

Skunk Creek Watershed

Minnesota's Lake Superior Basin

Project objectives

Effectiveness monitoring provides a scientific framework for evaluating the outcomes of watershed restoration and conservation projects and for applying lessons learned to improve future watershed management efforts. Through a partnership between the Minnesota Pollution Control Agency (MPCA), local watershed organizations, and other resource management partners, monitoring is being conducted in selected watersheds across Minnesota to assess the effectiveness of projects implemented with support from Clean Water Act Section 319 and related funding programs. Monitoring activities are designed to evaluate multiple components of watershed health, including hydrology, geomorphology, connectivity, water quality, and biological condition, providing a comprehensive assessment of watershed response to restoration efforts. This report summarizes effectiveness monitoring activities conducted in the Skunk Creek Watershed during the 2025 open water season and presents preliminary findings and observations.

Restoration and implementation

Restoration and best management practice (BMP) efforts implemented in the watershed over the past decade are detailed in the 2024 annual report and include implementation of agricultural BMPs, roadway runoff containment, removal of barriers to fish passage (i.e., dams and culverts), and full-scale stream restorations. Future projects, currently in the planning stages, include ongoing BMPs on private land and a culvert replacement on Elim Creek to address channel incision, streambank erosion, and overall streambank and hillslope stability at a state recreational trail (Soo Line) crossing.

