STATE OF MICHIGAN
DEPARTMENT OF NATURAL RESOURCES

Cheboygan River Assessment

2011 DRAFT

Neal A. Godby, Todd C. Wills,
Timothy A. Cwalinski, and Brian Bury

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EXECUTIVE SUMMARY

This is one of a series of river assessments being prepared by the Michigan Department of Natural Resources and Environment Fisheries Division for Michigan Rivers. This report describes the physical and biological characteristics of the Cheboygan River, discusses how human activities have influenced the river, and serves as an information base for future management of the river.

River assessments are intended to provide a comprehensive reference for citizens and agency personnel who need information about a river. By pulling together and synthesizing existing information, river assessments show the intertwined relations between the river, watershed landscapes, biological communities, and humans. These assessments will provide an approach to identifying opportunities and solving problems related to aquatic resources in the Cheboygan River watershed. We hope it will encourage citizens to become more actively involved in decision-making processes that provide sustainable benefits to the river and its users. Assessments also identify the types of information needed to better understand, manage, and protect the river.

This document consists of four parts: an introduction, a river assessment, management options, and public comments (with our responses). The river assessment is the nucleus of each report. It provides a description of the Cheboygan River and its watershed in thirteen sections: geography, history, geology, hydrology, soils and land use, channel morphology, dams and barriers, water quality, special jurisdictions, biological communities, fishery management, recreational use, and citizen involvement.

The **Management Options** section of the report identifies a variety of actions that could be taken to protect, restore, rehabilitate, or better understand the Cheboygan River and its watershed. These management options are categorized and follow the main sections of the river assessment. They are intended to provide a foundation for public discussion, setting priorities, and planning future management activities for the watershed.

The Cheboygan River drains 1,493 square miles of the northern Lower Peninsula. Its basin comprises portions of six counties: Emmet, Cheboygan, Presque Isle, Charlevoix, Otsego, and Montmorency. The Cheboygan River actually is only a very small portion of the river system. For purposes of this assessment, the watershed is divided into eighteen segments, each reflecting the characteristics of the river and its tributaries as they flow across different landforms, receive tributaries, and pass through impoundments. There is a variety of stream types present from coldwater to warmwater. A multitude of lakes can be found within the watershed, including three of the largest inland lakes in Michigan. The diversity of water types lead to the incredible aquatic biodiversity of the watershed.

Much of the Cheboygan River watershed was formed during the last glaciation. Ice sheets scoured the land and deposited material in the form of moraines and other glacial features. This glacial activity determined, to a large extent, the character of our streams today. The river system, or inland waterway, was used by Native Americans and early settlers as a transportation and trading corridor. Later, the waterways were used to transport trees cut from the watershed during the logging era of late 1800s and early 1900s. Instream substrate and fish cover are still recovering from those logging days. Tourism, hunting, and fishing, have long been an important part of the economy in the watershed.

The geology of the Cheboygan River watershed results in high groundwater inputs to many of the tributaries, particularly in the upper (headwater) reaches. The more permeable surficial (glacial) geology types, combined with elevation changes, produce the most groundwater input. These areas typically have stable flows and colder summer water temperatures.

Groundwater inflows are directly linked to the characteristics of biotic communities in rivers because of their effects on physical habitat features including temperature, flow stability, and channel morphology. Although the groundwater loading to the Cheboygan River watershed is the highest of any watershed in Michigan, actual groundwater inflows into particular segments vary considerably due to variation in soil type (permeability) and topographical relief. Small, coldwater streams and medium coldwater rivers (such as the Sturgeon and Pigeon rivers) have higher groundwater inflow due to the presence of permeable soils and large changes in topography. The soil types and moderate to flat topography of the landscape in segments such as the East Branch Maple, Lower Black, and Cheboygan rivers lead to lower groundwater inflows in these reaches. Groundwater inflow is even less in the areas of the watershed with the lowest topographical relief, such as the Rainy River. Annual flow regimes are also variable among segments due to soil types and the surrounding landscape; daily flow regimes generally are stable, but extreme fluctuations in stream flow occur on the Pigeon River due to operation of the Golden Lotus Dam.

Soil type and slope determine potential land use, infiltration rates, water-holding capacity, and erodibility, and are therefore directly related to the amount of nonpoint source pollution (such as sedimentation) in the watershed. Soils in the Cheboygan River watershed range from well-drained, sandy soils to poorly-drained organic soils. Although most of the watershed is forested with wetlands scattered throughout, anthropogenic activities such as residential and commercial growth, high levels of oil and gas development, and the accompanying road construction and maintenance contribute to increased rates of erosion and sedimentation, which can negatively affect aquatic communities.

Gradient (the general slope, or change in vertical elevation, of a river's channel) is directly related to a stream's habitat features, and accordingly, the biological community that is present. Many of the major tributaries in the Cheboygan River watershed are steep and contain some of the highest gradient in the Lower Peninsula. Such reaches generally receive higher groundwater inflow, have good to excellent hydraulic diversity, are colder, and are more likely to support coldwater fish community assemblages than the low to moderate gradient areas located within the downstream reaches of the basin.

Channel cross sections can be used to monitor the quality of fish habitat since the width of a stream channel can be influenced and modified by a number of factors. Deviations from the expected widths can indicate alterations such as direct disturbance (dredging or channelization) or changes within the watershed due to deforestation, poor agricultural land practices, and construction of road-stream crossings. Three-quarters of the measured channel widths in the watershed were within the expected range, while the remaining quarter was narrower than the expected range of values. This is not surprising given the abundance of coldwater streams in the watershed and their stable flow nature.

There are 48 dams in the Cheboygan River watershed. Dams effectively act as a barrier, disrupting natural flows, and preventing fish passage and movement of other biota. Structures other than dams can act as barriers as well, including undersized or poorly placed culverts at road-stream crossings. Some barriers are intentionally placed in rivers to preclude undesirable fish species from a reach of river; sea lamprey barriers, for instance, have become important in the control of this invasive species. Dams can also affect water temperatures, stream substrate, channel morphology, and nutrient transport.

A major consequence of these barriers is making a large amount of habitat unavailable to migratory fish species, such as steelhead, Chinook salmon, lake sturgeon, and brown trout. Production of many of these species could be greatly enhanced if they were able to access habitat upstream of dams.

Overall water quality in the Cheboygan River watershed is good. Water quality is evaluated by the Michigan Department of Environmental Quality through rapid biological surveys throughout the watershed, and application of standardized water quality metrics to the survey data. Water chemistry data and fish contaminant monitoring are also important measures of water quality. The Cheboygan River watershed has relatively few point source pollutant sources. Non point source pollution, particularly sediment, is a threat to the watershed. Sedimentation can cover substrate suitable for fish spawning and nursery habitat, change channel shape, decrease habitat heterogeneity, and decrease invertebrate diversity and density. Airborne pollutants also are deposited in the watershed, and contribute to fish consumption advisories.

Federal, State, and local units of government are all involved, in varying capacities, with the administration of environmental regulations and the management of natural resources in the watershed. The Federal government regulates three hydroelectric facilities located on the Black River, and one facility on the Cheboygan River. Local governments are involved with planning and zoning. The state has the most environmental regulatory responsibility in the watershed – administering a wide range of regulations that includes water quality standards, Natural River zoning, and wetlands protection. In addition, thirty-six percent of the land in the watershed is under the State's ownership and is managed by the DNR. In the physical sense, navigability in the watershed is partially influenced by the work of Federal and state agencies involved with waterway management. However, the legal navigability of a particular water body is largely determined by Michigan courts.

Currently, 78 fish species are known to inhabit the Cheboygan River watershed. Coldwater fish communities, typically with brook/brown trout and sculpin, are found primarily in the headwater reaches of this watershed. The remainder of the riverine portion contains a mix of cool- and some warmwater species whose distribution is a product of the amount of water warming. Some sub-watersheds such as the Maple, Sturgeon, and Pigeon have relatively cooler waters in the downstream reaches while other watersheds (Black, Rainy) are warmer in the downstream reaches. The lower reaches of the Black River and Black Lake are home to a threatened fish species, the lake sturgeon. This species can also be found in Burt and Mullett lakes.

The biological communities of the Cheboygan River watershed are affected by numerous dams. These dams serve as significant barriers to migrating fish, and fragment the biotic communities of the inland watersheds. These structures, as well as poorly designed culverts and beaver dams, can restrict the movement of important native fishes such as walleye, lake sturgeon, and brook trout and have prevented the passage of important naturalized species such as salmon, steelhead, and brown trout. It is likely that the removal of certain dams in the watershed would drastically change the dynamics of certain fish populations in this region. Such management practices would reduce the reliance on high cost stocking programs to maintain popular trout and salmon fisheries.

Aquatic invertebrates in the watershed have been sampled by MDEQ during water quality surveys. These surveys show a diverse and abundant macroinvertebrate community in most locations sampled. Diversity and abundance scores were lower where habitat has been degraded. A variety of amphibians, reptiles, birds, and mammals inhabit the Cheboygan River watershed. Habitat loss threaten some of the rare species that have specific habitat requirements. Aquatic nuisance species such as round goby, zebra mussels, and Eurasian milfoil have also colonized parts of the watershed and compete with native species.

The Cheboygan River watershed contains a diverse array of warm, cool, and coldwater rivers, and a multitude of lake types. Due to this diversity and wealth of fishery resources, a substantial amount of fisheries management activities have occurred within the watershed. Past management activities have included fish stocking, habitat improvements, fishing regulations, chemical reclamations, and numerous fish surveys. A multitude of fish species have been stocked at various times and locations throughout the watershed. The watershed supports several blue ribbon trout streams for brook, brown, and rainbow trout, as well as fishing opportunities for cool and warmwater fish species in many inland lakes. The large lakes within the watershed, including Crooked, Pickerel, Douglas, Burt, Mullett, and Black Lakes, provide great fishing opportunities for a variety of species. There are ongoing stocking efforts at various lakes in the watershed.

Recreational opportunities are abundant in the Cheboygan River watershed due to the large amount of publicly-owned land and the variety of lakes, streams, and rivers within its boundaries. Public access to these water bodies can be found throughout the watershed and includes state-owned canoe and boat launches as well as many informal, publicly-owned access points. Many water bodies may also be accessed through state forest lands and at road-stream crossings where not precluded by law. Recreational activities include fishing, biking, bird watching, berry and mushroom picking, camping, cross-country skiing, horseback riding, hunting, off-road vehicle (ORV) riding, and trapping. Four state parks and 18 state forest campgrounds exist within the watershed, most of which are located in close proximity to a river or lake.

Citizen involvement in management of the natural resources within the Cheboygan River watershed occurs primarily through interaction with government agencies that manage the resource, or involvement with nongovernmental or not-for-profit organizations that work in the area. Lake associations and sportsmen’s clubs also provide an opportunity for citizen involvement at the local level. Public involvement provides the opportunity to open a dialogue on natural resources issues and promotes the exchange of experiences, ideas, and proposals among individuals, communities, interest groups, and government agencies. Numerous opportunities exist for concerned citizens to become involved in issues affecting the watershed; citizens are encouraged to take advantage of these opportunities for participation.

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INTRODUCTION

This river assessment is one of a series of documents being prepared by the Michigan Department of Natural Resources (MDNR), Fisheries Division, for rivers in Michigan. We have approached this assessment from an ecosystem perspective, as we believe that fish communities and fisheries must be viewed as parts of a complex ecosystem. However, this assessment is admittedly biased towards the aquatic components of this ecosystem.

As stated in the Fisheries Division Strategic Plan, our aim is to develop a better understanding of the structure and functions of various aquatic ecosystems, to appreciate their history, and to understand changes to systems. Using this knowledge, we will identify opportunities that provide and protect sustainable aquatic benefits while maintaining, and at times rehabilitating, system structures or processes.

Healthy aquatic ecosystems have communities that are resilient to disturbance, are stable through time, and provide many important environmental functions. As system structures and processes are altered in watersheds, overall complexity decreases. This results in a simplified ecosystem that is less able to adapt to additional change. All of Michigan's rivers have lost some complexity due to human alterations in the channel and on surrounding land. Therefore, each assessment focuses on ecosystem maintenance and rehabilitation. Maintenance involves either slowing or preventing the losses of ecosystem structures and processes. Rehabilitation is putting back some of the original structures or processes.

River assessments are based on ten guiding principles in the Fisheries Division Strategic Plan. These are: 1) recognize the limits on productivity in the ecosystem; 2) preserve and rehabilitate fish habitat; 3) preserve native species; 4) recognize naturalized species; 5) enhance natural reproduction of native and desirable naturalized fishes; 6) prevent the unintentional introduction of exotic species; 7) protect and enhance threatened and endangered species; 8) acknowledge the role of stocked fish; 9) adopt the genetic stock concept, that is protecting the genetic variation of fish stocks; and 10) recognize that fisheries are an important cultural heritage.

River assessments provide an organized approach to identifying opportunities and solving problems. They provide a mechanism for public involvement in management decisions, allowing citizens to learn, participate, and help direct decisions. As well, these assessments provide an organized reference for Fisheries Division personnel, other agencies, and citizens who need information about a particular aspect of the river system.

The nucleus of each assessment is a description of the river and its watershed, using a standard list of important ecosystem components. These include:

Geography–a brief description of the location of the river and its watershed; a general overview of the river from its headwaters to its mouth, including topography. This section sets the scene.

History–a description of the river as seen by early settlers and a history of human uses and modifications of the river and the watershed.

Geology–a description of both the surficial and bedrock geology of the area.

Hydrology–patterns of water flow, over and through a landscape. This is the key to the character of a river. River flows reflect watershed conditions and influence temperature regimes and habitat characteristics.

Soils and Land Use Patterns–soils and land use in combination with climate determine much of the hydrology and thus the channel form of a river. Changes in land use often drive change in river habitats.

Channel Morphology–the shape of the river channel: width, depth, and sinuosity. River channels are often thought of as fixed, aside from changes made by people. However, river channels are dynamic, constantly changing as they are worked on by the unending, powerful flow of water. Diversity of channel form affects habitat available to fish and other aquatic life.

Dams and Barriers–affect almost all river ecosystem functions and processes, including flow patterns, water temperature, sediment transport, animal drift and migration, and recreational opportunities.

Water Quality–includes temperature, and dissolved or suspended materials. Temperature and a variety of chemical constituents can affect aquatic life and river uses. Degraded water quality may be reflected in simplified biological communities, restrictions on river use, and reduced fishery productivity. Water quality problems may be due to point-source discharges (permitted or illegal) or to nonpoint-source land runoff.

Special Jurisdictions–stewardship and regulatory responsibilities under which a river is managed.

Biological Communities–species present historically and today, in and near the river; we focus on fishes, however associated mussels, mammals and birds, key invertebrate animals, special concern, threatened and endangered species, and pest species are described where possible. This component is the foundation for the rest of the assessment. Maintenance of biodiversity is an important goal of natural resource management. Species occurrence, extirpation, and distribution are important clues to the character and location of habitat problems.

Fishery Management–goals are to provide diverse and sustainable game fish populations. Methods include management of fish habitat and fish populations.

Recreational Use–types and patterns of use. A healthy river system provides abundant opportunities for diverse recreational activities along its mainstem and tributaries.

Citizen Involvement–an important indication of public views of the river. Issues that citizens are involved in may indicate opportunities and problems that Fisheries Division or other agencies should address.

Throughout this assessment we use data and shape files downloaded from the Michigan Geographic Data Library, maintained by the Michigan Center for Geographic Information (MDNR 2004). These data provide measures of watershed surface area for numerous categories (e.g., soil types, land use, surficial geology), measures of distance (e.g., stream lengths), and creation of associated figures. We used ArcView GIS 3.2a or Arc GIS (Environmental Systems Research Institute, Inc.; Copyright) to display and analyze these data, and to create the landscape figures presented in this report. Unless otherwise referenced, all such measures and associated figures reported within the sections of this report were derived from these data.

Management options follow the river assessment sections of this report, and list alternative actions that will protect, rehabilitate, and enhance the integrity of the river system. These options are intended to provide a foundation for discussion, setting of priorities, and planning the future of the river system. Identified options are consistent with the mission statement of Fisheries Division.

A fisheries management plan will be written after completion of this river assessment. This plan will identify options chosen by Fisheries Division based on our analysis and comments received. In general, the Fisheries Division management plan will: focus on a shorter time; include options within the authority of Fisheries Division; and be adaptive.

The comment period for this assessment is open until March 11, 2011. Anyone who reviews this draft is urged to comment, in writing, to:

Neal Godby, Fisheries Division
Michigan Department of Natural Resources
1732 M-32 West
Gaylord, Michigan 49735

Comments received after March 11, 2011 will be considered during future revisions of this assessment.

RIVER ASSESSMENT

Geography

The Cheboygan River drains an area of the northern Lower Peninsula encompassing 1,493 square miles (Figure 1). The watershed drains all or parts of six counties: Emmet, Charlevoix, Otsego, Montmorency, Presque Isle, and Cheboygan. The basin is approximately 37 miles wide, 44 miles long, and is comprised of 68% forested, 6% agricultural, and less than 2% urban land use (NOAA 2001).

The Cheboygan River watershed is unique in Michigan in that it has many headwater reaches that flow through large lakes. The main river systems in this watershed that form the Cheboygan River include the Maple, Crooked, Sturgeon, Indian, Pigeon, Black, and Rainy rivers. The Crooked and Indian rivers are connecting waterways between large lakes whereas the other rivers have a more typical structure and primarily originate from groundwater sources. In fact, the relative groundwater loading to this watershed is the highest for any watershed in the Lower Peninsula (Gooding 1995). The larger lakes of the watershed include: Douglas, Crooked-Pickerel, Burt, Mullett, and Black lakes.

There are many rivers within the Cheboygan River watershed. The Maple River drains the northwest portion of the watershed. The West Branch Maple River drains extensive swamps while the East Branch Maple River begins as the outlet of Douglas Lake. The Crooked River is comprised of a group of large lakes and small streams that drain the highlands on the western edge of the watershed. The Sturgeon, Pigeon, and Black rivers begin in the southern half of the watershed, where groundwater inflow is particularly high, and all flow in a northerly direction into Burt, Mullett, and Black lakes, respectively. The relatively short section comprising the Cheboygan River leaves Mullett Lake on the north end and flows a short distance before being joined by the lower Black River. The Cheboygan River empties into Lake Huron at the port of Cheboygan.

The character of the Cheboygan River watershed and its associated biota varies considerably throughout this region. We will discuss the Cheboygan River and its watershed (Table 1, Figure 1) using a variation of the Valley Segment Ecological Classification System described by Seelbach et al. (1997). They defined 69 valley segments within the Cheboygan River watershed that were relatively distinct in terms of geological setting, hydrology, channel morphology, and temperature regime. We pooled continuous valley segments into larger geographic units to simplify the description of the watershed. We used criteria such as confluences with tributaries and lakes, and dams to set boundaries for our larger units. Consequently, this assessment is organized around 19 segments (Figure 2). We defined three segments each for the Maple, Sturgeon, and Pigeon river watersheds, six for the Black River watershed, and one for the Cheboygan River. Segments were defined for each of the largest lakes in the watershed (Black, Burt, and Mullett) and their smaller tributaries. A more detailed discussion of each segment follows.

West Branch Maple River - Headwaters to Maple River Dam

The 16 mile long West Branch Maple River arises from the extensive Pleasantview Swamp, a 6,544-acre uninterrupted expanse of organic soils in central Emmet County (Tip of the Mitt Watershed Council 2006). This rich coniferous swamp is surrounded by hardwood ridges that direct the river flow to the north, then east, and then south. The West Branch Maple River drains 93 square miles of land. Tributaries include Brush Creek and Cold Creek. Brush Creek is the outlet of Larks Lake and the most notable tributary to the West Branch Maple River. The only population center in this catchment is the town of Pellston.

East Branch Maple River - Headwaters to Maple River Dam

The East Branch Maple River arises from Douglas Lake. Douglas Lake drains nearly 63 square miles of land near the tip of Michigan's Lower Peninsula. Three major tributaries flow into Douglas Lake and drain a 6,000-acre mosaic of wetlands, particularly along the lake's west and north shores (Fuller 2006). The East Branch Maple River flows for approximately six miles from its source to Lake Kathleen where it joins the West Branch. The East Branch Maple River flows mainly through private forested land and crosses two main roads. The only significant tributary to the East Branch is Van Creek.

Maple River – Maple River Dam to Burt Lake

The Maple River main stem begins from the confluence of the East Branch Maple River and West Branch Maple River at the Maple River Dam in eastern Emmet County near the town of Pellston. This segment begins from cascading top water at the dam and flows for approximately seven miles south through a forested riparian corridor of private and public land to Burt Lake. This river is known to carry a heavy sand bedload which helps to form a natural delta near its mouth at Burt Lake. Vast wetlands are located along the lower river reaches and Burt Lake shoreline (Fuller 2006).

Sturgeon River – Headwaters to confluence with West Branch Sturgeon River

The Sturgeon River is one of the most pristine and high gradient streams in the Lower Peninsula and is one of the largest free-flowing trout streams in Michigan. It arises from a series of springs and groundwater-fed swamps near the high ground of Gaylord, Michigan and flows over deep sandy glacial deposits and limestone bedrock (Fuller 2006). This segment drains approximately 192 square miles of land and flows in a northerly direction through a heavily forested region until it meets the West Branch Sturgeon River in the town of Wolverine. Land relief is dramatic in this segment. Most of the riparian corridor is privately owned but there are reaches of the river that flow through public forest land. Tributaries to the Sturgeon River in this segment include Mossback, Pickerel, and Stewart creeks, and Club Stream.

West Branch Sturgeon River

West Branch Sturgeon River arises from a series of upper watershed lakes in southeastern Charlevoix County and flows northeast for approximately 18 miles to its confluence with the main stem in the town of Wolverine. This segment drains approximately 30 square miles. The riparian corridor is entirely forested with a mixture of public and private land. Riparian development is more prominent along the downstream reaches of the West Branch Sturgeon River. Various small tributaries enter the stream as small springs, with the largest being Marl Creek. Lakes are relatively abundant in this catchment.

Sturgeon River – Confluence with West Branch Sturgeon River to Burt Lake

The main stem Sturgeon River flows fast and deep from the town of Wolverine to its confluence with Burt Lake. The river originally flowed into the Indian River where it deposited vast amounts of sand that became a navigational hazard. The river was redirected and now flows directly into the southeast side of Burt Lake and has a drainage area of approximately 244 square miles. Other than the West Branch, tributaries are few and include Beebe Creek. The river flows through meadows and forested corridors and is surrounded by high valley walls. Riparian ownership is primarily private, yet fair amounts of public land can also be found along the river.

Burt Lake

Burt Lake, at more than 17,000 acres, is the largest inland lake in the Cheboygan River watershed and the fourth largest inland lake in the state. Its watershed includes more than 250,000 acres and has 32 miles of shoreline (NEMCOG 1987). Major tributaries entering Burt Lake include the Little Carp, Maple, Crooked, and Sturgeon rivers. The Crooked River enters Burt Lake at the west shoreline and drains moderate sized lakes (Round, Crooked, Pickerel) and various smaller tributaries (Table 1). The Indian River leaves Burt Lake on the southeast shore and flows to neighboring Mullett Lake as part of the popular inland waterway. The lake's shoreline is mostly developed with private and commercial residences (Hanchin et al. 2005). Some public land exists along the lake in the form of state forest or park.

Pigeon River – Headwaters to Golden Lotus Dam

The Pigeon River begins northeast of the town of Gaylord, Michigan and flows in a northerly direction to Mullett Lake. It is formed by an extensive series of groundwater tributaries along with the South Branch Pigeon River which keep the upper river cold throughout the year. The majority of the riparian corridor of the Pigeon River in this upper segment is under private ownership and is heavily forested. A few inland lakes exist in this segment (Table 2) including Lansing Club Pond which is an impounded portion of the river.

Pigeon River – Golden Lotus Dam to confluence with Little Pigeon River

The Pigeon River from Golden Lotus Dam to the confluence with the Little Pigeon River is approximately 15 miles long. Tributaries are few but include Cornwall, Bird Tally, and Grindstone creeks. The riparian zone is heavily forested with some meadows present. Stream velocity in these middle reaches is moderate. This river segment drains a few lakes larger than 10 acres and many smaller lakes are present.

Pigeon River – Confluence with Little Pigeon River to Mullett Lake

The lower 14 miles of the Pigeon River begin at the confluence of the Little Pigeon River and end at Mullett Lake. The Little Pigeon River is the major tributary and a source of cold water. Other waters in this segment include Wilkes Creek and various unnamed tributaries. The riparian corridor throughout this segment is heavily forested with little development. Few lakes exist in this portion of the watershed.

Mullett Lake

Mullett Lake, at just less than 17,000 acres, is the second largest inland lake in the Cheboygan River watershed and the fifth largest inland lake in Michigan. Its watershed includes more than 162,000 acres (not including Burt Lake) and has 28 miles of shoreline (Tip of the Mitt Watershed Council 2002). Major tributaries entering Mullett Lake include the Indian, Pigeon, and Little Pigeon rivers, as well as Mullett and Ballard creeks. The Indian River flows from Burt Lake for 4 miles with an elevation drop of less than one foot and enters Mullett Lake at the south end. The Little Sturgeon River and Crumley Creek are tributaries to the Indian River (Table 1; Figure 1). The Cheboygan River leaves Mullett Lake on the north shore and flows to Lake Huron to complete the inland waterway (Figure 1). The lake's shoreline is mostly developed and private. Few other inland lakes exist within the Mullett Lake segment (excluding Burt Lake drainage).

Black River – Headwaters to Clark Bridge Road

The Black River arises from a series of groundwater fed springs east of the town of Gaylord. The entire Black River upstream of Black Lake is commonly referred to as the Upper Black River and is 57 miles long. The river begins at an elevation of around 1,060 feet and is 800 feet above sea level at Clark Bridge Road, a distance of 28 miles downstream. This upstream segment is fed by various tributaries such as Saunders, Tubbs, Hardwood, Stewart, and Little McMasters creeks, as well as the East Branch Black River. Approximate drainage for this segment is 232 square miles (Hendrickson and Doonan 1971). The riparian corridor is heavily forested with an equal amount of public and private ownership. Only a handful of small lakes are present in the drainage (Table 2).

East Branch Black River

The East Branch Black River is the major tributary to the Upper Black River. The drainage area is 48 square miles. It arises from a vast coniferous swamp rich with groundwater flow. This wetland is known as the Green Swamp and is located north of Johannesburg, Michigan. The river flows for approximately 20 miles to the north until it meets the main stem Black River and nearly doubles in volume. Two significant tributaries include Foch and Rattlesnake creeks. The East Branch Black River flows through a heavily forested corridor of both private and public land. There is only one lake 10 acres or larger present in this area.

Black River – Clark Bridge Road to Kleber Dam

This 19 mile segment of stream begins as coldwater and ends as cool- to warmwater at Kleber Dam. Significant tributaries include McMasters, Canada, Tomahawk, Gregg, and Bowen creeks. The Black River flows through a forested corridor in this reach of private and public land. Two hydropower dams are located near the end of the segment (see **Dams and Barriers**) that effectively block upstream fish passage. Tower Dam is smaller and impounds 65-acre Tower Pond. Downstream only a small distance and at the end of this segment lies Kleber Pond Dam, which impounds 257-acre Kleber Pond. These impoundments are partially developed along their shorelines. A good number of other natural lakes and impoundments exist in this part of the watershed.

Canada Creek

Canada Creek is the second largest tributary to the upper Black River. It is a 20-mile long stream that begins from a series of lakes in northwest Montmorency County. Its drainage is 67 square miles and flows through a mixture of private and public land and has a heavily forested stream corridor. Major tributaries include Van Hetton, Montague, and Oxbow creeks. Lakes 10 acres or larger are quite common in the Canada Creek drainage.

Black River – Kleber Pond Dam to Black Lake

The Black River flows for approximately 9.5 miles from Kleber Dam to Black Lake and drains 33 square miles of land. Milligan Creek drains most of this area and flows for eight miles. The river flows through a forested corridor with steep valley walls paralleling the river for many miles. Riparian ownership is almost completely public. Five lakes 10 acres or greater occur in this Black River segment.

Black Lake

Black Lake, at more than 10,000 acres, is the third largest lake in the watershed and the tenth largest inland lake in Michigan. Its watershed includes more than 350,000 acres and has 18 miles of shoreline. The Black Lake watershed comprises 38% of the entire Cheboygan River watershed. Black Lake has a much higher watershed size to surface area ratio when compared to neighboring Mullett and Burt lakes. This means that it is much more vulnerable to nutrient enrichment (Huron Pines Resource Conservation and Development Council 2002). The lake's shoreline is mainly developed. Major tributaries which enter Black Lake include the Black and Rainy rivers, as well as Stewart, Mud, and Stony creeks. The outlet of Black Lake is the Black River, commonly referred to as the Lower Black River. The Rainy River flows for approximately 24 miles in a northerly direction and enters Black Lake on the southeast shore. A moderate number of other lakes exist in the area drained by the Black Lake segment (Table 2).

Lower Black River

The Lower Black River leaves the north shore of Black Lake, flows approximately 11 miles to its confluence with the Cheboygan River, and drains approximately 44 square miles. One large hydroelectric dam is located halfway in this segment (see **Dams and Barriers**). Major tributaries that empty into the river include Long Lake Outlet and Myers and Owens creeks. Only a small number of lakes exist within this river segment drainage.

Cheboygan River

The Cheboygan River leaves the north shore of Mullett Lake, flows approximately 7 miles north to Lake Huron, and excluding upstream inputs, drains 10 square miles. A large dam and state owned lock system operate on the lower reaches of this river in the town of Cheboygan. The riparian corridor is mainly developed throughout the river and industrialized in the town of Cheboygan. The major tributary the Cheboygan River is the Lower Black River and other, smaller tributaries include Laperell Creek and a multitude of city drains and creeks.

History

The name "Cheboygan" is a Native American term meaning "through passage," referring to the inland waterway route (Olson and Turner 1989). The inland waterway route allows travel from Lake Huron, up the Cheboygan River, through Mullett Lake and Indian River. From the Indian River, one can travel through Burt Lake and up the Crooked River, to Crooked Lake. This inland route enables travel from Lake Huron to within 8 miles of Lake Michigan. The Cheboygan Lock and Dam, originally built in 1869, allowed larger commercial vessels to use the inland waterway.

Archaeological information for the Cheboygan River watershed has been documented at only a few sites. Late prehistoric native culture is documented in the region at the Juntunen site (on nearby Bois Blanc Island), representing the Woodland Algonquian Association (Tanner 1987). Fishing is documented in the region as early as the late Archaic period (3000-1000 B.C.), as evidenced by barbless copper fishhooks and gorges found at sites in northern Michigan (Cleland 1982). The Juntunen site shows the importance of fish to that society, which used multibarbed harpoons and copper and bone gorges between 800 A.D. and 1350 A.D. Seines or small mesh gill nets were also presumably used (Cleland 1982). McPherron (1967) describes the use of natural resources at this site as an inland fishing complex.

Much of the Cheboygan River's recent history relates to the natural resources and use of the river as a transportation corridor. The region was occupied by both the Ottawa and Ojibwa tribes, with an Ojibwa village at Cheboygan around 1810 (Tanner 1987). Fur bearing animals and the proximity to an established fur trading post (Mackinac Island) brought early European settlers to the area in the late 1770s (Olson and Turner 1989). Not only did the watershed provide abundant fur bearing animals and a means to transport them through the inland waterway, but Cheboygan was also close to Mackinac Island and its French fur traders (Strudley 2002).

The vast lumber resources of the region attracted permanent European settlers to the watershed during the lumbering era of the mid- to late 1800s. The area was surveyed by William Austin Burt in the early 1840's, along with deputy surveyor, John Mullett (Guth and Guth 1975). The forests and their logging potential brought permanent European settlers to Cheboygan by 1845, while Duncan City (part of present day Cheboygan) became one of the busiest ports in the Great Lakes (Olson and Turner 1989, Strudley 2002).

The village of Quick was established around the turn of the century in the Pigeon River area east of Gaylord to take advantage of that area's vast timber resources (Warner and Gilardy 1996). Quick was home to a number of logging companies but ceased to exist after the timber resources had been harvested. Vanderbilt, settled around 1880, had three saw mills, and a planing and shingle mill (Warner and Gilardy 1996). The railroad was an important means of settling the headwaters area of the watershed, as well as for transporting timber products south.

Michigan Log Marks (1942) describes the logging activity in the watershed as follows:

> On the Cheboygan system of waters…, many mills and booms were built on Burt, Mullet, and Black lakes. A problem arose because of the great rapids over which that river dropped after leaving Mullet Lake. This was solved by building a lock and canal, 18 feet wide, 85 feet long, with a lift of nine feet, through which the company annually passed millions of feet of logs and lumber, besides the operating tug boats. A large sluice dam at the outlet of Black Lake took care of a like problem there, controlling the level of the lake for booming logs at the Black Lake mouth of the Upper Black.

The dams discussed above are the Cheboygan Dam and Alverno Dam (on Black River). The dams were built to allow navigation and log transport through the rapids of those areas.

Central to the logging of the region was the use of the rivers for transporting the logs. A report by the US Army Corps of Engineers (1979) indicated that the Cheboygan River, the Inland Waterway, and several of its tributaries were used for transporting logs from the lumbering regions upstream. Black River and Black Lake were used for transporting logs to the mills in the Cheboygan area. According to an 1871 report, "logs are now run for an extent of 45 miles in the Pigeon River" (quoted in USACE 1979). The Maple River and Douglas Lake also were used for transporting timber and supported a number of mills, and the Crooked River carried logs to mills in Alanson (USACE 1979). The USACE (1979) report also describes the magnitude of the logging industry in the Cheboygan River drainage and the importance of the river:

> That the Cheboygan River itself was used follows from the discussion above. A booming company operated at Cheboygan, (Rector, 1953, p. 128) and for the year 1887, the company on the Cheboygan handled 76,000,000 board feet (Maybee, 1960, p. 36). In 1893, Cheboygan reached its peak of 200,000,000 board feet of lumber and overall, more than 25,500,000,000 board feet of white pine were cut in the Cheboygan River valley (Hudgins, 1961, pp. 62-63).

Other natural resources of the region were important during the watershed's history, including fishery resources, passenger pigeon populations, and recreation and tourism.

Commercial fisheries were established in the nearshore areas of Lake Huron during the fur trading and lumbering eras (O'Neil 1977). O'Neil (1977) reports that during the peak years of the fishery, up to five refrigerated railroad cars would leave Mackinaw City daily for larger markets. The fishing industry, along with lumbering, would contribute to Cheboygan's "boomtown" status until the late 1890s (Olson and Turner 1989).

A state fish hatchery was established at Oden, near Crooked Lake in 1920 to raise trout for stocking throughout the state. The facility was renovated in 2002 and is the current home of the Sturgeon River brown trout broodstock.

The Cheboygan River watershed was well known for its pigeon population; indeed, the Pigeon River and the Pigeon River Country State Forest are within the bounds of this watershed. In the late 1800s, large numbers of passenger pigeons arrived, with some colonies up to 30 miles long and 3-4 miles wide (O'Neil 1977, Franz 1985). "[Passenger pigeons] preferred cedar stands, common in the wetlands along the Sturgeon, Pigeon, and Black rivers…. Sometimes there were 90 nests in a single tree" (Franz 1985). Harvest of these birds was high, resulting in the extirpation of that species from Michigan in 1898.

The village of Cheboygan was also the transportation hub of northern Michigan, as described by Olson and Turner (1989):

> Cheboygan was the center for most all of Northern Michigan land and water transportation. The D&C boats came regularly to Cheboygan. We had a horse drawn street car running from Lincoln Ave to Duncan City. The Michigan Central Railroad (Jackson, Lansing and Saginaw division) reached Cheboygan in 1881. Five State Roads, which serviced three stagecoach lines, connected Cheboygan with the outside world.
>
> Cheboygan had as many as five steamboat lines at one time. They regularly took passengers to Mackinac Island, St. Ignace, Les Cheneaux Islands, DeTour Village, and Sault Ste. Marie. Several Inland Route ferryboats daily took freight and passengers from Cheboygan to Oden.

For many years, the Cheboygan River watershed has been a popular destination for tourists. As reported by O'Neil (1977),

> An adventuresome traveler might explore the area on a Circular Water Route trip, boarding an excursion boat at Petoskey, Harbor Springs, or Charlevoix to travel through Lake Michigan to Cheboygan. The trip then joined an Inland Water Route steamer to travel through Mullett Lake, Indian River, Burt Lake, Crooked River and finally Crooked Lake. Passengers could then board dummy trains at Conway and return to their original destinations. Less rugged visitors often chose only the Inland Water Route trip. Boats journeyed back and forth daily between Conway and Cheboygan.

The abundance of public land, inland lakes, and blue ribbon trout streams attract many visitors to the watershed each year, and tourism continues to be an important part of the local economy.

Geology

Geology is a primary factor determining watershed character. Channel shape, drainage network density, quantity of groundwater inflow, stream temperatures, water chemistry, and the biota found in a stream are all influenced by geology (Wiley and Seelbach 1997, Bedient and Huber 1992, Wehrly et al. 2003).

Much of the Cheboygan River watershed was formed about 11,000 years ago during the Wisconsinan Glaciation, the last major glacial advance and retreat in the Great Lakes region (Farrand 1988). Glacial deposits form the surficial geology of the watershed, affecting the flow of groundwater and surface water in the watershed today (See **Hydrology**).

Surface Geology

The surficial geology of the Cheboygan River watershed was formed during the last glaciation. Glaciers deposited two main types of material when they melted: till and outwash. Deposited directly by the ice, till is unsorted and unstratified, and is typically found in several types of moraines. Outwash, on the other hand, refers to material that is sorted and stratified as it is deposited by flowing glacial meltwaters Dorr and Eschman (1970).

The various types of surficial materials have different permeability and therefore different interactions with groundwater. The surficial geologic types in the Cheboygan River watershed, from highest permeability (and most groundwater interaction) to lowest permeability are: ice-contact terrain, coarse-textured till, dunes, glacial outwash, lacustrine sand, organic deposits, thin till over bedrock, medium-textured till, fine-textured till, and lacustrine clay (Baker et al. 2003). The relative permeability of each material has a direct relationship to the groundwater inflow to a stream (see **HYDROLOGY**).

The Cheboygan River watershed is dominated by coarse-textured glacial till (38%), glacial outwash sand and gravel and postglacial alluvium (21%), and lacustrine sand and gravel (17%) (Figure 3). The catchments associated with each segment, however, differ in their surficial geology composition (Table 3).

Headwaters of the Pigeon, Sturgeon, and Black Rivers originate near Gaylord in an area characterized by steep end-moraines and ground moraines. The steep topography, combined with the high hydraulic conductivity of coarse-textured materials, result in high groundwater potential for these streams.

The upper reaches of the Sturgeon River, West Branch Sturgeon River, Pigeon River, and Black River (segments D, E, H, and L of Figure 2) are comprised of 24.2%, 50.6%, 12.9%, and 16.4%, respectively, of end moraines of coarse-textured glacial till (Figure 3). Large portions of these reaches are also associated with coarse-textured till.

Lower reaches of these streams are comprised of high percentages of coarse till but also include ice-contact outwash sand and gravel. The geology of the Sturgeon River, from its confluence with the West Branch Sturgeon River to Burt Lake, is comprised of 52.7% ice-contact outwash sand and gravel. Lower portions of the Pigeon River are also dominated by coarse-textured glacial till.

The headwaters of the Maple River originate in coarse-textured glacial till, glacial outwash sand and gravel, and postglacial alluvium (West Branch Maple River) and coarse-textured glacial till and lacustrine sand and gravel (East Branch Maple River). The Maple River is comprised almost entirely of lacustrine sand and gravel (82.1%).

Bedrock Geology

Lying beneath the surficial geology is bedrock. Formations comprising the majority of bedrock within the Cheboygan River watershed include Traverse Group Reef, Antrim Shale, and Detroit River Group (Michigan Geographic Data Library; Figure 4). The propensity of these rock types to contain oil and natural gas make the bedrock of this region economically important (see **Soils and Land Use**).

Karst Topography

The Cheboygan River watershed contains some unique Karst topography and land features. Karst features are formed when groundwater dissolves underlying limestone bedrock to form subterranean caves. When these caves collapse, sinkholes are formed on the surface (Dorr and Eschman 1970). There are a number of sinkhole lakes having fairly stable water levels in the Pigeon River Country State Forest (see **Fisheries Management**). Dorr and Eschman (1970) describe a sinkhole lake where water levels are not so constant:

> Rainy Lake, about ten miles southeast of Onaway, has had an especially interesting history. It apparently occupies a sinkhole depression…, the bottom drainage exit of which is usually plugged with sediment. On occasion, however, the "plug" is naturally released, allowing the lake waters to drain away underground.

Hydrology

The United States Geological Survey (USGS) collected and reported discharge records at nine gage locations in the Cheboygan River watershed during various time periods between 1942 and 2006 (Table 4). Seven of these locations are now discontinued, while two (Sturgeon River at Wolverine and Pigeon River near Vanderbilt) are currently in operation. USGS records indicate that both of these gages were previously operated at different sites in close proximity to their existing locations before being moved in the early 1990's.

The Sturgeon and Rainy rivers are the only reaches with data available where discharge is unaffected by dams. Mean annual discharge at these locations ranged from 26 cubic feet per second (cfs) in the Rainy River near Onaway to 216 cfs in the Sturgeon River near Wolverine, which equates to an annual runoff of 0.33 $ft^{3}\cdot s^{-1}\cdot mi^{-2}$ and 1.13 $ft^{3}\cdot s^{-1}\cdot mi^{-2}$, respectively. Mean annual discharge at other sites in the watershed ranged from 42 cfs in the Rainy River near Ocqueoc to 822 cfs in the Cheboygan River near Cheboygan (Table 5).

The seasonal discharge pattern for all gage locations in the watershed is typical for streams in Michigan's Northern Lower Peninsula, even though seven of the nine sites are affected by dams. Seasonally, with few exceptions, the highest discharges occur in April and the lowest discharges in August (Table 4, Figure 5). High spring flows coincide with runoff from melting snow, while low summer flows correspond to seasonally low precipitation levels.

Base Flow and Groundwater Inflows

Although the groundwater loading to the Cheboygan River watershed is the highest of any watershed in Michigan (Gooding 1995), groundwater inflows into particular segments vary considerably due to variation in geology (permeability) and topographical relief (Figure 6). Streams that flow through coarse-textured glacial deposits with high differences in elevation have higher groundwater inflows

(Wiley et al. 1997), since these conditions are favorable for down-slope transport of groundwater to the river channel. Streams with high groundwater inflows have higher summer base flow and cooler summer water temperatures compared to streams with low groundwater inflow. Because of its effects on physical habitat features including temperature, flow stability, and channel morphology, groundwater inflows are directly linked to the characteristics of biotic communities in rivers (Zorn et al. 1997, 2002).

A measure of groundwater inflow to streams is low-flow yield, which is calculated by dividing the 90% exceedence flow by the drainage area of the watershed. Small, coldwater streams and medium coldwater rivers have higher groundwater inflow, and thus higher low-flow yields, than other river segments in the watershed. For example, USGS gage data indicate that the catchment of the Sturgeon River from the headwaters to Wolverine has a low-flow yield of 0.82 $ft^3 \cdot s^{-1} \cdot mi^{-2}$, which is high compared to other similar-sized catchments in Michigan (Figure 7). This segment receives high groundwater inflows due to extensive deposits of permeable soils (glacial outwash sand, gravel, and postglacial alluvium), and large variation in elevation (see **Geology**). Low-flow yield for the Pigeon River headwaters to Lansing Club Pond, the only other coldwater segment with gage data available, cannot be calculated due to peaking operations of the Golden Lotus Dam (see *Streamflow variability* below). However, we infer that groundwater inflows are high in this and other similar segments (Table 1), including their tributaries, in which gage data are not available, due to the observed July and August cold water temperatures (Table 6).

The operation of dams within many of the coolwater segments within the watershed renders the USGS gage data inappropriate for calculating low-flow yield. Low-flow yield for these segments is undoubtedly lower than that of the coldwater segments within the watershed, due in part to less permeable soil types present in segments such as the East Branch Maple, Lower Black, and Cheboygan rivers and the moderate to flat topography of the landscape. Modest groundwater inflow in portions of these segments can be inferred from the cool to cold July and August water temperatures observed for some tributaries (Table 6).

Groundwater inflow for stream reaches and tributaries located within large lake segments is variable depending upon soil type and topography. Low-flow yield for the Rainy River near Ocqueoc (within the Black Lake catchment) is extremely low (0.03 $ft^3 \cdot s^{-1} \cdot mi^{-2}$) compared to other similar sized catchments within Michigan (Figure 8). Although this reach flows through an area of considerable coarse-textured glacial till, the flat topography does not provide the hydraulic head needed to drive significant lateral movement of groundwater to the stream channel. Due to flow regulation from dams, gage data appropriate for calculating low-flow yield are unavailable for any locations within the Burt and Mullett lake catchments. High groundwater inflow can be inferred for some tributaries within lake segments such as Berry Creek, Cedar Creek, and portions of Mullett Creek. These tributaries flow through permeable soils with considerable changes in topography and have cold summer water temperatures. Conversely, groundwater inflow for tributaries that flow through less permeable soils and flatter topography is lower as indicated by warmer observed water temperatures. Examples of these tributaries include the main stem and North Branch of the Little Pigeon River (Table 6).

Streamflow Variability

<u>*Annual Streamflows*</u>

Annual flow regime, the seasonal discharge pattern of flow over a year, strongly influences the abundance and composition of biotic communities in streams (Hynes 1970). For example, the stability, timing, and volume of stream flows influence the reproductive success of fish (Nuhfer et al. 1994; Strange et al. 1992; Bovee et al. 1994; Zorn and Nuhfer 2007a; Zorn and Nuhfer 2007b) as well as their abundance, growth, and survival (Coon 1987, Seelbach 1986). Streams with a stable flow regime, or uniform flow throughout the year, typically have more stable channel morphology and fish assemblages compared to streams with variable flow regimes (Leopold et al. 1964; Poff and Allan 1995). Channel morphology in streams with variable flow regimes, which experience more frequent high-flow events, is less stable because the erosive power of a stream increases in proportion to its discharge. In Michigan, streams with variable flow regimes are typically runoff (rather than groundwater) driven, warm in summer, and have high year-to-year variability in fish reproductive success.

We described annual flow stability at USGS gaged sites within the Cheboygan River watershed using the 10:90% exceedence flow ratio. The 10% exceedence flow is the discharge that is exceeded 10% of the time (i.e., high flows) and typically occurs in conjunction with peak snowmelt runoff and high precipitation levels present during March and April in northern Michigan. The 90% exceedence flow is the discharge exceeded 90% of the time (i.e., base flows) and is representative of typical summer or winter low-flow conditions. Higher 10:90% exceedence ratio values indicate flashiness, or lower flow stability.

The Sturgeon River from its headwaters to the USGS gage at Wolverine has the most stable annual flow regime of any segment within the watershed. The 10:90% exceedence ratio at this location was 1.8, which is lower than the ratio found in other Michigan catchments of similar size (Figure 9) and comparable to the average 10:90% exceedence ratio of 1.9 for all gaged sites on the Au Sable River, a renowned trout stream (Zorn and Sendek 2001). The stable flow regime in the headwaters of the Sturgeon River is due to the high ground water inflow resulting from the permeable soils and variable topography present in this catchment.

Annual flow regimes at most other gage locations within the watershed are also stable. The 10:90% exceedence flow ratio for sites on the Indian River, Pigeon River, Cheboygan River, and Black River near Tower ranged from 2.0 to 3.2 (Table 5), which are low compared to the ratio found in other similar-sized Michigan catchments (Figures 10-13). Permeable soils in the Pigeon River catchments, the buffering capacity of large lakes, and run-of-river operation of dams near the Cheboygan and Black river gage locations (see **Dams and Barriers**) all contribute to stable annual flow regimes. The annual flow regime of the Black River near Cheboygan is slightly less stable than the Black River near Tower. The 10:90% exceedence flow ratio of 6.7 at this gage is moderate compared to other catchments of similar size in Michigan (Figure 14).

In contrast to the stable annual flow regimes at most gage locations within the Cheboygan River watershed, the 10:90% exceedence flow ratio at the two Rainy River sites is very high. Although the data set is relatively small and dated compared to other gages, the flow regime of the Rainy River near Onaway appears to be unstable, with a 10:90% exceedence flow ratio of 64.0. More recent data collected from the Rainy River near Ocqueoc also show an unstable annual flow regime, with a 10:90% exceedence ratio of 33.3 (Table 5). This is high compared to other similar-sized catchments in Michigan (Figure 15), even those such as the River Rouge at Southfield and Lower River Rouge at Dearborn, which are influenced by urban development. Very low minimum flows in the Rainy River (Table 5) result from the flat, karst topography of the catchment (see **Geology**), and limit fisheries management potential.

Daily streamflows

USGS gage data indicate that daily flow regimes are stable throughout most of the watershed. The exception is at the Pigeon River near Vanderbilt, where the gage is located one mile downstream of Golden Lotus Dam (see **Dams and Barriers**). In natural systems, or impounded systems that operate at run-of-river flow, changes in daily discharge are usually gradual. However, dramatic changes in discharge occur over a very short period in impounded systems with peaking operations, where sudden releases of impounded water occur to meet increased power demands. This is the case in the Pigeon River, where the Golden Lotus Dam at Lansing Club Pond is peaked to generate electricity for the Song of the Morning Ranch.

The peaking operation of the Golden Lotus Dam causes extreme flood and drought conditions daily, which is stressful to aquatic organisms. Alteration in daily flow regimes creates unnatural changes in the hydrological function of the river with accompanying changes in erosion, sedimentation, shape of the channel (see **Channel Morphology**), and ultimately instream habitat. High flow conditions during the time of incubation and fry emergence negatively impacts survival of eggs and young fish, and reduces the density of older age classes, for salmonids such as brown trout in Michigan (Nuhfer et al. 1994, Zorn and Nuhfer 2007a, Zorn and Nuhfer 2007b) and elsewhere (Strange et al. 1992; Jensen and Johnsen 1999; Spina 2001; Cattanéo et al. 2002; Lobón-Cerviá 2004).

Zorn and Nuhfer (2007b) estimated the 50% swim-up dates for brown trout fry in several northern Michigan streams during a ten-year period (1995-2006) and found that the average date varied from mid-April to mid-May, depending upon winter severity. The time period of elevated streamflows due to increased runoff from spring snowmelt and seasonally high precipitation levels overlaps these emergence dates in Northern Michigan; thus peaking operations in the Pigeon River further exacerbate the problem of fluctuating stream flows during a time when young fry are already at risk from natural variability in discharge. For example, daily stream flows in the Pigeon River below Golden Lotus Dam fluctuated as much as 519% in a 24-hr time period during April of 2006 (USGS 2007). Daily flow fluctuations in the neighboring Sturgeon River, which is unaffected by dams, was much more gradual (Figure 16). Such extreme fluctuations undoubtedly have a negative effect on the habitat quality and aquatic community (particularly salmonid populations) in the Pigeon River.

Climate

The 115 to 120-day average growing season in the Cheboygan River watershed is short compared to other climate districts in the Northern Lower Peninsula (Albert et al. 1986). Since less evapotranspiration occurs due to the shorter growing season, more rainfall can contribute to streamflow. Mean annual precipitation is about 30.3 inches, but there is considerable local variation in climatic conditions such as snowfall, rainfall, and temperature due to the watershed's proximity to the Great Lakes, large inland lakes, and variable topography (Albert et al. 1986).

Soils and Land Use

Soils and Sedimentation

The water quality of a river is determined, in part, by soil types and slopes present within the watershed. Soil type and slope determine potential land use, infiltration rates, water-holding capacity, and erodibility, and are therefore directly related to the amount of non-point source pollution (such as sedimentation) in the watershed (NEMCOG 2003). Soils in the Cheboygan River watershed range from well-drained, sandy soils to poorly-drained organic soils. Sand and loamy-sand soils are most common (Figure 17), and located throughout the entire watershed. Other soil types are less common and are distributed sporadically throughout the watershed (Figure 18). Detailed soil information is available from the local county Conservation District.

Natural erosion and sedimentation are inherent to a sandy watershed such as the Cheboygan, and are of less concern than those influenced by human activity. Historic logging activities (see **History**) dramatically increased erosion, and accordingly, sedimentation rates in the watershed. Clear-cutting forests and transporting the logs downstream to sawmills increased erosion rates and introduced tremendous amounts of sediment into river systems throughout northern Michigan. Runoff from cutover land increased due to reduced evapotranspiration by the remaining plant cover, exacerbating the problem. After the construction of hydropower dams in the watershed (see **Dams and Barriers**), peaking operations increased the discharge and erosive power of rivers and further destabilized raw stream banks, many of which continue to contribute sediment in some areas of the watershed.

In addition to diminishing water quality, excess sediment may result in reduced areas suitable for fish spawning (Alexander and Hansen 1983, Alexander and Hansen 1986), less diverse fish communities (Alexander et al. 1995), reduction of aquatic insect abundance and diversity (Alexander and Hansen 1986), and reduced recreational opportunities. To correct these problems, streambank erosion inventories have recently been conducted by local non-profit organizations, county Conservation Districts, and watershed councils to identify priority sites for repair by scoring them with a severity index based upon the size and cause of erosion. Although the Best Management Practices (BMPs) such as stairways, seeding or planting banks, fencing, and rip-rap used to correct erosion problems are fairly straightforward to implement, they are costly. Costs for streambank erosion repairs at priority sites in the Maple and Sturgeon river catchments alone are estimated at $150,000 (Tip of the Mitt Watershed Council 2001).

Present activities such as residential and commercial development, oil and gas development, and the accompanying road construction and maintenance contribute to increased rates of erosion and sedimentation. Road-stream crossings are of special concern, because they provide access and a path for sediment and other pollutants to enter surface waters. There are 779 road-stream crossings in the Cheboygan River watershed (Figure 19). Similar to streambank erosion sites, local not-for-profit organizations and their partners have inventoried many of these crossings in order to characterize their potential to deliver sediment to the streams and rivers of the watershed. These inventories use a severity ranking index based upon the soil type, steepness of approaches, impacts to habitat, and other conditions present at each site to help determine priority sites for repair. Again, such repairs are costly; for example, repair costs to install BMPs at 127 road-stream crossings inventoried in the Black Lake catchment are estimated at nearly six million dollars (Huron Pines RC&D 2002).

Reducing erosion and sediment contributions from human development involves not only funding, but also education. Erosion and sediment control can protect aquatic resources within the watershed by minimizing erosion and off-site sedimentation through a practical combination of procedures, BMPs, and people (MDEQ 2005). Incorporation of BMPs for reducing erosion and sedimentation requires public education on the ecological and economic effects of sediment on streams; proper site planning; soil erosion prevention practices; sediment control practices; and site inspection, maintenance, and follow-up. Although incorporation of some BMPs may involve more upfront costs, they can protect a stream and save money in the long run (Zorn and Sendek 2001). Educating riparian owners about erosion and sedimentation is important, as many of the erosion sites will be on private property.

Past and Present Land Cover

Land cover in the Cheboygan River watershed has changed over the last 200 years. Historical land cover data circa 1800 (Figures 20a and 21) show the watershed was almost entirely covered by forests (75%) and wetlands (19%). Forests and wetlands still predominate today (68% and 18%, respectively), although some of the land has been converted to agriculture or urban development (Figures 20b and 22). This loss of forest and wetland is less severe than in other watersheds within the region. For example, in the neighboring Thunder Bay River watershed, wetlands comprised 34% of the watershed in 1800, but decreased to 18% by 1983, a 47% net loss (Cwalinski et al. 2006).

The distribution of current land cover types across the Cheboygan River watershed is similar to historical patterns. The majority of the watershed is forested, with wetland scattered throughout. Agriculture is also scattered throughout the entire watershed, and is most common in the Maple River, lower Cheboygan River, and Mullett Lake catchments as well as the headwaters of the Sturgeon and Pigeon rivers (Figure 22).

Land Use

Slightly more than 63% of the Cheboygan River watershed is under private ownership. The remaining public land is within state forest (94.1%), followed by general state ownership (5.7%) and state parks and hatcheries (less than 1% each, Michigan Geographic Data Library 2007). The largest parcel of public land is the Pigeon River Country State Forest, which is comprised of 180 square miles of southeastern Cheboygan, northeastern Otsego, and northwestern Montmorency counties.

Even though urban or developed land comprises less than 2% of the watershed (Figure 20b), it can affect aquatic resources in many ways. Hay-Chmielewski et al. (1995) noted:

> Landscape development for urban use also has dramatic effects on the aquatic environment (Leopold 1968; Booth 1991; Toffaleti and Bobrin 1991). Development noticeably increases the percentage of impervious land area, resulting in more water reaching the stream channel more quickly as surface runoff. Urban and higher-density suburban areas typically have 50-100% and 25-45% impervious surface areas, respectively (Toffaleti and Bobrin 1991). Impervious surfaces include pavement (roads and parking lots) and roofs of buildings. These have runoff coefficients 6-14 times greater than for undisturbed land (Toffaleti and Bobrin 1991). Engineered storm water runoff systems also speed surface runoff. Increased runoff causes greater peak flows, harmful to reproduction and survival of many aquatic organisms, more erosion, decreased groundwater recharge and thus base flow, increased summer temperatures, and decreased available habitat (Leopold 1968; Booth 1991). Development that brings the construction of wells reduces groundwater table levels and stream summer base flows, with a resulting increase in water temperature and decrease in available stream habitat. Following use, most of this water returns to the system as heated surface water, causing increased and more variable water temperatures.

Although the majority of the Cheboygan River watershed is currently forested, residential growth and development is expected to increase (Michigan Society of Planning Officials 1995). For example, the populations of Montmorency and Otsego counties are projected to grow by more than one-third between 2005 and 2020 (Michigan Information Center 1996). This population increase is of concern because the headwaters of the Sturgeon, Pigeon, and Black rivers are located within these two counties. The overall health of a river system is often dependent upon its headwater stream network, which plays a critical role in sediment and nutrient control as well as the hydrologic and biological processes that supply water and food for aquatic organisms. Residential or commercial development within the watershed that is concentrated in close proximity to surface waters, particularly in headwater areas, may stress aquatic systems.

Increased residential development is not solely attributable to an increase in the number of full-time residents within the watershed. The six counties within the Cheboygan River watershed (see **Geography**) are also popular locations for second homes, including summer residences and cottages, due to the natural resources and abundant recreational opportunities that are present. The number of second homes is expected to increase at least 41% in these counties between 1990 and 2020 (Michigan Society of Planning Officials 1995).

Agricultural land use also can alter the quality of aquatic resources. Intensive farming practices such as heavy applications of fertilizers, pesticides, and herbicides; high densities of livestock in pastures; and stream channelization and wetlands drainage to expand agricultural acreage intensify the degradation of aquatic communities (Wang et al. 1997). Although the total area of agricultural development within the Cheboygan River watershed is small (6%, Figure 20b), efforts to reduce nutrient inputs, sedimentation, and runoff from agricultural practices through education and the use of BMPs, particularly in headwater and tributary reaches, will help protect these sensitive areas.

Oil and Gas Development

Oil and gas development can have adverse effects within a watershed. The disturbance of soils from road construction, clearing well pads, and drilling and laying subsurface pipelines contributes to increased runoff and sedimentation. Illegal use of pipeline right-of-ways and access roads by all-terrain vehicles further exacerbates this problem. Pollution from spills of drilling fluids and cuttings, equipment lubricant, and deteriorating flow lines also threaten aquatic resources, including groundwater. In addition to these environmental concerns, noise pollution from facilities such as compression stations detracts from a peaceful outdoor experience for recreationists.

Recent efforts to minimize the adverse effects of oil and gas development have met with some success (Zorn and Sendek 2001):

> Improved techniques have been developed for drilling and laying subsurface pipelines. Replanting work areas has reduced sedimentation, but work is needed to ensure that disturbed soils are quickly re-vegetated. Problems with excess noise from facilities have been addressed with varying degrees of success. Density of future wells is limited to one well per 80 acres. Increased spacing of wells and use of angular drilling techniques would reduce the density of well pads and resulting sedimentation. Regulations have been passed that require on-site containment of accidental spills. Most spills from the past (20-40 years ago) have been, or are nearly, cleaned up.

There are currently 2,980 oil and gas wells within the Cheboygan River watershed (Figure 23). The oil and gas deposits in the Cheboygan River watershed are near full development. Development is most intense and nearing capacity in the southern portion of the watershed near the headwaters of the Sturgeon, Pigeon, and Black rivers in southern Cheboygan and northern Otsego and Montmorency counties. Development is much less intense in the northern portion of the watershed, where the Antrim formation disappears and seismic information from Niagaran exploration has ruled out drilling further exploratory wells (Figure 4). Very little future development is likely to occur in this area (A. Sullivan, MDEQ Office of the Geological Survey, personal communication). Continued vigilance is needed to minimize the effects of current oil and gas development and protect the surface and groundwater resources within the watershed.

Channel Morphology

Channel Gradient

Gradient is the general slope, or change in vertical elevation, of a river's channel (usually in feet per mile). The gradient of a river is directly related to its habitat features; accordingly, the biological community that is present is directly related to gradient. Zorn and Sendek (2001) summarize the importance of gradient to the hydrological and biological function of a river:

> River gradient, together with flow volume, is one of the main controlling influences on the structure of river habitat. Steeper gradients allow faster water flows with accompanying changes in depth, width, channel meandering, and sediment transport (Knighton 1984). In the glaciated Midwest, high stream gradients often occur where streams cut through end moraine deposits. When the deposits are coarse-textured (e.g., sands or gravels) and elevation changes are large, stream channels receive high inflows of groundwater (Wiley and Seelbach 1997). In this way, stream gradient is related to other important variables such as stream temperature, current velocity, bottom substrate, and flow stability, and is especially important to coldwater fishes (Zorn et al. 1997). Gradient has also been used to describe habitat requirements of cool- and warmwater fish species including smallmouth bass (Trautman 1942; Edwards et al. 1983), largemouth bass (Stuber et al. 1982), northern pike (Inskip 1982), white sucker (Twomey et al. 1984), black crappie (Edwards et al. 1982), blacknose dace (Trial et al. 1983), and creek chub (McMahon 1982).

In general, gradient decreases in a downstream direction with a commensurate increase in stream flow and corresponding decrease in sediment size (Rosgen 1996). However, as the landscape within a river's watershed changes from its headwaters to its mouth, some portions of the river drop more rapidly than others. These changes in gradient create a diversity of habitat types for fish and other aquatic life. Typical channel patterns in relation to gradient for Michigan are shown below (G. Whelan, MDNR Fisheries Division, unpublished data):

Gradient class	Value (ft/mi)	Channel characteristics
Low	0–2.9	Mostly run habitat with low hydraulic diversity
Medium	3–4.9	Some riffles with modest hydraulic diversity
High	5–9.9	Riffle-pool sequences with good hydraulic diversity
Very high	10–69.9	Well-established regular riffle-pool sequences with excellent hydraulic diversity
	70–149.9	Chute and pool habitats with only fair hydraulic diversity
	>150	Falls and rapids with poor hydraulic diversity

Hydraulic diversity refers to the variety of water velocities and depths found in a river. The best habitat offers high hydraulic diversity with a wide array of depths and velocities (e.g., pools, riffles, and runs) to support the various life stages of different species (Zorn and Sendek 2001). Fish and other life are typically most diverse and productive in those parts of a river with gradient between 10 and 69.9 feet per mile (G. Whelan, MDNR Fisheries Division, unpublished data). Such gradients are rare in most areas of Michigan because of the low relief of the landscape and because these areas were typically where dams were constructed. In the high-relief landscape of the Cheboygan River watershed, however, very high gradient reaches are fairly common.

Gradient in the Cheboygan River watershed was estimated using a geographic information system (GIS) and methods used by Brenden et al. (2006). The spatial data layers used included a digital elevation model (DEM) and the National Hydrography Dataset for streams (USGS 2000). Gradient was calculated using elevation in meters from the DEM of the upstream and downstream nodes of each stream reach in the NHD layer. This method produces a conservative estimate of gradient, and was the most efficient technique for calculating gradient across a watershed. The results are not intended for detecting fine-scale changes, as they depend upon the location of the beginning and ending nodes for each stream reach and the elevation where each node was located. For example, an impoundment may cover some higher gradient reaches of river that may not be accurately depicted using this methodology. Rather, the results are intended for broad-scale use and interpretation of gradient.

