DEPARTMENT OF NATURAL RESOURCES AND ENVIRONMENT
WATER BUREAU
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STAFF REPORT

A BIOLOGICAL SURVEY OF THE TAHQUAMENON, TWO HEARTED, MANISTIQUE, AND MILLECOQUINS RIVERS WATERSHEDS SCHOOLCRAFT, MACKINAC, CHIPPEWA, LUCE, ALGER, AND DELTA COUNTIES, MICHIGAN JUNE AND JULY 2009

INTRODUCTION

Biological, chemical, and physical habitat conditions of selected streams located in the Tahquamenon (HUC 04020202), Two Hearted (HUC 04020201), Manistique (HUC 04060106), and Millecoquins (HUC 04060107) Rivers watersheds (Figures 1 and 2) were assessed by staff from the Surface Water Assessment Section (SWAS).

The specific survey objective of these monitoring activities included the following:

- Evaluate the current biological and physical conditions at targeted and randomly selected stations in the Tahquamenon, Two Hearted, Manistique, and Millecoquins Rivers watersheds for attainment of Michigan Water Quality Standards (WQS).
- Support water quality-based effluent limit development for National Pollutant Discharge Elimination System (NPDES) permits.
- Identify potential nonpoint source problems and evaluate the effectiveness of specific nonpoint source projects.
- Evaluate general water quality trends within the watershed.
- Satisfy monitoring requests submitted by internal and external customers.

GENERAL WATERSHED HISTORY AND BACKGROUND INFORMATION

The Tahquamenon, Two Hearted, Manistique, and Millecoquins Rivers watersheds are part of the Northern Lakes and Forests ecoregion (Omernik and Gallant, 1988). Numerous water quality reports documented the biological and habitat conditions found within the watersheds since the 1990s (Goodwin, 2000; Holden, 2005; Madison and Lockwood, 2004; Michigan Department of Natural Resources (MDNR), 1988; Sayles, 1990; Taft, 1989; 1990; 1992a; 1992b; 1994a; 1994b; 1994c; 1998; 2000a; 2000b; and 2005; and Wolf, 2005).

Tahquamenon River Watershed

The Tahquamenon River, made famous in H.W. Longfellow's 1855 epic poem, "*The Song of Hiawatha*," flows approximately 87 miles eastward discharging to Whitefish Bay of Lake Superior. The Tahquamenon River originates in coarse glacial till or outwash materials, flowing down a relatively steep gradient (Waybrant and Zorn, 2008) before entering a large riparian wetland complex that extends for miles to Whitefish Bay.

The headwaters of the Tahquamenon River are considered quality trout water due to the relatively high stream gradient, excellent large woody structure, and an abundance of exposed cobble and gravel. Considerable habitat enhancement work conducted in recent years has protected eroding banks, exposed rock and gravel beds, and scoured the sand bedload to

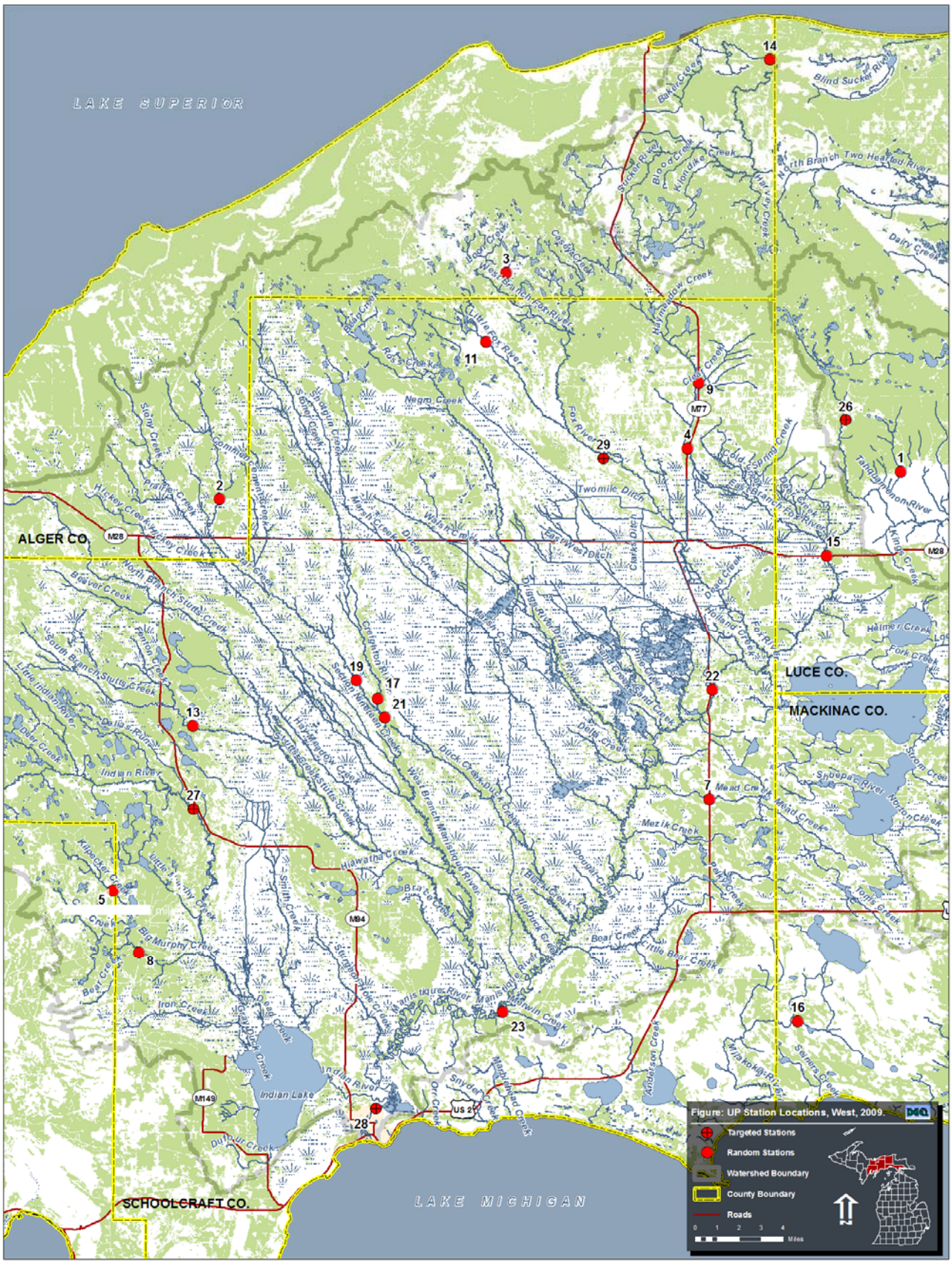

Figure 1. Upper Peninsula Locations (West) 2009.

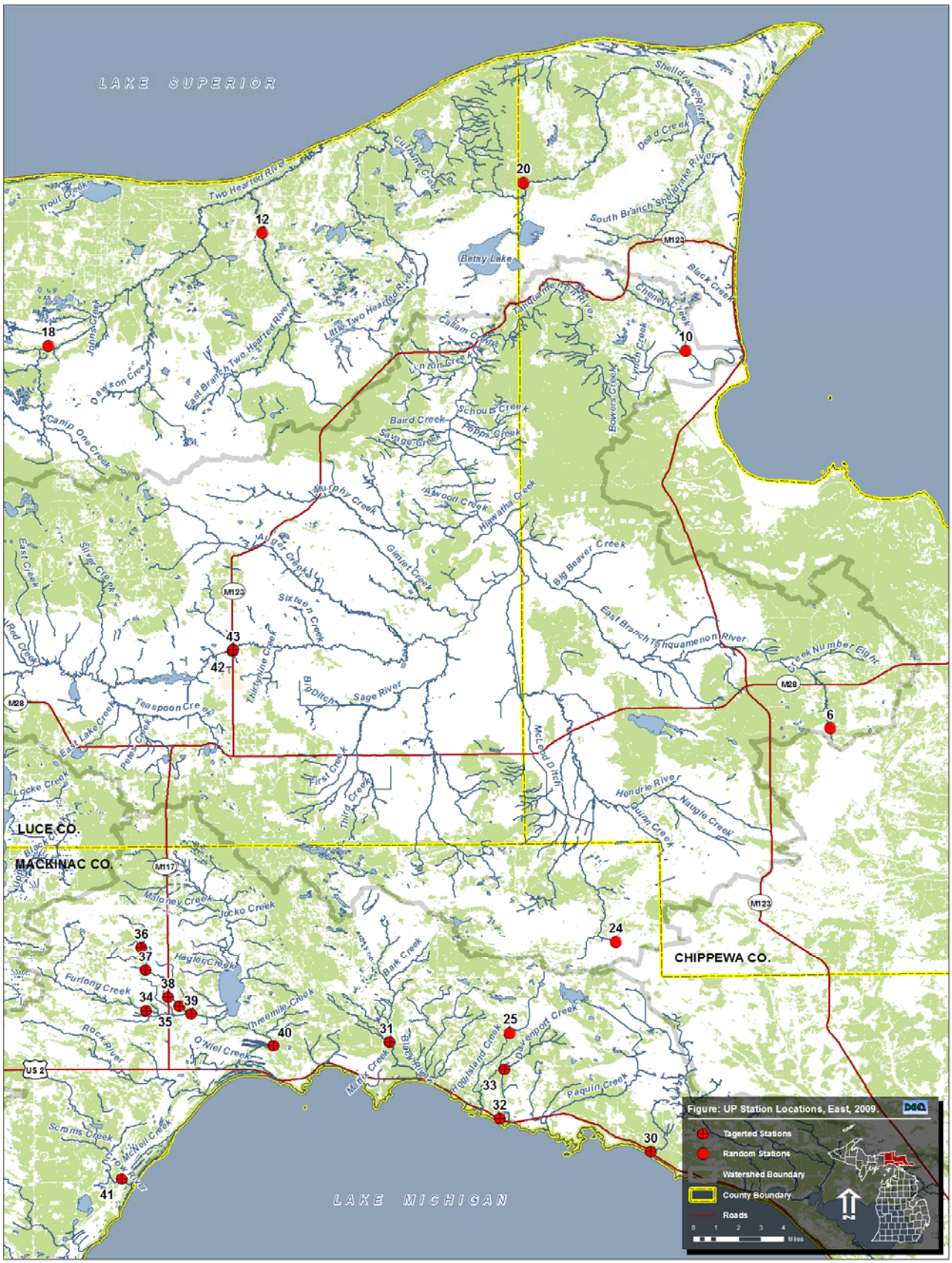

Figure 2. Upper Peninsula Locations (East) 2009.

produce deeper holding waters. The fish community reflects a traditional brook trout – mottled sculpin species complex, with large numbers of wild brook trout (Waybrant and Zorn, 2008).

Much of the Tahquamenon River is dark amber colored due to tannins that originate from wetland drainage and organic soils found extensively within the watershed. The lower watershed has light inorganic soils near the main branch, which are well drained and sandy. The sand throughout the region is easily eroded and deposited into rivers and streams (Holden, 2005). The lower river has the second largest waterfall found east of the Mississippi River called Tahquamenon Falls. The Upper Falls has a drop of nearly 50 feet and is more than 200 feet across. The Lower Falls, four miles downstream (Figure 3), is a series of 5 smaller falls (Exploring the North, Inc., 2009).

Figure 3. Tahqaumenon River-Lower Falls.

Two Hearted River Watershed

Two Hearted River originates northwest of Newberry and flows northeast through state forest lands before discharging to Lake Superior. This famous trout stream drains deep sand outwash plains, moraine ridges, and kettle depressions that contain peat bogs (MDNR, 2010 [Draft]). This river system is a snowmelt driven system, which makes the associated groundwater base flow rate very steady (Fongers, 2007). Also within this watershed, the Betsy River discharges to Whitefish Bay of Lake Superior and the Sucker River discharges to Lake Superior near Grand Marais. Department of Natural Resources and Environment (DNRE) staff monitored this watershed in 1999 and 2004 (Taft, 2000b; Holden, 2005).

Manistique River Watershed

The Manistique River watershed lies within portions of 5 central Upper Peninsula counties (Alger, Delta, Luce, Mackinac, and Schoolcraft) and drains 1,461 square miles (MDEQ, 2004). This large river system was named for the Ojibway word “Monistique,” which means “vermillion” (a vivid reddish orange) (New deal/WPA Art in Manistique, Michigan, 2009). The “Monistique River” name was misspelled when registered with the state and became the Manistique River.

The lower 1.7 miles of the Manistique River from the Paper Mill Dam downstream to Lake Michigan are listed as a federal Area of Concern (MDNR, 1987) due to historic problems with polychlorinated biphenyl-contaminated sediment and combined sewer overflows.

Manistique River watershed surveys by DNRE staff were conducted in August 1999 and August 2004. Qualitative biological surveys and habitat evaluations were completed at 10 locations in 1999 (Goodwin, 2000). In 1999, the macroinvertebrate communities rated acceptable and habitat rated from fair to good. Based on the results of the surveys, sampled reaches were determined to attain WQS. Eighteen monitoring sites throughout the entire Manistique River

watershed were evaluated in August 2004 (Wolf, 2005). All stations rated the macroinvertebrate communities either acceptable or excellent and were meeting WQS.

Millecoquins River Watershed

The Millecoquins River watershed has been surveyed by the DNRE three times since 1990 (Taft, 1990; 2000a; and 2005). The waters of the upper watershed originate from springs and lakes south of the city of Newberry and from wetland drainage from the Furlong Creek watershed. All of the flow enters Millecoquins Lake before entering the outlet channel to Lake Michigan through a series of sand dune ridges.

