MULLETT LAKE WATERSHED

PROTECTION PLAN

A PLAN TO PROTECT THE
HIGH QUALITY WATER
RESOURCES IN THE
MULLETT LAKE WATERSHED

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To be completed

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1. Introduction

Mullett Lake is a large, deep, high quality lake located just east of I-75 in Cheboygan County. Mullett Lake is part of northeast Michigan's Inland Waterway and is the state's fifth largest lake, with a surface area of 16,630 acres. The lake is considered mesotrophic and is ranked among Michigan's top 50 fishing lakes. Mullett Lake lies within six townships: Aloha, Benton, Inverness, Koehler, Mullett, and Tuscarora, and is under the auspices of the Cheboygan County Zoning Ordinance.

The Mullett Lake Watershed encompasses over 162,000 acres and is primarily located in Cheboygan County with the headwaters of the Pigeon River originating in Otsego County (just east of the City of Gaylord). Located within Mullett Lake's Watershed area are the unincorporated communities of Indian River and Topinabee. The Watershed is easily accessible by Interstate 75 and is primarily a water-based recreation area. The major tributaries to Mullett Lake are the Indian River (six river miles), Pigeon River (forty-two river miles), the Little Pigeon River (seven river miles), and Mullett Creek (eight river miles). The Watershed is mostly forested, with lesser amounts of agricultural and urban areas.

Cheboygan County is utilized extensively as a tourist area. Recreational activities are primarily water-based and focus on large, clean lakes and high quality rivers such as Mullett Lake and the Pigeon River. During periods of high recreational use, the county's population can increase by at least three-fold. This tourist trade is vital to the local economy and is increasing each year. Homes that were once used only as seasonal homes are now being converted to year-round use. The combined pressures of these trends can, throughout time, result in water quality degradation. Left unmanaged, serious long-term effects occur, rapidly changing the quality of the water. The continued recreational attractiveness of the area depends almost exclusively on maintaining high water quality in area lakes and streams. It has been shown that, in areas where water quality degradation has been allowed to occur, a decline in water quality can severely hurt a local economy by reducing tourist trade and causing a decline in property values, which directly affect the local tax revenues.

2. Local Government Agencies

The Mullett Lake Watershed lies within the authorities of two governmental agencies: Cheboygan and Otsego Counties, and one regional planning agency – the Northeast Michigan Council of Governments (NEMCOG). Cheboygan and Otsego Counties both maintain county planning and zoning commissions and soil conservation districts. Neither county employs a county planner; however, Otsego County does employ a county coordinator to oversee county operations. The Huron Pines Resource Conservation and Development Council includes Cheboygan and Otsego Counties and has been active within the Watershed, participating on streambank projects. Cheboygan County comes under the jurisdiction of District #4 Health Department, while Otsego County is within District #3 Health Department. A complete discussion of local land use control is provided in the Management Review section of this report.

3. Waterbody Locations

The Indian River, Little Sturgeon, Mullett Creek, and East Little Pigeon – tributaries of Mullett Lake – are located in Cheboygan County with the Pigeon and West Branch of the Little Pigeon originating in Otsego County. The Pigeon River originates in Chester/Dover Township, east of Gaylord in Otsego County and passes through Corwith Township. The river then enters Cheboygan County in Nunda Township and flows northerly through Walker, Ellis, and Koehler Townships. The Little Pigeon River is entirely in Cheboygan County, originating in Walker

Township, with the majority of the river within Koehler Township. The Little Sturgeon has its headwaters in Nunda Township and flows through Ellis, Tuscarora, and Koehler Townships. The Indian River, connecting Burt Lake with Mullett Lake, is entirely within Tuscarora Township. Mullett Creek originates in Munro Township and flows to Mullett Lake through Mullett Township.

4. Population

The Mullett Lake Watershed is primarily rural in nature, and contains only small, unincorporated communities. However, the northern boundary of Mullett Lake is within four miles of the City of Cheboygan, which has a population of approximately 2,000.

Located within the Mullett Lake Watershed are the unincorporated communities of Indian River, Topinabee, Aloha, and Afton. Although the year-round population of these communities is small, they all receive an extreme number of seasonal tourists. It has been estimated that during the summer months the influx of tourists to the Cheboygan County portion of the Watershed increases in population three-plus fold over the resident population, and this seasonal influx increases each year. It is projected that, within the Watershed, the year-round population will increase 21% by the year 2000. (**See Table 1**).

TABLE 1

POPULATION OF THE MULLETT LAKE WATERSHED IN YEAR 1985 AND PROJECTED FOR YEAR 2000

County	1985*	2000
Cheboygan (Mullett Watershed Townships)	13,760	17,219
Otsego (Mullett Watershed Townships)	8,262	9,577

*All population projections were extrapolated from Michigan Department of Management and Budget estimates for growth rate through the year 2,005.

5. Uses of The Water

The Mullett Lake Watershed is well known for its recreational and aesthetic opportunities. Not only is Mullett Lake itself heavily utilized but many visitors come north to enjoy the 88,000 square miles of the Pigeon River Country State Forest. These recreational areas are easily accessed from the south via I-75 and U.S. 27. U.S. 27 parallels the western border of Mullett Lake.

Mullett Lake's recreational activities are plentiful. Boating, swimming, and fishing are popular activities among year-round residents, seasonal residents, and tourists. There are approximately 1,050 dwellings along its shores. The community of Indian River is located on the Indian River just upstream from Mullett Lake. Several other small communities -- Topinabee, Aloha, and Mullett Lake Village -- are located on the shores of the lake. The area has a long history as a resort community, and the local population increases greatly during the summer. There are two Michigan Department of Natural Resources (DNR) public access sites on the lake, along with several marinas. Aloha State Park is popular and receives heavy use. Mullett Lake is considered

an excellent fishery resource and is a high priority for DNR fish management programs. It is also one of the top 50 fishing lakes in Michigan. Highlights of the fishery include several cold water species -- lake trout and cisco -- along with perch, pike, bass, muskie, and walleye. A remnant population of the endangered lake sturgeon is present in the lake.

The Pigeon River, designated by the State of Michigan as a wild and scenic river, is well known as an excellent blue ribbon trout stream. The river also receives extensive usage by canoeists.

The Indian River is not only used as a navigational route between Burt and Mullett Lakes, but it also supports a wide range of fish such as walleye, pike, perch, bass, and ciscos. The Indian River Spreads, northern Michigan's largest cattail marsh, is located near the mouth of Mullett Lake and is also extensively used for fishing.

There is one point source discharge within the Watershed located at the headwaters of the Pigeon River. Sylvan Resort, a golf and winter ski recreational facility, received a National Pollution Discharge Elimination System (NPDES) Permit from the DNR in 1987 to discharge non-contact cooling water to a feeder stream of the Pigeon River.

6. Adjacent Water Bodies

Within the Cheboygan River Watershed, there are a number of large lakes in the immediate vicinity of the Mullett Lake Subwatershed, which together comprise the Inland Waterway (**See Figure 1**). Pickerel/Crooked Lakes, the Crooked River, Burt Lake, the Indian River, Mullett Lake, and the Cheboygan River make up the Inland Watwrway, which boasts over 35 miles of navigable waters. Mullett Lake receives Burt Lake's discharge through the Indian River. Douglas Lake, located a few miles north of Burt Lake, discharges to Burt Lake through the East Branch of the Maple River. Crooked/Pickerel Lakes discharge to Burt Lake via the Crooked River. The Pigeon, Little Pigeon, and Mullett Creek also discharge directly to Mullett Lake.

All of the lakes of the Inland Waterway have public access, and recreational boaters are served by a number of marinas scattered throughout the length of the waterway.

7. Land Use in the Watershed

The land use information that was utilized was obtained from the Clean Water Interim Outputs – May, 1977. The predominant land use category within the Mullett Lake Watershed is forested, which occupies 73% of the area (**See Table 2**). The second greatest land use category is agricultural, which occupies approximately 12% of the Watershed. The Cheboygan County Soil Conservation Service estimates that approximately 10% of the county's agricultural land is in crop or animal production and the remaining 90% is either permanent pasture or hay. Wetlands occupy approximately 11% of the Watershed. The majority of the wetlands in the watershed are forested, and are typically characterized by white cedar, balsam fir, red maple, balsam poplar, and black ash associations. Forested wetlands are common along tributary streams and the Mullett Lake shoreline. Urban/Residential areas occupy 12% of the Watershed acreage.

TABLE 2

CHEBOYGAN COUNTY LAND USE

Category	Acreage	Percentage
Forested	337,200	73%
Agriculture	54,847	12%
Wetlands	50,348	11%
Transportation	14,000	3%
Urbanization	5,000	1%

DETAILED DESCRIPTIONS OF MULLETT LAKE AND ITS WATERSHED

1. Mullett Lake Watershed

A watershed is a natural unit which is utilized to develop an ecosystem approach to lake management and land use planning. The Mullett Lake Watershed is that area from which precipitation eventually drains into the lake through direct runoff, surface streams, or ground water discharge. As water moves throughout the Watershed, certain chemical characteristics are imparted to the water. Factors such as watershed size, topography, soil type, drainage patterns, geology, vegetation, land use, and the amount of precipitation can all influence water quality. Most of these influences are natural and uncontrollable.

Certain cultural activities along the shoreline and throughout the watershed can contribute pollutants to the water. The pollutant of primary concern for Mullett Lake is nutrients, which are those elements and compounds necessary for plant growth. When nutrient levels are low, lake waters are relatively clear, weed-free, and contain adequate levels of dissolved oxygen at all depths to support fish populations. Low nutrient conditions are desirable for most recreational uses of the lake. Nutrients are a natural part of the lake ecosystem. The amount of nutrients within a lake gradually increases over time, resulting in a decrease in water quality. This process, called EUTROPHICATION, normally takes many thousands of years.

When the nutrient enrichment of a lake increases due to human activities, the rate of eutrophication can, and often does, become accelerated. Culturally-generated nutrients originate from such sources as construction activities, septic systems, sewer and industrial discharges, poor agricultural practices, storm water runoff, wetland destruction, and deposition of airborne pollutants. Development along the lakeshore is most likely to cause nutrient enrichment from these sources because of its close proximity to surface water. Other sources of nutrients to Mullett Lake originate throughout its watershed and are delivered to the lake by its tributary streams. These sources are often overlooked because they are widespread, inconspicuous, and difficult to assess. Many of these sources of pollution are referred to as nonpoint sources because they often do not have a single point of origin or discharge.

The Mullett Lake Watershed is large, encompassing 744 square miles. However, the majority of the Watershed is located upstream from Burt Lake. The seven lakes which are found in this area act as nutrient and sediment traps, preventing adverse water quality impacts from the upper portion of the watershed. The immediate watershed of Mullett Lake is of much greater importance to the lake's water quality. The area of the immediate watershed is also large, about 250 square miles. However, the size of a lake's watershed relative to the size of the lake is a more descriptive statistic. Lakes in which the ratio of watershed area to lake area is large are more susceptible to nutrient enrichment and other types of pollution from throughout the watershed than lakes with small ratios. The ratio of Mullett Lake's Watershed to its surface area is 9.74, which indicates that the watershed is not very large in relation to the lake's size. The watershed-to-surface-area ratio for other nearby lakes ranges from 1.7 to 177.5

The primary tributaries of Mullett Lake, in descending order of size, are the Indian, Pigeon, Little Sturgeon, and Little Pigeon Rivers and Mullett Creek. Numerous smaller streams also flow into Mullett Lake in various locations.

The watershed boundary west of Mullett Lake runs approximately halfway between Burt and Mullett Lakes. In the north part of the watershed, the surface drainage comes to within about one-half mile of Douglas Lake. Mullett Creek drains this portion of the watershed and discharges near the mid-point of the western shore. The northeastern boundary of the watershed lies between Mullett and Long Lakes. The watershed attains its greatest width here, nearly 13 miles. Southeast of Mullett Lake, four small lakes are located within the watershed. Devereaux and Cochran Lakes are seepage lakes, while Silver and Roberts Lakes are drainage lakes with surface connections for Mullett Lake. Four of Mullett Lake's five major tributaries flow into the south end of the lake. The longest of these tributaries is the Pigeon River, whose headwaters lie approximately 35 miles south of its mouth. The Mullett Lake Watershed has its greatest length here, 46 miles on a north-south axis. The Pigeon River discharges into Pigeon Bay after flowing through a wetland area.

The mouth of the Little Sturgeon River discharges into the Indian River just downstream from the town of Indian River. The Sturgeon River was formerly a tributary of Mullett Lake, also emptying into the Indian River, but its channel was diverted into Burt Lake to facilitate navigation on the Inland Waterway. The Little Pigeon flows into Mullett Lake near the mouth of the Pigeon River. The Indian River is formed from the surface outflow from Burt Lake. It flows through a large cattail marsh, called the Indian River Spreads, before discharging into Mullett Lake.

The outlet of Mullett Lake is the Cheboygan River. In approximately 1922, a dam was constructed on the river four miles downstream from Mullett Lake. The damming caused the lake level to rise, resulting in increased shoreline erosion, which is still occurring at the present time. The damming also resulted in flooded bays and inlets, and some areas of submerged timber. The dam is equipped with a lock to allow boat traffic to access Lake Huron. The Watershed of Mullett Lake is shown in **Figure 2**. The Watershed has been divided into six sub-watersheds. Five of the sub-watersheds are areas drained by the lake's major tributaries, and the sixth subwatershed consists of shoreland areas with no major surface streams.

2. Mullett Lake

Lake managers and limnologists have developed standard size and shape measurements and calculations to describe the physical features of lakes. These can also provide insights into a lake's productivity and trophic status, and reflect a lake's sensitivity to human impacts.

Mullett Lake is one of the largest inland lakes in Michigan. It has a surface area of 17,360 acres (27 square miles), including the Indian River Spreads. The lake has a maximum length of ten miles, and a maximum width of nearly four miles. The mean width is 2.6 miles.

Mullett Lake is very deep for an inland lake, its maximum depth being 145 feet (**Figure 3**). However, its <u>average</u> depth is only 37 feet. The northern half of the lake is quite shallow, and extensive shallows are also present at the southern end. A trough containing the deepest area is located in the southern half of the lake, with a second deep area in Scotts Bay. A mathematical expression called a Volume Development Factor (VDF) has been developed to show the relative form of a lake's basin. It describes the ratio of a lake's volume to the volume of a cone with the basal area equal to the depth of the lake. The VDF of a cone is 1.0. Most lakes have a VDF greater than one. The VDF of Mullett Lake is 0.8, meaning that it has large shoal areas and a relatively small, deep area. These extensive shallow areas are sites for potential weed growth if

the lake's nutrient levels increase in the future. The relatively small volume contained in the deep basins makes these areas chemically and biologically sensitive to changing water quality.

Mullett Lake's volume is large, nearly 200 billion gallons. The lake's large volume also helps protect it from pollutants because of the large dilutional effect it provides. The lake's tributaries deliver a large amount of water annually, resulting in a flushing rate or water renewal time of 11 months. This is a fairly rapid rate, and it lessens the lake's sensitivity to shoreline pollution, because the lake is replaced with unpolluted sources fairly rapidly.

The shoreline of Mullet Lake is 28 miles long. The shoreline development factor (SDF) is the ratio of a lake's shoreline to the length of the circumference of a circle with an area equal to that of the lake. A perfectly circular lake would have a SDF of one. The higher the SDF, the more sensitive a lake is to pollutants from runoff and shoreline development. The SDF of Mullet Lake is 1.6, which is moderately low, and reflects the relatively straight shorelines of the lake, and the absence of deeply indented bays and islands. The SDF for other lakes in northern Michigan ranges from 1.1 to 4.3.

The water quality of Mullett Lake is currently good. It is a deep, hardwater lake. The term "hardwater" means that high concentrations of alkalinity, calcium, and magnesium are present. This causes the water to resist large changes in pH, such as result in some areas from acid precipitation. This characteristic also provides some natural protection from nutrient enrichment because phosphorus, the limiting nutrient, coprecipitates with calcium carbonated into the sediments. The concentrations of phosphorus, the lake's most critical nutrient, are low. Dissolved oxygen is present in the bottom waters throughout the year. Deep lakes with low nutrient levels and well oxygenated bottom waters are termed OLIGOTROPHIC lakes. Lakes of this type are the most sensitive to nutrient pollution. Currently some oxygen depletion is occurring in Mullett Lake in the deep waters during summer months, and it is approaching the critical level for cold water species such as lake trout.

3. Geologic Setting

The bedrock in the Mullett Lake Watershed is composed of layers of dolomite, limestone, and shale. These rocks were formed from sediments deposited by a succession of ancient seas 300-400 million years ago. These seas eventually retreated due to uplifting of the earth's surface. The land was subject to erosion by weather and streams, creating a landscape of steep valleys and upland ridges.

The Pleistocene Age, or "Ice Age", began about two million years ago. Continental glaciers covered Michigan four times during this period, and the last advance of the glacier was responsible for many of the surface features present today in the Mullett Lake Watershed. The glaciers reworked previous glacial deposits and plucked and abraded the sedimentary bedrock, wearing down and rounding hills and broadening and deepening river valleys. They left behind deposits of till, (material carried and deposited directly by the ice), and outwash (till that has been washed, sorted, and transported by glacial meltwaters). Many of the high hills in the Mullett Lake Watershed are deposits of glacial till called moraines. The thickness of the glacial deposits varies from less than 50 feet to more than 600 feet. Outwash deposits are found in the vicinity of Indian River, and the headwaters of the Pigeon River.

The major pre-existing topographic features of the Great Lakes region influenced the advance of the ice and the modifications it made. Ice moved most easily and was thickest in river valleys.

The present Great Lakes were originally the valleys of large streams draining the mid-continental region. Mullett Lake is part of the Inland Waterway, a 40-mile-long series of interconnected lakes and rivers running from near Little Traverse Bay in Emmet County to Cheboygan through a region known as the Indian River lowland. This lowland is underlain by a channel incised in the bedrock by the erosive actions of a pre-glacial tributary of the river which occupied the Great Lakes Basin. As the ice advanced and retreated in this valley it left behind a series of moraines, outwash plains, and stranded lobes of ice. These conditions interacted to form the lake basins of the inland waterway. Southern Mullett Lake, the Indian River, and the deepest areas of Mullett Lake lie in glacial deposits centered directly over this ancient channel. However, the shallow northern portion of Mullett Lake and other lakes of the Inland Waterway lie parallel to the original channel. The Pigeon River also flows partially over a pre-glacial stream channel in the bedrock. Other lakes and streams in the Mullett Lake Watershed appear to exist in valleys and depressions in the glacial deposits.

Following the end of the Ice Age, approximately 12,000 years ago, the level of the Great Lakes went through a period of fluctuation. Portions of the Mullett Lake Watershed were inundated several times, at depths up to 150 feet above the present level of Mullett Lake. Wave actions, current, and the deposition of lake sediments influenced the surface topography and soil type within this area. The waters of these lakes planed off the hilltops, softening the sharp relief and depositing veneers of sand, clay, or marl in places. A series of level terrains were created along these old shorelines, forming sites conducive to the construction of railroads, highways, and buildings today.

The important ground water aquifers of the Mullett Lake Watershed lie in glacial deposits. The characteristics of these aquifers depend upon the nature and thickness of materials composing the deposits. Silt and clay are less permeable than sand and gravel, and thick deposits have more water holding capacity than thin deposits. Generally, areas of glacial till are less productive aquifers than outwash deposits. Outwash deposits were most commonly formed in glacial meltwater channels, and these areas are where most streams are found today.

The hydrology of thick glacial deposits is complex because of the lateral and vertical discontinuity of sediments, variations in permeability, and the underlying bedrock topography. Extensive subsurface information is needed to accurately determine the direction and amount of ground water movement. However, the surface watershed usually gives a reasonable estimate of a lake or stream's actual watershed.

The generally thick glacial deposits in the Mullett Lake Watershed result in ample ground water aquifers and a large number of springs and streams with cold, steady, high quality flows of ground water. The bedrock geology and the large amount of limestone in the glacial deposits influences the chemical quality of ground water and most surface waters, resulting in moderately high hardness and alkalinity.

4. Subwatershed Descriptions

Mullett Lake's immediate watershed has been subdivided into six separate sections, called subwatersheds. These subwatersheds are the drainage basins of each of Mullett Lake's five major tributaries, along with the shoreland area undrained by a single tributary. Each of these subwatersheds has distinct characteristics which are most easily studied and managed as individual units.