Only about 18% of the nearly 842 miles of stream and river channel in the entire Cheboygan River watershed are classified as low gradient when both tributaries and main stem river segments are considered (Table 7). Slightly less than 5% of the watershed is moderate gradient, while about 16% is high gradient. The majority of the watershed, over 62%, is classified as very high gradient (including chutes, pools, falls, and rapids), which is not surprising given the high relief of the landscape. However, the inclusion of small headwater streams in the GIS model may overestimate the amount of channel in the very high gradient classes. Some of these streams, many of which are groundwater-fed springs, originate in the upper-most parts of the watershed. These small tributaries are included as part of the entire basin, but some care should be taken when interpreting the data. Nevertheless, many of the major tributaries in the Cheboygan River watershed are predominantly high-gradient or steeper (Figures 24-28). In fact, Gooding (1995) noted that the watershed contains some of the highest gradient in the Lower Peninsula. Such reaches generally receive higher groundwater inflow, have good to excellent hydraulic diversity, are colder, and are more likely to support coldwater fish assemblages than low to moderate gradient reaches within the basin.

The gradient within specific segments varies due to local topology and the position of different segments within the landscape. For example, beginning in the Maple River sub-watershed the 16-mile long segment of the West Branch Maple River from its headwaters to Maple River Dam is nearly 60% low gradient, while the remainder is high gradient. The greatest hydraulic diversity in this reach occurs downstream of the segment's origin in the Pleasantview Swamp where the river accrues groundwater as it flows downstream and ends with high gradient, high groundwater, and cold temperatures. Conversely, almost three-quarters of the 6.2-mile reach of the East Branch Maple River from its headwaters at Douglas Lake down to the Maple River Dam is very high gradient with less low-gradient habitat (low-gradient habitat is found primarily between Douglas Lake and the confluence of Van Creek). The East Branch Maple River is similar to the West Branch in that it starts as low gradient (in this case as a lake outlet) with little groundwater and warm temperatures, but also ends with high gradient, high groundwater input, and cold temperatures (Table 6). Moving further downstream, the 6.8-mile long segment of the main stem Maple River from the dam at Lake Kathleen to its mouth at Burt Lake is classified as over 50% high gradient, with the remainder of this segment classified as either medium or very high gradient (Table 8). The combination of high gradient and moderate groundwater inflows throughout this reach create high-quality coldwater habitat.

Moving east to the Sturgeon River and Burt Lake segments, the gradient in 24.6 river miles of the main stem Sturgeon River from its headwaters to the confluence with the West Branch Sturgeon River, as well as 14.1 miles from the West Branch Sturgeon River to Burt Lake, is considerable. More than 90% of both reaches are high or very high gradient. The riffle-pool sequences that are characteristic of this high-gradient habitat create good to excellent hydraulic diversity, which in combination with the high groundwater inflows contribute to exceptional coldwater habitat in these segments. Excellent hydraulic diversity and high-quality coldwater habitat are also present in the West Branch Sturgeon River, where more than 95% of the segment's 17.8 miles are very high gradient (the only low gradient portion of this reach occurs in the vicinity of Hoffman Lake in Charlevoix County). Besides the Sturgeon River, the most notable tributary within the Burt Lake segment is the Crooked River. This 5.2 mile-long section of the Inland Waterway is low-gradient habitat that is dredged by the U.S. Army Corp of Engineers to support navigation and, therefore, has little hydraulic diversity (Table 8).

Further east in the Pigeon River and Mullet Lake segments, the mainstem Pigeon River flows for 14.3 miles from its headwaters to Golden Lotus Dam and another 15.4 miles from Golden Lotus Dam to the confluence of the Little Pigeon River. Due to the considerable relief of the landscape, the majority of both segments flow through a channel classified as either high or very high gradient with substantial groundwater inflows and good to excellent hydraulic diversity (although a small amount of this reach near Lansing Club Pond is classified as low gradient). Moving downstream, nearly two-thirds of the Pigeon River from its confluence with the Little Pigeon River to its mouth at Mullett Lake has a channel classified as very high gradient. The remainder of this 14.5-mile segment is low gradient, which occurs due to the decreasing relief of the landscape as the river approaches the “spreads” at Mullett Lake. Coldwater habitat is available in the upper portions of the segment but becomes less abundant as gradient and groundwater inflow decline in the lower portion of the river. The other major tributary in the Mullet Lake sub-watershed, the 4 mile-long Indian River, is dredged by the U.S. Army Corp of Engineers to support navigation within the Inland Waterway. The Indian River drops less than one foot over its length and the entire river is classified as 100% low gradient with little hydraulic diversity (Table 8).

In the upper Black River more than 70% of the two upstream-most main stem reaches (the 28-mile long stretch of the Black River from its headwaters to Clark Bridge Road, and the 19-mile segment from Clark Bridge Road to Kleber Dam) have high or very high gradient. Groundwater inflows are high throughout most of these two segments (but not as substantial as the Sturgeon or Pigeon rivers) and create good hydraulic diversity and abundant coldwater habitat. The exception is the lower portion of the segment from Clark Bridge Road to Kleber Dam, where groundwater inflows decrease and cause in an increase in water temperature and coolwater habitat. Gradient decreases downstream, where nearly 90% of the 9.5-mile segment of the main stem Black River between Kleber Dam and Black Lake is comprised of medium gradient (Table 8). Groundwater inflow throughout this entire segment is low, creating mostly coolwater habitat with modest hydraulic diversity.

The gradient of the two major tributaries in the upper Black River are somewhat different. The 20 mile-long East Branch Black River segment is classified as high or very high gradient. Groundwater inflows in the East Branch Black River are substantial and contribute to good coldwater habitat with good to excellent hydraulic diversity. In contrast, the gradient of Canada Creek is more variable. Less than 5% of this 20.4-mile segment is low gradient, while 80% of the segment is comprised of medium and high gradient. The remaining portion of Canada Creek has very high gradient (Table 8). Groundwater inflows increase from upstream to downstream and are not as significant as the East Branch Black River, creating cool to coldwater habitat with modest to good hydraulic diversity.

The most notable tributary within the lower Black River watershed (beginning in the Black Lake segment) is the Rainy River. More than 80% of the Rainy River is classified as high or very high gradient. However, groundwater inflows are very low due to the local karst geology. Thus, the Rainy River has little fishery management potential. Gradient in the Lower Black River from Black Lake to its mouth at the Cheboygan River is mostly low to moderate gradient (Table 8). There is one very high gradient reach located about two miles downstream from Black Lake, which extends downstream to the area currently impounded by Alverno Dam. Due to the proximity of Black Lake and the local geology, warmwater habitat with low to moderate hydraulic diversity is common throughout the 11-mile segment.

In the most downstream portion of the Cheboygan River watershed, the majority of the Cheboygan River from its outlet at Mullett Lake to the mouth at Lake Huron is classified as low gradient, although some moderate gradient exists (Table 8). The surrounding low-relief landscape in this segment combined with the influence of large lakes, overall watershed size, and dredging create warmwater habitat with low to modest hydraulic diversity.

Channel Cross Sections

Channel cross sections vary as a function of annual flow regime, sediment bedload, size and type of bed material (substrate), and bank materials (Rosgen 1996). Since the width of a stream channel can be influenced and modified by a number of factors such as direct disturbance (i.e., dredging or channelization) or changes within the watershed (deforestation, poor agricultural land practices, construction of road-stream crossings, etc.) channel cross sections can be used to monitor the quality of fish habitat.

Changes in width, or deviation from an expected value, often indicate disturbance or change to a river. For example, dredging, channelization, and bridge construction may artificially deepen a river by creating an overly narrow channel. Sedimentation from eroding streambanks, poor road-stream crossings, and deforestation can fill a channel, causing it to become overly wide in order to accomodate the volume of water being transported. Some changes in width occur because of characteristics inherent to the channel, such as bank or bed materials that are naturally resistant to erosion, while others occur due to human-made materials added to streambanks to provide extra stabilization. Monitoring stream width can identify where changes are occurring, or have occurred in the past.

We evaluated channel characteristics by comparing the average width of rivers within the watershed to that of similar sized rivers using equations developed by Leopold and Maddock (1953) and Leopold and Wolman (1957). Channel widths within the Cheboygan River watershed were measured by the MDNR and the USGS while measuring stream discharge. Representative cross sections were measured when possible; every effort was made to ensure that measurements taken near road crossings were completed in a manner to avoid the constriction in flow caused by bridges or culverts.

Channel cross section and discharge were measured at 20 locations within the Cheboygan River watershed (Table 9) during low-flow periods between 2001 and 2007. We calculated expected cross-sectional width (ft) from measured discharge (cubic feet per second; CFS or ft^3/s) with the following equation:

$$\text{Log (Width)} = 0.741436 + 0.498473 * \text{Log (mean daily discharge)}.$$

We used actual (measured) discharge rather than mean daily discharge data at many of the sites because long-term data were not available. Some caution is advised when interpreting such single-point measurements because they do not incorporate the natural variability inherent to river channels.

Three-quarters of the measured channel widths in the watershed were within the expected range, while the remaining channel widths were narrower than expected. This result is not surprising given the abundance stable flow streams in the watershed. Comparisons of observed and expected widths for each segment are discussed below.

West Branch Maple River – Headwaters to Maple River Dam

One channel cross section was measured within the West Branch Maple River. Width at the site 200 ft upstream of Robinson Road was within the expected range at the estimated discharge (Table 9). This particular stretch of the river segment flows through a tag alder riparian zone with stable banks and a predominantly sand substrate.

East Branch Maple River – Headwaters to Maple River Dam

Width at the only cross-sectional measurement in the East Branch Maple River was well within the expected range (Table 9). The riparian zone at this site, 400 ft downstream of C64 (Mills Road), is primarily small deciduous forest, which in combination with the stable banks contributes to a stable channel.

Maple River – Maple River Dam to Burt Lake

Channel cross section data were available for one site in the Maple River located approximately 1100 ft below the dam at Lake Kathleen. The measured width at this location was slightly narrower than expected (Table 9), which is not surprising given the proximity of the dam. The dam constricts flow and contributes to the narrow channel, which is protected from further destabilization by the vegetated banks in the forested riparian zone and the abundant gravel substrate.

Sturgeon River – Headwaters to confluence with West Branch Sturgeon River

One channel cross section was measured in this segment of the Sturgeon River in 2005. Width in a 1000 ft stretch of river downstream of the ATV/snowmobile bridge near Trowbridge Road was narrower than expected given the estimated discharge (Table 9). Numerous bridges occur in this particular reach, including the all-terrain vehicle (ATV) / snowmobile bridge, Trowbridge Road, and I-75. The bridges constrict flow, which narrows the channel. Excessive downcutting (deepening) of the channel is prevented by the firm cobble and gravel substrate.

West Branch Sturgeon River

Width at the only cross-sectional measurement in the West Branch Sturgeon River was within the expected range of values. The proximity of the bridge at Old 27 Highway, which is located midway through the sampling station where discharge was measured, may explain why the measured value was on the narrow end of the expected range (Table 9). The vegetated riparian zone, stable banks, and firm substrates present at this location help to stabilize the channel.

Sturgeon River – Confluence with West Branch Sturgeon River to Burt Lake

The USGS collects cross-sectional width measurements at the gaging station located in Wolverine, just below the confluence of the West Branch Sturgeon River and towards the upstream end of the catchment for this segment. The width of the river at this location is well within the expected range of values for the given discharge (Table 9).

Burt Lake

Channel cross section data were available for one stream within the Burt Lake segment, the West Branch Minnehaha Creek. The width of the stream 150’ downstream of Berger Road was within the expected range of values (Table 9).

Pigeon River – Headwaters to Golden Lotus Dam

No cross-sectional data were available for the segment of the Pigeon River from its headwaters to Golden Lotus Dam. We assume that the width of the river in this reach is within the expected values due to the stable flows, forested riparian corridor, and infrequent road-stream crossings. The exception is the impounded reach of the river above the dam itself, which would cause the river (impoundment) to be wider than expected.

Pigeon River – Golden Lotus Dam to confluence with Little Pigeon River

Width was measured at three locations in this segment of the Pigeon River. Two sites were in the main stem river; the first at the USGS gage station at Sturgeon Valley Road near Vanderbilt, 1 mile below Lansing Club Pond and at the upstream end of the catchment for this reach. The second location was at Elk Hill Campground, located approximately 3.5 miles further downstream. A third site was located in the Little Pigeon River upstream of Burls Road.

At the USGS gage near Vanderbilt, the width of the channel was within the expected range of values for the given discharge. However, width at the Elk Hill Campground was narrower than expected (Table 9). The peaking operation of Golden Lotus Dam (see **Dams and Barriers**) causes stream flow (and accordingly, expected width) to vary widely within this reach, depending upon when discharge measurements are observed. Thus, actual width measurements likely fall above and below the expected range of values throughout the day as the water from Lansing Club Pond is released or held by the dam. These abrupt changes in flow create a disturbance that is devastating to the stream channel and aquatic community, as excessive flows can erode stream banks and increase sedimentation while extremely low flows can leave important spawning and nursery habitat high and dry.

Width at the Burls Road station was within the expected range of values (Table 9). The heavily forested riparian corridor, stable banks, and abundant woody habitat contribute to a stable channel at this site.

Pigeon River – Confluence with Little Pigeon River to Mullett Lake

Data are available for two sites within the segment from the confluence of the Little Pigeon River to Mullett Lake: at the discontinued USGS gage station at Afton, and within the Agnes Andreae Nature Preserve, north of M-68 and directly east of Indian River. Measured cross-sectional width was within the expected range of values at Afton, but was slightly narrower than expected (Table 9) further downstream at the nature preserve where the local topography confines the channel. Coarse bed materials composed of mostly small and large cobble prevent excessive downcutting at this site.

Mullett Lake

No cross-sectional data were available for any of the small tributaries in the Mullett Lake segment. We assume that width of coldwater tributaries to Mullett Lake (such as the upper reaches of Mullett Creek) are within the expected range due to stable flows created by groundwater inflows. Other tributaries that do not receive substantial groundwater inflows may deviate from expected widths due to their flashy nature.

Black River – Headwaters to Clark Bridge Road

Channel cross sections were measured in three locations of the headwaters segment of the Black River upstream of Clark Bridge Road. The first site is referred to as the “springs area” and is located midway through the segment off of Black River Road. The second site was located off of Sids Drive in the former Blue Lakes Club, and the third was downstream of the Main River Bridge on Blue Lakes Road. The width at each site was within the expected range of values for the observed discharge (Table 9). The forested riparian zone and groundwater inflows in this segment contribute to a stable channel.

East Branch Black River

One channel cross section was measured in the East Branch Black River in 2007. Width in a reach located 1400 ft downstream of the old railroad grade crossing near Huff Road was within the range expected (Table 9). Similar to other coldwater segments, high groundwater inflow, a forested riparian zone, stable banks, and few road-stream crossings lead to a stable channel.

Black River – Clark Bridge Road to Kleber Dam

Cross section data were not available for the segment of the Black River from Clark Bridge Road to Kleber Dam. Due to the heavily forested riparian zone (particularly in the upper reaches of this segment) we assume that the channel is relatively stable upstream of the influence of Tower and Kleber ponds.

Canada Creek

Three cross sections were measured in Canada Creek within the boundaries of the Canada Creek Ranch. Width at each location (Geodetic Road, Doty Trail, and Wilson Bridge) was within the expected range of values (Table 9).

Black River – Kleber Dam to Black Lake

The USGS collected cross-sectional width measurements at a gage station located near Tower, just below Kleber Dam. The width of the river at this location was narrower than expected (Table 9). This is not surprising given the proximity of the dam, which constricts flow and contributes to the narrow channel.

Black Lake

No cross-sectional data were available for any of the notable tributaries in the Black Lake segment. We assume that width of tributaries within this segment, such as the Rainy River, may deviate from expected because of their flashy nature, a product of the local geology and landscape.

Black River – Lower Black River

Channel cross sections were not available for the Lower Black River. Due to flow regulation from Alverno Dam, width likely deviates from expected values.

Cheboygan River

There were no cross section data available for the main stem Cheboygan River. Given the operation of a large dam and lock system in the lower portion of this segment, and the dredging activities that occur to ensure navigability of the inland waterway, we assume that actual width probably is narrower than expected.

We did not directly calculate hydraulic diversity of stream channels in the Cheboygan River watershed because data available for analysis were all collected from sites where discharge was estimated. Stream cross sections used to estimate discharge were selected because they had more laminar (smooth) flow than other cross sections in the same reach. Such cross sections are very likely to have less hydraulic diversity than randomly selected cross sections and therefore are not appropriate for calculating hydraulic diversity.

Dams and Barriers

There are more than 2,500 dams in Michigan, over 300 of which are located on main stem rivers. Dams were built for a number of different reasons, including log transportation (see **History**), milling operations, hydroelectric generation, recreation, flood control, navigation, for irrigation or domestic water supply, or to hold mine tailings. State and federally-owned dams in Michigan provide water control for waterfowl and fisheries management.

Cwalinski et al. (2006) discuss issues associated with aging and deteriorating structures:

> The majority of dams in Michigan were built decades ago and many have deteriorated due to age, erosion, poor maintenance, flood damage, and poor designs (S. Hanshue, personal communication). Dams in disrepair that are not removed are at a significant risk of failure, particularly during high flow events. Hydropower dams that are no longer economical to operate for power generation are often sold to local government or community organizations interested in protecting the recreational uses or park lands associated with the impoundment. These dams are often taken on without adequate funding budgeted for structure maintenance. Maintenance and licensure can be costly. Many dams are eventually abandoned since local governments and community organizations are not financially prepared for the long-term costs associated with dam ownership.

Dams act as a barrier, disrupting natural flows, and preventing fish passage and movement of other biota. Structures other than dams can act as barriers as well, including undersized or poorly placed culverts at road-stream crossings. Some barriers are intentionally placed in rivers to preclude undesirable fish species from a reach of river; sea lamprey barriers, for instance, have become critical in the control of this invasive species.

There are 48 dams in the Cheboygan River watershed (Table 10, Figure 29). Of the 48 dams in the Cheboygan watershed, 33% are in the Black River drainage (3 dams on the main stem Black); 22% are in the Pigeon River drainage (one dam on the main stem); and 21% are in the Sturgeon River drainage (none on the main stem). Other major dams in the system include a dam on the main stem Maple River. The remaining dams are on various tributary streams. Twenty-six dams (54%) have a head of less than 6 feet, including small impoundments lacking head information; 10 have a head of 6-10 feet; 9 have a head of 11-20 feet; and 3 dams have a head of greater than 20 feet. Most of these dams do not have a large storage capacity for water: 30 dams (62.5%) have a water storage capacity of less than 100 acre-feet; 7 have a storage capacity of 100-999 acre-feet; and 11 can store over 1000 acre-feet of water.

Dams in the Cheboygan River watershed are of varying age. All of the hydropower dams (Tower, Kleber, Alverno, Cheboygan, and Golden Lotus) were built between 1904 and 1955. Most of the dams built for recreational purposes were constructed since 1950, including a private dam built as recently as 2000 in the Black River watershed. Four dams in the watershed have a high or significant hazard rating. High hazard dams could cause loss of life (MDEQ-LWMD, unpublished data). The Golden Lotus Dam on the Pigeon River failed in 1984, releasing a pulse of sediment and water downstream (Franz 1985, Kelley v. Golden Lotus 1984, Fisheries Division files). This failure resulted in a substantial fish kill (Alexander and Ryckman 1986). An even larger fish kill occurred in conjunction with a significant release of sediment from the Golden Lotus Dam in 2008 (Nuhfer et al. 2009a). On April 5, 2010, an interim order was entered with the 46th Circuit Court calling for removal of the Golden Lotus Dam after a plan for dam removal is developed and monitoring is conducted.

In the Cheboygan River watershed, the State of Michigan regulates 16 dams that impound five or more acres and have a dam height of greater than six feet (J. Pawloski, MDEQ, personal communication). Legal lake levels have been established on two lakes in the watershed (see **Special Jurisdictions**). The Federal Energy Regulatory Commission, with assistance from the State of Michigan, regulates four dams: Cheboygan Dam, Alverno Dam, Tower Dam, and Kleber Dam.

Effects of Dams on Ecosystems

Dams have the potential to alter hydrological, geological, and biological processes of a watershed. Dams can alter hydraulic characteristics such as width, depth, and velocity; affect temperature and dissolved oxygen; alter sediment and nutrient transport dynamics; and result in habitat alteration and fragmentation (Cushman 1985, Brooks et al. 1991, Burroughs 2007, Godby 2000, Lessard 2001, Woldt 1998).

Temperature/Dissolved Oxygen

Dams have a major influence on water temperatures. Depending on the location of the outflow mechanism and the degree of stratification in the impoundment, the downstream effect can be either warming or cooling. If the reservoir is deep enough, it will stratify like a natural lake, resulting in a warmer epilimnion (top layer) and a colder hypolimnion (bottom layer). Top-draw dams will generally result in warmer downstream water temperatures during summer months, while bottom-draw dams will generally result in cooler downstream water temperatures during summer months if the impoundment stratifies (Cushman 1985, Petts 1984, Woldt 1998).

Lessard (2001) reports that even small dams can increase downstream temperatures by more than 9°F. A significant impact of warm water discharge is that it elevates temperatures around the clock. In free flowing rivers, water temperatures typically fall at night as the ambient temperature decreases. Below top-draw impoundments, however, there is little cooling at night, so no thermal relief is provided to downstream biota (Woldt 1998).

In the Cheboygan River watershed, dams can affect downstream water temperatures. The Maple River Dam warms the water 4-5°F, based on mean July water temperatures. Tower and Kleber Dams on the Black River have a thermal effect, enough to change the river from a cold transitional stream above Tower Pond to a warm transitional stream below Kleber. This thermal effect is magnified in warm summers. While this longitudinal warming of river systems is natural, the presence of the two dams accelerates that warming trend.

Another dam that changes stream temperatures is Golden Lotus Dam on the Pigeon River. In 2005, the reach of river that included the impoundment warmed 0.49°F per river mile, compared with an increase of 0.18 to 0.26°F per river mile in unimpounded reaches of the Pigeon River (MDNR Fisheries Division, unpublished data).

Flow/Substrate

Dams significantly alter a river's flow upstream and downstream of the barrier. Dams are usually placed in high-gradient areas to capture the potential energy of the elevation change. Upstream of the dam, the water is obviously slowed, and turns a previously lotic, or flowing, system, into a lentic, or standing water, system. When water is slowed at a dam, it also drops most of the sediment that it has carried. In this manner, the impoundment acts a giant sediment trap, capturing the silts and sands that are deposited. Alverno Dam on the lower Black River is an example of a dam that impounds a previously high-gradient reach of river.

Downstream of the dam, the changes to substrate can vary, depending upon the flow regime. The artificial fluctuation of flows can create highly unstable habitat (Bain et al. 1988).

Dams that operate in a peaking mode are typically hydropower dams, and operate by holding water back (ponding) when energy demand is lower, and discharging high volumes of water (peaking) when energy demand is higher. Changes in streamflow result in changes to water depth and velocity, as well as a change in the overall aquatic habitat available to fish (Bain et al. 1988). These changes can either flush finer substrate (and incubating fish eggs and fry) downstream, or dewater productive riffle areas within a stream.

Golden Lotus Dam, located on the main stem Pigeon River, is an example of a hydropower dam operating under a peaking mode. As discussed in the **Hydrology** Section of this report, monthly and seasonal flows in the Pigeon River are not inconsistent with other rivers of similar size. The unnatural flow regime becomes obvious, however, when actual flows are examined over a shorter time period. In the Pigeon River below Golden Lotus Dam, regular flow fluctuations are characteristic of a stream below a peaking dam (Figure 30, USGS unpublished data). Flow changes of 100–300% over intervals of just 6 to 12 hours are common, while flow increases of 300–480% and flow decreases of 70–90% over a 6 to 12 hour time period also occur. August of 2005 saw even larger fluctuations downstream of Golden Lotus Dam: flow increased 1,100% in a day, then dropped 90% in 12 hours (Figure 31, USGS unpublished data). The nearby, unimpounded Sturgeon River increased only 290% and then dropped 3% over the same time period. The extreme fluctuations in discharge at this dam were also experienced in May 2006, when flows dropped from a peak of about 145 cfs to a low of less than 21 cfs in a six hour time period (Figure 32, USGS unpublished data). Extreme daily flow variation of 100% downstream of Golden Lotus Dam occurs about 25% of the time whereas similar variation in daily flow occurs only about once every 2 years in the adjacent unregulated Sturgeon River.

A quote form Nuhfer et al. (2009b) summarizes the contrast in flow variation for these neighboring streams:

> MDNR's analysis of flow data collected from October 1989 through September 2007 showed that in the Pigeon River daily flow varied by over 100% about 24% of the time, or 1,388 out of 5,818 days. In the adjacent Sturgeon River, daily flow varied over 100% on only 9 days out of 5,812 days of flow records (0.15% of days). The contrast in daily flow variation between the two rivers was even more striking when MDNR examined how much higher daily maximum flows were than daily minimum flows. From October 1989 through September 2007 daily maximum flows in the Pigeon River averaged 2.2 times higher than daily minimum flows and in one instance daily maximum flow was 17.8 times higher than minimum flow. By contrast, in the Sturgeon River daily maximum flow averaged only 1.1 times higher than daily minimum flows and the most extreme difference was only 4.0 times higher than daily minimum flow during the same 18-year period from 1989 to 2007. On June 23, 2008 the daily maximum discharge of 170.7 cfs in the Pigeon River was 23.4 times higher than the daily minimum flow of 7.3 cfs. In the

> Sturgeon River, the maximum discharge of 225.4 cfs on June 23, 2008 was only 1.16 times higher than the minimum discharge of 195.1 cfs.

Flow changes of this magnitude can exert extremes in erosive force within the river channel. These forces also affect the biota, as discussed below in the aquatic community section. A large log, approximately 14 feet long and about 42 inches in diameter, moved approximately ¼ mile downstream in the upper Pigeon River during one high-flow event. This log was assumed to be left over from the logging era.

Walker (2008c), described siltation below Golden Lotus Dam and its likely source:

> It is probable that the… siltation is associated with the [Golden Lotus] dam and its operation. The siltation could be caused by the widely fluctuating flow regimes eroding the banks upstream of Station 10 and/or from the export of accumulated impoundment silts which are mobilized during periods of rapid impoundment drawdown. When the dam gates are closed, the river discharge and velocity decrease which lets the silt particles settle out. The presence of such a ubiquitous silt coating without much of the main or lateral channel area showing the typical associated thicker depositional areas suggests the silts are regularly exported during rising flows and redeposited during falling flows. During a high flow event in early August 2005, the river was opaque and dark brown… as one would expect with a large concentration of suspended silts.

Golden Lotus Dam is not regulated (licensed) by the Federal Energy Regulatory Commission (FERC). Out of concerns that the project was negatively impacting fish populations and other aquatic resources of the Pigeon River, the State of Michigan requested a FERC jurisdictional review in April 2005. FERC licenses generally require run-of-river (ROR) flow regimes, which provide more stable flows downstream. A FERC order finding that licensing of the Golden Lotus Dam was not required was issued in January 2006. This order identified the circumstances under which a non-federal hydroelectric project must be licensed. Specifically, a license is required if the project:

- is located on a navigable water of the United States;
- occupies lands of the United States;
- uses surplus water or waterpower from a government dam; or
- is located on a body of water over which Congress has Commerce Clause jurisdiction, project construction has occurred on or after August 26, 1935, and the project affects the interests of interstate or foreign commerce [Appendix 1].

The order indicated that the project was not connected to an interstate grid, and that no evidence was found "to document past or present usage of the Pigeon River for navigation in interstate commerce from above and past the project site." The navigation in interstate commerce generally refers to whether the river was used to float logs during the logging era.

In February 2006, the DNR submitted a request for rehearing of the commission's order finding licensing of hydroelectric project not required. In addition to correcting some factual inaccuracies in the FERC order, the request contained additional information to support the contention that Golden Lotus Dam is subject to FERC jurisdiction. The request referenced a Michigan Supreme Court case determining that the Pigeon River was deemed navigable based on floating logs 40 miles upstream of Mullet Lake; a 1910 deed for a dam at that location which specifically referenced use of the property for a dam to float timber; and a US Army Corps of Engineers report which indicates that the Pigeon River was used to float logs from its sources (USACE 1979). The request also indicated that the project was in fact connected to the interstate grid at the time of the jurisdictional review, but was allowed to disconnect from the grid for the sole purpose of avoiding jurisdiction.

FERC issued an order denying rehearing in June 2006, with a detailed response to each argument the Department made in its request. Among other items, the order indicated that it is acceptable for an operator of an unlicensed hydroelectric project to disconnect from the interstate grid to avoid jurisdiction. FERC also indicated that although a deed was issued for a dam at that location for use to float logs, no evidence was provided that indicates logs were actually floated there.

The jurisdictional review correspondence is provided in Appendix 1.

Other dams in the watershed are operated as ROR dams, and do not have the extreme daily flow fluctuations observed at the Golden Lotus facility. Specific flow data for these locations are not presented because flow gages are not present on those other rivers.

Morphology

Rivers can shape landscapes through erosion, transport, and deposition of sediment (Cushman 1985). Morphology refers to the structure and form of stream and river channels including width, depth, and bottom type. By altering fluvial processes, including sediment transport and flow characteristics, fundamental changes to a river's morphology can result. Because of the large, immediate change in elevation at a dam's discharge, erosion is increased immediately downstream of dams, particularly those that operate in a peaking mode.

Nutrient Flow

Dams can also affect the flow of nutrients downstream, since they impound not just water, but hold back woody debris and other organic matter as well. Many stream ecosystems are dependant upon leaves and other coarse particulate matter for the base of the food chain. Dams may prevent downstream transport of debris, resulting in food web changes. Nutrient availability generally decreases downstream of an impoundment because production within the impoundment uses available nitrogen and phosphorous (Petts 1984).

Migration/Movement

Dams present a barrier to fish movement and fragment available habitat. When barriers are present, resident stream fish may not have access to important habitats such as overwinter refugia. Dams and other barriers can also block access to habitats important for various life stages, such as spawning and nursery habitat. Potamodromous fish populations, or those that migrate from fresh water lakes up fresh water streams to spawn, can be greatly affected by dams and perched or undersized culverts. Important potamodromous sport fish species such as lake sturgeon, Chinook salmon, and steelhead (lake-run rainbow trout) depend on coarse gravel or cobble river substrate for spawning. One reason for the threatened status of lake sturgeon is the loss of access to historic spawning grounds (Hay-Chmielewski et al. 1997).

The Cheboygan Dam is a hydroelectric facility and is the first barrier upstream from Lake Huron. Because there is a lock at the dam that enables larger vessels to use the inland waterway, The Cheboygan dam is not a complete barrier. Sea lamprey are able to get upstream around the dam (through the locks), so the USFWS treats the upstream waters with lampricide. The dam, however, does effectively block most fish species from passing upstream. Removal of the Cheboygan Dam would give access to the Sturgeon River watershed and much of the Pigeon River watershed, as well as some of the large lakes (Burt and Mullett). The Cheboygan Dam blocks the upstream migration of species such as lake sturgeon, walleye, chinook salmon, white suckers, and various redhorse species.

Migratory runs and potential production of these species have been severely curtailed or eliminated because of the Cheboygan Dam.

Removal of the dams in the Black River system would increase available sturgeon spawning habitat. Alverno Dam, in particular, impounds a high gradient reach known as Smith Rapids, which historically provided sturgeon spawning habitat (Hay-Chmielewski et al., 1997). Tower and Kleber dams have a negative effect on water quality, inhibit fish passage, and impound an area that would likely be suitable lake sturgeon spawning habitat.

Other major dams in the watershed are significant barriers to fish movement. The East and West Branches of the Maple River have a barrier, Maple River Dam, which isolates those streams from migrating fish populations. The Golden Lotus Dam on the Pigeon River also blocks suitable spawning and nursery habitat for potamodromous fish species.

Barriers to movement of some fish species may have desirable effects. Sea lamprey are a parasitic invasive species and barriers are an important tool for controlling lamprey populations. Lamprey barriers are low-head dams that block access to spawning grounds for sea lamprey, yet most jumping fish species are able to pass these barriers.

Aquatic Community

Dams can affect aquatic communities in a variety of ways. Water depth, current velocity, and substrate are important components of physical habitat that influence fish community composition, and all are parameters that can be affected by dams (Bain et al. 1988, Cushman 1985). Since community composition is primarily dependant upon temperature, dams that alter thermal regimes can change riverine communities. As Lessard (2001) reports,

> Increasing temperatures below impoundments resulted in lower densities of coldwater fish species, specifically brown trout, brook trout, and slimy sculpin, while fish species richness generally increased downstream…. Macroinvertebrates responded to warming with shifts in community composition below dams that significantly increase summer temperature.

An example in the shift of aquatic communities is the Maple River Dam, which forms Lake Kathleen. The West Branch Maple River and the main stem contain good trout populations, and the East Branch Maple has trout at least seasonally. Lake Kathleen reportedly has a northern pike population, which can prey upon trout in the upstream coldwater areas. Dams and their impoundments also contribute warmwater and coolwater species to downstream coldwater habitat.

The Pigeon River macroinvertebrate community was assessed by the Department of Environmental Quality Water Bureau in 2005 as part of that agency’s water quality monitoring program. While water quality was still high downstream of the dam, a shift in the composition of the macroinvertebrate community composition was obvious to the investigator (Walker 2008c).

> …At the first road crossing downstream of the dam [Golden Lotus Dam], the macroinvertebrate community had the highest percentage of tolerant organisms (Isopoda, snails, leeches) out of all the 2005 Pigeon River [and it] was the only station which did not receive a +1 score for the percent tolerent metric. While recognizing the excellent Station 10 [Sturgeon Valley Road] macroinvertebrate metric indicates there is not a water chemistry issue at this location, the elevated numbers of tolerant organisms suggests that the overall conditions at this location are somewhat degraded. Additionally, this was the only station in the survey where Isopoda were found. Compared to the macroinvertebrate community at Station 11, the next upstream location, the Station 10 macroinvertebrate

> community contained fewer mayfly, stonefly, and caddisfly taxa, it had lower community percentages of mayflies and caddisflies, and it had a higher percentage of air breathing taxa. Additionally, organisms in the taxon Mollusca showed a notable increase at Station 10 compared to Station 11. It is not uncommon below lake or impoundment outflows to find increased numbers of macroinvertebrate community taxa, including increased numbers of Mollusca, below lake or impoundment outlets.

The impact of peaking flow regimes on rivers is even more pronounced. High flows can flush fish eggs, juvenile fish, and invertebrates downstream, while low flows can strand fish and invertebrates in pools, or completely dewater productive riffle habitats. The pools associated with dewatering usually have dissolved oxygen levels that are greatly reduced. Downstream of Golden Lotus Dam, steelhead redds are dewatered at 51.7 cfs (MDNR, unpublished data); flows have been documented as low as 20 cfs there (Figure 32). Peaking operations can result in lower biotic productivity downstream (Cushman 1985). Not only are fish communities affected by peaking operations, but the diversity, density, and type of macroinvertebrate communities are also diminished or changed downstream (Cushman 1985). Gislason (1985) reported that abundance of benthic insects was 1.8-59 times higher under a stable flow pattern compared to abundance in the same river when hydroelectric power-peaking induced large daily flow fluctuations.

Dam Removal

Removal of the Cheboygan Dam on the main stem; Alverno, Kleber, and Tower Dams on the Black River; Maple River Dam; Golden Lotus on the Pigeon River would open a significant amount of spawning and nursery habitat to migratory fish species, and has the potential to increase production of chinook salmon and steelhead smolts.

The potential increased production of potamodromous species illustrates the benefits that restoring connectivity to the Great Lakes could provide. Removing all dams within the watershed is unrealistic, however, and may not be desirable from a fisheries management perspective. Fisheries Division Policy on Dams and Barriers (Policy Number 02.01.002; April 2005) states that “dam removal will be considered where the dam serves little or no purpose and there is a reasonable expectation that dam removal will benefit the environment or aquatic resources. If the dam is likely to cause significant damage to public health, safety, welfare, property, natural resources, or the public trust in those natural resources, Fisheries Division will recommend that MDEQ order its removal.” The policy also identifies that some dams function as a sea lamprey barrier or serve other fisheries management objectives. Removal may not be the preferred option for dams that are functional sea lamprey barriers or serve other fisheries management objectives. For example, the Cheboygan Dam is considered a barrier to the movement of viral hemorrhagic septicemia (VHS), a fish disease that was recently documented in Lake Huron. Because of the Cheboygan Dam, waters upstream of the dam are considered somewhat protected from the transport of the disease by fish movement.

The Cheboygan Dam also helps Fisheries Division with management of certain species within the watershed. The Sturgeon River, for instance, is a premier brown trout stream. The Sturgeon River also serves as a broodstock source for the Sturgeon River strain of brown trout reared in MDNR fish hatcheries (see **Fisheries Management**). The Cheboygan Dam limits migration of Lake Huron steelhead and salmon, which may have adverse effects on brown trout to age-1 (Nuhfer 2005). Because of the locks, however, the Cheboygan Dam it is not a complete barrier. Sea lamprey and an occasional salmon are found upstream in the Cheboygan River.

There are additional areas within the Cheboygan River drainage that would benefit from removal or change in dam operations. These dams include the Golden Lotus Dam on the Pigeon River, and the Maple River Dam on the Maple River.

Golden Lotus Dam on the Pigeon blocks the upstream migration of brown trout and steelhead from Mullet Lake. Its peaking flow regime results in numerous impacts to the river and its biota, as described previously. Dam removal would alleviate these problems. Alternate scenarios such as switching to run-of-river (ROR) flow regime and providing fish passage would also improve conditions. Bringing the Golden Lotus Dam under FERC regulation would address some of these concerns through license conditions and 401 water quality certification requirements (see **Special Jurisdictions**). As discussed earlier, on April 5, 2010, an interim order was entered with the 46th Circuit Court calling for removal of the Golden Lotus Dam after a plan for dam removal is developed and monitoring is conducted.

Maple River Dam fragments the Maple River system, blocking upstream migration of brown trout from Burt Lake, and increasing downstream water temperatures. It also provides a lentic environment for predators such as pike to flourish, which may in turn prey on trout. Although Maple River temperatures downstream of Lake Kathleen are relatively cool, temperatures may be further reduced by installing a bottom draw discharge on the dam. A fish ladder could be used to provide passage for migratory brown trout from Burt Lake, but probably would not be effective for non-salmonids. Dam removal would also accomplish these goals while restoring natural flows to the system. The Maple River Dam currently serves as a sea lamprey barrier, and this management concern must be considered in any structural change to the dam. Threatened and endangered species such as the Michigan monkey flower also are present in this area, so their protection must be considered as well (see **Biological Communities**).

Water Quality

General Water Quality, Point and Nonpoint Source Issues

Water quality in the Cheboygan River watershed is affected by point- and nonpoint source inflows and atmospheric deposition. Overall water quality within the basin is generally good, as determined by the criteria described below.

Point source pollutants from sources such as factories and wastewater treatment plants reach the river from designated outfalls or discharge points. These point source discharges are regulated by National Pollution Discharge Elimination System (NPDES) permits. The Michigan Department of Environmental Quality (MDEQ), Water Bureau, has federally regulated authority to administer the NPDES permit program in Michigan. There are 30 NPDES permits in the Cheboygan River watershed, of which 7 are wastewater treatment permits, 7 are general permits, 15 are industrial storm water permits, and one is a construction site permit (Table 11). Wastewater permits cover discharges from treatment facilities and are based on the technology used in treatment, while general permits are standard permits for activities such as sand and gravel mining, hydrocarbon cleanups, and noncontact cooling water discharges. Storm water and construction site permits require that water pollution prevention plans be submitted by the facility and tend to focus more on site management and prevention than point source treatment (R. Shoemaker, MDEQ-WB, personal communication).

Nonpoint source pollutants including nutrients, sediments, and pesticides, reach water bodies through erosion and runoff. Poorly designed road-stream crossings and eroding stream banks can be primary inputs of these pollutants. Inventories of road-stream crossing and eroding stream banks for many parts of the watershed have been conducted by various groups (see **Soils and Land Use**). Although correcting some of these road-stream crossing and eroding stream bank issues is straightforward, it is very costly when examined on a watershed-wide basis.

Air transport from distant sources also contributes pollutants to the watershed. The pollutants from local and distant sources may be deposited via precipitation in the Cheboygan River watershed and Lake Huron. Mercury is an example of a nonpoint source type of pollutant that can affect distant areas through air transport and deposition.

Although water quality in the Cheboygan River watershed is generally good, some measures do indicate that certain water quality standards are not being met. Based on elevated PCB levels found in water chemistry samples near the river mouth, MDEQ reported that the Cheboygan River watershed did not attain Michigan Water Quality Standards, as discussed below (Edly and Wuycheck 2006). Fish consumption advisories are one measure of water quality standard attainment or nonattainment. Lake Huron has fish consumption advisories for some fish species based on PCBs and dioxin. Additionally, several lakes within the Cheboygan River drainage do not meet water quality standards, as discussed below.

Measures of Water Quality

MDEQ Procedure 51 Monitoring

MDEQ Water Bureau surveyed the Cheboygan River watershed streams most recently in 2005, as detailed in a series of reports (Walker 2008a, 2008b, 2008c, 2008d). These stream surveys were conducted using the Qualitative Biological and Habitat Survey Protocols for Wadable Streams and Rivers (Procedure 51, MDEQ 1990). Macroinvertebrate communities, habitat quality, and water quality were evaluated. Assessment and sampling activities were conducted at a total of 66 stations in the Cheboygan watershed in 2005, while reconnaissance observations and notes were made at an additional 86 locations.

Walker (2008a, 2008b, 2008c, 2008d) reported that all assessed streams within the Cheboygan River watershed were supporting the “Other Indigenous Aquatic Life and Wildlife” designated use, and were generally high quality waters. Macroinvertebrate community composition was assessed at 38 sites, and the macroinvertebrate community at 31 sites rated “excellent,” while the other 7 sites rated “acceptable.” Each site had between 20 and 40 taxa, or groups of macroinvertebrates. Some macroinvertebrates (mayflies, stoneflies, and caddisflies) are important indicators of water quality because they have a long life history and are intolerant of stressors such as toxicants and/or low dissolved oxygen. These three orders of insects are often grouped together and termed EPT, an acronym for the names used as part of their scientific classification (mayflies-Ephemeroptera, stoneflies-Plecoptera, caddisflies-Trichoptera). At the surveyed locations, EPT taxa comprised 34-60% of the total number of taxa found at each site (Table 12; see **Biological Communities**).

Walker also noted that in several instances the instream habitat quality was lower than that of the overall habitat quality rating, because of less than optimal in-stream conditions. This was typically the result of excessive sediment (sand or silt) deposition, or limited hard substrate and cover due to a high degree of embeddedness (i.e., the extent to which gravel and cobble are buried by finer sediments).

Water Chemistry

Water chemistry samples were also collected at selected locations during the 2005 biosurvey. Water chemistry data were generally consistent with the macroinvertebrate community findings and indicated high-quality waters.

Milligan Creek had an elevated total copper concentration (150 ug/l) in one sample, but an excellent macroinvertebrate community was present at that location. Potential explanations for the elevated copper concentration include sample contamination or a brief spike in copper levels from an unknown source (Walker 2008a). Walker (2008a) also found elevated levels of sodium, chloride, and potassium in Bowen Creek, near the town of Onaway.

Increased nutrients, sodium, and chlorides were observed in Mullet Creek, suggesting potential anthropogenic sources such as livestock, residences, oil and gas operations, and/or road brining or salting (Walker 2008b).

Slightly elevated levels of chloride, hardness, nitrite/nitrate, iron, and conductivity were found in the upper-most part of the Pigeon River watershed (Walker 2008c). Concentrations of these parameters also increased in an upstream direction in the Sturgeon River watershed (Walker 2008d). Some of the increased levels in the headwaters region of the watershed are likely due to land use activities. These headwater regions contain the City of Gaylord and are the most heavily developed areas of the watershed.

MDEQ Water Bureau also administers a water chemistry program for trend monitoring purposes. A trend site is located near the mouth of the Cheboygan River watershed, at the Lincoln Avenue crossing of the Cheboygan River in the City of Cheboygan. Parameters measured include nutrients and conventionals; base/neutral organics; methyl tert-butyl ether (MTBE); benzene, toluene, ethylbenzene, and xylene (BTEX); mercury and trace metals; and polychlorinated biphenyls (PCBs) (Aiello 2006). Water samples from this site are analyzed at least 4 times annually. In 2004, the Cheboygan River ranked lowest for median concentration of total lead (Pb) and for median total suspended solids. All samples for total mercury (Hg) and trace metals met the applicable Rule 57 Water Quality values (Aiello 2006), and therefore met water quality standards.

Samples collected from the Cheboygan River at Lincoln Avenue as part of the trend monitoring program had elevated PCB concentrations. Although one sample met the Rule 57 water quality value, others samples did not meet that standard. MDEQ listing criteria for nonattainment of water quality standards indicate that a sample size of 1 is sufficient information to determine water quality standard nonattainment for PCBs (Edly and Wuycheck 2006). Elevated PCB levels were not unique to the Cheboygan River, as high PCB levels were ubiquitous in the trend monitoring program, with 99% of the samples collected statewide from 2002-2004 exceeding the PCB Rule 57 water quality value of 0.026 ng/L. “Because the industrial use of PCBs has been banned, the primary sources of PCBs to water likely are historical sediment contamination and on-going atmospheric deposition” (Edly and Wuycheck 2006).

Temperature and Dissolved Oxygen Issues

Temperature and dissolved oxygen concentrations in the Cheboygan River are influenced by the 48 dams in the system. Dams can increase water temperature and decrease dissolved oxygen concentrations (see **Dams and Barriers**). Because they impound coldwater reaches of the Black River, temperature and dissolved oxygen have been issues at the Tower and Kleber dams (Kyle Kruger, MDNR, personal communication).

Fish Contaminant Monitoring

MDEQ also monitors chemical contaminants in fish from waters throughout the State of Michigan. These data are evaluated by MDEQ and the Michigan Department of Community Health (MDCH). MDCH then issues appropriate fish consumption advisories on a species and water body basis. From a human safety standpoint, mercury is the most important contaminant in the Cheboygan River watershed.

Zorn and Sendek (2001) summarized the effects that mercury can have on humans:

> Mercury is highly toxic to aquatic organisms and very persistent in the environment. The methyl form of mercury is most common in fish, and bioconcentration factors from water to fish range between 1,800 and 85,000 (O'Neal 1997). Long-term ingestion of mercury-contaminated fish can produce symptoms such as numbness of extremities, tremors, spasms, personality and behavior changes, difficulty in walking, deafness, blindness, and death. Mercury levels in Michigan fish tend to be higher in larger, fattier fishes of inland lakes than fishes in streams (Michigan Department of Community Health 1998)."

Mercury can enter water bodies from point-source discharges, nonpoint source runoff, or atmospheric deposition. Annual mercury discharge to Michigan's surface waters is approximately 490 pounds (MDEQ Mercury Strategy 2007). Atmospheric emissions of mercury in Michigan total approximately 7,000 pounds per year (MDEQ Mercury Strategy 2007). Most of these emissions are deposited within 622 miles of the sources.

Most of the air emissions of mercury in Michigan in 2002 came from coal combustion (37%), volatilization during solid waste collection and processing (12%), cement manufacturing (10%), mercury-containing products (6%), blast/basic oxygen furnace steel manufacturing (5%), and natural gas combustion (5%). Michigan land (waste) releases total approximately 900 pounds per year. Mercury sources include dental amalgam, switches and relays (including thermostats), measurement and control devices (including thermometers), and fluorescent lights (MDEQ Mercury Control Strategy 2007).

A general fish consumption advisory exists for all Michigan inland lakes (Michigan Department of Community Health 2007) due to the likelihood that top predators have elevated levels of mercury (J. Bohr, MDEQ-Water Bureau, personal communication). A number of lakes within the Cheboygan River watershed were specifically identified as exceeding standards because mercury concentrations have been tested specifically for fish from those lakes. Burt, Crooked, Mullett, and Pickerel Lakes were identified in a report to the EPA as not meeting water quality standards because of high mercury concentrations found in fish from those lakes. For these lakes, "at least one of the fish species [tested] exceeds the acceptable concentration of 0.35 ppm [of mercury], the concentration not expected to pose a health concern to people consuming 15 grams of fish per day" (Edly and Wuycheck 2006).

Stream Classification

In 1967, the MDNR Fisheries Division classified streams throughout the state based on temperature, habitat quality, size, and riparian development. River classification assists with establishing water quality standards for Michigan streams; assessing stream recreation values; designating "wild and scenic" rivers; administering stream frontage improvement and preservation; identifying dam and impoundment problems; administering fishing and boating access; targeting fishing regulations; determining designated trout streams, and guiding riparian land acquisition. Most of the Cheboygan River system is classified as top-quality cold water based on this classification scheme (Figure 33). Top-quality cold water (trout water) is defined as having good self-sustaining trout or salmon populations. Second-quality cold water is defined as having significant trout or salmon populations, which may be appreciably limited by such factors as inadequate natural reproduction, competition, siltation, or pollution (Anonymous 2000).

In 2008, Fisheries Division developed a new classification system for its streams, based on average July water temperatures and fish community composition. Most of the streams in the Cheboygan River watershed are classified as "cold" (Figure 34). The new temperature classification is as follows (Zorn et al. 2008):

Cold: Mean July water temperature ≤ 63.5°F. Fish community is nearly all coldwater fishes; small changes in temperature do not affect species composition.

Cold-transitional: Mean July water temperature > 63.5°F and ≤ 67.1°F. Fish community is mostly coldwater fishes, but some warmwater fishes are present; small changes in temperature cause significant changes in species composition.

Warm-transitional: Mean July water temperature > 67.1°F and ≤ 69.8°F. Fish community is mostly warmwater fishes, but some coldwater fishes are present; small changes in temperature cause significant changes in species composition.

Warm: Mean July water temperature > 69.8°F. Fish community is nearly all warmwater fishes; small changes in temperature do not affect species composition.

Although Fisheries Division primarily uses the new (2008) classification, the 1967 classification is still used for water quality standards. The 1967 classification has legal standards associated with designated cold water systems.

Special Jurisdictions

Federal and state statutes and local land use regulations provide protection to the Cheboygan River watershed. Management plans and special designations provide guidance for public lands management. Case law provides the framework for determining navigability of streams and lakes in the watershed.

State and Federally Designated River Segments

The Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (NREPA) consolidated the majority of the State of Michigan's environmental and natural resource laws into one act. Part 305, Natural Rivers, NREPA, was established in 1971 and provides a means for the state to protect select river systems from unwise development patterns. A river system is designated a Natural River for the purpose of preserving and enhancing a range of values, including its free flowing condition, and its fisheries, wildlife, scenic, and recreational resources. Management guidelines are discussed in a Natural River Plan that is written by the MDNR with consultation from citizen advisory groups. Drawing from the management plan, zoning standards are then established for the regulation of private lands adjacent to the river. The standards include restrictions on lot size, minimum building set backs, riparian vegetation buffer zones, and limits on commercial use. The Natural Rivers district extends to 400 feet back from the ordinary high water mark. Currently, the Pigeon River is the only designated Natural River in the Cheboygan River watershed, and was so designated in 1982. The Pigeon River main stem as well as many of its tributaries are included in the designation. While the Black River is not a designated Natural River, it was included in a 1972 list of potential Natural Rivers.

If a local governmental unit adopts riverfront development standards that equate to or are more stringent than the state Natural River standards, Part 305 allows for that township or county to directly administer the program in lieu of the state. Cheboygan County has been approved by the MDNR to administer the program directly. At their own initiative, the county also applies similar development standards on the Black River. To date, Otsego County has not adopted Natural River zoning standards. As a result, the MDNR has been administering Natural River standards in Otsego County since the establishment of the Pigeon River Natural River Zoning Rules, which became effective in 1985. The rules require that all new structures are a minimum of 200 feet from the edge of the river on the main stem of the Pigeon River and 150 feet from the edge of a designated tributary. A vegetation buffer must be maintained at a width of 100 feet on the main stem and 75 feet on designated tributaries. An administrative process is available to land owners who want to request a special exception to the development standards.

The Wild and Scenic Rivers Act of 1968, Public Law 90-542 (16 USC 1271-1287), was established at the federal level to preserve selected rivers that possess outstanding geologic, fish and wildlife, historic, cultural, or other values. Standards and guidelines that direct management activities within the designated area are intended to keep the river in a free-flowing condition for the benefit and enjoyment of present and future generations. There are currently no river segments in the Cheboygan River watershed that have been designated or are being studied for inclusion in the federal Wild and Scenic Rivers Act.

Inland Lake Levels and Dams Regulated Under State Dam Safety Standards

Part 307, Inland Lake Levels, NREPA, outlines the process involved in establishing a legal inland lake level. A county board, through its legal counsel, may petition the local circuit court to establish a legal lake level. The court will evaluate environmental and social factors in considering the request. Legal lake levels have been established at two lakes within the watershed: Alverno Dam Pond and Muskellunge Lake (J. Pawloski, MDEQ, personal communication).

Part 315, Dam Safety, NREPA, gives the MDEQ the authority to regulate the construction, enlargement, repair, reconstruction, alteration, removal, or abandonment of a dam. The authority is limited to dams impounding five or more acres and having a dam height greater than six feet. There are a total of forty-eight known dams in the Cheboygan River watershed and of this number, sixteen are regulated under Part 315 (J. Pawloski, MDEQ, personal communication). Dams that are regulated by the Federal Energy Regulatory Commission (FERC) under the Federal Powers Act, Chapter 41, are not regulated under Part 315, as the state’s dam safety regulations are superseded by federal dam safety regulations. However, water quality associated with dams and dam operation, including dams regulated by the FERC, require a 401 water quality certification from the MDEQ (J. Suppnick, MDEQ, personal communication)

Federally Regulated Dams

Four hydroelectric dams in the Cheboygan River watershed are under license from FERC. Three of these are located on the main stem of the Black River. Cheboygan Dam operates under an exempt license (i.e., the license does not require periodic renewal). While the hydroelectric power production at Cheboygan dam is owned and managed by the Great Lakes Tissue Company, regulation of the water flow is conducted by the MDNR. The license exemption and the operating agreement for the Cheboygan dam are found in Appendix 2. Alverno dam is currently operating under a license that expires in 2040. The dam releases water in a modified run of the river fashion that limits peaking activity. Tower and Kleber dams operate under one license that is due to expire in 2024. The Tower-Kleber dams have a negative effect on water quality, inhibit fish passage, and impound an area that would likely be suitable lake sturgeon spawning habitat. A settlement agreement is part of the current license and, as first drafted, incorporated a number of fish protection measures. The licensee appealed some of the requirements in the settlement agreement and FERC removed several of the fish protection measures required in the license (barrier nets or screening to prevent turbine entrainment and mortality). However, other measures such as those requiring the licensee to participate in lake sturgeon enhancement activities remain in the license (K. Kruger, MDNR, personal communication). The Alverno dam and Tower-Kleber dam licenses are found in Appendix 2.

Dredge and Fill Activities

The federal government has the authority to regulate dredge and fill activities in the Cheboygan River proper with authority derived from the Rivers and Harbors Act of 1899 (33 U.S.C. 401, et seq.) and the 1972 amendments made to the Federal Water Pollution Control Act (33 U.S.C. 1344). This second act is commonly known as the Clean Water Act and the 1972 amendments are commonly known as Section 404. These guidelines are published in the Federal Register, Volume 45, Number 249, Part 230.

The State of Michigan has authority to regulate development activities affecting lakes, streams, or wetlands under Parts 301, Inland Lakes and Streams, and Part 303, Wetlands Protection, NREPA. Part 301 gives the state the authority to regulate dredging or filling of bottomlands; construction, enlargement or removal of structures on bottomlands; marina construction and operation; creation, enlargement or removal of an inland lake or stream; excavation or dredging within 500 feet of a lake or stream; and the connecting of any natural or artificial waterway with an existing body of water. Part 303 gives the state the authority to regulate certain activities within wetlands including: placement of fill material in a wetland; dredging or removal of soils from a wetland; construction within a wetland; and draining surface water from a wetland. Both parts are administered by the Land and Water Management Division of the MDEQ. Many of the activities regulated by Parts 301 and 303 are also subject to Natural River zoning ordinances and rules.

Water Quality and Floodplain Regulations

The State of Michigan implements the Federal Water Pollution Control Act (Clean Water Act, Section 404 authority) by means of Part 31, Water Resources, NREPA. Part 31 gives the state the authority to protect and conserve Michigan’s water resources and to control pollution of surface or underground waters. It is administered by the Water Bureau of the MDEQ. The Water Bureau establishes water quality standards, provides regulatory oversight for public water supplies, issues permits to regulate the discharge of industrial and municipal wastewaters, and monitors state water resources for water quality, the quantity and quality of aquatic habitat, the health of aquatic communities, and compliance with state laws. The State of Michigan’s Floodplain Regulatory Authority is also found in Part 31. The program requires that a permit be obtained prior to any alteration or occupation of the 100-year floodplain of a river, stream, or drain.

Contaminated Sites

Part 201, Environmental Response, NREPA, gives the state the authority to identify sites of environmental contamination, to request liable parties to take response action for site cleanup, and to prioritize contaminated sites for state funded clean up. As of April 2007, 27 contaminated sites regulated under Part 201 have been identified in the Cheboygan River watershed (Table 13). Part 213, Leaking Underground Storage Tanks, NREPA, mandates that corrective action must be taken by owners/operators of leaking underground storage tanks. There are currently 45 sites regulated under Part 213 in the watershed (Table 14).

Sport Fishing Regulations and Designated Trout Streams

Part 487, Sport Fishing, NREPA, gives the State of Michigan the authority to regulate the take of fish, mollusks, amphibians, and reptiles. Harvest level, minimum size, seasons, and other parameters are determined, published, and enforced by the MDNR.

A significant amount of stream mileage in the Cheboygan River watershed is classified as designated trout stream by order of the Director of the MDNR (Table 15; Figure 35). Designated trout streams are streams that contain a significant population of trout or salmon and are managed for trout and salmon prevalence. Trout streams can be regulated as coldwater streams in accordance with Michigan Surface Water Quality Standards. Fishing regulations for trout streams and trout lakes are specified in the Michigan Inland Trout and Salmon Guide. Regulations for other species are listed in the Michigan Fishing Guide.

Blue Ribbon Trout Stream Classification

A designated trout stream may also be classified as a Blue Ribbon Trout Stream. The Blue Ribbon Trout Stream Program recognizes some of the state's best trout streams. Like trout stream designation, the program is administered by the Fisheries Division of the MDNR. Certain standard criteria must be met to receive the classification. The stream must support excellent stocks of wild resident trout, be large enough to permit fly casting but shallow enough to wade, produce diverse insect life and good fly hatches, have earned a reputation for providing a quality trout fishing experience, and have excellent water quality (Anonymous 1988). Management of Blue Ribbon Trout Streams is directed toward providing for the needs of trout anglers through protection of wild trout stocks, protection and enhancement of trout habitat, maintenance of the natural stream environment, and acquisition and maintenance of public access.

The Cheboygan River watershed contains 134 stream miles classified as Blue Ribbon Trout stream. These include the Black River from McKinnon's Bend to the Cheboygan/Presque Isle County line, the East Branch of the Black River from Section 26 (T31N, R1E) to the junction with the Black River, Canada Creek from the junction with Montague Creek to the Cheboygan County line, the Maple River from the Maple River Dam to the Cheboygan County line, the Pigeon River from the Section 25-26 boundary (T32N, R2W) to M-68, the Sturgeon River from Sturgeon Valley Road to Burt Lake, and the West Branch of the Sturgeon River from Wilderness Road to the junction with the mainstream.

Special Local Watercraft Controls

Part 801, Marine Safety, NREPA, allows for the establishment of watercraft controls. Limitations can range from the prohibition of motorized watercraft, establishment of slow-no wake areas, and restrictions on hours of operation. A list of local watercraft controls, including those within the Cheboygan River watershed, can be found at: http://www.michigan.gov/dnr/0,1607,7-153-10366_37141_37701---,00.html

Permission to Use State Lands

Since 1973, a permit has been required from the MDNR for events or commercial use of state lands under the *Rules for the Regulation of Lands Administered by the Department of Natural Resources*. A change in the definition of commercial use in 2001, followed by the implementation of a new fee schedule and revised procedures on January 1, 2006, improved the MDNR's ability to effectively and uniformly apply the rules to all events and commercial users of state land. Requests to use state lands are reviewed for their intensity, potential facility impact and resource damage, and the potential for conflict with the use of state land by others.

2007 Inland Consent Decree

The 1836 Treaty of Washington, Article 13 preserved the right of Indian tribes "to hunt and the usual privileges of occupancy until the land is required for settlement." Litigation involving the scope of the treaty has been ongoing since 1973. In 1979 a federal court ruled that the 1836 tribes still had a viable treaty right to fish in the Great Lakes. As a result of this ruling, the State of Michigan, the United States, and the tribes entered into a Consent Decree in 1985 and again in 2000 to implement the court's 1979 ruling. However, Indian fishing and hunting rights on inland waters and lands remained unclear. In 2003 the State of Michigan filed a claim in federal court to resolve the issue of inland treaty rights. This action resulted in the 2007 Inland Consent Decree. Under this decree, tribal members may engage in hunting, fishing, and gathering activities on tribal lands and lands that are open to the public for those activities. Tribes have seasons and bag limits that differ somewhat from non-tribal regulations, however being that the decree grants the tribes subsistence hunting and fishing rights, not commercial harvest rights, it is unlikely that any significant impacts on fisheries and wildlife resources will result from these differences.

Local Government

Local units of government have authority to create master plans and implement zoning ordinances that can, by effect, play a large role in protecting watershed integrity. County road commissions can reduce the amount of sediment and other pollutants that reach watershed lakes and streams from roads and road ditches through careful design of road projects as well as the incorporation of best management practices in road maintenance activities.

The Michigan Drain Code (1956 PA 40, as amended) provides the legal framework for establishing and maintaining county and intercounty drains. A drain can vary in form, ranging from streams, open ditches, or underground pipes. To establish or improve a county drain, the county drain commissioner must receive a petition from landowners, a road commission, a county board of health, a municipality, or a developer. In addition, if the MDEQ determines that sewage or wastes carried by a drain is an unlawful discharge, the MDEQ, in an effort to clean up the drain, may issue an order of determination that takes the place of a petition to construct a project. However, in general drain projects are intended to prevent flooding and provide adequate drainage for agriculture or development (F. Fuller, St. Clair County Drain Commissioner, personal communication).

There are no known designated drains in the Cheboygan River watershed. The potential for a previously recorded drainage easement to surface remains a possibility however, as organized records for established drainage easements have not been well maintained by individual counties (B. Bury, MDNRE, personal communication).

Major Public and Private Landowners

There are approximately 346,500 acres of state owned land in the Cheboygan River watershed, an amount that accounts for 36 percent of the total land base in the watershed (M. Tonello, MDIT, personal communication). The majority of state owned lands in the watershed are managed as part of the MDNR, Forest, Mineral, and Fire Management Division's (FMFMD) Eastern Lower Peninsula District. The district is subdivided into Forest Management Units. Of particular interest is the Pigeon River Country Unit (PRC), which is located entirely within the boundaries of the Cheboygan River watershed. At 105,049 acres the PRC is the smallest of the state's 14 forest management units; however, it is distinct in that it has the most contiguous state ownership of all the units.

State forest management practices, which include land use, timber production, and recreation are co-planned by the FMFMD and Wildlife Division. Input from other MDNR divisions, other agencies, and public stakeholders is considered in the planning process (J. Pilon, MDNR, personal communication). Resource management decisions in the PRC are further guided by the Pigeon River Concept of Management Plan. The Plan contains objectives intended to maintain and promote the remote and wild feel of the PRC, sustain healthy fish and other wildlife populations, including elk, and provide for timber management that is in concert with other management goals (Anonymous, 1973).

There are no federally owned lands of notable size in the Cheboygan River watershed. The largest private land owner is the Canada Creek Ranch Association (M. Tonello, MDIT, personal communication). The Ranch is a private outdoor recreation club that owns 13,897 acres of land (Canada Creek Ranch, personal communication). Also of size is the Black River Ranch, a private hunting and fishing club that totals 9,080 acres of land (Black River Ranch, personal communication).

