



Two Hearted River

WATERSHED MANAGEMENT PLAN

Water Quality Protection, Habitat Restoration and Pollution Prevention
Supporting the recommendations of the Lake Superior Binational Program



Provided by the
Superior Watershed Partnership
1030 Wright St. Marquette, MI 49855
906-228-6095
www.superiorwatersheds.org

In cooperation with
The Nature Conservancy



Two Hearted River

WATERSHED MANAGEMENT PLAN

May 2008

TWO HEARTED RIVER WATERSHED ADVISORY COUNCIL:

Geraldine Larson *Superior Watershed Partnership*
Lisa Niemi *The Nature Conservancy*
Sharon Brown *Luce County Conservation District*
Jim Waybrant *Michigan Department of Natural Resources*
Greg Zimmerman *Department of Biology Lake Superior State University*
Dave Fehringer *Forestland Group LLC*
Lisa DenBoer *Luce County Planning & Development*
Larry Frost *East Branch Sportsman Club*
Gerald Grossman *Grossman Forestry*
Dave Mitchell *Trout Unlimited, Luce County Conservation District*
Richard Robinson *Rainbow Lodge*
Bob Devillez *Luce County Planning & Development*
Stan Ronquist *Luce County Road Commission*
Peter Villemuer *McMillan Township*
P. Mike Farrell *Superior Watershed Partnership*

TECHNICAL SUPPORT STAFF:

Carl Lindquist *Superior Watershed Partnership*
Vicki Baldini *Superior Watershed Partnership*
Emily Wessels *Superior Watershed Partnership/The Nature Conservancy*
Cameron Fuess *Greenstone Mapping*
Chad Kotke *Project Administrator, MDEQ*
Dave Fongers *Hydrologic Studies Unit, MDEQ*
Robert Sweet *319 Grants Specialist, MDEQ*
Agnes Moore *Financial Analyst, MDEQ*

STAKEHOLDERS:

The State of Michigan (DNR, DEQ)
The Nature Conservancy in Michigan
Rainbow Lodge
East Branch Sportsman's Club
Spile Dam Club
Luce County (Planning, Road Commission, Conservation District)
Forestland Group LLC
McMillan Township
Columbus Township
Burt Township (Alger County)
Superior Watershed Partnership
Alger County Conservation District
Corporate and Private Landowners
Grossman Forestry
Two Hearted Chapter of Trout Unlimited
Tahquamenon Sportsman's Club
Great Lakes Fishery Commission

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EXECUTIVE SUMMARY

"He felt he had left everything behind, the need for thinking, the need to write, other needs." ~Ernest Hemingway

People love the Two Hearted River. They love the water, the land, the name. Even Ernest Hemingway loved the Two Hearted River. Perhaps his best known story set solely in the Upper Peninsula is "The Big Two Hearted River". The story chronicles the journey of Nick Adams, a character loosely based on Hemingway, who is returning to one of his favorite fishing haunts seeking solace after experiencing the horrors of World War One.

Some argue that he chose the title mainly for its poetic quality and implied metaphors; merely a literary device. Others argue that, like any true fisherman, he was averse to sharing the locations of his favorite fishing spots so he intentionally misguided readers when in reality he was writing about the nearby Fox River. Regardless, Hemingway and other Michigan authors, including John Voelker and Jim Harrison, have written about the rivers of the Upper Peninsula and in so doing have, perhaps unintentionally, helped raise awareness about the incredible natural assets of this beautiful peninsula.

The Superior Watershed Partnership (SWP) works with a wide range of stakeholders to help protect and restore the rivers and watersheds of the Upper Peninsula. The Two Hearted River Watershed Project is another example of a cooperative SWP planning, protection and restoration project.

The Two Hearted River Watershed includes high quality aquatic and terrestrial ecosystems of regional significance and should be protected and maintained as such. The recommendations of this plan are intended to promote coordinated and collaborative actions among these stakeholders and to provide guidance for implementation of actions that will reduce existing water quality impacts and provide a basis for protection from future impacts.

The first step in the creation of this plan was to analyze the character and condition of the natural features of the watershed. Next, an analysis of the human environment was completed and factors that could prevent the natural features from meeting their potential were identified. The final step was to develop management strategies that will help protect and enhance water quality and improve the quality of life for current and future residents.

Key recommendations were based on prioritized sources of pollutants and other environmental stressors that are currently threatening designated and desired watershed uses. They include:

- Work with local, state, and federal partners to protect and restore the watershed
- Protect and restore habitat for fish and aquatic organisms
- Control sources of sediment to the Two Hearted River and its tributaries
- Promote responsible land use practices
- Promote coordinated and collaborative efforts by stakeholders
- Inform and involve the public

The most important factor in achieving the goals identified in this plan is the continued involvement of local residents and regional stakeholders, who will ensure the long-term health and sustainability of this unique watershed.

We thank the members of the Two Hearted River Watershed Advisory Council for their continued dedication and commitment to this project and many others for their valuable insight and contributions during the development of this plan.

Carl Lindquist, Executive Director



Superior Watershed Partnership

Geraldine Larson, Senior Planner



Superior Watershed Partnership



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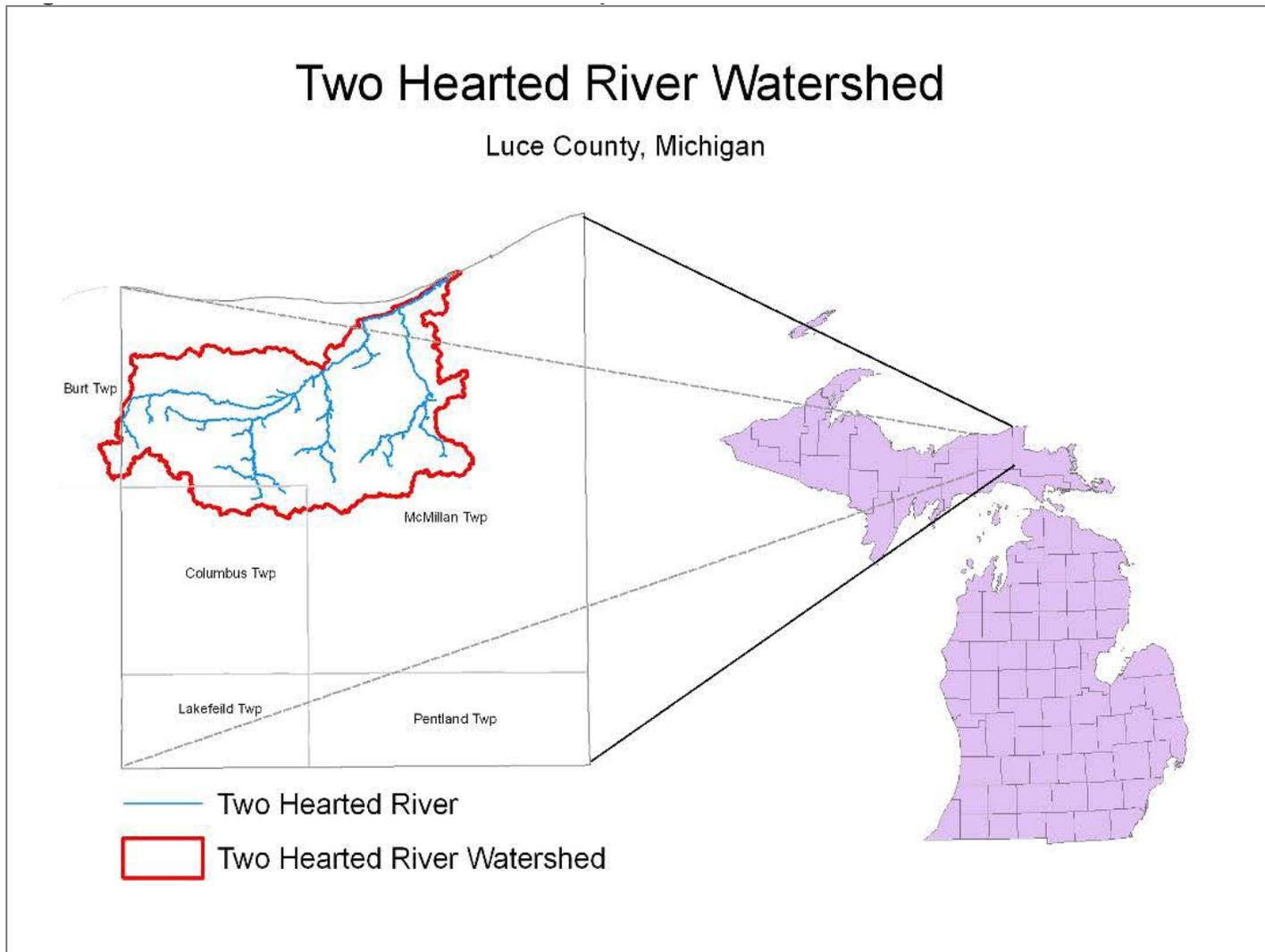
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APPENDICES

Appendix A - Water Quality Monitoring Data
Appendix B - Road/stream Crossing Inventory Data
Appendix C - Erosion Inventory Maps

Figure 1.1 Watershed Location Map



THE NATURAL ENVIRONMENT

The following sections summarize the natural character and condition of the Two Hearted River watershed based on the results of past and recent inventories of natural features. Included are general descriptions of the location, climate, geology, topography and soils, hydrology and significant natural features.

Location

The Two Hearted River watershed (Hydrologic Unit 04020201 Betsy-Chocolay) lies within the Lake Superior drainage and encompasses over 130,000 acres (203 square miles). The Two Hearted River watershed refers to all the land area that is drained by the Two Hearted River and its tributaries. It is located in the eastern region of Michigan's Upper Peninsula in Luce County with a small portion of the watershed located in Alger County (Figure 1.1). The majority of the watershed is located in McMillan Township with portions of the headwaters located in Columbus Township and Burt Township (Alger County). There are no villages within the watershed and the nearest town is Newberry.

Climate

The climate of the Two Hearted River watershed is affected by its close proximity to Lake Superior, which moderates the temperatures of the surrounding land resulting in cooler summers and warmer winters. In summer, the average temperature is between 62 and 73 degrees F. The highest recorded temperature, which occurred at Newberry on July 13, 1936, was 103 degrees F. In winter, the average temperature is between 9 and 17 degrees Fahrenheit (F). The lowest temperature on record for Luce County, which occurred at Newberry on January 26, 1927, was -30 degrees F. (USDA 2003).

The average annual total precipitation is 32 inches. Of this total, 13.21 inches, or about 41 percent, usually falls in June through September. The heaviest 1-day rainfall during the period of record was 4 inches on July 22, 1994. Thunderstorms occur on about 29 days each year, and most occur between June and September. The average seasonal snowfall is 112 inches. The greatest snow depth at any one time during the period of record was

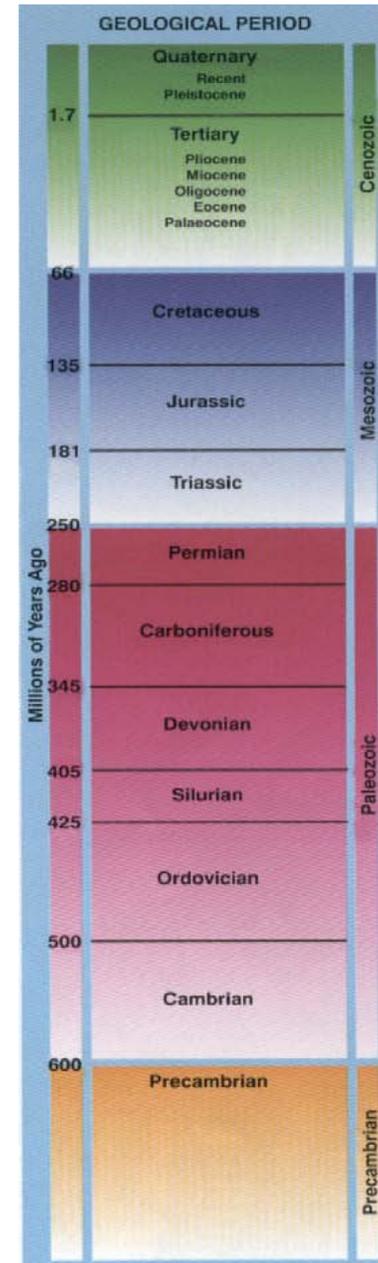
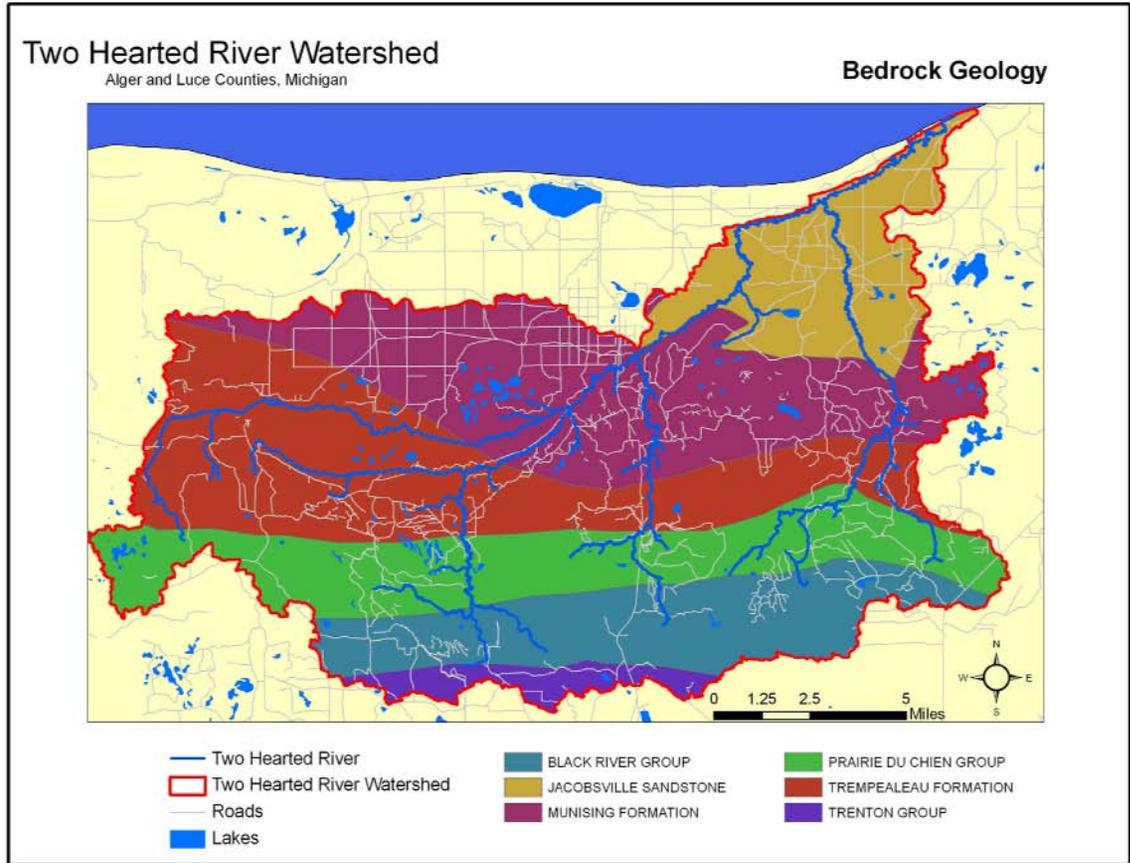


Aerial photo of Two Hearted River



Main Branch Two Hearted River near mouth at Lake Superior

Figure 1.2 Bedrock Geology of the Two Hearted River Watershed



www.ukfossils.co.uk/timeline/charts/Timeline.gif

49 inches, recorded on January 27, 1994. On average, about 117 days per year have at least 1 inch of snow on the ground. The heaviest 1-day snowfall on record was 23 inches, recorded on January 4, 1982 (USDA 2003).

Geology

The geology of the Two Hearted River watershed consists of six (6) sedimentary bedrock formations (Figure 1.2). The oldest of these is the Jacobsville Sandstone Formation, which was formed during the Early to Middle Cambrian age. It consists of red and white-streaked sandstone due to the oxidation, reduction, and leaching of iron. This sandstone occurs along Lake Superior in Alger, Luce, Chippewa, Marquette, Baraga, Houghton and Keweenaw Counties (USDA 2006).

By the Middle Cambrian Period inland seas were covering much of North America. During the Late Cambrian Period the Munising Sandstone Formation was formed. This sandstone generally consists of white to light gray, dolomitic and glauconitic sandstone, red, green and gray shale, and a basal conglomerate. Dramatic exposures of the Munising Sandstone can be seen in the cliffs along the nearby Pictured Rocks National Lakeshore and at many of the waterfalls throughout the area including the Upper Tahquamenon

Figure 1.3 Landforms of the Two Hearted River Watershed

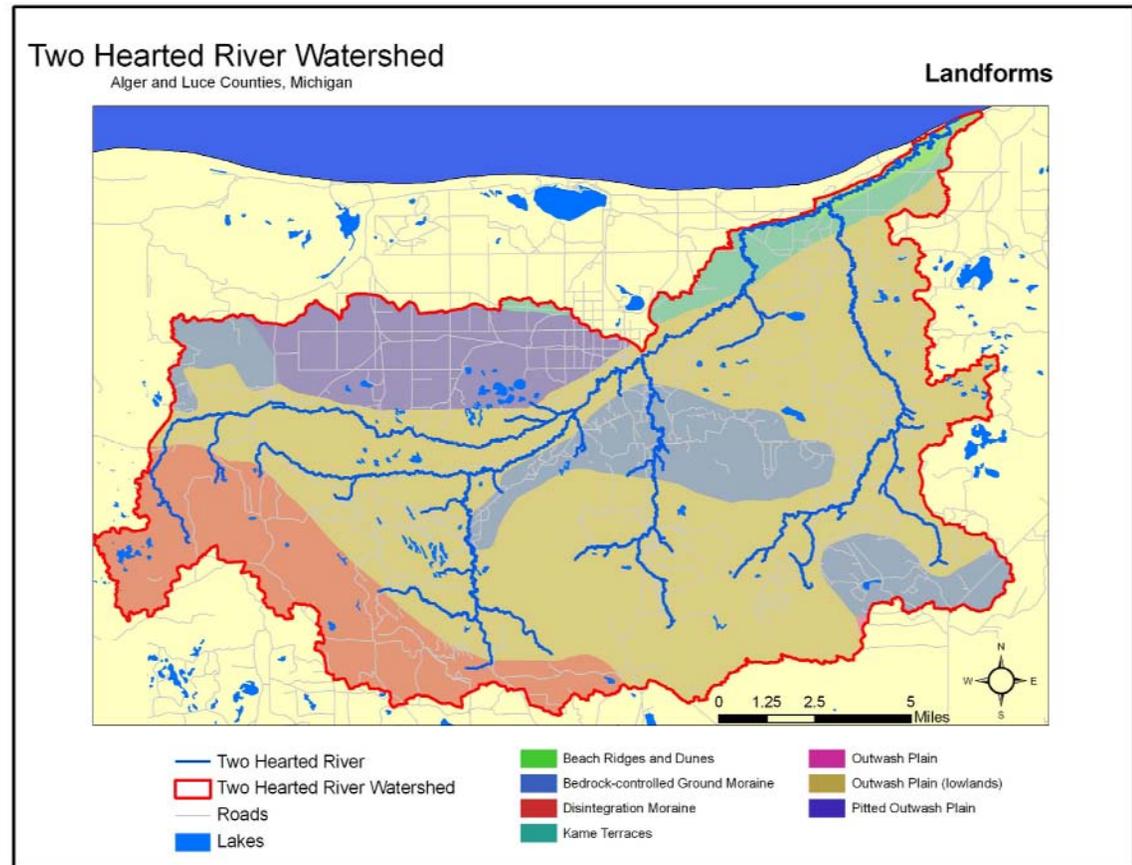


Figure 1.4 Topographic Relief in the Two Hearted River Watershed

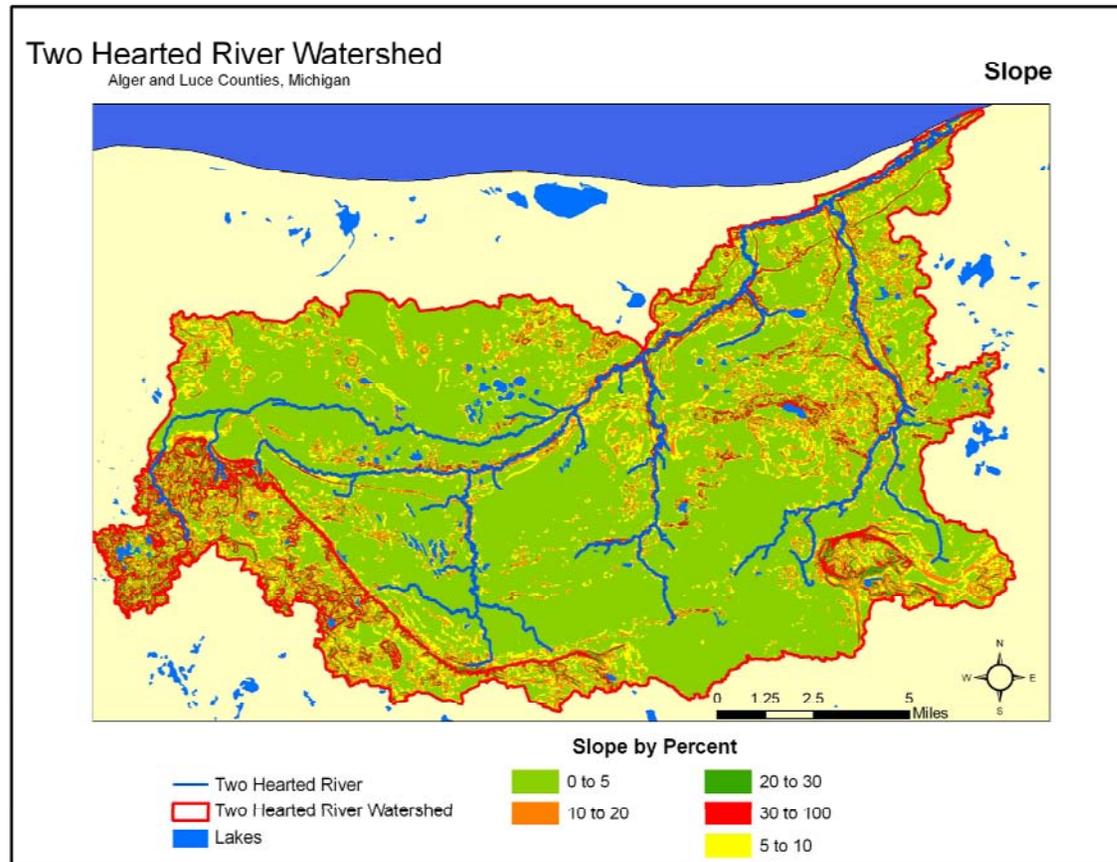


Table 1.1 Topographic Relief in the Two Hearted River Watershed

Percent Slope	Acres	Percent of Watershed
0 to 5	85,645	65
5 to 10	18,556	14
10 to 20	16,143	12
20 to 30	6,014	4
30 to 100	6,120	5
Total	132,478	100

Falls in Luce County. The Munising Formation is a narrow band that spans the eastern half of the U.P (USDA 2006).

Further south the bedrock formed in marine sediments during the Early Ordovician Period. The dolomitic sandstone and dolomite of the Trempealeau Formation and Prairie du Chien Group were formed during this time period. During the Middle Ordovician Period, the dolomite and limestone bedrock of the Black River and Trenton Group were formed (USDA 2006).

Landforms

The landforms of the Upper Peninsula of Michigan are a product of the glaciers that occupied the region during the Pleistocene Epoch.

During the Wisconsin glacial stage the entire Upper Peninsula was covered with a thick sheet of ice that went as far south as southern Indiana and Ohio. A massive deposition of glacial drift and the subsequent melting of the glacial ice combined to create a variety of landforms. Most of these landforms are a result of the last major glacial stage known as the Greatlakean (formerly Valderan). Glacial depositions throughout the Upper Peninsula of Michigan range from 0 to over 500 feet thick. The variety of soils

found on each landform formed in material deposited 4,000 to 10,000 years ago (USDA 2003). There are seven distinct landform types in the Two Hearted River watershed. They are shown in Figure 1.3.

Topography and Soils

The topography of the Two Hearted River watershed can be viewed on the Muskallonge Lake East, Betsy Lake NW, Betsy Lake SW, Muskallonge Lake SE, Muskallonge Lake SW, Grand Marias SE, Roy Lake, Buckeye Lake, and Auger Lake U.S. Geological Survey (USGS) 7.5 minute series topographic maps.

The watershed as a whole has very little topographic relief with the highest elevations only about 350 feet above Lake Superior. Sixty-five percent (65%) of the watershed has a slope of 0-5% (Table 1.1). Locations with the greatest percent slope (30-100%) include the headwaters of the North Branch and West Branch and along portions of the West Branch, Dawson Creek, East Branch, and Main Branch (Figure 1.4).

The U.S. Department of Agriculture Natural Resources Conservation Service Soil Survey Geographic (SSURGO) database for Luce County, Michigan indicates the presence of 46 soil types within the boundary of the Two Hearted River watershed (USDA 2003,

Figure 1.5 Soil Types in the Two Hearted River Watershed

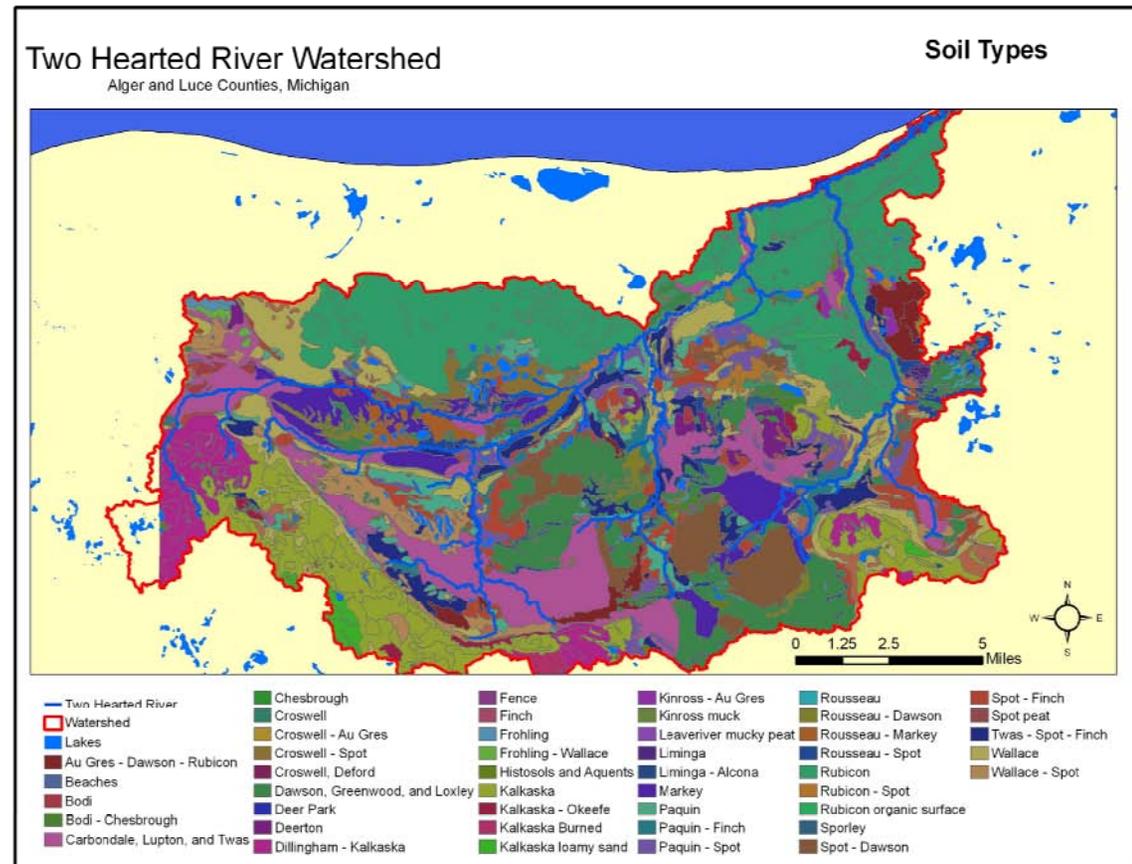


Figure 1.6 Hydric and Non-hydric Soils in the Two Hearted River Watershed

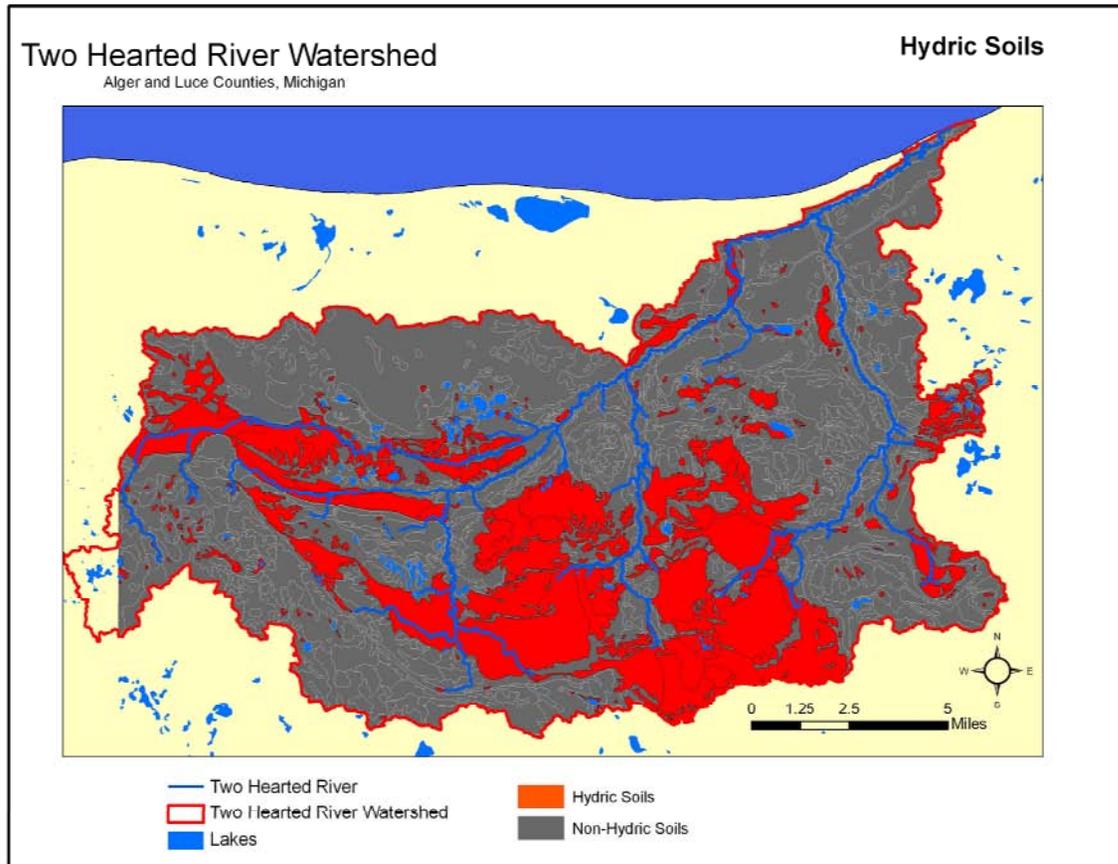


Figure 1.5). These soil types range from well drained sandy soils to poorly drained muck. SSURGO soil data was not available for Alger County.

Of the 46 mapped soil types in the Two Hearted River watershed, eight (8) meet the definition of hydric soils. Hydric soils are soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part. Under natural conditions, these soils are either saturated or inundated long enough during the growing season to support the growth and reproduction of hydrophytic (wetland) vegetation (USDA 2003). Hydric soils occupy 86,194 acres (65%) of the watershed and support the wetland communities found in the headwaters of Dawson Creek, the East Branch, South Branch, and the North and West Branches (Figure 1.6).

Soil survey information can be used to adjust land uses to the limitations and potentials of natural resources and the environment. In preparing a soil survey, soil scientists collect extensive field data about the nature and behavioral characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. This information can be used to identify the potentials and limitations of

each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties (USDA 2003).

Interpretive ratings are used to identify the limitations that affect specific uses and to indicate the severity of those limitations. Rating classes are expressed in terms that indicate the extent to which the soils are limited by all of the soil features that affect a specified use or in terms that indicate the suitability of the soils for the use. Terms for the limitation classes include: not limited, somewhat limited, and very limited; or slight, moderate and severe. The suitability ratings are expressed as well suited, moderately suited, poorly suited, and unsuited or as good, fair, and poor (USDA 2003). The following sections describe soil limitations for various uses in the Two Hearted River watershed.

Soil Erosion Potential

Soil erosion potential is based on the probability that damage will occur where soils are exposed as a result of management activities. This attribute is directly connected with slope and other attributes of the soil type. The ratings slight, moderate, and severe indicate the degree at which erosion-control measures should be taken with the severe rating requiring the most precautions (USDA 1997).

Figure 1.7 Soil Erosion Potential in the Two Hearted River Watershed

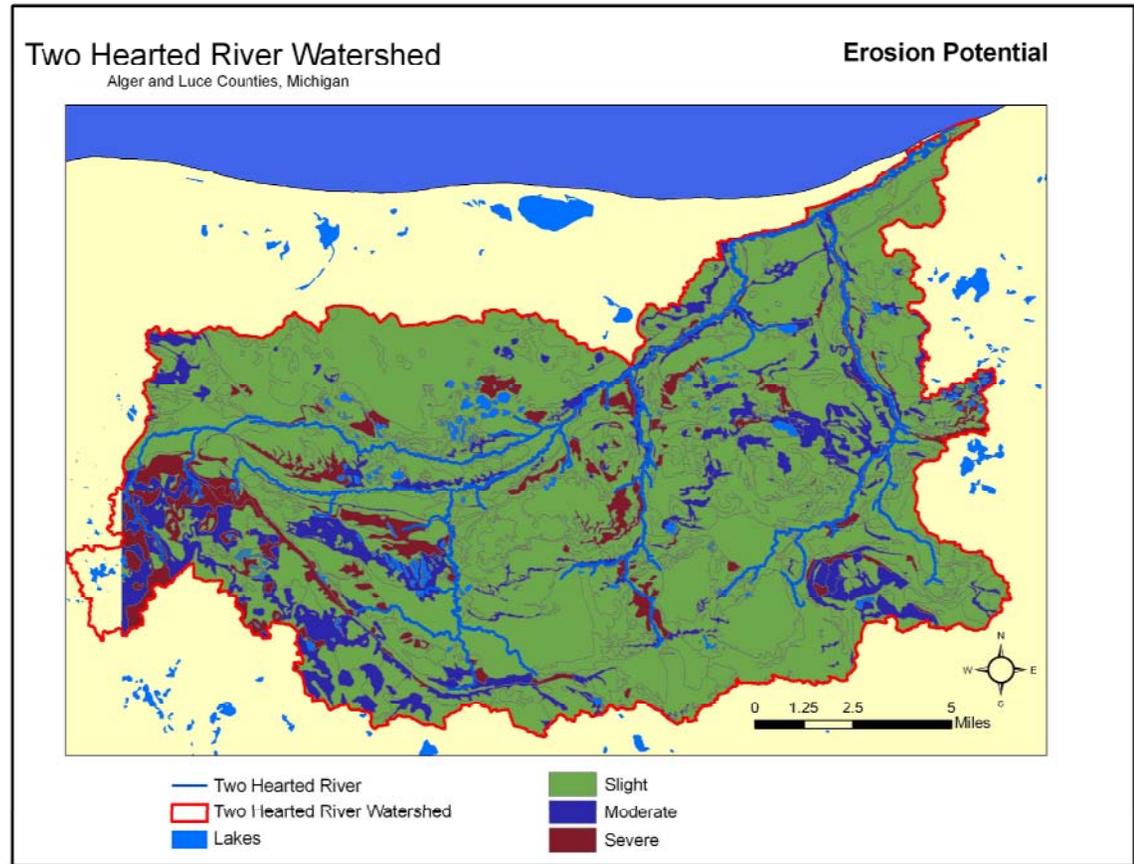
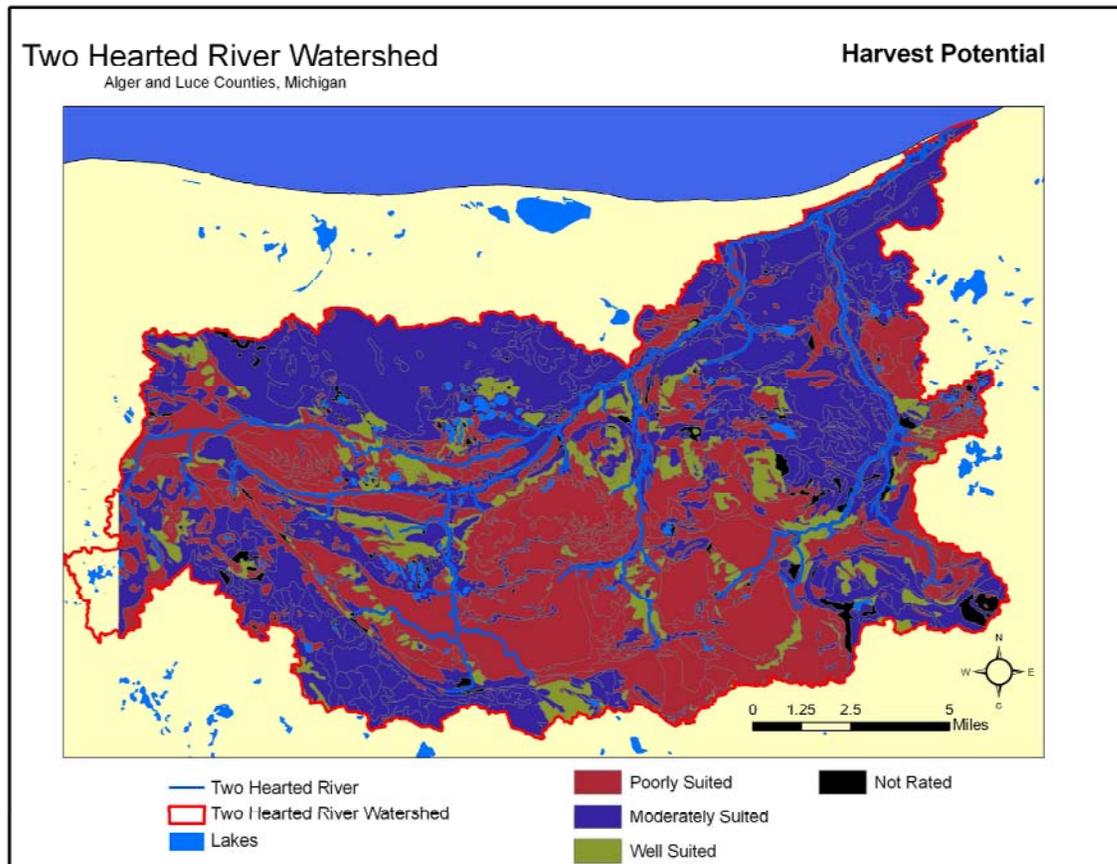


Table 1.2 Erosion Potential in the Two Hearted River Watershed

Erosion Potential Rating	Acres	Percent of Watershed
Slight	103,288	78
Moderate	16,530	12
Severe	9,244	7
Not Rated	3,416	3
Total	132,478	100

Figure 1.8 Harvest Potential in the Two Hearted River Watershed



The majority of the land in the Two Hearted River watershed (78%) is characterized as having a slight erosion potential rating (Table 1.2, Figure 1.7). The locations with a severe erosion potential rating mostly correspond with locations that have greater percent slopes such as the headwaters areas of the North and West Branches (see Figure 1.4).

