STATE OF MICHIGAN
DEPARTMENT OF NATURAL RESOURCES

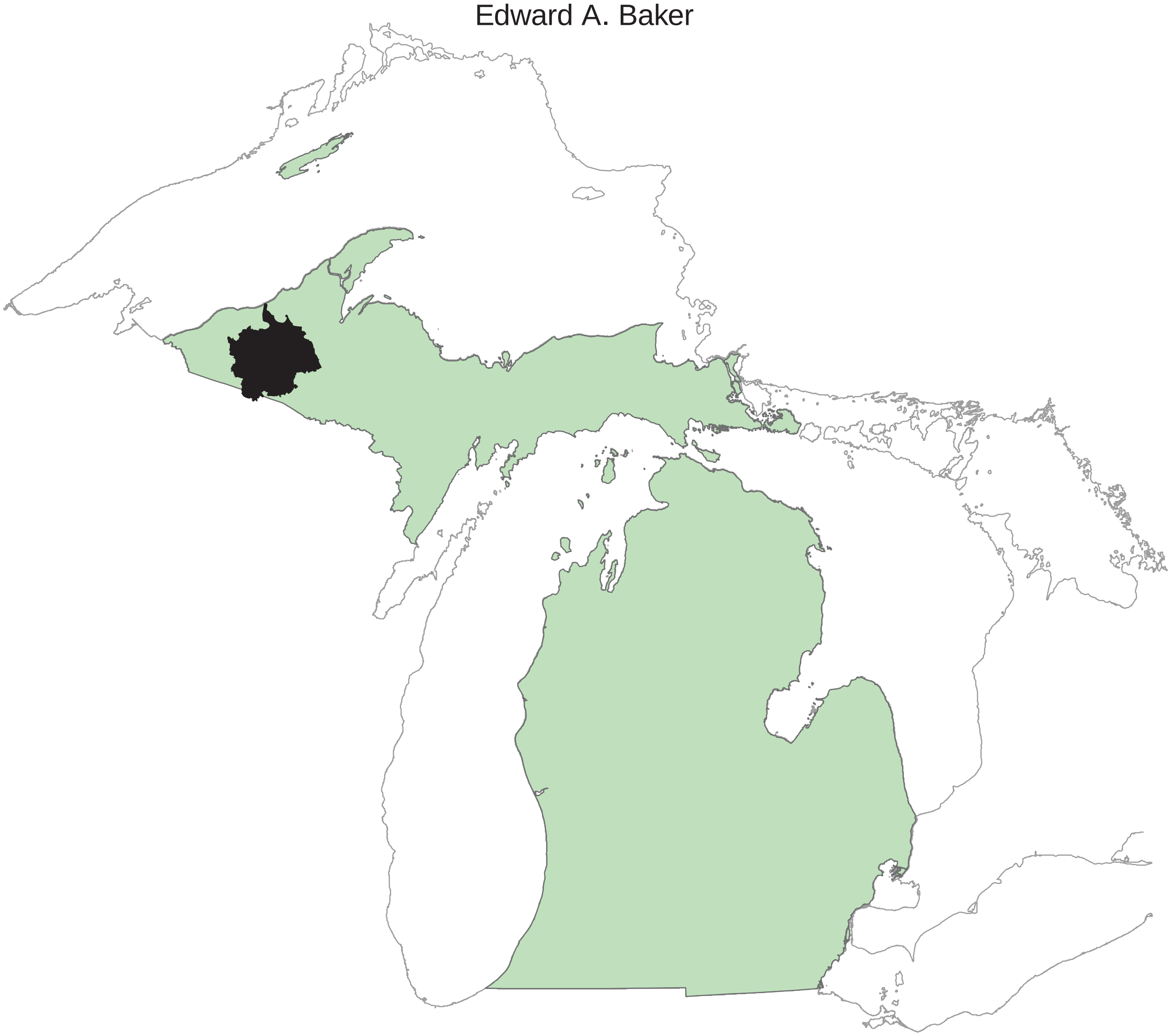
SR46 October 2008

Ontonagon River Assessment

Brian J. Gunderman

and

Edward A. Baker



www.michigan.gov/dnr/

FISHERIES DIVISION

SPECIAL REPORT 46

MICHIGAN DEPARTMENT OF NATURAL RESOURCES
FISHERIES DIVISION

Special Report 46
October 2008

Ontonagon River Assessment

Brian J. Gunderman
and
Edward A. Baker

Printed under authority of Michigan Department of Natural Resources
Total number of copies printed 40 — Total cost $1,769.56 — Cost per copy $44.24

Suggested Citation Format

Gunderman, B.J., and E.A. Baker. 2008. Ontonagon River assessment. Michigan Department of Natural Resources, Fisheries Special Report 46, Ann Arbor.

TABLE OF CONTENTS

LIST OF PHOTOGRAPHS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

ACKNOWLEDGMENTS

We thank the many individuals who contributed to this report. We especially appreciate the following individuals for their input and data for the different sections of this assessment: Barbara Mead, Michigan Department of State, Office of the State Archaeologist; Bruce Petersen, Natural Resources Conservation Service; John Pagel, United States Forest Service, Ottawa National Forest; Robert Kahl, United States Fish and Wildlife Service, Marquette Biological Station; Mitch Koetje and Tina Mitchell, Michigan Department of Environmental Quality, Water Bureau; James Ellis, United States Geological Survey, Water Resources Division; Stephen Gilbert and Michael Vogelsang, Wisconsin Department of Natural Resources, Bureau of Fisheries Management; Tina Tincher, Jessica Mistak, George Madison, Joseph Pearce, Valerie Miller, William Wellenkamp, and Barry Miller (retired), Michigan Department of Natural Resources, Fisheries Division. We are grateful for the assistance from previous river assessment authors whose documents served as guides during the development of this report. James Breck served as editor for this assessment, and additional comments were provided by our panel of reviewers: George Madison, Phil Schneeberger, and Joe Leonardi. Lidia Szabo Kraft, Al Sutton, and Ellen Johnston provided technical assistance during the creation of this report. Finally, we would like to thank Liz Hay-Chmielewski for overseeing and coordinating production of this river assessment.

EXECUTIVE SUMMARY

This river assessment is one of a series of documents being prepared by Michigan Department of Natural Resources (MDNR), Fisheries Division, for Michigan rivers. This report describes the physical and biological characteristics of the Ontonagon River, discusses how human activities have influenced the river, and serves as an information base for future management activities. Our approach is consistent with Fisheries Division's mission to "protect and enhance fish environments, habitat, and populations and other forms of aquatic life and to promote the optimum use of these resources for the benefit of the people of Michigan."

River assessments are intended to provide a comprehensive reference for citizens and agency personnel seeking information on a particular river. By compiling and synthesizing existing information, river assessments reveal the complex relationships between rivers, watershed landscapes, biological communities, and humans. This assessment shows the influence of humans on the Ontonagon River and provides an approach for identifying opportunities and addressing problems related to aquatic resources in the Ontonagon River watershed. We hope that this document will increase public awareness of the Ontonagon River and its challenges, and encourage citizens to become more actively involved in decision-making processes that provide sustainable benefits to the river and its users.

This document consists of three parts: an introduction, a river assessment, and management options. The river assessment is the nucleus of the report. It provides a description of the Ontonagon 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 part of the report identifies a variety of actions that could be taken to protect, restore, rehabilitate, or better understand the Ontonagon River. These management options are categorized and presented following the organization of the main sections of the river assessment. They are intended to provide a foundation for public discussion, assist in prioritization of projects, and facilitate planning of future management activities.

The Ontonagon River is located in the western Upper Peninsula of Michigan and drains an area of 1,362 square miles. Its watershed covers portions of five counties: Gogebic, Ontonagon, Houghton, Iron, and Vilas (Wisconsin). Although the main stem is relatively short, the combined length of the Ontonagon River and its tributaries is approximately 1,291 miles. There are 200 lakes larger than 10 acres within the Ontonagon River watershed. Lake Gogebic, with a surface area of 13,048 acres, is the largest lake in the Upper Peninsula.

For purpose of discussion, the Ontonagon River basin is divided into seven subwatersheds: upper Middle Branch (above Agate Falls), lower Middle Branch, Main Stem, East Branch, Cisco Branch, South Branch, and West Branch. Criteria used to set boundaries for the subwatersheds included drainage patterns, barriers to fish passage, confluences with major tributaries, and changes in geology or soil types.

The Ontonagon River watershed has a rich and varied history that can be traced back to the late Archaic Period (approximately 4,000 years ago). Prehistoric peoples mined copper within the basin and established hunting and fishing camps along the Ontonagon River and its tributaries. By the time of European settlement, Chippewa Indians had constructed elaborate weirs in the main stem to harvest lake sturgeon. European fur traders set up outposts within the watershed as early as the 1630s, but no permanent (European) settlements were established until the 1840s.

Two resources attracted European settlers to the region during the nineteenth century: copper and timber. Europeans had known about the rich copper deposits in the Ontonagon River basin since at least 1670, but the first profitable mine (in historic times) was not established until 1847. The main copper rush spanned only two decades, but mining activity continued at a reduced level until 1921. Soon after the copper boom subsided, the logging era began. During the 1880s and 1890s, the vast forests of the Ontonagon River basin were cut down and the main stem and its tributaries were used to transport logs to sawmills at the mouth of the river.

During the first half of the 20th century, various branches of the Ontonagon River were harnessed to provide hydroelectric power. Numerous farms were also founded during this period, but most were abandoned due to the harsh climate and infertile soils. The Ottawa National Forest, which includes roughly 57% of the Ontonagon River watershed, was established in the 1930s. In recent years, the lakes and streams of the Ontonagon River system have attracted thousands of visitors, and tourism has become an important part of the local economy.

The hydrology of the Ontonagon River system is strongly influenced by the surficial geology of the watershed. Coarse-textured materials predominate in the southern and extreme eastern and western portions of the basin. Water rapidly percolates through these materials, providing substantial groundwater inflow to streams in these areas. For example, the upper Middle Branch Ontonagon River and the headwaters of the East Branch Ontonagon River receive strong groundwater inflows that produce relatively stable water flows and temperatures. Large deposits of finer-textured materials exist in the north-central portion of the watershed. These materials are less permeable, so the South Branch, lower Middle Branch, and main stem Ontonagon rivers receive minimal groundwater inflow. Consequently, these streams have flashy flow regimes with rapidly varying water temperatures.

Soils influence the hydrology, channel morphology, and water quality of river systems. Sandy soils allow greater infiltration and groundwater production compared to relatively impermeable clay soils. In addition, sandy soils are more easily eroded than clay soils, so sedimentation and bank slumping can be major concerns in sandy watersheds. Sandy soils are common in the upper Middle Branch and Cisco Branch subwatersheds. The soils in the South Branch, lower Middle Branch, and Main Stem subwatersheds primarily are composed of finer particles such as clay and silt. Both sandy and silt-clay dominated soils are found in the East Branch and West Branch subwatersheds. Small regions of peat and muck dominated soils are scattered throughout the southern two-thirds of the basin.

Approximately 74% of the Ontonagon River watershed is forested; however, the species composition of the forest community has been altered by human activities. Acreage of lowland conifers has declined since European settlement of the region, while acreage of lowland hardwoods (primarily aspen) has increased dramatically. Wetlands are the second most abundant land cover type (15% of watershed area). Due to its remote location, wetland losses within the Ontonagon River basin have been less severe than in southern Michigan. Approximately 5% of the watershed is in agricultural use, and only 0.1% is classified as “urban/industrial.”

Gradient, or drop in elevation over distance, is an important indicator of fish habitat quality. The average gradient for the main stem and Middle Branch Ontonagon rivers is 11.1 ft/mi, which is considerably higher than the reported gradients for most Michigan rivers. Gradient varies throughout the watershed, ranging from 0.5 ft/mi at the mouth to 2,493 ft/mi at Victoria Falls. Gradient averages 12.6 ft/mi on the upper Middle Branch, 16.5 ft/mi on the lower Middle Branch, 2.4 ft/mi on the main stem, 12.2 ft/mi on the East Branch, 14.3 ft/mi on the Cisco Branch, 5.2 ft/mi on the South Branch, and 18.4 ft/mi on the West Branch.

The highest quality fish habitat generally is found in high gradient (5.0–69.9 ft/mi) stream reaches because a wide variety of water depths and velocities (i.e., habitat types) is available to fish in those areas. Relative abundance (expressed in percentage of stream length) of high gradient habitat varied widely between the different branches of the Ontonagon River system: main stem (12%), South Branch (31%), upper Middle Branch (47%), West Branch (73%), Cisco Branch (78%), East Branch (89%), and lower Middle Branch (98%). Although chutes and waterfalls (gradient ≥70 ft/mi) are present within the watershed, most of the remaining stream reaches have gradients lower than 5.0 ft/mi.

Fish habitat quality can also be evaluated by comparing channel cross-section measures with expected measures calculated from stream discharge data. Frequent flood events (e.g., from dam operations) create channels that are excessively wide. Unexpectedly narrow channels typically are caused by channelization or bank armoring. Most United States Geological Survey gauge sites in the Ontonagon River system have stream widths that are within the range predicted by average discharge values. The upper Middle Branch and Bond Falls Canal gauge sites have channel widths that are narrower than expected due to bridge construction and channelization activities.

There are 17 registered dams in the Ontonagon River watershed. Five of these dams are operated by the Upper Peninsula Power Company to facilitate power generation at the Victoria hydroelectric facility. Four dams are operated by various governmental organizations to enhance recreational opportunities, six dams are privately owned (i.e., for private lakes and ponds), and two dams are operated for other purposes.

Dams affect aquatic ecosystems by impeding fish spawning migrations, fragmenting resident fish populations, blocking downstream movement of large woody structure and detritus (e.g., small pieces of wood and leaves), disrupting the sediment balance above and below impoundments, altering flow regimes and channel morphology, and elevating stream water temperatures. Dams at lake outlets also prevent movement of fish between lake and stream habitats and may disrupt natural variations in water levels needed to maintain shoreline wetlands.

The Bond Falls Dam and Bond Falls Control Dam are operated to store water and divert flow from the Middle Branch into the South Branch via the Bond Falls Canal. (The South Branch ultimately flows into the West Branch a few miles upstream of the Victoria hydroelectric facility.) Operation of these dams strongly affects the seasonal flow patterns in the lower Middle Branch and the South Branch. The Cisco and Bergland dams are located at the outlets of natural lakes and are used to ensure a consistent water supply to the Victoria Dam and hydroelectric facility.

In 2003, the Federal Energy Regulatory Commission issued a new operating license for the five hydroelectric-related dams in the Ontonagon River watershed. This license specifies minimum flow releases from the Bond Falls Dam into the Middle Branch and Bond Falls Canal, and from Bergland Dam into the West Branch. The license also sets maximum allowable drawdowns for the Bond Falls Flowage and Victoria Reservoir. These new license conditions are expected to improve fish habitat quality in the impoundments and the stream reaches below the impoundments.

There are 24 named waterfalls and numerous unnamed waterfalls within the Ontonagon River basin. Some of the larger waterfalls (e.g., Bond, Agate, and Victoria falls) are natural barriers to fish movement. The two largest dams in the watershed, Bond Falls Dam and Victoria Dam, were constructed on low gradient stream reaches immediately upstream of major waterfalls.

In general, water quality in the Ontonagon River watershed is excellent, but poor land use practices have led to increased sediment in some areas. Because most of the dams within the basin are relatively small or were constructed at the outlet of natural lakes, thermal pollution from impoundments is a minor concern throughout most of the Ontonagon River system. Few factories and wastewater treatment plants are located within the watershed, with only eleven discharges permitted through the National Pollutant Discharge Elimination System.

Airborne mercury contamination affects the Ontonagon River and most other waters in Michigan. The rock surrounding many of the lakes and streams in the basin also provides a natural source of mercury to surface waters. Statewide fish consumption advisories apply to inland lakes and the Michigan Department of Community Health has issued additional fish consumption advisories for the Cisco Chain and Duck, Gogebic, and Langford lakes.

Numerous federal, state, and local units of government have jurisdictional responsibility over various portions of the Ontonagon River watershed. The Federal Energy Regulation Commission oversees operations at the five hydroelectric-related dams within the basin. About 57% of the watershed is in federal ownership and is managed by the United States Forest Service. The United States Fish and Wildlife Service is responsible for sea lamprey control in streams with Lake Superior access, and the United States Army Corps of Engineers possesses navigational jurisdiction over the lower Ontonagon River. Fishing and hunting regulations are established and enforced by the MDNR, and water quality regulations are administered by the Michigan Department of Environmental Quality. Local units of government influence the river through zoning restrictions and road commission activities.

Special restrictions on human activities have been established to protect areas with outstanding recreational or ecological values. Four of the five main branches of the Ontonagon River system have stream reaches that are classified as Federal Wild and Scenic Rivers, and twelve lakes are included in the federally designated Sylvania Wilderness Area.

Fisheries surveys conducted during the last 80 years have documented the presence of 74 fish species within the watershed, but identification was questionable for three of the species. Of the 71 species that have been positively identified, 60 are native to the Ontonagon River basin, five were intentionally introduced, and six colonized the drainage via canals, ballast water, or dispersal from previous introductions.

Coldwater fish species (e.g., brook trout and mottled sculpin) dominate the fish communities in groundwater-fed streams in the southern portion of the watershed. Water temperatures generally increase in a downstream direction, and coolwater fish species (e.g., walleye, smallmouth bass, and northern pike) become more common as the various branches approach the main stem. Several migratory fishes from Lake Superior (e.g., coho salmon and rainbow trout [steelhead]) spawn in portions of the East Branch, Middle Branch, West Branch, and the main stem.

Two threatened fish species are known to inhabit the Ontonagon River watershed: lake herring and lake sturgeon. Lake herring have been found in a few large lakes within the basin. Lake sturgeon were historically abundant in the Ontonagon River. Commercial overfishing and habitat degradation during the late 19th and early 20th centuries led to the extirpation of this species. The MDNR began stocking lake sturgeon in the main stem in 1998, but it will be several years before adult lake sturgeon are expected to begin reproducing in the Ontonagon River system.

Macroinvertebrates are an important indicator of water quality and are an integral part of the aquatic food web. Macroinvertebrate communities have been evaluated at 25 sites within the Ontonagon River system. The macroinvertebrate communities were rated as “excellent” at six sites, “acceptable” at 18 sites, and “poor” at one site.

Numerous species of mussels, amphibians, reptiles, birds, mammals, and plants occur within the Ontonagon River watershed, many of which are listed as threatened or of special concern. Several aquatic pest species have been found within the basin, including sea lamprey, ruffe, rusty crayfish, spiny water flea, Chinese mystery snail, and Eurasian water-milfoil.

Active fisheries management within the watershed began during the 1920s. For the first decade, fisheries management consisted primarily of surveying and documenting the fish populations within the basin and the human use of those populations. During the late 1930s and early 1940s, warmwater fish stocking became an important management tool. Walleye fry, largemouth and smallmouth bass, and bluegill were introduced into numerous lakes during this period. From 1945 to 1964, legal-sized trout were stocked into many of the streams in the Ontonagon River system. These high-cost stocking programs often produced only modest put-and-take fisheries, and trout stocking was greatly reduced after 1964. In recent years, trout stocking has been used to maintain or establish trout fisheries in several lakes and to enhance the steelhead fishery in the Ontonagon River.

During the mid-1980s, advancements in rearing operations and growing interest from anglers led to a rapid expansion of the MDNR walleye stocking program. Spring fingerling walleyes were stocked in numerous lakes during the last 25 years. Many of these stocking programs have been discontinued, but fisheries managers continue to use walleye stocking to maintain popular walleye fisheries and control the abundance and size structure of panfish populations.

Habitat protection and enhancement have been important components of fisheries management since the 1930s. Early habitat improvement projects primarily involved instream habitat work, such as installation of wing dams and other human-made structures. In recent years, resource managers have adopted a more holistic approach to habitat management. Riparian buffer strips are used to prevent sedimentation associated with timber harvest operations, and sediment traps are installed at problem locations to mitigate the effects of anthropogenic sedimentation on stream environments. New stream crossings are designed to withstand flood flows and facilitate fish passage. Hard-armoring techniques (e.g., riprap and bulkheads) are used sparingly, and more natural methods of stream bank protection (e.g., seeding and mulching, tree plantings, or whole tree revetments) are increasing in popularity. Beaver removals are prescribed to protect high-quality trout streams from thermal pollution, but beavers are allowed to persist in many warmwater streams. The various natural resource agencies also work with the Federal Energy Regulatory Commission to mitigate the effects of hydroelectric-related dams on aquatic ecosystems. Instream habitat projects still play a role in habitat management, but natural materials (such as root wads, boulders, or entire trees) are preferred over human-made structures.

Fishing regulations are one of the most broadly recognized tools for controlling the harvest, size structure, and abundance of fish populations. Restrictive regulations have been instituted to maintain high-quality smallmouth bass fisheries in the Sylvania Wilderness Area. Limitations on the use of live bait are enforced on some trout lakes to reduce the risk of colonization by undesirable species. Closed fishing seasons also protect many fish species from harvest during their most vulnerable periods (i.e., spawning).

The large tracts of publicly owned land in the Ontonagon River watershed provide a wide array of recreation opportunities. Popular outdoor activities within the basin include fishing, boating, water skiing and tubing, canoeing, kayaking, hunting, trapping, berry and mushroom picking, camping, swimming, off-road-vehicle (ORV) trail riding, snowmobiling, snowshoeing, cross-country skiing, hiking, bike riding, bird and wildlife watching, and waterfall viewing. Steep gradients and rock-strewn rapids make many stream reaches unsuitable for safe boating, so there are few boat launches on the Ontonagon River system. Boat launches have been constructed on over 30 lakes, and walk-in access is available for many additional lakes and streams.

Protecting and rehabilitating the aquatic resources in the Ontonagon River basin is a monumental task that cannot be accomplished solely through the actions of governmental agencies. Numerous citizen groups have been involved in watershed planning and aquatic habitat restoration projects during the last 70 years. As the human population grows and a greater percentage of the watershed is subdivided for residential and vacation homes, public involvement in natural resource protection will be critical for the long-term health of the watershed.

This page was intentionally left blank.

Michigan Department of Natural Resources
Fisheries Special Report 46, 2008

ONTONAGON RIVER ASSESSMENT

Brian J. Gunderman

Michigan Department of Natural Resources, Plainwell Operations Service Center,
621 North 10th Street, Plainwell, Michigan 49080

Edward A. Baker

Michigan Department of Natural Resources, Marquette Fisheries Research Station,
484 Cherry Creek Road, Marquette, Michigan 49855

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. Our approach is consistent with the mission of MDNR, Fisheries Division, namely to "protect and enhance the public trust in populations and habitat of fishes and other forms of aquatic life, and promote optimum use of these resources for benefit of the people of Michigan".

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 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 invasive 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. They also 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 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 a river channel: width, depth, and sinuosity. River channels are often thought of as fixed, apart 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 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 main stem 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. 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 Arc View GIS 3.2a or Arc GIS (Environmental Systems Research Institute, Inc.; Copyright) to display and analyze these data, and 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 priorities, and planning the future of the river system. Identified options are consistent with the mission statement of Fisheries Division.

Copies of the draft assessment were distributed for public review beginning April 8, 2008. A public meeting was held at the Ontonagon Village Office on April 28, 2008, and 25 people attended. Written comments were received through June 15, 2008. Comments were responded to in the Public Comment and Response section.

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

Individuals who review this assessment and wish to comment should do so in writing to:

Michigan Department of Natural Resources
Fisheries Division
Baraga Operations Service Center
427 US 41 North
Baraga, Michigan 49908

Comments received will be considered in preparing future updates of the Ontonagon River Assessment.

RIVER ASSESSMENT

Geography

The Ontonagon River is located in the western Upper Peninsula of Michigan and drains an area of 1,362 square miles (Figure 1). Its watershed includes portions of Gogebic, Houghton, Iron, and Ontonagon Counties in Michigan and Vilas County in Wisconsin. The river flows from south to north and enters Lake Superior at the village of Ontonagon. Much of the upper drainage consists of well-defined valleys. Near Lake Superior, the gradient lessens, and the river flows through a gently sloping plain.

The main stem of the Ontonagon River is formed by the confluence of its East and Middle branches near Rockland, Michigan. The larger of these two branches (the Middle Branch) originates in Crooked Lake near the Michigan-Wisconsin border just south of Watersmeet, Michigan at an elevation of 1,702 feet above sea level. The main stem is joined by the West Branch 1.5 miles downstream of the confluence of the East and Middle branches and flows another 22.5 miles before emptying into Lake Superior at an elevation of 602 feet above sea level. Although the main stem is relatively short, the basin also includes over 110 named tributaries and many unnamed tributaries totaling 1,291 miles (Table 1; Figure 2). The highest point in the watershed (1900 ft above sea level) is an unnamed hill south of Imp Lake. Precipitation that falls on the north side of this hill flows northward into the Ontonagon River, while precipitation that falls on the south side flows southward into the Wisconsin River.

There are 200 lakes and ponds larger than 10 acres within the Ontonagon River watershed (Table 2). The vast majority of these lakes are located in the southern portion of the basin, and many of the lakes have direct discharges to the river system.

The Ontonagon River watershed encompasses a large area and includes a multitude of streams with varying physical and ecological characteristics. To facilitate discussion of this diverse watershed, the Ontonagon River and its tributaries will be treated as seven distinct subwatersheds (Figure 3): Middle Branch – upper, Middle Branch – lower, Main Stem, East Branch, Cisco Branch, South Branch, and West Branch. Criteria used to set boundaries for the subwatersheds included drainage patterns, barriers to fish passage (such as waterfalls), confluences with major tributaries, and changes in geology or soil types.

In addition to the subwatershed groupings of the Ontonagon River watershed, we will discuss the river and its tributaries using the Valley Segment Ecological Classification (VSEC) system. This system was developed and used (1) to divide rivers into approximately 1- to 23-mile pieces (segments) that are ecologically similar, and then (2) to classify these segments of rivers throughout Michigan based on segment and watershed characteristics including gradient, temperature regime, discharge regime, catchment size, surficial geology, land use, expected fish communities, etc. (Seelbach et al. 2006, Baker 2006). This classification system enhances our understanding of the complex nature of river systems and permits the grouping of river segments by common attributes (e.g., small coldwater trout streams). The Ontonagon River and its tributaries were classified into 65 distinct valley segments (Baker 2006). Of these 65 valley segments, 27 were classified as coldwater segments capable of supporting trout, and 32 were classified as cool water segments capable of supporting marginal trout populations with minnows, suckers, and walleye more dominant in the fish communities. Four segments in the Ontonagon watershed are classified as warmwater segments with a corresponding fish community of redhorse, suckers, and walleye.

Middle Branch—upper

The upper portion of the Middle Branch Ontonagon River extends 43 miles from the origin at Crooked Lake to Agate Falls. Agate Falls is the upstream barrier for fish migrating from Lake Superior, so different fish communities exist above and below the falls. Bond Falls, located approximately 8 miles upstream of Agate Falls, is another barrier to fish passage. Despite this barrier, similar fish communities exist above and below Bond Falls, so both portions of the Middle Branch are included in this subwatershed. The upper Middle Branch and its tributaries were classified into 10 distinct segments using the VSEC system. Most segments are small, receive strong groundwater inflows, have relatively stable flows, and have fish communities dominated by coldwater species. Major tributaries to the upper Middle Branch include the Tamarack River and Duck, McGinty, Interior, and Deadman creeks. Numerous lakes are located within this subwatershed, including Bond Falls Flowage, Crooked Lake, Clark Lake, Duck Lake, and Tamarack Lake.

Middle Branch—lower

The lower portion of the Middle Branch Ontonagon River extends 25 miles from Agate Falls to the confluence with the East Branch Ontonagon River. There are 9 VSEC classified river segments in this subwatershed. Because this subwatershed occupies an area of extensive deposits of lacustrine clay and silt, segments have relatively flashier flows, higher turbidity, and are warmer than the upper Middle Branch. The fish communities in the lower Middle Branch include both coldwater and coolwater species. Three major tributaries flow into the lower Middle Branch: Trout Creek, Spring Creek, and the Baltimore River. Few lakes are located within this subwatershed.

Main Stem

This portion of the river includes the main stem Ontonagon River from the confluence of the East and Middle branches to the mouth (distance = 24 miles). Through most of this segment, the river is confined to a narrow well-developed valley of lacustrine clay and silt. Turbidity is high in the main stem, especially after rain events. Compared to the other branches within the river system, gradient in the main stem is relatively low (generally <5 ft/mi). The fish community in the main stem changes seasonally with the immigration and emigration of potamodromous species from Lake Superior. The only major tributary to the main stem is the West Branch Ontonagon River.

East Branch

The East Branch Ontonagon River originates in Gasley Lake and flows 54 miles to the confluence with the Middle Branch Ontonagon River. There are 18 distinct VSEC classified segments in this subwatershed. They flow through a mosaic of soil types and, as a result, these segments range from cold trout streams to relatively warm minnow-dominated communities. Groundwater inflows are moderate to strong in the upper segments of the East Branch, while the lower portion of the East Branch receives minimal groundwater inflows. Consequently, the upper reaches of the East Branch are less turbid and have more stable flows than the lower sections of the stream. Coldwater fish species predominate in the upper portions of the East Branch, while coolwater species are more abundant near the confluence with the Middle Branch. The vast majority of the East Branch is accessible to fish migrating from Lake Superior. Major tributaries to the East Branch include the Jumbo River and Smith, Stony, Beaver, Onion, Newholm, and Adventure creeks. Most of the lakes in this subwatershed are relatively small and have required few if any fish community or habitat manipulations. Some important exceptions to this generalization include Tepee, Bob, On-three, and Lower Dam lakes.

Cisco Branch

The Cisco Branch Ontonagon River arises in Cisco Lake and flows 31 miles to the confluence with Tenmile Creek. The 5 VSEC classified segments in the Cisco Branch subwatershed have low turbidity and relatively flashy flows. Above Kakabika Falls, the gradient is low and water temperatures are relatively warm. The fish communities in this portion include a mixture of coolwater and warmwater species. The gradient increases below Kakabika Falls, and the water temperature decreases due to groundwater seepage and the entrance of coldwater tributaries. Coldwater species seasonally inhabit the lower portion of the stream. There are two major tributaries to the Cisco Branch: Twomile Creek and Tenderfoot Creek. Numerous lakes are also found within the Cisco Branch subwatershed, including the Cisco Chain (composed of 14 interconnected lakes), Beatons, Langford, Whitefish, and Tenderfoot lakes.

South Branch

The South Branch Ontonagon River begins at the confluence of the Cisco Branch and Tenmile Creek and flows 32 miles before entering the West Branch Ontonagon River. The South Branch and its tributaries flow through large deposits of lacustrine clay and silt. These flashy streams were classified into 10 distinct segments. These segments receive minimal groundwater and are much more turbid than the Cisco Branch. Coolwater species dominate the fish communities in this subwatershed. Major tributaries to the South Branch include Tenmile Creek and Sucker Creek. The Bond Falls Canal (Roselawn Creek) shunts water from the Middle Branch Ontonagon River into Sucker Creek (see **History**). This shunt increases flow in the South Branch and West Branch Ontonagon rivers and increases power generation at the Victoria hydroelectric facility. Few lakes are located within the South Branch subwatershed.

West Branch

The West Branch Ontonagon River arises in Lake Gogebic and flows 35 miles to the confluence with the main stem Ontonagon River. The West Branch subwatershed streams have been classified into 8 distinct segments. Flows in the West Branch are strongly influenced by water releases from the Bergland and Bond Falls dams (see **Dams and Barriers**). The fish communities in this stream consist of a mixture of coolwater and warmwater species. Cascade Creek, Mill Creek, and the South Branch Ontonagon River are major tributaries to the West Branch. Two large lakes are directly connected to the West Branch: Lake Gogebic and the Victoria Reservoir. Lake Gogebic, with a surface area of 13,048 acres, is the largest inland lake in the Upper Peninsula.

History

After a series of glacial advances and retreats, the last great ice sheets left the Ontonagon River watershed approximately 11,000 years ago (Bailey and Smith 1981; Farrand 1988). As the ice retreated, the meltwaters carried away the lighter clay and silt particles, but the heavier sands and gravels were left behind in the southern portions of the basin (see **Geology**). The channels cut by these glacial meltwaters formed the basis for the modern drainage network in the Ontonagon River watershed.

The earliest archaeological evidence of human settlement within the watershed dates to around 2000 BCE during the Late Archaic period (B. Mead, Michigan Department of State, Office of the State Archaeologist, personal communication; Table 3). Fish were an important food source for these early inhabitants, and Late Archaic peoples used spears, fishhooks, gaffs, and other tools to capture fish in the Ontonagon River and Lake Superior (B. Mead, Michigan Department of State, Office of the State Archaeologist, personal communication). One of the principal materials used to make this fishing gear was copper.

Prehistoric peoples had mined copper from the Ontonagon region for millennia before the first modern mines were developed. It has been estimated that there are over 5,000 of these prehistoric copper pits around Lake Superior, and most of these pits have been found between Ontonagon and

Copper Harbor (Drier and Du Temple 1961). The copper in this area is so pure that early peoples could easily shape it into tools using cold hammering. Lake Superior copper artifacts have been discovered as far south as Mexico, indicating that prehistoric miners developed extensive trade networks (Johanson 1985).

During the Late Woodland period (around 1,000 years ago), fishing technology became more elaborate. Weirs were constructed on the Ontonagon River to facilitate harvest of lake sturgeon, and gill nets were used to capture whitefish and walleye. Late Woodland peoples also constructed earthen burial mounds over their dead, and some of these mounds have been found along the shores of Lake Gogebic (B. Mead, Michigan Department of State, Office of the State Archaeologist, personal communication).

The Chippewa (Ojibwa) people moved into the Ontonagon watershed during the late 16th or early 17th century (Danziger 1979). The main Chippewa village was at the mouth of the river where they spent the summer months fishing. Following the tradition of their predecessors, the Chippewa constructed elaborate weirs on the main stem during the lake sturgeon spawning season. Spawning lake sturgeon were allowed to pass upstream, and were hooked as they moved back downstream (Danziger 1979). The Chippewa also planted gardens near the shores of Lake Gogebic and other inland lakes during the spring, and returned to harvest their crops in autumn (B. Mead, Michigan Department of State, Office of the State Archaeologist, personal communication). During the winter, small hunting camps were established on various tributaries within the watershed.

The name “Ontonagon” is derived from the Chippewa language. According to legend, the name originated when a young girl dropped her bowl in the river and began running along the bank crying “On-to-nagon” or “My bowl is lost.” (Jamison 1948). European visitors apparently struggled with translation of this phrase. Thus, the name has been spelled in a variety of ways, including Nantounaganing, Nunda-Norgan, Donegan, Atounagon, and Nanton Nagun (Johanson 1996).

French fur traders were among the first Europeans to visit the Ontonagon River watershed. The fur trade in the Lake Superior region began during the 1630s (Jamison 1948), and the “River Nanton nagun” first appears on a map published in Paris in 1651 (Johanson 1985). Although many different animals were harvested by these early trappers, the beaver was the most targeted species. The organized fur trade persisted until around 1840. It is impossible to estimate how many beaver were harvested during these 200 years of exploitation, but various sources indicate that beaver were nearly extirpated from some areas (Jamison 1948). The dramatic decline in beaver populations presumably affected the fish communities in the Ontonagon River system through the removal of barriers to fish passage (beaver dams) and alteration of the hydrology and channel morphology of previously impounded streams.

The abundant deposits of mass copper in the Ontonagon River watershed also attracted attention from early European visitors. In 1670, Father Claude Dablon sent samples of Ontonagon copper to Paris (Johanson 1985). Pierre Le Seur started the first modern copper mine in the region in 1690, but personal problems with French officials caused him to quickly abandon his new venture (Johanson 1985). In 1766, Alexander Henry persuaded Chippewa guides to take him to the site of the great copper boulder. This giant mass of pure copper was located on the bank of the West Branch Ontonagon River in the area that is now flooded by the Victoria Reservoir. Henry was not able to remove the boulder, but he estimated the weight to be around 5 tons. During the winter of 1771–72, Henry and his crew attempted to mine copper in the river bank near the site of the famous boulder. Their efforts were largely unsuccessful, and the project was aborted when the tunnel collapsed during the spring floods (Johanson 1996).

The copper boulder also attracted other famous visitors. Henry Rowe Schoolcraft, the geologist and explorer who "discovered" the source of the Mississippi River, visited the site in 1819. Douglass Houghton (Michigan's first state geologist) examined the specimen in 1840 and provided this cautionary note to potential prospectors (as quoted in Jamison 1948).

> While this mass of native copper cannot fail to excite much interest, from its size and purity, it must be borne in mind that it is a perfectly isolated mass, having no connection with any other; nor does the character of the country lead to the inference that veins of the metal occur in the immediate vicinity, though the mineral district crosses the country at a distance of a few miles.

The legendary boulder was finally removed by Julius Eldred in 1843 (Jamison 1948). This mass of pure copper currently resides in the Smithsonian Institution. After years of being cut and hacked by treasure seekers, the actual weight of the boulder was determined to be 3,708 lb (Johanson 1996).

Although the "great copper boulder" attracted much fanfare, the real copper rush did not begin until 1847. In that year, Samuel Knapp discovered a series of prehistoric copper pits near the present day town of Rockland. Knapp quickly recognized the significance of his discovery and founded the Minesota (spelling intentional) Mine at this location. The Minesota Mine became the richest project in the region, paying out $1,800,000 in dividends during its 22 years of operation (Lankton 1991). The largest mass of native copper ever recorded (527 tons) was discovered in this mine (Johanson 1996).

The success of the Minesota project prompted the establishment of numerous other mines within the northern portion of the watershed. Some of the most important mines were the Adventure, Mass, and Toltec mines near Adventure Creek and the Norwich, Ohio Trap Rock, and Victoria mines near the West Branch Ontonagon River. (The Victoria Mine is of particular importance from a watershed perspective and will be discussed in detail below.) Although a few mining companies continued operations well into the twentieth century, the copper boom came to a halt in 1865 when the end of the civil war caused copper prices to plummet (Johanson 1996).

Copper mining affected the Ontonagon River watershed in a variety of ways. Trees were cut down to provide timbers for the mines, and roads were constructed to transport copper and mining supplies. Waste rock from the mines was deposited on the surface. When this rock contained sulfur-bearing minerals (e.g., anhydrite, gypsum, or barite), these materials reacted with water to form sulfuric acid. Because several of the mines were located near streams, it is likely that some of this acid mine drainage reached the Ontonagon River system.

Commercial fishing activity near the mouth of the Ontonagon River probably commenced during the mid-1800s, but accurate records of early commercial fishing operations are lacking. By 1880, there were 134 commercial fishers operating between Ontonagon and L'Anse (Nute 1944). The numbers of commercial fishers began to decline after the turn of the century, but there were still 16 commercial fishing businesses operating out of Ontonagon in the 1930s (Doyle 1988). Lake trout and lake whitefish made up the bulk of the harvest from this port.

Commercial fishing probably was a major factor contributing to the extirpation of lake sturgeon in the Ontonagon River system. In the early days of the Great Lakes commercial fishery, lake sturgeon were regarded as a nuisance because they often ruined the nets of fishers targeting other species. Lake sturgeon were clubbed to death, thrown on land, and even used to fire steamboat boilers (Brousseau 1987). As markets were created for caviar and smoked lake sturgeon flesh, some commercial fishers began targeting lake sturgeon. Throughout most of the Great Lakes, lake sturgeon populations had been extirpated or severely reduced by the end of the nineteenth century (Tody 1974).

During the early days of European settlement, ship travel on Lake Superior provided the only link between the city of Ontonagon and the outside world. The Soo Locks were not in operation until 1855, so early explorers had to build new boats at Sault Ste. Marie or haul their vessel around the rapids. Even after the Soo Locks were completed, ship travel was seasonal, and winter meant long periods of isolation. During the open water period, a large sand bar prevented ships from entering the Ontonagon River, and cargo had to be "lightered" to shore in small boats (Jamison 1948). This method was cumbersome (especially for companies trying to export copper), so it is no surprise that harbor improvements were a major concern of early settlers.

Opening the Ontonagon River to commercial shipping traffic proved to be a formidable task. By 1852, James Carson had constructed the first pier at the mouth of the Ontonagon River (Jamison 1948). This pier was inadequate to meet the needs of the burgeoning population and was repeatedly washed away during storms. In 1855, the people of Ontonagon recruited Charles T. Harvey (the designer of the first Soo Lock) to remedy the situation. During his stay in Ontonagon, Harvey completed 900 ft of piers, dredged a 16 ft wide channel, and reduced the width of the sand bar from 800 ft to 200 ft (Anonymous 1883).

> Inadequate still were the improvements made by Harvey, but navigation managed as best it could with them. It was not until 1867 that improvements were begun by the federal government. But then wider channels, the elimination of the sand bar, more and better piers, and harbor lights came slowly but certainly. By 1880 two hundred thousand dollars had been spent. That year the federal harbor record shows one hundred twenty-one vessels in and out of Ontonagon. [From Jamison 1948.]

For early explorers, the Ontonagon River provided the only access to the southern portions of the watershed. A number of local roads were constructed by the mining companies during the 1850s, but a well-connected road system was lacking. (To give some indication of the winter travel conditions during this period, dog trains were used to deliver the mail from Green Bay to Ontonagon until 1864 [Jamison 1948].)

The first "highway" in the region was the Military Road which connected Fort Wilkins (Copper Harbor) to Fort Howard (Green Bay).

> In March, 1863, President Lincoln had signed the act of Congress which gave the two states of Michigan and Wisconsin land grants which enabled them to construct the "Military Road." These states proceeded at once to let contracts, the contractors' pay being in government lands, alternate sections on both sides of the route for three miles. Thus under this checkerboarded [sic] plan, a contractor received sixteen sections of land for every five miles of road built…. In the Ontonagon country, this is the road as we know it from Watersmeet to Rockland through Bruce Crossing. The present trunk line highway [Hwy 45] is almost identical with the Military Road in location. [From Jamison 1948.]

This "highway," which was impassable in spring for many years, provided a much desired connection with the outside world. Fears of a British attack on the Lake Superior copper country were never realized, and the road served little military purpose. Nevertheless, the gorge where Highway 45 crosses the main stem Ontonagon River is still commonly referred to as "Military Hill."

The government's policy of paying contractors in land strongly influenced the pattern of land ownership in the western Upper Peninsula. For example, similar land grants were given to the Portage Lake and Lake Superior Ship Canal Land Company and the Ontonagon and Brule River Railroad. The federal government also granted the states large tracts of land for agricultural schools. Many investment companies scrambled to acquire these lands for timber production. Raphael Pumpelly, a land speculator with the Portage Lake and Lake Superior Ship Canal Land Company, describes the land acquisition process.

> The United States Government had made large grants of land to the states for agricultural schools, and issued the scrip to be used in selecting the land. Some of these states had sold the scrip, preferring the money to the land and, while the regular government price for lands in Michigan was $1.25 an acre, the Agricultural College scrip sold in the market for sixty cents an acre. [From Pumpelly 1918.]

The vast pine forests of the Ontonagon River watershed were only lightly exploited by early settlers. Trees were cut to produce mine timbers and lumber for houses, but there was little commercial harvest of timber prior to the 1880s. During the 1860s and 1870s, a number of developments occurred that drew new attention to the timber resources of the watershed. (1) Most of the land within the watershed was acquired by investment companies looking to make a quick profit. (2) The rebuilding and rapid expansion of Chicago after the Great Fire of 1871 created increased demand for lumber. (3) Harbor improvements at the mouth of the Ontonagon River made cargo loading and unloading a less laborious process.

In 1881, the newly established Ontonagon Lumber Company mill (located on the east bank of the main stem near the mouth) began producing 200,000 board feet of lumber daily (Johanson 1996). Sisson and Lilly established a slightly larger mill on the opposite bank of the river in 1882. These local companies were soon surpassed by the Diamond Match Company. By the mid-1880s, this giant corporation eventually controlled not only the mills, but also much of the land within the watershed. During the period of peak timber production (mid-1880s through the mid-1890s), the Diamond Match Company mills produced 100,000,000 board feet of lumber annually (Johanson 1985).

The various branches and tributaries in the Ontonagon River system were used to transport logs downstream to the mills. Some lumber companies used temporary dams to assist with log drives. Once sufficient water was stored behind the dam, the gates were opened, and the logs were flushed downstream. One such dam was constructed on the West Branch above Glenn Falls in the area currently inundated by the Victoria Reservoir (Lulich 1998).

Logging operations dramatically affected the watershed in a number of ways. Throughout much of the region, the forests had been replaced by stump fields and slash piles. Forest removal resulted in accelerated erosion and increased transport of sediment into the streams. This sediment increased turbidity and led to stream bed aggradation.

> The great River which had been the highway to the interior for first the Native People, then those of the successive races, was now running red with clay, as though the country it drained into the Big Lake was bleeding from within as each tree was torn from its bosom and taken away. [From Johanson 1996.]

Because rivers were the primary means of transportation during the 1880s, trees near streams were often the first to be cut down. In addition to reducing bank stability, removal of these trees exposed a larger area of the water surface to radiant sunlight. Thus, water temperatures increased after timber harvest was completed. Greater fluctuations in daily flow also resulted because trees were not present to slow movement of water into the streams.

The famous log drives substantially altered channel morphology. The rapid release of water from logging dams scoured the banks and streambed downstream. This rush of water, coupled with the "stampede" of logs, caused considerable mortality of fishes and other aquatic animals. Log jams were a common occurrence and in 1895, a massive log jam on the main stem allowed people to walk across the river without getting their feet wet (Johanson 1996).

Logging activity also provided the impetus for the construction of railroads within the watershed. By 1882, the Ontonagon and Brule River Railroad was completed between the cities of Ontonagon and Rockland. The Milwaukee and Northern Railroad connected with the Ontonagon and Brule River line in 1889, providing Ontonagon County with a direct rail connection to the major lumber markets in Chicago (Johanson 1996).

The Ontonagon logging era lasted only 15 years. A fire swept through the town of Ontonagon in 1896, destroying the Diamond Match Company mills. The pine forests of the region were severely depleted by that time, so the company's mills were never rebuilt. Logging activities never completely ceased within the watershed, and logging continues to be an important part of the local economy.

As the logging era ended, many of the stump fields were converted into farms. Agriculture provided food for mine workers as early as the 1850s, but the peak of agricultural activity in the watershed occurred between 1910 and 1920 (Jamison 1948). Today most of the remaining farms raise cattle for beef or milk production. The major crop produced in the watershed is birdsfoot trefoil (a small plant related to alfalfa that is a popular forage item for livestock producers). Due to the harsh climate, agricultural land never has covered a large percentage of the watershed, and many of the farms established during the early 1900s have since reverted to forest.

The Ontonagon River and its tributaries have been used for power generation since the early 1900s. One of the most elaborate systems for harnessing the river's energy was constructed at the Victoria Mine. The Victoria Mine was located adjacent to Glenn Falls on the West Branch Ontonagon River, so the mine's superintendent (Thomas Hooper) decided to build a dam to generate electricity. Construction of the dam and canal system began in 1902. The dam was completed, but the plans for the hydroelectric plant were abandoned in 1903 after Hooper visited a hydraulic compressor site in Norwich, Connecticut (Johanson 1993). Hooper was so impressed with the technology that he hired Charles Taylor to install a hydraulic compressor at Victoria. Work commenced on the compressor system in 1904, and the project was completed in 1906.

The new compressor used the dam and canal system previously constructed by Thomas Hooper. Some of the water reaching the dam passed downstream into the river below, while the rest was diverted into the canal system. At the end of the canal were three vertical shafts (each 334 ft deep) that led to an underground cavern. This cavern functioned as the air chamber for the compressor.

> As the water of the river fell down the intake tubes, air from the atmosphere was drawn down the tubes along with the water by venturi action,… with air being trapped in the water in the form of countless bubbles. These bubbles would rise to the roof of the air chamber underground, and by the weight of the columns of falling water, be compressed to 117.5 pounds per square inch. [From Johanson 1993.]

The compressed air was channeled through a series of pipes to provide pneumatic power for the mine and associated stamp mill. When compressed air production exceeded demands, the air was released through a safety "blow-off". (Ice formation around this discharge led to disastrous blow-backs during the winters of 1916 and 1930 [Johanson 1993].) After passing through the compressor, the water was released back into the river.

The Victoria Mine's compressor system worked well, but company officers were concerned that the system would not function effectively during low water conditions. To provide for a more consistent flow at Victoria, the company constructed another dam at the outlet of Lake Gogebic in 1906. Installation of this dam sparked a series of Lake Gogebic water level disputes that continues to this day (Lulich 1998).

The compressor system provided a cheap power source that allowed the Victoria Mine to outlast other area mines. The Victoria Mine finally closed operations in 1921, and the mine was sold to the Copper District Power Company in 1928 (Johanson 1993), who constructed the current dam slightly downstream of Hooper's dam by 1931. The new Victoria Dam (head = 120 ft) is much larger than the previous dam. Water reaching Victoria Dam is diverted into a pipeline that leads to the powerhouse. (The original pipeline was made of wood, but a steel pipeline was installed in 2001.) After passing through the turbines, the water is released back into the river. When the storage capacity of the dam is exceeded, water flows over the spillway into the original riverbed.

To increase water reserves for power generation, additional dams were built on the Ontonagon River system during the 1930s. The Cisco Dam was constructed at the Cisco Lake outlet in 1931, raising lake levels in the Cisco Chain approximately five feet. In 1938, the Bond Falls dam and canal system was completed. The Bond Falls project diverts water from the Middle Branch Ontonagon River through Bluff and Sucker creeks and into the South Branch Ontonagon River. The construction of the Victoria hydroelectric facility and associated dams brought electricity to much of the region, but the environmental effects of hydroelectric operations on the watershed have been substantial and long-lasting (see **Dams and Barriers**).

Another important development during the 1930s was the establishment of the Ottawa National Forest. The Ottawa National Forest was created in 1931. The original forest encompassed 253,551 acres. By 1937, the forest had been expanded to include approximately one million acres in the western Upper Peninsula. Roughly 50% of this land is located within the Ontonagon River watershed, and 57% of the land in the watershed is currently under federal ownership.

During the last half of the 20th century, tourism became a major contributor to the local economy. The myriad lakes and streams in the Ontonagon River watershed, coupled with the vast tracts of forest in the region, attract thousands of visitors every year. Waterfront properties are now highly desirable, and it is likely that there will be considerable development of residential and vacation homes in the watershed during the next few decades.

Geology

Biological communities within the Ontonagon River system have been strongly influenced by the physical characteristics of the watershed. The geology of the region is of particular importance because surficial geology largely determines the channel morphology, hydrologic stability, temperature regime, and water quality of the various streams within the watershed.

Surface Geology

Surficial materials affect river systems by determining how water enters the stream. Although rivers receive some water as direct precipitation, most water enters rivers as groundwater or surface runoff.

> Rain arriving at the soil surface infiltrates at a rate set by capillary action and permeability. When (1) precipitation rate exceeds infiltration rate or (2) the soil surface becomes saturated…, water accumulates and flows overland and downslope. [From Wiley and Seelbach 1997.]

The texture and composition of surficial materials determines the rate at which water is able to percolate through the ground. Coarse materials (e.g., sand and gravel) allow water to infiltrate rapidly. In areas with permeable soils, most water infiltrates the ground and enters streams at a steady rate. Finer materials (e.g., clay and organic matter) are less permeable, so streams that flow through these types of materials receive a large percentage of their water as surface runoff. Surface runoff (i.e., rainwater and snowmelt) flows into streams relatively quickly, and runoff volume varies by season. Thus, daily and seasonal flow variations are greater in streams that receive the majority of their water from surface runoff.

The permeability of adjacent surficial materials also affects water temperatures within a stream (Table 4). The temperature of groundwater at a given location closely approximates the mean annual air temperature. For the Ontonagon River system, this means that groundwater temperatures range from 36.7°F around the upper West Branch to 51.2°F near the confluence of the East and Middle branches (Mean monthly and annual maximum, minimum, and mean temperature 2000). The temperature of surface runoff, by contrast, is strongly influenced by the ambient air temperature. Thus, runoff water is warm during the summer, cold during spring snowmelt, and frozen during the winter. Groundwater inflows provide a thermal buffer against these temperature extremes, so coldwater and coolwater fish species are generally more abundant in streams that receive substantial groundwater inflows.

Middle Branch—upper

End moraines of coarse-textured till and glacial outwash sand and gravel compose the vast majority of the surficial materials in this subwatershed (Figures 4 and 5). These materials are highly permeable, and the upper Middle Branch receives strong groundwater inflows.

Middle Branch—lower

The lower Middle Branch flows through large deposits of lacustrine clay and silt, so surface runoff provides most of the water inflows to the Middle Branch in this region. End moraines of coarse-textured till are limited to the southern portion of the subwatershed near the headwaters of Trout Creek and the Baltimore River.

Main Stem

The upper end of the main stem is flanked by end moraines of coarse-textured till to the east and thin to discontinuous glacial till over bedrock to the west. Lacustrine clay and silt composes 83% of the surficial materials in the main stem subwatershed. Groundwater inflows to the main stem are minimal.

East Branch

A mosaic of surficial materials is found within the East Branch subwatershed. The permeability of these materials generally decreases from the headwaters to the confluence with the Middle Branch. Above Onion Creek, end moraines of coarse-textured till and glacial outwash sand and gravel are abundant. Between Onion Creek and Adventure Creek, the river flows through a large deposit of lacustrine sand and gravel. The lower reaches of the East Branch are surrounded by lacustrine clay and silt. Groundwater inflow is substantial above Onion Creek and minimal below Adventure Creek.

Cisco Branch

The upper (southern) portion of the Cisco Branch flows through coarse-textured glacial till and end moraines of coarse-textured glacial till. Near the confluence with Twomile Creek, the surficial materials transition to lacustrine clay and silt. Groundwater inflow is moderate throughout most of the Cisco Branch, with the strongest entering just above the confluence with Twomile Creek.

South Branch

Lacustrine clay and silt surround the entire length of the South Branch Ontonagon River, and surface runoff provides most of the water inflows to the South Branch. Bluff and Sucker creeks flow through end moraines of coarse-textured glacial till, so there is some groundwater inflow to these streams.

West Branch

The headwater streams south of Lake Gogebic flow through end moraines of coarse-textured glacial till. Groundwater inflow to these tributaries is strongest near the southern tip of Lake Gogebic. From Lake Gogebic to Mill Creek, the West Branch is flanked by deposits of coarse-textured glacial till. There is some groundwater inflow in this region (especially around Cascade Creek). Below Mill Creek, the West Branch flows through lacustrine clay and silt deposits. Groundwater inflow to the lower section of the stream is minimal.

Bedrock Geology

Bedrock geology has heavily influenced human settlement patterns and economic development within the Ontonagon River watershed. Large masses of pure copper have been found within the Portage Lake volcanic deposits in the northern portion of the watershed (Figure 6). These large copper deposits attracted prehistoric miners to the region and provided the main impetus for European settlement of the basin (see **History**). The Minesota, Victoria, and Adventure Mines all were founded over the basaltic lava flows of the Portage Lake series.

Hydrology

The hydrologic cycle of a watershed is affected by many factors, including climate, land use, surficial geology, evapotranspiration rates, topographic relief within the watershed, and dam operations. Consideration of hydrologic regime in a watershed is important because of the proximal influence hydrology has on the habitat, fish, and other biota present in a stream (Poff and Ward 1989). Generally speaking, streams with a stable hydrologic regime are characterized by high inflows of groundwater, low surface runoff, and consequently high base flow. In Michigan, these streams are typically cold- or coolwater streams that support relatively simple coldwater fish communities, including trout and salmon. On the other end of the spectrum, streams with an unstable or flashy hydrologic regime are characterized by low groundwater inflow, high surface runoff, and low base flow. In Michigan, these streams are typically warm streams that support more diverse warmwater fish communities.

Prior to discussing the hydrology of the Ontonagon River system, it is important to first understand a major change that has taken place in the water routing network of the watershed. In the early 1900s hydropower dam construction began in the Ontonagon River basin (see **History**). Hydropower dam operation alone is enough to alter the flow regime in a river system. However, in the case of the Ontonagon watershed, dam construction and operation also changed the way that water flows from the headwaters to Lake Superior. The Bond Falls Dam on the Middle Branch Ontonagon River was constructed for the purpose of capturing the water in the Middle Branch and diverting it, via the Bond Falls Canal and Sucker Creek, to the South Branch Ontonagon River and eventually through the Victoria Dam hydropower facility. Diverting flow from the Middle Branch to the South Branch has resulted in a much higher generating capacity at the Victoria Dam. However, the diversion has also resulted in radical changes to both the hydrology and ecology of the Middle Branch Ontonagon River downstream from Bond Falls as well as Sucker Creek and the South Branch Ontonagon River.

Climate

The climate of the Ontonagon River watershed varies from north to south. In the northern portion of the watershed, Lake Superior exerts a significant influence on the climate resulting in cooler summer temperatures, warmer winter temperatures, and higher snowfall than recorded in the southern half of the watershed, away from Lake Superior. The growing season is short and varies from approximately 140 days near Lake Superior to approximately 87 days in the southern portion of the watershed, which is roughly 1,000 ft above the level of Lake Superior (Albert 1995). Winters are relatively long and cold. Extreme minimum temperatures can be as low as -51°F, and snowfall can exceed 200 inches (Eichenlaub 1990). Average annual precipitation also varies across the watershed from 29 inches north of Kenton to 36 inches around Lake Gogebic. Annual evapotranspiration ranges from 16 to near 20 inches across the Ontonagon watershed, and runoff ranges from 14 to 16 inches (Hendrickson et al. 1973).

Annual Stream Flows

Discharge data were obtained from the United States Geological Survey (USGS) for stream flow gauges in the Ontonagon River watershed (Figure 7, Table 5). Although the annual flow regime in the Ontonagon River and tributaries is affected by hydropower-related dam operations, the annual flow pattern for the main stem Ontonagon River is typical of that for other streams in northern Michigan. Stream flow is greatest during the period of snowmelt in spring and is much lower at other times of the year (Figure 8). Mean discharge for the Ontonagon River at the USGS gauge site below the West Branch confluence was 1,380 cubic feet per second (cfs). The maximum discharge recorded at the same location was 42,000 cfs on August 22, 1942 and the minimum discharge was 170 cfs on August 14, 1991. It is important to note that seasonal and daily discharge recorded at this gauge site is influenced by the operation of the Bond Falls and Victoria dams. Ontonagon River water yield (defined as flow volume per watershed unit area) at this location averaged 1.03 cfs/mi^2. For comparison, most gauge sites in the Au Sable and Thunder Bay watersheds had yields lower than 1.0 cfs/mi^2 (Cwalinski et al. 2006; Zorn and Sendek 2001), whereas mean water yields for gauging stations on the Manistique River (which receives more annual precipitation than the Ontonagon River watershed) ranged from 1.03 cfs/mi^2 to 1.32 cfs/mi^2 (Madison and Lockwood 2004).

The East Branch is the only Ontonagon River tributary that is not affected by hydropower dam operations. The annual stream flow pattern is similar to that seen in the main stem; discharge is greatest during snowmelt in spring and is low at other times of the year (Figure 9). Average stream flow in the East Branch Ontonagon River was 257 cfs, and water yield averaged 0.94 cfs/mi^2 during the period of record.

As mentioned previously, the Middle Branch Ontonagon River is affected by the operation of the Bond Falls Dam. The annual stream flow pattern in the Middle Branch upstream of Bond Falls (Paulding gauge station) is similar to the main stem (Figure 10). The annual hydrograph includes the spring snowmelt peak and a smaller peak associated with fall rain events. Water yield for the Middle Branch subwatershed upstream from Bond Falls has averaged 1.03 cfs/mi^2 for the period of record. However, downstream from Bond Falls (Trout Creek gauge station) the annual stream flow pattern is obviously altered from what it would be in the absence of Bond Falls Dam (Figure 10). Downstream from Bond Falls the annual stream flow pattern does contain a peak during the spring snowmelt period, but the smaller peak corresponding to fall rain events is absent from the hydrograph. Also, the water yield for the Middle Branch downstream from Bond Falls has been reduced to 0.33 cfs/mi^2, only 32% of the water yield upstream of Bond Falls. Therefore, the Bond Falls diversion of water from the Middle Branch to the South Branch is removing approximately 68% of the Middle Branch flow. The effect of this diversion can also be seen in the South Branch. Although the annual stream flow pattern is similar to the other tributaries (Figure 10), the water yield for the South Branch is 1.42 cfs/mi^2, much higher than it would be in the absence of the diversion at Bond Falls Dam.

The Bond Falls Canal gauge monitors water diversions from the Middle Branch to the South Branch. The annual pattern of stream flow in the Bond Falls Canal is completely different from the natural patterns seen in the other tributaries within the watershed (Figure 10). High flows in the South and West branches reduce the need for water diversion during spring snowmelt. When flows naturally are low in the South and West branches (e.g., during summer), the Bond Falls diversion shunts greater volumes of water from the Middle Branch into the canal. Thus, the Bond Falls Canal stream flow pattern is characterized by high flows from summer through midwinter and low flows during late winter through spring.

Additional annual stream flow data for the Ontonagon watershed are available for the USGS gauges on the Cisco and West branches. The Cisco and West Branch gauges are both located at lake outlets. The annual stream flow patterns at these sites are affected by the operation of lake-level control structures (Figure 9), and therefore, the annual stream flow patterns do not closely resemble the patterns seen at other gauges in the watershed. Annual water yields were 0.90 cfs/mi^2 for the Cisco Branch and 1.05 cfs/mi^2 for the West Branch.

Seasonal Stream Flows

Indices of flow stability can be valuable tools in understanding river systems. One measure of flow stability is a standardized flow-exceedence curve. A standardized flow-exceedence curve is a plot of standardized discharge (discharge divided by the median discharge value) on the y-axis versus the percent of time that flow is equaled or exceeded on the x-axis (e.g., Figure 11). Flows that are equaled or exceeded 90% of the time are considered base flow and the higher the base flow value, the more stable the flow regime in a river. Flows that are equaled or exceeded 10% of the time are considered flood flows, and rivers with high flood flow values generally have flashy flow regimes.

The Ontonagon River and its tributaries exhibit a broad range of seasonal flow patterns (Figures 11–14, Table 6). Although this broad range may be attributed in part to the operation of hydropower-related dams, much of the variation can also be attributed to the geology and soils present in the subwatersheds. For example, coarse glacial tills and sandy soils that are highly permeable dominate the East Branch and upper Middle Branch subwatersheds. These streams have relatively high base flows (Figure 11) because precipitation falling in these subwatersheds infiltrates into the soil, and the groundwater is slowly released to the streams over a long period of time. In contrast, the West and Cisco branches have very low base flows that are due in part to the operation of lake-level control structures just upstream of the gauge locations. Because lake levels are held at an artificially high level, little water is released from the impoundments during the summer leading to much lower base flows.

Flood flow values are less variable across the Ontonagon River and tributaries (Figure 12). Standardized 10% exceedence flows vary from 2.3 to 3.0 in the free-flowing upper Middle Branch and East Branch respectively. The upper Middle Branch subwatershed has a higher percentage of permeable soils than the East Branch subwatershed. Thus, infiltration rates are higher in the upper Middle Branch subwatershed, resulting in lower flood flows.

Discharge patterns at the other gauge stations within the Ontonagon River watershed are affected by the Bond Falls diversion (Figures 13 and 14). The effects of the diversion are perhaps most obvious for the South Branch Ontonagon River. This runoff-driven stream flows through large deposits of lacustrine clay and silt, so it should have a flashy flow regime and a low base flow. In reality, the standardized 90% exceedence flow for the South Branch is similar to those observed for the groundwater-fed East Branch and upper Middle Branch systems because operation of the Bond Falls diversion artificially increases base flow in the South Branch.

The 10:90% exceedence flow ratio provides another useful index for comparing the flow stability of different streams. Streams with very stable annual flow regimes have low ratios of high:low flow yield (e.g., Au Sable and White rivers, Tables 6 and 7). Flashy streams, or those with unstable annual flow regimes, have high ratios of high:low flow yield (e.g., Kawkawlin River).

The Ontonagon River and its tributaries have annual flow regimes that are less stable than the White and Au Sable rivers, but are much more stable than the Kawkawlin River (Table 6). Flow ratios for the free-flowing portions of the East and Middle branches fall within the "good" range defined by Seelbach (MDNR, Fisheries Division, personal communication; Table 7). Gauge sites located immediately below dams (West and Cisco branches and the Bond Falls Canal) have the least stable flow regimes. As mentioned previously, the West and Cisco branches have unstable annual flow regimes primarily because operation of lake level controls on both of these streams maintain artificially high lake levels during summer by virtually eliminating outflow from lakes. Conversely, operation of the Bond Falls diversion increases flow stability at the South Branch and Middle Branch (Trout Creek) gauge sites.

Daily Stream Flows

Under natural conditions daily stream flows vary in relation to precipitation (or snowmelt) in a watershed. The rate of increase or decrease in daily stream flow depends primarily on the amount of precipitation and the infiltration rate of surrounding soils. Watersheds with soils that are highly permeable will have stable daily stream flow patterns. As with annual stream flow stability, daily stream flow stability is affected by dams, particularly hydropower dams.

Daily flow patterns in the Ontonagon River and its tributaries are similar for free-flowing reaches (Figure 15). The East Branch and upper Middle Branch (Paulding) hydrographs show discharge increases in response to major storm events and gradual decreases as surface runoff subsides. The upper Middle Branch has a more stable daily flow regime than the East Branch. Compared to the East Branch, the upper Middle Branch takes a longer time to reach peak discharge after a storm event, and it also takes a longer period of time for the discharge to decline to pre-storm levels. Again, this is due in large part to the higher proportion of permeable soils in the upper Middle Branch subwatershed.

The effect of the Bond Falls Dam and reservoir can be clearly seen from the daily discharge data for the Middle Branch near Trout Creek (downstream from Bond Falls). The daily hydrograph for this site is nearly flat and does not display the discharge peaks seen in the other streams in the Ontonagon watershed (Figure 15). In the case of the storm that occurred on August 22–23, 1979, the Bond Falls reservoir captured the entire increased flow and routed it through the Victoria Dam reservoir and generating station.

The daily stream flow patterns for the West and Cisco branches are also greatly affected by dam operations (Figure 16). Discharge peaks for these streams, such as the winter peaks observed for the Cisco Branch, do not correspond to storm events. Water releases from the Cisco Lake and Bergland dams are influenced by the water needs at the Victoria hydroelectric facility, so discharge peaks often correspond to periods when runoff inflows are low.

Although the Ontonagon River hydrology has been dramatically altered by dams and their operation, the future hydrologic cycle should more closely resemble the pre-dam cycle. The dams in the watershed that are operated by Upper Peninsula Power Company (UPPCo; Bond Falls Dam, Cisco Lake Dam, Bergland Dam, and Victoria Dam) were recently relicensed by the Federal Energy

Regulatory Commission (FERC) under conditions that were agreed to by UPPCo, MDNR, and other interested parties (Appendix A). The conditions of the new FERC license include minimum flows in the Middle Branch below Bond Falls and the West Branch below Lake Gogebic, and minimum and maximum flows in the Bond Falls Canal. In addition, target lake levels were set for Cisco Lake, Lake Gogebic, and the Bond Falls Flowage. These and the other negotiated changes hopefully will improve the aquatic and other natural resources in the Ontonagon River watershed.

Flooding and Floodplains

Flood events dramatically affect the physical characteristics of the stream and its associated biological communities. Flood flows reshape river channels and facilitate the movement of sediment downstream and onto the floodplain. Water flowing onto the floodplain also expands the area available to fish for feeding and reproduction. Large floods may give fish access to waters (e.g., adjacent lakes) that previously were not accessible, thus permanently altering the species assemblage in the adjacent water bodies. Large woody structure and insects may also be washed into streams during flood events, providing cover and food for riverine fish species (Wesley 2005).

On the Ontonagon River system, floods occur naturally as the result of spring snowmelt and prolonged or extremely heavy rainfall. Ice dams at the river mouth have led to increased water levels during some previous floods. The construction and breaching of logging dams also resulted in numerous small floods on Ontonagon River tributaries during the late 1800s.

Land use practices within the watershed can alter the frequency and severity of flood events. The construction of impervious surfaces, such as roads and parking lots, reduces infiltration and increases the amount of water entering the stream as surface runoff. Filling wetlands and floodplains also reduces the water storage capacity of a watershed and increases the rate at which water enters the river. Improperly installed road crossings can further influence water levels by acting as temporary dams during flood events.

There have been several major floods in the lower (northern) Ontonagon River watershed during the last 100 years. Two of the most notable floods occurred in 1942 and 1963. During the night of August 21–22, 1942, an intense rainstorm struck the northwestern part of the watershed. Rainfall during this storm may have been as high as 14 inches in some areas (Noecker and Wiitala 1948). Stream flows rose dramatically, and a peak discharge of 42,000 cfs was recorded at the main stem (below the West Branch confluence) gauge on August 22, 1942. Bridges and culverts were washed out, and three lives were lost as a result of this flood (Noecker and Wiitala 1948). In April 1963, heavy runoff from snowmelt and the formation of ice dams near the river mouth led to severe flooding in the town of Ontonagon. Although the discharge was much lower (only 17,700 cfs) than in the 1942 flood, ice dams at the M-64 bridge caused water levels near the mouth to rise two feet higher than any known previous flood (Department of the Army 1970).

Because the Ontonagon River watershed is so sparsely populated, the economic effect of flood events is generally much lower than in the densely populated watersheds of southern Michigan. The village of Ontonagon and Ontonagon Township are the only municipalities in the watershed that participate in the National Flood Insurance Program (Federal Insurance Administration, Federal Emergency Management Agency 2006). Under this program, floodplain maps have been developed for the greater Ontonagon area. These maps are used by federal, state, and local agencies and private citizens to plan future developments and determine the need for flood insurance.

Soils and Land Use

Soils

Soils influence the hydrology, channel morphology, and water quality of river systems. Sandy soils allow greater infiltration and groundwater production compared to relatively impermeable clay soils. In addition, sandy soils are more easily eroded than clay soils, so sedimentation and bank slumping can be major concerns in sandy watersheds (see **Channel Morphology**). Soil type and distribution can also influence land use patterns within a watershed, as areas with fertile soils are more likely to be used for agricultural purposes.

The formation and composition of soils is determined by a variety of factors, including the parent material, climate, topography, biological factors, and disturbance regimes (e.g., glaciation or flood events; Owen and Chiras 1990). The influence of surficial geology (i.e., parent material) on soil type is clearly seen in the Ontonagon River watershed (Figures 4 and 17). Sandy soils predominate in the southern half of the watershed where the surficial materials consist largely of coarse-textured glacial till. Fine-textured soils are associated with the lacustrine clay and silt deposits in the northern half of the basin.

Soil type also plays a role in shaping plant community composition. The soils in the northern part of the watershed are classified as alfisols and are relatively fertile (Natural Resources Conservation Service 2006), and the dominant plant community in this region is deciduous forest. Most soils in the southern half of the watershed are classified as spodosols, which are more acidic and less fertile than alfisols (Natural Resources Conservation Service 2006). Coniferous forests are common in the southern (spodosol) portion of the basin.

Land Use

Compared to most other Michigan watersheds, the Ontonagon River watershed is sparsely populated. Population densities for the five counties in the watershed range from 6.0 people/mi^2 in Ontonagon County to 35.6 people/mi^2 in Houghton County (United States Census Bureau 2006). With the exception of Ontonagon County, the major population centers for the counties are outside of the Ontonagon River basin, so the average population density within the watershed is probably less than 10 people/mi^2. This is much lower than the statewide average of 175 people/mi^2 (United States Census Bureau 2006). Although the statewide population increased by 1.8% from 2000 to 2004, census data indicate that population density actually declined in the Ontonagon River watershed during that period (United States Census Bureau 2006).

Forests and wetlands covered almost the entire Ontonagon River watershed prior to settlement by Europeans. Sugar maple, hemlock, basswood, and yellow birch dominated most upland regions, while mixed conifer swamps (e.g., cedar, tamarack, hemlock, and black spruce) were common in lowland areas (Comer 1996). White pine was a notable component of the forest community throughout the watershed and was particularly common in the sand outwash deposits south of Watersmeet (Comer 1996).

Forest continues to be the dominant land cover type in the Ontonagon River watershed (Figures 18 and 19). The majority of the forestland in the watershed is included in the Ottawa National Forest, but private and commercial forests are also common (e.g., near Lake Gogebic). Human activities have dramatically altered the species composition of the forest community during the last two centuries. Acreage of lowland conifers has declined by approximately 50% since Europeans settled in the region, while the acreage of lowland hardwoods (primarily aspen) has increased by several hundred percent during the same period (Comer 1996). More frequent disturbance regimes (e.g., timber harvesting) and herbivory by a greatly increased whitetail deer population are major factors limiting regeneration of slow-growing coniferous species (Doepker 2003).

Wetlands are the second most abundant land cover type in the Ontonagon River watershed. Wetlands function as natural floodwater controls and groundwater recharge and discharge areas. Wetlands also filter pollutants and sediment, stabilize shorelines, and provide fish and wildlife habitat and recreation opportunities. The loss of wetlands has become a concern of national importance. During the last 200 years, wetland acreage in the lower 48 states has declined by 53% (Dahl 1990). Wetland acreage in Michigan has declined by 28–35%, with the greatest losses occurring in the southern half of the Lower Peninsula (Comer 1996). Due to its remote location, wetland losses in the Ontonagon River watershed probably have not exceeded 5% (Comer 1996).

Approximately 5% of the watershed is agricultural land. Most agricultural lands fall within the South Branch and lower Middle Branch subwatersheds, but some farming also occurs near Mass City (East Branch subwatershed). Beef production is the dominant agricultural enterprise in the area, but dairy farms are also common (Johanson 1996). Crops produced in the watershed include alfalfa, birdsfoot trefoil (a small plant related to alfalfa), and corn (Bruce Petersen, Natural Resources Conservation Service, personal communication).

An emerging land use issue in the Ontonagon River watershed is the sale, subdividing, and development of former commercial forest and power company lands. One of the most controversial scenarios is occurring along the Bond Falls Flowage. The UPPCo recently sold 960 acres of its nonproject lands to a real estate development company. (Note: The project lands surrounding the impoundment have not been sold. The distance from the project boundary to the shoreline of the impoundment is variable, but the average width of these riparian “buffers” is about 200 ft.) In 2007, UPPCo prepared a shoreline management plan outlining the company’s plans to provide dockage, pedestrian access, and viewing windows for adjacent property owners and submitted this plan to FERC. MDNR, other resource agencies, and various nonprofit organizations have reviewed this document and provided comments to FERC. FERC is in the process of evaluating the shoreline management activities to determine if they are consistent with the requirements of the current hydropower license.

Bridges and Other Stream Crossings

There are 662 road and utility stream crossings in the Ontonagon River watershed (MIRIS Base Data 1998; Table 8 and Figure 20). Road crossings (77%) are the most common type, followed by railroads (15%) and utilities (8%). These numbers are approximate, because newly developed roads (e.g., logging trails) and unauthorized stream crossings may not be represented in the MIRIS database.

Improperly installed stream crossings can adversely affect stream ecosystems in several ways. One of the most obvious effects of poor stream crossings is the fragmentation of fish populations (Angermeier et al. 2004; Gibson et al. 2005). Culverts are more likely to create fish barriers than other structures (Warren and Pardew 1998), but the low installation cost for culverts has led to their widespread use. Stream crossings may prevent fish passage through a variety of mechanisms. For example, perched culverts are barriers to upstream fish passage, particularly for nonjumping species. Undersized culverts can also impede upstream movement by creating a velocity barrier, especially for small fish (Gibson et al. 2005).

Sedimentation and streambank erosion are additional concerns associated with stream crossings. Raw streambanks typically are created during the installation of a new stream crossing. When these banks are not properly stabilized (e.g., with vegetation or rock riprap), accelerated erosion and bank slumping occurs. Stream crossings on gravel roads are of particular concern to fisheries managers. In hilly areas, diversions and infiltration basins may be needed to prevent sedimentation from road approaches. Road grading can also contribute large amounts of sediment to streams, but proper grading practices can substantially reduce sedimentation from road maintenance activities.

Another concern associated with stream crossings is the potential for pollution (both willful and accidental). Road salt, gasoline, and oil are some of the most common pollutants, but other chemicals could be introduced through accidental spills. Littering is a problem in many Upper Peninsula watersheds, and it is not uncommon for violators to dispose of household refuse at stream crossings.

In the past, open ditching has been used to install pipeline crossings. This method disturbs the stream bed and alters habitat for aquatic species. Newer methods of pipeline installation (e.g., directional drilling or bore and jacking) involve less alteration of aquatic habitat and are recommended by fisheries managers.

A thorough inventory of streambank erosion at bridge sites or improperly installed stream crossings has not been completed for the Ontonagon River watershed. In some other watersheds, sport fishing groups and other organizations have conducted stream crossing inventories and applied for grant funds to fix problem crossings (Wesley 2005).

Channel Morphology

Gradient

River gradient, measured as the drop in elevation (ft) per mile of river, is an important determinant of habitat in a river. Together with discharge, river gradient influences many of the physical characteristics of a stream, including channel sinuosity, water depth, and current velocity. Not surprisingly, stream gradient also influences fish species composition within a river system. For example, the distributions within a river of smallmouth bass (Edwards et al. 1983), creek chub (McMahon 1982), blacknose dace (Trial et al. 1983), northern pike (Inskip 1982), and largemouth bass (Stuber et al. 1982) have all been related to river gradient. Some species (e.g., brook trout) use high gradient reaches for spawning and lower gradient reaches for feeding and resting.

Because aquatic species often require different habitats during their various life stages, optimal river habitat is also diverse. The “best” river habitat is found in reaches with moderate gradient, because depths and velocities are most variable in those areas (Table 9).

Gradients for the main branches of the Ontonagon River system were estimated using the Maptech Terrain Navigator® program. This process utilized electronic versions of 1:24,000 scale topographic maps coupled with a tool for measuring distance. The stream length measurements from Terrain Navigator® did not always match those obtained from the National Hydrography Dataset (1999; Table 1). There was close agreement for the Middle and West branches of the Ontonagon River, but some discrepancies were observed on the other branches (especially the East Branch).

Compared to most other Michigan streams, the Ontonagon River has considerable gradient. The mean gradient for the main stem (including the Middle Branch) is 11.1 ft/mi. Gradients (in ft/mi) reported for other main stem rivers include 3.9 for the Au Sable River (Zorn and Sendek 2001), 3.0 for the Kalamazoo River (Wesley 2005), 1.3 for the Manistique River (Madison and Lockwood 2004), and 2.9 for the Flint River (Leonardi and Gruhn 2001).

Gradients between 10.0 ft/mi and 69.9 ft/mi, the “excellent” gradient category for fish habitat, are common in the upper portions of the Ontonagon River watershed. With the exception of the main stem, this gradient class makes up ≥20% of the river miles in each of the major branches of the Ontonagon River system. Low gradient reaches, though common in the main stem and South Branch, are virtually absent from some of the other branches (e.g., the East Branch).

In many large rivers in Michigan, valuable high gradient reaches of river have been lost as riverine fish habitat because they have been inundated under hydropower reservoirs. However, the Ontonagon River has lost very little high gradient habitat to dam construction. In fact, the two major dams in the Ontonagon watershed (Bond Falls and Victoria) were constructed at the sites of waterfalls and impound relatively low gradient reaches of river upstream from the falls sites. Also, dam construction in the Ontonagon River watershed has not resulted in a loss of usable habitat for migratory fishes from Lake Superior because the dams were constructed at falls that were natural barriers to upstream fish migration (see **Dams and Barriers**).

Specific Power

Specific stream power ω, with units of watts/m^2, measures the rate at which potential energy is supplied to an average square-meter area of the river channel. Power (in watts) is the rate at which work is done. (A force of 1 newton pushing a small rock a horizontal distance of 1 meter would represent 1 joule of energy expended or work performed; expending this much energy in 1 second would be 1 watt of power.) Specific power depends on discharge Q (in units of m^3/s), channel slope s (in m of drop per m of downstream distance), cross-sectional width w (in m), water density ρ (approximately 1,000 kg/m^3), and gravitational acceleration g (approximately 9.81 m/s^2). Specific power is expressed as:

$$\omega = \frac{\rho g Q s}{w}$$

Specific power is a useful index for evaluating the stability of a stream channel. Stream channels are dynamic and typically move laterally within their meander belts. The speed of this lateral movement is determined by the surrounding materials and the specific stream power at a given location.

Under natural conditions, stream channels are shaped by the erosion of surrounding particles (e.g., sand) and the transport and eventual deposition of these particles within the river channel or floodplain. The conditions needed to erode and transport these particles vary substantially. Sand particles are easily eroded and require moderate flow velocities for downstream transport (Hjulstrom 1935). Clay particles are more difficult to erode, but are easily transported even at low flow velocities. Once eroded, clay particles tend to stay in suspension until they reach an area where flow velocity essentially drops to zero (e.g., an impoundment or Lake Superior). Large particles (e.g., cobble) require considerable flow velocities for erosion and transport. In Michigan streams, movement of these large particles is generally limited to the spring high flow periods.

For streams flowing through sandy soils, stream bed movement occurs when specific power reaches 15 watts/m^2 (Madison and Lockwood 2004; M. Wiley, University of Michigan, personal communication). At this point, the river must decrease specific power by down cutting (decreasing slope) or moving laterally (i.e., increasing channel width or increasing sinuosity). The specific power needed to initiate stream bed movement is somewhat higher for rivers flowing through surficial materials other than sand (e.g., the large silt and clay deposits in the northern portion of the Ontonagon River watershed).

Human alterations of river channels often lead to changes in specific power. For example, channelized river segments generally are narrower and deeper than unaltered segments. Because the stream width has been reduced, the specific power in that location increases. Channelized river segments often are lined with riprap or concrete to prevent erosion, but this practice only pushes the erosive energy farther downstream. A similar circumstance occurs when an undersized culvert is installed at a stream crossing. The smaller width inside the culvert increases the specific power, and substantial erosion occurs on the downstream side of the culvert.

There is considerable variation in both gradient and specific power among the different stream reaches in the Ontonagon River watershed. The following sections include gradient and specific stream power information for each of the seven subwatersheds.

Middle Branch—upper

The upper Middle Branch drops 574 ft from the origin at Crooked Lake to the top of Agate Falls (Figure 21). Gradient averages 12.6 ft/mi in this segment and varies from 1.1 ft/mi in the Bond Falls Flowage to 1,546.7 ft/mi at Bond Falls. Approximately 50% of this segment falls within the gradient classes rated good or excellent in terms of fish habitat (Figure 22), but some low gradient reaches occur above Bond Falls.

Specific power at the USGS gauge site near Paulding was 8.6 watts/m^2 at 5% exceedence and 1.7 watts/m^2 at 95% exceedence (Figure 23). Specific power is 15 watts/m^2 at a discharge of 712 cfs. Flows of this magnitude occur in 6 of 10 years, so the stream channel is regularly reshaped in this area of sandy soils (see **Soils and Land Use**).

Middle Branch—lower

In this segment, the Middle Branch drops 469 ft from the top of Agate Falls to the confluence with the East Branch (Figure 21). Gradient is generally steep in the lower Middle Branch, averaging 16.5 ft/mi and ranging from 6.4 ft/mi to 458.3 ft/mi at Agate Falls. Nearly 98% of the lower Middle Branch is in the good to excellent gradient classes, with chutes and waterfalls on the remaining stream reaches (Figure 24).

Specific power at the gauge site near Trout Creek was 5.9 watts/m^2 at 5% exceedence and 1.9 watts/m^2 at 95% exceedence (Figure 25). For this site, specific power is 15 watts/m^2 at a discharge of 341 cfs. Due in part to the Bond Falls Diversion, flows greater than 341 cfs have only occurred during 5 of 10 years for the period of record.

Main Stem

The main stem drops 61 ft from the confluence of the East and Middle branches to the mouth at Lake Superior (Figure 21). The main stem has a much lower gradient than any of the branches within the Ontonagon River system. Gradient averages 2.4 ft/mi and varies from 0.5 ft/mi at the mouth to 5.4 ft/mi below the confluence with the West Branch. Gradient class is good for 12% of the main stem and poor to fair for the remaining 88% (Figure 26).

Specific power was calculated for both USGS gauge sites on the main stem. Specific power at the gauge site above the West Branch confluence was 10.0 watts/m^2 at 5% exceedence and 1.1 watts/m^2 at 95% exceedence (Figure 27). Specific power at this site is 15 watts/m^2 at 2,635 cfs. Flows of this magnitude have occurred every year for the period of record. For the USGS gauge site below the West Branch confluence, specific power was 31.4 watts/m^2 at 5% exceedence and 2.8 watts/m^2 at 95% exceedence (Figure 28).

East Branch

The East Branch falls 869 feet from the origin at Gasley Lake to the confluence with the Middle Branch (Figure 29). Stream gradient varies from 4.3 ft/mi to 92.7 ft/mi and averages 12.2 ft/mi. Good and excellent gradient reaches compose 89% of this stream, and low gradient reaches are essentially absent from the East Branch (Figure 30).

Specific power for the East Branch near Mass City was 10.4 watts/m^2 at 5% exceedence and 1.4 watts/m^2 at 95% exceedence (Figure 31). Specific power was 15 watts/m^2 at a discharge of 1,135 cfs. Flows greater than 1,135 cfs have occurred every year for the period of record.

Cisco Branch

The Cisco Branch drops 551 ft from Cisco Lake to the confluence with Tenmile Creek (beginning of South Branch; Figure 32). Gradient averages 14.3 ft/mi and varies from 3.6 ft/mi to 151.9 ft/mi. Good and excellent gradient reaches compose 78% of the Cisco Branch (Figure 33). As with the East Branch, low gradient reaches are virtually nonexistent on the Cisco Branch.

