlet (-641) is a 5.57-mile long reach that is impaired for aquatic life due the fish and macroinvertebrate assemblages. This stream reach extends from approximately 0.6 miles upstream of County Road 20 to approximately 1 mile downstream of County Road 23. Along this stream section there are two biological monitoring stations, 04DM006 and 14DM080.

Biology

Fish

The fish community in Unnamed Creek (-641) was sampled for fish in August of 2014 at its biological monitoring station 14DM080. The FBI score at this reach was 44.8, which is below the Fish Class 3 Southern Headwaters General Use Threshold of 55. This site did have three metrics (SLvd, SSpnPct, VtolTxPct) reach the average metric score needed to meet the threshold (Figure 21), however, the remaining three metrics comprising this FBI scored well below average with one metric scoring zero (Sensitive).

Figure 21. Lake Shetek Inlet (-641) fish IBI metric scores.

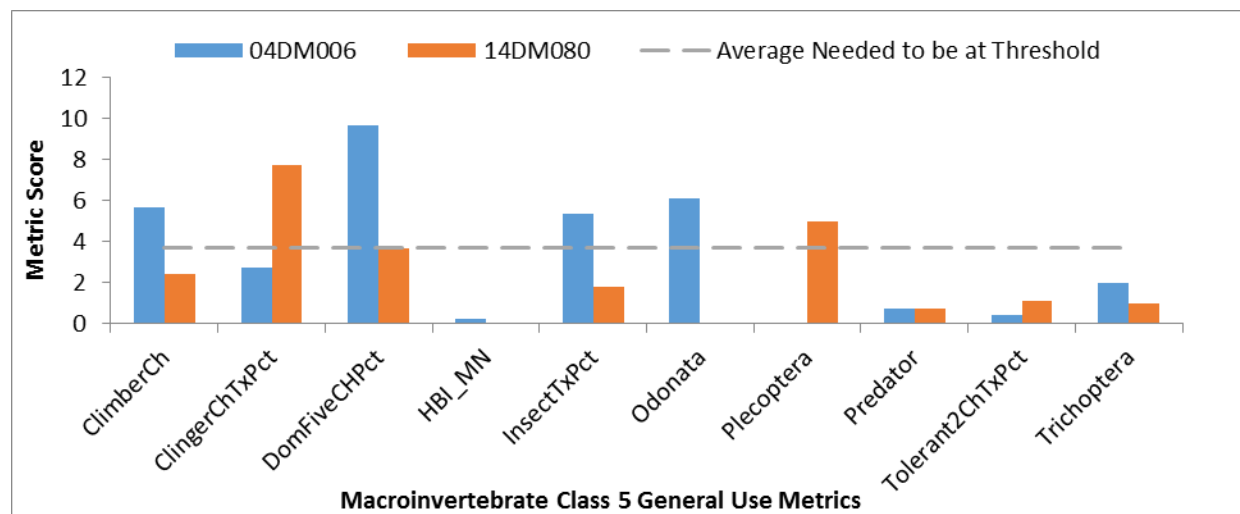


Macroinvertebrates:

The macroinvertebrate assemblage at sites 04DM006 and 14DM080 were sampled in August of 2014. This visit had a MIBI score of 33.1 at 04DM006 and 23.5 at 14DM080, which are both below the Macroinvertebrate Class 5 Southern Streams RR General Use Threshold of 37. Site 040DM006 had four

metrics and 14DM080 had two metrics scoring above the average needed to reach the threshold. However, the remaining metrics at these sites scored below average. See Figure 22 for a complete breakdown of the metric scores at this site.

Figure 22. Lake Shetek Inlet (-641) macroinvertebrate IBI metric scores.



DO

Three DO measurements were taken from one biological monitoring station (14DM080) in 2014. The average of all the values is 8.59 mg/L with a low of 7.73 mg/L and a high of 9.57 mg/L. The summer average (June-Aug) is 8.59 mg/L. The DO values did not fall below the 5 mg/L daily minimum standard.

The HSPF model calculated daily minimum DO values for this subwatershed from 1994-2014. Of these calculations, 844 (11.00%) of the days had a daily minimum DO level below 5 mg/L.

Table 40. DO related fish metrics in Lake Shetek Inlet (-641). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-641 Fish Class 3 – General Use	MA>3 Avg	SspnPct Avg	Taxa Count Avg	DO TIV Avg
14DM080	9.16	0.00	6.00	8.19
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	13.32	17.09	12.16	8.44
Expected response to DO stress	↓	↑	↓	↓

The fish community in Lake Shetek Inlet (-641) at site 14DM080 scored below average in three of the four DO related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 40). This reach had a lower overall taxa count, few mature fish, and a poor DO TIV score. These results are common in streams with DO issues. However, site 14DM080 did not have any serial spawning individuals, which are very prominent in streams with low DO conditions.

Table 41. DO related macroinvertebrate metrics in Lake Shetek Inlet (-641). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-641 Macroinvertebrate Class 5 – General Use	HBI_MN Value	% DO Tolerant Taxa	# DO Tolerant Taxa	ChemTV _DO
04DM006	8.26	15.58	7.00	6.58
14DM080	8.34	11.46	5.00	7.04
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	7.04	8.62	4.33	7.10
Expected response to DO stress	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in all four of the DO related metrics at both sites when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 41). This reach had increased numbers and percentages of DO tolerant taxa, while also having poor HBI_MN and DO TIV scores. These results are common in streams with DO issues.

The biological metrics in this reach suggest that DO is a stressor. The model predicts an average exceedance rate, while the small observed data set does not indicate that DO is a stressor. Therefore, DO is inconclusive as a stressor in Lake Shetek Inlet (-641) at this time. Further DO monitoring with a sonde is needed to better determine the impact, if any, that the DO conditions are having on aquatic life.

Eutrophication

A total of three phosphorus samples were taken from one biological monitoring station (14DM080) in 2014. The average of all the values is 0.14 with a low of 0.06 mg/L and a high of 0.27 mg/L. Phosphorus values exceeded the standard of 0.150 mg/L one time.

The HSPF model also calculated daily phosphorus concentrations for this subwatershed from 1994-2014. These values ranged from 0.06-3.28 mg/L with an average concentration of 0.43 mg/L. Of these calculations, 6590 (98.39%) were above the 0.15 mg/L standard.

Table 42. Eutrophication related fish metrics in Lake Shetek Inlet (-641). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-641 Fish Class 3 – General Use	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct
14DM080	0.00	6.11	93.89	10.69
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	8.9	12.11	70.79	14.71
Expected response to Eutrophication stress	↓	↓	↑	↑

The fish community in Lake Shetek Inlet (-641) at site 14DM080 scored below average in three of the four eutrophication related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 42). This reach did have a lower amount of omnivorous

individuals, however, there was also an increased amount of tolerant individuals and low amounts of both darter and sensitive individuals. These results are common in streams with eutrophic conditions.

Table 43. Eutrophication related macroinvertebrate metrics in Lake Shetek Inlet (-641). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-641 Macroinvertebrate Class 5 – General Use	EPT Pct	Tanytarsini Pct	CrustMoll Pct	Scraper Pct	% Tolerant Taxa	% Intolerant Taxa
04DM006	28.39	28.91	12.62	15.46	40.19	0.31
14DM080	33.23	4.73	11.18	19.49	30.89	0.00
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	43.90	27.84	9.23	15.78	17.17	5.79
Expected response to Eutrophication stress	↓	↓	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in four (04DM006) and six (14DM080) of the six eutrophication metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 43). Both sites had decreased amounts of EPT individuals and phosphorus intolerant taxa, while also having increased levels of crustacean/mollusca individuals and phosphorus tolerant taxa. Site 14DM080 also had lower numbers of tanytarsini individuals and increased numbers of scraper individuals. All of these results are common in streams being negatively impacted by eutrophic conditions.

The phosphorus concentrations do get to levels that exceed the standard according to the observed and modeled data sets, the majority of the fish and macroinvertebrate metrics related to eutrophication score below average, therefore, eutrophication is a stressor to aquatic life in Lake Shetek Inlet (-641).

Nitrates

Three samples taken from two biological monitoring stations (04DM006, 14DM080) from 2004-2014 were analyzed for Inorganic Nitrogen (NO₂-NO₃). The average of all the values is 8.17 mg/L with a low of 1.5 mg/L and a high of 13.00 mg/L. Nitrate values exceeded 4 mg/L twice.

The HSPF model calculated daily nitrate concentrations for this subwatershed from 1994-2014. These values ranged from 0.15-3165.4mg/L, with an average value of 7.29 mg/L. Of the nitrate calculations, 10 (0.15%) were above 18.1 mg/L.

Table 44. Nitrate related macroinvertebrate metrics in Lake Shetek Inlet (-641). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-641 Macroinvertebrate Class 5 – General Use	TrichopteraChTx Pct	N Index Score	% N Tolerant	% N Intolerant
04DM006	8.33	3.69	72.27	0.31
14DM080	8.57	4.37	78.66	0.00
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	13.16	3.00	48.68	0.96
Expected response to N stress	↓	↑	↑	↓

The macroinvertebrate community in Lake Shetek Inlet (-641) scored below average in all four nitrate related metrics at both sites, 04DM006 and 14DM080, when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 44). This reach had low levels of trichoptera taxa, poor nitrate index scores, a high amount of nitrate tolerant individuals, and very few nitrate intolerant taxa.

While the nitrate related macroinvertebrate metrics score poorly, the majority of the observed and modeled nitrate values do not reach levels that would likely cause stress to the community. Further monitoring may be needed to better understand the nitrate concentrations in this reach. Nitrates are inconclusive as a stressor to aquatic life in Lake Shetek Inlet (-641).

Suspended Solids

Three samples taken from two biological monitoring stations (04DM006, 14DM080) from 2004-2014 were analyzed for TSS. The average of all the values is 17.67 mg/L with a low of 11 mg/L and a high of 31 mg/L. The TSS concentrations did not exceed the 65 mg/L standard.

Additionally, 10 secchi tube measurements were taken from this reach. These values ranged from 27-100 cm, with an average reading of 53.75 cm. No values fell below the 10 cm minimum standard for secchi tube.

The HSPF model calculated daily TSS values for this subwatershed from 1994-2014. These concentrations ranged from 2.35-594.29 mg/L with an average TSS value of 11.26 mg/L. Of these calculations, 87 (1.30%) were above the TSS standard of 65 mg/L.

Table 45. TSS related fish metrics in Lake Shetek Inlet (-641). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-641 Fish Class 3 – General Use	BenFdFrimPct	Centr-TolPct	HerbVPct	Percfm-TolPct	RifflePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14DM080	15.2 7	0.0 0	0.00 0.00	6.11 6.11	9.16 9.16	0.0 0	13.74 13.74	0.0 0	1.5 3	15.85 15.85
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	37.8 3	0.9 0	13.3 3	13.9 3	28.3 3	8.5 5	33.71	1.9 5	3.5 6	15.27
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

The fish community in Lake Shetek Inlet (-641) at site 14DM080 scored below average in all ten of the TSS related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 45). This site had a poor TSS Index Score, while also having very few or completely lacking many species that can be sensitive to increased TSS concentrations.

Table 46. TSS related macroinvertebrate metrics in Lake Shetek Inlet (-641). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-641 Macroinvertebrate Class 5 – General Use	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plectoptera Pct
04DM006	16.33	0.00	14.00	34.89	18.93	0.00
14DM080	21.88	0.00	12.00	68.79	13.10	0.96
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)</i>	15.87	3.02	11.59	35.23	26.89	0.54
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

The macroinvertebrate assemblage in this reach scored below average in four (04DM006) and six (14DM080) of the six TSS related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 46). Both sites along this reach had poor TSS Index scores, lacked TSS intolerant taxa, had decreased numbers of collector-filterer individuals, while also having an increased number of TSS tolerant taxa. These results are common in streams stressed by TSS.

Despite the majority of the fish and macroinvertebrate metrics related to TSS scoring below average, both the observed and modeled data show very few indications that TSS concentrations reach levels that negatively impact aquatic life. Other stressors are likely causing the poor metric scores in this reach. Therefore, TSS is not a stressor to aquatic life in Lake Shetek Inlet (-641) at this time.

Habitat

Lake Shetek Inlet (-641) had a qualitative habitat assessment take place at its biological monitoring site, 04DM026 and 14DM080, during the fish and macroinvertebrate sampling events in 2004 and 2014. The average MSHA scores for these sites were 76.1 (Good) at 04DM026 and 61.18 (Fair) at 14DM080. Limiting the habitat at this site was the row crop agriculture as the dominant nearby land use, moderate bank erosion at 14DM080, the presence of sand substrates, moderate embeddedness at 14DM080, and moderate channel stability at 14DM080. Further MSHA analysis can be seen in Figure 23.

Figure 23. MSHA metric scores in Lake Shetek Inlet (-641).

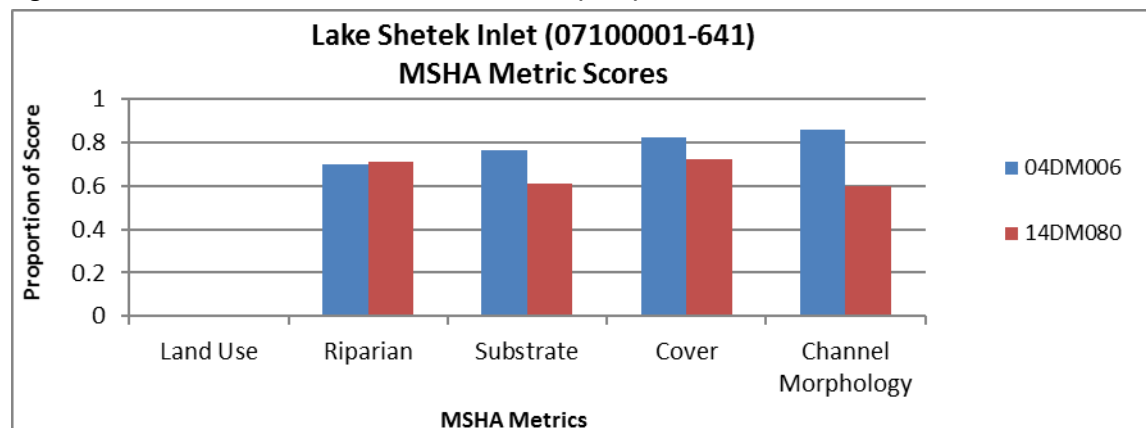


Table 47. Habitat related fish metrics in Lake Shetek Inlet (-641). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-641 Fish Class 3 – General Use	BenthicTolPct	SlithopPct	DarterSculpsucPct	RifflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14DM080	6.11	13.74	6.11	9.16	0.00	83.21	93.89	75.57
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	14.22	33.71	12.55	28.33	1.62	69.21	70.64	37.79
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

The fish community at site 14DM080 scored below average in seven of the eight habitat related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 47). The fish assemblage mostly consisted of creek chubs, white suckers, and brook sticklebacks, which are all very tolerant to poor habitat conditions. The fish data at site 04DM006 was deemed non-reportable and was not included in the metric analysis.

Table 48. Habitat related macroinvertebrate metrics in Lake Shetek Inlet (-641). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-641 Macroinvertebrate Class 5 – General Use	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14DM080	5.11	32.91	40.58	33.23	49.84	13.10
04DM006	17.03	16.09	31.23	28.39	56.78	22.40
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)</i>	5.66	12.52	49.77	42.46	34.53	13.99
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate assemblage in Lake Shetek Inlet (-641) scored below average in six out of eight of the habitat related metrics at both biological monitoring stations when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 48). Both sites had a good amount of climber individuals, however, the majority of the other metrics did not score well at both sites.

Based on the majority of the habitat related biological metrics scored below average at both sites, and the MSHA score was fair at 14DM080, habitat should be considered a stressor to the impaired biological communities at this time.

Altered Hydrology and Connectivity

Monitoring stations 04DM006 and 14DM080 are located in Lake Shetek Inlet (-641). Just upstream of this reach the stream splits into the headwater agricultural ditches, including a likely ditched and drained wetland or shallow lake that is currently used for crop production. There is a barrier that prohibits fish migration from the stream to Currant Lake upstream of reach (-637), which flows directly into reach (-641). There is also a dam approximately eight miles downstream on the Lake Shetek Inlet stream that would limit fish migration.

Altered Hydrology is prevalent in most of the watershed, as ditching and tiling are common practices in these sections. Both these forms of alterations are influencing the water volume as well as water quality downstream at stations 04DM006 and 14DM080. As channels take on extra water, they change their dimension, pattern, and profile to adjust; resulting in high sediment loads, loss of habitat, and water quality impairments.

This reach is mostly natural; however, the majority of its entire upstream watershed is altered according to the MPCA altered watercourse layer.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The average percentage for generalist fish within the reach was 88.7% Class 3 general use waters meeting the standard of 59.1%. General fish populations ranged from 83.1-98.4%.

The numbers of nest guarder species are also positively correlated with increased low flows. The average percentage for nest guarder fish within the reach was 9.8% compared to the average in Class 3 general use waters meeting the standard of 19.2%. Nest guarder fish species ranged from 6.5-15.3%.

Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The average percentage for long-lived macroinvertebrates within the reach was 7.7% compared to the average in Class 5 general use waters meeting the standard of 9%. Long-lived macroinvertebrates ranged from 7.0-9.1%.

The Flow Alteration/Connectivity biological metrics in this reach score below average, while the reach itself is on a mostly natural channel. While some of the altered streams in the headwaters of this watershed may be having an impact on this reach itself, more information is needed to make this determination. Therefore, Flow Alteration/Connectivity is inconclusive as a stressor in this reach.

Summary

The impaired fish and macroinvertebrate communities in Lake Shetek Inlet (-641) are being stressed by Eutrophication, Nitrates, and Habitat (Table 49). DO and Flow Alteration/Connectivity were inconclusive as stressors while Suspended Sediment was ruled out as a stressor to aquatic life at this point. For further information on the stressors and recommendations to fixing the stressors in the Lake Shetek HUC 10 Watershed, please see Page 59.

Table 49. Stressor determinations for Lake Shetek Inlet (-641).

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Lake Shetek Inlet	07100001-641	o	●	o	---	●	o

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Lake Shetek Inlet (07100001-642)

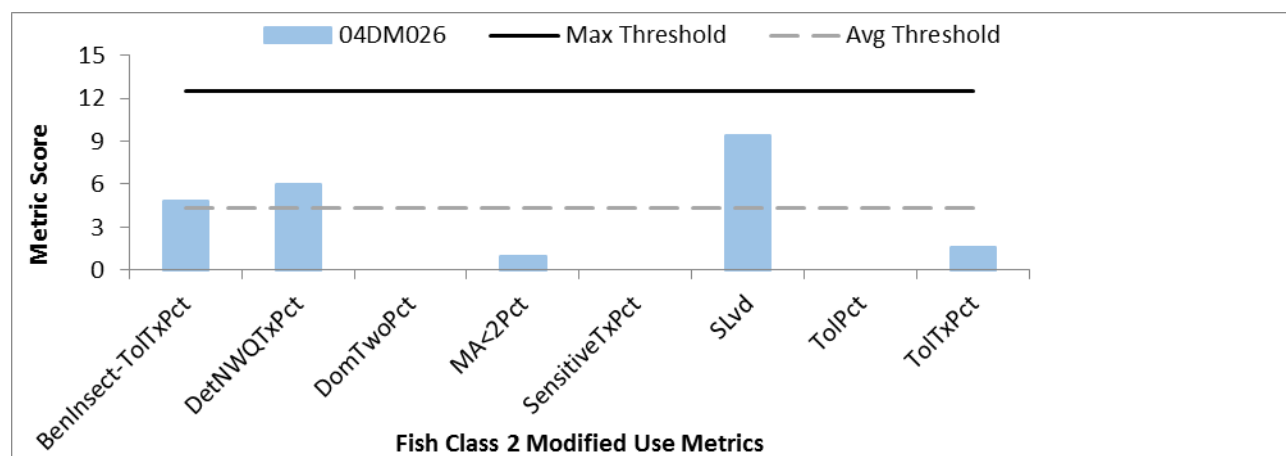
Located in south central Lyon County, Lake Shetek Inlet (-642) is a 2.88-mile long reach that is impaired for aquatic life due to the fish assemblage. This stream reach extends from approximately 1 mile downstream of County Road 23 to approximately 0.5 miles downstream of County Road 63. Along this stream section there is one biological monitoring station, 04DM026.

Biology

Fish

The fish community in Lake Shetek Inlet (-642) was sampled for fish in July of 2004 and August of 2014 at its biological monitoring station 04DM026. The average FIBI score at this site was 17.75, which is below the Fish Class 2 Southern Streams Modified Use Threshold of 35. This site did have three metrics (BenInsect-TolTxPct, DetNWQTxPct, SLvd) reach the average metric score needed to meet the threshold (Figure 24), however, the remaining five metrics comprising this FIBI scored well below average with three of these metrics scoring zero. This site was also dominated by the presence of fathead minnows (91.48% of sampled individuals) during the most recent sample. Fathead minnows are often found in large numbers in degraded stream systems.

Figure 24. Lake Shetek Inlet (-642) fish IBI metric scores.

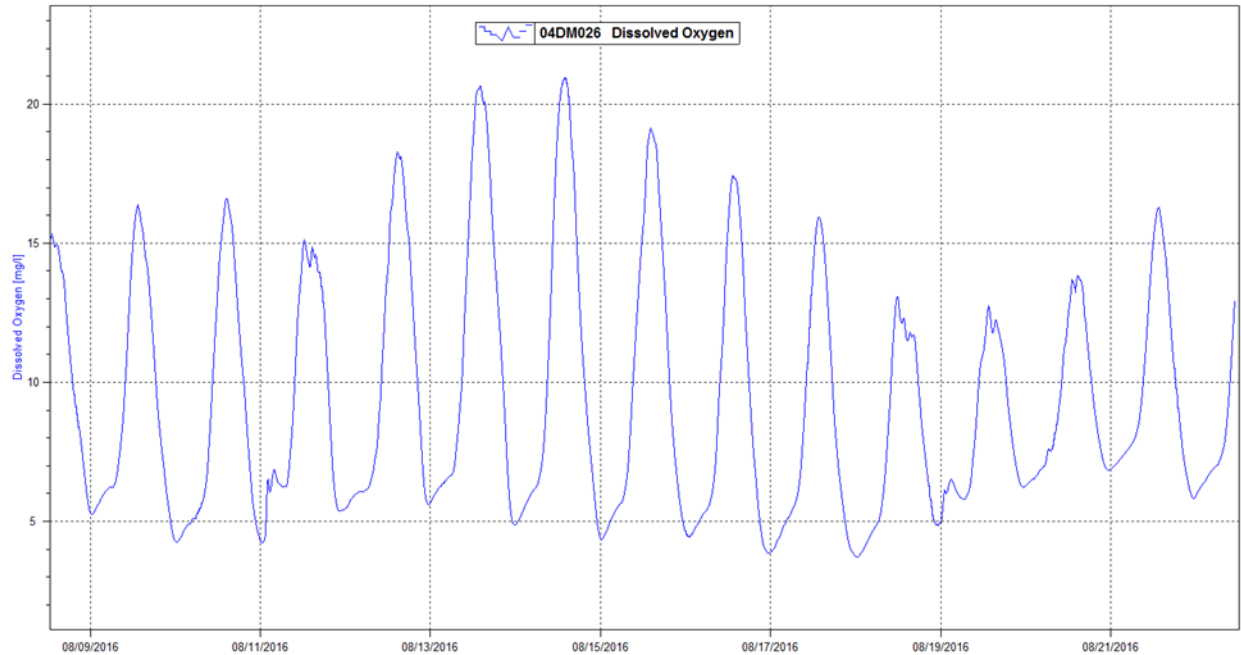


Dissolved Oxygen

Three dissolved oxygen samples were taken from one chemistry site (S009-145) and one biological monitoring station (04DM026) from 2004-2016. The average of all the values is 12.78 mg/L with a low of 8.40 mg/L and a high of 17.42 mg/L. The summer average (June-Aug) is 12.78 mg/L. The DO values did not fall below 5 mg/L.

Continuous DO monitoring was done at site 04DM026 in 2016 (Figure 25). This monitoring showed that the DO levels in this reach frequently fall below the 5 mg/L daily minimum standard. In addition, the daily flux for DO was consistently above the 4.5 mg/L standard, which can potentially indicate eutrophic conditions.

Figure 25. Continuous DO monitoring in Lake Shetek Inlet (-642) at site 04DM026.



Additionally, the HSPF model calculated daily minimum DO values for this subwatershed from 1994-2014. Of these calculations, 581 (7.57%) of the days had a daily minimum DO level below the daily minimum standard of 5 mg/L.

Table 50. DO related fish metrics in Lake Shetek Inlet (-642). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-642 Fish Class 2 – Modified Use	MA>3 AVG	SspnPct Avg	Taxa Count Avg	DO TIV Avg
04DM026 (2014)	0.33	91.86	7.00	8.35
04DM026 (2004)	0.00	12.50	6.00	8.35
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)</i>	27.98	25.34	14.52	8.41
Expected response to DO stress	↓	↑	↓	↓

The fish community in Lake Shetek Inlet (-642) at site 04DM026 scored below average in three (2004 visit) and four (2014 visit) of the four DO related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI Modified Use Threshold (Table 50). Both visits had very few mature fish greater than three years, a low overall taxa count, and below average DO TIV scores. The 2014 visit also had a very high amount of serial spawning individuals present. These results are indicative of a community being stressed by DO.

Table 51. DO related macroinvertebrate metrics in Lake Shetek Inlet (-642). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-642 Macroinvertebrate Class 7 – Modified Use	HBI_MN Value	% DO Tolerant Taxa	# DO Tolerant Taxa	ChemTV_DO
04DM026 (2004)	8.65	30.88	11.00	6.74
04DM026(2014)	8.13	18.27	6.00	6.74
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22)</i>	8	31.37	9.33	6.19
Expected response to DO stress	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in one (2014 visit) and two (2004 visit) of the four DO related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 51). Both visits at site 04DM026 had poor HBI_MN values, and the 2004 visit to this site also had an elevated amount of DO tolerant taxa. The percentages of DO tolerant taxa and the DO TIV scores were both above average at this site.

Based on the frequency that the daily minimum standard was exceeded during the continuous DO monitoring, the high rate of daily flux standard exceedances, as well as the majority of the fish metrics related to DO scoring poorly concludes that DO is a stressor to aquatic life in Lake Shetek Inlet (-642).

Eutrophication

Three samples were taken from one chemistry site (S009-145) and one biological monitoring station (04DM026) from 2004-2016. The average of all the values is 0.104 mg/L with a low of 0.05 mg/L and a high of 0.22 mg/L. The summer average (June-Aug) is 0.104 mg/L. Phosphorus values exceeded the standard of 0.150 mg/L once. Figure 26 shows the presence of algae, which is often found in streams with eutrophic conditions.

Figure 26. Algae present at site 04DM026.



Table 52. Eutrophication related fish metrics in Lake Shetek Inlet (-642). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-642 Fish Class 2 – Modified Use	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct
04DM026 (2004)	0.00	6.25	93.75	17.19
04DM026 (2014)	0.00	1.90	98.05	91.77
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)</i>	8.24	13.32	45.53	25.1
Expected response to Eutrophication stress	↓	↓	↑	↑

The fish community in Lake Shetek Inlet (-642) at site 04DM026 scored below average in three (2004 visit) and four (2014 visit) of the four eutrophication related metrics when compared to all other Class 2

Southern Streams stations that meet the FIBI Modified Use Threshold (Table 52). Both visits had few darter individuals, zero sensitive fish species, while also having a very high amount of tolerant individuals. These results are common in streams being negatively impacted by eutrophic conditions.

Table 53. Eutrophication related macroinvertebrate metrics in Lake Shetek Inlet (-642). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-642 Macroinvertebrate Class 7 – Modified Use	EPT Pct	Tanytarsini Pct	CrustMoll Pct	Scraper Pct	% Tolerant Taxa	% Intolerant Taxa
04DM026	38.97	14.50	8.52	7.82	40.09	0.31
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22)</i>	20.58	22.11	23.21	17.73	45.87	1.43
Expected response to Eutrophication stress	↓	↓	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in two of the six eutrophication related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 53). Site 04DM026 had lower amounts of tanytarsini individuals and a low percentage of phosphorus intolerant taxa, while scoring well in the remaining metrics.

With the limited number of samples taken, one of the three samples had a phosphorus concentration exceeding the 0.15 mg/L standard, algae present, the high range of DO flux likely signaling eutrophic conditions, and the majority of the fish metrics related to eutrophication scoring poorly concludes that eutrophication is a stressor to aquatic life in Lake Shetek Inlet (-642).

Nitrates

Three samples taken from one chemistry site (S009-145) and one biological monitoring station (04DM026) from 2004-2016 were analyzed for Inorganic Nitrogen (NO₂-NO₃). The average of all the values is 3.96 mg/L with a low of 0.89 mg/L and a high of 7.10 mg/L. The summer average (June-Aug) is 3.96 mg/L. Nitrate values exceeded 4 mg/L once.

The HSPF model also calculated daily nitrate concentrations for this subwatershed. These values ranged from 0.15-3165.4 mg/L with an average nitrate concentration of 7.29 mg/L. Of these calculations, 1287 (18.47%) were above 11.5 mg/L. A quantile regression analysis of Class 7 stream sites showed that when nitrate concentrations exceeded this level, there was a 90% probability for impairment.

Table 54. Nitrate related macroinvertebrate metrics in Lake Shetek Inlet (-642). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-642 Macroinvertebrate Class 7 – Modified Use	TrichopteraChTx Pct	N Index Score	% N Tolerant	% N Intolerant
04DM026	9.15	3.85	77.1	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22)</i>	5.71	3.30	62.54	0.00
Expected response to N stress	↓	↑	↑	↓

The macroinvertebrate community in Lake Shetek Inlet (-642) scored at or below average in three of the four nitrate related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold. (Table 54) Site 04DM026 did show an above average amount of trichoptera taxa, however, this site had a very high presence of nitrate tolerant individuals, a poor nitrate index score, and a lack of nitrate intolerant taxa.

The amount of observed nitrate data in this stream is fairly low, however, the HSPF model and quantile regression analysis showed how levels of nitrates in this reach and a high likelihood for impairment based on nitrate concentrations. While not impaired, the nitrate related metrics in the macroinvertebrate community also strongly suggest issues related to excess nitrates. Therefore, nitrates are a stressor to aquatic life in Lake Shetek Inlet (-642) at this time.

Suspended Solids

Three samples taken from one chemistry site (S009-145) and one biological monitoring station (04DM026) from 2004-2016 were analyzed for TSS. The average of all the values is 16.73 mg/L with a low of 5.2 mg/L and a high of 33 mg/L. The TSS concentrations did not exceed the 65 mg/L standard mg/L.

Additionally, ten secchi tube measurements were taken from this reach. These values ranged from 34-96 cm, with an average value of 56.33 cm. No values fell below the 10 cm minimum standard for secchi tube.

The HSPF model calculated daily TSS values for this subwatershed from 1994-2014. These concentrations ranged from 2.56-6062.80 mg/L with an average TSS value of 14.65 mg/L. Of these calculations, 89 (1.30%) were above the TSS standard of 65 mg/L.

Table 55. TSS related fish metrics in Lake Shetek Inlet (-642). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-642 Fish Class 2 – Modified Use	BenFdrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RifflePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
04DM026	4.22	0.00	1.56	4.10	0.14	0.00	0.14	0.00	0.02	20.61
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)</i>	30.08	6.17	2.88	28.69	19.54	8.38	26.17	0.86	21.25	17.59
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

The fish community in Lake Shetek Inlet (-642) at site 04DM026 scored below average in all ten of the TSS related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI Modified Use Threshold (Table 55). This reach had a high percentage of creek chubs and black bullheads present. These two species are often found in higher numbers in degraded stream systems.

Table 56. TSS related macroinvertebrate metrics in Lake Shetek Inlet (-642). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-642 Macroinvertebrate Class 7 – Modified Use	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plectoptera Pct
04DM026	19.02	0.00	16.00	46.89	10.68	0.16
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)</i>	16.02	0.60	10.98	35.60	9.91	0.02
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

The macroinvertebrate assemblage in this reach scored below average in four of the six TSS related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 56). Site 04DM026 did have above average numbers of both collector-filterer and plectoptera individuals; however, the site also had a high percentage and amount of TSS tolerant taxa, few TSS intolerant taxa, and a poor TSS Index Score. These results are often found in streams with high TSS concentrations.

Like in Lake Shetek Inlet (-641) the majority of the fish and macroinvertebrate metrics related to TSS scored below average, but both the observed and modeled data show very few indications that TSS concentrations reach levels that negatively impact aquatic life. Other stressors are likely causing the poor metric scores in this reach. Therefore, TSS is not a stressor to aquatic life in Lake Shetek Inlet (-642) at this time.

Habitat

Lake Shetek Inlet (-642) had a qualitative habitat assessment take place at its biological monitoring site, 04DM026, during the fish and macroinvertebrate sampling events in 2014. The average MSHA score from these visits was 45.88 (Fair). Limiting the habitat at this site was the row crop agriculture and open pasture as the dominant nearby land uses, moderate bank erosion, no stream shading, the presence of sand and silt substrates, sparse to moderate fish cover, fair sinuosity, and fair channel development. Further MSHA analysis can be seen in Figure 27.

Figure 27. MSHA metric scores in Lake Shetek Inlet (-642).

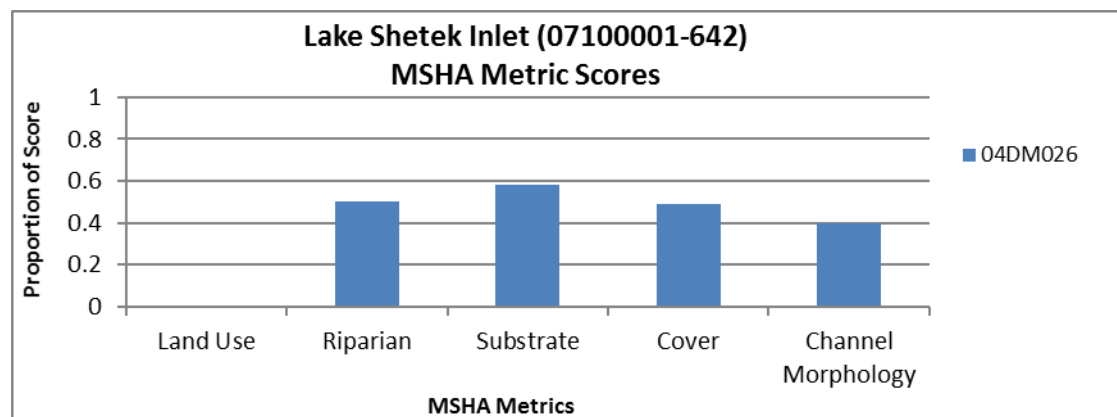


Table 57. Habitat related fish metrics in Lake Shetek Inlet (-642). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-642 Fish Class 2 – Modified Use	BenInsect- TolPct	SLithopPct	DarterSculpS ucPct	RifflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
04DM026	4.08	0.14	4.08	0.14	0.00	35.98	95.90	87.92
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)	19.05	26.17	16.45	19.54	8.02	35.59	46.38	23.58
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

The fish community in Lake Shetek Inlet (-642) at site 04DM026 scored below average in seven of the eight habitat related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI Modified Use Threshold (Table 57). Site 04DM026 had a very high amount of fathead minnows during the 2014 visit. A total of 1923 individuals were sampled, which comprised 91.48% of the fish assemblage. The lack of overall diversity and the presence of fathead minnows, which are very tolerant to poor habitat conditions, likely indicates degraded habitat.

Table 58. Habitat related macroinvertebrate metrics in Lake Shetek Inlet (-642). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-642 Macroinvertebrate Class 7 – Modified Use	BurrowerPc _t	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPc _t
04DM026	11.00	19.24	28.34	38.97	46.24	27.94
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)</i>	9.74	24.34	20.62	15.52	59.46	22.88
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate assemblage in this reach scored below average in two of the six evaluated habitat related metrics when compared to all other Class 7 Prairie Streams GP stations that met the MIBI Modified Use Threshold (Table 58). The reach had lower numbers of climber individuals, while also having elevated burrower individuals. These results can indicate habitat issues. However, site 04DM026 did have a high amount of EPT, clinger, and sprawler individuals which can often signal good habitat conditions.

The habitat conditions in Lake Shetek Inlet (-642) are considered to be fair. The macroinvertebrate community does not strongly suggest habitat as a stressor, however, the fish community, with its overall lack of diversity and very tolerant community strongly suggests otherwise. It appears that the modified stream channel and resulting conditions are indeed stressing the fish community enough to cause the fish impairment.

Altered Hydrology and Connectivity

There is a barrier to fish passage upstream of reach (-637) and downstream of reach (-643), which is causing the isolation of three impaired reaches (-637, 642, and 643). Monitoring station 04DM026 is located in Lake Shetek Inlet 07100001(-642). Just upstream of this reach is reach (-641). There is a barrier that prohibits fish migration from the stream to Currant Lake up stream of reach (-637), which flows directly into reach (-641). There is also a dam downstream that would limit fish migration.

Altered Hydrology is prevalent in most of the watershed, as ditching and tiling are common practices in these sections. Both these forms of alterations are influencing the water volume as well as water quality downstream at station 04DM026. As channels take on extra water, they change their dimension, pattern, and profile to adjust; resulting in high sediment loads, loss of habitat, and water quality impairments.

This reach is on the Lake Shetek Inlet is completely altered and the majority of its entire upstream watershed is altered according to the MPCA altered watercourse layer.

Extreme weather events affect high flow events as well as also low flows during drought. HSPF models show this section of Lake Shetek Inlet (-642) experiencing low flow at less than five cfs 42.4% of the time and less than one cfs 11.8% of the time.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The average percentage for generalist fish within the reach was 90.2% compared to the average in Class 2 modified use waters meeting the standard of 43.9%. General fish populations ranged from 82.8-97.7%.

The numbers of nest guarder species are also positively correlated with increased low flows. The average percentage for nest guarder fish within the reach was 52.2% compared to the average in Class 2 modified use waters meeting the standard of 30.6%. Nest guarder fish species ranged from 10.9-93.4%.

Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The average percentage for long-lived macroinvertebrates within the reach was 8.9% compared to the average in Class 7 modified use waters meeting the standard of 5.6%. Long-lived macroinvertebrates ranged from 8.9-8.9%.

Based on the channelized condition of this stream, the frequent low flow events, in addition to the poor scoring related biological metrics, Flow Alteration/Connectivity is a stressor to aquatic life in Lake Shetek Inlet (-642).

Summary

The impaired fish community in Lake Shetek Inlet (-642) is being stressed by DO, Eutrophication, Nitrates, Habitat, and Flow Alteration/Connectivity (Table 59). Suspended Sediment was ruled out as a stressor to aquatic life at this point. For further information on the stressors and recommendations to fixing the stressors in the Lake Shetek HUC 10 Watershed, please see Page 59.

Table 59. Stressor determinations for Lake Shetek Inlet (-642).

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Lake Shetek Inlet	07100001-642	●	●	●	---	●	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Lake Shetek Watershed (0710000102) HUC 10 conclusion and recommendations

The Lake Shetek subwatershed has six biologically impaired streams that are being negatively impacted by a multitude of stressors throughout the watershed. Stressors found in at least three of the six impaired reaches include DO, Eutrophication, Nitrates, Habitat, and Flow Alteration/Connectivity. Suspended sediment was also found to be a stressor in two of the reaches (Table 60).

The predominant land use in this subwatershed is row crop agriculture. This is a significant contributor to the stressors found in these reaches. The land use combined with the channelization of these stream reaches and their tributaries are a major reason why these streams are impaired for aquatic life. These practices often lead to high nitrate and phosphorus levels through excessive use of fertilizers that can quickly reach the stream system by drain tiles and field runoff as evidenced by six of the reaches stressed by eutropic conditions and three currently stressed by excess nitrates. The elevated phosphorus levels will also impact the DO conditions resulting in many more tolerant fish and macroinvertebrate communities.

Channelizing streams can also lead to very high flow rates resulting in bank erosion. Bank erosion leads to higher amounts of both bedded and suspended sediment in the stream resulting in poor habitat and visibility conditions impacting the breeding and feeding environments for more sensitive fish and macroinvertebrate species. Habitat stress was one of the most frequently found stressors in this subwatershed, while suspended sediment was found to be a stressor in two reaches as well.

A large effort is needed in the Lake Shetek Watershed to improve biological conditions in the many impaired streams found throughout. A high priority in this watershed should be to better manage the flow alteration and the effects of it. This can be achieved by increasing the storage and infiltration of water in locations with flow alteration stressors. This will also help reduce sediment inputs from stream banks, improve habitat by protecting streambanks, reduce erosion and overall stream sedimentation. Re-establishing a quality riparian corridor to increase stream stabilization, shading, and habitat features is also needed to improve conditions. Also, utilizing a variety of nutrient reducing Best Management Practices (BMPs) including: cover crops, nutrient management, saturated buffers, etc., will also help in the nitrate and phosphorus reduction. This could also help with the eutrophication and resulting DO issues as well.

Table 60. Stressor determinations for the Lake Shetek Watershed.

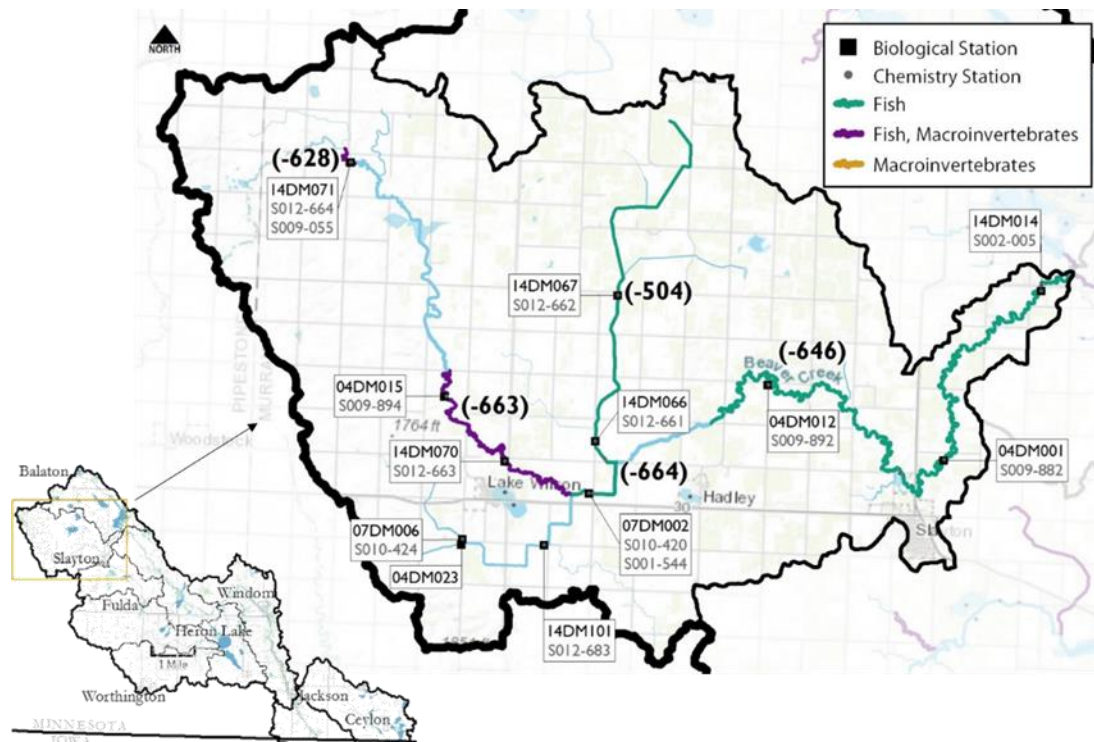
Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Lower Lake Sarah Outlet	07100001-508	●	●	---	●	---	●
Unnamed Creek	07100001-632	o	---	●	---	●	●
Lake Shetek Inlet	07100001-643	●	●	o	●	●	●
Unnamed Creek	07100001-637	●	●	●	---	●	●
Lake Shetek Inlet	07100001-641	o	●	o	---	●	o
Lake Shetek Inlet	07100001-642	●	●	●	---	●	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

5.2. Beaver Creek Watershed (0710000101)

The Beaver Creek HUC-10 Watershed (0710000101) is a 177.65 mi² watershed (Figure 28) located in the far northwestern portion of the Des Moines River-Headwaters watershed. This watershed contains six biologically impaired reaches. The primary land use within this watershed is row crop agriculture.

Figure 28. Beaver Creek Watershed with monitoring stations and biological impairments.



Beaver Creek (07100001-646)

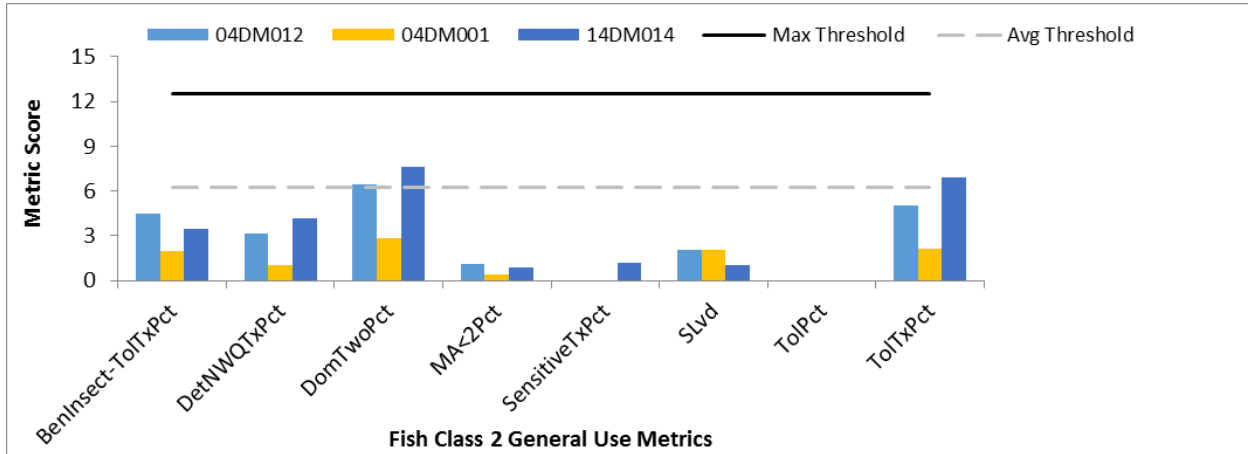
Located in central Murray County, Beaver Creek (-646) is a 28.13 mile long reach that is impaired for aquatic life due to the fish assemblage. This stream reach extends from 121st Ave to the Des Moines River. Along this stream section there are three biological monitoring stations, 04DM001, 04DM012, and 14DM014.

Biology

Fish

The fish community in Beaver Creek (-646) was sampled at the biological monitoring stations located along the reach, 04DM012, 04DM001, and 14DM014. Site 04DM012 was sampled in July and September of 2004 and had an average FIBI score of 23.0, site 04DM001 was also sampled July 2004 and again in August of 2012. The average FIBI score of this site was 19.6. Site 14DM014 was sampled twice in August of 2014 and had an average FIBI score of 25.35. All of these scores were far below the Fish Class 2 Southern Streams General Use Threshold of 50. Site 14DM014 had two, 04DM012 had one, and 04DM001 had zero metrics score above the average needed to reach the class threshold. The remaining metrics at these sites scored below average. See Figure 29 for further analysis of the metric scores in this reach.

Figure 29. Beaver Creek (-646) fish IBI metric scores.

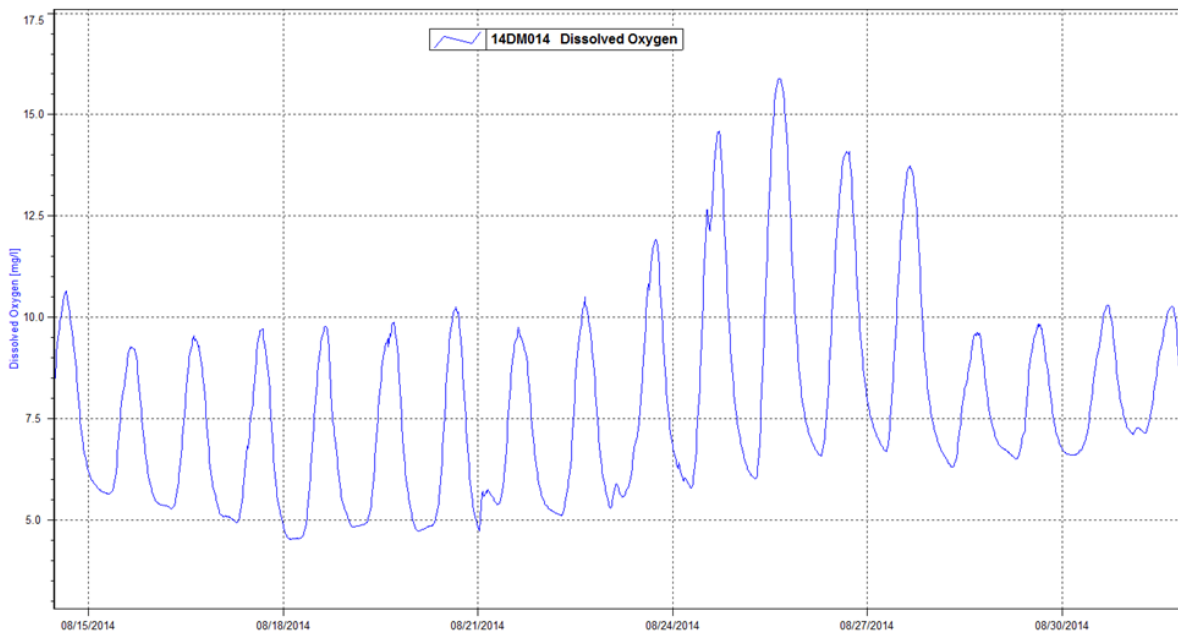


Dissolved Oxygen

A total of 86 DO measurements were taken from one chemistry site (S002-005) and one biological monitoring station (04DM001) from 2003-2015. The average of all the values is 6.63 mg/L with a low of 2.7 mg/L and a high of 16.20 mg/L. The summer average (June-Aug) is 4.61 mg/L. The DO values fell below the 5 mg/L daily minimum standard 34 times. This wide range of DO values may also indicate potential issues with daily flux.

Continuous DO monitoring took place at site 14DM014 in 2014 (Figure 30). These results showed that the DO values in this reach frequently fell below the 5 mg/L daily minimum standard. The daily flux values also exceeded the 4.5 mg/L standard for the southern region of the state. These results indicate likely DO and eutrophication issues.

Figure 30. Continuous DO monitoring results in Beaver Creek (-646) at site 14DM014.



The HSPF model calculated daily minimum DO values for this subwatershed from 1994-2014. Of these calculations, 5217 (71.43%) of the days had a daily minimum DO level below 5 mg/L.

Table 61. DO related fish metrics in Beaver Creek (-646). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-646 Fish Class 2 – General Use	MA>3 Avg	SspnPct Avg	Taxa Count Avg	DO TIV Avg
04DM001	2.40	77.12	16.00	8.85
04DM012	4.68	60.31	21.00	8.82
14DM014	5.97	69.31	22.50	8.87
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)</i>	23.89	28.72	20.38	8.56
Expected response to DO stress	↓	↑	↓	↓

The fish community in Beaver Creek at sites 04DM001, 04DM012, and 14DM014 scored below average in two (04DM012, 14DM014) and three (04DM001) of the four DO related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 61). While all three sites did have good DO TIV scores, all three sites also lacked many mature fish individuals and also had increased numbers of serial spawning individuals. Few mature fish and high numbers of serial spawning individuals can be a sign of potential DO stress.

Table 62. DO related macroinvertebrate metrics in Beaver Creek (-646). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-663 Macroinvertebrate Class 5 – General Use	HBI_MN Value	% DO Tolerant Taxa	# DO Tolerant Taxa	ChemTV DO
04DM001	8.17	12.71	2.00	7.17
04DM012	8.27	23.49	6.00	6.46
14DM014	8.04	0.93	3.00	7.65
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	7.04	8.62	4.33	7.10
Expected response to DO stress	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in one (14DM014), two (04DM001), and four (04DM012) of the four DO related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 62). All three sites had a poor HBI_MN value and two of the sites had elevated numbers of DO tolerant taxa. Site 04DM012 also had a poor DO TIV score while the remaining two sites scored above average.

Based on the high number of exceedances of the daily minimum standard in the observed and modeled data, the high ranges of values observed during the continuous monitoring indicated flux issues, as well as the many poor scoring metrics in both the fish and macroinvertebrate communities related to DO concludes that DO is a stressor to aquatic life in Beaver Creek (-646).

Eutrophication

A total of 106 phosphorus samples were taken from one chemistry site (S002-005) and one biological monitoring station (04DM001) from 2007-2014 were analyzed for phosphorus. The average of all the values is 0.193 mg/L with a low of 0.03 mg/L and a high of 1.06 mg/L. The summer average (June-Aug) is 0.199 mg/L. Phosphorus values exceeded the standard of 0.150 mg/L 56 times.

Additionally, 46 samples from one chemistry site (S002-005) from 2003-2004 were analyzed for Bioavailable Oxygen Demand (BOD). The average for all the values is 2.34 mg/L with a low of 0.70 mg/L and a high of 7.10 mg/L. The summer average is (June-Aug) is 1.92 mg/L. The BOD values exceeded the standard of 3.50 mg/L nine times.

Three samples from one chemistry site (S002-005) in 2003 were analyzed for chlorophyll a. The average for all the values is 70.83 ug/L with a low of 42.20 ug/L and a high of 85.40 ug/L. The summer average is (June-Aug) is 70.83 ug/L. The chlorophyll a values exceeded the standard of 40 ug/L three times.

Table 63. Eutrophication related fish metrics in Beaver Creek (-646). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-646 Fish Class 2 – General Use	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct
04DM001	0.00	3.16	91.72	4.79
04DM012	0.00	5.71	86.26	7.20
14DM014	0.47	8.27	79.59	11.21
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)</i>	19	11.47	45.1	17
Expected response to Eutrophication stress	↓	↓	↑	↑

The fish community in Beaver Creek (-646) at sites 04DM001, 04DM012, and 14DM014 scored below average in three of the four metrics related to eutrophication when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 63). All of these sites had low numbers of sensitive and darter individuals, while also having very high amounts of tolerant fish individuals. These results signal a stream likely impacted by high levels of phosphorus.

Table 64. Eutrophication related macroinvertebrate metrics in Beaver Creek (-646). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-663 Macroinvertebrate Class 5 – General Use	EPT Pct	Tanytarsini Pct	CrustMoll Pct	Scraper Pct	% Tolerant Taxa	% Intolerant Taxa
04DM001	56.12	10.19	1.02	12.59	44.48	0.33
04DM012	45.51	17.31	8.01	19.87	50.16	0.32
14DM014	82.81	15.15	0.63	15.31	40.87	0.62
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	43.90	27.84	9.23	15.78	17.17	5.79
Expected response to Eutrophication stress	↓	↓	↑	↑	↑	↓

The macroinvertebrate community in Beaver Creek (-646) scored below average in three (04DM001, 14DM014) and four (04DM012) of the six metrics related to eutrophication when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 64). All three sites had lower amounts of tanytarsini individuals and intolerant taxa, while also having higher amounts of tolerant species.

Based on the frequency of the phosphorus and chlorophyll a concentrations and BOD exceeding their respective standards, the high range of DO values observed with many below the standard, the majority of the fish metrics related to eutrophication scoring below average, as well as some signals from the macroinvertebrate community of potential stress, eutrophication is a stressor to aquatic life in Beaver Creek (-646).

Nitrates

A total of 87 samples taken from one chemistry site (S002-005) and one biological monitoring station (04DM001) from 2004-2014 were analyzed for Inorganic Nitrogen (NO₂-NO₃). The average of all the values is 7.99 mg/L with a low of 0.05 mg/L and a high of 15.00 mg/L. The spring average (March-May) is 8.27 mg/L. The summer average (June-Aug) is 8.7 mg/L. Nitrate values exceeded 4 mg/L 70 times.

The HSPF model calculated daily nitrate concentrations for this subwatershed from 1994-2014. These values ranged from 0.13-34.95 mg/L with an average value of 4.47 mg/L.

Table 65. Nitrate related macroinvertebrate metrics in Beaver Creek (-646). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-646 Macroinvertebrate Class 5 – General Use	TrichopteraChTx Pct	N Index Score	% N Tolerant	% N Intolerant
04DM001	9.52	3.67	78.93	0.00
04DM012	7.32	3.27	51.75	0.00
14DM014	12.12	3.79	73.99	0.31
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	13.16	3.00	48.68	0.96
Expected response to N stress	↓	↑	↑	↓

The macroinvertebrate community in Beaver Creek (-646) at sites 04DM001, 04DM012, and 14DM014 scored below average in all four of the nitrate related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 65). All of the sites had lower levels of trichoptera and nitrate intolerant taxa, while also having high amounts of nitrate tolerant individuals, and below average nitrate index scores. These results are indicative of a community being negatively impacted by high nitrate levels.

The nitrate levels in Beaver Creek (-646) can get elevated at times based on the observed data set. In addition, the macroinvertebrate community at all three biological monitoring stations scored poorly in all of the nitrate related metrics, therefore, nitrates are a stressor to aquatic life in this reach.

Suspended Solids

A total of 138 samples taken from one chemistry site (S002-005) from 2002-2014 were analyzed for TSS. The average of all the values is 85.77 mg/L with a low of 3 mg/L and a high of 810 mg/L. The TSS concentrations were at or exceeded the 65 mg/L standard mg/L 60 times.

This reach was determined to be impaired for turbidity during the most recent watershed assessment.

The HSPF model calculated daily TSS values for this subwatershed from 1994-2014. These concentrations ranged from 2.85-2216.90 mg/L with an average TSS value of 35.84 mg/L. Of these calculations, 257 (5.94%) were above the TSS standard of 65 mg/L.

This reach was determined to be impaired for turbidity during the 2004 assessment. The 2016 assessment confirmed this impairment as well.

Table 66. TSS related fish metrics in Beaver Creek (-646). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-646 Fish Class 2 – General Use	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiflePct	SensitivePct	SlithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
04DM001	9.58	0.38	3.41	7.73	3.07	0.00	7.53	0.00	1.65	24.61
04DM012	12.60	0.66	12.29	6.44	6.52	0.00	15.28	0.00	1.08	23.28
14DM014	12.72	0.00	2.21	10.38	5.20	0.47	7.62	0.00	3.67	25.42
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)</i>	37.38	4.89	9.61	18.66	32.49	18.65	39.38	4.97	11.68	17.59
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

The fish community in Beaver Creek (-646) scored below average in nine (04DM012) and ten (04DM001, 14DM014) of the ten TSS related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 66). All three of these sites had poor TSS Index Scores and for the most part scored poorly in all of the other metrics. These results strongly suggest a community being negatively impacted by the current TSS conditions.

Table 67. TSS related macroinvertebrate metrics in Beaver Creek (-646). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-646 Macroinvertebrate Class 5 – General Use	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plectoptera Pct
04DM001	19.93	0.00	15.00	44.48	9.52	0.00
04DM012	19.37	1.00	20.00	51.43	3.85	0.00
14DM014	23.38	1.00	12.00	64.71	29.69	0.63
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)</i>	15.87	3.02	11.59	35.23	26.89	0.54
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

The macroinvertebrate assemblage in this reach scored below average in four (14DM014) and six (04DM001, 04DM012) of the six TSS related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 67). All three sites had poor TSS Index Scores, few TSS intolerant taxa, while also having a high amount and percentage of TSS tolerant taxa. These results strongly suggest a community negatively impacted by the TSS conditions in this reach.

Based on the high rate of standard exceedances in the observed data, the vast majority of the TSS related metrics in both the fish and macroinvertebrate communities scoring below average, as well as the current turbidity impairment, TSS is a stressor to aquatic life in Beaver Creek (-646).

Habitat

Beaver Creek (-646) had a qualitative habitat assessment take place at its biological monitoring sites, 04DM001, 04DM012, and 14DM014, during the fish and macroinvertebrate sampling events in 2004, 2012, and 2014. The average MSHA scores for these sites were 52.83 (Fair) at 04DM001, 53.1 (Fair) at 04DM012, and 59.6 (Fair) at 14DM014. Limiting the habitat at these sites was the row crop agriculture as the dominant nearby land use, a narrow riparian buffer, moderate to heavy bank erosion, the presence of sand and silt substrates, sparse to moderate fish cover, fair channel development, and moderate channel stability. Further MSHA analysis can be seen in Figure 31.

Figure 31. MSHA metrics scores in Beaver Creek (-646).

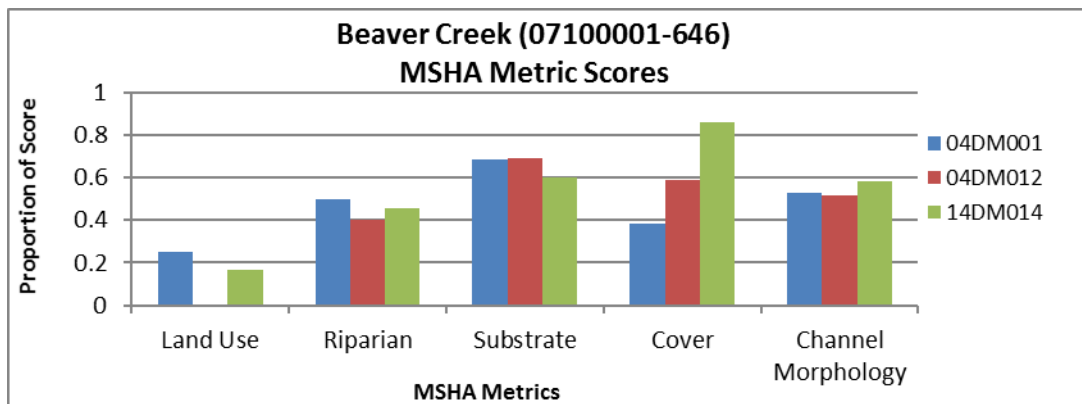


Table 68. Habitat related fish metrics in Beaver Creek (-646). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-646 Fish Class 2 – General Use	BenInsect-TolPct	SLithopPct	DarterSculpSu cPct	RifflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
04DM001	7.58	7.53	7.29	3.07	0.92	15.38	85.40	49.70
04DM012	6.05	15.28	5.89	6.52	0.66	21.82	86.26	42.62
14DM014	8.37	7.62	8.27	5.20	1.37	20.90	79.59	35.74
Statewide average for Class 2 Southern Streams stations that are meeting the FBI General Use Threshold (50.0)	20.4	39.38	18.18	32.49	5.24	58.26	44.85	19.02
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

The fish community in Beaver Creek (-646) at sites 04DM001, 04DM012, and 14DM014 scored below average in all eight of the habitat related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 68). The fish assemblage in this reach was dominated by tolerant and pioneering individuals. This is generally an indication of degraded habitat. This reach also lacked many species requiring specialized habitat conditions for spawning.

Table 69. Habitat related macroinvertebrate metrics in Beaver Creek (-646). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-646 Macroinvertebrate Class 5 – General Use	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
04DM001	12.93	7.82	30.27	56.12	40.14	35.03
04DM012	28.21	12.82	21.47	45.51	45.51	25.64
14DM014	2.19	7.81	42.19	82.81	10.63	26.88
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)</i>	5.66	12.52	49.77	42.46	34.53	13.99
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate assemblage in Beaver Creek (-646) scored below average in two (14DM014), three (04DM012), and four (04DM001) of the six habitat related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 69). All three sites had higher numbers of both sprawler and EPT individuals, which can signal a community not affected by poor habitat conditions. However, each site also had lower numbers of clinger individuals, while also scoring poorly in various other metrics.

The habitat was considered to be “fair” at all three of the biological monitoring stations along this reach. The macroinvertebrate community had many metrics related to habitat score poorly, while the fish community seemed to be much more impacted as all of the habitat related metrics at the three sites scored poorly. Therefore, habitat is a stressor to aquatic life in Beaver Creek (-646).

Altered Hydrology

This reach of Beaver Creek (-646) and the majority of its entire upstream watershed is altered according to the MPCA altered watercourse layer.

“Much of the headwaters to the Lower Beaver Creek site is intensively channelized. All of the sub-watersheds within the study site’s catchment have had at least 40% of their stream miles channelized, straightened, or altered in a fashion other than impoundment.” (DNR 2016).

Extreme weather events affect high flow events as well as also low flows during drought. HSPF models show this section of Beaver Creek experiencing low flow at less than 5 cfs 5.4% of the time.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The average percentage for generalist fish within the reach was 46.7% compared to the average in Class 2 general use waters meeting the standard of 42.4%. General fish populations ranged from 33.5-59.2%.

The numbers of nest guarder fish are also positively correlated with increased low flows. The average percentage for nest guarder fish within the reach was 36.6% compared to the average in Class 2 general use waters meeting the standard of 19%. Nest guarder fish ranged from 22-50.1%.

Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The average percentage for long-lived macroinvertebrates within the reach was 2.7% compared to the average in Class 5 general use waters meeting the standard of 9%. Long-lived macroinvertebrates ranged from 1.6-4.5%.

Channelization is connected to and contributing to the lack of habitat. The effects of altered hydrology seem to be contributing to the increase of generalized fish percentages, which are more adaptable to changing conditions and food sources. Altered hydrology is a contributing stressor too through channelization and drainage changes. Altered hydrology is also likely contributing to both eutrophication and lack of habitat. Increased flow events can cause increased bank erosion and bedload transport, eventually leading to excess sedimentation once flows subside, affecting fish and macroinvertebrate species that rely on clean substrate for habitat and/or reproduction. This section of stream also has fish migration limitations as it is upstream of several fish barriers along the mainstem Des Moines River. Based on extended low flow periods shown in the models, sediment deposition, increased generalized species, and decreased long-lived individuals; altered hydrology is a stressor that is also affecting habitat.

Summary

The impaired fish community in Beaver Creek (-646) is being stressed by DO, Eutrophication, Nitrates, Suspended Sediment, Habitat, and Flow Alteration/Connectivity (Table 70). For further information on the stressors and recommendations to fixing the stressors in the Beaver Creek HUC 10 Watershed, please see pages 99-100.

Table 70. Stressor determinations for Beaver Creek (-646).

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Beaver Creek	07100001-646	●	●	●	●	●	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Beaver Creek (07100001-663)

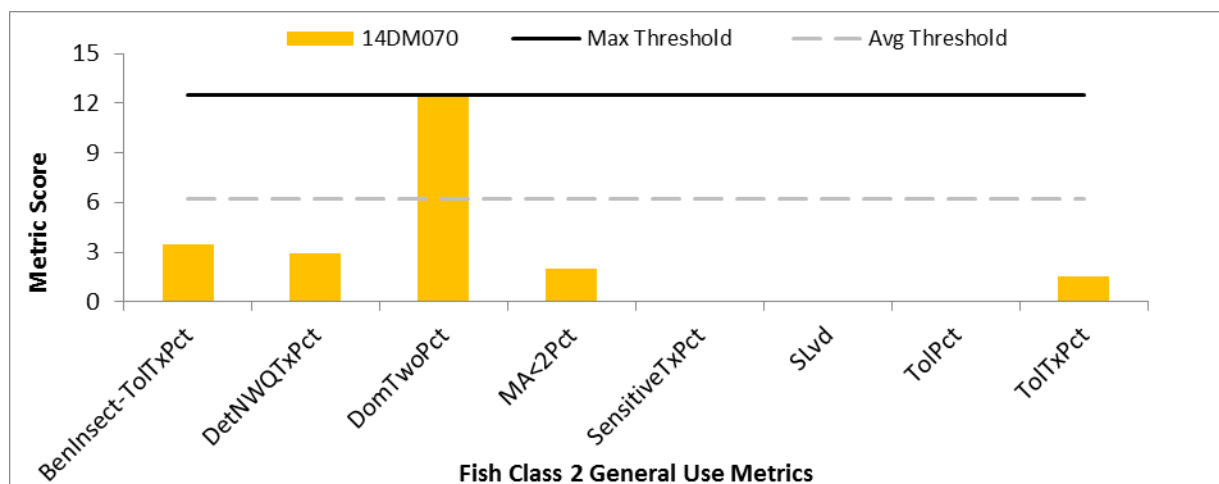
Located in west central Murray County, Beaver Creek (-663) is a 8.9 mile long reach that is impaired for aquatic life due to both the fish and macroinvertebrate assemblages. This stream reach extends from 131st St to the confluence with Judicial Ditch 14. Along this stream section, there are two biological monitoring stations, 04DM015 and 14DM070.

Biology

Fish

The fish community in Beaver Creek (-663) was sampled for fish in August of 2014 at its biological monitoring station 14DM070. The FBI score at this reach was 22.4, which is far below the Fish Class 2 Southern Streams General Use Threshold of 50. This site did have one metric (DomTwoPct) reach the average metric score needed to meet the threshold (Figure 32), however, the remaining seven metrics comprising this FBI scored well below average with three of those metrics scoring zero.

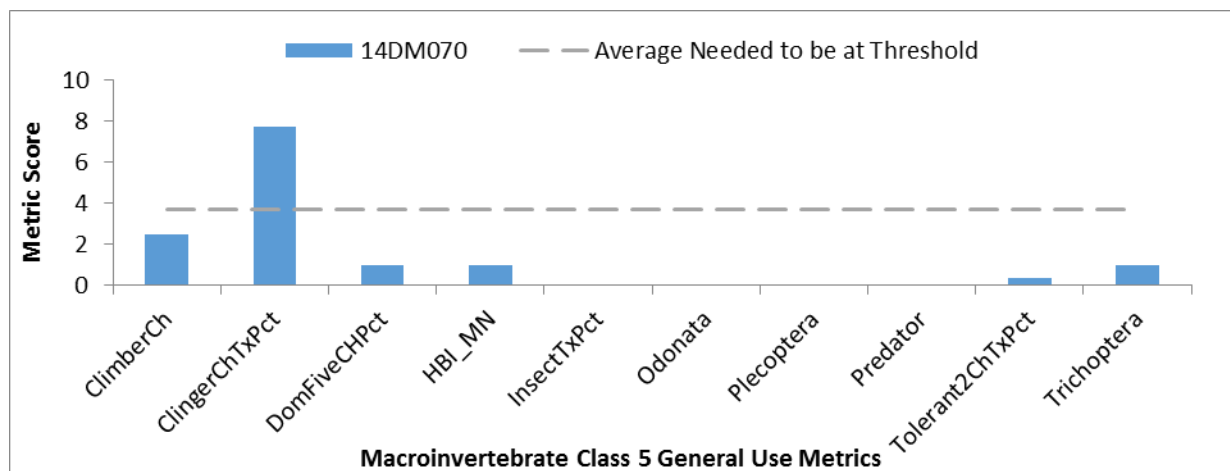
Figure 32. Beaver Creek (-663) fish IBI metric scores.



Macroinvertebrates

The macroinvertebrate assemblage at site 14DM070 was sampled in August of 2014. This visit had a MIBI score of 13.5, which is below the Macroinvertebrate Class 5 Southern Streams RR General Use Threshold of 37. This site had one metric scoring above the average needed to reach the threshold (ClingerChTxPct). However, the remaining nine metrics comprising the MIBI for this class scored below average and four of those metrics had a score of zero. See Figure 33 for a complete breakdown of the metric scores at this site.

Figure 33. Beaver Creek (-663) macroinvertebrate IBI metric scores.



Dissolved Oxygen

Two DO measurements were taken from one biological monitoring station (14DM070) in 2014. The average of all the values is 10.12 mg/L with a low of 7.63 mg/L and a high of 12.60 mg/L. The DO values did not fall below 5 mg/L.

The HSPF model calculated daily minimum DO values for this subwatershed from 1994-2014. Of these calculations, 432 (5.63%) of the days had a daily minimum DO level below the daily minimum standard of 5 mg/L. This rate of exceedance is relatively low.

Table 71. DO related fish metrics in Beaver Creek (-663). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-663 Fish Class 2 – General Use	MA>3 Avg	SspnPct Avg	Taxa Count Avg	DO TIV Avg
14DM070	0.28	45.10	18.00	8.68
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)</i>	23.89	28.72	20.38	8.56
Expected response to DO stress	↓	↑	↓	↓

The fish community in Beaver Creek (-663) at site 14DM070 scored below average in three of the four DO related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 71). This reach had a slightly below average taxa count, while also having decreased numbers of mature fish individuals, and increased amounts of serial spawning individuals. These results are common in streams with DO issues. This reach did however have an above average DO TIV score.

Table 72. DO related macroinvertebrate metrics in Beaver Creek (-663). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-663 Macroinvertebrate Class 5 – General Use	HBI_MN Value	% DO Tolerant Taxa	# DO Tolerant Taxa	ChemTV_DO
14DM070	8.02	3.67	4.00	7.15
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	7.04	8.62	4.33	7.10
Expected response to DO stress	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in one of the four DO related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 72). This site, 14DM070, had a higher HBI_MN value resulting in a poor score, while the remaining metrics all scored well in this reach.

Based on the lack of exceedances in the observed data, the very low exceedance rate in the modeled data, as well as the low amount of DO related metrics scoring poorly in the macroinvertebrate assemblage, DO is not a stressor to aquatic life in Beaver Creek (-663). Other stressors may be impacting the fish community resulting in some lower metric scores.

Eutrophication

Two phosphorus samples were taken from Beaver Creek (-663) from 2004-2014. The average of the values is 0.1 mg/L with a low of 0.073 mg/L and a high of 0.127 mg/L. Phosphorus values did not exceed the standard of 0.150 mg/L.

The HSPF model calculated daily phosphorus values for this subwatershed from 1994-2014. These values ranged from 0.08-43.25 mg/L with an average value of 0.41 mg/L. Of these calculations, 6,237 (99.02%) were above the 0.15 mg/L standard.

Table 73. Eutrophication related fish metrics in Beaver Creek (-663). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-663 Fish Class 2 – General Use	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct
14DM070	0.00	17.09	81.51	19.33
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)</i>	19	11.47	45.1	17
Expected response to Eutrophication stress	↓	↓	↑	↑

The fish community in Beaver Creek (-663) at site 14DM070 scored below average in three of the four metrics related to eutrophication when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 73). This site did have an above average amount of darter individuals, however, the site scored poorly in the remaining metrics with especially high numbers of tolerant fish individuals present.

Table 74. Eutrophication related macroinvertebrate metrics in Beaver Creek (-663). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-663 Macroinvertebrate Class 5 – General Use	EPT Pct	Tanytarsini Pct	CrustMoll Pct	Scraper Pct	% Tolerant Taxa	% Intolerant Taxa
14DM070	64.00	5.33	3.67	8.67	8.67	0.00
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	43.90	27.84	9.23	15.78	17.17	5.79
Expected response to Eutrophication stress	↓	↓	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in just two of the six metrics related to eutrophication at site 14DM070 when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 74). This reach did have a low amount of tanytarsini individuals and completely lacked intolerant taxa; however, this reach did score well in the remaining metrics.

The very limited observed data set for phosphorus showed zero exceedances of the standard, while the HSPF model calculated a very high level of exceedance (99%). The majority of the fish metrics related to eutrophication in this stream scored below average indicating likely stress, while the macroinvertebrate metrics fared much better and the majority of those metrics scored well. Based on these conflicting results, eutrophication is inconclusive as a stressor to aquatic life in Beaver Creek (-663).

Nitrates

Only one sample was analyzed for Inorganic Nitrogen (NO₂-NO₃). This sample was taken during the fish sampling event on August 19, 2014 at site 14DM070, and had a nitrate concentration of 1.1 mg/L. This concentration is very low.

The HSPF model also calculated daily nitrate concentrations from 1994-2014 from this subwatershed. These values ranged from 0.81-373.68 mg/L with an average value of 6.47 mg/L. Of these calculations,

45 (0.65%) were above 18.1 mg/L. A quantile regression analysis of Class 5 sites showed that when nitrate concentrations exceeded 18.1 mg/L, there was a 75% probability for impairment.

Table 75. Nitrate related macroinvertebrate metrics in Beaver Creek (-663). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-663 Macroinvertebrate Class 5 – General Use	TrichopteraChTx Pct	N Index Score	% N Tolerant	% N Intolerant
14DM070	12.00	3.94	75.67	0.00
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	13.16	3.00	48.68	0.96
Expected response to N stress	↓	↑	↑	↓

The macroinvertebrate community scored below average in all four of the nitrate related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 75). This site completely lacked nitrate intolerant taxa, while also having lower amounts of trichoptera species. There was also an abundance of nitrate tolerant individuals and the nitrate index score was poor. These results can all indicate potential stress from nitrates.

The nitrate related biological metrics all scored poorly or below average and indicate stress on the macroinvertebrate community. However, there was a very limited observed data set and the HSPF model predicted relatively low nitrate concentrations. Therefore, nitrates are inconclusive as a stressor at this time. More nitrate data is recommended to better understand the impacts that nitrates are having on the biological communities in Beaver Creek (-663).

Suspended Solids

One sample taken from biological monitoring station (14DM070) in 2014 was analyzed for TSS. This value was 40 mg/L which is below the 65 mg/L standard for TSS. Additionally, two secchi tube measurements were taken from this reach. These values ranged from 9-18 cm, with one of the values falling below the 10 cm minimum standard for secchi tube.

The HSPF model calculated daily TSS values for this subwatershed from 1994-2014. These concentrations ranged from 3.58-554.83 mg/L with an average TSS value of 14.57 mg/L. Of these calculations, 130 (2.06%) were above the TSS standard of 65 mg/L.

Table 76. TSS related fish metrics in Beaver Creek (-663). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-663 Fish Class 2 – General Use	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RifflePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14DM070	28.57	0.00	19.89	17.09	12.32	0.00	9.24	0.00	0.28	19.93
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)</i>	37.38	4.89	9.61	18.66	32.49	18.65	39.38	4.97	11.68	17.59
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

The fish community in Beaver Creek (-663) at site 14DM070 scored below average in nine of the ten TSS related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 76). This reach did have an above average amount of herbivorous fish, which are not often found in streams stressed by TSS conditions. However, the remaining metrics scored poorly and suggest potential stress from the TSS conditions.

Table 77. TSS related macroinvertebrate metrics in Beaver Creek (-663). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-663 Macroinvertebrate Class 5 – General Use	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
14DM070	19.16	0.00	8.00	75.33	55.00	0.00
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)</i>	15.87	3.02	11.59	35.23	26.89	0.54
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

The macroinvertebrate assemblage in this reach scored below average in four of the six TSS related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 77). Site 14DM070 did have a lower amount of TSS tolerant species present and an above average amount of collector-filterer individuals. However, the remaining metrics, including TSS Index Score, scored poorly.

The limited observed data set as well as the HSPF data both do not indicate stress from the TSS conditions present, however, the majority of the fish and macroinvertebrate metrics related to TSS do suggest likely stress. Beaver Creek (-646) is a reach further downstream of this reach and is impaired (turbidity) and stressed by the TSS conditions present. Therefore, TSS is a stressor to aquatic life in this reach.

Habitat

Beaver Creek (-663) had qualitative habitat assessment take place at its biological monitoring site, 14DM070, during the sampling events in 2014. The average MSHA scores from these visits was 38.4 (Poor) at 14DM070. Limiting the habitat at these sites was the row crop agriculture as the primary land use, minimal riparian buffer, light stream shading, moderate to heavy bank erosion, sparse fish cover,

moderate channel stability, fair channel sinuosity, and poor channel development. See Figure 34 for further MSHA analysis.

Figure 34. MSHA metric scores in Beaver Creek (-663).

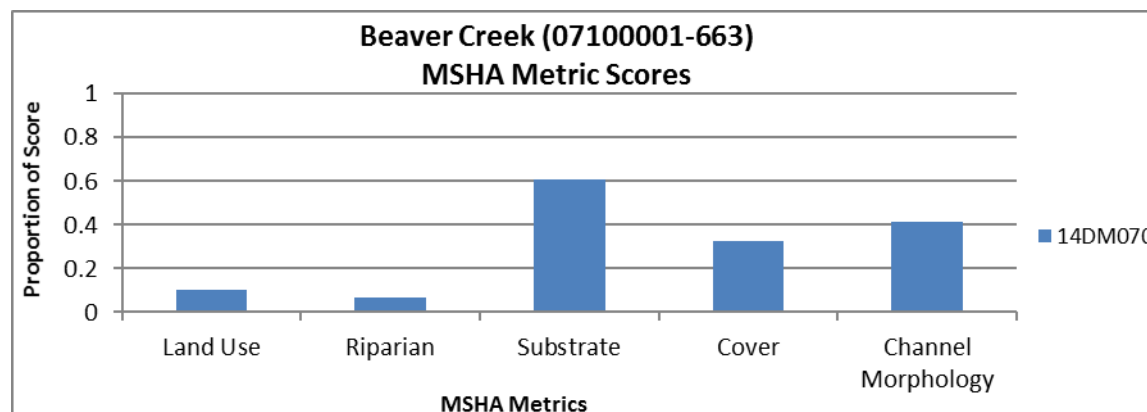


Table 78. Habitat related fish metrics in Beaver Creek (-663). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-663 Fish Class 2 – General Use	BenInsect- ToIPct	SluthopPct	DarterSculpS ucPct	RifflePct	PiscivorePct	LithFrimPct	ToIPct	PioneerPct
14DM070	17.09	9.24	17.09	12.32	0.00	29.41	81.51	48.46
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)</i>	20.4	39.38	18.18	32.49	5.24	58.26	44.85	19.02
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

The fish community in Beaver Creek (-663) scored below average in all of the habitat related metrics when compared to all other Class 2 Southern Stream stations that meet the Fish IBI General Use Threshold (Table 78). The fish assemblage at this site was predominantly tolerant and lacked many species that prefer more diverse habitat conditions.

Table 79. Habitat related macroinvertebrate metrics in Beaver Creek (-663). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-663 Macroinvertebrate Class 5 – General Use	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14DM070	2.00	20.33	70.00	64.00	29.67	3.33
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)</i>	5.66	12.52	49.77	42.46	34.53	13.99
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate assemblage in Beaver Creek (-663) at site 14DM070 scored below average in one 14DM070 of the six habitat related metrics when compared to all other Class 5 Southern Streams RR

stations that meet the MIBI General Use Threshold (Table 79). This reach did have a low amount of sprawler species, but did score well in the remaining metrics.

Based on the poor MSHA score, the overwhelmingly poor metric scores related to habitat at both sites in the fish community and one in the macroinvertebrate community concludes that the habitat conditions in Beaver Creek (-663) are a stressor to aquatic life.

Altered Hydrology

This reach of Beaver Creek (-663) is mostly a natural channel and site 14DM070 is located within the natural channel; however, the majority of its entire upstream watershed is altered according to the MPCA altered watercourse layer. Site 04DM015 is located in a small section of the impaired reach that is categorized as altered.

“Much of the headwaters to the Lower Beaver Creek site is intensively channelized. All of the sub-watersheds within the study site’s catchment have had at least 40% of their stream miles channelized, straightened, or altered in a fashion other than impoundment.” (DNR 2016).

Extreme weather events affect high flow events as well as also low flows during drought. HSPF models show this section of Beaver Creek experiencing low flow at less than five cfs 26.7% of the time and less than one cfs 2.3% of the time.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The average percentage for generalist fish within the reach was 54.2% compared to the average in Class 2 general use waters meeting the standard of 42.4%. General fish populations ranged from 41.7-66.7%.

The numbers of nest guarder species are also positively correlated with increased low flows. The average percentage for nest guarder fish within the reach was 35.7% compared to the average in Class 2 general use waters meeting the standard of 19%. Nest guarder fish species ranged from 30.6-40.9%.

Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The average percentage for long-lived macroinvertebrates within the reach was 1.2% compared to the average in Class 5 general use waters meeting the standard of 9%. Long-lived macroinvertebrates ranged from 1.0-1.4%.

The Flow Alteration/Connectivity biological metrics in this reach score below average, while the reach itself is on a mostly natural channel. While some of the altered streams in the headwaters of this watershed may be having an impact on this reach itself, more information is needed to make this determination. Therefore, Flow Alteration/Connectivity is inconclusive as a stressor in this reach.

Summary

The impaired fish and macroinvertebrate communities in Beaver Creek (-663) are being stressed by Suspended Sediment and Habitat (Table 80). Eutrophication, Nitrates, and Flow Alteration/Connectivity were inconclusive as stressors at this point, while DO was ruled out as a stressor to aquatic life. For further information on the stressors and recommendations to fixing the stressors in the Beaver Creek HUC 10 Watershed, please see pages 99-100.

Table 80. Stressor determinations for Beaver Creek (-663).

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Beaver Creek	07100001-663	---	0	0	●	●	0

● = stressor; 0 = inconclusive stressor; --- = not an identified stressor

County Ditch 20 (07100001-504)

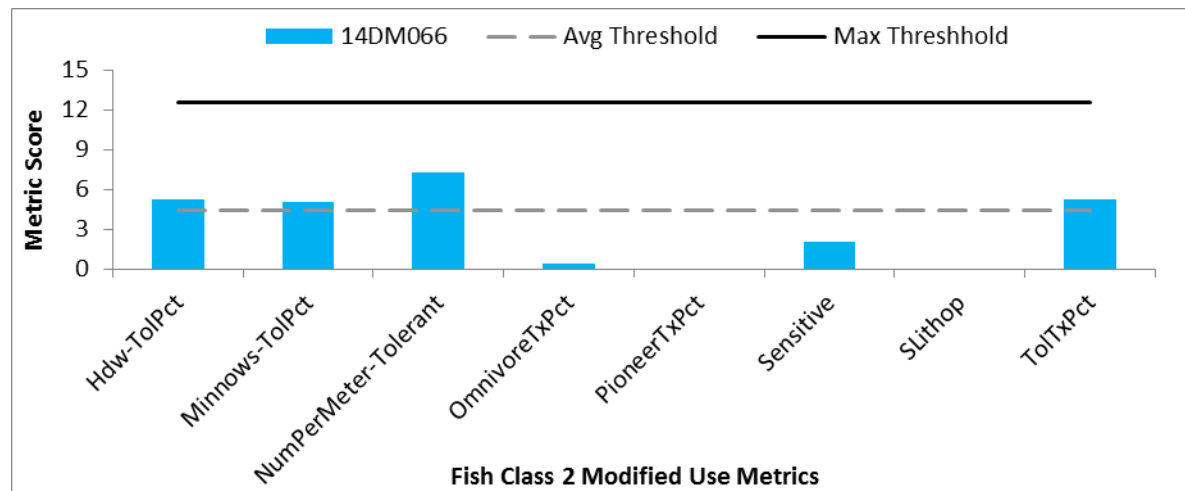
Located in west central Murray County, County Ditch 20 (-504) is a 10.2 mile long reach that is impaired for aquatic life due to the fish assemblage. This stream reach extends from the headwaters in this watershed down to the confluence with Beaver Creek. Along this stream section, there are two biological monitoring stations, 14DM066 and 14DM067.

Biology

Fish

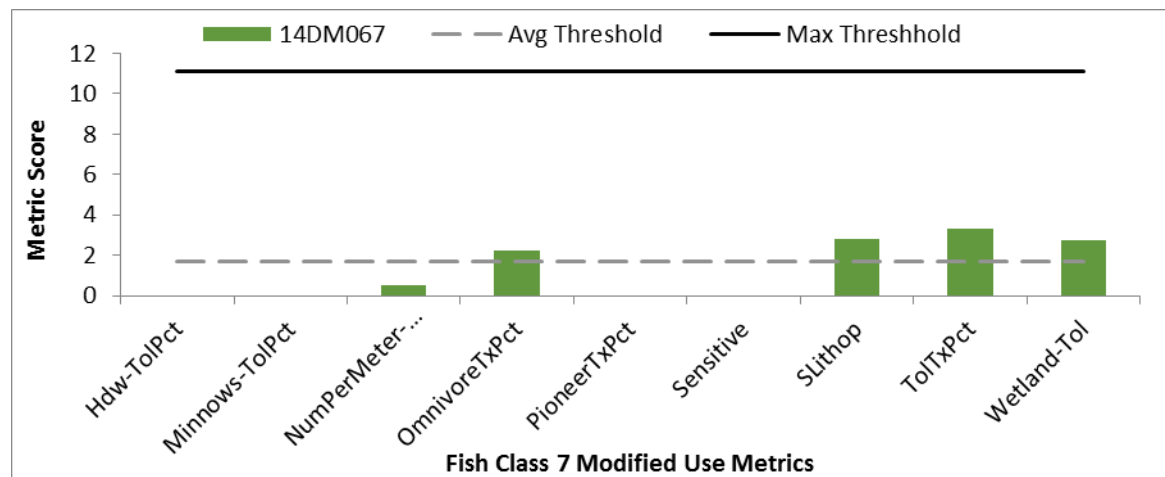
The fish community in County Ditch 20 (-504) was sampled in July of 2014 at site 14DM066. The FIBI score at this site was 25.3, which is below the Fish Class 2 Southern Streams Modified Use Threshold of 35. This site had four metrics (Hdw-TolPct, Minnows-TolPct, NumPerMeter-Tolerant, TolTxPct) score above the average needed to reach the threshold, while the remaining four metrics scored below average with two of those metrics scoring zero. See Figure 35 for a breakdown of the metric scoring at this site.

Figure 35. County Ditch 20 (-504) fish IBI metric scores.



The fish community at site 14DM067 was sampled in September of 2015 at biological and had a FIBI score of 11.6, which is far below the Fish Class 7 Low Gradient Streams Modified Use Threshold of 15. This site had four metrics (OmnivoreTxPct, SLithop, TolTxPct, Wetland-Tol) score above the average needed to reach the threshold, however, the remaining five metrics that comprise this FIBI scored below average with four of those metrics scoring zero. See Figure 36 for a breakdown of the metric scoring at this site.

Figure 36. County Ditch 20 (-504) macroinvertebrate IBI metric scores.



Dissolved Oxygen

Thirteen DO measurements were taken from one chemistry site (S001-545) and two biological monitoring stations (14DM066, 14DM067) from 2014-2016. The average of all the values is 9.53 mg/L with a low of 4.76 mg/L and a high of 15.92 mg/L. The summer average (June-Aug) is 9.72 mg/L. The DO values fell below 5 mg/L once.

The HSPF model calculated daily minimum DO values for this subwatershed from 1994-2014. Of these calculations, 672 (8.76%) of the days had a daily minimum DO level below the daily minimum standard of 5 mg/L. This rate of exceedance is relatively low.

Table 81. DO related fish metrics in County Ditch 20 (-504). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-504 Fish Class 2, 7 – Modified Use	MA>3 Avg	SspnPct Avg	Taxa Count Avg	DO TIV Avg
14DM066	1.19	36.46	18.00	8.74
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)</i>	23.89	28.72	20.38	8.56
14DM067	6.50	26.02	10.00	8.61
<i>Statewide average for Class 7 Low Gradient stations that are meeting the FIBI Modified Use Threshold (15.0)</i>	9.79	28.58	11.74	7.81
Expected response to DO stress	↓	↑	↓	↓

The fish community in County Ditch 20 (-504) at sites 14DM066 and 14DM067 scored below average in two (14DM067) and three (14DM066) of the four DO related metrics when compared to all other Class 2 Southern Streams and Class 7 Low Gradient stations that meet the FIBI Modified Use Threshold (Table 81). Both sites had below average taxa counts and very few mature fish, which can signal potential DO stress. Site 14DM066 also had an increased amount of serial spawning individuals. These species are often found in high numbers in low DO conditions.

Table 82. DO related macroinvertebrate metrics in County Ditch 20 (-504). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-504 Macroinvertebrate Class 5, 7 – Modified Use	HBI_MN Value	% DO Tolerant Taxa	# DO Tolerant Taxa	ChemTV _DO
14DM066	7.76	42.33	7.00	5.98
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI Modified Use Threshold (35)</i>	7.57	18.23	6.45	6.75
14DM067	6.48	16.30	12.00	1.39
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22)</i>	8	31.37	9.33	6.19
Expected response to DO stress	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in two (14DM067) and four (14DM066) of the four DO related metrics when compared to all other Class 5 Southern Stream RR and Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 82). Both sites had a poor DO TIV score, an increased number of DO tolerant taxa, while site 14DM066 had a higher percentage of these taxa and a poor HBI_MN value as well.

While only one of the observed DO measurements fell below 5 mg/L, there was a wide range of values, which can indicate potential issues with the daily flux. The model calculated a slightly below average exceedance rate and the majority of the DO biological metrics scored below average in both fish and macroinvertebrate assemblages. This reach also had a high amount of algae, plant growth, and excess phosphorus which may also be causing DO issues. Therefore, DO is a stressor to aquatic life in County Ditch 20 (-504) at this time.

Eutrophication

Thirteen samples from one chemistry site (S001-545) and two biological monitoring stations (14DM066, 14DM067) from 2014-2016 were analyzed for phosphorus. The average of all the values is 0.134 mg/L with a low of 0.03 mg/L and a high of 0.32 mg/L. The summer average (June-Aug) is 0.156. Phosphorus values exceeded 0.150 mg/L three times. Significant amounts of algae were also present at site 14DM067 (Figure 37).

The HSPF model also calculated daily phosphorus concentrations for this subwatershed from 1994-2014. These values ranged from 0.11-15.29 mg/L with an average phosphorus concentration of 0.48 mg/L. Of these calculations, 5,582 (99.61%) were above the 0.15 mg/L phosphorus standard.

Figure 37. Algae present at site 14DM067.



Table 83. Eutrophication related fish metrics in County Ditch 20 (-504). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-504 Fish Class 2, 7 – Modified Use	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct
14DM066	0.00	6.70	86.76	3.57
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)</i>	8.24	13.32	45.53	25.1
14DM067	0.00	8.94	89.43	76.42
<i>Statewide average for Class 7 Low Gradient stations that are meeting the FIBI Modified Use Threshold (15.0)</i>	16.71	6.74	55.88	16.77
Expected response to Eutrophication stress	↓	↓	↑	↑

The fish community in County Ditch 20 (-504) at sites 14DM066 and 14DM067 scored below average in three of the four eutrophication related metrics when compared to all other Class 2 Southern Stream and Class 7 Low Gradient stations that meet the FIBI Modified Use Threshold (Table 83). Both sites had a very high amount of tolerant individuals, while lacking any sensitive fish species. Site 14DM067 also had a very high amount of omnivorous individuals, which can also be a strong signal for eutrophic conditions.

Table 84. Eutrophication related macroinvertebrate metrics in County Ditch 20 (-504). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-504 Macroinvertebrate Class 5, 7 – Modified Use	EPT Pct	Tanytarsini Pct	CrustMoll Pct	Scraper Pct	% Tolerant Taxa	% Intolerant Taxa
14DM066	8.02	19.86	33.64	1.85	44.48	0.00
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI Modified Use Threshold (24)</i>	33.6	23.74	15.6	13.48	27.87	3.27
14DM067	0.00	26.53	4.73	0.63	15.36	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22)</i>	20.58	22.11	23.21	17.73	45.87	1.43
Expected response to Eutrophication stress	↓	↓	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in two (14DM067) and five (14DM066) of the six eutrophication related metrics when compared to all other Class 5 Southern Streams RR and Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 84). Both sites had decreased amounts of EPT individuals, and completely lacked phosphorus intolerant taxa. Site 14DM067 did score well in the remaining metrics.

Based on the high rate of standard exceedances in both the observed and modeled data sets, the presence of algae, as well as the majority of the eutrophication related metrics in both the fish and macroinvertebrate communities scoring below average, eutrophication is a stressor to aquatic life in County Ditch 20 (-504).

Nitrates

A total of 13 samples were taken from one chemistry site (S001-545) and two biological monitoring stations (14DM066, 14DM066) from 2014-2016 were analyzed for Inorganic Nitrogen (NO₂-NO₃). The average of all the values is 10.48 mg/L with a low of 0.68 mg/L and a high of 25 mg/L. The spring average (March-May) is 24.00 mg/L. The summer average (June-Aug) is 8.76 mg/L. Nitrate values exceeded 4 mg/L eight times.

The HSPF model also calculated daily nitrate concentrations for this subwatershed from 1994-2014. These values ranged from 1.09-413.45 mg/L with an average nitrate concentration of 7.71 mg/L. Of these calculations, 132 (1.89%) were above 18.1 mg/L. A quantile regression analysis for Class 5 streams showed that with 75% probability that sites at or exceeding this value would be impaired.

Table 85. Nitrate related macroinvertebrate metrics in County Ditch 20 (-504). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-504 Macroinvertebrate Class 5, 7 – Modified Use	TrichopteraChTx Pct	N Index Score	% N Tolerant	% N Intolerant
14DM066	8.11	2.98	51.53	0.00
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI Modified Use Threshold (35)</i>	10.99	3.22	57.02	0.30
14DM067	0.00	0.75	12.85	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22)</i>	5.71	3.30	62.54	0.00
Expected response to N stress	↓	↑	↑	↓

The macroinvertebrate community at sites 14DM066 and 14DM067 both scored at or below average in two of the four nitrate related metrics when compared to all other stations that meet their respective classes, Class 5 Southern Streams RR stations Modified Use Threshold and Class 7 Prairie Streams GP stations Modified Use Thresholds. (Table 85) Both sites had lower numbers of trichoptera taxa, while also completely lacking nitrate intolerant species. These sites did have good nitrate index scores and also had decreased amounts of nitrate tolerant individuals, especially at site 14MN067.

The nitrate concentrations do become elevated at times in County Ditch 20 based on both the observed and calculated data, however, the nitrate related macroinvertebrate metrics score fairly well for the most part as both sites along this reach had good nitrate index scores and lower amounts of nitrate tolerant individuals. These results do not typically happen in streams with elevated nitrate levels, therefore, nitrates are inconclusive as a stressor.

Suspended Solids

Ten samples taken from one chemistry site (S001-545) in 2016 were analyzed for TSS. The average of all the values is 6.6 mg/L with a low of 1.0 mg/L and a high of 12 mg/L. The TSS concentrations did not exceed the 65 mg/L standard.

Additionally, ten secchi tube measurements were taken from this reach. These values ranged from 84-100 cm, with no values falling below the 10 cm minimum standard for secchi tube.

The HSPF model calculated daily TSS values for this subwatershed from 1994-2014. These concentrations ranged from 2.68-1991.12mg/L with an average TSS value of 20.93 mg/L. Of these calculations, 175 (3.12%) were above the TSS standard of 65 mg/L.

Table 86. TSS related fish metrics in County Ditch (504). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

0710001-504 Fish Class 2,7 – Modified Use	BenFrimPct	Centr-TolPct	HerbVpct	Perfcm-TolPct	RifflePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14DM066	10.42	0.00	3.13	7.44	3.57	0.00	40.18	0.00	1.79	17.94
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)</i>	30.08	6.17	2.88	28.69	19.54	8.38	26.17	0.86	21.25	19.19
14DM067	6.91	0.00	0.00	5.28	2.44	0.00	2.44	0.00	69.11	28.45
<i>Statewide average for Class 7 Low Gradient stations that are meeting the FIBI Modified Use Threshold (15.0)</i>	12.20	4.38	8.17	13.36	7.35	17.28	20.49	3.61	7.09	14.09
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

The fish community in County Ditch 20 (-504) scored below average in seven (14DM066) and nine (14DM067) of the ten TSS related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI Modified Use Threshold (Table 86). Site 14DM067 fared worse than site 14DM066 as it only had an above average amount of long-lived individuals, while having very few if any species that are sensitive to elevated TSS concentrations. The TSS Index Score was also very poor at this site, while it was good at site 14DM066.

Table 87. TSS related macroinvertebrate metrics in County Ditch 20 (-504). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

0710001-504 Macroinvertebrate Class 5, 7 – Modified Use	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plectoptera Pct
14DM066	14.52	0.00	11.00	20.25	4.63	0.00
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)</i>	15.87	3.02	11.59	35.23	26.89	0.54
14DM067	3.89	0.00	9.00	5.64	0.32	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (22.0)</i>	17.35	1.33	13.20	48.28	19.13	0.22
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

The macroinvertebrate assemblage in this reach scored below average in three of the six TSS related metrics at both sites when compared to all other Class 5 Southern Streams RR and Class 7 Prairie

Streams GP stations that meet the MIBI General Use Threshold (Table 87). Both sites had good TSS Index scores, while also having a lower amount and percentage of TSS tolerant taxa and individuals. These results are not common in streams being negatively impacted by elevated TSS concentrations.

The observed data set does show a few instances in which the TSS standard is exceeded, while the HSPF model shows a very low exceedance rate. The macroinvertebrate metrics related to TSS score fairly well as there was a low amount of TSS tolerant taxa and individuals at both sites, while both sites also had good TSS Index scores. These results are very unlikely if TSS concentrations are negatively impacting aquatic life. Therefore, TSS is not a stressor to the biological communities in County Ditch 20 (-504) at this time. The fish community is likely being impacted by other stressors resulting in lower metric scores.

Habitat

County Ditch 20 (-504) had a qualitative habitat assessment take place at its biological monitoring sites, 14DM066 and 14DM067, during the fish and macroinvertebrate sampling events in 2014 and 2015. The average MSHA scores for these sites were 51.5 (Fair) at 14DM066 and 19.67 (Poor) at 14DM067. Limiting the habitat at this site was the row crop agriculture as the dominant nearby land use, narrow to moderate riparian buffer, little bank erosion, light stream shading, the presence of sand and silt substrates, sparse fish cover, severe embeddedness at 14DM067, limited depth variability at 14DM067, poor sinuosity (Figure 37), and poor to fair channel development. Further MSHA analysis can be seen in Figure 38.

Figure 38. Poor sinuosity along County Ditch 20 (-504).

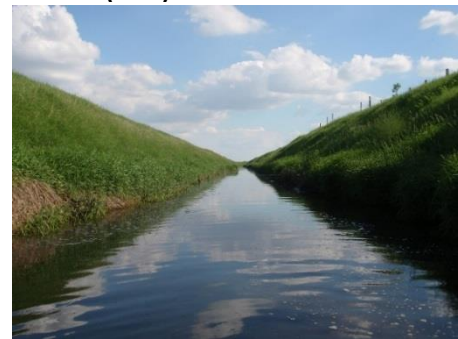


Table 88. Habitat related fish metrics in County Ditch 20 (-504). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

0710001-504 Fish Class 2,7 – Modified Use	BenInsect- ToIPct	SlithopPct	DarterSculpSuc Pct	RifflePct	PiscivorePct	LithFrimPct	ToIPct	PioneerPct
14DM066	7.29	40.18	6.70	3.57	0.15	55.06	86.76	35.42
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)</i>	19.05	26.17	16.45	19.54	8.02	35.59	46.38	23.58
14DM067	4.47	2.44	4.47	2.44	50.00	4.07	44.72	21.14
<i>Statewide average for Class 7 Low Gradient stations that are meeting the FIBI Modified Use Threshold (15.0)</i>	7.06	20.49	6.80	7.35	3.67	25.67	56.03	19.20
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

The fish community in County Ditch 20 (-504) at sites 14DM066 and 14DM067 scored below average in six of the eight habitat related metrics at both sites when compared to all other Class 2 Southern Streams stations that meet the FIBI Modified Use Threshold (Table 88). Both sites had lower numbers of benthic insectivore, darter/sculpin/sucker species, riffle dwelling individuals, while also having a higher amount of pioneering taxa. These results signal a stream likely being stressed by the habitat conditions present.

Table 89. Habitat related macroinvertebrate metrics in County Ditch 20 (-504). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-504 Macroinvertebrate Class 5, 7 – Modified Use	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14DM066	13.58	16.36	25.62	8.02	55.86	42.28
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI Modified Use Threshold (24.0)</i>	6.43	19.88	38.44	27.84	44.43	18.90
14DM067	80.44	1.58	7.57	0.00	92.11	8.20
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)</i>	9.74	24.34	20.62	15.52	59.46	22.88
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate assemblage in this reach scored below average in five (14DM066) and six (14DM067) of the six habitat related metrics when compared to all other Class 5 Southern Streams RR and Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold for the respective classes (Table 89). Site 14DM066 did have an above average amount of sprawler individuals; however, the remaining metrics scored poorly similarly to site 14DM067. These results reflect an assemblage likely being negatively impacted by the current habitat conditions.

Based on the fair (14DM066) and very poor (14DM067) MSHA results, and the biotic communities that reflect these relatively poor scores related to habitat, habitat is indeed as stressor to aquatic life in County Ditch 20 (-504).

Altered Hydrology

This reach of County Ditch 20 (-504) is almost entirely altered and the majority of its upstream watershed is altered according to the MPCA altered watercourse layer.

“Much of the headwaters to the Lower Beaver Creek site is intensively channelized. All of the sub-watersheds within the study site’s catchment have had at least 40% of their stream miles channelized, straightened, or altered in a fashion other than impoundment.” (DNR 2016).

Extreme weather events affect high flow events as well as also low flows during drought. HSPF models show this section of County Ditch 20 (-504) experiencing low flow at less than five cfs 39.9% of the time and less than one cfs 6.4% of the time.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The average percentage for generalist fish within the reach was 52.3% compared to the average in Class 2 and 7 modified use waters meeting the standard of 43.9% and 35%. General fish populations ranged from 0-87%.

The numbers of nest guarder species are also positively correlated with increased low flows. The average percentage for nest guarder fish within the reach was 22% compared to the average in Class 2 and 7 modified use waters meeting the standard of 30.6% and 29.6%. Nest guarder fish species ranged from 0-41.5%.

Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The average percentage for long-lived macroinvertebrates within the reach was 0.8%

compared to the average in Class 5 and 7 modified use waters meeting the standard of 6.5% and 5.6%. Long-lived macroinvertebrates ranged from 0-2.5%.

Given the poor scoring related biological metrics, the channel alteration in this reach, as well as the high frequency of low flow events, Flow Alteration/Connectivity is a stressor to aquatic life in County Ditch 20 (-504).

Summary

The impaired fish and macroinvertebrate communities in County Ditch 20 (-504) are being stressed by DO, Eutrophication, Habitat and Flow Alteration/Connectivity (Table 90). Nitrates were inconclusive as a stressor at this point, while Suspended Sediment was ruled out as a stressor to aquatic life. For further information on the stressors and recommendations to fixing the stressors in the Beaver Creek HUC 10 Watershed, please see pages 98-99.

Table 90. Stressor determinations for County Ditch 20 (-504).

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
County Ditch 20	07100001-504	●	●	o	---	●	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Beaver Creek (07100001-664)

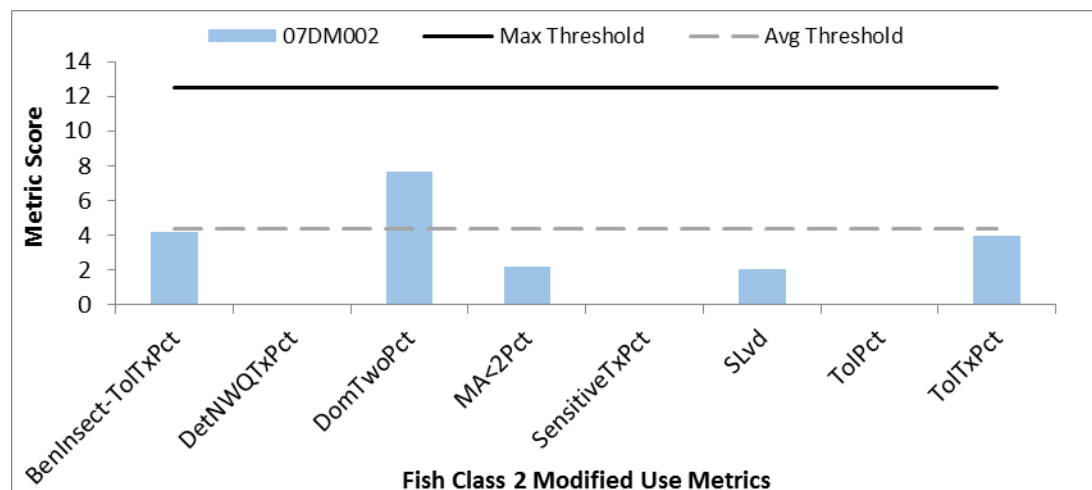
Located in west central Murray County, Beaver Creek (-664) is a 1.79 mile long reach that is impaired for aquatic life due to the fish assemblage. This stream reach extends from Judicial Ditch 14 down to the confluence with County Ditch 20. Along this stream section there is one biological monitoring station, 07DM002.

Biology

Fish

The fish community in Beaver Creek (-664) was sampled in September of 2007 at biological monitoring station 07DM002. This site had an FBI score of 20.1, which is far below the Fish Class 2 Southern Streams Modified Use Threshold of 35. This reach scored below the average needed to reach the threshold in seven of the eight metrics that comprise the FBI for this class (Figure 39). Three of the eight metrics had a score of zero. Site 07DM002 had many bigmouth shiners (368), blacknose dace (317), and bluntnose minnows (231). These species are generally fairly tolerant species often found in high numbers in degraded streams.

Figure 39. Beaver Creek (-664) fish IBI metric scores.



Dissolved Oxygen

A total of 11 DO measurements were taken from one chemistry site (S001-544) and one biological monitoring station (07DM002) from 2007-2016. The average of all the values is 10.23 mg/L with a low of 7.21 mg/L and a high of 13.43 mg/L. The summer average (June-Aug) is 9.49 mg/L. The observed DO values never fell below 5 mg/L.

The HSPF model calculated daily minimum DO values for this subwatershed from 1994-2014. Of these calculations, 2086 (38.97%) of the days had a daily minimum DO level below the daily minimum standard of 5 mg/L. This is a very high exceedance rate for DO.

Table 91. DO fish related metrics in Beaver Creek (-664). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-664 Fish Class 2 – Modified Use	MA>3 Avg	SspnPct Avg	Taxa Count Avg	DO TIV Avg
07DM002	0.87	56.33	15.00	8.94
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)	27.98	25.34	14.52	8.41
Expected response to DO stress	↓	↑	↓	↓

The fish community in Beaver Creek (-664) at site 07DM002 scored below average in two of the DO related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI Modified Use Threshold (Table 91). This reach had very few mature fish, while also having an increased amount of serial spawning individuals. These results can potentially indicate DO stress. However, this reach also had an above average taxa count and a good DO TIV score.

Table 92. DO related macroinvertebrate metrics in Beaver Creek (-664). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-664 Macroinvertebrate Class 7 – Modified Use	HBI_MN Value	% DO Tolerant Taxa	# DO Tolerant Taxa	ChemTV _DO
07DM002	8.59	10.63	8.00	5.41
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22)</i>	8	31.37	9.33	6.19
Expected response to DO stress	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in one of the four DO related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 92). This reach had a below average HBI_MN and DO TIV score, but did have a lower percentage and number of DO tolerant taxa present.

Based on the rather mixed results from the observed, calculated, and biological data, DO is inconclusive as a stressor in Beaver Creek (-664) at this time. Continuous DO monitoring with a sonde is recommended to better determine the DO conditions in this reach and potential impacts on aquatic life.

Eutrophication

A total of 11 phosphorus samples were taken from one chemistry site (S001-544) and one biological monitoring station (07DM002) from 2007-2016. The average of all the values is 0.092 mg/L with a low of 0.04 mg/L and a high of 0.19 mg/L. The summer average (June-Aug) is 0.083 mg/L. Phosphorus values exceeded the standard of 0.150 mg/L twice.

Algae, a common product of increased phosphorus levels, was found at site 07DM002 during the fish sampling event. (Figure 40)

Figure 40. Algae present at site 07DM002.



The HSPF model also calculated daily phosphorus values for this subwatershed from 1994-2014. These values ranged from 0.23-1.1 mg/L with an average phosphorus concentration of 0.45 mg/L. All of these calculations were above the 0.15 mg/L standard.

Table 93. Eutrophication related fish metrics in Beaver Creek (-664). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-664 Fish Class 2 – Modified Use	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct
07DM002	0.00	2.04	96.87	2.55
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)</i>	8.24	13.32	45.53	25.1
Expected response to Eutrophication stress	↓	↓	↑	↑

The fish assemblage in Beaver Creek (-664) at site 07DM002 scored below average in three of the four eutrophication related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI Modified Use Threshold (Table 93). This stream reach was dominated by tolerant fish species as the vast majority of the community fell into this category. Very few darter species and no sensitive taxa were sampled. These results are common in streams being negatively impacted by eutrophication.

The observed phosphorus values had a couple exceedances of the standard in the eleven samples taken, while the HSPF model predicted very high concentrations. The fish community had most of the eutrophication related metrics score below average as well. This information, in addition to the photographic evidence of algae present in this stream reach, concludes that eutrophication is a stressor to aquatic life in Beaver Creek (-664).

Nitrates

This reach had 11 samples taken from one chemistry site (S001-544) and one biological monitoring station (07DM002) from 2007-2016 that were analyzed for Inorganic Nitrogen (NO₂-NO₃). The average of all the values is 7.11 mg/L with a low of 0.15 mg/L and a high of 13.00 mg/L. The spring average (March-May) is 12.50 mg/L. The summer average (June-Aug) is 12.50 mg/L. The nitrate values exceeded 4 mg/L eight times. A quantile regression analysis showed that when Class 7 stream stations exceeded 11.5 mg/l, there was a 90% probability for impairment. This stream reach had values in excess of this level.

The HSPF model calculated daily nitrate concentrations for this subwatershed from 1994-2014. These values ranged from 1.14-18.33 mg/L with an average nitrate concentration of 8.07 mg/L. Of these calculations, 582 (27.64%) were above 11.5 mg/L.

Table 94. Nitrate related macroinvertebrate metrics in Beaver Creek (-664). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-664 Macroinvertebrate Class 7 – Modified Use	TrichopteraChTx Pct	N Index Score	% N Tolerant	% N Intolerant
07DM002	6.45	3.57	64.78	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22)</i>	5.71	3.30	62.54	0.00
Expected response to N stress	↓	↑	↑	↓

The macroinvertebrate community in this reach scored below average in three of the four nitrate related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 94). The site, 07DM002, did have an above average number of trichoptera taxa, however, this site also had a high amount of nitrate tolerant individuals, a complete lack of nitrate intolerant species, and a poor nitrate index score.

Beaver Creek (-664) had high observed and predicted nitrate values. Although the macroinvertebrate community is not impaired at this time, the majority of the nitrate related metrics show signs of stress. The quantile regression analysis also suggests a likely stressor; therefore, nitrates are indeed a stressor to aquatic life in this reach.

Suspended Solids

Ten samples taken from one chemistry site (S001-544) in 2016 were analyzed for TSS. The average of all the values is 31.4 mg/L with a low of 4 mg/L and a high of 86 mg/L. The TSS concentrations exceeded the 65 mg/L standard twice.

Additionally, 10 secchi tube measurements were taken from this reach. These values ranged from 18-100 cm, with an average reading of 53.56 cm. No values fell below the 10 cm minimum standard for secchi tube.

The HSPF model calculated daily TSS values for this subwatershed from 1994-2014. These concentrations ranged from 2.25-432.30 mg/L with an average TSS value of 24.00 mg/L. Of these calculations, 92 (4.37%) were above the TSS standard.

Table 95. TSS related fish metrics in Beaver Creek (-664). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-664 Fish Class 2 – Modified Use	BenFrdFrimPct	Centr-TolPct	HerbivPct	Percfm-TolPct	RifflePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
07DM002	15.87	0.00	12.88	2.04	13.61	0.00	23.94	0.00	0.22	18.62
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)</i>	30.08	6.17	2.88	28.69	19.54	8.38	26.17	0.86	21.25	19.19
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

The fish community in Beaver Creek (-664) at site 07DM002 scored below average in eight of the ten TSS related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI Modified Use Threshold (Table 95). This site had an above average amount of herbivorous individuals, while also having a good TSS Index Score; however, the remaining metrics did score below average or poorly.

Table 96. TSS related macroinvertebrate metrics in Beaver Creek (-664). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-664 Macroinvertebrate Class 7 – Modified Use	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plectoptera Pct
07DM002	14.67	0.00	13.00	52.82	6.04	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)</i>	16.02	0.60	10.98	35.60	9.91	0.02
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

The macroinvertebrate community in this reach scored below average in five of the six TSS related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 96). Site 07DM002 did have a good TSS Index Score, however, the remaining metrics scored poorly with a high percentage and amount of TSS tolerant taxa present.

The observed data set did show a couple instances in which the TSS concentrations exceeded the standard, but the HSPF model calculated a very low exceedance rate. The majority of both the fish and

macroinvertebrate metrics related to TSS scored poorly or below average, except for the TSS Index Scores, which were above average for both assemblages. Based on the mixed results, TSS is inconclusive as a stressor at this time in Beaver Creek (-664).

Habitat

Beaver Creek (-664) had qualitative habitat assessment take place at its biological monitoring site, 07DM002, during the sampling event in 2007. The MSHA score from this visit was 24.0 (Poor). Limiting the habitat at this site was the row crop agriculture as the primary land use, light stream shading, sand substrates, moderate embeddedness, sparse fish cover, fair channel sinuosity, and fair channel development. Further analysis of the MSHA categories can be seen in Figure 41.

Figure 41. Beaver Creek (-664) MSHA metric scores.

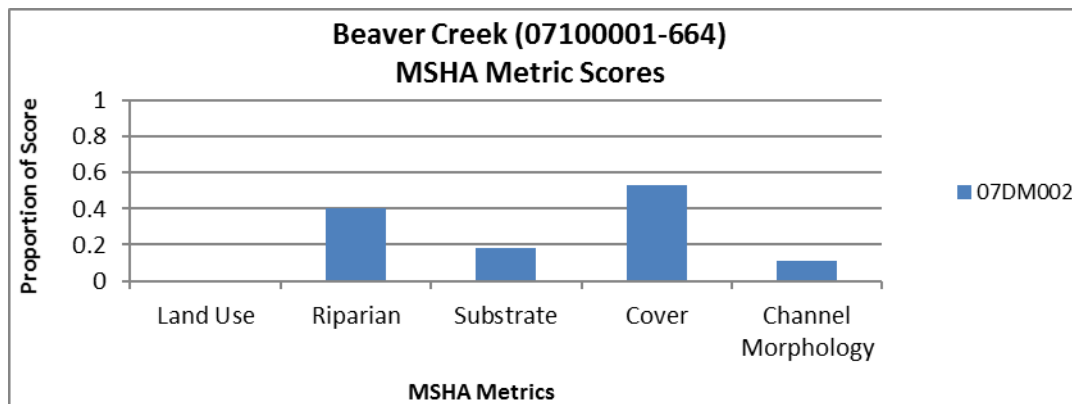


Table 97. Habitat related fish metrics in Beaver Creek (-664). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-664 Fish Class 2 – Modified Use	BenInsect-TolPct	SLithopPct	DarterSculpsucPct	RifflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
07DM002	2.26	23.94	2.04	13.61	0.00	41.05	96.87	22.85
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)	19.05	26.17	16.45	19.54	8.02	35.59	46.38	23.58
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

The fish assemblage in Beaver Creek (-664) at site 07DM002 scored below average in six of the eight habitat related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI Modified Use Threshold (Table 97). This reach did have a slightly above average number of lithophilic spawning individuals, as well as a lower amount of pioneering individuals. These scores are common in streams not being stressed by the habitat conditions. However, the remaining six habitat related metrics scored poorly. The fish community was completely dominated by tolerant fish species. This occurs in streams with poor habitat.

Table 98. Habitat related macroinvertebrate metrics in Beaver Creek (-664). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-664 Macroinvertebrate Class 7 – Modified Use	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
07DM002	29.53	56.04	6.71	5.70	88.26	6.04
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)</i>	9.74	24.34	20.62	15.52	59.46	22.88
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate community in Beaver Creek (-664) scored below average in five of the six habitat related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 98). The site, 07DM002, did have a higher amount of climber individuals, however, the stream reach had a large amount of legless and burrower individuals which can be related to the sand substrate and the moderate amount of embeddedness found in this reach. This reach also had a low amount of EPT, clinger, and sprawler individuals, which may also indicate degraded habitat.

Based on the very poor MSHA score, as well as the numerous poor scoring biological metrics in both the fish and macroinvertebrate communities, habitat is a stressor to aquatic life in Beaver Creek (-664).

Altered Hydrology

This reach of Beaver Creek is almost entirely altered and the majority of its upstream watershed is altered according to the MPCA altered watercourse layer.

“Much of the headwaters to the Lower Beaver Creek site is intensively channelized. All of the sub-watersheds within the study site’s catchment have had at least 40% of their stream miles channelized, straightened, or altered in a fashion other than impoundment.” (DNR 2016).

Extreme weather events affect high flow events as well as also low flows during drought. HSPF models show this section of Beaver Creek experiencing low flow at less than five cfs 39.9% of the time and less than one cfs 6.7% of the time.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The percentage for generalist fish within the reach was 45.5% compared to the average in Class 2 modified use waters meeting the standard of 43.9%

The numbers of nest guarder species are also positively correlated with increased low flows. The percentage for nest guarder fish within the reach was 19.2% compared to the average in Class 2 modified use waters meeting the standard of 30.6%.

Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The percentage for long-lived macroinvertebrates within the reach was 3.0% compared to the average in Class 7 waters meeting the standard of 5.6%.

Based on this information, altered hydrology is a stressor to aquatic life in Beaver Creek (-664).

Summary

The impaired fish community in Beaver Creek (-664) is being stressed by Eutrophication, Nitrates, Habitat and Flow Alteration/Connectivity (Table 99). DO and Suspended Sediment were inconclusive as

stressors at this point. For further information on the stressors and recommendations to fixing the stressors in the Beaver Creek HUC 10 Watershed, please see pages 99-100.

Table 99. Stressor determinations for Beaver Creek (-664).

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Beaver Creek	07100001-664	o	●	●	o	●	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Unnamed Creek (07100001-628)

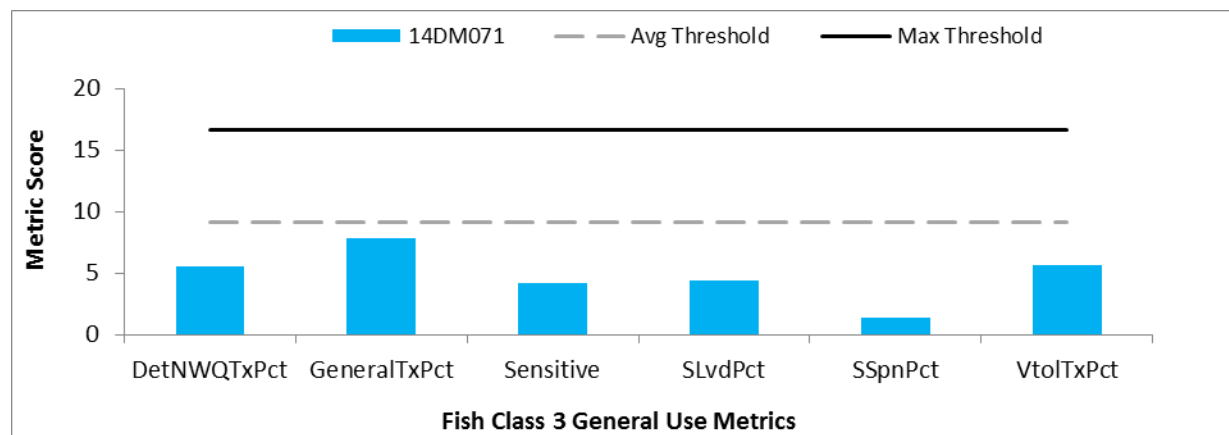
Located in western Murray County, Unnamed Creek (-628) is a 0.95 mile long reach that is impaired for aquatic life due to both the fish and macroinvertebrate assemblages. This stream reach extends from Unnamed Creek down to the confluence with Unnamed Creek (-629). Along this stream section there is one biological monitoring station, 14DM071.

Biology

Fish

Unnamed Creek (-628) was sampled for fish at its biological monitoring station, 14MN071, in August of 2014. The FBI score for this visit was 29.0, which is below the Fish Class Southern Headwaters General Use Threshold of 55. None of the six metrics comprising the FBI scored above the average needed to reach the threshold. (Figure 42)

Figure 42. Unnamed Creek (-628) fish IBI metric scores.

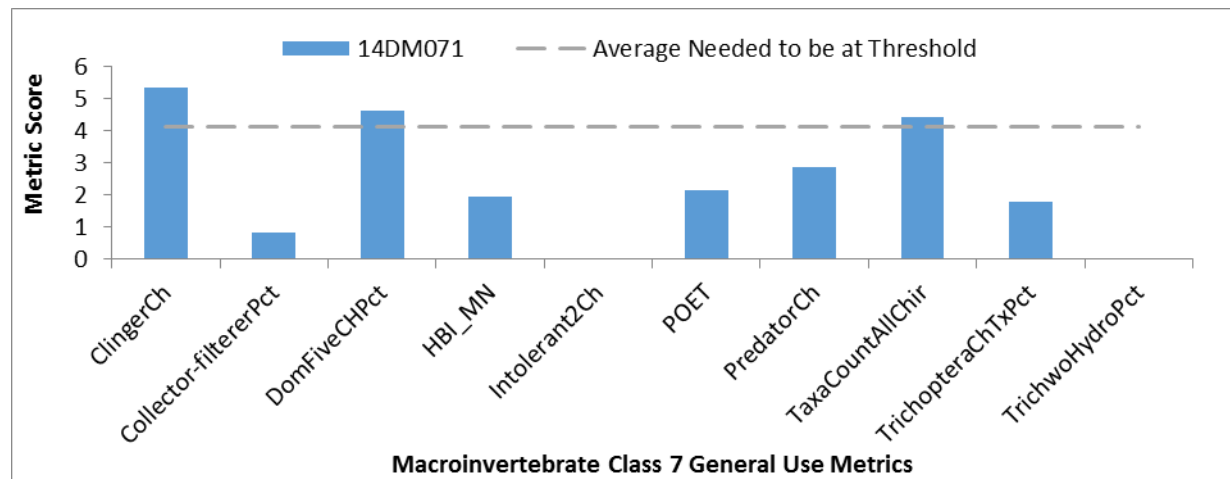


Macroinvertebrates

The macroinvertebrate assemblage at site 14DM071 was sampled in August of 2014. This visit had a MIBI score of 23.9, which is below the Macroinvertebrate Class 7 Prairie Streams GP General Use Threshold of 41. This site had three metrics scoring above the average needed to reach the threshold (ClingerCh, DomFiveCHPct, TaxaCountAllChir). However, the remaining seven metrics scored below

average and two of those metrics had a score of zero. See Figure 43 for a complete breakdown of the metric scores at this site.

Figure 43. Unnamed Creek (-628) macroinvertebrate IBI metric scores.



Dissolved Oxygen

A total of 11 dissolved oxygen (DO) measurements were taken from one chemistry site (S009-055) and one biological monitoring station (14DM071) from 2014-2016. The average of all the values is 9.39 mg/L with a low of 3.62 mg/L and a high of 13.40 mg/L. The summer average (June-Aug) is 9.04 mg/L. The DO values fell below 5 mg/L once.

The HSPF model calculated daily minimum DO values for this subwatershed from 1994-2014. Of these calculations, 1664 (21.69%) of the days had a daily minimum DO level below the daily minimum standard of 5 mg/L.

Table 100. DO related fish metrics in Unnamed Creek (-628). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-628 Fish Class 3 – General Use	MA>3 AVG	SspnPct AVG	Taxa Count AVG	DO TIV AVG
14DM071	4.87	70.49	18.00	8.55
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	13.32	17.09	12.16	8.44
Expected response to DO stress	↓	↑	↓	↓

The fish community in Unnamed Creek (-628) at site 14DM071 scored below average in two of the four DO related metrics when compared to all other Class 3 Southern Streams stations that meet the FIBI General Use Threshold (Table 100). This streams reach had an increased amount of serial spawning individuals, while having few late maturing individuals. These results are common in streams being negatively impacted by the DO conditions. However, this stream did have a higher taxa count and above average DO TIV score, which would not typically occur in a stream with poor DO conditions.

Table 101. DO related macroinvertebrate metrics in Unnamed Creek (-628). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-628 Macroinvertebrate Class 7 – General Use	HBI_MN Value	% DO Tolerant Taxa	# DO Tolerant Taxa	ChemTV _DO
14DM071	8.28	49.00	14.00	5.75
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	7.55	12.98	5.74	6.91
Expected response to DO stress	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in all four of the DO related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 101). This reach had high numbers and percentages of DO tolerant taxa, while also having a poor DO TIV score and HBI_MN value. These results are common in streams potentially stressed by DO.

The DO levels in this reach fall below 5 mg/L as evidenced by the observed and modeled data. Half of the fish metrics and all of the macroinvertebrate metrics related to DO score below average. Additionally, the presence of phosphorus at elevated levels may be causing stress do to DO flux as well. Therefore, DO is a stressor to aquatic life in Unnamed Creek (-628) at this time.

Eutrophication

Eleven phosphorus samples were taken from one chemistry site (S009-055) and one biological monitoring station (14DM071) from 2014-2016. The average of all the values is 0.123 mg/L with a low of 0.06 mg/L and a high of 0.28 mg/L. The summer average (June-Aug) is 0.135 mg/L. Phosphorus values exceeded the standard of 0.150 mg/L three times.

The HSPF model calculated daily phosphorus values for this subwatershed from 1994-2014. These values ranged from 0.07-36.77 mg/L with an average value of 0.36 mg/L. Of these calculations, 5315 (98.3%) were above the 0.15 mg/L standard for phosphorus. This is an extremely high exceedance rate.

Table 102. Eutrophication related fish metrics in Unnamed Creek (-628). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-628 Fish Class 3 – General Use	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct
14DM071	1.15	12.03	87.11	55.87
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	8.9	12.11	70.79	14.71
Expected response to Eutrophication stress	↓	↓	↑	↑

The fish community in Unnamed Creek (-628) at site 14DM071 scored below average in all four of the eutrophication related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 102). This reach had a very high amount of tolerant and omnivorous individuals, while having a slightly below average amount of darter individuals and very few sensitive fish. These results are common in streams negatively impacted by eutrophic conditions.

Table 103. Eutrophication related macroinvertebrate metrics in Unnamed Creek (-628). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-628 Macroinvertebrate Class 7 – General Use	EPT Pct	Tanytarsini Pct	CrustMoll Pct	Scraper Pct	% Tolerant Taxa	% Intolerant Taxa
14DM071	3.01	36.11	21.40	18.39	48.33	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	38.45	18.46	11.78	16.11	26.84	4.03
Expected response to Eutrophication stress	↓	↓	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in five of the six eutrophication related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 103). This reach did have an above average amount of tanytarsini individuals, which is not common in streams with high phosphorus levels, however, this stream scored poorly in the remaining metrics signaling likely stress from eutrophic conditions.

Based on the high frequency of standard exceedances in the observed and modeled data sets, as well as the majority of the eutrophication related metrics in both the fish and macroinvertebrate communities scoring below average, eutrophication is a stressor to aquatic life in Unnamed Creek (-628).

Nitrates

There were 11 samples taken from one chemistry site (S009-055) and one biological monitoring station (14DM071) from 2014-2016 and were analyzed for Inorganic Nitrogen (NO₂-NO₃). The average of all the values is 13.63 mg/L with a low of 2.70 mg/L and a high of 22.00 mg/L. The spring average (March-May) is 21.50 mg/L. The summer average (June-Aug) is 10.32 mg/L. Nitrate values exceeded 4 mg/L 10 times. A quantile regression analysis showed that when Class 7 stream stations exceeded 11.5 mg/l, there was a 90% probability for impairment. This stream reach had values in excess of this level.

The HSPF model calculated daily nitrate concentrations for this subwatershed from 1994-2014. These values ranged from 0.74-313.06 mg/L with an average nitrate concentration of 5.19 mg/L. Of these calculations, 236 (3.39%) were above 11.5 mg/L.

Table 104. Nitrate related macroinvertebrate metrics in Unnamed Creek (-628). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-628 Macroinvertebrate Class 7 – General Use	TrichopteraChTx Pct	N Index Score	% N Tolerant	% N Intolerant
14DM071	2.94	4.05	65.33	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	10.00	3.30	57.57	0.91
Expected response to N stress	↓	↑	↑	↓

The macroinvertebrate assemblage in Unnamed Creek (-628) scored below average in all four of the nitrate related metrics when compared to all other Class 7 Prairie Stream GP stations that meet the MIBI General Use Threshold (Table 104). This reach had very few trichoptera taxa, zero nitrate intolerant

species, while also having a poor nitrate index score and high numbers of nitrate tolerant individuals. All of these results signal likely nitrate stress.

Based on the high observed and predicted values as well as the very poor scoring nitrate related macroinvertebrate metrics, especially the nitrate index score, nitrates are a stressor to aquatic life in Unnamed Creek (-628).

Suspended Solids

Ten samples taken from one chemistry site (S009-055) in 2016 were analyzed for TSS. The average of all the values is 22.14 mg/L with a low of 6.8 mg/L and a high of 43 mg/L. The TSS concentrations did not exceed the 65 mg/L standard mg/L.

Additionally, 10 secchi tube measurements were taken from this reach. These values ranged from 33-100 cm, with an average reading of 58.57 cm. No values fell below the 10 cm minimum standard for secchi tube.

The HSPF model calculated daily TSS values for this subwatershed from 1994-2014. These concentrations ranged from 2.29-2110.20 mg/L with an average TSS value of 9.87 mg/L. Of these calculations, 57 (1.05%) were above the TSS standard of 65 mg/L.

Table 105. TSS related fish metrics in Unnamed Creek (-628). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-628 Fish Class 3 – General Use	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RifflePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14DM071	15.76	0.00	0.29	12.03	4.87	1.15	8.02	0.00	4.01	22.08
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	37.83	0.90	13.33	13.93	28.33	8.55	33.71	1.95	3.56	15.27
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

The fish community in Unnamed Creek (-628) at site 14DM071 scored below average in nine of the ten TSS related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 105). This reach did have a slightly above average amount of long lived individuals, however the remaining metrics did score below average or poorly including TSS Index score. These results are common in streams with elevated TSS concentrations.

Table 106. TSS related macroinvertebrate metrics in Unnamed Creek (-628). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-628 Macroinvertebrate Class 7 – General Use	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plectoptera Pct
14DM071	17.80	0.00	14.00	49.00	3.34	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (22.0)</i>	17.35	1.33	13.20	48.28	19.13	0.22
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

The macroinvertebrate community in this reach scored below average in all six of the TSS related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 106). Site 14DM071 had a poor TSS Index score, lacked TSS intolerant taxa and plecoptera, while also having few collector-filterer species, and increased amounts of TSS tolerant taxa. These results are common in streams being negatively impacted by the TSS conditions present.

While the TSS related metrics in both the fish and macroinvertebrate communities score below average or poorly, the observed chemical and modeled data sets show very few exceedances and a very low exceedance rate. It is unlikely that TSS concentrations become elevated in this stream for longer periods of time that may negatively impact aquatic life. Therefore, TSS is not a stressor to the biological communities in Unnamed Creek (-628) at this time. Other stressors are likely impacting the biota resulting in lower metric scores.

Habitat

Unnamed Creek (-628) had a qualitative habitat assessment take place at its biological monitoring site, 14DM071, during the fish and macroinvertebrate sampling events in 2014. The average MSHA score from these visits was 41.33 (Poor). Limiting the habitat at this site was the fenced pasture and row crop agriculture as nearby land uses, no riparian buffer, bank erosion (Figure 44), light stream shading, sand and silt substrates, moderate embeddedness, and fair channel development. Further MSHA analysis can be seen in Figure 45.

Figure 44. Bank erosion at site 14DM071.



Figure 45. MSHA metric scores in Unnamed Creek (-628).

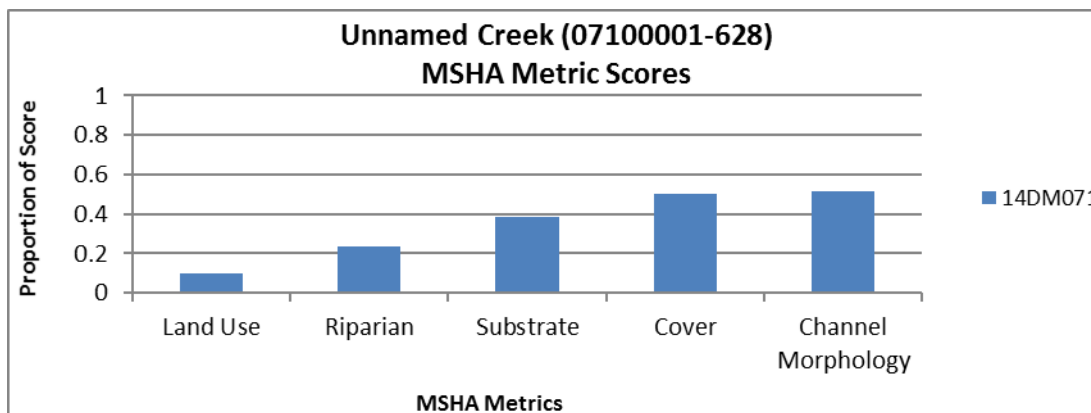


Table 107. Habitat related fish metrics in Unnamed Creek (-628). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-628 Fish Class 3 – General Use	BenInsect- ToIPct	SLithopPct	DarterSculps ucPct	RifflePct	PiscivorePct	LithFrimPct	ToIPct	PioneerPct
14DM071	12.32	8.02	12.03	4.87	0.00	11.17	87.11	76.79
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	14.22	33.71	12.55	28.33	1.62	69.21	70.64	37.79
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

The fish community in Unnamed Creek (-628) at site 14DM071 scored below average in all eight of the habitat related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 107). This stream reach did have a high number of tolerant fish individuals, with fathead minnows and bluntnose minnows being the two most abundant species comprising 63.51% of the community.

Table 108. Habitat related macroinvertebrate metrics in Unnamed Creek (-628). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-628 Macroinvertebrate Class 7 – General Use	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14DM071	14.05	36.45	37.46	3.01	88.63	8.70
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)</i>	5.40	20.35	36.94	37.77	37.96	19.49
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate assemblage in Unnamed Creek (-628) scored below average in four of the six habitat related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 108). Site 14DM071 had a high amount of both burrower and legless individuals, which corresponds to the sand and silt substrates that were found in this stream reach. This reach also had low numbers of EPT and sprawler individual which can signal likely habitat stress.

Based on the poor MSHA score at site 14DM071, in addition to the poor scoring habitat related metrics in both communities, especially fish, habitat is a stressor to aquatic life in Unnamed Creek (-628).

Altered Hydrology

This reach of an unnamed creek is on an unaltered section of the stream though the majority of its upstream watershed is altered according to the MPCA’s altered watercourse layer.

“Much of the headwaters to the Lower Beaver Creek site is intensively channelized. All of the sub-watersheds within the study site’s catchment have had at least 40% of their stream miles channelized, straightened, or altered in a fashion other than impoundment.” (DNR 2016).

Extreme weather events affect high flow events as well as also low flows during drought. HSPF models show this section of Unnamed Creek (-628) experiencing low flow at less than five cfs 62.3% of the time and less than one cfs 17.5% of the time.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The percentage for generalist fish within the reach was 80.8% compared to the average in Class 3 general use waters meeting the standard of 59.1%.

The numbers of nest guarder species are also positively correlated with increased low flows. The percentage for nest guarder fish within the reach was 75.1% compared to the average in Class 3 general use waters meeting the standard of 19.2%.

Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The percentage for long-lived macroinvertebrates within the reach was 0.7% compared to the average in Class 7 general use waters meeting the standard of 8%

Based on this information, altered hydrology is a stressor to aquatic life in Unnamed Creek (-628).

Summary

The impaired fish and macroinvertebrate communities in Unnamed Creek (-628) are being stressed by DO, Eutrophication, Nitrates, Habitat and Flow Alteration/Connectivity (Table 109). Suspended Sediment was ruled out as a stressor to aquatic life. For further information on the stressors and recommendations to fixing the stressors in the Beaver Creek HUC 10 Watershed, please see pages 99-100.

Table 109. Stressor determinations for Unnamed Creek (-628).

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Unnamed Creek	07100001-628	●	●	●	---	●	●

● = stressor; ○ = inconclusive stressor; --- = not an identified stressor

Beaver Creek Watershed (0710000101) HUC 10 Conclusion and Recommendations

The Beaver Creek subwatershed has five biologically impaired streams that are being negatively impacted by a multitude of stressors throughout the watershed. Stressors found in at least three of the five impaired reaches include DO, Eutrophication, Nitrates, Habitat, and Flow Alteration/Connectivity. Suspended sediment was also found to be a stressor in two of the reaches (Table 110).

The predominant land use in this subwatershed is row crop agriculture, with some areas of hay/pasture and herbaceous woods in the headwaters. Row crop agriculture is a significant contributor to the stressors found in these reaches. The land use combined with the channelization of these stream reaches and their tributaries are a major reason why these streams are impaired for aquatic life. These practices often lead to high nitrate and phosphorus levels through excessive use of fertilizers that can quickly reach the stream system by drain tiles and field runoff. These elevated phosphorus levels will also impact the DO conditions resulting in many more tolerant fish and macroinvertebrate communities.

Channelizing streams can also lead to very high flow rates resulting in bank erosion. Bank erosion leads to higher amounts of both bedded and suspended sediment in the stream resulting in poor habitat and visibility conditions impacting the breeding and feeding environments for more sensitive fish and macroinvertebrate species. Habitat was found to be a stressor in all five of the impaired reaches in this subwatershed, while suspended sediment was determined to be a stressor in two sections of Beaver Creek.

The Beaver Creek Watershed needs an extensive effort to improve biological conditions in the many impaired streams found throughout. A high priority in this watershed should be to better manage the flow alteration and the effects of it. This can be achieved by increasing the storage and infiltration of water in locations with flow alteration stressors. This will also help reduce sediment inputs from stream banks, improve habitat by protecting streambanks, reduce erosion and overall stream sedimentation. Re-establishing a quality riparian corridor with deep rooted vegetation to increase stream stabilization, shading, and habitat features is also needed to improve conditions. Also, utilizing a variety of nutrient reducing BMPs including: cover crops, nutrient management, saturated buffers, etc., will also help in the

nitrate and phosphorus reduction. This could also help with the eutrophication and resulting DO issues as well.

