MULLETT CREEK WATERSHED MANAGEMENT PLAN

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CHAPTER 1: PROJECT OVERVIEW

Introduction

The Mullett Creek Watershed Management Plan provides a watershed based management approach for improving water quality and preserving the ecological integrity of Mullett Creek, which is located in Cheboygan County in the Northern Lower Peninsula of Michigan. Water quality concerns in the watershed include nutrient pollution, excessive sedimentation, high bacteria concentrations, and elevated water temperatures. The stream ecosystem is also under threat from aquatic invasive species and habitat loss. Stressors affecting the Mullett Creek ecosystem include: agricultural operations, residential land use, road-stream crossings, and beaver dams.

Mullett Creek is the third largest tributary of Mullett Lake with a main channel length of approximately 11 miles (Figure 1). Fed by multiple groundwater streams in its headwaters east of 75 and west of Douglas Lake, Mullett Creek flows southeast and empties into the midwest side of Mullett Lake, which is Michigan's fifth largest inland lake. The watershed of Mullett Creek encompasses 11,874 acres. Brook trout fishing is the primary recreational activity associated with the creek.

A watershed management approach to protecting the stream and addressing problems is not only important for the health of Mullett Creek, but for the receiving waters of Mullett Lake as well. During an assessment of Mullett Lake tributaries, Mullett Creek was found to contribute disproportionately high levels of nutrients, such as phosphorus (TOMWC 2008). The excessive nutrient inputs, also called "nutrient pollution", are likely derived from many sources, though agricultural land use has been implicated as the primary source. Nutrient pollution can stimulate nuisance aquatic plant and algae growth, increase water turbidity, result in potentially harmful algal blooms, and lead to dissolved oxygen deficits which negatively impact the fishery.

The Mullett Creek Watershed Management Plan consists of the following: 1) a project overview with goals and objectives, 2) general watershed information, 3) water quality monitoring, 4) inventories and surveys, 5) watershed issues and concerns, and 6) watershed management recommendations for addressing problems. Successful implementation of the Plan's recommendations will result in improved water quality conditions in Mullett Creek, as well as restoration and maintenance of the stream ecosystem.

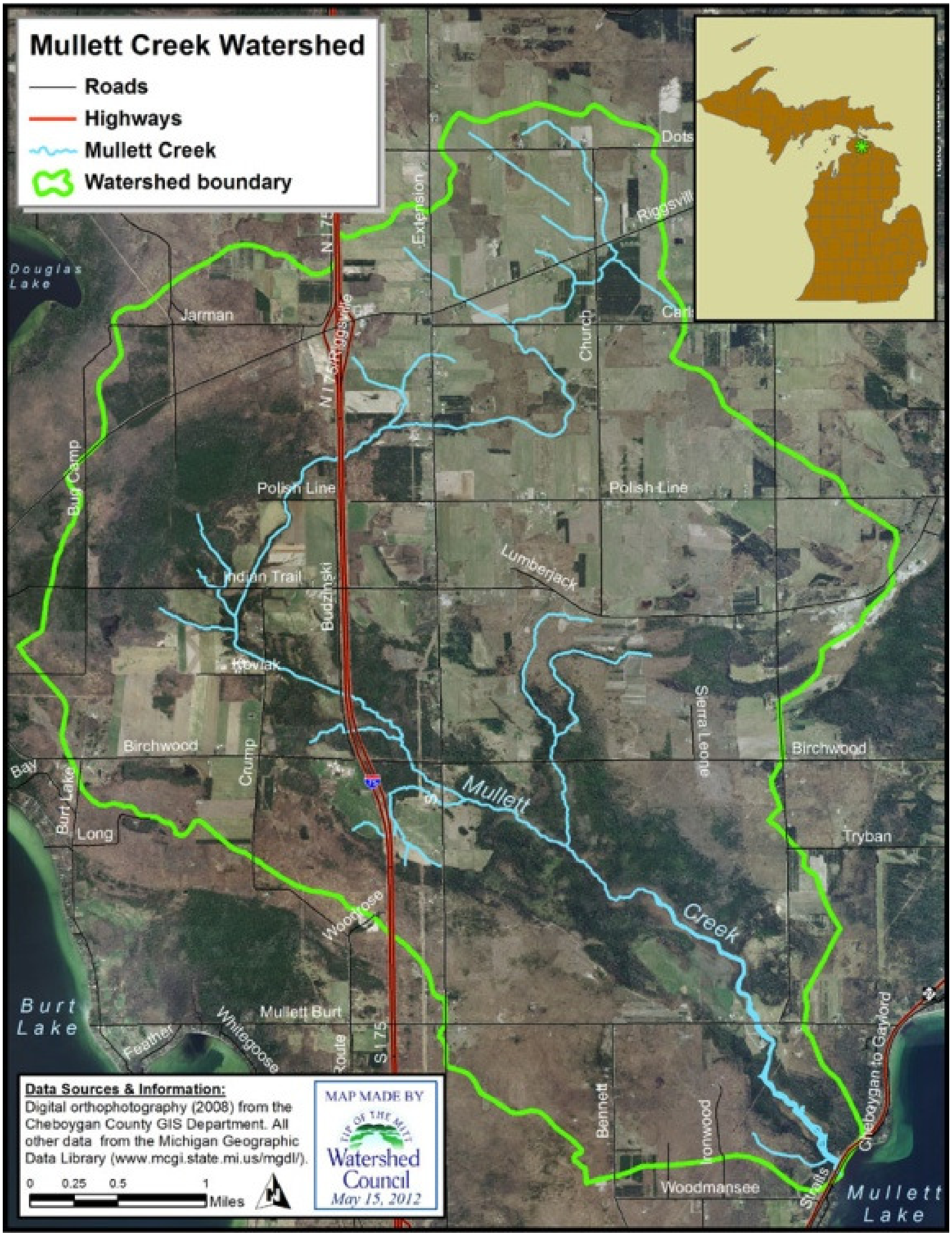


Figure 1. Mullett Creek Watershed.

Goals and Objectives

The Mullett Creek Watershed Management Plan includes three goals that can be achieved by following specific objectives. The goals and objectives reflect Tip of the Mitt Watershed Council's determination to protect and improve Mullett Creek, as well as increase community support of watershed protection practices, programs, and projects.

Goal 1: Protect the integrity and diversity of aquatic habitats in the Mullett Creek Watershed.
Objectives:

- Inventory and monitor aquatic habitats to document conditions and changes.
- Protect and restore critical habitat including headwater streams, springs and seeps, wetlands, and riparian areas.
- Protect and restore natural hydrologic connectivity through improvement of road stream crossings.
- Control the spread of invasive species through monitoring, treatment, and education.

Goal 2: Protect and improve the quality of water resources in the Mullett Creek Watershed.
Objectives:

- Reduce nutrient and sediment inputs to surface waters and groundwater from agricultural sources such as manure and erosion.
- Reduce nutrient and sediment inputs to surface waters and groundwater from residential and developed areas.
- Reduce nutrient and sediment inputs to surface waters and groundwater from road stream crossings.
- Reduce thermal impacts from human and animal sources (i.e. road runoff, beaver dams).
- Monitor water quality at locations throughout the watershed.

Goal 3: Coordinate with local stakeholders to support the implementation of the Plan.
Objectives:

- Involve watershed stakeholders with plan implementation, such as government agencies, universities, non-profit organizations, local residents, and recreation enthusiasts.
- Educate stakeholders about the importance of the Plan and what they can do for a healthier watershed.

Partner Organizations and Agencies

The following organizations have provided support by means of data, maps, information, or other assistance for the development of the Mullett Creek Watershed Management Plan.

Tip of the Mitt Watershed Council (TOMWC)

University of Michigan Biological Station (UMBS)

Mullett Lake Area Preservation Society (MAPS)

Michigan Department of Natural Resources (MDNR)

Natural Resource Conservation Service (NRCS)

Little Traverse Conservancy (LTC)

US Fish and Wildlife Service (USFWS)

Northeast Michigan Council Government (NEMCOG)

Huron Pines

Geology and Soils

The surface geology of the Mullett Creek Watershed is primarily the result of the most recent glacial events in the Great Lakes region, particularly the deglaciation that occurred between 10,000 and 15,000 years ago (Farrand 1988). The series of glacial advances and retreats during this period resulted in the deposition of course-textured, generally unsorted glacial till in the northern area of the watershed. In the western and southern areas of the watershed, post-glacial erosion led to the deposition of well-sorted lacustrine sand and gravel, along with patches of dune sand (Figure 2). The nearby lakes, including Douglas, Burt and Mullett Lakes, are associated with kettle holes, or large pieces of glacial ice that were deposited and gradually melted, leaving areas of low elevation. The resulting local topography is what guides the flow of Mullett Creek today.

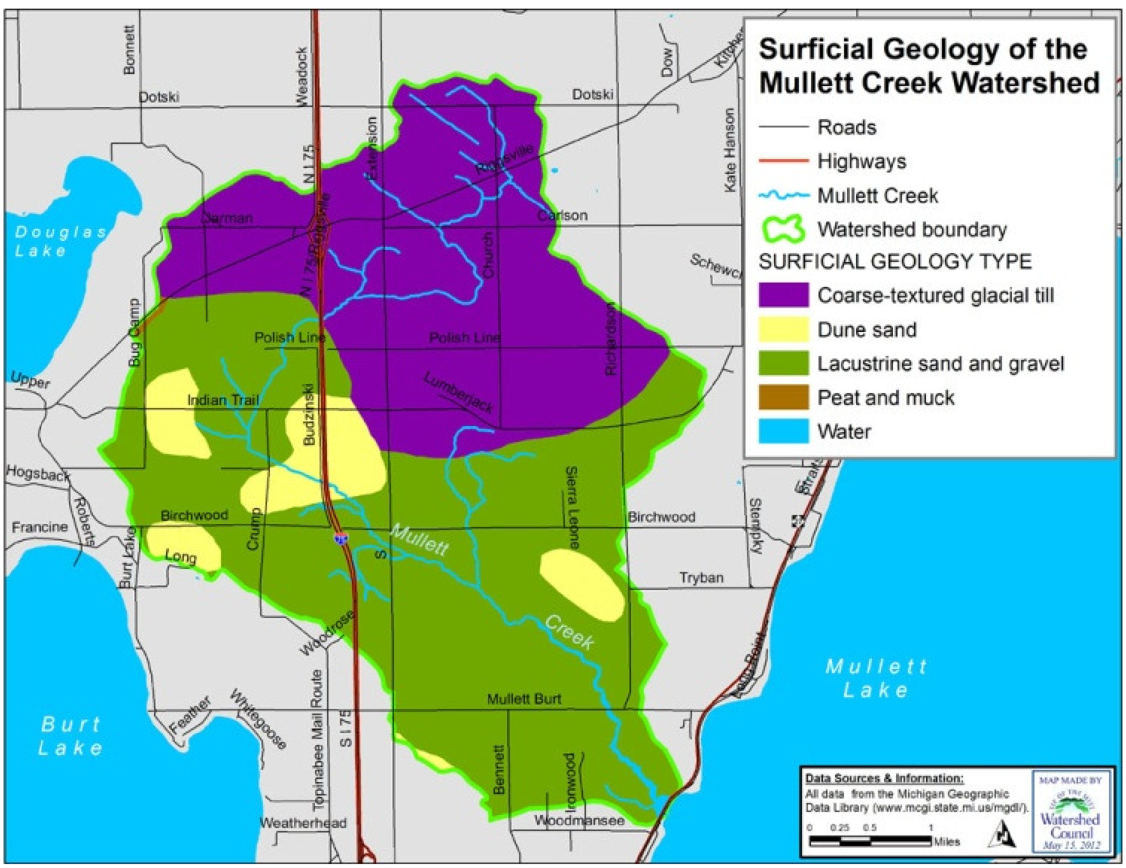


Figure 2. Geology of the Mullett Creek Watershed.

