

Fish Passage Culvert Assessment in the St. Louis River Area of Concern in Wisconsin

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Executive Summary

This project assessed 159 culvert crossings within the Wisconsin St. Louis River Area of Concern (AOC) to identify those disrupting hydrology and impeding aquatic organisms from accessing upstream and downstream habitats. Culvert assessment data was used in conjunction with stream habitat data, target species data and local road data to prioritize and recommend crossings that should be upgraded in order to restore hydrologic connections to high priority stream habitat. Recommendations from this project will be used by the WDNR to obtain funding for a minimum of two culvert upgrades. Rehabilitating crossings to allow fish movement will help the WDNR meet one of its AOC BUI Removal Targets. The Wisconsin Department of Natural Resources contracted with the University of Wisconsin Superior – Lake Superior Research Institute from November 2016 to September 2017 to assess culvert crossings and to work with stakeholders to develop a list of priority crossings.

Problem Definition/Background:

The "Loss of Fish and Wildlife Habitat", is one of nine beneficial use impairments (BUI) listed for the St. Louis River Area of Concern (AOC) in the Remedial Action Plan (RAP; MPCA, 2013). The BUI Removal Target for Loss of Fish and Wildlife Habitat is that, "Additional aquatic or hydrologically connected habitat throughout the AOC watersheds has been successfully protected and rehabilitated sufficiently to maintain healthy fish and wildlife populations through implementation of projects at prioritized restoration sites."

The tributaries in the AOC support cold, cool and warm water species, such as brook trout, muskellunge and walleye (respectively). White Suckers, a primary prey species for muskellunge, also depend on tributaries for spawning and rearing. Both walleye and muskellunge are species with specific population targets listed in the RAP under the Degraded Fish and Wildlife Populations BUI (MPCA, 2013).

Over time, urbanization and road development in the AOC has resulted in the fragmentation of many streams, preventing fish from accessing vital upstream habitats. During the development of the RAP, road-stream crossings were identified as likely barriers to fish passage in the Wisconsin portion of the AOC (MPCA, 2013 - <http://www.pca.state.mn.us/index.php/view-document.html?gid=19677>) which led to the RAP priority action 9-17 to "replace or retrofit a minimum of two perched culverts to allow for fish passage and other aquatic organism passage."

With the exception of a few large barriers, most road crossings and other potential obstructions in the AOC have not been inventoried. Limited data is available from the City of Superior and Douglas County however it is unknown the degree to which the estimated 159 culvert crossings are inhibiting fish movement within the AOC.

This project provided the assessment data necessary to understand the status of stream connectivity in the AOC.

Project Objectives

- Select a subset of crossings within the AOC using LiDAR digital elevation models (DEMs), the elevation drop from the upstream side of the culvert to the downstream side of the culvert was measured at each site.
- Convene a technical team to assist with compiling, ranking and vetting relevant stream, road and watershed data which will be used in developing a final list of priority crossings.
- Conduct a preliminary culvert assessment to determine which culverts are acting as a barrier to fish passage.
- Propose a list of 15-20 crossings (Tier 2) out of the preliminary culvert assessments for review by the Technical Team. Target streams that support walleye, musky and resident brook trout and develop additional ranking criteria that will result in maximizing the ecological benefit.
- Develop a list of 5-10 highest priority crossings (Tier 1) based on Technical Team review.
- Conduct follow up assessments at the Tier 1 Priority Crossings to determine value of the habitat being blocked and summarize additional data to be used in recommending crossings for upgrading.
- Rank the Tier 1 Priority Crossings in the WI SLR AOC where upgrading will remove fish passage barriers and maximize the ecological benefit to aquatic organisms.
- WDNR uses the list of recommended as Tier 1 Priority Crossings (5-10 culverts) to develop a project proposal for project implementation to meet RAP Project 9-17, as well as to develop proposals for additional projects to implement the Biodiversity Conservation Strategy.

Technical Team

A Technical Team was convened at the beginning of the project for the purpose of providing the background information necessary to meet the project objectives and to guide decision-making.

Members:

Matt Steiger, WDNR, Project Manager/AOC Coordinator
Madeline Roberts, WDNR, Project Manager/Water Resources Management Specialist
Paul Piszczek, WDNR, Fisheries Biologist
Amy Cronk, WDNR, Environmental Analysis and Review Specialist
Craig Roesler, WDNR, Water Quality Biologist
Matt Diebel, WDNR, Water Resources Management Specialist
Tom Simmons, WDNR, GIS Analyst
Christine Ostern, Douglas County Conservationist
Cameron Bertsch, Douglas County Engineering Technician
Kevin Schmid, Douglas County Highway Technician
Darienne McNamara, City of Superior, Environmental Regulatory Coordinator
Ted Koehler, USFWS Fish and Wildlife Biologist

Meeting Summaries:

The kickoff meeting was held on October 12, 2016 to provide the project overview, identify target species, and identify background information relevant to meeting the project objectives. Assessment methods, training and timelines were discussed and finalized for use in the QAPP.

Meeting 2 was held on June 30, 2017 to share the results of the preliminary culvert assessments and discuss the ranking of the proposed Tier 2 Priority Crossings. The initial proposed Tier 2 streams, placed a higher rank on trout streams and included all trout streams that had a passability score of less than 1. The Technical Team directed LSRI to revise the draft Tier 2 list and develop it primarily on passability scores and potential stream length opened. The revised Tier 2 list of 19 streams was further vetted by the Technical Team for ranking and to determine a list of additional assessment needs (Table 4).

Meeting 3 was held on September 15, 2017 to share the ranked results from Tier 1. Barriers that ranked highest were included on the Tier 1 Priority Crossings list. Results of the follow up field assessments and a summary of the stream quality data were also presented. Stakeholders from the Town of Summit and the Town of Superior were invited. Local needs and stream values were discussed and the final recommendations to prioritize the Little Balsam Creek system was made.

Methods

Stream Crossing Selection

The Wisconsin Department of Natural Resources (WDNR) created a geodatabase consisting of approximately 600 stream crossings in the St. Louis River Area of Concern in Wisconsin (WI AOC) (Figure 1). The stream crossings were identified by intersecting 2012 TIGER Roads data and Douglas County ATV trails data with WDNR 1:24,000 scale stream flowlines and by analyzing digital ortho-photographs to locate railroad crossings. Only culvert crossings that could be legally accessed were included on the list. Potential barriers located on railroad grades or trails were not included due to access issues. Bridges were not assessed because they were assumed to be passable.

Using LiDAR DEMs and digital ortho-photographs, the WDNR further classified the 600 crossings based on crossing type and elevation drop. From previous studies, the WDNR determined that elevation drops of $\geq 0.3\text{m}$ were strong indicators of potential fish passage problems. Additional evidence revealed that elevation drops of $< 0.3\text{m}$ may also be barriers to fish with poor swimming abilities. Using these data as guidelines, an elevation drop of $\geq 0.2\text{m}$ was used to generate the subset of 159 crossings that would be targeted for assessment (

Figure 2).

Figure 1 - ~600 Stream Crossings in the St. Louis River Area of Concern in WI

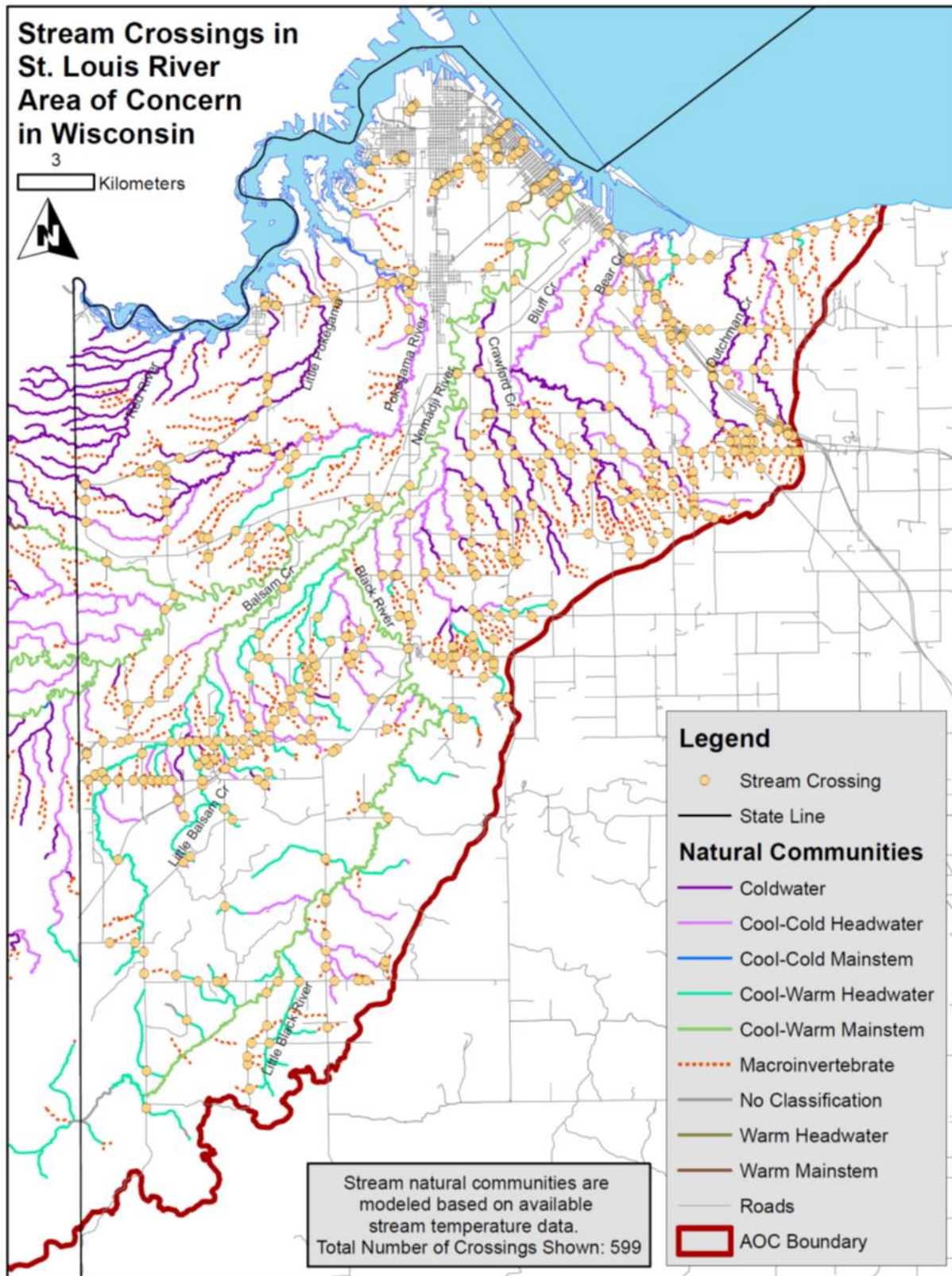
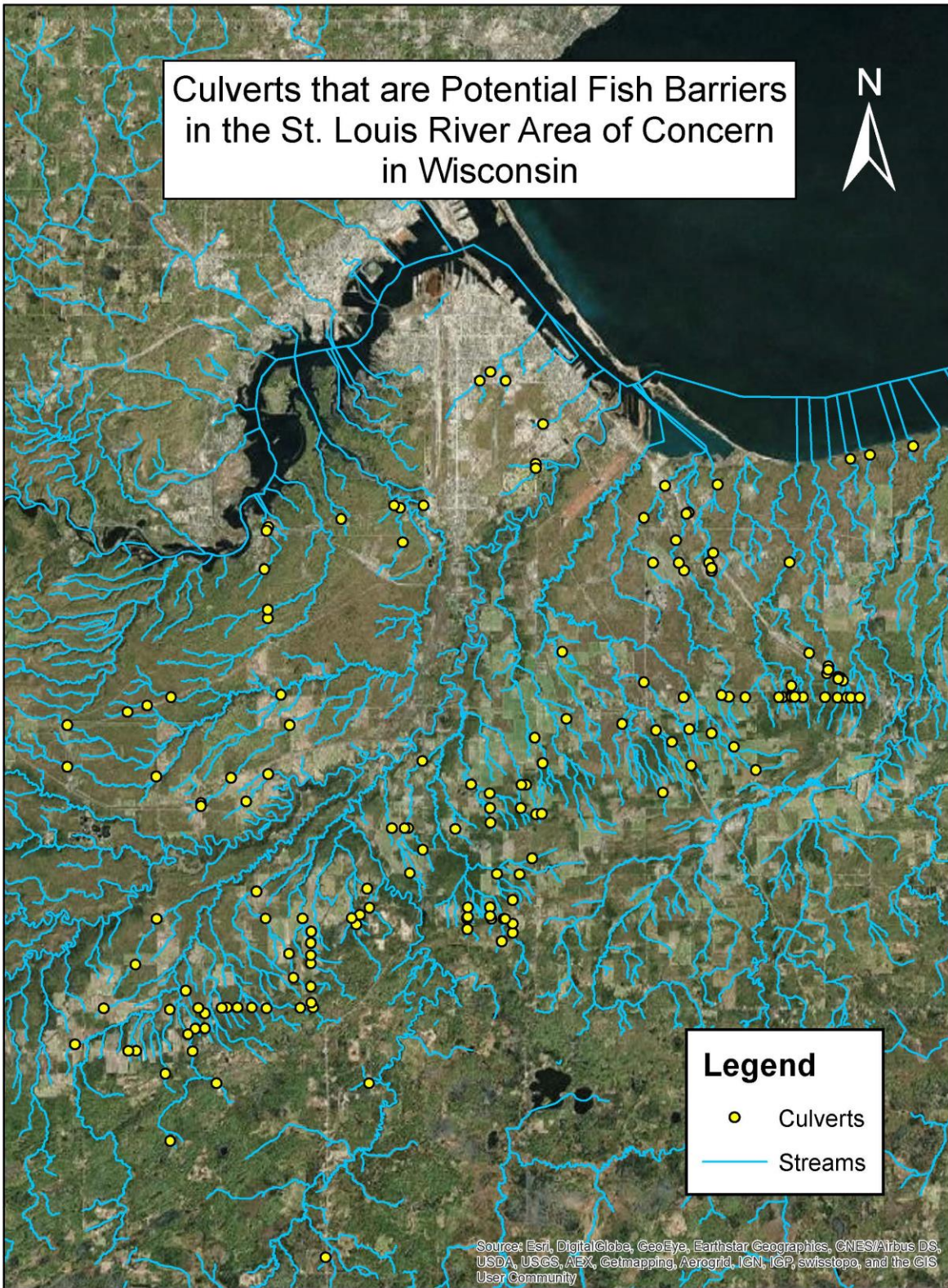