Several characteristics are commonly used to describe a watershed. The shape of a drainage area influences the stream runoff. A compactness coefficient has been developed to describe the shape of a basin. The coefficient is analogous to the SDF determination for a lake. Watersheds with compact basins have values approaching one, while long, narrow basins will have higher values. Watersheds with high compactness coefficients tend to have relatively short tributaries which join the mainstream at intervals along its length, rather than at a central location such as in more compact watersheds. This means that following a runoff event, the runoff peaks of the lower tributaries will have left the mainstream by the time runoff from the upper tributaries arrives. Watersheds with high compactness coefficients are less subject to high runoff peaks, and the associated erosion, pollutant loading, and possible flooding than streams with low coefficients.

There is a continuous movement of weathered surface material from all parts of the drainage basin towards and through the stream channels. This movement mainly occurs from surface erosion, subsurface erosion, slope slumping, and stream channel erosion. These processes generally influence water quality only within a limited corridor alongside a stream channel.

The surface relief throughout a watershed influences the amount of precipitation which infiltrates to ground water verses the amount of surface or subsurface flow. Infiltration is most likely to occur in flat areas, and surface and subsurface flows are more likely in areas of steep topography.

Soil type also influences infiltration and runoff characteristics. Open textured sandy soils permit greater infiltration than fine-grained clay soils. A generalized map of soil types in the Mullett Lake Watershed is found in **Figure 4**. It is not accurate enough for planning and land use decisions on individual parcels. More detailed soil information is available from Soil Conservation Service field offices in Cheboygan and Otsego Counties.

Stream gradient is important relative to streambed scouring and streambank erosion. Steep gradients generate more erosive and scouring power than slight gradients.

Drainage density is the length of stream channels per unit area of the drainage basin. It is a reflection of the physical characteristics of a drainage basin. The response of runoff to precipitation is closely related to drainage density, with efficient drainage being found in areas of high density. Streams with high drainage density may also be more likely to export pollutants from the watershed to the lake.

Riparian wetlands can function to protect the water quality of Mullett Lake and its tributaries by trapping nutrients and sediments. Wetlands and lakes along a stream course tend to absorb runoff, exerting a modifying influence on flood peaks. Poorly-drained soils typical of wetland areas are shown in **Figure 4**.

5. Indian River Subwatershed

The surface watershed of the Indian River covers approximately 3,758 acres, or slightly more than two percent of Mullett Lake's immediate watershed. These figures exclude the watershed of the Little Sturgeon River, which is actually a tributary of the Indian, but is treated here as a separate subwatershed. The length of the river is 3.8 miles from the outlet of Burt Lake to its mouth at Mullett Lake. This subwatershed has a drainage density of .72, the lowest in the Mullett Lake Watershed. The compactness coefficient is 1.4.

The river and its watershed lie within Koehler and Tuscarora Townships. Two roads, expressway I-75 and highway M-27, and a railroad cross the river. Dense residential development is present, adjacent to the river upstream from I-75. The shoreline has been greatly altered with piers, bulkheads, and filled areas. In some areas, dredged canals extend inland as far as 1,000 feet from the river. Most of the town of Indian River lies within the Indian River Watershed. Approximately 200 residences are located within a 300-foot corridor of the river or its canals. Several marinas and commercial businesses are also located in this area.

Downstream from I-75, the stream flows through the Indian River Spreads, which is the largest inland cattail marsh in northern Michigan. The spreads is considered an important area for fish spawning, marsh and shore birds, waterfowl, and other wildlife. A shallow, 23-acre lake—Mud Lake—is located in the spreads. In 1968, portions of this lake, along with a connecting channel to the river, were dredged for a marina development, which was never constructed. Soils in this area are Rifle Peat and Edwards Muck.

Other portions of the watershed are mostly forested, with conifers in lowland areas and mixed forests in upland areas. Most of the watershed was formerly covered by the waters of the post-glacial Great Lakes. However, two "islands" of moraine deposits are found in the east and west ends of the watershed. The highest point is found in the west end, where the elevation reaches 894 feet, 300 feet above the river. The river itself occupies an outreach channel, and the topography along the banks varies from flat to gently sloping. The glacial deposits vary in thickness from 200 to more than 30 feet.

Land ownership along the river is mostly private. However, approximately 37 percent of the riverfront is owned by state and township governments. This public land is located in the Indian River Spreads.

The average discharge volume of the Indian River is 16.1 cubic meters per second, making it by far the largest of Mullett Lake's tributaries. It is nearly four times larger than the Pigeon River. The Indian River's surface drops less than one foot between Burt and Mullett Lakes. Since 1948, the U.S. Army Corps of Engineers has maintained a channel for navigation five feet deep and thirty feet wide. The channel is marked by navigation aids.

6. Pigeon River Subwatershed

The surface watershed of the Pigeon River is approximately 91,000 acres, or 57 percent of Mullett Lake's immediate watershed. The length of the mainstream of the Pigeon River is 48 miles. Numerous tributaries bring the total length of the channel system to 132 miles. The drainage density of this Subwatershed is 0.95. The compactness coefficient is 2.5, the highest value of Mullett Lake's subwatersheds.

The largest tributary of the Pigeon River is the Little Pigeon, not to be confused with another Mullett Lake tributary with the same name. Other large tributaries of the Pigeon include the South Branch of the Pigeon River, and Wilkes, McIntosh, and Cornwall Creeks. The average discharge of the Pigeon River at its mouth is 4.3 cubic meters per second.

The Pigeon River Watershed is found in both Cheboygan and Otsego Counties. In Cheboygan County, it includes portions of Nunda, Ellis, Walker, and Koehler Townships. In Otsego County, it includes portions of Corwith, Dover, and Charlton Townships. Approximately 120 dwellings

are located within a 300-foot corridor of the stream system. There are numerous stream crossings with many being private roads.

Most of the watershed of the Pigeon River is forested. Agricultural areas are found near the headwaters along M-32. Much of the development along the stream system is recreational homes. Hydrocarbon development occurs in some portions of the watershed.

The portion of the Pigeon River from the headwaters to the Lansing Club Pond flows mostly through private land. Between the pond and Pigeon River Road the river flows through the Pigeon River Country State Forest, and most of the stream frontage is in public ownership. The remainder of the stream downstream to Mullett Lake flows again through mostly private lands. Approximately 59 percent of the land ownership in the subwatershed is private, and 70 percent of the stream system's land frontage is private.

The greatest elevation of the river's headwaters is 1,200 feet, on the South Branch of the Pigeon. The river drops 600 feet to the elevation of Mullett Lake for an average stream gradient of 12 feet per mile. In one portion of the river, between Munger Road and M-68, the river's gradient increases to 27 feet per mile.

The greatest elevation in the watershed is 1,400 feet northwest of Lake Fifteen. The altitude drops approximately 375 feet to the river over a distance of 1.5 miles in this area. The stream channel and a large portion of the watershed north of Munger Road lie in the area of inundation by the post-glacial Great Lakes. As a result, steep sided terraces are found near the river in some places.

The thickness of glacial drift varies from less than 50 feet in the region south of the town of Afton, to nearly 300 feet near the mouth of the river. The drift thickness also increases in southern Cheboygan County, to greater than 200 feet. Drift thickness in the Otsego County portion of the watershed is unknown.

The State of Michigan recognizes the Pigeon River as being navigable for a distance of 40 miles upstream from its mouth, which includes nearly the entire river. In 1982 the river and its tributaries were designated a wild and scenic river by the Natural Resources Commission. The river is regarded as one of the state's outstanding trout streams and recreational resources.

Twenty-eight impoundments are located on the Pigeon River system, ranging in size from small beaver ponds to 222-acre Cornwall Creek Flooding. Many of the impoundments are privately owned. The largest private impoundment, the Lansing Club Pond, was the site of an uncontrolled drawdown of water in July 1984. Tons of silt were released which seriously damaged the river's ecosystem, and may have impacted Mullett Lake's water quality. Nineteen inland lakes are located within the Pigeon River subwatershed. Most of these are small seepage lakes. Only Lake Fifteen and Grass Lake have a surface connection to the Pigeon River. Many of the seepage lakes are formed in limestone sinkholes.

7. Little Sturgeon River Subwatershed

The surface watershed of the Little Sturgeon River is approximately 16,200 acres, or ten percent of Mullett Lake's immediate watershed. The mainstream of the Little Sturgeon is approximately 12 miles in length and flows in a northerly direction. The stream has several tributaries and the length of the stream system's surface channels totals approximately 25 miles. Other named

tributaries in the system are Johnson Creek, Crumley Creek, and Twin Lakes Creek. The stream flows for a short distance through the abandoned streambed of the Sturgeon River before discharging into the Indian River. The channel of the Sturgeon was diverted to Burt Lake in 1886 to improve navigation on the Indian River. The drainage density of the Little Sturgeon subwatershed is 0.99 and the compactness coefficient is 1.7. There is no data available for the average discharge of the Little Sturgeon.

The stream's watershed occupies portions of three townships: Ellis, Koehler, and Tuscarora. The stream system has 19 crossings of 13 different public and private roads. The watershed is mostly forested, however, some cleared and agricultural land is found in the southern portions of the watershed. The greatest residential development is found in this area, along Shooks, Afton, and Rondo Roads, as well as the western portion of the town of Indian River. Approximately 50 structures are found within a 300-foot-wide corridor of the stream system.

The elevation of the headwaters of the Little Sturgeon is 869 feet, the stream descends 276 feet in 12 miles for an average gradient of 23 feet per mile. The greatest elevation in the watershed, 1,017 feet in the west-central portion, rises nearly 300 feet above the stream. The northern half of the watershed, and all but the upper portions of the Little Sturgeon and Johnson Creek, lie in areas which were inundated by higher stages of the Great Lakes. Steep-sided terraces are found along the Little Sturgeon and Crumley Creek in the vicinity of M-68. The thickness of glacial deposits throughout the watershed varies from less than 50 feet to more than 200 feet.

A large amount of state-owned land is located within the Little Sturgeon Watershed. More than eight miles of this stream system flows through state land. The major private landowner is the Little Sturgeon Trout Club, which owns five miles of stream frontage along the lower Little Sturgeon and its tributaries. A footbridge and concrete dam are located in this area. Except for the portion of the river that flows through the town of Indian River, most of the private land ownership occurs as large tracts.

There is one inland lake located within the Little Sturgeon Watershed. Roberts Lake is a shallow, 67-acre impoundment on Twin Lakes Creek. It is entirely surrounded by state land.

8. Little Pigeon River Subwatershed

The surface watershed of the Little Pigeon River is approximately 10,200 acres, or 6.5 percent of Mullett Lake's immediate watershed. The permanent mainstream of the Little Pigeon, including the headwaters area known as Kimberly Creek, is approximately 12 miles long. The stream has several permanent and intermittent tributaries, and the total length of the stream system's surface channels totals about 30 miles. Other named tributaries in the system are the North and Middle Branches of the Little Pigeon, Silver Creek, and Morrow Creek. The drainage density is 1.9, the highest in the Mullett Lake Watershed. The compactness coefficient is 1.8. The river's average discharge is estimated to be 0.6 cubic meters per second.

The stream's watershed occupies portions of three townships: Koehler, Ellis, and Walker. The stream system has 21 crossings of 10 different public and private roads. The watershed is mostly forested, especially in the northern half, however, there is a significant amount of cleared and agricultural lands in the southern portion of the watershed. The greatest residential development occurs along M-68, M-33, Walker and Montgomery Roads; and the small communities of Afton, Legrand, and the Fingerboard Corner are located in this area.

The elevation of the Little Pigeon's headwaters lie at 905 feet, near Fingerboard Corner. The stream descends 312 feet to Mullett Lake in 9.5 miles, for an average stream gradient of 32 feet per mile. The headwater portions of these streams generally have the steepest gradients.

The greatest elevation in the watershed – 985 feet – is found on Blats Hill, northwest of Afton, and again southeast of Fingerboard Corner. Most of the stream channels and the watershed lie at an elevation of less than 740 feet, the level which was once inundated by the post-glacial Great Lakes. The influence of lacustrine processes is evidenced in this area by the presence of steep-sided terraces along the Little Pigeon and some of its tributaries. These steep "drop-offs" adjoin the stream channel in sections 10, 13, 14, 15, 23, and 24 of Koehler Township, creating areas prone to erosion. Steep topography is also found in the vicinity of stream channels northwest of Afton and northeast of Legrand.

The thickness of glacial deposits is slight in most of the area of the Little Pigeon's headwaters, being generally less than 50 feet. Bedrock is actually at the surface just south of Legrand. The depth of glacial deposits increases in the northern portion of the watershed, to more than 200 feet near the stream's mouth.

A large portion of the northern half of the Little Pigeon's Watershed, including 7.5 miles of frontage along several streams, is in state ownership. Private land ownership occurs as large tract holdings along the tributaries of the upper watershed, and as approximately 17 small private tracts along the lower two miles of the stream. Thirty-eight dwellings are located within a 300-foot corridor of the stream.

There is one inland lake located within the Little Pigeon Watershed. Silver Lake is a shallow, 78-acre lake which is drained by Silver Creek. The lake was formerly owned by the Detroit Area Boy Scout Council, but is now surrounded by small tracts.

9. Mullett Creek Subwatershed

The surface watershed of Mullett Creek drains approximately 10,250 acres, or 6.5 percent of Mullett Lake's immediate watershed. The permanent mainstream of Mullett Creek, downstream from south Extension Road, near the old town of Riggsville, is seven miles long. The stream has numerous small permanent and intermittent tributaries, and the total length of this stream system's surface channels is approximately 20 miles. The drainage density of this subwatershed is 1.25, and the compactness coefficient is 1.2, the lowest value of any Mullett Lake subwatershed. No data is available for Mullett Creek's average streamflow.

The stream flows through Munro, Inverness, Mullett, and Burt Townships. The stream system has 21 road crossings on 11 different roads. The southern half of the Mullett Creek Watershed is mostly forested, whereas the northern half is generally not. A large portion of the land near the headwaters of the stream is used for agriculture. Downstream from the second crossing of I-75, the stream flows mostly through a broad, forested wetland, which forms a protective corridor from surface runoff. The stream flows primarily through upland areas in the upper portion of the watershed. Some areas of steep topography are found near the stream, in section 30 of Inverness Township, and sections 25, 35, and 36 of Munro Township. Twenty-one dwellings or other structures are located within 300 feet of the Mullett Creek system.

The elevation of the intermittent headwaters of Mullett Creek is 853 feet, and the stream descends 259 feet per mile. Most of this elevation drop occurs in the northern half of the stream.

Downstream from the second I-75 crossing the stream gradient averages only 6.78 feet per mile. The greatest elevation in the watershed is 910 feet.

Approximately half of the watershed is unaltered glacial till. The thickness of the glacial deposits is great in this area, ranging from more than 300 feet to 680 feet, which is the greatest depth found in Cheboygan County. The other half of the watershed is covered with glacial deposits which have been modified by high levels of the post-glacial Great Lakes. Most of the land within the watershed is privately owned.

Public lands are found in Munro Township (University of Michigan Biological Station property), and in Mullett Township, where 1.5 miles of the stream flows through state land. The lower two miles of Mullett Creek are navigable by canoe. There are no lakes within the Mullett Creek Watershed, and the Creek is unimpounded.

10. Shoreline Subwatershed

The shoreline watershed of Mullett Lake includes approximately 38,600 acres, or 18 percent of Mullett Lake's immediate watershed. This shoreline watershed is divided into several distinct areas by the major tributaries of Mullett Lake. The east shoreland runs from the mouth of the Little Pigeon River to the head of the Cheboygan River. The northwest shoreline lies between the head of the Cheboygan River and the mouth of Mullett Creek. The southwest shoreland drains an area between the mouth of Mullett Creek and the Indian River. A fourth small shoreland watershed lies between the mouths of the Indian and Pigeon Rivers.

The shoreline watersheds are not drained by any major tributaries, however, they contain numerous small, short streams which can convey pollutants from portions of the shoreland watershed to Mullett Lake. Several of these streams are large enough to be named. These include Hatt, Ballard, Scott, and Mullett Lake Creeks.

The shoreland watershed lies in portions of seven townships: Benton, Inverness, Mullett, Aloha, Burt, Tuscarora, and Koehler. Nearly all of the land in the shoreland watershed lies on the post-glacial lakebed. Some exceptions are uplands located near the headwaters of Mullett Lake Creek, south of Devereaux Lake, and southwest of Mullett Creek. The greatest elevation in the shoreline watershed, 820 feet, is found in the latter area. Drift thickness varies from 200 to 600 feet, with the greatest depth occurring in Inverness Township. Land ownership in the shoreland's watershed is mostly private, with the only public land being 3,500 acres west and south of Devereaux Lake. The headwaters of Scott Creek lie on state land.

Most of the shoreland watershed is forested. Agricultural and cleared areas occur along the north part of Mullett Lake in Inverness, Burt, and Aloha Townships. Dense residential shoreline developments occur in many places.

Devereaux Lake is the only lake contained within the shoreland watershed boundary. It is a small, shallow seepage lake. The lake appears to be part of a perched water table, and exhibits large yearly water level fluctuations.

EXISTING WATER QUALITY IN THE MULLETT LAKE WATERSHED

1. Mullett Lake

The Tip of the Mitt Watershed Council's Comprehensive Monitoring (CM) Program samples Mullet Lake every three years.

The CM Program was started in 1987, when 10 lakes were sampled. The CM program is designed to characterize the water quality conditions in the lake and help reveal any changes over time, rather than identify the sources of pollution. If significant change becomes apparent, then other testing programs can be designed to help identify the cause of the problem. Comprehensive Monitoring (CM) data for Mullett Lake has been collected four times, in 1987, 1992, 1995, and 1998. The results are presented in the following tables.

MULLETT LAKE - May 19, 1998

DEPTH (meters)	TEMP. (^{0}C)	D.O. (mg/l, % Sat.)	pH	CHLORIDE (mg/l)	TOTAL NITROGEN (ug/l)	NITRATE + NITRITE NITROGEN (ug/l)	TOTAL PHOS-PHORUS (ug/l)	CONDUC-TIVITY (uhmo/cm^2)
0.0	17.20	9.50, 100%	7.98	7.4	197.0	40.0	5.5	294
24.0	8.05	10.54, 90.0%	7.79	7.5	229.0	80.0	15.4	287
43.4	7.33	10.42, 87.0%	7.72	7.3	229.0	90.0	6.5	287

MULLETT LAKE - May 11, 1995

DEPTH (meters)	TEMP. (^{0}C)	D.O. (mg/l, % Sat.)	pH	CHLORIDE (mg/l)	TOTAL NITROGEN (ug/l)	NITRATE + NITRITE NITROGEN (ug/l)	TOTAL PHOS-PHORUS (ug/l)	CONDUC-TIVITY (uhmo/cm^2)
0.0	8.40	11.29, 100%	7.88	7.0	350.0	140.0	10.0	317
20.0	7.10	11.17, 94.0%	7.87	7.0	420.0	140.0	14.0	317
43.0	5.87	10.83, 88.0%	7.84	7.0	430.0	150.0	9.0	350

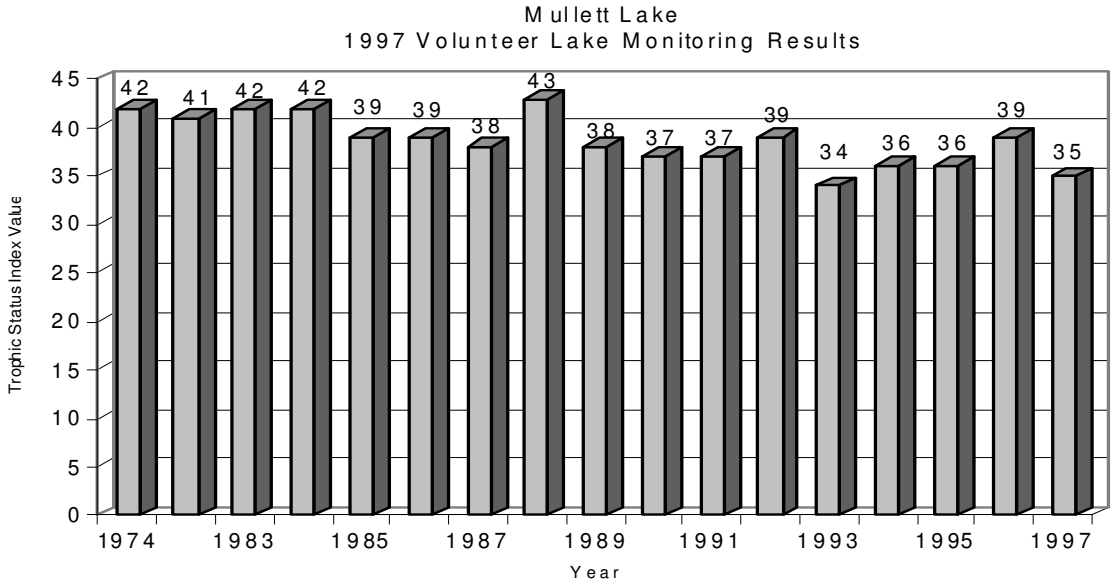
MULLETT LAKE - May 6, 1992

DEPTH (meters)	TEMP. (^{0}C)	D.O. (mg/l)	pH	CHLORIDE (mg/l)	TOTAL NITROGEN (ug/l)	NITRATE + NITRITE NITROGEN (ug/l)	TOTAL PHOS-PHORUS (ug/l)	CONDUC-TIVITY (uhmo/cm^2)
0.0	6.00	12.37	7.47	5.5		71.0	11.2	274
18.0	5.30	12.00	7.48	5.4		84.0	11.7	274
38.0	4.86	11.78	7.43	5.4		95.0	5.4	277

MULLETT LAKE - September 14, 1987								
DEPTH (meters)	**TEMP. (°C)**	**D.O. (mg/l)**	**pH**	**CHLORIDE (mg/l)**	**TOTAL NITROGEN (ug/l)**	**NITRATE + NITRITE NITROGEN (ug/l)**	**TOTAL PHOS-PHORUS (ug/l)**	**CONDUC-TIVITY (uhmo/cm²)**
0.0	18.5	9.1	7.8	8.0		<110.0	<25	290
16.0	12.3	4.9	8.2	9.0		<110.0	<25	288
30.0	9.0	1.7	7.3	9.0		~110.0	<25	270

MULLETT LAKE - April 24, 1987								
DEPTH (meters)	**TEMP. (°C)**	**D.O. (mg/l)**	**pH**	**CHLORIDE (mg/l)**	**TOTAL NITROGEN (ug/l)**	**NITRATE + NITRITE NITROGEN (ug/l)**	**TOTAL PHOS-PHORUS (ug/l)**	**CONDUC-TIVITY (uhmo/cm²)**
0.0	7.0	12.2		5.0		<50.0	<10.0	220
10.0	6.5	11.6		4.0		<50.0	<10.0	222
22.0	5.5	11.3		5.0		<50.0	<10.0	210

Tip of the Mitt Watershed Council's Volunteer Lake Monitoring (VLM) Program
In 1998 Mullet Lake has an average Secchi disc measurement of 13.5 feet and an average chlorophyll-a concentration of 0.82 micrograms per liter. The deepest Secchi disc measurement was 17 feet and the shallowest was 10 feet. Using the average data the Trophic Status Index (TSI) is 34, classifying the lake as oligotrophic. Below are the annual results of the VLM tests.