The federal Clean Water Act Section 319 nonpoint source implementation projects that included cattle exclusion, fencing, stream crossing upgrades, and erosion prevention projects were first implemented within the Doe Creek and Furlong Creek watersheds in the early 1990s. Numerous Best Management Practices and stream habitat improvement projects using federal Section 319 or the Clean Michigan Initiative bond monies have been implemented since 1990 by the Luce-West Mackinac County Conservation District. Several of the sites assessed during 2009 are discussed below.

METHODS

The habitat and macroinvertebrate community were qualitatively evaluated using the SWAS Procedure 51 (MDEQ, 1990; Creal et al., 1996) at 37 sites and water chemistry samples were collected at 9 sites (Tables 1, 2, and 5).

The macroinvertebrate communities were assessed and scored with metrics that rate the communities on a scale from excellent to poor. Scores can range from 9 to -9 for macroinvertebrates. Stations with a score greater than or equal to +5 are considered excellent. Stations with a score less than or equal to -5 are classified as poor. Stations with a score of -4 through +4 are classified as acceptable (moderately impaired). Habitat evaluations are based on 10 metrics, with a possible maximum total score of 200. Stations are classified as excellent with a habitat score >154, good with a score between 105 and154, marginal with a score between 56-104, and poor with a score <56.

Two site selection methods were used to assess monitoring locations within the Tahquamenon, Two Hearted, Manistique, and Millecoquins Rivers watersheds in 2009: (1) stratified random; and (2) targeted. A probabilistic monitoring approach, using stratified random site selection to address statewide and regional questions about water quality, was used to select several stations within the Tahquamenon, Two Hearted, Manistique, and Millecoquins Rivers watersheds (DNREa, in preparation). In addition to probabilistic monitoring, sites within the Tahquamenon, Two Hearted, Manistique, and Millecoquins Rivers watersheds were selected for targeted monitoring to fulfill specific monitoring requests, assess known or potential areas of concern, collect information and assess attainment of designated uses from areas where historic information was lacking, or to provide information for NPDES activities.

All of the samples from the rivers were collected, preserved (if necessary), stored at 4^{o} Celsius, and transported to the DNRE's Environmental Laboratory for chemical analysis using standard protocols (MDNR, 1994). The targeted river samples were analyzed for nutrients and the point source discharges were analyzed for nutrients, metals, and conventional parameters.

Three stations were assessed using Michigan's Qualitative Biological and Habitat Survey

Protocols for Nonwadeable Rivers (DNREb, in preparation). These nonwadeable stations were located on both the East Branch Fox River and the Manistique River. Using this nonwadeable procedure, macroinvertebrate communities were scored with metrics that rate water bodies from excellent to poor. Macroinvertebrate ratings from 76-100 are considered excellent, 50-75 good, 25-49 fair, and 0-24 are considered poor.

RESULTS

Probabilistic Sites

Stations 1-25

The DNRE, Water Bureau, has recently begun to incorporate a stratified random sampling design component into the annual watershed assessments (DNREa, in preparation). The purpose of this probabilistic monitoring is to collect biological data for attainment status and temporal trend analysis. Probabilistic sampling allows the conclusions from a limited number of sampling stations to be extended to an entire watershed. The resulting data can be used to infer the condition of the state's waters at site-specific, watershed, or statewide scales.

The DNRE's Macroinvertebrate Community Status and Trend Monitoring Procedure (DNREa, in preparation) is used to estimate the number of river miles supporting the other indigenous aquatic life and wildlife designated use. The status and trend program utilizes river valley segments to provide the basic sampling unit. A river valley segment is defined as a stream reach that is relatively homogenous with respect to ecological segments of rivers and streams that share common geologic, flow, and temperature characteristics. The smallest river unit (i.e., valley segment) that can be interpreted from large-scale geologic maps, are in reality relatively large with each segment having its own unique identification number coupled with a known specific length. As such, valley segments provide a randomly selectable sampling unit that can be stratified by size and/or thermal regime.

To develop a statistically-based estimate of attainment status in the Tahquamenon, Two Hearted, Manistique, and Millecoquins Rivers watersheds, a total of 25 randomly selected sites were assessed using Procedure 51 (N = 22) and our draft nonwadable procedure (N = 3) (DNREb, in preparation). Sites were stratified based on size and water temperature. The strata included small cold, medium cold, small warm, medium warm, large warm, very large warm, and coastal rivers. Large cold and very large cold river segments are not represented in the Tahquamenon, Two Hearted, Manistique, and Millecoquins Rivers watersheds. Two sites located on the Manistique River (Stations 22 and 23) and one in the East Branch Fox River (Station 15) were sampled using the nonwadable protocol (DNREb, in preparation). The number of sites in each category, total watershed miles, and probabilistic results are summarized in Table 1. The probabilistic sites correspond to Stations 1-25 in Figures 1 and 2.

All of the 25 probabilistic sites in the 2009 Tahquamenon, Two Hearted, Manistique, and Millecoquins Rivers watersheds were supporting the "other indigenous aquatic life" component of the designated use specified in Rule 323.1100(1)(e) of the Michigan WQS. Based on the data and probabilistic monitoring methodology, we are 95 percent confident that at least 89 percent of the river miles in these watersheds are attaining the "other indigenous aquatic life" component of the designated use.

The overall mean Procedure 51 score for benthic macroinvertebrates at the 22 wadable probabilistic sites was 3.2. Three of 22 wadable sites rated excellent (+5 or greater) with the

remaining 19 stations rating acceptable. Only 2 of 22 sites had a negative, but still acceptable metric score. The lowest score (-2) occurred in the Shelldrake River (Station 20) that drains a vast wetland landscape.

The total number of taxa in the wadable probabilistic sites ranged from 16-39 (Tables 3A and 3B). The number of Ephemeroptera, Plecoptera, and Trichoptera (EPT) families ranged from 4-15. Mayflies and caddisflies composed 18-65 percent of the macroinvertebrate communities at the wadable probabilistic sites.

Three stations were assessed using Michigan's Qualitative Biological and Habitat Survey Protocols for Nonwadeable Rivers. All 3 sites surveyed in 2009 scored either good or excellent.

Targeted Sites

Station 26

A DNRE, Fisheries Division, status and trends site is located in the **upper Tahquamenon River** at a historic logging site called the Eagle's Nest location. A Procedure 51 biological survey was conducted at this station to compliment Fisheries Division data. The macroinvertebrate community rated excellent with a combined metric score of +8. Thirty-four taxa were found at Station 26, and approximately 60 percent of the individuals found at this station were EPT taxa. The habitat conditions rated excellent.

Station 27

The **Indian River off M-94** is a DNRE, Fisheries Division, status and trends site. This station was previously assessed by DNRE staff in 1999 and 2004 (Goodwin, 2000 and Wolf, 2005). In 1999, the macroinvertebrate community rated acceptable, 24 taxa were found, and approximately 50 percent of the individuals found at this station were EPT taxa. The habitat conditions rated good in 1999 (Goodwin, 2000). In 2004, the macroinvertebrate community rated excellent, 30 taxa were found, and approximately 50 percent of the individuals found were EPT taxa. The habitat conditions rated good in 2004 (Wolf, 2005). The 2009 macroinvertebrate community rated excellent with a combined metric score of +7. Thirty-three taxa were found at Station 27, and approximately 50 percent of the individuals found at this station were EPT taxa. The habitat conditions rated good.

Station 28

Biological surveys on wadable sites in the **lower Manistique River** have not been conducted in the past; therefore, the boat launch location, upstream of the town, was assessed to provide additional watershed coverage. This launch site is upstream of the Manistique Area of Concern, but within the river segment where the limestone river bottom was modified by pine log sorting activities that ended in the early 1930s (Crowe, 1979). The macroinvertebrate community rated acceptable with a combined metric score of +1. Thirty-two taxa were found at Station 28 and approximately 9 percent of the individuals found at this station were EPT taxa. The habitat conditions rated good.

Station 29

A DNRE Water Chemistry Monitoring Program (WCMP) minimally impacted site is located on the **Fox River at the Fox River Campground**. This station was assessed to provide a link

between the WCMP data and macroinvertebrate community. The macroinvertebrate community rated acceptable with a combined metric score of +4. Thirty taxa were found at Station 29, and approximately 40 percent of the individuals found at this station were EPT taxa. The habitat conditions rated excellent.

The Fox River source water is primarily composed of filtered groundwater emanating from the Kingston sand plains. Water data taken in 2004 (Aiello, 2006) indicates this river system is very soft (hardness range of 39-60 $CaCo_3$ parts per million [ppm]) with low conductivity (85-114 micromhos per centimeter), elevated dissolved oxygen (10-12 ppm), and neutral pH (7.6-8.1 standard units).

Station 30

The **Cut River**, a small Lake Michigan coastal tributary, was sampled upstream of US-2 in Mackinac County, southeast of Rexton (Figure 4). This river flows through large areas of forested wetland and steep sand dune ridges before entering Lake Michigan through a deep gorge. The DNRE has conducted only limited macroinvertebrate sampling in the Cut River headwaters. Our Procedure 51 macroinvertebrate survey indicated an acceptable community (+4) with excellent habitat conditions. Eighteen taxa were collected, with baetid mayflies, midges, and blackflies dominating the community.

Figure 4. Cut River upstream US-2.

Station 31

The **Black River**, a Lake Michigan tributary, was sampled near the Black River State Forest Campground in Mackinac County, southwest of Garnet. This water body flows through large areas of swamp and sand ridges before entering Lake Michigan. The Procedure 51 macroinvertebrate survey indicated an excellent macroinvertebrate community (+6) with good habitat conditions. Thirty-two taxa were collected with lepidostomatid and limnephilid caddisflies, midges, and baetid mayflies dominating the community.

Station 32

Davenport Creek, a Lake Michigan coastal tributary, was sampled upstream of US-2 in Mackinac County, south of Rexton. This stream flows through large areas of swamp and sand dune ridges before entering Lake Michigan. We conducted Procedure 51 fish and

macroinvertebrate sampling at this specific site approximately 15 years ago (Taft, 1994c). The 2009 Procedure 51 macroinvertebrate survey indicated an acceptable community (+1) with good available habitat present upstream of the highway. Twenty-one taxa were collected with brachycentrid and limnephilid caddisflies, midges, and scuds dominating the community.

Station 33

Davenport Creek at Great Lake Gas Natural Gas Pipeline Crossing - This stream segment was last visited and photographed in 1994 (Figure 5). This site needed to be reassessed to determine the impacts of continued off-road vehicle use at the ford location. The images below (Figures 5 and 6) show that this site has revegetated with speckled alder (*Alnus incana*) and the off-road vehicle usage is much reduced due to fencing that has been erected by the natural gas pipeline company (Figure 6). Procedure 51 macroinvertebrate community and habitat scores were acceptable (+1) and good, respectively. This revegetation appears to have substantially reduced the sand load eroding from this site.

Figure 5. 1994.

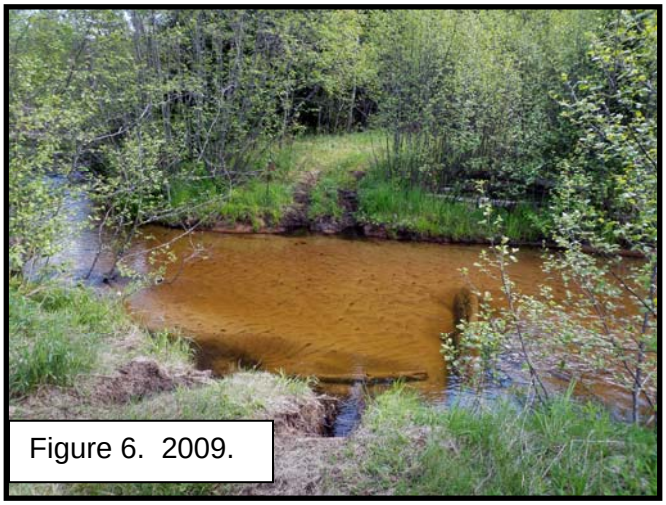

Figure 6. 2009.

Station 34

Furlong Creek downstream Pleasant Avenue - Furlong Creek is a tributary to Millecoquins Lake and was the target of nonpoint source habitat improvement projects in the early 1990s. A macroinvertebrate survey was conducted at this site for the third time (Taft, 1990; 2000a; and 2005) to verify that the post-project water quality improvements are still being realized. A new properly engineered culvert (Figure 8) was installed to replace a cast-off steel form (Figure 7)

Figure 7. 1990.

Figure 8. 2009.

used during the construction of the Mackinac Bridge. This short tube was perched, and created a barrier to the upstream migration of fish as well as a large, 85-foot eddy below the road that eroded the stream bank. Perched culverts have been identified as having numerous negative environmental consequences (Stranahan, 2009). The 2009 Procedure 51 macroinvertebrate survey indicated an excellent community (+5) with good habitat conditions present. Thirty-two taxa were collected with greater than 60 percent of the macroinvertebrate community composed of mayflies and caddisflies.

Station 35

Doe Creek - Historically, this small tributary to Furlong Creek has been impacted by nutrients from local farmsteads, field runoff, and disturbed riparian cover from unrestricted animal access. It is currently listed in Michigan's Clean Water Act Section 305(b), 303(d) and 313 Integrated Report (LeSage and Smith, 2008) as having insufficient water quality information. This creek tends to lose its base flow in dry years so conducting macroinvertebrate assessments in mid-summer can be problematic. The estimated flow on June 10, 2009, was 17 cubic feet per second, which was due to recent rains. The 2009 macroinvertebrate community and habitat were assessed using Procedure 51 at the Raski Road crossing. The June 2009 macroinvertebrate survey indicated an acceptable community (0) with good available habitat conditions present downstream of M-117. Twenty-eight taxa were collected with large numbers of midges, hydroptilid caddisflies, baetid mayflies, and haliplid beetles present. These insects are typically found in abundance in small streams with variable flow conditions and wetland influences.

