Grass River Natural Area Stream Monitoring Report
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Sponsored by Grass River Natural Area

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Introduction

Three cold water streams flow through Grass River Natural Area (GRNA). At the request of the Executive Director of GRNA, Cold Creek, Shanty Creek, and Finch Creek, were assessed based on habitat quality, water chemistry, and biota. Macroinvertebrate sampling has previously been performed, and the sampling points picked for this assessment match macroinvertebrate sampling locations (Figure 1).

The physical habitat assessment was conducted using the Department of Environmental Quality Water Bureau procedure "Qualitative Biological and Habitat Survey Protocols for Wadeable Streams and Rivers". Based on this procedure, Finch and Shanty Creeks are classified as riffle/run while Cold Creek is classified as a glide/pool stream. Riffle/Run streams are have steeper grades or slopes while glide/pool streams are shallower grades.

Water samples collected from each site were sent to Grand Valley State University Annis Water Resource Institute for analysis. Each sample was analyzed for chloride (Cl-), nitrate (NO3-N), total nitrogen (TN), ammonia (NH3-N), soluble reactive phosphorus (SRP), and total phosphorus (TP). These analytes are used to help determine impacts of human activities on and near the streams.

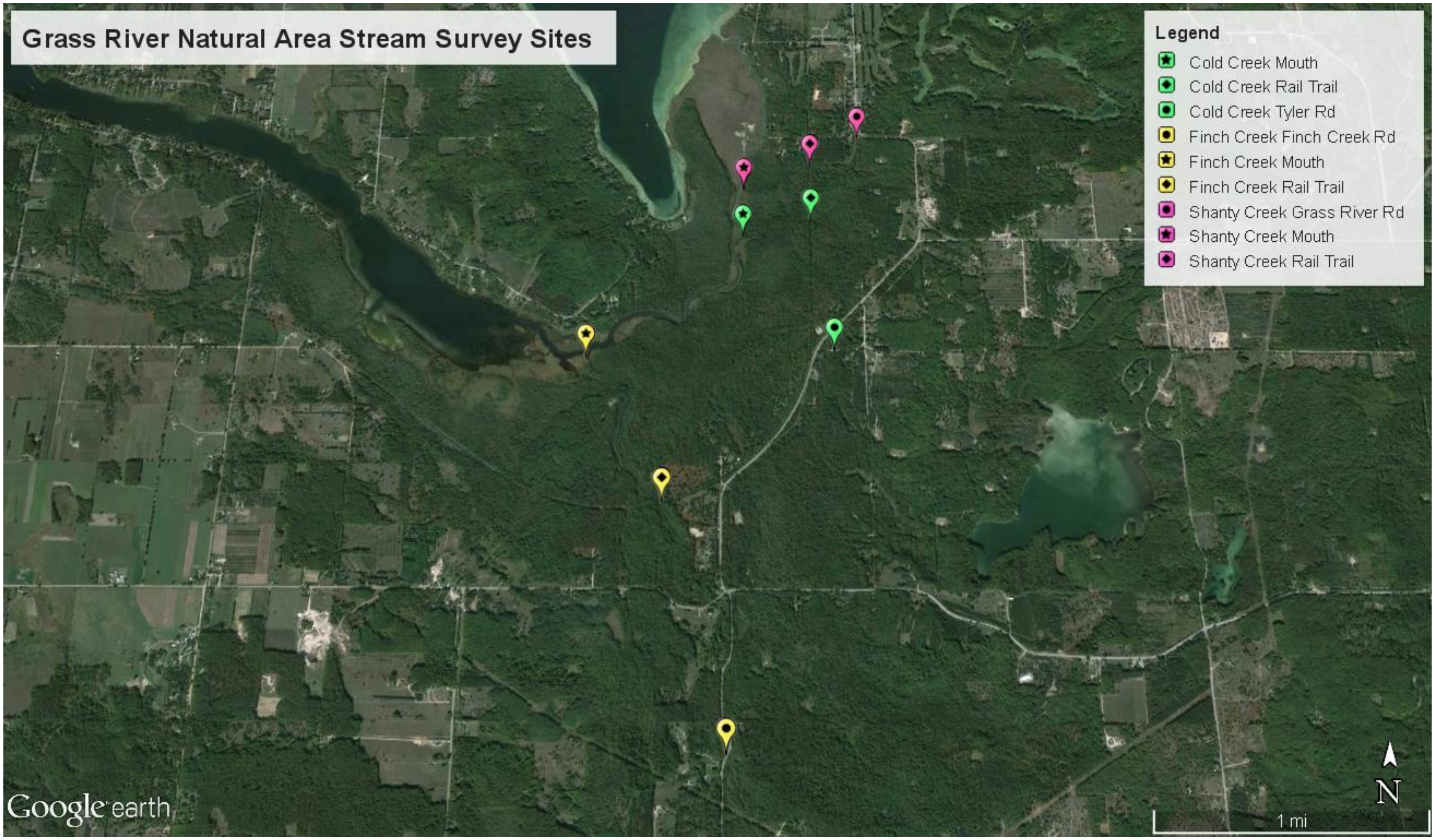

Figure 1. Map of the sampling sites for Cold Creek, Finch Creek, and Shanty Creek

Habitat Assessment

Cold Creek

- Rail Trail Crossing (CCRT)

  The stream at this site has relatively good habitat availability. Riparian habitat was undisturbed and had a mixture of old and new growth. There is little evidence of recent erosion at this site. This site had poor substrate quality due to extreme embeddedness of the substrate leaving very little visible cobble exposed. Embeddedness is an important metric in stream assessment because the less interstitial space available means the less habitat for invertebrates. Open gravel and cobble substrate is also very important spawning habitat for trout species.

- Tyler Road Crossing (CCTR)

  This site had more visible erosion but it was mainly near the road crossing. The road crossing consists of a large culvert surrounded by stone and sand (Figure 2 & 3). The culvert is likely undersized for this crossing. Undersized culverts tend to hold water back on the upstream side causing stream widening on either side of the culvert. This widening increase the sediment load coming from the road crossing. The small culvert also increases water speed through the culvert that can cause scouring effects and increased bank erosion on the downstream side of the culvert. There were also visible areas of erosion on both the upstream and downstream sides of the culvert caused by road runoff. The embeddedness in this area was also high, however the area within the culvert was mostly free from sand and contained only small rocks which may prove a viable spawning habitat for fish. Other than the areas immediately adjacent to the road crossing, the riparian habitat was relatively un-impacted and had significant wild growth on each side of the stream.