Figure 2- 159 Crossings that are Potential Fish Barriers in the WI AOC



Preliminary Culvert Assessment

The *Great Lakes Road Stream Crossing Protocol* was used for preliminary culvert assessments. Data collected included: Site ID; Stream Name; Road Name; Date; GPS Waypoint; County; Township/Range/Section; Adjacent Landowner Information; Crossing Type; Culvert Type, Shape, Material, Length, Width, Height and General Condition; Inlet and Outlet Types; Presence of Substrate in Structure; Estimate of Percent Blocked (plugged), Crushed or Rusted; Structure Inlet/Outlet Water Depths; Inlet/Outlet Water Velocity; Perch Height; Embedded Depth of Structure; Stream Flow and Condition (Degree Bankfull); Scour Pool and Upstream Pond Data; Riffle Velocity, Depth and Dominant Substrate; Road Class/Type (i.e. Ownership); Road Surface and Condition (Good, Fair, Poor); Road Width at Culvert; Location of Low Point (At Stream/Offset); Runoff Path (Along Road/To Ditch); Embankment Fill Depth and Slope; Fill Depth (Top of Culvert); Embankment Slope Visual Estimate (Both Culvert Ends); Left/Right Approach Lengths; Left/Right Approach Slope; Ditch Vegetation; and Extent of Erosion. Field data was recorded on the *Great Lakes Road Stream Crossing Datasheet, February 28, 2011 rev. 4-26-2016/LSRI*. LSRI revised the datasheet to include the WBIC, stream order and presence of targeted fish species. A site sketch, digital photo documentation, and a summary assessment were also included on each datasheet.

Passability Score Calculation

A culvert passability score was generated for assessed culverts using a Microsoft Office Access 2013 database called "RSX_StLouis_LSRI.mdb" (RSX Database). The RSX Database created by the WDNR contains a query that calculates a passability score based on field parameters measured for each culvert. Passability score values ranged from 0 to 1. The definition for each passability score is as follows:

- 0 = Not passable by most species at most flows
- 0.5 = Not passable by some species/life stages at most flows
- 0.9 = Not passable at high flows
- 1 = Passable by most species/life stages at most flows

Ranking Criteria for 15-20 Priority Crossings (Tier 2)

The ranking criteria used to identify 15-20 priority crossings (Tier 2) included: a culvert passability score of 0 or 0.5; the length of stream opened up once a barrier was removed; the exclusion of any 303d list streams; and the high potential to improve outcomes by being able to work on multiple culverts on the same stream.

Length of Stream: The length of stream segment opened to migration once a barrier was removed was calculated using road, trail, railroad and dam data intersected with stream

flowline data in ArcMap. The total length of stream opened was obtained by tallying the length of each segment (main channel and tributaries) from the crossing barrier upstream to the next potential barrier.

Ranking Criteria for 5-10 Priority Crossings (Tier 1)

The ranking criteria used to identify 5-10 priority crossings (Tier 1) was based on known stream quality; the ability of the stream to support the target fish species; the potential to open fish migration from Superior Bay or Lake Superior; the potential for the highest ecological benefit for dollars spent; the potential to improve outcomes by being able to work on multiple culverts on the same stream; Technical Team knowledge of potential for a high or low success rate; and crossings with the highest need for replacement.

Stream quality was determined by acquiring existing WDNR data and by conducting further field assessments. Existing data was obtained from the WDNR SWIMS Database, the Fisheries Management Database; the Surface Water Data Viewer and the general water condition summaries for each stream found at www.dnr.wi.gov/water/WaterDetail.

Follow up field assessments were conducted to obtain habitat data and to examine nearby barriers not assessed during the preliminary assessments phase.

Follow-Up Assessments

Tier 2 streams were further evaluated prior to making the final priority recommendations. The follow up field work involved determining passability at railroad and ATV crossings that had not been analyzed during the preliminary culvert assessments. The same protocols used in the preliminary culvert assessments were used in the follow up assessments. When legal access was an issue, a visual assessment was done to determine passability. Habitat conditions were also evaluated on some stream segments to determine the quality of habitat that could be accessed by fish if the barrier was removed. The WDNR Guidelines for Evaluating Habitat of Wadable Streams Protocol was used to evaluate stream habitat.

Background Information

Stream Information

Existing stream background information and data was acquired from Wisconsin Department of Natural Resources web sources. Stream background data was summarized and used in conjunction with the preliminary culvert assessment data to identify and rank the Tier 2 15-20 Priority Crossings. These data were also used along with follow-up assessment data by the Technical Team to recommend the 5-10 Tier 1 Priority Crossings.

To simplify communication of the data, four summary sheets were created for the Tier 1 Priority Crossings (Figures 3, 5, 7 and 9). Streams with multiple crossings were consolidated onto one summary sheet. Summaries included the length of stream that would be opened if one or more of the barriers were removed; the culvert passability score; the Modeled Natural Community classification; trout class; ORW/ERW status; general stream condition; general culvert characteristics; unique field observations; and, where available, a habitat score, fish index and/or HBI score.

Road and Watershed Information

Road and watershed data, such as % open lands, flood hazard areas, location of dams or natural barriers, was acquired from the Technical Team and web and published sources. Research demonstrates that water quality impairments and aquatic habitat degradation begin to occur in streams when forest cover is reduced to 40-50% of the sub-watershed area (Verry, 1997). Road and watershed information was used in conjunction with culvert and stream data to help identify the final recommendations for the Tier 1 Priority Crossings.

Species Specific Information

Species specific information was acquired from the Technical Team and from published literature and summarized in Table 1. The information includes life history, spawning and rearing habitat elements, species specific information as well as more generalized barriers (full and partial) to fish passage. This data was used to determine if existing culvert conditions could pass the target species and will likely be used in culvert design. It could also be used to determine stream suitability for a specific species.

Table 1 -Species Specific Information

Common Species Name	Brook Trout	walleye	Musky
Spawning [Source]			
Preferences	prefer areas of upwelling [1]	gravel bars in streams; shoals in lakes [10]	utilize stumps, logs for spawning cover [1]
Life history & Reproductive Biology	<p>Within the Lake Superior basin, some brook trout are stream residents while others are lacustrine or adfluvial. []</p> <p>Brook trout adapts well to a variety of stream and lake environments. It is found primarily in cold, clear headwater streams, but also lives in cold lakes. Distribution is mainly controlled by water temperature (Raleigh 1982). The preferred temperature is 13.9 – 15.6 C. The species does poorly in waters warmer than 20 C for an extended time and 25 C is considered lethal. [12]</p>	<p>Migratory from Great Lakes to shorelines, shallow reefs and tributaries; Exhibit homing behavior; generally coolwater species; can adapt to turbid waters. [8]</p>	<p>Muskellunge are found in a wide variety of habitats, typically thriving in large rivers, lakes, and flowages. Good musky waters usually contain both deep and shallow basins, with thriving beds of submerged aquatic vegetation. [13]</p>
Average spawning season in Northern WI	Late October [6]	Mid-March to June [7]	Spring
Spawning water temp (Celsius)	2-13	4-12	8-18
Spawning Water Depth (m)	0-2	0->5	0-2
Spawning Guild	brood hider*	broadcast**	broadcast**
Spawning Cover Utilized	High use of Submergent/Emergent	Low use of Submergent/Emergent	High use of Submergent/Emergent
Spawning Substrate (Use of)	High use of rubble/gravel, medium use of sand, low use of silt	High use for all overhanging bedrock, boulder, cobble, rubble, gravel, sand, hardpan-clay	Medium use for sand, high silt, high clay

Common Species Name	Brook Trout	walleye	Musky
Barriers - General [Source]	<p>[7] Sustainable swimming speeds vary with species, size and life stage of the fish. The maximum culvert water velocity should be based on the slowest sustainable swimming speed for the fish in the stream. The minimum water depth must be adequate for fish to be completely immersed and not scraping the bottom. Stream temperature and oxygen requirements motivate upstream/downstream migration in addition to spawning behaviors. A 6-inch minimum water depth or 10-20% of the culvert diameter (whichever is greater) is recommended. Deeper placement may be necessary on high-gradient streams to allow sediment to reach equilibrium inside the pipe and establish a more "natural" slope. Bridges are preferred on high-value streams. Open-bottom culverts are alternatives which cost ~ 30-50% more than round culverts and require footings. [9] The ability of fish to migrate past velocity barriers results from both attempt rates and swimming capacity. Attempt rates vary between species and over time are influenced by velocity of flow and discharge. Distance of ascent is primarily influenced by flow velocity. Swimming performance is influenced by motivation and is measured by the number of attempts. [11] Passage performance is superior in rough culverts, especially for smaller fish.</p>		
Limiting Perch Height (outlet drop) for small fish (10-15 cm) with 50 cm deep plunge pool/Motivation to jump appears to be related to fish density/ Flow, water temperature, and current velocity at waterfall crest may influence jumping success	>15cm (<100cm) @ low flow [2] 63.5 cm [3]	Unknown	Unknown
Limiting Perch Height (outlet drop) large fish (15-20 cm) with 40-50 cm deep plunge pool/Motivation to jump appears to be related to fish density/ Flow, water temperature, and current velocity at waterfall crest may influence jumping success	>21cm (<100cm) @ low flow [2] 73.5 cm [3]	Unknown	Unknown
Limiting Water Velocity (Burst Speeds)	~3.1 f/s for 10 foot length(estimated from graph on p.3) [7]	~7.8 f/s for 10 foot length(estimated from graph on p.3) [7]*** 5.30 f/s to 8.50 f/s [4]***	Unknown

Species Specific Background Information

Common Species Name	Brook Trout	walleye	Musky
Highest Maintainable Speed (60min)	Unknown	0.98 f/s to 2.39 f/s [4]***	Unknown
Highest Maintainable Speed (10min)	Unknown	1.40 f/s to 3.74 f/s [4]***	Unknown
Prolonged Swimming Speed	Unknown	1.20 - 2.76 f/s [5]	Unknown
Water Velocity over Swimming Distance	~2.5 f/s up to 150 feet (estimated from graph on p.3) [7]	~3.0 f/s up to 150 feet (estimated from graph on p.3) [7] Hatchery experiment w/sexually mature adults at typical spawning temperatures (10°C) show that a walleye can swim any length if water velocities are set below = 1.38 ft/s [4]	Unknown

*brood hider- eggs are buried in substrate after fertilized, then abandoned

**broadcast- sperm and eggs are released into water column

***[4] Highest swimming speed that walleye can maintain is quite low, however, walleye can attain relatively high speeds when startled. The pattern suggests that walleye are capable of burst swimming, but are disinclined to do so.