Suitability for Timber Harvest

The degree to which the lands are suitable for timber harvesting reflects the characteristics and conditions of the soil that restrict the use of equipment generally utilized in timber management and harvesting (TNC 2007). Based on this information, only 8% of the Two Hearted River watershed is considered well suited for timber management, whereas 46% is moderately suited and 42% is considered poorly suited (Table 1.3, Figure 1.8). However, this does not mean that the lands categorized as poorly suited for timber harvesting cannot be harvested; rather, specific precautions for harvest in these areas should be implemented, such as harvesting during frozen conditions or adequate snow cover. These poorly suited lands mostly correspond with the extensive wetlands and those lands considered well suited for harvesting largely correspond with upland areas (TNC 2007).

Table 1.3 Suitability for Timber Harvest in the Two Hearted River Watershed

Suitability for Harvesting	Acres	Percent of Watershed
Poorly Suited	55,194	42
Moderately Suited	61,827	47
Well Suited	10,250	8
Not Rated or Open Water	5,207	3
Total	132,478	100

Suitability for Buildings and Septic Systems

Similarly, soil characteristics also play a role in determining the suitability of a site for building construction and sanitary facilities. Within the Two Hearted River watershed, the majority of the land is considered not well suited for building construction (70% with basement; 53% with out basement; or 96% septic) (See Tables 1.4, 1.5, and 1.6 and Figures 1.9, 1.10 and 1.11 respectively). This means that overcoming the limitations, due to soil properties or features at the site, would most likely be too cost prohibitive, both due to initial and potential ongoing maintenance costs. Those areas that are somewhat limited for building construction indicate that although the site conditions are unfavorable, these limitations may be overcome through special planning, design and maintenance (TNC 2007).

Figure 1.9 Suitability for Buildings in the Two Hearted River Watershed (with basements)

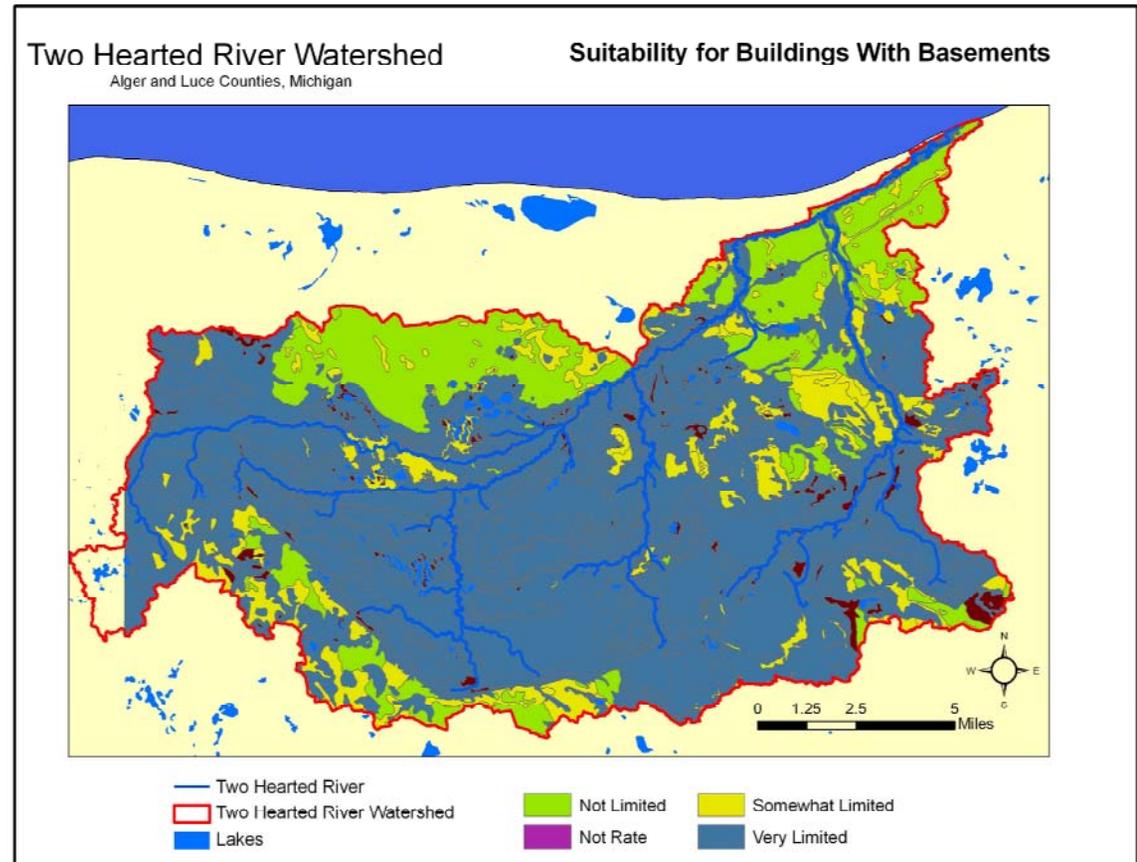


Table 1.4 Suitability for Buildings in the Two Hearted River Watershed (with basements)

Suitability for Buildings With Basements	Acres	Percent of Watershed
Very Limited	92,923	70
Somewhat Limited	13,335	10
Not Limited	21,119	16
Not Rated	5,101	4
Total	132,478	100

Figure 1.10. Suitability for Buildings in the Two Hearted River Watershed (without basements)

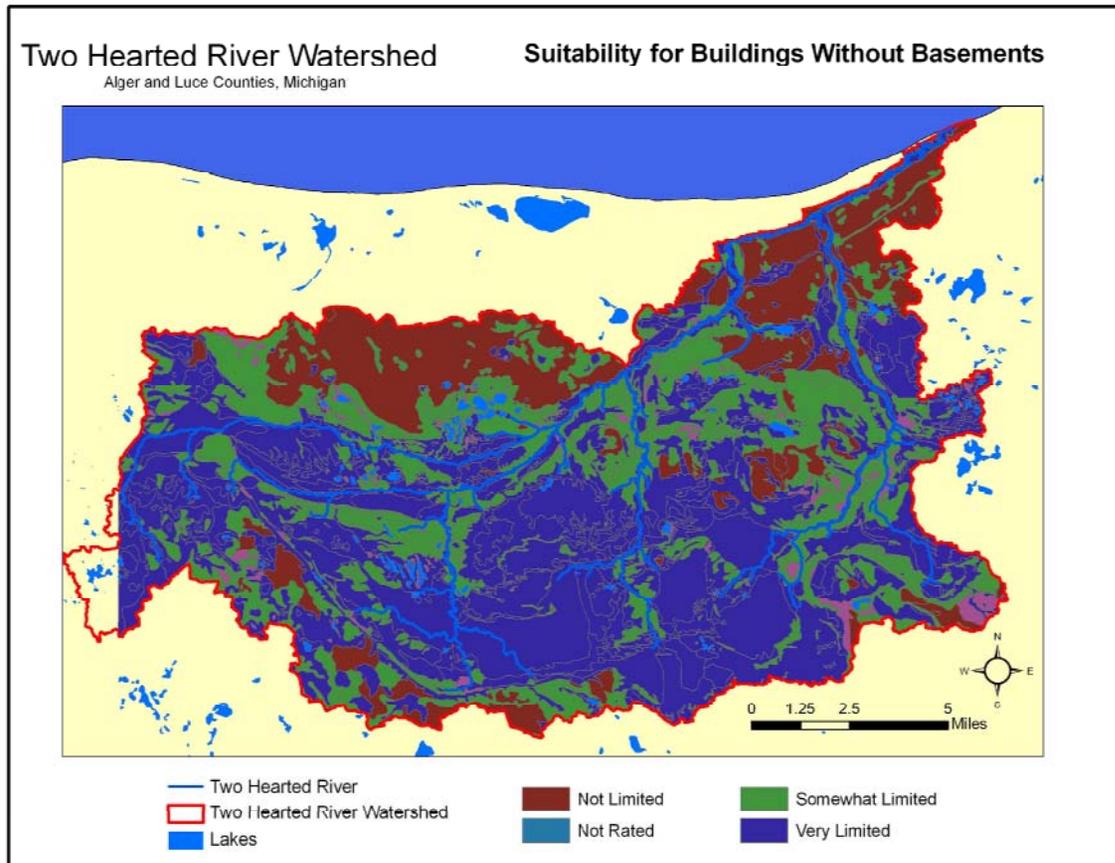


Table 1.5 Suitability for Buildings in the Two Hearted River Watershed (without basements)

Suitability for Buildings With Out Basements	Acres	Percent of Watershed
Very Limited	70,325	53
Somewhat Limited	34,844	26
Not Limited	22,208	17
Not Rated	5,101	4
Total	132,478	100

Figure 1.11 Suitability for Septic Systems in the Two Hearted River Watershed

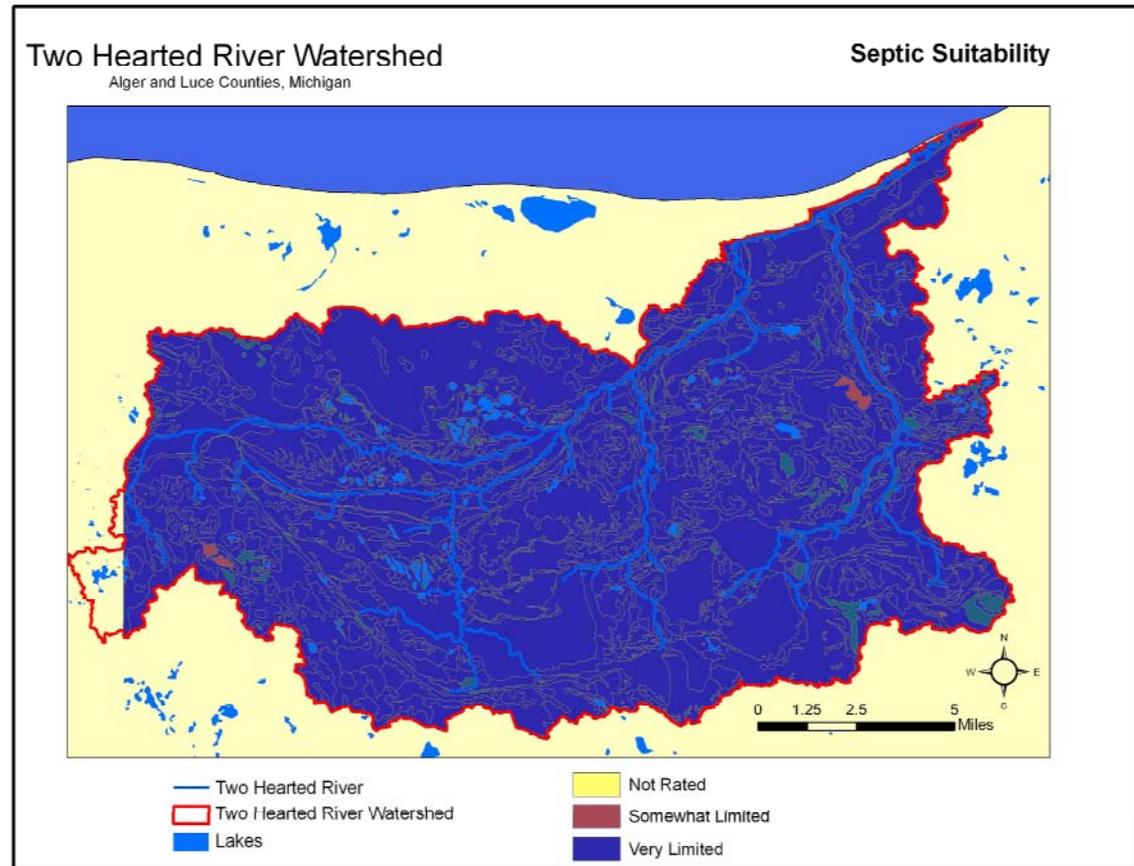
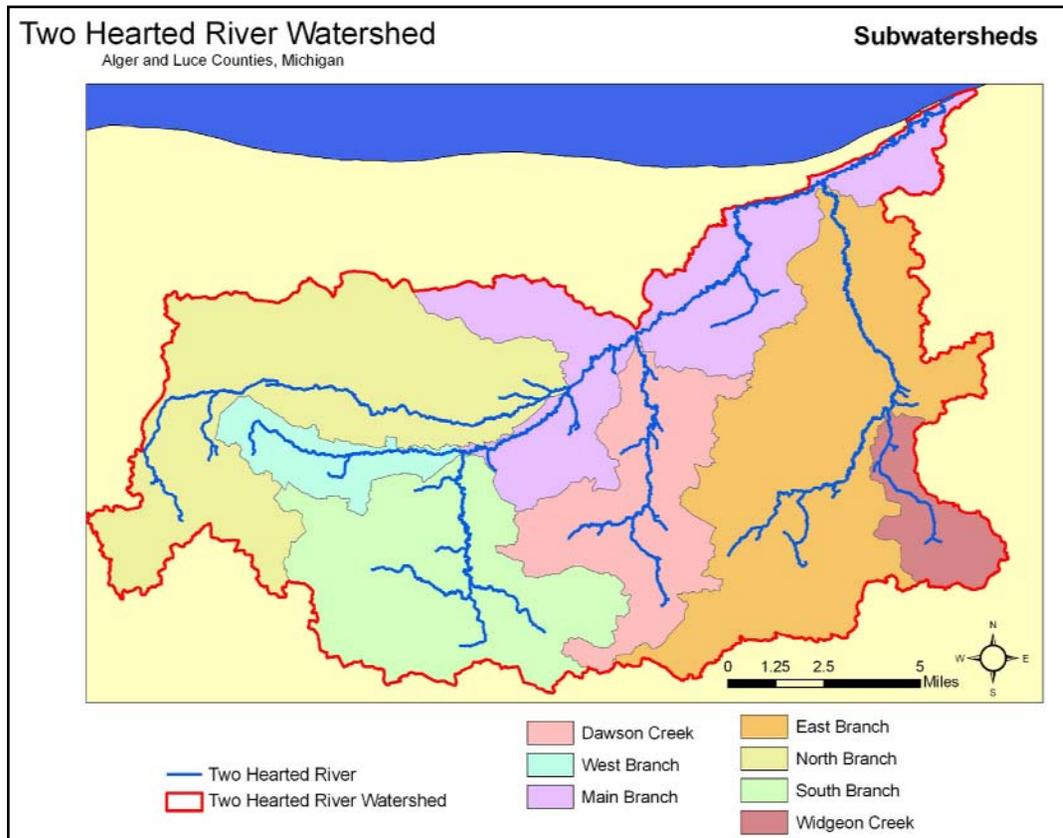


Table 1.6 Septic System Suitability in the Two Hearted River Watershed

Septic Suitability	Acres	Percent of Watershed
Very Limited	126,967	96
Somewhat Limited	292	<1%
Not Rated	5,219	4
Total	132,478	100

Figure 1.12 Subwatersheds and Main Tributaries of the Two Hearted River Watershed



Hydrology

The Two Hearted River watershed includes 7 sub-watersheds and over 118 miles of river (Figure 1.12). Lakes are widely distributed throughout the watershed and constitute features of scenic interest and recreational value (MDNR 2002).

The Two-Hearted River is a cold water trout stream and was designated as a Michigan Natural River in December of 1973. It has also been designated as an Outstanding State Resource Water (TNC 2007). A general description of the main tributaries to the Two Hearted River including headwater location and average length is provided in Table 1.7.



Main Branch Two Hearted River upstream from Reed and Green Bridge

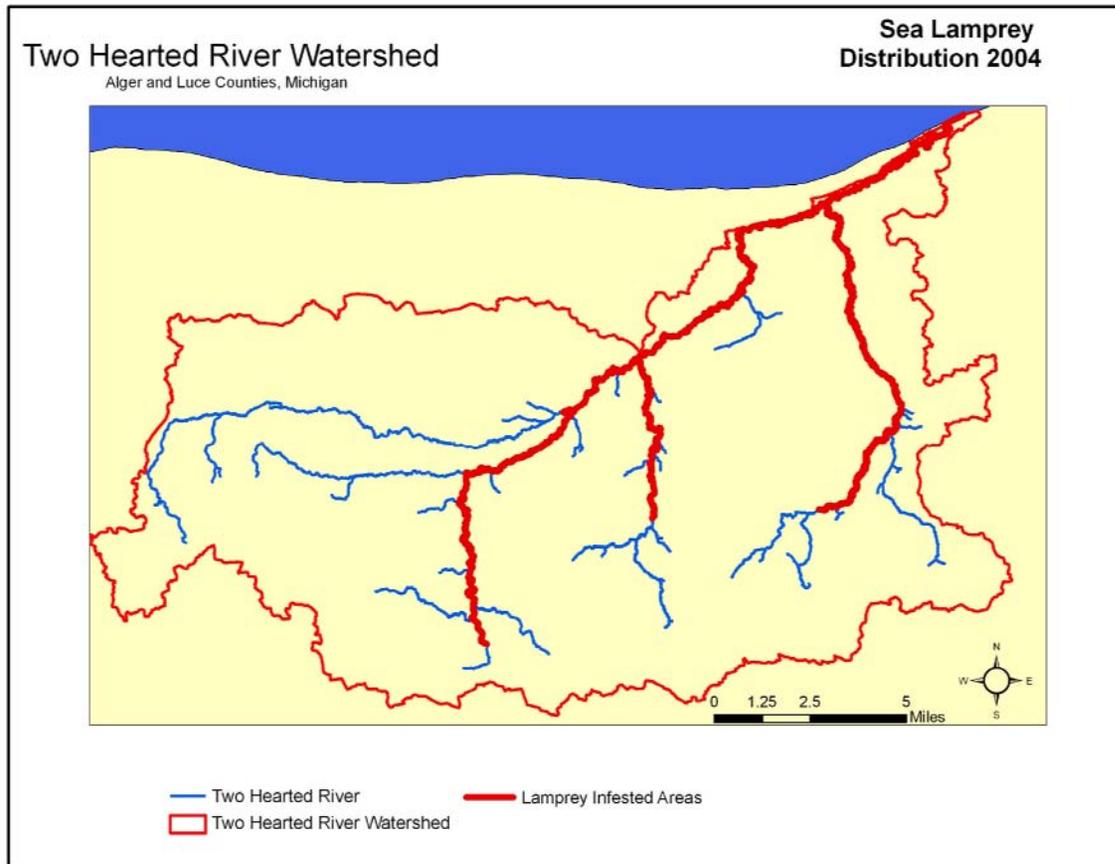
In addition to providing excellent brook trout and steelhead fishing, the Two Hearted River and its tributaries also support larval populations of the undesirable Great Lakes invader the sea lamprey. Sea lampreys are parasitic fish that feed on desirable fish such as trout and salmon and if left uncontrolled, have a devastating impact on the sport, commercial and tribal fisheries of the Great Lakes.

The Great Lakes Fishery Commission oversees a Sea Lamprey Management Program for all five Great Lakes and contracts with the U.S. Fish and Wildlife Service and Fisheries and Oceans Canada to implement an integrated program of sea lamprey control. The U.S. Fish and Wildlife Service Marquette Biological Station oversee larval sea lamprey assessments and control (with the lampricide TFM) in the Two Hearted River watershed on a 3-5 year cycle. The distribution of larval sea lampreys in the Two Hearted River and its tributaries during 2004 is shown in Figure 1.13. This distribution is scheduled for re-evaluation and treatment during 2008 (Shawn Nowicki, Marquette Biological Station, personal communication).

Table 1.7 Description of the Main Tributaries of the Two Hearted River

Name	Headwater Location	Average Length (miles)
Main Branch	T48N, R11W, Sec.9 (confluence with South Branch)	28.9
Wabash Creek	T49N, R10W, Sec. 27	2.6
West Branch	T48N, R12W, Sec. 9/10 (West Branch Lakes)	7.9
John's Creek	T48N, R11W, Sec. 12	1.4
East Branch	T48N, R10W, Sec. 27	22.8
Widgeon Creek	T48N, R9W, Sec. 28	5.0
Dawson Creek	T48N, R11W, Sec. 25	10.0
Little Dawson Creek	T48N, R10W, Sec. 32	3.3
South Branch	T48N, R11W, Sec. 33 (Whorl Lake) and T47N, R11W, Sec. 4 (Whorl Pond)	8.8
Jack Creek	T48N, R12W, Sec. 25 (Jack Lake)	3.7
Camp One Creek	T47N, R11W, Sec. 2	3.0
North Branch	T48N, R12W, Sec. 20	19.2
Potters Creek	T48N, R12W, Sec. 9 (Potters Lake)	2.2
Total		118.8

Figure 1.13. Sea Lamprey Distributions in Tributaries of the Two Hearted River Watershed (2004).



Stream Order

Stream order provides a comparison of the size and potential power of streams. It is a numbering sequence which starts when two first order or headwater, streams join, forming a second order stream, and so on. Two second order streams converging form a third order. Streams of lower order joining a higher order stream do not change the order of the higher, as shown in Figure 1.14. The Two Hearted River results are shown in Figure 1.15. The stream orders shown are not absolute. If larger scale maps are used or actual channels are found through field reconnaissance, the stream orders designated in Figure 1.15 may increase, because smaller channels are likely to be included (Fongers 2007)

Figure 1.14 Stream Ordering Procedure (Fongers 2007)

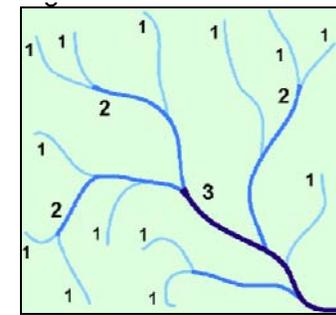


Figure 1.15 Two Hearted River Watershed Stream Orders (Fongers 2007)

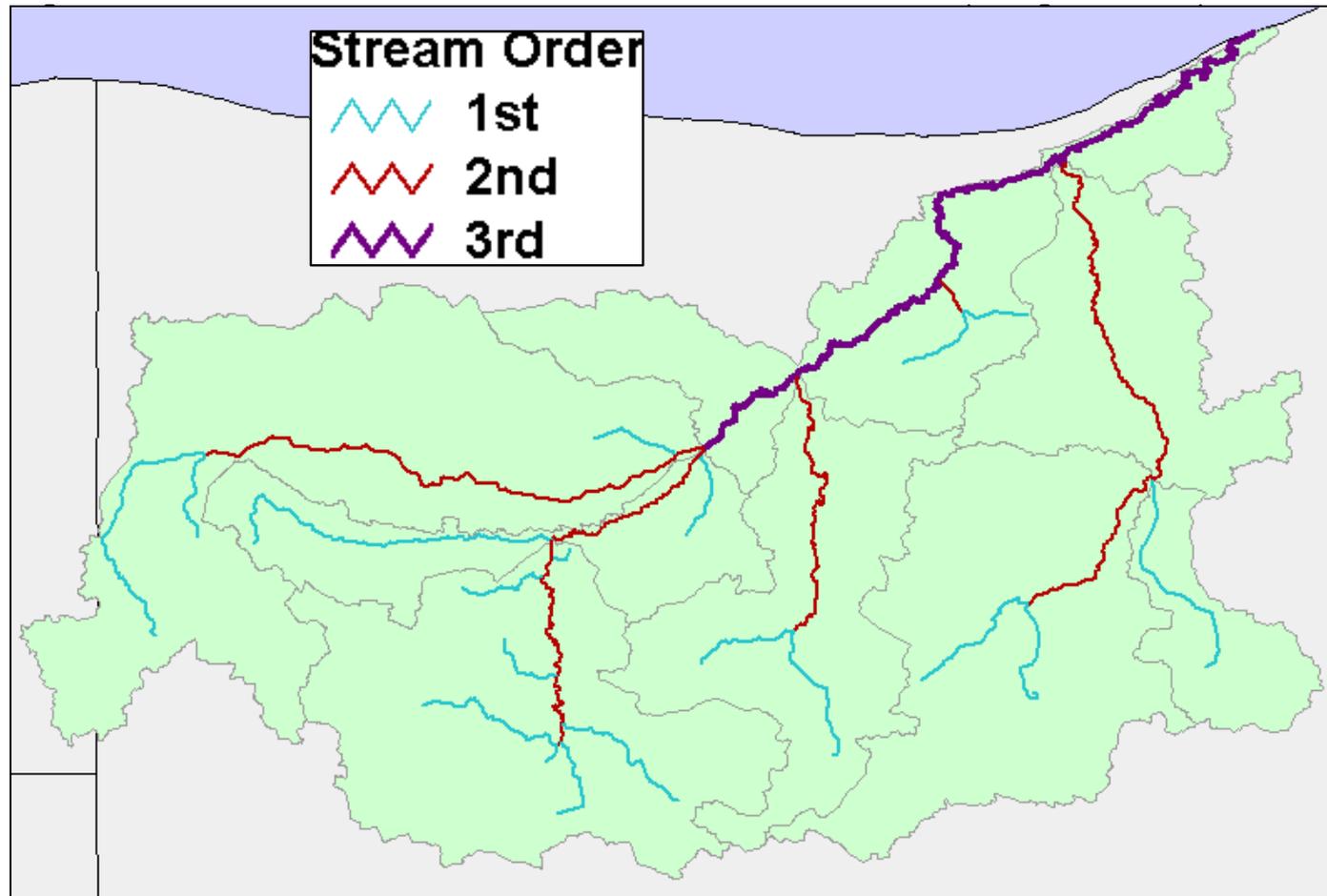
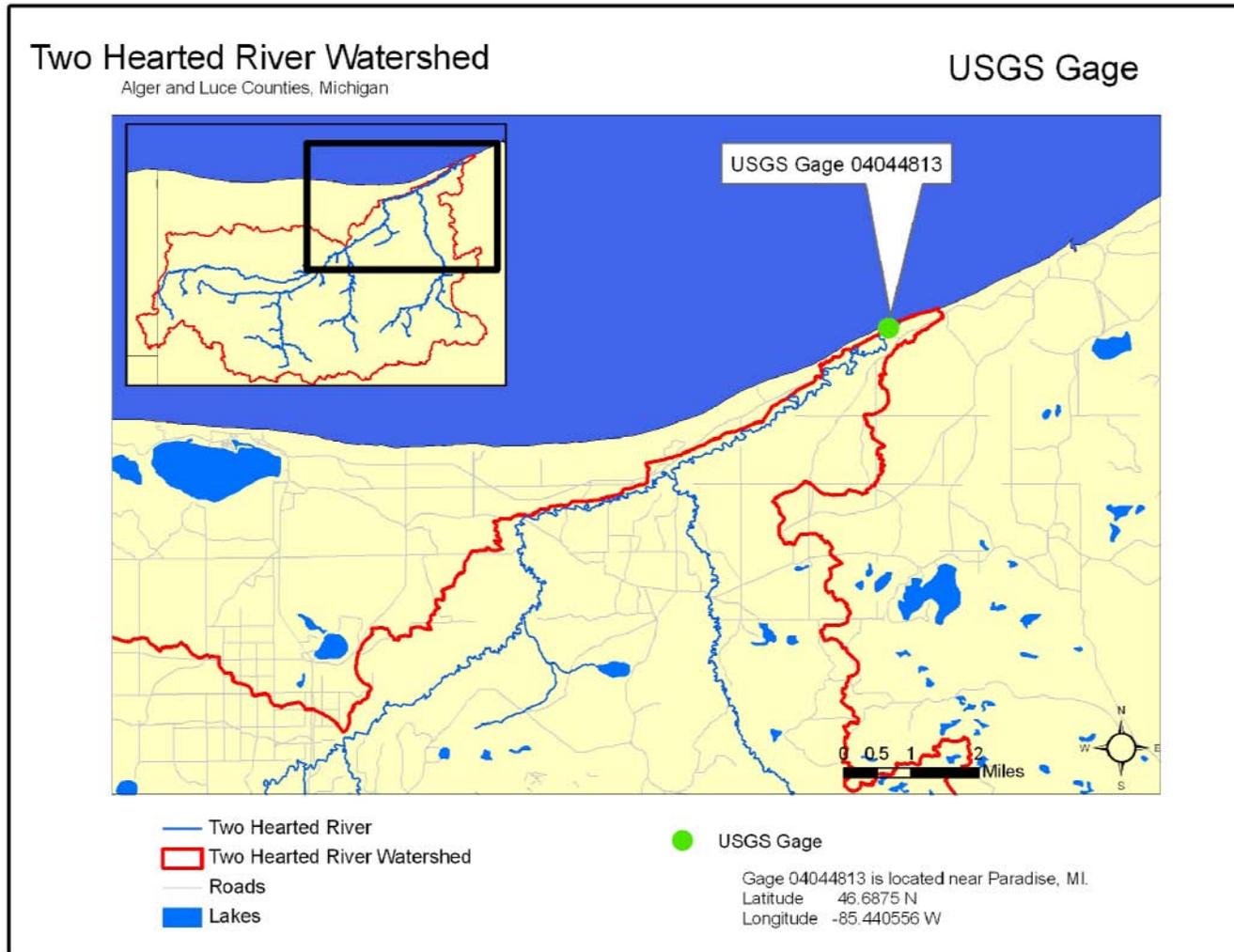


Figure 1.16 Location of USGS Stream Gage (04044813) in the Two Hearted River Watershed



Peak Flows

A USGS stream gage (Gage Number 04044813) is located at the mouth of the Two Hearted River near Lake Superior (Figure 1.16). The contributing drainage area for this gage is 200 square miles. This gage has provided peak flow data since 1973 (Figure 1.17).

Figure 1.17 Peak Flow Data From USGS Gage 04044813 (USGS 2007)

Water Year	Date	Gage Height (feet)	Stream-flow (cfs)
1973	Mar. 17, 1973	7.05	885
1974	Apr. 23, 1974	8.33	1,730
1975	May 02, 1975	7.71	1,520
1976	Apr. 19, 1976		1,600
1977	Apr. 20, 1977		2,000
1978	May 15, 1978	4.18	2,200
1979	Apr. 27, 1979	4.92	2,550
1980	Apr. 12, 1980		3,100
1981	Apr. 05, 1981	6.52	1,650
1982	Apr. 27, 1982	5.88	2,000
1983	Apr. 17, 1983	7.35	880
1984	Apr. 17, 1984	6.27	1,360
1985	Apr. 25, 1985	8.42	3,210
1986	Apr. 09, 1986	7.72	2,480
1987	Jul. 22, 1987	5.96	908
1988	Apr. 09, 1988	5.14	2,500 ²
1989	Apr. 26, 1989	9.31	903
1990	Apr. 25, 1990	9.65	987
1991	Apr. 09, 1991	12.36	1,720
1992	Apr. 22, 1992	10.64	1,250
1993	May 06, 1993	9.99	1,080
1994	Apr. 19, 1994	10.58	1,230
1995	Apr. 28, 1995	9.33	917
1996	Apr. 25, 1996	11.94	1,600
1997	Apr. 26, 1997	9.78	1,030
1998	Mar. 31, 1998	11.46	1,470
1999	Apr. 06, 1999	10.44	1,190
2000	Mar. 09, 2000	9.27	903
2001	Apr. 12, 2001	10.19	1,130
2002	Apr. 19, 2002	14.53	3,350 ⁷
2003	Apr. 21, 2003	10.68	1,260
2004	Apr. 07, 2004	9.90	1,060
2005	Apr. 07, 2005	10.87	1,370

2 -- Discharge is an Estimate
 7 -- Discharge is an Historic Peak

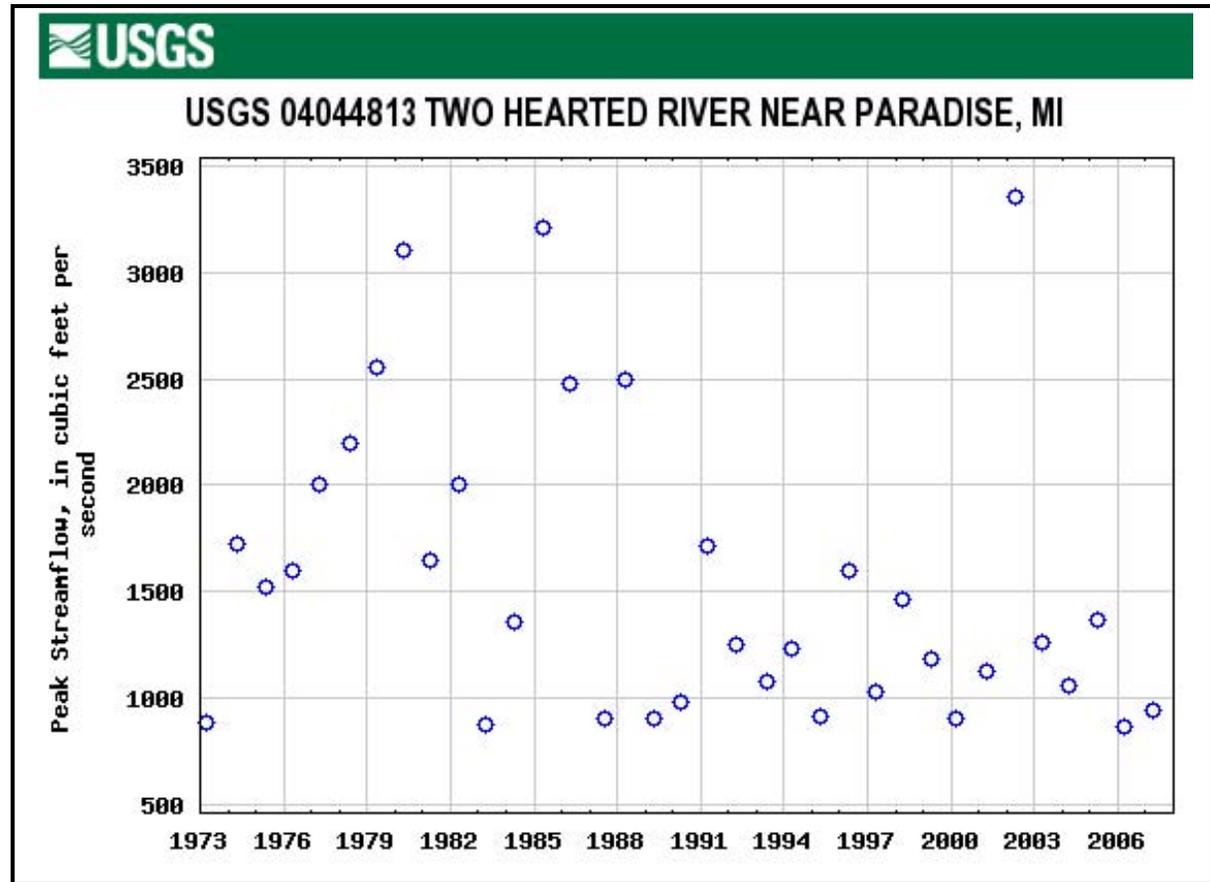
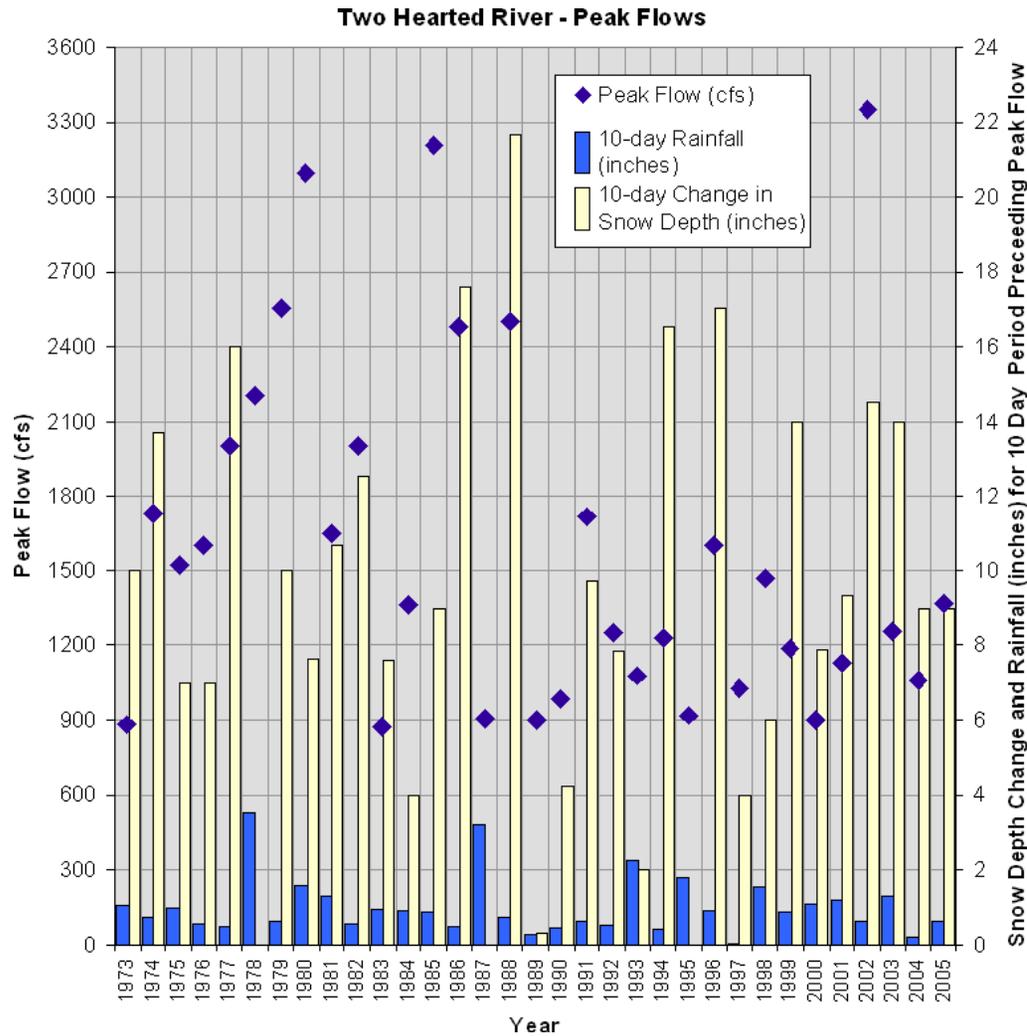


Figure 1.18 Peak Flows from Two Hearted River USGS Gage 04044813, 10-day Snow Depth Changes and Rainfall averaged from National Weather Stations at Grand Marias, Newberry, and Tahquamenon Falls (Fongers 2007).



A hydrologic study of the Two Hearted River watershed was conducted by the Michigan Department of Environmental Quality Hydrologic Studies Unit (HSU) in support of the Two Hearted River Nonpoint Source watershed planning project (MDEQ Tracking Number 2005-0149). This analysis was conducted to 1) better understand the watershed’s hydrologic characteristics, 3) provide a basis for storm water management to protect stream morphology, and 3) help determine the watershed management plan’s critical areas (Fongers 2007).