In general, the soils of the Mullett Creek Watershed tend to be sandy, well-drained, and slightly acidic (USDA 1991). Close to the creek and its tributaries, however, there is greater build up organic material and therefore, more loamy soils and muck (Figure 3).

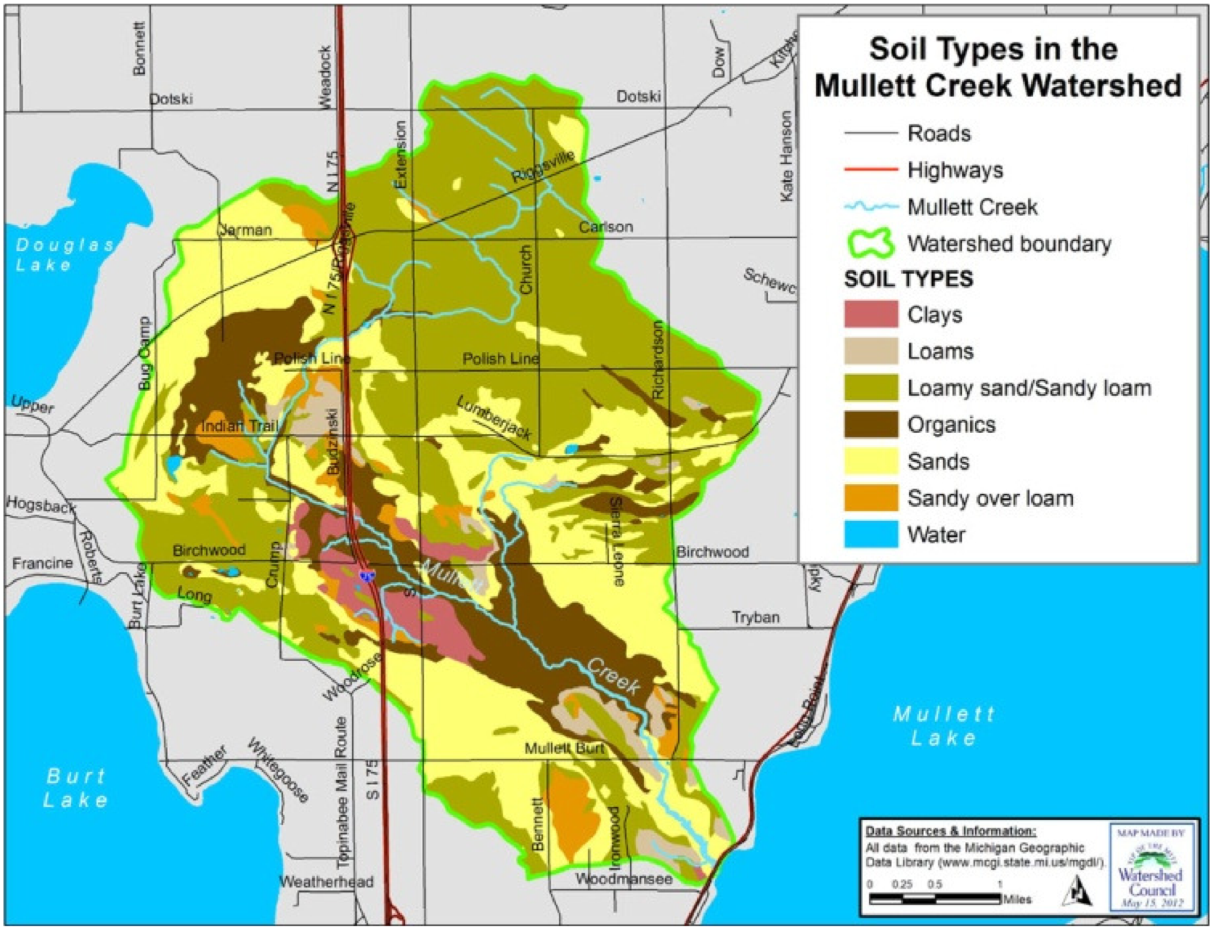


Figure 3. Soils of the Mullett Creek Watershed.

Hydrology

The main branch of Mullett Creek flows a total of 11 miles (17.7 km) southeast into Mullett Lake. The creek originates from two areas: from southeast of Riggsville Road near the UMBS where several groundwater-fed streams come together near Douglas Lake, and from east of 75 near Riggsville Road. The elevation of the headwaters of Mullett Creek is 853 feet above sea level and the mouth at Mullett Lake sits at just under 600 feet of altitude. The northern stream section from the headwaters to I-75 descends precipitously at a rate of 34 feet per mile, while the stream gradient below I-75 averages just 6 feet per mile.

Data are not available for Mullett Creek's average stream flow. However, discharge measurements collected six times from 2005 to 2007 ranged from 1.6 cubic feet per second (cfs) to 11.2 cfs immediately downstream of Crump Road and from 6.6 to 23.6 cfs at the mouth into Mullett Lake (TOMWC 2008). Because the creek is primarily ground-water fed, local weather conditions are less likely to have a major impact on stream temperature or flow (MDNR 2011).

Land Use

The watershed of Mullett Creek encompasses 11,874 acres, which amounts to approximately 6.5% of the Mullett Lake watershed (MDNR 2011). Land cover in the watershed is dominated by forests, agriculture, and wetlands (Table 1, Figure 4). Although residential land cover in the watershed remains low at 4%, the percentage of agricultural land cover (28.5%) is relatively high compared to other watersheds in the Northern Lower Peninsula (NOAA 2006). Most of the watershed is privately owned with twenty-one structures located within 300 feet of the creek (TOMWC and MAPS 2002). There are 15 state-owned parcels in the lower watershed and six University of Michigan parcels in the upper watershed (Cheboygan County 2012).

Table 1. Land cover in the Mullett Creek and Mullett Lake Watersheds (NOAA 2006).

Land-cover Type	Mullett Creek Acreage	Mullett Creek Percentage	Mullett Lake Acreage	Mullett Lake Percentage
Agriculture	3,386	28.5	49,002	8.8
Barren	22	0.2	897	0.2
Forested	3,602	30.3	286,234	51.2
Grassland	1,508	12.7	51,929	9.3
Residential	477	4.0	22,402	4.0
Scrub/Shrub	442	3.7	18,755	3.4
Wetland	2,440	20.5	45,929	8.2
Water	4	0.03	84,138	15.0
Total	11,874	100.0	559,286	100.0

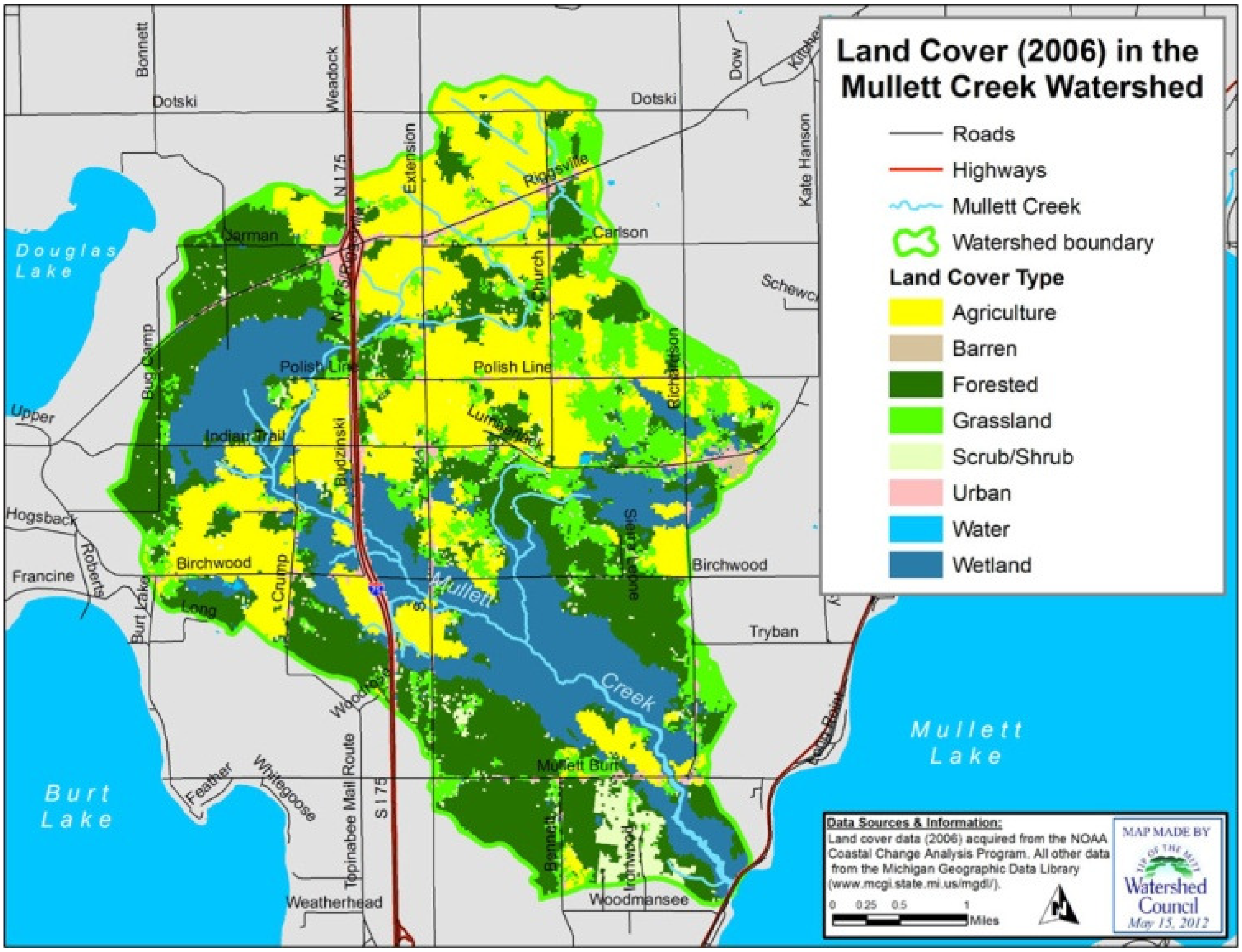


Figure 4. Land cover in the Mullett Creek Watershed.

Land Use Categories

Residential

According to 2006 NOAA land cover data, 4% or about 477 acres of the watershed's total 11,874 acre land area is residential. For the most part, residential development found in the watershed consists of single-family dwellings and is concentrated away from the main stream channel.

Agricultural Lands

With nearly 3,400 acres classified as farmland (28.5%), agriculture is the watershed's second largest land cover type. Predominate agricultural activities in the Mullett Creek Watershed are dairy, alfalfa, and corn. The majority of agricultural land cover is located in the upper portion of the watershed.

Forests

Forest is the largest single land cover type, encompassing 3,600 acres or just over 30% of the watershed’s total surface area. The forest category includes deciduous, evergreen and mixed forest types.

Scrub-Shrub and Grasslands

Scrub-shrub and grasslands are defined as areas supporting early stages of plant succession consisting of plant communities characterized by grasses or shrubs, including abandoned or idle farmland. These types make up approximately 16% of the Mullett Creek Watershed’s land area.