Stations 36-39

Water samples were collected (where flow conditions permitted) from Station 35 plus 4 additional sites (Stations 36-39) in June 2009 (Table 5). The total phosphorus concentrations were variable with the highest levels found in close proximity to working farms with associated livestock and pasture lands, as would be expected within an agricultural landscape. The total phosphorus concentrations have been relatively constant when compared with past sampling events (Taft, 1990; 2000a).

Station 40

Lower Millecoquins River at the Lower Rapids - This site is downstream of Millecoquins Lake and located within the Hiawatha Club property between US-2 and the Hiawatha Trail (Figure 2). The lower Millecoquins River has not been sampled for macroinvertebrates in the past by the DNRE. This site was selected and sampled for macroinvertebrates and water chemistry to assess WQS attainment. The Procedure 51 macroinvertebrate survey indicated an acceptable community (+4) with excellent available habitat conditions present at this gradient break upstream of the confluence with Lake Michigan. The broken limestone outcropping in the streambed provided optimal hard substrate conditions for colonization by crayfish, snails, mayflies, and caddisflies that require such habitat. Thirty taxa were collected with large numbers of algae grazing glossosomatid caddisflies and lymnaeid snails present.

Station 41

Crow River near Mouth - The State of Michigan acquired most of the property within the Crow River watershed along Lake Michigan within the last 15 years. This place, known locally as Simmons Woods was held by steel companies that needed a source of limestone close to the

surface for flux material. We sampled the Crow River at one station below Amadon Pond in 1999 (Taft, 2000a), which indicated that the stream was meeting WQS with a macroinvertebrate metric score of acceptable (+2). The 2009 Procedure 51 macroinvertebrate survey indicated an acceptable community (+2) with good available habitat conditions present upstream of the confluence with Lake Michigan (Figure 9). Thirty-two taxa were collected with hydropsychid and limnephilid caddisflies, midges, and baetid mayflies dominating the community. We have encountered fishermen that were catching brook trout in past surveys.

Figure 9. Crow River upstream of Lake Michigan.

NPDES Program Support

To support water quality-based effluent limit development, water chemistry samples were collected at locations on the Tahquamenon River near the Newberry Wastewater Treatment Plant (WWTP). This river has been monitored several times in the past by DNRE staff (Goodwin, 2000; Holden, 2005; and Taft, 1989).

The Newberry WWTP is authorized by their NPDES permit to discharge treated sanitary wastewater to the Tahquamenon River. The Tahquamenon River in the vicinity of the Newberry WWTP was not wadable; therefore, Procedure 51 biological surveys were not conducted upstream and downstream of the WWTP. However, water chemistry grab samples were collected from the WWTP effluent and from the Tahquamenon River upstream of the WWTP. Nutrient concentrations in the WWTP effluent were higher (as expected) than background concentrations measured upstream of the WWTP. The Newberry WWTP is currently in compliance with their total phosphorus limitations and no nuisance plant conditions were observed during our monitoring. Metals such as cadmium, chromium, lead, selenium, silver, and mercury were not detected in either sample; however, it should be noted that mercury was

analyzed using USEPA Method 245.1 with a detection level of 0.2 micrograms per liter, which is significantly higher than the current WQS of 0.0013 micrograms per liter. Chemical data generated for the stations indicate that no toxic chemicals were detected at levels that exceed their respective Rule 57 water quality values.

Nonpoint Source Program Support

The DNRE conducted biological and channel morphology assessments on the Fox River in the vicinity of a bank stabilization project supported by federal Clean Water Act Section 319 funds (Taft, 1992b; and Suppnick, 1996). Biological and physical habitat assessments were also conducted by the DNRE on the Driggs River to collect baseline water quality data prior to the implementation of a bank stabilization project (Taft, 1994b).

As previously discussed, the Luce-West Mackinac Conservation District staff received $214,000 Section 319 implementation funding for the Doe Creek and Furlong Creek watersheds to address nutrient levels, livestock access, and stream habitat issues in the early 1990s. In 1996, a four-mile section of Furlong Creek was placed on Michigan's Clean Water Act Section 303(d) list for an impaired macroinvertebrate community and excess nutrients due to unrestricted cattle access. The landowner, in collaboration with the DNRE and Michigan Department of Agriculture, developed and implemented a farm management plan, which was successful in recovering the stream reach. Subsequently, the DNRE removed this site from the Section 303(d) list in 2005. Furlong Creek is now recognized as a Section 319 nonpoint source success story, which can be found on the USEPA's Web site (USEPA, 2008).

WATER CHEMISTRY

Ambient water chemistry samples were taken at eight locations within the Tahquamenon, Two Hearted, Manistique, and Millecoquins Rivers watersheds, along with the primary outfall 001A of the Newberry WWTP (Table 5). The Newberry WWTP effluent total phosphorus concentration was 0.56 milligrams per liter (mg/l), which is well below the 1.0 mg/l monthly average effluent limit in their NPDES permit. A water hardness concentration of 229 mg/l calcium carbonate ($CaCo_3$) was measured at the Newberry WWTP outfall 001A. No chemicals were detected upstream of the Newberry WWTP or in the outfall 001A discharge that exceeded the Michigan WQS.

Flowing waters directly influenced by dairy and cattle farming activities on Doe Creek had higher phosphorus concentrations as compared to forested or pasture sites. The results appear to be very consistent with past sampling events as the watershed land use has changed little over the last 20 years (Taft, 1990 and 2000a).

CONCLUSION

All 25 probabilistic sites in the 2009 Tahquamenon, Two Hearted, Manistique, and Millecoquins Rivers watersheds were supporting the "other indigenous aquatic life" component of the designated use (DNREa and DNREb in preparation) specified in Rule 323.1100(1)(e) of the Michigan WQS. Based on the data and probabilistic monitoring methodology, we are 95 percent confident that at least 89 percent of the river miles in these watersheds are attaining the "other indigenous aquatic life" component of the designated use. This is encouraging given the extensive historic logging, limestone mining activities, and past nutrient enrichment pollution problems documented by DNRE staff (Taft, 1990; 1992a; 1992b; 1994a; and 2000a) in the Tahquamenon, Two Hearted, Manistique, and Millecoquins Rivers watersheds.

Among 12 targeted sites assessed for benthic macroinvertebrates, 3 scored excellent and 9 rated acceptable (only 1 of the 9 had a metric score less than 0). The habitat condition at five of these targeted sites rated excellent and seven rated good. All targeted stations monitored were meeting Michigan WQS.

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Table 1. 2009 Tahquamenon, Two-Hearted, Manistique,and Millecoquins Rivers watersheds probabilistic sampling sites.

Station	Waterbody	Location	County	Storet	Lat	Long	TRS	Sample Type
Cold Small								
1	Syphon Creek	County Road 442	Luce	480038	46.39071	85.74531	46N/12W/12	M, H
2	Star Creek	County Road 454	Manistique	020124	46.37216	86.39305	46N/17W/23	M, H
3	Grass Creek	Old RR Grade off Sunset Landing	Alger	020159	46.52231	86.12086	48N/15W/25	M, H
4	E B Fox River	M-77	Schoolcraft	770090	46.40607	85.94795	46N/13W/05	M, H
5	Kilpecker Creek	Two Track off FF2438	Delta	210305	46.11395	86.49214	43N/18W/24	M, H
6	E B Tahquamenon River	Arbutus Truck Trail	Chippewa	170288	46.3177	84.9527	45N/05W/05	M, H
7	Mead Creek	M-77	Schoolcraft	770089	46.17484	85.92751	44N/13W/27	M, H
8	Big Murphy Creek	County Road 437	Schoolcraft	770159	46.07281	86.46690	43N/17W/32	M, H
9	Clear Creek	M-77	Schoolcraft	770108	46.44928	85.93728	47N/13W/21	M, H
10	Cheney Creek	upstream Tahquamenon River confluence	Chippewa	170191	46.56306	85.08312	48N/06W/08	M, H
11	Little Fox River	Stanley Lake Road	Schoolcraft	770157	46.47622	86.13987	47N/15W/11	M, H
12	E B Two Hearted River	County Road 414	Luce	480028	46.64188	85.47916	49N/09W/18	M, H
13	S B Stutts Creek	Clear Lake Road	Schoolcraft	770158	46.22240	86.41703	44N/17W/10	M, H
Cold Medium								
14	Sucker River	Grand Marais Truck Trail	Alger	020160	46.66203	85.86893	49N/13W/12	M, H
15	E B Fox River	M-28	Luce	480068	46.33551	85.81582	46N/12W/33	M, H
Warm Small								
16	Milakokia River	Betty Doe Lake Road (Huntspur Road)	Schoolcraft	490065	46.02832	85.84404	42N/12W/18	M, H
Warm Medium								
17	Creighton River	Creighton Truck Trail	Schoolcraft	770156	46.24108	86.24185	44N/16W/01	M, H
18	W B Two Hearted River	County Road 418	Luce	480067	46.56948	85.68017	48N/11W/09	M, H
19	W B Manistique River	Hickey Truck Trail	Schoolcraft	770155	46.25291	86.26238	45N/16W/35	M, H
20	Shelldrake (Betsy) River	Betsy River Truck Trail	Chippewa	170287	46.6729	85.2339	49N/07W/06	M, H
21	W B Manistique River	off Creighton Truck Trail	Schoolcraft	770160	46.22857	86.23506	44N/15W/07	M, H
Warm Large								
22	Manistique River	CR 498	Schoolcraft	770161	46.24695	85.92453	45N/13W/34	M, H
Warm Very Large								
23	Manistique River	Merwin Creek Road	Schoolcraft	770162	46.03433	86.12276	42N/15W/13	M, H
Coastal								
24	Paquin Creek	Hiawatha Trail	Mackinac	490195	46.1813	85.1545	43N/07W/35	M, H
25	Hog Island Creek	Strickler Truck Trail	Mackinac	490200	46.1228	85.254	43N/08W/13	M, H

M- Benthic macroinvertebrate community assessment
H- Habitat assessment

Table 2. 2009 Tahquamenon, Two-Hearted, Manistique, and Millecoquins Rivers watersheds targeted sampling sites.

Station	Waterbody	Location	County	Storet	Lat	Long	TRS	Sample Type
26	Tahquamenon River	Near Eagles Nest	Luce	480066	46.42482	85.79771	47N/12W/34	M, H
27	Indian River	off M-94	Schoolcraft	770085	46.16791	86.41597	44N/17W/34	M, H
28	Manistique River	at Boat Launch	Schoolcraft	770154	45.97088	86.24275	41N/16W/01	M, H
29	Fox River	Fox River Campground	Schoolcraft	770082	46.39997	86.02787	46N/14W/11	M, H
30	Cut River	US-2	Mackinac	490002	46.0452	85.1242	42N/07W/12	M, H
31	Black River	State Forest Campground	Mackinac	490198	46.11758	85.36597	43N/09W/13	M, H
32	Davenport Creek	US-2	Mackinac	490059	46.06772	85.26448	42N/08W/02	M, H
33	Davenport Creek	at gas pipeline	Mackinac	490199	46.09928	85.2595	43N/08W/26	M, H
34	Furlong Creek	Pleasant Avenue	Mackinac	490068	46.13899	85.59196	43N/10W/08	M, H
35	Doe Creek	Raski Road	Mackinac	490104	46.14193	85.56093	43N/10W/09	M, H, WC
36	Doe Creek	Kover	Mackinac	490202	46.18031	85.59601	44N/10W/30	WC
37	Doe Creek	Mile/Pleasant	Mackinac	490070	46.16545	85.5923	44N/10W/31	WC
38	Doe Creek	M-117	Mackinac	490053	46.14761	85.5714	44N/10W/05	WC
39	Doe Creek	Krause Road	Mackinac	490069	46.13668	85.55039	43N/10W09	WC
40	Millecoquins River	Lower Rapids	Mackinac	490196	46.11568	85.47358	43N/09W/18	M, H, WC
41	Crow River	end of Summer Trail	Mackinac	490197	46.03036	85.61533	42N/11W/13	M, H, WC
42	Tahquamenon River	upstream Newberry WWTP	Luce	480002	46.3713	85.50972	46N/10W/24	WC
43	Newberry WWTP Effluent	Oufall 001A	Luce	480039	46.3723	85.509	46N/10W/24	WC

M - Benthic macroinvertebrate community assessment
H - Habitat assessment
WC - Water Chemistry

Table 3A. Qualitative macroinvertebrate sampling results for the Tahquamenon, Two-Hearted, Manistique, and Millecoquins River probabilistic sampling sites.