Table 110. Stressor determinations for the Beaver Creek Watershed.

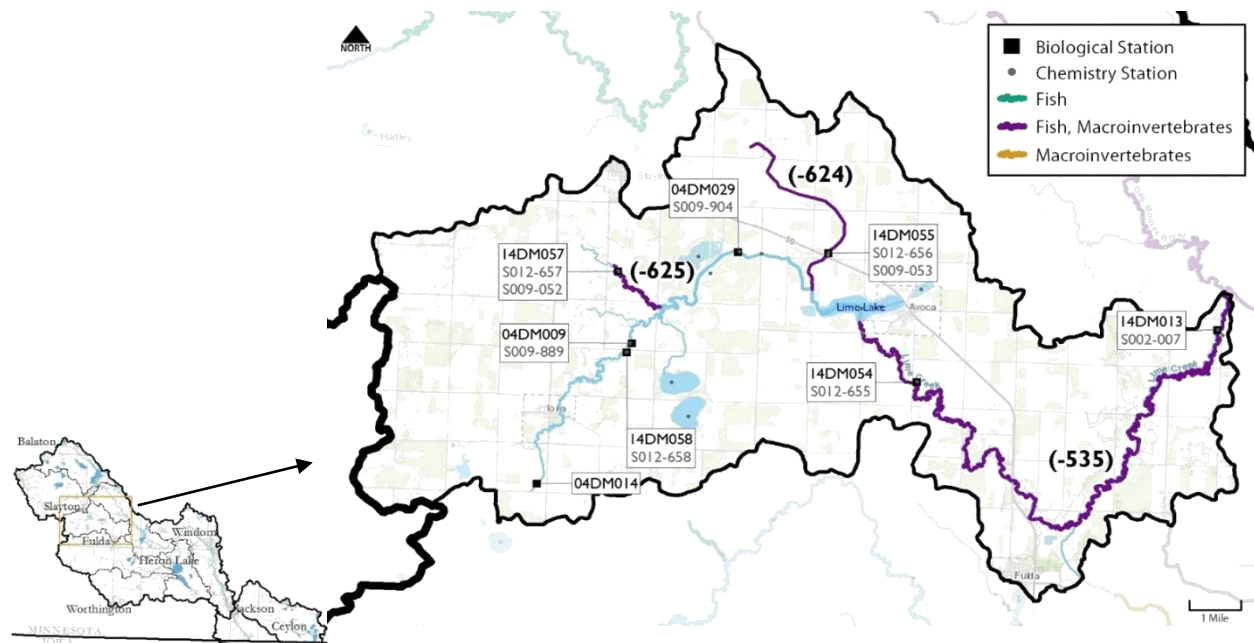
Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Beaver Creek	07100001-646	●	●	●	●	●	●
Beaver Creek	07100001-663	---	○	○	●	●	○
County Ditch 20	07100001-504	●	●	○	---	●	●
Beaver Creek	07100001-664	○	●	●	○	●	●
Unnamed Creek	07100001-628	●	●	●	---	●	●

● = stressor; ○ = inconclusive stressor; --- = not an identified stressor

5.3. Lime Creek Watershed (0710000103)

The Lime Creek HUC-10 Watershed (0710000103) is a 97.68 mi² watershed located in the central portion of the Des Moines River-Headwaters Watershed (Figure 46). This watershed contains three biologically impaired reaches. The primary land use within this watershed is row crop agriculture.

Figure 46. Lime Creek Watershed with monitoring stations and biological impairments.



Lime Creek (07100001-535)

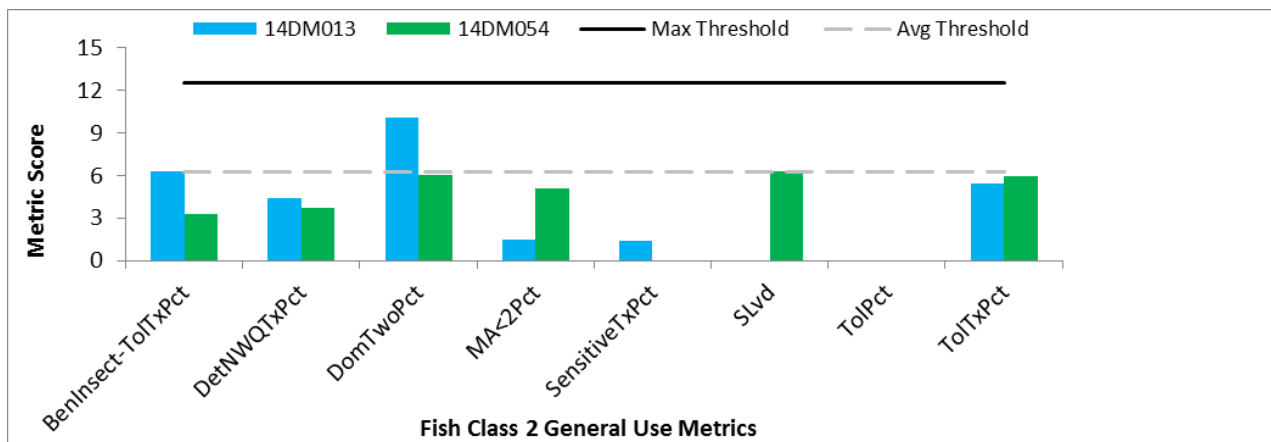
Located in southeastern Murray County, Lime Creek (-535) is a 26.77 mile long reach that is impaired for aquatic life due to both the fish and macroinvertebrate assemblages. This stream reach extends from the outlet of Lime Lake to the confluence with the Des Moines River. Along this stream section there are two biological monitoring stations, 14DM013 and 14DM054.

Biology

Fish

The fish community in Lime Creek (-535) was sampled in August of 2014 at biological monitoring stations 14DM013 and 14DM054. Site 14DM013 had an FBI score of 29.1 and 14DM054 had an FBI score of 30.3, which is far below the Fish Class 2 Southern Streams General Use Threshold of 50. This reach scored at or above the average needed to reach the threshold in two metrics (BenInsect-TolTxPct, DomTwoPct) at 14DM013 and in one metric (SLvd) at 14DM054 while scoring below average in the remaining metrics. Both sites had a very high amount of tolerant individuals resulting in a metric score of zero. See Figure 47 for a breakdown of the FBI metric scores for this reach.

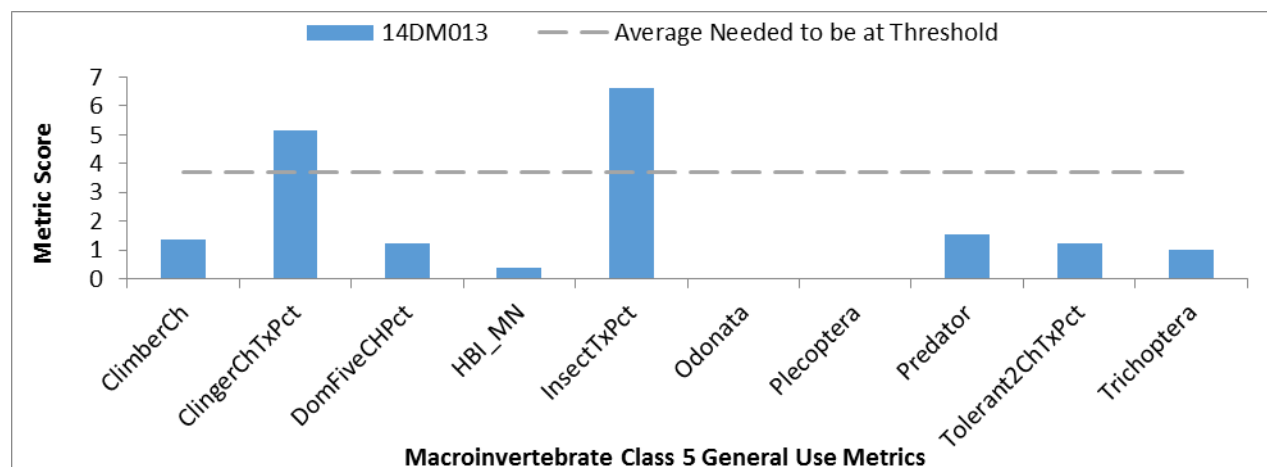
Figure 47. Lime Creek (-535) fish IBI metric scores.



Macroinvertebrates:

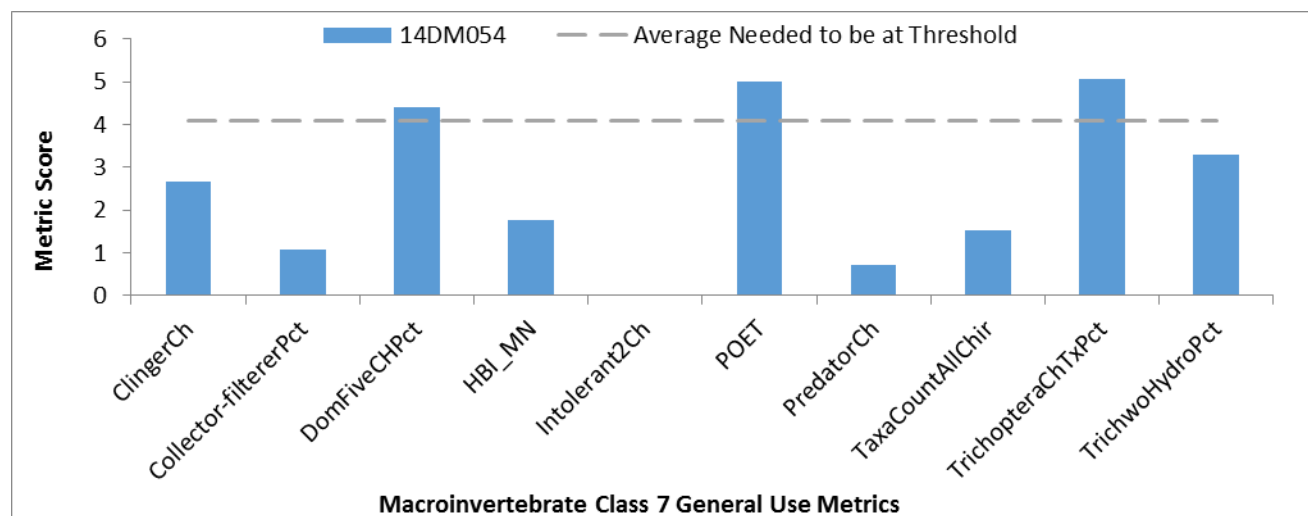
The macroinvertebrate assemblage at site 14DM013 was sampled in August of 2014. This visit had a MIBI score of 18.6, which is below the Macroinvertebrate Class 5 Southern Streams RR General Use Threshold of 37. This site had two metrics scoring above the average needed to reach the threshold (ClingerCh, InsectTxPct). However, the remaining eight metrics scored below average and two of those metrics had a score of zero. See Figure 48 for a complete breakdown of the metric scores at this site.

Figure 48. Lime Creek (-535) macroinvertebrate IBI Class 5 metric scores.



The macroinvertebrate assemblage at site 14DM054 was sampled in August of 2014. This visit had a MIBI score of 25.5, which is below the Macroinvertebrate Class 7 Prairie Streams GP General Use Threshold of 41. This site had three metrics scoring above the average needed to reach the threshold (DomFiveCHPct, POET, TrichopteraCHTxPct). However, the remaining seven metrics scored below average and one of those metrics had a score of zero (Intolerant2Ch). See Figure 49 for a complete breakdown of the metric scores at this site.

Figure 49. Lime Creek (-535) macroinvertebrate IBI Class 7 metric scores.

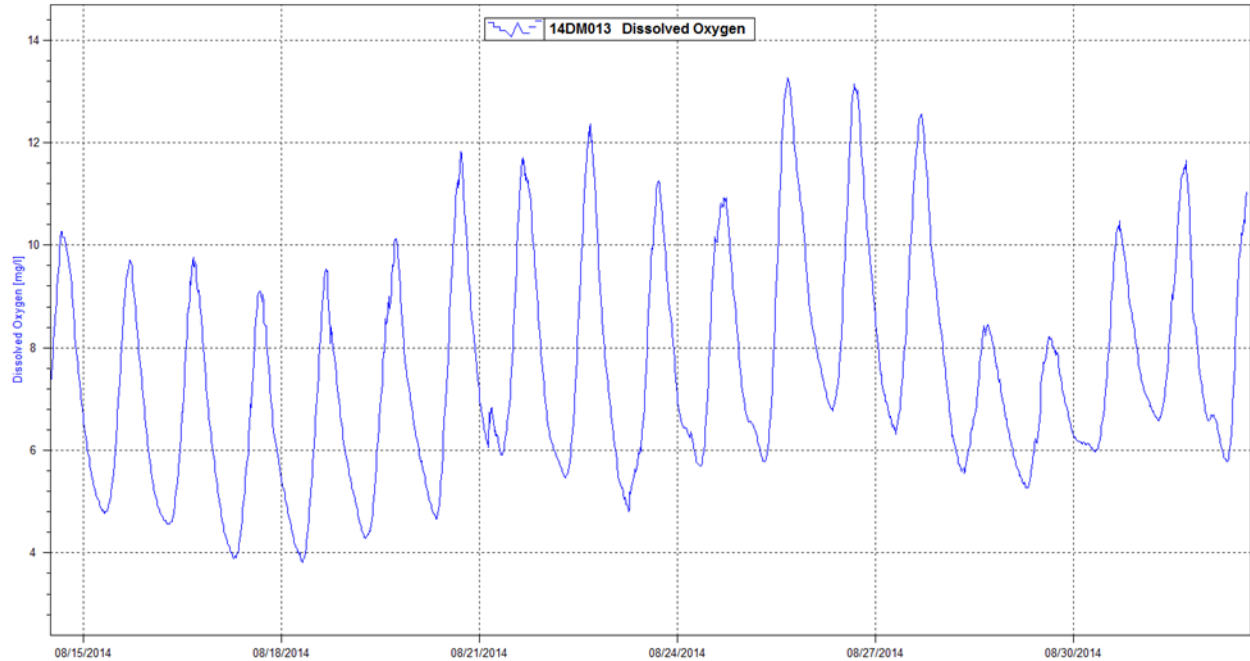


Dissolved Oxygen

A total of 29 DO measurements were taken from one chemistry site (S002-007) and one biological monitoring station (14DM054) from 2003-2015. The average of all the values is 6.66 mg/L with a low of 1.42 mg/L and a high of 17.16 mg/L. The summer average (June-Aug) is 5.27 mg/L. The DO values fell below 5 mg/L 14 times.

Continuous DO monitoring took place at site 14DM013 in 2014 (Figure 50). These results showed that the DO values in this reach frequently fell below the 5 mg/L daily minimum standard. The daily flux values also exceeded the 4.5 mg/L standard for the southern region of the state. These results indicate likely DO and eutrophication issues.

Figure 50. Continuous DO monitoring at site 14DM013 in 2014.



The HSPF model calculated daily minimum DO values for this subwatershed from 1994-2014. Of these calculations, 2,635 (35.07%) of the days had a daily minimum DO level below the daily minimum standard of 5 mg/L. This is a very high exceedance rate for DO.

Table 111. DO related fish metrics in Lime Creek (-535). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-535 Fish Class 2 – General Use	MA>3 Avg	SspnPct Avg	Taxa Count Avg	DO TIV Avg
14DM013	9.79	61.63	20.00	8.68
14DM054	25.80	58.73	19.00	8.66
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)</i>	23.89	28.72	20.38	8.56
Expected response to DO stress	↓	↑	↓	↓

The fish community in Lime Creek (-535) at site 14DM013 and 14DM054 scored below average in two (14DM054) and three (14DM013) of the DO related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 111). Both of these sites had increased amounts of serial spawning individuals, while also having slightly below average taxa counts. Site 14DM013 did also have a lower amount of mature individuals. Site 14DM054 (508) and 14DM013 (200) both had a large amount of fathead minnows sampled. Fathead minnows are often present in large amounts in streams with DO issues.

Table 112. DO related macroinvertebrate metrics in Lime Creek (-535). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-535 Macroinvertebrate Class 5, 7 – General Use	HBI_MN Value	% DO Tolerant Taxa	# DO Tolerant Taxa	ChemTV _DO
14DM013	8.21	4.58	7.00	7.24
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	7.04	8.62	4.33	7.10
14DM054	8.34	52.35	6.00	6.65
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	7.55	12.98	5.74	6.91
Expected response to DO stress	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in two (14DM013) and four (14DM054) of the four DO related metrics when compared to all other Class 5 Southern Streams and Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 112). Both of these streams had elevated amounts of DO tolerant taxa, while also having poor HBI_MN values. Site 14DM054 also had a low DO TIV score.

Based on the high exceedance rate from the observed, continuous, and modeled data sets, in addition to the majority of the DO related metrics for both the fish and macroinvertebrate communities scoring below average, DO is a stressor to aquatic life in Lime Creek (-535).

Eutrophication

A total of 46 phosphorus samples were taken from one chemistry site (S002-007) and one biological monitoring station (14DM054) from 2004-2014. The average of all the values is 0.198 mg/L with a low of 0.04 mg/L and a high of 0.41 mg/L. Phosphorus values exceeded the standard of 0.150 mg/L 30 times.

Fifty-one samples from one chemistry site (S002-007) from 2003-2014 were analyzed for BOD. The average for all the values is 6.40 mg/L with a low of 0.90 mg/L and a high of 23.00 mg/L. The summer average is (June-Aug) is 0.214 mg/L. The BOD values exceeded the standard of 3.50 mg/L 42 times.

Two samples from one chemistry site (S002-007) in 2003 were analyzed for chlorophyll a. The average for all the values is 99.90 ug/L with a low of 23.80 ug/L and a high of 176 ug/L. The summer average is (June-Aug) is 99.90 ug/L. The chlorophyll a values exceeded the standard of 40 ug/L once.

Table 113. Eutrophication related fish metrics in Lime Creek (-535). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-535 Fish Class 2 – General Use	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct
14DM035	0.27	17.85	75.48	24.65
14DM054	0.00	4.81	79.97	57.69
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)</i>	19	11.47	45.1	17
Expected response to Eutrophication stress	↓	↓	↑	↑

The fish community in Lime Creek (-535) at sites 14DM035 and 04DM0564 scored below average in three (14DM035) and four (04DM054) of the four eutrophication related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 113). Both increased amounts of tolerant and omnivorous individuals, while also having very few sensitive and darter (04DM054) individuals. These results are a signal for potentially eutrophic conditions.

Table 114. Eutrophication related macroinvertebrate metrics in Lime Creek (-535). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-535 Macroinvertebrate Class 5, 7 – General Use	EPT Pct	Tanytarsini Pct	CrustMoll Pct	Scraper Pct	% Tolerant Taxa	% Intolerant Taxa
14DM013	49.02	9.15	1.31	4.90	13.73	0.00
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	43.90	27.84	9.23	15.78	17.17	5.79
14DM054	65.20	6.67	23.51	26.65	70.22	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	38.45	18.46	11.78	16.11	26.84	4.03
Expected response to Eutrophication stress	↓	↓	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in two (14DM013) and five (14DM054) of the six eutrophication related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 114). This reach did have an above average number of EPT individuals at both sites, which is not commonly found in streams with eutrophic conditions. However, this reach also had decreased amounts of tanytarsini and phosphorus intolerant taxa at both sites, while also having increased numbers of crustacean/mollusca and scraper individuals, as well as high numbers of phosphorus tolerant taxa site 14DM054. These results are often found in eutrophic stream systems.

Based on the high rate of standard exceedances in the phosphorus, BOD, and the limited chlorophyll-a datasets, the high amount of DO flux likely indicating eutrophic conditions, as well as the majority of the eutrophication related metrics scoring below average in both the biotic communities (except 14DM013 for macroinvertebrates), eutrophication is a stressor to aquatic life in Lime Creek (-535).

Nitrates

This reach had 46 samples taken from one chemistry site (S002-007) and one biological monitoring station (14DM054) from 2004-2014 were analyzed for Inorganic Nitrogen (NO₂-NO₃). The average of all the values is 5.97 mg/L with a low of 0.20 mg/L and a high of 13.00 mg/L. The spring average (March-May) is 5.05 mg/L. The summer average (June-Aug) is 7.21. Nitrate values exceeded 4 mg/L 27 times. A quantile regression analysis for Class 7 streams showed that with 90% probability that sites at or exceeding 11.5 mg/L would be impaired.

The HSPF model also calculated daily nitrate concentrations for this subwatershed from 1994-2014. These values ranged from 0.06-13.82 mg/L and had an average nitrate concentration of 3.39 mg/L.

Table 115. Nitrate related macroinvertebrate metrics in Lime Creek (-535). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-535 Macroinvertebrate Class 5, 7 – General Use	TrichopteraChTx Pct	N Index Score	% N Tolerant	% N Intolerant
14DM013	9.09	3.97	84.31	0.00
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)</i>	15.87	3.02	11.59	35.23
14DM054	8.33	3.78	65.20	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	10.00	3.30	57.57	0.91
Expected response to N stress	↓	↑	↑	↓

The macroinvertebrate community in Lime Creek (-535) scored below average in all four of the nitrate related metrics at both biological monitoring sites, 04DM013 and 14DM054, when compared to both Class 2 Prairie Forest River stations and Class 7 Prairies Streams GP stations that meet the MIBI General Use Threshold (Table 115). Both sites had a high amount of nitrate tolerant individuals, poor nitrate index scores, while also lacking nitrate intolerant species and having low amounts of trichoptera taxa. These results indicate likely stress from nitrates.

The nitrate concentrations in Lime Creek (-535) can get elevated at times as evidenced by the observed and calculated data. This information along with the quantile regression analysis, and the poor scoring nitrate related macroinvertebrate metrics at both sites concludes that nitrates are a stressor to aquatic life in this stream reach.

Suspended Solids

Forty samples taken from one chemistry site (S002-007) from 2002-2014 were analyzed for TSS. The average of all the values is 121.83 mg/L with a low of 14 mg/L and a high of 360 mg/L. The TSS concentrations exceeded the 65 mg/L standard mg/L 28 times. This is a high rate of exceedance.

Additionally, 35 secchi tube measurements were taken from this reach from 2002-2014. These values ranged from 4-26 cm, with 16 values falling below the 10 cm minimum standard for secchi tube. This is also a high rate of exceedance.

The HSPF model calculated daily TSS values for this subwatershed from 1994-2014. These concentrations ranged from 6.28-1117.50 mg/L with an average TSS value of 26.40 mg/L. Of these calculations, 407 (5.64%) of the days had a level above the TSS standard of 65 mg/L.

This reach is currently impaired for turbidity from the 2004 assessment. This impairment was confirmed during the 2016 assessment as well.

Table 116. TSS related fish metrics in Lime Creek (-535). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-535 Fish Class 2 – General Use	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RifflePct	SensitivePct	SlithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14DM013	16.99	1.60	4.57	19.31	12.34	0.00	14.26	0.00	16.83	23.47
14DM054	25.58	0.00	6.66	18.05	9.13	0.27	10.99	0.00	2.27	23.81
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)</i>	37.38	4.89	9.61	18.66	32.49	18.65	39.38	4.97	11.68	19.19
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

The fish community in Lime Creek (-535) at sites 14DM013 and 14DM054 scored below average in eight (14DM013) and ten (14DM054) of the ten TSS related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 116). Site 14DM013 did have an above average number of perch-like and long-lived fish individuals, while scoring poorly in the remaining metrics like site 14DM054.

Table 117. TSS related macroinvertebrate metrics in Lime Creek (-535). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-535 Macroinvertebrate Class 5, 7 – Modified Use	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plectoptera Pct
14DM013	19.30	0.00	11.00	60.78	34.97	0.00
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)</i>	15.87	3.02	11.59	35.23	26.89	0.54
14DM054	20.97	0.00	11.00	38.24	4.39	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (22.0)</i>	17.35	1.33	13.20	48.28	19.13	0.22
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

The macroinvertebrate assemblage in this reach scored below average in four of the six TSS related metrics at both sites when compared to all other Class 5 Southern Streams RR and Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 117). Both sites had lower amounts of TSS tolerant taxa, while site 14DM054 also had a lower TSS tolerant percentage and site 14DM013 had an above average number of collector-filterer individuals. These results are not often found in streams with TSS issues; however, the remaining metrics scored poorly including the TSS Index Scores.

Based on the high rate of standard exceedances in the observed data set, the majority of the TSS related metrics scored below average in both biological communities, as well as the current turbidity impairment in this reach, TSS is a stressor to aquatic life in Lime Creek (-535).

Habitat

Lime Creek (-535) had a qualitative habitat assessment take place at its biological monitoring sites, 14DM013 and 14DM054, during the fish and macroinvertebrate sampling events in 2014. The average MSHA scores from these visits were 50.28 (Fair) at 14DM013 and 32.5 (Poor) at 14DM054. Limiting the habitat at these sites were the row crop agriculture as the dominant nearby land use, moderate bank erosion (Figure 51), light stream shading, silty substrate, moderate embeddedness, sparse fish cover, very little depth variability at 14DM054, moderate channel stability, poor channel development at 14DM054. Further MSHA analysis can be seen in Figure 52.

Figure 51. Moderate bank erosion located along Lime Creek (-535).



Figure 52. Lime Creek (-535) MSHA metric scores.

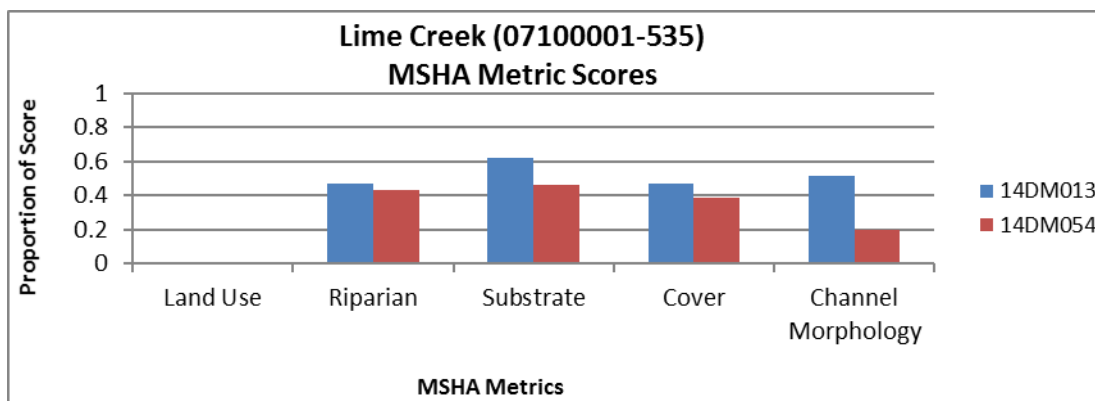


Table 118. Habitat related fish metrics in Lime Creek (-535). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-535 Fish Class 2 – General Use	BenInsect- ToIPct	SLithopPct	DarterSculpSuc Pct	RifflePct	PiscivorePct	LithFrimPct	ToIPct	PioneerPct
14DM013	17.99	10.99	17.85	9.13	0.27	12.06	75.48	53.30
14DM054	4.81	14.26	4.81	12.34	3.77	28.85	79.97	48.80
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	20.4	39.38	18.18	32.49	5.24	58.26	44.85	19.02
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

The fish community in Lime Creek (-535) at sites 14DM013 and 14DM054 scored below average in all eight habitat related metrics at both sites when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 118). These sites had especially high numbers of tolerant and pioneering individuals, which are good indications of a community being stressed by the habitat conditions.

Table 119. Habitat related macroinvertebrate metrics in Lime Creek (-535). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-535 Macroinvertebrate Class 5, 7 – General Use	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14DM013	3.27	19.93	58.50	49.02	46.73	9.48
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)</i>	5.66	12.52	49.77	42.46	34.53	13.99
14DM054	17.55	6.27	29.15	65.20	14.42	39.81
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)</i>	5.40	20.35	36.94	37.77	37.96	19.49
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate assemblage in this reach scored below average in two (14DM013) and three (14DM054) of the six habitat related metrics when compared to all other Class 5 Southern Streams and Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 119). Both sites had above average numbers of EPT individuals, but scored differently in the remaining metrics. Site 14DM013 had high numbers of legless and sprawler individuals, while site 14DM054 had higher numbers of burrower individuals and lower numbers of climber and clinger individuals signaling potential stress from habitat.

Based on the fair to poor MSHA scores in these streams, as well as the very poor scoring habitat related metrics in the fish community and some below average scores in the macroinvertebrate assemblage as well, habitat is a stressor to aquatic life in Lime Creek (-535) at this time.

DNR Summary for Lime Creek (535)

Similar to the Upper Beaver Creek survey site, the channel at the Lime Creek WMA survey site was also classified as an E5 channel. The Lime Creek survey location, however, was only moderately incised and slightly entrenched. The entrenchment ratio at the riffle cross section was 75.3 indicating that Lime Creek has a wide floodplain when compared to the channel’s bankfull width. Bank height ratio at the riffle cross section was 1.43, where an additional foot of incision would entrench the channel completely. Some previous incision may have been attributed to the channel straightening that removed roughly 1,000 feet of channel at the immediate downstream road crossing. Channel cut offs, both natural and man-made, steepen the slope of the channel. The over steepened portion of channel, as well as the channel upstream of that point, begin to incise (i.e. down cut) as a stable slope works to be reestablished by the watersheds hydraulics.

Sediment supply from streambank erosion was estimated using the BANCS (i.e. BEHI matched with NBS) model. The average streambank erosion rate estimates were 0.236 tons (i.e. pounds) of sediment per linear foot of streambank annually when using the Colorado erosion rate curve (Rosgen 2001). In order to validate streambank erosion estimates, a monumented cross section was established at an eroding bank. Bank erosion estimates at the monumented study bank was 0.1097 tons/ft/yr during both the 2013 and 2014 assessments. Erosion rates at the study bank were measured to be 1.083 feet per year on average from 2013 to 2014, and 0.145 feet per year on average from 2014 to 2015.

The monumented study bank cross section was located across a pool feature that was relatively shallow when compared to other pool features within the stream reach. Cross sections of the study bank appear

to show minimal water depth and inadequate habitat during the 2013 and 2014 survey dates. The longitudinal profile of the survey reach, however, indicates that some deeper pools exist (i.e. ~2.5 feet in depth during base flow) within the channel that would provide refuge and habitat for aquatic species during base flow. (MN DNR 2017)

Altered Hydrology

This reach of Lime Creek is mostly a natural channel; however, the majority of its entire upstream watershed is altered according to the MPCA altered watercourse layer.

“The relative proportion of channel alteration within the Lime Creek Watershed is less than that of the Beaver Creek Watershed. On average, 30% of the channel miles within the Lime Creek subwatersheds have previously been altered.” (DNR 2016).

Extreme weather events affect high flow events as well as also low flows during drought. HSPF models show this section of Lime Creek (-535) experiencing low flow at less than five cfs 1.2% of the time and less than one cfs 0% of the time.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The average percentage for generalist fish within the reach was 55.1% compared to the average in Class 2 general use waters meeting the standard of 42.4%. General fish populations ranged from 49.0-61.1%.

The numbers of nest guarder species are also positively correlated with increased low flows. The average percentage for nest guarder fish within the reach was 52.3% compared to the average in Class 2 general use waters meeting the standard of 19%. Nest guarder fish species ranged from 50.5-54.2%.

Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The average percentage for long-lived macroinvertebrates within the reach was 1.7% compared to the average in Class 7 general use waters meeting the standard of 8%. Long-lived macroinvertebrates ranged from 0.3-3.1%.

The Flow Alteration/Connectivity biological metrics in this reach score below average, while the reach itself is on a mostly natural channel. While some of the altered streams in the headwaters of this watershed may be having an impact on this reach itself, more information is needed to make this determination. Therefore, Flow Alteration/Connectivity is inconclusive as a stressor in this reach.

Summary

The impaired fish and macroinvertebrate communities in Lime Creek (-535) are being stressed by DO, Eutrophication, Nitrates, Suspended Sediment, and Habitat (Table 120). Flow Alteration/Connectivity was inconclusive as a stressor to aquatic life at this point. For further information on the stressors and recommendations to fixing the stressors in the Lime Creek HUC 10 Watershed, please see page 126.

Table 120. Stressor determinations for Lime Creek (-535).

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Lime Creek	07100001-535	●	●	●	●	●	o

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Unnamed Creek (07100001-624)

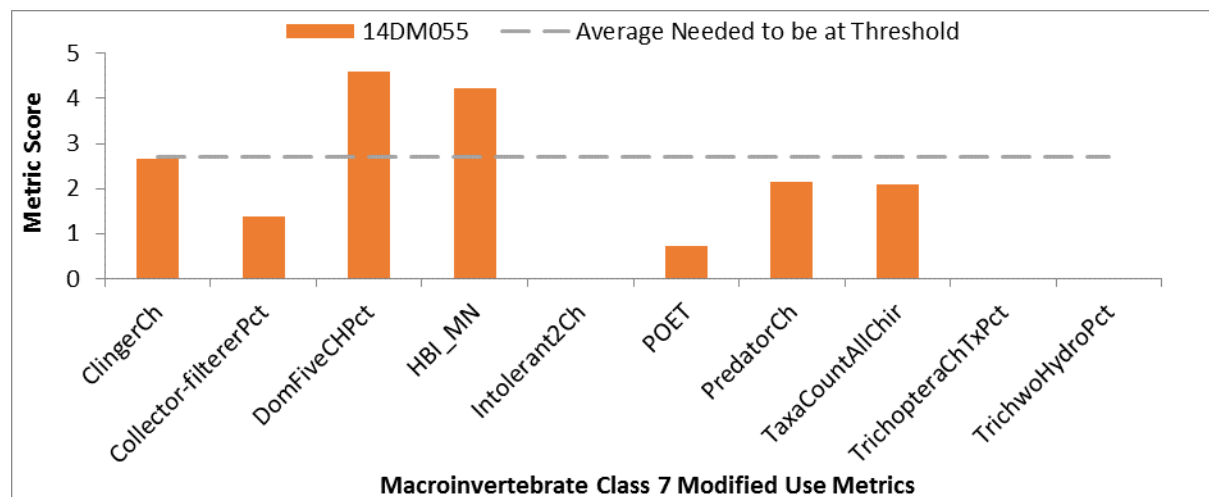
Located in east central Murray County, Unnamed Creek (-624) is a 4.56 mile long reach that is impaired for aquatic life due to both the fish and macroinvertebrate assemblages. This stream reach extends from the watershed headwaters to the confluence with the Unnamed Creek (-550). Along this stream section there is one biological monitoring station, 14DM055.

Biology

Fish

The fish community in Unnamed Creek (-624) was sampled in September of 2015 at biological monitoring station 14DM055. This site had an FBI score of 16.2, which is far below the Fish Class 3 Southern Headwaters Modified Use Threshold of 33. This reach scored below the average needed to reach the threshold in all six of the metrics that comprise the FBI for this class (Figure 53). Three of the eight metrics had a score of zero. Site 14DM055 was dominated by the presence of fathead minnows (83.13% of individuals), which are a very tolerant taxa often found in high numbers in degraded streams.

Figure 53. Unnamed Creek (-624) macroinvertebrate IBI metric scores.



Dissolved Oxygen

A total of 11 DO measurements were taken from one chemistry site (S009-053) and one biological monitoring station (14DM053) from 2014-2016. The average of all the values is 8.58 mg/L with a low of 5.45 mg/L and a high of 11.70 mg/L. The summer average (June-Aug) is 7.51 mg/L. The DO values did not fall below 5 mg/L.

The HSPF model calculated daily minimum DO values for this subwatershed from 1994-2014. Of these calculations, 1987 (25.91%) of the days had a daily minimum DO level below the daily minimum standard of 5 mg/L.

Table 121. DO related fish metrics in Unnamed Creek (-624). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-624 Fish Class 3 – Modified Use	MA>3 Avg	SspnPct Avg	Taxa Count Avg	DO TIV Avg
14DM055	1.20	93.67	7.00	8.45
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)</i>	14.39	10.56	10.03	8.25
Expected response to DO stress	↓	↑	↓	↓

The fish community in Unnamed Creek (-624) at site 14DM055 scored below average in three of the four DO related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI Modified Use Threshold (Table 121). This reach had a decreased amount of overall taxa and late maturing fish, while also having a very high number of serial spawning individuals. These results are common in streams stressed by DO.

Table 122. DO related macroinvertebrate metrics in Unnamed Creek (-624). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-624 Macroinvertebrate Class 7 – Modified Use	HBI_MN Value	% DO Tolerant Taxa	# DO Tolerant Taxa	ChemTV _DO
14DM055	7.58	54.27	8.00	5.34
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22)</i>	8	31.37	9.33	6.19
Expected response to DO stress	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in two of the four DO related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 122). The site, 14DM055, had a very high percentage of DO tolerant taxa, while also having a below average DO TIV score.

The DO levels had zero exceedances from the observed data set; however, the model calculated a very high exceedance rate. Half of the macroinvertebrate and the majority of the fish metrics related to DO scored below average. This reach also had high phosphorus concentrations and algae present likely signaling potential issues related to daily flux. Therefore, based on this information, DO is a stressor to aquatic life in Unnamed Creek (-624).

Eutrophication

A total of 11 phosphorus samples were taken from one chemistry site (S009-053) and one biological monitoring station (14DM055) from 2014-2016. The average of all the values is 0.165 mg/L with a low of 0.03 mg/L and a high of 0.88 mg/L. The summer average (June-Aug) is 0.206 mg/L. Phosphorus values exceeded the standard of 0.150 mg/L three times. Site S009-053 also had algae present, which can be a sign for increased phosphorus levels and eutrophic conditions. (Figure 54)

The HSPF model also calculated daily phosphorus values for this subwatershed from 1994-2014. These values ranged from 0.23-35.17 mg/L with an average concentration of 0.59 mg/L. All of these calculations were above the 0.15 mg/L standard for phosphorus.

Figure 54. Algae present at chemistry site S009-053.



Table 123. Eutrophication related fish metrics in Unnamed Creek (-624). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-624 Fish Class 3 – Modified Use	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct
14DM055	0.00	0.00	28.57	28.57
14DM055	0.00	0.90	99.10	84.34
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)</i>	5.54	10.36	76.45	19.58
Expected response to Eutrophication stress	↓	↓	↑	↑

The fish community in Unnamed Creek (-624) at site 14DM055 scored below average in three (June 2014 visit) and four (September 2015 visit) of the four eutrophication related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI Modified Use Threshold (Table 123). The June 2014 visit only had six fish individuals sampled resulting in data that may not accurately reflect the true conditions of the stream. In general, the fish community reflected one that is likely stressed by eutrophication.

Table 124. Eutrophication related macroinvertebrate metrics in Unnamed Creek (-624). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-624 Macroinvertebrate Class 7 – Modified Use	EPT Pct	Tanytarsini Pct	CrustMoll Pct	Scraper Pct	% Tolerant Taxa	% Intolerant Taxa
14DM055	0.91	51.56	22.26	2.74	42.07	0.00
<i>Statewide average for Class 7 Prairie Streams Glide Pool stations that are meeting the MIBI Modified Use Threshold (22)</i>	20.58	22.11	23.21	17.73	45.87	1.43
Expected response to Eutrophication stress	↓	↓	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in two of the six metrics related to eutrophication when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 124). The station, 14DM055, had very low amounts of EPT individuals and completely lacked intolerant taxa. The remaining metrics did score above average.

While the macroinvertebrate community generally scores fairly well, the high amounts of phosphorus observed, the very high amount calculated by the HSPF model, the photographic evidence of algae, as well as the vast majority of the fish metrics related to eutrophication signal likely issues, therefore, eutrophication is a stressor to aquatic life in Unnamed Creek (-624).

Nitrates

A total of 11 samples taken from one chemistry site (S009-053) and one biological monitoring station (14DM055) from 2014-2016 were analyzed for Inorganic Nitrogen (NO₂-NO₃). The average of all the values is 12.97 mg/L with a low of 0.06 mg/L and a high of 25.00 mg/L. The spring average (March-May) is 22.00 mg/L. The summer average (June-Aug) is 10.44 mg/L. Nitrate values exceeded 4 mg/L eight times. Quantile regression analysis showed that when a Class 7 station had a nitrate concentration at or exceeding 11.5 mg/L there was 90% probability for impairment. The nitrate concentrations in this reach easily exceeded this level.

The HSPF model calculated daily nitrate concentrations for the subwatershed from 1994-2014. These values ranged from 1.61-254.37 mg/L with an average nitrate concentration of 9.05 mg/L. Of these calculations 1616 (23.2%) were above 11.5 mg/L. This is a pretty high rate.

Table 125. Nitrate related macroinvertebrate metrics in Unnamed Creek (-624). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-624 Macroinvertebrate Class 7 – Modified Use	TrichopteraChTx Pct	N Index Score	% N Tolerant	% N Intolerant
14DM055	0.00	3.20	55.49	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22)</i>	5.71	3.30	62.54	0.00
Expected response to N stress	↓	↑	↑	↓

The macroinvertebrate community in Unnamed Creek (-624) scored below average in two of the four nitrate related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 125). The site, 14DM055, completely lacked both trichoptera and nitrate intolerant species, which can signal potential nitrate stress. The site did have a slightly above average nitrate index score and a lower amount of nitrate tolerant individuals.

The nitrate related metric results for the macroinvertebrate community were rather mixed, however, the high observed and calculated nitrate values, as well as the quantile regression analysis indicates that nitrates are indeed a stressor to aquatic life in Unnamed Creek (-624).

Suspended Solids

Nine samples taken from one chemistry site (S009-053) in 2016 were analyzed for TSS. The average of all the values is 15.18 mg/L with a low of 1 mg/L and a high of 36 mg/L. The TSS concentrations did not exceed the 65 mg/L standard.

Additionally, nine secchi tube measurements were taken from this reach. These values ranged from 10-100 cm, with an average reading of 35.4 cm. No values fell below the 10 cm minimum standard for secchi tube.

The HSPF model calculated daily TSS values for this subwatershed from 1994-2014. These concentrations ranged from 1.78-794.84 mg/L with an average TSS value of 28.39 mg/L. Of these calculations, 759 (13.91%) were above the TSS standard of 65 mg/L.

Table 126. TSS related fish metrics in Unnamed Creek (-624). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-624 Fish Class 3 – Modified Use	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RifflePct	SensitivePct	SlithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14DM055	1.05	0.00	1.36	29.02	0.60	0.00	0.60	0.00	50.00	24.51
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)</i>	31.38	1.01	10.83	12.43	22.62	6.02	30.09	0.52	4.91	15.49
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

The fish community in Unnamed Creek (-624) at site 14DM055 scored below average in eight of the ten TSS related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI Modified Use Threshold (Table 126). This reach did have an above average number of long-lived and perch-like individuals, however the remaining metrics scored poorly especially the TSS Index score. This reach had a very high amount of fathead minnows sampled. Fathead minnows are often found in high amounts in degraded stream systems.

Table 127. TSS related macroinvertebrate metrics in Unnamed Creek (-624). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-624 Macroinvertebrate Class 7 – Modified Use	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plectoptera Pct
14DM055	12.25	0.00	6.00	6.40	5.49	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)</i>	16.02	0.60	10.98	35.60	9.91	0.02
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

The macroinvertebrate assemblage in this reach scored below average in three of the six TSS related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 127). Site 14DM055 had a good TSS Index score, while also having a low amount and percentage of TSS tolerant taxa and individuals. These results are not common in streams being negatively impacted by poor TSS conditions.

Both the observed and modeled data sets show little to no indications that the TSS concentrations in Unnamed Creek (-624) exceed the standard and begin harming aquatic life. The macroinvertebrate community did not signal TSS stress either as this community had few TSS tolerant taxa and individuals, and site 14DM055 had a good TSS Index score. Therefore, TSS is not a stressor in this reach. It is likely that other stressors are causing the lower metric scores in the fish community in this reach.

Habitat

Unnamed Creek (-624) had a qualitative habitat assessment take place at its biological monitoring site, 14DM055, during the fish and macroinvertebrate sampling events in 2014 and 2015. The average MSHA score from these visits was 35.07 (Poor). Limiting the habitat at this site was the row crop agriculture as the dominant nearby land use, a narrow riparian buffer (Figure 55), light stream shading, silty substrates without any coarse material, sparse fish cover, limited depth variability, poor channel development, moderate channel stability and fair sinuosity. Further MSHA analysis can be seen in Figure 56.

Figure 55. Limited riparian buffer at site 14DM055.



Figure 56. Unnamed Creek (-624) MSHA metric scores.

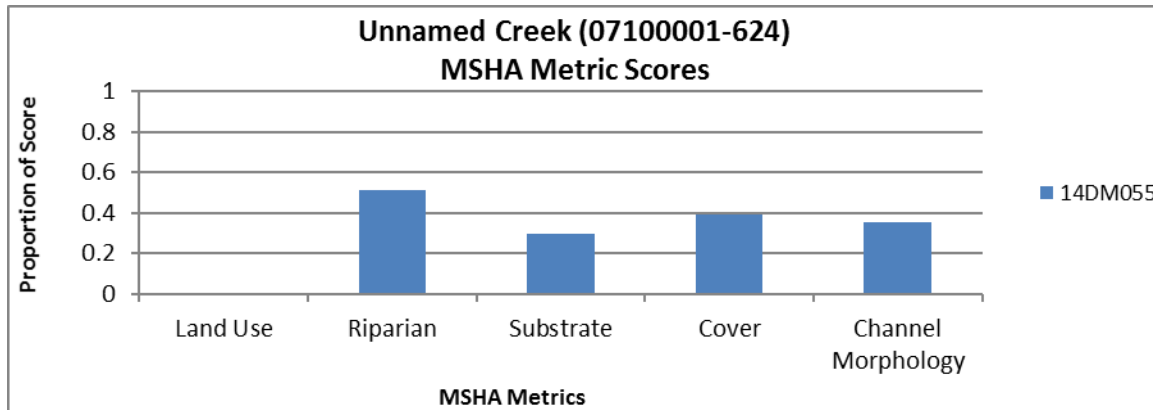


Table 128. Habitat related fish metrics in Unnamed Creek (-624). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-624 Fish Class 3 – Modified Use	BenInsect- ToIPct	SLithopPct	DarterSculpSu cPct	RifflePct	PiscivorePct	LithFrimPct	ToIPct	PioneerPct
14DM055	0.45	0.60	0.45	0.60	7.14	1.36	63.83	42.92
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	10.91	30.09	10.59	22.62	1.97	57.98	46.70	32.54
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

The fish community in Unnamed Creek at site 14DM055 scored below average in seven of the eight habitat related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI Modified Use Threshold (Table 128). This site did have an above average amount of piscivore individuals, however, the fish community scored poorly in the remaining metrics and was mostly comprised of fathead minnows (83.13%), which are a very tolerant species and thrive in poor habitat conditions.

Table 129. Habitat related macroinvertebrate metrics in Unnamed Creek (-624). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-624 Macroinvertebrate Class 7 – Modified Use	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14DM055	28.35	13.72	24.09	0.91	75.61	29.57
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)</i>	9.74	24.34	20.62	15.52	59.46	22.88
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate assemblage in this reach scored below average in four of the six habitat related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 129). Site 14DM055 did have above average numbers of both clinger and sprawler individuals, which can typically signal a stream not stressed by poor habitat, however, this reach also had high numbers of both legless and burrower species, which are often found in streams with silty substrates. This reach also had low numbers of EPT taxa and climber individuals, which is common in streams with degraded habitat.

Based on the poor habitat observed resulting in a low MSHA score, as well as the majority of the fish and macroinvertebrate metrics related to habitat scoring below average, habitat is a stressor to aquatic life in Unnamed Creek (-624).

Altered Hydrology

Unnamed Creek (-624) is altered and the majority of its entire upstream watershed is altered according to the MPCA altered watercourse layer.

“The relative proportion of channel alteration within the Lime Creek Watershed is less than that of the Beaver Creek Watershed. On average, 30% of the channel miles within the Lime Creek subwatersheds have previously been altered.” (DNR 2016).

Extreme weather events affect high flow events as well as also low flows during drought. HSPF models show this section of Unnamed Creek (-624) experiencing low flow at less than five cfs 67.8% of the time and less than one cfs 21.6% of the time.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The average percentage for generalist fish within the reach was 57.4% compared to the average in Class 3 modified use waters meeting the standard of 56.3%. General fish populations ranged from 28.6-86.1%.

The numbers of nest guarder species are also positively correlated with increased low flows. The average percentage for nest guarder fish within the reach was 42.2% compared to the average in Class 3 modified use waters meeting the standard of 24%. Nest guarder fish species ranged from 0-84.3%.

Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The average percentage for long-lived macroinvertebrates within the reach was 0.3% compared to the average in Class 7 modified use waters meeting the standard of 5.6%. Long-lived macroinvertebrates ranged from 0.3-0.3%.

Based on this information, Altered Hydrology is a stressor to aquatic life in Unnamed Creek (-624).

Summary

The impaired fish and macroinvertebrate communities in Unnamed Creek (-624) are being stressed by DO, Eutrophication, Nitrates, Habitat and Flow Alteration/Connectivity (Table 130). Suspended Sediment was ruled out as a stressor to aquatic life. For further information on the stressors and recommendations to fixing the stressors in the Lime Creek HUC 10 Watershed, please see page 126.

Table 130. Stressor determinations for Unnamed Creek (-624).

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Unnamed Creek	07100001-624	●	●	●	---	●	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Unnamed Creek (07100001-625)

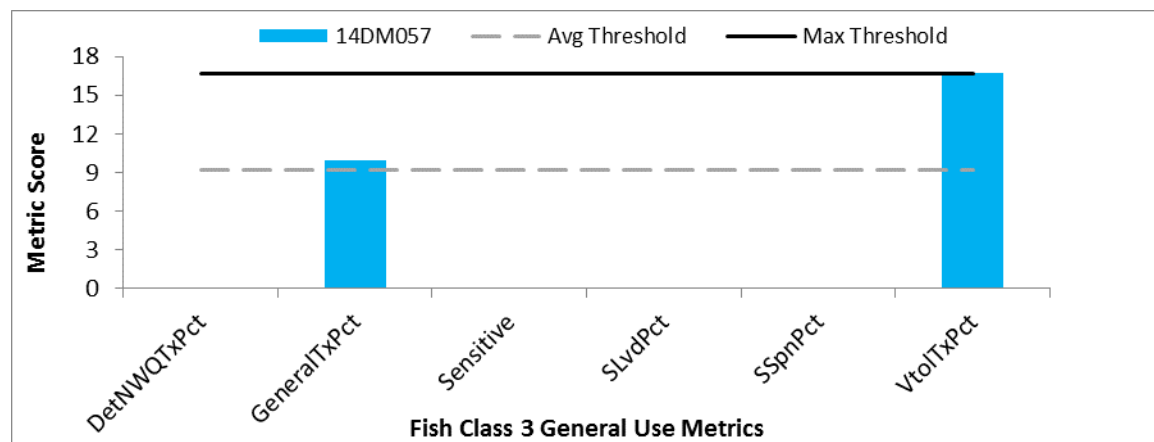
Located in east central Murray County, Unnamed Creek (-625) is a 2.34 mile long reach that is impaired for aquatic life due to both the fish and macroinvertebrate assemblages. This stream reach extends from an unnamed ditch to the inlet of Lime Lake. Along this stream section there is one biological monitoring station, 14DM057.

Biology

Fish

The fish community in Unnamed Creek (-625) was sampled in July of 2014 at biological monitoring station 14DM057. This site had an FIBI score of 26.6, which is far below the Fish Class 3 Southern Headwaters General Use Threshold of 55. This reach scored above the average needed to reach the threshold in two of the metrics (GeneralTxPct, VtolTxPct) that comprise the FIBI for this class (Figure 57). The remaining four metrics had a score of zero. Site 14DM057 had a very low sample size (< 25 fish sampled).

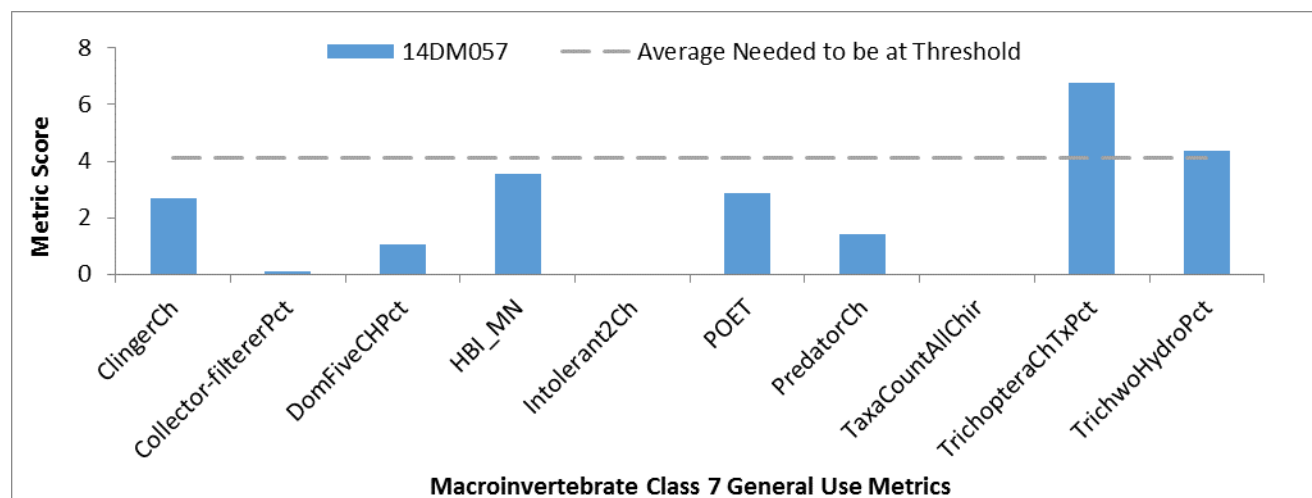
Figure 57. Unnamed Creek (-625) fish IBI metric scores.



Macroinvertebrates:

The macroinvertebrate assemblage at site 14DM057 was sampled in August of 2014. This visit had a MIBI score of 22.8, which is below the Macroinvertebrate Class 7 Prairie Streams GP General Use Threshold of 41. This site had two metrics (TrichopteraChTxPct, TrichwoHydroPct) scoring above the average needed to reach the threshold. However, the remaining eight metrics scored below average with two of these metrics scoring zero. See Figure 58 for a complete breakdown of the metric scores at this site.

Figure 58. Unnamed Creek (-625) macroinvertebrate IBI metric scores.



Dissolved Oxygen

A total of 10 DO measurements were taken from one chemistry site (S009-052) and one biological monitoring station (14DM057) from 2014-2016. The average of all the values is 8.98 mg/L with a low of 5.84 mg/L and a high of 12.45 mg/L. The summer average (June-Aug) is 8.35 mg/L. The DO values did not fall below 5 mg/L.

The HSPF model calculated daily minimum DO values for this subwatershed from 1994-2014. Of these calculations, 955 (35.83%) of the days had a daily minimum DO level below the daily minimum standard of 5 mg/L.

Table 131. DO fish related metrics in Unnamed Creek (-625). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-625 Fish Class 3 – General Use	MA>3 Avg	SspnPct Avg	Taxa Count Avg	DO TIV Avg
14DM057	16.67	0.00	4.00	8.27
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	13.32	17.09	12.16	8.44
Expected response to DO stress	↓	↑	↓	↓

The fish community in Unnamed Creek (-625) at site 14DM057 scored below average in two of the four DO related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 131). This reach had an increased amount of late maturing fish, while also having zero serial spawning individuals. In addition, this reach did have a below average DO TIV score and only four different species were sampled. Altogether, only six individual fish were sampled which may be skewing the results for this community.

Table 132. DO related macroinvertebrate metrics in Unnamed Creek (-625). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-625 Macroinvertebrate Class 7 – General Use	HBI_MN Value	% DO Tolerant Taxa	# DO Tolerant Taxa	ChemTV_DO
14DM057	7.79	59.03	3.00	6.27
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	7.55	12.98	5.74	6.91
Expected response to DO stress	↑	↑	↑	↓

The macroinvertebrate assemblage in Unnamed Creek (-625) scored below average in three of the four DO related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 132). This reach had a lower amount of DO tolerant taxa, but did have a very high percentage of DO tolerant taxa present in the community. This reach also had a below average DO TIV score. These results are common in streams stressed by DO conditions.

The observed DO data did not fall below the daily minimum standard; however, the modeled data calculated a high frequency of exceedances of the standard. The majority of the fish and macroinvertebrate metrics related to DO scored below average including the DO TIV scores for both communities. This reach also experiences high concentrations of phosphorus, which can negatively impact the DO levels. Therefore, DO is a stressor to aquatic life in Unnamed Creek (-625).

Eutrophication

A total of 10 phosphorus samples were taken from one chemistry site (S009-052) and one biological monitoring station (14DM057) from 2014-2016. The average of all the values is 0.180 mg/L with a low of 0.05 mg/L and a high of 0.28 mg/L. The summer average (June-Aug) is 0.216 mg/L. Phosphorus values exceeded the standard of 0.150 mg/L seven times.

The HSPF model also calculated daily phosphorus concentrations for this subwatershed from 1994-2014. These values ranged from 0.27-1.95 mg/L with an average phosphorus concentration of 0.55 mg/L. All of these calculations were above the 0.15 mg/L standard.

Table 133. Eutrophication related fish metrics in Unnamed Creek (-625). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-625 Fish Class 3 – General Use	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct
14DM057	0.00	0.00	83.33	16.67
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	8.9	12.11	70.79	14.71
Expected response to Eutrophication stress	↓	↓	↑	↑

The fish assemblage in Unnamed Creek (-625) at site 14DM057 scored below average in all four of the eutrophication related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 133). This site had a high percentage of tolerant fish individuals, while also completely lacking darter and sensitive fish individuals. These results are common

in streams being negatively impacted by eutrophication. The fish community only had six individuals sampled, so the metric data may be skewed with such a small sample size.

Table 134. Eutrophication related macroinvertebrate metrics in Unnamed Creek (-625). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

	EPT Pct	Tanytarsini Pct	CrustMoll Pct	Scraper Pct	% Tolerant Taxa	% Intolerant Taxa
07100001-625						
Macroinvertebrate Class 7 – General Use						
14DM057	21.04	3.85	65.05	20.71	75.16	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	38.45	18.46	11.78	16.11	26.84	4.03
Expected response to Eutrophication stress	↓	↓	↑	↑	↑	↓

The macroinvertebrate community in this reach scored below average in all six of the eutrophication related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 134). This reach had a very high amount of phosphorus tolerant taxa, while also having increased amounts of scraper and crustacean/mollusca individuals, which can be a signal for eutrophication stress. This reach also had decreased numbers of EPT and tanytarsini individuals. These results also indicate likely stress from eutrophic conditions.

Based on the very high observed and modeled phosphorus concentrations, in addition to the very poor scoring metrics related to eutrophication in both the fish and macroinvertebrate assemblages, eutrophication is a stressor to aquatic life in Unnamed Creek (-625).

Nitrates

Ten samples taken from one chemistry site (S009-052) and one biological monitoring station (14DM057) from 2014-2016 were analyzed for Inorganic Nitrogen (NO₂-NO₃). The average of all the values is 9.02 mg/L with a low of 2.40 mg/L and a high of 19.00 mg/L. The spring average (March-May) is 16.50 mg/L. The summer average (June-Aug) is 7.39 mg/L. Nitrate values exceeded 4 mg/L seven times. Quantile regression analysis showed that when a Class 7 station had a nitrate concentration at or exceeding 11.5 mg/L there was 90% probability for impairment. The nitrate concentrations in this reach easily exceeded this level.

The HSPF model calculated daily nitrate concentrations for the subwatershed from 1994-2014. These values ranged from 1.87-17.76 mg/L with an average nitrate concentration of 10.23 mg/L. Of these calculations 310 (38.51%) were above 11.5 mg/L. This is a very high rate.

Table 135. Nitrate related macroinvertebrate metrics in Unnamed Creek (-625). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-625 Macroinvertebrate Class 7 – General Use	TrichopteraChTx Pct	N Index Score	% N Tolerant	% N Intolerant
14DM057	11.11	3.33	36.13	0.00
<i>Statewide average for Class 7 Prairie Streams Glide Pool stations that are meeting the MIBI General Use Threshold (41)</i>	10.00	3.30	57.57	0.91
Expected response to N stress	↓	↑	↑	↓

The macroinvertebrate assemblage scored below average in two of the four nitrate related metrics when compared to all other Class 7 Prairies Streams GP stations that meet the MIBI General Use Threshold (Table 135). The site, 14DM057, did have above average amount of trichoptera taxa while also having a lower amount of nitrate tolerant individuals. This site did have a slightly below average nitrate index score and completely lacked nitrate intolerant species as well.

The nitrate related metric results for the macroinvertebrate community were rather mixed, however, the high observed and calculated nitrate values, as well as the quantile regression analysis indicates that nitrates are indeed a stressor to aquatic life in Unnamed Creek (-625).

Suspended Solids

Nine samples taken from one chemistry site (S009-052) in 2016 were analyzed for TSS. The average of all the values is 44 mg/L with a low of 14 mg/L and a high of 120 mg/L. The TSS concentrations exceeded the 65 mg/L standard three times.

Additionally, nine secchi tube measurements were taken from this reach. These values ranged from 4-49 cm, with an average reading of 26.67 cm. Two values fell below the 10 cm minimum standard for secchi tube.

The HSPF model calculated daily TSS values for this subwatershed from 1994-2014. These concentrations ranged from 2.69-1139.02 mg/L with an average TSS value of 124.13 mg/L. Of these calculations, 291 (36.15%) were above the TSS standard. This is a very high average TSS concentration and standard exceedance rate.

Table 136. TSS related fish metrics in Unnamed Creek (-625). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-625 Fish Class 3 – General Use	BenFdFrimPct	Centr-TolPct	HerbVPct	Percfm-TolPct	RifflePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14DM057	16.67	0.00	50.00	0.00	16.67	0.00	16.67	0.00	16.67	21.05
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	37.83	0.90	13.33	13.93	28.33	8.55	33.71	1.95	3.56	15.27
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

The fish community in Unnamed Creek (-625) at site 14DM057 scored below average in eight of the ten TSS related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 136). Only six individual fish were sampled, which may skew the metric results in this reach.

Table 137. TSS related macroinvertebrate metrics in Unnamed Creek (-625). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-625 Macroinvertebrate Class 7 – General Use	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plectoptera Pct
14DM057	18.65	0.00	5.00	25.81	0.65	0.32
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (22.0)</i>	17.35	1.33	13.20	48.28	19.13	0.22
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

The macroinvertebrate community in this reach scored below average in four of the six TSS related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 137). Site 14DM057 did have a lower amount and percentage of TSS tolerant taxa and individuals present. However, the reach did score poorly in the remaining metrics signaling possible stress due to elevated TSS conditions.

Based on the relatively high exceedance rate in the observed data set, the very high exceedance rate predicted by the HSPF model, as well as the majority of the TSS related metrics in both biotic communities, TSS is a stressor to aquatic life in Unnamed Creek (-625) at this time.

Habitat

Unnamed Creek (-625) had a qualitative habitat assessment take place at its biological monitoring site, 14DM057, during the fish and macroinvertebrate sampling events in 2014. The average MSHA score from these visits was 36.9 (Poor). Limiting the habitat at this site was the row crop agriculture as the dominant nearby land use, severe bank erosion (Figure 59), light stream shading, sparse fish cover, fair channel development, moderate channel stability and poor sinuosity. Further MSHA analysis can be seen in [Figure 60](#).

Figure 59. Bank erosion at site 14DM057.



Figure 60. Unnamed Creek (-625) MSHA metric scores.

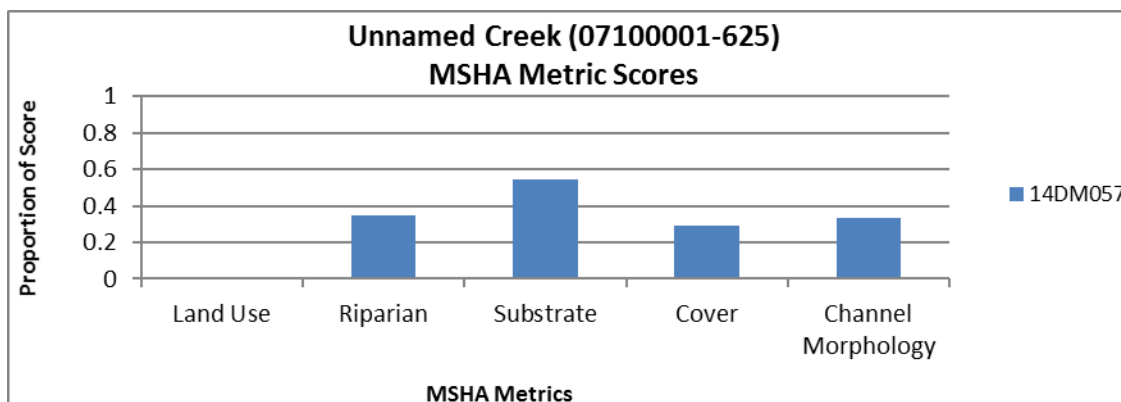


Table 138. Habitat related fish metrics in Unnamed Creek (-625). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-625 Fish Class 3 – General Use	BenInsect- ToIPct	SlithopPct	DarterSculps ucPct	RifflePct	PiscivorePct	LithFrimPct	ToIPct	PioneerPct
14DM057	0.00	16.67	0.00	16.67	16.67	33.33	83.33	16.67
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	14.22	33.71	12.55	28.33	1.62	69.21	70.64	37.79
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

The fish community in Unnamed Creek (-625) at site 14DM057 scored below average in six of the eight habitat related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 138). The stream reach did show above average numbers of piscivore and pioneer individuals, while scoring low in the other metrics. The metric data for this community may be skewed as only six fish individuals were sampled: brassy minnow (3), white sucker (1), northern pike (1), and creek chub (1). The lack of fish present may also be an indicator of poor habitat conditions available.

Table 139. Habitat related macroinvertebrate metrics in Unnamed Creek (-625). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-625 Macroinvertebrate Class 7 – General Use	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14DM057	1.94	9.39	19.09	21.04	16.50	59.55
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)</i>	5.40	20.35	36.94	37.77	37.96	19.49
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate assemblage in this reach scored below average in three of the six habitat related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 139). This reach had an above average number of sprawler individuals, while also having lower amounts of both burrower and legless individuals. The numbers of burrowers and legless species are often higher in streams being negatively impacted by sedimentation. The substrate in this reach was mostly sand and gravel. This site also had lower numbers of climber, clinger, and EPT individuals, which is common in streams being stressed by the habitat conditions.

Based on the poor MSHA score, low amount of fish sampled, in addition to many of the poor scoring fish and macroinvertebrate metrics related to habitat, habitat is a stressor to aquatic life at this time. Small habitat improvements may have a large impact on the current habitat conditions in this reach.

Altered Hydrology

Unnamed Creek (-625) is altered and 29% of its entire upstream watershed is altered according to the MPCA altered watercourse layer.

“The relative proportion of channel alteration within the Lime Creek Watershed is less than that of the Beaver Creek Watershed. On average, 30% of the channel miles within the Lime Creek subwatersheds have previously been altered.” (DNR 2016).

Extreme weather events affect high flow events as well as also low flows during drought. HSPF models show this stream section experiencing low flow at less than five cfs 70.8% of the time and less than one cfs 23.8% of the time (Figure 61).

Figure 61. Low flow through culvert at S009-052.



Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The percentage for generalist fish within the reach was 33.3% compared to the average in Class 3 general use waters meeting the standard of 59.1%.

The numbers of nest guarder species are also positively correlated with increased low flows. The percentage for nest guarder fish within the reach was 0.0% compared to the average in Class 3 general use waters meeting the standard of 19.2%.

Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The percentage for long-lived macroinvertebrates within the reach was 0.6% compared to the average in Class 7 general use waters meeting the standard of 8%.

Based on the relatively poor scoring biological metrics along with the high frequency of low flow conditions that this reach experiences, Flow Alteration/Connectivity is a stressor to aquatic life in Unnamed Creek (-625).

Summary

The impaired fish and macroinvertebrate communities in Unnamed Creek (-625) are being stressed by DO, Eutrophication, Nitrates, Suspended Sediment, Habitat and Flow Alteration/Connectivity (Table 140). For further information on the stressors and recommendations to fixing the stressors in the Lime Creek HUC 10 Watershed, please see page 126.

Table 140. Stressor determinations for Unnamed Creek (-625).

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Unnamed Creek	07100001-625	●	●	●	●	●	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Lime Creek Watershed (0710000103) HUC 10 conclusion and recommendations

The Lime Creek subwatershed has three biologically impaired streams that are being negatively impacted by a number of stressors throughout the watershed. Stressors found in all three of the impaired reaches include DO, Eutrophication, Nitrates, and Habitat. Suspended sediment and Flow Alteration/Connectivity were also found to be a stressor in two of the reaches (Table 141).

Like many of the subwatersheds, the predominant land use is row crop agriculture. This is a significant contributor to the stressors found in these reaches. The land use combined with the channelization of these stream reaches and their tributaries are a major reason why these streams are impaired for aquatic life. These practices often lead to high nitrate and phosphorus levels through excessive use of fertilizers that can quickly reach the stream system by drain tiles and field runoff. The elevated phosphorus levels will also impact the DO conditions resulting in many more tolerant fish and macroinvertebrate communities.

Channelizing streams can also lead to very high flow rates resulting in bank erosion. Bank erosion leads to higher amounts of both bedded and suspended sediment in the stream resulting in poor habitat and visibility conditions impacting the breeding and feeding environments for more sensitive fish and macroinvertebrate species. Habitat was found to be a stressor in all three reaches, while suspended sediment was determined to be a stressor in two.

A large effort is needed in the Lime Creek Watershed to improve biological conditions in the impaired streams found throughout. Better managing the effects of flow alteration should be a high priority in this watershed. This can be achieved by increasing the storage and infiltration of water in locations with flow alteration stressors. This will also help reduce sediment inputs from stream banks, improve habitat by protecting streambanks, reduce erosion and overall stream sedimentation. Re-establishing a quality riparian corridor with deep rooted vegetation to increase stream stabilization, shading, and habitat features is also needed to improve conditions. Also, utilizing a variety of nutrient reducing BMPs including: cover crops, nutrient management, saturated buffers, etc., will also help in the nitrate and phosphorus reduction. This could also help with the eutrophication and resulting DO issues as well.

Table 141. Stressor determinations for the Lime Creek Watershed.

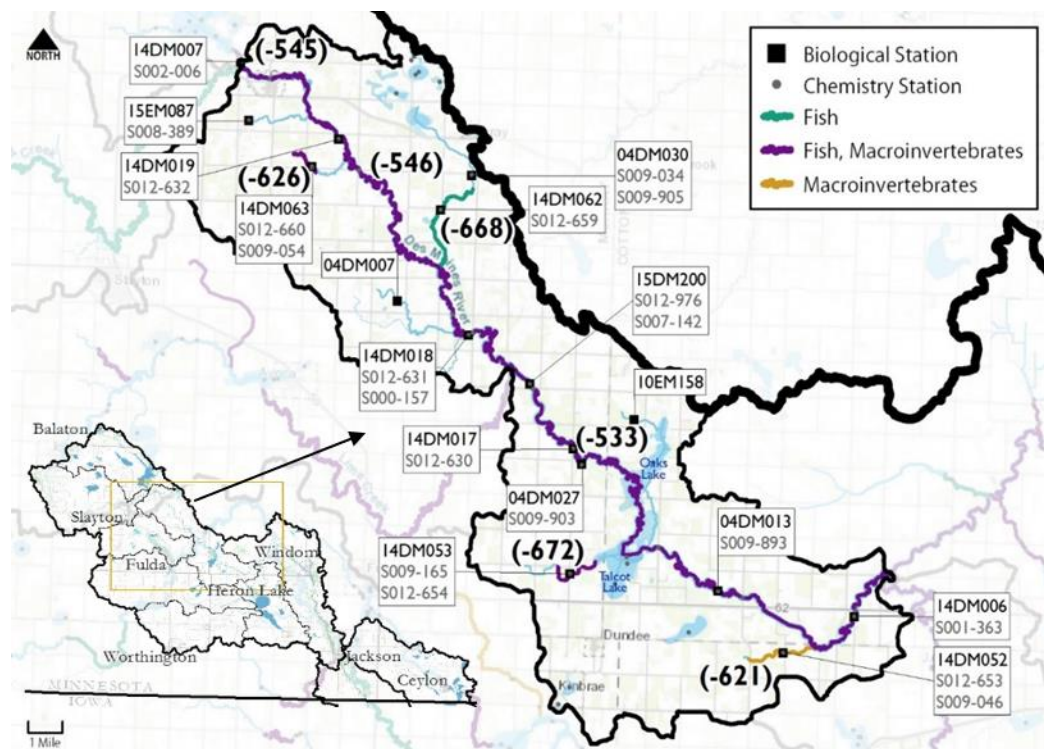
Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Lime Creek	07100001-535	●	●	●	●	●	o
Unnamed Creek	07100001-624	●	●	●	---	●	●
Unnamed Creek	07100001-625	●	●	●	●	●	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

5.4. Talcot Lake – Des Moines River Watershed (0710000104)

The Talcot Lake-Des Moines River HUC-10 Watershed (0710000104) is a 151.34 mi² watershed (Figure 62) located in the east central portion of the Des Moines River-Headwaters Watershed. This watershed contains seven biologically impaired reaches. The primary land use within this watershed by far is row crop agriculture.

Figure 62. Talcot Lake-Des Moines River Watershed with monitoring stations and biological impairments.



Des Moines River (07100001-533)

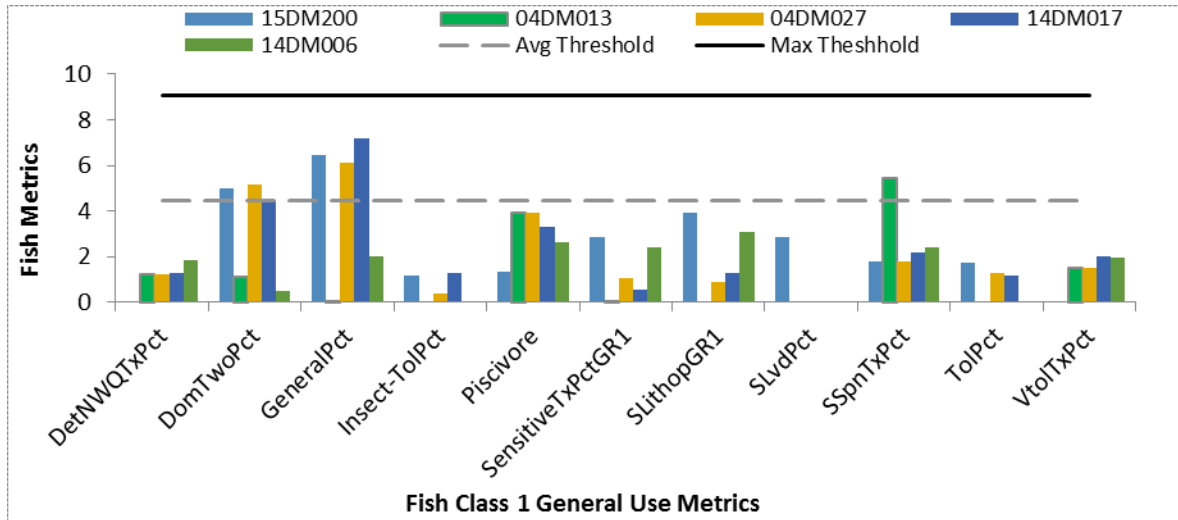
Located in southeast Murray County and southwest Cottonwood County, the Des Moines River (-533) is a 28.34 mile long reach that is impaired for aquatic life due to both the fish and macroinvertebrate assemblages. This stream reach extends from Lime Creek to the outlet of Heron Lake. Along this stream section, there are five biological monitoring stations, 04DM013, 04DM027, 14DM006, 14DM017, and 15DM200.

Biology

Fish

The fish community in Des Moines River (-533) was sampled at the biological monitoring stations located along the reach, 15DM200, 04DM013, 04DM027, 14DM017, and 14DM006. Site 15DM200 was sampled in August of 2016 and had a FIBI score of 26.2. Site 04DM013 was sampled in July of 2004 and had a FIBI score of 13.3. Site 04DM027 was sampled in August of 2004 and had a FIBI score of 23.4. Site 14DM017 was sampled twice in August of 2014 and had an average FIBI score of 24.8. Finally, site 14DM006 was sampled in August of 2014 and had an FIBI score of 16.8. All of these scores are below the Fish Class 1 Southern Rivers General Use Threshold of 49. See Figure 63 for further analysis of the metric scores in this reach.

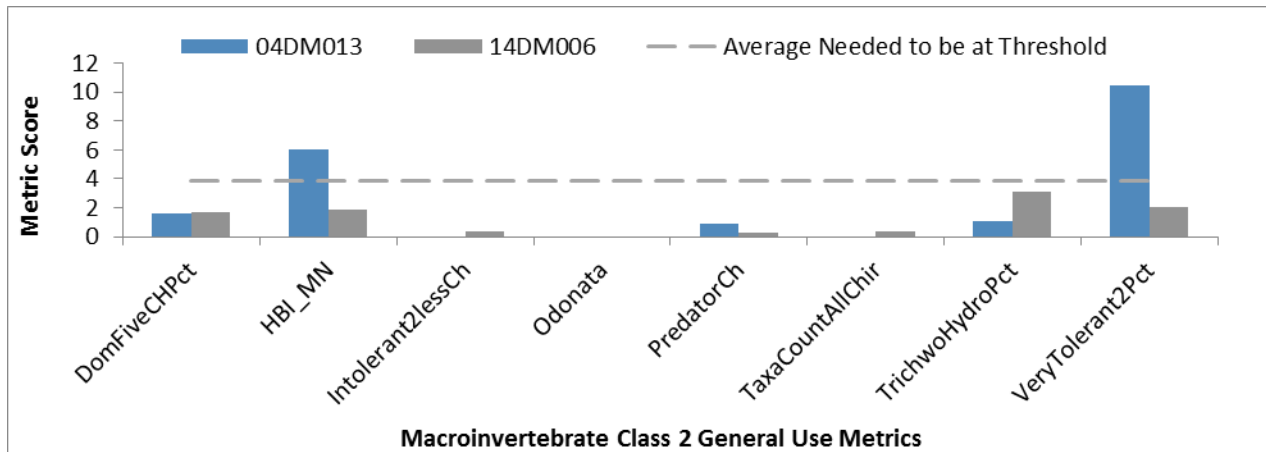
Figure 63. Des Moines River (-533) fish IBI metric scores.



Macroinvertebrates

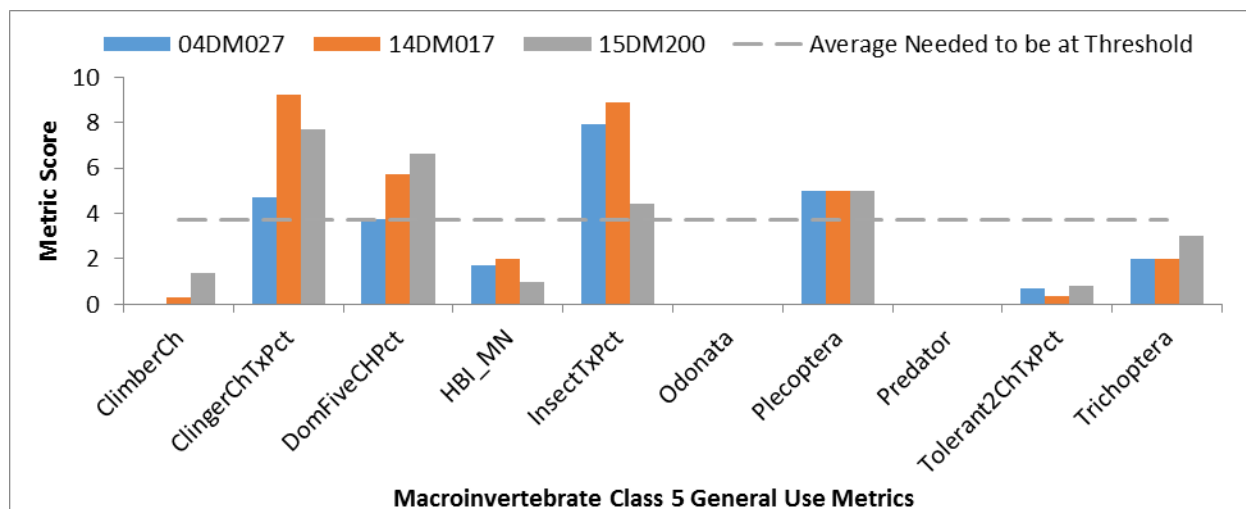
The macroinvertebrate assemblages were sampled at sites 04DM013 in September of 2004 and 14DM006 was sampled in August of 2014 and 2015. The average MIBI scores from these visits were 20.15 (04DM013) and 9.65 (14DM006). These scores are below the Macroinvertebrate Class 2 Prairie Forest Rivers General Use Threshold of 31. Site 04DM013 had two metrics (HBI_MN, VeryTolerant2Pct) scoring above the average needed to reach the threshold, while the remaining metrics scored below average. All of the metrics at site 14DM006 scored below average needed to reach the threshold. See Figure 64 for a complete breakdown of the metric scores at this site.

Figure 64. Des Moines River (-533) macroinvertebrate IBI Class 2 metric scores.



The macroinvertebrate assemblage was sampled at sites 04DM027 in September of 2004 and had a MIBI score of 25.1. Site 14DM017 was sampled in August of 2014 and had a MIBI score of 34.4 while 15DM200 was sampled in August of 2015 and had a MIBI score of 30.5. All of these scores were below the Macroinvertebrate Class 5 Southern Streams RR General Use Threshold of 37. All three sites had four metrics (ClingerChTxPct, DomFiveChPct, InsectTxPct, Plecoptera) scoring above the average needed to reach the threshold. However, the remaining six metrics scored below average. See Figure 65 for a complete breakdown of the metric scores at this site.

Figure 65. Des Moines River (-533) macroinvertebrate IBI Class 5 metric scores.



Dissolved Oxygen

A total of 91 DO measurements were taken from two chemistry sites (S007-142, S001-363) and four biological monitoring stations (04DM013, 04DM027, 14DM017, 15DM200) from 2003-2016. The average of all the values is 9.27 mg/L with a low of 4.27 mg/L and a high of 12.96 mg/L. The summer average (June-Aug) is 8.37 mg/L. The DO values fell below 5 mg/L twice.

The HSPF model calculated daily minimum DO values for this subwatershed from 1994-2014. Of these calculations, 736 (9.60%) of the days had a daily minimum DO level below the daily minimum standard of 5 mg/L.

Table 142. DO related fish metrics in Des Moines River (-533). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-533 Fish Class 1 – General Use	MA>3 Avg	SspnPct Avg	Taxa Count Avg	DO TIV Avg
04DM013	7.89	78.41	21.00	8.66
04DM027	6.46	39.02	21.00	8.59
14DM006	4.97	86.19	22.00	8.79
14DM017	9.65	61.21	18.50	8.79
15DM200	8.31	75.08	18.00	9.07
Statewide average for Class 1 Southern Rivers stations that are meeting the FIBI General Use Threshold (49.0)	40.4	35.61	22.44	8.76
Expected response to DO stress	↓	↑	↓	↓

The fish community in Des Moines River (-533) scored below average in three (14DM006, 14DM017, 15DM200) and four (04DM027, 04DM013) of the DO related metrics when compared to all other Class 1 Southern Rivers stations that meet the FIBI General Use Threshold (Table 142). All of these sites had slightly below average taxa counts, high percentages of serial spawning individuals, and few mature fish. Three of the sites did have an above average DO TIV score though.

Table 143. DO related macroinvertebrate metrics in Des Moines River (-533). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-533 Macroinvertebrate Class 2, 5 – General Use	HBL_MN Value	% DO Tolerant Taxa	# DO Tolerant Taxa	ChemTV _DO
04DM013	6.96	4.82	4.50	5.93
14DM006	7.91	2.59	3.50	7.29
<i>Statewide average for Class 2 Prairie Forest River stations that are meeting the MIBI General Use Threshold (31)</i>	7.32	8.67	4.41	7.13
04DM027	7.76	3.60	4.00	7.46
14DM017	7.68	2.27	4.00	7.62
15DM200	8.01	6.77	7.00	7.48
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	7.04	8.62	4.33	7.10
Expected response to DO stress	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in one (14DM006, 04DM027, 14DM017) and two (04DM013, 15DM200) of the four DO related metrics when compared to all other Class 2 Prairie Forest River and Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 143). All of these sites had a below average percentage of DO tolerant taxa present, while most of the sites also had a good DO TIV score. These results are not common in streams with DO issues.

Based on the low standard exceedance rate in the observed and modeled data, as well as the majority of the DO related metrics in the macroinvertebrate community scoring above average, DO is not a stressor to aquatic life in Des Moines River (-533). The fish community is likely being negatively impacted by other stressors causing lower metric scores.

Eutrophication

A total of 150 phosphorus samples were taken from two chemistry sites (S007-142, S001-363) and four biological monitoring stations (04DM013, 04DM027, 14DM017, 15DM200) from 2004-2017. The average of all the values is 0.208 mg/L with a low of 0.03 mg/L and a high of 0.90 mg/L. The summer average (June-Aug) is 0.217 mg/L. Phosphorus values exceeded the standard of 0.150 mg/L 96 times.

A total of 44 samples from one chemistry site (S001-363) from 2003-2004 were analyzed for BOD. The average for all the values is 7.18 mg/L with a low of 2.80 mg/L and a high of 14.00 mg/L. The summer average is (June-Aug) is 6.85 mg/L. The BOD value exceeded the standard of 3.50 mg/L 40 times.

Thirteen samples from one chemistry site (S007-142) in 2014 were analyzed for chlorophyll a. The average for all the values is 69.14 ug/L with a low of 6.96 ug/L and a high of 181 ug/L. The summer average is (June-Aug) is 69.14 ug/L. The chlorophyll a value exceeded the standard of 40 ug/L seven times.

Table 144. Eutrophication related fish metrics in Des Moines River (-533). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-533 Fish Class 1 – General Use	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct
04DM013	0.31	2.32	89.40	61.46
04DM027	1.81	4.39	71.32	14.47
14DM006	0.76	2.55	89.45	42.67
14DM017	0.11	10.37	72.34	10.40
15DM200	0.00	8.64	67.77	17.61
<i>Statewide average for Class 1 Southern Rivers stations that are meeting the FIBI General Use Threshold (49.0)</i>	13.75	4.46	22.36	15.72
Expected response to Eutrophication stress	↓	↓	↑	↑

The fish community in Des Moines River (-533) scored below average in two (14DM017), three (04DM027, 15DM200), and four (04DM013, 14DM006) of the four eutrophication related metrics when compared to all other Class 1 Southern Rivers stations that meet the FIBI General Use Threshold (Table 144). All five sites had very high amounts of tolerant individuals, while also lacking sensitive individuals. Many of these sites also had few darter individuals and had increased numbers of omnivorous individuals. These results largely reflect a community stressed by eutrophic conditions.

Table 145. Eutrophication related macroinvertebrate metrics in Des Moines River (-533). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-533 Macroinvertebrate Class 2, 5 – General Use	EPT Pct	Tanytarsini Pct	CrustMoll Pct	Scraper Pct	% Tolerant Taxa	% Intolerant Taxa
04DM013	29.75	1.96	2.48	4.35	6.37	0.00
14DM006	67.97	23.45	1.31	5.89	16.67	0.31
<i>Statewide average for Class 2 Prairie Forest River stations that are meeting the MIBI General Use Threshold (31)</i>	54.79	17.03	6.59	13.83	25.29	6.53
04DM027	69.09	6.25	0.00	31.27	15.47	0.36
14DM017	69.16	1.82	0.32	16.23	14.89	0.32
15DM200	80.50	2.86	4.64	30.03	32.92	0.62
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	43.90	27.84	9.23	15.78	17.17	5.79
Expected response to Eutrophication stress	↓	↓	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in one (14DM006), three (04DM013, 04DM027, 14DM017) and four (15DM200) of the six eutrophication related metrics when compared to all other Class 2 Prairie Forest River and Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 145). All five sites lacked many phosphorus intolerant taxa, while the majority of the sites low numbers of tanytarsini individuals and increased numbers of scraper individuals. These results signal potential eutrophic conditions.

Based on the very high exceedance rate of the phosphorus, BOD, and chlorophyll-a observed data sets, as well as the majority of the eutrophication related metrics in both the fish and macroinvertebrate

communities scoring below average, eutrophication is a stressor to aquatic life in Des Moines River (-533).

Nitrates

There were 173 samples taken from two chemistry sites (S007-142, S001-363) and four biological monitoring stations (04DM013, 04DM027, 14DM017, 15DM200) from 2004-2017 were analyzed for Inorganic Nitrogen (NO₂-NO₃). The average of all the values is 5.30 mg/L with a low of 0.05 mg/L and a high of 13.00 mg/L. The spring average (March-May) is 5.30 mg/L. The summer average (June-Aug) is 3.23 mg/L. Nitrate values exceeded 4 mg/L 103 times.

The HSPF model also calculated daily nitrate concentrations for this subwatershed from 1994-2014. These values ranged from .01-9.1 mg/L with an average nitrate concentration of 0.74 mg/L. These values are relatively low when compared to other areas in the watershed.

Table 146. Nitrate related macroinvertebrate metrics in Des Moines River (-533). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-533 Macroinvertebrate Class 2, 5 – General Use	TrichopteraChTx Pct	N Index Score	% N Tolerant	% N Intolerant
04DM013	13.35	2.17	16.12	0.00
14DM006	16.39	3.60	71.95	0.31
<i>Statewide average for Class 2 Prairie Forest River stations that are meeting the MIBI General Use Threshold (31)</i>	15.65	2.94	47.56	1.22
04DM027	12.90	2.91	32.73	0.36
14DM017	16.00	3.46	48.22	0.00
15DM200	16.67	3.33	48.62	0.31
<i>Statewide average for Class 5 Southern Streams Rock Riffle stations that are meeting the MIBI General Use Threshold (37)</i>	13.16	3.00	48.68	0.96
Expected response to N stress	↓	↑	↑	↓

The macroinvertebrate community in the Des Moines River (-533) scored below average in two (04DM013, 04DM027, 14DM017, 15DM200) and three (14DM006) of the four nitrate related metrics at the various sites located along this reach when compared to all other Class 2 Prairie Forest River and Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 146). All five sites had a very low amount of nitrate intolerant species, while the majority of the sites also had a very low nitrate index score. However, site 14DM006 was the only site to have a high amount of nitrate tolerant individuals.

The nitrate related biological metric results were rather mixed in this reach. The large data set of observed results indicate that the nitrate concentrations in this reach rarely get elevated. The HSPF model predicted similar results as the observed data. Therefore, it is likely other stressors that are negatively impacting some of the lower scoring metrics as nitrates are not a stressor to aquatic life in the Des Moines River (-533) at this time.

Suspended Solids

A total of 33 samples taken from one chemistry site (S001-363) from 2002-2014 were analyzed for TSS. The average of all the values is 154 mg/L with a low of 24 mg/L and a high of 2100 mg/L. The TSS concentrations exceeded the 65 mg/L standard mg/L 22 times. This is a very high exceedance rate.

Additionally, 143 secchi tube measurements were taken from this reach. These values ranged from 4-22 cm, with an average reading of 11.24 cm. A total of 55 values fell below the 10 cm minimum standard for secchi tube.

The HSPF model calculated daily TSS values for this subwatershed from 1994-2014. These concentrations ranged from 0.03-1581.18 mg/L with an average TSS value of 33.33 mg/L. Of these calculations, 501 (6.53%) were above the TSS standard of 65 mg/L.

This reach was determined to be impaired for turbidity during the 2004 assessment. This impairment was confirmed again during the 2016 assessment.

Table 147. TSS related fish metrics in Des Moines River (-533). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-533 Fish Class 1 – General Use	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RifflePct	SensitivePct	SlithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
04DM013	2.94	0.46	0.31	3.56	0.31	0.31	1.24	0.00	16.64	28.92
04DM027	7.49	9.04	36.95	13.70	2.33	1.81	2.84	0.00	7.49	26.96
14DM006	4.30	0.05	3.45	4.12	2.18	0.76	3.97	0.00	4.97	28.02
14DM017	12.99	0.11	16.80	14.94	4.67	0.11	11.16	0.00	6.36	28.03
15DM200	6.31	0.00	1.00	10.96	2.99	0.00	11.30	0.00	7.97	30.86
<i>Statewide average for Class 1 Southern Rivers stations that are meeting the FIBI General Use Threshold (49.0)</i>	21.36	4.12	1.04	17.97	13.92	13.53	24.97	4.63	43.61	25.99
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

The fish community in Des Moines River (-533) scored below average in eight (04DM027), nine (14DM006, 14DM017), and ten (04DM013, 15DM200) of the ten TSS related metrics when compared to all other Class 1 Southern Rivers stations that meet the FIBI General Use Threshold (Table 147). These metrics scores strongly suggest that the fish community is being stressed by the TSS conditions in this reach.

Table 148. TSS related macroinvertebrate metrics in Des Moines River (-533). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-533 Macroinvertebrate Class 2, 5 – General Use	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
04DM013	12.74	0.00	9.00	27.70	50.90	0.00
14DM006	21.00	0.50	12.50	76.37	48.36	0.00
<i>Statewide average for Class 2 Prairie Forest River stations that are meeting the MIBI General Use Threshold (31)</i>	18.18	2.52	14.09	49.06	22.93	0.55
04DM027	19.90	1.00	16.00	55.76	43.27	0.00
14DM017	19.89	0.00	14.00	62.46	49.68	0.32
15DM200	21.22	1.00	16.00	56.92	30.34	0.31
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)</i>	15.87	3.02	11.59	35.23	26.89	0.54
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

The macroinvertebrate community in this reach scored below average in two (04DM013), four (14DM006), and five (04DM027, 14DM017, 15DM200) of the six TSS related metrics when compared to all other Class 2 Prairie Forest River and Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 148). All five of the sites had very few plecoptera individuals and TSS intolerant taxa, while most of the sites also had a poor TSS Index score and elevated amounts of TSS tolerant individuals. These results are common in streams with elevated TSS concentrations.

Based on the high exceedance rate in the observed data set, the majority of the TSS related metrics scoring poorly in both the fish and macroinvertebrate communities, as well as the current turbidity impairment in this reach, TSS is a stressor to aquatic life.

Habitat

The Des Moines River (-533) had qualitative habitat assessments take place at its biological monitoring sites, 04DM013, 04DM027, 14DM006, 14DM017, and 15DM200, during the fish and macroinvertebrate sampling events in 2004, 2014, 2015, and 2016. The average MSHA scores from these visits were 51.15 (Fair) at 04DM013, 47.6 (Fair) at 04DM027, 59.47 (Fair) at 14DM006, 56.52 (Fair) at 14DM017, and 51.75 (Fair) at 15DM200. Limiting the habitat at these sites was the fenced pasture and row crop agriculture as nearby land uses, no riparian buffer, at times severe bank erosion (Figure 66), light stream shading, sand and silt substrates, light embeddedness, moderate channel stability, and fair channel development. Further MSHA analysis can be seen in Figure 67.

Figure 66. Bank erosion along Des Moines River (-533).



Figure 67. Des Moines River (-533) MSHA metric scores.

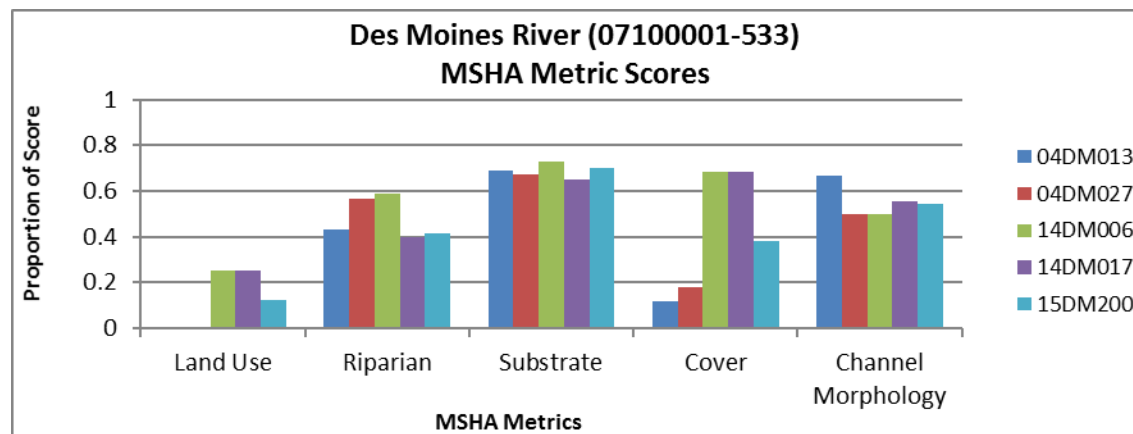


Table 149. Habitat related fish metrics in Des Moines River (-533). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-533 Fish Class 1 – General Use	BenInsect- ToIPct	SLithopPct	DarterSculpS ucPct	RifflePct	PiscivorePct	LithFrimPct	ToIPct	PioneerPct
04DM013	2.32	1.24	2.32	0.31	1.70	1.55	89.40	49.38
04DM027	4.65	2.84	4.39	2.33	10.34	3.36	71.32	17.31
14DM006	3.64	3.97	3.64	2.18	2.27	6.76	89.45	50.24
14DM017	10.37	11.16	10.37	4.67	5.67	12.77	72.34	20.80
15DM200	8.64	11.30	8.64	2.99	4.32	27.91	67.77	11.30
<i>Statewide average for Class 1 Southern Rivers stations that are meeting the FIBI General Use Threshold (49.0)</i>	20.61	24.97	18.51	13.92	15.18	29.21	22.05	5.21
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

The fish community in the Des Moines River (-533) at sites 04DM013, 04DM027, 14DM006, 14DM017, and 15DM200 scored below average in all eight of the habitat related metrics when compared to all other Class 1 Southern Rivers stations that meet the FIBI General Use Threshold (Table 149). All of these sites had high numbers of tolerant species, as well as pioneer taxa, which are commonly found in streams with degraded habitat. This stream reach also lacked many species that require specialized habitat conditions to spawn.

Table 150. Habitat related macroinvertebrate metrics in Des Moines River (-533). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-533 Macroinvertebrate Class 2, 5 – General Use	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
04DM013	10.03	21.12	35.74	33.00	43.44	20.66
14DM006	2.71	13.85	54.35	67.97	24.55	19.14
<i>Statewide average for Class 2 Prairie Forest Rivers stations that are meeting the MIBI General Use Threshold (31.0)</i>	4.24	11.76	44.81	57.13	22.86	15.51
04DM027	8.00	3.27	74.91	69.09	13.09	5.09
14DM017	0.65	18.51	65.26	69.16	17.86	3.25
15DM200	3.41	18.58	58.51	80.50	16.10	11.76
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)</i>	5.66	12.52	49.77	42.46	34.53	13.99
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate assemblage in this reach scored below average in zero (14DM006), one (14DM017, 15DM200), three (04DM027), and four (04DM013) of the six habitat related metrics when compared to all other Class 2 Prairie Forest Rivers and Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 150). Sites 04DM013 and 04DM027 fared much worse than the remaining three sites. Most of these sites did have a good amount of EPT and clinger individuals which can indicate a community not being negatively impacted by habitat conditions.

The habitat conditions in this reach are considered to be fair throughout the reach. The macroinvertebrate community did have some poor scoring habitat related metrics, but many did score well. However, all eight of the habitat related metrics in the fish community at all five stations along this reach scored poorly. Therefore, habitat is a stressor to aquatic life, especially the fish community, in the Des Moines River (-533).

Altered Hydrology

This reach of the Des Moines River is partly natural and partly altered and approximately 29% of the entire upstream watershed is altered according to the MPCA altered watercourse layer. This reach also goes through Talcot Lake, which has a fish barrier impoundment at the outlet of the lake.

Extreme weather events affect high flow events as well as also low flows during drought. HSPF models show this stream section experiencing low flow at less than five cfs 0.09% of the time and less than one cfs 0% of the time.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The average percentage for generalist fish within the reach was 58.2% compared to the average in Class 1 general use waters meeting the standard of 20.7%. General fish populations ranged from 51.7-64.6%.

The numbers of nest guarder species are also positively correlated with increased low flows. The average percentage for nest guarder fish within the reach was 50.8% compared to the average in Class 1 general use waters meeting the standard of 16%. Nest guarder fish species ranged from 50.4-51.2%.

Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The average percentage for long-lived macroinvertebrates within the reach was 4.7% compared to the average in Class 2 waters meeting the standard of 6.7%. Long-lived macroinvertebrates ranged from 4.2-5.2%. The average percentage for long-lived macroinvertebrates within the reach was 7.1% compared to the average in Class 5 general use waters meeting the standard of 9%. Long-lived macroinvertebrates ranged from 2.2-16.4%.

Despite the fish barrier as part of Talcot Lake, the fish community does not appear to be negatively impacted by it. The flow conditions do not reach low levels limiting the biological community either. Therefore, flow alteration/connectivity is not a stressor to aquatic life in Des Moines River (-533).

Summary

The impaired fish and macroinvertebrate communities in Des Moines River (-533) are being stressed by Eutrophication, Suspended Sediment, and Habitat (Table 151). DO, Nitrates, and Flow Alteration/Connectivity were ruled out as stressors to aquatic life in this reach. For further information on the stressors and recommendations to fixing the stressors in the Talcot Lake-Des Moines River HUC 10 Watershed, please see pages 182-183.

Table 151. Stressor determinations for Des Moines River (-533).

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Des Moines River	07100001-533	---	●	---	●	●	---

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Des Moines River (07100001-545)

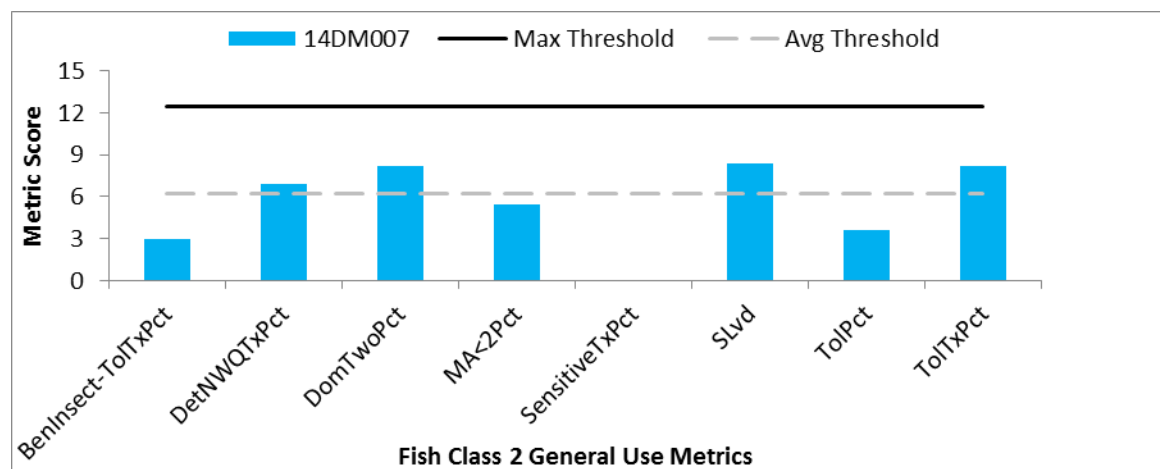
Located in north central Murray County, the Des Moines River (-545) is a 0.63 mile long reach that is impaired for aquatic life due to both the fish and macroinvertebrate assemblages. This stream reach extends from the outlet of Lake Shetek to the confluence with Beaver Creek. Along this stream section there is one biological monitoring station, 14DM007.

Biology

Fish

The fish community in Des Moines River (-545) was sampled for fish in August of 2014 at its biological monitoring station 14DM007. The FIBI score at this reach was 43.6, which is below the Fish Class 2 Southern Streams General Use Threshold of 50. This site did have four metrics (DetNWQTxPct, DomTwoPct, SLvd, TolTxPct) reach the average metric score needed to meet the threshold (Figure 68), however, the remaining four metrics comprising this FIBI scored well below average with one metric (SensitiveTxPct) scoring zero.

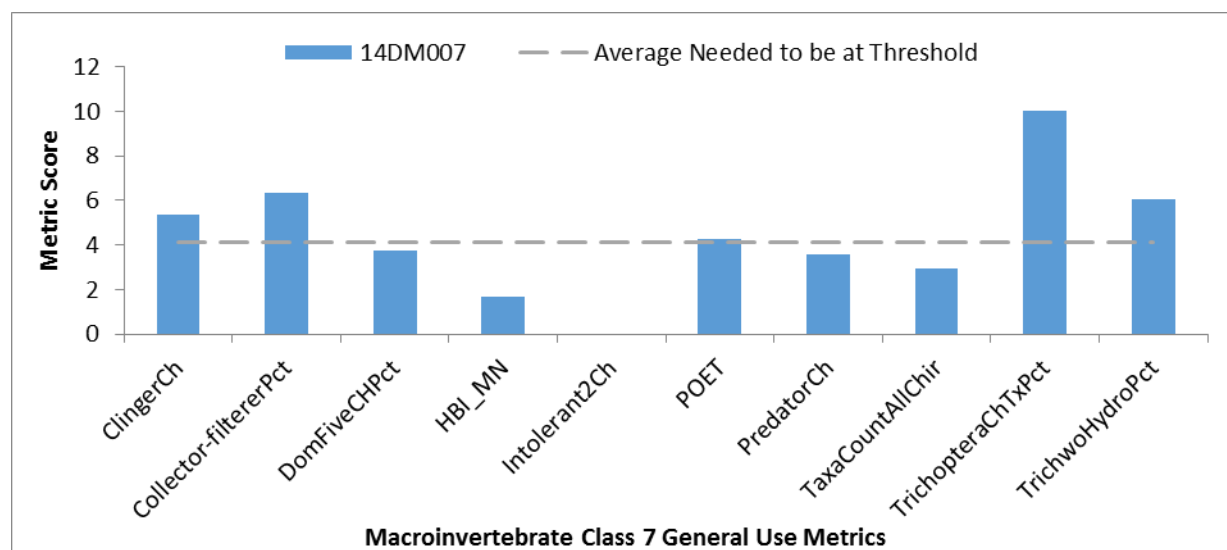
Figure 68. Des Moines River (-545) fish IBI metric scores.



The macroinvertebrate assemblage at site 14DM007 was sampled in August of 2014. This visit had a MIBI score of 44.0, which is above the Macroinvertebrate Class 7 Prairie Streams GP General Use Threshold of 41. This site had five metrics (ClingerCH, Collector-filtererPct, POET, TrichopteraChTxPct, TrichwoHydroPct) scoring above the average needed to reach the threshold. The remaining eight metrics scored below average with one of these metrics (Intolerant2Ch) scoring zero. See Figure 69 for a complete breakdown of the metric scores at this site.

This station scores better than all other mainstem Des Moines River sites yet appears to have some of the worst habitat; site was barely flowing with very little habitat to sample. Part of the reason for the relatively high IBI score is the classification of this stretch of the river as a low gradient stream. Even so, the IBI score at this site does not seem to reflect the poor (BCG 5) invertebrate community that is apparent when looking at the raw community data. The sample had 97% tolerant taxa, a cumulative of 73% represented by the top 5 dominant taxa, POET richness of 8, 0 intolerant taxa, 29 total taxa, and an HBI of 8.4 (low scores are better). This community is no better than any of the other downstream samples even after taking into consideration the low-gradient nature of this segment of the river. (MPCA 2016)

Figure 69. Des Moines River (-545) macroinvertebrate IBI metric scores.



Dissolved Oxygen

A total of 25 dissolved oxygen (DO) measurements were taken from one chemistry site (S002-006) from 2003-2015. The average of all the values is 6.90 mg/L with a low of 0.32 mg/L and a high of 15.70 mg/L. The summer average (June-Aug) is 5.43 mg/L. The DO values fell below 5 mg/L six times.

The HSPF model calculated daily minimum DO values for this subwatershed from 1994-2014. Of these calculations, 3262 (43.29%) of the days had a daily minimum DO level below the daily minimum standard of 5 mg/L.

Table 152. DO fish related metrics in Des Moines River (-545). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-545 Fish Class 2 – General Use	MA>3 Avg	SspnPct Avg	Taxa Count Avg	DO TIV Avg
14DM007	24.43	51.67	21.00	9.22
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)</i>	23.89	28.72	20.38	8.56
Expected response to DO stress	↓	↑	↓	↓

The fish community in Des Moines River (-545) at site 14DM007 scored below average in one of the four DO related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 152). This site had a high amount of serial spawning individuals, which is common in streams with poor DO conditions, however, the remaining metrics scored well.

Table 153. DO related macroinvertebrate metrics in Des Moines River (-545). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-545 Macroinvertebrate Class 7 – General Use	HBI_MN Value	% DO Tolerant Taxa	# DO Tolerant Taxa	ChemTV _DO
14DM007	8.35	38.99	10.00	6.18
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	7.55	12.98	5.74	6.91
Expected response to DO stress	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in all four of the DO related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 153). This reach had a high percentage and amount of DO tolerant taxa, while also having poor DO TIV and HBI_MN values. These results are common in communities stressed by DO.

The DO levels in this stream reach do fall below 5 mg/L based on the observed data set. These levels often occur during low flow events. The HSPF model also calculated a high rate of standard exceedances as well. The fish community did have a high amount of serial spawning fish and all of the DO related metrics in the macroinvertebrate community scored below average, therefore, DO is a stressor to aquatic life in Des Moines River (-545). The high phosphorus levels this stream also experiences may also be a contributor to the poor DO conditions.

Eutrophication

A total of 40 phosphorus samples were taken from one chemistry site (S002-006) and one bio site (14DM007) from 2004-2014. The average of all the values is 0.174 mg/L with a low of 0.10 mg/L and a high of 0.33 mg/L. Phosphorus values were at or exceeded the standard of 0.150 mg/L 26 times.

A total of 28 samples from one chemistry site (S002-006) from 2004 were analyzed for BOD. The average for all the values is 5.79 mg/L with a low of 3.8 mg/L and a high of 11.00 mg/L. The BOD values exceeded the standard of 3.50 mg/L all 28 times.

Table 154. Eutrophication related fish metrics in Des Moines River (-545). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-545 Fish Class 2 – General Use	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct
14DM007	0.00	12.04	61.42	21.18
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)</i>	19	11.47	45.1	17
Expected response to Eutrophication stress	↓	↓	↑	↑

The fish community in Des Moines River (-545) at site 14DM007 scored below average in three of the four eutrophication related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 154). This reach did have an above average number of darter individuals; however, this reach also lacked sensitive species and also had increased amounts of tolerant and omnivorous individuals. These results are often found in streams with eutrophication issues.

Table 155. Eutrophication related macroinvertebrate metrics in Des Moines River (-545). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-545 Macroinvertebrate Class 7 – General Use	EPT Pct	Tanytarsini Pct	CrustMoll Pct	Scraper Pct	% Tolerant Taxa	% Intolerant Taxa
14DM007	28.93	0.64	9.75	2.52	43.40	0.00
<i>Statewide average for Class 7 Prairie Streams Glide Pool stations that are meeting the MIBI General Use Threshold (41)</i>	38.45	18.46	11.78	16.11	26.84	4.03
Expected response to Eutrophication stress	↓	↓	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in four of the six eutrophication related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 155). This reach had decreased numbers of EPT and tanytarsini individuals, and phosphorus intolerant taxa, while also having a higher number of phosphorus tolerant species.

Based on the very high exceedance rate of the phosphorus and BOD data sets, as well as the majority of the eutrophication related metrics in both the fish and macroinvertebrate communities scoring below average, eutrophication is a stressor to aquatic life in Des Moines River (-545).

Nitrates

There were 29 samples taken from one chemistry site (S002-006) from 2004-2014 were analyzed for Inorganic Nitrogen (NO₂-NO₃). The average of all the values is 0.35 mg/L with a low of 0.06 mg/L and a high of 2.10 mg/L. The spring average (March-May) is 0.15 mg/L. The summer average (June-Aug) is 0.41 mg/L.

Table 156. Nitrate related macroinvertebrate metrics in Des Moines River (-545). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-545 Macroinvertebrate Class 7 – General Use	TrichopteraChTx Pct	N Index Score	% N Tolerant	% N Intolerant
14DM007	20.69	3.11	50.31	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	10.00	3.30	57.57	0.91
Expected response to N stress	↓	↑	↑	↓

The macroinvertebrate assemblage in Des Moines River (-545) scored below average in just one of the four nitrate related metrics when compared to all other Class 7 Prairies Streams GP stations that meet the MIBI General Use Threshold (Table 156). This site lacked nitrate intolerant taxa, but did have a lower amount of nitrate tolerant individuals, a higher amount of trichoptera taxa, and a good nitrate index score.

Based on the low nitrate concentrations from large observed data set as well as the majority of the nitrate related macroinvertebrate metrics scoring above average, nitrates are not a stressor to aquatic life in this reach.

Suspended Solids

A total of 46 samples taken from one chemistry site (S002-006) from 2002-2014 were analyzed for TSS. The average of all the values is 49.70 mg/L with a low of 18 mg/L and a high of 120 mg/L. The TSS concentrations exceeded the 65 mg/L standard eight times.

Additionally, 30 secchi tube measurements were taken from this reach. These values ranged from 2-46 cm, with an average reading of 16.84 cm. Eighteen of the measurements fell below the 10 cm minimum standard for secchi tube.

The HSPF model calculated daily TSS values for this subwatershed from 1994-2014. These concentrations ranged from 0.02-2667.87 mg/L with an average TSS value of 36.17 mg/L. Of these calculations, 625 (8.39%) were above the TSS standard of 65 mg/L.

This reach was listed as impaired for turbidity in 2006. This impairment was confirmed during the 2016 assessment as well.

Table 157. SS related fish metrics in Des Moines River (-545). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-545 Fish Class 2 – General Use	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RifflePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14DM007	14.67	3.43	0.00	25.92	2.20	0.00	6.77	0.00	26.63	31.59
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)</i>	37.38	4.89	9.61	18.66	32.49	18.65	39.38	4.97	11.68	17.59
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

The fish community in Des Moines River (-545) at site 14DM007 scored below average in eight of the ten TSS related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 157). This site had an above average amount of perch-like and long-lived individuals, however, the remaining metrics scored poorly especially the TSS Index Score. These results suggest a fish assemblage stressed by TSS.

Table 158. TSS related macroinvertebrate metrics in Des Moines River (-545). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-545 Macroinvertebrate Class 7 – General Use	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plectoptera Pct
14DM007	21.52	0.00	15.00	75.47	24.21	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (22.0)</i>	17.35	1.33	13.20	48.28	19.13	0.22
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

The macroinvertebrate assemblage in this reach scored below average in five of the six TSS related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 158). Site 14DM007 did have an above average amount of collector-filterer individuals, however, the site scored below average in the remaining metrics and had a very high amount of TSS tolerant individuals. These results are indicative of a community being stressed by TSS.

Based on the high exceedance rate in the observed data set, the majority of the TSS related metrics scoring poorly in both the fish and macroinvertebrate communities, as well as the current turbidity impairment in this reach, TSS is a stressor to aquatic life.

Habitat

Des Moines River (-545) had a qualitative habitat assessment take place at its biological monitoring site, 14DM007, during the fish and macroinvertebrate sampling events in 2014. The average MSHA score from these visits was 43.23 (Poor). Limiting the habitat at this site was the row crop agriculture as a nearby land use, a moderate riparian buffer, heavy bank erosion, sand and silt substrates, sparse fish cover, moderate embeddedness, fair channel development, and moderate channel stability. Further MSHA analysis can be seen in Figure 70.

Figure 70. Des Moines River (-545) MSHA metric scores.

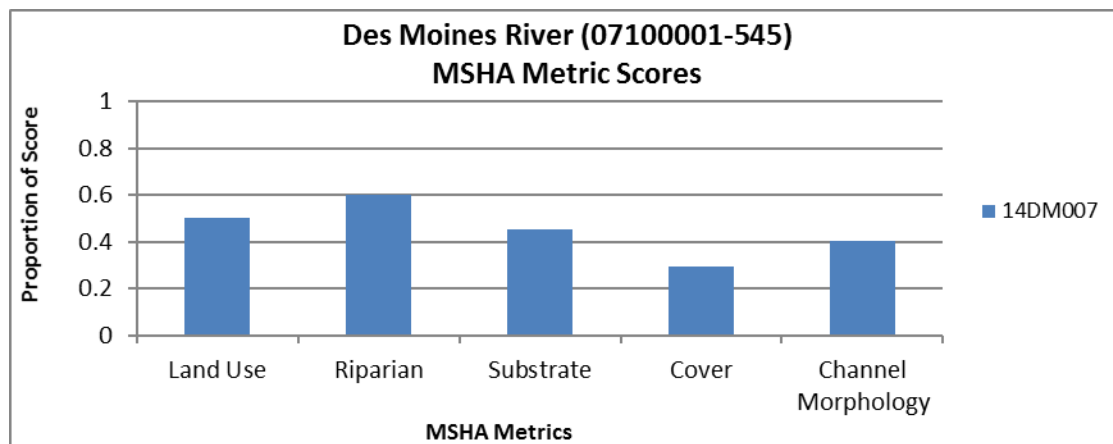


Table 159. Habitat related fish metrics in Des Moines River (-545). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-545 Fish Class 2 – General Use	BenInsect- ToIPct	SlithopPct	DarterSculpS ucPct	RifflePct	PiscivorePct	LithFrimPct	ToIPct	PioneerPct
14DM007	12.48	6.77	12.04	2.20	17.49	43.06	61.42	23.29
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	20.4	39.38	18.18	32.49	5.24	58.26	44.85	19.02
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

The fish community in Des Moines River (-545) at site 14DM007 scored below average in seven of the eight habitat related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 159). This site did have an above average amount of piscivore individuals, however, this reach also had a high number of tolerant and pioneer individuals, while also lacking many species requiring specialized habitat conditions to live and reproduce. These results are common in streams stressed by the current habitat conditions.

Table 160. Habitat related macroinvertebrate metrics in Des Moines River (-545). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-545 Macroinvertebrate Class 7 – General Use	BurrowerP ct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPc t
14DM007	15.09	22.01	35.85	28.93	51.26	23.27
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	5.40	20.35	36.94	37.77	37.96	19.49
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate assemblage in this stream reach scored below average in four of the six habitat related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 160). This stream did have above average numbers of both climber and

sprawler individuals, which can be a sign of good habitat. However, this reach also had a high amount of both burrower and legless individuals, which corresponds to the sand and silt substrates present. This site also had lower amounts of EPT and clinger individuals, which are signs of habitat stress.

Based on the poor MSHA score, in addition to the vast majority of the habitat related metrics in both the fish and macroinvertebrate communities scoring poorly or below average, habitat is a stressor to aquatic life in Des Moines River (-545).

Altered Hydrology

This reach of the Des Moines River partly natural and partly altered. This reach is the outlet of Lake Shetek and the lakes impoundment structure is located roughly in the middle of the AUID, which is a fish barrier impoundment at the outlet of the lake. The majority of the watershed upstream is altered according to the MPCA altered watercourse layer and has multiple lake impoundments and fish barriers.

Extreme weather events affect high flow events as well as also low flows during drought. HSPF models show this stream section experiencing low flow at less than five cfs 34.7% of the time and less than one cfs 30.6% of the time.

Generalist fish species, which are adaptable to different habitats through generalized food preferences are correlated with channelization. The percentage for generalist fish within the reach was 23.9% compared to the average in Class 2 general use waters meeting the standard of 42.4%.

The numbers of nest guarder species are also positively correlated with increased low flows. The percentage for nest guarder fish within the reach was 36.8% compared to the average in Class 2 general use waters meeting the standard of 19%.

Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The percentage for long-lived macroinvertebrates within the reach was 1.6% compared to the average in Class 7 general use waters meeting the standard of 8%.

Des Moines River (-545) does experience some low flow conditions and has a fish barrier located in the middle of the AUID, however, the biological response does not indicate stress as many of the metrics scored fairly well. Therefore, flow alteration/connectivity is inconclusive as a stressor to aquatic life in this reach.

Summary

The impaired fish and macroinvertebrate communities in Des Moines River (-545) are being stressed by DO, Eutrophication, Suspended Sediment, and Habitat (Table 161). Flow Alteration/Connectivity was inconclusive as a stressor while Nitrates were ruled out as a stressor to aquatic life in this reach. For further information on the stressors and recommendations to fixing the stressors in the Talcot Lake-Des Moines River HUC 10 Watershed, please see pages 182-183.

Table 161. Stressor determinations for Des Moines River (-545).

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Des Moines River	07100001-545	●	●	---	●	●	o

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Des Moines River (07100001-546)

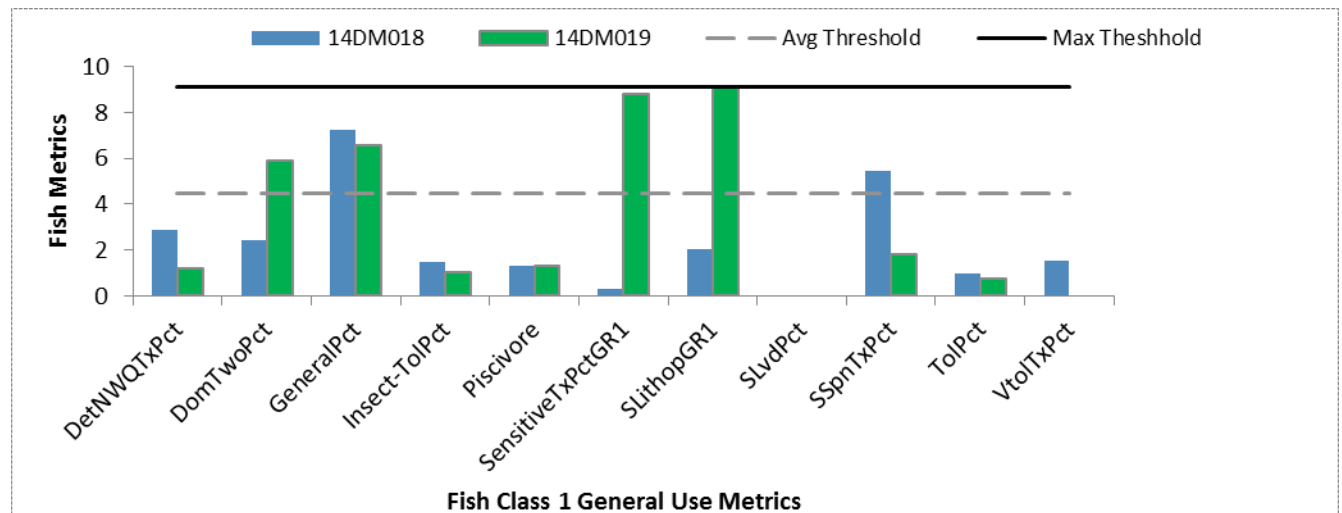
Located in eastern Murray County, the Des Moines River (-546) is a 24.80 mile long reach that is impaired for aquatic life due to both the fish and macroinvertebrate assemblages. This stream reach extends from Beaver Creek to the confluence with Lime Creek. Along this stream section, there are two biological monitoring stations, 14DM018 and 14DM019.

Biology

Fish

The fish community in Des Moines River (-546) was sampled for fish in August of 2014 at its biological monitoring stations 14DM018 and 14DM019. The FIBI score at these sites were 25.6 at 14DM018 and 36.5 at 14DM019, which are both below the Fish Class 1 Southern Rivers General Use Threshold of 49. Site 14DM019 had four while site 14DM018 had two metrics reach the average metric score needed to meet the threshold (Figure 71), however, the remaining metrics comprising this FIBI scored well below average.

Figure 71. Des Moines River (-546) fish IBI metric scores.

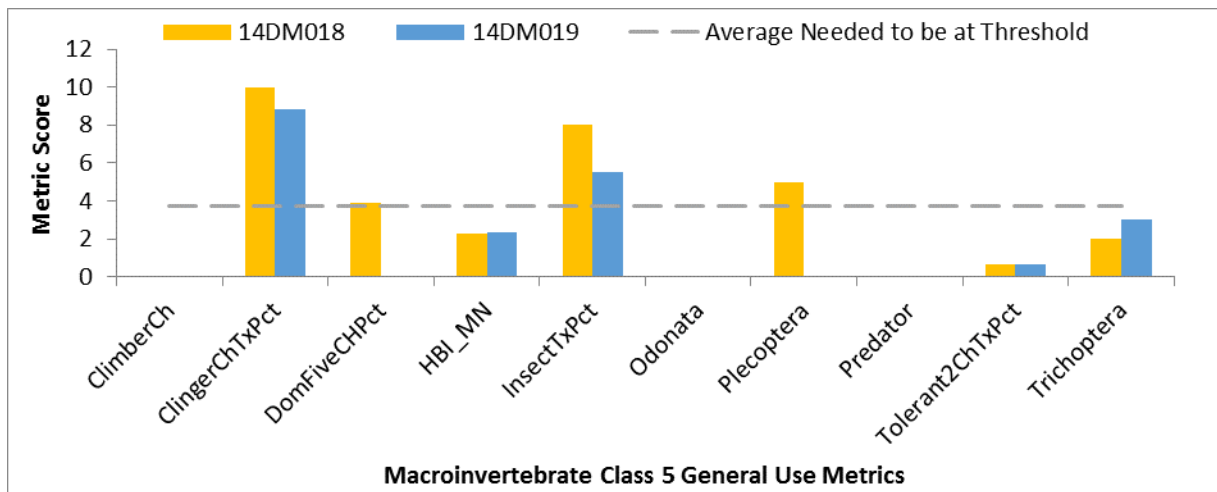


Macroinvertebrates:

The macroinvertebrate assemblage was sampled at sites 14DM018 and 14DM019 in August of 2014. The MIBI scores at these sites were 31.9 at 14DM018 and 20.4 at 14DM019. Both of these scores were below the Macroinvertebrate Class 5 Southern Streams RR General Use Threshold of 37. Site 14DM018

at three, while site 14DM019 had two metrics scoring above the average needed to reach the threshold. However, the remaining metrics scored below average. See Figure 72 for a complete breakdown of the metric scores at this site.

Figure 72. Des Moines River (-546) macroinvertebrate IBI metric scores.



Dissolved Oxygen

A total of 18 DO measurements were taken from one chemistry site (S002-008) and one biological monitoring station (14DM019) from 2003-2016. The average of all the values is 10.01 mg/L with a low of 7.74 mg/L and a high of 12.79 mg/L. The summer average (June-Aug) is 9.84 mg/L. The DO values never fell below 5 mg/L.

The HSPF model calculated daily minimum DO values for this subwatershed from 1994-2014. Of these calculations, 26 (0.34%) of the days had a daily minimum DO level below the daily minimum standard of 5 mg/L. This is a very low exceedance rate for DO.

Table 162. DO related fish metrics in Des Moines River (-546). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-546 Fish Class 1 –General Use	MA>3 Avg	SspnPct Avg	Taxa Count Avg	DO TIV Avg
14DM018	11.37	32.68	21.00	8.57
14DM019	8.93	60.54	21.00	8.87
<i>Statewide average for Class 1 Southern Rivers stations that are meeting the FIBI General Use Threshold (49.0)</i>	40.4	35.61	22.44	8.76
Expected response to DO stress	↓	↑	↓	↓

The fish community in Des Moines River (-546) at sites 14DM018 and 14DM019 scored below average in three of the four DO related metrics at both sites when compared to all other Class 1 Southern River stations that meet the FIBI General Use Threshold (Table 162). This reach had a decreased amount of mature fish, and both sites had a slightly below average overall taxa count. Site 14DM019 had an increased amount of serial spawning individuals, but did have a good DO TIV score. Site 14DM018 was the opposite has the site had a below average TIV score, but a decreased amount of serial spawning fish.

Table 163. DO related macroinvertebrate metrics in Des Moines River (-546). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

	HBI_MN Value	% DO Tolerant Taxa	# DO Tolerant Taxa	ChemTV_DO
07100001-546				
Macroinvertebrate Class 5 – General Use				
14DM018	7.56	0.00	0.00	7.68
14DM019	7.55	1.24	2.00	7.48
<i>Statewide average for Class 5 Southern Streams Rock Riffle stations that are meeting the MIBI General Use Threshold (37)</i>	7.04	8.62	4.33	7.10
Expected response to DO stress	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in one of the DO related metrics at both sites when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 163). Both sites had below average HBI_MN values, while scoring well in the remaining metrics. This reach had very few and a low percentage of DO tolerant taxa. This very low amount is a strong signal that this community is not being stressed by poor DO conditions.

None of the observed DO measurements fell below the 5 mg/L standard, while the HSPF model calculated a very low exceedance rate. The macroinvertebrate community strongly suggested that DO is not a stressor based on the very few DO tolerant taxa sampled in this stream. The fish metrics in this reach did score poorly; however, it is likely due to other stressors given that the DO levels or flux do not exceed the respective standards. DO is not a stressor to aquatic life in Des Moines River (-546) at this time.

Eutrophication

A total of 38 phosphorus samples were taken from one chemistry site (S002-008) and one biological monitoring station (14DM019) from 2004-2016. The average of all the values is 0.195 mg/L with a low of 0.05 mg/L and a high of 0.42 mg/L. The summer average (June-Aug) is 0.209 mg/L. Phosphorus values exceeded the standard of 0.150 mg/L 24 times.

A total of 44 samples from one chemistry site (S002-008) from 2003-2004 were analyzed for BOD. The average for all the values is 3.81 mg/L with a low of 0.70 mg/L and a high of 11.00 mg/L. The summer average is (June-Aug) is 4.39 mg/L. The BOD value exceeded the standard of 3.50 mg/L 20 times.

Two samples from one chemistry site (S002-008) in 2003 were analyzed for chlorophyll-a. The average for all the values is 62.80 ug/L with a low of 50.50 ug/L and a high of 75.10 ug/L. The summer average is (June-Aug) is 62.80 ug/L. The chlorophyll-a value exceeded the standard of 40 ug/L twice.

Table 164. Eutrophication related fish metrics in Des Moines River (-546). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-546 Fish Class 1 –General Use	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct
14DM018	0.55	5.14	74.21	12.90
14DM019	0.00	13.99	75.77	6.96
<i>Statewide average for Class 1 Southern Rivers stations that are meeting the FIBI General Use Threshold (49.0)</i>	13.75	4.46	22.36	15.72
Expected response to Eutrophication stress	↓	↓	↑	↑

The fish community in Des Moines River (-546) at sites 14DM018 and 14DM019 scored below average in two of the four eutrophication related metrics when compared to all other Class 1 Southern Rivers stations that meet the FIBI General Use Threshold (Table 164). Both sites had very few sensitive individuals, while also both having a high amount of tolerant fish present. These scores can potentially be due stress from eutrophic conditions.

Table 165. Eutrophication related macroinvertebrate metrics in Des Moines River (-546). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-546 Macroinvertebrate Class 5 – General Use	EPT Pct	Tanytarsini Pct	CrustMoll Pct	Scraper Pct	% Tolerant Taxa	% Intolerant Taxa
14DM018	74.85	8.16	0.00	18.40	10.40	0.31
14DM019	81.00	9.76	0.93	6.85	1.86	0.00
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	43.90	27.84	9.23	15.78	17.17	5.79
Expected response to Eutrophication stress	↓	↓	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in two (14DM019) and three (14DM018) of the six eutrophication related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 165). Both sites had very few phosphorus intolerant taxa and tanytarsini individuals, while site 14DM018 also had an increased amount of scraper individual potentially indicate stress from eutrophic conditions. The remaining metrics in this reach scored fairly well.

Based on the high amount of standard exceedances from the phosphorus, BOD, and chlorophyll-a samples, as well as many of the eutrophication related metrics in the fish and macroinvertebrate communities scoring below average, eutrophication is a stressor to aquatic life in the Des Moines River (-546) at this time.

Nitrates

There were 38 samples taken from one chemistry site (S002-008) and one biological monitoring station (14DM019) from 2004-2016 were analyzed for Inorganic Nitrogen (NO₂-NO₃). The average of all the values is 5.16 mg/L with a low of 0.05 mg/L and a high of 13.00 mg/L. The spring average (March-May) is 8.74 mg/L. The summer average (June-Aug) is 3.90 mg/L. Nitrate values exceeded 4 mg/L 22 times.

The HSPF model also calculated daily nitrate concentrations for this subwatershed from 1994-2014. These values ranged from 0.02-13.65 mg/L with an average nitrate concentration of 2.06 mg/L. This average is relatively low when compared to other nitrate concentrations in the watershed.

Table 166. Nitrate related macroinvertebrate metrics in Des Moines River (-546). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-546 Macroinvertebrate Class 5 – General Use	TrichopteraChTx Pct	N Index Score	% N Tolerant	% N Intolerant
14DM018	19.05	3.41	51.68	0.31
14DM019	23.81	3.24	37.58	0.00
<i>Statewide average for Class 5 Southern Streams Rock Riffle stations that are meeting the MIBI General Use Threshold (37)</i>	13.16	3.00	48.68	0.96
Expected response to N stress	↓	↑	↑	↓

The macroinvertebrate community in Des Moines River (-546) scored below average in two (14DM019) and three (14DM018) of the four nitrate related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 166). Both sites did have a high amount of trichoptera taxa, which normally is not the case in streams being negatively impacted by high nitrate concentrations. Both sites did have poor scoring nitrate index scores and a very low amount of nitrate intolerant individuals.

The nitrate related biological metric results were mixed. The observed and predicted nitrate concentrations both signal that the nitrate levels stay rather low for the most part. The average nitrate concentrations both observed and predicted were both low. It is likely that other stressors are negatively impacting some of the macroinvertebrate metric results causing lower scores as nitrates are not a stressor to aquatic life in this reach.

Suspended Solids

Fourteen samples taken from one chemistry site (S002-008) and two biological monitoring stations (14DM018, 14DM019) were analyzed for TSS. The average of all the values is 97 mg/L with a low of 27 mg/L and a high of 340 mg/L. The TSS concentrations exceeded the 65 mg/L standard eight times.

Additionally, 10 secchi tube measurements were taken from this reach. These values ranged from 20-73 cm, with no values falling below the 10 cm minimum standard for secchi tube.

The HSPF model calculated daily TSS values for this subwatershed from 1994-2014. These concentrations ranged from 0.24-969.69 mg/L with an average TSS value of 34.96 mg/L. Of these calculations, 717 (9.35%) of the days had a level above the TSS standard of 65 mg/L.

This reach was determined to be impaired for turbidity during the 2004 assessment. This impairment was confirmed during the 2016 assessment as well.

Table 167. TSS related fish metrics in Des Moines River (-546). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-546 Fish Class 1 –General Use	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RifflePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14DM018	12.79	0.00	46.23	7.98	8.96	0.55	11.69	0.00	6.78	27.52
14DM019	12.92	0.00	13.27	18.87	5.12	0.00	14.40	0.00	5.77	26.06
<i>Statewide average for Class 1 Southern Rivers stations that are meeting the FIBI General Use Threshold (49.0)</i>	21.36	4.12	1.04	17.97	13.92	13.53	24.97	4.63	43.61	25.99
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

The fish community in Des Moines River (-546) scored below average in eight (14DM019) and nine (14DM018) of the ten TSS related metrics when compared to all other Class 1 Southern River stations that meet the FIBI General Use Threshold (Table 167). Both sites had an elevated amount of herbivorous individuals, while site 14DM019 also had an above average amount of perch-like individuals. However, the remaining metrics scored below average at these sites and suggests that TSS is a stressor to the fish community.

Table 168. TSS related macroinvertebrate metrics in Des Moines River (-546). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-546 Macroinvertebrate Class 5 – General Use	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
14DM018	19.02	1.00	10.00	54.43	54.91	0.31
14DM019	18.32	0.00	8.00	76.71	71.34	0.00
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)</i>	15.87	3.02	11.59	35.23	26.89	0.54
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

The macroinvertebrate assemblage in this reach scored below average in four of the six TSS related metrics at both sites when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 168). Both sites, 14DM018 and 14DM019, had above average numbers of collector-filterer individuals and a below average amount of TSS tolerant taxa present. However, the remaining metrics scored poorly as these sites also had a high percentage of TSS tolerant individual, poor TSS Index scores, few plecoptera individuals, and very few TSS intolerant taxa. These results are often found in streams with elevated TSS conditions.

Based on the high exceedance rate in the observed data set, the majority of the TSS related metrics scoring poorly in both the fish and macroinvertebrate communities, as well as the current turbidity impairment in this reach, TSS is a stressor to aquatic life.

Habitat

Des Moines River (-546) had qualitative habitat assessments take place at its biological monitoring sites, 14DM018 and 14DM019, during the fish and macroinvertebrate sampling events in 2014. The average MSHA score from these visits were 49.95 (Fair) at 14DM018 and 49.63 (Fair) at 14DM019. Limiting the habitat at these sites was the row crop agriculture as a nearby land use, severe bank erosion (Figure 73), sand and silt substrates, sparse to moderate fish cover, light embeddedness, fair channel development, and low to moderate channel stability. Further MSHA analysis can be seen in Figure 74.

Figure 73. Eroded Bank at site 14DM019



Figure 74. Des Moines River (-546) MSHA metric scores.

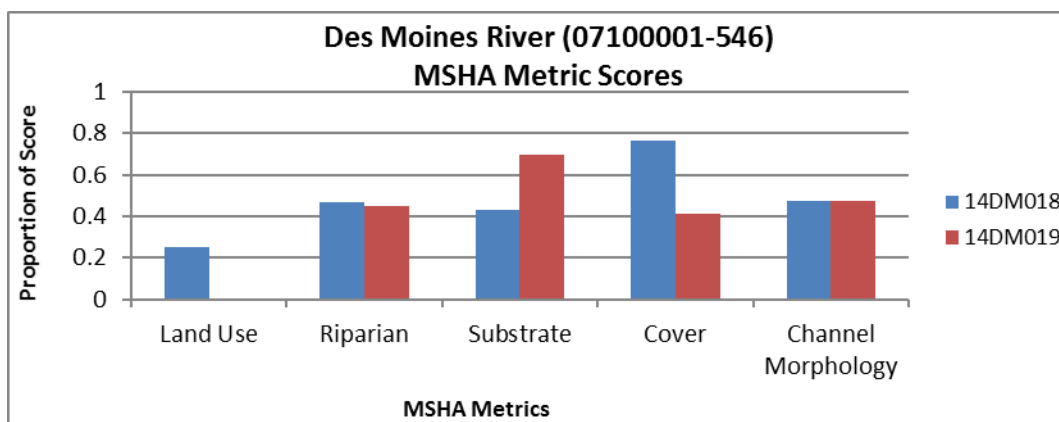


Table 169. Habitat related fish metrics in Des Moines River (-546). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-546 Fish Class 1 –General Use	BenInsect- ToPct	SLithopPct	DarterSculps ucPct	RifflePct	PiscivorePct	LithFrimPct	ToPct	PioneerPct
14DM018	5.25	11.69	5.25	8.96	2.51	13.99	74.21	9.40
14DM019	14.11	14.40	13.99	5.12	4.17	20.06	75.77	24.82
Statewide average for Class 1 Southern Rivers stations that are meeting the FIBI General Use Threshold (49.0)	20.61	24.97	18.51	13.92	15.18	29.21	22.05	5.21
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

The fish assemblage in Des Moines River (-546) at sites 14DM018 and 14DM019 scored below average in all eight of the habitat related metrics when compared to all other Class 1 Southern Rivers stations that meet the FIBI General Use Threshold (Table 169). This stream reach had high amounts of tolerant and pioneer individuals, which is common in streams with poor habitat conditions. Additionally, this stream section had lower numbers of fish species that require specialized habitat conditions for spawning purposes.

Table 170. Habitat related macroinvertebrate metrics in Des Moines River (-546). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-546 Macroinvertebrate Class 5 – General Use	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14DM018	0.61	13.19	73.93	74.85	15.03	1.23
14DM019	1.25	10.90	78.82	81.00	13.71	1.56
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)</i>	5.66	12.52	49.77	42.46	34.53	13.99
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate community in this stream reach scored below average in one (14DM018) and two (14DM019) of the six habitat related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 170). Both sites did have few sprawler individuals, while site 14DM019 had a lower amount of climber individuals as well. The remaining metrics in this reach scored above average.

The MSHA scores in this reach were both considered “Fair” and were just above the “Poor” designation. The fish community at both sites scored very poorly in all of the habitat related metrics, and the macroinvertebrate community had a couple lower scoring metrics, but overall scored fairly well. Habitat is a stressor to the fish community in the Des Moines River (-546) at this time.

Altered Hydrology

This reach of the Des Moines River is almost entirely natural though approximately 30% of its entire upstream watershed is altered according to the MPCA altered watercourse layer.

Extreme weather events affect high flow events as well as also low flows during drought. HSPF models show this stream section experiencing low flow at less than five cfs 0% of the time and less than one cfs 0% of the time.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The average percentage for generalist fish within the reach was 19.9% compared to the average in Class 1 general use waters meeting the standard of 20.7%. General fish populations ranged from 17.8-22.1%.

The numbers of nest guarder species are also positively correlated with increased low flows. The average percentage for nest guarder fish within the reach was 15.9% compared to the average in Class 1 general use waters meeting the standard of 16%. Nest guarder fish species ranged from 9-22.8%.

Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The average percentage for long-lived macroinvertebrates within the reach was 2.3% compared to the average in Class 5 general use waters meeting the standard of 9%. Long-lived macroinvertebrates ranged from 1.2-3.4%.

Based on this information, Flow Alteration/Connectivity is not a stressor to aquatic life in Des Moines River (-546).