Results

Preliminary Culvert Assessment Summary

Out of the 159 proposed, 140 preliminary culvert assessments were completed (Table 2). Of those not surveyed: access was not possible without permits on 9 culverts located on the Interstate Freeway and access was not possible without special permission at 5 crossings located on private roads; stream channels could not be located at 3 locations; a bridge was installed at 1 crossing; and 1 crossing was located on a private pond.

Passability scores were generated for 129 culverts. Scores were not generated at 11 of the crossings, most likely because riffle data was missing in the database. Riffle data could not be collected in these streams because downstream access was blocked by no trespassing signs or fences.

Fifty-four culvert crossings (39%) had a passability score of 0 (not passable by most species at most flows) and 53 of those culverts were perched. 60 culvert crossings (43%) had a passability score of 0.5 (Not passable by some species/life stages at most flows); 9 culverts had a passability score of 0.9 (Not passable at high flows); and 6 culvert crossings had a passability score of 1 (Passable by most species/life stages at most flows).

Sixty-five of the crossings with passability scores of 0 or 0.5 were located on town roads; 41 were on county roads; and 7 were on state highways. Thirty-seven of these culverts were damaged, either crushed to some degree or rusted or both. Most of the culvert embankments were stable or had only minor erosion. Twenty-seven culverts had moderate erosion and 15 had severe erosion. Thirty-three of the streams were intermittent and 11 streams were classed as 1 or 2 Trout Water. Seven trout waters had a passability score of 0.

Replacement cost estimates ranged from \$7600 to \$150,000. Actual replacement cost estimates were not considered due to the high degree of variability and uncertainty regarding these numbers. Relative cost estimates were considered but did not factor heavily in the culvert ranking.

Table 2 - Preliminary Culvert Assessment Summary

Preliminary Culvert Assessment

Summary Results and Passability Score

SiteID	WBIC	Road_name	StreamName	Perch_YN	Crush %	Rusted?	Erosion_extent	Intermittent_YN	Trout Class	Pass Score
102-56	2844200	Unnamed Rd	Unnamed stream to Pokegama River	NoSurvey						
205-12	2837200	Britton Rd	Unnamed Stream to Miller Cr	NoSurvey						
205-30	2837600	Mansky Rd	Unnamed Stream	NoSurvey						
207-43	Private	Unnamed Rd	Unnamed Stream	NoSurvey						
207-46	5001679	Co Rd BB	Unnamed Stream to Balsam Cr (Ditch)	NoSurvey						
207-47	5001676	Co Rd B	Unnamed Stream to Balsam Cr	NoSurvey						
209-32	5001521	Leggate Rd	Unnamed Stream to Copper Cr	NoSurvey						
210-19	2834200	Windmill Rd	Unnamed Stream to Bluff Cr (Bridge)	NoSurvey						
220-20	NotRec	Tri-County Corridor	Unnamed Stream	NoSurvey						
220-32	NotRec	Tri-County Corridor	Unnamed stream	NoSurvey						
205-27	5001318	E Station Rd	Unnamed Stream to Black River	no	0	Yes	Minor	yes	no	NotCalc
207-25	5001587	E Co Rd W	Unnamed Stream to Balsam Cr	no	0	Yes	None	yes	no	NotCalc
000-02	None	Tuff Rd	Unnamed Stream	yes	0	No	Minor	N/A	no	NotCalc
207-32	5001642	Co Rd B	Unnamed Stream to Balsam Cr	no	20	Yes	None	yes	no	NotCalc
207-35	5001718	E Co Rd B	Unnamed Stream to Balsam Cr	yes	20	Yes	Minor	yes	no	NotCalc
207-39	2841900	E Moen Rd	Unnamed Stream to Balsam Cr	yes	0	No	Moderate	yes	no	NotCalc
207-58	5001671	Co Rd B	Unnamed Stream to Empire Cr	no	0	No	Minor	yes	no	NotCalc
209-27	3000143	Leggate Rd	Unnamed Stream to Copper Cr	no	0	No	Moderate	yes	no	NotCalc
209-39	5001285	Twin Creek Rd	Unnamed Stream to Copper Cr	no	1	Yes	Moderate	yes	no	NotCalc
212-26	2835100	Humane Society Rd	Unnamed Stream	no	0	No	Stablized	no	no	NotCalc
207-48	5001682	Town Line Rd	Unnamed Stream to Balsam Cr	no	0	No	Minor	no	no	NotCalc
000-00	None	Co Rd B	Unnamed Stream (Ditch)	no	0	No	Minor	N/A	no	0.5
000-01	5001332	Co Rd A	Unnamed Stream to Unnamed Cr	no	0	No	Minor	yes	Unk	0.5
102-10	2844300	Midbon Rd	Unnamed Stream to Pokegama River	no	5	No	None	yes	no	0.5
102-11	2844000	Co Rd C	Pokegama River	yes	0	No	Minor	no	no	0
102-13	2844400	Irondale Rd	Unnamed stream to Pokegama River	no	0	No	Moderate	no	no	0
102-14	2844300	Co Rd C	Unnamed stream to Pokegama River	yes	0	No	Moderate	no	no	0
102-15	2844300	Irondale Rd	Unnamed stream to Pokegama River	no	5	No	Minor	no	no	0.5
102-16	2844200	State Hwy 105	Unnamed stream to Pokegama River	yes	0	No	Minor	no	no	0
102-17	2844200	Cemetery Access Rd	Unnamed stream to Pokegama River	no	0	No	Minor	no	no	0.5
102-18	2844500	Co Rd W	Unnamed stream to Pokegama River	yes	0	No	Minor	no	no	0

Preliminary Culvert Assessment

Summary Results and Passability Score

102-21	2844600	Co Rd W	Unnamed stream to Pokegama River	yes	0	Yes	Severe	yes	no	0
102-23	2844700	Co Rd W	Unnamed stream to Pokegama River	no	0	No	Minor	no	no	0.5
102-28	5000690	State Hwy 105	Unnamed stream to Pokegama River	no	0	No	None	yes	no	0.5
102-31	5001049	Co Rd W	Unnamed stream to Pokegama River	no	0	No	Minor	yes	no	0.5
102-35	5001221	Midbon Rd	Unnamed stream to Pokegama River	no	5	No	None	yes	no	0.5
102-5	2844000	S Barnes Rd	Pokegama River	no	0	No	Moderate	no	no	0
103-11	2845500	Co Rd W	Unnamed Stream to St Louis River	no	0	Yes	Minor	no	no	0.5
103-12	2845500	State Hwy 105	Unnamed Stream to St Louis River	no	0	No	Minor	no	no	1
103-21	5000717	State Hwy 105	Unnamed Stream to St Louis River	no	0	No	Minor	yes	no	0.5
103-23	5000931	Co Rd W	Unnamed Stream to Little Pokegama Ri	no	0	Yes	Minor	yes	no	0.5
103-24	5000722	S Irondale Ave	Unnamed Stream	no	0	No	Minor	yes	no	0.5
103-3	2845300	Co Rd W	Unnamed Stream to Pokegama River	yes	0	No	Moderate	no	no	0
104-18	2843700	N 28th St	Unnamed Stream	no	0	No	Minor	no	no	0.5
104-19	2843700	Catlin Ave	Unnamed Stream to Faxon Cr	NoData	0	No	Moderate	no	no	0.5
104-51	5000547	N 28th St	Unnamed Stream	no	0	No	Stablized	yes	no	0.9
204-13	2840900	Gruhlke	Unnamed Stream to Black River	yes	0	No	Minor	no	no	0
204-22	2839800	State Hwy 35	Unnamed Stream	no	0	No	Minor	no	no	0.5
205-11	2837200	Polish Rd	Unnamed Stream to Miller Cr	yes	5	Yes	Moderate	no	no	0
205-14	2837200	Schmid Rd	Unnamed Stream to Miller Cr	yes	0	No	Minor	no	no	0
205-16	2837000	Co Rd B	Miller Creek	yes	0	No	Moderate	no	2	0
205-2	2837100	Dedham Rd	Unnamed Stream to Miller Cr	no	5	No	Minor	no	no	0.5
205-20	2837000	Polish Rd	Miller Creek	yes	0	No	Severe	no	2	0
205-22	2837200	Co Rd B	Unnamed Stream to Miller Cr	no	0	No	Minor	no	no	0.5
205-25	2838800	S Rancon Rd	Unnamed Stream to Black River	yes	0	Yes	Minor	no	no	0
205-29	2837600	Co Rd B	Unnamed Stream	yes	0	No	Severe	no	no	0
205-3	5001496	Polish Rd	Unnamed Stream to Miller Cr	yes	5	No	Minor	yes	no	0
205-34	2837100	E Town Line Rd	Unnamed Stream to Miller Cr	no		No	Severe	no	no	0.5
205-35	2837100	Polish Rd	Unnamed Stream to Miller Cr	yes	0	No	Moderate	no	no	0
205-39	5001458	Co Rd B	Unnamed Stream to Rock Cr	no	0	No	Minor	yes	no	0.5
205-41	5001511	Polish Rd	Unnamed Stream to Miller Cr	yes	5	No	None	yes	no	0
205-43	5001480	S Meirotto Rd	Unnamed Stream to Rock Cr	yes	0	No	Minor	yes	no	0
205-46	5001647	Town Line Rd	Unnamed Stream to Miller Cr	yes	0	No	Minor	no	no	0
205-5	2837300	Co Rd B	Unamed Stream to Rock Cr	no	0	NA	Severe	no	no	0.9
205-7	5001532	Polish Rd	Unnamed Stream to Miller Cr	yes	5	No	Severe	yes	no	0

Preliminary Culvert Assessment

Summary Results and Passability Score

207-12	5001705	Co Rd BB	Unnamed Stream to Little Balsam Cr	NoData	0	No	Minor	yes	no	0.9
207-14	5001664	Co Rd B	Unnamed Stream to Balsam Cr	no	0	No	Minor	yes	no	0.5
207-24	2841800	Breitzman Lake Rd	Unnamed Stream	yes	0	No	Moderate	no	no	0
207-26	5001587	S CR-W	Unnamed Stream to Balsam Cr	yes	0	No	Minor	yes	no	0
207-27	2841700	Big Balsam Rd	Little Balsam Creek	no	0	No	Minor	yes	no	0.9
207-30	2841500	Town Line Rd	Unnamed Stream to Balsam Cr	yes		No	Moderate	no	1	0
207-43alt	2842100	S North Rd	Unnamed Stream to Balsam Cr	no	0	No	Moderate	no	no	0.5
207-53	5001690	Burger Rd	Unnamed Stream to Balsam Cr	no	0	No	Minor	yes	no	0.5
207-54	2842000	E Patzau Foxboro Rd	Unnamed Stream to Balsam Cr	no	0	Yes	Minor	yes	no	0.9
207-55	5001739	E Patzau Foxboro Rd	Unnamed Stream to Balsam Cr	no	0	No	None	yes	no	0.5
207-8	2841700	E Patzau Foxboro Rd	Little Balsam Creek	yes	0	No	Minor	no	1	0
207-9	2841700	E Severson Rd	Little Balsam Creek	no	0	No	Severe	no	1	0.5
208-6	2842600	S Jt Johnson Road	Unnamed Stream to Nemadji River	no	0	No	Severe	no	no	0.5
208-7	2842600	Miller Rd	Unnamed Stream to Nemadji River	yes	0	No	Minor	no	no	0
209-11	2836400	State Hwy 35	Stony Brook	no	0	No	Minor	no	no	1
209-14	2836100	Leggate Rd	Copper Creek	no	0	No	Moderate	no	2	0.5
209-16	2836100	Co Rd B	Copper Creek	no	0	No	Minor	no	2	0.5
209-17	2836100	Leggate Rd	Copper Creek	no	0	No	Minor	no	2	0
209-21	2836300	S Darrow Rd	Rocky Run	yes	0	No	Moderate	yes	no	0
209-22	2836700	Co Rd B	Unnamed Stream to Copper Cr	no	0	No	Minor	no	1	0.5
209-23	2836700	Tuff Rd	Unnamed Stream to Copper Cr	yes	0	No	Moderate	no	1	0
209-24	2836700	Tuff Rd	Unnamed Stream to Copper Cr	yes	2	Yes	Moderate	no	1	0
209-25	2836400	State Hwy 35	Stony Brook	no	0	No	Minor	yes	no	0.5
209-26	2836400	E Station Rd	Stony Brook	no	10	No	Minor	yes	no	0.5
209-29	2836200	Ridgeview Dr	Unnamed Stream to Copper Cr	yes	5	Yes	Moderate	yes	no	0
209-31	2836200	Twin Creek Rd	Unnamed Stream to Copper Cr	no	0	No	Stablized	yes	no	0.5
209-33	5001521	Co Rd B	Unnamed Stream to Copper Cr	no	0	No	Minor	yes	no	0.5
209-34	5001302	S Darrow Rd	Unnamed Stream to Rocky Run	yes	0	No	Minor	yes	no	0
209-35	2836500	Baumgartner Rd	Unnamed Stream to Copper Cr	yes	0	No	Minor	yes	no	0
209-36	5001299	S Darrow Rd	Unnamed Stream to Rocky Run	yes	0	Yes	Minor	yes	no	0
209-37	5001397	E Neuman Rd	Unnamed Stream to Copper Cr	no	10	Yes	Severe	yes	no	0.5
209-38	5001285	Marquardt Rd	Unnamed Stream to Copper Cr	no	0	Yes	Severe	yes	no	0.5
209-40	5001403	E Manitou Valley Rd	Unnamed Stream to Copper Cr	no	0	No	Minor	yes	no	0.5
209-45	5001332	Co Rd A	Unnamed Stream to Copper Cr	no	0	No	None	yes	no	0.5