The University of Michigan Biological Station (UMBS) consists of approximately 10,000 acres in the Cheboygan River watershed. UMBS was established in 1909 for education and research opportunities in field biology and related sciences. The station has property on Douglas and Burt Lakes, as well as the East Branch Maple River.

Navigability

Issues associated with public rights on Michigan waters including navigability are discussed in detail in A Guide to Public Rights on Michigan Waters (Anonymous, 1997). Water law is complex and because it is established through both legislative and judicial action, it is continually evolving. The MDNR, Law Enforcement Division, generally considers all water bodies as navigable unless otherwise determined by a court. With limited exception, a navigable inland lake is any lake accessible to the public via publicly-owned lands, waters or highways contiguous, or via the bed of a navigable stream, and which is reasonably capable of supporting a beneficial public interest. A navigable inland stream is defined as 1) any stream declared navigable by the Michigan Supreme Court; 2) any stream included within the navigable waters of the United States by the U.S. Army Corps of Engineers for administration of the laws enacted by congress for the protection and preservation of the navigable waters of the United States; 3) any stream which floated logs during the lumbering days, or a stream of sufficient capacity for the floating of logs in the condition which it generally appears by nature; 4) any stream: having an average flow of approximately 41 ft3/s; an average width of some 30 feet; an average depth of about one foot; capacity for floating during spring seasonal periods; used for fishing by the public for an extended period of time; and stocked with fish by the state; 5) any stream which has been or is susceptible to navigation by boats for purposes of commerce or travel; or 6) all streams meandered by the General Land Office Survey in the mid 1800s.

The right to public use of navigable waters includes the right of trespass upon the submerged soil, but not the adjacent uplands. The public also has the common right of fishing in navigable streams, subject to state regulations.

The following reaches of the Cheboygan River system are being managed, have been adjudicated, or have been indicated as being navigable:

1. United States, navigable water jurisdiction exercised by the United States Army Engineering District, Detroit
   a. Cheboygan River, entire river

2. Michigan Supreme Court, determined to be navigable by judicial decision
   a. Cheboygan River, Cheboygan County, entire river
   b. Black River, from the mouth upstream to Black Lake
   c. Black Lake, Cheboygan and Presque Isle Counties
   d. Crooked Lake, Emmet County
   e. Mullet Lake, Cheboygan County
   f. Pickerel Lake, Emmett County

3. Michigan Supreme Court, indicated navigable by judicial notices or references (i.e., streams have a history of floating logs)
   a. Black River, Otsego County, downstream to Black Lake from lands owned by John Davis in 1885 in vicinity of "Chandler's Dam"
   b. Black River, Otsego County, unspecified
   c. Maple River, Emmet and Cheboygan Counties, 30 miles upstream from mouth
   d. Pigeon River, Otsego County, 40 miles upstream from mouth
   e. Rainy River, Presque Isle County, 30 miles upstream from mouth
   f. Sturgeon River, Cheboygan and Otsego Counties
   g. Sturgeon River, West Branch, Cheboygan County

4. Cheboygan County Circuit Court, court approved Consent Judgment confirming navigability (*Hamp et al. v. Department of Natural Resources et al.*, Cheboygan County Circuit Court, 1993)
   a. Sturgeon River, Cheboygan County, T33N, R2W, Sections 27, 28, 29, and 34

The following reaches of the Cheboygan River system have been adjudicated as being non-navigable:

1. Otsego County Circuit Court, court decision determining reach non-navigable (*Sturgeon Valley Ranch v Department of Natural Resources et al.*, Otsego County Circuit Court, 1989)
   a. Sturgeon River, Otsego County, T31N, R3W, beginning just north of the north line of Sections 13 and 14 and running northerly to Whitmarsh Road

Inland Waterway

The Inland Waterway, also known as the Inland Route, is a series of interconnected lakes and streams contained within the Cheboygan River Watershed. The Inland Waterway is approximately 38 miles long and allows travel by boat from Crooked Lake to Lake Huron. Beginning in Crooked Lake, one can navigate through the Crooked River, Burt Lake, the Indian River, Mullett Lake, the Cheboygan River, and then enter Lake Huron. The route was originally developed and used primarily for transporting logs, freight, and passengers aboard commercial boats. Today it is largely a recreational boating destination. The route is maintained by the United States Army Corps of Engineers (COE). The COE routinely dredges various sections of the Inland Waterway with a design depth of five feet. Two lock systems on the route also facilitate boat passage. A lock system at the Cheboygan Lock and Dam (see *Federally Regulated Dams* in **Special Jurisdictions**, and *Migration/Movement* in **Dams & Barriers**) was built in 1869 by the Cheboygan Slack Water Navigation Company. However, the current lock system is now owned and operated by the DNR's Parks and Recreation Division. The gate system at this lock can lower a boat by approximately 15 feet and can accommodate a boat up to 60 feet in length. A second lock system was built by the COE on the Crooked River. The Alanson Lock & Dam, also known as the Crooked River Lock and Weir, is also operated by the Parks and Recreation Division, although the site is still owned by the COE.

Biological Communities

Original Fish Communities

Presettlement fish community information of the Cheboygan River watershed is generally lacking. Madison and Lockwood (2004) provide an overview of the fish colonization of the Great Lakes region:

> The glacial activity that shaped Michigan and the [Cheboygan River] watershed also played an important role in re-populating the area with numerous fish species. The Great Lakes region has 153 species of native fish. Presence or absence of each species varied throughout glaciation. Connecting glacier-free refugia served as sources for re-population following glacial retreats. Three such areas of particular importance to the Great Lakes region were the Bering, Atlantic, and Mississippi refugia. The Great Lakes region was connected to the Bering drainage (refuge) by lake and river system created along the face of the retreating Laurentide glacier. Current day Great Slave Lake and Great Bear Lake are part of this system. Lake trout, grayling, and northern pike were some of the fish species that used the Bering refugia (Bailey and Smith 1981). The Atlantic refugia extended east from the northern Great Lakes region to the Atlantic Ocean. Fossil remains of walruses discovered near the Straits of Mackinac (Handley 1953) are linked to the North Bay outlet that drained Northern Michigan waters into the Atlantic Ocean. Fourteen species of fish populated the region solely from the Atlantic refugia. However, the primary source for re-population of fish species in the Great Lakes region came from the Mississippi refugia. This refugia alone supplied 122 species of fish to the region (Bailey and Smith 1981).

Evidence from the Juntunen site on Bois Blanc Island in northern Lake Huron provides some insight into fish assemblages in this region and their importance to early cultures. The site was occupied by natives in the Late Woodland period from 800 A.D. to 1300 A.D. (Cleland 1982) and is relatively close to the Cheboygan River mouth. Remains of eighteen fish species have been documented at the site, including lake sturgeon; longnose gar; late trout; lake whitefish; various redhorse suckers; brown bullhead; channel catfish; northern pike; yellow perch; walleye; sauger; largemouth, smallmouth, and rock bass; and freshwater drum (McPherron 1967).

There remains some uncertainty whether brook trout were historically native to the Cheboygan River watershed. Vincent (1962) discusses in-depth the topic of whether brook trout were native to Michigan and the presence of Arctic grayling in Michigan. Vincent also reports that brook trout were very common in the lower reaches of the Cheboygan River. Whether they colonized this and other reaches of the watershed from northern populations (Upper Peninsula) or from stocking is unclear.

Thorough searches for brook trout in the Sturgeon River found none of this species (Norman 1887). Brook trout were also not reported in the Pigeon and Black rivers until 1884 (Anonymous 1884). Only grayling were found in the Maple River in 1885 (Anonymous 1885b), but both grayling and brook trout were found in this river by 1891 (Anonymous 1897). Arctic grayling were last documented in the Maple and Black rivers in 1899 and 1906, respectively (Hough 1899; Mershon 1916). It is likely that brook trout populations spread through natural colonization and stocking efforts on the heels of the Arctic grayling demise statewide.

According to MacCrimmon and Gots (1972), rainbow trout had been introduced into the Lake Huron watershed by 1876. Major spawning runs of rainbow trout (steelhead) had been established by the early 1900s in rivers to the south of the Cheboygan River watershed. Stocking efforts for this species became popular and continued throughout the Lake Huron watershed. Rainbow trout are sustained throughout the Lake Huron watershed today by both natural reproduction and supplemental stocking. This is a popular species in the Cheboygan River watershed. Strong, self-sustaining populations of rainbow trout live in both Burt and Mullett lakes and use the tributaries for spawning. These tributaries include the Pigeon, Sturgeon, and Maple rivers. The lower Cheboygan River also receives a run of rainbow trout (steelhead) that live in Lake Huron and provide both an offshore and river fishery. This reach of lower river below the Cheboygan River Dam is stocked annually with rainbow trout.

The lake sturgeon is a state threatened species in Michigan. According to Baker (1980), lake sturgeon were considered historically abundant throughout the Great Lakes region, particularly before the appearance of Europeans in the region. Lake sturgeon would have been common throughout the lower reaches of the watershed and probably common in Black, Burt, and Mullett lakes. The species still exists today in each lake, with the largest population found in Black Lake. Hay-Chmielewski and Whelan (1997) consider the Cheboygan River watershed as highly suitable for future lake sturgeon rehabilitation and enhancement.

Modifying Factors

The Cheboygan River watershed has been significantly altered by human activities since the arrival of European settlers. These changes have had profound effects on both the physical characteristics of the river system and the associated fish communities. Three specific activities have caused major changes, including intensive logging in the late 1800s and early 1900s, the construction of dams, and the stocking of nonnative fish species. These three activities have dramatically altered the ecology of the Cheboygan River watershed and most other watersheds in Michigan.

The impressive forests of this watershed were harvested and the river and lakes were used as means of transport. Log drives likely caused major streambank erosion and streambed scouring. Prior to log drives, it was common practice to send work crews down the river to clear the river of any existing jams. This often released large amounts of sand and sediment from the banks directly into the river. Meanwhile, clearing the river of natural woody debris reduced diversity of in-stream habitat.

Dams were first constructed in the Cheboygan River watershed in the late 1800s (**see Dams and Barriers**). Many of the prominent dams in this watershed are located in the lower reaches near Black Lake and the town of Cheboygan. These dams have restricted the movement of important native fishes such as walleye and lake sturgeon and have prevented passage of important naturalized species such as salmon and steelhead. It is likely that the removal of certain dams (Cheboygan, Alverno, Kleber, and Tower) would drastically change the dynamics of fish populations in this region. Zorn and Sendek (2001) summarize the effects of dams on resident fishes:

> Fishes require distinct spawning, growth, and refuge habitats in their life cycle (Schlosser 1991). Equally important, fishes must be able to freely migrate between these habitats. If any one habitat is lacking or if the ability to migrate from one to another is restricted, the population can become restricted or locally extinct. Migrations allow fish populations to fully use the best available feeding, growth, and refuge habitats within the aquatic system, and thus realize the potential of the river system. Migration corridors also provide a means for populations to recolonize disturbed areas. Dams in the [Cheboygan River] system prevent the river from realizing its potential to support thriving fish populations.

Beaver populations have fluctuated over time in this watershed and can have significant effects on the riparian area with successional setback and the associated impacts on channel evolution. High beaver populations in certain watersheds can block fish movement and change thermal regimes of streams. Many of the coldwater streams of this watershed are marginal for trout. Thus, a series of beaver dams will often pool large amounts of water and raise critical temperatures outside the tolerance range for certain species, particularly brook trout. Trapping was at one time an organized effort in the Black River watershed. Reductions in pelt prices and the increasing costs of the sport have reduced trapping in recent decades statewide, thus allowing furbearer numbers to surge.

Species introductions, both intentional and unintentional, have affected the biological communities in numerous ways. Some species introductions have created valuable sport fisheries and include steelhead, brown trout, Chinook salmon, coho salmon, and pink salmon. Other exotic species like zebra mussels, sea lamprey, and gobies continue to cause problems both to industry and to native ecosystems (see Pest Species sub-section).

Brown trout were imported to the United States from Germany in 1883. They were stocked in a variety of locations throughout Michigan in the late 1880s with mixed results. Stocking efforts for brown trout increased by the 1920s (MDNR 1974) in response to perceived declines in brook trout populations. Historical stocking records show that brown trout were stocked frequently throughout the streams of the Cheboygan River watershed, most certainly dating back to the early part of the twentieth century. Today this species is self-sustaining throughout parts of the Sturgeon, Maple, and Pigeon river watersheds. The Black River remains relatively free of brown trout and is a haven for brook trout.

Salmon were introduced to the Great Lakes by the late 1960s. It is without doubt that they began to migrate into the Cheboygan River soon after these lake-wide stocking efforts began. Direct stocking efforts into the lower Cheboygan River did not begin until as recently as 2003. This species provides a popular off-shore fishery as well as a fishery for river anglers up to the Cheboygan River Dam. Salmon occasionally may swim through the Cheboygan lock system and migrate further upstream but do not provide a substantial fishery.

Other modifying factors for the Cheboygan River watershed include urbanization, road development, and oil and gas development. These activities have negative effects on waters in the basin through both point and nonpoint source pollution (see **Water Quality**). Current industrial discharges to the river are subject to requirements of National Pollution Discharge Elimination System (NPDES) permits (see **Water Quality**). A fair amount of the aquatic shoreline in the Cheboygan River watershed is developed, particularly in the lower reaches and large lakes. Development along the water will shape the way water flows through and over the watershed. Such development will increase erosion and sedimentation to the watershed, alter hydrology by increasing impervious surfaces, and change the natural water-land interface. Oil and gas development is also quite prominent in this watershed, particularly in the headwaters of the Black, Pigeon, and Sturgeon rivers. Continued vigilance is needed to minimize the effects of current oil and gas development and protect the surface and groundwater resources within the watershed (see **Soils and Land Use Patterns**).

Current Fish Communities

Seventy-eight fish species are found in the Cheboygan River watershed (Table 16; Appendix 3). Maps of their known distribution within the watershed were prepared using MDNR, Fisheries Division files, University of Michigan's Museum of Natural History records, the Michigan Fish Atlas (Bailey et al. 2004), and the best professional judgment of the authors. Many stream reaches inhabited by fish may be used only seasonally by some species. These reaches were still included in the distribution map as part of the species range.

Five species within the watershed were intentionally introduced and six species have colonized the watershed from Lake Huron. The Cheboygan River watershed is also home to four rare fish species. Historical records indicate the presence of pugnose shiners in the watershed. This species has special concern status in Michigan. The pugnose shiner requires streams with sand substrate or clear, weedy lakes, and is intolerant of turbidity. The lake sturgeon and lake herring are threatened species in Michigan. The lake sturgeon is relatively common in the Cheboygan River watershed and is found in Black Lake and the lower Black River, as well as the Cheboygan River. Lake sturgeon are also present, albeit in lower numbers, in Mullett and Burt lakes. It is unknown how many lake sturgeon migrate up the Cheboygan River from Lake Huron but cannot pass upstream beyond the dam. Lake herring often live in deep, oligotrophic lakes that possess good amounts of cold and highly oxygenated waters. This species has recently been found in Douglas, Burt, Mullett, and Black lakes, and is probably common in many other small inland lakes that possess these characteristics. One historical record of a channel darter exists for the Cheboygan River watershed. This species is currently considered endangered in Michigan.

Temperature plays a large role in the distribution and abundance of fishes. Fish can be placed into categories or guilds based on their temperature preference and temperatures at which they spawn. These guilds are comprised of fish species that typically inhabit water bodies of cold, cool, or warm water (Diana 1995). Membership within one of these guilds is based on a number of factors, including the upper thermal tolerance limits for survival, the thermal preference for fishes in which they achieve optimum growth, and observations of presence-absence under certain conditions (Eaton et al. 1995). The effects of mean July temperatures on fish communities in Michigan rivers were examined by Wehrly et al. (2003). The study found relatively distinct community composition within three thermal categories based on July mean temperature values: cold (<66ºF), cool (66ºF to 72ºF), and warm (≥72ºF). Although we use a more complex classification system for streams (see **Water Quality**), the simpler classification system of cold, cool, and warm is used here to be inclusive of lakes and to simplify the discussion.

Coldwater fish communities are comprised of species with a relatively narrow tolerance range of temperatures, especially in the summer months. In rivers, coldwater fish communities typically have low species diversity. These communities include species such as rainbow, brown, and brook trout as well as sculpin species. Coldwater fish inhabit the headwater reaches of much of the Cheboygan River watershed and occupy other reaches seasonally (e.g., salmon migrations). Coolwater fish communities are comprised of fishes that tolerate a broader range of temperatures, and generally have higher species diversity. Coolwater species of fish can live in cold water, but maximum growth and survival is typically limited. Coolwater fish species in the Cheboygan River watershed include walleye, yellow perch, darters; northern pike, muskellunge; suckers; and some minnow species, such as blacknose dace, longnose dace, and northern redbelly dace. Warmwater fish communities are composed of fishes that tolerate an even broader range of temperatures but do best in warmer waters. Warmwater streams typically have high species diversity. Warmwater fish species include bass, sunfish, minnow, and catfish species. Smallmouth bass, largemouth bass, rock bass, pumpkinseed sunfish, bullhead catfish, and bluegill are common throughout much of the watershed, except in the coldwater reaches of certain streams. Much of the lotic systems of this watershed have overlapping temperature regimes (coldwater, coolwater, warmwater) at various points as the rivers progress downstream. Consequently, fish communities typically transition from cold, to cool, to warm water communties.

Streams in the Cheboygan River watershed with coldwater fish communities are common in the southern portion of the watershed. These include the headwater reaches of the Sturgeon, Pigeon, and Black River. Some coldwater streams do exist in the northern portion of the watershed but are limited to smaller tributaries (e.g., Laperell Creek, Maple River, Mullett Creek). A coldwater reach is defined in this watershed by the geology and hydrology which result in large inflows of groundwater. Some coldwater streams receive more groundwater than other groundwater streams. For example, the Sturgeon, Pigeon, and Black rivers all start in areas of high groundwater discharge and have coldwater designation as earlier mentioned. However, the Sturgeon River maintains its coldwater status nearly the entire length. The Pigeon River has coldwater status for much of its length except the last river segment, where it changes to coolwater designation based on empirical temperature assessments. The Black River makes a transition from coldwater to coolwater much higher in the watershed compared to the other mentioned rivers. Ironically, this latter stream has a brook trout community which is a species that has the strictest temperature tolerances. Because of this, brook trout have evolved to adapt to variation in annual temperature changes in this river by often migrating from cool seasonal waters to areas with colder thermal refuge, such as springs or deeper pools. Coldwater species will often inhabit the lower, warmer reaches of these rivers during the cooler parts of the year. The lowest portion of the Cheboygan River downstream of Cheboygan dam supports coldwater fish seasonally, as potamodromous fish such as steelhead and salmon migrate up the river. This reach normally has a mix of cool- and warmwater fish species.

Large lakes are a prominent feature in this watershed (see **Geography**). Rivers of the Cheboygan River watershed flow in and out of these lake systems which include: Crooked, Pickerel, Douglas, Burt, Mullett, and Black lakes. Species diversity and abundances are thus dictated by the temperature and morphology of the lakes. Diversity is typically much higher in the lake systems, particularly those lowest in the watershed drainage. Coolwater species are very common in the lakes (e.g., smallmouth bass, walleye, and northern pike). Yet warmwater species such as largemouth bass and coldwater species including trout can also be found within these lakes. Lakes also influence what is found in adjacent streams, as some fish may move from the lake into the stream.

Mussels and Aquatic Invertebrates

Mussel data are very limited in the Cheboygan River watershed. The University of Michigan, Museum of Zoology (http://www.liath.com/ummz) lists historical records for various species of mussels in this watershed (Table 17). There is little doubt that the distribution of some species listed is more widespread. Nineteen species of mussels are listed under special status throughout Michigan (MNFI 2008).

The MDEQ-Water Bureau conducted macroinvertebrate community surveys within the Cheboygan River watershed in 1991, 1994, 2000, 2001, and 2005. This report will focus primarily on the most recent survey.

A total of 80 aquatic macroinvertebrate families have been identified over 38 sites in the 2005 Cheboygan River watershed surveys (Walker 2008). In comparison, Cwalinski et al (2006) reported 76 aquatic macroinvertebrate families were surveyed in the nearby Thunder Bay River watershed at 15 sites in 2000 (Taft 2003). A variety of habitat types were surveyed in the Cheboygan River watershed, ranging from small coldwater streams to medium sized coolwater rivers. Macroinvertebrates are generally identified only to family so the number of genera and species found in the Cheboygan River watershed is much higher than 80. The mean richness across all sites was 32, while individual sampling locations ranged from 21 to 42 taxa (Table 18a-c). The lowest score (number) was for Minnehaha Creek at Pickerel Lake Road, while the highest score (number) was for the Black River at Black River Road.

Three species of aquatic invertebrates are listed as having special concern status in Michigan and have been found in the counties of the Cheboygan River watershed. These include the slippershell mussel (*Alasmidonta viridis*), Douglas Stenelmis riffle beetle (*Stenelmis douglasensis*), and splendid clubtail (*Gomphus lineatifrons*). Two species of aquatic invertebrates are considered endangered in the State of Michigan and have been found in the Cheboygan River watershed. These include the Hine's emerald dragonfly (*Somatochlora hineana*), and Hungerford's crawling water beetle (*Brychius hungerfordi*). This latter species has gained the most notoriety across the watershed and was even found in Canada Creek at Canada Creek Highway during the 2005 survey. The Hungerford's crawling water beetle has also been found in recent years in Van Hetton Creek, East Branch Black River, and the East Branch Maple River (USFWS 2006).

Amphibians and Reptiles

Nine species of frogs and toads and seven species of salamanders live within the Cheboygan River watershed (Harding and Holman 1992). None of these species has a state or federal status of endangered, threatened, or special concern (Table 19).

Eleven species of snakes and one lizard (five-lined skink) reside within the Cheboygan River watershed (Holman et al. 1993, Harding and Holman 1990). The eastern massasauga rattlesnake has special concern status in Michigan (Table 19). The massssauga rattlesnake is unique because it is the only poisonous snake species found in Michigan. This species prefers marsh and swamp habitat but may be found in upland meadows and woodlands in summer (Holman et al. 1993). The massasauga rattlesnake is locally common in distinct parts of the Cheboygan River watershed.

The Cheboygan River watershed is home to five species of turtles. Two of these (wood and Blandings) are species of special concern in Michigan (Harding and Holman 1990) (Table 19). Populations of wood turtles have been reduced primarily through mortality from crossing roads and from pet collection. Habitat loss and road crossing mortality are the major causes of mortality for the Blandings turtle (Harding and Holman 1990). Egg predators also can have a large impact on nest success.

A fishing license is required to take frogs and turtles for personal use and as such may not be bought, sold, or offered for sale. The take of various reptiles and amphibians is regulated by the DNR Fisheries Division and specific regulations by species are listed in the Michigan Fishing Guide.

Birds

Doepker et al. (2001) list 121 breeding birds associated with aquatic and wetland habitats in the Cheboygan River watershed (Table 20). The rivers, lakes, and wetland areas provide valuable habitat for a variety of game and nongame birds. Ducks, geese, and mergansers nest and forage along the rivers and lakes, while upland birds forage and travel within riparian corridors. Other species of birds not listed use the watershed seasonally on migration routes (e.g., northern pintail duck) or live in the uplands year-round (e.g., ruffed grouse). The state-threatened common loon breeds on the lakes while stream edges are popular habitat types for several species of shorebirds and wading birds, such as great blue herons. Nine species of birds are of special concern status in Michigan, while eight species are listed as threatened, and one species (piping plover) is listed as endangered (Table 20).

Mammals

The abundant forest and wetlands (**see Soils and Land Use**) in the Cheboygan River watershed support a variety of mammalian species (Table 21). The river and riparian corridor provide food, cover, and travel or migration routes for such game species as black bear, white-tailed deer, coyote, and bobcat. Sport harvest is an important activity in this watershed, both in the form of hunting and trapping. Various mammal species are important to the trapping industry and include American beaver, muskrat, and mink (Table 21). Rare mammals in the watershed include the American marten (threatened) and woodland vole (special concern).

Much of the Cheboygan River watershed is home to one of the largest wild elk herds east of the Mississippi River. Prime elk range can be found throughout the upper and middle reaches of the Sturgeon, Pigeon, and Black river catchments. Herds are healthy enough to support an annual managed harvest. The current elk herd is managed for 800-900 animals and often fluctuates over this range prior to harvest. Eastern Elk were native to Michigan but were extirpated from the state by 1877 (Baker 1983). Seven Rocky Mountain elk were released near the town of Wolverine in 1918 in order to reestablish a local Michigan population.

Other Natural Features of Concern

Michigan Natural Features Inventory lists 22 vascular plants, 16 invertebrates, 4 fishes, 8 birds, 1 snake, 2 turtles, 1 mammal, 4 plant communities, and 2 other natural features as being of concern status within the Cheboygan River watershed (Table 22).

Plant community types listed as natural features inlcude the dry-mesic northern forest, intermittent wetlands, pine barrens, and northern fens. Dry mesic northern forests are pine or pine-hardwood dominated and often originate following catastrophic fire events and are maintained through low-intensity ground fires. Pine barrens are dominated by clumped or scattered coniferous trees in fire dependent savannas which occur on sandy outwash plains or glacial lake plains. Pine barrens often are comprised of jack pine and pin oak. Intermittent wetlands are sedge and herb-dominated areas often found along lakeshores and are influenced by fluctuating water levels. Northern fens are sedge and rush dominated wetlands occurring on neutral or alkaline saturated peat or marl and fed by rich groundwater.

Great blue heron rookeries are also listed as a natural feature of concern in the Cheboygan River watershed (Tale 22). These rookeries contain groups of nests and are located in wooded wetlands with large trees. These rookeries are often used annually by these birds.

Aquatic Nuisance Species

An aquatic nuisance species (ANS) is defined as an organism that is waterborne, nonnative, and has the potential to threaten the existence or diversity of native species or disrupt a natural community. ANS can also threaten commerce or recreational activity. Since the 1800s, at least 140 nonindigenous aquatic organisms have been introduced in the Great Lakes ecosystem (Coscarelli and Bankard 1999). Some of these organisms have already entered the inland waters of the Cheboygan River watershed.

Adult sea lamprey are parasitic on other fish species and can kill up to 40 pounds of fish per year (Coscarelli and Bankard 1999). This species lives most of its life in the larval stage within high quality rivers of Michigan. The United States Fish and Wildlife Service (USFWS) aims to control sea lamprey by treating these rivers with a chemical that is selectively kills larval lamprey without harming resident fish populations. Many parts of the Cheboygan River watershed are treated for larval lamprey, especially the Sturgeon, Maple, and Pigeon Rivers. Despite this control effort, many larval lamprey transform into adults and feed on fish in both Lake Huron and Lake Michigan. Some of the highest concentrations of adult sea lamprey in the Great Lakes are found in northern Lake Huron.

Eurasian ruffe and round goby are exotic fish species that can reduce native fish populations through predation on eggs and larvae or through direct competition for forage and habitat. Round gobies are common in the lower Cheboygan River. A recent netting of fish in a pool below the Cheboygan River Dam found this species to be prevalent. Round gobies were also observed in high numbers during a recent (fall 2007) walleye evaluation on Mullett Lake. The connectivity of the lower reaches of the watershed via the inland waterway suggests that gobies will become common throughout Burt, Crooked, and Pickerel lakes. The USFWS has surveyed various Great Lakes ports and river mouths for ruffe in recent years. This species has not been reported in the lower Cheboygan River, but has been found to the south in the Thunder Bay River mouth.

Zebra mussels are a small exotic mollusk that attach to hard surfaces underwater and filter microscopic algae and animals (zooplankton) from the water. Zooplankton are an important food source for young fish such as walleye, yellow perch, and bass. Though tiny, zebra mussels can become quite prolific and form dense colonies of over one-million per square meter (Coscarelli and Bankard 1999). These mussels can have detrimental effects upon Michigan's lakes by killing native clams and filtering out essential nutrients from the water column which fish rely upon for survival. They can also outcompete macroinvertebrates for food and habitat. It is not completely understood how zebra mussel colonization in inland waters affects populations of various fish species. Michigan Sea Grant (http://www.miseagrant.umich.edu/ais/lakes-m-r.html#o) lists eight lakes in the Cheboygan River watershed where zebra mussels have colonized. These lakes include Black, Long, Thumb, Mullett, Burt, Crooked, and Pickerel lakes. The first three lakes listed are not part of the inland waterway and zebra mussels were probably transferred to these waters through anglers or recreational boaters. The remaining listed lakes are part of the inland waterway and colonization could have been from those using the water route. Zebra mussels likely occur in additional waters not yet included on the official list kept by Sea Grant. Douglas Lake, for instance, has zebra mussels. The entire Cheboygan River is also home to zebra mussels. Earliest reports of zebra mussel colonization to the watershed date back to 1993.

Other invasive species and diseases that may currently inhabit the watershed or may do so in the future are the rusty crayfish, Eurasian water milfoil, purple loosestrife, viral hemorrhagic septicemia, and whirling disease. Whirling disease is caused by a parasite which infects trout and salmon. The parasite enters the head and spine of young fish, leading to erratic swimming behavior and potentially death. The spores of whirling disease have been found throughout Michigan streams, including the Sturgeon River. Yet spore densities are quite low and the species do not develop clinical signs of the disease. Viral Hemorrhagic Septicemia (VHS) is a newly introduced fish virus to Michigan. It does not affect humans, but has the potential to cause large-scale mortalities in fish populations. It was recently discovered in the Great Lakes but has not appeared within most inland water bodies in Michigan. The lakes and rivers of the Cheboygan River inland waterway are at high risk of being colonized by this virus due to the movement of boats between the great Lakers and inland waters through the Inland Waterway.

Rusty crayfish are a nonnative invertebrate from the Ohio River valley. They can grow large and often out-compete native species of crayfish. Rusty crayfish are also known to remove or shred large amounts of aquatic vegetation that is essential for lake productivity and fish shelter. Reports of this species exist through parts of the inland waterway including Pickerel, Crooked, Burt, and Mullett lakes and outside the waterway in Long Lake. They may exist at other locations in the watershed and future aquatic community surveys will help document their spread as well as that of other invasive species.

Eurasian water milfoil and purple loosestrife are two invasive species of plants which can be found in parts of the Cheboygan River watershed. Purple loosestrife is a perennial wetland plant native to Europe and Asia. The plant can form dense monoculture stands and eventually displace native vegetation and reduce plant species richness. Many lake association members and volunteer groups seek to reduce this species through manual removal.

Eurasian water milfoil is a submergent plant that grows rapidly in lakes once established. This nuisance species out-competes native aquatic vegetation and often significantly disrupts the aquatic ecosystem for many years. It is hard to eliminate once large stands become established. This species does best in lake environments, and has been found in Burt, Thumb, and Long lakes but most likely exists in many lakes in the watershed. Treatment of Eurasian water milfoil is expensive and elimination is nearly impossible. Treatment can occur through chemicals, or biologically with weevils which reduce plant growth.

The preceding paragraphs provide a brief summary of the exotic species that affect the Cheboygan River watershed. All anglers and waterway users should educate themselves on these nuisance species and learn methods to prevent the spread of these and other nonnative organisms.

Fisheries Management

Historical and modern fisheries management in the Cheboygan River watershed has been shaped by the varying aquatic habitat types in its rivers and lakes. The watershed contains a diverse array of rivers and a multitude of lake types. The valley segments of small coldwater streams such as the West Branch Maple River (headwaters to Maple River Dam), Sturgeon River (headwaters to confluence with West Branch Sturgeon River), West Branch Sturgeon River, Pigeon River (headwaters to Golden Lotus Dam), Black River (headwaters to Clark Bridge Road), East Branch Black River, and Canada Creek drain a region of high groundwater loading (see **Hydrology** and **Geology**) and maintain summer stream temperatures and top-quality habitat suitable for trout. These streams are managed primarily through habitat protection measures, such as permit reviews, and angling regulations that promote self-sustaining trout populations. The watershed also contains a number of medium-sized coldwater streams. These include valley segments in the Maple River (Maple River Dam to Burt Lake), Sturgeon River (confluence with West Branch Sturgeon River to Burt Lake), Pigeon River (Golden Lotus Dam to confluence with Little Pigeon River), and the Black River (Clark Bridge Road to Kleber Dam). Portions of these streams may be managed to take advantage of populations of migratory steelhead and brown trout from the large lakes discussed later in this section.

Although known primarily for its coldwater streams, the Cheboygan River watershed also contains a number of rivers with warmer water temperatures. These include the East Branch Maple River, the Pigeon River (confluence with Little Pigeon to Mullett Lake), the Black River (Kleber Dam to Black Lake), the Lower Black River, and the Cheboygan River. Most of these rivers are designated trout streams, but since all are thermally marginal for trout the designation is intended to protect migrating salmonids (adults and smolts). The Black River segments and the Cheboygan River also have special regulations to protect spawning lake sturgeon and muskellunge.

The Cheboygan River watershed includes three of the twenty largest inland lakes in the state (Burt, Mullett, and Black), as well as other large lakes over 1,000 acres in size including Pickerel-Crooked and Douglas lakes. These lakes are primarily managed through habitat protection and angling regulations that are protective of the fish populations within those lakes (See **Biological Communities**). Lake sturgeon fishing is currently limited in the watershed to a 5-fish total winter season on Black Lake, where the primary method of take is by spear. Burt and Mullett lakes support good populations of rainbow trout (steelhead) and brown trout, which migrate into the Sturgeon River, Pigeon River, and other tributaries for spawning.

In addition to its large lakes, the Cheboygan River watershed contains numerous smaller lakes. Fish stocking, angling regulations, and habitat protection are again the primary methods of fishery management for these lakes. There are, however, a number of specially-managed lakes in the watershed which are discussed later in this section.

Fish stocking was historically a common fisheries management method throughout the watershed and remains an important tool today, although at a much smaller scale (Table 23). Most fish stocking has been done by the Michigan Department of Natural Resources. Many warm and coolwater fish species, such as walleye, bluegill, and hybrid sunfish, were stocked in the watershed prior to the 1950s. These fish were typically large enough to be legally harvested in a short-lived put-and-take fishery. Fish stocking records from 1979 to present are available on the Fisheries Division website.

In the past, many streams in the watershed were stocked with trout, but this management practice was stopped because it was ineffective and costly. Today, trout streams within the watershed are managed through a combination of regulations that recognize the ecological importance and social values of salmonid species. Trout populations in nearly the entire Cheboygan River watershed were managed by uniform regulations prior to 2000, although statewide regulations on creel limits, seasons, and length limits varied substantially in the past (Borgeson 1974). The most recent changes for inland trout regulations were established in 2000 as a result of a statewide review of the existing regulations. Today, trout streams in the watershed are managed as Type 1, Type 2, Type 4, and Type 3 waters (Table 24, listed here in descending order of occurrence). Type 1 trout streams are the most common because they are the “standard” regulation for trout streams throughout the state. There are also a number of Type 2 trout streams in the watershed, including the Maple River from Maple River Dam downstream to mouth, the Pigeon River from Golden Lotus Dam downstream to M-68 bridge, and the Black River from Town Corner Lake stairs downstream to Tower Dam.

Type 4 trout streams in the Cheboygan River watershed include the Pigeon River from M-68 bridge downstream to its mouth and Sturgeon River from Afton Road downstream to its mouth. Type 4 regulations allow anglers to fish for migratory rainbow trout (steelhead) from Mullett and Burt Lakes all year. One reach within the Cheboygan River watershed (the Cheboygan River from Cheboygan Dam downstream to Lake Huron) has Type 3 trout stream regulations, which are appropriate to allow fishing for potamodromous fish species, such as Chinook salmon.

In 2008, a reach within the Cheboygan River watershed was designated as a special regulation research area. For the Black River from Tin Shanty Bridge Road downstream to the Town Corner Lake stairs the season is open all year, but the possession season is from the last Saturday in April to September 30 (limit 2 trout). Only artificial lures may be used, and it is unlawful to use or possess live bait, dead or preserved bait, organic or processed food, or scented food on any of the waters or on shore. The minimum size limits (MSLs) are 10 inches for brook trout and 12 inches for brown trout. The objective of this special regulation is to determine if restricting anglers to the use of only artificial lures or flies on a reach of the Black River results in an increase in survival and abundance of larger and older brook trout as compared to a reach of the same river where bait angling is permitted.

Stocked and self-sustaining trout populations in the Cheboygan River watershed have been monitored by MDNR field staff and by staff from the Hunt Creek Fisheries Research Station and the Pigeon River Trout Research Station which have conducted over 50 years of trout stream research. The Pigeon River Trout Research Station operated from 1949-1965, and was located at the present site of the Pigeon River Country State Forest Headquarters. Staff from both research stations studied lakes and streams throughout the watershed, helping guide statewide trout management.

Data gathered from creel surveys of anglers and their catches provide another important fisheries management tool. These surveys allow managers to evaluate the effectiveness of management actions such as stocking or regulation changes. The oldest creel survey data for many lakes in the watershed were collected by conservation officers from 1928–64 (Appendix 4). This effort was discontinued, in part, because the methods were rather informal and the data gathered did not allow for expanded estimates of total catch, harvest, or angling effort.

Fisheries Division has a number of long-term sampling sites in the Cheboygan River watershed. These long-term sampling sites are fixed sites in the Stream Status and Trends Program (SSTP), which was recently developed by Fisheries Division to standardize data collection and allow for spatial and temporal comparisons among water bodies (Wills 2008). Fish populations within a 1000-foot section of the river are estimated using standard mark-recapture fish sampling methods employed by the MDNR (Schneider 2000). The abundance (number and pounds per acre) of trout populations were estimated from samples collected in July or August of each year on a three-year rotation.

The following sections highlight fisheries management throughout the Cheboygan River watershed. The descriptions will follow the river valley segment approach defined earlier in this report (see **Geography**). The 2008 stream classification, based on temperatures and fish community, are used to classify streams (see **Water Quality**). Fisheries management for each reach is described for the main stem river reach, the tributaries to that reach, and the lakes within that catchment. Fish stocking events prior to 1978 are also listed for each waterbody.

West Branch Maple River—Headwaters to Maple River Dam

Main Stem

This reach has a number of habitat types. The West Branch Maple River originates in the Pleasantview Swamp and is classified as warm in its headwaters due to its surface drainage origins. However, the river quickly accrues groundwater along its length, cooling rapidly to warm-transitional by the time it crosses Ralmer Road and becomes even colder at the confluence of Cold Creek. Water temperatures (and classification) remain cold to Lake Kathleen. The majority of the West Branch Maple River supports a typical coldwater fish community and is managed with Type 1 trout stream regulations throughout.

The West Branch Maple River contains a mix of brown, brook, and rainbow trout. The stream is dominated by brook trout, which had the highest densities (number per acre) and standing crop (pounds per acre) of the three trout species each year it was sampled. In fact, the density of brook trout at the Robinson Road site is higher than any other Stream Status and Trends fixed site in the Northern Lake Huron Management Unit (NLHMU). Brook trout standing crop is second only to the North Branch of the Au Sable River, and is more than twice the statewide average of other high quality trout streams sampled during Stream Status and Trends fixed site surveys (Figure 36). This reach had an average of 1,415 trout per acre (5,156 trout per mile) from 2002-04. Standing crop of all trout during the same time period averaged nearly 51 pounds per acre (Fisheries Division, unpublished data).

Because the West Branch Maple River is relatively warm in its headwaters, the fish community is susceptible to small changes in water temperature, which can cause a significant change in species composition (P. Seelbach, MDNR, personal communication). Therefore, a partnership was formed in 2007 to begin managing multiple beaver dams which were thought to be warming the river. The group was organized by the Miller VanWinkle Chapter of Trout Unlimited and Conservation Resource Alliance (CRA). Volunteers floated the river in the fall of 2007 and documented a total of 36 beaver dams. Afterwards, staff of CRA and the MDNR worked with local trappers over the winter of 2007-08 to reduce the beaver population near the river. Once the population has been reduced, the partnership will remove a number of beaver dams to restore flows.

Other fisheries management activities for the West Branch Maple River include maintaining a sand trap near the airport; stocking brook trout in the 1950s and 1960s; and a number of trout population estimates.

Tributaries

The principal tributaries in this segment include Brush Creek and Cold Creek. Brush Creek, which originates as an outlet from Larks Lake (discussed below), is classified as a warm-transitional stream. There are no fisheries data on file for Brush Creek. Cold Creek is also classified as a warm-transitional stream and was last surveyed in 1972, when an excellent brook trout population was documented. Numerous gravel riffles which provide important spawning habitat were reported. Both streams are managed with Type 1 trout stream regulations.

Lakes

There are two lakes in this segment: Larks Lake and Lake Kathleen. Larks Lake, last surveyed in 2005, is very shallow (most of the lake is less than 5 feet deep) and unproductive. Nongame species, such as white sucker and bullheads, dominated the catch in terms of numbers and biomass. Sport fish species collected include yellow perch, pumpkinseed, rock bass, largemouth bass, and northern pike. The fish community is typical for a shallow lake with limited nutrient availability, low vegetation levels, and marl substrate. Largemouth bass, northern pike, and panfish populations are limited by the low productivity of the lake. The lake periodically winterkills due to its shallow nature.

Lake Kathleen is a 42-acre impoundment formed by the Maple River Dam. The entire shoreline of Lake Kathleen is privately owned, limiting public access. Average depth of the impoundment is 4.2 feet, with a maximum depth of 12.9 feet. The lake does stratify, and has cold temperatures (maximum of 64.1°F on August 22, 2007) and good oxygen levels (6.79 ppm at 11.1 ft. depth). A 1973 survey conducted by the University of Michigan Biological Station (Curless 1973) found a mix of coldwater and warmwater species, typical of an impoundment on a coldwater river. The species included brown trout, sculpin, northern pike, white suckers, Johnny darters, yellow perch, pumpkinseeds, bluegills, rock bass, largemouth bass, and several minnow species.

Because of their nature and limited access, no fisheries management activities beyond general statewide sport fishing regulations occur in Larks Lake or Lake Kathleen.

East Branch Maple River—Headwaters to Maple River Dam

Main Stem

The East Branch Maple River is a warm-transitional stream and originates as the outlet from Douglas Lake, and flows to its confluence with the West Branch Maple River at Lake Kathleen, forming the main stem Maple River downstream of the dam. Because it is a lake outlet, the fish community is comprised primarily of warm and coolwater fish species, although it does have some coldwater habitat as it accrues groundwater in the lower portion of the river. The East Branch Maple River has Type 1 trout stream regulations.

The stream was sampled in 2002 at the Robinson Road crossing as a random survey site in the SSTP. The primary purpose of random survey data is to characterize different types of streams in the state, and to answer questions best answered by comparing different streams. The species encountered include bowfin, mudminnows, four cyprinid (minnow) species, grass pickerel, largemouth bass, mottled sculpin, pumpkinseed, white sucker, and yellow perch. This mix of coolwater species is typical of a marginal trout stream, with dace and sculpin alongside perch and centrarchids. No trout were found during the 2002 survey. The stream has good habitat for trout (gravel and woody debris), but temperatures get high enough during the summer to make it thermally marginal for these species. Therefore, trout only use the stream on a seasonal basis.

Tributaries

The tributaries in this segment include Beavertail Creek and Lancaster Creek (also known as Bessey Creek), which flow into Douglas Lake, and Van Creek, which flows directly to the East Branch Maple River. These three tributaries are all classified as warm-transitional streams. Lancaster Creek provides fish access to a large flooded marsh in the spring, which is important spawning habitat for esocid species such as grass pickerel and northern pike. This “pike marsh” has been operated by members of the Douglas Lake Preservation Society (DLPS) for a number of years in cooperation with the MDNR.

No fisheries data are available for Beavertail Creek or Van Creek. Management is limited to standard sport fishing regulations.

Lakes

Lancaster Lake is a 52-acre natural lake in northwestern Cheboygan County, in the Maple River watershed. Maximum depth is 57 feet. Lancaster Lake has two tributaries: Lancaster Creek flows into the northwest corner of the lake, and Munro Creek flows into the northeast portion of the lake. The lake outlet, Bessey Creek, flows into Douglas Lake to the south. Lancaster Lake was last surveyed in 2005. The survey showed a healthy fish community, with good numbers of both predators and prey. Predators such as largemouth bass and northern pike have good size distributions. Black crappie and bluegill also had good size distributions, but black crappie were much more abundant. Although slightly below state average, growth of black crappie and largemouth bass was satisfactory. Northern pike were especially slow growing, averaging 1.7 inches smaller than the state average length-at age. Bluegill were also growing below state average, with a growth index of -0.7.

Munro Lake is a 515-acre natural lake in northwest Cheboygan County. Although large in size, Munro Lake is relatively shallow, with a mean depth of about 5 feet, and a maximum depth of 15 feet. Because of its shallow depths, Munro Lake is prone to periodic winterkill and does not thermally stratify in the summer as the wind continually mixes the water column. Munro Lake has an unnamed tributary, and the lake’s outlet, on the north end of the lake, flows into Lancaster Lake. Munro Lake was last surveyed in 2006, and although the catch was numerically dominated by yellow perch and rock bass, largemouth bass comprised the largest percentage of biomass in the catch. Growth of all species was above the state average, indicative of a productive lake. Bluegill and pumpkinseed had good size distributions up to 8 and 9 inches, respectively. The number of large rock bass (10 inches or greater) was impressive. The absence of larger predators in the catch may indicate that anglers are harvesting fish once they reach an acceptable size. Other fish have a good distribution of sizes, with many inch groups represented. This indicates a balanced fish community, good survival, and that the lake has not experienced a complete winterkill in a number of years.

Douglas Lake is a 3,350-acre natural lake with a maximum depth of 80 feet, although most of the lake is less than 30 feet deep. The lake was most recently surveyed in 2000. Cwalinski (2004) discusses this survey and the management direction for Douglas Lake:

> The overall fish community of Douglas Lake has not changed much through time, with a few exceptions. The current community can generally be characterized as having the following: 1) an average growing and diverse panfish community with some species more abundant than others, 2) an abundant rough fish community, 3) a remnant coldwater fish community, 4) and a predator game fish component consisting mainly of two abundant species (northern pike and smallmouth bass) and one uncommon species (largemouth bass). The large game fish tend to exhibit average to slightly below average growth.

Panfish species include yellow perch (most common), rock bass, bluegill, pumpkinseed sunfish, and black crappie. Ongoing fishery management within Douglas Lake includes cooperative operation of the pike rearing marsh between the DLPS and the MDNR. A better public access site for Douglas Lake should be pursued.

Maple River—Maple River Dam to Burt Lake

Main Stem

The main stem Maple River originates at the confluence of the East and West branches at Lake Kathleen, above Maple River dam. Although originating as a tailwater below Maple River Dam, water temperatures are fairly cold because there is a considerable amount of groundwater input in the area. This cold-transitional reach is managed with Type 2 trout stream regulations.

The main stem was last surveyed in 2002 as a random site in the SSTP. Random sites involve a one-pass electrofishing effort to document species presence and relative abundance. Three species of trout (brook, brown, and rainbow) were collected at this station, in addition to 10 other species of fish representing both warm and coldwater preferences. This mix of fish types within the community reflects the origins of the main stem, which starts at the confluence of its two tributaries just upstream. The West Branch Maple River is a coldwater stream, with a good trout population. The East Branch Maple River is a marginal trout stream, due to its lentic origin (Douglas Lake) and the limited groundwater input provided by the surficial geology through which it flows. The upstream impoundment, Lake Kathleen, is also a likely source for warmwater species encountered below the dam. Brown trout were the most abundant game fish encountered, with lengths fairly well distributed but age-0 trout less abundant than one would expect. Five legal brown trout (12-14 inches) were observed during sampling. Brown trout growth was above the state average. Current regulations appear to be adequate; more restrictive size limits would not be appropriate.

Average width of this reach was 47.6 feet, with depths of 0.5–4.7 feet. Gravel was the predominant substrate throughout the reach, and there was a good variety of pool, riffle, and run habitat. In the past, two sand traps were maintained on the main stem near Brutus Road. Maintenance of these traps was discontinued because they were located relatively close to the mouth and the benefits of sand removal were only realized for a small part of the watershed. The heavy equipment pads at the sand traps became popular for illegal ORV use and trash dumping. To help address this issue, volunteers worked with the MDNR to place gates to limit motorized access to these areas. Initial results have been promising.

Other management activities in the main stem Maple River include streambank stabilization that was completed in 1989-1990 using stone rip rap. The river was also stocked with brown trout, brook trout, and rainbow trout in the 1960s, 1970s, and early 1980s. Stocking was discontinued after fisheries managers realized it was providing little benefit to the established fish community.

Tributaries

There are no major tributaries in this valley segment.

Lakes

There are no major lakes in this valley segment. Burt Lake will be discussed in another subsection of Fisheries Management.

Sturgeon River—Headwaters to confluence with West Branch Sturgeon River

Main Stem

The Sturgeon River begins as a series of springs that emerge from coarse-textured moraines near Gaylord. This reach receives a substantial amount of groundwater loading, and is appropriately classified as a cold water stream above the confluence with Club Stream. Downstream of that confluence is classified as cold-transitional. The entire reach is regulated as a Type 1 trout stream.

The contributing watershed in this reach contains a number of large, privately-owned parcels. The river itself has been the subject of two court cases concerning its navigability (whether it is public water or private). A two-mile segment of this reach has been adjudicated as nonnavigable by the courts (see **Special Jurisdictions**) and is therefore considered private. Another segment in this reach was confirmed as navigable (public) by the courts (see **Special Jurisdictions**). The reach also includes a large parcel of state-owned land referred to as "Green Timbers." Green Timbers is managed as a special use area within the Pigeon River Country State Forest by the Forest, Mineral, and Fire Management Division (FMFM) of the MDNR. Special management for this parcel includes prohibiting the use of motorized vehicles and an emphasis on wildlife management and a wilderness experience.

Fisheries Division has a fixed sampling site on the Sturgeon River at the river's crossing of Trowbridge Road. Brown trout were the most abundant salmonid species captured at this station, followed by rainbow trout. No brook trout were present. Standing crop of brown trout (31 pounds per acre) was less than that of other fixed sites in the NLHMU (Figure 37). Standing crop of rainbow trout (17 pounds per acre) was the highest of any fixed site in NLHMU and above the average for other high quality trout streams sampled as fixed sites in the Stream Status and Trends Program (Figure 38).

There was a considerable amount of habitat work done in this reach during the 1980s in conjunction with the Michigan Youth Corps. Most of the work involved placing stone for bank stabilization and to prevent additional sediment from entering the river. Approximately 4,500 feet of stream bank was stabilized using clean fieldstone rip rap in the main stem Sturgeon River from 1983–89. A small portion of this work was done in the adjacent downstream reach below the confluence with the West Branch Sturgeon River.

A sand trap project was initiated in the mid-1980s in conjunction with the bank stabilization work and in cooperation with Trout Unlimited. Twelve sand traps, approximately one every mile, were dug in the upper Sturgeon River. This was done largely to address sediment from construction of a ski resort and golf course in the headwaters and other human development. Currently, only one of the traps (at Sturgeon Valley Road) is being maintained. Fisheries Division is also studying the effectiveness of the sand trap at Old Vanderbilt Road by monitoring bed elevations and channel cross sections at a number of locations in the reach. The other sand traps initiated in the mid-80s are no longer used due to either access issues or because they were deemed ineffective.

Tributaries

Mossback Creek, Pickerel Creek, Club Stream, Stewart Creek (including its tributary Blackjack Creek), are mostly small, groundwater-fed streams. All have Type 1 trout stream regulations, and are classified as coldwater streams.

Lakes

There are six lakes of note within this valley segment: Clifford, Lance, Murner, Olund, Pickerel, and Wildwood. Clifford and Lance Lakes are small private lakes and are not actively managed by Fisheries Division. The MDNR attempted to acquire property on Lance Lake to provide a small carry-in access site for the public, but the property was sold before the purchase could be made. The state should pursue property acquisition on this lake to provide for public access if future opportunities become available. Pickerel Lake is a Designated Type A trout lake (Table 25), and is annually stocked with 2,500 rainbow trout. Pickerel Lake was last surveyed in 2007 and also supports populations of bluegill, yellow perch, pumpkinseed, and largemouth bass. The rainbow trout are surviving and providing a fishery, although growth rates are variable. Wildwood Lake is a 350-acre shallow lake with a lake-level control structure (dam) on it. Due to an abundance of small pike, there is a no minimum size limit, or “no MSL,” regulation for pike on this lake. Wildwood Lake was last surveyed in 2002, when game fish collected included yellow perch, bluegill, rock bass, and pumpkinseed, and a large number of northern pike. No fisheries data are available for Murner or Olund lakes.

West Branch Sturgeon River

Main Stem

The West Branch Sturgeon River is classified as a cold stream, and was stocked with rainbow trout and brook trout in the 1950s, but managers quickly realized that natural reproduction was more than adequate to maintain the fishery. Fisheries Division has a SSTP fixed sampling site on the West Branch Sturgeon River at the crossing of highway Old 27. Brown trout were the most abundant salmonid species captured at this station, followed by rainbow trout. Only a few brook trout were present. Standing crop of brown trout (66 pounds per acre) was slightly above that of other fixed sites in the NLHMU (Figure 37). Standing crop of rainbow trout (10 pounds per acre) was comparable to other high quality trout streams within NLHMU (Figure 38). Brook trout are also present in the upstream areas of the West Branch Sturgeon River.

Tributaries

Marl Creek is classified as a coldwater stream and has Type 1 trout stream regulations. No fisheries data are available for this stream.

Lakes

Four lakes within this segment that are actively managed by the MDNR include Hoffman, Thumb, Silver, and Weber lakes. General fisheries surveys of Hoffman Lake and Thumb Lake were conducted in spring 2008. Thumb Lake, also known as Lake Louise, is annually stocked with 20,000 splake (a cross between brook trout and lake trout) and has Type B trout lake regulations (Table 25). Thumb Lake has been stocked with trout on a fairly regular basis since 1942, with an initial rainbow trout plant as early as 1922. Splake have been stocked in the lake since 1976, except 1978-1980, when lake trout were stocked. Rainbow trout were also stocked in 2008. In the 1930s and 1940s, managers stocked warm and coolwater species such as largemouth and smallmouth bass, walleye, perch, and bluegill. In addition to splake and rainbow trout, game fish species encountered in the 2008 survey of Thumb Lake included panfish species (yellow perch, bluegill, and pumpkinseed), and northern pike. A creel survey was done on Thumb Lake in 2006, which indicated a fairly low catch of splake (MDNR, unpublished information). These results should be interpreted with caution however, as the creel survey was conducted only from April through September. Angler reports indicate that there is a substantial winter fishery for splake, but this information was not captured in the creel survey.

Hoffman Lake was stocked with rainbow trout in the 1920s and 1940s, and brook trout in the 1930s and 1940s. Bluegill were also stocked in Hoffman Lake in 1937. The 2008 survey of Hoffman Lake found largemouth bass, northern pike, bluegill, and yellow perch. There is no MSL for northern pike in Hoffman Lake, a regulation that was put in place to reduce the abundance of small fish and keep the population size in check. Based on the 2008 survey, which showed good northern pike size and age structure, the “no MSL” regulation will be removed for Hoffman Lake. The lake responded well to the no-MSL regulation, but we believe the size structure is currently such that the population will be self-regulating, and that standard, statewide regulations should be restored.

Silver Lake and Weber Lake have Type B trout lake regulations (Table 25), and are stocked annually with trout by the MDNR. Current management prescriptions call for Silver Lake and Weber Lake to receive an annual plant of 5,000 rainbow trout and 2,500 brown trout, respectively.

A general survey of Silver Lake was conducted in 1995. A good number of rainbow trout were captured in the nets, indicating that the stocked fish were surviving. Rainbow trout growth was acceptable at the time. Other species in the lake, including bluegills, pumpkinseeds, rock bass, and smallmouth bass, were not growing very well and did not have the size distributions that attract much angling attention. The lake primarily supports a trout fishery but perch fishing can be good there on occasion.

Weber Lake was last surveyed in 1992 to assess the trout population. Good survival of stocked brown trout was noted. Reports indicate that the yellow perch fishery was improving, with an average size of 8.4 inches in the catch.

Sturgeon River – Confluence with West Branch Sturgeon River to Burt Lake

Main Stem

The Sturgeon River becomes fast and deep with increased discharge from the added flow of the West Branch Sturgeon River, downstream of which it is classified as warm-transitional. The most recent fisheries survey for this reach was completed in 2007, at the township park in Wolverine, just downstream of the confluence with the West Branch Sturgeon River. This survey found a mix of brook, brown, and rainbow trout, with brown trout dominating the catch. Some warmwater species such as bluegill and pumpkinseed also were captured in 2007. This reach is similar to the adjacent reach upstream, and along with the West Branch Sturgeon River has a mix of resident and lake-run brown trout and rainbow trout (steelhead). The mostly coldwater fish community in this reach also has some cool and warmwater species present. In addition to the lake-run brown and rainbow trout, the river supports runs of other species from Burt Lake such as walleye and white suckers. Similar to the reach above the West Branch Sturgeon River, there was a considerable amount of habitat work done in this reach during the 1980s by the Michigan Youth Corps.

Tributaries

The only tributary to the Sturgeon River downstream of its confluence with West Branch Sturgeon River is Beebe Creek, which is classified as a cold water stream and has Type 1 trout stream regulations. No fisheries data are available for Beebe Creek.

Lakes

Inland lakes are absent within this segment

Burt Lake

The most recent netting survey of Burt Lake was done in 2001-2002 as part of Fisheries Division's Large Lakes Program, a statewide program designed to improve assessment and monitoring of fish communities and fisheries in Michigan's largest inland lakes.

Hanchin et al. (2005a) provide a description of the fish community based on that survey:

> We collected a total of 17,227 fish of 28 species…. Total sampling effort was 321 trapnet lifts, 31 fyke-net lifts and 6 electrofishing runs. We captured 2,899 walleyes and 203 northern pike. Other game species collected in order of abundance of total catch were: rock bass, smallmouth bass, yellow perch, rainbow trout, brown trout, largemouth bass, pumpkinseed, bluegill, black crappie, muskellunge, and brook trout.
>
> The trout populations in Burt Lake are a testimony to the quality of the rivers that feed the lake. The Sturgeon and Maple river systems harbor quality spawning runs of rainbow and brown trout. The young fish, particularly rainbow trout, often migrate downstream and live out their remaining life cycle in Burt Lake. Trout have access to more forage in the lake, and can grow to impressive sizes.

Hanchin et al. (2005a) also reported that an estimated 42,032 adult walleye (approximately 2.4 fish per acre were in Burt Lake. An estimated 1,779 adult northern pike (approximately 0.1 fish per acre) were also in Burt Lake at the time of the survey.

Burt Lake has a long history of fisheries management. Since 1925 various fish species have been stocked in the lake, including rainbow trout, lake trout, walleye, lake sturgeon, rock bass, northern pike, and yellow perch. The most recent MDNR fish stockings in Burt Lake were a 1987 rainbow trout plant and lake sturgeon plants in 1990 and 2009. Burt Lake supports diverse and popular sport fisheries for everything from walleye and perch to rainbow trout and brown trout.

Tributaries

Tributaries to Burt Lake include the Sturgeon and Maple Rivers, which were discussed previously. The Little Carp River, also a tributary to Burt Lake, is classified as a coldwater stream and has Type 1 trout stream regulations. Several unnamed tributaries to Burt Lake are also classified as coldwater streams: two at the northwest corner of the lake, and one in the northeast corner of the lake (tributary to White Goose Bay). None of the unnamed streams have trout stream regulations.

Other tributaries to Burt Lake are in the Crooked River drainage, which includes Pickerel and Crooked Lakes. These tributaries include Minnehaha Creek, West Branch Minnehaha Creek, Silver Creek, Berry Creek, Cedar Creek, and McPhee Creek. All of these tributaries have Type 1 trout stream regulations and are classified as coldwater streams. The Crooked River does not have trout stream regulations and is classified as a warm transitional river. A 2003 survey of West Branch Minnehaha Creek found brook trout and brown trout, with brook trout being much more abundant. Silver Creek, a tributary to Crooked Lake, was stocked with brook trout from 1959-1965, and with rainbow trout in 1988. No contemporary survey data exist for Silver Creek.

Other Lakes

Pickerel and Crooked lakes are managed primarily for coolwater fish species including walleye and northern pike. Walleye and pike populations were evaluated in 2001 as part of the large lakes program, with an estimated 12,346 adult walleye and 628 adult northern pike present at the time (Hanchin et al. 2005b). Both lakes were previously stocked with walleye in alternate years. However, fall walleye evaluations for Pickerel and Crooked lakes subsequent to the 2001 large lake survey have documented good natural reproduction of walleye so the stocking frequency has been reduced to every three years. Walleye stocking was not completely discontinued due to an agreement with the Pickerel-Crooked Lakes Association.

Round Lake is a 353-acre natural lake and has a maximum depth of 14 feet. The lake is at the head of the Cheboygan River watershed, with an unnamed outlet that flows to Crooked Lake. Round Lake was stocked with smallmouth and largemouth bass, perch, bluegill, and perch in the 1930s and 1940s. Walleye were stocked in 1957, 1991, 1995, 1996, and 1998. The lake was last surveyed in 1968, when northern pike, walleye, smallmouth and largemouth bass, and bluegill were the most abundant game fish species.

Pigeon River – Headwaters to Golden Lotus Dam

Main Stem

This reach and its tributaries are designated trout streams with Type 1 trout stream regulations, and are classified as coldwater streams. The primary game fish within this reach is brook trout. Golden Lotus Dam at the downstream end of this reach prevents access for migratory brown and rainbow trout.

Tributaries

The South Branch Pigeon River has Type 1 trout stream regulations, and is classified as a coldwater stream. The stream was last surveyed in 2007 and brook trout, brown trout, and tiger trout (a cross between brook and brown trout) were found.

Lakes

The most notable lake within this reach is Lansing Club Pond, an impoundment of the main stem formed by Golden Lotus Dam. Lansing Club Pond is not valuable from a fisheries management perspective; it is very shallow, with substrate that is thick organic silt accumulated along the bottom. This dark substrate absorbs sunlight and heats the water, warming the reach of the Pigeon River below the dam.

A more valuable lake from a fisheries management perspective is Big Lake. This lake is stocked with walleye by the DNR and was most recently surveyed in 2005 to evaluate walleye recruitment. The survey found a good walleye population, with a substantial amount of natural reproduction. Based on an analysis of oxytetracycline (OTC) marks, 77% of the 22 age-0 walleye captured were of wild origin.

Other lakes within this segment include Denny Lake, Fifteen Lake, Ginsell Lake, Lewis Lake, and Oley Lake. No fisheries data are available for these water bodies, and fisheries management is limited to typical sport fishing regulations.

Pigeon River—Golden Lotus Dam to confluence with Little Pigeon River

Main Stem

Brook, brown, and rainbow trout are all present in this reach, which is greatly influenced by the presence and operation of Golden Lotus Dam. In addition to the warming effects of the impoundment reducing coldwater fisheries potential, the reach is affected by the peaking operation of the dam (see **Dams and Barriers**). This peaking and ponding operation results in the dewatering of steelhead redds, the stranding of fish and invertebrate species, and the downstream flushing of small fish, eggs, and invertebrates during high flows. This stretch of the Pigeon River is managed with Type 2 trout stream regulations.

In 1954 and 1984 sediment was released from the impoundment, resulting in fish kills downstream. Another sediment release and subsequent fish kill occurred in June 2008. Extensive sampling to determine the magnitude of the fish kill was conducted and is summarized in Nuhfer et al. 2009a. In addition, electronic temperature recording thermometers have been deployed above the dam and at various locations downstream of the dam over the past decade. Analyses of these temperature data show that summer water warming caused by the dam reduces thermal habitat suitability for trout downstream and that dam removal could expand optimal thermal habitat for trout by up to 16 miles (Nuhfer et al. 2009c). For the most recent case, an interim order was entered with the 46th Circuit Court on April 5, 2010, which called for removal of the Golden Lotus Dam after a plan for dam removal is developed and monitoring is done.

Fisheries Division has a SSTP fixed sampling site on the Pigeon River at Elk Hill Campground. Abundance, density, and standing crop of trout populations were estimated from samples collected in July or August of each year from 2002-2004. Fish populations within the 1000-foot reach of river sampled were estimated using standard mark-recapture fish sampling methods employed by the

MDNR (Schneider 2000). Brown trout, brook trout, and rainbow trout populations at this site were lower than the NLHMU and statewide averages (Figures 36-38).