Summary

The impaired fish and macroinvertebrate communities in Des Moines River (-546) are being stressed by Eutrophication, Suspended Sediment, and Habitat (Table 171). DO, Nitrates, and Flow Alteration/Connectivity were all ruled out as stressors to aquatic life in this reach. For further information on the stressors and recommendations to fixing the stressors in the Talcot Lake-Des Moines River HUC 10 Watershed, please see pages 182-183.

Table 171. Stressor determinations for Des Moines River (-546).

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Des Moines River	07100001-546	---	●	---	●	●	---

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Unnamed Creek (07100001-621)

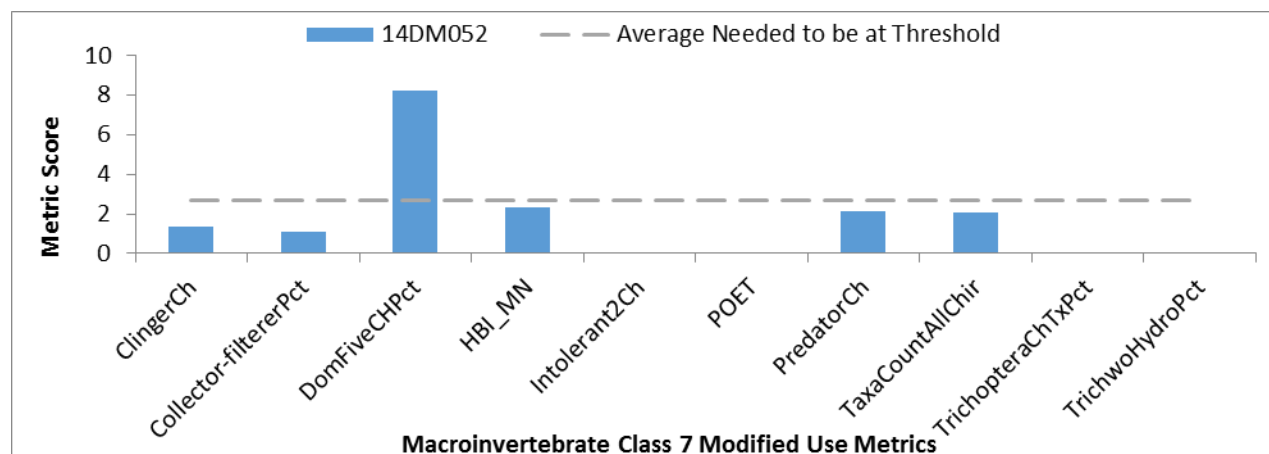
Located in far northwestern Murray County, Unnamed Creek (-621) is a 2.28 mile long reach that is impaired for aquatic life due to the macroinvertebrate assemblage. This stream reach extends from an unnamed lake down to the confluence with the Des Moines River. Along this stream section there is one biological monitoring station, 14DM052.

Biology

Macroinvertebrates

The macroinvertebrate assemblage in Unnamed Creek (-621) at site 14DM052 was sampled in August of 2014. This visit had a MIBI score of 17.2, which is below the Macroinvertebrate Class 7 Prairie Streams GP Modified Use Threshold of 22. This site had one metric (DomFiveCHPct) scoring above the average needed to reach the threshold. However, the remaining nine metrics scored below average with four of those metrics having a score of zero. See Figure 75 for a complete breakdown of the metric scores at this site.

Figure 75. Unnamed Creek (-621) macroinvertebrate IBI metric scores.



Dissolved Oxygen

A total of 10 DO measurements were taken from one chemistry site (S009-046) and one biological monitoring station (14DM052) from 2014-2016. The average of all the values is 10.66 mg/L with a low of 5.66 mg/L and a high of 19.08 mg/L. The summer average (June-Aug) is 10.91 mg/L. The DO values never fell below 5 mg/L. The high ranged of DO values may also indicate issues regarding DO flux.

The HSPF model calculated daily minimum DO values for this subwatershed from 1994-2014. Of these calculations, 2016 (50.39%) of the days had a daily minimum DO level below the daily minimum standard of 5 mg/L. This is a relatively high amount of exceedances.

Table 172. DO related fish metrics in Unnamed Creek (-621). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-621 Fish Class 7 – Modified Use	MA>3 Avg	SspnPct Avg	Taxa Count Avg	DO TIV Avg
14DM052	14.11	33.93	7	8.58
<i>Statewide average for Class 7 Low Gradient stations that are meeting the FIBI Modified Use Threshold (15.0)</i>	9.79	28.58	11.74	7.81
Expected response to DO stress	↓	↑	↓	↓

The fish community in Unnamed Creek (-621) at site 14DM052 scored below average in two of the four DO related metrics when compared to all other Class 7 Low Gradient stations that meet the FIBI Modified Use Threshold (Table 172). This reach had an increased amount of serial spawning individuals, while also having a lower taxa count. However, the DO TIV for the fish community was good and the reach had an increased amount of late maturing individuals, which is not common in streams with poor DO conditions.

Table 173. DO related macroinvertebrate metrics in Unnamed Creek (-621). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-621 Macroinvertebrate Class 7 – Modified Use	HBI_MN Value	% DO Tolerant	# DO Tolerant	ChemTV DO
14DM052	8.17	35.00	11.00	5.60
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22)</i>	8	31.37	9.33	6.19
Expected response to DO stress	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in all four of the DO related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 173). This reach had a high number and percentage of DO tolerant taxa, while also having poor DO TIV and HBI_MN scores. These results are common in streams with poor DO conditions.

While the limited observed data set does not have DO values below 5 mg/L, the modeled data does calculate a very high percentage of standard exceedances. The majority of the fish and macroinvertebrate metrics related to DO also score poorly. The very high range of DO values along with the elevated phosphorus in this stream system can also signal potential issues regarding DO flux.

Therefore, DO is a stressor to aquatic life in Unnamed Creek (-621).

Eutrophication

A total of 11 phosphorus samples were taken from one chemistry site (S009-046) and one biological monitoring station (14DM052) from 2014-2016. The average of all the values is 0.204 mg/L with a low of 0.08 mg/L and a high of 0.52 mg/L. The summer average (June-Aug) is 0.221 mg/L. Phosphorus values exceeded the standard of 0.150 mg/L seven times. This reach did have some notable macrophyte and algae growth during the macroinvertebrate sampling event. (Figure 76)

Figure 76. Algae grown in Unnamed Creek (-621).



The HSPF model calculated daily phosphorus concentrations for this subwatershed from 1994-2014. These values ranged from 0.26-1.20 mg/L with an average phosphorus concentration of 0.5 mg/L. All of these calculated values are above the 0.15 mg/L standard.

Table 174. Eutrophication related fish metrics in Unnamed Creek (-621). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-621 Fish Class 7 – Modified Use	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct
14DM052	3.00	3.00	95.80	95.80
<i>Statewide average for Class 7 Low Gradient stations that are meeting the FIBI Modified Use Threshold (15.0)</i>	16.71	6.74	55.88	16.77
Expected response to Eutrophication stress	↓	↓	↑	↑

The fish assemblage in Unnamed Creek (-621) at site 14DM052 scored below average in all four of the eutrophication related metrics when compared to all other Class 7 Low Gradient stations that meet the FIBI Modified Use Threshold (Table 174). This reach had a very high amount of tolerant and omnivorous individuals, while also having very few sensitive species and darters present. These results are indicative of a fish community likely impacted by eutrophic conditions.

Table 175. Eutrophication related macroinvertebrate metrics in Unnamed Creek (-621). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-621 Macroinvertebrate Class 7 – Modified Use	EPT Pct	Tanytarsini Pct	CrustMoll Pct	Scraper Pct	% Tolerant Taxa	% Intolerant Taxa
14DM052	8.13	25.53	14.69	10.94	43.44	0.00
<i>Statewide average for Class 7 Prairie Streams Glide Pool stations that are meeting the MIBI Modified Use Threshold (22)</i>	20.58	22.11	23.21	17.73	45.87	1.43
Expected response to Eutrophication stress	↓	↓	↑	↑	↑	↓

The macroinvertebrate community in this reach scored below average in two of the six eutrophication related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 175). This reach had decreased numbers of EPT and phosphorus intolerant taxa; however, the reach did score well in the remaining metrics.

Based on the high number of exceedances in the observed and modeled data sets, photographic evidence of plant and algae growth, as well as the very poor scoring fish metrics and some low scoring

macroinvertebrate metrics related to eutrophication, eutrophication is a stressor to aquatic life in Unnamed Creek (-621) at this time.

Nitrates

There were 11 samples taken from one chemistry site (S009-046) and one biological monitoring station (14DM052) from 2014-2016 were analyzed for Inorganic Nitrogen (NO₂-NO₃). The average of all the values is 4.44 mg/L with a low of 0.05 mg/L and a high of 12.00 mg/L. The spring average (March-May) is 12.00 mg/L. The summer average (June-Aug) is 3.40 mg/L. Nitrate values exceeded 4 mg/L five times. A quantile regression analysis for Class 7 stations showed that when the nitrate concentration was at or exceeded 11.5 mg/L, there was a 90% probability for impairment. The nitrate concentration exceeded this level in this reach.

The HSPF model also calculated nitrate concentrations for this subwatershed from 1994-2014. These values ranged from 1.8-17.29 mg/L with an average nitrate concentration of 8.99 mg/L. Of these calculations, 362 (32.55%) were above 11.5 mg/L.

Table 176. Nitrate related macroinvertebrate metrics in Unnamed Creek (-621). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-621 Macroinvertebrate Class 7 – Modified Use	TrichopteraChT xPct	N Index Score	% N Tolerant	% N Intolerant
14DM052	0.00	4.02	69.06	0.31
<i>Statewide average for Class 7 Prairie Streams Glide Pool stations that are meeting the MIBI Modified Use Threshold (22)</i>	5.71	3.30	62.54	0.00
Expected response to N stress	↓	↑	↑	↓

The macroinvertebrate community at 14DM052 in Unnamed Creek (-621) scored below average in three of the four nitrate related biological metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 176). This site lacked trichoptera taxa, while also having a high amount of nitrate tolerant individuals and a poor nitrate index score.

Based on the sometimes elevated observed nitrate concentrations, the high concentrations predicted by the HSPF model, the quantile regression analysis, as well as the majority of the nitrate related macroinvertebrate metrics scoring below average, nitrates are a stressor to aquatic life in this reach.

Suspended Solids

Ten samples taken from one chemistry site (S009-046) in 2016 were analyzed for TSS. The average of all the values is 39.4 mg/L with a low of 11 mg/L and a high of 140 mg/L. The TSS concentrations exceeded the 65 mg/L standard one time.

Additionally, ten secchi tube measurements were taken from this reach. These values ranged from 6-55 cm, with an average reading of 25.5 cm. One value fell below the 10 cm minimum standard for secchi tube.

The HSPF model calculated daily TSS values for this subwatershed from 1994-2014. These concentrations ranged from 3.15-444.21 mg/L with an average TSS value of 24.98 mg/L. Of these calculations, 45 (4.05%) were above the TSS standard of 65 mg/L.

Table 177. TSS related fish metrics in Unnamed Creek (-621). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-621 Fish Class 7 – Modified Use	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfrm-TolPct	RifflePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14DM052	12.31	0.00	0.00	3.60	12.31	3.00	12.31	0.00	50.75	29.79
<i>Statewide average for Class 7 Low Gradient stations that are meeting the FIBI Modified Use Threshold (15.0)</i>	12.20	4.38	8.17	13.36	7.35	17.28	20.49	3.61	7.09	14.09
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

The fish community in Unnamed Creek (-621) at site 14DM052 scored below average in seven of the ten TSS related metrics when compared to all other Class 7 Low Gradient stations that meet the FIBI Modified Use Threshold (Table 177). This reach did have an above average amount of benthic feeding, riffle dwelling, and long-lived individuals; however, the reach scored poorly in the remaining metrics and especially had a poor TSS Index Score.

Table 178. TSS related macroinvertebrate metrics in Unnamed Creek (-621). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-621 Macroinvertebrate Class 7 – Modified Use	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plectoptera Pct
14DM052	13.69	0.00	6.00	17.19	4.38	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)</i>	16.02	0.60	10.98	35.60	9.91	0.02
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

The macroinvertebrate assemblage in this reach scored below average in three of the six TSS related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 178). This reach had a good TSS Index score, while also having a lower percentage and amount of TSS Tolerant Taxa. These results are not common in streams being negatively impacted by the TSS conditions.

The TSS concentrations can get elevated as evidenced by the one observed measurement and the relatively low amount of standard exceedances calculated by the HSPF model. However, many of the macroinvertebrate metrics related to TSS scored above average including the TSS Index score as well as the percentage and amount of TSS tolerant taxa. These results do not normally occur in streams with TSS issues. Therefore, TSS is not a stressor to aquatic life in Unnamed Creek (-621) at this time. It is likely that other stressors are causing poor metric scores in the fish community.

Habitat

Unnamed Creek (-621) had a qualitative habitat assessment take place at its biological monitoring site, 14DM052, during the fish and macroinvertebrate sampling events in 2014. The average MSHA score from these visits was 17.5 (Poor). Limiting the habitat at this site was the row crop agriculture and open pasture as the dominant land uses (Figure 78), no stream riparian buffer, no stream shading, heavy silt

substrates, no coarse substrates, very little depth variability, poor channel stability, and poor channel development. Further MSHA analysis can be seen in Figure 77.

Figure 77. Unnamed Creek (-621) MSHA metric scores.

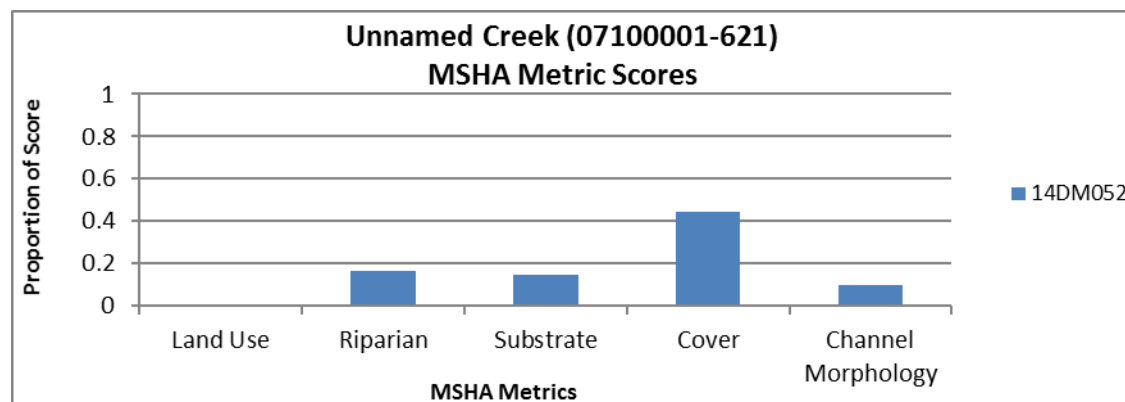


Table 179. Habitat related fish metrics in Unnamed Creek (-621). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-621 Fish Class 7 – Modified Use	BenInsect-TolPct	SLithopPct	DarterSculp SucPct	RifflePct	PiscivorePct	LithFrimPct	ToIPct	PioneerPct
14DM052	3.00	12.31	3.00	12.31	0.60	12.31	95.80	33.93
<i>Statewide average for Class 7 Low Gradient stations that are meeting the FBI Modified Use Threshold (15.0)</i>	7.06	20.49	6.80	7.35	3.67	25.67	56.03	19.20
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

The fish community in Unnamed Creek (-632) at site 14DM052 scored below average in seven of the eight habitat related metrics when compared to all other Class 7 Low Gradient stations that meet the FBI Modified Use Threshold (Table 179). The fish assemblage was dominated by common carp (161 individuals) and fathead minnows (113 individuals). Both of these species are very tolerant of degraded habitat conditions and can thrive in those situations.

Table 180. Habitat related macroinvertebrate metrics in Unnamed Creek (-621). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-621 Macroinvertebrate Class 7 – Modified Use	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14DM052	28.44	14.69	25.94	8.13	76.56	17.81
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)</i>	9.74	24.34	20.62	15.52	59.46	22.88
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate assemblage in this reach scored below average in five of the six habitat related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 180). This reach did have an above average number of clinger individuals, which can signal good habitat conditions. However, site 14DM052 did have higher numbers of both legless and burrower individuals indicating a larger presence of fine substrates. This correlates to the heavy silted stream bottom found during the habitat assessment.

The MSHA in this stream section was very poor. This corresponds to the vast majority of the poor scoring habitat related metrics in both the fish and macroinvertebrate communities. Therefore, habitat is a stressor to aquatic life in Unnamed Creek (-621).

Figure 78. Heavily pastured land use along Unnamed Creek (-621).



Altered Hydrology

Unnamed Creek (-621) is a tributary to the Des Moines River and is downstream of two shallow lakes. The reach is roughly 50% altered and the biological monitoring station is located on a natural section of the stream. The majority of the watershed upstream is altered according to the MPCA altered watercourse layer.

Extreme weather events affect high flow events as well as also low flows during drought (Figure 79). HSPF models show this stream section experiencing low flow at less than five cfs 74.7% of the time and less than one cfs 33.1% of the time.

Generalist fish species, which are adaptable to different habitats through generalized food preferences are correlated with channelization. The percentage for generalist fish within the reach was 95.8% compared to the average in Class 7 modified use waters meeting the standard of 35%.

The numbers of nest guarder species are also positively correlated with increased low flows. The percentage for nest guarder fish within the reach was 33.9% compared to the average in Class 7 modified use waters meeting the standard of 29.6%.

Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The percentage for long-lived macroinvertebrates within the reach was 0.3% compared to the average in Class 7 modified use waters meeting the standard of 5.6%.

Based on the poor scoring biological metrics as well as the frequent low flow conditions present in this reach, Unnamed Creek (-621) is being stressed by the Flow Alteration/Connectivity conditions in this reach.

Figure 79. Changes in water level at S009-046 in Unnamed Creek (-621).



Summary

The impaired macroinvertebrate community in Unnamed Creek (-621) is being stressed by DO, Eutrophication, Nitrates, Habitat and Flow Alteration/Connectivity (Table 181). Suspended Sediment was ruled out as a stressor to aquatic life in this reach. For further information on the stressors and recommendations to fixing the stressors in the Talcot Lake-Des Moines River HUC 10 Watershed, please see pages 182-183.

Table 181. Stressor determinations for Unnamed Creek (-621).

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Unnamed Creek	07100001-621	●	●	●	---	●	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Unnamed Creek (07100001-672)

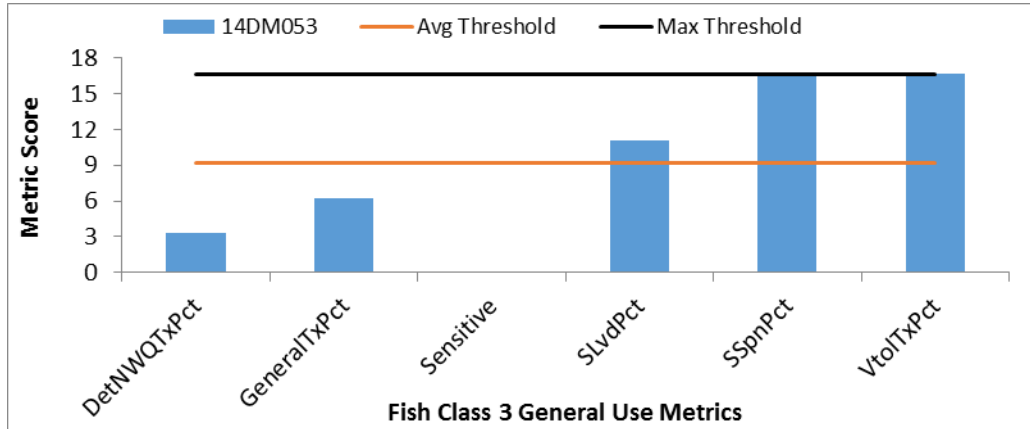
Located in southwestern Murray County, Unnamed Creek (-672) is a 1.94 mile long reach that is impaired for aquatic life due to both the fish and macroinvertebrate assemblages. This stream reach extends from 21st Street down to the confluence with Talcot Lake. Along this stream section there is one biological monitoring station, 14DM053.

Biology

Fish

Unnamed Creek (-672) was sampled for fish in July of 2015 at its biological monitoring station, 14DM053. The FIBI score for this visit was 54, which is just slightly below the Fish Class 3 Southern Headwaters General Use Threshold of 55. This site had three of the six metrics score above the average needed to reach the threshold (VtoITxPct, SLvdPct, SSpnPct) (Figure 80), however this site had many detritivorous feeding and generalist species resulting in lower FIBI metric scores and completely lacked sensitive fish taxa resulting in a metric score of zero.

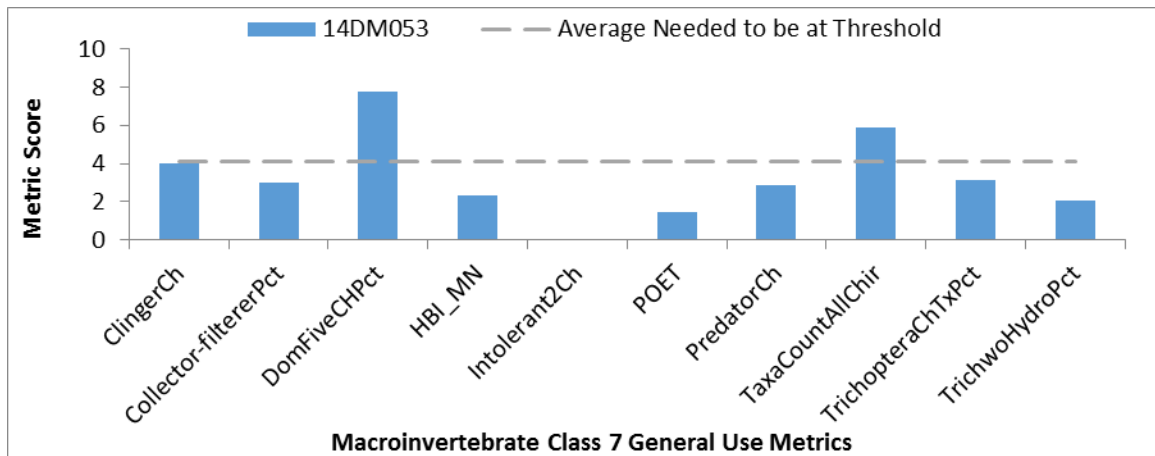
Figure 80. Unnamed Creek (-672) fish IBI metric scores.



Macroinvertebrates

The macroinvertebrate assemblage at site 14DM053 was sampled in August of 2014. This visit had a MIBI score of 32.5, which is below the Macroinvertebrate Class 7 Prairie Streams GP General Use Threshold of 41. This site had two metrics scoring above the average needed to reach the threshold. However, the remaining seven metrics scored below average or poorly resulting in the impairment designation. See Figure 81 for a complete breakdown of the metric scores at this site.

Figure 81. Unnamed Creek (-672) macroinvertebrate IBI metric scores.



Dissolved Oxygen

A total of 11 DO measurements were taken from one chemistry site (S009-165) and one biological monitoring station (14DM053) from 2014-2016. The average of all the values is 10.63 mg/L with a low of 6.51 mg/L and a high of 14.51 mg/L. The summer average (June-Aug) is 11.06 mg/L. The DO values never fell below 5 mg/L.

The HSPF model calculated daily minimum DO values for this subwatershed from 1994-2014. Of these calculations, 3253 (42.41%) of the days had a daily minimum DO level below the daily minimum standard of 5 mg/L. This is a very high exceedance rate for DO.

Table 182. DO related fish metrics in Unnamed Creek (-672). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-672 Fish Class 3 – General Use	MA>3 Avg	SspnPct Avg	Taxa Count Avg	DO TIV Avg
14DM053	16.67	0.00	5.00	8.19
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	13.32	17.09	12.16	8.44
Expected response to DO stress	↓	↑	↓	↓

The fish community in Unnamed Creek (-672) scored below average in two of the four habitat related metrics at site 14DM053 when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 182). This reach had a lower taxa count and DO TIV score potentially indicating DO stress. This reach did have an above average amount of late maturing fish and did not have any serial spawning species. These results are not common in streams with poor DO conditions.

Table 183. DO related macroinvertebrate metrics in Unnamed Creek (-672). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-672 Macroinvertebrate Class 7 – General Use	HBI_MN Value	% DO Tolerant Taxa	# DO Tolerant Taxa	ChemTV DO
14DM053	8.16	12.94	7.00	6.75
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	7.55	12.98	5.74	6.91
Expected response to DO stress	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in three of the four DO related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 183). This reach had a high amount of DO tolerant taxa, a poor HBI_MN value and a below average DO TIV score. These results are common in streams being negatively impacted by the DO conditions present.

The observed data set did not have any standard exceedances while the HSPF model calculated a very high rate of exceedance. Half of the fish and the majority of the macroinvertebrate metrics related to DO scored below average including the DO TIV scores in both communities. There are also high levels of phosphorus and algae present in this reach likely causing issues with daily flux of DO. Based on this information, DO is a stressor to aquatic life in Unnamed Creek (-672).

Eutrophication

A total of 11 phosphorus samples were taken from one chemistry site (S009-165) and one biological monitoring station (14DM053) from 2014-2016. The average of all the values is 0.20 mg/L with a low of 0.07 mg/L and a high of 0.65 mg/L. The summer average (June-Aug) is 0.212 mg/L. Phosphorus values exceeded the standard of 0.150 mg/L five times. Abundant algae was also present along this reach (Figure 82).

Figure 82. Algae at site 14DM053.



The HSPF model calculated daily phosphorus values for this subwatershed from 1994-2014. These values ranged from 0.10-6.69 mg/L with an average value of 0.48 mg/L. Of these calculations, 4229 (99.60%) were above the 0.15 mg/L standard. This is a very high exceedance rate.

Table 184. Eutrophication related fish metrics in Unnamed Creek (-672). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-672 Fish Class 3 – General Use	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct
14DM053	0.00	0.00	100.00	16.67
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	8.9	12.11	70.79	14.71
Expected response to Eutrophication stress	↓	↓	↑	↑

The fish community in Unnamed Creek (-672) at site 14DM053 scored below average in all four of the eutrophication related metrics when compared to all other Class 3 Southern Headwaters Stations that meet the FIBI General Use Threshold (Table 184). This reach was completely comprised of tolerant fish species, while containing no sensitive or darter species. These results are often found in streams with eutrophic conditions.

Table 185. Eutrophication related macroinvertebrate metrics in Unnamed Creek (-672). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-672 Macroinvertebrate Class 7 – General Use	<i>EPT Pct</i>	Tanytarsini Pct	CrustMoll Pct	Scraper Pct	% Tolerant Taxa	% Intolerant Taxa
14DM053	8.41	22.09	28.80	20.71	22.65	0.65
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	38.45	18.46	11.78	16.11	26.84	4.03
Expected response to Eutrophication stress	↓	↓	↑	↑	↑	↓

The macroinvertebrate community in this reach scored below average in four of the six eutrophication related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 185). This reach had decreased amounts of EPT and phosphorus intolerant taxa, while also having increased numbers of scraper and crustacean/mollusca individuals. These results are common in streams with eutrophication issues.

Based on the high observed and modeled exceedance rates, the photographic evidence of eutrophic conditions, and the majority of the eutrophication related metrics in both fish and macroinvertebrate communities scoring poorly, eutrophication is a stressor to aquatic life in Unnamed Creek (-672).

Nitrates

There were 11 samples taken from one chemistry site (S009-165) and one biological monitoring station (14DM053) from 2014-2016 were analyzed for Inorganic Nitrogen (NO₂-NO₃). The average of all the values is 8.02 mg/L with a low of 0.05 mg/L and a high of 21.00 mg/L. The summer average (June-Aug) is 6.97 mg/L. Nitrate values exceeded 4 mg/L six times. A quantile regression analysis for Class 7 stations showed that when the nitrate concentration was at or exceeded 11.5 mg/L, there was a 90% probability for impairment. The nitrate concentration exceeded this level at this reach.

The HSPF model also calculated nitrate concentrations for this subwatershed from 1994-2014. These values ranged from 1.22-122.9 mg/L with an average nitrate concentration of 7.28 mg/L. Of these calculations, 973(22.92%) were above 11.5 mg/L.

Table 186. Nitrate related macroinvertebrate metrics in Unnamed Creek (-672). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-672 Macroinvertebrate Class 7 – General Use	TrichopteraChTx Pct	N Index Score	% N Tolerant	% N Intolerant
14DM053	5.13	5.51	86.08	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	10.00	3.30	57.57	0.91
Expected response to N stress	↓	↑	↑	↓

The macroinvertebrate assemblage in Unnamed Creek (-672) scored below average in all four of the nitrate related metrics at its biological monitoring station, 14DM053), when compared to all other Class 7 Prairies Streams GP stations that meet the MIBI General Use Threshold (Table 186). This reach showed zero or very few nitrate intolerant individuals and trichoptera taxa, while also having a high amount of nitrate tolerant individuals and a very poor nitrate index score.

Based on the elevated observed nitrate concentrations, the high concentrations predicted by the HSPF model, the quantile regression analysis, as well as all of the nitrate related macroinvertebrate metrics scoring below average, nitrates are a stressor to aquatic life in this reach.

Suspended Solids

Eight samples taken from one chemistry site (S009-165) in 2016 were analyzed for TSS. The average of all the values is 6.2 mg/L with a low of 2 mg/L and a high of 13 mg/L. The TSS concentrations did not exceed the 65 mg/L standard.

Additionally, eight secchi tube measurements were taken from this reach. These values ranged from 35-100 cm, with no values falling below the 10 cm minimum standard for secchi tube.

The HSPF model calculated daily TSS values for this subwatershed from 1994-2014. These concentrations ranged from 1.60-1435.03 mg/L with an average TSS value of 10.60 mg/L. Of these calculations, 78 (1.84%) were above the TSS standard of 65 mg/L.

Table 187. TSS related fish metrics in Unnamed Creek (-672). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-672 Fish Class 3 – General Use	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RifflePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14DM053	8.33	0.00	60.00	0.00	8.33	0.00	10.00	0.00	0.00	17.87
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	37.83	0.90	13.33	13.93	28.33	8.55	33.71	1.95	3.56	15.27
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

The fish community in Unnamed Creek (-672) at site 14DM053 scored below average in nine of the ten TSS related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 187). This site did have an above average amount of herbivorous individuals; however, the remaining metrics scored poorly suggesting possible stress from the TSS conditions.

Table 188. TSS related macroinvertebrate metrics in Unnamed Creek (-672). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-672 Macroinvertebrate Class 7 – General Use	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
14DM053	18.55	0.00	11.00	46.60	11.65	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (22.0)</i>	17.35	1.33	13.20	48.28	19.13	0.22
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

The macroinvertebrate assemblage in this reach scored below average in four of the six TSS related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 188). Site 14DM053 did have a poor TSS Index score, while lacking or having few TSS intolerant taxa, collector-filterer and plecoptera individuals. Conversely, this reach also had a lower amount and percentage of TSS tolerant taxa and individuals. This does not often occur in streams negatively impacted by high TSS concentrations.

The observed TSS data does not show any standard exceedances, while the model predicted very few exceedances. The macroinvertebrate assemblage also contained very few TSS tolerant taxa and individuals, which is very uncommon in streams potentially stressed by TSS. Therefore, TSS is not a stressor to aquatic life in Unnamed Creek (-672). It is likely that other stressors are negatively impacting the biotic communities resulting in lower metric scores.

Habitat

Unnamed Creek (-672) had a qualitative habitat assessment take place at its biological monitoring site, 14DM053, during the fish and macroinvertebrate sampling events in 2014. The average MSHA score from these visits was 50.52 (Fair). Limiting the habitat at this site was the row crop agriculture and open pasture as the dominant land uses, no stream riparian buffer, light stream shading, sand (Figure 83) and silt substrates, moderate embeddedness, and moderate channel stability. Further MSHA analysis can be seen in Figure 84.

Figure 83. Sand substrates at 14DM053.



Figure 84. Unnamed Creek (-672) MSHA metric scores.

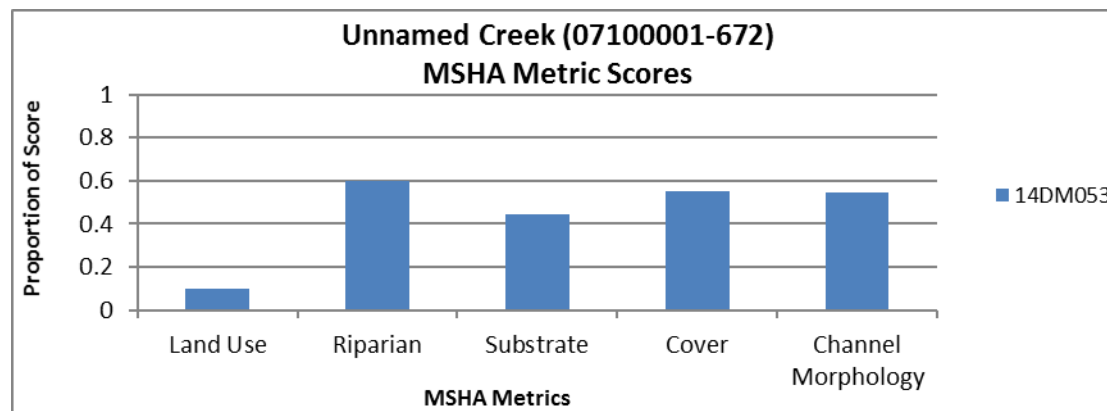


Table 189. Habitat related fish metrics in Unnamed Creek (-672). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-672 Fish Class 3 – General Use	BenInsect- ToIPct	SLithopPct	DarterSculps ucPct	RifflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14DM053	0.00	10.00	0.00	8.33	0.00	35.00	100.00	25.00
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	14.22	33.71	12.55	28.33	1.62	69.21	70.64	37.79
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

The fish community in Unnamed Creek (-672) at site 14DM053 scored below average in seven of the eight habitat related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 189). This site was dominated by tolerant species, while also lacking many species requiring specialized habitat conditions for spawning purposes.

Table 190. Habitat related macroinvertebrate metrics in Unnamed Creek (-672). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-672 Macroinvertebrate Class 7 – General Use	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14DM053	10.68	30.10	21.68	8.41	76.38	22.98
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)</i>	5.40	20.35	36.94	37.77	37.96	19.49
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate assemblage in this reach scored below average in four of the six habitat related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 190). The site, 14DM053, had good numbers of both climber and sprawler individuals, however, this site also had higher numbers of both legless and burrower individuals which are commonly found in streams with sand and silt dominant substrates. This reach also had lower numbers of both clinger and EPT individuals as well, which can signal habitat stress as well.

The MSHA at 14DM053 was designated as fair, but both the fish and macroinvertebrate communities had the majority of their habitat related metrics score poorly, therefore, habitat is a stressor to aquatic life in Unnamed Creek (-672).

Altered Hydrology

Unnamed Creek (-672) is approximately half-altered and half-natural, though the majority of its entire upstream watershed is altered according to the MPCA altered watercourse layer. This reach is an inlet to Talcot Lake, which has an impoundment and fish barrier at its outlet.

Extreme weather events affect high flow events as well as also low flows during drought. HSPF models show this stream section experiencing low flow at less than five cfs 83.6% of the time and less than one cfs 42.4% of the time.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The average percentage for generalist fish within the reach was 35% compared to the average in Class 3 general use waters meeting the standard of 59.1%. Generalist fish populations ranged from 0-70%.

The numbers of nest guarder species are also positively correlated with increased low flows. The average percentage for nest guarder fish within the reach was 5% compared to the average in Class 3 general use waters meeting the standard of 19.2%. Nest guarder fish species ranged from 0-10%.

Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The average percentage for long-lived macroinvertebrates within the reach was 8.4% compared to the average in Class 7 general use waters meeting the standard of 8%. Long-lived macroinvertebrates ranged from 8.4-8.4%.

Unnamed Creek (-672) has very frequent low flow conditions according to the HSPF model, however, the related biological metrics in this reach scored fairly well. At this time, flow alteration/connectivity is inconclusive as a stressor as the low flow conditions, and partial channelization of the stream may be impacting other stressors including habitat.

Summary

The impaired fish and macroinvertebrate communities in Unnamed Creek (-672) are being stressed by DO, Eutrophication, Nitrates, and Habitat (Table 191). Flow Alteration/Connectivity was inconclusive as a stressor while Suspended Sediment was ruled out as a stressor to aquatic life in this reach. For further information on the stressors and recommendations to fixing the stressors in the Talcot Lake-Des Moines River HUC 10 Watershed, please see pages 182-183.

Table 191. Stressor determinations for Unnamed Creek (-672).

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Unnamed Creek	07100001-672	●	●	●	---	●	o

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Unnamed Creek (07100001-626)

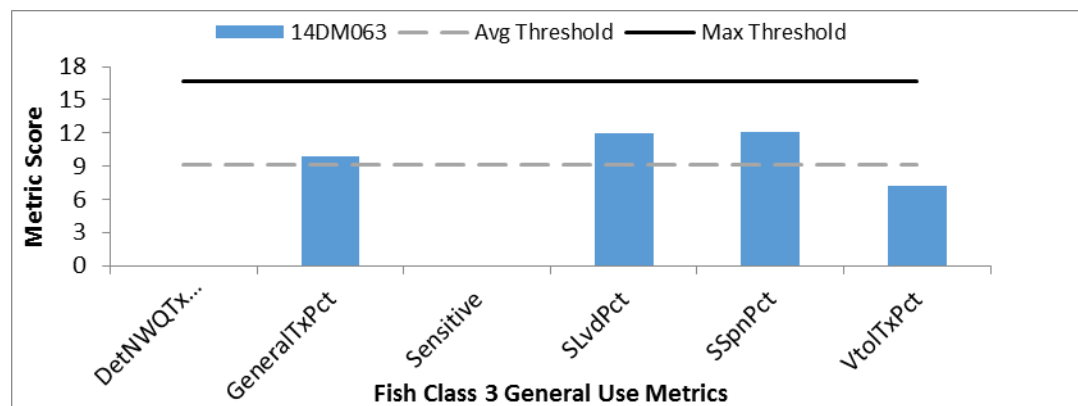
Located in east central Murray County, Unnamed Creek (-626) is a 1.30 mile long reach that is impaired for aquatic life due to both the fish and macroinvertebrate assemblages. This stream reach extends from Unnamed Creek down to the confluence with Unnamed Creek (-621). Along this stream section there is one biological monitoring station, 14DM063.

Biology

Fish

Unnamed Creek (-626) was sampled for fish in September of 2015 at its biological monitoring station, 14DM063. The FIBI score for this visit was 41.2, which is below the Fish Class 3 Southern Headwaters General Use Threshold of 55. This site had three of the six metrics score above the average needed to reach the threshold (GeneralTxPct, SLvdPct, SSpnPct) (Figure 85), however this site had many detritivorous feeding species and completely lacked sensitive fish taxa resulting in metric scores of zero.

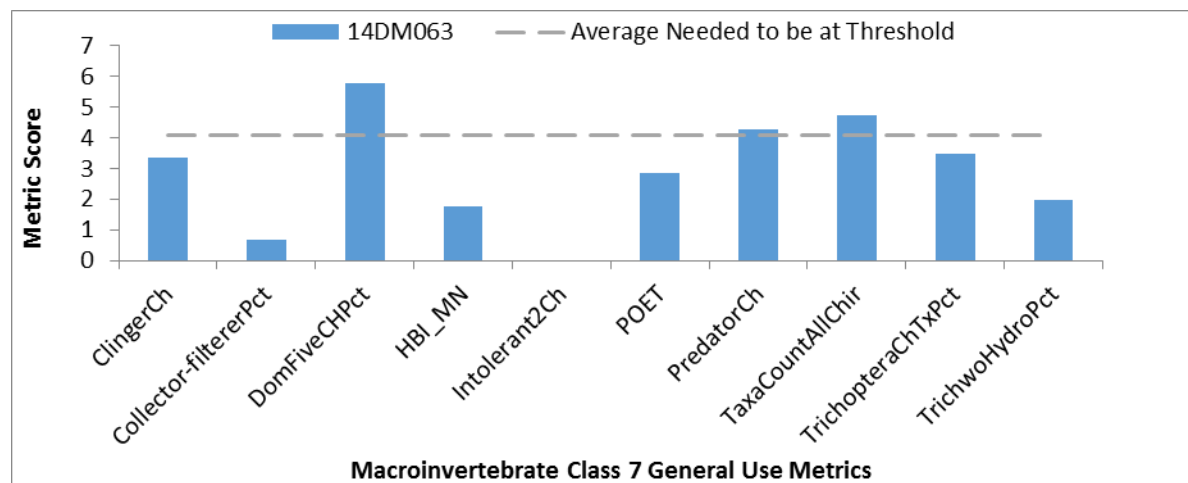
Figure 85. Unnamed Creek (-626) fish IBI metric scores.



Macroinvertebrates

The macroinvertebrate assemblage at site 14DM063 was sampled in August of 2014. This visit had a MIBI score of 28.8, which is below the Macroinvertebrate Class 7 Prairie Streams GP General Use Threshold of 41. This site had three metrics scoring above the average needed to reach the threshold. However, the remaining seven metrics scored below average or poorly resulting in the impairment designation. See Figure 86 for a complete breakdown of the metric scores at this site.

Figure 86. Unnamed Creek (-626) macroinvertebrate IBI metric scores.



Dissolved Oxygen

This reach had 11 DO measurements taken from one chemistry site (S009-054) and one biological monitoring station (14DM062) from 2014-2016. The average of all the values is 8.65 mg/L with a low of 3.66 mg/L and a high of 10.86 mg/L. The summer average (June-Aug) is 7.62 mg/L. The DO values fell below 5 mg/L twice.

The HSPF model calculated daily minimum DO values for this subwatershed from 1994-2014. Of these calculations, 1,899 (48.08%) of the days had a daily minimum DO level below the daily minimum standard of 5 mg/L. This is a very high exceedance rate for DO.

Table 192. DO related fish metrics in Unnamed Creek (-626). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-626 Fish Class 3 – General Use	MA>3 Avg	SspnPct Avg	Taxa Count Avg	DO TIV Avg
14DM063	8.11	21.08	12.00	8.61
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	13.32	17.09	12.16	8.44
Expected response to DO stress	↓	↑	↓	↓

The fish community in Unnamed Creek (-626) at site 14DM063 scored below average in three of the four DO related metrics when compared to all of the Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 192). This reach did have a good DO TIV score, however, site 14DM063 also had few mature fish, a slightly below average taxa count, and an increased amount of serial spawning individuals. These results are commonly found in streams with poor DO conditions.

Table 193. DO related macroinvertebrate metrics in Unnamed Creek (-626). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-626 Macroinvertebrate Class 7 – General Use	HBI_MN Value	% DO Tolerant Taxa	# DO Tolerant Taxa	ChemTV_DO
14DM063	8.33	12.73	7.00	6.85
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	7.55	12.98	5.74	6.91
Expected response to DO stress	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in three of the four DO related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 193). This reach had a slightly below average percentage of DO tolerant taxa, however the number of different DO tolerant species was elevated. This reach also had a poor HBI_MN and DO TIV score. Those results are common for communities negatively impacted by DO.

The DO levels do fall below 5 mg/L occasionally according to the observed data set, while the model calculated an extremely high exceedance rate. In addition, the majority of the fish and macroinvertebrate metrics related to DO scored below average. Based on this information, DO is a stressor to aquatic life in Unnamed Creek (-626).

Eutrophication

A total of 11 phosphorus samples were taken from one chemistry site (S009-054) and one biological monitoring station (14DM062) from 2014-2016. The average of all the values is 0.124 mg/L with a low of 0.04 mg/L and a high of 0.29 mg/L. The summer average (June-Aug) is 0.132 mg/L. Phosphorus values exceeded the standard of 0.150 mg/L twice.

The HSPF model calculated daily phosphorus values for this subwatershed from 1994-2014. These values ranged from 0.28-1.93 mg/L with an average value of 0.55 mg/L. All of these calculations were above the 0.15 mg/L standard for phosphorus.

Table 194. Eutrophication related fish metrics in Unnamed Creek (-626). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-626 Fish Class 3 – General Use	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct
14DM063	0.00	0.27	98.92	51.74
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	8.9	12.11	70.79	14.71
Expected response to Eutrophication stress	↓	↓	↑	↑

The fish community in Unnamed Creek (-626) at site 14DM063 scored below average in all four of the eutrophication related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 194). This reach had a very high amount of tolerant and omnivorous individuals, while having a decreased amount of darter and sensitive individuals. These results are common in streams stressed by eutrophic conditions.

Table 195. Eutrophication related macroinvertebrate metrics in Unnamed Creek (-626). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-626 Macroinvertebrate Class 7 – General Use	EPT Pct	Tanytarsini Pct	CrustMoll Pct	Scraper Pct	% Tolerant Taxa	% Intolerant Taxa
14DM063	12.11	12.21	29.81	36.65	25.47	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	38.45	18.46	11.78	16.11	26.84	4.03
Expected response to Eutrophication stress	↓	↓	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in five of the six eutrophication related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 195). This reach did have a slightly below average amount of phosphorus tolerant taxa, however, the reach scored poorly in the remaining metrics. These results reflect a stream likely being negatively impacted by eutrophication.

Based on the high observed phosphorus levels, the high rate of exceedances in the modeled data, as well as the majority of the eutrophication related metrics in both the fish and macroinvertebrate assemblages scoring below average, eutrophication is a stressor to aquatic life in Unnamed Creek (-626).

Nitrates

There were 11 samples taken from one chemistry site (S009-054) and one biological monitoring station (14DM063) from 2014-2016 were analyzed for Inorganic Nitrogen (NO₂-NO₃). The average of all the values is 12.37 mg/L with a low of 2.30 mg/L and a high of 21.00 mg/L. The spring average (March-May) is 20.00 mg/L. The summer average (June-Aug) is 10.24 mg/L. Nitrate values exceeded 4 mg/L eight times. A quantile regression analysis for Class 7 stations showed that when the nitrate concentration was at or exceeded 11.5 mg/L, there was a 90% probability for impairment. The nitrate concentration easily exceeded this level at this reach.

The HSPF model also calculated nitrate concentrations for this subwatershed from 1994-2014. These values ranged from 1.96-26.39 mg/L with an average nitrate concentration of 9.84 mg/L. Of these calculations, 416 (37.55%) were above 11.5 mg/L.

Table 196. Nitrate related macroinvertebrate metrics in Unnamed Creek (-626). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-626 Macroinvertebrate Class 7 – General Use	TrichopteraChTx Pct	N Index Score	% N Tolerant	% N Intolerant
14DM063	5.71	6.19	94.72	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	10.00	3.30	57.57	0.91
Expected response to N stress	↓	↑	↑	↓

The macroinvertebrate assemblage in Unnamed Creek (-626) scored below average in all four of the nitrate related metrics at its biological monitoring station, 14DM063, when compared to all other Class 7

Prairies Streams GP stations that meet the MIBI General Use Threshold (Table 196). This reach showed zero or very few nitrate intolerant individuals and trichoptera taxa, while also having a high amount of nitrate tolerant individuals and a very poor nitrate index score.

Based on the elevated observed nitrate concentrations, the high concentrations predicted by the HSPF model, the quantile regression analysis, as well as all of the nitrate related macroinvertebrate metrics scoring below average (especially nitrate index score), nitrates are a stressor to aquatic life in this reach.

Suspended Solids

Nine samples taken from one chemistry site (S009-054) in 2016 were analyzed for TSS. The average of all the values is 19.04 mg/L with a low of 4 mg/L and a high of 40 mg/L. The TSS concentrations did not exceed the 65 mg/L standard.

Additionally, nine secchi tube measurements were taken from this reach. These values ranged from 21-100 cm, with an average reading of 47.25 cm. No values fell below the 10 cm minimum standard for secchi tube.

The HSPF model calculated daily TSS values for this subwatershed from 1994-2014. These concentrations ranged from 1.61-770.37 mg/L with an average TSS value of 27.40 mg/L. Of these calculations, 90 (8.12%) were above the TSS standard of 65 mg/L.

Table 197. TSS related fish metrics in Unnamed Creek (-626). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-626 Fish Class 3 – General Use	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RifflePct	SensitivePct	SlithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14DM063	5.14	0.00	7.53	0.27	4.86	0.00	8.91	0.00	17.03	25.07
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	37.83	0.90	13.33	13.93	28.33	8.55	33.71	1.95	3.56	15.27
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

The fish community in Unnamed Creek (-626) at site 14DM063 scored below average in nine of the ten TSS related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 197). This reach did have an above average amount of long-lived individuals; however, the remaining metrics scored poorly especially the TSS Index score. These results are common in a stream with elevated TSS concentrations.

Table 198. TSS related macroinvertebrate metrics in Unnamed Creek (-626). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-626 Macroinvertebrate Class 7 – General Use	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
14DM063	20.00	0.00	12.00	57.14	2.80	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (22.0)</i>	17.35	1.33	13.20	48.28	19.13	0.22
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

The macroinvertebrate assemblage in this reach scored below average in five of the six TSS related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 198). Site 14DM063 did have a lower amount of TSS Tolerant taxa, but this site did have a high amount of TSS tolerant individuals. This reach also lacked many plecoptera and collector-filterer individuals, TSS Intolerant taxa, while also having a poor TSS Index score. These results are common in streams with TSS issues.

The observed TSS data does not show any standard exceedances, while the model predicted a lower exceedance rate. Based on this data, TSS is not a stressor to aquatic life in Unnamed Creek (-626). It is likely that other stressors are negatively impacting the biotic communities resulting in lower metric scores.

Habitat

Unnamed Creek (-626) had a qualitative habitat assessment take place at its biological monitoring site, 14DM063, during the fish and macroinvertebrate sampling events in 2014 and 2015. The average MSHA score from these visits was 46.57 (Fair). Limiting the habitat at this site was row crop agriculture as the dominant nearby land use, very narrow riparian buffer, little bank erosion, light stream shading, light embeddedness, and sand substrates. Further MSHA analysis can be seen in Figure 87.

Figure 87. Unnamed Creek (-626) MSHA metric scores.

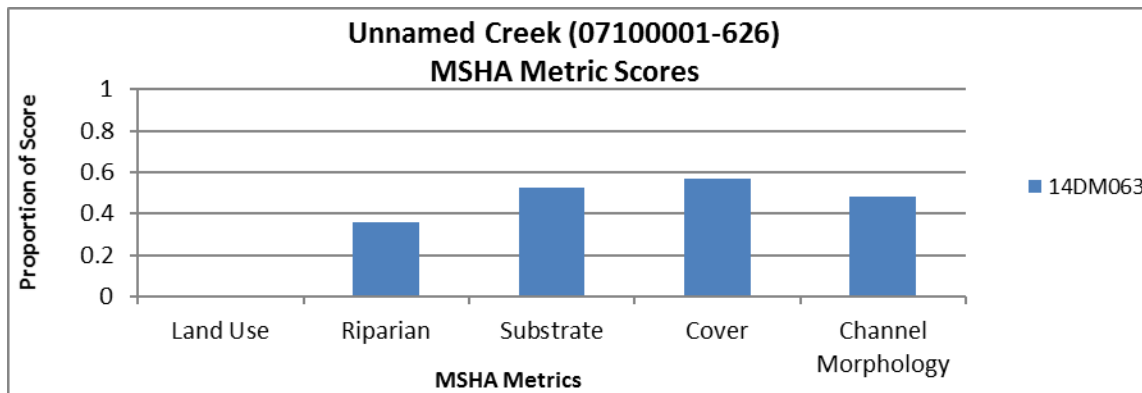


Table 199. Habitat related fish metrics in Unnamed Creek (-626). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-626 Fish Class 3 – General Use	BenInsect- ToIPct	SLithopPct	DarterSculps ucPct	RifflePct	PiscivorePct	LithFrimPct	ToIPct	PioneerPct
14DM063	0.27	8.91	0.27	4.86	0.00	36.14	99.46	65.45
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	14.22	33.71	12.55	28.33	1.62	69.21	70.64	37.79
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

The fish community in Unnamed Creek (-626) at site 14DM063 scored below average in all eight of the habitat related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 199). The fish community was dominated by tolerant fish species and also had a large number of pioneer individuals. These results are common in streams with poor habitat. This site also lacked many fish requiring specialized habitat conditions to live and reproduce signaling likely habitat stress.

Table 200. Habitat related macroinvertebrate metrics in Unnamed Creek (-626). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-626 Macroinvertebrate Class 7 – General Use	BurrowerP ct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPc t
14DM063	11.80	46.89	15.22	12.11	85.40	15.84
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)</i>	5.40	20.35	36.94	37.77	37.96	19.49
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate assemblage in Unnamed Creek (-626) scored below average in five of the six habitat related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 200). This reach did have an above average amount of climber individuals, but scored poorly in the other remaining metrics. The high amount of legless and burrower individuals, corresponds to the sand substrates present in this reach.

The habitat in this reach is considered to be fair, while both the fish and macroinvertebrate community metrics related to habitat score very poorly, therefore, habitat is a stressor to aquatic life in Unnamed Creek (-626) at this time.

Altered Hydrology

Unnamed Creek (-626) has a natural channel, though the majority of its entire upstream watershed is altered according to the MPCA altered watercourse layer.

Extreme weather events affect high flow events as well as also low flows during drought. HSPF models show this stream section experiencing low flow at less than five cfs 76.5% of the time and less than one cfs 34.2% of the time.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The average percentage for generalist fish within the reach was 91.1% compared to the average in Class 3 general use waters meeting the standard of 59.1%. Generalist fish populations ranged from 87.1-95.1%.

The numbers of nest guarder species are also positively correlated with increased low flows. The average percentage for nest guarder fish within the reach was 39.3% compared to the average in Class 3 general use waters meeting the standard of 19.2%. Nest guarder fish species ranged from 20.5-58.1%.

Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The average percentage for long-lived macroinvertebrates within the reach was 0.6% compared to the average in Class 7 general use waters meeting the standard of 8%. Long-lived macroinvertebrates ranged from 0.6-0.6%.

Unnamed Creek (-626) has very low flow conditions the majority of the time according to the modelled data set. The biological metrics in this reach also score poorly, however, it is also a natural stream section and difficult to accurately assess the impact that upstream channelization may be having on this reach. Therefore, flow alteration/connectivity is inconclusive as a stressor in this reach.

Summary

The impaired fish and macroinvertebrate communities in Unnamed Creek (-626) are being stressed by DO, Eutrophication, Nitrates, and Habitat (Table 201). Flow Alteration/Connectivity was inconclusive as a stressor while Suspended Sediment was ruled out as a stressor to aquatic life in this reach. For further information on the stressors and recommendations to fixing the stressors in the Talcot Lake-Des Moines River HUC 10 Watershed, please see pages 182-183.

Table 201. Stressor determinations for Unnamed Creek (-626).

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Unnamed Creek	07100001-626	●	●	●	---	●	o

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Devils Run Creek (07100001-668)

Located in west central Murray County, Devils Run Creek (-668) is a 4.00 mile long reach that is impaired for aquatic life due to the fish assemblage. This stream reach extends from Unnamed Creek down to the confluence with the Des Moines River. Along this stream section there is one biological monitoring station, 14DM062.

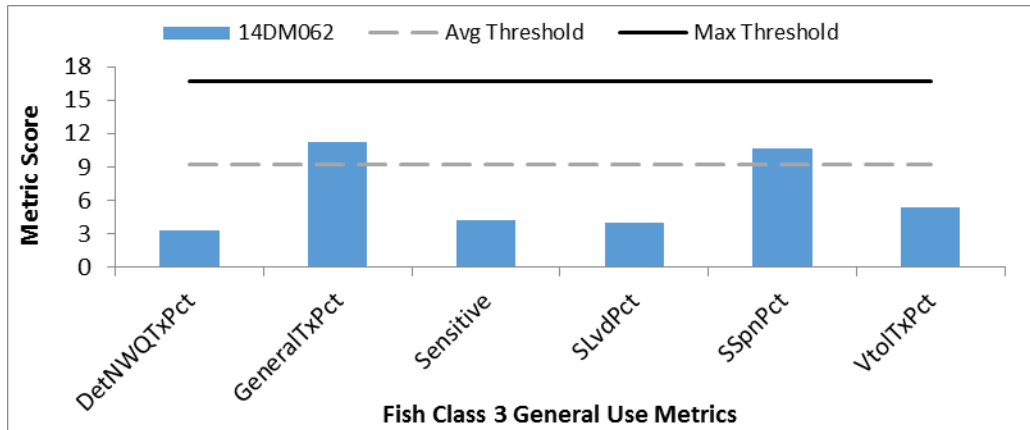
Biology

Fish

The fish community in Devil's Run Creek (-668) was sampled at biological station 14DM062 in August of 2015. The FBI score at this site was 38.6, which is well below the Fish Class 3 Southern Headwaters General Use Threshold of 55. This site scored above the average needed to reach the threshold by

having lower amounts of both serial spawning and generalist feeding taxa resulting in high metric scores. This reach did score below average in the remaining four metrics comprising the FIBI (Figure 88).

Figure 88. Devils Run Creek (-668) fish IBI metric scores.



Dissolved Oxygen

A total of three DO measurements were taken from one biological monitoring station (14DM062) from 2014-2015. The average of all the values is 6.79 mg/L with a low of 5.32 mg/L and a high of 8.20 mg/L. The summer average (June-Aug) is 6.79 mg/L. The DO values did not fall below 5 mg/L.

The HSPF model calculated daily minimum DO values for this subwatershed from 1994-2014. Of these calculations, 2183 (44.93%) of the days had a daily minimum DO level below the daily minimum standard of 5 mg/L. This is a very high exceedance rate for DO.

Table 202. DO related fish metrics in Devils Run Creek (-668). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-668 Fish Class 3 – General Use	MA>3 Avg	SspnPct Avg	Taxa Count Avg	DO TIV Avg
14DM062	2.36	27.95	15.00	8.35
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	13.32	17.09	12.16	8.44
Expected response to DO stress	↓	↑	↓	↓

The fish community in Devils Run Creek (-668) at site 14DM062 scored below average in three of the four DO related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 202). This reach had a low DO TIV score, few mature individuals, while also having an increased amount of serial spawning individuals. However, the reach did have an above average taxa count, which is uncommon in streams with DO problems.

Table 203. DO related macroinvertebrate metrics in Devils Run Creek (-668). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-668 Macroinvertebrate Class 7 – General Use	HBI_MN Value	% DO Tolerant	# DO Tolerant Taxa	ChemTV _DO
14DM062	8.19	43.89	5.00	6.42
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	7.55	12.98	5.74	6.91
Expected response to DO stress	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in three of the four DO related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 203). This reach had an increased percentage of DO tolerant taxa, while also having a poor HBI_MN and DO TIV scores. These results are common in streams with potential DO issues.

There were no standard exceedances in the very limited observed data set; however, the model calculated an extremely high exceedance rate. The majority of the fish and macroinvertebrate metrics related to DO scored poorly. Additionally, this reach had a lot of algae present and high phosphorus values that likely causes issues related to DO flux. Based on this information, DO is a stressor to aquatic life in Devils Run Creek (-668) at this time.

Eutrophication

Two phosphorus samples were taken from one biological monitoring station (14DM062) from 2014-2015. The average of all the values is 0.18 mg/L with a low of 0.15 mg/L and a high of 0.21 mg/L. Phosphorus values exceeded the standard of 0.150 mg/L once. Additionally, the reach immediately upstream of (-668) had nine phosphorus samples taken from chemistry site S009-034. These values ranged from 0.01-0.34 mg/L with an average concentration of 0.20 mg/L. Of these samples, seven were above the 0.15 mg/L standard. A photo showing large amounts of algae growth was taken along this reach (Figure 89).

Figure 89. Algae growth at site 14DM062.



The HSPF model calculated daily phosphorus values for this subwatershed from 1994-2014. These values ranged from 0.17-1.24 mg/L with an average value of 0.39 mg/L. All of these calculations were above the 0.15 mg/L standard for phosphorus.

Table 204. Eutrophication related fish metrics in Devils Run Creek (-668). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-668 Fish Class 3 – General Use	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct
14DM062	3.73	5.58	93.92	53.06
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	8.9	12.11	70.79	14.71
Expected response to Eutrophication stress	↓	↓	↑	↑

The fish community in Devils Run Creek (-668) at site 14DM062 scored below average in all four of the eutrophication related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 204). This reach had increased numbers of tolerant and omnivorous individuals, while also having lower numbers of darter and sensitive individuals. These results are often found in streams with eutrophic conditions.

Table 205. Eutrophication related macroinvertebrate metrics in Devils Run Creek (-668). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-672 Macroinvertebrate Class 7 – General Use	EPT Pct	Tanytarsini Pct	CrustMoll Pct	Scraper Pct	% Tolerant Taxa	% Intolerant Taxa
14DM062	32.92	12.71	17.24	6.90	53.92	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	38.45	18.46	11.78	16.11	26.84	4.03
Expected response to Eutrophication stress	↓	↓	↑	↑	↑	↓

The macroinvertebrate community in this reach scored below average in five of the six eutrophication related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 205). This reach had lower numbers of EPT, tanytarsini, and phosphorus intolerant individuals, while also having increased levels of crustacean/mollusca individuals and phosphorus tolerant taxa. These results also reflect an assemblage being stressed by eutrophication.

Based on the high number of exceedances in the observed and modeled results, the photographic evidence of eutrophic conditions, as well as the majority of the fish and macroinvertebrate metrics related to eutrophication scoring below average, eutrophication is a stressor to aquatic life in Devils Run Creek (-668).

Nitrates

A total of 11 samples taken from one chemistry site (S009-034) and one biological monitoring station (14DM062) from 2014-2016 were analyzed for Inorganic Nitrogen (NO₂-NO₃). The average of all the values is 1.19 mg/L with a low of 0.05 mg/L and a high of 3.3 mg/L. These nitrate concentrations were very low when compared to other parts of the watershed.

The HSPF nitrate information was unavailable for this reach.

Table 206. Nitrate related macroinvertebrate metrics in Devils Run Creek (-668). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-668 Macroinvertebrate Class 7 – General Use	TrichopteraChTx Pct	N Index Score	% N Tolerant	% N Intolerant
14DM062	12.12	3.63	74.92	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	10.00	3.30	57.57	0.91
Expected response to N stress	↓	↑	↑	↓

The macroinvertebrate community in Devils Run Creek (-668) scored below average in three of the four nitrate related metrics when compared to all other Class 7 Prairies Streams GP stations that meet the MIBI General Use Threshold (Table 206). Site 14DM062 did have a higher amount of trichoptera taxa, however, the site also lacked nitrate intolerant taxa, had a below average nitrate index score and a high amount of nitrate tolerant individuals.

Based on the very low observed nitrate concentrations, nitrates are not a stressor to aquatic life in this reach. It is likely that other stressors are negatively impacting the biological metrics causing lower metric scores.

Suspended Solids

Nine samples taken from one chemistry site (S009-034) in 2016 were analyzed for TSS. The average of all the values is 7.31 mg/L with a low of 2.4 mg/L and a high of 15 mg/L. The TSS concentrations did not exceed the 65 mg/L standard.

Additionally, ten secchi tube measurements were taken from this reach. These values ranged from 49-100 cm, with no values falling below the 10 cm minimum standard for secchi tube.

The HSPF model calculated daily TSS values for this subwatershed from 1994-2014. These concentrations ranged from 2.53-485.31 mg/L with an average TSS value of 18.20 mg/L. Of these calculations, 51 (3.30%) were above the TSS standard of 65 mg/L.

Table 207. TSS related fish metrics in Devils Run Creek (-668). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-668 Fish Class 3 – General Use	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RifflePct	SensitivePct	SlithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14DM062	3.46	0.00	26.28	5.57	1.61	3.72	1.61	0.00	0.17	22.79
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	37.83	0.90	13.33	13.93	28.33	8.55	33.71	1.95	3.56	15.27
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

The fish community in Devils Run Creek (-668) at site 14DM062 scored below average in nine of the ten TSS related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 207). This reach had an above average amount of herbivorous individuals,

but scored poorly in the remaining metrics and had a very poor TSS Index score. These results are common in streams with elevated TSS concentrations.

Table 208. TSS related macroinvertebrate metrics in Devils Run Creek (-668). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-668 Macroinvertebrate Class 7 – General Use	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
14DM062	16.45	0.00	9.00	25.39	8.46	0.31
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (22.0)</i>	17.35	1.33	13.20	48.28	19.13	0.22
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

The macroinvertebrate assemblage in this reach scored below average in two of the six TSS related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 208). Site 14DM062 had a good TSS Index Score, while also having a lower amount and percentage of TSS tolerant taxa and individuals. This site also had a slightly above average amount of plecoptera individuals as well. These results are not common in streams with high TSS concentrations.

Both the observed and modeled data sets show very few standard exceedances, while the macroinvertebrate community scores very well in the majority of the TSS related metrics. Therefore, TSS is not a stressor to aquatic life in Devils Run Creek (-668). The fish assemblage is likely being impacted by other stressors resulting in lower metric scores.

Habitat

Devils Run Creek (-668) had a qualitative habitat assessment take place at its biological monitoring site, 14DM062, during the fish and macroinvertebrate sampling events in 2014 and 2015. The average MSHA score from these visits was 33.97 (Poor). Limiting the habitat at this site was row crop agriculture as the dominant nearby land use (Figure 90), light stream shading, moderate embeddedness, sand and silt substrates, sparse fish cover, limited depth variability, moderate channel stability, and fair channel development. Further MSHA analysis can be seen in Figure 91.

Figure 90. Land Use at 14DM062



Figure 91. Devils Run Creek (-668) MSHA metric scores.

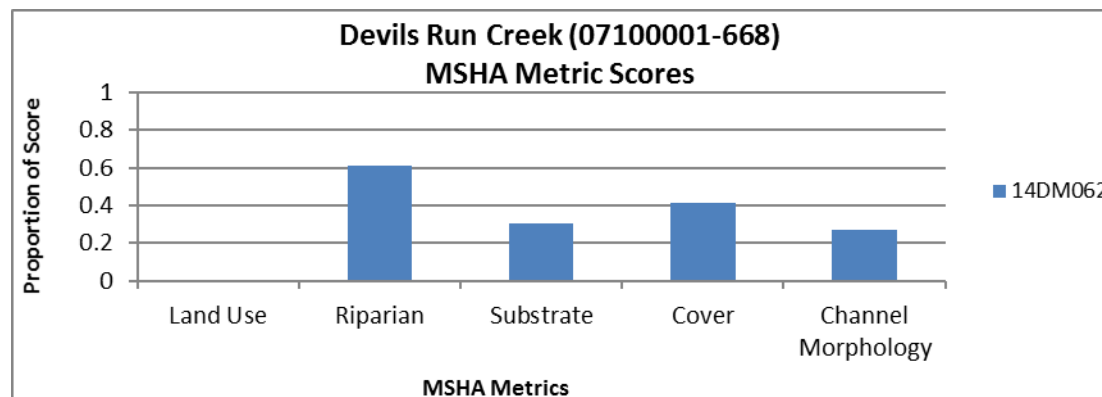


Table 209. Habitat related fish metrics in Devils Run Creek (-668). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-668 Fish Class 3 – General Use	BenInsect-TolPct	SlithopPct	DarterSculpsucPct	RifflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14DM062	5.57	1.61	5.57	1.61	0.00	15.36	93.92	65.64
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	14.22	33.71	12.55	28.33	1.62	69.21	70.64	37.79
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

The fish community in Devils Run Creek (-668) at site 14DM062 scored below average in all eight of the habitat related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 209). This site was dominated by fathead minnows (73.82%). Fathead minnows are a very tolerant fish species and tend to be found in large numbers in degraded habitat conditions. This stream lacked many habitat specializing species as well, which is another signal for potential habitat stress.

Table 210. Habitat related macroinvertebrate metrics in Devils Run Creek (-668). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-668 Macroinvertebrate Class 7 – General Use	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14DM062	4.08	20.69	21.94	32.92	44.51	50.78
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)</i>	5.40	20.35	36.94	37.77	37.96	19.49
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate assemblage in this stream reach scored below average in three of the six habitat related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 210). This reach had good numbers of both climber and sprawler individuals, while also having few burrower individuals. These results are not common in streams with degraded habitat. However, this reach also had lower numbers of both EPT and clinger individuals, while also having an increased amount of legless individuals. These results are typical of reaches with degraded habitat.

Based on the poor MSHA score, some poor scoring macroinvertebrate related metrics related to habitat, as well as all of the fish metrics related to habitat scoring well below average, habitat is indeed a stressor to aquatic life in Devils Run Creek (-668).

Altered Hydrology

Devils Run Creek (-668) is roughly half-natural and half-altered, though the majority of its entire upstream watershed is altered according to the MPCA altered watercourse layer. There is also an identified fish barrier downstream of biological monitoring station 14DM062.

Extreme weather events affect high flow events as well as also low flows during drought. HSPF models show this stream section experiencing low flow at less than five cfs 64.5% of the time and less than one cfs 19.6% of the time.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The average percentage for generalist fish within the reach was 67.1% compared to the average in Class 3 general use waters meeting the standard of 59.1%. Generalist fish populations ranged from 45.8-88.5%.

The numbers of nest guarder species are also positively correlated with increased low flows. The average percentage for nest guarder fish within the reach was 52.4% compared to the average in Class 3 general use waters meeting the standard of 19.2%. Nest guarder fish species ranged from 31.0-73.8%.

Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The average percentage for long-lived macroinvertebrates within the reach was 3.1% compared to the average in Class 7 general use waters meeting the standard of 8%. Long-lived macroinvertebrates ranged from 3.1-3.1%.

Based on the frequent low flow conditions, an identified fish barrier nearby the downstream site, as well as the poor scoring biological metrics in this reach, Flow Alteration/Connectivity is a stressor in Devils Run Creek (-668).

Summary

The impaired fish and macroinvertebrate communities in Devils Run Creek (-668) are being stressed by DO, Eutrophication, Habitat and Flow Alteration/Connectivity (Table 211). Nitrates and Suspended Sediment were ruled out as stressors to aquatic life in this reach. For further information on the stressors and recommendations to fixing the stressors in the Talcot Lake-Des Moines River HUC 10 Watershed, please see pages 182-183.

Table 211. Stressor determinations for Devils Run Creek (-668).

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Devils Run Creek	07100001-668	●	●	---	---	●	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Talcot Lake-Des Moines River Watershed (0710000104) HUC 10 conclusion and recommendations

The Talcot Lake-Des Moines River subwatershed has seven biologically impaired streams that are being negatively impacted by a number of stressors throughout the watershed. Stressors found in at least five of the seven impaired reaches include DO, Eutrophication, and Habitat. Nitrates and Suspended Sediment were also issues in three of the reaches, while Flow Alteration/Connectivity were found to be a stressor in two thus far (Table 212).

The predominant land use in this subwatershed is row crop agriculture with some smaller areas of hay/pasture. Row crop agriculture is a significant contributor to the stressors found in these reaches. These land use practices often lead to high nitrate and phosphorus levels through excessive use of fertilizers that can quickly reach the stream system by drain tiles and field runoff. These elevated phosphorus levels will also impact the DO conditions resulting in many more tolerant fish and macroinvertebrate communities. Much of the DO, Eutrophication, and Flow Alteration/Connectivity issues occurred in the headwaters, while habitat and nitrates were problems throughout.

Channelizing streams can also lead to very high flow rates resulting in bank erosion. Bank erosion leads to higher amounts of both bedded and suspended sediment in the stream resulting in poor habitat and visibility conditions impacting the breeding and feeding environments for more sensitive fish and macroinvertebrate species. This subwatershed did experience some issues with flow alteration/connectivity, habitat, and suspended sediment as well.

A large effort is needed in the Talcot Lake-Des Moines River Watershed to improve biological conditions in the many impaired streams found throughout. A high priority in this watershed is to utilize a variety of nutrient reducing BMPs including: cover crops, nutrient management, saturated buffers, etc., will also help in the nitrate and phosphorus reduction. This could also help with the eutrophication and resulting DO issues as well. Additionally, better managing the effects of flow alteration could lead to improvements as well. This can be achieved by increasing the storage and infiltration of water in locations with flow alteration stressors. This will also help reduce sediment inputs from stream banks, improve habitat by protecting streambanks, reduce erosion and overall stream sedimentation. Re-establishing a quality riparian corridor to increase stream stabilization, shading, and habitat features is also needed to improve conditions

Table 212. Stressor determinations for the Talcot Lake -Des Moines River Watershed.

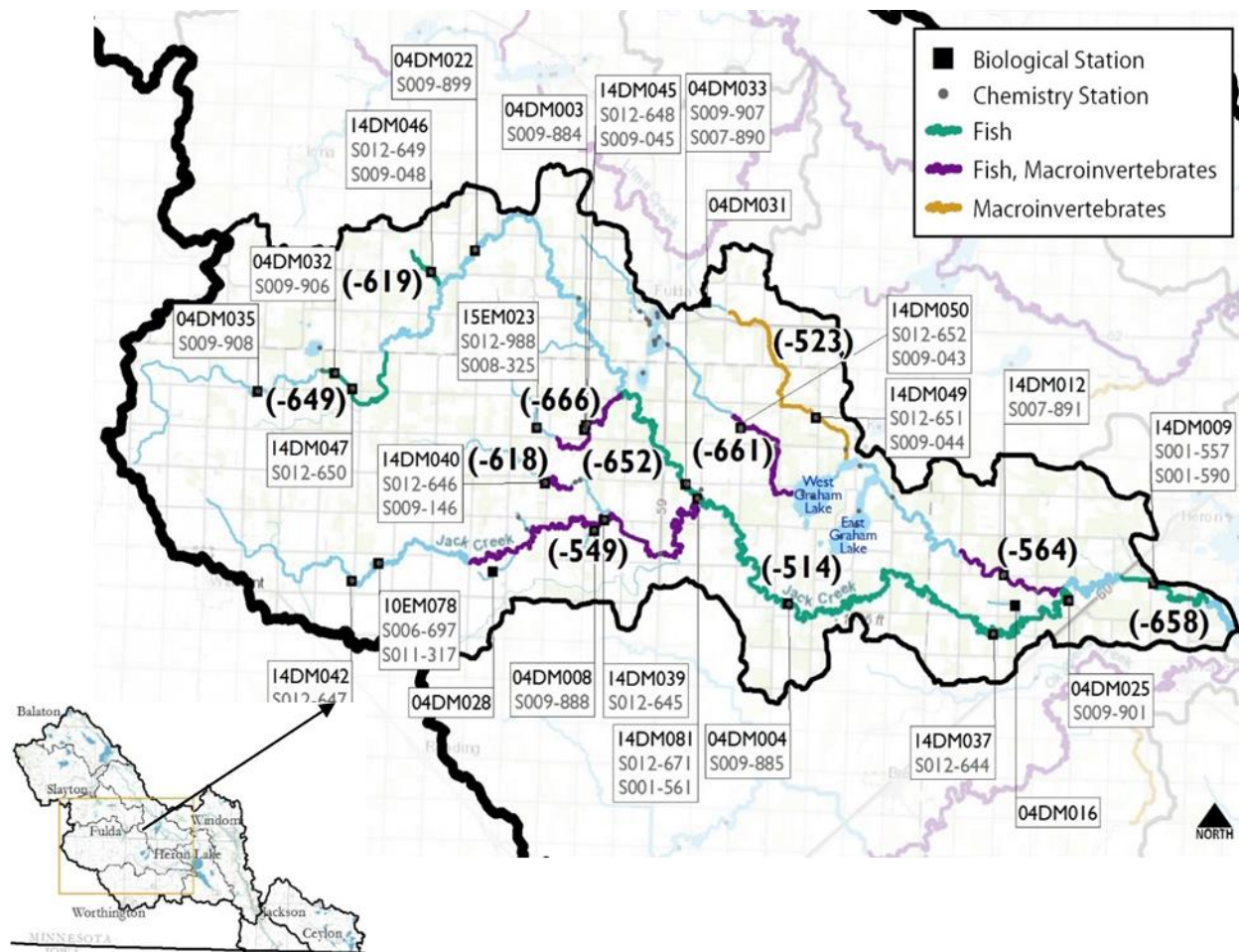
Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Des Moines River	07100001-533	---	●	---	●	●	---
Des Moines River	07100001-545	●	●	---	●	●	o
Des Moines River	07100001-546	---	●	---	●	●	---
Unnamed Creek	07100001-621	●	●	●	---	●	●
Unnamed Creek	07100001-672	●	●	●	---	●	o
Unnamed Creek	07100001-626	●	●	●	---	●	o
Devils Run Creek	07100001-668	●	●	---	---	●	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

5.5. Jack Creek Watershed (0710000106)

The Jack Creek HUC-10 Watershed (0710000106) is a 209.23 mi² watershed (Figure 92) located in the west central portion of the Des Moines River-Headwaters Watershed. This watershed contains eleven biologically impaired reaches. The primary land use within this watershed by far is row crop agriculture.

Figure 92. Jack Creek Watershed with monitoring stations and biological impairments.



Jack Creek (07100001-658)

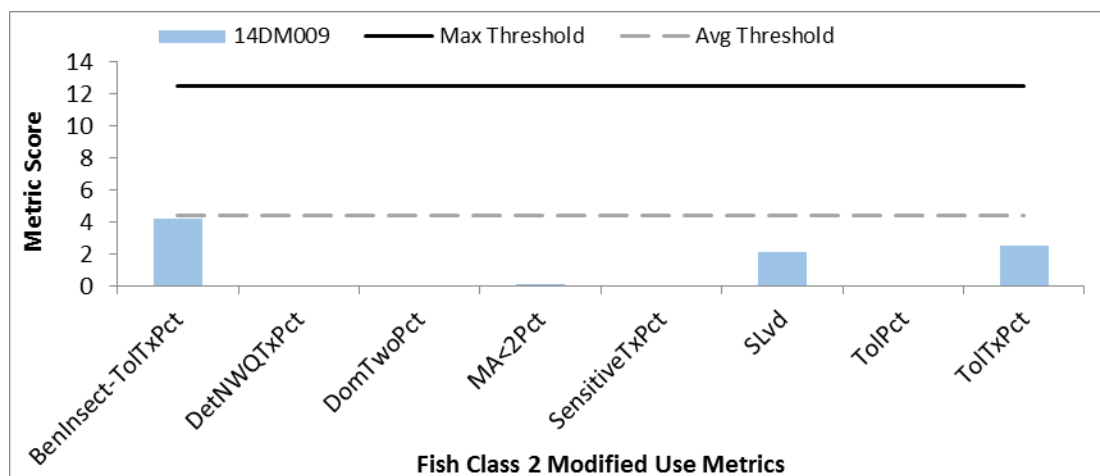
Located in northwestern Jackson County, Jack Creek (-658) is a 3.73 mile long reach that is impaired for aquatic life due to the fish assemblage. This stream reach extends from Unnamed Creek down to the confluence with the Des Moines River. Along this stream section there is one biological monitoring station, 14DM009.

Biology

Fish

The fish community in Jack Creek (-658) was sampled in August of 2014 at biological monitoring station 14DM009. This site had an FBI score of 8.9, which is far below the Fish Class 2 Southern Streams Modified Use Threshold of 35. This reach scored below the average needed to reach the threshold in all eight of the metrics that comprise the FBI for this class (Figure 93). Five of the eight metrics had a score of zero. Site 14DM009 was dominated by the presence of fathead minnows (84.03% of individuals), which are a very tolerant taxa often found in high numbers in degraded streams.

Figure 93. Jack Creek (-658) fish IBI metric scores.

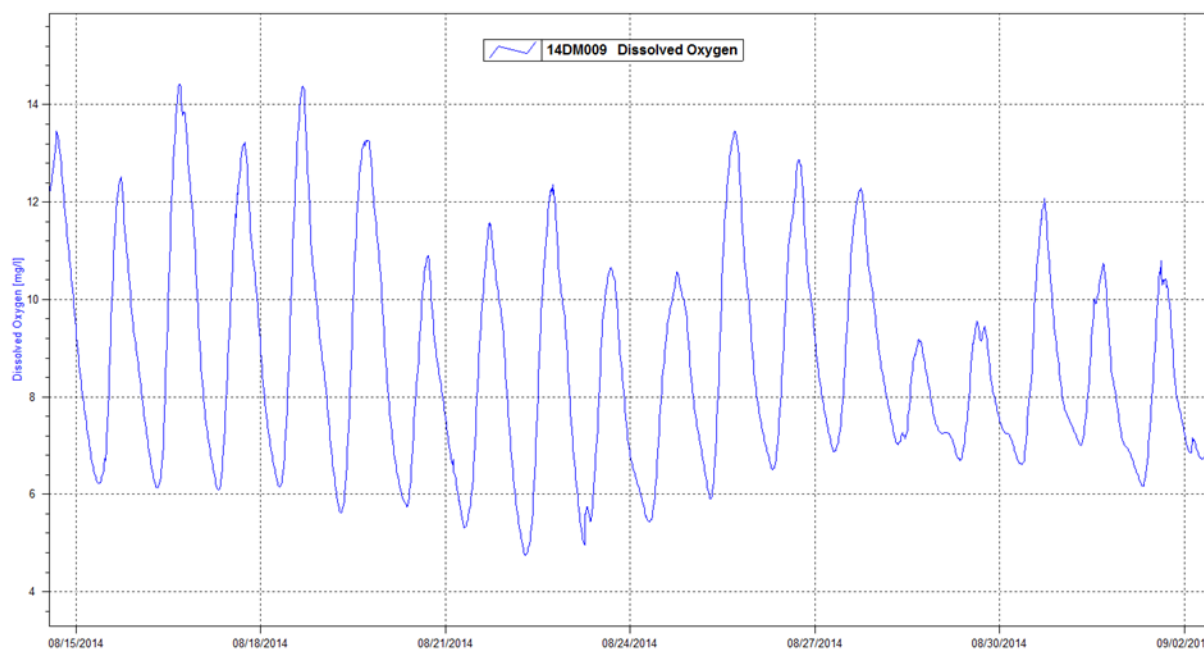


Dissolved Oxygen

A total of 266 dissolved oxygen (DO) measurements were taken from one chemistry site (S001-658) from 2003-2016. The average of all the values is 7.89 mg/L with a low of 3.81 mg/L and a high of 14.03 mg/L. The summer average (June-Aug) is 6.6 mg/L. The DO values fell below 5 mg/L nine times.

Site 14DM009 also had continuous DO monitoring take place in 2014 (Figure 94). During this monitoring, the DO levels did fall below 5 mg/L. The daily flux of DO often exceeded the 4.5 mg/L standard for the southern region of the state. These high rates of flux can be indicative of DO and eutrophication stress.

Figure 94. Continuous DO monitoring at site 14DM009 in Jack Creek (-658).



Additionally, the HSPF model calculated daily minimum DO values for this subwatershed from 1994-2014. Of these calculations, 4700 (66.44%) of the days had a daily minimum DO level below the daily minimum standard of 5 mg/L. This is a very high exceedance rate for DO.

Table 213. DO related fish metrics in Jack Creek (-658). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-658 Fish Class 2 – Modified Use	MA>3 Avg	SspnPct Avg	Taxa Count Avg	DO TIV Avg
14DM009	2.70	95.78	15.00	8.46
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)</i>	27.98	25.34	14.52	8.41
Expected response to DO stress	↓	↑	↓	↓

The fish community in Jack Creek (-658) at site 14DM009 scored below average in two of the four DO related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI Modified Use Threshold (Table 213). This reach had a very high amount of serial spawning individuals, which are very common in streams with poor DO conditions. Site 14DM009 also had very few mature individuals, which can also indicate DO stress.

Table 214. DO related macroinvertebrate metrics in Jack Creek (-658). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-658 Macroinvertebrate Class 7 – Modified Use	HBI_MN Value	% DO Tolerant Taxa	# DO Tolerant Taxa	ChemTV DO
14DM009	8.33	7.40	6.00	7.28
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22)</i>	8	31.37	9.33	6.19
Expected response to DO stress	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in one of the four DO related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 214). Site 14DM009 did have a low amount of both DO individuals and taxa, while also having a good TIV score. These results are not as common in streams with DO issues.

While many of the macroinvertebrate metrics related to DO scored well in this reach, the fish community fared worse especially with the very high number of serial spawning species. The DO levels in this reach do fall below 5 mg/L frequently according to the observed and modeled data sets and the DO flux greatly exceeds the 4.5 mg/L standard. Based on this information, DO is a stressor to aquatic life in Jack Creek (-658) at this time.

Eutrophication

A total of 350 samples were taken from one chemistry site (S001-557) from 2004-2016 were analyzed for phosphorus. The average of all the values is 0.180 mg/L with a low of 0.03 mg/L and a high of 0.62 mg/L. The summer average (June-Aug) is 0.206 mg/L. Phosphorus values exceeded the standard of 0.150 mg/L 198 times.

A total of 105 samples from one chemistry site (S001-557) from 2004-2008 were analyzed for BOD. The average for all the values is 2.79 mg/L with a low of 2.00 mg/L and a high of 8.00 mg/L. The summer average is (June-Aug) is 3.00 mg/L. The BOD value exceeded the standard of 3.50 mg/L 19 times.

Seven samples from one chemistry site (S001-557) in 2014 were analyzed for chlorophyll-a. The average for all the values is 14.94 ug/L with a low of 3.20 ug/L and a high of 30.80 ug/L. The summer average is (June-Aug) is 15.30 ug/L. The chlorophyll-a value exceeded the standard of 40 ug/L zero times.

Table 215. Eutrophication related fish metrics in Jack Creek (-658). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-658 Fish Class 2 – Modified Use	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct
14DM009	0.00	0.21	99.11	86.19
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)</i>	8.24	13.32	45.53	25.1
Expected response to Eutrophication stress	↓	↓	↑	↑

The fish community in Jack Creek (-658) scored below average in all four of the eutrophication related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI Modified Use Threshold (Table 215). The site, 14DM009, had very high amounts of both tolerant and omnivorous fish species, while also having very few or completely lacking darter and sensitive fish taxa.

Table 216. Eutrophication related macroinvertebrate metrics in Jack Creek (-658). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-658 Macroinvertebrate Class 7 – Modified Use	EPT Pct	Tanytarsini Pct	CrustMoll Pct	Scraper Pct	% Tolerant Taxa	% Intolerant Taxa
14DM009	82.32	14.29	4.50	48.55	48.55	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22)</i>	20.58	22.11	23.21	17.73	45.87	1.43
Expected response to Eutrophication stress	↓	↓	↑	↑	↑	↓

The macroinvertebrate community in this reach scored below average in four of the six metrics related to eutrophication when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 216). Site 14DM009, did have a very high amount of EPT and very few crustacea/mollusca individuals, which can signal that eutrophication is not an issue, however, this reach also had elevated numbers of phosphorus tolerant taxa, scraper individuals, while also having fewer tanytarsini individuals and phosphorus intolerant taxa. These results are commonly found in streams with elevated phosphorus concentrations.

Based on the very high amount of exceedances of the phosphorus standard, the high rate of DO flux from the DO monitoring, in addition to the very poor scoring fish and macroinvertebrate metrics related to eutrophication, eutrophication is a stressor to aquatic life in Jack Creek (-658) at this time.

Nitrates

A total of 332 samples were taken from one chemistry site (S001-557) from 2004-2016 were analyzed for Inorganic Nitrogen (NO₂-NO₃). The average of all the values is 8.29 mg/L with a low of 0.05 mg/L and a high of 22.40 mg/L. The spring average (March-May) is 8.79 mg/L. The summer average (June-Aug) is 8.51 mg/L. Nitrate values exceeded 4 mg/L 270 times.

Quantile regression analysis showed that when a Class 7 station had a nitrate concentration at or exceeding 11.5 mg/L there was 90% probability for impairment. The nitrate concentrations in this reach easily exceeded this level.

The HSPF model calculated daily nitrate concentrations for the subwatershed from 1994-2014. These values ranged from 0.01-20.12 mg/L with an average nitrate concentration of 2.94 mg/L. Of these calculations 57 (0.82%) were above 11.5 mg/L.

The presence of drain tiles were also noted during a biological sampling event. Drain tiles are a common pathway for nitrates to enter a stream system.

Table 217. Nitrate related macroinvertebrate metrics in Jack Creek (-658). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-658 Macroinvertebrate Class 7 – Modified Use	TrichopteraChTx Pct	N Index Score	% N Tolerant	% N Intolerant
14DM009	13.64	4.52	77.81	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22)</i>	5.71	3.30	62.54	0.00
Expected response to N stress	↓	↑	↑	↓

The macroinvertebrate community in Jack Creek (-658) scored below average in three of the four nitrate related metrics when compared to all other Class 7 Prairies Streams GP stations that meet the MIBI Modified Use Threshold (Table 217). This reach did have an above average amount of trichoptera taxa, which tend to be less abundant in streams negatively impacted by nitrates. This reach also had a high amount of nitrate tolerant individuals, completely lacked nitrate intolerant species, and had a very poor nitrate index score.

While the HSPF model calculated relatively lower nitrate concentrations, the observed nitrate concentrations from a rather large data set showed that nitrate concentrations to get elevated in this reach. The quantile regression analysis, the presence of drain tiles, and the majority of the nitrate related macroinvertebrate metrics all indicate that nitrates are indeed a stressor to aquatic life in Jack Creek (-658).

Suspended Solids

A total of 102 samples taken from one chemistry site (S001-557) from 2002-2014 were analyzed for TSS. The average of all the values is 129 mg/L with a low of 20 mg/L and a high of 418 mg/L. The TSS concentrations exceeded the 65 mg/L standard mg/L 73 times. This is a very high exceedance rate.

The HSPF model calculated daily TSS values for this subwatershed from 1994-2014. These concentrations ranged from 0.07-952.32 mg/L with an average TSS value of 31.48 mg/L. Of these calculations, 490 (7.16%) were above the TSS standard.

This reach was determined to be impaired for turbidity in 2006 and this impairment was confirmed during the 2016 assessment.

Table 218. TSS related fish metrics in Jack Creek (-658). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-658 Fish Class 2 – Modified Use	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RifflePct	SensitivePct	SlithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14DM009	2.02	0.00	0.21	0.85	1.88	0.00	2.59	0.00	0.85	23.85
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)</i>	30.08	6.17	2.88	28.69	19.54	8.38	26.17	0.86	21.25	19.19
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

The fish community in Jack Creek (-658) at site 14DM009 scored below average in all ten of the TSS related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI Modified Use Threshold (Table 218). This reach had a poor TSS Index Score and bad metric scores. These results reflect a community that is likely stressed by elevated TSS concentrations.

Table 219. TSS related macroinvertebrate metrics in Jack Creek (-658). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-658 Macroinvertebrate Class 7 – Modified Use	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
14DM009	26.46	0.00	8.00	86.17	23.15	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)</i>	16.02	0.60	10.98	35.60	9.91	0.02
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

The macroinvertebrate assemblage in this reach scored below average in four of the six TSS related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 219). Site 14DM009 did have a below average amount of TSS tolerant taxa present and an above average amount of collector-filterer individuals. However, this reach had a very poor TSS Index score, zero TSS intolerant and plecoptera taxa, and a very high amount of TSS tolerant individuals. These results are common in streams with TSS issues.

Based on the high rate of standard exceedances from the observed data, the majority of the TSS related metrics in both the fish and macroinvertebrate communities scoring below average, as well as the current turbidity impairment in this reach, TSS is a stressor to aquatic life in Jack Creek (-658).

Habitat

Jack Creek (-658) had a qualitative habitat assessment take place at its biological monitoring site, 14DM009, during the fish and macroinvertebrate sampling events in 2014. The average MSHA score from these visits was 30.78 (Poor). Limiting the habitat at this site was the row crop agriculture as the dominant nearby land uses, severe to heavy bank erosion (Figure 95), the presence of silt and sand substrates, moderate embeddedness, sparse fish cover, no riffles, low

Figure 95. Heavy bank erosion at site 14DM009.



channel stability, fair sinuosity, and fair channel development. Further MSHA analysis can be seen in Figure 96.

Figure 96. Jack Creek (-658) MSHA metric scores.

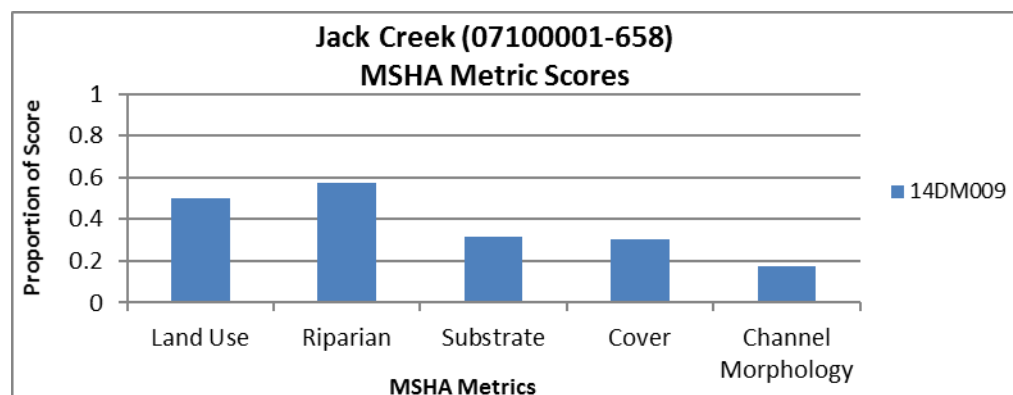


Table 220. Habitat related fish metrics in Jack Creek (-658). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-658 Fish Class 2 – Modified Use	BenInsect-TolPct	SlithopPct	DarterSculps ucPct	RifflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14DM009	0.21	2.59	0.21	1.88	0.64	3.51	99.11	85.20
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)</i>	19.05	26.17	16.45	19.54	8.02	35.59	46.38	23.58
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

The fish community in Jack Creek at site 14DM009 scored below average in all eight of the habitat related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI Modified Use Threshold (Table 220). This stream reach was completely dominated by very tolerant species, particularly the fathead minnow. Fathead minnows are a fish species that is very tolerant and often found in high numbers in degraded stream systems. Site 14DM009 had a fish assemblage consisting of 84.03% of fathead minnows.

Table 221. Habitat related macroinvertebrate metrics in Jack Creek (-658). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-658 Macroinvertebrate Class 7 – Modified Use	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14DM009	2.25	4.82	72.67	82.32	9.97	9.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)</i>	9.74	24.34	20.62	15.52	59.46	22.88
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate assemblage in this reach fared much better than the fish community as it scored below average in two of the six habitat related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 221). This site did have lower numbers of climber and sprawler individuals, which can signal degraded habitat conditions. This site did have a very high number of EPT and clinger individuals, which are commonly found in streams with good habitat conditions.

Based on the poor MSHA score and the very poor habitat related in the fish community, habitat is a stressor to aquatic life, especially the impaired fish assemblage, in Jack Creek (-658) at this time. The macroinvertebrate community did score fairly well, however, if conditions do not improve it is likely that the metric scores will begin to decline.

Altered Hydrology

This reach of Jack Creek (-658) is almost an entirely altered channel which flows into Heron Lake. The majority of the upstream watershed is altered according to the MPCA altered watercourse layer. There is a fish barrier downstream of the reach at the outlet of Heron Lake. "Riffle cross section measurements identified that the BHR was 2.12 and entrenchment ratio was 1.37. These ratios indicate that the channel at the study location is both entrenched and deeply incised. Flood-prone elevations are roughly 1 foot lower than the top of the low bank height and means that flood flows (i.e. 2 times bankfull max depth at the riffle) cannot access the rivers floodplain. The confinement of flood flows within the channel is a leading factor as to why the channel is in such poor shape" (DNR 2016).

Extreme weather events affect high flow events as well as also low flows during drought. HSPF models show this stream section experiencing low flow at less than five cfs 3.8% of the time and less than one cfs 0% of the time.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The percentage for generalist fish within the reach was 87.2% compared to the average in Class 2 modified use waters meeting the standard of 43.9%.

The numbers of nest guarder species are also positively correlated with increased low flows. The percentage for nest guarder fish within the reach was 84.3% compared to the average in Class 2 modified use waters meeting the standard of 30.6%.

Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The percentage for long-lived macroinvertebrates within the reach was 0.6% compared to the average in Class 7 modified use waters meeting the standard of 5.6%.

Based on the altered channel condition, the upstream channelization of tributaries, downstream fish barriers, the lack of floodplain access for the channel, as well as the poor scoring biological metrics, Flow Alteration/Connectivity is a stressor to aquatic life in Jack Creek (-658).

Summary

The impaired fish community in Jack Creek (-668) is being stressed by DO, Eutrophication, Nitrates, Suspended Sediment, Habitat and Flow Alteration/Connectivity (Table 222). For further information on the stressors and recommendations to fixing the stressors in the Jack HUC 10 Watershed, please see pages 268-269.

Table 222. Stressor determinations for Jack Creek (-658).

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Jack Creek	07100001-658	●	●	●	●	●	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Unnamed Creek (07100001-564)

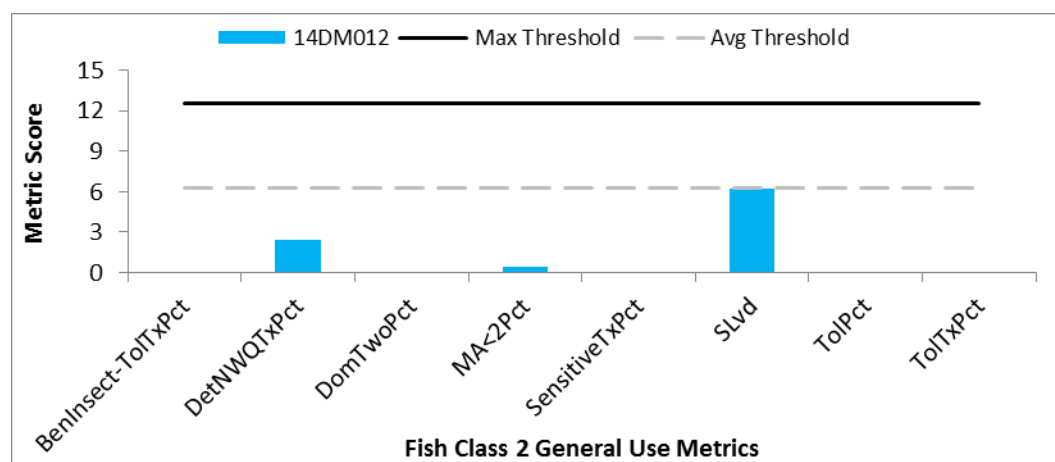
Located in northwestern Jackson County, Unnamed Creek (-564) is a 4.29 mile long reach that is impaired for aquatic life due to the fish and macroinvertebrate assemblages. This stream reach extends from unnamed ditch down to the confluence with the Jack Creek. Along this stream section there is one biological monitoring station, 14DM012.

Biology

Fish

The fish community in Unnamed Creek (-564) was sampled for fish in August of 2014 at its biological monitoring station 14DM012. The FBI score at this reach was 9.2, which is far below the Fish Class 2 Southern Streams General Use Threshold of 50. This site did have one metric (SLvd) reach the average metric score needed to meet the threshold (Figure 97), however, the remaining seven metrics comprising this FBI scored well below average with five metrics scoring zero. This site was also dominated by the presence of fathead minnows (90.42% of sampled individuals).

Figure 97. Unnamed Creek (-564) fish IBI metric scores.

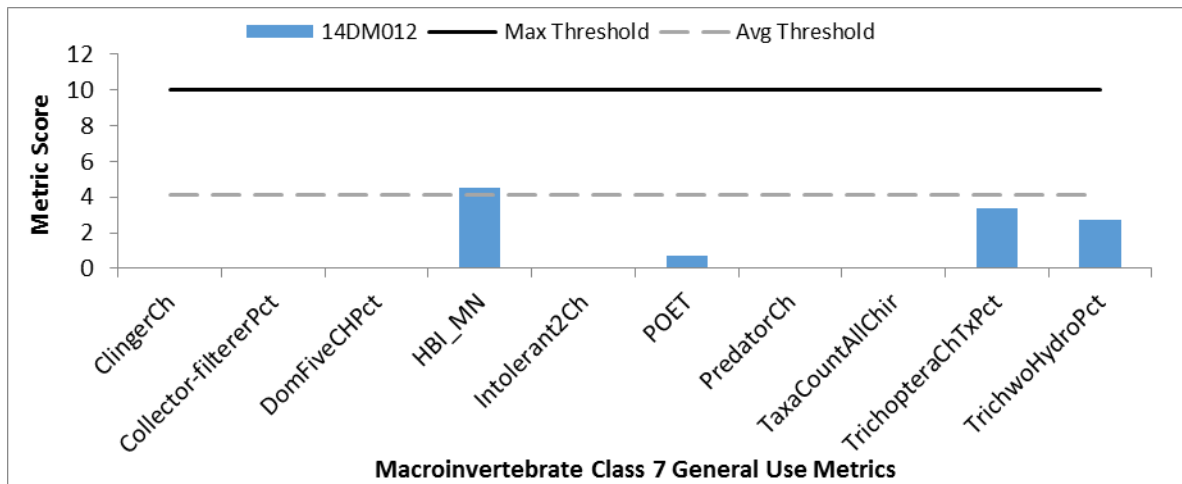


Macroinvertebrates:

Macroinvertebrates were also sampled at site 14DM012 in August of 2014. The MIBI score from this visit was 11.3, which is far below the Macroinvertebrate Class 7 Prairie Streams GP Modified Use Threshold of 41. This site had one metric (HBI_MN) score above the average needed to reach the threshold in this class (Figure 98). The remaining nine metrics scored below average (3) or zero (6). The macroinvertebrate

community was dominated by *Hyalella*, which are tolerant amphipods that can be very abundant in degraded stream systems.

Figure 98. Unnamed Creek (-564) macroinvertebrate IBI metric scores.

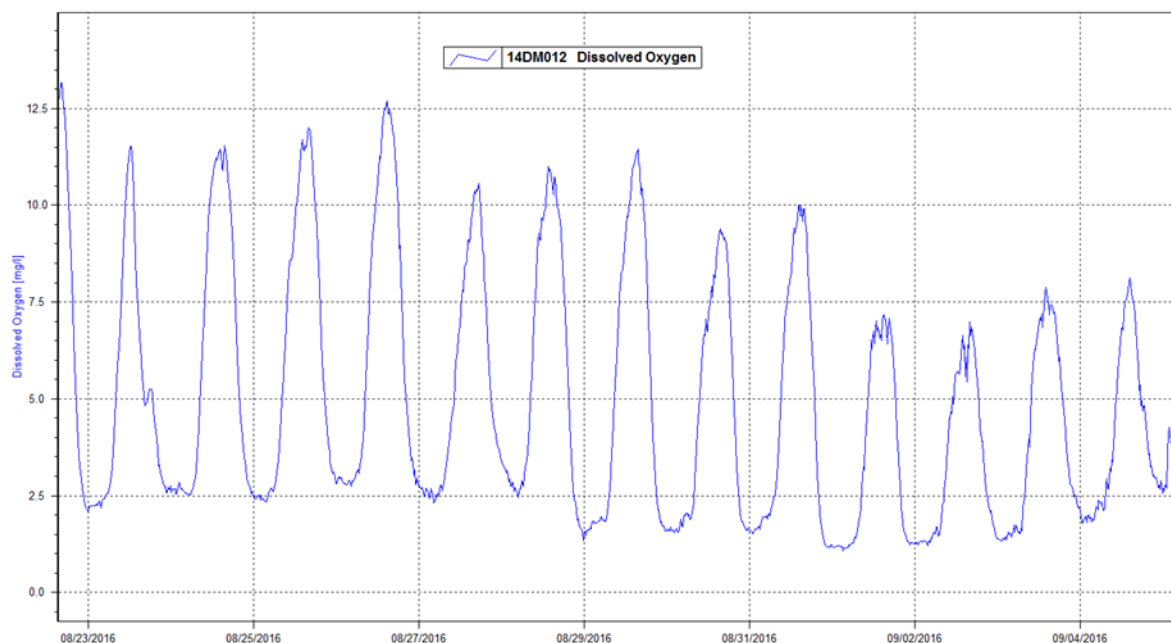


Dissolved Oxygen

A total of 25 DO measurements were taken from one chemistry site (S007-891) from 2014-2016. The average of all the values is 9.18 mg/L with a low of 4.13 mg/L and a high of 18.50 mg/L. The summer average (June-Aug) is 9.03 mg/L. The DO values fell below 5 mg/L once. This wide range of values may be an indicator for potential issues with daily flux of DO.

Continuous DO monitoring took place at site 14DM012 in 2016 (Figure 99). This monitoring showed that the daily DO levels fell below 5 mg/L on a daily basis. The daily flux at this site was also very high and exceeded the 4.5 mg/L standard for the southern region of the state. These results indicate that DO and potentially eutrophication are likely stressors.

Figure 99. Continuous DO monitoring at site 14DM012 in Unnamed Creek (-564).



Additionally, the HSPF model calculated daily minimum DO values for this subwatershed from 1994-2014. Of these calculations, 1360 (17.73%) of the days had a daily minimum DO level below the daily minimum standard of 5 mg/L.

Table 223. DO related fish metrics in Unnamed Creek (-564). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-564 Fish Class 2 – General Use	MA>3 Avg	SspnPct Avg	Taxa Count Avg	DO TIV Avg
14DM012	3.93	91.40	10.00	8.36
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)</i>	23.89	28.72	20.38	8.56
Expected response to DO stress	↓	↑	↓	↓

The fish community in Unnamed Creek (-564) at site 14DM012 scored below average in all four of the DO related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 223). This stream had few mature fish, while also having a lower taxa count and poor DO TIV score. Site 14DM012 also had a very high amount of serial spawning fish was due to the large amount of fathead minnows present (368). Fathead minnows are a very tolerant fish species that are often found in large numbers in streams with poor DO conditions.

Table 224. DO related macroinvertebrate metrics in Unnamed Creek (-564). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-564 Macroinvertebrate Class 7 – General Use	HBI_MN Value	% DO Tolerant Taxa	# DO Tolerant Taxa	ChemTV_DO
14DM012	7.50	86.44	5.00	5.99
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	7.55	12.98	5.74	6.91
Expected response to DO stress	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in one of the four DO related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 224). Site 14DM012 had a very high percentage of DO tolerant taxa present, which can indicate stress from the DO conditions. The remaining metrics did score above average however.

Based on the high rate of daily minimum standard exceedances predicted by the model and observed with the continuous DO monitoring, the high rate of daily flux, as well as the majority of the fish metrics related to DO scoring poorly, DO is a stressor to aquatic life in Unnamed Creek (-564).

Eutrophication

Twelve phosphorus samples were taken from one chemistry site (S007-891) from 2014-2016. The average of all the values is 0.212 mg/L with a low of 0.15 mg/L and a high of 0.36 mg/L. The summer average (June-Aug) is 0.237 mg/L. Phosphorus values exceeded the standard of 0.150 mg/L 10 times.

Table 225. Eutrophication related fish metrics in Unnamed Creek (-564). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-564 Fish Class 2 – General Use	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct
14DM012	0.00	0.00	99.75	97.05
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)</i>	19	11.47	45.1	17
Expected response to Eutrophication stress	↓	↓	↑	↑

The fish assemblage in Unnamed Creek (-564) scored below average in all four of the metrics related to eutrophication at site 14DM012 when compared to all other Class 2 Southern Streams stations that meet the General Use Threshold (Table 225). This reach was dominated by tolerant and omnivorous fish species, while also lacking sensitive and darter individuals. These results indicate potential stress related to eutrophication.

Table 226. Eutrophication related macroinvertebrate metrics in Unnamed Creek (-564). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-564 Macroinvertebrate Class 7 – General Use	EPT Pct	Tanytarsini Pct	CrustMoll Pct	Scraper Pct	% Tolerant Taxa	% Intolerant Taxa
14DM012	4.42	0.00	86.44	6.62	90.22	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	38.45	18.46	11.78	16.11	26.84	4.03
Expected response to Eutrophication stress	↓	↓	↑	↑	↑	↓

The macroinvertebrate community at site 14DM012 in this stream reach scored below average in five of the six metrics related to eutrophication when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 226). This reach did have a lower amount of scraper individuals, which is common in streams not affected by excess phosphorus; however, the remaining five metrics scored poorly and had strong signals of eutrophication issues. The high abundance of *Hyallela* at this site can signal eutrophication as they feed on organic material and detritus.

Based on the very high observed phosphorus values, with the majority exceeding the 0.15 mg/L standard, the daily flux of DO frequently exceeded the 4.5 mg/L standard indicating potential eutrophic conditions, as well as the strong signals of stress from both of the fish and macroinvertebrate community metrics related to phosphorus, eutrophication is a stressor to aquatic life in Unnamed Creek (-564).

Nitrates

Twelve samples taken from one chemistry site (S007-891) from 2014-2016 were analyzed for Inorganic Nitrogen (NO₂-NO₃). The average of all the values is 1.13 mg/L with a low of 0.20 mg/L and a high of 5.67 mg/L. The spring average (March-May) is 0.43 mg/L. The summer average (June-Aug) is 1.71 mg/L. Nitrate values exceeded 4 mg/L once.

The HSPF model calculated daily nitrate concentrations for this subwatershed from 1994-2014. These values ranged from 0.04-63.65 mg/L with an average value of 2.66 mg/L. This average value is relatively low when compared to other areas in the Des Moines River Watershed.

Table 227. Nitrate related macroinvertebrate metrics in Unnamed Creek (-564). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-564 Macroinvertebrate Class 7 – General Use	TrichopteraChTxP ct	N Index Score	% N Tolerant	% N Intolerant
14DM012	5.56	2.46	12.62	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	10.00	3.30	57.57	0.91
Expected response to N stress	↓	↑	↑	↓

The macroinvertebrate assemblage at site 14DM012 scored below average in two of the four nitrate related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 227). This reach did have a lower amount of both trichoptera and nitrate intolerant taxa, however the nitrate index score was very good and there were few nitrate tolerant individuals present.

Both of the observed and predicted nitrate values in this reach are relatively low. The nitrate related macroinvertebrate metrics showed few nitrate tolerant individuals and the nitrate index score was also very good. This information concludes that nitrates are not a stressor to aquatic life in Unnamed Creek (-564) at this time.

Suspended Solids

One sample taken from one chemistry site (S007-891) in 2016 was analyzed for TSS. The TSS concentration of this sample was 39 mg/L, which is below the 65 mg/L standard for TSS.

Additionally, three secchi tube measurements were taken from this reach. These values ranged from 7-25 cm, with two values falling below the 10 cm minimum standard for secchi tube.

The HSPF model calculated daily TSS values for this subwatershed from 1994-2014. These concentrations ranged from 27.17-233.87 mg/L with an average TSS value of 57.01 mg/L. Of these calculations, 2145 (27.97%) were above the TSS standard. This is a very high exceedance rate.

Table 228. TSS related fish metrics in Unnamed Creek (-564). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-564 Fish Class 2 – General Use	BenFdrFrimPct	Centr-TolPct	HerbvPct	Perfrm-TolPct	RifflePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14DM012	2.95	0.25	1.23	0.25	2.95	0.00	2.95	0.00	3.44	23.98
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)</i>	37.38	4.89	9.61	18.66	32.49	18.65	39.38	4.97	11.68	17.59
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

The fish community in Unnamed Creek (-564) at site 14DM012 scored below average in all ten of the TSS related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 228). This reach had a poor TSS Index score and scored low in the remaining metrics showing very few fish species that are not tolerant of elevated TSS concentrations.

Table 229. TSS related macroinvertebrate metrics in Unnamed Creek (-564). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-564 Macroinvertebrate Class 7 – General Use	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plectoptera Pct
14DM012	16.81	0.00	7.00	13.56	0.00	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (22.0)</i>	17.35	1.33	13.20	48.28	19.13	0.22
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

The macroinvertebrate assemblage in this reach scored below average in three of the six TSS related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 229). This reach had a good TSS Index score, while also having a lower amount and percentage of TSS tolerant taxa and individuals. These results are not common in streams with elevated TSS concentrations.

The observed data set in this reach is very limited. There were a few instances in which the standard for secchi tube transparency was exceeded. The HSPF model calculated a very high exceedance rate while the majority of the TSS related metrics in the fish community scored poorly. However, the macroinvertebrate assemblage scored fairly well as site 14DM012 had a good TSS Index score and a low amount of TSS tolerant taxa. These results do not often occur in streams with TSS issues. Therefore, based on the conflicting results, TSS is inconclusive as a stressor to aquatic life in Unnamed Creek (-564) at this time.

Habitat

Unnamed Creek (-564) had a qualitative habitat assessment take place at its biological monitoring site, 14DM012, during the fish and macroinvertebrate sampling events in 2014. The average MSHA score from these visits was 29.25 (Poor). Limiting the habitat at this site was the row crop agriculture as the dominant nearby land use (Figure 100), the presence of silt substrates, no coarse substrates, sparse fish cover, no riffles, moderate channel stability, and poor channel development. Further MSHA analysis can be seen in Figure 101.

Figure 100. Land Use at site 14DM012.



Figure 101. Unnamed Creek (-564) MSHA metric scores.

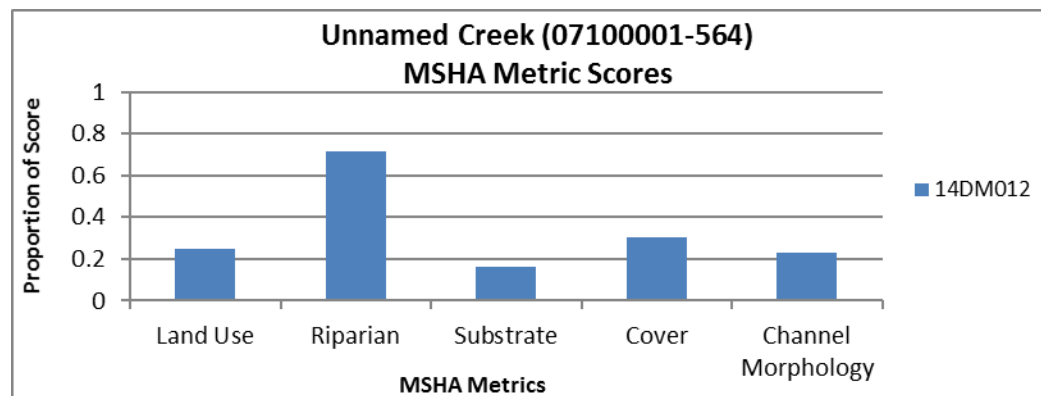


Table 230. Habitat related fish metrics in Unnamed Creek (-564). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-564 Fish Class 2 – General Use	BenInsect- ToIPct	SLithopPct	DarterSculps ucPct	RifflePct	PiscivorePct	LithFrimPct	ToIPct	PioneerPct
14DM012	0.00	2.95	0.00	2.95	0.25	3.19	99.75	90.66
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	20.4	39.38	18.18	32.49	5.24	58.26	44.85	19.02
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

The fish community in Unnamed Creek (-564) at site 14DM012 scored below average in all eight of the habitat related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 230). This stream reach was completely dominated by very tolerant species, particularly the fathead minnow. Fathead minnows are a fish species that is very tolerant and often found in high numbers in degraded stream systems. Site 14DM009 had a fish assemblage consisting of 90.42% of fathead minnows.

Table 231. Habitat related macroinvertebrate metrics in Unnamed Creek (-564). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-564 Macroinvertebrate Class 7 – General Use	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14DM012	5.36	7.26	2.84	4.42	12.30	82.65
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)</i>	5.40	20.35	36.94	37.77	37.96	19.49
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate assemblage in Unnamed Creek (564) scored below average in three of the six habitat related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 231). The site, 14DM012, had very low numbers of EPT, climber, and clinger individuals, which is common in streams with degraded habitat.

Based on the poor MSHA score, the very poor habitat related metrics in the fish community, as well as many below average scoring macroinvertebrate metrics related to habitat, habitat is indeed a stressor to aquatic life in Unnamed Creek (-564).

Altered Hydrology

Unnamed Creek (-564) is a tributary of Jack Creek. It is almost an entirely natural channel which flows into reach 07100001-658. The majority of the upstream watershed is altered according to the MPCA altered watercourse layer. There are fish barriers both upstream of the reach at the outlet of Graham Lake as well as downstream of the reach at the outlet of Heron Lake. “Riffle cross section measurements identified that the BHR was 2.12 and entrenchment ratio was 1.37. These ratios indicate that the channel at the study location is both entrenched and deeply incised. Flood-prone elevations are roughly 1 foot lower than the top of the low bank height and means that flood flows (i.e. 2 times bankfull max depth at the riffle) cannot access the rivers floodplain. The confinement of flood flows within the channel is a leading factor as to why the channel is in such poor shape” (DNR 2016).

Extreme weather events affect high flow events as well as also low flows during drought. HSPF models show this stream section experiencing low flow at less than five cfs 43.9% of the time and less than one cfs 22.4% of the time.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The percentage for generalist fish within the reach was 97.3% compared to the average in Class 2 general use waters meeting the standard of 42.4%.

The numbers of nest guarder species are also positively correlated with increased low flows. The percentage for nest guarder fish within the reach was 90.9% compared to the average in Class 2 general use waters meeting the standard of 19%.

Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The percentage for long-lived macroinvertebrates within the reach was 0.6% compared to the average in Class 7 general use waters meeting the standard of 8%.

Based on the work from the Minnesota DNR, the presence of fish barriers nearby, as well as the poor biologically metric scores, Flow Alteration/Connectivity is a stressor to Unnamed Creek (-564).

Summary

The impaired fish and macroinvertebrate communities in Unnamed Creek (-564) are being stressed by DO, Eutrophication, Habitat and Flow Alteration/Connectivity (Table 232). Suspended Sediment was inconclusive as a stressor at this time, while Nitrates were ruled out as a stressor to aquatic life. For further information on the stressors and recommendations to fixing the stressors in the Jack Creek HUC 10 Watershed, please see pages 268-269.

Table 232. Stressor determinations for Unnamed Creek (-564).

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Unnamed Creek	07100001-564	●	●	---	o	●	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Jack Creek (07100001-514)

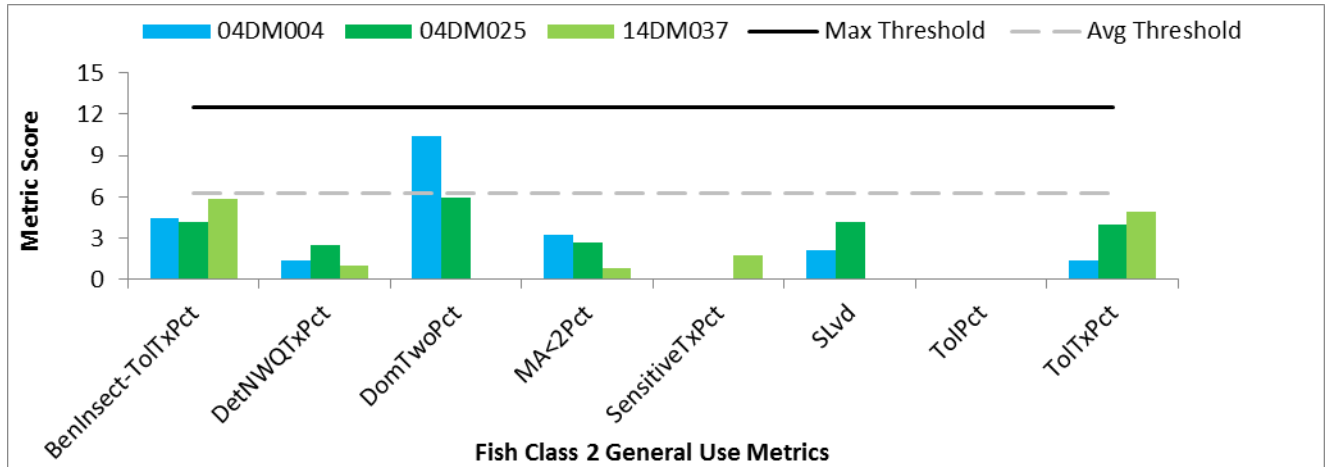
Located in northeastern Nobles and flowing into northwestern Jackson County, Jack Creek (-514) is a 26.10 mile long reach that is impaired for aquatic life due to the fish assemblage. This stream reach extends from North Branch Jack Creek down to the confluence with the Judicial Ditch 26. Along this stream section, there are three biological monitoring stations, 04DM004, 04DM025, and 14DM037.

Biology

Fish

The fish community in Jack Creek (-514) was sampled once at each of the biological monitoring stations located along the reach, 04DM004, 04DM025, and 14DM037. Site 04DM004 was sampled in July of 2004 and had a FIBI score of 23.0, site 04DM025 was also sampled July 2004 and had a FIBI score of 23.0, and 14DM025 was sampled in August of 2014 and had a FIBI score of 14.4. All of these scores were far below the Fish Class 2 Southern Streams General Use Threshold of 50. Only site 04DM004 had a metric score above the average needed to reach the class threshold (DomTwoPct), the remaining metrics at this site scored below average, as did all of the metrics at sites 04DM025 and 14DM037. See Figure 102 for further analysis of the metric scores in this reach.

Figure 102. Jack Creek (-514) fish IBI metric scores.

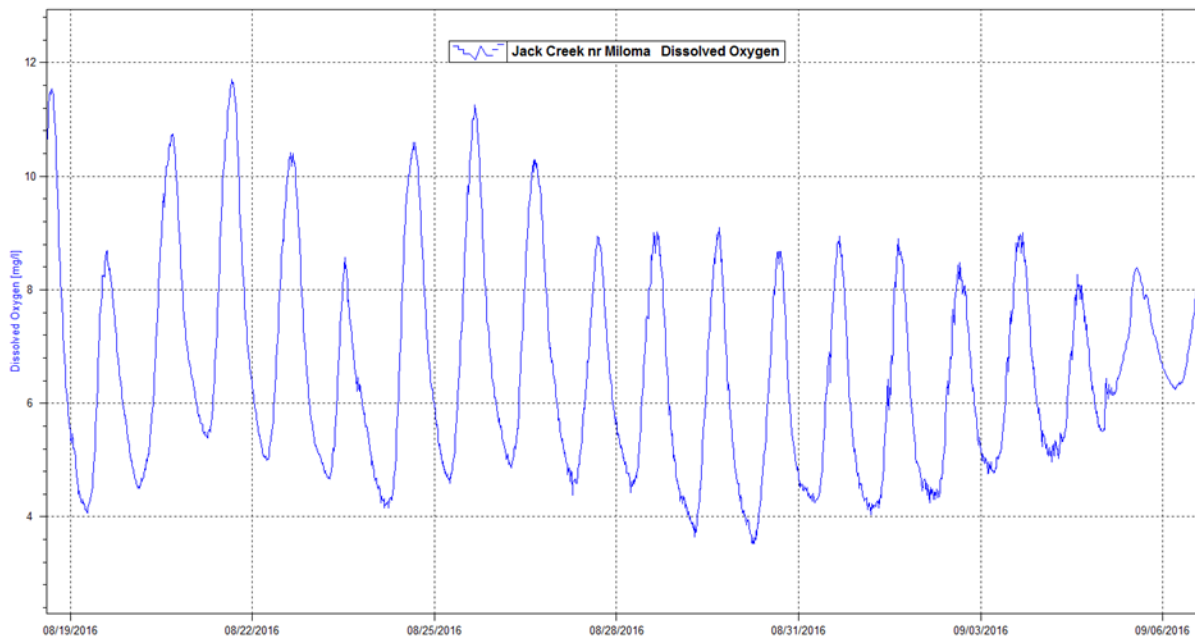


Dissolved Oxygen

Thirteen DO measurements were taken from one chemistry site (S001-560) and three biological monitoring stations (04DM004, 04DM025, 14DM037) from 2004-2016. The average of all the values is 9.53 mg/L with a low of 4.76 mg/L and a high of 15.92 mg/L. The summer average (June-Aug) is 9.72 mg/L. The DO values did not fall below 5 mg/L.

Continuous DO monitoring was also done on this reach in 2016 (Figure 103). The results of this monitoring show that the DO levels frequently fell below the 5 mg/L daily minimum standard and the daily flux often exceeded the 4.5 mg/L standard for the southern region of the state. These results can often indicate issues with DO as well as eutrophication.

Figure 103. Continuous DO monitoring along Jack Creek (-514).



Additionally, the HSPF model calculated daily minimum DO values for this subwatershed from 1994-2014. Of these calculations, 4189 (61.16%) of the days had a daily minimum DO level below the daily minimum standard of 5 mg/L. This is a high exceedance rate for DO.

Table 233. DO related fish metrics in Jack Creek (-514). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-514 Fish Class 2 – General Use	MA>3 Avg	SspnPct Avg	Taxa Count Avg	DO TIV Avg
04DM004	7.56	27.32	14.00	8.60
04DM025	4.12	18.08	15.00	8.48
14DM037	6.40	85.82	16.00	8.52
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)</i>	23.89	28.72	20.38	8.56
Expected response to DO stress	↓	↑	↓	↓

The fish community in Jack Creek (-514) scored below average in two (04DM004), three (04DM025), and four (14DM037) of the four DO related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 233). All three sites had a below average amount of mature fish (greater than three years), a lower overall taxa count, while two of the sites had below average DO TIV scores. Site 14DM037 also had a high amount of serial spawning individuals which can indicate potential DO issues.

Table 234. DO related macroinvertebrates metrics in Jack Creek (-514). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-661 Macroinvertebrate Class 5, 7 – General Use	HBI_MN Value	% DO Tolerant Taxa	# DO Tolerant Taxa	ChemTV_DO
04DM004	8.34	19.93	5.00	6.81
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	7.04	8.62	4.33	7.10
04DM025	8.42	1.58	2.50	7.40
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	7.55	12.98	5.74	6.91
Expected response to DO stress	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in one (04DM025) and four (04DM004) of the four DO related metrics when compared to all other Class 5 Southern Streams RR and Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 234). Both sites had a poor HBI_MN value, while site 04DM004 also had increased numbers of DO tolerant individuals and taxa, while also having a poor DO TIV score.

Based on the frequency of the DO levels to fall below the 5 mg/L standard found during the continuous DO monitoring, the high rate of standard exceedance regarding DO flux, as well as many of the fish and macroinvertebrate metrics related to DO scoring poorly, DO is a stressor to aquatic life in Jack Creek (-514).

Eutrophication

Thirteen samples were taken from one chemistry site (S001-560) and three biological monitoring stations (04DM004, 04DM025, 14DM037) from 2004-2016. The average of all the values is 0.143 mg/L

with a low of 0.03 mg/L and a high of 0.24 mg/L. The summer average (June-Aug) is 0.142 mg/L. Phosphorus values exceeded 0.150 mg/L eight times.

Table 235. Eutrophication related fish metrics in Jack Creek (-514). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-514 Fish Class 2 – General Use	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct
04DM004	0.00	9.38	88.98	8.65
04DM025	0.00	11.21	84.90	7.09
14DM037	0.05	4.30	94.89	74.36
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)</i>	19	11.47	45.1	17
Expected response to Eutrophication stress	↓	↓	↑	↑

The fish community in Jack Creek (-514) scored below average in three (04DM004, 04DM025) and all four (14DM037) of the eutrophication related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 235). All three sites had high amounts of tolerant fish species, while also having below average amounts of darter species, while completely lacking sensitive taxa. Site 14DM037 also had a very high amount of omnivorous individuals. These results are common in streams being negatively impacted by the effects of eutrophication.

Table 236. Eutrophication related macroinvertebrates metrics in Jack Creek (-514). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-514 Macroinvertebrate Class 5, 7 – General Use	EPT Pct	Tanytarsini Pct	CrustMoll Pct	Scraper Pct	% Tolerant Taxa	% Intolerant Taxa
04DM004	45.08	10.40	3.05	17.29	46.96	2.03
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	38.45	18.46	11.78	16.11	26.84	4.03
04DM025	78.24	13.57	0.93	36.91	37.04	0.33
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	43.90	27.84	9.23	15.78	17.17	5.79
Expected response to Eutrophication stress	↓	↓	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in four of the six eutrophication related metrics at both sites when compared to all other Class Prairie Streams GP and Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold for the respective class (Table 236). Both sides had higher amounts of EPT individuals and lower amounts of crustacean/mollusca species resulting in better metric scores. However, both sites scored poorly in the remaining four metrics.

Based on the high observed phosphorus values, the high rate of flux found during the continuous DO monitoring possibly indicating eutrophic conditions, the frequency of the standard exceedances, as well as the poor scoring eutrophication related metrics in both the fish and macroinvertebrate communities, eutrophication is a stressor to aquatic life in Jack Creek (-514).

Nitrates

A total of 13 samples taken from one chemistry site (S001-560) and three biological monitoring stations (04DM004, 04DM025, 14DM037) from 2004-2016 were analyzed for Inorganic Nitrogen (NO₂-NO₃). The average of all the values is 7.61 mg/L with a low of 0.08 mg/L and a high of 20.00 mg/L. The spring average (March-May) is 18.00 mg/L. The summer average (June-Aug) is 7.46 mg/L. Nitrate values exceeded 4 mg/L seven times. A quantile regression analysis for Class 7 stream stations showed that sites having a nitrate concentration in excess of 11.5 mg/L there was a 90% probability for impairment. The nitrate concentrations in this reach exceeded this level.

The HSPF model calculated daily nitrate concentrations for this subwatershed from 1994-2014. These values ranged from 0.13-17.03 mg/L with an average value of 5.09 mg/L. Of these calculations, 490 (7.03%) were above 11.5 mg/L.

Table 237. Nitrate related macroinvertebrates metrics in Jack Creek (-514). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-514 Macroinvertebrate Class 5, 7 – General Use	TrichopteraChTx Pct	N Index Score	% N Tolerant	% N Intolerant
04DM025	8.33	3.31	81.23	0.35
04DM025	9.76	4.61	67.84	0.35
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	13.16	3.00	48.68	0.96
04DM004	8.11	3.89	82.43	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	10.00	3.30	57.57	0.91
Expected response to N stress	↓	↑	↑	↓

The macroinvertebrate community in Jack Creek (-514) scored below average in all four metrics for each visit at both biological monitoring stations when compared to all other Class 5 Southern Streams RR and Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 237). All three of the visits had very few nitrate intolerant taxa, a low amount of trichoptera species, while also having a high amount of nitrate tolerant individuals and poor nitrate index scores.

Based on the relatively high observed and predicted nitrate values, the quantile regression analysis for Class 7 stream stations, and the below average scoring nitrate related metrics in the macroinvertebrate community at all three visits, nitrates are a stressor to aquatic life in Jack Creek (-514).

Suspended Solids

Ten samples taken from one chemistry site (S001-560) in 2016 were analyzed for TSS. The average of all the values is 63.22 mg/L with a low of 44 mg/L and a high of 88 mg/L. The TSS concentrations were at or exceeded the 65 mg/L standard four times.

Additionally, ten secchi tube measurements were taken from this reach. These values ranged from 10-19 cm, with an average reading of 13.3 cm. No values fell below the 10 cm minimum standard for secchi tube.

The HSPF model calculated daily TSS values for this subwatershed from 1994-2014. These concentrations ranged from 0.40-728.80 mg/L with an average TSS value of 35.21 mg/L. Of these calculations, 562 (8.95%) were above the TSS standard of 65 mg/L.

Table 238. TSS related fish metrics in Jack Creek (-514). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-514 Fish Class 2 – General Use	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RifflePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
04DM004	29.33	0.00	29.33	9.38	20.04	0.00	9.29	0.00	0.46	20.01
04DM025	26.09	0.00	20.82	11.90	16.48	0.00	8.70	0.00	1.14	17.93
14DM037	10.60	0.00	1.10	4.78	6.40	0.05	6.45	0.00	1.19	22.69
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)</i>	37.38	4.89	9.61	18.66	32.49	18.65	39.38	4.97	11.68	17.59
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

The fish community in Jack Creek (-514) scored below average in nine (04DM004, 04DM025) and ten (14DM037) of the ten TSS related metrics when compared to all other Class 2 Southern streams stations that meet the FIBI General Use Threshold (Table 238). Sites 04DM004 and 04DM025 did have above average amounts of herbivorous individuals, however, the remaining metrics scored poorly similarly to site 14DM037. These results reflect a community likely stressed by the TSS conditions.

Table 239. TSS related macroinvertebrates metrics in Jack Creek (-514). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-514 Macroinvertebrate Class 5, 7 – General Use	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
04DM025	23.90	1.00	16.50	72.98	25.16	0.00
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	15.87	3.02	11.59	35.23	26.89	0.54
04DM004	18.13	0.00	13.00	39.53	4.07	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	17.35	1.33	13.20	48.28	19.13	0.22
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

The macroinvertebrate assemblage scored below average in four (04DM004) and six (04DM025) of the six TSS related metrics when compared to all other Class 5 Southern Streams RR and Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 239). Both sites had poor TSS Index scores, few TSS intolerant and plecoptera taxa, and below average amounts of collector-filterer individuals. Site 04DM025 also had increased amounts and a higher percentage of TSS Tolerant taxa and individuals. These results suggest likely stress from the TSS conditions.

The observed TSS data had a relatively high exceedance rate, while the majority of the fish and macroinvertebrate metrics related to TSS scored below average. Therefore, TSS is a stressor to aquatic life in Jack Creek (-514) at this time.

Habitat

Jack Creek (-514) had qualitative habitat assessments take place at its biological monitoring sites, 04DM004, 04DM025, and 14DM037, during the fish sampling events in 2004 and 2014. The average MSHA scores from these visits were 28 (Poor) at 04DM004, 49.65 (Fair) at 04DM025, and 26.5 (Poor) at 14DM037. Limiting the habitat at these sites was the open pasture and row crop agriculture as a nearby land uses, no stream riparian buffer (04DM004) heavy to severe bank erosion (04DM004,14DM037) (Figure 104), light to moderate stream shading, sand and silt substrates, nearly absent to sparse fish cover, moderate to severe embeddedness (04DM004,14DM037), fair sinuosity (04DM004), fair channel development, and low to moderate channel stability. Further MSHA analysis can be seen in Figure 105.

Figure 104. Severe bank erosion at site 14DM037



Figure 105. Jack Creek (-514) MSHA metric scores.

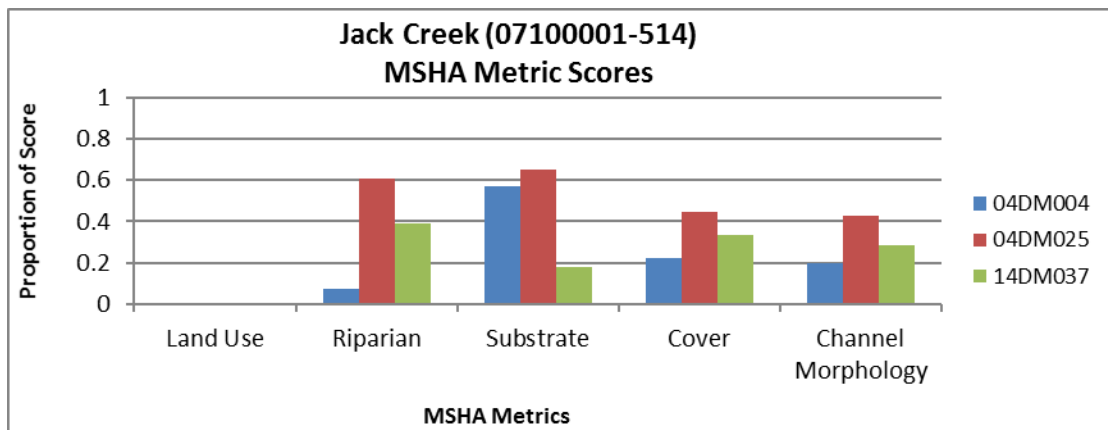


Table 240. Habitat related fish metrics in Jack Creek (-514). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-514 Fish Class 2 – General Use	BenInsect- ToIPct	SLithopPct	DarterSculps ucPct	RifflePct	PiscivorePct	LithFrimPct	ToIPct	PioneerPct
04DM004	9.38	9.29	9.38	20.04	0.00	45.72	88.98	44.54
04DM025	11.21	8.70	11.21	16.48	0.92	64.30	84.90	62.70
14DM037	4.30	6.45	4.30	6.40	0.57	8.21	94.89	75.50
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FBI General Use Threshold (50.0)</i>	20.4	39.38	18.18	32.49	5.24	58.26	44.85	19.02
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

The fish community in Jack Creek (-514) at sites 04DM004, 04DM025, and 14DM037 scored below average in seven (04DM025) and eight (04DM004, 14DM037) of the eight habitat related metrics when

compared to all other Class 2 Southern Streams stations that meet the FBI General Use Threshold (Table 240). Site 04DM025 did have an above average amount of simple lithophilic spawning individuals, however, the site scored poorly in the remaining metrics. All three sites had a very high amount of tolerant individuals present, which is a strong indicator of degraded habitat conditions.

Table 241. Habitat related macroinvertebrates metrics in Jack Creek (-514). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-514 Macroinvertebrate Class 5, 7 – General Use	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
04DM025	4.81	4.94	50.76	78.24	20.57	15.66
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)</i>	5.66	12.52	49.77	42.46	34.53	13.99
04DM004	18.31	11.53	20.68	45.08	47.12	34.58
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)</i>	5.40	20.35	36.94	37.77	37.96	19.49
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate assemblage in this reach scored below average in one (04DM025) and four (04DM004) of the six habitat related metrics when compared to all other Class 5 Southern Streams RR and Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 241). Site 04DM025 did have a lower amount of climber individuals, but scored above average in the remaining metrics. This site is the most downstream on Jack Creek and may be sign of improved habitat conditions. Site 04DM004 is located further upstream on this reach and had higher numbers of both burrower and legless individuals which may correlate to the very sandy substrates found. Site 14DM037 was not sampled for macroinvertebrates.

Based on the poor to fair MSHA scores, as well as the majority of the habitat related metrics in both the fish and macroinvertebrate communities, habitat is a stressor to aquatic life in Jack Creek (-514).

Altered Hydrology

Jack Creek (-514) is mostly a natural channel which flows into reach (-658). The majority of the upstream watershed is altered according to the MPCA altered watercourse layer. There is a fish barrier downstream of the reach at the outlet of Heron Lake. “Riffle cross section measurements identified that the BHR was 2.12 and entrenchment ratio was 1.37. These ratios indicate that the channel at the study location is both entrenched and deeply incised. Flood-prone elevations are roughly 1 foot lower than the top of the low bank height and means that flood flows (i.e. 2 times bankfull max depth at the riffle) cannot access the rivers floodplain. The confinement of flood flows within the channel is a leading factor as to why the channel is in such poor shape” (DNR 2016).

Extreme weather events affect high flow events as well as also low flows during drought. HSPF models show this stream section experiencing low flow at less than five cfs 6.3% of the time and less than one cfs 0.3% of the time.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The average percentage for generalist fish within the reach was 60.9% compared to the average in Class 2 general use waters meeting the standard of 42.4%. General fish populations ranged from 45.0-77.8%.

The numbers of nest guarder species are also positively correlated with increased low flows. The average percentage for nest guarder fish within the reach was 38.6% compared to the average in Class 2 general use waters meeting the standard of 19%. Nest guarder fish species ranged from 20.4-74.6%.

Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The percentage for long-lived macroinvertebrates within the reach was 6.4% compared to the average in Class 7 general use waters meeting the standard of 8%.

Based on the upstream channelization of tributaries, downstream fish barriers, the lack of floodplain access for the channel, as well as the poor scoring biological metrics, Flow Alteration/Connectivity is a stressor to aquatic life in Jack Creek (-514).

Summary

The impaired fish community in Jack Creek (-514) is being stressed by DO, Eutrophication, Nitrates, Suspended Sediment, Habitat and Flow Alteration/Connectivity (Table 242). For further information on the stressors and recommendations to fixing the stressors in the Jack HUC 10 Watershed, please see pages 268-269.

Table 242. Stressor determinations for Jack Creek (-514).

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Jack Creek	07100001-514	●	●	●	●	●	●

● = stressor; ○ = inconclusive stressor; --- = not an identified stressor

Unnamed Creek (07100001-661)

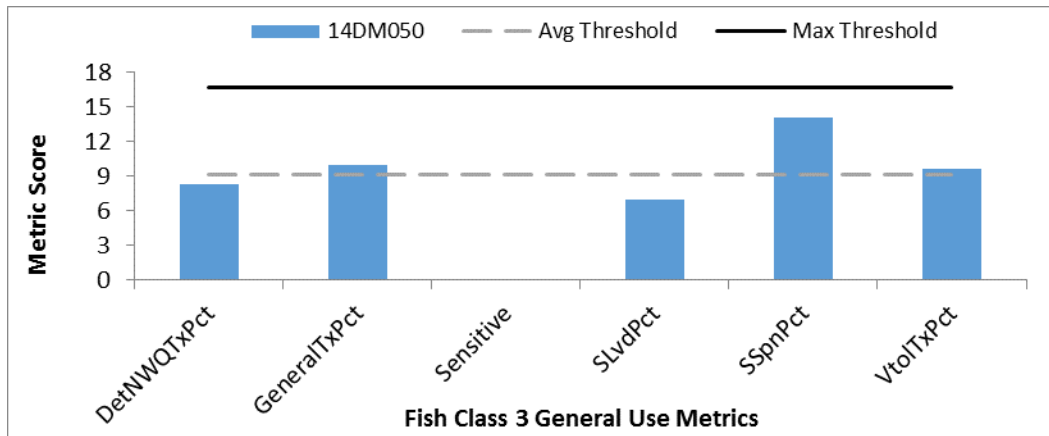
Located in northeastern Nobles County, Unnamed Creek (-661) is a 4.90 mile long reach that is impaired for aquatic life due to the fish and macroinvertebrate assemblages. This stream reach extends from just upstream of Roberts Avenue down to the confluence with West Graham Lake. Along this stream section there is one biological monitoring station, 14DM050.