Figure 2. The upstream side of the Tyler road crossing on Cold Creek. You can see the culvert with no “bank” to prevent road material from washing into the stream. This culvert is likely undersized causing bank erosion and stream widening

Figure 3. The downstream side of the Tyler road crossing. In the second photo you can see where the road had washed out and was "fixed" with more stone. These wash out events can increase sediments loads far greater than typical sediment loads of poor quality road crossings

- Mouth (CCM)

Mouth of Cold Creek seemed to be the most impacted. The embeddedness was very high along with limited available cover. This area also had the highest rates of sediment deposition. This increased rate of sediment deposition is to be expected at the mouths of streams and rivers do to the decreased flow of these areas. The current rates seem to be higher than should be expected which is likely due to the increased sediment load of the upstream reaches. Again, the riparian habitat was very healthy and seemed to have reached a natural state.

Shanty Creek

- Grass River Road Crossing (SCGR)

This site on Shanty Creek had relatively high sedimentation rates, high embeddedness and relatively poor cover. The increased sedimentation rates here are likely due to the increased runoff from the road crossing along with a limited buffer zone adjacent to the stream (Figure 4). Once away from the road crossing, the more natural riparian zone increases in both width and denseness of natural vegetation.

Figure 4. Upstream side of the Grass River Rd crossing. The farthest structure upstream is the M88 Crossing of Shanty Creek. This picture was also taken during a rain event and the stream is pushing into its flood plain

Figure 5. Downstream side of the Grass River Rd crossing. Again, the river is starting to push into its flood plain during the recent rain event

- Rail Trail Crossing (SCRT)

  The crossing here has a very large and natural riparian zone, however it suffers from high rates of embeddedness and higher than expected sedimentation. Other than those two negatives it is a relatively healthy stretch.

- Mouth (SCM)

  Shanty Creek's mouth suffers from the same negatives as Cold Creek; high rates of sediment deposition and limited instream habitat. These are likely caused by the same types of "legacy" sedimentation problems along with newer construction road crossings.