A. Dissolved Oxygen

Much of the information on the water quality of the lake concerns summer hypolimnetic dissolved oxygen (D.O.) concentrations.

Hypolimnetic D.O. concentrations are a valuable means of assessing lake water quality. As the nutrient enrichment of a lake increases, the biological productivity increases resulting in more algae and possibly rooted aquatic plants. The decomposition of this organic matter on the lake bottom can depress D.O. concentrations to the point where the bottom waters of a lake become devoid of oxygen. If this occurs, chemical reactions release phosphorus that is normally bound in bottom sediments into the overlying water. At fall overturn the nutrient enriched waters are recirculated to the surface, where the nutrients are again available to algae and other aquatic plants. The cyclic internal loading of phosphorus can become a very severe lake management problem on some lakes. Mullett Lake's level of eutrophication has not progressed to this stage.

Historical D.O. data begins with a 1956 water quality report by the Fisheries Division of the Michigan Department of Conservation, which stated that deep water D.O. concentrations were normally found between 7.6 and 8.9 parts per million (ppm). This is a high level of dissolved oxygen and would be typical of an oligotrophic lake.

The University of Michigan Biological State Station field classes have also periodically collected data on the status of mid-summer hypolimnetic D.O. concentrations in Mullett Lake. **Table 3** shows unpublished data from Bio Station field work. The dissolved oxygen concentrations observed by the field classes indicate that no significant mid-summer oxygen depletion was occurring in the mid-1960's and early 1970's.

TABLE 3

HYPOLIMNETIC DISSOLVED OXYGEN CONCENTRATIONS

Year	Date	Dissolved Oxygen (ppm)
1965	8/3	5.2
1966	7/14	6.7
1971	7/26	5.0
1972	7/14	5.7
1973	7/10	7.8

A regional study of water quality performed in 1979 by the Northeast Michigan Council of Governments (NEMCOG) found that the dissolved oxygen concentration in the hypolimnion of the lake was 4.0 ppm on September 3, 1979.

Investigations by the Tip of the Mitt Watershed Council have found dissolved oxygen concentrations substantially lower than those previously recorded. In August 1983, D.O. was recorded at 1.0 ppm, while in September 1987, D.O. was found to be 1.8 ppm. Dissolved oxygen concentrations in this range are characteristic of mesotrophic conditions.

Since the dissolved oxygen data presented here comes from a variety of sources, it is not appropriate to draw conclusions about changes in lake water quality based solely on this data.

B. Phosphorus

Mullett Lake is considered to be phosphorus-limited. This means that the availability of phosphorus controls the biologic productivity of the lake. Lakes with high levels of phosphorus generally support large amounts of algae and/or aquatic vascular plants, and have poor water quality. High quality lakes, on the other hand, are low in phosphorus and support only minimal amounts of plant growth. Total phosphorus concentrations at spring turnover are considered to be a reliable indicator of a lake's level of nutrient enrichment.

There is a very limited amount of phosphorus data available for Mullett Lake. The regional water quality study performed by NEMCOG in 1979 found spring turnover total phosphorus concentration of 4.0 parts per billion (ppb). Sampling performed by the Tip of the Mitt Watershed Council in 1987 recorded a total phosphorus concentration that was below the laboratory's detection limit of 10 ppb. A total phosphorus concentration of less than 10 ppb at spring turnover is indicative of oligotrophic conditions.

The measurement of secchi disc transparency and chlorophyll-a concentrations are simple yet useful ways of determining lake water quality. These two parameters have been routinely measured in the Tip of the Mitt Watershed Council Volunteer Lake Monitoring Program since 1983. The two parameters are measured by the participants in the deepest part of the lake. Clarity measurements, which are taken with a secchi disc, are taken weekly. Composite water samples to twice the secchi depth are collected for chlorophyll-a analysis every two weeks. Both parameters are sampled from June through August.

Average summer secchi disc depth and chlorophyll-a concentrations are used to determine water quality through the Carlson Trophic Status Index (TSI). This allows water quality to be ranked on a numerical scale from 1 to 100. Water quality increases with lower TSI values. Trophic Status Index values from 1 to 38 are considered oligotrophic; values from 39 to 49 are considered mesotrophic; and values above 50 are considered eutrophic. **Table 4** shows Carlson TSI values recorded in the Volunteer Monitoring Program.

TABLE 4

Carlson TSI Values Based on Average Summer Secchi Disc And Chlorophyll-a Values from 1983 to 1988

1983 . . .42	Mesotrophic
1984 . . . 42	Mesotrophic
1985 . . . 39	Oligotrophic
1986 . . . 39	Oligotrophic
1987 . . . 38	Oligotrophic
1988 . . . 43	Mesotrophic

Year-to-year variability of TSI values is common and is related to the variability of climatic conditions. The data indicates that the water quality of Mullett Lake fluctuates near the dividing line between oligotrophic and mesotrophic conditions.

While the TSI data since 1983 shows no clear water quality trend, the low dissolved oxygen concentrations recorded in recent years indicate that the lake is sensitive to hypolimnetic dissolved oxygen depletion. Therefore, further nutrient enrichment of the lake could result in substantial negative impacts on the lake's water quality and biological integrity.

2. Indian River

The Indian River is Mullett Lake's largest tributary. The unincorporated village of Indian River covers a significant portion of its watershed near the river's outlet from Burt Lake. The village contains approximately 700 homes and 150 businesses, and is completely served by individual septic systems and wells. While many of the homes only receive seasonal use, it appears that ever-increasing numbers are being converted to year-round use. A large number of wells are artesian, indicating the presence of a clay layer beneath the village.

Within the last twenty years, there has been a substantial concern about the need to have the community sewered. In 1979, community residents defeated a sewer referendum. Since that time, the Cheboygan County Health Department has taken steps to upgrade septic systems. Yet, due to the high ground water table beneath the community and its dense residential and commercial development, it is possible that septic systems may be discharging large nutrient loads to the ground water which discharge to Mullett Lake through the Indian River.

In August of 1988, personnel from the Surface Water Quality Division of the Michigan Department of Natural Resources conducted a survey of the surface waters in and around the community of Indian River. The survey found only one direct sewer discharge to the Indian River. The report states that sample results from ditches that drain an older residential area may be showing the influence of the large number of drainfields in the area. Dilution from flowing wells are believed to have masked the true magnitude of the problem.

During this survey, water samples taken from the Indian River indicated high water quality. The only difference in water quality between samples taken above and below the influence of the community was a doubling of Kjeldahl nitrogen below the community.

3. Little Sturgeon River

Very little information is available about the water quality of the Little Sturgeon River. In its upper reaches, the river supports native brook trout, so it can be assumed to have cold, clean waters. As the river approaches the town of Indian River, the character of the river changes. Flow velocity decreases and the river becomes wider once the river emerges from its underground passage under I-75. From this point to its confluence with the Indian River, the Little Sturgeon River flows through mostly residential land. The river may be receiving nutrients from nearby septic drainfields, lawn fertilizers, and possibly storm sewer discharges.

The MDNR water quality survey of the waters in and around the town of Indian River found that the river generally has good water quality. However, bacterial sampling above and below the influence of the residential areas identified more than a doubling of fecal coliform and more than

a tripling of fecal strep. This may indicate the presence of inadequately functioning septic systems along the Little Sturgeon River.

4. Pigeon River

A water quality study of the Pigeon River was conducted in the summer of 1984 by staff of MDNR in response to a spill of organic silt resulting from the improper drawdown of an impoundment called the Lansing Club Pond. The report stated that the river is classified as a cold-water fishery with very high water quality.

According to the report, above the influence of the silt spill, water quality analysis revealed that the river had very high dissolved oxygen concentrations that were consistently at or near 100% saturation. Biochemical oxygen demand was very low, indicating the presence of very little organic matter in the river. Total suspended solids concentrations were also low and ranged from 4 to 12 mg/liter. These values were similar to those recorded at the river's outlet to Mullett Lake. It is reasonable to assume that before the silt spill, the water quality of the entire river was similar to that at the monitoring station upstream of the spill site.

The silt spill resulted in an immediate and dramatic decline in the river's water quality, killing trout and other aquatic organisms. Water quality degradation was greatest immediately downstream from the spill, and decreased in severity further downstream. In the intervening years since the spill, the river has returned to its former water quality and once again supports a cold-water fishery. The impact of the silt spill on the water quality of Mullett Lake was never investigated.

5. Little Pigeon River

There is no data available on the water quality of the Little Pigeon River. However, the river supports native brook trout, so it can be assumed to have cold, clean waters.

6. Mullett Creek

The water quality of Mullett Creek has never been studied. The creek drains substantial areas of agricultural land in its upper watershed. In this area, the creek is narrow and is generally paralleled by streambank wetlands and is clear and cool. In the lower portion of its watershed, the creek is approximately 35 feet wide, shallow, with a dark organic bottom. Emergent vegetation is common, and the water is stained brown from wetland drainage. Mullett Creek may support brook trout in its upper reaches, while the lower portion of the creek appears more suited to warm-water fish.

Several agricultural problems have been identified in the watershed and may be increasing the stream's nutrient and sediment load. Some of those agricultural sites have since been remediated.

7. Miscellaneous Streams

A large number of small unnamed and unmapped streams flow into Mullett Lake along many portions of the shoreline. These streams usually originate from springs and seepages in wetlands and flow for only a short distance before discharging into the lake. These flows are generally of high quality. However, some may pick up nutrients from lawn fertilizers and septic effluent as they flow through shoreline residential developments.

MANAGEMENT REVIEW OF WATERSHED

1. Designated Uses and Water Quality Summary

The Water Resources Commission Act (P.A. 451 of 1994, Part 31, Chapter 1 requires all waters of the State of Michigan to be of the quality to meet seven designated uses: (1) agriculture; (2) navigation; (3) industrial water supply; (4) public water supply; (5) warm water fishery; (6) habitat for indigenous aquatic life and wildlife; and (7) partial or total body contact recreation. An eighth designated use -- cold water fishery -- is applicable for many rivers and lakes in Michigan.

Mullett Lake has excellent water quality and currently meets all eight of the designated uses. Active designated uses include agriculture, navigation, industrial water supply, warm water fishery, habitat for aquatic life, and total body contact recreation. Although Mullett Lake's water quality is good enough for public water supply it is not being used for this purpose. Mullett Lake's major tributaries -- the Maple, Crooked, and Pigeon Rivers – also meet all eight of the designated uses. Some of the small tributaries, such as Carp and Hassler Creeks, meet seven of the designated uses, with the exception of navigation due to their small size.

A variety of activities and changing land uses in the watershed threaten some of the designated uses (Table 1).

Table 1: Mullett Lake Watershed Threatened Uses
Navigation (N)
Habitat for indigenous aquatic life and wildlife (H)
Partial or total body contact recreation (R)
Cold water fishery (C)

A. Watershed Concerns

In the spring of 2001 a series of meetings were held with local government officials, conservation groups, environmental organizations, regional planning agencies, and other stakeholders within the Mullett Lake Watershed to discuss concerns about water quality. The group identified many different issues and committed to working together in a partnership to develop a watershed management plan. The group also prioritized the main issues of concern summarized in Table 2.

Navigation (N) Habitat for indigenous aquatic life and wildlife (H) Partial or total body contact recreation (R) Cold water fishery (C)

Table 2: Priority Concerns and Threats to Designated Uses	N	H	R	C
Loss of forest lands, agricultural lands to development, and increasing impervious surface			□	□
Urban runoff directly discharging to lakes and streams	□	□	□	□
Lakeshore and streambank erosion	□	□	□	□
Shoreline septic systems		□	□	□
Impacts from lawns and golf courses		□		□
Erosion from recreational uses on the Sturgeon and s	□	□		□
Impacts to fisheries from erosion and habitat destruction		□		□
Agricultural impacts livestock in streams, manure application, pesticide use	□	□	□	□
Erosion and stream habitat destruction from logging activities	□	□		□
Shoreline algae		□		□
Erosion and runoff from road/stream crossings	□	□		□

B. Known and Suspected Pollutants in the Mullett Lake Watershed

Sediment, nutrients, and toxics such as oils, grease, and heavy metals were identified as the main pollutants of concern that threaten the designated uses in the Mullett Lake Watershed. Table 3 lists the known and suspected pollutants.

Table 3: Known and Suspected Pollutants	
Impaired Use	***Pollutants****
Navigation	Sediment (k)
Aquatic life/wildlife	Sediment (k) Nutrients (s) Oils, grease, heavy metals (s)
Partial and total body contact recreation	Nutrients (s) Bacteria (s)
Cold water fishery	Sediment (k) Nutrients (s) Oils, grease, heavy metals (s) Pesticides (s)

* k = known s = suspected

C. Sources of Pollutants in the Mullett Lake Watershed

The diversity of land uses is extensive in the Mullett Lake Watershed. Table 4 identifies the main sources for each primary pollutant of concern.

Table 4: Sources of Pollutants in the Mullett Lake Watershed	
Pollutant	***Sources***
Sediment	Lakeshore and streambank erosion (k) Road/stream crossings (k) Livestock in streams (s) New construction (s) Logging activities (s)
Nutrients	Lawn care on shoreline properties (k) Septic systems (s) Livestock in streams (s) Road/stream crossings (k) Lakeshore and streambank erosion (k) Stormwater discharges in urban areas (k) Manure applications and management (s) Golf courses (s) New construction (s)
Oils, grease, and heavy metals	Stormwater discharges in urban areas (k) Road/stream crossings (k)
Pesticides	Lawn care on shoreline properties (s) Agricultural fields (s) Golf courses (s)
Bacteria	Failing septic systems (s) Stormwater discharges in urban areas (k) Livestock waste (s)

* k = known s = suspected

D. Causes for Each Pollutant Source in the Mullett Lake Watershed

Understanding the potential causes of the pollution is essential in developing goals and action strategies. Below (Table 5) is a list of the causes connected to each pollutant source.

Table 5: Pollutant Information Following the Inventory		
Pollutants	***Pollutant Source***	***Cause***
Nutrients (P and N) (k)	Agricultural fields (s)	Use of fertilizers (s)
	Septic systems (s)	Outdated, poorly maintained, and improperly designed systems (s)
	Manure applications and management (s)	Over-application of manure (s), lack of proper storage for manure (s), inadequate testing of soil properties (s)
	Stormwater discharges in urban areas (k)	Inadequate treatment of stormwater that may contain oils, grease, heavy metals, pet waste, etc. (s)
	Lawn care on shoreline properties (k)	Use of phosphorus fertilizer (s), over-application of fertilizers (s), misuse and overuse of pesticides (s), removal of native shoreline vegetation (k)
Sediment (k)	Agricultural fields (s)	Plowing on slopes with erodable soils(s)
	Lakeshore and streambank erosion (k)	Shoreline development and removal of shoreline vegetation (k), angler and canoeist access (k), road/stream crossings (k)
	Livestock in streams (s)	Unrestricted access and no alternative water source (s)
	Logging activities (s)	Inadequate buffer strips near streams (s)
	New construction (s)	Lack of proper erosion control and stormwater management measures (s)
	Road/stream crossings (k)	Undersized and short culverts (k), lack of runoff diversions (k), inadequate fill on road surface (k), lack of vegetation
	Stormwater discharges in urban areas (k)	Inadequate treatment of stormwater that may contain oils, grease, heavy metals, pet waste, etc. (s)
E. coli bacteria (k)	Septic systems (s)	Outdated, poorly maintained, and improperly designed systems (s)
	Livestock in streams (s)	Unrestricted access and no alternative water source (s)
Oils, grease	Stormwater	Inadequate treatment of stormwater that may

and metals (k)	discharges in urban areas (k)	contain oils, grease, heavy metals, pet waste, etc. (s)

* k = known s = suspected

E. Watershed Goals

The mission of the Mullett Lake Watershed Protection Plan is to protect and enhance the water quality of Mullett Lake and its tributaries by reducing current and future polluted runoff. The planning committee was composed of a variety of local stakeholders, some of which included the Mullett Lake Preservation Association, Tip of the Mitt Watershed Council, Cheboygan County Road Commission, Little Traverse Conservancy, Cheboygan County Natural Resource Conservation District, and Northeast Michigan Council of Governments. In addition to those that regularly the planning meetings there was a wider range of stakeholders who were invited to the meetings but did not show up. These included township officials, health departments, the local tribe and county commissions. The meetings were posted in local papers. The goals of the project are to address each designated use in Table 6.

Table 6: Watershed Goals to Address Threatened Uses	
Navigation	Maintain navigation in the rivers and lake by reducing any sediment inputs.
Aquatic life/wildlife	Protect the diversity of aquatic life within the Mullett Lake Watershed by reducing the contribution of sediment, nutrients, and toxic pollutants.
Partial or total body contact	Maintain the excellent recreational opportunities in the rivers and lake by reducing sediment and nutrient contributions.
Cold water fishery	Reduce sediment and nutrient loads that threaten to harm habitat conditions for the cold water fishery in Mullett Lake and its tributaries.

F. Water Quality Summary

The Mullett Lake Watershed has four designated uses that are threatened: (1) navigation; (2) aquatic life/wildlife; (3) partial or total body contact; and (4) cold water fishery.

G. Project Goals

The mission of the Mullett Lake Watershed Protection Plan is to protect and enhance the water quality of Mullett Lake and its tributaries by reducing current and future polluted runoff. Specific goals are as follows:

(1) Maintain navigation in the rivers and lake by reducing any sediment inputs.

(2) Protect the diversity of aquatic habitats within the Mullett Lake Watershed by reducing the contribution of sediment, nutrient, and toxic pollutants (warm water fishery and other aquatic species and wildlife).

(3) Maintain the excellent recreational partial and total body contact opportunities in the rivers and lake by reducing sediment and nutrient contributions.

(4) Reduce sediment and nutrient loads which threaten to harm habitat conditions for the cold water fishery in Mullett Lake and its tributaries.

A. Navigation

Navigation is threatened in the Pigeon River and locations in Mullett Lake from increasing sediment. Lakeshore and streambank erosion along with road/stream crossings are known sources of sediment pollution. Suspected sources of sediment include livestock in streams, new construction, and logging activities.

