GRASS RIVER & TRIBUTARIES RESTORATION ASSESSMENT: 2011 FINDINGS

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by

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and

TLA Volunteers

August 31, 2011

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INTRODUCTION

The objectives of this study were to determine whether or not human practices are affecting the health of Grass River and its tributaries and warrant corrective intervention. This study will allow a preliminary understanding of the following four things about Grass River and its three tributaries (Shanty Creek, Cold Creek, and Finch Creek) and is part of a larger effort to build a sediment loading model for the immediate watershed.

- ✓ Identify sources of sediment currently accumulating in Grass River, including the road-stream crossings
- ✓ Identify barriers to fish passage in the tributaries
- ✓ Develop time-temperature profiles for Grass River and its tributaries
- ✓ Measure stream flows and macroinvertebrate populations

This study was conducted as part of a collaborative partnership with the Elk River Chain of Lakes-Watershed Protection Plan Implementation Team (ERCOL-WPIT) that involved the Watershed Center, Tip of the Mitt Watershed Council, Grass River Natural Area, Friends of Clam Lake, the Three Lakes Association, and the Central Lake and Kalkaska High Schools. A concurrent similar study of the Rapid River was spearheaded by the Elk-Skegemog Lakes Association using the same methodologies. Training of volunteers for both studies was provided by Michigan Department of Natural Resources (Todd Kalish), the Watershed Center (Maureen McManus), and the Traverse Band of Ottawa and Chippewa Indians (Brett Fessell). The preliminary sediment loading modeling of these streams was provided by Paul Richards, Professor of Hydrogeology at the College of Brockport, SUNY (reference 13).

Macroinvertebrate Factors of Stream Quality

by Roger Barber, Kalkaska High School

One of the most readily observable indicators of stream health is the amount and diversity of certain macroinvertebrate species within the body of water (reference 1). When streams are polluted with certain types of chemicals, or when fertilizer runoff is particularly high, or when large amounts of sediment are being deposited from sources such as road crossings and erosion, the impact is always seen within the living community of the body of water. Researchers and scientists use samples of the stream's insect and macroinvertebrate life to assess water quality because of how responsive it is to rapid changes and because it is a good predictor of how well the stream is functioning as a whole to support life (reference 2) and provide food to the resident fish population.

Carrick, Becky, and David collecting macroinvertebrates

When evaluating macroinvertebrate populations, one starts at the collection phase. The collection phase has a standard interval of time for each body of water being tested, which is normally 30 minutes. Collection is done using a series of canvas nets with mesh bottoms, which are used to collect both water and sediment samples in which the macroinvertebrates are present. The samples are then deposited into a container, and transported to a location convenient for the next stage of testing.

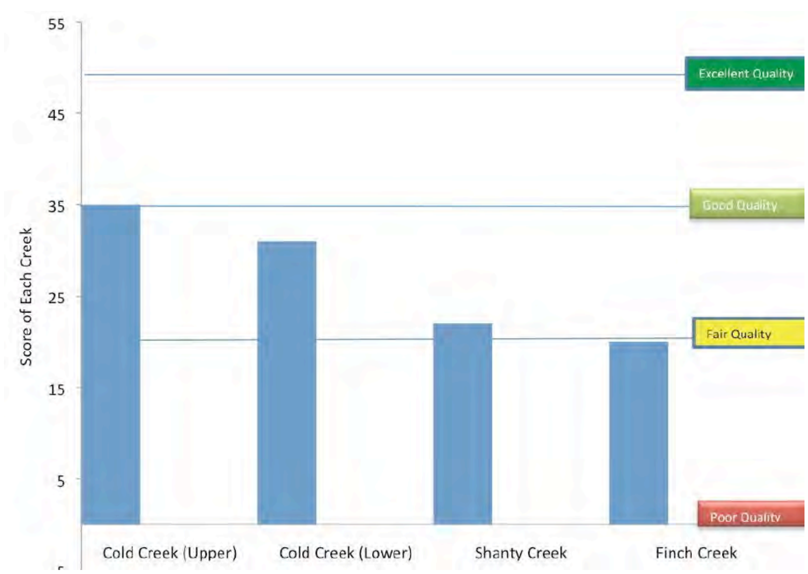
The collected materials are deposited onto white plastic trays, where the macroinvertebrates can be picked out with tweezers and small pipettes and deposited into a “kill jar” (a jar with a solution of ethyl alcohol that kills and preserves). During this stage you pick up what you can find -- up to 15 samples of each species. The final testing stage never uses more than 15 of any species to determine water quality, so it is generally encouraged to preserve as great a diversity of the stream life as possible. The searching stage does not have an enforced time limit on it, however, about an hour provides sufficient time to get a solid and diverse representative profile of the macroinvertebrates.

The next stage involves sorting the macroinvertebrates into groups by species using an identification aid. This sampling process is done one site at a time. If done multiple times on the same river or stream, it is advisable to total each area separately in order to achieve the highest possible accuracy. Ideally, counting macroinvertebrates to assess water quality is best accomplished with spring and fall samplings over three years. Once sorted, the macroinvertebrates must then be counted and recorded on a standard recording sheet.