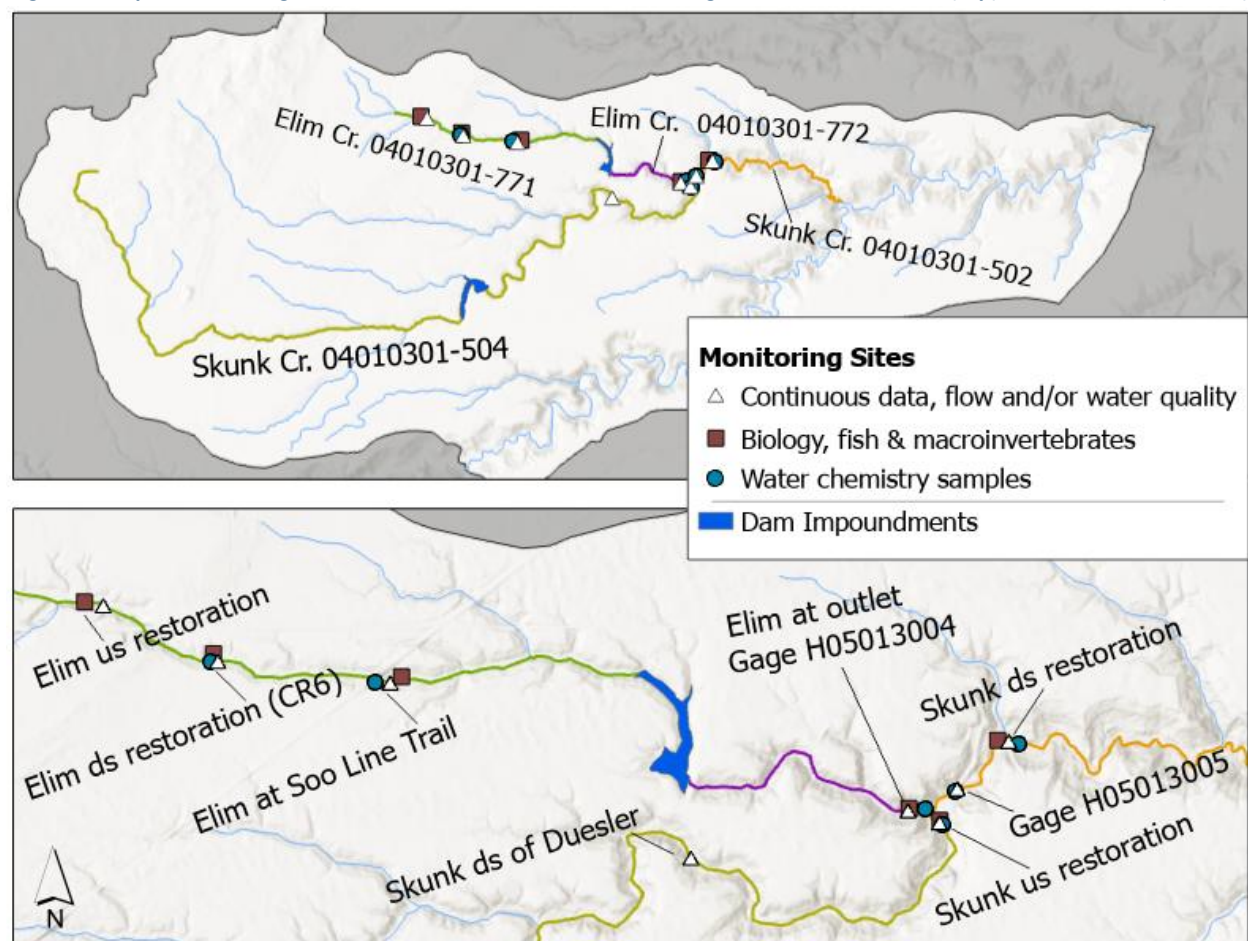
Monitoring progress and results

In 2025, monitoring focused mostly on hydrology, water quality, aquatic habitat, and biological conditions as certain components of the watershed health framework have a greater focus in given years. Monitoring locations and associated data identifiers are provided in Table 1 and Figure 1.

Table 1. Monitoring site identification numbers for water quality samples, continuous hydrology/water quality, and biological samples.

Monitoring Site Name	Water Quality Sample ID	Continuous Data ID	Biological Site ID
Skunk ds restoration	S005-617	H05013003	25LS009
Skunk at CR103	S002-600	H05013005	-
Skunk us restoration	S011-857	W05013009	11LS059
Skunk ds of Duesler	-	W05013010	-
Elim at outlet	S007-453	H05013004	11LS072
Elim at Soo Line	S002-601	H05013006	21LS027
Elim ds restoration (CR6)	S017-299	W05013007	21LS028
Elim us restoration	-	W05013011	25LS011

Figure 1. Map of monitoring sites in the Skunk Creek Watershed noting stream Watershed IDs (top) and site names (bottom).



The MPCA recognizes two temperature types: coldwater (2A) and non-coldwater (2B) for the purposes of fish and macroinvertebrate classification and community expectations. Additionally, numeric and narrative water quality and biological standards are set in state rule for each of the two stream types. Skunk Creek and Elim Creek are both designated coldwater (2A) streams and have set expectations for supporting cold-water species. Monitoring and analyses were designed accordingly; and the terms *coldwater* and *cold-water* are reported in line with the above definitions.

Hydrology

Streamflow data is collected at two locations in the watershed: Skunk Creek gage H05013005 and Elim Creek gage H05013004 (Figure 1). Historical flow records are available for the Skunk Creek gage for years 2009-2013 (pre-restoration project years) and 2020-2024 (post-restoration), while Elim Creek is a newer gage, installed in the fall season of 2024. Flows for the 2025 season were not calculated at either location due to the development of new and updated water level-stream flow rating curves at both sites. Flows for the 2025 season will be reported in one to two years when the new rating curves are complete.

Skunk Creek gage H05013005

In 2025, the water level sensor was moved to the upstream side of the road crossing where a flatter water surface there would result in improved water level data and a correspondingly improved rating curve (water level to streamflow relationship). Water level data was collected from the estimated ice-

out date of April 3rd to estimated ice-in on November 16th. Eight flow measurements were collected during the season, and a new rating curve (Rating 3.0) was started.

Flow data captured low to normal snowmelt conditions. A few rainfall events caused minor to moderate rises in streamflow during May and June, though major flash flooding did not occur. The highest preliminary estimated stream discharge was 95 cfs, recorded on May 2nd following just over one inch of cumulative rain over a five-day period.