Lakeshore and streambank erosion is often a result of the removal of shoreline vegetation. Angler and canoeing access points are another source of erosion on the Sturgeon and s. Improperly sized culverts and lack of runoff diversions are the main reason for erosion and sedimentation associated with road/stream crossings.

Livestock access to streams for a watering source can destroy the bank and cause sedimentation. New construction in the shoreline area can contribute sediment, particularly if inadequate erosion controls are used. Not maintaining buffer strips during logging is also suspected of contributing to erosion and sedimentation.

B. Habitat Protection for Aquatic Life/Wildlife

Aquatic habitat is threatened throughout the watershed from sediment, nutrients, and toxic chemicals such as oils, grease, heavy metals, and pesticides. Sediment impacts aquatic habitat by covering fish spawning areas, which makes feeding difficult and clogs gills. Nutrients harm wildlife by encouraging excessive aquatic plant growth that can deplete oxygen supplies when the plants decompose. Toxic chemicals harm aquatic life by weakening immune systems and making organisms more susceptible to disease. They can also harm reproduction, and, if concentrations of the toxic materials are high enough, they can kill aquatic life.

Sources of sediment pollution are the same as mentioned above under threats to navigation. Known sources of nutrient pollution include lakeshore and streambank erosion, road crossings, and lawn care on residential properties. Suspected sources of nutrient pollution include septic systems, livestock in streams, stormwater discharges in urban areas, manure application and management, golf courses, and new construction. Oils, grease, and heavy metals are known to originate from stormwater discharges in urban areas and road/stream crossings. Pesticides may be contributed from agricultural fields and residential lawns.

Nutrients often attach to sediment particles. So when erosion from lakeshores, streambanks, and road/stream crossings occurs, it contributes not only sediment pollution but also nutrient pollution. Residential properties are possible sources of fertilizers with phosphorus which can contribute nutrients that encourage nuisance plant and algae growth.

C. Recreation (Partial and Total Body Contact)

Nutrient pollution can stimulate nuisance levels of aquatic plant and algae growth that disrupt recreational activities and make swimming and boating undesirable.

Additionally, high bacteria counts can make it *unsafe* for swimming. Although these scenarios currently do not exist for Mullett Lake and its tributaries, preventative measures are essential to maintain the diversity and quality of recreational opportunities in this watershed.

Sources and causes of nutrients have been described previously. Suspected sources of bacteria include stormwater discharges in urban areas, manure application and storage, and livestock access to streams. Stormwater discharge in urban areas can collect and deposit pet and wildlife waste into Mullett Lake. Agricultural areas are also possible sources of bacteria. Excessive application of manure, runoff from manure piles, or livestock access to streams can all be causes of bacteria pollution.

D. Cold Water Fishery

Mullett Lake is fortunate to be able to support both a warm- and cold-water fishery. The majority of the rivers and streams in the watershed also support a cold-water fishery. Sediment, nutrient, and toxic pollution (oils, grease, heavy metals, and pesticides) can all be harmful to a cold-water fishery.

In the lake, nutrients are potentially the most harmful. Excessive aquatic plant growth as a result of nutrient pollution can decrease the oxygen available in the bottom of the lake (hypolimnion) during the summer months. In rivers, sediment may be the most harmful pollutant to the cold-water fishery. As mentioned previously, it destroys habitat and can harm the health of fish.

CHAPTER TWO: PRIORITY AREAS

The "priority area" is that portion of the watershed which is most sensitive to environmental impacts, and which has the greatest likelihood to affect water quality and aquatic habitat. USGS topographic maps were used as a base for delineating the priority area for Mullett Lake. Supplemental information was used to identify sensitive areas. Other sources used included USDA Soil Surveys, Groundwater Education in Michigan (GEM) ground water studies, the Farrand map of surficial geology, the Cheboygan River Watershed Habitat Partnership Conservation Area Plan, and a Tip of the Mitt Watershed Council survey of shoreline wetlands.

The priority area for Mullett Lake includes the following areas:

1. Areas within 1,000 feet of the following features:
    A. Mullett Lake
    B. Other inland lakes in the watershed
    C. Tributary streams (including intermittent drainages)
    D. Contiguous wetlands. (For the Mullett Lake Watershed, a contiguous wetland is defined as a wetland within 500 feet of streams or other lakes within the watershed.)

2. Urban areas which drain to surface waters via storm sewers and/or drainage ditches.

3. Areas of steep slopes contiguous with any priority perimeter described above. Regarding water resources, the definition of a steep slope seems to range widely in the literature (from 8 to

25%). For this priority area determination, a 10% slope (or 1:10 ratio, or 6 degrees) or greater is recommended.

CHAPTER THREE: NONPOINT SOURCE POLLUTION INVENTORIES AND MANAGEMENT STRATEGIES

The inventories conducted to document nonpoint source pollution included field data collecting inventories to identify current sources and causes of pollution as well as potential sources. Below are summaries of the inventories conducted and their results.

1. Streambank Erosion Inventory
Mullett Lake's three largest tributaries, the Indian, Pigeon, and Little Pigeon Rivers are good quality fisheries. All three of the systems have been impacted to an extent by streambank erosion, but for the purposes of the lake management plan, the focus is on the Maple and the Sturgeon. The omission of the is due to the recognition that most of the erosion sites on the Crooked are classified as minor and that they are largely a result of boat wake.

Table 8: Mullett Lake Streambank Erosion Survey Results

Subwatershed	***Severe***	***Moderate***	***Minor***
Pigeon River			

2. Road/Stream Crossing Inventory
The Road/Stream Crossing Inventory was coordinated by Tip of the Mitt Watershed Council. The Tip of the Mitt Watershed Council and the Mullett Lake Protection Association coordinated the surveys for the Pigeon River and the smaller tributary streams. All of the data was collected into an Access database and was utilized to compile the final report.

The purpose of the inventory was to comprehensively identify and document all of the crossing sites on the tributaries in the Mullett Lake Watershed. Potential road/stream crossings were identified using a variety of map sources and field exploration. Each crossing that appeared to have regular flow connected to Mullett Lake was inventoried. With the exception of private drives, all vehicle access roads were included. All potential sites were investigated. In some instances, no crossing was present, or there appeared to be no significant flow (and therefore no significant pollutant contribution) during any time of the year. These locations were not identified as numbered crossings and do not appear in the inventory.

Each site was visited to assess potential impacts and problems. Data collected at the crossings included detailed information about the location: road characteristics (width, shoulder, drainage, surface); culvert condition; and erosion and runoff problems. Basic stream characteristics such as width, depth, current, and substrate were also recorded. Field data was collected by both resource professionals and trained volunteers.

In order to help prioritize road/stream crossings for improvement, a severity ranking index was used. The severity ranking system used is identical to that used on a number of previous road/stream inventories completed by the Conservation Resource Alliance and other agencies

throughout Michigan. Three classifications are used in the severity ranking: SEVERE (30 points or more); MODERATE (15-29 points); and MINOR (less than 15 points).

The inventory information is organized by sub-watershed (– Appendix II, – Appendix III, and the Pigeon River and remaining Mullett Lake sites – Appendix IV). The inventories contain maps of compiled sites and site-specific plates with individual location maps, a photograph, and key information for each crossing. Also included in the inventories are the field data forms with site sketches, site severity scoring worksheets, and the cost estimating worksheets used to record all inventory information. The table below summarizes the crossings by each sub-watershed.

Table 9: Mullett Lake Road/Stream Crossing Survey Results

Subwatershed	***Severe***	***Moderate***	***Minor***
Little Pigeon River			
Pigeon River			
~~Little Sturgeon River~~			
Lakeshore Watershed			

3. Recreational Impact Assessment

The Pigeon River is known throughout Michigan as an excellent trout stream and a great canoeing river. The Pigeon River pathway follows along the banks of the Pigeon in many locations. The trail is becoming a popular hiking spot, biking, and skiing destination. These activities are important for fostering an appreciation of natural resources and supporting the local economy that depends on nature-based tourism. However, recreational activities can be a source of nonpoint source pollution. An assessment of the impacts of canoeing and canoe access sites, fishing and angler access sites, and hiking was conducted.

A. Canoeing

The majority of canoeing on the Pigeon River is between Sturgeon Valley Road and the old Ostander Rd. bridge. Because of the heavy use, there is erosion occurring at some canoe access locations.

B. Fishing

Fishing access to the Pigeon River largely consists of “pullover” spots off the gravel roads. Access sites, including the MDNR access sites, were inventoried and assessed. Some of these sites are linked to short trails to access the river. Some of these sites had campfire circles and small piles of trash. Although most people who fish take responsibility for their actions, there are those who may leave litter behind. This was one main problem with such sites. The other main problem was that of bank erosion at heavily used sites. Since most of the sites are not official access locations, maintenance is not managed by any governmental entity or organization.

C. Non-Motorized Trail Along Mullett Lake

A railway corridor travels along much of the western portion of Mullett Lake. After years of neglect the cumulative impact has led to resource degradation in some areas. There are several locations where the rail corridor crosses spring-fed seeps or feeder streams in wet, mucky areas that are eroding or washing out. In other areas there is erosion from the impact of users up and down the embankments.

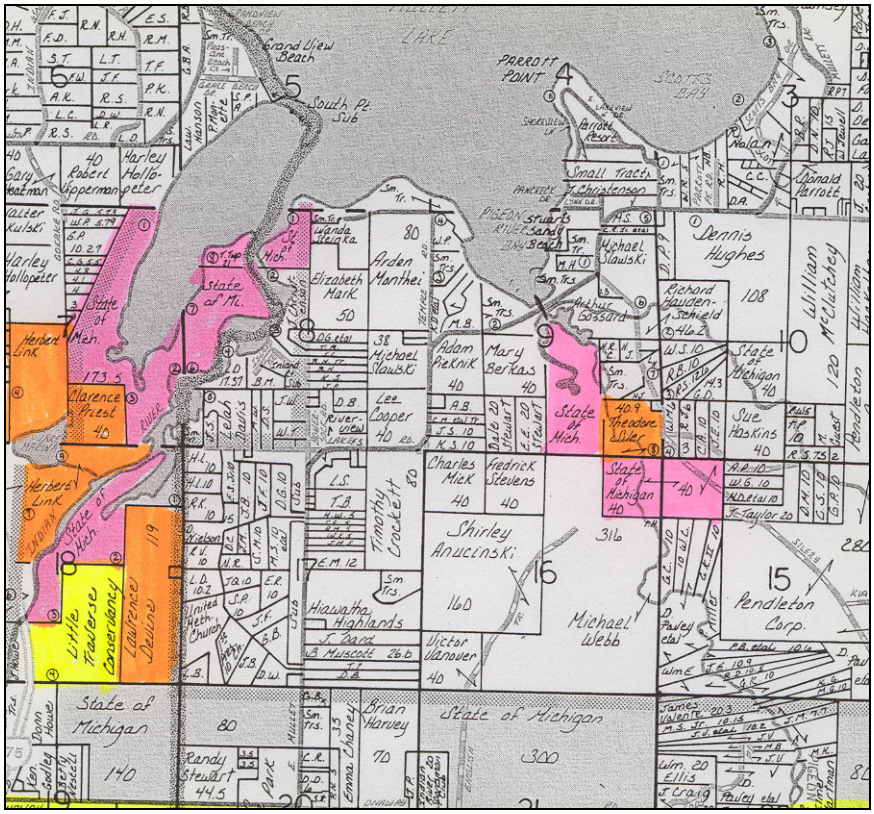
4. Land Protection

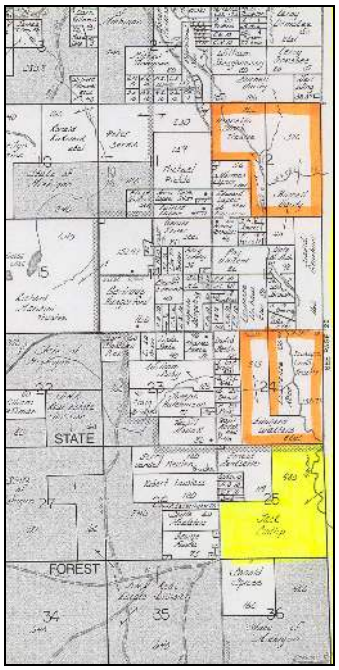
Mullett Lake is a high quality water resource and to preserve this status it is essential to work towards reducing future sources of pollution as well as addressing known sources. Protecting valuable shoreline wetlands and maintaining the ecological integrity of the uplands and wetlands in the priority area are particularly important. The Little Traverse Conservancy (LTC) is working to identify which parcels of land, if protected, would help to maintain and/or improve the water quality of lakes and rivers in the Mullett Lake Watershed. The Mullett Lake Preservation Association has coordinated with the LTC in past land protection efforts.

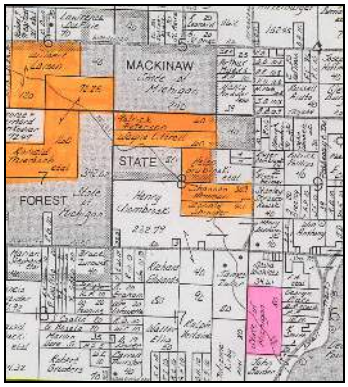
LTC has recently put more focus on protecting lands within the Pigeon River State Forest. A 360-acre property, the second largest undeveloped parcel in Koehler Township, Cheboygan County, in 2001 was placed in permanent protection thanks to a creative agreement reached by the property's owner and the Little Traverse Conservancy. The property includes 2.9 miles of Pigeon River frontage – the single longest stretch of privately-owned land along the entire river. The land is bordered by Mackinaw State Forest land to the northeast and also adjoins the Conservancy's Agnes Andreae Preserve to the north. An ecologically-diverse mix of habitats are found within the large property. The land provides outstanding wildlife habitat for many species. Thick stands of aspen are ideal for grouse, turkey, woodcock, and deer. Bear and coyote tracks are found in abundance and large individual red pine and red oak are testament to the wild nature of the land.

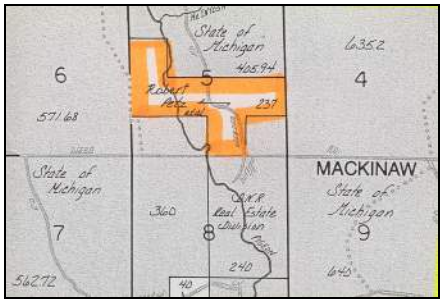
Pigeon River country is home to the state's only elk herd and many other wildlife species including black bear, bobcat, and deer. State wildlife managers' concerns over the ecological integrity of the forest have grown as private parcels surrounding the forest come under increased development pressure, fragmenting important wildlife habitat. Last year, the Conservancy worked with the Cudlip Family who placed a conservation easement on their 480 acres with one mile of Pigeon River frontage.

The following maps show some of the priority areas for land protection. The properties are usually adjacent to Mullett Lake or a significant tributary to Mullett Lake and are of a sufficient size to warrant an approach to the landowner.


Grand View Beach
South Pt. Sub
PARROTT POINT
Small Tracts
Stuarts Sandy Beach
Dennis Hughes
William McCluskey
Donald Parrott
Arden Manthei
Elizabeth Mark
Michael Slawski
Richard Hayden-Schield
State of Mich.
Herbert Link
Clarence Priest
Herbert's Link
State of Mich.
Little Traverse Conservancy
Lawrence Devine
Adam Pieknik
Mary Berkas
Lee Cooper
Charles Mick
Fredrick Stevens
Timothy Crockett
Shirley Anucinski
Hiawatha Highlands
Victor Vanoven
Michael Webb
Pendleton Corp.
Sue Haskins
Theodore Siler
State of Michigan
Brian Harvey
Randy Stewart
Emma Cheney
James Valente
Wm. Ellis
J. Craig


STATE
FOREST





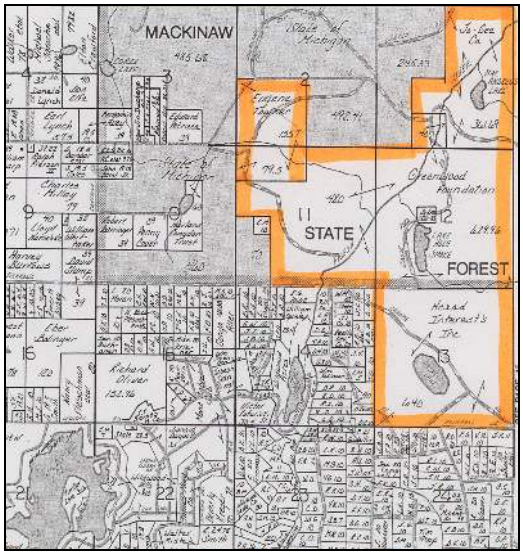


Table 10: Causes for Each Pollutant Source	
Pollutant Source	***Cause***
Lakeshore and streambank erosion (k)	Shoreline development and removal of shoreline vegetation (k), angler and canoeist access (k), road/stream crossings (k)
Road/stream crossings (k)	Undersized and short culverts (k), lack of runoff diversions (k), inadequate fill on road surface (k), lack of vegetation

Livestock in streams (k)	Unrestricted access and no alternative water source (k)
New construction (s)	Lack of proper erosion control and stormwater management measures (s)
Logging activities (s)	Inadequate buffer strips near streams (s)
Lawn care on shoreline properties (k)	Use of phosphorus fertilizer (s), over application of fertilizers (k), misuse and over use of pesticides (s), removal of native shoreline vegetation (k)
Septic systems (k)	Outdated, poorly maintained, and improperly designed systems (k)
Stormwater discharges in urban areas (k)	Inadequate treatment of stormwater that may contain oils, grease, heavy metals, pet waste, etc. (k)
Manure applications and management (k)	Over application of manure (k), lack of proper storage for manure (k), inadequate testing of soil properties (s)
Golf courses (s)	Heavy applications of fertilizers and pesticides (s) Lack of buffer strips in riparian areas (s)
Agricultural fields (s)	Heavy use of pesticides(s)

* k = known s = suspected

5. Land Use Controls

Zoning is the principal means of land use control in the watershed. Tucarora Township is under Cheboygan County Zoning. Historically, zoning was devised to avoid conflicting land uses in urban areas with only minimal concern given to water quality and environmental concerns. Historically, a lack of local land use controls allowed lakeshore development to occur which may affect water quality. This includes dense shoreline development on small lots, funnel development, and inadequate setbacks. All of these have the potential to increase nutrient loading to the lake. In addition to zoning, other similar land use control measures include: critical area protection, property acquisition, taxation, and charges.

Zoning and land use controls are applicable to areas that are in the process of development and can be effective in controlling nonpoint pollution. Zoning methods that serve to diminish water resource impacts are:

a) Large lot zoning whereby minimum lot size requirements are imposed
b) Zoning for protection of open space, which can be used for limiting the extent of impervious areas
c) Anti-funneling, which restricts extensive back-lot development
d) Greenbelt Requirements
e) Setback Requirements

The existing Cheboygan County Ordinance attempts to provide water resource protection through the Lake and Stream Overlay District and Resource Conservation District.

6. Cladophora, Septic Systems, and Shoreline Surveys

A septic system that is carefully designed, built, and maintained can be an effective, environmentally safe means of disposing of household wastewater, but misuse, neglect, overuse, inadequate soils, etc. may lead to overflow of solids and overloading of the capacity of the bacterial system or the oxygen supply needed for the decay process in the drain field. The tile may then become clogged causing the odorous effluent to seep up to the surface. Soils, too, can become overloaded with waste by accumulating particles or slime from the wastewater. Nutrient absorption sites on soil particles can also become saturated. Structural damage to the system can also occur from compaction caused by driving vehicles over the drain tile. These situations can all lead to septic system failure. Health hazards may develop if bacteria, viruses, or certain chemical compounds reach the surface or ground water that is used for drinking, fishing, or body contact recreation. Nutrients from the wastewater may reach the lake and cause excessive growth of algae and acceleration of the eutrophication process.

The management of unsewered development throughout the Mullett Lake Watershed occurs at the local government level. The governmental structure which regulates individual land use decisions is composed of the following: local elected officials, planning commissions, district boards of health, appeals boards, and civil servants (Health Department and code enforcement officials).

Water quality protection is indirectly reflected through the District's Sanitary Code, which specifies septic system isolation distances, and through the County zoning ordinances which also specify isolation distances and standards. The District Health Department, operating under the Sanitary Code, enforces onsite wastewater treatment design and construction standards. The Health Department's responsibility is to insure that proposed onsite systems are allowed in locations which will provide adequate wastewater treatment and public health protection.