Wetlands

Over 2,400 acres or just over 20% of the watershed's land area was identified as palustrine wetlands, which consist of non-tidal, perennial wetland system with various vegetation. In the watershed, wetland types consist of 7% palustrine emergent, 19% palustrine scrub/shrub, and 74% palustrine forested.

Demographics

The population of Cheboygan County as of the 2010 U.S. Census was 26,152. The county experienced steady growth from 1930 to 2000, leveling off in 2010 (Figure 5). The four townships of the Mullett Creek Watershed (Burt, Inverness, Mullett, and Munro) have all experienced population growth since 1980, though to varying degrees (Figure 6). Between 1980 and 2010, the population of Burt Township increased 31% (520 to 680); Inverness Township increased 4% (2,179 to 2,261); Mullett Township increased 40% (934 to 1,312); and Munro Township increased 24% (459 to 571).

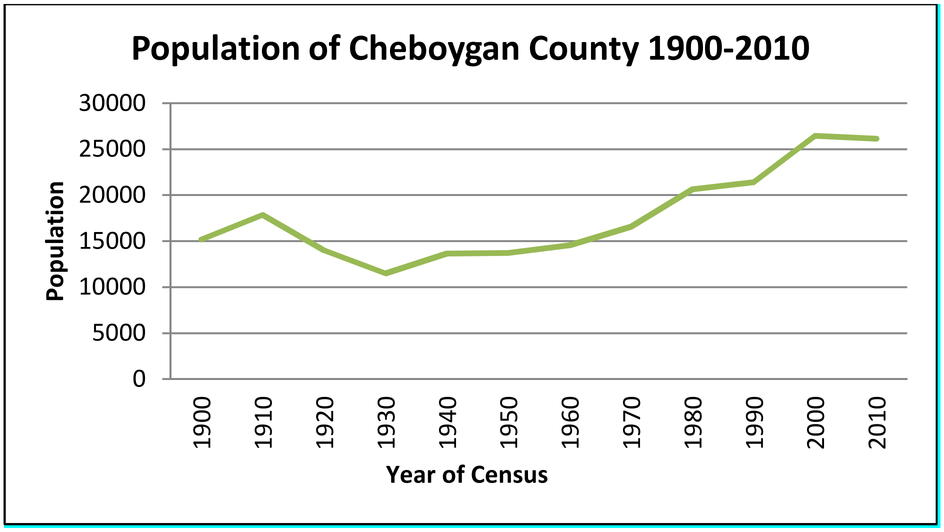


Figure 5. Population of Cheboygan County 1900-2010 (Forstall 1995, US Census data).

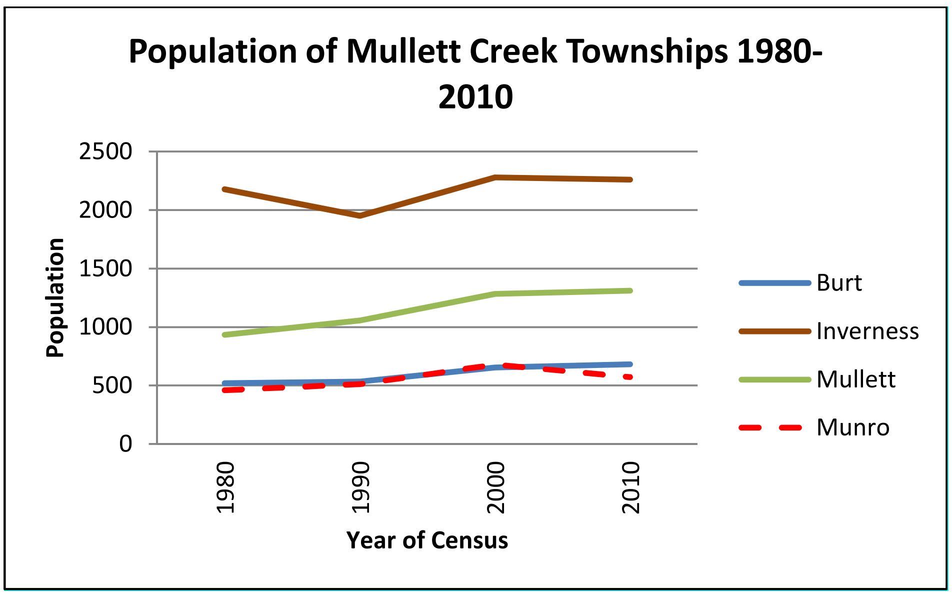


Figure 6. Population of Mullett Creek townships 1980-2010 (Cheboygan County 2011).

Recreation

In terms of recreation, Mullett Creek proper is primarily used for brook trout fishing. Fur trapping and hunting of deer, coyote, turkeys, grouse, woodcock, and rabbits also occur in the watershed. The 62-mile North Central State Trail, which runs from Gaylord to Mackinaw City, crosses the creek by its mouth, and is regularly used by walkers, joggers, and bikers. The surface of the trail is crushed limestone

CHAPTER 3: WATER QUALITY

Introduction

During recent years, local organizations and governmental agencies have been taking a closer look at the water quality of Mullett Creek. Aquatic macroinvertebrates have been monitored in Mullett Creek since 2005 as part of TOMWC's Volunteer Stream Monitoring Program. Physical, chemical, and bacteriological water quality data were collected from 2005 to 2007 by TOMWC during a study focusing on Mullett Lake tributaries. In addition, water temperature has been monitored by the Michigan DNR. Despite recent efforts, there remain many gaps in the water quality data, as well as a lack of historical data. Figure 7 shows the locations of water quality monitoring sites in the watershed.

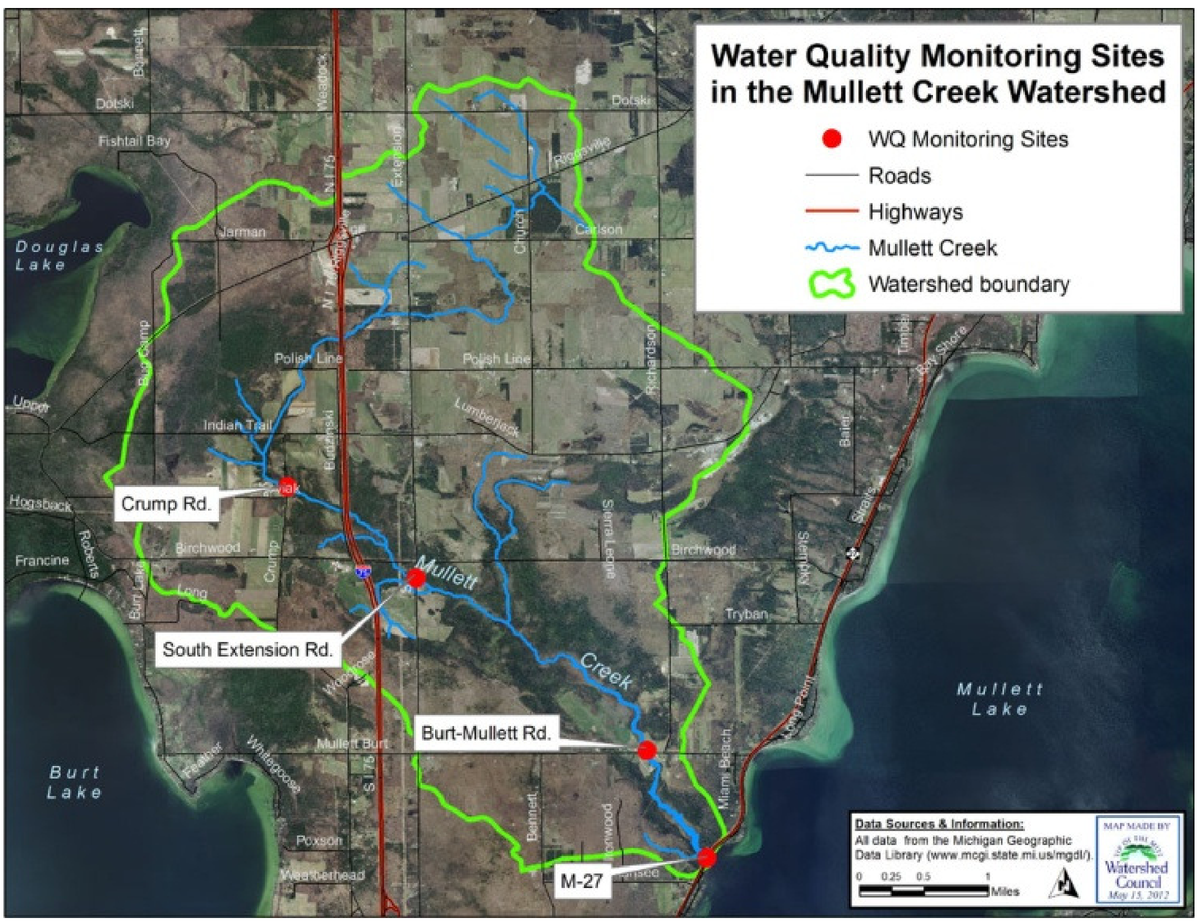


Figure 7. Mullett Creek Water Quality Monitoring Sites.

Physical Water Quality Monitoring

Water Temperature

Water temperature is important because of its impact on the stream ecosystem, particularly in terms of dissolved oxygen concentrations and temperature-sensitive biota, such as brook trout (*Salvelinus fontinalis*) and stoneflies. The MDNR collected hourly water temperature data from two locations on Mullett Creek from May to September of 2004. The data showed pronounced differences between upstream and downstream stations (Table 2).

Table 2. Averaged water temperature data from Mullett Creek (MDNR 2004).

Month	S. Extension Rd. Temperature (˚F)	Burt-Mullett Lake Rd Temperature (˚F)
May	50.0	56.6
June	53.7	64.8
July	55.9	67.8
August	54.7	64.2
September	54.3	62.6
October	47.3	48.8
November	44.2	44.0
All Data	52.9	61.1

Minimum and maximum hourly temperature data from Mullett Creek show the influence of heavy groundwater inflow, which helps maintain cool water temperatures throughout the summer (Table 3). Averaged summer water temperatures during 2004 at S. Extension Rd did not exceed 61º Fahrenheit (16º Celsius), which studies have shown to be the upper end of the optimal range of water temperatures for growth and survival of brook trout (Raleigh 1982). However, averaged water temperatures at the downstream site at Burt-Mullett Road were above this threshold.

Table 3. Summer water temperature data from Mullett Creek (MDNR 2009).

Location	Month	Minimum (°F)	Average (°F)	Maximum (°F)
S. Extension Rd.	June	46.0	53.7	65.7
S. Extension Rd.	July	49.9	55.9	63.4
S. Extension Rd.	August	46.8	54.7	61.7
Burt-Mullett Rd.	June	50.5	64.8	80.5
Burt-Mullett Rd.	July	55.7	67.8	78.3
Burt-Mullett Rd.	August	54.4	64.2	75.5

<u>Dissolved Oxygen</u>

Dissolved oxygen is one of the most important parameters to monitor for assessing a stream's water quality. It is essential for the survival of most aquatic life, including fish, neotenic amphibians, and aquatic invertebrates. Dissolved oxygen concentrations in the stream ecosystem are governed by atmospheric diffusion, photosynthetic activity of aquatic plants and algae, and respiration by aquatic organisms ranging from fish to bacteria.

Water temperature and the decomposition of organic matter are important factors affecting dissolved oxygen concentrations. The solubility of oxygen is greater in colder water than in warmer water, which means that cooler waters can hold more dissolved oxygen. Rain on a hot summer day could lead to a reduction in the stream's dissolved oxygen concentrations due to warm stormwater runoff entering the stream. In addition, any organic matter, such as manure from a nearby farm, which washes into the stream during a rainstorm will further reduce dissolved oxygen concentrations due to microbial respiration associated with decomposition. The brook trout and stoneflies that inhabit Mullett Creek are especially vulnerable to low dissolved oxygen levels.