Specific power at the USGS gauge site near the Cisco Lake outlet was 3.6 watts/m^2 at 5% exceedence and 0.1 watts/m^2 at 95% exceedence (Figure 34). Flows of 538 watts/m^2 are needed to generate a specific power of 15 watts/m^2 at this site; however, the highest discharge recorded at this site was 288 cfs. The position of this gauge station at the headwaters of the Cisco Branch (only 51 mi^2 of watershed area), coupled with operation of the Cisco Lake Dam to maintain artificially high lake levels in the Cisco Chain, preclude the high stream flows needed to accomplish channel movement at this site.

South Branch

The South Branch falls 172 ft from the confluence of the Cisco Branch and Tenmile Creek to the confluence with the West Branch (Figure 32). Compared to the other branches within the Ontonagon River system, the South Branch is a relatively low gradient stream. Gradient averages 5.2 ft/mi in the South Branch and varies from 1.3 ft/mi to 28.2 ft/mi. Sixty-nine percent of the South Branch falls within the lowest gradient class (Figure 35). Stream gradient increases as the river approaches the West Branch, and the last ten miles of the stream received fish habitat ratings of good to excellent.

For the South Branch gauge site, specific power was 4.2 watts/m^2 at 5% exceedence and 0.5 watts/m^2 at 95% exceedence (Figure 36). Specific power is 15 watts/m^2 at a discharge of 5,026 cfs. Flows of this magnitude occur in 3 of 10 years. The stream channel is relatively stable in this location due to the gentle gradient and the cohesive nature of the surrounding soils (clay and silt).

West Branch

The West Branch drops 640 ft from Lake Gogebic to the confluence with the main stem (Figure 37). With a mean gradient of 18.4 ft/mi, the West Branch is the steepest branch in the Ontonagon River system. Gradient varies from 2.8 ft/mi in the Victoria Reservoir to 2,493.4 ft/mi (124.7 ft drop in 0.05 miles) at Victoria Falls. The stream reach impounded by Victoria Dam is the only low gradient reach in the West Branch. Seventy-three percent of the West Branch falls within the good or excellent gradient classes (Figure 38).

Specific power for the West Branch gauge site was 35.5 watts/m^2 at 5% exceedence and 0.2 watts/m^2 at 95% exceedence (Figure 39). Specific power was higher at this site than at any other gauge site in the watershed. Flows sufficient to generate 15 watts/m^2 occur nearly 15% of the time in this river segment.

Channel Cross Section

Channel cross section is another measure of channel morphology that can be used to determine if river habitat has become degraded. Under natural conditions channel cross section width is related to mean daily discharge according to the following equation:

$$\log_{10}(\text{Expected mean width}) = 0.741436 + 0.498473*\log_{10}(\text{mean daily discharge})$$

where width is channel width measured in feet and discharge is measured in cfs (G. Whelan, MDNR Fisheries Division, personal communication).

If a channel deviates from the expected value based on discharge, it can be an indication of problems in the watershed that are affecting instream habitat. For example, unstable flows will create a channel that is wide and shallow during base flow. Unusually high sediment loads can lead to channel widening (Alexander and Hansen 1988) and low sediment loads can lead to a deep, narrow channel. Other factors (culverts, bridges, erosion, channelization, etc.) can also lead to unexpected channel cross section widths.

The data necessary for evaluating channel width relative to discharge are scarce in the Ontonagon River watershed, but data are available at USGS gauge sites. Seven of the nine gauge sites had channel widths that were within the range predicted from the mean discharge values (Table 10). Observed channel widths were narrower than expected for the upper Middle Branch (Paulding) and Bond Falls Canal sites. The channel width for the upper Middle Branch gauge site probably was not representative of that stream segment because the gauge station is located just 25 ft downstream from the bridge on Forest Hwy 5250. The Bond Falls Canal was constructed by humans, and the flow regime is controlled by operation of the Bond Falls diversion. As typically observed for channelized river segments, the Bond Falls Canal is deeper and narrower than a natural stream channel.

Local residents report that channel widening occurred on the Middle Branch downstream of Agate Falls due to high-flow releases from the Bond Falls Dam during spring 2003 (G. Madison, MDNR, Fisheries Division, personal communication). No data are available for the stream reach immediately downstream of Agate Falls, but the observed channel width at the closest USGS gauge site (Trout Creek) did not deviate significantly from the expected width.

The fact that the channel cross sections are not drastically different from predicted indicates that channel morphology in the Ontonagon watershed is not seriously altered or degraded. This is not surprising given that much of the watershed remains undeveloped.

Dams and Barriers

There are 17 dams in the Ontonagon River watershed that are registered with MDEQ (Figure 40; Table 11). Five of these dams are operated by UPPCo to facilitate power generation at the Victoria hydroelectric facility. Four dams are operated by various governmental organizations to enhance recreational opportunities, six dams are privately owned (i.e., for private lakes and ponds), and two dams are operated for other purposes. An unknown number of small unregistered dams also exist within the watershed.

Dam construction within the Ontonagon River basin began in the 19th century. Numerous temporary dams were constructed during the 1800s to facilitate log drives, but little documentation remains regarding the number and locations of these dams. By the early 1900s, dams were also being used to facilitate power generation (see **History**), and all of the existing hydroelectric dams within the watershed were in place by 1938. Most of the private and recreational dams were built during the 1960s and 1970s, and no registered dams have been constructed since 1988.

In Michigan, dam construction and operation are regulated by two different agencies. The five hydroelectric-related dams within the watershed are regulated by FERC. Hydroelectric dam owners must obtain operating licenses from FERC. These licenses often specify a variety of conditions, such as minimum flow releases and target reservoir elevations. MDEQ is the primary regulatory agency for nonhydroelectric dams, as specified in the Natural Resources and Environmental Protection Act of 1994 (Public Act 451; see **Special Jurisdictions**).

The Dam Safety Section of MDEQ assigns hazard ratings to all dams in the watershed. Hazard ratings are determined primarily by the size of the dam and its location relative to human population centers.

> Failure of dams with a hazard rating of 1 would result in the loss of human life, those with a hazard rating of 2 would result in severe property damage, and those with a hazard rating of 3 are low head dams located in remote areas. [From Madison and Lockwood 2004.]

Three dams, Bond Falls, Bond Falls Control, and Victoria, are rated as Type 1; Trout Creek Dam is classified as Type 2. The 13 remaining dams have a hazard rating of 3.

The detrimental effects of dams on river ecosystems are well documented. One of the most obvious ways that dams influence stream communities is by restricting fish movements. Potamodromous fish species (e.g., coho salmon and steelhead) spend most of their lives in Lake Superior and use stream environments for spawning and nursery areas. In addition, river resident fishes (e.g., brook trout) typically exhibit seasonal movements to spawning areas and to find coldwater refuges during the summer months. Dam construction interferes with these movements and fragments fish populations within a river system.

Downstream movement of fish through dams can lead to mortality or injury, especially when the dam is equipped with hydroelectric turbines. A variety of stresses (e.g., pressure changes, blade contact, water velocity accelerations) can injure or kill fish that are entrained in hydroelectric facilities (Cada 1990).

Dams also interfere with the downstream movement of large woody structure and detritus (Shuman 1995). Large woody structure provides important habitat for fish and aquatic insects. Detritus (decaying organic matter) provides some of the nutrients needed to drive the food web in aquatic ecosystems. Not surprisingly, many studies have demonstrated that the diversity or density of fish and aquatic insects is reduced in stream reaches below impoundments (Trotzky and Gregory 1974; Cushman 1985; Bain et al. 1988).

The impoundments created by dams also act as large sediment traps. Dam construction reduces the stream gradient above dams and often causes sedimentation in stream reaches immediately above impoundments (Petts 1980). In addition, water released from impoundments is essentially “sediment-starved”. To restore the sediment balance, the stream must pick up sediment in the lower reaches of the stream. This results in accelerated erosion of the stream bed and banks below dams (Petts 1980).

Impoundments expose a large surface area of water to radiant sunlight. Thus, the warm surface waters leaving an impoundment typically increase water temperatures in the stream below (Wesley 2005). This alteration of water temperatures is especially noticeable during the summer months. Several fish species (e.g., brook trout, rainbow trout, and coho salmon) are not tolerant of high water temperatures, and temperature increases of only a few degrees can make a stream unsuitable for these species.

Another mechanism by which dams affect aquatic ecosystems is the alteration of natural flow regimes. Flow alteration is most obvious for hydropower peaking operations, but all dams alter stream flows to some extent. Changes in flow regimes can interfere with fish spawning activities (Auer 1996; Paragamian et al. 2005; Friday 2006) and alter channel morphology in downstream reaches (Ligon et al. 1995). In addition, dam operations affect the connectivity of the stream with its floodplain.

> The seasonal distribution of flow is also disrupted by reducing [the] incidence and severity of flooding. This reduces the inundation of floodplains causing a decrease in backwater habitat for fish spawning and juvenile rearing. The decrease in flooding also reduces the amount of food deposited into the river. Intense short-term flow fluctuations immediately below dams can strand aquatic organisms during severe low flows and destroy habitat during extremely high flows. [From Wesley and Duffy 1999.]

Because dams adversely affect stream ecosystems as described above, MDNR Fisheries Division generally opposes new dam construction. Fisheries Division also works with dam owners to minimize the negative effects of existing dams.

Dams are not the only barriers that restrict movement of aquatic organisms. Improperly constructed stream crossings (e.g., perched culverts) can block fish movements and fragment stream populations (see **Soils and Land Use**). In the Ontonagon River watershed, waterfalls also provide natural barriers to fish movement. There are 24 named waterfalls and a myriad of unnamed waterfalls within the Ontonagon River and its tributaries (Figure 41; Table 12). Although many of these waterfalls allow fish passage at least seasonally, the larger waterfalls (e.g., Bond, Agate, and Victoria Falls) are year-round barriers to upstream fish movement.

Middle Branch—upper

The two largest dams in this subwatershed are associated with the Bond Falls diversion. The Bond Falls Dam and Bond Falls Control Dam are operated by UPPCo to store water and divert flow from the Middle Branch to the South Branch via the Bond Falls Canal. Water yield calculations indicate that approximately two-thirds of the Middle Branch flow is routed to the South Branch through this diversion (see **Hydrology**).

Operation of the Bond Falls diversion strongly influences the seasonal flow patterns in the lower Middle Branch and the South Branch. All of UPPCo’s dams in the Ontonagon River watershed were relicensed in 2003, and operational changes set forth in the new license should produce stream flows that more closely mimic a natural flow regime. Under the previous license, required minimum flows into the Middle Branch were 40 cfs during June through August, and 30 cfs during the remainder of the year. Under the new license, minimum flows to the Middle Branch were increased to 110 cfs in April, 100 cfs in May, 80 cfs in June through October, 90 cfs in November, and 80 cfs in December through March (Appendix A). The new license also specifies minimum and maximum water releases to the Bond Falls Canal.

The two dams at Bond Falls maintain a 2,160 acre impoundment known as the Bond Falls Flowage. Historically, this reservoir was drawn down as much as 20 ft during the winter months, decreasing the surface area of the reservoir to around 1,400 acres. Under the new license, the maximum allowable drawdown has been decreased to 8 ft. This change in operations will increase the amount of available winter habitat for fish and other aquatic organisms, and should increase overwinter survival of fish in the impoundment.

The temperature of the water released from the Bond Falls Flowage has been a major concern for fisheries managers. As mentioned above, dams that spill surface waters can substantially increase summer water temperatures in the stream below. The outlet at the Bond Falls Dam is located at a depth of 30 ft (at full pool), so the water discharged into the Middle Branch is noticeably cooler than water at the surface of the reservoir. Eschmeyer (1942) and Hazzard (1945) monitored water temperatures in the Middle Branch shortly after the dams were constructed. They found that water releases from the Bond Falls Flowage actually decreased summer stream temperatures below the impoundment.

Photo 1.–Bond Falls, Middle Branch Ontonagon River.

Although Bond Falls Dam is a barrier to fish migration, the dam was built just upstream of a natural barrier – Bond Falls. Thus, the dam itself does not significantly influence fish movement. The corresponding alteration of flow regimes, however, undoubtedly has affected movements of fish in the Middle Branch and South Branch Ontonagon rivers.

The only other dam within this subwatershed is the Wolf Lake Dam. This dam is located on a small tributary (Wolf Lake Creek) to the Middle Branch and is used to control the water level in Wolf Lake. Both the dam and the lake are privately owned.

There are three named waterfalls on the upper Middle Branch: Mex-i-min-e Falls, Little Falls, and Bond Falls. Bond Falls is the only one of these waterfalls that is considered a barrier to fish passage.

Middle Branch – lower

The Calderwood Pond Dam was constructed by MDNR in 1982 to create a walleye rearing pond, and the dam is currently owned by the United States Forest Service (USFS). Walleye fry were stocked in this pond during the 1980s. Contamination with competing species (dace and other minnows) was a continual problem, and few fish survived to be harvested as spring fingerlings. Calderwood Pond was converted to trout management in the late 1990s, and brown trout were stocked in the pond from 1998 through 2005. Netting surveys and angler reports indicated poor survival of stocked trout, and the plants were discontinued in 2006. Because the impoundment is not serving its intended purpose, the future management of this dam is currently under review by USFS and MDNR.

The Trout Creek Dam was originally constructed to create a mill pond for the local sawmill. The pond has become a local landmark, and Interior Township continues to operate the dam to maintain this popular resource. MDNR has stocked brook trout in Trout Creek Pond since 1998, and the pond receives heavy fishing pressure in the spring. Because Trout Creek is one of the best trout streams in the area, fish passage has been a major concern at this dam. To facilitate passage of fall spawning salmonids (e.g., brook trout and brown trout), a Denil fish ladder was installed at the dam in 1995. The fish ladder is still operating, but a systematic evaluation of fish movement through the ladder has not been conducted.

Photo 2.–Trout Creek Dam and fish ladder.

There are three named waterfalls in the lower Middle Branch subwatershed. Agate Falls is actually a series of cascading waterfalls that have a vertical drop of approximately 40 ft. This falls is the upstream barrier for fish migrating from Lake Superior, but anecdotal reports suggest that a few steelhead may be able to ascend the falls under the proper flow conditions. The other waterfall on the lower Middle Branch, Three Rapids Falls, is not a major barrier to fish passage. O Kun de Kun Falls is the upstream barrier for fish movement in the Baltimore River.

Main Stem

There are no dams in the main stem subwatershed. There are two small waterfalls (rapids) on the main stem, but neither of these falls is considered a barrier to fish passage.

East Branch

Lower Dam is located within the Ottawa National Forest. USFS operates this dam to provide additional boating and trout fishing opportunities for Forest visitors. Lower Dam and the other impoundments owned by USFS (Calderwood Pond, Robbins Pond, and Paulding Pond) are drawn down only when necessary for dam repair or pond maintenance (e.g., aquatic vegetation control or sediment removal). Lower Dam is the upstream barrier for fish migrating up the East Branch.

The only other dam within this subwatershed, Nordine Dam, is privately owned. This low-head dam was constructed on a tributary to the Jumbo River in 1970, creating a 26-acre impoundment.

There are three waterfalls on East Branch tributaries. Onion Falls is a major barrier to fish passage. Jumbo and Duppy Falls can be ascended by steelhead and coho salmon, but they may limit movements of other fish species.

Photo 3.–Agate Falls, Middle Branch Ontonagon River.

Cisco Branch

Cisco Dam controls the water level in the Cisco Lake Chain. The Copper District Power Company constructed this dam in 1931 to provide water for the Victoria hydroelectric facility, but MDNR, Fisheries Division files suggest that logging companies may have constructed wooden dams at the outlet prior to this date. The UPPCo acquired ownership of the Cisco Lake Dam and the Victoria hydroelectric facility in 1947.

The Cisco Dam raises lake levels in the Cisco Chain by 4–5 ft. The elevated lake levels provide some recreational benefit, as they increase the ability of boaters to travel between different lakes within the chain. Fluctuations in lake levels are relatively minor. For example, the target elevation range for Cisco Lake under the current license is 1,683.4–1,683.9 ft above sea level.

Operation of the Cisco Dam dramatically alters the flow regime in the Cisco Branch Ontonagon River (see **Hydrology**). In order to maintain the artificially high lake levels in the Cisco Chain, outflow from the dam often is reduced to less than 1 cfs during late summer (e.g., during 13 August – 18 September 2005). Water releases into the Cisco Branch are dictated primarily by water needs at the Victoria hydroelectric facility and target water levels in the Cisco Chain (as specified in the current FERC license), so flow patterns in the Cisco Branch vary substantially from the flow patterns in the other branches of the Ontonagon River system.

The Beatons Lake Dam was constructed by MDNR to prevent white suckers from entering Beatons Lake from Twomile Creek. (The original dam was constructed in 1967, but the existing structure was installed in 1988.) This dam has a head of only 3 ft, so it has minimal effect on the water level in Beatons Lake or the flow regime in Twomile Creek.

There are two waterfalls on the Cisco Branch: Kakabika Falls and Wolverine Falls. Neither of these waterfalls is considered a barrier to fish passage.

South Branch

There are five small dams on tributaries to the South Branch Ontonagon River. Two of these dams, Paulding Pond and Robbins Pond, are owned by USFS. Both of these dams were built during the 1950s to create ponds for trout fishing. Paulding Pond has supported a good trout fishery for many years. Trout historically did well in Robbins Pond, but stocking was halted in the mid-1990s due to excessive weed growth.

The other three dams on South Branch tributaries are privately owned. Little information is available regarding the operation of these small, low-head dams.

The two waterfalls (rapids) on the South Branch are not considered barriers to fish passage. Ajibikoka Falls and Rock Bluff Falls are larger waterfalls that probably restrict fish movements.

West Branch

Bergland Dam was built in 1906 to control the water supply for the Victoria hydroelectric facility. The dam artificially raises the water level in Lake Gogebic, and regulation of the water level has been a contentious issue since the dam was constructed. As with the Cisco Dam, UPPCo operates the dam to provide water for their hydroelectric plant, but they also strive to maintain the surface water level within a target range of 2 ft.

Operation of the Bergland Dam alters the flow regime in the West Branch so that it differs markedly from discharge patterns in the unregulated branches of the Ontonagon River system (e.g., East Branch; see **Hydrology**). To improve fish habitat in the West Branch, the current FERC license specifies minimum water releases from the Bergland Dam. The dual requirements of minimum flow releases and target lake levels could be conflicting during dry periods, so UPPCo, MDNR, and other interested parties are in the process of refining the minimum flow requirements to ensure that discharge requirements for the West Branch can be met without compromising recreational opportunities on Lake Gogebic.

A structure known as a Barr Fish Lock was installed in 1934 to facilitate upstream fish passage at the Bergland Dam. Few records remain regarding operation of this structure, but it appears that it was not very successful.

Victoria Dam is the focal point of UPPCo's hydroelectric operations in the Ontonagon River watershed. The existing dam was built in 1931 to replace the old Copper District Power Company dam at the same location (see **History**). Water reaching Victoria Dam is diverted into a steel pipeline that leads to the powerhouse. After passing through the turbines, the water is released back into the river approximately 1.6 miles downstream of the dam. When the storage capacity of the dam is exceeded, water flows over the spillway into the original riverbed. The current FERC license requires minimum flows of 82 cfs into the original stream channel from 01 May through 10 June. During the rest of the year, this bypassed reach of the West Branch is generally dewatered.

Entrainment of fish at the Victoria hydroelectric facility was evaluated from April, 1994 to February, 1995. The estimated annual entrainment for all species was 234,784 fish, and the estimated mortality was 71,141 fish (RMC Environmental Services 1995). The species most commonly entrained were yellow perch, golden shiner, common shiner, and black crappie. Small fish (≤4 in total length) made up over 93% of all estimated mortalities (RMC Environmental Services 1995).

Photo 4.–Victoria Dam, West Branch Ontonagon River.

During late spring through autumn, UPPCo maintains a target reservoir elevation of 907.1 ft above sea level to provide maximum head for power generation, but reservoir water levels often fluctuate as much as 3 ft per day. The Victoria impoundment is drawn down 14 ft (elevation = 893.1 ft above sea level) in March to allow deicing of spillway gates and provide additional storage for spring runoff. As discussed above for the Bond Falls Flowage, these winter drawdowns substantially reduce the amount of available habitat for fish and other aquatic organisms.

Trout Brook Dam is the only registered private dam in the West Branch subwatershed. Fisheries Division files indicate that this dam was built in the early 1960s to create a small trout pond. Trout Brook Dam is located about 250 ft upstream from the confluence of Trout Brook with Lake Gogebic.

Victoria Falls is the upstream barrier for fish migrating from Lake Superior. (Victoria Dam is located immediately above Victoria Falls, so the dam and falls act as one barrier.) There are three waterfalls on tributaries to Lake Gogebic and three additional waterfalls on tributaries to the West Branch. Some of these waterfalls may restrict fish movements, especially under low flow conditions.

Water Quality

In general, water quality in the Ontonagon River watershed is excellent and essentially unchanged since the time of settlement by Europeans. Three factors have favored the retention of high water quality within the basin: low human population density, sparse agricultural land, and minimal industrial development.

Sediment is the primary pollutant. The main stem Ontonagon River is naturally turbid, as evidenced by early historical accounts. Henry Rowe Schoolcraft (1992), who visited the region in 1820, left this description of the main stem. “Its waters have a reddish colour [sic], like those of the Arkansas, and are moderately turbid.”

Poor land use practices associated with stream crossings, road maintenance, and logging operations have led to increased erosion and sedimentation in some areas. MDNR, USFS, and other organizations have completed various habitat improvement projects to reduce sediment inflows and remove sediment that had entered the system as a result of human activities.

Thermal pollution is a concern for stream reaches immediately downstream of dams (see **Dams and Barriers**). Most of the dams are relatively small, and two of the larger dams (Cisco Dam and Bergland Dam) were built at the outlets of large natural lakes. Thus, thermal pollution probably has only minor effects on aquatic communities in the Ontonagon River system.

During the mining era (1847–1921), waste rock from copper mines was deposited on the surface (see **History**). When sulfur-bearing minerals were present in the waste rock, these materials reacted with water to form sulfuric acid. Several mines were located near streams, so some of this acid mine drainage may have reached the Ontonagon River system. The effects of acid mine drainage on fish communities within the Ontonagon River watershed are unknown, but recent studies indicate that most fish eggs cannot hatch in water with a pH ≤5 (United States Environmental Protection Agency 2007). Thus, acid mine drainage may have prevented reproduction of fish species in stream reaches immediately downstream of waste rock piles.

Airborne mercury contamination affects the Ontonagon River and most other waters in Michigan. The rock surrounding many of the lakes and streams in the western Upper Peninsula also provides a natural source of mercury to surface waters. Mercury accumulates in the tissues of fish (especially piscivorous species), and the effects of this mercury contamination on humans who consume fish is a matter of great public concern. Due to the broad geographic scale of mercury contamination, the Michigan Department of Community Health (2007) has issued statewide fish consumption advisories for several game fish species from inland lakes. Additional fish consumption advisories have been issued for walleye in the Cisco Chain and Duck, Gogebic, and Langford lakes in the Ontonagon River basin (Michigan Department of Community Health 2007).

NPDES Permit Program

Point source discharges to surface waters are regulated by the National Pollutant Discharge Elimination System (NPDES) permitting program. This is a federal permit system that is administered by the Michigan Department of Environmental Quality – Water Bureau. Under the NPDES program, point source discharges to state waters must be authorized by permit. These permits, which must be renewed every five years, specify limits on the amount and types of pollutants that can be discharged.

Permittees are required to sample their discharges for pollutants and report these results to MDEQ. In addition, MDEQ personnel periodically inspect the facilities to ensure compliance with permit conditions.

There are eleven active NPDES permits in the Ontonagon River watershed (Table 13; T. Mitchell, Michigan Department of Environmental Quality, Water Bureau, personal communication). Seven of these permits were issued for municipal waste water sewage lagoons, one was issued to the Ontonagon County Road Commission, and two were issued to private industries. In 2005, an additional permit was issued to the Michigan Department of Transportation for the M-64 bridge relocation project at the Ontonagon River in the village of Ontonagon.

NPDES Storm Water Permits

Storm water running through urban areas, industrial facilities, or construction sites can transport pollutants into adjacent lakes and streams. Storm water drainage systems from large impervious areas (e.g., parking lots) can concentrate runoff and transport it to the stream rapidly, leading to more flashy flow regimes and accelerated erosion of stream banks. The NPDES storm water permit system administered by MDEQ regulates storm water discharges to state waters. Pitlik and Wick, Inc. of Watersmeet, which manufactures asphalt for road and driveway paving, has the only active NPDES storm water permit.

MDEQ Procedure 51 Monitoring

The MDEQ staff surveyed the Ontonagon River watershed in 2003 using the methods outlined in Procedure 51 – Qualitative Biological and Habitat Protocols for Wadeable Streams and Rivers (Michigan Department of Environmental Quality 2002). This comprehensive sampling protocol was designed to evaluate macroinvertebrate communities, instream and riparian habitat, and water quality within the subject streams.

Macroinvertebrate community composition was evaluated at nine sites within the basin. The macroinvertebrate communities at six of these sites were rated “acceptable”, and three were rated “excellent” (Taft 2004).

> Macroinvertebrates such as mayflies, stoneflies, and caddisflies are important indicators of water quality because they have a long life history and are intolerant of pollution and low dissolved oxygen. Three orders of insects are often grouped together and termed EPT for their scientific names (mayflies – Ephemeroptera, stoneflies – Plecoptera, caddisflies – Trichoptera). [From Cwalinski et al. 2006.]

Stations that were rated “excellent” had macroinvertebrate communities that were dominated by EPT species.

Water chemistry samples were collected at 11 sites within the Ontonagon River watershed. Although no chemicals were found at levels exceeding Michigan Water Quality Standards, analysis of the samples indicated that the Ontonagon River system has very soft water. Alkalinities for the various streams ranged from 46 mg/L for Pelton Creek to 82 mg/L for the Middle Branch at Watersmeet (Taft 2004). Soft water systems have limited buffering capacities, and several lakes within the basin are acidic. During the 1980s, MDNR contracted Living Lakes Inc. to apply lime to some of these lakes (e.g., Bob and Long lakes) to raise the pH to slightly above neutral. These lime applications only caused temporary pH changes. For example, Bob Lake was limed twice, and after both treatments the lake returned to its pretreatment pH in less than ten years (MDNR, Fisheries Division files).

Water Quality Legislation

Most state laws administered by MDEQ – Water Bureau are contained in Parts 31 (Water Resources Protection), 41 (Sewerage Systems), and 88 (Water Pollution Prevention and Monitoring) of the Natural Resources and Environmental Protection Act, Act 451 of 1994. Public Act 451 can be viewed on the Michigan Legislature web site at www.legislature.mi.gov.

> [The MDEQ – Water Bureau] also administers parts of the Federal Clean Water Act (CWA) including the National Pollutant Discharge Elimination System and Section 319.… The CWA is a 1977 amendment to the Federal Water Pollution Control Act of 1972, which set the basic structure for regulating discharges of pollutants to waters of the United States. The law gave EPA [Environmental Protection Agency] the authority to set effluent standards on an industry basis (technology-based) and continued the requirements to set water quality standards for all contaminants in surface waters. The CWA makes it unlawful for any person to discharge any pollutant from a point source into navigable waters unless a permit (NPDES) is obtained under the Act. The 1977 amendments focused on toxic pollutants. In 1987, the CWA was reauthorized and again focused on toxic substances, authorized citizen suit provisions, and funded sewage treatment plants … under the Construction Grants Program.
>
> The CWA contains provisions for the delegation of many permitting, administrative, and enforcement aspects of the law by EPA to state governments. In states [such as Michigan] with the authority to implement CWA programs, EPA still retains oversight responsibilities. [From Madison and Lockwood 2004.]

Stream Classification

In 1967, MDNR, Fisheries Division instituted a stream classification system based on water temperature, stream size, habitat quality, and riparian development. This classification system was developed to help resource managers establish water quality standards, evaluate stream recreation values, determine priorities for fishing or boating access and riparian land acquisitions, identify stream reaches with the greatest needs for improvement or preservation, develop appropriate fishing regulations, and detect potential dam and impoundment problems.

Coldwater stream reaches encompass 389 mi (30%) of the Ontonagon River system (Figure 42). Portions of the upper Middle Branch, the Baltimore River, and several small tributaries to the East Branch and Lake Gogebic were classified as top quality coldwater reaches. The main stem, South Branch, and West Branch are primarily warmwater systems.

Baker (2006) developed a new landscape-based classification system for stream valley segments in Michigan's Upper Peninsula using an approach that was originally developed for Lower Peninsula streams (Seelbach et al. 2006). Attributes such as stream size, temperature, hydrology, gradient, water chemistry, fish community, and Great Lakes connectivity were used to delineate and classify 65 discrete valley segments within the Ontonagon River watershed. Two of these valley segments are covered by the Bond Falls and Victoria impoundments.

For the purposes of this assessment, valley segment classifications will be discussed in relation to stream size and temperature. Valley segments were divided into four size categories based on the catchment area at the midpoint of the segment: small (headwater) = 10–40 mi^2, medium = 40–179 mi^2, large = 180–620 mi^2, and very large = >620 mi^2. Valley segments were also classified into three temperature categories based on the mean stream temperature during the first three weeks of July: cold = <66°F, cool = 66–72°F, and warm = >72° F. Because brook trout rarely are abundant in streams with mean July water temperatures greater than 66°F (A. Nuhfer, MDNR, Fisheries Division, personal communication), streams classified as "cold" are considered to have the most potential for trout production.

Cold headwater valley segments make up 26% of the total river miles within the Ontonagon River basin (Table 14). These valley segments are distributed primarily in the southern half of the watershed (Figure 43). Cold medium valley segments exist on the upper reaches of the East and Middle branches. The East Branch (between Kenton and Mass City) is the only cold large stream in the basin.

Cool small streams (29% of total) are common in the central portion of the watershed. Cool medium valley segments exist on Ten Mile Creek, Trout Creek, the Baltimore River, and the lower Cisco Branch. The South Branch, lower Middle Branch, and the lower East Branch are cool large streams, whereas the main stem and the lower West Branch (downstream of the South Branch confluence) are considered cool very large streams.

The upper portions of the Cisco and West branches are classified as warm medium streams. The only warm large valley segment in the watershed is on the West Branch between the Mill Creek and South Branch confluences.

Special Jurisdictions

Several different governmental entities have jurisdiction over various portions of the Ontonagon River watershed. The regulations instituted by these organizations greatly influence human development in the watershed.

United States Army Corps of Engineers

The United States Army Corps of Engineers, Detroit District, possesses navigational jurisdiction over United States waters up to the ordinary high water mark for Lake Superior (603.1 ft above sea level). The Corps' management authorities are derived from the following laws.

> **Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. 403)** prohibits the obstruction or alteration of navigable waters of the United States without a permit from the Corps of Engineers.
>
> **Section 404 of the Clean Water Act (33 U.S.C. 1344, [Section 301])** … prohibits the discharge of dredged or fill material into the waters of the United States without a permit from the Corps of Engineers. [From Madison and Lockwood 2004.]

The Corps of Engineers is also responsible for maintaining shipping channels at various Great Lakes ports. The lower Ontonagon River, from the mouth to the old M-64 bridge (which was removed in 2006), is regularly dredged by the Corps to facilitate ship traffic and coal delivery to the fiber mill (Stone Container) in Ontonagon.

Navigable Waters

Issues pertaining to navigability and public use of navigable waters have been debated for many years, and water laws continue to evolve through legislative processes and judicial action. Currently, a navigable inland stream is defined as (1) any stream declared navigable by the Michigan Supreme Court; (2) any stream included within the list of navigable waters regulated by the Corps of Engineers 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 cfs, an average width of 30 feet, an average depth of about 1 foot, capacity for floatage during spring periods of high water, 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 commerce or travel; or (6) any stream meandered by the General Land Office Survey in the mid-1800s (Anonymous 1993).

The lower Ontonagon River from the mouth to the first railroad bridge (0.76 miles upstream from the mouth) is included within the list of navigable waters under the jurisdiction of the Corps of Engineers. Although no streams within the basin have been declared navigable by the Michigan Supreme Court, many streams could be considered navigable based on criteria 3 through 6.

In Michigan, the right to public use of navigable waters includes the right to float the stream and the right of trespass upon submerged soil (but not on the adjacent uplands). The public also has the right to fish in navigable streams, subject to state regulations.

Federally Regulated Dams

Under the Federal Power Act of 1935, all hydroelectric dams are required to obtain operating licenses through FERC. Before FERC issues a new license for a dam within the Ontonagon River basin, various resource agencies and stakeholder groups (e.g., MDNR, MDEQ, USFWS, USFS, Trout Unlimited, Keweenaw Bay Indian Community, local sport fishing groups, and lake associations) have an opportunity to articulate their concerns regarding the proposed dam operations. After a lengthy review process, all five of the hydroelectric-related dams in the Ontonagon River watershed were relicensed in August 2003 (Appendix A).

Wild and Scenic Rivers

Four of the five main branches in the Ontonagon River system have stream reaches that are designated as Federal Wild and Scenic Rivers under the National Wild and Scenic Rivers Act (Public Law 90-542). The purpose of this act is to ensure that “certain selected rivers of the Nation which, with their immediate environments, possess outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values, shall be preserved in free-flowing condition, and that they and their immediate environments shall be protected for the benefit and enjoyment of present and future generations.” This Act specifies a variety of restrictions on human activities (e.g., dam construction and road development) along designated stream reaches that are designed to preserve the wild character of these streams. The Wild and Scenic River designation only applies to federal lands, so designated stream reaches generally flow mostly or entirely through National Forest land.

Under the National Wild and Scenic Rivers Act, designated river reaches are assigned to one of three categories: wild, scenic, or recreational. Wild rivers are free of impoundments, have shorelines that are essentially undeveloped, and are generally inaccessible except by trails. Scenic rivers are also free of impoundments and have largely undeveloped shorelines, but road construction has made these rivers readily accessible. Recreational rivers often have some development along their shorelines, may have undergone some diversion or impoundment in the past, and are readily accessible by train or automobile. In the Ontonagon River system, 42.9 miles are classified as wild, 41.0 miles are classified as scenic, and 73.5 miles are classified as recreational. These designated river reaches include portions of the East, Middle, West, and Cisco branches of the Ontonagon River (Figure 44).

National Forest

Much of the Ontonagon River watershed is located within the Ottawa National Forest and is under the jurisdiction of USFS. The Ottawa National Forest was established in 1931 and currently encompasses nearly one million acres of land in the western Upper Peninsula. The forest is managed from the supervisory office in Ironwood and four district offices in Iron River, Watersmeet, Kenton, and Ontonagon. The Ottawa Visitor Center, located at the junction of US-2 and US-45 in Watersmeet, provides visitors with information on the natural resources and recreational opportunities within the forest. In addition, the J. W. Tourney Nursery (also in Watersmeet) raises tree seedlings for seven national forests in Michigan, Wisconsin, and Minnesota. USFS manages eight campgrounds within the Ontonagon River watershed (Table 15).

Three wilderness areas (Sylvania, McCormick, and Sturgeon River Gorge) exist within the Ottawa National Forest, and one of these, the Sylvania Wilderness, is located in the Ontonagon River watershed (Figure 44). The Sylvania Wilderness encompasses an area of 18,327 acres and includes 34 named lakes. Public use of this area includes fishing, canoeing, hiking, and primitive camping. Motors are prohibited on all Sylvania lakes except Crooked Lake, where electric motors are allowed. A combination of high minimum size limits, reduced bag limits, and gear restrictions have been used by MDNR to maintain high quality fisheries in Sylvania lakes. In particular, the catch-and-release fisheries for smallmouth bass in several Sylvania lakes have received widespread recognition.

The USFS Fisheries Program evaluates aquatic habitat conditions and performs habitat improvement projects on waters within the Ottawa National Forest. Fisheries Program personnel also conduct fish community surveys and assist MDNR with various fisheries projects within the Ontonagon River watershed.

United States Fish and Wildlife Service

The USFWS Marquette Biological Station maintains responsibility for sea lamprey control and assessment activities on Lake Superior tributaries. USFWS Ashland Fishery Resources Office also conducts fisheries surveys and habitat improvement projects on United States waters within the Lake Superior basin.

State Government

The two state agencies that have the most influence on land and water management activities within the Ontonagon River watershed are MDNR and MDEQ. MDNR is responsible for managing fish, wildlife, and forestry resources, and MDEQ institutes and enforces water quality standards. For the Wisconsin portion of the watershed, the Wisconsin Department of Natural Resources (WDNR) performs roles similar to those of MDNR and MDEQ in Michigan.

Michigan Department of Natural Resources

Various divisions of MDNR are involved in managing the natural resources within the Ontonagon River watershed. MDNR offices located in Baraga, Crystal Falls, Marquette, and Twin Lakes all have some management jurisdiction within the watershed.

As outlined in the Sikes Act (Public Law 86-797), MDNR, Fisheries Division is the lead authority for fisheries management in Michigan waters (including those waters that are within the Ottawa National Forest). Fisheries Division activities include fish stocking, fish community assessments, and aquatic habitat restoration. In addition, Fisheries Division establishes fishing regulations in Michigan waters. Amphibians and reptiles also fall under the jurisdiction of MDNR, Fisheries Division.

Hunting and trapping activities within the watershed are supervised by MDNR, Wildlife Division. Wildlife Division activities include monitoring populations of game animals, instituting and evaluating hunting and trapping regulations, and working with MDNR, Forest, Mineral and Fire Management Division (FMFM) to protect and enhance wildlife habitat in the western Upper Peninsula.

The MDNR, FMFM manages silvicultural and recreational activities within the Copper Country State Forest. FMFM maintains snowmobile and off-road vehicle trails, plans and oversees logging operations, and maintains hiking pathways and campgrounds on state lands. In the Ontonagon River watershed, state forest land largely is limited to the area around Mill Creek (Main Stem subwatershed).

The MDNR, Parks and Recreation Division operates Lake Gogebic State Park on the west shore of Lake Gogebic. This park spans 360 acres and includes nearly one mile of lake frontage. Parks and Recreation Division also oversees access to two state scenic sites: Bond Falls and Agate Falls on the Middle Branch Ontonagon River. In addition, Parks and Recreation Division maintains jurisdiction over 11 public boat launches in the watershed (see **Recreational Use**).

Fishing and hunting regulations are enforced by MDNR Law Enforcement Division. Law Enforcement Division works with Fisheries and Wildlife divisions to develop regulations that are biologically sound and practical to implement.

Michigan Department of Environmental Quality

The MDEQ is the primary regulatory authority for administering the Michigan Natural Resources and Environmental Protection Act of 1994 (Public Act 451) as it pertains to water quality issues (Table 16). Among other things, this Act gives the State the authority to protect and conserve its water resources, to identify sites of environmental contamination, and to request responsible parties to take actions to repair affected areas. Examples of activities that require MDEQ approval include dredging, installation of dams or stream crossings, and shoreline modifications (e.g., riprap installation).

Local Government

Local units of government have authority to implement special ordinances and zoning restrictions that can influence land use patterns within the basin. County road commissions also influence sediment inflows to streams through their road construction and maintenance activities. County drain commissioners are responsible for maintaining legally established drains under the Michigan Drain Code Act of 1956 (Act 40). Ontonagon County is the only county within the watershed that does not have a drain commissioner. Due to scarcity of suitable agricultural land and the remote location of the Ontonagon River, there are no designated drains in the watershed.

University of Notre Dame

University of Notre Dame owns several thousand acres of land in the southern portion of the Cisco Branch subwatershed. Tenderfoot Creek bisects the Notre Dame property, and numerous lakes (e.g., Bay, Long, and Bergner lakes) are located entirely within the university's ownership. These lakes are closed to the public, which allows researchers to conduct controlled experiments that would not be practical to perform on public waters.

Biological Communities

Original Fish Communities

Little information is available regarding the fish communities that existed in the Ontonagon River basin prior to settlement by Europeans. Archeological research and descriptions by early European visitors provided basic information on the major fish species used by humans. Distributions of nongame species were reconstructed primarily from regional (usually Lake Superior wide) descriptions of native fish fauna.

The main species mentioned by virtually all early European visitors to the area was lake sturgeon. Lake sturgeon typically spend most of their lives in Lake Superior and return to their native rivers to spawn during spring. The Chippewa constructed elaborate weirs to facilitate harvest of spawning lake sturgeon in the Ontonagon River (Danziger 1979; Jamison 1948; Lulich 1998). Lake sturgeon were allowed to pass upstream through a small opening in the weir. This opening was eventually closed, and the fish were harvested during their downstream migration. Lake sturgeon were so abundant in the Ontonagon River that they provided the main means of subsistence for the Chippewa (Schoolcraft 1992).

At least two different weir sites were used by the Chippewa. Henry Rowe Schoolcraft described a weir located four miles upstream of the river mouth (Schoolcraft 1992), and Lt. James Allen observed a similar weir approximately 17 miles from the mouth (B. Mead, Michigan Department of State, Office of the State Archaeologist, personal communication). These historical accounts indicate that lake sturgeon migrated through most of the main stem. Previous authors (Harkness and Dymond 1961) have observed that lake sturgeon often migrate as far upstream as possible before spawning. "All accounts agree in suggesting that sturgeon pass through minor rapids in the course of a spawning river and only spawn in rapids at the foot of falls which bar their further progress upstream."

If Harkness and Dymond were correct, then lake sturgeon probably spawned below Victoria Falls (West Branch), Agate Falls (Middle Branch), and perhaps Onion or Duppy falls (East Branch subwatershed).

Additional fish species harvested by the Chippewa included lake trout, lake whitefish, lake herring, round whitefish, walleye, white sucker, yellow perch, and northern pike (Cleland 1982; Jamison 1948; B. Mead, Michigan Department of State, Office of the State Archaeologist, personal communication). Although the Chippewa harvested fish from a variety of waters within the Ontonagon River basin, it appears that most fishing activity was concentrated near the mouth of the main stem (B. Mead, Michigan Department of State, Office of the State Archaeologist, personal communication).

Coon (1999) estimated that 69 fish species were native to the Lake Superior basin. Many of these species occupied the Ontonagon River system, at least on a seasonal basis. Brook trout resided in cold groundwater-fed streams, while coolwater fishes (e.g., northern pike and smallmouth bass) were found in the lakes and lower stream reaches within the watershed.

Numerous Lake Superior fish species used the Ontonagon River and its tributaries for spawning and nursery habitat. Lake sturgeon, white sucker, longnose sucker, shorthead redhorse, and walleye ascended the river in the spring. Lake trout, lake whitefish, lake herring, and round whitefish moved into the main stem during fall, and burbot probably migrated into the Ontonagon River during winter. Waterfalls prevented upstream movement of fish into some streams. Major barriers to fish passage included Agate Falls (Middle Branch), Victoria Falls (West Branch), O Kun de Kun Falls (Baltimore River), and Onion Falls (Onion Creek; Figure 41).

Factors Affecting Fish Communities

Many changes have occurred in the Ontonagon River watershed since the arrival of Europeans. As populations expanded, human activities in the region resulted in physical alterations of the stream channel and changes in the species composition of aquatic communities.

The intensive removal of beaver during the fur trading era (approximately 1630 to 1840) presumably altered the hydrology, channel morphology, and temperature regimes in many of the smaller streams within the Ontonagon River watershed. Declining numbers of beaver dams likely reduced water temperatures, exposed larger areas of gravel substrate, and reduced fragmentation of fish populations. Brook trout abundance probably increased as a result of these habitat changes, but abundance of some other fish (e.g., bluegill, yellow perch, and northern redbelly dace) and wildlife (e.g., ducks and herons) species may have declined.

Logging operations during the late 1800s dramatically affected the Ontonagon River watershed (see **History**). Removal of trees from riparian areas led to increased erosion of stream banks and subsequent inflow of sediment to the stream. The absence of shade trees also caused water temperatures to increase, and removal of large woody structure decreased habitat for fish and aquatic invertebrates. Removal of trees from the riparian zone and adjacent uplands also increased the rate at which water entered the stream during storm events, resulting in a flashier flow regime.

River logging drives substantially altered the morphology of stream channels. The rapid release of logs and water from logging dams led to extensive scouring of the stream bed and banks downstream. These human-caused flood events also resulted in mortality of fishes and other aquatic animals.

Logging continues to be a major industry in the Ontonagon River watershed. Most modern logging companies employ best management practices (e.g., riparian buffer strips) to minimize negative effects on streams, lakes, and wetlands, but poor land use practices by some loggers still contribute large amounts of sediment to adjacent waters.

Commercial overfishing during the late 19th century and early 20th century also affected fish communities in the Ontonagon River watershed. Although accurate records of commercial harvest were not recorded until the 1880s, it appears that habitat degradation (i.e., from logging operations) and commercial harvest had already depleted many Great Lakes fish populations by that time. Michigan Fisheries Superintendent Walter D. Marks provided this description of Great Lakes commercial fisheries in 1884.

> The fishing grounds are one after the other fished out, and then new places sought where the same process is repeated. If each ground, as it becomes unprofitable for large operations was actually abandoned and allowed to rest, it would undoubtedly be slowly restored to productiveness by natural processes, because the fishing would become unprofitable before the last fish was taken, but this seldom happens. [From Tody 1974.]

Lake trout and lake whitefish composed the bulk of the commercial harvest near the mouth of the Ontonagon River (Nute 1944). Although primarily lake-dwelling species, these fishes seasonally occupied the lower reaches of the main stem and were important food sources for the Chippewa.

Commercial fishing probably was a major factor contributing to the extirpation of lake sturgeon in the Ontonagon River system. In the early days of the Great Lakes commercial fishery, lake sturgeon were regarded as a nuisance and often were clubbed to death or thrown on land (Brousseau 1987). As markets were created for caviar and smoked lake sturgeon flesh, a targeted lake sturgeon fishery developed. This fishery was short-lived, however, because the life history characteristics of lake sturgeon (late age of maturity and infrequent spawning after maturity) make them particularly vulnerable to overexploitation. By 1900, most lake sturgeon populations around the Great Lakes had been extirpated or severely depleted (Tody 1974).

Temporary logging dams were constructed in a variety of streams during the late 1800s, but the first “permanent” dam was not built until after the turn of the century (see **Dams and Barriers**). Victoria Dam and the associated Taylor compressor were in operation by 1906. In 1931, the original Victoria Dam was replaced by the new Victoria Dam and hydroelectric facility. The four dams (Cisco, Bergland, Bond Falls, and Bond Falls Control) associated with the Victoria hydroelectric facility were all in place by 1938.

Dam construction has affected the Ontonagon River and its tributaries through a variety of mechanisms. Dams interfere with fish migrations, alter flow regimes, reduce the frequency and severity of flooding, and block the downstream movement of sediment, large woody structure, and detritus. Impounding water behind dams also exposes a larger surface area of water to radiant sunlight, leading to increased evaporation rates and elevated water temperatures in the stream below.

Operation of the Bond Falls diversion has dramatically altered the hydrology of the Middle Branch, South Branch, and West Branch of the Ontonagon River (see **Hydrology**). Although all dams alter flow regimes to some extent, the Bond Falls diversion actually shunts water from the Middle Branch into the South Branch. Previous studies have demonstrated that alterations in stream flow patterns can affect fish spawning activities (Auer 1996; Paragamian et al. 2005; Friday 2006). During the recent FERC relicensing process for the Bond Falls Development, MDNR and other interested parties negotiated with UPPCo to provide water releases into the Middle Branch that more closely approximate a natural flow regime (Appendix A).

The introduction of nonnative species has markedly altered the fish assemblages. Some of these species were intentionally introduced to create additional fishing opportunities. Intentionally introduced species, such as rainbow trout, brown trout, and coho salmon, have become major components of the fish community in many stream reaches. Three species (common carp, pink salmon, and Atlantic salmon) that were introduced into other regions of the Great Lakes basin have also been collected near the mouth of the Ontonagon River. Additional fish species have gained access to Lake Superior and the Ontonagon River via the Welland Canal around Niagara Falls and associated ship traffic. The most notable aquatic invasive species is the sea lamprey, which has established populations in many streams that have Great Lakes access.

Various other human activities have modified fish communities within the basin. For example, the construction of road stream crossings has affected fish communities by interfering with fish movements, fragmenting fish populations, and increasing sediment to streams (see **Soils and Land Use**). Harbor improvement activities (e.g., dredging and bank stabilization) have also affected fish communities in the lower main stem by increasing the water depth and altering the morphology of the river channel.

Present Fish Communities

Biological surveys conducted since the 1920s have documented the presence of 74 fish species in the Ontonagon River watershed (Table 17). Many fish species are widely distributed within the basin, while others are restricted to isolated lakes or stream reaches (Appendix B). The recorded distributions are only rough approximations, however, because detailed survey information is only available for a small percentage of the waters in the basin. Little or no data are available for remote regions of the watershed, including many of the smaller lakes and tributaries.

A few of the species included in MDNR, Fisheries Division records may have been misidentified. For example, the juvenile northern longear sunfish reported in Thousand Island Lake probably was a misidentified bluegill or pumpkinseed. Records from numerous MDNR surveys and the University of Michigan, Museums Fisheries Library indicate that longear sunfish are not present in the Upper Peninsula, whereas bluegill and pumpkinseed are common in Thousand Island Lake. Shiners (family Cyprinidae) are notoriously difficult to assign to species, and it is likely that some of the shiners collected in the Ontonagon River watershed have been misidentified. For example, the spotfin shiners documented in Perch Lake actually may have been spottail shiners or perhaps common shiners which are known to inhabit Perch Lake. In addition, researchers did not always distinguish between bullhead species on survey forms, and in some instances it appears that the same species was identified as black bullhead and brown bullhead during consecutive surveys at the same location. Similarly, researchers rarely discriminated between the two species of native lampreys, coding them both as "*Ichthyomyzon* spp."

A particularly intriguing situation regarding fish identification has occurred on Clark Lake (upper Middle Branch subwatershed). In 1966, MDNR researchers collected 7 margined madtoms in this lake. Identification of these specimens was corroborated by Dr. William R. Taylor, one of the leading experts in *Noturus* species. Margined madtoms subsequently were collected in Clark Lake in 1986 and 1989. Within the Great Lakes basin, margined madtoms are only native to a few southern Lake Ontario tributaries. There are no other known populations of margined madtoms within hundreds of miles of the Clark Lake population. In an interesting twist to this story, a similar fish species, the stonecat, was reported in Clark Lake during surveys conducted in 1997 and 2000. Stonecats are native to portions of the Lower Peninsula and northern Wisconsin, but no there are no other known stonecat populations in the Upper Peninsula. It is possible that the "stonecats" reported during recent surveys were misidentified margined madtoms. However, it also is plausible that stonecats were inadvertently transferred to Clark Lake by anglers. Voucher specimens should be collected during future surveys to facilitate positive identification of samples.

The distribution of fish species is strongly influenced by physical attributes such as water temperature, stream size, hydrology, and gradient. Water temperature and stream size are two of the most important factors determining the distribution of fishes. For example, coldwater species (e.g., brook trout) typically are found in groundwater-fed streams that remain cold throughout the summer, whereas coolwater species (e.g., yellow perch) can survive in streams with wider temperature fluctuations. Lake sturgeon and Chinook salmon generally are found in large rivers, whereas brook trout and mottled sculpin more commonly inhabit small- to medium-sized streams. Because fish distributions are so strongly influenced by physical habitat, Fisheries Division's valley segment classification system can be used to generate expected fish communities in streams with little or no survey data. The valley segment model can also be used to identify fish communities that differ markedly from the expected species composition, perhaps due to human activities.

Although the following discussion is restricted to riverine fish communities, productive fisheries exist in many of the lakes within the Ontonagon River watershed. The fish communities in these lakes typically consist of a mixture of coolwater and warmwater species. Game fish species present in these lakes include northern pike, muskellunge, pumpkinseed, bluegill, smallmouth bass, largemouth bass, black crappie, yellow perch, and walleye. Lake trout and lake herring inhabit some of the larger lakes in the basin (e.g., Clark Lake), but these species are generally found only in low numbers. Nongame species commonly found in lakes include white sucker, creek chub, golden shiner, common shiner, mottled sculpin, and johnny darter.

Middle Branch—upper

Twenty-five fish species have been collected in the upper Middle Branch. Most of the stream valley segments within this subwatershed are classified as cold headwaters and have fish communities dominated by coldwater species (Figure 43).

From the origin at Crooked Lake to US-2, coolwater and warmwater fish species compose a large percentage of the fish community. Downstream from US-2, the influx of cold water from springs and tributaries (e.g., Duck Creek) creates better habitat conditions for trout and other coldwater species. Brook trout are abundant in the Middle Branch near Watersmeet. Mottled sculpin, blacknose dace, and white sucker are also common in this stream reach.

Both brook trout and brown trout are found between Bond Falls and Agate Falls, with brook trout being the more abundant species. Other common species in this river segment include longnose dace, blacknose dace, and mottled sculpin. This stream reach is classified as a cool large stream. The valley segment model identified this reach as “marginal trout” water, with brown trout as the primary game fish species. In this instance, survey data indicate that brook trout abundance is higher than the model predicted.

Duck and McGinty creeks are major coldwater tributaries to the upper Middle Branch. The fish communities in these streams consist largely of brook trout, mottled sculpin, and creek chub. The Tamarack River is classified as a cool small stream. This river supports a modest brook trout population (which may have to move into the Middle Branch to find thermal refugia during summer). Mottled sculpin, creek chub, hornyhead chub, and longnose dace are also common in the Tamarack River.

Middle Branch—lower

The lower Middle Branch and most of its tributaries are classified as coolwater streams. Groundwater inflows subside as the stream flows northward, so resident coldwater species are more abundant in the upper end of this river segment. The lower Middle Branch is accessible to fish species migrating from Lake Superior, and the species composition of the fish community varies throughout the year.

Due to the scarcity of road access to the lower Middle Branch, fisheries surveys have only been conducted on the stream reach immediately below Agate Falls. Seventeen fish species have been captured at this location. Brook trout and some brown trout reside below Agate Falls throughout the year. Steelhead, coho salmon, and potamodromous brown trout also use the lower Middle Branch as spawning and nursery habitat. Additional fish species collected below Agate Falls include mottled sculpin, white sucker, creek chub, and smallmouth bass.

Under the valley segment classification system, the lower Middle Branch is expected to be a marginal trout stream with brown trout as the dominant trout species. Based on survey data and angler reports, brown trout make up a substantial portion of the salmonid community in the lower Middle Branch, so the model predictions are accurate for this stream.

The headwaters of Trout Creek is the only coldwater stream reach in the lower Middle Branch subwatershed. When this stream was surveyed in 2004, brook trout, blacknose dace, creek chub, and northern redbelly dace were found to be common (J. Pagel, USFS, Ottawa National Forest, personal communication). The downstream half of Trout Creek is considered a cool medium stream. During the 2006 survey, a few brown trout were collected in this valley segment, but coolwater and warmwater fish composed the bulk of the fish community.

The Baltimore River is another major tributary to the lower Middle Branch. The only substantial groundwater inflows are at the headwaters, so the Baltimore River and all of its tributaries are classified as coolwater streams. Thirteen fish species have been found in this stream, including brook trout, brown trout, steelhead, white sucker, trout perch, and slimy sculpin. Based on the valley segment model, trout were not expected to reside in the Baltimore River system. The limited data available suggest that the Baltimore River and its tributaries are marginal trout streams, but trout are able to find localized areas (e.g., small groundwater seeps) with suitable habitat.

Main Stem

The fish community in the main stem Ontonagon River changes seasonally due to the migratory patterns of potamodromous fishes from Lake Superior. Spring migrants include steelhead, walleye, and muskellunge. In the fall, brown trout, coho salmon, and Chinook salmon enter the main stem. A number of other fishes occupy the main stem year-round, including warmwater species such as black crappie, rock bass, and brown bullhead. Overall, 39 species have been collected in the main stem.

Lake sturgeon were reintroduced into the Ontonagon River in 1998 (see **Fishery Management**). Although it is much too soon to expect the return of adult lake sturgeon, numerous juveniles have been captured during sampling efforts in the lower river (Fillmore 2003).

East Branch

The East Branch is considered a coldwater stream for most of its length, with predicted fish communities dominated by brook trout and brown trout. Surveys indicate that brook trout, brown trout (resident and potamodromous), coho salmon, and steelhead are the main game fish species in the East Branch. Blacknose dace, longnose dace, slimy sculpin, white sucker, and creek chub are also commonly encountered in this stream. Resident trout are most abundant in the stream reach from Lower Dam to Sparrow Rapids (Kenton). Trout abundance decreases below Sparrow Rapids, and warmwater fish species dominate the fish community downstream from Newholm Creek.

Several coldwater tributaries flow into the East Branch. Potamodromous steelhead, coho salmon, and brown trout use most of these tributaries for spawning, but Onion Falls blocks upstream movement of fish into the Onion River. East Branch tributaries generally have strong populations of wild brook trout. The Keweenaw Bay Indian Community Natural Resources Department has recently developed a new hatchery strain of brook trout from the Jumbo River population for stocking in various Lake Superior tributaries, including some streams within the Ontonagon River basin (see **Fishery Management**). A variety of nongame species also inhabit East Branch tributaries, including blacknose dace, creek chub, mottled sculpin, longnose dace, and white sucker.

Cisco Branch

The Cisco Branch is classified as a warm medium stream. In 2006, the mean July water temperature at the Forest Route 6930 crossing (about 2 miles upstream of Twomile Creek) was 71.1°F, so the temperature classification for this stream is questionable. The valley segment model identified the various reaches of the Cisco Branch as “creek chub” or “white sucker” water, with predicted fish communities consisting of minnow species and other warmwater fishes.

Survey data indicate that warmwater fish species predominate in the upper Cisco Branch from Cisco Lake downstream to Kakabika Falls. Common fish species in this stream reach include hornyhead chub, creek chub, longnose dace, common shiner, and johnny darter (Doepke 1998). Groundwater seepage and the entrance of several coldwater tributaries moderate water temperatures in the lower Cisco Branch. During the 2006 MDNR survey of the lower Cisco Branch, only warmwater species (e.g., creek chub, blacknose dace, longnose dace, and hornyhead chub) were collected. The water temperature at the time of the survey was 69°F, which is above the optimal temperature for brook trout. Anecdotal reports indicate that brook trout have been caught in the Cisco Branch, but it appears that these fish move to coldwater tributaries (e.g., Twomile Creek) during the hot summer months.

There are two major tributaries to the Cisco Branch: Tenderfoot Creek and Twomile Creek. Both of these creeks are classified as cool small streams. Although the valley segment model suggests that Tenderfoot Creek provides marginal habitat conditions for brook trout, electrofishing surveys have revealed a warmwater fish community consisting primarily of creek chub, hornyhead chub, white sucker, blacknose dace, and bluntnose minnow. Temperature monitoring conducted during June–August 1981 indicates that summer water temperatures are marginal for trout survival (J. Edde, USFS, Ottawa National Forest, personal communication). Twomile Creek is a coldwater stream that receives most of its groundwater inflows in the lower half of the river. Fisheries surveys conducted on the upper reaches of Twomile Creek indicated a warmwater fish community dominated by blacknose dace, creek chub, and slimy sculpin. Brook trout, mottled sculpin, longnose dace, and blacknose dace are commonly encountered in the lower portion of Twomile Creek. The fish community in the lower reaches of Twomile Creek closely resembles the predicted fish assemblage from the valley segment model.

South Branch

With the exception of a short river segment above Eighteen Mile Rapids, the South Branch is considered to be a cool large stream. Due to the absence of trout and the scarcity of vehicular access, the South Branch receives light fishing pressure. The absence of a suitable boat launch has also prevented biologists from conducting electrofishing surveys on this stream. A brief netting survey during September 2007 indicated the presence of muskellunge, smallmouth bass, rock bass, burbot, creek chub, and common shiner near the town of Ewen. Fishing reports suggest that northern pike, bluegill, yellow perch, and walleye are also harvested in the South Branch. The valley segment model indicates suitable habitat conditions for a “river minnow” species assemblage.

Sucker Creek flows into the South Branch near Eighteen Mile Rapids. The upper portion of Sucker Creek is a cool small stream that supports populations of brook trout, common shiner, creek chub, and blacknose dace. Groundwater inflows subside as the stream approaches the South Branch, and water temperatures in the lower reaches are less suitable for coldwater species. Tenmile Creek is a coolwater tributary to the South Branch with a fish community consisting of blacknose dace, mottled sculpin, creek chub, and white sucker.

West Branch

The West Branch varies in size from “medium” near Bergland to “very large” below Victoria Reservoir (Figure 43). The valley segments upstream of the South Branch confluence are classified as warmwater, whereas the stream reach below the South Branch is classified as a coolwater stream. Hornyhead chub, creek chub, and common shiner were the three most abundant species collected during the most recent electrofishing survey on this stream (Taft 1999). Walleye, smallmouth bass, and northern pike are also known to inhabit the West Branch.

Cascade Creek is the only major coldwater tributary to the West Branch. Brook trout, mottled sculpin, white sucker, and several minnow species have been captured in this stream. Mill Creek, which flows into the West Branch below the Cascade Creek confluence, is a cool small stream. No fisheries surveys have been conducted on this system, but the valley segment model indicates a “creek minnow” assemblage that includes species such as creek chub and brook stickleback.

Mussels

Little is known about the status and distribution of freshwater mussels in the Ontonagon River watershed, but data from Cummings and Mayer (1992) and MDNR, Fisheries Division files suggest that 15 species of native mussels could reside within the basin (Table 18.) One exotic mussel species, the zebra mussel *Dreissena polymorpha*, has been found in the lower main stem near the mouth (see *Aquatic Pest Species*). A comprehensive inventory of mussel distributions within the watershed is needed.

Aquatic Invertebrates (except mussels)

Aquatic invertebrates are an important food source for many fish species, and they play a vital role in the cycling of nutrients in stream ecosystems. In addition, invertebrate species vary in their tolerances to environmental conditions such as temperature, substrate, nutrient levels, and current velocity (McCafferty 1998). Thus, the diversity and abundance of macroinvertebrate taxa are widely used to evaluate water quality and habitat conditions in streams.

Researchers from MDEQ conducted qualitative biological surveys on various portions of the Ontonagon River watershed in 1995, 1998, and 2003 (Taft 1995; Taft 1998; Taft 1999; Taft 2004). These surveys followed the protocols outlined in Procedure 51, which were designed to assess the abundance and diversity of fish and macroinvertebrate taxa and to evaluate various parameters (e.g., substrate, instream cover, and channel morphology) associated with the physical habitat in the stream (see Michigan Department of Environmental Quality 2002 for the most recent version of Procedure 51). After macroinvertebrate sampling and identification were completed, each sampling site was assigned a rating (excellent, acceptable, or poor) based on the number of macroinvertebrate taxa collected and the taxonomic composition of the macroinvertebrate community.

During MDEQ surveys, the macroinvertebrate communities at most sites were rated as “acceptable” (Tables 19 and 20). Six stations received “excellent” macroinvertebrate scores: Bluff Creek, Cascade Creek, Marshall Creek, Trout Brook, Spargo Creek, and Twomile Creek. Many of the macroinvertebrate families collected in the Ontonagon River system are intolerant of warm water temperatures and low dissolved oxygen levels (Taft 2004). The presence of these organisms is indicative of high water quality within the watershed (see **Water Quality**).

Amphibians and Reptiles

Nine species of frogs and toads, and six species of salamanders reside in the Ontonagon River watershed (Table 21). Five species of snakes have also been found in the basin. None of these species are listed as endangered, threatened, or of special concern.

Six turtle species are found within the watershed, including five species typically associated with aquatic habitats. Three species from the Ontonagon River basin are listed as being of “special concern” by the State of Michigan: wood turtle, eastern box turtle, and Blanding’s turtle. Primary threats to these species include nest predation, traffic fatalities, habitat loss, poaching, and incidental collection by the general public (Harding 1997).

Birds

The rivers, lakes, and wetlands of the Ontonagon River watershed provide habitat for a wide variety of birds. Several species of ducks and geese nest along the Ontonagon River and its tributaries.

Herons forage along the stream edges, and swallows feed on insects emerging from the river. Woodcock and Ruffed Grouse reside along the riparian corridors, and numerous other birds use these corridors during migration. Common Loons breed on many lakes within the watershed, while male Red-winged Blackbirds establish territories in the adjacent marshes. A variety of raptors also inhabit the basin, including Osprey and Bald Eagle.

A total of 180 bird species have been found within the watershed, including 6 birds listed as threatened and 14 birds listed as special concern species by the State of Michigan (Table 22). One state endangered species, the Peregrine Falcon, is known to inhabit the Ontonagon River basin.

A few Double-crested Cormorants have been observed within the watershed (e.g., at Lake Gogebic). These fish-eating birds form large nesting colonies on islands in Lake Michigan and Lake Huron, and predation by cormorants has been identified as a possible factor leading to local declines in game fish abundance. No nesting colonies have been found within the Ontonagon River watershed, and it does not appear that Double-crested Cormorants are having a measurable effect on fish populations within the basin at this time.

Another fish-eating bird, the American White Pelican, occasionally has been observed in the Upper Peninsula (McPeek and Adams 1994). No specific reports of American White Pelicans in the Ontonagon River watershed have been documented.

Mammals

The large tracts of forest present within the watershed are occupied by numerous mammal species (Table 23), including popular game animals such as black bear, white-tailed deer, eastern cottontail, and snowshoe hare. Several fur-bearing mammals, such as American beaver, mink, fisher, northern river otter, coyote, red fox, and common gray fox, also inhabit the basin. Two state special concern species, moose and eastern pipistrelle (a bat), have been found within the Ontonagon River watershed. One mammal species, gray wolf, was listed as threatened at the federal level. Wolves in the western Great Lakes region (including the Upper Peninsula) were removed from the federal list of threatened species on 12 March 2007. A federal judge overturned this decision on 29 September 2008, so the gray wolf is once again a federally threatened species. Cougar sightings have also been reported throughout the western Upper Peninsula, but attempts to scientifically document the presence of wild cougars in this region have been unsuccessful.

The waters of the Ontonagon River basin and their associated riparian zones are used by a variety of mammal species. Beavers feed on aspen growing along stream banks and use the logs from these trees to construct their dams. Wetlands along streams provide excellent habitat for muskrats and are popular yarding areas for white-tailed deer. The fish and aquatic invertebrates produced in the Ontonagon River system are also consumed by several species of mammals (e.g., northern river otter, mink, and common raccoon).

Other Natural Features of Concern

Sixty species in the Ontonagon River watershed are classified as endangered, threatened, or of special concern by the State of Michigan (Table 24; Anonymous 2006a). This group includes two fishes, twenty-one birds, three mammals, three turtles, three invertebrates, and twenty-eight plants. Two rare species of lichens, anzia lichen and treeflute, also occur within the watershed. In addition, six rare community types (bedrock glade, dry-mesic northern forest, dry nonacid cliff, moist nonacid cliff, mesic northern forest, and poor conifer swamp), two unusual geographic features (extrusive igneous feature and meander), and a great blue heron rookery have been identified in the Ontonagon River basin.

Many of the listed plant species found in the watershed are associated with rare community types. For example, flat oat grass, purple clematis, and pine drops are typically found in dry-mesic northern forests, while assiniboia sedge, male fern, ginseng, showy orchis, and fairy bells occur in mesic northern forests (Anonymous 2006a). Three other listed plant species grow along the shores of softwater lakes: American shore-grass, hedge-hyssop, and small yellow pond-lily (Anonymous 2006a).

From a global perspective, none of the listed species appear to be in immediate danger of extinction. Many organisms that are listed as special concern or threatened species in Michigan are relatively common in other areas (i.e., species with a G5 global ranking, meaning demonstrably secure).

Aquatic Pest Species

The most destructive and widely established aquatic pest species in the Ontonagon River basin is the sea lamprey. Sea lampreys are a parasitic fish that entered the Great Lakes in 1921 when the Welland Canal was opened to allow ship traffic to bypass Niagara Falls. Parasitism by sea lampreys was a major factor leading to declines in lake trout and whitefish abundance throughout the Great Lakes during the 1920s through the 1950s. Since the mid-1950s, a variety of methods have been employed to control lamprey populations and mitigate their effects on Great Lakes fisheries. The recent restoration of lake trout populations in Lake Superior probably would not have occurred in the absence of these control efforts.

In the Ontonagon River watershed, sea lampreys have access to the entire main stem and the lower portions of the West, Middle, and East branches. The upstream limits of sea lamprey distribution for each stream are as follows: West Branch – Victoria Dam, Middle Branch – Agate Falls, and East Branch – Lower Dam (Robert Kahl, U. S. Fish and Wildlife Service, Marquette Sea Lamprey Control Office, personal communication). Sea lampreys are also present in the downstream reaches of at least 12 tributaries, including Beaver Creek and the Jumbo River. Since 1960, TFM (3-trifluoromethyl-4-nitrophenol) treatments have been conducted (generally every 2–4 years) to reduce sea lamprey abundance in this system.

The ruffe is another exotic invader that has the potential to negatively affect native fish populations in the Ontonagon River. Ruffe were introduced into western Lake Superior through ballast water discharged from ocean-going vessels. These fish were first collected in Duluth Harbor in 1986. By 1991, ruffe had become the most abundant species in Duluth Harbor (Ruffe Task Force 1992). The first ruffe was captured in the Ontonagon River main stem during June 1994 (Kindt et al. 1996). In 2003, researchers from USFWS and Michigan Technological University captured 151 ruffe in the main stem, suggesting that ruffe are reproducing in this system (Czypinski et al. 2004).

The United States Fish and Wildlife Service captured a common carp in the lower Ontonagon River during their 1994 ruffe surveillance survey (Slade et al. 1995). Carp were also reported during the 2002 creel survey on the Cisco Chain (Hanchin et al. 2008), but the identification of these specimens was questionable. A pacu was captured in the lower Ontonagon River during the summer of 2006. The pacu (which is native to the Amazon River basin) is a popular aquarium species, so the individual collected in the main stem probably was a pet fish that had been released into the river. Pacu require water temperatures in excess of 70°F, so released pacu are not expected to survive through a winter in the Ontonagon River. Additional aquatic invasive fish species present in Lake Superior that could enter the Ontonagon River watershed include round goby and three-spine stickleback.

Rusty crayfish have been found in Crooked Lake, Tamarack Lake, and the Bond Falls Flowage on the upper Middle Branch, and in the Cisco Chain at the headwaters of the Cisco Branch Ontonagon River (Anonymous 2006b). The species has also been observed in the Bond Falls Canal and in the Middle Branch below the Bond Falls Flowage (G. Lamberti, University of Notre Dame, personal communication). Rusty crayfish are native to the Ohio River basin, but the species recently has become established in several other watersheds in the upper Midwest. Anglers commonly transport crayfish for use as bait, and this method of transport has been suggested as the primary means of rusty crayfish dispersal in the Great Lakes region (Gunderson 1995). Rusty crayfish can affect aquatic ecosystems by displacing native crayfish species, destroying aquatic plant beds, reducing macroinvertebrate density, and decreasing fish reproductive success through egg predation (Gunderson 1995).

Eurasian water-milfoil is an exotic plant species that has become established in several lakes within the Ontonagon River basin. At this time, Eurasian water-milfoil has been found in Langford, Clearwater, and Forest lakes within the Cisco Branch subwatershed, and Crooked, Duck, and Bass lakes in the upper Middle Branch subwatershed (Anonymous 2006b). Eurasian water-milfoil forms dense mats of vegetation that interfere with boating, swimming, and fishing. These dense milfoil beds also crowd out native plant species, increase the nighttime oxygen demand, and reduce available habitat for fish, invertebrates, and waterfowl. Two other exotic plant species, curlyleaf pondweed and purple loosestrife (predominantly a wetland species), have been found in the southern portion of the Ontonagon River basin. Curlyleaf pondweed and purple loosestrife can crowd out native vegetation, indirectly reducing abundance of the vertebrate and invertebrate organisms that rely on native plants for food or cover.

Three aquatic invasive invertebrates have been identified in the Ontonagon River system. Spiny water fleas have been found in Lake Gogebic, and zebra mussels have become established near the mouth of the main stem Ontonagon River. Both of these exotic invaders can affect aquatic ecosystems by altering the abundance and diversity of planktonic organisms. Mystery snails have been found in Lake Gogebic and in several lakes within the Cisco Branch subwatershed. These snails are popular in the aquarium trade, so they may have been introduced into the basin through the release of pet snails. Although the effects of mystery snails on aquatic ecosystems are still being determined, it appears that they may displace native snails and alter aquatic food webs.

Infectious pancreatic necrosis (IPN) virus has been isolated from fish produced in a private hatchery near Watersmeet. The IPN virus has been shown to cause substantial mortality of fry and fingerling salmonids in other areas (Murray et al. 2003). Fisheries managers are concerned that the IPN virus may have been introduced into the upper Middle Branch from the infected facility. The virus has not been detected in the Middle Branch; however, no comprehensive fish health surveys have been conducted on this system.

Viral hemorrhagic septicemia (VHS) virus was detected in the Great Lakes in 2003. This virus originally was reported from the maritime provinces of Canada and may have entered the Great Lakes via ballast water discharge (G. Whelan, MDNR, Fisheries Division, personal communication). The VHS virus has caused substantial fish kills in the lower Great Lakes (Erie, Huron, and Lake St. Clair) and in a few inland lakes in New York, Wisconsin, and the Lower Peninsula of Michigan. Fish infected with VHS often exhibit hemorrhaging in the skin (red patches) and around the eyes. On June 28, 2007, MDNR instituted new regulations (Fisheries Order 245) regarding the use of fish or fish eggs as bait. The purpose of the new regulations is to prevent (or at least delay) the spread of VHS to new waters. To date, VHS has not been detected in the Lake Superior watershed.

Fishery Management

Fisheries management in the Ontonagon River basin has been shaped by a variety of factors, including the physical characteristics of the watershed, anthropogenic habitat alterations, native fish species assemblage, social values, advancements in biological knowledge, and changes in hatchery production and distribution capabilities. Some of these factors have been relatively stable through time (e.g., physical characteristics of the watershed), while others are continuously evolving (e.g., social values and fish production capabilities).

Active fisheries management within the watershed began during the 1920s. For the first decade, fisheries management consisted primarily of surveying and documenting the fish populations within the basin and the human use of those populations. By the late 1930s, warmwater fish stocking had become a popular method for manipulating fish community structure. During the late 1930s through the early 1940s, walleye fry, largemouth and smallmouth bass, and bluegill were stocked into numerous lakes. While many of these introductions were unsuccessful, some warmwater fish plants did establish naturally reproducing populations.

By the mid-1940s, trout stocking had become a prominent fisheries management tool. After World War II, the state fish hatchery system expanded rapidly to include nearly 100 hatcheries and fish rearing stations (Anonymous 1974). From 1945 through 1964, legal-sized trout were stocked into many streams.

The stocking of legal-sized trout into streams provided short-term put-and-take fisheries. These high-cost stocking programs often yielded minimal returns to the creel (Shetter et al. 1964). In addition, the existence of naturally reproducing trout populations within many stream reaches made continued stocking unnecessary.

Since the mid-1960s, trout stocking primarily has been used to create additional fishing opportunities on inland lakes. Because there typically is little or no natural reproduction of trout in these lakes (due to the absence of suitable spawning habitat), continued stocking is needed to maintain these popular fisheries.

During the mid-1980s, advancements in rearing operations and growing interest from anglers led to a rapid expansion of the MDNR walleye stocking program. Spring fingerling walleyes have been introduced into numerous lakes within the watershed during the last 25 years. The objectives of these walleye stocking programs generally have fallen within one or more of the following categories: (1) create a new walleye fishery, (2) supplement an existing fishery in a system where natural reproduction is minimal, or (3) alter the abundance and size structure of panfish populations. In some instances, survival of stocked walleye was poor, and the stocking programs were discontinued. The remaining stocking programs are routinely evaluated to determine if they are meeting management objectives.

In some situations, fisheries managers have used complete or selective fish removals to alter the species or size composition of fish communities. For example, rotenone treatments have been conducted to eliminate competing species (e.g., yellow perch) from single-species trout lakes. Manual removals have been used to reduce panfish abundance and improve growth rates in stunted panfish lakes. Manual removals of rough fish have also been conducted to restore the predator-prey ratio to a more desirable level.

Habitat management techniques have also evolved during the last 80 years. Instream habitat management programs first became popular during the 1930s (Madison and Lockwood 2004). Logging activities during the late 1800s had severely reduced recruitment of large woody structure into streams (see **History**), so early habitat improvement projects focused on providing cover for game fish (primarily trout). Providing cover for game fish is still a major goal of many modern habitat improvement projects, but the methods used to achieve that objective have changed. Modern projects generally incorporate natural materials (e.g., root wads or whole trees) whereas the early fish cover structures often were constructed with lumber which provided less habitat complexity and fewer "hiding places" for stream fishes. The gradual reforestation of the watershed and utilization of best management practices (e.g., riparian buffer strips) have also increased natural recruitment of large woody structure into the Ontonagon River system.

Stabilizing eroding stream banks has been a major concern for fisheries managers and riparian landowners. For many years, hard armoring techniques (e.g., riprap and bulkheads) were used to control bank erosion. These techniques have become less common in recent years because: (1) they interfere with the natural migration of the stream channel, (2) hard-armored banks provide poor habitat for amphibians and reptiles (e.g., wood turtles), and (3) they reflect the kinetic energy of the water, which frequently leads to accelerated erosion downstream. Soft-armoring techniques (e.g., seeding and mulching, tree plantings, or whole tree revetments) are growing in popularity because they provide erosion control without producing the side effects outlined above. Through the MDEQ permitting process, MDEQ and Fisheries Division personnel have worked to educate riparian landowners and road commissions about the benefits of soft-armoring techniques.

Fisheries managers have also installed sand traps (artificial pools excavated by backhoes) to reduce the sand bedload in several stream reaches within the Ontonagon River system. Sand traps have been installed on Duck Creek, Twomile Creek, and the upper Middle Branch. USFS maintains two sand traps on Twomile Creek; USFS and MDNR personnel continue to monitor this stream to determine effects of sand traps on stream substrate and brook trout abundance.

The construction of dams to create additional trout fishing opportunities was a common practice during the 1950s and 1960s. Fisheries Division abandoned this practice when numerous studies revealed the negative effects of dams on river ecosystems (see **Dams and Barriers**). The small impoundments created by these dams typically provided good fisheries for several years, but sediment deposition has reduced the suitability of the reservoirs for trout management.

Fisheries Division, Wildlife Division, FMFM, Parks and Recreation Division, and Law Enforcement Division have worked cooperatively to manage the abundance and distribution of beaver within the Ontonagon River watershed. In 2001, the MDNR beaver management policy (Policy No. 39.21-20) was adopted. As outlined in this policy, MDNR manages for the less common resource (high quality coldwater streams). Fisheries Division recently developed a list of coldwater streams that are considered high priority candidates for active beaver control. When construction of beaver dams alters water temperatures and substrate conditions in these streams making the habitat less suitable for trout production, removal of beavers and beaver dams may be implemented. (It is important to note that Fisheries Division's goal is not to eliminate beaver from all coldwater streams, but rather to reduce beaver abundance when beaver activity is degrading high quality trout fisheries.) Although beaver activity often is detrimental to trout populations, beaver ponds provide valuable habitat for many plant and animal species. Thus, beaver colonization of coolwater streams (or cold streams ≥50 ft wide) typically is not discouraged.

The most common method of reducing beaver abundance is through manipulation of their primary food source – aspen. Aspen is a shade intolerant species that thrives in recently disturbed areas. Shade tolerant species (e.g., eastern hemlock and sugar maple) generally replace aspen as a forest matures. Retention of uncut buffer strips is used to discourage aspen regeneration along trout streams that flow through state land. Although the standard minimum buffer strip width is 100 ft, wider buffer strips (generally 300 ft) are left along high priority trout streams to further reduce the available food supply for beaver.

When beavers become established in an area in which their presence is not desired, additional control efforts may be necessary. For example, MDNR staff or volunteers have worked to remove beaver dams on several streams within the Ontonagon River basin. To reduce beaver abundance, MDNR personnel have worked with local trappers to remove beaver during the legal trapping season. When these methods are not feasible or are insufficient, MDNR issues beaver damage control permits to allow trapping outside of the normal harvest season.

Fishing regulations are one of the most broadly recognized tools for controlling the harvest, size structure, and abundance of fish populations. Special regulations have been instituted to maintain high quality smallmouth bass fisheries in the Sylvania Wilderness Area. Limitations on the use of live bait are enforced on some trout lakes to reduce the risk of colonization by undesirable species. Closed fishing seasons also protect many fish species from harvest during their most vulnerable (i.e., spawning) periods. Current trout fishing regulations are described in Appendix C.

For the last 80 years, MDNR has used fisheries surveys to formulate and evaluate management strategies. These surveys provide information on the abundance, size structure, sex ratio, distribution, growth, and harvest of fish species within the watershed. Waters that receive intense fishing pressure or are regularly stocked generally have been surveyed more frequently than less intensively exploited systems (e.g., small tributary streams).

The MDNR is the primary fisheries management authority for the Ontonagon River watershed (except the Wisconsin portion of the watershed, which falls under the jurisdiction of WDNR); however, a variety of other agencies and constituent groups have participated in fisheries programs under the leadership of MDNR. USFS has completed a large number of habitat improvement projects in lakes and streams within the Ottawa National Forest. USFS also completes fisheries surveys within the watershed and provides the results of these surveys to MDNR. The United States Fish and Wildlife Service routinely performs sea lamprey assessment and control efforts in streams with Lake Superior access and conducts trawling surveys for aquatic invasive species in the lower main stem. The Keweenaw Bay Indian Community – Natural Resources Department (KBIC) has stocked Jumbo River strain brook trout in several streams within the Ontonagon River basin. A few lake associations and sport fishing clubs have paid for private fish stocking programs within the watershed. (Note: Agencies and other entities interested in stocking fish in public waters or lakes connected to public waters must obtain a fish stocking permit from MDNR before fish are planted.) The Great Lakes Indian Fish and Wildlife Commission and the Lac Vieux Desert Band of Chippewa Indians (LVD) have collaborated with MDNR to set tribal walleye spearing quotas for various lakes in the southern half of the Ontonagon River watershed. The Great Lakes Indian Fish and Wildlife Commission also performs spring spawning surveys and fall recruitment surveys for walleye on this same set of lakes.

The following sections provide a summary of fisheries management activities within the various subwatersheds of the Ontonagon River basin. A comprehensive discussion of all fisheries management activities within the basin is beyond the scope of this document, so only the more intensively managed waters within each subwatershed are discussed below.

Middle Branch—upper

The upper Middle Branch has a long and varied fisheries management history. Several coldwater tributaries flow into the Middle Branch, and some of these tributaries also provide popular trout fisheries. There are 72 lakes within the upper Middle Branch subwatershed. Fisheries management summaries are provided for a subset of these lakes.

Upper Middle Branch Ontonagon River.–The upper Middle Branch is one of the most popular trout streams within the Ontonagon River basin. The stream reaches between US-2 and Forest Route 5250 and between Bond Falls and Agate Falls are widely recognized for producing large brook trout.

Brook trout, rainbow trout, and brown trout were stocked in the upper Middle Branch until 1964. Brook trout were stocked above and below Bond Falls during the 1980s and 1990s (Table 25). Brown trout were planted below Bond Falls during 1985–97, but these plants were discontinued to reduce competition with wild brook trout.

The MDNR has completed numerous fisheries surveys on the upper Middle Branch since 1942. One of the most detailed studies on this stream was conducted by Wagner et al. (1994). Wagner et al. (1994) used a combination of electrofishing and creel surveys to evaluate the effects of stocking on the population density and harvest of brook trout in the upper Middle Branch near Watersmeet. The catch rate (in fish/angler hour) was significantly higher during years when yearling brook trout were planted (Wagner et al. 1994). Overwinter survival of stocked brook trout was essentially zero, so the trout plants only created a put-and-take fishery. Fisheries managers generally expect more pounds of fish to be harvested than were stocked in the receiving water (Borgeson 1987). The estimated weight of hatchery trout harvested in the upper Middle Branch was only 15.9% of the total weight at stocking (Wagner et al. 1994). Due to the poor returns from fish stocking and the presence of a strong naturally reproducing brook trout population, the annual brook trout plants in the upper Middle Branch have been discontinued.

The upper Middle Branch currently is classified under the Type 2 trout fishing regulations (Table C.1). Past survey and creel data indicate that this stream has the potential to produce large brook trout. Anecdotal observations suggest that fishing pressure has been increasing on the upper Middle Branch, and the Type 2 regulations were instituted on this stream to retain production of “quality-size” brook trout.

The MDNR and cooperating organizations have conducted a wide variety of habitat improvement projects in the upper Middle Branch, with most of the work occurring between US-2 and the town of Watersmeet. Habitat improvement projects on this stream reach have included the installation of wing deflectors and bank cover structures, beaver removal, sand trap excavation and maintenance, tag alder removal, and addition of spawning gravel. MDNR also collaborated with the Ontonagon County Chapter of Michigan Steelheaders to install 60 fish cover structures in the Middle Branch between Bond and Agate Falls in 1984.

Because the portion of the Middle Branch below Bond Falls is strongly affected by operation of the Bond Falls diversion, MDNR has been a major participant in the FERC relicensing process for the Bond Falls Development (which includes all five hydroelectric-related dams within the watershed; see **Dams and Barriers**). The new minimum flow conditions specified in the 2003 license are expected to positively affect the brook trout fishery between Bond and Agate Falls.

Tributaries.–Duck Creek has provided a quality brook trout fishery for many years. Brook trout were stocked in this stream annually from 1951 to 1963. Since that time, the trout fishery has been sustained by natural reproduction. USFS conducted an intensive beaver removal project on Duck Creek during 1989–91, and MDNR installed a sediment trap below US-2 in 1993. Duck Creek receives considerable fishing pressure for a stream of its size, so special regulations were enacted in 1989 to preserve this popular fishery. Type 6 trout stream regulations currently are in place on the lower 6 miles of Duck Creek. Only artificial lures may be used on this stream reach, the minimum size limit for brook trout is 10 inches, and the possession limit is two fish. MDNR continues to monitor the brook trout population in Duck Creek to determine if the existing regulations are meeting the population objectives for this stream.

The Tamarack River is the largest tributary to the upper Middle Branch. Although the Tamarack River is classified as Type 1 trout water, this stream is only occupied by trout on a seasonal basis.