The first step in evaluating septic system suitability under the district sanitary code is the soil evaluation. Test borings are required to at least five feet below the finished grade to determine ground water table and soil formation. Percolation tests are then conducted to determine the porosity of the soil at a 3- to 4-foot depth. Minimum depth to the high ground water table must be at least four feet below finished grade. Isolation distances are also specified in the District #4 Sanitary Code (the code that applies to Mullett Lake) and are shown in the following Table.

Minimum Isolation Distances

	Septic Tank	Tile Field	Absorption Bed
Lake or Stream	75'	100'	100'
Drop Off – Sheer Cliff	10'	15'	20'
Foundation Wall	5'	10'	10'
Property Line	10'	10'	10'
Water Pressure Lines	10'	10'	10'
All Wells or Suction Lines	50'	50'	50'

If the physical conditions of the site meet the requirements within the sanitary code, then a construction permit may be issued by the sanitarian. If the soil evaluation indicates that the soil will not support a standard septic system designed using the criteria established in the sanitary code, then design modifications are considered to determine if an alternative type of system can be designed to meet sanitary code requirements. In the majority of the sites that do not meet the minimum isolation distance to the high ground water table in District #4, mound systems are recommended.

If the soil evaluation and/or construction permit is denied, a formal appeals procedure is available. In Cheboygan County, the Appeals Board is composed of elected officials. In most cases in Cheboygan County, if the denied permit is appealed, the decision of the Cheboygan County Health Department staff is almost always overturned and the permit is approved with design modifications.

Once the septic system is installed, the role of the Health Department is largely to disseminate information and advice -- and usually only if problems occur. Problems can range from clogging of drainfields with sewage effluent ponding on the surface to contamination of a lake, stream, or ground water. If a septic system is not functioning properly the Health Department can rectify the problem by recommending construction of an alternative system. If adequate space is available and isolation distance to the groundwater table is not a problem, then a second drainfield would be constructed. Around Mullett Lake, mound systems are the most common replacement systems used.

Currently, there is no periodic water quality monitoring of the impact of septic systems on ground or surface water quality. One exception is that certain lending institutions are requiring well water to be sampled and minimal septic inspections conducted prior to real estate closings.

7. Aquatic Habitat Restoration

A. Pigeon River Spreads

The Pigeon River Spreads on the southern end of Mullett Lake is one of northern Michigan's richest aquatic habitat. The Spreads is known habitat for the Black Tern, Osprey, Bald Eagle, Lake Sturgeon, River Otter, and other special wildlife species. Despite its value as wildlife habitat the Spreads has seen on-going habitat destruction and alteration of the years. The historical aerial photos below show some of the changes over a fifty year period. Some of the changes include: replacing a free-standing bridge with a single culvert (restricting the free flow of water out of the embayment and causing increased inundation), the dredging of canals on the east side of the bay for recreational boating, recent extensive unpermitted wetland fill on the east side of the bay, and continuing deposition of sediment from the Pigeon River.

Pigeon River Spreads – 1938

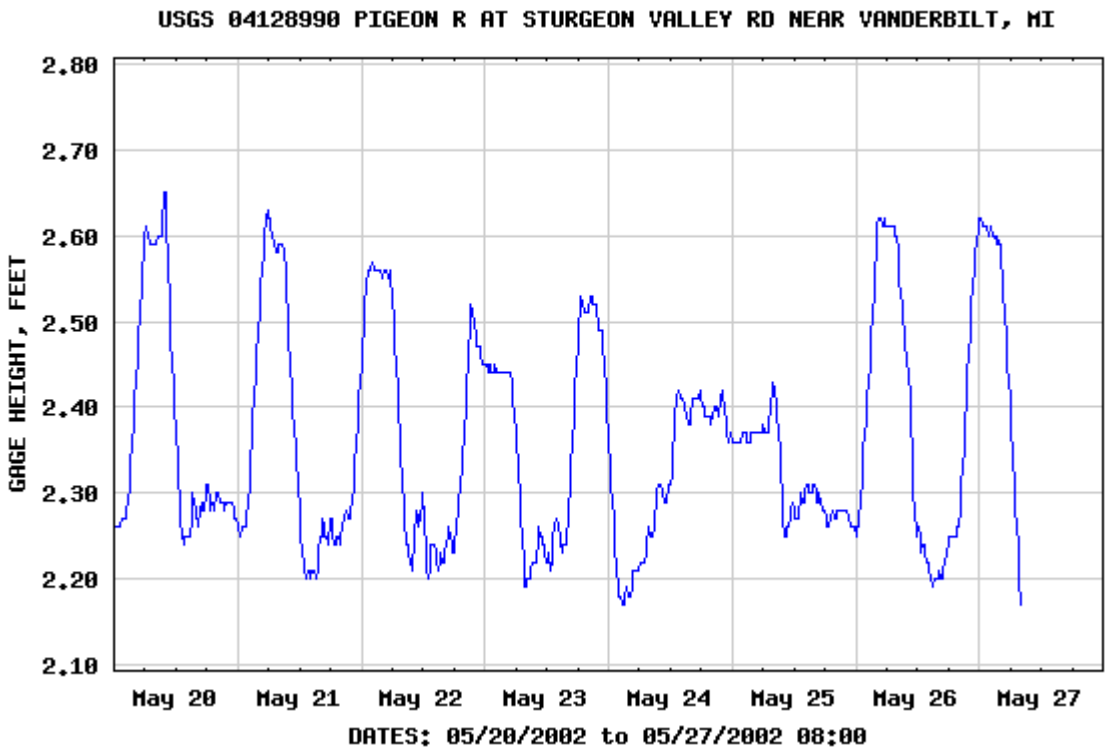
Pigeon River Spreads - 1987

B. Indian River Spreads

Like the Pigeon River Spreads, the Spread at the mouth of the Indian River is a unique wetland habitat, not only is are wetlands of the Spreads important nesting areas for Black Tern, Osprey, and Bald eagle, but the extensive beds of wetland vegetation are important areas for fish rearing and act to filter out and trap pollutants originating from Indian River and I-75 before they reach Mullett Lake.

8. Riverine Hydrology Restoration

The dam on the Lansing Club pond on the Pigeon River has had historical problems with how it is managed. Consultations will be undertaken to research how the current dam management affects the Pigeon River and recommendations will be made to the dam owners and regulators on how. To improve the dams management. Below is a United States Geological Survey hydrograph detailing the varying flow rates of the river downstream of the Lansing Pond dam.



9. Polluted Groundwater and Stormwater Runoff From Indian River

The unincorporated community of Indian River is immediately upstream from Mullett Lake. Indian River does not have a community sewer system and has a very rudimentary stormwater system. Due to the high water table and lack of sewer and stormwater system, many of the pollutants that are found in the street and parking lots (road salt/sand and litter), and that are discharged into the shallow groundwater via septic and floor drains have a likelihood of reaching the Indian River and eventually Mullett Lake with little or no treatment.

There are a variety of techniques that can be employed to minimize the amount of pollutants entering the Indian River via groundwater and stormwater. Public education about the need to properly dispose of household hazardous wastes is one method of reducing groundwater

pollution. Working with local government officials to establish a periodic household hazardous waste drop-off site is another groundwater protection approach.

Polluted runoff can be minimized through management techniques such as more regular street sweeping (a particularly important time for street sweeping is in the spring between the final thaw and the first big spring storm.) Also, information and education techniques for the public should be explored.

Aerial Photo of Indian River from 1991

CHAPTER FOUR: RANKING OF POLLUTION CAUSES AND SOURCES

Based on the preceding inventories and analyses the follow pollutants found in Table 11 were determined to be of priority.

Table 11: Mullett Lake Priority Pollutants

Pollutants	***Priority Ranking***
Sediment	1
Nutrients	2
Oil, grease and metals	3

Bacteria	4

Table 12 outlines how each of the priority pollutants impacts designated water uses.

Table 12: Pollutant Priorities for Each Designated Use		
Designated Uses	***Pollutant***	***Priority Ranking***
Habitat	Sediment Nutrients Oil, grease, and metals	1 2 3
Coldwater	Sediment Nutrients Oils Pesticides	1 2 3 4
Recreation	Nutrients Bacteria	1 2
Navigation	Sediment	1

After prioritizing the pollutants, the pollution sources and causes were prioritized. In large part the rank of both the source and the cause corresponded.

Table 13: Mullett Lake Priority Sources and Causes			
Pollutant Source	***Rank***	***Cause***	***Rank***
Agricultural fields (s)	9	Uses of fertilizers and pesticides (s)	9
Septic systems (s)	5	Outdated, poorly maintained, and improperly designed systems (s)	5
Lawn care on shoreline properties (k)	2	Use of phosphorus fertilizer (s), over-application of fertilizers (s), misuse and over-use of pesticides (s), removal of native shoreline vegetation (k)	2
Lakeshore and streambank erosion (k)	3	Shoreline development and removal of shoreline vegetation (k), angler and canoeist access (k), road/stream crossings (k)	3
Livestock in streams (s)	8	Unrestricted access and no alternative water source (s)	8
Logging activities (s)	7	Inadequate buffer strips near streams (s)	6
New construction	4	Lack of proper erosion control and stormwater	4

(s)		management measures (s)	
Road/stream crossings (k)	1	Undersized and short culverts (k), lack of runoff diversions (k), inadequate fill on road surface (k), lack of vegetation	1
Stormwater discharges in urban areas (k)	6	Inadequate treatment of stormwater that may contain oils, grease, heavy metals, pet waste, etc. (s)	7

CHAPTER FIVE: GOALS AND OBJECTIVES

Goal 1: Aquatic life and wildlife. Protect the diversity of aquatic habitats within the Mullett Lake Watershed by reducing the contribution of sediment, nutrient, and toxic pollutants.

Goal 2: Cold water fishery. Reduce sediment and nutrient loads which threaten to harm habitat conditions for the cold water fishery in Mullett Lake and its tributaries.

Goal 3: Partial or total body contact. Maintain the excellent recreational opportunities in the rivers and lake by reducing sediment and nutrient contributions.

Goal 4: Navigation. Maintain navigation in the rivers and lake by reducing sediment inputs.

Table 14 lists the main objectives to accomplish the above four primary goals.

Table 14: Goals and Objectives of the Mullett Lake Plan

Goals	*Objectives*
Aquatic life **Cold-water fishery** **Recreation** **Navigation**	***Reduce the amount of sediment by:*** Stabilizing erosion at road/stream crossings. Correcting most severe lakeshore erosion sites. Restoring streambank erosion from recreational access. Reducing the pollutant load from stormwater in the urban areas. Restricting livestock from streams.
Aquatic life **Cold-water fishery** **Recreation**	***Reduce the amount of nutrients by:*** Reducing the pollutant load from stormwater in the urban areas. Reducing the amount of fertilizer used on residential lawns. Educating about manure application rates and improving manure storage. Stabilizing the erosion at road/stream crossings. Restricting livestock from streams. Educating about septic system maintenance.
Aquatic life **Cold-water fishery** **Recreation**	***Reduce the amount of toxics (oils, grease, heavy metals) by:*** Reducing the pollutant load from stormwater in urban areas. Restoring erosion and diverting runoff at road/stream crossings.
Aquatic life **Cold-water fishery**	***Reduce the amount of pesticides by:*** Reducing the amount of pesticides used on residential lawns.
Recreation	***Reduce the amount of bacteria by:*** Reducing the pollutant load of stormwater in urban areas. Restricting livestock from streams. Improving the maintenance of septic systems.

CHAPTER SIX: SELECTING THE MOST APPROPRIATE BEST MANAGEMENT PRACTICES (BMPS) FOR THE MULLETT LAKE WATERSHED

Today there exists a wide variety of sources of information on BMPs for water quality protection and restoration. Selecting which BMP is most appropriate for the problem is a critical component of any watershed management plan. Based on the aforementioned findings and a review of existing literature on BMPs, the management systems found in Table 15 were selected for the Mullett Lake Watershed.

Table 15: Mullett Lake Watershed Best Management Practices

Source	***BMP Manual***	***Potential Systems of BMPs***
Road/Stream Crossings	Guidebook of BMPs	water course crossings detention basin
Streambank Lakeshore	Guidebook U,L,C-SE	Streambank - biotechnical
Stormwater	Stormwater Mgt., I/E*, Guidebook, Center for Watershed Protection	Retrofitting drainage systems with BMPs to improve water quality
Recreation	I/E	Create brochures for marinas and boat launches
Lawn/Shoreline Care	Guidebook, I/E	Newsletter, brochures, and one-on-one site assessments
Agriculture-Livestock	Guidebook, Michigan Agriculture BMP	Cattle exclusion fencing, streambank restoration, alternative water supplies
Agriculture-Manure	Guidebook, Michigan Agriculture BMP	Alternative waste storage systems
Septic	I/E	Newsletter, brochures, and one-on-one site assessments

*I/E = Information and education

CHAPTER 7: INFORMATION AND EDUCATION STRATEGY

The long-term protection of Mullett Lake's water quality will depend on the values and actions of future generations. Educating Mullett Lake Watershed residents about how their actions impact water quality is a priority. Increasing awareness and ultimately changing behaviors is the long-term antidote for water quality protection. Target audiences for education programs are identified in the table below.

Table 16: Target Audiences

Sources	*Target Audiences*	*Specific Target Audiences*	*Priority*
Urban stormwater	Homeowners Local government officials	Urban homeowners and residents, riparian property owners, and local government officials (townships bordering cities)	2
Lakeshore erosion	Homeowners	Riparian property owners	5
Streambank erosion	Recreational groups	Canoe liveries, canoeists, hikers, anglers	4
Livestock in streams	Agricultural landowners	Agricultural landowners with livestock (cattle, horses, sheep, etc.)	6
Lawn care	Homeowners	Riparian property owners, urban homeowners, and all watershed residents in priority area	1
Manure management	Agricultural landowners	Agricultural landowners with livestock (cattle, horses, sheep, etc.)	9
Septic systems	Homeowners	Riparian property owners	7
Shoreline development	Contractors, Realtors, Homeowners	Shoreline property builders/contractors, realtors, homeowners	8
Road/stream crossings	Road Commissions	Road Commission managers, crew workers	3

The Information and Education Strategy was developed using our existing knowledge of the target audiences. Consideration of the targeted audiences perspectives was used to create the message and identify delivery mechanisms. Additional review of the message will be done prior to the implementation of any education programs.

The information and education activities will use a variety of approaches including installing demonstration sites, building partnerships, sponsoring seminars, and distributing education materials. Information and Education Strategy for Mullett Lake Watershed.

Table 17: I/E Strategy					
Pollutant	***Source/Cause***	***Target Audience***	***Messages***	***Delivery Mechanism***	***Potential Evaluation***
SEDIMENT	Lakeshore erosion	Homeowners, riparian property owners	Protect lake water quality for future generations and your investment	Use model biotechnical erosion control site to demonstrate restoration, newsletters and brochures.	Photographic and survey to homeowners with erosion
	Streambank erosion	Canoeists, anglers, canoe liveries	Protect the Sturgeon and s	Build partnership with local canoe liveries, involve local groups with restoration and other creative education approaches.	Interviews
	Livestock in streams	Agricultural landowners	Help protect water quality and save money	Conservation District and NRCS to meet with contacts and provide assistance.	Photographic and interviews
	Road/stream crossings	Road Commissions	Help protect water quality and save money	Work with Road Commissions for standard designs that reduce pollution and are cost effective.	Photographic and interviews
	Lakeshore development-construction	Contractors, Realtors, Local Government Officials, Homeowners	Protect water quality and property values	Give presentations at contractors workshop, work with local governments to standardize setback distances, and using print media educate riparians about the importance of setbacks.	Focus group
NUTRIENTS	Lawn maintenance	Landscaping and lawn care companies, homeowners, riparian property owners	Protect water quality and marketing (for lawn care companies)	Sponsor seminars for landscaping companies to learn more about water quality friendly yard maintenance. Sponsor workshops and use print media to reach riparians.	Survey
	Septic systems	Riparian property owners	Protect water quality and keep the water safe	Meet one-on-one with property owners that may have potential septic system	Interview

Table 17: I/E Strategy					
			for swimming	problems. Provide assistance to address problems.	
	Manure application management	Agricultural landowners with livestock	Protect water quality and save money	Conservation District and NRCS to meet with contacts and provide assistance.	Photographic and interview
TOXICS --oil, heavy metals, grease, etc.	Urban stormwater	Homeowners	We are all lakefront property owners (via drains)	Media campaign with local newspapers, radio, and TV. Mail residents information on reducing nonpoint source pollution. Storm drain stenciling in Alanson and Indian River	Survey
PESTICIDES	Lawn maintenance	Homeowners, riparian property owners	Protect lake water quality for future generations and your investment	Sponsor seminars for landscaping companies to learn more about water quality friendly yard maintenance. Sponsor workshops and use print media to reach riparians.	Focus group and survey
	Agricultural fields	Agricultural landowners	Protect water quality and save money	Conservation District and NRCS to meet with contacts and provide assistance.	Photographic and interview
BACTERIA	Stormwater	Shoreline and urban pet owners	Keep the water safe for swimming and protect water quality	Implement media campaign about proper disposal of pet waste and storm drain stenciling.	Survey

CHAPTER EIGHT: FRAMEWORK OF ACTIONS TO PROTECT THE MULLETT LAKE WATERSHED

The Mullett Lake Watershed Planning Project developed an integrative approach to reduce existing sources of sediment and nutrient pollution and prevent future contributions. Integrating the use of (1) systems of best management practices (BMPs); (2) partnerships, community consensus building, and work with local governments, and (3) information and education components.

Action Steps:
Reduce sediment, nutrient, and toxic pollution to Mullett Lake and its tributaries by implementing systems of best management practices on identified priority problem sites and by conducting a program of information and education for targeted audiences.

Evaluation

Conduct an evaluation of the project to assess whether the goals were met.

Responsible Organizations:	Tip of the Mitt Watershed Council
Milestones:	Design evaluation method
Timeline:	Years 1
Estimated Cost:	$1,000

Document each structural site before with multiple pictures, physical measurements, engineering plan if necessary, and a written description.

Responsible organizations:	Tip of the Mitt Watershed Council
Milestones:	Document before and after BMPs of priority road stream crossings
Timeline:	Years 1-5
Estimated Cost:	$1,000

Select and implement methods to properly evaluate the construction, operation, and effectiveness, of each best management practice.

Responsible Organizations:	Tip of the Mitt Watershed Council, Cheboygan County Road Commissions
Milestones:	Design and evaluate success of priority road stream crossings BMPs
Timeline:	Years 1-5
Estimated Cost:	$1,000

Select and implement methods to evaluate the success of the information and outreach components of the program

Responsible Organizations:	Tip of the Mitt Watershed Council
Milestones:	Design and conduct selected evaluation methods
Timeline:	Years 1-5
Estimated Cost:	$1,000

Road/stream Crossings

Restore priority road/stream crossings.

Responsible Organizations: Cheboygan County Road Commissions
Tip of the Mitt Watershed Council
Mullett Lake Preservation Association,
Huron Pines Resource Conservation and Development
Milestones: Design and repair priority road stream crossings using BMPs
Timeline: Years 1-5
Estimated Cost: $400,000

Develop long-term strategy to work with Emmet and Cheboygan Road Commissions and others to restore sites/periodic reassessment.

Responsible Organizations: Cheboygan County Road Commissions
Tip of the Mitt Watershed Council
Milestones: Establish steering committee. Develop long-term strategy
Timeline: Year 3
Estimated Cost: $1,000

Develop database method to keep track of repairs/records of culverts and problems.

Responsible Organizations: Cheboygan County Road Commissions
Tip of the Mitt Watershed Council
Milestones: Develop database. Install database at necessary agencies. Train staff in use and upkeep of the database.
Timeline: Year 3
Estimated Cost: $1,500

Work with road commissions to use BMPs on all road maintenance/work.

Responsible Organizations: Cheboygan County Road Commissions
Tip of the Mitt Watershed Council
Milestones: Identify suitable road-related BMPs. Compile graphics and written material on the BMPs.
Timeline: Years 2-3
Estimated Cost: $1,000

Shoreline Inventory Recommendations:

Develop remedial guidelines for redevelopment of lakeshore properties to protect/improve shoreline from nonpoint source pollution.

Responsible Organizations: Mullett Lake Area Preservation Society
Tip of the Mitt Watershed Council
Milestones: Repeat a version of the survey periodically with follow-up.
Timeline: Years 1-5
Estimated Cost: $1,500

Send a general summary of the survey results and water quality info to all shoreline residents. (Specific results will be kept confidential.)

Responsible Organizations: Mullett Lake Area Preservation Society
Tip of the Mitt Watershed Council

Milestones: Complete the survey and mail results
Timeline: Years 1-2
Estimated Cost: $2,000

Inform property owners that have Cladophora w/questionnaire. Conduct site visits with property owners (perform ground water testing if necessary) to gain more insight on the nature of findings in the results.