TAXA	Syphon Creek M-442 7/29/2009 STATION 1	Star Creek Off Star Siding Road 6/24/2009 STATION 2	Grass Creek Railroad Grade off Sunset Landing 7/28/2009 STATION 3	East Branch Fox River M-77 crossing 6/9/2009 STATION 4
ANNELIDA (segmented worms)				
Hirudinea (leeches)	1			
Oligochaeta (worms)	49	2	2	2
ARTHROPODA				
Crustacea				
Decapoda (crayfish)			3	
Isopoda (sowbugs)				10
Arachnoidea				
Hydracarina	3	1		1
Insecta				
Ephemeroptera (mayflies)				
Baetiscidae		1		
Baetidae	35		14	76
Caenidae	4	7	5	
Ephemerellidae	1			43
Ephemeridae	4			
Heptageniidae			2	
Odonata				
Anisoptera (dragonflies)				
Aeshnidae		3	3	
Cordulegastridae		5	2	
Gomphidae		9	1	
Zygoptera (damselflies)				
Calopterygidae		3	1	
Plecoptera (stoneflies)				
Nemouridae	11			1
Perlidae		2		
Pteronarcyidae		1		
Hemiptera (true bugs)				
Corixidae		4		
Gerridae	1		8	
Megaloptera				
Corydalidae (dobson flies)		3		
Sialidae (alder flies)			2	
Trichoptera (caddisflies)				
Brachycentridae	5		53	37
Glossosomatidae		3		1
Helicopsychidae		10		
Hydropsychidae	7	3	2	1
Hydroptilidae			4	
Lepidostomatidae	5	7		
Leptoceridae		4		
Limnephilidae	24	24	9	18
Molannidae	1	1		
Philopotamidae	3			1
Phryganeidae			2	
Polycentropodidae		4		
Psychomyiidae			1	
Rhyacophilidae				1
Uenoidae		1		
Coleoptera (beetles)				
Dytiscidae (total)	1		3	
Gyrinidae (adults)	4			
Hydrophilidae (total)			4	
Dryopidae		1		
Elmidae		5		
Diptera (flies)				
Athericidae		1		
Ceratopogonidae	5	1	3	
Chironomidae	37	15	94	30
Dixidae	2			
Ptychopteridae	32		1	
Simuliidae	37		5	96
Tabanidae			1	
Tipulidae	1		2	2
MOLLUSCA				
Gastropoda (snails)				
Ancylidae (limpets)		1		
Physidae		4	2	1
Viviparidae			1	
Pelecypoda (bivalves)				
Sphaeriidae (clams)	48	3	29	
TOTAL INDIVIDUALS	321	129	259	321

Table 3B. Macroinvertebrate metric evaluation of the Tahquamenon, Two-Hearted, Manistique, and Millecoquins River probabilistic sampling sites.

	Syphon Creek M-442 7/29/2009 STATION 1		Star Creek Off Star Siding Road 6/24/2009 STATION 2		Grass Creek Railroad Grade off Sunset Landing 7/28/2009 STATION 3		East Branch Fox River M-77 crossing 6/9/2009 STATION 4	
METRIC	Value	Score	Value	Score	Value	Score	Value	Score
TOTAL NUMBER OF TAXA	24	0	29	1	28	1	16	0
NUMBER OF MAYFLY TAXA	4	0	2	-1	3	0	2	-1
NUMBER OF CADDISFLY TAXA	6	1	9	1	6	1	6	1
NUMBER OF STONEFLY TAXA	1	0	2	1	0	-1	1	0
PERCENT MAYFLY COMP.	13.71	0	6.20	0	8.11	0	37.07	1
PERCENT CADDISFLY COMP.	14.02	0	44.19	1	27.41	0	18.38	0
PERCENT DOMINANT TAXON	15.26	1	18.60	0	36.29	-1	29.91	-1
PERCENT ISOPOD, SNAIL, LEECH	0.31	1	3.88	1	1.16	1	3.43	1
PERCENT SURF. AIR BREATHERS	11.84	0	3.10	1	6.18	0	0.00	1
TOTAL SCORE		3		5		1		2
MACROINV. COMMUNITY RATING		ACCEPT.		EXCELLENT		ACCEPT.		ACCEPT.

Table 3A con't. Qualitative macroinvertebrate sampling results for the Tahquamenon, Two-Hearted, Manistique, and Millecoquins River probabilistic sampling sites.

TAXA	Kilpecker Creek two-track off Federal Forest Rd 2438 7/27/2009 STATION 5	East Branch Tahquamenon River Arbutus Truck Trail 6/11/2009 STATION 6	Mead Creek M-77 crossing 6/9/2009 STATION 7	Big Murphy Creek County Road 437 6/22/2009 STATION 8
ANNELIDA (segmented worms)				
Hirudinea (leeches)	1			
Oligochaeta (worms)	1	3	11	
ARTHROPODA				
Crustacea				
Amphipoda (scuds)			26	
Decapoda (crayfish)			1	5
Isopoda (sowbugs)				11
Arachnoidea				
Hydracarina	2	1		
Insecta				
Ephemeroptera (mayflies)				
Baetiscidae				1
Baetidae	14		9	
Caenidae			1	7
Ephemerellidae	2	17	1	8
Heptageniidae	1		1	4
Odonata				
Anisoptera (dragonflies)				
Aeshnidae			5	2
Cordulegastridae			2	
Gomphidae			3	1
Zygoptera (damselflies)				
Calopterygidae			4	
Coenagrionidae			4	
Plecoptera (stoneflies)				
Leuctridae	6	60		1
Nemouridae	26			
Perlidae				1
Pteronarcyidae				1
Hemiptera (true bugs)				
Gerridae		1	3	
Megaloptera				
Corydalidae (dobson flies)				1
Sialidae (alder flies)		3		
Trichoptera (caddisflies)				
Brachycentridae	24			33
Helicopsychidae			3	
Hydropsychidae				56
Lepidostomatidae	5	61		
Leptoceridae			1	1
Limnephilidae	15	2	40	2
Molannidae	1			
Philopotamidae	2			
Polycentropodidae			1	
Uenoidae	1			
Coleoptera (beetles)				
Dytiscidae (total)	1			1
Gyrinidae (adults)			7	
Hydrophilidae (total)		1		
Elmidae			18	3
Diptera (flies)				
Athericidae	2			
Ceratopogonidae	2	3	4	
Chironomidae	100	80	113	14
Ptychopteridae	1	2		
Simuliidae	6	8	46	2
Stratiomyidae				17
Tabanidae	1	1		
Tipulidae		2	2	1
MOLLUSCA				
Gastropoda (snails)				
Hydrobiidae			4	
Lymnaeidae				5
Physidae	2			
Pelecypoda (bivalves)				
Sphaeriidae (clams)	54	3	1	5
Unionidae (mussels)			1	
TOTAL INDIVIDUALS	270	248	312	183

Table 3B con't. Macroinvertebrate metric evaluation of the Tahquamenon, Two-Hearted, Manistique, and Millecoquins River probabilistic sampling sites.

	Kilpecker Creek two-track off Federal Forest Rd 2438 7/27/2009 STATION 5		East Branch Tahquamenon River Arbutus Truck Trail 6/11/2009 STATION 6		Mead Creek M-77 crossing 6/9/2009 STATION 7		Big Murphy Creek County Road 437 6/22/2009 STATION 8	
METRIC	Value	Score	Value	Score	Value	Score	Value	Score
TOTAL NUMBER OF TAXA	23	0	16	0	26	0	24	0
NUMBER OF MAYFLY TAXA	3	0	1	-1	4	0	4	0
NUMBER OF CADDISFLY TAXA	6	1	2	-1	4	0	4	0
NUMBER OF STONEFLY TAXA	2	1	1	0	0	-1	3	1
PERCENT MAYFLY COMP.	6.30	0	6.85	0	3.85	0	10.93	0
PERCENT CADDISFLY COMP.	17.78	0	25.40	0	14.42	0	50.27	1
PERCENT DOMINANT TAXON	37.04	-1	32.26	-1	36.22	-1	30.60	-1
PERCENT ISOPOD, SNAIL, LEECH	1.11	1	0.00	1	1.28	1	8.74	0
PERCENT SURF. AIR BREATHERS	0.74	1	1.61	1	3.21	1	9.84	0
TOTAL SCORE		3		-1		0		1
MACROINV. COMMUNITY RATING		ACCEPT.		ACCEPT.		ACCEPT.		ACCEPT.

Table 3A con't. Qualitative macroinvertebrate sampling results for the Tahquamenon, Two-Hearted, Manistique, and Millecoquins River probabilistic sampling sites.

TAXA	Clear Creek upstream M-77 6/9/2009 STATION 9	Cheney Creek u/s Tahq. River confluence 6/10/2009 STATION 10	Little Fox River Stanley Lake Road 6/23/2009 STATION 11	East Branch Two Hearted River County Road 414 7/30/2009 STATION 12
ANNELIDA (segmented worms)				
Hirudinea (leeches)			1	
Oligochaeta (worms)	4	3	2	39
ARTHROPODA				
Crustacea				
Amphipoda (scuds)	1			2
Decapoda (crayfish)			1	
Isopoda (sowbugs)			92	
Arachnoidea				
Hydracarina	1			10
Insecta				
Ephemeroptera (mayflies)				
Baetiscidae			1	1
Baetidae	116	20	11	39
Caenidae				1
Ephemerellidae	5		5	8
Ephemeridae			2	1
Heptageniidae		8	7	2
Odonata				
Anisoptera (dragonflies)				
Aeshnidae		1	1	1
Cordulegastridae			3	1
Gomphidae			1	
Zygoptera (damselflies)				
Calopterygidae			5	
Plecoptera (stoneflies)				
Leuctridae	8	10		
Nemouridae	18	3		
Perlidae			2	
Perlodidae		3		
Pteronarcyidae				9
Hemiptera (true bugs)				
Corixidae			1	1
Gerridae		1		3
Veliidae			1	
Megaloptera				
Sialidae (alder flies)			1	
Trichoptera (caddisflies)				
Brachycentridae	61		2	1
Helicopsychidae			1	
Hydropsychidae	4	1	39	
Lepidostomatidae		6		6
Leptoceridae			7	
Limnephilidae	52	22	7	14
Molannidae			1	
Philopotamidae	1	1		
Phryganeidae			2	
Psychomyiidae			1	
Uenoidae			4	
Coleoptera (beetles)				
Dytiscidae (total)	2	2		1
Gyrinidae (adults)				1
Hydrophilidae (total)		1		2
Elmidae		1	2	
Diptera (flies)				
Athericidae				1
Ceratopogonidae		1	5	2
Chironomidae	10	100	27	64
Simuliidae	69	70	6	7
Tabanidae		1	3	3
Tipulidae	1	1		
MOLLUSCA				
Gastropoda (snails)				
Hydrobiidae			1	
Physidae			1	1
Pelecypoda (bivalves)				
Sphaeriidae (clams)	16		6	22
TOTAL INDIVIDUALS	369	256	252	243

Table 3B con't. Macroinvertebrate metric evaluation of the Tahquamenon, Two-Hearted, Manistique, and Millecoquins River probabilistic sampling sites.

	Clear Creek upstream M-77 6/9/2009 STATION 9		Cheney Creek u/s Tahq. River confluence 6/10/2009 STATION 10		Little Fox River Stanley Lake Road 6/23/2009 STATION 11		East Branch Two Hearted River County Road 414 7/30/2009 STATION 12	
METRIC	Value	Score	Value	Score	Value	Score	Value	Score
TOTAL NUMBER OF TAXA	16	0	20	0	34	1	27	0
NUMBER OF MAYFLY TAXA	2	0	2	-1	5	1	6	1
NUMBER OF CADDISFLY TAXA	4	0	4	0	9	1	3	0
NUMBER OF STONEFLY TAXA	2	1	3	1	1	0	1	0
PERCENT MAYFLY COMP.	32.79	1	10.94	0	10.32	0	21.40	0
PERCENT CADDISFLY COMP.	31.98	1	11.72	0	25.40	0	8.64	0
PERCENT DOMINANT TAXON	31.44	-1	39.06	-1	36.51	-1	26.34	0
PERCENT ISOPOD, SNAIL, LEECH	0.00	1	0.00	1	37.70	-1	0.41	1
PERCENT SURF. AIR BREATHERS	0.54	1	1.56	1	0.79	1	3.29	1
TOTAL SCORE		4		1		2		3
MACROINV. COMMUNITY RATING		ACCEPT.		ACCEPT.		ACCEPT.		ACCEPT.

Table 3A con't. Qualitative macroinvertebrate sampling results for the Tahquamenon, Two-Hearted, Manistique, and Millecoquins River probabilistic sampling sites.

TAXA	South Branch Stutts Creek Clear Lake Road 6/25/2009 STATION 13	Sucker River Grand Marais Truck Trail 7/29/2009 STATION 14	Creighton River Creighton Truck Trail 6/24/2009 STATION 16	Milakokia River Betty Doe Lake Rd 6/9/2009 STATION 17
PORIFERA (sponges)				1
ANNELIDA (segmented worms)				
Hirudinea (leeches)	1	1		
Oligochaeta (worms)	3	6	2	3
ARTHROPODA				
Crustacea				
Amphipoda (scuds)	2			10
Decapoda (crayfish)		2	3	1
Arachnoidea				
Hydracarina			3	
Insecta				
Ephemeroptera (mayflies)				
Baetiscidae	2		5	
Baetidae	16	35	10	23
Caenidae	1	3		5
Ephemerellidae		4	24	
Ephemeridae	15		1	
Heptageniidae	9	7		21
Leptophlebiidae	3			18
Odonata				
Anisoptera (dragonflies)				
Aeshnidae		4	5	8
Cordulegastridae	1	2	1	
Gomphidae	1	11	3	30
Zygoptera (damselflies)				
Calopterygidae		2	2	1
Plecoptera (stoneflies)				
Leuctridae			3	
Nemouridae				1
Perlidae		2	4	4
Perlodidae			3	
Pteronarcyidae	2	24	3	
Hemiptera (true bugs)				
Corixidae	4		11	
Gerridae		4	3	1
Megaloptera				
Corydalidae (dobson flies)	2		1	17
Sialidae (alder flies)	10			
Trichoptera (caddisflies)				
Brachycentridae		3		
Helicopsychidae				3
Hydropsychidae	1	15	11	5
Lepidostomatidae	15	5	1	
Leptoceridae	3		1	
Limnephilidae	52	1	20	25
Molannidae	2		1	1
Philopotamidae			3	
Polycentropodidae	4		2	
Uenoidae	2	1		1
Coleoptera (beetles)				
Dytiscidae (total)	1		3	
Haliplidae (adults)	1		1	
Hydrophilidae (total)	1		3	4
Dryopidae		2	1	
Elmidae	4	4		8
Diptera (flies)				
Athericidae		4	2	
Ceratopogonidae	2	3	1	1
Chironomidae	12	72	1	6
Ptychopteridae	1			
Simuliidae	2	13		2
Tabanidae	4	2	2	
Tipulidae		10		
MOLLUSCA				
Gastropoda (snails)				
Ancylidae (limpets)				1
Physidae	2	2		
Pelecypoda (bivalves)				
Sphaeriidae (clams)	61	4	94	75
TOTAL INDIVIDUALS	242	248	234	276

Table 3B con't. Macroinvertebrate metric evaluation of the Tahquamenon, Two-Hearted, Manistique, and Millecoquins River a probabilistic sampling sites.