Biology

Fish

The fish community in Unnamed Creek (-661) was sampled for fish in July of 2015 at its biological monitoring station 14DM050. The FIBI score at this reach was 48.9, which is below the Fish Class 3 Southern Headwaters General Use Threshold of 55. This site did have three metrics (GeneralTxPct, SSpnPct, VtoITxPct) reach the average metric score needed to meet the threshold (Figure 106), however, the remaining three metrics comprising this FIBI scored below average with one of these metrics scoring zero (Sensitive).

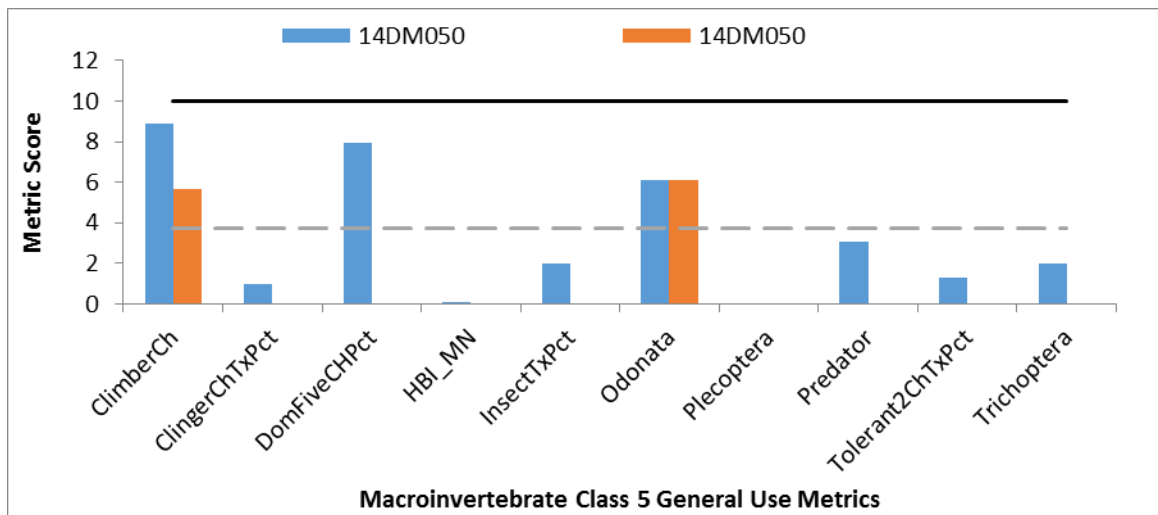
Figure 106. Unnamed Creek (-661) fish IBI metric scores.



Macroinvertebrates:

The macroinvertebrate assemblage at site 14DM050 was sampled in August of 2014 and 2015. The 2014 visit had a MIBI score of 32.3 and the 2015 visit had a MIBI score of 11.8, which are below the Macroinvertebrate Class 5 Southern Streams General Use Threshold of 37. The 2014 visit had three and the 2015 visit had two metrics scoring above the average needed to reach the threshold. However, the remaining metrics scored below average or poorly resulting in the impairment designation. See Figure 107 for a complete breakdown of the metric scores at this site.

Figure 107. Unnamed Creek (-661) macroinvertebrate IBI metric scores.

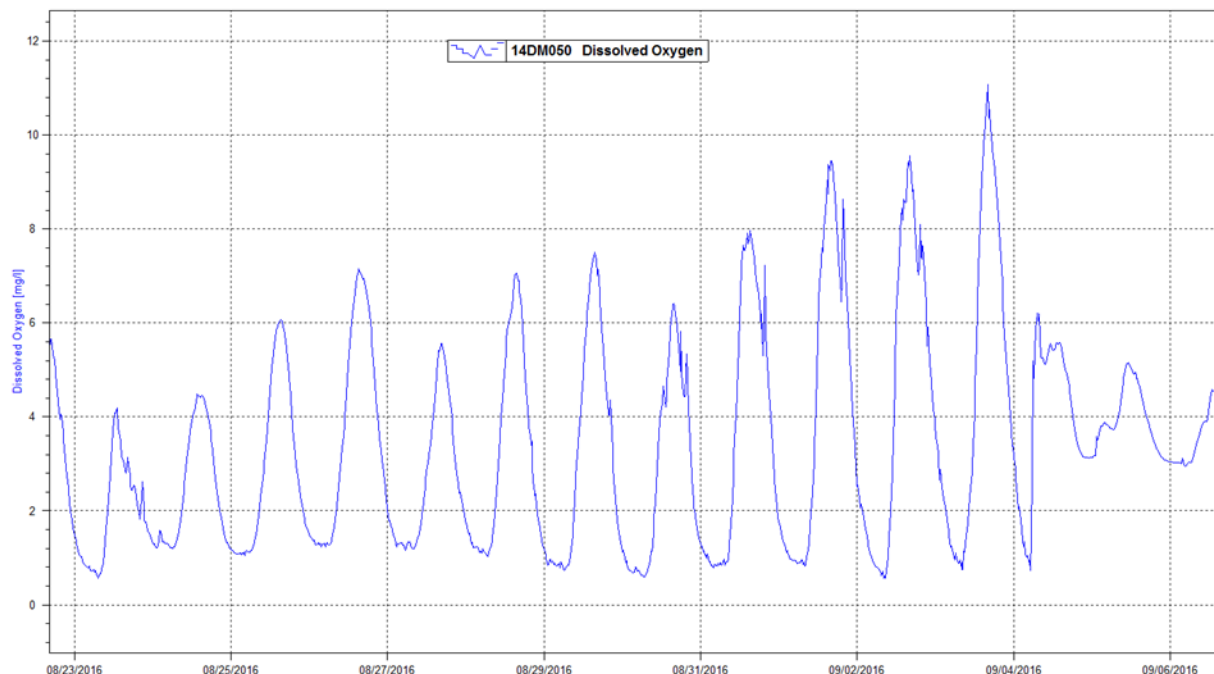


Dissolved Oxygen

A total of 12 DO measurements were taken from one chemistry site (S009-043) from 2014-2016. The average of all the values is 6.54 mg/L with a low of 2.25 mg/L and a high of 14.84 mg/L. The summer average (June-Aug) is 5.76 mg/L. The DO value fell below 5 mg/L six times.

Continuous DO monitoring was done at site 14DM050 in 2016 (Figure 108). These results show that the DO level fell well below the 5 mg/L standard daily and even was recorded lower than 1 mg/L. The daily flux during this monitoring period also exceeded the 4.5 mg/L daily standard for the southern region of the state. The results from this monitoring strongly suggest DO and potential eutrophication stress.

Figure 108. Continuous DO monitoring at site 14DM050 in Unnamed Creek (-661).



The HSPF model calculated daily minimum DO values for this subwatershed from 1994-2014. Of these calculations, 1752 (22.84%) of the days had a daily minimum DO level below the daily minimum standard of 5 mg/L. This is a relatively high exceedance rate for DO.

Table 243. DO related fish metrics in Unnamed Creek (-661). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-661 Fish Class 3 – General Use	MA>3 Avg	SspnPct Avg	Taxa Count Avg	DO TIV Avg
14DM050	0.00	11.80	4.00	7.72
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	13.32	17.09	12.16	8.44
Expected response to DO stress	↓	↑	↓	↓

The fish community in Unnamed Creek (-661) at site 14DM050 scored below average in three of the four DO related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 243). This reach did not have any mature fish greater than three years, had a lower overall taxa count, while also having a poor DO TIV score. These results are indicative of a community stressed by the current DO conditions.

Table 244. DO related macroinvertebrate metrics in Unnamed Creek (-661). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-661 Macroinvertebrate Class 5 – General Use	HBI_MN Value	% DO Tolerant Taxa	# DO Tolerant Taxa	ChemTV_DO
14DM050 (2014)	8.31	21.97	17.00	6.04
14DM050 (2015)	9.12	52.38	10.00	6.04
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	7.04	8.62	4.33	7.10
Expected response to DO stress	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in all four DO metrics during both visits when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 244). The poor HBI_MN and DO TIV scores, as well as the increased amount and percentage of DO tolerant taxa all indicate that DO is stressing the macroinvertebrate community.

Based on the very high frequency of standard exceedances indicated by the observed and modeled data, the high DO flux values, as well as the poor scoring fish and macroinvertebrate metrics related to DO, DO is a stressor to aquatic life in Unnamed Creek (-661).

Eutrophication

Twelve samples were taken from one chemistry site (S009-043) and one biological monitoring station (14DM050) from 2014-2016. The average of all the values is 0.376 mg/L with a low of 0.03 mg/L and a high of 1.78 mg/L. The summer average (June-Aug) is 0.508 mg/L. Phosphorus values exceeded the standard of 0.150 mg/L six times.

Table 245. Eutrophication related fish metrics in Unnamed Creek (-661). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-661 Fish Class 3 – General Use	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct
14DM050 (2014)	0.00	0.00	90.00	90.00
14DM050 (2015)	0.00	1.24	98.76	11.80
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	8.9	12.11	70.79	14.71
Expected response to Eutrophication stress	↓	↓	↑	↑

The fish community in Unnamed Creek (-661) at site 14DM050 scored below average in three (2015 visit) and four (2014 visit) of the four eutrophication related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 245). The 2014 visit to site 14DM050 scored poorly in all of the related metrics, however, the results may be skewed as only 20 fish were sampled during this visit. The 2015 visit had many more fish sampled (161) and may better indicate the conditions of the community, which still appears to be negatively impacted by eutrophication as this visit had a very high amount of tolerant fish individuals, while also lacking sensitive taxa and containing few darter individuals.

Table 246. Eutrophication related macroinvertebrate metrics in Unnamed Creek (-661). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-661 Macroinvertebrate Class 5 – General Use	EPT Pct	Tanytarsini Pct	CrustMoll Pct	Scraper Pct	% Tolerant Taxa	% Intolerant Taxa
14DM050 (2014)	23.57	5.88	29.30	28.98	34.08	0.00
14DM050 (2015)	0.63	0.00	86.67	73.65	67.30	0.00
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	43.90	27.84	9.23	15.78	17.17	5.79
Expected response to Eutrophication stress	↓	↓	↑	↑	↑	↓

The macroinvertebrate assemblage in this stream reach scored below average in all six of the eutrophication related metrics at both visits of site 14DM050 when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 246). Both visits scored poorly throughout, especially the visit in 2015 as this visit had much fewer EPT and tanytarsini individuals, while also having many more scraper, crustacean/mollusca, and tolerant species. These results are strong indications that eutrophication is a stressor to this assemblage.

Based on the very high observed phosphorus values, the high level of standard exceedances, the high levels of DO flux possibly indicating eutrophic conditions, as well as the poor scoring fish and macroinvertebrate metrics related to eutrophication, eutrophication is a stressor to aquatic life in Unnamed Creek (-661).

Nitrates

There were 12 samples taken from one chemistry site (S009-043) and one biological monitoring station (14DM050) from 2014-2016 were analyzed for Inorganic Nitrogen (NO₂-NO₃). The average of all the values is 2.61 mg/L with a low of 0.19 mg/L and a high of 9.00 mg/L. The spring average (March-May) is 6.75 mg/L. The summer average (June-Aug) is 1.43 mg/L. Nitrate values exceeded 4 mg/L three times.

Drain tiles were noted as being present along this reach. Drain tiles are a common pathway for nitrates to enter a stream system.

HSPF model data for nitrates was unavailable for this stream reach.

Table 247. TSS related macroinvertebrate metrics in Unnamed Creek (-661). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-661 Macroinvertebrate Class 5 – General Use	TrichopteraChTx Pct	N Index Score	% N Tolerant	% N Intolerant
14DM050 (2014)	8.16	5.03	90.79	0.00
14DM050 (2015)	4.17	6.43	77.71	0.00
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	13.16	3.00	48.68	0.96
Expected response to N stress	↓	↑	↑	↓

The macroinvertebrate community in Unnamed Creek (-661) scored below average in all four of the nitrate related metrics at both visits at site 14DM050 when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 247). Both of these visits had low numbers of trichoptera taxa and nitrate intolerant species, while also having a high amount of nitrate tolerant individuals and a poor nitrate index score. All of these results signal a likely nitrate stressor.

The presence of drain tiles and the biological information available signal that nitrates are a stressor to aquatic life; however, the observed chemical data shows relatively low nitrate levels in this stream reach. Therefore, nitrates are inconclusive as a stressor in Unnamed Creek (-661) at this time.

Suspended Solids

Ten samples taken from one chemistry site (S009-043) in 2016 were analyzed for TSS. The average of all the values is 8.2 mg/L with a low of 1.6 mg/L and a high of 16 mg/L. The TSS concentrations did not exceed the 65 mg/L standard.

Additionally, ten secchi tube measurements were taken from this reach. These values ranged from 36-100 cm, with an average reading of 56.5 cm. No values fell below the 10 cm minimum standard for secchi tube.

The HSPF model calculated daily TSS values for this subwatershed from 1994-2014. These concentrations ranged from 1.85-461.09 mg/L with an average TSS value of 28.96 mg/L. Of these calculations, 426 (7.71%) were above the TSS standard of 65 mg/L.

Table 248. TSS related fish metrics in Unnamed Creek (-661). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-661 Fish Class 3 – General Use	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RifflePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14DM050	3.12	0.00	0.00	5.62	2.50	0.00	2.50	0.00	15.00	16.23
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	37.83	0.90	13.33	13.93	28.33	8.55	33.71	1.95	3.56	15.27
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

The fish community in Unnamed Creek (-661) at site 14DM050 scored below average in nine of the ten TSS related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 248). This reach did have an above average amount of long-lived individuals, however, the remaining metrics scored poorly with very few fish species present that are sensitive to elevated TSS conditions.

Table 249. TSS related macroinvertebrate metrics in Unnamed Creek (-661). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-661 Macroinvertebrate Class 5 – General Use	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plectoptera Pct
14DM050	21.13	0.00	14.50	72.16	6.84	0.00
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)</i>	15.87	3.02	11.59	35.23	26.89	0.54
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

The macroinvertebrate assemblage in this reach scored below average in all six of the TSS related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 249). Site 14DM050 had a poor TSS Index score, while also having an increased percentage and amount of TSS tolerant taxa and individuals. These results are commonly found in streams with elevated TSS concentrations.

The observed and modeling data sets both indicate that the TSS concentrations in this reach are low and remain low. It is likely that other stressors are causing the fish and macroinvertebrate communities to score poorly as the chemical and model data give no indication of potential stress. Therefore, TSS is not a stressor to aquatic life in Unnamed Creek (-618) at this time.

Habitat

Unnamed Creek (-661) had a qualitative habitat assessment take place at its biological monitoring site, 14DM050, during the fish and macroinvertebrate sampling events in 2014 and 2015. The average MSHA score from these visits was 42.01 (Poor). Limiting the habitat at this site was row crop agriculture as the dominant nearby land use, moderate riparian buffer, heavy bank erosion, light stream shading, severe embeddedness, sand and silt substrates, fair channel development, limited depth variability, and moderate channel stability. Further MSHA analysis can be seen in Figure 109.

Figure 109. Unnamed Creek (-661) MSHA metric scores.

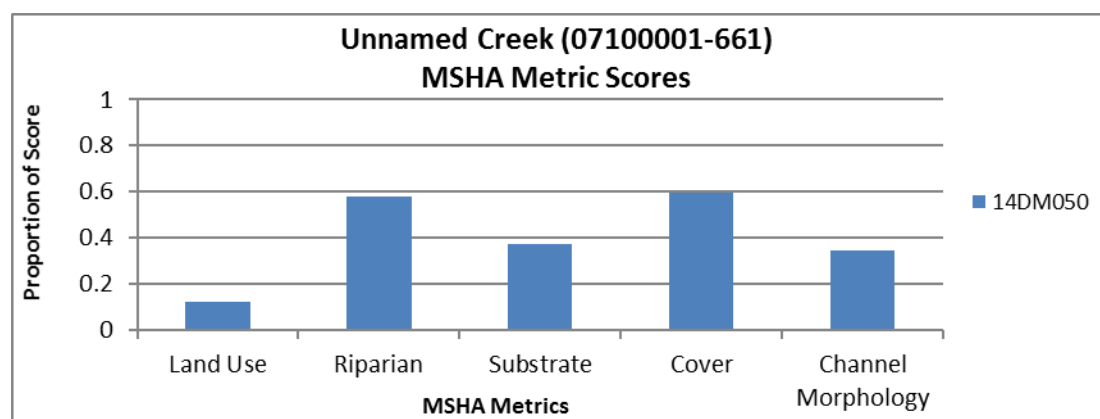


Table 250. Habitat related fish metrics in Unnamed Creek (-661). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-661 Fish Class 3 – General Use	BenInsect-TolPct	SLithopPct	DarterSculpSu cPct	RifflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14DM050	0.62	2.50	0.62	2.50	0.00	23.00	94.38	27.02
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	14.22	33.71	12.55	28.33	1.62	69.21	70.64	37.79
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

The fish assemblage in Unnamed Creek (-661) at site 14DM050 scored below average in seven of the eight habitat related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 250). The fish sample did have a lower amount of pioneering species; however, the remaining metrics scored very poorly. The sample was comprised of just two johnny darters, while containing 159 other fish consisting of creek chubs, fathead minnows, and brook sticklebacks, which are species tolerant to poor habitat conditions.

Table 251. Habitat related macroinvertebrate metrics in Unnamed Creek (-661). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-661 Macroinvertebrate Class 5 – General Use	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14DM050	10.02	60.07	11.30	12.10	75.34	13.83
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)</i>	5.66	12.52	49.77	42.46	34.53	13.99
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate community in Unnamed Creek (-661) scored below average in five of the six habitat related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 250). The site did have a high number of climber individuals, which is normally a good sign, however, the remaining metrics scored poorly. The high amount of legless and burrower individuals correlates to the sand and silt substrates that are present in this reach.

Based on the poor MSHA score in this reach, as well as the vast majority of the habitat related metrics in the fish and macroinvertebrate communities scoring poorly or below average, habitat is a stressor to aquatic life in Unnamed Creek (-661) at this time.

Altered Hydrology

Unnamed Creek (-661) is a tributary of Jack Creek. It is a roughly half-natural and half-altered channel which flows directly into West Graham Lake, which flows into East Graham Lake. The majority of the upstream watershed is altered according to the MPCA altered watercourse layer. There are fish barriers both upstream of the reach at the outlet of First Fulda Lake as well as downstream at the outlet of East Graham Lake.

“Riffle cross section measurements identified that the BHR was 2.12 and entrenchment ratio was 1.37. These ratios indicate that the channel at the study location is both entrenched and deeply incised. Flood-prone elevations are roughly 1 foot lower than the top of the low bank height and means that flood flows (i.e. 2 times bankfull max depth at the riffle) cannot access the rivers floodplain. The confinement of flood flows within the channel is a leading factor as to why the channel is in such poor shape” (DNR 2016).

Extreme weather events affect high flow events as well as also low flows during drought. HSPF models show this stream section experiencing low flow at less than five cfs 63.6% of the time and less than one cfs 20.5% of the time.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The average percentage for generalist fish within the reach was 71.4% compared to the average in Class 3 general use waters meeting the standard of 59.1% Generalist fish populations ranged from 52.8-90.0%.

The numbers of nest guarder species are also positively correlated with increased low flows. The average percentage for nest guarder fish within the reach was 29.5% compared to the average in Class 3 general use waters meeting the standard of 24%. Nest guarder fish species ranged from 0-59%.

Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The average percentage for long-lived macroinvertebrates within the reach was 3.2% compared to the average in Class 5 general use waters meeting the standard of 9%. Long-lived macroinvertebrates ranged from 3.2-3.2%.

Based on the partial channelization of this reach, the upstream channelization of tributaries, downstream fish barriers, the lack of floodplain access for the channel, as well as the poor scoring biological metrics, Flow Alteration/Connectivity is a stressor to aquatic life in Unnamed Creek (-661).

Summary

The impaired fish and macroinvertebrate communities in Unnamed Creek (-661) are being stressed by DO, Eutrophication, Habitat and Flow Alteration/Connectivity (Table 252). Nitrates were inconclusive as a stressor at this time, while Suspended Sediment was ruled out as a stressor to aquatic life. For further information on the stressors and recommendations to fixing the stressors in the Jack Creek HUC 10 Watershed, please see pages 268-269.

Table 252. Stressor determinations in Unnamed Creek (-661)

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Unnamed Creek	07100001-661	●	●	o	---	●	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Judicial Ditch 26 (07100001-523)

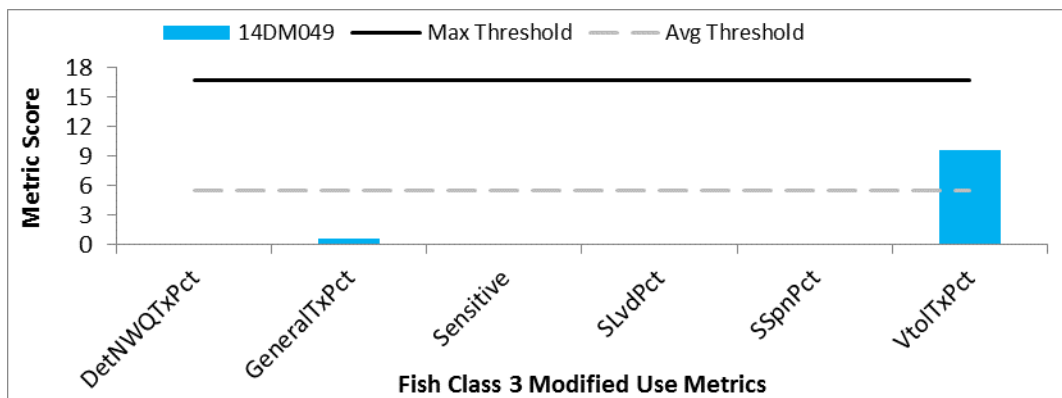
Located in southeastern Murray County and northeastern Nobles County, Judicial Ditch 26 (-523) is a 6.45 mile long reach that is impaired for aquatic life due to the macroinvertebrate assemblage. This stream reach extends from Unnamed Creek down to the confluence with Jack Lake. Along this stream section there is one biological monitoring station, 14DM049.

Biology

Fish:

The fish community in Judicial Ditch 26 (-523) was sampled for fish in June of 2014 at its biological monitoring station 14DM049. The FBI score at this reach was 0.2, which is far below the Fish Class 3 Southern Headwaters Modified Use Threshold of 33. This site did have one metric (VtoITxPct) reach the average metric score needed to meet the threshold (Figure 110), however, the remaining five metrics comprising this FBI scored well below average with four metrics scoring zero. This site had a lower sample size (23 fish) and consisted of predominantly tolerant species (creek chubs, white suckers, fathead minnows, brook sticklebacks).

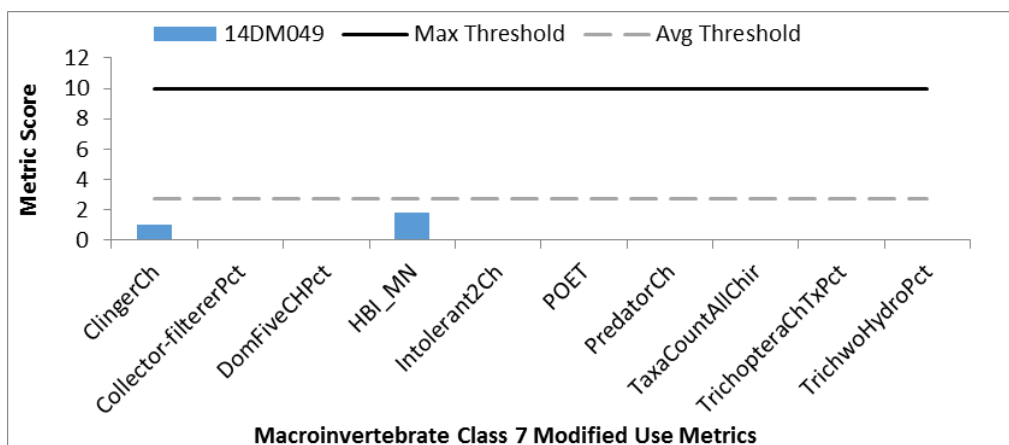
Figure 110. Judicial Ditch 26 (-523) fish IBI metric scores



Macroinvertebrates:

The macroinvertebrate assemblage at site 14DM049 was sampled in August of 2014. This visit had a MIBI score of 2.9, which is far below the Macroinvertebrate Class 7 Prairie Streams GP Modified Use Threshold of 22. This site had zero metrics scoring above the average needed to reach the threshold resulting in the impairment designation. See Figure 111 for a complete breakdown of the metric scores at this site.

Figure 111. Judicial Ditch 26 (-523) macroinvertebrate IBI metric scores



Dissolved Oxygen

A total of 10 DO measurements were taken from one chemistry site (S009-044) and one biological monitoring station (14DM049) in 2016. The average of all the values is 8.93 mg/L with a low of 4.25 mg/L and a high of 17.48 mg/L. The summer average (June-Aug) is 8.24 mg/L. The DO values fell below 5 mg/L twice.

The HSPF model calculated daily minimum DO values for this subwatershed from 1994-2014. Of these calculations, 1070 (13.95%) of the days had a daily minimum DO level below the daily minimum standard of 5 mg/L.

Table 253. DO related fish metrics in Judicial Ditch 26 (-523). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-523 Macroinvertebrate Class 7 – Modified Use	HBI_MIN Value	% DO Tolerant Taxa	# DO Tolerant Taxa	ChemTV_ DO
14DM049	8.32	66.87	6.00	6.38
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22)</i>	8	31.37	9.33	6.19
Expected response to DO stress	↑	↑	↑	↓

The macroinvertebrate assemblage in Judicial Ditch 26 (-523) scored below average in two of the four DO related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 253). This reach had a high percentage of DO tolerant taxa, while also having a poor HBI_MIN value. However, site 14DM049 did have a good DO TIV score, which normally does not happen in streams with poor DO conditions.

The DO values in this reach do occasionally fall below 5 mg/L according to the observed measurements. The exceedance rate of the model does not strongly signal a likely stressor, while the macroinvertebrate metrics related to DO gave mixed results as half of the metrics signaled stressor while the other half did not. Based on this information, DO is inconclusive as a stressor in Judicial Ditch 26 (-523) at this time. Continuous DO with a sonde and a fish sample are both recommended to better determine the impacts DO is having on this reach.

Eutrophication

A total of 10 phosphorus samples were taken from one chemistry site (S009-044) and one biological monitoring station (14DM049) from 2014-2016. The average of all the values is 0.143 mg/L with a low of 0.05 mg/L and a high of 0.24 mg/L. The summer average (June-Aug) is 0.169 mg/L. Phosphorus values exceeded 0.150 mg/L four times. Algae was observed at site 14DM049 during a sampling visit. (Figure 112)

The HSPF model also calculated daily phosphorus concentrations for this subwatershed from 1994-2014. These values ranged from 0.11-10.98 mg/L with an average concentration of 0.39 mg/L. Of these calculations, 5,377 (98.99%) were above the 0.15 mg/L.

Figure 112. Observed algae present at site 14DM049



Table 254. Eutrophication related macroinvertebrate metrics in Judicial Ditch 26 (-523). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-523 Macroinvertebrate Class 7 – Modified Use	EPT Pct	Tanytarsini Pct	CrustMoll Pct	Scraper Pct	% Tolerant Taxa	% Intolerant Taxa
14DM049	0.00	1.32	1.74	1.42	6.96	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22)</i>	20.58	22.11	23.21	17.73	45.87	1.43
Expected response to Eutrophication stress	↓	↓	↑	↑	↑	↓

The macroinvertebrate community in Judicial Ditch 26 (-523) at site 14DM049 scored below average in three of the six eutrophication related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 254). This reach had very few tanytarsini and EPT individuals, while also completely lacking phosphorus intolerant taxa. These results can be a potential sign for stress due to eutrophic conditions.

Based on the high observed and modeled exceedances of the phosphorus standard, the presence of algae at the sampling site, as well as many of the eutrophication related metrics in the macroinvertebrate community scoring poorly, eutrophication is a stressor to aquatic life in Judicial Ditch 26 (-523).

Nitrates

There were 10 samples taken from one chemistry site (S009-044) and one biological monitoring station (14DM049) from 2014-2016 were analyzed for Inorganic Nitrogen (NO₂-NO₃). The average of all the values is 7.63 mg/L with a low of 2.00 mg/L and a high of 14 mg/L. The spring average (March-May) is 11.45 mg/L. The summer average (June-Aug) is 6.63 mg/L. Nitrate values exceeded 4 mg/L eight times. A quantile regression analysis for Class 7 stream stations showed that sites having a nitrate concentration in excess of 11.5 mg/L there was a 90% probability for impairment. The nitrate concentrations in this reach exceeded this level.

The HSPF model calculated daily nitrate concentrations for this subwatershed from 1994-2014. These values ranged from 1.31-334.32 mg/L with an average value of 8.04 mg/L. Of these calculations, 1357 (24.98%) were above 11.5 mg/L.

Drain tiles were noted as being present along this reach. Drain tiles are a common pathway for nitrates to enter a stream system.

Table 255. Nitrate related macroinvertebrate metrics in Judicial Ditch 26 (-523). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-523 Macroinvertebrate Class 7 – Modified Use	TrichopteraChTx Pct	N Index Score	% N Tolerant	% N Intolerant
14DM049	0.00	4.09	94.80	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22)</i>	5.71	3.30	62.54	0.00
Expected response to N stress	↓	↑	↑	↓

The macroinvertebrate community in Judicial Ditch 26 (-523) at site 14DM049 scored below average in all four of the nitrate related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 255). This reach completely lacked both trichoptera and nitrate intolerant taxa, while also having a high amount of nitrate tolerant individuals and a poor nitrate index score. These results signal that nitrates are likely a stressor.

Based on the high observed and calculated results, the presence of drain tiles, the quantile regression analysis, and all of the nitrate related macroinvertebrate metrics scoring below average, nitrates are a stressor to aquatic life in Judicial Ditch 26 (-523).

Suspended Solids

Ten samples taken from one chemistry site (S001-547) in 2016 were analyzed for TSS. The average of all the values is 19.2 mg/L with a low of 4 mg/L and a high of 33 mg/L. The TSS concentrations did not exceed the 65 mg/L standard.

Additionally, nine secchi tube measurements were taken from this reach. These values ranged from 27-88 cm, with no values falling below the 10 cm minimum standard for secchi tube.

The HSPF model calculated daily TSS values for this subwatershed from 1994-2014. These concentrations ranged from 2.09-683.66 mg/L with an average TSS value of 17.42 mg/L. Of these calculations, 145 (2.67%) were above the TSS standard of 65 mg/L.

Table 256. TSS related macroinvertebrate metrics in Judicial Ditch 26 (-523). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-523 Macroinvertebrate Class 7 – Modified Use	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plectoptera Pct
14DM049	14.34	0.00	5.00	4.89	0.63	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)</i>	16.02	0.60	10.98	35.60	9.91	0.02
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

The macroinvertebrate assemblage in Judicial Ditch 26 (-523) at site 14DM049 scored below average in three of the six TSS related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 255). This reach had a good TSS Index score, while also having a decreased amount and percentage of TSS tolerant individuals. These results reflect a community not being stressed by the current TSS conditions.

Based on the lack of exceedances in the observed data set, the low exceedance rate in the modeled data set, as well as the decreased amount of TSS tolerant taxa and individuals, and good TSS Index score for the macroinvertebrate assemblage, TSS is not a stressor to aquatic life in Judicial Ditch 26 (-523).

Habitat

Judicial Ditch 26 (-523) had a qualitative habitat assessment take place at its biological monitoring site, 14DM049, during the fish and macroinvertebrate sampling events in 2014. The average MSHA score from these visits was 25.25 (Poor). Limiting the habitat at this site was the row crop agriculture as the dominant nearby land use, light stream shading, no coarse substrates, silt and detritus substrates, moderate channel stability, poor channel development, very little depth variability, and poor sinuosity (Figure 113). Further MSHA analysis can be seen in Figure 114.

Figure 113. Poor sinuosity at site 14DM049.



Figure 114. Judicial Ditch 26 (-523) MSHA metric scores.

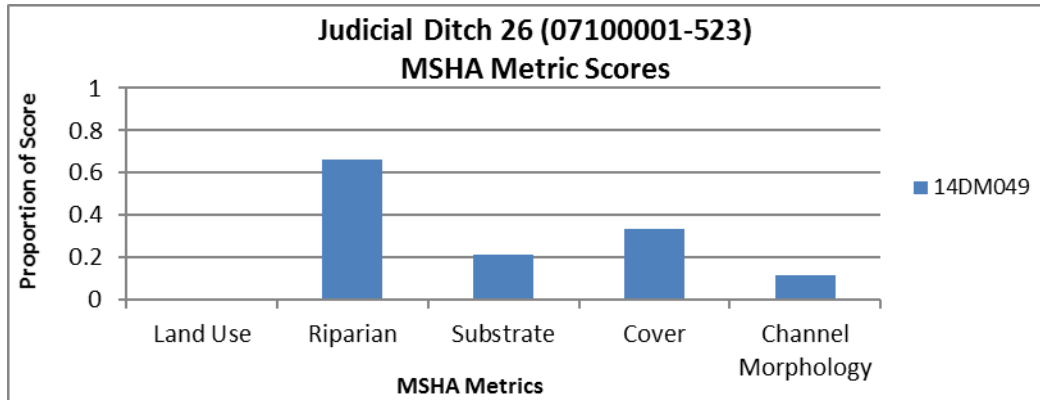


Table 257. Habitat related macroinvertebrate metrics in Judicial Ditch 26 (-523). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-523 Macroinvertebrate Class 7 – Modified Use	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14DM049	65.60	2.21	30.93	0.00	99.37	0.79
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	9.74	24.34	20.62	15.52	59.46	22.88
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate assemblage in Judicial Ditch 26 (-523) scored below average in five of the six habitat related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 257). The site, 14DM049, did have an above average amount of clinger individuals, which can be a signal for good habitat. However, the remaining metrics scored poorly. This reach had a very high amount of legless and burrower individuals, which are often found in streams that have fine silts for substrates like that found in 14DM049.

Based on the poor MSHA rating based on multiple assessments, as well as the majority of the habitat related metrics in the macroinvertebrate community scoring poorly, habitat is a stressor to aquatic life in Judicial Ditch 26 (-523).

Altered Hydrology

This reach is on a section of Judicial Ditch 26 (-523) and a tributary of Jack Creek. The reach is an entirely altered channel which flows through Eagle Lake and then directly into Jack Lake, which flows into East Graham Lake. The majority of the upstream watershed is altered according to the MPCA altered watercourse layer. There is a fish barrier downstream at the outlet of East Graham Lake.

“Riffle cross section measurements identified that the BHR was 2.12 and entrenchment ratio was 1.37. These ratios indicate that the channel at the study location is both entrenched and deeply incised. Flood-prone elevations are roughly 1 foot lower than the top of the low bank height and means that flood flows (i.e. two times bankfull max depth at the riffle) cannot access the rivers floodplain. The confinement of flood flows within the channel is a leading factor as to why the channel is in such poor shape” (DNR 2016).

Extreme weather events affect high flow events as well as also low flows during drought. HSPF models show this stream section experiencing low flow at less than five cfs 65.3% of the time and less than one cfs 19.8% of the time.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The percentage for generalist fish within the reach was 95.7% compared to the average in Class 3 modified use waters meeting the standard of 56.3%

The numbers of nest guarder species are also positively correlated with increased low flows. The percentage for nest guarder fish within the reach was 8.7% compared to the average in Class 3 modified use waters meeting the standard of 24%.

Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The average percentage for long-lived macroinvertebrates within the reach was 0% compared to the average in Class 7 modified use waters meeting the standard of 5.6%.

Based on the altered channel condition, the upstream channelization of tributaries, downstream fish barriers, the frequent low flow conditions, the lack of floodplain access for the channel, as well as the poor scoring biological metrics, Flow Alteration/Connectivity is a stressor to aquatic life in Judicial Ditch 26 (-523).

Summary

The impaired macroinvertebrate community in Judicial Ditch 26 (-523) is being stressed by Eutrophication, Nitrates, Habitat and Flow Alteration/Connectivity (Table 258). DO was inconclusive as a stressor at this time, while Suspended Sediment was ruled out as a stressor to aquatic life. For further information on the stressors and recommendations to fixing the stressors in the Jack Creek HUC 10 Watershed, please see pages 268-269.

Table 258. Stressor determinations for Judicial Ditch 26 (-523).

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Judicial Ditch 26	07100001-523	o	●	●	---	●	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Jack Creek (07100001-549)

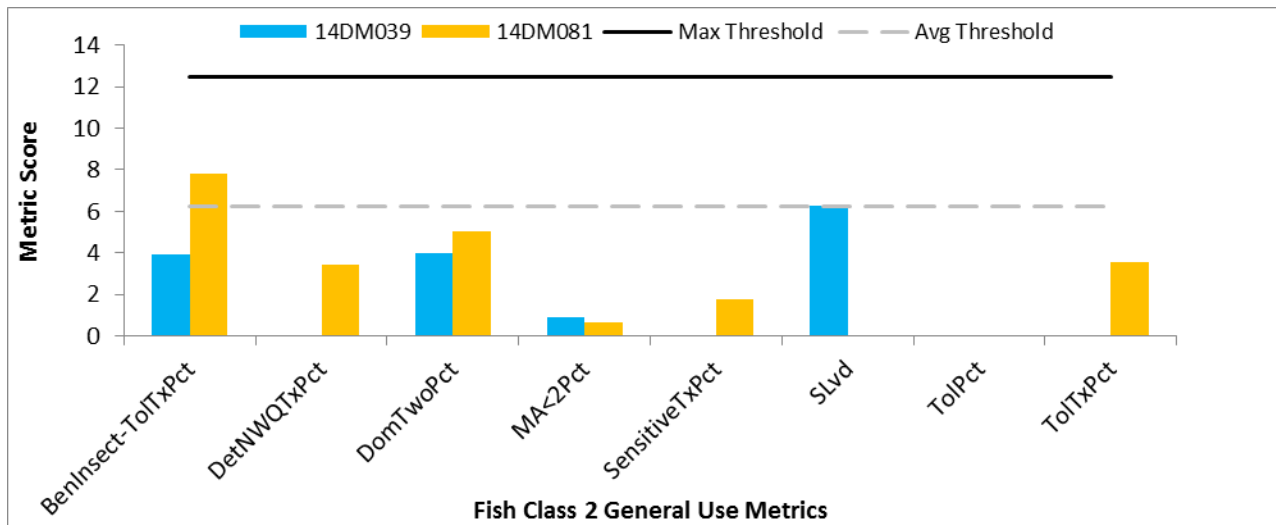
Located in central Nobles County, Jack Creek (-549) is a 15.49 mile long reach that is impaired for aquatic life due to the fish and macroinvertebrate assemblages. This stream reach extends from downstream of Monroe Avenue to the confluence with North Branch Jack Creek. Along this stream section, there are two biological monitoring stations, 14DM039 and 14DM081.

Biology

Fish

The fish community in Jack Creek (-564) was sampled for fish in July of 2014 at its biological monitoring station 14DM039 and August 2014 at site 14DM081. The FBI score at 14DM039 was 15 and 22.2 at site 14DM081, which are far below the Fish Class 2 Southern Streams General Use Threshold of 50. These sites did have one metric each to reach the average metric score needed to meet the threshold (Figure 115), however, the remaining seven metrics comprising this FBI scored well below average with a few metrics scoring zero.

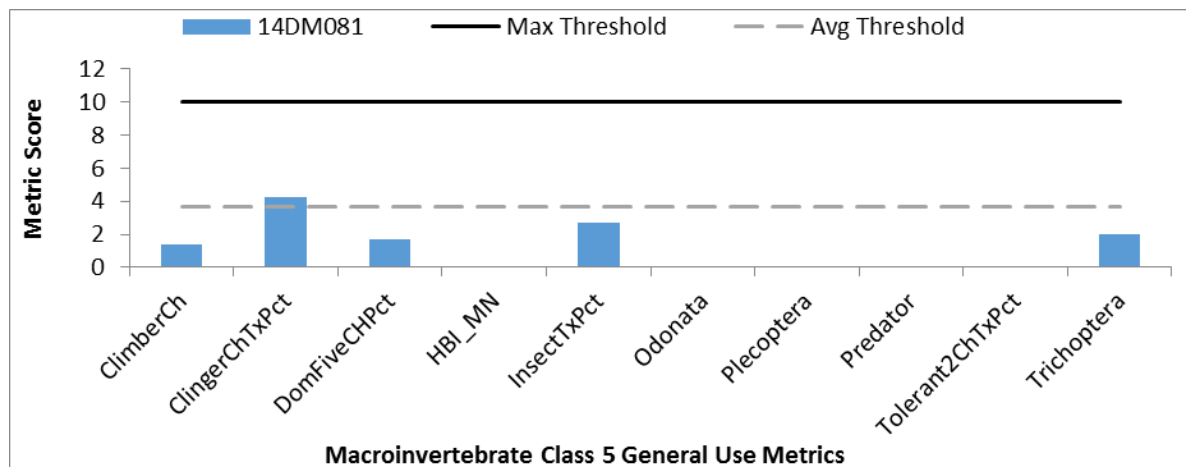
Figure 115. Jack Creek (-549) fish IBI metric scores.



Macroinvertebrates

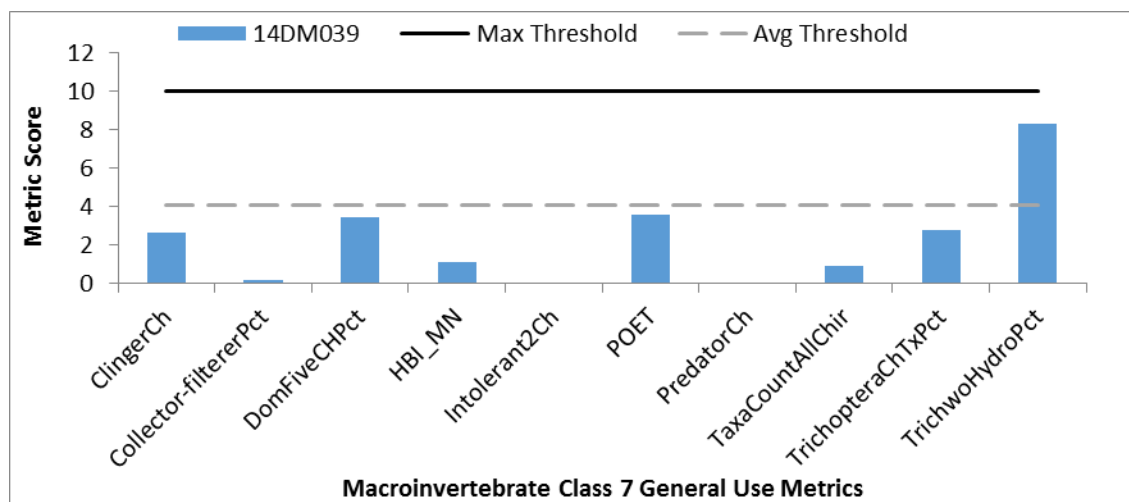
The macroinvertebrate assemblage at site 14DM081 was sampled in August of 2014. This visit had a MIBI score of 12.0, which is below the Macroinvertebrate Class 5 Southern Streams RR General Use Threshold of 37. This site had one metric score above the average needed to reach the threshold (ClingerChTxPct). However, the remaining nine metrics scored below average, with five of these metrics scoring zero resulting in the impairment designation. See Figure 116 for a complete breakdown of the metric scores at this site.

Figure 116. Jack Creek (-549) macroinvertebrate class 5 IBI metric scores.



The macroinvertebrate assemblage at site 14DM039 was sampled in August of 2014. This visit had a MIBI score of 22.9, which is below the Macroinvertebrate Class 7 Prairie Streams GP General Use Threshold of 41. This site also had one metric score above the average needed to reach the threshold (TrichwoHydroPct). The remaining nine metrics scored below average or poorly resulting in the impairment designation. See Figure 117 for a complete breakdown of the metric scores at this site.

Figure 117. Jack Creek (-549) macroinvertebrate class 7 IBI metric scores.



Dissolved Oxygen

A total of 11 DO measurements were taken from one chemistry site (S001-561) and two biological monitoring stations (14DM039, 14DM081) from 2014-2016. The average of all the values is 8.97 mg/L with a low of 7.70 mg/L and a high of 10.01 mg/L. The summer average (June-Aug) is 8.85 mg/L. The DO values never fell below 5 mg/L.

The HSPF model calculated daily minimum DO values for this subwatershed from 1994-2014. Of these calculations, 643 (8.38%) of the days had a daily minimum DO level below the daily minimum standard of 5 mg/L.

Table 259. DO related fish metrics in Jack Creek (-549). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-549 Fish Class 2 – General Use	MA>3 Avg	SspnPct Avg	Taxa Count Avg	DO TIV Avg
14DM039	2.38	52.38	8.00	8.64
14DM081	3.13	62.40	16.00	8.71
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)</i>	23.89	28.72	20.38	8.56
Expected response to DO stress	↓	↑	↓	↓

The fish community in Jack Creek (-549) at sites 14DM039 and 14DM081 scored below average in three of the four DO related metrics at both sites when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 259). Both sites had lower taxa counts, few mature fish, and increased amounts of serial spawning individuals. However, both sites did have good DO TIV scores.

Table 260. DO related macroinvertebrate metrics in Jack Creek (-549). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-549 Macroinvertebrate Class 5, 7 – General Use	HBI_MN Value	% DO Tolerant Taxa	# DO Tolerant Taxa	ChemTV_ DO
14DM081	8.39	9.21	7.00	7.20
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	7.04	8.62	4.33	7.10
14DM039	8.54	15.86	5.00	6.99
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	7.55	12.98	5.74	6.91
Expected response to DO stress	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in two (14DM039) and three (14DM081) of the four DO related metrics when compared to all other Class 5 Southern Streams RR and Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 260). Both sites had poor HBI_MN values, while also having increased percentages of DO tolerant taxa. However, both sites also had good DO TIV scores, which does not normally occur in communities stressed by DO conditions.

Based on the relatively low exceedance rate calculated by the HSPF model, zero exceedances in the observed data set, as well as the low phosphorus concentrations present in the stream likely signaling that daily flux of DO is not an issue, DO is not a stressor at this time. It is likely that other stressors are causing the biological metrics to score below average.

Eutrophication

A total of 11 phosphorus samples were taken from one chemistry site (S001-561) and two biological monitoring stations (14DM039, 14DM081) from 2014-2016. The average of all the values is 0.092 mg/L

with a low of 0.03 mg/L and a high of 0.14 mg/L. The summer average (June-Aug) is 0.087. Phosphorus values never exceeded the standard of 0.150 mg/L.

The HSPF model also calculated daily phosphorus values for this subwatershed from 1994-2014. These values ranged from 0.12-4.31 mg/L with an average phosphorus concentration of 0.36 mg/L. Of these calculations, 5660 (99.74%) were above the 0.15 mg/L standard for phosphorus.

Table 261. Eutrophication related fish metrics in Jack Creek (-549). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-549 Fish Class 2 – General Use	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct
14DM039	0.00	4.76	95.24	7.14
14DM081	0.21	23.02	76.77	32.50
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)</i>	19	11.47	45.1	17
Expected response to Eutrophication stress	↓	↓	↑	↑

The fish community in Jack Creek (-549) at sites 14DM039 and 14DM081 scored below average in three of the four metrics related to eutrophication when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 261). Both stream sites had increased numbers of tolerant fish individuals, while both having very few sensitive individuals. Site 14DM039 also had a decreased amount of darter individuals, while site 14DM081 had an increased amount of omnivorous individuals. These results are often found in streams with eutrophic conditions.

Table 262. Eutrophication related macroinvertebrate metrics in Jack Creek (-549). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-549 Macroinvertebrate Class 5 and 7 – General Use	EPT Pct	Tanytarsini Pct	CrustMoll Pct	Scraper Pct	% Tolerant Taxa	% Intolerant Taxa
14DM081	49.52	0.76	6.35	6.03	26.35	0.00
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	43.90	27.84	9.23	15.78	17.17	5.79
14DM039	45.95	4.03	11.97	25.24	52.43	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	38.45	18.46	11.78	16.11	26.84	4.03
Expected response to Eutrophication stress	↓	↓	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in three (14DM081) and five (14DM039) of the six eutrophication related metrics when compared to all other Class 5 Southern Streams RR and Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 262). Both of these sites had low levels of tanytarsini individuals and phosphorus intolerant taxa, while having an increased amount of phosphorus tolerant species. Site 14DM039 also had increased number of crustacean/mollusca and scraper individuals resulting in poor metric scores. These results can indicate potential stress from eutrophic conditions.

The observed data set does not indicate stress as no samples exceeded the phosphorus standard. The modeled data had a very high rate of standard exceedance, while the majority of the fish and macroinvertebrate metrics did score below average in eutrophication related metrics. Due to the conflicting results, phosphorus is inconclusive as a stressor in Jack Creek (-549) at this time.

Nitrates

There were 11 samples taken from one chemistry site (S001-561) and two biological monitoring stations (14DM039, 14DM081) from 2014-2016 were analyzed for Inorganic Nitrogen (NO₂-NO₃). The average of all the values is 8.01 mg/L with a low of 0.30 mg/L and a high of 20 mg/L. The spring average (March-May) is 19.00 mg/L. The summer average (June-Aug) is 6.62. Nitrate values exceeded 4 mg/L six times. A quantile regression analysis for Class 7 stream stations showed that sites having a nitrate concentration in excess of 11.5 mg/L there was a 90% probability for impairment. The nitrate concentrations in this reach exceeded this level.

The HSPF model calculated daily nitrate concentrations for this subwatershed from 1994-2014. These values ranged from 1.14-71.68 mg/L with an average value of 7.81 mg/L. Of these calculations, 1398 (24.63%) were above 11.5 mg/L.

Drain tiles were noted as being present along this reach. Drain tiles are a common pathway for nitrates to enter a stream system.

Table 263. Nitrate related macroinvertebrate metrics in Jack Creek (-549). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-549 Macroinvertebrate Class 5, 7 – General Use	TrichopteraChTx Pct	N Index Score	% N Tolerant	% N Intolerant
14DM081	13.79	4.27	92.38	0.00
<i>Statewide average for Class 5 Southern Streams Rock Riffle stations that are meeting the MIBI General Use Threshold (37)</i>	13.16	3.00	48.68	0.96
14DM039	4.55	4.40	84.79	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	10.00	3.30	57.57	0.91
Expected response to N stress	↓	↑	↑	↓

The macroinvertebrate community in Jack Creek (-549) scored below average in three (14DM081) and four (14DM039) of the four nitrate related metrics when compared to all other Class 5 Southern Streams RR and Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 263). Both sites completely lacked nitrate intolerant species, while also having a high amount of nitrate tolerant individuals and poor nitrate index scores.

Based on both the elevated observed and predicted nitrate concentrations, the quantile regression analysis, the presence of drain tiles, as well as the poor scoring nitrate related biological metrics, nitrates are a stressor to aquatic life in Jack Creek (-549).

Suspended Solids

Nine samples taken from one chemistry site (S001-561) in 2016 were analyzed for TSS. The average of all the values is 33.22 mg/L with a low of 10 mg/L and a high of 66 mg/L. The TSS concentrations exceeded the 65 mg/L standard once.

Additionally, nine secchi tube measurements were taken from this reach. These values ranged from 16-52 cm, with no values falling below the 10 cm minimum standard for secchi tube.

The HSPF model calculated daily TSS values for this subwatershed from 1994-2014. These concentrations ranged from 4.08-1419.23 mg/L with an average TSS value of 39.31 mg/L. Of these calculations, 283 (10.47%) were above the TSS standard of 65 mg/L.

Table 264. TSS related fish metrics in Jack Creek (-549). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-549 Fish Class 2 – General Use	BenFdfRimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RifflePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14DM039	11.90	0.00	11.90	4.76	7.14	0.00	2.38	0.00	0.00	24.77
14DM081	27.81	0.00	3.13	23.02	5.83	0.21	4.69	0.00	1.15	18.65
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)</i>	37.38	4.89	9.61	18.66	32.49	18.65	39.38	4.97	11.68	17.59
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

The fish community in Jack Creek (-549) at sites 14DM039 and 14DM081 scored below average in nine of the ten TSS related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 264). Site 14DM039 did have an above average amount of herbivorous individuals, while site 14DM081 had an increased amount of perch-like individuals. These results are commonly found in streams without TSS issues, however, the remaining metrics at both sites scored poorly.

Table 265. TSS related macroinvertebrate metrics in Jack Creek (-549). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-549 Macroinvertebrate Class 5, 7 – General Use	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plectoptera Pct
14DM081	20.89	0.00	13.00	20.89	22.54	0.00
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	15.87	3.02	11.59	35.23	26.89	0.54
14DM039	24.19	0.00	8.00	75.08	0.97	0.32
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	17.35	1.33	13.20	48.28	19.13	0.22
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

The macroinvertebrate assemblage in this reach scored below average in four (14DM039) and five (14DM081) of the six TSS related metrics when compared to all other Class 5 Southern Streams RR and Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 265). Both sites had poor TSS index scores, while also having few collector filterer individuals and TSS intolerant taxa. Site 14DM039 did also have a very high amount of TSS tolerant individuals. These results suggest likely stress from TSS.

The observed TSS data does show a instance when the TSS concentrations exceed the standard, while the HSPF model calculated an elevated standard exceedance rate (10.47%). The majority of the TSS related metrics in both the fish and macroinvertebrate communities scored poorly as well. Therefore, TSS is a stressor to aquatic life in Jack Creek (-549).

Habitat

Jack Creek (-549) had qualitative habitat assessments take place at its biological monitoring sites, 14DM039 and 14DM081, during the fish and macroinvertebrate sampling events in 2014. The average MSHA scores from these visits were 49.7 (Fair) at 14DM039 and 43.3 (Poor) at 14DM081. Limiting the habitat at these sites was the row crop agriculture as a nearby land uses, a very narrow to moderate riparian buffer, moderate to severe bank erosion (Figure 118), light stream shading, sand and silt substrates, sparse fish cover, severe embeddedness (14DM039), fair sinuosity (14DM081), and low to moderate channel stability. Further MSHA analysis can be seen in Figure 119.

Figure 118. Severe bank erosion at site 14DM039



Figure 119. Jack Creek (-549) MSHA metric scores.

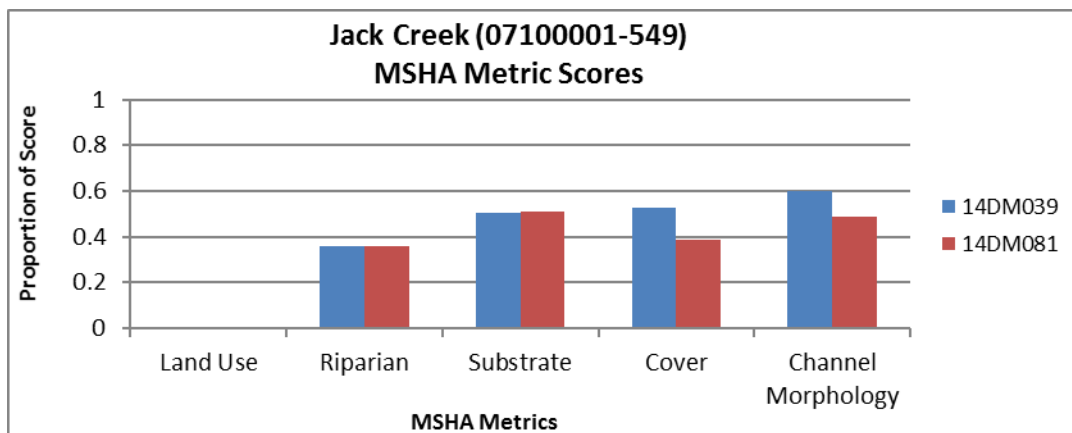


Table 266. Habitat related fish metrics in Jack Creek (-549). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-549 Fish Class 2 – General Use	BenInsect-TolPct	SlithopPct	DarterSculpSu cPct	RifflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14DM039	4.76	2.38	4.76	7.14	0.00	21.43	95.24	23.81
14DM081	23.13	4.69	23.02	5.83	0.00	12.50	76.77	55.94
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)</i>	20.4	39.38	18.18	32.49	5.24	58.26	44.85	19.02
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

The fish assemblage in Jack Creek (-549) at sites 14DM039 and 14DM081 scored below average in six (14DM081) and eight (14DM039) of the eight habitat related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 266). Site 14DM081 did have higher numbers of both benthic insectivore and darter individuals, but scored poorly in the remaining metrics similarly to 14DM039. Both sites had a high amount of tolerant fish individuals, which is often a sign of habitat degradation.

Table 267. Habitat related macroinvertebrate metrics in Jack Creek (-549). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-549 Macroinvertebrate Class 5, 7 – General Use	BurrowerPc	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPc
14DM081	6.35	42.86	30.16	49.52	46.35	13.02
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)</i>	5.66	12.52	49.77	42.46	34.53	13.99
14DM039	3.24	35.60	31.07	45.95	42.07	17.48
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)</i>	5.40	20.35	36.94	37.77	37.96	19.49
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate assemblage in this reach scored below average in three (14DM039) and four (14DM081) of the six habitat related metrics when compared to all other Class 5 Southern Streams RR and Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 267). Both sites had below average numbers of both clinger and sprawler individuals, while also having a higher number of legless individuals. These results are common in streams potentially being affected by poor habitat conditions. Site 14DM081 also had a slightly higher number of burrower individuals, which corresponds to the sand and silt substrates present.

Based on the poor to fair MSHA scores between the two sites, as well as the majority of the habitat related metrics in both the fish and macroinvertebrate communities scoring below average, habitat is a stressor to aquatic life in Jack Creek (-549).

DNR summary for Upper Jack Creek (-549)

The attributes measured at the study site classified the stream channel as an E4 stream type. Characteristics of E4 channels are identical to E5 channels (e.g. upper Beaver Creek channel) with the exception that E4 channels have predominantly gravel sized substrates in contrast to the finer substrates of an E5 channel (Rosgen 1996). The BHR at the riffle cross section was measured to be 1.82. A BHR of 1.82 classifies the upper Jack Creek channel as deeply incised, however, the entrenchment ratio of 2.12 classifies the channel as only moderately entrenched.

The entrenchment ratio at this site is sensitive to minimal amounts of incision. Currently the flood-prone width is slightly two times the width of the bankfull channel. However, if the channel were to incise just 0.6 feet, the entrenchment ratio would become 1.39 (i.e. entrenched). One channel alteration that likely resulted in previous channel incision was the straightening of the downstream portion of this stream reach for the road crossing. This forced the stream to make up the change in elevation over a shorter length of stream likely causing down cutting of the streambed.

Vegetation within the riparian corridor at the upper Jack Creek survey site was primarily Reed Canary and Brome grass. Banks that had a moderate to gentle angle of repose appeared to be well vegetated and relatively stable due to the vegetative cover and root density. Banks with steeper angles, and outside bends, were much more unstable. These banks showed evidence of mass failure where steep angled bank faces were primarily non-vegetated. The riparian corridor in this location had adequate width; however, incision, entrenchment ratio, and vegetative species have culminated in tall vulnerable outside bend banks. Sediment supply from streambank erosion was estimated using the BANCS (i.e. BEHI matched with NBS) model. The mean streambank erosion estimates were 0.1078 tons (i.e. 215.6 pounds) of sediment per linear foot of streambank annually when using the Colorado erosion rate curve (Rosgen 2001). A monumented cross section was established to validate the BEHI erosion estimates. The model estimated that 0.1281 tons (i.e. 256.2 pounds) of sediment were eroding from the study bank per foot each year. Measured erosion rates indicated that the study bank (i.e. from the toe of the bank to the top) eroded 0.7979 feet from 2013 to 2014, and 0.5274 feet from 2014 to 2015.

Another area of high sediment contribution is the previously straightened portion of the channel. Upstream of the road, the channel is working to re-meander itself and is creating tall cut banks on the outside bends. Downstream of the culvert, the road authority left a very tight radius of curvature where the straightened channel intersected the old channel. This angle, in accordance with increased velocities due to flood flow confinement (FFC) caused by the culverts, has increased erosion and meander bend migration rates downstream of the road. The increase in erosion rate was high enough that public funding was used in order to place BMPs at the outside bends to slow the rate of land loss and instream sediment input.

Initial survey efforts were conducted in the fall of 2013 when water levels were below base flow. The intermittent channel had shallow pools of less than 1.5 feet in depth. Return visits to resurvey the study bank were also conducted in the fall but flows were at least base flow or above. Deeper pool depths were witnessed during these return visits, however, biota may struggle to find adequate refuge habitat during base flow or lower flows. Shallow pool depths in part are due to the w/d ratio of the channel. Rosgen (1996) identifies that E4 channels have an average w/d ratio of 5.86 and that w/d ratios between 8 and 10 represent less than 25% of the channels included in the data set used in the publication. Therefore, pools become shallower as a similar volume of water does not fill the channel to the same depth as when the w/d ratio is lower. Furthermore, the less constricted flow in an over widened channel has less capacity to scour sediment in order to create pools of greater depth.

Altered Hydrology

Jack Creek (-549) is a roughly half-natural and half-altered channel. The majority of the upstream watershed is altered according to the MPCA altered watercourse layer.

“Riffle cross section measurements identified that the BHR was 2.12 and entrenchment ratio was 1.37. These ratios indicate that the channel at the study location is both entrenched and deeply incised. Flood-prone elevations are roughly 1 foot lower than the top of the low bank height and means that flood flows (i.e. 2 times bankfull max depth at the riffle) cannot access the rivers floodplain. The confinement of flood flows within the channel is a leading factor as to why the channel is in such poor shape” (DNR 2016).

Extreme weather events affect high flow events as well as also low flows during drought. HSPF models show this stream section experiencing low flow at less than five cfs 23.7% of the time and less than one cfs 2.8% of the time.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The average percentage for generalist fish within the reach was 30.2% compared to the average in Class 2 general use waters meeting the standard of 42.4%. Generalist fish populations ranged from 21.4-39.1%.

The numbers of nest guarder species are also positively correlated with increased low flows. The average percentage for nest guarder fish within the reach was 38.2% compared to the average in Class 2 general use waters meeting the standard of 19%. Nest guarder fish species ranged from 23.8-52.5%.

Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The percentage for long-lived macroinvertebrates within the reach was 0.3% compared to the average in Class 5 general use waters meeting the standard of 9%. The percentage for long-lived macroinvertebrates within the reach was 1.9% compared to the average in Class 7 general use waters meeting the standard of 8%.

Based on the upstream channelization of tributaries, the partial channelization of this reach, the lack of floodplain access for the channel, as well as the majority of the biological metrics scoring poorly, Flow Alteration/Connectivity is a stressor to aquatic life in Jack Creek (-549).

Summary

The impaired fish and macroinvertebrate communities in Jack Creek (-549) are being stressed by Nitrates, Suspended Sediment, Habitat and Flow Alteration/Connectivity (Table 268). Eutrophication was inconclusive as a stressor at this time, while DO was ruled out as a stressor to aquatic life. For further information on the stressors and recommendations to fixing the stressors in the Jack HUC 10 Watershed, please see pages 268-269.

Table 268. Stressor determinations for Jack Creek (-549).

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Jack Creek	07100001-549	---	o	●	●	●	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Unnamed Creek (07100001-618)

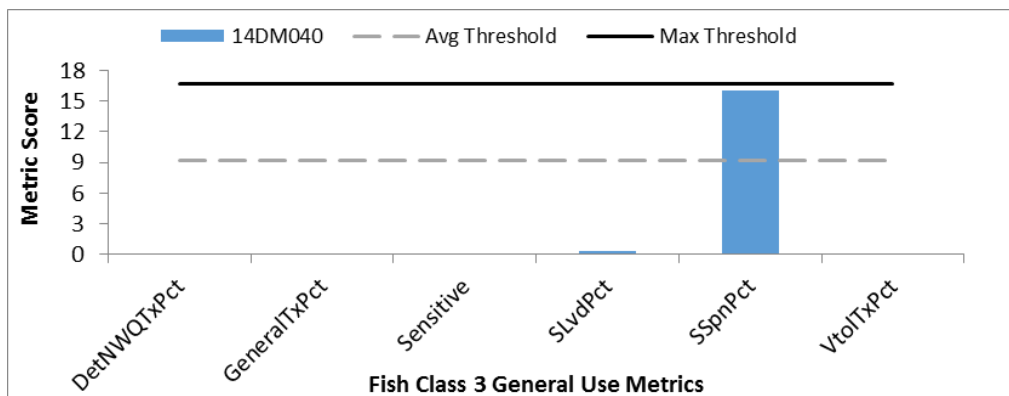
Located in northcentral Nobles County, Unnamed Creek (-618) is a 2.03 mile long reach that is impaired for aquatic life due to the fish and macroinvertebrate assemblages. This stream reach extends from an unnamed creek just upstream of Oliver Avenue down to the confluence with an unnamed lake. Along this stream section there is one biological monitoring station, 14DM040.

Biology

Fish

The fish community in Unnamed Creek (-618) was sampled for fish in August of 2014 at its biological monitoring station 14DM040. The FBI score at this reach was 16.3, which is far below the Fish Class 3 Southern Headwaters General Use Threshold of 55. This site did have one metric (SSpnPct) reach the average metric score needed to meet the threshold (Figure 120), however, the remaining five metrics comprising this FBI scored well below average with four metrics scoring zero. This site was dominated by the presence of brook sticklebacks (93.77%% of sampled individuals). Brook sticklebacks are a very tolerant species often found in large numbers in degraded streams.

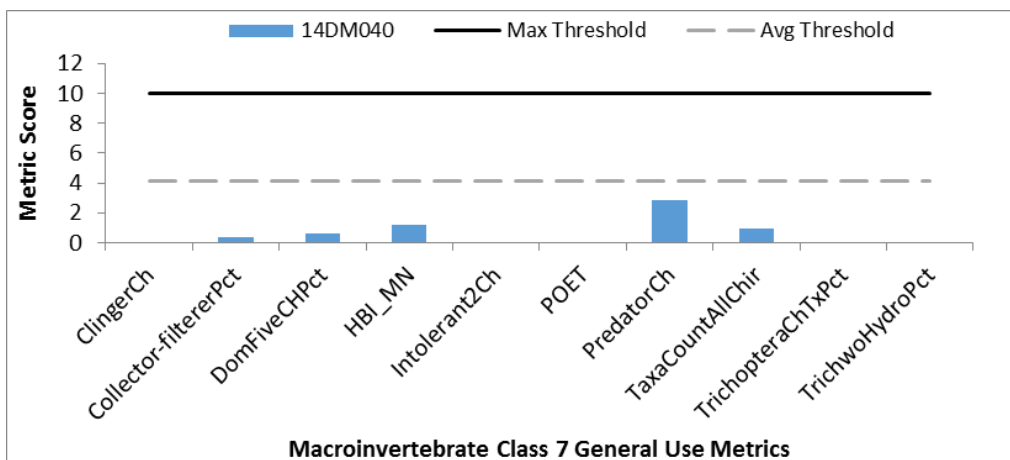
Figure 120. Unnamed Creek (-618) fish IBI metric scores.



Macroinvertebrates

The macroinvertebrate assemblage at site 14DM040 was sampled in August of 2014. This visit had a MIBI score of 6.0, which is below the Macroinvertebrate Class 7 Prairie Streams GP General Use Threshold of 41. This site had zero metrics scoring above the average needed to reach the threshold with five of the metrics scoring zero resulting in the impairment designation. See Figure 121 for a complete breakdown of the metric scores at this site.

Figure 121. Unnamed Creek (-618) macroinvertebrate IBI metric scores.

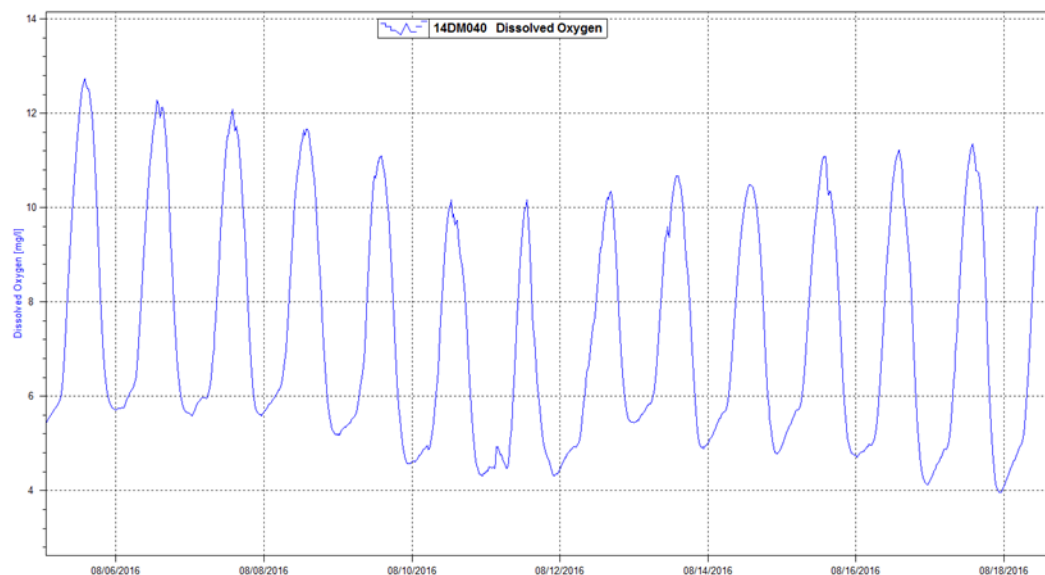


Dissolved Oxygen

A total of 12 DO measurements were taken from one chemistry site (S009-146) and one biological monitoring station (14DM040) from 2014-2016. The average of all the values is 8.40 mg/L with a low of 4.9 mg/L and a high of 9.98 mg/L. The summer average (June-Aug) is 8.47 mg/L. The DO values fell below 5 mg/L once.

Continuous DO monitoring took place at site 14DM040 in 2016 (Figure 122). This monitoring did show instances in which the daily minimum DO levels fell below the 5 mg/L standard. The daily flux from this monitoring also frequently exceeded the 4.5 mg/L standard for the southern region of the state. These results indicate likely stress from DO as well as eutrophication.

Figure 122. Continuous DO monitoring results at site 14DM040 in Unnamed Creek (-618).



The HSPF model calculated daily minimum DO values for this subwatershed from 1994-2014. Of these calculations, 1270 (16.56%) of the days had a daily minimum DO level below the daily minimum standard of 5 mg/L.

Table 269. DO related fish metrics in Unnamed Creek (-618). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-618 Fish Class 3 – General Use	MA>3 Avg	SspnPct Avg	Taxa Count Avg	DO TIV Avg
14DM040	0.00	3.24	3.00	7.15
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	13.32	17.09	12.16	8.44
Expected response to DO stress	↓	↑	↓	↓

The fish community in Unnamed Creek (-618) at site 14DM040 scored below average in three of the four DO related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 269). This reach lacked mature fish greater than three years had a low overall taxa count, and a poor DO TIV score. These results are commonly found in streams with DO issues.

Table 270. DO related macroinvertebrate metrics in Unnamed Creek (-618). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-618 Macroinvertebrate Class 7 – General Use	HBI_MN Value	% DO Tolerant Taxa	# DO Tolerant Taxa	ChemTV DO
14DM040	8.51	7.02	7.00	6.57
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	7.55	12.98	5.74	6.91
Expected response to DO stress	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in three of the four DO related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 270). Site 14DM040 had poor HBI_MN and DO TIV scores, while also having an increased amount of DO tolerant taxa. These results are commonly found in streams with DO issues.

Based on the high frequency that the daily minimum DO levels fell below 5 mg/L during the continuous DO monitoring, the high DO flux values that exceeded the standard, the low DO data calculated by the HSPF model, as well as the majority of the fish and macroinvertebrate metrics related to DO scoring poorly, DO is a stressor to aquatic life in Unnamed Creek (-618).

Eutrophication

A total of 11 phosphorus samples were taken from one chemistry site (S009-146) and one biological monitoring station (14DM040) from 2015-2016. The average of all the values is 0.105 mg/L with a low of 0.04 mg/L and a high of 0.30 mg/L. The summer average (June-Aug) is 0.122 mg/L. Phosphorus values exceeded the standard of 0.150 mg/L once.

Table 271. Eutrophication related fish metrics in Unnamed Creek (-618). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-618 Fish Class 3 – General Use	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct
14DM040	0.00	0.00	100.00	3.24
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	8.9	12.11	70.79	14.71
Expected response to Eutrophication stress	↓	↓	↑	↑

The fish community in Unnamed Creek (-618) at site 14DM040 scored below average in three of the four eutrophication related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 271). This reach had zero sensitive and darter individuals, while also having a fish assemblage consisting of 100% tolerant fish species. These results are likely to be found in streams with eutrophication issues.

Table 272. Eutrophication related macroinvertebrate metrics in Unnamed Creek (-618). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-618 Macroinvertebrate Class 7 – General Use	EPT Pct	Tanytarsini Pct	CrustMoll Pct	Scraper Pct	% Tolerant Taxa	% Intolerant Taxa
14DM040	0.00	2.38	80.00	50.53	35.79	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	38.45	18.46	11.78	16.11	26.84	4.03
Expected response to Eutrophication stress	↓	↓	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in all six of the eutrophication related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 272). Site 14DM040 had a very high amount of crustacea/mollusca individuals present, as well as phosphorus tolerant taxa, these results are often found in streams being negatively impacted by eutrophic conditions. The complete lack of EPT individuals also is a strong indicator of eutrophication stress.

The phosphorus levels in Unnamed Creek (-618) do at times exceed the 0.15 mg/L standard, the DO flux values in this reach also frequently exceeded the 4.5 mg/L daily standard which often indicates eutrophic conditions. The eutrophication related metrics in both the fish and macroinvertebrate communities scored poorly in this reach as well, therefore, based on this information eutrophication is a stressor to aquatic life.

Nitrates

There were 12 samples taken from one chemistry site (S009-146) and one biological monitoring station (14DM040) from 2014-2016 were analyzed for Inorganic Nitrogen (NO₂-NO₃). The average of all the values is 9.44 mg/L with a low of 0.41 mg/L and a high of 19.00 mg/L. The spring average (March-May) is 19.00 mg/L. The summer average (June-Aug) is 7.66 mg/L. Nitrate values exceeded 4 mg/L seven times.

A quantile regression analysis for Class 7 stream stations showed that sites having a nitrate concentration in excess of 11.5 mg/L there was a 90% probability for impairment. The nitrate concentrations in this reach easily exceeded this level.

The HSPF model calculated daily nitrate concentrations for this subwatershed from 1994-2014. These values ranged from 1.16-174.06 mg/L with an average value of 7.66 mg/L. Of these calculations, 1296 (24.6%) were above 11.5 mg/L.

Table 273. Related macroinvertebrate metrics in Unnamed Creek (-618). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-618 Macroinvertebrate Class 7 – General Use	TrichopteraChTx Pct	N Index Score	% N Tolerant	% N Intolerant
14DM040	0.00	7.66	94.39	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	10.00	3.30	57.57	0.91
Expected response to N stress	↓	↑	↑	↓

The macroinvertebrate assemblage at site 14DM040 in Unnamed Creek (-618) scored below average in all four of the nitrate related metrics when compared to all other Class 7 Prairie Streams GP stations that met the MIBI General Use Threshold (Table 273). This site completely lacked trichoptera and nitrate intolerant species, while also having a high amount of nitrate tolerant taxa and a very poor nitrate index score. These results strongly suggest that nitrates are a stressor.

Based on the elevated nitrate concentrations in both the observed and calculated results, the quantile regression analysis, as well as the strong signal from the macroinvertebrate metrics related to nitrates, nitrates are a stressor to aquatic life in Unnamed Creek (-618).

Suspended Solids

Ten samples taken from one chemistry site (S009-146) in 2016 were analyzed for TSS. The average of all the values is 10.2 mg/L with a low of 2.4 mg/L and a high of 33 mg/L. The TSS concentrations did not exceed the 65 mg/L standard.

Additionally, nine secchi tube measurements were taken from this reach. These values ranged from 36-100 cm, with no values falling below the 10 cm minimum standard for secchi tube.

The HSPF model calculated daily TSS values for this subwatershed from 1994-2014. These concentrations ranged from 1.76-986.43 mg/L with an average TSS value of 13.97 mg/L. Of these calculations, 134 (2.54%) were above the TSS standard.

Table 274. TSS related fish metrics in Unnamed Creek (-618). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-618 Fish Class 3 – General Use	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RifflePct	SensitivePct	SlithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14DM040	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.69
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	37.83	0.90	13.33	13.93	28.33	8.55	33.71	1.95	3.56	15.27
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

The fish community in Unnamed Creek (-618) at site 14DM040 scored below average in nine of the ten TSS related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 274). This reach did have a good TSS Index score, which is not common in streams potentially stressed by excessive TSS concentrations.

Table 275. TSS related macroinvertebrate metrics in Unnamed Creek (-618). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-618 Macroinvertebrate Class 7 – General Use	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plectoptera Pct
14DM040	23.76	0.00	8.00	81.40	1.75	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (22.0)</i>	17.35	1.33	13.20	48.28	19.13	0.22
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

The macroinvertebrate community in this reach scored below average in five of the six TSS related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 275). This reach did have a lower amount of TSS tolerant taxa, but the remaining metrics scored poorly. Site 14DM040 had an especially high amounts of TSS tolerant individuals present and the TSS Index score was well below average.

The observed and modeling data sets both indicate that the TSS concentrations in this reach are low and remain low. It is likely that other stressors are causing the fish and macroinvertebrate communities to score poorly as the chemical and model data give no indication of potential stress. Therefore, TSS is not a stressor to aquatic life in Unnamed Creek (-618) at this time.

Habitat

Unnamed Creek (-618) had a qualitative habitat assessment take place at its biological monitoring site, 14DM032, during the fish and macroinvertebrate sampling events in 2014 and 2015. The average MSHA score from these visits was 42.98 (Poor). Limiting the habitat at this site was row crop agriculture as the dominant nearby land use, light stream shading, severe embeddedness, sand and silt substrates, sparse fish cover, very little depth variability, and fair channel development. Further MSHA analysis can be seen in Figure 123.

Figure 123. Unnamed Creek (-618) MSHA metric scores.

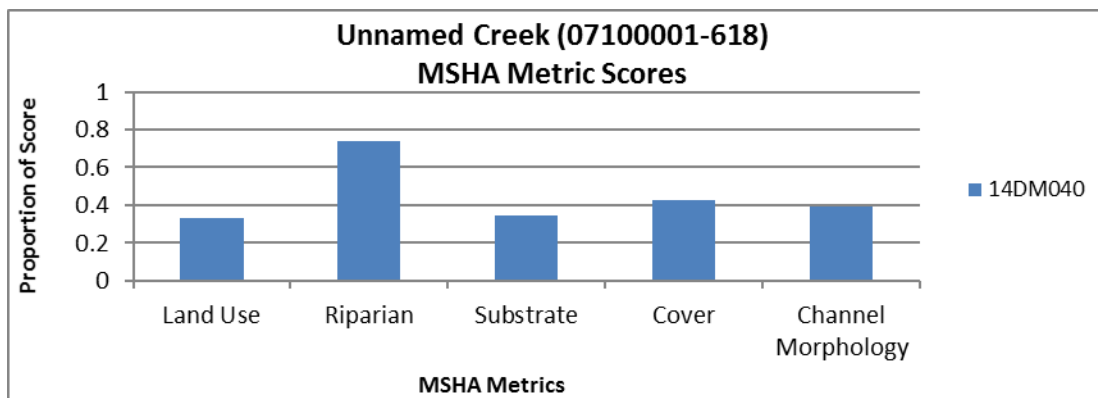


Table 276. Habitat related fish metrics in Unnamed Creek (-618). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-618 Fish Class 3 – General Use	BenInsect- ToIPct	SLithopPct	DarterSculpSuc Pct	RifflePct	PiscivorePct	LithFrimPct	ToIPct	PioneerPct
14DM040	0.00	0.00	0.00	0.00	0.00	51.50	100.00	53.12
Statewide average for Class 3 Southern Headwaters stations that are meeting the FBI General Use Threshold (55.0)	14.22	33.71	12.55	28.33	1.62	69.21	70.64	37.79
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

The fish community in Unnamed Creek (-618) at site 14DM040 scored below average in all eight of the habitat related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FBI General Use Threshold (Table 276). Only three species were sampled (brook stickleback, fathead minnow, and creek chub) in this reach and all three are very tolerant of poor habitat conditions. The

complete lack of species requiring specialized habitat to live and reproduce is a signal of the poor habitat conditions present.

Table 277. Habitat related macroinvertebrate metrics in Unnamed Creek (-618). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-618 Macroinvertebrate Class 7 – General Use	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14DM040	3.86	60.70	0.70	0.00	69.82	29.47
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)</i>	5.40	20.35	36.94	37.77	37.96	19.49
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate assemblage in this reach scored below average in three of the six habitat related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 277). This reach had a high number of legless individuals, while also having very low amounts of clinger and EPT individuals. These results are often found in streams with poor habitat conditions.

Based on the poor MSHA score, as well as the majority of the habitat related metrics in the biotic communities (especially fish) scoring below average or very poorly, habitat is a stressor to aquatic life in Unnamed Creek (-618).

Altered Hydrology

Unnamed Creek (-618) is a tributary of Jack Creek. It is an almost entirely natural channel though directly downstream a sediment basin and impoundment creates a fish barrier. Roughly, half of the upstream watershed is altered according to the MPCA altered watercourse layer.

“Riffle cross section measurements identified that the BHR was 2.12 and entrenchment ratio was 1.37. These ratios indicate that the channel at the study location is both entrenched and deeply incised. Flood-prone elevations are roughly 1 foot lower than the top of the low bank height and means that flood flows (i.e. two times bankfull max depth at the riffle) cannot access the rivers floodplain. The confinement of flood flows within the channel is a leading factor as to why the channel is in such poor shape” (DNR 2016).

Extreme weather events affect high flow events as well as also low flows during drought. HSPF models show this stream section experiencing low flow at less than five cfs 71.4% of the time and less than one cfs 23.6% of the time.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The average percentage for generalist fish within the reach was 53.1% compared to the average in Class 3 general use waters meeting the standard of 59.1%. Generalist fish populations ranged from 6.2-100%.

The numbers of nest guarder species are also positively correlated with increased low flows. The average percentage for nest guarder fish within the reach was 48.5% compared to the average in Class 3 general use waters meeting the standard of 19.2%. Nest guarder fish species ranged from 0-97%.

Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The percentage for long-lived macroinvertebrates within the reach was 28.8%

compared to the average in Class 7 general use waters meeting the standard of 8%. Long-lived macroinvertebrates ranged from 28.0-28.0%.

Unnamed Creek (-618) has a downstream fish barrier, lacks floodplain access, has frequent low flow conditions, however, many of the related biological metrics score above average when compared to similar streams that reach the respective class threshold. Flow Alteration/Connectivity may be having further downstream impacts in this watershed; however, the localized effects in this reach are currently inconclusive.

Summary

The impaired fish and macroinvertebrate communities in Unnamed Creek (-618) are being stressed by DO, Eutrophication, Nitrates, and Habitat (Table 278). Flow Alteration/Connectivity was inconclusive as a stressor at this time, while Suspended Sediment was ruled out as a stressor to aquatic life. For further information on the stressors and recommendations to fixing the stressors in the Jack HUC 10 Watershed, please see pages 268-269.

Table 278. Stressor determinations in Unnamed Creek (-618).

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Unnamed Creek	07100001-618	●	●	●	---	●	o

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Jack Creek, North Branch (07100001-652)

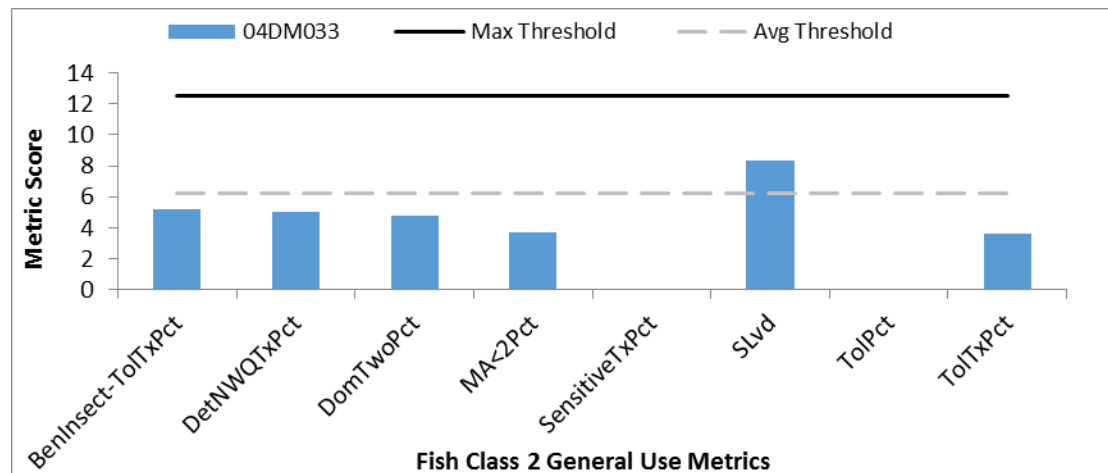
Located in northeastern Nobles County, North Branch Jack Creek (-652) is a 7.12 mile long reach that is impaired for aquatic life due to the fish assemblage. This stream reach extends from Judicial Ditch 12 down to the confluence with Jack Creek. Along this stream section there is one biological monitoring station, 04DM033.

Biology

Fish

The fish community in North Branch Jack Creek (-652) was sampled for fish in August of 2004 and 2014 at its biological monitoring station 04DM033. The average FIBI score at this reach was 30.7, which is far below the Fish Class 2 Southern Streams General Use Threshold of 50. This site did have one metric (SLvd) reach the average metric score needed to meet the threshold (Figure 124), however, the remaining seven metrics comprising this FIBI scored well below average with two metrics scoring zero (SensitiveTxPct, TolPct).

Figure 124. North Branch Jack Creek (-652) fish IBI metric scores.



Dissolved Oxygen

A total of 22 DO measurements were taken from one chemistry site (S007-890) and one biological monitoring station (04DM033) from 2004-2015. The average of all the values is 8.44 mg/L with a low of 5.6 mg/L and a high of 14.69 mg/L. The summer average (June-Aug) is 8.11 mg/L. The DO values did not fall below 5 mg/L.

The HSPF model calculated daily minimum DO values for this subwatershed from 1994-2014. Of these calculations, 3445 (64.67%) of the days had a daily minimum DO level below the daily minimum standard of 5 mg/L. This is a very high rate of exceedance for DO.

Table 279. DO related fish metrics in North Branch Jack Creek (-652). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-652 Fish Class 2 – General Use	MA>3 Avg	SspnPct Avg	Taxa Count Avg	DO TIV Avg
04DM033	17.41	23.11	12.5	8.38
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)</i>	23.89	28.72	20.38	8.56
Expected response to DO stress	↓	↑	↓	↓

The fish community in North Branch Jack Creek (-652) at site 04DM033 scored below average in three of the four DO related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 279). This reach had a below average amount of serial spawning individuals, but also had a low overall taxa count, few mature fish, and a poor DO TIV score. These results are often found in streams with DO issues.

Table 280. DO related macroinvertebrate metrics in North Branch Jack Creek (-652). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-652 Macroinvertebrate Class 7 – General Use	HBI_MN Value	% DO Tolerant Taxa	# DO Tolerant Taxa	ChemTV DO
04DM033	8.53	18.27	6.50	6.82
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	7.55	12.98	5.74	6.91
Expected response to DO stress	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in all four of the DO related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 280). The site, 04DM033, had an increased amount and percentage of DO tolerant taxa, while also having a poor HBI_MN and DO TIV score. These results are common in streams negatively impacted by DO conditions.

Both the modeled data set and the biological metrics strongly signal that DO is a stressor in this reach; however, the observed data did not have any standard exceedances in 22 measurements. Based on this conflicting information, DO is inconclusive as a stressor to aquatic life at this time in North Branch Jack Creek (-652). Further DO monitoring with a sonde is needed to better determine the impacts that DO is having on aquatic life in this reach.

Eutrophication

A total of 12 phosphorus samples were taken from one chemistry site (S007-890) from 2014-2015. The average of all the values is 0.160 mg/L with a low of 0.02 mg/L and a high of 0.46 mg/L. The summer average (June-Aug) is 0.216 mg/L. Phosphorus values exceeded the standard of 0.150 mg/L five times.

Additionally, the HSPF model calculated daily phosphorus concentrations for this subwatershed from 1994-2014. These values ranged from 0.04-1.73 mg/L with an average concentration of 0.28 mg/L. Of these calculations, 2358 (85.56%) were above the 0.15 mg/L standard.

Table 281. Eutrophication related fish metrics in North Branch Jack Creek (-652). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-652 Fish Class 2 – General Use	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct
04DM033 (2004)	0.00	5.02	92.83	58.42
04DM033 (2014)	0.00	14.58	82.64	18.06
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)</i>	19	11.47	45.1	17
Expected response to Eutrophication stress	↓	↓	↑	↑

The fish community in North Branch Jack Creek (-652) at site 04DM033 scored below average in three (2014) and all four (2004) of the eutrophication related metrics during the sampling visits and compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 281). Both visits had a very high amount of tolerant and omnivorous individuals, while also completely lacking sensitive species. The 2014 visit did have a slightly above average amount of darter individuals. Overall, the metric results signal a community likely stressed by eutrophic conditions.

Table 282. Eutrophication related macroinvertebrate metrics in North Branch Jack Creek (-652). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-652 Macroinvertebrate Class 7 – General Use	EPT Pct	Tanytarsini Pct	CrustMoll Pct	Scraper Pct	% Tolerant Taxa	% Intolerant Taxa
04DM033 (2004)	52.63	11.94	9.12	23.51	25.26	0.00
04DM033 (2014)	59.37	1.72	16.51	24.13	72.70	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	38.45	18.46	11.78	16.11	26.84	4.03
Expected response to Eutrophication stress	↓	↓	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in three (2004) and five (2014) of the six eutrophication related metrics during the visits when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 282). Both visits at this site showed decreased numbers of tanytarsini individuals, phosphorus intolerant taxa, while also having increased numbers of scraper individuals. The 2014 visit also had a very high amount of phosphorus tolerant taxa and increased numbers of crustacean/mollusca individuals. All of these results signal likely stress due to eutrophic conditions.

Based on the high amount of exceedances in the observed and modeled data sets, as well as the majority of the eutrophication related metrics in both the fish and macroinvertebrate communities scoring below average or poorly, eutrophication is a stressor to aquatic life in North Branch Jack Creek (-652).

Nitrates

There were 12 samples taken from one chemistry site (S007-890) from 2014-2015 analyzed for Inorganic Nitrogen (NO₂-NO₃). The average of all the values is 5.18 mg/L with a low of 0.20 mg/L and a high of 13.00 mg/L. The spring average (March-May) is 3.77 mg/L. The summer average (June-Aug) is 7.20 mg/L. Nitrate values exceeded 4 mg/L six times. A quantile regression analysis for Class 7 stream stations showed that sites having a nitrate concentration in excess of 11.5 mg/L there was a 90% probability for impairment. The nitrate concentrations in this reach exceeded this level.

The HSPF model calculated daily nitrate concentrations for this subwatershed from 1994-2014. These values ranged from 0.44-20.62 mg/L with an average value of 7.46 mg/L. Of these calculations, 538 (19.52%) were above 11.5 mg/L.

Drain tiles were noted as being present along this reach. Drain tiles are a common pathway for nitrates to enter a stream system.

Table 283. Nitrate related macroinvertebrate metrics in North Branch Jack Creek (-652). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-652 Macroinvertebrate Class 7 – General Use	TrichopteraChTx Pct	N Index Score	% N Tolerant	% N Intolerant
04DM033 (2014)	8.70	3.33	86.67	0.00
04DM033 (2004)	7.89	4.80	50.53	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	10.00	3.30	57.57	0.91
Expected response to N stress	↓	↑	↑	↓

The macroinvertebrate assemblage in North Branch Jack Creek (-652) scored below average in three (04DM033-2004) and four (04DM033-2014) of the four nitrate related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 283). Both visits had low numbers of trichoptera and nitrate intolerant taxa, while also having below average nitrate index scores. The 2014 visit at site 04DM033 also had a high amount of nitrate tolerant individuals.

Based on the sometimes elevated observed and calculated nitrate concentrations, the presence of drain tiles, the quantile regression analysis as well as vast majority of the nitrate related macroinvertebrate metrics scoring below average at the two site visits, nitrates are a stressor to aquatic life in this reach.

Suspended Solids

Twelve samples taken from one chemistry site (S007-890) in 2016 were analyzed for TSS. The average of all the values is 50.25 mg/L with a low of 3 mg/L and a high of 230 mg/L. The TSS concentrations exceeded the 65 mg/L standard twice.

Additionally, 19 secchi tube measurements were taken from this reach. These values ranged from 6-38 cm, with three measurements falling below the 10 cm minimum standard for secchi tube.

The HSPF model calculated daily TSS values for this subwatershed from 1994-2014. These concentrations ranged from 5.30-1492.31 mg/L with an average TSS value of 48.25 mg/L. Of these calculations, 414 (15.02%) were above the TSS standard of 65 mg/L. This is a high exceedance rate.

This reach was determined to be impaired for turbidity during the 2006 assessment. This impairment was confirmed during the 2016 assessment as well.

Table 284. TSS related fish metrics in North Branch Jack Creek (-652). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-652 Fish Class 2 – General Use	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RifflePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
04DM033	28.93	0.00	4.36	9.98	21.58	0.00	21.07	0.00	3.37	18.07
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)</i>	37.38	4.89	9.61	18.66	32.49	18.65	39.38	4.97	11.68	17.59
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

The fish community in North Branch Jack Creek (-652) at site 04DM033 scored below average in all 10 of the TSS related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 284). This site lacked many species tolerant to elevated TSS concentrations and reflects an assemblage likely being stressed by elevated TSS levels.

Table 285. TSS related macroinvertebrate metrics in North Branch Jack Creek (-652). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-652 Macroinvertebrate Class 7 – General Use	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plectoptera Pct
04DM033	21.86	0.00	15.00	63.63	9.77	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (22.0)</i>	17.35	1.33	13.20	48.28	19.13	0.22
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

The macroinvertebrate assemblage in this reach scored below average in all six of the TSS related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 285). This reach had a poor TSS Index score, while also having an elevated presence of TSS tolerant taxa and individuals. These results strongly suggest that TSS is a stressor.

The observed data sets did show some standard exceedances, while the HSPF model calculated a fairly high standard exceedance rate. Both the fish and macroinvertebrate communities scored poorly in all of the TSS related metrics. In addition, this reach is currently designated as impaired for turbidity. Based on this information, TSS is a stressor to aquatic life in North Branch Jack Creek (-652).

Habitat

North Branch Jack Creek (-652) had a qualitative habitat assessment take place at its biological monitoring site, 04DM033, during the fish and macroinvertebrate sampling events in 2004 and 2014. The average MSHA score from these visits was 48.97(Fair). Limiting the habitat at this site was the row crop agriculture as the dominant nearby land use, a moderate riparian buffer, light stream shading, and the presence of silt and sand substrates, light embeddedness, moderate channel stability, and fair channel development. Further MSHA analysis can be seen in Figure 125.

Figure 125. North Branch Jack Creek (-652) MSHA metric scores.

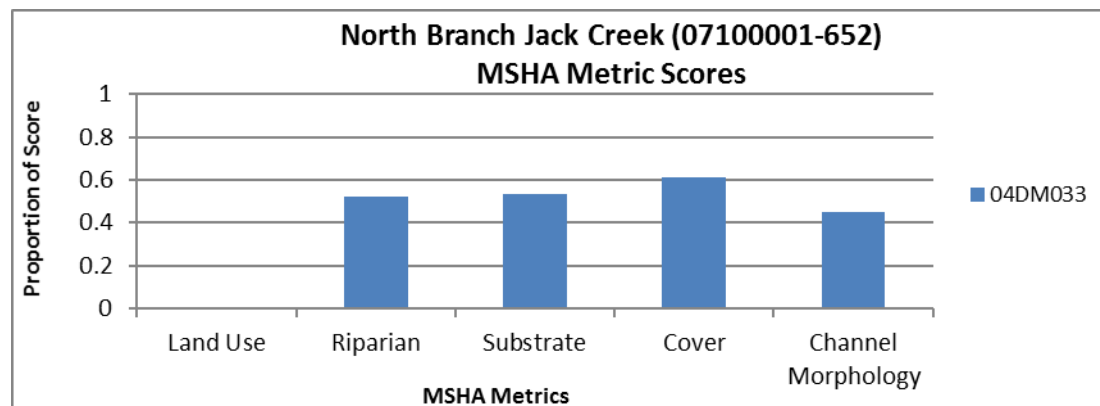


Table 286. Habitat related fish metrics in North Branch Jack Creek (-652). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-652 Fish Class 2 – General Use	BenInsect-TolPct	SLithopPct	DarterSculpSu cPct	RifflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
04DM033	9.80	21.07	9.80	21.58	0.54	64.57	87.74	67.99
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)</i>	20.4	39.38	18.18	32.49	5.24	58.26	44.85	19.02
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

The fish community in North Branch Jack Creek (-652) at site 04DM033 scored below average in seven of the eight habitat related metrics when compared to all other Southern Streams stations that meet the FIBI General Use Threshold (Table 286). Like many streams in this watershed, the fish community was dominated by both tolerant and pioneering species, which are frequently found in streams with poor habitat conditions. This stream also had lower amounts of species requiring specialized habitats for living and reproducing.

Table 287. Habitat related macroinvertebrate metrics in North Branch Jack Creek (-652). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-652 Macroinvertebrate Class 7 – General Use	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
04DM033	12.94	26.60	29.18	56.00	33.21	19.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)</i>	5.40	20.35	36.94	37.77	37.96	19.49
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate assemblage in this reach scored below average in three of the six habitat related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 287). This stream reach had below average amounts of both clinger and sprawler individuals, while having an increased amount of burrower individuals. The higher amount of burrower individuals may be related to the sand and silt substrates found in this reach. Site 04DM033 did have above average numbers of climber and EPT individuals, while also having a below average amount of legless individuals. These results are not typical in streams with poor habitat conditions.

Site 04DM033 had a fair MSHA score, while the macroinvertebrate metrics related to habitat had mixed results, however, the fish community in this reach had habitat related metrics score very poorly, therefore, habitat is a stressor to aquatic life in North Branch Jack Creek (-652).

Altered Hydrology

North Branch Jack Creek (-652) and the majority of its upstream watershed are altered according to the MPCA altered watercourse layer.

“Riffle cross section measurements identified that the BHR was 2.12 and entrenchment ratio was 1.37. These ratios indicate that the channel at the study location is both entrenched and deeply incised.

Flood-prone elevations are roughly 1 foot lower than the top of the low bank height and means that flood flows (i.e. 2 times bankfull max depth at the riffle) cannot access the rivers floodplain. The confinement of flood flows within the channel is a leading factor as to why the channel is in such poor shape” (DNR 2016).

Extreme weather events affect high flow events as well as also low flows during drought. HSPF models show this stream section experiencing low flow at less than five cfs 27.6% of the time and less than one cfs 3.6% of the time.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The average percentage for generalist fish within the reach was 82.8% compared to the average in Class 2 general use waters meeting the standard of 42.4%. General fish populations ranged from 77.8-87.8%.

The numbers of nest guarder species are also positively correlated with increased low flows. The average percentage for nest guarder fish within the reach was 29.4% compared to the average in Class 2 general use waters meeting the standard of 19%. Nest Guarder populations ranged from 22.9-35.8%.

Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The average percentage for long-lived macroinvertebrates within the reach was 1.8% compared to the average in Class 7 general use waters meeting the standard of 8%. Long-lived macroinvertebrate populations ranged from 1.8-1.8%.

Based on the current channelization in this reach and the reaches upstream, the lack of floodplain access, as well as the poor scoring biological metrics, Flow Alteration/Connectivity is a stressor to aquatic life in North Branch Jack Creek (-652).

Summary

The impaired fish community in North Branch Jack Creek (-652) is being stressed by Eutrophication, Nitrates, Suspended Sediment, Habitat and Flow Alteration/Connectivity (Table 288). DO, was inconclusive as a stressor at this time. For further information on the stressors and recommendations to fixing the stressors in the Jack HUC 10 Watershed, please see pages 268-269.

Table 288. Stressor determinations for North Branch Jack Creek (-652).

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
North Branch Jack Creek	07100001-652	o	●	●	●	●	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Judicial Ditch 12 (07100001-666)

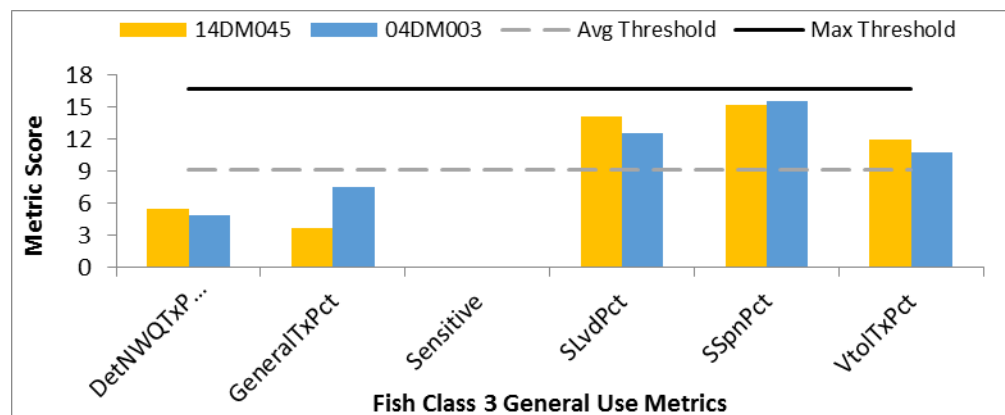
Located in northwestern Nobles County, Judicial Ditch 12 (-666) is a 4.03 mile long reach that is impaired for aquatic life due to the fish and macroinvertebrate assemblages. This stream reach extends from CSAH 18 down to the confluence with North Branch Jack Creek. Along this stream section, there are two biological monitoring stations, 04DM003 and 14DM045.

Biology

Fish

The fish community in Judicial Ditch 12 (-666) was sampled for fish in July and August of 2004 at its biological monitoring station 04DM003 and in July of 2015 at site 14DM045. Site 04DM003 had an average FIBI score of 51.4, while site 14DM045 had a FIBI score of 50.6. Both of these scores are below the Fish Class 3 Southern Headwaters General Use Threshold of 55. These sites had three metrics (SLvd, SSpnPct, VtoITxPct) reach the average metric score needed to meet the threshold (Figure 126), however, the remaining three metrics comprising this FIBI scored well below average with one of the metrics (Sensitive) scoring zero.

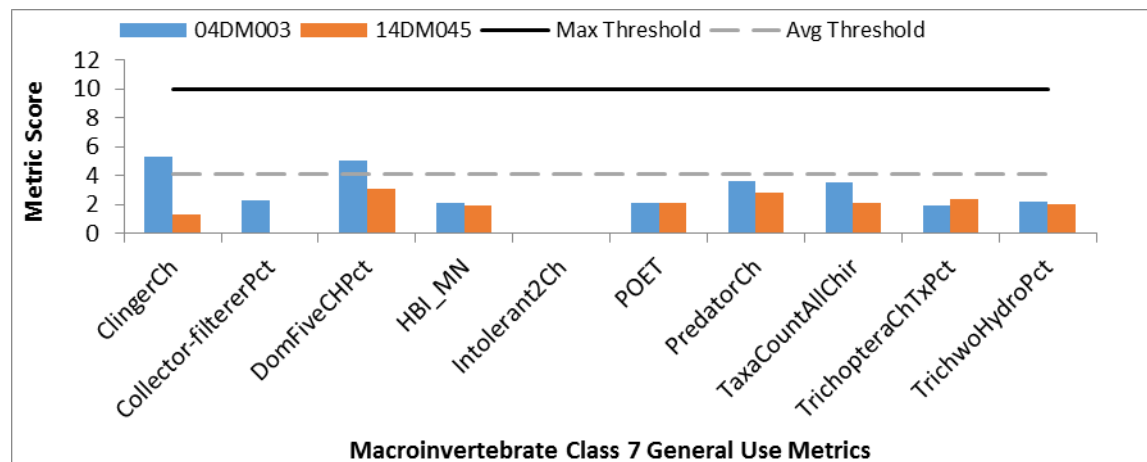
Figure 126. Judicial Ditch 12 (-666) fish IBI metric scores.



Macroinvertebrates:

The macroinvertebrate assemblage at site 04DM003 was sampled in August and September of 2004 and had an average MIBI score of 27.2. Site 14DM045 was sampled in August of 2014 and had a MIBI score of 17.8. Both of these scores are below the Macroinvertebrate Class 7 Prairie Streams GP General Use Threshold of 41. Site 04DM003 had two metrics score above the average needed to reach the threshold (ClingerCh, DomFiveCHPct). However, the remaining eight metrics scored below average, with one of these metrics scoring zero. Site 14DM045 had zero metrics score above the average needed to reach the threshold. See Figure 127 for a complete breakdown of the metric scores at this site.

Figure 127. Judicial Ditch 12 (-666) macroinvertebrate IBI metric scores.



Dissolved Oxygen

A total of 13 DO measurements were taken from one chemistry site (S009-045) and two biological monitoring stations (04DM003, 14DM045) from 2004-2016. The average of all the values is 6.93 mg/L

with a low of 3.79 mg/L and a high of 11.25 mg/L. The summer average (June-Aug) is 6.31 mg/L. The DO values fell below 5 mg/L three times.

The HSPF model calculated daily minimum DO values for this subwatershed from 1994-2014. Of these calculations, 1,995 (39.89%) of the days had a daily minimum DO level below the daily minimum standard of 5 mg/L. This is a very high exceedance rate for DO.

Table 289. DO related fish metrics in Judicial Ditch 12 (-666). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-666 Fish Class 3 – General Use	MA>3 Avg	SspnPct Avg	Taxa Count Avg	DO TIV Avg
04DM003	1.93	5.04	7.00	8.21
14DM045	4.40	6.92	6.00	8.19
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	13.32	17.09	12.16	8.44
Expected response to DO stress	↓	↑	↓	↓

The fish community in Judicial Ditch 12 (-666) at sites 04DM003 and 14DM045 scored below average in three of the four DO related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 289). This reach had low taxa counts, few mature fish, and poor DO TIV scores. These results are often found in streams with poor DO conditions.

Table 290. DO related macroinvertebrate metrics in Judicial Ditch 12 (-666). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-666 Macroinvertebrate Class 7 – General Use	HBI_MN Value	% DO Tolerant Taxa	# DO Tolerant Taxa	ChemTV_DO
04DM003	8.35	11.73	6.00	6.16
14DM045	8.29	8.83	7.00	6.11
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	7.55	12.98	5.74	6.91
Expected response to DO stress	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in three of the four DO related metrics at both sites when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 290). These sites had an increased amount of DO tolerant taxa, while also having poor HBI_MN and DO TIV scores. These results are common for a community stressed by DO conditions.

The observed and modeled data sets had both high exceedance rates of the DO standard of 5 mg/L. The majority of the DO related metrics in both the fish and macroinvertebrate communities at both sites scored below average. Additionally, high phosphorus was present in this stream, which could lead to potential issues with daily flux. Based on this information, DO is a stressor to aquatic life in Judicial Ditch 12 (-666).

Eutrophication

A total of 13 phosphorus samples were taken from one chemistry site (S009-045) and two biological monitoring stations (04DM003, 14DM045) from 2004-2016. The average of all the values is 0.143 mg/L with a low of 0.04 mg/L and a high of 0.32 mg/L. The summer average (June-Aug) is 0.149 mg/L. Phosphorus values exceeded the standard of 0.150 mg/L seven times.

The HSPF model calculated daily phosphorus values for this subwatershed from 1994-2014. These values ranged from 0.16-1.76 mg/L with an average value of 0.42 mg/L. All of these calculations were above the 0.15 mg/L standard.

Table 291. Eutrophication related fish metrics in Judicial Ditch 12 (-666). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-666 Fish Class 3 – General Use	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct
04DM003	0.00	2.66	93.67	2.66
14DM045	0.00	4.09	95.91	31.85
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	8.9	12.11	70.79	14.71
Expected response to Eutrophication stress	↓	↓	↑	↑

The fish community in Judicial Ditch 12 (-666) at sites 04DM003 and 14DM045 scored below average in three (04DM003) and all four (14DM045) of the metrics related to eutrophication when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 291). All three of these sites had very high numbers of tolerant individuals, while also having decreased numbers of darter and sensitive individuals. Site 14DM045 also had an increased number of omnivorous individuals. These results are common in streams negatively impacted by eutrophication.

Table 292. Eutrophication related macroinvertebrate metrics in Judicial Ditch 12 (-666). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-666 Macroinvertebrate Class 7 – General Use	EPT Pct	Tanytarsini Pct	CrustMoll Pct	Scraper Pct	% Tolerant Taxa	% Intolerant Taxa
04DM003	31.58	25.06	18.95	42.60	21.91	0.00
14DM045	5.05	10.81	56.78	42.59	28.39	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	38.45	18.46	11.78	16.11	26.84	4.03
Expected response to Eutrophication stress	↓	↓	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in four (04DM003) and six (14DM045) of the six eutrophication related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 292). Both sites had lower levels of EPT individuals (especially 14DM045), while also lacking phosphorus intolerant species altogether. These sites also had increased number of crustacean/mollusca and scraper individuals, which are more commonly found in streams with eutrophic conditions.

Based on the high number of exceedances in the observed and modeled data sets, as well as the majority of the eutrophication related metrics scoring poorly at both sites for fish and macroinvertebrates, eutrophication is a stressor to aquatic life in Judicial Ditch 12 (-666).

Nitrates

There were 13 samples taken from one chemistry site (S009-045) and two biological monitoring stations (04DM003, 14DM045) from 2004-2016 were analyzed for Inorganic Nitrogen (NO₂-NO₃). The average of all the values is 12.87 mg/L with a low of 1.50 mg/L and a high of 22.00 mg/L. The spring average (March-May) is 11.63 mg/L. The summer average (June-Aug) is 0.149 mg/L. Nitrate values exceeded 4 mg/L eight times. A quantile regression analysis for Class 7 stream stations showed that sites having a nitrate concentration in excess of 11.5 mg/L there was a 90% probability for impairment. The nitrate concentrations in this reach easily exceeded this level.

The HSPF model calculated daily nitrate concentrations for this subwatershed from 1994-2014. These values ranged from 1.6-27.07 mg/L with an average value of 9.87 mg/L. Of these calculations, 682 (37.15%) were above 11.5 mg/L.

Table 293. Nitrate related macroinvertebrate metrics in Judicial Ditch 12 (-666). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-666 Macroinvertebrate Class 7 – General Use	TrichopteraChTx Pct	N Index Score	% N Tolerant	% N Intolerant
04DM003	1.62	3.71	79.3	0.00
14DM045	3.85	6.43	83.28	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	10.00	3.30	57.57	0.91
Expected response to N stress	↓	↑	↑	↓

The macroinvertebrate assemblage in Judicial Ditch 12 (-666) scored below average in all four of the nitrate related metrics at both sites, 04DM003 and 14DM045, when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 293). Both of these sites had very few or completely lacked trichoptera and nitrate intolerant taxa while also having high amounts of nitrate tolerant individuals and poor (especially 14DM045) nitrate index scores. These results strongly signal nitrate stress.

Based on both the elevated nitrate concentrations in the observed and calculated results, the quantile regression analysis, as well as the strong signals from the macroinvertebrate data based on the poor scoring nitrate related metrics, nitrates are a stressor to aquatic life in Judicial Ditch 12 (-666).

Suspended Solids

Nine samples taken from one chemistry site (S009-045) in 2016 were analyzed for TSS. The average of all the values is 17.93 mg/L with a low of 6.4 mg/L and a high of 46 mg/L. The TSS concentrations did not exceed the 65 mg/L standard.

Additionally, 10 secchi tube measurements were taken from this reach. These values ranged from 11-70 cm, with no values falling below the 10 cm minimum standard for secchi tube.

The HSPF model calculated daily TSS values for this subwatershed from 1994-2014. These concentrations ranged from 1.96-693.52 mg/L with an average TSS value of 30.28 mg/L. Of these calculations, 81 (4.41%) were above the TSS standard of 65 mg/L.

Table 294. TSS related fish metrics in Judicial Ditch 12 (-666). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-666 Fish Class 3 – General Use	BenFdrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RifflePct	SensitivePct	SlithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
04DM003	9.17	0.00	4.59	2.66	6.51	0.00	5.60	0.00	0.00	16.01
14DM045	6.29	0.00	0.00	4.09	2.20	0.00	2.52	0.00	0.00	16.25
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	37.83	0.90	13.33	13.93	28.33	8.55	33.71	1.95	3.56	15.27
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

The fish community in Judicial Ditch 12 (-666) at sites 04DM003 and 14DM045 scored below average in all then of the TSS related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 294). Both sites had poor TSS Index scores while also lacking fish species that may be sensitive to higher concentrations of TSS. These results are often found in streams with high levels of TSS.

Table 295. TSS related macroinvertebrate metrics in Judicial Ditch 12 (-666). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-666 Macroinvertebrate Class 7 – General Use	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
04DM003	15.57	0.00	7.50	49.36	10.73	0.00
14DM045	21.24	0.00	9.00	71.29	0.00	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (22.0)</i>	17.35	1.33	13.20	48.28	19.13	0.22
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

The macroinvertebrate assemblage in this reach scored below average in four (04DM003) and five (14DM045) of the six TSS related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 294). Both sites had higher numbers of TSS tolerant individuals, few TSS intolerant taxa, collector-filterer, and plecoptera individuals. Site 04DM003 did have a good TSS Index score, which is not common in streams negatively impacted by elevated TSS conditions.

The observed and modeling data sets both indicate that the TSS concentrations in this reach are low and remain low. It is likely that other stressors are causing the fish and macroinvertebrate communities to score poorly as the chemical and model data give no indication of potential stress. Therefore, TSS is not a stressor to aquatic life in Unnamed Creek (-618) at this time.

Habitat

Judicial Ditch 12 (-666) had qualitative habitat assessments take place at its biological monitoring sites, 04DM003 and 14DM045, during the fish and macroinvertebrate sampling events in 2004, 2014, and 2015. The average MSHA scores from these visits were 44.25 (Poor) at 04DM003 and 37.45 (Poor) at 14DM045. Limiting the habitat at these sites was the row crop agriculture as a nearby land use (Figure 128), a narrow riparian buffer (14DM045), light stream shading (14DM045), sand and silt substrates, no coarse substrates present, limited depth variability (14DM045), poor to fair channel development, and moderate channel stability. Further MSHA analysis can be seen in Figure 129.

Figure 128. Riparian area and land use at 14DM045.



Figure 129. Judicial Ditch 12 (-666) MSHA metric scores.

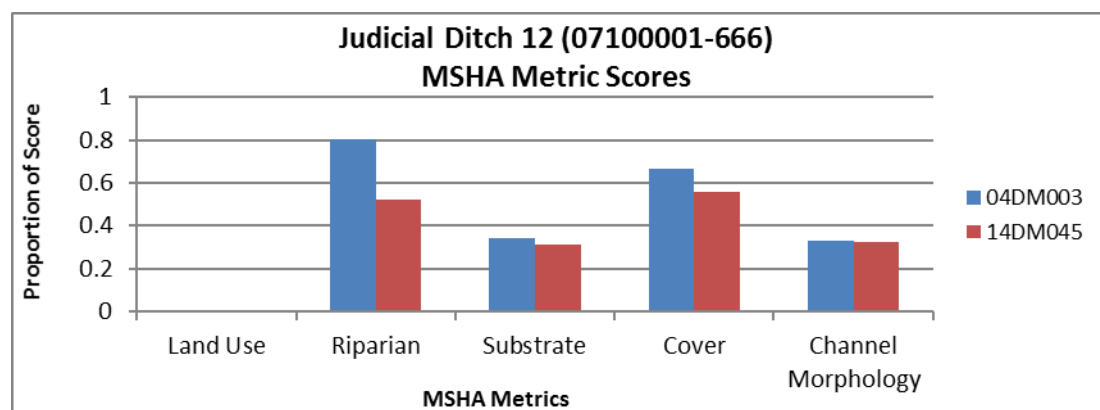


Table 296. Habitat related fish metrics in Judicial Ditch 12 (-666). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-666 Fish Class 3 – General Use	BenInsect-TolPct	SlithopPct	DarterSculpsucPct	RifflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
04DM003	2.66	5.60	2.66	6.51	0.00	72.69	93.66	70.20
14DM045	4.09	2.52	4.09	2.20	0.00	60.11	95.91	91.33
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	14.22	33.71	12.55	28.33	1.62	69.21	70.64	37.79
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

The fish community in Judicial Ditch 12 (-666) at sites 04DM003 and 14DM045 scored below average in seven (04DM003) and eight (14DM045) of the eight habitat related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 296). This stream reach was dominated by the high amount of tolerant and pioneer individuals, which is a strong signal of habitat stress. In addition, this reach lacked many species requiring specialized habitat conditions to live and reproduce.

Table 297. Habitat related macroinvertebrate metrics in Judicial Ditch 12 (-666). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-666 Macroinvertebrate Class 7 – General Use	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
04DM003	12.98	20.50	35.24	32.51	47.07	17.29
14DM045	6.31	58.68	6.31	5.05	74.13	22.08
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)</i>	5.40	20.35	36.94	37.77	37.96	19.49
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate assemblage in Judicial Ditch 12 (-666) scored below average in four (14DM045) and five (04DM003) of the six habitat related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 297). Both sites did have an above average amount of climber individuals, while site 14DM045 had a good amount of sprawler individuals as well. However, these sites also had lower levels of EPT and clinger individuals, while also having high numbers of both burrower and legless individuals. The high number of burrowers and legless individuals can be linked to the sand and silt substrates present in this reach.

Based on the poor scoring MSHA scores at both sites, as well as the majority of the habitat related metrics in both the fish and macroinvertebrate communities scoring poorly or below average, habitat is a stressor to aquatic life in Judicial Ditch 12 (-666).

Altered Hydrology

Judicial Ditch 12 (-666) is roughly half-altered and the majority of its upstream watershed is altered according to the MPCA altered watercourse layer.

“Riffle cross section measurements identified that the BHR was 2.12 and entrenchment ratio was 1.37. These ratios indicate that the channel at the study location is both entrenched and deeply incised. Flood-prone elevations are roughly 1 foot lower than the top of the low bank height and means that flood flows (i.e. 2 times bankfull max depth at the riffle) cannot access the rivers floodplain. The confinement of flood flows within the channel is a leading factor as to why the channel is in such poor shape” (DNR 2016).

Extreme weather events affect high flow events as well as also low flows during drought. HSPF models show this stream section experiencing low flow at less than five cfs 62.1% of the time and less than one cfs 17.7% of the time.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The average percentage for generalist fish within the reach was 81.5% compared to the average in Class 3 general use waters meeting the standard of 59.1%. General fish populations ranged from 59.5-95.2%.

The numbers of nest guarder species are also positively correlated with increased low flows. The average percentage for nest guarder fish within the reach was 33.6% compared to the average in Class 3 general use waters meeting the standard of 19.2%. Nest guarder populations ranged from 11.8-57.1%.

Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The average percentage for long-lived macroinvertebrates within the reach was 8.6%

compared to the average in Class 7 general use waters meeting the standard of 8%. Long-lived macroinvertebrate populations ranged from 1.1-16.1%.

Based on the partial channelization of this reach and corresponding effects on habitat/sediment, the majority of the related biological metrics scoring poorly, the lack of floodplain access, as well as the frequent low flow conditions, Flow Alteration/Connectivity is a stressor to aquatic life in Judicial Ditch 12 (-666).

Summary

The impaired fish and macroinvertebrate communities in Judicial Ditch 12 (-666) are being stressed by DO, Eutrophication, Nitrates, Habitat and Flow Alteration/Connectivity (Table 298). Suspended Sediment was inconclusive as a stressor at this time. For further information on the stressors and recommendations to fixing the stressors in the Jack HUC 10 Watershed, please see pages 268-269.

Table 298. Stressor determinations for Judicial Ditch 12 (-666).

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Judicial Ditch 12	07100001-666	●	●	●	---	●	●

● = stressor; ○ = inconclusive stressor; --- = not an identified stressor

Unnamed Creek (07100001-619)

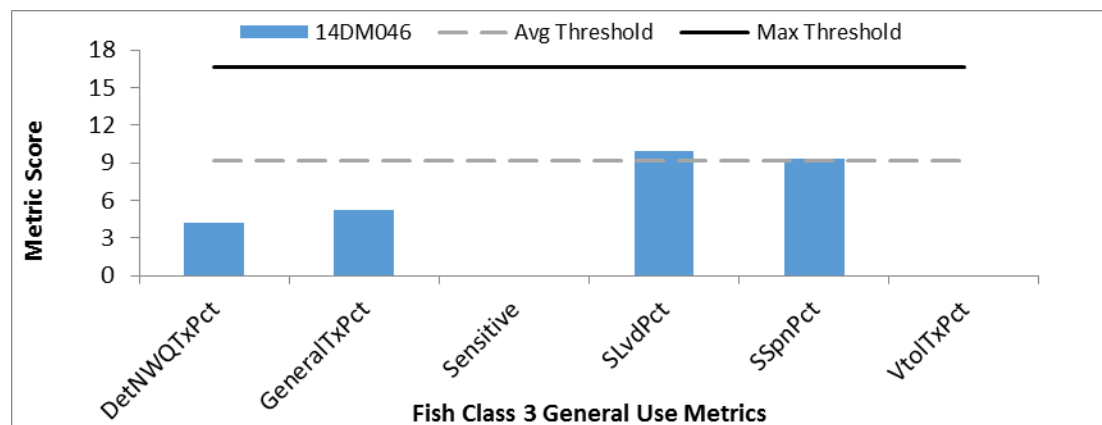
Located in southcentral Murray County, Unnamed Creek (-619) is a 1.65 mile long reach that is impaired for aquatic life due to the fish assemblage. This stream reach extends from an unnamed creek down to the confluence with Judicial Ditch 20. Along this stream section there is one biological monitoring station, 14DM046.

Biology

Fish

Unnamed Creek (-619) was sampled for fish in July of 2014 at its biological monitoring station, 14DM046. The FIBI score for this visit was 28.8, which is below the Fish Class 3 Southern Headwaters General Use Threshold of 55. This site had two of the six metrics score above the average needed to reach the threshold (SLvdPct, SSpnPct) (Figure 130), however this site had two metrics score zero (Sensitive, VtolTxPct) limiting the FIBI score. This stream reach was dominated by tolerant species as common carp (36) and fathead minnows (27) were by far the most common species sampled.

Figure 130. Unnamed Creek (-619) fish IBI metric scores.



Dissolved Oxygen

Eight dissolved oxygen (DO) measurements were taken from one chemistry site (S009-048) and one biological monitoring station (14DM046) from 2014-2016. The average of all the values is 9.99 mg/L with a low of 7.36 mg/L and a high of 16.49 mg/L. The summer average (June-Aug) is 8.36 mg/L. The DO valued never fell below 5 mg/L.

The HSPF model calculated daily minimum DO values for this subwatershed from 1994-2014. Of these calculations, 1436 (18.72%) of the days had a daily minimum DO level below the daily minimum standard of 5 mg/L. This is a higher exceedance rate for DO.

Table 299. DO related fish metrics in Unnamed Creek (-619). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-619 Fish Class 3 – General Use	MA>3 Avg	SspnPct Avg	Taxa Count Avg	DO TIV Avg
14DM046	0.00	33.73	8.00	8.55
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	13.32	17.09	12.16	8.44
Expected response to DO stress	↓	↑	↓	↓

The fish community in Unnamed Creek (-619) at site 14DM046 scored below average in three of the four DO related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 299). This reach had a high amount of serial spawning individuals, while also having a decreased taxa count and few mature individuals. However, this reach did have an above average DO TIV score.

The observed DO data did not have any standard exceedances, while the modeled data calculated a relatively high exceedance rate. The majority of the fish metrics related to DO scored poorly, but the reach did have a good DO TIV score. This conflicting data concludes that DO is inconclusive as a stressor to aquatic life in Unnamed Creek (-619). Continuous DO monitoring with a sonde and a macroinvertebrate sample are recommended to better determine the impact that DO is having on aquatic life in this reach.

Eutrophication

A total of eight samples were taken from one chemistry site (S009-048) and one biological monitoring station (14DM046) from 2014-2016. The average of all the values is 0.225 mg/L with a low of 0.08 mg/L and a high of 0.54 mg/L. The summer average (June-Aug) is 0.232 mg/L. Phosphorus values exceeded the standard of 0.150 mg/L five times.

The HSPF model also calculated daily phosphorus values for this subwatershed from 1994-2014. These values ranged from 0.08-16.38 mg/L with an average phosphorus concentration of 0.39 mg/L. Of these calculations, 5,180 (97.37%) were above the 0.15 mg/L standard.

Table 300. Eutrophication related fish metrics in Unnamed Creek (-619). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-619 Fish Class 3 – General Use	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct
14DM046	0.00	0.00	100.00	84.34
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	8.9	12.11	70.79	14.71
Expected response to Eutrophication stress	↓	↓	↑	↑

The fish community in Unnamed Creek (-619) at site 14DM046 scored below average in all four of the eutrophication related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 300). This reach had a very high amount of both tolerant and omnivorous individuals, while also completely lacking any darter or sensitive fish taxa. These results are often found in streams stressed by eutrophic conditions.

Based on the high exceedances from both the observed and modeled data sets as well as the very poor scoring eutrophication related metrics in the fish community, eutrophication is a stressor to aquatic life in Unnamed Creek (-619) at this time.

Nitrates

Eight samples taken from one chemistry site (S009-048) and one biological monitoring station (14DM046) from 2014-2016 were analyzed for Inorganic Nitrogen (NO₂-NO₃). The average of all the values is 8.93 mg/L with a low of 0.05 mg/L and a high of 15.00 mg/L. The spring average (March-May) is 12.50 mg/L. The summer average (June-Aug) is 0.232 mg/L. Nitrate values exceeded 4 mg/L six times.

The HSPF model calculated daily nitrate concentrations for this subwatershed from 1994-2014. These values ranged from 1.13-447.51 mg/L with an average nitrate concentration of 8.13 mg/L. This average is comparable to the observed data.

No macroinvertebrate samples were taken due to lack of flow during two visits.

Based on both the observed and calculated data, nitrate concentrations in this reach do become elevated at times with the majority of the high concentrations in the spring months. Without macroinvertebrate data it is difficult to determine the impact that nitrates are having on aquatic life in this reach, therefore, nitrates are inconclusive as a stressor. More biological monitoring is recommended to better understand the impacts of nitrates, if any, on aquatic life.

Suspended Solids

Eight samples taken from one chemistry site (S009-048) and one biological monitoring station (14DM046) from 2014-2016 were analyzed for TSS. The average of all the values is 59.13 mg/L with a low of 11 mg/L and a high of 260 mg/L. The TSS concentrations exceeded the 65 mg/L standard once.

Additionally, eight secchi tube measurements were taken from this reach. These values ranged from 4-48 cm, with one value falling below the 10 cm minimum standard for secchi tube.

The HSPF model calculated daily TSS values for this subwatershed from 1994-2014. These concentrations ranged from 1.96-1325.87 mg/L with an average TSS value of 13.65 mg/L. Of these calculations, 165 (3.10%) were above the TSS standard.

Table 301. TSS related fish metrics in Unnamed Creek (-619). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-619 Fish Class 3 – General Use	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RifflePct	SensitivePct	SlithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14DM046	0.00	0.00	3.61	0.00	0.00	0.00	0.00	0.00	43.37	30.05
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	37.83	0.90	13.33	13.93	28.33	8.55	33.71	1.95	3.56	15.27
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

The fish community in Unnamed Creek (-619) at site 14DM046 scored below average in nine of the ten TSS related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 301). This reach had a high amount of long lived individuals, which were primarily common carp. The TSS Index score in this reach was very poor as were the remaining metrics related to TSS.

The TSS levels in this reach can get to very high concentrations as evidenced by the 260 mg/L reading taken during the fish sampling visit. The fish community reflects an assemblage likely impacted or stressed by the TSS conditions in the streams as the vast majority of the TSS related metrics score below average. Therefore, TSS is a stressor to aquatic life in Unnamed Creek (-619) at this time.

Habitat

Unnamed Creek (-619) had a qualitative habitat assessment take place at its biological monitoring site, 14DM046, during the fish sampling event in 2014. The MSHA score from the visits was 22.45 (Poor). Limiting the habitat at this site was row crop agriculture as the dominant nearby land use, no riparian buffer (Figure 131), heavy bank erosion, no stream shading, moderate embeddedness, sand and silt substrates, nearly absent fish cover, low channel stability, and fair channel development. Further MSHA analysis can be seen in Figure 132.

Figure 131. Lack of riparian buffer at 14DM046.



Figure 132. Unnamed Creek (-619) MSHA metric scores.

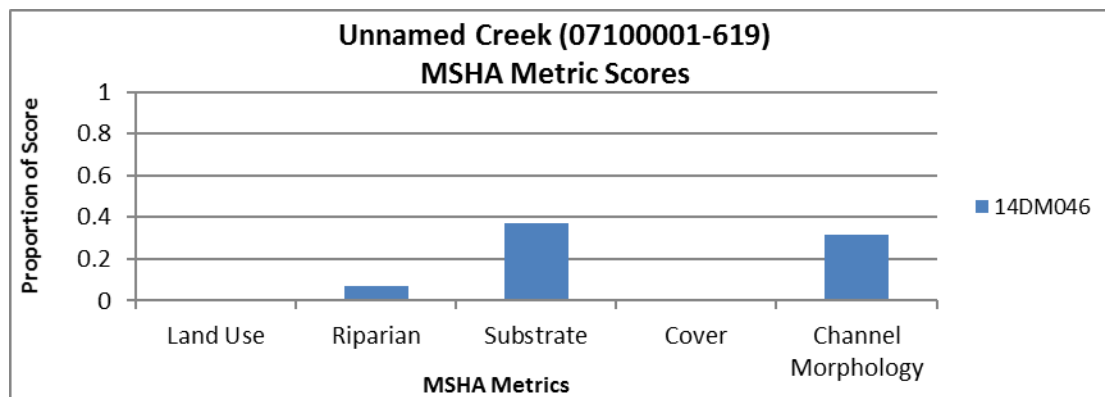


Table 302. Habitat related fish metrics in Unnamed Creek (-619). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-619 Fish Class 3 – General Use	BenInsect- ToIPct	SLithopPct	DarterSculps ucPct	RifflePct	PiscivorePct	LithFrimPct	ToIPct	PioneerPct
14DM046	0.00	0.00	0.00	0.00	0.00	4.82	100.00	40.96
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FBI General Use Threshold (55.0)</i>	14.22	33.71	12.55	28.33	1.62	69.21	70.64	37.79
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

The fish community in Unnamed Creek (-619) at site 14DM046 scored below average in all eight of the habitat related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FBI General Use Threshold (Table 302). This stream was completely dominated by tolerant taxa as every fish sampled was considered tolerant. This reach also had many pioneering individuals, which are most often present in streams with degraded habitat conditions. This reach also completely lacked any species requiring specialized habitat conditions to live and reproduce. These results strongly indicate habitat stress.

Based on the very poor MSHA score, as well as the very poor scoring habitat related metrics and the dominance of tolerant fish species, habitat is indeed a stressor to aquatic life in Unnamed Creek (-619).

Altered Hydrology

Unnamed Creek (-619) is a tributary to the North Branch of Jack Creek. Roughly half of the reach and the majority of its upstream watershed are altered according to the MPCA altered watercourse layer.

“Riffle cross section measurements identified that the BHR was 2.12 and entrenchment ratio was 1.37. These ratios indicate that the channel at the study location is both entrenched and deeply incised. Flood-prone elevations are roughly 1 foot lower than the top of the low bank height and means that flood flows (i.e. 2 times bankfull max depth at the riffle) cannot access the rivers floodplain. The confinement of flood flows within the channel is a leading factor as to why the channel is in such poor shape” (DNR 2016).

Extreme weather events affect high flow events as well as also low flows during drought. HSPF models show this stream section experiencing low flow at less than five cfs 64.3% of the time and less than one cfs 18.4% of the time.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The percentage for generalist fish within the reach was 92.8% compared to the average in Class 3 general use waters meeting the standard of 59.1%.

The numbers of nest guarder species are also positively correlated with increased low flows. The average percentage for nest guarder fish within the reach was 38.6% compared to the average in Class 3 general use waters meeting the standard of 19.2%.

Based on the partial channelization of this reach and corresponding effects on habitat/sediment, the related biological metrics scoring poorly, the lack of floodplain access, as well as the frequent low flow conditions, Flow Alteration/Connectivity is a stressor to aquatic life in Unnamed Creek (-619).

Summary

The impaired fish community in Unnamed Creek (-619) is being stressed by Eutrophication, Suspended Sediment, Habitat and Flow Alteration/Connectivity (Table 303). DO and Nitrates were inconclusive as stressors at this time. For further information on the stressors and recommendations to fixing the stressors in the Jack HUC 10 Watershed, please see pages 268-269.

Table 303. Stressor determinations for Unnamed Creek (-619).

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Unnamed Creek	07100001-619	o	●	o	●	●	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Jack Creek, North Branch (07100001-649)

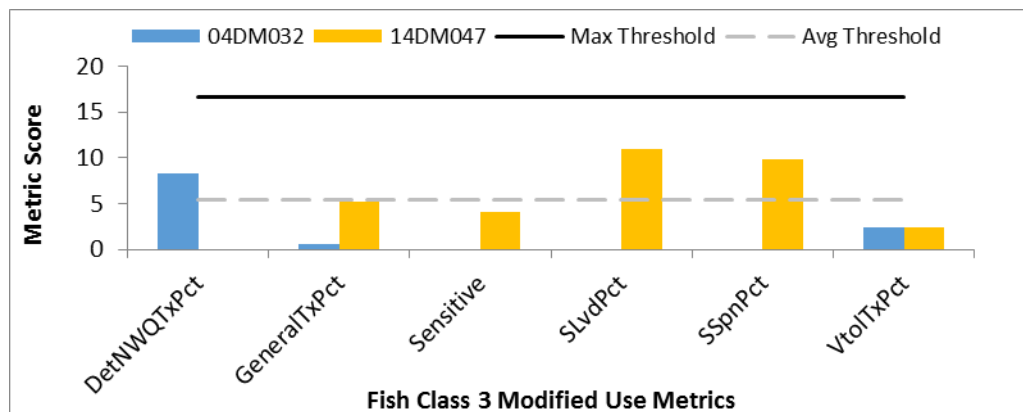
Located in northcentral Nobles County, North Branch Jack Creek (-649) is a 3.79 mile long reach that is impaired for aquatic life due to the fish assemblage. This stream reach extends from Township RD-148 downstream to 1st Street. Along this stream section there are two biological monitoring stations, 04DM032 and 14DM047.

Biology

Fish

The fish community in North Branch Jack Creek (-649) was sampled for fish in July of 2004 at site 04DM032 and in July of 2014 at site 14DM047. The FIBI scores at these sites were 11.4 at 04DM032 and 27.7 at 14DM047 which are below the Fish Class 3 Southern Headwaters Modified Use Threshold of 33. Site 04DM032 had one (DetNWQTxPct) and site 14DM047 had two (SLvd, SSpnPct) reach the average metric score needed to meet the threshold (Figure 133), however, the remaining metrics comprising this FIBI scored well below average. Both of these sites were dominated by tolerant fish species.

Figure 133. North Branch Jack Creek (-649) fish IBI metric scores.



Dissolved Oxygen

Three DO measurements were taken from two biological monitoring stations (04DM032, 14DM047) from 2004-2016. These values ranged from 7.1-9.78 mg/L with an average DO value of 8.34 mg/L. No DO measurements fell below the 5 mg/L daily minimum standard.

The HSPF model calculated daily minimum DO values for this subwatershed from 1994-2014. Of these calculations, 1139 (14.85%) of the days had a daily minimum DO level below the daily minimum standard of 5 mg/L.

Table 304. DO related fish metrics in North Branch Jack Creek (-649). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-649 Fish Class 3 – Modified Use	MA>3 Avg	SspnPct Avg	Taxa Count Avg	DO TIV Avg
04DM032	0.00	8.33	4.00	7.37
14DM047	0.00	31.62	8.00	8.89
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)</i>	14.39	10.56	10.03	8.25
Expected response to DO stress	↓	↑	↓	↓

The fish community in North Branch Jack Creek (-649) at sites 04DM032 and 14DM047 scored below average in three of the four DO related metrics at both sites when compared to all other Class 3 Southern Headwaters stations that meet the FIBI Modified Use Threshold (Table 304). Both sites had a below average taxa count and completely lacked mature fish greater than three years old, while site 04DM032 also had a poor DO TIV score and site 14DM047 had an increased amount of serial spawning individuals. These results are common in a community potentially stressed by DO.

Table 305. DO related macroinvertebrate metrics in North Branch Jack Creek (-649). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-649 Macroinvertebrate Class 7 – Modified Use	HBI_MN Value	% DO Tolerant	# DO Tolerant	ChemTV DO
04DM032	7.96	11.85	7.00	5.53
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22)</i>	8	31.37	9.33	6.19
Expected response to DO stress	↑	↑	↑	↓

The macroinvertebrate community in this reach scored below average in one of the four DO related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 305). This reach had a poor DO TIV score while scoring well in the remaining metrics. Site 04DM032 had a lower amount and percentage of DO tolerant taxa, which likely indicates that DO is not stressing the macroinvertebrate community.

The limited observed data set had zero values fall below 5 mg/L while the HSPF model calculated a slightly above average exceedance rate. The macroinvertebrate community scored fairly well as the reach had lower amounts of DO tolerant taxa, while also having a slightly above average HBI_MN value. These results do not often occur in streams with DO issues, therefore, DO is not a stressor to aquatic life at this time. Other stressors are likely impacting the fish community resulting in lower metric scores.

Eutrophication

Two phosphorus samples were taken from one biological monitoring station (14DM047) from 2004-2014. The values of these samples were 0.20 mg/L and 0.13 mg/L. One of these samples was above the 0.15 mg/L phosphorus standard.

The HSPF model also calculated daily phosphorus values for this subwatershed from 1994-2014. These values ranged from 0.09-11.08 mg/L with an average phosphorus concentration of 0.36 mg/L. Of these calculations, 5193 (98.15%) were above the 0.15 mg/L standard.

Table 306. Eutrophication related fish metrics in North Branch Jack Creek (-649). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-649 Fish Class 3 – Modified Use	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct
04DM032	0.00	0.00	100.00	12.50
14DM047	0.74	0.74	99.26	67.65
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)</i>	5.54	10.36	76.45	19.58
Expected response to Eutrophication stress	↓	↓	↑	↑

The fish community in North Branch Jack Creek (-649) sat sites 04DM032 and 14DM047 scored below average in three (04DM032) and four (14DM047) of the four eutrophication related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI Modified Use Threshold (Table 306). These results are indicative of a fish community stressed by eutrophication.

Table 307. Eutrophication related macroinvertebrate metrics in North Branch Jack Creek (-649). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-649 Macroinvertebrate Class 7 – Modified Use	EPT Pct	Tanytarsini Pct	CrustMoll Pct	Scraper Pct	% Tolerant Taxa	% Intolerant Taxa
04DM032	23.17	20.95	7.33	22.67	23.53	0.82
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22)</i>	20.58	22.11	23.21	17.73	45.87	1.43
Expected response to Eutrophication stress	↓	↓	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in three of the six eutrophication related metrics at site 04DM032 when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 307). This reach had decreased amounts of tanytarsini individuals and phosphorus intolerant taxa, while also having an increased number of scraper individuals. These results are common in streams negatively impacted by eutrophic conditions.

The phosphorus concentrations in this reach do exceed the standards based on the limited observed data, the modeled data showed a very high rate of exceedance. Additionally, the majority of the eutrophication related metrics in the fish and macroinvertebrate communities scored below average, therefore, eutrophication is a stressor to aquatic life in North Branch Jack Creek (-649) at this time.

Nitrates

Two samples were analyzed for Inorganic Nitrogen (NO₂-NO₃) from 2004-2014. These values were 13 mg/L in July of 2004 and 8.9 mg/L in July of 2014. A quantile regression analysis for Class 7 stream stations showed that sites having a nitrate concentration in excess of 11.5 mg/L there was a 90% probability for impairment. The nitrate concentrations in this reach exceeded this level.

The HSPF model calculated daily nitrate concentrations for this subwatershed from 1994-2014. These values ranged from 1.13-486.84 mg/L with an average value of 7.75 mg/L. Of these calculations, 1,264 (23.67%) were above 11.5 mg/L.

Table 308. Nitrate related macroinvertebrate metrics in North Branch Jack Creek (-649). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-649 Macroinvertebrate Class 7 – Modified Use	TrichopteraChTx Pct	N Index Score	% N Tolerant	% N Intolerant
04DM032	3.08	3.38	73.87	0.33
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22)</i>	5.71	3.30	62.54	0.00
Expected response to N stress	↓	↑	↑	↓

The macroinvertebrate community in North Branch Jack Creek (-649) scored below average in three of the four nitrate related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 308). The site, 04DM032, had low numbers of trichoptera

taxa, high numbers of nitrate tolerant individuals, and a slightly below average nitrate index score. These results signal a likely stressor.

Based on the elevated observed results despite limited sampling, high calculated nitrate concentrations, the quantile regression analysis, and the majority of the nitrate related macroinvertebrate metrics scoring below average, nitrates are indeed a stressor to aquatic life in this reach.

Suspended Solids

Two samples taken from two biological monitoring stations (04DM032, 14DM047) from 2004-2014 were analyzed for TSS. The average of all the values is 43 mg/L with a low of 42 mg/L and a high of 44 mg/L. The TSS concentrations did not exceed the 65 mg/L standard.