Macroinvertebrates are divided into three categories and two subcategories. Certain species are more sensitive to water quality changes than others and are therefore a significant indicator of stream health. Macroinvertebrates fall into three categories; Group 1, sensitive, Group 2, somewhat sensitive, and Group 3, tolerant. Within these groups there are both rare and common species, which further affect the water quality scores. Rare species within Group 1, for example, have a higher score than common species within the same group, and indicate a much more hospitable environment for aquatic life.

The Three Lakes Association conducted macroinvertebrate testing on 3 streams: Cold Creek, Shanty Creek, and Finch Creek. One of the streams was tested at two sites. Cold Creek had a dam that had burst a few years before these studies, and the Association was interested in whether or not a significant amount of sediment had been washed downstream and affected the water quality. Therefore, Cold Creek was sampled above and below the dam burst site.

This graph shows the scores for the streams sampled during this project.



Macroinvertebrate scores

Streams that score less than 19 are considered poor quality, those from 19 to 33 are considered fair quality, those from 34 to 48 are considered good quality, and those above 48 are considered excellent quality (reference 1). The results displayed above rank the upper portion of Cold Creek as the only good quality stream, while the lower portion of Cold Creek, Shanty Creek, and Finch Creek all have a fair quality rating.

The macroinvertebrate tests are a valid method for testing hypotheses about how sediment impacts the environment in the Grass River area. The study highlights serious implications of the sediment problems being encountered in the area and shows that sedimentation may lead to a gradual degradation of natural beauty within the streams and a loss of recreational activities, most specifically, fishing.

Stream Flow Measurements

by Carrick Conway, Central Lake High School

Over the summer, we took measurements of water flow in Finch Creek, Cold Creek, Shanty Creek, and Grass River. Using different flow meters, we measured the velocity of these rivers. Multiplying the velocity by the cross sectional areas of each stream, we could determine a total output (called discharge rate) in cubic feet per second (cfs). Since flow data were taken in 2006 (reference 3), taking flow measurements now allows us to see differences that may have appeared. While conclusions cannot necessarily be made, we can combine these findings with other observations that will allow us to discover if this change is something to be worried about.

We used a variety of methods to measure velocity in these streams. Three flow meters were used at least once to measure velocity; all of which were compared against each other in Shanty Creek at the railroad crossing.

The Gurley flow velocity meter (reference 4) consists of a wading pole and a propeller made of cups that spins like a windmill. The meter determines velocity based on rotations per 40 second time period. The more rotations in this time, the faster the velocity of the water. A wading pole is a metal rod with 1/10 of a foot increments marked on the lower portion. A smaller metal rod attached to the apparatus can be adjusted to move the measuring point of the device to 40% of the water depth. A Gurley meter does not accurately measure slow flows, and may not even register a flow if it is too slow.

The other two flow meters that we used were Marsh-McBirney meters. One was set to record velocity in feet/second while the other was set in meters/second. This type of meter (reference 5) uses an electromagnetic probe. Water, being a polar molecule, distorts the magnetic field produced by the probe as it flows around the probe. The more rapid the flow, the higher the distortion. Marsh-McBirney meters are more accurate than Gurley meters at low flow rates, able to register a velocity as low as 0.01 meters/second. The Marsh-McBirney meter also has an almost immediate reading time, not having to initialize and rotate for 40 seconds.

The table below shows the discharge rates calculated at the old railroad crossing on Shanty Creek with three different meters.

	Total Discharge (cfs)	% of TLA Meter
Paul Richard's meter (Marsh-McBirney)	9.5	104
TLA Meter (Gurley Meter)	9.2	100
Tip of the Mitt's meter (Marsh-McBirney)	7.1	78

The difference between meters was sufficient to recheck calibrations and adjust the meter that was reading low.

We took a number of flow measurements from many sites on Cold, Finch, and Shanty Creeks as well as at two locations on Grass River. Of the 23 road stream crossings we identified, we took flow and cross sectional stream areas at 16 sites. The flow measurements were used to support the ongoing development of a local watershed sedimentation model being developed by Paul Richards, a professor of hydrology (reference 13).

Another reason that we made measurements of flow was to be able to make comparisons with data taken in 2006 (reference 3). If an abnormal change in flow was detected, action could be proposed to remedy the problem. It was important to remember that weather occurrences, such as storms or periods of low rainfall, can have a large effect on flow. Because of this, it can be difficult to determine whether changes in flow are natural occurrences or the result of human action. That is where walking the streams helped because it allowed the group to see areas of concern in the rivers that may affect flow. As shown on the table below, we discovered that there were differences in flow from 2006 until 2011.