The Michigan Natural Resources and Environmental Protection Act of 1994 states that the minimum concentration of dissolved oxygen for a coldwater fishery is 7 mg/L (Part 4 Rule 64). Dissolved oxygen concentrations measured in Mullett Creek during the Mullett Lake Tributary Water Quality Monitoring Project were consistently above the required minimum, ranging from 7.59 to 11.64 mg/L (Table 4). However, dissolved oxygen was only measured in the spring and fall; summer levels would probably be lower.

Table 4. Dissolved oxygen data for Mullett Creek.

	Dissolved Oxygen (mg/l)*						
Sample Site	**Apr-2005**	**Sep-2005**	**May-2006**	**Sep-2006**	**May-2007**	**Nov-2007**	**Avg.**
Crump Rd	10.45	9.83	9.33	9.36	10.32	11.64	10.16
M27	7.59	7.68	7.70	7.65	10.48	10.23	8.55

**Dissolved oxygen measured in mg/l or parts per million, Avg. = average.*

pH

Hydrogen ion concentration, expressed as pH, was monitored during the Mullett Lake Tributary Water Quality Monitoring Project, with values ranging from 7.65 to 8.09 in Mullett Creek (Table 5). Measured values were within the range of 6.5 to 9.0, which is required for all Michigan surface waters according to DEQ Part 4 Water Quality Standards, Rule 53 (323.1053).

Table 5. pH data for Mullett Creek (TOMWC, 2008).

	pH*						
Sample Site	**Apr-2005**	**Sep-2005**	**May-2006**	**Sep-2006**	**May-2007**	**Nov-2007**	**Avg.**
Crump Rd	7.85	8.00	7.60	7.78	8.08	8.09	7.90
M27	7.84	7.65	7.73	7.72	8.26	8.04	7.87

**pH ranges from 0 (acidic) to 14 (basic), with 7 being neutral. Avg. = average.*

Conductivity

Conductivity is a measure of water's ability to pass an electrical current; specific conductivity is a measure of the same at a specific temperature. Among other things, conductivity is influenced by the surficial geology of the surrounding area and nonpoint source pollution. Conductivity increases due to pollution from road salts, septic systems, wastewater treatment plants, urban/agricultural runoff, and other sources.

Specific conductivity in Mullett Creek ranged from 300 to 442 microSiemens/cm (Table 6). Most conductivity levels recorded during the Mullett Lake Tributary Water Quality Monitoring Project were within the range of river and stream data from the TOMWC Comprehensive Water Quality Monitoring Program (CWQM) (Table 7). Of the streams monitored during the tributary monitoring project, average conductivity levels were highest in Mullett Creek. The high conductivity readings in Mullett Creek are a concern because they indicate that farms, residences, and roads in the watershed may be influencing the creek's water quality and negatively impacting the stream ecosystem.

Table 6. Conductivity data for Mullett Creek (TOMWC, 2008).

	Specific Conductivity*						
Sample Site	**Apr-2005**	**Sep-2005**	**May-2006**	**Sep-2006**	**May-2007**	**Nov-2007**	**Avg.**
Crump Road	299.9	366.3	311.3	441.8	376.6	302.8	349.8
M27	345.9	387.4	380.3	342.8	353.2	302.6	352.0

**Conductivity reported in microSiemens/cm, Avg. = average.*

Table 7. Nutrient, chloride, and conductivity data from the CWQM program.

	TP*	**$NO3^{-*}$**	**TN***	**CL^{-} ***	**Conductivity***
All rivers – Low	1.0	28	202	3.3	222
All rivers – High	14.3	1122	1567	14.5	405
All rivers – Average	5.1	245	425	8.7	305

**TP = total phosphorus, $NO3^{-}$ = nitrate-nitrogen, TN = total nitrogen, CL^{-} = Chloride. Chloride reported in mg/l (parts per million), all other units in ug/l (parts per billion).*

Sediments

Sediment is a major threat to water quality in streams and rivers due to its negative impacts on aquatic plant and animal life. Sediments clog gills of fish and invertebrates, smother spawning habitats and substrates, reduce habitat availability by filling interstitial spaces, increase water temperature by absorbing sunlight, and block sunlight needed for photosynthesis. Sediment loading occurs when the influx of sediment into a stream exceeds the export, which can disrupt a stream's natural flow regime and alter the stream channel. Sediment pollution in a stream can be assessed through various means including water sample collection to measure total suspended and dissolved solids, turbidity measurements using water quality instrumentation, and geomorphological channel surveys. To date, sediment monitoring has not been performed in the Mullett Creek Watershed.

Chemical Water Quality Monitoring

Nutrients

Nutrients are needed by organisms to live, grow, and reproduce; occurring naturally in soils, water, air, plants, and animals. Phosphorus and nitrogen are essential nutrients for plant growth and important for maintaining healthy, vibrant, aquatic ecosystems. However, excess nutrients from sources such as fertilizers, faulty septic systems, and stormwater runoff lead to nutrient pollution, which can have negative impacts on our surface waters.

Phosphorus

Phosphorus is generally the most important nutrient for plant productivity in the lakes and streams of Northern Michigan because it is usually in shortest supply relative to nitrogen and carbon. A water body is considered phosphorus limited if the ratio of nitrogen to phosphorus is greater than 15:1. In fact, most water bodies monitored by the Watershed Council are found to be phosphorus limited. Excessive phosphorus inputs can cause eutrophication of a water body, which results in decreased dissolved oxygen levels and thus, jeopardizes aquatic life. Because of the negative impacts that phosphorus can have on surface waters, legislation has been passed in Michigan to ban phosphorus in soaps, detergents, and fertilizers.

Water quality standards for nutrients in surface waters have not been established by the State of Michigan, but a total phosphorus concentration of 12 parts per billion (ppb) or less for streams in the Northern Michigan ecoregion is preferred by the United States Environmental Protection Agency (USEPA) “because it is likely associated with minimally impacted conditions, will be protective of designated uses, and provides management flexibility” (USEPA, 2001). The majority of total phosphorus concentrations measured during the Mullett Lake Tributary Water Quality Monitoring Project were above 12 ppb, as well as above CWQM program averages for streams and rivers (Table 8). At the Crump Road site, phosphorus levels were above CWQM river data highs.

Nitrogen

Nitrogen is a very abundant element throughout the earth’s surface and is a major component of all plant and animal matter. Nitrogen is also generally abundant in our lakes and streams and needed for plant and algae growth. Too much nitrogen, however, can lead to the acidification of water and problematic algae and plant growth. Nitrate-nitrogen in drinking water is detrimental to human health, particularly infants. There are no water quality standards for nitrogen in surface waters, but nitrate-nitrogen in drinking water should not surpass 10 mg/l (parts per million) according to DEQ Part 4 Water Quality Standards, Rule 53 (323.1053). Total nitrogen and nitrate-nitrogen concentrations in Mullett Creek measured during the Mullett

Lake Tributary Water Quality Monitoring Project were above CWQM program data averages during all sample events at Crump Road, and during most sample events at M27 (Table 9).

Table 8. Phosphorus concentrations in Mullett Creek (TOMWC, 2008).

	Total Phosphorus*						
Sample Site	**Apr 2005**	**Sept 2005**	**May 2006**	**Sept 2006**	**May 2007**	**Nov 2007**	**Avg.**
Crump Rd	143.4	28.7	106.4	355.4	11.1	5.0	108.3
M27	25.9	18.2	57.1	13.4	17.1	8.9	23.4
	Soluble Reactive Phosphorus*						
Sample Site	**Apr 2005**	**Sept 2005**	**May 2006**	**Sept 2006**	**May 2007**	**Nov 2007**	**Avg.**
Crump Rd	82.0	20.1	42.9	240.5	ND	ND	96.4
M27	13.9	10.5	8.0	5.1	ND	ND	9.4

**All units in ug/l (micrograms per liter or parts per billion); Avg = average, ND = no data.*

Table 9. Nitrogen concentrations in Mullett Creek (TOMWC, 2008).

	Total Nitrogen*						
Sample Site	**Apr 2005**	**Sept 2005**	**May 2006**	**Sept 2006**	**May 2007**	**Nov 2007**	**Avg.**
Crump Rd	1645	1260	1386	2897	1778	1456	1737
M27	653	444	488	611	691	990	646
	Nitrate-Nitrogen*						
Sample Site	**Apr 2005**	**Sept 2005**	**May 2006**	**Sept 2006**	**May 2007**	**Nov 2007**	**Avg.**
Crump Rd	872	789	725	1218	1532	1230	1061
M27	385	117	300	186	356	732	346

**All units in ug/l (milligrams per liter or parts per billion); Avg = average.*

Chloride

Chloride is found naturally in Northern Michigan surface waters at low concentrations. However, if present in high concentrations, chloride can be detrimental to freshwater aquatic fauna and flora (Nagpal et al. 2003). Whether or not chloride has a deleterious effect on freshwater organisms depends on factors such as temperature, dissolved oxygen concentration, exposure time, the presence of other compounds and elements, and other variables. Anthropogenic sources, such as road salt and sewage, can be significant contributors to chloride levels in the aquatic environment.

Chloride concentrations in Mullett Creek measured during the Mullett Lake Tributary Water Quality Monitoring Project were commonly above average and high values from the CWQM program, but well within National Recommended Water Quality Criteria put forth by the USEPA. The *Aquatic Life Criteria Table* from USEPA places the chronic value of chloride at 230 mg/l and the acute value at 860 mg/l. The chloride concentrations in Mullett Creek were far below the chronic value recommended by USEPA at both sites (Table 10).

Table 10. Chloride concentrations in Mullett Creek (TOMWC, 2008).

	Chloride (Cl-)*						
Sample Site	**Apr-2005**	**Sep-2005**	**May-2006**	**Sep-2006**	**May-2007**	**Nov-2007**	**Avg.**
Crump Road	16.5	21.3	14.7	31.2	29.7	23.0	22.7
M27	19.9	23.2	25.3	27.3	27.9	25.4	24.8

**Chloride reported in mg/l (milligrams per liter or parts per million), Avg. = average.*

Biological Monitoring

Bacteria

Escherichia coli (E. coli) is a bacterium excreted in human and animal fecal material. *E. coli* levels are a good indicator of the presence of other pathogenic bacteria, viruses, and protozoans, as well as more general fecal pollution. *E. coli* concentrations are monitored to determine whether or not freshwater is safe for recreational activities, such as swimming. Variables influencing *E. coli* levels include river flow, rain storms, presence of wildlife, and proximity to agricultural or urban development. In terms of standard *E. coli* surface water, DEQ Part 4 rule 62 states “All water of the state protected for total body contact recreation shall not contain more than 130 *E. coli* per 100 milliliters, as a 30-day geometric mean. At no time shall the waters of the state protected for total body contact recreation contain more than a maximum of 300 *E. coli* per 100 milliliters". Although there are no DEQ water quality standards for fecal coliforms in surface waters, R 323.1062 of Part 4 Water Quality Standards states "discharge containing treated or untreated human sewage shall not contain more than 200 fecal coliform bacteria per 100 milliliters."