Additionally, two secchi tube measurements were taken from this reach. These values ranged from 20-39 cm, with no values falling below the 10 cm minimum standard for secchi tube.

The HSPF model calculated daily TSS values for this subwatershed from 1994-2014. These concentrations ranged from 2.02-600.62 mg/L with an average TSS value of 15.79 mg/L. Of these calculations, 189 (3.57%) were above the TSS standard.

Table 309. TSS related fish metrics in North Branch Jack Creek (-649). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-649 Fish Class 3 – Modified Use	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RifflePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
04DM032	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.85
14DM047	0.00	0.00	0.00	0.74	0.00	0.74	0.00	0.00	60.29	34.89
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)</i>	31.38	1.01	10.83	12.43	22.62	6.02	30.09	0.52	4.91	15.49
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

The fish community in North Branch Jack Creek (-649) scored below average in nine (14DM047) and ten (04DM032) of the TSS related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI Modified Use Threshold (Table 309). Site 14DM047 did have a high amount of long lived individuals, which was aided by the presence of 82 common carp in the reach. The remaining metrics, especially TSS Index score, scored poorly similarly to site 04DM032. These results are common in streams with elevated TSS concentrations.

Table 310. TSS related macroinvertebrate metrics in North Branch Jack Creek (-649). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-649 Macroinvertebrate Class 7 – Modified Use	TSS Index Score	TSS Intolerant	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
04DM032	13.48	0.00	12.00	30.73	8.50	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)</i>	16.02	0.60	10.98	35.60	9.91	0.02
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

The macroinvertebrate community in this reach scored below average in four of the six TSS related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 310). Site 04DM032 did have a below average amount of TSS Tolerant individuals and a good TSS Index score. These results can indicate an assemblage not being stressed by the TSS conditions. However, the remaining four metrics did score poorly indicating potential TSS stress.

The observed data set for this reach is very limited, while the HSPF model calculated a relatively low standard exceedance rate. The majority of the TSS related metrics in both the fish and macroinvertebrate assemblages score below average potentially indicating signs of stress from the TSS conditions. With the limited chemical data set available, TSS is inconclusive as a stressor to aquatic life at this time in North Branch Jack Creek (-649).

Habitat

North Branch Jack Creek (-649) had qualitative habitat assessments take place at its biological monitoring sites, 14DM039 and 14DM081, during the fish sampling events in 2004 and 2014. The MSHA scores from these visits were 52 (Fair) at 04DM032 and 18 (Poor) at 14DM047. Limiting the habitat at these sites was the row crop agriculture and open pasture as nearby land uses, little to no riparian buffer, severe bank erosion (14DM047) (Figure 134), no stream shading (14DM047), sand substrates, nearly absent to sparse fish cover, moderate embeddedness, poor channel development, poor to fair sinuosity, and low channel stability (14DM047). Further MSHA analysis can be seen in Figure 135.

Figure 134. Severe bank erosion at site 14DM047.



Figure 135. North Branch Jack Creek (-649) MSHA metric scores.

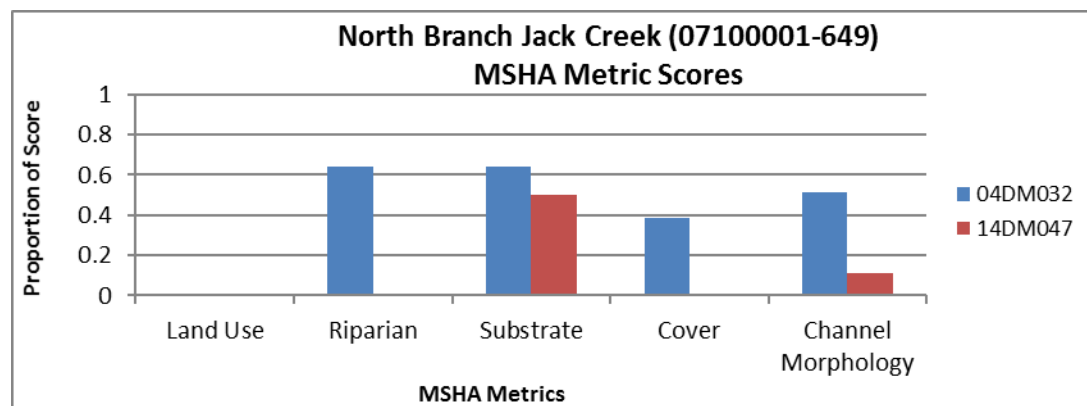


Table 311. Habitat related fish metrics in North Branch Jack Creek (-649). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-649 Fish Class 3 – Modified Use	BenInsect-TolPct	SLithopPct	DarterSculpSu cPct	RifflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
04DM032	0.00	0.00	0.00	0.00	0.00	12.50	100.00	20.83
14DM047	0.74	0.00	0.74	0.00	0.00	2.94	99.26	8.09
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)</i>	10.91	30.09	10.59	22.62	1.97	57.98	46.70	32.54
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

The fish community in North Branch Jack Creek (-649) at sites 04DM032 and 14DM047 scored below average in seven of the eight habitat related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI Modified Use Threshold (Table 311). Both of these sites did have lower amounts of pioneer individuals, however, both sites also had a very high amount of tolerant individuals, while also lacking species requiring specialized habitat conditions. These results are common in streams with degraded habitat.

Table 312. Habitat related macroinvertebrate metrics in North Branch Jack Creek (-649). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-649 Macroinvertebrate Class 7 – Modified Use	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
04DM032	26.33	14.67	4.67	23.17	74.33	26.33
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)</i>	9.74	24.34	20.62	15.52	59.46	22.88
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate assemblage in this reach scored below average in four of the six habitat related metrics at site 04DM032 when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 312). This site did have an above average amount of both EPT and sprawler individuals, but scored poorly in the remaining metrics. The high amount of both burrower and legless individuals does correspond to the sand substrates present.

Based on the poor to fair MSHA scores, as well as the majority of the habitat related metrics in both the fish and macroinvertebrate communities scoring poorly, habitat is a stressor to aquatic life in North Branch Jack Creek (-649).

Altered Hydrology

North Branch Jack Creek (-649) and the majority of its upstream watershed are altered according to the MPCA altered watercourse layer.

“Riffle cross section measurements identified that the BHR was 2.12 and entrenchment ratio was 1.37. These ratios indicate that the channel at the study location is both entrenched and deeply incised.

Flood-prone elevations are roughly 1 foot lower than the top of the low bank height and means that flood flows (i.e. two times bankfull max depth at the riffle) cannot access the rivers floodplain. The confinement of flood flows within the channel is a leading factor as to why the channel is in such poor shape” (DNR 2016).

Extreme weather events affect high flow events as well as also low flows during drought. HSPF models show this stream section experiencing low flow at less than five cfs 44.8% of the time and less than one cfs 7.9% of the time.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The average percentage for generalist fish within the reach was 48.2% compared to the average in Class 3 modified use waters meeting the standard of 56.3% General fish populations ranged from 25-71.3%.

The numbers of nest guarder species are also positively correlated with increased low flows. The average percentage for nest guarder fish within the reach was 45.0% compared to the average in Class 3 modified use waters meeting the standard of 24%. Nest Guarder populations ranged from 6.6-83.3%.

Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The percentage for long-lived macroinvertebrates within the reach was 1.7% compared to the average in Class 7 modified use waters meeting the standard of 5.6%.

The current channel alteration, the frequent low flow conditions, the lack of floodplain access, as well as the majority of the related biological metrics scoring poorly, Flow Alteration/Connectivity is a stressor to aquatic life in North Branch Jack Creek (-649).

Summary

The impaired fish community in North Branch Jack Creek (-649) is being stressed by Eutrophication, Nitrates, Habitat and Flow Alteration/Connectivity (Table 313). Suspended Sediment was inconclusive as a stressor at this time, while DO was ruled out as a stressor to aquatic life. For further information on the stressors and recommendations to fixing the stressors in the Jack HUC 10 Watershed, please see pages 268-269.

Table 313. Stressor determinations for North Branch Jack Creek (-649).

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
North Branch Jack Creek	07100001-649	---	●	●	o	●	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Jack Creek Watershed (0710000106) HUC 10 conclusion and recommendations

The Jack Creek subwatershed has eleven biologically impaired streams that are being negatively impacted by numerous stressors throughout the watershed. Stressors found in at least five of the eleven impaired reaches include DO, Eutrophication, Nitrates, Suspended Sediment, Habitat, and Flow Alteration/Connectivity (Table 31).

By far, the predominant land use in this subwatershed is row crop agriculture. This is a significant contributor to the stressors found in these reaches. The land use combined with the channelization of these stream reaches and their tributaries are a major reason why these streams are impaired for aquatic life. These practices often lead to high nitrate and phosphorus levels through excessive use of fertilizers that can quickly reach the stream system by drain tiles and field runoff. These elevated phosphorus levels will also impact the DO conditions resulting in many more tolerant fish and macroinvertebrate communities. Much of the DO, Eutrophication, and Flow Alteration/Connectivity issues occurred in the headwaters, while habitat and nitrates were problems throughout.

Channelizing streams can also lead to very high flow rates resulting in bank erosion. Bank erosion leads to higher amounts of both bedded and suspended sediment in the stream resulting in poor habitat and visibility conditions impacting the breeding and feeding environments for more sensitive fish and macroinvertebrate species.

A large effort is needed in the Jack Creek Watershed to improve biological conditions in the many impaired streams found throughout. A high priority in this watershed should be to better manage the flow alteration and the effects of it. This can be achieved by increasing the storage and infiltration of water in locations with flow alteration stressors. This will also help reduce sediment inputs from stream banks, improve habitat by protecting streambanks, reduce erosion and overall stream sedimentation. Re-establishing a quality riparian corridor with deep-rooted vegetation to increase stream stabilization, shading, and habitat features is also needed to improve conditions. Also, utilizing a variety of nutrient reducing BMPs including: cover crops, nutrient management, saturated buffers, etc., will also help in the nitrate and phosphorus reduction. This could also help with the eutrophication and resulting DO issues as well.

Table 314. Stressor determinations for the Jack Creek Watershed.

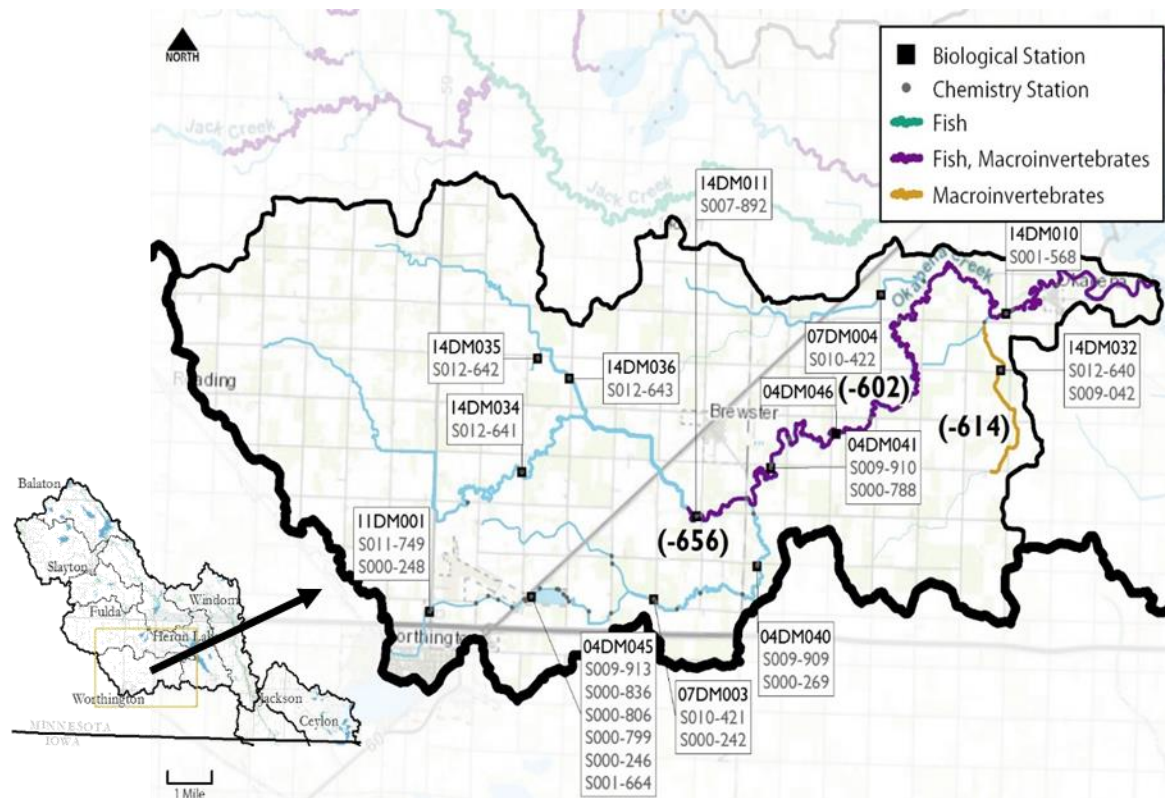
Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Jack Creek	07100001-658	●	●	●	●	●	●
Unnamed Creek	07100001-564	●	●	---	o	●	●
Jack Creek	07100001-514	●	●	●	●	●	●
Unnamed Creek	07100001-661	●	●	o	---	●	●
Judicial Ditch 26	07100001-523	o	●	●	---	●	●
Jack Creek	07100001-549	---	o	●	●	●	●
Unnamed Creek	07100001-618	●	●	●	---	●	o
North Branch Jack Creek	07100001-652	o	●	●	●	●	●
Judicial Ditch 12	07100001-666	●	●	●	---	●	●
Unnamed Creek	07100001-619	o	●	o	●	●	●
North Branch Jack Creek	07100001-649	---	●	●	o	●	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

5.6 Okabena Creek Watershed (0710000105)

The Okabena Creek HUC-10 Watershed (0710000105) is a 137.67 mi² watershed (Figure 136) located in the southwest portion of the Des Moines River-Headwaters Watershed. This watershed contains three biologically impaired reaches. The primary land use within this watershed by far is row crop agriculture.

Figure 136. Okabena Creek Watershed with monitoring stations and biological impairments.



Elk Creek (07100001-656)

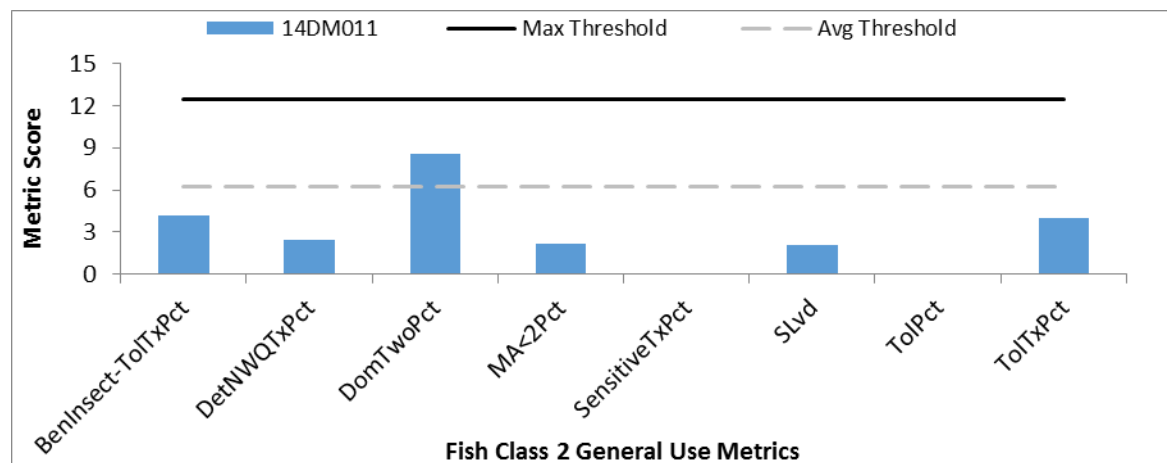
Located in east central Nobles County and west central Jackson County, Elk Creek (-656) is a 2.29 mile long reach that is impaired for aquatic life due to the fish and macroinvertebrate assemblages. This stream reach extends from just upstream of Wass Avenue to the confluence with Okabena Creek. Along this stream, section there is one biological monitoring station, 14DM011.

Biology

Fish

The fish community in Elk Creek (-656) was sampled in August of 2014 at biological monitoring station 14DM011. This site had an FIBI score of 23.5, which is far below the Fish Class 2 Southern Streams General Use Threshold of 50. This reach scored below the average needed to reach the threshold in seven of the eight metrics that comprise the FIBI for this class. Two of the eight metrics had a score of zero (Figure 137). Site 14DM011 had many bigmouth shiners (305), creek chubs (170), and bluntnose minnows (144). These species are generally fairly tolerant species often found in high numbers in degraded streams.

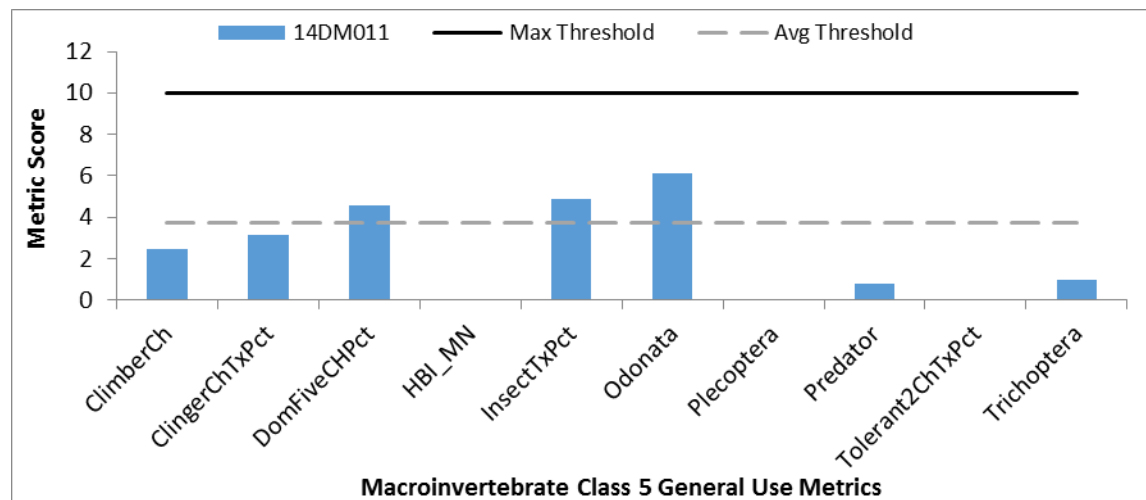
Figure 137. Elk Creek (-656) fish IBI metric scores.



Macroinvertebrates

The macroinvertebrate community was also sampled in August of 2014. Site 14DM011 had a MIBI score of 22.9, which is below the Macroinvertebrate Class 5 Southern Streams RR General Use Threshold of 37. This reach scored below the average needed to reach the threshold in seven of the ten metrics that comprise the FIBI for this class. Three of the ten metrics had a score of zero (HBI_MN, Plecoptera, Tolerant2ChTxPct). For a further breakdown of the MIBI metric scores for this reach, see Figure 138.

Figure 138. Elk Creek (-656) macroinvertebrate IBI metric scores.

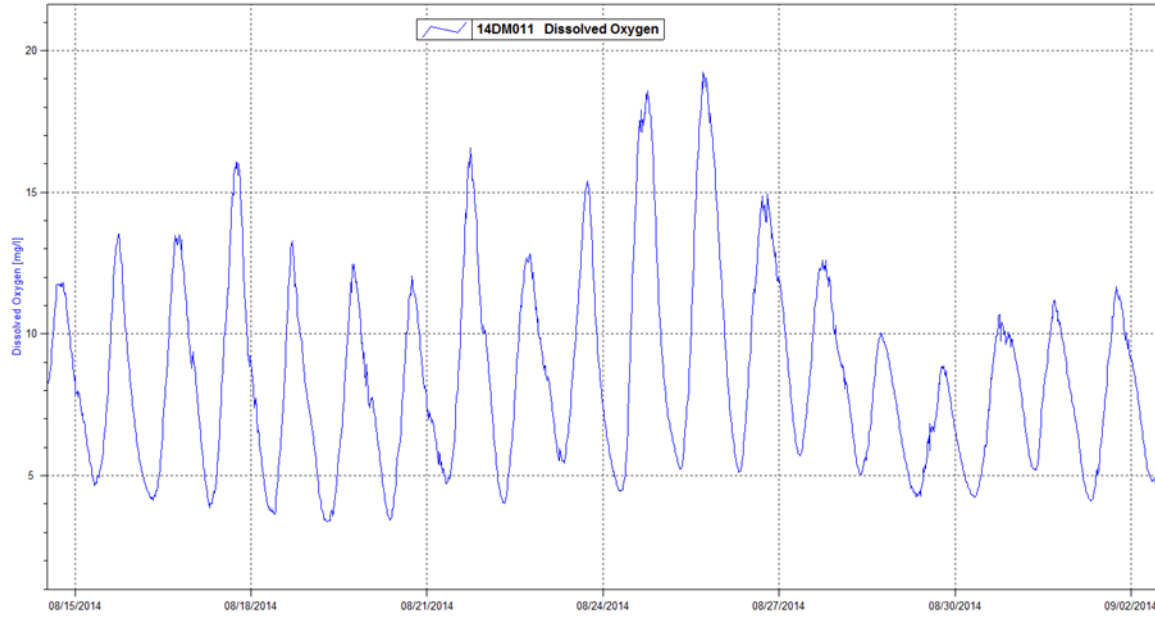


Dissolved Oxygen

This reach had 23 DO measurements taken from one chemistry site (S007-892) from 2014-2015. The average of all the values is 8.41 mg/L with a low of 5.58 mg/L and a high of 10.94 mg/L. The summer average (June-Aug) is 8.43 mg/L. The DO values did not fall below 5 mg/L.

Continuous DO monitoring was done at site 14DM011 in 2014 (Figure 139). This monitoring showed that the DO levels frequently fell below the 5 mg/L daily minimum standard, while also greatly exceeding the 4.5 mg/L standard for daily flux. These results indicate potential DO and eutrophication issues in this reach.

Figure 139. Continuous DO monitoring at site 14DM011 in Elk Creek (-656).



The HSPF model calculated daily minimum DO values for this subwatershed from 1994-2014. Of these calculations, 482 (6.28%) of the days had a daily minimum DO level below the daily minimum standard of 5 mg/L.

Table 315. DO related fish metrics in Elk Creek (-656). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-656 Fish Class 2 – General Use	MA>3 Avg	SspnPct Avg	Taxa Count Avg	DO TIV Avg
14DM011	5.31	49.31	15.00	8.81
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)</i>	23.89	28.72	20.38	8.56
Expected response to DO stress	↓	↑	↓	↓

The fish community in Elk Creek (-656) at site 14DM011 scored below average in three of the four DO related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 315). This site had few mature fish, a low taxa count, and an increased amount serial spawning individuals. This site did have an above average DO score as well.

Table 316. DO related macroinvertebrate metrics in Elk Creek (-656). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-656 Macroinvertebrate Class 5 – General Use	HBI_MN Value	% DO Tolerant Taxa	# DO Tolerant Taxa	ChemTV DO
14DM011	8.55	18.03	9.00	7.01
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	7.04	8.62	4.33	7.10
Expected response to DO stress	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in all four of the DO related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 316). This reach had a high amount of DO tolerant taxa, while also having a poor DO TIV and HBI_MN scores. These results are common in streams negatively impacted by the DO conditions.

None of the observed DO measurements fell below the 5 mg/L standard, however, the continuous DO monitoring showed that the daily DO level frequently fell below 5 mg/L while the daily flux for this reach was also well above the 4.5 mg/L standard. The fish and macroinvertebrate metrics in this reach did score poorly as well. DO is a stressor to aquatic life in Elk Creek (-656) at this time.

Eutrophication

A total of 11 phosphorus samples were taken from one chemistry site (S007-892) in 2014. The average of all the values is 0.074 mg/L with a low of 0.03 mg/L and a high of 0.18 mg/L. The summer average (June-Aug) is 0.087. Phosphorus values exceeded the standard of 0.150 mg/L once.

Table 317. Eutrophication related fish metrics in Elk Creek (-656). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-656 Fish Class 2 – General Use	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct
14DM011	0.00	6.50	90.65	6.20
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)</i>	19	11.47	45.1	17
Expected response to Eutrophication stress	↓	↓	↑	↑

The fish community in Elk Creek (-656) at site 14DM011 scored below average in three of the four eutrophication related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 317). This reach completely lacked sensitive fish species had very few darter individuals, while also having an elevated amount of tolerant fish individuals. These results are common in streams being negatively impacted by eutrophic conditions.

Table 318. Eutrophication related macroinvertebrate metrics in Elk Creek (-656). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-656 Macroinvertebrate Class 5 – General Use	EPT Pct	Tanytarsini Pct	CrustMoll Pct	Scraper Pct	% Tolerant Taxa	% Intolerant Taxa
14DM011	40.00	2.20	28.20	25.90	43.61	0.00
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	43.90	27.84	9.23	15.78	17.17	5.79
Expected response to Eutrophication stress	↓	↓	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in all six of the eutrophication related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 318). Site 14DM011 had a very high amount of phosphorus tolerant taxa, crustacea/mollusca individuals, while also lacking tanytarsini individuals and phosphorus intolerant species. These results are commonly found in streams with eutrophic conditions.

The phosphorus levels in Elk Creek do exceed the 0.15 mg/L standard at times, while the daily flux of DO was very high and can indicate eutrophic conditions. Additionally, the majority of the fish and macroinvertebrate metrics related to eutrophication scored poorly, therefore, eutrophication is a stressor to aquatic life in Elk Creek (-656).

Nitrates

There were 11 samples taken from one chemistry site (S007-892) in 2014 that were analyzed for Inorganic Nitrogen (NO₂-NO₃). The average of all the values is 5.54 mg/L with a low of 0.20 mg/L and a high of 21.70 mg/L. The spring average (March-May) is 1.77 mg/L. The summer average (June-Aug) is 9.47. Nitrate values exceeded 4 mg/L three times.

A quantile regression analysis for Class 5 stream stations showed that sites having a nitrate concentration in excess of 18.1 mg/L there was a 75% probability for impairment. The nitrate concentrations in this reach exceeded this level.

The HSPF model calculated daily nitrate concentrations for this subwatershed from 1994-2014. These values ranged from 0.63-263.01 mg/L with an average value of 8.42 mg/L. Of these calculations, 151 (2.41%) were above 18.1 mg/L.

Table 319. Nitrate related macroinvertebrate metrics in Elk Creek (-656). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-656 Macroinvertebrate Class 5 – General Use	TrichopteraChTx Pct	N Index Score	% N Tolerant	% N Intolerant
14DM011	9.38	4.76	86.56	0.00
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	13.16	3.00	48.68	0.96
Expected response to N stress	↓	↑	↑	↓

The macroinvertebrate community in Elk Creek (-656) scored below average in all four of the nitrate related metrics at site 14DOM011 when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 319). This reach had low numbers of both nitrate intolerant and trichoptera taxa, as well as a high amount of nitrate tolerant individuals and a poor nitrate index score.

Based on the high observed and calculated nitrate concentrations, the quantile regression analysis, as well as the poor scoring nitrate related macroinvertebrate metrics, nitrates are a stressor to aquatic life in this reach.

Suspended Solids

Eleven samples taken from one chemistry site (S007-892) in 2014 were analyzed for TSS. The average of all the values is 22.18 mg/L with a low of 3 mg/L and a high of 48 mg/L. The TSS concentrations did not exceed the 65 mg/L standard.

Additionally, 25 secchi tube measurements were taken from this reach. These values ranged from 21-87 cm, with no values falling below the 10 cm minimum standard for secchi tube.

The HSPF model calculated daily TSS values for this subwatershed from 1994-2014. These concentrations ranged from 0.68-1211.47 mg/L with an average TSS value of 29.82 mg/L. Of these calculations, 560 (8.92%) were above the TSS standard.

Table 320. TSS related fish metrics in Elk Creek (-656). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-656 Fish Class 2 – General Use	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RifflePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14DM011	20.28	0.00	8.86	6.59	13.88	0.00	18.41	0.00	0.10	17.62
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)</i>	37.38	4.89	9.61	18.66	32.49	18.65	39.38	4.97	11.68	17.59
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

The fish community in Elk Creek (-656) at site 14DM011 scored below average in all ten of the TSS related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 320). This reach did have 15 species, however, very few of the fish sampled were from species considered sensitive to elevated TSS concentrations. These results are common in streams with elevated TSS concentrations.

Table 321. TSS related macroinvertebrate metrics in Elk Creek (-656). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-656 Macroinvertebrate Class 5 – General Use	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
14DM011	21.89	0.00	14.00	73.77	11.80	0.00
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)</i>	15.87	3.02	11.59	35.23	26.89	0.54
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

The macroinvertebrate community in this reach scored below average in all six of the TSS related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 321). Site 14DM011 had a poor TSS Index score, while also having very few collector-filterer, plecoptera, and TSS intolerant taxa. This reach also had increased numbers and a high percentage of TSS tolerant taxa. These results suggest that TSS is a stressor.

The observed data set did not have any instances in which the TSS or transparency standards were exceeded. The HSPF model predicted an exceedance rate that is slightly below the rate that is considered impaired (10%). Both the fish and macroinvertebrate metrics related to TSS all scored below average or poorly in this reach. Based on this information, TSS is inconclusive as a stressor in Elk Creek (-656) at this time.

Habitat

Elk Creek (-656) had a qualitative habitat assessment take place at its biological monitoring site, 14DM011, during the fish and macroinvertebrate sampling events in 2014. The average MSHA score from these visits was 52.65 (Fair). Limiting the habitat at this site was row crop agriculture as the dominant nearby land use, moderate bank erosion, light stream shading, moderate embeddedness, sand and silt substrates (Figure 140), sparse fish cover, and moderate channel stability. Further MSHA analysis can be seen in Figure 141.

Figure 140. Sand substrates at site 14DM011.



Figure 141. Elk Creek (-656) MSHA metric scores.

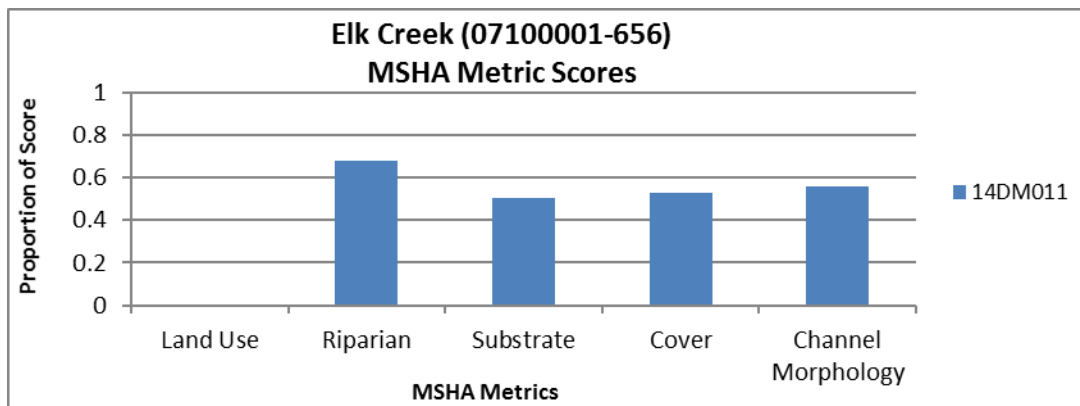


Table 322. Habitat related fish metrics in Elk Creek (-656). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-656 Fish Class 2 – General Use	BenInsect-TolPct	SLithopPct	DarterSculpSu cPct	RifflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14DM011	6.50	18.41	6.50	13.88	0.10	43.80	90.65	37.99
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)</i>	20.4	39.38	18.18	32.49	5.24	58.26	44.85	19.02
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

The fish community in Elk Creek (-656) at site 14DM011 scored below average in all eight of the habitat related metrics when compared to all other Class 2 Southern Stream stations that meet the FIBI General Use Threshold (Table 322). This stream reach had very large amounts of both tolerant and pioneer individuals, which is common in streams with potentially degraded habitat. This reach also had lower numbers of fish that require specialized habitat conditions for living and breeding purposes.

Table 323. Habitat related macroinvertebrate metrics in Elk Creek (-656). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-656 Macroinvertebrate Class 5 – General Use	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14DM011	9.84	43.93	15.74	40.00	54.10	20.33
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)</i>	5.66	12.52	49.77	42.46	34.53	13.99
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate assemblage in this reach scored below average in four of the six habitat related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 323). This stream reach had good numbers of both climber and sprawler individuals, however, the remaining metrics scored poorly. The higher number of burrower and legless individuals is likely in response to the sand and silt substrates that are present in this stream.

The habitat conditions in this stream reach are fair, both the majority of the fish and macroinvertebrate metrics related to habitat score below average, therefore, habitat is a stressor to aquatic life in Elk Creek (-656).

Altered Hydrology

Elk Creek (-656) has roughly half of the reach and the majority of its upstream watershed altered according to the MPCA altered watercourse layer.

Extreme weather events affect high flow events as well as also low flows during drought. HSPF models show this stream section experiencing low flow at less than five cfs 37.9% of the time and less than one cfs 13.7% of the time.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The percentage for generalist fish within the reach was 50.1% compared to the average in Class 2 general use waters meeting the standard of 42.4%.

The numbers of nest guarder species are also positively correlated with increased low flows. The percentage for nest guarder fish within the reach was 21.3% compared to the average in Class 2 general use waters meeting the standard of 19%.

Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The percentage for long-lived macroinvertebrates within the reach was 1.0% compared to the average in Class 5 general use waters meeting the standard of 9%.

Based on the partial channelization of this reach, the frequent low flow conditions, as well as the poor scoring biological metrics related to channelization, Flow Alteration/Connectivity is a stressor to aquatic life in Elk Creek (-656).

Summary

The impaired fish and macroinvertebrate communities in Elk Creek (-656) are being stressed by DO, Eutrophication, Nitrates, Habitat and Flow Alteration/Connectivity (Table 323). Suspended Sediment was inconclusive as a stressor at this time. For further information on the stressors and recommendations to fixing the stressors in the Okabena Creek HUC 10 Watershed, see pages 295-296.

Table 324. Stressor determinations for Elk Creek (-656).

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Elk Creek	07100001-656	●	●	●	○	●	●

● = stressor; ○ = inconclusive stressor; --- = not an identified stressor

Okabena Creek (07100001-602)

Located in northwest Jackson County, Okabena Creek (-602) is a 24.66 mile long reach that is impaired for aquatic life due to the fish and macroinvertebrate assemblages. This stream reach extends from Elk Creek down to the confluence with Division Creek. Along this stream section, there are three biological monitoring stations, 04DM041, 04DM046, and 14DM010.

Okabena Creek (-602) also has aquatic life impairments due to the turbidity and chloride conditions present. The turbidity impairment will be evaluated in the suspended solids portion of this reach, while the chloride impairment is a known and accepted stressor to aquatic life and will not be further evaluated in this report.

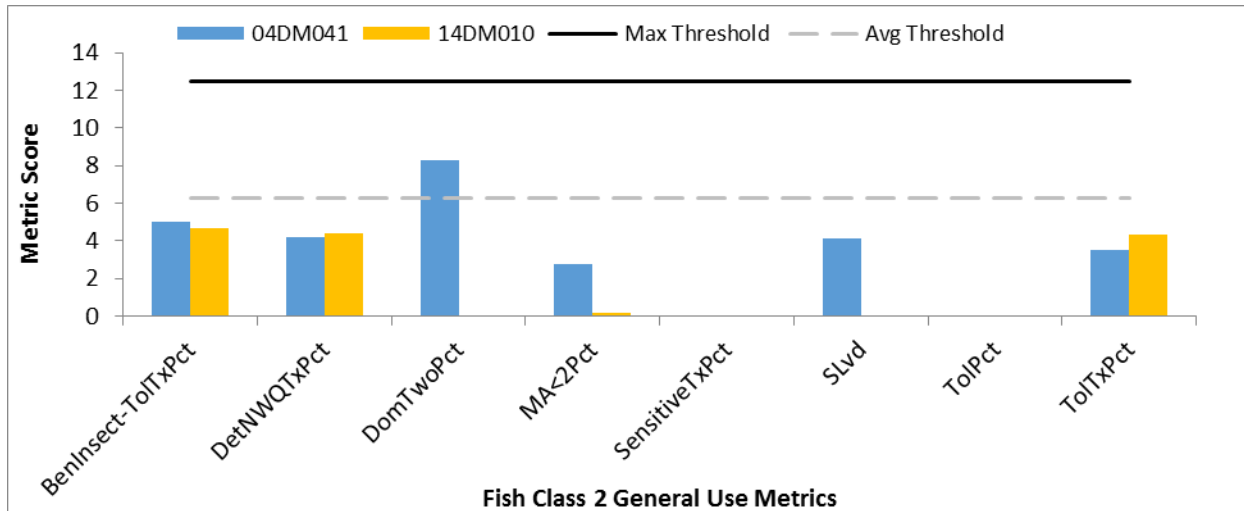
Biology

Fish

The fish community in Okabena Creek (-602) was sampled for fish in July of 2004 and again in August of 2014 at site 04DM041. This site had an average FIBI score of 28. Site 14DM010 was sampled for fish in August of 2014 and had a FIBI score of 13.6. Both sites had FIBI scores below the Fish Class 2 Southern

Streams General Use Threshold of 50. Site 04DM041 site did have one metric (DomTwoPct) reach the average metric score needed to meet the threshold (Figure 142), however, the remaining metrics comprising this FBI scored well below average. Site 14DM010 had zero metrics meeting the average metric score needed to reach the threshold.

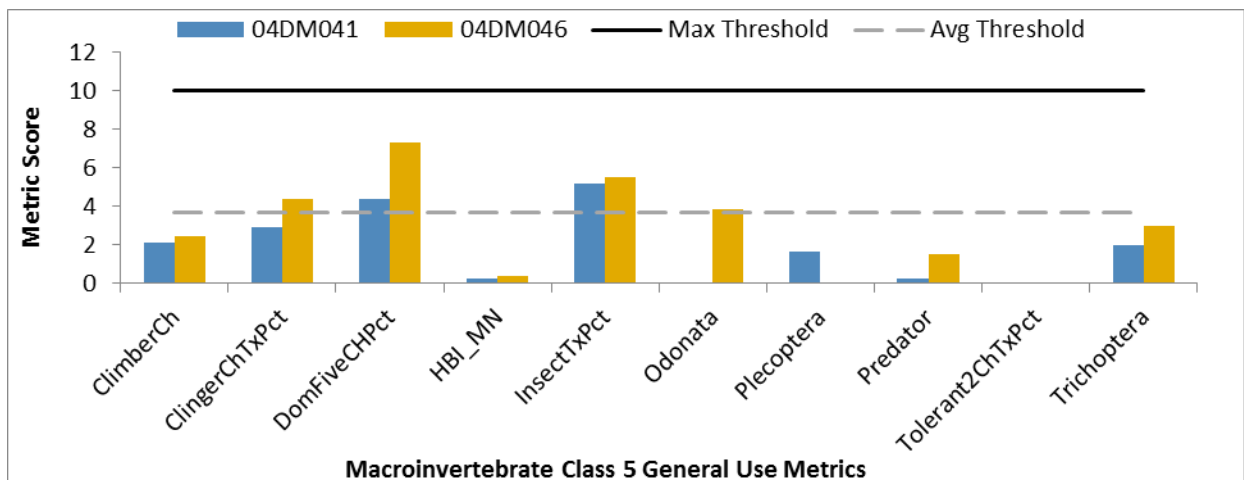
Figure 142. Okabena Creek (-602) fish IBI metric scores.



Macroinvertebrates

The macroinvertebrate assemblage at site 04DM041 was sampled in August and September of 2004 and again in August of 2014 and had an average MIBI score of 18.75. Site 04DM046 was sampled in August of 2014 and had a MIBI score of 28.5. Both of these scores are below the Macroinvertebrate Class 5 Southern Streams RR General Use Threshold of 37. Site 04DM041 had two and site 14DM046 had four metrics score above the average needed to reach the threshold. However, the remaining metrics scored below average. See Figure 143 for a complete breakdown of the metric scores at this site.

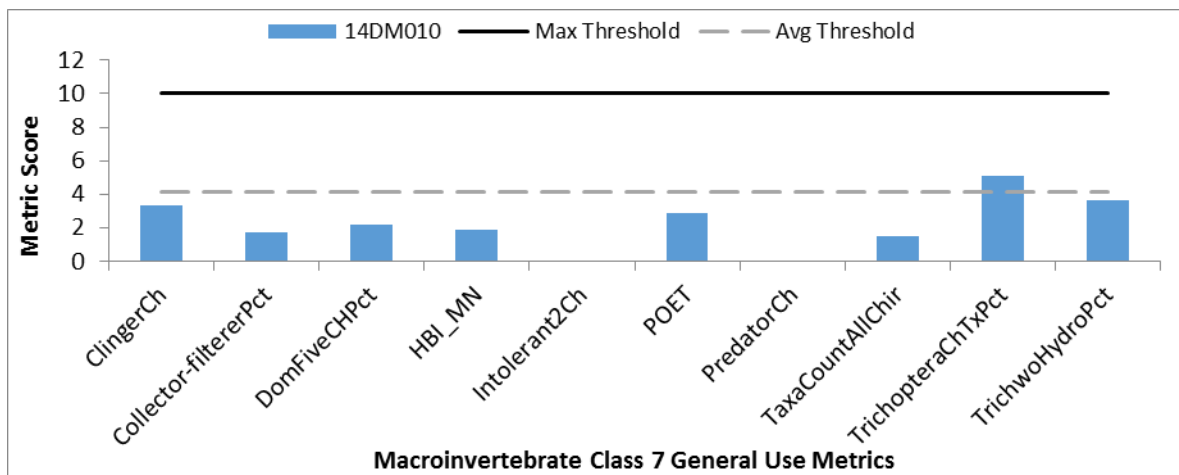
Figure 143. Okabena Creek (-602) macroinvertebrate IBI class 5 metric scores.



The macroinvertebrate assemblage at site 14DM010 was sampled in August of 2014 and had an average MIBI score of 22.1, which is below the Macroinvertebrate Class 7 Prairie Streams GP General Use Threshold of 41. Site 14DM010 had one metric score above the average needed to reach the threshold (TrichopteraChPct). However, the remaining nine metrics scored below average, with two of these

metrics scoring zero (Intolerant2Ch, PredatorCh). See Figure 144 for a complete breakdown of the metric scores at this site.

Figure 144. Okabena Creek (-602) macroinvertebrate IBI Class 7 metric scores.

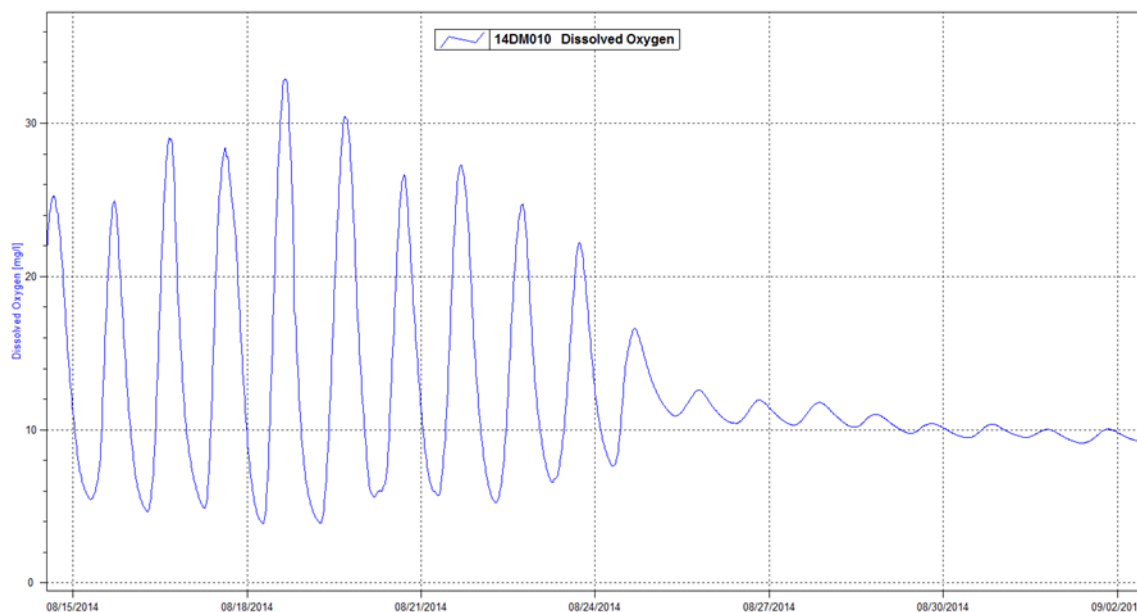


Dissolved Oxygen

A total of 264 DO measurements were taken from one chemistry site (S001-568) and one biological monitoring station (04DM041) from 2004-2016. The average of all the values is 8.89 mg/L with a low of 3.13 mg/L and a high of 18.50 mg/L. The summer average (June-Aug) is 7.77 mg/L. The DO values fell below 5 mg/L twice.

Continuous DO monitoring occurred at site 14DM010 in 2014 (Figure 145). This monitoring showed that the DO levels did fall below the 5 mg/L daily minimum standard, while the daily flux values were extremely high and easily exceeded the 4.5 mg/L standard for over half of the sonde deployment.

Figure 145. Continuous DO monitoring at site 14DM010 in Okabena Creek (-602).



The HSPF model calculated daily minimum DO values for this subwatershed from 1994-2014. Of these calculations, 432 (5.63%) of the days had a daily minimum DO level below the daily minimum standard of 5 mg/L.

Table 325. DO related fish metrics in Okabena Creek (-602). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-602 Fish Class 2 – General Use	MA>3 AVG	SspnPct AVG	Taxa Count AVG	DO TIV AVG
04DM041	5.98	48.36	15.5	8.63
14DM010	2.98	91.38	20.00	8.45
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)</i>	23.89	28.72	20.38	8.56
Expected response to DO stress	↓	↑	↓	↓

The fish community in Okabena Creek (-602) scored below average in three (04DM041) and four (14DM010) of the four DO related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 325). Both sites had very few mature fish greater than three years, elevated numbers of serial spawning individuals, while also having a lower overall taxa count. Site 14DM010 also had a below average DO TIV score. These results are commonly found in streams being negatively impacted by the DO conditions.

Table 326. DO related macroinvertebrate metrics in Okabena Creek (-602). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-602 Macroinvertebrate Class 5, 7– General Use	HBI_MN Value	% DO Tolerant Taxa	# DO Tolerant Taxa	ChemTV _DO
04DM041	8.27	3.03	4.67	7.22
04DM046	8.22	3.78	4.00	7.19
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	7.04	8.62	4.33	7.10
14DM010	8.31	27.27	7.00	7.01
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	7.55	12.98	5.74	6.91
Expected response to DO stress	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in one (04DM046) and three (14DM010) of the four DO related metrics when compared to all other Class 5 Southern Streams RR and Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 326). Both sites had poor HBI_MN values, while site 14DM010 also had an increased percentage and number of DO tolerant taxa. These results are commonly found in streams with poor DO conditions.

DO levels in this reach occasionally fall below 5 mg/L according to the observed and continuous monitoring data sets. The continuous monitoring also had an extremely high level of DO flux that easily exceeded the 4.5 mg/L standard. The majority of the fish and macroinvertebrate metrics related to DO scored poorly as well. Therefore, DO is a stressor to aquatic life in Okabena Creek (-602).

Eutrophication

A total of 345 phosphorus samples were taken from one chemistry site (S001-568) and one biological monitoring station (04DM041) from 2004-2016. The average of all the values is 0.277 mg/L with a low of

0.03 mg/L and a high of 2.05 mg/L. The summer average (June-Aug) is 0.284 mg/L. Phosphorus values exceeded the standard of 0.150 mg/L 236 times.

Ninety samples from one chemistry site (S001-568) from 2004-2008 were analyzed for BOD. The average for all the values is 2.70 mg/L with a low of 2.00 mg/L and a high of 17.00 mg/L. The summer average is (June-Aug) is 2.81 mg/L. The BOD value exceeded the standard of 3.50 mg/L 13 times.

Seven samples from one chemistry site (S001-568) in 2014 were analyzed for chlorophyll-a. The average for all the values is 27.36 ug/L with a low of 3.20 ug/L and a high of 65.80 ug/L. The summer average is (June-Aug) is 29.33 ug/L. The chlorophyll-a value exceeded the standard of 40 ug/L twice.

Table 327. Eutrophication related fish metrics in Okabena Creek (-602). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-602 Fish Class 2 – General Use	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct
04DM041 (2004)	0.00	8.54	82.81	10.22
04DM041 (2014)	0.00	0.88	95.60	5.10
14DM010	0.00	2.18	95.68	82.43
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)</i>	19	11.47	45.1	17
Expected response to Eutrophication stress	↓	↓	↑	↑

The fish community in Okabena Creek (-602) scored below average in three (04DM041-both visits) and four (14DM010) of the four eutrophication related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 327). Both sites and visits completely lacked sensitive fish species, had few darter individuals, and had elevated numbers of tolerant individuals. Site 14DM010 also had a very high amount of omnivorous individuals. These results are indicative of a community stressed by eutrophic conditions.

Table 328. Eutrophication related macroinvertebrate metrics in Okabena Creek (-602). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-602 Macroinvertebrate Class 5, 7 – General Use	EPT Pct	Tanytarsini Pct	CrustMoll Pct	Scraper Pct	% Tolerant Taxa	% Intolerant Taxa
04DM041	55.78	14.53	1.28	11.61	37.54	0.33
04DM046	47.51	19.62	1.47	12.32	40.12	0.00
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	43.90	27.84	9.23	15.78	17.17	5.79
14DM010	41.47	5.22	23.24	5.88	60.70	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	38.45	18.46	11.78	16.11	26.84	4.03
Expected response to Eutrophication stress	↓	↓	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in three (04DM041, 04DM046) and four (14DM010) of the six eutrophication related metrics when compared to all other Class 5 Southern Streams RR and Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold

(Table 328). All three of these sites had lower amounts of both phosphorus intolerant taxa and tanytarsini individuals, while also having elevated amounts of phosphorus tolerant taxa. These results are often found in streams with eutrophic conditions.

Based on the numerous standard exceedances for phosphorus, BOD, and chlorophyll-a, as well as DO flux, and the poor scoring eutrophication related metrics in both the fish and macroinvertebrate communities, eutrophication is a stressor to aquatic life in Okabena Creek (-602).

Nitrates

A total of 328 samples were taken from one chemistry site (S001-568) and one biological monitoring station (04DM041) from 2004-2016 and were analyzed for Inorganic Nitrogen (NO₂-NO₃). The average of all the values is 17.48 mg/L with a low of 0.75 mg/L and a high of 77.80 mg/L. The spring average (March-May) is 16.52 mg/L. The summer average (June-Aug) is 18.86 mg/L. Nitrate values exceeded 4 mg/L 321 times.

A quantile regression analysis for Class 7 stream stations showed that sites having a nitrate concentration in excess of 11.5 mg/L there was a 90% probability for impairment. The nitrate concentrations in this reach averaged more than this level. Similarly, a quantile regression analysis for Class 5 stream stations showed that sites having a nitrate concentration in excess of 18.1 mg/L there was a 75% probability for impairment. The nitrate concentrations in this reach well exceeded this level.

Table 329. Nitrate related macroinvertebrate metrics in Okabena Creek (-602). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

	TrichopteraChTx Pct	N Index Score	% N Tolerant	% N Intolerant
07100001-602				
Macroinvertebrate Class 5, 7 – General Use				
04DM041 (2004)	12.31	4.43	83.15	0.00
04DM041 (2014)	9.38	4.19	70.61	0.00
04DM046	14.29	4.66	80.52	0.00
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	13.16	3.00	48.68	0.96
14DM010	8.33	3.74	75.66	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	10.00	3.30	57.57	0.91
Expected response to N stress	↓	↑	↑	↓

The macroinvertebrate assemblage in Okabena Creek (-602) scored below average in three (04DM046) and four (04DM041, 14DM010) of the four nitrate related metrics when compared to all other Class 5 Southern Streams RR and Class 7 Prairie Streams GP stations that met the MIBI General Use Thresholds (Table 329). Site 04DM046 did have a slightly above average amount of trichoptera taxa present, however, the remaining metrics related to nitrates scored poorly at all sites and visits. This reach showed an especially high number of nitrate tolerant individuals.

Based on the extensive observed data set with numerous elevated nitrate concentrations, the quantile regression analysis for both Class 5 and 7 stations, and the very poorly scoring nitrate related biological

metrics at three different sites and many different visits, nitrates are a stressor to aquatic life in this reach.

Suspended Solids

A total of 33 samples taken from one chemistry site (S001-568) from 2007-2014 were analyzed for TSS. The average of all the values is 98.08 mg/L with a low of 22 mg/L and a high of 272 mg/L. The TSS concentrations exceeded the 65 mg/L standard 24 times.

The HSPF model calculated daily TSS values for this subwatershed from 1994-2014. These concentrations ranged from 4.69-690.59 mg/L with an average TSS value of 26.85 mg/L. Of these calculations, 245 (3.20%) were above the TSS standard.

This reach was determined to be impaired for turbidity in 2006. This impairment was confirmed again during the 2016 assessment.

Table 330. TSS related fish metrics in Okabena Creek (-602). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-602 Fish Class 2 – General Use	BenFdFrimPct	Centr- TolPct	HerbvtPct	Percfm- TolPct	RifflePct	SensitivePct	SlithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
04DM041	21.19	0.00	11.24	4.74	16.85	0.00	19.82	0.00	0.83	21.12
14DM010	3.73	0.00	0.21	3.73	1.55	0.00	3.11	0.00	2.28	23.80
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)</i>	37.38	4.89	9.61	18.66	32.49	18.65	39.38	4.97	11.68	17.59
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

The fish community in Okabena Creek (-602) scored below average in nine (04DM041) and 10 (14DM010) of the 10 TSS related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 330). Site 04DM041 did have an increased amount of herbivorous individuals, however, this site scored poorly in the remaining metrics similarly to site 14DM010. Both sites also had poor TSS Index scores. These results are often found in streams with elevated TSS concentrations.

Table 331. TSS related macroinvertebrate metrics in Okabena Creek (-602). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plectoptera Pct
07100001-602						
Macroinvertebrate Class 5, 7 – General Use						
04DM041	21.15	0.00	15.33	67.66	25.08	0.00
04DM046	21.58	0.00	16.00	55.52	9.38	0.00
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	15.87	3.02	11.59	35.23	26.89	0.54
14DM010	22.80	0.00	13.00	68.62	6.76	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	17.35	1.33	13.20	48.28	19.13	0.22
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

The macroinvertebrate assemblage in this reach scored below average in five (14DM010) and six (04DM041, 04DM046) of the six TSS related metrics when compared to all other Class 5 Southern Streams RR and Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 330). Site 14DM010 did have a slightly below average amount of TSS tolerant taxa, however, the remaining metrics scored poorly. All three of these sites had very high amounts of TSS tolerant individuals and very poor TSS Index scores. These results are common in streams with elevated TSS concentrations.

Based on the high rate of standard exceedances from the observed data set, the vast majority of TSS related metrics in both the fish and macroinvertebrate communities scoring poorly, as well as the current turbidity impairment in this reach, TSS is a stressor to aquatic life in Okabena Creek (-602).

Habitat

Okabena Creek (-602) had qualitative habitat assessments take place at its biological monitoring sites, 04DM041 and 14DM010, during the fish and macroinvertebrate sampling events in 2004 and 2014. The average MSHA scores from these visits were 57.53 (Fair) at 04DM041 and 41.13 (Poor) at 14DM010. Limiting the habitat at these sites was the row crop agriculture as a nearby land uses, no riparian buffer (04DM041), heavy to severe bank erosion (Figure 146), light stream shading, sand substrates, sparse fish cover (14DM010), light to moderate embeddedness, fair sinuosity and channel development (14DM010), and low to moderate channel stability. Further MSHA analysis can be seen in Figure 147.

Figure 146. Severe Bank erosion at 04DM041



Figure 147. Okabena Creek (-602) MSHA metric scores.

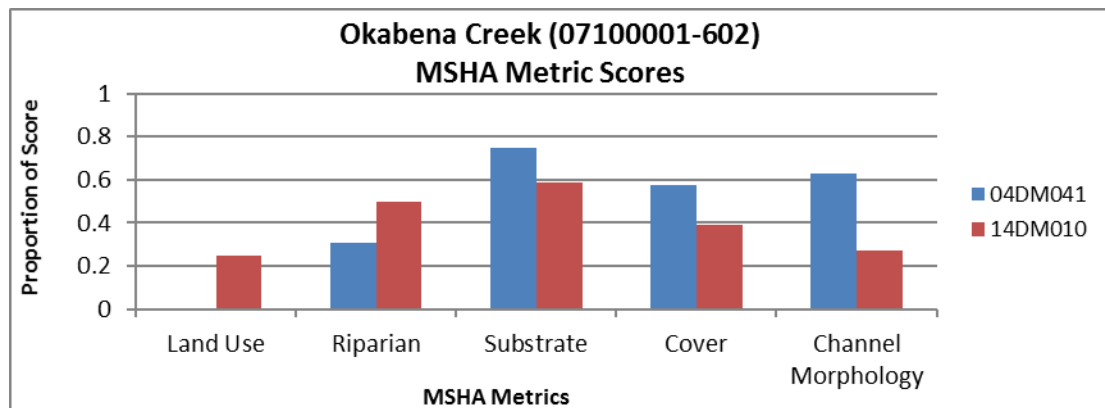


Table 332. Habitat related fish metrics in Okabena Creek (-602). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-602 Fish Class 2 – General Use	BenInsect-TolPct	SLithopPct	DarterSculpSu cPct	RifflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
04DM041	5.59	19.82	4.71	16.85	0.03	47.25	89.21	32.18
14DM010	2.22	3.11	2.18	1.55	1.56	5.59	95.68	86.29
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FBI General Use Threshold (50.0)</i>	20.4	39.38	18.18	32.49	5.24	58.26	44.85	19.02
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

The fish community in Okabena Creek (-602) at sites 04DM041 and 14DM010 scored below average in all eight of the habitat related metrics when compared to all other Class 2 Southern Streams stations that meet the FBI General Use Threshold (Table 332). Both sites had a very high amount of tolerant and pioneering individuals, while also having lower amounts of species requiring specialized habitat conditions to live and reproduce. These results reflect a community likely being negatively impacted by the current habitat conditions.

Table 333. Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-602 Macroinvertebrate Class 5, 7 – General Use	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
04DM041	10.41	21.26	34.78	28.76	47.50	21.65
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)</i>	5.66	12.52	49.77	42.46	34.53	13.99
14DM010	5.59	27.06	10.00	41.47	37.65	53.53
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)</i>	5.40	20.35	36.94	37.77	37.96	19.49
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate assemblage in this reach scored below average in two (14DM010) and four (04DM041) of the six habitat related metrics when compared to all other Class 5 Southern Streams RR and Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 333). Both sites had lower numbers of clinger individuals, while also having above average numbers of burrower individuals. The high amount of burrower and legless individuals at 04DM041 corresponds to the sand substrates in this stream. Site 04DM041 also had a below average amount of EPT individuals which can signal potential habitat stress.

Based on the poor to fair MSHA scores in this reach, as well as the many poor scoring habitat related metrics in both biotic communities, especially the fish community, habitat is a stressor to aquatic life in Okabena Creek (-602).

Altered Hydrology

Okabena Creek (-602) the reach itself is mostly un-altered though the majority of the upstream watershed is altered according to the MPCA altered watercourse layer.

“Though the channel was moderately incised, the entrenchment ratio was only slightly entrenched at 23.23 due to an expansive, flat floodplain. A large entrenchment ratio and very low slope has helped to maintain a relatively stable reach through this portion of Okabena Creek.” (DNR 2016).

Extreme weather events affect high flow events as well as also low flows during drought. HSPF models show this stream section experiencing low flow at less than five cfs 2.1% of the time and less than one cfs 0% of the time.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The average percentage for generalist fish within the reach was 61.0% compared to the average in Class 2 general use waters meeting the standard of 42.4%. General fish populations ranged from 37.9-86.5%.

The numbers of nest guarder species are also positively correlated with increased low flows. The average percentage for nest guarder fish within the reach was 39.3% compared to the average in Class 2 general use waters meeting the standard of 19%. Nest Guarder populations ranged from 14.3-84.0%.

Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The average percentage for long-lived macroinvertebrates within the reach was

0.3% compared to the average in Class 5 general use waters meeting the standard of 9%. Long-lived macroinvertebrate populations ranged from 0.3-0.3%. The percentage for long-lived macroinvertebrates within the reach was 0% compared to the average in Class 7 general use waters meeting the standard of 8%.

While many of the related biological metrics score poorly and many of the upstream tributaries to this reach are channelized, Okabena Creek (-602) has a relatively natural stream channel that is also fairly stable. Low flow conditions are also rarely present in this reach. Based on this information, Flow Alteration/Connectivity is inconclusive as a stressor.

Summary

The impaired fish and macroinvertebrate communities in Okabena Creek (-602) are being stressed by DO, Eutrophication, Nitrates, Suspended Sediment and Habitat (Table 334). Additionally, chloride is a known and accepted stressor to aquatic life. Flow Alteration/Connectivity was inconclusive as a stressor at this time. For further information on the stressors and recommendations to fixing the stressors in the Okabena Creek HUC 10 Watershed, please see pages 295-296.

Table 334. Stressor determinations in Okabena Creek (-602).

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Okabena Creek	07100001-602	●	●	●	●	●	o

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Unnamed Creek (07100001-614)

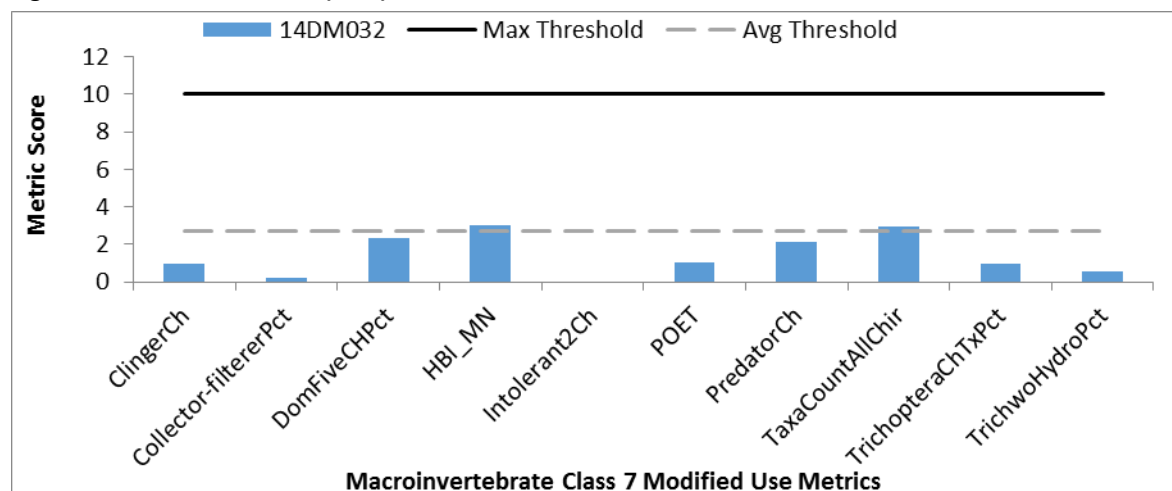
Located in northwest Jackson County, Unnamed Creek (-614) is a 3.78 mile long reach that is impaired for aquatic life due to the macroinvertebrate assemblage. This stream reach extends from unnamed creek down to the confluence with Judicial Ditch 84. Along this stream section there is one biological monitoring station, 14DM032.

Biology

Macroinvertebrates

The macroinvertebrate community in Unnamed Creek (-614) was sampled in August of 2014 and had an MIBI score of 14.32 which is below the Macroinvertebrate Class 7 Prairie Streams GP Modified Use Threshold of 22. This site did have two metrics (HBI_MN, TaxaCountAllChir) reach the average metric score needed to meet the threshold (Figure 148), however, the remaining eight metrics comprising this MIBI scored well below average with one metric scoring zero (Intolerant2Ch).

Figure 148. Unnamed Creek (-614) macroinvertebrate IBI metric scores.



Dissolved Oxygen

A total of 10 DO samples were taken from one chemistry site (S009-042) and one biological monitoring station (14DM032) from 2014-2016. The average of all the values is 11.82 mg/L with a low of 4.82 mg/L and a high of 19.95 mg/L. The summer average (June-Aug) is 12.54 mg/L. The DO values fell below 5 mg/L once. The wide range of measured DO values may be an indication that daily flux is an issue in this reach.

The HSPF model calculated daily minimum DO values for this subwatershed from 1994-2014. Of these calculations, 827 (10.78%) of the days had a daily minimum DO level below the daily minimum standard of 5 mg/L.

Table 335. DO related fish metrics in Unnamed Creek (-614). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-614 Fish Class 3 – Modified Use	MA>3 Avg	SspnPct Avg	Taxa Count Avg	DO TIV Avg
14DM032	0.00	26.83	9.00	8.43
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	14.39	10.56	10.03	8.25
Expected response to DO stress	↓	↑	↓	↓

The fish community in Unnamed Creek (-614) at site 14DM032 scored below average in three of the four DO related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI Modified Use Threshold (Table 335). This reach had an increased amount of serial spawning individuals, while also having no mature fish and a slightly below average taxa count. However, the DO TIV score was above average.

Table 336. DO related macroinvertebrate metrics in Unnamed Creek (-614). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-614 Macroinvertebrate Class 7 – Modified Use	HBI_MN Value	% DO Tolerant Taxa	# DO Tolerant Taxa	ChemTV_DO
14DM032	7.94	67.27	10.50	6.12
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22)</i>	8	31.37	9.33	6.19
Expected response to DO stress	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in three of the four DO related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 336). This reach had an increased percentage and number of DO tolerant taxa, while also having a slightly below average DO TIV score. The HBI_MN value did score above average in this reach.

The DO levels do fall below 5 mg/L and the model calculated an average exceedance rate. The majority of the fish and macroinvertebrate metrics related to DO to score below average. This reach also does have algae present, high phosphorus values, and a wide range of measured DO value, which are signals that daily flux is an issue in this reach. Based on this information, DO is a stressor to aquatic life in Unnamed Creek (-614) at this time.

Eutrophication

A total of 10 phosphorus samples were taken from one chemistry site (S009-042) and one biological monitoring station (14DM032) from 2014-2016. The average of all the values is 0.220 mg/L with a low of 0.01 and a high of 0.70 mg/L. The summer average (June-Aug) is 0.184 mg/L. Phosphorus values exceeded the standard of 0.150 mg/L four times. Site 14DM032 did have algae present during a sampling visit (Figure 149).

Figure 149. Algae present at site 14DM032.



The HSPF model calculated daily phosphorus values for this subwatershed from 1994-2014. These values ranged from 0.06-13.49 mg/L with an average value of 0.34 mg/L. Of these calculations, 4,835 (78.03%) were above the 0.15 mg/L standard.

Table 337. Eutrophication related fish metrics in Unnamed Creek (-614). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-614 Fish Class 3 – Modified Use	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct
14DM032	0.00	0.00	99.19	21.14
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)</i>	5.54	10.36	76.45	19.58

Expected response to Eutrophication stress | ↓ | ↓ | ↑ | ↑

The fish assemblage in Unnamed Creek (-614) at site 14DM032 scored below average in all four of the eutrophication related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI Modified Use Threshold (Table 337). This reach had a very high number of tolerant individuals, a slightly above average amount of omnivorous individuals, while completely lacking sensitive and darter species. These results are often found in streams with eutrophic conditions.

Table 338. Eutrophication related macroinvertebrate metrics in Unnamed Creek (-614). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-614 Macroinvertebrate Class 7 – Modified Use	EPT Pct	Tanytarsini Pct	CrustMoll Pct	Scraper Pct	% Tolerant Taxa	% Intolerant Taxa
14DM032	3.01	46.90	60.50	20.35	63.35	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22)</i>	20.58	22.11	23.21	17.73	45.87	1.43
Expected response to Eutrophication stress	↓	↓	↑	↑	↑	↓

The macroinvertebrate community in this reach scored below average in five of the six eutrophication related metrics when compared to all other Class 78 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 338). This reach did have an increased amount of tanytarsini individuals, however, this reach scored poorly in the remaining metrics by having low numbers of EPT and phosphorus intolerant taxa, while also having increased amounts of crustacean/mollusca and scraper individuals, as well as numerous phosphorus tolerant taxa.

Based on the high rate of standard exceedances in the observed and modeled data sets, the photographic evidence of abundant algae, as well as the majority of the eutrophication related metrics scoring poorly in both the fish and macroinvertebrate communities, eutrophication is a stressor to aquatic life in Unnamed Creek (-614).

Nitrates

There were 10 samples taken from one chemistry site (S009-042) and one biological monitoring station (14DM032) from 2014-2016 were analyzed for Inorganic Nitrogen (NO₂-NO₃). The average of all the values is 10.04 mg/L with a low of 0.98 mg/L and a high of 22.00 mg/L. The spring average (March-May) is 21.00 mg/L. The summer average (June-Aug) is 9.80 mg/L. Nitrate values exceeded 4 mg/L six times. A quantile regression analysis for Class 7 stream stations showed that sites having a nitrate concentration in excess of 11.5 mg/L there was a 90% probability for impairment. The nitrate concentrations in this reach easily exceeded this level.

The HSPF model calculated daily nitrate concentrations for this subwatershed from 1994-2014. These values ranged from 0.74-3022.4 mg/L with an average value of 9.17 mg/L. Of these calculations, 1738 (28.05%) were above 11.5 mg/L.

Table 339. Nitrate related macroinvertebrate metrics in Unnamed Creek (-614). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-614 Macroinvertebrate Class 7 – Modified Use	TrichopteraChtXP ct	N Index Score	% N Tolerant	% N Intolerant
14DM032	1.62	4.1	50.65	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22)</i>	5.71	3.30	62.54	0.00
Expected response to N stress	↓	↑	↑	↓

The macroinvertebrate assemblage at site 14DM032 in Unnamed Creek (-614) scored below average in three of the four nitrate related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 339). This reach did have a lower amount of nitrate tolerant individuals; however, this reach also had few trichoptera and nitrate intolerant taxa, while also having a poor nitrate index score. These results signal a stream likely being negatively impacted by nitrate conditions.

Based on the high observed and calculated nitrate concentrations, the quantile regression analysis, as well as the majority of the nitrate related macroinvertebrate metrics scoring below average, nitrates are indeed a stressor to aquatic life in Unnamed Creek (-614).

Suspended Solids

Nine samples taken from one chemistry site (S009-042) in 2016 were analyzed for TSS. The average of all the values is 3.33 mg/L with a low of 1.2 mg/L and a high of 5.6 mg/L. The TSS concentrations did not exceed the 65 mg/L standard.

Additionally, nine secchi tube measurements were taken from this reach. These values ranged from 79-100 cm, with no values falling below the 10 cm minimum standard for secchi tube.

The HSPF model calculated daily TSS values for this subwatershed from 1994-2014. These concentrations ranged from 0.60-1046.26 mg/L with an average TSS value of 17.65 mg/L. Of these calculations, 194 (3.13%) were above 65 mg/L.

Table 340. TSS related fish metrics in Unnamed Creek (-614). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-614 Fish Class 3 – Modified Use	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RifflePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14DM032	0.81	0.00	1.63	0.00	0.81	0.00	10.57	0.00	4.88	18.12
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)</i>	31.38	1.01	10.83	12.43	22.62	6.02	30.09	0.52	4.91	15.49
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

The fish community in Unnamed Creek (-614) at site 14DM032 scored below average in all ten of the TSS related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI Modified Use Threshold (Table 340). This reach had a poor TSS Index score and had very few species that are sensitive to elevated TSS conditions.

Table 341. TSS related macroinvertebrate metrics in Unnamed Creek (-614). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-614 Macroinvertebrate Class 7 – Modified Use	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
14DM032	16.80	0.00	9.00	25.58	1.11	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)</i>	16.02	0.60	10.98	35.60	9.91	0.02
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

The macroinvertebrate assemblage in this reach scored below average in four of the six TSS related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 341). Site 14DM032 did have a lower amount and percentage of TSS tolerant taxa, which is common in streams not affected by high TSS conditions. However, the remaining metrics did score poorly.

Both the observed and modeled data sets show little to no indications that the TSS concentrations in Unnamed Creek (-614) exceed the standard and begin harming aquatic life. It is likely that other stressors are causing the lower metric scores in both the fish and macroinvertebrate communities in this reach. Therefore, TSS is not a stressor at this time.

Habitat

Unnamed Creek (-614) had a qualitative habitat assessment take place at its biological monitoring site, 14DM032, during the fish and macroinvertebrate sampling events in 2014. The average MSHA score from these visits was 35.15 (Poor). Limiting the habitat at this site was row crop agriculture as the dominant nearby land use, light stream shading, severe embeddedness, sand and silt substrates, very little depth variability, poor channel development, and poor sinuosity (Figure 150). Further MSHA analysis can be seen in Figure 151.

Figure 150. Poor Sinuosity at 14DM032



Figure 151. Unnamed Creek (-614) MSHA metric scores.

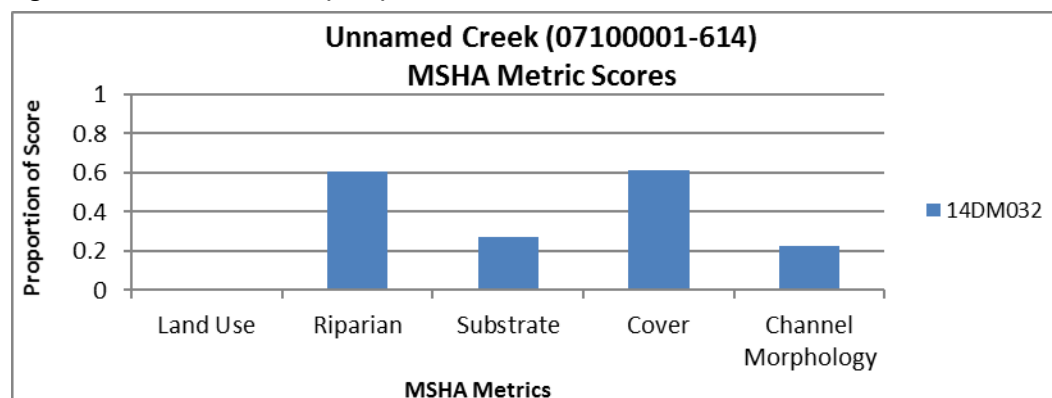


Table 342. Habitat related fish metrics in Unnamed Creek (-614). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-614 Fish Class 3 – Modified Use	BenInsect-TolPct	SLithopPct	DarterSculps ucPct	RifflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14DM032	0.00	10.57	0.00	0.81	0.81	66.67	99.19	72.36
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)</i>	10.91	30.09	10.59	22.62	1.97	57.98	46.70	32.54
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

The fish community in Unnamed Creek (-614) at site 14DM032 scored below average in seven of the eight habitat related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI Modified Use Threshold (Table 342). This site had a fish community dominated by creek chubs and fathead minnows, which are both really tolerant fish species and are often found in large numbers at streams with poor habitat conditions. This stream reach also lacked many species requiring specialized habitat conditions to live and reproduce which is a signal for potential habitat stress.

Table 343. Habitat related macroinvertebrate metrics in Unnamed Creek (-614). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-614 Macroinvertebrate Class 7 – Modified Use	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14DM032	11.58	23.84	15.96	3.01	52.83	43.98
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)</i>	9.74	24.34	20.62	15.52	59.46	22.88
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate assemblage in this reach scored below average in four of the six habitat related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 343). This reach did have a higher number of burrower individuals, which corresponds to the sand and silt substrates found in this stream. This site also had very few EPT individuals, and lower amounts of both clinger and climber individuals. These results are often found in streams with degraded habitat.

Based on the poor MSHA score as well as the majority of the habitat related metrics in both the fish and macroinvertebrate communities scoring below average, habitat is a stressor to aquatic life in Unnamed Creek (-614).

Altered Hydrology

Unnamed Creek (-614) is a tributary to Okabena Creek. The reach itself and almost its entire upstream watershed is altered according to the MPCA altered watercourse layer.

Extreme weather events affect high flow events as well as also low flows during drought. HSPF models show this stream section experiencing low flow at less than five cfs 56.2% of the time and less than one cfs 30.1% of the time.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The percentage for generalist fish within the reach was 87.0% compared to the average in Class 3 modified use waters meeting the standard of 56.3%.

The numbers of nest guarder species are also positively correlated with increased low flows. The percentage for nest guarder fish within the reach was 17.9% compared to the average in Class 3 modified use waters meeting the standard of 24%.

Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The average percentage for long-lived macroinvertebrates within the reach was 0.7% compared to the average in Class 7 modified use waters meeting the standard of 5.6%.

Based on the channelized conditions of this reach and the upstream tributaries, the frequent low flow conditions, as well as the majority of the related biological metrics scoring poorly, Flow Alteration/Connectivity is a stressor to aquatic life in Unnamed Creek (-614).

Summary

The impaired macroinvertebrate community in Unnamed Creek (-614) is being stressed by DO, Eutrophication, Nitrates, Habitat and Flow Alteration/Connectivity (Table 344). Suspended Sediment was ruled out as a stressor to aquatic life at this time. For further information on the stressors and recommendations to fixing the stressors in the Okabena Creek HUC 10 Watershed, please see pages 295-296.

Table 344. Stressor determinations for Unnamed Creek (-614).

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Unnamed Creek	07100001-614	●	●	●	---	●	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Okabena Creek Watershed (0710000105) HUC 10 conclusion and recommendations

The Okabena Creek subwatershed has three biologically impaired streams that are being negatively impacted by a number of stressors throughout the watershed. Stressors found in at all three impaired reaches include DO, Eutrophication, Nitrates, and Habitat. Flow Alteration/Connectivity was found at two of the streams thus far, while Suspended sediment was also found to be a stressor in just Okabena Creek (-602) (Table 345).

The predominant land use in this subwatershed is row crop agriculture with some development in the city of Worthington, located in the southwest portion of the watershed. Row crop agriculture is a significant contributor to the stressors found in these reaches. The land use combined with the channelization of these stream reaches and their tributaries are a major reason why these streams are impaired for aquatic life. These practices often lead to high nitrate and phosphorus levels through excessive use of fertilizers that can quickly reach the stream system by drain tiles and field runoff.

Elevated phosphorus levels will also impact the DO conditions resulting in many more tolerant fish and macroinvertebrate communities.

Channelizing streams can also lead to very high flow rates resulting in bank erosion. Bank erosion leads to higher amounts of both bedded and suspended sediment in the stream resulting in poor habitat and visibility conditions impacting the breeding and feeding environments for more sensitive fish and macroinvertebrate species.

A large effort is needed in the Okabena Creek Watershed to improve biological conditions in the impaired streams throughout. A high priority in this watershed should be to better manage the flow alteration and the effects of it. This can be achieved by increasing the storage and infiltration of water in locations with flow alteration stressors. This will also help reduce sediment inputs from stream banks, improve habitat by protecting streambanks, reduce erosion and overall stream sedimentation. Re-establishing a quality riparian corridor to increase stream stabilization, shading, and habitat features is also needed to improve conditions. Also, utilizing a variety of nutrient reducing BMPs including: cover crops, nutrient management, saturated buffers, etc., will also help in the nitrate and phosphorus reduction. This could also help with the eutrophication and resulting DO issues as well.

Table 345. Stressor determinations for the Okabena Creek Watershed.

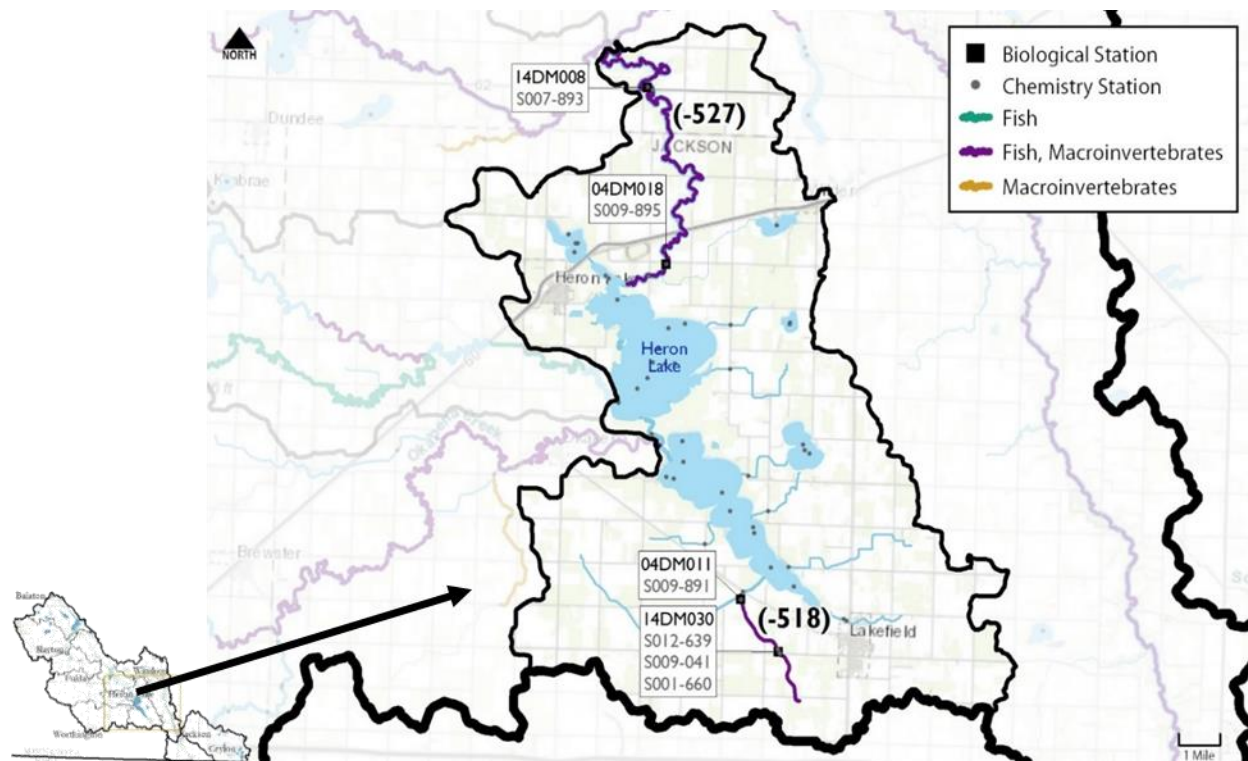
Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Elk Creek	07100001-656	●	●	●	o	●	●
Okabena Creek	07100001-602	●	●	●	●	●	o
Unnamed Creek	07100001-614	●	●	●	---	●	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

5.7 Heron Lake Watershed (0710000107)

The Heron Lake HUC-10 Watershed (0710000107) is a 119.98 mi² watershed (Figure 152) located in the southeastern portion of the Des Moines River-Headwaters Watershed. This watershed contains two biologically impaired reaches. The primary land use within this watershed by far is row crop agriculture with some open water areas.

Figure 152. Heron Lake Watershed with monitoring stations and biological impairments.



Heron Lake Outlet (07100001-527)

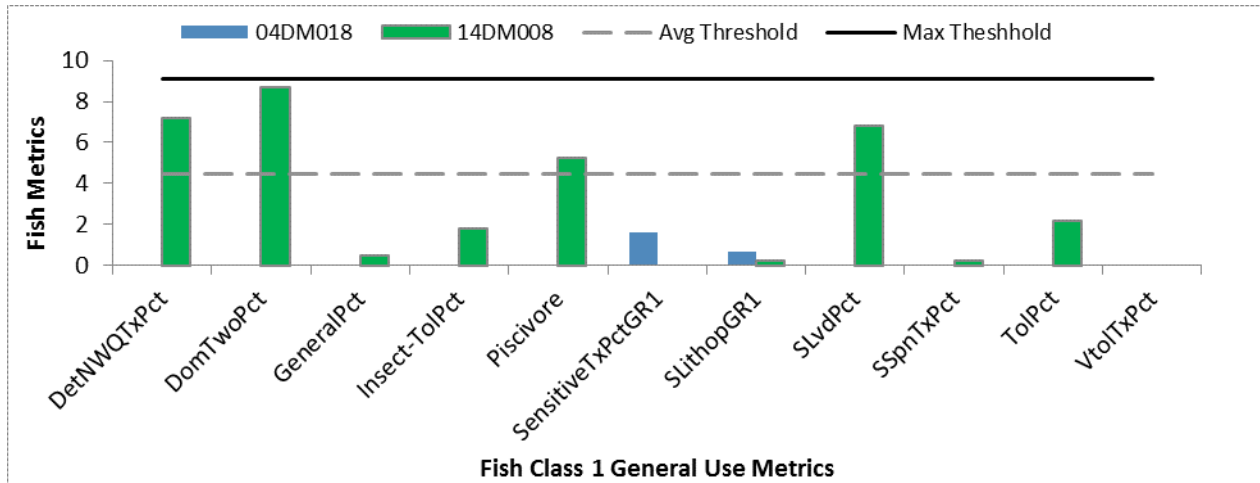
Located in parts of southcentral Cottonwood and northcentral Jackson County, Heron Lake Outlet (-527) is a 13.61 mile long reach that is impaired for aquatic life due to the fish and macroinvertebrate assemblages. This stream reach extends from the outlet of Heron Lake down to the confluence with the Des Moines River. Along this stream section, there are two biological monitoring stations, 04DM018 and 14DM008.

Biology

Fish

The fish community in Heron Lake Outlet (-527) was sampled for fish in August of 2014 at site 04DM018 in September of 2004 and had a FIBI score of 2.3, while site 14DM008 was sampled in August of 2014 and had a FIBI score of 22.9. Both of these scores are far below the Fish Class 1 Southern Rivers General Use Threshold of 49. Site 14DM008 did have four metrics (DetNWQTXPct, DomTwoPct, Piscivore, SLvdPct) reach the average metric score needed to meet the threshold (Figure 153), however, the remaining seven metrics comprising this FIBI scored well below average with two metrics scoring zero. Site 04DM018 had all eleven metrics score below average with nine of them scoring zero.

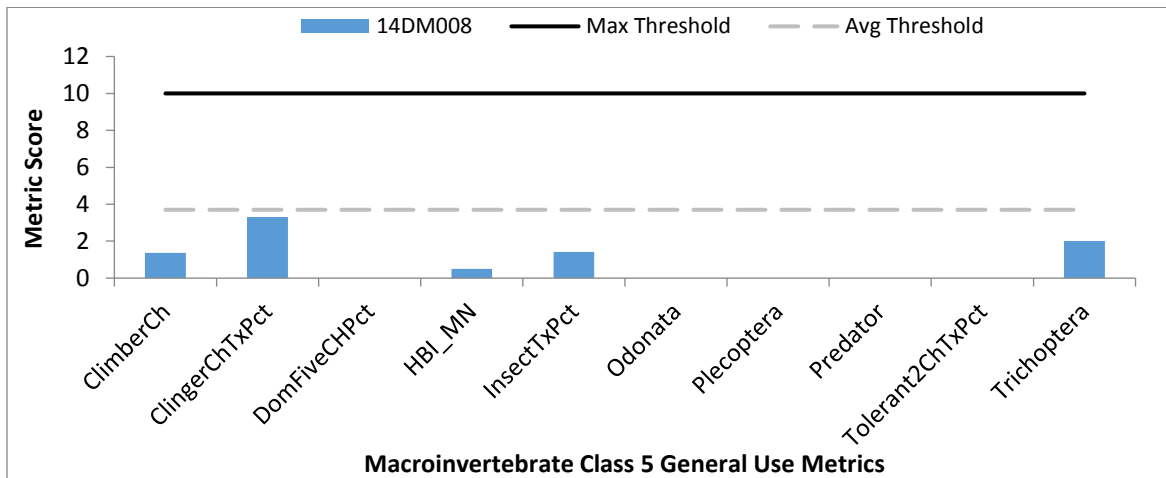
Figure 153. Heron Lake Outlet (-527) fish IBI metric scores.



Macroinvertebrates

The macroinvertebrate assemblage at site 14DM008 was sampled in August 2014 and had a MIBI score of 8.6, which is far below the Macroinvertebrate Class 5 Southern Streams RR General Use Threshold of 37. Site 04DM041 had zero metrics score above the average needed to reach the threshold with five of the metrics scoring zero. See Figure 154 for a complete breakdown of the metric scores at this site.

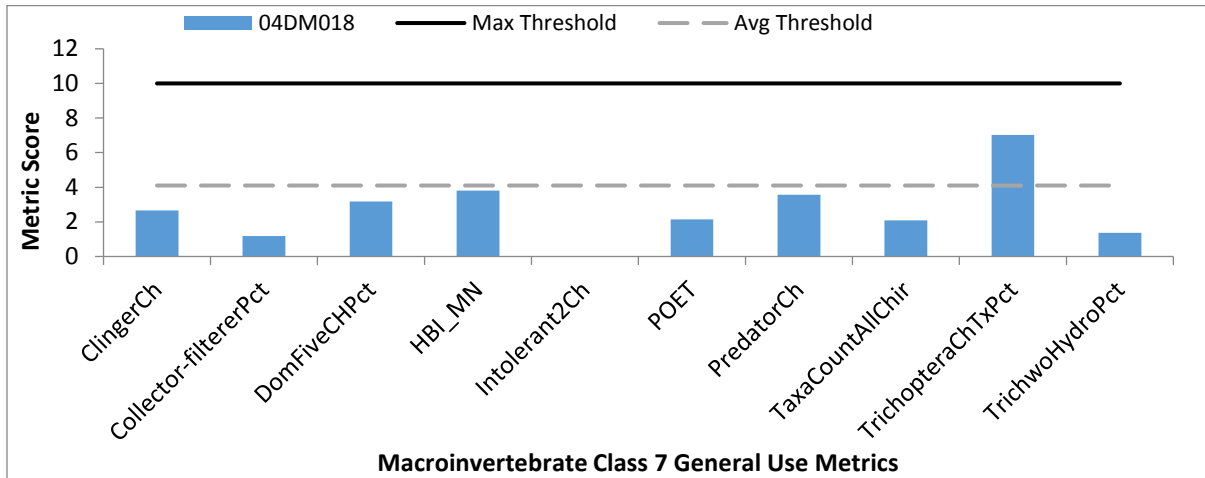
Figure 154. Heron Lake Outlet (-527) macroinvertebrate IBI class 5 IBI metric scores.



Macroinvertebrates

The macroinvertebrate assemblage at site 04DM018 was sampled in September of 2004 and had a MIBI score of 27.0, which is below the Macroinvertebrate Class 7 Prairie Streams GP General Use Threshold of 37. Site 04DM041 had one metric (TrichopteraChTxPct) score above the average needed to reach the threshold with the remaining nine metrics scoring below average. One of those nine metrics had a score of zero. See Figure 155 for a complete breakdown of the metric scores at this site.

Figure 155. Heron Lake Outlet (-527) macroinvertebrate IBI class 7 metric scores.

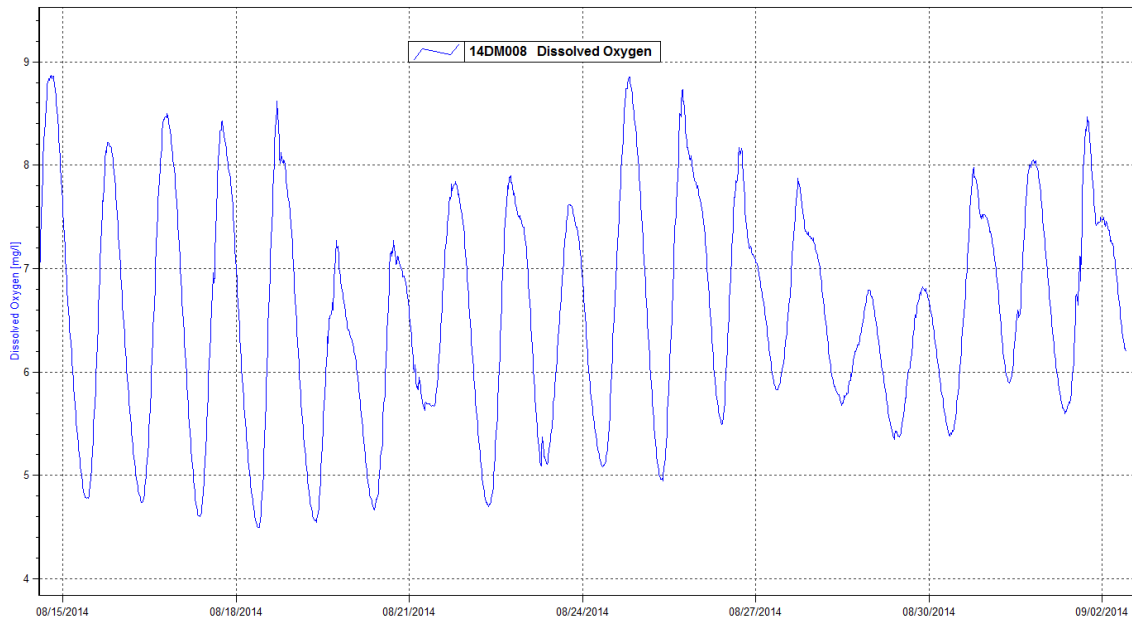


Dissolved Oxygen

A total of 269 DO measurements were taken from two chemistry sites (S002-009, S007-893) and one biological monitoring station (04DM018) from 2004-2016. The average of all the values is 8.86 mg/L with a low of 3.04 mg/L and a high of 21.37 mg/L. The summer average (June-Aug) is 7.46 mg/L. The DO values fell below 5 mg/L 21 times.

Continuous DO monitoring took place at site 14DM008 in 2014 (Figure 156). This monitoring showed that the daily DO levels frequently fell below the 5 mg/L daily minimum standard. The DO flux did not appear to exceed the 4.5 mg/L standard.

Figure 156. Continuous DO monitoring at site 14DM008 in Heron Lake Outlet (-527).



Additionally, the HSPF model calculated daily minimum DO values for this subwatershed from 1994-2014. Of these calculations, 224 (2.92%) of the days had a daily minimum DO level below the standard of 5 mg/L.

Table 346. DO related fish metrics in Heron Lake Outlet (-527). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-527 Fish Class 1 – General Use	MA>3 Avg	SspnPct Avg	Taxa Count Avg	DO TIV Avg
04DM018	2.00	68.38	7.00	8.51
14DM008	17.25	35.60	24.00	8.52
<i>Statewide average for Class 1 Southern Rivers stations that are meeting the FIBI General Use Threshold (49.0)</i>	40.4	35.61	22.44	8.76
Expected response to DO stress	↓	↑	↓	↓

The fish community in Heron Lake Outlet (-527) scored below average in two (14DM008) and four (04DM018) of the four DO related metrics when compared to all other Class 1 Southern Rivers stations that meet the FIBI General Use Threshold (Table 346). Both sites along this reach had decreased amounts of mature fish, while also having below average DO TIV scores. Site 04DM018 also had a high amount of serial spawning fish and a lower taxa count. These results are common in streams negatively impacted by low DO conditions.

Table 347. DO related macroinvertebrate metrics in Heron Lake Outlet (-527). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-527 Macroinvertebrate Class 5, 7 – General Use	HBI_MN Value	% DO Tolerant Taxa	# DO Tolerant Taxa	ChemTV _DO
14DM008	8.18	8.49	4.00	7.23
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	7.04	8.62	4.33	7.10
04DM018	7.71	43.75	10.00	5.16
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	7.55	12.98	5.74	6.91
Expected response to DO stress	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in one (14DM008) and four (04DM018) of the four DO related metrics when compared to all other Class 5 Southern Streams RR and Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 347). Both sites had poor HBI_MN values, while site 04DM018 fared worse in the remaining metrics by also having a high amount and percentage of DO tolerant taxa, and also a poor DO TIV score.

Based on the high frequency that the daily minimum DO standard of 5 mg/L is exceeded, as well as the majority of the fish and macroinvertebrate metrics related to DO score poorly, especially at site 04DM018, DO is a stressor to aquatic life in Heron Lake Outlet (-527).

Eutrophication

A total of 358 phosphorus samples taken from two chemistry sites (S002-009, S007-893) and one biological monitoring station (04DM018) from 2004-2016. The average of all the values is 0.247 with a low of 0.01 and a high of 0.93. The summer average (June-Aug) is 0.231. Phosphorus values exceeded the standard of 0.150 mg/L 242 times.

A total of 141 samples from one chemistry site (S002-009) from 2003-2008 were analyzed for BOD. The average for all the values is 8.92 mg/L with a low of 2.00 mg/L and a high of 37.00 mg/L. The summer average is (June-Aug) is 7.25 mg/L. The BOD value exceeded the standard of 3.50 mg/L 116 times.

Six samples from one chemistry site (S007-893) in 2014 were analyzed for chlorophyll-a. The average for all the values is 19.62 ug/L with a low of 1.10 ug/L and a high of 47 ug/L. The summer average is (June-Aug) is 14.14 ug/L. The chlorophyll-a value exceeded the standard of 40 ug/L one time.

Furthermore, this reach is currently impaired for nutrient/eutrophication biological indicators and is also located downstream of Heron Lake which is currently impaired for nutrients.

Table 348. Eutrophication related macroinvertebrate metrics in Heron Lake Outlet (-527). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-527 Fish Class 1 – General Use	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct
04DM018	0.00	0.00	100.00	98.28
14DM008	0.63	5.54	63.77	44.62
<i>Statewide average for Class 1 Southern Rivers stations that are meeting the FIBI General Use Threshold (49.0)</i>	13.75	4.46	22.36	15.72
Expected response to Eutrophication stress	↓	↓	↑	↑

The fish community in Heron Lake Outlet (-527) at sites 04DM018 and 14DM008 scored below average in three (14DM008) and all four (04DM018) of the eutrophication related metrics when compared to all other Class 1 Southern Rivers stations that meet the FIBI General Use Threshold (Table 348). Both sites along this reach had very high amounts of tolerant and omnivorous individuals, while also having very few sensitive individuals. Site 04DM018 also completely lacked darter species. These results are a strong indicator of stress due to eutrophic conditions.

Table 349. Eutrophication related macroinvertebrate metrics in Heron Lake Outlet (-527). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-527 Macroinvertebrate Class 7 – General Use	EPT Pct	Tanytarsini Pct	CrustMoll Pct	Scraper Pct	% Tolerant Taxa	% Intolerant Taxa
14DM008	54.89	0.00	8.20	5.36	10.69	0.00
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	43.90	27.84	9.23	15.78	17.17	5.79
04DM018	3.19	19.27	31.47	1.99	60.94	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	38.45	18.46	11.78	16.11	26.84	4.03
Expected response to Eutrophication stress	↓	↓	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in four (04DM018) and two (14DM008) of the six eutrophication related metrics when compared to all other Class 5 Southern Streams RR and Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold

(Table 349). Site 04DM018 had decreased amounts of EPT individuals and phosphorus intolerant taxa, while also having increased amounts of phosphorus tolerant taxa and crustacean/mollusca individuals, while site 14DM008 completely lacked any tanytarsini and phosphorus intolerant individuals. These results are common in streams with eutrophic conditions.

Based on the high rate of standard exceedances for phosphorus, BOD, and chlorophyll-a, the current nutrient/eutrophication impairment, the proximity to the nutrient impaired Heron Lake, as well as the majority of the eutrophication related fish and macroinvertebrate metrics scoring below average, eutrophication is a stressor to aquatic life in Heron Lake Outlet (-527).

Nitrates

There were 331 samples taken from two chemistry sites (S002-009, S007-893) and one biological monitoring station (04DM018) from 2004-2016 were analyzed for Inorganic Nitrogen (NO₂-NO₃). The average of all the values is 4.18 with a low of 0.05 and a high of 13.20. The spring average (March-May) is 4.966 mg/L. The summer average (June-Aug) is 3.81. Nitrate values exceeded 4 mg/L twice. A quantile regression analysis for Class 7 stream stations showed that sites having a nitrate concentration in excess of 11.5 mg/L there was a 90% probability for impairment. The nitrate concentrations in this reach exceeded this level.

The HSPF model calculated daily nitrate concentrations for this subwatershed from 1994-2014. These values ranged from 0.06-11.91 mg/L with an average value of 2.8 mg/L. Of these calculations, 9 (0.12%) were above 11.5 mg/L.

Table 350. Nitrate related macroinvertebrate metrics in Heron Lake Outlet (-527). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

	TrichopteraChTx Pct	N Index Score	% N Tolerant	% N Intolerant
07100001-527 Macroinvertebrate Class 5, 7 – General Use				
14DM008	19.05	4.28	85.22	0.00
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	13.16	3.00	48.68	0.96
04DM018	11.54	2.23	23.44	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	10.00	3.30	57.57	0.91
Expected response to N stress	↓	↑	↑	↓

The macroinvertebrate community in Heron Lake Outlet (-527) scored below average in one (04DM018) and three (14DM008) of the four nitrate related metrics when compared to all other Class 7 Prairie Streams GP and Class 5 Southern Streams RR stations that meet their respective MIBI General Use Thresholds (Table 350). Both sites had good numbers of trichoptera taxa, while they both lacked nitrate intolerant species. Site 14DM008 also had a very high number of nitrate tolerant individuals and a poor nitrate index score. Site 04DM018 fared much better.

With the extensive observed data set, the nitrate concentrations stay fairly low in Heron Lake Outlet (-527). The HSPF model calculated similar results to this. The nitrate related biological metrics were rather mixed in this reach as site 04DM018 scored very well as opposed to 14DM008. There are likely other

stressors limiting the biological metric scores at 14DM008 as nitrates are not a stressor to aquatic life at this time.

Suspended Solids

A total of 375 samples taken from one chemistry site (S002-009, S007-893) from 2004-2017 were analyzed for TSS. The average of all the values is 63.11 mg/L with a low of 6 mg/L and a high of 484 mg/L. The TSS concentrations was at or exceeded the 65 mg/L standard 140 times.

The HSPF model calculated daily TSS values for this subwatershed from 1994-2014. These concentrations ranged from 15.37-1019.32 mg/L with an average TSS value of 49.60 mg/L. Of these calculations, 885 (11.55%) were above the TSS standard of 65 mg/L.

This reach was determined to be impaired for turbidity during the 2006 assessment. This impairment was confirmed during the 2016 assessment as well.

Table 351. TSS related fish metrics in Heron Lake Outlet (-527). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

0710001-527 Fish Class 1 – General Use	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RifflePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
04DM018	0.29	0.00	0.14	0.00	0.29	0.00	0.29	0.00	31.19	28.59
14DM008	6.33	0.95	0.00	15.51	2.69	0.63	10.13	0.00	28.32	28.33
<i>Statewide average for Class 1 Southern Rivers stations that are meeting the FIBI General Use Threshold (49.0)</i>	21.36	4.12	1.04	17.97	13.92	13.53	24.97	4.63	43.61	25.99
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

The fish community in Heron Lake Outlet (-527) at site 04DM018 and 14DM008 scored below average in all ten of the TSS related metrics when compared to all other Class 1 Southern Rivers stations that meet the FIBI General Use Threshold (Table 351). These sites had very few species that are sensitive to elevated TSS concentrations, while also having poor TSS Index scores. These results are common in streams with high TSS levels.

Table 352. TSS related macroinvertebrate metrics in Heron Lake Outlet (-527). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-527 Macroinvertebrate Class 5, 7 – General Use	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plectoptera Pct
14DM008	20.22	0.00	11.00	90.25	48.90	0.00
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	15.87	3.02	11.59	35.23	26.89	0.54
04DM018	14.43	0.00	13.00	20.31	4.78	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	17.35	1.33	13.20	48.28	19.13	0.22
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

The macroinvertebrate assemblage in this reach scored below average in three (04DM018) and four (14DM008) of the six TSS related metrics when compared to all other Class 5 Southern Streams RR and Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 352). Site 04DM018 fared much better than site 14DM008 as this site had a good TSS Index score, while also having a lower amount and percentage of TSS tolerant taxa and individuals. These results do not often occur in streams with elevated TSS concentrations. Site 14DM008 did have an above average amount of collector-filterer individuals and a slightly below average amount of TSS tolerant taxa, but scored poorly in the remaining metrics and had a macroinvertebrate community similar to one that is likely stressed by TSS.

Based on the high standard exceedance rate from the very large observed data set, the very poor scoring fish metrics related to TSS, the below average macroinvertebrate metrics related to TSS at site 14DM008, as well as the current turbidity impairment on this reach, TSS is a stressor to aquatic life in Heron Lake Outlet (-527).

Habitat

Heron Lake Outlet (-527) had qualitative habitat assessments take place at its biological monitoring sites, 04DM018 and 14DM008, during the fish and macroinvertebrate sampling events in 2004 and 2014. The average MSHA scores from these visits were 27 (Poor) at 04DM018 and 71.8 (Good) at 14DM008. Limiting the habitat at these sites was the row crop agriculture as a nearby land use, a narrow riparian buffer, moderate bank erosion (14DM008), no stream shading (04DM018), sand and silt substrates, nearly absent fish cover (14DM018), severe embeddedness, poor sinuosity, moderate channel stability, and poor channel development (14DM018) Further MSHA analysis can be seen in Figure 157.

Figure 157. Heron Lake Outlet (-527) MSHA metric scores.

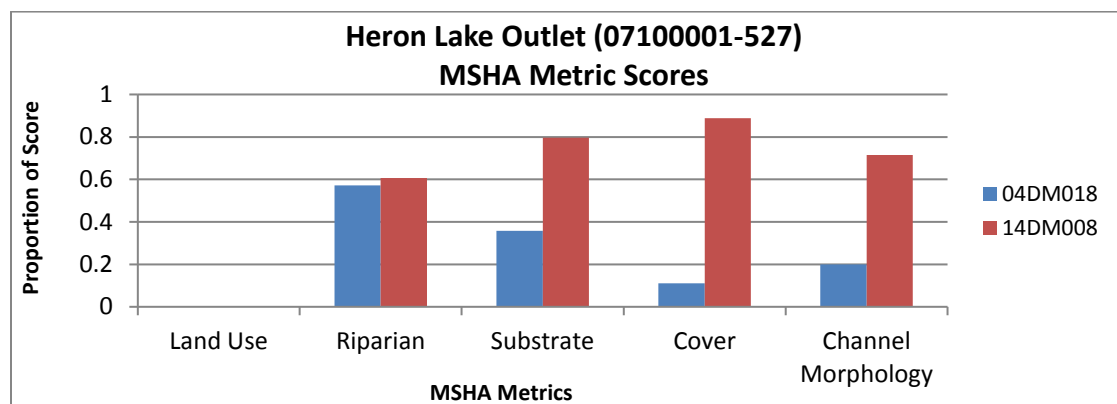


Table 353. Habitat related fish metrics in Heron Lake Outlet (-527). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-527 Fish Class 1 – General Use	BenInsect-TolPct	SLithopPct	DarterSculpSu cPct	RifflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
04DM018	0.00	0.29	0.00	0.29	0.00	0.29	100.00	67.38
14DM008	6.65	10.13	5.70	2.69	9.18	11.87	63.77	33.86
<i>Statewide average for Class 1 Southern Rivers stations that are meeting the FIBI General Use Threshold (49.0)</i>	20.61	24.97	18.51	13.92	15.18	29.21	22.05	5.21
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

The fish community in Heron Lake Outlet (-527) at sites 04DM018 and 14DM008 scored below average in all eight of the habitat related metrics when compared to all other Class 1 Southern River stations that meet the FIBI General Use Threshold (Table 353). There was a large difference in the number of species sampled at each site as site 04DM018 had seven species, while site 14DM008 had 24 species. However, at both sites the species captured were mainly tolerant and pioneer species. These species are often present in higher numbers at sites with poor habitat conditions. Both sites also lacked many species needing specialized habitat conditions to live and reproduce. Site 04DM018 fared worse than site 14DM008.

Table 354. Habitat related macroinvertebrate metrics in Heron Lake Outlet (-527). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-527 Macroinvertebrate Class 5, 7 – General Use	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14DM008	3.79	36.91	51.10	54.89	40.69	6.94
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)</i>	5.66	12.52	49.77	42.46	34.53	13.99
04DM018	18.33	27.49	15.14	3.19	63.75	37.85
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)</i>	5.40	20.35	36.94	37.77	37.96	19.49
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate assemblage in this reach scored below average in two (14DM008) and four (04DM018) of the six habitat related metrics when compared to all other Class 5 Southern streams RR and Class 7 Prairie streams GP stations that meet the MIBI General Use Threshold (Table 354). Both sites had a high amount of legless individuals, while site 04DM018 also had a high number of burrower individuals. These results may be due to the excessive sand and silt substrates found at this site. Site 04DM018 also had lower numbers of clinger and EPT individuals signaling likely habitat stress.

The habitat conditions in this reach vary greatly at the two biological monitoring stations. Habitat does not appear to be a stressor at site 14DM008 as this site had a good MSHA score and the majority of the macroinvertebrate metrics related to habitat scored very well. The fish community is likely being stressed by other factors. In the upstream portion of this stream reach, site 04DM018 is being stressed by the habitat conditions due to the poor MSHA score, as well as the majority of both the fish and macroinvertebrate metrics related to habitat scoring below average or poorly. Site 14DM008 is located on more of a natural stream section as opposed to site 04DM018, which appears to be channelized.

Altered Hydrology

Heron Lake Outlet (-527) flows directly into the Des Moines River. The reach itself is almost entirely natural though almost its entire upstream watershed is altered according to the MPCA altered watercourse layer. The lake outlet itself has been identified as a fish barrier.

Extreme weather events affect high flow events as well as also low flows during drought. HSPF models show this stream section experiencing low flow at less than five cfs 0.3% of the time and less than one cfs 0% of the time.

Generalist fish species, which are adaptable to different habitats through generalized food preferences are correlated with channelization. The average percentage for generalist fish within the reach was 80.3% compared to the average in Class 1 general use waters meeting the standard of 20.7%. Generalist fish species ranged from 61.7-98.9%.

The numbers of nest guarder species are also positively correlated with increased low flows. The average percentage for nest guarder fish within the reach was 52.8% compared to the average in Class 1 general use waters meeting the standard of 21.4%. Nest guarder species ranged from 38.1-67.4%.

Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The percentage for long-lived macroinvertebrates within the reach was 0%

compared to the average in Class 5 general use waters meeting the standard of 9%. The percentage for long-lived macroinvertebrates within the reach was 0.4% compared to the average in Class 7 general use waters meeting the standard of 8%.

This reach does score poorly in the related biological metrics and is close to a fish barrier, however, the reach is completely natural and has consistent flow, therefore, it is inconclusive if the fish barrier and upstream channelization in the headwaters of this watershed are stressing aquatic life in Heron Lake Outlet (-527) at this time.

Summary

The impaired fish and macroinvertebrate communities in Heron Lake Outlet (-527) are being stressed by DO, Eutrophication, Suspended Sediment, Habitat (Table 355). Flow Alteration/Connectivity was inconclusive as a stressor while Nitrates were ruled out as a stressor to aquatic life at this time. For further information on the stressors and recommendations to fixing the stressors in the Heron Lake HUC 10 Watershed, please see pages 316-317.

Table 355. Stressor determinations for Heron Lake Outlet (-527).

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Heron Lake Outlet	07100001-527	●	●	---	●	●	○

● = stressor; ○ = inconclusive stressor; --- = not an identified stressor

Unnamed Creek (07100001-518)

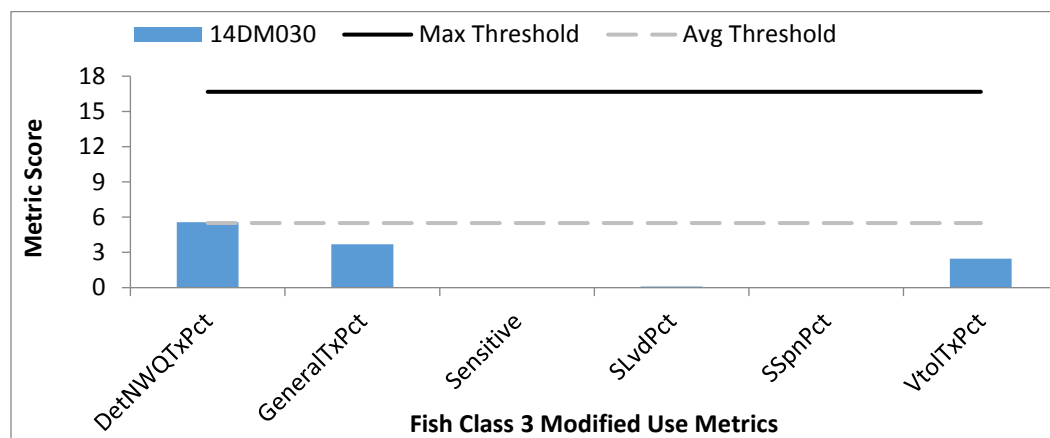
Located in central Jackson County, Unnamed Creek (-518) is a 3.11 mile long reach that is impaired for aquatic life due to the fish and macroinvertebrate assemblages. This stream reach extends from unnamed creek down to the confluence with Judicial Ditch 3. Along this stream section there are two biological monitoring stations, 04DM011 and 14DM030.

Biology

Fish

The fish community in Unnamed Creek (-518) was sampled for fish in July of 2015 at its biological monitoring station 14DM030. The FBI score at this reach was 23, which is below the Fish Class 3 Southern Headwaters Modified Use Threshold of 33. This site did have one metric (DetNWQTxPct) reach the average metric score needed to meet the threshold (Figure 158), however, the remaining five metrics comprising this FBI scored well below average with two metrics scoring zero (Sensitive, SSpnPct). This site was also dominated by the presence of fathead minnows and brook sticklebacks, two very tolerant fish species often found in large numbers in degraded streams.

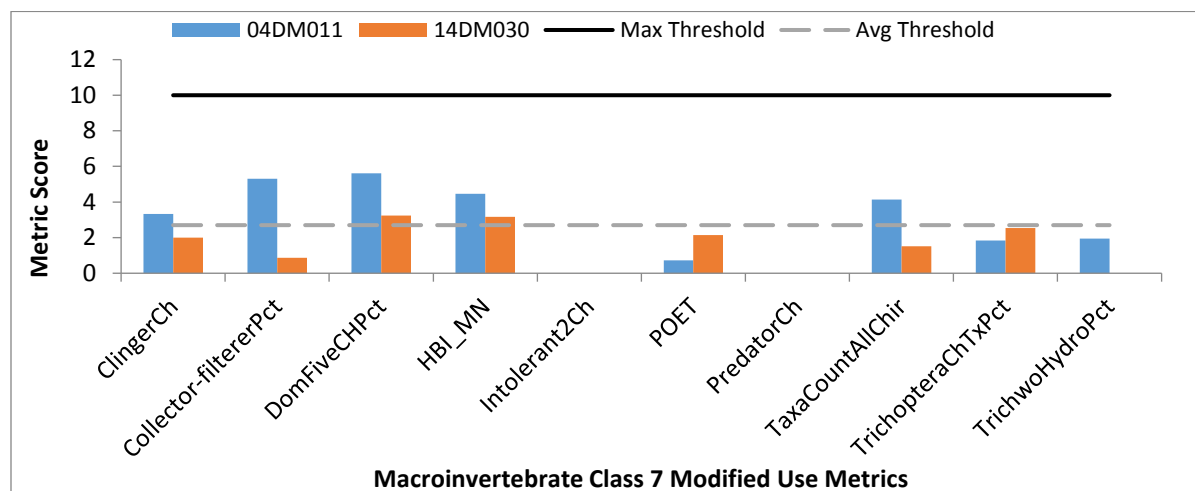
Figure 158. Unnamed Creek (-518) fish IBI metric scores.



Macroinvertebrates

The macroinvertebrate assemblage at site 04DM011 was sampled in August of 2004 and had a MIBI score of 27.3, while site 14DM030 was sampled in August of 2014 and had a MIBI score of 15.5. The MIBI score at site 14DM030 is below the Macroinvertebrate Class 7 Prairie Streams GP General Use Threshold of 22. Site 04DM011 had five while site 14DM030 had two metrics score above the average needed to reach the threshold with the remaining metrics scored below average. See Figure 159 for a complete breakdown of the metric scores at these sites.

Figure 159. Unnamed Creek (-518) macroinvertebrate IBI metric scores.

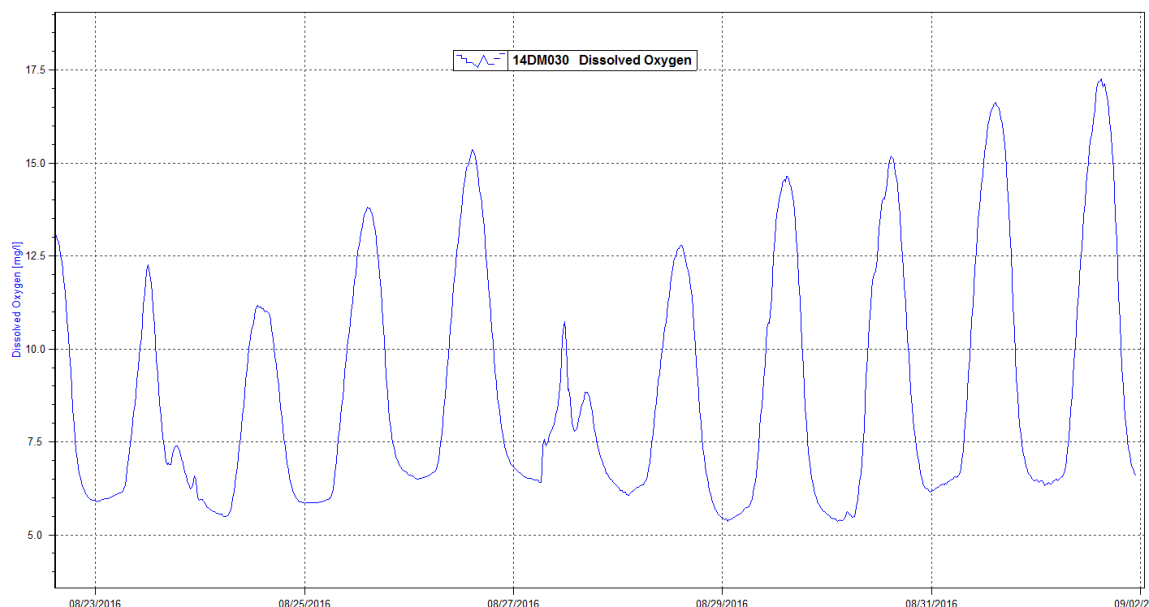


Dissolved Oxygen

A total of 13 dissolved oxygen (DO) measurements were taken from one chemistry site (S009-041) and two biological monitoring stations (14DM030, 04DM011) from 2004-2016. The average of all the values is 8.33 mg/L with a low of 4.31 mg/L and a high of 12.52 mg/L. The summer average (June-Aug) is 8.08 mg/L. The DO values fell below 5 mg/L three times.

Continuous DO monitoring took place at site 14DM030 in 2016 (Figure 160). During this monitoring, the DO levels did stay above 5 mg/L, however the daily flux frequently exceeded the 4.5 mg/L standard for the southern region of the state. These results often indicate stress from DO and potentially eutrophication as well.

Figure 160. Continuous DO monitoring at site 14DM030 in Unnamed Creek (-518).



Additionally, the HSPF model calculated daily minimum DO values for this subwatershed from 1994-2014. Of these calculations, 1359 (17.72%) of the days had a daily minimum DO level below the standard of 5 mg/L.

Table 356. DO related fish metrics in Unnamed Creek (-518). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-518 Fish Class 7 – Modified Use	MA>3 Avg	SspnPct Avg	Taxa Count Avg	DO TIV Avg
04DM011	4.69	4.69	8.00	7.68
<i>Statewide average for Class 7 Low Gradient stations that are meeting the FIBI Modified Use Threshold (15.0)</i>	9.79	28.58	11.74	7.81
Expected response to DO stress	↓	↑	↓	↓

The fish community in Unnamed Creek (-518) at site 04DM011 scored below average in three of the four DO related metrics when compared to all other Class 7 Low Gradient stations that meet the FIBI Modified Use Threshold (Table 356). This reach did have a low amount of serial spawning individuals, which can dominate a community when DO conditions are poor, however, this reach had few mature fish (greater than three years), a lower overall taxa count, and a below average DO TIV score. These results are often found in streams being negatively impacted by the DO conditions.

Table 357. DO related macroinvertebrate metrics in Unnamed Creek (-518). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-518 Macroinvertebrate Class 7 – Modified Use	HBI_MN Value	% DO Tolerant Taxa	# DO Tolerant Taxa	ChemTV DO
04DM011	7.51	20.00	9.00	5.73
14DM030	7.91	41.64	4.00	5.70
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22)</i>	8	31.37	9.33	6.19
Expected response to DO stress	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in one (04DM011) and two (14DM030) of the four DO related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 357). Both sites had poor DO TIV scores, while site 14DM030 also had an increased percentage of DO tolerant taxa. These results signal potential DO stress.

The DO levels according to the observed measurements and modeled data show a high rate of times in which the 5 mg/L daily minimum standard was exceeded. The continuous monitoring showed a very high level of DO flux that constantly exceeded the 4.5 mg/L standard. Additionally, many of the DO related metrics, especially in the fish community, scored poorly. Therefore, DO is a stressor to aquatic life in Unnamed Creek (-518) at this time.

Eutrophication

A total of 13 phosphorus samples were taken from one chemistry site (S009-041) and two biological monitoring stations (14DM030, 04DM011) from 2004-2016. The average of all the values is 0.163 with a low of 0.09 and a high of 0.35. The summer average (June-Aug) is 0.146. Phosphorus values exceeded 0.150 mg/L six times. Algae and excessive plant growth was observed at site S009-041 in 2016 (Figure 161).

Figure 161. Algal growth at site S009-041.



The HSPF model also calculated daily phosphorus concentrations for this subwatershed from 1994-2014. These values ranged from 0.05-9.14 mg/L with an average concentration of 0.33 mg/L. Of these calculations, 4879 (77.86%) were above the 0.15 mg/L standard.

Table 358. Eutrophication related fish metrics in Unnamed Creek (-518). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-518 Fish Class 7 – Modified Use	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct
04DM011	0.00	0.00	99.53	33.80
<i>Statewide average for Class 7 Low Gradient stations that are meeting the FIBI Modified Use Threshold (15.0)</i>	16.71	6.74	55.88	16.77
Expected response to Eutrophication stress	↓	↓	↑	↑

The fish community in Unnamed Creek (-518) at site 04DM011 scored below average in all four of the eutrophication related metrics when compared to all other Class 7 Low Gradient stations that meet the FIBI Modified Use Threshold (Table 358)., This reach had very high amounts of tolerant and omnivorous individuals, while also completely lacking darter and sensitive fish species. These results are common in streams with eutrophic conditions.

Table 359. Eutrophication related macroinvertebrate metrics in Unnamed Creek (-518). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

	EPT Pct	Tanytarsini Pct	CrustMoll Pct	Scraper Pct	% Tolerant Taxa	% Intolerant Taxa
07100001-518 Macroinvertebrate Class 7 – Modified Use						
04DM011	3.99	46.82	3.37	0.00	33.03	0.00
14DM030	5.25	38.89	39.67	10.49	45.90	0.00
<i>Statewide average for Class 7 Prairie Streams Glide Pool stations that are meeting the MIBI Modified Use Threshold (22)</i>	20.58	22.11	23.21	17.73	45.87	1.43
Expected response to Eutrophication stress	↓	↓	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in two (04DM011) and four (14DM030) of the six eutrophication related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 359). Both sites had low numbers of EPT and phosphorus intolerant taxa. Site 14DM030 also had increased numbers of crustacean/mollusca individuals and phosphorus tolerant taxa. These results are common in streams with eutrophic conditions.

Based on the high rate of standard exceedances in both the observed and modeled phosphorus data sets, the high DO flux values that can indicate potentially eutrophic conditions, the photo of excessive algae/plant growth, as well as the majority of the eutrophication related metrics in both the fish and macroinvertebrate assemblages scoring below average, eutrophication is a stressor to aquatic life in Unnamed Creek (-518).

Nitrates

There were 13 samples taken from one chemistry site (S009-041) and two biological monitoring stations (14DM030, 04DM011) from 2004-2016 were analyzed for Inorganic Nitrogen (NO₂-NO₃). The average of all the values is 9.80 with a low of 2.50 and a high of 19.00. The spring average (March-May) is 19.00 mg/L. The summer average (June-Aug) is 9.74. Nitrate values exceeded 4 mg/L 11 times. A quantile regression analysis for Class 7 stream stations showed that sites having a nitrate concentration in excess of 11.5 mg/L there was a 90% probability for impairment. The nitrate concentrations in this reach easily exceeded this level.

The HSPF model calculated daily nitrate concentrations for this subwatershed from 1994-2014. These values ranged from 1.45-232.88 mg/L with an average value of 9.17 mg/L. Of these calculations, 1399 (25.69%) were above 11.5 mg/L.

Table 360. Nitrate related macroinvertebrate metrics in Unnamed Creek (-518). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-518 Macroinvertebrate Class 7 – Modified Use	TrichopteraChTx Pct	N Index Score	% N Tolerant	% N Intolerant
04DM011	3.03	3.05	66.97	0.00
14DM030	4.17	3.31	55.41	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22)</i>	5.71	3.30	62.54	0.00
Expected response to N stress	↓	↑	↑	↓

The macroinvertebrate community in Unnamed Creek (-518) scored below average in three of the four metrics at sites 14DM030 and 04DM011 when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 360). These sites both lacked or had very few trichoptera and nitrate intolerant taxa. Site 04DM011 had a higher amount of nitrate tolerant individuals and site 14DM030 had a slightly above average nitrate index score.

The nitrate concentrations in this reach are elevated based on both the observed and calculated results. This information, along with the quantile regression analysis, and the majority of the nitrate related macroinvertebrate metrics scoring below average concludes that nitrates are a stressor to aquatic life in this reach.

Suspended Solids

Ten samples taken from one chemistry site (S009-041) in 2016 were analyzed for TSS. The average of all the values is 25.32 mg/L with a low of 10 mg/L and a high of 58 mg/L. The TSS concentrations did not exceed the 65 mg/L standard.

Additionally, ten secchi tube measurements were taken from this reach. These values ranged from 13-48 cm, with no values falling below the 10 cm minimum standard for secchi tube.

The HSPF model calculated daily TSS values for this subwatershed from 1994-2014. These concentrations ranged from 1.25-1408.00 mg/L with an average TSS value of 14.75 mg/L. Of these calculations, 153 (2.81%) were above 65 mg/L.

Table 361. TSS related fish metrics in Unnamed Creek (-518). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-518 Fish Class 3, 7 – Modified Use	BenFdFrimPct	Centr-TolPct	HerbivPct	Percfm-TolPct	RifflePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14DM030	1.35	0.00	1.35	0.00	1.35	0.00	20.45	0.00	0.00	21.51
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)</i>	31.38	1.01	10.83	12.43	22.62	6.02	30.09	0.52	4.91	15.49
04DM011	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.00	30.99	22.52
<i>Statewide average for Class 7 Low Gradient stations that are meeting the FIBI Modified Use Threshold (15.0)</i>	12.20	4.38	8.17	13.36	7.35	17.28	20.49	3.61	7.09	14.09
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

The fish community in Unnamed Creek (-518) scored below average in nine (04DM011) and 10 (14DM030) of the 10 TSS related metrics when compared to all other Class 3 Southern Headwaters stations and Class 7 Low Gradient stations that meet the FIBI Modified Use Threshold (Table 361). Site 04DM011 did have an above average amount of long lived individuals, however, the site scored poorly in the remaining metrics, similarly to site 14DM030.

Table 362. TSS related macroinvertebrate metrics in Unnamed Creek (-518). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-518 Macroinvertebrate Class 7 – Modified Use	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
04DM011	11.90	0.00	6.00	4.24	20.25	0.00
14DM030	15.20	0.00	10.00	30.49	3.61	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)</i>	16.02	0.60	10.98	35.60	9.91	0.02
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

The macroinvertebrate assemblage scored below average in two (04DM011) and three (14DM030) of the six TSS related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 362). Both sites had good TSS index scores, while also having a lower amount and percentage of TSS tolerant taxa. These results signal a community that is not likely stressed by the TSS conditions.

Based on the very low exceedance rate calculated by the model, zero exceedances of the observed data set, as well as the majority of the macroinvertebrate metrics related to TSS scoring above average including TSS Index scores at both sites, TSS is not a stressor to aquatic life in Unnamed Creek (-518). Other stressors are likely causing lower metric scores in the fish community in this reach.

Habitat

Unnamed Creek (-518) had a qualitative habitat assessment take place at its biological monitoring sites, 04DM011 and 14DM030, during the fish and macroinvertebrate sampling events in 2004 and 2014. The average MSHA score from these visits were 45 (Poor) at 04DM011 and 53.58 (Fair) at 14DM030. Limiting the habitat at these sites was the row crop agriculture and development as the dominant nearby land uses, a narrow to moderate stream riparian buffer, light stream shading (04DM011), sand and silt substrates, sparse to moderate fish cover, poor sinuosity (Figure 162) and poor to fair channel development. Further MSHA analysis can be seen in Figure 163.

Figure 162. Poor Sinuosity at 14DM030



Figure 163. Unnamed Creek (-518) MSHA metric scores.

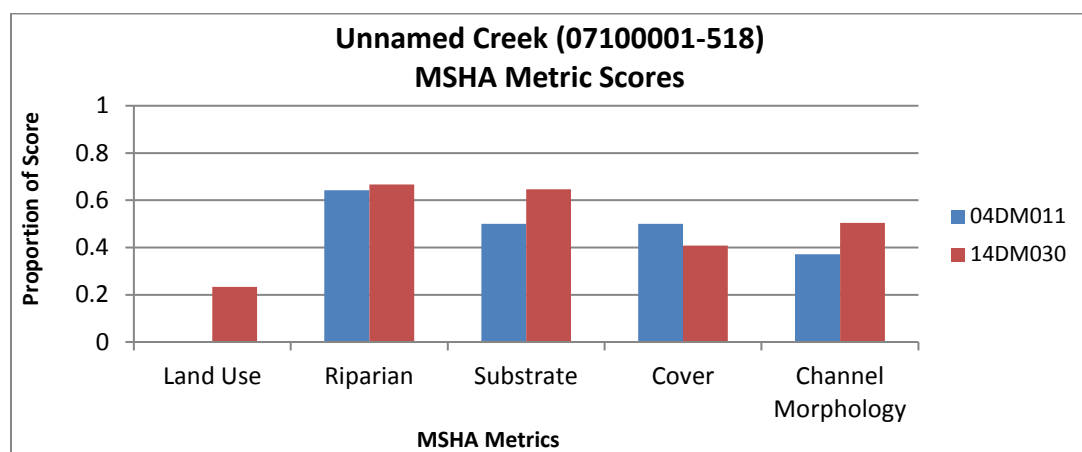


Table 363. Habitat related fish metrics in Unnamed Creek (-518). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-518 Fish Class 3, 7 – Modified Use	BenInsect- ToIPct	SLithopPct	DarterSculps ucPct	RifflePct	PiscivorePct	LithFrimPct	ToIPct	PioneerPct
14DM030	0.00	20.45	0.00	1.35	0.00	22.73	98.65	68.61
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FBI Modified Use Threshold (33.0)</i>	10.91	30.09	10.59	22.62	1.97	57.98	46.70	32.54
04DM011	0.00	0.47	0.00	0.00	0.00	1.88	99.53	4.69
<i>Statewide average for Class 7 Low Gradient stations that are meeting the FBI Modified Use Threshold (15.0)</i>	7.06	20.49	6.80	7.35	3.67	25.67	56.03	19.20
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

The fish community in Unnamed Creek (-518) at sites 14DM030 and 04DM011 scored below average in seven (04DM011) and eight (14DM030) of the eight habitat related metrics when compared to all other Class 3 Southern Headwaters and Class 7 Low Gradient stations that meet the FBI Modified Use Threshold (Table 363). Both sites were dominated by tolerant fish species, while having very few or

completely lacking species requiring specialized habitat conditions to live and reproduce. These results often are common in streams being negatively impacted by the habitat conditions.

Table 364. Habitat related macroinvertebrate metrics in Unnamed Creek (-518). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-518 Macroinvertebrate Class 7 – Modified Use	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14DM030	2.30	37.70	18.03	5.25	63.93	34.43
04DM011	32.82	2.45	49.39	3.99	83.13	12.88
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)</i>	9.74	24.34	20.62	15.52	59.46	22.88
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate community in Unnamed Creek (-518) scored below average in three (14DM030) and five (04DM011) of the six habitat related metrics when compared to all other Class 7 Prairie Streams GP station that meet the MIBI Modified Use Threshold (Table 364). Site 04DM011 had a high amount of both burrower and legless individuals, which corresponds to the sand and silt substrates found during the habitat assessment. Both sites also had very few EPT individuals, while site 04DM011 also lacked many climber and sprawler individuals as well. These results are common in streams being negatively impacted by the habitat conditions.

Based on the poor to fair MSHA ratings for this stream, as well as the majority of the habitat related metrics in both the fish and macroinvertebrate communities scoring below average, habitat is a stressor to aquatic life in Unnamed Creek (-518).

Altered Hydrology

Unnamed Creek (-518) flows into Heron Lake and the reach itself is entirely altered and as is the entire upstream watershed according to the MPCA altered watercourse layer.

Extreme weather events affect high flow events as well as also low flows during drought. HSPF models show this stream section experiencing low flow at less than five cfs 53.6% of the time and less than one cfs 11.4% of the time.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The average percentage for generalist fish within the reach was 89.1% compared to the average in Class 7 modified use waters meeting the standard of 35%. Generalist fish species ranged from 80.8-97.3%.

The numbers of nest guarder species are also positively correlated with increased low flows. The average percentage for nest guarder fish within the reach was 76.7% compared to the average in Class 7 modified use waters meeting the standard of 29.6%. Nest guarder species ranged from 59.5-94.0%.

Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The average percentage for long-lived macroinvertebrates within the reach was 3.9% compared to the average in Class 7 modified use waters meeting the standard of 5.6%. Long-lived macroinvertebrates ranged from 2.6-6.4%.

Based on the current stream channelization of this reach, the frequency of low flow conditions, as well as the poor scoring biological metrics, Flow Alteration/Connectivity is a stressor to aquatic life in Unnamed Creek (-518).

Summary

The impaired fish and macroinvertebrate communities in Unnamed Creek (-518) are being stressed by DO, Eutrophication, Nitrates, Suspended Sediment, Habitat and Flow alteration/Connectivity (Table 365). Suspended Sediment was ruled out as a stressor to aquatic life at this time. For further information on the stressors and recommendations to fixing the stressors in the Heron Lake HUC 10 Watershed, please see pages 316-317.

Table 365. Stressor determinations for Unnamed Creek (-518).

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Unnamed Creek	07100001-518	●	●	●	---	●	●

● = stressor; ○ = inconclusive stressor; --- = not an identified stressor

Heron Lake Watershed (0710000107) HUC 10 conclusion and recommendations

The Heron Lake subwatershed has two biological impaired streams that are being negatively impacted by numerous stressors in the watershed. Stressors found in both impaired reaches include DO, Eutrophication, and Habitat. Nitrates and Flow Alteration/Connectivity were found to be a stressor in Unnamed Creek (-518), while suspended sediment was found to be a stressor in Heron Lake Outlet (Table 366).

The predominant land use in this subwatershed is row crop agriculture, with some areas of open water (Heron Lake), and development (City of Heron Lake and Lakefield). Row crop agriculture is a significant contributor to the stressors found in these reaches. The land use combined with the channelization of these stream reaches and their tributaries are a major reason why these streams are impaired for aquatic life. These practices often lead to high nitrate and phosphorus levels through excessive use of fertilizers that can quickly reach the stream system by drain tiles and field runoff. These elevated phosphorus levels will also impact the DO conditions resulting in many more tolerant fish and macroinvertebrate communities.

Channelizing streams can also lead to very high flow rates resulting in bank erosion. Bank erosion leads to higher amounts of both bedded and suspended sediment in the stream resulting in poor habitat and visibility conditions impacting the breeding and feeding environments for more sensitive fish and macroinvertebrate species. Poor habitat was an issue in both reaches in this watershed, while flow alteration/connectivity and suspended sediment were also problematic in one reach a piece.

A large effort is needed in the Heron Lake watershed to improve biological conditions in the two impaired streams. A high priority in this watershed should be to better manage the flow alteration and the effects of it. This can be achieved by increasing the storage and infiltration of water in locations with flow alteration stressors. This will also help reduce sediment inputs from stream banks, improve habitat by protecting streambanks, reduce erosion and overall stream sedimentation. Re-establishing a quality riparian corridor with deep rooted vegetation to increase stream stabilization, shading, and habitat features is also needed to improve conditions. Also, utilizing a variety of nutrient reducing BMPs including: cover crops, nutrient management, saturated buffers, etc., will also help in the nitrate and phosphorus reduction. This could also help with the eutrophication and resulting DO issues as well.

Table 366. Stressor determinations for Heron Lake Watershed.

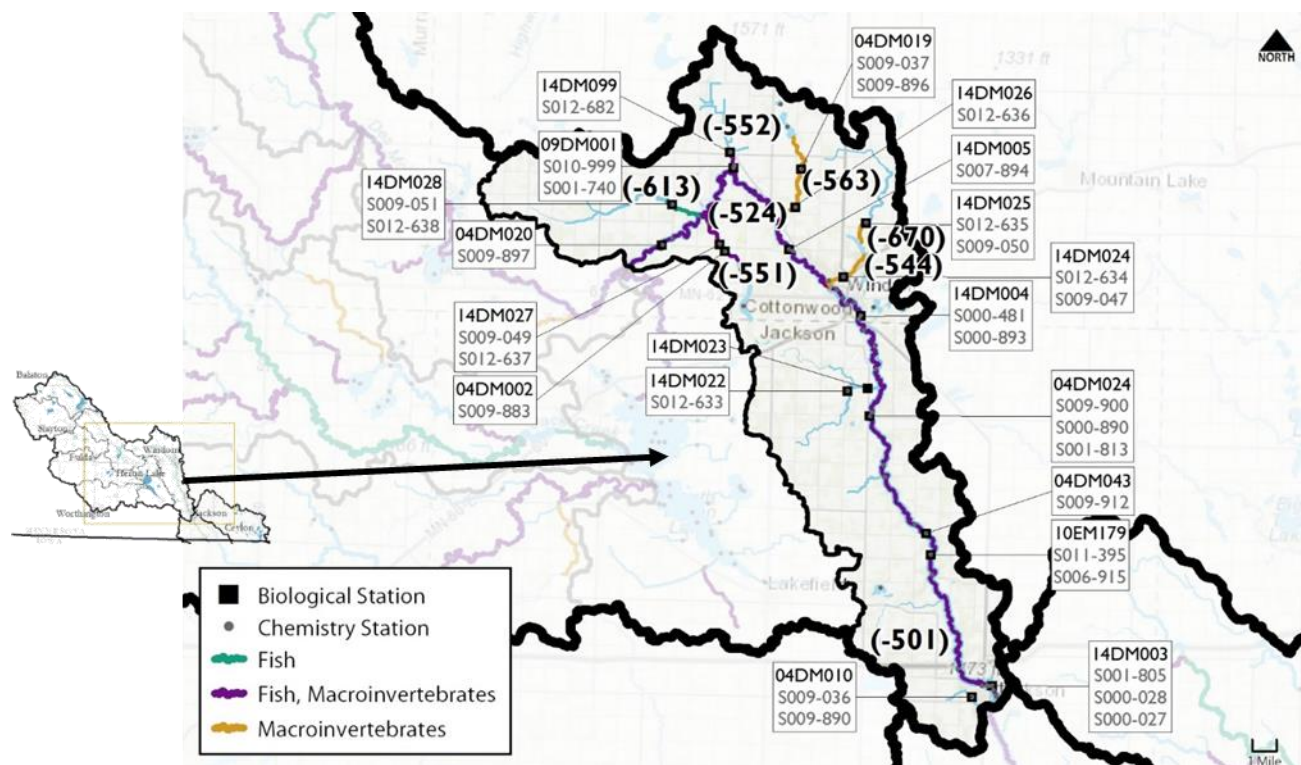
Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Heron Lake Outlet	07100001-527	●	●	---	●	●	○
Unnamed Creek	07100001-518	●	●	●	---	●	●

● = stressor; ○ = inconclusive stressor; --- = not an identified stressor

5.8 City of Windom – Des Moines River Watershed (0710000108)

The City of Windom-Des Moines River HUC-10 Watershed (0710000108) is a 224.38 mi² watershed (Figure 1643) located in the southeastern portion of the Des Moines River-Headwaters watershed. This watershed contains eight biologically impaired reaches. The primary land use within this watershed by far is row crop agriculture with some hay/pasture and developed areas as well.

Figure 164. City of Windom-Des Moines River Watershed with monitoring stations and biological impairments.