Elim Creek gage H05013004

An in-stream water level sensor was installed on April 10th, five days after ice-out, and collected data through November 6th when it was removed. Eight flow measurements were collected during the season and will be used along with 2024 measurements and future measurements to create a rating curve (Rating 1.0).

Elim Creek water level data captured the same May and June precipitation events and similar dry periods as described for Skunk Creek. The Elim Creek drainage area is smaller; therefore, the magnitudes of the event peaks were lower compared to those recorded on Skunk Creek. Because the water level sensor was installed several days after ice-out, the snowmelt peak was not recorded at this location.

Hydrology data storage and analysis

The 2025 streamflow data will be incorporated into the analysis methods outlined in the 2024 annual report, following the completion of the rating curves and subsequent stream flow calculations for both gage sites. These results will be reported in a future annual report.

Geomorphology

Fluvial geomorphology surveys continued in 2025, expanding on the geomorphology dataset reported out in the 2024 annual report. In 2025, Minnesota Department of Natural Resources (DNR) surveyed Skunk and Elim Creek stream reaches with recently completed or proposed restorations. An as-built survey was completed on Elim Creek at the County Road 6 culvert-to-bridge replacement site. The data will be compared to pre-restoration surveys and could be used for future effectiveness monitoring efforts. Additionally, a pre-restoration survey was completed on Elim Creek at the Soo Line recreational trail crossing in preparation for a proposed culvert replacement project. The pre-restoration data for the Soo Line will be used to define elevations of structures and the stream thalweg (a line connecting the deepest points along a stream/river) and provide boundary conditions to inform future crossing and stream restoration designs for the site.

Continuous water quality

Water temperature

A main watershed goal identified by local and state watershed planners is to maintain the Class 2A coldwater expectations and support cold-water species such as brook trout (*Salvelinus fontinalis*) in Skunk and Elim Creeks. Water temperature measured at 15-minute intervals was collected at seven locations (Figure 1, Table 2) in 2025. Changes from the 2024 monitoring plan included discontinued monitoring of water temperature at two locations in 2025: Duesler Creek at the Soo Line crossing and Skunk Creek at the County Road 103 crossing.

The 2025 observations were added to historical thermal statistic datasets (2006 to 2024) and compared to the 2024 findings. The variables used to measure thermal support of cold-water fish species include the average summer (June through August) water temperature and the percentage of time (Growth %) that summer temperatures are in an optimal range to support brook trout, or in ranges that cause stress

or become lethal to brook trout under prolonged periods. Thermal classes were assigned based on these combined statistics.

The 2025 average summer stream temperature was colder at all seven stations than reported in 2024 (Table 2). While *Growth %* remained stable at most stations, changing by only a few percent, there was a notable increase (+19%) at primary station *Elim at outlet*. Based on the statistics shown in Table 2, all three sites in Elim Creek reach 04010301-771 (headwaters to Elim dam) were within thermal class 4, which indicates it was cold enough to support trout and other cold-water species. The outlet location on Elim Creek (WID: 04010301-772) was within thermal class 3 (frequently supports cold-water fish but in lower densities) in 2025 but within thermal class 2 (more suitable to support a mix of cold, cool, and warm-water species) the previous year. Skunk Creek was warmer than Elim Creek and most suitable to support a mix of cold, cool, and warm-water species for both years.

Table 2. Temperature metrics compared for the 2024 and 2025 seasons; colors represent different thermal classes within MPCA's Northeast Minnesota thermal classification.