Preliminary Culvert Assessment

Summary Results and Passability Score

209-46	3000142	E Neuman Rd	Unnamed Stream to Copper Cr	yes	0	No	Moderate	yes	no	0
209-50	2836800	S Darrow Rd	Unnamed Stream to Copper Cr	yes	5		Moderate	no	no	0
209-52	5001443	S Darrow Rd	Unnamed Stream to Copper Cr	yes	0	Yes	Minor	yes	no	0
209-8	5001403	E Station Rd	Unnamed Stream to Stony Brook	no	0	NA	Minor	no	no	0.9
209-9	2836300	Twin Creek Rd	Rocky Run	yes	0	No	Severe	no	no	0
210-11	2833500	Stone Rd	Birch Creek	no	25	No	Severe	no	no	0.5
210-14	2833600	Co Rd C	Unnamed Stream to Birch Cr	no	0	No	Minor	no	no	0.5
210-21	2833900	Lyman Lake Rd	Unnamed Stream to Bluff Cr	no	0	No	Moderate	no	no	0
210-25	5001176	Johnson Rd	Unnamed Stream to Bluff Cr	no	0	No	Minor	yes	no	0.5
210-27	2834200	Way Rd	Unnamed Stream to Bluff Cr	yes	0	No	Severe	no	no	0
210-28	2834200	Huppert Rd	Unnamed stream to Bluff Cr	no	1	Yes	Moderate	yes	no	0.5
210-30	2833900	Huppert Rd	Unnamed stream to Bluff Cr	yes	0	No	Moderate	no	no	0
210-32	2833700	Co Rd K	Unnamed Stream to Birch Cr	no	0	No	Minor	no	no	0.5
210-38	2833200	Bluff Creek Trail	Bluff Creek	no	15	No	Minor	yes	no	0.5
210-42	5000995	Valley Brook Rd	Unnamed Stream to Bluff Cr	no	0	No	Minor	no	no	0.5
210-7	2833800	Swamp Rd	Unnamed Stream to Birch Cr	no	1	No	Minor	no	no	0.5
211-13	2835500	Co Rd A	Crawford Creek	no	0	No	Minor	no	no	0.5
211-16	2835400	Bardon Ave	Unnamed Stream to Nemadji River	no	0	No	Minor	no	no	0.5
211-18	2385500	E Ekelson Rd	Crawford Creek	yes	0	No	Minor	yes	no	0
211-19	5001169	Rivord Rd	Unnamed Stream to Crawford Cr	no	0	Yes	Minor	yes	no	0.5
211-20	2835500	Ridgeview Dr	Crawford Creek	no	0	No	Minor	yes	no	0.5
211-21	3000141	Bardon Ave	Unnamed Stream to Nemadji R	no	0	No	Minor	no	no	0.5
212-1	2834600	3rd St	Bear Creek	yes	0	No	Minor	no	no	0
212-12	2834700	Co Rd E	Unnamed Stream to Bear Cr	no	0	No	Minor	no	no	1
212-14	2834700	Co Rd Z	Unnamed Stream to Bear Cr	no	0	No	Minor	no	no	0.5
212-15	2834700	Co Rd E	Unnamed Stream to Bear Cr	yes	0	No	Minor	no	no	0
212-23	2834600	Co Rd C	Bear Creek	yes	0	No	Severe	no	no	0
212-28	2835100	Co Rd Z	Unnamed Stream	yes	0	No	Minor	no	no	0
212-3	2834600	E City Limits Rd	Bear Creek	no	0	No	Moderate	no	no	0.5
212-30	2835100	Humane Society Rd	Unnamed Stream	no	0	No	Minor	no	no	0.9
212-38	2834900	Co Rd C	Unnamed Stream to Bear Cr	no	0	No	Minor	no	no	0.5
212-4	2834600	Co Rd Z	Bear Creek	no	0	No	Minor	no	no	1
212-7	2835100	Moccasin Mike Rd	Unnamed Stream to Allouez Bay	yes	0	No	Minor	no	no	0
219-56	2850100	Co Rd E	Unnamed Stream to Amnicon River	no	90	No	Severe	no	no	0.9

Preliminary Culvert Assessment

Summary Results and Passability Score

220-1	2847100	Hwy 13	Dutchman Creek	yes	0	No	Minor	no	no	0
220-16	2848400	E Camp Amnicon Rd	Unnamed Stream	no	0	No	Minor	no	no	0.5
220-19	2848500	E Camp Amnicon Rd	Unnamed Stream	yes	0	No	Minor	no	no	0
220-2	5001112	Co Rd E	Unnamed Stream to Morrison Cr	no	50	No	Minor	yes	no	0.5
220-31	2848100	Co Rd E	Unnamed Stream to Morrison Cr	yes	2	No	Minor	no	no	0
220-35	2847800	Co Rd C	Unnamed Stream to Dutchman Cr	no	0	No	Minor	no	no	0.5
220-36	2848700	E Camp Amnicon Rd	Unnamed Stream	no		No	Minor	yes	no	1
220-36	2848700	E Camp Amnicon Rd	Unnamed Stream	no		Yes	Minor	yes	no	1
220-37	2847700	Co Rd C	Unnamed Stream to Dutchman Cr	no	0	No	Moderate	no	no	0.5
220-39	2847400	Co Rd C	Unnamed Stream to Dutchman Cr	no	5	No	Stablized	no	no	0.5
220-43	2847100	Co Rd E	Dutchman Creek	yes	0	Yes	Moderate	no	no	0
220-45	2847900	Co Rd E	Morrison Creek	yes	0	No	Minor	no	no	0
220-46	2848200	Co Rd E	Unnamed Stream to Morrison Cr	yes	0	No	Minor	no	no	0
220-51	2847500	Co Rd E	Unnamed Stream to Dutchman Cr	no	0	No	Minor	no	no	0.5
220-52	2847500	Co Rd C	Unnamed Stream to Dutchman Cr	no	0	No	Minor	no	no	0.9
220-53	2847500	Cloverdale Drive	Unnamed Stream to Dutchman Cr	yes	0	No	Minor	no	no	0
220-6	2847600	Co Rd E	Unnamed Stream to Dutchman Cr	no	0	No	Moderate	no	no	0.5

Discussion of Tier 2 Priority Crossings

The project objectives called for identifying 15-20 priority crossings (Tier 2) out of the 140 preliminary culvert assessment for further review by the Technical Team. Crossings were ranked first by the degree of passability at a crossing. Fifty-four culverts with a passability score of 0 represented the most severe passage issues and were included on the Tier 2 list.

The second criteria used in ranking was the stream's potential value and its ability to support the target fish species - walleye, musky or resident brook trout. Five of the 140 preliminary culvert crossings had a passability score of 0.5 (Not passable by some species/life stages at most flows) and the potential for supporting the target species - Four of those streams were classed as Trout 1 or 2 waters and one had high potential for walleye as well as a direct connection to Superior Bay. These 5 crossings were also included on the Tier 2 list.

The final step in ranking was to determine which barrier upgrades would result in the maximum ecological benefit. The Technical Team determined that the length of stream opened cross-referenced with stream value would best represent maximum ecological value.

The length of stream opened was measured for all 54 barriers with a passability score of 0; the 4 barriers with a passability score of 0.5 that were located on trout waters; and the 1 barrier with a passability score of 0.5 that was located on a walleye water with a direct connection to Superior Bay. The length of stream channel that would be opened if the barriers were removed ranged from 0.02 to 3.85 miles.

Of the 59 stream lengths measured, upgrading barriers at 17 of the crossings would open up ≥ 1 mile of stream habitat. In 2 cases, miles opened would be > 1 mile if a nearby upstream barrier (not previously surveyed) was determined to be passable (102-18 Unnamed to Pokegama – 0.04 miles would increase to 3.4 miles and at 103-3 Unnamed to Pokegama – 0.93 miles would increase to 2.9 miles). Stream measurements for Miller Creek and Little Balsam Creek (both trout waters) revealed opportunities to open up the most stream length if each system was considered as a group (4.51 miles and 5.07 miles, respectively).

The 4.51 miles along the Miller Creek system included: 205-16 at County Hwy B (1.66 miles); 205-18 at the State trail (0.56 miles); 205-20 at Polish Rd (1.63 miles); and 205-7 Unnamed to Miller at Polish Rd (0.67 miles). The 5.07 miles along the Little Balsam Creek system included: 207-7 at County Hwy B (0.73 miles); 207-9 at Severson Rd (0.46 miles); 207-8 at E Patzau-Foxboro Rd (0.15 miles); and 207-6 on a State trail (3.72 miles).

In total, 24 streams were listed as the Tier 2 Priority Crossings based on passability, miles of stream and the potential for maximum ecological benefit (Table 3).

Table 3 - Tier 2 Priority Crossings

SiteID	Road_name	StreamName/System	Perch_YN	Intermittent_yn	Trout Class	Pass Score	Miles Opened	Note	StreamsNatComm	Tech Team Personal Knowledge	Final Action and Reason
102-13	Irondale Rd	Unnamed stream to Pokegama River	no	no	no	0	3.85		cool-cold headwater, macroinvertebrate		Remove/macro stream
102-18	Co Rd W	Unnamed stream to Pokegama River	yes	no	no	0	0.04	3.4 miles if 102-41 is passable	coldwater, macroinvertebrate	102-41 not passable	Remove/macro stream/beaver dam problems
102-5	S Barnes Rd	Pokegama River	no	no	no	0	1.87		cool-cold headwater, macroinvertebrate		Remove/macro stream
103-3	Co Rd W	Unnamed Stream to Little Pokegama River	yes	no	no	0	0.93	2.9 if 103-4 is passable	coldwater, macroinvertebrate	103-4 not passable	Remove/macro stream/Fewer miles/better if part of group
205-16	Co Rd B	Miller Creek	yes	no	2	0	1.65	4.51 miles if part of group	cool-warm headwater, macroinvertebrate		Include/high quality/potential for working on group
205-18	Snowmobile Trail	Miller Creek	no	no	2	0.9*	0.56	4.51 miles if part of group	cool-warm headwater		Include/high quality/potential for working on group
205-20	Polish Rd	Miller Creek	yes	no	2	0	1.63	4.51 miles if part of group	cool-warm headwater		Include/high quality/potential for working on group
205-7	Polish Rd	Unnamed Stream to Miller Cr	yes	yes	no	0	0.67	4.51 miles if part of group	macroinvertebrate		Remove/macro stream
207-6	Snowmobile Trail	Little Balsam Creek	yes	no	1	0*	3.72	5.07 miles if part of group	cool-warm headwater		Include/high quality/potential for working on group
207-7	Co Rd B	Little Balsam Creek	yes	no	1	0	0.73	5.07 miles if part of group	cool-warm headwater		Include/high quality/potential for working on group
207-8	E Patzau Foxboro Rd	Little Balsam Creek	yes	no	1	0	0.15	5.07 miles if part of group	cool-warm headwater		Include/high quality/potential for working on group
207-9	E Severson Rd	Little Balsam Creek	no	no	1	0.5	0.47	5.07 miles if part of group	cool-warm headwater		Include/high quality/potential for working on group
205-25	S Rancon Rd	Unnamed Stream to Black River	yes	no	no	0	1		macroinvertebrate		Remove/macro stream
205-29	Co Rd B	Unnamed Stream to Rock Creek	yes	no	no	0	1.04		cool-cold headwater		Remove/unknown barrier downstream
207-26	S CR-W	Unnamed Stream to Balsam Cr	yes	yes	no	0	1.35		macroinvertebrate		Remove/macro stream
207-30	Town Line Rd	Unnamed Stream to Balsam Cr	yes	no	1	0	1.02		cool-warm headwater, macroinvertebrate		Remove/macro stream
207-35	E Co Rd B	Unnamed Stream to Little Balsam Cr	yes	yes	no	0	1.1	PassScore_est. from field	macroinvertebrate		Remove/macro stream
209-17	Leggate Rd	Copper Creek	no	no	2	0	1.24		cool-warm headwater, macroinvertebrate		Remove/macro stream
209-21	S Darrow Rd	Rocky Run	yes	yes	no	0	2.19		macroinvertebrate		Remove/macro stream
209-46	E Neuman Rd	Unnamed Stream to Copper Cr	yes	yes	no	0	1.1		macroinvertebrate		Remove/macro stream
212-3	E City Limits Rd	Bear Creek	no	no	no	0.5	1.27		cool-cold headwater		Remove/barrier up/down stream
212-7	Moccasin Mike Rd	Unnamed Stream to Allouez Bay (Dutchmans)	yes	no	no	0	2.76		cool-cold headwater, macroinvertebrate		Include/Direct migration to bay
220-1	Hwy 13	Dutchman Creek	yes	no	no	0	1.79		macroinvertebrate, cool-		Include/Direct migration to lake superior
220-19	E Camp Amnicon Rd	Unnamed Stream to Lake Superior	yes	no	no	0	2.27		macroinvertebrate		Remove/macro stream
* Determined in Follow Up Assessments											