River	**2006 flow* (cfs)**	**2011 flow (cfs)**	**Percentage Change**
Upper Grass River	**131 - 164**	**116**	**- 8**
Lower Grass River (GRNA dock)	**181**	**190**	**+ 5**
Cold Creek	**29 - 31**	**38**	**+ 23**
Finch Creek	**28 - 36**	**30**	**- 9**
Shanty Creek	**10**	**9**	**- 1**

* ***Development of a Predictive Nutrient-Based Water Quality Model for Lake Bellaire and Clam Lake, pp 22,*** **Three Lakes Association 2006** (www.3lakes.com)

Logging Stream Temperature Data

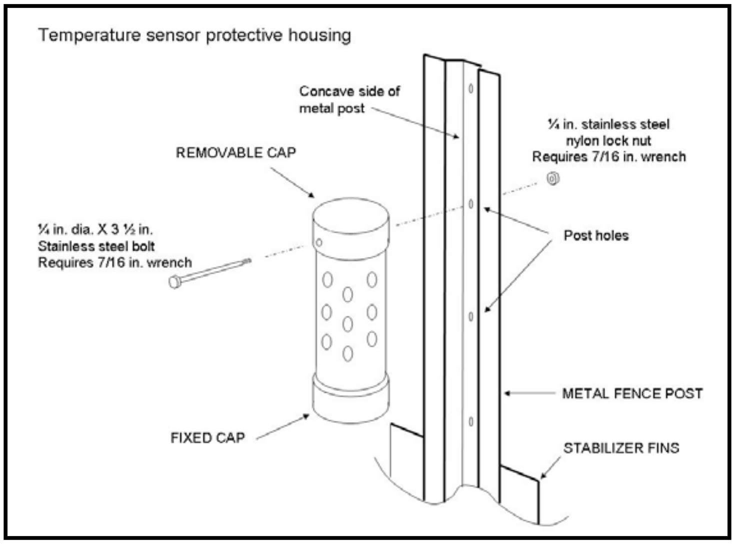
by Erik Youmans, Central Lake High School

Erik Youmans and Carrick Conway with a successfully installed stream temperature logger.

Stream temperature logger (center) with protective housing

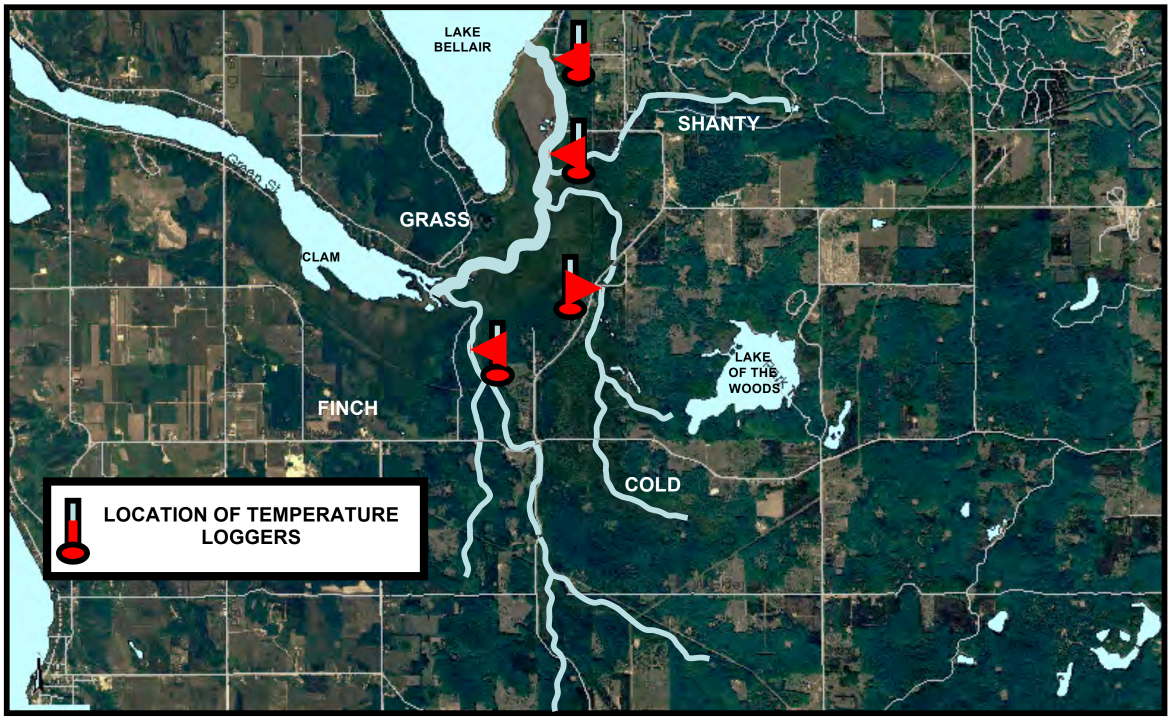
On August 5, 2011, we set up four temperature loggers in Grass River, and the three tributaries feeding into it. The temperature loggers were set up to record the temperature variations in the waterways.