Based on peak flow dates for the USGS gage and weather data (Figure 1.18), this analysis indicated that the Two Hearted River watershed is a snowmelt-driven system. A snowmelt-driven system is usually much less flashy than a storm-driven system, because the snow pack supplies a steadier rate of flow. However, a rain-on-snow event, where rain and snowmelt simultaneously contribute to runoff, can produce dramatic flow increases. The runoff from the rain and snowmelt also likely occur with saturated or frozen soil conditions, when the ground can absorb or store less water, resulting in more over-land flow to surface waters than would occur otherwise (Fongers 2007).

Sediment Transport Capacity

A stream's ability to move sediment, both size and quantity, is directly related to the stream's slope and flow. Steeper reaches generally move larger material, such as stones and pebbles and the flatter reaches tend to accumulate sediment. A typical river profile is steeper in the headwaters and flatter toward the mouth. The Two Hearted River's profile is somewhat different, with a steeper section in the middle (Figure 1.19). The MDNR Natural River Plan (2002) describes this river reach as a series of shallow sandstone ledges with intermittent deep pockets. The steeper reach is likely a reflection of the underlying geology and not an indicator of morphologic instability (Fongers 2007).

Figure 1.19 Two Hearted River Profile (Fongers (2007)).

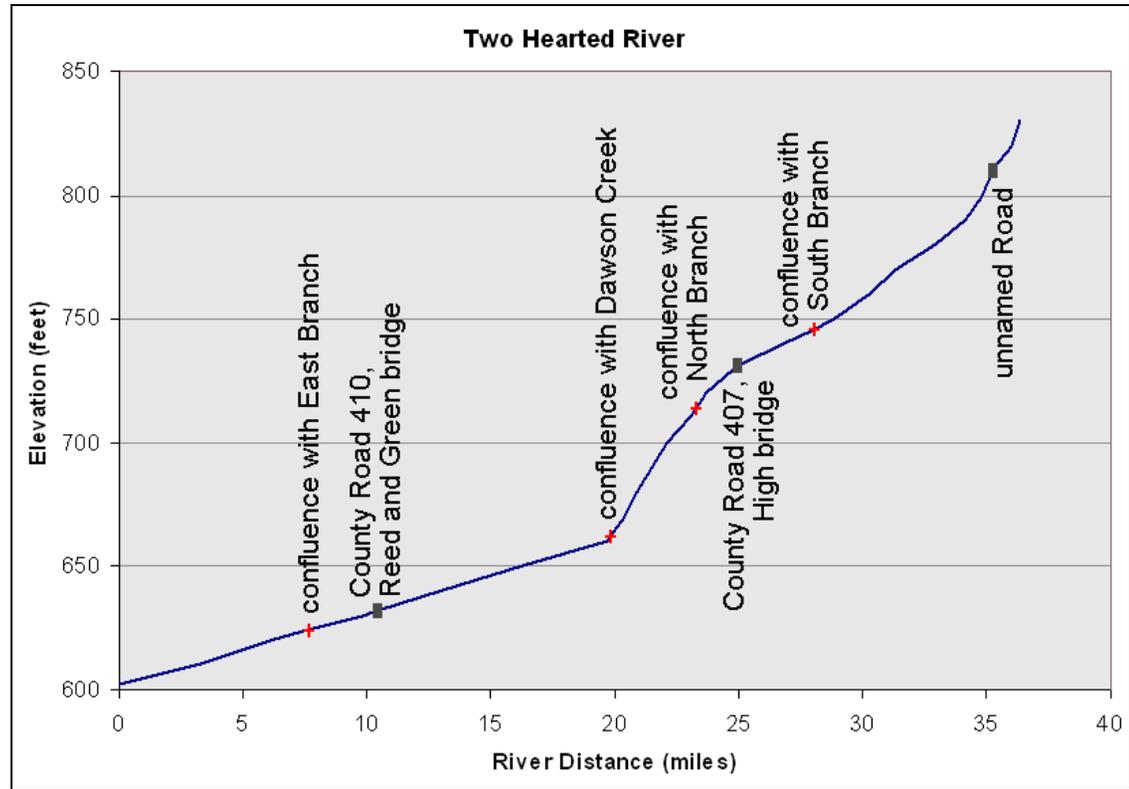
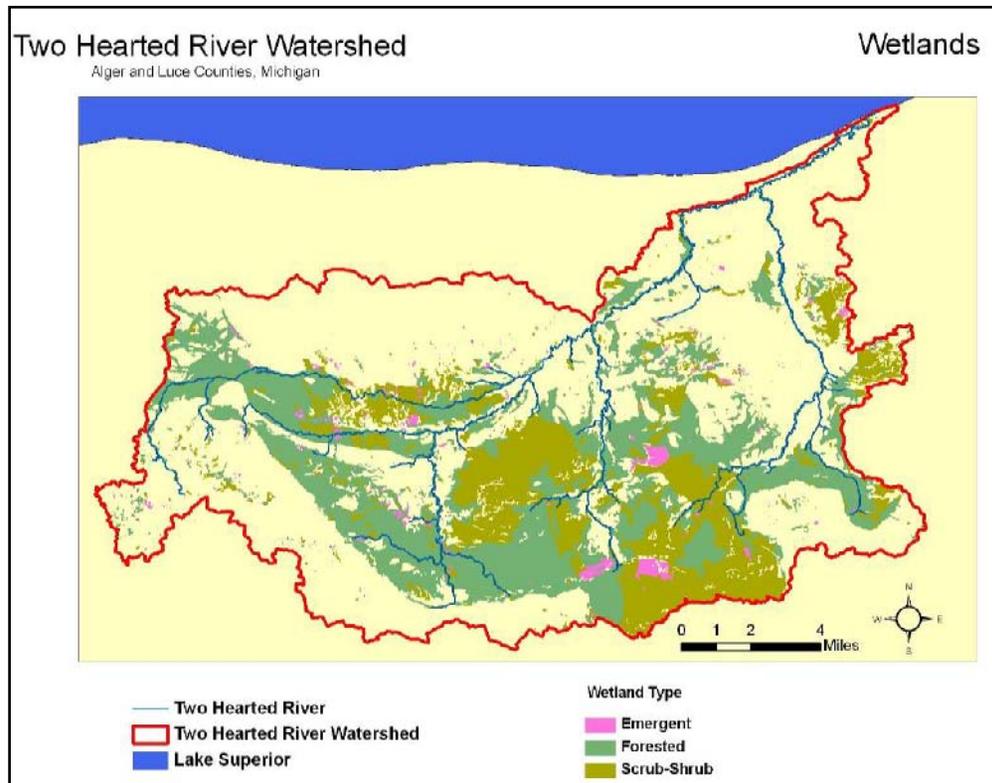


Table 1.8 Wetland Types in the Two Hearted River Watershed

Type of Wetland	Acres
Beach	10
Emergent	1,624
Forested	31,709
Open Water/Unknown Bottom	2,214
Scrub-Shrub	21,024
Total	56,581

Figure 1.23 General Wetland Types in the Two Hearted River Watershed



Wetlands

Freshwater wetlands provide cool water sources to streams, shade, flood storage, wildlife habitat, and water quality protection. The U.S. Fish and Wildlife Service National Wetland Inventory indicates five (5) wetland types within the Two Hearted River watershed (USFWS 1980). These wetlands cover over 56,500 acres or 43% the total watershed land area (Table 1.8). The most prevalent wetland type is forested, covering 31,709 acres. Scrub shrub wetlands make up over 21,024 acres and emergent wetlands comprise over 1,624 acres of the watershed (Figure 1.23).



Wetlands near South Branch Two Hearted River

Groundwater Recharge Potential

Groundwater is the primary source of drinking water within in the Two Hearted River watershed. Groundwater and surface water are closely linked, and any contamination of one has the potential to significantly impact the other. It also supplies much of the water in the mainstream and tributaries of the Two Hearted River. This helps keep water temperatures relatively cold, even in the summer.

The groundwater recharge potential in the Two Hearted River watershed ranges from 13-16 inches/year (based on a scale of 1-22 inches/year). Those areas with the greatest recharge potential (15/16 inches/year) are at the mouth of the Two Hearted River, along portions of the Main Branch (just downstream from the confluence with Wabash Creek) and the East Branch, and in the headwaters of the North Branch. The areas with the least groundwater recharge potential are located along the middle of the North Branch, West Branch, portions of the South Branch, and the headwaters of Dawson Creek (Figure 1.24).

Figure 1.24 Groundwater Recharge Potential in the Two Hearted River Watershed

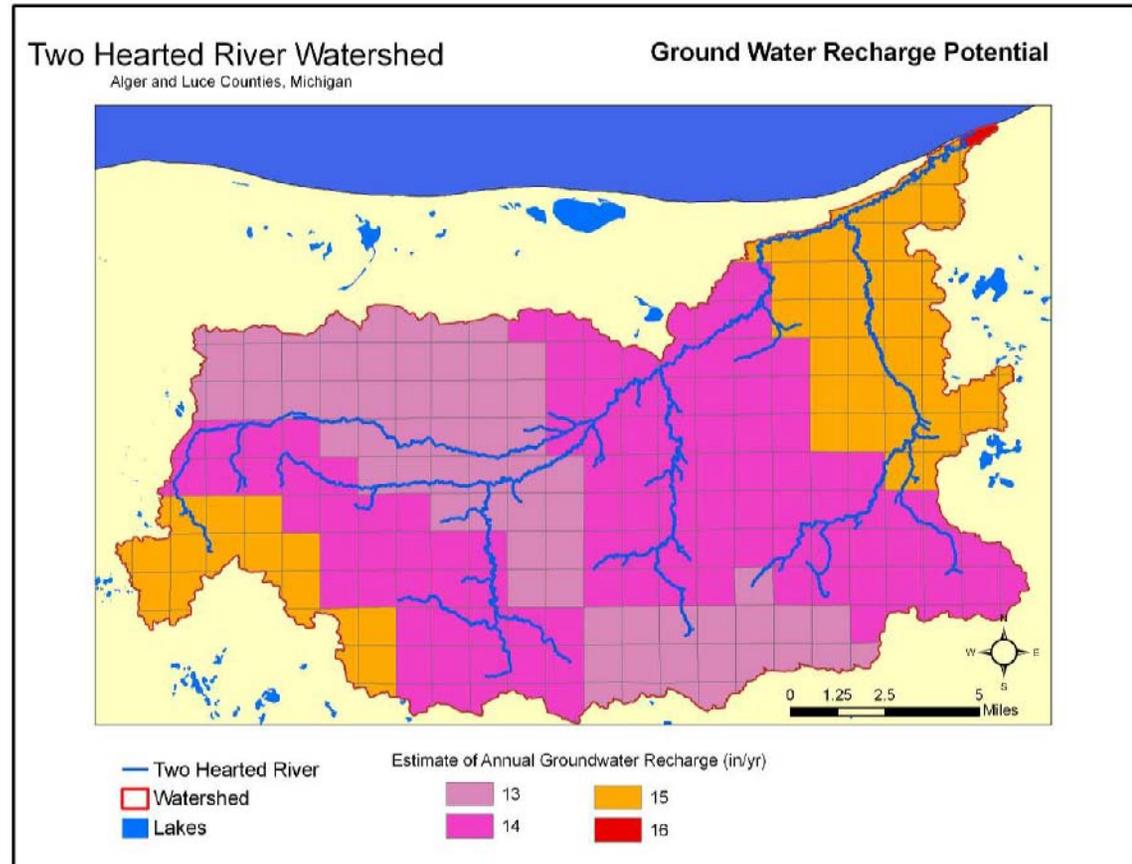
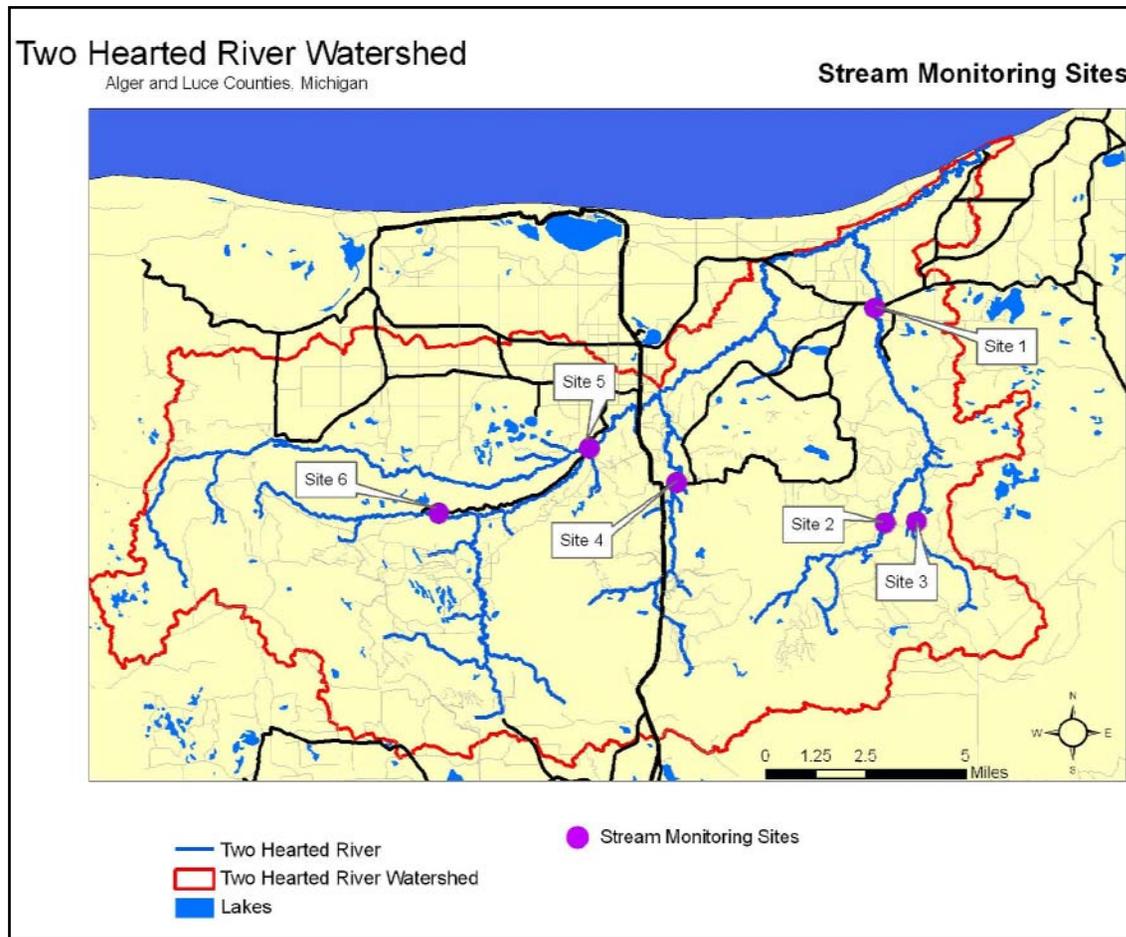


Figure 1.25 Location of Stream Monitoring Sites in the Two Hearted River Watershed



Water Quality

During 2008, the Superior Watershed Partnership and watershed volunteers conducted stream monitoring at six (6) sites throughout the Two Hearted River watershed. The Michigan Clean Water Corps (MiCorps) Volunteer Stream Monitoring Procedures (Latimore 2006) were utilized for data collection. The MiCorps program was created through an executive order by Governor Jennifer M. Granholm to assist the Michigan Department of Environmental Quality in collecting and sharing water quality data for use in water resources management and protection programs and provides standardized assessment and data recording procedures that can be easily used by trained volunteers. The MiCorps program also provides a web-based data exchange platform with online access to enter and view volunteer monitoring data through a searchable database. (www.micorps.net)

Specific objectives included collecting baseline data, characterizing stream ecosystems, identifying water quality problems, and informing and involving the public. The sampling procedures included assessments of stream habitat characteristics and the macroinvertebrate community. The stream habitat assessment is a visual assessment of stream conditions and watershed characteristics. The macroinvertebrate sampling procedure is used in con-

junction with the stream habitat assessment to provide a measure of stream health.

Assessments were conducted at six (6) sites distributed throughout the watershed (Figure 1.25). Four (4) of these sites were established previously by the Michigan Department of Environmental Quality (MDEQ 2004). The assessments covered approximately 300 feet of stream at most sites. A description of each site is provided in Table 1.9.

The procedure utilized consists of evaluation of physical and biological parameters including stream substrate composition, channel morphology, physical appearance, instream cover, riparian vegetation, adjacent land uses and the macroinvertebrate community. The biological integrity of each monitoring site is based on the results of the macroinvertebrate community evaluation, which provides a qualitative rating of stream quality (excellent, good, fair, or poor). Stream quality ratings are based on scores for the number of sensitive, somewhat sensitive, and pollution tolerant taxa present. Scores are assigned to each group (sensitive, somewhat sensitive, tolerant) based on the number of rare (1-10) and common (11 or more) organisms present. The total stream quality score for each site is a sum of the scores for each group. A total stream quality score less than 19 indicates water quality is poor, 19 to 33 is fair, 34 to 48 is good, and a score greater than 48 indicates excellent water quality.

Data from the spring 2008 monitoring event indicates stream quality is fair to good at most sites (Figure 1.26). Table 1.10 includes macroinvertebrates collected at the six sites during the monitoring event. Appendix A provides complete monitoring data collected during 2008.

Table 1.9 Description of Stream Monitoring Sites in the Two Hearted River Watershed

Site Number	Waterbody	Location	Latitude	Longitude	Stream Quality Score	DEQ Site
1	East Branch	CR 412 (T49N, R9W, Sec. 18)	46.64175	-85.47870	27.3	Yes
2	East Branch	East Branch Sportsman's Club (T49N, R9W, Sec. 7)	46.56407	-85.47432	35.3	Yes
3	Widgeon Creek	East Branch Sportsman's Club (T49N, R9W, Sec. 8)	46.56491	-85.45863	14.1	Yes
4	Dawson Creek	Pine Stump Junction (T48N, R10W, Sec. 5)	46.57893	-85.58411	32.3	Yes
5	North Branch	CR 418 (T48N, R11W, Sec. 1)	46.591	-85.63	34.3	No
6	West Branch	CR 418/Jeep Trail (T48N, R11W, Sec. 8)	46.568	-85.709	32.8	No

Figure 1.26 Stream Quality Scores and Ratings for Six Sites in the Two Hearted River Watershed



Table 1.10 Macroinvertebrates Collected from Six Sites in the Two Hearted River Watershed

Taxa	Site Number					
	1	2	3	4	5	6
Group 1: Sensitive						
Caddisfly larvae (Trichoptera)	X	X	X	X	X	X
Hellgrammites (Megaloptera)				X	X	X
Mayfly nymphs (Ephemeroptera)	X	X	X	X	X	X
Gilled snails (Gastropoda)						
Stonefly nymphs (Plecoptera)	X	X		X	X	X
Water penny (Coleoptera)	X					
Water snipe fly (Diptera)	X	X			X	
Group 2: Somewhat Sensitive						
Alderfly larvae (Megaloptera)						
Beetle adults (Coleoptera)		X		X		X
Beetle larvae (coleoptera)				X		
Black fly larvae (Diptera)						
Clams (Pelecypoda)						
Crayfish (Decapoda)						
Crane fly larvae (Diptera)		X		X		
Damselfly nymphs (Odonata)		X			X	
Dragonfly nymphs (Odonata)	X		X		X	X
Net-spinning caddisfly larvae (Hydropsychidae; Trichoptera)	X	X		X	X	X
Scuds (Amphipoda)						X
Sowbugs (isopoda)						
Group 3: Tolerant						
Aquatic worms (Oligochaeta)						
Leeches (Hirudinea)						
Midge larvae (Diptera)						
Pouch snails (Gastropoda)		X	X			
True bugs (Hemiptera)		X				
Other true flies (Diptera)						

Table 1.11 Natural Features Found within the Two Hearted River Watershed

Common Name	Scientific Name	Protection Status	Global Rank	State Rank
Bald Eagle	<i>Haliaeetus leucocephalus</i>	T	G4	S4
Common Loon	<i>Gavia immer</i>	T	G5	S3S4
Merlin	<i>Falco columbarius</i>	T	G5	S1S2
Osprey	<i>Pandion haliaetus</i>	T	G5	S4
Yellow Rail	<i>Coturnicops noveboracensis</i>	T	G4	S1S2
English Sundew	<i>Drosera anglica</i>	SC	G5	S3
Northern Prostate Clubmoss	<i>Lycopodiella margueriteae</i>	SC	G2	S2
Panicled Screw-stem	<i>Bartonia paniculata</i>	T	G5	S2
Wiegand's Sedge	<i>Carex wiegandii</i>	T	G3	S2
Fir Clubmoss	<i>Huperzia selago</i>	SC	G5	S3
Alga Pondweed	<i>Potamogeton confervoides</i>	SC	G4	S3
American Dune Wild-rye	<i>Elymus mollis</i>	SC	G5	S3
Black Crowberry	<i>Empetrum nigrum</i>	T	G5	S2
Moor Rush	<i>Juncus stygius</i>	T	G5	S1S2
American Shore-grass	<i>Littorella uniflora</i>	SC	G5	S2S3
Lake Huron Tansy	<i>Tanacetum huronense</i>	T	G4	S3
Lake Huron Locust	<i>Trimerotropis huroniana</i>	T	G2G3	S2S3
Dry Northern Forest			G3?	S3
Intermittent wetland			G2	S3
Patterned Fen			GU	S2
Muskeg, Bog			G4	S3
Dry-mesic northern forest			G4	S3
Mesic northern forest			G4	S3
Rich conifer swamp			G4	S3
Hardwood-conifer swamp			G4	S3

G2	Imperiled: at high risk of extinction due to very restricted range, very few occurrences (often 20 or fewer), steep declines, or other factors.	S1	Critically imperiled in the state because of extreme rarity (often 5 or fewer occurrences) or because of some factor(s) such as very steep declines making it especially vulnerable to extirpation from the state.
G3	Vulnerable: at moderate risk of extinction due to a restricted range, relatively few occurrences (often 80 or fewer), recent and widespread declines, or other factors.	S2	Imperiled in the state because of rarity due to very restricted range, very few occurrences (often 20 or fewer), steep declines, or other factors making it very vulnerable to extirpation from the state.
G4	Apparently secure: uncommon but not rare; some cause for long-term concern due to declines or other factors.	S3	Vulnerable in the state due to a restricted range, relatively few occurrences (often 80 or fewer), recent and widespread declines, or other factors making it vulnerable to extirpation.
G5	Secure: common; widespread.	S4	Uncommon but not rare; some cause for long-term concern due to declines or other factors.
GU	Currently unrankable due to lack of information or due to substantially conflicting information about status or trends.	G?	Incomplete data

Significant Natural Resources

The variety of wetland communities and the complexity of the peat-land forest ecosystem found within the Two Hearted River watershed are incomparable within the Great Lakes region. This landscape remains un-fragmented and relatively undeveloped. The high diversity of natural communities and broad expanse supports a great number of species including wide-ranging mammals such as black bear, fisher, pine marten and moose (TNC 1995).

The Michigan Natural Features Inventory has identified a number of significant natural features in the watershed including a listing of all known occurrences of threatened (T), endangered and special concern species (SC) and high quality natural communities that are either significant at a global or statewide scale (Table 1.11). This list is based on known and verified sightings of threatened, endangered, and special concern species and represents the most complete data set available.

Sleeper Lake Fire

Only about 2 percent of all wildfires in Michigan are caused by lightning strikes and the rest are caused by human activity (MDNR 2008). One of these rare events occurred in the early morning hours of Thursday August 2, 2007 when a lightning strike started a wildfire in the Two Hearted River watershed. The fire was discovered later that day near Sleeper Lake approximately 6.5 miles north of the Village of Newberry and east of County Road 407.

A severe drought during 2007 had resulted in optimal conditions for wildfire. The Michigan Department of Natural Resources have a drought code to help monitor potential conditions for a wildfire. The drought code is zero when the ground is saturated with snow melt. A code of 500 indicates serious drought conditions and a high potential for a wildfire. During the summer of 2007, the area where the Sleeper Lake Fire began reached a record drought code of over 600 (TNC 2007).

The fire presented immediate challenges for containment due to the extreme drought conditions, strong winds (reaching up to 30 miles per hour) and its remote location. By Tuesday August 7, more than 15,000 acres had burned and the fire was considered only 10% contained (TNC 2007).

Figure 1.27 Sleeper Lake Fire Burn Area and Dozer Lines

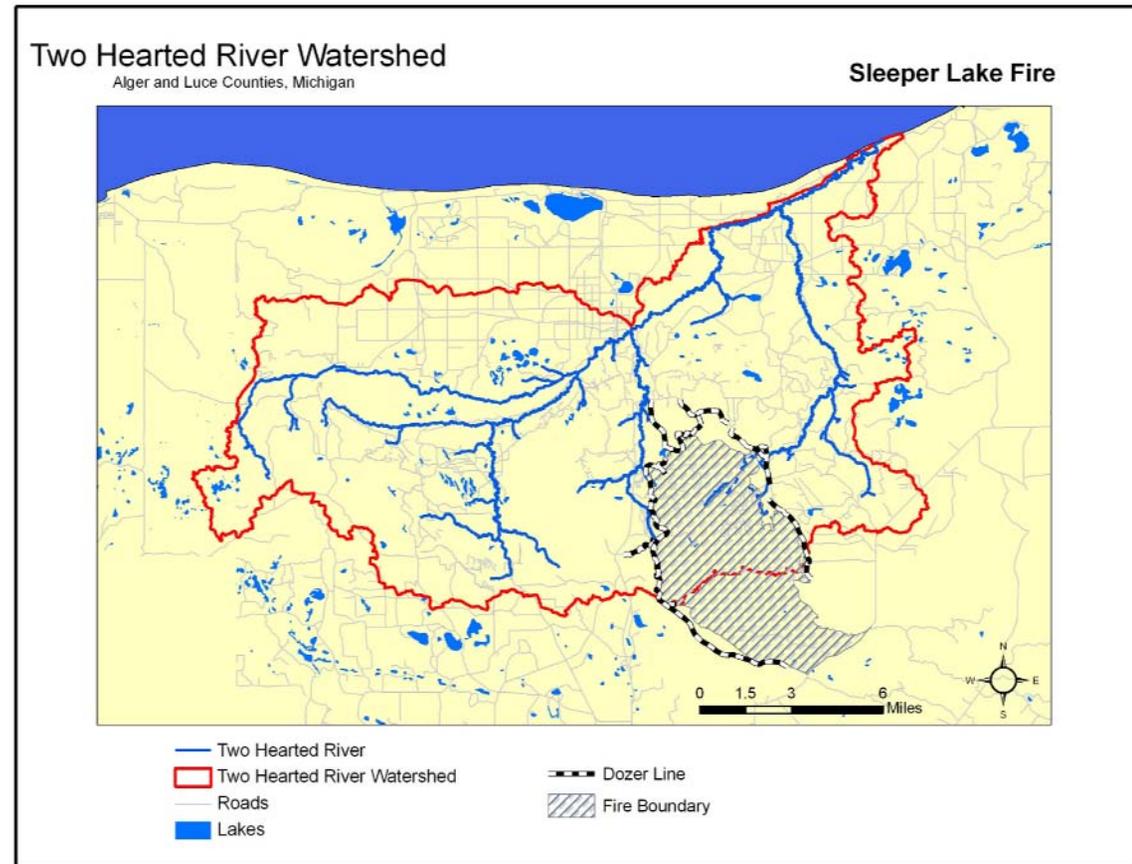
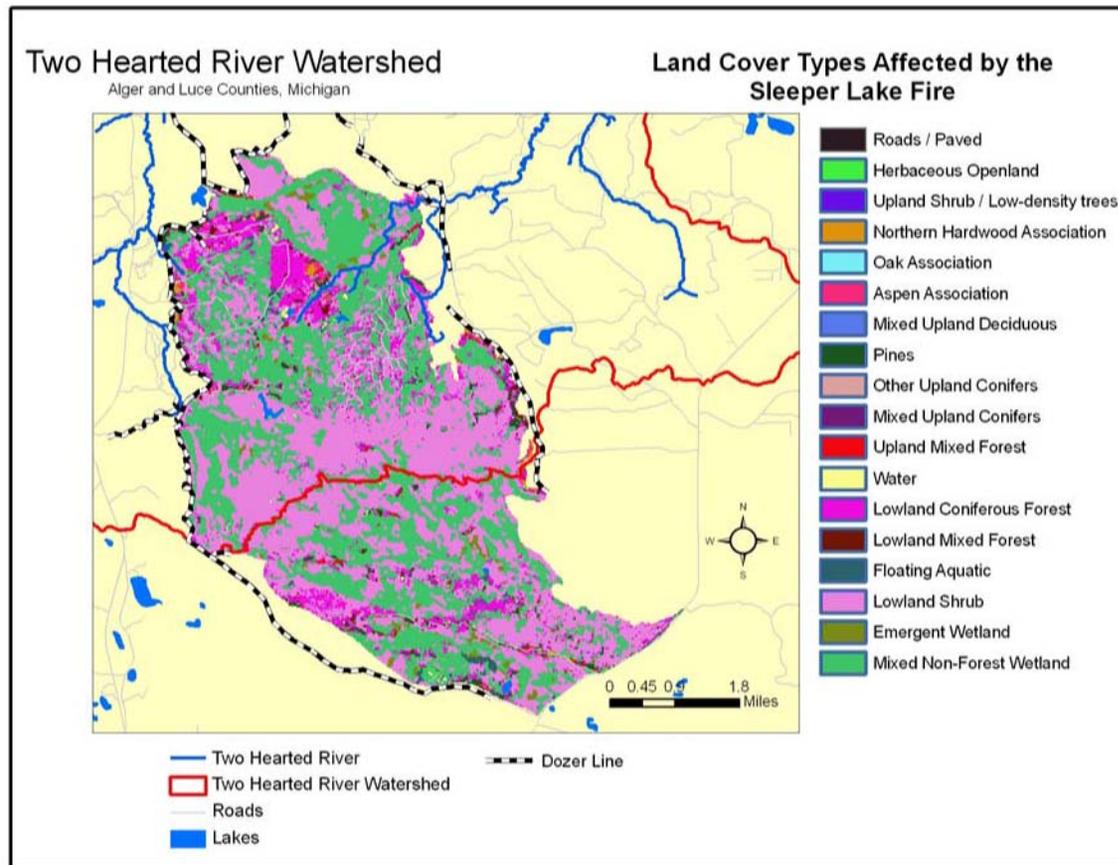


Figure 1.28 Land Cover Types Affected by the Sleeper Lake Fire



Over 200 personnel from numerous agencies responded, bringing land and air support including six helicopters with 700 and 2000 gallon water buckets, a CL 215 water bomber, 6 tractor plows with pumpers, and tracked marsh vehicles. Many local citizens of Luce County provided additional support for the fire suppression efforts by feeding and caring for firefighters and keeping moral high by showing their local support on local signs along roadways (Lisa DenBoer, Luce County Planning personal communication). Approximately 26 miles of dozer lines were constructed to provide access for containment efforts (Figure 1.27).

By August 29, 2007, the fire was considered 95% contained and the last of the firefighting crews were dismissed as of Labor Day weekend (Lisa DenBoer, Luce County Planning personal communication). The Sleeper Lake fire was considered the third largest wildfire recorded in the history of Michigan. Approximately 18,185 acres burned in total, including over 1,000 acres of commercial forest lands and 17,000 acres of swamp and marshlands. Remarkably, while a few firefighters sustained minor injuries, there was no loss of life and only one structure was lost. The last time pilots spotted any smoke from the more than 28-square mile charred footprint was mid-September (Mining Journal 2007). The total cost to contain the fire was estimated

at approximately \$6 million. A summary of the land cover types effected by the fire is provided in Figure 1.28 and Table 1.12.

The effect of fire on the survival of wetland and forest communities depends on the intensity, frequency, and extent of fire and the ecological requirements of particular species. Most vertebrate groups can escape low intensity fires by sheltering until the fire front has passed, or by avoiding the fire edge. Low frequency, high intensity, broader scale summer fires have the most dramatic impact on the survival of local species (WRC 2000). A summary of potential ecological advantages and disadvantages of wildfires is provided in Table 1.13.

Post-fire assessments were conducted by the MDNR Eastern Lake Superior Management Unit of the Fisheries Division during late September of 2007 in tributaries with the highest potential for impact as a result of the Sleeper Lake fire. The surveys indicated no impact to the fish community (James Waybrant, MDNR personal communication).

During the spring of 2008, less than one year after the fire, the marsh lands of the Two Hearted River watershed and other areas impacted by the Sleeper Lake fire appeared to be substantially re-vegetated and the fire boundary was no longer visible by air.

Table 1.12 Acres of Land Cover Types Effected by the Sleeper Lake Fire

Land Cover Types Effected by the Sleeper Lake Fire	Area (acres)
Roads / Paved	10
Herbaceous Open land	101
Upland Shrub / Low density trees	2
Northern Hardwood Association	61
Oak Association	2
Aspen Association	87
Mixed Upland Deciduous	11
Pines	317
Other Upland Conifers	19
Mixed Upland Conifers	75
Upland Mixed Forest	90
Water	56
Lowland Coniferous Forest	1823
Lowland Mixed Forest	134
Floating Aquatic	128
Lowland Shrub	7971
Emergent Wetland	224
Mixed Non-Forest Wetland	7064
Total	18176



Sleeper Lake Fire Cooperating Agencies

- Michigan Department of Natural Resources
- Minnesota Department of Natural Resources
- Wisconsin Department of Natural Resources
- Bureau of Indian Affairs
- U.S. Fish and Wildlife Service
- U.S. Forest Service
- Ontario Ministry of Natural Resources
- Michigan National Guard
- Air Guard
- Michigan State Police
- Luce County Sheriff's Department
- National Weather Service
- The Nature Conservancy
- Numerous Volunteer Fire Departments
- Salvation Army
- American Red Cross
- Local Keyman Firefighters working for MDNR

Table 1.13 Ecological Advantages and Disadvantages of Wildfires (WRC 2000)

Advantages	Disadvantages
May trigger seed release and germination in some species	Loss of seed as a consequence of inappropriate timing of fires
Stimulates the development of new green shoots, roots and rhizomes of grasses, and sedges producing food sources for wildlife	Degradation or loss of peat soils (organic-rich soils)
May create pools for nesting and feeding water birds and amphibians	Increased predation of seed by insects
Can provide favorable habitat for wildlife by eliminating impenetrable growth of plants	Increased potential for fungal attack on seeds
	Changes in vegetation composition and structure including increased potential for invasive species invasion
	Exposure of roots and rhizomes
	Loss of vegetation, resulting in reduced bio-filtering of incoming surface water flows
	Erosion of soil and increased turbidity in wetlands and surface waters
	An increase in water temperature as a result of the loss of vegetation and shade

U.S. Army National Guard photo



MDNR photo



MDNR photo

Red Cross photo



MDNR photo

THE HUMAN ENVIRONMENT

Many people are attracted to the Two Hearted River watershed not only for its wilderness-like nature but also for the recreational opportunities that it supports, such as excellent brook trout and steelhead fishing, canoeing, hunting, dog sledding, and many other activities. The Two Hearted River Natural Rivers Plan (MDNR 2002) sums up the potential threat to this pristine water resource by stating, "As the demand for quality recreation increases, the natural beauty and wilderness characteristics of the area could be destroyed by unregulated land use" (TNC 2007).

The following sections summarize the human environment in and around the Two Hearted River watershed including community profile, land uses, transportation routes, the political landscape, and future growth areas.

Community Profile

The sparse population and associated lack of development in the area contribute to maintaining the high quality waters of the Two Hearted River and the wilderness character of the watershed (TNC 1995). During 2000, Luce County had the second lowest population in the state (7,024) with 7.8 people per square mile (U.S. Census Bureau 2000).

Similarly, the Two Hearted River watershed has remained largely unpopulated with an estimated population of only 396 people during 2000 (U.S. Census Bureau 2000). This is primarily due to physical characteristics of the watershed that limit development as well as landownership, Natural Rivers Program restrictions, and additional restrictions imposed by Luce County. While the total population of the watershed remains low, increasing demands for recreational uses including second home (camp) development have resulted in a 94% increase in population between 1990 and 2000. The majority of this change has occurred around the East Branch, Widgeon Creek, Dawson Creek, and the Main Branch of the Two Hearted River (Table 2.1, Figure 2.1)



Table 2.1 Population Change in the Two Hearted River Watershed (1990 to 2000)

Subwatershed	Total Population (1990 Census)	Total Population (2000 Census)	Percent Change
Main and West Branches	39	80	105
South Branch	40	63	57
North Branch	70	95	35
Dawson Creek	19	44	131
East Branch/Widgeon Creek	25	77	208
East Branch	11	37	236
Total	204	396	94

These increases are also reflected in changes in occupied housing units (houses and apartments) between 1990 and 2000 with an estimated 51% increase of in occupied housing units in the watershed (Table 2.2, Figure 2.2). However, in comparison with population changes, changes in housing were more prevalent along the South Branch and Main and West Branches.

Figure 2.1 Population Change in the Two Hearted River Watershed (1990 to 2000)

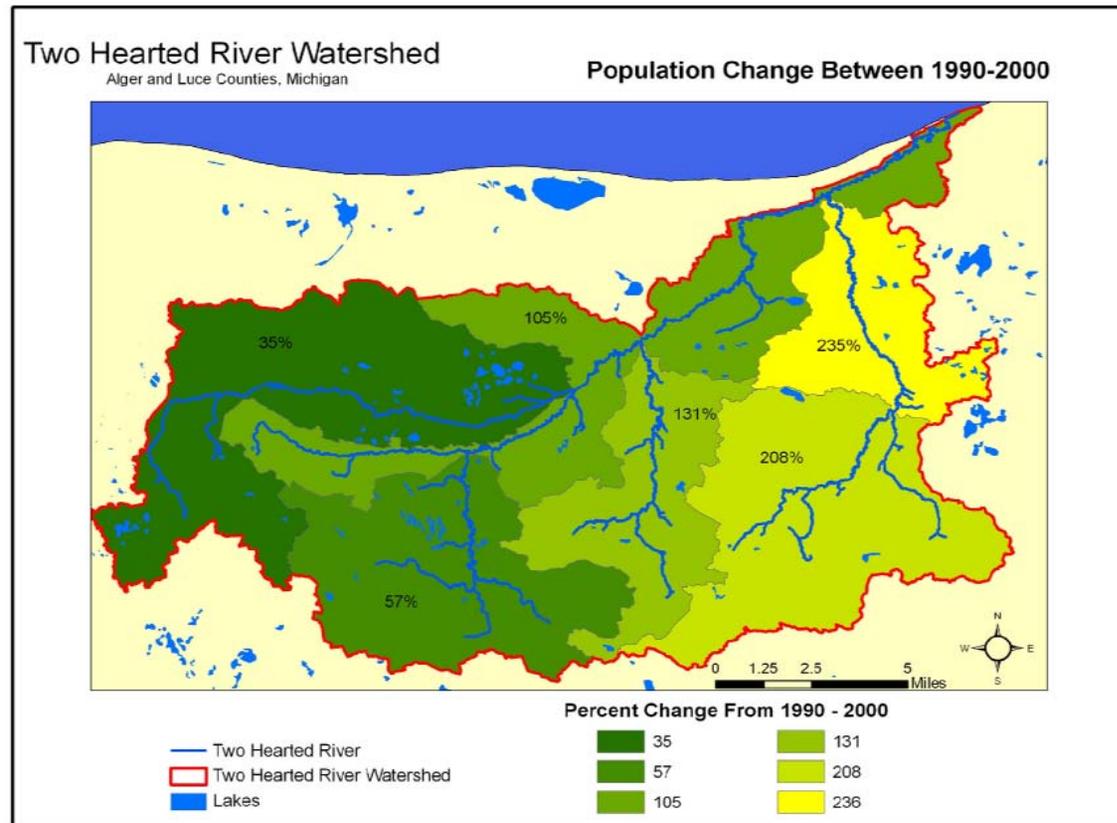


Table 2.2 Housing Changes in the Two Hearted River Watershed (1990 to 2000)

Subwatershed	Total Homes (1990 Census)	Total Homes (2000 Census)	Percent Change
Main and West Branches	62	112	80
South Branch	48	88	83
North Branch	82	126	53
Dawson Creek	35	61	74
East Branch/Widgeon Creek	60	104	73
East Branch	29	52	75
Total	316	477	51

Landownership

The history of the Two Hearted River watershed and surrounding area is closely associated with logging. Logging companies came into the area in the late nineteenth century to cut the virgin white pine. After the pine was removed, fires and hard times caused many landowners to allow their land to revert to the state for non-payment of taxes (MDNR 2002).