Site	Growth % 2024/25	Stress % 2024/25	Lethal % 2024/25	Avg Temp (Celcius) 2024/25	Thermal Class (Northeast MN) 2024/25
Elim us restoration	100/99	0/1	0/0	15.3/13.3	4/4
Elim ds restoration (CR6)	95/94	5/6	0/0	16.7/15.9	4/4
Elim at Soo Line Trail	97/98	3/2	0/0	16.7/15.8	4/4
Elim at outlet	68/87	32/13	0/0	18.5/17.1	2/3
Skunk ds of Duesler	--/67	--/32	--/1	--/18.7	--/2
Skunk us restoration	66/69	33/31	1/0	19.2/18.7	2/2
Skunk ds restoration	69/75	30/25	1/0	18.9/18.0	2/2

Thermal Class 2: Can support Brook Trout/other coldwater species, often a mix of cold, cool, and warmwater taxa

Thermal Class 3: Frequently supports Brook Trout and other coldwater species, lower relative densities

Thermal Class 4: Frequently supports Brook Trout and other coldwater species, higher relative densities

Stream turbidity

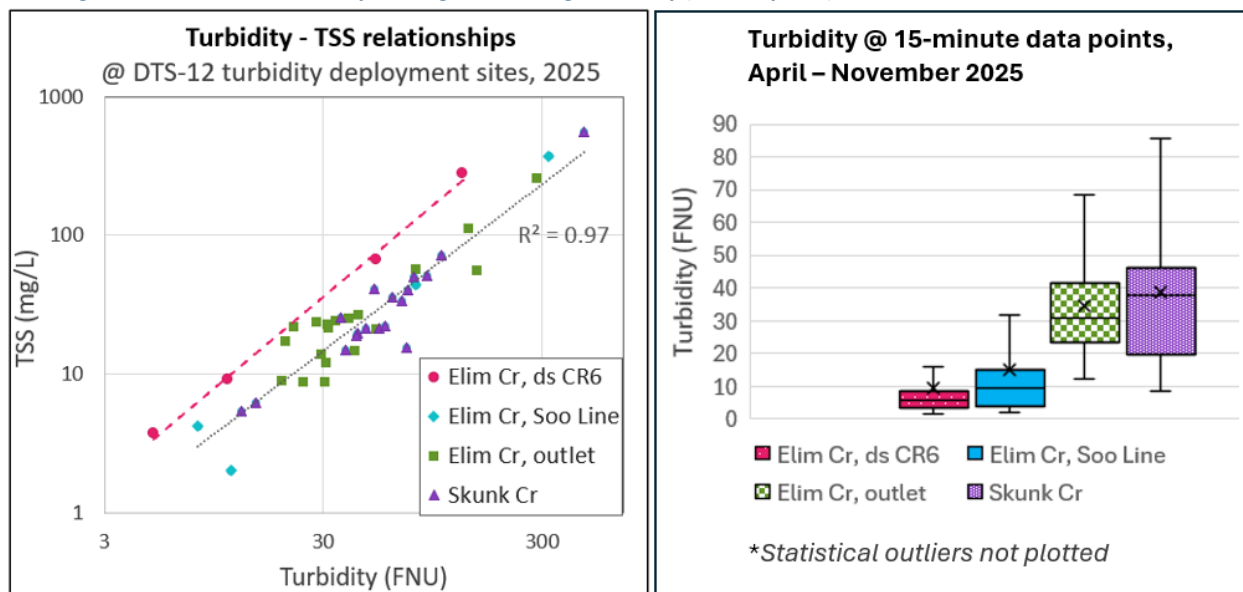
Continuous turbidity sensors (FTS model DTS-12) recording at 15-minute intervals were deployed at four locations: 1) Elim ds restoration CR6, 2) Elim at Soo Line Trail, 3) Elim at outlet, and 4) Skunk ds restoration in 2025.

Turbidity results (Figure 2, right) show an increase longitudinally downstream in Elim Creek between the headwaters (red box plot), dam-influenced middle reach (Soo Line, blue box plot), and the outlet (green box plot). The greatest increase is observed between the Soo Line site and Elim outlet site. Higher turbidity at the outlet site is attributed to high erosion rates associated with both in-channel and streambank erosion within the Elim outlet reach, as was identified in the 2024 geomorphology findings.