The loggers were set up to record data for two major purposes. Trout populations prefer waters below 60 deg F (reference 6). Higher temperatures can cause dissolved oxygen levels to drop too low for the fish to survive (reference 7). Finch Creek, Cold Creek, and Shanty Creek are all believed to be passageways for local trout populations, as brought to our attention by Todd Kalish, DNR's Regional Fish Biologist (reference 10). High temperatures may hinder the ability of trout to survive in the streams. Brett Fessell, local stream hydrology expert with the Grand Traverse Band of Ottawa and Chippewa Indians, brought to our attention concerns about the water sources feeding the tributaries (references 10, 12). The temperature data may reveal to what extent the creeks are flowing from sources of ground water and from surface runoff. Creeks flowing from ground water sources will have lower temperatures than creeks flowing mainly from runoff sources. This information will play an important role in further study of the Grass River watershed, anticipated to continue in 2012. The temperature loggers (HOBO U22 Water Temp Pro V2 purchased from Ben Meadows Company, Janesville, WI 53547) consist of a thermometer that records temperature at intervals that can be set by the user (reference 8). The logger is placed inside a PVC pipe capped at both ends with holes drilled to allow for water to flow past the logger. This setup is attached to a post set into water at least one foot deep, where swiftly moving water will rush over it. So far the only concern is that the post could possibly conduct heat when in sunlight and affect the records given by the temperature logger.

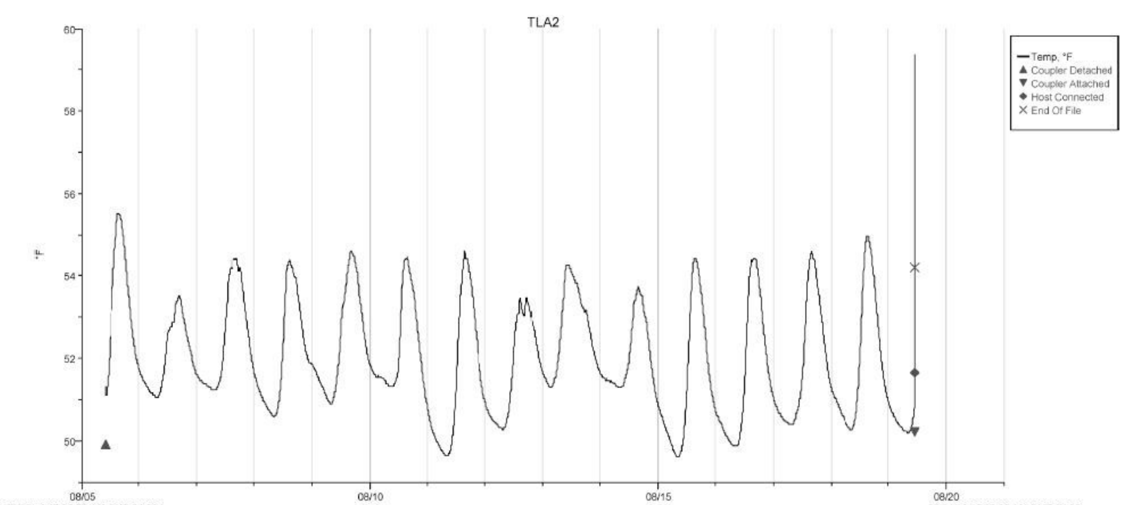


Temperature Sensor Housing

Sites	Logger IDs	GPS Coordinates
Shanty Creek at Railroad Crossing	TLA-1	N44°55’48” W85°12’10’’
Cold Creek at Tyler Rd.	TLA-2	N44°55’02” W85°12’05”
Finch Creek on Woodland Wildfire Trail in GRNA	TLA-3	N44°54’31” W85°13’02’’
Grass River at Gary Knapp’s	TLA-4	N44°56’16” W85°12’29”



Location of the four Stream-Temperature Loggers



Example of time-temperature profile data, Shanty Creek

(Railroad culvert at Grass River Natural Area)

Road-Stream Crossings

by David Witt, Central Lake High School

We made use of the Huron Pines methodology for road stream crossing assessment (reference 9). We made measurements of size and flow and created pictorial documentation at the culverts or bridges where roads crossed Cold Creek, Finch Creek, and Shanty Creek (see table below), to see if they were inhibiting the flow of the steam, causing erosion, and/or keeping fish from finding their way upstream. We assessed each crossing for problems that could possibly be fixed in the future. Of all the sites, we found several that were of concern and illustrate the findings with the following four sites.

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Old Hydroelectric Dam Spillway on Shanty Creek

We found an old dam on Shanty Creek below where there used to be a pond that had drained away. Though the pond is gone, the water still falls a long way when it goes over the dam and is a fish passage barrier.

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Pine Brook Iron Dam on Shanty Creek

Farther upstream on Shanty Creek, in the Pine Brook development, there is a footbridge with a slab of metal underneath it creating a 4-5 foot waterfall, and a barrier to fish passage. It may have been originally intended as a sand trap but is full and no longer effective. The supervisor for a Pine Brook homeowners' association expressed interest in future restoration actions to remove this water blockage.

]

Cold Creek, Comfort Road Crossing

This culvert on Cold Creek had a perched outlet which produces another barrier to fish passage. The culvert appears to be very undersized and the water is rushing out at a great speed. There was a lot of debris up on the bank of the upstream side due to storm water overflowing the banks as well as tree die-off along the banks of the creek all the way upstream to the Tyler Road culvert.

]

Finch Creek, Way Road Crossing

This culvert is a relatively small culvert as well. Located on Finch Creek, it backed up the water and made a pond. Some of the trees upstream have died because of high water.