Des Moines River (07100001-501)

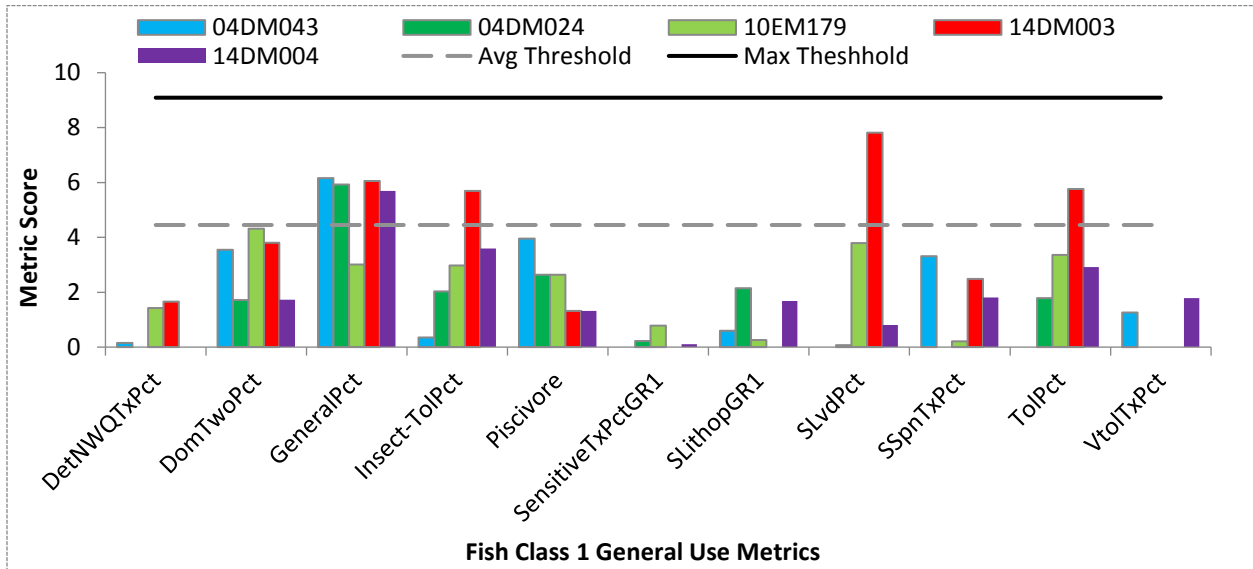
Located in a small section southcentral Cottonwood County and predominately the eastern portion of Jackson County, the Des Moines River (-501) is a 24.86 mile long reach that is impaired for aquatic life due to the fish and macroinvertebrate assemblages. This stream reach extends from the Windom Dam down to the Jackson Dam. Along this stream section, there are five biological monitoring stations, 04DM024, 04DM043, 10EM179, 14DM003 and 14DM004.

Biology

Fish

The fish community in Des Moines River (-501) was sampled at the biological monitoring stations located along the reach, 04DM043, 04DM024, 10EM179, 14DM003, and 14DM004. Site 04DM043 was sampled in August of 2004 and had a FBI score of 19.3. Site 04DM024 was also sampled in August of 2004 and had a FBI score of 16.5. Site 10EM179 was sampled in September of 2011 and had a FBI score of 22.7. Site 14DM003 was sampled in August of 2014 and had a FBI score of 29.6 and 14DM004 was also sampled in August of 2014 and had a FBI score of 21.4. All of these scores are below the Fish Class 1 Southern Rivers General Use Threshold of 49. See Figure 165 for further analysis of the metric scores in this reach.

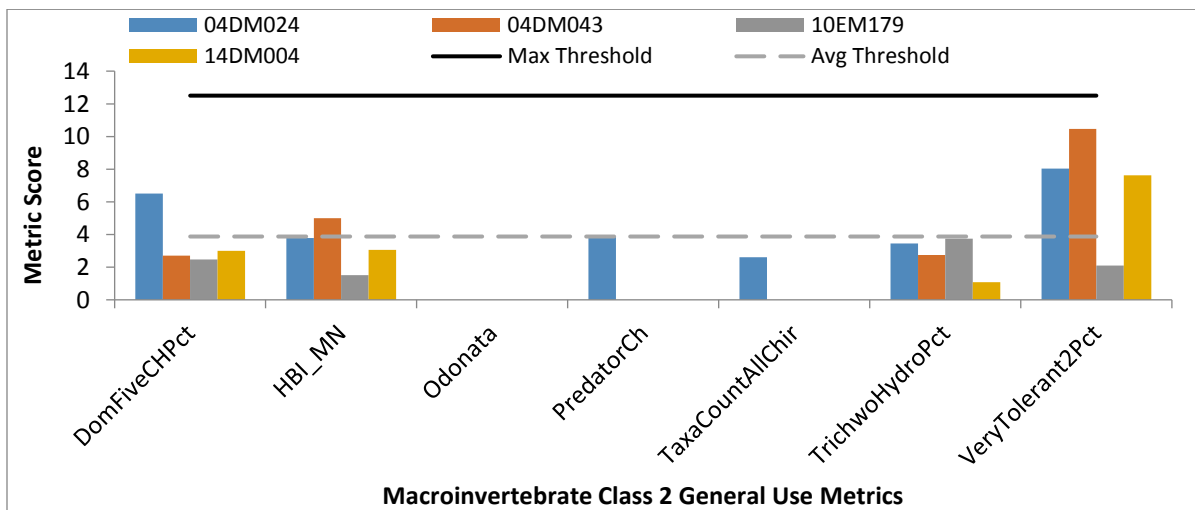
Figure 165. Des Moines River (-501) fish IBI metric scores.



Macroinvertebrates

The macroinvertebrate assemblage was sampled at sites 04DM024 in September of 2004 and had a MIB score of 28.9. Site 04DM043 was sampled in September of 2004 and had a MIBI score of 20.9. Site 10EM179 was sampled in August of 2010 and had a MIBI score of 9.8. Lastly, site 14DM004 was sampled in August of 2014 and had a MIBI score of 14.8. All of these scores were below the Macroinvertebrate Class 2 Prairie Forest Rivers General Use Threshold of 31. See Figure 166 for a complete breakdown of the metric scores at these sites.

Figure 166. Des Moines River (-501) macroinvertebrate IBI metric scores.

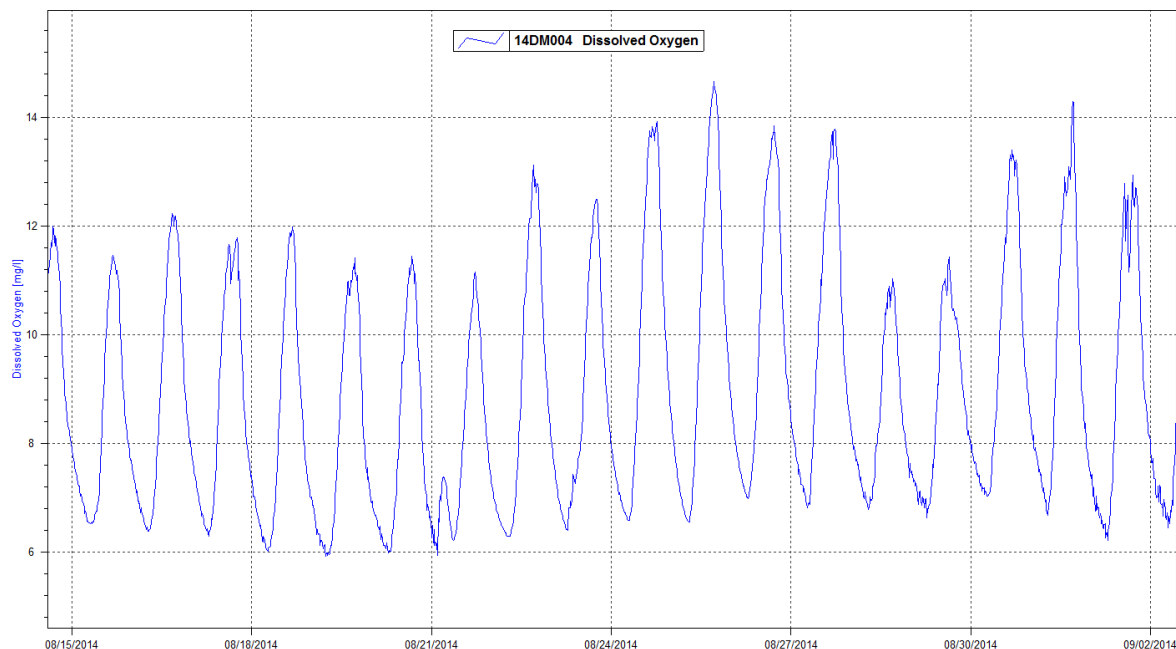


Dissolved Oxygen

A total of 186 DO measurements were taken from four chemistry sites (S000-027, S000-481, S000-893, S005-936) and five biological monitoring stations (04DM024, 04DM043, 10EM179, 14DM003, 14DM004) from 2004-2017. The average of all the values is 9.24 mg/L with a low of 4.32 mg/L and a high of 21.07 mg/L. The DO values fell below 5 mg/L twice.

Continuous DO monitoring took place at site 14DM004 in 2014 (Figure 167). This monitoring showed that the daily DO levels stayed above the 5 mg/L daily minimum standard. However, the DO flux frequently exceeded the 4.5 mg/L standard indicating potential stress from DO as well as eutrophication.

Figure 167. Continuous DO monitoring at site 14DM004 in Des Moines River (-501).



This reach was determined to be impaired for DO during a 1994 assessment. This impairment was confirmed again during the 2016 assessment.

Table 367. DO related fish metrics in Des Moines River (-501). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-501 Fish Class 1 – General Use	MA>3 Avg	SspnPct Avg	Taxa Count Avg	DO TIV Avg
04DM024	5.48	85.59	18.00	8.93
04DM043	2.54	69.46	17.00	8.84
10EM179	13.33	67.18	16.00	8.83
14DM003	11.17	67.51	19.00	8.61
14DM004	3.74	91.39	18.00	8.73
<i>Statewide average for Class 1 Southern Rivers stations that are meeting the FIBI General Use Threshold (49.0)</i>	40.4	35.61	22.44	8.76
Expected response to DO stress	↓	↑	↓	↓

The fish community in the Des Moines River (-501) scored below average in three (04DM024, 04DM043, 10EM179) and four (14DM003, 14DM004) of the four DO related metrics when compared to all other Class 1 Southern Rivers stations that meet the FIBI General Use Threshold (Table 367). All five sites had a below average taxa count, few mature fish greater than 3 years, while also having a very high amount of serial spawning individuals. Two of the sites also had poor DO TIV scores. These results are commonly found in streams being negatively impacted by the DO conditions.

Table 368. DO related macroinvertebrate metrics in Des Moines River (-501). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-501 Macroinvertebrate Class 2 – General Use	HBI_MN Value	% DO Tolerant Taxa	# DO Tolerant Taxa	ChemTV _DO
04DM024	7.47	2.09	3.00	7.26
04DM043	7.20	1.66	3.00	7.77
10EM179	7.99	4.11	3.00	7.42
14DM004	7.64	1.89	3.00	7.48
<i>Statewide average for Class 2 Prairie Forest River stations that are meeting the MIBI General Use Threshold (31)</i>	7.32	8.67	4.41	7.13
Expected response to DO stress	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in zero (04DM043) and one (04DM024, 10EM179, 14DM004) of the four DO related metrics when compared to all other Class 2 Prairie Forest River stations that meet the MIBI General Use Threshold (Table 368). Three sites had poor HBI_MN values, while scoring well in the remaining metrics. These results are not common in streams with DO issues.

The DO levels in the Des Moines River (-501) rarely fall below the 5 mg/L daily minimum standard, however, the daily flux greatly exceeds the daily 4.5 mg/L standard for the southern region of the state. This reach is also currently impaired for DO. The DO related metrics in the fish community also scored very poorly, therefore, DO is a stressor to aquatic life in this reach.

Eutrophication

A total of 200 phosphorus samples taken from four chemistry sites (S000-027, S000-481, S000-893, S005-936) and five biological monitoring stations (04DM024, 04DM043, 10EM179, 14DM003, 14DM004) from 2004-2017. The average of all the values is 0.19 mg/L with a low of 0.05 mg/L and a high of 0.68 mg/L. Phosphorus values exceeded the standard of 0.150 mg/L 112 times.

Eleven samples from one chemistry site (S005-936) from 2011-2013 were analyzed for chlorophyll-a. The average for all the values is 119.95 ug/L with a low of 20.2 ug/L and a high of 294 ug/L. The chlorophyll-a values exceeded the standard of 40 ug/L eight times.

Furthermore, this reach is currently impaired for Nutrient/eutrophication biological indicators.

Table 369. Eutrophication related fish metrics in Des Moines River (-501). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-501 Fish Class 1 –General Use	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct
04DM024	0.00	0.58	67.15	7.64
04DM043	0.00	0.66	82.66	4.62
14DM003	0.00	0.51	33.50	11.68
14DM004	0.08	0.49	57.60	24.86
10EM179	2.05	8.72	53.85	10.77
<i>Statewide average for Class 1 Southern Rivers stations that are meeting the FIBI General Use Threshold (49.0)</i>	13.75	4.46	22.36	15.72
Expected response to Eutrophication stress	↓	↓	↑	↑

The fish community in the Des Moines River (-501) scored below average in two (10EM179), three (04DM024, 04DM043, 14DM003), and four (14DM004) of the four eutrophication related metrics when compared to all other Class 1 Southern Rivers stations that meet the FIBI General Use Threshold (Table 369). All five sites had very few sensitive individuals, while also having elevated numbers of tolerant fish. In addition, four of the sites had very few darter individuals, which can also signal stress from eutrophic conditions.

Table 370. Eutrophication related macroinvertebrate metrics in Des Moines River (-501). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-501 Macroinvertebrate Class 2 – General Use	EPT Pct	Tanytarsini Pct	CrustMoll Pct	Scraper Pct	% Tolerant Taxa	% Intolerant Taxa
04DM024	74.83	12	0	9.44	13.59	0.35
04DM043	82.89	17.07	0	21.14	6.31	0.33
10EM179	72.38	20.78	0	13.33	25.95	0
14DM004	70.35	6.90	0	2.84	10.09	0
<i>Statewide average for Class 2 Prairie Forest River stations that are meeting the MIBI General Use Threshold (31)</i>	54.79	17.03	6.59	13.83	25.29	6.53
Expected response to Eutrophication stress	↓	↓	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in two out of the six eutrophication related metrics at all four sites located along this reach when compared to all other Class 2 Prairie Forest River stations that meet the MIBI General Use Threshold (Table 370). All four of the sites did have a very low amount of phosphorus intolerant taxa. These sites did also have a high amount of EPT individuals, which is not common in streams with potentially eutrophic conditions.

Based on the current nutrient impairment, the high rate of phosphorus and chlorophyll-a standard exceedances, the high amount of DO flux present in this reach, as well as the many poor scoring eutrophication related metrics in both the fish and macroinvertebrate communities, eutrophication is a stressor to aquatic life in Des Moines River (-501).

Nitrates

A total of 282 samples taken from four chemistry sites (S000-027, S000-481, S000-893, S000-894, S005-936) and three biological monitoring stations (04DM024, 04DM043, 10EM179) from 2004-2017 were analyzed for Inorganic Nitrogen (NO₂-NO₃). The average of all the values is 4.18 mg/L with a low of 0.05 mg/L and a high of 16 mg/L. The spring average (March-May) is 3.92 mg/L. The summer average (June-Aug) is 3.5 mg/L.

Table 371. Nitrate related macroinvertebrate metrics in Des Moines River (-501). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-501 Macroinvertebrate Class 2 – General Use	TrichopteraChTx Pct	N Index Score	% N Tolerant	% N Intolerant
04DM024	22.58	2.90	54.35	0.00
04DM043	20.83	2.57	21.59	0.00
10EM179	27.27	3.44	66.14	0.00
14DM004	23.81	3.21	39.75	0.00
<i>Statewide average for Class 2 Prairie Forest River stations that are meeting the MIBI General Use Threshold (31)</i>	15.65	2.94	47.56	1.22
Expected response to N stress	↓	↑	↑	↓

The macroinvertebrate community in Des Moines River (-501) scored below average in one (10EM179), two (04DM024, 14DM004) and three (10EM179) of the four nitrate related metrics when compared to all other Class 2 Prairie Forest River stations that meet the MIBI General Use Threshold (Table 371). All four sites completely lacked nitrate intolerant taxa; however, all four sites did have an increased amount of trichoptera taxa. Half of the sites also had a good nitrogen index score and decreased numbers of nitrate tolerant individuals.

The very large nitrate dataset generally showed that the nitrate levels in this reach remain fairly low. The macroinvertebrate community has half of the nitrate related metrics score well, while the other half score below average or poorly. Given the predominantly low nitrate concentrations recorded in this reach, nitrates are not a stressor to aquatic life at this time in Des Moines River (-501). Other stressors may be contributing to some of the lower metric scores observed in the macroinvertebrate community.

Suspended Solids

A total of 295 samples taken from four chemistry sites (S000-027, S000-894, S000-481, S005-936) from 2004-2016 were analyzed for TSS. The average of all the values is 79.01 mg/L with a low of 1 mg/L and a high of 640 mg/L. The TSS concentrations was at or exceeded the 65 mg/L standard 119 times. This is a very high exceedance rate in a large data set.

Table 372. TSS related fish metrics in Des Moines River (-501). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-501 Fish Class 1 –General Use	BenFdfFrimPct	Centr-TolPct	HerbvPct	Perfrm-TolPct	RifflePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
04DM024	1.73	0.72	0.72	3.03	1.15	0.00	3.17	0.00	10.37	31.76
04DM043	10.26	0.51	0.00	12.31	3.59	2.05	3.59	0.00	18.97	29.81
10EM179	0.47	0.19	24.03	1.51	0.09	0.00	0.94	0.00	5.47	29.74
14DM003	4.06	11.17	0.00	15.23	2.54	0.00	5.08	0.00	25.38	30.77
14DM004	1.46	0.08	2.03	1.87	0.97	0.08	2.27	0.00	5.61	31.39
<i>Statewide average for Class 1 Southern Rivers stations that are meeting the FIBI General Use Threshold (49.0)</i>	21.36	4.12	1.04	17.97	13.92	13.53	24.97	4.63	43.61	25.99
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

The fish community in Des Moines River (501) scored below average in nine (14DM004, 14DM003, 10EM179) and ten (04DM024, 04DM043) of the ten TSS related metrics when compared to all other Class 1 Southern Rivers stations that meet the FIBI General Use Threshold (Table 372). Sites 10EM179 and 14DM004 did have above average numbers of herbivorous individuals, while site 14DM003 had an above average number of centrarchid individuals. However, the remaining metrics scored poorly similarly to sites 04DM024 and 04DM043. All five of the sites lacked species sensitive to elevated TSS concentrations and had poor TSS Index Scores. These results strongly suggest that TSS is a stressor to the fish community in this reach.

Table 373. TSS related macroinvertebrate metrics in Des Moines River (-501). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-501 Macroinvertebrate Class 2 – General Use	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
04DM024	18.86	1.00	18.00	63.07	59.44	0.35
04DM043	17.64	0.00	13.00	40.86	54.03	0.00
10EM179	21.12	0.00	12.00	77.85	42.86	0.00
14DM004	19.01	0.00	11.00	70.35	65.30	0.00
<i>Statewide average for Class 2 Prairie Forest Rivers stations that are meeting the MIBI General Use Threshold (31.0)</i>	18.18	2.52	14.09	49.06	22.93	0.55
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

The macroinvertebrate assemblage in this reach scored below average in two (04DM043), four (10EM179, 14DM004), and five (04DM024) of the six TSS related metrics when compared to all other Class 2 Prairie Forest Rivers stations that meet the MIBI General Use Threshold (Table 373). All four sites either lacked or had very few TSS intolerant and plecoptera taxa, while three out of the four sites had poor TSS Index scores and a high percentage of TSS tolerant individuals. These results suggest a community likely stressed by the current TSS conditions in this reach.

Based on the very high rate of standard exceedances in the very large data set, the majority of the fish and macroinvertebrate metrics related to TSS scoring below average or poorly, as well as the current turbidity impairment in this reach, TSS is a stressor to aquatic life in Des Moines River (-501).

Habitat

Des Moines River (-501) had a qualitative habitat assessment take place at its biological monitoring sites, 04DM024, 04DM043, 10EM179, 14DM003, and 14DM004, during the fish and macroinvertebrate sampling events in 2004, 2011, and 2014. The average MSHA score from these visits were 51.3 (Fair) at 04DM024 and 45.7 (Fair) at 14DM005, 45 (Poor) at 10EM179, 43.25 (Poor) at 14DM003, and 46.75 (Fair) at 14DM004. Limiting the habitat at these sites was the row crop agriculture as the dominant nearby land use, narrow to moderate riparian buffer, moderate bank erosion, light stream shading, sand and silt substrates (Figure 168), moderate to severe embeddedness, sparse fish cover, moderate channel stability and poor to fair channel development. Further MSHA analysis can be seen in Figure 169.

Figure 168. Sand substrate at site 14DM004 during low water.



Figure 169. Des Moines River (-501) MSHA metric scores.

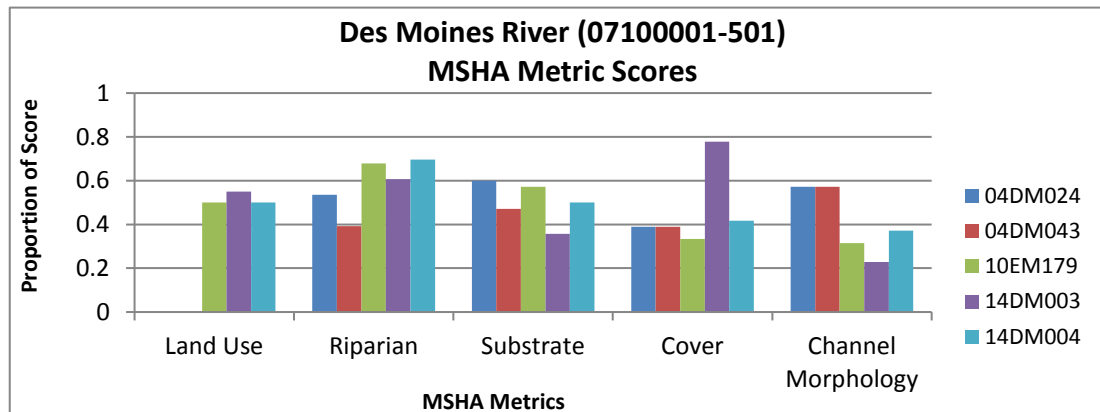


Table 374. Habitat related fish metrics in Des Moines River (-501). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-501 Fish Class 1 –General Use	BenInsect-TolPct	SLithopPct	DarterSculpSu cPct	RifflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
04DM024	1.30	3.17	1.30	1.15	4.76	3.31	67.15	20.32
04DM043	0.66	0.94	0.66	0.09	2.64	1.04	82.66	22.05
10EM179	9.74	3.59	9.74	3.59	11.28	9.23	53.85	43.59
14DM003	2.54	5.08	2.54	2.54	9.64	11.68	33.50	15.74
14DM004	0.97	2.27	0.97	0.97	2.52	2.27	57.60	25.02
<i>Statewide average for Class 1 Southern Rivers stations that are meeting the FIBI General Use Threshold (49.0)</i>	20.61	24.97	18.51	13.92	15.18	29.21	22.05	5.21
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

The fish community in Des Moines River (-501) scored below average in all eight habitat related metrics at all five biological monitoring sites when compared to all other Class 1 Southern Rivers stations that meet the FIBI General Use Threshold (Table 374). The common theme for all of these sites was the high amount of tolerant and pioneer individuals, while also having very few fish species requiring any sort of specialized habitat conditions to live and reproduce. These results reflect a stream reach with poor habitat.

Table 375. Habitat related macroinvertebrate metrics in Des Moines River (-501). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-501 Macroinvertebrate Class 2 – General Use	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
04DM024	8.74	9.44	69.23	74.83	21.33	4.55
04DM043	4.70	8.39	74.83	82.89	14.77	2.68
10EM179	2.54	15.56	56.83	72.38	24.76	24.13
14DM004	3.79	14.83	69.09	70.35	19.56	7.26
<i>Statewide average for Class 2 Prairie Forest Rivers stations that are meeting the MIBI General Use Threshold (31.0)</i>	4.24	11.76	44.81	57.13	22.86	15.51
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate assemblage fared better than the fish community in this reach as one (10EM179, 14DM004) and three (04DM024, 04DM043) of the six habitat related metrics scored below average when compared to all other Class 2 Prairie Forest Rivers stations that meet the MIBI General Use Threshold (Table 375). All four sites did have increased numbers of both clinger and EPT individuals, which can be a signal for a community not affected by poor habitat. Three of the four sites did have

decreased amount of sprawler individuals, while two other sites also lacked many climber individuals and had increased numbers of burrowers.

Based on the poor to fair MSHA scores along this reach, as well as some macroinvertebrate metrics related to habitat scoring poorly and all of the fish metrics related to habitat scoring well below average, habitat is a stressor to aquatic life in the Des Moines River (-501) at this time.

Altered Hydrology

This reach is part of the mainstem of the Des Moines River. The reach itself is almost entirely natural though a majority of its upstream watershed is altered according to the MPCA altered watercourse layer.

Extreme weather events affect high flow events as well as also low flows during drought. HSPF models show this stream section experiencing low flow at less than five cfs 1.04% of the time and less than one cfs 0 % of the time.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The average percentage for generalist fish within the reach was 29.9% compared to the average in Class 1 General use waters meeting the standard of 20.7%.

The numbers of nest guarder species are also positively correlated with increased low flows. The average percentage for nest guarder fish within the reach was 30.7% compared to the average in Class 1 general use waters meeting the standard of 21.4%.

Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The average percentage for long-lived macroinvertebrates within the reach was 1.6% compared to the average in Class 2 general use waters meeting the standard of 9%.

While many of the related biological metrics score poorly in this reach, the reach itself is natural, and does not experience low flow events, therefore, Flow Alteration/Connectivity is not a stressor to aquatic life in Des Moines River (-501).

Summary

The impaired fish and macroinvertebrate communities in Des Moines River (-501) are being stressed by DO, Eutrophication, Suspended Sediment, and Habitat (Table 376). Nitrates and Flow Alteration/Connectivity were ruled out as stressors to aquatic life at this time. For further information on the stressors and recommendations to fixing the stressors in the City of Windom-Des Moines River HUC 10 Watershed, please see pages 378-379.

Table 376. Stressor determinations for Des Moines River (-501).

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Des Moines River	07100001-501	●	●	---	●	●	---

● = stressor; ○ = inconclusive stressor; --- = not an identified stressor

Des Moines River (07100001-524)

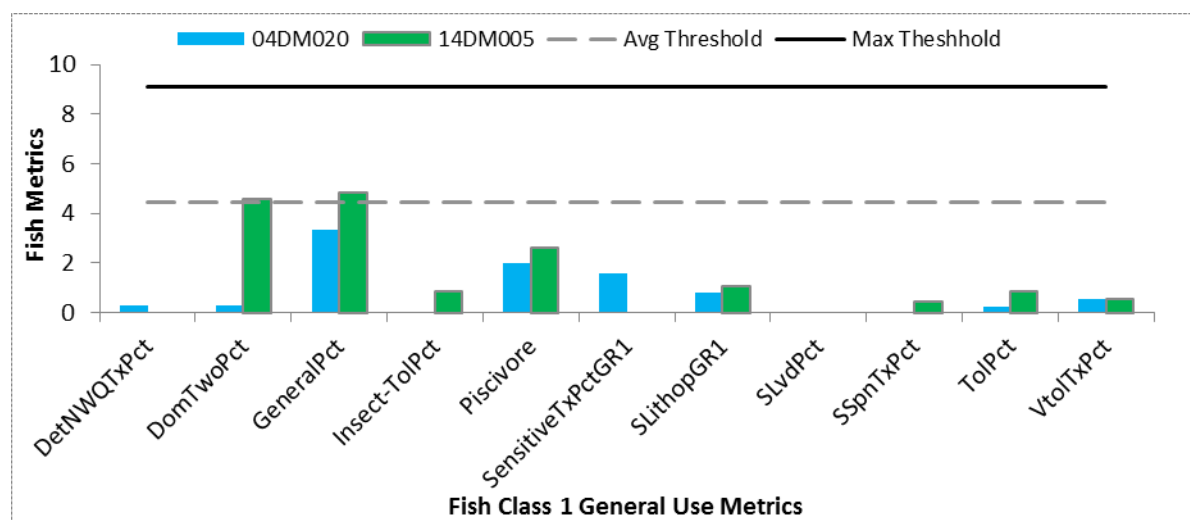
Located in southcentral Cottonwood County, the Des Moines River (-524) is an 18.10 mile long reach that is impaired for aquatic life due to the fish and macroinvertebrate assemblages. This stream reach extends from Heron Lake Outlet down to the Windom Dam. Along this stream section there are two biological monitoring stations, 04DM020 and 14DM005.

Biology

Fish

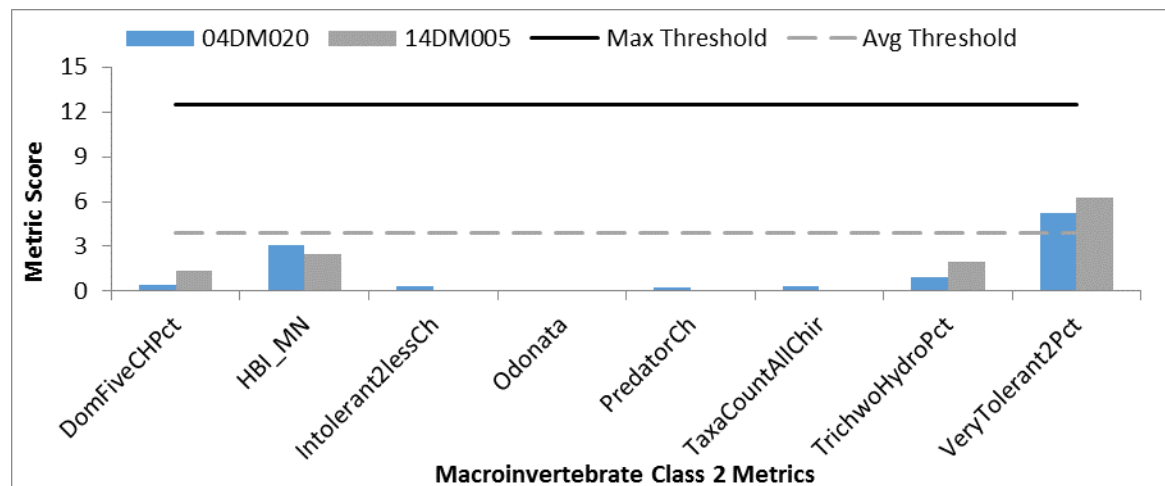
The fish community in Des Moines River (-524) was sampled for fish in August of 2004 and 2014 at site 04DM020. The average FBI score at this site was 9.1. Site 14DM005 was sampled in August 2014 and had a FBI score of 15.9. Both of the FBI scores, are far below the Fish Class 1 Southern Rivers General Use Threshold of 49. Site 14DM005 had two metrics (DomTwoPct, GeneralPct) reach the average metric score needed to meet the threshold (Figure 170), however, the remaining eight metrics comprising this FBI scored well below average. All of the FBI metrics at site 04DM020 scored below average.

Figure 170. Des Moines River (-524) fish IBI metric scores.



The macroinvertebrate assemblage at site 04DM020 was sampled in September of 2004 and August 2014 and had an average MIBI score of 10.6 while site 14DM005 was sampled in August of 2014 and had a MIBI score of 12.0. Both of these MIBI scores are below the Macroinvertebrate Class 2 Prairie Forest Rivers General Use Threshold of 31. Both sites had one metric (VeryTolerant2Pct) score above the average needed to reach the threshold with the remaining metrics scored below average. See Figure 171 for a complete breakdown of the metric scores at these sites.

Figure 171. Des Moines River (-524) macroinvertebrate IBI metric scores.



Dissolved Oxygen

A total of 21 DO measurements were taken from one chemistry site (S007-894) and one biological monitoring station (04DM020) from 2004-2016. The average of all the values is 9.03 mg/L with a low of 5.43 mg/L and a high of 13.75 mg/L. The summer average (June-Aug) is 8.61 mg/L. The DO values never fell below 5 mg/L.

The HSPF model calculated daily minimum DO values for this subwatershed from 1994-2014. Of these calculations, 239 (3.13%) of the days had a daily minimum DO level below the daily minimum standard of 5 mg/L.

Table 377. DO related fish metrics in Des Moines River (-524). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-524 Fish Class 1 – General Use	MA>3 Avg	SspnPct Avg	Taxa Count Avg	DO TIV Avg
04DM020	9.27	85.49	17.5	8.74
14DM005	13.50	71.17	19.00	8.76
Statewide average for Class 1 Southern Rivers stations that are meeting the FIBI General Use Threshold (49.0)	40.4	35.61	22.44	8.76
Expected response to DO stress	↓	↑	↓	↓

The fish community in Des Moines River (-524) at sites 04DM020 and 14DM005 scored below average in all four of the DO related metrics at both sites when compared to all other Class 1 Southern River stations that meet the FIBI General Use Threshold (Table 377). Both sites had very few mature fish, a low taxa count, slightly below average DO TIV scores, and very high amounts of serial spawning species. These results are often found in streams stressed by DO.

Table 378. DO related macroinvertebrate metrics in Des Moines River (-524). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-524 Macroinvertebrate Class 2 – General Use	HBI_MN Value	% DO Tolerant Taxa	# DO Tolerant Taxa	ChemTV_DO
04DM020	7.64	0.81	1.50	7.43
14DM005	7.78	1.89	3.00	7.46
<i>Statewide average for Class 2 Prairie Forest River stations that are meeting the MIBI General Use Threshold (31)</i>	7.32	8.67	4.41	7.13
Expected response to DO stress	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in one of the four dissolved oxygen related metrics at both sites when compared to all other Class 2 Prairie Forest River stations that meet the MIBI General Use Threshold (Table 378). Both sites had below average HBI_MN values, however, this reach had few DO tolerant taxa, while also having above average DO TIV scores. These results are common in streams not being stressed by the DO conditions.

None of the observed DO measurements fell below 5 mg/L, while the modeled data had a very low exceedance rate. The macroinvertebrate community also strongly suggested that DO is not having a negative impact as very few DO tolerant species were sampled. Therefore, DO is not a stressor to aquatic life in Des Moines River (-524). Other stressors are likely impacting the fish community causing lower metric scores.

Eutrophication

A total of 13 phosphorus samples were taken from one chemistry site (S007-894) and one biological monitoring station (04DM020) from 2004-2016. The average of all the values is 0.201 mg/L with a low of 0.09 mg/L and a high of 0.32 mg/L. The summer average (June-Aug) is 0.211 mg/L. The summer average (June-Aug) is 0.211 mg/L. Phosphorus values exceeded 0.150 mg/L 10 times.

The HSPF model also calculated daily phosphorus concentrations for this subwatershed from 1994-2014. These values ranged from 0.18-2.61 mg/L with an average concentration of 0.48 mg/L. All of these calculations were above the 0.15 mg/L standard.

Table 379. Eutrophication related fish metrics in Des Moines River (-524). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-524 Fish Class 1 – General Use	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct
04DM020	0.20	0.74	84.20	40.40
14DM005	0.00	1.05	75.10	31.72
<i>Statewide average for Class 1 Southern Rivers stations that are meeting the FIBI General Use Threshold (49.0)</i>	13.75	4.46	22.36	15.72
Expected response to Eutrophication stress	↓	↓	↑	↑

The fish community in the Des Moines River (-524) at sites 04DM020 and 14DM005 scored below average in all four of the eutrophication related metrics when compared to all other Class 1 Southern Rivers stations that meet the FIBI General Use Threshold (Table 379). Both of these sites had decreased amounts of sensitive and darter individuals, while also having increased numbers of tolerant and omnivorous individuals. These results are common in streams stressed by eutrophic conditions.

Table 380. Eutrophication related macroinvertebrate metrics in Des Moines River (-524). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-524 Macroinvertebrate Class 2 – General Use	EPT Pct	Tanytarsini Pct	CrustMoll Pct	Scraper Pct	% Tolerant Taxa	% Intolerant Taxa
04DM020	79.83	11.42	0.16	5.64	20.87	0.00
14DM005	82.33	9.38	0.00	5.36	18.55	0.00
<i>Statewide average for Class 2 Prairie Forest River stations that are meeting the MIBI General Use Threshold (31)</i>	54.79	17.03	6.59	13.83	25.29	6.53
Expected response to Eutrophication stress	↓	↓	↑	↑	↑	↑

The macroinvertebrate assemblage in this reach scored below average in two of the six eutrophication related metrics at both sites when compared to all other Class 2 Prairie Forest River stations that meet the MIBI General Use Threshold (Table 380). Both sites had decreased amounts of tanytarsini individuals and phosphorus intolerant taxa, while scoring above average in the remaining metrics.

Based on the very high exceedance rate in the observed and modeled data sets in addition to the majority of the fish and some of the macroinvertebrate metrics related to eutrophication scoring below average, eutrophication is a stressor to aquatic life in the Des Moines River (-524) at this time.

Nitrates

There were 13 samples taken from one chemistry site (S007-894) and one biological monitoring station (04DM020) from 2004-2015 were analyzed for Inorganic Nitrogen (NO₂-NO₃). The average of all the values is 1.48 mg/L with a low of 0.09 mg/L and a high of 6.59 mg/L. The spring average (March-May) is 1.00 mg/L. The summer average (June-Aug) is 1.95 mg/L. Nitrate values exceeded 4 mg/L twice.

The HSPF model calculated daily nitrate concentrations for this subwatershed from 1994-2014. These values ranged from 0.03-12.54 mg/L with an average value of 1.80 mg/L. This value is very low when compared throughout the watershed.

Table 381. Nitrate related macroinvertebrate metrics in Des Moines River (-524). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-524 Macroinvertebrate Class 2 – General Use	TrichopteraChTx Pct	N Index Score	% N Tolerant	% N Intolerant
04DM020 (2004)	21.05	2.41	13.99	0.00
04DM020 (2014)	11.54	3.71	76.01	0.00
14DM005	21.05	3.43	51.89	0.00
<i>Statewide average for Class 2 Prairie Forest River stations that are meeting the MIBI General Use Threshold (31)</i>	15.65	2.94	47.56	1.22
Expected response to N stress	↓	↑	↑	↓

The macroinvertebrate community in Des Moines River (-524) scored below average in one (04DM020-2004), three (14DM005), and four (04DM020-2014) of the four nitrate related metrics when compared to all other Class 2 Prairie Forest River stations that meet the MIBI General Use Threshold (Table 381). All visits at both sites completely lacked nitrate intolerant species. The sites sampled in 2014 (14DM005, 04DM020-2014) both had a high amount of nitrate tolerant individuals and below average nitrate index scores. These results can be common in streams being negatively impacted by nitrates.

The nitrate related biological metrics had mixed results in this reach. However, the nitrate concentrations in this stream reach stay relatively low based on the observed and calculated data; therefore, nitrates are not a stressor to aquatic life in this stream reach. It is likely that other stressors are negatively impacting the biological metrics leading to lower metric scores.

Suspended Solids

Ten samples taken from one chemistry site (S007-894) in 2014 were analyzed for TSS. The average of all the values is 55.1 mg/L with a low of 14 mg/L and a high of 124 mg/L. The TSS concentrations exceeded the 65 mg/L standard three times.

Additionally, 296 secchi tube measurements were taken from this reach. These values ranged from 00-46 cm, with 118 values falling below the 10 cm minimum standard for secchi tube. This is a very high exceedance rate.

The HSPF model calculated daily TSS values for this subwatershed from 1994-2014. These concentrations ranged from 19.58-1143.10 mg/L with an average TSS value of 46.19 mg/L. Of these calculations, 763 (10.01%) were above 65 mg/L.

This reach was determined to be impaired for turbidity during the 2006 assessment. This impairment was confirmed during the 2016 assessment as well.

Table 382. TSS related fish metrics in Des Moines River (-524). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-524 Fish Class 1 – General Use	BenFdfRimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RifflePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
04DM020	4.43	0.16	1.33	3.19	1.65	0.20	3.93	0.00	11.50	29.76
14DM005	10.75	0.13	12.84	2.75	6.82	0.00	8.52	0.00	9.17	29.67
<i>Statewide average for Class 1 Southern Rivers stations that are meeting the FIBI General Use Threshold (49.0)</i>	21.36	4.12	1.04	17.97	13.92	13.53	24.97	4.63	43.61	25.99
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

The fish community in Des Moines River (-524) at sites 04DM020 and 14DM005 scored below average in nine of the 10 TSS related metrics when compared to all other Class 1 Southern Rivers stations that meet the FIBI General Use Threshold (Table 382). Both sites had an above average amount of herbivorous individuals present, however the remaining metrics scored poorly or below average. This reach lacked many species sensitive to elevated TSS conditions and strongly suggests that TSS is a stressor to the fish community.

Table 383. TSS related macroinvertebrate metrics in Des Moines River (-524). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-524 Macroinvertebrate Class 2 – General Use	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
4DM020 (2004)	17.94	0.00	10.00	34.13	81.85	0.00
04DM020 (2014)	21.21	0.00	11.00	81.93	54.21	0.00
14DM005	21.28	0.00	11.00	88.99	60.57	0.00
<i>Statewide average for Class 2 Prairie Forest Rivers stations that are meeting the MIBI General Use Threshold (31.0)</i>	18.18	2.52	14.09	49.06	22.93	0.55
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

The macroinvertebrate community in this reach scored below average in two (04DM020-2004) and four (04DM020-2014, 14DM005) of the six TSS related metrics when compared to all other Class 2 Prairie Forest River stations that meet the MIBI General Use Threshold (Table 383). All of the visits along this reach had a slightly below average amount of TSS tolerant taxa, while also having an increased number of collector-filterer individuals. However, many of the remaining metrics scored poorly and all sites lacked TSS intolerant and plecoptera taxa.

Based on the high exceedance rates in the observed and modeled data sets, the majority of the TSS related metrics in both the fish and macroinvertebrate communities scoring below average, as well as the current turbidity impairment on this reach, TSS is a stressor to aquatic life in Des Moines River (-524).

Habitat

Des Moines River (-524) had a qualitative habitat assessment take place at its biological monitoring sites, 04DM020 and 14DM005, during the fish and macroinvertebrate sampling events in 2004 and 2014. The average MSHA score from these visits were 43.3 (Poor) at 04DM020 and 47.58 (Fair) at 14DM005. Limiting the habitat at these sites was the row crop agriculture as the dominant nearby land use (04DM020), very narrow to moderate riparian buffer, moderate to severe bank erosion (Figure 172), light stream shading, sand and silt substrates, moderate embeddedness, sparse fish cover, low to moderate channel stability and fair channel development. Further MSHA analysis can be seen in Figure 173.

Figure 172. Eroded bank at site 04DM020.



Figure 173. Des Moines River (-524) MSHA metric scores.

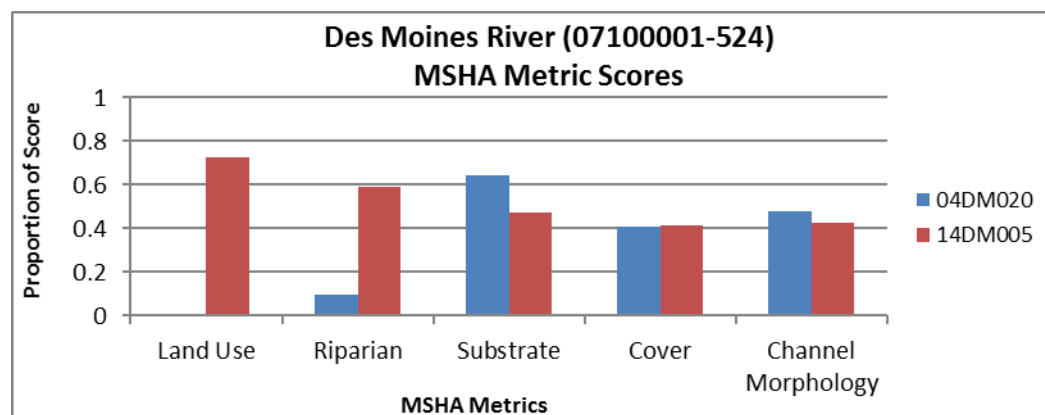


Table 384. Habitat related fish metrics in Des Moines River (-524). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-524 Fish Class 1 – General Use	BenInsect- ToIPct	SLithopPct	DarterSculpS ucPct	RifflePct	PiscivorePct	LithFrimPct	ToIPct	PioneerPct
04DM020	1.96	3.93	1.81	1.65	4.62	3.93	84.20	36.67
14DM005	2.23	8.52	2.10	6.82	3.54	9.17	75.10	23.72
Statewide average for Class 1 Southern Rivers stations that are meeting the FIBI General Use Threshold (49.0)	20.61	24.97	18.51	13.92	15.18	29.21	22.05	5.21
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

The fish community in the Des Moines River (-524) at sites 04DM020 and 14DM005 scored below average in all eight of the habitat related metrics when compared to all other Class 1 Southern Rivers stations that meet the FIBI General Use Threshold (Table 384). These sites both had very high numbers of both tolerant and pioneer individuals, which is often a sign for degraded habitat conditions. These sites also lacked species requiring specialized habitat conditions to live and reproduce. This is also a signal for potential habitat stress.

Table 385. Habitat related macroinvertebrate metrics in Des Moines River (-524). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-524 Macroinvertebrate Class 2 – General Use	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
04DM020	4.97	3.81	75.63	79.83	14.12	11.14
14DM005	1.58	7.89	66.25	82.33	10.09	15.46
<i>Statewide average for Class 2 Prairie Forest Rivers stations that are meeting the MIBI General Use Threshold (31.0)</i>	4.24	11.76	44.81	57.13	22.86	15.51
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate community in this reach fared much better than the fish assemblage as it scored below average in two (14DM005) and three (04DM020) of the six habitat related metrics when compared to all other Class 2 Prairie Forest River stations that meet the MIBI General Use Threshold (Table 385). Both sites did have high numbers of both clinger and EPT individuals, while also having lower numbers of legless individuals, which can signal a community not being negatively impacted by degraded habitat conditions. However, this reach did have a below average amount of both sprawler and climber individuals and site 04DM020 had a higher number of burrower individuals. These results are common in streams being stressed by the habitat conditions.

Based on the poor to fair MSHA scores along this reach, as well as all of the fish metrics related to habitat scoring below average, and some of the macroinvertebrate metrics related to habitat scoring poorly, habitat is a stressor to aquatic life in the Des Moines River (-524) at this time.

Altered Hydrology

This reach is part of the mainstem of the Des Moines River. The reach itself is almost entirely natural though a majority of its upstream watershed is altered according to the MPCA altered watercourse layer.

Extreme weather events affect high flow events as well as also low flows during drought. HSPF models show this stream section experiencing low flow at less than five cfs 1.4% of the time and less than one cfs 0.9% of the time.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The average percentage for generalist fish within the reach was 39.7% compared to the average in Class 1 General use waters meeting the standard of 20.7%. Generalist fish species ranged from 33.2-51.5%.

The numbers of nest guarder species are also positively correlated with increased low flows. The average percentage for nest guarder fish within the reach was 34.7% compared to the average in Class 1 general use waters meeting the standard of 21.4%. Nest guarder species ranged from 25.8-46.7%.

Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The average percentage for long-lived macroinvertebrates within the reach was 0.6% compared to the average in Class 2 general use waters meeting the standard of 9%. Long-lived macroinvertebrates ranged from 0.3-1.3%.

While many of the related biological metrics score poorly in this reach, the reach itself is natural, and does not experience low flow events, therefore, Flow Alteration/Connectivity is not a stressor to aquatic life in Des Moines River (-524).

Summary

The impaired fish and macroinvertebrate communities in Des Moines River (-524) are being stressed by Eutrophication, Suspended Sediment, and Habitat (Table 386). DO, Nitrates and Flow Alteration/Connectivity were ruled out as stressors to aquatic life at this time. For further information on the stressors and recommendations to fixing the stressors in the City of Windom-Des Moines River HUC 10 Watershed, please see pages 378-379.

Table 386. Stressor determinations for Des Moines River (-524).

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Des Moines River	07100001-524	---	●	---	●	●	---

● = stressor; ○ = inconclusive stressor; --- = not an identified stressor

Perkins Creek (07100001-544)

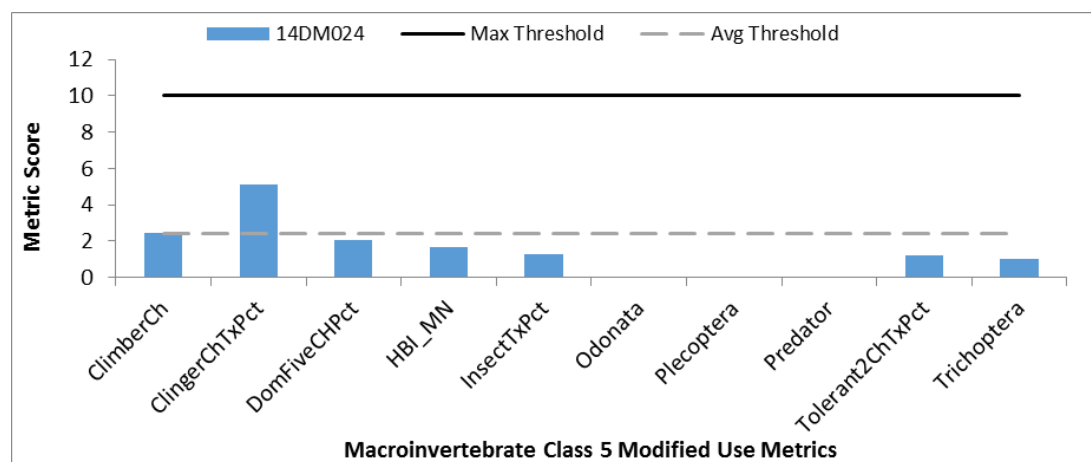
Located in southcentral Cottonwood County, Perkins Creek (-544) is a 2.45 mile long reach that is impaired for aquatic life due to the macroinvertebrate assemblage. This stream reach extends from Warren Lake down to the confluence with the Des Moines River. Along this stream section there is one biological monitoring station, 14DM024.

Biology

Macroinvertebrates

The macroinvertebrate community in Perkins Creek (-544) was sampled in August of 2014 at its biological monitoring station 14DM024. The MIBI score at this site was 14.8, which is far below the Macroinvertebrate Class 5 Southern Streams RR Modified Use Threshold of 24. This site had two metrics (ClimberCh, ClingerChTxPct) reach the average metric score needed to meet the threshold (Figure 174), however, the remaining eight metrics comprising this MIBI scored well below average with three metrics scoring zero.

Figure 174. Perkins Creek (-544) macroinvertebrate IBI metric scores.



Dissolved Oxygen

A total of 10 DO measurements samples were taken from one chemistry site (S009-047) and one biological monitoring station (14DM024) from 2014-2016. The average of all the values is 7.13 mg/L with a low of 3.87 mg/L and a high of 10.36 mg/L. The summer average (June-Aug) is 6.75 mg/L. The DO values fell below 5 mg/L twice.

The HSPF model calculated daily minimum DO values for this subwatershed from 1994-2014. Of these calculations, 1203 (33.25%) of the days had a daily minimum DO level below the daily minimum standard of 5 mg/L. This is a very high exceedance rate.

Table 387. DO related macroinvertebrate metrics in Perkins Creek (-544). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-544	HBI_MN Value	% DO Tolerant Taxa	# DO Tolerant Taxa	ChemTV_ DO
Macroinvertebrate Class 5 – Modified Use				
14DM024	7.77	40.78	7.00	6.60
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI Modified Use Threshold (35)</i>	7.57	18.23	6.45	6.75
Expected response to DO stress	↑	↑	↑	↓

The macroinvertebrate community in Perkins Creek (-544) scored below average in all four of the DO related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI Modified Use Threshold (Table 387). This reach had a high number and percentage of DO tolerant taxa, while also having poor DO TIV and HBI_MN scores. These results often occur in streams with DO issues.

The DO levels do fall below the 5 mg/L standard occasionally in this stream reach based on the observed measurements. The model calculated a very high exceedance rate, while all of the DO related metrics in the macroinvertebrate community scored poorly. Additionally, this reach also has elevated phosphorus levels and eutrophic conditions, which can cause problems with DO levels. Therefore, DO is a stressor to aquatic life in Perkins Creek (-544).

Eutrophication

Ten phosphorus samples were taken from one chemistry site (S009-047) and one biological monitoring station (14DM024) from 2004-2014. The average of all the values is 0.123 mg/L with a low of 0.04 mg/L and a high of 0.20 mg/L. The summer average (June-Aug) is 0.119 mg/L. Phosphorus values exceeded the standard of 0.150 mg/L four times.

The HSPF model calculated daily total phosphorus concentrations for this subwatershed from 1994-2014. These values ranged from 0.233-1.46 mg/L with an average value of 0.47 mg/L. All of the calculated values were above the 0.15 mg/L standard.

Table 388. Eutrophication related macroinvertebrate metrics in Perkins Creek (-544). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-544 Macroinvertebrate Class 5 – Modified Use	EPT Pct	Tanytarsini Pct	CrustMoll Pct	Scraper Pct	% Tolerant Taxa	% Intolerant Taxa
14DM024	18.12	19.05	34.95	1.62	46.28	0.00
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI Modified Use Threshold (24)</i>	33.6	23.74	15.6	13.48	27.87	3.27
Expected response to Eutrophication stress	↓	↓	↑	↑	↑	↓

The macroinvertebrate assemblage in Perkins Creek (-544) at site 14DM024 scored below average in five of the six eutrophication related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI Modified Use Threshold (Table 388). This site did have a decreased amount of scraper individuals, which tends to be higher in streams with high levels of phosphorus. This stream did have decreased numbers of EPT, tanytarsini, and intolerant individuals, while also having increased numbers of both tolerant and crustacea/mollusca individuals. These results are often seen in streams being negatively impacted by the effects of eutrophication.

Based on the high number of exceedances in the observed data and calculated data, as well as the majority of the eutrophication related metrics scoring below average in the macroinvertebrate community, eutrophication is a stressor to aquatic life in Perkins Creek (-544) at this time.

Nitrates

A total of 10 samples were taken from one chemistry site (S009-047) and one biological monitoring station (14DM024) from 2014-2016 and were analyzed for Inorganic Nitrogen (NO₂-NO₃). The average of all the values is 6.38 mg/L with a low of 0.61 mg/L and a high of 12.00 mg/L. The spring average (March-May) is 12.00 mg/L. The summer average (June-Aug) is 6.09 mg/L. Nitrate values exceeded 4 mg/L seven times.

The HSPF model calculated daily nitrate concentrations for this subwatershed from 1994-2014. These values ranged from 01.64-17.82 mg/L with an average value of 9.66 mg/L.

Table 389. Nitrate related macroinvertebrate metrics in Perkins Creek (-544). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-544 Macroinvertebrate Class 5 – Modified Use	TrichopteraChTx Pct	N Index Score	% N Tolerant	% N Intolerant
14DM024	9.09	3.17	53.72	0.00
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI Modified Use Threshold (35)</i>	10.99	3.22	57.02	0.30
Expected response to N stress	↓	↑	↑	↓

The macroinvertebrate assemblage in Perkins Creek (-544) scored below average in two of the four nitrate related biological metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI Modified Use Threshold (Table 389). Site 14DM024 did have a slightly below average number of trichoptera taxa, while also completely lacking nitrate intolerant species. However, this site

did have a slightly above average nitrate index score and a lower amount of nitrate tolerant individuals present.

The nitrate concentrations can get slightly elevated, but seem to stay relatively low based on the observed results. The calculated data reflects this information as well. The nitrate related macroinvertebrate metrics are mixed, however, the lower presence of nitrate tolerant individuals and an above average nitrate index score indicate that the stream is likely not impacted by the nitrate concentrations. Therefore, nitrates are not a stressor for aquatic life in Perkins Creek (-544) at this time.

Suspended Solids

Ten samples taken from one chemistry site (S009-047) in 2016 were analyzed for TSS. The average of all the values is 26.02 mg/L with a low of 11 mg/L and a high of 48 mg/L. The TSS concentrations did not exceed the 65 mg/L standard.

Additionally, 52 secchi tube measurements were taken from this reach. These values ranged from 3-63 cm, with three values falling below the 10 cm minimum standard for secchi tube.

The HSPF model calculated daily TSS values for this subwatershed from 1994-2014. These concentrations ranged from 5.68-652.10 mg/L with an average TSS value of 20.55 mg/L. Of these calculations, 42 (3.43%) were above the TSS standard.

Table 390. TSS related macroinvertebrate metrics in Perkins Creek (-544). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-544 Macroinvertebrate Class 5 – Modified Use	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
14DM024	16.62	0.00	9.00	34.30	12.62	0.00
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI Modified Use Threshold (24.0)</i>	16.10	1.16	10.53	36.67	22.05	0.10
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

The macroinvertebrate assemblage in Perkins Creek (-544) at site 14DM024 scored below average in four of the six TSS related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI Modified Use Threshold (Table 390). This reach did have a decreased amount and percentage of TSS tolerant taxa and individuals. However, the remaining metrics, including TSS Index score, scored poorly.

Based on the lack of exceedances in the observed data set, the low exceedance rate in the modeled data set, as well as the decreased amount of TSS tolerant taxa and individuals, TSS is not a stressor to aquatic life in Perkins Creek (-544).

Habitat

Perkins Creek (-544) had a qualitative habitat assessment take place at its biological monitoring site, 14DM024, during the fish and macroinvertebrate sampling events in 2014. The average MSHA score from these visits was 50.95 (Fair). Limiting the habitat at this site was the urban/industrial as the dominant nearby land use, very narrow riparian area (Figure 175), moderate bank erosion, light

Figure 175. Narrow riparian buffer at site 14DM024.



stream shading, light embeddedness, sand and clay substrates, moderate channel stability and poor sinuosity. Further MSHA analysis can be seen in Figure 176.

Figure 176. Perkins Creek (-544) MSHA metric scores.

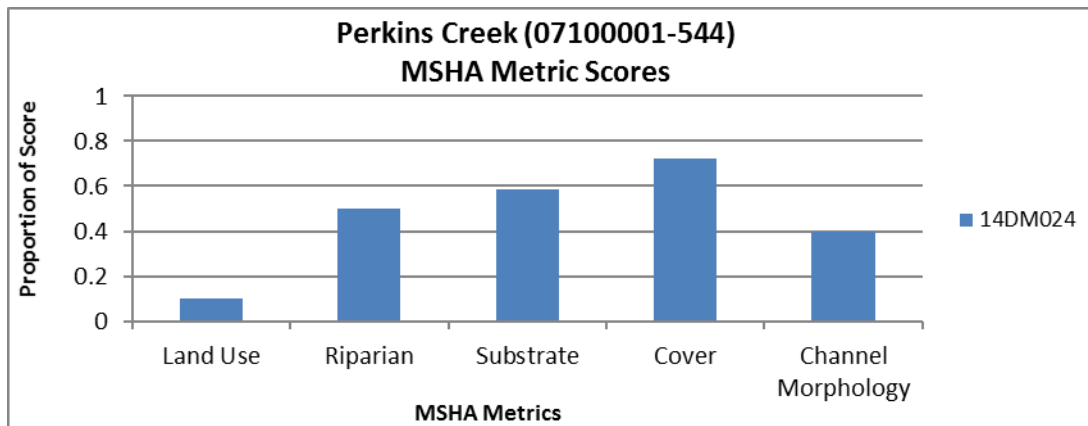


Table 391. Habitat related macroinvertebrate metrics in Perkins Creek (-544). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-544 Macroinvertebrate Class 5 – Modified Use	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14DM024	7.44	25.24	27.83	18.12	44.66	37.54
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI Modified Use Threshold (24.0)</i>	6.43	19.88	38.44	27.84	44.43	18.90
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate assemblage in this reach scored below average in four of the six habitat related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI Modified Use Threshold (Table 391). The site, 14DM024, did have a good number of both climber and sprawler individuals, however, this reach also had higher numbers of both burrower and legless individuals which correlates to the sand and clay substrates found during the habitat assessment. This reach also had lower numbers of both EPT and clinger individuals which can signal potential stress from the habitat conditions.

The MSHA assessment gave site 14DM024 a habitat score that was Fair. The macroinvertebrate community in this reach had the majority of their habitat related metrics score poorly. Therefore, habitat is a stressor to Perkins Creek (-544) at this time.

Altered Hydrology

Perkins Creek (-544) is a tributary to the Des Moines River. The reach itself is entirely altered and the majority of its upstream watershed is altered according to the MPCA altered watercourse layer. The reach flows from the outlet of Lake Warren, which has an identified fish barrier at the outlet of the lake.

Extreme weather events affect high flow events as well as also low flows during drought. HSPF models show this stream section experiencing low flow at less than five cfs 68.2% of the time and less than one cfs 40.8% of the time.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The percentage for generalist fish within the reach was 77.2% compared to the average in Class 3 modified use waters meeting the standard of 56.3%.

The numbers of nest guarder species are also positively correlated with increased low flows. The percentage for nest guarder fish within the reach was 19.6% compared to the average in Class 3 modified use waters meeting the standard of 24%.

Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The percentage for long-lived macroinvertebrates within the reach was 0.3% compared to the average in Class 5 modified use waters meeting the standard of 6.5%.

Based on the channelization of this reach, the high amount of altered tributaries to this reach, the high frequency of low flow conditions, as well as majority of the related biological metrics scoring poorly, Flow Alteration/Connectivity is a stressor to aquatic life in Perkins Creek (-544).

Summary

The impaired macroinvertebrate community in Perkins Creek (-544) is being stressed by DO, Eutrophication, Habitat and Flow Alteration/Connectivity (Table 392). Nitrates and Suspended Sediment were ruled out as stressors to aquatic life at this time. For further information on the stressors and recommendations to fixing the stressors in the City of Windom-Des Moines River HUC 10 Watershed, please see pages 378-379.

Table 392. Stressor determinations for Perkins Creek (-544).

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Perkins Creek	07100001-544	●	●	---	---	●	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Unnamed Creek (07100001-551)

Located in southcentral Cottonwood County, Unnamed Creek (-551) is a 2.62 mile long reach that is impaired for aquatic life due to the fish and macroinvertebrate assemblages. This stream reach extends from String Lake down to the confluence with the Des Moines River. Along this stream section, there are two biological monitoring stations, 04DM002 and 14DM027.

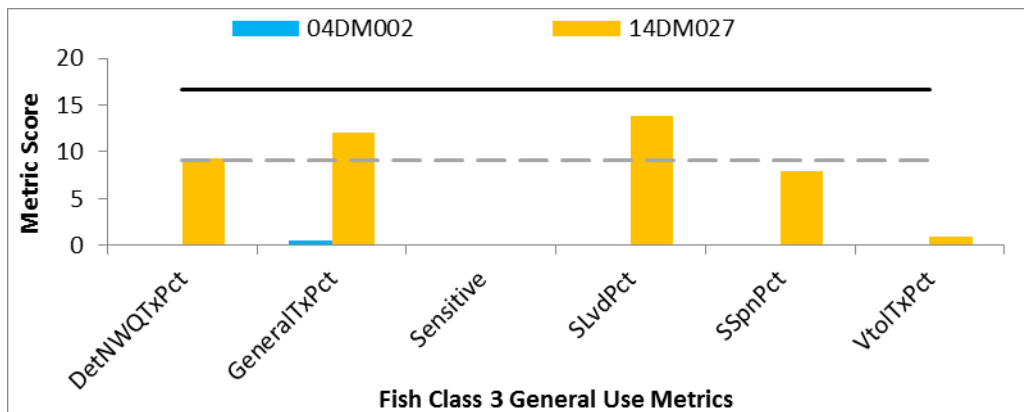
Biology

Fish

The fish community in Unnamed Creek (-551) was sampled for fish in August of 2004 and had a FIBI score of 0.6. Site 14DM027 was sampled in June of 2014 and had a FIBI score of 33.9. Both of these scores are below the Fish Class 3 Southern Headwaters General Use Threshold of 50. Site 14DM027 had three metrics (DetNWQTxPct, GeneralTxPct, SLvdPct) reach the average metric score needed to meet the threshold (Figure 177), however, the remaining three metrics comprising this FIBI scored well below

average with one metric scoring zero. Site 04DM002 scored below average in all six metrics with five of those metrics scoring zero.

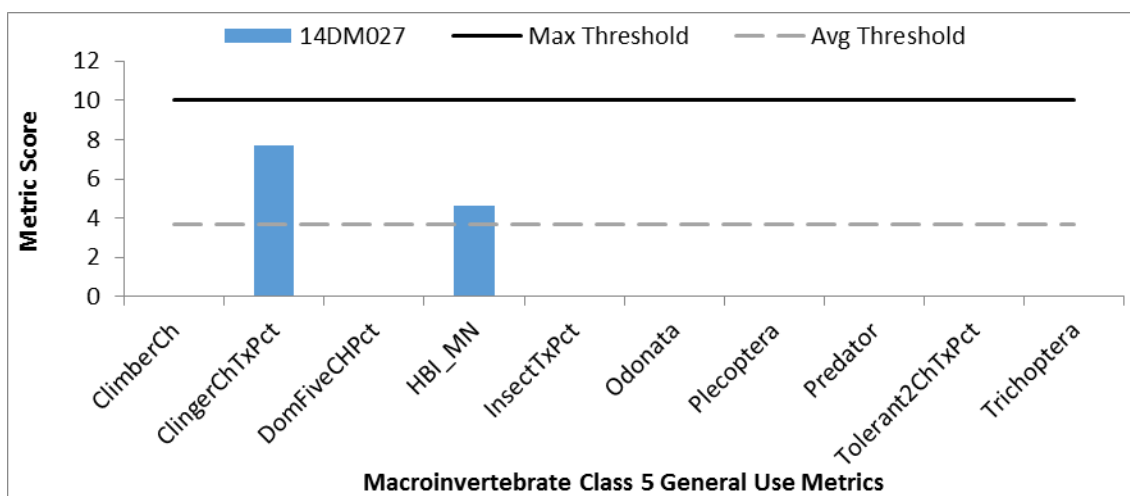
Figure 177. Unnamed Creek (-551) fish IBI metric scores.



Macroinvertebrates

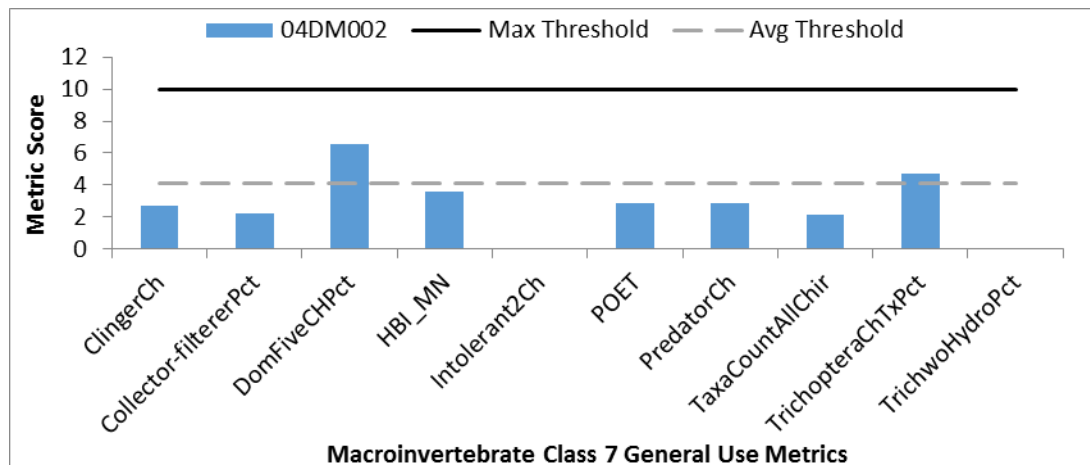
The macroinvertebrate assemblage at site 14DM027 was sampled in August of 2014. This site had a MIBI score of 12.3, which is below the Macroinvertebrate Class 5 Southern Streams RR General Use Threshold of 37. The site had two metrics score above the average needed to reach the threshold. However, the remaining eight metrics scored had a metric score of zero resulting in the impairment designation. See Figure 178 for a complete breakdown of the metric scores at this site.

Figure 178. Unnamed Creek (-551) macroinvertebrate class 5 IBI metric scores.



The macroinvertebrate assemblage at site 04DM002 was sampled in September 2004. This site had a MIBI score of 27.5, which is below the Macroinvertebrate Class 7 Prairie Streams GP General Use Threshold of 41. The site had two metrics (DomFiveCHPct, TrichopteraChTxPct) score above the average needed to reach the threshold. However, the remaining eight metrics scored below average with two of those metrics having a score of zero resulting in the impairment designation. See Figure 179 for a complete breakdown of the metric scores at this site.

Figure 179. Unnamed Creek (-551) macroinvertebrate Class 7 IBI metric scores.



Dissolved Oxygen

A total of 11 DO measurements were taken from one chemistry site (S009-049) and two biological monitoring stations (04DM002, 14DM027) from 2014-2016. The average of all the values is 5.24 mg/L with a low of 0.65 mg/L and a high of 9.71 mg/L. The summer average (June-Aug) is 4.20 mg/L. The DO values fell below 5 mg/L five times.

The HSPF model calculated daily minimum DO values for this subwatershed from 1994-2014. Of these calculations, 1214 (32.75%) of the days had a daily minimum DO level below the daily minimum standard of 5 mg/L. This is a very high exceedance rate.

Table 393. DO related fish metrics in Unnamed Creek (-551). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-551 Fish Class 3 – General Use	MA>3 Avg	SspnPct Avg	Taxa Count Avg	DO TIV Avg
04DM002	0.00	99.36	4.00	8.35
14DM027	6.78	40.68	9.00	8.68
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	13.32	17.09	12.16	8.44
Expected response to DO stress	↓	↑	↓	↓

The fish community in Unnamed Creek (-551) at sites 04DM002 and 14DM027 scored below average in three (14DM027) and four (04DM002) of the four DO related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 393). Both sites along this reach had low taxa counts, few mature fish, and high amounts of serial spawning individuals. These results are common in streams with DO issues.

Table 394. DO related macroinvertebrate metrics in Unnamed Creek (-551). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-551 Macroinvertebrate Class 5, 7 – General Use	HBI_MN Value	% DO Tolerant Taxa	# DO Tolerant Taxa	ChemTV_D O
14DM027	6.77	30.16	2.00	6.56
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	7.04	8.62	4.33	7.10
04DM002	7.79	34.96	13.00	4.68
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	7.55	12.98	5.74	6.91
Expected response to DO stress	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in two (14DM027) and four (04DM002) of the four DO related metrics when compared to all other Class 5 Southern Streams RR and Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 394). Both sites had increased percentages of DO tolerant taxa, while also having poor DO TIV scores. Site 04DM002 also had a low HBI_MN value. These results are indicative of a community negatively impacted by the current DO conditions.

Based on the high rate of exceedances in the observed and modeled data sets, as well as the majority of the DO related metrics in both the fish and macroinvertebrate scoring below average, DO is a stressor to aquatic life in Unnamed Creek (-551).

Eutrophication

Ten phosphorus samples were taken from one chemistry site (S009-049) and two biological monitoring stations (04DM002, 14DM027) from 2004-2016. The average of all the values is 0.215 mg/L with a low of 0.09 mg/L and a high of 0.47 mg/L. The summer average (June-Aug) is 0.238 mg/L. Phosphorus values exceeded the standard of 0.150 mg/L seven times.

The HSPF model calculated daily total phosphorus concentrations for this subwatershed from 1994-2014. These values ranged from 0.19-2.29 mg/L with an average value of 0.41 mg/L. All of the calculated values were above the 0.15 mg/L standard.

Table 395. Eutrophication related fish metrics in Unnamed Creek (-551). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-551 Fish Class 3 – General Use	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct
04DM002	0.00	0.00	100.00	99.91
14DM027	0.00	0.00	84.75	50.85
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	8.9	12.11	70.79	14.71
Expected response to Eutrophication stress	↓	↓	↑	↑

The fish community in Unnamed Creek (-551) at sites 04DM002 and 14DM027 scored below average in all four of the eutrophication related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 395). Both sites had a high amount of tolerant and omnivorous individuals, while also lacking darter and sensitive species. These results are common in streams being negatively impacted by the effects of eutrophication.

Table 396. Eutrophication related macroinvertebrate metrics in Unnamed Creek (-551). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-551 Macroinvertebrate Class 5, 7 – General Use	EPT Pct	Tanytarsini Pct	CrustMoll Pct	Scraper Pct	% Tolerant Taxa	% Intolerant Taxa
14DM027	1.59	95.72	30.48	0.63	29.84	0.00
<i>Statewide average for Class 5 Southern Streams Rock Riffle stations that are meeting the MIBI General Use Threshold (37)</i>	43.90	27.84	9.23	15.78	17.17	5.79
04DM002	6.02	62.90	14.90	7.74	45.27	0.00
<i>Statewide average for Class 7 Prairie Streams Glide Pool stations that are meeting the MIBI General Use Threshold (41)</i>	38.45	18.46	11.78	16.11	26.84	4.03
Expected response to Eutrophication stress	↓	↓	↑	↑	↑	↑

The macroinvertebrate assemblage in this reach scored below average in four of the six metrics related to eutrophication at both sites when compared to all other Class 5 Southern Streams RR and Class 7 Prairie Streams GP stations that meet the MIB General Use Threshold (Table 396). Both sites had low levels of both EPT and phosphorus intolerant taxa, while also having increased numbers of both phosphorus tolerant species and crustacea/mollusca individuals. Those results are common in streams being negatively impacted by eutrophication.

Based on the very high observed and calculated phosphorus data, as well as the majority of the eutrophication related metrics scoring poorly or below average in both biotic communities, eutrophication is a stressor to aquatic life in Unnamed Creek (-551).

Nitrates

Ten samples taken from one chemistry site (S009-049) and two biological monitoring stations (04DM002, 14DM027) from 2004-2016 were analyzed for Inorganic Nitrogen (NO₂-NO₃). The average of all the values is 1.30 mg/L with a low of 0.05 mg/L and a high of 5.40 mg/L. The spring average (March-May) is 5.10 mg/L. The summer average (June-Aug) is 0.0.313 mg/L.

The HSPF model calculated daily nitrate concentrations for this subwatershed from 1994-2014. These values ranged from 1.18-23.12 mg/L with an average value of 8.04 mg/L. Of these calculations, 318 (21.12%) were above 11.5 mg/L. A quantile regression analysis for Class 7 stream stations showed that sites having a nitrate concentration in excess of 11.5 mg/L there was a 90% probability for impairment.

Table 397. Nitrate related macroinvertebrate metrics in Unnamed Creek (-551). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-551 Macroinvertebrate Class 5, 7 – General Use	TrichopteraChTx Pct	N Index Score	% N Tolerant	% N Intolerant
14DM027	10.00	2.26	4.76	0.00
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	13.16	3.00	48.68	0.96
04DM002	7.69	2.39	39.54	0.29
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	10.00	3.30	57.57	0.91
Expected response to N stress	↓	↑	↑	↓

The macroinvertebrate community at biological stations 14DM027 and 04DM002 in Unnamed Creek (-551) scored below average in two of the four nitrate related biological metrics when compared to all other Class 5 Southern Streams RR and Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 397). Both sites had low amounts of nitrate intolerant and trichoptera taxa while also having a low amount (especially at 14DM027) of nitrate tolerant individuals and very good nitrate index scores.

The observed nitrate data shows very low concentrations in this reach. In contrast, the calculated data showed more elevated levels. The nitrate related biological metrics in the macroinvertebrate community does not appear to be negatively impacted by nitrates as the nitrate index score was good at both sites and there were lower amounts of nitrate sensitive individuals at both sites. These results would not likely occur if nitrates were negatively affecting this assemblage. Therefore, nitrates are not a stressor to aquatic life in Unnamed Creek (-551) at this time.

Suspended Solids

Nine samples taken from one chemistry site (S009-049) in 2016 were analyzed for TSS. The average of all the values is 79 mg/L with a low of 32 mg/L and a high of 120 mg/L. The TSS concentrations exceeded the 65 mg/L standard eight times.

Additionally, nine secchi tube measurements were taken from this reach. These values ranged from 8-19 cm, with two values falling below the 10 cm minimum standard for secchi tube.

The HSPF model calculated daily TSS values for this subwatershed from 1994-2014. These concentrations ranged from 2.45-966.79 mg/L with an average TSS value of 18.65 mg/L. Of these calculations, 62 (4.12%) were above the TSS standard.

This reach was determined to be impaired for turbidity during a 2008 assessment. This impairment was confirmed in 2016 as well.

Table 398. TSS related fish metrics in Unnamed Creek (-551). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-551 Fish Class 3 – General Use	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RifflePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
04DM002	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.46	23.90
14DM027	0.00	1.69	0.00	5.08	0.00	0.00	0.00	0.00	6.78	28.65
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	37.83	0.90	13.33	13.93	28.33	8.55	33.71	1.95	3.56	15.27
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

The fish community in Unnamed Creek (-551) scored below average in eight (14DM027) and ten (04DM002) of the ten TSS related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 398). Site 14DM027 did have increased numbers of centrarchid and long lived individuals, however, this site scored poorly in the remaining metrics similarly to site 04DM002. Both sites had very poor TSS Index scores. These results indicate a community likely being stressed by the current TSS conditions.

Table 399. TSS related macroinvertebrate metrics in Unnamed Creek (-551). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-551 Macroinvertebrate Class 5, 7 – General Use	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plectoptera Pct
14DM027	13.73	0.00	3.00	4.44	62.22	0.00
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	15.87	3.02	11.59	35.23	26.89	0.54
04DM002	12.62	0.00	9.00	22.92	8.60	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	17.35	1.33	13.20	48.28	19.13	0.22
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

The macroinvertebrate assemblage in this reach scored below average in two (14DM027) and three (04DM002) of the six TSS related metrics when compared to all other Class 5 Southern Streams and Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 399). Both sites had good TSS Index scores, while also having a lower amount and percentage of TSS tolerant taxa and individuals. These results are not common in streams with elevated TSS concentrations.

While the macroinvertebrate community scores fairly well in the TSS related metrics, the fish community scores very poorly at both sites along this reach. The observed data set shows a very high rate of standard exceedance and the reach is also currently designated as impaired for turbidity. Therefore, TSS is indeed a stressor to aquatic life in Unnamed Creek (-551) at this time.

Habitat

Unnamed Creek (-551) had a qualitative habitat assessment take place at its biological monitoring sites, 04DM002 and 14DM027, during the fish and macroinvertebrate sampling events in 2004 and 2014. The average MSHA score from these visits were 35 (Poor) at 04DM002 and 54.63 (Fair) at 14DM027. Limiting the habitat at this site was the row crop agriculture as the dominant nearby land use, little to heavy bank erosion, light stream shading, sand and silt substrates, moderate channel stability and fair channel development. Further MSHA analysis can be seen in Figure 180.

Figure 180. Unnamed Creek (-551) MSHA metric scores.

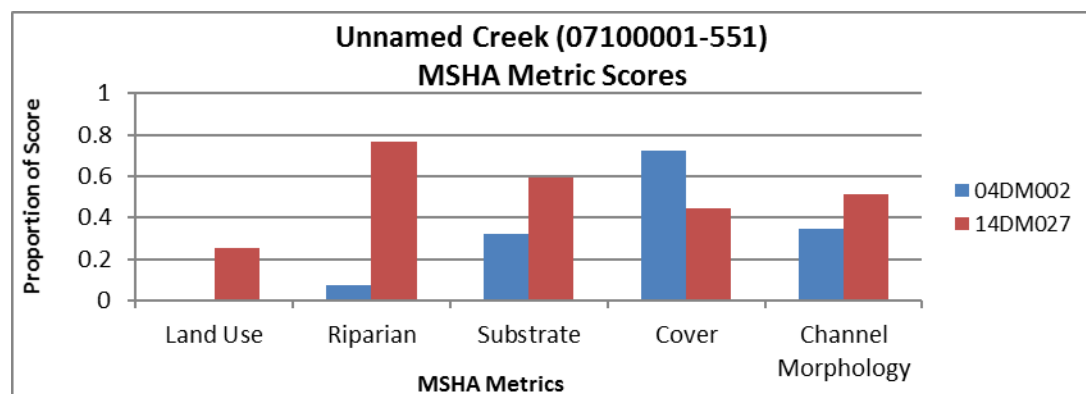


Table 400. Habitat related fish metrics in Unnamed Creek (-551). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-551 Fish Class 3 – General Use	BenInsect- TolPct	SLithopPct	DarterSculpSu cPct	RifflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
04DM002	0.00	0.00	0.00	0.00	0.00	0.00	100.00	99.36
14DM027	0.00	0.00	0.00	0.00	3.39	15.25	84.75	35.59
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	14.22	33.71	12.55	28.33	1.62	69.21	70.64	37.79
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

The fish community in Unnamed Creek (-551) at sites 04DM002 and 14DM027 scored below average in six (14DM027) and all eight of the habitat related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 400). Site 14DM027 did have an above average amount of piscivore individuals, while also having a lower number of pioneer individuals. These results are common in streams unaffected by poor habitat conditions. However, the remaining metrics scored poorly as did the habitat metrics at site 04DM002. This reach had a very high number of tolerant fish individuals, while also completely lacking many habitat specializing species.

Table 401. Habitat related macroinvertebrate metrics in Unnamed Creek (-551). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-551 Macroinvertebrate Class 5, 7 – General Use	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
04DM002	33.24	28.94	11.75	6.02	69.63	15.76
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)</i>	5.40	20.35	36.94	37.77	37.96	19.49
14DM027	0.32	2.86	63.49	1.59	63.49	30.16
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)</i>	5.66	12.52	49.77	42.46	34.53	13.99
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate assemblage in Unnamed Creek (-551) scored below average in three (14DM027) and five (04DM002) of the six habitat related metrics when compared to all other Class 5 Southern Streams RR and Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 401). Both sites had low amounts of EPT individuals and also high numbers of legless individuals, which can indicate potential stress due to poor habitat conditions. Site 04DM002 also had a high number of burrower individuals, which can be linked to the sand and silt substrates found in this stream.

Based on the poor to fair MSHA scores, as well as the majority of the habitat related metrics in both the fish and macroinvertebrate communities in Unnamed Creek (-551), habitat is a stressor to aquatic life in this reach.

Altered Hydrology

Unnamed Creek (-551) is a tributary to the Des Moines River. The reach itself is almost entirely natural though the majority of its upstream watershed is altered according to the MPCA altered watercourse layer. The reach flows from the outlet of the String Lakes and flows directly into the Des Moines River.

Extreme weather events affect high flow events as well as also low flows during drought. HSPF models show this stream section experiencing low flow at less than five cfs 71.3% of the time and less than one cfs 29.2% of the time.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The average percentage for generalist fish within the reach was 84.7% compared to the average in Class 3 general use waters meeting the standard of 59.1%. Generalist fish species ranged from 69.5-99.9%.

The numbers of nest guarder species are also positively correlated with increased low flows. The percentage for nest guarder fish within the reach was 19.6% compared to the average in Class 3 general use waters meeting the standard of 19.2%.

Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The percentage for long-lived macroinvertebrates within the reach was 0% compared to the average in Class 5 general use waters meeting the standard of 9%. The percentage for long-lived macroinvertebrates within the reach was 0.9% compared to the average in Class 7 general use waters meeting the standard of 8%.

Unnamed Creek (-551) frequently has low flow conditions that can impact biological conditions, the biological metrics in this reach all score poorly as well, however, the reach itself is in a natural condition, therefore Flow Alteration/Connectivity is inconclusive as a stressor to aquatic life.

Summary

The impaired fish and macroinvertebrate communities in Unnamed Creek (-551) are being stressed by DO, Eutrophication, Suspended Sediment, and Habitat (Table 402). Flow Alteration/Connectivity is inconclusive as a stressor at this point, while Nitrates were ruled out as a stressor to aquatic life at this time. For further information on the stressors and recommendations to fixing the stressors in the City of Windom-Des Moines River HUC 10 Watershed, please see pages 378-379.

Table 402. Stressor determinations for Unnamed Creek (-551).

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Unnamed Creek	07100001-551	●	●	---	●	●	o

● = stressor; o = inconclusive stressor; --- = not an identified stressor

County Ditch 43/Scheldorf Creek (07100001-552)

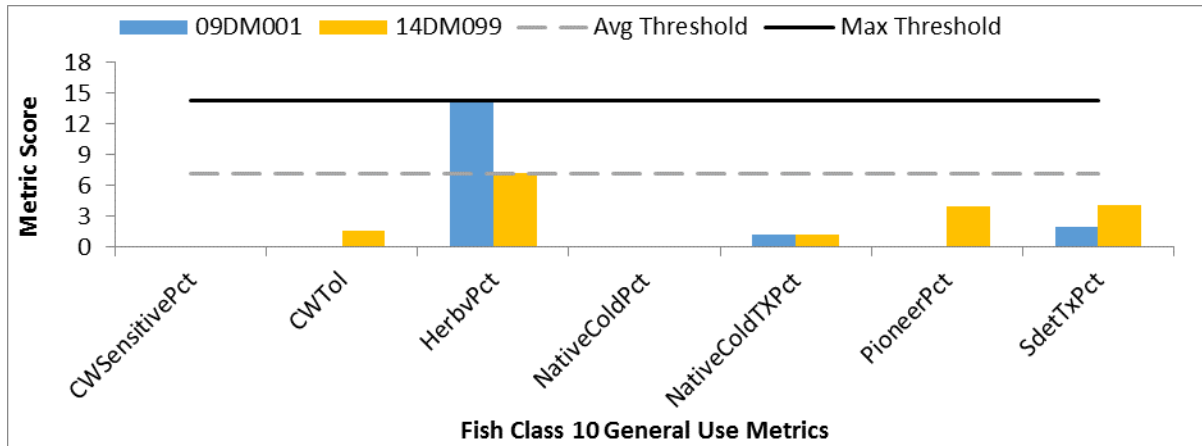
Located in central Cottonwood County, County Ditch 43/Scheldorf Creek (-552) is a 1.26 mile long reach that is impaired for aquatic life due to the fish and macroinvertebrate assemblages. This stream reach extends from unnamed creek down to the confluence with the Des Moines River. Along this stream section, there are two biological monitoring stations, 09DM001 and 14DM099.

Biology

Fish

The fish community in County Ditch 43 (Scheldorf Creek) (-552) was sampled for fish in August of 2010 at site 09DM001. The FIBI score at this site was 17.4. Site 14DM099 was also sampled in June 2014 and had a FIBI score of 17.9. Both of these FIBI scores are below the Fish Class 10 Southern Coldwater General Use Threshold of 50. Each site did have one metric (HerbvPct) reach the average metric score needed to meet the threshold (Figure 181), however, the remaining six metrics comprising this FIBI scored below average with many metrics-scoring zero.

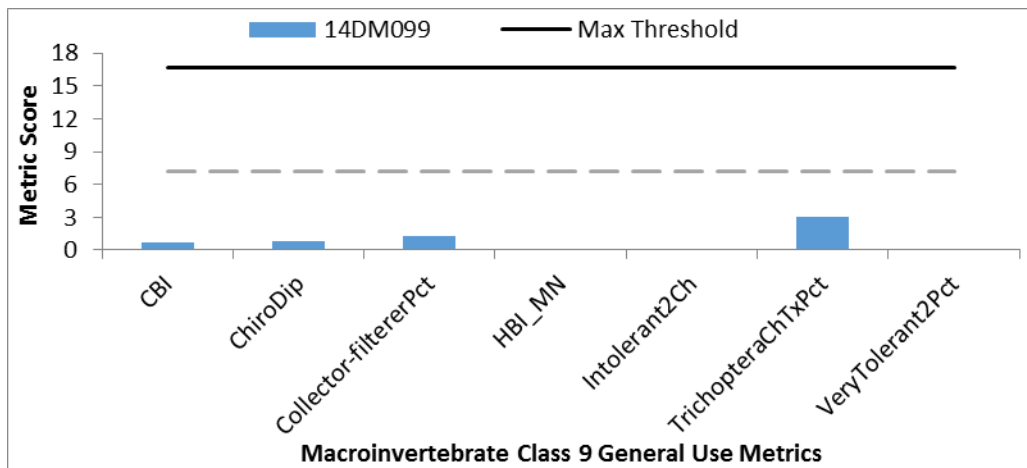
Figure 181. County Ditch 43/Scheldorf Creek (-552) fish IBI metric scores.



Macroinvertebrates

The macroinvertebrate assemblage at site 14DM099 was sampled in August of 2014. This site had a MIBI score of 5.89, which is far below the Macroinvertebrate Class 9 Southern Coldwater General Use Threshold of 43. All of the metrics comprising the MIBI at this site scored below the average needed to reach the threshold with three of the metrics scoring zero resulting in the impairment designation. See Figure 182 for a complete breakdown of the metric scores at this site.

Figure 182. County Ditch 43/Scheldorf Creek (-552) macroinvertebrate IBI metric scores.



Dissolved Oxygen

A total of 11 DO measurements were taken from one chemistry site (S001-740) and two biological monitoring stations (09DM001, 14DM099) from 2010-2016. The average of all the values is 8.91 mg/L with a low of 5.28 mg/L and a high of 13.20 mg/L. The summer average (June-Aug) is 8.28 mg/L. The DO values did not fall below 5 mg/L.

The HSPF model calculated daily minimum DO values for this subwatershed from 1994-2014. Of these calculations, 1769 (42.27%) of the days had a daily minimum DO level below the daily minimum standard of 5 mg/L. This is a very high exceedance rate for DO.

Table 403. DO related fish metrics in County Ditch 43/Scheldorf Creek (-552). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-552 Fish Class 10 – General Use	MA>3 Avg	SspnPct Avg	Taxa Count Avg	DO TIV Avg
09DM001	10.40	67.30	20.00	8.39
14DM099	22.70	26.99	14.00	8.13
<i>Statewide average for Class 10 Southern Coldwater stations that are meeting the FIBI General Use Threshold (50.0)</i>	75.13	1.79	5.69	9.4
Expected response to DO stress	↓	↑	↓	↓

The fish community in County Ditch 43/Scheldorf Creek (-552) at sites 09 scored below average in three of the four DO related metrics when compared to all other Class 10 Southern Coldwater stations that meet the FIBI General Use Threshold (Table 403). Both sites had increased numbers of serial spawning fish, while also having few mature fish and poor DO TIV scores.

Table 404. DO related macroinvertebrate metrics in County Ditch 43/Scheldorf Creek (-552). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-552 Macroinvertebrate Class 9 – General Use	HBI_MN Value	% DO Tolerant Taxa	# DO Tolerant Taxa	ChemTV DO
09DM001	1.51	2.20	4.00	5.88
14DM099	1.28	44.39	6.50	5.91
<i>Statewide average for Class 9 Southern Coldwater stations that are meeting the MIBI General Use Threshold (43)</i>	0	1.66	1.84	7.44
Expected response to DO stress	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in all four of the DO related metrics at both sites when compared to all other Class 9 Southern Coldwater stations that meet the MIBI General Use Threshold (Table 404). Both sites, especially 14DM099, had high percentages and numbers of DO tolerant taxa, while also have a poor HBI_MN and DO TIV scores. These results are often found in streams negatively impacted by DO.

The observed data in this reach does not fall below the 5 mg/L standard for DO, while the modeled data calculated a very high exceedance rate. The majority of the DO related metrics in the biological communities score below average as well. In addition, this reach does not have elevated phosphorus values, which can indicate plant growth negatively impacting the daily flux of DO. Based on this conflicting information, DO is inconclusive as a stressor to aquatic life. Continuous DO monitoring with a sonde is recommended to better determine the conditions in this reach.

Eutrophication

Twelve phosphorus samples were taken from one chemistry site (S001-740) and two biological monitoring stations (09DM001, 14DM099) from 2010-2016. The average of all the values is 0.029 mg/L with a low of 0.01 mg/L and a high of 0.07 mg/L. The summer average (June-Aug) is 0.029 mg/L. Phosphorus values never exceeded the standard of 0.150 mg/L.

Table 405. Eutrophication related fish metrics in County Ditch 43/Scheldorf Creek (-552). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-552 Fish Class 10 – General Use	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct
09DM001	2.08	7.94	73.53	55.58
14DM099	6.13	7.98	89.57	48.47
<i>Statewide average for Class 10 Southern Coldwater stations that are meeting the FIBI General Use Threshold (50.0)</i>	74	3.27	22.46	14.51
Expected response to Eutrophication stress	↓	↓	↑	↑

The fish community in County Ditch 43/Scheldorf Creek (-552) at sites 09DM001 and 14DM099 scored below average in three of the four eutrophication related metrics at both sites when compared to all other Class 10 Coldwater stations that meet the FIBI General Use Threshold (Table 405). This reach had decreased amounts of sensitive individuals, while also having increased numbers of both tolerant and omnivorous individuals. These results are often found in streams stressed by eutrophication. This reach did have increased numbers of darter individuals, which is not normally found in streams potentially stressed by eutrophication.

Table 406. Eutrophication related macroinvertebrate metrics in County Ditch 43/Scheldorf Creek (-552). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-552 Macroinvertebrate Class 9 – General Use	EPT Pct	Tanytarsini Pct	CrustMoll Pct	Scrapper Pct	% Tolerant Taxa	% Intolerant Taxa
09DM001	8.28	28.57	3.18	5.10	12.89	0.00
14DM099	1.27	34.31	6.98	2.70	21.68	0.00
<i>Statewide average for Class 9 Southern Coldwater stations that are meeting the MIBI General Use Threshold (43)</i>	40.36	29.04	16.94	7.54	7.48	7.67
Expected response to Eutrophication stress	↓	↓	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in three (14DM099) and four (09DM001) of the six eutrophication related metrics when compared to all other Class 9 Southern Coldwater stations that meet the MIBI General Use Threshold (Table 406). Both sites in this reach had decreased numbers of EPT individuals, as well as phosphorus intolerant taxa, while also having elevated numbers of phosphorus tolerant species. These results are common in streams potentially stressed due to eutrophication.

Based on the extremely low phosphorus values sampled in County Ditch 43/Scheldorf Creek (-552) and the rather mixed results in the macroinvertebrate metrics related to phosphorus, eutrophication is not a stressor to aquatic life in this reach. It is likely other stressors are having a great impacted on the fish and macroinvertebrate community resulting in low metric scores.

Nitrates

Twelve samples taken from one chemistry site (S001-740) and two biological monitoring stations (09DM001, 14DM099) from 2010-2016 were analyzed for Inorganic Nitrogen (NO₂-NO₃). The average of

all the values is 2.75 mg/L with a low of 0.27 mg/L and a high of 6.40 mg/L. The spring average (March-May) is 6.20 mg/L. The summer average (June-Aug) is 2.03 mg/L.

The HSPF model calculated daily nitrate concentrations for this subwatershed from 1994-2014. These values ranged from 1.71-18.44 mg/L with an average nitrate concentration of 9.51 mg/L.

Table 407. Nitrate related macroinvertebrate metrics in County Ditch 43/Scheldorf Creek (-552). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-552 Macroinvertebrate Class 9 – General Use	TrichopteraChTx Pct	N Index Score	% N Tolerant	% N Intolerant
09DM001	7.89	3.46	66.04	0.00
14DM099	8.75	3.53	70.5	0.31
<i>Statewide average for Class 9 Southern Coldwater stations that are meeting the MIBI General Use Threshold (43)</i>	16.00	3.08	58.72	0.63
Expected response to N stress	↓	↑	↑	↓

The macroinvertebrate assemblage in County Ditch 43/Scheldorf Creek (-552) scored below average in all four nitrate related metrics at both sites, 09DM001 and 14DM099, when compared to all other Class 9 Southern Coldwater stations that meet the MIBI General Use Threshold (Table 407). Both sites had high numbers of nitrate tolerant individuals, poor nitrate index scores, while also having lower amounts of both trichoptera and nitrate intolerant species.

The nitrate related biological metrics strongly signal that nitrates are a stressor, however, the observed chemical data shows lower nitrate concentrations. The HSPF model does predict elevated nitrate levels. More nitrate sampling is needed to better determine the impacts that nitrates are having on aquatic life in this reach, therefore, nitrates are inconclusive as a stressor.

Suspended Solids

Ten samples taken from one chemistry site (S001-740) in 2016 were analyzed for TSS. The average of all the values is 3.86 mg/L with a low of 1 mg/L and a high of 14 mg/L. The TSS concentrations exceeded the 10 mg/L standard once.

Additionally, nine secchi tube measurements were taken from this reach in 2016. These values ranged from 95-100 cm, with no values falling below the 55 cm minimum standard for secchi tube.

The HSPF model calculated daily TSS values for this subwatershed from 1994-2014. These concentrations ranged from 2.30-473.81 mg/L with an average TSS value of 14.32 mg/L.

Table 408. TSS related fish metrics in County Ditch 43/Scheldorf Creek (-552). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-552 Fish Class 10 – General Use	BenFdFrimPct	Centr-TolPct	HerbvPct	Perfrm-TolPct	RifflePct	SensitivePct	SlithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
09DM001	10.40	0.00	1.89	15.50	3.97	2.08	2.65	0.00	10.59	22.53
14DM099	30.06	0.00	3.68	9.20	27.61	6.13	23.31	0.00	1.84	18.16
<i>Statewide average for Class 10 Southern Coldwater stations that are meeting the FIBI General Use Threshold (50.0)</i>	28.37	0.53	0.32	3.85	34.82	72.53	21.06	26.00	53.81	10.39
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

The fish community in County Ditch 43/Scheldorf Creek (-552) scored below average in six (14DM099) and eight (09DM001) of the 10 TSS related metrics when compared to all other Class 10 Southern Coldwater stations that meet the FIBI General Use Threshold (Table 408). This reach had above average numbers of herbivorous and perch-like individuals, while site 14DM099 also had increased numbers of benthic feeding and simple lithophilic individuals. These results are common in streams without TSS issues. However, the remaining metrics at this site scored poorly similarly to site 019DM001.

Table 409. TSS related macroinvertebrate metrics in County Ditch 43/Scheldorf Creek (-552). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-552 Macroinvertebrate Class 9 – General Use	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plectoptera Pct
09DM001	12.94	0.00	11.00	33.96	8.60	0.00
14DM099	12.91	0.00	6.50	9.90	11.68	0.00
<i>Statewide average for Class 9 Southern Coldwater stations that are meeting the MIBI General Use Threshold (43.0)</i>	13.56	2.33	5.49	13.36	32.86	0.26
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

The macroinvertebrate assemblage in this reach scored below average in four (14DM099) and five (09DM001) of the six TSS related metrics when compared to all other Class 9 Southern Coldwater stations that meet the MIBI General Use Threshold (Table 409). Both sites did have a good TSS Index Score and site 14DM099 did have a decreased percentage of TSS tolerant individuals. These results are not often found in streams with elevated TSS concentrations.

The observed and modeling data sets both indicate that the TSS concentrations in this reach are low and remain low. It is likely that other stressors are causing the fish and macroinvertebrate communities to score poorly as the chemical and model data give no indication of potential stress. Therefore, TSS is not a stressor to aquatic life in County Ditch 43/Scheldorf Creek (-552) at this time.

Habitat

County Ditch 43/Scheldorf Creek (-552) had a qualitative habitat assessment take place at its biological monitoring sites, 09DM001 and 14DM099, during the fish and macroinvertebrate sampling events in 2010 and 2014. The average MSHA score from these visits were 62.1 (Fair) at 09DM001 and 44 (Poor) at 14DM099. Limiting the habitat at these sites was the row crop agriculture and development as the dominant nearby land uses, light stream shading, sand and silt substrates; moderate to severe embeddedness, moderate channel stability, poor sinuosity (14DM099) (Figure 183) and poor channel development (14DM099). Further MSHA analysis can be seen in Figure 184.

Figure 183. Poor Sinuosity at site 14DM099.



Figure 184. County Ditch 43/Scheldorf Creek (-552) MSHA metric scores.

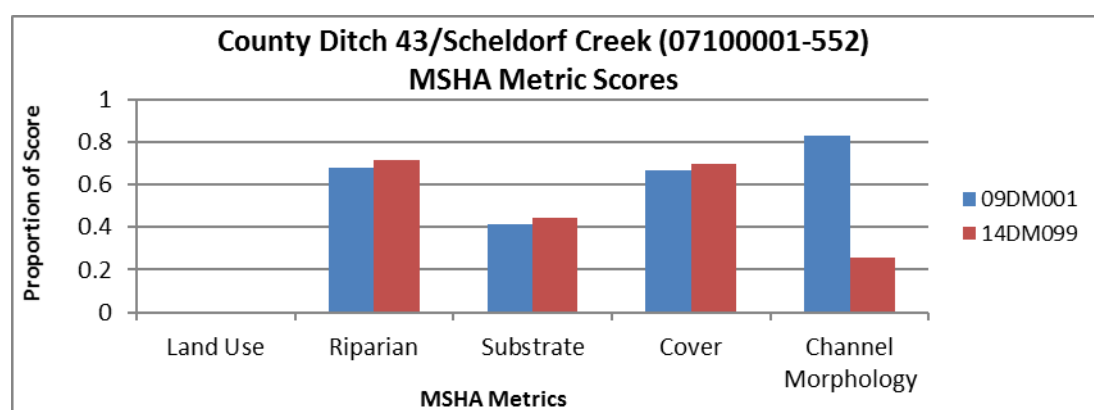


Table 410. Habitat related fish metrics in County Ditch 43/Scheldorf Creek (-552). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-552 Fish Class 10 – General Use	BenInsect-TolPct	SLithopPct	DarterSculpSu cPct	RifflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
09DM001	8.13	2.65	7.94	3.97	3.21	13.80	73.53	73.16
14DM099	7.98	23.31	7.98	27.61	0.61	36.81	89.57	39.88
<i>Statewide average for Class 10 Southern Coldwater stations that are meeting the FIBI General Use Threshold (50.0)</i>	21.41	21.06	18.34	34.82	53.58	76.14	23.90	4.80
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

The fish community in County Ditch 43/Scheldorf Creek at sites 09DM001 and 14DM099 scored below average in seven (14DM099) and eight (09DM001) of the eight habitat related metrics when compared to all other Class 10 Southern Coldwater stations that meet the FIBI General Use Threshold (Table 410). These two sites were dominated by tolerant and pioneering species, while having relatively few species requiring specialized habitat conditions to live and reproduce. These results are indicative of a stream being stressed by the habitat conditions.

Table 411. Habitat related macroinvertebrate metrics in County Ditch 43/Scheldorf Creek (-552). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-552 Macroinvertebrate Class 9 – General Use	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
09DM001	25.80	20.06	21.66	8.28	77.39	28.98
14DM099	38.58	18.68	30.66	1.27	82.92	9.58
<i>Statewide average for Class 9 Southern Coldwater stations that are meeting the MIBI General Use Threshold (43.0)</i>	3.23	7.24	44.78	39.30	23.21	19.10
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate community in this reach scored below average in four (09DM001) and five (14DM099) when compared to all other Class 9 Southern Coldwater stations that meet the MIBI General Use Threshold (Table 411). Both sites had very high numbers of both legless and burrower individuals, which really corresponds to the sand and silt substrates found in these streams as well as the embeddedness issues discovered during the habitat assessment. These results are common in streams with degraded habitat conditions.

Based on the poor to fair MSHA scores at the two sites along this reach, as well as the majority of the habitat related metrics in the fish and macroinvertebrate assemblages scoring below average, habitat is a stressor to aquatic life in County Ditch 43/Scheldorf Creek (-552).

Altered Hydrology

County Ditch 43/ Sheldorf Creek (-552) is a tributary to the Des Moines River. The reach itself is half altered and half natural over half of the upstream watershed is altered according to the MPCA altered watercourse layer.

Extreme weather events affect high flow events as well as also low flows during drought. HSPF models show this stream section experiencing low flow at less than five cfs 64.3% of the time and less than one cfs 25.1% of the time.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The average percentage for generalist fish within the reach was 67.2% compared to the average in Class 10 general use waters meeting the standard of 20.5%. Generalist fish species ranged from 65.0-69.4%.

The numbers of nest guarder species are also positively correlated with increased low flows. The average percentage for nest guarder fish within the reach was 58.2% compared to the average in Class 10 general use waters meeting the standard of 11.6%. Nest guarder species ranged from 52.8-63.7%.

Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The average percentage for long-lived macroinvertebrates within the reach was 4.1% compared to the average in Class 9 general use waters meeting the standard of 3.1% Long-lived macroinvertebrates ranged from 0-8.3%.

Based on the partial channelization of this stream, the higher frequency of low flow conditions, as well as the poor scoring biological metrics, Flow Alteration/Connectivity is a stressor to aquatic life in County Ditch 43/Scheldorf Creek (-552) at this time.

Summary

The impaired fish and macroinvertebrate communities in County Ditch 43/Scheldorf Creek (-552) are being stressed by Habitat and Flow Alteration/Connectivity (Table 412). DO and Nitrates are inconclusive as stressors at this point, while Eutrophication and Suspended Sediment were ruled out as stressors to aquatic life. For further information on the stressors and recommendations to fixing the stressors in the City of Windom-Des Moines River HUC 10 Watershed, please see pages 378-379.

Table 412. Stressor determinations for County Ditch 43/Scheldorf Creek (-552).

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
County Ditch 43/Scheldorf Creek	07100001-552	o	---	o	---	●	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Unnamed Creek (07100001-563)

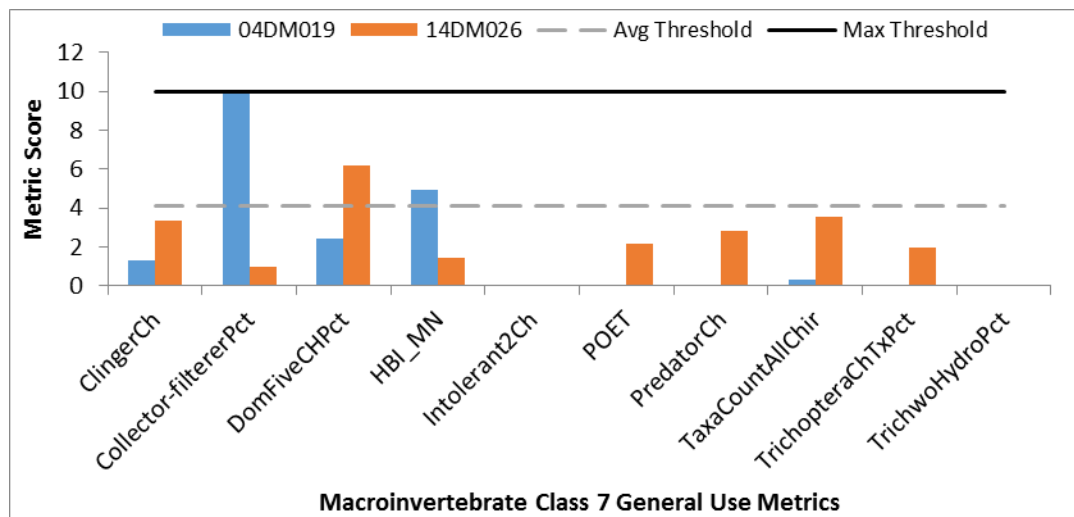
Located in central Cottonwood County, Unnamed Creek (-563) is a 3.90 mile long reach that is impaired for aquatic life due to the macroinvertebrate assemblage. This stream reach extends from Harder Lake down to the confluence with an unnamed creek. Along this stream section, there are two biological monitoring stations, 04DM019 and 14DM026.

Biology

Macroinvertebrates

The macroinvertebrate assemblage in Unnamed Creek (-563) at site 04DM019 was sampled in August of 2004 and had a MIBI score of 19.1 while site 14DM026 was sampled in August 2015 and had a MIBI score of 22.6. Both of these MIBI scores are below the Macroinvertebrate Class 7 Prairie Streams GP General Use Threshold of 41. Site 14DM026 had one (DomFiveCHPct) and site 04DM019 had two metrics (Collector-FiltererPct, HBI_MN) score above the average needed to reach the threshold. However, the remaining metrics scored below average with many having a metric score of zero resulting in the impairment designation. See Figure 185 for a complete breakdown of the metric scores at this site.

Figure 185. Unnamed Creek (-563) macroinvertebrate IBI metric scores.



Dissolved Oxygen

A total of 11 DO measurements were taken from one chemistry site (S009-037) and two biological monitoring stations (04DM019, 14DM026) from 2004-2016. The average of all the values is 6.26 mg/L with a low of 3.94 mg/L and a high of 10.02 mg/L. The summer average (June-Aug) is 5.44 mg/L. The DO values fell below 5 mg/L three times.

The HSPF model calculated daily minimum DO values for this subwatershed from 1994-2014. Of these calculations, 1652 (41.31%) of the days had a daily minimum DO level below the daily minimum standard of 5 mg/L. This is a very high standard exceedance rate for DO.

Table 413. DO related fish metrics in Unnamed Creek (-563). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-563 Fish Class 3 – General Use	MA>3 Avg	SspnPct Avg	Taxa Count Avg	DO TIV Avg
04DM019	0.00	0.00	1.00	8.87
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	13.32	17.09	12.16	8.44
Expected response to DO stress	↓	↑	↓	↓

The fish community in Unnamed Creek (-563) at site 04DM019 scored below average in two of the four DO related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 413). The sampled at 04DM019 consisted of 25 common carp, which are a very tolerant species that can tolerate low DO conditions.

Table 414. DO related macroinvertebrate metrics in Unnamed Creek (-563). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-563 Macroinvertebrate Class 7 – General Use	HBI_MN Value	% DO Tolerant Taxa	# DO Tolerant Taxa	ChemTV_DO
04DM019	7.36	25.08	4.00	6.15
14DM026	8.43	30.16	4.00	6.21
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	7.55	12.98	5.74	6.91
Expected response to DO stress	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in two (04DM019) and three (14DM026) of the four DO related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 414). Both sites had a high percentage of DO tolerant taxa present, while also having poor DO TIV scores. Site 14DM026 also had a poor HBI_MN value. These results are common in streams with DO issues.

Based on the high exceedance rate in the observed data set as well as the very high exceedance rate in the modeled data, as well as many of the DO related metrics in both biological communities scoring below average, DO is a stressor to aquatic life in Unnamed Creek (-563).

Eutrophication

A total of 11 phosphorus samples were taken from one chemistry site (S009-037) and two biological monitoring stations (04DM019, 14DM026) from 2004-2016. The average of all the values is 0.136 mg/L with a low of 0.07 mg/L and a high of 0.19 mg/L. The summer average (June-Aug) is 0.150 mg/L. Phosphorus values exceeded the standard of 0.150 mg/L three times. Figure 186 shows a large amount of algae growing in a small trib entering this stream system.

The HSPF model calculated daily phosphorus values for this subwatershed from 1994-2014. These values ranged from 0.25-2.85 mg/L with an average value of 0.51 mg/L. All of these calculations were above the 0.15 mg/L standard.

Figure 186. Algae filled tributary to Unnamed Creek (-563).



Table 415. Eutrophication related fish metrics in Unnamed Creek (-563). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-666 Fish Class 3 – General Use	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct
04DM019	0.00	0.00	100.00	100.00
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	8.9	12.11	70.79	14.71
Expected response to Eutrophication stress	↓	↓	↑	↑

The fish community in Unnamed Creek (-653) at site 04DM019 scored below average in all four of the eutrophication related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBIG General Use Threshold (Table 415). This fish community was comprised of 25 common carp. These species are very tolerant and can thrive in eutrophic stream conditions.

Table 416. Eutrophication related macroinvertebrate metrics in Unnamed Creek (-563). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-563 Macroinvertebrate Class 7 – General Use	EPT Pct	Tanytarsini Pct	CrustMoll Pct	Scraper Pct	% Tolerant Taxa	% Intolerant Taxa
04DM019	1.66	77.13	15.89	3.97	67.66	0.00
14DM026	13.77	9.90	42.62	34.43	44.59	0.00
<i>Statewide average for Class 7 Prairie Streams Glide Pool stations that are meeting the MIBI General Use Threshold (41)</i>	38.45	18.46	11.78	16.11	26.84	4.03
Expected response to Eutrophication stress	↓	↓	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in four (04DM019) and six (14DM026) of the six eutrophication related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 416). Both of the sites, 04DM019 and 14DM026, had low amounts of EPT individuals and phosphorus intolerant taxa, while also having increased amounts of crustacean/mollusca individuals and phosphorus tolerant taxa. These results are common in streams stressed by eutrophic conditions.

Based on the high number of exceedances in the observed and modeled data, the presence of algae in an immediate tributary, as well as the majority of the eutrophication related metrics in both the fish and macroinvertebrate communities scoring below average, eutrophication is a stressor to aquatic life in Unnamed Creek (-563).

Nitrates

Eleven samples taken from one chemistry site (S009-037) and two biological monitoring stations (04DM019, 14DM026) from 2004-2016 were analyzed for Inorganic Nitrogen (NO₂-NO₃). The average of all the values is 5.22 mg/L with a low of 1.30 mg/L and a high of 9.50 mg/L. The spring average (March-May) is 5.50 mg/L. The summer average (June-Aug) is 4.60 mg/L. Nitrate values exceeded 4 mg/L nine times.

The HSPF model calculated daily nitrate concentrations for this subwatershed from 1994-2014. These values ranged from 1.76-38.97 mg/L with an average value of 10.1 mg/L. Of these calculations, 1399 (25.69%) were above 11.5 mg/L. A quantile regression analysis for Class 7 stream stations showed that sites having a nitrate concentration in excess of 11.5 mg/L there was a 90% probability for impairment. The nitrate concentrations in this reach easily exceeded this level.

Drain tiles were noted as being present along this reach. Drain tiles are a common pathway for nitrates to enter a stream system.

Table 417. Nitrate related macroinvertebrate metrics in Unnamed Creek (-563). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-563 Macroinvertebrate Class 7 – General Use	TrichopteraChTx Pct	N Index Score	% N Tolerant	% N Intolerant
04DM019	0.00	3.11	63.37	0.00
14DM026	3.23	4.99	87.87	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	10.00	3.30	57.57	0.91
Expected response to N stress	↓	↑	↑	↓

The macroinvertebrate assemblage in Unnamed Creek (-563) scored below average in three (04DM019) and four (14DM026) of the four nitrate related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 417). Both sites had lacked or had low amounts of trichoptera and nitrate intolerant taxa, while also having very high amounts of nitrate tolerant individuals especially at site 14DM026.

The observed data did not reach very high levels, however, based on the elevated nitrate concentrations calculated by the HSPF model, the quantile regression analysis, the presence of drain tiles, as well as the vast majority of the nitrate related biological metrics, nitrates are a stressor to aquatic life in Unnamed Creek (-563).

Suspended Solids

Nine samples taken from one chemistry site (S009-037) in 2016 were analyzed for TSS. The average of all the values is 23.27 mg/L with a low of 6.4 mg/L and a high of 54 mg/L. The TSS concentrations did not exceed the 65 mg/L standard.

Additionally, nine secchi tube measurements were taken from this reach. These values ranged from 12-80 cm, with no values falling below the 10 cm minimum standard for secchi tube.

The HSPF model calculated daily TSS values for this subwatershed from 1994-2014. These concentrations ranged from 2.14-697.24 mg/L with an average TSS value of 13.96 mg/L. Of these calculations, 45 (3.00%) were above the TSS standard.

Table 418. TSS related fish metrics in Unnamed Creek (-563). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-563 Fish Class 3 – General Use	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RifflePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
04DM019	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	38.85
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	37.83	0.90	13.33	13.93	28.33	8.55	33.71	1.95	3.56	15.27
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

The fish community in Unnamed Creek (563) at site 04DM019 scored below average in nine of the ten TSS related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 418). The fish sample in this reach consisted of 25 common carp. Common carp are very tolerant to poor TSS conditions.

Table 419. TSS related macroinvertebrate metrics in Unnamed Creek (-563). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-563 Macroinvertebrate Class 7 – General Use	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
04DM019	13.13	0.00	6.00	4.29	49.67	0.00
14DM026	19.84	0.00	11.00	51.15	3.93	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (22.0)</i>	17.35	1.33	13.20	48.28	19.13	0.22
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

The macroinvertebrate assemblage in this reach scored below average in three (04DM019) and five (14DM026) of the six TSS related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 419). Both sites lacked TSS intolerant and plecoptera taxa. Site 04DM019 fared much better of the two sites as it also had a good TSS Index score, while having a lower amount and percentage of TSS tolerant taxa and individuals. Site 04DM049 also had a very high amount of collector-filterer individuals. These results at site 04DM019 suggest that TSS is not a stressor.

Based on the lack of exceedances in the observed data set, the low exceedance rate in the modeled data set, as well as the decreased amount of TSS tolerant taxa and individuals and increased amount of collector-filterer taxa at site 04DM019, TSS is not a stressor to aquatic life in Unnamed Creek (-563). It is likely that other stressors are causing the lower metric scores in the fish community.

Habitat

Unnamed Creek (-563) had a qualitative habitat assessment take place at its biological monitoring sites, 04DM019 and 14DM026, during the fish and macroinvertebrate sampling events in 2004 and 2014. The average MSHA score from these visits were 38 (Fair) at 04DM019 and 39.25 (Poor) at 14DM026. Limiting the habitat at these sites was the row crop agriculture as the dominant nearby land use, light stream shading, sand, clay and silt substrates, moderate to severe embeddedness, and poor to fair channel development. Further MSHA analysis can be seen in Figure 187.

Figure 187. Unnamed Creek (-563) MSHA metric scores.

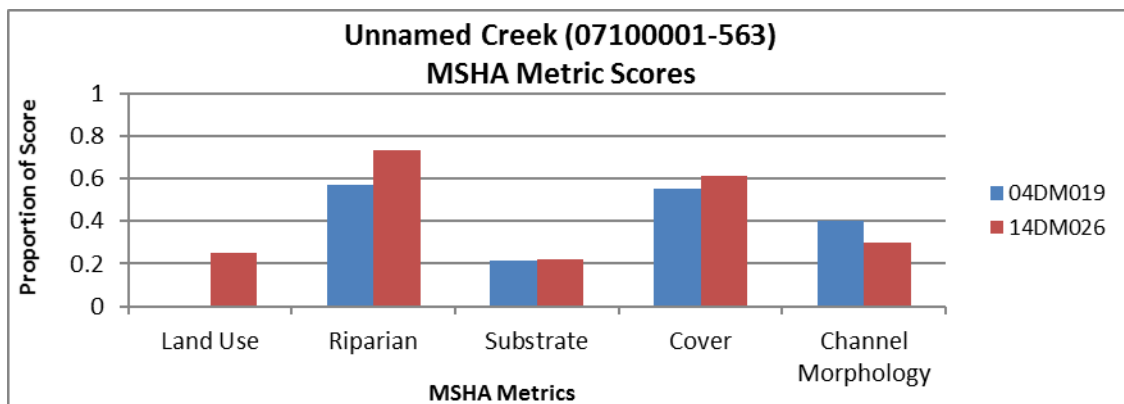


Table 420. Habitat related fish metrics in Unnamed Creek (-563). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-563 Fish Class 3 – General Use	BenInsect-TolPct	SLithopPct	DarterSculpSu cPct	RifflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
04DM019	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	14.22	33.71	12.55	28.33	1.62	69.21	70.64	37.79
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

The fish community in Unnamed Creek (-563) at sites 04DM019 scored below average in all eight habitat related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 420). Site 04DM019 had only common carp present, which are very tolerant of poor habitat conditions.

Table 421. Habitat related macroinvertebrate metrics in Unnamed Creek (-563). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-563 Macroinvertebrate Class 7 – General Use	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
04DM019	47.68	2.98	37.75	1.66	84.44	4.97
14DM026	10.49	51.48	5.90	13.77	71.48	21.97
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)</i>	5.40	20.35	36.94	37.77	37.96	19.49
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate community in Unnamed Creek (-563) scored below average in four (14DM026) and five (04DM019) of the six habitat related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 421). Both sites had lower numbers of EPT individuals, while also having high numbers of both burrower and legless individuals. The high amount

of burrower and legless macroinvertebrates corresponds to the sand, silt, and clay substrates found and the high amount of embeddedness. These results are common in streams with likely habitat issues.

Based on the poor MSHA scores at both sites, in addition to the majority of the habitat related metrics scoring poorly in both the fish and macroinvertebrate communities, habitat is a stressor to aquatic life in Unnamed Creek (-563).

Altered Hydrology

Unnamed Creek (-563) is a tributary to the Des Moines River that is mostly natural though most of the upstream watershed is altered according to the MPCA altered watercourse layer.

Extreme weather events affect high flow events as well as also low flows during drought. HSPF models show this stream section experiencing low flow at less than five cfs 70.8% of the time and less than one cfs 29.4% of the time.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The average percentage for generalist fish within the reach was 100% compared to the average in Class 3 general use waters meeting the standard of 59.1% Generalist fish species ranged from 100-100%.

The numbers of nest guarder species are also positively correlated with increased low flows. The average percentage for nest guarder fish within the reach was 5.6% compared to the average in Class 3 general use waters meeting the standard of 19.2%. Nest guarder species ranged from 0-11.1%.

Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The average percentage for long-lived macroinvertebrates within the reach was 5.6% compared to the average in Class 7 general use waters meeting the standard of 8%. Long-lived macroinvertebrates ranged from 0-11.1%.

Unnamed Creek (-563) is a natural stream section with significant stream channelization in the upstream portions of the watershed. The stream often experiences low flow conditions and the related biological metrics did score poorly in this reach. The upstream channelization may be causing stress in this reach; therefore, Flow Alteration/Connectivity is inconclusive as a stressor.

Summary

The impaired macroinvertebrate community in Unnamed Creek (-563) is being stressed by DO, Eutrophication, Nitrates, and Habitat (Table 422). Flow Alteration/Connectivity was inconclusive as a stressor at this point, while and Suspended Sediment was ruled out as a stressor to aquatic life. For further information on the stressors and recommendations to fixing the stressors in the City of Windom-Des Moines River HUC 10 Watershed, please see pages 378-379.

Table 422. Stressor determinations for Unnamed Creek (-563).

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Unnamed Creek	07100001-563	●	●	●	---	●	0

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Unnamed Creek (07100001-613)

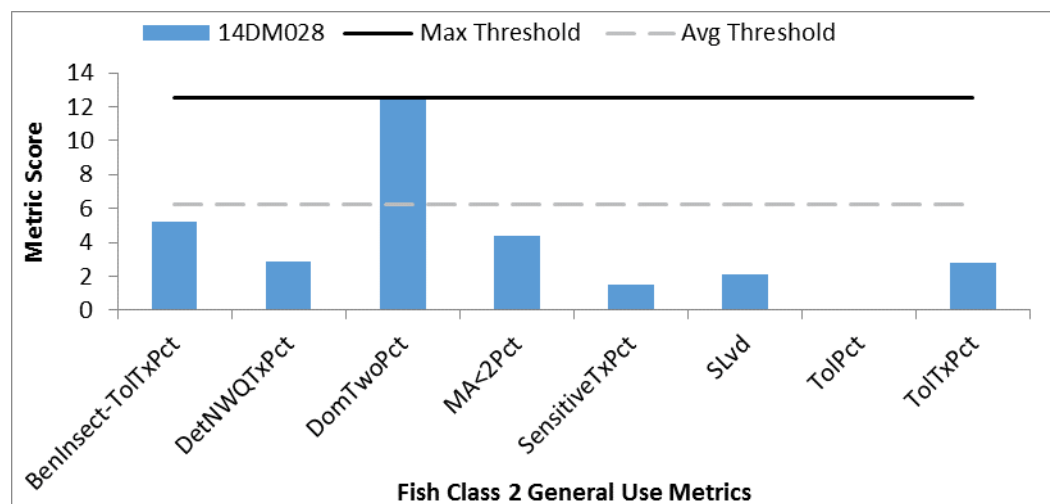
Located in southcentral Cottonwood County, Unnamed Creek (-613) is a 1.84 mile long reach that is impaired for aquatic life due to the fish assemblage. This stream reach extends from an unnamed creek down to the confluence with the Des Moines River. Along this stream section there is one biological monitoring station, 14DM028.

Biology

Fish

The fish community in Unnamed Creek (-613) was sampled for fish in July of 2014 at its biological monitoring station 14DM028. The FBI score at this reach was 31.4, which is below the Fish Class 2 Southern Streams General Use Threshold of 50. This site did have one metric (DomTwoPct) reach the average metric score needed to meet the threshold (Figure 188), however, the remaining seven metrics comprising this FBI scored well below average with one metric (TolPct) scoring zero.

Figure 188. Unnamed Creek (-613) fish IBI metric scores.



Dissolved Oxygen

A total of 11 DO measurements were taken from one chemistry site (S009-051) and one biological monitoring station (14DM028) from 2014-2016. The average of all the values is 9.04 mg/L with a low of 5.32 mg/L and a high of 11.72 mg/L. The DO values did not fall below 5 mg/L.

The HSPF model calculated daily minimum DO values for this subwatershed from 1994-2014. Of these calculations, 3683 (64.78%) of the days had a daily minimum DO level below the daily minimum standard of 5 mg/L. This is an extremely high exceedance rate for DO.

Table 423. DO related fish metrics in Unnamed Creek (-613). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-613 Fish Class 2 – General Use	MA>3 Avg	SspnPct Avg	Taxa Count Avg	DO TIV Avg
14DM028	7.02	52.92	18.00	8.70
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)</i>	23.89	28.72	20.38	8.56
Expected response to DO stress	↓	↑	↓	↓

The fish community in Unnamed Creek (-613) at site 14DM028 scored below average in three of the four DO related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 423). This reach had very few mature fish, while also having a slightly below average taxa count. This reach also had a high amount of serial spawning fish species, which is common in streams with DO issues.

Table 424. DO related macroinvertebrate metrics in Unnamed Creek (-613). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-613 Macroinvertebrate Class 7 – General Use	HBI_MN Value	% DO Tolerant Taxa	# DO Tolerant Taxa	ChemTV DO
14DM028	8.42	40.80	6.00	5.82
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	7.55	12.98	5.74	6.91
Expected response to DO stress	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in all four of the DO related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 424). This reach had a very high percentage of DO tolerant species, while also having a poor DO TIV score and HBI_MN value. These results are indicative of a community stressed by DO.

The observed DO data did not fall below 5 mg/L in the 11 measurements taken, while the modeled data set calculated a high exceedance rate. The vast majority of the fish and macroinvertebrate metrics related to DO did score below average although the fish community did have an above average TIV score for DO. Based on these mixed results, DO is inconclusive as a stressor at this point. Continuous DO monitoring with a sonde is recommended to better understand the impacts that DO is having on aquatic life in Unnamed Creek (-613).

Eutrophication

A total of 10 phosphorus samples were taken from one chemistry site (S009-051) and one biological monitoring station (14DM028) from 2014-2016. The average of all the values is 0.07 mg/L with a low of 0.03 mg/L and a high of 0.14 mg/L. The summer average (June-Aug) is 0.07 mg/L. Phosphorus values did not exceed the standard of 0.150 mg/L.

The HSPF model calculated daily phosphorus values for this subwatershed from 1994-2014. These values ranged from 0.10-1.66 mg/L with an average value of 0.39 mg/L. Of these calculations, 2920 (95.86%) were above the 0.15 mg/L standard.

Table 425. Eutrophication related fish metrics in Unnamed Creek (-613). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-613 Fish Class 2 – General Use	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct
14DM028	6.73	13.45	82.75	23.98
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)</i>	19	11.47	45.1	17
Expected response to Eutrophication stress	↓	↓	↑	↑

The fish community in Unnamed Creek (-613) at site 14DM028 scored below average in three of the four eutrophication related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 425). This reach did have a slightly above average amount of darter individuals, however, this reach also had very few sensitive individuals, while also having increased numbers of omnivorous and tolerant fish individuals. These results are more commonly found in streams stressed by eutrophic conditions.

Table 426. Eutrophication related fish metrics in Unnamed Creek (-613). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-563 Macroinvertebrate Class 7 – General Use	EPT Pct	Tanytarsini Pct	CrustMoll Pct	Scraper Pct	% Tolerant Taxa	% Intolerant Taxa
14DM028	26.69	29.69	11.35	8.90	41.72	0.61
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	38.45	18.46	11.78	16.11	26.84	4.03
Expected response to Eutrophication stress	↓	↓	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in three of the six eutrophication related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 426). The site, 14DM028, had below average amounts of both EPT and phosphorus intolerant taxa, while also having an increased amount of phosphorus tolerant species. However, this reach had increased numbers of tanytarsini, while also having lower levels of crustacea/mollusca and scraper individuals. These results are less common in streams being negatively impacted by eutrophic conditions.

The observed data did not have any samples exceed the phosphorus standard, while the HSPF model calculated a very high exceedance rate. The metrics related to eutrophication for both communities, especially the macroinvertebrates, had mixed results. Based on this information, eutrophication is inconclusive as a stressor to aquatic life in Unnamed Creek (-613) at this time.

Nitrates

A total of 10 samples taken from one chemistry site (S009-051) and one biological monitoring station (14DM028) from 2014-2016 were analyzed for Inorganic Nitrogen (NO₂-NO₃). The average of all the values is 7.17 mg/L with a low of 2.70 mg/L and a high of 13.00 mg/L. The spring average (March-May) is 13.00 mg/L. The summer average (June-Aug) is 5.80 mg/L. Nitrate values exceeded 4 mg/L eight times. A

quantile regression analysis for Class 7 stream stations showed that sites having a nitrate concentration in excess of 11.5 mg/L there was a 90% probability for impairment. The nitrate concentrations exceeded this level in this reach.

The HSPF model calculated daily nitrate concentrations for this subwatershed from 1994-2014. These values ranged from 1.76-38.97 mg/L with an average value of 10.1 mg/L. Of these calculations, 537 (35.8%) were above 11.5 mg/L.

Table 427. Nitrate related macroinvertebrate metrics in Unnamed Creek (-613). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-613 Macroinvertebrate Class 7 – General Use	TrichopteraChTx Pct	N Index Score	% N Tolerant	% N Intolerant
14DM028	10.52	3.74	78.22	0
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	10.00	3.30	57.57	0.91
Expected response to N stress	↓	↑	↑	↓

The macroinvertebrate community in Unnamed Creek (-613) at site 14DM028 scored below average in three of the four nitrate related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 427). This reach did have a slightly above average amount of trichoptera taxa, however, this reach also had a poor nitrate index score, a high amount of nitrate tolerant individuals, and a complete lack of nitrate intolerant taxa.

Based on the sometimes elevated observed and calculated nitrate concentrations, the quantile regression analysis, as well as the majority of the nitrate related macroinvertebrate metrics scoring below average, nitrates are a stressor to aquatic life in Unnamed Creek (-613) at this time.

Suspended Solids

Nine samples taken from one chemistry site (S009-051) in 2016 were analyzed for TSS. The average of all the values is 9.04 mg/L with a low of 3.2 mg/L and a high of 25 mg/L. The TSS concentrations did not exceed the 65 mg/L standard.

Additionally, nine secchi tube measurements were taken from this reach. These values ranged from 46-100 cm, with no values falling below the 10 cm minimum standard for secchi tube.

The HSPF model calculated daily TSS values for this subwatershed from 1994-2014. These concentrations ranged from 1.21-683.04 mg/L with an average TSS value of 14.37 mg/L. Of these calculations, 81 (2.66%) were above the TSS standard.

Table 428. TSS related fish metrics in Unnamed Creek (-613). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-613 Fish Class 2 – General Use	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RifflePct	SensitivePct	SlithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14DM028	39.18	0.00	18.13	13.45	31.58	6.73	12.28	0.00	0.29	20.32
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)</i>	37.38	4.89	9.61	18.66	32.49	18.65	39.38	4.97	11.68	17.59
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

The fish community in Unnamed Creek (-613) at site 14DM028 scored below average in eight of the ten TSS related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 428). This reach did have an above average amount of benthic feeding and herbivorous individuals, however, the remaining metrics scoring below average or poorly including TSS Index Score. These results are common in streams with elevated TSS concentrations.

Table 429. TSS related macroinvertebrate metrics in Unnamed Creek (-613). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
14DM028	15.54	1.00	11.00	21.17	4.60	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (22.0)</i>	17.35	1.33	13.20	48.28	19.13	0.22
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

The macroinvertebrate assemblage in this reach scored below average in three of the six TSS related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 429). This reach did have a good TSS Index score, while also having a lower amount and percentage of TSS tolerant taxa and individuals. These results do not reflect a community being stressed by the TSS conditions.

Both of the observed and modeled data sets indicate that TSS concentrations are an issue as there were no observed exceedances and the calculated exceedance rate was very low. The macroinvertebrate assemblage also fared well as the TSS Index score was good and the community had decreased amounts and a lower percentage of TSS tolerant taxa and individuals. Based on this information, TSS is not a stressor to aquatic life in Unnamed Creek (-613) at this time. The fish community is likely being impacted by other stressors resulting lower metric scores.

Habitat

Unnamed Creek (-613) had a qualitative habitat assessment take place at its biological monitoring site, 14DM028, during the fish and macroinvertebrate sampling events in 2014. The average MSHA score from these visits was 56.1 (Fair). Limiting the habitat at these sites was the row crop agriculture as the dominant nearby land use, no stream shading, sand substrates, and light embeddedness. Further MSHA analysis can be seen in Figure 189.

Figure 189. Unnamed Creek (-613) MSHA metric scores.

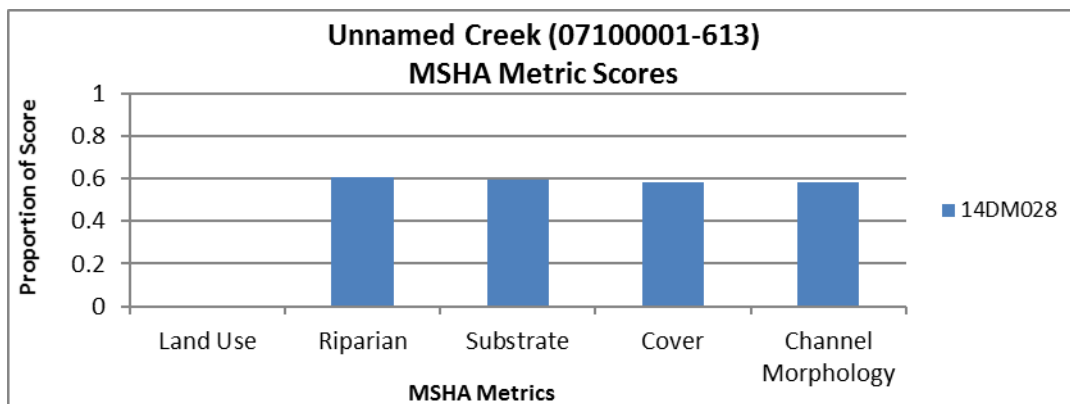


Table 430. Habitat related fish metrics in Unnamed Creek (-613). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-613 Fish Class 2 – General Use	BenInsect- TolPct	SlithopPct	DarterSculps ucPct	RifflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14DM028	14.33	12.28	13.45	31.58	0.00	37.72	82.75	45.32
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)</i>	20.4	39.38	18.18	32.49	5.24	58.26	44.85	19.02
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

The fish community in Unnamed Creek (-613) at site 14DM028 scored below average in all eight of the habitat related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 430). This stream reach did have a higher amount of tolerant and pioneer individuals, which can be a signal for degraded habitat conditions. This reach also had below average amounts of species requiring specialized habitat conditions to live and reproduce.

Table 431. Habitat related macroinvertebrate metrics in Unnamed Creek (-613). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-613 Macroinvertebrate Class 7 – General Use	BurrowerPc t	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPc t
14DM028	19.63	23.31	27.61	26.69	54.91	26.07
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)</i>	5.40	20.35	36.94	37.77	37.96	19.49
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate assemblage in this reach scored below average in four of the six habitat related metrics when compared to all other all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 431). This reach did have above average amounts of both legless and

burrower individuals, which corresponds to the sand substrates found in this reach. This reach also had lower amounts of both EPT and clinger individuals as well, which can also be a signal for habitat stress.

The MSHA had a fair habitat designation, while the majority of the habitat metrics in both the fish and macroinvertebrate communities scored below average, therefore, habitat is a stressor to aquatic life in Unnamed Creek (-613) at this time.

Altered Hydrology

Unnamed Creek (-613) is a tributary to the Des Moines River that is mostly natural though most of its upstream watershed is altered according to the MPCA altered watercourse layer.

Extreme weather events affect high flow events as well as also low flows during drought. HSPF models show this stream section experiencing low flow at less than five cfs 44.9% of the time and less than one cfs 9.5% of the time.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The percentage for generalist fish within the reach was 52.0% compared to the average in Class 2 general use waters meeting the standard of 42.4%.

The numbers of nest guarder species are also positively correlated with increased low flows. The percentage for nest guarder fish within the reach was 38.6% compared to the average in Class 2 general use waters meeting the standard of 19.6%.

Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The percentage for long-lived macroinvertebrates within the reach was 9.5% compared to the average in Class 7 general use waters meeting the standard of 8%.

Unnamed Creek (-613) is a natural stream section with significant stream channelization in the upstream portions of the watershed. The stream often experiences low flow conditions and the majority of related biological metrics did score poorly in this reach. The upstream channelization may be causing stress in this reach; therefore, Flow Alteration/Connectivity is inconclusive as a stressor.

Summary

The impaired fish community in Unnamed Creek (-613) is being stressed by Nitrates and Habitat (Table 432). DO, Eutrophication, and Flow Alteration/Connectivity are inconclusive as stressors at this point, while Suspended Sediment was ruled out as a stressor to aquatic life. For further information on the stressors and recommendations to fixing the stressors in the City of Windom-Des Moines River HUC 10 Watershed, please see pages 378-379.

Table 432. Stressor determinations for Unnamed Creek (-613).

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Unnamed Creek	07100001-613	o	o	●	---	●	o

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Unnamed Creek (07100001-670)

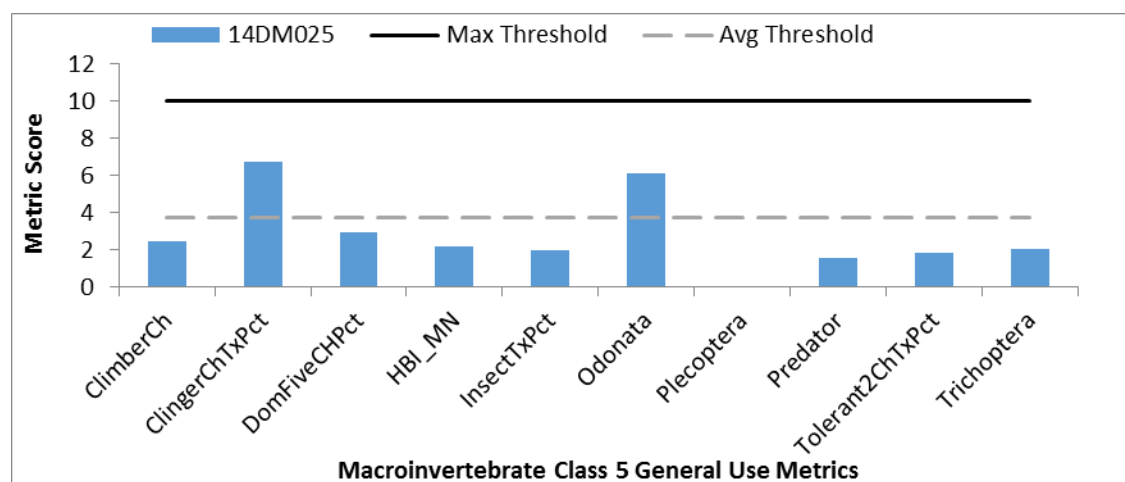
Located in southcentral Cottonwood County, Unnamed Creek (-670) is a 1.16 mile long reach that is impaired for aquatic life due to the macroinvertebrate assemblage. This stream reach extends from 490th Avenue down to the confluence with Warren Lake. Along this stream section there is one biological monitoring station, 14DM025.

Biology

Macroinvertebrates

The macroinvertebrate assemblage in Unnamed Creek (-563) at site 14DM025 was sampled in August of 2014 and had a MIBI score of 27.8. This MIBI score is below the Macroinvertebrate Class 5 Southern Streams RR General Use Threshold of 37. Site 14DM025 had two (ClingerChTxPct, Odonata) metrics score above the average needed to reach the threshold. However, the remaining metrics scored below average with one metric score of zero (Plecoptera) resulting in the impairment designation. See Figure 190 for a complete breakdown of the metric scores at this site.

Figure 190. Unnamed Creek (-670) macroinvertebrate IBI metric scores.



Dissolved Oxygen

A total of 10 samples were taken from one chemistry site (S009-050) and one biological monitoring station (14DM025) from 2014-2016. The average of all the values is 8.00 mg/L with a low of 4.47 mg/L and a high of 13.25 mg/L. The summer average (June-Aug) is 6.88 mg/L. The DO values fell below 5 mg/L once.

The HSPF model calculated daily minimum DO values for this subwatershed from 1994-2014. Of these calculations, 1781 (37.27%) of the days had a daily minimum DO level below the daily minimum standard of 5 mg/L. This is a high exceedance rate for DO.

Table 433. DO related macroinvertebrate metrics in Unnamed Creek (-670). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-670 Macroinvertebrate Class 5 – General Use	HBI_MN Value	% DO Tolerant Taxa	# DO Tolerant Taxa	ChemTV_DO
14DM025	7.60	36.48	6.00	6.45
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	7.04	8.62	4.33	7.10
Expected response to DO stress	↑	↑	↑	↓

The macroinvertebrate community in Unnamed Creek (-670) at site 14DM025 scored below average in all four of the DO related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 433).

Only one of the observed DO measurements fell below 5 mg/L while the HSPF model calculated a high exceedance rate. The macroinvertebrate assemblage strongly suggests DO stress. Based on the lack of observations below 5 mg/L, DO is inconclusive at this time. A fish community sample and continuous DO monitoring is needed to better determine the impact that this stressor is having on aquatic life in Unnamed Creek (-670).

Eutrophication

Ten phosphorus samples were taken from one chemistry site (S009-050) and one biological monitoring station (14DM025) from 2014-2016. The average of all the values is 0.081 mg/L with a low of 0.02 mg/L and a high of 0.21 mg/L. The summer average (June-Aug) is 0.095 mg/L. Phosphorus values exceeded the standard of 0.150 mg/L once. Photos of algae growth were also taken at site 14DM025. (Figure 191)

Figure 191. Algae growth at site 14DM025.