Tributaries

Cornwall Creek, Grindstone Creek, and Nelson Creek are all designated trout streams and have Type 1 trout stream regulations. Although all of Cornwall Creek is classified as cold water, the Type 1 regulations apply only to the reach upstream of Cornwall Flooding. A 1984 survey of this stream found brook and brown trout.

Lakes

Cornwall Creek Flooding and Grass Lake support warmwater fish communities. Cornwall Creek Flooding is a good panfish lake, with notable catches of bluegills and perch. It was stocked with tiger muskellunge in alternate years from 1979 to 1991. Because of the muskellunge plants, spearing on the lake was banned. The spearing ban remained in place (except for carp) on the lake until 2010, when the spearing ban was removed. Cornwall Lake was last surveyed in 1995 and a good number of largemouth bass were found. Grass Lake is small and shallow and prone to periodic winterkill. The lake was stocked with bluegill and smallmouth bass in the 1930s. Grass Lake was last surveyed in 2003, when four species of fish were documented: bluegill, brown bullhead, green sunfish, and pumpkinseed.

A number of small, unique “sinkhole” lakes are located in this reach: North Twin, South Twin, Hemlock, Ford, West Lost, Lost, and Section 4 lakes. These lakes were formed when underground limestone caves collapsed to form sinkhole depressions at the surface. The seven sinkhole lakes, ranging in size from 3-10 acres, were closed to fishing in the 1960s to allow for research studies in their waters. While the lakes were used for a number of important studies, they had not been used for research since the 1990s. In an effort to increase fishing opportunity the fishing ban was removed for these lakes in 2008, and four of the lakes (Hemlock, Ford, West Lost, and Section 4 Lakes) are stocked with trout. Measures were taken to ensure that the fishing pressure on these lakes would not increase erosion and sedimentation. Watercraft restrictions were placed on the lakes so that vessels are prohibited where launching and recovery of such craft were expected to cause erosion. The exceptions are as follows: nonmotorized single-user float tubes are permitted on North and South Twin Lakes, Section 4 Lake, and Lost Lake; while it is unlawful to operate a vessel powered by a motor except an electric motor on Hemlock, Ford, and West Lost Lakes. The four stocked lakes are now classified under Type D trout lake regulations. Only artificial lures may be used on these lakes, and the minimum size limit for brown trout, brook trout and rainbow trout is 15 inches.

Pigeon River—Confluence with Little Pigeon River to Mullett Lake

Main Stem

The upper portions of this reach support high populations of subyearling rainbow trout along with fairly low-density populations of brook trout and brown trout. We believe that mortality of trout in this reach is high because during most years, summer water temperatures in this reach are higher than optimal for trout. Brown trout are the predominant salmonid species species based on biomass. Summer populations of brown trout are augmented by immigrants from Mullet Lake that ascend the river during the summer before spawning later in the fall. The warmer summer water temperatures in this reach support a more diverse and abundant community of non-trout fish species as compared to reaches farther upstream. Type 2 trout stream regulations are in place upstream of M-68, while Type

4 trout stream regulations occur downstream of M-68 to allow anglers to fish for steelhead that ascend the river from Mullett Lake.

A number of fish surveys have been done in this reach in the past, with the most recent survey completed in 2003 as a random site under the SSTP. A 1200-foot reach was surveyed at the Andrea Agnes Nature Preserve downstream of M-68. Young rainbow trout and brook trout, which use this reach only seasonally, were captured along with a number of brown trout.

Tributaries

The Little Pigeon River is a designated trout stream with Type 1 trout stream regulations. It is a coldwater stream in its upper reaches and a cold-transitional stream in its lower half. The Little Pigeon River has not been stocked. A survey conducted in 2002 found brook and brown trout, with brook trout dominating. Forage fish such as shiners, dace, chubs, and suckers were common. Although there are no fisheries data for Kimberly Creek, a small tributary to the Little Pigeon River, angler reports indicate that it is an excellent brook trout stream.

Lakes

Lakes in this segment include Mud Lake, Echo Lake, Hackett Lake, and Sixteen Lake. Mud Lake is a small, shallow lake that is prone to winterkill. A 2003 survey of the lake found only two species of fish (yellow perch and golden shiners), both of which are relatively tolerant of low dissolved oxygen conditions. The limited fisheries data available for Echo Lake indicate the lake supports populations of bluegill and northern pike. No fisheries data are available for Hackett Lake or Sixteen Lake. Fisheries management is limited to general statewide sport fishing regulations.

Mullett Lake

Fisheries management in Mullett Lake has included fish surveys, creel surveys, and the stocking of numerous species such as lake trout, brown trout, brook trout, rainbow trout, splake, lake sturgeon, and walleye. The lake supports popular walleye and smallmouth bass fisheries, as well as fisheries for brown and rainbow trout. Although the lake has been stocked with a small number of walleye in recent years, the main source of walleye is from natural recruitment throughout the system. Mullett Lake, like the other large lakes in this watershed, has a population of lake sturgeon, although the size of that population is unknown. Mullett Lake supported a popular winter ice fishery (spearing) for lake sturgeon until 2000, when sturgeon spearing was closed statewide (with a few exceptions) due to population concerns. A research project that began in 2009 will attempt to quantify the size of the lake sturgeon population within this lake. Mullett Lake is scheduled to have a large lake survey (including population estimates for northern pike and walleye) completed in 2011.

Tributaries

The Indian River is the principal tributary to Mullett Lake and is part of the Inland Waterway, connecting Burt Lake to Mullett Lake. The Indian River “spreads” provides good habitat for Great Lakes muskellunge and for a number of years was the collection site for the muskellunge egg take for Michigan’s hatchery system. From 1972 into the late 1980s and early 1990s muskellunge were trapped at the “spreads” for an egg take; the fertilized eggs were then flown to a hatchery in Wisconsin for incubation and hatching. Reports of lake sturgeon spawning in the Indian River have also been received.

Tributaries to the Indian River include the Little Sturgeon River and Crumley Creek. The Little Sturgeon River is home to the Little Sturgeon Trout Club, which is a large property holder in this reach. The trout club stocks a substantial number of fish in this river, and has done a considerable amount of stream alteration on club property, including the addition of bulkheads, diverters, check dams, and fish cover. A 1958 survey of Crumley Creek found brook trout, sculpin, and yellow bullhead.

Mullett Creek is a small tributary to Mullett Lake. It is a coldwater stream in the upper reaches and a cold-transitional stream in its lower half. Mullett Creek has fairly high groundwater loading and supports a brook trout population, but the lower reaches are susceptible to elevated temperatures due to beaver dams and some agricultural land use practices. In 2007, a group was formed involving the U.S. Fish and Wildlife Service (USFWS), the Natural Resources Conservation Service, and the MDNR Fisheries Division out of concern about loss of in-stream habitat and increased sediment load. The last survey in 2007 revealed an excellent brook trout population along with other common coldwater species such as sculpins.

Other Lakes

Cochran Lake was stocked in 1940s to the early 1960s with a variety of species including smallmouth and largemouth bass, bluegill, redear sunfish, and rainbow trout. Numerous surveys show a fish community with yellow perch, largemouth bass, bluegill, bullhead, and a few northern pike. The lake was chemically reclaimed with rotenone in 1959, and restocked with bluegill and largemouth bass.

Roberts Lake is considered a twin lake to Cochran Lake. Roberts Lake was stocked with hybrid bluegill in the 1990s, and is known as a good panfish lake. MDNR Fisheries Division maintains a water level control structure on this lake.

Devereaux Lake is a private lake, but creel census records from the 1940s and 1950s indicate the presence of smallmouth bass, pumpkinseed sunfish, rock bass, and yellow perch.

Black River—Headwaters to Clark Bridge Road

Main Stem

The Black River watershed is known for its outstanding brook trout fishery which is managed through a variety of coldwater fisheries regulations (Table 24). The upper part of this reach is under Type 1 trout stream regulations while special regulations (see previous research area description) are in place from Tin Shanty Bridge to the Town Corner Lake stairs. Below the stairs, Type 2 trout streams regulations extend to Tower Pond.

The Upper Black River Watershed Restoration Committee (UBRWRC), comprised of many different partners including the MDNR (see **Citizen Involvement**), has been involved with fisheries management in this watershed. In this reach, the UBRWRC has placed large woody debris within the stream for fish habitat, and plans to continue this in-stream habitat work in the future. The UBRWRC works closely with trappers in the area to reduce the beaver population on the Black River and its tributaries. The group also employs a summer work crew to remove beaver dams.

The UBRWRC also spearheaded the completion of a number of watershed inventories, including those for road-stream crossings and eroding streambanks. These inventories have helped guide and prioritize restoration activities in the watershed. The group also collects hourly temperatures at various locations throughout the Black River watershed.

Past fisheries management activities within this reach of the Black River by the MDNR include maintenance of a sand trap at Tin Shanty Bridge. There are also three sand traps in this section that are maintained by a private association, the Black River Ranch. The reach was stocked with brook trout from 1959-1965 and numerous fisheries surveys have been conducted throughout the years. Brown trout were manually removed in 1981 and 1983 to reduce competition with brook trout.

Tributaries

Stewart Creek, Tubbs Creek, and Little McMasters Creek are all classified as cold-transitional streams. Stewart and Tubbs Creeks have Type 1 trout stream regulations.

Lakes

Notable lakes in this segment include North and South Blue lakes, Town Corner Lake, and Hardwood Lake. North and South Blue lakes are managed under special “quality” regulations with an open season of last Saturday in April to September 30. Possession is not allowed (catch and release only), and only artificial lures may be used. North Blue Lake has a good yellow perch population, while South Blue Lake provides quality fishing for bluegill and largemouth bass. This was confirmed when the lakes were last surveyed in 2001.

The primary game fish in Town Corner Lake is largemouth bass. Green sunfish and brown trout were also encountered at lower numbers in the most recent (1983) survey. The lake was chemically reclaimed in 1962, and restocked with rainbow trout and largemouth bass. Subsequent stocking was done with brook trout (1964), brown trout (1965 and 1983), and rainbow trout (1973). Hardwood Lake was stocked in 1932 and 1933 with bluegill. There have been no other fisheries management actions in Hardwood Lake due to its low fisheries value.

East Branch Black River

Main Stem

The East Branch Black River is also known for its brook trout fishery and has seen a considerable amount of fisheries management over the years, with stream improvement plans dating back to 1932. These plans included placement of current deflectors and fish cover. Current fisheries management activities in this reach include Type 1 trout stream regulations, periodic maintenance of a sand trap, and numerous trout population estimates. There are plans to maintain the sand trap in this reach more frequently.

Tributaries

Rattlesnake Creek is a coldwater stream with Type 1 trout stream regulations. Rattlesnake Creek is a popular brook trout stream that was most recently surveyed in 2008 when population estimates were made at four stations. Management plans for this river include spawning riffle enhancements to increase the production of young-of-year brook trout.

Lakes

Foch Lake is an impoundment managed by Fisheries Division. The impoundment/flooding was originally proposed by Wildlife Division in 1949 or 1950, built by Fish Division in 1955 (52 acres), and raised in 1963 (85 acres). Foch Lake has largemouth bass and bluegill populations, and the impoundment here provides increased recreational fishing opportunity. The adjacent state-owned land is popular for dispersed camping.

Black River—Clark Bridge Road to Kleber Dam

Main Stem

Fisheries management in this segment of the Black River has been limited. Future activities in this reach may be conducted by the UBRWRC.

Tributaries

No fisheries management activities have occurred on the tributary streams, with the exception of Canada Creek (discussed below). McMasters Creek, Tomahawk Creek, Welch Creek, and Gregg Creek are warm transitional streams. Bowen Creek is classified as a cold-transitional stream. All of these tributaries have Type 1 trout stream regulations, except for Bowen and Gregg Creeks, which are not designated.

Lakes

Lakes in this segment include two floodings – one that is managed by Wildlife Division (Dog Lake), and one that is managed by Fisheries Division (Tomahawk Creek Flooding). Dog Lake flooding is prone to periodic winterkill, and the only fisheries management activity was a plant of bluegill and smallmouth bass in 1937. Tomahawk Creek Flooding was stocked in 1967 with golden shiners, largemouth bass, and tiger muskellunge. The most recent survey (2004) found good numbers of panfish (e.g., bluegills, pumpkinseed, and yellow perch), northern pike, and largemouth bass. Northern pike are a popular game fish on this flooding.

Kleber Pond is an impoundment of the Black River, and was last surveyed in 1969. Northern pike, bluegill, pumpkinseed, and rock bass were all common. Tower Pond impounds the Black River upstream of Kleber pond and has pike and panfish, as well as some brook trout that use the pond seasonally for refuge. Northern pike spearing is allowed in Tower Pond December 1 through March 15 through the ice. This regulation is designed to reduce predation on brook trout in the pond. Tower Pond was last surveyed in 1979.

Tomahawk Lake has good bass, pike, and bluegill populations based on the last survey (1979). The lake was stocked with smallmouth bass, perch, and bluegill from 1937-40. Little Tomahawk Lake was stocked with smallmouth and largemouth bass, perch, and bluegill in the 1930s and 40s. It was most recently stocked with splake in 1988.

Shoepac Lake was stocked with a variety of fish species over time. Smallmouth bass, largemouth bass, perch, and bluegill were stocked in the 1930s, rainbow trout in the 1960s, rainbow trout and steelhead in the 1970s, and brook trout, rainbow trout, and brown trout in the 1980s and early 1990s. The most recent survey of Shoepac Lake in 2007 documented a coolwater fish community with game fish species such as largemouth bass, northern pike, and various pan fish species.

Francis Lake was stocked with smallmouth bass, perch, and bluegill in the 1930s and early 1940s, and then with rainbow trout from 1966-72. There is no MSL for northern pike in Francis Lake.

Canada Creek

Main Stem

Canada Creek is well known for its brook trout fishery. The UBRWRC has added some large woody debris in this reach, and two sand traps are maintained by the MDNR. Four additional sand traps in Canada Creek are maintained by a private association, Canada Creek Ranch. Canada Creek is mostly a cold transitional stream, except in the area downstream of Valentine Lake, where it is warm transitional, and near the mouth, where it is classified as a coldwater stream.

The Hungerford's crawling water beetle (HCWB, *Brychius hungerfordi*) was recently found in Canada Creek and has been known to inhabit one of its tributaries, Van Hetton Creek. The HCWB is an endangered species, and fisheries management plans that have the potential to disturb its habitat (such as stream habitat improvement) now must be reviewed by the USFWS.

Tributaries

Van Hetton, also known as Van Hellon, Creek was last surveyed in 2004. One brook trout, along with creek chubs, blacknose dace, and a blackside darter were found. MDEQ Water Bureau surveyed Oxbow Creek in 2005, and found mostly blacknose dace and creek chubs, along with a few mudminnows, fathead minnows, and northern redbelly dace. No fisheries data are available for the other streams. All tributaries in this reach have Type 1 trout stream regulations. Montague Creek is classified as a coldwater stream, Van Hetton Creek as a cold transitional stream, and Oxbow Creek as a warm transitional stream.

Lakes

Several small- to medium-sized lakes are present within this segment. Bear Den Lake was first stocked with warm and coolwater species from 1937-1942, and then stocked with brook trout, rainbow trout, and brown trout from 1942-1971. Since 2004, Bear Den Lake has been stocked with rainbow trout (Eagle Lake strain) and brook trout (Assinica strain). Bear Den Lake has Type B trout lake regulations.

Muskellunge Lake is a bass-bluegill lake, with a population of northern pike. The lake was last surveyed in 1952. Pug Lakes are a chain of lakes adjacent to Muskellunge Lake. The last official survey of Pug Lakes was in 1969, which documented largemouth bass, brook trout, pumpkinseed, northern pike, bluegill, and rock bass. Recent angler information indicates there is a high number of small northern pike. East Town Corner Lake is also a bass-bluegill-pike lake. East and West Town Corner Lakes have no MSL for northern pike. Doty Lake is also a bass-bluegill lake but is prone to periodic winterkill. A 1975 survey of Jackson Lake revealed a strong panfish community (e.g., yellow perch, bluegill, and pumpkinseed sunfish), along with northern pike and largemouth bass.

Clear Lake receives a substantial amount of recreational fishing pressure, due in part to the presence of a state park on its shore. The lake has been stocked, primarily with trout, since the early 1960s. A number of chemical fish reclamations using rotenone have been done for trout management. Since 1990, splake have been stocked into Clear Lake annually (except in 1998, when no fish were stocked). A 2004 general survey found good populations of splake and smallmouth bass in this 2-story fishery (splake in the deeper water, and bass in the shallow areas). Angler reports of good splake fishing were also noted.

Valentine Lake is surrounded by private property, and reportedly has good populations of largemouth bass, smallmouth bass, and northern pike. Lake Geneva, Little Joe Lake, Virginia Lake, and Wildfowl Lake are all private lakes completely surrounded by Canada Creek Ranch Association property.

Black River—Kleber Pond Dam to Black Lake

Main Stem

This reach is managed primarily for lake sturgeon spawning habitat, and is a warm transitional river. Black Lake supports a substantial lake sturgeon population, which spawns within this reach. Numerous research projects have been undertaken here by the MDNR, Michigan State University, Central Michigan University, and Sturgeon for Tomorrow. A lake sturgeon head start program is also initiated here. Larval lake sturgeon are collected from the stream, brought to a hatchery to grow, and then released back into the Black River or other nearby streams. This program helps increase survival of this state-threatened fish species.

Tributaries

Two headwater tributaries, Gokee Creek and Adair Creek, are coldwater streams. Milligan Creek is a warm transitional stream, with Type 1 trout stream regulations. Because Milligan Creek is a warm transitional stream, it is susceptible to changes in fish community composition from small changes in temperature. For this reason, a beaver control and beaver dam removal program has been implemented in recent years on this stream to restore brook trout habitat. Much of the dam removal work has been done by the UBRWRC.

Lakes

Fisheries survey data are available for McLavey and Osmun Lakes. McLavey Lake was netted in 1969 and 1974. A coolwater fish community dominated by northern pike, yellow perch, and pumpkinseed was documented. Osmun Lake is known for its healthy largemouth bass and bluegill populations. A survey of the lake was done in 2007, and the lake is being considered for classification as a “Quality Lake.” Stony Creek Flooding is managed by Wildlife Division for waterfowl. No fisheries data are available for Duby Lake or Lost Lake.

Black Lake

Main Stem

Black Lake is managed primarily for lake sturgeon and coolwater fisheries (walleye, northern pike, and muskellunge). A survey was done on Black Lake in 2005, as part of the Large Lakes program. This survey estimated that 14,013 adult walleye and 8,826 adult northern pike were in Black Lake (Cwalinski and Hanchin, in press).

Tributaries

Coldwater tributaries in this reach include Fisher, Stewart, Stony, and Mud Creeks. Stony Creek is managed with Type 1 trout stream regulations. The Rainy River is classified as a warm transitional stream, but also has Type 1 trout stream regulations upstream of M-68. Cold Creek is classified as cold transitional stream.

Lakes

This reach contains a number of lakes within its drainage. Loon Lake was last surveyed in 1968 and pumpkinseed sunfish, yellow perch, and northern pike were documented. Excellent growth rates for northern pike were noted. Fisheries management in Big Mud Lake is limited to stocking a small number of smallmouth bass in 1939. Since Rainy Lake periodically drains (see **Geology**), little fisheries management activity has occurred there beyond commenting on lake augmentation strategies proposed by the lake association. Little Tomahawk Lake was stocked with bluegill, largemouth bass, and smallmouth bass in the 1930s, and was stocked with splake in 1988. The lake was surveyed in 1966, and good bass reproduction was noted. Big Tomahawk Lake was last surveyed in 1979 when a fish community of largemouth bass, rock bass, yellow perch, pumpkinseed sunfish, and northern pike were present. The lake was stocked with smallmouth bass, yellow perch, and bluegill in the 1930s and early 1940s.

Lower Black River

Main Stem

The lower Black River is a warm water stream, and is primarily managed through fisheries regulations. Lake sturgeon spawning has been reported in the area below Alverno Dam. Accordingly, the fishing season in the lower Black River is restricted from Alverno Dam down to Mograin Bridge. There is no fishing from April 1 to May 15 to protect spawning lake sturgeon as well as northern pike, muskellunge, and walleye.

Tributaries

All tributaries in this segment are classified as warm transitional, except for Long Lake Outlet, which is cold transitional. There are no designated trout streams in this portion of the watershed. Fisheries management on Myers Creek includes helping with designs for stream channel restoration to a coldwater tributary. In 2002, a private property owner placed a 225-ft culvert along the stream and placed fill over top of the culvert. In December 2005, a circuit court judge ruled that the culvert must be removed and the stream restored. Fisheries Division has been assisting in an advisory capacity for the stream restoration.

Lakes

Walleye and northern pike are the primary game fish in Long Lake. The lake was last surveyed in 2005, when some natural reproduction of walleye was documented. The level of reproduction is inadequate to maintain the fishery, so walleye are stocked on an alternate year basis.

Twin Lakes refers to five lakes in northeastern Cheboygan County. Twin Lake #1 is a designated trout lake with Type D regulations (Table 25). It has been stocked with trout since 1963. Brown trout have been stocked annually since 1990 and will be alternated with rainbow trout plants beginning in 2008. There is a local watercraft control for Twin Lakes which prohibits high speed boating, making the lakes ideal to fish from a float tube or canoe.

Twin Lakes #2-5 were stocked with tiger muskellunge in the 1970s, and then with splake in the 1980s and early 90s. Based on a 2000 survey, major game species include bluegill, northern pike, and largemouth bass.

Cheboygan River

Main Stem

Steelhead and chinook salmon are stocked annually in the Cheboygan River, which is classified as warm water. The chinook salmon are kept in net pens near the mouth of the river for a number of days in the spring, allowing the fish to smolt in ambient river water. Holding the salmon in net pens prior to their release greatly improves the rate of return of adult salmon to their stocking location (J. Johnson, MDNRE, personal communication).

Tributaries

Laperell Creek is a small brook trout stream with a few brown and rainbow trout. It is classified as a coldwater stream and is currently managed with Type 1 trout stream regulations. Laperell Creek was stocked with brook trout from 1959-1965, and was last surveyed in 1972.

Lakes

There are no lakes within this segment.

Recreational Use

Recreational opportunities are abundant in the Cheboygan River watershed due to the large amount of publicly-owned land (Figure 39) and the variety of lakes, streams, and rivers within its boundaries. Public access to these water bodies can be found throughout the watershed and includes state-owned canoe and boat launches (Figure 40) as well as many informal, publicly-owned access points. Many water bodies may also be accessed through state forest lands (see **Special Jurisdictions**) and at road-stream crossings where allowed by law. There is a lack of public access sites (or access through forest land) in some regions of the watershed, particularly the Maple River, Rainy River, and the headwaters of the Sturgeon and Pigeon Rivers. Access to some of the small tributaries within the watershed, such as Minnehaha Creek, Club Stream, and Mullett Creek, is also limited.

Although angling is one of the primary recreational activities within the watershed, very little angler pressure and use data exist. Historical catch rate data was gathered by Michigan Department of Conservation officers through angler interviews from the late 1920s through the 1960s (Appendix 4; see **Fishery Management**). Much of these data were gathered during a period when small inland streams in Michigan were stocked with legal-size trout and should be interpreted with caution due to the lack of project design. For instance, effort and target species were not recorded in these historical interviews. Fishing pressure data has been gathered via creel surveys for many of the large lakes (see **Fishery Management**), but data on angler use, preferences, and demographics are lacking for most parts of the watershed and should be acquired. This is especially important for sections of the watershed where fish stocking is an ongoing management tool.

Boating opportunities exist in many of the rivers and lakes throughout the watershed. The Inland Waterway is Michigan’s longest chain of rivers and lakes, with a navigable route of nearly 40 miles from the mouth of the Cheboygan River at Lake Huron to Crooked and Pickerel lakes in Emmet County. The waterway is used by both pleasure boaters and anglers seeking recreational opportunities throughout its course, which also includes Mullett Lake, the Indian River, Burt Lake, and the Crooked River. Passage through the waterway is aided by lock systems located on the Cheboygan

River in Cheboygan and on the Crooked River in Alanson. Smaller rivers throughout the watershed are frequently used by canoeists and kayakers.

Other recreational activities in the Cheboygan River watershed include biking, bird watching, berry and mushroom picking, camping, cross-country skiing, horseback riding, hunting, off-road vehicle (ORV) riding, and trapping. Four state parks and eighteen state forest campgrounds exist within the watershed (Figure 41), most of which are located in close proximity to a river or lake. Biking, cross-country skiing, and hiking opportunities are available at state-owned pathways and trails throughout the watershed. Horseback riding is available at three locations (Elk Hill State Forest Campground and Trail Camp, Johnson's Crossing Trail Camp, and Stoney Creek Trail camp); all have connections to the north spur of the Shore-to-Shore Riding/Hiking Trail. Ample hunting opportunities for small and large game are available on publicly-owned land throughout the watershed.

The operation of off-road vehicles (ORVs) is allowed on six loop systems within state forest land including the 38-mile Black Lake trail (which contains one of five scramble areas in Michigan), the 28-mile Red Bridge motorcycle trail, the 21-mile Bummer's Roost motorcycle loop, and the Tomahawk A (17 mile-long), B (40 mile-long), and C (37 mile-long) motorcycle trails. It is unknown to what extent the operation of ORVs occurs on private land and illegally on public lands. Illegal operation of ORVs is of special concern since it can lead to increased erosion, particularly at stream crossings.

Citizen Involvement

Citizen involvement in management of the natural resources within the Cheboygan River watershed occurs primarily through interaction with government agencies that manage the resource. Government agencies involved are the MDNR; MDEQ; United States Fish and Wildlife Service; United States Forest Service; United States Department of Agriculture – Natural Resource Conservation Service; various county road commissions; township and county offices; NEMCOG; and the Charlevoix, Cheboygan, Emmet, Montmorency, Otsego, and Presque Isle Conservation Districts (see **Glossary** for acronym definitions).

In addition to interaction with governmental agencies, citizens may become involved with nongovernmental or non-profit organizations that work on various aspects of the Cheboygan River watershed. Such associations include the Conservation Resource Alliance; Headwaters Land Conservancy; Huron Pines Resource Conservation and Development Council; Little Traverse Land Conservancy; Michigan Chapter of the Nature Conservancy; Michigan Council of Trout Unlimited; Pigeon River Country Advisory Council; SEE-North; Sturgeon for Tomorrow; Tip of the Mitt Watershed Council; and the Upper Black River Watershed Restoration Committee. The Cheboygan River Watershed Habitat Partnership, formed in 2001, combines the talents and experiences of many of these nongovernmental organizations with state and local government agencies to further protect the natural resources of the Cheboygan River watershed.

Lake associations and sportsmen's clubs also provide an opportunity for citizen involvement at the local level. Large lakes within the watershed are represented by the Black Lake Association, the Burt Lake Preservation Association, the Douglas Lake Improvement Association, the Mullett Lake Area Preservation Society, and the Pickerel-Crooked Lakes Association. A number of other lake associations represent the smaller water bodies located throughout the watershed.

As the population within a watershed increases, the potential for conflict among natural resource stakeholders becomes greater. Therefore, public involvement in the management and stewardship of these resources is critical for the long-term protection and enhancement of the Cheboygan River watershed. The Northern Inland Lakes Citizens Fishery Advisory Committee, established in 2009, provides an excellent opportunity for citizens to become involved with natural resource management within the watershed through a multi-agency, multi-organization partnership. Public involvement through the advisory committee, one of its member organizations, or other citizen groups provides the opportunity to open a dialogue on natural resources issues and promotes the exchange of experiences, ideas, and proposals among individuals, communities, interest groups, and government agencies. Numerous opportunities exist for concerned citizens to become involved in issues affecting the watershed; citizens are encouraged to take advantage of these opportunities for participation.

Management Options

The Cheboygan River watershed is healthy relative to some other watersheds in Michigan, with a broad range of habitat and water types. The thermal regime of the rivers is determined by the glacial geology, soils and land use types through which the river flows, but may be altered somewhat by dams and barriers within the watershed. Habitat degradation of the watershed is being addressed in some areas of the watershed, but will continually need work throughout the basin. The management options identified in this assessment are intended to address some of the more important problems that are now understood.

Many of the management options are recommended based on the need to protect and preserve the health of a river's ecosystem (Dewberry 1992). The protection and restoration of headwater streams, riparian corridors, and floodplains are of great importance. We must view the river ecosystem as a whole, for many elements of fish habitat are driven by whole system processes.

The following options are consistent with the mission statement of the MDNR, Fisheries Division, which is to protect and enhance public trust in populations and habitat of fishes and other forms of aquatic life, and promote optimum use of these resources for the benefit of the people of Michigan. In particular, the division seeks to protect and maintain healthy aquatic environments and fish communities and rehabilitate those that are degraded; provide diverse angling opportunities and maximize the values of these fisheries; and to foster and contribute to public and scientific understandings of fish, fishing, and fishery management.

The options presented here are not intended for MDNR, Fisheries Division action only, but should also be initiated by citizen groups and other agencies as appropriate.

Hydrology and Geology

The surficial geology of the Cheboygan River watershed is diverse, ranging from coarse-textured glacial deposits to peat. The different geological types greatly affect how water moves through the basin. Streams that flow through permeable glacial deposits with high differences in elevation have higher groundwater inflows than streams that flow through less permeable deposits where elevation differences are small (see **Hydrology**). Therefore, groundwater inflows into particular segments of the watershed vary considerably due to variation in permeability and topographical relief. Dams contribute to flow variability at certain locations within the Cheboygan River watershed; peaking operations at Golden Lotus Dam on the Pigeon River continue to create extremely unstable flow conditions in this segment.

Option: Protect natural hydrologic regimes of streams by protecting existing wetlands, flood plains, and upland areas that provide recharge to the water table.

Option: Protect and restore groundwater recharge by requiring that all development-related runoff be captured by infiltration basins.

Option: Protect natural seasonal flow patterns of the river by incorporating best management practices and requiring that no additional runoff enter the river from land development.

Option: Protect existing hydrologic conditions of lakes and remaining natural lake outlets by prohibiting construction of new lake-level control structures. This would ensure natural water level fluctuations needed to maintain wetlands around a lake and at lake outlets as well as reducing drought flow conditions in outlet streams.

Option: Restore the natural hydrologic regime of streams by removing dams when possible and requiring existing dams to strictly adhere to run-of-river flow operations.

Option: Restore natural hydrologic regime of lakes and lake outlets by removing lake-level control structures when possible.

Option: Restore headwater, tributary, and main stem run-of-river flows by operating lake level control structures as fixed-crest structures with wide spillways rather than by opening and closing gates or adding or removing stop logs.

Option: Explore opportunities to recreate wetland habitats by plugging or otherwise disabling drain tile systems that are no longer needed for their original purpose (such as drainage fields on retired agricultural lands).

Option: Explore the possibilities of reestablishing USGS stream flow gages.

Option: Protect all existing stable streams from the effects of land use changes, channelization, irrigation, and construction of dams and other activities that may disrupt the hydrologic cycle, by working with land managers, planners, and MDEQ personnel.

Option: Protect natural movement of water to the river by restricting addition of impervious surfaces in the watershed.

Option: Preserve the unique geological features of the watershed by protecting regional sinkholes from development, modification, and contamination.

Soils and Land Use Patterns

While still relatively undeveloped, the Cheboygan River watershed has a variety of land use issues that can affect its water bodies. Sandy soils are susceptible to erosion, particularly in road construction and maintenance, and riparian development. The loss of wetlands, combined with potential residential and commercial growth, existing oil and gas development, and some agricultural practices may increase sedimentation.

Option: Protect watershed soils from improper land use by encouraging the participation of watershed councils in land use planning, development, and other river protection issues.

Option: Protect undeveloped private riparian lands by bringing lands under public ownership or through economic incentives such as tax credits, deed restrictions, conservation easements, or other means.

Option: Protect lands through land-use planning and zoning guidelines that emphasize protection of critical areas and discourage alteration of natural drainage patterns. Support development of zoning standards for townships presently not zoned.

Option: Protect the river from excessive sedimentation by encouraging education of workers involved with road siting, construction, and maintenance in the use of best management practices (BMPs).

Option: Protect the river from excessive sedimentation by increasing spacing between oil and gas well pads and supporting increased use of angular or directional drilling techniques.

Option: Restore retired well sites and access roads through best management practices to minimize potential impacts of continued erosion and sedimentation.

Option: Protect the river from excessive sedimentation associated with oil and gas development by requiring quicker revegetation of soils in affected areas. Access roads for wells should also be closed when wells are retired.

Option: Protect stream channels from excessive sediment delivery by using BMPs at road-stream crossings. Support cooperative funding in situations when local road commission budgets are inadequate for use of BMPs.

Option: Protect and maintain forested buffers along lake shores and river corridors to retain critical habitats and to allow for natural wood inputs to rivers.

Option: Rehabilitate or improve instream culverts or road crossings that are under-sized, perched, misaligned, or placed incorrectly.

Option: Encourage the use of bridges to improve road-stream crossings and discourage the use of culverts.

Channel Morphology

Stream channels within the Cheboygan River watershed support substantial amounts of important high- to very high-gradient habitat with good to excellent hydraulic diversity. Impoundments mask some of the higher gradient reaches in the watershed, particularly in the Maple, Pigeon, and Black rivers. The majority of stream channels in the watershed appear stable, which is not surprising given the abundance of coldwater streams and their steady flows.

Option: Protect diverse stream channel habitats by preventing removal of large woody structure from the channel.

Option: Protect channel morphology by using bridges or properly sized culverts at road-stream crossings.

Option: Protect and restore riparian function by educating riparian residents on how riparian areas influence water quality, stream temperatures, trophic conditions, channel morphology, bank erosion and stability, and aquatic, terrestrial, and avian communities.

Option: Protect riparian greenbelts through adoption and enforcement of zoning standards.

Option: Prioritize stream sections and erosion locations with restoration groups to maximize biological benefit to the aquatic community.

Option: Survey coldwater streams to identify where high beaver activity (or beaver dam density) adversely affects riparian habitats and stream channel morphology.

Option: Rehabilitate channel diversity by removing excess streambed sediment load and controlling sediment contributions.

Option: Rehabilitate channel configuration in reaches where dam peaking operations have altered river appearance and function.

Option: Increase channel diversity by improving habitat in reaches where channel diversity is low, sedimentation is high, or where natural contributions of large woody debris have been reduced.

Option: Protect natural channel movement by encouraging and requiring the use of soft armor/engineering methods of bank stabilization (e.g., vegetative plantings or whole tree revetments rather than rock riprap) through permitting processes and cooperative planning.

Dams and Barriers

Forty-eight dams are known to exist in the Cheboygan River watershed. Some impound considerable high-gradient habitat, block migrations of potamodromous and resident fishes, alter flow regimes, and may create flow fluctuations in streams. Other dams increase stream temperatures, degrade water quality, trap sediments and woody structure, and eliminate natural lake-level fluctuations.

Option: Protect the public trust by requiring dam owners to make appropriate financial provisions for future dam removal or perpetual maintenance and proper operation.

Option: Pursue removal of Golden Lotus Dam.

Option: Survey dams throughout the watershed to examine conditions and identify areas where environmental damage and the need for mitigation are greatest.

Option: Survey state-owned dams, especially floodings, and examine ways of creating better fish habitat in these impoundments. Also assess their need and potential for removal.

Option: Survey beaver dams and use throughout coldwater tributaries.

Option: Work with anglers and citizen groups to promote beaver trapping and beaver dam removal on coldwater tributaries that may be affected by excessive beaver populations and damming.

Option: Restore free flowing river conditions by removing dams no longer used for their original purpose.

Option: Rehabilitate the former productivity of the Cheboygan River for Lake Huron fishes by removing the Cheboygan Dam.

Option: Partially rehabilitate the former productivity of the Cheboygan River for Lake Huron fishes by installing fish passage at the Cheboygan Dam.

Option: Identify and rehabilitate poorly designed road-stream crossings including undersized bridges and culverts, perched culverts, and poor approaches.

Option: Work with DEQ to prevent the construction of new dams and lake level control structures within the watershed.

Option: Educate public on the effects of dams.

Water Quality

Water quality is generally good throughout the Cheboygan River watershed. Threats to water quality in the basin include nonpoint source pollution such as agricultural and construction site runoff and poor road-stream crossings; atmospheric deposition; mercury deposition in inland water bodies and accumulation in fish, and toxics found in Great Lakes fishes migrating into the river.

Option: Promote public stewardship of the watershed and support educational programs teaching best management practices that prevent further degradation of aquatic resources.

Option: Protect water quality by protecting existing wetlands, rehabilitating former wetlands, and maximizing use of wetlands and floodplains as natural filters.

Option: Protect the river by implementing best management practices for storm water and nonpoint source pollution.

Option: Evaluate water quality characteristics (especially nutrient levels) at sites where historic data exist to better determine the extent of temporal changes in water quality.

Option: Survey effects of nonpoint source pollutants on river water quality characteristics.

Option: Survey thermal effects of dams and develop a list of dams having the greatest thermal effect on downstream reaches.

Option: Survey dissolved oxygen levels below dams to determine where effects are the greatest.

Option: Restore water quality by supporting Act 307 cleanups.

Special Jurisdictions

Four hydroelectric facilities in the watershed are licensed by the Federal Energy Regulatory Commission. The State's Department of Environmental Quality and Department of Natural Resources are responsible for the administration of many environmental regulations as well as the management of a large percentage of the land base in the watershed. Local units of government are responsible for planning, zoning, and road management.

Option: Implement additional fish protection measures, such as entrainment protection, at Tower Dam and Kleber Dam.

Option: Protect additional stream mileage from unwise development practices by designating the Black River and/or Sturgeon River systems as Natural Rivers.

Option: Protect existing aquatic and riparian habitat by establishing Biodiversity Stewardship Areas where appropriate.

Option: Protect watershed integrity by ensuring all state environmental regulatory programs with jurisdiction in the watershed are adequately funded, staffed, and enforced.

Option: Protect stream habitat and water quality by discouraging the designation of County Drains.

Biological Communities

Biological communities in the Cheboygan River watershed have been affected by fragmentation by dams, habitat loss from sedimentation, and exotic species introductions. Dams in key locations prevent upstream migration of important game fish such as lake sturgeon and walleye; sediment from nonpoint source pollution can cover important spawning substrate, and exotic species such as zebra mussels and gobies and burgeoning numbers of double-breasted cormorants can have large affects on aquatic ecosystems.

Option: Better define and understand the effects of varying habitat components and actions on Hungerford's crawling water beetle so potential fisheries management actions can be evaluated from a more informed perspective.

Option: Protect gravel habitats from sedimentation due to land development by enforcing local soil and sedimentation codes. Implement nonpoint source best management practices at all construction sites.

Option: Protect stream margin habitats, including floodplains and wetlands.

Option: Evaluate the status of fish communities on river segments and lakes without recent survey data. Surveys should encompass the fish community and should follow MDNR Fisheries Division sampling procedures.

Option: Protect resident, naturally-reproducing fish populations by screening all private and public fish stocking efforts to ensure they are free of diseases and undesirable species.

Option: Prevent the spread of more invasive species to the inland waterway and entire watershed through education practices and best management practices.

Option: Survey present distribution and status of fishes, aquatic invertebrates, mussels, amphibians, reptiles, aquatic plants, and pest species throughout the river system.

Option: Enhance understanding of fish communities in rivers and lakes through surveys conducted under the Status and Trends program.

Option: Restore potential for fishes to migrate throughout the river system by removing appropriate dams (e.g., Alverno Dam and Golden Lotus Dam) or by restoring appropriate flow regimes (e.g., Golden Lotus Dam).

Option: Restore free flowing cold/cool-water reaches of the watershed where beaver populations degrade the coldwater fishery (e.g., Milligan Ck).

Option: Restore lake sturgeon populations throughout the appropriate sections of the watershed by stocking. Create a management plan for this species for the Cheboygan River watershed which defines appropriate adult sturgeon populations and stocking levels, as well as habitat restoration plans to achieve a self-sustaining population.

Fishery Management

Many of the tributaries in the watershed support self-sustaining populations of brook, brown, and rainbow trout. Dams on some of the rivers prevent access to spawning ground for migrating salmonids, or may adversely affect downstream populations because of their unstable flow regimes and temperature effects. Inland lakes and trout streams provide a wealth of fishing opportunities in this watershed.

Option: Protect self-sustaining trout stocks by discouraging stocking on top of these populations.

Option: Require disease-free certification for any fish to be stocked.

Option: Protect the brown trout population in the Sturgeon River through appropriate seasons, harvest limits, protection of spawning habitat, and prohibiting brown trout stocking in that river. This should be done for protection of the Sturgeon River strain of brown trout, recently brought into our hatcheries for brood stock.

Option: Protect fisheries habitats by protecting and appropriately managing existing riparian forests by working with foresters, loggers, ORV users, farmers, and oil and gas developers.

Option: Protect fish communities by working with private citizens, communities, and the permitting agency (DEQ) to restrict construction of new dams.

Option: Survey fish communities and habitats to assess their condition and identify threats to guide management.

Option: Determine the relative contribution of stocked walleye in lakes where we currently have stocking prescriptions through oxytetracycline marking and analysis.

Option: Gather fish and temperature data on streams and change designated trout stream status and regulation classification where appropriate.

Option: Survey anglers in the watershed to gain insight into effort, preferences, and harvest rates.

Option: Evaluate lakes with walleye or trout stocking prescriptions to evaluate survival and growth of stocked fish and to determine whether stocking is meeting management objectives.

Option: Identify streams or stream segments, in cooperation and coordination with the MDNR-Wildlife Division, where more aggressive control of beaver and beaver dams would restore trout habitat.

Option: Restore connectivity between habitats by removing dams no longer used for their original purpose, dams that are a safety hazard, and dams serving little purpose.

Option: Work with partners to restore sites of severe erosion and poor road-stream crossings.

Option: Continue stocking cool- and cold-water fish species where it is ecologically appropriate to maintain diverse fishing opportunities in the watershed.

Recreational Use

The Cheboygan River watershed is highly valued for its ample recreation opportunities. Although angling is one of the primary recreational activities within the watershed, very little angler pressure and use data exist. Public access to its lakes and rivers is good in most locations, but can be improved in some regions such as the Maple River, Rainy River, and the headwaters of the Sturgeon and Pigeon Rivers.

Option: Survey the level of angling pressure and use throughout the watershed’s lakes, rivers, and streams.

Option: Improve public access opportunities where lacking (especially those already identified) through MDNR, county, township, and other municipal recreation departments.

Option: Increase recreational access by developing additional launch sites and purchasing additional potential sites.

Option: Improve canoe portages and boat launches at all dams along the main stem and branches. These sites can be maintained by hydropower facilities under FERC relicensing agreements where applicable.

Option: Improve recreational fishing potential by removing dams or providing fish passage when possible and providing upstream passage of Lake Huron fishes into existing riverine reaches with appropriate sea lamprey barriers.

Option: Protect river by encouraging the use of dedicated ORV, bicycle, and equestrian trail systems within the watershed to decrease illegal road-stream crossings and reduce erosion.

Option: Limit recreational access for trailered boats to designated launch sites to prevent erosion and sedimentation.

Option: Work with user groups and outfitters to set appropriate guidelines for river use and to ease user conflicts.

Option: Increase number of handicapped-accessible fishing opportunities (e.g., fishing piers on lakes).

Citizen Involvement

Citizen involvement is crucial to resource management in the Cheboygan River watershed. Future management of the watershed should incorporate participation from the public.

Option: Educate citizens and other governmental agencies and resource managers about important management issues by providing information through various media outlets, sports groups, civic leaders, and other management agencies.

Option: Protect the watershed by building public support through a network of citizen involvement groups.

Option: Support and improve communication between interest groups and governmental agencies.

Option: Support citizen group efforts to seek funding for the protection and restoration of the river system.

Option: Provide additional opportunities for public input into fisheries management decisions and into fisheries management plans.

GLOSSARY

alluvium – sediment deposited by flowing water, such as glacial meltwaters

base flow – the portion of stream discharge that is derived from natural storage (i.e., groundwater inflow, lakes, or swamps), or sources other than rainfall that create surface runoff

basin – an area of the earth's surface that drain toward a receiving body of water (such as a lake or stream) at a lower elevation; a complete drainage area including both land and water from which water flows to a central point; synonymous with watershed

BCE – before the common era

benthic – associated with the bottom of a stream or lake; plants and animals living on, or associated with, the bottom of a water body

biomass – the total mass of living material in an area (e.g., the total weight of brook trout in a stream reach)

biodiversity – the number and type of biological organisms in a system

biological integrity – the ability of biotic communities to withstand and survive natural and human perturbations

biota – animal and plant life

BMPs – best management practices used to protect water quality, generally from erosion; examples are buffer strips, location and design of roads, and proper design of road crossings of streams

boom shocker – an electrofishing boat used to sample fishes in waters that are generally too deep to wade; electrodes mounted on booms extend from the bow of the boat and are used to transfer electricity into the water to temporarily stun fish so they can be captured with dip nets

broodstock – adult fish used for obtaining gametes for hatchery-reared fish

buffer strip – an area adjacent to a waterbody in which harvest of trees is limited or precluded; designed to protect water quality

bulkhead – a retaining wall along a waterbody; a low-head dam

catchment – the area of the earth's surface that drains to a particular location on a stream

CE – common era

centrarchidae – sunfishes; species such as bluegill, crappies, and largemouth and smallmouth bass

cfs – cubic feet per second; ft^3/s; a unit commonly used to express stream discharge, the volume of water flowing past a point each second; one cubic foot of water equals 7.48 gallons

channelization – the conversion of a stream to a ditch; channelized streams are narrower, deeper, and straighter than natural channels; channelization may be done for navigation, flood control at that site, or to improve drainage for agricultural or other purposes channel morphology – the structure and form of stream and river channels including width, depth, and bottom type (substrate)

coldwater fish species – a term commonly applied to trout species, although nongame species such as slimy and mottled sculpin also need and prefer colder waters

confluence – the joining or convergence of two streams

coniferous – cone-bearing, typically evergreen, trees

coolwater fish species – a term usually referring to game fish in the perch or pike families; examples are walleye, yellow perch, northern pike, and muskellunge

creel survey – a statistically designed survey of angler trips on a water body to provide information regarding effort, catch, and harvest

deciduous – vegetation that sheds its foliage annually

discharge – a common term that refers to the volume of water flowing in, or discharged by, a stream into another stream or water body; also referred to as streamflow discharge or stream discharge

drought flow – the water flow during a prolonged period of dry weather

ecosystem – stands for ecological system; a biological community functioning with its environment

electrofishing – the process of putting an electric current, either AC or DC, through water for the purpose of stunning and capturing fish

embeddedness – the extent to which gravel and cobble are buried by finer sediments such as sand

entrain – to pass through the turbines of a hydroelectric dam; varying percentages of fish entrained at hydroelectric dams are killed

EPT – refers to three orders of insects (Ephemeroptera-Mayflies, Plecoptera-Stoneflies, and Trichoptera-Caddisflies); often used as an indicator of water quality

Esocid – species of fish that are in the Esocidae family. In the Cheboygan River watershed this is generally northern pike or muskellunge

exceedence flow – a discharge amount that is exceeded by the stream for a given percentage of time; for example, for 90% of the year the stream’s discharge is greater than its 90% exceedence flow value; consequently, the 90% exceedence flow represents a stream’s summer low (drought) flow

exotic species – successfully-reproducing organisms transported by human actions into regions where they did not previously exist

extirpation – to make extinct; eliminate completely

fauna – the animals of a specific region or time

FERC – Federal Energy Regulatory Commission

fixed-crest – a dam that is fixed at an elevation and whose elevation can not be changed flashy – streams and rivers characterized by rapid and substantial fluctuations in streamflow

flow regime – a term used to describe the constancy or stability of stream discharge over periods ranging from days to years; discharge of streams with stable flow regimes does not fluctuate quickly or substantially through time whereas streams with unstable flow regimes are referred to as "flashy" (see above definition)

flushing rate – the amount of time it takes for the total volume of water in an impoundment to be replaced by incoming streamflow; also referred to as retention time

forage fish – the term applied to small-bodied fishes that can be eaten by piscivorous fish species such as walleye, pike, or bass

game fish – the term applied to fishes that sport fishing anglers are most likely to pursue; most of these species are in the trout, sunfish, and perch families

glacial-fluvial valley – a river valley formed by glacial melt waters cutting through deposits left by a glacier

glacial outwash – gravel and sand carried by running water from the melting ice of a glacier and laid down in stratified deposits

GLEAS – Great Lakes and Environmental Assessment Section

gradient – rate of decent of a stream, usually expressed in feet per mile

groundwater – water that is beneath the surface of the ground and is the source of a spring or well water; groundwater may also flow laterally to discharge into streams or lakes at lower elevations

hydraulic diversity – the variability of water depths and velocities in a stream or river channel

hydrology – the study of water

impoundment – water of a river system that has been held up by a dam creating an artificial lake

indigenous – a species that is native to a particular area

invertebrates – animals without a backbone

karst – an area of limestone formation, characterized by sinks, caves, ravines, and underground streams

lake plain – land once covered by a lake that is now elevated above the water table

lake-level control structure – a dam placed at the outlet of a lake to control the water-level

large woody material – larger trees, logs, and logjams at or beneath the surface of stream or lake waters

lentic – nonflowing water typically associated with lakes; for example, lentic fishes typically inhabit nonflowing waters

loam – a soil consisting of an easily crumbled mixture containing from 7 to 27% clay, 28 to 50% silt, and less than 52% sand lotic – flowing water; for example, lotic habitats are habitats present in flowing waters

low-flow yield – defined in this document as the 90% exceedence flow divided by catchment area and expressed as $ft^3/s/mi^2$; streams with high low-flow yields in Michigan generally are colder, have higher drought flows, and are more suitable for habitation by coldwater fish species

LWD – Large woody debris; a term used to refer to larger woody material in a stream or lake that may provide instream fish cover or be colonized by fish-food organisms; see large woody material

macroinvertebrate – animals without a backbone that are visible to the naked eye

main stem – primary branch of a river or stream

MDEQ – Michigan Department of Environmental Quality

MDIT – Michigan Department of Information Technology

MDNR – Michigan Department of Natural Resources

MDOC – Michigan Department of Conservation; this organization was reorganized and renamed as the Michigan Department of Natural Resources circa 1968

mesotrophic – a term applied to clear water lakes and ponds with beds of submerged aquatic plants and medium levels of nutrients; these lakes are also of intermediate clarity, depth, and temperature.

mitigation – action required to be taken to compensate for adverse effects of an activity

MNFI – Michigan Natural Features Inventory

moraine – a mass of rocks, gravel, sand, clay, and other material carried and deposited directly by a glacier

morphology – pertaining to form or structure of a river or organism

MSL – minimum size limit

naturalized – animals or plants previously introduced into a region that have become permanently established as if native

NEMCOG – Northeast Michigan Council of Governments

NLHMU – Northern Lake Huron Management Unit

nongame fish – term applied to fishes that sport fishing anglers generally do not attempt to catch; this term is also applied to certain species sought by a minority of anglers; for example, carp, suckers, and bullhead catfishes

NPDES – National Pollution Discharge Elimination System

NREPA – Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (NREPA) consolidated the majority of the State of Michigan's environmental and natural resource laws into one act oligotrophic lakes – lakes where nutrient levels and biological productivity are low; these lakes typically contain high levels of dissolved oxygen in their waters at all depths

organic – of, relating to, or derived from living organisms; often used to describe fine substrate of decaying vegetation (muck)

oxytetracycline (OTC) – an antibiotic which produces a mark on a fish once it is submersed in the chemical, thus allowing for differentiation between stocked and wild fish

panfish – used to refer collectively to the following: bluegill, pumpkinseed, green sunfish, rock bass, black and white crappies, hybrid sunfish, and yellow perch

peaking – operational mode for a hydroelectric project that maximizes economic return by operating at maximum possible capacity during peak demand periods (generally 8 a.m. to 8 p.m.) and reducing or ceasing operations and discharge during nonpeak periods; streamflows in rivers with peaking operations may alternate between flood and drought on a daily basis

permeability – the ability of a substance to allow passage of fluids; sands and gravels have high permeability for water because it readily moves through them

perched culvert – a culvert that blocks upstream movement of aquatic organisms by creating a significant drop between the culvert outlet and the downstream stream surface

permeable – soils with coarse particles that allow passage of water

piscicide – a chemical applied to water which selectively kills fish

point source – a discharge from a designated outfall or other specific source

potamodromous – fish that migrate from fresh water lakes up fresh water streams to spawn; in the context of this report, it refers to fish that could migrate into the Cheboygan River watershed from Lake Huron

PRC – Pigeon River Country State Forest

private stocking – fish stocking by private individuals; a permit from the Michigan Department of Natural Resources, Fisheries Division is required to legally stock fish in public waters of the state

Quality Lake – A lake with the potential for growing larger fish under special fishing regulations.

recruitment – usually refers to number of fish reaching sexual maturity, harvestable size, or some size that is vulnerable to a particular sampling gear; refers to natural reproduction of fishes in the context of this report

riparian – adjacent to or living on the bank of a river or other body of water; also refers to the owner of stream or lakefront property

riprap – rock or other solid material used to armor shorelines, bridges, streambeds, etc.

riverine – a reach or portion of a river that is free-flowing and not impounded by dams; of or pertaining to a river

ROR – see run-of-river

rotenone – a white, crystalline poisonous compound obtained from derris root; fisheries managers use it as a toxicant to kill undesired fish species; it is not toxic to other nongill breathing aquatic organisms

rotenone survey – a method sometimes used to sample fish in a water body; in the context of the Cheboygan River watershed, fishes in some stream sections were killed with rotenone and collected with dip nets or blocking nets; the rotenone compound was detoxified at the downstream end of the sampled section with potassium permanganate

run habitat – fast, nonturbulent water

run-of-river – refers to impounded systems where the instantaneous inflow of water approximately equals the instantaneous outflow of water at the dam; this flow regime mimics the natural flow regime of a river

salmonid – fishes in the family Salmonidae; includes trouts, salmon, whitefish, and herring species

savanna – a treeless plain or grassland with scattered trees

sedimentation – the deposition or accumulation of sediment

self-sustaining population – a fish population that remains at an acceptable level of abundance by naturally reproducing young

Serns index – a method for determining levels of walleye natural reproduction, or the survival of stocked walleye from boom shocker catch-per-unit-effort

smolt – the physiological change in a young salmon or steelhead that usually corresponds with a migration from a river setting to a lake (Cheboygan River watershed to Lake Huron)

species richness – the number of different species collected at a site

sport fish – fish sought by anglers for sport and food

SSTP – Stream Status and Trends Program

substrate – a term used to refer to materials lying beneath the waters of a lake or stream; examples are clay, silt, sand, gravel, and cobble

surficial – referring to something on or at the surface

temperature regime – a phrase commonly used by fisheries biologists to describe the seasonal or daily pattern of temperature fluctuations (maximums, minimums, and averages); for example, streams with cold temperature regimes are those where summer daily mean water temperatures generally are colder than 68^{o}F and maximum daily temperatures do not reach levels lethal or unduly stressful to coldwater fish species

till – unstratified, unsorted glacial deposits of clay, sand, boulders, and gravel

turbidity – suspended particles in water that cause it to be less transparent

two-story lake – lakes that thermally stratify during warm weather periods and contain sufficient dissolved oxygen to support life in the deep, lower strata; warmwater fishes inhabit the shallow, upper strata and coldwater fishes (such as trout) inhabit the deep, lower strata topography – the configuration of the earth's surface including its relief and the position of its natural features

Type 1-7 trout stream regulation – trout streams in the State of Michigan are typically managed with one of seven regulation types ranging from more liberal to more conservative; see Table 24

UBRWRC – Upper Black River Watershed Restoration Committee

USDA – Unites States Department of Agriculture

USFS – United States Forest Service

USFWS – United States Fish and Wildlife Service

USGS – United States Geological Survey

valley segment – a river segment with homogenous features, such as hydrology, channel shape, temperature, fish community, etc.

wadeable – a stream that is shallow enough to be traversed by someone wearing chest waders

warmwater fish species – species that grow and thrive in waters that are seasonally warm; most game fish species in this classification are members of the sunfish family

watershed – an area of the earth's surface that drains toward a receiving body of water (such as a stream or lake) at a lower elevation

wetland – areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support types of vegetation typically adapted to life in saturated soil; includes swamps, marshes, fens, and bogs

wigglers – mayfly larva

winterkill – to die from exposure to winter cold; in the context of this text, heavy snow and oxygen depletion in the water may kill fish living in shallow lakes

young-of-year (YOY) – fish that is in its first year of life, which is defined to end on December 31

FIGURES

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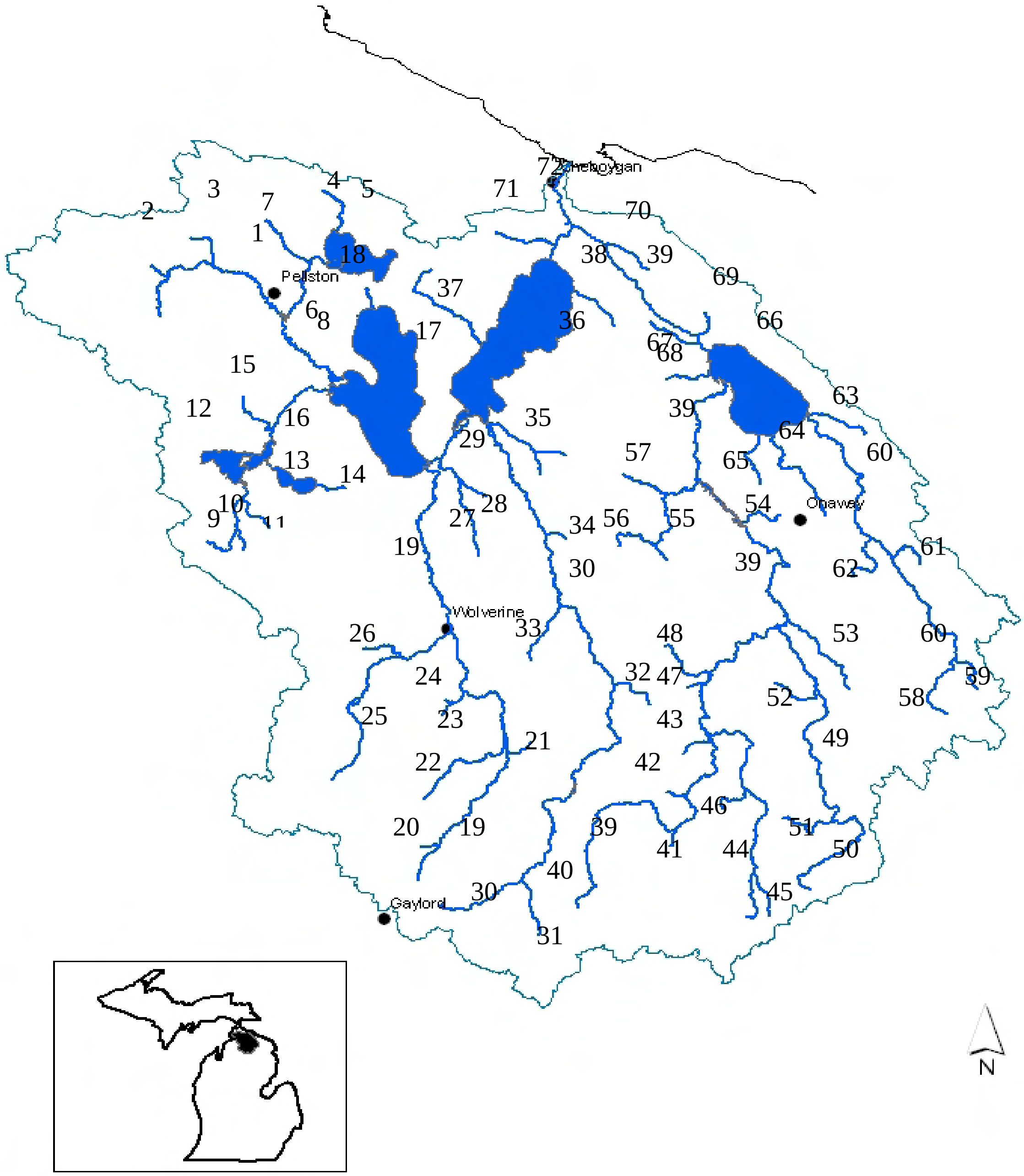

Figure 1.–Map of Cheboygan River watershed and major tributaries.

Figure 1.-Legend

1. West Branch Maple River
2. Brush Creek
3. Cold Creek
4. Lancaster Creek
5. Douglas Lake
6. East Branch Maple River
7. Van Creek
8. Maple River
9. West Branch Minnehaha Creek
10. Minnehaha Creek
11. Silver Creek
12. Crooked Lake
13. Pickerel Lake
14. Berry Creek
15. McPhee Creek
16. Crooked River
17. Burt Lake
18. Little Carp River
19. Sturgeon River
20. Mossback Creek
21. Pickerel Creek
22. Club Stream
23. Stewart Creek
24. Blackjack Creek
25. West Branch Sturgeon River
26. Marl Creek
27. Little Sturgeon River
28. Crumley Creek
29. Indian River
30. Pigeon River
31. South Branch Pigeon River
32. Cornwall Creek
33. Little Pigeon River
34. Wilkes Creek
35. Little Pigeon River
36. Mullett Lake
37. Mullett Creek
38. Ballard Creek
39. Black River
40. Saunders Creek
41. Tubbs Creek
42. Hardwood Creek
43. Stewart Creek
44. East Branch Black River
45. Rattlesnake Creek
46. Foch Creek
47. Little McMasters Creek
48. McMasters Creek
49. Canada Creek
50. Packer Creek
51. Van Hetton Creek
52. Oxbow Creek
53. Tomahawk Creek
54. Bowen Creek
55. Milligan Creek
56. Gokee Creek
57. Stony Creek
58. West Branch Upper Rainy River
59. Healy Creek
60. Rainy River
61. East Branch Rainy River
62. Little Rainy River
63. Cold Creek
64. Stony Creek
65. Stewart Creek
66. Black Lake
67. Mud Creek
68. Long Lake Outlet
69. Owens Creek
70. Myers Creek
71. Laperell Creek
72. Cheboygan River

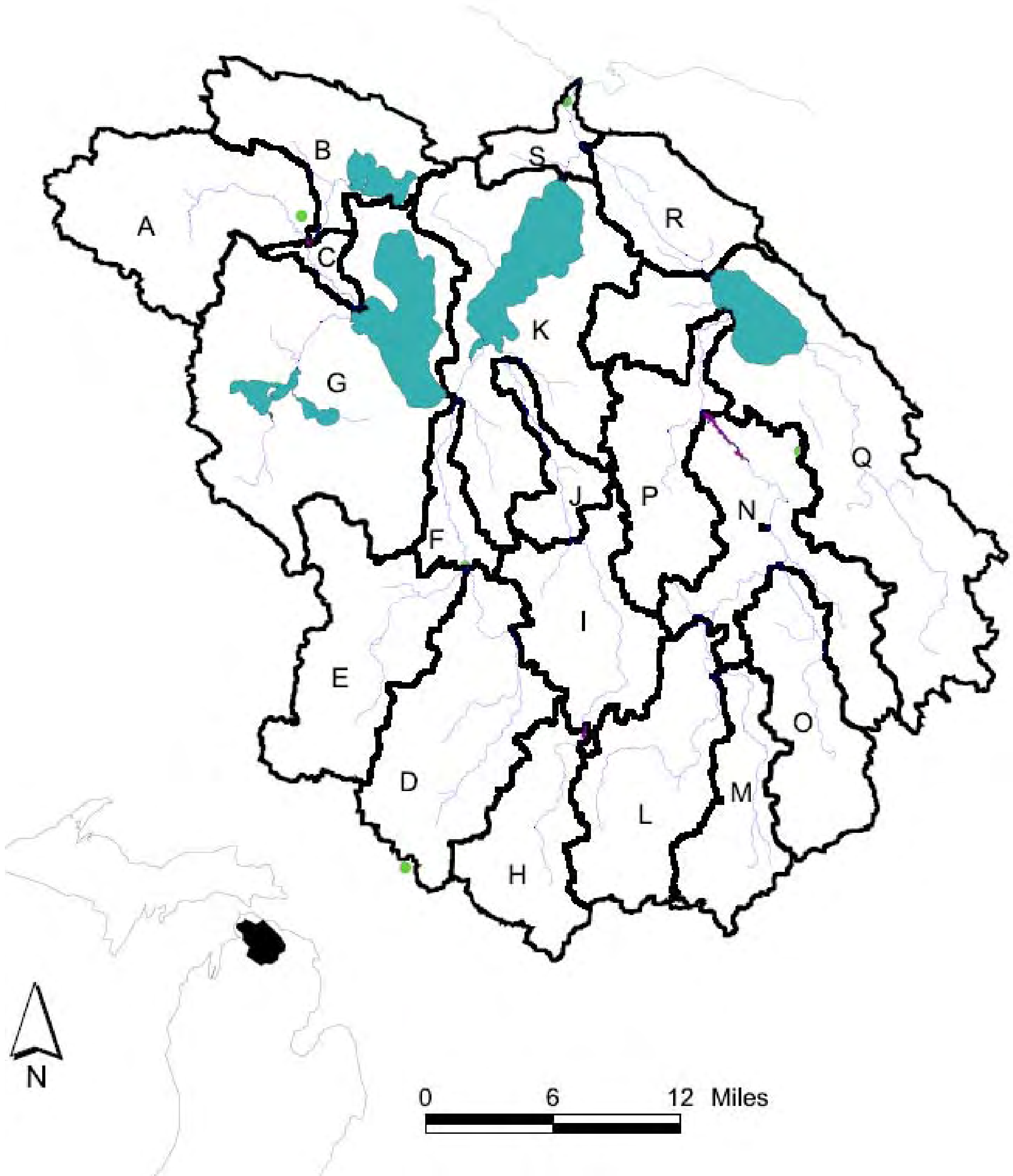

Figure 2.–River valley segments within the Cheboygan River watershed.