During the Mullett Lake Tributary Monitoring Project, water samples collected for bacteriological analysis were tested for fecal coliforms in the spring of 2005 and for *E. coli* from the fall of 2005 through 2007. Fecal coliform counts in Mullett Creek ranged from less than 10 to 60,000 fecal coliform organisms per 100 milliliters, while *E. coli* counts ranged from 20 *E. coli* per 100 milliliters to over 2419 (the maximum countable amount at the Health Department of Northwest Michigan laboratory). Bacteria concentrations were generally much higher at the upstream site, the water quality standard maximum of 300 *E. coli* per 100 milliliters exceeded four times at Crump Road (Table 11). Thus, there is strong evidence that bacteriological contamination is occurring in the upper Mullett Creek watershed, probably as a result of agricultural activity on privately owned land directly upstream of the crossing.

Table 11. Bacteria concentrations in Mullett Creek (TOMWC, 2008).

Sample Site	April 2005*	Sept. 2005†	May 2006†	Sept. 2006†	May 2007†	Nov. 2007†
Crump Rd.	60000	727	>2419.6	>2419.6	20.1	517.2
M27	140	61.3	143.9	68.9	42	204.6

**Reported in units of fecal coliform bacteria per 100 milliliters.*
†Reported in units of E. coli bacteria per 100 milliliters.

<u>*Aquatic Macroinvertebrates*</u>

The aquatic macroinvertebrate community paints a picture of stream ecosystem health. Community diversity and species sensitivity are key factors in determining water quality. A variety of pollution-sensitive stoneflies, mayflies, and caddisflies portrays a healthy ecosystem with good diversity and high water quality. A sample with only pollution-tolerant aquatic worms and midges reveals a stream ecosystem that is likely suffering.

The Watershed Council uses three different aquatic macroinvertebrate measurements of diversity (i.e., indices) to determine stream ecosystem health: 1) total taxa = the total number of macroinvertebrate families found at the site; 2) EPT taxa = the number of families in the most sensitive insect orders (mayflies, stoneflies, and caddisflies); and 3) sensitive taxa = the number of families determined to be the most sensitive to non-point source pollution by PhD William Hilsenhoff (those rated as 0, 1, or 2 in a scale of zero to 10 developed by Hilsenhoff).

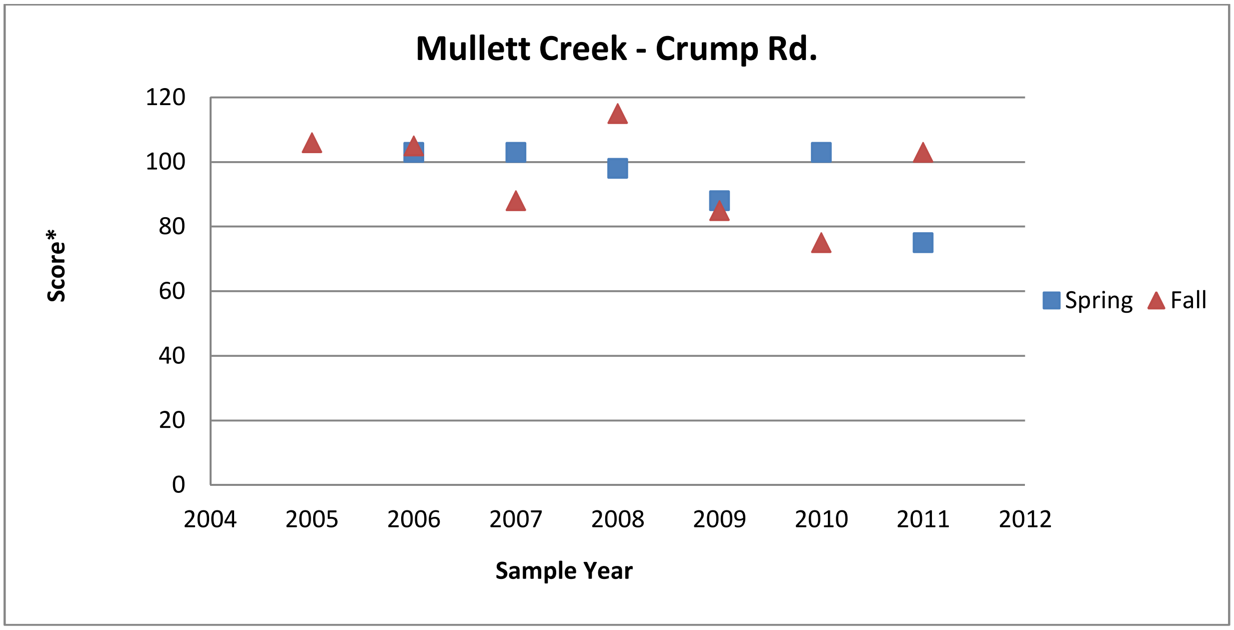
Since 2005, two sites on Mullett Creek have been monitored for macroinvertebrate diversity as part of the TOMWC Volunteer Stream Monitoring Program. Volunteers monitor the upstream reach at Crump Road, where the channel winds through dense woods, water flow is fast, and substrate is variable with a mix of sand, gravel, rock and wood. At the downstream site near the creek mouth and M27 road crossing, flow is slower, the channel is much wider and exposed to the sun, the creek bottom is silty, and wetlands are common in the riparian area. In spite of the physical and ecological differences between sites, the total diversity is approximately the same (Table 12). However, sensitive family diversity is much higher at the upstream site where dissolved oxygen levels are higher, water temperature is cooler due to shade and groundwater inputs, and where there is greater habitat variety.

Table 12. Averaged aquatic macroinvertebrate data from Mullett Creek (TOMWC, 2012)

Location	Total Taxa	EPT Families*	Sensitive Families
Crump Rd.	19.5	9.7	5.1
M27	22.0	5.4	0.8

**EPT = Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies).*

Using an unpublished method developed by TOMWC in 2012, standardized 'stream scores' were calculated using total diversity, EPT diversity, and sensitive diversity index data (Figure 8). Sites that score 70+ are considered excellent, 50-69 is good, 30-49 is moderate, 20-29 poor, and below 20 very poor. An excellent score indicates a healthy stream ecosystem with high water quality, often a result of limited agricultural and urban development in the watershed. The Jordan River in Antrim County, which is designated as both a Natural River and a Blue Ribbon Trout Stream by the MDNR, is an example of a stream that scores in the excellent category, consistently scoring over 95 points (Table 13). A poor score indicates a stream that is negatively impacted by factors such as habitat loss, water quality impairment from urban and agricultural stormwater runoff, and the removal of riparian vegetation. Tannery Creek near Petoskey, which flows through an urban area, is an example of a poor stream. At its mouth, Tannery Creek typically scores 20 to 30 points, because there is limited habitat diversity, a large concentration of nearby impervious surfaces, and little riparian vegetation (Table 13).



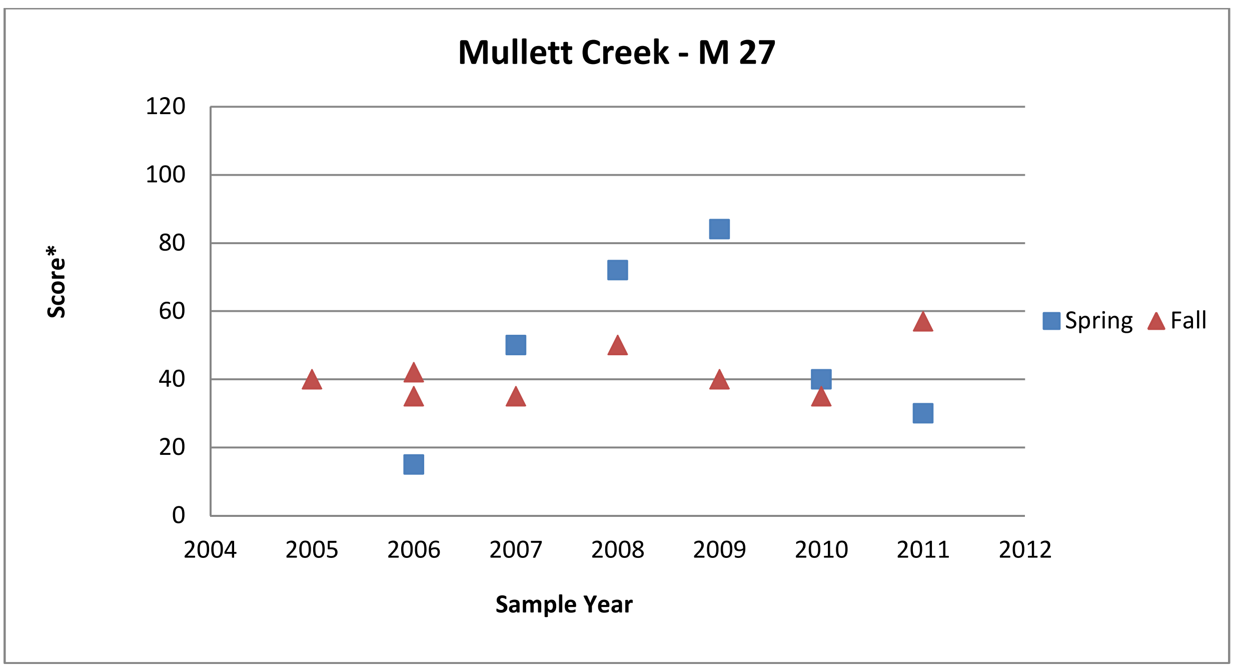


Figure 8. Stream quality scores base on aquatic macroinvertebrate diversity (TOMWC, 2012).
**Scores range from zero to 120, higher scores indicative of higher water quality. Full tabular data can be found in Appendix B: Macroinvertebrate Data and Grading Scale.*

Table 13. Averaged aquatic macroinvertebrate data for Mullett Creek, Jordan River, and Tannery Creek 2005-2011 (TOMWC 2012).

Stream Name and Location	Total Taxa	EPT Families	Sensitive Families	Stream Score	Rating
Jordan River -Fair Rd.	20.6	10.8	5.6	99	Excellent
Jordan River - Webster Rd.	20.6	10.8	5.6	106	Excellent
Mullett Creek - Crump Rd.	19.5	9.7	5.1	96	Excellent
Mullett Creek - M27	22.0	5.4	0.8	45	Moderate
Tannery Creek - Boyer Rd.	18.3	8	3.1	75	Excellent
Tannery Creek - Mouth	11.4	3.1	0.9	25	Poor

CHAPTER 4: INVENTORIES AND SURVEYS

Fisheries

(Mullett Creek fisheries survey summary provided by Tim Cwalinski, MDNR Fisheries Biologist)

The fish survey was performed in response to increased sediment loads in the creek. Backpack electrofishing was used to examine brook trout populations and water temperatures were recorded. Five sites along the creek were surveyed and all were found to contain healthy brook trout populations. Growth of trout was slightly lower in the creek compared to the state average, but this may be attributed to colder water temperatures.

Concern has arisen in the Mullett Creek watershed regarding loss of in-stream habitat and increased sediment load. A partnership to study various aspects of this small watershed was initiated in 2007 and involved the U.S. Fish and Wildlife Service, the Natural Resources Conservation Service, and the Michigan DNR Fisheries Division. All three agencies participated in a watershed tour in the spring of 2007 and prioritized work within the watershed that needed to occur. Future work planning included but would not be limited to 1) fisheries inventories, 2) coordination with local farmers to practice best management practices, 3) prioritization and money acquisition for improving road-stream crossings, 4) temperature monitoring, and 5) beaver activity/fish passage monitoring (MDNR 2011).