	South Branch Stutts Creek Clear Lake Road 6/25/2009 STATION 13		Sucker River Grand Marais Truck Trail 7/29/2009 STATION 14		Creighton River Creighton Truck Trail 6/24/2009 STATION 16		Milakokia River Betty Doe Lake Rd 6/9/2009 STATION 17	
METRIC	Value	Score	Value	Score	Value	Score	Value	Score
TOTAL NUMBER OF TAXA	33	1	29	1	34	1	27	0
NUMBER OF MAYFLY TAXA	6	1	4	0	4	0	4	0
NUMBER OF CADDISFLY TAXA	7	1	5	0	7	1	5	0
NUMBER OF STONEFLY TAXA	1	0	2	1	4	1	2	1
PERCENT MAYFLY COMP.	19.01	0	19.76	0	17.09	0	24.28	1
PERCENT CADDISFLY COMP.	32.64	1	10.08	0	16.67	0	12.68	0
PERCENT DOMINANT TAXON	25.21	0	29.03	-1	40.17	-1	27.17	0
PERCENT ISOPOD, SNAIL, LEECH	1.24	1	1.21	1	0.00	1	0.36	1
PERCENT SURF. AIR BREATHERS	3.31	1	1.61	1	8.97	0	1.81	1
TOTAL SCORE		6		3		3		4
MACROINV. COMMUNITY RATING		EXCELLENT		ACCEPT.		ACCEPT.		ACCEPT.

Table 3A con't. Qualitative macroinvertebrate sampling results for the Tahquamenon, Two-Hearted, Manistique, and Millecoquins River probabilistic sampling sites.

TAXA	West Branch Two Hearted River County Road 418 7/29/2009 STATION 18	West Branch Manistique River Hickey Truck Trail 7/27/2009 STATION 19	Shelldrake River Betsy River Truck Trail 6/10/2009 STATION 20	West Branch Manistique River off Crieghton Truck Trail 6/24/2009 STATION 21
ANNELIDA (segmented worms)				
Hirudinea (leeches)	1	1		
Oligochaeta (worms)	13	1	4	23
ARTHROPODA				
Crustacea				
Amphipoda (scuds)	16	15	1	2
Decapoda (crayfish)		53		1
Arachnoidea				
Hydracarina	3		1	
Insecta				
Ephemeroptera (mayflies)				
Baetiscidae		2		4
Baetidae	11	12	43	1
Caenidae	3	3		
Ephemerellidae	3	7	4	19
Ephemeridae	14	1		
Heptageniidae	3	5		1
Leptophlebiidae	1			
Odonata				
Anisoptera (dragonflies)				
Aeshnidae		10	1	6
Cordulegastridae	1	2		2
Libellulidae			1	
Zygoptera (damselflies)				
Calopterygidae		20	2	2
Coenagrionidae			1	
Plecoptera (stoneflies)				
Leuctridae		1		4
Perlidae		1		1
Perlodidae				3
Pteronarcyidae	2	2		5
Hemiptera (true bugs)				
Corixidae	10	2		
Gerridae	2	1		
Veliidae		5	2	1
Megaloptera				
Corydalidae (dobson flies)	1	3		
Sialidae (alder flies)			1	3
Trichoptera (caddisflies)				
Brachycentridae	18	8		
Helicopsychidae		2		
Hydropsychidae		11		21
Hydroptilidae	1			
Lepidostomatidae			2	1
Leptoceridae		1		5
Limnephilidae	5	10	14	9
Molannidae	2			
Philopotamidae				1
Coleoptera (beetles)				
Dytiscidae (total)	2	5		
Gyrinidae (adults)		1	2	
Haliplidae (adults)		1	1	
Hydrophilidae (total)	1		1	
Dryopidae		6		4
Elmidae	1	1		
Gyrinidae (larvae)		1		
Diptera (flies)				
Athericidae	4			1
Ceratopogonidae	1	1	2	
Chironomidae	28	20	30	41
Dixidae		1		
Ptychopteridae				1
Simuliidae	14	6	163	4
Tabanidae	7	4		2
Tipulidae		3		2
MOLLUSCA				
Gastropoda (snails)				
Ancylidae (limpets)		1		
Physidae	12	7	3	
Planorbidae			1	
Pelecypoda (bivalves)				
Sphaeriidae (clams)	86	9	45	71
TOTAL INDIVIDUALS	266	246	325	241

Table 3B con't. Macroinvertebrate metric evaluation of the Tahquamenon, Two-Hearted, Manistique, and Millecoquins River probabilistic sampling sites.

	West Branch Two Hearted River County Road 418 7/29/2009 STATION 18		West Branch Manistique River Hickey Truck Trail 7/27/2009 STATION 19		Shelldrake River Betsy River Truck Trail 6/10/2009 STATION 20		West Branch Manistique River off Crieghton Truck Trail 6/24/2009 STATION 21	
METRIC	Value	Score	Value	Score	Value	Score	Value	Score
TOTAL NUMBER OF TAXA	29	1	39	1	22	0	29	1
NUMBER OF MAYFLY TAXA	6	1	6	1	2	-1	4	0
NUMBER OF CADDISFLY TAXA	4	0	5	0	2	-1	5	0
NUMBER OF STONEFLY TAXA	1	0	3	1	0	-1	4	1
PERCENT MAYFLY COMP.	13.16	0	12.20	0	14.46	0	10.37	0
PERCENT CADDISFLY COMP.	9.77	0	13.01	0	4.92	0	15.35	0
PERCENT DOMINANT TAXON	32.33	-1	21.54	0	50.15	-1	29.46	-1
PERCENT ISOPOD, SNAIL, LEECH	4.89	0	3.66	1	1.23	1	0.00	1
PERCENT SURF. AIR BREATHERS	5.64	0	6.10	0	1.85	1	0.83	1
TOTAL SCORE		1		4		-2		3
MACROINV. COMMUNITY RATING	ACCEPT.		ACCEPT.		ACCEPT.		ACCEPT.	

Table 3A con't. Qualitative macroinvertebrate sampling results for the Tahquamenon, Two-Hearted, Manistique, and Millecoquins River probabilistic sampling sites.

TAXA	Paquin Creek Hiawatha Trail 6/7/2009 STATION 24	Hog Island Creek Strickler Truck Trail 6/10/2009 STATION 25
ANNELIDA (segmented worms)		
Oligochaeta (worms)		2
ARTHROPODA		
Crustacea		
Amphipoda (scuds)		54
Arachnoidea		
Hydracarina	1	
Insecta		
Ephemeroptera (mayflies)		
Baetidae	103	26
Ephemerellidae		3
Heptageniidae		4
Leptophlebiidae	1	
Odonata		
Anisoptera (dragonflies)		
Aeshnidae	1	
Cordulegastridae	2	
Libellulidae		1
Plecoptera (stoneflies)		
Leuctridae	3	
Nemouridae	16	1
Perlodidae	1	
Hemiptera (true bugs)		
Gerridae	1	1
Trichoptera (caddisflies)		
Brachycentridae		2
Hydropsychidae	3	2
Lepidostomatidae	2	13
Limnephilidae	42	50
Philopotamidae		6
Uenoidae	11	3
Lepidoptera (moths)		
Noctuidae	1	
Coleoptera (beetles)		
Dytiscidae (total)	12	3
Hydrophilidae (total)		2
Diptera (flies)		
Ceratopogonidae	3	
Chironomidae	33	11
Ptychopteridae	1	1
Simuliidae	52	58
Tabanidae	3	1
Tipulidae	1	1
MOLLUSCA		
Gastropoda (snails)		
Planorbidae	1	
TOTAL INDIVIDUALS	294	245

Table 3B con't. Macroinvertebrate metric evaluation of the Tahquamenon, Two-Hearted, Manistique, and Millecoquins River probabilistic sampling sites.

	Paquin Creek Hiawatha Trail 6/7/2009 STATION 24		Hog Island Creek Strickler Truck Trail 6/10/2009 STATION 25	
METRIC	Value	Score	Value	Score
TOTAL NUMBER OF TAXA	22	0	21	0
NUMBER OF MAYFLY TAXA	2	-1	3	0
NUMBER OF CADDISFLY TAXA	4	0	6	1
NUMBER OF STONEFLY TAXA	3	1	1	0
PERCENT MAYFLY COMP.	35.37	1	13.47	0
PERCENT CADDISFLY COMP.	19.73	0	31.02	1
PERCENT DOMINANT TAXON	35.03	-1	23.67	0
PERCENT ISOPOD, SNAIL, LEECH	0.34	1	0.00	1
PERCENT SURF. AIR BREATHERS	4.76	1	2.86	1
TOTAL SCORE		2		4
MACROINV. COMMUNITY RATING		ACCEPT.		ACCEPT.

Table 3A con't. Qualitative macroinvertebrate sampling results for the Tahquamenon, Two-Hearted, Manistique, and Millecoquins River targeted sampling sites.

TAXA	Tahquamenon River near Eagles Nest 7/30/2009 STATION 26	Indian River 2-track east off 94 7/27/2009 STATION 27	Manistique River Manistique boat launch 7/28/2009 STATION 28	Fox River Fox River campground 7/28/2009 STATION 29
ANNELIDA (segmented worms)				
Oligochaeta (worms)	5	28		11
ARTHROPODA				
Crustacea				
Amphipoda (scuds)	19		80	1
Decapoda (crayfish)		3	1	
Isopoda (sowbugs)			2	36
Arachnoidea				
Hydracarina			1	
Insecta				
Ephemeroptera (mayflies)				
Baetiscidae	1	1		1
Baetidae	16	10	6	26
Caenidae	9	6	1	23
Ephemerellidae	2	1	1	11
Ephemeridae		1		2
Heptageniidae	3	2	1	3
Isonychiidae		2		
Siphlonuridae			1	
Tricorythidae	59			
Odonata				
Anisoptera (dragonflies)				
Aeshnidae	1	1	3	
Cordulegastridae				1
Gomphidae	3	1		1
Macromiidae			1	
Zygoptera (damselflies)				
Calopterygidae		2	3	
Coenagrionidae			2	
Plecoptera (stoneflies)				
Leuctridae	1			
Nemouridae				3
Perlidae	6	3	1	
Perlodidae	3			5
Pteronarcyidae	2	10		13
Hemiptera (true bugs)				
Corixidae	2			1
Gerridae	1	1	1	2
Mesoveliidae			2	
Veliidae		1		
Megaloptera				
Corydalidae (dobson flies)		1		
Trichoptera (caddisflies)				
Brachycentridae	28	50	4	4
Glossosomatidae	9			13
Helicopsychidae			3	
Hydropsychidae	18	18		
Lepidostomatidae	5	1		
Leptoceridae		4	1	
Limnephilidae	2	4	1	
Molannidae	1			
Philopotamidae	36	16		
Polycentropodidae			2	
Uenoidae	1			
Lepidoptera (moths)				
Pyralidae			1	
Coleoptera (beetles)				
Dytiscidae (total)	1	1		2
Gyrinidae (adults)				1
Haliplidae (adults)			1	
Elmidae	6	5	4	4
Ptilodactylidae (larvae)			1	
Diptera (flies)				
Athericidae	4	3		11
Ceratopogonidae	7			1
Chironomidae	77	18	2	35
Ephydridae				1
Ptychopteridae				1
Simuliidae	3	2		14
Tabanidae	1	1	1	1
Tipulidae	2			3
MOLLUSCA				
Gastropoda (snails)				
Ancylidae (limpets)		1	1	
Hydrobiidae			30	
Lymnaeidae		1		
Physidae	1	2	42	
Viviparidae			43	
Pelecypoda (bivalves)				
Sphaeriidae (clams)	3	61	9	32
TOTAL INDIVIDUALS	338	262	253	263

Table 3B con't. Macroinvertebrate metric evaluation of the Tahquamenon, Two-Hearted, Manistique, and Millecoquins River targeted sampling sites.

	Tahquamenon River near Eagles Nest 7/30/2009 STATION 26		Indian River 2-track east off 94 7/27/2009 STATION 27		Manistique River Manistique boat launch 7/28/2009 STATION 28		Fox River Fox River campground 7/28/2009 STATION 29	
METRIC	Value	Score	Value	Score	Value	Score	Value	Score
TOTAL NUMBER OF TAXA	34	1	33	1	32	1	30	1
NUMBER OF MAYFLY TAXA	6	1	7	1	5	1	6	1
NUMBER OF CADDISFLY TAXA	8	1	6	1	5	0	2	-1
NUMBER OF STONEFLY TAXA	4	1	2	1	1	0	3	1
PERCENT MAYFLY COMP.	26.63	1	8.78	0	3.95	0	25.10	1
PERCENT CADDISFLY COMP.	29.59	1	35.50	1	4.35	0	6.46	0
PERCENT DOMINANT TAXON	22.78	0	23.28	0	31.62	-1	13.69	1
PERCENT ISOPOD, SNAIL, LEECH	0.30	1	1.53	1	46.64	-1	13.69	-1
PERCENT SURF. AIR BREATHERS	1.18	1	1.15	1	1.58	1	2.66	1
TOTAL SCORE		8		7		1		4
MACROINV. COMMUNITY RATING		EXCELLENT		EXCELLENT		ACCEPT.		ACCEPT.

Table 3A con't. Qualitative macroinvertebrate sampling results for the Tahquamenon, Two-Hearted, Manistique, and Millecoquins River targeted sampling sites.