> This gentle brown colored stream becomes too warm for trout in June and it receives little fishing pressure after that time. Brook trout migrate upstream [during the fall], sometimes as far as Tamarack Lake where ice fishermen catch them in good numbers. Fish up to two pounds have been reported. [From Juetten 1973.]

Several small coldwater tributaries flow into the upper Middle Branch. Deadman, Interior, McGinty, Morrison, Sargents, Henderson, Zig Zag, and Marathon creeks are classified as Type 1 trout streams. These streams provide spawning and nursery areas for brook trout. Most of the trout collected during surveys on these streams have been young-of-year or yearling fish, but a few legal-sized brook trout have been found. Fishing pressure on these streams is generally light; however, fishing reports from local residents suggest that large brook trout are occasionally caught in the beaver ponds that are so ubiquitous on these tributaries. Marion, Boniface, and Wolf Lake creeks are coolwater streams that flow out of inland lakes. Nongame fishes (primarily minnows and suckers) dominate the fish communities in these streams, but coolwater and warmwater game fish (e.g., largemouth bass and yellow perch) occasionally move into these streams from their source lakes (Juetten 1973).

Lakes.–Numerous surveys have revealed that panfish are abundant in Allen Lake, but stunting has been a persistent problem for fisheries managers. Stocking of spring fingerling walleye and USFS manual removal of small bluegills and pumpkinseeds have not resulted in noticeable improvements in the size structure of the panfish populations in this system (Table 26). Surveys completed in 2000 and 2004 indicated that survival of stocked walleye has been poor, so MDNR is reevaluating the management strategy for this lake.

Despite its name, Bass Lake does not have a large bass population. Few largemouth bass have been found during most surveys, and legal-sized fish have rarely been encountered. Northern pike abundance appears to have increased dramatically in the last decade, and the lake has provided good fishing for this species. Bass Lake generally produces large numbers of panfish. Few trophy-sized panfish are encountered, but small “keeper-sized” fish are abundant. Bluegill and pumpkinseed have been the dominant panfish species for many years, but black crappies were also found in good numbers during the 2005 fisheries survey. Muskellunge were introduced into Bass Lake in 1963, and the lake was managed as a muskellunge broodstock lake from 1967 to 1980. Survival of stocked muskellunge was marginal, and Bass Lake was removed from the muskellunge broodstock list in 1980.

The MDNR completed an intensive fisheries survey on the Bond Falls Flowage in 2003 as part of the Large Lakes Survey Program (LLSP). This survey consisted of a spring tagging effort for walleyes and northern pike, and a creel survey to evaluate angler harvest of all species and estimate annual exploitation rates for walleye and northern pike. The single-census population estimates for adult walleyes and northern pike were 6.1 fish/acre and 3.1 fish/acre, respectively (Hanchin, in press). The recommended minimum population goal for these species is 2.0 fish/acre (Dexter and O’Neal 2004). Thus, for the Bond Falls Flowage, both walleye and northern pike were present in sufficient numbers to support popular fisheries. The mean growth indices during the 2003 survey were -3.3 for walleye and -0.6 for northern pike (Hanchin, in press). Growth indices between -1 and +1 are considered average, while growth indices lower than -1 indicate that growth is well below the state average. Growth of Bond Falls walleyes, though much slower than the state average, was similar to that of walleye in other large lakes in the western Upper Peninsula. The estimated annual exploitation rates were 35% for walleye and 27% for northern pike (Hanchin, in press). Annual exploitation rates determined for other walleye populations as part of the LLSP ranged from 3% to 32% (Hanchin et al. 2008). Harvest of walleye in the Bond Falls Flowage was higher than expected, but the population estimates suggest that this level of harvest may be sustainable. Further monitoring is necessary to ensure that the walleye population in this system is not overexploited. The annual exploitation rate for northern pike was below the range reported by Hanchin et al. (2008), so overharvest of pike does not appear to be a problem.

A fish community survey conducted during June–August 2003 indicated that piscivores made up a disproportionate percentage (63%) of the total biomass in the Bond Falls Flowage. The annual winter drawdowns probably have contributed to the scarcity of forage fish in this reservoir. Because all of the fish in this system have been crowded into a much smaller area during the winter, the predation pressure has been greatly intensified. The reduced winter drawdowns specified in the 2003 FERC license should lessen the severity of this situation and allow the forage base to recover (Appendix A).

Castle Lake has been stocked with brook trout nearly every year since 1965. Surveys repeatedly have indicated that legal-size trout are abundant in this lake, and angler reports generally have been favorable. Castle Lake is a unique trout lake because it has never been chemically treated to remove undesirable species. The use of minnows as bait has been prohibited since 1965, and it appears that this prohibition has eliminated the need for chemical reclamation.

Walleye have been stocked in Dinner Lake on a periodic basis since 1983. Although the initial results of the walleye introduction were encouraging, surveys conducted during the last ten years suggest that survival from recent walleye plants has been minimal. This lake has strong populations of largemouth bass, smallmouth bass, and panfish, and the fish community appears to be well-balanced (biomass = 57% panfish, 41% piscivores, and <2% rough fish during the 2004 survey). To avoid disrupting this well-balanced community, walleye stocking will be discontinued. Northern pike entered Dinner Lake in the mid-1990s. The origin of these fish is uncertain, but they may have entered the lake via an unauthorized introduction by private citizens. Only five northern pike were found during the 2004 survey, and the absence of juvenile pike in the catch suggests that there has been little (if any) natural reproduction of this species in Dinner Lake.

Duck Lake consistently has provided good fishing opportunities for bluegill, black crappie, pumpkinseed, and smallmouth bass. Walleye and northern pike were first captured in this lake in 1968. These fish may have moved upstream from the Middle Branch Ontonagon River or been introduced through an unauthorized stocking event. Both walleye and northern pike have become major components of the fish community in Duck Lake, and the walleye in particular have been popular with anglers. In 1990, MDNR initiated a supplemental stocking program to augment the existing walleye fishery in this system.

Since the 1930s, Imp Lake has been managed to provide a two-story fishery (trout and coolwater species), and several species of salmonids have been stocked in this system. Rainbow trout were stocked during the 1940s and 1950s, but returns from these plants were generally poor. Brook trout occasionally have been stocked in Imp Lake, but few brook trout were collected during subsequent surveys. Lake trout were also planted in Imp Lake on an irregular basis from 1936 to 1979. These fish survived well, and the presence of adult lake trout (some larger than 30 inches) added to the diversity of the fishery in Imp Lake. Limited stocking effort is necessary to maintain a modest lake trout fishery in this system, so periodic lake trout plants may be part of the future management strategy for Imp Lake. Splake have been the focus of fisheries management in Imp Lake since 1961. Although catch-per-unit-effort of splake was not exceptionally high during most surveys (typically around 2 fish/net night during fall gill net surveys), the size structure of the splake population has been impressive. Imp Lake has produced many splake larger than 20 inches, and the limited growth data available indicated that these fish were growing faster than the state average. Rainbow smelt were introduced into Imp Lake in 1942, and the presence of this forage species probably has contributed to the rapid growth observed for splake in this system.

Smallmouth bass, bluegill, pumpkinseed, and yellow perch also reside in Imp Lake. Steep drop-offs make it difficult to effectively sample these species during fisheries surveys. The panfish populations apparently are not large enough to attract much attention from anglers. Most of the smallmouth bass collected during surveys were sublegal, but fish up to 17 inches have been captured.

Little Duck Lake has also been managed as a two-story fishery. Bluegill, largemouth bass, and yellow perch make up the warmwater component of the fishery. Rainbow trout have been planted in Little Duck Lake for the last 60 years. Multiple fisheries surveys have indicated acceptable survival and growth of stocked rainbow trout in this system. In an attempt to convert some of the minnow biomass into trout biomass, splake (which are more piscivorous than rainbow trout) have been stocked in Little Duck Lake nearly every year since 1983. Only two legal-sized (≥12 inches) splake have been collected during the last three fisheries surveys on this lake, so the splake stocking program has been discontinued. Three adult walleyes were collected during the 2006 survey on Little Duck Lake. Walleye would place additional predation pressure on stocked trout, so the unauthorized introduction of this species is a major concern. If walleye begin reproducing in this lake (which is unlikely given the paucity of suitable spawning substrate), a chemical reclamation might be necessary to reestablish the trout fishery.

Walleye fry were stocked in Marion Lake from 1968 to 1972. During 1973 through 1989, the walleye population was maintained solely by natural reproduction. A survey conducted in 1990 indicated that walleye abundance was decreasing, and a supplemental walleye stocking program was initiated. Surprisingly, catch-per-unit-effort of walleye has actually declined since the supplemental stocking program was instituted. Although this lake has never been an excellent walleye producer, the walleye population is large enough to support a targeted fishery. Tiger muskellunge were also planted in Marion Lake in 1968, 1969, and 1979. Subsequent survey data indicate good survival from these stocking events, so this lake is a potential candidate for future muskellunge plants.

Marion Lake has earned a reputation for providing good bluegill fishing. Past survey data indicated that growth of this species was above state average, and individuals as large as 11 inches have been collected during sampling. Surveys have repeatedly shown that smallmouth bass were abundant in Marion Lake; however, these fish were slow growing and rarely attained legal size. At least three species of fish have been introduced into this lake (either by unauthorized stocking or entrance through Marion Creek): black crappie (1935), rock bass (1972), and northern pike (1992). Northern pike and black crappie have become only minor components of the fish community. The rock bass population expanded rapidly during the 1970s, and the 2005 survey indicated that rock bass had become the dominant fish species in Marion Lake.

Spring fingerling walleye were stocked in Tamarack Lake from 1984 to 1989. Since that time, natural reproduction has sustained a popular walleye fishery. Several rusty crayfish were found in this lake in 2001. The effects of this species introduction on the fish community in Tamarack Lake have yet to be determined. University of Notre Dame researchers and USFS are investigating the use of crayfish traps to control rusty crayfish abundance in lakes within the Ottawa National Forest (G. Lamberti, University of Notre Dame, personal communication).

Twelve lakes within the upper Middle Branch subwatershed are included in the Sylvania Wilderness Area: Crooked, Clark, Mountain, East Bear, West Bear, Corey, Germain, Helen, High, Katherine, Snap Jack, and Trapper lakes. Although some fish stocking occurred in the Sylvania Tract during the 1930s and 1960s, restrictive fishing regulations have been the foundation of modern fisheries management in this wilderness area since 1974. Sylvania lakes are only open to fishing from the last Saturday in April through October 31. High minimum size limits (20 inches for walleye, 30 inches for lake trout and northern pike) and low bag limits (1 fish total for walleye, lake trout, and northern pike, 10 fish for panfish species) provide further protection for Sylvania fish communities. Largemouth and smallmouth bass are the most popular species in the Sylvania Tract. The bass fishery is strictly catch-and-release. To reduce hooking mortality, only artificial lures with barbless hooks may be used within the Sylvania Wilderness Area. In addition, motors are not allowed on Sylvania lakes. This prohibition adds to the “wilderness experience” of visitors and makes it more challenging for anglers to access the remote regions of the Sylvania Tract.

Fisheries surveys and angler reports indicate that excellent fisheries still exist on Sylvania lakes. All evidence suggests that Sylvania's restrictive regulations have created some high quality fishing opportunities for anglers looking for a unique fishing experience.

Middle Branch—lower

The lower Middle Branch fishery is primarily dependent on migrations of potamodromous fishes from Lake Superior. Two coldwater tributaries to the lower Middle Branch also support trout fisheries. This subwatershed includes only two lakes larger than 10 acres, but some trout stocking has occurred in smaller ponds within the lower Middle Branch basin.

Lower Middle Branch Ontonagon River.–Logging roads and trails provide the only access to the lower Middle Branch. Due to the lack of vehicular access and correspondingly low fishing pressure, the fisheries management on the lower Middle Branch has been much less intensive than on the upper Middle Branch. Logistical considerations have limited nearly all fisheries surveys to within one mile of Agate Falls.

Although MDNR has not stocked fish in the lower Middle Branch, fish have moved into this stream reach from fish plants in the upper Middle Branch and the main stem Ontonagon River. Brown trout (stocked between Bond Falls and Agate Falls) have moved downstream into the lower Middle Branch and established a naturally reproducing population. Some brown trout reside in the lower Middle Branch year-round, but a large percentage of the brown trout are potamodromous. Thus, most of the brown trout fishing below Agate Falls occurs during fall spawning migrations. The wild steelhead population in the lower Middle Branch has been attracting anglers to Agate Falls for many years, and the main stem steelhead plants during 1988–2002 probably augmented the existing fishery. A few brook trout and coho salmon have also been collected during fisheries surveys below Agate Falls.

Tributaries.–Two tributaries to the lower Middle Branch, Trout Creek and the Baltimore River, support popular fisheries for brook trout and brown trout. With the exception of Trout Creek Pond (which is stocked with brook trout each year), the trout fisheries in these streams are supported entirely by natural reproduction. The Ontonagon Valley Conservation Club conducted a beaver removal project on the Baltimore River in 1991.

Lakes.–Bluegill, largemouth bass, and smallmouth bass were introduced into Erickson Lake during the 1930s and 1940s. The most recent survey (conducted in 1977) on Erickson Lake indicated that bluegill and largemouth bass were established in the lake, but no smallmouth bass were collected. The 1977 survey also indicated that the lake supported strong populations of northern pike and yellow perch. There is no public boat launch on Erickson Lake, but most of the lake is surrounded by the Ottawa National Forest.

Trout Creek Pond is a small impoundment that has been managed as a trout fishery for many years. Approximately 400 yearling brook trout are stocked in the pond each year. Trout Creek Pond receives heavy fishing pressure, so most fish are harvested soon after attaining legal size.

The MDNR stocked rainbow trout in Tanlund Lake from 1955 through 1996. As noted for Trout Creek Pond, the majority of the fish stocked in Tanlund Lake were harvested soon after reaching legal size. Survival of stocked rainbow trout declined substantially during the 1990s, and no trout were captured during the 1992 survey. The reasons for the abrupt change in trout survival were never identified.

Main Stem

The main stem Ontonagon River provides a wide array of fishing opportunities. Although some coolwater species inhabit the main stem throughout the year, the bulk of the fishing activity is directed toward potamodromous salmonids. The tributaries that flow into the main stem are warmwater streams that receive little (if any) fishing pressure. Lakes are essentially absent from this subwatershed.

Ontonagon River.–The Ontonagon River supports a diverse fishery that changes seasonally. Steelhead are the focus of most fishing activity during mid-April through mid-May. During late May–mid-September, anglers target walleye, northern pike, and smallmouth bass in the main stem. Potamodromous brown trout ascend the Ontonagon River from late August through October, initiating another pulse of angler activity. A few coho and Chinook salmon are also caught in the main stem, but abundance of these species is low relative to steelhead and brown trout.

The brown trout and salmon fisheries in the main stem are supported by natural reproduction and immigration of stocked fish from adjacent river systems. (Chinook salmon are stocked in the Big Iron River, 12 miles to the west, and brown trout are stocked in the Firesteel River, 7 miles to the east.) Yearling steelhead were stocked in the main stem until 2002. Fish stocked at this site (US-45 crossing) had to be dropped about 15 ft to the stream, and the logistics of safely releasing fish made this a less than ideal location. The annual steelhead plant was moved to the Jumbo and East Branch Ontonagon rivers in 2003 to minimize stocking stress and enhance returns of adult steelhead.

The walleye fishery near the mouth of the Ontonagon River is supported primarily by natural reproduction, but a periodic stocking program has been used to bolster the existing fishery. The United States Fish and Wildlife Service stocked lake trout in the main stem during 1982–94 as part of the Lake Superior lake trout rehabilitation effort. Some of these fish may have been caught in the lower main stem, but the lake trout stocking program primarily was used to supplement the Lake Superior fishery. Walleyes probably consumed some of the stocked lake trout; however, the extent of this predation was never quantified.

Habitat degradation and commercial overfishing led to the extirpation of lake sturgeon from the Ontonagon River during the early 1900s (see **History**). MDNR recently initiated a lake sturgeon stocking program to reestablish this native species in the Ontonagon River system. Approximately 33,000 fall fingerling lake sturgeon have been stocked in the main stem since 1998. Gametes were collected from spawning lake sturgeon in the Sturgeon River (Baraga County), and the fish were raised to fingerling size at the Wolf Lake State Fish Hatchery in southern Michigan.

Lake sturgeon return to their natal streams to spawn, and recent genetics studies have revealed that the few remaining lake sturgeon populations around Lake Superior are genetically distinct from each other. Because fish generally imprint at a young age, biologists became concerned that fish raised in traditional hatcheries and stocked as fall fingerlings might stray into other coastal streams and spawn with the native populations upon reaching sexual maturity. The influx of stocked fish into these historically isolated populations could “swamp” genes for local adaptations and reduce the fitness of remnant lake sturgeon populations.

Due to these genetic concerns, MDNR established a streamside rearing facility near the mouth of the Ontonagon River in 2007. Lake sturgeon gametes were collected from the Sturgeon River population as before, and the fish were raised to the fall fingerling stage in a rearing facility that uses water from the Ontonagon River. Approximately 750 lake sturgeon were stocked in the Ontonagon River from the streamside rearing facility in October 2007. The objective of this program is to allow the fish to imprint to the Ontonagon River, thus increasing the likelihood that they will return to the Ontonagon River to spawn. Because it often takes 15–20 years for male and 20–25 years for female lake sturgeon to reach sexual maturity, it will be many years before the results of these stocking efforts can be fully evaluated. Fillmore (2003) found numerous juvenile lake sturgeon in the lower main stem, so it appears that initial survival of stocked lake sturgeon has been acceptable.

East Branch

Resident trout fisheries exist on the East Branch Ontonagon River and several of its tributaries. Potamodromous salmonids also contribute to the fishery in the lower East Branch. There are 34 lakes larger than 10 acres within this subwatershed, and several of these lakes provide popular coldwater or warmwater fisheries.

East Branch Ontonagon River.–Throughout most of its length, the East Branch is considered a high quality trout stream. The portion of the East Branch above M-28 is classified as a Type 1 trout stream. Resident brook trout and brown trout fisheries attract many anglers to this stream reach during the summer months. Below M-28, the East Branch is classified as a Type 3 trout stream. The portion of the East Branch between M-28 and Sparrow Rapids is a popular destination for anglers seeking steelhead, coho salmon, and potamodromous brown trout.

The brook trout and brown trout fisheries have been sustained by natural reproduction for over 40 years. Coho salmon were introduced into the East Branch in 1968. The species has become well-established, and modern salmon runs consist entirely of wild fish. Wild fish also make up a large percentage of the steelhead population, but alternating plants on the East Branch and the Jumbo River are used to supplement the wild steelhead fishery.

Since at least the 1950s, fisheries managers have been working to improve fish habitat in the East Branch Ontonagon River. For example, MDNR installed “sweeper logs” and half-log structures in the East Branch below Lower Dam during 1978–86, and USFS completed an intensive beaver removal project on this stream in 1992.

Tributaries.–The Jumbo River is the largest and most heavily fished tributary to the East Branch. Resident brook trout and brown trout inhabit the Jumbo River and both of its branches. Numerous juvenile steelhead have been found during fisheries surveys on this stream, and it appears that the Jumbo River is an important nursery area for the East Branch steelhead population.

Since the late 1990s, KBIC has been collecting brook trout from the upper Jumbo River (above Jumbo Falls) and its tributaries to use as broodstock in their hatchery operations. Previous hatchery strains of brook trout were developed from populations within the Lake Michigan watershed or outside the Great Lakes basin. Fisheries managers prefer to stock fish from locally adapted populations whenever possible, so development of a brook trout strain from the Lake Superior watershed was a high priority. The Jumbo River was chosen as a broodstock stream because it (1) had not been stocked with brook trout for many years, (2) contained a healthy, self-sustaining brook trout population, (3) was accessible for capturing sufficient numbers of brook trout, (4) contained a barrier (Jumbo Falls) which prevented mixing with other stocked streams, and (5) was located within the Lake Superior watershed (Mike Donofrio, WDNR, personal communication). To date, most of the Jumbo River strain fish have been stocked in streams within the KBIC Indian Reservation or in tributaries to the East Branch Ontonagon River. Some preliminary stocking evaluations have been completed, but a more thorough evaluation of the performance of these fish after stocking is needed before expansion of this program is deemed appropriate.

USFS has conducted extensive habitat work to enhance the fisheries in the Jumbo River and its tributaries. Recent habitat projects include beaver removal, sediment trap construction and maintenance, bank stabilization, and installation of gravel spawning riffles.

Additional trout fisheries exist on several other tributaries to the East Branch. Smith, Spargo, and Stony creeks enter the East Branch above the confluence with the Jumbo River. Brook trout dominate the fish communities in these streams, but a few brown trout are also taken by anglers. These trout populations are largely sustained by natural reproduction, but KBIC stocked Jumbo River strain brook trout in Spargo Creek during 2004–05. USFS completed beaver removal projects on Spargo and Stony Creeks in 1992.

Groundwater inflows decline in the northern portion of this subwatershed, and many of the tributaries that flow into the lower East Branch are marginal trout streams. The lower reaches of Onion Creek and Beaver Creek have wild brook trout populations that support modest fisheries.

Lakes.–Bob Lake has a long management history that extends back to the late 1930s. Bluegills and smallmouth bass were stocked in this lake as early as 1935. These introductions apparently were not successful, as neither species was collected in subsequent surveys. In 1959, the existing fish populations were eliminated with toxaphene, and brook trout stockings were initiated in 1960. Annual trout plants produced an acceptable fishery for a few years. Competing species quickly increased to nuisance levels, and the lake was chemically reclaimed with rotenone in 1967. A mixture of brook trout, rainbow trout, and brown trout were planted during the next decade. Once again, the trout plants produced a popular fishery for several years. By the late 1970s, yellow perch abundance had increased exponentially, and trout survival had declined. Another rotenone treatment was completed in 1979, followed by three years of brook trout stocking.

By 1982, yellow perch and bullheads had become so well established in Bob Lake that trout management no longer appeared feasible. A series of manual removals were conducted by MDNR and USFS during 1982–98 to reduce abundance of yellow perch and bullheads in this system. During these efforts, over 5,000 lb of yellow perch and 2,000 lb of bullheads were removed from Bob Lake. MDNR also initiated a walleye stocking program in 1984. Despite all these efforts, overabundance of yellow perch and bullheads continues to be a problem in Bob Lake. Walleye abundance has gradually increased since 1984, and it appears that the stocking program has created a modest walleye fishery on the lake.

Like many lakes in the area, Bob Lake is a softwater system with limited buffering capacity. The acidity of the water was identified as an additional hindrance to fishery management on Bob Lake. On two occasions (1984 and 1989), the lake was treated with lime to raise the pH closer to neutral. The pH increases after lime treatments were short-lived, and the liming program has been discontinued.

The MDNR has stocked rainbow trout in Lake On-three since the early 1960s. Most fisheries surveys during the last 40 years have shown acceptable survival and growth of stocked trout. Lake On-three has been a relatively low maintenance trout lake, and only one rotenone treatment (completed in 1976) has been necessary since the beginning of trout management on this system.

Crystal Lake was managed as a trout fishery from 1956 to 1996. During the early 1990s, the water level in this lake declined steadily, making it less suitable for trout survival. Largemouth bass and bluegill abundance increased during this period, and these species currently support a warmwater fishery in this small lake. Rainbow trout were also planted in Kunze Lake during the 1980s, but fisheries surveys indicated that low summer oxygen levels were severely limiting trout survival.

Lower Dam was constructed on the East Branch Ontonagon River in 1964 (see **Dams and Barriers**). MDNR was the original owner of this dam, but ownership was transferred to USFS in 1984. Brook trout were stocked in Lower Dam Lake from 1964 to 1970. Only one brook trout was collected during the 1970 survey, and approximately 99% of the biomass in the catch consisted of white sucker and northern pike. The pond was drawn down in 1973 and was not refilled until 1983. Brown trout were stocked for several years after the pond was refilled. Subsequent surveys indicated that adequate brook trout and (to a lesser extent) brown trout fisheries could be sustained entirely by natural reproduction in the stream reach above the dam. Overabundance of white sucker continued to be a concern for fisheries managers during the 1990s. Over 1,000 lb of suckers were manually removed from this impoundment by USFS during 1991–98. In the past Lower Dam Lake received heavy fishing pressure, due in part to the presence of the adjacent National Forest campground. The Lower Dam campground was converted to a “dispersed camping” site in 2005, and this change probably decreased fishing pressure on the impoundment. Lower Dam Lake is not a designated trout lake, so the minimum size limit for brook trout is 8 inches. The length-frequency distribution of brook trout collected during fisheries surveys suggests that trout ≥8 inches are common, but few fish attain lengths greater than 10 inches.

Stunting of bluegill has been a long-standing problem in Tepee Lake. A partial treatment with antimycin was conducted in 1976 to reduce bluegill abundance and improve the size structure of the population. This treatment yielded only temporary benefits, so subsequent management efforts were directed toward increasing predation pressure on the bluegill population. Walleye were stocked in Tepee Lake periodically from 1980 to 1995, and northern pike were transferred to this lake on multiple occasions. The walleye plants yielded poor returns, but northern pike made up 40% of the biomass during the 2003 survey on this system. The presence of several sublegal northern pike in the catch also suggests that natural reproduction may be sufficient to sustain this predator population. There was no evidence of stunting during the 2003 survey, as nearly 70% of the bluegill collected were of harvestable size (≥6 inches).

Cisco Branch

With the exception of Twomile Creek, the streams in this subwatershed receive little fishing pressure. Numerous lakes are connected to the Cisco Branch and its tributaries, and these lakes provide a wide variety of fishing opportunities.

Cisco Branch Ontonagon River.–The upper Cisco Branch is considered a warmwater stream. Some smallmouth bass and walleye inhabit the upper Cisco Branch, but these populations attract little attention from anglers. Although the lower portion of the Cisco Branch (below Kakabika Falls) is a designated trout stream, trout only occupy this stream on a seasonal basis. Juetten (1973) indicated that both brook trout and brown trout were found in the lower Cisco Branch, but no trout were found during the 2006 summer survey on this stream reach. Trout probably enter this stream from coldwater tributaries (e.g., Twomile Creek) during the spring and fall. Because of the seasonal nature of the fishery, difficult wading and boating conditions, and a virtual lack of road access, there is little fishing pressure on this stream.

Tributaries.–Twomile Creek is the only tributary in the subwatershed that receives any substantial use by anglers. There is a strong population of wild brook trout in this Type 1 trout stream. Brook trout in the 7–8 inch size classes are common in Twomile Creek, but it appears that most fish are harvested before they can attain lengths ≥10 inches.

The MDNR recently established a fisheries index station on Twomile Creek. The same stream reach was sampled for three years in a row (2004–06) as part of the MDNR Stream Status and Trends program. During this comprehensive sampling effort, information was collected on various habitat parameters (e.g., substrate, bank stability, riparian vegetation, and channel morphology) and the abundance, size structure, and growth of brook trout. MDNR will return to this stream in 2010–12 to repeat another three years of sampling. The information gained from these Status and Trends surveys will allow fisheries managers to track local and (in conjunction with similar surveys on other Michigan streams) regional changes in fisheries and habitat parameters through time.

USFS installed two sand traps on Twomile Creek in 2001, and an additional trap was installed by another party as part of a disciplinary action by MDEQ. USFS continues to maintain their traps to reduce the sand bedload in Twomile Creek. USFS has also installed several skyboom structures on this stream to increase the amount of cover available for brook trout and other fish species.

Lakes.–The Cisco Lake Chain is the most popular fishing destination within the Cisco Branch subwatershed. The chain consists of 14 interconnected lakes with a combined surface area of approximately 4,000 acres. Most of the lakes are located entirely within the State of Michigan, but three lakes (Big, West Bay, and Mamie) extend southward into Wisconsin. Past management activities in the Cisco Lake Chain generally have focused on improving the walleye fishery. Walleye were stocked in Cisco and Thousand Island lakes during the late 1930s and early 1940s. After a long hiatus, walleye stocking resumed in 1983. Lake trout, muskellunge, and tiger muskellunge have also been stocked in the Cisco Lake Chain. Stunting of northern pike has been a continual problem, and there is no minimum size limit for northern pike in this system. Big, West Bay, and Mamie lakes are governed by Michigan-Wisconsin boundary water regulations.

The MDNR conducted an intensive survey on the Cisco Lake Chain during 2002–03 as part of the LLSP (see Bond Falls Flowage discussion, earlier this section, for more information on the LLSP). The information provided in the following three paragraphs is from Hanchin et al. (2008).

The population estimates generated from the LLSP survey were 10.1 adult walleyes/acre and 3.7 adult northern pike/acre. The northern pike estimate was within the range expected for lakes with strong pike fisheries. The adult walleye population estimate for the Cisco Lake Chain was higher than all previous estimates obtained from lakes in the LLSP (average = 3.1 fish/acre). The annual harvest estimates for walleye and northern pike in the Cisco Lake Chain were 18% and 23%, respectively.

During the LLSP creel survey, the main species harvested (from most to least) were yellow perch, bluegill, black crappie, walleye, northern pike, rock bass, pumpkinseed, smallmouth bass, and largemouth bass. An estimated 304 muskellunge were caught and released during the 2002 open water fishing season. Eight Master Angler muskellunge entries have come from the Cisco Lake Chain since 1980, suggesting that growth of muskellunge in this system is at or above the state average.

Tag returns of adult walleye and northern pike provided considerable information on the movement patterns of these species within the Cisco Chain. Although fish frequently moved between lakes within the chain, the walleye and pike populations could be divided into relatively distinct north and south populations. When a dividing line was drawn through the narrows between Lindsley and Morley lakes, the tag return data indicated that only a small percentage of fish tagged in the north and south halves of the chain were subsequently recaptured in the opposite half. Differences in growth rate were also observed for walleyes in the two halves of the chain. The mean growth indices for the north and south walleye populations were -0.6 and -3.2, respectively. Walleye population density was much higher in the southern lakes, so the slow growth observed for the southern population may have been related to forage availability. No significant differences in growth were observed for the northern pike populations in the two halves of the Cisco Lake Chain. The mean growth index for the entire northern pike population was -4.0. This slow growth prevents most pike from reaching the statewide minimum size of 24 inches, so the existing no minimum size limit regulation on the chain appears to be appropriate.

Beatons Lake also receives substantial fishing pressure. This lake is managed to provide a two-story fishery. During the last 15 years, rainbow trout, splake, and walleye have been stocked in Beatons Lake. Rainbow trout generally have been the main species of interest, and rainbow trout larger than 20 inches are not uncommon in this system. Returns from the annual splake plants have been less impressive. During the 2004 survey, only 12 splake were captured compared to 81 rainbow trout. The 2004 survey also indicated that the forage base (e.g., bluegill and yellow perch) was depleted. To facilitate recovery of the panfish populations in Beatons Lake, the splake and walleye stocking programs have been temporarily discontinued.

Cornelia Lake is a small (14 acre) lake that has been stocked with brook trout since 1964. These plants have produced a popular fishery, and the length-frequency data from fisheries surveys suggests that most fish are harvested soon after reaching legal size. The existing Type A trout regulations (which prohibit the use of minnows as bait) apparently have been successful in preventing the introduction of undesirable species into Cornelia Lake, as no rotenone treatments have been necessary since 1977 (Table C.2).

Langford Lake supports a diverse fishery for largemouth bass, smallmouth bass, northern pike, and panfish. MDNR fisheries surveys on this lake indicate that natural reproduction sustained a strong walleye population during the 1950s to early 1980s. Black crappies became established in Langford Lake during the early 1980s. Although this species may have entered the lake from Langford Creek, unauthorized stocking activity is a more probable explanation for the appearance of black crappie in this system. Surveys conducted during the late 1980s and early 1990s suggested that natural recruitment of walleye had declined dramatically. Adult black crappie prey on small minnows and other fishes (e.g., young-of-year walleye), and predation by black crappies was identified as the most likely cause for the decline in juvenile walleye abundance. A spring fingerling walleye stocking program was instituted in 1990 in an attempt to restore the walleye fishery in Langford Lake. Although walleye have been stocked for several years, the population in this lake still has not recovered.

Several lakes in the Cisco Branch subwatershed are located within the Sylvania Wilderness Area and are governed by special regulations (see Sylvania regulations discussion for the upper Middle Branch subwatershed). Whitefish Lake is the most notable lake in this category. This lake supports productive fisheries for smallmouth bass and walleye. No whitefish (family Salmonidae – subfamily Coregoninae) have ever been collected during MDNR fisheries surveys on Whitefish Lake.

Tenderfoot Lake is a Michigan-Wisconsin boundary water. The Michigan portion of Tenderfoot Lake falls within the University of Notre Dame Environmental Research Center, and the only public access to the lake is from the Wisconsin side. Because of the access situation, most fisheries management activities on this lake have been completed by WDNR. Walleye, muskellunge, largemouth bass, and smallmouth bass were stocked in Tenderfoot Lake by WDNR during 1935–53. Since that time, the fish populations in this lake have been sustained solely by natural reproduction.

Eighteen of the lakes in this subwatershed are located entirely within the State of Wisconsin and fall under the jurisdiction of WDNR. Several of these lakes (e.g., Forest and Palmer lakes) support popular fisheries for coolwater and warmwater fish species.

South Branch

Fishing activity on the South Branch is limited compared to other branches of the Ontonagon River system, but wild trout fisheries exist on a few tributaries to this stream. Lakes are scarce in this subwatershed.

South Branch Ontonagon River.–Although the upper end of this river is classified as Type 1 trout water, the South Branch is primarily a coolwater stream (Figure 43). There is little fishing pressure on the South Branch, but local anglers report catching smallmouth bass, walleye, muskellunge, bluegill, yellow perch, and northern pike in this stream near the town of Ewen.

Tributaries.–Sucker Creek and its tributaries (e.g., Bluff Creek) are the only designated trout streams that flow into the South Branch. These streams support wild populations of brook trout and brown trout. The Ottawa National Forest surrounds large reaches of these tributaries, and several stream crossings provide easy access for anglers.

The flow regimes in Bluff and Sucker creeks are strongly influenced by operation of the Bond Falls diversion (see **Dams and Barriers**). In 1995, a biological survey conducted by MDEQ indicated that dam operations at the Bond Falls diversion were adversely affecting fish populations in Bluff Creek (Taft 1995). In 2003, FERC issued a new license for the Bond Falls Hydroelectric Project which established ramping rate restrictions and specified minimum and maximum water releases into the Bond Falls Canal (Appendix A). MDEQ conducted another survey in 2004 to evaluate the effects of the new flow restrictions on the fish communities in Bluff Creek. Both the number of fish collected and the number of species collected were higher in 2004 than in 1995, so Taft (2005) concluded that the new operating regulations had "substantially improved the quality and density of the Bluff Creek fish community."

Lakes.–Sucker Lake is the largest lake in the South Branch subwatershed. This nutrient-rich lake has a mean depth of 9 ft, and winterkills have been common in this system. The fish community in Sucker Lake is dominated by species that are tolerant of low winter oxygen levels (e.g., yellow perch, white sucker, and brown bullhead). During the 1970s, USFS evaluated the feasibility of constructing a dam at the outlet of Sucker Lake (Crumrine 1974). Crumrine (1974) concluded that damming the outlet to create an additional 10 ft head was hydrologically possible, but he predicted that winterkill (though less frequent) would still be a problem during winters with heavy snowfall.

Bluegill and smallmouth bass were introduced into County Line Lake during 1936–43. These introductions apparently were successful, as the lake still supports productive fisheries for both species. A variety of salmonid species were stocked in County Line Lake from 1960 to 1980. These fish plants produced only modest returns, so the stocking program was discontinued.

Two small (<10 acre) impoundments in this subwatershed have been stocked to provide additional trout fishing opportunities. Brook trout and brown trout have been planted in Paulding Pond since 1958. Although this impoundment is only 7 acres in size, fisheries surveys have repeatedly documented acceptable growth and carryover of stocked trout in this system. Robbins Pond is an even smaller impoundment that was stocked with trout (primarily brown trout) for nearly 40 years. Annual trout plants historically supported popular fisheries in this pond. The impoundment gradually filled in with sediment, and aquatic plant growth increased the biological oxygen demand and interfered with fishing and boating activity. Habitat conditions eventually became unsuitable for trout survival, and the trout stocking program in Robbins Pond was discontinued in 1996.

West Branch

West Branch Ontonagon River.–Coolwater game fish (smallmouth bass, walleye, and northern pike) are fairly abundant in the West Branch above the Victoria Reservoir, but there is little fishing pressure on this stream reach (Juetten 1973). A major factor limiting fishing pressure on this stream is the paucity of access sites. There are only three access sites on the West Branch: M-28 (near Bergland), Norwich Road, and Victoria Dam.

Special fishing regulations have been implemented on the West Branch to protect spawning lake sturgeon. The portion of the West Branch between Victoria Dam and the confluence with the Victoria hydroelectric facility tail race is closed to fishing from 01 April through 10 June. In addition, the new FERC license specifies minimum water releases into this portion of the river during the spring to ensure adequate flow conditions for lake sturgeon reproduction (see **Dams and Barriers**). Although lake sturgeon are thought to be extirpated from the Ontonagon River system, these regulations should protect any fish that might remain and will aid restoration efforts as stocked fish begin returning to the river. The lake sturgeon stocking program in the main stem Ontonagon River was initiated in 1998, so adult fish are not expected to enter the West Branch until at least 2013 (see **Biological Communities**).

Downstream from the Victoria tail race, the West Branch is classified as a Type 3 trout stream (no closed season for salmonids). This portion of the West Branch supports seasonal fisheries for walleye and steelhead.

Tributaries.–Most of the tributaries that flow into the West Branch are considered coolwater streams. Cascade Creek is a designated trout stream, and the wild brook trout population in this creek provides some fishing opportunities. Although road access is limited, the surrounding federal lands allow walk-in access to much of the stream.

A few coldwater tributaries flow into Lake Gogebic. Wild brook trout populations inhabit these tributaries, but fishing pressure is low due to the small size of the streams.

Lakes.–Lake Gogebic has been one of the most intensely studied waters within the Ontonagon River watershed. Fisheries management activities on this lake date back to the 19th century. Eschmeyer (1941) provided this description of early fisheries management on Lake Gogebic.

> Smallmouth bass, largemouth bass, bluegills, and sunfish comprised the principal game fishes [sic] previous to 1900. In the late 1890s, northern pike were introduced and subsequently became the dominant game fish [sic] species of the lake, until about 1920, when the walleyed pike, which had been introduced in 1913 as fry, became of first importance in the lake. With its relative, the yellow perch, this species has continued in this position since that time, with the northern pike dwindling in numbers and the centrarchid species becoming increasingly scarce.

Additional research suggests that walleyes may have been introduced into Lake Gogebic before 1913.

> On May 3, 1985, the Baraga office of the Michigan Department of Natural Resources received word from Florence Daniels of Bergland, that her grandfather, Adolph Martin Borseth, was hired by G. A. Bergland to plant walleyes in Lake Gogebic in 1904. The fish, which came in by train, were planted from a rowboat into Bergland Bay just east of the Bergland dock. According to Bob Haas, Biologist, Mt. Clemens (personal communication), archive records indicate 300,000 fry were planted in 1904, their source unknown, but Haas suggests they came from the hatchery in Sault Ste. Marie, Michigan. [From Norcross 1986.]

The walleye fishery still brings thousands of people to Lake Gogebic every year, and many local businesses depend heavily on walleye anglers for their livelihood. The rocky shoreline of Lake Gogebic provides excellent spawning habitat for walleye, and natural reproduction essentially has sustained the population for at least 90 years. From 1971 to 1988, MDNR collected gametes from Lake Gogebic walleye and used these gametes to produce fry and fingerlings for stocking in other waters. In an attempt to offset any effect these gamete collections might have had on the donor population, some fry were planted back into Lake Gogebic during this time period.

Slow growth of Lake Gogebic walleye has been a major concern for anglers and fisheries managers. Forage fish introductions during the 1980s and 1990s yielded no noticeable improvement in walleye growth, and few individuals of the stocked forage species have been collected during subsequent surveys.

To compensate for the slow growth of Lake Gogebic walleye, the minimum size limit on this lake remained at 13 inches even after the statewide limit was raised to 15 inches in 1976. Population modeling conducted during the 1990s suggested that a 15-inch minimum size limit would increase the total pounds of harvestable fish in the lake and produce a better overall fishery (Miller 1997). As a result of this modeling effort, the minimum size limit for walleye was increased to 15 inches in 1996.

During 2005–06, MDNR completed a comprehensive survey on Lake Gogebic as part of the LLSP. Analysis of the data from this survey will allow fisheries managers to evaluate the effects of the 15-inch minimum size limit on the walleye fishery in Lake Gogebic.

Though walleye are the featured species in Lake Gogebic, two other species are worthy of mention. Smallmouth bass (originally the premier species in the lake) continue to provide a popular summer fishery in this system. Lake Gogebic is also famous for its trophy yellow perch fishery. Twelve-inch yellow perch are common in this lake, and a few 14-inch individuals were found during the LLSP survey.

Habitat manipulations in Lake Gogebic primarily have consisted of water level control (see **Dams and Barriers**) and installation of fish cover structures. Since 1948, MDNR and various other organizations have installed hundreds of fish cover structures in this system. Though the effects of such structures on fish populations are difficult to quantify, the structures are very popular with local anglers.

Victoria Reservoir is one of the better panfish waters in Ontonagon County. A 2002 fisheries survey of this impoundment found strong populations of black crappie and yellow perch. Northern pike and smallmouth bass are also common in this reservoir, but few legal-sized fish of either species were found during the 2002 survey. Walleye fry were stocked in Victoria Reservoir during 1971–72. These fish apparently survived well, and natural reproduction was sufficient to sustain a modest walleye fishery for nearly 30 years. A fisheries survey conducted in 2000 suggested that several year class failures had depleted the walleye population, and supplemental walleye plants were made during 2000–02. The walleye plants have been temporarily discontinued, and additional monitoring will be conducted to determine if further walleye plants are needed.

Recreational Use

The large tracts of publicly owned land in the Ontonagon River watershed provide a wide variety of recreation opportunities (Figure 45). Popular outdoor activities within the basin include fishing, boating, water skiing and tubing, canoeing, kayaking, hunting, trapping, berry and mushroom picking, camping, swimming, off-road vehicle (ORV) trail riding, snowmobiling, snowshoeing, cross-country skiing, hiking, bike riding, bird and wildlife watching, and waterfall viewing.

Boating is a major recreational activity on lakes within the watershed (Table 27). Motor boating and water skiing generally occur on larger lakes, while canoeing and kayaking are popular pastimes on smaller lakes and ponds. Rental boats are available at several resorts along the shorelines of Lake Gogebic and the Cisco Chain.

Motors are prohibited on most lakes within the Sylvania Wilderness Area. Canoeing and hiking are the only modes of transportation in this roadless wilderness, and many visitors use canoes to access remote lakes within the Sylvania Wilderness Area.

Steep gradients and rock-strewn rapids make many of the streams in the Ontonagon River system unsuitable for leisurely canoeing. Juetten (1973) provided this description of canoeing on the West Branch.

> The stream is said to be canoeable from Norwich Road down to Victoria Dam, however, during periods of low water, protruding rocks and boulders make canoeing difficult. One local canoe enthusiast commented that the most enjoyable part of his trip was taking his canoe out at Victoria Dam. Canoeing from Lake Gogebic downstream to Norwich Road is not recommended. [From Juetten 1973.]

A few stream reaches within the basin are frequented by canoeists. The upper Middle Branch, South Branch, and the main stem are popular canoeing destinations (Dennis and Date 2005). These streams still can be challenging to float in a canoe, and portages may be required around rapids and small waterfalls. A canoe livery in Watersmeet provides rental crafts for use on the upper Middle Branch and Sylvania Wilderness Area lakes.

The turbulent waters of the Ontonagon River system attract visitors looking for a challenging whitewater experience. No guided trips are available, but many whitewater enthusiasts bring their own canoes and kayaks to descend the steeper stream reaches within the watershed. It is difficult to quantify the importance of this activity to the local economy, but anecdotal information suggests that whitewater paddling has been increasing in popularity. A local canoe enthusiast provided this description of the whitewater opportunities on the West and Cisco branches.

> I believe the West Branch contains some of the best intermediate whitewater recreational opportunities in the Ontonagon River watershed. Although there are only short periods of adequate water levels, usually in early spring and late fall, the USGS gauge near Bergland provides “real time” water level data [http://waterdata.usgs.gov/mi/nwis/rt]. Since 1975 I have regularly canoed the West Branch from the Bergland Dam to Lake Victoria with water levels ranging from 200-800 cfs. At 200 cfs, the stretch from Bergland Dam to about a mile upstream from its confluence with Cascade Creek is Class II and Class I from Cascade Creek to the Norwich Bridge. The uppermost segment (just below the dam) is Class III at higher water levels (600-800 cfs).
>
> The segment from Norwich Bridge to Lake Victoria begins with flat water for the first two miles and ends with a two-mile paddle across Lake Victoria. However, there is spectacular scenery, camping opportunities and long intermittent stretches of Class II rapids (Class II/III at higher water levels) in between [sic]. Each of these segments can be easily paddled within four-five hours.
>
> The Cisco [Branch], from its confluence with Tenderfoot Creek to [Forest Hwy] 6930 has even shorter periods of adequate water volume for paddling. However, when conditions are right it has a longer continuous stretch of Class II/III whitewater than the East Branch. Most of the stretch beginning shortly upstream of an old USFS gravel pit on [Forest Hwy] 527 (Section 23 T46N R41W) is continuous Class II with Wolverine Falls Class III. Wolverine Falls approaches Class IV at higher water levels. [From A. Warren, personal communication]

Canoeing or kayaking on the West and Cisco branches is not recommended for novice paddlers. Flows in the West and Cisco branches can change rapidly due to dam operations (see **Hydrology**). In addition, maps may not accurately depict the locations of rapids and waterfalls, so paddlers should exercise caution when running a stream reach for the first time.

The public lands within the watershed provide a myriad of hunting and trapping opportunities. Waterfowl hunting is a common activity on the lakes and streams within the basin. Riparian corridors are also prime trapping locations for beaver, muskrat, and otter. Deer, bear, and upland bird hunting are popular activities on the forested lands within the Ontonagon River watershed.

An extensive network of trails exists for snowmobiling, hiking, biking, cross-country skiing, and horseback riding. Hundreds of miles of snowmobile trails cross the Ontonagon River watershed, and snowmobiling has become an important source of revenue for many area businesses. Many other trails function as hiking (or biking) trails during the summer and cross-country ski trails during the winter. Over 30 miles of such trails exist within the Sylvania Wilderness Area, and several shorter trails are located near campgrounds and waterfalls. The North Country National Scenic Trail crosses the northern portion of the watershed (from Bob Lake to Cascade Creek). When completed, this hiking trail will connect the Lewis and Clark Trail in North Dakota to the Appalachian Trail in Vermont.

Off-road vehicles are a popular method of transportation in the Upper Peninsula. Although the only state designated ORV trail in the Ontonagon River basin is the Iron River-Marenisco Route (which runs through the southern portion of the watershed near Watersmeet), Michigan state forest lands are open to ORVs unless posted otherwise. The Ottawa National Forest historically had a similar policy, but increasing ORV traffic in recent years has prompted USFS to revise this policy. As of May 2006, cross-country use of ORVs is prohibited in the Ottawa National Forest. Under the new regulations, ORVs still are allowed on designated roads and trails within the forest.

There are 13 public campgrounds and several private campgrounds in the Ontonagon River watershed (Table 15). Dispersed camping is also practiced on state and federal lands throughout the basin.

> Camping is permitted anywhere on State Forest property as long as it is not posted “No Camping,” and is one mile or more from a designated State Forest Campground. Campers must follow all state land rules and must also post a registration card at the campsite. On National Forest lands, no permit is needed to primitive camp for up to [16] days, no closer than 50 ft from a lake or stream and not less than 100 ft from a road. [From Madison and Lockwood 2004.]

Dispersed camping is not permitted in the Sylvania Wilderness Area. Permits to camp at designated campsites within the Sylvania Wilderness Area can be obtained from the Wilderness Entrance Station or the Watersmeet Visitor Center.

The numerous waterfalls in the Ontonagon River watershed attract thousands of tourists each year. Marked trails lead to many of these falls. Two waterfalls within the basin, Bond Falls and Agate Falls, are designated as State Scenic Sites.

Fishing is one of the most popular outdoor activities in the watershed. For many years, MDNR has used angler creel surveys to monitor fishing activity on Michigan lakes and streams. During 1928–64, conservation officers recorded catch and effort data for several streams within the watershed (Table D.1). These “General Creel Census” surveys were qualitative in nature, and it was not possible to estimate total annual harvest or effort from this data. More comprehensive creel surveys have been conducted on some of the heavily fished waters within the basin. These surveys were designed to evaluate total fishing effort (i.e., through regular angler or boat counts) and annual harvest (i.e., through angler interviews) of one or more game fish species.

The available creel data for each subwatershed are summarized in the following sections. The catch-per-hour (CPH) estimates for game fish reported below were calculated by dividing the total estimated harvest of the subject species by the total estimated fishing effort (regardless of targeted species) during the study period.

Middle Branch—upper

General Creel Census data indicated that brook trout was the premier game fish species in the upper Middle Branch from the late 1920s through the early 1960s. Conservation officers checked 4,191 brook trout during this period, compared to 233 brown trout and 648 rainbow trout. Brook trout was also the most abundant species harvested on upper Middle Branch tributaries during the General Creel Census.

Wagner et al. (1994) used an intensive creel survey to estimate the relative contributions of stocked and wild brook trout to the upper Middle Branch fishery. The mean annual effort during the pre-stocking period (1988–89) was 1,760 angler hours. The mean estimated harvest was 539 brook trout, yielding a CPH of 0.306. During the stocking period (1990–92), the mean annual effort was 1,488 angler hours. The mean estimated brook trout harvest was 959 fish, resulting in a CPH of 0.645. Hatchery fish made up 41% of the total annual harvest during 1990–92 (see **Fishery Management**).

Walleye was the most abundant fish species harvested during the 2003 LLSP creel survey on the Bond Falls Flowage (Hanchin, in press). Walleye CPH was 0.0453 during this survey. By comparison, the mean walleye CPH for all LLSP open water creel surveys conducted during 2001–05 was 0.0403 (Hanchin, in press). Additional fish species harvested, in order of decreasing abundance, were rock bass, yellow perch, smallmouth bass, black crappie, northern pike, bluegill, largemouth bass, muskellunge, green sunfish, and pumpkinseed. Piscivorous game fish composed 49% of the total harvest (by number). The high relative abundance of predators in the creel corroborates the catch data from the 2003 fisheries surveys which suggested that the forage base was depleted in this reservoir.

Another creel survey was conducted on Duck Lake during the 1993 open water fishing season. Species harvested (from most to least abundant) were bluegill, black crappie, pumpkinseed, rock bass, yellow perch, walleye, northern pike, and smallmouth bass. Panfish composed 97% of the total harvest during this period. Catch-per-hour values for bluegill and black crappie were 0.31 and 0.28, respectively. Although walleye made up only a small percentage of the total harvest, a substantial number of anglers targeted this species. Fourteen percent of the anglers surveyed indicated that they were fishing for walleye.

Middle Branch—lower

Rainbow trout (steelhead) was the most abundant species harvested in the lower Middle Branch during the General Creel Census, followed by brook trout and brown trout. The lower Middle Branch supports a seasonal fishery, with most angling effort occurring during the spring steelhead migration.

General Creel Census data indicated that brook trout was the primary species caught in lower Middle Branch tributaries, although brown trout made up a substantial portion of the catch in the Baltimore River. Surprisingly, few rainbow trout were harvested from any of the tributaries to the lower Middle Branch.

Main Stem

Coolwater fish species (i.e., walleye and northern pike) dominated the catch during the General Creel Census surveys on the main stem. During the last 20 years, several intensive creel surveys have been conducted at the mouth of the Ontonagon River as part of the Great Lakes Creel Program. Many of the anglers interviewed at this port were fishing in Lake Superior rather than the main stem. The major game fish species recorded during these surveys were lake trout, walleye, coho salmon, Chinook salmon, brown trout, and steelhead.

East Branch

General Creel Census data indicated that anglers were catching brook trout, brown trout, and rainbow trout in the East Branch and its tributaries. Although rainbow trout composed a substantial percentage of the East Branch harvest in some years, brook trout clearly was the dominant species in the East Branch and associated tributaries.

USFS conducted a creel survey on Lower Dam Lake in 1983. Estimated fishing effort for June–September was 952 angler hours. The CPH for trout (brook trout and brown trout combined) was 0.46.

Cisco Branch

Limited creel census information is available for the Cisco Branch and associated tributaries. Although brook trout were harvested in this stream during 1941 and 1962, recent electrofishing surveys and anecdotal reports suggest that the Cisco Branch is a marginal trout stream that receives little fishing pressure.

General Creel Census data were collected on Cisco and Thousand Island lakes during 1928–64. For Cisco Lake, species harvested (most to least abundant) were yellow perch, bluegill, walleye, northern pike, pumpkinseed, largemouth bass, smallmouth bass, rock bass, black crappie, muskellunge, and lake trout. The CPH values were 0.13 for walleye and 0.62 for all species. On Thousand Island Lake, species harvested were yellow perch, bluegill, walleye, northern pike, pumpkinseed, smallmouth bass, rock bass, largemouth bass, black crappie, lake trout, and muskellunge. Catch-per-hour was 0.08 for walleye and 0.60 for all fish species.

Another creel study was conducted on Cisco and Thousand Island lakes in 1978. As in previous surveys, yellow perch was the most abundant species in the creel for both lakes. The CPH estimates for all species combined were 0.87 for Cisco Lake and 0.56 for Thousand Island Lake. Walleye CPH was relatively low in both lakes during 1978: 0.02 in Cisco Lake and 0.03 in Thousand Island Lake. The apparent decline in walleye catch rates may have been due to survey design. Conservation officers probably patrolled the Cisco Chain more frequently in May (around the opening of walleye season) when walleye catch rates were higher, which would have biased the General Creel Census data. The 1978 creel survey was conducted from mid-May through August, so it encompassed the late summer period when walleye harvest is typically lower.

The most recent creel data for the Cisco Chain were collected during the 2002–03 large lake survey (Hanchin et al. 2008; Table D.3). This creel survey encompassed the entire Cisco Chain, so it was not directly comparable to the previous surveys on Cisco and Thousand Island Lakes. During the open water season (May–October), the main species harvested were yellow perch, bluegill, black crappie, walleye, northern pike, rock bass, smallmouth bass, and largemouth bass. The CPH estimates were 0.02 for walleye and 0.66 for all species. Creel data were also collected during the winter ice fishery. Species harvested during the winter included yellow perch, bluegill, northern pike, walleye, pumpkinseed, rock bass, and black crappie. Winter CPH estimates were 0.02 for walleye and 0.81 for all fish species.

South Branch

Little creel census information is available for the South Branch. General Creel Census data indicated that brook trout fisheries existed on some South Branch tributaries, including Bluff Creek, Scott and Howe Creek, and Sucker Creek. Anglers were also catching brown trout and rainbow trout in Bluff and Sucker Creeks during 1945–64.

West Branch

General Creel Census data were collected on the West Branch during 1937–59. Walleye dominated the catch in this stream, followed by northern pike, yellow perch, and smallmouth bass. Walleye and northern pike were also important components of the fishery in the Slate River. During the General Creel Census, brook trout fisheries existed on several Lake Gogebic tributaries, including Marshall Creek, Pelton Creek, Trout Brook, and the Slate River. Cascade Creek is the only direct tributary to the West Branch that supports a targeted trout fishery. Over 900 brook trout were harvested during the General Creel Census on Cascade Creek.

Several creel surveys have been conducted on Lake Gogebic during the last 70 years. Walleye and yellow perch consistently have composed over 80% of the harvest on this lake. During the 2005 open water fishing season, CPH estimates for walleye and yellow perch were 0.0479 and 0.0891, respectively (Z. Su, MDNR Fisheries Division, unpublished; Table D.4). Smallmouth bass (CPH = 0.0114) are also an important part of the fishery, but the 2005 creel data indicated that about 85% of the smallmouth bass caught were subsequently released. Lake Gogebic is one of the most heavily fished lakes in the western Upper Peninsula, and over 100,000 angler hours were expended on this system during the 2005 open water season.

Citizen Involvement

Various citizen groups have been involved in watershed planning and aquatic habitat improvement projects within the Ontonagon River basin. Natural resource agencies (e.g., MDNR, MDEQ, USFS, USFWS, KBIC, or United States Department of Agriculture – Natural Resources Conservation Service) collaborate with these groups and provide technical and (in some instances) financial assistance.

Sport fishing clubs have worked on numerous habitat improvement projects during the last 70 years. These groups have assisted with beaver removals, installation of fish cover structures and spawning riffles, and construction of a walleye rearing pond. The Ontonagon Valley Sportsmen’s Club, the Copper Country Chapter of Trout Unlimited, the Ottawa Sportsmen’s Club, and the Upper Peninsula Sport Fishing Association are active clubs that regularly interact with MDNR regarding fisheries issues.

Various lake associations have also participated in fisheries projects. These associations have assisted with fisheries surveys, manual removals, installation of fish cover structures, and public education regarding aquatic invasive species. Some lake associations have paid private hatcheries to stock fish in their respective lakes. These fish plants were conducted after receiving the required fish stocking permits from MDNR.

Several nongovernmental organizations provided comments during the relicensing period for the five hydroelectric-related dams in the watershed. Trout Unlimited, Michigan United Conservation Clubs, Anglers of Au Sable, Great Lakes Council, Inc., Federation of Fly Fishers, Inc., American Rivers and American Whitewater Affiliation, the Cisco Chain Riparian Owners Association, the Lake Gogebic Improvement Association, North Shore Concerned Citizens Group of Lake Gogebic, the Upper Peninsula Sport Fishing Association, and the Upper Peninsula Sportsmen’s Alliance all participated in the FERC relicensing process. The Upper Peninsula Public Access Coalition and other nongovernmental organizations have also provided comments to FERC regarding UPPCo’s shoreline management plan for the Bond Falls Flowage.

LVD maintains a small walleye hatchery along the shore of Lac Vieux Desert (Wisconsin River watershed). LVD is working to expand their walleye rearing capabilities, and it is likely that many of the walleye produced at this facility would be stocked within the Ontonagon River watershed. As mentioned in previous sections, KBIC has their own fish hatchery, and they have stocked Jumbo River strain brook trout in several East Branch tributaries. Keweenaw Bay Indian Community is also in the process of developing a walleye rearing pond. MDNR will continue to work with LVD, KBIC, and USFS to ensure that the various organizations are not employing competing stocking strategies on the same water body.

Basinwide watershed councils have been established for many Michigan watersheds, but no equivalent council exists for the Ontonagon River basin. Watershed councils provide a means for the various government and nongovernmental organizations to exchange information, set common goals for DNR management, and prioritize proposed projects. Because watershed councils involve multiple entities, they also have the financial and labor resources to complete projects that are too large for individual organizations to address.

MANAGEMENT OPTIONS

The Ontonagon River watershed is a valuable resource that supports a diverse array of recreational opportunities. Although the Ontonagon River is healthy relative to most other streams in Michigan, human activities over the last two centuries have altered many of the physical and biological characteristics of the watershed. The management options presented below are intended to address the most significant known problems within the basin and establish priorities for further investigations.

Management options follow the recommendations of Dewberry (1992), who outlined measures necessary to protect the health of riverine ecosystems. Dewberry (1992) stressed protection and rehabilitation of headwater streams, riparian areas, and floodplains. Streams need to be reconnected to their floodplains where possible. A river system must be viewed as a whole, because system-level processes strongly influence aquatic habitat and fish community composition.

Options identified herein are consistent with the MDNR, Fisheries Division mission 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 current and future generations. In particular, the division seeks to protect and maintain healthy aquatic environments and fish communities and rehabilitate those now degraded, provide diverse public fishing opportunities to maximize the value to anglers, and foster and contribute to public and scientific understanding of fish, fishing, and fishery management.

The following options reflect five approaches to watershed management: (1) protection of existing resources, (2) identification of issues requiring further investigation, (3) restoration of degraded resources, (4) enhancement of natural resources above and beyond their original condition (e.g., boat launch construction or management of single species trout lakes), and (5) public education regarding watershed function and management. Many management options listed below are already being put into practice, while other options will be implemented within the next five years. Remaining options (e.g., dam removal) will be implemented as opportunities arise. These options were developed to guide watershed activities and are applicable for citizen groups and other resource agencies with interest in the Ontonagon River basin.

Geology and Hydrology

Streams in the southern portion of the Ontonagon River watershed (e.g., the upper Middle Branch) have stable flows due to an abundance of coarse textured glacial till and highly permeable soils. Large deposits of lacustrine clay and silt in the northern half of the basin prevent infiltration and produce flashier stream flows in the main stem and lower Middle Branch. Operations at the Bond Falls diversion and other dams have substantially altered the flow regimes in large portions of the Ontonagon River system. Human development within the watershed is relatively sparse, and an important goal of future management is to preserve the hydrologic function of existing pristine areas.

Option: Protect the natural hydrologic regime of streams by preserving existing wetlands, floodplains, and upland areas that provide recharge to the water table.

Option: Work with MDEQ, FMFM, land managers, local authorities, timber companies, and private citizens to protect natural flow regimes by incorporating best management practices (e.g., riparian buffer strips, infiltration basins, seeding and mulching, etc.) throughout the watershed.

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

Option: Protect natural lake outlets by opposing construction of new lake-level control structures.

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

Option: Restore natural hydrologic regimes by removing dams when possible and requiring existing dams to operate in a manner that mimics natural flow regimes.

Option: Reestablish flow gauges at former East Branch and South Branch gauge sites, and explore the possibility of establishing additional gauge stations (e.g., upper East Branch near Kenton and lower Cisco Branch near Twomile Creek) within the watershed.

Option: Protect groundwater and stream flows by supporting laws that require major water withdrawals to be registered with MDEQ. Water withdrawal operations should indicate the volume and timing of proposed withdrawals and demonstrate that these withdrawals will not diminish the biological and recreational values of affected streams.

Soils and Land Use

Compared to other Michigan watersheds, the Ontonagon River watershed is sparsely populated. Forest continues to be the dominant land cover type, and wetland loss has been relatively minor. The sandy soils in the southern portion of the Ontonagon River watershed are highly susceptible to erosion when vegetation is removed by timber harvesting, agricultural activities, roadway development, or other earth-disturbing activities. The fine-textured soils in the northern half of the watershed are less subject to erosion, but bank slumping is a major concern in hilly areas. Improperly constructed stream crossings can fragment fish populations and contribute excess sediment to streams. A thorough stream crossing inventory has not been completed for the Ontonagon River watershed.

Option: Protect and maintain forested buffers along lake shores and river corridors.

Option: Protect remaining stream margin habitats, including floodplains and wetlands, by encouraging vegetation buffer strips in zoning regulations.

Option: Work with MDEQ to protect streams from excessive sedimentation by supporting the use of best management practices in commercial timber harvest operations.

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: Prevent excessive sedimentation from agricultural lands by supporting best management practices and agricultural zoning plans.

Option: In conjunction with local sport fishing groups and other organizations, survey road-stream crossings to identify problem areas and implement best management practices at these crossings.

Option: Conduct aerial surveys to identify nonpermitted stream crossings within the watershed.

Option: Replace or improve culverts or road-stream crossings that are undersized, perched, or misaligned.

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

Option: Protect streams from excessive sedimentation by reviewing stream crossing proposals to ensure that adequate erosion control measures (e.g., diversions and revegetation) are implemented.

Option: Reduce sediment from roadways by encouraging education of workers involved in road construction and maintenance regarding the use of best management practices.

Option: Protect streams from degradation by promoting bore and jacking or directional drilling methods of pipeline stream crossings as an alternative to open ditching.

Option: Use soft-armoring techniques to restore stream banks that are eroding as a result of human activities.

Option: Continue to evaluate proposed shoreline development activities around the Bond Falls Flowage and Victoria Reservoir and provide comments to FERC regarding the potential biological and recreational impacts of such activities.

Channel Morphology

Relative to other river systems in Michigan, the Ontonagon River and its tributaries are high gradient streams. Channel morphology within the watershed has been shaped primarily by natural processes, but human activities (e.g., construction of dams and road crossings) have altered channel morphology on some stream reaches. Due to the location of the major dams, little high gradient habitat has been lost as a result of dam construction.

Option: Protect diverse stream channel habitats by preventing removal of large woody structure from stream channels and educating riparian landowners on the value of large woody structure to fish and other aquatic species.

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

Option: Survey coldwater streams to identify where beaver activity is adversely affecting riparian habitats or stream channel morphology.

Option: Work with FMFM, USFS, timber companies, and private landowners to reduce growth of aspen (the primary food for beavers) along coldwater streams.

Option: Restore channel diversity by controlling unnatural sediment contributions and by removing artificially introduced streambed sediment.

Option: Protect channel morphology by using bridges or bottomless arch structures at stream crossings.

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

Option: Maintain natural channel morphology by opposing channelization of streams within the watershed.

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

Option: Increase channel diversity by adding woody structure or habitat improvement structures in stream reaches where habitat diversity is low due to past or present land management activities (e.g., residential development or removal of old-growth forests).

Dams and Barriers

There are 17 registered dams and an unknown number of smaller dams within the Ontonagon River watershed. These dams may negatively affect aquatic resources by impeding potamodromous fish migrations, fragmenting resident fish populations, blocking downstream movement of large woody structure and detritus, disrupting the sediment balance above and below impoundments, altering flow regimes and channel morphology, and elevating stream water temperatures. Dams do provide some recreational and economic benefits, so both the positive and negative effects of dams need to be considered when making decisions regarding the operation and removal of existing dams.

Option: Protect fish habitat and river functionality by actively opposing construction of new dams and within-stream-channel storm water detention basins.

Option: Examine dams owned by MDNR and USFS to determine their usefulness or potential for removal.

Option: Work with private and corporate dam owners to remove dams that are no longer used for their original purpose.

Option: Protect the public trust by encouraging dam owners to make appropriate financial provisions for future dam removal and supporting legislation that requires dam owners to establish such funds.

Option: Work with dam owners to rehabilitate stream and wetland habitats at lake outlets by removing dams, modifying dams to fixed-crest structures, or modifying operations of existing dams.

Option: Educate resource managers and citizens on the effects of lake-level control structures and the ecological benefits of allowing lakes to function naturally.

Option: When feasible, work with dam owners to provide upstream and downstream fish passage at existing dams.

Option: Continue to require minimum water releases from Bond Falls Dam (Middle Branch Ontonagon River) and Victoria Dam (West Branch Ontonagon River).

Option: For Bergland Dam, work with UPPCo, FERC, local residents, and other interested parties to establish minimum water releases and lake level requirements that benefit the West Branch aquatic communities without negatively affecting recreational opportunities on Lake Gogebic.

Option: Protect fish from entrainment and injury by requiring screened turbine intakes at the Victoria hydroelectric facility.

Option: Survey and develop an inventory of other barriers to fish passage, such as culverts, and explore options for correcting each problem.

Water Quality

Water quality is excellent throughout most of the watershed. Sedimentation (e.g., at stream crossings) is the primary water quality concern within the basin. Thermal pollution is an additional concern for stream reaches below impoundments.

Option: Enhance public stewardship of the watershed by supporting educational programs that provide interested constituents and local organizations with information regarding best management practices and the effects of land use practices on water quality.

Option: Survey stream temperature conditions throughout the watershed to assess the potential of these waters to support populations of different fish species.

Option: Rehabilitate coldwater valley segments by promoting harvest of beaver in areas where beaver dams are blocking fish migration and elevating stream temperatures to levels unsuitable for trout production. Beaver harvest generally will be conducted during the regulated fur harvest season. When this is not feasible, Fisheries Division will work with Wildlife Division (and other divisions as necessary) to secure permits for harvest outside of the normal trapping season.

Option: Evaluate effects of existing human-made dams on downstream temperature regimes.

Option: Measure late winter oxygen profiles in current and potential trout lakes to determine if dissolved oxygen levels are adequate for trout survival.

Option: Conduct limnological surveys on lakes within the watershed to establish current data on pH, alkalinity, dissolved oxygen, and water clarity.

Option: Work with MDEQ to evaluate effects of NPDES permitted discharges on receiving waters.

Special Jurisdictions

The State of Michigan exercises jurisdiction over most of the Ontonagon River watershed through MDNR and MDEQ. The Wisconsin portion of the watershed is under the jurisdiction of WDNR. Much of the watershed is included in the Ottawa National Forest, so USFS heavily influences land management practices within the basin. FERC oversees operations at the five dams associated with the Victoria hydroelectric facility, and the United States Army Corps of Engineers addresses issues pertaining to navigability. The United States Fish and Wildlife Service, coordinating with the Great Lakes Fishery Commission, controls sea lamprey abundance in Lake Superior tributaries (see **Biological Communities**). Various units of local government also have jurisdiction over portions of the watershed. The activities of these governmental organizations can affect the aquatic habitat and biological communities in the Ontonagon River system.

Option: Protect the river system by supporting cooperative planning and decision making that involves all units of government and interested citizens.

Option: Support continued protection of stream reaches designated under the federal Wild and Scenic Rivers Act.

Option: Identify remaining high quality stream reaches for inclusion in the Michigan Natural Rivers program.

Option: Protect the health of wetlands, streams, and lakes through enforcement of the Natural Resources and Environmental Protection Act of 1994 (Public Act 451; Parts 31, 91, 301, and 303).

Option: Work with the United States Army Corp of Engineers on dredging and channel maintenance issues to minimize effects on stream habitat and aquatic communities.

Option: Continue collaborative habitat restoration efforts involving MDNR, Fisheries Division; MDNR, Forest, Mineral, and Fire Management Division; USFS; USFWS; and other interested parties.

Biological Communities

The biological communities in the Ontonagon River watershed have changed dramatically during the last two centuries. Logging during the late 1800s accelerated erosion of stream banks and increased sediment inflows to the river system. Dams have affected fish communities by fragmenting fish populations, altering flow regimes and water temperatures, and interfering with the downstream transport of large woody structure, detritus, and sediment. Commercial fishing depleted populations of several fish species, and overexploitation was a major factor leading to the extirpation of lake sturgeon in the Ontonagon River. Exotic species introductions (both intentional and unintentional) have further altered the species composition of biological communities within the basin.

Option: Review fish stocking permit applications and require documentation of fish health testing for all private and public stockings to prevent introduction of pathogens and undesirable species into public waters.

Option: Disinfect all sampling gear (including boat, motor, and trailer) between surveys to reduce the risk of transferring aquatic invasive species or pathogens to new waters.

Option: Educate the public regarding aquatic invasive species by maintaining informative signage at boat launch sites and continuing discussions with sport fishing groups, lake associations, and other interested groups.

Option: Work with the United States Fish and Wildlife Service Sea Lamprey Control Unit to monitor sea lamprey abundance and distribution within the watershed, and implement control measures as necessary.

Option: Work with local lake associations and other organizations to suppress or eliminate Eurasian water-milfoil infestations.

Option: Conduct surveys to evaluate the survival, movement, and growth of lake sturgeon stocked in the main stem.

Option: Conduct surveys to evaluate the fish communities in river valley segments and lakes without recent survey data.

Option: Conduct surveys to determine the abundance and distribution of native mussels in the Ontonagon River system.

Option: Work with MDEQ to continue monitoring the aquatic macroinvertebrate communities in the Ontonagon River watershed.

Option: Consider potential effects on amphibians and reptiles (e.g., wood turtles) when developing new boat launches and other recreational facilities. Adjust designs as necessary to protect critical habitats for these organisms.

Option: Record observations of amphibians and reptiles during MDNR fish community surveys.

Option: Collaborate with various universities to determine the effects of habitat manipulations on fish and macroinvertebrate communities.

Option: Monitor the distribution of aquatic invasive species and pathogens within the Ontonagon River watershed and maintain a database of the results.

Fishery Management

The various branches and tributaries of the Ontonagon River present a diverse array of fishing opportunities. Brook trout is the principal game fish species in the southern portion of the watershed, while potamodromous brown trout, steelhead, and coho salmon provide seasonal fisheries in the stream reaches with Great Lakes access. Although stocking is a part of the management strategy for this system, the salmonid populations primarily are sustained by natural reproduction. Popular fisheries for coolwater and warmwater species also exist on many lakes.

Option: Continue fish stocking programs in various parts of the watershed to maintain well-balanced fish communities and diverse angling opportunities.

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

Option: When fish are to be stocked in the Ontonagon River watershed, require that stocked fish be certified as disease-free.

Option: Develop an educational pamphlet to inform angler clubs, lake associations, and other interested parties of Fisheries Division's concerns regarding fish stocking.

Option: Whenever possible, use fish marked with oxytetracycline (OTC) for walleye stocking to facilitate evaluation of the relative contributions of hatchery and wild walleye to the fisheries of interest.

Option: Maintain and enhance the streamside rearing facility for lake sturgeon on the main stem. Collaborate with other resource agencies and universities to monitor the survival, growth, and movements of stocked lake sturgeon.

Option: Continue to survey fish communities and habitats within the basin. Prioritization should be given to waters that are currently stocked (e.g., Duck Lake), support intensive fisheries (e.g., the upper Middle Branch), or have not been surveyed in many years.

Option: Conduct electrofishing and creel surveys to evaluate the effects of Type 6 trout regulations on the brook trout fishery in Duck Creek.

Option: Conduct netting and creel surveys to evaluate the effects of special fishing regulations on the fisheries within the Sylvania Wilderness Area.

Option: Continue to work with WDNR to develop boundary water fishing regulations that are biologically sound and simple for anglers to understand.

Option: Continue to consult with LVD, KBIC, and Great Lakes Indian Fish and Wildlife Commission to develop methodology for setting biologically-sound spearing quotas for harvesting walleyes in the 1842 Treaty-ceded inland territory of Michigan. Continue to work with LVD, KBIC, and Great Lakes Indian Fish and Wildlife Commission to set spearing quotas and help enforce such quotas.

Option: Collect water temperature data for streams within the basin and change trout stream designations or stocking strategies if warranted.

Option: Work with FMFM, USFS, timber companies, and private landowners to discourage growth of aspen near designated trout streams.

Option: Work with MDNR, Wildlife Division, USFS, and other organizations to identify streams where more aggressive beaver control should be instituted to protect trout habitat.

Option: Identify river reaches in need of habitat improvement (e.g., erosion control or fish cover installation) and work with interested partners to restore or enhance fish habitat in these streams.

Option: Work with the United States Fish and Wildlife Service to ensure that appropriate measures are taken to control sea lamprey abundance within the watershed.

Option: Conduct manual removals of panfish or rough fish (e.g., suckers or bullheads) as necessary to restore the predator-prey balance in lakes within the watershed.

Option: Conduct rotenone treatments as necessary to eliminate competing species in managed trout lakes.

Recreational Use

A myriad of recreational opportunities exist throughout the watershed due to the abundance of public-owned land. The public has legal access to much of the watershed, but the paucity of roads complicates access to some stream reaches. Steep gradients and abundant rapids further limit canoeing and kayaking opportunities on many streams. Fishing and boating are common activities on lakes within the basin, and over 40 boat launches provide public access to these water bodies. Roadless areas (e.g., the Sylvania Wilderness Area) provide unique recreational opportunities for persons desiring a true wilderness experience.

Option: Maintain or improve existing parks and public boat launch facilities.

Option: Secure and develop additional access sites on waters where public access is lacking, while still maintaining a good array of roadless and remote fishing opportunities.

Option: Support funding for handicapped-accessible fishing piers, walkways, and other facilities to enhance recreational opportunities within the watershed.

Option: Improve public access at or below hydropower-related impoundments through the FERC relicensing process.

Option: Use best management practices at primitive access sites to reduce erosion and sedimentation.

Option: Protect recreational use of small tributaries by supporting the establishment of a "recreational" definition of legal navigability.

Option: Work with responsible parties to reduce effects of ORV usage on streams and wetlands.

Citizen Involvement

Citizen involvement is a necessary component for effective management of the Ontonagon River watershed. Collaboration between resource agencies, universities, user groups, and interested citizens increases the knowledge and resource base available for watershed projects and enhances public acceptance and understanding of watershed management activities.

Option: Educate citizens and local governments regarding significant management issues by providing information through various media outlets, sport groups, civic leaders, and public meetings.

Option: Protect and rehabilitate the watershed by educating river users and riparian property owners on watershed management principles.

Option: Support and provide technical assistance to groups seeking funding for stream protection and restoration projects.

Option: Support the establishment of a watershed council to facilitate communication between different user groups within the basin.

Option: Survey other watersheds in the state to identify watershed councils that could assist with the formation of an Ontonagon River Watershed Council.

GLOSSARY

alfisols – well-developed, fertile soils that typically are associated with deciduous forests

alkalinity – capacity of water to neutralize an acid; for aquatic situations, alkalinity is generally determined by the concentrations of carbonate (CO_3^{-2}), bicarbonate (HCO_3^-), and hydroxide (OH^-) and is expressed in mg/L of calcium carbonate ($CaCO_3$) equivalent

alluvium – clay, silt, sand, gravel, or similar detrital material deposited by running water

angler hour – one hour of fishing by one angler

anthropogenic – of, relating to, or resulting from the influence of humans on nature

antimycin – chemical compound historically used to eliminate or reduce fish populations in lakes, streams, or ponds; this chemical is also used as an antibiotic

assemblage – collection of species living within a defined region or stream segment

avian – of or pertaining to birds

base flow – discharge amount that is equaled or exceeded 90% of the time and essentially equals the groundwater discharge to a stream; equivalent to 90% exceedence flow

basin – 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; synonymous with watershed

biological oxygen demand – measure of the consumption of oxygen in an ecosystem within a fixed period of time

biomass – total weight of fish collected in sampling gear

biota – animal and plant life

broodstock – group of sexually mature individuals of a cultured species that is kept separate for breeding purposes

buffer strip – vegetated land adjacent to a stream or lake that is not altered during timber harvest or construction activities

bulkhead – retaining wall along the edge of a lake or stream

capillary action – the action that causes a liquid (e.g., water) to move through a porous solid (e.g., soil) due to attractive forces between the two substances; a process that can move groundwater from wet areas of soil to dry areas

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

centrarchid – sunfishes of the family Centrarchidae; examples include largemouth and smallmouth bass, bluegill, pumpkinseed, and black crappie

cfs – cubic feet per second

channelization – conversion of a stream into a ditch; channelized streams are narrower, deeper, and straighter than natural channels; channelization may be done for navigation or to improve drainage for agricultural purposes

coldwater fish species – fish that generally achieve their maximum growth potential at water temperatures below 65°F; examples include brook trout, rainbow trout, brown trout, and slimy sculpin

community – an interacting group of organisms of multiple species

confluence – the joining or convergence of two streams

coniferous – cone-bearing, typically evergreen, trees

coolwater fish species – fish that generally achieve their maximum growth potential at water temperatures between 65°F and 75°F; examples include walleye, yellow perch, northern pike, muskellunge, and smallmouth bass

CPH – catch per angler hour; number of fish harvested by 1 angler in 1 hour

creel survey – fisheries assessment method that typically involves angler interviews, boat or angler counts, and collection of biological information about angler-caught fish

CWA – Federal Clean Water Act of 1977

deciduous – vegetation that sheds its foliage annually

detritus – nonliving particulate organic material (e.g., small pieces of wood or leaves)

discharge – volume of water flowing past an arbitrary line through a stream during a specified time period; usually expressed in cubic feet per second (cfs)

diversion – earthen or stone dike used to direct water flow away from an area that is susceptible to erosion

ecosystem – functional unit consisting of a biological community and the nonliving factors of its environment

electrofishing – method of sampling that uses electrical currents to stun or attract fish

entrain – to pass through the turbines of a hydroelectric dam

EPA – Environmental Protection Agency

EPT – organisms in the following families: Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies); commonly used as water quality indicators

erosion – the process of moving soil particles by wind or water

evapotranspiration – loss of water from the soil and the plants growing on the soil to the atmosphere

exceedence flow – discharge amount that is exceeded by a 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

extinct – completely and globally eliminated

extirpated – an extirpated species is no longer present in a specific region, but (in contrast with an extinct species) may persist elsewhere on earth

fall fingerling – fish that is in the fall of its first year of life

FERC – Federal Energy Regulatory Commission

flashy – streams characterized by rapid and substantial fluctuations in stream flow

flood flow – discharge amount that is equaled or exceeded 10% of the time; equivalent to 10% exceedence flow

floodplain – flat valley floor adjacent to a stream that is subject to periodic inundation

flow regime – term used to describe the pattern 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 definition above)

game fish – species that commonly are targeted by anglers

gamete – mature sexual reproductive cell, as a sperm or egg, capable of participating in fertilization

General Creel Census – refers to direct contact angler creel data collected by MDNR conservation officers from 1928 through 1964; this was a qualitative survey that provided general information on catch rates for various fish species, but cannot be used to estimate total annual harvest or effort

GLIFWC – Great Lakes Indian Fish and Wildlife Commission

gradient – rate of descent of a stream from an upstream location to a downstream location

gravitational acceleration – downward acceleration due to the force of gravity; generally approximated as 9.8 m/s^2

growth index – difference between the average length-at-age for fish in a given population and the statewide average length; positive growth indices indicate fish are growing faster than the state average, and negative indices indicate fish are growing slower than the state average

head – the difference in stream elevation above and below a dam

headwaters – the upper end of a stream, near its source

herbivory – consumption of plants

hydrograph – graph of the water level or discharge of a stream as a function of time

hydrology – science pertaining to the distribution and circulation of water on and below the earth's surface and in the atmosphere

impervious – not permitting penetration or passage

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

imprint – create a lasting impression of the physical and chemical properties of a stream; such an impression allows migratory fish to return to their native (or stocked) streams to spawn

infiltration – downward movement of water through gaps between soil particles

infiltration basin – excavated basin with a porous (e.g., sandy) bottom that intercepts water flow and prevents transport of sediment to a stream; often used in conjunction with one or more diversions

KBIC – Keweenaw Bay Indian Community

kinetic energy – energy associated with motion (e.g., water movement)

lacustrine – pertaining to lakes

LLSP – Large Lakes Survey Program

LVD – Lac Vieux Desert Band of Chippewa Indians

macroinvertebrate – animal without a backbone that is visible to the naked eye; aquatic examples include insects, crayfish, worms, snails, sponges, and mussels

main stem – primary branch of a river

MDEQ – Michigan Department of Environmental Quality

MDNR – Michigan Department of Natural Resources

mean – arithmetic average obtained by adding together all of the values and dividing the sum by the number of values

meander belt – the zone within which a stream routinely shifts its course by eroding one bank and depositing sediment on the opposite bank

median – a value in an ordered set of values below and above which there is an equal number of values

mesic – characterized by, relating to, or requiring a moderate amount of moisture

MIRIS – Michigan Resource Inventory System

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

net night – one overnight set of one net; used to describe sampling effort for fyke net or gill net surveys

nongame – refers to fish species that rarely are targeted by anglers

NPDES – National Pollution Discharge Elimination System

organic – of, relating to, or derived from living organisms

ORV – off-road vehicle

OTC – oxytetracycline; antibiotic that produces a mark on the bony structures of a fish once it is submersed in the chemical, thus allowing for differentiation between stocked and wild fish

outwash – glacial deposits that have been sorted by flowing water; outwash deposits typically consist of coarse substrates such as sand or gravel

panfish – small game fish species in the families Centrarchidae and Percidae; for the Ontonagon River watershed, this term applies to bluegill, pumpkinseed, black crappie, rock bass, and yellow perch

parent material – substance from which soil is formed; examples include glacial till and lacustrine clay and silt

percolate – to pass a liquid through small spaces or a porous substance

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

piscivorous – fish-eating

planktonic – floating or drifting in a body of water

point source discharge – pollution to a water course that is attributable to a single, well-defined source (e.g., outfall of a wastewater treatment plant)

potamodromous – fish that migrate from freshwater lakes into freshwater rivers to spawn; in the context of this report, it refers to fish that migrate into the Ontonagon River from Lake Superior

proximal – close or immediate

raptor – carnivorous bird that feeds primarily on meat taken by hunting or on carrion

regeneration – renewal or restoration of a forest

revetment – facing for protecting an embankment

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 – layer of stones or chunks of concrete used to prevent erosion of stream banks, hillsides, or stream crossings

riverine – of or pertaining to a river; refers to organisms that reside in a stream or river

rotenone – substance used to eliminate or reduce fish populations in lakes, streams, or ponds; naturally occurring compound found in the roots of several species of tropical trees

rough fish – fish species that most anglers consider undesirable (e.g., bullheads and suckers)

runoff – precipitation that flows over the earth's surface into lakes or streams; usually referred to as surface runoff

sand trap – an artificial pool that typically is created and maintained with a backhoe; because the current velocity subsides as water enters the pool, suspended sand particles fall to the bottom of the stream and can be removed when the sand trap is "emptied"

sedimentation – deposition of silt, sand, or gravel within a stream bed or floodplain

silvicultural – pertaining to the development or management of forests

sinuosity – refers to the bending or meandering pattern of the stream channel; often expressed in ratio form as the distance between two points on the stream measured along the channel divided by the straight line distance between the two points (meandering streams have higher sinuosity ratios than straight streams)

skyboom – fish cover structure that is designed to simulate an undercut bank

softwater – water that has a limited capacity for neutralizing acids (i.e., low alkalinity)

specific power – rate at which potential energy is supplied to a stream channel bed and banks; primarily a function of discharge and slope

spodosols – acidic, infertile soils that typically are associated with coniferous forests

spring fingerling – fish that is in the spring or summer of its first year of life

standardized discharge – discharge divided by the median discharge for a particular location on a stream

strain – a group of organisms of the same species, having distinctive characteristics but not usually considered a separate subspecies

substrate – materials lying beneath the waters of a lake or stream

surficial – referring to something on or at the surface

tail race – flume or channel leading away from a mill or turbine

taxonomic – relating to the orderly classification of organisms; examples of taxa include species and families

TFM – 3-trifluoromethyl-4-nitrophenol; substance used to kill sea lampreys in Great Lakes tributaries

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

topographic relief – differences in elevation of the earth's surface; high relief areas have steep slopes, while low relief areas have more gradual slopes

toxaphene – organic insecticide historically used to eliminate or reduce fish populations in lakes, streams, or ponds; use of this environmentally persistent organochlorine was banned in 1990 in the United States because of health and environmental concerns

trophic – of, or relating to, the nutritional habits and food relationships between the organisms in a biological community

turbidity – measure of suspended particles in the water column; turbid waters have large amounts of suspended particles and low water clarity

Type 1 trout stream – stream governed by standard trout stream fishing regulations (see Table C.1)

Type 2 trout stream – stream with the same open season and possession limits as standard (Type 1) trout streams, but with higher minimum size limits (see Table C.1)

Type 3 trout stream – stream that is open to fishing all year with no special gear restrictions; minimum size limits for brook trout, brown trout, rainbow trout, and splake are higher than for standard (Type 1) streams (see Table C.1)

Type 6 trout stream – stream in which only artificial lures or flies may be used for fishing; possession limits and minimum size limits also differ from standard (Type 1) streams (see Table C.1)

UPPCo – Upper Peninsula Power Company

USFS – United States Forest Service

USFWS – United States Fish and Wildlife Service

valley segment – a portion of a stream classified as a distinct ecological unit based on catchment size, hydrology, water chemistry, water temperature, valley character, channel character, and fish assemblages; a valley segment may be comprised of one or more stream reaches and may be 1 to 25 miles (or so) in length

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

warmwater fish species – fish that generally achieve their maximum growth potential at water temperatures above 75°F; examples include largemouth bass, bluegill, pumpkinseed, and black crappie

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

water yield – stream discharge divided by the area of the contributing watershed; usually expressed in cfs/mi^2

WDNR – Wisconsin Department of Natural Resources

weir – fence or enclosure set in a stream to facilitate sampling or harvesting of fish

wild – fish that have never been in a hatchery

wing deflector – structure that redirects water currents; used to minimize bank erosion, create pools, and provide desirable scouring and sorting of channel materials

yearling – fish that is in its second year of life, which is defined to start on January 1

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

PUBLIC COMMENT AND RESPONSE

A draft of this assessment was made available on the MDNR web site in March 2008. Statewide MDNR press releases were also issued, describing how citizens could access the draft, advertising the public meeting in Ontonagon, and stating how to send comments to the authors.