Figure 2.–Legend.

A. West Branch Maple River - Headwaters to Maple River Dam
B. East Branch Maple River - Douglas Lake to Maple River Dam
C. Maple River – Maple River Dam to Burt Lake
D. Sturgeon River – Headwaters to confluence with West Branch Sturgeon River
E. West Branch Sturgeon River
F. Sturgeon River – Confluence with West Branch Sturgeon River to Burt Lake
G. Burt Lake
H. Pigeon River – Headwaters to Golden Lotus Dam
I. Pigeon River – Golden Lotus Dam to confluence with Little Pigeon River
J. Pigeon River – Confluence with Little Pigeon River to Mullett Lake
K. Mullett Lake
L. Black River – Headwaters to Clark Bridge Road
M. East Branch Black River
N. Black River – Clark Bridge Road to Kleber Dam
O. Canada Creek
P. Black River – Kleber Dam to Black Lake
Q. Black Lake
R. Lower Black River
S. Cheboygan River

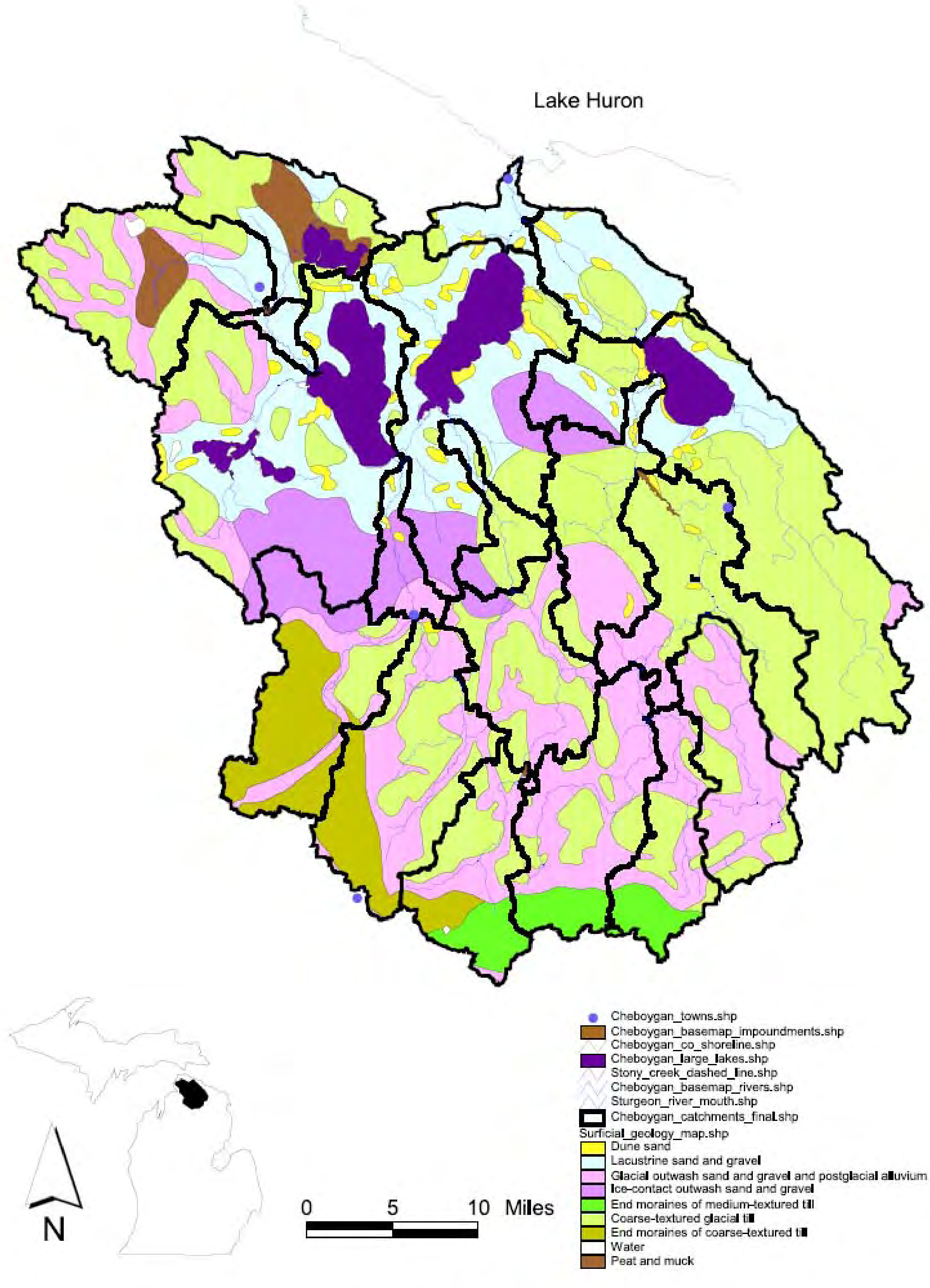

Figure 3.–Surficial geology of the Cheboygan River watershed (Fisheries Division, unpublished data).

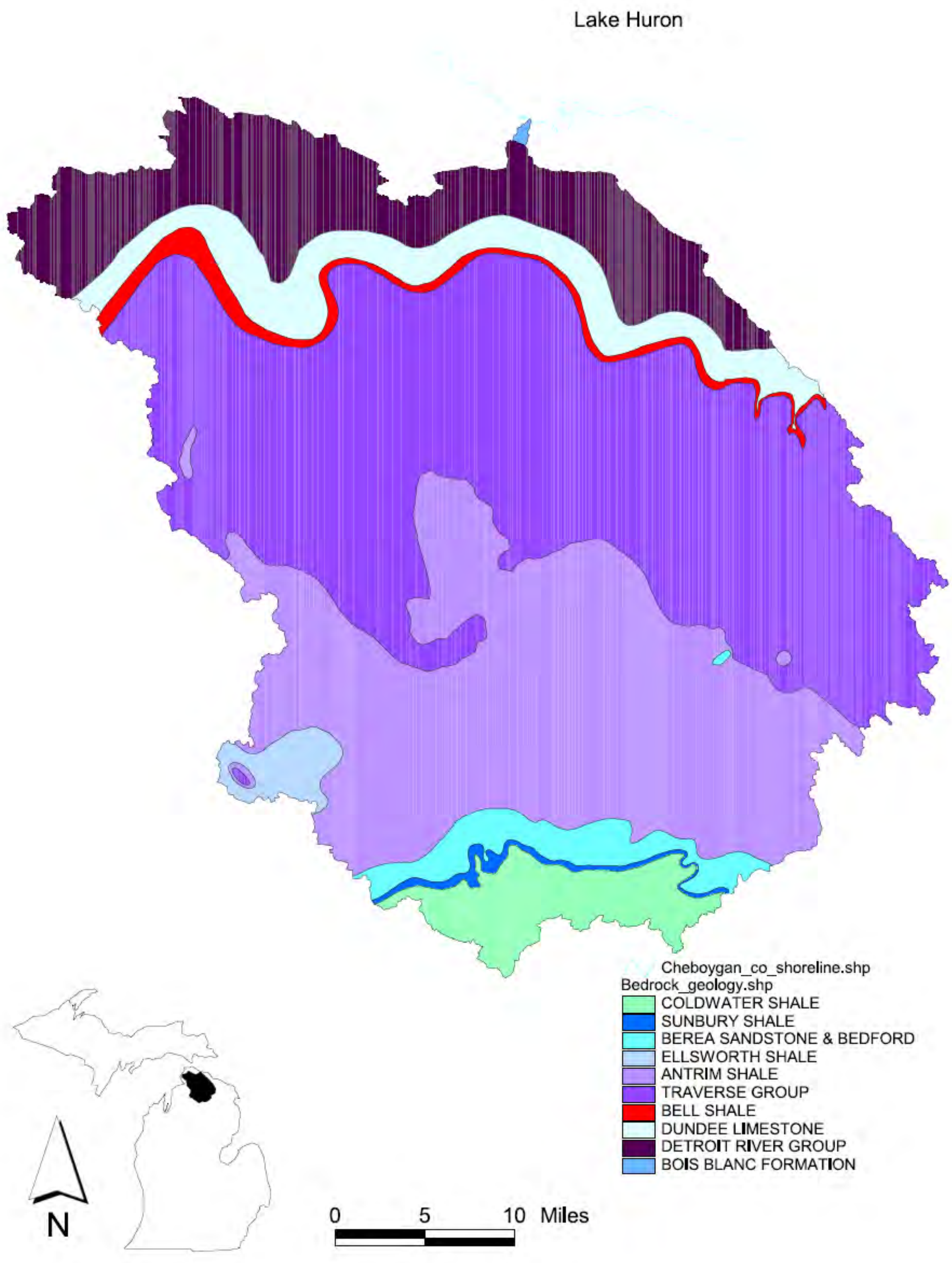

Figure 4.–Bedrock geology of Cheboygan River watershed.

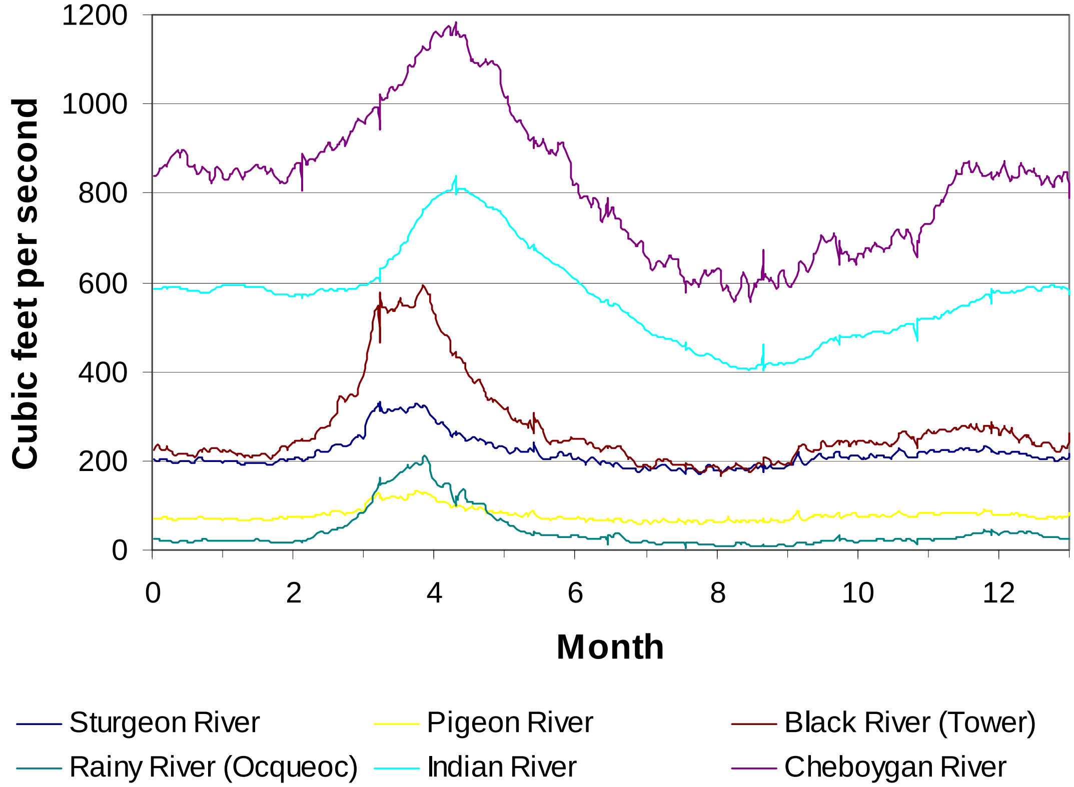

Figure 5.–Annual hydrograph for entire period of record at six United States Geological Survey gage sites in the Cheboygan River watershed.

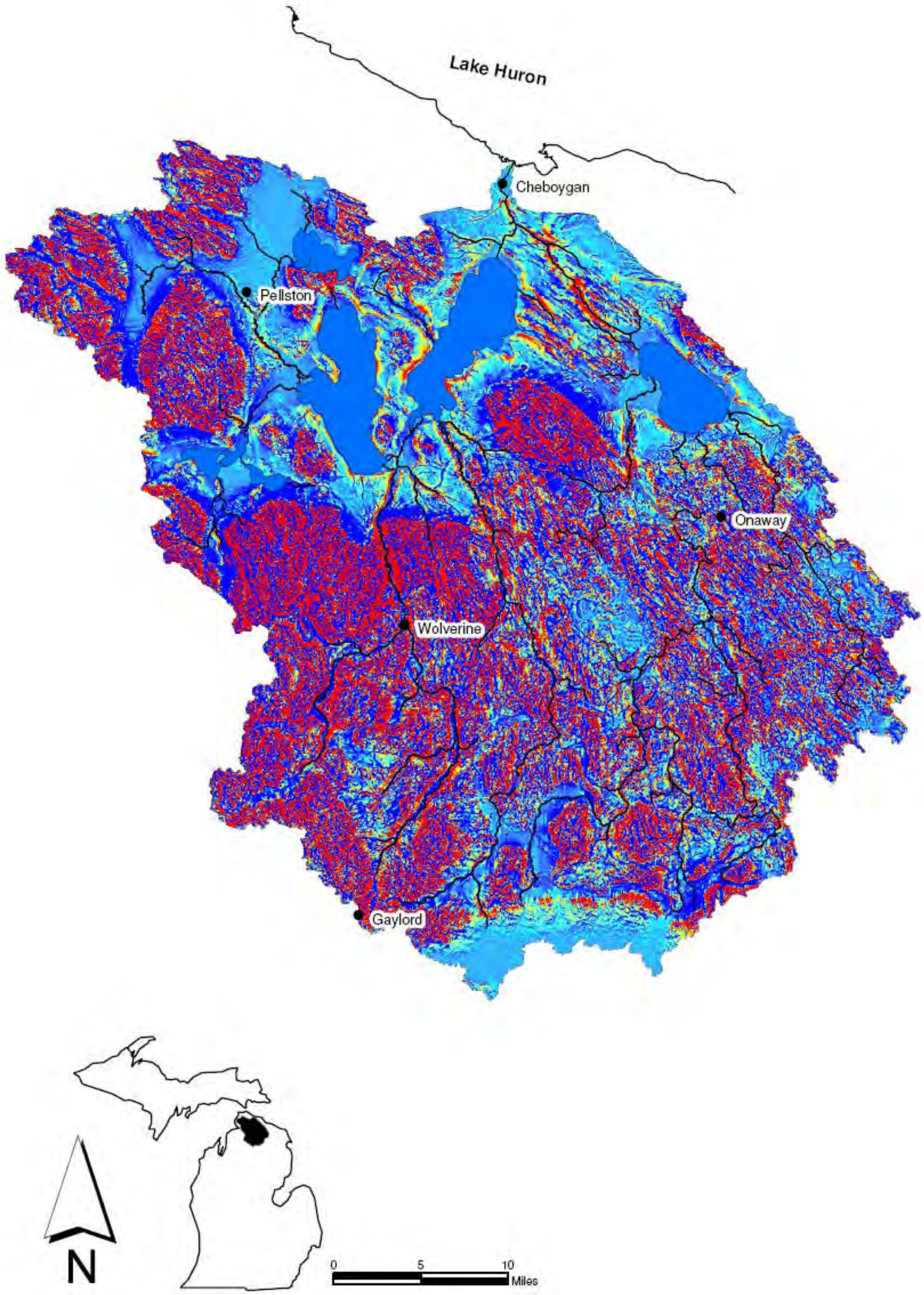

Figure 6.–Darcy groundwater movement predictions for the Cheboygan River watershed (Baker et al. 2003). Groundwater movement increases from blue (lowest potential) to red (highest potential).

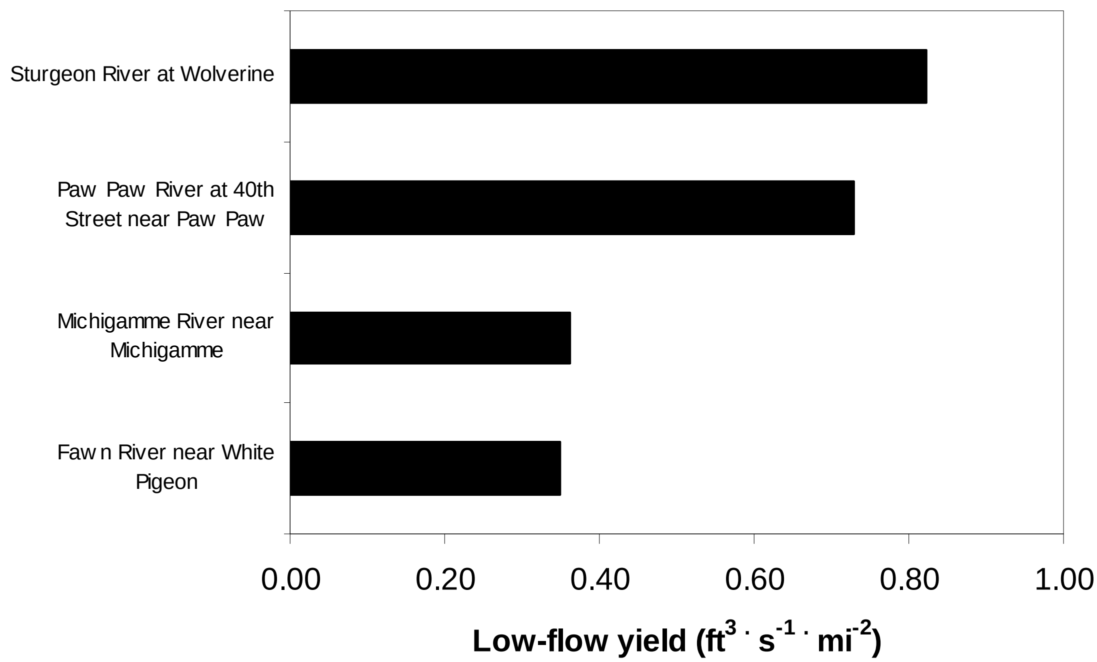

Figure 7.–Low-flow yield (90% exceedence flow divided by catchment area) expressed as $ft^3/s/mi^2$ for the Sturgeon River at Wolverine, compared to low-flow yields for other Michigan streams with similar-sized catchments. Note that some flow regulation occurs upstream of gages on the Paw Paw and Fawn rivers. Data are from the United States Geological Survey.

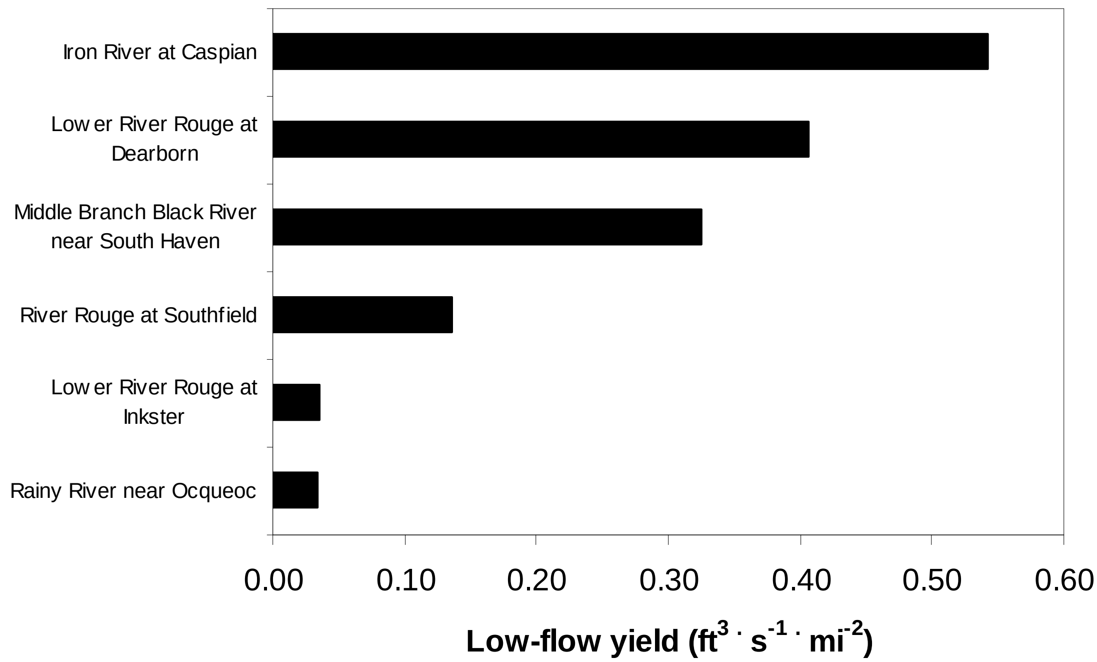

Figure 8.–Low-flow yield (90% exceedence flow divided by catchment area) expressed as $ft^3/s/mi^2$ for the Rainy River near Ocqueoc, compared to low-flow yields for other Michigan streams with similar-sized catchments. Data are from the United States Geological Survey.

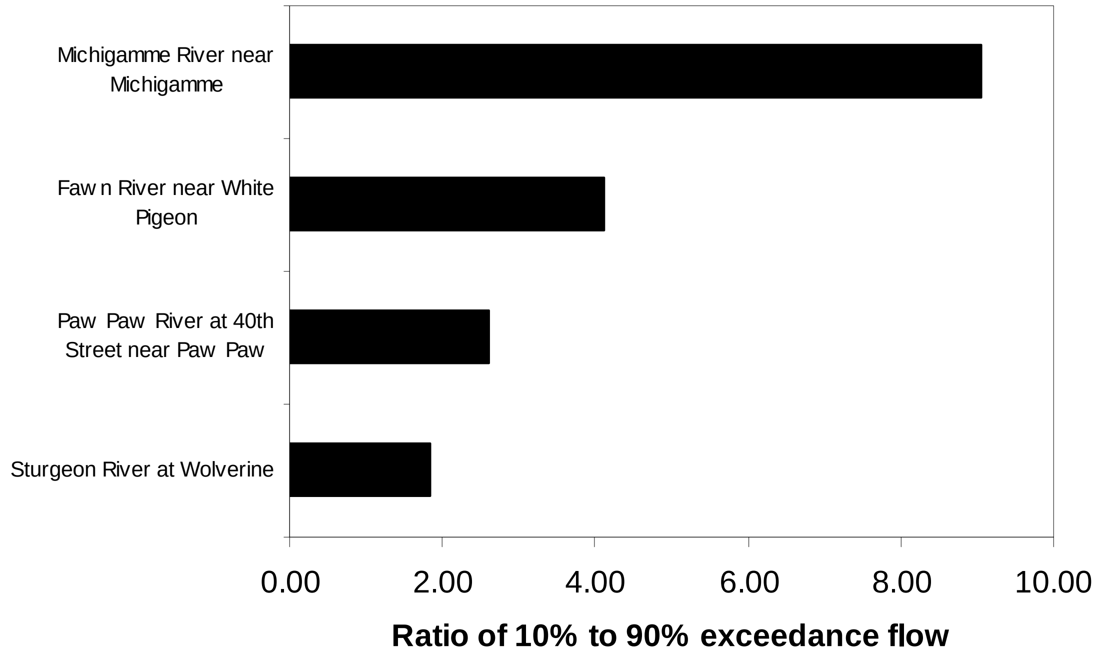

Figure 9.–Flow stability (expressed as the ratio of 10% and 90% exceedence flows) of Michigan streams having catchments comparable in size to the Sturgeon River at Wolverine. Note that some flow regulation occurs upstream of the gages on the Fawn and Paw Paw rivers. Data are from the United States Geological Survey.

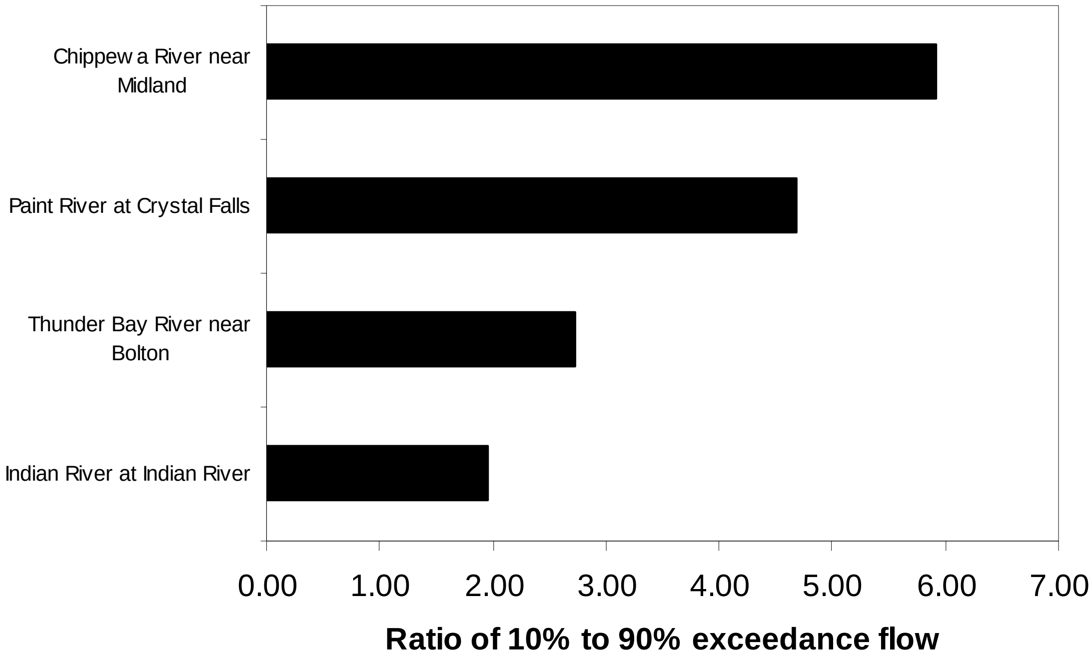

Figure 10.–Flow stability (expressed as the ratio of 10% and 90% exceedence flows) of Michigan streams having catchments comparable in size to the Indian River at Indian River. Note that some flow regulation occurs upstream of gages on the Chippewa, Paint, and Thunder Bay rivers; some flow regulation occurs downstream of the gage on the Indian River. Data are from the United States Geological Survey.

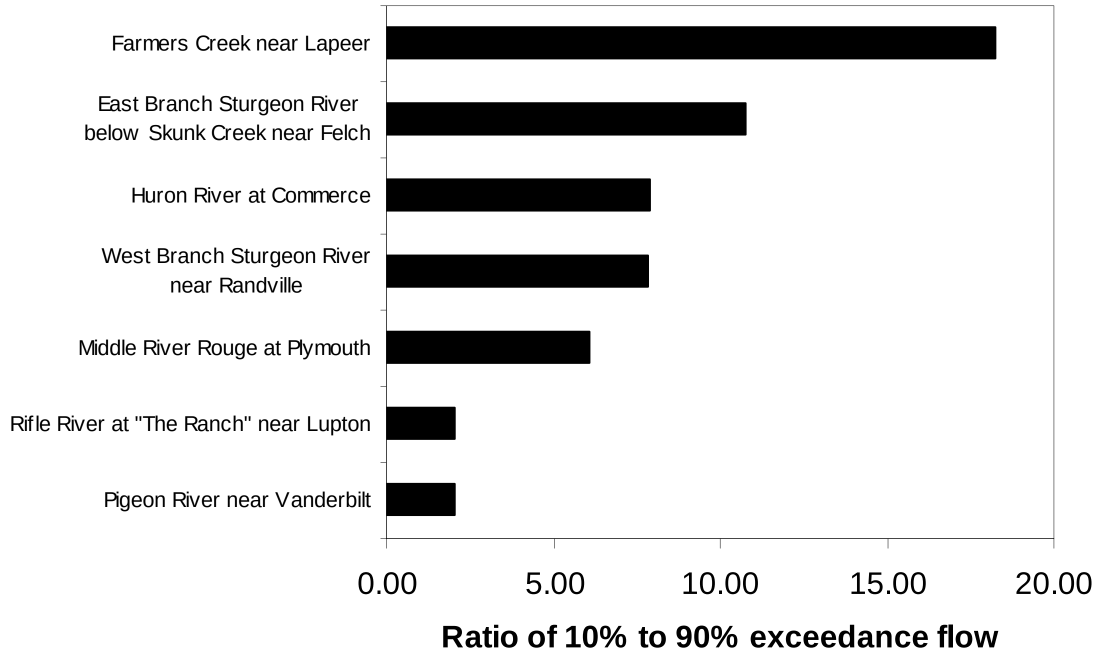

Figure 11.–Flow stability (expressed as the ratio of 10% and 90% exceedence flows) of Michigan streams having catchments comparable in size to the Pigeon River near Vanderbilt. Note that some flow regulation occurs upstream of all gages. Data are from the United States Geological Survey.

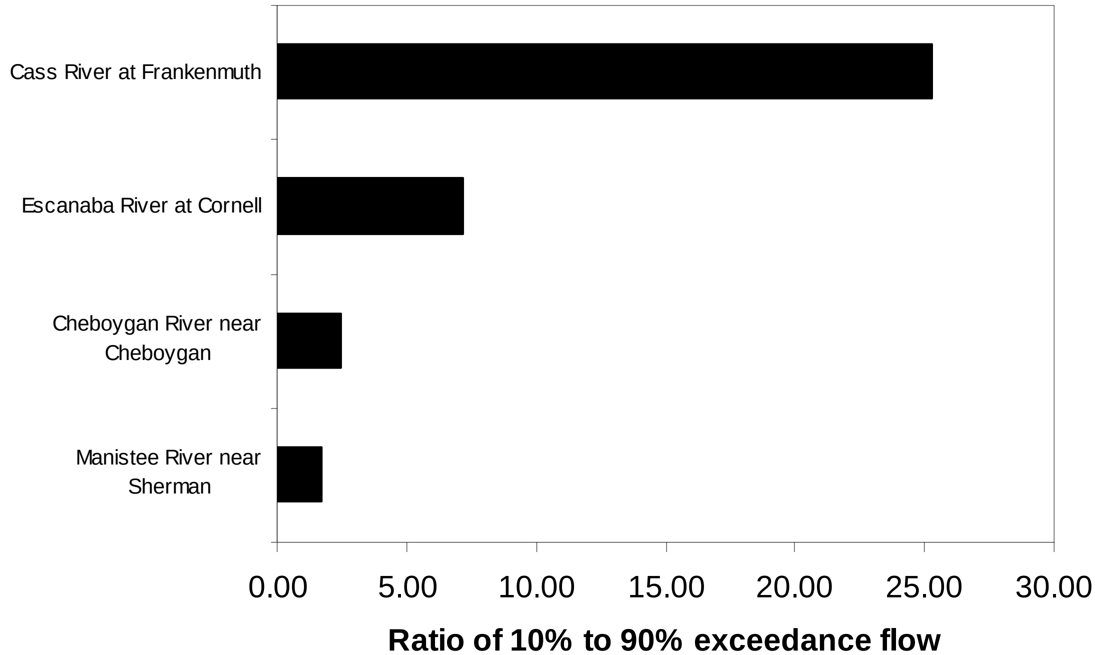

Figure 12.–Flow stability (expressed as the ratio of 10% and 90% exceedence flows) of Michigan streams having catchments comparable in size to the Cheboygan River near Cheboygan. Note that some flow regulation occurs upstream of gages on the Cass and Escanaba rivers; some flow regulation occurs downstream of the gage on the Cheboygan River. Data are from the United States Geological Survey.

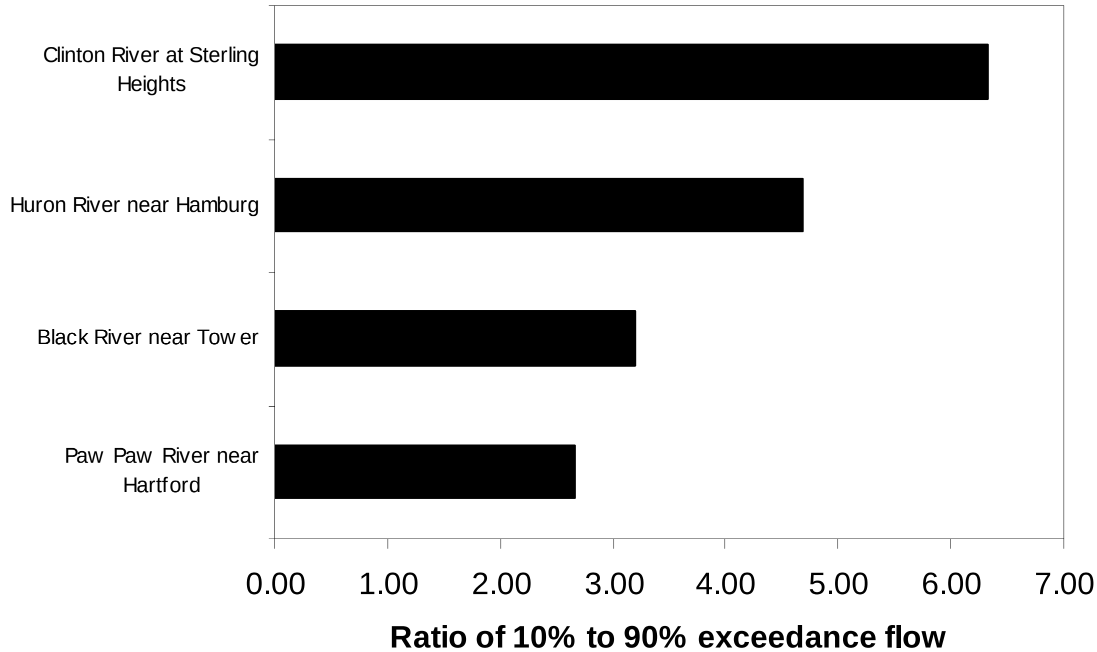

Figure 13.–Flow stability (expressed as the ratio of 10% and 90% exceedence flows) of Michigan streams having catchments comparable in size to the Black River near Tower. Note that some flow regulation occurs upstream of gages on the Huron, Black, and Paw Paw rivers. Data are from the United States Geological Survey.

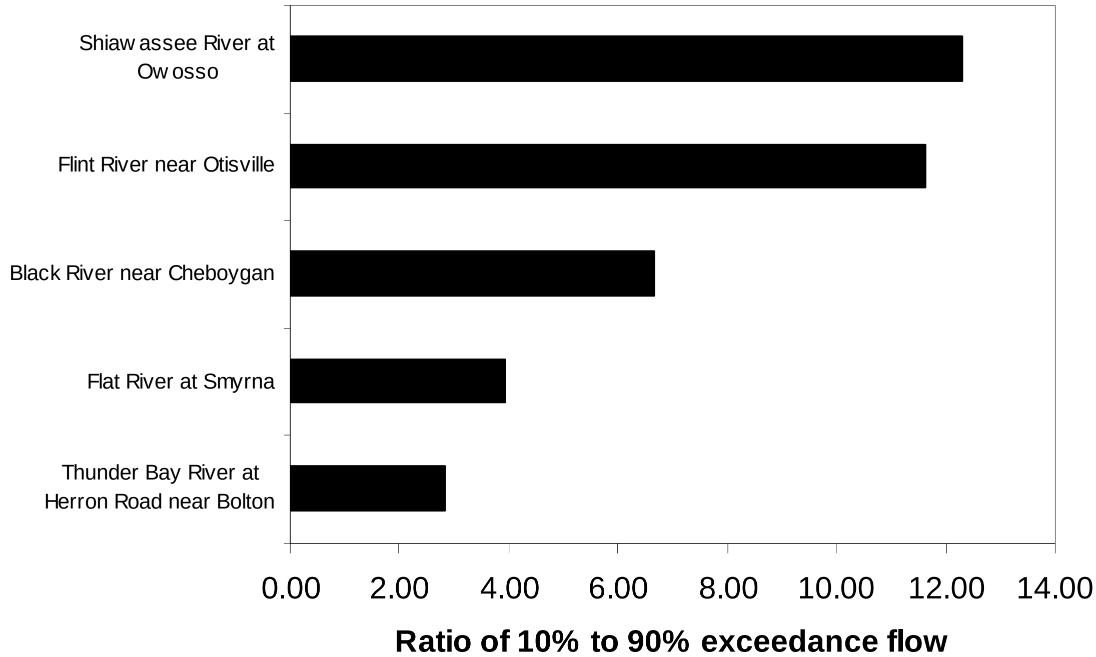

Figure 14.–Flow stability (expressed as the ratio of 10% and 90% exceedence flows) of Michigan streams having catchments comparable in size to the Black River near Cheboygan. Note that some flow regulation occurs upstream of all gages except the Black River, where some regulation occurs downstream of the gage. Data are from the United States Geological Survey.

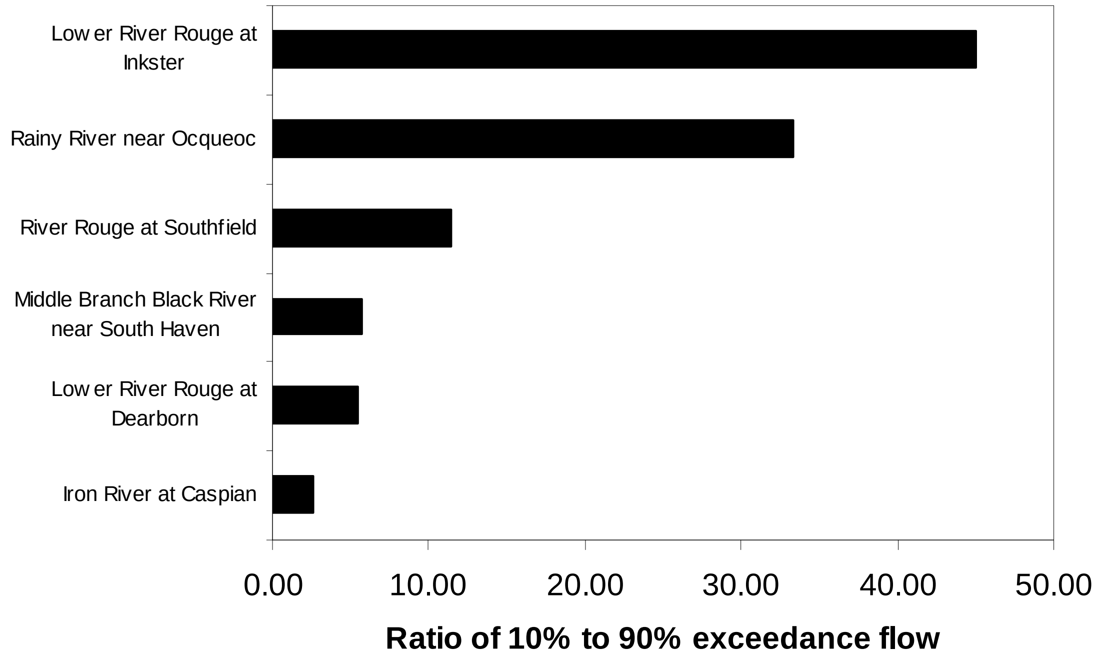

Figure 15.–Flow stability (expressed as the ratio of 10% and 90% exceedence flows) of Michigan streams having catchments comparable in size to the Rainy River near Ocqueoc. Data are from the United States Geological Survey.

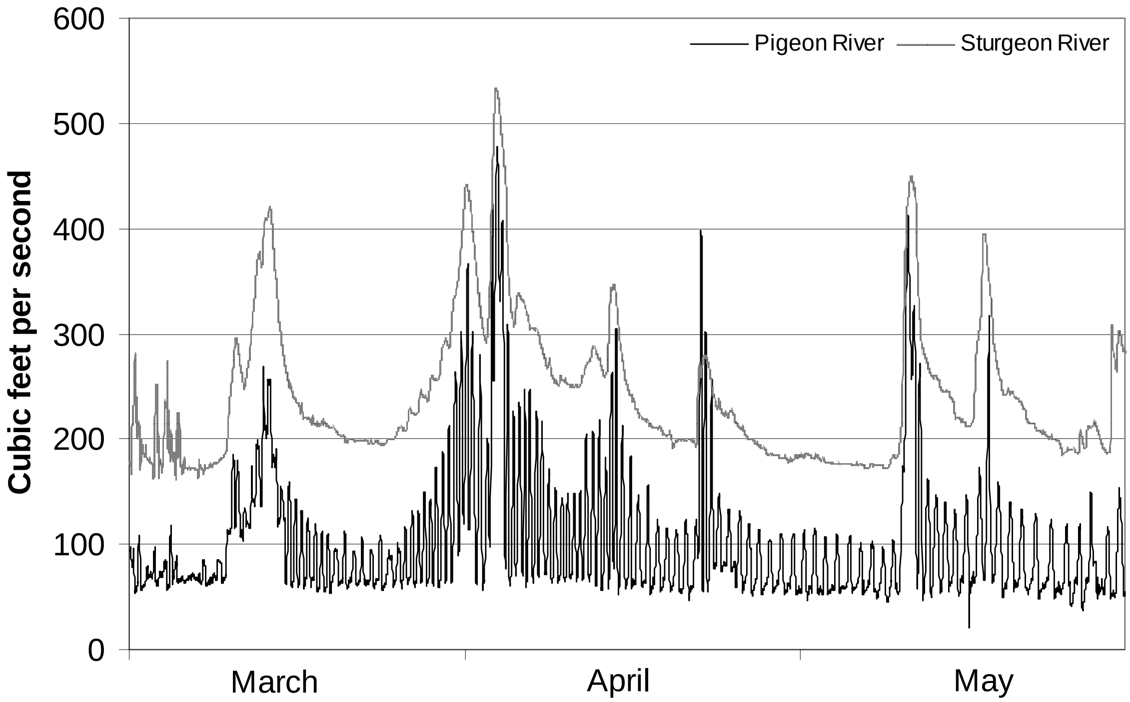

Figure 16.–Daily variation in stream flow (cubic feet per second) of the Pigeon River (solid line) and Sturgeon River (dashed line), March 01–May 31, 2006. Data are from the United States Geological Survey (2007).

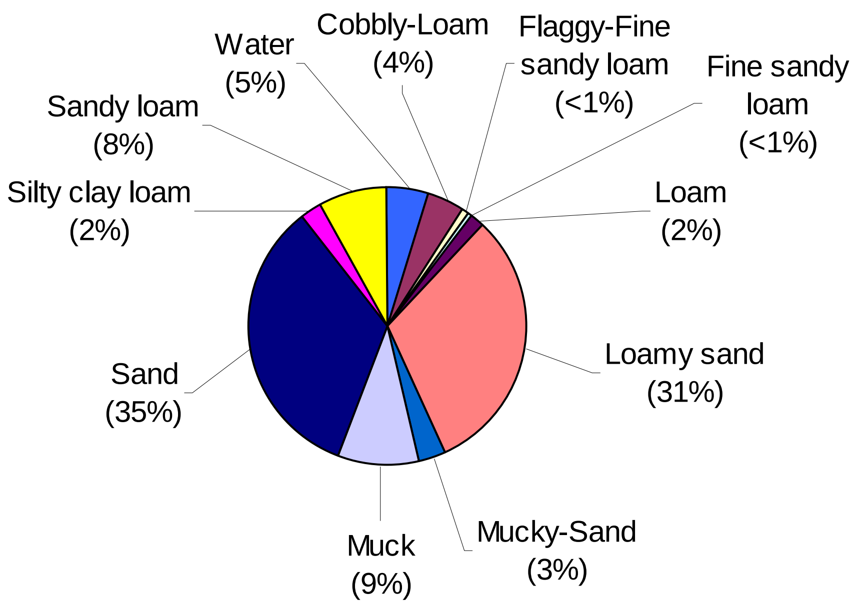

Figure 17.–Percentage of soil types within the Cheboygan River watershed (NRCS 1994).

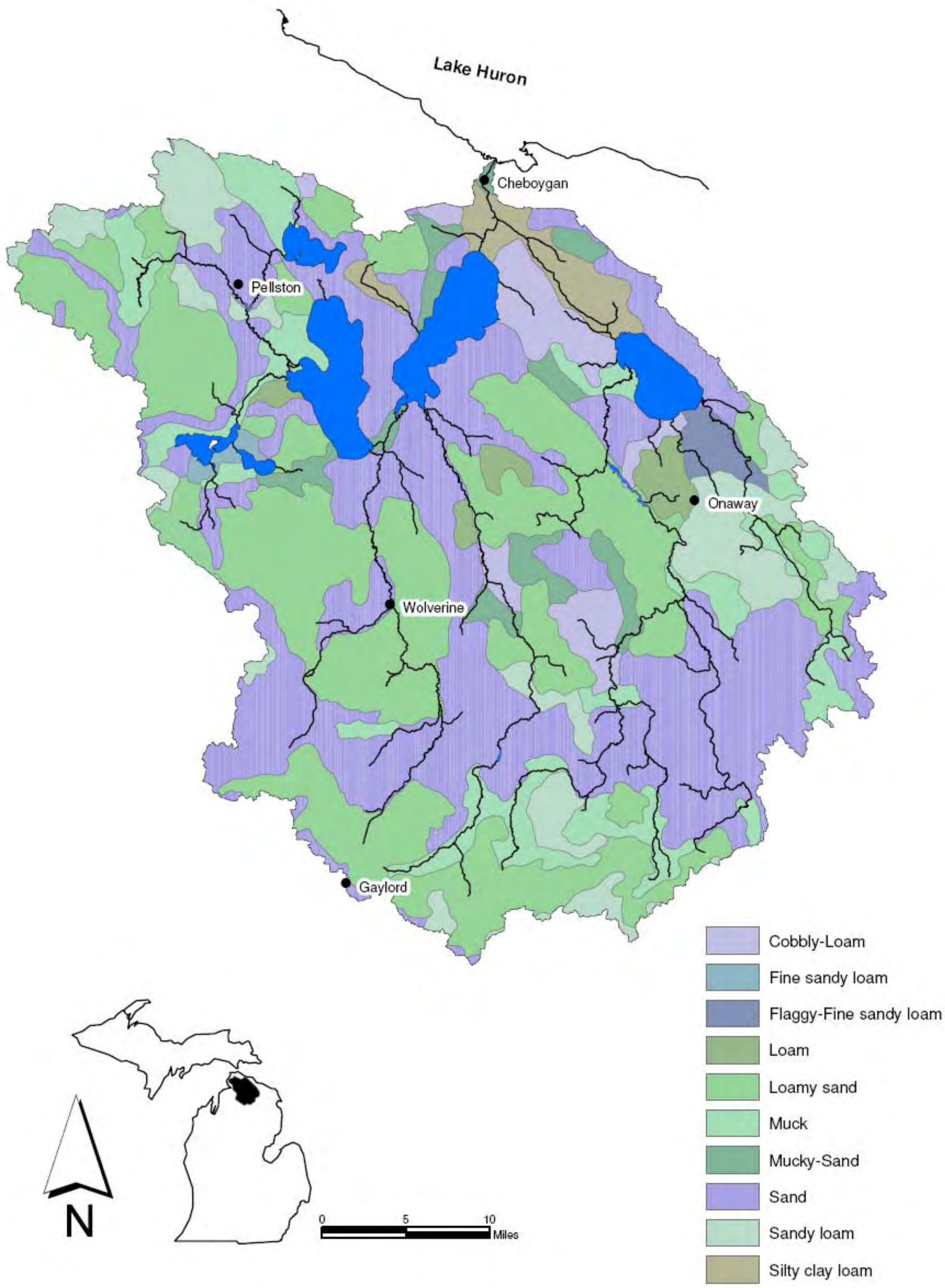

Figure 18.–Soils in the Cheboygan River watershed (NRCS 1994).

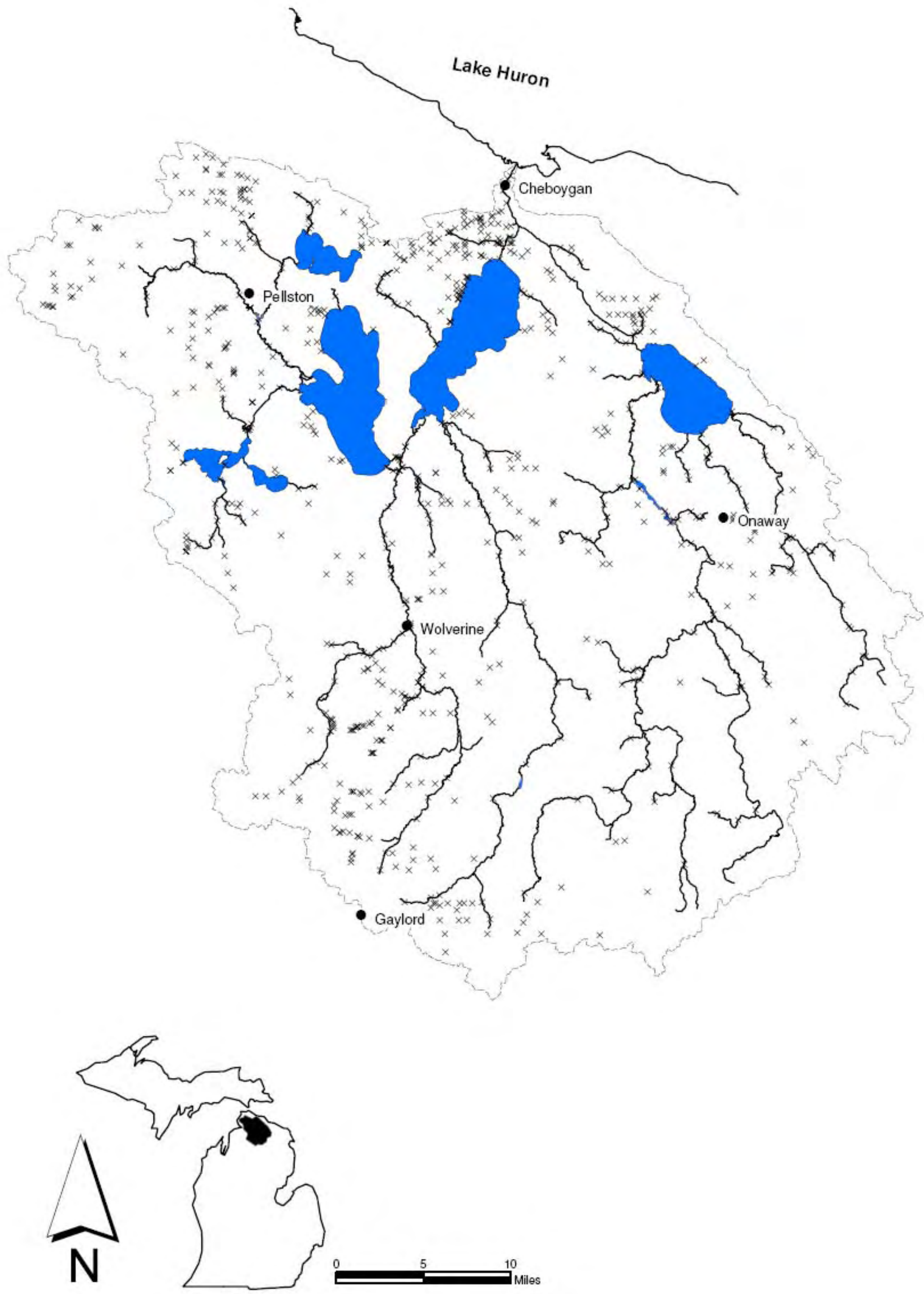

Figure 19.–Road-stream crossings in the Cheboygan River watershed. Data are from a MIRIS-based 1:24,000 scale map clipped to the Cheboygan River watershed (Michigan Geographic Data Library 2007).

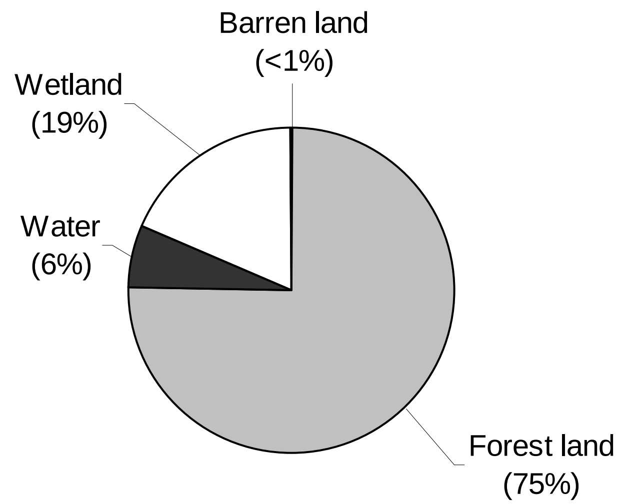

Figure 20a.–Percent land cover in the Cheboygan River watershed circa 1800 (MIRIS 1978).

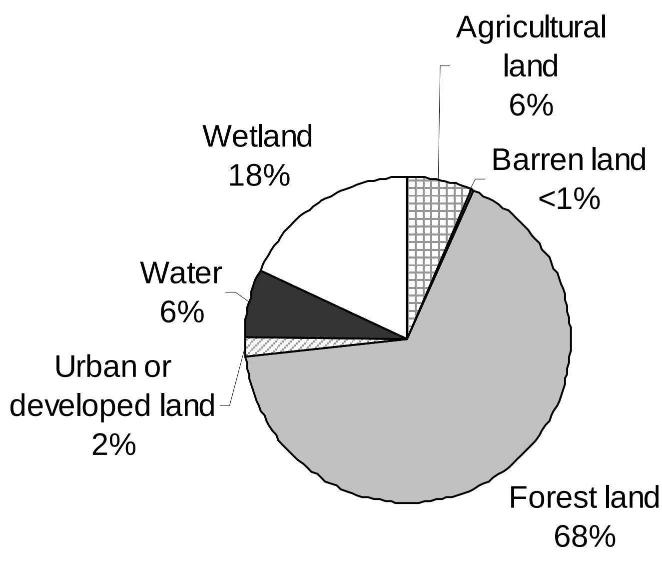

Figure 20b.–Percent land use and land cover in the Cheboygan River watershed in 2000 (NOAA 2001).

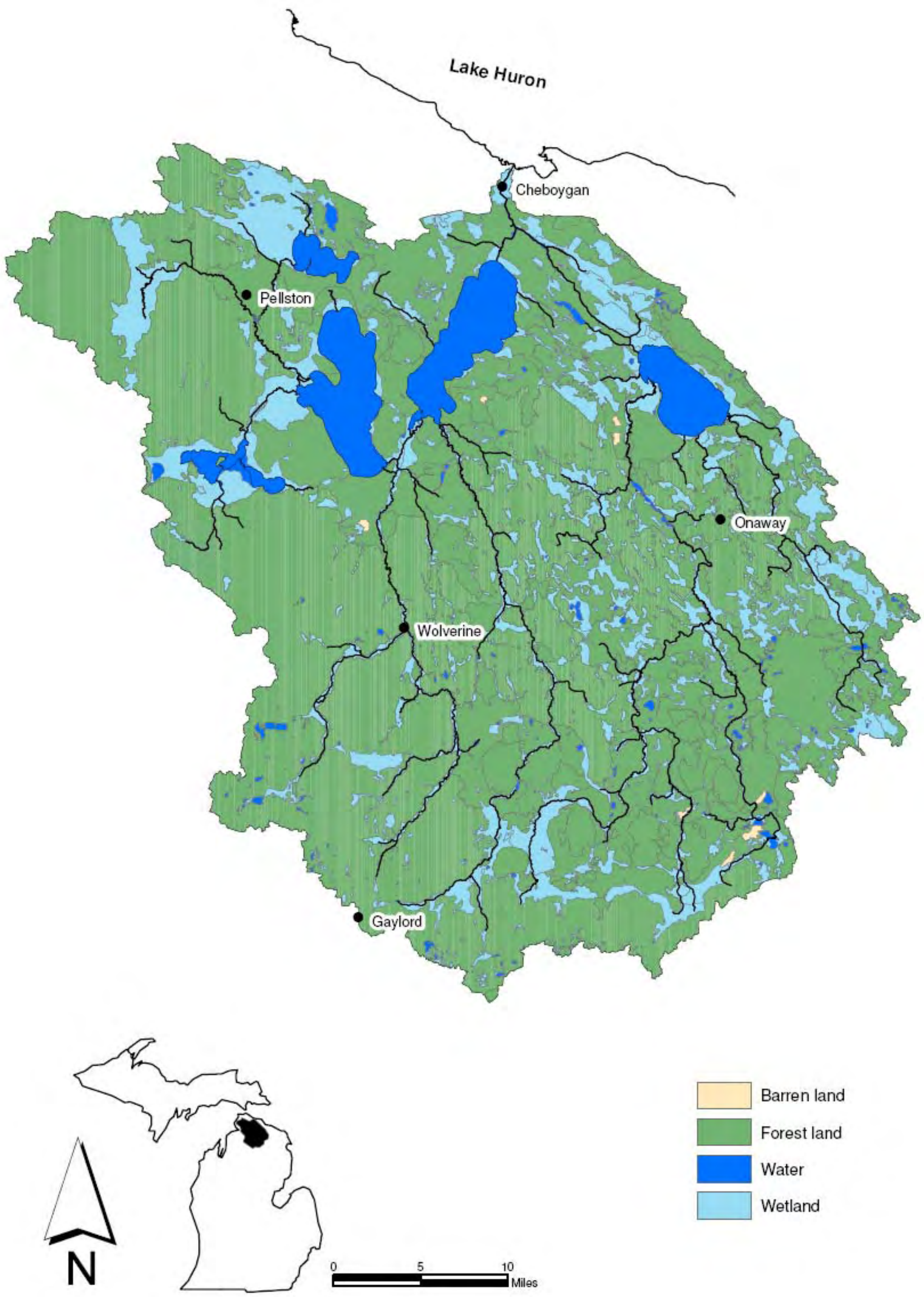

Figure 21.–Land cover in the Cheboygan River watershed circa 1800 (Michigan Geographic Data Library 2007).

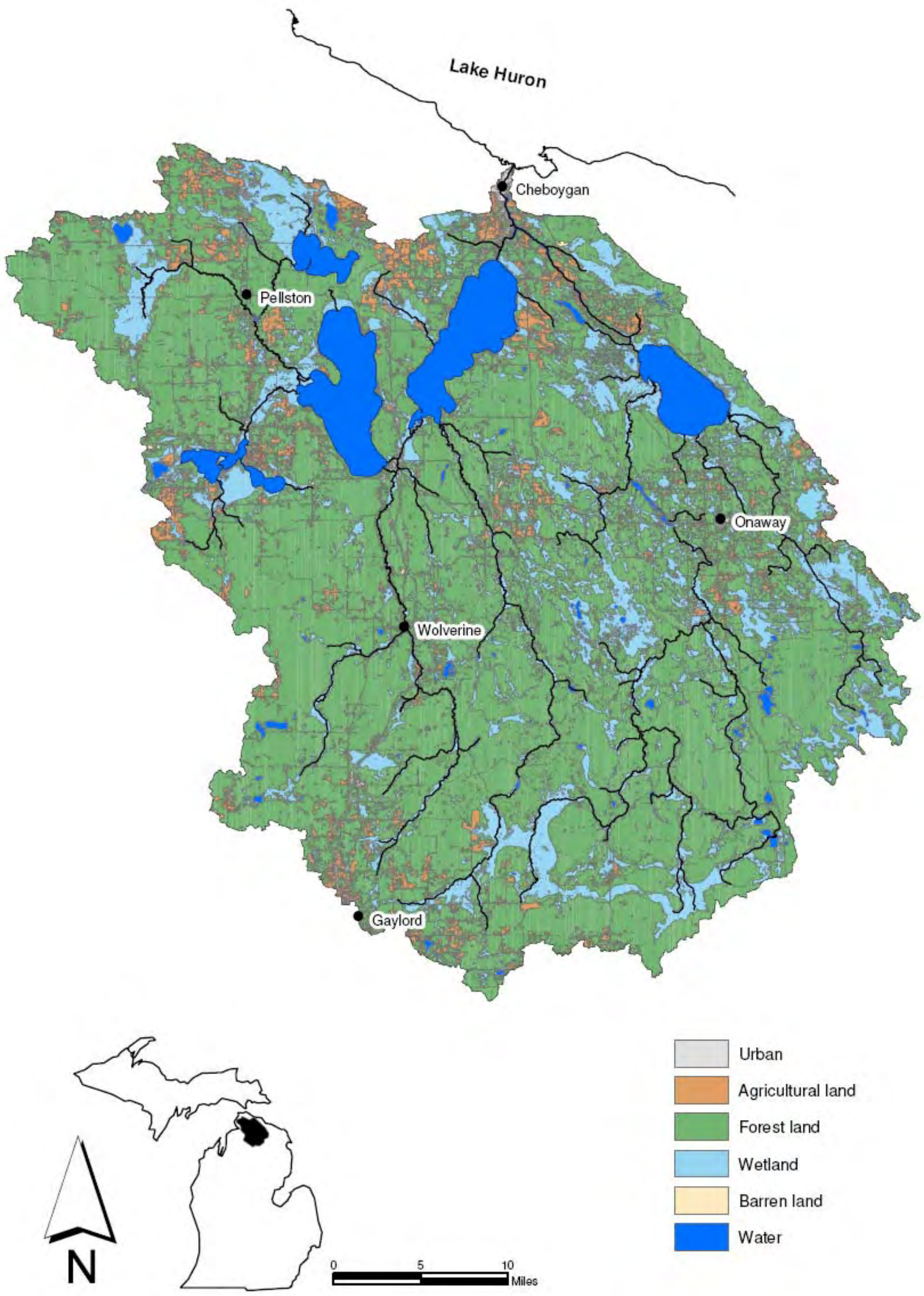

Figure 22.–Land use and land cover in the Cheboygan River Watershed in 2000 (NOAA 2001).