Responsible Organizations: Mullett Lake Area Preservation Society
Tip of the Mitt Watershed Council
Milestones: Mail questionnaire and conduct site visits
Timeline: Years 1-3
Estimated Cost: $12,000

Develop guidelines for zoning to build a modest deck or other similar structures in a shoreline area.

Responsible Organizations: Mullett Lake Area Preservation Society
Tip of the Mitt Watershed Council
Northeast Michigan Council of Governments
Milestones: Complete proposed waterfront standards. Present to County /Townships.
Timeline: Years 2-4
Estimated Cost: $2,000

Create and distribute educational packages to realtors, contractors, landscapers, nurseries and other whose clients are shoreline property clients. Develop/sponsor education program (certification) for lake/river realtors on special regulations and management for lake properties.

Responsible Organization: Tip of the Mitt Watershed Council
Mullett Lake Preservation Association
Milestones: Design certification program and certify no fewer then five realtors
Timeline: Years 2-3
Estimated Cost: $5,000

Educate shoreline residents and local government officials on nearshore habitat impact from beach sand, living in mucky areas, shoreline vegetation.

Responsible Organizations: Mullett Lake Preservation Association
Tip of the Mitt Watershed Council
Milestones: Develop and disseminate educational materials and hold seminars on "environmentally friendly lakefront living"
Timeline: Years 1-3
Estimated Cost: $5,000

Lake and Streambank Erosion Inventory:

Repair priority streambank erosion sites on a cost/share basis along the Pigeon River.

Responsible Organizations: Tip of the Mitt Watershed Council
Huron Pines RC&D

Mullett Lake Area Preservation Society.
Milestones: Design and implement streambank erosion BMPs for priority erosion sites.
Timeline: Years 1-5
Estimated Cost: $150,000

Repair 15 lakeshore erosion sites on a cost-share basis along the Mullett Lake Shoreline.
Responsible Organizations: Tip of the Mitt Watershed Council
Mullett Lake Area Preservation Society
Milestones: Design and implement lakeshore erosion BMPs for 15 erosion sites.
Timeline: Years 1-5
Estimated Cost: $100,000

Look at possible erosion on smaller streams.
Responsible Organizations: Tip of the Mitt Watershed Council
Milestones: Complete inventory of erosion sites on smaller streams.
Timeline: Year 3
Estimated Cost: $2,000

Forestry Recommendations:

Establish private road standards to improve construction of forestry roads.
Responsible Organization: Northeast Michigan Council of Governments
County Conservation Districts
Milestones: Set up appropriate meetings with governmental units establish private road standards for forestry roads.
Timeline: Year 2
Estimated Cost: $2,000

Send information packet on forestry best management practices to key property owners in the critical areas of the watershed. Offer cost-share for development of forest management plans for private landowners in the critical area that emphasize BMPs to protect water quality.
Responsible Organization: Northeast Michigan Council of Governments,
County Conservation Districts
Milestones: Disseminate information and hold meetings with private landowners.
Timeline: Years 1-5
Estimated Cost: $4,000

Wetland Ecosystem Restoration Recommendations:

Develop partnerships with area interested landowners to restore properties that were once wetland but have Been converted to upland. In some situations, work with the Little Traverse Conservancy to acquire identified properties. The two most critical areas are the Pigeon River Spreads and the Indian River Spreads.
Responsible Organizations: Tip of the Mitt Watershed Council
Little Traverse Conservancy
Milestones: Restore properties that have unique aquatic ecosystem values.

Timeline: Year 2 -5
Estimated Cost: $400,000

Convert the road/stream crossing at Pigeon Bay from a constricted culvert to a free standing bridge. This restoration effort will lead to dramatic improvement in restoring the natural hydrology and improving fish passage of the Pigeon River Spread. Since Lake Sturgeon have been observed spawning in this area, particular attention should paid to sensitive ecological design and construction, and creating suitable conditions for Sturgeon spawning.

Responsible Organizations: Tip of the Mitt Watershed Council
Michigan Department of Natural Resources
Mullett Lake Area Preservation Society
Milestones: Acquire funding for free standing bridge.
Restore road crossing to a more natural hydrologic regime.
Timeline: Year 2 -5
Estimated Cost: $300,000

Riverine Hydrology Restoration Recommendations:

The Lansing Club dam on the Pigeon River has had historical problems with how it is managed. Efforts will be undertaken to research how current dam management is effecting the Pigeon River and recommendations will be made to the dam owners and regulators.

Responsible Organizations: Tip of the Mitt Watershed Council
Michigan Department of Natural Resources
Michigan Department of Environmental Quality
Milestones: Work with dam owners to improve dam management.
Timeline: Year 2 -5
Estimated Cost: $5,000

Recreation Recommendations:

Develop partnerships with area liveries; inform and involve them in efforts to improve water quality. Encourage liveries to keep track of number of users to assess overall use.

Responsible Organizations: Tip of the Mitt Watershed Council
Local canoe liveries
Michigan Department of Natural Resources
Milestones: Establish committee and hold series of meetings on river management.
Timeline: Year 2
Estimated Cost: $800

Educate boaters and PWC users about ecologically sound boating practices (use existing materials and cooperation of Coast Guard Auxiliary).

Responsible Organization: Mullett Lake Preservation Association
Milestones: Establish most effective mechanisms for dissemination.
Timeline: Years 1-5
Estimated Cost: $1,000

Reduce nonpoint source pollution from the Pigeon River Pathway by planting vegetation, rerouting of the trail and adding educational signage.

Responsible Organizations:	Tip of the Mitt Watershed Council
	Top of Michigan Trails Council
Milestones:	Implement BMPs in high usage areas.
	Determine appropriate signage areas and place educational signage.
Timeline:	Years 2-3
Estimated Cost:	$5,000

Zoning Assessment Recommendations:

Provide training program to townships and planning commissions to promote conservation planning to protect water resources.

Responsible Organization:	Northeast Michigan Council of Governments
	Tip of the Mitt Watershed Council
Milestones:	Hold a series of training workshops for county and township officials.
Timeline:	Years 2-5
Estimated Cost:	$20,000

Promote better enforcement of greenbelt regulations

Responsible Organizations:	Tip of the Mitt Watershed Council,
	Mullett Lake Area Preservation Society
Milestones:	Mtgs with Township/County officials to discuss enforcement of greenbelts
Timeline:	Year 2-4
Estimated Cost:	$1,200

Develop a yearly summary of variances of sanitary code/zoning to determine if there are potential water quality impacts.

Responsible Organization:	Tip of the Mitt Watershed Council
Milestones:	Develop and disseminate yearly summaries
Timeline:	Years 1-5
Estimated Cost:	$800

Publish (more widely) time and place of appeals sanitary appeals to get more citizen involvement in decision making process.

Responsible Organization:	Tip of the Mitt Watershed Council
Milestones:	Work with County officials to create dissemination mechanisms.
Timeline:	Year 2
Estimated Cost:	$500

Stormwater Recommendations:

Install a series of BMPs to address stormwater problems in the Indian River area.

Responsible Organization:	Tip of the Mitt Watershed Council
	Cheboygan County Road Commission

	Local governments
	Local landowners
Milestones:	Prioritize stormwater problem sites.
	Retrofit three of the highest priority sites with improved BMPs
Timeline:	Years 2 and 3
Estimated Cost:	$20,000

Government official education to help with stormwater management.

Responsible Organization:	Tip of the Mitt Watershed Council
Milestones:	Conduct training sessions for local government officials on good stormwater management techniques
Timeline:	Year 3
Estimated Cost:	$2,000

Sample stormwater runoff as part of a school age education program.

Responsible Organization:	Tip of the Mitt Watershed Council
Milestones:	Offer to three area school systems a two-day curriculum on water quality and stormwater runoff
Timeline:	Years 2 and 3
Estimated Cost:	$2,100

Educate businesses in Indian River about housekeeping to reduce nonpoint source pollution.

Responsible Organization:	Tip of the Mitt Watershed Council
Milestones:	Reproduce and distribute nonpoint pollution education materials to 75 businesses and institutions
Timeline:	Years 2-4
Estimated Cost:	$2,000

Public education in Indian River about the need to properly dispose of household hazardous wastes is one method of reducing groundwater pollution.

Responsible Organization:	Tip of the Mitt Watershed Council
	Cheboygan County Health Department
Milestones:	Reproduce and distribute household toxics education materials to 75 businesses and institutions and 400 private residences.
Timeline:	Years 2-4
Estimated Cost:	$4,000

Work with local government officials to establish a periodic household hazardous waste drop-off site.

Responsible Organization:	Tip of the Mitt Watershed Council
Milestones:	Fund and establish a household hazardous waste drop-off center
Timeline:	Years 2-4
Estimated Cost:	$22,000

Land Protection:

Send letter to landowners of the identified priority properties

Responsible Organization: Little Traverse Conservancy
Mullett Lake Preservation Association
Milestones: Send letters to identified landowners
Timeline: Year 2
Estimated Cost: $1,000

Make personal contacts with landowners to properties adjacent to existing preserves.

Responsible Organization: Little Traverse Conservancy
Mullett Lake Preservation Association
Milestones: Establish personal contacts with 20 landowners
Timeline: Year 2
Estimated Cost: $4,000

Continue to work with MDNR on potential assist and transfer projects.

Responsible Organization: Little Traverse Conservancy
Mullett Lake Preservation Association
Milestones: Phone consultations with MDNR on transfer priorities
Timeline: Years 1-3
Estimated Cost: $0.00

Long-term follow up with interested landowners

Responsible Organization: Little Traverse Conservancy
Mullett Lake Preservation Association
Milestones: Continue to track interested landowners and follow up on a regular basis.
Timeline: Year 3-5
Estimated Cost: $2,000

Work with MAPS to look at all the undeveloped properties on Mullett Lake and include in inventory)

Responsible Organizations: Mullett Lake Preservation Association
Little Traverse Conservancy
Milestones: Complete an inventory of undeveloped properties on Mullett Lake shoreline. Establish acquisition priorities.
Timeline: Years 1-3
Estimated Cost: $3,000

The Cheboygan River Watershed Habitat Partnership Conservation Area Plan
Draft

Organizations involved in planning process:

Headwaters Land Conservancy
Huron Pines Resource Conservation & Development Council
Michigan Department of Natural Resources
Little Traverse Conservancy
The Nature Conservancy, MI Chapter
Tip of the Mitt Watershed Council
Northeast Michigan Council of Governments

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Executive Summary

The Cheboygan River Watershed supports habitat for high-quality terrestrial and aquatic biodiversity and provides important commodities for the resource and tourist-based economy of the northern Lower Peninsula. The landscape is characterized by large, inland glacial lakes, wild rivers, and large forested areas that provide habitat for a variety of species, both common and rare. While much of the watershed is in state ownership, critical areas along lakeshores and riparian corridors are in private ownership.

The Cheboygan River Watershed Habitat Partnership was created to bring together several agencies and organizations dedicated to the protection of the watershed's natural resources including: Tip of the Mitt Watershed Council, Little Traverse Conservancy, The Michigan Chapter of the Nature Conservancy, Northeast Michigan Council of Governments, Headwaters Land Conservancy, The Michigan Department of Natural Resources, and Huron Pines Resource Conservation & Development Council. Over the course of several months these partners developed this conservation plan in an effort to devise strategies to preserve biological diversity throughout the watershed in a comprehensive and complementary manner.

Following the model outlined in "The Five-S Framework for Site Conservation: A Practitioner's Handbook for Site Conservation Planning and Measuring Conservation Success" (The Nature Conservancy, 2001), the planning team identified a set of conservation targets that provide the basis for conservation activities in the watershed. The conservation targets are: bogs, fens and hardwood conifer swamps, Michigan monkey flower, Hungerford's crawling water beetle, lakes and associated wetlands, lakes and streams in karst terrain, ground water-driven streams and riparian corridors, and wildlife corridors and core habitat. In spite of historical and ongoing impacts from human activities, these targets and the ecological processes that support them remain relatively intact. The overall healthy condition of the conservation targets is reflected in the "Good" biodiversity health assessment rank.

The primary sources of stress impacting the conservation targets are residential development, roads and utilities, dams, increased imperviousness, and shoreline alteration and hardening. While these threats are projected to increase given continued expansion of residential, commercial, and recreational development in the region, numerous opportunities exist to minimize the impacts of human activities and to educate both residents and visitors to the watershed on the importance of natural resource protection. The planning team identified 16 strategies to address threats to the conservation targets. Six of these were selected for immediate development and implementation: stabilizing and upgrading road-stream crossings, coordinated land protection, establishing and enforcing sound planning and zoning, implementing shoreline best management practices (BMPs), promoting economic benefits of resource protection, and retrofitting existing developed areas to reduce polluted stormwater runoff.

Background and Introduction

The Cheboygan River Watershed – long recognized by local residents and conservation groups for its natural resource values – was identified in 1996 as a key aquatic biodiversity site in the Great Lakes Ecoregion during an intensive ecoregional planning process conducted by an inter-organizational

group of experts (The Nature Conservancy, 2000). This process of ecoregional planning was initiated by the Great Lakes Program of The Nature Conservancy (TNC) to identify high priority biodiversity conservation areas that represent the full range of biodiversity across the ecoregion, including common and rare species, communities, and other significant natural features. The Cheboygan River Watershed supports high-quality examples of aquatic and terrestrial biodiversity that, in conjunction with other identified sites in the Great Lakes Ecoregion, contribute to this objective of comprehensive biodiversity conservation.

In addition to large kettle lakes, large forested areas, and an expansive network of streams and wetlands, this 900,000 acre watershed is home to a variety of aquatic species including several endangered species, the Michigan monkey flower (*Mimulus glabratus* var. *michiganensis*), Hungerford's crawling water beetle (*Brychius hungerfordi*), and the state threatened lake sturgeon (*Acipenser fulvescens*). Several large wetlands, such as the Indian River Spreads and the Pigeon River Spreads, also provide important nesting habitat for rare birds such as the bald eagle (*Haliaetus leucocephalus*), the common loon (*Gavia immer*) and the black tern (*Chlidonias niger*).

The purpose of developing this conservation plan is to develop management strategies to preserve representative conservation targets throughout the Cheboygan River Watershed. This process was developed through a partnership. This partnership includes Tip of the Mitt Watershed Council, Little Traverse Conservancy, The Nature Conservancy, Northeast Michigan Council of Governments, Headwaters Land Conservancy, Michigan Department of Natural Resources, and Huron Pines Resource Conservation & Development Council.

The planning team followed the guidelines from *"The Five-S Framework for Site Conservation: A Practitioner's Handbook for Site Conservation Planning and Measuring Conservation Success"* (The Nature Conservancy, 2001). This process entails identifying conservation targets and assessing their viability; identifying stresses to those targets; developing the sources of those stresses; developing strategies to abate those sources of stress; and, measures to determine the success of these strategies**.** The conservation plan contains a number of Microsoft Excel spreadsheets that the team developed as part of the Five-S Framework. Select spreadsheets appear as tables in this plan.

1. Site Description and Context

1.1 Geographic Location/ Ecoregional-Bioregional Location

The Cheboygan River (Map 1) drains areas of Emmet, Cheboygan, Presque Isle, Charlevoix, Otsego, and Montmorency Counties at the northern tip of Michigan's Lower Peninsula, including parts of 45 townships. The Cheboygan River itself is a short reach between Mullett Lake and the Straits of Mackinac, where the Cheboygan empties into Lake Huron. The drainage area of the Cheboygan River includes over 900,000 acres and numerous rivers and lakes. In addition to Mullett Lake, other large lakes include Douglas Lake, Burt Lake, Pickerel Lake, Crooked Lake, and Black Lake. The major rivers in the Cheboygan River Watershed's drainage basin include the Crooked River, Maple River, Sturgeon River, Pigeon River, and Black River. Several of these systems are connected in what is called the Inland Waterway.

Numerous glacial retreats and advances define the irregular topography of this watershed. The

current landscape is a direct product of this ice scouring and redeposition, as well as postglacial erosion and soil formation processes. The resulting landscape is defined by steep morainal ridges, rolling drumlins, kettle lakes, swamps, marshes, and depressions (Albert, 1995).

1.2 SITE CONTEXT

Ecological Context

Ecoregional planning identified aquatic systems in the Cheboygan River Watershed as exemplary of their types. Large kettle lakes in the project area are the least developed and highest quality in Michigan's Lower Peninsula. Their native fish communities are virtually intact. The headwater streams in the project area are largely ground water fed and drain a relatively unfragmented, forest matrix. As hydrology is a major ecosystem process in relationship to the conservation targets at this site, the conservation area boundaries are defined by the watershed boundaries.

Human Context

The political landscape of the Cheboygan River Watershed consists of parts of 6 counties, 45 townships, numerous small towns, and the cities of Gaylord, Indian River, Atlanta, Onaway, Pellston, and Cheboygan. The Cheboygan River Watershed contains extensive public lands including the Pigeon River Country State Forest, but also has a significant number of privately owned tracts. Approximately 37% of the watershed is in public ownership (Map 2).

The Cheboygan River Watershed supports some of Michigan's highest quality lakes and trout streams. From boating on the 43-mile-long Inland Waterway to catching native brook trout in headwater streams, the Cheboygan River Watershed is the quintessential water wonderland. Because of lakes like Burt, Mullett, Black, Douglas, Crooked, and Pickerel, and rivers such as the Black, Pigeon, Maple, and Sturgeon, aquatic habitats in the Cheboygan River Watershed are the focus of a thriving resource-based tourist and resort economy and are experiencing some of the fastest residential growth in the state (Map 3; U.S. Census Bureau 2001).

The Cheboygan River Watershed is at a crossroads. One direction involves uncoordinated development that threatens the very resources that drive the local economy and upon which thousands of residents and visitors rely for their recreation. Another direction involves the coordination of land use decisions across the watershed in a way that promotes a sustainable economy based on protecting the resources that make this area special.

Stakeholder Analysis

Natural resources are a critical component to the region's economy. As such, the stakeholders for this project are varied and many. For the purposes of this project, stakeholders are considered to be those that affect or are affected by conservation efforts. The list below is not intended to be a comprehensive list of stakeholders, but rather some examples of the specific stakeholders and the broad categories of businesses, organizations, and agencies that are important to the success of this project. It is important to note that given the nature of the conservation targets in this watershed, all residents and visitors affect, and will be affected by, the strategies included in this plan.

Conservation and Environmental Organizations:
Audubon Society (two chapters in the watershed)
Ducks Unlimited (four chapters in the watershed)
Headwaters Land Conservancy
Little Traverse Conservancy
Mackinaw Forest Council
Sierra Club (local chapter)
SEE-North (Science and Environmental Education)
Sturgeon for Tomorrow
The Nature Conservancy, Michigan Chapter
Trout Unlimited (two chapters in the watershed)
Tip of the Mitt Watershed Council
Upper Black River Restoration Committee

Businesses and Business Organizations:
Banks
Chambers of Commerce
Realtors/Builders Associations
Hotels/Motels
Lodges
Cabins

Local Government/Quasi-Government:
County Building, Planning, and Erosion Agencies
County Conservation Districts
County Road Commissions
Conservation Resource Alliance
Huron Pines Resource Conservation & Development Council
Northeast Michigan Council of Governments
Regional Economic Development Councils
Townships

Recreational Groups and Homeowner Associations:
Canoe Liveries
Camping Facilities
Fishing Guides
Hunt Clubs
Cross-Country Skiing Facilities/Trails
Marinas
Lake and River Associations
Snowmobile and ATV user groups
Pigeon River Country State Forest Advisory Committee

State and Federal Governments:
Michigan Department of Natural Resources

Michigan Department of Environmental Quality
Michigan Department of Agriculture
Michigan Department of Transportation
U.S. Fish and Wildlife Service
U.S. Department of Agriculture
U.S. Environmental Protection Agency
U.S. Army Corps of Engineers

Academic Institutions:
North Central Michigan College
Public and Private Schools
University of Michigan Biological Station

2. Conservation Targets

The intent of the target selection in the conservation planning process is to help define conservation goals in the landscape (The Nature Conservancy, 2000). Conservation targets may be species, ecological communities or ecological systems. These focal conservation targets guide the identification of conservation strategies at individual sites by determining which critical threats and persistent stresses must be abated in order to maintain or enhance the viability of the conservation targets. Human activities have influenced these targets, yet they continue to persist, retaining most of their key components, patterns, and processes. Nested targets have also been identified for each of the focal conservation targets. While these nested targets are of equal conservation concern, the area and ecological processes upon which they depend are encompassed by that of the focal conservation targets: when the conservation target and its sustaining ecological processes are protected, the nested targets are also protected.