Grass River Tributaries: Road-Stream Crossings

Site #	Tributary	Road	Location Comments	GPS (N)	GPS (W)
1	Shanty	Road to Nowhere			
2	Shanty	Railroad Crossing	Bridge	44.92972	85.20278
3	Shanty	Old hydropower site			
4	Shanty	Grass River Road	Macroinvertebrate site		
5	Shanty	M-88	Bridge	44.93238	85.19836
6	Shanty	Pine Brook (iron dam/walkway)	Walking bridge, fish passage concern		
7	Shanty	Shanty Creek Golf Course?	Creek-side drive bridge		
8	Shanty	Upstream culvert	Gravel road above golf course	44.93472	85.185
9	Shanty	Creek Side Drive downstream	Between Pine Brook & pond		
10	Shanty	Creek Side Drive upstream	Between Pine Brook & pond	44.95866	85.19722
11	Cold	Railroad Crossing	Bridge		
12	Cold	Private Road	Private road, old boiler used as culvert	44.92194	85.18861
13	Cold	Comfort Road	Undersized, dead trees upstream	44.91942	85.20031
14	Cold	Tyler Road	Large culvert, macroinvertebrate site	44.9174	85.20148
15	Cold	Fish-farm road			
16	Cold	Alden Highway	Macroinvertebrate site	44.90279	85.20282
17	Finch	Railroad Crossing	Bridge	44.90806	85.21583
18	Finch	Alden Highway	Upstream pond	44.9024	85.21126
19	Finch	9310 Finch Creek Road	Bridge, macroinvertebrate site	44.89839	85.21082
20	Finch	Finch Creek Road		44.9586	85.1972
21	Finch	Elder Road, East		44.88843	85.20766
22	Finch	Elder Road, West		44.88842	85.20894
23	Finch	Bebb Road			
24	Finch	Way Road	Undersized, large upstream pond		

Observations, Shanty Creek upstream of M-88 Crossing
by Jim Kelderhouse.

(*Jim, a junior at Northwest Michigan College, was working with Grass River Natural Area as a summer intern and actively participated in this project to investigate the sources of sediment in Grass River. The following observations were made as part of Jim's walking up Shanty Creek.)*

Runoff from blacktop is entering Shanty Creek directly from each side of the wooden bridge at the Pine Brook road crossing.

Houses and condominiums are within 50-75 feet of Shanty Creek with very little stream bank vegetation. The buildings have no rain gutters or diversions for roof runoff. Stream banks adjacent to building foundations are visibly eroded. There is a steep stream gradient alongside the condominiums and a rainstorm left gravel bars in the stream and dry washed out channels indicating two feet or more of high water. There are also so many fallen trees in the stream below the condominiums that people can no longer walk in the stream. Pine Brook supervisor Pam Janise came out and talked to us saying the water rose three to four feet during the last rainstorm and she was upset about all the fallen trees because children can not fish anymore and the deer are no longer able to cross the stream with their fawns. This logjam is causing a lot of sand and silt buildup causing a widening of the streambed.

There is a steel dam or barrier with approximately a four to five foot waterfall downstream of the golf course with sand accumulation behind the barrier. Where the creek passes through the golf course there is no riparian buffer. You can see the paths that runoff took during a recent storm across the green and golf cart trails.

Upstream of the golf course there are two road-stream crossings. Both road-stream crossings are eroding sand directly into the Creek, One road leads to a storage building with an earthen dam behind it creating a wetland filled up with organic matter that is overflowing into the creek.

Leaving Shanty Creek resort, the steep paved roads have curbing directing the runoff directly into the creek probably carrying sand from the washed out gravel driveways. It also seems likely that these roads might be sanded in the winter, and in the spring the sand would be carried to the creek during snow melt.

No man-made diversions to accommodate runoff were observed on Shanty Creek and from the evidence above as well as a conversation with the supervisor for Pine Brook, the stream appears burdened with excess runoff carrying sand, silt, and organic matter into Shanty Creek from development at the Shanty Creek resort and golf course. This is reshaping and relocating the stream bed through sediment deposition, widening of the stream bed, and the creation of new dry eroded channels.

An Example of consequences of stormwater erosion, Shanty Creek in the Pine Brook area

Discussion

Heavy sediment load being washed downstream negatively impacts the overall quality of the stream life as evidenced by the macroinvertebrate scores we observed. Cold creek suffered from dam breakage, with long term effects showing up downstream of the break. Shanty Creek experiences high sediment loads from runoff from the golf course and areas of bank flooding. Finch Creek has no signs of unusual sediment buildup besides that due to natural scouring and stream bank erosion.

All three creeks have barriers to fish passage due to dams and/or perched culverts. Results from water temperature tracking, ongoing at the time of this report, will also be useful in assessing the health of the fish habitat of these creeks. Antrim County has established criteria for roads (reference 11) that deal with road stream crossings and surface water runoff. The findings from this study may provide some of the evidence necessary to support corrective actions at sites that represent fish barriers, excessive erosion, and excessive water flow restriction.