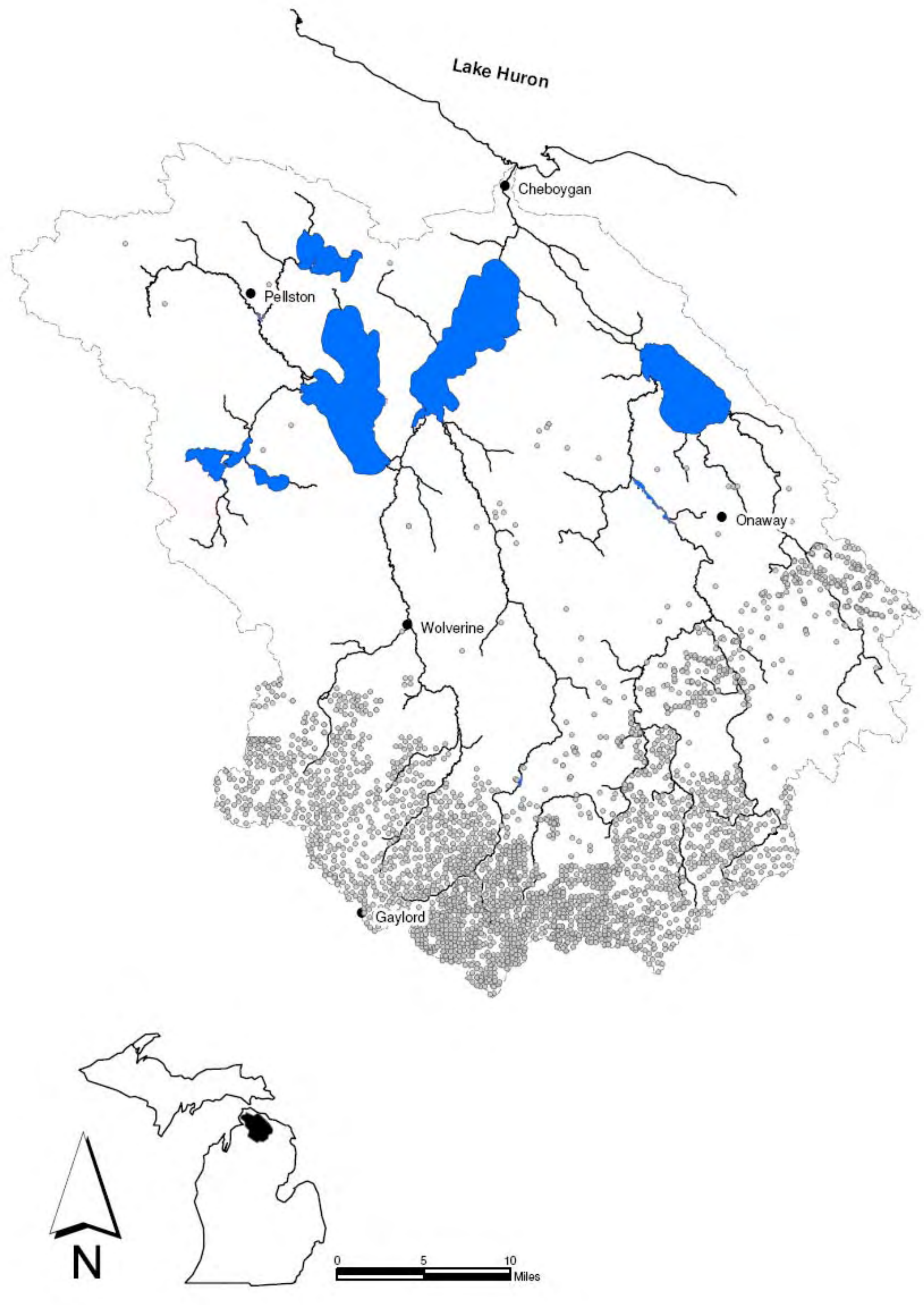

Figure 23.–Oil and gas wells in the Cheboygan River watershed (MDNR Spatial Data Library 2007).

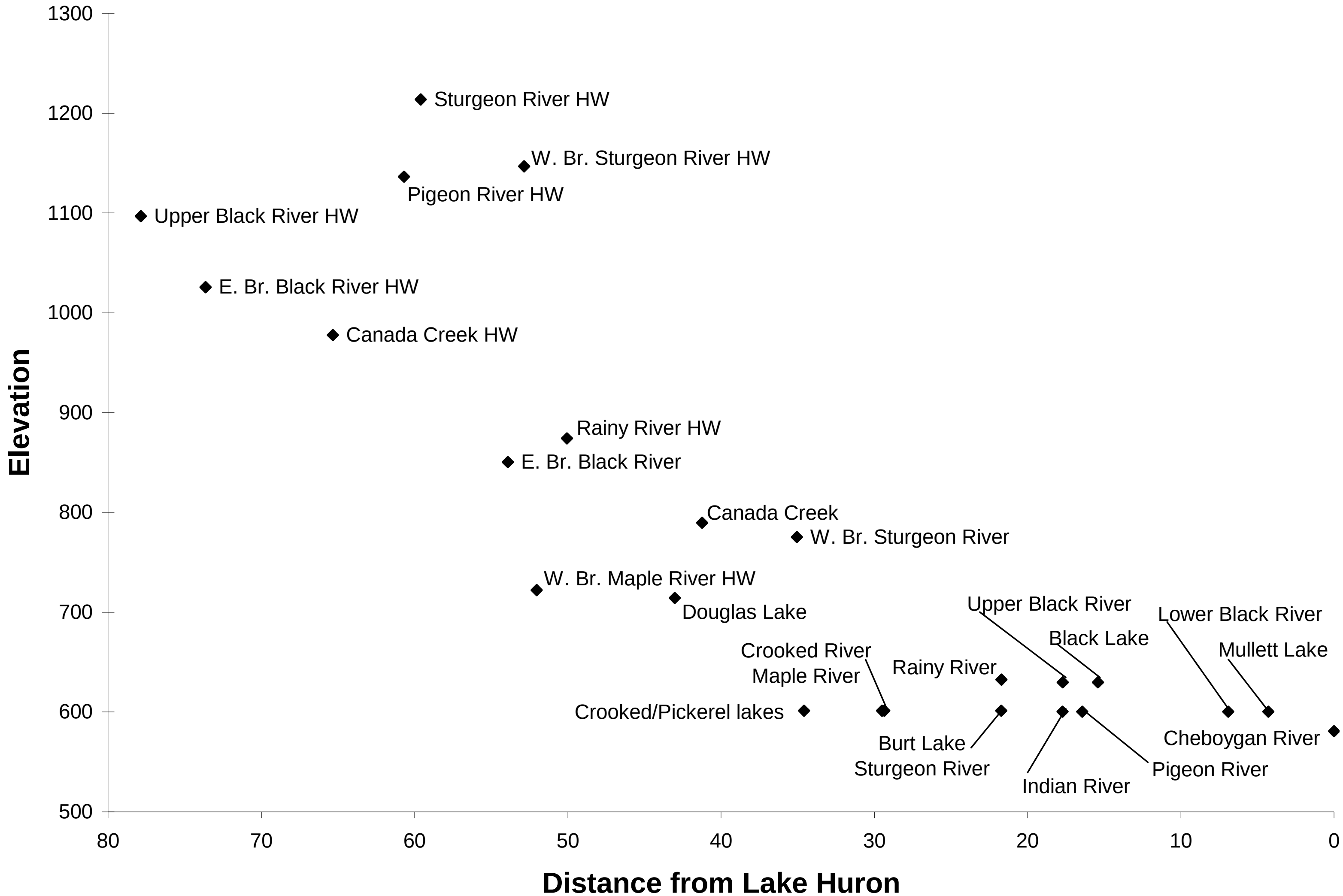

Figure 24.–Approximate elevation (feet above sea level) and distance from Lake Huron (river miles) of select water bodies in the Cheboygan River watershed. HW = headwaters; elevations of all other points are at the confluence of the next downstream river or lake.

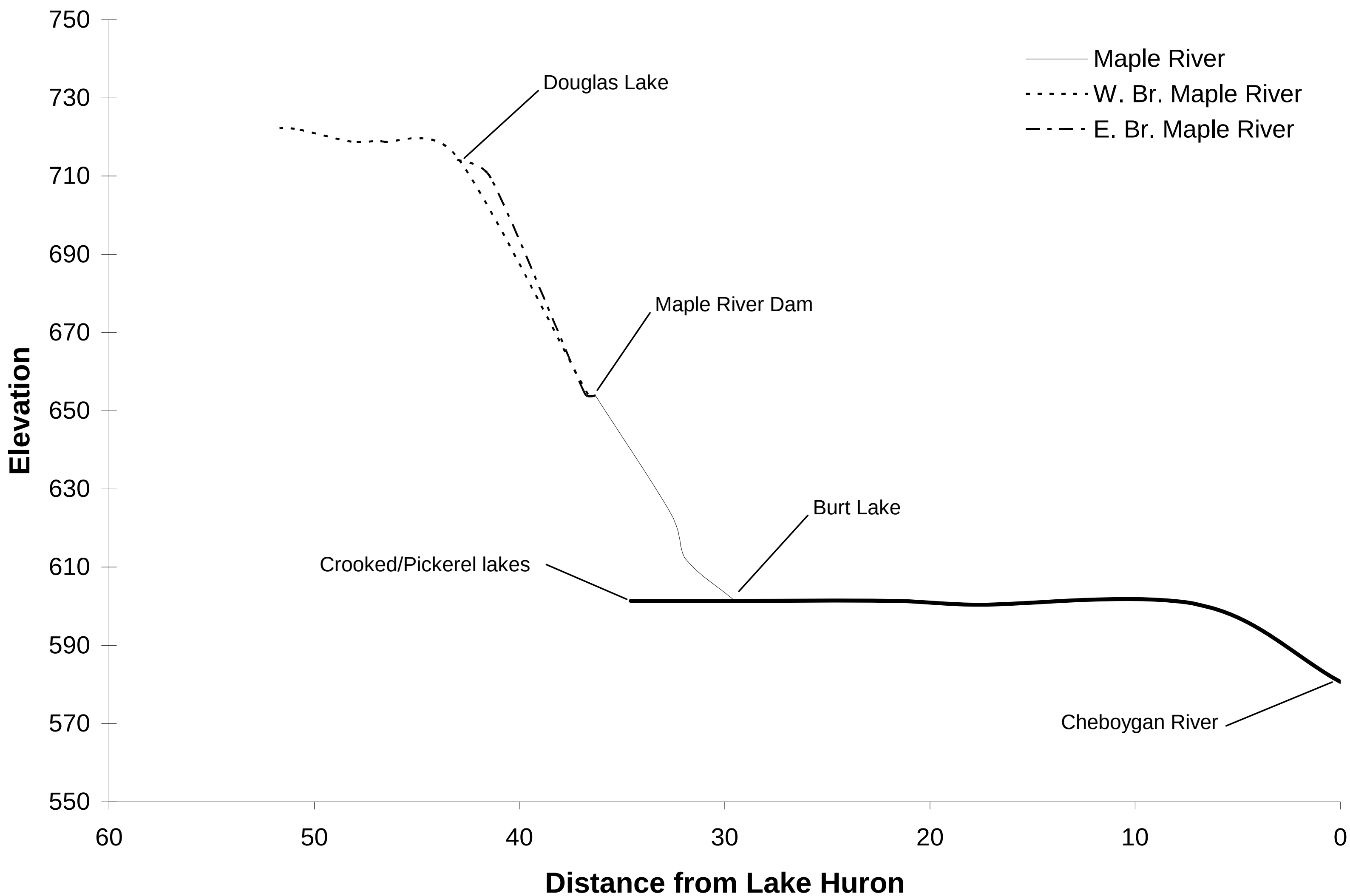

Figure 25.–Approximate elevation (feet above sea level) and distance from Lake Huron (river miles) of the Maple River and other water bodies in the Cheboygan River watershed.

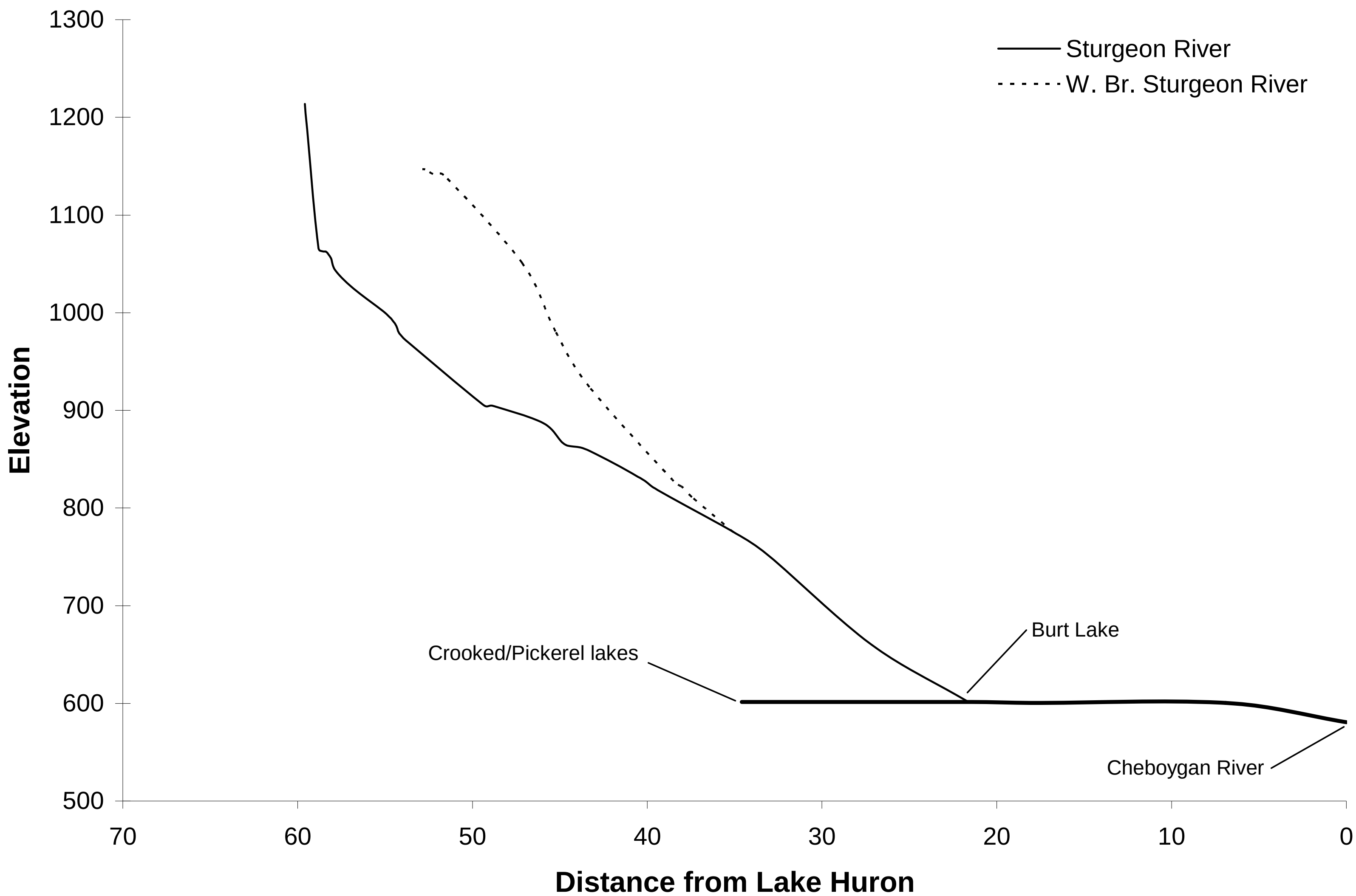

Figure 26.–Approximate elevation (feet above sea level) and distance from Lake Huron (river miles) of the Sturgeon River and other water bodies in the Cheboygan River watershed.

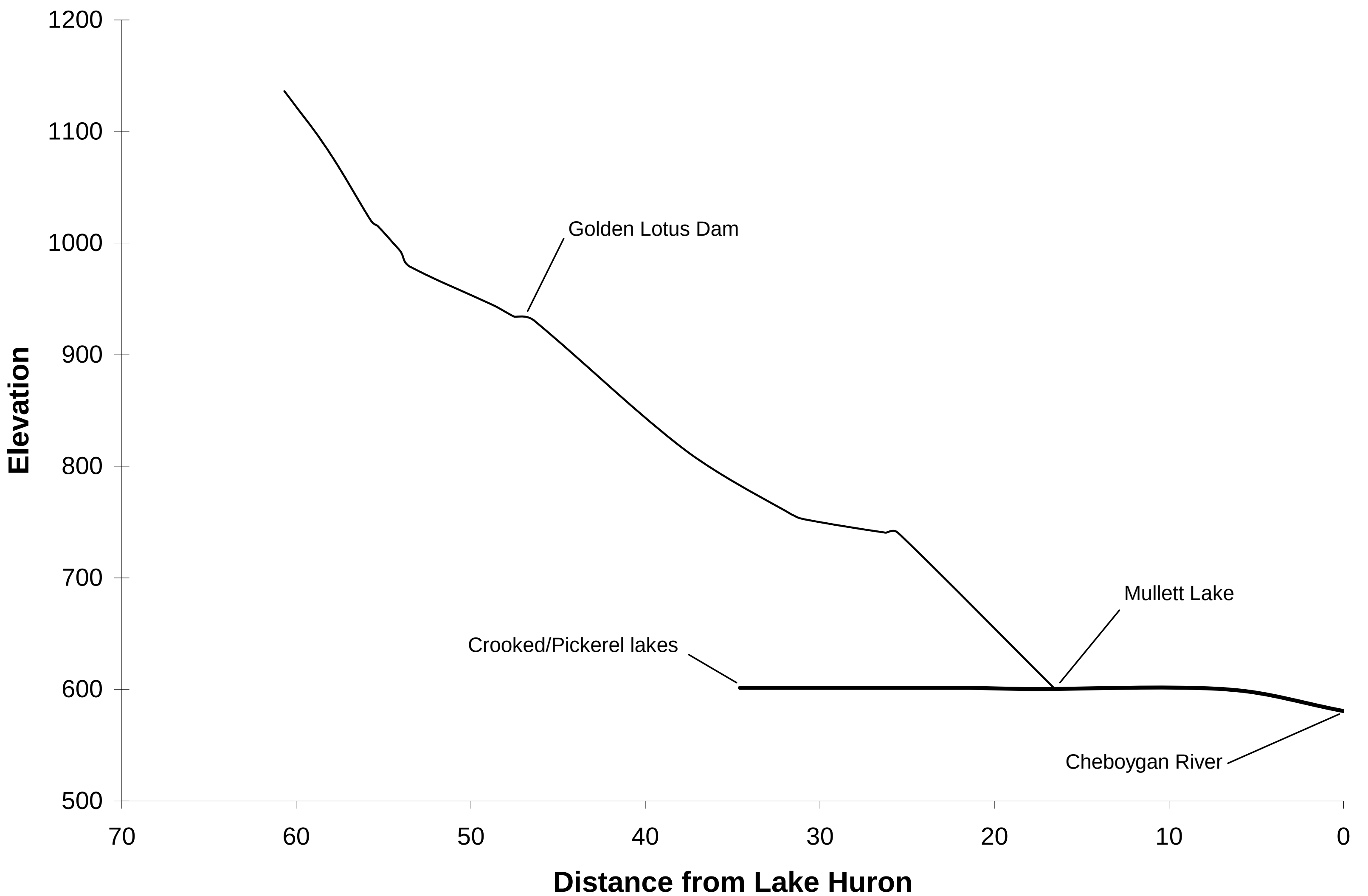

Figure 27.–Approximate elevation (feet above sea level) and distance from Lake Huron (river miles) of the Pigeon River and other water bodies in the Cheboygan River watershed.

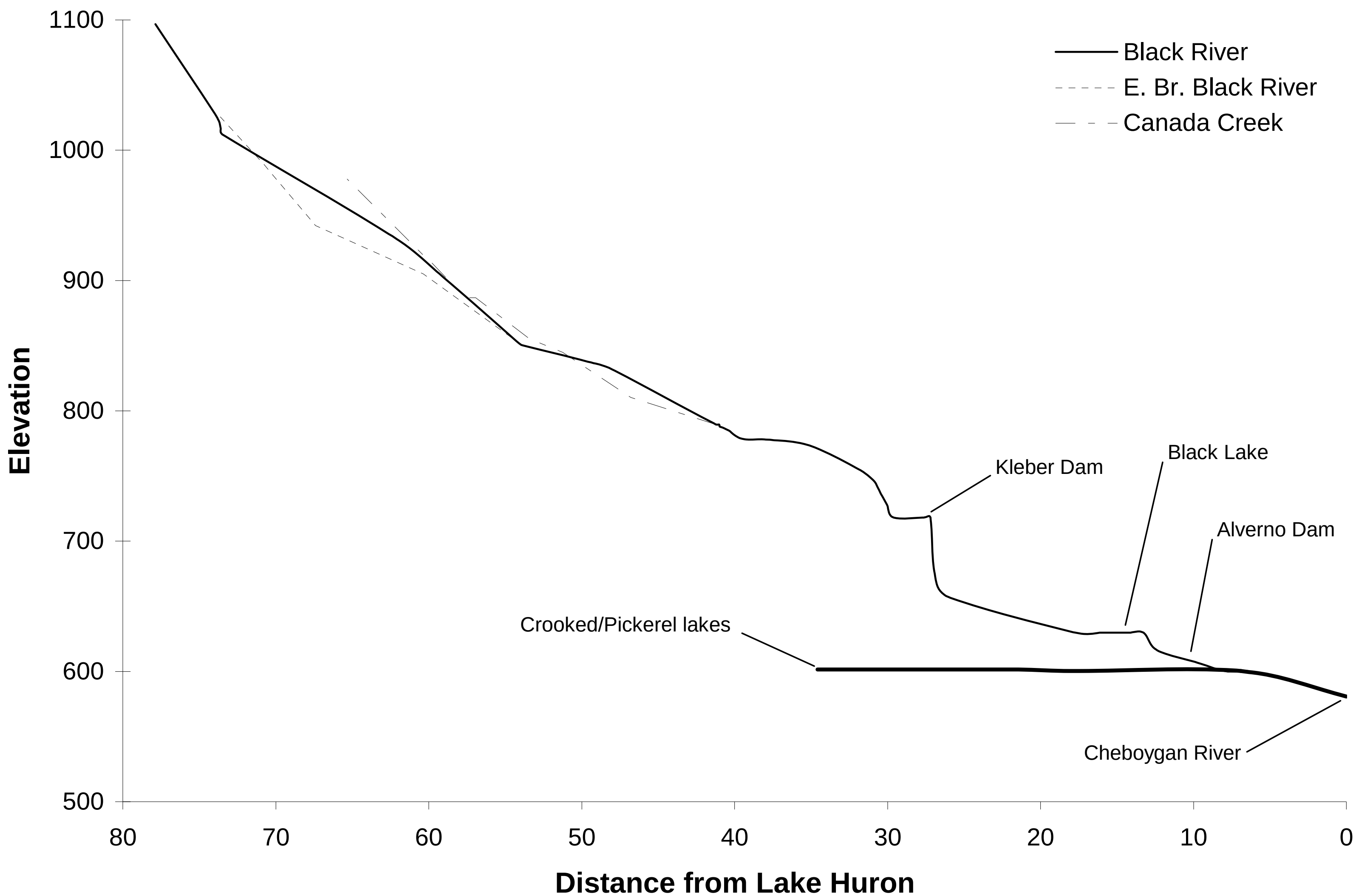

Figure 28.–Approximate elevation (feet above sea level) and distance from Lake Huron (river miles) of the Black River and other water bodies in the Cheboygan River watershed.

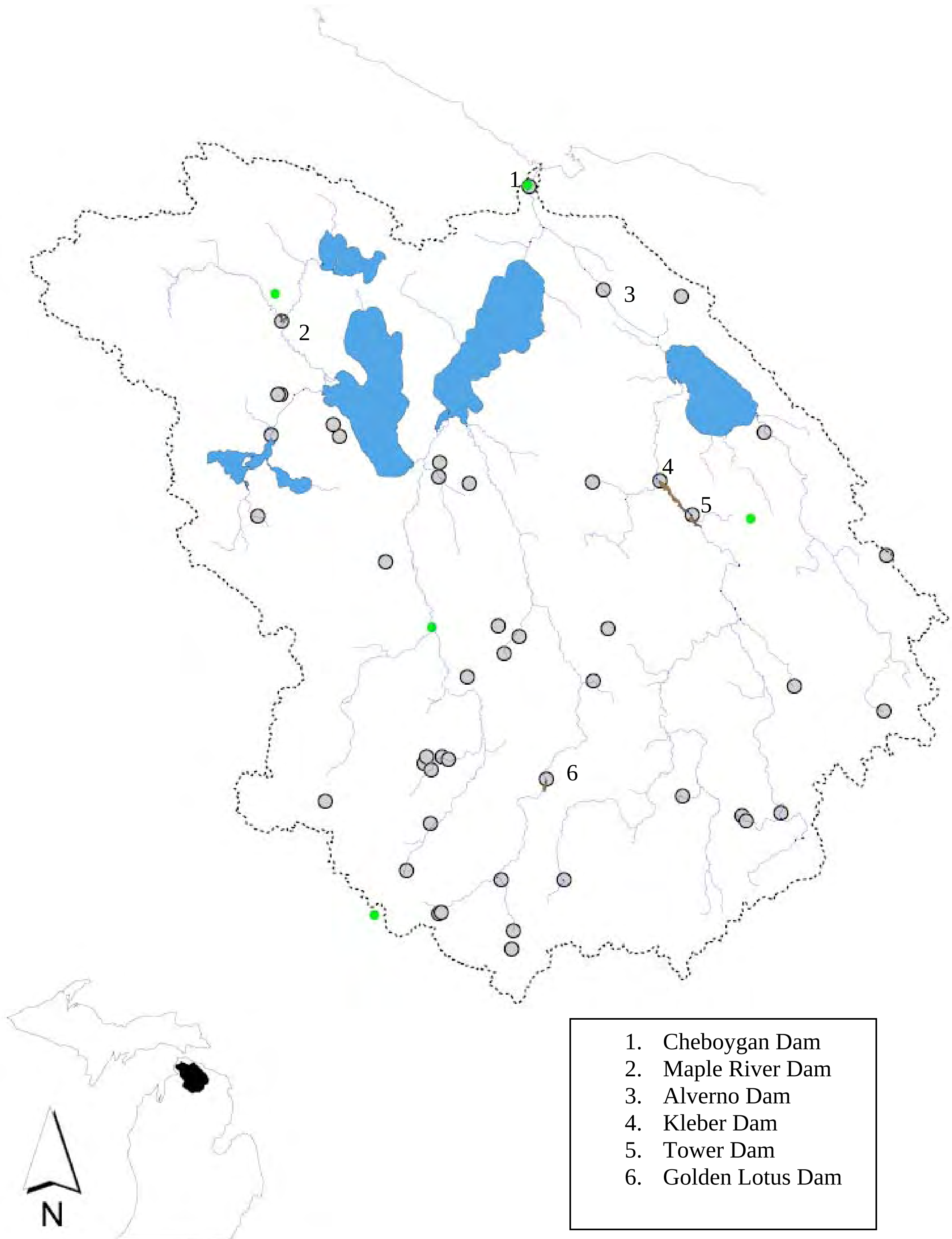

Figure 29.–Locations of dams in the Cheboygan River watershed. Principal dams are labeled numerically (Michigan Department of Environmental Quality, Land and Water Management Division, unpublished data).

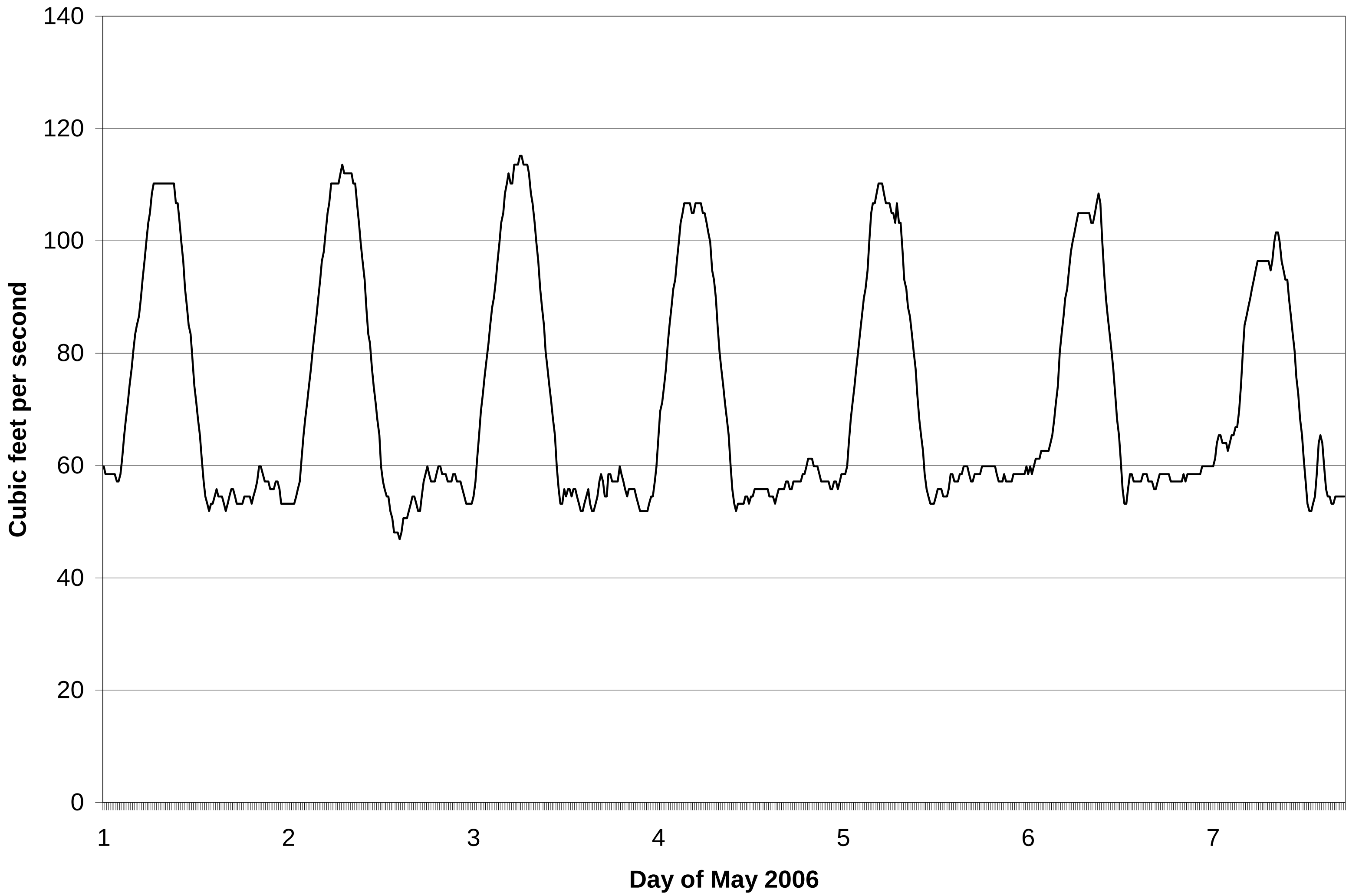

Figure 30.–Pigeon River flows at Sturgeon Valley Road, May 1–7, 2006.

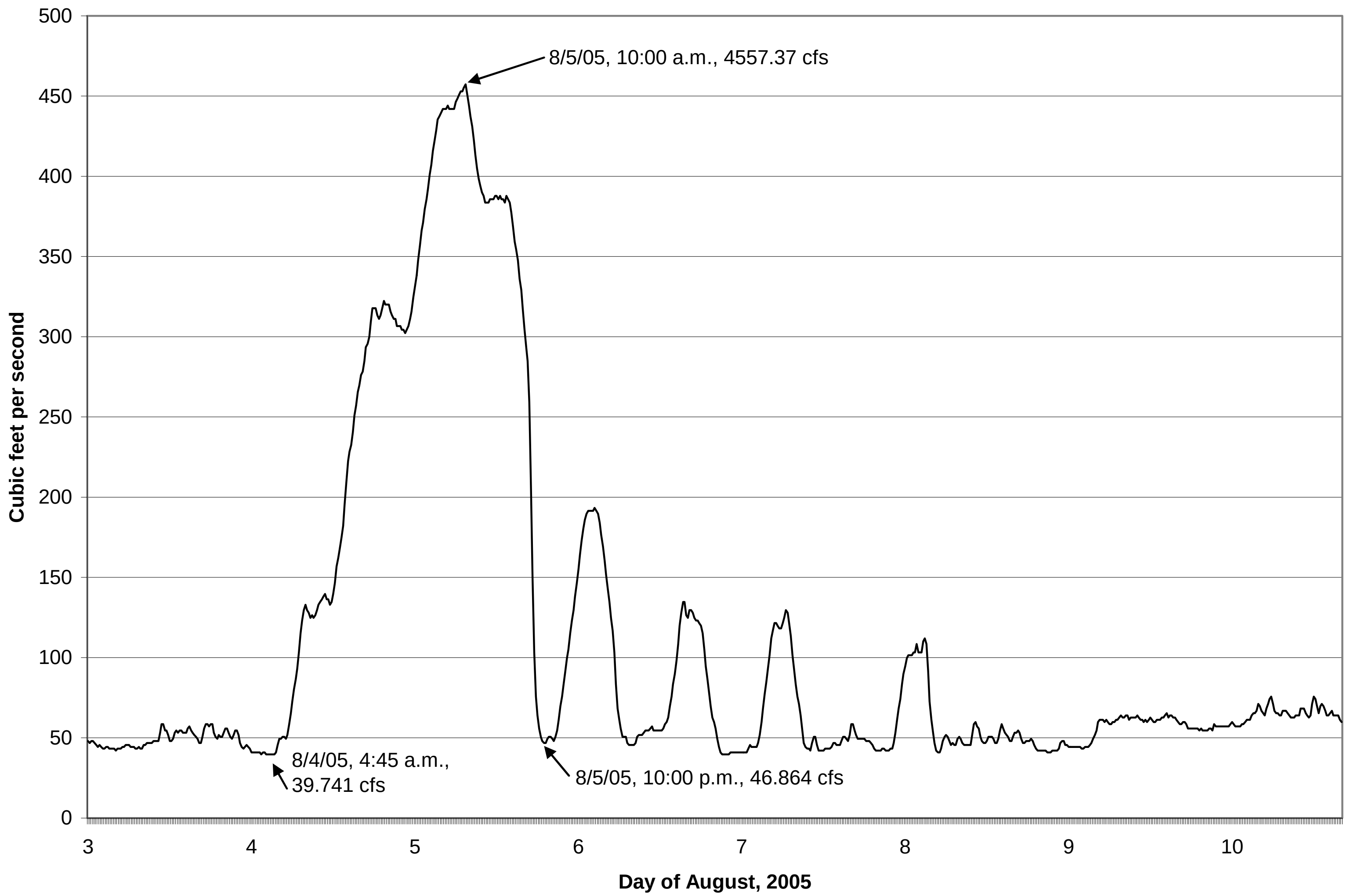

Figure 31.–Pigeon River flows at Sturgeon Valley Road, August 3-10, 2005 (USGS unpublished data).

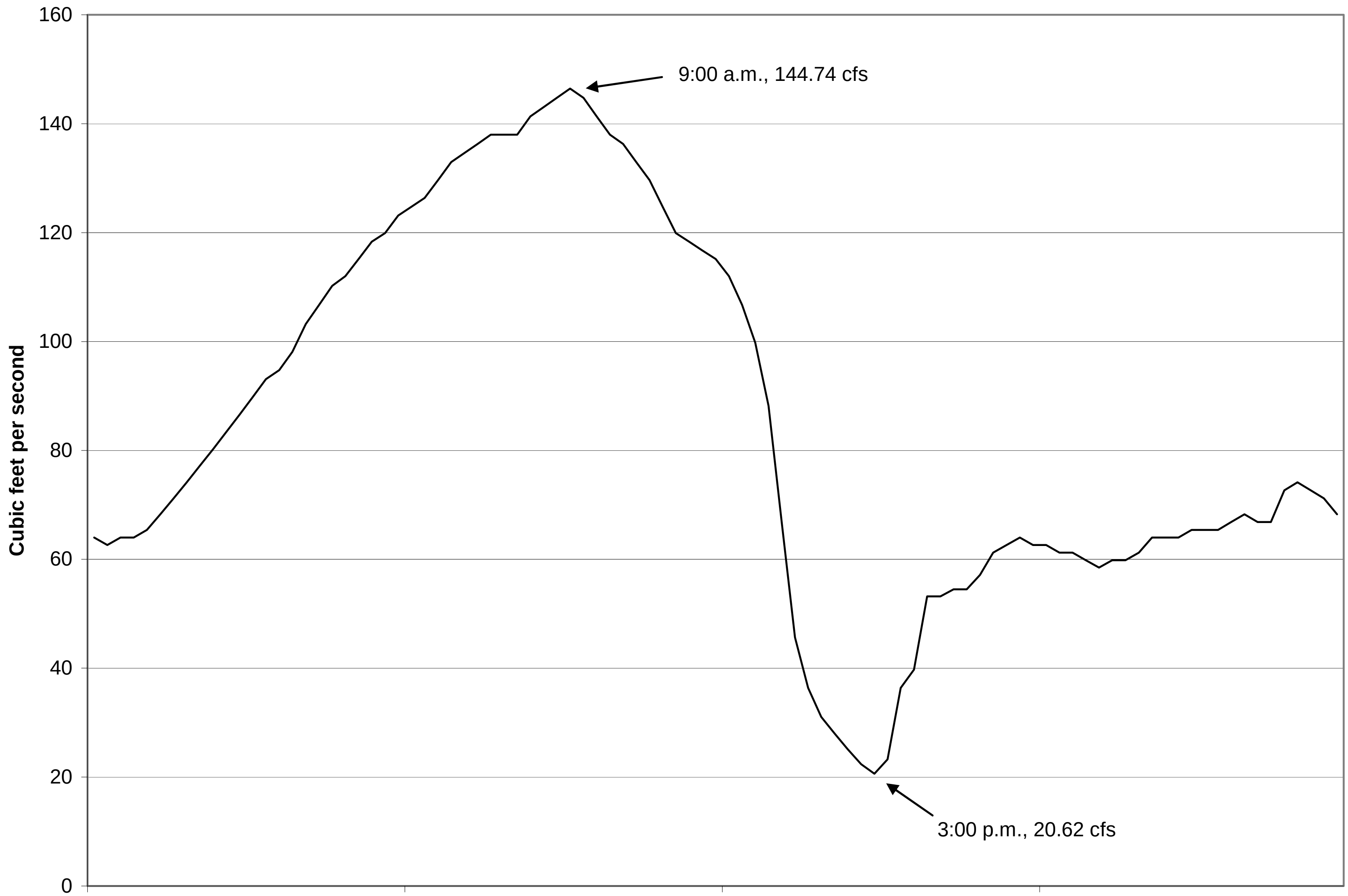

Figure 32.–Pigeon River flows at Sturgeon Valley Road on May 17, 2006 (USGS unpublished data).

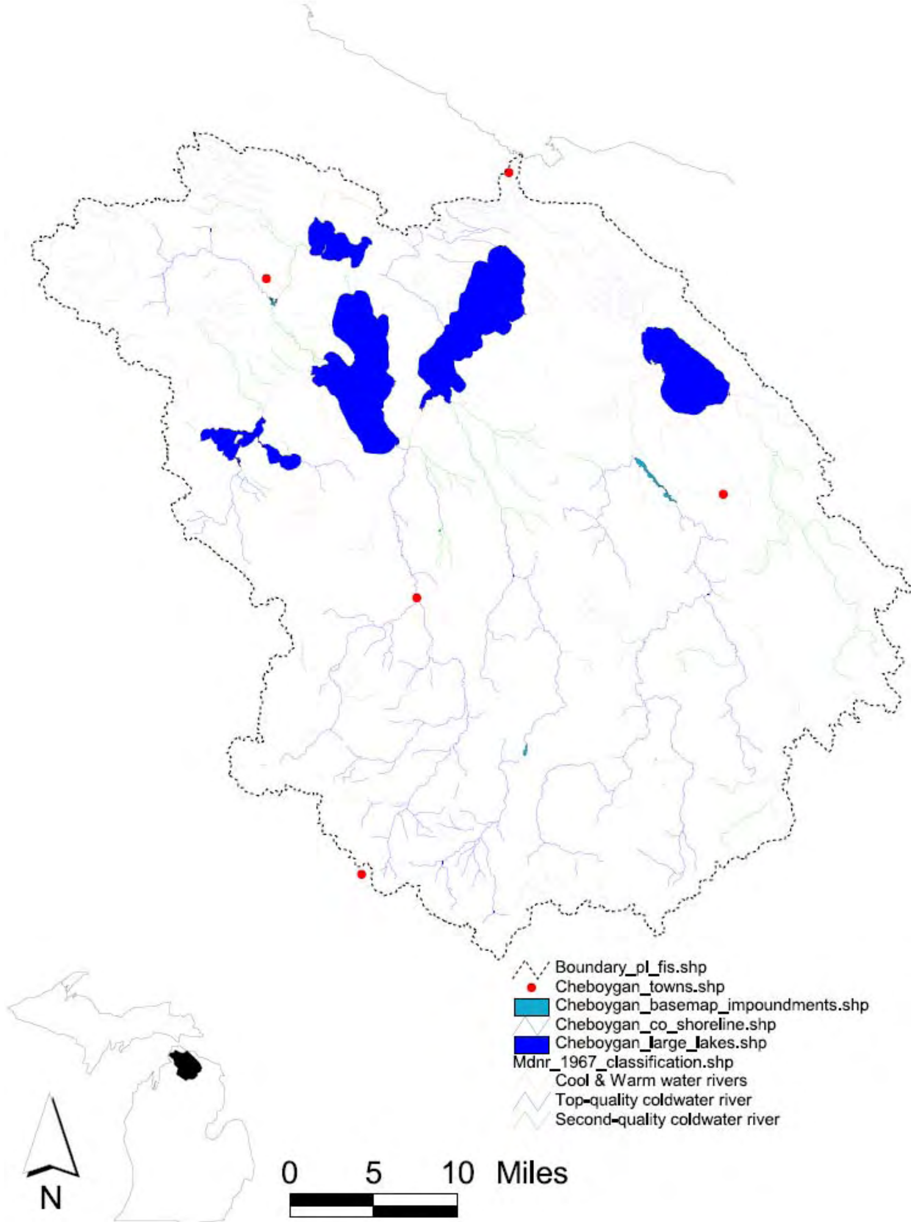

Figure 33.–MDNR 1967 stream classification.

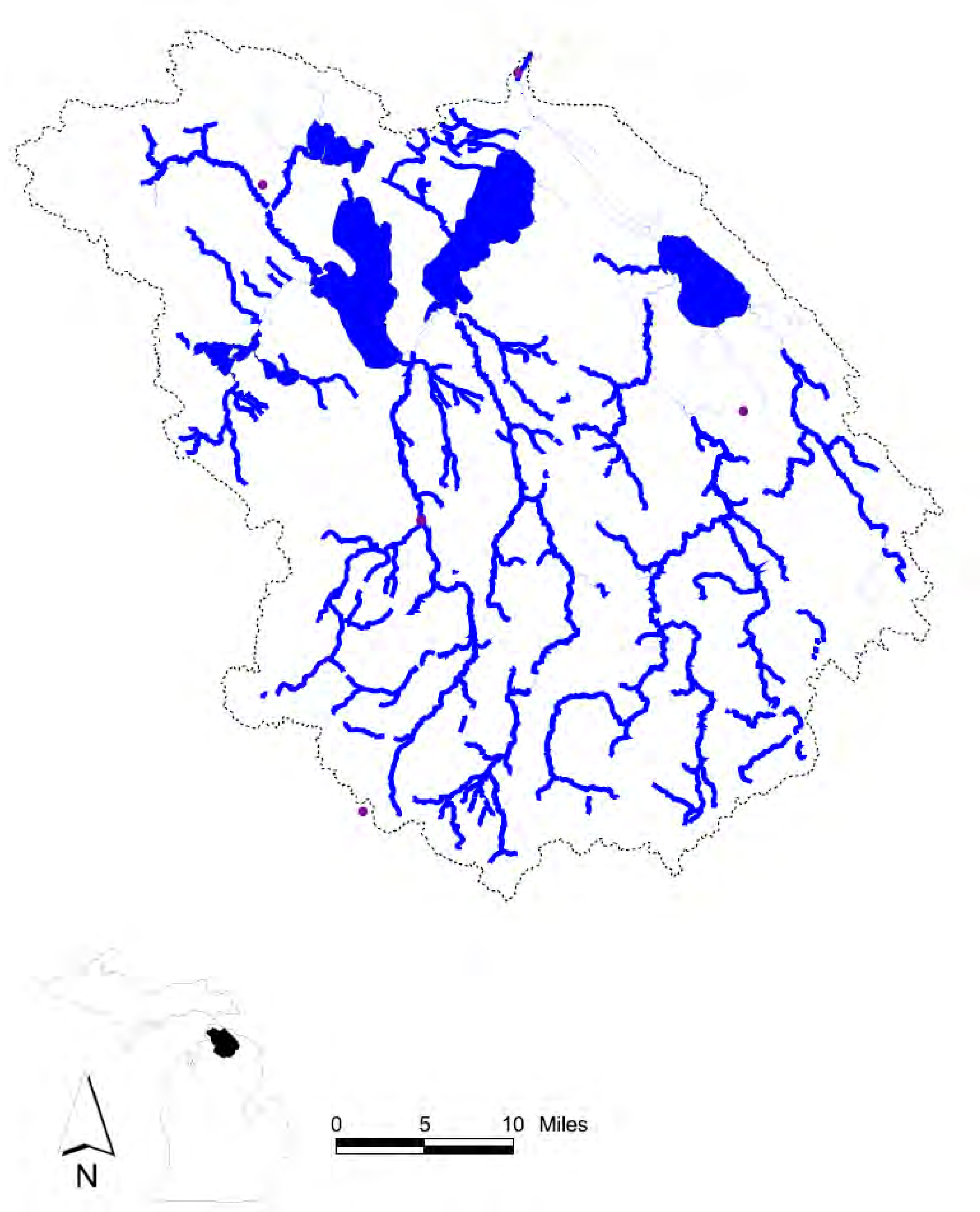

Figure 35.–Designated trout streams (bold in the above figure) of the Cheboygan River watershed. Designations are listed in Michigan Department of Natural Resources-DFI 101, designated trout streams. Map is from Michigan Department of Natural Resources Digital Water Atlas.

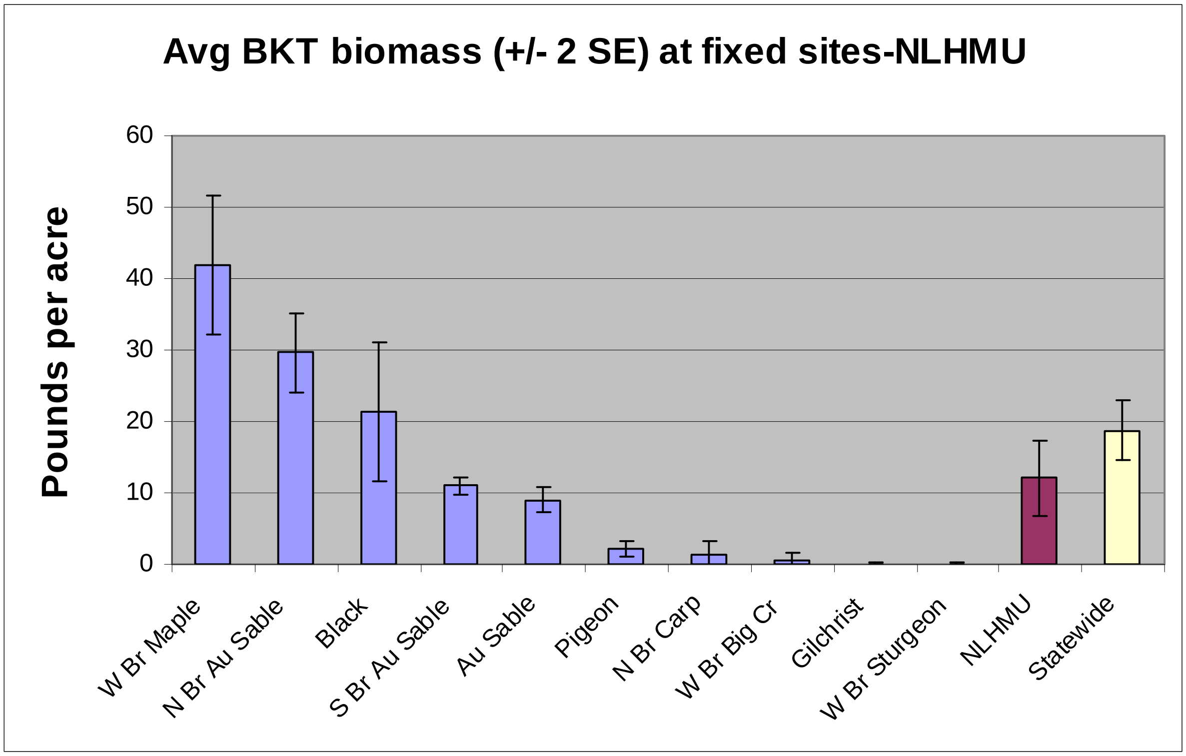

Figure 36.–Average brook trout biomass at fixed sites within Northern Lake Huron Management Unit (MDNR Fisheries Division, unpublished information).

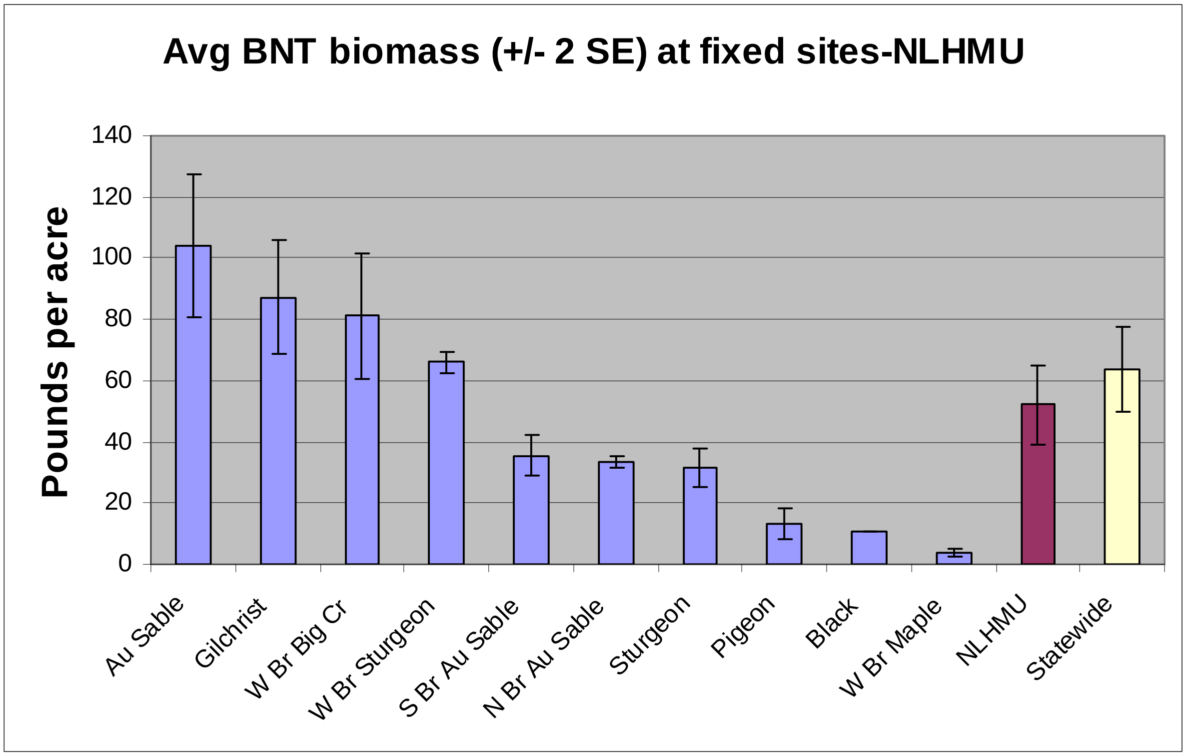

Figure 37.–Average brown trout biomass at fixed sites within Northern Lake Huron Management Unit (MDNR Fisheries Division, unpublished information).

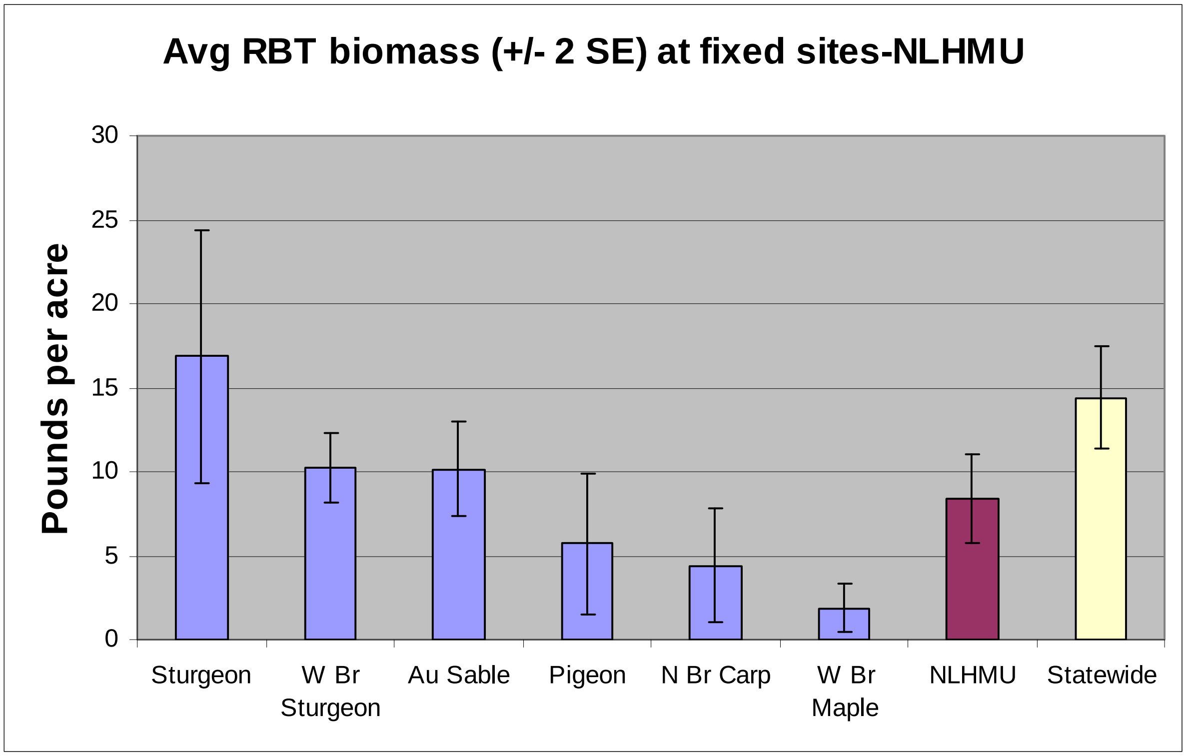

Figure 38.–Average rainbow trout biomass at fixed sites within the Northern Lake Huron Management Unit (Fisheries Division, unpublished information).

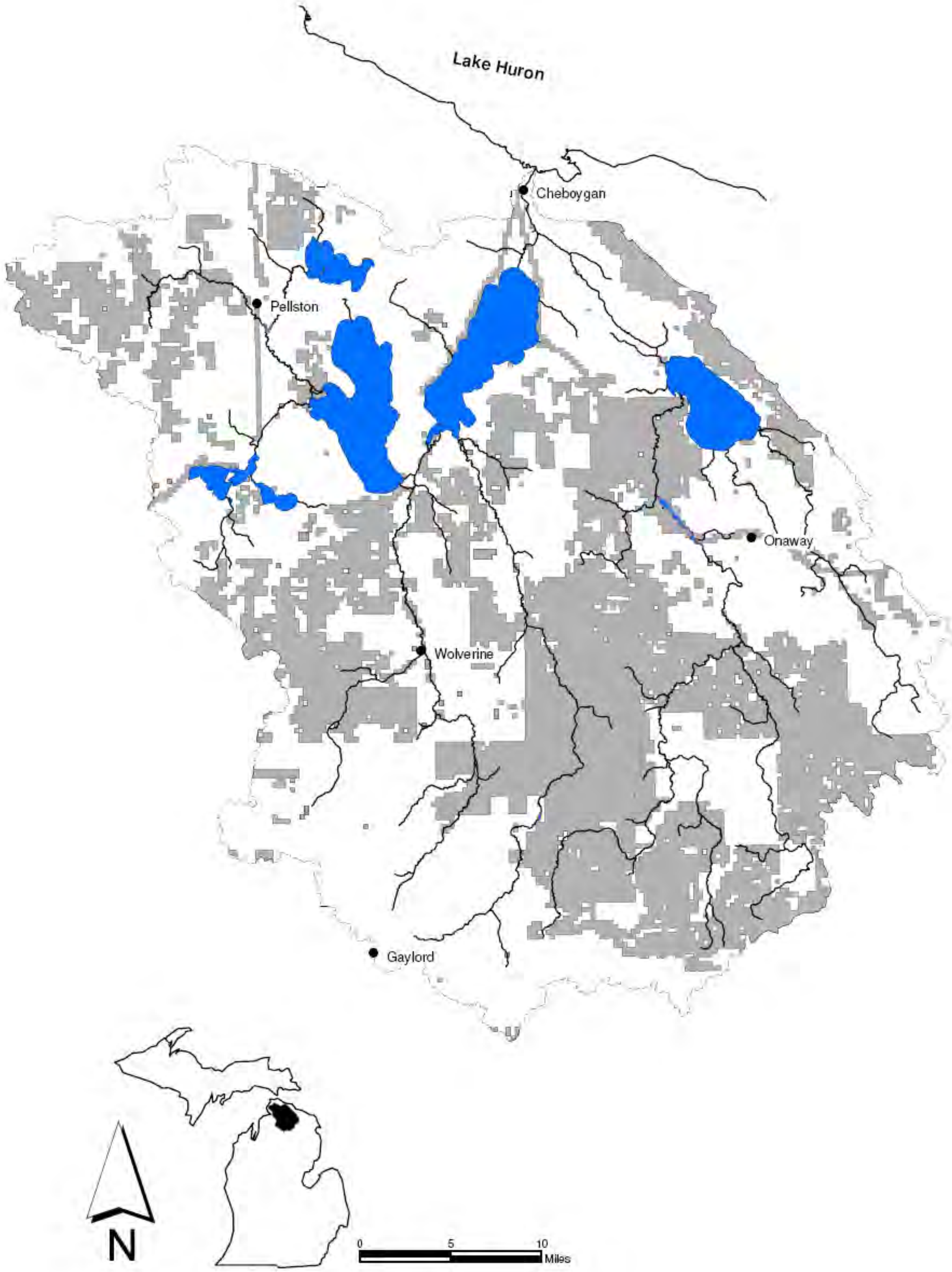

Figure 39.–Public land in the Cheboygan River watershed.

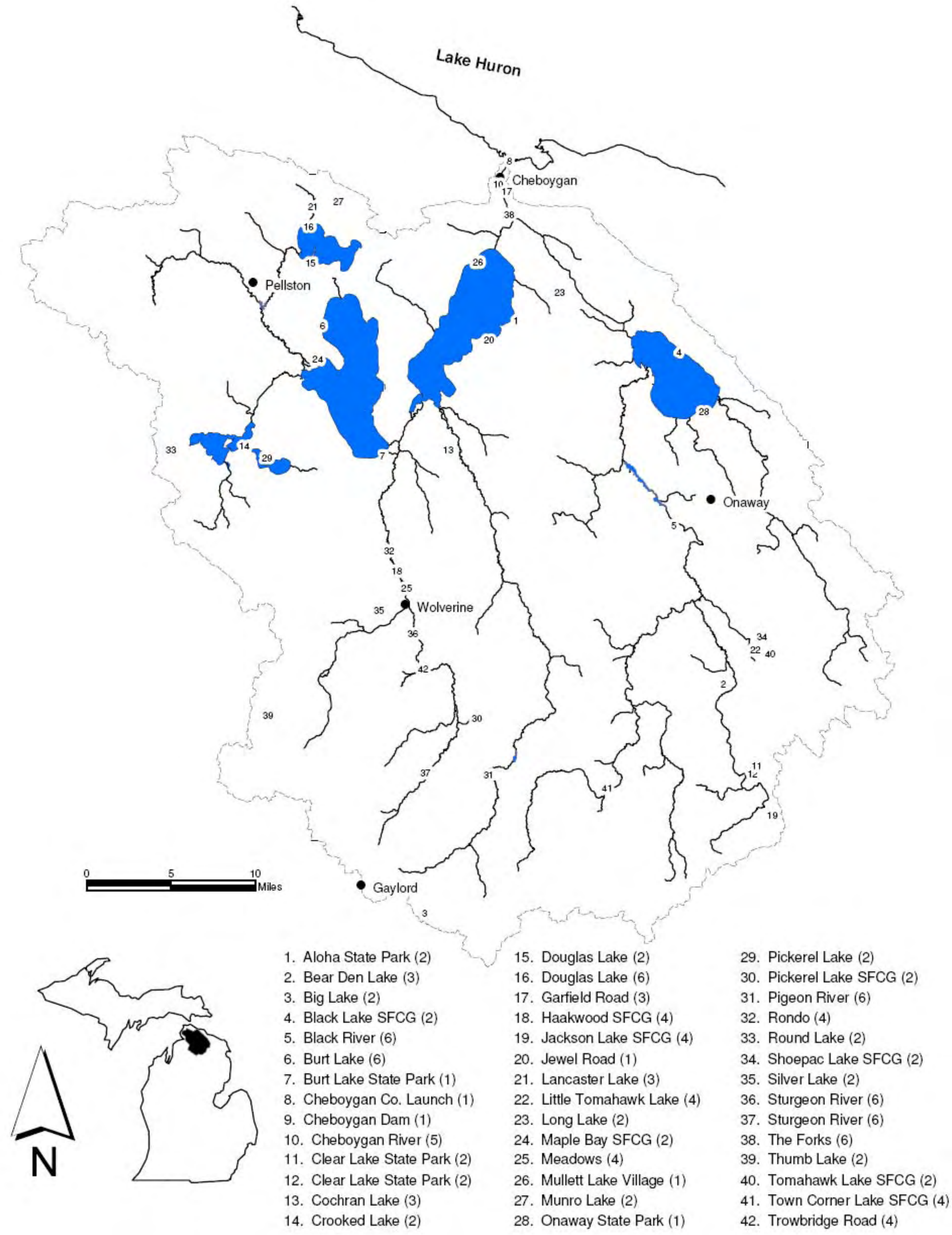

Figure 40.–Designated public access sites in the Cheboygan River watershed. Ramp description codes (in parentheses) include signed, hard-surface ramps which accommodate all trailerable watercraft (1), hard-surfaced ramps where launching large watercraft may be difficult (2), gravel ramps for medium to small-sized watercraft (3), carry-down launching areas (4); signed, shore-fishing access (5); and unsigned, undeveloped sites (6). SFCG = State Forest Campground.

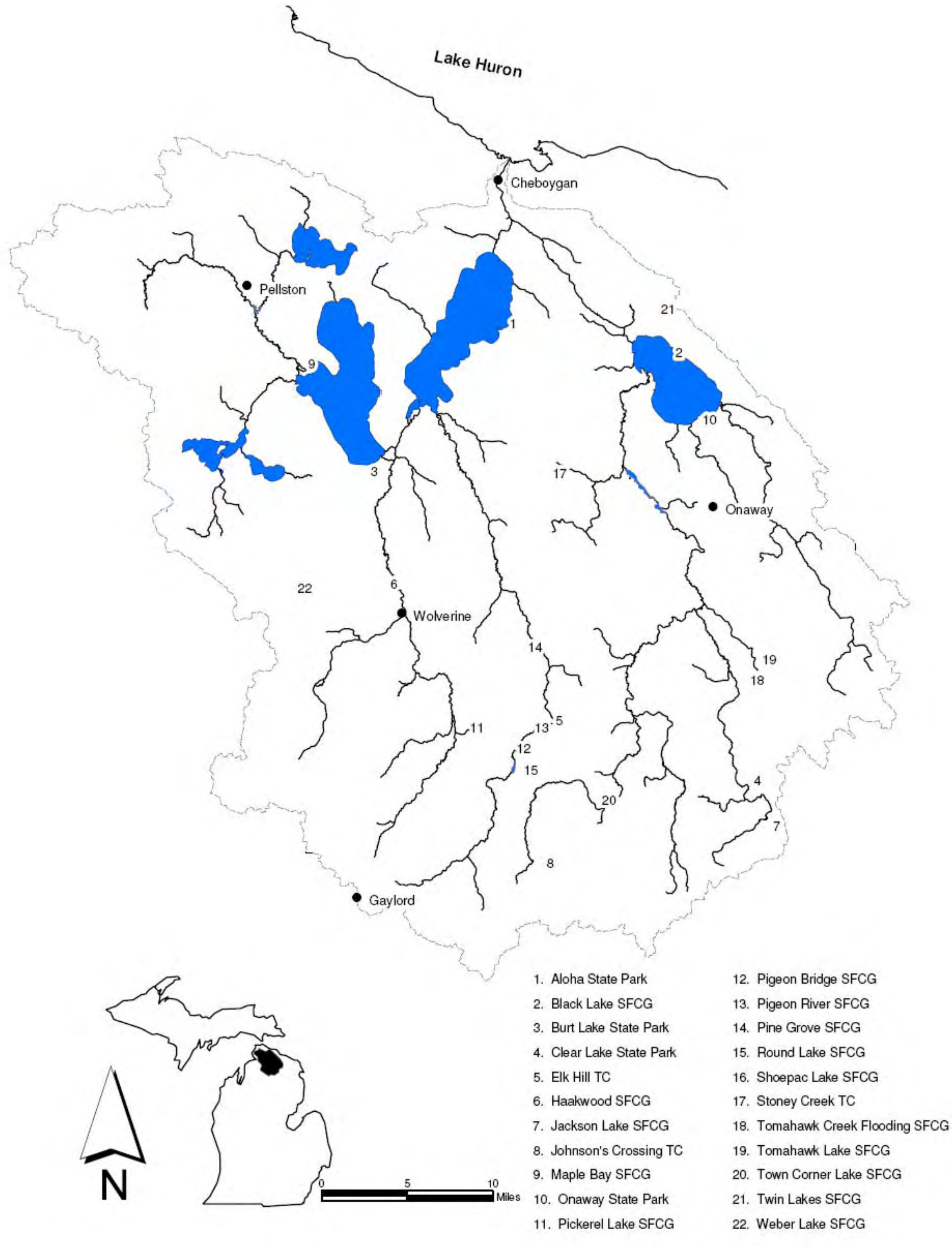

Figure 41.–State parks and state forest campgrounds in the Cheboygan River watershed. SFCG = state forest campground; TC = trail camp.