A public meeting was held on April 28, 2008 at the Ontonagon Village Hall. Twenty-five people attended and their comments were incorporated into this river assessment. Public comments were received until June 15, 2008. All comments received were considered, and similar comments were combined to avoid unnecessary duplication. Suggested changes were incorporated into the final document.

Comment: Several individuals commented that this river assessment was highly informative and thought-provoking.

> Response: Thank you!

Comment: "In several places (pages xvii, 27, 33, and 41) you refer to Victoria Falls (which is now submerged behind the backwaters of Victoria Dam) as a natural fish barrier. I am not sure that this contention is supported by historical fact, given that certain coldwater species which almost certainly must have come originally out of Lake Superior (lake herring in Crooked Lake, and lake herring as well as burbot in Lake Gogebic) are occasionally caught by anglers to this day. If you have a reference for your contention, or if you can otherwise explain the existence of these coldwater species in these water bodies, please provide same."

> Response: These coldwater species probably colonized Crooked Lake, Lake Gogebic, and other parts of the Ontonagon River watershed from the Mississippi refugium as the glaciers retreated from this area (Bailey and Smith 1981; Coon 1999). Given the impressive vertical drop (124.7 ft drop in 0.05 miles) at Victoria Falls, it is very unlikely that there has been any upstream movement of fish over Victoria Falls during the last few millennia.

Comment: "On page 36 under United States Army Corps of Engineers you define the lower Ontonagon River channel 'from the mouth to the M-64 bridge' as being regularly dredged. You actually mean the old M-64 swing bridge that has since been removed, not the new M-64 bridge above the railroad crossing."

> Response: You are correct. This section of the river assessment has been reworded for clarification.

Comment: "On page 37 under 'Navigable Waters' you include the 0.76 miles of the lower river from the mouth to the first railroad bridge upstream as being within the list of navigable waters maintained by the Corps of Engineers. Now, do you mean the *list* that is maintained by the Corps, or the *navigable waters* that are maintained by the Corps? The distinction is important, since the Village of Ontonagon is currently embroiled in a running debate with the Corps about getting the channel dredged above the old M-64 swing bridge location."

> Response: The United States Army Corps of Engineers, Detroit District, possesses navigational jurisdiction over United States waters up to the ordinary high water mark for

Lake Superior (603.1 ft above sea level). The railroad bridge 0.76 miles above the Ontonagon River mouth is the upstream limit of the Corps' jurisdiction. The text in the Navigable Waters section has been reworded for clarification.

Comment: "On page 40, you point out that Ontonagon County is the only county in the watershed that does not have a drain commissioner. This brings up a question that I have always entertained regarding Trout Creek: why, when the creek is clear as it leaves the pond in Trout Creek village, is it permanently dingy by the time it gets to the Gardner Road bridge only a couple miles downstream? If next spring I hike the length of [Trout Creek] and discover that an illegal drain is causing this condition, to whom and how should I report it?"

Response: We have also noticed this rapid decrease in water clarity below the Trout Creek Dam. This phenomenon probably is due to natural causes. The upper portion of Trout Creek flows through sandy soils and end moraines of coarse-textured glacial till. Thus, the upper reaches of Trout Creek are relatively clear. Trout Creek Pond also acts as a sediment trap, so the water leaving the impoundment is "sediment-starved" and unnaturally clear.

As the water leaves the impoundment, it flows through extensive deposits of lacustrine clay and silt (vastly different from the sandy soils a few miles upstream). To restore equilibrium, the "sediment-starved" water rapidly picks up sediment (in this instance clay and silt) as it flows downstream. In addition, Dover Creek (which flows through silt/clay dominated soils for most of its length) merges with Trout Creek a short distance upstream of Gardner Road. We suspect that Dover Creek contributes a substantial amount of sediment to Trout Creek.

If you hike this stream and find an illegal drain or any other environmental violations, please contact the MDEQ office in Crystal Falls at (906) 875-2071.

Comment: "On page 59 under 'Ontonagon River' you specify that Chinook salmon are planted in the Big Iron River. Please be advised that the same special interest group that is working on the Big Iron River is currently planning an imprinting attempt on Chinook [salmon] this spring in the Ontonagon Marina proper."

Response: This imprinting (pen-rearing) effort did not occur in 2008. MDNR has had discussions with sport fishing groups regarding this issue for many years. Piscivorous fish (e.g., walleye) that could consume stocked salmon are abundant in the lower Ontonagon River. This is not a good stocking location, so MDNR does not support pen-rearing of salmon in the lower Ontonagon River. The existing stocking site in the Big Iron River has a much lower abundance of fish predators.

Comment: "On pages 72-73 and pages 82-83 under 'Citizen Involvement', you are strangely silent on UPPAC and its efforts regarding UPPCo and Naterra Land's development attempts at Bond Falls Flowage, which, if successful, will likely change and/or undo everything which this river assessment has attempted to accomplish. You cannot ethically avoid at least mentioning the current P-1864 development controversy somewhere in this river assessment."

Response: To address this issue, additional language was added to the Soils and Land Use, Citizen Involvement, and Management Options sections.

Comment: "A popular book, *Canoeing Michigan Rivers* by Jerry Dennis and Craig Date offers excellent descriptions of the Ontonagon's East, South, and Main branches access points, paddling times, and required skill levels. This valuable resource book should be mentioned in the assessment."

Response: This book is referenced in the **Recreational Use** section of the assessment.

Comment: One local citizen provided considerable information regarding whitewater paddling opportunities on the West and Cisco branches.

Response: This information has been incorporated into the **Recreational Use** section of the assessment. Thank you!

Comment: "Under Management Options – Geology and Hydrology, page 75, the draft mentions reestablishing flow gauges at the former East Branch and South Branch gauge sites and to explore the possibility of establishing additional gauge sites. I support this option and recommend if a new gauge can be established on the lower Cisco [Branch], it should be located on the [Forest Hwy] 6930 bridge crossing where it would provide valuable information to paddlers and fishermen (as would the reestablishment of the East and South branch gauges)."

Response: We agree with this recommendation. The Forest Hwy 6930 bridge would be an excellent location for a gauging station.

FIGURES

Major Streams and Lakes

1 Pelton Creek
2 Slate River
3 Marshall Creek
4 Trout Brook
5 Lake Gogebic
6 West Branch Ontonagon River
7 Cascade Creek
8 Mill Creek
9 Livingston Creek
10 Tenmile Creek
11 Weir Creek
12 Sisson–Lilley Creek
13 Tenderfoot Lake
14 Tenderfoot Creek
15 Cornelia Lake
16 Langford Lake
17 Cisco Chain
18 Cisco Branch Ontonagon River
19 Beatons Lake
20 Twomile Creek
21 Sucker Creek
22 Bluff Creek
23 Paulding Creek
24 Bond Falls Canal (Roselawn Creek)
25 Kostlenick Creek
26 South Branch Ontonagon River
27 Erickson Creek
28 Victoria Reservoir
29 Long Lake
30 Whitefish Lake
31 Clark Lake
32 Crooked Lake
33 Middle Branch Ontonagon River (upper)
34 Duck Lake
35 Duck Creek
36 Imp Creek
37 Imp Lake
38 Marion Lake
39 Tamarack Lake
40 Tamarack River
41 Castle Lake
42 McGinty Creek
43 Interior Creek
44 Deadman Creek
45 Bond Falls Flowage
46 Middle Branch Ontonagon River (lower)
47 Trout Creek
48 Dover Creek
49 Clear Creek
50 Mile and One-half Creek
51 Baltimore River
52 Sandstone Creek
53 Spring Creek
54 West Branch Jumbo River
55 Walton Creek
56 Jumbo River
57 Stony Creek
58 Lake On-three
59 Smith Creek
60 East Branch Ontonagon River
61 Beaver Creek
62 Onion Creek
63 Kits Creek
64 Tank Creek
65 Newholm Creek
66 Leveque Creek
67 Bob Lake
68 Hubbell Creek
69 Adventure Creek
70 Ontonagon River

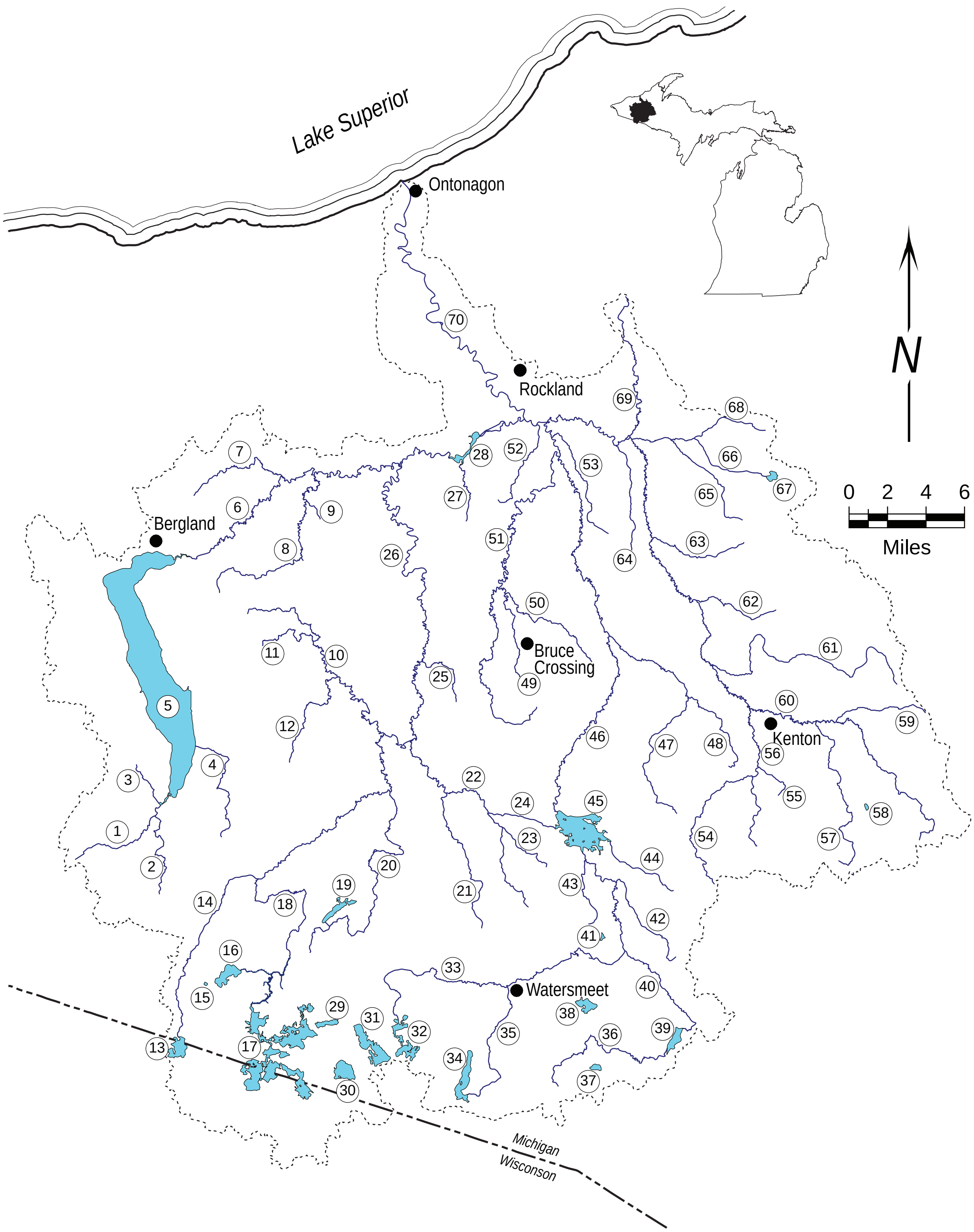


Figure 1.–Major streams and lakes in the Ontonagon River watershed. Numbers correspond to legend.

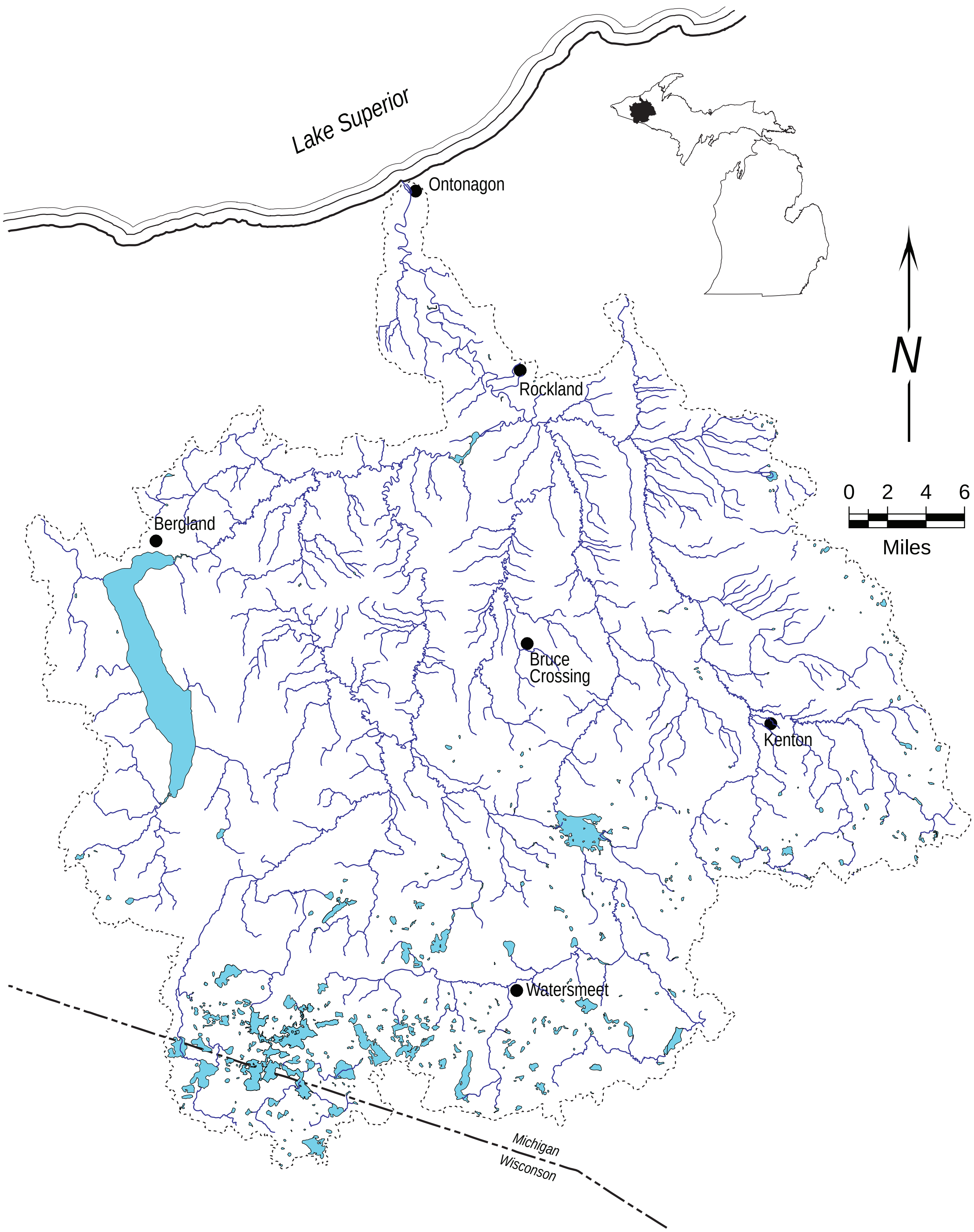


Figure 2.–Streams and lakes in the Ontonagon River watershed.

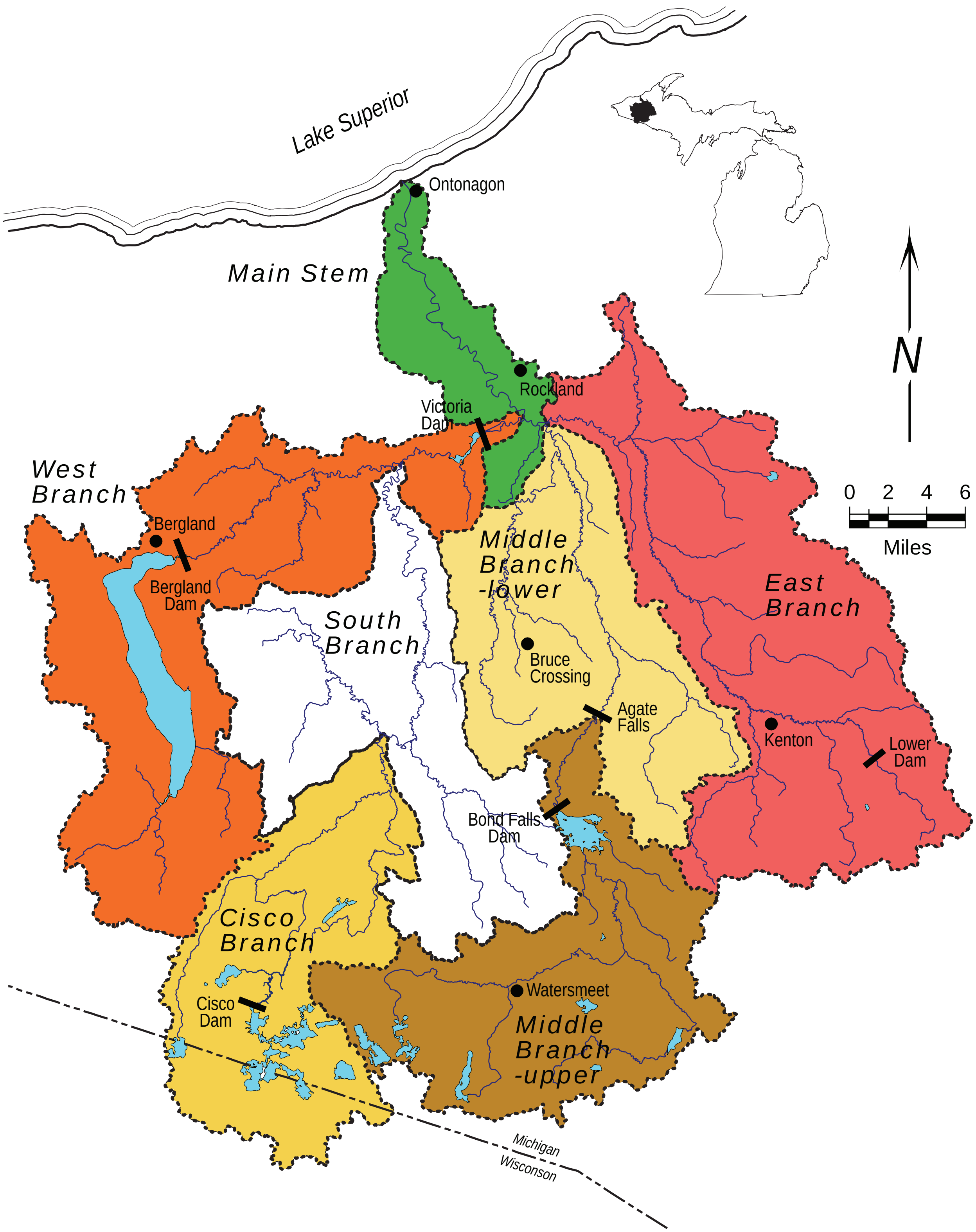


Figure 3.–Subwatersheds in the Ontonagon River basin.

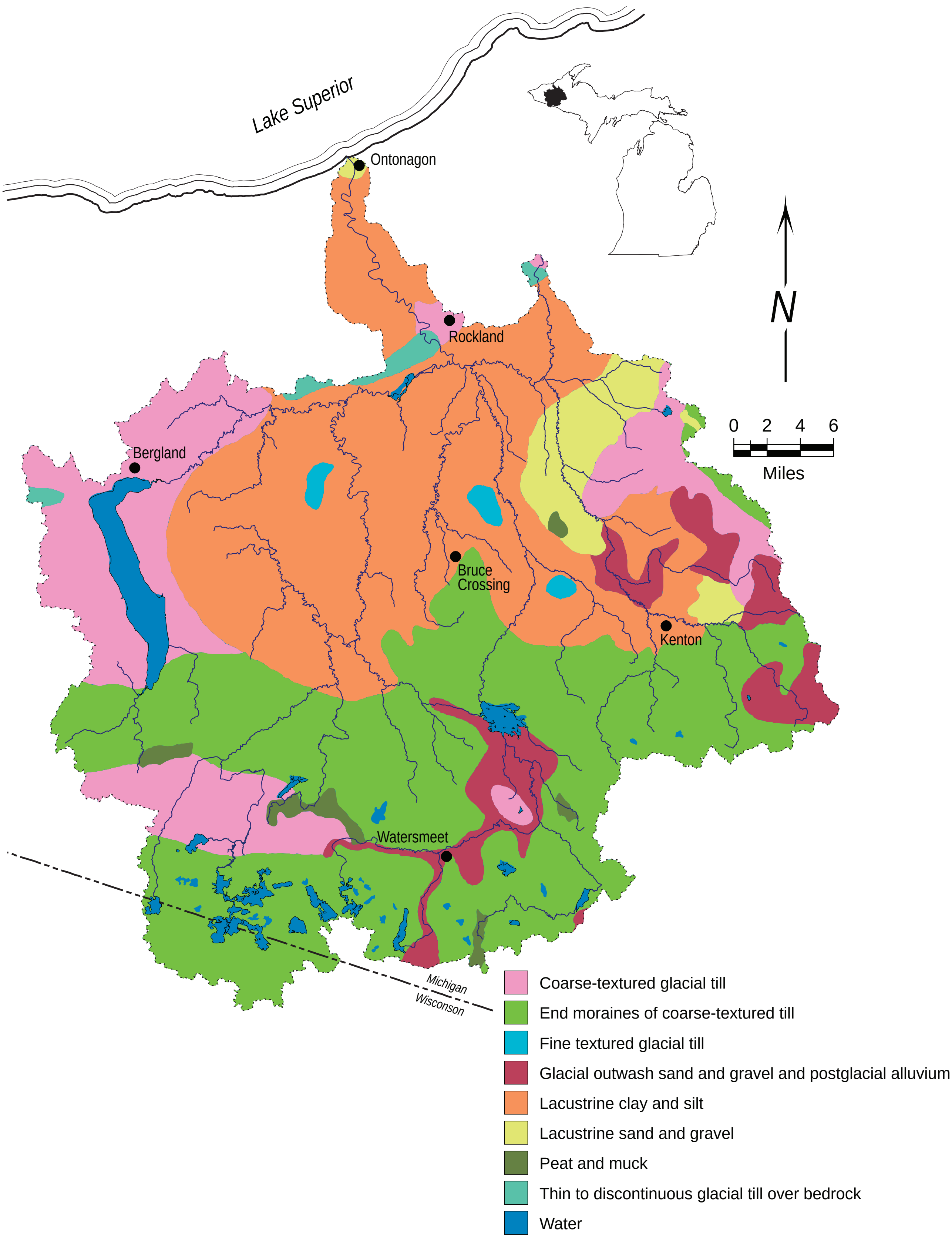


Figure 4.–Surficial geology of the Ontonagon River watershed. Michigan data from Quaternary Geology of Michigan (1998). Wisconsin data from Attig (2003).

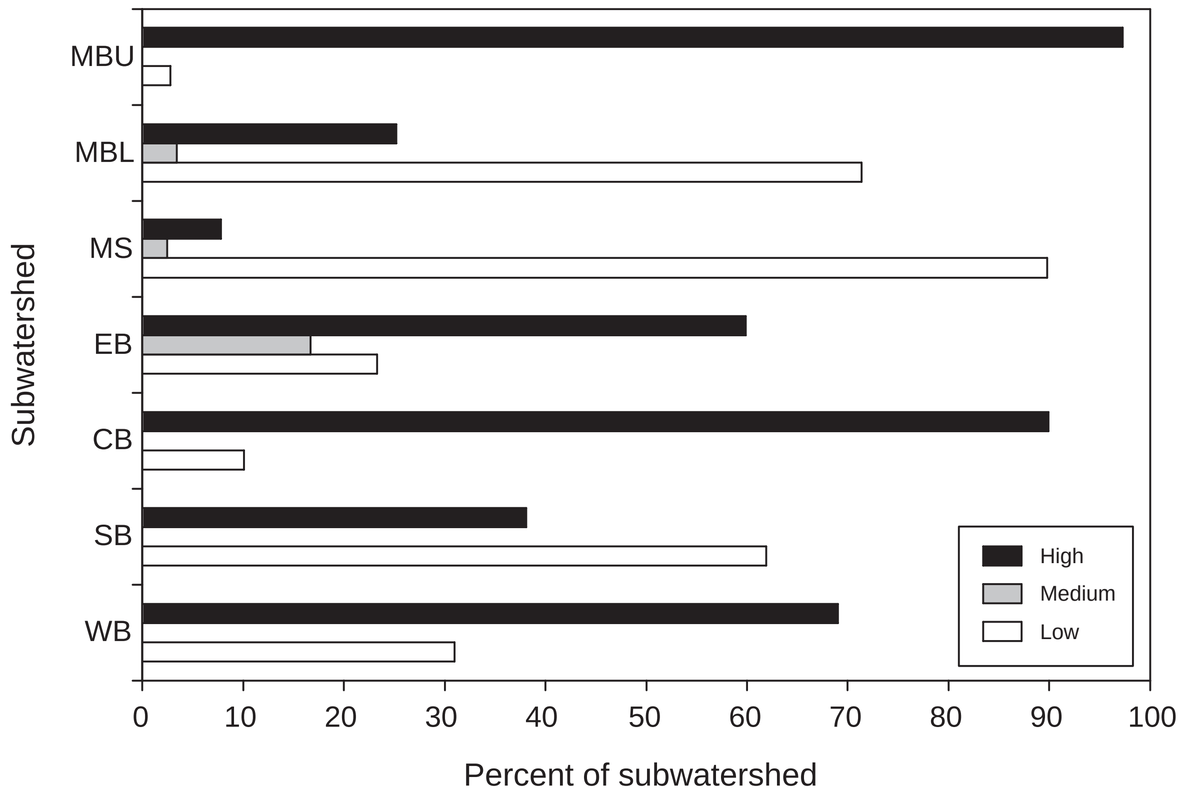


Figure 5.–Composition of surficial deposits within the seven subwatersheds of the Ontonagon River basin. High, medium, and low refer to the permeability of the surficial material. Subwatershed codes: MBU = upper Middle Branch, MBL = lower Middle Branch, MS = Main Stem, EB = East Branch, CB = Cisco Branch, SB = South Branch, and WB = West Branch.

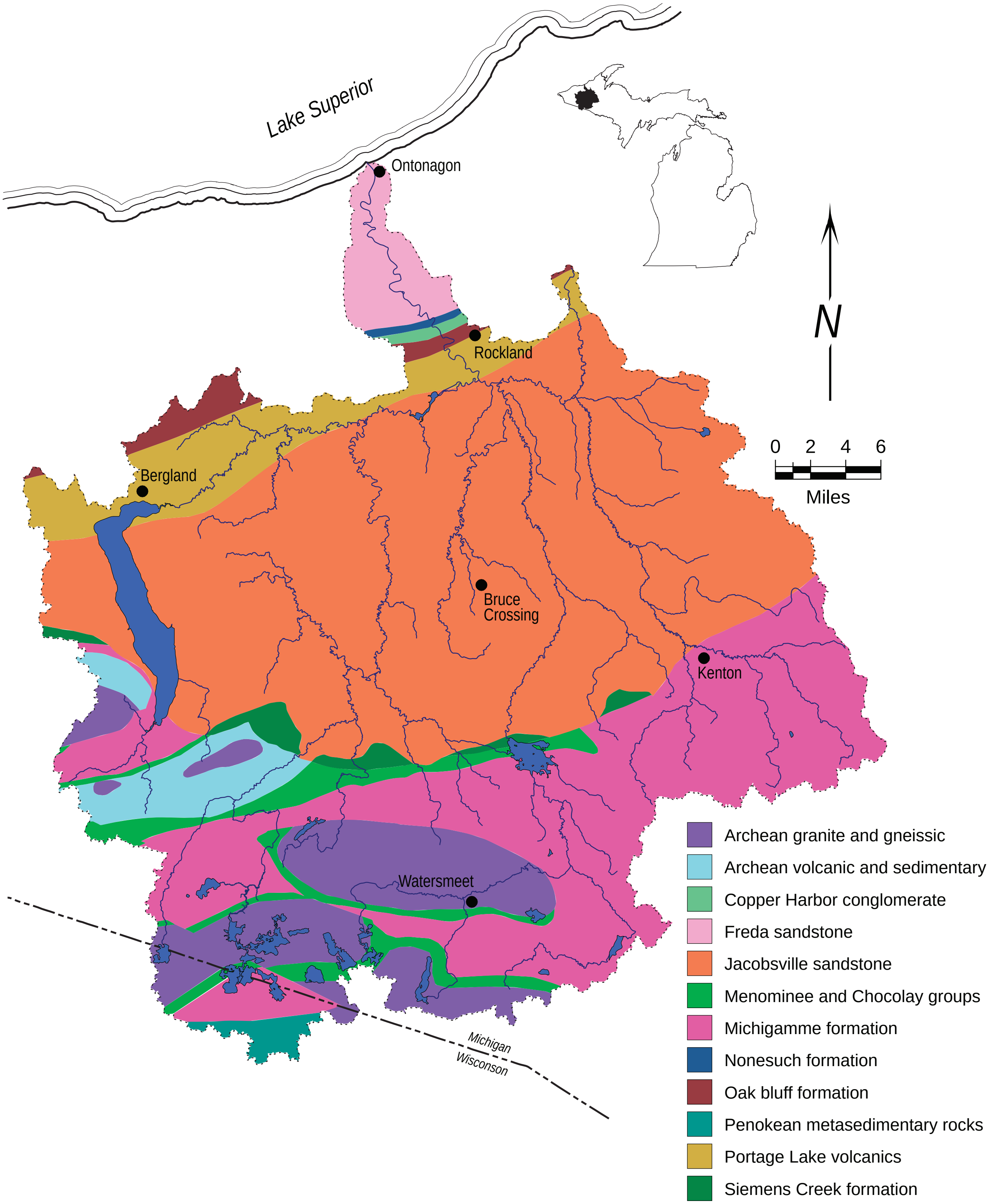
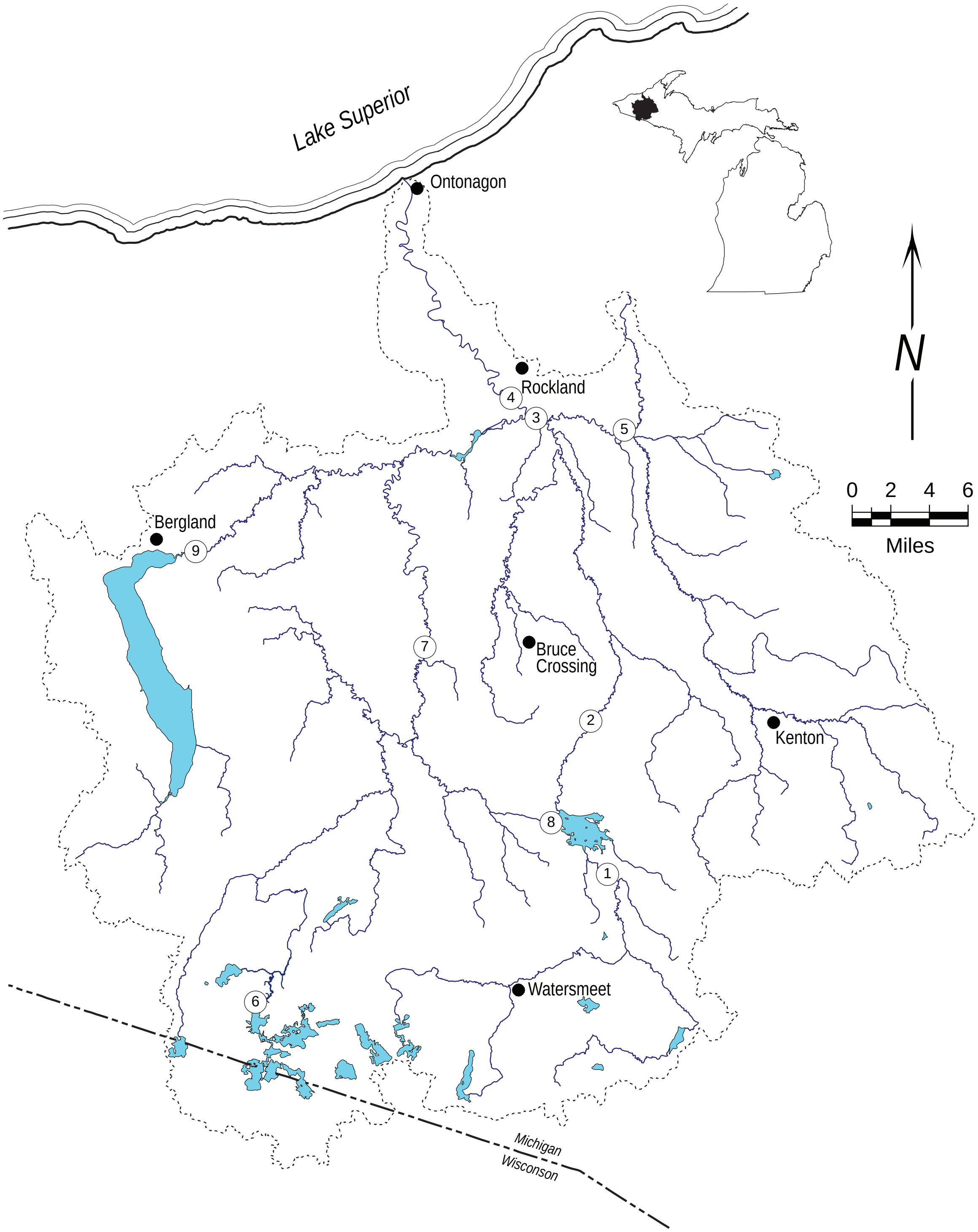


Figure 6.–Bedrock geology of the Ontonagon River watershed. Michigan data from Bedrock Geology of Northern Michigan (1987). Wisconsin bedrock geology approximated from Dutch (2003) and Cannon (1999).



1. Middle Branch (Paulding)
2. Middle Branch (Trout Creek)
3. Ontonagon River (upstream of West Branch confluence)
4. Ontonagon River (downstream of West Branch confluence)
5. East Branch (Mass City)
6. Cisco Branch (Cisco Lake outlet)
7. South Branch (Ewen)
8. Bond Falls Canal (Paulding)
9. West Branch (Bergland)

Figure 7.–United States Geological Survey gauge sites in the Ontonagon River watershed. (See Table 5 for descriptions of these nine gauges.)

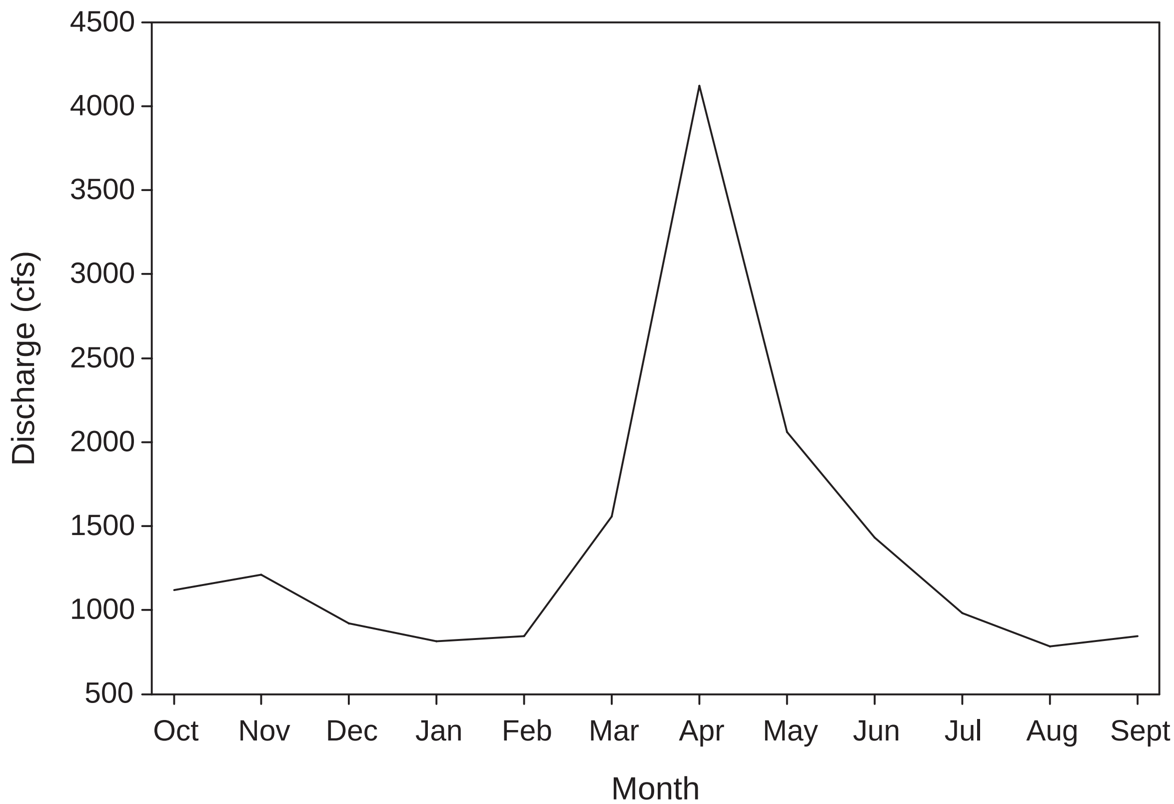


Figure 8.–Mean monthly discharge for the Ontonagon River near Rockland, 1942–2004.

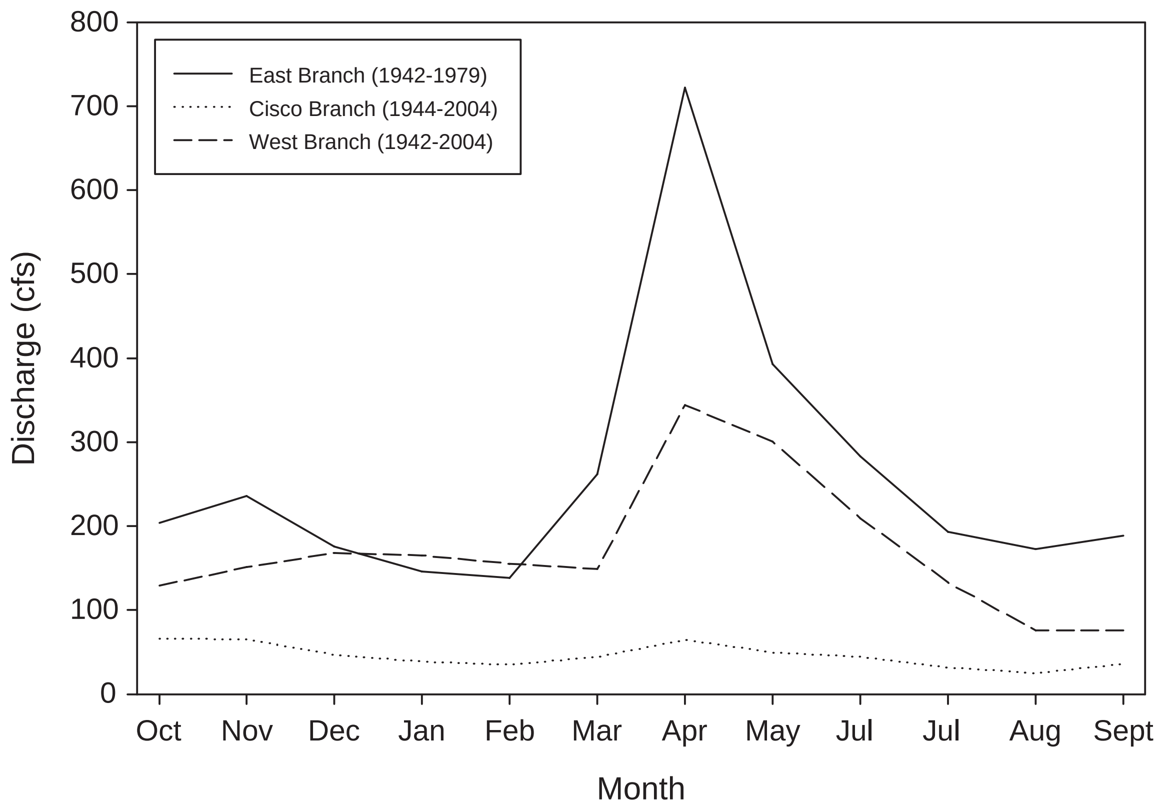


Figure 9.–Mean monthly discharge for the East, Cisco, and West branches of the Ontonagon River.

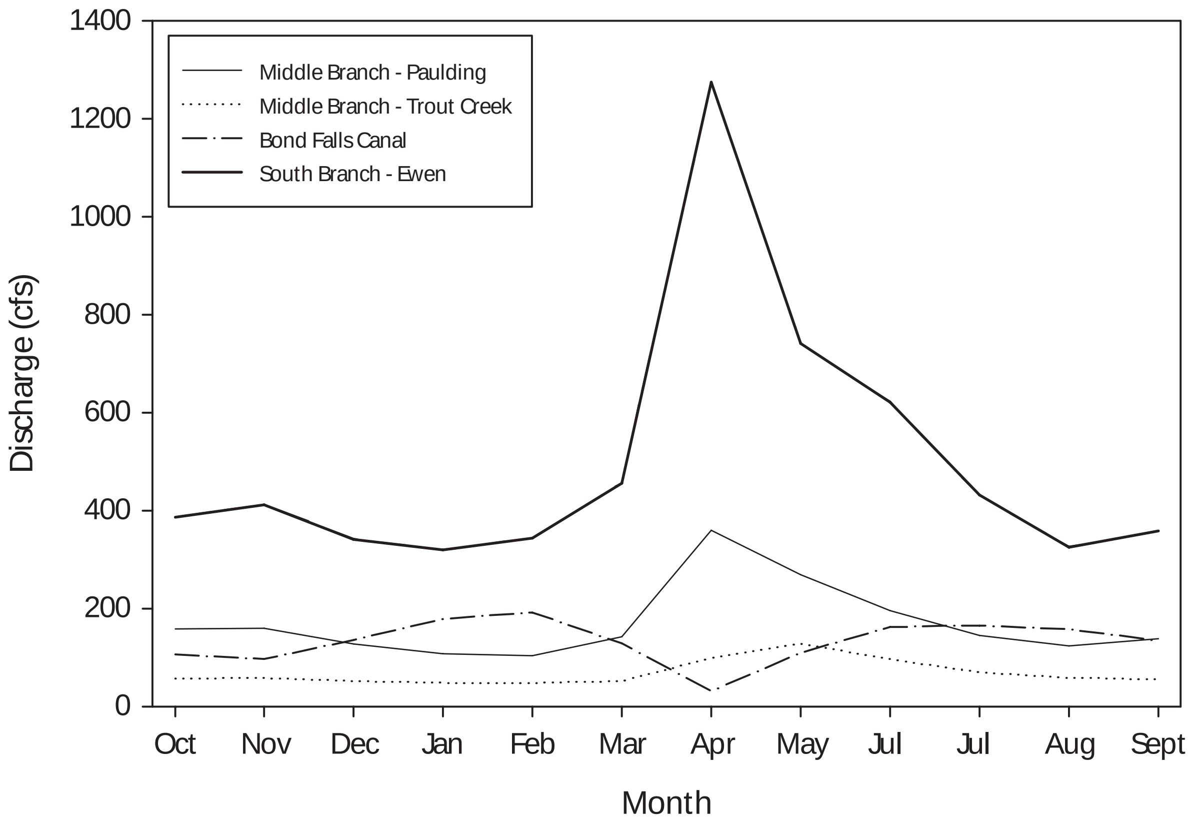


Figure 10.–Mean monthly discharge at United States Geological Survey gauge sites on the Middle Branch Ontonagon River (Middle Branch – Paulding [above Bond Falls] and Middle Branch – Trout Creek [below Bond Falls]), the Bond Falls Canal, and the South Branch Ontonagon River. The period of record was 1942–71 for the South Branch and 1942–2004 for the other three sites. Note that less water was diverted through the Bond Falls Canal during April, the time of peak discharge in the South Branch.

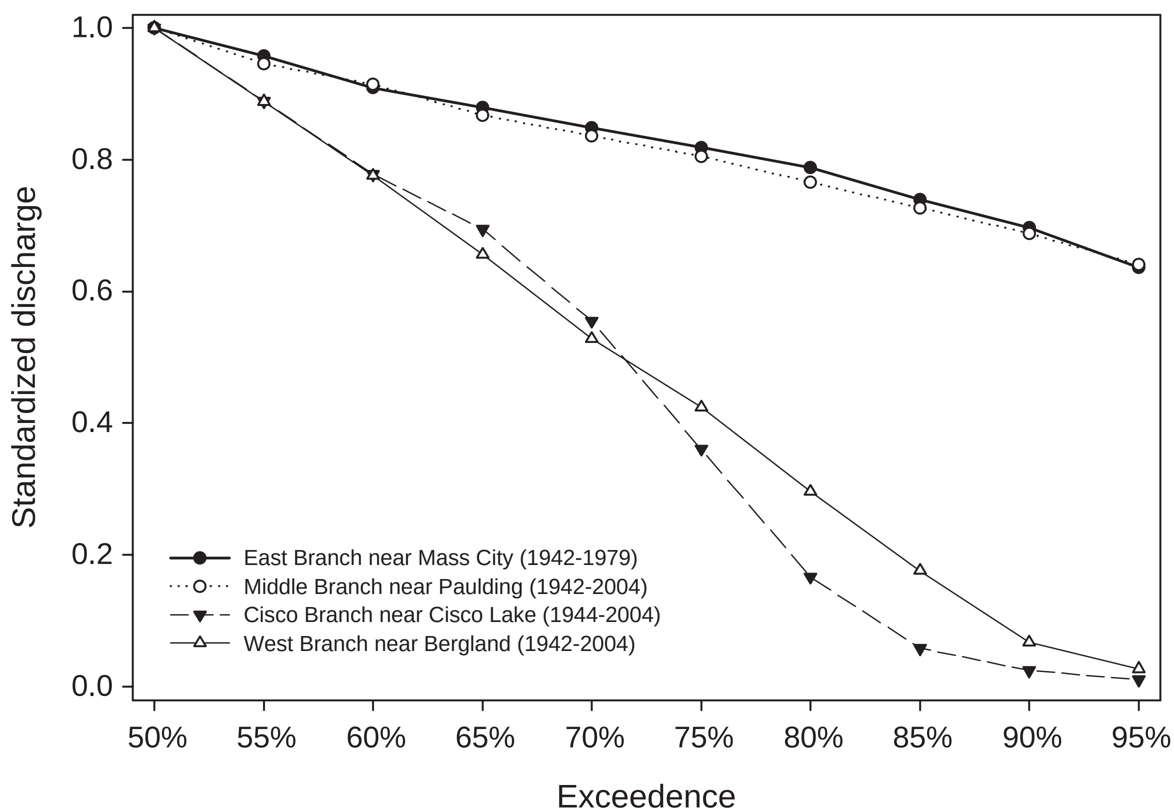


Figure 11.–Standardized low-flow duration curves for sites in the Ontonagon River watershed that are not affected by the Bond Falls diversion. Data from United States Geological Survey gauge stations for period of record.

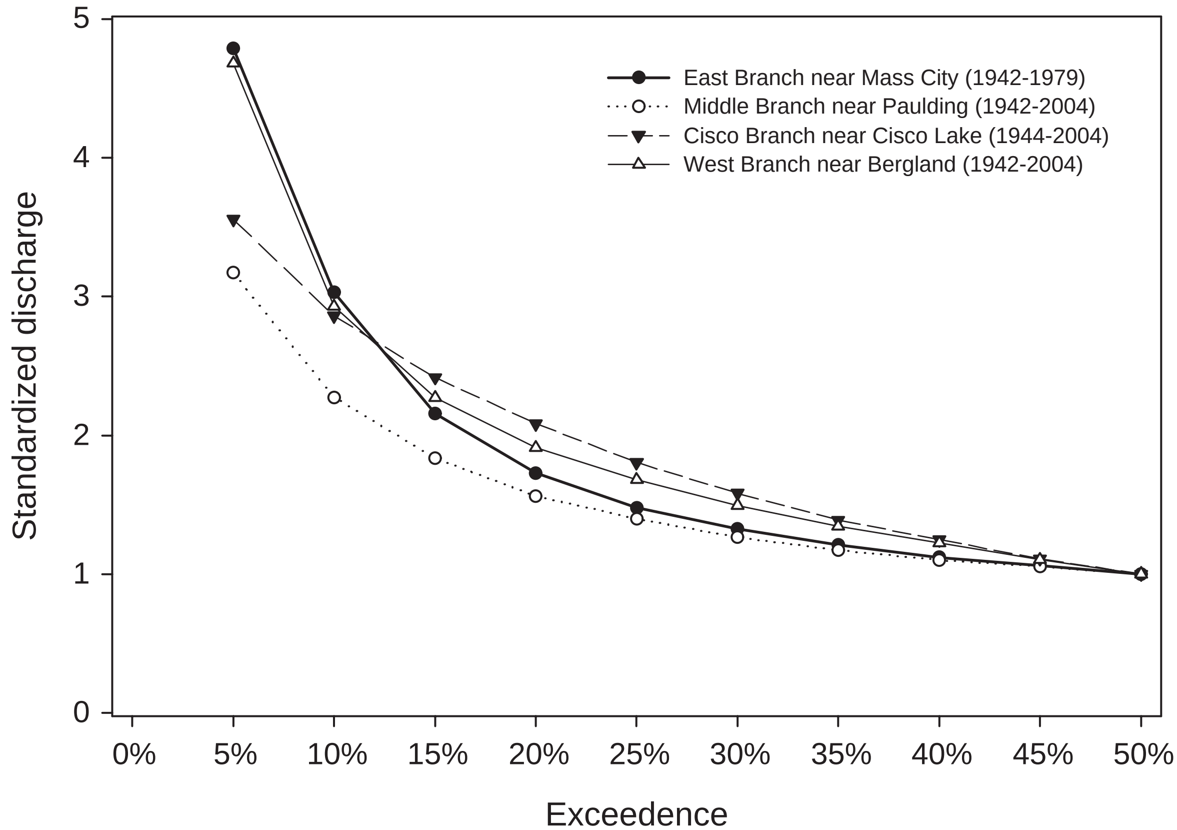


Figure 12.–Standardized high-flow duration curves for sites in the Ontonagon River watershed that are not affected by the Bond Falls diversion. Data from United States Geological Survey gauge stations for period of record.

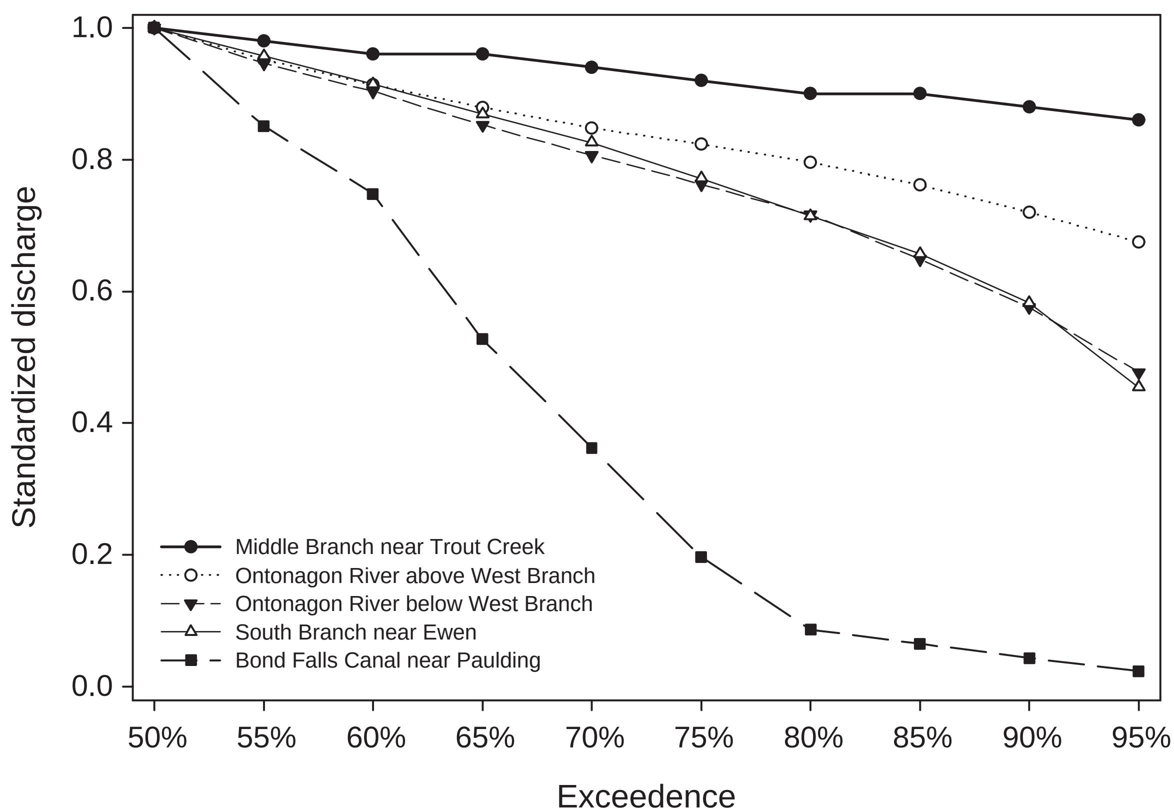


Figure 13.–Standardized low-flow duration curves for sites in the Ontonagon River watershed that are affected by the Bond Falls diversion. Data from United States Geological Survey gauge stations. Period of record was 1942–71 for the South Branch and 1942–2004 for the other four sites.

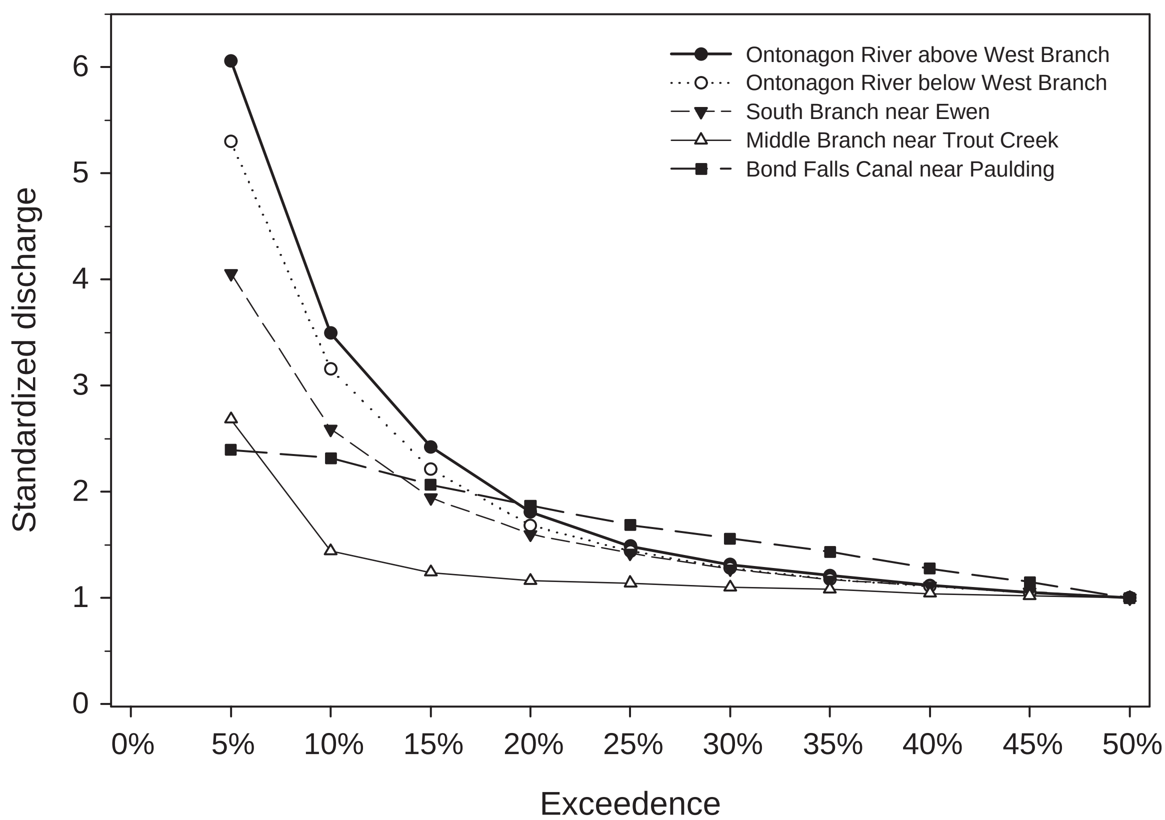


Figure 14.–Standardized high-flow duration curves for sites in the Ontonagon River watershed that are affected by the Bond Falls diversion. Data from United States Geological Survey gauge stations. Period of record was 1942–71 for the South Branch and 1942–2004 for the other four sites.

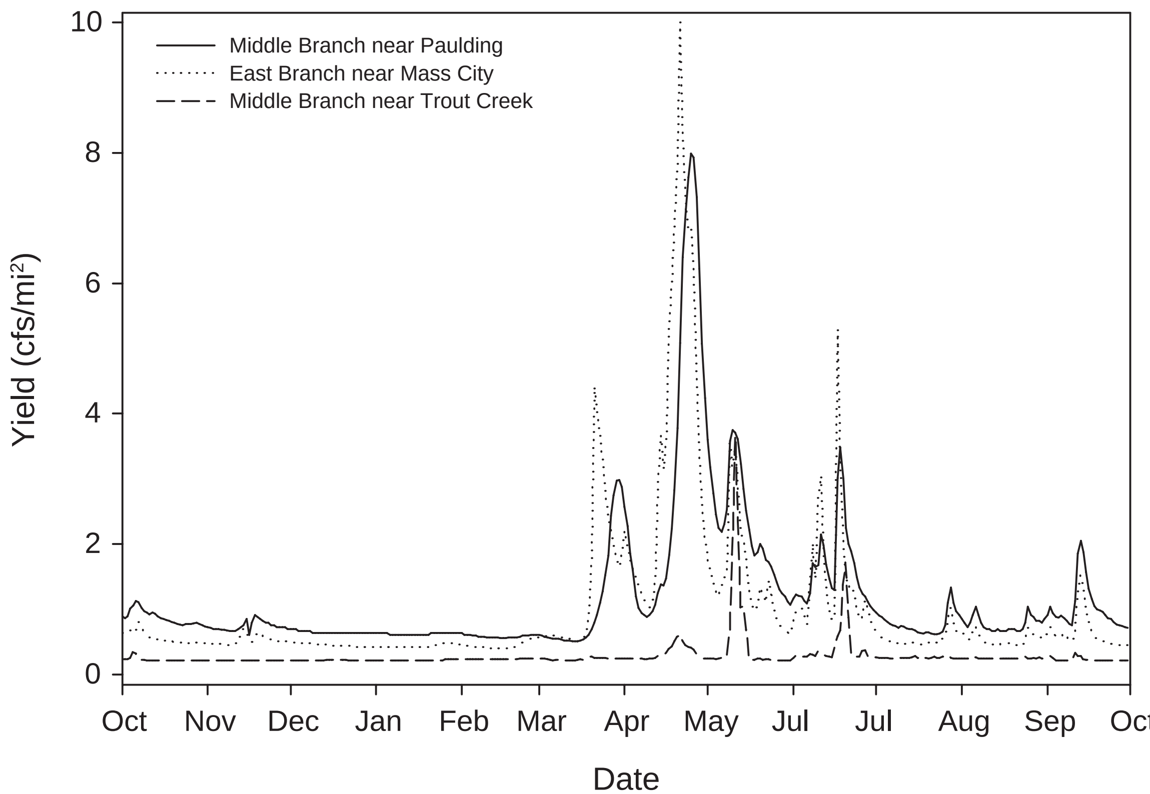


Figure 15.–Daily water yields at three gauge sites within the Ontonagon River watershed during October 1978 through September 1979. Data from United States Geological Survey.

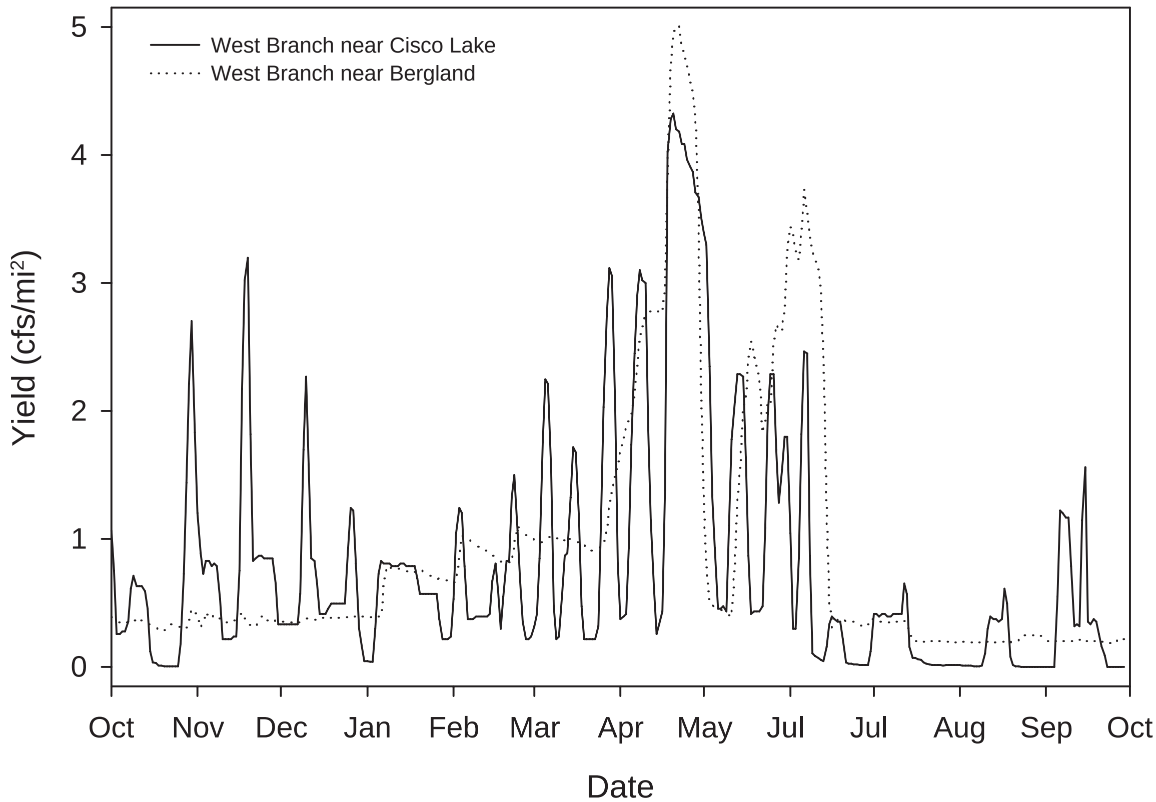


Figure 16.–Daily water yields for the Cisco Branch Ontonagon River and the West Branch Ontonagon River during October 2003 through September 2004. Data from United States Geological Survey.

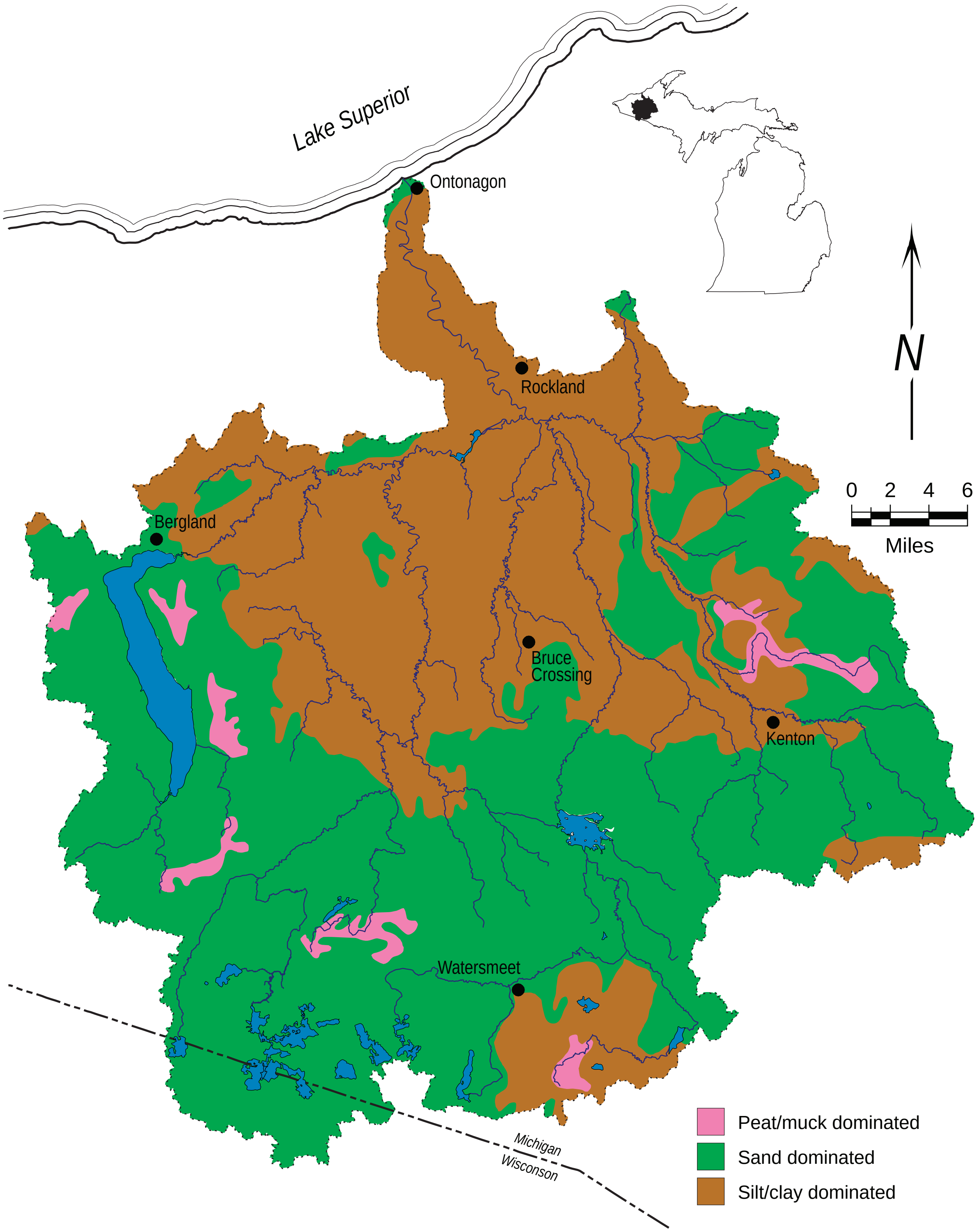


Figure 17.–Soil types in the Ontonagon River watershed. Michigan data from State Soil Geographic Database (1994). Wisconsin data from Madison and Gundlach (1993).

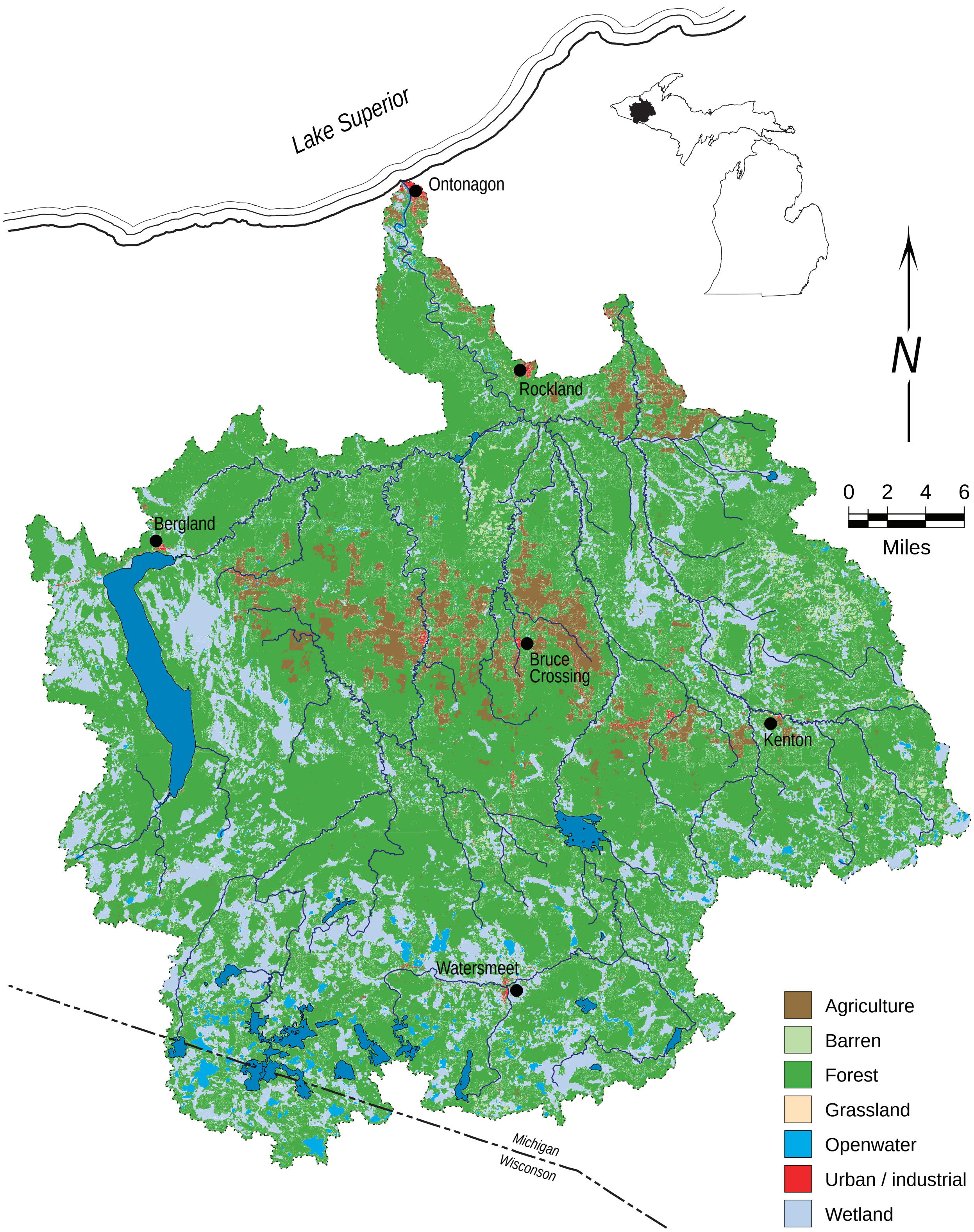


Figure 18.–Land use in the Ontonagon River watershed. Michigan data from Michigan 1992 NLCD Shapefile by County (2002). Wisconsin data from WISCLAND Land Cover (1998).

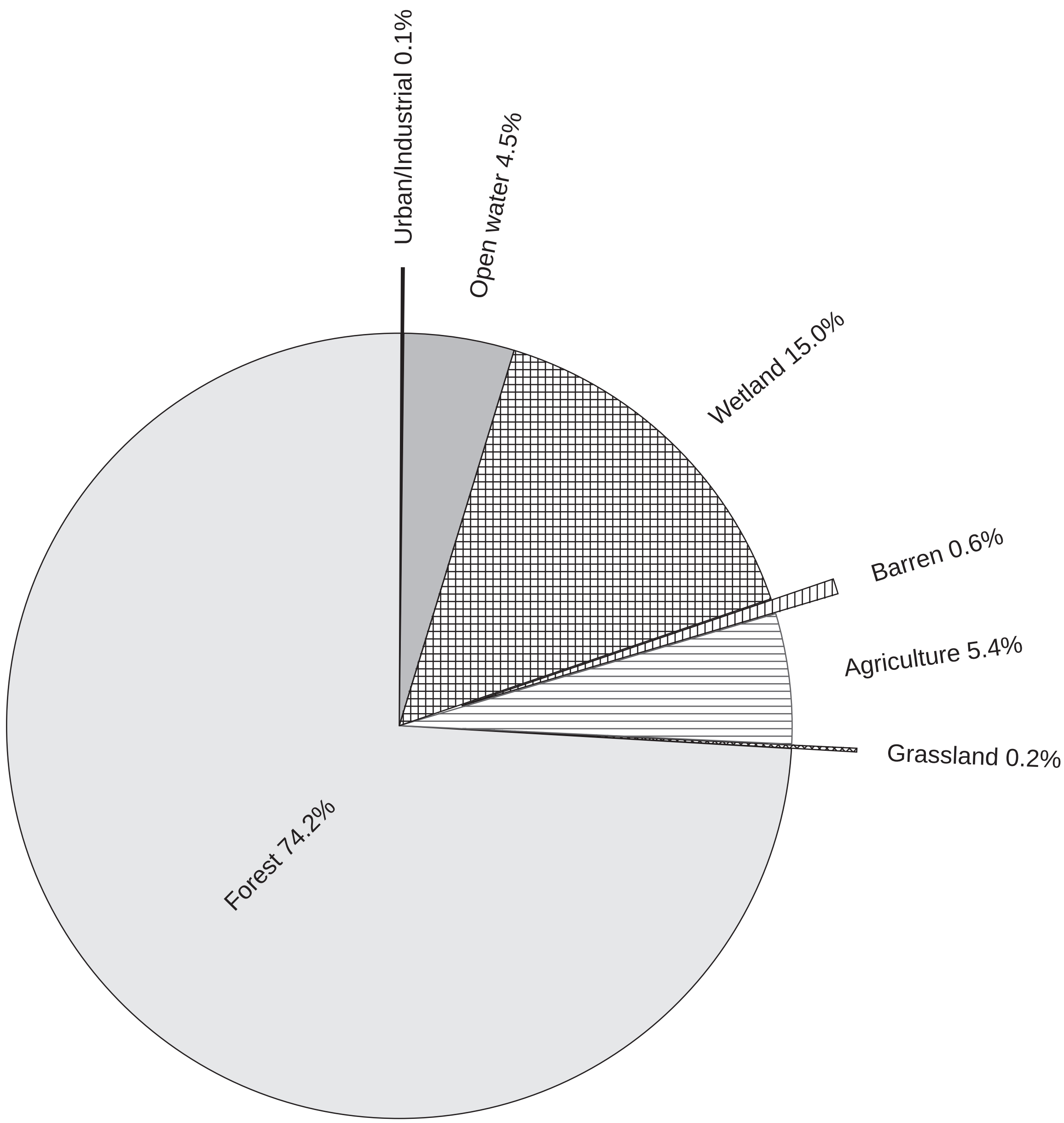


Figure 19.–Percent land use in the Ontonagon River watershed. Michigan data from Michigan 1992 NLCD Shapefile by County (2002). Wisconsin data from WISCLAND Land Cover (1998).

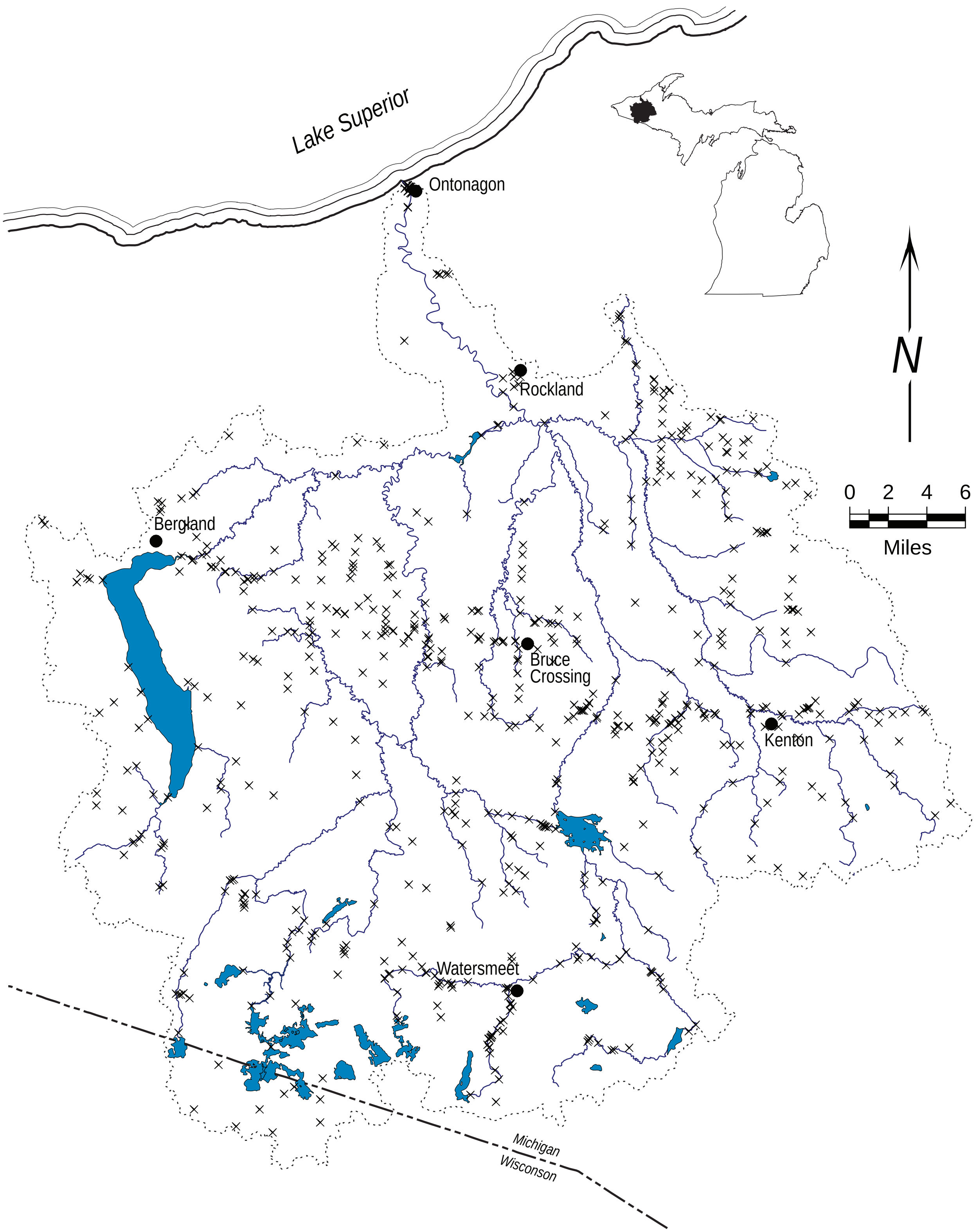


Figure 20.–Stream crossings in the Ontonagon River watershed (includes roads, railroads, and utilities). Stream crossing data derived from MIRIS Base Data (1998).

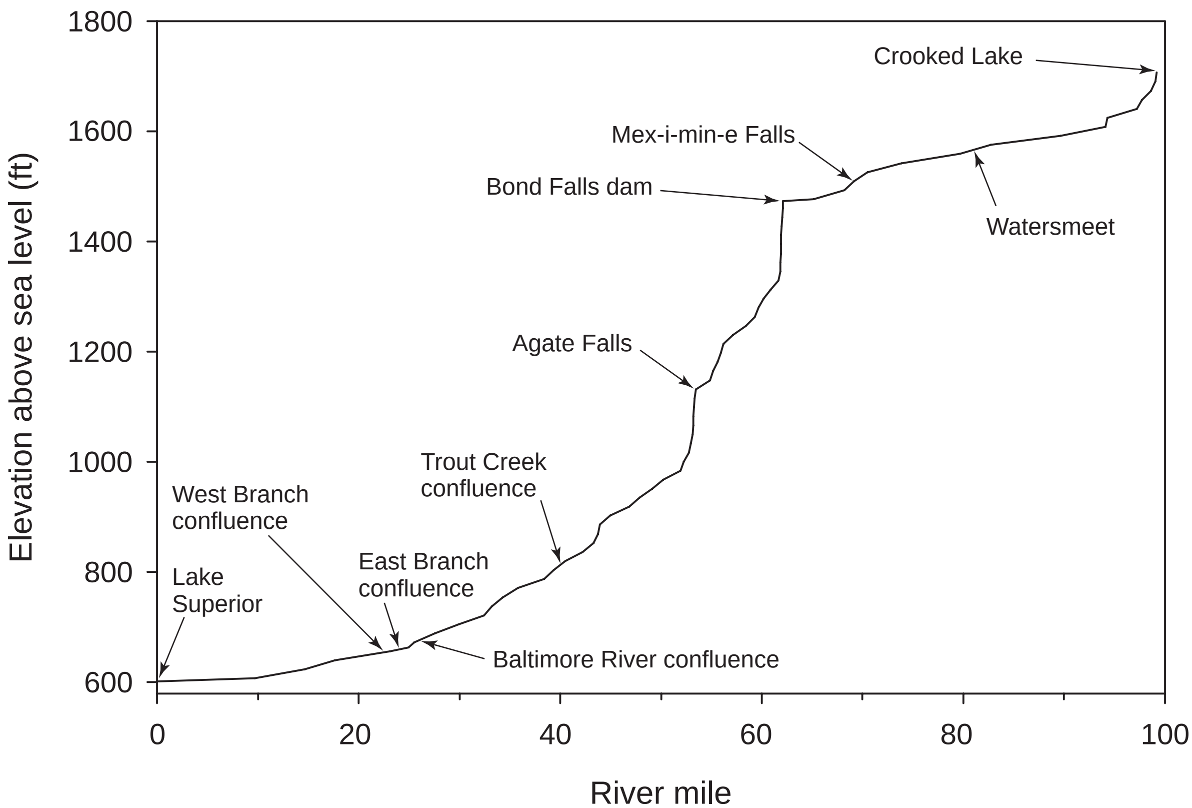


Figure 21.–Elevation changes by river mile for the Middle Branch and main stem Ontonagon rivers.

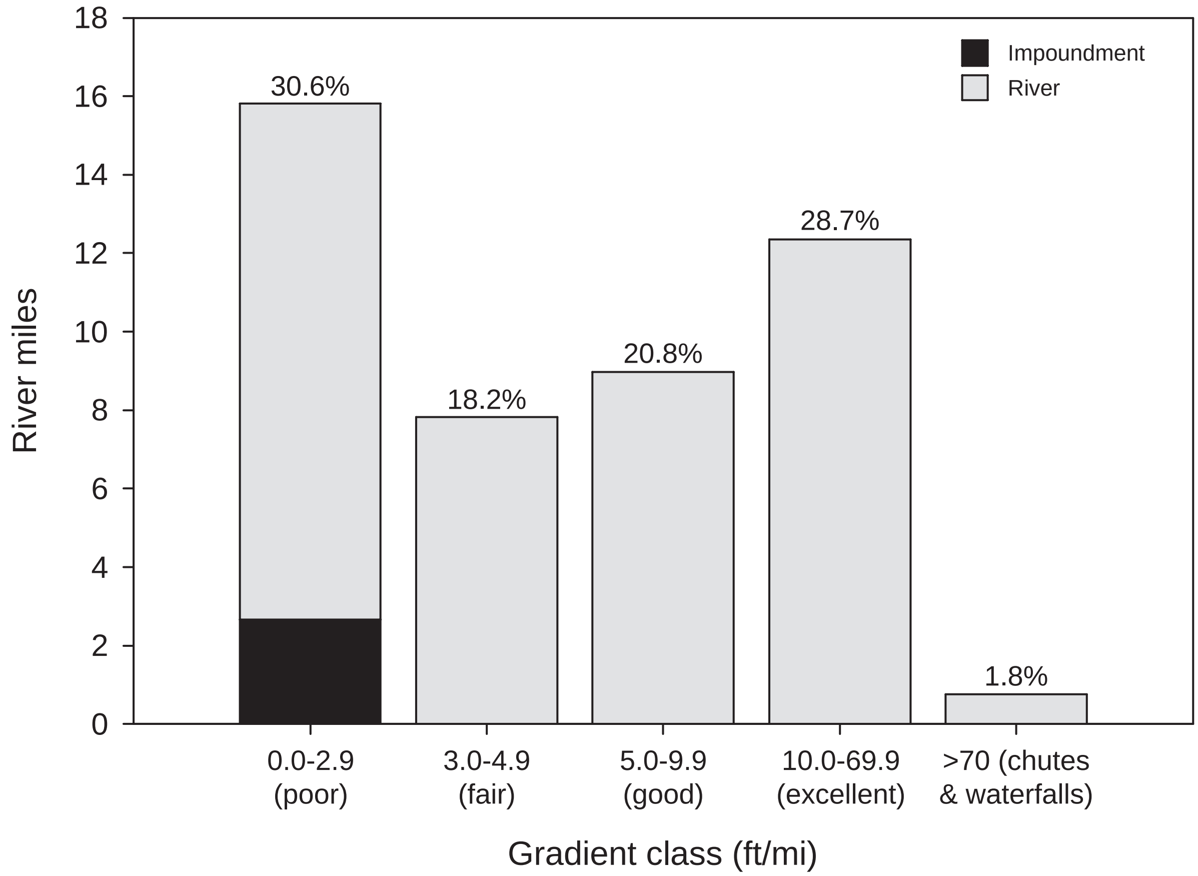


Figure 22.–Stream gradient distribution for the Middle Branch Ontonagon River from the origin at Crooked Lake to Agate Falls. Fish habitat ranking in parentheses.