Conclusions

1. Based on the scores for macroinvertebrate populations sampled in June 2011, Shanty Creek, Finch Creek, and the lower reach of Cold Creek showed **fair** water quality (scores less than 20). Only the upper reach of Cold Creek could be classified as **good** with a score of 35. None of the populations of

macroinvertebrates indicated excellent water quality (scores greater than 50, based on the number and diversity of aquatic insects).

2. The following barriers to fish passage were identified:
    a. An abandoned hydropower dam on Shanty Creek
    b. A small dam (sand trap) with a foot bridge on Shanty Creek
    c. A perched culvert on Alden Highway on Finch Creek
    d. A perched culvert on Elder Road, east branch of Finch Creek
    e. A perched culvert on Comfort Road on Cold Creek.
3. Twenty-four road-stream crossings were identified for these three tributaries. Several of the culverts appeared to be undersized based on observations of upstream dead trees: Elder Road on east branch of Finch Creek and Comfort Road on Cold Creek.
4. Stream flow measurements were similar to those made in 2006.
5. The lack of a storm water management plan for the Shanty Creek Watershed, including the Pine Brook area, is of concern. It is not unusual for the flow rate of these tributaries to double during major storm events surge (increase from 10 cfs during normal flow to about 20 cfs during a major storm event), which typically causes the stream depth to increase 10 to 12 inches. But the observations of high-water marks in the Pine Brook area indicate increases from 24 to 36 inches, which results in significant erosions and a major source of sediment. Efforts to manage the storm water during major storm events would be expected to reduce the amount sedimentation from these events.

<u>Acknowledgments</u>

We, the 2011 Summer Interns, thank Three Lakes Association for providing this summer internship opportunity, and especially the volunteers who guided us:

Fred Sittel, Gary Knapp, Trish Narwold, Becky Norris, Dean Branson, Norton Bretz.

Thank you to the college-level mentors who worked with us Jim Kelderhouse, Braden Ackerman, and Professor Paul Richards.

Thank you to Jim Argo for providing us the opportunity to overfly our study area and take aerial photos.

Thank you to the Grand Traverse Regional Community Foundation for grant money to help provide stipends to us for our summer work and experience.

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Appendix 1: Stream Macroinvertebrate Datasheet

MiCorps Site ID#:_______________

Michigan Clean Water Corps

Stream Macroinvertebrate Datasheet

Stream Name: ____

Location:____________________________ (Circle one: *Upstream* or *Downstream* of road?)

Date:______________________ Collection Start Time:___________ (AM/PM)

Major Watershed:________________ HUC Code (if known):______________

Latitude:______________________ Longitude:______________________

Monitoring Team:

Name of Person Completing Datasheet:______________________________

Collector:____

Other Team Members:______________________________________

Stream Conditions: Average Water Depth:______________ feet

Is the substrate covered with excessive silt? ____ No ____ Yes (describe:______________)

Substrate Embeddedness in Riffles: ____ 0-25% ____ 25-50% _____ > 50% ____ Unsure

Did you observe any fish or wildlife? ( ) Yes ( ) No If so, please describe:________________

Macroinvertebrate Collection: Check the habitats that were sampled. Include as many as possible.

____ Riffles
____ Cobbles
____ Aquatic Plants
____ Runs
____ Stream Margins
____ Leaf Packs
____ Pools
____ Undercut banks/Overhanging Vegetation
____ Submerged Wood
____ Other (describe:________ ______________)

Did you see, but not collect, any **live crayfish**? (___ Yes ___ No), or **large clams**? (___ Yes ___ No)
remember to include them in the assessment on the other side!

Collection Finish Time:___________(AM/PM)

Datasheet checked for completeness by:_________________________________ Datasheet version 10/08/05
Data entered into MiCorps database by:_________________________________ Date:___________

MiCorps Site ID#:_______________

Michigan Clean Water Corps

IDENTIFICATION AND ASSESSMENT

Use letter codes [**R** (rare) = 1-10, **C** (common) = 11 or more] to record the approximate numbers of organisms in each taxa found in the stream reach.

*** Do NOT count empty shells, pupae, or terrestrial macroinvertebrates***

Group 1: Sensitive

____ Caddisfly larvae (Trichoptera)
EXCEPT Net-spinning caddis
____ Hellgrammites (Megaloptera)
____ Mayfly nymphs (Ephemeroptera)
____ Gilled (right-handed) snails (Gastropoda)
____ Stonefly nymphs (Plecoptera)
____ Water penny (Coleoptera)
____ Water snipe fly (Diptera)

Group 2: Somewhat-Sensitive

____ Alderfly larvae (Megaloptera)
____ Beetle adults (Coleoptera)
____ Beetle larvae (Coleoptera)
____ Black fly larvae (Diptera)
____ Clams (Pelecypoda)
____ Crane fly larvae (Diptera)
____ Crayfish (Decapoda)
____ Damselfly nymphs (Odonata)
____ Dragonfly nymphs (Odonata)
____ Net-spinning caddisfly larvae
(Hydropsychidae; Trichoptera)
____ Scuds (Amphipoda)
____ Sowbugs (Isopoda)