2.1 Conservation Target Definitions and Justification

<u>Bogs, Fens, and Conifer-Hardwood Swamps</u>

This target includes several large conifer swamps interspersed between morainal uplands, as well as scattered fens and bogs. Varying glacial terrain with abrupt ecotones define these hydrologically dependent systems. Although few endangered or threatened species are associated with these wetlands, they tend to harbor an incredible diversity of species. The Green Swamp, which feeds the headwaters of two major branches of the Black River, supports at least two-thirds of all orchids known in Michigan and is home to a thriving population of State Threatened red-shouldered hawks (*Buteo lineatus)*. The bogs, fens, and conifer-hardwood swamps serve a range of important functions that contribute to the health of aquatic and terrestrial ecosystems in the watershed. The primary conservation concerns for this target are forest and hydrologic connectivity.

Nested Targets: Yellow pitcher plant

Orchids

Red-shouldered hawk

Northern white cedar

Michigan Monkey Flower (*Mimulus glabratus var. michiganensis*)

Michigan monkey flower, endemic to Michigan, was federally listed as endangered in 1990. The species is restricted to alkaline habitats with a consistent flow of cold ground water and abundant sunshine (Penskar and Higman, 2001). Michigan monkey flower (*M. glabratus var. michiganensis)* has an apparently low degree of sexual reproduction and is largely clonal, growing in localized, but dense colonies with low genetic diversity. Consequently, the species has a limited capacity for dispersal and its adaptive ability is also likely to be quite low. The population at Lake Kathleen has experienced some human disturbance, but remains vigorous, and was the only population found to set viable seed in a 1986 study, making it perhaps the most important occurrence for the long-range seed dispersal of the species. Michigan monkey flower is highly vulnerable to isolated disturbances including, residential and recreational development, lake level fluctuations, upstream water diversions, and increased shoreline and riparian activity by humans. Protection efforts should therefore focus on known habitat and the protection of water flow and quality via buffer areas. Transplantation may provide a viable mechanism for restoring population numbers given the vegetative reproductive ability of the species.

Nested Targets: Ground water seeps

Hungerford's Crawling Water Beetle (*Brychius hungerfordi*)

This post-glacial relict species is endemic to the Great Lakes, and three of the five known occurrences of the species are found in the Cheboygan River Watershed. While much remains unknown about the beetle's life cycle and habitat requirements, it is generally found in stream segments with moderate to fast stream flow, inorganic substrate, and good stream aeration. Cool water conditions and impoundments (beaver dams or similar man-made structures) appear to be integral aspects of the beetle's habitat. The impoundments regulate stream flow fluctuations and create the riffle environment preferred by the beetle. The larvae also require clean gravel substrate, but prefer stream segments with slower currents and dense growths of macroalgae. All habitat conditions must be protected in order to maintain viable beetle populations. *B. hungerfordi* dispersal mechanisms seem to be limited to movement within the stream system and they are not likely to fly between tributaries or stream segments (Hyde and Smar, 2000). Beetle populations are primarily threatened by changes in habitat due to human activities, such as logging, stream channel modification, and incompatible fisheries management.

Nested Targets: East Branch of the Maple River
Van Etten Creek

East Branch of the Black River

Lake Sturgeon (*Acipenser fulvescens*)

Historically, lake sturgeon inhabited numerous inland lakes and rivers in Michigan. Currently, known spawning populations persist in only a few of these systems, most notably, in Black Lake and Mullett Lake. It is a bottom dwelling species, most frequently associated with large lakes or the deep pools of rivers where benthic organisms are abundant, and generally avoid areas with aquatic vegetation.

Preferred spawning habitat consists of gravelly tributary streams that flow into the larger rivers and lakes (Goforth, 2000). Migratory barriers, loss of spawning and nursery areas, fishing and poaching pressures, combined with the species late maturity and low reproductive rates, have led to the decline of sturgeon populations. Reestablishing habitat connectivity could benefit the sturgeon and other fish species that require access to a variety of aquatic habitats, such as the Great Lakes Muskellunge.

Nested Targets:
- Black Lake
- Upper Black River
- Burt Lake
- Mullett Lake
- Great Lakes Muskellunge
- Northern Pike

Lakes and Associated Wetlands

Large, deep, oligotrophic, kettle lakes support an array of fish and wildlife and serve as the core attraction for a thriving resource-based tourist economy. Expansive estuarine systems that have formed where the large rivers filter into these lakes likewise provide crucial habitat for a variety of species. As much of the shoreline around these lakes has already been heavily developed (with the exception of Douglas Lake), conservation efforts are required to preserve (and restore) remaining wetland and shoreline habitats, and to protect water quality.

Nested Targets:
- Large, glacial lakes (Douglas, Burt, Mullet, Crooked, Pickerel, and Black Lakes)
- Bird habitat (common loon, black tern, osprey, bald eagle)
- Pugnose shiner (Black Lake)

Lakes and Streams in Karst Terrain

The eastern side of the Watershed is distinguished by a karst landscape composed of sinkholes, abrupt ridges, caverns, and disappearing and underground streams. This topography provides numerous pathways for surface contaminants to infiltrate very rapidly into an unpredictable subterranean network. In addition, high permeability and rock solubility preclude adequate filtering of point and nonpoint source pollutants. Many of these sinkholes continue to be used as dumps.

Nested Targets:
- Rainy River (upstream of Black Lake)
- Rainy Lake
- Pigeon River Country State Forest
- Lake Louise

Ground Water-Driven Streams and Riparian Corridors

The Sturgeon, Pigeon, and Black Rivers are low-gradient streams with high base flow and low surface flow. These streams and their associated riparian corridors define the hydrology of the southwest portion of the Watershed. Both the Sturgeon and the Pigeon Rivers are used for spawning by migratory fish from Burt and Mullet Lakes. Kleber and Alverno dams inhibit such migratory spawning behavior on the Black River. These ground water-driven streams have all been subjected to erosion from past logging activities as well as on-going human uses. Nested Targets: Sturgeon, Pigeon, and Black Rivers and their tributaries
- Instream spawning habitat
- Ground water seeps

Wildlife Core Habitat and Corridors

This target addresses the need to preserve and restore large, contiguous tracts of intact forest to provide critical habitat for a variety of wildlife species. These forests have been highly altered by historical and current logging practices, oil and gas development, roads, development pressure, and agricultural activities.

Nested Targets: Northern hardwood forest
Elk, bear, bobcat, red-shouldered hawk, and pine marten
Potential habitat for wolf, lynx, and cougar

3. Biodiversity Health Assessment

An important part of the conservation strategy is to assess the biodiversity health, or viability, of the conservation targets. The expertise of the individuals on the conservation planning team was utilized to assess viability based on considerations of size, condition, and landscape context. The summary of this assessment is presented in Table 1. Although degradation has occurred in various ways in this Watershed, ecological systems and processes remain relatively intact. This condition is reflected by the "Good" overall biodiversity health ranking, indicating that the Watershed may be considered a functional landscape (Pioani and Richter, 2000).

Table 1: Viability Assessment for Cheboygan River Watershed Targets

Site Conservation Target	SIZE		CONDITION		LANDSCAPE CONTEXT		Overall Biod. Health Score
	Rank	Justification	Rank	Justification	Rank	Justification	
Bogs, Fens, and Conifer-Hardwood Swamps	***Very Good***	Many of the cedar swamps were logged and didn't regenerate as cedar due to deer browsing. Nevertheless, many swamps still remain. There are only a few bog systems in the watershed, but the number/size of these have not notably decreased over time. Size has not greatly changed over time.	**Good**	Vegetation community in many of the swamps has been altered due to historic timbering and deer browsing causing a change in species composition. Decline in snowshoe hare population due to decline in cedar. Bogs in Very Good condition.	**Good**	Landscape fragmentation due to development, gas, and oil development and associated roads. Grazing impacts from surrounding areas.	**Good**
Michigan Monkey Flower	***Fair***	Species has a very specific habitat niche, but seems to be thriving where it occurs. It has not been found in some areas where it seems that it could grow. There is only one known sexual reproducing population of this species. Continued survey and discovery of additional populations could lead to a change in the ranking.	**Poor**	Mostly vegetatively reproducing. Even sites that occur on protected land are not completely protected from external impacts (changes in ground water hydrology, foot traffic, adjacent development, changes in available sunlight). Need further information on species genetics and genetic viability of existing populations.	**Fair**	Populations are highly sensitive to anthropogenic impacts due to the vulnerability of its niche.	**Fair**
Hungerford's Crawling Water Beetle	**Fair**	Few known populations exist although there is additional potential habitat in the Watershed (especially Black River, Tomahawk Creek, and Canada Creek). Prefers warmer water below lakes and natural impoundments, fallen debris and blockages. A glacial relict, small population numbers have further declined due to historic logging and current fisheries management (removal of beaver dams and increased predation by introduced brown and rainbow trout).	**Fair**	Small populations may have a negative impact on the genetic viability of the species, but more information is needed to assess the condition of known populations. Known populations are spatially distributed across the Watershed, suggesting that the beetle populations may be greater than currently known. Reintroduction may be possible in streams where it is not currently known.	**Fair**	Current cold-water fisheries management can adversely impact known beetle habitat niches. Not all streams in the watershed are appropriate for cold-water trout management.	**Fair**

Site Conservation Target	SIZE		CONDITION		LANDSCAPE CONTEXT		Overall Biod. Health Score
	Rank	Justification	Rank	Justification	Rank	Justification	
Lake Sturgeon	**Fair**	Black Lake population currently meets the minimum criteria to be restorable (sturgeon are currently reproducing naturally as well as spawning in the same streams they have spawned in the past). The best habitat (high gradient streams downstream from lakes) is currently inundated behind impoundments.	**Fair**	Habitat fragmented due to dams - spawning habitat particularly limited. Historically, downstream of Black Lake was probably the best habitat, but it is now inundated. The Black Lake population is disconnected from the Great Lakes, Burt, and Mullett Lakes. DNR Fisheries is currently researching genetic viability of the population - appears to be currently viable.	**Fair**	Dams have affected hydrology of the system, aquatic corridors and, consequently, species' life cycles. Development in the Watershed and along the shorelines has impacted water quality and flow.	**Fair**
Lakes and Associated Wetlands	**Fair**	Big lakes are not changing in size over time so we are not considering them in the size ranking. Only wetlands are being considered for this rank score. Less than half of the original wetlands area around the big lakes is remaining. Roads (road fill and culverts) impact water flow, cutting off wetland systems. Canals through former wetlands have both destroyed wetland areas and altered species composition. Many shoreline wetlands have been filled for new home sites.	**Good**	Canals have altered the species composition of some wetland areas. Condition has been impacted by invasive species (zebra mussel, purple loosestrife, etc.). Water quality is good, although anthropogenic nutrient inputs are significant.	**Fair**	Landscape context varies across the Watershed. Target is subject to extensive shoreline development and continued development pressures.	**Fair**
Lakes and Streams in Karst Terrain	**N/A**		**Good**	Due to the natural flashiness of these systems they may be particularly impacted by imperviousness. The target is also particularly sensitive to climate change in addition to seasonal changes, whether natural or human-induced. Many of the small lakes are in state forest ownership. The Rainy River corridor is largely in private ownership (mostly farm land). The target has been	**Good**	Many of the small lakes are in state ownership, but Rainy Lake and much of the Rainy River are in private ownership. The landscape is heavily fragmented by agriculture. The system is highly sensitive to climate change. Target needs further research to confirm ranking. This portion of the Watershed is not experiencing severe	**Good**

Site Conservation Target	SIZE Rank	SIZE Justification	CONDITION Rank	CONDITION Justification	LANDSCAPE CONTEXT Rank	LANDSCAPE CONTEXT Justification	Overall Biod. Health Score
				impacted by nutrient loading from agriculture. Agricultural runoff has also caused some groundwater contamination because there is little filtering of groundwater inputs through glacial till. Landfills have also resulted in contamination, but these problems have since been remediated. Condition is ranked as Fair to Good, but needs further research		development pressure as other areas.	
Ground Water-Driven Streams and Riparian Corridors	**Very Good**	Size of streams has not changed over time. Riparian corridor remains Very Good with regards to size, although the lower reaches are more disturbed than the headwaters.	**Good**	Condition depends on location in the Watershed, but Good overall. Several restoration activities are already in place. Road placement has a large impact on condition. Headwaters to the Sturgeon are impacted by sediment.	**Good**	Geomorphology is excellent for supporting ground water streams, but relatively steep slopes and erodable soils pose a high risk to the system.	**Good**
Wildlife Core Habitat and Corridors	**Good**	Good core habitat exists in Pigeon River Country and large blocks of intact habitat in state and private ownership, but lacks connectivity. Existing corridors represented by state lands and other protected lands do not provide optimal connectivity for far-ranging species. I-75 blocks wildlife corridors and fragments contiguous habitat. Exclusion/inclusion fences also constrict wildlife movement. Future development may also adversely affect viability.	**Good**	Healthy bear and elk populations. Bobcat population okay. Nested targets have different habitat requirements, but across the Watershed, core habitat is fairly diverse (forest dominated and more open areas). Condition of corridors varies across the Watershed from excellent to poor.	**Fair**	Gaylord is developing and growing rapidly, as well as other human population centers in and around the watershed (Petoskey, Indian River, etc.) Also oil and gas development and associated roads on public and private land increase fragmentation across the landscape.	**Good**

4. Threats Assessment

Every natural system is subject to various disturbances. For our planning purposes, however, only the destruction, degradation or impairment of conservation targets resulting directly or indirectly from human causes was considered a stress. Understanding the stresses that impact each target (Table 2), and the relative severity and scope of that stress (Table 3), is critical to developing conservation strategies. Stresses are described in the Appendices.

Table 2: Summary of Stresses to Conservation Targets in the Cheboygan River Watershed

Conservation Target	Stress	Severity	*Scope*
Bogs, Fens, and Conifer-Hardwood Swamps	Habitat destruction and conversion	**Very High**	**Medium**
	Habitat fragmentation	**High**	**Medium**
	Altered hydrology	**High**	**High**
	Altered composition/structure	**High**	**Medium**
	Excessive herbivory	**High**	**High**
	Habitat disturbance	**Medium**	**High**
Michigan Monkey Flower	Habitat destruction or conversion	**Very High**	**High**
	Altered hydrology	**High**	**High**
	Habitat disturbance	**High**	**High**
	Sedimentation	**High**	**High**
	Nutrient loading	**Medium**	**High**
	Thermal alteration	**High**	**High**
	Shading/light competition	**High**	**Medium**
Hungerford's Crawling Water Beetle	Modification of natural flow patterns	**High**	**Medium**
	Habitat disturbance	**Very High**	**High**
	Excessive predation	**Medium**	**High**
	Sedimentation	**High**	**Very High**
	Habitat destruction or conversion	**High**	**Medium**
	Habitat fragmentation	**High**	**Medium**
Lake Sturgeon	Sedimentation	**Medium**	**Medium**

Conservation Target	Stress	Severity	*Scope*
	Altered hydrology	High	High
	Habitat fragmentation	Very High	High
	Excessive predation	Medium	Medium
	Nutrient loading	Low	Low
	Habitat disturbance	Medium	Low
	Habitat destruction or conversion	High	High
Lakes and Associated Wetlands	Habitat destruction or conversion	Very High	Very High
	Nutrient loading	High	High
	Habitat disturbance	High	Very High
	Habitat fragmentation	Very High	Very High
	Altered composition and structure	Very High	Very High
	Toxins/contaminants	Medium	Very High
	Sedimentation	Medium	Very High
	Altered hydrology	Medium	High
Lakes and Streams in Karst Terrain	Toxins/contaminants (ground water)	High	High
	Ground water depletion	Very High	Low
	Habitat destruction or conversion	High	High
	Nutrient loading	Very High	Very High
	Sedimentation	Very High	Very High
	Habitat fragmentation	High	High
	Altered hydrology	High	Medium
Ground Water-Driven Streams and Riparian Corridors	Sedimentation/erosion	Very High	High
	Thermal alteration	Medium	High
	Habitat destruction or conversion	High	High
	Altered hydrology	High	Medium
	Nutrient loading	Medium	Medium
	Habitat disturbance	Medium	High
	Habitat fragmentation	High	High
Wildlife Core Habitat and Corridors	Habitat destruction or conversion	Very High	High

Conservation Target	Stress	**Severity**	***Scope***
	Habitat disturbance	**High**	**High**
	Habitat fragmentation	**High**	**High**
	Altered composition/structure	**Medium**	**High**

Table 3: Critical Active Threats for The Cheboygan River Watershed Habitat Partnership

Active Threats Across Systems	Bogs, Fens, and Conifer-Hardwood Swamps	Michigan Monkey Flower	Hungerford's Crawling Water Beetle	Lake Sturgeon	Lakes and Associated Wetlands	Lakes and Streams in Karst Terrain	Ground Water-Driven Streams and Riparian Corridors	Wildlife Core Habitat and Corridors	**Overall Threat Rank**
Residential development	High	Very High	Medium	High	Very High	Very High	Very High	Very High	**Very High**
Roads or utilities	High	Very High	High	Medium	-	Very High	Very High	High	**Very High**
Dams	-	-	High	Very High	Very High	-	High	-	**Very High**
Increased imperviousness	-	Very High	-	Medium	High	Very High	Medium	-	**Very High**
Shoreline alteration/hardening	-	Very High	-	-	Very High	-	-	-	**Very High**
Oil or gas	High	-	-	-	-	Very High	High	Medium	**High**
Agricultural practices	High	-	-	Low	Medium	Very High	Medium	-	**High**
Dredging and filling	-	-	-	High	Very High	-	-	-	**High**
Forestry practices	Medium	-	Medium	-	-	Very High	Medium	Medium	**High**
Invasive/alien species	Low	Medium	-	-	Very High	-	-	-	**High**
Inappropriate disposal of potentially hazardous substances by homeowners	-	-	-	-	-	Very High	-	-	**High**
Recreational Use	-	Medium	-	Low	Medium	High	Medium	-	**Medium**
Artificially high deer populations	High	-	-	-	-	-	-	Medium	**Medium**
Beaver dam removal	-	-	High	-	-	-	-	-	**Medium**
Fencing	-	-	-	-	-	-	-	High	**Medium**
Commercial/Recreational Development	-	-	-	-	-	-	-	High	**Medium**
Threat Status for Targets and Site	**High**	**Very High**	**High**	**High**	**Very High**	**Very High**	**Very High**	**Very High**	**Very High**

5. Conservation Strategies

Each of the potential conservation strategies was analyzed by the conservation planning team and prioritized based on leadership capacity, benefits to the target (and across targets), feasiblity, and cost.

Immediate Strategies

Stabilize and Upgrade Road-Stream Crossings

- Bogs, Fens, and Conifer Hardwood Swamps
- Michigan Monkey Flower
- Hungerford's Crawling Water Beetle
- Lake Sturgeon
- Lakes and Associated Wetlands
- Lakes and Streams in Karst Terrain
- Ground Water-Driven Streams and Riparian Corridors

- Stabilize or upgrade, and in some cases, remove road-stream crossings. Determine appropriate actions on a case-by-case basis.
- The focus of this strategy is to deal with constrictions on water flow, sedimentation, runoff, and other hydrological alterations caused by road crossings.

Assumptions

- Improved road-stream crossings will decrease sediment and chemical inputs affecting the targets and can improve the hydrologic regime in areas where it has been altered by roads.
- Roads may be related to oil and gas, residential or commercial development.
- Some roads (e.g., East Mullet Lake Road) act like dams constricting the flow of water between wetlands and lakes; need to restore the hydrology in areas where roads cross drainage ways.

Leverage: High. Strategy has high visibility on public roads.

Lead: Very High. Huron Pines RC&D Council (with support).

Ease: Very High.

Cost: Very High.
* Cost is calculated on a 10-year time frame throughout.

Protect Land Through Coordinated Strategies

- Bogs, Fens, and Conifer Hardwood Swamps
- Michigan Monkey Flower
- Hungerford's Crawling Water Beetle
- Lake Sturgeon
- Lakes and Associated Wetlands
- Lakes and Streams in Karst Terrain
- Ground Water-Driven Streams and Riparian Corridors
- Wildlife Corridors and Core Habitat

- Develop land protection strategies for each key target (e.g., key buffer lands, corridors, shoreline tracts, tracts to prevent subdividing around oil and gas leases, or identified habitat – such as the East Branch of the Maple River and critical areas along Burt Lake shoreline for the Michigan Monkey Flower). Protection tools may include conservation easements, conservation buyers, and acquisition. Negotiations with landowners can be undertaken by the LTC and Headwaters with support of TNC. Work with ranches and hunt clubs to obtain conservation easements on large, intact habitat. Also consider grants to increase state ownership (NRTF).