Finch Creek

- Finch Creek Road Crossing (FCFC)

    This site had good instream cover, and downstream of the culvert there was lower embeddedness and good riffle habitat. However, the undersized and perched culverts make this a site prime for remediation. The undersized culverts have caused water to back up and form eddies upstream of the culvert, which widens the river and increases sediment load downstream. You can see this on both sides of the stream bank circled in red (Figure 6). The eddies that form also allow for the settling of sediments that would otherwise be washed downstream. The downstream side of the crossing is not only perched but also has a increased rate of flow that increases bank erosion and stream widening due to the culvert being incorrectly sized (Figure 7). The perched culvert prevents fish, in this case both brown and brook trout, from moving upstream. The riparian zone along the downstream side of the road is more disturbed with only a few cedar and pine trees and mostly grasses (typical of lawn species) to the edge of the stream.

Figure 6. The upstream side of the Finch Creek Rd Crossing of Finch Creek. Backwash eddies causing stream bank widening and increased sediment load

Figure 7. Downstream side of the Finch Creek Rd crossing of Finch Creek

- Rail Trail (FCRT)

  This stretch of the stream has deeper areas and some nice sized pools. The in stream habitat is a relatively good mixture of old dead fall and some new. The substrate had areas of high embeddedness but this may be typical of this part of the stream. If there was any cobble substrate I would expect to see very high usage of this area by trout. The riparian zone is almost completely undeveloped except for the small swath used by the rail trail to cross.

- Mouth (FCM)

  This was the largest stream mouth that entered into Grass River. This area was almost entirely derived of newly deposited sediment. There was almost a complete lack of instream cover and habitat. Sediment deposition was high and was mostly coarse particulate matter. The stream was very slow here and the mouth was also affected by heavy winds.

Table 1. Scoring results for the habitat assessment of all three streams. Total score groupings: >156 Excellent, 105-154 Good, 56-104 Marginal, <56 Poor. Overall scores may be inflated due to high scoring riparian and flow metrics. Furthermore, these metrics were not intended to assess the habitat of the mouth of streams and therefore their total scores may be biased. Cold Creek Rail Trail (CCRT) Cold Creek Tyler Rd (CCTR) Cold Creek Mouth (CCM), Shanty Creek Rail Trail (SCRT), Shanty Creek Mouth (SCM) Finch Creek Finch Creek Rd (FCFC) Finch Creek Rail Trail (FCRT), and Finch Creek Mouth (FCM) all fell into the "Good" category while Shanty Creek Grass River Rd (SCGR) was scored as marginal. See Department of Environmental Quality Water Bureau procedure "Qualitative Biological and Habitat Survey Protocols for Wadeable Streams and Rivers" for detailed description of habitat parameters

Habitat Parameter: GLIDE/POOL	CCRT	CCTR	CCM
Epifaunal Substrate/Available Cover (20)	9	15	5
Pool Substrate characterization (20)	8	12	7
Pool Variability (20)	6	1	5
Sediment Deposition (20)	8	8	4
Channel Flow Status-Maintained Flow Volume (10)	9	9	10
Channel Flow Status-Flashiness (10)	9	9	9
Channel Alteration (20)	11	15	20
Chanel Sinuosity (20)	10	8	5
Bank Stability L (10)	8	5	10
Bank Stability R (10)	8	5	10
Vegetative Protection L (10)	8	9	10
Vegetative Protection R (10)	8	9	10
Riparian Vegetative Zone Width L (10)	9	9	10
Riparian Vegetative Zone Width R (10)	9	9	10
Total	**120**	**123**	**125**

Habitat Parameter: RIFFLE/RUN	SCGR	SCRT	SCM	FCFC	FCRT	FCM
Epifaunal Substrate/Available Cover (20)	5	10	7	11	11	0
Embeddedness (20)	1	6	1	7	6	0
Velocity/Depth Regime (20)	7	7	2	9	10	3
Sediment Deposition (20)	5	6	0	8	8	4
Channel Flow Status-Maintained Flow Volume (10)	9	9	9	9	9	10
Channel Flow Status-Flashiness (10)	9	9	9	9	9	10
Channel Alteration (20)	9	12	19	16	15	18
Frequency of Riffles (or Bends) (20)	12	9	3	12	8	1
Bank Stability L (10)	7	8	9	7	7	9
Bank Stability R (10)	7	8	9	7	7	9
Vegetative Protection L (10)	6	9	10	9	7	10
Vegetative Protection R (10)	6	9	10	9	7	10
Riparian Vegetative Zone Width L (10)	3	9	10	9	9	10
Riparian Vegetative Zone Width R (10)	3	9	10	8	9	10
Total	**89**	**120**	**108**	**130**	**122**	**104**

Water Chemistry

Chloride (Cl^-)

The EPA states that water will acquire a salty taste with a chloride (Cl-) value greater than 250 mg/l. Head water streams have typical chloride concentrations of less than 10 mg/l; however, this can change based on geology and source of stream water. Increasing Cl- concentrations among streams has been linked to increased urbanization and runoff. All three Shanty Creek sites had a Cl- value of 11 mg/l while the other six sampling locations were less than 10 mg/l (Table 2).