Discussion of Draft Tier 1 Priority Crossings and Follow-Up Assessments

After further evaluation by members of the Technical Team, 15 of the Tier 2 Priority Crossings were classified as macroinvertebrate streams and were removed from consideration based on lower ecological values (Table 3). The remaining 9 streams were recommended for follow up assessments and further evaluation (Table 4). A visual inspection of a railroad grade on Miller Creek downstream of County Rd B determined it was a box culvert that was passable. Two additional culvert assessments were conducted on the State trail at Miller Creek and Little Balsam Creek. The trail crossing over Miller Creek (205-18) had a passability score of 0.9 and the trail crossing over Little Balsam Creek (207-6) had a passability score of 0. Eight Quantitative Habitat Assessments were conducted out of 12 proposed. High rain events and time constraints prevented assessments on two streams, 212-7 Unnamed Stream to Allouez Bay and 220-1 Dutchman Creek. The results of the habitat assessments are reported in Table 4.

Table 4 – Follow-Up Assessments on Tier 1 Priority Crossings

SiteID	Road_name	StreamName/System	Additional Data Needed For Final Recommendation	Results
205-16	Co Rd B	Miller Creek	Investigate passability at railroad crossing downstream. Conduct a quantitative habitat assessment upstream and downstream.	Up=65 Dn=32
205-18	Snowmobile Trail	Miller Creek	Conduct culvert assessment. If it is a barrier, conduct quantitative habitat assessment upstream.	205-18 is passable / No Hab. Assess Required
205-20	Polish Rd	Miller Creek	Conduct quantitative habitat assessment upstream.	Up=60
207-6	Snowmobile Trail	Little Balsam Creek	Conduct a culvert assessment. If it is a barrier, conduct quantitative habitat assessment upstream.	207-6 is a barrier / Up=55
207-7	DRN Survey/Co Rd B	Little Balsam Creek	Conduct quantitative habitat assessment upstream and downstream.	Up=50 Dn=63
207-8	E Patzau Foxboro Rd	Little Balsam Creek	No additional work needed.	N/A
207-9	E Severson Rd	Little Balsam Creek	Conduct quantitative habitat assessment upstream and downstream.	Up=68 Dn=58
212-7	Moccasin Mike Rd	Unnamed Stream to Allouez Bay	Conduct quantitative habitat assessment upstream and downstream.	No survey due to field conditions
220-1	Hwy 13	Dutchman Creek	Conduct quantitative habitat assessment upstream and downstream.	No survey due to field conditions

Discussion of Final Tier 1 Priority Crossings

After reviewing the results of the follow up assessments, it was determined that 8 of the 9 Tier 1 Priority Crossings met the full objectives outlined by the Technical Team. One crossing (205-18 State Trail on Miller Creek) was found to be passable except in high flows (Score = 0.9). Due to the passability score, this crossing was placed lower on the priority list for upgrading. However, it remains an important crossing that allows for maximum connection along the Miller Creek system. Since one of the two culverts at that crossing is damaged, it should be inspected regularly to ensure stream connectivity is maintained. Eventually, this crossing should be upgraded.

There were opportunities at 3 crossings (212-7 Unnamed Creek to Allouez Bay and 207-8 and 207-9 both on Little Balsam Creek) to work with local municipalities already in the process of upgrading. The Little Balsam Creek crossings have serious flood damage and are high priorities for the Town of Summit and FEMA. The Technical Team determined these culverts should be of highest priority for this project and that design and implementation funds potentially enabled under this project would be critical to improving the crossings for ecological benefit. Except for some additional mitigation damage (i.e, armoring the embankments), FEMA funds would only cover the cost of replacing the crossings to "pre-disaster conditions", which would not be adequate for fish passage.

Detailed culvert data for the 9 priority crossings can be found in Table 5 - Tier 1 Priority Culvert Assessment Database Summary on pages 37-39. This data along with a watershed and road context and species specific data was used to identify priorities for upgrading.

A summary for each of the Tier 1 Priority Crossings considered by the Technical Team follows:

Little Balsam Creek System

The Little Balsam Creek system (

Figure 3) was selected as the highest priority for this project by the Technical Team. This system has the highest stream quality values, the greatest length of stream opened if taken as a group (5.07 miles), and the highest local need for culvert replacement. The Habitat Assessment values on this system range from 50-68, all indicating good habitat along the entire length. Personal correspondence with WDNR staff indicated that habitat scores in the “excellent” range are rare and, therefore, the “good” scores on the Little Balsam Creek represent the highest quality habitat available in the SLRAOC.

The high percentages of open lands (46%) in the watershed and the flood hazard zone (Figure 4), and the history of wash-outs will, however, present challenges to designing and installing replacement culverts.

The culvert crossings at 207-9 Severson Road and 207-8 E Patzau-Foxboro Road have suffered extreme damage following a storm event. FEMA and the Town of Summit are developing a plan to replace both culverts to pre-disaster conditions. The pre-disaster condition design, however, does not account for fish passage and will in all likelihood fail in the future. Collaborating with the Town of Summit and FEMA on the design and construction costs for these crossings will ensure a more ecological result.

The culvert crossing at 207-7 – County Road B is perched and has an estimated passability score of 0. This crossing was analyzed previously by WDNR and therefore was not included in the preliminary culvert assessment work. Habitat assessed under this project indicate good habitat quality on both the upstream (Score=50) and downstream (Score=63) segments. A HBI score from 2004 indicates excellent quality upstream of County Road B. It was determined under this project that a railroad trestle downstream of the crossing is passable. It appears that removing this barrier would restore connectivity all the way to Balsam Creek downstream.

Another challenge is a concrete box culvert (207-6 State Trail) spanning 211 feet below an estimated 86 feet of fill. Additional open bottom aprons extend another 50 feet on both the upstream and downstream ends. Although a series of benches at both the inlet and outlet may be inhibiting fish passage, it is highly likely that shallow water depths (0.2-0.3 ft.) in the structure at normal flow conditions are obstructing larger – if not all - fish from moving upstream. It is also likely that the length of culvert combined with increased flow velocity and increased stream discharge during high flows would be a barrier to fish passage in all size classes (Table 1). Although costs and design at this crossing will be a challenge, upgrading would result in 3.72 miles of Class I Trout Water opened up.

The Little Balsam Creek system best meets the BUI Removal Target for Loss of Fish & Wildlife Habitat by rehabilitating four culverts on one stream to restore connectivity throughout the entire system.

Figure 3 - Little Balsam Creek Summary

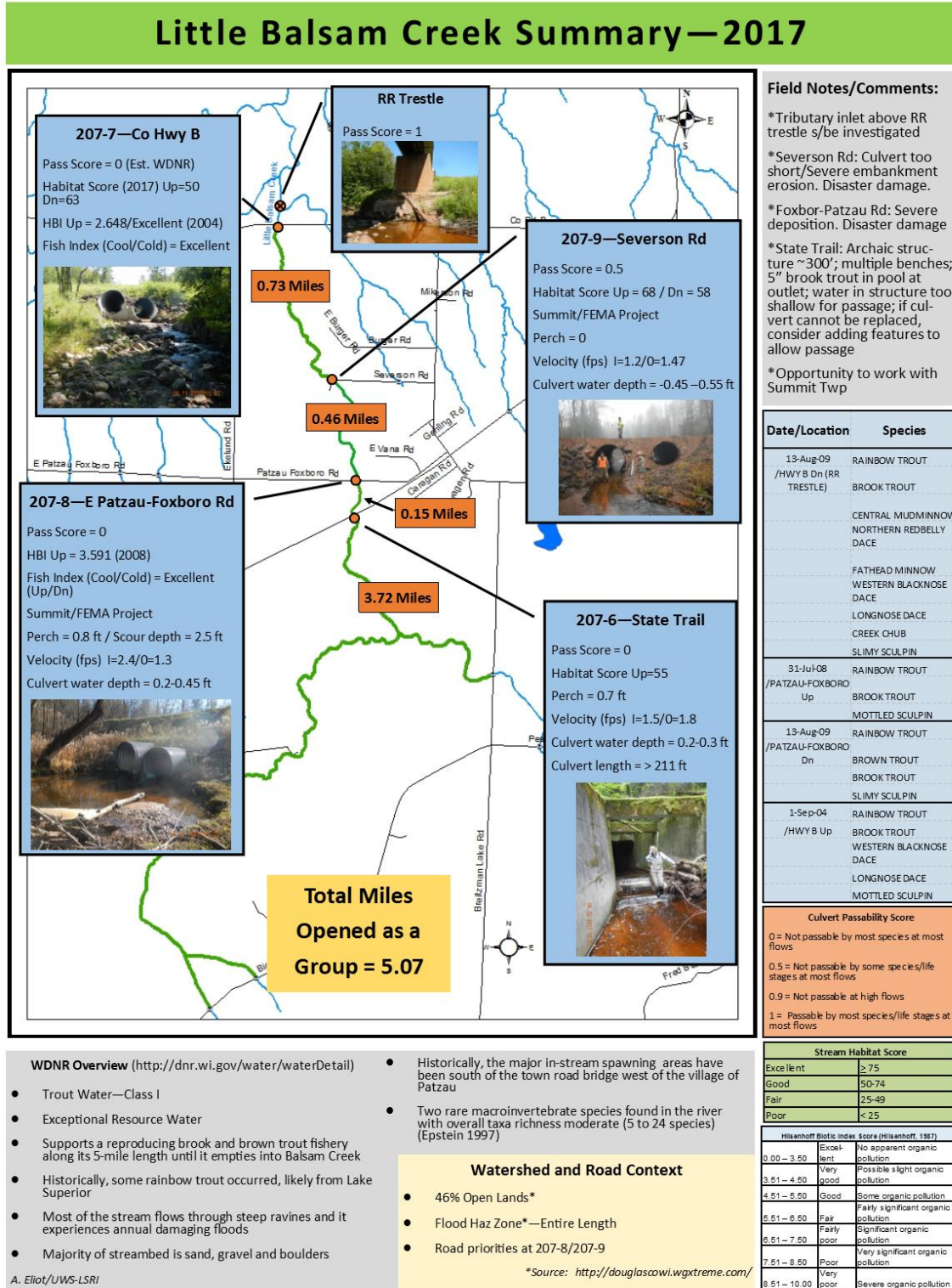


Figure 4 - Little Balsam Creek % Open Lands



Miller Creek System Summary

The Miller Creek system (32-Fair) along that segment. There is also some residential development along one side of the bank above County Rd B. Habitat scores in upstream segments of Miller Creek range from 60-65 (good). The habitat score of 65 upstream of County Road B indicates fish would have high quality habitat to move to if this barrier was removed. Any work on Miller Creek should include shoreline restoration recommendations for areas in pasture or residential land use.