Preliminary fisheries surveys were conducted at various sites in the watershed in 2007 (Figure 9). Backpack electrofishing was utilized at five Mullett Creek sites (Table 14). Brook trout populations appear to be healthy at each index site. Brook trout (age-0) were found at all sites except Site D, though sampling efficiency for this small size of fish was poor so numbers may not reflect actual abundance (Tables 14 and 15). Legal trout (8 inches and larger) were present at each site on the main branch of Mullett Creek (Site A through D) and legal fish comprised a significant number of the total catch at three sites, particularly Site D (Table 14 and 15). Site D has quality habitat comprised of deep water, undercut vegetated banks, and a narrow stream channel. The quality habitat found at Site D may not be indicative of adjacent reaches of Mullett Creek upstream or downstream of this site. Large brook trout (10 inches and larger) were captured at Sites B, C, and D and were particularly abundant at Site D (Table 14 and 15). Growth information for brook trout at all sampling sites is provided in Table 16.

Growth is slightly slower in this stream compared to brook trout growth statewide. This is most likely a product of the colder water temperatures. The growth index was -0.4, indicating that brook trout grow approximately a half-inch slower than brook trout from other Michigan streams at each age. Growth appears slowest particularly for age-0 fish. Overall, brook trout growth is considered average or normal for this stream (MDNR 2011).

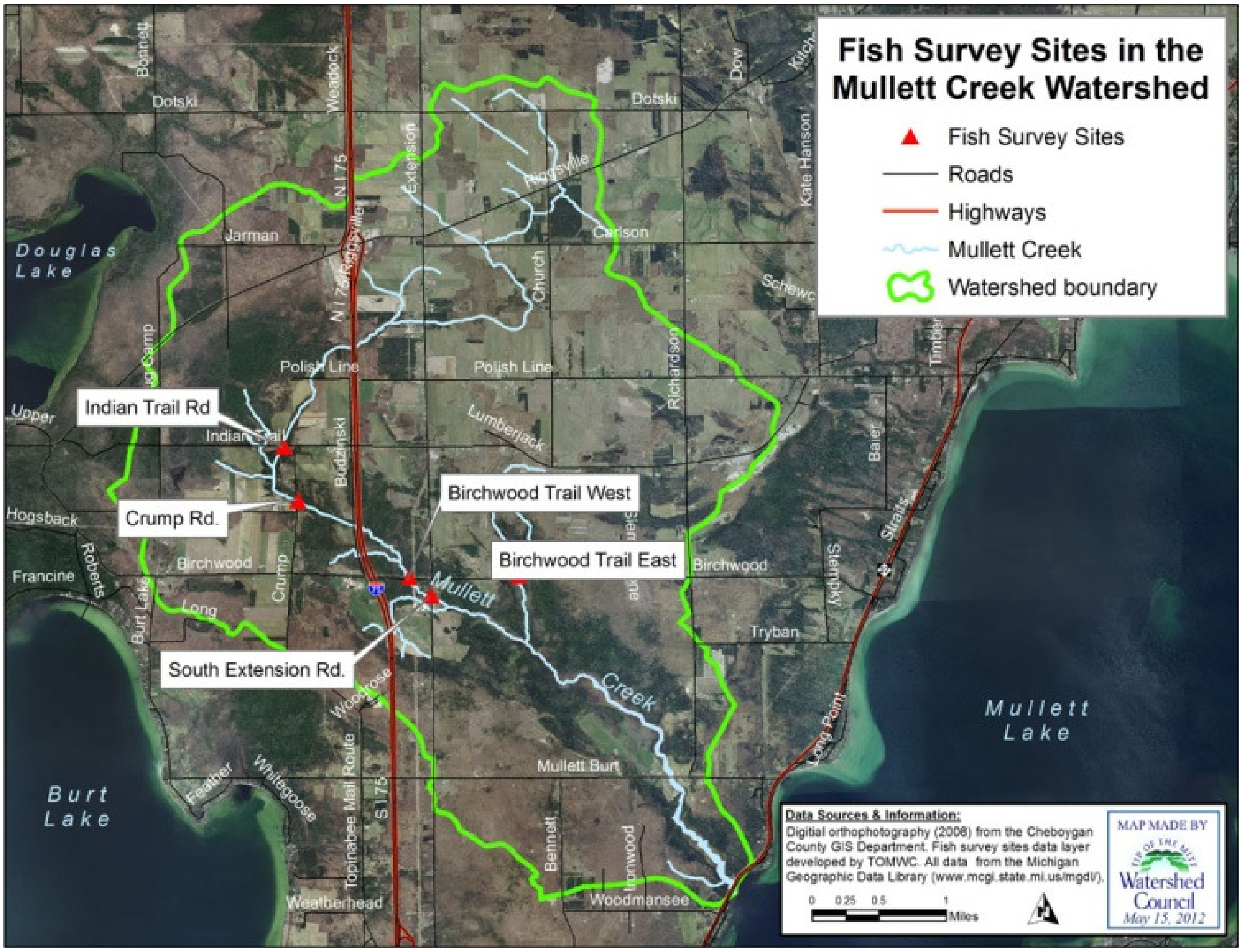


Figure 9. Mullett Creek fish survey sites.

Table 14. Electrofishing data for the Mullett Creek Watershed, 2007 (MDNR, 2011).

Location	Site	Survey Distance (ft)	Electrofishing Efficiency	Water Temp (F)	Number of Trout	Number of Age-0 Trout	Number of Legal Trout*
Indian Trails Rd.	A	400	Good	55	51	5	7
Crump Rd.	B	600	Poor	51	72	10	4
Birchwood Trail, W	C	450	Fair	55	56	10	8
South Extension Rd.	D	550	Good	54	83	0	28
Birchwood Trail, E	E	300	Poor	54	20	8	0

** Minimum legal size is 8 inches.*

Table 15. Brook trout length-frequency for the Mullett Creek Watershed (MDNR 2011).

Length Group (in)	Site A*	Site B*	Site C*	Site D*	Site E*
1	5	10	10	0	7
2	0	0	0	0	1
3	3	9	1	1	0
4	15	17	16	11	7
5	8	10	10	18	3
6	5	14	3	15	2
7	8	8	8	10	0
8	7	3	4	11	0
9	0	0	2	5	0
10	0	0	1	4	0
11	0	1	0	6	0
12	0	0	1	0	0
13	0	0	0	2	0

**Site locations described in Table 13.*

Table 16. Brook trout age/growth information for the Mullett Creek Watershed (MDNR 2011).

Age Group	Number aged	Length range (in)	State Avg length (in)	Weighted mean length (in)	Mean growth index (in)*
Age 0	25	1.1 – 1.9	2.3	1.6	-0.4
Age I	120	3.4 – 7.4	5.3	5.0	ND
Age II	77	5.9 – 11.5	8.1	7.8	ND
Age III	14	7.6 – 12.4	10.9	10.4	ND
Age IV	2	13.2 – 13.6	13.7	13.4	ND

**ND=No data*

Road-stream Crossings

Road-stream crossings can act as conduits for sediment pollution, conveying road runoff and eroded soil directly into streams. Roads alter natural drainage systems, potentially increasing water velocity, and accelerating stream bank erosion. Inadequate or undersized road-stream crossings can result in the formation of scouring/plunge pools, as well as cause a barrier to fish passage due to perched culverts and increased flow velocities. Poor approaches, such as improper stormwater conveyance, also potentially contribute to the problem.

Structures used for road-stream crossings vary according to the size of stream or river being crossed. Culverts are the most common type of crossing for smaller streams that have year-round or continuous flow, such as Mullett Creek. Whether culvert or bridge, the road-stream crossing should be designed to match the stream channel width and account for flood-level stream discharge. In the case of culverts, bottomless structures are best for the steam environment.

To reduce their impact, road-stream crossings should be designed with adequate riparian buffers, which are vegetated (often forested) areas that separate the aquatic and terrestrial environments. By slowing surface runoff, riparian buffers reduce erosion and protect streams and rivers from adjacent land use, particularly in downstream areas where the natural vegetation reduces flooding impacts.

In 2009, NRCS, USFWS, and MDNR Fisheries Division conducted an inventory of the ten road-stream crossings in the Mullett Creek Watershed (Figure 10). The inventory found that culverts are used at all ten crossings, culverts are undersized at six locations, six crossings are dirt roads, barriers to fish passage exist at two locations, and poor approaches are found at two locations (Table 17). The Crump Road crossing is perhaps the most damaging to the Mullett Creek ecosystem in that it is a dirt road, experiences heavy farm vehicle traffic, has an undersized culvert, and has poor approaches. Other problematic road-stream crossings in the Watershed include Polish Line Road, Birchwood Road West, and South Extension Road. Sediment loading and costs estimates were developed by Huron Pines for the priority road-stream crossing sites (Table 18).

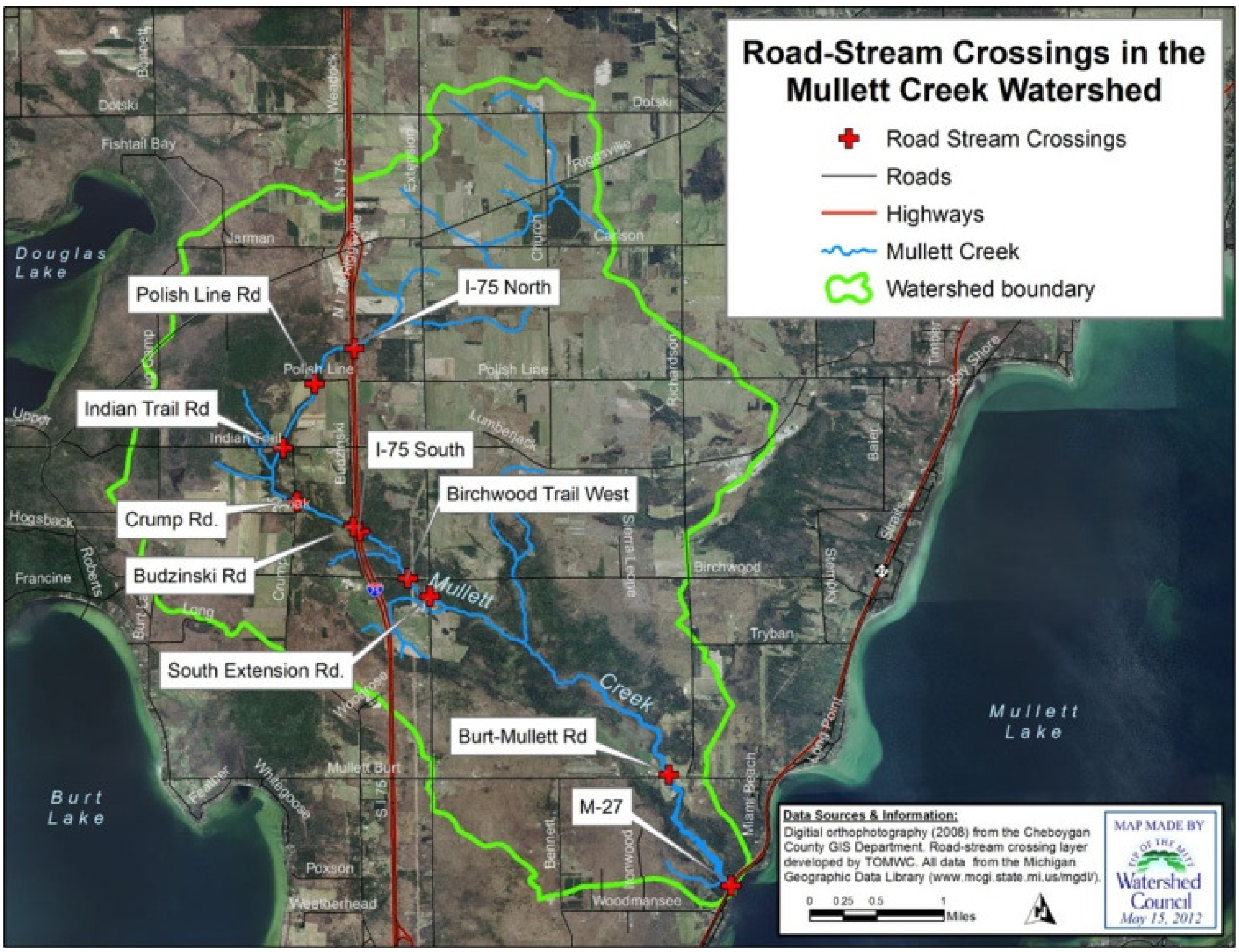


Figure 10. Mullett Creek road-stream crossings.