Today, the Michigan Department of Natural Resources (MDNR) remains the largest landowner, owning approximately 50% of the land area in the watershed (Table 2.3, Figure 2.3). This land is managed by the Forest Management Unit under the Lake Superior State Forest.

Another 18% of the watershed is owned and managed by The Nature Conservancy (TNC) as a part of the Northern Great Lakes Forest Project. Other private landowners occupy 15% of the watershed including 4,309 acres owned by private hunting clubs including the East Branch Sportsman's Club. The remaining 17% is owned by corporate landowners (Timber Product Industry), much of which (19,585 acres) is under a working forest conservation easement.

This relatively simple pattern of ownership provides the potential for concerted programs to protect large areas of wetland and forest (TNC 1995).

Figure 2.2 Percent Change in Housing in the Two Hearted River Watershed (1990-2000)

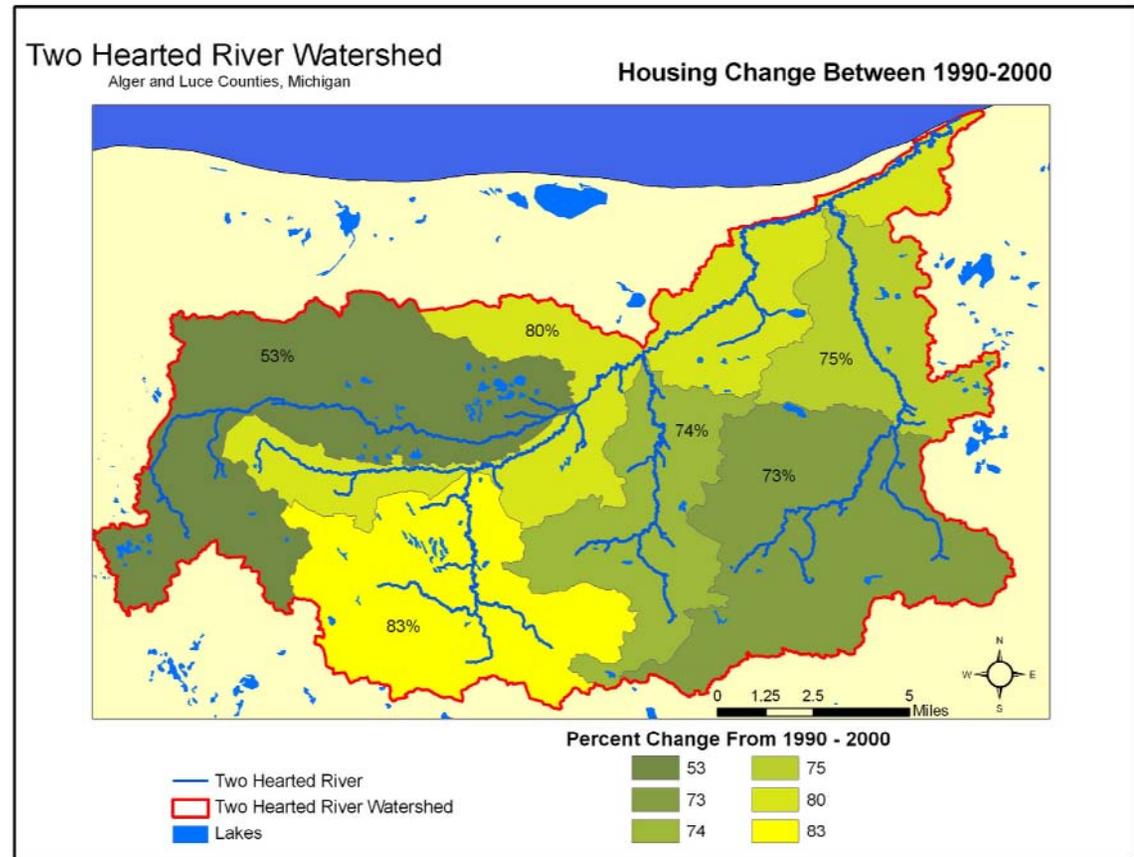
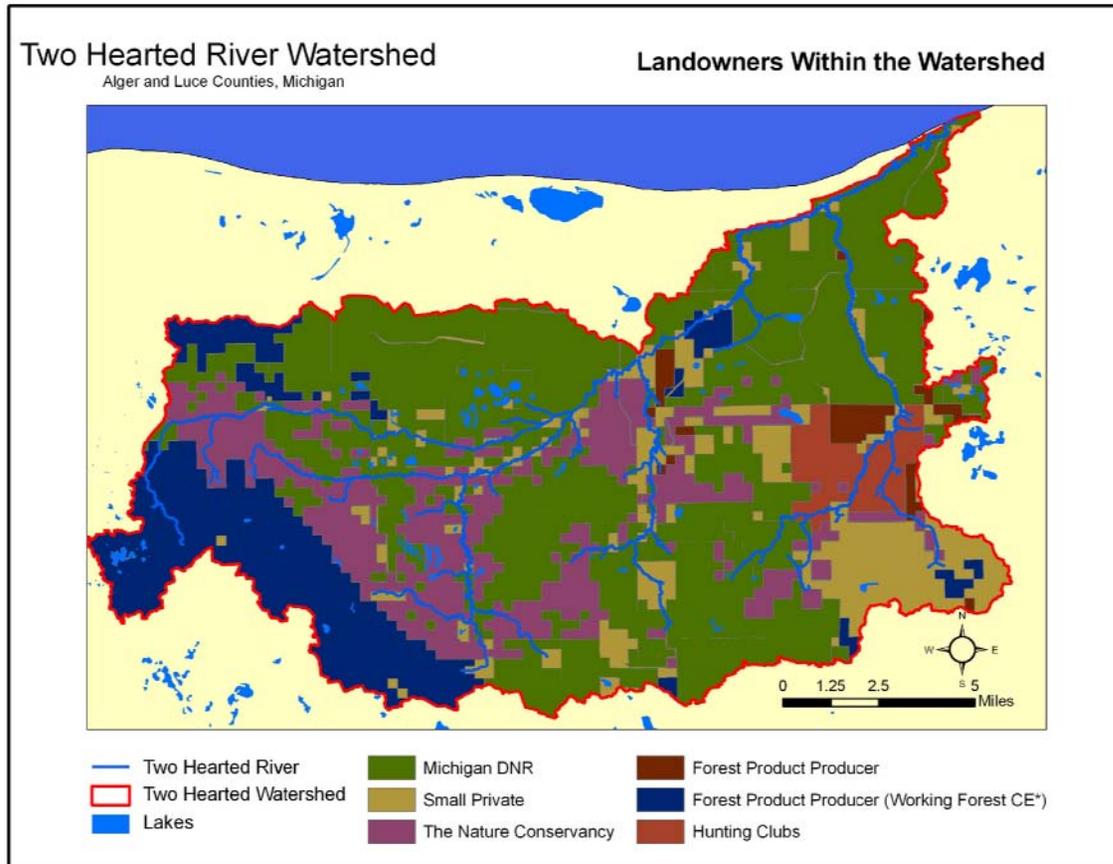


Table 2.3 Landownership in the Two Hearted River Watershed

Landowners	Acres	Percent of Watershed
State of Michigan	66,638	50
The Nature Conservancy	23,338	18
Private Landowners	16,280	12
Hunting Clubs	4,309	3
Forest Product Producer (Working Forest Conservation Easement)	19,585	15
Other Forest Product Producer	2,328	2
Total	132,478	100

Figure 2.3 Landownership in the Two Hearted River Watershed



Land Uses

The land uses within the Two Hearted River watershed have remained relatively unchanged since the early 1800's. This is likely due to the remoteness of the area and limitations based on soils and topography (TNC 2007).

Land use maps based on the MDEQ Geographic Information Systems (GIS) data for 1800 and 1978 are shown in Figures 2.4 and 2.5, respectively. Percent land use within each of the subwatersheds is also detailed in Table 2.4. Land use circa 1800 is from a statewide database based on original surveyors' tree data and descriptions of the vegetation and land between 1816 and 1856. Michigan was systematically surveyed during that time by the General Land Office, which had been established by the federal government in 1785. The detailed notes taken by the land surveyors have proven to be a useful source of information on Michigan's landscape as it appeared prior to wide-spread European settlement. The database creators recognize that there are errors in the database due to interpretation and data input (Fongers 2007).

The 1978 land use files represent a compilation of data from county and regional planning commissions or their subcontractors.

Figure 2.4 Land Use in the Two Hearted River Watershed circa 1800 (Fongers 2007)

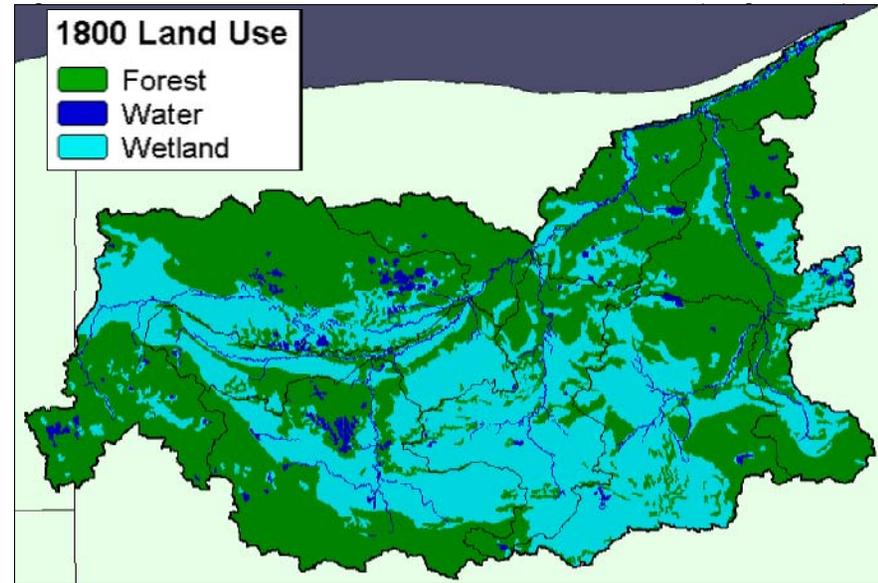


Figure 2.5 Land Use in the Two Hearted River Watershed circa 1978 (Fongers 2007)

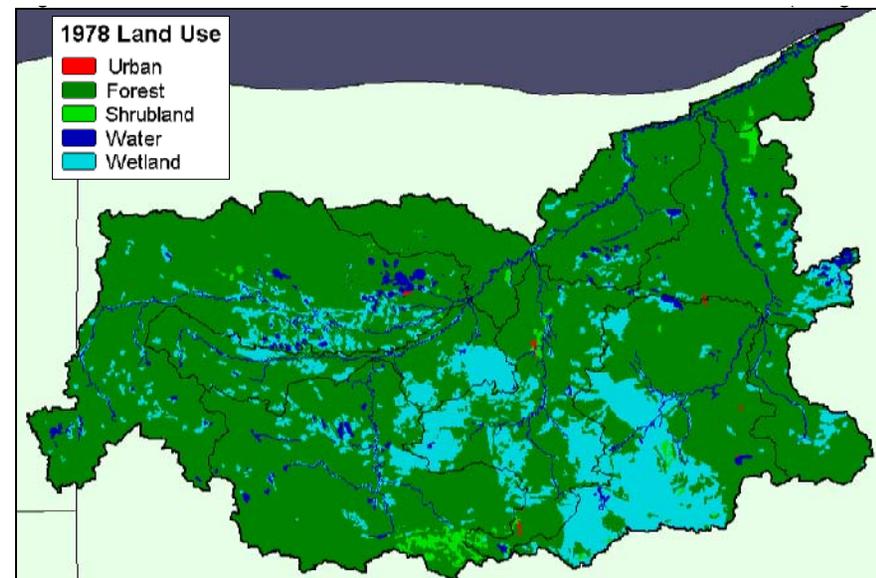


Table 2.4 Land Use Types in the Two Hearted River Watershed (Land use percentages that round to 0 are not listed) (Fongers 2007)

Description	Scenario	Percent Land Cover (%)			
		Shrubland	Forest	Water	Wetland
Dawson Creek	1800		32		68
	1978	1	68		30
East Branch, lower	1800		79	1	20
	1978	2	89	2	7
East Branch, upper	1800		42	1	57
	1978	1	59	1	40
North Branch	1800		69	2	29
	1978		90	2	8
South Branch	1800		56	2	42
	1978	3	89	1	7
Two Hearted, lower	1800		84	1	16
	1978	1	95	1	3
Two Hearted, upper	1800		31		69
	1978		76		24
Widgeon Creek	1800		68		32
	1978		93		7
Entire Watershed	1800		59	1	41
	1978	1	83	1	17

This data set is intended for general planning purposes. It is not intended for site specific use. Data editing, manipulation, and evaluation was completed by the Michigan State University Center for Remote Sensing and GIS and by the MDNR. Files have been checked by MDNR against original MDNR digital files for errant land cover classification codes (Fongers 2007).

Comparison of 1800 and 1978 land use data indicates changes in land use types. Minor changes (<1%) to more urban land use types can be seen in Figure 2.5. These changes are located primarily on private lands and along heavily traveled routes and correspond roughly to increases in population density and occupied housing units (Figures 2.1 and 2.2).

Two Hearted River - Land Use Comparison

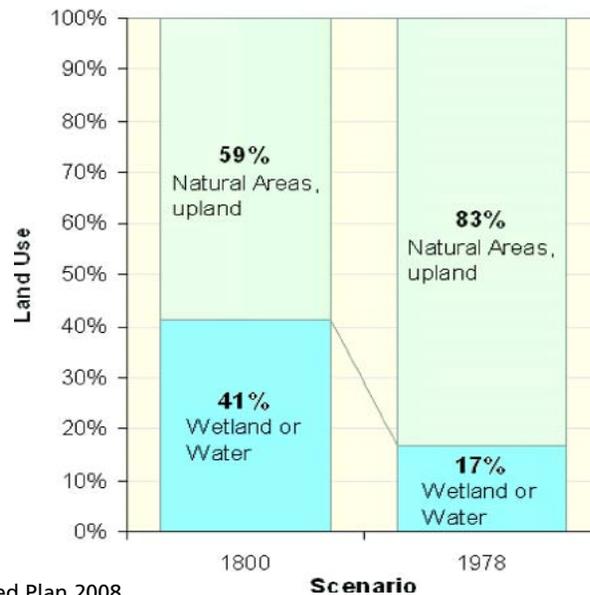


Figure 2.6 Changes in Upland and Wetland Land Use Types (1800 - 1978) in the Two Hearted River Watershed (Fongers 2007)

Changes in upland (forest) and wetland land use types (Figure 2.6) can likely be attributed to classification of forested wetlands as a Forest land use type in the 1978 data layer. National Fish and Wildlife Service National Wetlands Inventory data (USFWS 1980) indicate a variety of wetland types occupying approximately 43% of the watershed including 31,709 acres of forested wetlands (see Table 1.8 and Figure 1.23). These data suggest relatively no change in wetland and upland land use types.

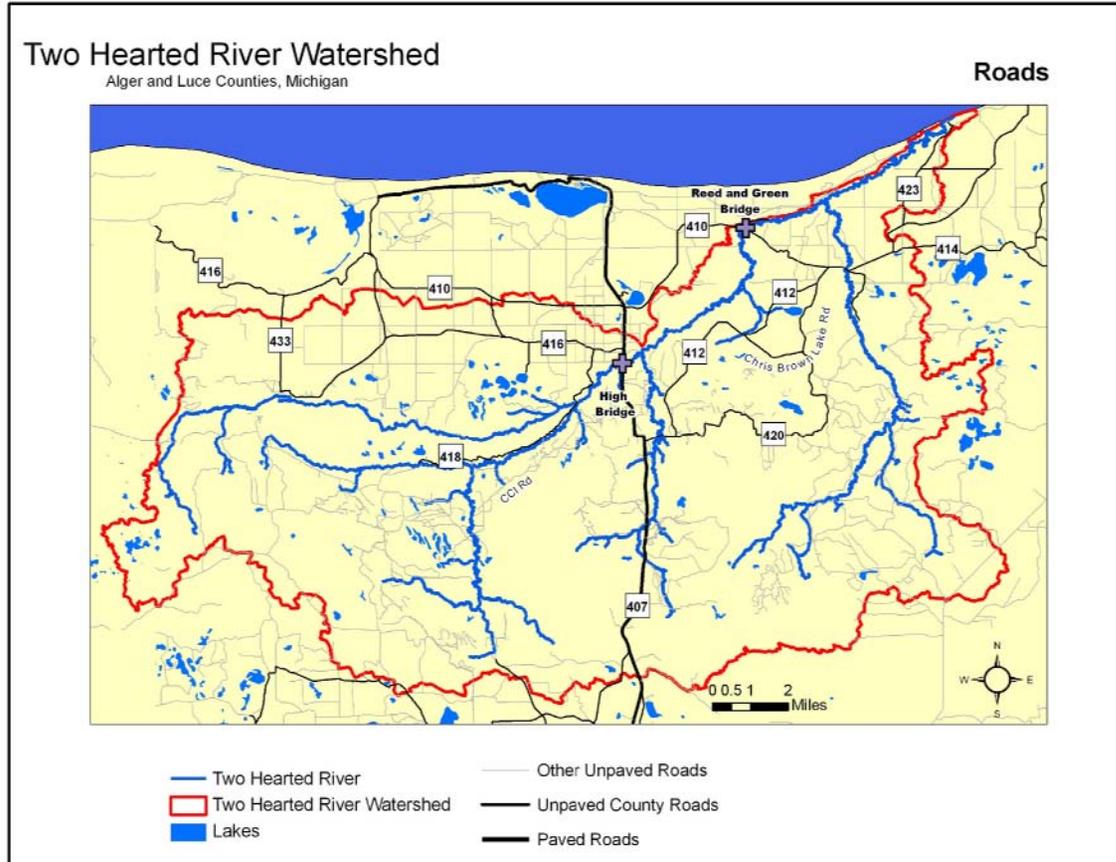
Transportation Routes

The Two Hearted River watershed is relatively inaccessible by improved road. The main route for access is County Road (CR) 407 which runs north-south through the center of the watershed. A sparse network of unimproved county roads and seasonal "jeep trails" and logging roads traverse the remainder of the watershed and provide limited access to otherwise remote areas (Figure 2.7). With the exception of County Road 407, all are dirt roads subject to continuous erosion. Only two bridges cross the Main Branch, High Bridge (CR 407) and Reed and Green Bridge (CR 410), dividing its length roughly into thirds. A footbridge crosses the Main Branch at the forest campground near the mouth.



Main Branch Two Hearted River at High Bridge

Figure 2.7 Roads in the Two Hearted River Watershed



Roads can have a significant impact on the landscape because they often destroy and fragment habitat (including wetlands), contribute sediment to streams, block passage for fish, and provide pathways for other threats including increased recreation or development pressures and invasions of non-native invasive plants.



County Road 414

With the help of watershed volunteers from the Lake Superior State University (LSSU) Fish and Wildlife Club, the majority of the road/stream crossings in the Two Hearted River watershed were inventoried to evaluate impacts to water quality and aquatic life (Figure 2.8). Stream crossing that were not inventoried included those that were determined to be having little or no impact on the stream (such as High Bridge, Reed and Green Bridge, and the CR 414 crossing of the East Branch), those that appeared on a map but were not actual crossings, and crossings that were too difficult to reach due to road conditions.

On a watershed-wide scale, the unimproved nature of the roads combined with sandy soils has been a bad combination for erosion at most crossing sites during high water and rain events and grading operations. The upper East Branch and Dawson Creek are the most impacted by transportation routes due to the number of crossings. In addition, some of the crossings structures are poorly aligned, undersized, and/or perched, thus impacting stream flow and movement of fish and aquatic organisms. Many of the crossings are situated at the lowest elevation point of the road that they service and function as a focal point to funnel sediment into the river. Some crossings consist of old or improvised materials or have no crossing structure at all, with vehicle traffic driving directly through the stream.

A summary of the road/stream crossings in the Two Hearted River watershed is provided in Table 2.5. Inventory data sheets and photos are provided in Appendix B. Sediment loading from crossing sites was quantified in a watershed-wide analysis of erosion and pollutant loading using USDA National Agriculture Imagery Program (NAIP) 2005 digital orthophotos and the U.S. Environmental Protection Agency's Spreadsheet Tool for Estimating Pollutant Loads (STEPL 4.1 beta). Discussion and results of this analysis are provided in Chapter Three: Pollutants, Sources, and Causes.

Figure 2.8 Road/stream crossing inventory sites in the Two Hearted River Watershed

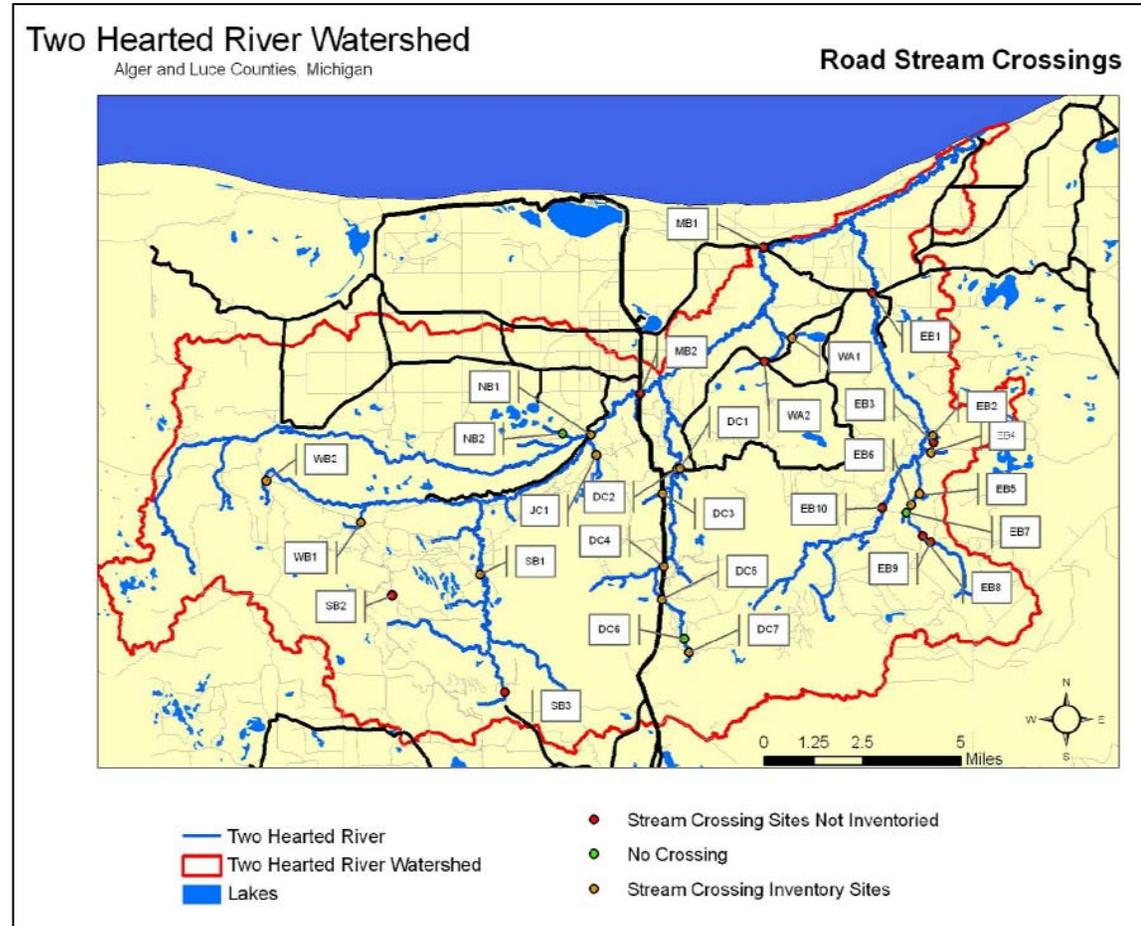


Table 2.5 Summary of Road/Stream Crossings in the Two Hearted River Watershed

Site #	Steam Name	Road Name	Location	Crossing type	Crossing Material	Road Surface	Perched	Erosion	Site Description
MB1	Main Branch Two Hearted River	CR 410 (Reed and Green Bridge)	T49N, R10W, Sec 10	Bridge	N/A	Gravel/Native	N/A	No	Not Inventoried, crossing is stable
MB2	Main Branch Two Hearted River	CR 407 (High Bridge)	T49N, R10W, Sec 31	Bridge	N/A	Paved	N/A	No	Not Inventoried, crossing is stable
DC1	Unnamed Tributary to Dawson Creek	CR 414	T48N R10W Sec 5	2' Round Culvert	Metal	Gravel/Native	No	Yes	Minor erosion reaching stream from the downstream embankment
DC2	Dawson Creek	CR 414	T48N R10W Sec 5	Bridge	Concrete	Gravel/Native	N/A	No	Not Inventoried – New bridge and approach work in 2007
DC3	Whiskey Creek	CR 407	T48N R10W Sec 8	4' Round Culvert	Metal	Paved	Yes	No	Crossing structure is poorly aligned and perched (<3") during low flow conditions
DC4	Dawson Creek	CR 407	T48N R10W Sec 20	Bridge	Concrete	Paved	N/A	No	Bridge abutments appear to restrict flow, however crossing is stable and channel protection is preventing erosion
DC5	Little Dawson Creek	CR 407	T48N R10W Sec 29	Multiple Culverts	Concrete	Paved	No	No	Crossing consists of two culverts; one at Little Dawson and one at nearby wetland. Both appear to restrict flow
DC6	Little Dawson Creek	Unnamed Road off Sleeper Lake Road	T48N R10W Sec 32	N/A	N/A	Native	N/A	N/A	Crossing identified on map but not found in the field
DC7	Little Dawson Creek	Sleeper Lake Road	T48N R10W Sec 32	ATV/foot bridge	Wood	Native	N/A	No	Rugged ATV/foot bridge at end of Sleeper Lake Road.
EB1	East Branch Two Hearted River	CR 414	T49N R9W Sec 18	Bridge	N/A	Gravel/Native	N/A	No	Not Inventoried, crossing is stable
EB2	Unnamed Tributary to East Branch	Widgeon Trail	T48N R9W Sec 4	2' Round Culvert	Cement	Native	No	No	Culvert is overgrown and plugged and restricts flow and fish passage
EB3	Unnamed Tributary to East Branch	Widgeon Trail	T48N R9W Sec 4	N/A	N/A	Native	N/A	N/A	Not inventoried, intermittent drainage – no stream channel present
EB4	Unnamed Tributary to East Branch	Widgeon Trail	T48N R9W Sec 5	1.5' Round Culvert	Plastic	Native	Yes	Yes	Culvert is undersized (large wetland/pond upstream), perched on downstream end (>6") and has minor erosion from road embankments

Site #	Steam Name	Road Name	Location	Crossing type	Crossing Material	Road Surface	Perched	Erosion	Site Description
EB5	Unnamed Tributary to Widgeon Creek	Widgeon Trail	T48N R9W Sec 8	Bridge	Metal with Open Wood Decking	Native	N/A	No	Crossing is stable
EB6	Widgeon Creek	Widgeon Trail	T48N R9W Sec 8	Bridge	Metal with Open Wood Decking	Native	N/A	Yes	Moderate erosion of bridge side slopes, cement blocks and rock used for stabilization washes away during high water events (Larry Frost, EBSC President personal communication)
EB7	Unnamed Tributary to Widgeon Creek	Widgeon Trail	T48N R9W Sec 17	N/A	N/A	Native	N/A	N/A	Crossing identified on map but not found in the field
EB8	Widgeon Creek	South Widgeon Trail	T48N R9W Sec 17	No Structure	N/A Former Crossing	Native	N/A	Yes	Road closed due to removal of previous crossing structure, severe erosion along stream banks, water was too deep to inventory
EB9	Widgeon Creek	Unnamed Road	T48N R9W Sec 17	Bridge	Metal with Open Wood Decking	Native	N/A	No	Site is stable, not inventoried due to deep water and adjacent wetlands
EB10	East Branch Two Hearted River	Widgeon Trail	T48N R9W Sec 7	Bridge	Metal with Open Wood Decking	Native	N/A	No	Not inventoried, crossing is stable, moderate stream bank erosion site downstream
JC1	Johns Creek	CCI Road	T48N R11W Sec 1	4' Round Culvert	Metal	Native	Yes	Yes	Crossing structure is poorly aligned and perched (<3"), evidence of old stream channel upstream suggests structure was previously well aligned
NB1	North Branch Two Hearted River	CR 418	T48N R11W Sec 1	Bridge	Metal with Open Wood Decking	Gravel/Native	N/A	Yes	Crossing is at low point in road, minor erosion of road approaches
NB2	North Branch Two Hearted River	Unnamed Road/Trail	T48N R11W Sec 2	N/A	N/A	N/A	N/A	N/A	Crossing identified on map but not found in the field due to limited access
SB1	South Branch Two Hearted River	CCI Road	T48N R11W Sec 21	One 4' and Three 6' Round Culverts	Metal	Native	No	Yes	Crossing structures are severely undersized for the site, moderate erosion from embankments, deep water at site
SB2	Dairy Creek (South Branch)	Unnamed Road	T48N R11W Sec 30	N/A	N/A	N/A	N/A	N/A	Site not inventoried due to limited access
SB3	South Branch Two Hearted	Unnamed Road	T47N R11W Sec 3	N/A	N/A	N/A	N/A	N/A	Site not inventoried

Site #	Stream Name	Road Name	Location	Crossing type	Crossing Material	Road Surface	Perched	Erosion	Site Description
	River								
WA1	Chris Brown Creek (Wabash Creek)	CR 414	T49N R10W Sec 23	2' Round Culvert	Metal	Gravel/Native	No	Yes	Crossing structure is severely undersized (length) and located at low point in road, severe erosion from embankments and road approaches
WA2	Wabash Creek	CR 414	T49N R10W Sec 27	4' or 6' Round Culvert	Metal	Gravel/Native	No	No	Crossing structure is severely undersized for site conditions, not inventoried due to deep water and adjacent wetlands
WB1	Unnamed Tributary to West Branch	Jeep Trail off Dillingham Lake Road	T48N12W Sec 13 (NW)	Ford	None	Native	N/A	Yes	Crossing is at low point in road, severe erosion from approaches, no structure in place, vehicles drive directly through stream
WB2	West Branch Two Hearted River	Jeep Trail off Dillingham Lake Road	T48N R12W Sec 9	Ford	None	Native	N/A	Yes	Unauthorized stream ford (previously closed off by owner), some armoring with minor erosion on north approach, large beaver dam immediately upstream has created an impoundment

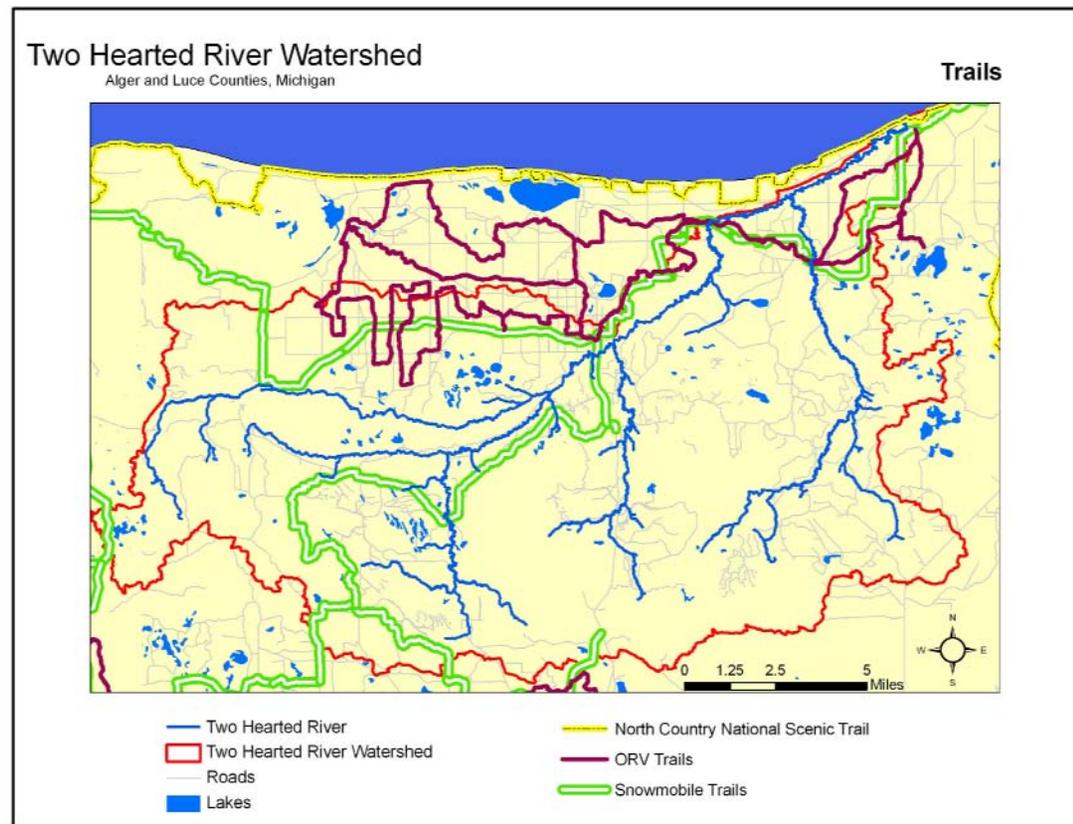
Trails

Luce County offers miles of well groomed and scenic snowmobile and Off Road Vehicle (ORV) trails along with sections of the North County National Scenic Trail, a premier footpath that stretches for about 4,600 miles linking communities, forests, and prairies across seven northern states.

Approximately 135 miles of snowmobile trails exist in Luce County with over 53 miles located within the Two Hearted River watershed. Similarly, ORV operation is permitted on designated trails, routes and areas, and state forest roads unless they are posted closed (MDNR 2008). The Two Heart and Pine Ridge ORV trails, located in McMillan Township, provide over 37 miles of trails within the watershed (Figure 2.9). These trails are designed for ORVs less than 50" in width, off road motorcycles, and All Terrain Vehicles (ATVs). Off Road Vehicle operation is not permitted off roads or trails or on private land without written permission.

The Grand Marais Chapter of the North Country Trail Association has responsibility for approximately 150 miles of trail which runs from the mouth of the Two-Hearted River, west to Grand Marais and then to Munising and ending at the Rock River Canyon. Sections of this trail, while not

Figure 2.9 Designated Trails in and around the Two Hearted River Watershed





ORV tracks in wetlands



Unauthorized stream ford

located within the boundary of the watershed, offer beautiful forest and cliff walks with tremendous views of Lake Superior (<http://www.northcountrytrail.org/gmc/index.htm>).

In September of 2006, the Luce County Board of Commissioners opened all Luce County roads to ORV traffic. With the county roads open, ORV riders now have the means to reach every fire lane, two-track and logging road in the county. Many two-tracks lead to or across private property which has led to an increase in trespass issues involving ORVs. This also affords them access to lakes, streams, rivers, marshes, Lake Superior beaches and many areas that were previously inaccessible. While most ORV users are responsible in their riding habits, the availability of new routes has resulted in escalating environmental damage. The website www.lucecountyorvdamage.com provides information on the damage that has resulted from ORV use in northern Luce County, including details of a recent lawsuit in which a private landowner was awarded \$22,071 for damages to wetlands on his property.

Illegal ORV use not only hurts the environment but harms the reputation of responsible users and threatens the future of legal ORV use in Michigan. The issue has prompted many law-abiding ORV riders to take action before the majority loses privileges as a result of the law-abusing few. Organizations such as "Tread Lightly", a national nonprofit organization of ORV users, seek to protect recreational access through education and stewardship initiatives (www.treadlightly.org).

Similarly, the Michigan Department of Natural Resources Draft Off-Road Vehicle (ORV) Management Plan (MDNR 2008) provides recommendations to fulfill the public's desire for more riding opportunities while ensuring safety of riders and protection of the environment. Some of the recommendations include in the plan:

- More emphasis on education and public awareness campaigns
- Mandatory ORV youth education/certification programs with emphasis on the importance of legally operating ORVs
- More patrols and tougher enforcement in areas with heavy damage caused by ORVs and high ORV use
- A toll-free line to report illegal ORV use similar to the Report All Poaching (RAP) line
- An ORV license with a readily identifiable number to aid law enforcement officials
- Partnerships between conservation officers and local law enforcement agencies to crack down on ORV enforcement

- Increased penalties for illegal ORV use
- More effective management plans for restoring environmentally damaged sites

Political Landscape

McMillan Township occupies the majority of the Two Hearted River watershed (123,906 acres) with portions of the headwaters located in Columbus Township (6,997 acres) and Burt Township, Alger County (1,575 acres). Zoning in the watershed is regulated by Luce County, one of only 24 of the 83 counties in Michigan that have county-wide zoning ordinances.

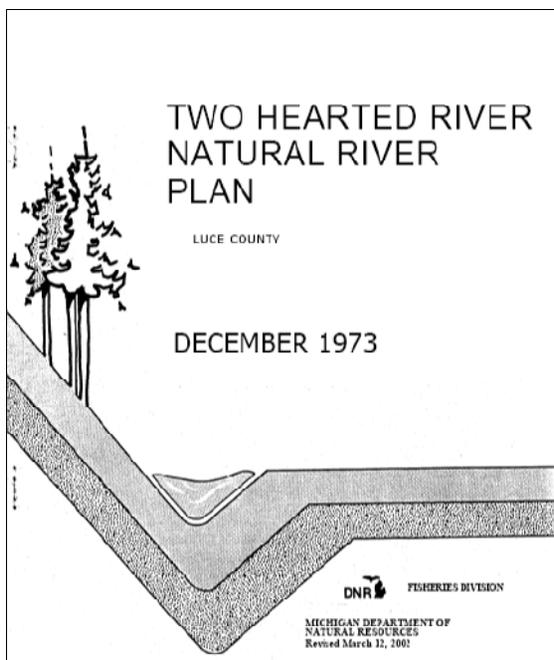
In 2002, the Luce County Planning Commission developed a Comprehensive Plan for the County, laying the framework for future land use decisions. The Plan identifies the County's vision "to define the path that will provide an opportunity for controlled growth and progress while maintaining Luce County's unique setting, attitude, community and independent way of life" (Gove Associates, 2002). The goals outlined in the Plan include the preservation of the area's natural character and forestlands, expansion of services and facilities, improvement of commercial corridors, and the development of a Lake Superior Shoreline Management Plan (TNC 2007).