Phosphorus (P)

Total phosphorus (TP) and soluble reactive phosphorus (SRP) were very low in all streams. Soluble reactive phosphorus is phosphorus that is readily available for biological uptake by plants and animals while TP is all the phosphorus that is in a sample of water (both dissolved and organic forms). The EPA suggested criteria for selecting reference streams is a TP concentration of 0.01 mg/l (Evans-White et al. 2013). Reference streams are streams that are considered to be in a relatively pristine state. All of the stream sites sampled fall well below this criteria (Table 2). Phosphorus is considered to have low mobility on the landscape typically binding with other compounds especially iron and aluminum in the soil. For this reason phosphorus is commonly the limiting nutrient in aquatic systems.

Ammonia (NH_3^-N)

Ammonia is very low in all of the streams. Ammonia can be toxic to animal life in high concentrations but is naturally occurring in nature as part of the nitrogen cycle through the decomposition of plant and animal matter.

Nitrogen (N)

The EPA suggested TN (Total Nitrogen) concentration for a reference stream is 0.38 mg/L, others have shown that reference conditions of less than 0.38 exist in our region (Evans-White et al. 2013). The TN concentration of Finch and Shanty Creek were significantly higher that values recommended by the EPA, however, Cold Creek's average TN fell slightly below the range of impairment or 0.38 mg/l (Table 2). The majority of the TN in Finch and Shanty Creek is composed of nitrate (N03-N). Nitrate is a natural occurring compound within the nitrogen cycle; however, humans typically increase the amount of NO3-N in the system by using fertilizers. Nitrate is a very mobile nutrient allowing it to be easily washed off the landscape into surrounding waterways and the high levels of nitrate in these streams is indicative of human induced nutrient pollution. Cold Creeks average nitrate composition was 47% of the total nitrogen in the system. I suspect this high composition of nitrate is due to anthropogenic effects rather than naturally occurring processes.

Table 2. Water chemistry results. Chloride was within range of forested streams that were minimally affected by humans. TP and SRP were low and far below EPA recommendations for reference streams. TN was much higher in Finch and Shanty Creeks than that recommended by EPA for reference streams with cold creek falling just below the EPA recommendation. NO3 made up a significant proportion of TN likely caused by high rates of nutrient rich runoff from the landscape

Station	Cl (mg/l)	N03-N (mg/l)	NH3-N (mg/l)	TN (mg/l)	%NO3 of TN	SRP-P (mg/l)	TP-P (mg/l)
Finch Creek Finch Creek RD	6	0.59	<0.01	0.7843	0.75	<0.005	<0.006
Finch Creek Rail Trail	7	0.71	<0.01	0.9479	0.75	<0.005	0.0076
Finch Creek Mouth	7	0.7	0.0102	0.892	0.78	<0.005	<0.006
Cold Creek Tyler RD	8	0.16	0.0469	0.3701	0.43	<0.005	<0.006
Cold Creek Rail Trail	9	0.17	<0.01	0.3906	0.44	<0.005	0.0064
Cold Creek Mouth	8	0.19	<0.01	0.3325	0.57	<0.005	<0.006
Shanty Creek Grass River RD	11	0.85	<0.01	1.151	0.74	<0.005	0.0056
Shanty Creek Rail Trail	11	0.75	<0.01	1.0052	0.75	<0.005	0.0069
Shanty Creek Mouth	11	0.75	<0.01	1.0013	0.75	0.0067	0.0056

Biota

Macroinvertebrates were sampled twice each year since 2012 during a MI Corps project. The spring sample period data was analyzed for 2014 and 2015 to assess change in community composition as well as community evenness. Community evenness is a measure of how even the populations of the species are that are present at a site (Table 3). Typically the higher the evenness of a community the more resilient the community is. Percent community similarity was also calculated. Similar communities among sites within streams is beneficial because if a species is removed by a disturbance at a particular site it is likely that the same species can recolonize it from another location in the stream. However communities are likely to differ across streams because of the varying habitat within each stream including water temperature, flow rates and other physical habitats. Percent community similarity was calculate between the two sampling periods for each site (Table 4). Community similarity was also analyzed by each stream (Table 5). This was done by adding all species present between all three sites at each stream and comparing those to the other two streams.