Table 17. Inventory of road-stream crossings in the Mullett Creek Watershed (MDNR 2011)

Road Name	Type of Road	Use	Approach*	Culvert/Bridge*	Fish Passage Barrier*
I-75 north	Paved	Heavy	ND	ND	ND
Polish Line	Dirt/gravel	Light-farming	Poor	1 undersized culvert	Yes
Indian Trail	Dirt/gravel	Light-farming	ND	ND	ND
Crump Road	Dirt/gravel	Heavy-farming and regular traffic	Poor	1 undersized culvert	No
Budzinski	Dirt/gravel	Moderate farming	Fair	1 undersized concrete structure, 2 culverts	ND
I-75 south	Paved	Heavy	ND	ND	ND
Birchwood-west	Dirt	Light	Fair	1 undersized culvert	Yes
South Extension	Dirt/gravel	Moderate	Fair	1 undersized culvert	ND
Burt-Mullett	Paved	Heavy	Good	2/3 undersized culverts	ND
M-27	2 way paved	Heavy	Good	ND	ND

**ND=No data*

Table 18. Sedimentation Load and Cost Estimates for Prior Road Stream Crossings

Location	Benefit to Creek	Estimated Cost
MC 06 Wendell Road	Reduces 2 tons of sediment/ year	$50,000
MC07 Indian Trail Road (east)	Reduce 1.5 tons of sediment/ year	$60,000
MC09 Crump Road	Reduce 8 tons of sediment/ year	$80,000
MC10 Budzinski Road	Reduce 1 ton of sediment/ year	$80,000
MC12 Birchwood Road	Sediment reduced minimal	$80,000

CHAPTER 5: WATERSHED ISSUES AND CONCERNS

Introduction

Mullett Creek is a small stream in the Cheboygan River Watershed that has been found to contribute high amounts of nutrients to Mullett Lake (TOMWC, 2008). Nutrient enrichment can alter the biological productivity of an aquatic ecosystem, stimulating problematic algal and plant growth that becomes a nuisance and potentially degrades water quality, primarily due to dissolved oxygen deficits. The apparent nutrient pollution may be negatively impacting Mullett Creek and Mullett Lake ecosystems and, in fact, heavy algal growth was documented at the creek mouth during a 2007 aquatic plant survey (TOMWC, 2009). Nutrient pollution is also a problem in the context of groundwater contamination because high levels of nitrates in drinking water is known to cause “blue-baby” syndrome, a potentially fatal respiratory illness in children caused by consuming high levels of nitrates. Bacteriological contamination, as evidenced by extremely high concentrations of *E. coli* documented in the creek, is another public health concern in the Mullett Creek Watershed.

The nutrient and bacteria concentrations were found to be much higher in the upper watershed than downstream near the mouth. Farming practices in the upper watershed, including improper animal waste management and unrestricted livestock access to the stream, are likely culprits for the nutrient pollution and bacteriological contamination. These farming practices may also cause erosion and sedimentation. Residential areas contribute to the problem, though relatively few homes are located directly adjacent to the creek. Additionally, inadequate or failing road-stream crossings are sources of sediment and nutrient pollution in the upper to middle watershed. It is important to note that, as these pollutants are carried down the stream system, biological uptake, deposition, and dilution all serve to diminish concentrations and reduce impacts.

In addition to nonpoint source pollution originating from agricultural operations, residential development, and road-stream crossings, the following watershed concerns have been identified.

Invasive Species

- Invasive plant species are a serious concern in the watershed because of their impacts to both the aquatic and terrestrial ecosystems. There are a number of highly aggressive and dominant invasive plants in the area, including terrestrial, semi-aquatic, and aquatic species.
- Of highest concern are high-profile invasive plants, such as Purple Loosestrife [*Lythrum salicaria*], Canary Reed Grass [*Phalaris arundinacea*], exotic Cattails [*Typha* x *glauca, T. angustifolia*], and the exotic genotype of Common Reed [*Phragmites australis*]. Invasive Phragmites has been documented at the M27 road-stream crossing. Other invasive plants of concern include Japanese Knotweed [*Fallopia japonica*], Wild Parsnip [*Pastonaca sativa*], and European Swallow-wort [*Vincetoxicum rossicum*].
- More study is required regarding the status of submerged aquatic plant species, but it is unlikely that the invasive Eurasian watermilfoil [*Myriophyllum spicatum*] or curly-leaved pondweed [*Potamogeton crispus*] present in Mullett Lake have migrated upstream into Mullett Creek.
- Of lesser concern are the extensively spread invasive and adventive exotics in the region growing in disturbed areas such as roadsides and private property. These include, but are not limited to, Bladder Campion [*Silene vulgaris*], Spotted Knapweed [*Centaurea maculosa*], and Oriental Staff Vine [*Celastrus orbiculatus*].
- Invasive aquatic animals may also be present in the creek and impacting the stream ecosystem. In particular, Zebra mussels [*Dreissena polymorpha*] and Round Gobies [*Neogobius melanostomus*] are found in Mullett Lake and may have invaded the lower reaches of Mullett Creek.

Fisheries

- Based on MDNR surveys, Mullett Creek was rated as “good”. However, aquatic ecosystem stressors, such as habitat loss, nutrient pollution, thermal pollution, sedimentation, and invasive species threaten the creek’s fishery. Excessive sedimentation appears to be occurring in Mullett Creek, particularly upstream of I75 Highway. Excessive sand bedload can be found in the creek at many locations and often covers up more suitable substrate as woody debris, gravel, and cobble.

Beaver Dams

- Beaver dams are a very controversial and multi-faceted issue in the Mullett Creek Watershed.
- Beaver dams cause the creek to flood, encroaching on private land, producing waterlogged soil and killing vegetation. The slower moving water increases water temperature and reduces habitat viability for macroinvertebrates and cold water fish species such as brook trout and sculpin. Algal counts are also greatly affected by water temperature.
- Some beaver activity is highly beneficial to this type of ecosystem. Flooding is a natural part of the aquatic ecosystem (community turnover), and may even prevent the spread of invasive plants, which commonly prefer, and in turn produce, dryer habitats. There are cases around Michigan in which the constant removal of beaver dams has turned large areas of marshland into dry, scrubby fields.

Agriculture

- Inappropriate use of fertilizers (e.g., quantity, type, and timing) and improper storage of manure can result in nutrients entering Mullett Creek via stormwater runoff.
- Livestock with unrestricted access to streams and riparian areas can cause erosion and sedimentation.
- Overuse of pesticides on agricultural fields can harm aquatic macroinvertebrates, amphibians, and fish.

CHAPTER 6: WATERSHED MANAGEMENT RECOMMENDATIONS

The following watershed management recommendations are intended to guide future management efforts of the resource. Recommendations identify the corrective action necessary to address specific nonpoint source pollution or other watershed concerns. Recommendations are based on the results of resource inventories and stakeholders' overall understanding of the watershed's priorities.

Reduce Impacts from Agricultural and Residential Land Use

Agricultural and residential land uses have a variety of impacts on Mullett Creek ranging from bacterial contamination to hydrological disturbance. Many best management practices can be instituted to reduce impacts from both types of land use. Efforts to address problems will be coordinated by MAPS, NRCS, Huron Pines, and TOMWC.

Considerations:

- Although agriculture has been implicated in water quality problems associated with nutrient pollution and bacterial contamination, residential land use also has negative impacts on the stream ecosystem.
- Water quality and other information for Mullett Creek and the Watershed are limited. To accurately assess impacts from different stressors, more monitoring data and other information, such as pollutant load calculations based on land use, are needed.
- Securing and providing funding for instituting or installing best management practices increases the likelihood of long-term management success.

Recommendations:

- Continue to monitor water quality from established sample sites in the watershed and expand monitoring to include additional sites. Monitor the same parameters as in previous efforts, particularly dissolved oxygen, phosphorus, nitrogen, and chloride.
- Monitor total suspended solids and dissolved solids throughout the watershed to determine where sedimentation problems are occurring.
- Perform habitat and geomorphological assessments at locations throughout the watershed to assess sedimentation issues and identify areas that have experienced habitat loss.
- Assess impacts from agriculture and residential land use using landscape-level models or other tools.

- Inform and educate Watershed residents about best management practices that reduce impacts to the stream ecosystem, such as vegetative buffers along the creek, installation of rain gardens to treat stormwater, and restricting livestock access to the creek.
- Encourage coordination between farmers, the USDA-NRCS, Huron Pines, and the Cheboygan Conservation District in issues regarding soil erosion, nutrient pollution, and habitat conservation.
- Encourage the use of agricultural best management practices.
- Identify sources and procure funding to support adoption or installation of best management practices.

Improve Road-Stream Crossings

Road-stream crossings are a significant source of nonpoint source pollution, particularly sedimentation. Corrective measures would decrease or eliminate these pollutants. Efforts to address problems will be coordinated by USFWS, Huron Pines, MAPS and TOMWC.

Considerations:

- When designing road crossings, it is very important to balance environmental benefit, economic cost, and aesthetic value. A clear-span bridge starting well before the creek and ending well past the creek is the best option. However, this can be very expensive, and unnecessary for the smaller crossings.
- For a quick, inexpensive, easy to install, aesthetically pleasing, and erosion/runoff preventing crossing, bottomless box culverts with gravel or steel footers are a great choice. If this is still too expensive or otherwise unfeasible, elliptical culverts offer another good option.
- Due to the high cost of raising or re-grading roads and the shallow level of bedrock in many areas, "lower" options are required, which is why elliptical, rather than circular culverts are recommended
- In some cases, the addition of a second culvert some distance away from the primary culvert may be sufficient to prevent flooding/blockage.
- The lowest point in the trough of roads is often directly above the creek/culvert. Grading the road so the lowest point isn't directly above the culvert can prevent much of the runoff from flowing directly into the creek.
- The Crump Road stream crossing should be a priority due to heavy farm equipment use, poor construction, and the fact that some of the best brook trout spawning areas are located in this vicinity.

Recommendations:

- Prioritize road-stream crossings in need of restoration or replacement based on severity ranking (low, medium, and high priority).
- Work with the Cheboygan County Road Commission (CCRC) and partners, such as USFWS, to secure funding for road-stream crossing projects.
  - Determine match that CCRC could contribute (in-kind or cash).
  - Identify and apply to appropriate grant programs and other funding sources.
  - Develop preliminary engineering plans for high priority crossings. Preliminary engineering plans will increase likelihood of acquiring project funding.
- Re-inventory all road-stream crossings in the watershed within the next 3-5 years. Use the most current road-stream crossing inventory sheet developed by Conservation Resource Alliance.