TAXA	Millecoquins River Lower Rapids 6/8/2009 STATION 30	Furlong Creek Pleasant Ave 6/7/2009 STATION 31	Davenport Creek US-2 6/7/2009 STATION 32	Cut River US-2 6/7/2009 STATION 33
ANNELIDA (segmented worms)				
Oligochaeta (worms)	6	4	2	4
ARTHROPODA				
Crustacea				
Amphipoda (scuds)		1	52	
Decapoda (crayfish)	1	4		
Isopoda (sowbugs)			2	1
Insecta				
Ephemeroptera (mayflies)				
Baetidae	13	28	13	98
Caenidae	2	5		
Ephemerellidae	26		17	4
Heptageniidae	25	69		4
Isonychiidae	6			
Leptophlebiidae		44		
Odonata				
Anisoptera (dragonflies)				
Aeshnidae	1	5		
Cordulegastridae	1	5		
Gomphidae	2			
Zygoptera (damselflies)				
Calopterygidae	2			
Plecoptera (stoneflies)				
Leuctridae			1	3
Nemouridae			4	
Perlidae	2	5		
Perlodidae	2			4
Hemiptera (true bugs)				
Gerridae	2	1	1	
Veliidae			1	1
Megaloptera				
Corydalidae (dobson flies)	1	11		
Trichoptera (caddisflies)				
Brachycentridae			29	
Glossosomatidae	115	2		3
Helicopsychidae	16	4		
Hydropsychidae	12	3	19	4
Hydroptilidae		9		
Lepidostomatidae			5	7
Leptoceridae	3	1		
Limnephilidae	1	52	25	7
Philopotamidae		2		5
Polycentropodidae	1			2
Rhyacophilidae			1	1
Uenoidae		1		13
Coleoptera (beetles)				
Dytiscidae (total)			1	
Hydrophilidae (total)			1	
Dryopidae		2	1	
Elmidae	25	29		
Diptera (flies)				
Athericidae	6	1		
Ceratopogonidae	2	3		
Chironomidae	6	28	87	63
Simuliidae	1	12	10	85
Tabanidae		1	1	
Tipulidae	1	2	2	
MOLLUSCA				
Gastropoda (snails)				
Hydrobiidae		1		
Lymnaeidae	116			
Physidae		2		
Pelecypoda (bivalves)				
Sphaeriidae (clams)	13	21		
Unionidae (mussels)	1	1		
TOTAL INDIVIDUALS	411	359	275	309

Table 3B con't. Macroinvertebrate metric evaluation of the Tahquamenon, Two-Hearted, Manistique, and Millecoquins River targeted sampling sites.

	Millecoquins River Lower Rapids 6/8/2009 STATION 30		Furlong Creek Pleasant Ave 6/7/2009 STATION 31		Davenport Creek US-2 6/7/2009 STATION 32		Cut River US-2 6/7/2009 STATION 33	
METRIC	Value	Score	Value	Score	Value	Score	Value	Score
TOTAL NUMBER OF TAXA	30	1	32	1	21	0	18	0
NUMBER OF MAYFLY TAXA	5	1	4	0	2	-1	3	0
NUMBER OF CADDISFLY TAXA	6	1	8	1	5	0	8	1
NUMBER OF STONEFLY TAXA	2	1	1	0	2	1	2	1
PERCENT MAYFLY COMP.	17.52	0	40.67	1	10.91	0	34.30	1
PERCENT CADDISFLY COMP.	36.01	1	20.61	0	28.73	0	13.59	0
PERCENT DOMINANT TAXON	28.22	-1	19.22	0	31.64	-1	31.72	-1
PERCENT ISOPOD, SNAIL, LEECH	28.22	-1	0.84	1	0.73	1	0.32	1
PERCENT SURF. AIR BREATHERS	0.49	1	0.28	1	1.45	1	0.32	1
TOTAL SCORE		4		5		1		4
MACROINV. COMMUNITY RATING		ACCEPT.		EXCELLENT		ACCEPT.		ACCEPT.

Table 3A con't. Qualitative macroinvertebrate sampling results for the Tahquamenon, Two-Hearted, Manistique, and Millecoquins River targeted sampling sites.

TAXA	Davenport Creek at gas pipeline 6/10/2009 STATION 34	Doe Creek Raski Road 6/10/2009 STATION 35	Black River State Forest Campground bridge 6/8/2009 STATION 36	Crow River end of Summer Trail 6/8/2009 STATION 37
ANNELIDA (segmented worms)				
Hirudinea (leeches)		1	1	
Oligochaeta (worms)	1	2	3	1
ARTHROPODA				
Crustacea				
Amphipoda (scuds)	3	3	1	3
Decapoda (crayfish)		1		
Arachnoidea				
Hydracarina	1		1	
Insecta				
Ephemeroptera (mayflies)				
Baetiscidae				6
Baetidae	55	21	39	35
Caenidae		5		1
Ephemerellidae	29		11	1
Ephemeridae				2
Heptageniidae		3	1	8
Isonychiidae			6	
Odonata				
Anisoptera (dragonflies)				
Aeshnidae		1		8
Gomphidae				8
Zygoptera (damselflies)				
Calopterygidae				5
Coenagrionidae		1		
Plecoptera (stoneflies)				
Leuctridae			12	
Nemouridae	4		1	
Perlidae	3			
Perlodidae			9	
Hemiptera (true bugs)				
Corixidae				18
Gerridae	1		1	
Megaloptera				
Corydalidae (dobson flies)		3		1
Trichoptera (caddisflies)				
Brachycentridae	77		24	1
Helicopsychidae		1	1	
Hydropsychidae	12		3	22
Hydroptilidae		32	5	
Lepidostomatidae	16		40	1
Leptoceridae			1	3
Limnephilidae	47	3	40	28
Molannidae				1
Philopotamidae	1			
Polycentropodidae				1
Rhyacophilidae			1	
Coleoptera (beetles)				
Dytiscidae (total)		19	1	
Gyrinidae (adults)		10		
Haliplidae (adults)	1			
Hydrophilidae (total)		2	1	
Dryopidae		1	1	
Elmidae		10	1	
Diptera (flies)				
Athericidae				1
Ceratopogonidae	1	9	3	1
Chironomidae	53	121	52	45
Dixidae				1
Empididae		1		
Ptychopteridae			1	
Simuliidae	14	6	17	31
Tabanidae			1	3
Tipulidae	1	1	2	1
MOLLUSCA				
Gastropoda (snails)				
Hydrobiidae		3		4
Lymnaeidae		1		2
Physidae		1	1	4
Planorbidae		2		4
Pelecypoda (bivalves)				
Sphaeriidae (clams)	4	1	16	6
TOTAL INDIVIDUALS	324	265	298	257

Table 3B con't. Macroinvertebrate metric evaluation of the Tahquamenon, Two-Hearted, Manistique, and Millecoquins River targeted sampling sites.

	Davenport Creek at gas pipeline 6/10/2009 STATION 34		Doe Creek Raski Road 6/10/2009 STATION 35		Black River State Forest Campground bridge 6/8/2009 STATION 36		Crow River end of Summer Trail 6/8/2009 STATION 37	
METRIC	Value	Score	Value	Score	Value	Score	Value	Score
TOTAL NUMBER OF TAXA	19	0	28	1	32	1	32	1
NUMBER OF MAYFLY TAXA	2	-1	3	0	4	0	6	1
NUMBER OF CADDISFLY TAXA	5	0	3	0	8	1	7	1
NUMBER OF STONEFLY TAXA	2	1	0	-1	3	1	0	-1
PERCENT MAYFLY COMP.	25.93	1	10.94	0	19.13	0	20.62	0
PERCENT CADDISFLY COMP.	47.22	1	13.58	0	38.59	1	22.18	0
PERCENT DOMINANT TAXON	23.77	0	45.66	-1	17.45	0	17.51	0
PERCENT ISOPOD, SNAIL, LEECH	0.00	1	3.02	1	0.67	1	5.45	0
PERCENT SURF. AIR BREATHERS	0.62	1	11.70	0	1.34	1	7.00	0
TOTAL SCORE		4		0		6		2
MACROINV. COMMUNITY RATING		ACCEPT.		ACCEPT.		EXCELLENT		ACCEPT.

Table 4. Habitat evaluation for 2009 Tahquamenon, Two-Hearted, Manistique, and Millecoquins Rivers probabilistic sampling sites.

HABITAT METRIC	Syphon Creek M-442 GLIDE/POOL STATION 1	Star Creek Off Star Siding Road GLIDE/POOL STATION 2	Grass Creek Railroad Grade off Sunset Landing GLIDE/POOL STATION 3	East Branch Fox River M-77 crossing GLIDE/POOL STATION 4	Kilpecker Creek two-track off Federal Forest Rd 2438 GLIDE/POOL STATION 5
Substrate and Instream Cover					
Epifaunal Substrate/ Avail Cover (20)	10	10	10	12	14
Embeddedness (20)*					
Velocity/Depth Regime (20)*					
Pool Substrate Characterization (20)**	6	11	10	10	8
Pool Variability (20)**	1	8	5	13	11
Channel Morphology					
Sediment Deposition (20)	2	8	11	17	8
Flow Status - Maint. Flow Volume (10)	10	9	10	10	10
Flow Status - Flashiness (10)	10	8	10	10	10
Channel Alteration (20)	20	20	20	15	20
Frequency of Riffles/Bends (20)*					
Channel Sinuosity (20)**	15	14	15	12	18
Riparian and Bank Structure					
Bank Stability (L) (10)	10	9	10	10	10
Bank Stability (R) (10)	10	9	10	10	10
Vegetative Protection (L) (10)	10	8	10	10	9
Vegetative Protection (R) (10)	10	8	10	10	10
Riparian Veg. Zone Width (L) (10)	10	10	10	10	10
Riparian Veg. Zone Width (R) (10)	10	10	10	6	10
TOTAL SCORE (200):	134	142	151	155	158
HABITAT RATING:	GOOD (SLIGHTLY IMPAIRED)	GOOD (SLIGHTLY IMPAIRED)	GOOD (SLIGHTLY IMPAIRED)	EXCELLENT (NON-IMPAIRED)	EXCELLENT (NON-IMPAIRED)

Note: Individual metrics may better describe conditions directly affecting the biological community while the Habitat Rating describe the general riverine environment at the site(s).

Date:	7/29/2009	6/24/2009	7/28/2009	6/9/2009	7/27/2009
Weather:	Sunny	Sunny	Sunny	Cloudy	Cloudy
Air Temperature:	70 Deg. F.	75 Deg. F.	75 Deg. F.	49 Deg. F.	Deg. F.
Water Temperature:	48 Deg. F.	62 Deg. F.	66 Deg. F.	47 Deg. F.	50 Deg. F.
Ave. Stream Width:	15 Feet	18 Feet	8 Feet	22.5 Feet	15 Feet
Ave. Stream Depth:	0.83 Feet	1.5 Feet	1.5 Feet	1.8 Feet	0.67 Feet
Surface Velocity:	1.67 Ft./Sec.	0.33 Ft./Sec.	1 Ft./Sec.	1.5 Ft./Sec.	1 Ft./Sec.
Estimated Flow:	20.7915 CFS	8.91 CFS	12 CFS	60.75 CFS	10.05 CFS
Stream Modifications:	None	None	None	Relocated	None
Nuisance Plants (Y/N):	N	N	N	N	N
Report Number:					
STORET No.:	480038	20124	20159	770090	210305
Stream Name:	Syphon Creek	Star Creek	Grass Creek	East Branch Fox River	Kilpecker Creek
Road Crossing/Location:	M-442	Off Star Siding Road	Railroad Grade off Sunset Lan	M-77 crossing	two-track off Federal Forest Rd 2438
County Code:	48	02	02	77	21
TRS:	46N12W12	46N17W23	48N15W25	46N13W05	43N18W24
Latitude (dd):	46.39083	46.37216	46.52231	46.40607	46.11395
Longitude (dd):	-85.74472	-86.39325	-86.12086	-85.94795	-86.49214
Ecoregion:	NLAF	NLAF	NLAF	NLAF	NLAF
Stream Type:	Coldwater	Coldwater	Coldwater	Coldwater	Coldwater
USGS Basin Code:	4020202	4060106	4060106	4060106	4060106

* Applies only to Riffle/Run stream Survey
** Applies only to Glide/Pool stream Surveys

COMMENTS:

Table 4 con't. Habitat evaluation for 2009 Tahquamenon, Two-Hearted, Manistique, and Millecoquins River probabilistic sampling sites

HABITAT METRIC	East Branch Tahquamenon River Arbutus Truck Trail GLIDE/POOL STATION 6	Mead Creek M-77 crossing GLIDE/POOL STATION 7	Big Murphy Creek County Road 437 GLIDE/POOL STATION 8	Clear Creek upstream M-77 GLIDE/POOL STATION 9	Cheney Creek u/s Tahq. River confluence GLIDE/POOL STATION 10
Substrate and Instream Cover					
Epifaunal Substrate/ Avail Cover (20)	9	9	10	8	11
Embeddedness (20)*					
Velocity/Depth Regime (20)*					
Pool Substrate Characterization (20)**	12	12	8	11	8
Pool Variability (20)**	10	14	11	13	14
Channel Morphology					
Sediment Deposition (20)	20	14	6	20	12
Flow Status - Maint. Flow Volume (10)	9	8	9	10	9
Flow Status - Flashiness (10)	9	10	9	10	10
Channel Alteration (20)	20	20	20	20	20
Frequency of Riffles/Bends (20)*					
Channel Sinuosity (20)**	11	11	11	9	10
Riparian and Bank Structure					
Bank Stability (L) (10)	10	9	8	10	6
Bank Stability (R) (10)	10	9	8	10	6
Vegetative Protection (L) (10)	10	10	9	10	9
Vegetative Protection (R) (10)	10	10	9	10	9
Riparian Veg. Zone Width (L) (10)	10	10	10	10	9
Riparian Veg. Zone Width (R) (10)	10	10	10	10	9
TOTAL SCORE (200):	160	156	138	161	142
HABITAT RATING:	EXCELLENT (NON-IMPAIRED)	EXCELLENT (NON-IMPAIRED)	GOOD (SLIGHTLY IMPAIRED)	EXCELLENT (NON-IMPAIRED)	GOOD (SLIGHTLY IMPAIRED)

Note: Individual metrics may better describe conditions directly affecting the biological community while the Habitat Rating describes the general riverine environment at the site(s).