Turbidity readings in Skunk Creek, located 0.25 miles downstream of the Elim-Skunk , show another slight increase in turbidity. While multiple restorations have been completed in this section of Skunk Creek, geomorphology results shared in 2024 identified several areas that continue to contribute sediment through in-channel and streambank erosion.

A TSS-turbidity relationship (Figure 2, left) is being developed for the four continuous turbidity sensor sites and will be improved with future data collection, as current findings are based on a small dataset. Preliminary results suggest through the scatter of points that the TSS-turbidity relationship is different in the headwaters (Elim ds restoration CR6) compared to the three downstream sites. Lower turbidity relative to TSS observed at the headwaters site may be related to the sandier soils and bed materials found at that location compared to more clayey geology downstream as larger particles scatter light less per unit of mass. A preliminary regression based on forty-one paired data for the remaining three sites shows a strong TSS-turbidity relationship ($r^2 = 0.97$).

Figure 2. Continuous turbidity sensor results include a preliminary TSS-turbidity relationship (left) and box plots (right) showing the distribution of turbidity readings and average turbidity (noted by an x).



Discrete (sampled) water quality

In 2025, Carlton SWCD collected water quality samples and secchi readings at each of the two primary water quality sampling sites (Skunk ds restoration and Elim at outlet), which are co-located near the flow gages. Samples were collected during high, moderate, and low flow conditions. Samples were analyzed for TSS, total phosphorus (TP), chloride (Cl), total Kjeldahl nitrogen (TKN), and nitrate-nitrite. Additional TSS and TP samples were collected five times, capturing varying flow regimes and seasonality, at three additional monitoring locations (Figure 1 water chemistry samples).

Water quality results

Water quality sample results for the 2025 open water season are summarized in Table 3. As reported in the 2024 data analysis, Cl and nitrate-nitrite levels were again below the water quality target (criteria) in both Skunk and Elim Creeks. TKN values were also low. TP and TSS continued to exceed the respective water quality criteria for most samples.

Several water quality analyses are dependent on stream flow and cannot be completed until water level-streamflow rating curves are completed and flows are calculated. These include pollutant load, flow-weighted mean concentration, and discrete water chemistry analysis. Results will be reported in a future annual report.

Table 3. Water quality sample results for 2025 season at the primary sites. Median and maximum values as well as the percentage of samples exceeding the Minnesota water Quality Standards (criteria) are shown.

Stream Site	Analyte	Sample Count	Median (mg/l)	Maximum (mg/L)	Exceeding %	Criteria (mg/L)
Skunk Cr downstream of restoration ID: S005-617	Chloride	20	3.9	8.7	0	230
	Nitrate + Nitrite	18	0.08	0.19	0	10
	TKN	18	0.9	1.9	---	---
	Total Phosphorus	18	0.08	0.48	94	0.05
	Suspended solids	20	22	554	85	10
Elim Cr outlet ID: S007-453	Chloride	20	7.0	9.3	0	230
	Nitrate + Nitrite	19	0.05	0.15	0	10
	TKN	18	1.0	1.5	---	---
	Total Phosphorus	19	0.08	0.26	100	0.05
	Suspended solids	21	21	260	86	10

Biology and habitat

The MPCA and Carlton SWCD sampled fish and macroinvertebrates and collected habitat data at four locations of Elim Creek and two locations on Skunk Creek in 2025. Locations are identified with brown squares in the bottom subset map of Figure 1.

Elim Creek was sampled at three locations on upstream reach 04010301-771 which flows downstream from the headwaters to a sediment dam. The two most-upstream sites (25LS011 and 21LS028) bracket past restoration and crossing replacement projects. The downstream site (21LS027) is located between the Soo Line recreational trail and the sediment dam where a failing culvert is expected to be replaced.

Elim Creek reach 04010301-772 begins downstream of the sediment dam and continues to its confluence with Skunk Creek. Biological monitoring site 11LS072 near the confluence was sampled multiple times since 2011 including 2025.