TABLES

Table 1.–Inventory of major tributaries and lakes associated with the various Cheboygan River watershed segments. Tributaries are indented to show the stream they flow into.

Segment	Stream–tributary
West Branch Maple River – Headwaters to Maple River Dam	Brush Creek
	Cold Creek
East Branch Maple River – Headwaters to Maple River Dam	Douglas Lake
	Beavertail Creek
	Lancaster Creek
	Van Creek
Maple River – Maple River Dam to Burt Lake	
Sturgeon River – Headwaters to confluence with West Branch Sturgeon River	Mossback Creek
	Pickerel Creek
	Club Stream
	Stewart Creek
	Blackjack Creek
West Brach Sturgeon River	Marl Creek
Sturgeon River – Confluence with West Branch Sturgeon River to Burt Lake	Beebe Creek
Burt Lake	Crooked River
	Crooked Lake
	Minnehaha Creek
	West Branch Minnehaha Creek
	Silver Creek
	Pickerel Lake
	Berry Creek
	Cedar Creek
	McPhee Creek
	Little Carp River
Pigeon River – Headwaters to Lansing Club Pond Dam	South Branch Pigeon River
Pigeon River – Lansing Club Pond Dam to confluence with Little Pigeon River	Cornwall Creek
	Grindstone Creek
	Nelson Creek
Pigeon River – Confluence with Little Pigeon River to Mullett Lake	Little Pigeon River
	Wilkes Creek
Mullett Lake	Indian River
	Little Sturgeon River
	Crumley Creek
	Little Pigeon River
	Kimberly Creek
	Middle Branch Little Pigeon River
	North Branch Little Pigeon River
	Mullett Creek
	Ballard Creek

Table 1.–Continued.

Segment	Stream–tributary
Black River – Headwaters to Clark Bridge Road	Saunders Creek
	Tubbs Creek
	Hardwood Creek
	Stewart Creek
	Little McMasters Creek
	East Branch Black River
East Branch Black River	Rattlesnake Creek
Black River – Clark Bridge Road to Kleber Dam	McMasters Creek
	Canada Creek
	Tomahawk Creek
	Gregg Creek
	Bowen Creek
	Welch Creek
Canada Creek	Packer Creek
	Van Hetton Creek
	Montague Creek
	Oxbow Creek
Black River – Kleber Pond Dam to Black Lake	Milligan Creek
	Adair Creek
	Gokee Creek
Black Lake	Stewart Creek
	Stony Creek
	Rainy River
	West Branch Rainy River
	Healy Creek
	Little Rainy River
	East Branch Rainy River
	Cold Creek
	Mud Creek
Lower Black River	Long Lake Outlet
	Owens Creek
	Myers Creek
Cheboygan River	Laperell Creek
	Terry Creek
	Lower Black River

Table 2.–Inventory of lakes 10 acres or larger in the Cheboygan River watershed. Lakes are organized by river valley segment.

Segment	Lake	County	Latitude	Longitude	Acreage
West Branch Maple River – Headwaters to Maple River Dam					
	Kathleen Lake	Emmet	45.5300	-84.7752	45
	Larks Lake	Emmet	45.6047	-84.9298	592
East Branch Maple River – Headwaters to Maple River Dam					
	Arnott Lake	Emmet	45.6261	-84.7751	23
	Douglas Lake	Cheboygan	45.5811	-84.6970	3,727
	Galloway Lake	Emmet	45.6526	-84.7779	20
	Lancaster Lake	Cheboygan	45.6219	-84.7079	51
	Munro Lake	Cheboygan	45.6147	-84.6829	515
	Sherett Lake	Emmet	45.6367	-84.7695	14
	Vincent Lake	Cheboygan	45.6030	-84.6945	30
Sturgeon River – Headwaters to confluence with West Branch Sturgeon River					
	Clifford Lake	Otsego	45.0283	-84.6359	11
	Lance Lake	Cheboygan	45.2294	-84.5687	25
	Murner Lake	Otsego	45.0732	-84.7175	14
	Olund Lake	Otsego	45.0844	-84.7182	24
	Pickerel Lake	Otsego	45.1767	-84.5223	43
	Wildwood Lake	Cheboygan	45.2320	-84.5571	227
	unnamed lake	Cheboygan	45.2528	-84.5679	10
	unnamed lake	Otsego	45.1644	-84.6140	44
West Branch Sturgeon River					
	Barhite Lake	Cheboygan	45.2644	-84.6598	11
	Berry Lake	Otsego	45.1236	-84.7323	19
	Booth Lake	Charlevoix	45.1991	-84.7354	17
	Bows Lake	Charlevoix	45.1503	-84.7790	48
	Eighteen Lake	Otsego	45.1633	-84.7262	21
	Fleming Lake	Otsego	45.1780	-84.6837	11
	Heart Lake	Charlevoix	45.1364	-84.8176	10
	Hoffman Lake	Charlevoix	45.1319	-84.7804	119
	Kidney Lake	Charlevoix	45.1314	-84.7957	11
	Silver Lake	Cheboygan	45.2694	-84.6329	68
	Standard Lake	Charlevoix	45.1991	-84.7354	15
	Thumb Lake	Charlevoix	45.1917	-84.7626	511
	Weber Lake	Cheboygan	45.2980	-84.7243	28
	Woodin Lake	Otsego	45.1325	-84.7284	29
Burt Lake					
	Burt Lake	Cheboygan	45.4667	-84.6668	17,395
	Crooked Lake	Emmet	45.4108	-84.8259	2,352
	Pickerel Lake	Emmet	45.3967	-84.7684	1,082
	Round Lake	Emmet	45.4069	-84.8893	353

Table 2.–Continued.

Segment	Lake	County	Latitude	Longitude	Acreage
Pigeon River – Headwaters to Lansing Club Pond Dam					
	Big Lake	Otsego	45.0083	-84.5848	124
	Denny Lake	Otsego	44.9939	-84.4823	19
	Fifteen Lake	Otsego	45.0789	-84.5384	15
	Ginsell Lake	Otsego	44.9919	-84.4973	11
	Lansing Club Pond	Otsego	45.1455	-84.4732	51
	Lewis Lake	Otsego	44.9836	-84.4976	74
	Oley Lake	Otsego	44.9989	-84.5740	23
Pigeon River – Lansing Club Pond Dam to confluence with Little Pigeon River					
	Cornwall Creek				161
	Flooding	Cheboygan	45.2273	-84.4140	
	Grass Lake	Otsego	45.1936	-84.4576	29
Pigeon River – Confluence with Little Pigeon River to Mullett Lake					
	Echo Lake	Cheboygan	45.2501	-84.5197	27
	Hackett Lake	Cheboygan	45.2475	-84.4998	32
	Mud Lake	Otsego	45.1925	-84.4965	12
	Unnamed lake	Cheboygan	45.2641	-84.5018	17
	Sixteen Lake	Cheboygan	45.5936	-84.3254	10
Mullett Lake					
	Cochran Lake	Cheboygan	45.4067	-84.5512	29
	Devereaux Lake	Cheboygan	45.4853	-84.4573	36
	Marina Lake	Cheboygan	45.4333	-84.6015	23
	Mullett Lake	Cheboygan	45.4361	-84.5168	16,704
	Roberts Lake	Cheboygan	45.4014	-84.5565	68
	Silver Lake	Cheboygan	45.4330	-84.4859	77
Black River – Headwaters to Clark Bridge Road					
	Blue Lake North	Montmorency	45.1517	-84.3607	18
	Blue Lake South	Montmorency	45.1480	-84.3611	18
	Hardwood Lake	Otsego	45.1703	-84.4012	47
	Nineteen Lake	Otsego	45.0664	-84.4809	25
	Town Corner Lake	Montmorency	45.1142	-84.3657	15
	Walled Lake	Montmorency	45.1222	-84.3626	42
East Branch Black River					
	Foch Lakes	Montmorency	45.1300	-84.3176	59
Black River – Clark Bridge Road to Kleber Pond Dam					
	Dog Lake	Cheboygan	45.2839	-84.3987	192
	Dollar Lake	Montmorency	45.1928	-84.3176	10
	Francis Lake	Presque Isle	45.2405	-84.1834	40
	Kleber Pond	Cheboygan	45.3905	-84.3320	257
	Little Tomahawk Lake	Presque Isle	45.2319	-84.1807	23

Table 2.–Continued.

Segment	Lake	County	Latitude	Longitude	Acreage
	Long Lake	Presque Isle	45.2330	-84.2032	14
	Shoepac Lake	Presque Isle	45.2444	-84.1745	53
	Silver Lake	Cheboygan	45.2047	-84.3173	146
	Tomahawk Creek Flooding	Presque Isle	45.2168	-84.1790	574
	Tomahawk Lake	Presque Isle	45.2292	-84.1673	42
	Tower Pond	Cheboygan	45.3620	-84.2957	65
	Twin Tomahawk Lakes	Montmorency	45.1693	-84.1425	42
	unnamed lake	Montmorency	45.1827	-84.1267	15
	unnamed lake	Montmorency	45.1795	-84.1223	19
Canada Creek					
	Bear Lake	Montmorency	45.0711	-84.1909	12
	Bear Den Lake	Presque Isle	45.2036	-84.2212	30
	Clear Lake	Montmorency	45.1219	-84.1793	138
	Doty Lake	Montmorency	45.1086	-84.2419	24
	East Town Corner Lake	Montmorency	45.1133	-84.2493	17
	Geneva Lake	Montmorency	45.1800	-84.2154	92
	Jackson Lake	Montmorency	45.0867	-84.1607	30
	Little Joe Lake	Montmorency	45.1936	-84.2237	12
	Muskellunge Lake	Montmorency	45.1058	-84.1923	126
	Pug Lakes	Montmorency	45.1033	-84.2065	21
	unnamed lake	Montmorency	45.0914	-84.1916	17
	Valentine Lake	Montmorency	45.0917	-84.1782	310
	Virginia Lake	Montmorency	45.1680	-84.2107	16
	West Town Corner Lake	Montmorency	45.1142	-84.2568	10
	Wildfowl Lake	Montmorency	45.1853	-84.2065	35
Black River – Kleber Pond Dam to Black Lake					
	Duby Lake	Cheboygan	45.2755	-84.3470	68
	Lost Lake	Cheboygan	45.3100	-84.4082	16
	McLavey Lake	Cheboygan	45.2861	-84.3554	24
	Osmun Lake	Cheboygan	45.3247	-84.3890	48
	Stony Creek Flooding	Cheboygan	45.3913	-84.4121	41
Black Lake					
	Black Lake	Cheboygan/ Presque Isle	45.4667	-84.2668	10,114
	Burgess Lake	Presque Isle	45.2495	-84.0880	15
	Gorman Lakes	Presque Isle	45.2867	-84.0223	38
	Hackett Lake	Presque Isle	45.2860	-84.1730	15
	Healy Lake	Presque Isle	45.2286	-84.0387	25
	Little Tomahawk Lake	Montmorency	45.1844	-84.0615	104

Table 2.–Continued.

Segment	Lake	County	Latitude	Longitude	Acreage
	Loon Lake	Presque Isle	45.2583	-84.1690	55
	McAvoy Lake	Presque Isle	45.2483	-84.0951	11
	Mud Lake	Cheboygan	45.4914	-84.3307	39
	Mud Lake	Cheboygan	45.4483	-84.3051	12
	Rainy Lake	Presque Isle	45.2494	-84.0684	202
	Upper Tomahawk Lake	Montmorency	45.1800	-84.0815	39
Lower Black River					
	Long Lake	Cheboygan	45.5347	-84.3987	379
	Twin Lakes North	Cheboygan	45.5375	-84.2873	181
	Twin Lake South	Cheboygan	45.5322	-84.2813	10

Table 3.–Surficial geology composition of valley segment catchments in the Cheboygan River watershed.

Segment	LABEL	Area (mi^2) by surficial geology type in each catchment	% type by catchment
A	Coarse-textured glacial till	43.4	45.1
A	Glacial outwash sand and gravel and postglacial alluvium	30.5	31.6
A	Lacustrine sand and gravel	10.7	11.1
A	Peat and muck	10.7	11.1
A	Water	1.0	1.0
B	Coarse-textured glacial till	28.5	45.5
B	Glacial outwash sand and gravel and postglacial alluvium	2.1	3.4
B	Lacustrine sand and gravel	11.6	18.5
B	Peat and muck	14.9	23.7
B	Water	5.6	9.0
C	Coarse-textured glacial till	0.8	8.5
C	Dune sand	0.2	2.7
C	Glacial outwash sand and gravel and postglacial alluvium	0.6	6.7
C	Lacustrine sand and gravel	7.5	82.1
C	Water	0.0	0.0
D	Coarse-textured glacial till	37.3	37.3
D	Dune sand	0.5	0.5
D	End moraines of coarse-textured till	24.2	24.2
D	Glacial outwash sand and gravel and postglacial alluvium	37.9	38.0
E	Coarse-textured glacial till	12.1	13.7
E	End moraines of coarse-textured till	44.9	50.6
E	Glacial outwash sand and gravel and postglacial alluvium	16.9	19.0
E	Ice-contact outwash sand and gravel	14.8	16.7
F	Coarse-textured glacial till	0.0	0.2
F	Dune sand	1.1	5.1
F	Glacial outwash sand and gravel and postglacial alluvium	5.3	25.1
F	Ice-contact outwash sand and gravel	11.1	52.7
F	Lacustrine sand and gravel	3.6	17.0
G	Coarse-textured glacial till	40.4	20.0
G	Dune sand	7.6	3.8
G	Glacial outwash sand and gravel and postglacial alluvium	19.0	9.4
G	Ice-contact outwash sand and gravel	36.2	17.9
G	Lacustrine sand and gravel	69.7	34.5

Table 3.–Continued.

Reach	LABEL	Area (mi^2) by surficial geology type in each catchment	% type by catchment
G	Peat and muck	0.0	0.0
G	Water	29.3	14.5
H	Coarse-textured glacial till	18.5	33.1
H	End moraines of coarse-textured till	7.2	12.9
H	End moraines of medium-textured till	13.6	24.3
H	Glacial outwash sand and gravel and postglacial alluvium	16.5	29.5
H	Water	0.2	0.3
I	Coarse-textured glacial till	34.1	49.9
I	Glacial outwash sand and gravel and postglacial alluvium	30.4	44.6
I	Ice-contact outwash sand and gravel	3.7	5.5
J	Coarse-textured glacial till	15.4	62.8
J	Dune sand	0.0	0.0
J	Glacial outwash sand and gravel and postglacial alluvium	0.0	0.0
J	Ice-contact outwash sand and gravel	4.4	17.8
J	Lacustrine sand and gravel	4.8	19.4
K	Coarse-textured glacial till	27.4	18.9
K	Dune sand	10.1	6.9
K	Glacial outwash sand and gravel and postglacial alluvium	1.1	0.8
K	Ice-contact outwash sand and gravel	21.3	14.6
K	Lacustrine sand and gravel	62.5	42.9
K	Peat and muck	0.0	0.0
K	Water	23.1	15.9
L	Coarse-textured glacial till	22.0	26.3
L	End moraines of medium-textured till	13.7	16.4
L	Glacial outwash sand and gravel and postglacial alluvium	48.1	57.4
M	Coarse-textured glacial till	14.7	29.0
M	End moraines of medium-textured till	12.3	24.4
M	Glacial outwash sand and gravel and postglacial alluvium	23.5	46.6
N	Coarse-textured glacial till	72.5	79.2
N	Dune sand	1.2	1.3
N	Glacial outwash sand and gravel and postglacial alluvium	17.9	19.5
O	Coarse-textured glacial till	25.1	37.5
O	Glacial outwash sand and gravel and postglacial alluvium	42.0	62.5

Table 3.–Continued.

Reach	LABEL	Area (mi^2) by surficial geology type in each catchment	% type by catchment
P	Coarse-textured glacial till	35.5	53.3
P	Dune sand	1.5	2.2
P	Glacial outwash sand and gravel and postglacial alluvium	19.1	28.6
P	Ice-contact outwash sand and gravel	5.7	8.6
P	Lacustrine sand and gravel	4.8	7.2
P	Water	0.0	0.1
Q	Coarse-textured glacial till	127.6	65.3
Q	Dune sand	5.1	2.6
Q	Glacial outwash sand and gravel and postglacial alluvium	3.1	1.6
Q	Ice-contact outwash sand and gravel	10.4	5.3
Q	Lacustrine sand and gravel	34.7	17.8
Q	Water	14.3	7.3
R	Coarse-textured glacial till	12.5	27.3
R	Dune sand	2.7	5.8
R	Lacustrine sand and gravel	30.6	66.8
R	Water	0.0	0.0
S	Coarse-textured glacial till	2.1	12.0
S	Dune sand	1.2	6.8
S	Lacustrine sand and gravel	14.4	81.1

Table 4.–Monthly mean, maximum, and minimum flows in cubic feet per second (ft^3/s) from United States Geological Survey gages in the Cheboygan River watershed (United State Geological Survey 2007).

Station number (drainage area, mi^2) and location	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept
04127997 (192)												
Sturgeon River at Wolverine 1942–2006												
Mean	211	223	211	200	198	243	305	237	207	184	171	198
Maximum	326	301	306	295	275	354	431	353	272	255	301	290
Minimum	153	164	157	133	130	172	179	154	149	130	134	141
04128500 (598)												
Indian River at Indian River 1942–82												
Mean	489	540	584	586	582	586	730	757	615	502	424	435
Maximum	686	777	793	755	749	803	1,088	1,181	863	796	678	600
Minimum	318	408	422	451	382	453	379	501	360	260	277	262
04128990 (57.7)												
Pigeon River near Vanderbilt 1950–2006												
Mean	77.4	82.1	75.8	70.6	70.3	88.2	117	86.3	70.4	64.3	64.5	71.5
Maximum	112	112	105	94.9	90.1	136	164	142	94.5	106	116	120
Minimum	56.6	63.1	60.1	50.8	50.1	62.8	69.8	54.4	50.7	46.7	42.6	50
04129500 (139)												
Pigeon River at Afton (1942–81)												
Mean	123	137	126	117	114	174	260	172	131	108	95.5	114
Maximum	198	228	200	204	172	302	420	283	205	200	169	208
Minimum	81.9	85.3	90	77.5	80.2	96.5	144	93.2	80.4	59.2	64.5	76.4
04130000 (889)												
Cheboygan River near Cheboygan (1942–82)												
Mean	680	805	840	858	847	922	1,097	1,054	846	677	600	640
Maximum	1,019	1,228	1,157	1,177	1,173	1,317	1,537	1,733	1,367	1,137	977	1,009
Minimum	260	425	458	517	610	603	533	561	451	363	404	384

Table 4.–Continued.

Station number (drainage area, mi^2) and location	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept
04130500 (311)												
Black River near Tower (1942–2000)												
Mean	244	269	248	221	220	338	535	343	248	202	184	217
Maximum	459	489	409	433	398	594	882	638	405	408	351	367
Minimum	138	130	163	150	138	188	220	177	140	112	86.1	116
04131000 (79)												
Rainy River near Onaway (1942–52)												
Mean	10.2	18.2	11.5	11.4	9.2	52.2	126	41.7	17.5	8.7	1.9	3.3
Maximum	59.2	75.5	37.5	39.7	33.1	128	272	104	41.5	24.4	9	11.1
Minimum	0.5	1	2	2.7	2.3	9.3	38.2	23.2	2.7	0.8	0.2	0.2
04131500 (87.9)												
Rainy River near Ocqueoc (1952–79)												
Mean	21.3	28.6	35.2	20.2	19.2	60.5	167	80.0	30.2	20.0	11.8	14.5
Maximum	92.2	72.6	92.8	80.5	54.7	179	334	178	77.6	118	76.4	57.0
Minimum	2.0	4.1	3.0	2.5	3.6	8.8	70.7	16.9	4.3	1.5	0.7	1.1
04132000 (558)												
Black River near Cheboygan (1942–74)												
Mean	358	447	455	408	404	499	1,001	677	370	295	258	287
Maximum	898	916	791	636	671	904	1,708	1,564	722	718	734	749
Minimum	95.1	143	239	248	204	324	380	258	133	77.0	80.3	124

Table 5.–Mean annual discharge, drainage area in square miles, and exceedence flows at nine United States Geological Survey gage sites in the Cheboygan River watershed. All discharge data are presented as cubic feet per second. Sites are arranged in ascending order by gage number (United States Geological Survey 2007).

Gage site (station number)	Period of record	Drainage area	Mean annual discharge	Exceedence flows 10%	Exceedence flows 50%	Exceedence flows 90%	Ratio of 10% and 90% exceedence flow
Sturgeon River at Wolverine (04127997)	1942–2006	192	216	289	200	158	1.8
Indian River at Indian River (04128500)	1942–82	598	569	760	555	387	2.0
Pigeon River near Vanderbilt (04128990)	1950–2006	57.7	78.2	109	70	54	2.0
Pigeon River at Afton (04129500)	1942–81	139	139	215	118	82	2.6
Cheboygan River near Cheboygan (04130000)	1942–82	889	822	1,170	802	477	2.5
Black River near Tower (04130500)	1942–2000	311	272	463	228	145	3.2
Rainy River near Onaway (04131000)	1942–52	79	26	64	7	1	64.0
Rainy River near Ocqueoc (04131500)	1952–79	87.9	42	100	20	3	33.3
Black River near Cheboygan (04132000)	1942–74	558	455	853	380	128	6.7

Table 6.–July and August water temperature (°F) of the Cheboygan River watershed (MDNR, Fisheries Division, unpublished data). Data within segments are sorted in an upstream to downstream direction.

Segment number	Sub-watershed	Water body	Location	Date	Maximum	Minimum	Mean	Maximum weekly mean
1	W. Br. Maple River	W. Br. Maple River	Ralmer or Robinson Rd. West	Jul-05	84.2	64.0	74.2	79.7
				Aug-05	81.2	60.8	69.8	75.0
		Brush Creek	Van Rd.	Jul-05	77.0	54.8	68.0	71.8
				Aug-05	75.1	57.0	65.9	68.4
		W. Br. Maple River	Ely Br. Rd.	Jul-05	79.1	57.3	69.4	73.9
				Aug-05	78.4	58.7	66.6	70.6
		Cold Creek	Ely Rd.	Jul-05	80.2	60.2	70.2	74.8
				Aug-05	78.0	58.3	67.5	71.1
		W. Br. Maple River	Robinson Rd.	Jul-04	68.2	53.8	60.4	62.5
				Aug-04	68.4	51.2	58.8	61.3
2	E. Br. Maple River	E. Br. Maple River	Douglas Lake Rd.	Jul-05	84.3	61.7	73.3	78.6
				Aug-05	83.6	59.4	68.4	72.2
			C64	Jul-05	63.5	55.9	60.1	61.7
				Aug-05	63.5	57.0	60.8	61.8
3	Maple River	Maple River	Below Lake Kathleen Dam	Jul-05	72.3	61.2	65.7	68.4
				Aug-05	69.9	58.7	63.5	66.4
			Brutus Rd.	Jul-05	69.9	56.1	62.3	64.8
				Aug-05	68.7	55.3	60.2	62.6
4	Sturgeon River	Sturgeon River	Poquette Rd.	Jul-05	62.0	49.4	55.9	57.0
				Aug-05	65.2	49.1	55.6	57.9
		Mossback Creek	Nowak Rd.	Jul-05	60.9	47.5	53.7	54.9
				Aug-05	66.7	48.9	54.4	56.6
		Sturgeon River	Whitmarsh Rd.	Jul-05	68.5	51.4	60.8	62.6
				Aug-05	68.5	54.8	59.5	62.8
			Sturgeon Valley Rd.	Jul-05	65.5	53.0	60.4	62.2
				Aug-05	66.1	53.0	59.1	62.4
		Pickerel Creek	Near mouth	Jul-05	68.6	50.4	60.3	62.0
				Aug-05	68.9	52.7	60.2	62.4

Table 6.–Continued.

Segment number	Sub-watershed	Water body	Location	Date	Maximum	Minimum	Mean	Maximum weekly mean
		Club Creek	Sturgeon Valley Rd.	Jul-05	57.8	47.7	53.5	54.3
				Aug-05	63.2	49.7	55.0	57.5
			Fontinalis Rd.	Jul-05	74.6	57.4	67.0	69.7
				Aug-05	74.9	56.9	64.8	68.9
		Sturgeon River	Trowbridge Rd.	Jul-05	73.1	54.6	64.1	66.7
				Aug-05	73.5	54.0	62.0	65.8
		Blackjack Creek	Shire Rd.	Jul-05	54.4	48.2	50.8	51.7
				Aug-05	62.5	51.0	52.7	53.1
		Stewart Creek	Near mouth	Jul-05	77.1	51.4	64.7	67.2
				Aug-05	77.5	51.7	62.3	66.6
5	W. Br. Sturgeon River	W. Br. Sturgeon River	McGregor Rd.	Jul-05	77.1	56.0	67.6	71.1
				Aug-05	76.5	55.5	65.1	69.4
			Shingle Mill Br.	Jul-05	66.7	51.7	59.8	61.9
				Aug-05	66.7	51.7	58.6	61.9
			Old 27 Br.	Jul-06	68.9	53.3	60.9	62.8
				Aug-06	69.1	50.9	58.4	63.1
6	Sturgeon River	Sturgeon River	Wolverine Rd.	Jul-05	73.1	54.3	64.3	67.0
				Aug-05	73.1	54.1	62.2	66.0
			Rondo Rd.	Jul-05	72.3	55.0	64.5	67.4
				Aug-05	72.3	54.4	62.1	66.1
			Cutover or Hutch Rd.	Jul-05	70.0	56.0	64.4	67.3
				Aug-05	70.6	55.2	62.3	66.1
7	Burt Lake	Minnehaha Creek	Newson Rd.	Jul-06	75.3	63.1	68.9	70.7
				Aug-06	75.0	61.6	68.3	71.8
		W. Br. Minnehaha Creek	South of Mitchell Rd.	Jul-03	64.0	51.8	57.9	59.4
				Aug-03	64.3	50.3	58.6	60.4
7	Burt Lake	Minnehaha Creek	Pickerel Lake Rd.	Jul-05	62.8	48.4	55.4	57.0
				Aug-05	61.9	48.7	55.0	56.6
		Berry Creek	Reams Rd.	Jul-05	62.3	48.6	55.6	57.1
				Aug-05	62.1	50.3	55.9	56.9

Table 6.–Continued.

Segment number	Sub-watershed	Water body	Location	Date	Maximum	Minimum	Mean	Maximum weekly mean
		Cedar Creek	Pickerel Lake Rd.	Jul-05	52.8	45.6	48.8	49.5
				Aug-05	52.0	46.4	48.5	49.2
8	Pigeon River	Pigeon River	Whitehouse Trail	Jul-05	66.0	50.2	58.0	59.5
				Aug-05	66.0	51.2	57.3	59.8
		S. Br. Pigeon River	Sparr Rd.	Jul-05	68.6	52.8	61.3	63.2
				Aug-05	67.3	53.3	60.3	63.2
		Pigeon River	Old Vanderbilt Rd.	Jul-06	71.5	54.2	63.5	66.1
				Aug-06	75.1	52.0	60.7	65.6
9		Pigeon River	Below Lansing Club Pond	Jul-98	78.5	58.1	67.5	71.7
				Aug-98	72.3	59.8	66.2	67.0
			Sturgeon Valley Rd.	Jul-06	80.0	52.7	66.5	68.6
				Aug-06	78.3	44.7	62.3	68.5
			Tin Br./Cornwall Rd.	Jul-05	77.8	55.2	66.8	70.2
				Aug-05	75.9	56.1	63.7	68.0
		Cornwall Creek	Cornwall Rd.	Jul-05	71.9	52.4	62.4	65.5
				Aug-05	71.9	57.2	64.9	67.3
		Pigeon River	Webb Rd.	Jul-05	77.8	56.1	68.0	71.9
				Aug-05	76.6	51.1	64.3	69.0
		McIntosh Creek	Montgomery Rd.	Jul-05	79.6	61.7	71.1	74.7
				Aug-05	77.1	58.9	67.9	72.0
10		Little Pigeon River	Webb Rd.	Jul-05	71.7	55.2	64.7	67.9
				Aug-05	70.2	55.5	62.5	66.0
		Wilkes Creek	Montgomery Rd.	Jul-05	79.1	51.8	65.9	70.8
				Aug-05	74.5	57.9	64.6	68.1
10	Pigeon River	Wilkes Creek Tributary	Montgomery Rd. bend	Jul-05	84.9	58.0	71.0	75.4
				Aug-05	80.0	60.3	68.7	72.3
		Pigeon River	M-68	Jul-05	79.2	59.0	70.1	74.6
				Aug-05	77.0	57.9	66.0	70.4
			Agnes Andrea Nature Preserve	Jul-03	78.0	58.2	67.6	71.0
				Aug-03	77.3	58.7	68.5	71.2

Table 6.–Continued.

Segment number	Sub-watershed	Water body	Location	Date	Maximum	Minimum	Mean	Maximum weekly mean
11	Mullett Lake	Little Sturgeon River	Afton Rd.	Jul-05	79.6	58.0	68.8	72.8
				Aug-05	78.0	57.4	65.9	70.2
		Johnson Creek	Dunham Rd. ford	Jul-05	71.6	52.1	63.0	66.4
				Aug-05	70.7	54.4	61.8	64.9
		Little Sturgeon River	M-68	Jul-05	72.0	53.0	61.7	64.8
				Aug-05	68.1	53.9	60.6	63.6
		Kimberly Creek	M-68	Aug-05	80.1	57.6	66.5	70.7
		Little Pigeon River	Ormsbee Rd.	Jul-05	82.5	56.6	69.0	73.8
				Aug-05	82.1	57.1	65.8	70.7
		N. Br. Little Pigeon River	Silver Lake Rd.	Jul-05	81.9	62.2	72.2	76.6
				Aug-05	76.8	58.8	66.9	71.3
		Little Pigeon River	near mouth at Silery Rd	Jul-05	78.5	60.7	70.0	74.7
				Aug-05	76.6	59.5	66.7	71.1
		Mullett Creek	South Extension Rd.	Jul-04	63.4	49.9	55.9	57.5
				Aug-04	61.7	46.8	54.8	56.2
			Mullett-Burt Rd.	Jul-04	78.3	55.7	67.8	69.9
				Aug-04	75.5	54.4	64.2	67.9
		Ballard Creek	M-33	Jul-04	71.4	54.7	62.3	64.3
				Aug-04	67.0	50.8	59.3	61.8
12	Black River	Black River	Johnson’s Crossing	Jul-04	68.7	50.7	59.3	61.2
				Aug-04	66.3	48.8	57.5	59.7
12	Black River	Saunders Creek	Gingell Rd.	Jul-04	63.1	49.4	55.0	56.2
				Aug-04	61.4	47.4	53.8	55.0
		Black River	Tyrolean Hills	Jul-04	72.6	52.3	62.0	64.1
				Aug-04	70.8	49.2	59.4	62.2
			McKinnon’s Bend	Jul-06	75.6	55.0	65.3	68.3
				Aug-06	79.0	53.3	62.4	67.5
			Tin Shanty Br.	Jul-06	76.2	56.1	66.7	70.0
				Aug-06	79.8	54.3	63.5	69.0

Table 6.–Continued.

Segment number	Sub-watershed	Water body	Location	Date	Maximum	Minimum	Mean	Maximum weekly mean
		Tubbs Creek	High Country Pathway	Jul-04	79.1	71.4	75.3	76.7
				Aug-04	78.8	67.6	72.1	74.8
		Black River	Blue Lakes Rd.	Jul-06	77.0	55.7	66.3	69.1
				Aug-06	80.5	53.2	63.1	68.7
		Stewart Creek	Blue Lake Rd.	Jul-04	76.4	59.6	66.9	68.9
				Aug-04	73.1	54.9	63.6	66.8
		Little McMasters Creek	Clark Rd.	Jul-04	79.7	53.8	65.5	68.4
				Aug-04	76.6	49.1	61.7	64.4
		Black River	Clark Br. Rd.	Jul-06	75.9	59.2	68.2	71.2
				Aug-06	79.7	55.8	64.6	70.5
13	E. Br. Black River	E. Br. Black River	Huff Rd.	Jul-04	67.4	49.3	57.7	59.4
				Aug-04	66.0	47.1	56.0	57.9
		Rattlesnake Creek	Rattlesnake Creek Rd.	Jul-04	66.0	49.6	57.6	59.3
				Aug-04	64.0	46.6	55.7	57.8
		E. Br. Black River	Co. Rd. 622	Jul-06	71.2	55.0	63.6	66.1
				Aug-06	73.1	52.6	60.8	65.7
		Foch Creek	Below Foch Lake	Jul-04	79.9	65.4	73.2	76.0
				Aug-04	77.1	63.7	69.8	73.8
			Townline Lake Rd.	Jul-04	74.5	56.8	65.0	67.0
				Aug-04	71.8	51.8	62.5	64.5
13	E. Br. Black River	E. Br. Black River	Barber Br.	Jul-06	74.8	56.5	66.0	68.8
				Aug-06	78.2	53.7	62.7	68.1
14	Black River	McMasters Creek	Clute Rd.	Jul-05	81.2	58.2	70.3	74.4
				Aug-05	79.8	58.4	66.5	71.2
		Black River	Shangrila Rd.	Jul-04	73.0	57.6	65.3	67.4
				Aug-04	72.4	53.9	62.2	65.8
			Crockett Rapids Br.	Jul-06	77.7	60.9	69.5	72.6
				Aug-06	80.8	57.9	65.7	71.8
		Tomahawk Creek	Elk Hill Rd.	Jul-04	76.6	57.3	66.8	69.5
				Aug-04	73.8	50.9	62.1	65.3

Table 6.–Continued.

Segment number	Sub-watershed	Water body	Location	Date	Maximum	Minimum	Mean	Maximum weekly mean
			Co. Rd. 634	Jul-04	83.4	61.6	72.4	75.4
				Aug-04	82.4	55.4	68.2	72.4
			M-33	Jul-04	75.2	58.8	67.4	70.6
				Aug-04	73.1	54.4	63.4	67.3
		Gregg Creek	Black River Rd.	Jul-04	69.6	52.2	61.4	63.3
				Aug-04	68.2	48.0	59.0	61.9
		Black River	Black River Rd.	Jul-04	75.0	58.6	66.9	69.2
				Aug-04	74.1	55.8	63.8	67.8
15	Canada Creek	Packer Creek	Rouse Rd.	Jul-04	77.9	52.6	64.9	67.4
				Aug-04	76.4	48.7	61.6	64.7
		Van Hetton Creek	Roth Rd.	Jul-04	82.2	52.3	66.5	69.3
				Aug-04	79.6	49.3	63.5	67.2
		Canada Creek	Co. Rd. 622	Jul-04	81.8	62.2	70.5	73.2
				Aug-04	80.2	57.6	67.5	70.8
			South wire	Jul-06	80.4	62.3	71.7	74.4
			(Canada Creek Ranch)	Aug-06	82.3	59.7	68.5	74.3
			High banks	Jul-06	76.5	59.7	67.8	70.1
			(Canada Creek Ranch)	Aug-06	78.3	55.5	64.7	70.2
15	Canada Creek	Canada Creek	Gravel bottom	Jul-05	77.7	56.8	68.5	72.2
			(Canada Creek Ranch)	Aug-05	75.5	59.1	66.7	69.9
			Above Montague Creek	Jul-06	74.9	58.5	66.2	68.6
			(Canada Creek Ranch)	Aug-06	76.8	47.7	63.3	68.5
			Below Montague Creek	Jul-06	75.0	58.3	66.3	68.6
			(Canada Creek Ranch)	Aug-06	76.5	54.1	63.3	68.6
			Wilson Br.	Jul-05	74.7	54.7	64.8	67.8
			(Canada Creek Ranch)	Aug-05	72.6	57.5	63.6	66.2
			Wadsworth Br.	Jul-05	75.3	55.2	65.1	68.1
			(Canada Creek Ranch)	Aug-05	73.8	57.4	63.7	66.5
			North wire	Jul-06	76.8	57.4	66.9	69.5
			(Canada Creek Ranch)	Aug-06	80.6	54.6	63.7	69.0

Table 6.–Continued.

Segment number	Sub-watershed	Water body	Location	Date	Maximum	Minimum	Mean	Maximum weekly mean
			Canada Creek Highway	Jul-04	71.1	53.3	61.9	63.8
				Aug-04	69.9	50.0	59.0	61.0
		Oxbow Creek	Oxbow Creek Rd.	Jul-06	86.9	55.5	70.8	74.0
				Aug-06	91.5	48.9	66.1	72.5
			Near county line	Jul-06	80.8	58.2	70.1	73.2
				Aug-06	85.2	53.9	65.8	72.2
			Canada Creek Highway	Jul-04	73.8	56.1	64.7	67.1
				Aug-04	72.6	51.4	61.7	64.7
16	Black River	Black River	Below Kleber Dam	Jul-04	74.8	63.4	70.3	72.4
				Aug-04	92.3	55.2	72.0	75.5
		Milligan Creek	Near headwaters	Jul-04	77.5	55.8	66.6	68.8
				Aug-04	75.7	54.2	63.0	67.3
		Gokee Creek	Osmun Rd.	Jul-04	71.1	49.7	62.4	65.3
		Milligan Creek	Gokee Hill area	Jul-03	78.7	57.1	66.9	70.0
				Aug-03	77.4	54.6	67.8	70.6
16	Black River	Milligan Creek	Upstream of M-68	Jul-06	85.6	47.6	67.2	70.9
				Aug-06	81.4	46.7	62.4	67.5
			Near M-68	Jul-06	81.1	59.5	70.6	73.6
				Aug-06	79.8	53.5	66.3	72.0
		Black River	One mile below Kleber Dam	Jul-05	83.7	67.5	74.0	76.1
				Aug-05	79.0	62.6	69.8	74.5
			Near mouth of Black Lake	Jul-05	82.6	67.0	75.5	79.6
				Aug-05	79.3	61.9	70.3	75.5
17	Black Lake	Stewart Creek	Steel Rd.	Aug-04	76.9	47.1	60.7	63.9
		Stony Creek	Vermilya Highway	Jul-04	73.2	47.8	62.8	65.8
				Aug-04	73.2	41.9	59.7	62.6
			North Allis Highway	Jul-04	76.2	50.8	62.1	65.0
		W. Br. Upper Rainy River	Near mouth	Jul-04	71.7	56.0	64.2	67.2
				Aug-04	71.7	52.8	60.8	64.1

Table 6.–Continued.

Segment number	Sub-watershed	Water body	Location	Date	Maximum	Minimum	Mean	Maximum weekly mean
		Healy Creek	Near mouth	Jul-04	78.4	52.5	64.9	68.9
				Aug-04	71.1	46.7	58.3	61.1
		Rainy River	Below Rainy Lake	Jul-04	77.8	60.9	68.7	71.4
				Aug-04	81.0	46.9	61.9	66.3
		Stony Creek	End of Brady Rd.	Jul-04	77.1	58.8	67.5	70.0
		E. Br. Rainy River	Schnep Rd.	Jul-04	74.4	56.9	63.6	67.5
				Aug-04	67.3	50.3	55.8	62.9
		Rainy River	South Porter Rd.	Jul-04	79.5	59.3	68.1	69.1
				Aug-04	77.7	54.0	64.8	69.8
		Little Rainy River	South Porter Rd.	Jul-04	83.5	58.8	70.1	72.5
				Aug-04	81.9	52.1	66.7	70.6
		Rainy River	North Allis Highway	Jul-04	76.8	59.1	67.9	70.1
				Aug-04	75.9	54.9	64.4	68.2
17	Black Lake	Cold Creek	Roost Rd.	Jul-04	73.2	57.8	65.0	67.9
				Aug-04	69.3	53.3	61.2	63.8
18	Lower Black River	Long Lake Creek	Gaynor Rd.	Jul-04	73.1	54.4	64.0	66.5
				Aug-04	71.9	44.1	60.6	63.5
		Owens Creek	Ross Rd.	Jul-04	78.2	58.7	67.6	70.1
				Aug-04	74.5	55.4	64.8	67.5
	Black River	Stony Creek	End of Brady Rd.	Aug-04	74.3	53.8	63.2	66.4
19	Cheboygan River	Laperell Creek	Inverness Trail	Jul-04	60.8	52.4	55.9	56.9
				Aug-04	60.3	49.9	54.9	56.2
			Near Old 27	Jul-04	65.5	52.5	58.5	60.4
				Aug-04	63.5	48.6	56.8	58.5
		Cheboygan River	Bayview Drive	Jul-05	85.8	70.1	77.1	81.2
				Aug-05	82.2	60.2	73.2	77.3

Table 7.–Gradient of the entire Cheboygan River watershed (Michigan Department of Natural Resources, unpublished data).

Gradient class	Description	Miles	% of watershed
0–2.9 ft/mile	low	147.4	17.5
3.0–4.9 ft/mile	medium	39.1	4.6
5.0–9.9 ft/mile	high	132.2	15.7
10.0–69.9 ft/mile	very high	442.5	52.6
70–149.9 ft/mile	chutes and pools	65.6	7.8
>150 ft/mile	falls and rapids	14.7	1.8
Total:		841.6	

Table 8.–Gradient of the Cheboygan River and its tributaries by river segment (Michigan Department of Natural Resources, unpublished data).

Reach	Segment or major tributary	Gradient class (ft/mile)	Miles	% of reach
W. Br. Maple River	Headwaters to Maple River Dam	0–2.9	9.5	59.5
		5.0–9.9	6.5	40.5
		Total:	16.0	
E. Br. Maple River		0–2.9	1.6	26.3
		10.0–69.9	4.6	73.7
		Total:	6.2	
Maple River	Maple River Dam to Burt Lake	3.0–4.9	2.4	35.3
		5.0–9.9	3.7	54.3
		10.0–69.9	0.7	10.4
		Total:	6.8	
Sturgeon River	Headwaters to confluence with W. Br. Sturgeon River	0–2.9	0.4	1.8
		3.0–4.9	1.3	5.4
		5.0–9.9	10.3	42.0
		10.0-69.9	11.2	45.7
		>150	1.3	5.1
		Total:	24.6	
	Confluence with W. Br. Sturgeon	0–2.9	0.7	4.7
	River to Burt Lake	10.0-69.9	13.4	95.3
		Total:	14.1	
W. Br. Sturgeon River		0–2.9	0.8	4.4
		10.0–69.9	17.0	95.6
		Total:	17.8	
Burt Lake	Crooked River	0–2.9	5.2	100.0
		Total:	5.2	
Pigeon River	Headwaters to Golden Lotus Dam	0–2.9	1.1	7.7
		5.0–9.9	6.0	42.0
		10.0–69.9	7.2	50.4
		Total:	14.3	
	Golden Lotus Dam to confluence with Little Pigeon River	5.0–9.9	7.0	45.1
		10.0–69.9	8.5	54.9
		Total:	15.4	
	Confluence with Little Pigeon River to Mullett Lake	0–2.9	5.5	37.9
		10.0–69.9	9.0	62.1
		Total:	14.5	

Table 8.–Continued.

Reach	Segment or major tributary	Gradient class (ft/mile)	Miles	% of reach
Mullett Lake	Indian River	0–2.9	4.0	100.0
		Total:	4.0	
Black River	Headwaters to Clark Bridge Road	0–2.9	4.5	15.9
		5.0–9.9	14.3	50.5
		10.0–69.9	9.5	33.5
		Total:	28.4	
	Clark Bridge Road to Kleber Dam	0–2.9	5.5	28.5
		3.0–4.9	0.2	0.8
		5.0–9.9	12.3	63.8
		10.0–69.9	1.3	6.9
		Total:	19.2	
	Kleber Dam to Black Lake	3.0–4.9	8.3	87.8
		10.0–69.9	0.9	9.4
		>150	0.3	2.8
		Total:	9.5	
Black River	Lower Black River	0–2.9	5.8	52.4
		3.0–4.9	4.4	39.6
		10.0–69.9	0.9	8.0
		Total:	11.1	
	E. Br. Black River	5.0–9.9	13.5	68.4
		10.0–69.9	6.2	31.6
		Total:	19.7	
	Canada Creek	0–2.9	0.9	4.2
		3.0–4.9	7.7	38.0
		5.0–9.9	8.0	39.1
		10.0–69.9	3.8	18.7
		Total:	20.4	
Black Lake	Rainy River	0–2.9	1.8	7.6
		3.0–4.9	2.4	10.2
		5.0–9.9	7.1	29.9
		10.0–69.9	12.4	52.3
		Total:	23.8	
	Cheboygan River	0–2.9	4.2	60.3
		5.0–9.9	2.7	39.7
		Total:	6.9	

Table 9.–Analysis of channel morphology data for select tributaries of the Cheboygan River. Stream width was calculated from measurements made by the United States Geological Survey and Michigan Department of Natural Resources Fisheries Division. Status indicates whether site is outside of expected range; "W" is too wide and "N" is too narrow. Expected range (mean, upper 95%, and lower 95% widths) were calculated using equations developed by Leopold and Maddock (1953) and Leopold and Wolman (1957).

Water body	Location	Date	Actual width (ft)	Discharge (ft^3/s)	Expected width (ft) Lower 95%[a]	Expected width (ft) Mean[b]	Expected width (ft) Upper 95%[c]	Status
W. Br. Maple River	Robinson Rd.	08/07/2002	26.0	35.4	24.7	32.6	43.0	
E. Br. Maple River	C64 (Mills Rd.)	07/31/2002	23.9	21.3	19.5	25.3	33.0	
Maple River	below Maple River Dam	07/29/2002	40.0	115.2	43.1	58.7	80.0	N
Sturgeon River	Trowbridge Rd.	07/18/2005	30.0	75.0	35.2	47.4	63.9	N
	Wolverine	07/02/2007	54.0	145.0	48.1	65.9	90.3	
W. Br. Sturgeon River	Old 27 Highway	07/25/2005	30.0	51.7	29.6	39.4	52.5	
W. Br. Minnehaha Creek	Berger Rd.	07/25/2003	8.0	2.2	6.7	8.2	10.1	
Pigeon River	near Vanderbilt	08/03/2007	46.0	43.1	27.1	36.0	47.7	
	Elk Hill Campground	08/06/2002	38.0	105.1	41.3	56.1	76.2	N
	Afton	08/07/2007	57.0	67.1	33.4	44.9	60.2	
	Agnes Andreae Nature Preserve	07/24/2003	34.0	92.3	38.9	52.6	71.2	N
Little Pigeon River	Burls Rd.	07/25/2002	23.0	13.3	15.6	20.0	25.8	
Black River	Springs area (Black River Rd.)	08/17/2006	38.0	29.1	22.5	29.6	38.8	
	Sids Drive	08/16/2006	36.0	34.8	24.5	32.4	42.7	
	Blue Lakes Rd.	08/08/2005	38.0	62.1	32.2	43.2	57.8	
	near Tower	07/23/2001	51.0	174.0	52.4	72.2	99.4	N
E. Br. Black River	Old Railroad Grade (Huff Rd.)	08/23/2007	37.8	29.3	22.6	29.7	39.0	
Canada Creek	Geodetic Rd.	08/25/2005	21.0	22.2	19.8	25.8	33.6	
	Doty Trail	08/20/2004	25.0	29.4	22.7	29.8	39.1	
	Wilson Bridge	08/25/2005	31.5	31.0	23.2	30.6	40.2	

[a] Lower 95% = 10^(0.662895+(0.471522*$\log_{10}$(Q))).
[b] Mean= 10^(0.741436+(0.498473*$\log_{10}$(Q))).
[c] Upper 95%= 10^(0.819976+(0.525423*$\log_{10}$(Q))).

Table 10.–Dams in the Cheboygan River watershed, sorted by county. Date is the date of construction; location is provided by township (T.), range (R.), and section (Sec.); "Owner" indicates ownership as private, state, or local government; blanks indicate data are missing; an asterisk (*) indicates the dam is classified a high or significant hazard (J. Pawloski, MDEQ LWMD).

County Dam name	River reach	Date	T.	R.	Sec.	Owner	Head (ft)	Pond area (acres)	Storage (acre-ft)
Cheboygan									
Alverno Dam*	Black River	1904	37N	1W	35	private	16	1,025	1,260
Berry Creek Ranch Dam	Berry Creek	1942	34N	3W	22	private	6	4	0
Cheboygan Dam*	Cheboygan River	1922	38N	1W	31	private/state	21	18,150	82,947
Cornwall Creek Dam*	Cornwall Creek	1966	33N	1W	27	state	27	161	2,570
Crooked Lake Walleye Pond	Trib-Hassler Creek	1970	35N	3W	17	state	8	4	19
Dog Lake Dam	McMasters Creek	1957	33N	1W	11	state	4	520	1,870
Echo Lake Dam	Trib-Little Pigeon River	1971	33N	2W	14	state	4.5	25	150
Ginop Dam	Hasler Creek	1987	34N	3W	7	private	0	1	0
Jury Dam	Trib-Little Pigeon River	1958	33N	2W	12	private	0	20	0
Kleber Dam	Upper Black River	1949	35N	1E	29	private	42	270	7,320
Little Sturgeon Club Dam	Little Sturgeon River		35M	2W	30	private	1	1	
Maxson Dam	Morrow Creek		35N	2W	20	private	6	4	
Roberts Lake Dam	Twin Lakes Creek	1948	35N	2W	28	state	4.3	54	210
Stony Creek Dam	Stony Creek	1952	35N	1W	27	state	5	190	1,330
Tower Dam	Black River	1918	34N	1E	3	private	20	102	1,900
Towner Dam	Trib-Little Pigeon River		33N	2W	2	private		7	
Wildwood Lake Dam*	Bradley Creek	1962	33N	2W	21	private	20	222	2,800
Twin Lakes Dam	Twin Lakes Outlet		37N	1E	34	private	3	234	
Emmet									
Crooked Lake Dam	Crooked River	1967	35N	4W	10	state	1	2,300	
Maple River Dam	Maple river	1966	36N	4W	10	private	16	43	808
Ottawa Trout Pond #1 Dam	Trib-Crooked River	1920	36N	4W	34	private	4	0	1
Ottawa Trout Pond #3 Dam	Trib-Crooked River	1920	36N	4W	34	private	12	3	16
Spring Lake Dam	Trib-Crooked Lake		34N	5W	27	local		5	
Starks Mill Dam	Silver Creek	1951	34N	4W	4	private	20	4	60

Table 10.–Continued.

County Dam name	River reach	Date	T.	R.	Sec.	Owner	Head (ft)	Pond area (acres)	Storage (acre-ft)
Montmorency									
Doty Dam	Van Hetton Creek		31N	2E	6		3	24	
Foch Lakes Dam	Trib-East Branch Black	1948	32N	1E	28	state	9	60	440
Muskellunge Lake Level Control	Canada Creek	1957	32N	2E	33	private	4	126	1,000
Rainy River Dam	West Branch Upper	1960	32N	3E	4	state	7.5	270	1,755
Otsego									
Bailey Fund East Dam	Trib-Pigeon River		31N	2W	31	private	0	2	
Bailey Fund West Dam	Trib-Pigeon River		31N	2W	31	private	0	3	
Fontinalis Club Home Dam	Club Stream	1960	32N	2W	17	private	9.1	5	50
Fontinalis Club Middle Dam	Club Steam	1960	32N	2W	18	private	8.2	10	70
Fontinalis Club Upper Dam	Club Stream	1870	32N	2W	19	private	5.2	15	75
Golden Lotus Dam	Pigeon River	1955	32N	1W	19	private	13	45	565
Light Dam	Trib-Sturgeon River		31N	2W	6	private	0	2	
Platte Dam (Downstream)	Duck Creek		30N	2W	2	private	0	2	
Platte Dam (Upstream)	Duck Creek		30N	2W	2	private	0	1	
Quigley Dam	Trib-Club Stream	1965	32N	3W	13	private	15	50	120
Rogell Dam	Trib-Club Stream	1958	32N	3W	13	private	6	2	
Saunders Dam	Black River	1920	31N	1W	20	private	4	12	
Schrader Dam	Duck Creek		31N	2W	23	private	0	1	
Turner Dam	Sturgeon River		31N	3W	14	private		4	
Woodin Lake Dam	West Branch Sturgeon	1940	32N	3W	30	private	7	28	100
Presque Isle									
Feel Dam #2	Healy Creek	1974	33N	3E	22	private	8	6	26
Feel Dam #1	Healy Creek	1960	33N	3E	22	private	4	14	
Moreau Dam	Trib-Stony Creek	2000	34N	2E	16	private		5	
Ramsey Dam	Healy Creek	1963	35N	2E	8	private	0	2	16
Tomahawk Creek Flooding	Tomahawk Creek	1965	33N	2E	27	state	12	575	8,060

Table 11.–Active National Pollution Discharge Elimination System (NPDES) permits in the Cheboygan River watershed, as of May 9, 2007 (Kenneth Hozak, MDEQ Water Bureau, personnel communication). An * indicates that data were not available.

County and permittee	Permit type	Receiving water
Cheboygan County		
Great Lakes Tissue	Wastewater	Unnamed
Cheboygan Wastewater Treatment Plant	Wastewater	Cheboygan River
Blarney Castle Oil	General	Cheboygan River
Inverness Dairy Inc	General	*
Wolverine Power Supply – Tower	General	*
Rieth-Riley-Afton Site	General	Little Pigeon River
BP Products NA Inc-Cheboygan	General	Cheboygan River
Anchor In Marina	Storm water	Lake Huron via Cheboygan R
Burt Lake Marina	Storm water	Sturgeon River
Cheboygan Cement-Cheboygan	Storm water	Cheboygan River
Howe Marine-Indian River	Storm water	Indian River
Moran Iron Works-Bowen Road	Storm water	Bowen Creek
Link Industries	Storm water	Ditches to Indian River
WSM Ent-Indian River Marina	Storm water	Indian River
Baumgarten Forest Products	Storm water	Welch Creek
Circle M Ranch	Storm water	Sturgeon River
Walstrom Marine-Cheboygan	Storm water	Cheboygan River
R E Glancy-Crusher 3	Storm water	
BP Amoco – Cheboygan	Storm water	Cheboygan River
Emmet County		
MDNR-Oden Fish Hatchery	Wastewater	Unnamed tributary to Crooked Lake
UM Biological Station	Wastewater	Maple River
Harbor Springs Area Sewage	Wastewater	*
Karriger Eng & Mfg Inc	Construction	*
Up North Industries-Petoskey	Storm water	Round Lake
Ryde Marine Inc-Alanson	Storm water	Crooked Lake
Otsego County		
MACTEC Eng and Con Inc	Wastewater	Unnamed
Treetops Resort-Gaylord	General	Pigeon River
Treetops Resort-Gaylord	General	Pigeon River
Presque Isle County		
Onaway Wastewater Treatment Plant	Wastewater	Bowen Creek
Elk Run Landfill-Republic	Storm water	Little Rainy River

Table 12.–MDEQ Procedure 51 macroinvertebrate community information for the Cheboygan River watershed (from Walker 2006a, 2006b, 2006c, 2006d).

Water body	Location	# taxa	# mayfly taxa	# caddisfly taxa	# stonefly taxa	EPT %	Rating
Black River	Ninnever Cabin	33	7	7	2	48.5	Excellent
Black River	Blue Lakes Road	37	6	9	1	43.2	Excellent
E Br Black River	Blue Lakes Road	36	7	8	1	44.4	Excellent
Black River	Crocket Rapids	31	5	7	3	48.4	Excellent
McMasters Cr	N of Clark Bridge Rd	30	2	5	0	23.3	Acceptable
Black River	Black River Road	42	7	8	2	40.5	Excellent
Milligan Cr	Brady Rd	31	4	9	2	48.4	Excellent
Canada Cr	Canada Creek Hwy	38	6	10	2	47.4	Excellent
Oxbow Cr	S off Canada Cr Hwy	27	4	8	1	48.1	Excellent
Tomahawk Cr	M-33	29	3	6	1	34.5	Excellent
Bowen Cr	Bowen Rd	27	2	7	0	33.3	Acceptable
Rainy River	Allis Hwy	34	6	5	3	41.2	Excellent
Little Rainy River	1 Mile Hwy	25	3	5	0	32.0	Acceptable
Owens Cr	Ross Rd	22	2	3	0	22.7	Acceptable
Laperell Cr	Laperell Rd	29	5	6	1	41.4	Excellent
Mullett Cr	d/s Crump Rd	20	2	7	3	60.0	Excellent
E Br Maple R	Douglas Lake Rd	38	5	7	1	34.2	Acceptable
Maple River	Maple River Rd	37	7	10	3	54.1	Excellent
Maple River	Robinson Rd	37	5	10	3	48.6	Excellent
McPhee Cr	Valley Rd	25	2	8	1	44.0	Excellent
Minnehaha Cr	Pickerel Lake Rd	21	4	3	2	42.9	Acceptable
Little Pigeon River	Silery Road	29	3	7	1	37.9	Excellent
Pigeon River	M-68	38	4	7	2	34.2	Excellent

Table 12.–Continued.

Water body	Location	# taxa	# mayfly taxa	# caddisfly taxa	# stonefly taxa	EPT %	Rating
Pigeon River	Webb Rd	35	5	9	1	42.9	Excellent
Little Pigeon River	Webb Rd	34	6	7	3	47.1	Excellent
Pigeon River	Elk Hill Campground	39	7	8	1	41.0	Excellent
Pigeon River	Sturgeon Valley Rd	40	6	6	2	35.0	Excellent
Pigeon River	Old Vanderbilt Rd	36	7	8	4	52.8	Excellent
Pigeon River	Whitehouse Trail	31	6	6	2	45.2	Excellent
Sturgeon River	Fisher Woods Rd	35	5	9	2	45.7	Excellent
Sturgeon River	Rondo Rd	31	4	9	2	48.4	Excellent
Sturgeon River	Cornwall Grade Canoe Launch	35	5	10	2	48.6	Excellent
Sturgeon River	Sturgeon Valley Rd	25	5	5	2	48.0	Excellent
Sturgeon River	Poquette Rd	28	6	7	3	57.1	Excellent
Club Stream	Fontinalis Club	30	6	8	1	50.0	Excellent
Little Sturgeon River	Crumley Creek Rd	29	6	6	4	55.2	Excellent
W Br Sturgeon River	Shire Rd	35	4	8	3	42.9	Excellent
W Br Sturgeon River	McGregor Rd.	32	8	9	1	56.3	Excellent

Table 13.–Cheboygan River watershed sites regulated under Part 201 as of April 2007, data provided by Michigan Department of Environmental Quality, Remediation and Redevelopment Division. Acronyms: BTEX = benzene, toluene, ethylbenzene, xylene; PCE = perchloroethylene; PNAs = polynuclear aromatic hydrocarbons; TCA = trichloroethane; TCE = trichloroethylene; TMB = trimethylbenzene.

County common site name	Pollutant
Cheboygan County:	
1. Cheboygan DPW	Benzene, Xylenes
2. Amoco Oil Company	Benzene, PNAs
3. Cheboygan City Park	Lead, Zinc
4. 992 South Main St.	PCE, TCE
5. Inverness Twp. Dump	Diethyl ether, Lead
6. Center Tool	Arsenic, Lead, Cyanide, PNAs, BTEX
7. Lownsberry Salvage	Benzene, Cadmium, Lead, Zinc
8. Cheboygan County Rd Commission	Chloride
9. Rivertown Tannery	Arsenic, Lead, Bis(2-Ethylhexyl)phthalate
10. Arsenic Disposal Area	Arsenic, Lead
11. Northwood Oil	BTEX, Arsenic, 1,2,4-TMB, 1,3,5 TMB, MTBE, PNAs
12. State St. Bulk	BTEX, Lead
13. Wolverine Elementary School	TCE
14. Club Road Property	Benzene, PNAs
15. Former Rittenhouse Furniture	Arsenic, Barium, Lead
Emmet County:	
1. Martins Fruit Market	Selenium
2. One Way Auto Parts	1,2,4-TMB, 1,3,5- TMB, Benzene, Ethylbenzene, Napthalene, Toluene, Xylenes, n-Butylbenzene, n-Propylbenzene, sec-Butylbenzene
3. Pellston Dump Village	Solid waste
4. Littlefield Twp. Dump	Solid waste
5. McKinley Twp. Dump	Solid waste
6. Windjammer Marine	1,2,4-TMB, 1,3,5-TMB, 2-Methylnaphthalene, Arsenic, Benzene, Ethylbenzene, Naphthalene, Xylenes, n-Propylbenzene, Mercury, Indeno (1,2,3-cd) pyrene
7. Former Howes Leather Tannery	TCE, PCE
Otsego County:	
1. Shell Oil Company	Chlorides
2. Sparr Rd Spill	Benzene, Toluene
3. Wilkinson Rd	1,1,2 TCA
4. Res Wells East of Gaylord	Brine
5. Higgins Industries	TCE, PCE

* No listed Charlevoix County, Presque Isle County, or Montmorency County Part 201 sites in the Cheboygan River watershed.

Table 14.–Cheboygan River watershed sites regulated under Part 213 as of April 2007, data provided by Michigan Department of Environmental Quality, Remediation and Redevelopment Division

County Common site name	Pollutant
Cheboygan County:	
1. Corner Store	Gasoline
2. Stan Stelden (Old Orchard Trailer Park)	Gasoline
3. White's Sales Service	Gasoline
4. 9636 M-33 S (Crowley Store)	BTEX, PNAs, Metals
5. Zyco Distributing	Gasoline
6. Former Cook Corp.	Gasoline
7. Former Texaco Indian River	Gasoline
8. Cheboygan-Otsego-Presque Isle ISD	Closed
9. Bundy's Party Store (Tower Mini Mart)	Gasoline
10. Cheboygan Ct Rd Garage Tower	Diesel
11. Tri-River Party Store	Gasoline
12. Forward Indian River (Robert Mitchell Property)	Gasoline/Diesel
13. Jack Auto Repair	BTEX & PNAs
14. Vincent's Service	Gasoline
15. Alpena Oil Co. (Indian River Trading Post)	Gasoline
16. Paula's Café	Gasoline
17. Cheboygan Imperial #18	Gasoline
18. Schultz's Interstate	Gasoline
19. Hostettlers Office Supply	Used oil/Gasoline
20. Cheboygan Convenience Store (Convenient Food Mart)	BTEX/PNAs
21. Main St. (M-72 Hwy) Right Of	Gasoline
22. Blarney Castle France Super	Gasoline
23. Great Lakes Tissue	Gasoline
24. Cheboygan Clark (Clark #1011)	BTEX
25. Proctor & Gamble Paper	BTEX & PNAs
26. Holiday Station Store #173	Gasoline
27. Cheboygan EZ Mart (Cheboygan Bay Mart)	BTEX
28. Ormsbee Motors	Gasoline
29. Rex Oil & Gas Company	Gasoline
Emmet County:	
1. County General Store	Gasoline
2. Windjammer Marina	Gasoline
3. Williams Marathon	Gasoline
4. Emmet County Rd Commission	Gasoline
5. UPS Petoskey	Gasoline

Table 14.–Continued.