In 2005, the Luce County Planning Commission began the process of revising the County's zoning ordinances. The proposed ordinances work to begin to implement the Comprehensive Plan and include provisions to expand freshwater resource protection (TNC 2007). Some of these provisions include:

- Identifying wetlands, waterfront setback areas, sand dunes (with >18% slope), lands with steep slopes and other environmentally sensitive areas as "undevelopable land"
- Limiting impervious surfaces, both within the greater watershed and specifically within 500 -700 feet of the waterbody to protect overall watershed health, and lessen the local impacts to the stream channel and aquatic communities
- Maintaining a 50-100 foot vegetated buffer along the lake, stream or wetland with indigenous species
- Setting a minimum river frontage width (330') for all lots; and including all rivers and streams in the "River/stream overlay" in addition to those designated as Natural Rivers



Unauthorized stream ford



In 2008, the Luce County Planning Commission developed the Lake Superior Coastal Management Plan with funding from the Michigan Coastal Management Program, the MDEQ, the National Oceanic Atmospheric Administration and in-kind match provided by Luce County Planning and Luce West Mackinac Conservation District. The intent of this plan is to preserve the natural habitat, resources and beauty of the Lake Superior coast-line in Luce County. The plan identifies threats to natural features and provides recommendations to guide future improvement and protection efforts in coastal areas (Luce County Planning 2008). Many of the threats identified and recommendations included in the plan are also applicable to non-coastal areas.

In addition to county-wide zoning and the land/water interface laws in Michigan, other measures that protect the high quality aquatic resources of the Two Hearted River watershed include the Natural River designation and voluntary Best Management Practices (BMPs) regarding forest management (TNC 2007). In 1973, the MDNR developed a Two Hearted River Natural River Plan, which was updated in 2002. The plan identifies the Natural River District as a 400 foot buffer along either side of the designated natural river portions, including the Main Branch, North Branch, South Branch, West Branch, East Branch, and Dawson Creek. This District "establishes a zoning district in which certain types of future development and land use will be regulated so as not to be injurious to the river resource, property values and scenic and recreation values" (MDNR, 2002). The plan regulates activities near or adjacent to the River in order to protect the aquatic resources. The regulations outlined in the plan include:

- A natural vegetation strip 100 feet wide is maintained on each side of the water's edge,
- Commercial timber harvest is permitted beyond 100 feet of water's edge,
- Mining and extractive industries are permitted beyond 300 feet of water's edge, and
- Construction of structures beyond 75 - 100 feet of water's edge, depending on the river bank erodibility.

Other regulations address camping, boat launching, and specifics for development such as septic system placement and minimum lot size. The Natural Rivers Plan does not limit the Luce County Zoning Board from strengthening these regulations through county zoning (TNC 2007).

Table 2.6 Buffer Strip Widths According to Slope (TNC 2007)

The MDNR and MDEQ have developed guidelines for forest landowners in order to maintain high quality water on their land. This guide, "Water Quality Management Practices on Forest Land", is part of Michigan's Nonpoint Source Pollution Control Management Plan and includes practices for road construction and maintenance, use of log landings, and forest harvest within the riparian buffers, among others (MDNR 1994). Although these guidelines are voluntary, they are often utilized as mandatory practices for third party forest certification, such as Forest Stewardship Council. The guidelines outline the importance of buffer strips along rivers and streams with suggested limited activities within these areas in order to minimize soil disturbance and compaction and retain adequate tree cover. Table 2.6 outlines the minimum width of the buffer strips, based on slope, provided in the manual. The manual is currently being revised and is expected to be released during 2008 (TNC 2007) .

Slope of Land Above Waterbody or Stream	Minimum Width of Strip (Feet)
0 to 10	100
10 to 20	115
20 to 30	135
30 to 40	155
40 to 50	175
50+	Activity may not be advisable due to erosion potential

Future Growth Areas

The Michigan Land Use Institute has estimated an average increase of up to 40% in second home development for portions of the Two Hearted River watershed by the year 2020 (MLUI 2000). Given the rate of change observed in the watershed between 1990 and 2000, this estimate is likely low. However, despite observed increases in growth and development, human settlement remains largely limited by large tract land holdings with few private parcels, unimproved roads, and natural features including the extensive wetland complexes. Landowners such as the State of Michigan and The Nature Conservancy, who combined own almost 70% of the land in the watershed, offer an additional level of protection per current long-term land use plans. An additional 15% of the land in the watershed held by corporate forest products producers under working forest conservation easement allows for continued economic and environmental sustainability of these lands along with accessibility to the public.

Private land holdings along the upper East Branch and Dawson Creek offer the greatest potential for future growth and development. These lands have become increasingly attractive as demands for recreational opportunities increase and real estate values continue to rise including the high value of water front property. While this type of development appears to pose the greatest threat to water quality, Natural Rivers Program regulations and proper planning by Luce County including the proposed Luce County zoning ordinances and Lake Superior Coastal Management Plan for Luce County provide provisions for protection of water quality and the natural character of the watershed.

Future improvements to the road infrastructure leading from the population centers of Newberry and Grand Marias will increase the public's access to the Two Hearted watershed. These improvements will also likely result in increased development and recreation pressures. However, Luce County continues to prepare for this type of growth through proper planning and coordination with watershed stakeholders and the public.

DESIGNATED USES AND POLLUTANTS OF CONCERN

The first step in establishing goals for this watershed planning project was to evaluate the current condition of water quality in the watershed. The primary criterion for water quality is whether the waterbody meets designated uses.

Designated uses are recognized uses of water established by state and federal water quality programs. In Michigan, all surface waters of the state are protected by water quality standards for specific designated uses (Table 3.1). These standards and designated uses are designed to 1) protect the public's health and welfare, 2) to enhance and maintain the quality of water and 3) to protect the state's natural resources.

Table 3.1 Designated uses for all surface waters of the State of Michigan.

In Michigan, all surface waters of the state are designated for and shall be protected for all of the following uses:
<ol style="list-style-type: none">1. Agriculture2. Industrial water supply3. Public water supply and the point of intake4. Navigation5. Warmwater fishery (or coldwater fishery)6. Other indigenous aquatic life and wildlife7. Partial body contact recreation8. Total body contact recreation between May 1 and October 31
<small><i>Citation: R323.1100 of Part 4, Part 31 of the Natural Resources and Environmental Protection Act, 1994 PA 452, as amended</i></small>

Table 3.2 MDEQ 2008 Integrated Report Listings for the Two Hearted River Watershed (MDEQ 2008)

Stream Reach/Waterbody	Designated Use								
	Total Body Contact Recreation	Partial Body Contact Recreation	Navigation	Industrial Water Supply	Agriculture	Warm Water Fishery	Other Indigenous Aquatic Life and Wildlife	Cold Water Fishery	Fish Consumption
South Branch Two Hearted River	X	X	FS	FS	FS	X	FS	X	X
North Branch Two Hearted River	X	X	FS	FS	FS	X	FS	X	X
Dawson Creek (including Little Dawson Creek)	X	X	FS	FS	FS	X	FS	X	X
East Branch Two Hearted River	X	X	FS	FS	FS	X	FS	X	X
Widgeon Creek (East Branch)	X	X	FS	FS	FS	X	FS	X	X
West Branch Two Hearted River	X	X	FS	FS	FS	X	FS	X	X
Pretty Lake	X	X	FS	FS	FS	X	X	X	NS

X = Not Assessed, FS = Fully Supporting, NS = Not Supporting

Impaired and Threatened Designated Uses

The DEQ uses a rotating watershed cycle for surface water quality monitoring where each of the 58 major watersheds in the state is scheduled for monitoring at least once every five years. Data from this monitoring along with other readily available water quality data and information are used to assess surface water quality conditions. Each assessed waterbody is placed in at least one of five reporting categories based upon: 1) the degree of designated use support, 2) how much is known about the waterbody's water quality status, and 3) the type of impairment preventing designated use support.

If a body of water or stream reach is not meeting the water quality standards set for a specific designated use, then it is said to be in "nonattainment". An annually published listing of bodies of water and stream reaches in the state of Michigan that are supporting designated uses and those that are in nonattainment can be found in the Water Quality and Pollution Control in Michigan 2008 Sections 303(D), 305(B), and 314 Integrated Report (MDEQ 2008). Table 3.2 provides the 2008 Integrated Report listings for the Two Hearted River watershed.

Based on the bodies of water and stream reaches assessed and the designated uses they were assessed for, the only waterbody in the Two Hearted River watershed listed as not attaining a designated use is Pretty Lake. Pretty Lake is not currently supporting the designated use for fish consumption. The cause of this listing is mercury in fish tissue. No other designated uses are known to be impaired on a watershed wide scale. While the source of elevated mercury levels in Pretty Lake is unknown, it may be a result of atmospheric deposition or natural attenuation of mineral deposits or a combination of sources. Air pollutants can reach water bodies as direct deposition (falling directly into the water) or as indirect deposition (falling onto the land and washing into a waterbody). The impacts of atmospheric deposition of pollutants such as mercury on land and surface waters are well documented. There is also some evidence atmospheric pollutants can affect groundwater (USEPA 2006).

The combined pressures from recreation, development and forest management activities can dramatically affect water quality and aquatic habitat conditions resulting in threats to designated uses. Threatened water bodies are defined as those that currently meet water quality standards, but may not in the future. In the Two Hearted River watershed, three designated uses are currently threatened on a watershed-wide scale. They include the coldwater fishery, other indigenous aquatic life and wildlife, and public water supply (Table 3.3).

Table 3.3 Threatened Designated Uses in the Two Hearted River Watershed.

Designated Uses	Status
Coldwater Fishery	Threatened
Other Indigenous Aquatic Life and Wildlife	Threatened
Public Water Supply (groundwater)	Threatened

One source of threat to the coldwater fishery and other aquatic life is increasing public recreation pressures such as fishing, canoeing and camping which have aggravated stream bank erosion and sedimentation at many sites. Off Road Vehicles (ORV's), or four-wheelers, pose one of the most serious threats by accessing remote and sensitive areas prone to erosion or by simply driving through tributary streams. Sand and sediment harm fish and other aquatic life by covering the natural stream substrate they rely upon. Excessive inputs of sediment also fill in stream channels, making them shallower and wider and more susceptible to changes in hydrologic flow and increases in water temperature.

Table 3.4 Threatened Designated Uses in the Two Hearted River Watershed including Pollutants, Sources, and Causes

Threatened Designated Use	Pollutants	Sources	Causes
Coldwater fishery Other indigenous aquatic life and wildlife	Sediment (k)	Road stream crossings (k)	Poor design/construction/maintenance (k) Lack of erosion controls (k) Steep approaches (k) Culverts not aligned to stream bed (k) Undersized or perched culverts (k) Lack of crossing structure (k) Road grading operations (k)
		Forest management practices (k)	Removal of riparian vegetation (lack of riparian buffers (k) Clearing by landowners (k) Equipment problems due to steep topography (k) Numerous crossings of small streams and drainages routes (k)
		Recreational activities (k)	Off Road Vehicle crossings of wetlands and streams (k) Aggravated stream bank erosion from unauthorized or unimproved access points (k)
		Development (k)	Removal of riparian vegetation (lack of riparian buffers) (k) Clearing by landowners (k) Construction of secondary access roads (k)
Coldwater fishery Other indigenous aquatic life and wildlife	Nutrients (p)	Septic systems (p)	Unsuitable sites/soils (k) Poorly designed or maintained systems (p)
		Residential fertilizer use (p)	Improper application (amount, timing, frequency, location, method, chemical content) (p)
Public water supply			

Threatened Designated Use	Pollutants	Sources	Causes
Coldwater fishery Other indigenous aquatic life and wildlife Public water supply	Toxins (herbicides, pesticides, oils, gas, grease, salts/chloride, etc.) (p) and heavy metals (p)	Forest Management Practices (p) Recreational/residential uses (p)	Improper application of herbicides and/or pesticides (amount, timing, frequency, location, method, chemical content) (p) Hazardous waste spills from heavy equipment (p) Improper application of herbicides and/or pesticides (amount, timing, frequency, location, method, chemical content) (p) Illegal dumping (p) Burn barrel use (p) Oil/gas spills from ORVs, snowmobiles, or other equipment (p)

The coldwater fishery and aquatic life are also threatened by continued timber harvest. Corporate and private non-industrial logging operations pose both historic and modern challenges to maintaining water quality. Old logging roads continue to cause erosion and sedimentation problems especially at stream crossings. New logging access roads, if not properly designed, create similar problems as well as accelerating habitat fragmentation and development pressures.

Increasing trends in second home or camp development are a growing concern in the watershed with much of the new building occurring on waterfront or riparian property. This type of development can result in erosion, nutrient loading (septic systems) or other water quality impacts threatening the coldwater fishery, other aquatic life and the public water supply.

Pollutants, Sources, and Causes

There are known and potential pollutants in the Two Hearted River watershed that have the potential to adversely affect water quality and threaten designated uses (Table 3.4). The sources and causes of these pollutants were ascertained through literature review, water quality monitoring data, road/stream crossing inventory data, field observations, land use and erosion analysis, and personal contact with watershed residents and experts.



The Dawson Creek Ditch



Table 3.5 Desired Uses and Existing Threats in the Two Hearted River Watershed

Desired Use	Threat	Comment
Coldwater fishery	Erosion and sedimentation from unimproved roads and illegal crossings (fords), canoe put-in sites and campgrounds	Human influences have resulted in sedimentation to the Main Branch Two Hearted River and its tributaries; potential impacts include changes water quality, stream characteristics, and loss of spawning habitat and macroinvertebrate communities (food sources)
Non-motorized Boating	Unimproved put-in sites; forest pathogens	Lack of established put-in sites creates erosion and sedimentation issues; forest pathogens that affect riparian areas result in additional input of course woody structure (High Bridge downstream to mouth); potential impacts include loss of riparian cover, changes in stream characteristics and loss of recreational opportunities
Hunting, Trapping	Inappropriate use of State, Commercial Forest Act and other private lands, forest pathogens and invasive species	Potential impacts due to illegal uses and forest pathogens include loss or modification of habitat and loss of recreational opportunities
Forestry	Forest pathogens (example: Beech bark disease) and invasive species	Beech bark disease advancing at a rate of ~6 miles per year; very few trees are resistant – affects production; Forestland Group, LLC planting Northern red oak in place; loss of trees provides pathways for invasive species

Desired Uses

In addition to designated uses, the Two Hearted River Watershed Advisory Council identified a number of locally determined desired uses for the watershed. Desired uses are factors important to the watershed stakeholders. They reflect the way stakeholders want to use the watershed and their desire to maintain it for future generations. A summary of the desired uses identified by stakeholders of the Two Hearted River watershed and threats to those uses are included in Table 3.5.

Pollutant Loading

Similar to many watersheds of the Upper Peninsula of Michigan, sediment is the greatest pollutant of concern in the Two Hearted River watershed. Due to the number and extent of stream bank erosion sites, sediment was quantified in a watershed-wide analysis of erosion and pollution loading. Watershed surface runoff; nutrient loads, including nitrogen, phosphorus, and 5-day biological oxygen demand (BOD5); and sediment delivery were also analyzed based on various land uses and management practices.

The U.S. Environmental Protection Agency's Spreadsheet Tool for Estimating Pollutant Loads (STEPL) was used to calculate erosion and pollution loads in the Two Hearted River and its tributaries. Annual

sediment loading was calculated using STEPL and the Universal Soil Loss Equation (USLE). More STEPL information can be found at <http://it.tetrattech-ffx.com/stepl/>.

Erosion was characterized in two ways:

1. Soil loss for the watershed as a whole (not including streambank erosion)
2. Impaired streambank erosion points (both natural and manmade)

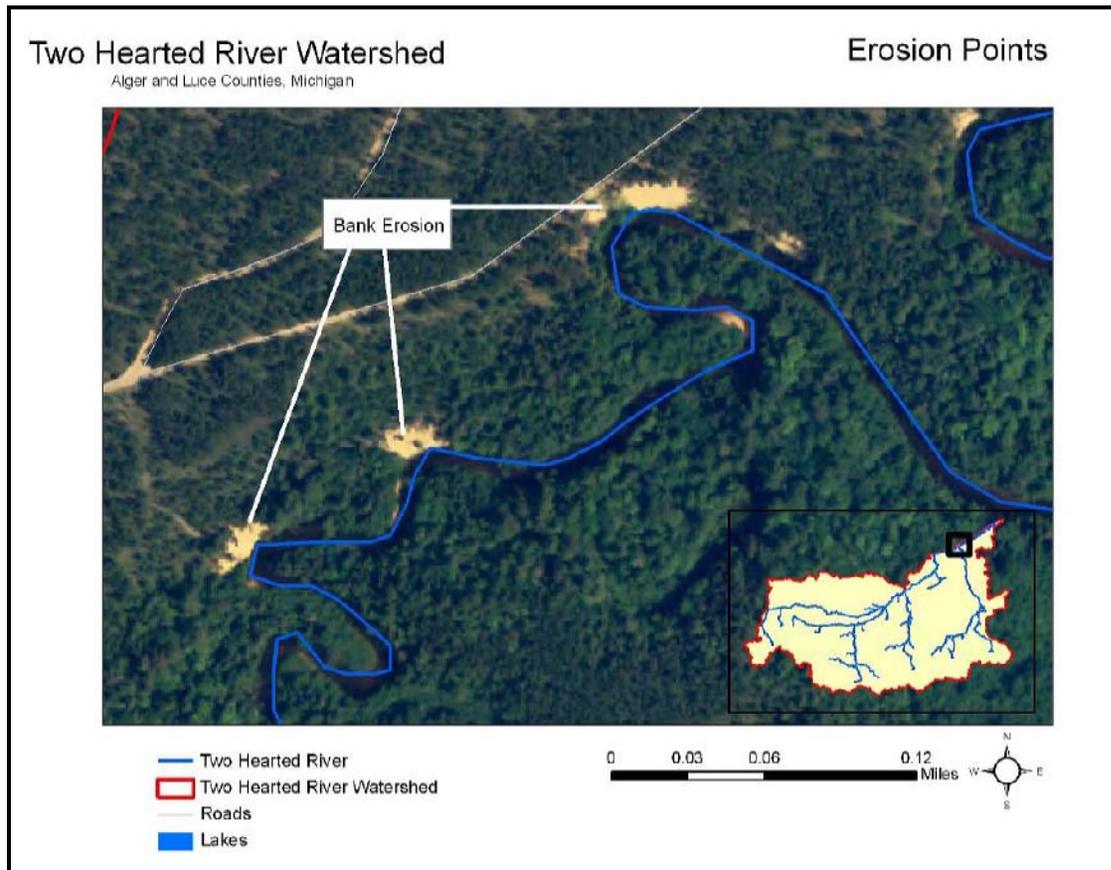
Watershed-wide Soil Loss

The USLE uses several parameters to calculate the soil loss in tons per acre per year, such as rainfall runoff, soil erodibility, topography, cover and management practices. Data for these parameters came from the U.S. Environmental Protection Agency STEPL website (<http://it.tetrattech-ffx.com/stepl/>), which contains the data for the Two Hearted River watershed located within the Betsy-Chocolay HUC (04020201).

Based on this information, the estimated sheet and rill soil loss for the Two Hearted River watershed was calculated to be 0.0049 tons per acre per year or 649 tons per year watershed wide. These results were compared to croplands such as in St. Joseph County in the Lower Peninsula of Michigan, which is primarily agricultural and often exceeds 10 tons per acre per year (<http://www.glc.org/basin/pubs/annual/pdf/AR-2002.pdf>). It is likely that the low amount of soil loss in the Two Hearted

Desired Use	Threat	Comment
Wildlife Observation (bird watching, etc.)	Incompatible recreational uses (ORVs); lack of designated areas and marketing; forest pathogens and invasive species	Need established viewing areas, signage and marketing; potential impacts include loss or modification of habitat due to damage, forest pathogens and invasive species and loss of recreational opportunities
Lake Superior shoreline at mouth of Two Hearted River – unique habitat and dynamic processes	Incompatible recreation use (ORV, snowmobile)	Need for additional signage, public information, education and enforcement; potential impacts include loss or modification of unique habitats due to damage
Vacation Cottages	Inappropriate vegetative buffers, location of structures in 100-year floodplain	Enforcement of setbacks and vegetative buffers needed to prevent loss of riparian cover, changes in stream characteristics and habitat; example of potential violation near confluence of Widgeon Creek and East Branch
Trail Riding (Snowmobile, ORV)	Inappropriate use on State, Commercial Forest Act and other private lands, illegal stream crossings	Need for additional signage, public information, education and enforcement; potential impacts include loss or modification of unique habitat and sensitive areas (wetlands, beaches, etc.) and loss of recreational opportunities
Dog Mushing	No designated trails; incompatible with existing trail uses (snowmobiles, ORVs)	Need for established trails, signage and marketing; ten (10) or more established kennels in area; at least 3 races annually from Rainbow Lodge
Hiking, cross-country skiing, snow shoeing	Few designated trails; incompatible with existing trail uses (snowmobiles, ORVs)	Need more established trails, signage and marketing; linkage to North County Trail, etc.

Figure 3.1 Example of Erosion Points Identified using NAIP 2005 Digital Orthophotos



River watershed is largely due to lack of agricultural croplands, the large amount of forests and wetlands, and how the land is managed by large landholders such as the MDNR, TNC, and corporate forest products producers.

Impaired Streambank Erosion Points

A stable stream is one that maintains a stable morphology, constant pattern (sinuosity), slope, and cross-section and neither aggrades or degrades over time. Stream stability is not the absence of erosion; some sediment movement and streambank erosion are natural. Possible causes of erosion are (Fongers 2007):

- Natural river dynamics
- Sparse vegetative cover due to too much animal or human traffic
- Concentrated runoff adjacent to the streambank (i.e. gullies, seepage)
- In-stream flow obstructions, i.e. log jams, failed bridge supports
- An infrequent event, such as an ice jam or low probability flood
- Unusually large or frequent wave action
- A significant change in the hydrologic characteristics (typically land use) of the watershed
- A change in the stream form impacting adjacent portions of the stream (i.e. dredging, channelization)

Impaired streambanks in the Two Hearted River watershed were identified using the National Agricultural Imagery Program (NAIP) 2005 digital orthophotos (Figure 3.1). The NAIP 2005 digital orthophotos and USGS 7.5 minute series topographic maps showing the Two Hearted River and its tributaries are provided in Appendix C.

A total of 256 possible impaired streambanks were identified and classified into natural (175) or manmade points (79) (Figure 3.2). Most points were associated with sandy soils and steep slopes. Natural erosion points were classified as points that occurred around bends in the river and where the banks are dominated by sand. Manmade points were classified as streambanks that appeared to be compromised due to roads, trails and access points (Figure 3.3).

Figure 3.2 Streambank Erosion Sites in the Two Hearted River Watershed

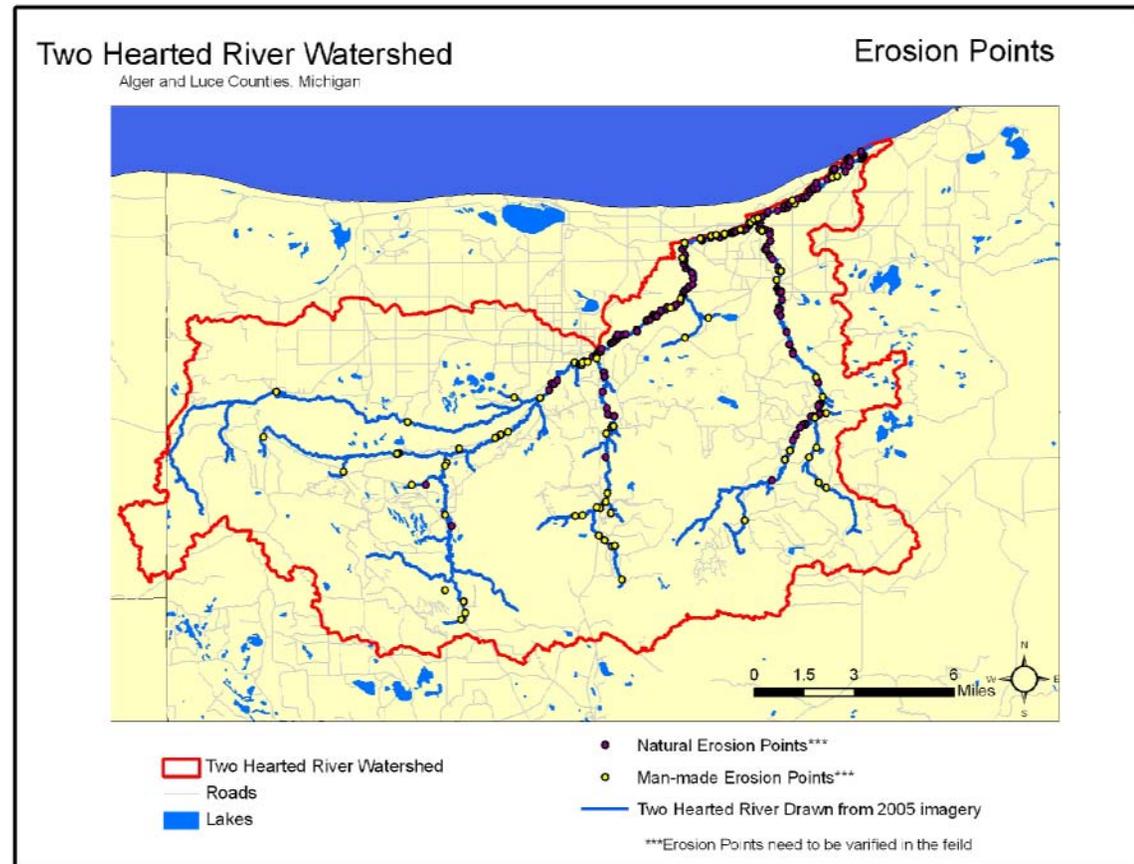
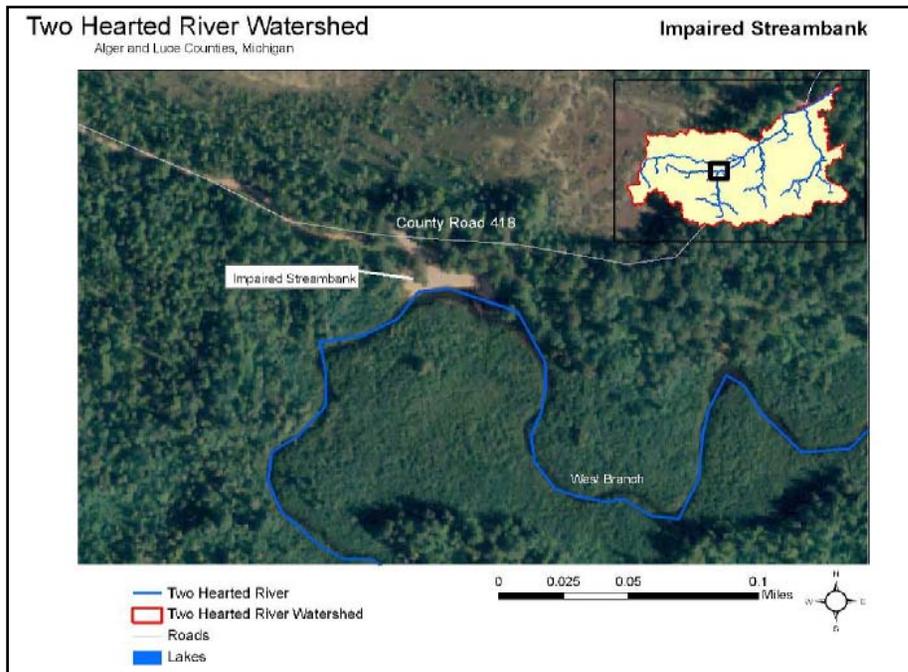


Figure 3.3 Example of "Manmade" Streambank Erosion Site
(see Photo of this site)



aerial photo of stream bank erosion site?



"Manmade" stream bank erosion site along the West Branch Two Hearted River near County Road 418. The person standing along the river (center) shows the magnitude of the erosion at this site.

The STEPL Impaired Streambank worksheet uses the length and height of the streambank erosion site, lateral recession rate, and soil type to calculate annual sediment loading. Length and height of each stream bank erosion site was measured from the NAIP 2005 digital orthophotos using GIS software. Information for each of the 70 manmade streambank erosion sites was entered into the STEPL Impaired Streambank worksheet, which provided a watershed-wide estimated sediment load of 1,255 tons per year from man-made erosion sites (Table 3.6).

Table 3.6 Summary of Manmade Streambank Erosion Points and the Annual Sediment Load for each Two Hearted River Subwatershed

Subwatershed	Number of Manmade Erosion Points	Annual Sediment Load (tons/year)
Main and West Branch	35	814
South Branch	8	16
East Branch	11	162
North Branch	3	3
Dawson Creek	17	252
Widgeon Creek	5	8
Watershed Total	79	1,255

Because the STEPL worksheet only allows 100 impaired stream banks to be entered and there were 175 naturally impaired sites, the averages for each naturally impaired stream bank point were calculated for four lateral regression rate categories. The averages were then applied to the number of points in the same category to calculate the annual sediment load. The results indicate an estimated annual sediment load of 1,048 tons per year from natural erosion sites (Table 3.7).

Table 3.7 Summary of Naturally Impaired Streambank Erosion Points and the Annual Sediment Load for each Two Hearted River Subwatershed

Subwatershed	Number of Natural Erosion Points	Annual Sediment Load (tons)
Main and West Branch	119	888
South Branch	2	1
East Branch	47	155
North Branch	0	0
Dawson Creek	7	4
Widgeon Creek	0	0
Watershed Total	175	1,048

Combined, natural and manmade erosion sites contribute an estimated 2,303 tons of sediment to the Two Hearted River and its tributaries each year (Table 3.8). The majority of this impact occurs along the Main and West branches, the East Branch and Dawson Creek with the Main and West branches having the highest number of erosion sites. While there are fewer erosion sites in the Dawson Creek subwatershed, it appears to be most impacted by human influences with over 70% of the erosion points classified as manmade.

Table 3.8 Total number of impaired Streambank Erosion Points and Annual Sediment Load for each Two Hearted River Subwatershed

Subwatershed	Number of Manmade Erosion Points	Number of Natural Erosion Points	Total Number of Erosion Points	Annual Sediment Load (tons)
Main and West Branch	35	119	154	1,702
South Branch	8	2	10	17
East Branch	11	47	58	317
North Branch	3	0	3	3
Dawson Creek	17	7	24	256
Widgeon Creek	5	0	5	8
Watershed Total	79	175	254	2,303

Potential Pollution Load

STEPL also computes watershed surface runoff; nutrient loads, including nitrogen, phosphorus, and 5-day biological oxygen demand (BOD5); and sediment delivery based on various land uses and management practices. Using STEPL and watershed-wide land use data, a watershed wide pollution load was calculated for Nitrogen (N), Phosphorus (P), Biological Oxygen Demand (BOD) and sediment based on current land use data (Table 3.9).

Table 3.9 Nitrogen, Phosphorus, Biological Oxygen Demand and Sediment loads based on land uses within the Two Hearted River Watershed

Total pollutant loading by land uses				
Source	N Load (lb/yr)	P Load (lb/yr)	BOD Load (lb/yr)	Annual Sediment Load (tons)
Urban	356	55	1,368	8
Forest	15,627	7,797	38,994	47
Septic	515	202	2,102	0
Streambank	85	33	171	155
Total	16,583	8,087	42,634	210

STEPL does not take into account the large amount of wetlands located within the Two Hearted River Watershed. The wetlands in the watershed are primarily sphagnum based which can greatly increase nitrogen levels within the system. As such, nitrogen, phosphorus and BOD should be tested in the field for comparison with model estimates.

Priority Pollutant Ranking

The pollutants listed in Table 3.4 were ranked and prioritized based on how they most affect or have the potential to affect water quality and the watershed's threatened designated uses (Table 3.10). Overall, sediment is the highest priority pollutant with known sources occurring from most land uses within the watershed. Without implementation of corrective actions at degraded sites as well as implementation of Luce County's improved zoning ordinances and improved land use practices, sedimentation problems will likely result in further degradation of water quality and designated and desired uses.

Table 3.10 Priority ranking of pollutants in the Two Hearted River Watershed

Pollutant	Priority Ranking
Sediment	1
Nutrients	2
Heavy metals, toxins	3

Impacts from nutrients (septic, residential fertilizer, etc.) pose a significant threat to designated and desired watershed uses. The majority of the land within the Two Hearted River watershed is considered not well suited for septic (96% or 126,967 acres). This means that overcoming the limitations, due to soil properties or features at the site, would most likely be too cost prohibitive, both due to initial and potential ongoing maintenance costs. It also means that there is a high probability that groundwater contamination could occur as a result of systems that are not properly installed or maintained (TNC 2007).

The potential for impacts from heavy metals, nutrients, and toxins also pose threats to water quality and designated uses in the Two Hearted River watershed. Future water quality monitoring efforts should include periodic sampling for these pollutants. While each pollutant has a different affect on water quality and threatened designated uses, all are important and should be priorities for periodic monitoring.

Priority Source Ranking

Pollutants were also ranked by their sources in order to prioritize implementation of corrective actions (Table 3.11). Also, because pollutants are often interconnected with each other, implementing corrective actions at one source can often result in reductions of pollutants from other sources.

Table 3.11 Priority Ranking of Sources of Pollutants in the Two Hearted River Watershed

Pollutant	Sources	Priority Ranking
Sediment	Recreational activities (k)	1
	Road/stream crossings (k)	2
	Forest management practices (k)	3
	Development (k)	4
Nutrients	Septic systems (p)	1
	Residential fertilizer use (p)	2
Toxins and Heavy Metals	Forest management practices (p)	1
	Recreational/residential uses (p)	2
		3

k=known, p=potential

ENVIRONMENTALLY SENSITIVE AREAS

Environmentally sensitive areas (ESAs) in the Two Hearted River watershed are defined as the portions of the watershed that are most sensitive to environmental degradation and those areas having the most impact or potential to impact water quality and designated and desired watershed uses. They include areas that may contribute the greatest amount of pollutants to the watershed, either now or in the future, and where preservation and restoration efforts will have the most profound results.

Environmentally sensitive areas were analyzed to identify potential critical habitat and areas sensitive to environmental degradation; to assess natural community condition; and to provide a basis for management decisions. This was accomplished through a comprehensive study of the functional riparian area of the Two Hearted River and its tributaries and comparison with ESAs identified in the revised Luce County zoning ordinances.

Two Hearted River Riparian Analysis

The Two Hearted River Riparian Analysis was conducted in partnership with The Nature Conservancy in Michigan to identify the functional riparian area of the Two Hearted River system and to assess its sensitivity to further development and forest management activities. The following sections are from the Two Hearted River Riparian Analysis (TNC 2007).

The Two Hearted River Riparian Analysis goes beyond the fixed buffer width concept (largely focused on the floodplain), which may not capture all of the diversity and ecosystem function that the riparian area represents. The objectives of the project were to:

- Identify potential critical habitat and areas sensitive to environmental degradation and to assess natural community condition by conducting a Geographic Information System (GIS) analysis on the Two Hearted River riparian area
- Verify the GIS analysis through field work conducted on representative and accessible lands
- Develop management recommendations for critical areas within the riparian corridor



Aerial photo of Two Hearted River

In this analysis, sensitive areas were defined as locations within the riparian area that, given their multiple attributes, create a unique area that if disturbed may affect the water quality of the Two Hearted River or its riparian area. A GIS analysis was conducted to identify these potentially sensitive areas, and was followed by limited field visits to monitor the accuracy of the data input. Characteristics such as physical distance from river, slope, erosion potential, presence of unique natural features, presence of wetlands, and other soil attributes related to building/development conditions were utilized to identify these sensitive areas.

Riparian Areas

Riparian areas have been defined in various ways ranging from a static area extending a fixed distance from a river to a more dynamic and variable width area defined by the ecosystem functions it performs in that particular system. For the purpose of this analysis, a definition closer to the latter example was adopted. As outlined by Ilhardt, Verry, and Palik (2000), "Riparian areas are the three-dimensional ecotones of interaction that include terrestrial and aquatic ecosystems that extend down into the groundwater, up above the canopy, outward across the floodplain, up the near-slopes that drain to the water, laterally into the terrestrial ecosystem, and along the water course at a variable width."

The riparian areas are extremely important since they play many different roles both at a local scale (i.e. neighboring aquatic and terrestrial ecosystems) and at a watershed scale. From the aquatic ecosystem perspective, the riparian area provides energy and nutrient inputs to the system while filtering sediments and absorbing nutrients and water from the uplands. These services help buffer aquatic organisms and maintain key aquatic ecosystem functions such as temperature regulation, energy flow, and hydrologic flow (Flaspohler et al. 2002). The riparian areas also provide the vital connection from the aquatic habitat to the upland habitats. At the watershed scale, riparian areas contain distinct species pools altogether (Sabo, 2005) and support habitat for diverse vegetation and increased species richness due to the diversity of the fluvial landforms (ie. floodplain, terrace, slope, etc) (Goebel et al. 2003).

Riparian Area Analysis Summary

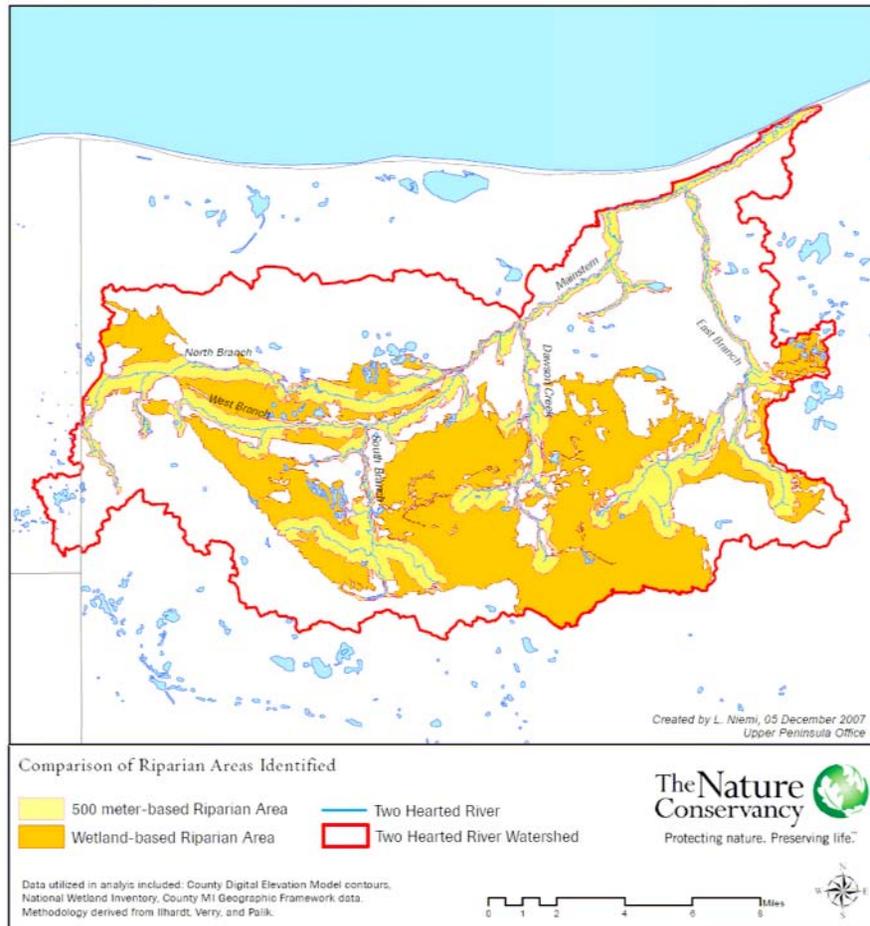
Based on the above discussion, it became clear that in order to truly provide added protection to the Two Hearted River System, its functional riparian areas needed to be identified. This goes beyond the fixed buffer width concept (largely focused on the floodplain), which may not capture all of the diversity and ecosystem function that the riparian areas represent.