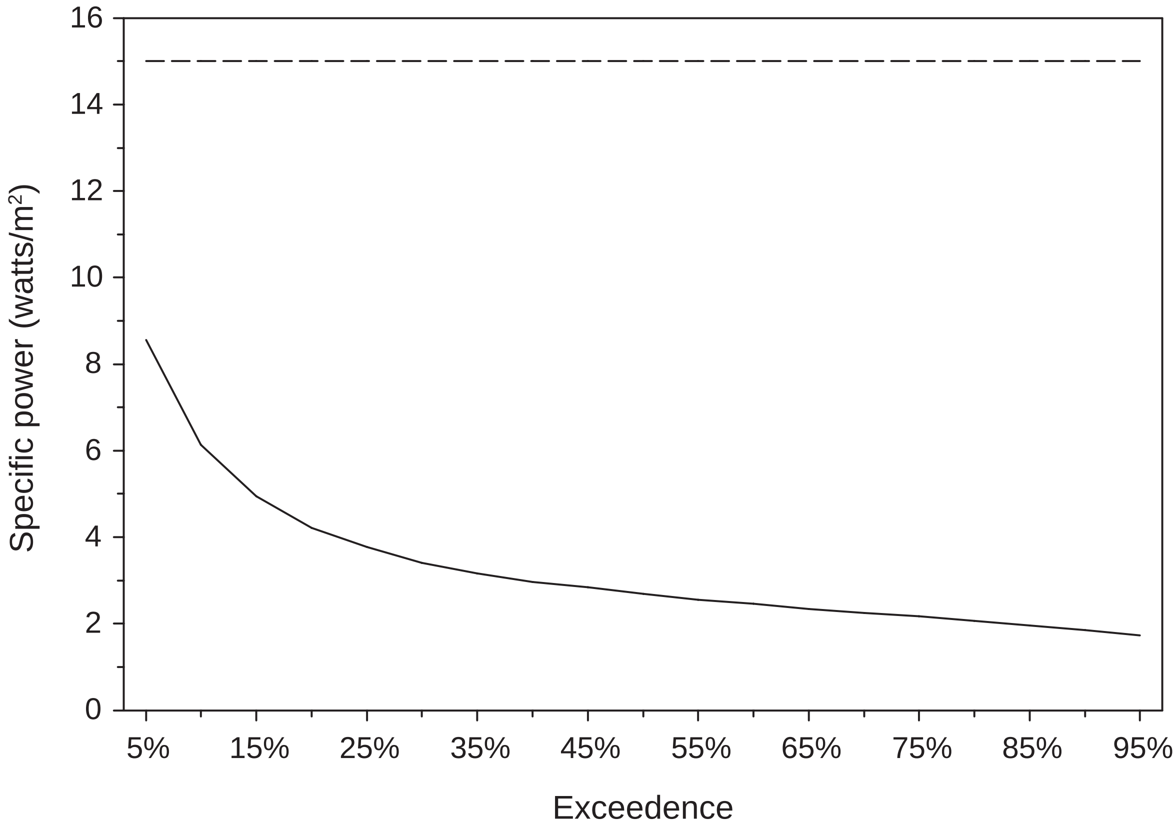


Figure 23.–Specific power for the Middle Branch Ontonagon River near Paulding.

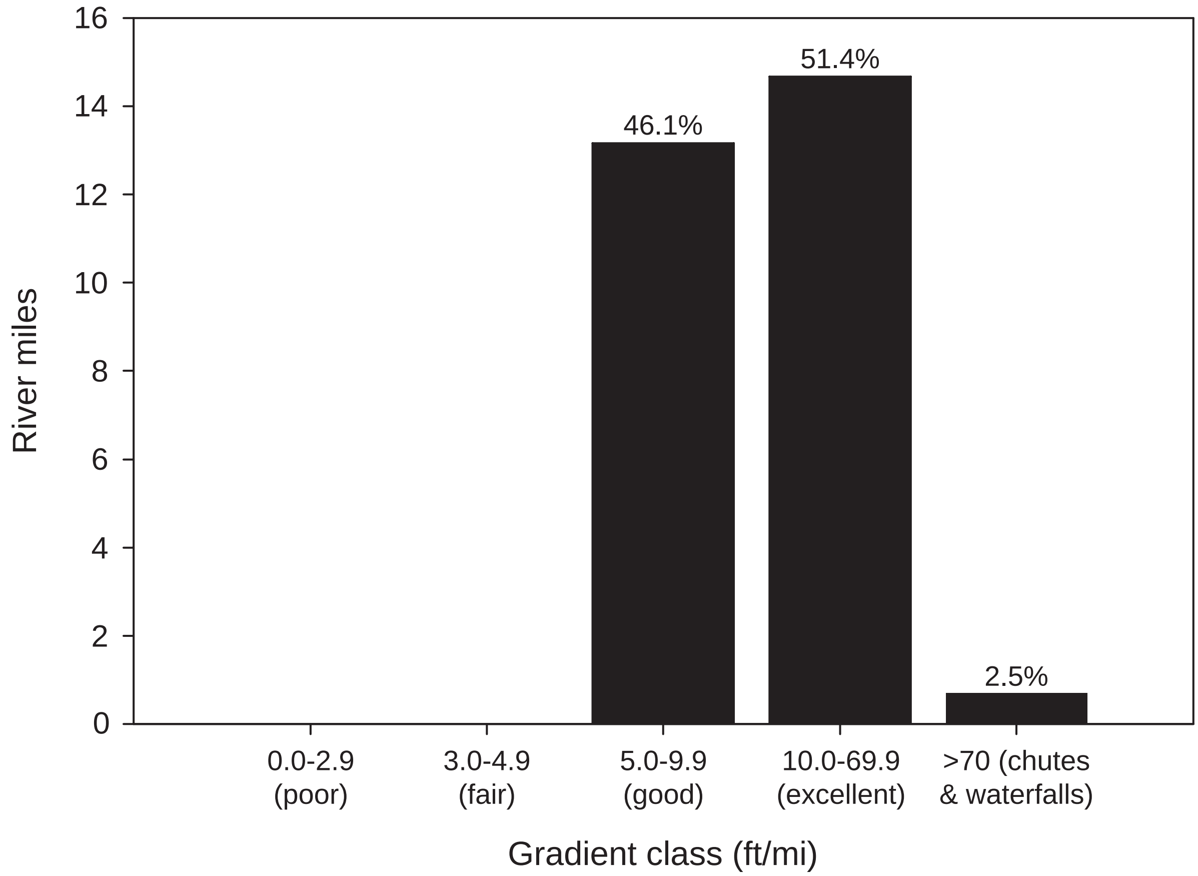


Figure 24.–Stream gradient distribution for the Middle Branch Ontonagon River from Agate Falls to the confluence with the East Branch Ontonagon River. Fish habitat ranking in parentheses.

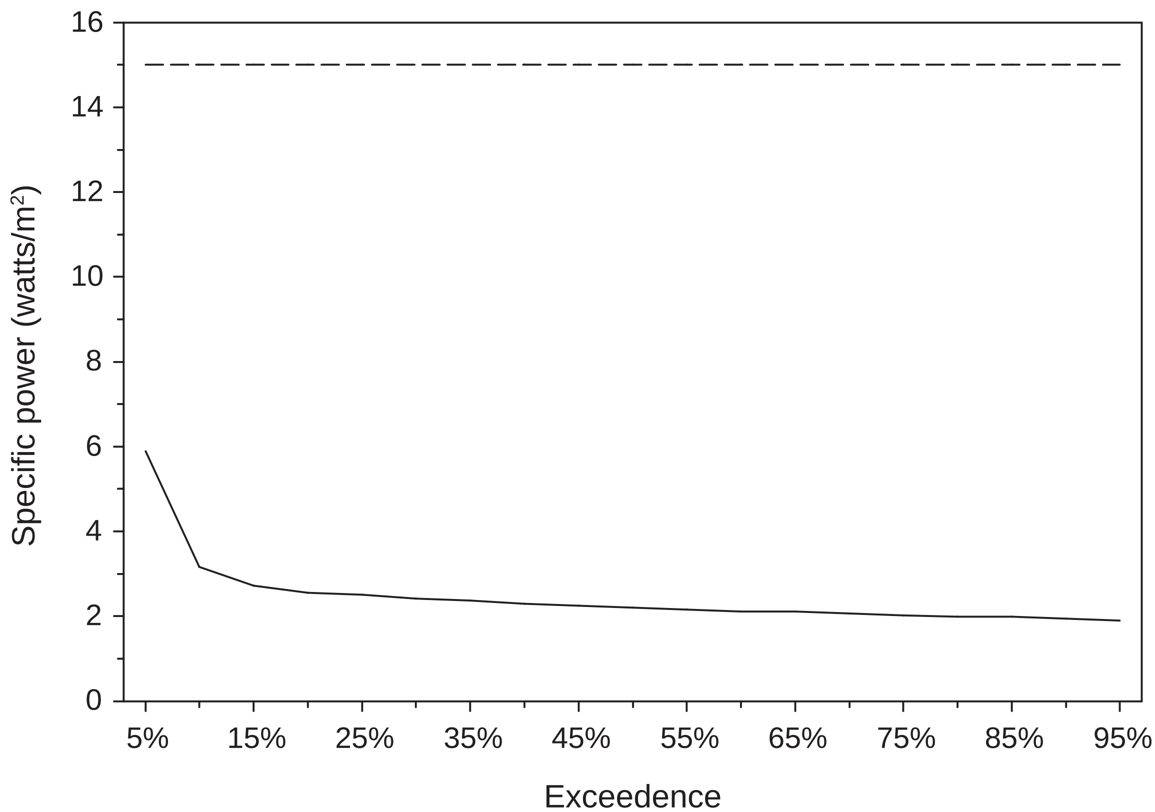


Figure 25.–Specific power for the Middle Branch Ontonagon River near Trout Creek.

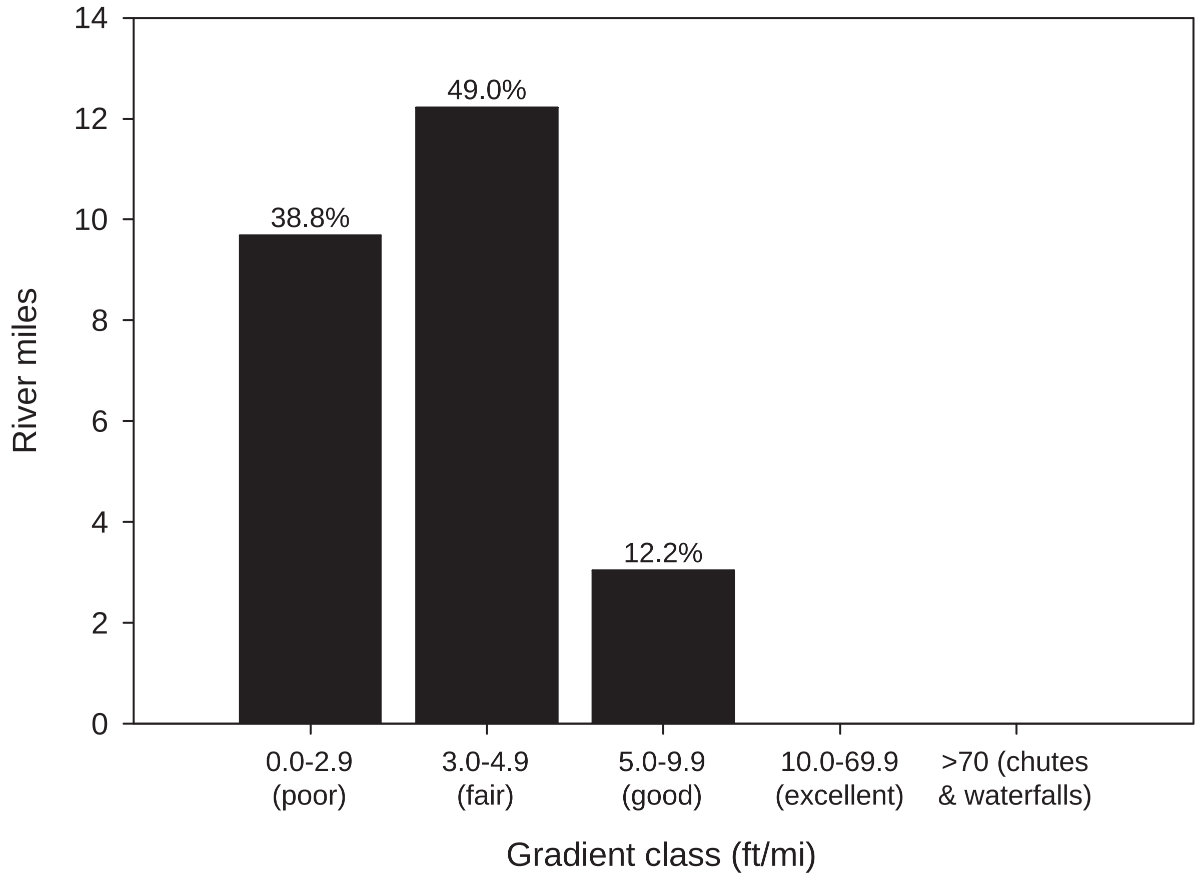


Figure 26.–Stream gradient distribution for the main stem Ontonagon River. Fish habitat ranking in parentheses.

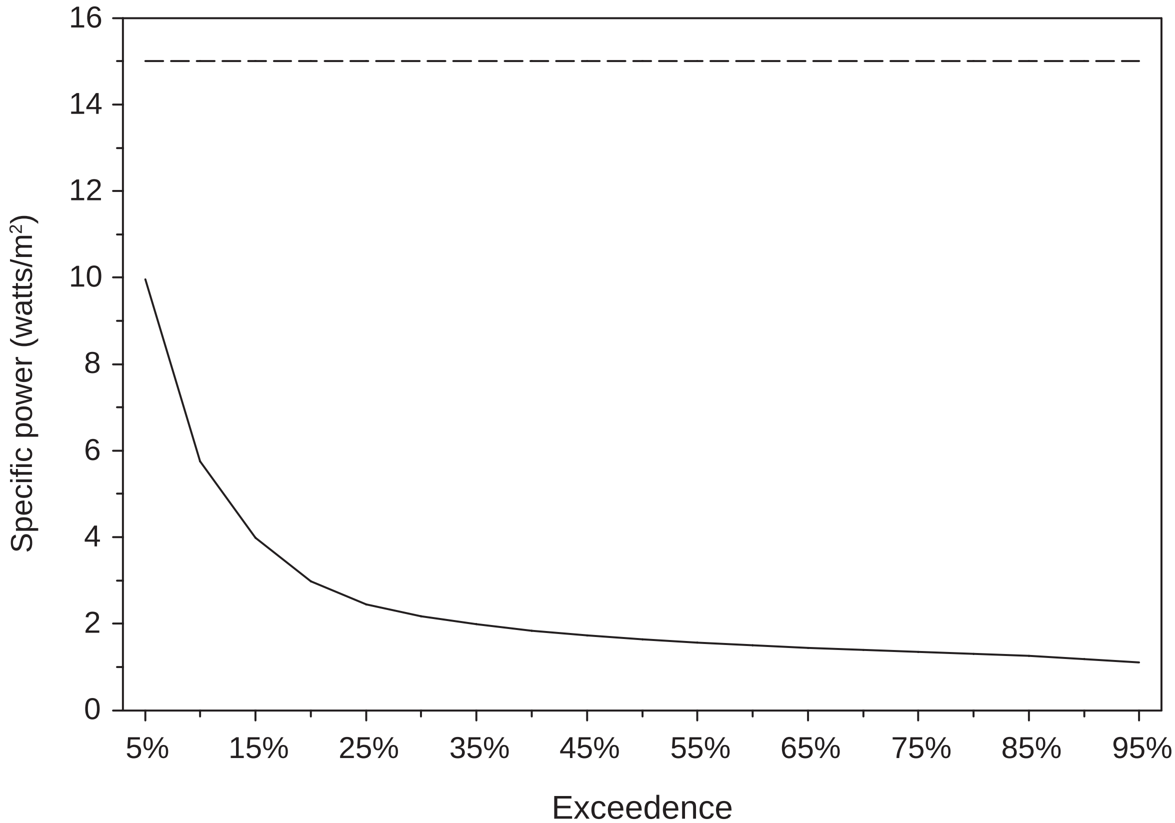


Figure 27.–Specific power for the main stem Ontonagon River upstream of the confluence with the West Branch.

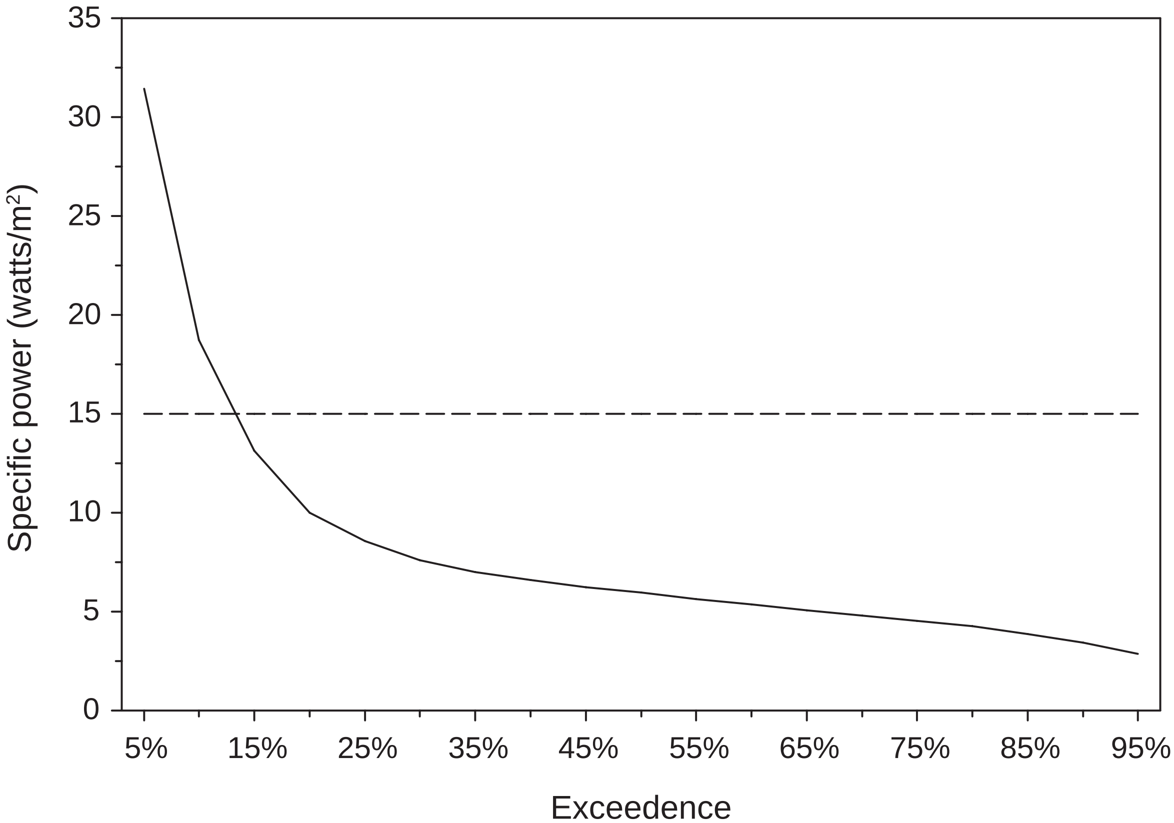


Figure 28.–Specific power for the main stem Ontonagon River downstream of the confluence with the West Branch.

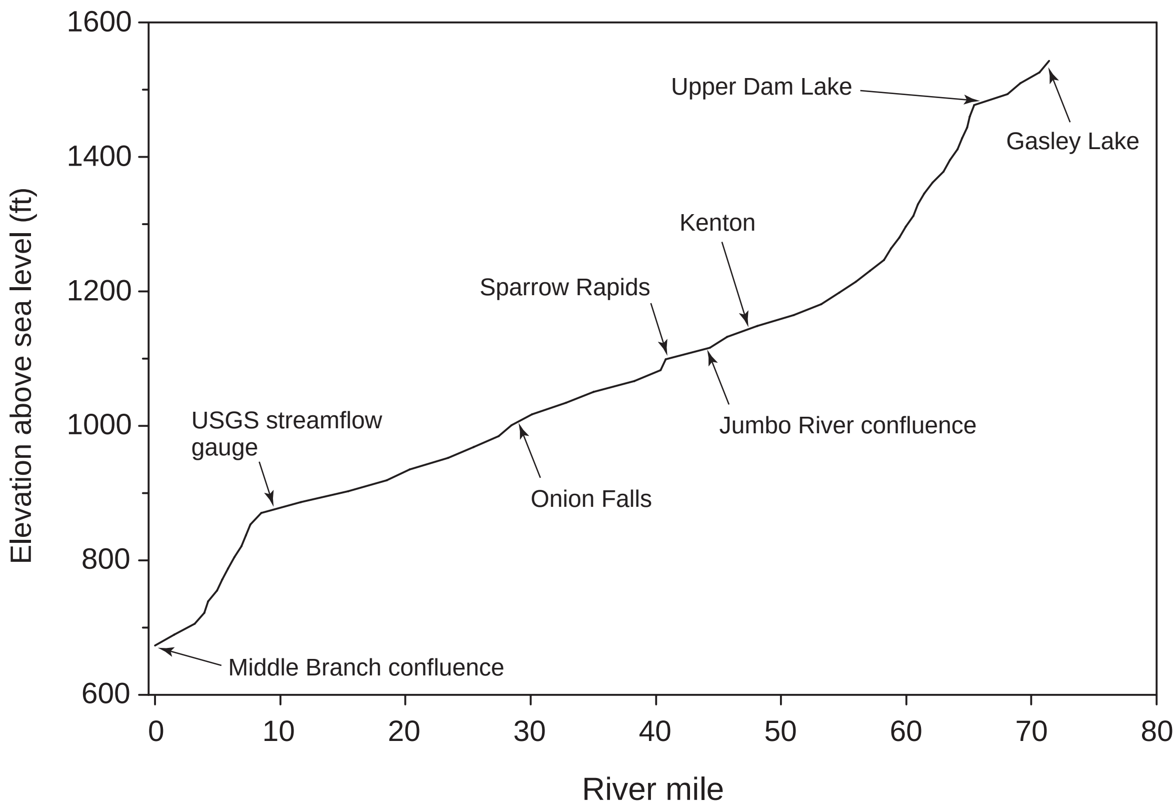


Figure 29.–Elevation changes by river mile for the East Branch Ontonagon River.

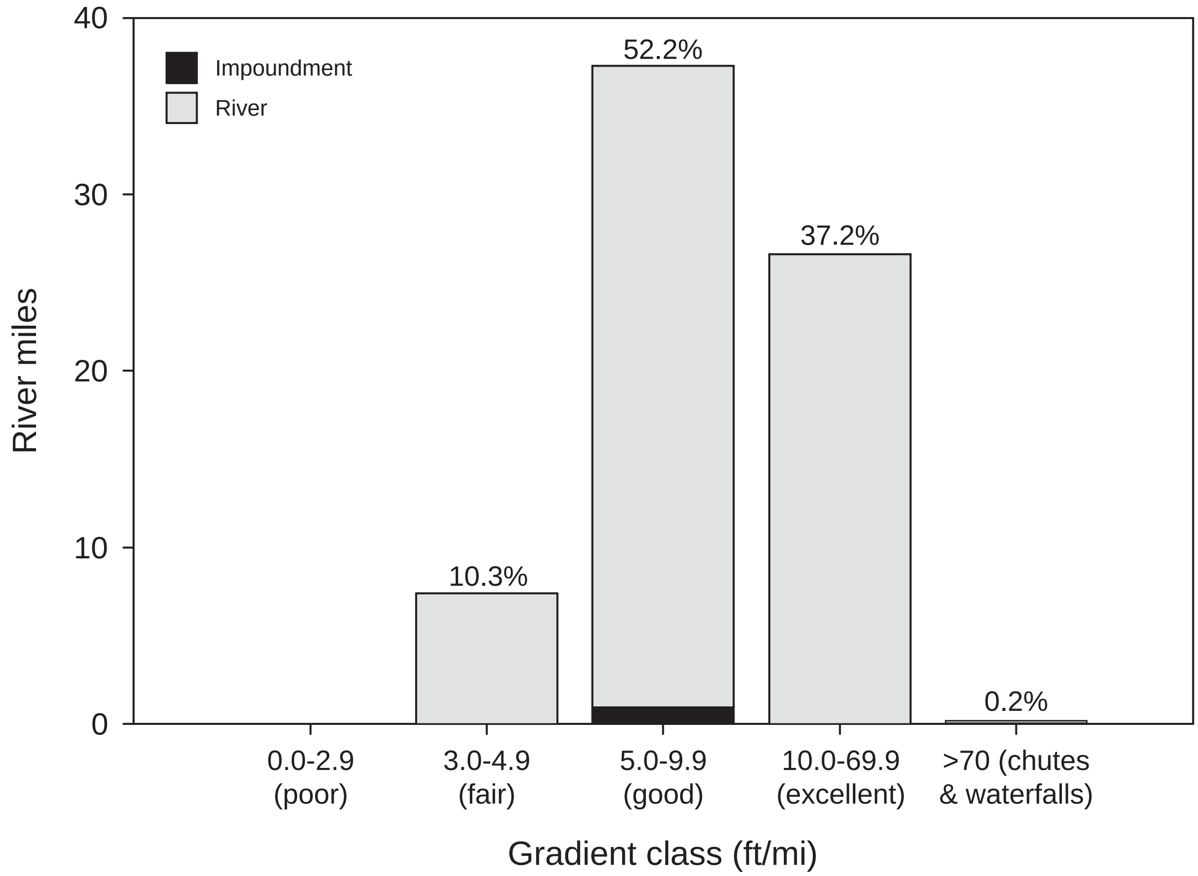


Figure 30.–Stream gradient distribution for the East Branch Ontonagon River. Fish habitat ranking in parentheses.

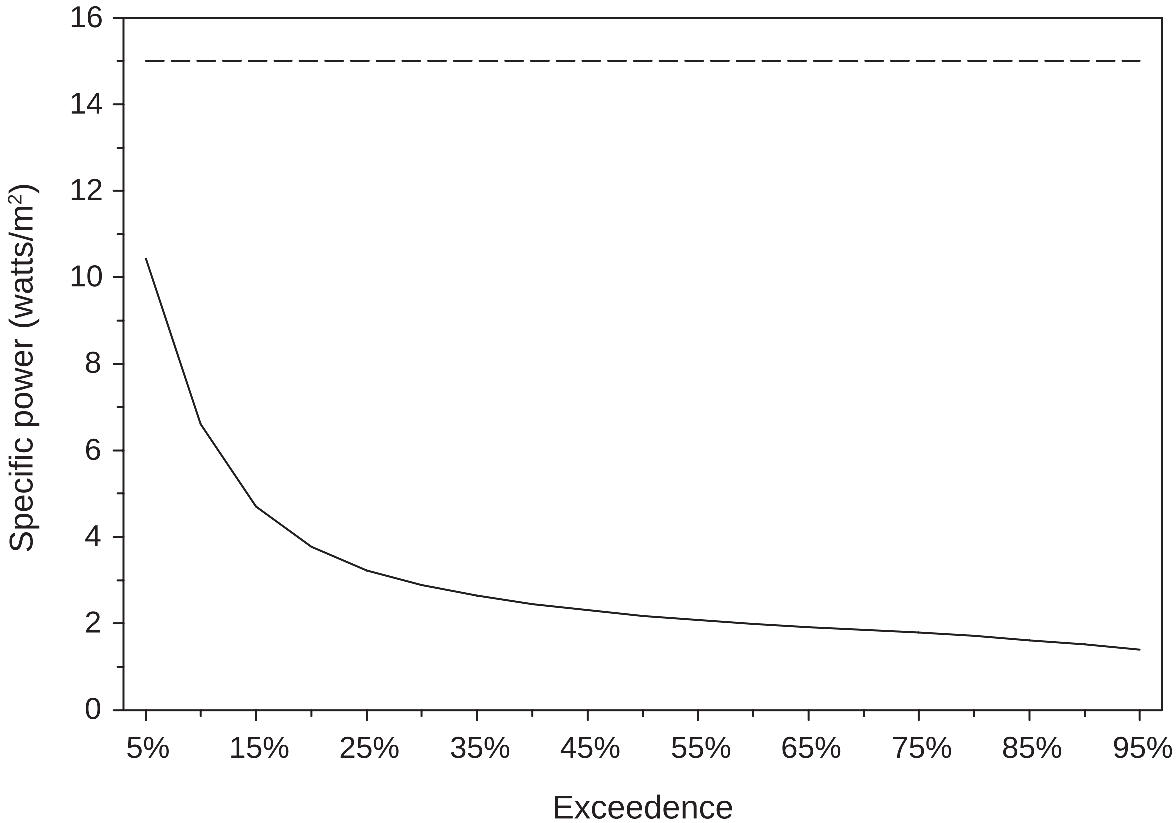


Figure 31.–Specific power for the East Branch Ontonagon River near Mass City.

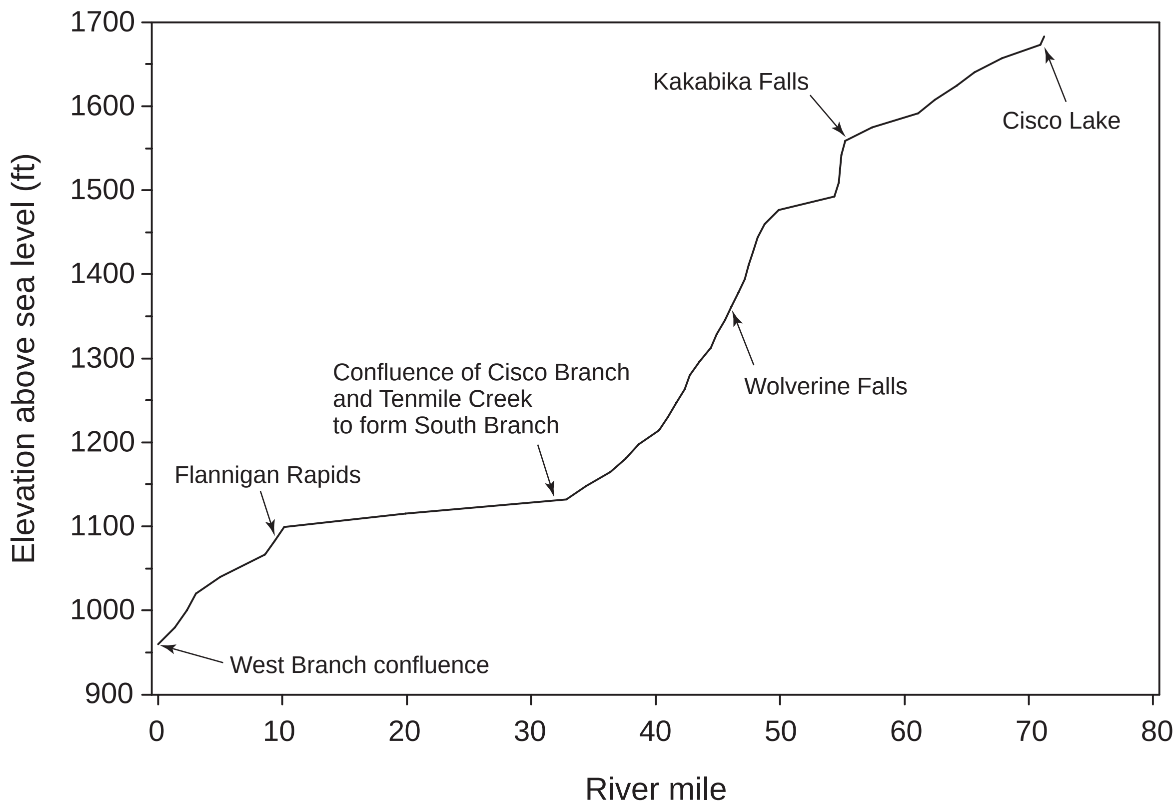


Figure 32.–Elevation changes by river mile for the Cisco Branch and South Branch Ontonagon rivers.

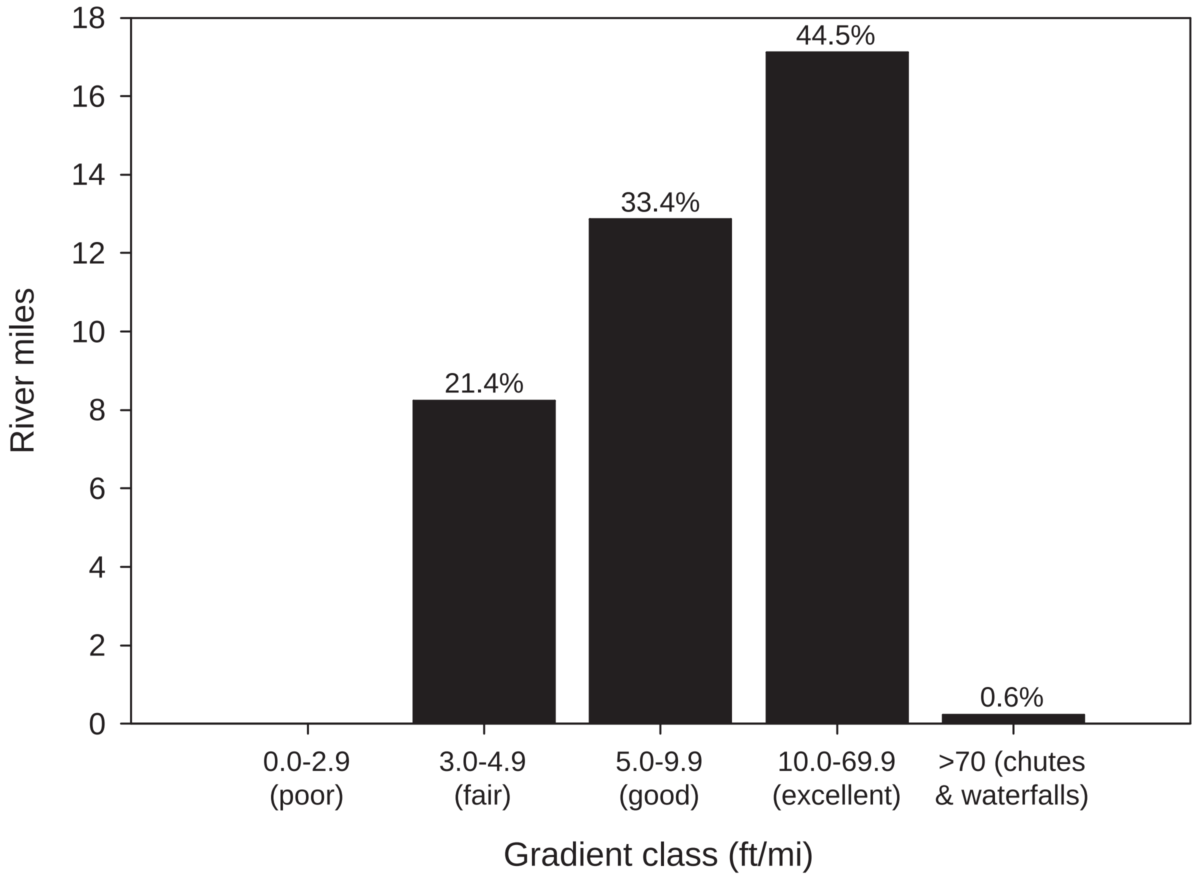


Figure 33.–Stream gradient distribution for the Cisco Branch Ontonagon River. Fish habitat ranking in parentheses.

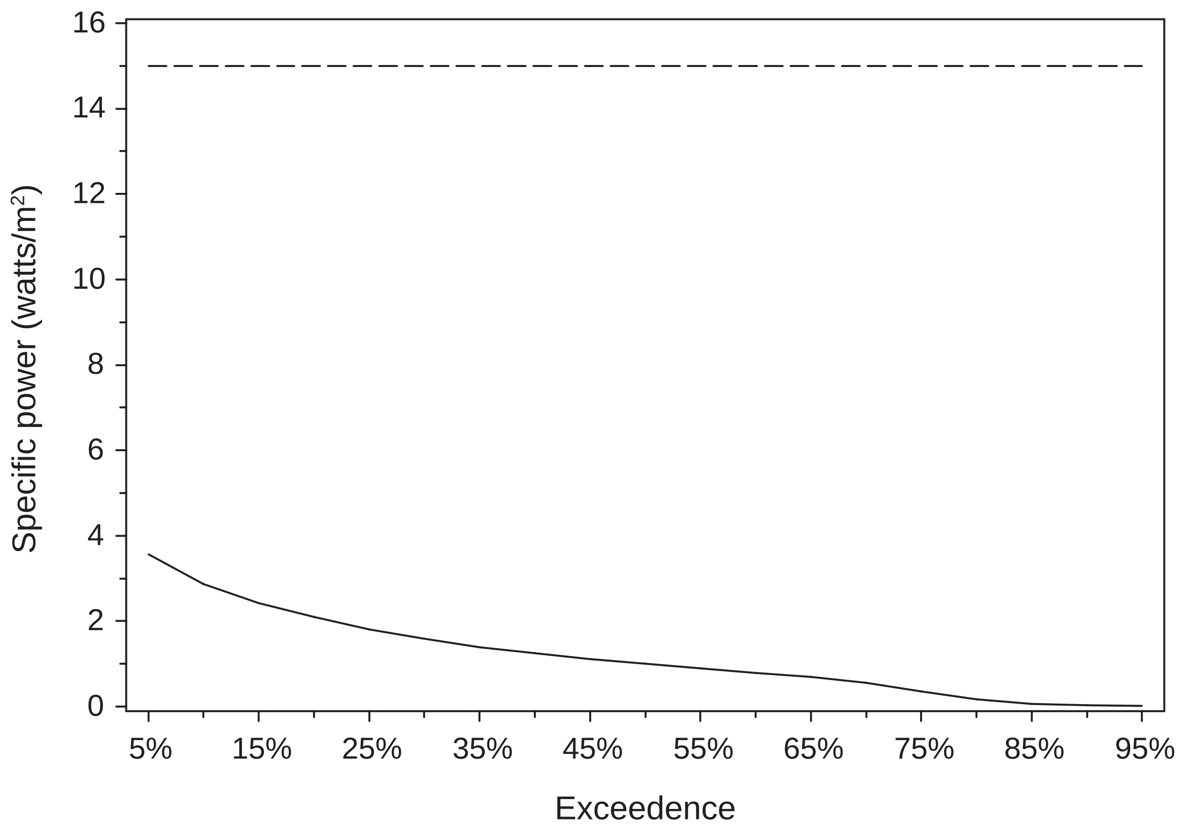


Figure 34.–Specific power for the Cisco Branch Ontonagon River near the Cisco Lake outlet.

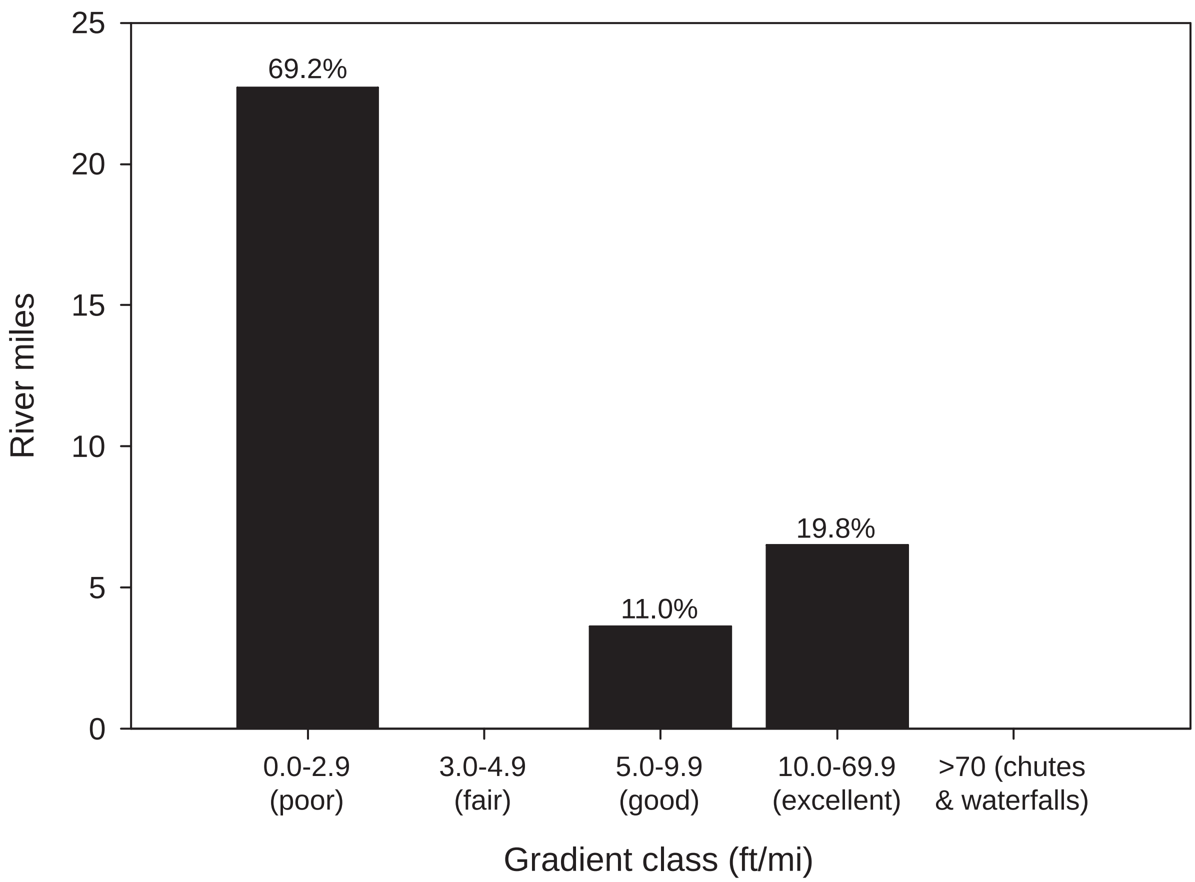


Figure 35.–Stream gradient distribution for the South Branch Ontonagon River. Fish habitat ranking in parentheses.

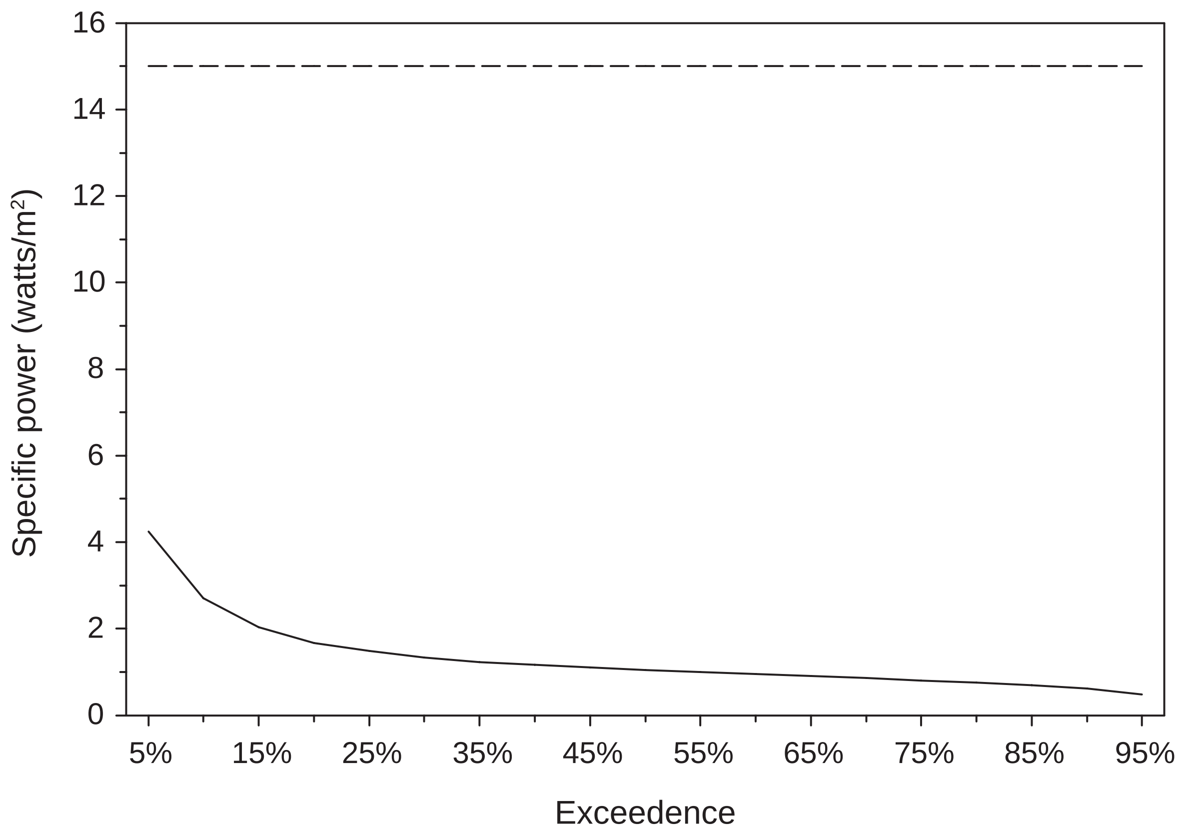


Figure 36.–Specific power for the South Branch Ontonagon River at Ewen.

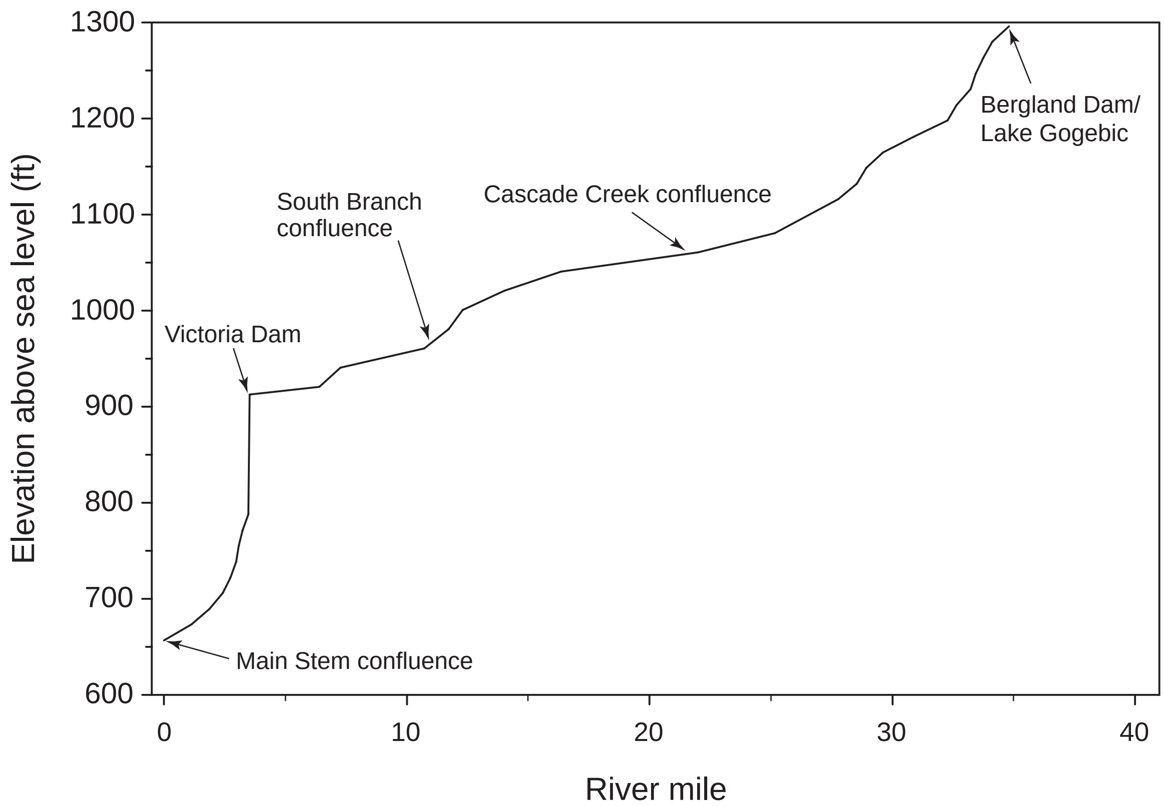


Figure 37.–Elevation changes by river mile for the West Branch Ontonagon River.

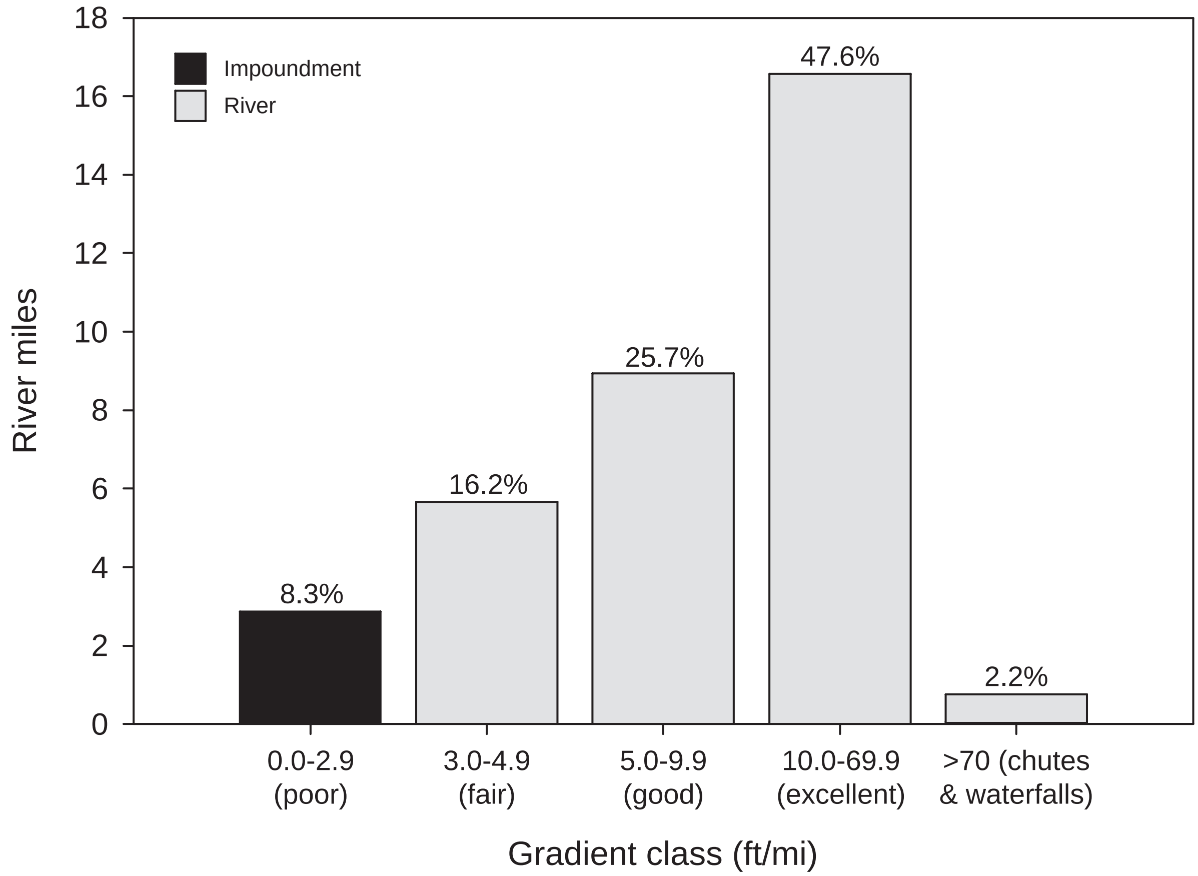


Figure 38.–Stream gradient distribution for the West Branch Ontonagon River. Fish habitat ranking in parentheses.

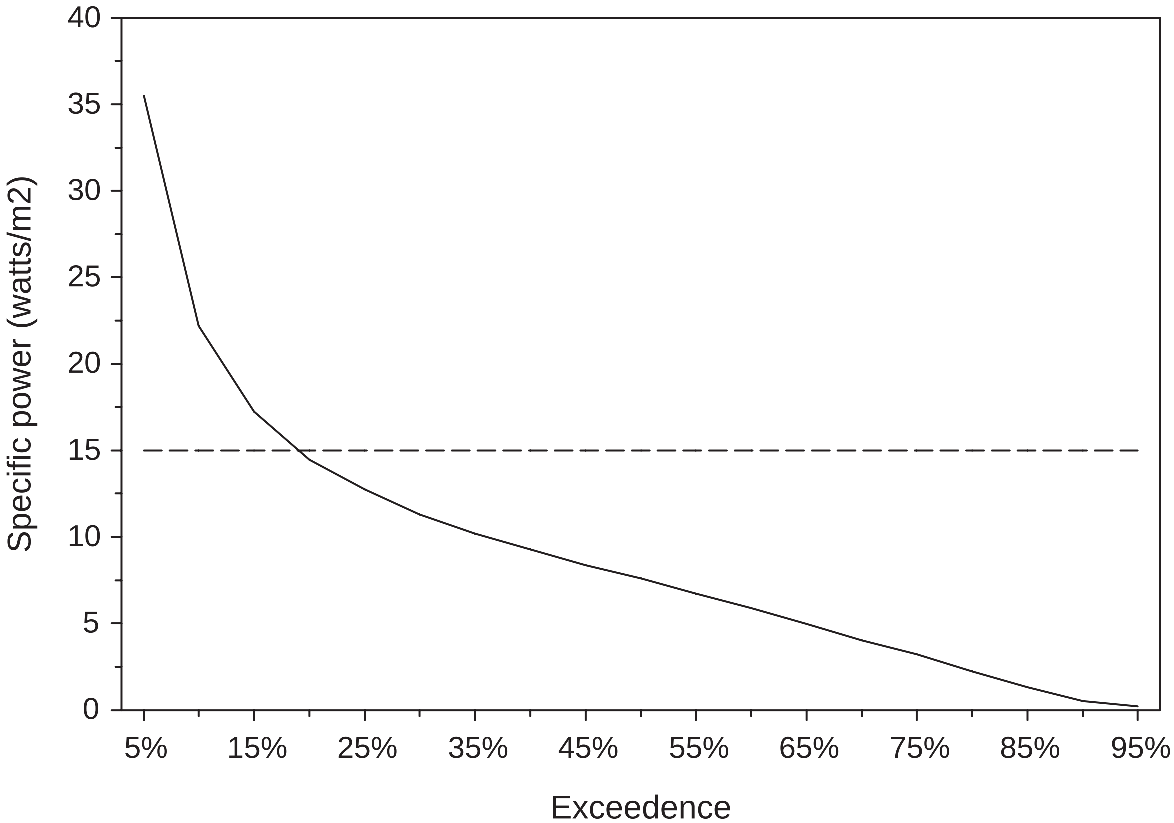


Figure 39.–Specific power for the West Branch Ontonagon River near Bergland.

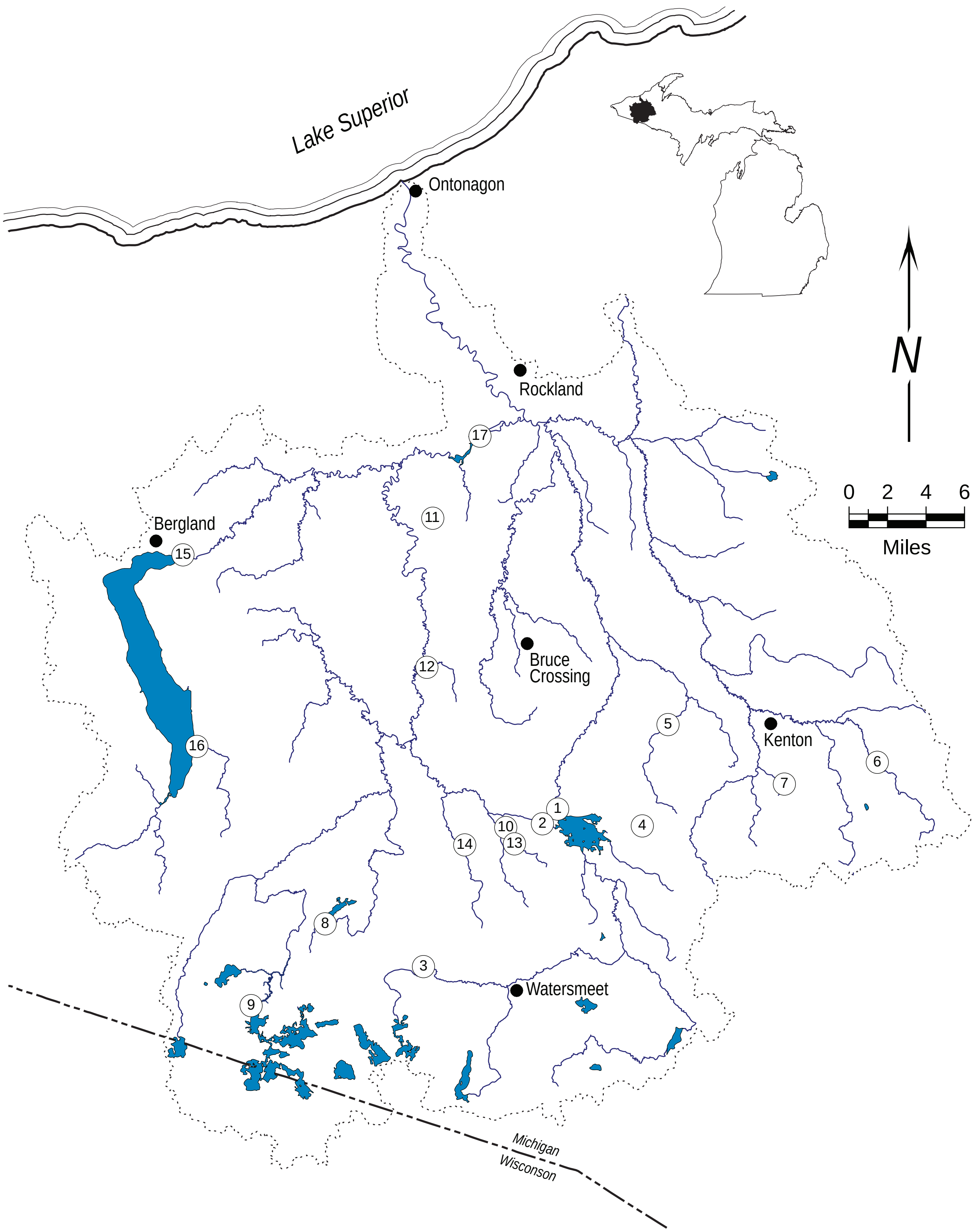


Figure 40.–Registered dams in the Ontonagon River watershed. (See Table 11 for dam descriptions.)

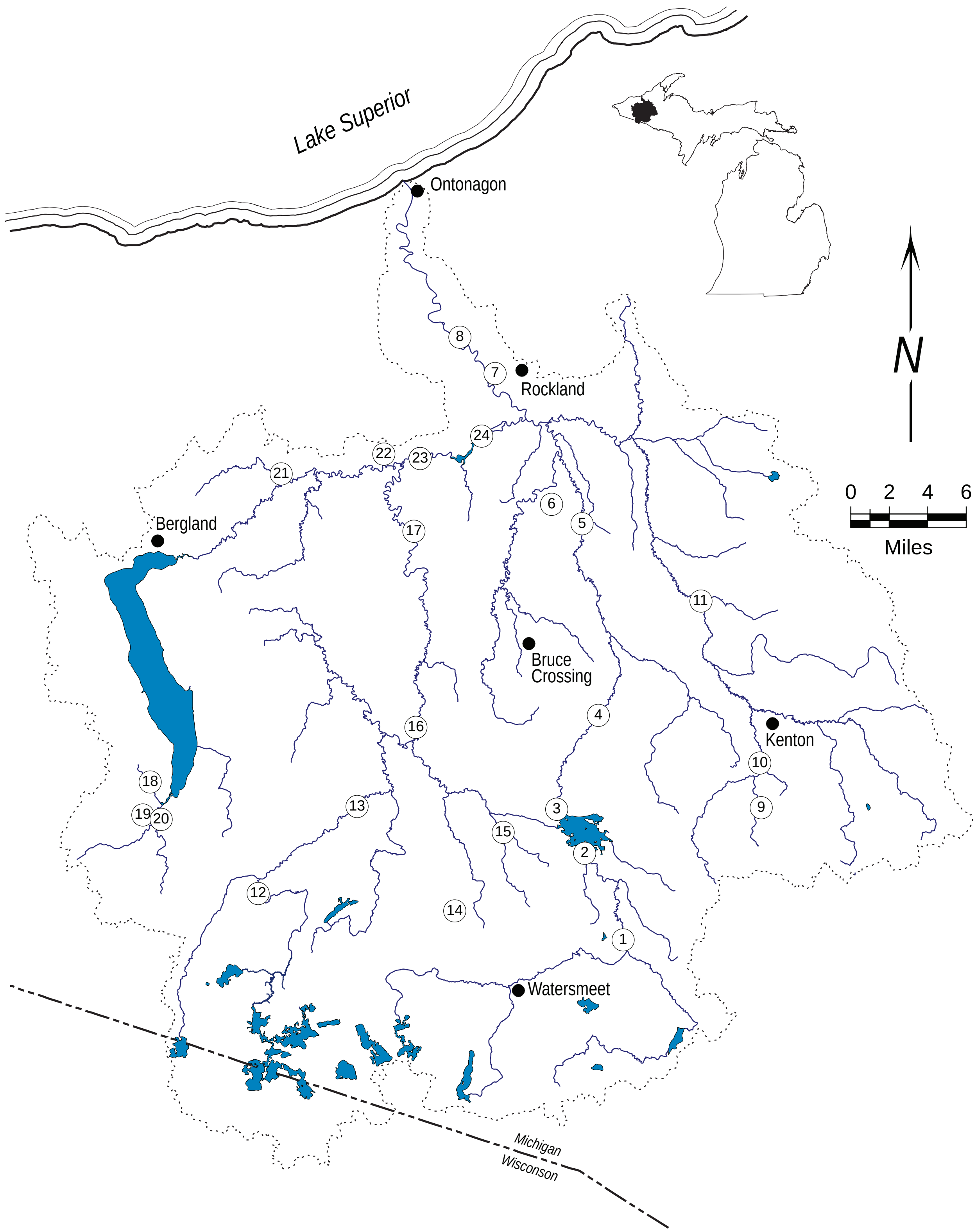


Figure 41.–Waterfalls in the Ontonagon River watershed. (See Table 12 for waterfall descriptions.)

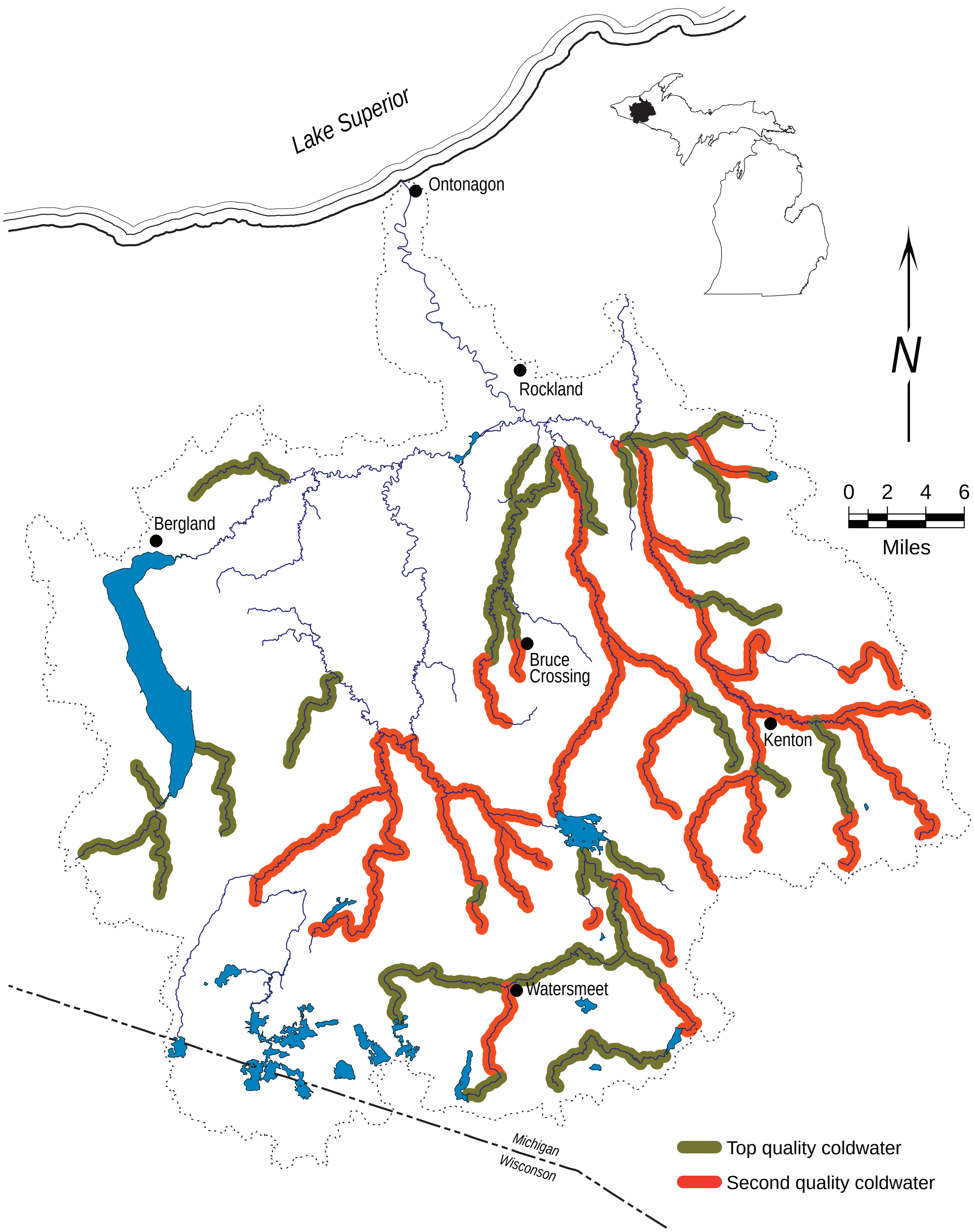


Figure 42.–Michigan Department of Natural Resources, Fisheries Division 1967 classification of the Ontonagon River watershed.

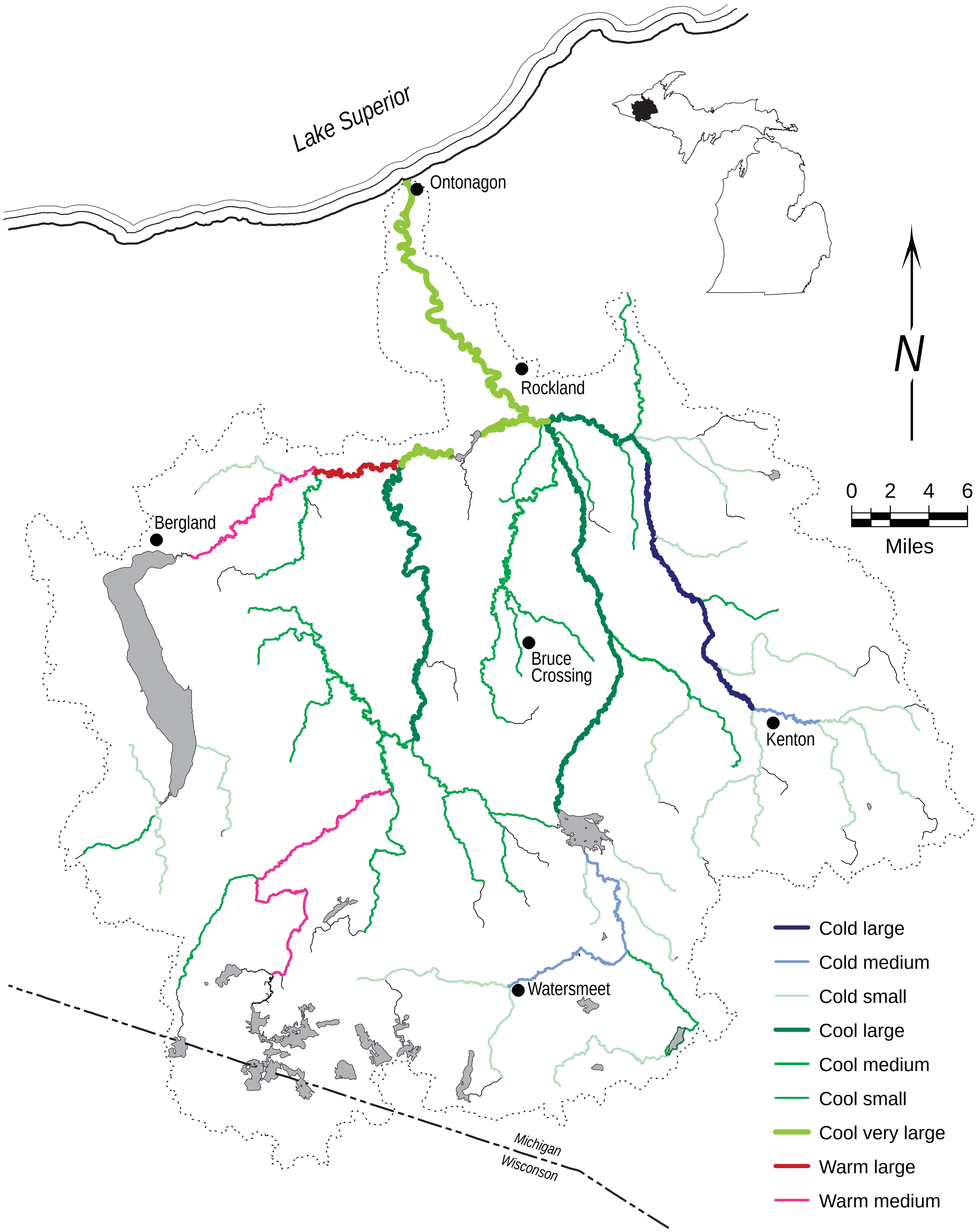


Figure 43.–Valley segments of the Ontonagon River watershed classified by stream temperature and catchment area (Baker 2006). Mean stream temperature during the first three weeks of July: cold = <66°F, cool = 66–72°F, and warm = >72°F; catchment area at the midpoint of the segment: small (headwater) = 10–40 mi^2, medium = 40–179 mi^2, large = 180–620 mi^2, and very large = >620 mi^2.

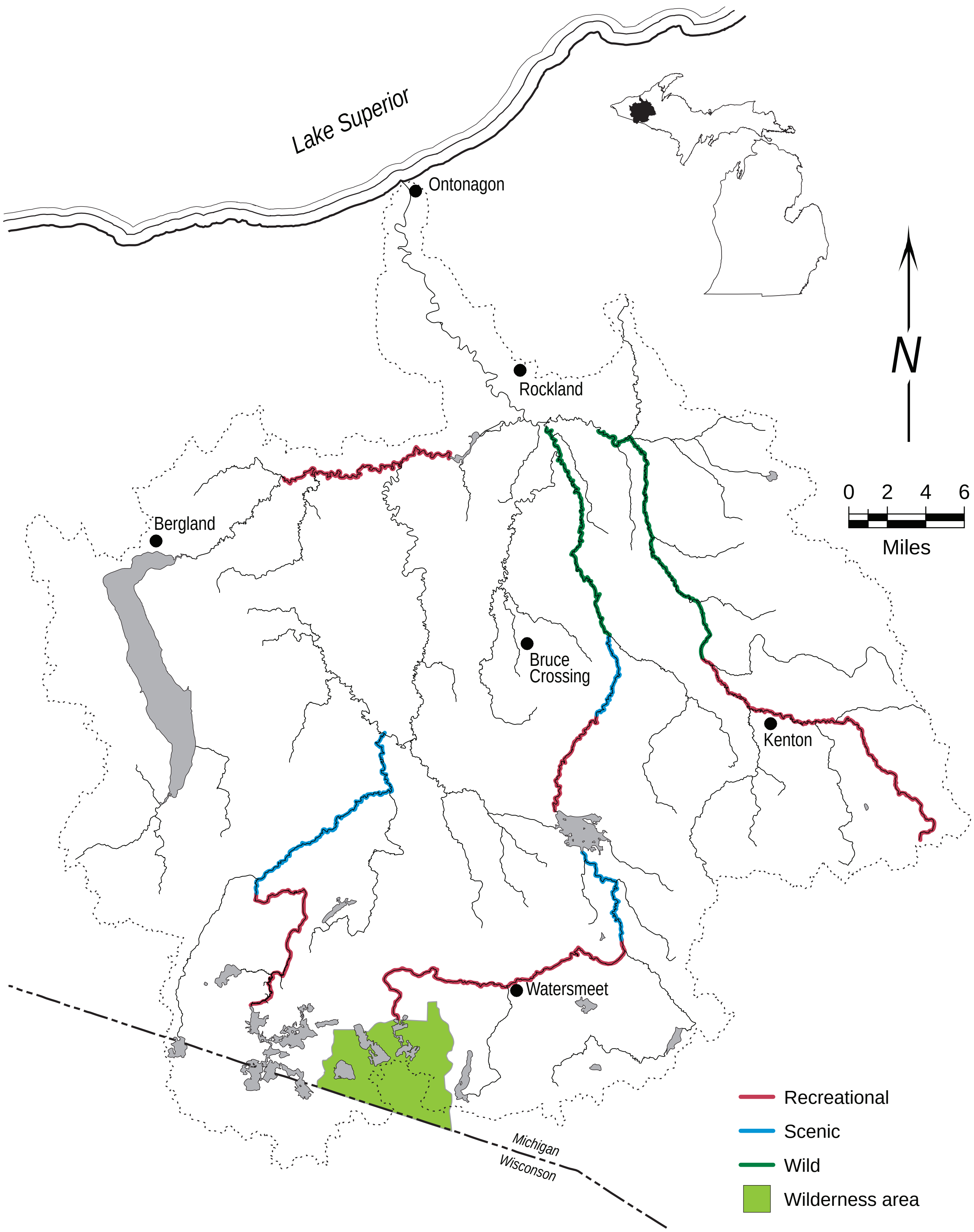


Figure 44.–Federal wild and scenic rivers within the Ontonagon River watershed and the Sylvania Wilderness Area in the Ottawa National Forest.

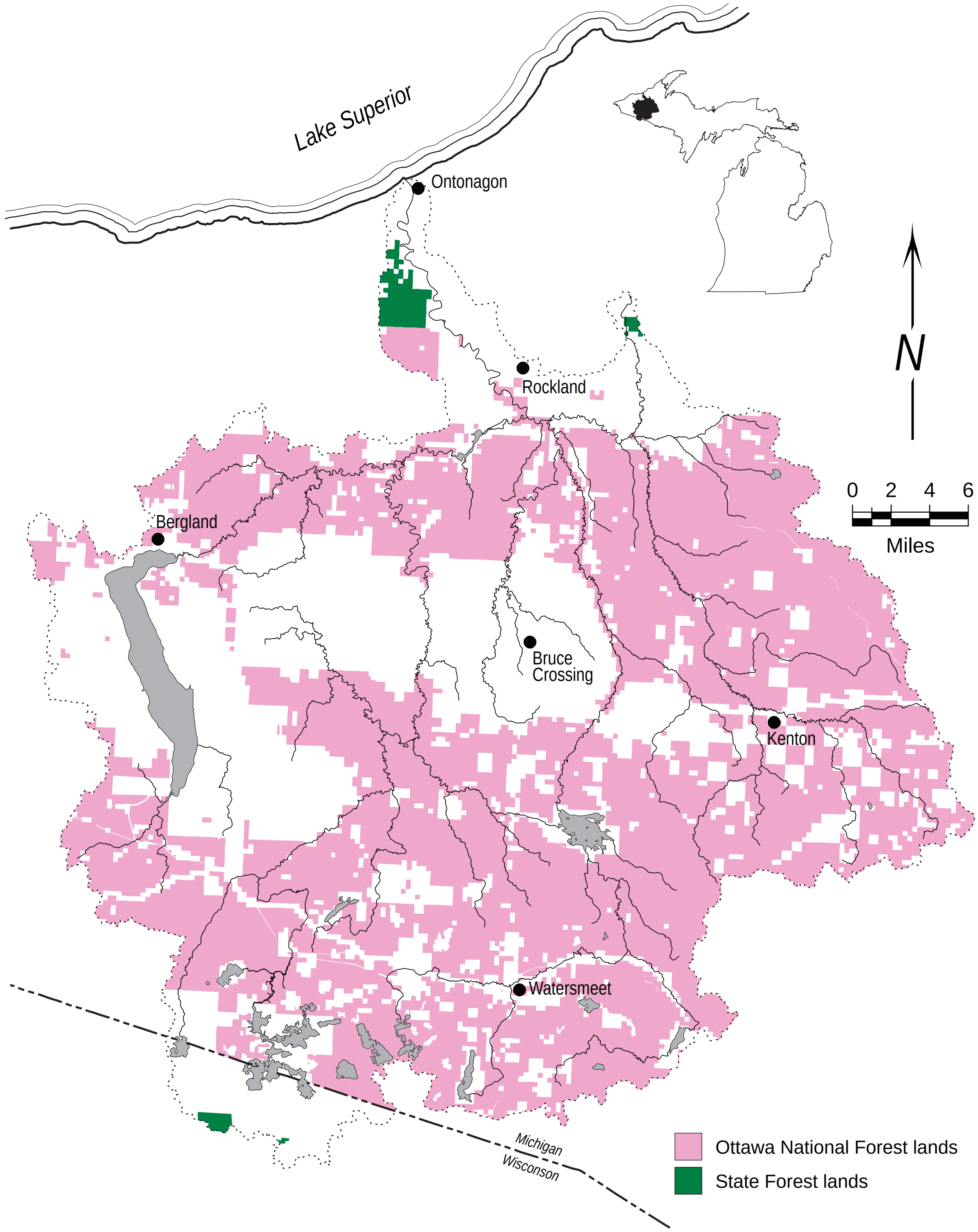


Figure 45.–Public land within the Ontonagon River watershed.

This page was intentionally left blank.

TABLES

This page was intentionally left blank.

Table 1.–Lengths of streams in the Ontonagon River watershed. Distances were measured from digital versions of 1:100,000 scale maps using ArcView GIS software (National Hydrography Dataset 1999).

Subwatershed stream name	Stream length (miles)
Middle Branch Main Stem—upper	43.1
Unnamed tributary	2.0
Unnamed tributary	1.9
Aho Creek	2.3
Deadman Creek & tributaries	4.7
Interior Creek	4.2
McGinty Creek	6.4
Tamarack River	23.7
Morrison Creek	2.5
Marion Creek	1.8
Perch Lake outlet	0.6
Boniface Creek	2.1
Sargents Creek	1.4
Duck Creek & tributaries	10.5
Henderson Creek & tributaries	4.7
Zigzag Creek	1.7
Wolf Creek & tributaries	3.8
Marathon Creek & tributaries	7.6
Total	125.0
Middle Branch Main Stem—lower	24.9
Spring Creek & tributaries	13.1
Baltimore River & tributaries	91.3
Unnamed tributary	1.6
Unnamed tributary	7.2
Unnamed tributary	1.5
Unnamed tributary	1.8
Unnamed tributary	1.6
Unnamed tributary	2.3
Unnamed tributary	1.5
Unnamed tributary	1.1
Trout Creek & tributaries	49.3
Unnamed tributary	1.5
Meto Creek	1.3
Tom Creek & tributaries	4.0
Payne Creek & tributaries	4.5
Total	208.5
Ontonagon River Main Stem	24.0
Unnamed tributary	5.7
Unnamed tributary	3.1
Unnamed tributary	1.9
Unnamed tributary	2.1
Unnamed tributary	1.9
Sucker Creek & tributaries	5.8

Table 1.–Continued.

Subwatershed stream name	Stream length (miles)
Ontonagon River Main Stem – continued	
Unnamed tributary	1.1
Gates Creek & tributaries	3.3
Unnamed tributary	2.8
Austin Creek	1.5
Unnamed tributary	2.2
Mill Creek & tributaries	19.7
Total	75.1
East Branch Main Stem	53.5
Deer Lick Creek & tributaries	7.3
Unnamed tributary	6.1
Adventure Creek & tributaries	20.7
Newholm Creek & tributaries	45.2
Bond Creek & tributaries	6.5
Unnamed tributary	1.3
Unnamed tributary	2.0
Porterfield Creek & tributaries	9.4
Unnamed tributary	3.4
Unnamed tributary	1.4
Kits Creek & tributaries	7.3
Unnamed tributary	2.6
Unnamed tributary	1.3
Unnamed tributary	2.1
Unnamed tributary	2.0
Onion Creek & tributaries	22.3
Unnamed tributary	0.9
Unnamed tributary	0.7
Debutant Creek & tributaries	2.8
Unnamed tributary	0.5
Beaver Creek & tributaries	32.4
Jumbo River & tributaries	40.2
Unnamed tributary	1.2
Unnamed tributary	1.8
Unnamed tributary	2.0
Spargo Creek	7.2
Stony Creek & tributaries	16.0
Smith Creek & tributaries	13.0
Johns Creek	4.4
Glitter Creek	3.6
Preston Creek & tributaries	2.6
Total	323.7
Cisco Branch Main Stem	30.9
Ratford Creek & tributaries	3.0
Custer Creek	1.2
Twomile Creek & tributaries	26.5

Table 1.–Continued.

Subwatershed stream name	Stream length (miles)
Cisco Branch Main Stem – continued	
Snuffbox Creek & tributaries	4.4
Unnamed tributary	1.8
Unnamed tributary	1.3
Tenderfoot Creek & tributaries	23.3
Grosbeck Creek	4.2
Unnamed tributary	1.2
Unnamed tributary	1.1
Langford Creek	1.8
Helen Creek & tributaries	3.7
Spring Creek & tributaries	4.2
Unnamed tributary	2.2
Unnamed tributary	0.2
Total	111.0
South Branch Main Stem	32.4
Unnamed tributary	1.4
Unnamed tributary	1.6
Farmer Creek & tributaries	5.2
Unnamed tributary	1.4
Unnamed tributary	1.7
Unnamed tributary	1.2
Unnamed tributary	2.6
Unnamed tributary	1.4
Cedar Creek & tributaries	14.9
Unnamed tributary	1.1
Unnamed tributary	1.2
Kostlenick Creek	4.1
Unnamed tributary	1.3
Unnamed tributary	1.6
Unnamed tributary	1.2
Sucker Creek & tributaries (including Bond Falls Canal)	67.5
Tenmile Creek & tributaries	83.5
Total	225.3
West Branch Main Stem	34.7
Victoria Bypass	1.6
Cushman Creek	1.1
Erickson Creek	3.7
Schaat Creek & tributaries	4.8
Johnson Creek	4.7
Gleason Creek	1.5
Whiskey Hollow Creek	1.7
Woodpecker Creek & tributaries	7.9
Mill Creek & tributaries	46.9
Cascade Creek & tributaries	31.1
Unnamed tributary	1.3

Table 1.–Continued.

Subwatershed stream name	Stream length (miles)
West Branch Main Stem – continued	
Trestle Creek	1.4
Stindt Creek	1.8
Unnamed tributary	0.8
Knute Creek	3.0
Merriweather Creek & tributaries	12.7
Hendrick Creek	3.1
Bingham Creek	3.4
Gillis Creek	1.3
Marshall Creek & tributaries	6.9
Slate River & tributaries	29.0
Trout Brook & tributaries	14.0
Montgomery Creek & tributaries	3.6
Total	222.0
Watershed total	1,290.6

Table 2.–Lakes with a surface area ≥10 acres in the Ontonagon River watershed.