It was determined from the follow up inspections that the railroad crossing below County Rd B is passable. It is a low gradient area with beaver dam issues on both sides, however, the fact that it is passable with management means that Miller Creek would be opened to the Black River if the County Rd B barrier was removed.

The 205-20 Polish Rd crossing on the upper end of this stream had good quality habitat on the upstream side (60). Replacing this culvert would open up 1.63 miles of stream. The culvert at this location is in poor condition and appears to be blocking a high number of fish. During our follow up visit, an individual was observed fishing in the scour pool below the culvert. Although the stream meanders back toward the road at the culvert outlet (which may require a stream re-alignment), there is the potential that this culvert would be inexpensive to replace.

Figure 5) was selected as the second highest priority by the Technical Team. It is a Class II Trout Water with aging infrastructure that would benefit from culvert upgrades, particularly at County Rd B (205-16) where a perch height of 1.7 feet is likely impeding fish passage. The deep plunge pool (2.6') at that location may allow brook trout to reach the jump height needed to enter the culvert (Kondratieff, 2011). However, Castro-Santos, 2004 shows that velocity barriers may impact motivation and the number of attempts so even if brook trout can jump the perch they may not. The velocity of 4.31 fps at inlet and 3.09 fps at outlet in an 80 foot culvert is also a barrier to brook trout (University of Wisconsin-Extension, No Date). The lower fish index score (WDNR, Figure 4) above the culvert (excellent downstream/good upstream) is another indicator that the culvert may be a barrier to fish.

Culvert design and replacement costs on this stream may be lower because areas upstream of County Rd B are not located in a flood hazard zone.

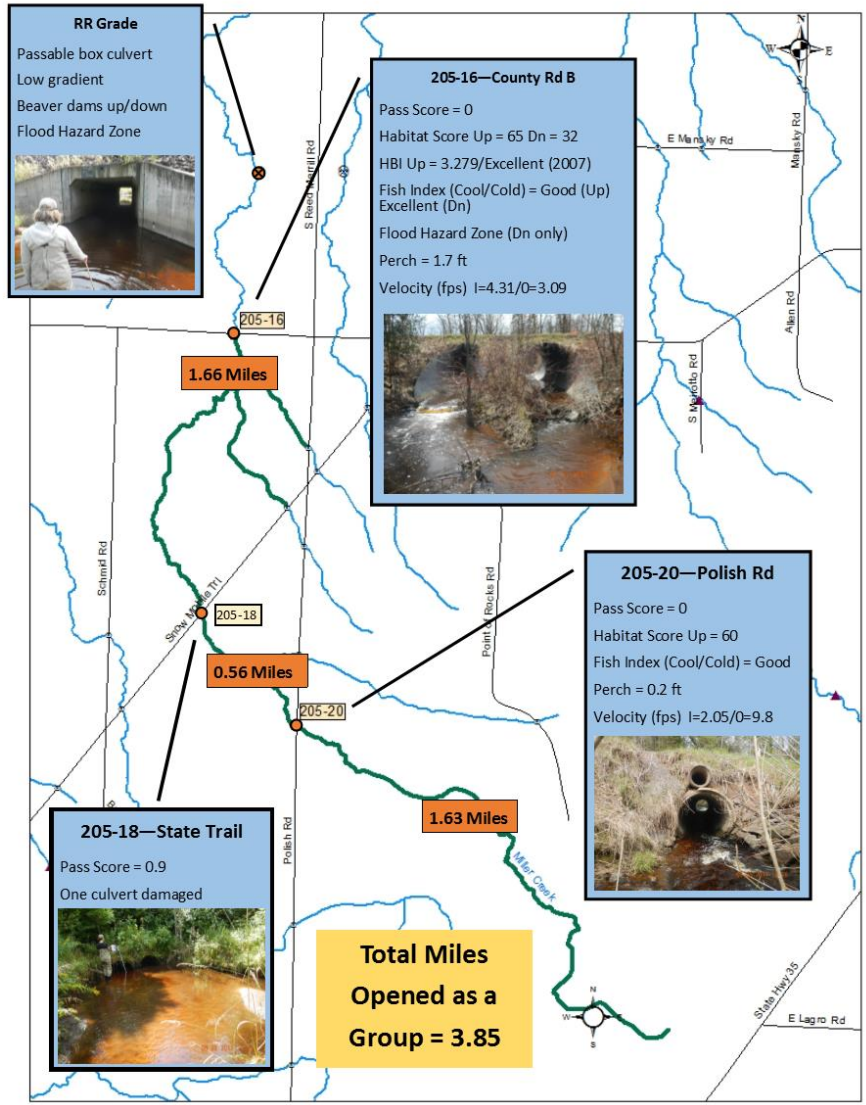
Figure 6) and although a good portion of the watershed is forested, the riparian area below County Rd B has been converted to pasture and is likely impacting the habitat score (32-Fair) along that segment. There is also some residential development along one side of the bank above County Rd B. Habitat scores in upstream segments of Miller Creek range from 60-65 (good). The habitat score of 65 upstream of County Road B indicates fish would have high quality habitat to move to if this barrier was removed. Any work on Miller Creek should include shoreline restoration recommendations for areas in pasture or residential land use.

It was determined from the follow up inspections that the railroad crossing below County Rd B is passable. It is a low gradient area with beaver dam issues on both sides, however, the fact that it is passable with management means that Miller Creek would be opened to the Black River if the County Rd B barrier was removed.

The 205-20 Polish Rd crossing on the upper end of this stream had good quality habitat on the upstream side (60). Replacing this culvert would open up 1.63 miles of stream. The culvert at this location is in poor condition and appears to be blocking a high number of fish. During our follow up visit, an individual was observed fishing in the scour pool below the culvert. Although the stream meanders back toward the road at the culvert outlet (which may require a stream re-alignment), there is the potential that this culvert would be inexpensive to replace.

Figure 5 - Miller Creek Summary

Miller Creek Summary—2017



Field Notes/Comments:

- *Co Hwy B downstream: Pasture on both sides; major deposition and debris dams
- *Co Hwy B upstream: Mowed yards along portion
- *Polish Rd: Damaged culvert; severe erosion on inlet and outlet
- *State Trail: Culvert passable except at high flows; debris dam blocking inlet; 1 concrete culvert has damage
- *Recommend subsequent in-stream work and shoreland restoration following any culvert replacements
- *Opportunity to work with Superior Twp

Date/Location	Species
8/8/2007/HWY B Up	BROOK TROUT
	WESTERN BLACKNOSE DACE
	CREEK CHUB
	WHITE SUCKER
	BROOK STICKLEBACK
	MOTTLED SCULPIN
8/14/2013/HWY B Culvert	BROOK TROUT
	REDSIDE DACE
	CREEK CHUB
	WHITE SUCKER
	JOHNNY DARTER
	SLIMY SCULPIN
8/14/2013 /Polish Rd	BROOK TROUT
	BROOK STICKLEBACK

Culvert Passability Score	
0 =	Not passable by most species at most flows
0.5 =	Not passable by some species/life stages at most flows
0.9 =	Not passable at high flows
1 =	Passable by most species/life stages at most flows

WDNR Overview (<http://dnr.wi.gov/water/waterDetail>)

- Stream Length = 3.01 Miles
- Natural Community—Cool-Warm Headwater
- Trout Water—Class II
- General Condition Unknown—1973 Surface Water Resources of Douglas County indicates the lower 2.9 miles is classed as “minnow water”

A. Elliot/UWS-LSRI

Watershed and Road Context

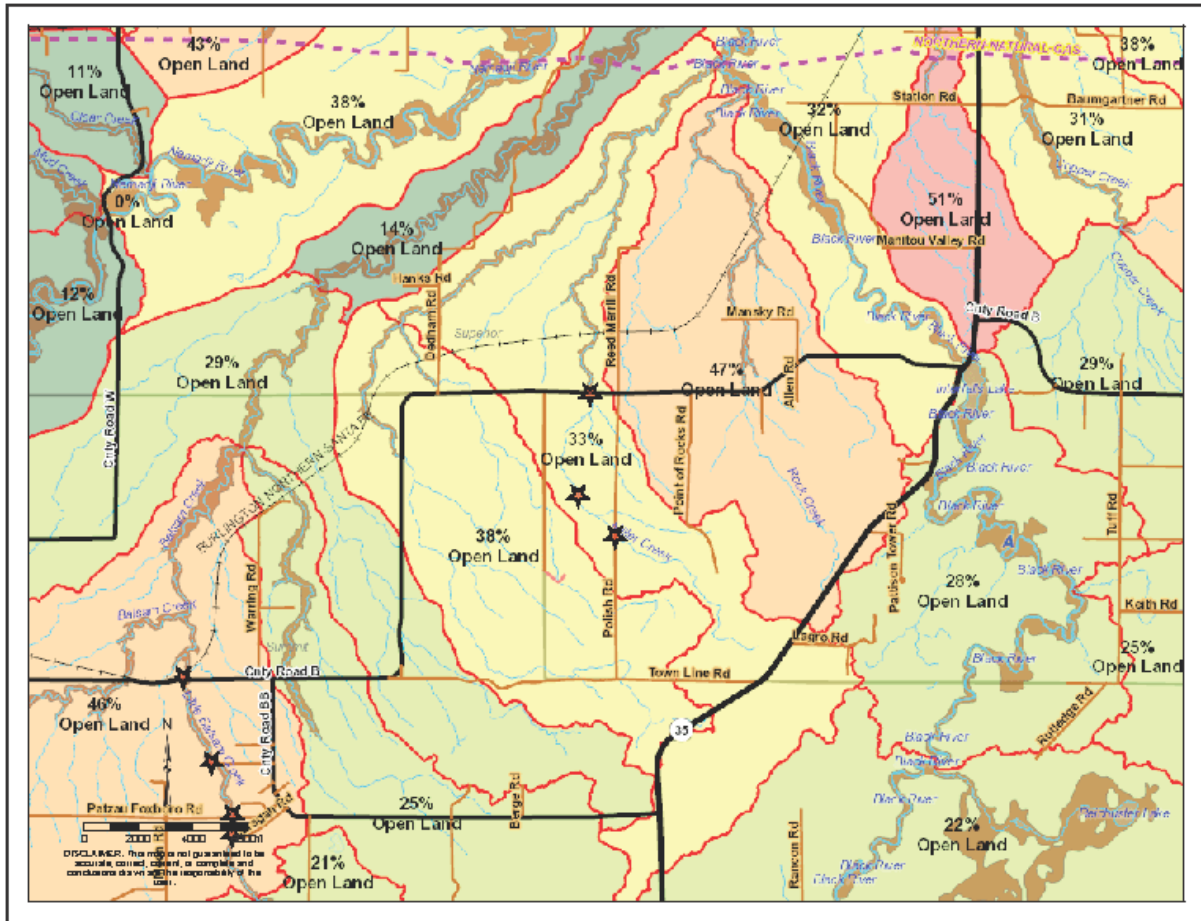
- 33% Open Lands*
- Pasture below Co Rd B/Some development above
- Flood Hazard Zone Downstream of Co Rd B*
- Road priorities unknown

*Source: <http://douglascowi.wgxtreme.com/>

Stream Habitat Score	
Excellent	≥ 75
Good	50-74
Fair	25-49
Poor	< 25

Wisemanoff Biotic Index Score (Wisemanoff, 1977)		
0.00 – 3.50	Excellent	No apparent organic pollution
3.51 – 4.50	Very good	Possible slight organic pollution
4.51 – 5.50	Good	Some organic pollution
5.51 – 6.50	Fair	Fairly significant organic pollution
6.51 – 7.50	Fairly poor	Significant organic pollution
7.51 – 8.50	Poor	Very significant organic pollution
8.51 – 10.00	Very poor	Severe organic pollution