Date:	6/11/2009	6/9/2009	6/22/2009	6/9/2009	6/10/2009
Weather:	Sunny	Cloudy	Partly Cloudy	Cloudy	Sunny
Air Temperature:	50 Deg. F.	52 Deg. F.	80 Deg. F.	48 Deg. F.	Deg. F.
Water Temperature:	50 Deg. F.	53 Deg. F.	66 Deg. F.	44 Deg. F.	52 Deg. F.
Ave. Stream Width:	7.5 Feet	19 Feet	20 Feet	10 Feet	16 Feet
Ave. Stream Depth:	0.43 Feet	1.2 Feet	1.5 Feet	0.75 Feet	1.25 Feet
Surface Velocity:	0.8 Ft./Sec.	1.2 Ft./Sec.	1 Ft./Sec.	1.4 Ft./Sec.	0.77 Ft./Sec.
Estimated Flow:	2.58 CFS	27.36 CFS	30 CFS	10.5 CFS	15.4 CFS
Stream Modifications:	None	None	None	None	None
Nuisance Plants (Y/N):	N	N	N	N	N
Report Number:					
STORET No.:	170288	770089	770159	770108	170191
Stream Name:	East Branch Tahquamenon River	Mead Creek	Big Murphy Creek	Clear Creek	Cheney Creek
Road Crossing/Location:	Arbutus Truck Trail	M-77 crossing	County Road 437	upstream M-77	u/s Tahq. River confluer
County Code:	17	77	77	77	17
TRS:	45N05W05	44N13W27	43N17W32	47N13W21	48N06W08
Latitude (dd):	46.3177	46.17484	46.07281	46.44928	46.56306
Longitude (dd):	-84.9527	-85.92751	-86.4669	-85.93728	-85.08312
Ecoregion:	NLAF	NLAF	NLAF	NLAF	NLAF
Stream Type:	Coldwater	Warmwater	Coldwater	Coldwater	Coldwater
USGS Basin Code:	4020202	4060106	4060106	4060106	4020202

* Applies only to Riffle/Run stream Surveys
** Applies only to Glide/Pool stream Surveys

COMMENTS:

Table 4 con't. Habitat evaluation for 2009 Tahquamenon, Two-Hearted, Manistique, and Millecoquins River probabilistic sampling sites

HABITAT METRIC	Little Fox River Stanley Lake Road GLIDE/POOL STATION 11	East Branch Two Hearted River County Road 414 GLIDE/POOL STATION 12	South Branch Stutts Creek Clear Lake Road GLIDE/POOL STATION 13	Sucker River Grand Marais Truck Trail GLIDE/POOL STATION 14	Creighton River Creighton Truck Trail GLIDE/POOL STATION 16
Substrate and Instream Cover					
Epifaunal Substrate/ Avail Cover (20)	11	10	10	10	9
Embeddedness (20)*					
Velocity/Depth Regime (20)*					
Pool Substrate Characterization (20)**	12	11	11	7	8
Pool Variability (20)**	9	13	5	16	11
Channel Morphology					
Sediment Deposition (20)	8	10	10	6	7
Flow Status - Maint. Flow Volume (10)	10	10	8	10	9
Flow Status - Flashiness (10)	10	10	7	10	6
Channel Alteration (20)	19	20	20	20	20
Frequency of Riffles/Bends (20)*					
Channel Sinuosity (20)**	15	13	13	13	13
Riparian and Bank Structure					
Bank Stability (L) (10)	10	9	7	2	8
Bank Stability (R) (10)	10	9	7	2	6
Vegetative Protection (L) (10)	9	10	10	10	10
Vegetative Protection (R) (10)	9	10	10	10	10
Riparian Veg. Zone Width (L) (10)	10	10	8	10	10
Riparian Veg. Zone Width (R) (10)	10	10	10	10	10
TOTAL SCORE (200):	152	155	136	136	137
HABITAT RATING:	GOOD (SLIGHTLY IMPAIRED)	EXCELLENT (NON-IMPAIRED)	GOOD (SLIGHTLY IMPAIRED)	GOOD (SLIGHTLY IMPAIRED)	GOOD (SLIGHTLY IMPAIRED)

Note: Individual metrics may better describe conditions directly affecting the biological community while the Habitat Rating describes the general riverine environment at the site(s).

Date:	6/23/2009	7/30/2009	6/25/2009	7/29/2009	6/24/2009
Weather:	Sunny	Partly Cloudy	Cloudy	Cloudy	Sunny
Air Temperature:	80 Deg. F.	70 Deg. F.	75 Deg. F.	70 Deg. F.	85 Deg. F.
Water Temperature:	62 Deg. F.	54 Deg. F.	Deg. F.	64 Deg. F.	62 Deg. F.
Ave. Stream Width:	12 Feet	85 Feet	22 Feet	30 Feet	32 Feet
Ave. Stream Depth:	1 Feet	1.5 Feet	1.25 Feet	0.83 Feet	2 Feet
Surface Velocity:	1.2 Ft./Sec.	1 Ft./Sec.	1 Ft./Sec.	1.67 Ft./Sec.	0.4 Ft./Sec.
Estimated Flow:	14.4 CFS	127.5 CFS	27.5 CFS	41.583 CFS	25.6 CFS
Stream Modifications:	None	None	None	None	None
Nuisance Plants (Y/N):	N	N	N	N	N
Report Number:					
STORET No.:	770157	480028	770158	20160	770156
Stream Name:	Little Fox River	East Branch Two Hearted River	South Branch Stutts Creek	Sucker River	Creighton River
Road Crossing/Location:	Stanley Lake Road	County Road 414	Clear Lake Road	Grand Marais Truck Trail	Creighton Truck Trail
County Code:	77	48	77	02	77
TRS:	47N15W11	49N09W18	44N17W10	49N13W12	44N16W01
Latitude (dd):	46.47622	46.64188	46.2224	46.66203	46.24108
Longitude (dd):	-86.13987	-85.47916	-86.41703	-85.86893	-86.24185
Ecoregion:	NLAF	NLAF	NLAF	NLAF	NLAF
Stream Type:	Coldwater	Coldwater	Coldwater	Coldwater	Warmwater
USGS Basin Code:	4060106	4020201	4060106	4020201	4060106

* Applies only to Riffle/Run stream Surveys
** Applies only to Glide/Pool stream Surveys

COMMENTS:

Table 4 con't. Habitat evaluation for 2009 Tahquamenon, Two-Hearted, Manistique, and Millecoquins River probabilistic sampling sites.

HABITAT METRIC	Milakokia River Betty Doe Lake Rd GLIDE/POOL STATION 17	West Branch Two Hearted River County Road 418 GLIDE/POOL STATION 18	West Branch Manistique River Hickey Truck Trail GLIDE/POOL STATION 19	Shelldrake River Betsy River Truck Trail GLIDE/POOL STATION 20	West Branch Manistique River off Crieghton Truck Trail GLIDE/POOL STATION 21
Substrate and Instream Cover					
Epifaunal Substrate/ Avail Cover (20)	18	12	7	12	8
Embeddedness (20)*					
Velocity/Depth Regime (20)*					
Pool Substrate Characterization (20)**	17	7	8	13	9
Pool Variability (20)**	15	3	13	12	11
Channel Morphology					
Sediment Deposition (20)	19	11	6	16	6
Flow Status - Maint. Flow Volume (10)	9	10	9	9	9
Flow Status - Flashiness (10)	10	10	7	9	5
Channel Alteration (20)	20	20	20	20	20
Frequency of Riffles/Bends (20)*					
Channel Sinuosity (20)**	10	17	14	13	15
Riparian and Bank Structure					
Bank Stability (L) (10)	10	1	4	9	4
Bank Stability (R) (10)	10	10	4	9	4
Vegetative Protection (L) (10)	10	8	6	10	10
Vegetative Protection (R) (10)	10	10	6	10	10
Riparian Veg. Zone Width (L) (10)	10	10	10	10	7
Riparian Veg. Zone Width (R) (10)	10	10	9	8	10
TOTAL SCORE (200):	178	139	123	160	128
HABITAT RATING:	EXCELLENT (NON-IMPAIRED)	GOOD (SLIGHTLY IMPAIRED)	GOOD (SLIGHTLY IMPAIRED)	EXCELLENT (NON-IMPAIRED)	GOOD (SLIGHTLY IMPAIRED)

Note: Individual metrics may better describe conditions directly affecting the biological community while the Habitat Rating describes the gener riverine environment at the site(s).

Date:	6/9/2009	7/29/2009	7/27/2009	6/10/2009	6/24/2009
Weather:	Cloudy	Cloudy	Partly Cloudy	Sunny	Sunny
Air Temperature:	53 Deg. F.	Deg. F.	Deg. F.	58 Deg. F.	80 Deg. F.
Water Temperature:	52 Deg. F.	56 Deg. F.	64 Deg. F.	57 Deg. F.	62 Deg. F.
Ave. Stream Width:	19 Feet	25 Feet	35 Feet	23 Feet	45 Feet
Ave. Stream Depth:	0.64 Feet	3 Feet	2.5 Feet	1.5 Feet	1 Feet
Surface Velocity:	1.3 Ft./Sec.	1.25 Ft./Sec.	0.71 Ft./Sec.	0.77 Ft./Sec.	1 Ft./Sec.
Estimated Flow:	15.808 CFS	93.75 CFS	62.125 CFS	26.565 CFS	45 CFS
Stream Modifications:	None	None	None	None	None
Nuisance Plants (Y/N):	N	N	N	N	N
Report Number:					
STORET No.:	490065	480067	770155	170287	770160
Stream Name:	Milakokia River	West Branch Two Hearted River	West Branch Manistique River	Shelldrake River	West Branch Manistique River
Road Crossing/Location:	y Doe Lake Rd	County Road 418	Hickey Truck Trail	Betsy River Truck Trail	off Crieghton Truck Trail
County Code:	49	48	77	17	77
TRS:	42N12W18	48N11W09	45N16W35	49N07W06	44N15W07
Latitude (dd):	46.02832	46.56948	46.25291	46.6729	46.22857
Longitude (dd):	-85.84404	-85.68017	-86.26238	-85.2339	-86.23506
Ecoregion:	NLAF	NLAF	NLAF	NLAF	NLAF
Stream Type:	Warmwater	Warmwater	Warmwater	Warmwater	Warmwater
USGS Basin Code:	4060107	4020201	4060106	4020201	4060106

* Applies only to Riffle/Run stream Survey
** Applies only to Glide/Pool stream Surveys

COMMENTS:

Table 4 con't. Habitat evaluation for 2009 Tahquamenon, Two-Hearted, Manistique, and Millecoquins River probabilistic sampling sites

HABITAT METRIC	Paquin Creek Hiawatha Trail GLIDE/POOL STATION 24	Hog Island Creek Strickler Truck Trail RIFFLE/RUN STATION 25
Substrate and Instream Cover		
Epifaunal Substrate/ Avail Cover (20)	10	18
Embeddedness (20)*		15
Velocity/Depth Regime (20)*		14
Pool Substrate Characterization (20)**	8	
Pool Variability (20)**	8	
Channel Morphology		
Sediment Deposition (20)	15	18
Flow Status - Maint. Flow Volume (10)	8	7
Flow Status - Flashiness (10)	8	10
Channel Alteration (20)	20	20
Frequency of Riffles/Bends (20)*		18
Channel Sinuosity (20)**	11	
Riparian and Bank Structure		
Bank Stability (L) (10)	7	10
Bank Stability (R) (10)	7	10
Vegetative Protection (L) (10)	10	10
Vegetative Protection (R) (10)	10	10
Riparian Veg. Zone Width (L) (10)	10	10
Riparian Veg. Zone Width (R) (10)	10	10
TOTAL SCORE (200):	142	180
HABITAT RATING:	GOOD (SLIGHTLY IMPAIRED)	EXCELLENT (NON-IMPAIRED)

Note: Individual metrics may better describe conditions directly affecting the biological community while the Habitat Rating describes the general riverine environment at the site(s).

Date:	6/7/2009		6/10/2009	
Weather:	Cloudy		Sunny	
Air Temperature:	52	Deg. F.		Deg. F.
Water Temperature:	50	Deg. F.	49	Deg. F.
Ave. Stream Width:	12	Feet	8.3	Feet
Ave. Stream Depth:	0.44	Feet	0.41	Feet
Surface Velocity:	0.9	Ft./Sec.	0.4	Ft./Sec.
Estimated Flow:	4.752	CFS	1.3612	CFS
Stream Modifications:	None		None	
Nuisance Plants (Y/N):	N		N	
Report Number:				
STORET No.:	490195		490200	
Stream Name:	Paquin Creek		Hog Island Creek	
Road Crossing/Location:	Hiawatha Trail		Strickler Truck Trail	
County Code:	49		49	
TRS:	43N07W35		43N08W13	
Latitude (dd):	46.0813		46.1228	
Longitude (dd):	-85.1545		-85.254	
Ecoregion:	NLAF		NLAF	
Stream Type:	Coldwater		Coldwater	
USGS Basin Code:	4060107		4060107	

* Applies only to Riffle/Run stream Surveys
** Applies only to Glide/Pool stream Surveys

COMMENTS:

Table 4 con't. Habitat evaluation for 2009 Tahquamenon, Two-Hearted, Manistique, and Millecoquins River targeted sampling sites.