Group 3: Tolerant

____ Aquatic worms (Oligochaeta)
____ Leeches (Hirudinea)
____ Midge larvae (Diptera)
____ Pouch snails (Gastropoda)
____ True bugs (Hemiptera)
____ Other true flies (Diptera)

STREAM QUALITY SCORE

Group 1:
____ # of R's * 5.0 = ____
____ # of C's * 5.3 = ____
Group 1 Total = ______

Group 2:
____ # of R's * 3.0 = ____
____ # of C's * 3.2 = ____
Group 2 Total = ______

Group 3:
____ # of R's * 1.1 = ____
____ # of C's * 1.0 = ____
Group 3 Total = ______

Total Stream Quality Score = _______
(Sum of totals for groups 1-3; round to nearest whole number)

Check one:
____ Excellent (>48)
____ Good (34-48)
____ Fair (19-33)
____ Poor (<19)

Identifications made by:____

Rate your confidence in these identifications: Quite confident 5 4 3 2 1 Not very confident

Datasheet checked for completeness by:________________________________ Datasheet version 10/08/05
Data entered into MiCorps database by:________________________________ Date:____________

Appendix 2: Road-Stream Crossing Data Sheet

Stream Crossing Data Sheet

Site ID: ______

General Information

Stream Name: ______ **Road Name:** ______

Name of Observer(s): ______ **Date:** ______

GPS Waypoint: ______ **GPS Lat/Long:** ______

County: ______ **Township:** ______ **Range:** ______ **Sec:** ______

Adjacent Landowner Information: ______ **Additional Comments:** ______

Crossing Information

Crossing Type: Culvert(s) no.: ______ Bridge Ford Dam Other: ______

Structure Shape: Round Square/Rectangle Open Bottom Square/Rectangle Pipe Arch Open Bottom Arch Ellipse

Inlet Type: Projecting Mitered Headwall Apron Wingwall 10-30° or 30-70° Trash Rack Other

Outlet Type: At Stream Grade Cascade over Riprap Freefall into Pool Freefall onto Riprap Outlet Apron Other

Structure Material: Metal Concrete Plastic Wood

Substrate in Structure: None Sand Gravel Rock Mixture

General Condition: New Good Fair Poor

Plugged: ______ % Inlet Outlet In Pipe

Crushed: ______ % Inlet Outlet In Pipe

Rusted Through? Yes No **Structure Interior:** Smooth Corrugated

Multiple Culverts/Spans

Number the culverts/spans left to right, facing downstream. Include #s in site sketch on back page

Culvert/ Span #	Width (ft)	Length (ft)	Height (ft)	Material

Structure Length (ft): [1] ______ **Structure Width (ft):**[1] ______ **Structure Height (ft):** [1] ______

Structure Water Depth (ft): [1] **inlet** ______ **outlet** ______ **Perch Height (ft):** [1] ______ or NA

Embedded Depth of Structure (ft):[1] **inlet** ______ **outlet** ______

Structure Water Velocity (ft/sec): [1] **inlet** ______ **outlet** ______

Structure Water Velocity Measured: At Surface or ______ **ft Below Surface** **Measured With:** Meter or Float Test

Stream Information

Stream Flow: None < ½ Bankfull < Bankfull = Bankfull > Bankfull

Scour Pool (if present) Length: ____ **Width:** ____ **Depth:** ____ **Upstream Pond (if present) Length:** ____ **Width:** ____

Riffle Information (measured in a riffle outside of zone of influence of crossing)

Water Depth (ft): ______ **Bankfull Width (ft):** ______ **Wetted Width (ft):** ______ **Water Velocity (ft/sec):** ______

Dominant Substrate: Cobble Gravel Sand Organics Clay Bedrock Silt **Measured With:** Meter or Float Test

Road Information

Type: Federal State County Town Tribal Private Other:

Road Surface: Paved Gravel Sand Native Surface **Condition:** Good Fair Poor

Road Width at Culvert (ft): ______ **Location of Low Point:** At Stream Other **Runoff Path:** Roadway Ditch

Embankment: **Upstream** **Fill Depth (ft):** ______ **Slope:** Vertical 1:1.5 1:2 >1:2

Downstream **Fill Depth (ft):** ______ **Slope:** Vertical 1:1.5 1:2 >1:2

Left Approach: **Length (ft):** ______ **Slope:** 0% 1-5% 6-10% >10% **Ditch Vegetation:** None Partial Heavy

Right Approach: **Length (ft):** ______ **Slope:** 0% 1-5% 6-10% >10% **Ditch Vegetation:** None Partial Heavy

[1] - Fill out for primary culvert (culvert #1). If multiple culverts are used, number each and use embedded table.

Form Date: February 28, 2011

Erosion Information

Use a new row for each distinct gully/erosion location. Note prominent streambank erosion within 50 feet of crossing.