Segment Lake	County	Latitude	Longitude	Acreage
Middle Branch—upper				
Albino Lake	Gogebic	46.26110	89.26260	16.6
Allen Lake	Gogebic	46.22498	89.17232	76.6
Anderson Lake	Gogebic	46.21387	89.14593	80.8
Bass Lake	Gogebic	46.30498	89.17427	183.4
Beaver Dam Lake	Gogebic	46.24110	89.17232	15.6
Beaver Pond	Gogebic	46.24259	89.08241	24.0
Beaver Station Lake	Gogebic	46.23332	89.17510	24.5
Bluegill Lake	Gogebic	46.30303	89.02470	10.4
Bond Falls Flowage	Ontonagon	46.39443	89.10343	2,080.1
Buck Lake	Gogebic	46.31998	89.10927	19.0
Camp Lake	Ontonagon	46.39809	89.05469	17.1
Castle Lake	Gogebic	46.31526	89.07371	30.4
Clark Lake	Gogebic	46.22498	89.31677	853.7
Clear Lake	Gogebic	46.24925	89.27221	35.3
Corey Lake	Gogebic	46.23203	89.29787	22.2
Crooked Lake	Gogebic	46.23332	89.29177	612.6
Damon Lake	Gogebic	46.26928	89.37784	109.7
Dellies Lake	Gogebic	46.24206	89.14415	11.1
Devils Head Lake	Gogebic	46.21387	89.24177	94.2
Dinner Lake	Gogebic	46.19998	89.13565	107.7
Doyle Lake	Gogebic	46.25368	89.28705	10.1
Duck Lake	Gogebic	46.20832	89.21677	609.6
East Bear Lake	Gogebic	46.24165	89.25427	39.5
Englesby Lake	Gogebic	46.27498	88.99593	39.3
Fleury Lake	Gogebic	46.23332	89.15010	10.1
Germain Lake	Gogebic	46.21315	89.26567	14.8
Hattie Lake	Gogebic	46.25693	89.36954	22.0
Helen Lake	Gogebic	46.24374	89.34077	67.7
High Lake	Gogebic	46.23748	89.27788	64.5
Hilltop Lake	Gogebic	46.24052	89.23378	18.0
Hoist Lake	Gogebic	46.18332	89.15843	32.9
Horseshoe Lake	Gogebic	46.25415	89.06677	58.8
Imp Lake	Gogebic	46.21665	89.07510	89.0
Jennings Lake	Gogebic	46.24026	89.20149	22.2
Joyce Lake	Gogebic	46.29443	89.27093	23.0
Katherine Lake	Gogebic	46.24026	89.31260	38.3
Kvidera Lake	Gogebic	46.23136	89.17006	31.9
Lindsley Lake	Gogebic	46.21804	89.42788	155.6
Little Duck Lake	Gogebic	46.22615	89.22754	43.2
Lumberjack Lake	Gogebic	46.25109	89.14490	20.5
Marion Lake	Gogebic	46.26387	89.08760	295.8
Mountain Lake	Gogebic	46.23054	89.25982	105.3
Ogima Lake	Gogebic	46.28973	89.27369	89.7
Partridge Lake	Gogebic	46.25415	89.30704	12.1
Perch Lake	Gogebic	46.31110	89.10427	82.0
Porcupine Lake	Gogebic	46.25832	89.23899	30.9

Table 2.–Continued.

Segment Lake	County	Latitude	Longitude	Acreage
Middle Branch—upper – continued				
Powwow Lake	Gogebic	46.24304	89.11954	53.4
Rickles Lake	Gogebic	46.24928	89.21191	14.6
Schneider Lake	Gogebic	46.25137	89.13482	37.1
Shadow Lake	Gogebic	46.22776	89.15565	21.3
Slope Lake	Gogebic	46.26665	89.11538	10.4
Snap Jack Lake	Gogebic	46.24721	89.35565	49.9
Sun Lake	Gogebic	46.24304	89.10010	32.4
Tamarack Lake	Iron	46.24739	88.98586	335.5
Taylor Lake	Gogebic	46.24276	89.04093	106.5
Temple Lake	Ontonagon	46.33998	89.05482	13.8
Tomassi Lake	Gogebic	46.25276	89.05704	27.4
Trail Lake	Gogebic	46.24721	89.23065	19.5
Trapper Lake	Gogebic	46.21351	89.25565	13.3
Twist Lake	Gogebic	46.17915	89.20288	18.5
Unnamed Lake	Iron	46.34598	88.98981	11.6
Unnamed Lake	Ontonagon	46.35986	89.00848	12.4
Unnamed Lake	Gogebic	46.26374	89.18557	12.6
Unnamed Lake	Gogebic	46.27464	89.01400	12.9
Unnamed Lake	Ontonagon	46.34688	89.09784	14.6
Unnamed Lake	Gogebic	46.24613	89.26056	18.5
Unnamed Lake	Gogebic	46.22136	89.00866	18.8
Unnamed Lake	Gogebic	46.29544	89.07419	24.0
Unnamed Lake	Ontonagon	46.39372	89.07166	27.2
West Bear Lake	Gogebic	46.24165	89.26260	63.0
Wilson Lake	Gogebic	46.20693	89.15843	30.6
Wilson Springs	Gogebic	46.18379	89.18376	15.8
Wolf Lake	Gogebic	46.29721	89.28760	248.1
Middle Branch—lower				
Erickson Lake	Ontonagon	46.45054	89.17038	17.1
Mattie Lake	Ontonagon	46.43248	89.06427	11.9
Main Stem				
Unnamed Lake	Ontonagon	46.78109	89.29055	16.1
East Branch				
Balcomb Lake	Iron	46.38387	88.95427	10.9
Bela Lake	Iron	46.37637	88.93343	64.3
Bender Lake	Houghton	46.59137	88.82538	12.6
Bob Lake	Houghton	46.66582	88.90871	129.0
Burns Lake	Houghton	46.34026	89.06899	13.3
Clear Lake	Iron	46.36915	88.95121	11.1
Crystal Lake	Houghton	46.50248	88.76177	16.6
Dog Lake	Iron	46.38276	88.73815	18.0
Dunn Lake	Iron	46.41637	88.84204	25.0
Echo Lake	Houghton	46.61248	88.84760	48.7
Gasley Lake	Iron	46.39990	88.75204	21.5
Glare Lake	Iron	46.40832	88.77649	10.4

Table 2.–Continued.

Segment Lake	County	Latitude	Longitude	Acreage
East Branch – continued				
Glitter Lake	Iron	46.41221	88.77565	25.0
Hager Lake	Houghton	46.46471	88.71815	41.5
Jingle Lake	Iron	46.39688	88.73342	29.7
Kunze Lake	Houghton	46.43899	88.72538	14.6
LaCrosse Lake	Iron	46.39776	88.76149	12.6
Lake On-three	Iron	46.42169	88.79440	28.7
Lake Thirteen	Houghton	46.46748	88.75371	73.1
Lewis Lake	Iron	46.38554	88.90149	26.7
Lower Dam Lake	Houghton	46.45203	88.78268	17.0
Maggie Lake	Houghton	46.42721	88.88843	18.5
Markey Lake	Houghton	46.57276	88.78232	47.9
McPherson Lake	Iron	46.37341	88.95568	24.2
Papoose Lake	Iron	46.37776	88.81815	30.6
Pathic Lake	Iron	46.40415	88.80565	16.6
Pine Lake	Houghton	46.57713	88.79584	12.1
Richard Lake	Houghton	46.58915	88.80593	10.1
Tepee Lake	Iron	46.38528	88.87804	121.8
Tinsel Lake	Iron	46.36161	88.98242	15.8
Unnamed Lake	Houghton	46.70555	88.91185	10.1
Unnamed Lake	Houghton	46.51234	88.97815	11.1
Unnamed Lake	Iron	46.39938	88.71739	32.9
Upper Dam Lake	Houghton	46.42708	88.74425	30.9
Cisco Branch				
Bay Lake	Gogebic	46.24369	89.48769	168.5
Beatons Lake	Gogebic	46.32804	89.36621	317.5
Benny Lake	Vilas	46.17227	89.45043	34.6
Bergner Lake	Gogebic	46.24582	89.51260	42.0
Big Lake	Vilas	46.20998	89.44399	771.0
Big African Lake	Gogebic	46.25163	89.39812	85.5
Big Mosquito Lake	Gogebic	46.24617	89.47046	13.8
Blair Lake	Ontonagon	46.34943	89.35704	15.3
Brown Lake	Gogebic	46.21665	89.47371	70.7
Cisco Lake	Gogebic	46.24165	89.44593	506.0
Clearwater Lake	Gogebic	46.25693	89.40982	173.5
Cleveland Lake	Vilas	46.17178	89.42785	34.6
Cloverleaf Lake	Gogebic	46.25520	89.45584	58.6
Cochran Lake	Vilas	46.18784	89.51652	125.8
Coffee Lake	Vilas	46.17275	89.46675	20.8
Cornelia Lake	Gogebic	46.26804	89.50288	13.6
Cox Lake	Gogebic	46.24165	89.42510	31.9
Crampton Lake	Vilas	46.20905	89.47091	65.2
Dalzell Lake	Vilas	46.19498	89.47474	24.0
Deadwood Lake	Vilas	46.20324	89.47513	24.2
Deeryard Lake	Gogebic	46.26665	89.44038	15.1
Devils Lake	Vilas	46.17407	89.52133	18.3
Dream Lake	Gogebic	46.20693	89.37510	24.5

Table 2.–Continued.

Segment Lake	County	Latitude	Longitude	Acreage
Cisco Branch – continued				
Dutch Lake	Gogebic	46.21387	89.45982	18.5
East Bay Lake	Gogebic	46.20276	89.40704	276.9
Emeline Lake	Gogebic	46.23887	89.47927	122.1
Erwin Lake	Vilas	46.16283	89.44726	13.6
Fishhawk Lake	Gogebic	46.21665	89.41677	77.1
Forest Lake	Vilas	46.14838	89.37807	461.6
Grace Lake	Gogebic	46.24721	89.46260	43.7
Gray Lake	Gogebic	46.22221	89.45010	46.2
Guides Lake	Gogebic	46.23918	89.45968	23.2
Hardin Lake	Vilas	46.17131	89.41284	63.0
Hartley Lake	Gogebic	46.32498	89.39177	23.0
Hay Lake	Gogebic	46.21387	89.33065	11.9
Helen Lake	Vilas	46.17989	89.42355	99.3
Indian Lake	Gogebic	46.21110	89.38482	94.6
Inkpot Lake	Vilas	46.18230	89.33511	11.9
Inkpot Lake	Gogebic	46.22776	89.50704	16.8
Jane Lake	Gogebic	46.21943	89.44177	18.3
Johnston Springs	Gogebic	46.19026	89.34371	12.1
Jones Lake	Vilas	46.18166	89.51723	53.9
Kickapoo Lake	Gogebic	46.22498	89.49788	13.1
Kinwamakwad Lake	Gogebic	46.23583	89.50222	19.5
Lake of the Woods	Vilas	46.15809	89.35475	14.8
Langford Lake	Gogebic	46.27498	89.47927	463.1
Little African Lake	Gogebic	46.25276	89.40427	20.5
Little Beatons Lake	Gogebic	46.33748	89.37371	73.4
Little Langford Lake	Gogebic	46.27498	89.49454	14.6
Long Lake	Gogebic	46.24165	89.36677	172.2
Mamie Lake	Gogebic	46.19165	89.38899	300.0
Merrill Lake	Vilas	46.16050	89.36217	22.7
Misty Lake	Gogebic	46.25274	89.48224	12.6
Moccasin Lake	Gogebic	46.23471	89.51260	15.3
Morley Lake	Gogebic	46.21387	89.43343	59.0
Morris Lake	Gogebic	46.25693	89.52093	12.6
Mule Lake	Gogebic	46.21804	89.38482	35.6
Palmer Lake	Vilas	46.19945	89.49973	649.9
Plum Lake	Gogebic	46.22360	89.50843	213.3
Poor Lake	Gogebic	46.21248	89.40427	98.1
Record Lake	Gogebic	46.25276	89.38760	68.3
Siskin Lake	Gogebic	46.21943	89.36954	10.4
Spider Lake	Gogebic	46.25415	89.46677	29.7
Spring Lake	Vilas	46.17624	89.35586	207.8
Tenderfoot Lake	Gogebic	46.22352	89.52581	443.3
Thousand Island Lake	Gogebic	46.22915	89.40010	1,078.0
Unnamed Lake	Vilas	46.20607	89.50858	11.4
West Bay Lake	Gogebic	46.20415	89.42788	283.0
Whitefish Lake	Gogebic	46.20832	89.35010	490.5

Table 2.–Continued.

Segment Lake	County	Latitude	Longitude	Acreage
South Branch				
Beaver Pond	Ontonagon	46.35230	89.16469	22.5
Brush Lake	Gogebic	46.32776	89.23760	20.5
County Line Lake	Ontonagon	46.33332	89.27510	62.3
Crane Lake	Gogebic	46.32082	89.30427	64.3
Deadman Lake	Ontonagon	46.33526	89.12232	46.0
Deer Lake	Ontonagon	46.37165	89.25038	12.4
Ox Yoke Lake	Gogebic	46.31928	89.28173	15.8
Pan Lake	Gogebic	46.31546	89.28816	18.8
Sand Lake	Ontonagon	46.38887	89.12371	12.9
Steusser Lake	Ontonagon	46.45304	89.25038	32.4
Sucker Lake	Gogebic	46.30370	89.25364	435.4
Unnamed Lake	Ontonagon	46.35026	89.13298	10.9
Unnamed Lake	Ontonagon	46.34910	89.20777	10.9
Unnamed Lake	Ontonagon	46.33455	89.21721	11.9
West Branch				
Banner Lake	Gogebic	46.32943	89.61288	27.4
Barb Lake	Gogebic	46.32693	89.58954	63.0
Cup Lake	Gogebic	46.38054	89.49177	88.2
Lake Gogebic	Ontonagon	46.49998	89.58343	13,048.1
Sun Dance Lake	Gogebic	46.35832	89.64454	55.9
Victoria Reservoir	Ontonagon	46.68695	89.23102	279.7
Weidman Lake	Ontonagon	46.64804	89.56732	27.4

Table 3.–Archaeological sites within the Ontonagon River watershed (B. Mead, Michigan Department of State, Office of the State Archaeologist, personal communication).

County Township(s)	Township coordinates	Number of archeological sites
Gogebic		
Watersmeet	T44N, R38W	7
Watersmeet	T44N, R39W	9
Watersmeet	T44N, R40W	0
Watersmeet	T44N, R41W	2
Watersmeet	T45N, R38W	37
Watersmeet	T45N, R39W	36
Watersmeet	T45N, R40W	18
Watersmeet	T45N, R41W	21
Marenisco	T45N, R42W	6
Marenisco	T45N, R43W	0
Marenisco	T46N, R41W	10
Marenisco	T46N, R42W	17
Marenisco	T46N, R43W	1
Marenisco	T47N, R41W	5
Marenisco	T47N, R42W	9
Marenisco	T47N, R43W	4
Houghton		
Duncan	T47N, R35W	7
Duncan	T47N, R36W	32
Duncan	T47N, R37W	36
Duncan	T48N, R36W	16
Duncan	T48N, R37W	13
Laird	T49N, R36W	10
Laird	T49N, R37W	28
Iron		
Stambaugh	T45N, R37W	8
Bates	T46N, R35W	1
Bates	T46N, R36W	7
Iron River	T46N, R37W	20
Ontonagon		
Interior	T46N, R38W	13
Haight	T46N, R39W	21
Haight	T46N, R40W	14
Interior	T47N, R38W	19
Haight	T47N, R39W	7
McMillan	T47N, R40W	20
Interior—Stannard	T48N, R38W	13
Stannard	T48N, R39W	0
McMillan	T48N, R40W	0
Matchwood	T48N, R41W	0
Bergland—Matchwood	T48N, R42W	8
Bergland	T48N, R43W	8
Stannard	T49N, R38W	16

Table 3.–Continued.

County Township(s)	Township coordinates	Number of archeological sites
Ontonagon – continued		
Stannard	T49N, R39W	12
Rockland—Matchwood	T49N, R40W	12
Matchwood	T49N, R41W	23
Bergland—Matchwood	T49N, R42W	13
Bergland	T49N, R43W	7
Bohemia	T50N, R37W	13
Greenland	T50N, R38W	3
Rockland	T50N, R39W	32
Ontonagon—Rockland	T50N, R40W	6
Ontonagon	T50N, R41W	5
Carp Lake	T50N, R42W	0
Greenland	T51N, R38W	0
Ontonagon—Rockland	T51N, R39W	2
Ontonagon	T51N, R40W	0
Ontonagon	T52N, R39W	10
Ontonagon	T52N, R40W	12
Total		649

Table 4.–Permeability and relative abundance of the various surficial materials found within the Ontonagon River watershed.

Material	Percent of watershed
High permeability	
Coarse-textured glacial till	16.9
End moraines of coarse-textured till	35.8
Glacial outwash sand, gravel, and postglacial alluvium	6.7
Medium permeability	
Lacustrine sand and gravel	4.3
Low permeability	
Fine-textured glacial till	0.6
Lacustrine clay and silt	33.8
Peat and muck	1.1
Thin to discontinuous till over bedrock	0.8

Table 5.–United States Geological Survey gauging stations used to monitor stream flows in the Ontonagon River watershed.

Subwatershed name, number, river, and location	Latitude Longitude	Period of record	Median discharge (ft^3/s)	(ft^3/s)	Watershed area (mi^2)	Mean yield ($ft^3 \cdot s^{-1} \cdot mi^{-2}$)
Middle Branch—upper						
1 Middle Branch Paulding	46.35694 89.07722	1942–2004	128	170	164	1.03
2 Middle Branch Trout Creek	46.47778 89.09028	1942–2004	50	66	203	0.33
Main Stem						
3 Ontonagon Above West Branch	46.69917 89.16000	1942–2004	289	514	671	0.77
4 Ontonagon Below West Branch	46.72083 89.20694	1942–2004	868	1,380	1,340	1.03
East Branch						
5 East Branch Mass City	46.69000 89.07333	1942–1979	165	257	272	0.94
Cisco Branch						
6 Cisco Branch Cisco Lake	46.25333 89.45139	1944–2004	36	46	51	0.90
South Branch						
7 South Branch Ewen	46.53278 89.27694	1942–1971	350	494	348	1.42
8 Bond Falls Canal Paulding	46.39917 89.14639	1942–2004	127	134	NA	NA
West Branch						
9 West Branch Bergland	46.58750 89.54167	1942–2004	125	170	162	1.05

Table 6.–Low flow (90% exceedence), median flow (50% exceedence), high flow (10% exceedence), low flow yield and high flow yield at United States Geological Survey gauging stations within the Ontonagon River watershed. Exceedence refers to the probability of a discharge exceeding a given value. Ratios of high flow to low flow for other Michigan streams are included for comparison.

Stream Location	Period of record	Median flow (ft^3/s)	Low flow (ft^3/s)	Low flow yield ($ft^3 \cdot s^{-1} \cdot mi^{-2}$)	High flow (ft^3/s)	High flow yield ($ft^3 \cdot s^{-1} \cdot mi^{-2}$)	High flow/ low flow
Middle Branch Ontonagon River							
Paulding	1942–2004	128	88.0	0.54	291	1.77	3.31
Trout Creek	1942–2004	50	44.0	0.22	72	0.35	1.64
Ontonagon River							
Above West Branch	1942–2004	289	208.0	0.31	1,010	1.51	4.86
Below West Branch	1942–2004	868	500.0	0.37	2,740	2.04	5.48
East Branch Ontonagon River							
Mass City	1942–1979	165	115.0	0.42	500	1.84	4.35
Cisco Branch Ontonagon River							
Cisco Lake Outlet	1944–2004	36	0.9	0.02	103	2.03	101.58
South Branch Ontonagon River							
Ewen	1942–1971	350	204.0	0.59	906	2.60	4.44
Bond Falls Canal							
Paulding	1942–2004	127	5.5	NA	294	NA	53.45
West Branch Ontonagon River							
Bergland	1942–2004	125	8.4	0.05	366	2.26	43.57
North Branch Kawkawlin River							
Kawkawlin							1,768.32
White River							
Whitehall							2.81
Au Sable River							
Grayling							1.94

Table 7.–Definition of flow stability indices using the ratio of high flow yield (10% exceedence) to low flow yield (90% exceedence). Data from P. Seelbach, Michigan Department of Natural Resources, Fisheries Division.

Flow index (high flow/low flow)	Classification	Description
1.0–2.0	Very good	Typical of self-sustaining trout streams
2.1–5.0	Good	Better warmwater rivers
5.1–10	Fair	Somewhat flashy warmwater rivers
>10	Poor	Very flashy warmwater rivers

Table 8.–Number of stream crossings, by county, for the Ontonagon River watershed (MIRIS Base Data 1998).

	County					
Stream crossings	Gogebic	Houghton	Iron	Ontonagon	Vilas	Total
County roads	63	54	6	175	2	300
Highways	19	6	0	47	0	72
Streets	2	0	0	12	7	21
Trails	21	15	3	79	0	118
Railroads	36	11	1	49	0	97
Powerlines	1	0	0	0	0	1
Pipelines	24	11	0	18	0	53
Total	166	97	10	380	9	662

Table 9.–Stream gradient classes and associated fish habitat rankings and channel characteristics (G. Whelan, MDNR, Fisheries Division, personal communication).

Gradient class	Fish habitat	Channel characteristics
0–2.9 ft/mi	poor	mostly run habitat with nearly uniform depths and velocities
3.0–4.9 ft/mi	fair	some riffles with low variability of depths and velocities
5.0–9.9 ft/mi	good	irregular riffle-pool sequences with moderate variability of depths and velocities
10.0–69.9 ft/mi	excellent	regular riffle-pool sequences with high variability of depths and velocities
70.0–149.9 ft/mi	fair	chute and pool habitats with moderate variability of depths and velocities
>150 ft/mi	poor	falls and rapids with low variability of depths and velocities

Table 10.–Measured and expected channel widths for United States Geological Survey gauge sites in the Ontonagon River watershed. Number references gauge site in Figure 7. Measured channel widths outside of the expected range are marked with an asterisk (*). Width and discharge (Q, ft^3/s) measurements were used to calculate expected width with the following formulas.

$$\text{Lower 95\% width} = 10^{(0.662895 + 0.471522 \cdot \log_{10}(Q))}$$
$$\text{Expected mean width} = 10^{(0.741436 + 0.498473 \cdot \log_{10}(Q))}$$
$$\text{Upper 95\% width} = 10^{(0.819976 + 0.525423 \cdot \log_{10}(Q))}$$

Subwatershed name, number, river, and location	Width (ft)	Mean discharge (ft^3/s)	Lower 95% width (ft)	Expected mean width (ft)	Upper 95% width (ft)
Middle Branch—upper					
1 Middle Branch Paulding	45*	170	52	71	98
2 Middle Branch Trout Creek	48	66	33	45	60
Main Stem					
3 Ontonagon Above West Branch	111	514	87	124	176
4 Ontonagon Below West Branch	139	1,340	139	203	295
East Branch					
5 East Branch Mass City	69	257	63	88	122
Cisco Branch					
6 Cisco Branch Cisco Lake	33	46	28	37	49
South Branch					
7 South Branch Ewen	99	494	86	121	172
8 Bond Falls Canal Paulding	28*	134	46	63	87
West Branch					
9 West Branch Bergland	71	170	52	71	98

Table 11.–Registered dams in the Ontonagon River watershed. Number references dam location in Figure 40. Dam purpose: hydroelectric (H), recreation (R), or other (O). Hazard type: 1 = high, 2 = significant, and 3 = low. High hazard means loss of life would occur if the dam failed, and significant hazard means large amounts of property damage would occur.

Subwatershed name, number, dam name, and stream	Date built	Current purpose	Owner	Height (ft)	Surface acres	Storage (acre-ft)	Mean depth (ft)	Hazard rating
Middle Branch—upper								
1 Bond Falls Dam Middle Branch Ontonagon River	1938	H	UPPCo	50	2,160	36,000	16.7	1
2 Bond Falls Control Dam Middle Branch Ontonagon River	1938	H	UPPCo	40	2,160	36,000	16.7	1
3 Wolf Lake Dam Wolf Lake Creek	1965	R	Private	14	250	468	1.9	3
Middle Branch—lower								
4 Calderwood Pond Dam West Branch Trout Creek	1982	O	USFS	11	13	86	6.6	3
5 Trout Creek Dam Trout Creek	1899	R	Township	12	6	34	5.7	2
East Branch								
6 Lower Dam East Branch Ontonagon River	1965	R	USFS	23	17	180	10.6	3
7 Nordine Dam Walton Creek	1970	R	Private	9	26	65	2.5	3
Cisco Branch								
8 Beatons Lake Dam Tributary to Twomile Creek	1988	O	MDNR	3	323			3
9 Cisco Dam Cisco Branch Ontonagon River	1931	H	UPPCo	11	4,025	10,500	2.6	3
South Branch								
10 Fulton's Pond Dam Tributary to Paulding Creek		R	Private	5	12			3
11 Kitchin Dam Tributary to South Branch Ontonagon River	1973	R	Private	7	14	58	4.1	3
12 Kostlenick Dam Tributary to South Branch Ontonagon River		R	Private	7	1			3
13 Paulding Pond Dam Paulding Creek	1958	R	USFS	6	7	20	2.9	3
14 Robbins Pond Dam Tributary to Sucker Creek	1955	R	USFS	4	6			3
West Branch								
15 Bergland Dam West Branch Ontonagon River	1906	H	UPPCo	8	14,080	276,000	19.6	3
16 Trout Brook Dam* Trout Brook		R	Private	8				3
17 Victoria Dam West Branch Ontonagon River	1930	H	UPPCo	115	250	10,300	41.2	1

* Dam built during the early 1960s, but exact date of construction is unknown

Table 12.–Waterfalls in the Ontonagon River watershed. Waterfall identification numbers are referenced in Figure 41.

Subwatershed, number, name	Stream	Potamodromous fish passage
Middle Branch—upper		
1 Mex-i-min-e Falls	Middle Branch Ontonagon River	NA
2 Little Falls	Middle Branch Ontonagon River	NA
3 Bond Falls	Middle Branch Ontonagon River	NA
Middle Branch—lower		
4 Agate Falls	Middle Branch Ontonagon River	No
5 Three Rapids Falls	Middle Branch Ontonagon River	Yes
6 O Kun de Kun Falls	Baltimore River	No
Main Stem		
7 Irish Rapids Falls	Ontonagon River	Yes
8 Grand Rapids Falls	Ontonagon River	Yes
East Branch		
9 Duppy Falls	Jumbo River	Yes
10 Jumbo Falls	Jumbo River	Yes
11 Onion Falls	Onion Creek	No
Cisco Branch		
12 Kakabika Falls	Cisco Branch Ontonagon River	NA
13 Wolverine Falls	Cisco Branch Ontonagon River	NA
South Branch		
14 Ajibikoka Falls	Sucker Creek	NA
15 Rock Bluff Falls	Bluff Creek	NA
16 Eighteen Mile Rapids Falls	South Branch Ontonagon River	NA
17 Flannigan Rapids Falls	South Branch Ontonagon River	NA
West Branch		
18 Marshall Falls	Marshall Creek	NA
19 Nelson Canyon Falls	Nelson Creek	NA
20 Judson Falls	Slate River	NA
21 Cascade Falls	Cascade Creek	NA
22 Gleason Creek Falls	Gleason Creek	NA
23 Sandstone Rapids Falls	Schaat Creek	NA
24 Victoria Falls	West Branch Ontonagon River	No

Table 13.–National Pollution Discharge Elimination System permits issued (as of 2006) in the Ontonagon River watershed by the Michigan Department of Environmental Quality, Water Bureau. (WWSL = waste water sewage lagoon, MDOT = Michigan Department of Transportation, OCRC = Ontonagon County Road Commission).

Facility	Watercourse	City
Middle Branch—upper		
Pitlik & Wick, Inc.*	Middle Branch Ontonagon River	Watersmeet
Watersmeet Township WWSL	Middle Branch Ontonagon River	Watersmeet
Middle Branch—lower		
Interior Township WWSL	Trout Creek	Trout Creek
Stannard Township WWSL	Tributary to Baltimore River	Bruce Crossing
Main Stem		
MDOT M-64 Relocation	Ontonagon River	Ontonagon
OCRC Rockland Road Garage	Ontonagon River	Ontonagon
Ontonagon WWSL	Ontonagon River	Ontonagon
Rockland Township WWSL	Ontonagon River	Rockland
Stone Container	Ontonagon River	Ontonagon
East Branch		
Greenland Township WWSL	Adventure Creek	Mass City
South Branch		
McMillan Township WWSL	South Branch Ontonagon River	Ewen

* Also has industrial storm water permit

Table 14.–Valley segments of the Ontonagon River watershed classified by stream temperature and catchment area, with number of segments and percent of total stream length (Baker 2006). Mean stream temperature during the first three weeks of July: cold = <66°F, cool = 66–72°F, and warm = >72° F; catchment area at the midpoint of the segment: small (headwater) = 10–40 mi^2, medium = 40–179 mi^2, large = 180–620 mi^2, and very large = >620 mi^2.

Valley segment type	Number of segments	% of total stream length
Cold small	23	25.9
Cold medium	3	4.4
Cold large	1	4.3
Cool small	20	28.5
Cool medium	4	7.8
Cool large	4	13.6
Cool very large	4	5.8
Warm medium	3	8.1
Warm large	1	1.5
Impounded	2	0.1

Table 15.–Public campgrounds in the Ontonagon River watershed. (USFS = United States Forest Service; MDNR—PRD = Michigan Department of Natural Resources, Parks and Recreation Division).

Subwatershed	Site name	Adjacent lakes or streams	Administrating agency
Middle Branch—upper	Burned Dam Campground	Middle Branch Ontonagon River	USFS
	Imp Lake Campground	Imp Lake	USFS
	Marion Lake Campground	Marion Lake	USFS
	Sylvania Campground	Clark Lake	USFS
Middle Branch—lower	Bruce Crossing Park	None	Stannard Township
East Branch	Bob Lake Campground	Bob Lake	USFS
	Sparrow Rapids Campground	East Branch Ontonagon River	USFS
Cisco Branch	Langford Lake Campground	Langford Lake	USFS
South Branch	Robbins Pond Campground	Robbins Pond	USFS
West Branch	Bergland Township Park	Lake Gogebic	Bergland Township
	Lake Gogebic County Park	Lake Gogebic	Gogebic County
	Ontonagon County Park	Lake Gogebic	Ontonagon County
	Lake Gogebic State Park	Lake Gogebic	MDNR—PRD

Table 16.–Statutes that protect aquatic resources and are administered by the Michigan Department of Environmental Quality, Water Bureau. (PA = Public Act, NRP = Natural Resources and Environmental Protection Act of 1994 [PA 451]).

State of Michigan Acts	Description of Acts
Public Health Code (1978 PA 386, as amended)	Aquatic nuisance control: regulates the application of substances to control swimmer's itch and aquatic vegetation
Part 13 NRP Act	Floodplain regulatory authority: regulates activities that occupy, fill, or grade lands within floodplains or rivers
Part 31 NRP Act	Water resource protection: regulates discharges to surface waters according to set water quality standards
Part 41 NRP Act	Sewerage systems: regulates wastewater or sewer treatment facilities
Part 91 NRP Act	Soil erosion and sedimentation control: regulates any earth change that disturbs one or more acres or is located within 500 ft of a lake or stream
Part 301 NRP Act	Inland lakes and streams: regulates structure placement or removal, dredge or fill activities below the ordinary high water mark, and operation or construction of marinas on lakes or streams
Part 303 NRP Act	Wetland protection: regulates dredging, filling, and structure placement within wetlands
Part 307 NRP Act	Inland lake level: regulates the establishment of legal lake levels and lake level control structures
Part 309 NRP Act	Inland improvement: regulates the establishment of lake boards and revolving funds to protect and improve lakes
Part 315 NRP Act	Dam safety: establishes a program to maintain a statewide inventory of dams, and provides staff to inspect dams to evaluate the integrity of the structures
Part 323 NRP Act	Shoreline protection and management: regulates construction activities within designated Great Lakes shoreline areas
Part 325 NRP Act	Great Lakes submerged lands: regulates certain activities on Great Lakes bottomlands, such as marina construction, dredging, filling, and placement of shore protection structures
Part 341 NRP Act	Irrigation: regulates the use of Great Lakes water for irrigation

Table 17.–Fishes in the Ontonagon River watershed. Data from University of Michigan Museum of Zoology and MDNR – Fisheries Division survey reports. Species origin: N = native, C = colonized, I = introduced, U = unknown. Current status: P = recent observation, R = extirpated and reintroduced, and U = status unknown. Asterisk (*) = Identification questionable.

Common name	Scientific name	Species origin	Current status
lampreys	Petromyzontidae		
northern brook lamprey	*Ichthyomyzon fossor*	N	P
silver lamprey	*Ichthyomyzon unicuspis*	N	P
sea lamprey	*Petromyzon marinus*	C	P
sturgeons	Acipenseridae		
lake sturgeon	*Acipenser fulvescens*	N	R
herrings	Clupeidae		
alewife	*Alosa pseudoharengus*	C	P
minnows	Cyprinidae		
lake chub	*Couesius plumbeus*	N	P
spotfin shiner*	*Cyprinella spiloptera*	U	U
common carp	*Cyprinus carpio*	C	U
brassy minnow	*Hybognathus hankinsoni*	N	P
common shiner	*Luxilus cornutus*	N	P
northern pearl dace	*Margariscus nachtriebi*	N	P
hornyhead chub	*Nocomis biguttatus*	N	P
golden shiner	*Notemigonus crysoleucas*	N	P
emerald shiner	*Notropis atherinoides*	N	P
bigmouth shiner	*Notropis dorsalis*	N	P
blackchin shiner	*Notropis heterodon*	N	P
blacknose shiner	*Notropis heterolepis*	N	P
spottail shiner	*Notropis hudsonius*	N	P
sand shiner	*Notropis stramineus*	N	P
mimic shiner	*Notropis volucellus*	N	P
northern redbelly dace	*Phoxinus eos*	N	P
finescale dace	*Phoxinus neogaeus*	N	P
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		
longnose sucker	*Catostomus catostomus*	N	P
white sucker	*Catostomus commersonii*	N	P
silver redhorse	*Moxostoma anisurum*	N	P
shorthead redhorse	*Moxostoma macrolepidotum*	N	P
catfishes	Ictaluridae		
black bullhead	*Ameiurus melas*	N	P
yellow bullhead	*Ameiurus natalis*	N	P
brown bullhead	*Ameiurus nebulosus*	N	P
stonecat*	*Noturus flavus*	I	U
margined madtom	*Noturus insignis*	I	U

Table 17.–Continued.

Common name	Scientific name	Species origin	Current status
pikes	Esocidae		
northern pike	*Esox lucius*	N	P
muskellunge	*Esox masquinongy*	N	P
tiger muskellunge	*Esox lucius x E. masquinongy*	N	P
mudminnows	Umbridae		
central mudminnow	*Umbra limi*	N	P
smelts	Osmeridae		
rainbow smelt	*Osmerus mordax*	I	P
trouts	Salmonidae		
lake herring	*Coregonus artedi*	N	P
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
round whitefish	*Prosopium cylindraceum*	N	P
Atlantic salmon	*Salmo salar*	C	P
brown trout	*Salmo trutta*	I	P
brook trout	*Salvelinus fontinalis*	N	P
lake trout	*Salvelinus namaycush*	N	P
splake	*Salvelinus fontinalis x S. namaycush*	N	P
trout-perches	Percopsidae		
trout-perch	*Percopsis omiscomaycus*	N	P
cods	Gadidae		
burbot	*Lota lota*	N	P
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
spoonhead sculpin	*Cottus ricei*	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*	U	U
smallmouth bass	*Micropterus dolomieu*	N	P
largemouth bass	*Micropterus salmoides*	N	P
black crappie	*Pomoxis nigromaculatus*	N	P

Table 17.–Continued.

Common name	Scientific name	Species origin	Current status
perches	Percidae		
Iowa darter	*Etheostoma exile*	N	P
johnny darter	*Etheostoma nigrum*	N	P
ruffe	*Gymnocephalus cernuus*	C	P
yellow perch	*Perca flavescens*	N	P
northern logperch	*Percina caprodes*	N	P
walleye	*Sander vitreus*	N	P

Table 18.–Mussels that could be expected to reside within the Ontonagon River watershed (SC = state listed special concern species). Data from Cummings and Mayer (1992). Asterisk (*) = Exotic species.

Common name	Scientific name
mucket	*Actinonaias carinata*
elktoe (sc)	*Alasmidonta marginata*
three-ridge	*Amblema plicata*
cylindrical papershell	*Anodontoides ferussacianus*
spike	*Elliptio dilatata*
fatmucket	*Lampsilis siliquoidea*
plain pocketbook	*Lampsilis cardium*
white heelsplitter	*Lasmigona complanta*
creek heelsplitter	*Lasmigona compressa*
fluted-shell	*Lasmigona costata*
black sandshell	*Ligumia recta*
giant floater	*Pyganodon grandis*
squawfoot	*Strophitus undulates*
Wabash pigtoe	*Fusconaia flava*
round pigtoe (sc)	*Pleurobema coccineum*
zebra mussel*	*Dreissena polymorpha*

Table 19.–Aquatic macroinvertebrates of the Middle Branch (upper and lower), East Branch, and Cisco Branch subwatersheds within the Ontonagon River basin. Phylogenetic phylum names in bold. Data code: X = present, dashes (–) = not collected, A = acceptable, and E = excellent. Data from Taft 2004, Taft 1999, and Taft 1998. (* Some stream reaches were sampled multiple times. Only the most recent macroinvertebrate ratings are recorded in this table. ** Two sites sampled in 1998. One site was rated "acceptable", and the other site was rated "poor".)

Taxa	M.B. Ontonagon (above Bond Falls)	M.B. Ontonagon (between Bond and Agate Falls)	Duck Creek	McGinty Creek	Baltimore River	E.B. Ontonagon (M-28)	E.B. Ontonagon (E.B. Rd)	Adventure Creek	Jumbo River	Spargo Creek	C.B. Ontonagon	Tenderfoot Creek	Twomile Creek
Porifera (sponges)	X	–	X	–	–	–	–	–	–	–	X	–	–
Bryozoa (moss animals)	–	–	–	–	–	–	–	X	–	–	–	–	–
Platyhelminthes (flatworms)													
Turbellaria	–	–	–	–	–	–	–	–	–	–	X	–	–
Annelida (segmented worms)													
Hirudinea (leeches)	–	–	–	–	–	–	–	–	–	–	–	–	–
Oligochaeta (worms)	–	–	–	–	–	X	–	–	–	X	X	X	X
Arthropoda													
Crustacea													
Amphipoda (scuds)	X	–	–	–	–	–	–	–	–	–	–	–	–
Decapoda (crayfish)	X	–	–	–	X	X	X	X	–	–	X	X	X
Isopoda (sowbugs)	X	–	–	–	–	–	–	X	–	–	–	–	–
Arachnoidea													
Hydracarina (mites)	X	X	X	–	X	X	X	–	–	X	X	X	X
Insecta													
Ephemeroptera (mayflies)													
Baetiscidae	X	–	–	–	–	–	–	–	–	–	–	–	–
Baetidae	X	X	X	X	X	X	X	X	X	X	X	X	X
Caenidae	X	–	–	–	X	–	–	X	–	–	–	–	–
Ephemerellidae	X	X	X	–	–	X	–	–	X	X	X	–	X
Ephemeridae	X	–	–	–	–	–	–	–	–	–	–	–	X
Heptageniidae	X	X	X	X	X	X	X	X	X	X	X	X	X
Isonychiidae	–	–	–	–	X	X	X	–	–	–	X	X	X
Leptophlebiidae	X	X	X	X	–	X	–	–	X	X	X	–	X
Tricorythidae	X	–	–	–	X	–	–	–	X	–	–	–	–
Odonata													
Anisoptera (dragonflies)													
Aeshnidae	X	–	X	X	X	–	X	–	X	X	X	–	–
Cordulegastridae	X	–	X	X	–	–	–	–	X	X	–	–	X

Table 19.–Continued.

Taxa	M.B. Ontonagon (above Bond Falls)	M.B. Ontonagon (between Bond and Agate Falls)	Duck Creek	McGinty Creek	Baltimore River	E.B. Ontonagon (M-28)	E.B. Ontonagon (E.B. Rd)	Adventure Creek	Jumbo River	Spargo Creek	C.B. Ontonagon	Tenderfoot Creek	Twomile Creek
Anisoptera (dragonflies) – continued													
Corduliidae	–	–	–	–	–	–	–	–	–	–	–	–	–
Gomphidae	X	X	X	X	X	X	X	–	–	–	X	X	X
Zygoptera (damselflies)													
Calopterygidae	X	X	–	X	X	X	–	–	–	X	X	X	X
Coenagrionidae	–	–	–	–	–	–	–	–	–	–	–	–	–
Plecoptera (stoneflies)													
Capniidae	–	–	–	–	–	–	–	–	–	–	–	–	X
Leuctridae	–	–	–	–	–	–	–	–	–	X	–	–	X
Perlidae	X	X	X	X	–	X	X	–	X	X	X	X	X
Perlodidae	X	–	X	–	–	X	–	–	–	–	–	–	–
Pteronarcyidae	X	–	–	–	–	X	X	–	–	–	–	–	X
Hemiptera (true bugs)													
Corixidae	X	–	X	–	X	–	X	X	–	–	X	–	–
Gerridae	X	X	X	–	X	X	X	X	X	X	X	X	X
Mesoveliidae	–	–	–	–	X	X	X	–	–	–	X	X	–
Saldidae	–	–	–	–	–	X	X	–	–	–	–	–	–
Veliidae	–	–	–	–	–	X	–	X	–	–	X	–	–
Megaloptera													
Corydalidae (dobson flies)	–	–	X	X	–	X	–	–	–	–	X	–	X
Sialidae (alder flies)	–	–	–	–	–	–	–	–	–	–	–	–	–
Neuroptera (spongilla flies)													
Sisyridae	–	–	–	–	–	–	–	–	–	–	X	–	–
Trichoptera (caddisflies)													
Brachycentridae	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
Hydroptilidae	X	–	–	–	–	X	X	X	–	–	X	X	X
Lepidostomadidae	X	X	X	–	–	–	–	–	X	X	–	–	X
Leptoceridae	X	–	X	–	X	X	–	–	–	–	–	X	X
Limnephilidae	X	X	X	X	X	X	–	X	X	X	–	X	X
Molannidae	–	–	X	X	–	–	–	–	–	–	–	–	–
Philopotamidae	X	–	–	X	–	X	–	–	X	X	X	X	X

Table 19.–Continued.

Taxa	M.B. Ontonagon (above Bond Falls)	M.B. Ontonagon (between Bond and Agate Falls)	Duck Creek	McGinty Creek	Baltimore River	E.B. Ontonagon (M-28)	E.B. Ontonagon (E.B. Rd)	Adventure Creek	Jumbo River	Spargo Creek	C.B. Ontonagon	Tenderfoot Creek	Twomile Creek
Trichoptera (caddisflies) – continued													
Phryganeidae	–	–	–	–	–	–	–	X	–	–	–	–	–
Polycentropodidae	X	–	X	–	–	–	–	–	X	–	–	–	–
Psychomyiidae	X	–	–	–	–	–	X	–	–	–	–	–	–
Rhyacophilidae	–	X	–	–	–	–	–	–	–	–	–	–	–
Uenoidae	X	–	–	–	–	X	–	–	–	X	–	–	X
Coleoptera (beetles)													
Dytiscidae	X	–	–	–	–	–	–	–	–	–	–	–	–
Elmidae	X	X	X	X	X	X	X	X	X	–	X	X	X
Gyrinidae	X	–	X	–	–	–	–	–	–	–	–	–	–
Haliplidae	X	–	–	–	–	–	–	–	–	–	–	–	–
Hydrophilidae	–	–	X	–	–	X	–	X	–	–	–	–	–
Diptera (flies)													
Athericidae	X	X	X	X	X	X	X	–	X	–	X	X	X
Ceratopogonidae	X	–	X	–	–	–	–	X	X	–	X	–	X
Chaoboridae								X	–	–	–	–	–
Chironomidae	X	X	X	X	X	X	X	X	X	X	X	X	X
Dixidae	–	–	–	–	–	–	–	–	–	–	–	X	–
Empididae	–	–	–	–	–	X	–	–	–	–	–	–	–
Ptychopteridae	–	–	–	–	–	–	–	–	–	–	–	–	–
Simuliidae	X	X	–	X	X	X	X	X	X	X	X	X	X
Tabanidae	X	–	X	–	X	X	–	–	–	–	X	–	X
Tipulidae	X	X	X	–	X	X	X	X	X	X	X	–	X
Mollusca													
Gastropoda (snails)													
Ancylidae (limpets)	X	–	X	–	X	X	X	–	X	–	X	X	–
Hydrobiidae	X	–	–	–	–	–	–	–	–	–	–	–	–
Physidae	X	X	X	X	X	X	–	–	X	–	X	–	X
Planorbidae	–	–	–	–	–	X	–	–	–	–	–	–	–
Valvatidae	X	–	–	–	–	–	–	–	–	–	–	–	–
Viviparidae	–	–	–	–	–	–	–	–	–	–	–	–	–
Pelecypoda (bivalves)													
Sphaeriidae (fingernail clams)	X	–	–	X	X	–	–	X	–	–	X	–	X
Unionidae (mussels)	–	–	–	–	–	–	–	X	–	–	–	–	–
Macroinvertebrate rating*	A	A	A	A	A	A	A	**	A	E	A	A	E

Table 20.–Aquatic macroinvertebrates of the Cisco Branch, South Branch, and West Branch subwatersheds within the Ontonagon River basin. Phylogenetic phylum names in bold. Data code: X = present, dashes (–) = not collected, A = acceptable, and E = excellent. Data from Taft 2004, Taft 1999, and Taft 1995. (* Some stream reaches were sampled multiple times. Only the most recent macroinvertebrate ratings are recorded in this table.)

Taxa	South Branch	Bluff Creek	Sucker Creek	W.B. Ontonagon (M-28)	W.B. Ontonagon (Norwich Road)	Cascade Creek	Marshall Creek	Merriweather Creek	Pelton Creek	Slate River	Trout Brook
Porifera (sponges)	–	–	–	X	–	–	–	X	–	X	–
Bryozoa (moss animals)	–	–	–	X	–	–	–	–	–	–	–
Platyhelminthes (flatworms)											
Turbellaria	–	X	–	–	–	–	–	X	–	–	–
Annelida (segmented worms)											
Hirudinea (leeches)	–	–	–	–	–	X	–	–	–	–	–
Oligochaeta (worms)	–	–	X	–	–	–	–	–	X	–	–
Arthropoda											
Crustacea											
Amphipoda (scuds)	–	X	–	–	–	–	–	X	–	–	–
Decapoda (crayfish)	X	X	X	X	X	–	–	X	–	X	X
Isopoda (sowbugs)	–	–	–	–	–	–	–	–	–	–	–
Arachnoidea											
Hydracarina (mites)	–	X	X	–	–	–	X	X	–	X	–
Insecta											
Ephemeroptera (mayflies)											
Baetiscidae	–	–	X	–	–	–	–	–	–	–	–
Baetidae	X	X	X	X	X	–	X	X	X	X	X
Caenidae	X	X	–	–	X	–	–	–	–	–	–
Ephemerellidae	–	X	–	X	–	–	X	X	–	X	X
Ephemeridae	–	–	–	–	X	–	–	–	–	–	–
Heptageniidae	X	X	X	X	X	X	X	X	X	X	X
Isonychiidae	–	X	–	–	–	–	–	–	–	–	–
Leptophlebiidae	–	X	–	–	–	–	X	–	X	–	X
Tricorythidae	–	–	–	–	–	–	–	–	–	–	–
Odonata											
Anisoptera (dragonflies)											
Aeshnidae	–	X	X	–	X	X	X	–	X	X	–
Cordulegastridae	–	–	–	–	–	X	X	–	X	X	X
Corduliidae	–	–	–	–	X	–	–	–	–	–	–
Gomphidae	X	X	X	–	X	X	–	–	–	X	–

Table 20.–Continued.

Taxa	South Branch	Bluff Creek	Sucker Creek	W.B. Ontonagon (M-28)	W.B. Ontonagon (Norwich Road)	Cascade Creek	Marshall Creek	Merriweather Creek	Pelton Creek	Slate River	Trout Brook
Zygoptera (damselflies)											
Calopterygidae	–	X	X	X	X	X	–	X	–	X	–
Coenagrionidae	–	–	–	–	X	–	–	–	–	–	–
Plecoptera (stoneflies)											
Capniidae	–	–	–	–	–	–	–	–	–	–	–
Leuctridae	–	–	–	–	–	–	–	–	–	–	–
Perlidae	X	X	X	X	X	X	X	–	–	X	X
Perlodidae	–	X	–	–	–	–	–	–	–	–	–
Pteronarcyidae	X	X	X	–	–	–	–	–	–	–	–
Hemiptera (true bugs)											
Corixidae	X	X	X	–	X	–	–	–	–	X	X
Gerridae	X	X	X	X	X	X	X	X	X	X	X
Mesoveliidae	–	–	–	X	–	–	–	–	–	–	–
Saldidae	–	–	–	–	–	–	–	–	X	–	–
Veliidae	–	–	–	–	X	–	–	X	–	X	–
Megaloptera											
Corydalidae (dobson flies)	–	X	X	X	–	X	–	–	–	X	X
Sialidae (alder flies)	–	–	X	–	X	X	–	–	–	X	–
Neuroptera (spongilla flies)											
Sisyridae	–	–	–	–	–	–	–	–	–	–	–
Trichoptera (caddisflies)											
Brachycentridae	X	X	–	–	–	–	–	–	X	–	–
Glossosomatidae	–	X	–	–	–	–	X	–	–	X	X
Helicopsychidae	–	X	–	X	–	–	–	–	–	–	–
Hydropsychidae	X	X	X	X	–	X	X	X	X	X	X
Hydroptilidae	–	X	X	X	–	–	–	X	–	–	–
Lepidostomadidae	–	–	–	–	–	–	X	–	–	X	X
Leptoceridae	X	X	–	–	–	–	X	–	–	X	–
Limnephilidae	X	X	–	X	–	X	X	X	X	X	X
Molannidae	–	–	–	–	–	–	–	–	X	–	X
Philopotamidae	X	X	–	X	–	X	X	X	–	X	X
Phryganeidae	–	–	–	–	X	–	–	–	–	–	–
Polycentropodidae	–	–	–	X	X	–	–	–	–	–	–
Psychomyiidae	–	X	–	–	–	–	–	–	–	–	–
Rhyacophilidae	–	–	–	X	X	–	X	–	–	X	X
Uenoidae	–	X	–	–	–	–	–	–	X	–	–

Table 20.–Continued.

Taxa	South Branch	Bluff Creek	Sucker Creek	W.B. Ontonagon (M-28)	W.B. Ontonagon (Norwich Road)	Cascade Creek	Marshall Creek	Merriweather Creek	Pelton Creek	Slate River	Trout Brook
Coleoptera (beetles)											
Dytiscidae	–	X	–	–	–	–	–	–	–	–	–
Elmidae	X	X	X	X	X	X	X	X	–	–	X
Gyrinidae	–	–	–	–	–	–	–	–	–	–	–
Haliplidae	X	X	–	–	–	–	–	–	–	X	–
Hydrophilidae	–	–	–	–	–	X	–	–	–	X	–
Diptera (flies)											
Athericidae	–	X	X	X	–	X	X	–	X	X	–
Ceratopogonidae	X	–	X	–	–	X	X	–	–	X	X
Chaoboridae	–	–	–	–	–	–	–	–	–	–	–
Chironomidae	X	X	X	X	X	X	X	X	X	X	X
Dixidae	–	–	–	–	–	–	–	–	–	–	–
Empididae	–	X	–	–	–	–	–	–	–	–	–
Ptychopteridae	–	–	–	–	–	X	–	–	–	–	–
Simuliidae	X	X	X	–	–	–	X	X	X	X	X
Tabanidae	–	X	X	–	X	–	–	–	–	X	–
Tipulidae	–	X	X	–	–	X	X	X	X	X	–
Mollusca											
Gastropoda (snails)											
Ancylidae (limpets)	–	–	X	X	–	–	–	–	–	X	–
Hydrobiidae	–	–	–	–	–	–	–	–	–	–	–
Physidae	X	–	–	–	X	–	X	–	X	X	–
Planorbidae	–	–	–	–	–	–	–	–	–	–	–
Valvatidae	–	–	–	–	–	–	–	–	–	–	–
Viviparidae	–	–	–	–	X	–	–	–	–	–	–
Pelecypoda (bivalves)											
Sphaeriidae (fingernail clams)	–	X	X	X	X	X	–	X	X	X	–
Unionidae (mussels)	–	–	–	–	–	–	–	–	–	–	–
Macroinvertebrate rating*	A	E	A	A	A	E	E	A	A	A	E

Table 21.–Amphibians and reptiles of the Ontonagon River watershed. Data from Harding and Holman (1990), Harding and Holman (1992), Holman et al. (1999), Doepker et al. (2001), and Anonymous (2006a). Status codes: SC = state-listed special concern.

Common name	Scientific name
frogs and toads	
eastern American toad	*Bufo americanus americanus*
northern spring peeper	*Pseudacris crucifer*
eastern gray tree frog	*Hyla versicolor*
green frog	*Rana clamitans*
bullfrog	*Rana catesbeiana*
northern leopard frog	*Rana pipiens*
pickerel frog	*Rana palustris*
mink frog	*Rana septentrionalis*
wood frog	*Rana sylvatica*
salamanders	
blue-spotted salamander	*Ambystoma laterale*
spotted salamander	*Ambystoma maculatum*
eastern newt – central subspecies	*Notophthalmus viridescens*
red-backed salamander	*Plethodon cinereus*
four-toed salamander	*Hemidactylium scutatum*
mudpuppy	*Necturus maculosus*
snakes	
northern red-bellied snake	*Storeria occipitomaculata occipitomaculata*
eastern garter snake	*Thamnophis sirtalis sirtalis*
northern ring-necked snake	*Diadophis punctatus edwardsi*
smooth green snake	*Liochlorophis vernalis*
western fox snake	*Elaphe vulpina*
turtles	
snapping turtle	*Chelydra serpentina*
wood turtle (sc)	*Clemmys insculpta*
eastern box turtle (sc)	*Terrapene carolina carolina*
Blanding’s turtle (sc)	*Emydoidea blandingii*
common map turtle	*Graptemys geographica*
painted turtle	*Chrysemys picta*

Table 22.–Bird species of the Ontonagon River watershed. Data from Doepker et al. (2001). State status codes: SC = special concern, T = threatened, and E = endangered.

Common name	Scientific name
Common Loon (T)	*Gavia immer*
Pied-billed Grebe	*Podilymbus podiceps*
Double-crested Cormorant	*Phalacrocorax auritus*
American Bittern (SC)	*Botaurus lentiginosus*
Least Bittern (T)	*Ixobrychus exilis*
Great Blue Heron	*Ardea herodias*
Green Heron	*Butorides virescens*
Canada Goose	*Branta Canadensis*
Wood Duck	*Aix sponsa*
Green-winged Teal	*Anas crecca*
American Black Duck	*Anas rubripes*
Mallard	*Anas platyrhynchos*
Northern Pintail	*Anas acuta*
Blue-winged Teal	*Anas discors*
Northern Shoveler	*Anas clypeata*
Gadwall	*Anas strepera*
American Wigeon	*Anas americana*
Redhead	*Aythya americana*
Ring-necked Duck	*Aythya collaris*
Common Goldeneye	*Bucephala clangula*
Bufflehead	*Bucephala albeola*
Hooded Merganser	*Lophodytes cucullatus*
Common Merganser	*Mergus merganser*
Red-breasted Merganser	*Mergus serrator*
Turkey Vulture	*Cathartes aura*
Osprey (T)	*Pandion haliaetus*
Bald Eagle (T)	*Haliaeetus leucocephalus*
Northern Harrier (SC)	*Circus cyaneus*
Sharp-shinned Hawk	*Accipiter striatus*
Cooper’s Hawk (SC)	*Accipiter cooperii*
Northern Goshawk (SC)	*Accipiter gentiles*
Red-shouldered Hawk (T)	*Buteo lineatus*
Broad-winged Hawk	*Buteo platypterus*
Red-tailed Hawk	*Buteo jamicensis*
Rough-legged Hawk	*Buteo lagopus*
American Kestrel	*Falco sparverius*
Merlin (T)	*Falco columbarius*
Peregrine Falcon (E)	*Falco peregrinus*
Spruce Grouse (SC)	*Falcipennis canadensis*
Ruffed Grouse	*Bonasa umbellus*
Sharp-tailed Grouse (SC)	*Tympanuchus phasianellus*
Wild Turkey	*Meleagris gallopavo*
Virginia Rail	*Rallus limicola*
Sora	*Porzana carolina*
American Coot	*Fulica americana*
Sandhill Crane	*Grus canadensis*

Table 22.–Continued.

Common name	Scientific name
Killdeer	*Charadrius vociferus*
Spotted Sandpiper	*Actitis macularia*
Upland Sandpiper	*Bartramia longicauda*
Common Snipe	*Gallinago gallinago*
American Woodcock	*Scolopax minor*
Ring-billed Gull	*Larus delawarensis*
Herring Gull	*Larus argentatus*
Black Tern (SC)	*Chlidonias niger*
Mourning Dove	*Zenaida macroura*
Black-billed Cuckoo	*Coccyzus erythropthalmus*
Yellow-billed Cuckoo	*Coccyzus americanus*
Great Horned Owl	*Bubo virginianus*
Barred Owl	*Strix varia*
Great Gray Owl	*Strix nebulosa*
Northern Saw-whet Owl	*Aegolius acadicus*
Common Nighthawk	*Chordeiles minor*
Whip-poor-will	*Caprimulgus vociferus*
Chimney Swift	*Chaetura pelagica*
Ruby-throated Hummingbird	*Archilochus colubris*
Belted Kingfisher	*Ceryle alcyon*
Red-headed Woodpecker	*Melanerpes erythrocephalus*
Red-bellied Woodpecker	*Melanerpes carolinus*
Yellow-bellied Sapsucker	*Sphyrapicus varius*
Downy Woodpecker	*Picoides pubescens*
Hairy Woodpecker	*Picoides villosus*
Black-backed Woodpecker (SC)	*Picoides arcticus*
Northern Flicker	*Colaptes auratus*
Pileated Woodpecker	*Dryocopus pileatus*
Olive-sided Flycatcher	*Contopus cooperi*
Eastern Wood-pewee	*Contopus virens*
Yellow-bellied Flycatcher	*Empidonax flaviventris*
Alder Flycatcher	*Empidonax alnorum*
Willow Flycatcher	*Empidonax traillii*
Least Flycatcher	*Empidonax minimus*
Eastern Phoebe	*Sayornis phoebe*
Great Crested Flycatcher	*Myiarchus crinitus*
Eastern Kingbird	*Tyrannus tyrannus*
Purple Martin	*Progne subis*
Tree Swallow	*Tachycineta bicolor*
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*
Bank Swallow	*Riparia riparia*
Cliff Swallow	*Petrochelidon pyrrhonota*
Barn Swallow	*Hirundo rustica*
Gray Jay	*Perisoreus canadensis*
Blue Jay	*Cyanocita cristata*
American Crow	*Corvus brachyrhynchos*
Common Raven	*Corvus corax*
Black-capped Chickadee	*Parus atricapillus*

Table 22.–Continued.

Common name	Scientific name
Boreal Chickadee	*Parus hudsonicus*
Red-breasted Nuthatch	*Sitta canadensis*
White-breasted Nuthatch	*Sitta carolinensis*
Brown Creeper	*Certhia americana*
House Wren	*Troglodytes aedon*
Winter Wren	*Troglodytes troglodytes*
Sedge Wren	*Cistothorus platensis*
Marsh Wren (SC)	*Cistothorus palustris*
Golden-crowned Kinglet	*Regulus satrapa*
Ruby-crowned Kinglet	*Regulus calendula*
Eastern Bluebird	*Sialia sialis*
Veery	*Catharus fuscescens*
Swainson’s Thrush	*Catharus ustulatus*
Hermit Thrush	*Catharus guttatus*
Wood Thrush	*Hylocichla mustelina*
American Robin	*Turdus migratorius*
Gray Catbird	*Dumetella carolinensis*
Brown Thrasher	*Toxostoma rufum*
Cedar Waxwing	*Bombycilla cedrorum*
Northern Shrike	*Larius excubitor*
Blue-headed Vireo	*Vireo solitarius*
Yellow-throated Vireo	*Vireo flavifrons*
Warbling Vireo	*Vireo gilvus*
Philadelphia Vireo	*Vireo philadelphicus*
Red-eyed Vireo	*Vireo olivaceus*
Golden-winged Warbler	*Vermivora chrysoptera*
Tennessee Warbler	*Vermivora peregrine*
Nashville Warbler	*Vermivora ruficapilla*
Northern Parula	*Parula americana*
Yellow Warbler	*Dendroica petechia*
Chestnut-sided Warbler	*Dendroica pensylvanica*
Magnolia Warbler	*Dendroica magnolia*
Cape May Warbler	*Dendroica tigrina*
Black-throated Blue Warbler	*Dendroica caerulescens*
Yellow-rumped Warbler	*Dendroica coronata*
Black-throated Green Warbler	*Dendroica virens*
Blackburnian Warbler	*Dendroica fusca*
Pine Warbler	*Dendroica pinus*
Palm Warbler	*Dendroica palmarum*
Bay-breasted Warbler	*Dendroica castanea*
Cerulean Warbler (SC)	*Dendroica cerulean*
Black-and-white Warbler	*Mniotilta varia*
American Redstart	*Setophaga ruticilla*
Ovenbird	*Seiurus aurocapillus*
Northern Waterthrush	*Seiurus noveboracensis*
Connecticut Warbler	*Oporornis agilis*
Mourning Warbler	*Oporornis philadelphia*
Common Yellowthroat	*Geothlypis trichas*

Table 22.–Continued.

Common name	Scientific name
Canada Warbler	*Wilsonia canadensis*
Northern Cardinal	*Cardinalis cardinalis*
Rose-breasted Grosbeak	*Pheucticus ludovicianus*
Indigo Bunting	*Passerina cyanea*
Dickcissel (SC)	*Spiza americana*
Eastern Towhee	*Pipilo erythrophthalmus*
Chipping Sparrow	*Spizella passerine*
Clay-colored Sparrow	*Spizella pallida*
Field Sparrow	*Spizella pusilla*
American Tree Sparrow	*Spizella arborea*
Vesper Sparrow	*Pooecetes gramineus*
Savannah Sparrow	*Passerculus sandwichensis*
Grasshopper Sparrow (SC)	*Ammodramus savannarum*
Le Conte's Sparrow	*Ammodramus leconteii*
Song Sparrow	*Melospiza melodia*
Lincoln's Sparrow	*Melospiza lincolnii*
Swamp Sparrow	*Melospiza Georgiana*
White-throated Sparrow	*Zonotrichia albicollis*
Dark-eyed Junco	*Junco hyemalis*
Snow Bunting	*Plectrophenax nivalis*
Bobolink	*Dolichonyx oryzivorus*
Red-winged Blackbird	*Agelaius phoeniceus*
Eastern Meadowlark	*Sturnella magna*
Western Meadowlark (SC)	*Sturnella neglecta*
Yellow-headed Blackbird (SC)	*Xanthocephalus xanthocephalus*
Brewer's Blackbird	*Euphagus cyanocephalus*
Common Grackle	*Quiscalus quiscula*
Brown-headed Cowbird	*Molothrus ater*
Baltimore Oriole	*Icterus galbula*
Purple Finch	*Carpodacus purpureus*
House Finch	*Carpodacus mexicanus*
Pine Grosbeak	*Pinicola enucleator*
Red Crossbill	*Loxia curvirostra*
White-winged Crossbill	*Loxia leucoptera*
Pine Siskin	*Carduelis pinus*
American Goldfinch	*Carduelis tristis*
Common Redpoll	*Carduelis flammea*
Evening Grosbeak	*Coccothraustes vespertinus*

Table 23.–Mammals of the Ontonagon River watershed. Data from Doepker et al. (2001). State status codes: SC = special concern and T = threatened. Federal status code: LT = threatened.

Common name	Scientific name
Virginia opossum	*Didelphis virginiana*
Arctic shrew	*Sorex arcticus*
masked shrew	*Sorex cinereus*
pygmy shrew	*Sorex hoyi*
water shrew	*Sorex palustris*
northern short-tailed shrew	*Blarina brevicauda*
star-nosed mole	*Condylura cristata*
northern myotis	*Myotis septentrionalis*
little brown myotis	*Myotis lucifugus*
silver-haired bat	*Lasionycteris noctivagans*
eastern pipistrelle (SC)	*Pipistrellus subflavus*
big brown bat	*Eptesicus fuscus*
eastern red bat	*Lasiurus borealis*
hoary bat	*Lasiurus cinereus*
eastern cottontail	*Sylvilagus floridanus*
snowshoe hare	*Lepus americanus*
eastern chipmunk	*Tamias striatus*
least chipmunk	*Tamias minimus*
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*
southern flying squirrel	*Glaucomys volans*
American beaver	*Castor canadensis*
deer mouse	*Peromyscus maniculatus*
southern red-backed vole	*Clethrionomys gapperi*
meadow vole	*Microtus pennsylvanicus*
muskrat	*Ondatra zibethicus*
southern bog lemming	*Synaptomys cooperi*
meadow jumping mouse	*Zapus hudsonius*
woodland jumping mouse	*Napaeozapus insignis*
common porcupine	*Erethizon dorsatum*
coyote	*Canis latrans*
gray wolf (T, LT)	*Canis lupus*
red fox	*Vulpes vulpes*

Table 23.–Continued.

Common name	Scientific name
common gray fox	*Urocyon cinereoargenteus*
black bear	*Ursus americanus*
common raccoon	*Procyon lotor*
American marten	*Martes Americana*
fisher	*Martes pennanti*
ermine	*Mustela erminea*
long-tailed weasel	*Mustela frenata*
least weasel	*Mustela nivalis*
mink	*Mustela vison*
American badger	*Taxidea taxus*
striped skunk	*Mephitis mephitis*
northern river otter	*Lutra Canadensis*
bobcat	*Lynx rufus*
white-tailed deer	*Odocoileus virginianus*
moose (SC)	*Alces alces*

Table 24.–Endangered, threatened, or otherwise significant plant and animal species, plant communities, and other natural features of the Ontonagon River watershed. Data from Anonymous (2006a) and MDNR, Fisheries Division records. State status codes: SC = special concern, T = threatened, E = endangered, S2 = imperiled, S3 = rare, S4 = apparently secure. Global rank codes: G3 = rare, G4 = apparently secure, G5 = demonstrably secure.

Common name	Scientific name	Global rank	State status
vertebrates			
lake sturgeon	*Acipenser fulvescens*	G3	T
lake herring	*Coregonus artedi*	G5	T
wood turtle	*Glyptemys insculpta*	G4	SC
eastern box turtle	*Terrapene carolina carolina*	G5	SC
Blanding’s turtle	*Emydoidea blandingii*	G4	SC
Common Loon	*Gavia immer*	G5	T
American Bittern	*Botaurus lentiginosus*	G4	SC
Least Bittern	*Ixobrychus exilis*	G5	T
Osprey	*Pandion haliaetus*	G5	T
Bald Eagle	*Haliaeetus leucocephalus*	G4	T
Northern Harrier	*Circus cyaneus*	G5	SC
Cooper’s Hawk	*Accipiter cooperii*	G5	SC
Northern Goshawk	*Accipiter gentiles*	G5	SC
Red-shouldered Hawk	*Buteo lineatus*	G5	T
Merlin	*Falco columbarius*	G5	T
Peregrine Falcon	*Falco peregrinus*	G4	E
Spruce Grouse	*Falcipennis canadensis*	G5	SC
Sharp-tailed Grouse	*Tympanuchus phasianellus*	G4	SC
Black Tern	*Chlidonias niger*	G4	SC
Black-backed Woodpecker	*Picoides arcticus*	G5	SC
Marsh Wren	*Cistothorus palustris*	G5	SC
Cerulean Warbler	*Dendroica cerulean*	G4	SC
Dickcissel	*Spiza americana*	G5	SC
Grasshopper Sparrow	*Ammodramus savannarum*	G5	SC
Western Meadowlark	*Sturnella neglecta*	G5	SC
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	G5	SC
eastern pipistrelle	*Pipistrellus subflavus*	G5	SC
gray wolf	*Canis lupus*	G4	T
moose	*Alces alces*	G5	SC
invertebrates			
rapids clubtail	*Gomphus quadricolor*	G3	SC
delicate vertigo	*Vertigo bollesiana*	G3	SC
land snail	*Vertigo paradoxa*	G3	SC
fungi			
anzia lichen	*Anzia colpodes*		
treeflute	*Menegazzia terebrata*		
plants			
flat oat grass	*Danthonia compressa*	G5	SC
American shore-grass	*Littorella uniflora*	G5	SC
Canadian milk-vetch	*Astragalus canadensis*	G5	T
Cooper’s milk-vetch	*Astragalus neglectus*	G4	SC
assiniboia sedge	*Carex assiniboinensis*	G4	T

Table 24.–Continued.

Common name	Scientific name	Global rank	State status
plants – continued			
calypso or fairy-slipper	*Calypso bulbosa*	G5	T
fragrant cliff woodfern	*Dryopteris fragrans*	G5	SC
male fern	*Drypoteris filix-mas*	G5	SC
goblin moonwort	*Botrychium mormo*	G3	T
purple clematis	*Clematis occidentalis*	G5	SC
veiny meadow-rue	*Thalictrum venulosum var. confine*	G4	SC
sweet coltsfoot	*Petasites sagittatus*	G5	T
hedge-hyssop	*Gratiola aurea*	G5	T
downy sunflower	*Helianthus mollis*	G4	T
fir clubmoss	*Huperzia selago*	G5	SC
swamp candles	*Lysimachia hybrida*	G5	SC
ginseng	*Panax quinquefolius*	G3	T
showy orchis	*Galearis spectabilis*	G5	T
western monkey-flower	*Mimulus guttatus*	G5	SC
small blue-eyed Mary	*Collinsia parviflora*	G5	T
fairy bells	*Disporum hookeri*	G5	E
prairie buttercup	*Ranunculus rhomboideus*	G5	T
pine-drops	*Pterospora andromedea*	G5	T
small yellow pond-lily	*Nuphar pumila*	G5	E
ram's head lady's-slipper	*Cypripedium arietinum*	G3	SC
farwell's water-milfoil	*Myriophyllum farwellii*	G5	T
big-leaf sandwort	*Arenaria macrophylla*	G4	T
northern reedgrass	*Calamagrostris lacustris*	G3	T
plant communities			
bedrock glade		G3	S2
dry-mesic northern forest		G4	S3
dry non-acid cliff		G4	S2
moist non-acid cliff		G4	S2
mesic northern forest		G4	S3
poor conifer swamp		G4	S4
other features			
great blue heron rookery			
extrusive igneous feature			
meander			

Table 25.–Fish stocking for streams within the Ontonagon River watershed, 1982–2005 (MDNR 2006). Life stage codes: AD = adult, FF = fall fingerling, SF = spring fingerling, and YR = yearling.

Subwatershed and location	Species	Life stage	Years	Total number
Middle Branch—upper				
Middle Branch (above Bond Falls)	brook trout	YR	85–86, 90–00	100,418
Middle Branch (between Bond and Agate Falls	brook trout	YR	85–88, 90–97, 05	60,600
	brown trout	YR	85–97	33,108
	rainbow trout[a]	YR	93	300
Tamarack River	brook trout[a]	YR	97	250
	brook trout[b]	YR	04–05	4,000
Main Stem				
Ontonagon River	brown trout	YR	89	14,060
	Chinook salmon	SF	87–93	516,132
	lake sturgeon	FF	98–02, 04	31,999
	lake sturgeon	YR	01	12
	lake trout	YR	82–83	50,000
	lake trout[c]	YR	84, 86, 88–89, 91, 94	398,650
	rainbow trout	FF	89, 92, 94, 96	748,581
	rainbow trout	SF	88	81,000
	rainbow trout	YR	88–02	448,553
	walleye	FF	93, 01	46,143
	walleye	SF	89–91, 01, 04	165,826
	yellow perch	AD	97	6,630
East Branch				
East Branch	rainbow trout	YR	05	31,000
E. Br. Jumbo River	brook trout[b]	SF	00	19,654
Jumbo River	rainbow trout	YR	03–04	69,500
Shane Creek	brook trout[b]	SF	00	4,010
	brook trout[b]	YR	00	1,639
Slave Creek	brook trout[b]	SF	00	2,476
Smith Creek	brook trout[b]	YR	04–05	3,000
State Creek	brook trout[b]	SF	00	1,717
	brook trout[b]	YR	00	736
Cisco Branch				
Twomile Creek	brook trout[b]	YR	05	2,000

[a] Private plant
[b] Keweenaw Bay Indian Community plant
[c] Federal plant

Table 26.–Fish stocking for lakes within the Ontonagon River watershed, 1935–2005. Data from MDNR (2006) and MDNR – Baraga Office files. Life stage codes: AD = adult, FF = fall fingerling, FG = fingerling (season not specified), SF = spring fingerling, and YR = yearling. Asterisk (*) = private plant and double asterisks (**) = fish planted by Wisconsin Department of Natural Resources.

Subwatershed and location	Species	Life stage	Years	Total number
Middle Branch—upper				
Albino Lake	largemouth bass	FF	42	100
	northern pike	AD	54–55, 64	132
	smallmouth bass	FF	40, 42	1,200
Allen Lake	bluegill	FF	35–40, 42	32,000
	largemouth bass	FF	37–38	500
	largemouth bass	SF	38–39	700
	smallmouth bass	FF	36	200
	smallmouth bass	SF	39	1,100
	walleye	SF	83, 89–90, 98, 00, 03	20,380
Anderson Lake	bluegill	FF	35–38	17,000
	largemouth bass	FF	37–38	600
	largemouth bass	SF	38	300
	smallmouth bass	FF	36	200
Bass Lake	bluegill	FF	35–40	84,000
	largemouth bass	SF	35, 38	700
	muskellunge	SF	63, 71–72, 76, 80	5,910
	muskellunge	Fry	76	150,000
	smallmouth bass	FF	36–37	900
	smallmouth bass	SF	35, 38, 40	1,700
	yellow perch	FF	35	1,000
Beaver Dam Lake	bluegill	FF	35–39	15,000
	largemouth bass	FF	37	300
	largemouth bass	SF	38	100
	smallmouth bass	FF	36	100
Beaver Station Lake	bluegill	FF	35–39	16,000
	largemouth bass	FF	37	300
	largemouth bass	SF	38	200
	smallmouth bass	FF	36	200
	walleye*	unknown	80	2,000
Bond Falls Flowage	walleye	SF	87, 89–91, 93, 98, 00–01	119,704
	yellow perch	AD	84, 88, 91, 95	63,004
	yellow perch	SF	90	4,376
Buck Lake	bluegill	SF	42	5,000
	brook trout	YR	61	5,000
	largemouth bass	SF	42–43	300
	smallmouth bass	SF	42–44	1,500
Castle Lake	brook trout	AD	62	250
	brook trout	FF	63, 76–77, 82–86, 03–05	24,520
	brook trout	SF	64, 66–70, 74–75, 79–81	28,700

Table 26.–Continued.

Subwatershed and location	Species	Life stage	Years	Total number
Middle Branch—upper – continued				
Castle Lake	brook trout	YR	72–73, 78, 87–02	38,406
Clear Lake	bluegill	FF	35, 37–40	23,000
	smallmouth bass	SF	35	200
Crooked Lake	bluegill	FF	35–41	113,000
	brook trout	YR	61	5,000
	largemouth bass	FF	36, 38	2,000
	rainbow trout	AD	44, 51, 53–61, 63–64	24,000
	rainbow trout	FF	66	10,000
	rainbow trout	YR	52	2,000
	smallmouth bass	FF	36–38	6,600
	smallmouth bass	SF	35, 38–40	6,600
	yellow perch	FF	35	12,500
Devils Head Lake	bluegill	FF	42	2,500
	bluegill	AD	67	273
	brook trout	AD	63	750
	brook trout	FF	64	1,000
	largemouth bass	FF	65	2,000
Devils Head Lake	rainbow trout	FF	63–64	6,000
Dinner Lake	bluegill	FF	35–40, 42	33,500
	largemouth bass	FF	38, 42–43, 45	1,500
	largemouth bass	SF	39	500
	smallmouth bass	FF	36–37, 41–43	2,300
	smallmouth bass	SF	38–40	3,700
	walleye	FF	97	1,115
	walleye	SF	83, 85–86, 89, 92, 98, 00, 04	39,217
Doyle Lake	bluegill	FF	39	11,000
	brook trout*	AD	57	500
Duck Lake	bluegill	FF	35–39	83,000
	bluegill	YR	45	500
	brook trout	YR	61	7,000
	brown trout	YR	92	400
	largemouth bass	FF	36–38, 45	3,100
	smallmouth bass	FF	36–37	1,500
	walleye	FF	93	2,500
	walleye	SF	90–91, 93, 95, 98, 00, 02, 04	170,983
	yellow perch	FF	35	12,000
Hilltop Lake	bluegill	YR	40	150
	brook trout	AD	43, 53, 93	1,700
	brook trout	FF	41, 50–52, 54–64, 80, 82–86	57,151
	brook trout	SF	81	2,700
Hilltop Lake	brook trout	YR	42, 87–88, 90–96	13,300
	brown trout	AD	47	8,000
	brown trout	FF	48	8,000

Table 26.–Continued.

Subwatershed and location	Species	Life stage	Years	Total number
Middle Branch—upper – continued				
Hilltop Lake – continued	largemouth bass	YR	40	25
	largemouth bass	SF	35	500
	rainbow trout	FF	40	2,000
	rainbow trout	FF	59–61, 63–64	10,000
	rainbow trout	YR	42	700
	smallmouth bass	SF	35	400
	splake	FF	66–67	8,000
Hoist Lake	bluegill	unknown	42	5,000
	bluegill	FF	35–39	21,000
	largemouth bass	FF	37, 42–43	1,100
	largemouth bass	SF	38–39	1,200
	smallmouth bass	FF	36, 42–43	500
	smallmouth bass	SF	35	200
Horseshoe Lake	bluegill	FF	35, 37	12,500
	largemouth bass	SF	35, 38–39	800
	smallmouth bass	FF	36	200
Imp Lake	bluegill	FF	35–40	31,000
	brook trout	FF	58	5,000
	brook trout	YR	61, 90	7,250
	brown trout	YR	89	2,500
	lake trout	FF	36	2,000
	lake trout	SF	38, 40	28,000
	lake trout	YR	61, 70–71, 79	21,210
	rainbow smelt	AD	42	668
	rainbow trout	AD	43–45, 52–55, 57, 59	11,000
	rainbow trout	FF	46, 48–51	36,700
	rainbow trout	YR	78	2,100
	smallmouth bass	FF	36–37	800
	smallmouth bass	SF	35, 38–40	2,600
	splake	FF	63–65, 67, 69, 75	49,700
	splake	SF	74	8,400
	splake	YR	61, 73, 81–82, 85, 87–88, 91–05	127,670
Jennings Lake	brook trout	AD	43	1,000
Joyce Lake	bluegill	FF	35	3,000
Lindsley Lake	tiger muskellunge	SF	79	800
Little Duck Lake	bluegill	FF	38	5,000
	brook trout	YR	89–90	4,000
	largemouth bass	FF	38	400
	largemouth bass	SF	38	200
	rainbow trout	FF	46–50, 52–56, 59–61, 63–64, 66	68,000
	rainbow trout	SF	72, 78	5,000

Table 26.–Continued.

Subwatershed and location	Species	Life stage	Years	Total number
Middle Branch—upper – continued				
Little Duck Lake – continued	rainbow trout	YR	51, 57–58, 62, 68–71, 77–85, 87–05	111,150
	splake	FF	66–71, 85	28,500
	splake	YR	72–74, 83, 85–88, 91–05	39,482
Lumberjack Lake	largemouth bass	AD	62	32
Marion Lake	bluegill	AD	92	647
	bluegill	FF	35–40	117,000
	largemouth bass	FF	37–38, 67	4,225
	largemouth bass	SF	38	500
	smallmouth bass	FF	36, 68	7,296
	smallmouth bass	SF	35, 39–40	5,500
	tiger muskellunge	SF	68, 79	2,800
	walleye	AD	61	260
	walleye	FF	91	2,409
	walleye	Fry	68–72, 91	6,900,000
	walleye	SF	90–91, 98, 00, 02, 04	59,287
	yellow perch	AD	90, 92	5,411
Perch Lake	bluegill	FF	35, 37–38	28,000
	largemouth bass	FF	37	300
	smallmouth bass	FF	36	200
	smallmouth bass	SF	40	1,000
	yellow perch	FF	35	1,000
Porcupine Lake	bluegill	FF	42	5,000
Powwow Lake	northern pike	AD	62	150
Schneider Lake	largemouth bass	AD	62	32
	largemouth bass	YR	62	32
Snap Jack Lake	bluegill	FF	35–38, 40	28,000
	largemouth bass	YR	40	200
	smallmouth bass	FF	36	200
	smallmouth bass	SF	35	200
	yellow perch	FF	35	1,000
Sun Lake	bluegill	FF	38, 40	19,000
Tamarack Lake	bluegill	FF	36–38	39,000
	brook trout	YR	61	6,000
	largemouth bass	FF	38	500
	largemouth bass	SF	38	400
Tamarack Lake	walleye	SF	84–86, 88–89	73,782
Taylor Lake	bluegill	FF	35–37	33,000
	brook trout	FF	64	5,000
	largemouth bass	FF	37	300
	largemouth bass	SF	35, 38	500
	smallmouth bass	FF	36	300

Table 26.–Continued.

Subwatershed and location	Species	Life stage	Years	Total number
Middle Branch—upper – continued				
Taylor Lake – continued	smallmouth bass	SF	39	500
	splake	YR	73–74	12,100
Tomassi Lake	largemouth bass	unknown	39	500
Twist Lake	bluegill	unknown	39–40	28,000
	bluegill	FF	42	5,000
	smallmouth bass	FF	68, 70	2,730
Wilson Lake	bluegill	YR	45	500
	largemouth bass	FF	45	300
Wolf Lake	bluegill	FF	35–38	36,000
	largemouth bass	FF	37	600
	largemouth bass	SF	38	200
	smallmouth bass	FF	36	200
	smallmouth bass	SF	35	200
	yellow perch	FF	35	2,000
Middle Branch—lower				
Erickson Lake	bluegill	FF	36–40, 42	30,000
	bluegill	YR	40	200
	largemouth bass	unknown	41	1,000
	largemouth bass	FF	36, 42	400
	largemouth bass	SF	38	100
	smallmouth bass	FF	37, 42, 44	1,600
	smallmouth bass	SF	39–40	1,600
Tanlund Lake	rainbow trout	FF	55–57, 59–64, 66	26,000
	rainbow trout	SF	58–59, 68–73, 79	14,500
	rainbow trout	YR	67, 74, 78, 80–83, 85–96	20,500
Trout Creek Pond	brook trout*	AD	89, 92	825
	brook trout	FF	76	500
	brook trout	SF	75	500
	brook trout	YR	74, 98–05	3,850
	brown trout	YR	77, 79–81, 03	2,900
	rainbow trout*	AD	90	400
	rainbow trout	YR	78	500
East Branch				
Bob Lake	bluegill	FF	35–40	85,500
	brook trout	FF	60, 62–64, 81–82	105,000
	brook trout	SF	70, 72, 80–81	51,000
	brook trout	YR	68, 71	37,000
	brown trout	YR	73–76	21,000
	largemouth bass	FF	36–38, 60	4,800
	largemouth bass	SF	35, 38	1,300
	rainbow trout	SF	70, 72	18,000
	rainbow trout	YR	68, 71	14,500

Table 26.–Continued.

Subwatershed and location	Species	Life stage	Years	Total number
East Branch – continued				
Bob Lake – continued	smallmouth bass	AD	97	61
	smallmouth bass	FF	36, 41	900
	smallmouth bass	SF	39–40	2,200
	walleye	FF	97	1,000
	walleye	SF	84–86, 88, 91, 93, 98–00, 02–03	42,258
	yellow perch	FF	35	5,000
Clear Lake	bluegill	FF	36–37	7,000
	brook trout	AD	44	1,000
	brook trout	YR	43	500
	largemouth bass	FF	37	400
	rainbow trout	AD	45	500
	rainbow trout	FF	47	5,700
	smallmouth bass	FF	36, 40	1,200
Crystal Lake	brown trout	YR	78–81, 83, 85, 87–96	24,195
	rainbow trout	AD	56, 58–64	13,500
	rainbow trout	FF	56, 66, 76	12,825
	rainbow trout	SF	67–68, 70	10,000
	rainbow trout	YR	56–57, 71–74, 76–77	14,665
	yellow perch	FF	35	1,000
Echo Lake	bluegill	FF	39	10,000
	bluegill	YR	40	300
	largemouth bass	FF	38	200
	largemouth bass	YR	40	350
	yellow perch	AD	54	105
Hager Lake	bluegill	FF	35	2,000
	brook trout	FF	64, 75	5,500
	brook trout	SF	66–67, 70	20,000
	brook trout	YR	73–74	7,000
	smallmouth bass	FF	35–36	400
	rainbow trout	YR	78–80	4,900
	splake	FF	69	5,000
Hager Lake	yellow perch	FF	35	1,000
Kunze Lake	bluegill	FF	35–36, 38	8,000
	largemouth bass	FF	42, 91	1,250
	rainbow trout	SF	79–80	4,000
	rainbow trout	YR	80–88	8,475
	smallmouth bass	FF	35	200
	yellow perch	FF	35	1,000
Lake On-three	brook trout	AD	60–64	3,000
	rainbow trout	AD	60, 63–64	2,000
	rainbow trout	FF	61–62, 71	6,500
	rainbow trout	SF	66, 68–70, 72, 79	31,250

Table 26.–Continued.