The initial step was the identification of the riparian areas. This was done by utilizing the concepts of the riparian area as a functional and dynamic component of both the aquatic and terrestrial systems (Ilhardt, Verry, and Palik 2000). Areas within the riparian area potentially sensitive to development and forestry were determined by using a rating system based on the areas' attributes such as slope, soil characteristics, land ownership, and significant natural communities. The riparian areas were categorized (e.g. high, medium, or low) based on the probability that degradation would occur as a result of development or forestry in these areas. Data was collected from 30 sites in or near the riparian area to confirm the riparian area extent and attributes. Management recommendations were developed based on the areas' attributes.

Defining Riparian Areas

The general process of identifying the riparian areas included a GIS analysis and limited field sampling. The GIS analysis incorporated soils, topography, and adjacent and/or nearby waterbodies (i.e. wetlands and lakes) to determine the extent of the riparian area along the Two Hearted River Main Branch and major tributaries. Initially, two riparian areas were identified: one with a defined maximum extent of 500 m from the river (500 m Based Riparian Area) and one without a defined maximum extent (Wetland Based Riparian Area) (Figure 4.1). Both methods yielded identical results for the riparian area along the Main Branch, the majority of the East Branch, downstream portions of Dawson Creek, the South Branch, and headwaters of the North Branch. The 500 m Based Riparian Area recognized the wetlands adjacent to the river, but did not include the full extent of these wetlands. The Wetland Based Riparian Area (WBRA) included the full extent of the wetlands adjacent to or near the river. Due to the nature of the watershed, a wetland-dominated system, the WBRA was utilized as the basis for the GIS analysis.

Figure 4.1 Comparison of Riparian Areas Identified for the Two Hearted River Watershed



In conducting any GIS analysis, the result is only as accurate as the original input data. The most evident data limitation encountered was the coarse scale topographic information utilized to decipher the various fluvial landforms, terrace, slope and floodplain. The watershed is largely characterized by slight topographic relief with microtopography playing a key role in determining specific habitats, especially in the peatland wetlands; therefore coarse scale data is definitely a limiting factor. Field sampling was conducted at thirty sites within the identified riparian areas across the watershed to further assess the accuracy of the GIS analysis.

Riparian Area Characteristics

As stated above, the riparian area methodology that encompassed the extensive adjacent wetlands was utilized for the remainder of this analysis. Therefore, the following information only pertains to these riparian areas. The Two Hearted River riparian area contains approximately 58,000 acres, roughly 40% of the entire watershed's area. This large percentage is greatly due to the extensive wetland complexes found in the headwaters of the East Branch, throughout Dawson Creek, and the middle portions of the South Branch (Figure 4.2). Only 13% of the riparian area is considered non-wetland. The wetland types within the ripari-

an area are dominantly forested and scrub-shrub with some emergent wetlands (see Table 4.1). A number of lakes are included within the riparian area such as North Branch Lakes, Otter Lake, Long Lake, Two Hearted Lakes, Beaver Lake, McMahon Lake, Sleeper Lake, Stuart Lake, Chris Brown Lake, and the Swamp Lakes.

Table 4.1 Wetland Types in Riparian Area

Type of Wetland	Acres
Beach	10
Emergent	1,282
Forested	28,669
Open water	1,159
Scrub-shrub	19,325
Total	50,445

Figure 4.2 Wetland Types in Riparian Area

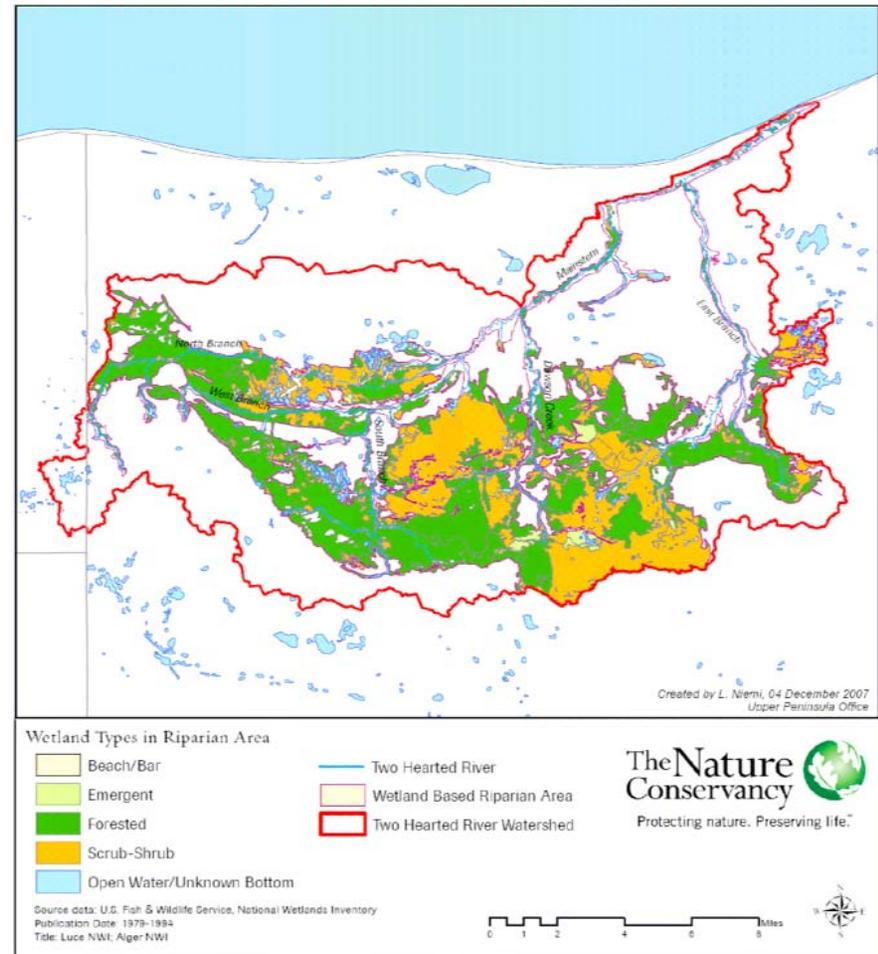
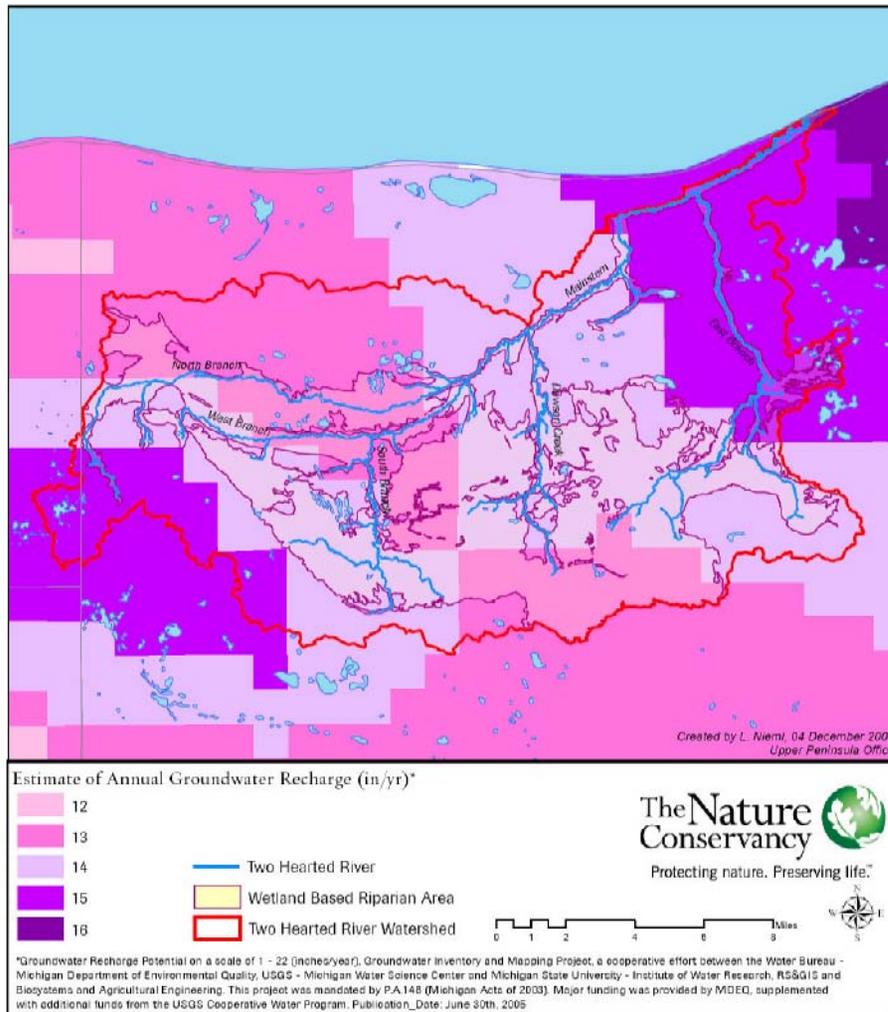


Figure 4.3 Groundwater Recharge in Riparian Area



Groundwater Recharge

The groundwater recharge potential in the riparian area is estimated to be 13 - 16 inches/year. Those areas with the greatest recharge potential (15-16 inches/year) are at the mouth of the Two Hearted River, along portions of the Main Branch (just downstream from Wabash Creek confluence) and the East Branch, and in the very headwaters of the North Branch. The areas with the least groundwater recharge potential are located along the middle of the North Branch, West Branch, and the downstream portions of the South Branch (Figure 4.3).

Topography

Similar to the watershed as a whole, the riparian area of the Two Hearted River has little topographic relief, especially within the extensive wetland areas. More than 80% of the riparian area has a slope of 0 - 5% (Table 4.2). Locations with the greatest percent slope (30 - 100%) include the extreme headwaters of the North Branch and West Branch and along portions of the West Branch, Dawson Creek, the East Branch, and the Main Branch (Figure 4.4).

Table 4.2 Percent Slope in Acres

Percent Slope	Acres
0 to 5	46,493
5 to 10	3,712
10 to 20	1,181
20 to 30	1,163
30 to 100	5,354

Figure 4.4 Topographic Relief in Riparian Area

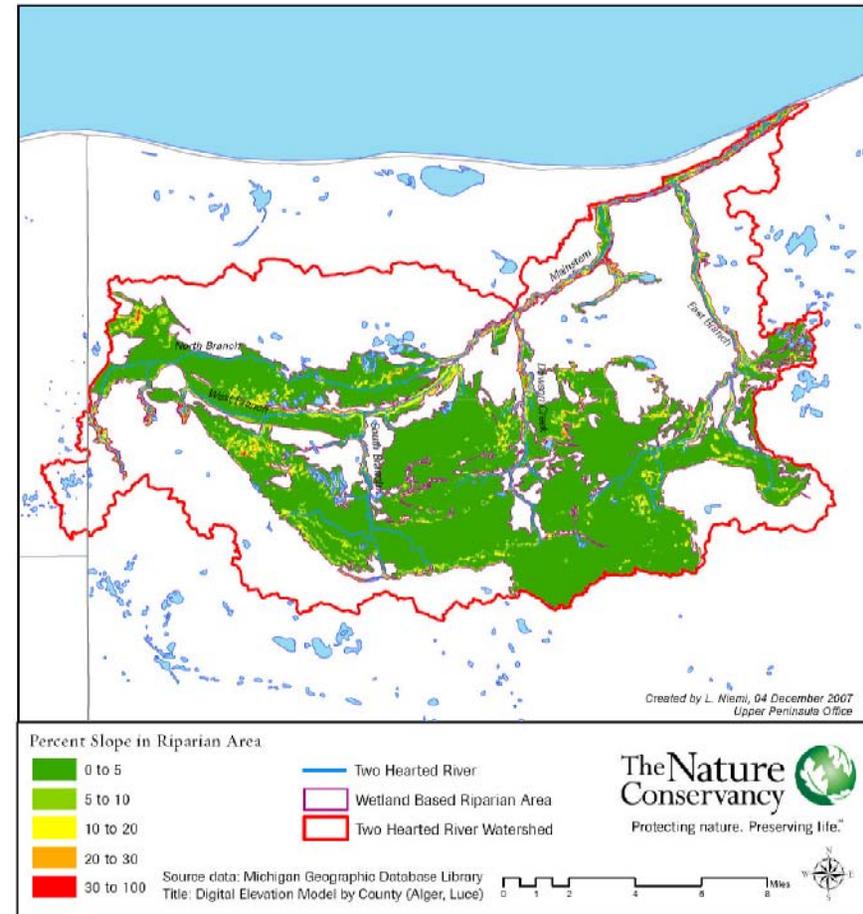


Table 4.3 Land Use/Land Cover Types in Riparian Area

Land Use Class Name	Acres	Percent of Riparian Area
Lowland coniferous forest	20,810	36
Lowland shrub	15,049	26
Mixed non-forest wetland	10,707	19
Lowland mixed forest	4,101	7
Pines	2,301	4
Aspen Association	728	1
Northern hardwood association	716	1
Water	649	1
Emergent wetland	571	1
Floating aquatic	528	1
Mixed upland conifers	461	<1
Upland mixed forest	406	<1
Other upland conifers	399	<1
Herbaceous openland	191	<1
Mixed upland deciduous	180	<1
Oak association	52	<1
Roads/paved	47	<1
Sand/soil	19	<1
Upland shrub.low-density trees	8	<1

Land Use / Land Cover

Due to the methodology utilized in defining the riparian area, the majority of the riparian area largely consists of lowland communities (Table 4.3). This is especially true where the riparian area is extensive, in the Dawson Creek and South Branch subwatersheds (Figure 4.5). These lowland areas create a matrix and include conifer forests, mixed deciduous-conifer forests, shrublands (eg. alder), non-forested wetlands, and patches of emergent wetlands. The few areas of upland communities found in the riparian areas, such as northern hardwood and pine forests, are isolated to the locations where the riparian area boundary was determined by topography, not by the extent of a wetland associated with the river. Similar to the land cover at a watershed wide scale, pine forests largely dominate the riparian area in the lower portions of the watershed on the sandy upland soils. Aspen is found in small patches associated with other upland forests.

The land cover within the riparian area has remained relatively unchanged since the early 1800's. This is most likely due to the remoteness of certain areas and limitations based on soil and topography. An analysis conducted by the Michigan Natural Features Inventory (MNFI) compared land cover data from circa 2000 with that of the early 1800s and categorized the change that occurred on the landscape.

Figure 4.5 Land Use circa 2000 in Riparian Area

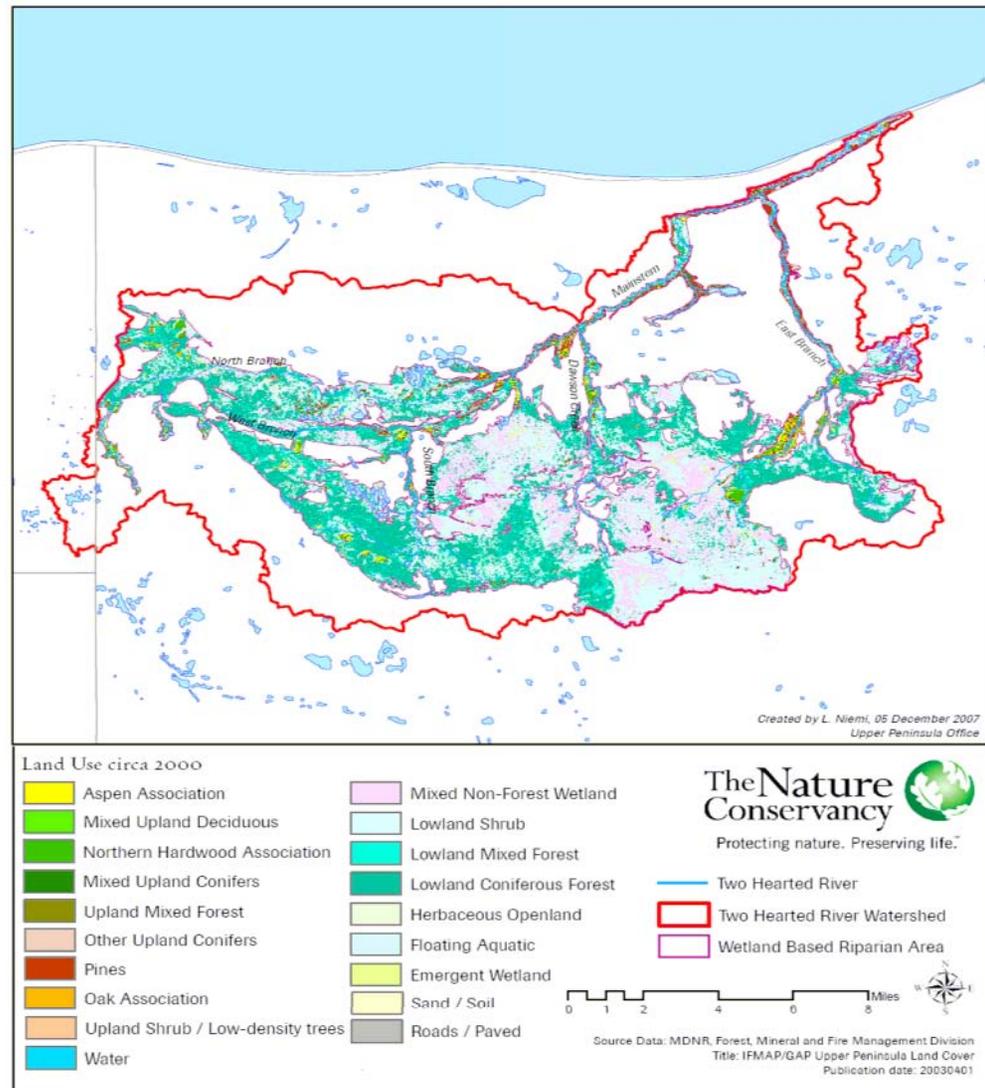


Figure 4.6 Land Use Change 1800 - circa 2000 in Riparian Area

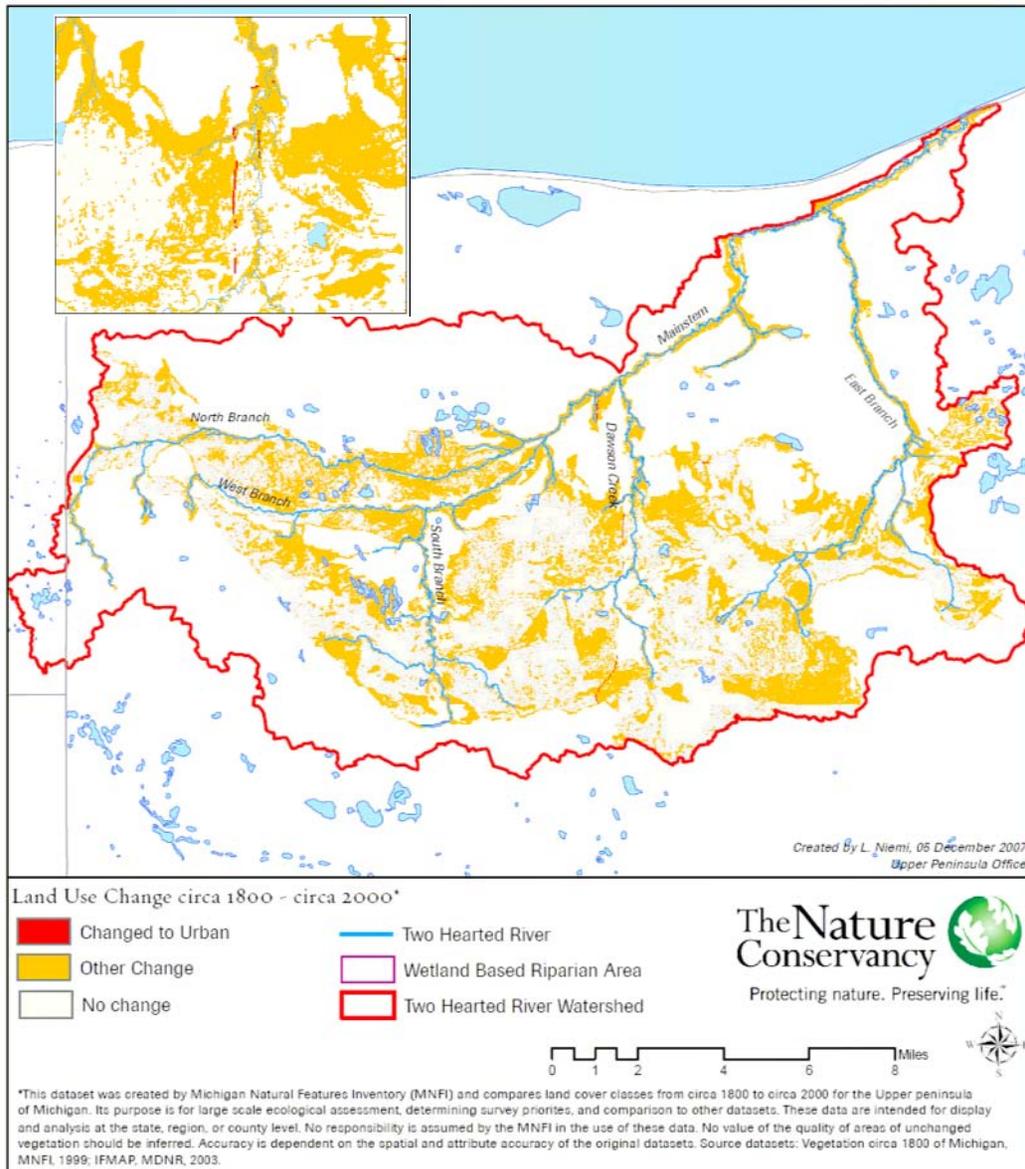


Figure 4.6 illustrates the land cover change classes for the Two Hearted riparian area, categorized as changed to urban, other change, and no change. The few changes to a more urban (or developed) landscape cannot be seen at the watershed-wide scale; however, most are concentrated along the river corridor and include the County Road 407 corridor. See inset in Figure 4.6 for an example (County Road 407 near Pine Stump Junction shown in red).

Unique Natural Features

In addition to the general land cover types; there are a number of natural features found within the riparian area. According to the MNFI, these include six species listed as state threatened (protection status = T), two plant species of special concern (protection status = SC), and a host of natural communities that are either significant at a global or statewide scale (see Table 4.4).

Land Ownership

The land ownership pattern within the riparian area reflects that of the overall watershed with a few exceptions. The State of Michigan and The Nature Conservancy together own approximately 82% of the riparian area, small private landowners own 11% of the riparian area, and the remainder is owned by private hunt clubs and forest product producers (Table 4.5). There is less land owned by the forest product producers in the riparian area compared to the overall watershed land ownership statistics. These entities tend to concentrate ownership on the watershed's uplands for forest management; however their ownership is dominant in the headwaters of both the North Branch and East Branch (Figure 4.7)

Table 4.4 Natural Features Found within Riparian Area

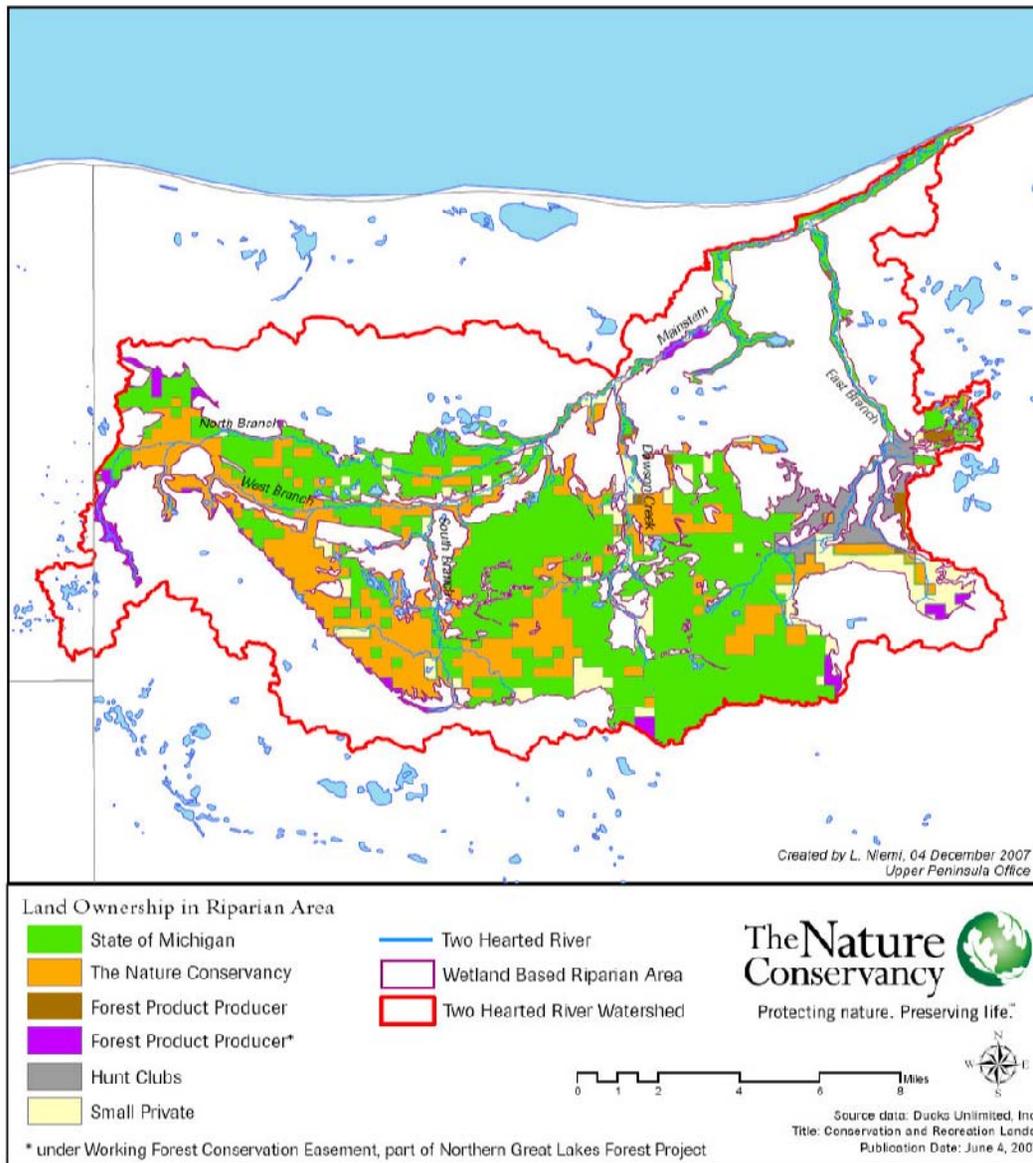
Common Name	Scientific Name	Protection Status	Global Rank*	State Rank*
Bald Eagle	<i>Haliaeetus leucocephalus</i>	T	G4	S4
Common Loon	<i>Gavia immer</i>	T	G5	S3S4
Merlin	<i>Falco columbarius</i>	T	G5	S1S2
Yellow Rail	<i>Coturnicops noveboracensis</i>	T	G4	S1S2
Alga Pondweed	<i>Potamogeton confervoides</i>	SC	G4	S3
English Sundew	<i>Drosera anglica</i>	SC	G5	S3
Panicled Screw-stem	<i>Bartonia paniculata</i>	T	G5	S2
Wiegand's Sedge	<i>Carex wiegandii</i>	T	G3	S2
Dry Northern Forest			G3?	S3
Intermittent wetland			G2	S3
Patterned Fen			GU	S2
Muskeg, Bog			G4	S3
Dry-mesic northern forest			G4	S3
Mesic northern forest			G4	S3
Rich conifer swamp			G4	S3
Hardwood-conifer swamp			G4	S3

* see Appendix D for key to global and state ranks

Table 4.5 Landowners within the Riparian Area

Landowners	Acres	Percent of Riparian Area
State of Michigan	30,962	53
The Nature Conservancy	23,338	29
Private Landowners	6,627	11
Hunting Clubs	2,169	4
Forest Product Producer (Working Forest Conservation Easement)	1,496	<3
Other Forest Product Producer	491	<1

Figure 4.7 Land Ownership within the Riparian Area



Soil Characteristics

Based on the most current Luce County soils data, the following characteristics were obtained: soil texture, hydric and non-hydric soils, suitability for structures (without basements), septic system ability, suitability for timber harvesting, and erosion potential.

The majority of the soils within the riparian area are considered to be hydric soils, or soils that were likely formed under saturated conditions and continue to be maintained under periods of flooding or saturation, hence the extensive wetlands in the landscape. The pockets of non-hydric soils are associated with the coarser textured soils, such as sand and silt loam found along portions of the Main Branch and East Branch, and in areas of the South Branch and North Branch subwatersheds (see Figure 4.8).

In addition to the pockets of sand and silt loam soils, there are extensive areas within the riparian area of organic soils, such as peat and mucky peat (Figure 4.9). These soil types support the unique patterned peatland found in the McMahon Lake area in the headwaters of Dawson Creek and East Branch of Two Hearted River, and the wetland communities between the North and West Branches. These soils are largely moist or saturated year round, except during extreme drought conditions, such as that experienced during the summer of 2007.

Figure 4.8 Hydric Soils in Riparian Area

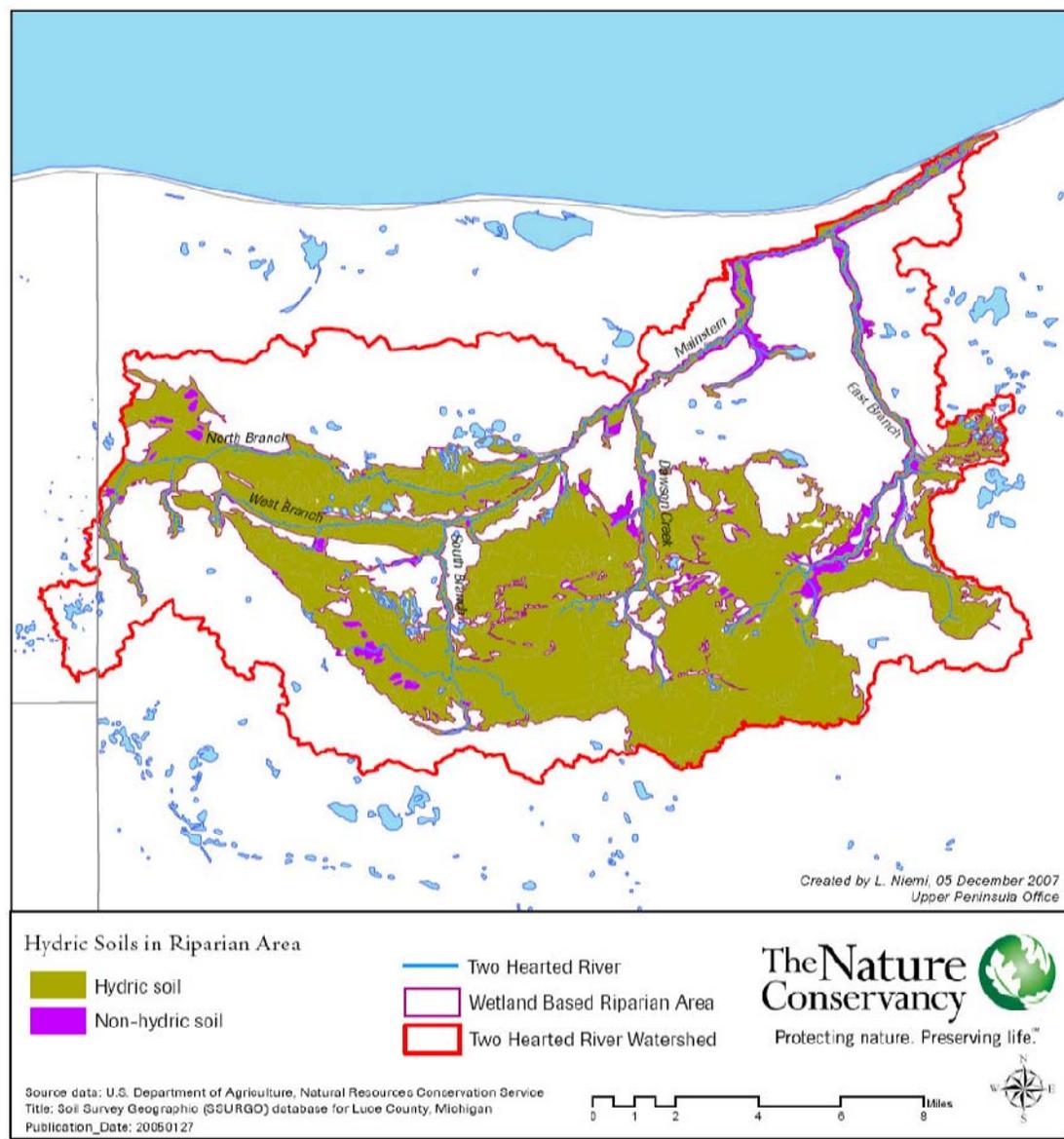
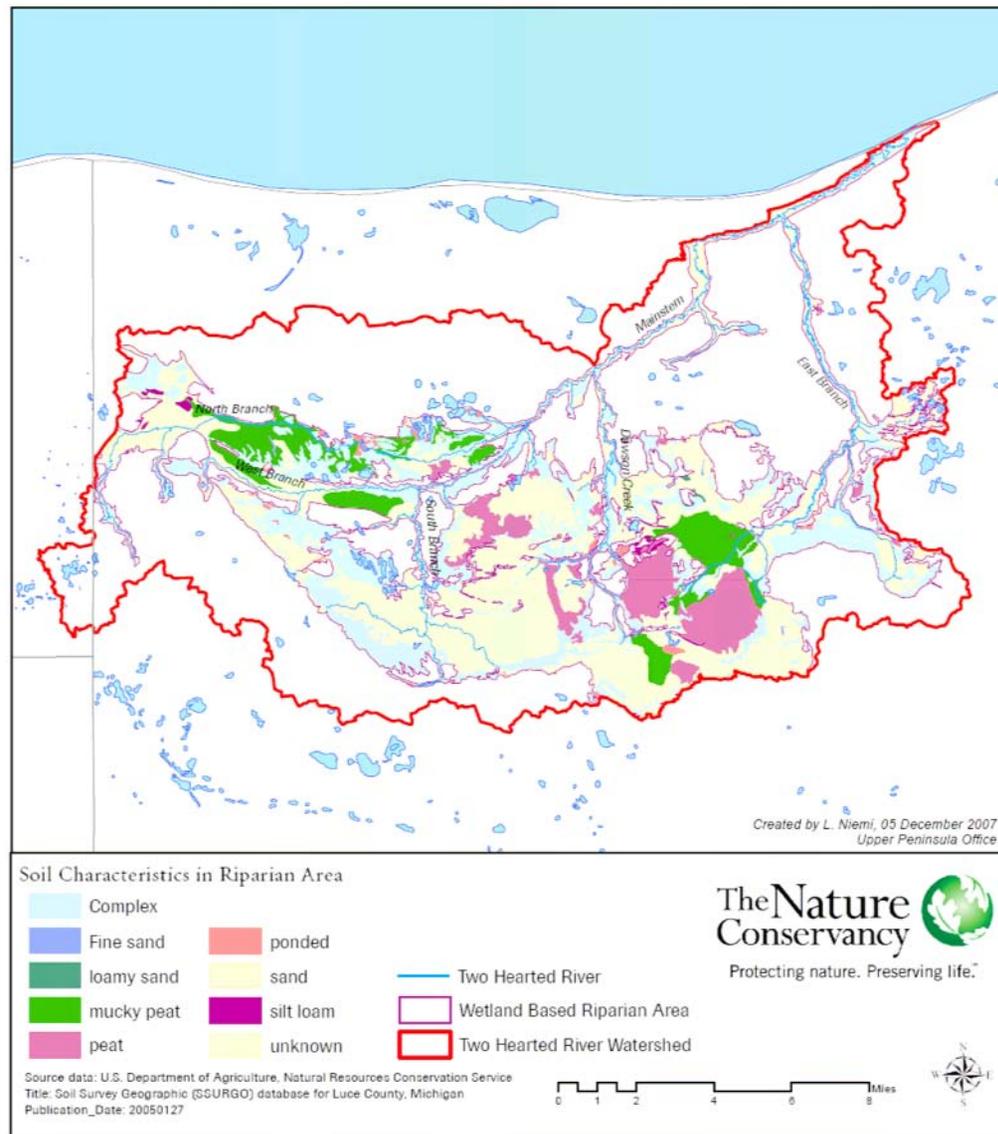


Figure 4.9 Soil Characteristics in Riparian Area



Soil erosion potential is based on the probability that damage will occur as a result of timber management activities such as site preparation and harvesting where the soil is exposed. This attribute is directly connected with slope and other attributes of the soil type. The ratings, slight - severe, indicate the degree at which erosion-control measures should be taken in silvicultural activities, with severe requiring the most precautions (USDA NRCS, 1997). In the Two Hearted River riparian area, the majority of the land is characterized as having a slight erosion potential rating with only 11% of the riparian area under a moderate or severe rating (Table 4.6). The locations with a severe erosion potential rating mostly correspond with locations within the riparian area that have greater percent slopes such as in the headwaters of the North Branch and West Branch (Figure 4.10).