Location of Erosion Ditch, approach, or streambank Left or right facing downstream	**Erosion Dimensions (ft)**			**Eroded Material Reaching Stream?**		**Material Eroded** Sand, Silt, Clay, Gravel, Loam, Sandy Loam or Gravelly Loam.
	Length	**Width**	**Depth**			
				Yes	**No**	
				Yes	**No**	
				Yes	**No**	
				Yes	**No**	
				Yes	**No**	

If there is erosion occurring, can corrective actions, such as road drainage measures, be installed to address the problem? **Y N**

Extent of Erosion: Minor Moderate Severe Stabilized

Erosion Notes:

Photos – enter photo number in blank corresponding to location

- ❑ Site ID ____
- ❑ Upstream Conditions ____
- ❑ Downstream Conditions ____
- ❑ Inlet ____
- ❑ Outlet ____
- ❑ Road Approach – Left ____
- ❑ Road Approach – Right ____

Summary Information

Would you consider this a priority site? Fish Passage Erosion Why?

Would you recommend a future visit to this site? Yes No **Why?**

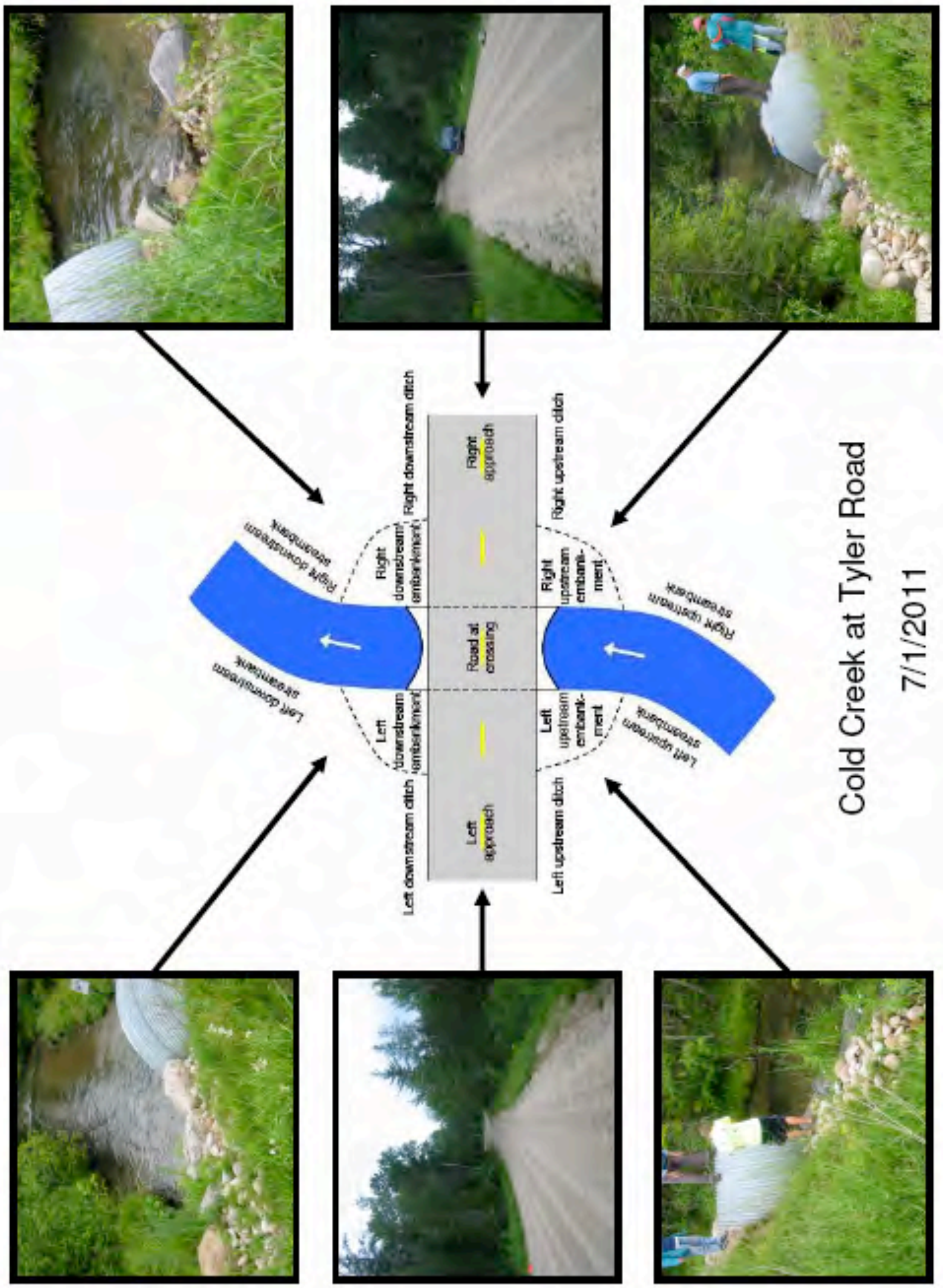
Were any non-native invasive species observed at the site? Yes No **If yes, what species were observed?**

Site Sketch

Draw an overhead sketch of crossing. Be sure to mark North on the map and to indicate the direction of flow. Include major features documented on form, such as erosion sites, multiple culverts, scour pool, impounded water, etc.

Form Date: February 28, 2011

Appendix 3: Road-Stream Crossing Pictorial Documentation



Appendix 4: Tree Die-Off from Undersized Culvert