Skunk Creek was sampled at two locations that are within 0.5 miles of each other yet have different watershed identifiers. Reach 04010301-504 begins at the headwaters and continues downstream to Elim Creek. It contains an existing biological sample site (11LS059) that has been sampled multiple times over the past decade and is located within a stream stabilization and habitat project site. Skunk Creek reach 04010301-502 begins at Elim Creek and continues downstream to the confluence with the Nemadji River and contains a newly established biological sample location (25LS009). This site is located within a culvert/weir removal and habitat project site.

Habitat

Habitat data was collected by two methods, Minnesota Stream Habitat Assessment (MSHA) and Quantitative Physical Habitat Assessment, at the biological sites described above. Results were reportable for the five locations identified in Table 4.

Quantitative habitat evaluations involve measured numerical evaluations of habitat features while MSHA is a visual, descriptive evaluation. Both methods consider land use, erosion, canopy and in-stream cover for aquatic life, stream substrate (bottom materials), and channel morphology.

The highest quality aquatic habitat was documented at Elim Creek site 11LS072 and Skunk Creek site 11LS059 (Table 4). While both locations show signs of channel incision and erosion, they also have favorable habitat features that result in MSHA scores that are noted as fair to good depending on the site visit. These include a high percentage of coarse substrate, moderate-to-low embeddedness/depth

of fines values, and healthy pool-riffle-run spacing. Also, pool depth was greater at the two higher scoring sites, which is reflected in the higher mean depth calculation in Table 4. Depth was greatest at the Skunk Creek site 11LS059, where pools were best established. The remaining three sites (21LS028, 21LS027, 25LS009) had a low percentage of pools, shallower pools, and high percentage of runs, which is an indication that excess sediment has filled in former pool features. This was most apparent at Elim Creek site 21LS028 where embeddedness of coarse substrate by sand and silt was also high (96%).

While excess sedimentation was observed at the two upstream Elim Creek sites (21LS028, 21LS027), it is also important to note that less habitat complexity is generally expected in smaller headwater streams. Compared to larger downstream rivers, they are naturally smaller, shallower, straighter, and tend to transport less streamflow, wood, and sediment, which are key habitat-forming processes and features.

Table 4. Quantitative (numerical data) and qualitative (MSHA rating) habitat results for biological sites. Pink denotes values that are contributing to inadequate conditions, where multiple parameters (within a grouped box) are considered together in the evaluation.

Site name (ID)	Mean width (m)	Mean depth (cm)	Depth of fines (cm)	Coarse substrate %	Embeddedness %	Pool %	Riffle %	Run %	Bends	Log jams	Shade %	MSHA Rating
Elim ds restoration CR6 (21LS028)	1.2	9.2	2.3	46.2	96.7	8	20	72	12	6	83	Poor/Fair
Elim at Soo Line Trail (21LS027)	1.4	12.9	2.6	47.7	58.1	17	16	67	7	11	90	Fair
Elim at outlet (11LS072)	3.1	27.4	1.3	86.2	37.5	43	30	27	2	2	87	Fair/Good
Skunk us restoration (11LS059)	4.2	39.2	2	70.8	46	55	29	16	1	1	56	Fair/Good
Skunk ds restoration (25LS009)	3.8	24.6	1.8	95.4	31	16	29	55	1	1	28	Fair

Fish

Two of three stations on the upstream Elim Creek reach 04010301-771 did not meet the Northern Coldwater fish index of biological integrity (F-IBI) impairment threshold of 35 (Table 5) and the most upstream site only contained three fish, two of which were stocked brook trout. Biological site 11LS072 on downstream Elim reach 04010301-772 scored above the F-IBI threshold; however, the sample contained numerous stocked brook trout, elevating the score. When brook trout were removed from the sample, the recalculated score (27.3) fell below the threshold but remained within the lower confidence interval. The fish community at 11LS072 remains relatively diverse for a coldwater stream, which is typical of streams in the Nemadji River Watershed due to the mix of warm, cool, and cold-water habitats. Mottled sculpin, another cold-water and pollution-intolerant fish, was sampled in 2025 and in three past samples, dating back to 2011.