The HSPF model calculated daily total phosphorus concentrations for this subwatershed from 1994-2014. These values ranged from 0.28-1.45 mg/L with an average value of 0.52 mg/L. All of the calculated values were above the 0.15 mg/L standard for phosphorus.

Table 434. Eutrophication related macroinvertebrate metrics in Unnamed Creek (-670). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-670 Macroinvertebrate Class 5 – General Use	EPT Pct	Tanytarsini Pct	CrustMoll Pct	Scraper Pct	% Tolerant Taxa	% Intolerant Taxa
14DM025	13.29	19.82	34.49	6.01	37.74	0.00
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	43.90	27.84	9.23	15.78	17.17	5.79
Expected response to Eutrophication stress	↓	↓	↑	↑	↑	↓

The macroinvertebrate community in this reach scored below average five of the six metrics related to eutrophication when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 434). The reach did have a lower amount of scraper individuals, resulting in a good metric score. However, the remaining metrics did score below average or poorly. This reach had many phosphorus tolerant taxa, while also completely lacking phosphorus intolerant species.

The phosphorus values do exceed the standard according to the observed data, while the modeled data showed a very high rate of exceedance (100%). The vast majority of the eutrophication related metrics in the macroinvertebrate community scored below average and this stream also had photographic evidence of algae growth, which is very common in eutrophic stream conditions. Based on this information, eutrophication is a stressor to aquatic life in Unnamed Creek (-670) at this time.

Nitrates

Ten samples were taken from one chemistry site (S009-050) and one biological monitoring station (14DM025) from 2014-2016. The average of all the values is 13.37 mg/L with a low of 7.90 mg/L and a high of 21.00 mg/L. The spring average (March-May) is 20.50 mg/L. The summer average (June-Aug) is 11.10 mg/L. Nitrate values exceeded 4 mg/L 10 times. A quantile regression analysis of macroinvertebrate Class 5 stream stations showed that when nitrate concentrations exceed 18.1 mg/L, there was a 75% probability for impairment. This reach easily exceeded this nitrate concentration.

The HSPF model did not have nitrate data available for this reach.

Table 435. Nitrate related macroinvertebrate metrics in Unnamed Creek (-670). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-670 Macroinvertebrate Class 5 – General Use	TrichopteraChTx Pct	N Index Score	% N Tolerant	% N Intolerant
14DM025	10.00	2.98	44.65	0.00
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	13.16	3.00	48.68	0.96
Expected response to N stress	↓	↑	↑	↓

The macroinvertebrate assemblage in Unnamed Creek (-670) at site 14DM025 scored below average in two of the four nitrate related biological metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 435). This reach did have a slightly above

average nitrate index score and a slightly below average amount of nitrate tolerant individuals, however, this reach did also have a lower amount of trichoptera and nitrate intolerant taxa.

The nitrate related biological metric results were rather mixed in this reach. The observed chemical data did show that nitrate concentrations do become elevated at times. More chemical data is needed to better determine the impacts that nitrates may be having on the biological communities in this reach. Therefore, nitrates are inconclusive as a stressor at this time.

Suspended Solids

Nine samples taken from one chemistry site (S009-050) in 2016 were analyzed for TSS. The average of all the values is 7.87 mg/L with a low of 4.8 mg/L and a high of 14 mg/L. The TSS concentrations did not exceed the 65 mg/L standard.

Additionally, nine secchi tube measurements were taken from this reach. These values ranged from 55-100 cm, with no values falling below the 10 cm minimum standard for secchi tube.

The HSPF model calculated daily TSS values for this subwatershed from 1994-2014. These concentrations ranged from 1.75-918.32 mg/L with an average TSS value of 14.92 mg/L. Of these calculations, 57 (3.00%) were above the TSS standard.

Table 436. TSS related macroinvertebrate metrics in Unnamed Creek (-670). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-670 Macroinvertebrate Class 5 – General Use	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
14DM025	15.46	1.00	7.00	27.36	17.41	0.00
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)</i>	15.87	3.02	11.59	35.23	26.89	0.54
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

The macroinvertebrate assemblage in Unnamed Creek (-670) at site 14DM025 scored below average in three of the six TSS related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 436). This reach had a good TSS Index score, while also having a lower amount and percentage of TSS tolerant taxa and individuals. These results are not common in communities being stressed by elevated TSS concentrations.

Based on the very low TSS concentrations in the observed data set, the low exceedance rate calculated by the HSPF model, as well as the good TSS Index score and lower amounts of TSS tolerant taxa, TSS is not a stressor to aquatic life in Unnamed Creek (-670) at this time.

Habitat

Unnamed Creek (-670) had a qualitative habitat assessment take place at its biological monitoring site, 14DM025, during the fish and macroinvertebrate sampling events in 2014. The average MSHA score from these visits was 72.45 (Good). Limiting the habitat at this site was row crop agriculture as part of the nearby land use, moderate stream shading, some sand substrates, and light embeddedness. Further MSHA analysis can be seen in Figure 192.

Figure 192. Unnamed Creek (-670) MSHA metric scores.

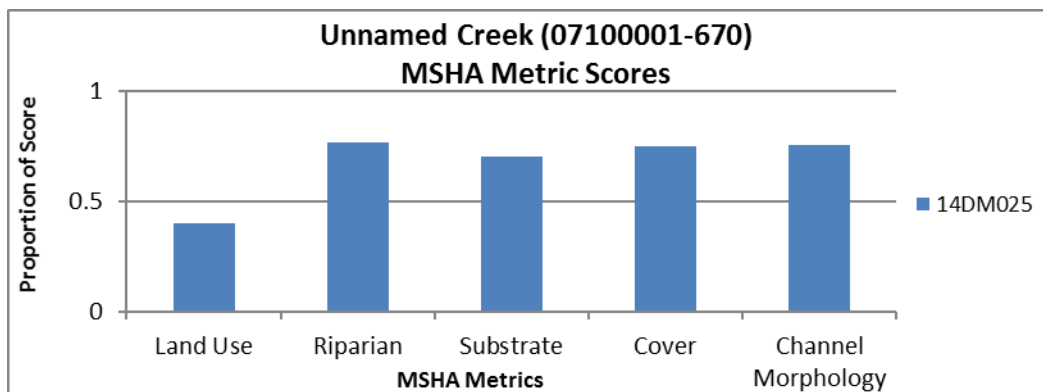


Table 437. Habitat related macroinvertebrate metrics in Unnamed Creek (-670). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-670 Macroinvertebrate Class 5 – General Use	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14DM025	5.38	19.30	34.81	13.29	40.19	36.08
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)</i>	5.66	12.52	49.77	42.46	34.53	13.99
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate assemblage in this reach scored below average in three of the six habitat related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 437). This stream reach did have a below average amount of burrower individuals, while also having higher amounts of both climber and sprawler individuals. These can be a sign of good habitat conditions. However, site 14DM025 also had a lower amount of both EPT and clinger individuals, while having elevated numbers of legless individuals. These results can signal potential habitat stress.

The MSHA score in this stream reach was good. The macroinvertebrate community had a rather mixed signal in terms of the habitat related metrics. With the good MSHA score and no obvious signs of habitat degradation, habitat is not a stressor to aquatic life in this reach.

Altered Hydrology

Unnamed Creek (-670) is a tributary to the Des Moines River that is mostly natural though most of its upstream watershed is altered according to the MPCA altered watercourse layer.

Extreme weather events affect high flow events as well as also low flows during drought. HSPF models show this stream section experiencing low flow at less than five cfs 48.1% of the time and less than one cfs 12.5% of the time.

Generalist fish species, which are adaptable to different habitats through generalized food preferences are correlated with channelization. The percentage for generalist fish within the reach was 86.4% compared to the average in Class 3 general use waters meeting the standard of 59.1%

The numbers of nest guarder species are also positively correlated with increased low flows. The percentage for nest guarder fish within the reach was 34.8% compared to the average in Class 3 general use waters meeting the standard of 19.2%.

Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The percentage for long-lived macroinvertebrates within the reach was 6.0% compared to the average in Class 5 general use waters meeting the standard of 9%.

Unnamed Creek (-670) is a natural stream section with significant stream channelization in the upstream portions of the watershed. The stream often experiences low flow conditions and the related biological metrics did score poorly in this reach. The upstream channelization may be causing stress in this reach; therefore, Flow Alteration/Connectivity is inconclusive as a stressor.

Summary

The impaired macroinvertebrate community in Unnamed Creek (-670) is being stressed by Eutrophication (Table 438). DO, Nitrates, and Flow Alteration/Connectivity are inconclusive as stressors at this point, while Suspended Sediment and habitat were ruled out as stressors to aquatic life. For further information on the stressors and recommendations to fixing the stressors in the City of Windom-Des Moines River HUC 10 Watershed, see pages 378-379.

Table 438. Stressor determinations for Unnamed Creek (-670).

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Unnamed Creek	07100001-670	o	●	o	---	---	o

● = stressor; o = inconclusive stressor; --- = not an identified stressor

City of Windom-Des Moines River Watershed (0710000108) HUC 10 conclusion and recommendations

The City of Windom-Des Moines River subwatershed has eight biologically impaired streams that are being negatively impacted by a multitude of stressors throughout the watershed. Stressors found in at least four of the eight impaired reaches include DO, Eutrophication, and Habitat. Suspended sediment (3), Nitrates (2) and Flow Alteration/Connectivity (2) were also significant stressors found in this watershed (Table 439).

The main land use in this subwatershed is row crop agriculture, with some areas of hay/pasture and development (cities of Jackson and Windom). These land uses are significant contributors to the stressors found in these reaches. The land use combined with the channelization of these streams and their tributaries are a major reason why these streams are impaired for aquatic life. These practices often lead to high nitrate and phosphorus levels through excessive use of fertilizers that quickly reach the stream system by drain tiles and field runoff. These elevated phosphorus levels will also affect the DO conditions resulting in many more tolerant fish and macroinvertebrate communities.

Channelizing streams can also lead to very high flow rates resulting in bank erosion. Bank erosion leads to higher amounts of both bedded and suspended sediment in the stream resulting in poor habitat and visibility conditions impacting the breeding and feeding environments for more sensitive fish and

macroinvertebrate species. Seven of the reaches were found to have habitat conditions causing stress to the biological communities, while flow alteration/connectivity was found to be a stressor in two reaches thus far, with four reaches being inconclusive.

A great effort is needed in the City of Windom-Des Moines River Watershed to improve biological conditions in the many impaired streams found in this watershed. A high priority should be to better utilize a variety of nutrient reducing BMPs including: cover crops, nutrient management, saturated buffers, etc., will also help in the nitrate and phosphorus reduction. This could also help with the eutrophication and resulting DO issues as well. In addition, managing the effects of flow alteration needs to be done to see improvements. This can be achieved by increasing the storage and infiltration of water in locations with flow alteration stressors. This will also help reduce sediment inputs from stream banks, improve habitat by protecting streambanks, reduce erosion and overall stream sedimentation. Re-establishing a quality riparian corridor with deep rooted vegetation to increase stream stabilization, shading, and habitat features is also needed to improve conditions.

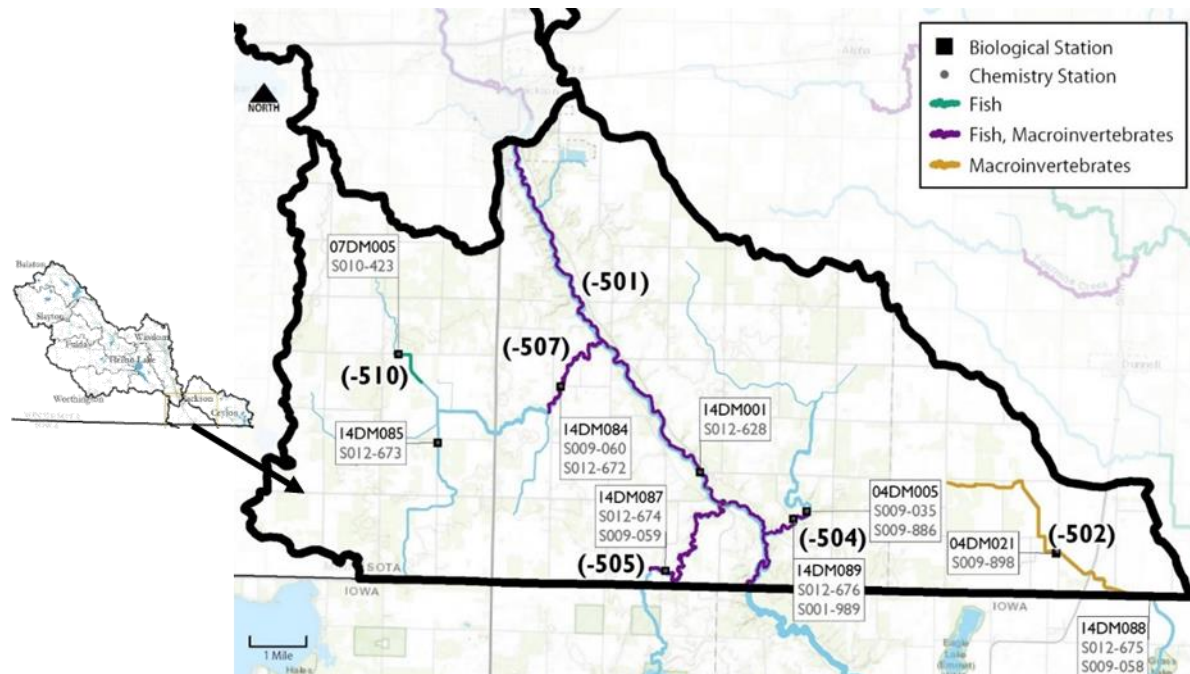
Table 439. Stressor determinations for the City of Windom-Des Moines River Watershed.

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Des Moines River	07100001-501	●	●	---	●	●	---
Des Moines River	07100001-524	---	●	---	●	●	---
Perkins Creek	07100001-544	●	●	---	---	●	●
Unnamed Creek	07100001-551	●	●	---	●	●	o
County Ditch 43/Scheldorf Creek	07100001-552	o	---	o	---	●	●
Unnamed Creek	07100001-563	●	●	●	---	●	o
Unnamed Creek	07100001-613	o	o	●	---	●	o
Unnamed Creek	07100001-670	o	●	o	---	---	o

● = stressor; o = inconclusive stressor; --- = not an identified stressor

5.9 Brown Creek-Des Moines River Watershed (0710000201)

Figure 193. Brown Creek-Des Moines River Watershed with monitoring stations and biological impairments.



Des Moines River (07100002-501)

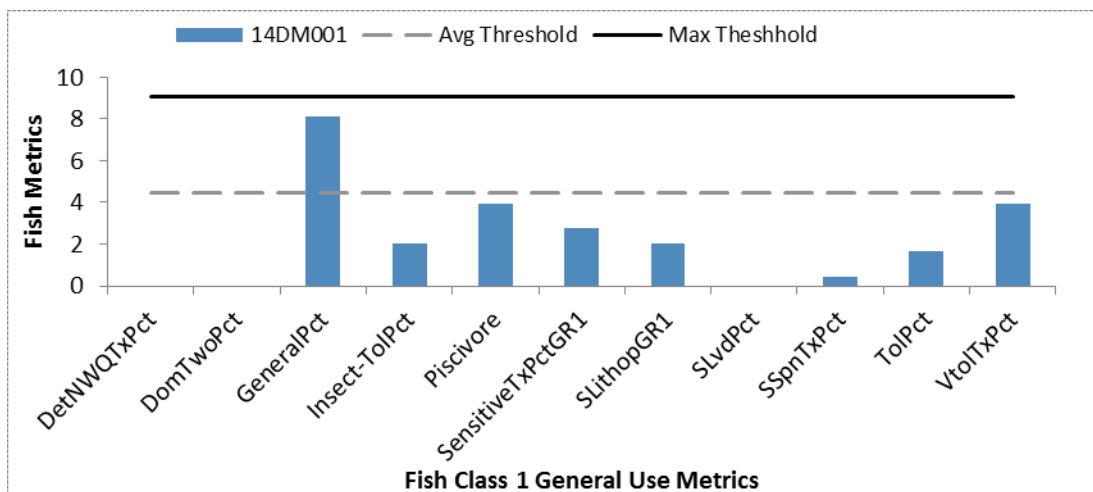
Located in southeastern Jackson County, the Des Moines River (-501) is an 11.56 mile long reach that is impaired for aquatic life due to the fish and macroinvertebrate assemblages. This stream reach extends from Judicial Ditch 66 down to the Minnesota/Iowa border. Along this stream, section there is one biological monitoring station, 14DM001.

Biology

Fish

The fish community in Des Moines River (-501) was sampled for fish in August of 2014 at its biological monitoring station 14DM001. The FIBI score at this reach was 25.0, which is far below the Fish Class 1 Southern Rivers General Use Threshold of 49. This site did have one metric (GeneralPct) reach the average metric score needed to meet the threshold (Figure 194), however, the remaining ten metrics comprising this FIBI scored well below average with three metrics scoring zero.

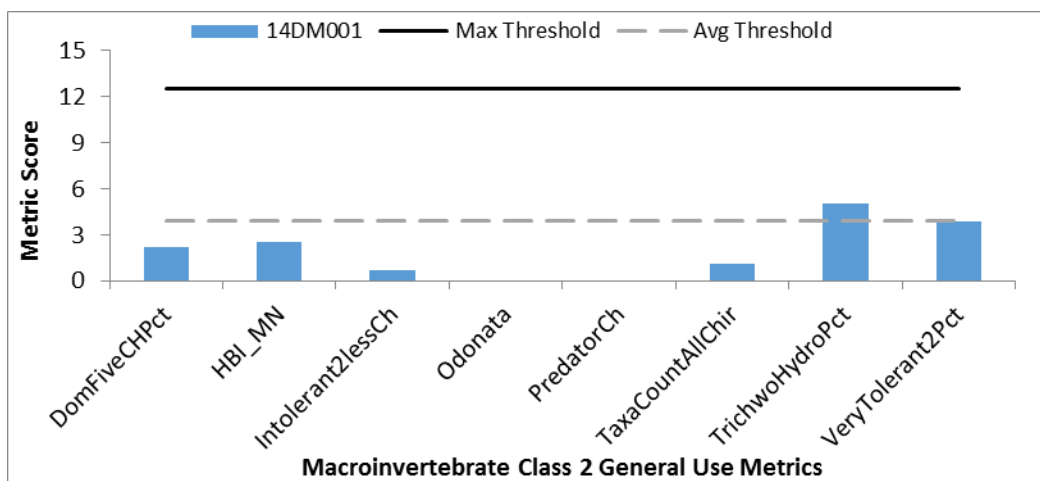
Figure 194. Des Moines River (-501) fish IBI metric scores.



Macroinvertebrates:

The macroinvertebrate assemblage in Des Moines River (-501) at site 14DM001 was sampled in August of 2014 and had a MIBI score of 15.4. This MIBI score is below the Macroinvertebrate Class 2 Prairie Forest Rivers General Use Threshold of 31. Site 14DM001 had one (TrichwoHydroPct) metric score above the average needed to reach the threshold. However, the remaining seven metrics scored below average with two metrics scoring of zero (Odonata, PredatorCh) resulting in the impairment designation. See Figure 195 for a complete breakdown of the metric scores at this site.

Figure 195. Des Moines River (-501) macroinvertebrate IBI metric scores.



Dissolved Oxygen

A total of 57 DO measurements were taken from one chemistry site (S000-156) from 2003-2015. The average of all the values is 9.57 mg/L with a low of 5.21 mg/L and a high of 14.40 mg/L. The summer average (June-Aug) is 8.69 mg/L. The DO values never fell below 5 mg/L.

The HSPF model calculated daily minimum DO values for this subwatershed from 1994-2014. Of these calculations, 945 (12.32%) of the days had a daily minimum DO level below the daily minimum standard of 5 mg/L.

Table 440. DO related fish metrics in Des Moines River (-501). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100002-501 Fish Class 1 –General Use	MA>3 Avg	SspnPct Avg	Taxa Count Avg	DO TIV Avg
14DM001	5.05	89.23	19.00	8.99
<i>Statewide average for Class 1 Southern Rivers stations that are meeting the FIBI General Use Threshold (49.0)</i>	40.4	35.61	22.44	8.76
Expected response to DO stress	↓	↑	↓	↓

The fish community in Des Moines River (-501) at site 14DM001 scored below average in three of the four DO related metrics when compared to all other Class 1 Southern River stations that meet the FIBI General Use Threshold (Table 440). This site had few mature fish, a lower overall taxa count, and a very high amount of serial spawning individuals. However, this reach did have an above average DO TIV score, which does not commonly happen in streams with DO problems.

Table 441. DO related macroinvertebrate metrics in Des Moines River (-501). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100002-501 Macroinvertebrate Class 2 – General Use	HBI_MN Value	% DO Tolerant Taxa	# DO Tolerant Taxa	ChemTV DO
14DM001	7.75	1.60	3.00	7.51
<i>Statewide average for Class 2 Prairie Forest River stations that are meeting the MIBI General Use Threshold (31)</i>	7.32	8.67	4.41	7.13
Expected response to DO stress	↑	↑	↑	↓

The macroinvertebrate community in this reach scored below average in just one of the four DO related metrics when compared to all other Class 2 Prairie Forest River stations that meet the MIBI General Use Threshold (Table 441). This reach had a poor HBI_MN value, but scored well in the remaining metrics. There were very few DO tolerant taxa present in this sampled. These results reflect a community not being stressed by the current DO conditions.

The observed data set did not have any values fall below the 5 mg/L daily minimum standard, while the HSPF model calculated a rather average exceedance rate. The macroinvertebrate community had only one DO related metric score below average, which is a strong signal that DO is not an issue. Therefore, DO is not a stressor to aquatic life at this time. It is likely that other stressors are impacting the fish community resulting in lower metric scores.

Eutrophication

A total of 38 phosphorus samples were taken from one chemistry site (S000-156) from 2004-2014. The average of all the values is 0.252 mg/L with a low of 0.09 mg/L and a high of 0.68 mg/L. The summer average (June-Aug) is 0.259 mg/L. Phosphorus values exceeded the standard of 0.150 mg/L 33 times.

A total of 12 samples from one chemistry site (S000-156) from 2004-2009 were analyzed for BOD. The average for all the values is 9.99 mg/L with a low of 5.10 mg/L and a high of 20 mg/L. The summer average is (June-Aug) is 9.61 mg/L. The BOD value exceeded the standard of 3.50 mg/L 12 times.

A total 12 samples from one chemistry site (S000-156) from 2004-2009 were analyzed for chlorophyll-a. The average for all the values is 134.51 ug/L with a low of 64 ug/L and a high of 262 ug/L. The summer average is (June-Aug) is 132.73 ug/L. The chlorophyll-a value exceeded the standard of 40 ug/L 12 times.

Table 442. Eutrophication related fish metrics in Des Moines River (-501). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100002-501 Fish Class 1 –General Use	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct
14DM001	0.55	1.87	68.24	2.53
<i>Statewide average for Class 1 Southern Rivers stations that are meeting the FIBI General Use Threshold (49.0)</i>	13.75	4.46	22.36	15.72
Expected response to Eutrophication stress	↓	↓	↑	↑

The fish community in Des Moines River (-501) at site 14DM001 scored below average in three of the four metrics related to eutrophication when compared to all other Class 1 Southern Rivers stations that meet the FIBI General Use Threshold (Table 442). This reach had a high amount of tolerant fish individuals, while also having a decreased amount of both darter and sensitive individuals. These results are often found in streams with eutrophic conditions.

Table 443. Eutrophication related macroinvertebrate metrics in Des Moines River (-501). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100002-501 Macroinvertebrate Class 2 – General Use	EPT Pct	Tanytarsini Pct	CrustMoll Pct	Scraper Pct	% Tolerant Taxa	% Intolerant Taxa
14DM001	69.77	7.04	0.64	5.14	8.33	0.64
<i>Statewide average for Class 2 Prairie Forest River stations that are meeting the MIBI General Use Threshold (31)</i>	54.79	17.03	6.59	13.83	25.29	6.53
Expected response to Eutrophication stress	↓	↓	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in two of the six eutrophication related metrics when compared to all other Class 2 Prairie Forest River stations that meet the MIBI General Use Threshold (Table 443). The site, 14DM001, did have decreased numbers of tanytarsini individuals and phosphorus intolerant taxa. These results can indicate potential stress. However, this reach also had a increased amount of EPT individuals, as well as decreased numbers of crustacean/mollusca, scraper, and phosphorus tolerant species. These results are not normally found in eutrophic conditions.

Based on the high number of exceedances in the observed phosphorus, BOD, and Chlorophyll a data sets, as well as the majority of the eutrophication related fish metrics scoring below average, eutrophication is a stressor to aquatic life in Des Moines River (-501). The macroinvertebrate assemblage did not respond as strongly as the fish community, but still had some metrics scoring poorly.

Nitrates

Thirty-five samples taken from one chemistry site (S000-156) from 2004-2014 were analyzed for Inorganic Nitrogen (NO₂-NO₃). The average of all the values is 3.23 mg/L with a low of 0.05 mg/L and a

high of 11.00 mg/L. The spring average (March-May) is 4.60 mg/L. The summer average (June-Aug) is 2.43 mg/L. Nitrate values exceeded 4 mg/L 13 times.

The HSPF model calculated daily nitrate concentrations for this subwatershed from 1994-2014. These values ranged from 0.14-17.56 mg/L with an average nitrate concentration of 2.51 mg/L. This average is relatively low when compared throughout the watershed.

Table 444. Nitrate related macroinvertebrate metrics in Des Moines River (-501). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100002-501 Macroinvertebrate Class 2 – General Use	TrichopteraChTx Pct	N Index Score	% N Tolerant	% N Intolerant
14DM001	22.22	3.34	55.77	0.32
<i>Statewide average for Class 2 Prairie Forest River stations that are meeting the MIBI General Use Threshold (31)</i>	15.65	2.94	47.56	1.22
Expected response to N stress	↓	↑	↑	↓

The macroinvertebrate community in Des Moines River (-501) scored below average in three of the four nitrate related biological metrics when compared to all other Class 2 Prairie Forest River stations that meet the MIBI General Use Threshold (Table 444). This reach did have an above average amount of trichoptera taxa, however, this reach did have a poor nitrate index score, higher amounts of nitrate tolerant individuals, and few nitrate intolerant taxa.

While the macroinvertebrate community does score below average in some of the nitrate related metrics both of the observed and calculated nitrate concentrations in this stream section are relatively low. It is likely that the biological metrics are being negatively impacted by other stressors as nitrates are not a stressor to aquatic life in Des Moines River (-501).

Suspended Solids

Thirty samples taken from one chemistry site (S000-156) from 2005-2014 were analyzed for TSS. The average of all the values is 59.47 mg/L with a low of 13 mg/L and a high of 210 mg/L. The TSS concentrations was at or exceeded the 65 mg/L standard mg/L 10 times.

Additionally, 58 secchi tube measurements were taken from this reach. These values ranged from 6-40 cm, with five values falling below the 10 cm minimum standard for secchi tube.

The HSPF model calculated daily TSS values for this subwatershed from 1994-2014. These concentrations ranged from 0.62-1262.90 mg/L with an average TSS value of 45.35 mg/L. Of these calculations, 824 (10.75%) were above the TSS standard.

This reach was determined to be impaired for turbidity during the 2002 assessment. This impairment was confirmed during the 2016 assessment as well.

Table 445. TSS related fish metrics in Des Moines River (-501). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100002-501 Fish Class 1 –General Use	BenFdFrimPct	Centr-TolPct	Herbvpct	Perfrm-TolPct	RifflePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14DM001	3.30	0.44	2.97	3.52	1.98	0.55	3.30	0.00	5.82	31.74
<i>Statewide average for Class 1 Southern Rivers stations that are meeting the FIBI General Use Threshold (49.0)</i>	21.36	4.12	1.04	17.97	13.92	13.53	24.97	4.63	43.61	25.99
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

The fish community in Des Moines River (-501) at site 14DM001 scored below average in nine of the ten TSS related metrics when compared to all other Class 1 Southern Rivers stations that meet the FIBI General Use Threshold (Table 445). This reach did have a slightly above average amount of herbivorous individuals, however, the remaining metrics scored poorly particularly the TSS Index Score.

Table 446. TSS related macroinvertebrate metrics in Des Moines River (-501). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100002-501 Macroinvertebrate Class 2 – General Use	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
14DM001	19.42	1.00	13.00	71.15	66.56	0.00
<i>Statewide average for Class 2 Prairie Forest Rivers stations that are meeting the MIBI General Use Threshold (31.0)</i>	18.18	2.52	14.09	49.06	22.93	0.55
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

The macroinvertebrate assemblage in this reach scored below average in four of the six TSS related metrics when compared to all other Class 2 Prairie Forest Rivers stations that meet the MIBI General Use Threshold (Table 446). Site 14DM001 did have an increased amount of collector-filterer individuals, while also having a lower amount of TSS tolerant taxa. However, this reach had a very high amount of TSS tolerant individuals, while also lacking plecoptera and TSS intolerant taxa. In addition, the TSS Index score was poor. These results reflect a community being stressed by TSS conditions.

Based on the high standard exceedance rates from the observed and modeled data sets, the majority of the TSS related metrics scoring poorly in both biological communities, as well as the current turbidity impairment in this reach, TSS is a stressor to aquatic life in Des Moines River (-501).

Habitat

Des Moines River (-501) had a qualitative habitat assessment take place at its biological monitoring site, 14DM001, during the fish and macroinvertebrate sampling events in 2014. The average MSHA score from these visits was 51.28 (Fair). Limiting the habitat at this site was row crop agriculture as the dominant nearby land use, light stream shading, severe erosion, moderate embeddedness, sand and silt substrates (Figure 196), fair sinuosity, moderate channel stability, and fair channel development. Further MSHA analysis can be seen in Figure 197.

Figure 196. Site 14DM001 at low water level showing the sand substrates present.



Figure 197. Des Moines River (-501) MSHA metric scores.

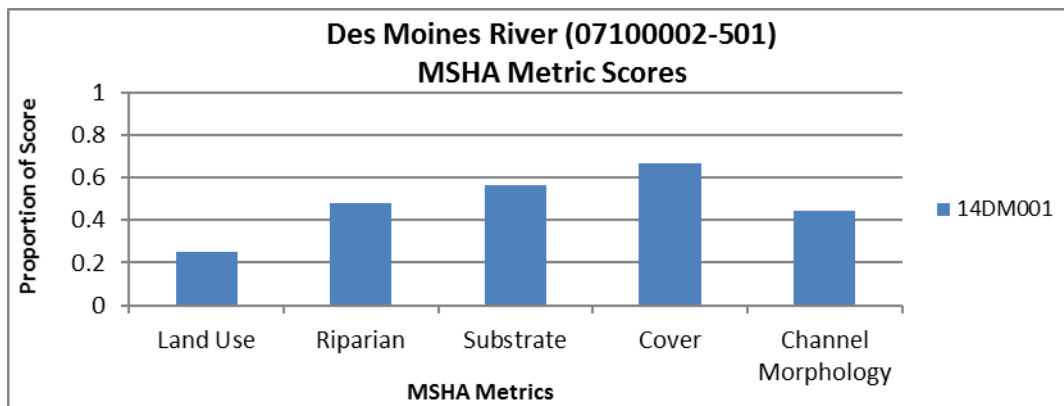


Table 447. Habitat related fish metrics in Des Moines River (-501). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100002-501 Fish Class 1 –General Use	BenInsect-TolPct	SlithopPct	DarterSculpSu cPct	RiflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14DM001	3.19	3.30	3.08	1.98	3.41	3.30	68.24	11.21
Statewide average for Class 1 Southern Rivers stations that are meeting the FIBI General Use Threshold (49.0)	20.61	24.97	18.51	13.92	15.18	29.21	22.05	5.21
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

The fish community in Des Moines River (-501) at site 14DM001 scored below average in all eight of the habitat related metrics when compared to all other Class 1 Southern Rivers stations that meet the FIBI General Use Threshold (Table 447). This reach had a high amount of tolerant and pioneer individuals, while also having very few fish that require specialized habitat conditions to live and reproduce. These results can indicate potential habitat stress.

Table 448. Habitat related macroinvertebrate metrics in Des Moines River (-501). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100002-501 Macroinvertebrate Class 2 – General Use	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14DM001	2.89	19.29	71.70	69.77	22.83	3.22
<i>Statewide average for Class 2 Prairie Forest Rivers stations that are meeting the MIBI General Use Threshold (31.0)</i>	4.24	11.76	44.81	57.13	22.86	15.51
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate assemblage in this reach scored below average in just one of the six habitat related metrics when compared to all other Class 2 Prairie Forest River stations that meet the MIBI General Use Threshold (Table 448). This reach had a below average amount of sprawler individuals, but scored well in the remaining metrics.

The habitat in this reach was fair, while the fish and macroinvertebrate metrics related to habitat varied greatly as the fish strongly suggest potential stress and the macroinvertebrate community strongly suggests not a stressor. Therefore, habitat is inconclusive as a stressor at this time. Further monitoring of the fish and macroinvertebrate communities throughout this stream reach is needed to better determine the impact of habitat on aquatic life.

Altered Hydrology

This reach part of the mainstem of the Des Moines River (-501). The reach flows south into Iowa. The reach itself is mostly natural though most of its upstream watershed and tributaries are altered according to the MPCA altered watercourse layer. A fish barrier was identified just upstream of the reach and is a dam located on the river itself.

Extreme weather events affect high flow events as well as also low flows during drought. HSPF models show this stream section experiencing low flow at less than five cfs 0.3% of the time and less than one cfs 0.0% of the time.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The percentage for generalist fish within the reach was 11.8% compared to the average in Class 1 general use waters meeting the standard of 20.7%.

The numbers of nest guarder species are also positively correlated with increased low flows. The percentage for nest guarder fish within the reach was 13.4% compared to the average in Class 1 general use waters meeting the standard of 21.4%.

Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The percentage for long-lived macroinvertebrates within the reach was 1.3% compared to the average in Class 2 general use waters meeting the standard of 6.7%

The main stem of the Des Moines River (-501) is a very large and natural stream channel that does not experience low flow conditions. The majority of the related biological metrics scored well. Based on this information, Flow Alteration/Connectivity is not a stressor to aquatic life in this reach.

Summary

The impaired fish and macroinvertebrate communities in Des Moines River (-501) are being stressed by Eutrophication and Suspended Sediment (Table 449). Habitat is inconclusive as a stressor at this point, while DO, Nitrates, and Flow Alteration/Connectivity were ruled out as stressors to aquatic life. For further information on the stressors and recommendations to fixing the stressors in the Brown Creek-Des Moines River HUC 10 Watershed, see pages 426-427.

Table 449. Stressor identifications for Des Moines River (-501).

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Des Moines River	07100002-501	---	●	---	●	o	---

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Unnamed Creek (07100002-504)

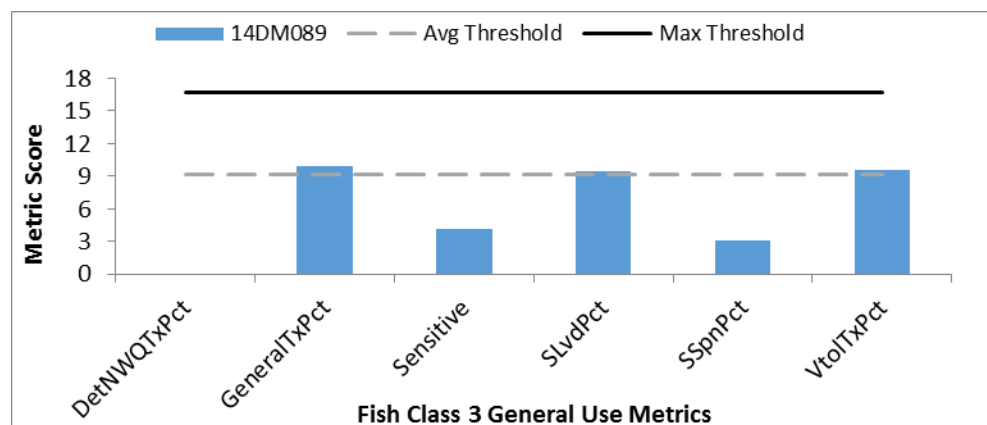
Located in southeastern Jackson County, Unnamed Creek (-504) is a 1.21 mile long reach that is impaired for aquatic life due to the fish and macroinvertebrate assemblages. This stream reach extends from Judicial Ditch 11 down to the confluence with the Des Moines River. Along this stream section there is one biological monitoring station, 14DM089.

Biology

Fish

The fish community in Unnamed Creek (-504) was sampled for fish in June of 2014 at its biological monitoring station 14DM089. The FIBI score at this reach was 36.3, which is below the Fish Class 3 Southern Headwaters General Use Threshold of 55. This site did have three metrics (GeneralTxPct, SLvdPct, VtolTxPct) reach the average metric score needed to meet the threshold (Figure 198), however, the remaining three metrics comprising this FIBI scored well below average with one metric scoring zero (DetNWQTxPct).

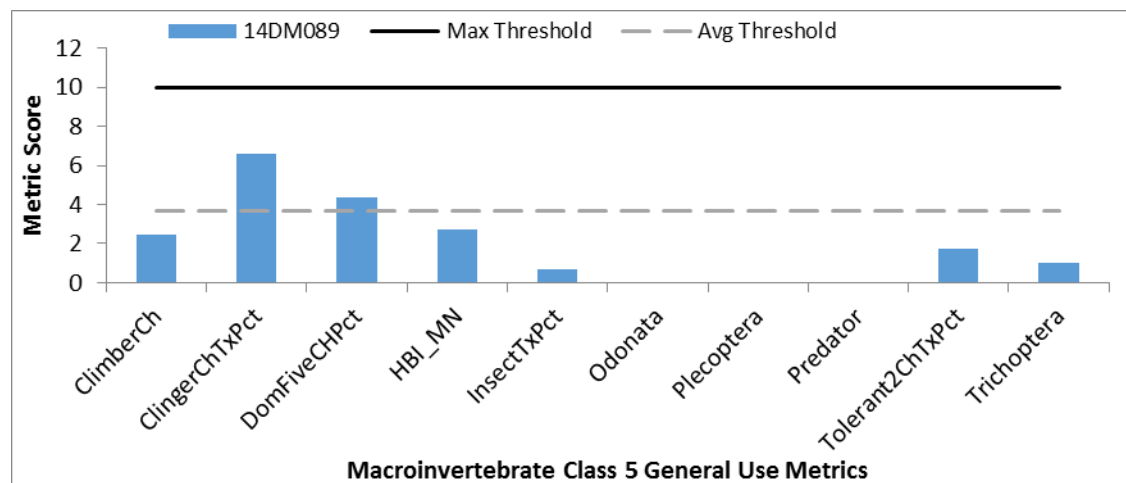
Figure 198. Unnamed Creek (-504) fish IBI metric scores.



Macroinvertebrates

The macroinvertebrate assemblage at site 14DM089 was sampled in August of 2014 and had a MIBI score of 19.5. This MIBI score is below the Macroinvertebrate Class 5 Southern Streams RR General Use Threshold of 37. Site 14DM089 had two (ClingerChTxPct, DomFiveCHPct) metrics score above the average needed to reach the threshold. However, the remaining eight metrics scored below average with three metrics score of zero (Odonata, Plecoptera, Predator) resulting in the impairment designation. See Figure 199 for a complete breakdown of the metric scores at this site.

Figure 199. Unnamed Creek (-504) macroinvertebrate IBI metric scores.



Dissolved Oxygen

A total of nine DO measurements were taken from one chemistry site (S001-989) and one biological monitoring station (14DM089) from 2014-2016. The average of all the values is 7.86 mg/L with a low of 4.57 mg/L and a high of 10.75 mg/L. The summer average (June-Aug) is 6.91 mg/L. The DO values fell below 5 mg/L once.

The HSPF model calculated daily minimum DO values for this subwatershed from 1994-2014. Of these calculations, 1577 (20.56%) of the days had a daily minimum DO level below the daily minimum standard of 5 mg/L.

Table 450. DO related fish metrics in Unnamed Creek (-504). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100002-504 Fish Class 3 – General Use	MA>3 Avg	SspnPct Avg	Taxa Count Avg	DO TIV Avg
14DM089	7.04	62.78	12.00	8.77
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FBI General Use Threshold (55.0)</i>	13.32	17.09	12.16	8.44
Expected response to DO stress	↓	↑	↓	↓

The fish community in Unnamed Creek (-504) scored below average in three of the four DO related metrics at site 14DM089 when compared to all other Class 3 Southern Headwaters stations that meet the FBI General Use Threshold (Table 450). This reach had a decreased amount of mature individuals

and overall taxa present. This reach also had an increased amount of serial spawning individuals. Serial spawning species are often found in elevated numbers in streams stressed by DO conditions.

Table 451. DO related macroinvertebrate metrics in Unnamed Creek (-504). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100002-504 Macroinvertebrate Class 5 – General Use	HBI_MN Value	% DO Tolerant Taxa	# DO Tolerant Taxa	ChemTV_ DO
14DM089	7.43	38.19	4.00	6.66
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	7.04	8.62	4.33	7.10
Expected response to DO stress	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in three of the four DO related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 451). This reach had a very high percentage of DO tolerant taxa, while also having poor DO TIV and HBI_MN scores. These results are common in streams being negatively impacted by DO.

Based on the very limited observed data set, the DO levels do fall below the 5 mg/L daily minimum standard. The modeled data showed a fairly high exceedance rate of the DO standard and the majority of the DO related metrics in the fish and macroinvertebrate communities reflect that. The macroinvertebrate community had a very high amount of DO tolerant taxa present. This information concludes that DO is a stressor to aquatic life in Unnamed Creek (-504) at this time.

Eutrophication

A total of nine phosphorus samples were taken from one chemistry site (S001-989) and one biological monitoring station (14DM089) from 2014-2016. The average of all the values is 0.122 mg/L with a low of 0.04 mg/L and a high of 0.33 mg/L. The summer average (June-Aug) is 0.102 mg/L. Phosphorus values exceeded the standard of 0.150 mg/L twice.

The HSPF model also calculated daily phosphorus concentrations for this subwatershed from 1994-2014. These values ranged from 0.16-26.30 mg/L with an average phosphorus concentration of 0.53 mg/L. All of these calculations were above the phosphorus standard.

Table 452. Eutrophication related fish metrics in Unnamed Creek (-504). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100002-504 Fish Class 3 – General Use	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct
14DM089	28.97	29.58	67.61	24.75
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	8.9	12.11	70.79	14.71
Expected response to Eutrophication stress	↓	↓	↑	↑

The fish community in Unnamed Creek (-504) at site 14DM089 scored below average in one of the eutrophication related metrics when compared to all other Class 3 Southern Headwaters stations that

meet the FIBI General Use Threshold (Table 452). This reach had an increased amount of omnivorous individuals, which can signal eutrophic conditions. However, this reach also had an increased amount of sensitive and darter individuals, while having a slightly below average amount of tolerant fish individuals. These results are not common in streams stressed by eutrophic conditions.

Table 453. Eutrophication related macroinvertebrate metrics in Unnamed Creek (-504). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100002-504 Macroinvertebrate Class 5 – General Use	EPT Pct	Tanytarsini Pct	CrustMoll Pct	Scraper Pct	% Tolerant Taxa	% Intolerant Taxa
14DM089	14.29	11.25	41.23	19.81	38.51	0.00
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	43.90	27.84	9.23	15.78	17.17	5.79
Expected response to Eutrophication stress	↓	↓	↑	↑	↑	↓

The macroinvertebrate community in this reach scored below average in all six of the eutrophication related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 453). This reach had low numbers of EPT, tanytarsini, and phosphorus intolerant individuals, while also having increased amounts of phosphorus tolerant taxa, and crustacean/mollusca and scraper individuals. These results are common in streams with eutrophic conditions present.

The observed and modeled data sets both show high concentrations of phosphorus and numerous standard exceedances. The biological responses from the fish and macroinvertebrate communities is rather mixed. Therefore, eutrophication is inconclusive as a stressor in Unnamed Creek (-504) at this time.

Nitrates

Nine samples taken from one chemistry site (S001-989) and one biological monitoring station (14DM089) from 2014-2016 were analyzed for Inorganic Nitrogen (NO₂-NO₃). The average of all the values is 10.72 mg/L with a low of 1.10 mg/L and a high of 18.00 mg/L. The spring average (March-May) is 15.50 mg/L. The summer average (June-Aug) is 10.27 mg/L. Nitrate values exceeded 4 mg/L seven times.

The HSPF model calculated daily nitrate concentrations for this subwatershed from 1994-2014. These values ranged from 1.09-413.45 mg/L with an average value of 7.71 mg/L. Of these calculations, 132 (2.36%) were above 18.1 mg/L. A quantile regression analysis for Class 5 stream stations showed that sites having a nitrate concentration in excess of 18.1 mg/L there was a 75% probability for impairment. The nitrate concentrations in this reach predicted by the model easily exceeded this level.

Table 454. Nitrate related macroinvertebrate metrics in Unnamed Creek (-504). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100002-504 Macroinvertebrate Class 5 – General Use	TrichopteraChTx Pct	N Index Score	% N Tolerant	% N Intolerant
14DM089	8.57	3.35	45.31	0.00
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	13.16	3.00	48.68	0.96
Expected response to N stress	↓	↑	↑	↓

The macroinvertebrate community in Unnamed Creek (-504) scored below average in three of the four nitrate related metrics at site 14DM089 when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 454). This reach had a lower amount of trichoptera and nitrate intolerant taxa, while also having a poor nitrate index score. This site did have a slightly below average amount of nitrate tolerant individuals.

Based on both the elevated observed and calculated nitrate concentrations, the quantile regression analysis, as well as the majority of the nitrate related biological metrics scoring below average, nitrates are a stressor to aquatic life in Unnamed Creek (-504) at this time.

Suspended Solids

Eight samples taken from one chemistry site (S001-989) in 2016 were analyzed for TSS. The average of all the values is 36.9 mg/L with a low of 3.6 mg/L and a high of 100 mg/L. The TSS concentrations exceeded the 65 mg/L standard three times.

Additionally, 10 secchi tube measurements were taken from this reach. These values ranged from 9.5-100 cm, with one measurement falling below the 10 cm minimum standard for secchi tube.

The HSPF model calculated daily TSS values for this subwatershed from 1994-2014. These concentrations ranged from 1.83-428.35 mg/L with an average TSS value of 11.30 mg/L. Of these calculations, 137 (2.50%) were above 65 mg/L.

Table 455. TSS related fish metrics in Unnamed Creek (-504). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100002-504 Fish Class 3 – General Use	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfrm-TolPct	RifflePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14DM089	47.48	0.00	11.67	29.58	46.88	28.97	17.91	0.00	0.00	17.58
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	37.83	0.90	13.33	13.93	28.33	8.55	33.71	1.95	3.56	15.27
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

The fish community in Unnamed Creek (-504) at site 14DM089 scored below average in six of the ten TSS related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 455). This reach did have above average numbers of benthic feeders,

perch-like, riffle dwelling, and sensitive individuals, which is uncommon in a stream with elevated TSS concentrations. The remaining metrics in this assemblage did score poorly including the TSS Index score.

Table 456. TSS related macroinvertebrate metrics in Unnamed Creek (-504). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100002-504 Macroinvertebrate Class 5 – General Use	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plectoptera Pct
14DM089	16.12	0.00	9.00	27.51	10.71	0.00
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)</i>	15.87	3.02	11.59	35.23	26.89	0.54
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

The macroinvertebrate assemblage in this reach scored below average in four of the six TSS related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 456). This reach did have a lower amount and percentage of TSS tolerant taxa and individuals. These results do not often occur in streams with elevated TSS concentrations. However, the remaining metrics did score poorly and potentially signal stress from TSS.

The TSS concentrations in the observed data set do show instances in which the standard is exceeded, while the modeled data set showed a very low exceedance rate. The biological communities both have conflicting results as well with many TSS sensitive fish species present, however many poor metric scores as well, while the macroinvertebrate assemblage had lower amounts of TSS tolerant taxa and Individuals. Based on these conflicting results, TSS is inconclusive as a stressor in Unnamed Creek (-504) at this time.

Habitat

Unnamed Creek (-504) had a qualitative habitat assessment take place at its biological monitoring site, 14DM089, during the fish and macroinvertebrate sampling events in 2014. The average MSHA score from these visits was 74.93 (Good). Limiting the habitat at this site was moderate bank erosion (Figure 200), light embeddedness, sand and silt substrates, and moderate channel stability. Further MSHA analysis can be seen in Figure 201.

Figure 200. Bank erosion at site 14DM089.



Figure 201. Unnamed Creek (-504) MSHA metric scores.

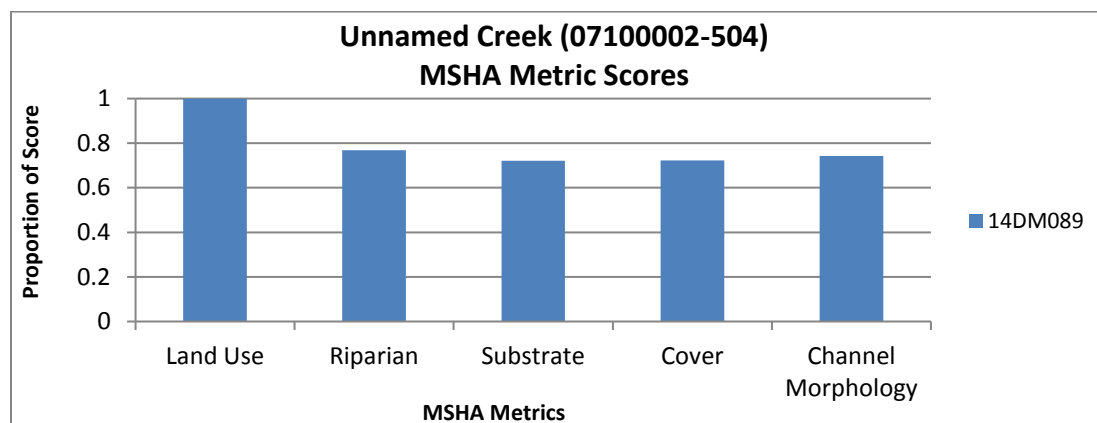


Table 457. Habitat related fish metrics in Unnamed Creek (-504). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100002-504 Fish Class 3 – General Use	BenInsect-TolPct	SLithopPct	DarterSculpSu cPct	RifflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14DM089	29.58	17.91	29.58	46.88	0.00	35.61	67.61	34.61
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	14.22	33.71	12.55	28.33	1.62	69.21	70.64	37.79
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

The fish community in Unnamed Creek (-504) at site 14DM089 scored below average in three of the eight habitat related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 457). This reach had lower numbers of simple lithophils, piscivores, and lithophilic spawning individuals. These results can be a signal for habitat stress. However, this reach also had very good numbers of benthic insectivore, darter/sculpin/sucker, and riffle dwelling individuals, while having below average amounts of tolerant and pioneering individuals.

Table 458. Habitat related macroinvertebrate metrics in Unnamed Creek (-504). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100002-504 Macroinvertebrate Class 5 – General Use	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14DM089	6.82	13.31	35.71	14.29	35.39	39.29
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)</i>	5.66	12.52	49.77	42.46	34.53	13.99
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate community in this reach scored below average in four of the six habitat related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General

Use Threshold (Table 458). This reach did have above average numbers of both climber and sprawler individuals. However, this reach did have higher numbers of both burrower and legless individuals, which corresponds to the sand and silt substrates found. This reach also had a lower amount of both EPT and clinger individuals.

Based on the very good MSHA scores, as well as the majority of the habitat related metrics in the fish community scoring very well, habitat is not a stressor to aquatic life in Unnamed Creek (-504). Other stressors may be impacting the macroinvertebrate community resulting in lower metric scores.

Altered Hydrology

Unnamed Creek (-504) flows south into Iowa and is mostly altered and most of its upstream watershed and tributaries are altered according to the MPCA altered watercourse layer.

Extreme weather events affect high flow events as well as also low flows during drought. HSPF models show this stream section experiencing low flow at less than five cfs 48.1% of the time and less than one cfs 12.5% of the time.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The percentage for generalist fish within the reach was 52.1% compared to the average in Class 3 waters meeting the standard of 52.0%.

The numbers of nest guarder species are also positively correlated with increased low flows. The percentage for nest guarder fish within the reach was 27.8% compared to the average in class 3 waters meeting the standard of 19.2%.

Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The percentage for long-lived macroinvertebrates within the reach was 14.6% compared to the average in class 5 waters meeting the standard of 9%.

Based on the current channelization of this stream, the higher frequency of low flow conditions, as well as the majority of the related biological metrics scoring poorly, Flow Alteration/Connectivity is a stressor to aquatic life in Unnamed Creek (-504).

Summary

The impaired fish and macroinvertebrate communities in Des Moines River (-501) are being stressed by DO, Nitrates and Flow Alteration/Connectivity (Table 459). Eutrophication and Suspended Sediment are inconclusive as stressors at this point, while Habitat was ruled out as a stressor to aquatic life. For further information on the stressors and recommendations to fixing the stressors in the Brown Creek-Des Moines River HUC 10 Watershed, see pages 426-427.

Table 459. Stressor determinations for Unnamed Creek (-504).

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Unnamed Creek	07100002-504	●	○	●	○	---	●

● = stressor; ○ = inconclusive stressor; --- = not an identified stressor

Brown Creek/Judicial Ditch 10 (07100002-502)

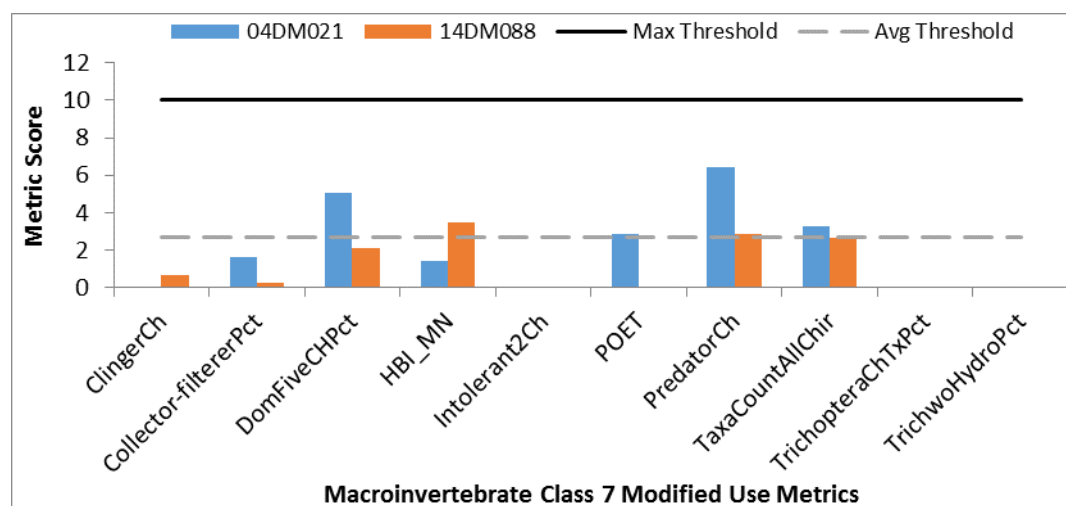
Located in southwestern Martin County, Brown Creek/Judicial Ditch 10 (-502) is a 5.17 mile long reach that is impaired for aquatic life due to the macroinvertebrate assemblage. This stream reach extends from the watershed headwaters down to the Minnesota/Iowa border. Along this stream section there are two biological monitoring stations, 04DM021 and 14DM088.

Biology

Macroinvertebrates

The macroinvertebrate assemblage in Brown Creek/Judicial Ditch 10 (-502) at site 04DM021 was sampled in August of 2004 and had a MIBI score of 20.6 while site 14DM088 was sampled in August of 2014 and had a MIBI score of 12.0. Both of these scores were below the Macroinvertebrate Class 7 Prairie Streams GP Modified Use Threshold of 22. Site 04DM021 had four and site 14DM088 had two metrics score above the average needed to reach the threshold. However, the remaining metrics scored below average with some metrics scoring of zero resulting in the impairment designation. See Figure 202 for a complete breakdown of the metric scores at this site.

Figure 202. Brown Creek/Judicial Ditch 10 (-502) macroinvertebrate IBI metric scores.



Dissolved Oxygen

A total of 10 DO measurements were taken from one chemistry site (S009-058) and two biological monitoring stations (04DM021, 14DM088) from 2004-2016. The average of all the values is 8.28 mg/L with a low of 3.24 mg/L and a high of 17.11 mg/L. The summer average (June-Aug) is 8.29 mg/L. The DO values fell below 5 mg/L once.

The HSPF model calculated daily minimum DO values for this subwatershed from 1994-2014. Of these calculations, 510 (6.65%) of the days had a daily minimum DO level below the daily minimum standard of 5 mg/L.

Table 460. DO related fish metrics in Brown Creek /Judicial Ditch 10 (-502). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100002-502 Fish Class 3 – Modified Use	MA>3 Avg	SspnPct Avg	Taxa Count Avg	DO TIV Avg
04DM021	9.09	0.00	5	8.16
14DM088	32.26	16.13	9	8.19
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)</i>	14.39	10.56	10.03	8.25
Expected response to DO stress	↓	↑	↓	↓

The fish community in Brown Creek/Judicial Ditch 10 (-502) scored below average in three of the DO related metrics at both sites when compared to all other Class 3 Southern Headwaters stations that meet the FIBI Modified Use Threshold (Table 460). Both of these sites had very low taxa counts, while also having poor DO TIV scores. Site 04DM021 had very few mature fish, but did have zero serial spawning individuals. Serial spawning fish are often found in high numbers in streams with poor DO. Site 14DM088 had an increased amount of mature fish, but also had an above average amount of serial spawning individuals.

Table 461. DO related macroinvertebrate metrics in Brown Creek /Judicial Ditch 10 (-502). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100002-502 Macroinvertebrate Class 7 – Modified Use	HBI_MN Value	% DO Tolerant Taxa	# DO Tolerant Taxa	ChemTV_DO
04DM021	8.44	19.38	11.00	6.37
14DM088	7.81	78.00	14.00	5.60
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22)</i>	8	31.37	9.33	6.19
Expected response to DO stress	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in two (04DM021) and three (14DM088) of the four DO related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 461). Both of these sites had an increased amount of DO tolerant taxa, while site 04DM021 had a below average percentage of these species, site 14DM088 had a very high amount. Site 04DM021 had a good DO TIV score while having a poor HBI_MN value, while site 14DM088 was the opposite.

The DO levels in this reach do fall below the 5 mg/L standard according to the observed data set. The model calculated a relatively low exceedance rate, while the majority of the DO related metrics in the fish and macroinvertebrate communities scored below average. The high range of DO values measured, as well as the large amounts of algae and high phosphorus concentrations in this stream are likely issues with daily flux. Based on this information, DO is a stressor to aquatic life in Brown Creek/Judicial Ditch 10 (-502) at this time.

Eutrophication

A total of 10 phosphorus samples were taken from one chemistry site (S009-058) and two biological monitoring stations (04DM021, 14DM088) from 2004-2016. The average of all the values is 0.149 mg/L with a low of 0.04 mg/L and a high of 0.42 mg/L. The summer average (June-Aug) is 0.141 mg/L. Phosphorus values exceeded the standard of 0.150 mg/L four times. Large amounts of algae were also observed in site 14DM088 (Figure 203).

Figure 203. Algae at site 14DM088.



The HSPF model also calculated daily phosphorus concentrations for this subwatershed from 1994-2014. These values ranged from 0.15-23.21 mg/L with an average phosphorus concentration of 0.50 mg/L. All of these calculations were above the phosphorus standard.

Table 462. Eutrophication related fish metrics in Brown Creek /Judicial Ditch 10 (-502). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100002-502 Fish Class 3 – Modified Use	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct
04DM021	0.00	0.00	54.55	45.45
14DM088	0.00	0.00	98.39	50.00
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)</i>	5.54	10.36	76.45	19.58
Expected response to Eutrophication stress	↓	↓	↑	↑

The fish community in Brown Creek/Judicial Ditch 10 (-502) at sites 04DM021 and 14DM088 scored below average in all four of the eutrophication related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI Modified Use Threshold (Table 462). This reach had increased numbers of tolerant and omnivorous individuals, while also having lower numbers of darter and sensitive individuals. These results are often found in streams with eutrophic conditions.

Table 463. Eutrophication related macroinvertebrate metrics in Brown Creek /Judicial Ditch 10 (-502). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100002-502 Macroinvertebrate Class 7 – Modified Use	EPT Pct	Tanytarsini Pct	CrustMoll Pct	Scraper Pct	% Tolerant Taxa	% Intolerant Taxa
04DM021	26.43	18.30	15.29	32.80	32.81	0.00
14DM088	0.00	27.36	53.02	9.40	62.33	0.00
<i>Statewide average for Class 7 Prairie Streams Glide Pool stations that are meeting the MIBI Modified Use Threshold (22)</i>	20.58	22.11	23.21	17.73	45.87	1.43
Expected response to Eutrophication stress	↓	↓	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in three (04DM021) and four (14DM088) of the six eutrophication related metrics when compared to all other Class 7 Prairie Streams

GP stations that meet the MIBI Modified Use Threshold (Table 463). Both of these streams completely lacked phosphorus intolerant taxa, while the remaining metrics showed one site scoring well, while the other site scoring below average.

Based on the high standard exceedance rate in the observed and modeled data sets, the photo of abundant algae growth, as well as all of the fish and many of the macroinvertebrate metrics related to eutrophication scoring below average or poorly, eutrophication is a stressor to aquatic life in Brown Creek/Judicial Ditch 10 (-502).

Nitrates

Ten samples taken from one chemistry site (S009-058) and two biological monitoring stations (04DM021, 14DM088) from 2004-2016 were analyzed for Inorganic Nitrogen (NO₂-NO₃). The average of all the values is 17.10 mg/L with a low of 1.90 mg/L and a high of 26.00 mg/L. The spring average (March-May) is 24.50 mg/L. The summer average (June-Aug) is 15.57 mg/L. Nitrate values exceeded 4 mg/L nine times. A quantile regression analysis for Class 7 stream stations showed that sites having a nitrate concentration in excess of 11.5 mg/L there was a 90% probability for impairment. The nitrate concentrations in this reach easily exceeded this level.

The HSPF model calculated daily nitrate concentrations for this subwatershed from 1994-2014. These values ranged from 1.12-7057.7 mg/L with an average value of 9.33 mg/L. Of these calculations, 1539 (25.28%) were above 11.5 mg/L.

Drain tiles were noted as being present along this reach. Drain tiles are a common pathway for nitrates to enter a stream system.

Table 464. Nitrate related macroinvertebrate metrics in Brown Creek /Judicial Ditch 10 (-502). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100002-502 Macroinvertebrate Class 7 – Modified Use	TrichopteraChTx Pct	N Index Score	% N Tolerant	% N Intolerant
04DM021	0.00	4.35	81.88	0.00
14DM088	0.00	3.07	41.00	0.67
<i>Statewide average for Class 7 Prairie Streams Glide Pool stations that are meeting the MIBI Modified Use Threshold (22)</i>	5.71	3.30	62.54	0.00
Expected response to N stress	↓	↑	↑	↓

The macroinvertebrate community in Brown Creek/Judicial Ditch 10 (-502) scored below average in one (14DM088) and all four (04DM021) of the four nitrate related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 464). Both sites, 04DM021 and 14DM088, completely lacked trichoptera taxa, while site 04DM021 also had a poor nitrate index score, zero nitrate intolerant species, and a very high amount of nitrate tolerant individuals. Site 14DM088 is located further downstream and the macroinvertebrate community fared much better.

Based on the high nitrate concentrations observed and calculated, the quantile regression analysis, the presence of drain tiles as a pathway, as well as the very poorly scoring nitrate related metrics in the macroinvertebrate community at site 04DM021, nitrates are a stressor to aquatic life in this reach. Nitrates may not be having as great of impact at the downstream portion of the reach.

Suspended Solids

Ten samples taken from one chemistry site (S009-058) and two biological monitoring stations (04DM021, 14DM088) from 2004-2016 were analyzed for TSS. The average of all the values is 40.66 mg/L with a low of 2.4 mg/L and a high of 230 mg/L. The TSS concentrations exceeded the 65 mg/L standard mg/L once.

Additionally, 11 secchi tube measurements were taken from this reach. These values ranged from 13-100 cm, with no values falling below the 10 cm minimum standard for secchi tube.

The HSPF model calculated daily TSS values for this subwatershed from 1994-2014. These concentrations ranged from 2.31-1057.00 mg/L with an average TSS value of 15.22 mg/L. Of these calculations, 233 (3.83%) were above the TSS standard.

Table 465. TSS related fish metrics in Brown Creek /Judicial Ditch 10 (-502). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100002-502 Fish Class 3 – Modified Use	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RifflePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
04DM021	9.09	27.27	0.00	27.27	9.09	0.00	9.09	0.00	18.18	17.43
14DM088	20.97	1.61	8.06	1.61	20.97	0.00	20.97	0.00	12.90	20.83
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)</i>	31.38	1.01	10.83	12.43	22.62	6.02	30.09	0.52	4.91	15.49
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

The fish community in Brown Creek/Judicial Ditch 10 (-502) scored below average in seven (04DM021) and eight (14DM088) of the ten TSS related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI Modified Use Threshold (Table 465). Both sites did have above average numbers of centrarchid and long-lived individuals, while site 04DM021 also had an increased amount of perch-like individuals. These results are common in streams not being negatively impacted by the TSS conditions. However, the remaining metrics in this reach did score below average.

Table 466. TSS related macroinvertebrate metrics in Brown Creek /Judicial Ditch 10 (-502). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100002-502 Macroinvertebrate Class 7 – Modified Use	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plectoptera Pct
04DM021	16.64	0.00	11.00	41.25	6.37	0.00
14DM088	14.44	1.00	8.00	10.33	1.34	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)</i>	16.02	0.60	10.98	35.60	9.91	0.02
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

The macroinvertebrate assemblage in this reach scored below average in three (14DM088) and six (04DM021) of the six TSS related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 466). Site 14DM088 fared much better than site 04DM021 as site 14DM088 had a good TSS Index score as well as decreased amounts and percentage of TSS tolerant taxa. These results are not common in streams with elevated TSS concentrations.

The observed and modeling data sets both indicate that the TSS concentrations in this reach are low and remain low. It is likely that other stressors are causing the fish and macroinvertebrate communities to score poorly as the chemical and model data give no indication of potential stress. Therefore, TSS is not a stressor to aquatic life in Brown Creek/Judicial Ditch 10 (-502) at this time.

Habitat

Brown Creek/Judicial Ditch 10 (-502) had a qualitative habitat assessment take place at its biological monitoring sites, 04DM021 and 14DM088, during the fish and macroinvertebrate sampling events in 2004 and 2014. The average MSHA score from these visits were 36.05 (Poor) at 04DM021 and 25.6 (Poor) at 14DM088. Limiting the habitat at these sites was the row crop agriculture as the dominant nearby land use, a narrow riparian buffer, no stream shading (14DM088), silt substrates, heavy siltation, choking vegetation (14DM088) (Figure 204), moderate channel stability, poor to fair sinuosity, and poor channel development. Further MSHA analysis can be seen in Figure 205.

Figure 204. Choking vegetation at site 14DM088.



Figure 205. Unnamed Creek (-502) MSHA metric scores.

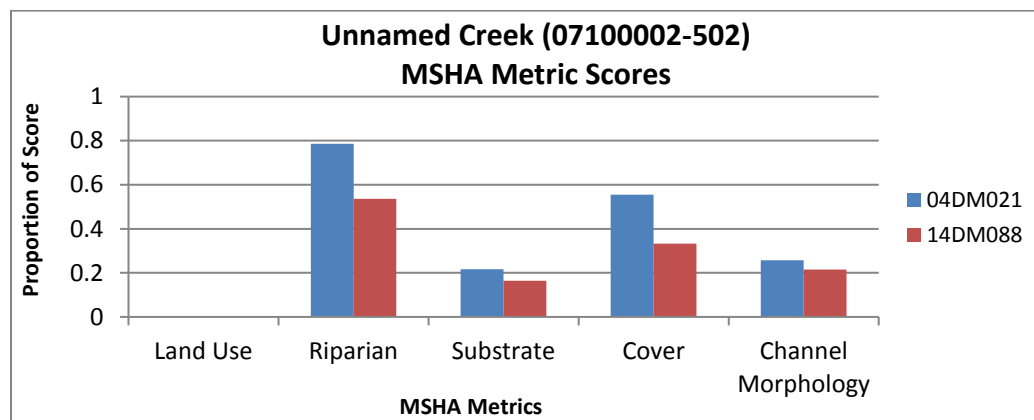


Table 467. Habitat related fish metrics in Brown Creek /Judicial Ditch 10 (-502). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100002-502 Fish Class 3 – Modified Use	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RifflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
04DM021	0.00	9.09	0.00	9.09	18.18	18.18	54.55	9.09
14DM088	0.00	20.97	0.00	20.97	1.61	53.23	98.39	50.00
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)</i>	10.91	30.09	10.59	22.62	1.97	57.98	46.70	32.54
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

The fish community in Brown Creek/Judicial Ditch 10 (-502) at sites 04DM021 and 14DM088 scored below average in six (04DM021) and eight (14DM088) of the eight habitat related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI Modified Use Threshold (Table 467). Site 04DM021 did have an above average amount of piscivore individuals, while also having a lower amount of pioneering individuals which can be a signal for improved habitat stress. However, the remaining metrics scored poorly as did site 14DM088. This reach was dominated by tolerant individuals, while also having decreased amounts of species requiring specialized habitat conditions to live and reproduce.

Table 468. Habitat related macroinvertebrate metrics in Brown Creek /Judicial Ditch 10 (-502). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100002-502 Macroinvertebrate Class 7 – Modified Use	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
04DM021	20.70	18.15	4.46	26.43	65.92	28.03
14DM088	25.50	10.74	11.07	0.00	53.36	46.31
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)</i>	9.74	24.34	20.62	15.52	59.46	22.88
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate assemblage in this reach scored below average in four of the six habitat related metrics at both sites, 04DM021 and 14DM088, when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 468). Both sites did have an increased number of sprawler individuals, which is a good sign. However, both sites had a high number of burrower individuals, while also lacking climber and clinger individuals. The heavy siltation in this reach likely contributed to the high number of burrower and legless individuals (04DM021), which is often a sign for habitat degradation.

Based on the poor MSHA scores at both sites, as well as the majority of the habitat related metrics in both the fish and macroinvertebrate communities scoring below average, habitat is a stressor to aquatic life in Brown Creek/Judicial Ditch 10 (-502).

Altered Hydrology

Brown Creek/Judicial Ditch 10 (-502) flows south into Iowa and is mostly altered as is most of the upstream watershed and tributaries according to the MPCA altered watercourse layer.

Extreme weather events affect high flow events as well as also low flows during drought. HSPF models show this stream section experiencing low flow at less than five cfs 39.8% of the time and less than one cfs 10.2% of the time.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The average percentage for generalist fish within the reach was 69.2% compared to the average in Class 3 general use waters meeting the standard of 59.1%. Generalist fish species ranged from 54.5-83.9%.

The numbers of nest guarder species are also positively correlated with increased low flows. The average percentage for nest guarder fish within the reach was 26.5% compared to the average in Class 3 general use waters meeting the standard of 19.2%. Nest Guarder Species ranged from 25.8-27.3%.

Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The average percentage for long-lived macroinvertebrates within the reach was 0.5% compared to the average in Class 7 general use waters meeting the standard of 8%. Long-lived macroinvertebrates ranged from 0-1.0%.

Based on the channelization of this stream, the higher frequency of low flow conditions, as well as the poor scoring biological metrics, Flow Alteration/Connectivity is a stressor to aquatic life in Brown Creek/Judicial Ditch 10 (-502).

Summary

The impaired macroinvertebrate community in Brown Creek/Judicial Ditch 10 (-502) is being stressed by DO, Eutrophication, Nitrates, Habitat and Flow Alteration/Connectivity (Table 469). Suspended Sediment was ruled out as a stressor to aquatic life. For further information on the stressors and recommendations to fixing the stressors in the Brown Creek-Des Moines River HUC 10 Watershed, see pages 426-427.

Table 469. Stressor determinations for Brown Creek/Judicial Ditch 10 (-502).

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Brown Creek/Judicial Ditch 10	07100002-502	●	●	●	---	●	●

● = stressor; ○ = inconclusive stressor; --- = not an identified stressor

Judicial Ditch 56 (07100002-505)

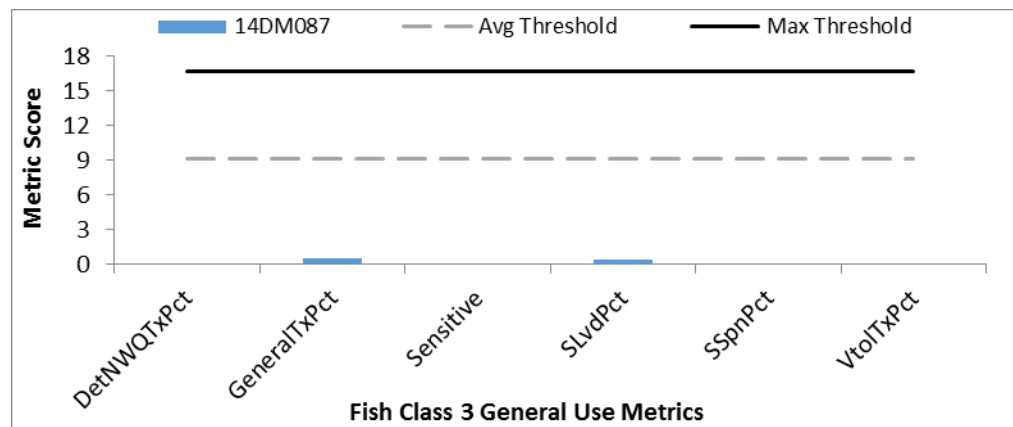
Located in southeastern Jackson County, Judicial Ditch 56 (-505) is a 3.65 mile long reach that is impaired for aquatic life due to the fish and macroinvertebrate assemblages. This stream reach extends from Unnamed Creek down to the confluence with the Des Moines River. Along this stream section there is one biological monitoring station, 14DM087.

Biology

Fish

The fish community in Judicial Ditch 56 (-505) was sampled for fish in June of 2014 at its biological monitoring station 14DM087. The FBI score at this reach was 0.0, which is far below the Fish Class 3 Southern Headwaters General Use Threshold of 55. All of the FBI metrics at this site scored below average with four of the six metrics comprising this FBI scoring zero (Figure 206). This site was dominated by the presence of fathead minnows (91.13% of sampled individuals), which are a very tolerant species of fish often found in high numbers in degraded stream systems.

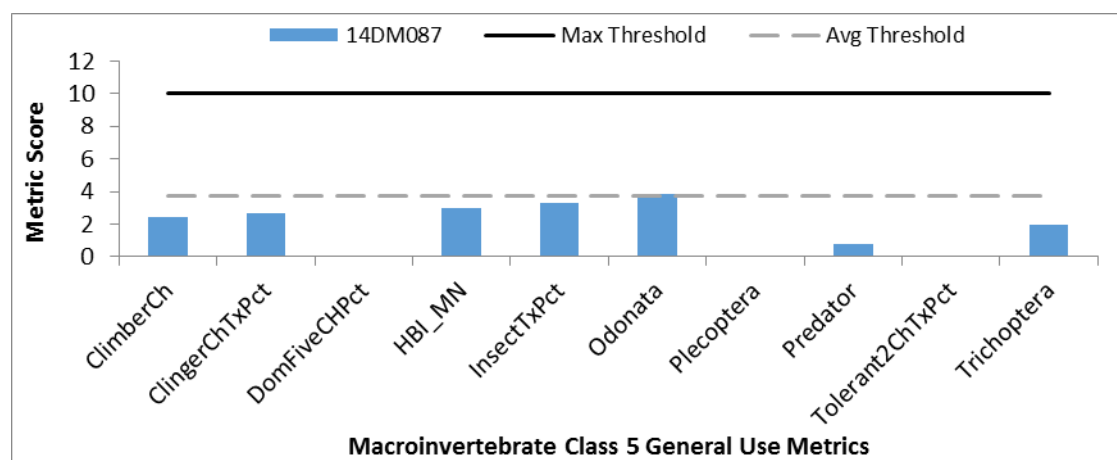
Figure 206. Judicial Ditch 56 (-505) fish IBI metric scores.



Macroinvertebrates

The macroinvertebrate assemblage at site 14DM087 was sampled in August of 2014 and had a MIBI score of 18.0. This MIBI score is below the Macroinvertebrate Class 5 Southern Streams RR General Use Threshold of 37. Site 14DM087 had one metric (Odonata) score above the average needed to reach the threshold. However, the remaining nine metrics scored below average with three metrics score of zero (DomFiveCHPct, Plecoptera, Tolerant2ChTxPct) resulting in the impairment designation. See Figure 207 for a complete breakdown of the metric scores at this site.

Figure 207. Judicial Ditch 56 (-505) macroinvertebrate IBI metric scores.



Dissolved Oxygen

A total of nine DO measurements were taken from one chemistry site (S009-059) and one biological monitoring station (14DM087) from 2014-2016. The average of all the values is 6.59 mg/L with a low of

4.50 mg/L and a high of 13.27 mg/L. The summer average (June-Aug) is 6.23 mg/L. The DO values fell below 5 mg/L four times.

The HSPF model calculated daily minimum DO values for this subwatershed from 1994-2014. Of these calculations, 2032 (26.49%) of the days had a daily minimum DO level below the daily minimum standard of 5 mg/L. This is a high exceedance rate for DO.

Table 470. DO related fish metrics in Judicial Ditch 56 (-505). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100002-505 Fish Class 3 – General Use	MA>3 Avg	SspnPct Avg	Taxa Count Avg	DO TIV Avg
14DM087	0.00	91.14	4.00	8.36
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	13.32	17.09	12.16	8.44
Expected response to DO stress	↓	↑	↓	↓

The fish community in Judicial Ditch 56 (-505) at site 14DM087 scored below average in all four of the DO related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 470). This stream had a low taxa count, zero mature fish, a poor DO TIV score, and a very high percentage of serial spawning individuals. This high percentage was driven by the high amount of DO tolerant fathead minnows present (72). Fathead minnows are common in high numbers in streams with poor DO conditions.

Table 471. DO related macroinvertebrate metrics in Judicial Ditch 56 (-505). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100002-505 Macroinvertebrate Class 5 – General Use	HBI_MN Value	% DO Tolerant Taxa	# DO Tolerant Taxa	ChemTV _DO
14DM087	7.33	44.04	6.00	6.79
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	7.04	8.62	4.33	7.10
Expected response to DO stress	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in all four of the DO related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 471). Site 14DM087 had a very high amount of DO tolerant taxa, while also having poor DO TIV and HBI_MN scores. These results are common in streams with DO issues.

Based on the high exceedance rate of the DO standard in both the observed and modeled data, as well as all of the DO related metrics in both the fish and macroinvertebrate communities scoring below average, DO is a stressor to aquatic life in Judicial Ditch 56 (-505).

Eutrophication

A total of nine phosphorus samples were taken from one chemistry site (S009-059) and one biological monitoring station (14DM087) from 2014-2016. The average of all the values is 0.281 mg/L with a low of 0.12 mg/L and a high of 0.41 mg/L. The summer average (June-Aug) is 0.329 mg/L. Phosphorus values exceeded the standard of 0.150 mg/L eight times. Site 14DM087 does accumulate algae at times (Figure 208) which is a strong signal for potential eutrophic conditions.

Figure 208. Algae at site 14DM087.



The HSPF model also calculated daily phosphorus concentrations for this subwatershed from 1994-2014. These values ranged from 0.07-16.55 mg/L with an average phosphorus concentration of 0.42 mg/L. Of these calculations, 5,339 (96.06%) were above the phosphorus standard.

Table 472. Eutrophication related fish metrics in Judicial Ditch 56 (-505). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100002-505 Fish Class 3 – General Use	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct
14DM087	0.00	0.00	100.00	92.41
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FBI General Use Threshold (55.0)</i>	8.9	12.11	70.79	14.71
Expected response to Eutrophication stress	↓	↓	↑	↑

The fish community in Judicial Ditch 56 (-505) at site 14DM087 scored below average in all four of the eutrophication related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FBI General Use Threshold (Table 472). This reach had a very high amount of Tolerant and Omnivorous individuals, while also lacking any sensitive and darter species. These results are often found in streams stressed by eutrophic conditions.

Table 473. Eutrophication related macroinvertebrate metrics in Judicial Ditch 56 (-505). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100002-505 Macroinvertebrate Class 5 – General Use	EPT Pct	Tanytarsini Pct	CrustMoll Pct	Scraper Pct	% Tolerant Taxa	% Intolerant Taxa
14DM087	14.29	11.25	41.23	19.81	38.51	0.00
<i>Statewide average for Class 5 Southern Streams Rock Riffle stations that are meeting the MIBI General Use Threshold (37)</i>	43.90	27.84	9.23	15.78	17.17	5.79
Expected response to Eutrophication stress	↓	↓	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in all six of the eutrophication related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 473). This reach had low numbers of EPT, tanytarsini, and phosphorus intolerant individuals, while also having increased amounts of phosphorus tolerant taxa, and crustacean/mollusca and scraper individuals. These results are common in streams with eutrophic conditions present.

Based on the high amount of standard exceedances in both the observed and modeled data sets, the presence of algae, as well as all of the eutrophication related metrics scoring below average or poorly in both fish and macroinvertebrate communities all conclude that eutrophication is a stressor to aquatic life in Judicial Ditch 56 (-505).

Nitrates

Nine samples taken from one chemistry site (S009-059) and one biological monitoring station (14DM087) from 2014-2016 were analyzed for Inorganic Nitrogen (NO₂-NO₃). The average of all the values is 0.281 mg/L with a low of 0.12 mg/L and a high of 0.41 mg/L. The spring average (March-May) is 2.85 mg/L. The summer average (June-Aug) is 3.10 mg/L. Nitrate values exceeded 4 mg/L three times.

The HSPF model calculated daily nitrate concentrations for this subwatershed from 1994-2014. These values ranged from 0.73-140.14 mg/L with an average nitrate concentration of 6.49 mg/L.

Table 474. Nitrate related macroinvertebrate metrics in Judicial Ditch 56 (-505). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100002-505 Macroinvertebrate Class 5 – General Use	TrichopteraChTx Pct	N Index Score	% N Tolerant	% N Intolerant
14DM087	15.38	2.83	25.38	0.00
<i>Statewide average for Class 5 Southern Streams Rock Riffle stations that are meeting the MIBI General Use Threshold (37)</i>	13.16	3.00	48.68	0.96
Expected response to N stress	↓	↑	↑	↓

The macroinvertebrate community in Judicial Ditch 56 (-505) scored below average in just one of the four nitrate related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 474). The site, 14DM087, completely lacked nitrate intolerant species. However, this site also had a high amount of trichoptera taxa, a good nitrate index score, and a lower amount of nitrate tolerant individuals. These results do not signal a stream being negatively impacted by nitrates.

While the model did calculate a few elevated nitrate values for this subwatershed, the observed data set showed very low nitrate concentrations and the nitrate related biological metrics scored well, therefore, nitrates are not a stressor to aquatic life in Judicial Ditch 56 (-505).

Suspended Solids

Nine samples taken from one chemistry site (S009-059) and one biological monitoring station (14DM087) from 2014-2016 were analyzed for TSS. The average of all the values is 73.29 mg/L with a low of 9.6 mg/L and a high of 170 mg/L. The TSS concentrations exceeded the 65 mg/L standard four times.

Additionally, 10 secchi tube measurements were taken from this reach. These values ranged from 7-83 cm, with one measurement falling below the 10 cm minimum standard for secchi tube.

The HSPF model calculated daily TSS values for this subwatershed from 1994-2014. These concentrations ranged from 1.97-906.06 mg/L with an average TSS value of 12.19 mg/L. Of these calculations, 154(2.77%) were above 65 mg/L.

Table 475. TSS related fish metrics in Judicial Ditch 56 (-505). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100002-505 Fish Class 3 – General Use	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RifflePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14DM087	0.00	0.00	5.06	0.00	0.00	0.00	0.00	0.00	0.00	24.07
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	37.83	0.90	13.33	13.93	28.33	8.55	33.71	1.95	3.56	15.27
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

The fish community in Judicial Ditch 56 (-505) scored below average in all ten of the TSS related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 475). This reach was dominated by fathead minnows (91%). These species are very tolerant to poor TSS conditions and are a large reason why the metric scores did so poorly in this reach.

Table 476. TSS related macroinvertebrate metrics in Judicial Ditch 56 (-505). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100002-505 Macroinvertebrate Class 5 – General Use	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plectoptera Pct
14DM087	15.34	0.00	13.00	17.13	36.73	0.00
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)</i>	15.87	3.02	11.59	35.23	26.89	0.54
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

The macroinvertebrate assemblage in this reach scored poorly in three of the six TSS related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 476). Site 14DM087 did have a good TSS Index score, few TSS tolerant individuals, and an increased amount of collector-filterer individuals. These results are not common in streams with elevated TSS concentrations.

The observed data set showed a high standard exceedance rate, while the HSPF model calculated a relatively low rate of exceedance. The fish community scored very poorly in the TSS related metrics while the macroinvertebrate community scored fairly well with a good TSS Index Score, few TSS tolerant individuals, and many collector-filterer individuals. Based on these conflicting results, TSS is inconclusive as a stressor in Judicial Ditch 56 (-505) at this time.

Habitat

Judicial Ditch 56 (-505) had a qualitative habitat assessment take place at its biological monitoring site, 14DM087, during the fish and macroinvertebrate sampling events in 2014. The average MSHA score from these visits was 51.8 (Fair). Limiting the habitat at this site was row crop agriculture and open pasture as the dominant nearby land uses (Figure 209), no riparian buffer, moderate bank erosion, light stream shading, severe embeddedness, sand and silt substrates, heavy siltation, sparse fish cover, and moderate channel stability. Further MSHA analysis can be seen in Figure 210.

Figure 209. Open pastureland use at site 14DM087.



Figure 210. Judicial Ditch 56 (-505) MSHA metric scores.

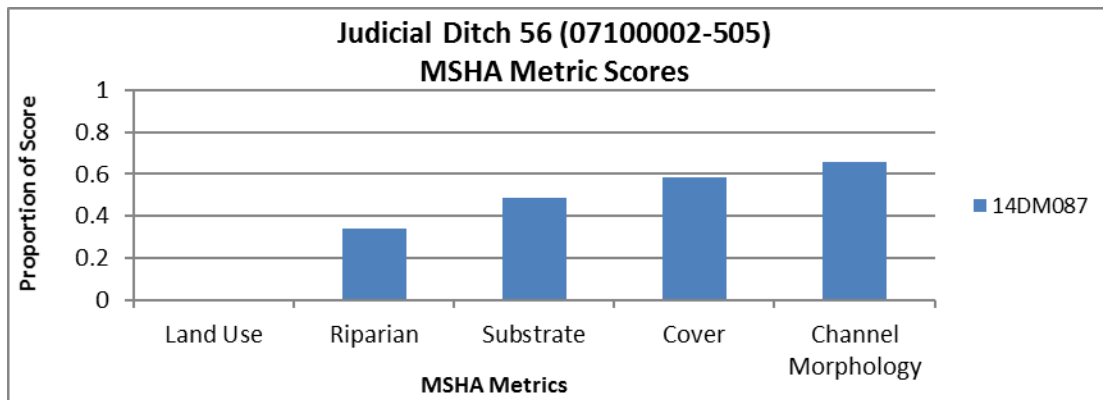


Table 477. Habitat related fish metrics in Judicial Ditch 56 (-505). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100002-505 Fish Class 3 – General Use	BenInsect-TolPct	SLithopPct	DarterSculpsucPct	RifflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14DM087	0.00	0.00	0.00	0.00	0.00	0.00	100.00	93.67
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	14.22	33.71	12.55	28.33	1.62	69.21	70.64	37.79
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

The fish community in Judicial Ditch 56 (-505) at site 14DM087 scored below average in all eight of the habitat related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 477). This reach was completely dominated by tolerant taxa as only four different species were collected: fathead minnows, brassy minnows, green sunfish, and black bullheads. Fathead minnows comprised 91.14% of the community sampled. These fish are very tolerant to poor habitat conditions.

Table 478. Habitat related macroinvertebrate metrics in Judicial Ditch 56 (-505). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
07100002-505						
Macroinvertebrate Class 5 – General Use						
14DM087	1.23	7.72	46.60	10.19	22.22	41.67
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)</i>	5.66	12.52	49.77	42.46	34.53	13.99
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate assemblage in this reach fared somewhat better as three of the six habitat metrics scored below average when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 478). This reach had lower amounts of both burrower and legless individuals, while also having good amounts of sprawler individuals. These results reflect a stream not being impacted by poor habitat. However, this reach also had decreased numbers of EPT, clinger, and climber individuals, which is common in streams stressed by the habitat conditions.

The habitat in this stream reach is fair. Many of the macroinvertebrate metrics related to habitat as well as all of the fish metrics related to habitat scored poorly, therefore, habitat is a stressor to aquatic life in Judicial Ditch 56 (-505) at this time.

Altered Hydrology

Judicial Ditch 56 (-505) is a direct tributary of the mainstem Des Moines River, which flows south into back into Iowa. The reach itself is entirely natural though its upstream watershed is altered according to the MPCA altered watercourse layer. Most of the watershed that drains into the reach itself is in Iowa and is not included in the MPCA altered watercourse layer.

Extreme weather events affect high flow events as well as also low flows during drought. HSPF models show this stream section experiencing low flow at less than five cfs 48.1% of the time and less than one cfs 12.5% of the time.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The percentage for generalist fish within the reach was 94.9% compared to the average in class 3 waters meeting the standard of 59.1%.

The numbers of nest guarder species are also positively correlated with increased low flows. The percentage for nest guarder fish within the reach was 93.7% compared to the average in class 3 waters meeting the standard of 19.6%.

Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The percentage for long-lived macroinvertebrates within the reach was 0.0% compared to the average in class 5 waters meeting the standard of 9%.

Judicial Ditch 56 (-505) is a natural stream section with significant stream channelization in the upstream portions of the watershed. The stream often experiences low flow conditions and the majority of related biological metrics did score poorly in this reach. The upstream channelization may be causing stress in this reach, therefore, Flow Alteration/Connectivity is inconclusive as a stressor.

Summary

The impaired fish and macroinvertebrate communities in Judicial Ditch 56 (-505) are being stressed by DO, Eutrophication, and Habitat (Table 479). Suspended Sediment and Flow Alteration/Connectivity were inconclusive as stressors, while Nitrates were ruled out as a stressor to aquatic life. For further information on the stressors and recommendations to fixing the stressors in the Brown Creek-Des Moines River HUC 10 Watershed, see pages 426-427.

Table 479. Stressor determinations for Judicial Ditch 56 (-505).

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Judicial Ditch 56	07100002-505	●	●	---	○	●	○

● = stressor; ○ = inconclusive stressor; --- = not an identified stressor

Story Brook (07100002-507)

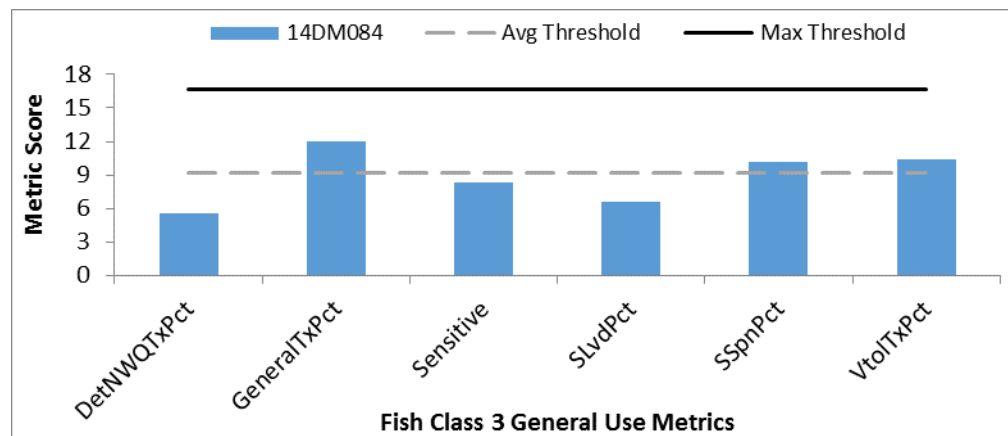
Located in southeastern Jackson County, Story Brook (-507) is a 2.46 mile long reach that is impaired for aquatic life due to the fish and macroinvertebrate assemblages. This stream reach extends from Judicial Ditch 56 down to the confluence with the Des Moines River. Along this stream section there is one biological monitoring station, 14DM084.

Biology

Fish

The fish community in Story Brook (-564) was sampled for fish in August of 2014 at its biological monitoring station 14DM084. The FIBI score at this reach was 53.1, which is just slightly below the Fish Class 3 Southern Headwaters General Use Threshold of 55. This site did have three metrics (GeneralTxPct, SSpnPct, VtolTxPct) reach the average metric score needed to meet the threshold (Figure 211), however, the remaining three metrics comprising this FIBI scored below average.

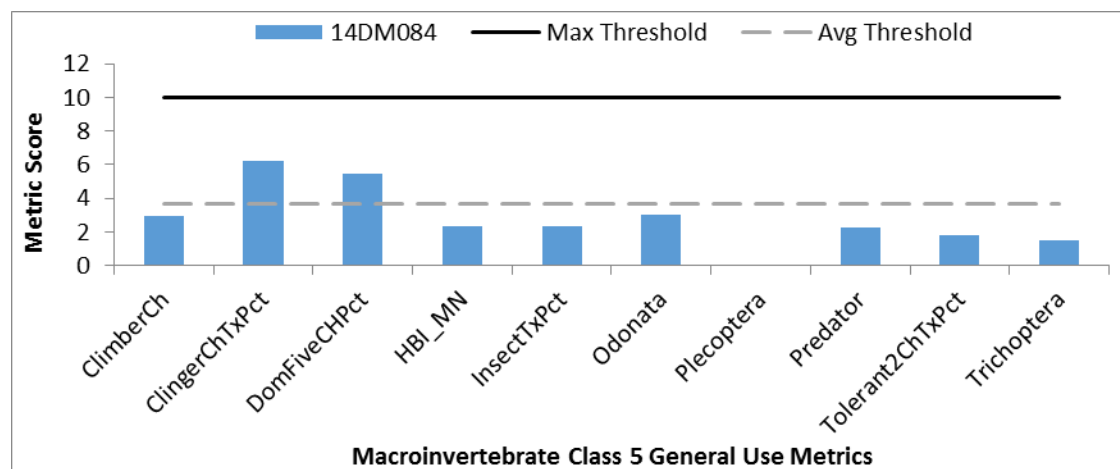
Figure 211. Story Brook (-507) fish IBI metric scores.



Macroinvertebrates

The macroinvertebrate assemblage at site 14DM084 was sampled in August of 2014 and had a MIBI score of 28.05. This MIBI score is below the Macroinvertebrate Class 5 Southern Streams RR General Use Threshold of 37. Site 14DM084 had two (ClingerChTxPct, DomFiveCHPct) metrics score above the average needed to reach the threshold. However, the remaining eight metrics scored below average with one metric score of zero (Plecoptera) resulting in the impairment designation. See Figure 212 for a complete breakdown of the metric scores at this site.

Figure 212. Story Brook (-507) macroinvertebrate IBI metric scores.



Dissolved Oxygen

A total of nine DO measurements were taken from one chemistry site (S009-060) and one biological monitoring station (14DM084) from 2014-2016. The average of all the values is 7.48 mg/L with a low of 4.06 mg/L and a high of 12.99 mg/L. The summer average (June-Aug) is 6.99 mg/L. The DO values fell below 5 mg/L twice.

The HSPF model calculated daily minimum DO values for this subwatershed from 1994-2014. Of these calculations, 581 (7.57%) of the days had a daily minimum DO level below the daily minimum standard of 5 mg/L.

Table 480. DO related fish metrics in Story Brook (-507). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100002-507 Fish Class 3 – General Use	MA>3 Avg	SspnPct Avg	Taxa Count Avg	DO TIV Avg
14DM084	6.00	30.00	9.00	8.76
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	13.32	17.09	12.16	8.44
Expected response to DO stress	↓	↑	↓	↓

The fish community in Story Brook (-507) at site 14DM084 scored below average in three of the four DO related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 480). The site had few mature individuals, while also having a lower taxa count and high amount of serial spawning individuals. Serial spawning fish are often found in high numbers in streams with DO issues.

Table 481. DO related macroinvertebrate metrics in Story Brook (-507). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100002-507 Macroinvertebrate Class 5 – General Use	HBI_MN Value	% DO Tolerant Taxa	# DO Tolerant Taxa	ChemTV DO
14DM084	7.55	16.79	6.00	6.69
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	7.04	8.62	4.33	7.10
Expected response to DO stress	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in all four of the DO related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 481). The site, 14DM084, did have increased amounts of DO tolerant taxa, while also having a poor HBI_MN and DO TIV score. These results are very common in streams stressed by the DO conditions.

The DO levels in Story Brook (-507) occasionally fell below the 5 mg/L standard based on the observed data set. The model calculated a relatively low exceedance rate; however, the majority of the DO related metrics in both the fish and macroinvertebrate communities scored below average. Based on this information, DO is a stressor to aquatic life in this reach.

Eutrophication

Nine samples were taken from one chemistry site (S009-060) and one biological monitoring station (14DM084) from 2014-2016. The average of all the values is 0.147 mg/L with a low of 0.02 mg/L and a high of 0.56 mg/L. The summer average (June-Aug) is 0.157 mg/L. Phosphorus values exceeded the standard of 0.150 mg/L three times.

The HSPF model also calculated daily phosphorus concentrations for this subwatershed from 1994-2014. These values ranged from 0.17-9.48 mg/L with an average phosphorus concentration of 0.57 mg/L. All of these calculations were above the phosphorus standard.

Table 482. Eutrophication related fish metrics in Story Brook (-507). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100002-507 Fish Class 3 – General Use	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct
14DM084	14.00	24.00	74.00	4.00
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	8.9	12.11	70.79	14.71
Expected response to Eutrophication stress	↓	↓	↑	↑

The fish community in Story Brook at site 14DM084 scored below average in one of the four eutrophication related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 482). This reach did have an above average amount of tolerant fish individuals, but also had a healthy amount of sensitive and darter individuals, while also having reduced numbers of omnivorous individuals. These results are common in streams not being stressed by eutrophic conditions.

Table 483. Eutrophication related macroinvertebrate metrics in Story Brook (-507). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100002-507 Macroinvertebrate Class 5 – General Use	EPT Pct	Tanytarsini Pct	CrustMoll Pct	Scraper Pct	% Tolerant Taxa	% Intolerant Taxa
14DM084	37.04	41.94	14.43	4.75	16.88	0.00
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	43.90	27.84	9.23	15.78	17.17	5.79
Expected response to Eutrophication stress	↓	↓	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in three of the six eutrophication related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 483). Site 14DM084 had decreased numbers of EPT individuals, and phosphorus intolerant taxa. This site also had an increased amount of crustacea/mollusca individuals. These results potentially signal stress from eutrophication. However, this reach also had high numbers of tanytarsini individuals as well as decreased numbers of scraper individuals and phosphorus tolerant taxa. These results are not common in streams stressed by eutrophic conditions.

The observed and modeled data sets both show high concentrations of phosphorus and numerous standard exceedances. The biological responses from the fish and macroinvertebrate communities is rather mixed. Therefore, eutrophication is inconclusive as a stressor in Story Brook (-507) at this time.

Nitrates

Nine samples taken from one chemistry site (S009-060) and one biological monitoring station (14DM084) from 2014-2016 were analyzed for Inorganic Nitrogen (NO₂-NO₃). The average of all the values is 10.58 mg/L with a low of 0.84 mg/L and a high of 19.00 mg/L. The spring average (March-May) is 16.50 mg/L. The summer average (June-Aug) is 9.11 mg/L. Nitrate values exceeded 4 mg/L seven times. A quantile regression analysis for Class 5 stream stations showed that sites having a nitrate concentration in excess of 18.1 mg/L there was a 75% probability for impairment. The nitrate concentrations in this reach exceeded this level.

The HSPF model calculated daily nitrate concentrations for this subwatershed from 1994-2014. These values ranged from 1.24-7225.6 mg/L with an average value of 10.2 mg/L. Of these calculations, 279 (5.12%) were above 18.1 mg/L.

Table 484. Nitrate related macroinvertebrate metrics in Story Brook (-507). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100002-507 Macroinvertebrate Class 5 – General Use	TrichopteraChTx Pct	N Index Score	% N Tolerant	% N Intolerant
14DM084	9.29	3.34	57.05	0.00
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	13.16	3.00	48.68	0.96
Expected response to N stress	↓	↑	↑	↓

The macroinvertebrate assemblage in Story Brook (-507) at site 14DM084 scored below average in all four of the nitrate related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 484). This reach had lower amounts of trichoptera taxa and completely lacked nitrate intolerant species, while also having a below average nitrate index score and a higher amount of nitrate tolerant individuals. These results are characteristic of a community being negatively impacted by nitrates.

Based on the elevated nitrate concentrations in both the observed and calculated data, the quantile regression analysis, as well as the strong signals indicated by the macroinvertebrate community, nitrates are a stressor to aquatic life in Story Brook (-507).

Suspended Solids

Nine samples taken from one chemistry site (S009-060) and one biological monitoring station (14DM084) from 2014-2016 were analyzed for TSS. The average of all the values is 67.71 mg/L with a low of 4.4 mg/L and a high of 460 mg/L. The TSS concentrations exceeded the 65 mg/L standard twice.

Additionally, ten secchi tube measurements were taken from this reach. These values ranged from 4-100 cm, with one reading falling below the 10 cm minimum standard for secchi tube.

The HSPF model calculated daily TSS values for this subwatershed from 1994-2014. These concentrations ranged from 1.92-993.83 mg/L with an average TSS value of 24.81 mg/L. Of these calculations, 834 (15.31%) were above 65 mg/L. This is a high exceedance rate.

Table 485. TSS related fish metrics in Story Brook (-507). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100002-507 Fish Class 3 – General Use	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RifflePct	SensitivePct	SlithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14DM084	30.00	0.00	0.00	24.00	18.00	14.00	48.00	0.00	0.00	14.24
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	37.83	0.90	13.33	13.93	28.33	8.55	33.71	1.95	3.56	15.27
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

The fish community in Story Brook (-507) at site 14DM084 scored below average in six of the 10 TSS related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 485). This reach had above average numbers of perch-like, sensitive, and sensitive individuals, while also having a good TSS Index Score. These results are not common in streams with elevated TSS concentrations.

Table 486. TSS related macroinvertebrate metrics in Story Brook (-507). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100002-507 Macroinvertebrate Class 5 – General Use	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plectoptera Pct
14DM084	16.34	0.00	11.00	39.23	37.42	0.00
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)</i>	15.87	3.02	11.59	35.23	26.89	0.54
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

The macroinvertebrate assemblage in this reach scored below average in four of the six TSS related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 486). Site 14DM084 had a below average amount of TSS tolerant taxa and an above average amount of collector-filterer individuals, however, the remaining metrics scored poorly.

Both the observed and modeled data sets showed a moderately high exceedance rate, while the majority of the TSS related metrics in both the fish and macroinvertebrate assemblages score below average or poorly. Based on this information, TSS is a stressor to aquatic life in Story Brook (-507).

Habitat

Story Brook (-507) had a qualitative habitat assessment take place at its biological monitoring site, 14DM084, during the fish and macroinvertebrate sampling events in 2014. The average MSHA score from these visits was 65.58 (Fair). Limiting the habitat at this site was row crop agriculture as the dominant nearby land use, moderate bank erosion (Figure 213), light embeddedness, sand and silt substrates, and moderate channel stability. Further MSHA analysis can be seen in Figure 214.

Figure 213. Bank Erosion at site 14DM084.



Figure 214. Story Brook (-507) MSHA metric scores.

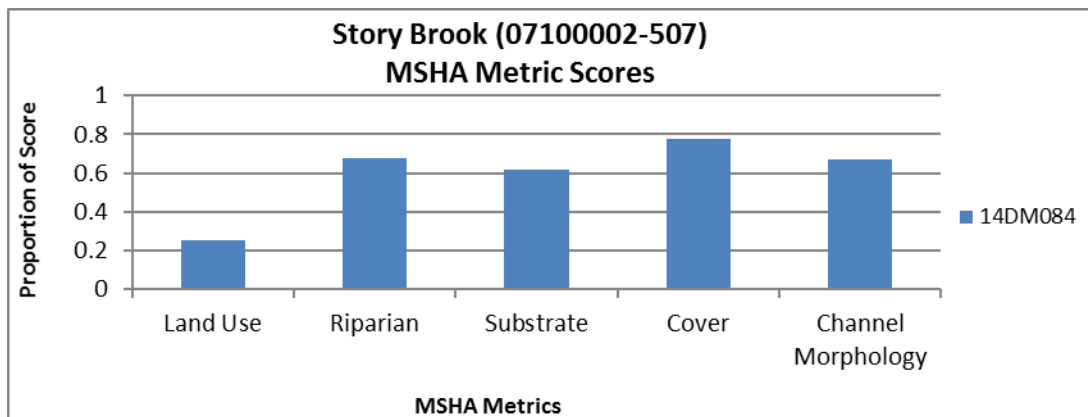


Table 487. Habitat related fish metrics in Story Brook (-507). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100002-507 Fish Class 3 – General Use	BenInsect-TolPct	SLithopPct	DarterSculpsucPct	RifflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14DM084	26.00	48.00	24.00	18.00	0.00	58.00	74.00	32.00
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FBI General Use Threshold (55.0)</i>	14.22	33.71	12.55	28.33	1.62	69.21	70.64	37.79
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

The fish community in Story Brook (-507) at site 14DM084 scored below average in four of the eight habitat related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FBI General Use Threshold (Table 487). This reach did have an increased number of tolerant individuals, while also having decreased amounts of riffle dwelling, piscivore, and lithophilic spawning individuals. These results are common in streams with degraded habitat. However, this reach also had good numbers of benthic insectivore, simple lithophils, and darter/sculpin/sucker individuals, while also having a below average amount of pioneer individuals. These results reflect a fish community not being negatively impacted by the habitat conditions.

Table 488. Habitat related macroinvertebrate metrics in Story Brook (-507). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100002-507 Macroinvertebrate Class 5 – General Use	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14DM084	5.07	14.16	54.46	37.03	43.43	15.27
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)</i>	5.66	12.52	49.77	42.46	34.53	13.99
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate assemblage in this reach scored below average in two of the six habitat related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 488). This reach had increased numbers of legless individuals, while also having lower numbers of EPT individuals. These results are common in streams stressed by habitat. However, this reach also had increased numbers of sprawler, clinger, and climber individuals, while also having decreased numbers of burrowers. These results reflect a community not being negatively impacted by the habitat.

The MSHA score in this reach scored just slightly below the “Good” rating, and the majority of the fish and macroinvertebrate metrics related to habitat score at or above average when compared to similar streams meeting the IBI thresholds, therefore, habitat is not a stressor to aquatic life in Story Brook (-507) at this time.

Altered Hydrology

Story Brook (-507) is a direct tributary of the Des Moines River. The reach itself is more than half altered and the majority of its upstream watershed is altered according to the MPCAs altered watercourse layer.

Extreme weather events affect high flow events as well as also low flows during drought. HSPF models show this stream section experiencing low flow at less than five cfs 42.1% of the time and less than one cfs 12.1% of the time.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The percentage for generalist fish within the reach was 68.0% compared to the average in class 3 waters meeting the standard of 59.1%.

The numbers of nest guarder species are also positively correlated with increased low flows. The percentage for nest guarder fish within the reach was 22.0% compared to the average in Class 3 waters meeting the standard of 19.2%.

Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The percentage for long-lived macroinvertebrates within the reach was 1.6% compared to the average in Class 5 waters meeting the standard of 9%.

Based on the partial channelization of this reach, the high frequency of low flow conditions, as well as the related biological metrics all scoring below average or poorly, Flow Alteration/Connectivity is a stressor to aquatic life in Story Brook (-507).

Summary

The impaired fish and macroinvertebrate communities in Story Brook (-507) are being stressed by DO, Nitrates, Suspended Sediment, and Flow Alteration/Connectivity (Table 489). Eutrophication was inconclusive as a stressor, while Habitat was ruled out as a stressor to aquatic life. For further information on the stressors and recommendations to fixing the stressors in the Brown Creek-Des Moines River HUC 10 Watershed, see pages 426-427.

Table 489. Stressor determinations for Story Brook (-507).

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Story Brook	07100002-507	●	o	●	●	---	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Unnamed Ditch (07100002-510)

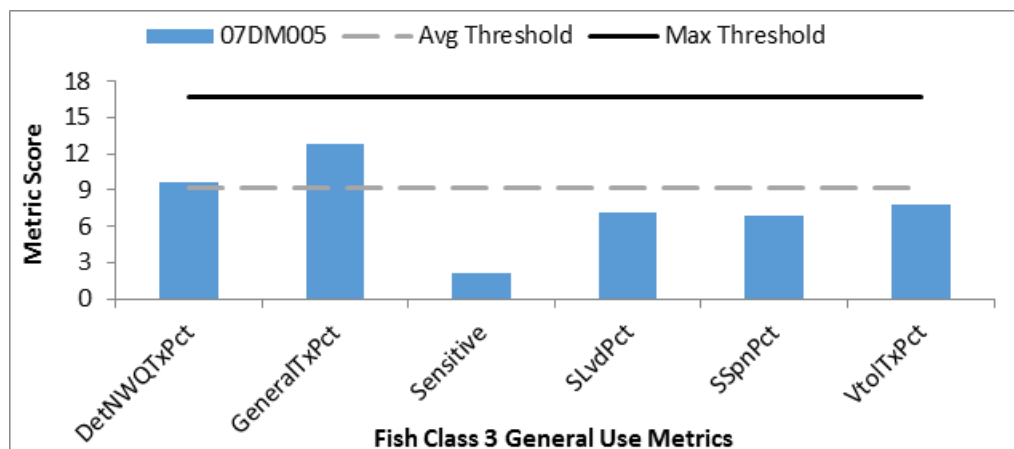
Located in southeastern Jackson County, Unnamed Ditch (-510) is a 0.86 mile long reach that is impaired for aquatic life due to the fish assemblage. This stream reach extends from 740th Street down to the confluence with an unnamed ditch. Along this stream section there are two biological monitoring stations, 07DM005 and 14DM086.

Biology

Fish

The fish community in Unnamed Ditch (-510) was sampled for fish in 2007 and 2015 at its biological monitoring station 07DM005. The average FIBI score at this site was 46.55, which is below the Fish Class 3 Southern Headwaters General Use Threshold of 55. This site did have two metrics (DetNWQTxPct, GeneralTxPct) reach the average metric score needed to meet the threshold (Figure 215), however, the remaining four metrics comprising this FIBI scored below average.

Figure 215. Unnamed Ditch (-510) fish IBI metric scores.



Dissolved Oxygen

A total of 11 dissolved oxygen (DO) measurements were taken from one chemistry site (S009-038) and one biological monitoring station (07DM005) from 2007-2016. The average of all the values is 8.43 mg/L with a low of 4.48 mg/L and a high of 13.08 mg/L. The summer average (June-Aug) is 7.84 mg/L. The DO values fell below 5 mg/L once.

The HSPF model calculated daily minimum DO values for this subwatershed from 1994-2014. Of these calculations, 2426 (31.63%) of the days had a daily minimum DO level below the daily minimum standard of 5 mg/L. This is a relatively high amount of exceedances.

Table 490. DO related fish metrics in Unnamed Ditch (-510). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100002-510 Fish Class 3 – General Use	MA>3 Avg	SspnPct Avg	Taxa Count Avg	DO TIV Avg
07DM005 (2007)	6.78	13.08	9.00	8.52
07DM005 (2015)	0.00	85.82	5.00	8.52
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	13.32	17.09	12.16	8.44
Expected response to DO stress	↓	↑	↓	↓

The fish community in Unnamed Ditch (-510) at site 07DM005 scored below average in two (2007) and three (2015) of the four DO related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 490). The 2015 visit to this site had much fewer taxa and mature individuals, while also having many serial spawning individuals. This visit was

dominated by a blacknose dace (82.09% of fish sampled). Blacknose dace are serial spawning taxa that can be found in large numbers in degraded stream systems.

Table 491. DO related macroinvertebrate metrics in Unnamed Ditch (-510). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100002-510 Macroinvertebrate Class 7 – General Use	HBI_MN Value	% DO Tolerant Taxa	# DO Tolerant Taxa	ChemTV_ DO
07DM005	8.21	10.73	6.00	6.68
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	7.55	12.98	5.74	6.91
Expected response to DO stress	↑	↑	↑	↓

The macroinvertebrate community at site 07DM005 scored below average in three of the four DO related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 491). This reach had a poor HBI_MN and DO TIV score, while also having a slightly above average amount of DO tolerant taxa.

Only one of the observed DO measurements fell below the 5 mg/L daily minimum standard. The model did show a high rate of exceedance, while the majority of the DO related metrics in both biological communities score below average. The fish community did have a good DO TIV score during both visits, which normally would not happen to a community stressed by DO. Right now, DO is inconclusive as a stressor. Continuous DO monitoring with a sonde is recommended to get a better understanding of the current conditions and their impacts on aquatic life in Unnamed Ditch (-510).

Eutrophication

A total of 11 phosphorus samples were taken from one chemistry site (S009-038) and one biological monitoring station (07DM005) from 2007-2016. The average of all the values is 0.066 mg/L with a low of 0.01 mg/L and a high of 0.21 mg/L. The summer average (June-Aug) is 0.065 mg/L. Phosphorus values exceeded the standard of 0.150 mg/L twice.

The HSPF model also calculated daily phosphorus concentrations for this subwatershed from 1994-2014. These values ranged from 0.20-23.24 mg/L with an average phosphorus concentration of 0.56 mg/L. All of these calculations were above the phosphorus standard.

Table 492. Eutrophication related fish metrics in Unnamed Ditch (-510). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100002-510 Fish Class 3 – General Use	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct
07DM005 (2007)	6.07	12.38	87.62	6.78
07DM005 (2015)	0.00	4.48	95.52	3.73
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	8.9	12.11	70.79	14.71
Expected response to Eutrophication stress	↓	↓	↑	↑

The fish assemblage in Unnamed Ditch (-510) at site 07DM005 scored below average in two (2007) and three (2015) of the four metrics at the two visits when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 492). Both visits had very high amounts of tolerant fish individuals, while also having low amounts of sensitive individuals. The 2015 visit to this site also had a decreased amount of darter individuals. These results can indicate potential stress from eutrophic conditions.

Table 493. Eutrophication related macroinvertebrate metrics in Unnamed Ditch (-510). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100001-563 Macroinvertebrate Class 7 – General Use	EPT Pct	Tanytarsini Pct	CrustMoll Pct	Scraper Pct	% Tolerant Taxa	% Intolerant Taxa
07DM005 (2007)	3.82	4.63	18.15	22.29	30.91	0.32
<i>Statewide average for Class 7 Prairie Streams Glide Pool stations that are meeting the MIBI General Use Threshold (41)</i>	38.45	18.46	11.78	16.11	26.84	4.03
Expected response to Eutrophication stress	↓	↓	↑	↑	↑	↓

The macroinvertebrate community scored below average in all six of the eutrophication related metrics when compared to all other Class 7 Prairie streams GP stations that meet the MIBI General Use Threshold (Table 493). This site had very low numbers of EPT, tanytarsini, and phosphorus intolerant taxa, while also having increased numbers of phosphorus tolerant taxa, as well as high numbers of crustacean/mollusca and scraper individuals. All of these results indicate a community likely stressed by eutrophic conditions.

The phosphorus concentrations can get elevated and exceed the standard according to the observed and modeled results. The majority of the fish and all of the macroinvertebrate metrics related to eutrophication score below average or poorly, therefore, eutrophication is a stressor to aquatic life in Unnamed Ditch (-510).

Nitrates

Eleven samples taken from one chemistry site (S009-038) and one biological monitoring station (07DM005) from 2007-2016 were analyzed for Inorganic Nitrogen (NO₂-NO₃). The average of all the values is 15.55 mg/L with a low of 11.00 mg/L and a high of 21.00 mg/L. The spring average (March-May) is 17.00 mg/L. The summer average (June-Aug) is 16.14 mg/L. Nitrate values exceeded 4 mg/L 11 times. A quantile regression analysis for Class 5 stream stations showed that sites having a nitrate concentration in excess of 18.1 mg/L there was a 75% probability for impairment. The nitrate concentrations in this reach exceeded this level.

The HSPF model calculated daily nitrate concentrations for this subwatershed from 1994-2014. These values ranged from 1.39-724.22 mg/L with an average value of 8.93 mg/L. Of these calculations, 336 (6.64%) were above 18.1 mg/L.

Table 494. Nitrate related macroinvertebrate metrics in Unnamed Ditch (-510). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100002-510 Macroinvertebrate Class 7 – General Use	TrichopteraChTx Pct	N Index Score	% N Tolerant	% N Intolerant
07DM005	5.98	3.90	73.50	0
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	10.00	3.30	57.57	0.91
Expected response to N stress	↓	↑	↑	↓

The macroinvertebrate community in Unnamed Ditch (-510) scored below average in all four of the nitrate related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 494). Site 07DM005 had a high amount of nitrate tolerant individuals, while also lacking nitrate intolerant taxa, lower amounts of trichoptera species, and a poor nitrate index score. These results are indicative of a macroinvertebrate community likely affected by nitrates.

Based on the very high observed and calculated nitrate concentrations, as well as all four of the nitrate related macroinvertebrate metrics scoring below average, nitrates are a stressor to aquatic life in Unnamed Ditch (-510).

Suspended Solids

Eleven samples taken from one chemistry site (S009-038) and one biological monitoring station (07DM005) in 2016 were analyzed for TSS. The average of all the values is 29.71 mg/L with a low of 2 mg/L and a high of 150 mg/L. The TSS concentrations exceeded the 65 mg/L standard twice.

Additionally, 11 secchi tube measurements were taken from this reach. These values ranged from 9.5-100 cm, with one value falling below the 10 cm minimum standard for secchi tube.

The HSPF model calculated daily TSS values for this subwatershed from 1994-2014. These concentrations ranged from 1.80-905.32 mg/L with an average TSS value of 10.91 mg/L. Of these calculations, 118 (2.33%) were above the TSS standard.

Table 495. TSS related fish metrics in Unnamed Ditch (-510). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100002-510 Fish Class 3 – General Use	BenFdFrimPct	Centr-TolPct	HerbivPct	Percfm-TolPct	RifflePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
07DM005 (2007)	39.49	0.00	20.33	12.38	33.18	6.07	15.19	0.00	0.00	15.43
07DM005 (2015)	4.48	0.00	0.00	4.48	0.00	0.00	0.75	0.00	0.00	17.47
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	37.83	0.90	13.33	13.93	28.33	8.55	33.71	1.95	3.56	15.27
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

The fish community in Unnamed Ditch (-510) at site 07DM005 scored below average in seven (2007) and ten (2015) of the TSS related metrics during the sampling visits when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 495). The 2015 visit fared much worse than the 2007 visit as the most recent visit had fewer and below average riffle dwelling, herbivorous, and benthic feeding individuals when compared to the 2007 visits. The remaining metrics scored poorly during both visits including TSS Index scores.

Table 496. TSS related macroinvertebrate metrics in Unnamed Ditch (-510). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100002-510 Macroinvertebrate Class 7 – General Use	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
07DM005	15.20	0.00	9.00	39.12	4.14	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (22.0)</i>	17.35	1.33	13.20	48.28	19.13	0.22
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

The macroinvertebrate assemblage in this reach scored below average in three of the six TSS related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 496). Site 07DM005 did have few collector filterer individuals, while also completely lacking TSS intolerant and plecoptera taxa. However, this reach did have a good TSS Index score, and had a lower amount and percentage of TSS tolerant taxa and individuals. These results are not common in streams with elevated TSS concentrations.

The observed data set had a couple standard exceedances, while the HSPF model calculated a very low exceedance rate. The macroinvertebrate community did not show a strong signal to TSS stress as the assemblage had a good TSS score, while also having a lower amount and percentage of TSS tolerant taxa and individuals. Based on this information, TSS is not a stressor in Unnamed Ditch (-510). It is likely other stressors are causing the lower metric scores in the fish community.

Habitat

Unnamed ditch (-510) had a qualitative habitat assessment take place at its biological monitoring site, 14DM032, during the fish and macroinvertebrate sampling events in 2007, 2014, and 2015. The average MSHA score from these visits was 46.98 (Fair). Limiting the habitat at this site was row crop agriculture as the dominant nearby land use, a narrow riparian buffer, light stream shading, light embeddedness, sand substrates, poor sinuosity, and fair channel development. Further MSHA analysis can be seen in Figure 216. This ditch was cleaned out late summer of 2014. The MSHA score prior to the clean out was 57.95 (Fair) and dropped to 30 (Poor) in 2015. After the ditch clean out, the embeddedness increased to severe, more silt substrates were present, and more bank erosion occurred.

Figure 216. Unnamed Ditch (-510) MSHA metric scores.

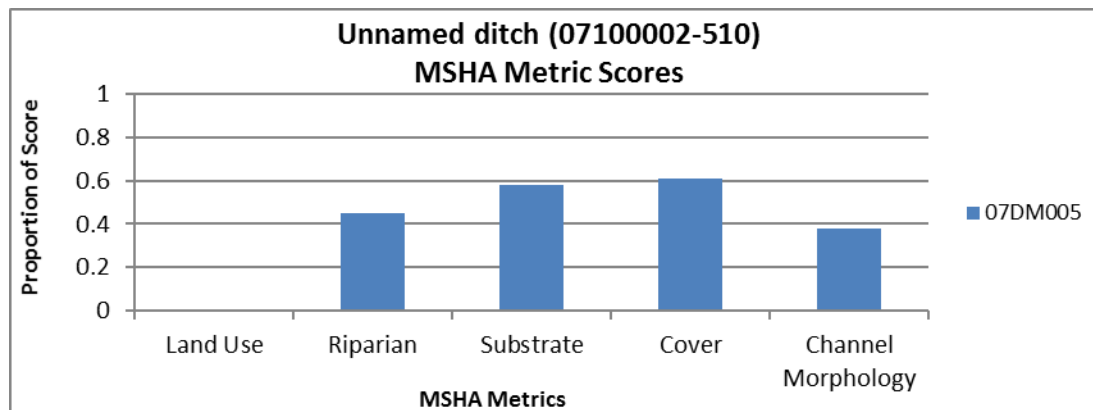


Table 497. Habitat related fish metrics in Unnamed Ditch (-510). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100002-510 Fish Class 3 – General Use	BenInsect- ToIPct	SlithopPct	DarterSculpSu cPct	RifflePct	PiscivorePct	LithFrimPct	ToIPct	PioneerPct
07DM005 (2007)	12.38	15.19	12.38	33.18	0.00	78.97	87.62	51.64
07DM005 (2015)	4.48	0.75	4.48	0.00	0.00	0.75	95.52	8.21
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	14.22	33.71	12.55	28.33	1.62	69.21	70.64	37.79
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

The fish community in Unnamed ditch (-510) at site 07DM005 scored below average in six (2007 visit) and seven (2015 visit) of the eight habitat related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 497). This site was dominated by tolerant species and following the ditch cleanout, the few species requiring specialized habitat conditions mostly left the stream system. This increased the number of tolerant individuals present.

Table 498. Habitat related macroinvertebrate metrics in Unnamed Ditch (-510). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100002-510 Macroinvertebrate Class 7 – General Use	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
07DM005	18.79	28.98	21.66	3.82	92.04	24.52
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)</i>	5.40	20.35	36.94	37.77	37.96	19.49
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate community in Unnamed ditch (-510) was only sampled in 2007. This visit scored below average in four of the six habitat related metrics when compared to all other Class 7 Prairie

Streams GP stations that meet the MIBI General Use Threshold (Table 498). This reach had a high amount of burrower and legless individuals, which corresponds to the fine sediments comprising the substrate in this reach. This site also showed decreased amounts of clinger and EPT individuals. These results are more than likely to be worse following the ditch clean out.

Overall, the habitat in this small ditched stream system was fair prior to the ditch clean out effort. Following the clean out, the MSHA and fish community showed declines in metric scores. The habitat related metrics in this reach were already scoring below average prior to this work and the dredging has appeared to make things worse. Therefore, habitat is a stressor to aquatic life in Unnamed ditch (-510).

Altered Hydrology

Unnamed ditch (-507) is entirely altered and the majority of its upstream watershed is altered according to the MPCAs altered watercourse layer.

Extreme weather events affect high flow events as well as also low flows during drought. HSPF models show this stream section experiencing low flow at less than five cfs 73.9% of the time and less than one cfs 33.0% of the time.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The average percentage for generalist fish within the reach was 32.5% compared to the average in Class 3 waters meeting the standard of 59.1%. Generalist fish species ranged from 4.5-60.5%.

The numbers of nest guarder species are also positively correlated with increased low flows. The average percentage for nest guarder fish within the reach was 13.5% compared to the average in Class 3 waters meeting the standard of 19.6%. Nest guarder species ranged from 9.8-17.2%.

Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The average percentage for long-lived macroinvertebrates within the reach was 1.3% compared to the average in class 7 waters meeting the standard of 8%. Long-lived macroinvertebrates ranged from 1.3-1.3%.

Unnamed ditch (-507) is an altered stream system that experiences low flow conditions a very frequently. While some of the related biological metrics do not indicate potential stress from Flow Alteration/Connectivity, there is a lack of long lived macroinvertebrates and the channelization of this stream may be also be leading to issues with habitat as well. Therefore, Flow Alteration/Connectivity is a stressor to aquatic life in this reach.

Summary

The impaired fish community in Unnamed Ditch (-510) is being stressed by Eutrophication, Nitrates, Habitat and Flow Alteration/Connectivity (Table 498). DO was inconclusive as a stressor, while Suspended Sediment was ruled out as a stressor to aquatic life. For further information on the stressors and recommendations to fixing the stressors in the Brown Creek-Des Moines River HUC 10 Watershed, see pages 426-427.

Table 499. Stressor determinations for Unnamed Ditch (-510).

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Unnamed Ditch	07100002-510	o	●	●	---	●	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Brown Creek-Des Moines River Watershed (0710000201) HUC 10 conclusion and recommendations

The Brown Creek-Des Moines River subwatershed has six biologically impaired streams that are being negatively impacted by a many of stressors throughout the watershed (Table 499). Stressors found in at least four of the six impaired reaches include DO, Eutrophication, Nitrates, and Flow Alteration/Connectivity. Suspended sediment (2) and Habitat (3) were also found to be problems in this watershed.

The predominant land use in this subwatershed is row crop agriculture. This is a significant contributor to the stressors found in these reaches. The land use combined with the channelization of these stream reaches and their tributaries are a major reason why these streams are impaired for aquatic life. These practices often lead to high nitrate and phosphorus levels through excessive use of fertilizers that can quickly reach the stream system by drain tiles and field runoff. These elevated phosphorus levels will also impact the DO conditions resulting in many more tolerant fish and macroinvertebrate communities.

Channelizing streams can also lead to very high flow rates resulting in bank erosion. Bank erosion leads to higher amounts of both bedded and suspended sediment in the stream resulting in poor habitat and visibility conditions impacting the breeding and feeding environments for more sensitive fish and macroinvertebrate species.

A large effort is needed in the Brown Creek-Des Moines River Watershed to improve biological conditions in the impaired streams found throughout this subwatershed. A high priority in this watershed should be to better manage the flow alteration and the effects of it. This can be achieved by increasing the storage and infiltration of water in locations with flow alteration stressors. This will also help reduce sediment inputs from stream banks, improve habitat by protecting streambanks, reduce erosion and overall stream sedimentation. Re-establishing a quality riparian corridor to increase stream stabilization, shading, and habitat features is also needed to improve conditions. Also, utilizing a variety of nutrient reducing BMPs) including: cover crops, nutrient management, saturated buffers, etc., will also help in the nitrate and phosphorus reduction. This could also help with the eutrophication and resulting DO issues as well.

Table 500. Stressor determinations for the Brown Creek-Des Moines River Watershed.

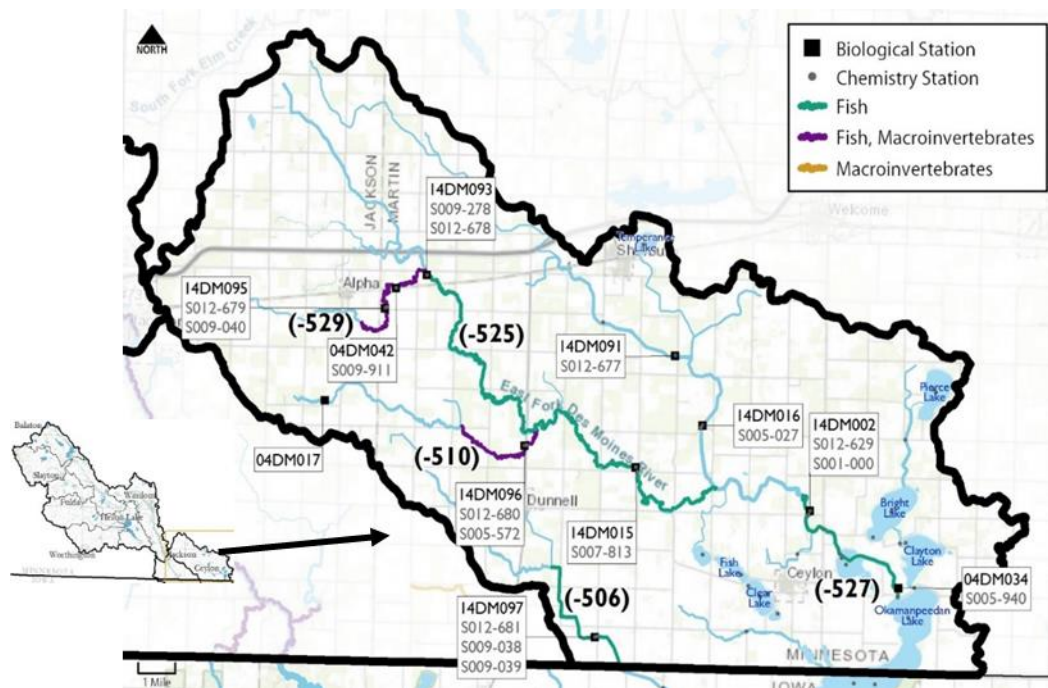
Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Des Moines River	07100002-501	---	●	---	●	o	---
Unnamed Creek	07100002-504	●	o	●	o	---	●
Brown Creek/Judicial Ditch 10	07100002-502	●	●	●	---	●	●
Judicial Ditch 56	07100002-505	●	●	---	o	●	o
Story Brook	07100002-507	●	o	●	●	---	●
Unnamed Ditch	07100002-510	o	●	●	---	●	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

5.10 Headwaters East Fork Des Moines River Watershed (0710000301)

The Headwaters East Fork Des Moines River HUC-10 Watershed (0710000301) is a 202 mi² watershed (Figure 217) located in the northern portion of the East Fork Des Moines River Watershed. This represents the area located within the state of Minnesota. This watershed contains five biologically impaired reaches. The primary land use within this watershed by far is row crop agriculture with small sections of open water and developed areas.

Figure 217. Headwaters East Fork Des Moines River Watershed with monitoring stations and biological impairments.



County Ditch 53 (07100003-506)

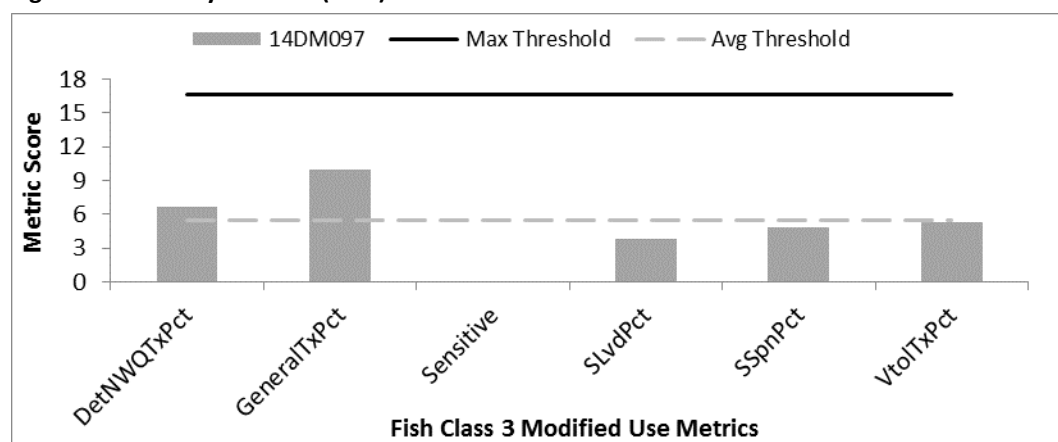
Located in southwestern Martin County, County Ditch 53 (-506) is a 4.00 mile long reach that is impaired for aquatic life due to the fish assemblage. This stream reach extends from an unnamed creek down to the Minnesota/Iowa border. Along this stream section there is one biological monitoring station, 14DM097.

Biology

Fish

The fish community in County Ditch (-506) was sampled for fish in June of 2015 at its biological monitoring station 14DM097. The FIBI score at this reach was 30.5, which is just below the Fish Class 3 Southern Headwaters Modified Use Threshold of 33. This site did have two metrics (DetNWQTxPct, GeneralTxPct) reach the average metric score needed to meet the threshold (Figure 218), however, the remaining four metrics comprising this FIBI scored below average with one metric (Sensitive) scoring zero. This site was also dominated by the presence of fathead minnows and creek chubs. These species are considered to be very tolerant and are often found in large numbers in degraded stream systems.

Figure 218. County Ditch 53 (-506) fish IBI metric scores.

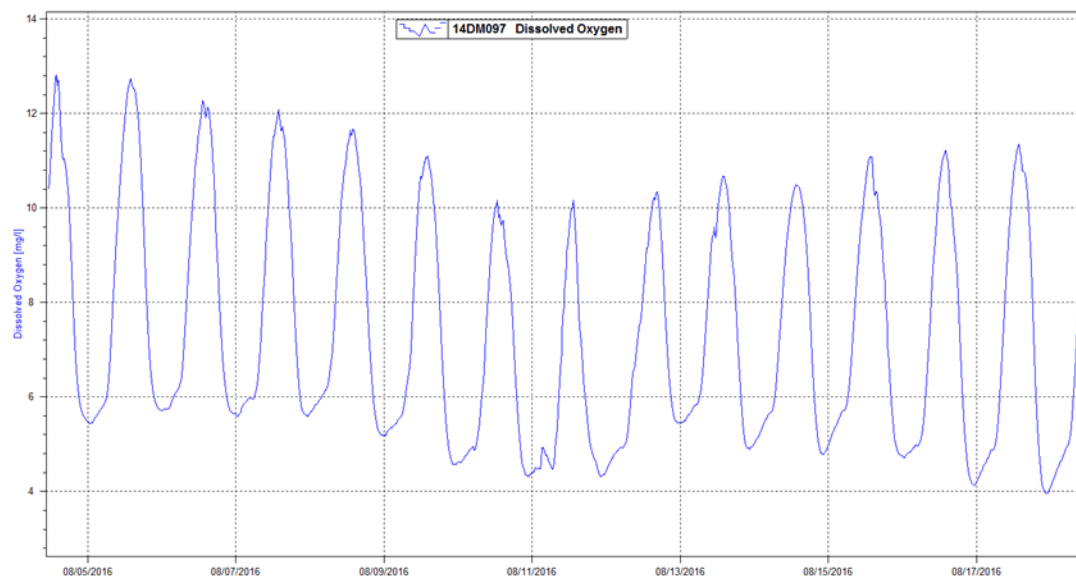


Dissolved Oxygen

A total of nine DO measurements were taken from one chemistry site (S009-039) in 2016. The average of all the values is 8.06 mg/L with a low of 5.21 mg/L and a high of 10.70 mg/L. The summer average (June-Aug) is 7.39 mg/L. The DO values never fell below 5 mg/L.

Continuous DO monitoring took place at site 14DM097 in 2016 (Figure 219). This monitoring showed that the DO levels frequently fell below the 5 mg/L daily minimum standard, while the daily flux also exceeded the 4.5 mg/L standard for the southern region of the state. These results indicate potential issues with DO as well as eutrophication.

Figure 219. Continuous DO monitoring at site 14DM097 in County Ditch 53 (-506).



The HSPF model calculated daily minimum DO values for this subwatershed from 1994-2014. Of these calculations, 1061 (13.83%) of the days had a daily minimum DO level below the 5 mg/L standard.

Table 501. DO related macroinvertebrate metrics in County Ditch 53 (-506). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100003-506 Macroinvertebrate Class 7 – Modified Use	HBI_MN Value	% DO Tolerant Taxa	# DO Tolerant Taxa	ChemTV_ DO
14DM097	8.05	45.78	11.00	6.07
<i>Statewide average for Class 7 Prairie Streams Glide Pool stations that are meeting the MIBI Modified Use Threshold (22)</i>	8	31.37	9.33	6.19
Expected response to DO stress	↑	↑	↑	↓

The macroinvertebrate community in this reach scored below average in all four of the DO related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 501). Dite 14DM097 had elevated amounts of DO tolerant species, while also having below average DO TIV and HBI_MN values.

The observed DO measurements did not fall below five mg/l, while the model calculated a slightly elevated exceedance rate. The continuous DO monitoring showed that the daily minimum standard fell below 5 mg/L often and the daily flux was in excess of the 4.5 mg/L standard. The majority of the DO related metrics in both the fish and macroinvertebrate communities scored below average. Based on these results, DO is a stressor to aquatic life in County Ditch 53 (-506).

Eutrophication

A total of 11 phosphorus samples were taken from one chemistry site (S009-039) and one biological monitoring station (14DM097) from 2014-2016. The average of all the values is 0.062 mg/L with a low of 0.02 mg/L and a high of 0.19 mg/L. The summer average (June-Aug) is 0.052 mg/L. Phosphorus values exceeded the standard of 0.150 mg/L once. Figure 220 shows algae present at site 14DM097.

Figure 220. Algae present at site 14DM097.



The HSPF model calculated daily phosphorus concentrations for this subwatershed from 1994-2014. These values ranged from 0.04-43.17 mg/L with an average phosphorus concentration of 0.43 mg/L. Of these calculations, 5612 (96.51%) were above the 0.15 mg/L.

Table 502. Eutrophication related fish metrics in County Ditch 53 (-506). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100003-506 Fish Class 3 – Modified Use	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct
14DM097	0.00	4.79	95.21	55.85
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)</i>	5.54	10.36	76.45	19.58
Expected response to Eutrophication stress	↓	↓	↑	↑

The fish community in County Ditch 53 (-506) at site 14DM097 scored below average in all four of the eutrophication related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI Modified Use Threshold (Table 502). This reach had a very high amount of tolerant and omnivorous individuals, while also having very few darter and sensitive individuals. These results are indicative of a community stressed by eutrophic conditions.

Table 503. Eutrophication related macroinvertebrate metrics in County Ditch 53 (-506). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100003-506 Macroinvertebrate Class 7 – Modified Use	EPT Pct	Tanytarsini Pct	CrustMoll Pct	Scraper Pct	% Tolerant Taxa	% Intolerant Taxa
14DM097	9.42	31.58	29.87	17.86	37.01	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22)</i>	20.58	22.11	23.21	17.73	45.87	1.43
Expected response to Eutrophication stress	↓	↓	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in four of the six eutrophication related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 503). This reach did have increased numbers of Tanytarsini individuals and a lower amount of phosphorus tolerant taxa, however, this reach also had decreased numbers of phosphorus tolerant taxa, EPT individuals, and had increased numbers of crustacean/mollusca and scraper individuals. These results are can be related to eutrophication stress.

The phosphorus concentrations in this reach do reach levels above the phosphorus standard according to the observed and modeled data sets, algae is present in this reach, the high daily flux of DO, and the majority of the fish and macroinvertebrate metrics related to eutrophication score below average or poorly, therefore, eutrophication is a stressor to aquatic life in County Ditch 53 (-506).

Nitrates

Eleven samples taken from one chemistry site (S009-039) and one biological monitoring station (14DM097) from 2014-2016 were analyzed for Inorganic Nitrogen (NO₂-NO₃). The average of all the values is 13.04 mg/L with a low of 3.60 mg/L and a high of 22.00 mg/L. The spring average (March-May) is 21.50 mg/L. The summer average (June-Aug) is 12.05 mg/L. Nitrate values exceeded 4 mg/L 10 times. A quantile regression analysis for Class 5 stream stations showed that sites having a nitrate concentration in excess of 11.5mg/L there was a 90% probability for impairment. The nitrate concentrations in this reach easily exceeded this level.

The HSPF model calculated daily nitrate concentrations for this subwatershed from 1994-2014. These values ranged from 0.35-541.64 mg/L with an average value of 8.68 mg/L. Of these calculations, 1577 (27.12%) were above 11.5 mg/L.

Table 504. Nitrate related macroinvertebrate metrics in County Ditch 53 (-506). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100003-506 Macroinvertebrate Class 7 – Modified Use	TrichopteraChTx Pct	N Index Score	% N Tolerant	% N Intolerant
14DM097	3.03	4.31	69.48	0.00
<i>Statewide average for Class 7 Prairie Streams GP that are meeting the MIBI Modified Use Threshold (22)</i>	5.71	3.30	62.54	0.00
Expected response to N stress	↓	↑	↑	↓

The macroinvertebrate assemblage at site 14DM097 in County Ditch 53 (-506) scored below average in all four of the nitrate related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 504). This reach had a low amount of both trichoptera and nitrate intolerant taxa, while also having a higher amount of nitrate tolerant individuals and a poor nitrate index score. These results indicate a community likely negatively impacted by nitrates.