Table 3. Evenness of all sampled sites for the spring sampling season in 2014 and 2015. The higher the evenness the more resilient the site may be to disturbances. Cold Creek Rail Trail (CCRT) Cold Creek Tyler Rd (CCTR) Cold Creek Mouth (CCM), Shanty Creek Rail Trail (SCRT), Shanty Creek Mouth (SCM) Finch Creek Finch Creek Rd (FCFC) Finch Creek Rail Trail (FCRT), and Finch Creek Mouth (FCM)

	CCM	CCRT	CCTR	FCFC	FCM	FCRT	SCGR	SCM	SCRT
2014	0.82	0.84	0.80	0.86	0.82	0.86	0.68	0.93	0.82
2015	0.90	0.93	0.89	0.87	0.91	0.86	0.81	0.85	0.90

Table 4. Percent community similarity for each site sampled between the 2014 and 2015 spring sampling season. Cold Creek Rail Trail (CCRT) Cold Creek Tyler Rd (CCTR) Cold Creek Mouth (CCM), Shanty Creek Rail Trail (SCRT), Shanty Creek Mouth (SCM) Finch Creek Finch Creek Rd (FCFC) Finch Creek Rail Trail (FCRT), and Finch Creek Mouth (FCM)

CCM	CCRT	CCTR	FCFC	FCM	FCRT	SCGR	SCM	SCRT
62	85	82.5	90	71	79	73	70	55

Table 5. Percent community similarity between each stream. All data from each site on a stream was compiled to form one community for each stream. Differences are likely due to differing chemical and physical composition of the streams

Cold Creek - Finch Creek	Cold Creek - Shanty Creek	Finch Creek- Shanty Creek
69	57	50

Fish were sampled in 2012 and 2013 by the DNR. Cold Creek was sampled in 2012 and Finch and Shanty Creeks were sampled in 2013. Shanty Creek was sampled at three locations along the stream whereas Finch and Cold Creeks were sampled at one location. The DNR also sampled an unnamed tributary to Finch Creek where they captured rainbow trout and brown trout.

Table 6. DNR backpack shocker results. Note that Shanty Creek was sampled much heavier than the other streams

Stream	Species	Number	Length Range (in)
Cold	Brown Trout	1	2.5
Cold	Sculpin Spp.	16	2.4
Finch	Brook Trout	15	2-8
Finch	Mottled Sculpin	4	2-2
Shanty	Brook Trout	56	1-11
Shanty	Brown Trout	8	6-9
Shanty	Rainbow Trout	4	2-4
Shanty	Sculpin Spp.	8	2-3

Conclusions

Overall all sites assessed on Shanty, Cold and Finch Creek are relatively healthy stream sites. The major concerns found throughout this assessment were increased sedimentation and poor stream road crossing structures. There is also high nitrogen load in Finch and Shanty Creek. The majority of nitrogen in Shanty Creek is likely caused by the increased fertilization of the golf course upstream of all the sites sampled. Finch Creek has high nitrates as well which is also likely from increased fertilization rates along some of its riparian zone. The fish in the streams seem to be naturally reproducing according to the DNR; however, the macroinvertebrate food that is available seems limited based on the MiCorp data. Increasing stream cover along with decreasing sediment load (and therefore embeddedness) should increase macroinvertebrate numbers and species.

Future direction

I would recommend continued monitoring of all sites that were sampled in this report. I would also recommend that future sites be added to these in a stratified random design. This design would allow more assumptions to be made about the habitat quality and availability of the entire stream rather than easily accessed reaches.

To assess the stream crossing issues I would look for funding to remediate and improve these crossings. The first crossing remediation I would attempt would be the Finch Rd crossing. This crossing blocks fish passage both upstream and downstream which limits not only livable habitat but also higher quality spawning areas. This road crossing is also widening the stream and causing increased sediment load for downstream areas. Next on the list would be the Tyler Rd crossing as it is likely a large source of sediment running into Cold Creek.

Literature Cited

Evans-White, M. A., B. E. Haggard, and J. T. Scott. 2013 "A review of stream nutrient criteria development in the United States." *Journal of environmental quality* 42.4: 1002-1014.

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