HABITAT METRIC	Tahquamenon River near Eagles Nest RIFFLE/RUN STATION 26	Indian River 2-track east off 94 GLIDE/POOL STATION 27	Manistique River Manistique boat launch GLIDE/POOL STATION 28	Fox River Fox River campground GLIDE/POOL STATION 29	Millecoquins River Lower Rapids RIFFLE/RUN STATION 30
Substrate and Instream Cover					
Epifaunal Substrate/ Avail Cover (20)	17	9	11	16	19
Embeddedness (20)*	14				20
Velocity/Depth Regime (20)*	15				15
Pool Substrate Characterization (20)**		8	8	14	
Pool Variability (20)**		13	2	15	
Channel Morphology					
Sediment Deposition (20)	8	7	15	11	20
Flow Status - Maint. Flow Volume (10)	10	9	9	10	9
Flow Status - Flashiness (10)	10	9	9	10	9
Channel Alteration (20)	20	19	13	20	20
Frequency of Riffles/Bends (20)*	16				16
Channel Sinuosity (20)**		13	5	13	
Riparian and Bank Structure					
Bank Stability (L) (10)	10	7	9	9	10
Bank Stability (R) (10)	9	9	9	9	10
Vegetative Protection (L) (10)	10	9	9	10	10
Vegetative Protection (R) (10)	10	10	9	10	10
Riparian Veg. Zone Width (L) (10)	10	10	4	10	10
Riparian Veg. Zone Width (R) (10)	9	10	7	9	10
TOTAL SCORE (200):	168	142	119	166	188
HABITAT RATING:	EXCELLENT (NON-IMPAIRED)	GOOD (SLIGHTLY IMPAIRED)	GOOD (SLIGHTLY IMPAIRED)	EXCELLENT (NON-IMPAIRED)	EXCELLENT (NON-IMPAIRED)

Note: Individual metrics may better describe conditions directly affecting the biological community while the Habita Rating describes the general riverine environment at the site(s).

Date:	7/30/2009	7/27/2009	7/28/2009	7/28/2009	6/8/2009
Weather:	Cloudy	Cloudy	Sunny	Partly Cloudy	Cloudy
Air Temperature:	70 Deg. F.	70 Deg. F.	70 Deg. F.	75 Deg. F.	57 Deg. F.
Water Temperature:	61 Deg. F.	60 Deg. F.	68 Deg. F.	61 Deg. F.	56 Deg. F.
Ave. Stream Width:	45 Feet	30 Feet	150 Feet	38 Feet	49 Feet
Ave. Stream Depth:	0.83 Feet	2.5 Feet	3 Feet	2 Feet	1.3 Feet
Surface Velocity:	1.67 Ft./Sec.	1 Ft./Sec.	0.71 Ft./Sec.	1.67 Ft./Sec.	1.4 Ft./Sec.
Estimated Flow:	62.3745 CFS	75 CFS	319.5 CFS	126.92 CFS	89.18 CFS
Stream Modifications:	None	Bank Stabilization	None	Bank Stabilization	None
Nuisance Plants (Y/N):	N	N	N	N	N
Report Number:					
STORET No.:	480066	770085	770154	770082	490196
Stream Name:	Tahquamenon River	Indian River	Manistique River	Fox River	Millecoquins River
Road Crossing/Location:	near Eagles Nest	2-track east off 94	Manistique boat launch	Fox River campground	Lower Rapids
County Code:	48	77	77	77	49
TRS:	47N12W34	44N17W34	41N16W01	46N14W11	43N09W18
Latitude (dd):	46.42482	46.17226	45.97088	46.39997	46.11568
Longitude (dd):	-85.79771	-86.4213	-86.24275	-86.02787	-85.47358
Ecoregion:	NLAF	NLAF	NLAF	NLAF	NLAF
Stream Type:	Coldwater	Coldwater	Warmwater	Coldwater	Warmwater
USGS Basin Code:	4020202	4060106	4060106	4060106	4060107

* Applies only to Riffle/Run stream Surveys
** Applies only to Glide/Pool stream Surveys

COMMENTS:

Table 4 con't. Habitat evaluation for 2009 Tahquamenon, Two-Hearted, Manistique, and Millecoquins River targeted sampling sites.

HABITAT METRIC	Furlong Creek Pleasant Ave RIFFLE/RUN STATION 31	Davenport Creek US-2 GLIDE/POOL STATION 32	Cut River US-2 RIFFLE/RUN STATION 33	Davenport Creek at gas pipeline GLIDE/POOL STATION 34	Doe Creek Raski Road GLIDE/POOL STATION 35
Substrate and Instream Cover					
Epifaunal Substrate/ Avail Cover (20)	20	10	19	11	11
Embeddedness (20)*	20		13		
Velocity/Depth Regime (20)*	20		10		
Pool Substrate Characterization (20)**		9		7	9
Pool Variability (20)**		13		7	13
Channel Morphology					
Sediment Deposition (20)	19	8	16	16	16
Flow Status - Maint. Flow Volume (10)	8	9	8	10	7
Flow Status - Flashiness (10)	9	9	10	10	10
Channel Alteration (20)	19	19	20	15	20
Frequency of Riffles/Bends (20)*	18		19		
Channel Sinuosity (20)**		12		7	9
Riparian and Bank Structure					
Bank Stability (L) (10)	7	9	8	10	9
Bank Stability (R) (10)	8	9	8	10	9
Vegetative Protection (L) (10)	10	10	10	10	6
Vegetative Protection (R) (10)	10	10	10	10	6
Riparian Veg. Zone Width (L) (10)	5	10	10	10	4
Riparian Veg. Zone Width (R) (10)	7	10	10	10	4
TOTAL SCORE (200):	180	147	171	143	133
HABITAT RATING:	EXCELLENT (NON-IMPAIRED)	GOOD (SLIGHTLY IMPAIRED)	EXCELLENT (NON-IMPAIRED)	GOOD (SLIGHTLY IMPAIRED)	GOOD (SLIGHTLY IMPAIRED)

Note: Individual metrics may better describe conditions directly affecting the biological community while the Habitat Rating describes the general riverine environment at the site(s).

Date:	6/7/2009	6/7/2009	6/7/2009	6/10/2009	6/10/2009
Weather:	Cloudy	Cloudy	Rainy	Partly Cloudy	Partly Cloudy
Air Temperature:	54 Deg. F.	52 Deg. F.	49 Deg. F.	Deg. F.	Deg. F.
Water Temperature:	59 Deg. F.	50 Deg. F.	48 Deg. F.	46 Deg. F.	Deg. F.
Ave. Stream Width:	16.5 Feet	18.5 Feet	15.6 Feet	14.5 Feet	16 Feet
Ave. Stream Depth:	0.38 Feet	0.77 Feet	0.44 Feet	0.72 Feet	0.76 Feet
Surface Velocity:	1.4 Ft./Sec.	2.4 Ft./Sec.	2.5 Ft./Sec.	1.7 Ft./Sec.	1.4 Ft./Sec.
Estimated Flow:	8.778 CFS	34.188 CFS	17.16 CFS	17.748 CFS	17.024 CFS
Stream Modifications:	t Improvement	None	None	Canopy Removal	None
Nuisance Plants (Y/N):	N	N	N	N	N
Report Number:					
STORET No.:	490068	490059	490002	490199	490104
Stream Name:	Furlong Creek	Davenport Creek	Cut River	Davenport Creek	Doe Creek
Road Crossing/Location:	Pleasant Ave	US-2	US-2	at gas pipeline	Raski Road
County Code:	49	49	49	49	49
TRS:	43N10W08	42N08W02	42N07W12	43N08W26	43N10W09
Latitude (dd):	46.13899	46.06772	46.0452	46.09928	46.14193
Longitude (dd):	-85.59196	-85.26448	-85.1242	-85.2595	-85.56093
Ecoregion:	NLAF	NLAF	NLAF	NLAF	NLAF
Stream Type:	Warmwater	Coldwater	Coldwater	Coldwater	Warmwater
USGS Basin Code:	4060107	4060107	4060107	4060107	4060107

* Applies only to Riffle/Run stream Surveys
** Applies only to Glide/Pool stream Surveys

COMMENTS:

HABITAT METRIC	Black River State Forest Campground bridge GLIDE/POOL STATION 36	Crow River end of Summer Trail GLIDE/POOL STATION 37
Substrate and Instream Cover		
Epifaunal Substrate/ Avail Cover (20)	9	12
Embeddedness (20)*		
Velocity/Depth Regime (20)*		
Pool Substrate Characterization (20)**	10	10
Pool Variability (20)**	12	13
Channel Morphology		
Sediment Deposition (20)	9	11
Flow Status - Maint. Flow Volume (10)	7	9
Flow Status - Flashiness (10)	8	10
Channel Alteration (20)	20	20
Frequency of Riffles/Bends (20)*		
Channel Sinuosity (20)**	17	17
Riparian and Bank Structure		
Bank Stability (L) (10)	8	5
Bank Stability (R) (10)	8	5
Vegetative Protection (L) (10)	7	10
Vegetative Protection (R) (10)	7	10
Riparian Veg. Zone Width (L) (10)	10	10
Riparian Veg. Zone Width (R) (10)	10	10
TOTAL SCORE (200):	142	152
HABITAT RATING:	GOOD (SLIGHTLY IMPAIRED)	GOOD (SLIGHTLY IMPAIRED)

Note: Individual metrics may better describe conditions directly affecting the biological community while the Habitat Ratin describes the general riverine environment at the site(s)

Date:	6/8/2009	6/8/2009
Weather:	Rainy	Rainy
Air Temperature:	48 Deg. F.	Deg. F.
Water Temperature:	48 Deg. F.	50 Deg. F.
Ave. Stream Width:	27 Feet	27.5 Feet
Ave. Stream Depth:	0.87 Feet	1.4 Feet
Surface Velocity:	1 Ft./Sec.	0.87 Ft./Sec.
Estimated Flow:	23.49 CFS	33.495 CFS
Stream Modifications:	None	None
Nuisance Plants (Y/N):	N	N
Report Number:		
STORET No.:	490198	490197
Stream Name:	Black River	Crow River
Road Crossing/Location:	State Forest Campground bridge	end of Summer Trail
County Code:	49	49
TRS:	43N09W13	42N11W13
Latitude (dd):	46.11758	46.03036
Longitude (dd):	-85.36597	-85.61533
Ecoregion:	NLAF	NLAF
Stream Type:	Coldwater	Coldwater
USGS Basin Code:	4060107	4060107

* Applies only to Riffle/Run stream Surveys
** Applies only to Glide/Pool stream Surveys

COMMENTS:

Table 5. Analytical results for 2009 Tahquamenon, Two-Hearted, Manistique, and Millecoquins Rivers watersheds sampling sites.

Location		Doe Creek	Doe Creek	Doe Creek	Doe Creek	Doe Creek	Millecoquins River	Crow River	u/s Newberry WWTP	Newberry WWTP Effluent
Station		Station 35	Station 36	Station 37	Station 38	Station 39	Station 40	Station 41	Station 42	Station 43
		Raski Road	Kovar Rd	Mile/Pleasant	M-117	Krause Road	Lower Rapids	End Simmon Trail	M-123 crossing	Outfall 001A
STORET ID #		490104	490202	490070	490053	490069	490196	490197	480002	480039
Parameter	Units									
Ammonia	mg N/L	0.016	0.021	0.023	0.015	0.012	0.011	0.01	0.02	15
Boron	ug/L	-	-	-	-	-	-	-	-	-
Calcium	mg/L	-	-	-	-	-	-	-	20.3	64.1
Chromium	ug/L	-	-	-	-	-	-	-	ND (< 1)	ND (< 1)
Hardness - Calculated	mg/L	-	-	-	-	-	-	-	-	229
Iron	ug/L	-	-	-	-	-	-	-	-	-
Lithium	ug/L	-	-	-	-	-	-	-	-	-
Magnesium	mg/L	-	-	-	-	-	-	-	5.3	16.8
Mercury	ug/L	-	-	-	-	-	-	-	ND (<0.2)	ND (<0.2)
Nitrate + Nitrite	mg N/L	0.013	0.013	0.086	0.005	0.046	0.005	0.059	ND (< 0.01)	ND (<0.2)
Nitrogen - Kjeldahl	mg N/L	0.87	0.81	0.85	0.87	0.66	0.43	0.31	0.63	17
Phosphorus	mg P/L	0.06	0.03	0.036	0.064	0.034	0.024	0.01	0.027	0.56
Potassium	mg/L	-	-	-	-	-	-	-	-	-
Selenium	ug/L	-	-	-	-	-	-	-	ND (< 1)	ND (< 1)
Sodium	mg/L	-	-	-	-	-	-	-	-	-
TOC	mg/L	20	19	22	21	18	9.3	6.1	18	13
COD	mg/L	46	46	50	49	38	19	12	38	42
Arsenic	ug/L	-	-	-	-	-	-	-	1.0	ND (<1)
Barium	ug/L	-	-	-	-	-	-	-	27	39
Cadmium	ug/L	-	-	-	-	-	-	-	ND (0.2)	ND (<0.2)
Copper	ug/L	-	-	-	-	-	-	-	ND (< 1)	9.9
Lead	ug/L	-	-	-	-	-	-	-	ND (< 1)	ND (< 1)
Nickel	ug/L	-	-	-	-	-	-	-	-	-
Silver	ug/L	-	-	-	-	-	-	-	ND (<0.2)	ND (< 0.2)
Zinc	ug/L	-	-	-	-	-	-	-	ND (< 10)	28

ND - Value reported is less than level of detection.
Metal values given are as total metals.