Figure 6 - Miller Creek Watershed % Open Lands



Dutchman Creek Summary

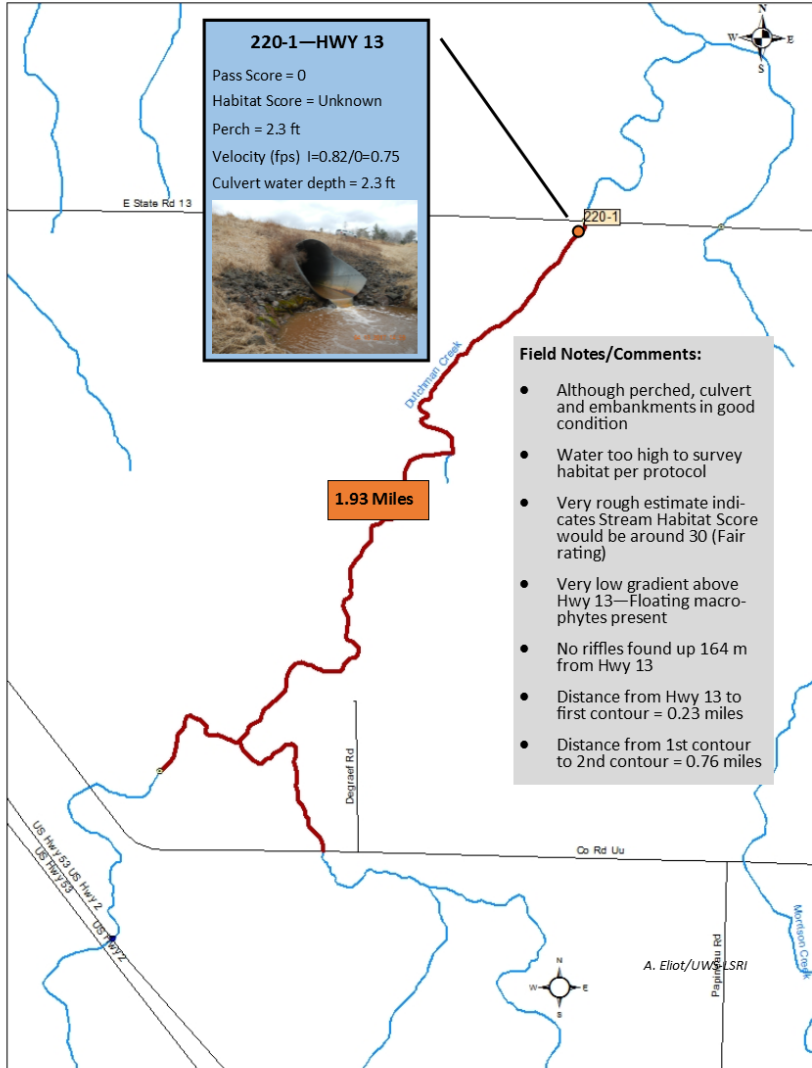
Dutchman Creek was maintained on the Tier 1 Priority Crossings List because of its potential to open up stream habitat to walleye and have a direct connection to Lake Superior (Figure 7). Although the culvert crossing at 220-1 Hwy 13 is perched 2.3 ft., it appears to be a new replacement and is in very good condition with stable embankments. State road priorities are not known for this site.

Removing this barrier would open up 1.93 miles of stream, however, the upstream value is unknown. The stream gradient is very low upstream of State Hwy 13 and a very rough habitat score calculated in the office estimated the habitat to have a score around 30 (fair). A map review indicates it is not likely to locate a riffle habitat within a mile of Hwy 13. The watershed is highly forested (6% open lands) and the stream is in a Flood Hazard Zone (Figure 8).

Navigating this stream on foot is very difficult and it is recommended that landowners upstream be contacted for access for any future attempts to assess habitat. Working with DOT to develop a strategy for any future work is recommended. A fish ladder or other fish passage design could also be implemented at this site as an alternative to replacement.

Figure 7 - Dutchman Creek Summary

Dutchman Creek Summary—2017



Date/Location	Species
7/12/2006 / HWY 13	CENTRAL MUDMINNOW
	HORNHEAD CHUB
	COMMON SHINER
	WESTERN BLACKNOSE DACE
	LONGNOSE DACE
	CREEK CHUB
	WHITE SUCKER
9/17/2009 / Near Mouth	CENTRAL MUDMINNOW
	BRASSY MINNOW
	HORNHEAD CHUB
	EMERALD SHINER
	COMMON SHINER
	CREEK CHUB
	WHITE SUCKER
6/23/2004 / Near Mouth	RAINBOW TROUT
	CENTRAL MUDMINNOW
	LAKE CHUB
	EMERALD SHINER
	COMMON SHINER
	SPOTTAL SHINER
	MIMIC SHINER
	FATHEAD MINNOW
	WESTERN BLACKNOSE DACE
	LONGNOSE DACE
	CREEK CHUB
	WHITE SUCKER
TROUTPERCH	
BURBOT	
BROOK STICKLEBACK	
THREESPINE STICKLEBACK	
ROCK BASS	
JOHNNY DARTER	
LOGPERCH	
RUFFE	

Field Notes/Comments:

- Although perched, culvert and embankments in good condition
- Water too high to survey habitat per protocol
- Very rough estimate indicates Stream Habitat Score would be around 30 (Fair rating)
- Very low gradient above Hwy 13—Floating macrophytes present
- No riffles found up 164 m from Hwy 13
- Distance from Hwy 13 to first contour = 0.23 miles
- Distance from 1st contour to 2nd contour = 0.76 miles

Culvert Passability Score

0 = Not passable by most species at most flows

0.5 = Not passable by some species/life stages at most flows

0.9 = Not passable at high flows

1 = Passable by most species/life stages at most flows

Stream Habitat Score

Excellent	≥ 75
Good	50-74
Fair	25-49
Poor	< 25

Wisconsin Biotic Index Score (Wisniewski, 1987)

0.00 – 3.50	Excellent	No apparent organic pollution
3.51 – 4.50	Very good	Possible slight organic pollution
4.51 – 5.50	Good	Some organic pollution
5.51 – 6.50	Fair	Fairly significant organic pollution
6.51 – 7.50	Fairly poor	Significant organic pollution
7.51 – 8.50	Poor	Very significant organic pollution
8.51 – 10.00	Very	Severe organic pollution

WDNR Overview (<http://dnr.wi.gov/water/waterDetail>)

- Flows near municipal landfill and can be affected by trash or litter
- Very turbid
- Riparian area relatively undeveloped
- 1964 fisheries survey description indicates a typical runoff-minnow stream limited by poor water quality, warm water temperatures, erosion and turbidity, and low or intermittent flow.
- 2006 baseline survey at Hwy 13 had eight fish species at somewhat higher densities
- At low flows, mouth disconnected from Lake Superior
- Potential important coastal wetland habitat at mouth.

- 2004 survey close to mouth found 20 fish species.
- Current and attainable uses are listed as “unknown”.
- Appears the most appropriate designation would be “warmwater forage fish community”.

Watershed and Road Context

- 6% Open Lands*
- Flood Hazard Zone*
- Road priority unknown—Appears to be recently upgraded

*Source: <http://douglascowi.wgxtreme.com/>

Unnamed Tributary to Allouez Bay Summary

The Unnamed Tributary to Allouez Bay (212-7) was maintained on the Tier 1 Priority Crossing because of its potential to open up stream habitat to walleye and have a direct connection to Superior Bay (

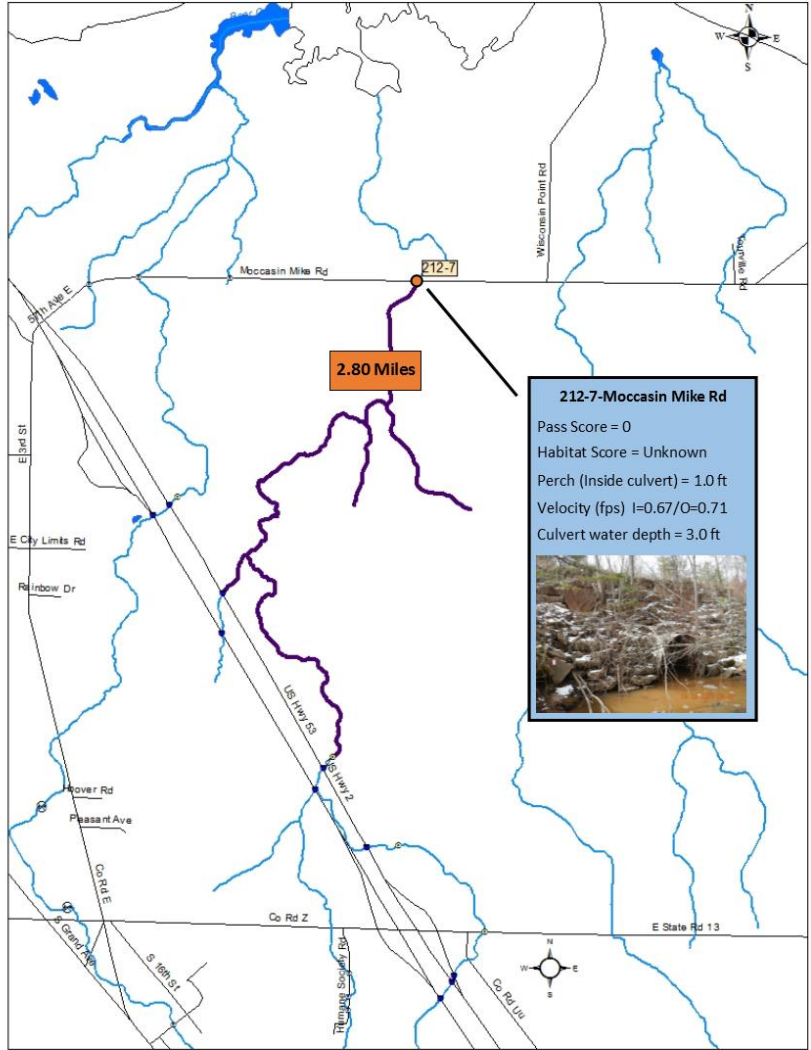
Figure 9). This crossing is not perched at the outlet, however there appears to be a perch of ~1 ft. in the middle of the culvert. The culvert water depth of 3.0 ft. and the low structure velocity (inlet=0.67 outlet=0.71) suggests that this culvert would be passable if the perch was eliminated.

Removing the barrier would open up 2.80 miles of stream, the general condition of which is unknown. A very rough habitat score calculated in the office estimated the habitat to have a score around 50-55 (good). Per the habitat protocol, water was too high at the time of the follow up visit to conduct a valid assessment. The assessment was attempted following a minor rain event the previous day which suggests flashy flows along this system which could reduce habitat values.

The watershed is mostly forested and consists of only 18% open lands and the entire length of the stream is in a Flood Hazard Zone (Figure 8). This crossing is a high priority for the City of Superior.

Figure 9 - Unnamed Stream to Allouez Bay

Unnamed Creek to Allouez Bay Summary—2017



- Field Notes/Comments:**
- No fish survey data
 - Culvert outlet not perched, however, culvert appears to be perched/sloped at mid-point—See outlet in photo below
 - Water too high to survey habitat per protocol
 - Very rough estimate indicates Stream Habitat Score would be 50-55 (Good rating)
 - Opportunity to work with City of Superior on its proposed replacement

- Watershed and Road Context**
- 18% Open Lands*
 - Flood Hazard Zone Entire Length
 - Road priority for City of Superior/Upgrade Scheduled
- *Source: <http://douglasowi.wgxtreme.com/>

Culvert Passability Score

0 = Not passable by most species at most flows

0.5 = Not passable by some species/life stages at most flows

0.9 = Not passable at high flows

1 = Passable by most species/life stages at most flows

Stream Habitat Score	
Excellent	≥ 75
Good	50-74
Fair	25-49
Poor	< 25

Wisconsin Biotic Index Score (Wisconsin, 1987)		
0.00 – 3.50	Excellent	No apparent organic pollution
3.51 – 4.50	Very good	Possible slight organic pollution
4.51 – 5.50	Good	Some organic pollution
5.51 – 6.50	Fair	Fairly significant organic pollution
6.51 – 7.50	Fairly poor	Significant organic pollution
7.51 – 8.50	Poor	Very significant organic pollution
8.51 – 10.00	Very poor	Severe organic pollution

WDNR Overview (<http://dnr.wi.gov/water/waterDetail>)

- Tributary to Allouez Bay / Length = 4.88 Miles
- Natural Community-Cool-Cold Headwater; Macroinvertebrate; Cool-Warm Headwater
- General Condition Unknown
- Stream drains to the eastern end of Allouez Bay which is a shallow marsh near the base of Wisconsin Point. Several other streams, Bear Creek, Bluff Creek and the Nemadji River, also empty into the bay. The bay is impacted by eutrophication, sedimentation, and other disturbances, however, plant diversity and wildlife values are quite high.
- Fish values in the bay are not reported. A few rare invertebrate species have been identified.
- Water flowing from this stream may positively impact wild rice being restored in the inlet (evidence is anecdotal).
- May 2016 electro-fish survey in Duck Hunter Bay (distant but within St. Louis River estuary): yellow perch, pumpkinseed, spottail shiner, golden shiner, northern pike, white sucker, shorthead redhorse, and carp.