County Common site name	Pollutant
Otsego County:	
1. Sparr Mall	Gasoline
Presque Isle:	
1. Onaway Food Mart	Gasoline
2. Village Corner Party Store	Gasoline
3. Winter Hawks/General Store	Gasoline
4. 211 Outpost	Gasoline
5. Presque Isle Electric Coop Inc.	Gasoline
6. Presque Isle Co Rd Commission	Gasoline
7. Croad Salvage	Gasoline
8. Onaway Tax Service	Gasoline
9. Painter Petroleum	Gasoline
10. Vance's Service Center	Gasoline

Table 15.–Designated trout streams in the Cheboygan River watershed. The entire stream, from its source to the downstream limit, including tributaries, is designated trout water, unless excepted.

Designated trout streams	County
Cheboygan River (T38N, R1W, S29) up to dam in S31	Cheboygan
EXCEPT: During the months of June, July and August	
Laperell Creek (T37N, R1W, S19)	Cheboygan
Tributaries of Crooked River:	
Whites Creek (T36N, R4W, S35)	Emmet
Unnamed Creek (T35N, R4W, S3)	Emmet
Unnamed Creek (T36N, R4W, S35)	Emmet
McPhee Creek (T35N, R4W, S10)	Emmet
Tributaries of Crooked Lake:	
Hatchery Outlet (T35N, R4W, S18)	Emmet
Unnamed Creek (T35N, R5W, S13)	Emmet
Unnamed Creek (T35N, R5W, S24)	Emmet
Minnehaha (T35N, R4W, S29) *EXCEPT:*	Emmet
Silver Creek Pond (T34N, R4W, S4)	*Emmet*
Tributaries of Pickerel Lake:	
Mud Creek (T35N, R4W, S27)	Emmet
Cedar River (Berry Creek, T35N, R4W, S25)	Emmet, Cheboygan
Unnamed Creek (T35N, R4W, S26)	Emmet
Tributaries of Burt Lake:	
Little Carp River (T36N, R3W, S4)	Cheboygan
Maple River (T36N, R3W, S29, 31) and following tributaries:	Cheboygan, Emmet
West Branch Maple River (T36N, R4W, S10)	Emmet
East Branch Maple River (T36N, R4W, S10)	Emmet
Cold Creek (T37N, R4W, S30)	Emmet
Brush Creek (T37N, R5W, S27)	Emmet
Sturgeon River (T35N, R3W, S24) & following tributaries:	Cheboygan, Otsego
Beebee Creek (T34N, R2W, S31)	Cheboygan, Otsego
West Branch Sturgeon River (T33N, R2W, S7)	Cheboygan, Otsego, Charlevoix
Marl Creek (T33N, R3W, S15)	Cheboygan
Allen Creek (T33N, R3W, S14)	Cheboygan
Bairds Creek (T34N, R3W, S12)	Cheboygan
No Name Creek (T34N, R3W, S25)	Cheboygan
Mud Creek (T33N, R3W, S18)	Cheboygan
Bradley Creek (T33N, R2W, S20)	Cheboygan
Stewart Creek (T33N, R2W, S31) and all other tributaries	Cheboygan
Pickerel Creek (T32N, R2W, S10)	Otsego
Unnamed Creek (T32N, R2W, S21)	Otsego
Club Stream (T32N, R2W, S10)	Otsego
Mossback Creek (T31N, R3W, S12)	Otsego
Indian River Tributaries:	
Little Sturgeon River (T35N, R2W, S19)	Cheboygan
Mullett Lake Tributaries:	
No Name Creek (T37N, R2W, S25)	Cheboygan
No Name Creek (T37N, R2W, S26)	Cheboygan

Table 15.–Continued.

Designated trout streams	County
Mullett Lake Tributaries–continued:	
Mullet Creek (T36N, R2W, S16)	Cheboygan
Little Pigeon River (T35N, R2W, S9)	Cheboygan
North Branch Little Pigeon River (T35N, R2W, S14)	Cheboygan
Middle Branch Little Pigeon River (T35N, R2W, S23)	Cheboygan
South Branch Little Pigeon River (T35N, R2W, S23)	Cheboygan
Pigeon River (T35N, R2W, S9) and the following tributaries:	Cheboygan, Otsego
Wilkes Creek (T34N, R2W, S12)	Cheboygan
Nelson Creek (T34N, R1W, S32)	Cheboygan
Little Pigeon River (T34N, R1W, S31)	Cheboygan
McIntosh Creek (T33N, R1W, S5)	Cheboygan
McPhee Creek (T33N, R1W, S8)	Cheboygan
Grindstone Creek (T33N, R1W, S17)	Cheboygan
Cornwall Creek (Cornwall Impoundment Dam)	Cheboygan
Unnamed Creek (T34N, R2W, S24)	Cheboygan
Unnamed Creek (T33N, R1W, S28)	Cheboygan
Unnamed Creek (T32N, R2W, S25)	Otsego
And all unnamed above T31N, R2W, S13	Otsego
Black River Basin	
Black River from Red Bridge (T35N, R1E, S5) upstream To Kleber Dam (T35N, R1E, S29)	Cheboygan
Black River from Tower Dam Pond upstream and the following tributaries:	Cheboygan, Presque Isle
Milligan Creek (T35N, R1E, S29)	Cheboygan
Sturgis Creek (T34N, R1E, S14)	Cheboygan
Two Unnamed Creeks (T34N, R2E, S19)	Presque Isle
Gregg Creek (T34N, R1E, S25)	Cheboygan
Unnamed Creek (T34N, R2E, S31)	Presque Isle
Canada Creek (T33N, R1E, S12)	Cheboygan
Unnamed Creek (T33N, R1E, S12)	Cheboygan
Unnamed Creek (T33N, R1E, S11)	Cheboygan
McMasters Creek (T33N, R1E, S21)	Cheboygan
East Branch Black River (T32N, R1E, S8)	Montmorency
Stewart Creek (T32N, R1E, S8)	Montmorency
Hardwood Creek (T32N, R1E, S30)	Montmorency
Tubbs Creek (T31N, R1W, S1)	Otsego
Unnamed Creek (T31N, R1W, S20)	Otsego
Unnamed Creek (T31N, R1W, S27)	Otsego
Little Mud Creek (T36N, R1E, S28)	Cheboygan
Stony Creek (T35N, R1E, S12)	Cheboygan, Presque Isle
Rainy River (T35N, R2E, S22)	Presque Isle
Unnamed Creek (T35N, R2E, S26)	Presque Isle
Little Rainy River (T34N, R2E, S11)	Presque Isle
East Branch Rainy River (T34N, R3E, S18)	Presque Isle
Unnamed Creek (T33N, R3E, S21)	

Table 16.–Fishes in the Cheboygan River watershed. Species origin: N=native; C=colonized; and I=introduced. Cheboygan River watershed status: P=recent observation; O=extirpated; U=historic record, or current status unknown.

Common name	Scientific name	Species origin	Cheboygan watershed status
Lampreys	Petromyzontidae		
northern brook lamprey	*Ichthyomyzon fossor*	N	P
American brook lamprey	*Lampetra appendix*	N	P
sea lamprey	*Petromyzon marinus*	C	P
silver lamprey	*Ichthyomyzon unicuspis*	N	P
Sturgeons	Acipenseridae		
lake sturgeon (threatened)	*Acipenser fulvescens*	N	P
Gars	*Lepisosteidae*		
longnose gar	*Lepisosteus osseus*	N	P
Bowfins	Amiidae		
bowfin	*Amia calva*	N	P
Herrings	Clupeidae		
alewife	*Alosa pseudoharengus*	C	P
Carps and minnows	Cyprinidae		
spotfin shiner	*Cyprinella spiloptera*	N	P
common carp	*Cyprinus carpio*	C	P
brassy minnow	*Hybognathus hankinsoni*	N	U
common shiner	*Luxilus cornutus*	N	P
northern pearl dace	*Margariscus nachtriebi*	N	P
hornyhead chub	*Nocomis biguttatus*	N	P
river chub	*Nocomis micropogon*	N	P
golden shiner	*Notemigonus crysoleucas*	N	P
pugnose shiner (special concern)	*Notropis anogenus*	N	U
emerald shiner	*Notropis atherinoides*	N	P
blackchin shiner	*Notropis heterodon*	N	U
blacknose shiner	*Notropis heterolepis*	N	U
spottail shiner	*Notropis hudsonius*	N	P
rosyface shiner	*Notropis rubellus*	N	U
sand shiner	*Notropis stramineus*	N	P
mimic shiner	*Notropis volucellus*	N	P
northern redbelly dace	*Phoxinus eos*	N	P
finescale dace	*Phoxinus neogaeus*	N	U
bluntnose minnow	*Pimephales notatus*	N	P
fathead minnow	*Pimephales promelas*	N	P
longnose dace	*Rhinichthys cataractae*	N	P
western blacknose dace	*Rhinichthys obtusus*	N	P
creek chub	*Semotilus atromaculatus*	N	P
Suckers	Catostomidae		
white sucker	*Catostomus commersonii*	N	P
silver redhorse	*Moxostoma anisurum*	N	P
greater redhorse	*Moxostoma valenciennesi*	N	P
Bullhead catfishes	Ictaluridae		
black bullhead	*Ameiurus melas*	N	P
yellow bullhead	*Ameiurus natalis*	N	P
brown bullhead	*Ameiurus nebulosus*	N	P
channel catfish	*Ictalurus punctatus*	N	P

Table 16.–Continued.

Common name	Scientific name	Species origin	Cheboygan watershed status
Pikes	Esocidae		
northern pike	*Esox lucius*	N	P
tiger muskellunge [a]	*E. lucius x E. masquinongy*	I	O
muskellunge	*Esox masquinongy*	N	P
Mudminnows	Umbridae		
central mudminnow	*Umbra limi*	N	P
Smelts	Osmeridae		
rainbow smelt	*Osmerus mordax*	I	U
Trouts	Salmonidae		
lake herring	*Coregonus artedi*	N	U
lake whitefish	*Coregonus clupeaformis*	N	P
pink salmon	*Oncorhynchus gorbuscha*	C	P
coho salmon	*Oncorhynchus kisutch*	I	P
rainbow trout	*Oncorhynchus mykiss*	I	P
Chinook salmon	*Oncorhynchus tshawytscha*	I	P
brown trout	*Salmo trutta*	I	P
brook trout	*Salvelinus fontinalis*	N	P
splake	*Salvelinus fontinalis x S. namaycush*	I	P
lake trout	*Salvelinus namaycush*	N	P
Arctic grayling (extinct)	*Thymallus arcticus*	N	O
Trout-Perch	Percopsidae		
trout-perch	*Percopsis omiscomaycus*	N	U
Cods	Lotidae		
burbot	*Lota lota*	N	P
Killifishes	Cyprinodontidae		
western banded killifish	*Fundulus diaphanus*	N	U
Sticklebacks	Gasterosteidae		
brook stickleback	*Culaea inconstans*	N	P
ninespine stickleback	*Pungitius pungitius*	N	P
Sculpins	Cottidae		
mottled sculpin	*Cottus bairdii*	N	P
slimy sculpin	*Cottus cognatus*	N	P
Sunfishes	Centrarchidae		
rock bass	*Ambloplites rupestris*	N	P
green sunfish	*Lepomis cyanellus*	N	P
pumpkinseed	*Lepomis gibbosus*	N	P
bluegill	*Lepomis macrochirus*	N	P
northern longear sunfish	*Lepomis peltastes*	N	U
smallmouth bass	*Micropterus dolomieu*	N	P
largemouth bass	*Micropterus salmoides*	N	P
black crappie	*Pomoxis nigromaculatus*	N	P
Perches	Percidae		
rainbow darter	*Etheostoma caeruleum*	N	P
Iowa darter	*Etheostoma exile*	N	P
least darter	*Etheostoma microperca*	N	U
johnny darter	*Etheostoma nigrum*	N	P

yellow perch	*Perca flavescens*	N	P

Table 16.–Continued.

Common name	Scientific name	Species origin	Cheboygan watershed status
northern logperch	*Percina caprodes*	N	P
channel darter	*Percina copelandi*	N	U
blackside darter	*Percina maculata*	N	P
walleye	*Sander vitreus*	N	P
Gobies	Gobiidae		
round goby	*Neogobius melanostomus*	C	P
Drum	Sciaenidae		
freshwater drum	*Aplodinotus grunniens*	C	P

[a] last stocked in Cornwall Impoundment in 1991

Table 17.–Mussel species documented in the Cheboygan River watershed (University of Michigan Museum of Zoology).

Common name	Scientific name	Year documented	Location
eastern pond mussel	*Ligumia nasuta*	1817	Indian River; Douglas and Valentine lakes
eastern floater	*Pyganodon cataracta*	1817	Cochran Lake
kidneyshell	*Ptychobranchus fasciolaris*	1820	Black River
limpet	*Ferrissia parallelus*	1841	Douglas Lake
giant floater	*Pyganodon grandis*	1829	Pickerel Lake (Otsego Co); Ford, Crooked, Jackson, Valentine, Town Corner lakes
fatmucket	*Lampsilis siliquoidea*	1823	Ford and Valentine lakes
creeper	*Strophitus undulates*	1817	Crooked Lake
cylindrical papershell	*Anodontoides ferussacianus*	1834	Valentine Lake

Table 18a.–Aquatic invertebrates in the Black River sub-watershed of the Cheboygan River watershed (modified from Walker 2008). Data code: X=present, dash (–) indicates not collected.

Taxa	Black R.-Tubbs Ck confluence	Black R.-Blue Lakes Rd	E B Black R.-Blue Lakes Rd	Black R.-Crockett Rapids Br	McMasters Ck-near Clark Bridge Rd	Black R.-Black R. Rd	Milligan Ck-Brady Rd	Canada Ck-Canada Ck Highway	Oxbow Ck-mid station	Tomahawk Ck-M33 Highway	Bowen Ck-Bowen Rd	Rainry R.-Allis Highway	Little Rainy R.-One Mile Highway	Owens Ck-Ross Rd
PORIFERA (sponges)	–	–	–	–	X	–	–	–	X	–	–	–	X	–
PLATYHELMINTHES (flatworms)														
Turbellaria	–	–	–	–	–	–	–	–	–	–	–	–	–	–
BRYOZOA (moss animals)	–	–	–	–	–	X	–	–	–	–	–	–	–	–
ANNELIDA (segmented worms)														
Hirudinea (leeches)	X	–	–	–	X	–	X	–	–	–	X	–	X	X
Oligochaeta (worms)	X	X	X	X	X	X	X	X	–	X	X	X	–	X
ARTHROPODA														
Arachnoidea														
Hydracarina	X	–	X	X	X	X	X	X	–	–	–	X	X	–
Crustacea														
Amphipoda (scuds)	–	–	X	–	X	X	–	X	X	X	–	X	X	X
Decapoda (crayfish)	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Isopoda (sowbugs)	X	X	–	X	X	X	–	–	–	–	X	–	X	X
Insecta														
Ephemeroptera (mayflies)														
Baetiscidae	X	X	X	–	–	X	–	X	–	–	–	X	–	–
Baetidae	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Caenidae	X	–	X	–	–	X	–	X	–	–	–	X	X	X
Ephemerellidae	X	X	X	X	–	X	–	X	X	–	–	–	–	–
Ephemeridae	X	X	X	X	–	X	–	X	–	–	–	–	–	–
Heptageniidae	X	X	X	X	X	X	X	X	X	X	X	X	X	
Isonychiidae	X	X	X	X	–	X	X	–	–	–	–	X	–	–

Table 18a.–Continued.

Taxa	Black R.-Tubbs Ck confluence	Black R.-Blue Lakes Rd	E B Black R.-Blue Lakes Rd	Black R.-Crockett Rapids Br	McMasters Ck-near Clark Bridge Rd	Black R.-Black R. Rd	Milligan Ck-Brady Rd	Canada Ck-Canada Ck Highway	Oxbow Ck-mid station	Tomahawk Ck-M33 Highway	Bowen Ck-Bowen Rd	Rainry R.-Allis Highway	Little Rainy R.-One Mile Highway	Owens Ck-Ross Rd
Leptophlebiidae	–	–	–	–	–	–	X	–	X	X	–	X	–	–
Tricorythidae	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Odonata														
Anisoptera (dragonflies)														
Aeshnidae	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Cordulegastridae	–	X	–	–	–	X	–	X	X	X	X	–	–	–
Gomphidae	X	X	X	X	X	X	X	X	X	X	–	X	X	–
Zygoptera (damselflies)														
Calopterygidae	–	X	X	X	X	X	X	X	X	X	X	X	X	X
Coenagrionidae	–	–	–	–	–	–	–	–	–	–	–	–	X	–
Lestidae	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Plecoptera (stoneflies)														
Nemouridae	–	–	–	–	–	–	–	–	–	X	–	X	–	–
Perlidae	X	–	–	X	–	X	X	X	X	–	–	X	–	–
Perlodida	X	X	–	X	–	X	X	X	–	–	–	X	–	–
Pteronarcyidae	–	–	X	X	–	–	–	–	–	–	–	–	–	–
Hemiptera (true bugs)														
Belostomatidae	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Corixidae	X	X	X	X	X	X	–	–	–	–	–	–	–	–
Gerridae	X	–	–	X	X	X	–	X	X	X	X	X	–	X
Mesoveliidae	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Nepidae	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Veliidae	–	X	X	X	–	X	X	–	X	X	–	X	–	X
Megaloptera														
Corydalidae (dobson flies)	X	X	X	X	–	X	X	X	–	X	X	X	–	X
Sialidae (alder flies)	–	X	–	–	–	–	–	–	–	–	X	–	–	–

Table 18a.–Continued.

Taxa	Black R.-Tubbs Ck confluence	Black R.-Blue Lakes Rd	E B Black R.-Blue Lakes Rd	Black R.-Crockett Rapids Br	McMasters Ck-near Clark Bridge Rd	Black R.-Black R. Rd	Milligan Ck-Brady Rd	Canada Ck-Canada Ck Highway	Oxbow Ck-mid station	Tomahawk Ck-M33 Highway	Bowen Ck-Bowen Rd	Rainry R.-Allis Highway	Little Rainy R.-One Mile Highway	Owens Ck-Ross Rd
Trichoptera (caddisflies)														
Brachycentridae	X	X	X	X	–	X	–	X	X	–	–	–	–	–
Glossosomatidae	–	X	X	–	–	–	X	–	–	–	–	X	–	–
Helicopsychidae	X	X	X	X	X	X	X	X	X	X	X	X	X	–
Hydropsychidae	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Hydroptilidae	–	–	–	–	–	–	X	–	–	–	–	–	–	–
Lepidostomatidae	–	–	X	–	–	–	–	X	X	–	X	–	–	–
Leptoceridae	–	X	–	X	–	X	X	X	–	–	–	–	–	–
Limnephilidae	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Molannidae	X	–	–	–	X	–	–	X	–	X	X	–	X	–
Philopotamidae	–	X	–	X	–	X	X	X	X	X	–	–	–	–
Phryganeidae	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Polycentropodidae	X	X	X	X	X	X	X	X	X	–	X	–	–	X
Psychomyiidae	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Uenoidae	X	X	X	–	–	X	X	X	X	X	X	X	X	–
Coleoptera (beetles)														
Dryopidae	–	–	–	–	–	–	–	–	–	–	X	X	–	–
Dytiscidae (total)	–	–	–	–	–	X	–	–	–	X	–	–	–	X
Elmidae	–	X	X	X	X	X	X	X	X	X	X	X	X	X
Gyrinidae (larvae)	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Gyrinidae (adults)	–	X	–	–	X	–	–	–	–	–	–	–	–	–
Haliplidae (larvae)	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Haliplidae (adults)	–	–	–	–	–	–	–	X	–	–	–	–	–	–
Hydrophilidae (total)	X	–	X	–	–	X	–	X	–	–	–	X	–	–
Psephenidae (larvae)	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Psephenidae (adults)	–	–	–	–	–	X	–	–	–	–	–	X	–	–

Table 18a.–Continued.

Taxa	Black R.-Tubbs Ck confluence	Black R.-Blue Lakes Rd	E B Black R.-Blue Lakes Rd	Black R.-Crockett Rapids Br	McMasters Ck-near Clark Bridge Rd	Black R.-Black R. Rd	Milligan Ck-Brady Rd	Canada Ck-Canada Ck Highway	Oxbow Ck-mid station	Tomahawk Ck-M33 Highway	Bowen Ck-Bowen Rd	Rainry R.-Allis Highway	Little Rainy R.-One Mile Highway	Owens Ck-Ross Rd
Diptera (flies)														
Athericidae	X	X	–	–	–	–	–	–	–	–	–	X	–	–
Ceratopogonidae	–	–	–	X	X	X	X	–	–	X	–	X	X	X
Chironomidea	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Culicidae	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Simuliidae	X	X	X	X	–	X	X	X	X	X	X	–	X	X
Stratiomyidae	–	–	–	–	X	–	–	–	–	X	–	–	–	–
Tabanidae	X	–	–	–	X	X	–	–	–	X	–	X	X	–
Tipulidae	X	X	X	–	–	–	X	X	–	X	X	X	–	–
MOLLUSCA														
Gastropoda (snails)														
Ancylidae (limpets)	–	–	X	–	–	–	–	–	–	–	–	–	–	–
Lymnaeidae	–	X	X	–	–	–	–	–	–	–	–	–	–	–
Physidae	X	X	X	–	X	X	–	X	X	X	X	–	X	–
Planorbidae	–	–	X	–	X	–	–	–	–	–	X	–	–	–
Plauronceridae	–	–	–	–	–	X	–	–	–	–	–	–	–	–
Viviparidae	–	–	–	–	X	–	–	X	–	–	–	–	–	X
Pelecypoda (bivalves)														
Pisidiidae	–	X	X	–	–	X	–	X	–	–	–	–	–	X
Sphaeriidae (clams)	–	X	–	X	X	–	X	X	X	–	X	X	X	–
Unionidae (mussels)	–	–	–	–	X	–	X	–	–	–	–	–	–	–
Total Number of Taxa	33	37	36	31	30	42	31	38	27	29	27	34	25	22
Macroinvertebrate Community Rating[a]	EXC	EXC	EXC	EXC	ACC	EXC	EXC	EXC	EXC	EXC	ACC	EXC	ACC	ACC

[a] ACC=acceptable; EXC=excellent

Table 18b.–Aquatic invertebrates in the Maple and Pigeon river sub-watersheds of the Cheboygan River watershed (modified from Walker 2008). Data code: X=present, dash (–) indicates not collected.

Taxa	Laperell Ck-Laperell Rd	Mullett Ck – near Crump Rd	E B Maple R.-Douglas Lk Rd	Maple R.-Maple R. Rd	Maple R.-Robinson Rd	McPhee Ck-Valley Rd	Minnehaha Ck-Pickerel Lk Rd	Little Pigeon R.-Silery Rd	Pigeon R.-M68 Highway	Pigeon R.-Webb Rd	Little Pigeon R.-Webb Rd	Pigeon R.-Elk Hill Campground	Pigeon R.-Sturgeon Valley Rd	Pigeon R.-Old Vanderbilt Rd	Pigeon R.-Whitehouse Trail
PORIFERA (sponges)	–	–	X	–	X	–	–	X	–	X	–	X	X	–	–
NEMATOMORPHA (roundworms)	–	–	–	–	–	X	–	–	–	–	–	–	–	–	–
PLATYHELMINTHES (flatworms)															
Turbellaria	–	–	–	–	–	–	–	–	–	–	–	–	X	–	–
BRYOZOA (moss animals)	–	–	–	–	–	–	–	–	X	–	–	–	–	–	–
ANNELIDA (segmented worms)															
Hirudinea (leeches)	–	–	X	X	X	–	–	X	X	–	–	X	X	–	–
Oligochaeta (worms)	X	X	X	X	X	X	X	–	X	X	X	X	X	X	X
ARTHROPODA															
Arachnoidea															
Hydracarina	X	–	–	X	X	–	X	X	–	X	–	X	X	X	X
Crustacea															
Amphipoda (scuds)	X	–	X	X	X	–	X	X	–	–	X	X	–	–	X
Decapoda (crayfish)	X	–	X	–	–	–	–	X	X	X	X	X	X	–	–
Isopoda (sowbugs)	–	–	X	X	X	–	X	–	–	–	–	–	X	–	–
Insecta															
Ephemeroptera (mayflies)															
Baetiscidae	–	–	X	X	X	–	–	–	–	–	X	–	X	X	–
Baetidae	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Caenidae	–	–	X	–	–	–	–	–	–	X	X	–	–	X	X
Ephemerellidae	X	–	X	X	X	–	X	–	X	X	X	X	X	X	X
Ephemeridae	X	–	–	X	X	–	X	–	–	–	–	X	–	X	X
Heptageniidae	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Table 18b.–Continued.

Taxa	Laperell Ck-Laperell Rd	Mullett Ck – near Crump Rd	E B Maple R.-Douglas Lk Rd	Maple R.-Maple R. Rd	Maple R.-Robinson Rd	McPhee Ck-Valley Rd	Minnehaha Ck-Pickerel Lk Rd	Little Pigeon R.-Silery Rd	Pigeon R.-M68 Highway	Pigeon R.-Webb Rd	Little Pigeon R.-Webb Rd	Pigeon R.-Elk Hill Campground	Pigeon R.-Sturgeon Valley Rd	Pigeon R.-Old Vanderbilt Rd	Pigeon R.-Whitehouse Trail
Isonychiidae	–	–	–	X	–	–	–	X	X	X	–	X	X	–	–
Leptophlebiidae	X	–	–	X	–	–	–	–	–	–	–	X	–	–	X
Tricorythidae	–	–	–	–	–	–	–	–	–	–	X	X	X	X	–
Odonata															
Anisoptera (dragonflies)															
Aeshnidae	X	–	X	X	X	X	–	X	X	X	X	X	X	X	–
Cordulegastridae	X	–	X	–	–	X	–	X	–	–	X	–	–	–	–
Gomphidae	–	–	–	–	X	–	–	X	X	X	X	–	X	X	X
Zygoptera (damselflies)															
Calopterygidae	–	–	X	X	–	–	–	X	X	X	X	X	X	–	–
Coenagrionidae	–	–	X	–	–	–	–	–	X	–	–	–	–	–	–
Lestidae	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Plecoptera (stoneflies)															
Leuctridae	–	X	–	–	–	–	–	–	–	–	X	–	–	X	–
Numouridae	X	X	–	–	–	X	X	–	–	–	–	–	–	X	X
Perlidae	–	–	X	X	X	–	–	X	X	X	X	X	X	X	–
Perlodida	–	X	–	X	X	–	X	–	–	–	–	–	–	–	–
Pteronarcyidae	–	–	–	X	X	–	–	–	X	–	X	–	X	X	X
Hemiptera (true bugs)															
Belostomatidae	–	–	–	–	–	–	–	–	X	–	–	–	–	–	–
Corixidae	–	–	X	–	X	–	–	–	X	X	–	X	X	X	X
Gerridae	X	X	X	X	X	X	X	X	–	X	X	X	X	X	X
Mesoveliidae	–	–	–	–	–	–	–	–	–	X	X	X	–	X	X
Nepidae	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Veliidae	–	–	–	–	–	–	–	–	X	–	–	–	–	–	–

Table 18b.–Continued.

Taxa	Laperell Ck-Laperell Rd	Mullett Ck – near Crump Rd	E B Maple R.-Douglas Lk Rd	Maple R.-Maple R. Rd	Maple R.-Robinson Rd	McPhee Ck-Valley Rd	Minnehaha Ck-Pickerel Lk Rd	Little Pigeon R.-Silery Rd	Pigeon R.-M68 Highway	Pigeon R.-Webb Rd	Little Pigeon R.-Webb Rd	Pigeon R.-Elk Hill Campground	Pigeon R.-Sturgeon Valley Rd	Pigeon R.-Old Vanderbilt Rd	Pigeon R.-Whitehouse Trail
Megaloptera															
Corydalidae (dobson flies)	X	–	X	X	X	–	–	–	X	X	X	X	X	X	–
Sialidae (alder flies)	X	X	–	–	–	X	X	–	–	X	–	X	X	X	–
Neuroptera (spongilla flies)															
Sisyridae	–	–	–	–	–	–	–	–	–	–	–	–	X	–	–
Trichoptera (caddisflies)															
Brachycentridae	X	–	–	X	X	–	–	X	X	X	X	X	X	X	X
Glossosomatidae	X	X	X	X	X	X	–	–	X	X	–	X	–	X	–
Helicopsychidae	–	–	X	–	–	–	–	–	–	X	–	X	X	X	–
Hydropsychidae	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Hydroptilidae	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Lepidostomatidae	X	X	–	X	X	X	–	–	–	–	X	–	–	–	X
Leptoceridae	–	–	X	X	X	X	–	X	X	X	X	X	X	X	X
Limnephilidae	X	X	X	X	X	X	–	X	X	X	X	X	X	X	X
Molannidae	–	–	X	X	X	–	–	–	–	–	–	–	–	–	–
Philopotamidae	X	X	–	X	X	X	X	X	X	–	–	–	–	X	X
Phryganeidae	–	–	–	–	–	–	–	–	–	X	X	–	–	–	–
Polycentropodidae	–	–	–	X	X	–	–	X	–	X	X	X	–	–	–
Psychomyiidae	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Rhyacophilidae	–	X	–	–	–	X	X	–	–	–	–	–	–	–	–
Uenoidae	–	X	X	X	X	X	–	X	X	X	–	X	X	X	–
Coleoptera (beetles)															
Dryopidae	–	–	–	–	–	–	–	X	X	–	–	–	–	X	–
Dytiscidae (total)	–	X	X	X	X	X	–	–	X	–	–	–	X	–	–

Table 18b.–Continued.

Taxa	Laperell Ck-Laperell Rd	Mullett Ck – near Crump Rd	E B Maple R.-Douglas Lk Rd	Maple R.-Maple R. Rd	Maple R.-Robinson Rd	McPhee Ck-Valley Rd	Minnehaha Ck-Pickerel Lk Rd	Little Pigeon R.-Silery Rd	Pigeon R.-M68 Highway	Pigeon R.-Webb Rd	Little Pigeon R.-Webb Rd	Pigeon R.-Elk Hill Campground	Pigeon R.-Sturgeon Valley Rd	Pigeon R.-Old Vanderbilt Rd	Pigeon R.-Whitehouse Trail
Elmidae	X	X	X	X	X	X	–	X	X	X	X	X	X	X	X
Gyrinidae (larvae)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Gyrinidae (adults)	X	–	–	–	–	–	–	–	–	–	–	–	–	–	X
Haliplidae (larvae)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Haliplidae (adults)	–	–	X	–	–	–	–	–	–	–	X	–	–	–	–
Hydrophilidae (total)	X	–	–	–	–	–	–	–	X	X	–	X	X	–	X
Psephenidae (larvae)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Diptera (flies)															
Athericidae	–	–	–	–	–	X	–	–	X	X	X	X	–	–	X
Ceratopogonidae	–	–	–	X	X	–	X	X	–	–	X	–	X	–	–
Chironomidea	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Culicidae	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Dixidae	–	–	–	–	–	–	–	–	X	–	–	–	–	X	X
Simuliidae	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Stratiomyidae	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Tabanidae	–	–	–	–	–	–	–	–	–	–	–	X	X	X	–
Tipulidae	X	X	X	–	X	X	X	X	–	–	–	–	–	–	X
MOLLUSCA															
Gastropoda (snails)															
Ancylidae (limpets)	–	–	X	X	–	–	–	–	–	–	–	–	–	–	–
Lymnaeidae	–	–	X	–	–	–	–	–	–	–	–	–	–	–	–
Physidae	X	–	X	X	X	X	–	X	X	–	X	X	X	X	X
Planorbidae	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Plauronceridae	–	–	–	–	–	–	–	–	X	X	–	X	X	–	–

Table 18b.–Continued.

Taxa	Laperell Ck-Laperell Rd	Mullett Ck – near Crump Rd	E B Maple R.-Douglas Lk Rd	Maple R.-Maple R. Rd	Maple R.-Robinson Rd	McPhee Ck-Valley Rd	Minnehaha Ck-Pickerel Lk Rd	Little Pigeon R.-Silery Rd	Pigeon R.-M68 Highway	Pigeon R.-Webb Rd	Little Pigeon R.-Webb Rd	Pigeon R.-Elk Hill Campground	Pigeon R.-Sturgeon Valley Rd	Pigeon R.-Old Vanderbilt Rd	Pigeon R.-Whitehouse Trail
Pomaiopsidae	–	–	–	–	–	–	–	–	X	–	–	–	–	–	–
Viviparidae	–	–	X	–	–	–	–	–	–	–	–	–	–	–	–
Pelecypoda (bivalves)															
Pisidiidae	X	–	X	–	–	–	X	X	X	X	–	X	X	–	X
Sphaeriidae (clams)	–	–	X	X	X	X	X	–	X	X	X	X	X	X	–
Unionidae (mussels)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Total Number of Taxa	29	20	38	37	37	25	21	29	38	35	34	39	40	36	31
Macroinvertebrate Community Rating[a]	EXC	EXC	ACC	EXC	EXC	EXC	ACC	EXC	EXC	EXC	EXC	EXC	EXC	EXC	EXC

[a] ACC=acceptable; EXC=excellent

Table 18c.–Aquatic invertebrates in the Sturgeon River sub-watershed of the Cheboygan River watershed (modified from Walker 2008). Data code: X=present, dash (–) indicates not collected.

Taxa	Sturgeon R.-Fisher Woods Rd	Sturgeon R.-Rondo Rd	Sturgeon R.-Cornwall Grade Canoe Access	Sturgeon R.-Sturgeon Valley Rd	Sturgeon R.-Poquette Rd	Club Stream-Fontinalis Rd	Little Sturgeon R.-Crumley Ck Rd	W Br Sturgeon R.-Shire Rd	W Br Sturgeon R.-MacGregor Rd
PORIFERA (sponges)	–	–	–	–	–	–	–	–	–
PLATYHELMINTHES (flatworms)									
Turbellaria	–	–	–	–	–	–	–	–	
BRYOZOA (moss animals)	–	–	–	–	–	–	–	–	–
ANNELIDA (segmented worms)									
Hirudinea (leeches)	–	–	–	–	–	–	–	–	–
Oligochaeta (worms)	X	X	X	–	X	–	X	X	–
ARTHROPODA									
Arachnoidea									
Hydracarina	X	X	X	X	X	X	–	X	X
Crustacea									
Amphipoda (scuds)	X	X	X	X	–	X	X	X	X
Decapoda (crayfish)	X	X	X	–	–	X	–	–	X
Isopoda (sowbugs)	X	X	X	–	X	X	–	X	–
Insecta									
Ephemeroptera (mayflies)									
Baetiscidae	–	–	–	X	X	–	–	X	–
Baetidae	X	X	X	X	X	X	X	X	X
Caenidae	–	–	X	–	–	–	X	–	X
Ephemerellidae	X	X	X	X	X	X	X	X	X
Ephemeridae	–	–	X	X	X	X	X	X	X
Heptageniidae	X	X	X	X	X	X	X	–	X
Isonychiidae	X	X	–	–	–	X	–	–	X
Leptophlebiidae	–	–	–	–	X	–	X	–	X
Tricorythidae	X	–	–	–	–	X	–	–	X
Odonata									
Anisoptera (dragonflies)									
Aeshnidae	X	X	X	–	–	X	X	X	X
Cordulegastridae	X	X	–	–	–	–	X	X	X
Gomphidae	–	–	–	–	–	–	–	–	X
Zygoptera (damselflies)									
Calopterygidae	X	–	X	X	–	X	X	X	X
Coenagrionidae	–	–	–	–	–	–	–	–	–
Lestidae	–	–	–	–	–	–	–	–	–
Plecoptera (stoneflies)									
Leuctridae	–	–	–	–	–	–	X	X	–
Nemouridae	–	–	–	X	X	–	X	X	–
Perlidae	X	X	X	–	–	X	X	–	–

Table 18c.–Continued.

Taxa	Sturgeon R.-Fisher Woods Rd	Sturgeon R.-Rondo Rd	Sturgeon R.-Cornwall Grade Canoe Access	Sturgeon R.-Sturgeon Valley Rd	Sturgeon R.-Poquette Rd	Club Stream-Fontinalis Rd	Little Sturgeon R.-Crumley Ck Rd	W Br Sturgeon R.-Shire Rd	W Br Sturgeon R.-MacGregor Rd
Perlodida	X	X	X	X	X	–	–	–	X
Pteronarcyidae	–	–	–	–	X	–	X	X	–
Hemiptera (true bugs)									
Belostomatidae	–	–	–	–	–	–	–	–	–
Corixidae	–	–	X	–	–	–	–	X	–
Gerridae	X	X	X	X	X	X	X	X	X
Mesoveliidae	–	–	–	–	–	–	–	–	–
Nepidae	–	–	–	–	–	–	–	–	–
Pleidae	X	–	–	–	–	–	–	–	–
Veliidae	–	–	–	–	X	X	–	–	–
Megaloptera									
Corydalidae (dobson flies)	X	X	X	X	–	X	X	X	X
Sialidae (alder flies)	X	–	X	–	–	–	–	–	–
Trichoptera (caddisflies)									
Brachycentridae	X	X	X	X	X	X	X	X	X
Glossosomatidae	X	X	X	–	–	X	–	X	X
Helicopsychidae	X	X	X	–	–	–	–	–	X
Hydropsychidae	X	X	X	X	X	X	X	X	X
Hydroptilidae	–	–	–	–	–	–	–	–	–
Lepidostomatidae	X	X	X	X	X	X	–	X	X
Leptoceridae	X	–	X	–	–	X	–	–	X
Limnephilidae	X	X	X	X	X	X	X	X	X
Molannidae	–	–	–	–	–	–	–	–	–
Philopotamidae	–	X	X	–	X	X	X	X	X
Phryganeidae	–	–	–	–	X	–	–	X	–
Polycentropodidae	X	X	X	X	X	–	X	–	X
Psychomyiidae	–	–	–	–	–	–	–	–	–
Uenoidae	X	X	X	–	–	X	X	X	–
Coleoptera (beetles)									
Dryopidae	–	X	–	X	–	–	–	–	–
Dytiscidae (total)	–	–	–	–	–	–	–	–	–
Elmidae	X	X	X	–	–	X	–	X	X
Gyrinidae (larvae)	–	–	–	X	–	–	–	–	–
Gyrinidae (adults)	–	–	–	–	–	–	–	–	–
Haliplidae (larvae)	–	–	–	–	–	–	–	–	–
Haliplidae (adults)	X	–	–	–	–	–	–	–	–
Hydrophilidae (total)	–	–	X	X	X	X	X	X	X
Psephenidae (larvae)	–	–	–	–	–	–	–	–	–
Diptera (flies)									
Athericidae	X	X	–	X	X	X	–	X	X

Table 18c.–Continued.

Taxa	Sturgeon R.-Fisher Woods Rd	Sturgeon R.-Rondo Rd	Sturgeon R.-Cornwall Grade Canoe Access	Sturgeon R.-Sturgeon Valley Rd	Sturgeon R.-Poquette Rd	Club Stream-Fontinalis Rd	Little Sturgeon R.-Crumley Ck Rd	W Br Sturgeon R.-Shire Rd	W Br Sturgeon R.-MacGregor Rd
Ceratopogonidae	–	–	–	X	X	–	X	X	–
Chironomidea	X	X	X	X	X	X	X	X	X
Culicidae	–	–	–	–	–	–	–	–	–
Simuliidae	X	X	X	X	X	X	X	X	–
Stratiomyidae	–	–	–	–	–	–	–	–	–
Tabanidae	–	–	X	–	X	–	X	X	–
Tipulidae	–	–	–	–	–	X	–	–	–
MOLLUSCA									
Gastropoda (snails)									
Ancylidae (limpets)	–	–	–	–	–	–	–	–	–
Lymnaeidae	–	–	–	–	–	–	–	–	–
Physidae	X	X	X	X	–	–	–	X	X
Planorbidae	–	–	–	–	–	–	X	–	–
Plauronceridae	–	–	–	–	–	–	–	–	–
Viviparidae	–	–	–	–	–	–	–	–	–
Pelecypoda (bivalves)									
Pisidiidae	–	X	X	–	X	–	–	X	–
Sphaeriidae (clams)	X	–	–	X	–	–	–	X	–
Unionidae (mussels)	–	–	–	–	–	–	–	–	–
Total Number of Taxa	35	31	35	26	28	30	29	35	32
Macroinvertebrate Community Rating[a]	EXC	EXC	EXC	EXC	EXC	EXC	EXC	EXC	ACC

[a] ACC=acceptable; EXC=excellent

Table 19.–Amphibian and reptile species found in counties of the Cheboygan River watershed (Holman et al. 1993, Harding and Holman 1992, and Harding and Holman 1990). Threatened (T) and Special Concern (SC) species are noted. O=Otsego, M=Montmorency, V=Charlevoix, C=Cheboygan, and P=Presque Isle.

Common name	Scientific name	O	M	V	C	P
Frogs and Toads						
eastern American toad	*Bufo americanus americanus*	X	X	X	X	X
eastern gray tree frog	*Hyla versicolor*	X	X	X	X	X
northern spring peeper	*Pseudacris crucifer crucifer*	X	X	X	X	X
western chorus frog	*Pseudacris triseriata triseriata*	X	X	X	X	X
bull frog	*Rana catesbeiana*	X	X	X	X	X
green frog	*Rana clamitans melanota*	X	X	X	X	X
pickerel frog	*Rana palustris*	X	X	X	X	X
northern leopard frog	*Rana pipiens*	X	X	X	X	X
wood frog	*Rana sylvatica*	X	X	X	X	X
Salamanders						
blue-spotted salamander	*Ambystoma laterale*	X	X	X	X	X
spotted salamander	*Ambystoma maculatum*	X	X	X	X	X
eastern tiger salamander	*Ambystoma tigrinum tigrinum*	X	X			
four-toed salamander	*Hemidactylium scutatum*	X	X	X	X	X
mudpuppy	*Necturus maculosus maculosus*	X	X	X	X	X
eastern newt-central subspecies	*Notophthalmus viridescens louisianensis*	X	X	X	X	X
red-backed salamander	*Plethodon cinereus*	X	X	X	X	X
Snakes and lizards						
northern ringneck snake	*Diadophis punctatus edwardsi*	X	X	X	X	X
five-lined skink	*Eumeces fasciatus*	X	X	X	X	X
eastern hognose snake	*Heterodon platirhinos*	X	X	X	X	X
blue racer	*Coluber constrictor*	X				
eastern milk snake	*Lampropeltis tringulum triangulum*	X	X	X	X	X
northern water snake	*Nerodia sipedon sipedon*	X	X	X	X	X
eastern smooth green snake	*Opheodrys vernalis vernalis*	X	X	X	X	X
eastern massasauga rattlesnake (SC)	*Sistrurus catenatus catenatus*	X	X	X	X	X
brown snake	*Storeria dekayi*	X	X	X	X	X
northern red-bellied snake	*Storeria occipitomaculate occipitomaculate*	X	X	X	X	X
northern ribbon snake	*Thamnophis sauritus septentrionalis*	X	X	X	X	X
eastern garter snake	*Thamnophis sirtalis sirtalis*	X	X	X	X	X
Turtles						
snapping turtle	*Chelydra serpentine*	X	X	X	X	X
painted turtle	*Chrysemys picta*	X	X	X	X	X
wood turtle (SC)	*Clemmys insculpta*	X	X	X	X	X
Blanding's turtle (SC)	*Emydoidea blandingii*	X	X	X	X	X
common musk turtle	*Sternotherus odoratus*	X	X	X	X	X

Table 20.–Breeding bird species associated with wetland habitats-Otsego, Montmorency, Emmet, Cheboygan, and Presque Isle counties, MI (Doepker et al. 2001). SC=special concern, T=threatened, E=endangered.

Common name	Scientific name
Gaviidae (loons)	
Common loon (T)	*Gavia immer*
Colymbidae (grebes)	
Pied-billed grebe	*Podilymbus podiceps*
Phalacrocoracidae (cormorants)	
Double-crested cormorant	*Phalacrocorax auritus*
Ardeidae (herons)	
Great blue heron	*Ardea herodias*
Green-backed heron	*Butorides striatus*
American bittern	*Botaurus lentiginosus*
Least bittern (SC)	*Ixobrychus exilis*
Black-crowned night heron (SC)	*Nycticorax nycticorax*
Greater egret	*Casmerodius albus*
Anatidae (swans, geese and ducks)	
Canada goose	*Branta canadensis*
Mallard	*Anas platyrhynchos*
American black duck	*Anas rubripes*
Blue winged teal	*Anas discors*
Green winged teal	*Anas crecca*
Gadwall	*Anas streperas*
Wood duck	*Aix sponsa*
Ring-necked duck	*Aythya collaris*
Common goldeneye	*Bucephala clangula*
Hooded merganser	*Lophodytes cucullatus*
Common merganser	*Mergus merganser*
Red-breasted merganser	*Mergus serrator*
Charadriidae (plovers)	
Piping plover (E)	*Charadrius melodus*
Laridae (gulls and terns)	
Herring gull	*Larus argentatus*
Ring-billed gull	*Larus dealawarensis*
Black tern (SC)	*Chlidonias niger*
Caspian tern (T)	*Sterna caspia*
Common tern (T)	*Sterna hirundo*
Accipitridae (hawks and eagles)	
Cooper’s hawk	*Accipiter cooperii*
Red-tailed hawk	*Buteo jamaicensis*
Red-shouldered hawk (T)	*Buteo lineatus*
Bald eagle (T)	*Haliaeetus Ieucicephalus*
Northern harrier (SC)	*Circus cyaneus*
Pandionidae (ospreys)	
Osprey (T)	Pandion haliaetus

Table 20.–Continued.

Common name	Scientific name
Falconidae (falcons)	
Merlin (T)	*Falco columbarius*
Tetraonidae (grouse)	
Ruffed grouse	*Bonasa umbellus*
Gruidae (cranes)	
Sandhill crane	*Grus canadensis*
Rallidae (rails)	
Virginia rail	*Rallus limicola*
Sora	*Porzana carolina*
American coot	*Fulica americana*
Common moorhen (SC)	*Gallinula chloropus*
Charadriidae (plovers)	
Killdeer	*Charadrius vociferus*
Scolopacidae (sandpipers)	
American woodcock	*Scolopax minor*
Common snipe	*Gallinago gallinago*
Spotted sandpiper	*Actitis macularia*
Upland sandpiper	*Bartramia longicauda*
Cuculidae (cuckoos)	
Yellow-billed cuckoo	*Coccyzus americanus*
Black-billed cuckoo	*Coccyzus erythropthalmus*
Tytonidae (barn owls)	
Great horned owl	*Bubo virginianus*
Barred owl	*Strix varia*
Long-eared owl (E)	*Asio otus*
Northern saw-shet owl	*Aegolius acadicus*
Eastern screech-owl	*Otus asio*
Common nighthawk	*Chordeiles minor*
Trochilidae (hummingbirds)	
Ruby-throated hummingbird	*Archilochus colubris*
Alcedinidae (kingfishers)	
Belted kingfisher	*Ceryle alcyon*
Picidae (woodpeckers)	
Red-bellied woodpecker	*Melanerpes carolinus*
Downy woodpecker	*Picoides pubescens*
Hairy woodpecker	*Picoides villosus*
Black-backed woodpecker	*Picoides arcticus*
Pileated woodpecker	*Dryocopus pileatus*
Tyrannidae (flycatchers)	
Olive-sided flycatcher	*Contopus cooperi*
Alder flycatcher	*Empidonax alnorum*
Willow flycatcher	*Empidonax traillii*
Great crested flycatcher	*Myiarchus crinitus*
Eastern kingbird	*Tyrannus tyrannus*

Table 20.–Continued.

Common name	Scientific name
Alaudidae (larks)	
Tree swallow	*Tachycineta bicolor*
Bank swallow	*Riparia riparia*
Barn swallow	*Hirundo rustica*
Cliff swallow	*Petrochelidon pyrrhonota*
Purple martin	*Progne subis*
Northern rough-winged swallow	*Stelgidopteryx serripennis*
Paridae (titmice)	
Black-capped chickadee	*Poecile atricapillus*
Tufted titmouse	*Baeolophus bicolor*
Sittidae (nuthatches)	
Red-breasted nuthatch	*Sitta canadensis*
Certhiidae (creepers)	
Brown creeper	*Certhia americana*
Troglodytidae (wrens)	
House wren	*Troglodytes aedon*
Winter wren	*Troglodytes troglodytes*
Carolina wren	*Thryothorus ludovicianus*
Sedge wren	*Cistothorus platensis*
Marsh wren (SC)	*Cistothorus palustris*
Mimidae (mockingbirds/thrashers)	
Gray catbird	*Dumetella carolinensis*
Turdidae (thrushes)	
American robin	*Turdus migratorius*
Wood thrush	*Hylocichla mustelina*
Swainson’s thrush	*Catharus ustulatus*
Veery	*Catharus fuscescens*
Sylviidae (gnatcatchers/kinglets)	
Blue-gray gnatcatcher	*Polioptila caerulea*
Golden-crowned kinglet	*Regulus satrapa*
Ruby-crowned kinglet	*Regulus calendulas*
Bombycillidae (waxwings)	
Cedar waxwing	*Bombycilla cedrorum*
Vireonidae (vireos)	
Yellow-throated vireo	*Vireo flavifrons*
Philadelphia vireo	*Vireo philadelphicus*
Red-eyed vireo	*Vireo olivaceus*
Parulidae (warblers)	
Northern parula	*Parula americana*
Nashville warbler	*Vermivora ruficapilla*
Yellow warbler	*Dendroica petechia*
Yellow-rumped warbler	*Dendroica coronata*
Cape May warbler	*Dendroica tigrina*
Black-and-white warbler	*Mniotilta varia*
American redstart	*Setophaga ruticilla*

Table 20.–Continued.

Common name	Scientific name
Northern waterthrush	*Seiurus noveboracensis*
Mourning warbler	*Oporornis philadelphia*
Connecticut warbler	*Oporornis agilis*
Common yellowthroat	*Geothlypis trichas*
Fringillidae (Finches, sparrows, buntings)	
Northern cardinal	*Cardinalis cardinalis*
Red crossbill	*Loxia curvirostra*
Rose-breasted grosbeak	*Pheucticus ludovicianus*
Savannah sparrow	*Passerculus sandwichensis*
Henslow's sparrow (SC)	*Ammodramus henslowii*
Song sparrow	*Melospiza melodia*
Lincoln's sparrow	*Melospiza lincolnii*
Swamp sparrow	*Melospiza georgiana*
White-throated sparrow	*Zonotrichia albicollis*
Icteridae (blackbirds and orioles)	
Red-winged blackbird	*Agelaius phoeniceus*
Brewer's blackbird	*Euphagus cyanocephalus*
Common grackle	*Quiscalus quiscula*
Northern oriole	*Icterus galbula*
Ploceidae (finches)	
Purple finch	*Carpodacus purpureus*
Pine siskin	*Carduelis pinus*

Table 21.–Mammals in the Cheboygan River watershed (Baker 1983). Threatened (T) and special concern (SC) species are noted.

Common name	Scientific name
Marsupiala (pouched mammals)	
opossum	*Didelphis virginiana*
Insectivora (shrews,moles, and allies)	
eastern mole	*Scalopus aquaticus*
starnose mole	*Condylura cristata*
masked shrew	*Sorex cinereus*
pygmy shrew	*Sorex hoyi*
water shrew	*Sorex palustris*
shorttail shrew	*Blarina brevicauda*
Chiroptera (bats and flying mammals)	
little brown myotis	*Myotis lucifugus*
silver-haired bat	*Lasionycteris noctivagans*
big brown bat	*Eptesicus fuscus*
red bat	*Lasiurus borealis*
hoary bat	*Lasiurus cinereus*
Lagamorpha (rabbits, hares and picas)	
snowshoe hare	*Lepus americanus*
eastern cottontail	*Sylvilagus floridanus*
Rodentia (rodents)	
eastern chipmunk	*Tamias striatus*
woodchuck	*Marmota monax*
thirteen-lined ground squirrel	*Spermophilus tridecemlineatus*
eastern gray squirrel	*Sciurus carolinensis*
eastern fox squirrel	*Sciurus niger*
red squirrel	*Tamiasciurus hudsonicus*
northern flying squirrel	*Glaucomys sabrinus*
beaver	*Castor canadensis*
white-footed mouse	*Peromyscus leucopus*
deer mouse	*Peromyscus maniculatus*
meadow vole	*Microtus pennsylvanicus*
southern red-backed vole	*Clethrionomys gapperi*
woodland vole (SC)	*Microtus pinetorum*
muskrat	*Ondatra zibethicus*
southern bog lemming	*Synaptomys cooperi*
Norway rat	*Rattus norvegicus*
house mouse	*Mus musculus*
meadow jumping mouse	*Zapus hudsonius*
woodland jumping mouse	*Napaeozapus insignis*
porcupine	*Erethizon dorsatum*
Carnivora (flesh eaters)	
coyote	*Canis latrans*
red fox	*Vulpes vulpes*
gray fox	*Urocyon cinereoargenteus*
black bear	*Ursus americanus*
raccoon	*Procyon lotor*

Table 21.–Continued.

Common name	Scientific name
marten (T)	*Martes americana*
ermine	*Mustela erminea*
long-tailed weasel	*Mustela frenata*
least weasel	*Mustela nivalis*
mink	*Mustela vison*
American badger	*Taxidea taxus*
striped skunk	*Mephitis mephitis*
river otter	*Lutra canadensis*
bobcat	*Lynx rufus*
Artiodactyla (even-toed ungulates)	
eastern elk	*Cervus elaphus*
whitetail deer	*Odocoileus virginianus*

Table 22.–Natural features in the Cheboygan River watershed. Status codes: E=endangered; T=threatened; SC=Special Concern. Blanks occur when none of the status categories apply. Michigan Department of Natural Resources, Natural Features Inventory, unpublished data.

Common name	Scientific name	State status
Vertebrate		
lake sturgeon	*Acipenser fulvescens*	T
Northern goshawk	*Accipiter gentiles*	SC
Grasshopper sparrow	*Ammodramus savannarum*	SC
Red-shouldered hawk	*Buteo lineatus*	T
Black tern	*Chlidonias niger*	SC
lake herring	*Coregonus artedi*	T
Blanding's turtle	*Emydoidea blandingii*	SC
Common loon	*Gavia immer*	T
wood turtle	*Glyptemys insculpta*	SC
Bald eagle	*Haliaeetus leucocephalus*	T
woodland vole	*Microtus pinetorum*	SC
pugnose shiner	*Notropis anogenus*	SC
Osprey	*Pandion haliaetus*	T
channel darter	*Percina copelandi*	E
King rail	*Rallus elegans*	E
eastern massasauga	*Sistrurus catenatus catenatus*	SC
Invertebrate		
secretive locust	*Appalachia arcana*	SC
spike-lip crater	*Appalachina sayanus*	SC
dusted skipper	*Atrytonopsis hianna*	T
slough grass	*Beckmannia syzigachne*	T
Hungerford's crawling water beetle	*Brychius hungerfordi*	E
watercress snail	*Fontigens nickliniana*	SC
splendid clubtail	*Gomphus lineatifrons*	SC
Henry's elfin	*Incisalia henrici*	SC
three-striped oncocnemis	*Oncocnemis piffardi*	SC
three-horned moth	*Pachypolia atricornis*	SC
eastern flat-whorl	*Planogyra asteriscus*	SC
aquatic snail	*Planorbella smithi*	SC
red-legged spittlebug	*Prosapia ignipectus*	SC
grizzled skipper	*Pyrgus Wyandot*	SC
Douglas stenelmis riffle beetle	*Stenelmis douglasensis*	SC
Lake Huron locust	*Trimerotropis huroniana*	T
Vascular Plant		
pale agoseris	*Agoseris glauca*	T
round-leaved orchis	*Amerorchis rotundifolia*	E
lake cress	*Armoracia lacustris*	T
goblin moonwort	*Botrychium mormo*	T
Pumpelly's brome grass	*Bromus pumpellianus*	T
large water-starwort	*Callitriche heterophylla*	T
fairy-slipper	*Calypso bulbosa*	T

Table 22.–Continued.

Common name	Scientific name	State status
Hill's thistle	*Cirsium hillii*	SC
Pitcher's thistle	*Cirsium pitcheri*	T
ram's head lady's slipper	*Cypripedium arietinum*	SC
false violet	*Dalibarda repens*	T
English sundew	*Drosera anglica*	SC
early hairstreak	*Erora laeta*	SC
rough fescue	*Festuca scabrella*	T
limestone oak fern	*Gytmnocarpium robertianum*	T
whiskered sunflower	*Helianthus hirsutus*	SC
bayonet rush	*Juncus militaris*	T
Michigan monkey flower	*Mimulus michiganensis*	E
bog bluegrass	*Poa paludigena*	T
Hill's pondweed	*Potamogeton hillii*	T
sloe plum	*Prunus alleghaniensis*	SC
blunt-lobed woodsia	*Woodsia obtuse*	T
Plant community		
dry-mesic northern forest		
intermittent wetland		
northern fen		
pine barrens		
Other features		
Great blue heron rookery		
lichen	*Menegazzia terebrata*	

Table 23.–Fish stocking, by county, in the Cheboygan River watershed, 1979-2007. Data from Michigan Department of Natural Resources Fisheries Division records. Includes known private fish stockings and rearing marsh plants.

County Location	Species	Years	Number stocked in period
Charlevoix			
Hoffman Lake	walleye	93–94	2,800
Thumb (Louise) Lake	lake trout	79–80	20,000
	rainbow trout	89, 07	44,068
	splake	81–06	512,870
Cheboygan			
Black Lake	lake sturgeon	82–84, 88	11,512
	walleye	89–93	50,650
Black River	lake sturgeon	01–03, 05–07	16,668
Burt Lake	atlantic salmon	86	38
	lake sturgeon	83–84, 90	13,543
	rainbow trout	87	194,963
	walleye	89–93	88,976
Cheboygan River	brown trout	88	10,000
	chinook salmon	03–07	410,766
	lake trout	01	115,425
	rainbow trout	80–07	488,600
Cornwall Impoundment	tiger musky	79–91 (alt yrs)	4,850
Douglas Lake	northern pike	79–80, 82–86, 88–89, 93–97, 99–04	425,682
Hemlock Lake	brook trout	07	295
	brown trout	82	148
	rainbow trout	92	600
Indian River	muskellunge	89–93, 96–97	69,320
Little Sturgeon River	brook trout	79–81, 83, 85, 88–99–03–07	26,135
	brown trout	92–99, 03–07	6,363
	rainbow trout	79–83, 85, 89–99, 03–07	41,953
Long Lake	walleye	79–86, 89–93, 97, 98, 00–01, 03, 05	869,655
Mullett Lake	brown trout	89, 91	60,000
	lake sturgeon	83–84, 90, 03, 05–07	18,007
	lake trout	79–87, 96–98	663,900
	rainbow trout	87, 89, 92, 07	76,258
	splake	87–88, 90–95	424,075
	walleye	99–03	413,870
Roberts Lake	hybrid sunfish	86	14,000
Silver Lake	rainbow trout	79–07	158,709
Sturgeon River	lake sturgeon	03, 05–07	4,338
	rainbow trout	79–93	213,757
Twin Lakes 2, 3, 4, 5	splake	82–88, 90–93	69,490
Weber Lake	brook trout	79–81, 83–87	18,140
	brown trout	88–07	50,990

Table 23.–Continued.

County Location	Species	Years	Number stocked in period
Emmet			
Crooked Lake	brown trout	88	127,410
	walleye	79–81, 84–86, 88–91, 94, 96, 98–00, 03–06	603,025
East Branch Maple River	brook trout	83–84	890
Four Lakes	brook trout	94-95	2,250
	rainbow trout	95	250
Maple River	brook trout	79, 86, 07	937
	brown trout	81-83	21,000
Pickerel Lake	walleye	81-85, 89, 94, 96, 98, 00, 04, 06	188,425
Round Lake	walleye	91, 95-96, 98	75,800
Silver Creek Pond	brook trout	81-85	2,250
	rainbow trout	79-85, 88, 90-94	17,300
Montmorency			
Clear Lake	rainbow trout	79-86, 89	59,300
	splake	88, 90-97, 99-07	139,540
Foch Lakes	largemouth bass	79	920
Lake Geneva	bluegill	05, 07	750
	hybrid sunfish	05	325
Town Corner Lake	brown trout	83	102
Wildfowl Lake	bluegill	05, 07	750
	hybrid sunfish	05	325
Otsego			
Big Lake	walleye	88, 91-05 (alt yrs)	98,000
Club Creek	brook trout	91, 98-99, 03-07	3, 900
	rainbow trout	90-07	14,545
Ford Lake	brown trout	82, 92	1,275
	rainbow trout	07	590
Lost Lake	brook trout	82, 85	770
North Twin Lake	brown trout	82, 92	600
Pickerel Lake	rainbow trout	79-07	82,022
Pigeon River	brook trout	84	23,300
Section Four Lake	brook trout	82, 85, 07	660
	brown trout	92	300
South Twin lake	brown trout	82, 92	518
Storey Lake	rainbow trout	03, 04	290
West Lost Lake	brook trout	82, 85	750
	rainbow trout	92, 07	570
Presque Isle			
Bear Den Lake	brook trout	05-07	4,590
	rainbow trout	04-07	8,514
Little Tomahawk Lake	brook trout	88	3,500
Rainy Lake	bluegill	79	700
	fathead minnow	79	17,250
	rainbow trout	80	1,200

Table 23.–Continued.

County Location	Species	Years	Number stocked in period
	walleye	99	1,400
	yellow perch	79	700
Shoepac Lake	brook trout	81, 84-88	13,694
	brown trout	88-93	20,774
	rainbow trout	79, 81-86	14,150

Table 24.–Trout stream fishing regulations by type (Anonymous 2008). LP = Lower Peninsula; UP = Upper Peninsula.

					Minimum size limit (in)						
Type	Open season	Possession season	Tackle	Daily possession limit	Brook trout	Brown trout	Rainbow trout (steelhead)	Splake	Lake trout	Coho, Chinook, & pink salmon	Atlantic salmon
1	Last Sat in April – Sept 30	Last Sat in April– Sept 30	All	5/3 [a]	8 LP 7 UP	8 LP 7 UP	10	8	24	10	15
2	Last Sat in April – Sept 30	Last Sat in April– Sept 30	All	5/3 [a]	10	12	12	10	24	10	15
3	All year	All year	All	5/3 [a]	15	15	15	15	24	10	15
4	All year	brown trout, brook trout, & Atlantic salmon: Last Sat in April– Sept 30 Other trout species all year	All	5/3 [a]	8	10	10	10	24	10	15

[a] 5 fish, with no more than 3 fish 15 inches or larger, and no more than 1 Atlantic salmon.

NOTE: It is unlawful to fish for any species or possess fishing devices along a stream closed to fishing.

Table 25.–Trout lake regulations by type.

Type	Open season	Possession season	Tackle	Daily possession limit	Minimum size limit (in)				
					Brook trout	Brown trout, rainbow trout, & splake	Lake trout	Coho, Chinook, & pink salmon	Atlantic salmon
A	Last Sat. in April – Sept. 30	Last Sat. in April – Sept. 30	All except minnows	5/3[a]	10	12	15	10	15
B	All year	All year	All	5/3[a]	10	12	15	10	15
C	All year	All year	All	5/3[a]	8	8	8	10	15
D	Last Sat. in April – Sept. 30	Last Sat. in April – Sept. 30	Artificial lures only[b]	1	15	15	15	10	15
E	All year	All year	All	3[c]	15	15	15	10	15
F	All year	Lake trout May 1 – Labor Day	All	5/3/2[d]	10	10	10	10	10
		Other trout species all year							

[a] 5 fish, with no more than 3 fish 15 inches or larger, and no more than 1 Atlantic salmon.
[b] On Type D lakes only artificial lures may be used. It is unlawful to use or possess live bait, dead or preserved bait, organic or processed food, or scented material on any of the waters or on shore.
[c] No more than 1 Atlantic salmon.
[d] Daily harvest limits: 5 in any combination, no more than 3 fish of any one species, except Lake trout and Splake, for Lake trout and Splake – 2 fish.

NOTE: It is unlawful to fish for any species or possess fishing devices along a stream closed to fishing.

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