Subwatershed and location	Species	Life stage	Years	Total number
East Branch – continued				
Lake On-three – continued	rainbow trout	YR	67, 73–74, 77–78, 80–82, 84–05	41,380
Lake Thirteen	bluegill	AD	71, 79	410
	bluegill	FF	35–39	30,000
	brook trout	FF	40	5,000
	brook trout	SF	43	2,000
	largemouth bass	FF	70	12,000
	largemouth bass	SF	38–39, 71	19,100
	largemouth bass	YR	70	200
	yellow perch	FF	35	1,000
Lower Dam Lake	brook trout	AD	94	50
	brook trout	FF	64	3,000
	brook trout	SF	66–68, 70	22,000
	brook trout	YR	65	1,190
	brown trout	YR	83–89	9,775
Markey Lake	bluegill	FF	39	5,000
	largemouth bass	FF	38	200
Tepee Lake	northern pike	AD	63, 79, 92	702
	northern pike	SF	86, 89, 95	3,569
	walleye	SF	80, 83, 92–93, 95	20,362
Upper Dam Lake	brook trout	FF	40	4,000
Cisco Branch				
Beatons Lake	bluegill	FF	35–41	78,000
	lake trout	AD	74–77, 84–85	8,591
	lake trout	FF	35–36, 38, 68, 83	94,500
	lake trout	SF	38, 40–42	118,000
	lake trout	YR	70–71, 79–83	113,760
	lake whitefish	AD	69	59
	rainbow smelt	AD	75	7,200
	rainbow trout	AD	43–44, 57–61, 63–64	19,275
	rainbow trout	SF	42, 70	70,000
	rainbow trout	FF	43, 51–55, 68	186,000
	rainbow trout	YR	72–73, 78, 81–05	355,622
	smallmouth bass	FF	36–37	1,500
	smallmouth bass	SF	38–39	2,000
	splake	SF	65	5,000
	splake	FF	63–64, 68, 70–71, 75–77, 85	248,175
	splake	YR	71, 81–83, 85–88, 92–93, 99–04	139,410
	walleye	FF	95	5,429
	walleye	Fry	94, 96	4,400,000
	walleye	SF	94–95, 97–99, 01–03	175,775
	yellow perch	FF	35	4,000

Table 26.–Continued.

Subwatershed and location	Species	Life stage	Years	Total number
Cisco Branch – continued				
Big Lake	muskellunge**	unknown	37	46,000
	muskellunge**	FF	39, 73, 90–93, 99, 01	3,460
	muskellunge**	Fry	38–41	10,502,928
	muskellunge**	SF	41–42, 51, 54, 73, 88	12,398
	northern pike**	Fry	38	3,000,000
	walleye	Fry	37	750,000
	walleye**	Fry	35, 37–38, 40–43	23,789,195
	walleye**	SF	50, 53, 64, 73, 75, 77	82,383
Cisco Lake	muskellunge	SF	81	400
	tiger muskellunge	SF	79	2,000
	walleye*	FF	83–85, 87–88, 94, 96	27,749
	walleye	Fry	35–40, 42, 85–86	7,050,000
	walleye	SF	83–84, 92–93, 98–00	85,865
	walleye*	SF	85–86	17,200
	walleye*	YR	89	8,500
	yellow perch	FF	35–37	19,000
Clearwater Lake	bluegill	FF	35	5,000
Cloverleaf Lake	bluegill	FF	35	5,000
Cornelia Lake	brook trout	FF	64, 66, 76, 82–86, 03–04	13,460
	brook trout	SF	67–68, 70, 74–75, 78–81	19,100
	brook trout	YR	73, 87–02, 05	19,578
	rainbow trout	FF	64	1,500
Devils Lake	largemouth bass**	FG	45	388
Forest Lake	bluegill**	AD	38	1,600
	bluegill**	YR	36	80
	largemouth bass**	FG	37, 44, 49–50, 52	15,580
	largemouth bass**	Fry	39–40	5,800
Forest Lake	walleye**	FG	65–67, 77	98,775
	yellow perch**	AD	38	200
	yellow perch**	YR	36	320
Langford Lake	bluegill	FF	37, 39–42	45,000
	largemouth bass	FF	37–38, 41–43	2,560
	largemouth bass	SF	38	500
	smallmouth bass	FF	41–44	4,300
	smallmouth bass	SF	39	1,000
	walleye	FF	94	10,366
	walleye	Fry	91	1,100,000
	walleye	SF	90–93, 95, 00, 03	125,000
Long Lake	bluegill	FF	35–41	68,000
	fathead minnow	AD	92	116,400
	lake trout	FF	36	2,000
	northern pike	AD	73	300
	largemouth bass	FF	36–38	1,900

Table 26.–Continued.

Subwatershed and location	Species	Life stage	Years	Total number
Cisco Branch – continued				
Long Lake – continued	smallmouth bass	FF	36–37, 41	2,100
	smallmouth bass	SF	38, 40	1,400
	walleye	SF	02	10,927
	yellow perch	AD	91	350
	yellow perch	FF	35	3,000
Mamie Lake	largemouth bass**	FG	44, 46, 49–50	11,350
	muskellunge**	FG	37–41, 54, 85	11,193
	muskellunge**	Fry	36–40	212,803
	walleye**	FG	53, 72, 74, 76, 85	40,912
	walleye**	Fry	35–41	11,526,635
Morris Lake	walleye*	AD	56	300
Palmer Lake	largemouth bass**	FG	49–50, 53–53, 55, 57	15,677
	muskellunge**	FG	51, 65–66, 70, 76, 84, 86, 88, 90–93, 97, 99, 03, 05	13,058
	walleye**	FG	75, 77, 83, 85, 87, 89, 91–92, 94, 98, 00, 02, 04	387,874
Spring Lake	bluegill**	AD	38	1,240
	walleye**	FG	52–53	9,850
	walleye**	Fry	39	270,000
	yellow perch**	FG	37	24,000
Tenderfoot Lake	largemouth bass**	FG	35, 50 , 52–53	14,380
	largemouth bass**	Fry	39	1,500
	muskellunge**	Fry	37, 39 , 41–42	75,000
	smallmouth bass**	FG	42, 44	24,600
	tiger muskellunge**	Fry	37	53,500
Tenderfoot Lake	walleye**	Fry	38–42	4,219,250
Thousand Island Lake	brook trout	YR	61	25,500
	lake trout	AD	75, 79	2,103
	lake trout	FF	35–36, 38, 42	70,500
	lake trout	SF	38, 40–42	120,000
	lake trout	YR	38	8,000
	rainbow trout	AD	51	2,500
	rainbow trout	YR	50	2,500
	walleye	FF	93	24,178
	walleye*	FF	97	5,300
	walleye	Fry	35–40, 42	7,700,000
	walleye	SF	86, 91, 95, 03	54,955
	walleye*	SF	98	8,000
	yellow perch	FF	35–37	34,500
West Bay Lake	walleye	Fry	37	625,000
South Branch				
County Line Lake	bluegill	unknown	41	5,000
	bluegill	FF	36–40, 42	27,300

Table 26.–Continued.

Subwatershed and location	Species	Life stage	Years	Total number
South Branch – continued				
County Line Lake - continued	bluegill	YR	40	200
	brook trout	AD	60–64	2,500
	largemouth bass	FF	36–37, 42–43	1,000
	largemouth bass	SF	38	100
	rainbow trout	AD	60–61, 63–64	4,930
	rainbow trout	FF	76	3,200
	rainbow trout	YR	68–70, 72–74, 76–80	38,425
	smallmouth bass	FF	42–43	600
	smallmouth bass	SF	39–40	1,800
	splake	SF	67–70	19,000
Crane Lake	bluegill	FF	41	5,000
	largemouth bass	FF	41	1,000
Deadman Lake	bluegill	FF	35–40	51,000
	largemouth bass	FF	37	400
	largemouth bass	SF	38	200
	northern pike	AD	50	267
	smallmouth bass	FF	36	200
	smallmouth bass	SF	40	1,000
	smallmouth bass	YR	92	73
Steusser Lake	bluegill	FF	38–39	13,000
	brook trout	FF	48–49	5,000
Sucker Lake	bluegill	FF	35, 38	10,000
	northern pike	AD	45	44
	walleye	Fry	35, 37–39	1,050,000
West Branch				
Cup Lake	northern pike	AD	64	100
Lake Gogebic	bluegill	FF	41	15,000
	bluegill	YR	43–45	54,000
	emerald shiner	AD	88	31,250
	fathead minnow*	AD	95–97	2,652,000
	sand shiner	AD	88	31,250
	smallmouth bass	FF	37	1,000
	walleye	Fry	35–40, 74–81	27,822,000
	yellow perch	FF	35–37	23,000
Victoria Reservoir	bluegill	FF	37	10,000
	smallmouth bass	FF	37	1,200
	smallmouth bass	SF	39	2,000
	walleye	Fry	38–40, 71–72	7,155,000
	walleye	SF	00–02	69,683

Table 27.–Public boat launches in the Ontonagon River watershed (MDNR 1996; Michael Vogelsang, WDNR , personal communication). Ramp codes: 1 = hard surfaced ramp with sufficient water depth to accommodate most trailerable boats, 2 = hard surfaced ramp with limited water depth, 3 = gravel ramp, and 4 = carry-down launching area. Administrating agencies: USFS = United States Forest Service, UPPCo = Upper Peninsula Power Company, MDNR = Michigan Department of Natural Resources, WDNR = Wisconsin Department of Natural Resources, and Local = county, township, or village.

Subwatershed	Launch name	Ramp code	Courtesy pier	Toilets	Administrating agency
Middle Branch—upper	Allen Lake	2	No	Yes	USFS
	Bond Falls Flowage	3	No	No	UPPCo
	Clark Lake	3	No	Yes	USFS
	Crooked Lake	1	No	Yes	USFS
	Dinner Lake	2	No	Yes	MDNR
	Duck Lake	1	No	Yes	MDNR
	Imp Lake	1	No	Yes	USFS
	Little Duck Lake	3	No	Yes	USFS
	Marion Lake NE	1	No	Yes	USFS
	Marion Lake NW	3	No	No	USFS
	Middle Branch—Watersmeet	4	No	No	USFS
	Tamarack Lake	2	No	Yes	MDNR
	Taylor Lake	3	No	Yes	USFS
Main Stem	Ontonagon Harbor	1	Yes	Yes	Local
East Branch	Bob Lake	3	No	Yes	USFS
	Crystal Lake	4	No	No	USFS
	Hager Lake	4	No	No	USFS
	Kunze Lake	4	No	No	USFS
	Lake On-three	4	No	No	USFS
	Lower Dam Lake	4	No	Yes	USFS
	Tepee Lake	3	No	Yes	USFS
Cisco Branch	Beatons Lake #1	3	No	Yes	USFS
	Beatons Lake #2	4	No	No	USFS
	Big Lake	1	Yes	No	WDNR
	Cisco Lake	1	Yes	Yes	MDNR
	Clearwater Lake	2	No	Yes	MDNR
	Forest Lake	3	No	No	Local
	Langford Lake	2	No	Yes	USFS
	Long Lake	3	No	Yes	USFS
	Mamie Lake	1	Yes	Yes	Local
	Merrill Lake	3	No	No	Local
	Palmer Lake	1	Yes	No	Local
	Thousand Island Lake	1	Yes	Yes	MDNR
South Branch	County Line Lake	2	No	Yes	MDNR
	Deadman Lake	3	No	No	USFS
	Paulding Pond	4	No	Yes	USFS
	Robbins Pond	4	No	Yes	USFS
	South Branch—Ewen	4	No	No	MDNR
	Steusser Lake	3	No	No	USFS
West Branch	Lake Gogebic—Bergland	1	Yes	Yes	MDNR
	Lake Gogebic—East	1	Yes	Yes	MDNR
	Lake Gogebic—Gog. Park	1	Yes	Yes	Local
	Lake Gogebic—Ont. Park	1	Yes	Yes	Local
	Lake Gogebic—State Park	1	Yes	Yes	MDNR
	Victoria Reservoir	1	Yes	No	UPPCo

REFERENCES

Albert, D. A. 1995. Regional landscape ecosystems of Michigan, Minnesota, and Wisconsin: a working map and classification. General Technical Report NC-178, United States Department of Agriculture, Forest Service, North Central Forest Experiment Station, St. Paul, Minnesota. Available: www.npwrc.usgs.gov/resource/1998/rlandscp/rlandscp.htm. (January 2006).

Alexander, G. R., and E. A. Hansen. 1988. Decline and recovery of a brook trout stream following an experimental addition of sand sediment. Michigan Department of Natural Resources, Fisheries Research Report 1943, Ann Arbor.

Angermeier, P. L., A. P. Wheeler, and A. E. Rosenberger. 2004. A conceptual framework for assessing impacts of roads on aquatic biota. Fisheries 29(12):19–29.

Anonymous. 1883. History of the Upper Peninsula of Michigan. Western Historical Company, Chicago.

Anonymous. 1974. Michigan fisheries centennial report 1873–1973. Michigan Department of Natural Resources, Fisheries Special Report 6, Lansing.

Anonymous. 1993. A guide to public rights on Michigan waters. Michigan Department of Natural Resources, Law Enforcement Division, Report Number 9, Lansing, Michigan.

Anonymous. 2006a. Michigan natural features inventory database. Michigan State University Extension. Available: http://web4.msue.edu/mnfi. (July 2006).

Anonymous. 2006b. GLIFWC's internet mapping site. Great Lakes Indian Fish and Wildlife Commission. Available: http://www.glifwc-maps.org. (July 2006).

Attig, J. W. 2003. Pleistocene geology of Vilas County. Wisconsin Geological and Natural History Survey Information Circular 50-DI, version 1.0. Available: www.uwex.edu/wgnhs/gis.htm. (August 2006).

Auer, N. A. 1996. Response of spawning lake sturgeons to change in hydroelectric facility operation. Transactions of the American Fisheries Society 125:66–77.

Bailey, R. M., and G. R. Smith. 1981. Origin and geography of the fish fauna of the Laurentian Great Lakes basin. Canadian Journal of Fisheries and Aquatic Sciences 38:1539–1561.

Bain, M. B., J. T. Finn, and H. E. Booke. 1988. Streamflow regulation and fish community structure. Ecology 69:382–392.

Baker, E.A. 2006. A landscape-based ecological classification system for river valley segments in Michigan's Upper Peninsula. Michigan Department of Natural Resources, Fisheries Research Report 2085, Ann Arbor.

Becker, G. C. 1983. Fishes of Wisconsin. University of Wisconsin Press, Madison.

Bedrock geology of northern Michigan (bedrock_geology.shp). 1987. Produced by the Michigan Department of Environmental Quality, Geological Survey Division, Lansing. Supplied by the Digital Water Atlas Project and the Michigan Department of Natural Resources Fisheries Division, Institute for Fisheries Research, Ann Arbor (October 2005).

Borgeson, D. P. 1987. Michigan fish stocking guidelines, revised 1987. Michigan Department of Natural Resources, Fisheries Special Report 11, Ann Arbor.

Brousseau, C. S. 1987. The lake sturgeon (*Acipenser fulvescens*) in Ontario. Pages 2–9 *in* Proceedings of a workshop on the lake sturgeon (*Acipenser fulvescens*). Ontario Ministry of Natural Resources Fisheries Technical Report Series No. 23, Toronto.

Cada, G. F. 1990. A review of studies relating to the effects of propeller-type turbine passage on fish early life stages. North American Journal of Fisheries Management 10:418–426.

Cannon, W. F. 1999. Digital geologic map of the Penokean continental margin, northern Michigan and Wisconsin. United States Geological Survey Open-File Report 99-547, United States Department of the Interior, United States Geological Survey, Eastern Mineral Resources Team, Reston, Virginia.

Cleland, C. E. 1982. The inland shore fishery of the northern Great Lakes: its development and importance in prehistory. American Antiquity 47:761–784.

Comer, P. J. 1996. Wetland trends in Michigan since 1800: a preliminary assessment. Michigan Department of Natural Resources, Natural Features Inventory, Lansing.

Coon, T. G. 1999. Ichthyofauna of the Great Lakes basin. Pages 55–71 *in* W. W. Taylor and C. P. Ferreri, editors. Great Lakes fisheries policy and management. Michigan State University Press, East Lansing.

Crumrine, J. P. 1974. Hydrology and limnology of Sucker Lake with respect to potential damming of the lake outlet. United States Forest Service, Ottawa National Forest, Ironwood, Michigan.

Cummings, K. S., and C. A. Mayer. 1992. Field guide to freshwater mussels of the Midwest. Illinois Natural History Survey, Manual 5, Champaign, Illinois.

Cushman, R. M. 1985. Review of ecological effects of rapidly varying flows downstream from hydroelectric facilities. North American Journal of Fisheries Management 5:330–339.

Cwalinski, T. A., N. A. Godby, Jr., and A. J. Nuhfer. 2006. Thunder Bay River assessment. Michigan Department of Natural Resources, Fisheries Division, Special Report 37, Ann Arbor.

Czypinski, G. D., A. K. Bowen, M. A. Goehle, S. Cogswell, and B. MacKay. 2004. Surveillance for ruffe in the Great Lakes, 2003. United States Fish and Wildlife Service Station Report, Fishery Resources Office, Ashland, Wisconsin.

Danziger, E. J., Jr. 1979. The Chippewas of Lake Superior. University of Oklahoma Press, Norman.

Dahl, T. E. 1990. Wetlands losses in the United States 1780's to 1980's. United States Department of the Interior, Fish and Wildlife Service, Washington D.C.

Dennis, J., and C. Date. 2005. Canoeing Michigan rivers: a comprehensive guide to 45 rivers. Thunder Bay Press, Holt, Michigan.

Department of the Army. 1970. Flood plain information on Ontonagon River, Ontonagon, Michigan, and Lake Superior shoreline, Ontonagon County, Michigan. Department of the Army, St. Paul District Corps of Engineers, St. Paul, Minnesota.

Dewberry, T. C. 1992. Protecting the biodiversity of riverine and riparian ecosystems: the national river public land policy development project. Transactions of the 57th North American Wildlife and Natural Resources Conference: 424–432.

Dexter, J. L., Jr., and R. P. O'Neal, editors. 2004. Michigan fish stocking guidelines II: with periodic updates. Michigan Department of Natural Resources, Fisheries Special Report 32, Ann Arbor.

Doepke, P. D. 1998. A biological survey of the Cisco Branch Ontonagon River. United States Forest Service, Ottawa National Forest – Fisheries Division, Bessemer, Michigan.

Doepker, R. V. 2003. Interim state forest management guidelines to emphasize mesic conifers in the western Upper Peninsula. Michigan Department of Natural Resources, Wildlife Division, Marquette.

Doepker, R., L. Thomasma, and S. Thomasma. 2001. MIWILDHAB: Michigan wildlife and habitats. Michigan Department of Natural Resources, Wildlife Division, Norway.

Doyle, E. L. 1988. Ontonagon's fishing industry: 1895–1968. Johnson's Quickprint & Graphics, Houghton, Michigan.

Drier, R. W., and O. J. Du Temple. 1961. Prehistoric copper mining in the Lake Superior region. R. W. Drier and O. J. Du Temple, Calumet, Michigan.

Dutch, S. 2003. Geology of Wisconsin. University of Wisconsin – Green Bay. Available: www.uwgb.edu/dutchs/geolwisc/geowisc.htm. (August 2006).

Edwards, E. A., G. Gebhart, and O. E. Maughan. 1983. Habitat suitability information: smallmouth bass. United States Department of the Interior, Fish and Wildlife Service Biological Report 82 (10.36), Washington D.C.

Eichenlaub, V. L. 1990. The climatic atlas of Michigan. University of Notre Dame Press, Notre Dame, Indiana.

Eschmeyer, P. 1941. Notes on the natural reproduction of the walleyed pike in Lake Gogebic, Michigan. Department of Natural Resources, Fisheries Research Report 695, Ann Arbor.

Eschmeyer, P. 1942. The effect of various stream flows on condition for trout in the Middle Branch of the Ontonagon River, Ontonagon County, Michigan. Michigan Department of Natural Resources, Fisheries Research Report 830, Ann Arbor.

Farrand, W. R. 1988. The glacial lakes around Michigan. Michigan Department of Natural Resources, Geological Survey Division, Bulletin 4, Lansing.

Federal Insurance Administration, Federal Emergency Management Agency. 2006. National flood insurance program – community status book. United States Department of Housing and Urban Development, Washington D.C.

Fillmore, K. L. 2003. Habitat selection and movement of stocked juvenile lake sturgeon *Acipenser fulvescens* and benthic invertebrate distribution in the lower Ontonagon River, Michigan. Master's thesis. Michigan Technological University, Houghton.

Friday, M. J. 2006. The migratory and reproductive response of spawning lake sturgeon to controlled flows over Kakabeka Falls on the Kaministiquia River, 2004. Ontario Ministry of Natural Resources, Upper Great Lakes Management Unit – Lake Superior, Technical Report 06.01, Thunder Bay.

Gibson, R. J., R. L. Haedrich, and C. M. Wernerheim. 2005. Loss of fish habitat as a consequence of inappropriately constructed stream crossings. Fisheries 30(1):10–17.

Gunderson, J. 1995. Rusty crayfish: a nasty invader. Minnesota Sea Grant, Duluth.

Hanchin, P. A. In press. The fish community and fishery of the Bond Falls Flowage, Ontonagon County, Michigan in 2003, with emphasis on walleyes and northern pike. Michigan Department of Natural Resources, Fisheries Special Report, Ann Arbor.

Hanchin, P. A., B. J. Gunderman, and R. D. Clark, Jr. 2008. The fish community and fishery of the Cisco Lake Chain, Gogebic County, Michigan and Vilas County, Wisconsin with emphasis on walleyes, northern pike, and muskellunge. Michigan Department of Natural Resources, Fisheries Special Report 47, Ann Arbor.

Harding, J. H. 1997. Amphibians and reptiles of the Great Lakes region. University of Michigan Press, Ann Arbor.

Harding, J. H., and J. A. Holman. 1990. Michigan turtles and lizards. Michigan State University Cooperative Extension Service E-2234, East Lansing.

Harding, J. H., and J. A. Holman. 1992. Michigan frogs, toads, and salamanders. Michigan State University Cooperative Extension Service Bulletin E-2350, East Lansing.

Harkness, W. J. K., and J. R. Dymond. 1961. The lake sturgeon. Ontario Department of Lands and Forests, Fish and Wildlife Branch, Toronto, Ontario.

Hazzard, A. S. 1945. A further check of the effect of the operation of Band Falls Dam on summer water temperatures in the Middle Branch of the Ontonagon River. Michigan Department of Natural Resources, Fisheries Research Report 987, Ann Arbor.

Hendrickson, G. E., R. L. Knutilla, and C. J. Doonan. 1973. Hydrology and recreation on the cold-water rivers of Michigan's Upper Peninsula. Water Information Series Report 4, United States Geological Survey.

Hjulstrom, F. 1935. Studies of the morphological activity of rivers as illustrated by the River Fyris. Bulletin of the Geological Institute, University of Uppsala, 25:221–527.

Holman, J. A., J. H. Harding, M. M. Hensley, and G. R. Dudderar. 1999. Michigan snakes. Michigan State University Cooperative Extension Service Bulletin E-2000, East Lansing.

Hubbs, C. L., and K. F. Lagler. 1947. Fishes of the Great Lakes region. University of Michigan Press, Ann Arbor.

Inskip, P. D. 1982. Habitat suitability index models: northern pike. United States Department of the Interior, Fish and Wildlife Service Biological Report 82 (10.17), Washington D.C.

Jamison, J. K. 1948. This Ontonagon country: the story of an American frontier, 3rd edition. Ontonagon Herald Company, Ontonagon, Michigan.

Johanson, B. H. 1985. This land, the Ontonagon, 2nd edition. Ontonagon Herald Company, Ontonagon, Michigan.

Johanson, B. H. 1993. Victoria: the gem of Forest Hill. Society for the Restoration of Old Victoria, Inc., Rockland, Michigan.

Johanson, B. H. 1996. Ontonagon: the river and the land. Firesteel Publications, Ontonagon, Michigan.

Juetten, R. P. 1973. The trout streams of Michigan: the Ontonagon River. Michigan Department of Natural Resources, Fisheries Technical Report 73-22, Ann Arbor.

Kindt, K., S. M. Keppner, and W. K. MacCallum. 1996. Surveillance for ruffe in the Great Lakes, 1995. United States Fish and Wildlife Service Station Report, Fishery Resources Office, Ashland, Wisconsin.

Lankton, L. 1991. Cradle to grave: life, work, and death at the Lake Superior copper mines. Oxford University Press, New York.

Leonardi, J. M., and W. J. Gruhn. 2001. Flint River assessment. Michigan Department of Natural Resources, Fisheries Special Report 27, Ann Arbor.

Ligon, F. K., W. E. Dietrich, and W. J. Trush. 1995. Downstream ecological effects of dams. BioScience 45:183–192.

Lulich, M. 1998. Akogibing: at, in, from, or to the lake called Akogib. Marko Lulich, Bergland, Michigan.

Madison, F. W., and H. F. Gundlach. 1993. Soil regions of Wisconsin. University of Wisconsin-Extension, Wisconsin Geological and Natural History Survey, Madison.

Madison, G., and R. N. Lockwood. 2004. Manistique River assessment. Michigan Department of Natural Resources, Fisheries Special Report 31, Ann Arbor.

McCafferty, W. P. 1998. Aquatic entomology. Jones and Barlett Publishers, Sudbury, Massachusetts.

McMahon, T. E. 1982. Habitat suitability index models: creek chub. United States Department of the Interior, Fish and Wildlife Service Biological Report 82 (10.4), Washington D.C.

McPeek, G. A., and R. J. Adams, editors. 1994. The birds of Michigan. Indiana University Press, Bloomington.

Mean monthly and annual, maximum, minimum, and mean temperature: conterminous United States. 2000. Produced by the National Oceanic and Atmospheric Administration – National Climatic Data Center, Asheville, North Carolina. Supplied by the Digital Water Atlas Project and the Michigan Department of Natural Resources Fisheries Division, Institute for Fisheries Research, Ann Arbor (October 2005).

Michigan 1992 NLCD Shapefile by County (land_use.shp). 2002. Produced by the Michigan Center for Geographic Information, Lansing. Supplied by the Digital Water Atlas Project and the Michigan Department of Natural Resources Fisheries Division, Institute for Fisheries Research, Ann Arbor (October 2005).

Michigan Department of Community Health. 2007. 2007 Michigan family fish consumption guide. Michigan Department of Community Health, Division of Environmental Health. Available: www.michigan.gov/documents/FishAdvisory03_67354_7.pdf (January 2008).

Michigan Department of Environmental Quality. 2002. Procedure 51 – Qualitative biological and habitat survey protocols for wadeable streams and rivers. Michigan Department of Environmental Quality, Surface Water Quality Division, Lansing.

MDNR (Michigan Department of Natural Resources). 1996. Michigan public boat launch directory. Michigan Department of Natural Resources, Parks and Recreation Division, Lansing.

MDNR (Michigan Department of Natural Resources). 2006. Fish stocking database. Michigan Department of Natural Resources, Fisheries Division. Available: www.michigandnr.com/fishstock. (August 2006).

Miller, B. R. 1997. Status of the Lake Gogebic walleye fishery, 1986–1996. Michigan Department of Natural Resources, Fisheries Technical Report 97-6, Ann Arbor.

MIRIS Base Data (multiple files). 1998. Produced by the Michigan Department of Natural Resources, Lansing. Supplied by the Supplied by the Digital Water Atlas Project and the Michigan Department of Natural Resources Fisheries Division, Institute for Fisheries Research, Ann Arbor (October 2005).

Murray, A.G., C. D. Busby, and D. W. Bruno. 2003. Infectious pancreatic necrosis virus in Scottish Atlantic Salmon farms, 1996–2001. Emerging Infectious Diseases 9:455–460.

National Hydrography Dataset (nhd_rivers.shp). 1999. Produced by the United States Geological Survey, Reston, Virginia. Supplied by the Digital Water Atlas Project and the Michigan Department of Natural Resources, Fisheries Division, Institute for Fisheries Research, Ann Arbor (October 2005).

Natural Resources Conservation Service. 2006. Distribution maps of dominant soil orders. United States Department of Agriculture, Washington D.C. Available: soil.usda.gov/technical/ classification/orders (April 2006).

Noecker, M., and S. W. Wiitala. 1948. Flood of August 1942 in the Ontonagon River basin, Michigan. Revised by R. L. Knutilla in 1969. United States Geological Survey, Water Resources Division, Lansing, Michigan.

Norcross, J. J. 1986. The walleye fishery of Michigan's Lake Gogebic. Michigan Department of Natural Resources, Fisheries Technical Report 86-9, Ann Arbor.

Nute, G. L. 1944. Lake Superior. Part of the American Lakes Series, edited by M. M. Quaife. Bobbs-Merrill Company, Indianapolis, Indiana.

Owen, O. S., and D. D. Chiras. 1990. Natural resource conservation: an ecological approach, 5th edition. MacMillan Publishing Company, New York.

Paragamian, V. L., R. Hardy, and B. Gunderman. 2005. Effects of regulated discharge on burbot migration. Journal of Fish Biology 66:1199–1213.

Petts, G. E. 1980. Long-term consequences of upstream impoundment. Environmental Conservation 7:325–332.

Pflieger, W. L. 1975. The fishes of Missouri. Missouri Department of Conservation, Jefferson City.

Poff, N. L., and J. V. Ward. 1989. Implications of streamflow variability and predictability of lotic community structure: a regional analysis of streamflow patterns. Canadian Journal of Fisheries and Aquatic Science 46:1805–1818.

Pumpelly, R. 1918. My reminiscences. H. Holt and Company, New York.

Quaternary geology of Michigan (surficial_geology_map.shp). 1998. Produced by the Michigan Natural Features Inventory and the Michigan Department of Natural Resources, Lansing. Supplied by the Digital Water Atlas Project and the Michigan Department of Natural Resources Fisheries Division, Institute for Fisheries Research, Ann Arbor (October 2005).

RMC Environmental Services. 1995. Entrainment and turbine mortality studies at the Bond Falls Hydroelectric Project, Victoria Powerhouse, Ontonagon River, Michigan. Report of RMC Environmental Services to Stone & Webster Michigan, Inc., Englewood, Colorado.

Ruffe Task Force. 1992. Ruffe in the Great Lakes: a threat to North American fisheries. Great Lakes Fishery Commission, Ann Arbor, Michigan.

Schoolcraft, H. R. 1992. Narrative journal of travels through the northwestern regions of the United States. Edited by M. L. Williams. Michigan State University Press, East Lansing.

Scott, W. B., and E. J. Crossman. 1973. Freshwater fishes of Canada. Bulletin 184. Fisheries Research Board of Canada, Ottawa.

Seelbach, P. W., M. J. Wiley, J. C. Kotanchik, and M. E. Baker. 2006. Initial classification of river valley segments across Michigan's lower peninsula. Pages 25–48 *in* R. M. Hughes, L. Wang, and P. W. Seelbach, editors. Landscape influences on stream habitats and biological assemblages. American Fisheries Society Symposium 48, Bethesda, Maryland.

Shetter, D. S., W. C. Latta, M. G. Galbraith, J. W. Merna, and G. P. Cooper. 1964. Returns on hatchery trout in Michigan. Michigan Department of Natural Resources, Fisheries Research Report 1691, Ann Arbor.

Shuman, J. R. 1995. Environmental considerations for assessing dam removal alternatives for river restoration. Regulated Rivers: Research & Management 11:249–261.

Slade, J. W., S. M. Keppner, and W. R. MacCallum. 1995. Surveillance for ruffe in the Great Lakes, 1994. United States Fish and Wildlife Service, Ashland Fishery Resources Office, Ashland, Wisconsin.

State Soil Geographic (STATSGO) data base for Michigan (soils.shp). 1994. Produced by the United States Department of Agriculture, Natural Resources Conservation Service, Fort Worth, Texas. Supplied by the Digital Water Atlas Project and the Michigan Department of Natural Resources Fisheries Division, Institute for Fisheries Research, Ann Arbor (October 2005).

Stuber, R. J., G. Gebhart, and O. E. Maughan. 1982. Habitat suitability index models: largemouth bass. United States Department of the Interior, Fish and Wildlife Services Biological Report 82 (10.16), Washington D.C.

Taft, W. 1995. A biological survey of Bluff Creek downstream of the Bond Falls Basin Copper District Flume. Ontonagon County, Michigan. Michigan Department of Environmental Quality, Surface Water Quality Division, Staff Report 95/080, Lansing.

Taft, W. 1998. A biological survey of Adventure Creek, Ontonagon County, Michigan. Michigan Department of Environmental Quality, Surface Water Quality Division, Staff Report 98/037, Lansing.

Taft, W. 1999. A biological survey of the Ontonagon River watershed, Ontonagon, Gogebic, and Houghton Counties, Michigan. Michigan Department of Environmental Quality, Surface Water Quality Division, Staff Report 98/082, Lansing.

Taft, W. 2004. A biological survey of the Ontonagon River watershed, Ontonagon, Gogebic, and Houghton Counties, Michigan. Michigan Department of Environmental Quality, Surface Water Quality Division, Staff Report 04/035, Lansing.

Taft, W. 2005. Fish community assessment of Bluff Creek downstream of the Bond Falls Basin Copper Flume Control Structure, Ontonagon County, Michigan. Michigan Department of Environmental Quality, Surface Water Quality Division, Staff Report 05/074, Lansing.

Tody, W. H. 1974. Whitefish, sturgeon, and the early Michigan commercial fishery. Pages 45–60 *in* Michigan fisheries centennial report 1873–1973. Michigan Department of Natural Resources, Lansing.

Trautman, M. B. 1981. The fishes of Ohio, revised edition. Ohio State University Press, Columbus.

Trial, J. G., J. G. Stanley, M. Batcheller, G. Gebhart, O. E. Maughan, P. C. Nelson, R. F. Raleigh, and J. W. Terrell. 1983. Habitat suitability information: blacknose dace. United States Department of the Interior, United States Fish and Wildlife Service Biological Report 82 (10.41), Washington D.C.

Trotzky, H. M., and R. W. Gregory. 1974. The effects of water flow manipulation below a hydroelectric power dam on the bottom fauna of the upper Kennebec River, Maine. Transactions of the American Fisheries Society 103:318–324.

United States Census Bureau. 2006. State & county quickfacts. United States Census Bureau, Washington D.C. Available: quickfacts.census.gov/qfd/states (April 2006).

United States Environmental Protection Agency. 2007. Effects of acid rain – surface water and aquatic animals. United States Environmental Protection Agency, Washington D.C. Available: www.epa.gov/acidrain/effects/surface_water.html (June 2007).

Wagner, W. C., R. G. Schorfhaar, and R. N. Lockwood. 1994. Evaluation of hatchery-reared brook trout stocked in the Upper Peninsula of Michigan. Michigan Department of Natural Resources, Fisheries Research Report 2008, Ann Arbor.

Warren, M. L., Jr., and M. G. Pardew. 1998. Road crossings as barriers to small-stream fish movement. Transactions of the American Fisheries Society 127:637–644.

Wesley, J. 2005. Kalamazoo River assessment. Michigan Department of Natural Resources, Fisheries Special Report 35, Ann Arbor.

Wesley, J. K., and J. E. Duffy. 1999. St. Joseph River assessment. Michigan Department of Natural Resources, Fisheries Special Report 24, Ann Arbor.

Wiley, M. J., and P. W. Seelbach. 1997. An introduction to rivers – the conceptual basis for the Michigan Rivers Inventory (MRI) project. Michigan Department of Natural Resources, Fisheries Special Report 20, Ann Arbor.

WISCLAND Land Cover (wlciw930.tif). 1998. Produced by the Wisconsin Department of Natural Resources, Madison. Provided by the Michigan Center for Geographic Information, Lansing (August 2006).

Zorn, T. G., and S. P. Sendek. 2001. Au Sable River assessment. Michigan Department of Natural Resources, Fisheries Special Report 26, Ann Arbor.

James E. Breck, Editor
Alan D. Sutton, Graphics
Ellen S. Grove, Desktop Publishing
Approved by E.M. Hay-Chmielewski

APPENDICES

This page was intentionally left blank.

Appendix A

Federal Energy Regulatory Commission settlement agreement between Upper Peninsula Power Company, Michigan Department of Natural Resources, United States Forest Service, United States Fish and Wildlife Service, Wisconsin Department of Natural Resources, Michigan Hydro Relicensing Coalition, American Rivers, American Whitewater Affiliation, Keweenaw Bay Indian Community, and Michigan Department of the Attorney General.

This page was intentionally left blank.

UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

104 FERC ¶ 62,135

Upper Peninsula Power Company Project No. 1864-005

ORDER APPROVING SETTLEMENT AND ISSUING NEW LICENSE
(August 20, 2003)

INTRODUCTION

1. Upper Peninsula Power Company (UPPCO) has filed an application for a new license, pursuant to Sections 15 and 4(e) of the Federal Power Act (FPA),[1] for the continued operation and maintenance of the 12-megawatt (MW) Bond Falls Hydroelectric Project No. 1864, located on the Ontonagon River in Ontonagon and Gogebic Counties, Michigan, and Vilas County, Wisconsin, partially on lands within the Ottawa National Forest.[2] UPPCO proposes to continue operating the existing project facilities for power production and to implement certain measures to enhance environmental conditions. UPPCO proposes no new capacity-related construction.

2. UPPCO filed a Settlement Agreement (Agreement) with the Commission on July 11, 2000. The Agreement proposes measures to resolve most of the relicensing issues that pertain to the operation of the project. For the reasons discussed below, this order approves the Agreement and issues a new license to UPPCO for the Bond Falls Project No. 1864.

BACKGROUND

3. The original license for the Bond Falls Project was issued on August 7, 1953, with a term expiring on December 31, 1988.[3] Since that time UPPCO has operated the project under annual licenses.[4]

4. UPPCO filed its application for a new license on December 24, 1987. Public notice of the application was issued on September 7, 1988. Timely motions to intervene were filed by the Wisconsin Department of Natural Resources (Wisconsin DNR) and by William Kananen.[5] Late

[1]16 U.S.C. §§ 808 and 797(e).

[2]One of the project's four developments, Bond Falls, occupies 73.5 acres of land within the Ottawa National Forest.

[3]12 F.P.C. 1135. The license was amended in 1981 to include UPPCO's constructed Victoria Project No. 2382. See Upper Peninsula Power Company, 14 FERC ¶ 62,274 (1981).

[4]See 15 (a)(1) of the FPA. 16 U.S.C. § 808(a)(1).

[5] Mr. Kananen and Wisconsin DNR’s motions were timely and unopposed, and therefore, automatically granted pursuant to Rule 214(c)(1) of the Commission’s Rules of Practice and Procedure. 18 CFR 385.214(c)(1).

motions to intervene were filed by the Anglers of AuSable, Great Lakes Council, Inc., Federation of Fly Fishers, Inc., Trout Unlimited, and the Michigan United Conservation Clubs, jointly (Anglers); and by American Rivers and American Whitewater Affiliation (American Rivers); Ray Caughran; Tom and Billie Banse; Tom and Ann Colgin; Cisco Chain Riparian Owners Association (Cisco Chain); the U.S. Department of the Interior's (Interior) Fish and Wildlife Service (FWS); the U.S. Forest Service (Forest Service); Keweenaw Bay Indian Community (Keweenaw Indians); Lake Gogebic Improvement Association, Inc. (Gogebic Association); Michigan Department of Natural Resources (Michigan DNR); Randy Myhren; North Shore Concerned Citizens Group of Lake Gogebic (North Shore Group); Upper Peninsula Sport Fisherman's Association (Fishermen's Association); and Upper Peninsula Sportsmen's Alliance. The late interventions have been granted.

5. On June 18, 1996, the Commission issued notice that UPPCO's application was ready for environmental analysis and established a deadline of August 17, 1996, for filing comments, recommendations, terms and conditions, and prescriptions. Michigan DNR, Wisconsin DNR, and FWS on August 16, 1996, August 8, 1996, and August 12, 1996, respectively, filed comments and recommendations. The Forest Service, on August 12, 1996, filed draft Section 4(e) terms and conditions; and on May 14 and 22, 2001, in response to the Settlement Agreement, filed new preliminary Section 4(e) terms and conditions. The new Section 4(e) terms and conditions are basically identical to the terms of the Settlement Agreement, addressed herein. The Forest Service filed its final Section 4(e) terms and conditions on November 22, 2002, with no substantive changes from the preliminary filing.

6. On July 11, 2000, UPPCO filed an Agreement reached between UPPCO and 10 entities.[6] Public notice of the Agreement was issued on September 25, 2000. No comments were filed in response to the notice.

7. On December 11, 2001, the Commission staff issued a draft environmental impact statement (EIS) that evaluates the potential impacts of relicensing the Bond Falls Project and recommends issuance of a new license, as proposed by UPPCO (consistent with the Agreement), and with additional staff-recommended measures. Comments on the draft EIS were filed by Cisco Chain, Michigan DNR, Keweena Indians, Michigan Hydro Relicensing Coalition, Steve Garske, Al Warren, Northwoods Wilderness Recovery, Wisconsin Public Service Corporation, on behalf of UPPCO, the Forest Service, and Interior. The comments primarily concerned minimum flows and recreational enhancements, elevation levels, fish passage, installation of a lake outlet control structure, updated information on threatened or endangered species, invasive plant species, and timber harvest rules, minimum flow monitoring, and flow data availability.

8. Commission staff considered the comments in preparing the final EIS, which was issued on June 27, 2002. In the final EIS, staff recommended adopting the Agreement and issuing a new license with certain additional staff-recommended measures.[7] FWS filed comments in support of the

[6] The settlement signatories are UPPCO, the Forest Service, FWS, Wisconsin DNR, Michigan Hydro Relicensing Coalition, American Rivers, American Whitewater Affiliation, Keweenaw Indians, Michigan DNR, Michigan Department of the Attorney General.

[7] In a June 25, 2002 filing, the North Shore Concerned Citizens Group of Lake Gogebic (North Shore Group), an intervenor, requested that action on UPPCO's relicense application be deferred until its concern regarding funding for shoreline protection measures is satisfactorily resolved. This concern is addressed in the discussion of shoreline protection measures below. North Shore Group had also filed a complaint, alleging that water levels on the project's Lake Gogebic exceeded the maximum elevations allowed by the project license, thereby causing homes, roads, and

Agreement, and the Gogebic Association filed comments requesting modification of a staff gage reference in the final EIS.[8]

9. The motions to intervene and comments received from interested agencies and individuals throughout the proceeding have been fully considered in determining whether, or under what conditions, to issue this license.

PROJECT DESCRIPTION

10. The Bond Falls Project consists of four developments, Bond Falls[9], Bergland, Cisco, and Victoria, which are located on the Middle, South (Cisco), and West Branches of the Ontonagon River in northeastern Wisconsin and the western Upper Peninsula of Michigan. The project's Bond Falls, Bergland, and Cisco developments provide seasonal reservoir storage and divert river flows to the Victoria development, where the flows are used by the project's sole generating facility, a 12-MW hydroelectric plant. Historically, UPPCO has conducted significant winter drawdowns at Bond Falls (20 feet) and Victoria (14 feet) reservoirs. Cisco and Gogebic reservoirs, where there is substantial shoreline development, have been operated to maintain relatively constant water levels, with modest winter drawdowns.

Bond Falls Development

11. The Bond Falls development, located on the Middle Branch of the Ontonagon River, consists of a 45-foot-high, 900-foot-long main dam with a spillway; a 35-foot-high, 850-foot-long control dam; the 2,160-acre Bond Falls storage reservoir with a maximum operating elevation of 1,475.9 feet msl; and a 7,500-foot-long canal.

12. UPPCO operates the Bond Falls development to store water and to divert river flow from the Middle Branch to the South Branch through the canal. The South Branch flows into the West Branch, where river flows are used for hydroelectric generation at the Victoria development, located on the West Branch of the Ontonagon River. As currently licensed, the Bond Falls development maintains a minimum flow release of 40 cubic feet per second (cfs) during June, July, and August, and 30 cfs during the remainder of the year.

---

shorelines to be flooded as far as 200 feet from the lake. The Commission determined that the licensee had not violated the license, and therefore dismissed the complaint. See North Shore Concerned Citizens Group of Lake Gogebic v. Upper Peninsula Power Company, 100 FERC ¶ 61,173 (issued August 6, 2002).

[8]The Gogebic Association indicated that the description of elevations on the Bergland staff gage (final EIS at 15) was incorrect and should be changed from "1.0 foot on the gage equals 1,293.7" to "0 foot elevation equals 1,293.7 feet msl (mean sea level)." Commission staff consulted with U.S. Geological Survey (USGS) personnel who explained that USGS reset the gaging equipment to record gage-height 1.0 foot higher, in order to prevent negative gage heights when lake levels fall below 1,293.7 msl. The gage designation in the final EIS is therefore correct.

[9]The Bond Falls development impoundment or reservoir is also known as Bond Falls Flowage.

13. As proposed in the Agreement, UPPCO will continue to divert water from the Bond Falls reservoir for power generation at the Victoria development. UPPCO will also maintain specified year-round minimum flows from Bond Falls into the Middle Branch, and reduce the maximum Bond Falls reservoir drawdown from 20 feet to 8 feet.

Bergland Development

14. The Bergland development, located on the West Branch of the Ontonagon River, consists of a 4-foot-high, 179-foot-long dam and the 276,000-acre Lake Gogebic storage reservoir. The Bergland development controls the water surface levels of Lake Gogebic, a natural lake, from which releases are used downstream for power generation at the Victoria development. Throughout the year, UPPCO maintains target water level elevations in Lake Gogebic, between the maximum normal water level of 1,296.2 feet msl and 1,294.2 feet msl, a range of 2 feet, in accordance with an agreement with the Gogebic Association.

15. The average annual outflow from the Bergland development into the West Branch is 169 cfs. Average monthly flows range from 321 cfs (April) to 77 cfs (August). There is no minimum instream flow requirement in the West Branch downstream of Bergland dam under the current license, and there are periods when only leakage flows through the plank structure of the dam.

16. As proposed in the Agreement, UPPCO will continue to use Lake Gogebic flow releases for power generation at the Victoria development with water levels similar to those under current operations. UPPCO will maintain specific seasonal and monthly minimum, maximum, and end-of-the-month target reservoir elevations and year-round minimum instream flows. Depending on the time of year and the elevation of the reservoir, UPPCO will release a minimum of 30 or 50 cfs from the Bergland development.

Cisco Development

17. The Cisco development, located in the headwaters of the Cisco Branch of the Ontonagon River, includes Cisco Lake, controlled by an 11-foot-high, 21-foot-long dam that is situated between concrete abutments and is controlled manually by placing or removing stoplogs in either of two concrete bays. Cisco Lake is on the downstream end of 15 interconnected lakes (Cisco Chain of Lakes) with a maximum water total surface area of 4,025 acres at a normal maximum surface elevation of 1,683.5 feet msl. There is no minimum instream flow requirement for the Cisco Branch.[10]

18. UPPCO has operated the Cisco development so as to maintain lake levels close to the normal maximum elevation of 1,683.5 feet msl during summer months. Between September 15 and November 1, drawdowns are limited to 1 foot, and thereafter the development releases water at the dam in basically a run-of-river mode.

19. As proposed in the Agreement, UPPCO will continue to operate the Cisco development without a minimum flow requirement. UPPCO will also operate the Cisco reservoir at or above 1,683.0 feet msl at all times, and will no longer fluctuate lake levels up to 1 foot. It will instead target the lake elevation between 1,683.4 and 1,683.9 feet msl, (0.5 foot).

[10] The Cisco Branch joins the South Branch of the Ontanagon River about 24 miles downstream of Cisco Dam.

20. The Agreement also states that UPPCO will attempt, with the Settlement Team's support, to find a new owner for Cisco Dam in order to allow it to be removed from the project license. However, the Agreement recognizes that any new owner shall be required to operate the dam according to the Operating Plan developed by the Settlement Team. If UPPCO files with the Commission to have Cisco Dam removed from the project license, UPPCO will be required to install and finance up to $75,000 (in December 1988 dollars) for a new 75-foot-long, fixed-crest spillway structure. Further, if UPPCO decides to pursue removal of Cisco Dam from the project license, UPPCO will be required to file a license amendment, that should include: (1) the reasons for removing Cisco Dam from the project license; (2) a description of the effects that removing Cisco Dam from the project would have on project operation and economics, and other resources such as recreation; (3) a statement of how Cisco Dam would be acquired (e.g., fee simple sale, etc.), maintained, and operated; and (4) consultation with and comments from the Bond Falls Project Implementation Team, Cisco Chain Riparian Owners Association, other federal, state, and local agencies, non-governmental organizations, and other appropriate parties.

Victoria Development

21. The Victoria development, located on the West Branch of the Ontonagon River, consists of a 301-foot-long, 118-foot-high dam; a gated spillway consisting of four concrete bays; the 250-acre Victoria reservoir with a maximum water surface elevation at 910 feet msl; a 9.5-foot-diameter, 6,050-foot-long, above-ground, steel pipeline connecting to a 32-foot-diameter, 120-foot-high steel surge tank, and then dividing into two, 7-foot-diameter penstocks before entering the powerhouse; two 6-MW turbine generator units; a tailrace; and a 1.6-mile-long bypassed reach. The Victoria development has an average annual generation of 72,270 MW-hours of power.

22. UPPCO operates the Victoria development to maximize energy generation during peak load periods and releases up to its maximum hydraulic capacity of about 800 cfs. Reservoir levels can fluctuate approximately 3 feet per day. UPPCO maintains the target reservoir elevation at 907.1 feet msl during the late spring, summer, and autumn, to provide maximum head for power generation. During March, UPPCO draws the reservoir down about 14 feet (to 893.1 feet msl) to allow de-icing of the spillway gates and to provide additional storage for spring runoff. UPPCO provides minimum flows of 82 cubic feet per second (cfs) below Victoria Dam in the bypassed reach of the West Branch from May 1 to June 10 of each year, unless Michigan DNR determines that such releases may be terminated at an earlier date. For the remainder of the year, there is no minimum instream flow requirement, and the bypassed reach is primarily dewatered.

23. The Victoria development will operate in a run-of-river mode during the spring for the protection of fish spawning in the West Branch of the Ontonagon River and during this period UPPCO will release flows from the powerhouse and the bypassed reach, as measured immediately downstream of the project tailwater and spillway, that approximate the sum of flows to the Victoria reservoir.[11]

THE SETTLEMENT AGREEMENT

24. The Agreement sets out the background, purpose, use, implementation, general conditions, and terms for its execution. The Agreement addresses the signatories' various concerns related to project operation, upstream fish passage, downstream fish protection, land management, project

[11] The project developments are described in greater detail in ordering paragraph (B)(2).

boundaries, water quality, woody debris management, instream flows, threatened, endangered and sensitive species management, soil and shoreline erosion control, and land-based recreational use, along with other related subjects.

Section 1.0 Background

25. Section 1 of the Agreement describes the Bond Falls Project and the project area, and identifies the parties to the Agreement.

Section 2.0 General Provisions

26. Section 2 defines the effective date of, and other terms that are used in, the Agreement; contains a schedule for implementing the Agreement 's requirements; and states the parties' preference for a 40-year license term.

Section 3.0 Project Operation and Compliance

27. Section 3.1 establishes minimum flow releases and proposed changes to basic operational modes and reservoir elevations.

28. Under the Agreement in Section 3.1.1., UPPCO will release to the Middle Branch of the Ontonagon River, immediately downstream of the Bond Falls Dam, minimum flows of 110 cfs in April, 100 cfs in May, 80 cfs from June through October, 90 cfs in November, and 80 cfs from December through March. UPPCO will release a year-round minimum flow of 25 cfs from the control dam into the canal and Roselawn Creek; release no more than 150 cfs from the control dam to the canal and Roselawn Creek from April 15 through June 15 and September 15 through November 15; and release a minimum of 25 cfs and no more than 175 cfs for the balance of the year. UPPCO will also reduce the maximum Bond Falls reservoir drawdown from 20 feet (1,455.9 msl) to 8 feet (elevation 1,467.9 to 1,475.9 feet msl) from February 1 through April 30, and 6 feet (elevation 1,469.9 to 1,475.9 feet msl) from May 1 through January 31; and control ramping rates in the Bond Falls canal ranging from 80 to 110 cfs, depending on the time of year, for the protection of aquatic resources and recreation in the Middle Branch of the Ontonagon River. A minimum flow of 25 cfs and a maximum of 150 to 175 cfs, depending on the time of the year, will be required for the Bond Falls Canal to protect downstream resources. UPPCO will make a good faith effort to meet or exceed end-of-the-month target elevations ranging from 1,468.4 feet msl to 1,474.9 feet msl at Bond Falls Flowage.

29. UPPCO will release from Bergland Dam to the West Branch of the Ontonagon River, minimum flows ranging from 30 cfs to 50 cfs, depending on the time of the year as specified in Section 3.1.3.3., for the protection and enhancement of fish and wildlife resources, water quality, aesthetic resources, and recreation. UPPCO will maintain seasonal reservoir elevation limits ranging from 1,293.7 feet msl to 1,296.2 feet msl, as specified in Section 3.1.3.1. To prevent overdrafting Lake Gogebic and control lake fluctuations, UPPCO will reduce the 50 cfs minimum flow to 30 cfs when the lake elevation is declining and the lake is at the seasonal target reservoir elevation limit specified in Section 3.1.3.3., or increase the 30 cfs minimum flow to 50 cfs when Lake Gogebic is increasing and reaches 0.1 feet above the seasonal target reservoir elevation limit specified in Section 3.1.3.3. During normal project operation, UPPCO will make a good faith effort to meet, as a minimum , the end-of-the-month target lake elevations listed in Section 3.1.3.2., ranging from 1,293.9 to 1,295.9 feet msl.

Project No. 1864-005

30. UPPCO will maintain Cisco Lake elevation at or above 1,683.0 feet msl at all times, target lake level elevations between 1,683.4 and 1683.9 feet msl, and develop and implement a Cisco Dam Operation Plan to ensure maintenance of the lake elevations.

31. As proposed in the Agreement in Section 3.1.2., UPPCO will continue to operate the Victoria development to generate power during peak load periods. Except during March and April, UPPCO will maintain the Victoria reservoir between elevation 905.0 and 908.0 feet msl, although this 3-foot drawdown range cannot be used on a daily basis. During March, UPPCO may draw down the reservoir to an elevation of 899.5 feet msl, but it will be required to return the reservoir to a minimum elevation of 906.6 feet msl by April 15 of each year. From April 15 through June 15, UPPCO will operate the powerhouse in a run-of-river mode, during which outflow from the powerhouse and spillway approximates inflow to the impoundment, and from June 15 through April 14, operate the powerhouse such that the minimum flow shall not be less than 50 percent of the maximum hourly generation flow from the previous day. During emergency conditions, UPPCO will provide a minimum flow of 200 cfs from the powerhouse. From April 15 through June 15, UPPCO will release a minimum flow of 150 cfs from the Victoria Dam into the bypassed reach.

32. Section 3.2. requires that, within six months of license issuance, UPPCO develop and implement an operation compliance plan in consultation with the Implementation Team established in Section 9 of the Agreement. Section 3.2. provides that UPPCO shall continue to cooperate with the United States Geological Survey (USGS) by providing 80 percent of the funding for four specified gages. UPPCO may discontinue funding for two other gages, and after 3 years, if certain conditions are met, discontinue funding for two other USGS gages.

33. Section 3.3. requires that, within six months of issuance of a new license, UPPCO file for Commission approval a reservoir drawdown plan, developed in consultation with the Bond Falls Implementation Team (Implementation Team) established in Section 9 of the Agreement.

Section 4.0 Natural Resource Management Issues

A. Water Quality

34. The Agreement, Section 4.1., provides that the Bond Falls Project shall meet specified water temperature and dissolved oxygen (DO) standards, and that UPPCO shall develop and implement a plan to monitor these parameters, and provide for subsequent monitoring based on the results of the initial three-year monitoring period.

B. Fish Passage

35. Michigan DNR agrees not to pursue upstream fish passage at the dams located at natural barriers or waterfalls (Bond Falls and Victoria).[12]

36. Interior reserves its authority, pursuant to FPA Section 18,[13] to prescribe upstream and downstream fishways at the project, after issuance of a new license.[14]

---

[12] Agreement, section 4.2.1.

[13] 16 U.S.C. § 811.

[14] Agreement, section 4.2.3.

37. UPPCO commits to install, in consultation with the Implementation Team, a downstream fish protection device at the Victoria Dam on or about year 10 of the Settlement (tens years after license issuance).[15]

C. Soil and Shoreline Erosion Control

38. UPPCO commits to develop and implement necessary soil erosion control plans and measures for future construction activities related to project structures. UPPCO agrees to address any other soil erosion control planning or mitigation, including stream or reservoir bank rehabilitation and Lake Gogebic shoreline protection, through the Mitigation Enhancement Fund established under Section 7 of the Agreement.[16]

D. Nuisance Plant Control and Woody Debris

39. UPPCO commits to develop for each of the four developments and file for Commission approval, plans for nuisance plant control and woody debris transport and management.[17] The woody debris plan would provide for the reasonable transport of vegetative material over the project dams and would specify the vegetative material to be passed and the procedures for passing.

E. Land Use and Wildlife Protection and Enhancement

40. In the land use management provisions, the Agreement refers to "UPPCO-owned project lands."[18] The Agreement provides that all lands currently within the project boundaries of the Bond Falls Project will remain within the boundaries under the new license.[19] The Agreement further provides that the existing project boundaries[20] are deemed sufficient for all regulatory purposes and

---

[15]Agreement, section 4.3.

[16]Agreement, section 4.4.

[17]Agreement, sections 4.5. and 4.6.

[18]See Agreement, Sections 4.7.2. and 4.7.3. Lands within the project boundaries are owned by UPPCO, U.S. Government, Forest Service, and by others. At Bond Falls, 1,182 acres of upland land are owned by UPPCO, 73.5 acres (19.5 upland and 54 surface water) are Forest Service lands, and the remaining 1,896 acres are surface water; at Bergland, 103 acres are owned by UPPCO, while 10,197 acres are owned by others; at Cisco, 10 acres are owned by UPPCO, and 1,000 acres are owned by others; and at Victoria, UPPCO owns the 408 acres, comprising upland property. See final EIS at 86.

[19]Agreement, section 4.7.1.

[20]The project boundary of the four developments lies above the maximum reservoir elevation of each development. The project boundary line shown on the Exhibit G drawings in the application generally show distances from the maximum reservoir elevation ranging from less than 200 feet wide to several hundred feet wide. The project boundaries do not follow an elevation contour, but generally zig-zag along the shorelines of the reservoirs.

that UPPCO shall have no obligation to expand the project boundaries beyond those previously established in the current license.[21]

41. UPPCO commits to develop a buffer zone plan covering "UPPCO-owned project lands" with a management objective to achieve old growth forest[22], and a wildlife and land management plan that includes timber management, revegetation measures, and threatened, endangered, and sensitive species protection for all "UPPCO-owned project lands."[23] UPPCO agrees to develop its wildlife and land management plan consistent with the bald eagle management guidelines of FWS, the Forest Service, and Wisconsin DNR, and any future Michigan DNR bald eagle management guidelines.[24] For the protection of gray wolf den sites, UPPCO agrees to develop its wildlife and land management plan consistent with the Michigan DNR wolf management guidelines and the Ottawa National Forest Land Management Plan and any future guidelines by FWS or Wisconsin DNR. For the protection and enhancement of loons, UPPCO's land management plan shall limit camping to designated locations on Bond Falls Project lands, and site and install the specified loon nesting structures on Bond Falls Flowage and Victoria Reservoir.[25]

Section 5.0 Recreation

42. The Agreement provides that the licensee will continue to maintain the existing recreational facilities at the project[26] and provides that UPPCO will develop additional recreational facilities. The proposed recreational development[27] includes recreational fishing access and an access trail at Victoria Reservoir; construction of reservoir boat launching facilities at Victoria and Bond Falls reservoirs; a shoreline fishing access area adjacent to the Victoria Reservoir boat launch; a marked canoe portage route with put-in and take-out sites at Victoria Reservoir; dispersed boat-in camp sites on Victoria Reservoir and Bond Falls Flowage; a tailwater fishing and canoe launching area at Bergland Dam; and two flatouts for accessible fishing at Lake Gogebic (one adjacent to Bergland Dam and one in the Bergland Dam tailwater). The Agreement states that no new or improved

[21]Agreement, section 4.7.1.

[22]Agreement, section 4.7.2.

[23]Agreement, sections 4.7.3 and 4.7.5. UPPCO commits to provide for wild rice restoration and enhancement, if determined feasible by the Implementation Team. Agreement, section 4.7.4.

[24]Agreement, section 4.7.6.

[25]Agreement, section 4.7.8.

[26]Existing recreational facilities at the Bond Falls development include 48 campsites, 4 unimproved boat access sites on the reservoir, picnic areas, and an unimproved hiking trail to Bond Falls. Lake Gogebic at the Bergland development provides recreational opportunities for camping, boating, fishing, swimming, hiking, and nature viewing, most of which take place off project lands, since UPPCO owns only 1 percent of the land (103 acres) within the project boundary at Bergland Dam. Extensive recreational opportunities exist at a

[26(continued)] number of the lakes in the Cisco Chain of Lakes. The Victoria development features existing boat-in campsites on the reservoir. See final EIS at 80-85.

[27]Agreement, sections 5.1., 5.2., 5.3., and 5.4.

facilities are proposed at Cisco Chain of Lakes, but facilities may be developed, if necessary.[28] UPPCO will operate and maintain all recreation sites from ice out to ice up (May through October).

Section 6.0 Cultural Resources

43. UPPCO agrees to comply with Section 106 of the National Historic Preservation Act, including all requirements of the State Historic Preservation Officer.[29]

Section 7.0 Mitigation and Enhancement Fund

44. The Agreement provides for establishment of a Mitigation and Enhancement Fund (Fund) totaling $2.46 million (in 1997 dollars). UPPCO is required to make contributions, as adjusted annually using the Consumer Price Index, less 0.5 percent. The Fund shall be managed by the Implementation Team established under Section 9, to fund specified measures adopted in the Agreement, including nuisance plant control, water quality monitoring, endangered, threatened, and sensitive species protection, soil and shoreline erosion control, upstream fish passage facilities, fish protection effectiveness studies, and recreational enhancements.

Section 8.0 Future Dam Responsibility

45. UPPCO commits to contributing $50,000 to a fund on the twentieth and thirtieth anniversaries of the date on which a new license is issued, for use in assuring compliance with applicable Commission regulations at the end of the new license.

Section 9.0 Implementation and Oversight

46. Section 9.1 of the Agreement establishes the Implementation Team that will meet annually and will coordinate and implement the Agreement, except the water quality provisions of the Agreement, which require coordination with the Michigan Department of Environmental Quality and its Surface Water Quality Division.[30] Section 9.3 of the Agreement provides a dispute resolution mechanism for conflicts that arise among members of the Implementation Team. The team members are required to engage in good-faith negotiations for a minimum of 90 days, and if agreement is not reached by then, the team is required to engage the services of a neutral third party (such as an arbitrator) to resolve the dispute. If the third party is unsuccessful, the team will then refer the dispute to the Commission for resolution.

DAM SAFETY

47. The Bond Falls and Victoria developments have historically been lowered in the late winter to allow for storage of high flows expected each spring. The developments' ability to safely pass the spring flows is related to the amount of drawdown. Under the Agreement, the maximum allowable

---

[28] Agreement, section 5.3.2.

[29] Agreement, section 6.1.

[30] The Implementation Team is comprised of representatives of UPPCO, Wisconsin DNR, Michigan DNR, FWS, the Forest Service, Keewanaw Bay, an intervenor in the relicensing proceeding, and “ex-officio members,” (currently, the Michigan Hydro Relicensing Coalition).

drawdown at the Bond Falls development will be reduced from 20 feet to 8 feet and the drawdown at the Victoria development will be reduced from 14 feet to 8.5 feet.

48. The reduced drawdowns will significantly decrease the amount of capacity available to store flows during the spring run-off. This could result in the reservoirs reaching higher levels than previously experienced during past spring run-offs and increase the likelihood of earth embankments at Bond Falls and Victoria developments being overtopped.

49. The drawdowns have also historically been used for de-icing the radial gates prior to the spring run-off at the Bond Falls and Victoria developments. It is not clear what effect the limited drawdowns will have on the continued safe operation of the gates.

50. Article 301 of this order requires the licensee to prepare a report assessing the effects of the limited drawdowns on overtopping the earth embankments and de-icing the spillway gates. The licensee cannot implement the limited drawdowns described in the Agreement until the effects of the drawdowns on dam safety are reviewed by the Commission and, if necessary, remedial measures performed. The timing to comply with license articles requirements for project operations, and for filing a project operations monitoring plan and a reservoir drawdown plan stipulated in Articles 401, 404, and 406, respectively, will be determined based on the timing to comply with Article 301 (see ordering paragraph F).

SECTION 4(e) OF THE FPA

51. Section 4(e) of the FPA[31] states that the Commission may issue a license for a project on a reservation only if it finds that the license will not interfere or be inconsistent with the purposes for which the reservation was created or acquired. Section 3(2) of the FPA[32] defines reservations as including national forests. There is no evidence or allegation in this proceeding to indicate that the relicensing of the Bond Falls Project would interfere with the purposes of the Ottawa National Forest within which the project is located. I conclude that this license, as conditioned, will not interfere or be inconsistent with the purposes for which the Ottawa National Forest was created.

52. Section 4(e) also requires that a license for a project located on a United States reservation must include all conditions that the Secretary of the department under whose supervision the reservation falls shall deem necessary for the adequate protection and utilization of such reservation.[33] The Bond Falls Project is located partially within the Ottawa National Forest, which is under the Forest Service's supervision. Specifically, the Bond Falls Development occupies 73.5 acres of Forest Service lands. These lands are generally located along a portion of the southern shoreline of the Bond Falls Flowage.[34]

[31] 16 U.S.C. § 797(e).

[32] 16 U.S.C. § 796(2).

[33] Escondido Mutual Water Co. v. LaJolla Band of Mission Indians, 466 U.S. 765 (1984).

[34] Of the 73.5 acres of Forest Service lands, 54 acres are situated within the impoundment; the remaining 19.5 acres are located along the shoreline, above the high water contour.

53. On November 22, 2002, the Forest Service, a signatory to the Agreement, filed 17 final conditions for the project pursuant to FPA Section 4(e). Condition 1 reserves the Forest Service's right to modify the Section 4(e) terms and conditions. Conditions 2, 3, and 4, respectively, require UPPCO to: (1) comply with all laws, ordinances, and regulations relating to the area or operation covered by the project license, to the extent federal law does not preempt them; (2) prepare site-specific plans for all habitat and ground-disturbing activities on Forest Service lands; (3) obtain approval from the Forest Service for any changes to as-licensed project works or operations on Forest Service lands. The remaining 13 conditions include, verbatim, the provisions of the Agreement. Of these conditions, only seven include provisions that qualify as mandatory conditions under Section 4(e). These seven conditions (Conditions 6, 8, 9, 10, 11, 12, and 13) pertain to the Bond Falls Development impoundment only, and not to the downstream conditions. The remaining conditions apply to the project's other three developments, which do not occupy Forest Service lands.

54. Condition 6 includes a reporting requirement for operational compliance at the Bond Falls Development. Condition 8 provides for the control of nuisance aquatic plants, potential restoration and enhancement of wild rice, woody debris transport and management, and a requirement to maintain current project lands for Bond Falls Flowage. Condition 9 requires the protection and enhancement of threatened and endangered species for Bond Falls Flowage. Condition 10 requires UPPCO to develop and implement soil erosion control plans and measures. Condition 11 holds UPPCO responsible for compliance with Section 106 of the National Historic Preservation Act. Condition 12 calls for UPPCO to enhance and maintain recreation sites at Bond Falls Flowage. Lastly, Condition 13 provides that the maximum annual fluctuation of water levels in the Bond Falls Flowage will be 8.0 feet, and requires specific monthly reservoir elevations. As discussed below, the remaining 10 conditions are included in the license under the Commission's comprehensive development authority provided for in Section 10(a) of the FPA,[35]

WATER QUALITY CERTIFICATION

55. Under Section 401(a)(1) of the Clean Water Act (CWA),[36] the Commission may not issue a license for a hydroelectric project unless the state water quality certifying agency has issued a water quality certification (WQC) for the project or has waived certification by failing to act on a request for certification within a reasonable period of time, not to exceed one year. Certification (or waiver) is required in connection with any application for a federal license or permit to conduct an activity which may result in a discharge into U.S. waters. Section 401(d) of the CWA provides that state certification shall become a condition of any federal license or permit that is issued.[37]

56. The Bond Falls Project has identifiable discharges in both Wisconsin and Michigan. Therefore, both states are empowered by Section 401(a)(1) of the CWA to issue water quality certification.

57. UPPCO requested water quality certification for the Bond Falls Project from Wisconsin DNR on December 16, 1987. By letter dated March 24, 1988, Wisconsin DNR waived water quality certification.

---

[35] 16 U.S.C. §803(a).

[36] 33 U.S.C. § 1341(a)(1).

[37] 33 U.S.C. § 1341(d).

58. UPPCO requested water quality certification for the project from Michigan DNR on April 10, 1986. When UPPCO had not received a response to its certification request after more than a year, it contacted Michigan DNR and the agency responded by letter dated March 18, 1988, stating that because there were unresolved issues concerning impoundment water levels and minimum flow releases and diversions from the reservoir, it "cannot issue a 401 Certification unless and until all issues regarding these topics are resolved." In 1994, Michigan DNR reviewed UPPCO's entire license application and by letter dated May 11, 1994, advised UPPCO that its 1991 response to an additional information request had materially changed the original application by changing the proposed minimum flows below Bond Falls reservoir and the proposed operation of the Victoria powerhouse. In addition, Michigan DNR asserted that the proposed operation of the project was likely to change as a result of UPPCO's planned Instream Flow Incremental Methodology study (for the bypassed river reach below the Victoria powerhouse), which UPPCO subsequently completed in December 1995.

59. The Commission's regulations require an applicant to submit a new request for a water quality certification if an amendment to the license application would have a material adverse impact on the water quality in the discharge from the project.[38] The Commission's regulations do not require UPPCO to reapply in this case because the company did not file either a material amendment to its license application under Section 4.35,[39] nor would the changes proposed by UPPCO have a material adverse impact on the water quality in the discharge from the project within the context of Section 16.8(f)(7)(iii). Because Michigan DNR did not act on the certification request within one year after the date of the initial request, Michigan DNR is deemed to have waived certification for the Bond Falls Project.

COASTAL ZONE MANAGEMENT ACT

60. Under Section 307(c)(3)(A) of the Coastal Zone Management Act (CZMA),[40] the Commission cannot issue a license for a hydropower project within or affecting a state's coastal zone, unless the state CZMA agency concurs with the license applicant's certification of consistency with the state's federally-approved CZMA program, or unless the state waives such concurrence.

61. On April 14, 1997, the Michigan Department of Environmental Quality issued a finding that the Bond Falls Project is located outside of Michigan's coastal boundaries.

HISTORIC PROPERTIES

62. On December 30, 1993, the Wisconsin State Historic Preservation Officer, the Michigan State Historic Preservation Officer, the Advisory Council on Historic Preservation, and the Commission executed a Programmatic Agreement (PA) for managing historic properties that may be

---

[38] See 18 C.F.R. § 16.8(f)(7)(iii).

[39] Section 4.35(b)(1) describes an amendment as a change ". . .to materially amend the proposed plans of development . . ." 18 C.F.R. §4.35(b)(1)(2002). UPPCO's response to the additional information request was not filed as an amendment to its application nor did the Commission subsequently determine that UPPCO's filing constituted an amendment to the license application.

[40] 16 U.S.C. §1456(c)(3)(A).

affected by relicensing the Bond Falls Project in the state of Michigan and adjacent portions of Wisconsin. Incorporating the PA in this license satisfies the Commission's responsibilities under Section 106 of the National Historic Preservation Act.[41]

THREATENED AND ENDANGERED SPECIES

63. Section 7(a)(2) of the Endangered Species Act of 1973 (ESA)[42] requires federal agencies to ensure that their actions are not likely to jeopardize the continued existence of federally listed threatened and endangered species, or result in the destruction or adverse modification of their designated critical habitat. The federally-listed endangered gray wolf and the federally-listed threatened bald eagle and Canada lynx are known to inhabit areas within the boundaries of the Bond Falls Project. No critical habitat has been designated in the project area for any of these species.

64. On July 31, 2002, pursuant to Section 7(a)(2) of the ESA, Commission staff submitted a biological assessment (BA) to the FWS. The BA concluded that, with staff's recommended measures, the proposed project is not likely to adversely affect the bald eagle, gray wolf, and Canada lynx. FWS notified the Commission that it concurred with staff's finding that relicensing would not adversely affect the gray wolf and Canada lynx provided the licensee follows the wolf management guidelines of the State of Michigan, the Wisconsin DNR guidelines, and the Ottawa National Forest Land Management Plan guidelines for the protection of den sites on all project lands, and consults with the Implementation Team, on any proposed road construction.[43] The FWS further concluded that relicensing is not likely to adversely affect the bald eagle, provided the land management and bald eagle management guidelines are adopted in the license, and the FWS is notified of any proposed development. The new license issued for Project No. 1864 (Article 415) includes such conditions.

FISHWAY PRESCRIPTIONS

65. Section 18 of the FPA[44] provides that the Commission shall require the construction, maintenance, and operation by a licensee of such fishways as the Secretaries of the U.S. Departments of Commerce and of the Interior may prescribe. By letter dated August 12, 1996, Interior requested the Commission to reserve in the license its authority to prescribe fishways. Consistent with the Commission's policy, Article 418 of this license reserves the Commission's authority to require fishways that may be prescribed by Interior for the Bond Falls Project.

RECOMMENDATIONS OF FEDERAL AND STATE FISH AND WILDLIFE AGENCIES

66. Section 10(j)(1) of the FPA[45] requires the Commission, when issuing a license, to include conditions based on recommendations of federal and state fish and wildlife agencies submitted

[41] 16 U.S.C. §470s.

[42] 16 U.S.C. §1536(a).

[43] See letter dated August 23, 2002, from Interior's Fish and Wildlife Service to the Commission Secretary, filed September 3, 2002.

[44] 16 U.S.C. § 811.

[45] 16 U.S.C. § 803(j)(1).

pursuant to the Fish and Wildlife Coordination Act,[46] to "adequately and equitably protect, mitigate damages to, and enhance, fish and wildlife (including related spawning grounds and habitat)" affected by the project.

67. Interior, Wisconsin DNR, and Michigan DNR submitted recommendations under FPA Section 10(j) for the Bond Falls Project on August 13, 1996, August 14, 1996, and August 16, 1996, respectively. These agencies are signatories to the Agreement, and it is assumed that they intend the terms in the Agreement to supersede the recommendations which they filed in 1996.

COMPREHENSIVE PLANS

68. Section 10(a)(2)(A) of the FPA[47] requires the Commission to consider the extent to which a hydroelectric project is consistent with federal and state comprehensive plans for improving, developing, or conserving waterways affected by the project.[48] Under Section 10(a)(2)(A), federal and state agencies filed 120 comprehensive plans that address various resources in Michigan and Wisconsin. Of these, the Commission staff identified and reviewed ten relevant to this project.[49] No inconsistencies were found.

DISCUSSION

69. The Commission encourages settlement agreements that resolve licensing issues in the public interest. The parties are to be commended for their extensive and ultimately successful efforts in reaching consensus on the broad range of issues related to the operation of the Bond Falls Project.

70. The Agreement provides for increased minimum flows, reduced reservoir drawdowns, maintenance of water quality standards, management of woody debris and riparian buffer zones, protection of threatened, endangered, and sensitive species, nuisance plant control, and fish passage measures. The Agreement also provides for cultural resources protection and additional recreational resources in the project vicinity. These measures will protect and enhance fish, wildlife, water quality, and aquatic resources of the Ontonagon River. For example, increased minimum flows will significantly enhance canoeing opportunities in the Middle Branch and will benefit fish species throughout the lower Ontonagon River system by reducing the potential for fish stranding, increasing

[46] 16 U.S.C. § 661 et seq.

[47] 16 U.S.C. § 803(a)(2)(A).

[48] Comprehensive plans for this purpose are defined at 18 C.F.R. § 2.19 (2002).

[49] (1) U.S. Forest Service, Ottawa National Forest Land and Resource Management Plan, 1986; (2) Great Lakes Fishery Commission, Fish Community Objectives for Lake Superior, 1993; (3) Michigan Department of Natural Resources, 1997. MDNR Draft Strategic Plan; (4) MDNR, 1991-1996 Michigan Recreation Plan, 1991; (5)Wisconsin Department of Natural Resources (WDNR), Wisconsin Water Quality Assessment Report to Congress, 1992; (6) WDNR, Wisconsin Statewide Comprehensive Outdoor Recreation Plan for 1991–1996, 1991; (7) U.S. Fish and Wildlife Service (FWS) and Canadian Wildlife Service, North American Wildlife Management Plan, 1986; (8) FWS and Canadian Wildlife Service, North American Waterfowl Management Plan, 1986;
(9) FWS, Fisheries USA: The Recreational Fisheries Policy of the U.S. Fish and Wildlife Service, undated; and (10) National Park Service. 1982. The nationwide rivers inventory. Department of the Interior, Washington, DC. January 1982. 432 pp.

spawning habitat for important migratory fish, including walleye, brown trout, steelhead, chinook salmon, coho salmon, and lake sturgeon, and increasing habitat area for important resident game fish populations, including brown trout, smallmouth bass, and walleye.[50]

71. For licensed projects, the Commission's authority extends only over the licensee; thus, the Commission can enforce all license terms, of whatever origin, that deal with the licensee's construction, operation, and maintenance of the licensed project, including environmental measures. Although there are provisions of the Agreement that impose obligations that do not come under the Commission's authority over the license or the licensee, or otherwise impose obligations that are beyond the Commission's jurisdiction to enforce,[51] they do not conflict with the license articles adopted for the project or interfere with the Commission's statutory authority. The license incorporates all of the provisions of the Agreement requiring specific licensee action to provide environmental measures for project impacts.

72. As previously stated, the land use management provisions of the Agreement describe UPPCO's commitment to develop a buffer zone plan and a wildlife and land management plan for all "UPPCO-owned project lands."[52] A licensee's responsibilities extend not only to licensee-owned lands, but to all lands within the project boundaries. Therefore, the terms and conditions of this license apply to all project lands.

OTHER ISSUES

Wild and Scenic River Designations

73. Section 7(a) of the Wild and Scenic Rivers Act (Rivers Act), 16 U.S.C. § 1278(a), bars the Commission from licensing "the construction of" any dam, water conduit, or other project works "on or directly affecting any river which is designated as a component of the national wild and scenic rivers system ... ."

74. Under Section 7(a) of the Rivers Act, the Forest Service is responsible for determining if a development below or above a designated river will "invade the area or unreasonably diminish the scenic, recreational, and fish and wildlife values present in the area at the date of designation." Section 7(b) requires the Forest Service to determine if a development below or above a potential Wild and Scenic River will "invade the area or diminish the scenic, recreational, and fish and wildlife values present in the area at the date of designation of a river for study."

75. Mr. Myhren and the Fishermen's Association, intervenors in the proceeding, point out that the Ontonagon River is under consideration as a Wild and Scenic River[53] and suggest that relicensing of the Bond Falls Project may affect the protected status of the river.

[50]See final EIS at 192-193.

[51]For example, Sections 1.0 through 2.2 contain general information, but impose no requirements on the licensee. Sections 2.3 through 2.4 and 9.0 address procedural requirements of the Agreement (enforceability, coordination, dispute resolution) that are binding on the parties to the Settlement. Such provisions are not included in the license.

[52]Agreement, Sections 4.7.2 and 4.7.3.

[53]Almost all of the Ontonagon River tributaries within the project boundaries are designated wild, scenic, recreation, and/or "study" rivers under the Wild and Scenic Rivers Act (Rivers Act), 106

76. Section 7(a) does not bar the issuance of a license for its continued operation, as long as no new construction is proposed,[54] and UPPCO proposes no new construction in its relicense application. In this case, the Forest Service did not submit conditions under Section 7(a) and (b) of the Rivers Act. In any event, Section 4.1 of the Agreement requires UPPCO to protect and enhance water quality, thereby protecting and improving the resource values of the Ottawa National Forest, including the wild and scenic rivers.

77. The Forest Service's Section 7 determination is that "there are no direct and adverse effects to the free-flowing condition of the river, or to the outstandingly remarkable values that are not mitigated by project design and/or permitting agency requirements and incorporated through reference in this analysis". Further, the Forest Service finds "that reasonable precautions and mitigations have been included within the scope of the proposed activity".[55]

Shoreline Protection Measures

78. North Shore Group, an intervenor, states that shoreline owners at Lake Gogebic have suffered extensive damage as a result of erosion caused by the project. North Shore Group has requested that the Commission defer action on the relicense application until it receives a satisfactory resolution for funding shoreline protection measures. In its complaint, filed May 28, 2002, North Shore Group proposed that they be allowed to install necessary barriers and be fully reimbursed by the Mitigation Fund Committee that is to be established pursuant to the Agreement.

79. Pursuant to the Agreement, UPPCO is committed to developing and implementing necessary soil erosion control plans and measures, and it specifically agrees to address Lake Gogebic shoreline protection through the Mitigation Enhancement Fund as required in the Agreement.[56] Article 410 provides that the licensee shall be fully responsible for funding and implementing appropriate shoreline protection measures at all project facilities and recreation sites that are owned and operated solely by the licensee, and for other shoreline areas required by the Commission. Article 410 also requires the licensee to assist and cooperate with various entities, including private property owners to minimize the adverse effects of shoreline erosion.

80. In addition, Article 401 stipulates that UPPCO delay increasing the Lake Gogebic water level if ice cover on the lake is sufficient to cause damage to shoreline structures.

81. The establishment of the Mitigation Enhancement Fund is an appropriate approach for addressing shoreline protection measures. While the Commission may include in the license a

---

Stat. 47. In 1991, 143 miles of the Ontonagon River system within the Bond Falls Project area, encompassing segments of the Cisco, Middle, South, and West Branches of the Ontonagon River, were federally designated as a Wild and Scenic River, including, wild, scenic, recreational, and study segments.

[54] See Northern States Power Company, 67 FERC ¶ 61,282 (1994).

[55] See the Forest Service Final Supplemental EIS for the Bond Falls Project at J-18,

[55(continued)] November 2002.

[56] See Agreement, Section 7.

condition requiring the Mitigation Enhancement Fund, the Commission does not oversee management of such a fund. Accordingly, North Shore Group must negotiate with UPPCO the terms for disbursing monies to fund the installation of barriers. There is no demonstrated reason why the Commission should defer relicensing of the Bond Falls Project while the parties work out details on the disbursement of funds.[57]

Minimum Flows

82. Numerous letters filed with the Commission assert that the Bond Falls Project has adversely affected recreational fishing, hunting, canoeing, boating, and camping, because of historically low flows in the Middle Branch of the Ontonogan River. Mr. Kananen, Mr. Caughran, Mr. Myhren, the Banses, the Colgins, and the Fishermen's Association, who intervened but did not become signatories to the Agreement, ask that the new license require increased flows.

83. Under the existing license, UPPCO released minimum flows ranging from 30 to 40 cfs. The new license provides for increased minimum flows immediately downstream of the Bond Falls Dam ranging from 80 to 110 cfs.

Request for a Hearing

84. In its motion to intervene, the Fishermen's Association requested that the Commission set a hearing for the relicensing proceeding. When, as here, a paper hearing provides a sufficient basis for resolving the material issues of fact in a proceeding, a trial-type evidentiary hearing is not necessary.[58]

APPLICANT’S PLANS AND CAPABILITIES

85. In accordance with Sections 10(a)(2)(C) and 15(a) of the FPA,[59] staff has evaluated UPPCO’S record as a licensee with respect to the following: (A) conservation efforts; (B) compliance history and ability to comply with the license; (C) safe management, operation, and maintenance of the project; (D) ability to provide efficient and reliable electric service; (E) need for power; (F) transmission services; (G) cost effectiveness of plans; (H) actions affecting the public; and (I) ancillary services. I accept the staff's findings in each of the following areas.

---

[57]The North Shore Group asks for a federal takeover of the Bond Falls Project, if its concerns are not satisfied by UPPCO. Section 14(b) of the FPA, 16 U.S.C. § 807(b), reserves to the United States the right to take over a non-publicly owned project upon expiration of the license, after paying to the licensee the net investment in the project, not to exceed the fair value of the property taken, plus severance damages, if any. There is no evidence to indicate that Federal takeover should be recommended to Congress in this case. No federal agency or department has expressed an interest in operating the project, recommended federal takeover, or objected to relicensing of the Bond Falls Project, and the project does not conflict with any project authorized or under study by the United States.

[57(continued)] Moreover, there appears to be no reason why federal takeover of the project would better serve the public interest than issuance of a license. Accordingly, federal takeover will not be recommended.

[58]<u>See</u> Citizens for Allegan County v. FPC, 414 F.2d 1125 (D.C. Cir. 1969).

[59]16 U.S.C. §§ 803(a)(2)(C) and 808(a).

A. Conservation Efforts (Section 10(a)(2)(c))

86. FPA Section 10(a)(2)(C) requires the Commission to consider the extent of electric consumption efficiency programs in the case of license applicants primarily engaged in the generation or sale of electricity. Based on the information detailed in the application, staff concludes that UPPCO has made a good faith effort to reduce consumption and increase efficiency for its customers and to comply with section 10(a)(2)(C) of the FPA.

B. Compliance History and Ability to Comply with the New License (Section 15(a)(2)(A))

87. The staff reviewed UPPCO's license application and other submissions in an effort to judge its ability to comply with the articles, terms, and conditions of any license issued, and with other applicable provisions of Part I of the FPA. UPPCO has generally complied with the terms and conditions of the existing license, and has made timely filings with the Commission. The staff concludes that UPPCO has or can acquire the resources and expertise necessary to carry out its plans and comply with all articles and terms and conditions of a new license.

C. Safe Management, Operation, and Maintenance of the Project (Section 15(a)(2)(B))

88. UPPCO owns and operates the Bond Falls Project. The project dams and appurtenant facilities are subject to Part 12 of the Commission's regulations concerning project safety. The staff reviewed UPPCO's management, operation, and maintenance of the project pursuant to the requirements of Part 12 and the associated Engineering Guidelines, including all applicable safety requirements such as warning signs and boat barriers, Emergency Action Plan, and Independent Consultant's Safety Inspection Reports. As the project currently operates, we conclude the project structures are safe and there is no reason to deny issuance of a new license based on the owner's record of managing, operating, and maintaining these facilities.