Table 4.6 Soil Erosion Potential

Erosion Potential Rating	Acres
Slight	50,176
Moderate	4,318
Severe	2,179
Unknown or open water	1,230

Figure 4.10 Erosion Potential in Riparian Area

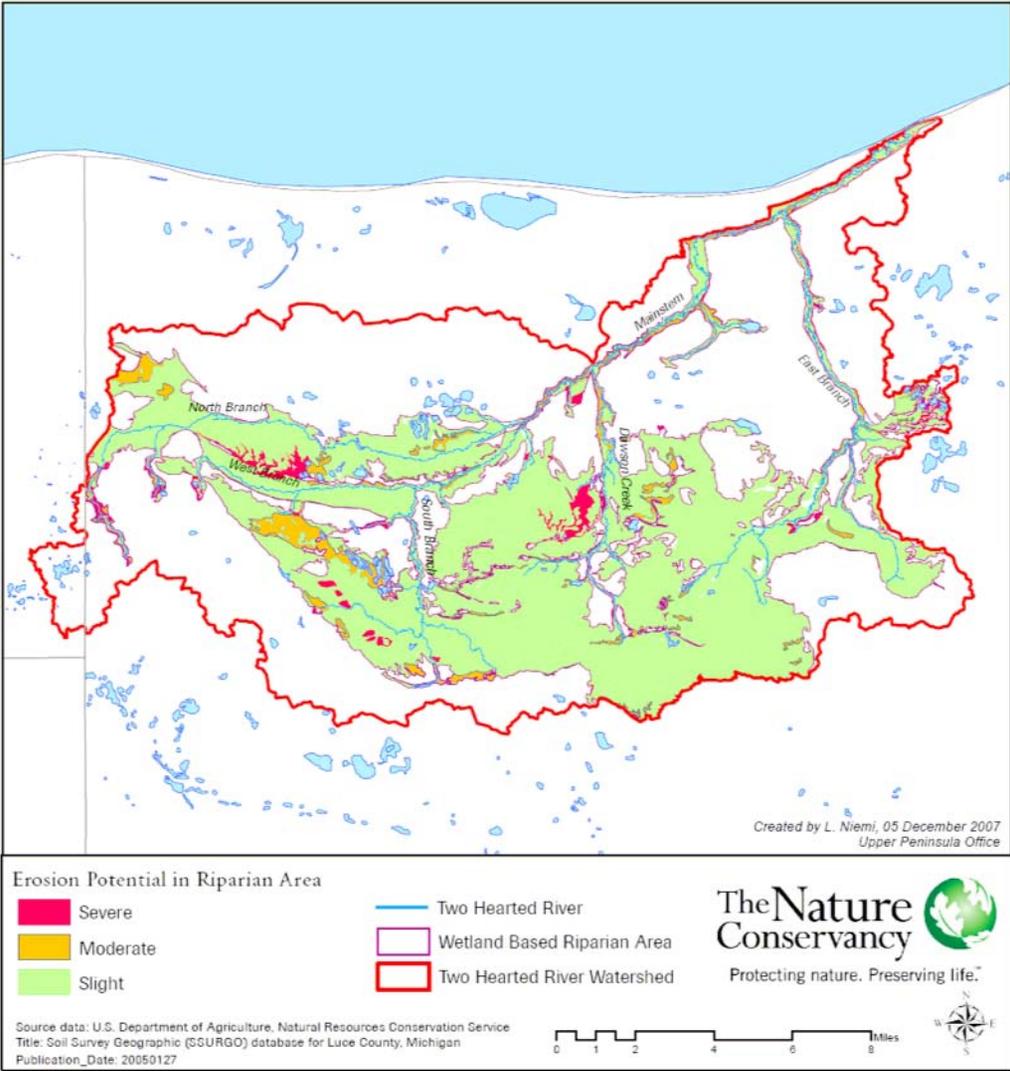
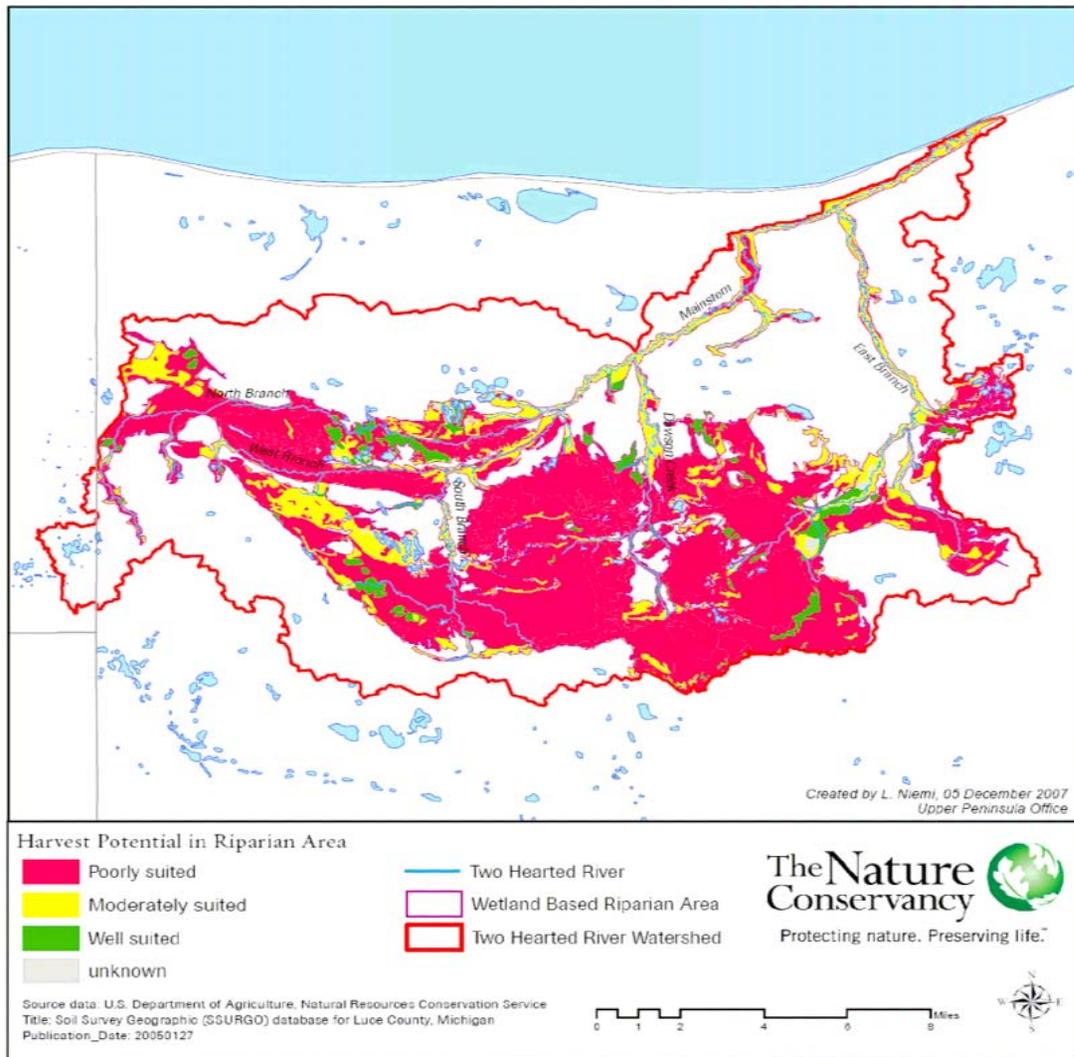


Table 4.7 Suitability for Timber Harvesting

Suitability for Harvesting	Acres	Percent of Riparian Area
Well suited	2,909	5
Moderately suited	10,609	18
Poorly suited	43,154	75
Unknown or open water	1,230	2

Figure 4.11 Suitability for Timber Harvesting



The degree to which the lands are suitable for timber harvesting reflects the characteristics and conditions of the soil that restrict the use of equipment generally utilized in timber management and harvesting. Based on this information, only 5% of the Two Hearted River riparian is considered well suited for timber management, whereas 75% is considered poorly suited (Table 4.7). However, this does not mean that the lands categorized as poorly suited for timber harvesting cannot be harvested; rather, specific precautions for harvest in these areas should be implemented, such as harvesting during frozen conditions or adequate snow cover. These poorly suited lands mostly correspond with the extensive wetlands, and those lands considered well suited for harvesting largely correspond with the pockets of uplands in the riparian area (see Figure 4.11).

Soil characteristics also play a role in determining the suitability of a site for building construction and sanitary facilities. Within the Two Hearted River riparian area, the majority of the land is not considered to be well suited for building construction (without basement) (83%) or for a septic system (98%) (see Tables 4.8 and 4.9). This means that overcoming the limitations, due to soil properties or features at the site, would most likely be too cost prohibitive, both due to initial and potential ongoing maintenance costs. Those areas that are somewhat limited for building construction indicate that although the site conditions are unfavorable, these limitations may be overcome through special planning, design and maintenance. Lands in this category are located north of the West Branch and North Branch, in the headwaters of the South Branch and East Branch, and along Dawson Creek, the Main Branch, and Wabash Creek. Less than 1% of the land is considered to have no limitations for buildings and occur in small pockets along Wabash Creek, the Main Branch, and the East Branch (Figure 4.12). The entire riparian area should be considered to be unsuitable for septic systems (Figure 4.13).

Table 4.8 Suitability for Buildings (without basement)

Suitability for Buildings*	Acres	Percent of Riparian Area
Very limited	43,308	83
Somewhat limited	7,873	14
Not limited	480	<1
Not Rated	11	<1
Unknown or open water	1,230	2

Figure 4.12 Suitability for Buildings (without basement)

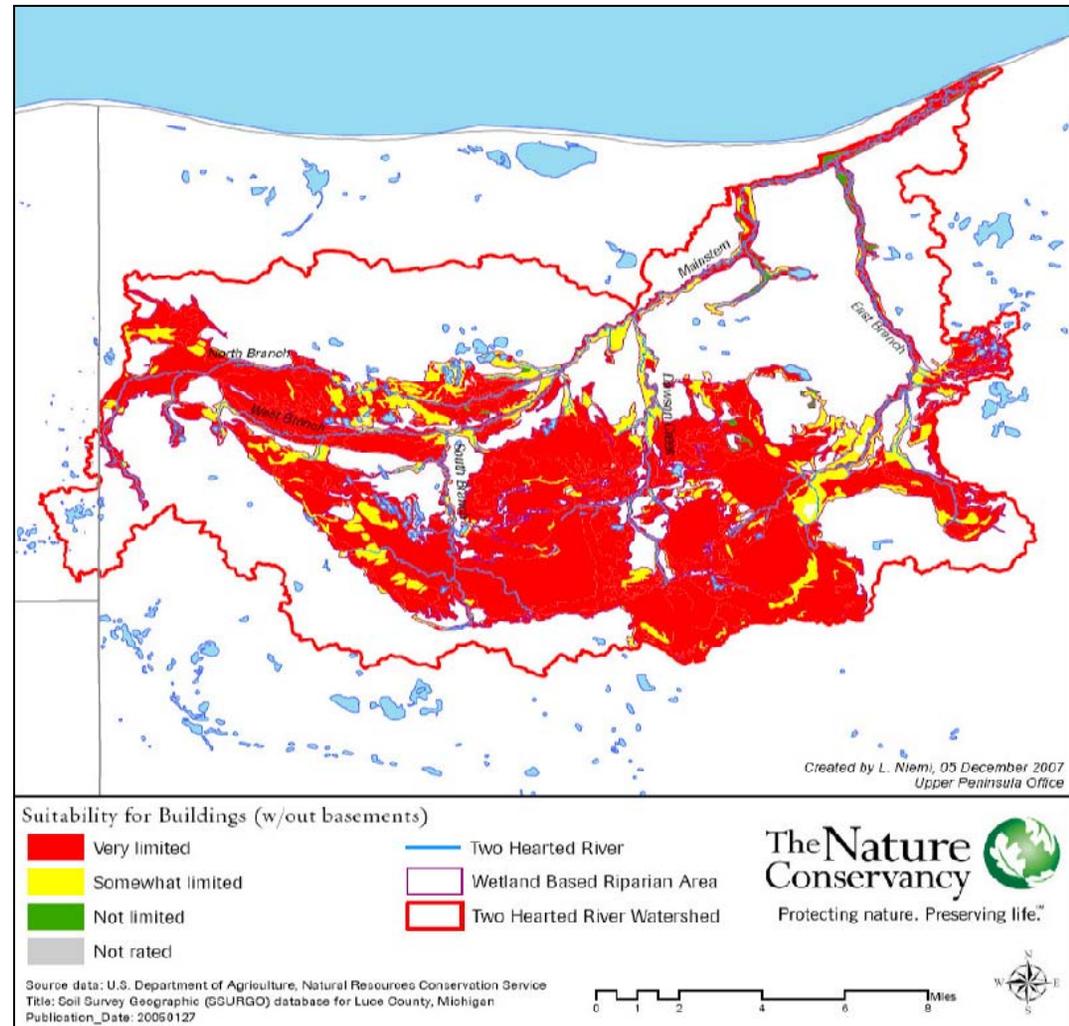
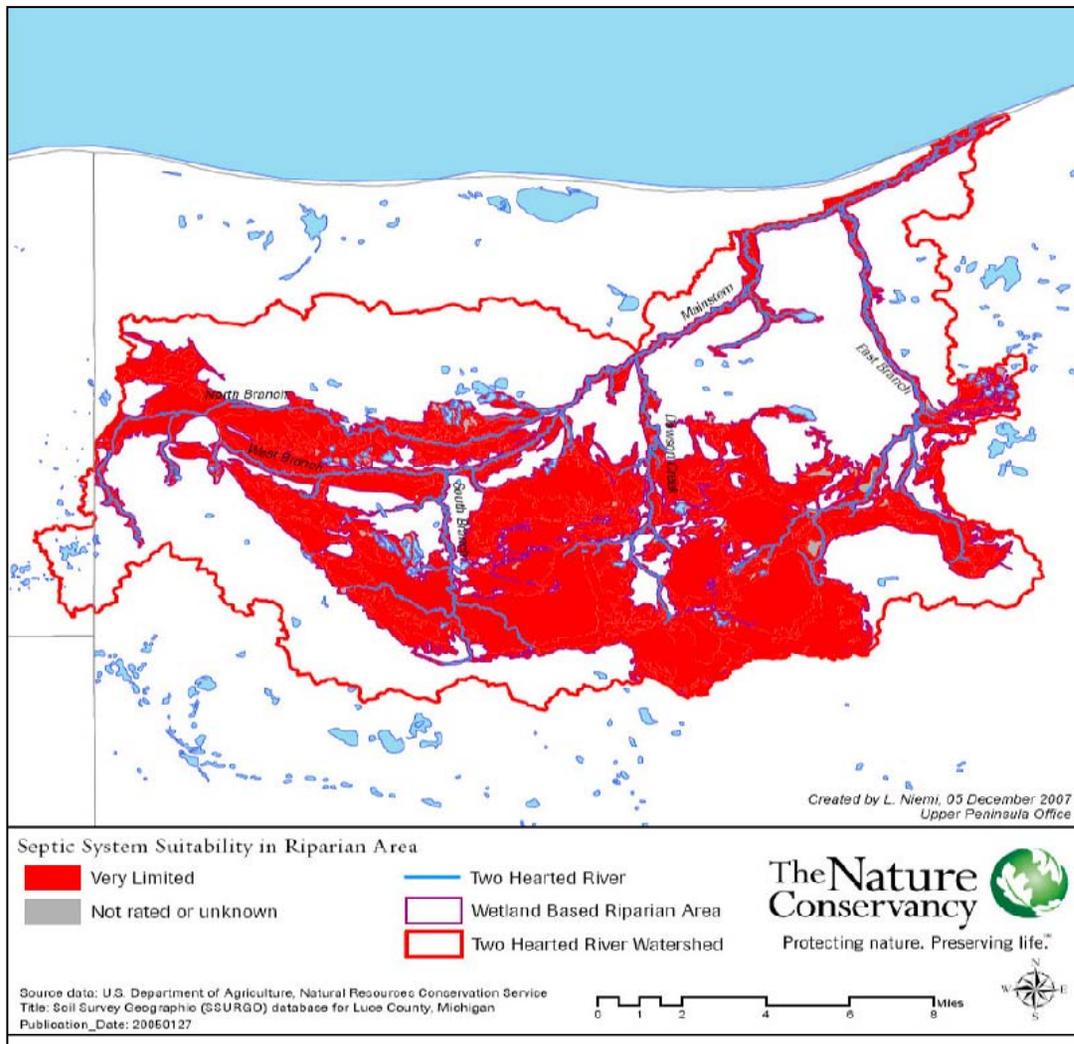


Table 4.8 Septic Suitability

Septic System Suitability	Acres	Percent of Riparian Area
Very limited	56,661	98
Not Rated	11	<1
Unknown	1,230	2

Figure 4.13 Suitability for Septic System



Comparison with Existing Regulations

The riparian areas identified in this analysis were compared with existing and proposed regulations pertaining to the Two Hearted River watershed. These include the voluntary riparian buffer widths recommended by MDEQ and MDNR, setbacks developed by the Natural Rivers program, and the proposed Luce County zoning ordinances. In some locations, the riparian area closely mimics the voluntary buffer recommendations and the Natural River District (Figure 4.14); whereas in other locations, it is significantly more expansive than the existing regulations due to its inclusion of the adjacent wetland systems (Figure 4.15). If buffers were created along the Two Hearted River utilizing the voluntary buffer widths laid out in the BMP manual (Table 4.9), only 3,900 acres would be within this corridor. This represents approximately 7% of the area encompassed in the riparian area identified through this analysis.

Figure 4.14 Riparian Area closely mimics existing regulations (left) along portions of the Main Branch and Chris Brown Creek and (right) in the headwaters of the West Branch

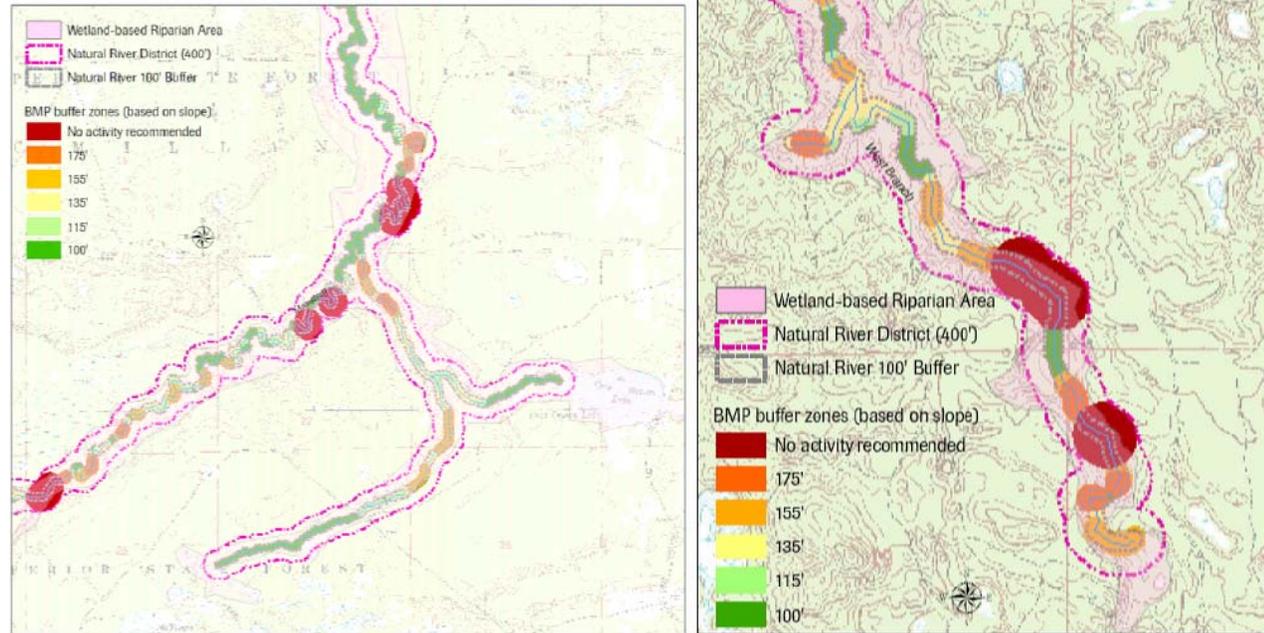
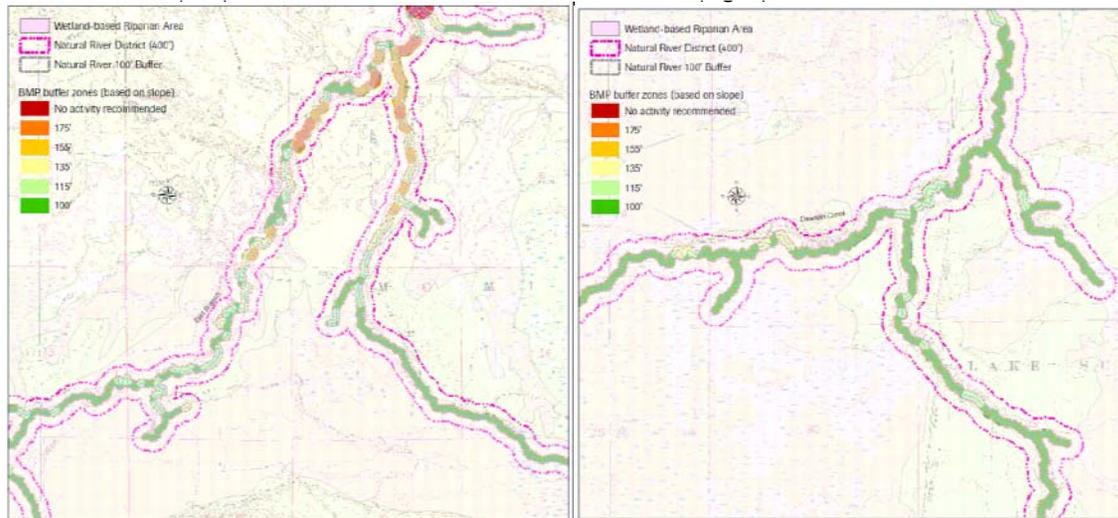


Figure 4.15 Riparian area extends well beyond the existing regulations on the Two Hearted River in locations dominated by wetlands, such as in the headwaters of the East Branch (left) and headwaters of Dawson Creek (right)



The narrowest portions of the riparian area are at least 300 feet wide, more than 100 feet greater than the minimum recommended buffer width in the BMPs. These occur in portions of the headwaters of the North Branch, the Main Branch (just downstream from the confluence of the North and West Branches), and in the East Branch.

The riparian area strongly mimics the Environmentally Sensitive Areas (ESAs) identified in the Draft Luce County Zoning Ordinance of February 2006 (Figure 4.16). In the draft ordinances, ESAs are identified as:

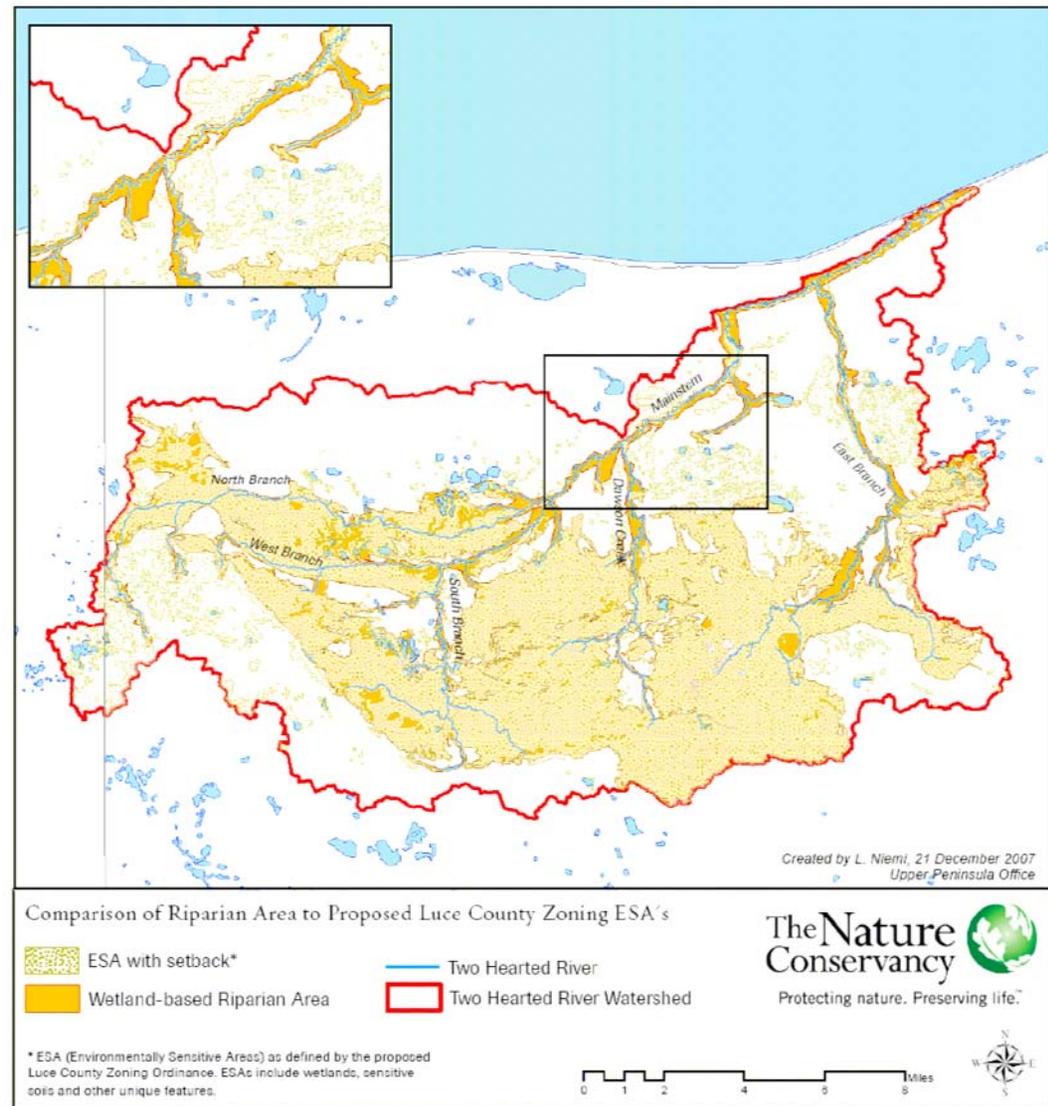
- Sand dunes with slopes greater than 18 percent as measured on 2 foot contours
- Beach contiguous to a lake or stream
- Wetlands
- Area which is not accepted by the District Health Department for on-site sewage disposal unless an alternate system of sewage disposal is approved by the District Health Department
- That part of a floodplain where flood waters are expected to have a destructive current
- Waterfront setback areas
- Soil mapping units identified in the Luce County Soil Survey as having slopes 35% or greater (specifically this includes soil mapping units 17F, 18F, 19F, 31F, 46F, 66F, 75F, 90F, 179F and 186F.)

Both methodologies include similar parameters such as wetlands, areas contiguous to streams, and certain soil parameters. One main difference is that the ESAs cover all lands in the County, not just those that are adjacent to the rivers and streams; therefore, there are areas within the Two Hearted River watershed that have been identified as an ESA but are not included in the riparian area identified in this analysis (see Inset in Figure 4.16). The ESA and its associated setbacks encompass approximately 62,500 acres, whereas the riparian area encompasses 58,000 acres.

Sensitive Areas

The main land use activity within the Two Hearted River watershed is forest management conducted by the State of Michigan, large forest product producers such as The Forestland Group, LLC and Plum Creek Timber, The Nature Conservancy, private hunt clubs, and other small private landowners. While a large portion of the watershed is undeveloped, there is further potential for residential development, especially along the rivers, tributaries, and lakes. Therefore, the goal of this analysis was to identify the riparian areas sensitive to development and/or forest management activities.

Figure 4.16 Comparison of Riparian Area with Luce County Proposed Zoning Ordinance's Environmentally Sensitive Areas. Inset provides one example of where the Riparian Area and ESAs differ in the watershed



In this analysis, sensitive areas are defined as locations within the riparian area that, given their multiple attributes, create a unique area that if disturbed may affect the water quality of the Two Hearted River or its riparian area. A GIS analysis was conducted to identify these potentially sensitive areas, and was followed by limited field visits to monitor the accuracy of the data input. Characteristics such as physical distance from river, slope, soil erosion potential, presence of unique natural features, presence of wetlands, and other soil attributes related to building/ development conditions were utilized to identify these sensitive areas. Each portion of the riparian area was assigned a score for each of these characteristics, and then the sum of all of these scores provided its overall rank. The ranking information may be analyzed in two ways, by breaking it out into categories (e.g. High, Medium, and Low) or by looking at the numerical ranks as a gradient of sensitivity to these activities. For illustration purposes, the entire riparian area was separated into five categories (using the equal interval classification) related to its sensitivity to development and to forest management activities. These categories (from High to Low) illustrate the varying degrees of sensitivity of the specific area.

Field monitoring was conducted to verify the accuracy of the input data for the GIS analysis, to gauge the general characteristics and condition of the riparian area within the Two Hearted River watershed, and to provide field verification of those sites identified as sensitive to develop and/or forestry through the analysis. In total, 30 sites were visited during the field seasons of 2006 and 2007. Overall, the input data for the GIS analysis was fairly representative of the on-the-ground characteristics. General topography was compared with the County Digital Elevation Models and land cover was compared with the IFMAP data. The vegetation composition identified through the field visits reflected the general land cover of the riparian area with the majority of the sites being characterized as forested wetlands or lowland coniferous forests. There were sites characterized as scrub-shrub wetlands, patterned fens, White pine- red maple/blueberry-wild sarsaparilla habitat type, White pine-red maple/blueberry habitat type, and Sugar maple-Hemlock-American beech/Spinulose shield fern habitat type (see Figures 4.17 and 4.18).

Sensitivity to Development

The riparian area was analyzed for its sensitivity to development utilizing the following parameters: nearness to river or stream, presence of wetlands, percent slope, ownership, soil suitability for septic, soil suitability for building construction (without basement), soil erosion potential, and presence of unique natural features.

Based on the classification utilized, equal interval, the majority of the riparian area within the watershed is considered to have a moderate to low - moderate sensitivity to development (Table 4.9). The areas with the highest sensitivity to development include the Swamp Lakes area, due to the presence of a unique natural community, and other specific locations along the West Branch, Main Branch and Dawson Creek (Figure 4.19). These latter areas all have a percent slope exceeding 30%; are under private ownership; have an erosion potential of moderate to severe; and most are within 100 feet of the river. The areas ranked moderate-high, which make up about 7% of the riparian area, are all located on soils considered very limited for septic suitability; most are located on soils with an erosion potential of moderate - severe; and the majority have a percent slope greater than 20%.

Figure 4.17 Wetland Complex at Site #15 in Riparian Area



Figure 4.18 Steep slope with large hemlock, white pine and sugar maple, at site #14



Table 4.9 Percent of Riparian Area by Sensitivity Categories

Rank Category	Sum Rank	Acres	Percent of Riparian Area
Low	1 to 5	902	2
Low-moderate	6 to 9	20,408	35
Moderate	10 to 14	32,532	56
Moderate-high	15 to 18	4,012	7
High	19 to 22	60	<1

There was not a strong correlation of this category to the property ownership or its nearness to the river. Approximately 2% of the riparian area ranked low in its sensitivity to development. In general, most of these locations were located at least 500 meters from the river or stream; are under public or a form of conservation ownership (ie. The Nature Conservancy); do not have limitations based on the soils (e.g. slight erosion potential and not limited for septic suitability); and have a percent slope of less than 10%. Some of these locations do overlap with unique natural features in the watershed and others are coincidental with lakes, such as the Two Hearted Lakes complex.

Table 4.10 Sensitivity to Develop Ranking for Subwatersheds

Subwatershed	Percent within Ranking Categories per Subwatershed				
	Low	Low-Moderate	Moderate	Moderate-High	High
North Branch	39	46	49	1	0
West Branch	1	35	61	3	4
South Branch	29	52	34	11	0
Dawson Creek	1	27	58	14	<1
East Branch	0	26	68	5	<1
Main Branch	2	20	61	18	<1
Watershed-wide	2	35	56	7	<1

The sensitivity to development in the riparian area by subwatershed has a similar pattern to the watershed-wide perspective (Table 4.10). Most of the riparian areas have a similar percentage of areas ranked low and high. The riparian area within the North and South Branches have a higher percentage of area within the low-moderate ranking, while the riparian area within the West and East Branches, the Main Branch, and Dawson Creek all have a greater percentage of land with a moderate ranking. The riparian area within the Main Branch, Dawson Creek, and the South Branch subwatersheds has a higher percentage ranked moderate-high. In the

Main Branch, this is likely due to the topography and erosion potential of the sandy soils, while in the South Branch and Dawson Creek subwatersheds, this is likely reflecting the extensive hydric soils limited for septic and construction suitability. The field monitoring reflected the GIS analysis. The majority of the sites visited, 21 out of 30, represented the attributes of an area that would be sensitive to development.

Sensitivity to Forest Management

Through a similar process, the riparian area was analyzed for its sensitivity to forest management activities. The following parameters were utilized: nearness to river or stream, presence of wetlands, percent slope, soil erosion potential, and presence of unique natural features. The parameters based on the soil data include considerations such as seasonal limitations for equipment use. Based on the classification utilized, equal interval, the majority of the riparian area within the watershed is considered to have a moderate to low - moderate sensitivity to forest management (Table 4.11). In comparison with the sensitivity to development, there is a greater percentage of land considered to have a low and moderate - high sensitivity to forest management.

Figure 4.19 Development Sensitivity Ranking categories across the Two Hearted River watershed riparian area with an illustration of a location with High rating along the Main Branch (inset)

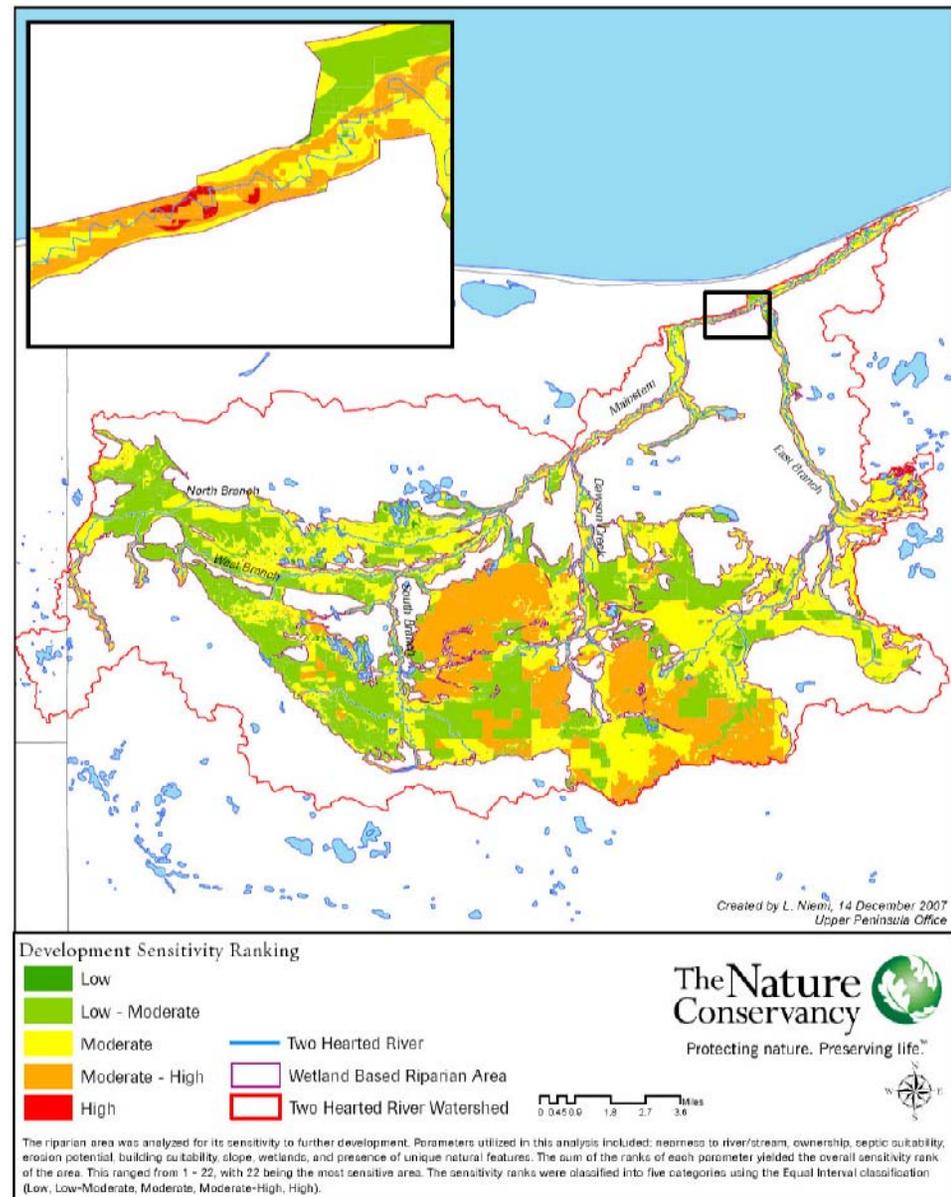


Table 4.11 Percent of Riparian Area in 5 Forestry Sensitivity Categories

Rank Category	Sum Rank	Acres	Percent of Riparian Area
Low	1 to 4	11,102	19
Low-moderate	5 to 7	20,524	35
Moderate	8 to 11	16,336	28
Moderate-high	12 to 14	9,883	17
High	15 to 17	57	<1

Figure 4.20 Swamp Lakes area, site #24



The area with the highest sensitivity to forest management is the Swamp Lakes area, due to the presence of a globally rare natural community (see Figures 4.20 and 4.21). It represents less than one percent of the riparian area land base. As with potential development, this area is very sensitive to forest management and would be greatly impacted by such activity. Approximately 17% of the riparian area is considered to have a moderate - high sensitivity to forest management activities. About one third of these areas include one or more unique natural features; the majority have a percent slope greater than 30% with an erosion potential rating of severe; and some are located within 100 feet of the river, while others are more than 500 meters from the river or stream. These lands are found within forested wetlands, but also on the uplands. Lands considered to have a low sensitivity to forest management (19% of the riparian area) are located mostly in the uplands; the majority have a slight slope of 0 to 10% with slight erosion potential rating; and the majority are located more than 100 feet from the river or stream. Some of these areas do support unique natural features and others have a severe erosion potential rating; however, these latter areas are located more than 500 meters from the river.

The sensitivity to forest management in the riparian area by subwatershed illustrates some similarities and deviations from the watershed-wide pattern (Table 4.12). The only subwatershed with areas considered to be high sensitivity is the East Branch, where Swamp Lakes is located. The Main Branch and the North Branch subwatersheds have less than 1% of their land base within the moderate - high category, greatly below the watershed-wide average of 17%. This deviation is most likely due to minimal amount of wetlands and hydric soils in the riparian areas of these two subwatersheds.