Assumptions
Protected lands will remove or lessen threats to targets, or in some cases prevent additional degradation.

Leverage: Very High. Publicly visible results; allows for immediate management of the land; may have high leverage towards other strategies depending on the parcel characteristics and location.

Lead: Very High. LTC, HWLC, and TNC

Ease: Very High.

Cost: Very High. Land is expensive, although pursuing a mix of land protection strategies may lower cost.

Establish and Enforce Sound Planning and Zoning

- Bogs, Fens, and Conifer Hardwood Swamps
- Michigan Monkey Flower
- Hungerford's Crawling Water Beetle
- Lake Sturgeon
- Lakes and Associated Wetlands
- Lakes and Streams in Karst Terrain
- Ground Water-Driven Streams and Riparian Corridors
- Wildlife Core Habitat and Corridors

- Establish ordinances so that all properties need BMPs to get permits, and establish regulatory review process for ground water, stormwater runoff, wetland and land protection. Develop BMPs for sedimentation and erosion.
- Monitor compliance to zoning regulations
- Work with local units of government on developing local wetland ordinances and zoning requirements for setbacks and riparian buffers, and stormwater management.
- Work with local governments to establish no-wake zones and regulate motorized use in sensitive habitat areas.
- Work with counties to develop an ordinance requiring septic testing at point of sale.
- Provide planners, permit reviewers, and other officials with information on threatened and endangered species locations and habitat requirements. Do further resource inventories of T&E species.
- Develop a "community watch" program that includes signage and fines to increase enforcement.
- The goal of this strategy is to get a critical mass of governments involved in zoning so that conservation-oriented planning and zoning becomes more "accepted" throughout

the region. May be most effective by focusing efforts on the west side of the Watershed and moving towards the east side later.

Assumptions

- Local regulations fill the gaps in state regulations.
- Regulations provide a level of protection on all parcels in the watershed (not just on select parcels).

Leverage: Very High. Strategy helps to improve state regulations.

Lead: High. TOMWC and NEMCOG. Strategy can be coordinated with the PAL grant.

Ease: High. There is a growing momentum for conservation in the region.

Cost: High.

Implement Shoreline BMPs

- Michigan Monkey Flower
- Hungerford's Crawling Water Beetle
- Lake Sturgeon
- Lakes and Associated Wetlands
- Lakes and Streams in Karst Terrain
- Ground Water-Driven Streams and Riparian Corridors

- Work with residential and commercial landowners, contractors, landscapers, Chemlawn, and other private businesses to preserve and restore the land-water interface. Create setbacks and buffer strips. Develop procedures for lawn care (to minimize clearing and herbicide use), stormwater management, setbacks and buffer strips, and septic systems.
- Reduce water resource impacts on already developed parcels.
- Implement biotechnical erosion control on streambanks and lakeshores (does not refer to bulkheads, large rock rip-rap, and other non-vegetative erosion control). Stabilize and improve riparian access sites for anglers and canoeists. Work with restoration committees, where existing. Utilize CMI and 319 funding where possible and update watershed management plans so that all watersheds in the Cheboygan River Watershed can be eligible for funding. Use this plan to leverage funds.
- Set up septic testing program and use contact as an opportunity to educate landowners.
- Use education and technical assistance as tools to implement riparian and shoreline management with the goal of providing people with the tools and awareness to induce a change in behavior.

Assumptions

- Assumes that education will translate into changed behaviors, professional practices.
- Traditional erosion control that hardens shorelines causes problems at the land-water interface, whereas biotechnical erosion control protects the shoreline from erosion and restores riparian habitat.

Leverage: Very High. Strategy will leverage local ordinances, stewardship opportunities with landowners, retrofitting existing developed areas.

Lead: Very High. TOMWC (Heidi Volkhardt), NEMCOG, and Huron Pines RC&D Council.

Ease: Very High. Sites have already been identified and we have a good sense of the work that needs to be done. TOMWC is currently working to update all CMI and 319 funded plans.

Cost: Very High.

Promote Economic Benefits and Opportunities Associated with Resource Protection

- Bogs, Fens, and Conifer Hardwood Swamps
- Hungerford's Crawling Water Beetle
- Lake Sturgeon
- Lakes and Streams in Karst Terrain
- Wildlife Core Habitat and Corridors

- Determine potential economic development projects such as ecotourism, the "Sturgeon Experience Festival," promoting karst terrain as a unique ecological system, and other opportunities.
- Work with chambers, trade associations, and realtors to market the benefits of natural resource protection.
- Use signage at strategic locations as an education tool.
- Empower recreational facilities to educate customers (e.g., brochures at canoe rental facilities).
- This strategy focuses on public education (develop an understanding of why people come to the north country to spend their time and money and what needs to be done to preserve those qualities); while a change in peoples' behavior is desirable as a "next step", that is not the goal of the current strategy.

Assumptions

- There are many opportunities for environmentally sustainable businesses.
- By expanding economically sound business opportunities, entrepreneurs will be able to take advantage of "natural capital" in a way that creates a marketplace for protection.

Leverage: Very High. Strategy connects to several other strategies.

Lead: Medium. Betsie Hansen (independent consultant working with TOMWC)

Ease: High. Need to determine the best way to reach people.

Cost: Medium.

Implement BMPs and Retrofit Existing Developed Areas to Reduce Stormwater Input

- Michigan Monkey Flower
- Lake Sturgeon
- Lakes and Associated Wetlands
- Lakes and Streams in Karst Terrain
- Ground Water-Driven Streams and Riparian Corridors

- The focus of this strategy is on advocacy for proper stormwater management.
- Work with townships to pass ordinances on stormwater management.
- Work with developers to demonstrate the advantages of stormwater management and avoiding imperviousness in ground water recharge areas.
- Use the strategy as an opportunity to educate people living in these areas about the adverse impacts of stormwater flowing into their lakes and streams and encourage behaviors that reduce toxic inputs.

Assumptions

- This strategy will not abate inputs from other sources (such as atmospheric deposition, agriculture, and forestry).
- Stormwater is the largest source of controllable water pollution inputs into the Cheboygan River Watershed.

Leverage: Medium. Strategy has immediate, visible results, but doesn't provide much leverage for other strategies. Could help leverage road-stream crossings, streambank stabilization, and local ordinances.

Lead: Very High. TOMWC (Doug Fuller), Huron Pines RC&D Council, and NEMCOG.

Ease: Medium. May be difficult to achieve because there are no regulatory requirements; instead strategy requires convincing people to give up certain conveniences.

Cost: Very High. Upgrading is difficult.

Ongoing Strategies

Practice Ecosystem Management

- Bogs, Fens, and Conifer-Hardwood Swamps
- Hungerford's Crawling Water Beetle
- Lakes and Streams in Karst Terrain
- Ground Water-Driven Streams and Riparian Corridors
- Wildlife Core Habitat and Corridors

- Research forestry BMPs and disseminate information. Encourage foresters to adhere to state-established BMPs.
- Develop strategies to reduce artificially high deer populations and to prevent baiting in TB zones.

Assumptions

- A large proportion of the landscape is in state ownership. State land management can play a large role in the viability of targets.

Leverage: High. Strategy influences local land use, but may be site or project-dependent.

Lead: Medium. DNR (Brian Mastenbrook).

Ease: Medium. Requires institutional change.

Cost: Medium. Cost will be in the implementation.

Ensure State and Federal Resource Regulations are Implemented and Enforced

- Bogs, Fens, and Conifer Hardwood Swamps
- Michigan Monkey Flower
- Hungerford's Crawling Water Beetle
- Lake Sturgeon
- Lakes and Associated Wetlands
- Lakes and Streams in Karst Terrain
- Ground Water-Driven Streams and Riparian Corridors
- Wildlife Core Habitat and Corridors

- Encourage DNR and DEQ to review projects under ESA.
- Need additional regulations, such as NEPA, Natural Rivers Program, Inland Lakes and Streams Act, Soil Erosion and Sedimentation Control Act, Land Division Control Act, and Flood Plains Control Act (Water Resources Protection).
- Strategy includes wetlands, lakes, and streams.
- Provide comment on applications.
- Further participation in wetland permit review.
- Develop and implement enforcement strategies; partnership members can be the eyes and ears for the DNR and DEQ when they are on site visits.

Assumptions

- State and Federal law provides a process to review potentially damaging projects and reduce or avoid the negative impacts.

Leverage: Very High. Permit review information can feed into land protection efforts on identified high priority parcels (properties that are more difficult to build on may be more open for other protection options).

Lead: Very High. TOMWC (Scott McEwen), with support from TNC.

Ease: Medium. Numerous permits to review across the watershed; permit load increases as population increases.

Cost: High. To fully implement would require an additional full time employee.

Research and Inventory

- Bogs, Fens, and Conifer Hardwood Swamps
- Michigan Monkey Flower
- Hungerford's Crawling Water Beetle
- Lake Sturgeon
- Lakes and Streams in Karst Terrain
- Wildlife Core Habitat and Corridors

- Michigan Monkey Flower: Research reproduction, historic habitat, impacts from invasive species. Further inventory on private lands. Inventory other seep sites downstream from the Maple River site. Encourage universities to study propagation and transplantation (perhaps leading to the development of an incentives program to encourage landowners to establish new populations).

- Beetle: Research habitat (how restrictive are its habitat requirements?), life cycle, the assemblage of species that share this habitat, predation (which species and how much?). Coordinate efforts with Brian Scholtens who is researching the beetle's habitat and life cycle.
- Karst: How much of a source of stress are oil and gas wells? How many wells affect this target? Research soils data on private lands. Identify vulnerable aquifers. Study hydrologic dynamics (Rainy Lake and others). Study the fate of agricultural chemicals in karst terrain. Research the oil and gas leasing process and determine whether non-development leases would be an efficient use of conservation resources.

Assumptions

- For each of the targets, it is assumed that research and inventory will ultimately further the abatement of stresses and sources of stress affecting that target.
- Additional information will support more accurate viability assessments. The discovery of additional occurrences of the flower or the beetle will increase their viability rankings.
- A greater understanding of the targets will allow for more focused conservation efforts in the future.

Leverage: Very High.

Lead: Very High. TNC (through SAC and University relationships), and DNR.

Ease: Very High.

Cost: Very High.

Conduct Household Refuse and Hazardous Waste Collection Programs
- Lakes and Streams in Karst Terrain

- Provide an alternative to dumping in sinkholes. Collection programs in the past have been highly successful, but too infrequent. Need to establish a regular program.
- Provides an opportunity for educational outreach.
- Organize through Department of Public Works or Conservation Districts. Program should include broad-based education and publicity.

Assumptions

- This strategy does not address other dumping that may occur.

Leverage: Medium. Strategy supports education efforts.

Lead: High. NEMCOG.

Ease: Very High. NEMCOG is already involved in these types of programs. Also, most solid waste departments have hazardous waste management as a requirement in their management plans.

Cost: High. Disposal rates can be very expensive.

Promote and Implement Conservation Design with Developers and Landowners

- Bogs, Fens, and Conifer Hardwood Swamps
- Michigan Monkey Flower
- Hungerford's Crawling Water Beetle
- Lake Sturgeon
- Lakes and Associated Wetlands
- Lakes and Streams in Karst Terrain
- Ground Water-Driven Streams and Riparian Corridors
- Wildlife Core Habitat and Corridors

- Promote the concept of conservation development – share models and provide examples of successful projects.
- Work with developers on creating plans for conservation developments.
- Foster an awareness of appropriate land uses and focus on 'special' areas.
- This strategy should be developed in conjunction with the PAL proposal.

Assumptions

- Well-planned and properly-sited development will have a significantly lower impact on the conservation targets.

Leverage: Very High. This strategy has economic benefits and may leverage zoning and planning efforts.

Lead: High. TOMWC (Maureen Radke). Enlist the support of MSU Extension.

Ease: Medium. Very Difficult. Requires overcoming many hurdles and mentality blocks ("it can't be done here" attitude).

Cost: High. Risk share with a developer as a demonstration project.

Encourage and Enable Stewardship on Private Land

- Bogs, Fens, and Conifer Hardwood Swamps
- Michigan Monkey Flower
- Hungerford's Crawling Water Beetle
- Lake Sturgeon
- Lakes and Associated Wetlands
- Lakes and Streams in Karst Terrain
- Ground Water-Driven Streams and Riparian Corridors
- Wildlife Core Habitat and Corridors

- Encourage the implementation of wetland BMPs and management at existing developed areas (e.g., buffer strips, setbacks, fertilizer use, and invasive species)
- Strategy provides opportunity to educate landowners; may open door for conservation easements or management agreements.
- Michigan Monkey Flower: Work with landowners at specific sites to put up barriers and signs to protect existing populations and seeps.

Assumptions

- Landowners themselves will voluntarily take steps to protect conservation values on their land.

- The majority of lakeshore property and a large percentage of sensitive lands in the watershed are privately owned. What landowners do on their property is critical to the health of the entire system.

Leverage: Very High. Property owners who manage their land will have significant influence on their neighbors.

Lead: Medium. TOMWC (Heidi Volkhardt). Enlist support of MNFI and others.

Ease: Medium. As development increases, the number of landowners increases, and parcel size decreases, making this strategy more difficult to implement on a watershed-wide scale. Also, this strategy will require the development of individual strategies for each of the conservation targets.

Cost: High.

Future Strategies

Address the Adverse Impacts of Dams

- Hungerford's Crawling Water Beetle
- Lake Sturgeon
- Lakes and Associated Wetlands
- Ground Water-Driven Streams and Riparian Corridors

- Promote alternative dam management techniques - work with dam owners and regulatory agencies on plans to replicate natural fluctuations in the lakes (especially at Alverno Dam relative to Black Lake) and natural flow regimes on rivers (such as the Pigeon River downstream of the Song of the Morning Ranch). Dams may need retrofitting to modify flow and/or allow fish passage. Also need to address the role of inundated areas.
- Pursue the removal of Kleber and Alverno Dams. Kleber Dam inundates high gradient spawning habitat. Removal of the Alverno Dam needs further investigation to assess its impacts. Tower Dam benefits coldwater fisheries by serving as a barrier to upstream migration by warmwater fish. Investigate other opportunities to remove private dams.

Assumptions

- Dam removal is the single most important strategy for restoring connectivity between the large, glacial lakes and restoring isolated sturgeon populations.

Leverage: High. This strategy will leverage other lake sturgeon strategies.

Lead: High. DNR (Dave Borgeson), and DEQ.

Ease: Medium.

Cost: Very High.

Implement Agricultural BMPs

- Bogs, Fens, and Conifer Hardwood Swamps
- Lake Sturgeon
- Lakes and Associated Wetlands

- Lakes and Streams in Karst Terrain
- Ground Water-Driven Streams and Riparian Corridors

- Coordinate efforts between farmers and NRCS/Conservation Districts (establish soil erosion/habitat incentive programs). Need 3rd party to support NRCS.
- Demonstrate, and encourage adoption of BMPs
- Research agricultural BMPs and disseminate information.
- Develop agricultural chemical waste collection programs.
- Includes agricultural land in both karst terrain and groundwater-driven landscapes.

Assumptions
- The BMPs will be practiced by a majority of private landowners. Incentives from recognition, negotiated management agreements, and easements will foster adoption of the BMPs.
- BMPs will reduce the nutrient loading, toxins/contaminants, sedimentation, and thermal alteration from impervious surfaces and residential development.

Leverage: Medium.

Lead: High. Huron Pines RC&D Council (Dan Sikarskie and Brad Jensen as liason).

Ease: High. Strong agricultural lobby.

Cost: High. Good funding exists, and some projects may be very low cost. BMPs in karst terrain involving chemical flows into the ground water may be more expensive to implement.

Restore Riparian Wetlands
- Bogs, Fens, and Conifer Hardwood Swamps
- Michigan Monkey Flower
- Lake Sturgeon
- Lakes and Associated Wetlands
- Lakes and Streams in Karst Terrain
- Ground Water-Driven Streams and Riparian Corridors

- Inventory potentially restorable wetland to determine the most cost effective projects.
- Focus on large wetland complexes associated with lakes and streams.
- Utilize cooperative funding and additional partners such as NRCS, SWCD, and NAWCA.

Assumptions
- Wetlands provide a myriad of functions that support aquatic ecosystem health.
- Nearly 75% of wetlands along the large lakes in the watershed have been developed.

Leverage: Medium. Strategy works hand-in-hand with land protection and may leverage shoreline BMPs, but most projects will be small and localized.

Lead: Medium. Huron Pines RC&D Council (Brad Jensen), with support from TOMWC and DNR.

Ease: Medium. Ease of implementation is project-dependent. Also requires convincing landowners.

Cost: High. Cost is site-dependent, but strategy should focus on the most cost-effective projects.

Work with DNR Fisheries and Maintain Beetle Habitat at Identified Sites

- Hungerford's Crawling Water Beetle

- Work with DNR Fisheries to maintain segments of certain streams as coldwater fisheries and others as beetle habitat.
- Work with UM Biological Station to maintain populations that occur on their land.
- Work with private landowners to educate them about the beetle and to encourage them to leave beaver dams where they support beetle habitat.

Assumptions

This strategy assumes that we have sufficient knowledge of the beetle's habitat to manage it properly.

Leverage: Medium. Site-specific.

Lead: High. TNC.

Ease: High.

Cost: Medium.

Table 4: Priority Conservation Strategies

Strategies Across Systems	Bogs, Fens, and Conifer-Hardwood Swamps	Michigan Monkey Flower	Hungerford's Crawling Water Beetle	Lake Sturgeon	Lakes and Associated Wetlands	Lakes and Streams in Karst Terrain	Ground Water-Driven Streams and Riparian Corridors	Wildlife Core Habitat and Corridors	Strategy Benefit Rank
Establish and enforce sound planning and zoning requirements for all conservation targets.	Very High	Very High	High	Very High	Very High	Very High	Very High	Very High	Very High
Promote and implement conservation design with developers and landowners.	Very High	Very High	Medium	High	Very High	Very High	Very High	Very High	Very High
Protect land through coordinated strategies.	High	Very High	Medium	High	Very High	Very High	Very High	Very High	Very High
Ensure state and federal resource regulations are implemented and enforced.	High	Very High	High	Very High	Very High	Very High	Very High	Very High	Very High
Encourage and enable stewardship on private land.	Very High	Very High	High	Very High	Very High	Very High	Very High	Very High	Very High
Restore riparian wetlands.	Very High	Very High	-	Very High	Very High	Very High	Medium	-	Very High
Implement shoreline BMPs.	-	Very High	High	High	Very High	Very High	Very High	-	Very High
Implement BMPs and retrofit existing developed areas to reduce stormwater input.	-	Very High	-	High	Very High	Very High	Very High	-	Very High
Stabilize and upgrade road crossings at streams and drainage ways.	High	Very High	High	Medium	Very High	Very High	High	-	Very High
Research and Inventory.	High	Very High	Very High	Low	-	Very High	-	Medium	Very High
Address adverse impacts of dams.	-	-	High	Very High	Very High	-	High	-	Very High
Practice ecosystem management.	High	-	Medium	-	Very High	Very High	Medium	Medium	Very High
Promote economic benefits and opportunities associated with resource protection.	Medium	-	High	Low	-	Very High	-	Very High	Very High
Implement agricultural BMPs.	Medium	-	-	Low	Medium	Very High	Medium	-	High
Work with DNR fisheries to maintain habitat at known sites (HCWB and Lake Sturgeon).	-	-	Very High	-	-	-	-	-	High
Conduct household refuse and hazardous waste collection programs.	-	-	-	-	-	Very High	-	-	High

6. Conservation Capacity

As noted by the long list of stakeholders, and the established programs and staff expertise housed in the partner organizations, there is a high level of conservation capacity in this watershed. Currently, there is funding by TNC for one full-time staff over the next two years to coordinate activities under this conservation plan. With the assistance of this funded coordinator, each of the primary partner organizations will be responsible for taking various specific strategies forward. This includes the development of strategic plans for each strategy and fundraising to implement those plans. In addition to the partners located in the watershed, TNC has committed access to its professional staff to provide advice and consultation.

7. Success Measures - Monitoring Plan

Conservation success is measured by making substantial progress towards the long-term abatement of critical threats and the sustained maintenance or enhancement of conservation target viability at sites identified for action.

Throughout this process, partners will meet to discuss strategies and develop action plans for each strategy. Addenda to the Conservation Area Plan will be made. This will include a review of the stakeholder analysis and updated review and revision of top strategies.

GLOSSARY OF TERMS