Control Invasive Species

Invasive species are a growing threat to the native aquatic and terrestrial ecosystems of the Mullett Creek Watershed. Effective monitoring and control efforts will minimize their impacts. Efforts to address problems will be coordinated by MAPS, MDNR, Huron Pines, and TOMWC.

Considerations:

- Manual and regular removal of these species and allowing native species to recolonize is the best approach to invasives management
- The use of herbicides and controlled burns are effective but should be used sparingly due to time, economic constraints, and environmental hazards. Herbicides kill both native and invasive plants, so exotics must be treated by certified pesticide applicators to ensure targeted removal. Fire is also species-impartial, killing all the vegetation, burning off topsoil, and releasing various atmospheric pollutants.
- Public education is an effective tool for controlling invasive species. Organizations and agencies can work together to control invasive species on public lands, such as roadsides, but participation by private property owners is necessary to effectively control invasive species. Thus, outreach to the local community is extremely important, so that Watershed residents become familiar with identification and control measures for invasive species of concern.

Recommendations:

- Conduct an invasive species inventory throughout the Watershed with a particular focus on Mullett Creek, the creek's riparian area, and roadside ditches. High priority aquatic invasive species for inventories include: purple loosestrife, Japanese knotweed, invasive Phragmites, invasive cattails, Eurasian watermilfoil, zebra mussels, and round gobies.

- Prioritize invasive species inventory information to plan feasible and effective control measures.
- Control high priority invasive species infestations using the most effective, yet least environmentally damaging methods.

Sustain and Improve Fish and Invertebrate Communities

The fish and aquatic macroinvertebrate communities in the Mullett Creek Watershed were found to be in good shape. However, the variety of stressors identified through monitoring and inventories pose a serious threat to the continued health of these communities. A number of actions can be taken to sustain and improve the creek's fish and invertebrate communities. Efforts will be coordinated by MAPS, MDNR, USFWS, NRCS, UMBS, and TOMWC.

Considerations:

- The fish and macroinvertebrate surveys were limited in scope (geographically), such that populations at other locations in the watershed may not be as diverse and healthy.
- Impervious surfaces in the watershed, such as roads, driveways, and roofs, cumulatively impact the stream ecosystem. Studies show that aquatic macroinvertebrate diversity declines severely when impervious surfaces in a watershed reach 8-10%.
- Riparian vegetation is critical for sustaining a healthy stream ecosystem because it provides habitat, food, shade, stream bank stabilization, stormwater infiltration, and filtration of pollutants in stormwater runoff. Research shows that a 300-foot buffer (or greater) of mixed native trees, shrubs, and herbaceous plants provides the greatest protection to the stream ecosystem.
- Sedimentation is one of the greatest threats to fish and macroinvertebrate populations. Primary sources include agriculture, dirt roads, and eroding streambanks.

Recommendations:

- Survey fish communities and aquatic macroinvertebrate populations throughout the watershed, focusing on locations that have not yet been surveyed. Assess habitat at locations surveyed and identify any potential stressors.
- Assess the current status of impervious surface area in the watershed.
- Survey the Mullett Creek stream channels and those of connecting tributaries to evaluate the status of riparian vegetation and streambank erosion in the watershed.

- Conduct a watershed-wide information and education campaign to teach residents the importance of 1) maintaining a buffer of mixed, native riparian vegetation along the edges of Mullett Creek, and 2) limiting the amount of impervious surfaces on individual properties and throughout the Watershed.
- Work on all fronts (road-stream crossings, agriculture, and residential) to reduce sediment inputs to the stream.
- Encourage local governments to adopt ordinances that limit riparian vegetation removal and the amount of impervious surface allowed on a parcel.

Manage Beaver Dams

Beaver dams are a natural component of stream ecosystems, but can substantially alter the stream ecosystem and negatively impact specific species, such as brook trout and stoneflies, particularly in the absence of sufficient numbers of native predators. Therefore, beaver populations and impacts need to be thoroughly assessed to determine management options. Efforts will be coordinated by MAPS, MDNR, USFWS, and TOMWC.

Considerations:

- Beavers should not be seen as an absolute bad. They play a very important role in local ecosystems, but that role has become uncontrolled in recent decades due to the removal of natural predators, such as wolves. The loss of these keystone species has resulted in large populations of beavers that worry fisheries managers today. It is important to find a balance in beaver control because of the natural role they play in the aquatic environment.
- Beavers build different kinds of dams. Some construct dams that span the entire width of a stream, causing flooding, creating barriers to fish passage, and raising water temperatures, which negatively impacts sensitive species like brook trout. However, other beavers only construct their homes along the bank without damaging the river.

Recommendations:

- Inventory all beaver dams in the watershed and assess water quality and ecosystem impacts associated with dams.
- Assess the inventory information and prioritize dam removal.
- Remove or install bypass systems as necessary to restore the natural stream ecosystem.
- Provide information and education to watershed residents to improve their understanding of beaver dam issues and the need for management.

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Appendix A. Mullett Creek water quality monitoring data 1995-97 (TOMWC, 2008)

Sample site	Date	Time	Tem	DO	Cond	pH	SS	TP	Cl	NO3-NO2
			˚C	mg/l	µS	units	mg/l	µg/l	mg/l	mg/l
Mullett Creek #1	4/26/1995	14:30:00	5.0	10.2	200	7.8	7	40	16	1.500
Mullett Creek #2	4/26/1995	14:05:00	5.0	12.2	230	7.9	17	43	27	2.200
Mullett Creek #3	4/26/1995	13:40:00	5.0	11.4	240	7.8	13	55	38	1.300
Mullett Creek #4	4/26/1995	13:15:00	8.0	12.2	220	8.0	2	21	18	0.450
Mullett Creek #1	8/1/1995	13:50:00	14.0	9.1	410	8.7	10	33	19	1.800
Mullett Creek #2	8/1/1995	14:05:00	14.0	9.2	430	8.3	13	36	25	2.200
Mullett Creek #3	8/1/1995	14:15:00	16.0	8.9	430	8.4	19	48	26	2.100
Mullett Creek #4	8/1/1995	14:40:00	25.0	8.1	380	8.3	4	40	13	0.010
Mullett Creek #5	8/1/1995	13:20:00	13.0	10.6	440	8.8	33	15	25	2.700
Mullett Creek #6	8/1/1995	14:30:00	23.0	5.1	400	8.4	ND	64	15	0.056
Mullett Creek #1	5/24/1996	13:50:00	ND	ND	ND	ND	1	12	17	1.900
Mullett Creek #2	5/24/1996	14:05:00	ND	ND	ND	ND	28	14	29	2.300
Mullett Creek #3	5/24/1996	14:15:00	ND	ND	ND	ND	3	44	34	2.000
Mullett Creek #4	5/24/1996	14:40:00	ND	ND	ND	ND	1	26	15	0.042
Mullett Creek #5	5/24/1996	13:20:00	ND	ND	ND	ND	2	4	27	3.000
Mullett Creek #6	5/24/1996	14:30:00	ND	ND	ND	ND	1	20	17	0.180
Mullett Creek #1	10/1/1996	12:48:00	9.0	10.2	338	7.5	9	14	30	2.400
Mullett Creek #2	10/1/1996	11:55:00	10.0	9.7	280	8.0	30	467	20	1.900
Mullett Creek #3	10/1/1996	14:15:00	10.5	10.2	330	7.0	3	74	18	1.600
Mullett Creek #4	10/1/1996	13:21:00	12.0	7.8	282	7.5	1	55	34	1.600
Mullett Creek #5	10/1/1996	13:35:00	14.0	7.4	285	7.5	ND	30	19	0.250
Mullett Creek #6	10/1/1996	14:30:00	ND	ND	ND	ND	ND	22	17	0.130
Mullett Creek #1	5/30/1997	12:00:00	9.5	10.8	320	8.0	9	10	27	1.900
Mullett Creek #2	5/30/1997	11:45:00	9.5	10.9	275	8.0	9	37	17	1.400
Mullett Creek #3	5/30/1997	12:30:00	10.5	11.1	305	8.2	7	33	28	1.100
Mullett Creek #4	5/30/1997	13:05:00	13.5	9.0	300	8.2	1	22	19	0.280
Mullett Creek #5	5/30/1997	12:20:00	9.5	11.2	295	8.1	4	25	24	1.400
Mullett Creek #6	5/30/1997	12:50:00	12.0	8.6	290	8.2	ND	26	19	0.500

**Tem=temperature, DO=dissolved oxygen, Cond=conductivity, SS=suspended solids, TP = total phosphorus, CL=Chloride, NO3-NO2=nitrate and nitrite, ˚C = degrees Celsius, µS = microSiemens, mg/l=milligrams per liter or parts per million, µg/l=micrograms per liter or parts per billion, ND=no data.*

Sample sites:

Mullett Creek #1 = Crump Rd. T.37N R.3W Sec.36
Mullett Creek #2 = Budzinski Rd. T.37N R.3E Sec.1
Mullett Creek #3 = South Extension Rd. T.36N R.2W Sec.6
Mullett Creek #4 = M-27 T.36N R.2W Sec.16
Mullett Creek #5 = Indian Trail Rd. T.37N R.3W Sec.35
Mullett Creek #6 = Mullett-Burt Rd. T.36N R.2W Sec.8

Appendix B. Aquatic macroinvertebrate data and grading scale (TOMWC, 2011).

Mullett Creek aquatic macroinvertebrate data from the TOMWC Volunteer Stream Monitoring Program 2005-2011

Location	Season	Date	Total Diversity	EPT* Diversity	Sensitive Diversity	Calculated† Score /100	Grade††
M27	Spring	5/20/2006	14	3	0	15	E
M27	Spring	5/19/2007	23	6	1	50	B
M27	Spring	5/17/2008	26	8	2	72	A
M27	Spring	5/16/2009	35	9	3	84	A
M27	Spring	5/22/2010	17	4	1	40	C
M27	Spring	5/21/2011	21	3	0	30	C
M27	Fall	9/24/2005	21	7	0	40	C
M27	Fall	9/23/2006	20	5	0	35	C
M27	Fall	9/22/2006	27	7	0	42	C
M27	Fall	9/22/2007	22	4	0	35	C
M27	Fall	9/27/2008	23	6	1	50	B
M27	Fall	9/19/2009	15	6	1	40	C
M27	Fall	9/13/2010	21	4	0	35	C
M27	Fall	9/17/2011	28	5	2	57	B
Crump Rd	Spring	5/20/2006	21	11	5	103	A+
Crump Rd	Spring	5/19/2007	20	10	5	103	A+
Crump Rd	Spring	5/17/2008	17	10	5	98	A
Crump Rd	Spring	5/16/2009	19	10	4	88	A
Crump Rd	Spring	5/22/2010	24	11	5	103	A+
Crump Rd	Spring	5/21/2011	14	6	6	75	A
Crump Rd	Fall	9/24/2005	17	13	7	106	A+
Crump Rd	Fall	9/23/2006	25	12	5	105	A+
Crump Rd	Fall	9/22/2007	19	10	4	88	A
Crump Rd	Fall	9/27/2008	26	12	8	115	A++
Crump Rd	Fall	9/19/2009	17	8	4	85	A
Crump Rd	Fall	9/13/2010	17	7	4	75	A
Crump Rd	Fall	9/17/2011	23	12	6	103	A+

**EPT = Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies).*

† Calculated using an unpublished scoring system developed by TOMWC in 2012, higher scores indicate higher water quality and a healthier stream ecosystem.

††Grades are assigned categorically based on the score: 120-100=A+, 100-70=A, 69-50=B, 49-30=C, 29-20=D, 19-0=E.