Figure 4.21 Forest Management Sensitivity Ranking categories across the Two Hearted River watershed riparian area

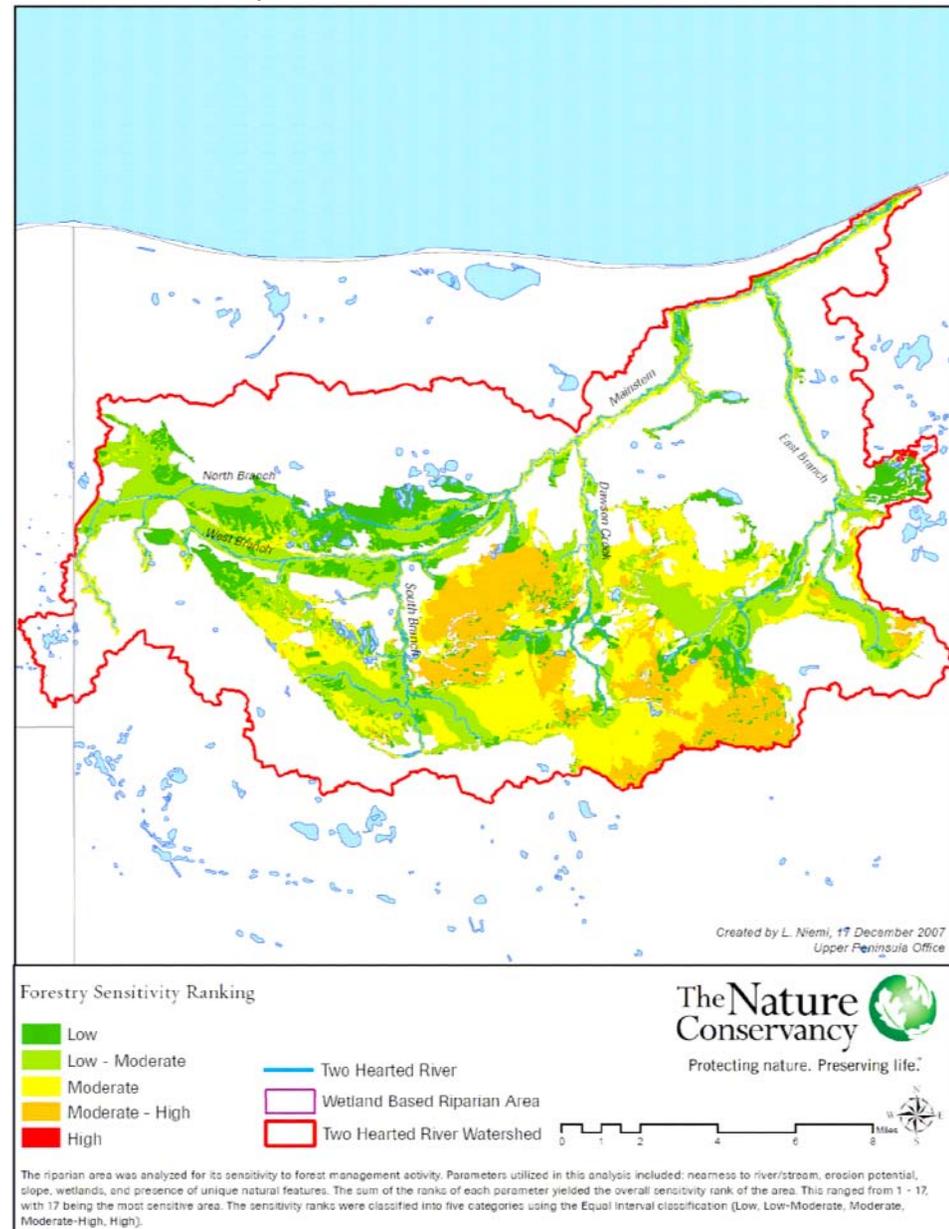


Table 4.12 Ranking of Sensitivity to Forestry by Subwatersheds

Subwatershed	Percent within Ranking Categories per Subwatershed				
	Low	Low-Moderate	Moderate	Moderate-High	High
North Branch	39	46	49	1	0
West Branch	1	35	61	3	4
South Branch	29	52	34	11	0
Dawson Creek	1	27	58	14	<1
East Branch	0	26	68	5	<1
Main Branch	2	20	61	18	<1
Watershed-wide	2	35	56	7	<1

and the majority are located more than 100 feet from the river or stream. Some of these areas do support unique natural features and others have a severe erosion potential rating; however, these latter areas are located more than 500 meters from the river.

The sensitivity to forest management in the riparian area by subwatershed illustrates some similarities and deviations from the watershed-wide pattern (Table 4.12). The only subwatershed with areas considered to be high sensitivity is the East Branch, where Swamp Lakes is located. The mainstem and the North Branch subwatersheds have less than 1% of their land base within the moderate - high category, greatly below the watershed-wide average of 17%. This deviation is most likely due to minimal amount of wetlands and hydric soils in the riparian areas of these two subwatersheds.

Overall, the riparian areas within the North and West Branches are less sensitive to forest management than the other subwatersheds. They both have a less percentage of land within the moderate sensitivity rating with higher percentages of land rated low - moderate and low.

The field monitoring reflected the GIS analysis conducted for areas sensitive to forest management activities. The majority of the sites visited, 24 out of 30, represented the attributes of an area that would be sensitive to forest management either due to the slope or soil characteristics. From the field work, it became clear that there is a great deal more wetlands on the landscape than what is represented in the GIS data. Most of these are less than one acre in size but still contribute to overall water quality and hydrologic connectivity within the riparian area. This stresses the need for on-the-ground field reconnaissance to identify these in order to ensure that they are protected if and when timber harvesting occurs.

Management Recommendations

In assessing the areas identified through this analysis, there are a few items that need to be addressed. First, some of the GIS data utilized is at a coarse scale and may not accurately represent the on-the-ground characteristics at the exact locations. The purpose of the analysis is to provide a tool in landscape level planning, not necessarily in planning at the site specific scale. Therefore, a field reconnaissance is necessary to make decisions and recommendations at a particular site. Second, in the GIS analysis, the areas within 100 feet of the river or stream were not automatically rated as having a

High sensitivity, even though this corridor is regulated under Michigan's Natural Rivers Program and is a mandatory vegetative buffer. Activities regarding timber harvesting and development are greatly restricted in this 100-foot buffer through the Natural Rivers Program, and these regulations should be adhered to in all instances.

Development

There are a few locations in the riparian area where the sensitivity to development ranked High. In these locations, further development should not be allowed unless a field reconnaissance illustrates a less vulnerable landscape from what the GIS analysis portrayed. The Swamp Lakes area is ranked high due to the presence of a globally rare natural community; therefore special precautions should be taken if and when further development is considered near this complex. The other sites that ranked High, were found to have

severe slopes, high potential for erosion, and are located near the river; therefore, development is not suitable on or near these sites.

The areas ranked moderate- high are all located on soils considered very limited for septic suitability, and most are located on soils with an erosion potential of moderate - severe. In general, it is recommended that these areas remain undeveloped. Similarly to above, these areas should be assessed at a site specific level to determine the potential impact of development.

Overall, further development in the Two Hearted River riparian area should be limited to ensure the protection of the river's water quality and unique habitat. The majority of the riparian area is considered unsuitable for building (see Figure 4.12) and also is considered to be very limited for septic suitability (see Figure 4.13). In general, further development should be guided and concentrated in those areas of uplands following the existing regulations and the proposed Luce County Zoning Ordinances. In addition, further measures should be utilized to ensure long-term protection of the aquatic system, including the utilization of conservation easements. In those areas adjacent to the river, stream, and/or a unique natural community owned by private entities, the purchase or donation of conservation easements should be considered. The terms of the conservation easement should be tailored to ensure the protection of the water resources at the site level, and they should be held by a qualified organization or agency dedicated to the long-term monitoring of these easements.

Forest Management

Similar to sensitivity to development, only a small percentage of the Two Hearted River riparian area is considered to have a High sensitivity to forest management. The Swamp Lakes complex is the only area that falls within this category, due to the presence of a globally rare natural community. Forest management within or near these complexes should be extremely limited, and conservation easements should be utilized to protect these resources for the long-term.

About 17% of the riparian area is considered to be in the moderate - high rating of sensitivity to forest management. The majority of these lands are considered to have a severe slope (>30%) with an erosion potential of severe. In general, forest management should be limited in these areas to enhance slope stability and prevent erosion. Further analysis of other factors that drove these areas into this category must be considered to develop additional recommendations. For example, about one-third of these areas include one or more unique natural features. Additional information on those natural features and the potential impacts of forest management should be considered prior to harvesting. In other areas, such as those located on hydric soils, forest management should be limited to the winter season with frozen conditions. This would minimize impacts to the soil and water resources of the riparian area.

Overall, the majority of the Two Hearted River riparian area is considered to be poorly suited for timber harvesting due to equipment limitations based on the soil characteristics (see Figure 4.11). This does not imply that all forest management should be restricted, rather that seasonal and/or conditional limitations for this activity are recommended. In general, forest management should be guided by existing regulations, the proposed Luce County Zoning Ordinances, and additional measures to ensure protection of the aquatic resources and unique habitat. Additional measures include conservation easements that recognize and limit forest management in areas that would negatively impact the aquatic resources and/or unique natural features, and better defined riparian management zones. The latter should be identified based on slope and soil characteristics and should exceed 100 feet from the waterbody. Activities that cause soil compaction should not be allowed within these areas, and native long-lived, larger trees should be promoted. The hydrology of the Two Hearted River watershed is complex due to the wetland-peatland complexes, and the groundwater flow is not well documented. To learn more about this function and the hydrology of the watershed, it is also recommended that demonstration areas are created to illustrate sustainable forestry practices in relation to the enhancement of water quality.

WATERSHED GOALS, OBJECTIVES AND MANAGEMENT STRATEGIES

The main goal of the Two Hearted River Watershed Management Plan is to promote and facilitate coordinated, collaborative action among stakeholders in order to protect and preserve water quality and the unique nature of the watershed. The watershed inventory and analysis identified and prioritized the causes and sources of pollution affecting or having the potential to affect water quality and designated and desired watershed uses. The following goals, objectives and management strategies provide guidance for implementation of actions that will reduce these affects and provide a basis for protection from further impacts.

Goals and Objectives

The following goals and objectives were developed as strategies to address known and potential pollutants and threats to water quality and designated and desired uses in the Two Hearted River watershed (Table 5.1). They provide a basis for protection of significant natural resources and reflect the desires of the stakeholders for the future state of the watershed.

Management Strategies

The goals and objectives of this watershed management plan will be implemented through a suite of strategies or tasks. These tasks were developed based on the prioritization of watershed pollutants, sources, and causes, and critical areas of the watershed. A ten-year timeline was used as the schedule for implementation. Tasks that should be done in the short term were given a completion timeline of 3 years. Tasks that should be undertaken annually were given a timeline of "ongoing". Estimated costs for implementation tasks do not include staff oversight or administrative costs. A summary of implementation tasks and milestones is provided in Table 5.2.

Table 5.1 Goals and Objectives

Goal	Objectives
1. Protect and improve the quality of water in order to support all designated and desired uses	A. Reduce non-point source pollution from manmade sources B. Monitor trends in water quality and aquatic habitat conditions C. Increase awareness of non-point source pollution and potential impacts to water quality
2. Protect the integrity of aquatic and terrestrial ecosystems	A. Reduce impacts from land uses including recreation, forest management and development B. Preserve and protect environmentally sensitive areas from invasive species and land use pressures
3. Increase stewardship practices of corporate and private landowners, recreational users and the public	A. Increase awareness of environmentally sensitive areas and impacts of non-point source pollution B. Promote environmentally sound and economically feasible land use management practices C. Promote protection/conservation of environmentally sensitive areas D. Provide opportunities for involvement in watershed programs and activities
4. Increase nature-based tourism opportunities that protect natural features and preserve the natural character of the watershed	A. Link to regional programs and initiatives B. Improve trail systems to accommodate desired low-impact recreational uses C. Promote new/improved recreational opportunities through marketing and outreach

Task 1: Reduce sediment from manmade erosion sites including road/stream crossings, fords and recreational access points

- Use bioengineering techniques and native plants to maintain the natural character of the watershed and comply with Natural Rivers Program requirements
- Replace undersized, poorly aligned, and/or perched crossing structures
- Install bottomless culverts and bridges where possible
- Stabilize road approaches, side slopes and embankments
- Plant native vegetation on disturbed or bare soil areas
- Create diversion outlets and spillways to direct road runoff away from surface waters

Goals Accomplished:

Goal 1: Protect and improve the quality of water

Goal 2: Protect the integrity of aquatic and terrestrial ecosystems

Designated Uses Addressed:

Coldwater fishery, other aquatic life

Desired Uses Addressed:

All

Estimated Cost:

Main tributary affected	Number of manmade erosion sites	Estimated Cost	Estimated sediment load reduction (Tons/year)
Main and West Branch	35	\$175,000-\$350,000	814
Dawson Creek	17	\$85,000-\$170,000	252
East Branch	11	\$55,000-\$110,000	162
South Branch	8	\$40,000-\$80,000	16
Widgeon Creek	5	\$25,000-\$50,000	8
North Branch	3	\$15,000-\$30,000	3
Total	79	\$395,000-\$790,000	1,255

*Based on an estimated average cost of \$5,000-\$10,000 per site

Timeline: 10 years

Priority: High

Milestones:

- Implement improvements at 1-2 sites/year (Years 1-10)
- Conduct pre and post BMP field evaluations (site condition evaluation and stream monitoring) (Years 1-10)
- Achieve 10% reduction in sediment load (Year 5)
- Achieve 25% reduction in sediment load (Year 10)
- Achieve water quality ratings of good or excellent at all monitoring sites (Year 10)

Measurements:

- Number of sites improved
- Number of partners participating
- Quantity of sediment reduced — pre and post BMP field data (overall reduction goal of 314 tons by Year 10)
- Improved water quality ratings (annual stream monitoring)

Potential Partners: Superior Watershed Partnership, Luce West Mackinac Conservation District, Luce County Road Commission, The Nature Conservancy in Michigan, Forestland Group LLC, Plumb Creek, Michigan Department of Natural Resources, East Branch Sportsman's Club, and other private land owners.

Task 2: Promote voluntary arrangements and regulatory incentives for corporate and private landowners

Work with Luce County to promote voluntary arrangements and regulatory incentives to preserve and protect water quality, sensitive or biologically important areas and high quality natural communities. Topics include:

- Avoid development that encroaches on sensitive or biologically important areas
 - Preserve high quality natural communities (conservation easements, etc.)
 - Protect critical riparian areas (avoid development, maintain appropriate riparian buffers and setbacks)
-

- Properly manage working lands (forest lands) and roads
- Install and maintain properly designed septic systems
- Minimize the number of access roads needed for land use practices such as timber harvest, private development, and recreation
- Avoid stream and wetland crossings when constructing new roads

Goals Accomplished:

Goal 1: Protect and improve the quality of water

Goal 2: Protect the integrity of aquatic and terrestrial ecosystems

Goal 3: Increase stewardship practices

Designated Uses Addressed:

Coldwater fishery, other aquatic life, public water supply

Desired Uses Addressed:

All

Estimated Cost: \$30,000

Timeline: 5 years

Priority: High

Milestones:

- Work with partners to develop and distribute information and education on voluntary landowner arrangements (Year 1)
- Work with Luce County to develop and adopt incentive programs (Years 1-3)
- Work with landowners to improve land use management practices (Years 2-5)

Measurements:

- Number of landowners participating
- Number of volunteer/incentive programs adopted
- Number of acres protected
- Number of improved land use management practices

Potential Partners: Luce County Planning and Development, McMillan Township, Columbus Township, Burt Township (Alger County), The Nature Conservancy in Michigan, Superior Watershed Partnership, and Luce West Mackinac Conservation District.

Task 3: Promote increased awareness of water quality/watershed issues

Develop information/education materials and programs to disseminate information to public and private sector partners, corporate and private landowners, recreational users, and the public. Work with Two Heart Chapter of Trout Unlimited to host annual "River Awareness Day" event. Information/education topics include:

- Sustainable land use practices including forest management and development
- Low-impact recreational opportunities
- Protecting water quality, aquatic habitat, and environmentally sensitive areas
- Preventing non-point source pollution (sediment, nutrients, heavy metals, nutrients, etc.)
- Invasive species identification and control methods

Goals Accomplished:

Goal 1: Protect and improve the quality of water

Goal 2: Protect the integrity of aquatic and terrestrial ecosystems

Goal 3: Increase stewardship practices

Goal 4: Increase nature-based tourism opportunities

Designated Uses Addressed:

Coldwater fishery, other aquatic life, public water supply

Desired Uses Addressed:

All

Estimated Cost: \$5,500/year

Timeline: Ongoing

Priority: High

Milestones:

- Create contact lists of focus groups and target audiences (Year 1)
- Develop and distribute a minimum of two I/E materials (articles, newsletters, brochures, etc.) per year to target audiences (Years 1-10)
- Conduct survey of recipients (Years 2, 5 and 10)
- Host annual "River Awareness Day" event (Years 1-10)
- Host invasive species work days (Years 1-10)

Measurements:

- Number of information/education materials developed and distributed per year
- Number of recipients per year (number of target audiences and individuals)
- Number of requests for more detailed information and/or technical assistance
- Number of people surveyed with increased knowledge of watershed issues, etc.
- Number of people surveyed with changes in behavior
- Number of people attending work days and events

Potential Partners: Trout Unlimited, Luce County Planning and Development, Luce West Mackinac Conservation District, Superior Watershed Partnership, The Nature Conservancy in Michigan, and the Upper Peninsula Invasives Council.

Task 4: Develop and maintain a project website

Develop, maintain, and promote a project website to serve as a centralized clearing house for all data and knowledge gained from the project. Provide detailed watershed information including data, studies, reports, photos, historical datasets, projects implemented, and any other available data.

Goals Accomplished:

- Goal 1: Protect and improve the quality of water
 - Goal 2: Protect the integrity of aquatic and terrestrial ecosystems
 - Goal 3: Increase stewardship practices
 - Goal 4: Increase nature-based tourism opportunities
-

Designated Uses Addressed:

Coldwater fishery, other aquatic life, public water supply

Desired Uses Addressed:

All

Estimated Cost: \$1,500/year

Timeline: ongoing

Priority: Medium

Milestones:

- Develop project website and post all existing information (Year 1)
- Update website (post new information, data, reports (Years 1-10))
- Evaluate website use/effectiveness (Years 2, 5 and 10)

Measurements:

- Number of website hits
- Number of contacts made and/or requests for information
- Public response related to usefulness

Potential Partners: The Superior Watershed Partnership, Luce West Mackinac Conservation District, and Luce County Planning and Development.

Task 5: Increase nature-based tourism opportunities and improve stewardship practices of recreational users and the public

Work with partners to improve trail systems and promote low-impact recreational uses and responsible high-impact recreational uses (ORVs, etc). Topics include:

- Evaluate current recreational uses and develop a watershed-wide recreation plan
 - Enhance existing trails systems or develop new trails for low-impact recreation (hiking, biking, dog sledding, wildlife viewing, skiing, etc.)
-

- Promote nature-based tourism opportunities through existing regional initiatives (Great Waters, Scenic Byways, recreational clubs, etc.)
- Promote responsible high-impact uses

Goals Accomplished:

Goal 1: Protect and improve the quality of water

Goal 2: Protect the integrity of aquatic and terrestrial ecosystems

Goal 3: Increase stewardship practices

Goal 4: Increase nature-based tourism opportunities

Designated Uses Addressed:

Coldwater fishery, other aquatic life, public water supply

Desired Uses Addressed:

All

Estimated Cost: \$3,000/year

Timeline: ongoing

Priority: High

Milestones:

- Evaluate existing recreational uses and opportunities for trail enhancement/development (Year 1)
- Develop watershed-wide recreation plan (Year 2)
- Identify target audiences and opportunities to link to regional initiatives (Years 1-2)
- Promote (market) existing, enhanced or new opportunities (Years 2-10)
- Evaluate effectiveness of marketing and implementation efforts (Years 4, 6 and 10)

Measurements:

- Watershed-wide recreation plan with recommendations for implementation
- Number of projects implemented
- Number of partners participating
- Number of contacts made
- Effectiveness of marketing efforts

Potential Partners: The Superior Watershed Partnership, Luce West Mackinac Conservation District, Luce County Planning and Development, The Nature Conservancy in Michigan, Trout Unlimited, Michigan Department of Natural Resources, Northern Initiatives and the Eastern Upper Peninsula Nature Tourism Alliance.

Task 6: Establish volunteer programs to monitor water quality and aquatic habitat conditions and track invasive species infestations and spread

Work with partners to establish volunteer programs to monitor trends in water quality and aquatic habitat conditions and invasive species infestations:

- Conduct volunteer training (stream monitoring and invasive species identification and control methods)
- Conduct annual (spring and fall) water quality monitoring at previously established sites using Michigan Department of Environmental Quality protocol or other acceptable methods (habitat and macroinvertebrate communities)
- Track invasive species infestations and control efforts (mapping)
- Host volunteer invasive plant work days
- Share data and results with volunteers, stakeholders, and local, state, and federal agencies other interested parties

Goals Accomplished:

Goal 1: Protect and improve the quality of water

Goal 2: Protect the integrity of aquatic and terrestrial ecosystems

Goal 3: Increase stewardship practices

Designated Uses Addressed:

Coldwater fishery, other aquatic life

Desired Uses Addressed:

All

Estimated Cost: \$5,000/year

Timeline: ongoing

Priority: Medium

Milestones:

- Conduct annual volunteer stream monitoring training sessions (Years 1-10 or as needed as new volunteers participate)
- Conduct periodic education sessions on invasive species identification and work days for volunteers and landowners (Years 1-10 or as needed as new volunteers participate)
- Conduct annual spring and fall water quality monitoring at previously established sites (Years 1-10)
- Map invasive species infestations and treatment/control areas (Years 1-10)

Measurements:

- Number of volunteers participating
- Annual water quality monitoring data and long-term trends analysis
- Number of invasive species infestations identified and mapped
- Number of invasive species controlled (acres)

Potential Partners: The Superior Watershed Partnership, Luce West Mackinac Conservation District, The Nature Conservancy in Michigan, Trout Unlimited, Michigan Department of Natural Resources, the Upper Peninsula Invasives Council, and corporate and private landowners.

Table 5.2 Implementation Tasks and Milestones

Implementation Task/Milestone	Timeline (years)									
	1	2	3	4	5	6	7	8	9	10
1. Reduce sediment from manmade erosion sites including road/stream crossings, fords and recreational access points	X	X	X	X	X	X	X	X	X	X
• Implement improvements at 1-2 sites/year (Years 1-10)	X	X	X	X	X	X	X	X	X	X
• Conduct pre and post BMP field evaluations (site condition evaluation and stream monitoring) (Years 1-10)	X	X	X	X	X	X	X	X	X	X
• Achieve 10% reduction in sediment load (Year 5)					X					
• Achieve 25% reduction in sediment load (Year 10)										X
• Achieve water quality ratings of good or excellent at all monitoring sites (Year 10)										X
2. Promote voluntary arrangements and regulatory incentives for corporate and private landowners	X	X	X	X	X					
• Work with partners to develop and distribute information and education on voluntary landowner arrangements (Year 1)	X									
• Work with Luce County to develop and adopt incentive programs (Years 1-3)	X	X	X							
• Work with landowners to improve land use management practices (Years 2-5)		X	X	X	X					
3. Develop and distribute information/education materials to watershed stakeholders and the public	X	X	X	X	X	X	X	X	X	X
• Create contact lists of focus groups and target audiences (Year 1)	X									
• Develop and distribute a minimum of two I/E materials (articles, newsletters, brochures, etc.) per year to target audiences (Years 1-10)	X	X	X	X	X	X	X	X	X	X
• Conduct survey of recipients (Years 2, 5 and 10)		X			X					X

Implementation	Timeline (years)									
Task/Milestone	1	2	3	4	5	6	7	8	9	10
• Host annual “River Awareness Day” event (Years 1-10)	X	X	X	X	X	X	X	X	X	X
• Host invasive species work days (Years 1-10)	X	X	X	X	X	X	X	X	X	X
4. Develop and maintain a project website	X	X	X	X	X	X	X	X	X	X
• Develop project website and post all existing information (Year 1)	X									
• Update website (post new information, data, reports (Years 1-10)	X	X	X	X	X	X	X	X	X	X
• Evaluate website use/effectiveness (Years 2, 5 and 10)		X			X					X
5. Increase nature-based tourism opportunities and improve stewardship practices of recreational users and the public	X	X	X	X	X	X	X	X	X	X
• Evaluate existing recreational uses and opportunities for trail enhancement/development (Year 1)	X									
• Develop watershed-wide recreation plan (Year 2)		X								
• Identify target audiences and opportunities to link to regional initiatives (Years 1-2)	X	X								
• Promote (market) existing, enhanced or new opportunities (Years 2-10)		X	X	X	X	X	X	X	X	X
• Evaluate effectiveness of marketing and implementation efforts (Years 4, 6 and 10)				X		X				X
6. Establish volunteer programs to monitor water quality and aquatic habitat conditions and track invasive species infestations and spread	X	X	X	X	X	X	X	X	X	X
• Conduct annual volunteer stream monitoring training sessions (Years 1-10 or as needed as new volunteers participate)	X	X	X	X	X	X	X	X	X	X
• Conduct periodic education sessions on invasive species identification and work days for volunteers	X	X	X	X	X	X	X	X	X	X

Implementation	Timeline (years)									
Task/Milestone	1	2	3	4	5	6	7	8	9	10
and landowners (Years 1-10 or as needed as new volunteers participate)										
<ul style="list-style-type: none"> Conduct annual spring and fall water quality monitoring at previously established sites (Years 1-10) 	X	X	X	X	X	X	X	X	X	X
<ul style="list-style-type: none"> Map invasive species infestations and treatment/control areas (Years 1-10) 	X	X	X	X	X	X	X	X	X	X

Existing Projects and Initiatives

Throughout the duration of this project, members of the Two Hearted River Watershed Advisory Council have been involved in a number of local and regional projects and initiatives related to protecting and enhancing the quality of water, natural character and the quality of life in Luce County and the Upper Peninsula of Michigan. These projects and initiatives are closely linked with the goals for protection and enhancement of the Two Hearted River watershed. They are mentioned here because they provide a foundation for future implementation of the recommendations of this plan.

Great Waters

The Great Waters is a unique sustainable economic development program developed by Northern Initiatives and the Eastern Upper Peninsula Nature Tourism Alliance to highlight nature-based tourism opportunities in the eastern Upper Peninsula. A series of trail maps and guides and an interactive web site are available to assist visitors in planning their vacation based on local points of interest and available services. A visitor can go to www.greatwaters.net and learn about 33 different waypoints to visit, including the mouth of the Two Hearted River and Rainbow Lodge. These waypoints are accessed by 3 primary driving trails along Lakes Michigan, Huron, and Superior. In addition, the Superior

Great Waters Trail Map with waypoints



Great Waters "Doing Our Part" campaign logos for participating businesses





River Awareness Day

*A Totally Free Family Event
and Fundraiser*

June 21, 2008

Sponsored by the Two Heart Chapter of Trout Unlimited

***Location: The Rainbow Lodge
located at the mouth of the Big Two Hearted River***

Events of the day to include:



10:00 - 11:30 Fly Tying and Fly Casting Instruction

12:00 - Hot dog lunch FREE FREE FREE

1:00 Stream Ecology at the river.

2:00 Eastern Upper Peninsula Fly Casting Contest

3:30 Children's Auction

4:00 Silent Auction Ends

We will have fly casting equipment available for participants or you may use your own. For camping and motel accommodations contact the Rainbow Lodge at 906-658-3357

For more information contact: Jim Rutledge 906-477-0035
Larry McEvers 906-477-8079

Watershed Partnership (SWP) has partnered with Northern Initiatives to provide visitors with an opportunity to get involved with the preservation of their favorite destination. Visitors can log onto www.superiorwatersheds.org and share their experiences, conduct basic stream monitoring, share a photo, and help SWP protect the watersheds of the Upper Peninsula.

The SWP also developed the Great Waters, "Doing Our Part" campaign where lodging facilities and other tourism businesses can participate to conserve energy, minimize water use, reduce waste and become a certified Green establishment. The Doing Our Part campaign features an energy and waste reduction checklist plus a series of water conservation materials for hotel and motel guest rooms. With these materials, businesses can take simple, low cost steps to conserve energy and minimize water use and solid waste at their business. According to the Travel Industry Association of America, 43 million people in America are self-proclaimed "eco-tourists" and are willing to pay 8.5% more to stay at a "Green" lodging facility. The SWP also provides Great Waters service outings for the local public and tourists where participants can assist with watershed protection projects such as habitat restoration and trail reconstruction. Funding for the Great Waters project was provided by People and Land and the Kellogg Foundation. The SWP is currently seeking additional funding to expand this successful project to other parts of the Upper Peninsula.

Trout Unlimited River Awareness Day

The Two Heart Chapter of Trout Unlimited "River Awareness Day" provides an opportunity for children and adults to learn about fly fishing techniques and the ecology of the Two Hearted River. Located at the mouth of the

Two Hearted River, this one-day family event also allows the chapter to raise funds for stream restoration projects and other initiatives.

Lake Superior Coastal Management Plan

During 2008, Luce County Planning and Development and the Luce West Mackinac Conservation District developed the Lake Superior Coastal Management Plan with funding from the Michigan Coastal Management Program, the Michigan Department of Environmental Quality and the National Oceanic Atmospheric Administration. The purpose of this plan is to

Lake Superior Coastal Management Plan for Luce County

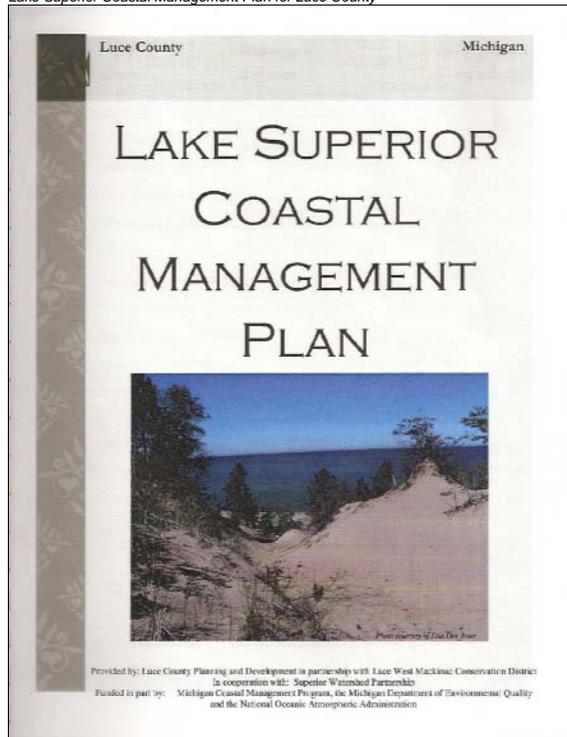
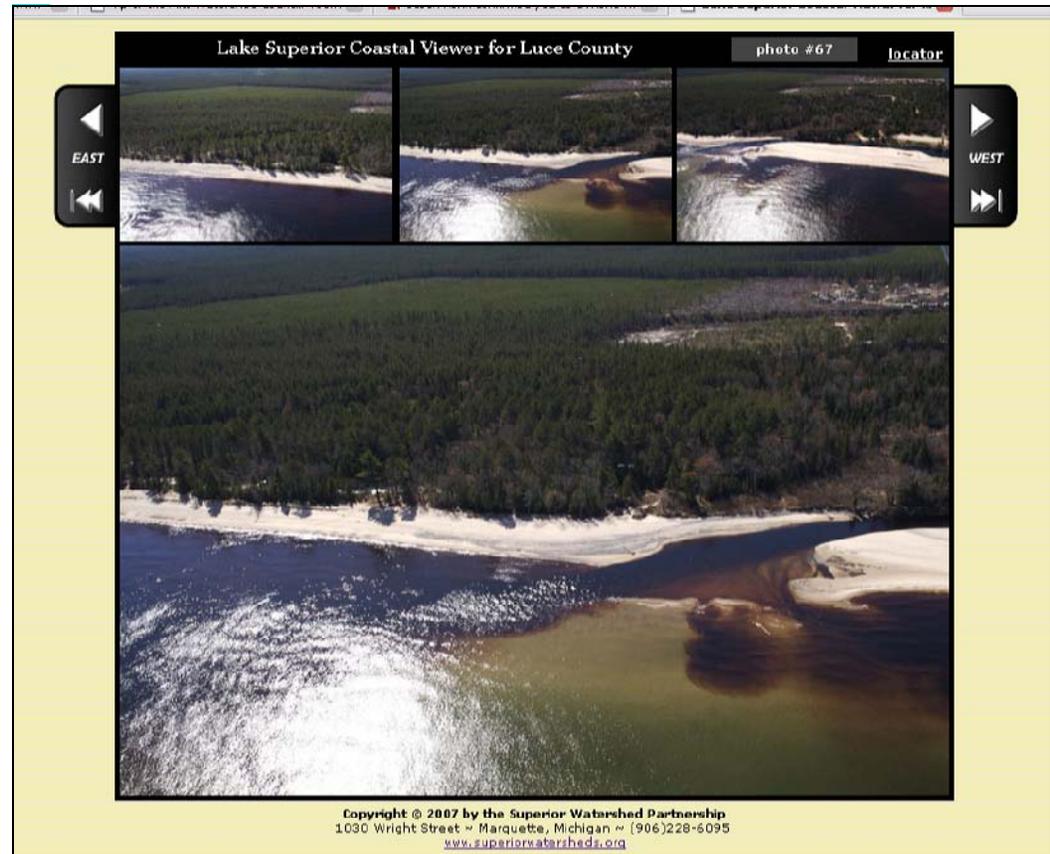


Image from Lake Superior Coastal Shoreline Viewer for Luce County — showing the mouth of the Two Hearted River



Read Before You Ride!
AVOID FINES!

ORV/ATV Riders - You NEED to know:
It is **unlawful** to ride an ORV/ATV in **ANY** wetlands, swamps or on **ANY** beaches or shorelines. **Violators riding on beaches or wetlands have been, and will continue to be, held liable for all restoration costs and fines. In order to protect this beautiful environment, court judgements in the thousands of dollars are being rendered against offenders.**

In LUCE COUNTY you also NEED to know:

Riding on county roads must be done single file and is **restricted to the outer 5 feet** at the right-hand side of the road. On paved roads that means to the right of the fog line!

The maximum ORV/ATV speed limit is **25 MPH** on **ANY** Luce County road unless posted lower.

These **County Roads** are **off limits** to ORV use:
County Road 392 (Industrial Park)
County Road 478 (Luce County Park Road)
County Road 439 (Pretty Lake Area)
Also off limits:
Luce County Fair Grounds
All Luce County Recreational Facilities
All State Parks

It is **illegal** to ride on or along these state roads:
M-28 M-123 M-117
They may be crossed at a right angle only!

Snowmobile trails and ORV/ATV trails are **NOT** the same! Many snowmobile trails are **OFF LIMITS** to ORV/ATV riders because they cross private property leased by snowmobile associations and not by ORV groups. Crossing Private Property is **TRESPASSING** and could jeopardize those leases!

Michigan Law **requires** Helmets when riding an ORV/ATV.
Did you know?... If you are riding an ORV/ATV, and have a traffic accident with a car/truck, **you** are automatically assumed at fault. Now you know!

Luce County Welcomes Safe and Responsible ORV and ATV Riders!



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allow Luce County to manage the resource and steer development and future use through education, community outreach and participating in the Michigan Department of Environmental Quality permitting process to preserve the natural habitat, resources and beauty of the Lake Superior Shoreline. As a part of this project, the Superior Watershed Partnership assisted with development of the Lake Superior Coastal Shoreline Viewer for Luce County. The Lake Superior Coastal Shoreline Viewer consists of unique oblique angle photographs of every inch of the Lake Superior shoreline in Luce County and provides a valuable land use planning tool for landowners, local units of government and regulatory agencies. The viewer can be accessed at www.superiorwatersheds.org and is also available on CD.

ORVIATV Information and Education Campaign
As a result of the recent problems and damage that has occurred as a result of ORV/ATV use, the Luce County Board of Commissioners has begun a campaign to inform and educate recreational users and the public about safe and responsible riding practices.

Potential Funding Sources

Increased communication between stakeholders and other local, state, and federal entities will provide a means to find more effective solutions, eliminate program duplication, and maximize human, financial, and institutional resources. However, these resources alone will not be sufficient to implement all the goals and objectives of this watershed management plan.

The following are some of the possible funding sources (grant, loan, and cost share programs) available to stakeholder agencies and non governmental organizations for implementation of this plan. This list is not exhaustive and many other funding sources exist, especially on the local level. Information on these funding sources can be found on the internet or by contacting the agency or nonprofit.

- Michigan Department of Environmental Quality (multiple programs)
- Federal Clean Water Act, Section 319(h)
- U.S. Environmental Protection Agency Targeted Watersheds Implementation
- U.S. Environmental Protection Agency Environmental Education Grants
- U.S. Environmental Protection Agency Five Star Restoration Program
- U.S. Fish and Wildlife Service (multiple programs)
- Michigan Department of Natural Resources Forest Land Enhancement Program
- Great Lakes Commission Great Lakes Basin Program for Soil Erosion and Sediment Control
- Great Lakes Commission MiCorps Volunteer Stream Monitoring Program
- People and Land — Kellogg Foundation
- Private Foundations
- Fundraisers
- Donations

EVALUATION

Evaluation provides stakeholders with an opportunity to assess the effectiveness and appropriateness of the original goals and objectives of this plan as tasks are implemented and conditions change over time. Evaluation also provides a feedback mechanism for periodically assessing the effectiveness of management practices and allows stakeholders to identify areas where program improvements are possible.

The measurements identified in relation to the goals and objectives of this plan provide helpful tools for local stakeholders to assess the effectiveness of their implementation projects or educational/outreach efforts. These measures however, are by no means exhaustive. Many other evaluation measures exist and local stakeholders must ensure evaluation programs and protocols meet local needs.

Evaluation programs typically include two types of measures: quantitative and qualitative. Quantitative attributes are those which are possible to measure. Qualitative measures try to shed light on changes in attitudes, perceptions and knowledge levels. Examples of the two approaches as they related to the goals and objectives of the Two Hearted River Watershed Management Plan are provide below.

Quantitative Measures

- Biological monitoring of surface waters (e.g. macroinvertebrate communities)
- Chemical monitoring of surface waters (e.g. temperature, dissolved oxygen, nutrients)
- Stream flow monitoring (e.g. volume, velocity)
- Sediment monitoring (e.g. deposition, quantity)
- Number of buffer ordinances adopted
- Number of acres protected (conservation easements)
- Educational workshop attendance levels
- Number of Best Management Practices implemented
- Number of restoration projects completed

Qualitative Measures

- Workshop evaluation surveys
- Public opinion surveys (e.g. increased awareness of impacts of non-point source pollutants on aquatic habitats, etc.)
- Increased cooperation and networking between stakeholders and other entities
- Level of enthusiasm expressed about revising zoning ordinances and master plans
- Public confidence that groundwater is safe
- Belief that information from the Two Heated River Watershed Advisory Council is accurate, non-partisan, and valuable

Whether using quantitative or qualitative measures, measuring the effectiveness of the Two Hearted River Watershed Management Plan will be two-tiered. First, individual agencies and communities will monitor certain projects and programs on the agency and community levels. Secondly, there will be a need to monitor progress and effectiveness on a regional watershed level in order to assess the health of the Two Hearted River and its tributaries as a result of administrative, environmental, and social effects of collective community and agency actions. This responsibility will most likely fall to the Two Hearted River Watershed Advisory Council.

Previously established water quality and road/stream crossing monitoring programs provide valuable information and offer a fairly objective and verifiable way to evaluate water quality trends, water quality differences related to land use, or to relate improvements in water quality to specific implementation objectives over time. Ideally, this data would be consistently incorporated into a data management system for sharing with other interested stakeholders and policy makers but at the present time is not. It is also critical to continue these programs in a consistent manner that ensures the data are reliable and useful to stakeholders throughout the watershed.

Although a common and valuable approach, water quality and road/stream crossing monitoring may not be sufficient for evaluation of all implementation efforts. Both natural and man-made factors affect water quality and limit the ability to attribute improvements to any specific Best Management Practice or educational tool. A combination of quantitative and qualitative measures should be an integral part of any evaluation program to provide a more comprehensive picture of the success of implementation.

In general, implementation activities should be reviewed and compared to results with interim milestones to ensure smooth implementation and to measure progress toward meeting goals. A sense of what messages, delivery mechanisms, and Best Management Practices are working and not working and why is dependent on conscientious evaluation and reporting by all stakeholders responsible for implementation of the watershed management plan. As the objectives outlined in this plan are implemented in subsequent years, an assessment based on trends as compared to previously established baseline data will be possible. Such an assessment is needed if the plan is to remain flexible, relevant, and effective for those who use it.

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