Based on the high nitrate concentrations in both the observed and calculated data, the quantile regression analysis, as well as the nitrate related biological metrics, nitrates are a stressor to aquatic life in County Ditch 53 (-506).

Suspended Solids

Eleven samples taken from one chemistry site (S009-039) in 2016 were analyzed for TSS. The average of all the values is 14.78 mg/L with a low of 2 mg/L and a high of 21 mg/L. The TSS concentrations did not exceed the 65 mg/L standard.

Additionally, 11 secchi tube measurements were taken from this reach. These values ranged from 13-100 cm, with no values falling below the 10 cm minimum standard for secchi tube.

The HSPF model calculated daily TSS values for this subwatershed from 1994-2014. These concentrations ranged from 0.14-251.84 mg/L with an average TSS value of 12.80 mg/L. Of these calculations, 16 (0.28%) were above the TSS standard.

Table 505. TSS Nitrate related fish metrics in County Ditch 53 (-506). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100003-506 Fish Class 3 – Modified Use	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RifflePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14DM097	6.91	0.00	12.50	4.79	2.13	0.00	5.59	0.00	0.53	21.30
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)</i>	31.38	1.01	10.83	12.43	22.62	6.02	30.09	0.52	4.91	15.49
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

The fish community in County Ditch 53 (-506) at site 14DM097 scored below average in nine of the ten TSS related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI Modified Use Threshold (Table 505). This reach did have an above average amount of herbivorous individuals; however, the remaining metrics scored poorly including the TSS Index score.

Table 506. TSS Nitrate related macroinvertebrate metrics in County Ditch 53 (-506). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100003-506 Macroinvertebrate Class 7 – Modified Use	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
14DM097	16.58	0.00	11.00	34.09	2.27	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)</i>	16.02	0.60	10.98	35.60	9.91	0.02
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

The macroinvertebrate assemblage in this reach scored below average in five of the six TSS related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 506). Site 14DM097 did have a slightly below average amount of TSS tolerant individuals, however, the remaining metrics did score below average.

The observed and modeling data sets both indicate that the TSS concentrations in this reach are low and remain low. It is likely that other stressors are causing the fish and macroinvertebrate communities to score poorly as the chemical and model data give no indication of potential stress. Therefore, TSS is not a stressor to aquatic life in County Ditch 53 (-506) at this time.

Habitat

Unnamed Creek (-506) had a qualitative habitat assessment take place at its biological monitoring site, 14DM097, during the fish and macroinvertebrate sampling events in 2014 and 2015. The average MSHA score from these visits was 39.17 (Poor). Limiting the habitat at this site was row crop agriculture as the dominant nearby land use (Figure 221), narrow riparian area, light bank erosion, severe embeddedness, sand and silt

Figure 221. Row cropland use at site 14DM097.



substrates, heavy siltation, poor sinuosity, and fair channel development. Further MSHA analysis can be seen in Figure 222.

Figure 222. County Ditch 53 (-506) MSHA metric scores.

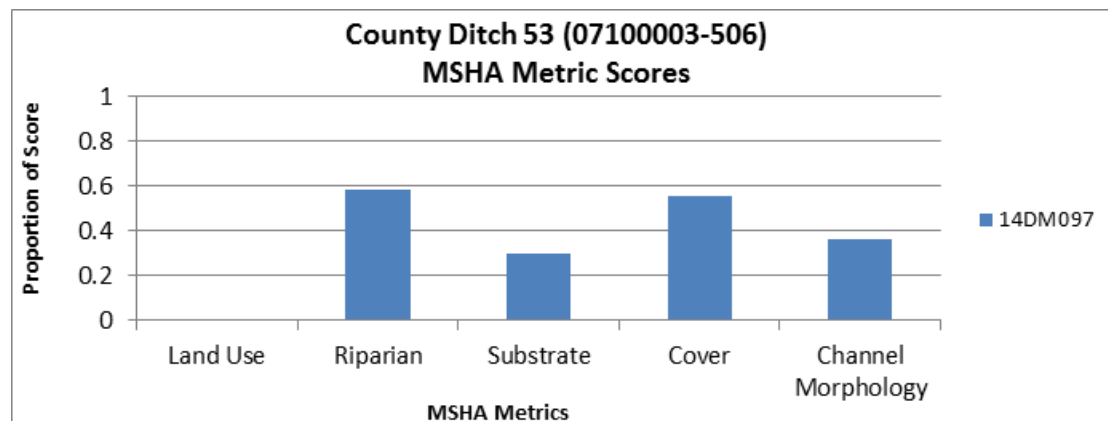


Table 507. Habitat Nitrate related fish metrics in County Ditch 53 (-506). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100003-506 Fish Class 3 – Modified Use	BenInsect- ToIPct	SLithopPct	DarterSculpSu cPct	RifflePct	PiscivorePct	LithFrimPct	ToIPct	PioneerPct
14DM097	2.39	2.79	2.39	1.06	0.00	10.77	97.61	80.17
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)</i>	10.91	30.09	10.59	22.62	1.97	57.98	46.70	32.54
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

The fish assemblage in County Ditch 53 at site 14DM097 scored below average in all eight of the habitat related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI Modified Use Threshold (Table 507). This reach had a very high amount of tolerant fish individuals at each of the two visits. This reach also lacked species requiring specialized habitat conditions to live and reproduce. These results reflect a fish community being stressed by the current habitat.

Table 508. Habitat Nitrate related macroinvertebrate metrics in County Ditch 53 (-506). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100003-506 Macroinvertebrate Class 7 – Modified Use	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14DM097	17.21	22.73	21.43	9.42	63.31	20.45
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)</i>	9.74	24.34	20.62	15.52	59.46	22.88
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate assemblage in this reach scored below average in five of the six habitat related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 508). This reach did have an increased amount of clinger individuals, which is a good sign, however, the reach scored poorly in the remaining metrics. The increased amounts of burrower and legless individuals reflects the heavy siltation and fine substrates found in this reach.

Based on the poor MSHA score, as well as the poor scoring fish and macroinvertebrate metrics related to habitat, habitat is a stressor to aquatic life in County Ditch 53.

Altered Hydrology

County Ditch 53 (-506) is entirely altered and the majority of its upstream watershed is altered according to the MPCAs altered watercourse layer. This reach ends at the border where it flows into Iowa.

“Analysis of the MPCA’s altered watercourse layer identified that 76% of stream miles within CD 53’s watershed have been channelized. The small sinuous channel that had developed in the bottom of CD 53 had features (i.e., glides, riffles, pools, and runs) of a natural river (Figures 55 and 56). These natural features can be seen in the longitudinal profile that was surveyed at the study location (Figure 56). After the initial survey of CD 53 in 2014, the channel was excavated to the originally designed trapezoidal shape. The reconfiguration and excavation back to the original engineer’s design removed the floodplain bench, substrate, and subsequently all of the natural stream features that had developed within the stream (Figures 56 and 57). Removal of these features removed all of the various habitat for aquatic and semi aquatic biota that had developed within and beside the small sinuous channel.” (MPCA 2016).

Extreme weather events affect high flow events as well as also low flows during drought. HSPF models show this stream section experiencing low flow at less than five cfs 64.3% of the time and less than one cfs 38.5% of the time.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The average percentage for generalist fish within the reach was 87.5% compared to the average in class 3 waters meeting the standard of 56.3%. Generalist fish species ranged from 75-100%.

The numbers of nest guarder species are also positively correlated with increased low flows. The average percentage for nest guarder fish within the reach was 75.4% compared to the average in class 3 waters meeting the standard of 24%. Nest guarder species ranged from 64.1-86.7%.

Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The average percentage for long-lived macroinvertebrates within the reach was 1.0% compared to the average in Class 7 waters meeting the standard of 5.6%. Long-lived macroinvertebrates ranged from 1.0-1.0%.

Based on the extensive channelization of this stream section and the headwaters of this reach, the high frequency of low flow conditions, as well as the related biological metrics scoring poorly, Flow Alteration/Connectivity is a stressor to aquatic life in County Ditch 53 (-506).

Summary

The impaired fish community in County Ditch 53 (-506) is being stressed by DO, Eutrophication, Nitrates, Habitat and Flow Alteration/Connectivity (Table 509). Suspended Sediment was ruled out as a stressor to aquatic life. For further information on the stressors and recommendations to fixing the stressors in the Headwaters East Fork Des Moines River HUC 10 Watershed, see page 465.

Table 509. Stressor determinations for County Ditch 53 (-506).

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
County Ditch 53	07100003-506	●	●	●	---	●	●

● = stressor; ○ = inconclusive stressor; --- = not an identified stressor

Fourmile Creek (07100003-510)

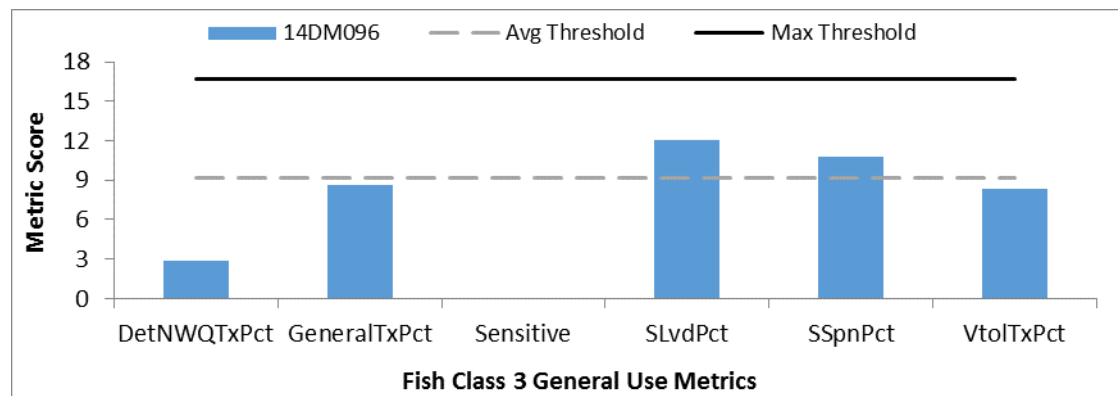
Located in southwestern Martin County, Fourmile Creek (-510) is a 4.14 mile long reach that is impaired for aquatic life due to the fish and macroinvertebrate assemblages. This stream reach extends from Judicial Ditch 105 down to the confluence with the Des Moines River. Along this stream section there is one biological monitoring station, 14DM096.

Biology

Fish

The fish community in Fourmile Creek (-510) was sampled for fish in July of 2014 and again in August of 2016 at its biological monitoring station 14DM096. The average FIBI score at this reach was 42.65, which is below the Fish Class 3 Southern Headwaters General Use Threshold of 55. This site did have one metric (SLvd, SSpnPct) reach the average metric score needed to meet the threshold (Figure 223), however, the remaining four metrics comprising this FIBI scored below average with one metric scoring zero (Sensitive).

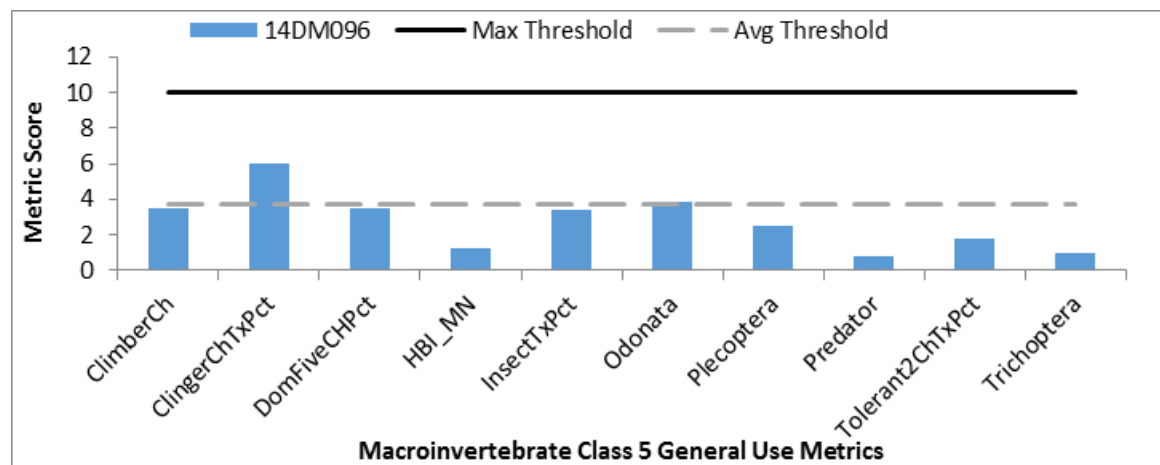
Figure 223. Fourmile Creek (-510) fish IBI metric scores.



Macroinvertebrates:

The macroinvertebrate assemblage at site 14DM096 was sampled in August of 2014 and 2016. This site had an average MIBI score of 27.6. This MIBI score is below the Macroinvertebrate Class 5 Southern Streams RR General Use Threshold of 37. Site 14DM089 had two (ClingerChTxPct, Odonata) metrics score above the average needed to reach the threshold. However, the remaining eight metrics scored below average resulting in the impairment designation. See Figure 224 for a complete breakdown of the metric scores at this site.

Figure 224. Fourmile Creek (-510) macroinvertebrate IBI metric scores.



Dissolved Oxygen

A total of 54 DO measurements were taken from one chemistry site (S005-572) in 2016. The average of all the values is 10.19 mg/L with a low of 5.93 mg/L and a high of 16.12 mg/L. The summer average (June-Aug) is 9.65 mg/L. The DO values never fell below 5 mg/L.

The HSPF model calculated daily minimum DO values for this subwatershed from 1994-2014. Of these calculations, 1286 (16.77%) of the days had a daily minimum DO level below the daily minimum standard of 5 mg/L.

Table 510. DO related fish metrics in Fourmile Creek (-510). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100003-510 Fish Class 3 – General Use	MA>3 Avg	SspnPct Avg	Taxa Count Avg	DO TIV Avg
14DM096 (2014)	83.14	4.21	7.00	8.49
14DM096 (2016)	2.82	50.26	10.00	8.49
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	13.32	17.09	12.16	8.44
Expected response to DO stress	↓	↑	↓	↓

The fish community in Fourmile Creek (-510) at site 14DM096 scored below average in one (2014 visit) and three (2016 visit) of the four DO related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIB had I General Use Threshold (Table 510). Both visits had a below average amount of taxa present, however, they both also had slightly above average DO TIV scores. The 2016 visit did have many more serial spawning individuals and few mature fish.

Table 511. DO related macroinvertebrate metrics in Fourmile Creek (-510). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100003-510 Macroinvertebrate Class 5 – General Use	HBI_MN Value	% DO Tolerant Taxa	# DO Tolerant Taxa	ChemTV DO
14DM096	7.94	3.86	3.5	7.01
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	7.04	8.62	4.33	7.10
Expected response to DO stress	↑	↑	↑	↓

The macroinvertebrate community in this reach scored below average in two of the four DO related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 511). Site 14DM096 had a poor HBI_MN and DO TIV score, but did have a lower percentage and number of DO tolerant taxa present. These lower amounts of DO tolerant taxa normally would not occur in a stream stressed by the DO conditions.

The observed DO data did not have an occurrence in which the DO levels fell below the 5 mg/L daily minimum standard. The model did predict an elevated exceedance rate however. The DO related metrics do not show convincing evidence of DO stress. The channel alteration that occurred in this stream after 2014 and before the 2016 sampling is a likely cause for the decrease in FIBI and metric scores at this site. Therefore, DO is not a stressor to aquatic life in Fourmile Creek (-510).

Eutrophication

A total of 59 phosphorus samples were taken from one chemistry site (S005-572) and one biological monitoring station (14DM096) from 2009-2016. The average of all the values is 0.204 mg/L with a low of 0.04 mg/L and a high of 0.89 mg/L. The summer average (June-Aug) is 0.179 mg/L. Phosphorus values exceeded the standard of 0.150 mg/L 29 times.

Table 512. Eutrophication related fish metrics in Fourmile Creek (-510). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100003-510 Fish Class 3 – General Use	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct
14DM096	0.00	6.23	87.37	57.08
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	8.9	12.11	70.79	14.71
Expected response to Eutrophication stress	↓	↓	↑	↑

The fish community in Fourmile Creek (-510) at site 14DM096 scored below average in all four of the eutrophication related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 512). This reach had a very high amount of tolerant and omnivorous individuals, while also having very few darter and sensitive individuals. These results are indicative of a community stressed by eutrophic conditions.

Table 513. Eutrophication related macroinvertebrate metrics in Fourmile Creek (-510). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100003-510 Macroinvertebrate Class 5 – General Use	EPT Pct	Tanytarsini Pct	CrustMoll Pct	Scraper Pct	% Tolerant Taxa	% Intolerant Taxa
14DM096	30.19	9.73	5.43	7.91	12.65	2.47
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	43.90	27.84	9.23	15.78	17.17	5.79
Expected response to Eutrophication stress	↓	↓	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in three of the six eutrophication related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 513). This reach had lower numbers of crustacean/mollusca individuals and phosphorus tolerant taxa, these results are not common in streams with eutrophication issues. However, this reach also had very few phosphorus intolerant species, while also having decreased amounts of EPT and tanytarsini individuals. These results are often found in eutrophic streams.

Based on the very high observed phosphorus concentrations and high rate of standard exceedances as well as the majority of the fish and macroinvertebrate metrics related to eutrophication scoring below average, eutrophication is a stressor to aquatic life in Fourmile Creek (-510).

Nitrates

A total of 59 samples taken from one chemistry site (S005-572) and one biological monitoring station (14DM096) from 2009-2016 were analyzed for Inorganic Nitrogen (NO₂-NO₃). The average of all the values is 12.27 mg/L with a low of 0.20 mg/L and a high of 18.00 mg/L. The spring average (March-May) is 13.20 mg/L. The summer average (June-Aug) is 12.50 mg/L. Nitrate values exceeded 4 mg/L 55 times.

The HSPF model calculated daily nitrate concentrations for this subwatershed from 1994-2014. These values ranged from 0.4-172.47 mg/L with an average value of 8.18 mg/L. Of these calculations, 147 (2.52%) were above 18.1 mg/L. A quantile regression analysis for Class 5 stream stations showed that sites having a nitrate concentration in excess of 18.1 mg/L there was a 75% probability for impairment. The nitrate concentrations in this reach exceeded this level.

Table 514. Nitrate related macroinvertebrate metrics in Fourmile Creek (-510). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100003-510 Macroinvertebrate Class 5 – General Use	TrichopteraChTx Pct	N Index Score	% N Tolerant	% N Intolerant
14DM096 (2014)	7.32	4.09	80.25	0.00
14DM096 (2016)	11.11	7.74	87.54	0.00
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37)</i>	13.16	3.00	48.68	0.96
Expected response to N stress	↓	↑	↑	↓

The macroinvertebrate community in Fourmile Creek (-510) at site 14DM096 scored below average in all four nitrate related metrics at both visits (2014, 2016) when compared to all other Class 5 Southern

Streams RR stations that meet the MIBI General Use Threshold (Table 514). This site had a lower amount of trichoptera taxa while also completely lacking nitrate intolerant species. This reach also had very high amounts of nitrate tolerant individuals and poor nitrate index scores. These results strongly suggest that nitrates are a stressor in this reach.

Based on the elevated nitrate concentrations observed in this stream with a large dataset, the calculated data, the quantile regression analysis, as well as the strong signal from the nitrate related biological metrics concludes that nitrates are a stressor to aquatic life in Fourmile Creek (-510).

Suspended Solids

A total of 57 samples taken from one chemistry site (S005-572) and one biological monitoring station (14DM096) from 2009-2014 were analyzed for TSS. The average of all the values is 19.17 mg/L with a low of 2 mg/L and a high of 149 mg/L. The TSS concentrations exceeded the 65 mg/L standard three times.

Additionally, 56 secchi tube measurements were taken from this reach. These values ranged from 7-60 cm, with three values falling below the 10 cm minimum standard for secchi tube.

The HSPF model calculated daily TSS values for this subwatershed from 1994-2014. These concentrations ranged from 0.21-208.60 mg/L with an average TSS value of 6.76 mg/L. Of these calculations, 5 (0.09%) were above the TSS standard.

Table 515. TSS related fish metrics in Fourmile Creek (-510). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100003-510 Fish Class 3 – General Use	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RifflePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14DM096	43.12	0.00	0.00	12.54	37.49	0.00	38.17	0.00	6.40	17.30
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	37.83	0.90	13.33	13.93	28.33	8.55	33.71	1.95	3.56	15.27
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

The fish community in Fourmile Creek (-510) at site 14DM096 scored below average in six of the ten TSS related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 515). This reach had above average numbers of benthic feeding, riffle dwelling, simple lithophilic, and long lived individuals, which does not normally occur in streams with elevated TSS concentrations. The remaining metrics, including TSS Index score, did score below average or poorly.

Table 516. TSS related macroinvertebrate metrics in Fourmile Creek (-510). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100003-510 Macroinvertebrate Class 5 – General Use	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
14DM096	17.08	0.00	8.00	34.86	22.44	0.15
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)</i>	15.87	3.02	11.59	35.23	26.89	0.54
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

The macroinvertebrate assemblage in this reach scored below average in four of the six TSS related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 516). Site 14DM096 did have a lower amount and percentage of TSS tolerant taxa and individuals. However, the remaining metrics, including TSS Index score, scored below average.

The observed data set did show a few instances in which the TSS concentration exceeded the standard, while the model calculated very few instances. While many of the TSS related biological metrics scored below average, it is likely due to other stressors as the chemical data showed very little indication of TSS issues. The presence of many fish species sensitive to elevated TSS conditions, while the lower amount of TSS tolerant macroinvertebrates also suggest that TSS is not negatively impacting the biota in this reach. Therefore, TSS is not a stressor in Fourmile Creek (-510) at this time.

Habitat

Fourmile Creek (-618) had a qualitative habitat assessment take place at its biological monitoring site, 14DM096, during the fish and macroinvertebrate sampling events in 2014 and 2016. The average MSHA score from these visits was 64.06 (Fair). Limiting the habitat at this site was row crop agriculture as the dominant nearby land use, moderate bank erosion, light embeddedness, sand substrates, and moderate channel stability. Further MSHA analysis can be seen in Figure 225.

Figure 225. Fourmile Creek (-510) MSHA metric scores.

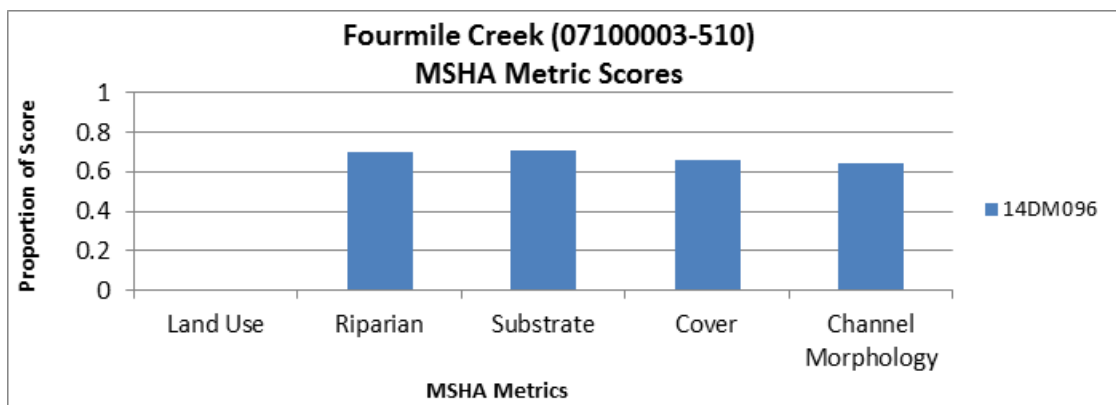


Table 517. Habitat related fish metrics in Fourmile Creek (-510). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100003-510 Fish Class 3 – General Use	BenInsect-TolPct	SLithopPct	DarterSculpSu cPct	RifflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14DM096	6.23	38.17	6.23	37.49	0.00	51.46	87.37	46.89
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	14.22	33.71	12.55	28.33	1.62	69.21	70.64	37.79
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

The fish community in Fourmile Creek (-510) at site 14DM096 scored below average in six of the eight habitat related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 517). Like many other reaches in the Des Moines River basin, this reach was dominated by tolerant and pioneer fish individuals signaling likely habitat stress. This reach also lacked many species needing specialized habitat conditions to live and reproduce.

Table 518. Habitat related macroinvertebrate metrics in Fourmile Creek (-510). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100003-510 Macroinvertebrate Class 5 – General Use	BurrowerPc	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14DM096	4.04	20.15	59.84	30.19	61.10	3.73
<i>Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)</i>	5.66	12.52	49.77	42.46	34.53	13.99
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate community in this reach scored below average in three of the six habitat related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 518). Site 14DM096 did have increased numbers of both climber and clinger individuals and had decreased amounts of burrower individuals. However, this reach did have below average numbers of both EPT and sprawler individuals, while also having an increased amount of legless individuals.

The habitat in this reach is considered to be fair, while the majority of the fish metrics related to habitat scored below average and half of the macroinvertebrate metrics related to habitat scored below average. Habitat is a secondary stressor to aquatic life in Fourmile Creek (-510).

Altered Hydrology

Fourmile Creek (-510) is a direct tributary of the East Branch Des Moines River. The reach itself is mostly natural though the majority of its upstream watershed is altered according to the MPCAs altered watercourse layer.

Extreme weather events affect high flow events as well as also low flows during drought. HSPF models show this stream section experiencing low flow at less than five cfs 64.6% of the time and less than one cfs 39.0% of the time.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The average percentage for generalist fish within the reach was 78.9% compared to the average in class 3 waters meeting the standard of 59.1%. Generalist fish species ranged from 63.6-89.3%.

The numbers of nest guarder species are also positively correlated with increased low flows. The average percentage for nest guarder fish within the reach was 37.1% compared to the average in class 3 waters meeting the standard of 19.2%.

Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The average percentage for long-lived macroinvertebrates within the reach was 1.9% compared to the average in class 5 waters meeting the standard of 9%. Long-lived macroinvertebrates ranged from 1.9-1.9%.

This reach experiences frequent low flow conditions and the related biological metrics score poorly, however, the reach itself is mostly natural. The upstream channelization in the watershed may be leading to issues in this reach, but at this time Flow Alteration/Connectivity is inconclusive as a stressor to aquatic life.

Summary

The impaired fish and macroinvertebrate communities in Fourmile Creek (-510) are being stressed by Eutrophication, Nitrates, and Habitat (Table 519). Flow Alteration/Connectivity is inconclusive as a stressor, while DO and Suspended Sediment were ruled out as stressors to aquatic life. For further information on the stressors and recommendations to fixing the stressors in the Headwaters East Fork Des Moines River HUC 10 Watershed, see page 465.

Table 519. Stressor determinations for Fourmile Creek (-510).

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Fourmile Creek	07100003-510	---	●	●	---	●	o

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Des Moines River, East Branch (07100003-525)

Located in southwestern Martin County, the East Branch Des Moines River (-525) is a 19.50 mile long reach that is impaired for aquatic life due to the fish assemblage. This stream reach extends from an unnamed creek down to the confluence with County Ditch 11. Along this stream section there two biological monitoring stations, 14DM015 and 14DM093.

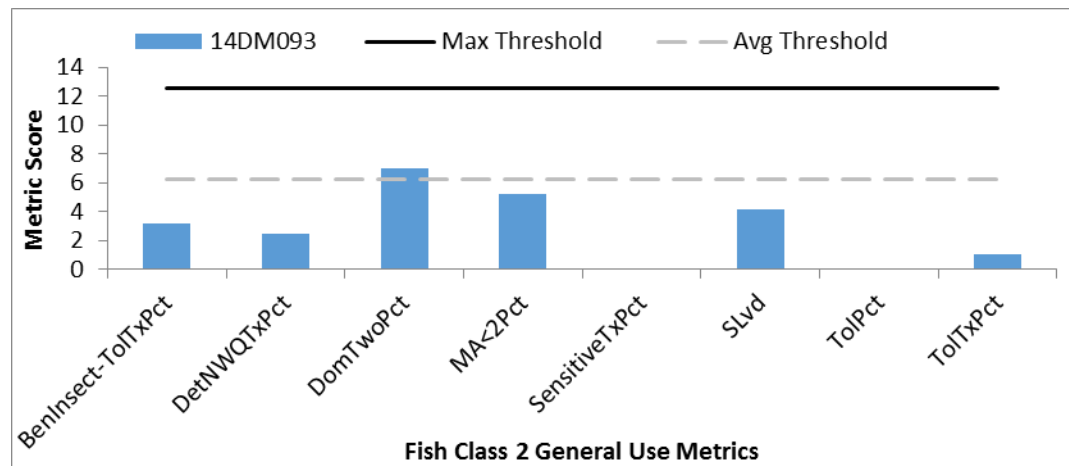
Biology

Fish

The fish community in East Branch Des Moines River (-525) was sampled for fish in July of 2014 at its biological monitoring station 14DM093. The FIBI score at this reach was 23.0, which is far below the Fish Class 2 Southern Streams General Use Threshold of 50. This site did have one metric (DomTwoPct) reach

the average metric score needed to meet the threshold (Figure 226), however, the remaining seven metrics comprising this FIBI scored well below average with two metrics scoring zero.

Figure 226. East Branch Des Moines River (-525) fish IBI metric scores.



Dissolved Oxygen

A total of 21 DO measurements were taken from one chemistry site (S007-813) and two biological monitoring stations (14DM015, 14DM093) from 2014-2016. The average of all the values is 6.10 mg/L with a low of 3.80 mg/L and a high of 10.25 mg/L. The DO values fell below 5 mg/L five times.

The HSPF model calculated daily minimum DO values for this subwatershed from 1994-2014. Of these calculations, 593 (7.73%) of the days had a daily minimum DO level below the daily minimum standard of 5 mg/L.

Table 520. DO related fish metrics in East Branch Des Moines River (-525). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100003-525 Fish Class 2 – General Use	MA>3 Avg	SspnPct Avg	Taxa Count Avg	DO TIV Avg
14DM093	30	52.86	10.00	8.69
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)</i>	23.89	28.72	20.38	8.56
Expected response to DO stress	↓	↑	↓	↓

The fish community in East Branch Des Moines River (-525) at site 14DM093 scored below average in two of the four DO related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 520). This site had a below average amount of total taxa, while also having an increased amount of serial spawning individuals. This reach did however have an increased amount of mature fish, while also having an above average DO TIV score.

Table 521. DO related macroinvertebrate metrics in East Branch Des Moines River (-525). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100003-525 Macroinvertebrate Class 7 – General Use	HBI_MN Value	% DO Tolerant Taxa	# DO Tolerant Taxa	ChemTV DO
14DM015	8.33	30.74	13.00	6.82
14DM093	8.38	23.75	8	6.37
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	7.55	12.98	5.74	6.91
Expected response to DO stress	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in all four of the DO related metrics at both sites when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 521). Both sites had a high amount and percentage of DO tolerant taxa present while also having a poor HBI_MN and DO TIV scores. These results are indicative of a community stressed by the DO conditions.

Based on the high exceedance rate in the observed data set, the very poor scoring DO related metrics in the macroinvertebrate community, as well as the increased amounts of serial spawning fish and decreased fish taxa present, which are often correlated to poor DO conditions, DO is a stressor to aquatic life in East Branch Des Moines River (-525) at this time.

Eutrophication

A total of 12 phosphorus samples were taken from two chemistry sites (S007-813, S009-278) from 2014-2016. The average of all the values is 0.14 mg/L with a low of 0.04 mg/L and a high of 0.31 mg/L. Phosphorus values exceeded the standard of 0.150 mg/L four times.

The HSPF model also calculated daily phosphorus concentrations from 1994-2014 for this subwatershed. These values ranged from 0.04-16.67 mg/L with an average concentration of 0.30 mg/L. Of these calculations, 5,084 (82.51%) were above the phosphorus standard.

Table 522. Eutrophication related fish metrics in East Branch Des Moines River (-525). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100003-525 Fish Class 2 – General Use	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct
14DM093	0.00	4.29	93.57	32.14
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)</i>	19	11.47	45.1	17
Expected response to Eutrophication stress	↓	↓	↑	↑

The fish community in East Branch Des Moines River (-525) at site 14DM093 scored below average in all four of the eutrophication related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 522). This reach had an increased amount of tolerant and omnivorous individuals, while also having very few darter and sensitive species. These results are common in streams with eutrophic conditions.

Table 523. Eutrophication related macroinvertebrate metrics in East Branch Des Moines River (-525). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100003-525 Macroinvertebrate Class 7 – General Use	EPT Pct	Tanytarsini Pct	CrustMoll Pct	Scraper Pct	% Tolerant Taxa	% Intolerant Taxa
14DM015	38.64	10.45	31.17	23.38	66.67	0.00
14DM093	40	27.54	26.25	36.25	55.31	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	38.45	18.46	11.78	16.11	26.84	4.03
Expected response to Eutrophication stress	↓	↓	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in four (14DM093) and five (14DM015) of the six eutrophication related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 523). Both of these sites had increased amounts of crustacea/mollusca and scraper individuals, high amounts of phosphorus tolerant taxa, and decreased amounts of phosphorus intolerant taxa. These results are common in streams with eutrophic conditions.

Based on the high observed and modeled values, in addition to the majority of the fish and macroinvertebrate metrics related to eutrophication scoring below average or poorly, eutrophication is a stressor to aquatic life in East Branch Des Moines River (-525).

Nitrates

Twelve samples taken from two chemistry sites (S007-813, S009-278) from 2014-2016 were analyzed for Inorganic Nitrogen (NO₂-NO₃). The average of all the values is 8.70 mg/L with a low of 0.63 mg/L and a high of 16.40 mg/L. The spring average (March-May) is 10.73 mg/L. The summer average (June-Aug) is 7.63 mg/L. Nitrate values exceeded 4 mg/L 14 times. A quantile regression analysis for Class 7 stream stations showed that sites having a nitrate concentration in excess of 11.5 mg/L there was a 90% probability for impairment. The nitrate concentrations in this reach easily exceeded this level.

The HSPF model calculated daily nitrate concentrations for this subwatershed from 1994-2014. These values ranged from 0.39-265.166 mg/L with an average value of 7.92 mg/L. Of these calculations, 1,551 (24.33%) were above 11.5 mg/L.

Table 524. Nitrate related macroinvertebrate metrics in East Branch Des Moines River (-525). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100003-525 Macroinvertebrate Class 7 – General Use	TrichopteraChTx Pct	N Index Score	% N Tolerant	% N Intolerant
14DM093	5.56	4.21	67.96	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	10.00	3.30	57.57	0.91
Expected response to N stress	↓	↑	↑	↓

The macroinvertebrate assemblage in East Branch Des Moines River (-525) scored below average in all four of the nitrate related metrics at site 14DM093 when compared to all other Class 7 Prairie Streams

GP stations that meet the MIBI General Use Threshold (Table 524). This reach had a lower amount of trichoptera and nitrate intolerant taxa, while also having an elevated number of nitrate tolerant individuals and a poor nitrate index score. These results are indicative of a stream likely impacted by elevated nitrate levels.

Based on the elevated nitrate concentrations in the observed and calculated data, the quantile regression analysis, as well as the poor scoring nitrate related metrics in the macroinvertebrate community, nitrates are a stressor to aquatic life in East Branch Des Moines River (-525).

Suspended Solids

Eleven samples taken from two chemistry sites (S007-813, S009-278) from 2014-2016 were analyzed for TSS. The average of all the values is 21.27 mg/L with a low of 8 mg/L and a high of 72 mg/L. The TSS concentrations exceeded the 65 mg/L standard once.

Additionally, 20 secchi tube measurements were taken from this reach. These values ranged from 15-100 cm, with no values falling below the 10 cm minimum standard for secchi tube.

The HSPF model calculated daily TSS values for this subwatershed from 1994-2014. These concentrations ranged from 0.41-390.85 mg/L with an average TSS value of 15.07 mg/L. Of these calculations, 26 (0.41%) were above the TSS standard.

Table 525. TSS related fish metrics in East Branch Des Moines River (-525). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

	BenFdFrimPct	Centr-TolPct	HerbvPct	Perfrm-TolPct	RifflePct	SensitivePct	SlithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
07100003-525										
Fish Class 2 – General Use										
14DM093	32.14	0.00	0.00	6.43	27.86	0.00	27.86	0.00	2.14	20.63
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)</i>	37.38	4.89	9.61	18.66	32.49	18.65	39.38	4.97	11.68	17.59
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

The fish community in East Branch Des Moines River (-525) at site 14DM093 scored below average in all ten of the TSS related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 525). This site lacked many species that are sensitive to TSS, while also having a below average TSS Index score. These results are common in streams with elevated TSS concentrations.

Table 526. TSS related macroinvertebrate metrics in East Branch Des Moines River (-525). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100003-525 Macroinvertebrate Class 7 – General Use	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
14DM015	23.67	0.00	17.00	63.75	0.97	0.00
14DM093	22.75	0.00	12.00	60.00	0.63	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (22.0)</i>	17.35	1.33	13.20	48.28	19.13	0.22
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

The macroinvertebrate assemblage in this reach scored below average in five (14DM015) and six (14DM093) of the six TSS related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 526). Site 14DM093 did have a lower amount of TSS tolerant taxa; however this site scored below average or poorly in the remaining metrics similarly to site 14DM015. These results suggest a streams reach with elevated TSS concentrations.

The observed data set did show an instance in which the TSS concentration exceeded the standard, while the model calculated very few instances. While many of the TSS related biological metrics scored below average, it is likely due to other stressors as the chemical data showed very little indication of TSS issues. Therefore, TSS is not a stressor in East Branch Des Moines River (-525) at this time.

Habitat

East Branch Des Moines River (-525) had a qualitative habitat assessment take place at its biological monitoring sites, 14DM015 and 14DM093, during the fish and macroinvertebrate sampling events in 2014 and 2016. The average MSHA score from these visits was 42.5 (Poor) at 14DM015 and 45.1 (Fair) at 14DM093. Limiting the habitat at this site was row crop agriculture as the dominant nearby land use, little to moderate bank erosion, moderate to severe embeddedness, sand and silt substrates, fair sinuosity, moderate channel stability, and fair channel development (14DM015). Further MSHA analysis can be seen in Figure 227.

Figure 227. East Branch Des Moines River (-525) MSHA metric scores.

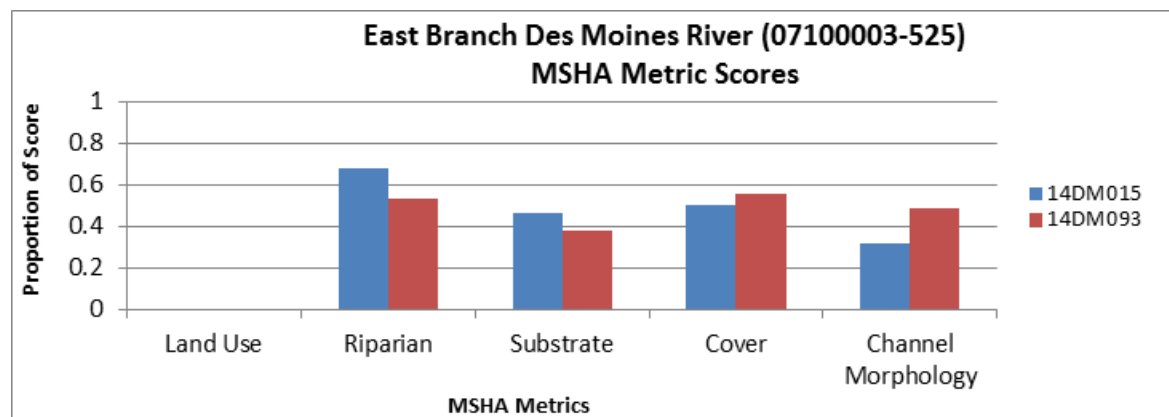


Table 527. Habitat related fish metrics in East Branch Des Moines River (-525). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100003-525 Fish Class 2 – General Use	BenInsect- ToIPct	SlithopPct	DarterSculps ucPct	RifflePct	PiscivorePct	LithFrimPct	ToIPct	PioneerPct
14DM093	4.29	27.86	4.29	27.86	0.00	39.29	93.57	43.57
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)</i>	20.4	39.38	18.18	32.49	5.24	58.26	44.85	19.02
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

The fish community in East Branch Des Moines River (-525) at site 14DM093 scored below average in all eight of the habitat related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 527). This reach had a very high amount of tolerant fish individuals and also lacked species requiring specialized habitat conditions to live and reproduce. These results reflect a fish community being stressed by the current habitat.

Table 528. Habitat related macroinvertebrate metrics in East Branch Des Moines River (-525). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100003-525 Macroinvertebrate Class 7 – General Use	BurrowerPc t	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14DM015	9.09	22.08	19.16	38.64	35.39	39.29
14DM093	20.00	28.44	25.63	40.00	46.56	13.44
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)</i>	5.40	20.35	36.94	37.77	37.96	19.49
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate assemblage in this reach at sites 14DM015 and 14DM093 scored below average in two (14DM015) and four (14DM093) of the six habitat related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 528). Both sites had increased amounts of both EPT and climber individuals, which can signal a community not affected by poor habitat. This reach did however have lower numbers of clinger individuals, and increased amounts of burrowers. These results in addition to the high amount of legless and decreased amount of sprawler individuals at site 14DM093 signal likely habitat stress.

Based on the poor to fair MSHA scores, as well as the majority of the fish and macroinvertebrate metrics related to habitat (except 14DM015 macroinvertebrates) scoring below average or poorly, habitat is a stressor to aquatic life in this reach.

Altered Hydrology

The East Branch Des Moines River (-525) itself is mostly natural though the majority of the upstream watershed is altered according to the MPCAs altered watercourse layer.

Adjacent to the East Fork Des Moines River channel, a ditch was dug in what appears to be an effort to straighten this portion of river. Beside the ditch is the ditch spoil that in turn creates a berm that crests at an elevation above the flood-prone elevation of the river. This berm, and the valley on the west side of the channel, constricts floodplain width through this portion of the East Fork Des Moines River. Longitudinal disruption of the floodplain also exists both upstream and downstream of the survey location. Upstream, an abandoned township bridge and road grade constricts floodplain flow.

Extreme weather events affect high flow events as well as also low flows during drought. HSPF models show this stream section experiencing low flow at less than five cfs 38.4% of the time and less than one cfs 17.1% of the time.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The percentage for generalist fish within the reach was 67.9% compared to the average in class 2 waters meeting the standard of 42.4%.

The numbers of nest guarder species are also positively correlated with increased low flows. The percentage for nest guarder fish within the reach was 37.1% compared to the average in class 2 waters meeting the standard of 19%.

Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The percentage for long-lived macroinvertebrates within the reach was 1.9% compared to the average in class 7 waters meeting the standard of 8%.

Based on the higher frequency of low flow conditions in this reach, the extensive channelization in the upstream tributaries, the poor scoring biological metrics as well as the lack of floodplain access for this reach, Flow Alteration/Connectivity is a stressor to aquatic life in East Branch Des Moines River (-525).

Summary

The impaired fish community in East Branch Des Moines River (-525) is being stressed by DO, Eutrophication, Nitrates, Habitat and Flow Alteration/Connectivity (Table 529). Suspended Sediment was ruled out as a stressor to aquatic life. For further information on the stressors and recommendations to fixing the stressors in the Headwaters East Fork Des Moines River HUC 10 Watershed, see page 465.

Table 529. Stressor determinations for East Branch Des Moines River (-525).

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
East Branch Des Moines River	07100003-525	●	●	●	---	●	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Des Moines River, East Branch (07100003-527)

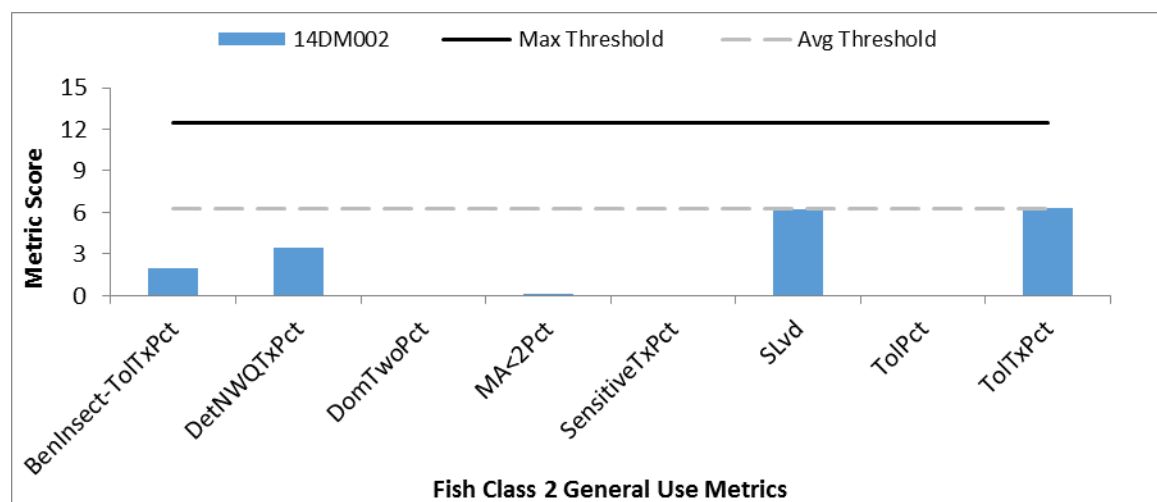
Located in southcentral Martin County, the East Branch Des Moines River (-527) is a 5.07 mile long reach that is impaired for aquatic life due to the fish assemblage. This stream reach extends approximately 1.8 miles upstream from Highway 263 downstream to the confluence with Okamanpeedan Lake. Along this stream section there are two biological monitoring stations, 04DM034 and 14DM002.

Biology

Fish

The fish community in Des Moines River (-527) was sampled for fish in August of 2014 at its biological monitoring station 14DM002. The FBI score at this reach was 18.0, which is far below the Fish Class 2 Southern Streams General Use Threshold of 50. This site did have two metrics (SLvd, TolTxPct) reach the average metric score needed to meet the threshold (Figure 228), however, the remaining six metrics comprising this FBI scored well below average with three metrics scoring zero (DomTwoPct, SensitiveTxPct, TolPct). This site was also dominated by the presence of fathead minnows (95.63% of sampled individuals).

Figure 228. East Branch Des Moines River (-527) fish IBI metric scores.



Dissolved Oxygen

A total of 47 DO measurements were taken from two chemistry sites (S001-000) and one biological monitoring station (14DM002) from 2005-2015. The average of all the values is 8.08 mg/L with a low of 3.77 mg/L and a high of 18.12 mg/L. The DO values fell below 5 mg/L five times. This is a very wide range of DO values which possibly suggest issues related to daily flux. This reach was also listed as impaired for DO in 2016.

The HSPF model calculated daily minimum DO values for this subwatershed from 1994-2014. Of these calculations, 349 (4.55%) of the days had a daily minimum DO level below the daily minimum standard of 5 mg/L.

Table 530. DO related fish metrics in East Branch Des Moines River (-527). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100003-527 Fish Class 2 – General Use	MA>3 Avg	SspnPct Avg	Taxa Count Avg	DO TIV Avg
14DM002	2.38	97.23	16.00	8.36
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)</i>	23.89	28.72	20.38	8.56
Expected response to DO stress	↓	↑	↓	↓

The fish community in East Branch Des Moines River (-527) at site 14DM002 scored below average in all four of the DO related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 530). This reach had very few mature fish, while also having a lower taxa count and DO TIV score. There was also a very high amount of serial spawning individuals present. These results are indicative of a community stressed by the DO conditions.

Table 531. DO related macroinvertebrate metrics in East Branch Des Moines River (-527). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100003-525 Macroinvertebrate Class 7 – General Use	HBI_MN Value	% DO Tolerant Taxa	# DO Tolerant Taxa	ChemTV_ DO
14DM002	8.16	33.86	8.00	6.84
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	7.55	12.98	5.74	6.91
Expected response to DO stress	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach also scored below average in all four of the DO related metrics when compared to all other Class 7 Prairie Stream GP stations that meet the MIBI General Use Threshold (Table 531). Site 14DM002 had a poor HBI_MN and DO TIV score, while also having increased amounts and percentage of DO tolerant species. These results reflect a community negatively impacted by the DO conditions.

Based on the current DO impairment, the observed data, as well as all of the DO related metrics in both biological communities scoring poorly, DO is a stressor to aquatic life in East Branch Des Moines River (-527).

Eutrophication

A total of two phosphorus samples were taken from two chemistry sites (S000-141 and S001-000) from 2009-2015. The average of all the values is 0.62 mg/L with a low of 0.17 mg/L and a high of 1.07 mg/L. Phosphorus values exceeded the standard of 0.150 mg/L both times.

The HSPF model also calculated daily phosphorus concentrations from 1994-2014 for this subwatershed. These values ranged from 0.11-12.19 mg/L with an average concentration of 0.39 mg/L. Of these calculations, 6,817 (98.94%) were above the 0.15 mg/L phosphorus standard.

Furthermore, Lake Okamanpeedan is located upstream of this reach and is also impaired for nutrients.

Table 532. Eutrophication related fish metrics in East Branch Des Moines River (-527). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100003-527 Fish Class 2 – General Use	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct
14DM002	0.00	0.09	98.95	97.55
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)</i>	19	11.47	45.1	17
Expected response to Eutrophication stress	↓	↓	↑	↑

The fish community in East Branch Des Moines River (-527) at site 14DM002 scored below average in all four of the eutrophication related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 532). This reach had a very high amount of tolerant and omnivorous individuals, while also lacking darter and sensitive individuals. These results are common in streams negatively impacted by eutrophic conditions.

Table 533. Eutrophication related macroinvertebrate metrics in East Branch Des Moines River (-527). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100003-527 Macroinvertebrate Class 7 – General Use	EPT Pct	Tanytarsini Pct	CrustMoll Pct	Scraper Pct	% Tolerant Taxa	% Intolerant Taxa
14DM002	45.89	11.94	31.01	16.14	67.08	0.31
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41)</i>	38.45	18.46	11.78	16.11	26.84	4.03
Expected response to Eutrophication stress	↓	↓	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in five of the six eutrophication related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 533). This reach did have an above average amount of EPT individuals, which can be a good sign, however, the remaining metrics scored below average or poorly.

Based on the high observed and modeled values, in addition to the majority of the fish and macroinvertebrate metrics related to eutrophication scoring below average or poorly, eutrophication is a stressor to aquatic life in East Branch Des Moines River (-527).

Nitrates

A total of 42 samples taken from two chemistry sites (S000-141, S001-000) from 2004-2015 were analyzed for Inorganic Nitrogen (NO₂-NO₃). The average of all the values is 8.36 mg/L with a low of 0.05 mg/L and a high of 22.90 mg/L. The spring average (March-May) is 8.70 mg/L. The summer average (June-Aug) is 9.58 mg/L. Nitrate values exceeded 4 mg/L 31 times. A quantile regression analysis for Class 7 stream stations showed that sites having a nitrate concentration in excess of 11.5 mg/L there was a 90% probability for impairment. The nitrate concentrations in this reach easily exceeded this level.

The HSPF model calculated daily nitrate concentrations for this subwatershed from 1994-2014. These values ranged from 0.73-2322.2 mg/L with an average value of 8.25 mg/L. Of these calculations, 1592 (22.24%) were above 11.5 mg/L.

Table 534. Nitrate related macroinvertebrate metrics in East Branch Des Moines River (-527). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100003-527 Macroinvertebrate Class 7 – General Use	TrichopteraChTx Pct	N Index Score	% N Tolerant	% N Intolerant
14DM002	5.71	3.71	65.52	0.31
<i>Statewide average for Class 7 Prairie Streams Glide Pool stations that are meeting the MIBI General Use Threshold (41)</i>	10.00	3.30	57.57	0.91
Expected response to N stress	↓	↑	↑	↓

The macroinvertebrate assemblage in East Branch Des Moines River (-527) scored below average in all four of the nitrate related metrics at site 14DM002 when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 534). This reach had a lower amount of trichoptera and nitrate intolerant taxa, while also having an elevated number of nitrate tolerant individuals and a poor nitrate index score. These results are indicative of a stream likely impacted by elevated nitrate levels.

Based on the high nitrate concentrations observed and calculated, the quantile regression analysis, in addition to the poor scoring nitrate related macroinvertebrate metrics concludes that nitrates are a stressor to aquatic life in this stream reach.

Suspended Solids

A total of 28 samples taken from two chemistry sites (S000-141, S001-000) from 2005-2014 were analyzed for TSS. The average of all the values is 22.47 mg/L with a low of 2 mg/L and a high of 87 mg/L. The TSS concentrations exceeded the 65 mg/L standard three times.

Additionally, 33 secchi tube measurements were taken from this reach. These values ranged from 9-100 cm, with one measurement falling below the 10 cm minimum standard for secchi tube.

The HSPF model calculated daily TSS values for this subwatershed from 1994-2014. These concentrations ranged from 0.81-310.16 mg/L with an average TSS value of 14.06 mg/L. Of these calculations, 16 (0.23%) were above the TSS standard.

This reach was determined to be impaired for turbidity during the 2002 assessment. This impairment was confirmed during the 2016 assessment as well.

Table 535. TSS related fish metrics in East Branch Des Moines River (-527). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100003-527 Fish Class 2 – General Use	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RifflePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14DM002	1.88	0.21	0.00	0.84	1.78	0.00	1.78	0.00	1.01	23.60
<i>Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)</i>	37.38	4.89	9.61	18.66	32.49	18.65	39.38	4.97	11.68	17.59
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

The fish assemblage in East Branch Des Moines River (-527) at site 14DM002 scored below average in all ten of the TSS related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 535). This reach lacked many fish species sensitive to elevated TSS values and had a very poor TSS Index Score. These results reflect a stream that is likely stressed due to the TSS conditions.

Table 536. TSS related macroinvertebrate metrics in East Branch Des Moines River (-527). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100003-527 Macroinvertebrate Class 7 – General Use	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plectoptera Pct
14DM002	22.19	1.00	16.00	57.68	4.75	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (22.0)</i>	17.35	1.33	13.20	48.28	19.13	0.22
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

The macroinvertebrate assemblage in this reach scored below average in all six of the TSS related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 536). Site 14DM002 had elevated amounts and a high percentage of TSS Tolerant taxa and individuals. This reach also had a poor TSS index score and lacked many species intolerant to elevated TSS conditions. These results are common in streams with elevated TSS concentrations.

The TSS levels in East Branch Des Moines River (-527) due exceed the standard occasionally. Both the fish and macroinvertebrate communities in this reach scored poorly in all of the TSS related metrics. Based on this information, as well as the current turbidity impairment in this reach, TSS is a stressor to aquatic life.

Habitat

East Branch Des Moines River (-527) had a qualitative habitat assessment take place at its biological monitoring site, 14DM002, during the fish and macroinvertebrate sampling events in 2014. The average MSHA score from these visits was 41.05 (Poor). Limiting the habitat at this site was, moderate bank erosion (Figure 229), moderate embeddedness, sand and silt substrates, sparse fish cover, fair sinuosity, moderate channel stability, and poor channel development. Further MSHA analysis can be seen in Figure 230.

Figure 229. Bank erosion at site 14DM002.



Figure 230. East Branch Des Moines River (-527) MSHA metric scores.

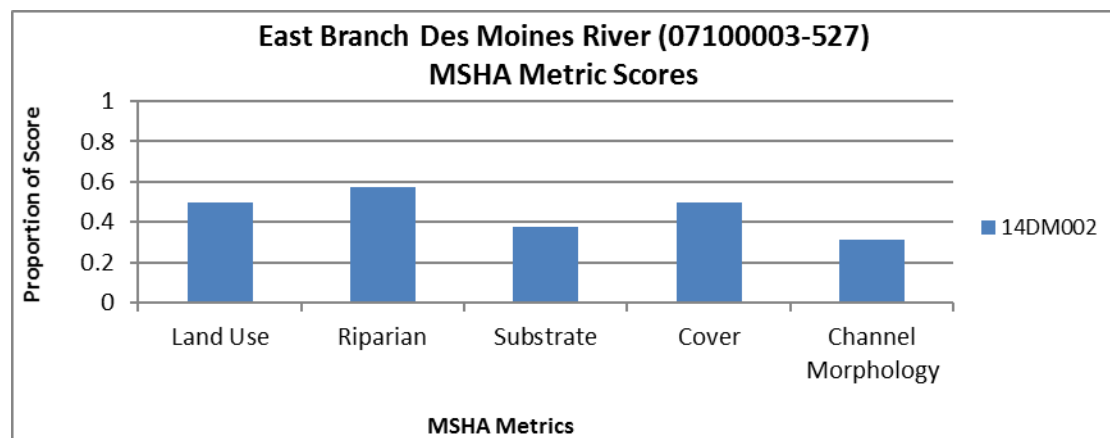


Table 537. Habitat related fish metrics in East Branch Des Moines River (-527). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100003-527 Fish Class 2 – General Use	BenInsect-TolPct	SlithopPct	DarterSculpSupPct	RifflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14DM002	0.09	1.78	0.09	1.78	0.17	1.83	98.95	95.92
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	20.4	39.38	18.18	32.49	5.24	58.26	44.85	19.02
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

The fish community in East Branch Des Moines River (-527) at site 14DM002 scored below average in all eight of the habitat related metrics when compared to all other CLASS 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 537). The fish assemblage was dominated by fathead minnows as 7380 (95.63%) were sampled. Fathead minnows present in very large amounts can be a strong signal for poor habitat conditions.

Table 538. Habitat related macroinvertebrate metrics in East Branch Des Moines River (-527). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100003-527 Macroinvertebrate Class 7 – General Use	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14DM002	5.38	24.68	21.84	45.89	23.73	42.41
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)	5.40	20.35	36.94	37.77	37.96	19.49
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate assemblage in this reach fared much better than the fish community as just one of the habitat related metrics scored below average when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 538). This reach had a decreased amount of clinger individuals, but scored very well in the remaining metrics.

Based on the poor MSHA scores as well as the very poor scores in the fish community for metrics related to habitat, habitat is a stressor to aquatic life in East Branch Des Moines River (-527). The macroinvertebrate assemblage scores fairly well at this point, but may begin to decrease with the current conditions.

Altered Hydrology

This reach is on the East Branch Des Moines River (-527) and ends flowing into Okamanpeedan Lake. The reach itself is almost entirely altered and most of its upstream watershed is altered according to the MPCA altered watercourse layer.

“The floodplain width at the study location has been reduced over time due to historical drainage efforts. Adjacent to the East Fork Des Moines River channel, a ditch was dug in what appears to be an effort to straighten this portion of river. Beside the ditch is the ditch spoil that in turn creates a berm that crests at an elevation above the flood-prone elevation of the river. This berm, and the valley on the west side of the channel, constricts floodplain width through this portion of the East Fork Des Moines River. Longitudinal disruption of the floodplain also exists both upstream and downstream of the survey location. Upstream, an abandoned township bridge and road grade constricts floodplain flow” (DNR 2016).

Extreme weather events affect high flow events as well as also low flows during drought. HSPF models show this stream section experiencing low flow at less than five cfs 28.3% of the time and less than one cfs 4.7% of the time.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The percentage for generalist fish within the reach was 97.7% compared to the average in class 2 waters meeting the standard of 42.4%.

The numbers of nest guarder species are also positively correlated with increased low flows. The percentage for nest guarder fish within the reach was 96.1% compared to the average in class 2 waters meeting the standard of 19%.

Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The percentage for long-lived macroinvertebrates within the reach was 0.9% compared to the average in class 7 waters meeting the standard of 8%.

Based on the extensive channelization of this reach in the upstream tributaries, the poor scoring biological metrics as well as the lack of floodplain access for this reach, Flow Alteration/Connectivity is a stressor to aquatic life in East Branch Des Moines River (-527).

Summary

The impaired fish community in East Branch Des Moines River (-527) is being stressed by DO, Eutrophication, Nitrates, Suspended Sediment, Habitat and Flow Alteration/Connectivity (Table 539). For further information on the stressors and recommendations to fixing the stressors in the Headwaters East Fork Des Moines River HUC 10 Watershed, see page 465.

Table 539. Stressor determinations for East Branch Des Moines River (-527).

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
East Branch Des Moines River	07100003-527	●	●	●	●	●	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Unnamed Creek (07100003-529)

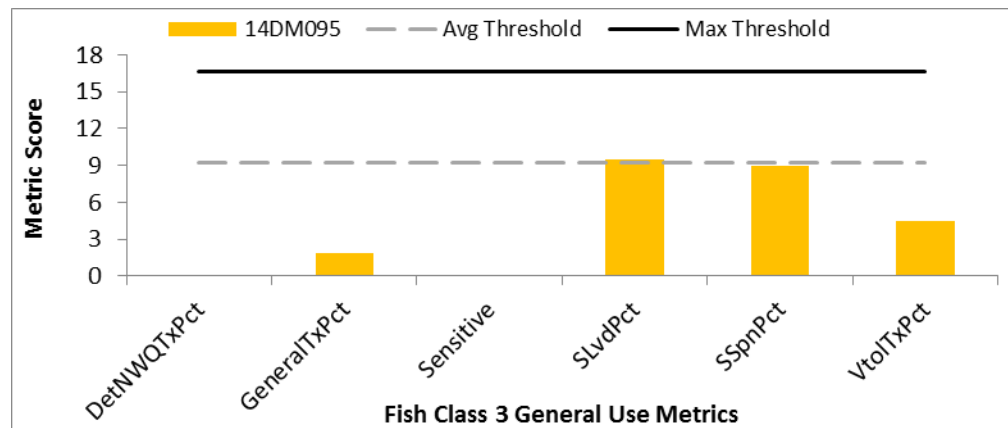
Located in parts of east central Jackson County and west central Martin County, Unnamed Creek (-529) is a 5.05 mile long reach that is impaired for aquatic life due to the fish and macroinvertebrate assemblages. This stream reach extends approximately 0.86 miles upstream from 10th Avenue downstream to the confluence with the Des Moines River. Along this stream section there are two biological monitoring stations, 04DM042 and 14DM095.

Biology

Fish

The fish community in Unnamed Creek (-529) was sampled for fish in September of 2015 at site 14DM095 and had a FIBI score of 24.8. This score is well below the Fish Class 3 Southern Headwaters General Use Threshold of 55. This site did have one metric (SLvd) reach the average metric score needed to meet the threshold (Figure 231), however, the remaining seven metrics comprising this FIBI scored well below average with two metrics scoring zero (DetNWQTxPct, Sensitive).

Figure 231. Unnamed Creek (-529) fish IBI metric scores.

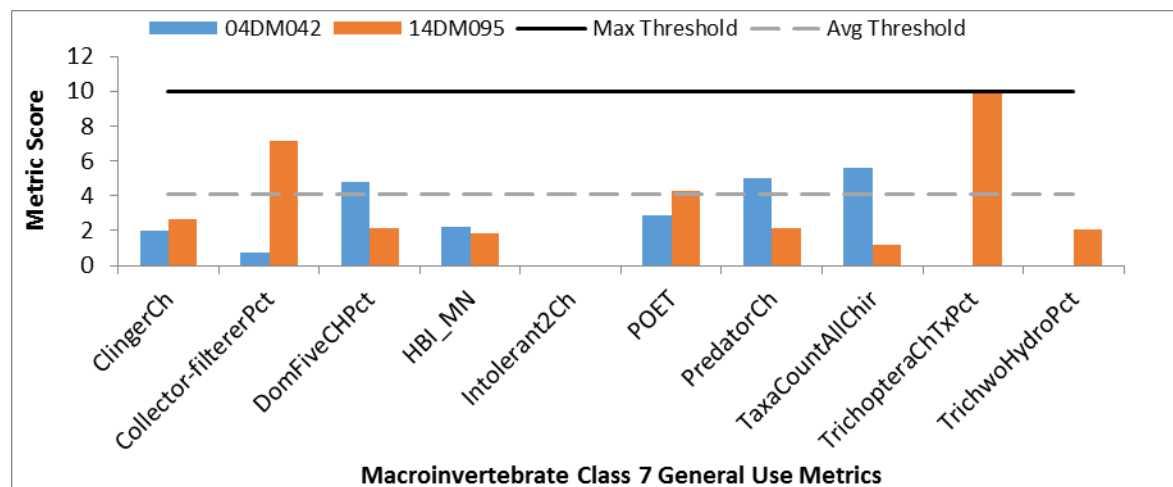


Macroinvertebrates:

The macroinvertebrate assemblage at site 04DM042 in August 2014 and had a MIBI score of 23.2. Site 14DM095 was sampled in August of 2014 and had a MIBI score of 33.5. Both of these MIBI scores are below the Macroinvertebrate Class 7 Prairie Streams GP General Use Threshold of 41. Both sites had three metrics score above the average needed to reach the threshold. However, the remaining seven

metrics scored below average with three metrics score of zero at site 04DM042 and one at site 14DM095. See Figure 232 for a complete breakdown of the metric scores at this site.

Figure 232. Unnamed Creek (-529) macroinvertebrate IBI metric scores.



Dissolved Oxygen

A total of 12 DO measurements were taken from one chemistry site (S009-040) and two biological monitoring stations (14DM095, 04DM042) from 2004-2016. The average of all the values is 6.77 mg/L with a low of 3.76 mg/L and a high of 8.84 mg/L. The DO values fell below 5 mg/L once.

The HSPF model calculated daily minimum DO values for this subwatershed from 1994-2014. Of these calculations, 1240 (16.17%) of the days had a daily minimum DO level below the daily minimum standard of 5 mg/L.

Table 540. DO related fish metrics in Unnamed Creek (-529). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100003-529 Fish Class 3 – General Use	MA>3 Avg	SspnPct Avg	Taxa Count Avg	DO TIV Avg
14DM095	19.05	35.71	7.00	8.34
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	13.32	17.09	12.16	8.44
Expected response to DO stress	↓	↑	↓	↓

The fish community in Unnamed Creek (-529) at site 14DM095 scored below average in three of the four DO related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 540). This site had an increased amount of serial spawning individuals, while also having a lower overall taxa count and a poor DO TIV score. These results can signal potential stress due to the DO conditions.

Table 541. DO related macroinvertebrates metrics in Unnamed Creek (-529). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100003-529 Macroinvertebrate Class 7 – General Use	HBI_MN Value	% DO Tolerant Taxa	# DO Tolerant Taxa	ChemTV DO
04DM042	8.20	4.24	8.00	5.68
14DM095	8.30	7.31	5.00	7.07
<i>Statewide average for Class 7 Prairie Streams Glide Pool stations that are meeting the MIBI General Use Threshold (41)</i>	7.55	12.98	5.74	6.91
Expected response to DO stress	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in one (14DM095) and three (04DM042) of the four DO related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 541). Both sites had poor HBI_MN scores, while site 04DM042 also had an increased number of DO tolerant taxa and a poor DO TIV score. Both sites did have a lower percentage of DO tolerant taxa, which can signal that DO is not a stressor.

Based on the observed data set, the DO measurements do fall below 5 mg/L on occasion, while the model calculated an above average exceedance rate. The majority of the DO related metrics in both communities scored below average except for the macroinvertebrates at site 14DM095. This information concludes that DO is inconclusive as a stressor to aquatic life in Unnamed Creek (-529) at this time. Further DO monitoring with a sonde is recommended to better determine the impact that DO is having in this reach.

Eutrophication

A total of four phosphorus samples were taken from one chemistry site (S009-040) and two biological monitoring station (04DM042 and 14DM095) from 2004-2016. The average of all the values is 0.14 mg/L with a low of 0.03 mg/L and a high of 0.21 mg/L. Phosphorus values exceeded the standard of 0.150 mg/L twice.

The HSPF model also calculated daily phosphorus concentrations from 1994-2014 for this subwatershed. These values ranged from 0.05-8.92 mg/L with an average concentration of 0.34 mg/L. Of these calculations, 5,364 (95.60%) were above the phosphorus standard.

Table 542. Eutrophication related fish metrics in Unnamed Creek (-529). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100003-529 Fish Class 3 – General Use	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct
14DM095	0.00	2.38	97.62	47.62
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	8.9	12.11	70.79	14.71
Expected response to Eutrophication stress	↓	↓	↑	↑

The fish community in Unnamed Creek (-529) at site 14DM095 scored below average in all four (14DM095) of the eutrophication related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 542). This site had very high

amounts of tolerant fish individuals, while also lacking sensitive and darter individuals. These results are often found in streams with eutrophic conditions.

Table 543. Eutrophication related macroinvertebrates metrics in Unnamed Creek (-529). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

	EPT Pct	Tanytarsini Pct	CrustMoll Pct	Scraper Pct	% Tolerant Taxa	% Intolerant Taxa
07100003-529						
Macroinvertebrate Class 7 – General Use						
04DM042	35.87	9.57	5.17	38.60	18.18	0.00
14DM095	33.89	2.25	30.56	17.61	23.26	0.00
<i>Statewide average for Class 7 Prairie Streams Glide Pool stations that are meeting the MIBI General Use Threshold (41)</i>	38.45	18.46	11.78	16.11	26.84	4.03
Expected response to Eutrophication stress	↓	↓	↑	↑	↑	↓

The macroinvertebrate assemblage in this reach scored below average in four (04DM042) and five (14DM095) of the six eutrophication related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 543). Both sites had decreased levels of EPT and tanytarsini individuals, phosphorus intolerant taxa, while also having increased numbers of scraper and crustacean/mollusca (14DM095) individuals. These results can often signal stress due to eutrophication.

Based on the high observed and modeled values, in addition to the majority of the fish and macroinvertebrate metrics related to eutrophication scoring below average or poorly, eutrophication is a stressor to aquatic life in Unnamed Creek (-529).

Nitrates

Eleven samples taken from one chemistry site (S009-040) and two biological monitoring stations (04DM042, 14DM095) from 2004-2016 were analyzed for Inorganic Nitrogen (NO₂-NO₃). The average of all the values is 14.67 mg/L with a low of 4.40 mg/L and a high of 23.00 mg/L. The spring average (March-May) is 16.50 mg/L. The summer average (June-Aug) is 16.14 mg/L. Nitrate values exceeded 4 mg/L 11 times. A quantile regression analysis for Class 7 stream stations showed that sites having a nitrate concentration in excess of 11.5 mg/L there was a 90% probability for impairment. The nitrate concentrations in this reach easily exceeded this level.

The HSPF model calculated daily nitrate concentrations for this subwatershed from 1994-2014. These values ranged from 0.37-9705.4 mg/L with an average value of 10.21 mg/L. Of these calculations, 1,514 (26.98%) were above 11.5 mg/L.

Table 544. Nitrate related macroinvertebrates metrics in Unnamed Creek (-529). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

	TrichopteraChTx Pct	N Index Score	% N Tolerant	% N Intolerant
07100003-529 Macroinvertebrate Class 7 – General Use				
04DM042	0.00	3.43	74.55	0.00
14DM095	17.39	5.46	92.03	0.00
<i>Statewide average for Class 7 Prairie Streams Glide Pool stations that are meeting the MIBI General Use Threshold (41)</i>	10.00	3.30	57.57	0.91
Expected response to N stress	↓	↑	↑	↓

The macroinvertebrate community in Unnamed Creek (-529) scored below average in three (14DM095) and four (04DM042) of the four nitrate related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 544). Both of these sites had poor nitrate index scores, very high amounts of nitrate tolerant individuals, and they both lacked nitrate intolerant species. Site 04DM042 also had zero trichoptera taxa present.

Based on the high nitrate concentrations observed and calculated, the quantile regression analysis, in addition to the poor scoring nitrate related macroinvertebrate metrics at both sites, nitrates are a stressor to aquatic life in this stream reach.

Suspended Solids

Seven samples taken from one chemistry site (S009-040) in 2016 were analyzed for TSS. The average of all the values is 23.29 mg/L with a low of 12 mg/L and a high of 42 mg/L. The TSS concentrations did not exceed the 65 mg/L standard.

Additionally, 10 secchi tube measurements were taken from this reach. These values ranged from 18.5-78 cm, with no values falling below the 10 cm minimum standard for secchi tube.

The HSPF model calculated daily TSS values for this subwatershed from 1994-2014. These concentrations ranged from 0.10-289.86 mg/L with an average TSS value of 6.29 mg/L. Of these calculations, 7 (0.12%) were above the TSS standard.

Table 545. TSS related fish metrics in Unnamed Creek (-529). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RifflePct	SensitivePct	SlithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
07100003-529 Fish Class 3 – General Use										
14DM095	21.43	0.00	0.00	2.38	19.05	0.00	19.05	0.00	7.14	20.10
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	37.83	0.90	13.33	13.93	28.33	8.55	33.71	1.95	3.56	15.27
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

The fish community in Unnamed Creek (-529) at site 14DM095 scored below average in nine of the ten TSS related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI

General Use Threshold (Table 545). This reach did have an above average number of long lived individuals, however, the remaining metrics, including TSS Index score, scored below average or poorly. These results reflect a community potentially stressed by the current TSS conditions in the reach.

Table 546. TSS related macroinvertebrates metrics in Unnamed Creek (-529). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100003-529 Macroinvertebrate Class 7 – General Use	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
04DM042	15.05	0.00	10.00	50.00	3.04	0.30
14DM095	22.08	0.00	15.00	90.70	27.24	0.00
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (22.0)</i>	17.35	1.33	13.20	48.28	19.13	0.22
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

The macroinvertebrate assemblage in this reach scored below average in three (04DM045) and five (14DM095) of the six TSS related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 546). Both sites had increased numbers of TSS tolerant individuals, especially site 14DM095. Of the two sites, site 04DM042 fared much better as it did have a slightly above average amount of plecoptera individuals, while also having a good TSS Index scores. These results do not typically happen in streams with elevated TSS concentrations.

The observed and modeling data sets both indicate that the TSS concentrations in this reach are low and remain low. It is likely that other stressors are causing the fish and macroinvertebrate communities to score poorly as the chemical and model data give no indication of potential stress. Therefore, TSS is not a stressor to aquatic life in Unnamed Creek (-529) at this time.

Habitat

Unnamed Creek (-529) had a qualitative habitat assessment take place at its biological monitoring sites, 04DM042 and 14DM095, during the fish and macroinvertebrate sampling events in 2004, 2014, and 2015. The average MSHA scores from these visits were 49.8 (Fair) at 04DM042 and 43.63 (Poor) at 14DM095. Limiting the habitat at these sites was row crop agriculture as the dominant nearby land use, moderate to heavy bank erosion, light stream shading, moderate to severe embeddedness, sand and silt substrates, sparse fish cover (04DM042), low to moderate channel stability, and fair channel development. Further MSHA analysis can be seen in Figure 233.

Figure 233. Unnamed Creek (-529) MSHA metric scores.

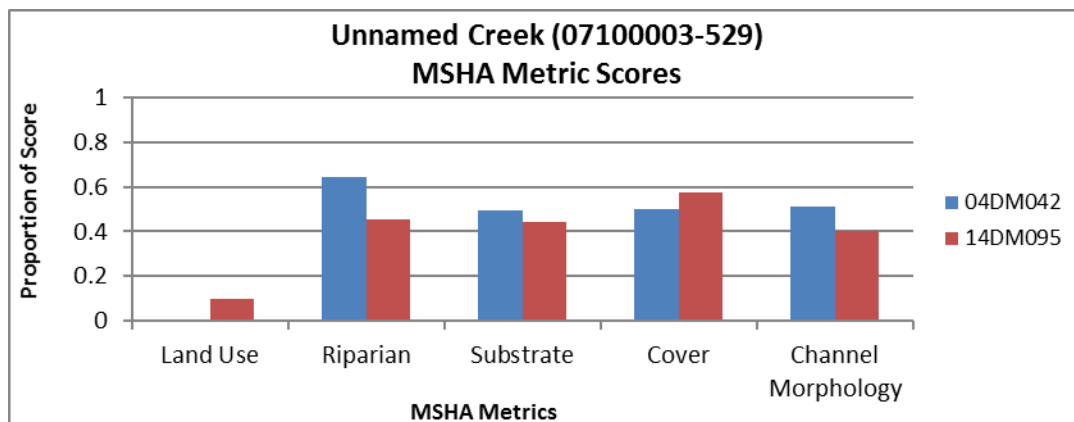


Table 547. Habitat related fish metrics in Unnamed Creek (-529). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100003-529 Fish Class 3 – General Use	BenInsect- ToIPct	SLithopPct	DarterSculpSu cPct	RifflePct	PiscivorePct	LithFrimPct	ToIPct	PioneerPct
14DM095	1.19	9.52	1.19	9.52	0.00	23.81	73.81	58.33
<i>Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)</i>	14.22	33.71	12.55	28.33	1.62	69.21	70.64	37.79
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

The fish community in Unnamed Creek (-529) at site 14DM095 scored below average in all eight of the habitat related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 547). Like many other reaches in the Des Moines River basin, this reach was dominated by tolerant and pioneer fish individuals signaling likely habitat stress. This reach also lacked many species needing specialized habitat conditions to live and reproduce.

Table 548. Habitat related macroinvertebrates metrics in Unnamed Creek (-529). Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

07100003-529 Macroinvertebrate Class 7 – General Use	BurrowerP ct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPc t
04DM042	29.18	13.07	4.26	35.87	61.09	14.89
14DM095	1.66	45.51	29.24	33.89	46.18	15.28
<i>Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI General Use Threshold (41.0)</i>	5.40	20.35	36.94	37.77	37.96	19.49
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate assemblage in this reach scored below average in four (14DM095) and six (04DM042) of the six habitat related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI General Use Threshold (Table 548). Both sites had decreased numbers of sprawler, clinger, and EPT individuals, while also having increased numbers of legless individuals. These results are common in streams with degraded habitat.

Based on the poor to fair MSHA scores in addition to the majority of the habitat related metrics in both the fish and macroinvertebrate communities scoring below average or poorly, habitat is a stressor to aquatic life in Unnamed Creek (-529) at this time.

Altered Hydrology

Unnamed Creek (-529) is a tributary to the East Branch Des Moines River. The reach itself is mostly natural and the majority of its upstream watershed is altered according to the MPCA altered watercourse layer. A pump station creates a fish barrier just downstream of the reach.

“Culvert sizing is having an influence on sediment transport throughout this portion of the river. In the 14,200 feet of stream containing the six crossings, four different stream crossing structures were employed. Both a double box and triple box culvert were employed, as well as a double culvert and clear

span bridge. The clear span bridge appears to be the only structure that is not accumulating sediment within the crossing. Sediment deposition within parts of the structures indicates that one culvert was likely the correct size to properly transport sediment within the stream (Figure 49). The second and third culverts are plugged with sediment and only see flows during bankfull and higher stages. What is not certain, however, is whether these extra culverts are adequately sized to be floodplain culverts. These crossings may require more floodplain connectivity to naturally transport water and sediment onto and throughout the floodplain.” (DNR 2016).

Extreme weather events affect high flow events as well as also low flows during drought. HSPF models show this stream section experiencing low flow at less than five cfs 66.1% of the time and less than one cfs 40.4% of the time.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The average percentage for generalist fish within the reach was 80.2% compared to the average in class 3 waters meeting the standard of 59.1%. Generalist fish species ranged from 50-100%.

The numbers of nest guarder species are also positively correlated with increased low flows. The average percentage for nest guarder fish within the reach was 31.7% compared to the average in Class 3 waters meeting the standard of 19.2%. Nest guarder species ranged from 0-50%.

Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The average percentage for long-lived macroinvertebrates within the reach was 9.7% compared to the average in Class 7 waters meeting the standard of 8%. Long-lived macroinvertebrates ranged from 0.6-14.3%.

Based on the frequent low flow conditions, the fish barrier just downstream of the reach, the improper culvert sizing possibly preventing proper stream flow, as well as the poor scoring biological metrics, Flow Alteration/Connectivity is a stressor to aquatic life in Unnamed Creek (-529).

Summary

The impaired fish and macroinvertebrate communities in Unnamed Creek (-529) are being stressed by Eutrophication, Nitrates, Habitat and Flow Alteration/Connectivity (Table 549). DO was inconclusive as a stressor at this time, while Suspended Sediment was ruled out as a stressor to aquatic life. For further information on the stressors and recommendations to fixing the stressors in the Headwaters East Fork Des Moines River HUC 10 Watershed, see pages page 465.

Table 549. Stressor determinations for Unnamed Creek (-529).

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
Unnamed Creek	07100003-529	o	●	●	---	●	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Headwaters East Fork Des Moines River Watershed (0710000301) HUC 10 conclusion and recommendations

The Headwaters East Fork Des Moines River subwatershed has five biologically impaired streams that are being negatively impacted by a multitude of stressors throughout the watershed. Stressors found in at least four of the five impaired reaches include Eutrophication, Nitrates, Habitat, and Flow Alteration/Connectivity. DO was found to be a stressor in three of the reaches, while Suspended Sediment was also found to be a stressor in one of the reaches (Table 550).

The predominant land use in this subwatershed is row crop agriculture. This is a significant contributor to the stressors found in these reaches. The land use combined with the channelization of these stream reaches and their tributaries are a major reason why these streams are impaired for aquatic life. These practices often lead to high nitrate and phosphorus levels through excessive use of fertilizers that can quickly reach the stream system by drain tiles and field runoff. These elevated phosphorus levels will also impact the DO conditions resulting in many more tolerant fish and macroinvertebrate communities.

Channelizing streams can also lead to very high flow rates resulting in bank erosion. Bank erosion leads to higher amounts of both bedded and suspended sediment in the stream resulting in poor habitat and visibility conditions impacting the breeding and feeding environments for more sensitive fish and macroinvertebrate species. Habitat was found to be an issue in all of the impaired reaches, while flow alteration/connectivity was found to be a stressor in five of the reaches thus far.

A large effort is needed in the Headwaters East Fork Des Moines River Watershed to improve biological conditions in the many impaired streams found throughout. A high priority in this watershed should be to better manage the flow alteration and the effects of it. This can be achieved by increasing the storage and infiltration of water in locations with flow alteration stressors. This will also help reduce sediment inputs from stream banks, improve habitat by protecting streambanks, reduce erosion and overall stream sedimentation. Re-establishing a quality riparian corridor with deep rooted vegetation to increase stream stabilization, shading, and habitat features is also needed to improve conditions. An equal priority should be given to reducing nutrients in this subwatershed by utilizing a variety of BMPs including: cover crops, nutrient management, saturated buffers, etc., will also help in the nitrate and phosphorus reduction. This could also help with the eutrophication and resulting DO issues as well.

Table 550. Stressor determinations for the Headwaters East Fork Des Moines River Watershed.

Stream Name	AUID	Stressors:					
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity
County Ditch 53	07100003-506	●	●	●	---	●	●
Fourmile Creek	07100003-510	---	●	●	---	●	o
East Branch Des Moines River	07100003-525	●	●	●	---	●	●
East Branch Des Moines River	07100003-527	●	●	●	●	●	●
Unnamed Creek	07100003-529	o	●	●	---	●	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

6. Conclusions and recommendations for the Des Moines River Watershed

6.1 Summary of stressors

The stressors for the biological impairments in the Des Moines River Watershed are listed in Table 551. The most common stressor in the watershed was habitat, followed closely by eutrophication, with DO, nitrates and flow alteration/connectivity. TSS was also a frequent stressor in this watershed. A more detailed version of this Table with potential sources/pathways and locations where additional monitoring is needed can be found in the **Appendix 8.1**.

Table 551. Stressor determinations for the Des Moines River Watersheds.

Stressors			DO	Eutrophication	Nitrate	TSS	Habitat	Flow Alteration /Connectivity
Stream Name	AUID	Aquatic Life Impairment						
Des Moines River	07100001-501	Fish, Macroinvertebrates	●	●	---	●	●	---
County Ditch 20	07100001-504	Fish	●	●	○	---	●	●
Lower Lake Sarah Outlet	07100001-508	Fish, Macroinvertebrates	●	●	---	●	---	●
Jack Creek	07100001-514	Fish	●	●	●	●	●	●
Unnamed creek	07100001-518	Fish, Macroinvertebrates	●	●	●	---	●	●
Judicial Ditch 26	07100001-523	Macroinvertebrates	○	●	●	---	●	●
Des Moines River	07100001-524	Fish, Macroinvertebrates	---	●	---	●	●	---
Heron Lake Outlet	07100001-527	Fish, Macroinvertebrates	●	●	---	●	●	○
Des Moines River	07100001-533	Fish, Macroinvertebrates	---	●	---	●	●	---
Lime Creek	07100001-535	Fish, Macroinvertebrates	●	●	●	●	●	○
Perkins Creek	07100001-544	Macroinvertebrates	●	●	---	---	●	●
Des Moines River	07100001-545	Fish, Macroinvertebrates	●	●	---	●	●	○
Des Moines River	07100001-546	Fish, Macroinvertebrates	---	●	---	●	●	---
Jack Creek	07100001-549	Fish, Macroinvertebrates	---	○	●	●	●	●
Unnamed creek	07100001-551	Fish, Macroinvertebrates	●	●	---	●	●	○
County Ditch 43 (Scheldorf Creek)	07100001-552	Fish, Macroinvertebrates	○	---	○	---	●	●
Unnamed creek	07100001-563	Macroinvertebrates	●	●	●	---	●	○
Unnamed creek	07100001-564	Fish, Macroinvertebrates	●	●	---	○	●	●
Okabena Creek*	07100001-602	Fish, Macroinvertebrates	●	●	●	●	●	○
Unnamed creek	07100001-613	Fish	○	○	●	---	●	○
Unnamed creek	07100001-614	Macroinvertebrates	●	●	●	---	●	●
Unnamed creek	07100001-618	Fish, Macroinvertebrates	●	●	●	---	●	○
Unnamed creek	07100001-619	Fish	○	●	○	●	●	●
Unnamed creek	07100001-621	Macroinvertebrates	●	●	●	---	●	●
Unnamed creek	07100001-624	Fish, Macroinvertebrates	●	●	●	---	●	●
Unnamed creek	07100001-625	Fish, Macroinvertebrates	●	●	●	●	●	●

Stressors			DO	Eutrophication	Nitrate	TSS	Habitat	Flow Alteration /Connectivity
Stream Name	AUID	Aquatic Life Impairment						
Unnamed creek	07100001-626	Fish, Macroinvertebrates	●	●	●	---	●	○
Unnamed creek	07100001-628	Fish, Macroinvertebrates	●	●	●	---	●	●
Unnamed creek	07100001-632	Fish, Macroinvertebrates	○	---	●	---	●	●
Unnamed creek	07100001-637	Macroinvertebrates	●	●	●	---	●	●
Lake Shetek Inlet	07100001-641	Fish, Macroinvertebrates	○	●	○	---	●	○
Lake Shetek Inlet	07100001-642	Fish	●	●	●	---	●	●
Lake Shetek Inlet	07100001-643	Fish	●	●	○	●	●	○
Beaver Creek	07100001-646	Fish	●	●	●	●	●	●
Jack Creek, North Branch	07100001-649	Fish	---	●	●	○	●	●
Jack Creek, North Branch	07100001-652	Fish	○	●	●	●	●	●
Elk Creek	07100001-656	Fish, Macroinvertebrates	●	●	●	○	●	●
Jack Creek	07100001-658	Fish	●	●	●	●	●	●
Unnamed creek	07100001-661	Fish, Macroinvertebrates	●	●	○	---	●	●
Beaver Creek	07100001-663	Fish, Macroinvertebrates	---	○	○	●	●	○
Beaver Creek	07100001-664	Fish	○	●	●	○	●	●
Judicial Ditch 12	07100001-666	Fish, Macroinvertebrates	●	●	●	---	●	●
Devils Run Creek	07100001-668	Fish	●	●	---	---	●	●
Unnamed creek	07100001-670	Macroinvertebrates	○	●	○	---	---	○
Unnamed creek	07100001-672	Fish, Macroinvertebrates	●	●	●	---	●	○
Des Moines River	07100002-501	Fish, Macroinvertebrates	---	●	---	●	○	---
Brown Creek (Judicial Ditch 10)	07100002-502	Macroinvertebrates	●	●	●	---	●	●
Unnamed creek	07100002-504	Fish, Macroinvertebrates	●	○	●	○	---	●
Judicial Ditch 56	07100002-505	Fish, Macroinvertebrates	●	●	---	○	●	○
Story Brook	07100002-507	Fish, Macroinvertebrates	●	○	●	●	---	●
Unnamed ditch	07100002-510	Fish	○	●	●	---	●	●
County Ditch 53	07100003-506	Fish	●	●	●	---	●	●
Fourmile Creek	07100003-510	Fish, Macroinvertebrates	---	●	●	---	● (secondary)	○
Des Moines River, East Branch	07100003-525	Fish	●	●	●	---	●	●
Des Moines River, East Branch	07100003-527	Fish	●	●	●	●	●	●
Unnamed creek	07100003-529	Fish, Macroinvertebrates	○	●	●	---	●	●

*Chloride is also a stressor in this reach.

6.2 Recommendations and additional monitoring

In the Des Moines River Watersheds, the most common stressors identified were habitat and eutrophication. These stressors are largely tied to land use activities in the watershed. Overall, the stressors will need to be addressed in various ways in the watershed (Table 552).

Table 552. Recommended prioritization of restoration activities relative to the stressors contributing to the biological impairment in the Des Moines River Watersheds.

Stressor	Priority	Comment
Habitat	High	Re-establish quality riparian corridor to increase woody debris, stream stability, and stream shading. Protect streambanks, reduce erosion and overall stream sedimentation
DO and Eutrophication	High	Collect information as needed for streams that are lacking necessary DO and Eutrophication related information, while also utilizing a variety of nutrient reducing BMPs including but not limited to: cover crops, nutrient management, saturated buffers, etc.
Nitrate	High	Utilize a variety of nutrient reducing BMP's including but not limited to: cover crops, nutrient management, saturated buffers, etc.
Flow Alteration/Connectivity	High	Increase storage and infiltration of water in locations with flow alteration stressors and solicit DNR recommendations for streams with existing connectivity stressors and/or determine if restoration is appropriate. Further monitoring may be needed to better determine the impact that this stressor may be having on many of the reaches especially in the headwaters of these watersheds.
Suspended Sediment	Medium	Focus on reducing sediment input from riparian corridor (cattle pastures) and immediate stream channel (stream banks).

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8. Appendix

8.1 Des Moines River Watershed Lake Stressor Identification Report

Key terms & abbreviations

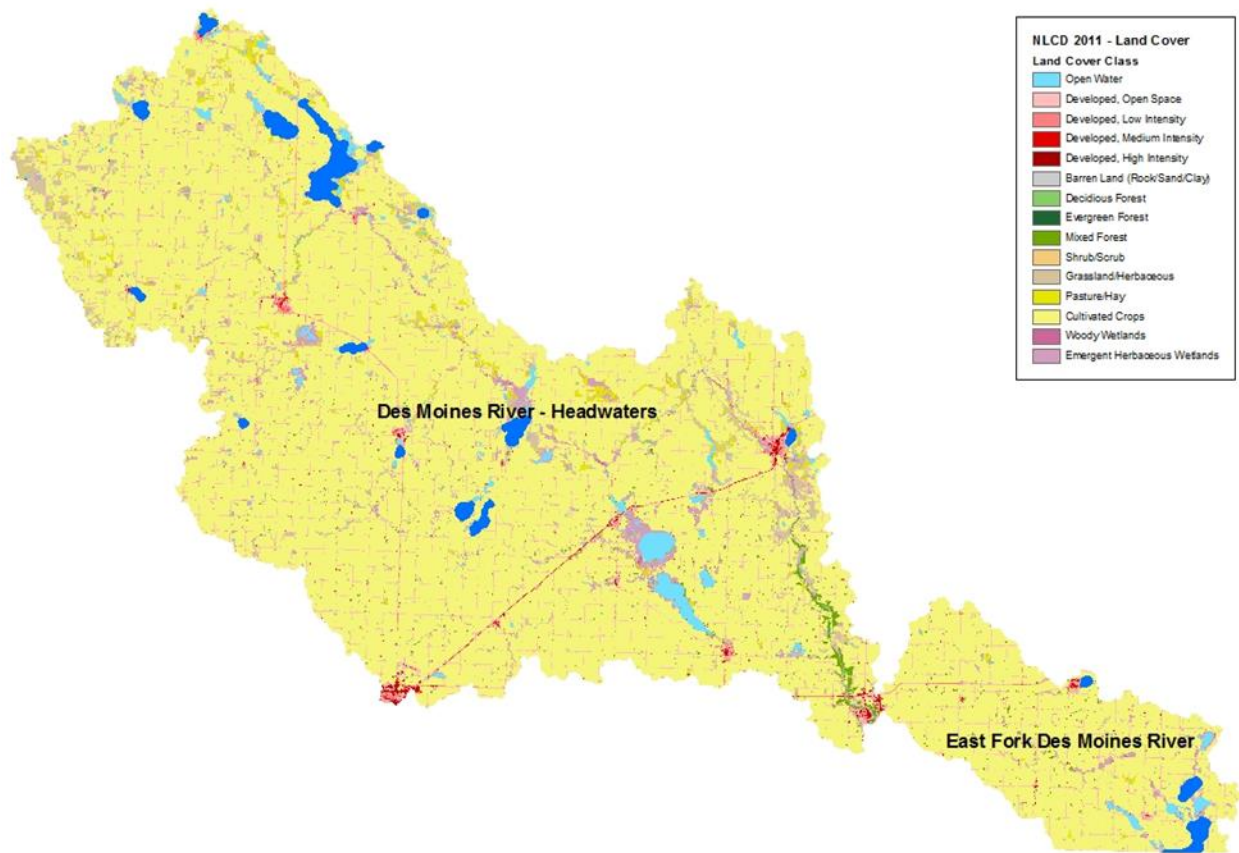
CADDIS	Causal Analysis/Diagnosis Decision Information System
EPA	Environmental Protection Agency of the United States
DMRW	Des Moines River Watersheds
FIBI	Fish Index of Biotic Integrity developed by MNDNR
FQI	Floristic Quality Index
IBI	Index of Biotic Integrity
MNDNR	Minnesota Department of Natural Resources
MPCA	Minnesota Pollution Control Agency
SID	Stressor Identification
SOE	Strength of Evidence
TMDL	Total Maximum Daily Load
TP	Total Phosphorus
TSI	Trophic State Index
WRAPS	Watershed Restoration and Protection Strategy

8.2 Monitoring and assessment overview and summary of biological impairments on lakes

The approach used to identify biological impairments on lakes includes assessment of fish and aquatic plant communities and habitat conditions throughout a watershed. Information collected can be used to calculate an index of biotic integrity (IBI) score. The IBI scores can then be compared to a range of thresholds to provide a measurement tool to assess the health of the aquatic communities.

This report summarizes data collected for assessment using the Fish IBI tool (FIBI) in the Des Moines River-Headwaters and East Fork Watersheds, hereafter referred to as the Des Moines River Watersheds (DMRW).

Figure 2.1 Lakes sampled with Fish IBI in the Des Moines River Watersheds.



Metrics developed for the FIBI were selected based on correlations with watershed land use, dock density, and/or floristic quality index. For FIBI Tool 7, a total of 8 metrics (total number of tolerant species, total number of insectivorous species, total number of small benthic-dwelling species, and total number of vegetation-dwelling species caught collectively in nearshore gears, standard trap nets, and standard gill nets; proportions of vegetation-dwelling individuals caught in nearshore gears, proportion of insectivores and tolerant species by biomass in standard trap nets, and proportion of vegetation-dependent top carnivores by biomass in gill nets) either increased or decreased with changes in trophic state, floristic quality, and/or land use among a set of Minnesota lakes (Drake and Pereira 2002; Drake and Valley 2005; J. Bacigalupi, DNR, unpublished data). Furthermore, probabilities of individual fish

species presence or absence in lake surveys either increased or decreased with total phosphorus (TP) concentration, trophic state index (TSI), or land-use among Minnesota lakes (J. Bacigalupi, DNR, unpublished data).

FIBI scores are compared to thresholds and confidence intervals that have been developed for similar lakes and determined through a weight of evidence approach using a Biological Condition Gradient Model (Gerritsen and Stamp 2014). FIBI scores that are higher than the impairment threshold indicate that the lake supports a fish community that has not been substantially altered. Conversely, scores below the impairment threshold indicate that the lake does not support the expected fish community. Confidence limits around the impairment threshold help to ascertain where additional information may be considered to help inform the impairment decision. When IBI scores fall within the confidence interval, interpretation and assessment of the waterbody condition involves consideration of potential stressors, and draws upon additional information regarding water chemistry, physical habitat, and land use, etc.

The purpose of stressor identification is to interpret the data collected during the biological monitoring and assessment process. Trends in the IBI scores can help to identify causal factors for biological impairments. The FIBI scores and plant IBI summary information in the DMRW are shown in Table 2.3.

Fish community information was collected from 17 lakes in the DMRW (Figure 2.1, Table 2.3). All lakes sampled were in Schupp lake class 41 or 43, which are shallow lakes (>80% littoral) located primarily in the southern half of the state. Of the 17 lakes surveyed, 13 were assessed as not supporting with FIBI Tool 7. The FIBI tools were not used to assess Okamanpeedan Lake because of the strong riverine influence or First Fulda Lake because of a recent fish reclamation (rotenone) project. Insufficient information existed to assess aquatic life use with the FIBI on two lakes, either due to sampling effort (Lake Wilson) or because the survey information and FIBI did not provide conclusive information (Buffalo Lake). None of the 14 assessed lakes scored above the impairment threshold for FIBI Tool 7 (36) and the mean FIBI score across lakes was 15. The average FIBI metric scores for the assessed lakes were below the mean for all 8 metrics compared to lakes used in the development of FIBI Tool 7 (mean metric was 0.6 standard deviations, (range 0.2-1.1) below the mean for lakes used in the Tool 7 development set). The low FIBI scores for the group of assessed lakes were primarily driven by three metrics: the relatively high number of tolerant species, the relatively high biomass of tolerant species in the trap nets, and the relatively low biomass of habitat dependent top carnivores in the gill nets.

Table 2.1 Biologically impaired lakes based on the FIBI in the Des Moines River Watersheds.

Lake Name	AUID (DOW #)	Impairments	
		Biological	Water Quality
Cottonwood	17002200	Not Supporting-FIBI	Aquatic Recreation: Insufficient Information
Talcot	17006000	Not Supporting-FIBI	Aquatic Recreation: Not Supporting-nutrient/eutrophication biological indicators
Yankton	42004700	Not Supporting-FIBI	Aquatic Recreation: Not Supporting-nutrient/eutrophication biological indicators
Bright	46005200	Not Supporting-FIBI	Aquatic Recreation: Insufficient Information
Temperance	46010300	Not Supporting-FIBI	Aquatic Recreation: Not Supporting-nutrient/eutrophication biological indicators
Lime	51002400	Not Supporting-FIBI	Aquatic Recreation: Not Supporting-nutrient/eutrophication biological indicators
Fox	51004300	Not Supporting-FIBI	Aquatic Recreation: Not Supporting-nutrient/eutrophication biological indicators
Shetek	51004600	Not Supporting-FIBI	Aquatic Recreation: Not Supporting-nutrient/eutrophication biological indicators
Corabelle	51005400	Not Supporting-FIBI	Aquatic Recreation: Not Supporting-nutrient/eutrophication biological indicators
Sarah	51006300	Not Supporting-FIBI	Aquatic Recreation: Not Supporting-nutrient/eutrophication biological indicators
Currant	51008200	Not Supporting-FIBI	Aquatic Recreation: Not Supporting-nutrient/eutrophication biological indicators
East Graham	53002000	Not Supporting-FIBI	Aquatic Recreation: Not Supporting-nutrient/eutrophication biological indicators
West Graham	53002100	Not Supporting-FIBI	Aquatic Recreation: Not Supporting-nutrient/eutrophication biological indicators

Table 2.2 Description of lakes assessed and Fish class (FIBI Tool) with IBI threshold and upper/lower confidence limits (CL) found in the Des Moines River Watersheds.

Class (FIBI Tool)	Description of Lakes Assessed	FIBI Impairment Threshold	Upper CL	Lower CL
7	Shallow, over 80% littoral, primarily in southern and western MN, Schupp Lake Classes 38, 41-43.	36	45	27

Table 2.3 Fish IBI scores and aquatic plant IBI summary scores by lake, organized by DOW. Key to color coding in Table 2.4.

AUID (DOW #)	Lake Name	Lake Acres	FIBI Sampling Year	FIBI Score (Tool 7)	FIBI Assessment	Aquatic Plant Eutrophication IBI Summary (* indicates survey ≥10 years old)
17002200	Cottonwood	155	2012, 2012	18, 17	Not Supporting	Full Support*
17006000	Talcot	873	2014, 2016	35, 29	Not Supporting	Not Supporting
42004700	Yankton	401	2014	6	Not Supporting	Insufficient Information
46005100	Okamanpeedan	2268	2007	8	Not Assessable	Full Support
46005200	Bright	651	2007, 2015	3, 14	Not Supporting	Not Assessed
46010300	Temperance	166	2013	15	Not Supporting	Not Supporting
51001800	Buffalo	127	2015	32	Insufficient Information	Insufficient Information (Surveys above and below threshold)
51002100	First Fulda	123	2011	33	Not Assessable	Full Support
51002400	Lime	326	2013	17	Not Supporting	Not Supporting
51004300	Fox	183	2014	19	Not Supporting	Full Support*
51004600	Shetek	3462	2007, 2012	16, 21	Not Supporting	Full Support
51005400	Corabelle	106	2014	12	Not Supporting	Full Support*
51006300	Sarah	1209	2008, 2014	0, 18	Not Supporting	Insufficient Information* (below threshold, but older data)
51008100	Wilson	179	2013	5	Insufficient information-Sampling Effort	Insufficient information (Surveys above and below threshold)
51008200	Currant	406	2013	5	Not Supporting	Not Supporting
53002000	East Graham	511	2011	8	Not Supporting	Insufficient information (Surveys above and below threshold)
53002100	West Graham	519	2014	8	Not Supporting	Insufficient information* (below threshold, but older data)

Table 2.4 Key to color coded IBI scores.

≤ lower CL	> lower CL & ≤ Threshold	> threshold & ≤ upper CL	> upper CL	NA = Not available
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8.3 Possible stressors to biological communities

A comprehensive list of potential stressors to aquatic biological communities compiled by the EPA (primarily for streams) can be found here (http://www.epa.gov/caddis/si_step2_stressorlist_popup.html).

This section of the report is designed to quantify responses of FIBI metrics or fish communities in lakes to known or potential environmental stressors. The stressors selected for consideration for lakes within the DMRW and discussed at least briefly include: excess nutrients and sedimentation, shoreline development and physical habitat alteration, toxic chemicals, non-native species (primarily carp), angling pressure and fish stocking, connectivity, and global climate change or local weather conditions.

Also included in the discussion are natural limitations affecting species diversity and FIBI scores of DMRW lakes.

8.3.1 Inconclusive causes

There are **natural limitations** affecting species diversity and consequently FIBI scores in DMRW lakes. The DMRW has the lowest diversity of the 10 major drainages in Minnesota (56 fish species recorded in the DMRW, compared to an average of 87 species) (Hatch and Schmidt 2004). In addition, all assessed lakes are shallow, 100% littoral, and have likely experienced periodic winterkill events naturally prior to winter aeration. Assessed lakes are nearly all aerated, and based on recent information have not experienced winterkill in recent years. However, depending on current and historical connections, historical winterkills could have influenced the species assemblages.

Although **connectivity** was not significantly related to the FIBI scores in the IBI Tool development or in the Biological Condition Gradient model development, connectivity influences the number of species available to inhabit lakes and can impact the abundance of certain species (Bouvier et al. 2009). Connection to other surface waters may be important to determine the number of species available to inhabit a given lake, but once established these species should persist if the lake has enough appropriate habitat and does not experience winterkill. Availability of accurate historic species lists is limited and makes substantiating claims of loss of species in an individual lake difficult.

Fisheries management plans identify **water level management** concerns in a number of DMRW lakes. According to DNR Windom Fisheries staff, much of the habitat used by Northern Pike for spawning, such as flooded waterways and wetlands connected to lakes have been altered or destroyed by agricultural practices, shoreline development, and urbanization. Water control structures have been installed on a number of lakes, which have altered natural hydrologic patterns. Northern Pike utilize spring flooded wetlands as their primary spawning habitat (Casselmann and Lewis 1996). These wetlands are particularly prone to altered hydrologic patterns (Petts and Calow 1996). Recruitment failure occurs when spawning areas are suddenly dewatered and eggs and larvae are stranded (Farrell et al. 2006). Loss of Northern Pike spawning potential is a possible driver for the low the top carnivore metric scores. There is limited data available to substantiate this observation, but it cannot be ruled out as contributing to impairment.

Introductions of non-native aquatic species have affected fish populations in Minnesota lakes and are a subject of continuous study. A statewide plan identified and ranked the potential threat from numerous invasive organisms including 38 aquatic plants and animals (DNR 2009). Fish communities experience stress caused by species introductions through direct competition or indirect impacts to lake ecology. Non-native fish and invertebrate species can compete directly with fish for food resources. Non-native species introductions can also indirectly alter fish habitat and food web dynamics due to specific life history and behavioral processes, such as the Common Carp's tendency to disrupt sediments and uproot aquatic vegetation during feeding.

Lake characteristics can also impact how much a non-native species will ultimately impact a lake. Lake morphology may limit the potential impacts of certain plants and favor others based on the amount of available habitat in each lake for each species. Regardless, lakes that maintain high biological diversity are more resilient to changes caused by new species introductions. Research continues to develop and improve techniques to quantify the impact of non-native species to aquatic ecosystem function.

Few non-native aquatic species are known to occur in lakes within the DMRW. The most ubiquitous is Common Carp, found in all assessed lakes. The impacts of Common Carp will be further discussed in subsequent sections in regard to habitat destruction.

Fish regulations, management, and angling pressure impact fish communities in a multitude of ways.

As the numbers of licensed anglers and overall fishing, pressure has increased in Minnesota, declines in catches of quality sized fish, size structure, and age at maturity occurred in many game fishes in Minnesota (Olson and Cunningham 1989; Cook and Younk 1998; DNR unpublished data). The impact of angling pressure on FIBI metrics has not been studied in lakes. **Fish stocking** increases angling opportunities, but stocking may affect fish species abundance or diversity by increasing predator abundance. Most research in the region has focused on the impact of predator stocking to other gamefish populations (Fayram, et al 2005; Knapp, et al 2008). Studies have shown a negative relationship between predator stocking and Yellow Perch abundance, an important forage fish in many Minnesota lakes (Anderson and Schupp 1986; Pierce, et al 2006). Strong Yellow Perch year-classes are thought to buffer small-bodied fishes like minnows and darters to the impact of Walleye predation (Forney 1974; Lyons and Magnuson 1987). Many of the lakes in the Des Moines Watersheds are regularly stocked with Walleye, and some lakes are stocked with other species such as Northern Pike and Yellow Perch. Research by the DNR FIBI Program has found no relationships between predator abundance, Walleye abundance, or stocking rates with a reduction in FIBI score or reduction in overall richness, number of cyprinid species, or intolerant species (J. Bacigalupi, DNR unpublished data, 2015). No relationship was found between Walleye stocking and the abundance of top carnivores metric, but other species stocking has not been evaluated. Fishing pressure, management, and stocking cannot be ruled out as contributing to impairment, but are considered relatively low likelihood on the lakes assessed in the DMRW.

A number of **toxic chemicals** can directly or indirectly affect fish populations. Impacts to fish communities range from direct lethal effects on individuals, altered food web from impacts to forage organisms, and reduced fitness from chronic exposure. Hazardous chemicals such as herbicides, pesticides, fertilizers, and petroleum-based products typically enter the aquatic environment as a result of an unintentional discharge or spill. A desktop review of Minnesota Department of Agriculture (MDA) incident reports indicated several documented spills and investigations within the DMRW (MDA 2016). However, there were no documented fish kills in the lakes assessed that were associated with toxic contamination from agricultural chemical contamination, but impacts from chronic exposure cannot be ruled out.

Chloride is a naturally occurring chemical, which, at high concentration, can be toxic to fish and aquatic plant life. Lakes with exposure to road salt run-off can have elevated chloride levels.

Mercury is another naturally occurring chemical which can be toxic to fish and other aquatic life. Currently mercury levels in fish tissue are used to assess lakes for aquatic consumption use. MPCA and local partners have developed a statewide mercury reduction plan approved by EPA to address these impairments (MPCA 2007). Mercury concentrations that are toxic to fish and other aquatic organisms would need to far exceed the current aquatic consumption standards. Therefore, current standards and actions intended to address aquatic consumption impairment should provide adequate protection to eliminate mercury as a likely candidate cause for the impaired fish community. Based on this

information, toxic chemicals cannot be eliminated as a candidate cause for the impairment, but are of low likelihood and will not be discussed further.

Global climate change is expected to affect fish populations in Minnesota lakes because of expected increases in water temperature, shorter ice cover periods and longer growing seasons, and reduced quantities of oxythermal habitat during summer months. Global climate change and other global or regional stochastic events such as large volcanic eruptions, drought/wet periods, and annual weather are not discussed in this report.

8.4 Summary and evaluation of Candidate Causes for Des Moines River Watersheds Lakes

The candidate causes selected as primary drivers of biological impairments in DMRW lakes that will be discussed in this report are combined into two general categories: 1) excess nutrients and sedimentation and 2) physical habitat alteration and shoreline development. Sedimentation impacts physical habitat availability, and so there is some cross-over between the discussions. Abundant carp and bullheads also impact nutrient levels and physical habitat and will be referred to in each discussion.

8.4.1 Candidate Cause: Excess nutrients and sedimentation

Poor water quality caused by excess nutrients is a driving factor influencing fish communities and the FIBI scores. During FIBI development, the probability of sampling several tolerant species was strongly associated with increasing Total Phosphorus (TP), Trophic State Index (TSI), watershed disturbance, percent agriculture, and negatively associated with FQI. Of the 8 metrics included in the Tool 7 FIBI, 7 are correlated with TP, and 6 are correlated with watershed disturbance variables.

Nearly all of the lakes listed for impairment based on the FIBI are also listed as impaired for aquatic recreation based on the TP, Secchi, and Chlorophyll A measurements by MPCA (Table 2.1 and Draft 2016 Inventory of All Impaired Waters found at: <https://www.pca.state.mn.us/sites/default/files/wq-iw1-55.xls>). Additional information on water quality standards in Minnesota (Minn. R. ch. 7050) can be found at: <https://www.revisor.leg.state.mn.us/rules/?id=7050>.

Research has shown that elevated TP levels significantly affect fish community structure and function in Minnesota lakes (Schupp and Wilson 1993; Heiskary and Willson 2008). Negative effects of eutrophication include increased plant growth, shifts in phytoplankton and zooplankton composition, and decreases in water transparency which lead to changes in the fish community that are detected by FIBI tools. Modeling by Cross and Jacobson (2013) in Minnesota lakes suggests that TP concentrations increase significantly over natural concentrations when land use disturbances occur in greater than around 40% of the watershed area.

Watershed and water quality effects on fish communities are strongly documented (Jeppesen et al. 2000, Drake and Pereira 2002). During FIBI development, increases in urbanization and agriculture were strongly associated with water quality degradation and changes in fish communities (Drake and Pereira 2002, J. Bacigalupi, DNR unpublished data, 2016).

There are several mechanisms by which eutrophication contributes to impaired fish communities. Excess nutrients impact plankton communities which make up the foundation of aquatic food webs. Increased primary production leads to more phytoplankton, reduced light penetration, and fewer rooted aquatic macrophytes. Loss of aquatic plants represents a physical alteration to available habitat which can alter fish community composition over time. Reduced plant cover can impact the success of vegetation dwelling species from a variety of feeding guilds. Decreased light penetration can also reduce

the efficiency of sight-feeding predators like Largemouth Bass and Northern Pike and can result in lower biomass of habitat dependent top carnivores in the community.

Increased phytoplankton can also lead to an unbalanced community with few large bodied zooplankton that are preferred food for forage fish and important to the diet of many young game fish. These conditions favor undesirable planktivorous fish species over predatory game fish, which are expressed over several generations of individual fish. In turn, some planktivorous fish such as Common Carp increase internal loading of nutrients in shallow lakes through foraging behaviors.

Fisheries management plans for lakes in the DMRW frequently identify high nutrient levels as a primary cause of frequent or partial winterkill conditions. High biological oxygen demand (BOD) in shallow lakes causes low wintertime oxygen levels. To compensate for low oxygen levels, wintertime aeration systems are used annually on most lakes. Low oxygen and partial winterkills contribute to high relative biomass of tolerant species such as Common Carp and Black Bullhead, which are tolerant of low oxygen, in many of the DMRW lakes. Common Carp exploit winterkill prone shallow bays for spawning habitat which reduces predation pressure on eggs and larvae (Bajer and Sorensen 2010).

Sedimentation can be caused by a variety of activities and can change available fish habitat. Excess erosion upstream can carry sediments to lakes via inlets, especially in a landscape with extensive cultivation. Development along lakeshores can also result in significant changes to the sediment characteristics in a lake (Francis et al. 2007). Destruction of nearshore aquatic vegetation and removal of woody material which help to stabilize substrates can lead to resuspension and redistribution of sediments. Several of the assessed lakes have Lake Management Plans that discuss sedimentation as a factor impacting spawning substrate and habitat for vegetation growth, primarily from upstream sources. DNR Fisheries researchers are currently investigating the spatial relationship between a variety of habitat measurements and their associated fish communities. Completion of this study is pending and may provide a more clear understanding of the importance of different habitats to the overall fish community living in a lake.

8.4.2 Candidate Cause: Physical habitat alteration and shoreline development

Changes in fish populations are oftentimes linked to available physical habitat, especially along shorelines. Healthy aquatic plant communities, woody or other complex habitat, and diverse substrates provide important benefits to fish communities including providing spawning habitat for many species, protection or refuge areas for juvenile fish, and foraging opportunities. During FIBI development, FQI and dock density were used as measures of structural habitat. However, as discussed in the previous section, FQI is significantly related to water quality (Radomski and Perleberg 2012) and there was a strong correlation in the IBI Tool development lakes between FQI, land use, and water quality variables.

During FIBI development, the probability of sampling tolerant species was negatively correlated with FQI score and the probability of sampling vegetation dwelling and insectivore species was positively correlated with FQI score. Of the 8 metrics included in the Tool 7 FIBI, 7 metrics were correlated with FQI, but none were significantly correlated with dock density. The dock density on Tool 7 lakes used in tool development was much lower than other Minnesota lakes.

Note that there is little research on shoreline development in agricultural landscapes, no relationships were present in the FIBI Tool 7 development set, and in general, there is much lower dock density on lakes in the DMRW than in other parts of the state. Research conducted on other types of lakes has found relationships with shoreline development and habitat variables. A study of class 23 lakes in Minnesota found that the number of seasonal cabins and homes along lakeshores increased six-fold from the 1950's through the 1990's and about two-thirds of nearshore emergent and floating leaf vegetation was lost as development increased on these lakes (Radomski and Goeman 2001). Density of

coarse woody habitat, emergent vegetation, and floating vegetation increased as shoreline development decreased among Wisconsin lakes (Christensen et al. 1996; Jennings et al. 2003). Among lakes in northern Wisconsin, several fish species were linked to specific nearshore habitats during spring, summer, and fall, and residential development altered spatial distribution patterns of fishes in Washington lakes (Jennings et al. 1999; Scheuerell and Schindler 2004). DNR fisheries research on a broader set of lakes, primarily in Central and Northern Minnesota, has found the likelihood of sampling intolerant species is diminished at dock densities exceeding 10 docks/km of shoreline (J. Bacigalupi, DNR 2016 unpublished data).

The importance of aquatic plants as fish habitat was also discussed in the preceding section as they are strongly influenced by water quality.

9 Evaluation of Candidate Causes

9.1 Impaired lakes within the Des Moines River Watersheds

9.1.1 Fish based lake IBI and metric scores

Table 4.1 Fish IBI metric summary. Raw metric values for the lakes assessed with the FIBI in the Des Moines River Watershed. # Tol=number of tolerant species sampled, # Insect=number of insectivore species sampled, # Small Benthic=number of small benthic species sampled, # Veg= number of obligate vegetation dwelling species sampled, Ppn Veg NS=Proportion of Vegetation Dwelling individuals sampled in nearshore gears, Ppn Insect TN= Relative Biomass of Insectivores in Trapnets, Ppn Tol TN= Relative biomass of Tolerants in Trapnets, Ppn HabTC GN= Relative Biomass of Habitat Dependent Top Carnivores Gillnets. “NA” indicates no gill nets set for that lake due to the lake depth – the FIBI score is scaled for 7 metrics for Bright, Lime, and Corabelle.

DOW	Lake Name	Year	FIBI Score	# Tol	# Insect	# Small Benthic	# Veg	Ppn Veg NS	Ppn Insect TN	Ppn Tol TN	Ppn HabTC GN
17002200	Cottonwood	2012	18	3	4	1	1	0.00	0.19	0.48	0.14
17002200	Cottonwood	2012	17	4	5	1	1	0.00	0.19	0.48	0.14
17006000	Talcot	2014	35	6	12	4	3	0.03	0.21	0.55	0.22
17006000	Talcot	2016	29	6	11	4	3	0.02	0.21	0.61	0.07
42004700	Yankton	2014	6	6	6	1	1	0.00	0.05	0.81	0.12
46005200	Bright	2007	3	6	4	0	1	0.00	0.01	0.44	NA
46005200	Bright	2015	14	5	5	1	1	0.00	0.24	0.67	NA
51001800	Buffalo	2015	32	3	3	1	2	0.35	0.00	0.87	0.35
46010300	Temperance	2013	15	5	3	0	1	0.00	0.48	0.64	0.10
51002400	Lime	2013	17	4	4	1	1	0.00	0.26	0.84	NA
51004300	Fox	2014	19	5	6	2	1	0.00	0.34	0.95	0.05
51004600	Shetek	2007	16	6	9	1	2	0.01	0.16	0.71	0.23
51004600	Shetek	2012	21	6	11	2	2	0.00	0.24	0.57	0.20
51005400	Corabelle	2014	12	5	3	0	1	0.00	0.20	0.48	NA
51006300	Sarah	2008	0	6	6	1	0	0.00	0.03	0.72	0.00
51006300	Sarah	2014	18	4	4	1	1	0.30	0.01	0.97	0.00
51008200	Currant	2013	5	4	2	0	1	0.00	0.16	0.80	0.00
53002000	East Graham	2011	8	6	9	1	1	0.00	0.03	0.94	0.17
53002100	West Graham	2014	8	5	6	1	1	0.00	0.01	0.90	0.16

9.1.2 Data evaluation for Candidate Causes

Most of the lakes assessed had just one FIBI survey, but nearly all of the scores were well below the impairment threshold.

The primary anthropogenic stressor on Des Moines River Watershed lakes is eutrophication. Based on ten-year seasonal average data (MPCA, 2016), of lakes assessed as impaired, transparency averaged 0.3 meters (range 0-1 meters), excluding Lake Sarah (3,900 ppb) chlorophyll-a averaged 103 ppb (range 43-177 ppb), and total mean seasonal phosphorous averaged 174 ppb (range 62-384 ppb). The impaired lakes averaged a TSI score of 76 (range 67-88) and all were considered eutrophic (TSI >60) (Heiskary and Wilson 2005). The historic (pre-European settlement) TP interquartile range for Western Corn Belt Plains lakes was 56-89 ppb (Heiskary and Swain 2002). Eutrophication in DMRW lakes has

been driven by nutrient loading from agriculture. The dominant land use type was agriculture, which averaged 67% across lake-sheds and made up 82% of the entire DMRW. On average, Tool 7 lakes used during FIBI development that were located in watersheds with approximately 40% disturbance were classified as impaired (Figure 4.2). Changes in water quality associated with land use were consistent with modeling by Cross and Jacobson (2013) in Minnesota lakes. Their research suggests that TP concentrations increase significantly over natural concentrations when land use disturbances occur in greater than approximately 40% of the watershed area, with shallow lakes most sensitive to increased nutrient loading. The effects of nutrient loading have cascading effects within lakes as discussed above.

Figure 4.1. Overall land use for the Des Moines River Watershed (NLCD 2011).

Developed includes land classified in any of the developed categories in NLCD.

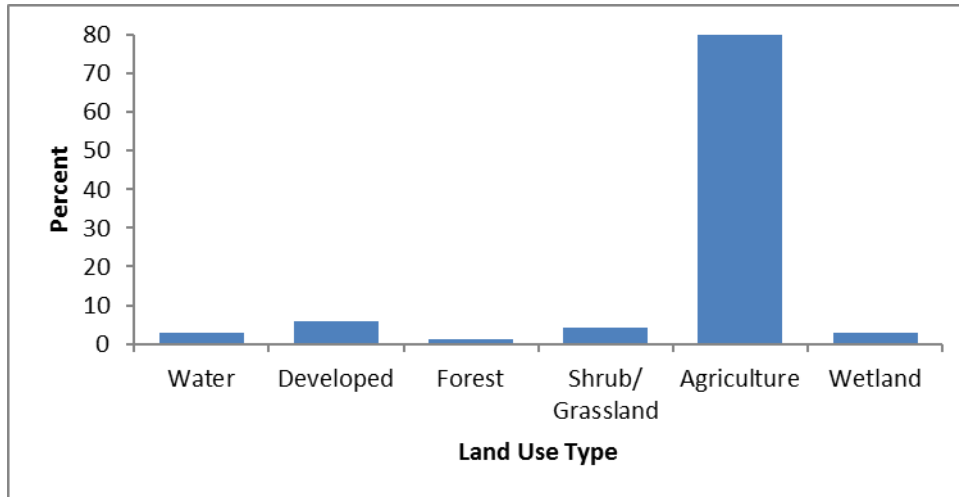


Table 4.2 Lake-shed land use. Summarized land use from the contributing watersheds for the 13 lakes listed as impaired per the FIBI in Des Moines River Watershed (NLCD 2011).

DOW	Lake Name	Contributing watershed Acres (Lake:WS Ratio)	% Open Water	% Developed	% Forest	% Grass/Shrub	% Agriculture	% Wetland
17002200	Cottonwood	2565 (1:17)	10	7	<1	9	72	2
17006000	Talcot	332,405 (1:381)	4	5	<1	6	81	3
42004700	Yankton	1193 (1:3)	36	15	<1	1	46	2
46005200	Bright	12963 (1:20)	8	5	<1	3	77	7
46010300	Temperance	995 (1:6)	18	24	3	6	49	0
51002400	Lime	37767 (1:116)	3	6	<1	4	82	5
51004300	Fox	568 (1:3)	36	2	<1	12	47	3
51004600	Shetek	83121 (1:24)	10	5	<1	5	76	3
51005400	Corabelle	490 (1:5)	22	4	2	1	69	2
51006300	Sarah	12788 (1:11)	13	5	<1	4	76	2
51008200	Currant	1929 (1:5)	33	6	<1	17	42	2
53002000	East Graham	3165 (1:6)	18	4	1	2	74	1
53002100	West Graham	11636 (1:22)	7	6	1	2	81	3

Lakes designated as impaired based on the FIBI averaged 4.9 tolerant species per lake. Tolerant species captured included Bigmouth Buffalo, Black Bullhead, Common Carp, Green Sunfish, Fathead Minnow and Orangespotted Sunfish. On average, 71% of the biomass in the trap net catches for the impaired lakes consisted of tolerant species (Table 4.1). The high proportions of tolerant species by weight were driven primarily by Black Bullhead and Common Carp, which on average made up 29% and 35% of the catch, respectively. On average, habitat dependent top carnivores only made up 12% of the gill net catch by weight for the impaired lakes (Table 4.1). Top carnivores captured in the gill nets were Black Crappie, Channel Catfish, Largemouth Bass, Northern Pike, Walleye, and White Crappie. Because Walleye populations on most lakes measured with FIBI Tool 7 are maintained through stocking, walleyes are excluded from the top carnivore metric score in FIBI Tool 7. Note that Lake Sarah and Talcot Lake both support naturally reproducing Walleye populations and FIBI scores were calculated both with and without their inclusion in the top carnivore metric calculations with minimal impact on the score.)

During the development of FIBI Tool 7, the number of tolerant fish species was found to be correlated with water chemistry variables (TP and TSI), watershed land use variables (percent agriculture and percent disturbance), and aquatic plant variables (number of plant species and FQI). TP, TSI, percent agriculture, and percent disturbance had a positive correlation with a higher number of tolerant species. Conversely the number of plant species and the FQI score showed a negative correlation to the number of tolerant species captured. The number of tolerant species metric in the development set was a good indicator for eutrophication, watershed disturbance, and the loss of aquatic plant habitat.

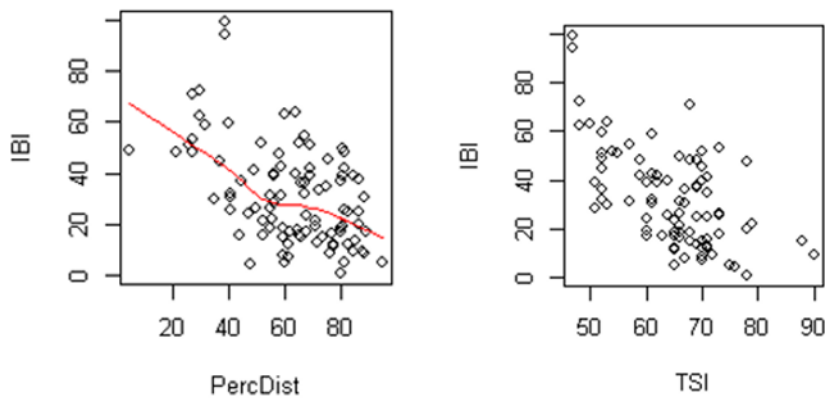
During the development of FIBI Tool 7, the relative biomass of tolerant fish species in the trap nets was correlated with TP, TSI, percent agriculture, percent disturbance, the number of plant species and the FQI. The relative biomass of tolerant species had a positive correlation with TP, TSI, percent agriculture, and percent disturbance and an inverse correlation with the number of plant species and the FQI. The relative biomass of tolerant species was a good indicator for eutrophication, watershed disturbance, and the loss of aquatic plant habitat.

During the development of FIBI Tool 7, the relative biomass of top carnivores in the gill nets was correlated with TP, TSI, the number of plant species and the FQI. The relative biomass of top carnivores was positively correlated with the number of plant species and the FQI and inversely correlated with TP and TSI. The relative biomass of top carnivores was a good indicator for eutrophication and the loss of aquatic plant habitat.

During the development of FIBI Tool 7, eight metrics were selected that correlated with changes in land use classifications and with FQI. Average TP and TSI were not used to select metrics, but showed a similar pattern and were strongly correlated with FIBI metrics and the overall FIBI score (Figure 4.2).

During the development of a Biological Condition Gradient model for Tool 7 lakes, the total number of tolerant species and the proportions of tolerant species increased with increasing degradation (Gerritsen and Stamp 2014).

Figure 4.2 Relationship with FIBI Score and Percent Disturbance and FIBI Score and TSI for FIBI Tool 7 tool development lakes. Seventy six lakes, J. Bacigalupi, unpublished data, 2014.



DNR fisheries management plans systematically identified sedimentation, erosion, and nutrient loading as limiting factors affecting aquatic habitat quality. Sources of sedimentation and erosion cited were unstable banks on lakes and contributing streams, row crops planted to the edge of the lake or contributing streams, and lack of vegetated buffers along lake and contributing streams. The proximity of planted row crops, drainage ditches, and intensive agriculture within lake-sheds were frequently identified as sources of nutrient runoff in the fisheries management plans.

Lack of in-lake cover and spawning habitat, specifically nearshore aquatic plant habitat, was another limiting factor for fish populations consistently identified in the fisheries management plans. DMRW lakes are typically shallow, productive lakes with naturally lower water clarity. Shallow lakes are prone to the re-suspension of sediments and nutrients from wind and wave action. Because aquatic macrophyte growth is limited by light penetration (Hootsmans 1999), loss of vegetative cover has been driven by algal blooms from eutrophication, and high turbidity as a result of sedimentation. Loss of submerged plant cover is exacerbated by the foraging activity of Common Carp and bullhead (Zambrano et al. 2001) through the resuspension of sediments and nutrients, which reduces light penetration (Breukelaar et al. 1994), and the uprooting of submerged macrophytes (Hootsmans 1999).

Emergent and floating-leaf vegetation mapping surveys were completed on four lakes: Cottonwood, East Graham, Sarah, and Yankton in 2015. Within those lakes, no floating-leaf vegetation was found and cattails and bulrush were very limited, ranging from 0.4 acres to 10 acres (Table 4.2). DNR and other researchers are working on models that develop expected emergent stands given the lake morphometry, fetch, and ecoregion but these models are still in development. In a few instances, historical survey information is available for comparison, which can assist with determining if emergent vegetation is naturally limited or has been impacted by human activities.

Several methods have been developed to quantify the status of riparian lakeshore habitat and to index the amount of human development in these areas. Dock density can be obtained easily from aerial photography (Radomski et al 2010) and computer analysis can be applied to quantify docks in many lakes quickly (Beck et al 2013). The dock density index is a surrogate for the measurement of physical habitat (i.e., the amount of tree cover near the lake, the amount of overhanging woody cover at the shoreline, or presence of emergent or floating-leaf vegetation). Dock density was considered in selecting FIBI metrics, although none were significant on Tool 7 lakes, which are in general less developed than deeper lakes. Ongoing research projects by DNR-Fisheries have found changes to fish species sampled detectable at about 10 docks per kilometer of shoreline.

“Score the Shore” (STS) survey protocols were developed by DNR – Ecological and Water Resources in 2013 as a rapid assessment of riparian lake habitat (Perleberg et al 2015) and adopted for use by DNR-

Fisheries beginning in 2015. Aquatic, upland (Shoreland), and transition zone (Shoreline) habitats are assessed and the lake-wide score (ranging for 0 to 100) is the sum of three habitat scores, which are equally weighted. STS surveys provide a lake-wide lakeshore habitat score that can be used to monitor changes in a lake over time and to compare lakes within and between watersheds.

STS surveys were conducted on six of the DMRW lakes. Surveyed lakes averaged a score of 78/100 (range 70-90) (Table 4.2). STS scores are summed from three component scores: shoreland, shoreline, and aquatic. In all surveyed lakes the aquatic scores suggested that there was minimal clearing of vegetation and woody habitat; the shoreline scores suggested some clearing of vegetation along the shoreline area; the shoreland scores were lowest indicating that on some lakes the upland area lacked trees, shrubs, or natural ground cover—mowed grass or agricultural lands were common. To help determine the impacts of development versus shoreline habitat that is naturally less complex, the difference between developed and undeveloped scores is presented. All lakes with data have a lower average site score at developed sites versus undeveloped sites, the difference is greatest on Lake Shetek, Cottonwood Lake, and Sarah Lake where the developed sites scored 31, 28, and 22 points lower on average than the undeveloped sites. DMRW lakes averaged 1.5 docks/km (range 0-6.5 docks/km), which is low compared to deeper lakes (Table 4.2). Shetek and Sarah Lakes had the highest density of docks, with over six docks per kilometer of shoreline. Based on STS scores and the number of docks/km, shoreline habitat is not likely a significant stressor affecting fish communities on most of the lakes in the Des Moines Watersheds.

Table 4.2 Shoreline habitat surveys. Number of docks (Beck et al. 2013), Score the Shore (STS) scores, and acres of emergent vegetation (EV) mapped for the 12 lakes assessed as impaired per the FIBI in the Des Moines River Watershed. Lakes with blank STS or EV values were not surveyed.

DOW	Lake Name	Docks per Shoreline km	# of Docks	STS Shoreland, Shoreline, Aquatic Zone Mean Site Score	STS Developed, Undeveloped Mean Site Scores	STS Mean Site Score	Acres of Emergent Vegetation (Percent of Littoral Area)
17002200	Cottonwood	1.79	10	21,23,27	59,81	71	5.8 (7.5% LA)
17006000	Talcot	0.29	4				
42004700	Yankton	3.66	28	20,23,29	70,83	72	0.4 (<1% LA)
46005200	Bright	0.28	2	25,32,27	77,91	83	
46010300	Temperance	0.29	1				
51002400	Lime	1.82	12				
51004300	Fox	0.38	2				
51004600	Shetek	6.46	368	21,23,28	62,93	73	
51005400	Corabelle	0.80	2				
51006300	Sarah	6.32	83	24,27,29	67,95	79	10 (<1% LA)
51008200	Currant	0.16	1				
53002000	East Graham	0.00	0	27,31,32	87,98	90	1.5 (<1% LA)
53002100	West Graham	1.02	6				

Fourteen lakes assessed with the FIBI were also assessed with the Lake Plant Eutrophication IBI. The Plant IBI is currently provisional so no official designations were made based on the Plant IBI. The thresholds for Plant and Fish impairments respond uniquely as different mechanisms and endpoints affect plant and fish populations, but the Plant IBI data generally supported the FIBI designations. Based on the Plant IBI, four lakes were not supporting aquatic life use due to eutrophication (Table 2.4). Four lakes were classified as insufficient information to make a determination of meeting aquatic life standards due to mixed results between surveys or scores below the threshold using older survey data (greater than 10 years old).

Aquatic plants most common in lakes within the watershed include sago pondweed (*Stuckenia pectinata*), coontail (*Ceratophyllum demersum*), muskgrass (*Chara*), bulrush (*Schoenoplectus*), river bulrush (*Bolboschoenus fluviatillis*), and species of narrow-leaf pondweed (*Potamogeton spp.*). Coontail and sago pondweed are turbid-water tolerant species. Lakes in this ecoregion generally had low species diversity and lower floristic quality (Table 4.3). Lakes in this ecoregion tend to have less diverse plant communities than lakes in ecoregions in northcentral Minnesota. The lakes below the impairment threshold for the Plant IBI had very low lake plant diversity. In addition, plant communities in these lakes were missing sensitive aquatic plant species.

Table 4.3 Summary of plant IBI in Des Moines Watershed lakes. Lakes surveyed with lake plant surveys and statistics on richness (R), floristic quality index (FQI), and percent difference from impairment thresholds.

	Mean R (range)	Percent Difference in R from Threshold	Mean FQI (range)	Percent Difference in FQI from Threshold
All Assessed Lakes in Des Moines Watershed- Shallow	2.2 (0-6)	-44.7 (-100 to 50)	6.3 (0-11.8)	-16.4 (-100 to 53.8)

10.0 Conclusions and recommendations

Table 5.1 summarizes the probable primary stressors and related information in the DMRW for each lake.

The primary stressor on DMRW lakes is eutrophication driven by nutrient run off from intensive agriculture within contributing lake-sheds. Eutrophication has cascading effects within lake systems causing loss of water clarity, negative impacts on the aquatic plants for fish habitat, and can lead to fish communities dominated by tolerant species such as Common Carp and Black Bullhead. Lakes with high numbers of Common Carp and Black Bullhead exacerbate water clarity issues caused by eutrophication by re-suspending nutrients and sediments through foraging activity.

The main method for improving fish community composition and resulting FIBI scores would be to limit nutrient loading and sedimentation in DMRW lakes. Some methods for limiting nutrient loads include implementing best management practices and improving vegetated buffers around lakes and along contributing streams. If nutrient loading was reduced, and water clarity improved, plants could be established.

Reducing Common Carp and bullhead biomass would directly improve the relative biomass of insectivores. Carp and bullhead reductions would also simultaneously improve water clarity and reduce

the rate at which submerged aquatic plants are uprooted. Increases in aquatic vegetation would improve other metrics, in particular the two insectivore based metrics which are typically driven by Centrarchids in Tool 7 lakes, and the two vegetation dwelling based metrics. However, in most lakes there is no feasible mechanism for direct reductions in carp or bullhead biomass. Direct reductions of carp and bullheads using large-scale seining and netting operations directly was attempted by DNR Fisheries as a programmatic action historically and by some commercial operations for decades with very poor long-term results. A less intensive option that may be considered in select lakes may be blocking access to carp spawning areas in suitable lakes which has been effective in some lakes where shallow bays with narrow openings are the primary spawning area (Bajer and Sorensen 2010). Reclamation projects are expensive and require treating an entire watershed, although with drain tile connections, there are very few lakes where long-term removal of Common Carp or other undesirable fish is feasible.

Managing water levels to ensure access to critical spawning areas for Northern Pike is likely to increase abundance of Northern Pike. However, the Windom Fisheries Management Area indicates there are not opportunities on lakes in this watershed to manage water levels for Northern Pike.

Conclusions in the DMRW lakes are consistent with prior research that indicates water quality and watershed effects have a more significant influence in structuring the fish community than shoreline and nearshore habitat (for example Jennings et al. 1999, Sondergaard and Jeppesen 2007).

While shoreline development reduces the availability and quality of shoreline habitat, shoreline disturbance is likely a relatively small contributor to the fish impairment in most DMRW lakes. Estimators of shoreland disturbance and the number of docks per kilometer of shoreline are below levels that are likely to impact fish and plant communities based on preliminary research. However, aquatic vegetation is extremely limited and effort should be focused on protecting existing emergent vegetation and riparian buffers.

Given the naturally lower species richness in the Des Moines drainage lakes, goals for fish community should not be focused on richness. Composition of the fish communities, with more representation of vegetation-dwelling and insectivore species and lower proportions of tolerant species is a more realistic objective.

Table 5.1 Summary of primary stressors by lake for lakes impaired based on the FIBI. Water quality is based on water chemistry data (TSI > 60 is considered a probable stressor) and contributing land use is used as supporting information (%Disturbance > 40%). Lakes are listed as probable for shoreline habitat condition if either or both of the following are true: STS < 75 and the difference between site scores for developed and undeveloped sites >20, and/or dock density > 10 docks/km). Lakes are listed as probable for lack of physical habitat if either or both of the following are true: below threshold for Plant Eutrophication IBI and/or emergent and floating leaf vegetation was mapped and the acres of emergent and floating leaf habitat (<1% of littoral area of the lake). Lakes are listed as probable for abundance of carp and/or bullhead if either of the composite trap net and gill net catches >40% biomass of Common Carp and/or Black Bullhead. Historic winterkill information and other considerations are based on survey data, lake management plans, and personal observations from DNR Windom Area Fisheries staff.

AUID (DOW #)	Lake Name	Water Quality Habitat limiting	Physical Habitat limiting		Fish	Comments on historical winterkill	Other Considerations and comments
			Poor water quality-eutrophication	Poor Shoreline habitat condition			
17002200	Cottonwood	○ / ●	●	○	●	Historic, none since aeration began in 1983.	Extreme water fluctuations. Water quality of water received from Warren Lake adversely impacts Cottonwood L.
17006000	Talcot	●	○	●	●	Aerated since 1991.	Strong riverine connections and very large contributing watershed, natural walleye population. Commercial removal of carp and buffalo.
42004700	Yankton	●	○	●	●	Historic, none since aeration began in 1983.	Light to moderate bank erosion in numerous areas of the shoreline, and runoff is received from Balaton City streets. Lake is at the top of watershed with higher potential for improvement.

AUID (DOW #)	Lake Name	Water Quality Habitat limiting	Physical Habitat limiting		Fish	Comments on historical winterkill	Other Considerations and comments
			Poor water quality-eutrophication	Poor Shoreline habitat condition			
46005200	Bright	●	O	NA	●	Historic but none recently.	Shallow average depth and overall fertility contribute to low winter DO levels and partial winterkills.
46010300	Temperance	●	O	●	●	Historic partial, perhaps in 2000-01.	Very shallow (4.5' maximum depth - 2001), which contributes to low DO levels and occasional winterkill. Area Fisheries noted that the lake is fringed with emergent vegetation. No submerged vegetation in most recent vegetation survey in 2011. 1948 survey noted turbidity and rough fish contributing to poor vegetation.
51002400	Lime	●	O	●	●	Some historic, aerated since 1997.	Areas of eroding banks and concern about septic impacts noted by Area Fisheries. Natural reproduction of Northern Pike and occasionally Yellow Perch. No plants in most recent vegetation survey (2010), in 1948 only sago pondweed was sampled.
51004300	Fox	●	O	O	●	Frequent historically, aerated since 2010.	Sporadic removal of carp, buffalo, and bullheads by a commercial operator.

AUID (DOW #)	Lake Name	Water Quality Habitat limiting	Physical Habitat limiting		Fish	Comments on historical winterkill	Other Considerations and comments
			Poor water quality-eutrophication	Poor Shoreline habitat condition			
51004600	Shetek	●	●	○	●	Some historic, very little since aerator installed in 1974.	Large watershed ratio. Previous Clean Water Partnership work to reduce phosphorus through BMPs, diversion removal, and centralized sewer installation. Some commercial removal of fish.
51005400	Corabelle	●	○	○	○	Some historic, partial in 2010-2011, aerated.	Areas of eroding banks with row crops planted up to the shoreline were noted by Area Fisheries. Subsurface drain tiles connect the lake to a larger watershed area.
51006300	Sarah	●	○	●	●	Some historic, none since 1979. Aerated since 1981.	Native walleye strain – not suitable spawning habitat for other top carnivore species. Some commercial removal of fish.
51008200	Currant	●	○	●	●	Some historic, no severe winterkill since aerator installed in 1981.	Severe bank erosion and sedimentation caused by high water levels. Historical surveys noted patchy areas of hardstem and river bulrush – no vegetation in most recent 2011 vegetation survey. Commercial removal of fish.

AUID (DOW #)	Lake Name	Water Quality Habitat limiting	Physical Habitat limiting		Fish	Comments on historical winterkill	Other Considerations and comments
			Poor water quality-eutrophication	Poor Shoreline habitat condition			
53002000	East Graham	●	○	●	●	Historic, none since aeration began in 1985.	Area fisheries identified opportunities to improve fish spawning habitat.
53002100	West Graham	●	○	○	●	Aerated since 1978. Partial winterkill in 2000-20001.	Commercial removal of buffalo, carp, and bullheads.

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