Both Skunk Creek sample locations met the F-IBI threshold and showed a similar presence of stocked brook trout. In the absence of stockers, the scores were below the threshold (Table 5), but the upstream

station was within the lower confidence interval. The fish community remains relatively diverse for a coldwater stream. Mottled sculpin were samples at both sites.

Improved fish movement into Skunk Creek (11LS059) and into the lower reach of Elim Creek (11LS072) is apparent when comparing 2021 through 2025 community data to older (2011) samples. A two to three-fold increase in species diversity and total number of fish were reported in the samples following downstream connectivity enhancement projects.

Table 5. Fish index of biological integrity scores calculated with and without brook trout demonstrate how stocking can affect the results. Samples influenced by stocking of brook trout are noted with an asterisk. Green denotes scores that are above the F-IBI impairment threshold, pink shaded scores fall below the threshold but above the lower confidence interval, and the darker orange shaded scores fall below the threshold and below the lower confidence interval.

Site name	Date	F-IBI	F-IBI w/out BKT	Comment
Elim us restoration (25LS011)	9/17/2025	74.2*	50	Headwaters. Low fish count. 2 of 3 fish were BKT, likely stocked.
Elim ds restoration CR6 (21LS028)	8/10/2021	20.6	20.6	No BKT. Mainly cool and warm-water fish despite cold stream temperatures.
	8/26/2025	30.5	30.5	
Elim at Soo Line Trail (21LS027)	7/21/2021	8.4	8.4	Site is 0.5 miles upstream of dam reservoir. BKT in sample, likely stocked. Mix of cold, cool, and warm-water fish. Presence of warm-water game fish (perch/bass) were likely sourced from reservoir.
	8/6/2025	18.5*	10.7	
Elim at outlet (11LS072)	9/15/2011	20.2	20.2	Site is 0.6 miles downstream of dam. Numerous stocked BKT with a mix of cold, cool, and warm-water fish. Diversity after a pipe culvert removal in 2018 is 2.7 times greater and total number of fish is 4 times greater than 2011 sample.
	8/3/2021	28.6	28.6	
	6/15/2022	46.3	43.7	
	8/6/2025	37.9**	27.3	
Skunk us restoration (11LS059)	8/1/2011	49.6	49.6	Mix of cold, cool, and warm-water fish. Some or perhaps all 2025 BKT were stocked (adipose clipped) while BKT in the 2022 sample were native. Time of year and seasonal conditions likely determine the presence of native fish. Diversity after a culvert removal in 2018 is 2 times greater and total number of fish is nearly 4 times greater than 2011 sample.
	6/15/2022	46.6	46.6	
	8/28/2025	43.1**	33.9	
Skunk ds restoration (25LS009)	8/28/2025	36.5**	26.7	Mix of cold, cool, and warm-water fish. All BKT where stocked as noted by fin clips. Lower score than 11LS059 driven by the presence of fathead minnows (very tolerant) and absence of longnose dace (pollution intolerant).

* Likely stocked trout

**Stocked trout noted

Macroinvertebrates

All six biological stations met the Northern Coldwater macroinvertebrate index of biological integrity (M-IBI) impairment threshold of 32 (Table 6). Although all are designated coldwater streams, the percentage of cold-water individuals in the samples were notably higher in Elim Creek, which reflects the colder temperatures documented there (Table 2) compared to Skunk Creek. Cold-water macroinvertebrates were present in Skunk Creek, but in lower numbers and with less taxa diversity.

The diversity of macroinvertebrates in the 2025 samples that belong to the sensitive orders of mayflies, stoneflies, caddisflies, and dragonflies; also known as the acronym POET, based on their scientific order names, is highest in the two Skunk Creek sites. The number of pollutant-intolerant taxa is functionally the same.