A. Eliot/UWS-LSRI

Table 5 - Tier 1 Priority Culvert Assessment Database Summary

SiteID	Date	Road_name	StreamName	Passability	Road_type	Flow	Scour_YN	Up Pond_YN
207-9	11/17/2016	E Severson Rd	Little Balsam	0.5	Town	< 1/2 Bankfull	yes	no
220-1	4/13/2017	Hwy 13	Dutchman	0	State	< Bankfull	yes	no
212-7	4/28/2017	Moccasin Mike	Unnamed	0	Town	< Bankfull	yes	yes
205-16	5/3/2017	Co Rd B	Miller Creek	0	State	< 1/2 Bankfull	yes	yes
207-8	11/11/2016	E Patzau	Little Balsam	0	County	< 1/2 Bankfull	yes	no
205-20	5/5/2017	Polish Rd	Miller Creek	0	Town	< 1/2 Bankfull	yes	no
205-18	8/22/2017	Snowmobile	Miller Creek	0.9	Other	< 1/2 Bankfull	yes	yes
207-6	8/22/2017	Snowmobile	Little Balsam	0	Other	< 1/2 Bankfull	yes	no
207-7	WDNR Survey	Co Rd B	Little Balsam	0 (est.)	County			

SiteID	Substr_YN	S1I_vel	S1I_dep	S1I_seddep	S1O_vel	S1O_dep	S1O_seddep	S1_width
207-9	no	1.16	0.55	0	1.47	0.45	0	7
220-1	no	0.82	1.3	0	0.75	1.3	0	13.9
212-7	no	0.67	1	0	0.71	1.5	0	3.5
205-16	no	4.31	0.7	0	3.09	0.7	0	11
207-8	no	2.4	0.2	0	1.3	0.45	0	6.9
205-20	no	2.05	0.7	0	9.8	0.4	0	4.5
205-18	yes	0.1	0.3	0.4	0.01	0.19	1.7	3.3
207-6	no	1.5	0.2	0	1.8	0.3	0	10
207-7								

SiteID	S1_height	S1_length	S2I_dep	S2O_dep	S2_width	S2_height	S2_length	S3I_dep
207-9	7.3	32	0	0	6.2	6.2	32	
220-1	14.7	180						
212-7	3.5	100.9			3.5	3.5	68.9	
205-16	11	80	0.4	0.6	11	11	81	
207-8	6.9	147			6.9	6.9	147	
205-20	4.5	39			1.6	1.6	39	
205-18	3.3	84	0.8	0.5	3.3	3.3	84	
207-6	8.25	211.5						
207-7								

SiteID	S3O_dep	S3_width	S3_height	S3_length	Debris_YN	Perch_YN	Perch_ht	Shape
207-9					no	no	0	Round
220-1					no	yes	2.3	Round
212-7		3.5	3.5	68	yes	yes	1	Round
205-16					no	yes	1.7	Round
207-8					no	yes	0.8	Round
205-20					no	yes	0.2	Round
205-18					yes	no	0	Round
207-6					no	yes	0.7	Rectangle
207-7								

Table 5 Continued

SiteID	Material	Interior	Condition	Plug%	Plug_loc	Crush%	Rusted?
207-9	Metal	Smooth	new	0	in pipe	0	No
220-1	Metal	Corrugated	good	0	n/a	0	No
212-7	Metal	Corrugated	good	30	inlet	0	No
205-16	Metal	Corrugated	new	0	n/a	0	No
207-8	Metal	Corrugated	new	0	n/a	0	No
205-20	Concrete	Smooth	good	0	n/a	0	No
205-18	Concrete	Smooth	fair	10	inlet	0	n/a
207-6	Concrete	Smooth	fair	0	in pipe	0	n/a
207-7							

SiteID	In_type	Out_type	Substrate	Scour_len	Scour_wth	Scour_dep	Up Pond_len	Pond_wth
207-9	Projecting	At stream	None	15	12	1.5	0	0
220-1	Mitered	Freefall onto	None	56	32.5			
212-7	Projecting	At stream	None	50.6	26.5	3	29	11
205-16	Mitered	Freefall into	None	36.7	24.5	2.6	5.5	33
207-8	Projecting	At stream	None	32.3	27.4	2.5		
205-20	Projecting	Freefall into	None	24	25.5	3.7		
205-18	Projecting	At stream	Sand	23.4	16.8	1.4	7.5	16
207-6	Apron	Outlet apron	None	19.7	21	2.6		
207-7								

SiteID	Bankfull	Wet_width	Stream_vel	Riffle_sub	Road_width	Fill_depth	Road_surf	Road_cond
207-9	25	7.3	1.19	Cobble	16.6	2.1	Gravel	Good
220-1	23	14.3	1.78	Cobble	40.1	15.1	Paved	Good
212-7	15	5.3	1.39	Cobble	25.9	15.8	Paved	Fair
205-16	NotMeas	NotMeas	NotMeas	NotMeas	22.7	2.1	Paved	Good
207-8	26.5	7	1.19	Cobble	30	20	Gravel	Good
205-20	NotMeas	NotMeas	NotMeas	NotMeas	21	3.5	Gravel	Good
205-18	14.5	7.75	0.9	Cobble	20	16.7	Gravel	Good
207-6	19.7	13.5	1.6	Cobble	20	85	Gravel	Good
207-7								

SiteID	Low_point	Run_path	D_fill_dep	Ero_extent	Ero_notes	Intermittent%_yn	StreamOrder	Musky_YN
207-9	At stream	Roadway	2.7	Severe	embankment	no	2	no
220-1	At stream	Ditch	15.4	Minor	Healthy	no	3	no
212-7	At stream	Ditch	15.8	Minor	Large scour	no	2	no
205-16	At stream	Ditch	2.3	Moderate	Most cuased	no	2	no
207-8	At stream	Roadway	20	Minor	Deposition is	no	1	no
205-20	At stream	Ditch	4.7	Severe	Moderate to	no	1	no
205-18	At stream	Roadway	17.8	Minor	Concrete slabs	no	2	no
207-6	At stream	Roadway	86 (est.)	Severe	Flanking	no	2	no
207-7								

Table 5 Continued

SiteID	TroutClass	Walleye_YN	numberofculverts	landowners	Total Cost
207-9	1	no	2	private	150000
220-1	no	no	1	county	100000
212-7	no	no	3	county	100000
205-16	2	no	2	private	NotCalc
207-8	1	no	2	private	150000
205-20	2	no	2	private	NotCalc
205-18	2	no	2	private	100000
207-6	1	no	1	private	100000
207-7					

S# = Structure and Number

I = Inlet

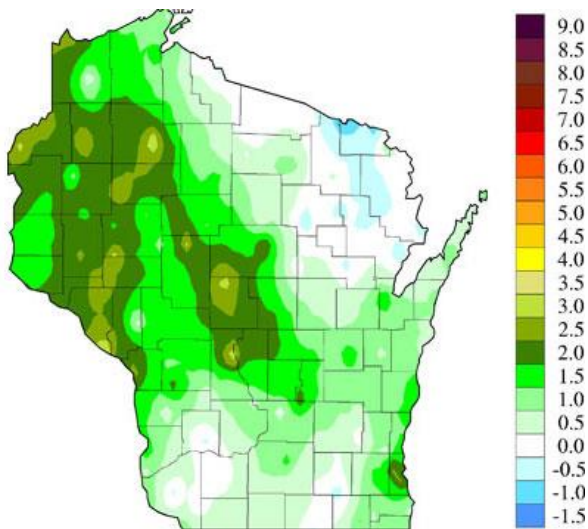
O = Outlet

Units = Feet per Second

Climate Change Summary

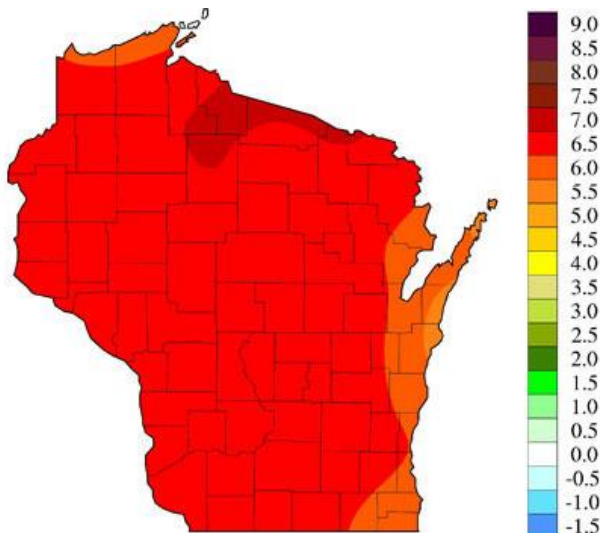
Peak warming of 2-2.5°F has occurred across northwest Wisconsin from 1950-2006 (Figure 10). The greatest warming is occurring during winter-spring and nighttime temperatures which are increasing more than daytime temperatures.

Figure 10 - Change in Average Annual Temp (°F) 1950-2006



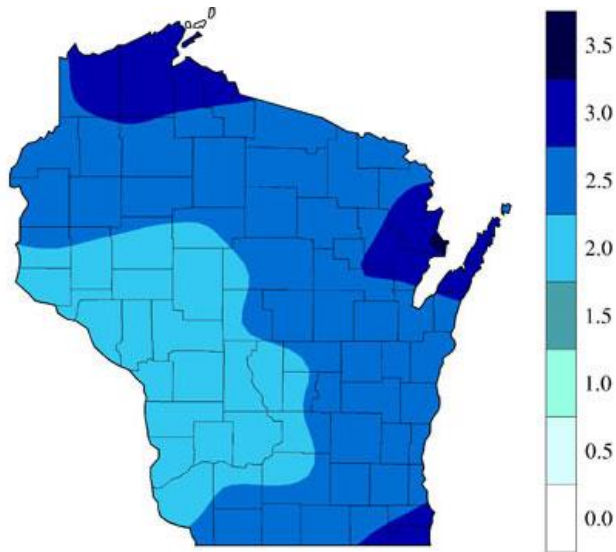
Wisconsin is projected to warm by 4-9°F by the middle of this century, based on one emission scenario (Figure 11). Northern Wisconsin is projected to warm the most, while the least warming is expected along Lake Michigan. The mean projected warming rate is about four times greater than what has been observed since 1950.

Figure 11 - Projected Change in Annual Average Temp (°F) from 1980 to 2055



Typically, heavy precipitation events of at least two inches occur roughly 12 times per decade (once every 10 months) in southern Wisconsin and 7 times per decade (once every 17 months) in northern Wisconsin. Based on one emission scenario, by the mid-21st century, Wisconsin may receive 2-3 more of these extreme events per decade, or roughly a 25% increase in their frequency (Figure 12).

Figure 12 - Projected Change in Frequency of 2 " Precipitation Event from 1980 to 2055



Source: Web <https://www.wicci.wisc.edu/climate-change.php#13> 29 Sep 2017

Coldwater fishes, such as Wisconsin's native brook trout, are sensitive to changes in environmental conditions, particularly water such as temperature. As such, they may be particularly susceptible to the effects of climate change on Wisconsin's cold water streams as well as spring ponds and inland lakes.

An increase in the frequency of extreme precipitation events has the potential to result in channel changing flows, especially in watersheds where runoff is quick. Channel changing flows can degrade habitat quality by eroding banks, down-cutting the stream bed and simplifying the channel. High flow velocities can also create barriers to fish passage. Replacement culverts should be designed for predicted climate conditions in order to be sustainable in the long term for the ecosystem.

Datasets and Storage

The populated culvert inventory dataset is stored in a Microsoft Office Access 2013 database called "RSX_StLouis_LSRI.mdb" (RSX Database). It will be delivered in this format to the WDNR Project Managers.

A copy of the scanned field datasheets and the original datasheets will be transferred to the WDNR. The WDNR will assist with generating any reports and analysis required from the database.

The habitat assessment datasheets from follow up assessments will be submitted in hard copy format to WDNR Project Coordinators for potential entry into the WDNR Fish Habitat Database (FHD). Storage in the FHD will allow for easier retrieval of data in the future. Habitat scores were generated manually by LSRI and subsequently shared with the Technical Team. An electronic copy of the MS Excel spreadsheet will be transferred to the WDNR.

Geo-referenced digital photographs were uploaded to an LSRI computer for temporary storage. The raw (unedited) photographs were filed by date taken and photo number generated automatically by the camera. The photo numbers from each site were documented on the datasheets. The geo-reference data is included in the digital record. Digital photographs will be transferred to WDNR at the end of the project.

References

[Note: Numbers preceding the citations below are used as references for sources in Table 1 -Species Specific Information)

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