Two sites (11LS072 and 11LS059) sampled in 2011 show an improvement in M-IBI scores in 2025. Additionally, an increase in the diversity of pollutant-intolerant and POET taxa was observed over the same period for both sites, as was the percentage of cold-water taxa at Elim site 11LS072. New habitat sampling procedures implemented in 2022 to include bank vegetation and wood have likely contributed to the increased diversity in samples. A habitat enhancement project completed in 2018 at Skunk Creek site 11LS059 also potentially contributed to a more diverse 2025 community.

Table 6. Macroinvertebrate index of biological integrity scores and biological metrics. Parenthesis denotes historical values, reported in 2011. Green-colored cells indicate that expectations for that parameter have been met, and pink indicates the value is poorer than expected for a coldwater stream based on criteria noted in the bottom row.

Site name	M-IBI	Cold-water %	Intolerant taxa #	POET taxa #
Elim us restoration (25LS011)	36.7	29	4	15
Elim ds restoration CR6 (21LS028)	50.0	16	5	17
Elim at Soo Line Trail (21LS027)	42.6	27	5	15
Elim at outlet (11LS072)	49.3 (32)	28 (11)	5 (4)	20 (14)
Skunk us restoration (11LS059)	48.9 (26)	4 (5)	5(2)	25 (10)
Skunk ds restoration (25LS009)	49.7	2	5	25
*Criteria, **average for passing	32*	10**		

Outreach and education

Outreach and education efforts in 2025 by the Carlton SWCD included informational mailings regarding watershed monitoring and restoration efforts taking place in the watershed and the benefits of livestock BMPs. BMP practices covered in a *“Does mud, muck, and manure get you down?”* mailing included information on heavy use protection areas, water access control, and prescribed grazing (Figure 3). Discussions with individual landowners continued about specific restoration projects including a potential stream crossing replacement on Elim Creek and the Elim Dam feasibility study.

Figure 3. Outreach efforts by Carlton SWCD included a mailing on agricultural BMPs.

Does mud, muck, and manure get you down?

Which of these conservation practices would benefit your operation?



Heavy Use Protection Areas Improve water quality by adding a stable or non-eroding surface, improve livestock health by reducing muddy, unstable areas, and reduce the wear and tear on farm equipment with a firm driving surface.

Before



After



Access Control, like fencing along waterways, improves the safety of the livestock, and reduces pathogen transport to surface water. Fencing can also provide the appropriate grazing time, intensity, duration, and frequency of pastures.



Livestock Pipelines Improve water quantity and quality for livestock to reach desired grazing areas. These can be used to facilitate winter bale grazing.



Prescribed Grazing improves manure distribution and plant productivity, benefiting soil health, reduces soil erosion, and compaction while controlling livestock access to identified areas.





Carlton SWCD can provide cost share assistance up to 90% based on location and project type.

Participation in Carlton SWCD cost share programs is completely voluntary.

Road stability

Roadway Materials Tracking

In 2025, the Carlton SWCD and the Carlton County Transportation Department partnered to create a roadway materials tracking application to record the volume of gravel used during grading, general maintenance, and flood repairs that include ditch, culvert, and general roadway washouts.

Routine road maintenance recorded in 2025 on County Road 103 within the Skunk Creek Watershed included a standard road-grading event on July 16, 2025, and brush management and mowing to manage vegetation along the roadway on July 22, 2025.

Roadway Runoff Secchi Tube Sampling

Secchi tube measurements and photographs were collected in roadside ditches and/or tributaries near roadway runoff and sediment control project sites seven times in 2025, targeting periods when ditches were flowing. Examples of flowing ditches after one-inch rain events are displayed in Figure 4 and show visual differences in roadway runoff for spring and summer events. The integrity of the roadway remained intact for both events. Analysis of the secchi tube data will be completed at the end of the four-year contract.

Figure 4. Roadway runoff documented during spring (left) and summer (right) precipitation events.



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