89. However, limiting reservoir drawdowns for the Bond Falls and Victoria developments with UPPCO's proposed project operation may affect the impoundment earth embankments by overtopping, and cause de-icing problems at the spillway gates. Article 30l of this order requires UPPCO to prepare and file a report describing effects of limiting the reservoir drawdowns in accordance with the settlement agreement on overtopping earth embankments and de-icing the spillway gates. This report must be accepted by the Commission and the construction of any remedial measures completed, if necessary, before the drawdown scenarios are implemented. These conditions would insure continuing safe operation of the project.

D. Ability to Provide Efficient and Reliable Electric Service (Section 15(a)(2)(C)

90. The staff reviewed UPPCO's plans and its ability to operate and maintain the project in a manner most likely to provide efficient and reliable electric service. UPPCO has operated the project in an efficient and reliable manner under the provisions of the existing license, and staff concludes that it would continue to provide efficient and reliable electric service in the future.

E. Need for Power (Section 15(a)(2)(D))

91. To assess the need for power, the staff reviewed UPPCO’s use of the project's power, together with that of the operating region in which the project is located. The Bond Falls Project has historically generated 72,270 MWh of electricity annually. This electricity from a non-polluting

renewable source currently helps meet a growing demand. Without the Bond Falls Project, UPPCO would have to either: (1) purchase power; (2) install additional diesel generators; or (3) purchase other hydroelectric facilities.

92. The project is located in the Mid-America Interconnected Network (MAIN) Region of the North American Electric Reliability Council (NERC). MAIN's most recent report (MAIN, 2002) summarizing annual supply and demand projections indicates that from 2002 through 2011, generation resources within the MAIN region, including generation from the Bond Falls Project, will be adequate to meet required reserve margins within the region. This projection assumes the placement in service of a number of new gas-fired peaking units, as well as the import of generation from other regions during high-demand conditions. Power produced by the project is needed to reduce required purchases into the MAIN region and to offset fossil-fueled generation.

93. The present and future use of the Bond Falls Project power, its displacement of nonrenewable fossil-fired generation, and contribution to a resource diversified generation mix, support a finding that the power from the project would help meet both a need for power in the MAIN region in both the short and long term.

F. Transmission Services (Section 15(a)(2)(E))

94. UPPCO can operate with purchased power replacing its project generation with no detrimental effects on line loading, line losses, or requirements of new construction of transmission facilities or upgrading of existing facilities. UPPCO's transmission lines need no improvements, and will also not be affected by the outcome of the licensing action because the license to be issued will authorize the project to operate with the same installed capacity as the previous license.

G. Cost-Effectiveness of Plans (Section 15(a)(2)(F))

95. UPPCO is not proposing any new capacity expansion of the Bond Falls Project. The project, under a new license, would continue to operate as an integrated system of storage reservoirs and dams providing for the regulation and storage of streamflow, flood control, diversion and power generation at the Victoria Development with some operational changes. The project, with all the proposed and recommended environmental measures included as part of this license, would produce about 64,300 MWh of power annually. We conclude that the project, as presently configured and as operated according to this order, is consistent with environmental considerations, and fully develops the economical hydropower potential of the site in a cost-effective manner.

H. Actions Affecting the Public (Section 15(a)(3)(A) and (B))

96. UPPCO sells all the power generated by the project to its customers. UPPCO pays taxes annually to local and state governments, and the project provides employment opportunities and attracts those interested in various forms of available recreation. Staff concludes that UPPCO would follow through with the implementation of the various environmental enhancement measures proposed in the Agreement and approved in this license. These measures, discussed elsewhere, herein, and in the final EIS, as well as the power generated by the project, would benefit the public.

I. Other Factors: Ancillary Services

97. In analyzing public interest factors, the Commission takes into account that hydroelectric projects offer unique operational benefits to the electric utility system (ancillary benefits). These benefits include their value as almost instantaneous load-following response to dampen voltage and

frequency instability on the transmission system, system-power-factor-correction through condensing operations, and a source of power available to help in quickly putting fossil-fuel based generating stations back on line following a major utility system or regional blackout.

98. Ancillary services are now mostly priced at rates that recover only the cost of providing the electric service at issue, which do not resemble the prices that would occur in competitive markets. As competitive markets for ancillary services begin to develop, the ability of hydro projects to provide ancillary services to the system will increase the benefits of the project.

COMPREHENSIVE DEVELOPMENT

99. Sections 4(e) and 10(a)(1) of the FPA,[60] respectively, require the Commission to give equal consideration to the power development purposes and to the purposes of energy conservation, the protection, mitigation of damage to, and enhancement of fish and wildlife, the protection of recreational opportunities, and the preservation of other aspects of environmental quality. Any license issued shall be such as in the Commission's judgment will be best adapted to a comprehensive plan for improving or developing a waterway or waterways for all beneficial public uses. The decision to license this project, and the terms and conditions included herein, reflect such consideration.

100. In determining whether a proposed project will be best adapted to a comprehensive plan for developing a waterway for beneficial public purposes, the Commission considers a number of public interest factors, including the economic benefits of project power.

101. Under the Commission's approach to evaluating the economics of hydropower projects, as articulated in *Mead Corp.*,[61] the Commission employs an analysis that uses current costs to compare the costs of the project and likely alternative power, with no forecasts concerning potential future inflation, escalation, or deflation beyond the license issuance date. The basic purpose of the Commission's economic analysis is to provide a general estimate of the potential power benefits and the costs of a project, and of reasonable alternatives to project power. The estimate helps to support an informed decision concerning what is in the public interest with respect to a proposed license. In making its decision, the Commission considers the project power benefits both with the applicant's proposed measures and with the Commission's modifications and additions to the applicant's proposal.

102. As proposed by UPPCO, and taking into account the estimated costs of the Settlement Agreement, the Bond Falls Project would produce an average of 64,300 MWh of energy annually at an annual cost of about $2,773,600 or 43.13 mills per kilowatt-hour (mills/kWh). Based on the cost of replacing the project's on and off-peaking power, the annual value of the project's power would be about $2,406,800 or 37.43 mills/kWh.[62] To determine if the project would be economically beneficial, we subtract the project's cost from the value of the project's power. Thus, the project's power would cost about $366,800 or 5.70 mills/kWh more than available alternative power, which comprises the actual requirements of the existing license (i.e., the alternative of No Action or least-cost alternative).

[60] 16 U.S.C. §§ 797(e) and 803(a)(1)

[61] 72 FERC ¶ 61,027 (1995).

[62] Power produced by the project is needed to reduce required purchases into the Mid-America Interconnected Network (MAIN) region and to offset fossil-fueled generation.

103. Staff recommends three measures, in addition to the Settlement Agreement. These measures include establishing a recreation telephone line, with an annual cost of $600 (Article 416), and allowing for a delay in the minimum elevation increase in Lake Gogebic surface elevation to protect shoreline structures from ice damage (no cost), after consultation with the Implementation Team (Article 401). The cost associated with preparing a dam safety report required by Article 301 is unknown and, therefore, not estimated.

104. Our evaluation of the economics of the proposed action and the proposed action with additional staff recommended measures shows in each analysis, that project energy would cost more than alternative energy. However, project economics is only one of the many public interest factors that is considered in determining whether or not to issue a license, and operation may be desirable for other reasons. For example, other public interest factors are to: (a) diversify the mix of energy sources in the area; (b) promote local employment; and (c) provide a fixed-cost source of power and reduce contract needs. In any event, it is the licensee which must make the business decision of whether to pursue the license in view of what appear be the net economic costs of the project.

105. Based on our independent review and evaluation of the Bond Falls Project, recommendations from the resource agencies and other stakeholders, and the no-action alternative, as documented in the final EIS, I have selected the Bond Falls Project, with the staff-recommended measures, as the preferred alternative.

106. I selected this alternative because: (1) issuance of a new license would serve to maintain a beneficial, dependable, and an inexpensive source of electric energy; (2) the required environmental measures would protect and enhance fish and wildlife resources, water quality, recreational resources, and historic properties; and (3) the 12-MW of electric energy generated from a renewable resource would continue to offset the use of fossil-fueled, steam-electric generating plants, thereby conserving nonrenewable resources and reducing atmospheric pollution.

107. The preferred alternative includes the following measures:

(1) modify allowable draw downs at Bond Falls and Victoria reservoirs, and delay raising the minimum Lake Gogebic elevation if ice cover is present (Article 401);

(2) increase minimum flows in the Middle Branch, West Branch, Victoria bypassed reach, and Bond Falls diversion canal (Article 402);

(3) provisions to modify reservoir levels required by Article 401 and minimum flows required by Article 402 during dry water years (Article 403);

(4) develop a project operations monitoring plan for the requirements of Articles 401 and 402 (Article 404);

(5) install a downstream fish passage device at the Victoria Dam (Article 405);

(6) develop a reservoir drawdown plan (Article 406);

(7) develop a Cisco Dam operation plan (Article 407);

(8) maintain water quality standards (temperature and dissolved oxygen) (Article 408);

(9) develop a water quality monitoring plan, and mitigation of temperature and dissolved violations (Article 409);

(10) develop an erosion and sediment control plan (Article 410);

(11) develop a nuisance plant control plan (Article 411);

(12) develop a woody debris transport and management plan (Article 412);

(13) develop a buffer zone plan (Article 413);

(14) develop a wildlife and land management plan (Article 414);

(15) develop a threatened and endangered species plan (Article 415);

(16) develop a recreation plan for the Bond Falls Project (Article 416);

(17) establish a Bond Falls Project Implementation Team (Article 417);

(18) reserve the Commission's authority to require fishways that may be prescribed by the Secretary of the Interior (Article 418);

(19) implement the Programmatic Agreement, including the HRMP Article 419);

(20) comply with the dispute resolution procedural requirements of the Agreement (Article 420); and

(21) establish a responsibility fund for use in complying with Commission regulations (Article 421).

LICENSE TERM

108. Section 15(e) of the FPA[63] provides that any new license issued shall be for a term which the Commission determines to be in the public interest, but the term may not be less than 30 years nor more than 50 years.

109. The Commission's general policy is to establish 30-year terms for projects that propose little or no redevelopment, new construction, new capacity, or environmental mitigative and enhancement measures; 40-year terms for projects that propose moderate redevelopment, new construction, new capacity, or mitigation and enhancement measures; and 50-year terms for projects that propose extensive redevelopment, new construction, new capacity, or enhancement.

110. In Section 2.5 of the Agreement, the signatories agree to a 40-year license term. In 1991, UPPCO completed reconstruction of the Victoria dam and related facilities costing approximately $14,000,000. UPPCO also completed a $6,000,000 replacement of the woodstave pipeline with a spiral wound steel pipeline in 2001. In light of these expenditures and the enhancement measures and operational changes proposed pursuant to the Agreement, a term of 40 years is appropriate. Accordingly, the new license for the Bond Falls Project will have a term of 40 years.

[63] 16 U.S.C. § 808(e).

SUMMARY OF FINDINGS

111. The final EIS contains background information, analysis of impacts, and support for related license articles. The design of this project is consistent with the engineering standards governing dam safety. The project will be safe if operated and maintained in accordance with the requirements of this license.

112. Based upon the review of the agency and public comments filed on the project, and the Commission staff's independent analysis under Sections 4(e), 10(a)(1), and 10(a)(2) of the FPA, I conclude that issuing a license for the Bond Falls Project, with the required environmental measures, and other special conditions, will be best adapted to the comprehensive development of the Ontonagon River for beneficial public uses.

The Director orders:

(A) This license is issued to Upper Peninsula Power Company (licensee), for a period of 40 years, effective the first day of the month in which this order is issued, to operate and maintain the Bond Falls Hydroelectric Project. This license is subject to the terms and conditions of the Federal Power Act (FPA), which is incorporated by reference as part of this license, and to the regulations the Commission issues under the provisions of the FPA.

(B) The project consists of four developments on the Middle Branch, Cisco Branch, and West Branch of the Ontonagon River. The Bond Falls, Bergland, and Cisco developments provide seasonal storage and diversion of river flow to the Victoria development, which is the only power-producing facility within the project.

(1) All lands, to the extent of the licensee's interest in those lands, enclosed by the project boundary shown by Exhibit G, filed December 24, 1987, except for the project transmission line:[64]

Exhibit G Drawing	Drawing No. 1864	Description
Sheet G-1	1001	General Area Map
Sheet G-2	1002	Storage Reservoir and Canal-Bond Falls Development
Sheet G-3	1003	Storage Reservoir -Bond Falls Development
Sheet G-4	1004	Bergland Development
Sheet G-5	1005	Bergland Development
Sheet G-6	1006	Cisco Development
Sheet G-7	1007	Victoria Development

[64]The project transmission line shown on the Exhibit G map of the December 24, 1987 filing was eliminated as a project facility by an Order Amending License, 57 FERC ¶ 62,190, December 9, 1991.

Project No. 1864-005

(2) The project consists of:

Bond Falls Development

The Bond Falls Development project works consist of: (1) a main dam consisting of a 45-foot-high, 900-foot-long earthfill embankment with a sheet pile core wall, and a 26-foot-long concrete overflow spillway (crest elevation of 1,462.9 feet msl) with discharge controlled by a 13-foot-high by 26-foot-wide steel radial crest gate; (2) the 2,160-acre Bond Falls reservoir with a maximum water surface elevation of 1,475.9 feet msl; (3) an outlet structure consisting of (a) a 7.5-foot-high by 5-foot-wide concrete intake equipped with a trashrack, (b) a 2.75-foot-high by 2.5-foot-wide concrete intake conduit, (c) a gate well and house, (d) a clapper valve upstream and a dish valve downstream, (e) two 24-inch-diameter discharge pipes, and (f) receiving basins; and (4) a control dam consisting of a 35-foot-high and 850-foot-long earthfill embankment with a steel sheet pile core wall, a 13.8-foot-high by 10-foot-wide concrete intake equipped with a trashrack; and three earthfill dikes on the rim of the reservoir consisting of one 15-foot-high, 250-foot-long, and 35-foot-wide, and two 5-foot-high, 110-foot-long, and 20-foot-wide; (5) a 20-foot-high, 7,500-foot-long trapezoidal canal; and (6) appurtenant facilities.

The Bond Falls Development has no power generating capability.

Bergland Development

The Bergland Development consists of: (1) the 4-foot-high and 179-foot-long Bergland dam consisting of 24 bays, each 7-feet- wide, and a series of wooden stoplogs stacked between steel I-beams; and (2) the 14,080-acre Lake Gogebic at a maximum operating elevation of 1,296.2 feet msl, and a gross storage capacity of 276,000 acre-feet. The Bergland Development has no power generating capability.

Cisco Development

The Cisco Development consists of: (1) the 11-foot-high and 21-foot-long Cisco dam on Cisco Lake consisting of a timber-decked concrete level control structure; and (2) the Cisco Chain of Lakes consisting of 15 interconnected lakes with a maximum surface area of 4,025 acres, at a maximum operating elevation of 1,683.5 feet msl. The Cisco Development has no power generating capability.

Victoria Development

The Victoria Development consists of: (1) a new 301-foot-long and 118 foot-high roller-compacted concrete dam[65]; (2) the 250-acre Victoria reservoir with a maximum operating elevation of 910 feet, and an effective storage area of 3,300 acre-feet at a drawdown of 14 feet; (3) a gated spillway consisting of four concrete bays, equipped with steel radial gates, 22 feet wide by 13 feet

[65] The original Victoria dam was replaced in 1991 with a roller-compacted concrete gravity dam that was constructed 15 feet downstream of the original dam. The upper portion of the original dam was removed after the replacement dam was constructed. The remainder of the original dam was left in place.

high; (4) a new 9.5-foot-diameter, 6,050-foot-long above-ground steel pipeline;[66] (5) a 32-foot-diameter, 120-foot-high steel surge tank (capacity 491,300 gallons); (6) a 10-foot-diameter steel penstock that bifurcates into two 7-foot-diameter penstocks before entering the powerhouse; (7) a 30-foot-wide by 82-foot-long by 50-foot-high powerhouse; (8) generating facilities consisting of two 6-MW Francis-type vertical shaft turbine-generator units, each unit rated at 9,300 horsepower (hp) at 210 feet of head and 300 revolutions per minute (rpm); (9) a tailrace; and (10) a 1.6-mile-long bypassed reach.

The project works generally described above are more specifically described in Exhibit A (pages A-1 through A-16) and Exhibit F (F-1 through F-5) of the license application filed December 24, 1987, except for the Victoria Development. New
Exhibit F Drawings are being required in this order for the Victoria Development to update the changes by construction of a new dam and replacement pipeline, and removing the primary transmission line from the project since the initial December 24, 1987 application filing date.

Exhibit F Drawing	Drawing No. 1864	Description
BOND FALLS DEVELOPMENT		
Sheet F-1	1008	Main Dam and Auxiliary Dike
Sheet F-2	1009	Plans, Sections, and Details
Sheet F-3	1010	Control Dam and Canal Structures
BERGLAND DEVELOPMENT		
Sheet F-4	1011	General Plan and Elevation
CISCO DEVELOPMENT		
Sheet F-5	1012	Plans, Sections and Details

(3) All of the structures, fixtures, equipment or facilities used to operate or maintain the project, all portable property that may be employed in connection with the project, and all riparian or other rights that are necessary or appropriate in the operation or maintenance of the project.

(C) Those sections of Exhibits A, F, and G described above are approved and made part of the license.

(D) The licensee shall file for Commission approval revised Exhibit F Drawings for the Victoria Development, within 90 days after issuance of a new license.

(E) This license is subject to the conditions submitted by the U.S. Department of Agriculture, Forest Service, under Section 4(e) of the FPA, as those conditions are set forth in Appendix A to this order, as modified by the Staff. The Commission reserves the right to amend this license as

[66] By letter dated January 24, 2002, UPPCO reports that during 2001, about 6,050 feet of the 10-foot-diameter woodstave pipeline was replaced with a 9.5-foot-diameter spiral-wound steel pipeline.

appropriate in light of the Forest Service's ultimate disposition of any appeals of, or modifications to, the mandatory Section 4(e) conditions that might arise.

(F) After Commission approval of the filing requirements in Article 301, the licensee shall implement the requirements in license Articles 401, 404, and 406.

(G) This license is subject to the articles set forth in Form L-1 (October 1975), entitled "TERMS AND CONDITIONS OF LICENSE FOR CONSTRUCTED MAJOR PROJECT AFFECTING LANDS OF THE UNITED STATES," and the following additional articles.

Article 201. The licensee shall pay the United States an annual charge, effective as of the date of commencement of project construction, for the purpose of:

(A) Reimbursing the United States for the cost of administering Part I of the Federal Power Act, a reasonable amount as determined in accordance with the provisions of the Commission's regulations in effect from time to time. The authorized installed capacity for that purpose is 12,000 kilowatts.

(B) Recompensating the United States for use, occupancy and enjoyment of 73.5 acres of lands other than for transmission line right-of-way.

Article 202. Within 45 days of the date of issuance of the license, the licensee shall file three sets of aperture cards of the approved exhibit drawings. The set of originals shall be reproduced on silver or gelatin 35mm microfilm. All microfilm shall be mounted on type D (3-1/4' X 7-3/8") aperture cards.

Prior to microfilming, the FERC Drawing Number (1864-1001 through 1864-1018) shall be shown in the margin below the title block of the approved drawing. After mounting, the FERC Drawing Number shall be typed on the upper right corner of each aperture card. Additionally, the Project Number, FERC Exhibit (e.g., F-1, G-1, etc.), Drawing Title, and date of this license shall be typed on the upper left corner of each aperture card.

Two of the sets of aperture cards shall be filed with the Secretary of the Commission, ATTN: OEP/DHAC. The third set of aperture cards shall be filed with the Commission's Chicago Regional Office.

Article 203. The licensee shall clear and keep clear to an adequate width all lands along open conduits and shall dispose of all temporary structures, unused timber, brush, refuse, or other material unnecessary for the purposes of the project which result from maintenance, operation, or alteration of the project works. All clearing of lands and disposal of unnecessary material shall be done with due diligence to the satisfaction of the authorized representative of the Commission and in accordance with appropriate federal, state, and local statutes and regulations.

Article 204. If the licensee's project is directly benefitted by the construction work of another licensee, a permittee, or of the United States of a storage reservoir or other headwater improvement, the licensee shall reimburse the owner of the headwater improvement for those benefits, at such time as they are assessed. The benefits will be assessed in accordance with Subpart B of the Commission's regulations.

Article 205. Pursuant to Section 10(d) of the Federal Power Act, a specified reasonable rate of return upon the net investment in the project shall be used for determining surplus earnings of the project for the establishment and maintenance of amortization reserves. The licensee shall set aside in a project amortization reserve account at the end of each fiscal year one-half of the project surplus earnings, if any, in excess of the specified rate of return per annum on the net investment.

To the extent that there is a deficiency of project earnings below the specified rate of return per annum for any fiscal year, the licensee shall deduct the amount of that deficiency from the amount of any surplus earnings subsequently accumulated, until absorbed. The licensee shall set aside one-half of the remaining surplus earnings, if any, cumulatively computed, in the project amortization reserve account. The licensee shall maintain the amounts established in the project amortization reserve account until further order of the Commission.

The specified reasonable rate of return used in computing amortization reserves shall be calculated annually based on current capital ratios developed from an average of 13 monthly balances of amounts properly included in the licensee's long-term debt and proprietary capital accounts as listed in the Commission's Uniform System of Accounts. The cost rate for such ratios shall be the weighted average cost of long-term debt and preferred stock for the year, and the cost of common equity shall be the interest rate on 10-year government bonds (reported as the Treasury Department's 10-year constant maturity series) computed on the monthly average for the year in question plus four percentage points (400 basis points).

Article 301. Within 90 days after the issuance of a new license, the licensee shall submit one copy to the Division of Dam Safety and Inspections - Chicago Regional Engineer and two copies to the Commission (one of these shall be a courtesy copy to the Director, Division of Dam Safety and Inspections), of a report describing the effects of limiting the reservoir drawdowns in accordance with the settlement agreement on overtopping earth embankments and de-icing the spillway gates.

The report shall include a flood routing study that evaluates the ability of the developments to safely pass flows up to the Inflow Design Flood. The frequency that the earth embankments would be overtopped under the historical and limited drawdowns should be compared. If necessary, the report shall include a plan and schedule for performing any remedial measures necessary to ensure the continued safe operation of the developments during high flows. The foundation materials of the embankment subject to overtopping should be assessed for erodibility. Based on the results of the assessment, the dambreak parameters assumed for determining the hazard potential classification of the structures should be verified and, if necessary, additional dambreak analysis performed and submitted to confirm the hazard potential classification.

The licensee shall not implement the drawdown scenario described in the settlement agreement and Article 401, or the operation monitoring plan required in Article 404 and the reservoir drawdown plan required in Article 406, until the Commission accepts the report and, if necessary, the licensee completes construction of the remedial measures.

Article 401. Upon Commission acceptance of the report required by Article 301, and approval of the plan required in Article 404, the licensee shall operate the water storage developments of the Bond Falls Project within the reservoir elevation limits, and according to the target elevations, described below.

Bond Falls Development – Bond Falls Reservoir (Flowage)

From February 1 through April 30, the licensee shall maintain the Bond Falls Reservoir between elevation limits 1,467.9 to 1,475.9 feet msl (132-140 feet, local datum). From May 1 through January 31, the licensee shall maintain the Bond Falls Reservoir between elevation limits 1,469.9 to 1,475.9 feet msl (134-140 feet, local datum).

In addition, the licensee shall make a good faith effort to operate the Bond Falls Reservoir to meet or exceed the following end-of-month target elevations. Further, the licensee shall maintain the following end-of-month minimum elevations:

	End-of-Month Target Elevation (feet)		End-of-Month Minimum Elevation (feet)	
Month	Local	msl	Local	msl
Jan	136.0	1,471.9	135.0	1,470.9
Feb	134.0	1,469.9	133.0	1,468.9
Mar	132.5	1,468.4	132.0	1,467.9
Apr	136.0	1,471.9	135.0	1,470.9
May	139.0	1,474.9	138.0	1,473.9
June	137.5	1,473.4	137.0	1,472.9
July	136.5	1,472.4	136.0	1,471.9
Aug	135.0	1,470.9	134.5	1,470.4
Sept	135.0	1,470.9	134.5	1,470.4
Oct	138.0	1,473.9	134.0	1,469.9
Nov	138.0	1,473.9	134.0	1,469.9
Dec	137.0	1,472.9	136.0	1,471.9

Victoria Development – Victoria Reservoir

From March 1 through April 15, the licensee may draw down the Victoria Reservoir to a minimum elevation of 899.5 feet msl to accommodate spring runoff. The licensee shall refill the Victoria Reservoir to elevation 906.6 by April 15, in order to operate the Victoria Development in a run-of-river mode during the spring, according to Article 402. From April 16 through February 28/29, the licensee shall operate the Victoria Reservoir between elevations 905.0 to 908.0 feet msl, with the entire range not to be used on a daily basis.

Bergland Development – Lake Gogebic

The licensee shall operate Bergland Dam to maintain Lake Gogebic within the following elevation limits (in feet msl):

	Minimum	Maximum
September 15 to February 28/29	1,293.7	1,295.7
March 1 to March 31	1,293.7	1,294.7
April 1 to April 24 (ice out)	1,293.7	1,296.2
April 25 (ice out) to June 10	1,295.7	1,296.2
June 11 to September 1	1,295.2	1,296.2

The licensee shall delay increasing the Lake Gogebic minimum water level to 1,295.7 feet msl on April 25, if ice cover on Lake Gogebic is sufficient to cause damage to shoreline structures at the higher lake elevation. The licensee shall consult with a designated representative of the Bond Falls Project Implementation Team (Implementation Team) regarding the timing of raising the lake elevation, and comply with the April 25 minimum elevation as soon practicable thereafter, once ice conditions no longer present a significant risk to shoreline structures.

In addition to the above elevations limits, the licensee shall make a good faith effort to operate Lake Gogebic to meet the following end of month target elevations:

	End of Month Target Elevation (feet msl)
January & February	1,293.9
March	1,294.2
April & May	1,295.9
June through September	1,295.7
October	1,294.7
November & December	1,294.2

Cisco Development – Cisco Chain of Lakes

The licensee shall operate Cisco Dam to maintain Cisco Lake at or above elevation 1,683.0 feet msl, with a target elevation between 1,683.4 to 1,683.9 feet msl.

Water elevations at the Bond Falls Project may be temporarily modified if required by operating emergencies beyond the control of the licensee, or for short periods upon mutual agreement between the licensee, the Michigan Department of Natural Resources (MDNR), and U.S. Fish and Wildlife Service (FWS) and other members of the Implementation Team. If the water elevations are so modified, the licensee shall notify the Commission as soon as possible, but no later than 10 days after each such incident, and shall file a report with the Commission explaining the reason(s) for the deviation from the required elevations. The report shall, to the extent possible, identify the cause, severity, and duration of any deviation, and any observed or reported adverse environmental impacts resulting from the deviation. The report shall also include: 1) operational data documenting the occurrence; 2) a description of any corrective measures implemented at the time of occurrence and the measures implemented or proposed to ensure that similar incidents do not recur; and 3) comments or correspondence, if any, received from the resource agencies regarding the incident.

Article 402. The licensee shall release minimum and maximum flows from each of the project developments, as described below, for the protection and enhancement of water quality, fish and wildlife resources, aesthetics, and recreation in the Middle, West, and South Branches of the Ontonagon River, and in Roselawn, Bluff, and Sucker Creeks.
These flows shall be released immediately after the issuance date of the license under the existing project reservoir drawdown operation, providing there is adequate water available in the reservoirs. If there is inadequate water for these releases, the licensee, within 30 days of the issuance date of this license, shall submit a report explaining the inadequate water supply including supporting documentation.

Bond Falls Development – Middle Branch Ontonagon River

The licensee shall release from the Bond Falls Dam, into the Middle Branch of the Ontonagon River, the following minimum flow releases, as measured downstream of the dam:

April	110 cfs
May	100 cfs
June 1 through October 31	80 cfs

Project No. 1864-005

November	90 cfs
December 1 through March 31	80 cfs

Bond Falls Development – South Branch Ontonagon River, Roselawn, Bluff, and Sucker Creeks

The licensee shall release from the Bond Falls Control Structure into the Bond Falls Canal, the minimum and maximum flows described below, as measured immediately downstream of the control structure:

	Minimum	Maximum
April 15 through June 15	25 cfs	150 cfs
September 15 through November 15	25 cfs	150 cfs
Balance of the Year	25 cfs	175 cfs

The licensee shall make all flow adjustments in the Bond Falls Canal in single increments during any 24-hour period. The licensee may make flow changes, either increases or decreases, that are less than or equal to 50 cfs in a single adjustment. For flow changes that are greater than 50 cfs, adjustments must be made in two increments: one-third of the total change on the first adjustment (the first 24-hour period), and two-thirds of the total change on the second adjustment (the second 24-hour period).

Victoria Development – West Branch Ontonagon River

The licensee shall operate the Victoria Development in a run-of-river (ROR) mode from April 15 through June 15, for the protection and enhancement of water quality and fisheries resources in the West Branch Ontonagon River. The licensee shall act during this period to maintain a discharge from the Victoria Dam and Powerhouse that, at all times, approximates the sum of the inflows to the Victoria Reservoir.

The licensee shall operate the Victoria Powerhouse, during the period from June 16 through April 14, such that in any day, the minimum flow is not less than 50 percent of the maximum hourly flow recorded on the previous day. The minimum and maximum flows shall be measured using generating unit output converted to discharge, or other appropriate methodology determined in accordance with Article 404. A minimum flow of 200 cfs shall be maintained during emergency generating conditions declared by the licensee, but these emergency conditions may not exceed 5 percent of the time, or 18 days per year. The Michigan Department of Environmental Quality and other members of the Bond Falls Project Implementation Team shall be notified within one working day of the occurrence of an emergency generating condition.

The licensee shall release a minimum flow of 150 cfs from the Victoria Dam into the bypassed river channel from April 15 through June 15, to protect spawning fish in the West Branch of the Ontonagon River. This flow may be modified in accordance with the monitoring provisions of Article 404, or as otherwise agreed to by the Bond Falls Project Implementation Team.

Bergland Development – West Branch Ontonagon River

The licensee shall release from the Bergland Dam into the West Branch of the Ontonagon River the minimum flows described below, as measured immediately downstream of the dam:

	Lake Gogebic Trigger Elevation (ft, msl)	Minimum Flow
Sept. 15 to Apr. 24	> 1,293.9	50 cfs
Sept. 15 to Apr. 24	≤ 1,293.9	30 cfs
Apr. 25 to June 10	> 1,295.9	50 cfs
Apr. 25 to June 10	≤ 1,295.9	30 cfs
June 11 to Sept. 14	> 1,295.4	50 cfs
June 11 to Sept. 14	≤ 1,295.4	30 cfs

To prevent over drafting Lake Gogebic and to prevent flow changes causing lake levels to fluctuate about the trigger elevation, the licensee shall adjust the minimum flow according to the following criteria:

(1) When the Lake Gogebic elevation is above the trigger elevation and declining, the 50-cfs minimum flow will be reduced to 30 cfs when the elevation is 0.1 feet above the trigger elevation.

(2) When the Lake Gogebic elevation is below the trigger elevation and increasing, the 30-cfs minimum flow will be increased to 50 cfs when the elevation is 0.1 feet above the trigger elevation.

Flow releases from the Bond Falls Project developments may be temporarily modified if required by operating emergencies beyond the control of the licensee, and for short periods upon mutual agreement between the licensee, the Michigan Department of Natural Resources (MDNR), U.S. Fish and Wildlife Service (FWS), and other members of the Bond Falls Project Implementation Team (Implementation Team). If the flow releases are so modified, the licensee shall notify the Commission as soon as possible, but no later than 10 days after each such incident, and shall file a report with the Commission explaining the reason(s) for the deviation from the required flow releases. The report shall, to the extent possible, identify the cause, severity, and duration of any deviation, and any observed or reported adverse environmental impacts resulting from the deviation. The report shall also include: 1) operational data documenting the occurrence; 2) a description of any corrective measures implemented at the time of occurrence and the measures implemented or proposed to ensure that similar incidents do not recur; and 3) comments or correspondence, if any, received from the resource agencies regarding the incident.

Article 403. When inflows to Victoria Reservoir fall to 250 cfs, during dry water years, the licensee shall consult with the Michigan Department of Natural Resources (MDNR), U.S. Fish and Wildlife Service (FWS), and other members of the Bond Falls Project Implementation Team (Implementation Team), to determine how to maintain a minimum of 200 cfs to the Victoria Powerhouse. The reservoir water level operating requirements of Article 401, and the minimum and maximum flow requirements of Article 402, may be adjusted, as agreed upon by the Implementation Team, in the following order of priority, upon approval of the plan required in Article 404:

(1) Bond Falls Flowage elevations;

(2) Bond Falls Canal flows;

(3) Victoria bypassed reach minimum flow;

(4) Lake Gogebic elevations and outflows;

(5) Middle Branch minimum flows; and

Project No. 1864-005

(6) Cisco Lake elevations and outflows.

The 200-cfs emergency-generating-condition minimum flow from the Victoria Development may be reduced or discontinued, when all of the following conditions are met:

Condition	**April - September**	**October - March**
Bond Falls Flowage elevation	1,461.9 ft. msl (126.0 ft. local)	1,461.9 ft. msl (126.0 ft. local)
Lake Gogebic elevation	1,295.0 ft. msl	1,293.7 ft. msl
Middle Branch flow	40 cfs	40 cfs
Cisco Lake elevation	1,683.4 ft. msl	1,683.0 ft. msl

Any adjustments to the Cisco Lake elevation shall be made prior to the formation of ice cover on the lake. Consultations between the licensee and the Implementation Team shall occur on at least a weekly basis during dry water year conditions, as defined by this article, and shall continue until the dry water year conditions have abated, and the requirements of Articles 401 and 402 have been restored.

Article 404. The licensee shall file for Commission approval, within 60 days of the date that the Commission has verified that the licensee has met the requirements of Article 301, a plan to monitor project operations as required by Articles 401 and 402. The plan shall be prepared in consultation with the Michigan Department of Natural Resources, U.S. Fish and Wildlife Service (FWS), and the other members of the Bond Falls Project Implementation Team (Implementation Team), and include a minimum of three years of monitoring reservoir elevations and discharges from each of the Project developments, in order to determine whether these elevations and discharges can be attained without affecting project operations, and to demonstrate whether gate openings, headwater elevations, verified rating curves, and power production can be used to verify compliance. At the conclusion of the three-year monitoring period, the licensee shall consult with the Implementation Team to determine if project operations should be modified. Following this consultation, the licensee shall file a report with the Commission, describing the results of the monitoring, and any recommended modifications to project operations. The monitoring plan shall include the following:

(1) Description of the methodology for providing flow data for Middle Branch minimum flows and Bond Falls Canal flows using a combination of recorded gate openings, headwater elevations and verified gate rating curves that are developed by the licensee in consultation with the Michigan Department of Natural Resources and the other members of the Implementation Team. This methodology must be equivalent to methods used by the U.S. Geological Survey (USGS) and must provide data of approximately the same quality to those of the USGS.

(2) Provisions for the licensee to record gate openings each time a gate is changed.

(3) Provisions for the licensee to continuously monitor (e.g., hourly measurement) the Bond Falls Flowage and Victoria Reservoir headwater elevations.

(4) Provision to provide the Team with a table of discharges for each dam, at each gate opening and headwater elevation, for the easy interpretation of compliance data.

(5) Description of the methodology to provide USGS-equivalent data for all other sites, including the Victoria Development bypassed reach, Victoria Powerhouse tailwater, Lake Gogebic, Cisco Lake, and Cisco Branch of the Ontonagon River.

(6) Provisions for the licensee to contract with USGS to verify gate openings, headwater elevations and gate rating curves at the Bond Falls Project semi-annually, or at a frequency recommended by USGS for the initial three-year period after license issuance. If USGS is unavailable, then an equivalent contractor can be used in consultation with the Implementation Team.

(7) The frequency of data recording for all sites, and format of compliance reports following the recommendations of the Implementation Team.

(8) Provisions to provide compliance reports required by the Commission to the Implementation Team for project operations review.

As part of the monitoring program, the licensee shall continue its existing level of cooperation with the USGS and shall fund 80% of the cost of the following gages, for the term of the license: Lake Gogebic near Bergland, USGS No. 04035995 (lake level monitoring gage); West Branch of the Ontonagon River near Bergland, USGS No. 04036000; Cisco Lake near Watersmeet, USGS No. 04037400 (lake level monitoring gage); and Cisco Branch Ontonagon River at Cisco Lake outlet, USGS No. 04037500.

The licensee shall also provide 80 percent of the funding for the following existing USGS gauges, for no more than three years following the date of issuance of this license, to determine if compliance data measured at the Bond Falls dam are accurate. Funding shall be discontinued if accuracy is demonstrated. The affected gages are: Bond Falls Canal near Paulding, USGS No. 04033500; and Middle Branch Ontonagon River near Trout Creek, USGS No. 04034500.

At the same time, the licensee may discontinue funding the following USGS gages in the Ontonagon River watershed: Middle Branch Ontonagon River near Rockland, USGS No. 04035500; and Ontonagon River near Rockland, USGS No. 04040000.

The licensee shall include with the operations monitoring plan an implementation schedule, documentation of consultation, copies of agency comments and recommendations on the draft plan, and specific descriptions of how the agencies' comments are accommodated by the final plan. The licensee shall allow a minimum of 30 days for the agencies to comment and to make recommendations before filing the plan with the Commission. If the licensee does not adopt a recommendation, the filing shall include the licensee's reasons, based on project-specific information.

The Commission reserves the right to require changes to the plan. The operations monitoring plan shall not be implemented until the licensee is notified that the plan is approved. Upon Commission approval, the licensee shall implement the plan according to the approved schedule, including any changes required by the Commission.

Article 405. The licensee shall install a downstream fish protection device at the Victoria Dam by year 10 of the issuance date of a new license, in consultation with the Michigan Department of Natural Resources (MDNR), U.S. Fish and Wildlife Service (FWS), and the other members of the Bond Falls Project Implementation Team (Implementation Team). The Implementation Team shall develop the fish protection device selection process and the final installation schedule. The licensee shall contribute the equivalent of the cost of in-kind replacement of the existing Victoria Dam trashracks, when such replacement is deemed necessary. Any additional costs for a fish protection device shall be borne by the Mitigation Enhancement Fund (see Section 7 of the Settlement).

Fish protection effectiveness studies shall be funded by the Mitigation Enhancement Fund, if such studies are deemed necessary by the Implementation Team. If studies are deemed necessary, then the licensee shall develop a study plan and implementation schedule in consultation with the Implementation Team, and file the plan for Commission approval. The licensee shall include with the filing, documentation of consultation, copies of agency comments and recommendations on the draft study plan, and specific descriptions of how the agencies' comments are accommodated by the final study plan. The licensee shall allow a minimum of 30 days for the agencies to comment and make recommendations before filing the study plan with the Commission. If the licensee does not adopt a recommendation, the filing shall include the licensee's reasons, based on project-specific information.

The Commission reserves the right to require changes to the study plan. No ground-disturbing or land-clearing activities for installing a fish protection device shall begin until the licensee is notified by the Commission that the plan is approved. Upon Commission approval, the licensee shall implement the study plan, including any changes required by the Commission.

Article 406. The licensee shall file for Commission approval, within 60 days of the date that the Commission has verified that the licensee has met the requirements of Article 301, a Reservoir Drawdown Plan. The purpose of the Plan is to minimize the impact of reservoir drawdowns on aquatic and riparian resources in any of the project reservoirs. The Plan shall be developed in consultation with the Michigan Department of Natural Resources (MDNR), U.S. Fish and Wildlife Service (FWS), and the other members of the Bond Falls Project Implementation Team (Implementation Team), and shall include notification procedures for drawdowns, drawdown and refill rates, procedures to prevent fish stranding, and any other operational modifications that may be required to protect riparian resources. The Plan shall require notification for all planned drawdowns prior to initiation of the drawdown or operational change. Notification for unplanned drawdowns or changes should occur as soon as practicable after the change, generally within one working day.

The licensee shall include documentation of consultation, copies of agency comments and recommendations on the draft Plan, and specific descriptions of how the agencies' comments are accommodated by the Plan. The licensee shall allow a minimum of 30 days for the agencies to comment and make recommendations before filing the Plan with the Commission. If the licensee does not adopt a recommendation, the filing shall include the licensee's reasons, based on project-specific information.

The Commission reserves the right to require changes to the Plan. The Reservoir Drawdown Plan shall not be implemented until the licensee is notified that the Plan is approved. Upon Commission approval, the licensee shall implement the Plan, including any changes required by the Commission, provided the drawdown scenario required in Article 301 has been filed with and approved by the Commission.

Article 407. Within six months after the issuance of a new license, the licensee shall file with the Commission, for approval, a Cisco Dam Operation Plan. The purpose of the Plan is to minimize flow fluctuations in the Cisco Branch and to minimize water level fluctuation in Cisco Lake. The licensee shall develop the Plan in consultation with the Michigan Department of Natural Resources (MDNR), U.S. Fish and Wildlife Service (FWS), and the other members of the Bond Falls Project Implementation Team (Implementation Team).

The licensee shall consult with the Implementation Team prior to filing the Plan with the Commission. The Plan shall include an implementation schedule, documentation of consultation, copies of comments and recommendations on the draft Plan, and specific descriptions of how agency comments are accommodated by the Plan. The licensee shall allow a minimum of 30 days for the Implementation Team members to comment and to make recommendations, before filing the Plan with the Commission. If the licensee does not adopt a recommendation, the filing shall include the licensee's reasons, based on project-specific information.

The Commission reserves the right to require changes to the Plan. The Cisco Dam Operation Plan shall not be implemented until the licensee is notified that the Plan is approved. Upon Commission approval, the licensee shall implement the Plan according to the approved schedule, including any changes required by the Commission.

Article 408. The licensee shall maintain water quality standards, for the protection and enhancement of aquatic resources in the Ontonagon River. The licensee shall not discharge water from the Bond Falls Project developments into the riverine reaches of the Ontonagon River that exceed the following temperature limits (Fahrenheit):

	Victoria, Bergland and Cisco Dams	Victoria Powerhouse and Bond Falls Dams
January	38	38
February	38	38
March	41	43
April	56	54
May	70	65
June	80	68
July	83	68
August	81	68
September	74	63
October	64	56
November	49	48
December	39	40

In addition, the licensee shall not cause the dissolved oxygen concentration in the Cisco and West Branches of the Ontonagon River downstream of the Cisco, Bergland and Victoria dams, and the Victoria Powerhouse, to be less than 5 mg/l. The licensee shall not cause the dissolved oxygen concentration measured in the Middle Branch of the Ontonagon River and in Roselawn Creek downstream of the Bond Falls Dams to be less than 7 mg/l.

In the event that these water temperature and dissolved oxygen limits are not met, the licensee shall notify the Surface Water Quality Division of the Michigan Department of Environmental Quality within one working day, and take all reasonable steps necessary to ensure that compliance with the water quality limits are achieved, consistent with the water quality mitigation requirements of Article 409.

Article 409. Within six months after the issuance of a new license, the licensee shall file for Commission approval, a Water Quality Monitoring Plan, to document compliance with the water quality requirements of Article 408. The monitoring plan shall include a three-year monitoring period for dissolved oxygen and temperature, provisions for subsequent monitoring based upon the results of the initial three-year monitoring period, and provisions for mitigation as described herein. All water quality monitoring shall be funded by the Mitigation Enhancement Fund described in Settlement

Project No. 1864-005

Condition 7. If the fund is exhausted, the licensee shall fund the remaining activities as determined in the Water Quality Monitoring Plan.

The licensee shall consult with the Michigan Department of Environmental Quality (MDEQ), and other members of the Bond Falls Project Implementation Team (Implementation Team), prior to filing the Plan with the Commission. Monitoring locations downstream of each of the project discharges shall be determined in consultation with the MDEQ and other Implementation Team members. These monitoring locations shall be in areas of complete mixing. The licensee shall include with the Plan an implementation schedule, documentation of consultation, copies of agency comments and recommendations on the draft Plan, and specific descriptions of how the comments are accommodated by the Plan. The licensee shall allow a minimum of 30 days for agency comments and recommendations before filing the Plan with the Commission. If the licensee does not adopt a specific recommendation, the filing shall include the licensee's reasons, based on project-specific information.

In the event that monitoring studies demonstrate that the water quality limits of Article 408 are exceeded, the licensee shall first implement operational measures to improve water quality, such as spilling a portion of required flow releases from applicable facilities. The licensee shall bear the cost of any operational measures to improve water quality. Least cost structural solutions shall be the next preferred option. Required structural mitigation shall be funded by the Mitigation Enhancement Fund until the Fund is exhausted, upon which the licensee shall fund the remaining amount. All water quality mitigative measures shall be developed and implemented in consultation with the MDEQ and other members of the Implementation Team.

Plans for structural modifications to improve water quality shall be filed with the Commission for approval, prior to construction of any such modifications. These plans must be developed in consultation with the MDEQ and other members of the Implementation Team, and must include design drawings and estimated construction and operations costs for any structural modifications, a schedule for constructing the modifications, documentation of consultation, copies of agency comments and recommendations on the structural modifications, and specific descriptions of how agency comments were addressed.

The Commission reserves the right to require changes to the Water Quality Monitoring Plan and any planned structural modifications. The Water Quality Monitoring Plan shall not be implemented until the licensee is notified that the Plan is approved. Further, no ground-disturbing or land-clearing activities shall begin until the licensee is notified by the Commission that the structural modification plan is approved. Upon Commission approval, the licensee shall implement the Water Quality Monitoring Plan and any necessary structural modifications according to the approved schedule, including any changes required by the Commission.

Article 410. Within one year after the issuance of a new license, the licensee shall file with the Commission, for approval, an Erosion and Sediment Control Plan. The licensee shall be fully responsible for funding and implementing appropriate shoreline protection and erosion control measures at all licensee-owned project facilities and recreation sites, and future construction activities related to project structures. The licensee shall be responsible for certain erosion problems on non-licensee-owned lands directly related to project operation, or other erosion problems requiring protection and control, as determined by the Bond Falls Project Implementation Team (Implementation Team). The Plan shall identify lands to be covered with implementation of the Plan, and shall include, but not be limited to, the following provisions:

(1) the final Plan shall be based on site specific conditions and shall include

(a) descriptions of actual site conditions, (b) detailed descriptions of final preventive measures, (c) detailed descriptions, design drawings, and topographic locations of final control measures, including rip-rap placement, stream set back and stabilization of spoil material, and class of rock to be used, (d) detailed descriptions and locations of actual Best Management Practices (BMP's) to be used, (e) a specific implementation schedule; and (f) provisions for an erosion control monitor;

(2) a provision to use a sediment pond or sediment filter bags during impoundment construction to prevent fine sediments generated from blasting from being transported downstream; and

(3) the final Plan shall include a revegetation plan that includes a complete prescription for revegetating all disturbed areas, including: (a) locations of treatment areas, (b) plant species and methods to be used, (c) planting densities,
(d) fertilizer formulations, (e) seed test results, (f) application rates, (g) locations and density of any plantings, and (h) a specific implementation schedule.

The licensee shall prepare the Plan after consultation with the U.S. Fish and Wildlife Service, U.S. Forest Service, Michigan Department of Natural Resources, Michigan Department of Environmental Quality, the Wisconsin Department of Natural Resources, other members of the Implementation Team, and other entities, including private property owners, to minimize the adverse effects of shoreline erosion, to include, but not limited to, the north shore of Lake Gogebic. The licensee shall include with the Plan documentation of consultation, copies of comments and recommendations on the completed Plan after it has been prepared and provided to the agencies and other entities, and specific descriptions of how the agencies' and other entities' comments are accommodated by the Plan. The licensee shall allow a minimum of 30 days for the agencies and other entities to comment and to make recommendations before filing the Plan with the Commission. If the licensee does not adopt a recommendation, the filing shall include the licensee's reasons, based on project-specific information.

The Commission reserves the right to require changes to the Plan. No ground-disturbing or land-clearing activities shall begin until the licensee is notified by the Commission that the plan is approved. Upon Commission approval, the licensee shall implement the Plan, including any changes required by the Commission.

Article 411. Within six months after the issuance of a new license, the licensee shall file for Commission approval, a Nuisance Plant Control Plan for the four project impoundments. Implementation of the Plan shall be funded by the Mitigation Enhancement Fund described in Section 7 of the Settlement.

The licensee shall consult with the Michigan Department of Natural Resources, U.S. Fish and Wildlife Service, and other members of the Bond Falls Project Implementation Team (Implementation Plan), prior to filing the Plan with the Commission. The Plan shall include an implementation schedule, documentation of agency consultation, copies of agency comments and recommendations, and specific descriptions of how the agency comments are accommodated by the Plan. The licensee shall allow a minimum of 30 days for the Team to comment and to make recommendations, before filing the Plan with the Commission. If the licensee does not adopt a recommendation, the filing shall include the licensee's reasons, based on project-specific information.

The Commission reserves the right to require changes to the Plan. The Nuisance Plant Control Plan shall not be implemented until the licensee is notified that the Plan is approved. Upon

Commission approval, the licensee shall implement the Plan according to the approved schedule, including any changes required by the Commission.

Article 412. Within six months after the issuance of a new license, the licensee shall file for Commission approval, a Woody Debris Transport and Management Plan for the four project developments. The Plan shall provide for the reasonable transport of vegetative material over the project dams. The estimated amount of vegetative material that would be passed, and the procedures for passing vegetative material, shall be included in the Plan.

The licensee shall consult with the Michigan Department of Natural Resources, U.S. Fish and Wildlife Service, and other members of the Bond Falls Project Implementation Team (Implementation Team), prior to filing the Plan with the Commission. The Plan shall include an implementation schedule, documentation of agency consultation, copies of agency comments and recommendations, and specific descriptions of how the agency comments are accommodated by the Plan. The licensee shall allow a minimum of 30 days for the Team to comment and to make recommendations, before filing the Plan with the Commission. If the licensee does not adopt a recommendation, the filing shall include the licensee's reasons, based on project-specific information.

The Commission reserves the right to require changes to the Plan. The Woody Debris Transport and Management Plan shall not be implemented until the licensee is notified that the Plan is approved. Upon Commission approval, the licensee shall implement the Plan according to the approved schedule, including any changes required by the Commission.

Article 413. Within twelve months after the issuance of a new license, the licensee shall file for Commission approval, a Buffer Zone Plan for all lands that are owned by the licensee and located within the Project boundary. The Plan shall include a variable width buffer zone with an average width of 200 feet, adjacent to the Project impoundments. The principal management objective for the buffer zone is to achieve old growth forest characteristics. The Plan shall also be consistent with the Threatened and Endangered Species Protection and Enhancement Plan described in Article 415.

The licensee shall consult with the U.S. Forest Service and other members of the Bond Falls Project Implementation Team (Implementation Plan) prior to filing the Plan with the Commission. The Plan shall include an implementation schedule, documentation of agency consultation, copies of agency comments and recommendations, and specific descriptions of how the agency comments are accommodated by the Plan. The licensee shall allow a minimum of 30 days for the Team to comment and to make recommendations before filing the Plan with the Commission. If the licensee does not adopt a recommendation, the filing shall include the licensee's reasons, based on project-specific information.

The Commission reserves the right to require changes to the Plan. The Buffer Zone Plan shall not be implemented until the licensee is notified that the Plan is approved. Upon Commission approval, the licensee shall implement the Plan according to the approved schedule, including any changes required by the Commission.

Article 414. Within twelve months after the issuance of a new license, the licensee shall file with the Commission, for approval, a Wildlife and Land Management Plan (Plan) for project lands. The Plan must be consistent with the Buffer Zone Plan described in Article 413, the Threatened and Endangered Species Protection and Enhancement Plan described in Article 415, as well as with specific measures implemented under the Mitigation and Enhancement Fund described in Section 7 of the Settlement. The Plan shall include, but not be limited to, the following provisions and specific measures:

(1) Use of the State of Michigan Best Management Practices for timber management within the Bond Falls Project boundaries, to the extent practicable.

(2) Measures for the protection and enhancement of common loon, including: limiting camping to designated locations on Bond Falls Project lands for the purpose of enhancing loon nesting potential; providing information to campers regarding islands not open to camping; promptly reporting known camping violations to the local law enforcement personnel; providing information, including signage, to campers and boaters regarding the protection of nesting loons, and penalties for disturbing and harassing loons; development of contour maps for Bond Falls Flowage and the Victoria Reservoir for siting of loon nesting structures; and the provision of two loon nesting structures on Bond Falls Flowage and one nesting structure on Victoria Reservoir.

(3) Consistency with U.S. Forest Service osprey management guidelines along with any future Wisconsin Department of Natural Resources or Michigan Department of Natural Resources osprey management guidelines, and installation of one osprey nesting platform on the Bond Falls Flowage, Lake Gogebic, and Victoria Reservoir.

(4) Use of native seed, to the extent practicable, in revegetation efforts.

(5) The restoration and enhancement of wild rice in Bond Falls Flowage, Cisco Lake, Lake Gogebic, and Victoria Reservoir, to the extent that restoration and enhancement are determined by the Bond Falls Project Implementation Team (Implementation Team) to be feasible and desirable.

(6) Annual consultations with the resource agencies on: the status of wildlife populations within the project boundaries; measures to protect and enhance wildlife populations; planned timber harvest; and other land management issues that may impact wildlife populations. The meetings should be scheduled to occur not later than 45 days after the resource agencies have received updated information from the annual bald eagle nest surveys. The meetings should address, among other issues, the implementation of the threatened and endangered species management guidelines during the following year.

The licensee shall implement any direct measures identified by the Plan, or the annual review, that the Implementation Team determines to be appropriate, for the study, mitigation, or enhancement of fish and wildlife resources. All direct measures identified through the Plan shall be funded by the Mitigation Enhancement Fund.

The licensee shall consult with the resource agencies, and other members of the Team, prior to filing the plan with the Commission. The Plan shall include an implementation schedule, documentation of agency consultation, copies of agency comments and recommendations, and specific descriptions of how the agency comments are accommodated by the Plan. The licensee shall allow a minimum of 30 days for the Parties to comment and to make recommendations before filing the Plan with the Commission. If the licensee does not adopt a recommendation, the filing shall include the licensee's reasons, based on project-specific information.

The Commission reserves the right to require changes to the Plan. No ground-disturbing or land-clearing activities shall begin until the licensee is notified by the Commission that the plan is approved. Upon Commission approval, the licensee shall implement the plan according to the approved schedule, including any changes required by the Commission.

Article 415. Within twelve months after the issuance of a new license, the licensee shall file with the Commission, for approval, a Threatened and Endangered Species Protection and Enhancement Plan (Plan) for all project lands. The Plan shall be consistent with the Buffer Zone Plan described in Article 413, as well as with specific measures implemented under the Mitigation and Enhancement Fund described in Section 7 of the Settlement. The Plan shall include, but not be limited to, the following provisions and specific measures:

(1) Protection of threatened and endangered species from timber harvesting, and associated activities, on project lands.

(2) Consistency with U.S. Fish and Wildlife Service (FWS), U.S. Forest Service (USFS), and Wisconsin Department of Natural Resources (WDNR) bald eagle management guidelines, along with any future Michigan Department of Natural Resources (MDNR) bald eagle management guidelines, as appropriate.

(3) Reimbursement of either MDNR or WDNR, as determined by the Implementation Team, for up to 50 percent of the costs of annual airplane flights to identify the location of bald eagle nests in the project area.

(4) Consistency with the MDNR wolf management guidelines and the Ottawa National Forest Land Management Plan guidelines for the protection of gray wolf den sites, and with any future FWS or WDNR wolf management guidelines, as appropriate, including consultation with the resource agencies on the construction of new roads on licensee-owned project lands.

(5) Annual consultations with the resource agencies on: the status of threatened and endangered species populations within the project boundaries; measures to protect and enhance threatened and endangered species populations; planned timber harvest; and land management issues that may impact threatened and endangered species. The meetings should be scheduled to occur not later than 45 days after the resource agencies have received updated information from the annual bald eagle nest surveys. The meetings should address, among other issues, the implementation of the threatened and endangered species management guidelines during the following year.

The licensee shall implement any direct measures identified by the Plan, or the annual review, that the Bond Falls Project Implementation Team (Implementation Team) determines to be appropriate, for the study, protection, or enhancement of threatened and endangered species. All direct measures identified through the Plan shall be funded by the Mitigation Enhancement Fund described in Section 7 of the Settlement.

The licensee shall consult with the resource agencies, and other members of the Implementation Team, prior to filing the Plan with the Commission. The Plan shall include an implementation schedule, documentation of agency consultation, copies of agency comments and recommendations, and specific descriptions of how the agency comments are accommodated by the Plan. The licensee shall allow a minimum of 30 days for the Parties to comment and to make recommendations before filing the Plan with the Commission. If the licensee does not adopt a recommendation, the filing shall include the licensee's reasons, based on project-specific information.

The Commission reserves the right to require changes to the Plan. The Plan shall not be implemented until the licensee is notified that the Plan is approved. Upon Commission approval, the licensee shall implement the Plan according to the approved schedule, including any changes required by the Commission.

Article 416. Within twelve months after license issuance, the licensee shall file with the Commission for approval, a Recreation Plan (Plan), for implementing all recreational enhancements at the Bond Falls Project. This Plan shall be consistent with the Buffer Zone Plan described in Article 413 and the Threatened and Endangered Species Protection and Enhancement Plan described in Article 415. The licensee shall prepare the Plan in consultation with the Bond Falls Project Implementation Team (Implementation Team), and shall implement the Plan after approval by the Commission. The Plan shall provide full access to licensee-owned facilities.

The Plan shall provide for the following recreational enhancements at the project:

(1) One accessible boat launching facility on the Victoria Reservoir. This facility shall include a 18-foot-wide concrete ramp, a skid pier, proper parking with designated sites near the ramp, signage, hardened paths and a vault toilet.

(2) A shoreline fishing access area adjacent to the boat launch on the Victoria Reservoir. This facility shall include five accessible fishing flatouts with connecting trails and picnic tables.

(3) Walk-in access to the tailwater of the Victoria Powerhouse. This shall include an access trail, stairs and a vault toilet.

(4) A marked canoe portage route with put-in and take-out sites at the Victoria Development.

(5) Designation and maintenance of the existing dispersed boat-in campsites on the Victoria Reservoir, with no restroom facilities, trash receptacles or other high-maintenance facilities to be provided at these campsites.

(6) An accessible tailwater fishing and canoe launching area at the Bergland Dam. This facility shall include an accessible trail, parking, vault toilet, and a canoe put-in or take-out area. In addition, two flatouts for accessible fishing shall be developed at Lake Gogebic; one adjacent to Bergland Dam and one in the Bergland Dam tailwater.

(7) One accessible boat launching facility on the Bond Falls Flowage. This shall include an 18-foot-wide concrete ramp, a skid pier, proper parking with designated sites, signage, hardened paths and a vault toilet or equivalent. Other existing gravel boat launching ramps shall be maintained in good condition, using the same or similar materials as currently exists at these sites.

(8) Continued operation of existing campgrounds at the Bond Falls Development, except as may be required for wildlife enhancement plans, including threatened and endangered species.

(9) Designation and development of dispersed camping sites at the Bond Falls Development on selected islands in Bond Falls Flowage, with no restroom facilities, trash receptacles or other high-maintenance facilities to be provided at these campsites. Camping on Bond Falls Flowage shall be limited to formal campgrounds or designated dispersed sites only.

(10) Maintenance of a canoe portage route, with take-out facility, at the Bond Falls Dam.

Project No. 1864-005

(11) Provision of a toll-free telephone number with information on projected flow releases from Bond Falls Project developments, and river flow information for the West Branch, Cisco Branch, South Branch, and Middle Branch of the Ontonagon River.

The Plan shall include, at a minimum, the following: (1) final site plans for the recreational facilities described above; (2) design drawings of the directional signs to the project recreational facilities, and a description of where they will be located;
(3) erosion and sediment control measures required in article 410, which shall be implemented during construction, and which shall minimize destruction of the area's natural vegetation, and provide for revegetation, stabilization, and landscaping of new construction areas and slopes damaged by erosion; and (4) an implementation schedule.

The licensee shall prepare the Plan after consultation with the Implementation Team. The licensee shall include with the Plan, documentation of agency consultation, copies of agency comments and recommendations on the draft Plan, and specific descriptions of how the agencies' comments are accommodated by the Plan. The licensee shall allow a minimum of 30 days for the agencies to comment and to make recommendations prior to filing the Plan with the Commission for approval. If the licensee does not adopt a recommendation, the filing shall include the licensee's reasons, based on project-specific information.

The Commission reserves the right to require changes to the Plan. No ground disturbing or land-clearing activities for new recreational facilities shall begin until the licensee is notified that the Plan is approved. Upon approval, the licensee shall implement the Plan, including any changes required by the Commission.

Article 417. The licensee shall establish a Bond Falls Project Implementation Team (Implementation Team), to provide for the coordination and implementation of the measures required by this license. The Implementation Team shall consist of a single official designate from: the licensee, Michigan Department of Natural Resources (MDNR), Wisconsin Department of Natural Resources (WDNR), U.S. Fish and Wildlife Service (FWS), U.S. Forest Service (USFS), and the Keweenaw Bay Indian Community (KBIC), plus ex-officio advisory members. The Michigan Hydro Relicensing Coalition (MHRC) shall be an ex-officio advisory member of the Implementation Team. The licensee’s designate will serve as Implementation Team Chair, and all Implementation Team members, once designated, shall remain as members, unless notification is made as to a successor, in writing, to all Implementation Team members and to the Director, Division of Hydropower Administration and Compliance (DHAC), 7 days prior to the date the change becomes effective.

The Implementation Team shall, at a minimum, have one annual meeting to review activities for the preceding year, but other meetings may be scheduled, as required, to provide for ongoing coordination and implementation of required measures. All meetings must be noticed at least 14 days in advance, and all official and ex-officio members of the Implementation Team must be notified. Notice of annual meetings must also be made to the DHAC and to the Surface Water Quality Division of the Michigan Department of Environmental Quality (MDEQ). Other Implementation Team meetings shall be held, if requested in writing to the Implementation Team Chair, by a minimum of two members of the Implementation Team. The Implementation Team, at its option, may invite any individual or organizational representative to any of its meetings, to serve in an ex-officio advisory capacity. The Implementation Team may also form ad hoc teams or committees that include other employees, interested parties, contractors, or consultants, to assist in the implementation or monitoring of measures required by the license. For Implementation Team meetings, a quorum to conduct business at a duly noticed Implementation Team meeting shall consist of any four of the five Team members (MDNR, WDNR, FWS, USFS, KBIC), plus the licensee’s representative

(Implementation Team Chair). All Implementation Team decisions shall be made by consensus vote of the Implementation Team members in attendance, but unanimous approval of the decision is not required. If one or more member, however, opposes a proposed decision, there is no consensus. The Implementation Team must periodically report to all interested parties and to the DHAC, regarding the actions taken and progress made in implementing the measures required by the license. At a minimum, the licensee shall prepare and file an annual report with the Commission, but additional reports may be prepared as determined by the Implementation Team.

All other actions of the Implementation Team, related to communications and correspondence, report reviews and consultations, concurrence or non-concurrence with reports or submittals, and dispute resolution, shall follow the procedures outlined in the Settlement Agreement.

Article 418. Authority is reserved by the Commission to require the licensee to construct, operate, and maintain, or to provide for the construction, operation, and maintenance of, such fishways as may be prescribed during the term of the license by the Secretary of the Interior under Section 18 of the Federal Power Act.

Article 419. The licensee shall implement the "Programmatic Agreement Among the Federal Energy Regulatory Commission, the Advisory Council on Historic Preservation, the State of Wisconsin, State Historic Preservation Officer, and the State of Michigan, State Historic Preservation Officer, For Managing Historic Properties That May Be Affected By New and Amended Licenses Issuing For the Continued Operation of Existing Hydroelectric Projects in the State of Wisconsin and Adjacent Portions of the State of Wisconsin," executed on December 30, 1993, including but not limited to the Historic Resources Management Plan (HRMP) for the project. In the event that the Programmatic Agreement is terminated, the licensee shall implement the provisions of its approved HRMP. The Commission reserves the authority to require changes to the HRMP at any time during the term of the license. If the Programmatic Agreement is terminated prior to Commission approval of the HRMP, the licensee shall obtain approval from the Commission before engaging in any ground disturbing activities or taking any other action that may affect any historic properties within the Bond Falls Project's area of potential effect.

Article 420. The licensee shall comply with the procedural requirements found in Section 9.3 (Dispute Resolution) of the Settlement Offer filed July 11, 2000.

Article 421. The licensee shall comply with all Commission regulations regarding any potential sale of the project, transfer of the license, surrender of the license, or application for new license, and shall keep the members of the Bond Falls Project Implementation Team fully informed of its future plans for the project. The licensee shall also establish a “Responsibility Fund,” which will consist of two contributions of $50,000 to an interest-bearing fund, on the twentieth and thirtieth anniversaries of the new license (total contribution of $100,000), for use in complying with applicable Commission regulations at the end of the license period, or to finance any requirements related to license surrender. The Fund shall become a project asset and will remain with the project in the event the license is transferred.

Article 422. (a) In accordance with the provisions of this article, the licensee shall have the authority to grant permission for certain types of use and occupancy of project lands and waters and to convey certain interests in project lands and waters for certain types of use and occupancy, without prior Commission approval. The licensee may exercise the authority only if the proposed use and occupancy is consistent with the purposes of protecting and enhancing the scenic, recreational, and other environmental values of the project. For those purposes, the licensee shall also have continuing responsibility to supervise and control the use and occupancies for which it grants permission, and to monitor the use of, and ensure compliance with the covenants of the instrument of conveyance for, any interests that it has conveyed, under this article.

If a permitted use and occupancy violates any condition of this article or any other condition imposed by the licensee for protection and enhancement of the project's scenic, recreational, or other environmental values, or if a covenant of a conveyance made under the authority of this article is violated, the licensee shall take any lawful action necessary to correct the violation. For a permitted use or occupancy, that action includes, if necessary, canceling the permission to use and occupy the project lands and waters and requiring the removal of any non-complying structures and facilities.

(b) The type of use and occupancy of project lands and water for which the licensee may grant permission without prior Commission approval are: (1) landscape plantings; (2) non-commercial piers, landings, boat docks, or similar structures and facilities that can accommodate no more than 10 watercraft at a time and where said facility is intended to serve single-family type dwellings; (3) embankments, bulkheads, retaining walls, or similar structures for erosion control to protect the existing shoreline; and (4) food plots and other wildlife enhancement.

To the extent feasible and desirable to protect and enhance the project's scenic, recreational, and other environmental values, the licensee shall require multiple use and occupancy of facilities for access to project lands or waters. The licensee shall also ensure, to the satisfaction of the Commission's authorized representative, that the use and occupancies for which it grants permission are maintained in good repair and comply with applicable state and local health and safety requirements. Before granting permission for construction of bulkheads or retaining walls, the licensee shall: (1) inspect the site of the proposed construction; (2) consider whether the planting of vegetation or the use of riprap would be adequate to control erosion at the site; and (3) determine that the proposed construction is needed and would not change the basic contour of the reservoir shoreline. To implement this paragraph (b), the licensee may, among other things, establish a program for issuing permits for the specified types of use and occupancy of project lands and waters, which may be subject to the payment of a reasonable fee to cover the licensee's costs of administering the permit program. The Commission reserves the right to require the licensee to file a description of its standards, guidelines, and procedures for implementing this paragraph (b) and to require modification of those standards, guidelines, or procedures.

(c) The licensee may convey easements or rights-of-way across, or leases of, project lands for: (1) replacement, expansion, realignment, or maintenance of bridges or roads where all necessary state and federal approvals have been obtained; (2) storm drains and water mains; (3) sewers that do not discharge into project waters; (4) minor access roads; (5) telephone, gas, and electric utility distribution lines; (6) non-project overhead electric transmission lines that do not require erection of support structures within the project boundary; (7) submarine, overhead, or underground major telephone distribution cables or major electric distribution lines (69-kV or less); and (8) water intake or pumping facilities that do not extract more than one million gallons per day from a project reservoir. No later than January 31 of each year, the licensee shall file three copies of a report briefly describing for each conveyance made under this paragraph (c) during the prior calendar year, the type of interest conveyed, the location of the lands subject to the conveyance, and the nature of the use for which the interest was conveyed.

(d) The licensee may convey fee title to, easements or rights-of-way across, or leases of project lands for: (1) construction of new bridges or roads for which all necessary state and federal approvals have been obtained; (2) sewer or effluent lines that discharge into project waters, for which all necessary federal and state water quality certification or permits have been obtained; (3) other pipelines that cross project lands or waters but do not discharge into project waters; (4) non-project overhead electric transmission lines that require erection of support structures within the project boundary, for which all necessary federal and state approvals have been obtained; (5) private or public marinas that can accommodate no more than 10 watercraft at a time and are located at least one-half mile (measured over project waters) from any other private or public marina; (6) recreational development consistent with an approved Exhibit R or approved report on recreational resources of an Exhibit E; and (7) other uses, if: (i) the amount of land conveyed for a particular use is five acres or less; (ii) all of the land conveyed is located at least 75 feet, measured horizontally, from project waters at normal surface elevation; and (iii) no more than 50 total acres of project lands for each project development are conveyed under this clause (d)(7) in any calendar year.

At least 60 days before conveying any interest in project lands under this paragraph (d), the licensee must submit a letter to the Director, Office of Energy Projects, stating its intent to convey the interest and briefly describing the type of interest and location of the lands to be conveyed (a marked Exhibit G or K map may be used), the nature of the proposed use, the identity of any federal or state agency official consulted, and any federal or state approvals required for the proposed use. Unless the Director, within 45 days from the filing date, requires the licensee to file an application for prior approval, the licensee may convey the intended interest at the end of that period.

(e) The following additional conditions apply to any intended conveyance under paragraph (c) or (d) of this article:

(1) before conveying the interest, the licensee shall consult with federal and state fish and wildlife or recreation agencies, as appropriate, and the State Historic Preservation Officer;

(2) before conveying the interest, the licensee shall determine that the proposed use of the lands to be conveyed is not inconsistent with any approved Exhibit R or approved report on recreational resources of an Exhibit E; or, if the project does not have an approved Exhibit R or approved report on recreational resources, that the lands to be conveyed do not have recreational value;

(3) the instrument of conveyance must include the following covenants running with the land: (i) the use of the lands conveyed shall not endanger health, create a nuisance, or otherwise be incompatible with overall project recreational use; (ii) the grantee shall take all reasonable precautions to ensure that the construction, operation, and maintenance of structures or facilities on the conveyed lands will occur in a manner that will protect the scenic, recreational, and environmental values of the project; and
(iii) the grantee shall not unduly restrict public access to project waters; and

(4) the Commission reserves the right to require the licensee to take reasonable remedial action to correct any violation of the terms and conditions of this article, for the protection and enhancement of the project's scenic, recreational, and other environmental values.

(f) The conveyance of an interest in project lands under this article does not in itself change the project boundaries. The project boundaries may be changed to exclude land conveyed under this article only upon approval of revised Exhibit G or K drawings (project boundary maps) reflecting exclusion of that land. Lands conveyed under this article will be excluded from the project only upon a determination that the lands are not necessary for project purposes, such as operation and maintenance, flowage, recreation, public access, protection of environmental resources, and shoreline control, including shoreline aesthetic values. Absent extraordinary circumstances, proposals to exclude lands conveyed under this article from the project shall be consolidated for consideration when revised Exhibit G or K drawings would be filed for approval for other purposes.

Project No. 1864-005

(g) The authority granted to the licensee under this article shall not apply to any part of the public lands and reservations of the United States included within the project boundary.

(H) The licensee shall serve copies of any Commission filing required by this order on any entity specified in this order to be consulted on matters related to the filing. Proof of service on these entities must accompany the filing with the Commission.

(I) This order is issued under authority delegated to the Director and is final unless a request for rehearing is filed within 30 days from the date of its issuance, as provided in Section 313 of the FPA. The filing of a request for rehearing does not operate as a stay of the effective date of this license or of any other date specified in this order, except as specifically ordered by the Commission. The licensee's failure to file a request for rehearing of this order shall constitute acceptance of this license.

J. Mark Robinson
Director
Office of Energy Projects

Appendix A.

**Final Terms and Conditions for License
Necessary for the Protection and Utilization of the Ottawa National Forest**

in Conjunction with the Application for License for FERC Project No. 1864, Bond Falls (Upper Peninsula Power Co.).

Submitted by: USDA Forest Service, Eastern Region, Milwaukee, Wisconsin, 53203. Randy Moore, Regional Forester. (414) 297-3170.
August, 2002

1 General

The Forest Service provides the following final 4(e) conditions for the Bond Falls Hydroelectric Project, FERC No. 1864. In accordance with 18 CFR 4.34(b)(1)(i), the Forest Service is providing these final conditions pending the outcome of any administrative appeals or litigation. These conditions reflect terms of the Settlement Agreement (June, 2000). License articles contained in the Commission's Standard Form L-5, issued by Order No. 540, dated October 31, 1972 (revised October 1975), cover general requirements that the Secretary of Agriculture, acting by and through the Forest Service, considers necessary for the adequate protection and utilization of the land and resources of the Ottawa National Forest. For the purposes of Section 4(e) of the Federal Power Act (16 USC 797(e)), the purposes for which the National Forest System Lands were created or acquired shall be the protection and utilization of those resources enumerated in the Organic Administration Act of 1897 (30 Stat. 11), the Multiple Use/Sustained Yield Act of 1960 (90 Stat. 2949), the National Forest Management Act of 1976 (90 Stat. 2949), and any other law specifically establishing a unit of the National Forest System or prescribing the management thereof (such as the Wilderness Act or the Wild and Scenic Rivers Act), as such laws may be amended from time to time, and as implemented by regulations and approved Forest Plans, prepared in accordance with the National Forest Management Act. Therefore, pursuant to Section 4(e) of the Federal Power Act, the following conditions covering specific requirements for the protection and utilization of National Forest System lands shall also be included in any license issued.

1.1 Abbreviations and Definitions

1.1.1 Abbreviations

ADA	- Americans with Disabilities Act
C	- Degrees Centigrade
CFS	- Cubic Feet per Second
CFR	- Code of Federal Regulations
CPI	- Consumer Price Index
CZM (P)	- Coastal Zone Management (Program)
DO	- Dissolved Oxygen
DOI	- U.S. Department of the Interior
DLC	- Division of Licensing and Compliance
EPA	- U.S. Environmental Protection Agency
F	- Degrees Fahrenheit
FERC	- Federal Energy Regulatory Commission
FPA	- Federal Power Act
FWS	- United States Department of Interior–Fish and Wildlife Service
KBIC	- Keweenaw Bay Indian Community
MDEQ	- Michigan Department of Environmental Quality

Project No. 1864-005

MDNR - Michigan Department of Natural Resources
mg/kg - Milligrams per Kilogram
mg/l - Milligrams per Liter
MHRC - Michigan Hydro Relicensing Coalition
MPSC - Michigan Public Service Commission
MSL - Mean Sea Level
NGO - Non-Governmental Organization
NGVD - National Geodetic Vertical Datum
O&M - Operations and Maintenance
ROR - Run-of-River
SWQD - Surface Water Quality Division
T/E/S - Threatened/Endangered/Sensitive
UPPCO- Upper Peninsula Power Company
USFS - United States Department of Agriculture–Forest Service
USGS - United States Geological Survey
WDNR - Wisconsin Department of Natural Resources

1.1.2 Definitions

"**Day**" is defined, for operational purposes, as a 24-hour period, midnight to midnight.
"Ex officio advisory member" is defined as an organization that participates in the settlement implementation process but does not have voting rights.
"Licensee" is Upper Peninsula Power Company (**UPPCO**).
"Maximum flow" is defined as the highest hourly flow for the day.
"Michigan Hydro Relicensing Coalition" is a coalition of Michigan conservation organizations that include the Anglers of the Au Sable, Michigan United Conservation Clubs, Michigan Council of Trout Unlimited and Great Lakes Council of the Federation of Fly Fishers.
"Minimum flow" is defined as the lowest allowable hourly flow at any facility.
"Parties" is defined to be Upper Peninsula Power Company, United States Department of the Interior-Fish and Wildlife Service, United States Department of Agriculture-Forest Service, Michigan Department of Natural Resources, Michigan Department of Environmental Quality, Michigan Department of Attorney General, Wisconsin Department of Natural Resources, Keweenaw Bay Indian Community, the Michigan Hydro Relicensing Coalition, American Rivers and American Whitewater Affiliation.
"Project" is the Bond Falls Hydroelectric Project (FERC Project No. 1864), which includes four dams, covered under this Settlement. The dams are Bond Falls Dam, Cisco Dam, Bergland Dam and Victoria Dam.
"Resource Agencies" are the Wisconsin Department of Natural Resources, Michigan Department of Natural Resources, Michigan Department of Environmental Quality, United States Department of Interior–Fish and Wildlife Service, Keweenaw Bay Indian Community, and United States Department of Agriculture–Forest Service.
"Riparian Lands" are lands adjacent to a watercourse.
"**Section 18 of the Federal Power Act"** is the section of the Federal Power Act that refers to the reservation of authority to the Secretary of the Department of the Interior to prescribe fishways.
"Settlement" or "Settlement Agreement" is defined as the Bond Falls Settlement Agreement.
"Team" is the Settlement Implementation Team as provided for in Section 9 including representatives of UPPCO, MDNR, WDNR, FWS, USFS, KBIC and ex officio advisory members.
"Upper Peninsula Power Company" or **"UPPCO"** means the company, its subsidiary and any affiliated companies and/or parent.

2.0 Standard Forest Service Provisions

2.1 Condition No. 1 – Modification of USDA Forest Service Conditions as a Result of Agency Administrative Appeals Process

Upon completion of the USDA Forest Service administrative appeals process at 36 Code of Federal Regulations (CFR) Part 215 or litigation, the Chief of the USDA Forest Service or the Secretary of Agriculture may direct that the terms and conditions submitted herein be modified. Therefore, the USDA Forest Service reserves the right to modify the terms and conditions submitted herein if so directed.

2.2 Condition No. 2 - Compliance with USDA Regulations and Other Laws

The Licensee shall comply with the regulations of the Department of Agriculture and all Federal, State, county, and municipal laws, ordinances, or regulations in regard to the area or operations covered by this license, to the extent federal law does not preempt ordinances or regulations.

2.3 Condition No. 3 - Habitat and Ground-Disturbing Activities on National Forest System Lands

The Licensee shall prepare site-specific plans, in consultation with USDA Forest Service, for all habitat and ground-disturbing activities on National Forest System Lands. The Licensee shall comply with USDA Forest Service sensitive species and integrated weed management guidelines and protocols in developing and executing such plans. The Licensee shall not file any such plans with the Commission or commence any such activities without approval from the USDA Forest Service.

2.4 Condition No. 4 - Changes to As-Licensed Project Works and Operations on National Forest System Lands

The Licensee shall consult with the USDA Forest Service regarding any proposed changes to as-licensed project works or operations on National Forest System Lands. The Licensee shall not commence or implement any changes to as-licensed project works or operations on National Forest System Lands without approval from the USDA Forest Service.

3.0 Additional Provisions

3.1 Condition No. 5 - Instream Flow Requirements

3.1.1 Bond Falls Dam and Flowage

3.1.1.1 *Middle Branch Minimum Flow Releases* [Section deleted]

3.1.1.2 *Bond Falls Canal Operation* [Section deleted]

3.1.2 Victoria Dam Operations

3.1.2.1 *Bypassed Channel Minimum Flow Release* [Section deleted]

3.1.3 Lake Gogebic and Bergland Dam Operations

3.1.3.1 *Minimum Flows* [Section deleted]

3.1.3.2 *Minimum Flow Trigger Conditions* [Section deleted]

3.1.3.3 *Lake Gogebic Dry Water Years Consultation* [Section deleted]

Project No. 1864-005

3.1.4 *Emergencies Beyond UPPCO's Control* [Section deleted]

3.1.5 System Operation in Dry Water Years [Section deleted]

3.2 Condition No. 6 - Guaranteed Priority Flow Bypass Device and Gauging

3.2.1 Operation Compliance Plan [Section deleted in part; provisions included as to Bond Falls Flowage only]

- Provisions to record gate opening changes will be recorded by UPPCO each time a gate is changed.
- Provisions to continuously monitor Bond Falls Flowage and Victoria Reservoir headwater elevations.
- Provision to provide the Team a table of discharges for each dam at each gate opening and headwater elevation for the easy interpretation of compliance data.
- A three year test period to determine if UPPCO can demonstrate compliance using gate openings, headwater elevations, verified rating curves and power production.
- Provisions for UPPCO to contract with USGS to verify gate openings, headwater elevations and gate rating curves at Bond Falls semi-annually or at a frequency recommended by USGS for the initial three year period after license issuance. If USGS is unavailable, then an equivalent contractor can be used in consultation with the Team.
- The frequency of data recording for all sites and format of compliance reports following the recommendations of the Team.
- Provisions to provide compliance reports required by the FERC to the Team for project operations review.

3.2.2 USGS Gauging Stations

3.2.2.1 *USGS Gauging Station Funding* [Section deleted]

3.2.2.2 *Discontinued USGS Gauging Stations* [Section deleted]

3.3 Condition No. 7 – Fish Screens and Passage Structures

3.3.1.1 *Upstream Fish Passage Funding* [Section deleted]

3.3.2 Downstream Fish Protection

3.3.2.1 *Schedule* [Section deleted]

3.3.2.2 *Funding* [Section deleted]

3.4 Condition No. 8 – Fish and Wildlife Mitigation Plan

3.4.1 Nuisance Plant Control [Section included as to Bond Falls Flowage only]

UPPCO shall, after consultation with the Team, file within 6 months of licensure for the FERC approval a nuisance plant plan for all four UPPCO impoundment. Funding for the implementation of this plan shall be from the Mitigation Enhancement Fund (Condition No. 15).

3.4.2 Woody Debris Transport and Management [Section included as to Bond Falls Flowage only]
UPPCO shall, after consultation with the Team, file within 6 months of licensure for the FERC approval a wood debris transport and management plan for all four UPPCO dams. The plan shall provide for the reasonable transport of vegetative material over the project dams. The extent of vegetative material that would be passed and the procedures for passing vegetative material shall be included in the plan and will depend on dam configuration, downstream hazards, cost of handling and ability of the downstream reach to transport the debris.

3.4.3 Wild Rice Restoration [Section included as to Bond Falls Flowage only]
The Team shall consider the restoration and enhancement of wild rice in Bond Falls Flowage, Cisco Lake, Lake Gogebic and Victoria Reservoir. If wild rice restoration and enhancement is determined to be feasible and desirable, it shall be funded by the Mitigation Enhancement Fund (Condition 14).

3.4.4 Wildlife Protection and Enhancement

3.4.4.1 *Project Lands* [Section included as Bond Falls Development only]
All lands currently included within the Bond Falls Project boundaries shall remain within the project boundaries under the new license. The existing project boundaries, as so modified, are deemed to be sufficient for all regulatory purposes, and UPPCO shall have no obligation to expand the project boundaries beyond those previously established in the current FERC license. Use and occupancy of UPPCO lands within the Bond Falls Project area and project waters shall conform to the appropriate standard FERC land use license article.

3.4.4.2 *Buffer Zone* [Section deleted]

3.4.4.3 *Wildlife and Land Management Plan* [Section deleted]

3.5 Condition No. 9 – Threatened, Endangered, and Sensitive Species Plan

3.5.1 Project Land Management [Section included as to Bond Falls Development only]
Project lands shall be managed in accordance with appropriate threatened, endangered, and sensitive species management guidelines as detailed below.

3.5.2 Annual Meetings Regarding Threatened, Endangered and Sensitive Species [Section included as to Bond Falls Development only]
Annual meetings shall be held by the Team to discuss land management issues that may impact threatened, endangered and sensitive species management. The meetings will be scheduled to occur not later than 45 days after the Resource Agencies have received updated information from the annual bald eagle nest surveys. The meetings will address implementation of the threatened and endangered species management guidelines during the following year.

3.5.3 Funding [Section deleted]

3.5.4 Bald Eagle Protection and Management

3.5.4.1 *Wildlife and Land Management Plan Consistency* [Section included as to Bond Falls Development only]
UPPCO's Wildlife and Land Management Plan shall follow Federal and State bald eagle management guidelines. Direct measures determined by the Team to be necessary to implement the bald eagle management guidelines shall be funded by the Mitigation Enhancement Fund (Condition No. 15).

Project No. 1864-005

3.5.4.2 ***Flight Reimbursement*** **[Section included as to Bond Falls Development only]**
MDNR or WDNR, as appropriate, shall at the discretion of the Team be reimbursed for flight time over the project boundary for the purpose of identifying bald eagle nest locations up to 50 percent of the total costs per year. Bald eagle flights and signage for eagles shall be funded by the Mitigation Enhancement Fund (Condition No. 15).

3.5.5 ***Gray Wolf Protection and Management*** **[Section included as to Bond Falls Development only]**
UPPCO's Wildlife and Land Management Plan shall be consistent with the MDNR wolf management guidelines and the Ottawa National Forest Land Management Plan guidelines for the protection of gray wolf den sites, along with any future USFWS or WDNR guidelines, as appropriate. UPPCO shall discuss with the Team any planned construction of new roads on UPPCO-owned project lands. Direct measures determined by the Team to be necessary to implement the gray wolf management guidelines shall be funded by the Mitigation Enhancement Fund (Condition No. 15).

3.5.6 Common Loon Protection and Mitigation

3.5.6.1 ***Common Loon Habitat Protection*** **[Section included as to Bond Falls Development only]**
UPPCO's land management plan shall limit camping to UPPCO designated locations on Bond Falls Project lands for enhancing loon nesting potential. UPPCO shall provide information to campers regarding islands not open to camping and promptly report known violation to the local law enforcement personnel**.** Boaters and campers shall be informed (through signage or other means) of laws and regulations related to protecting loons.

3.5.6.2 ***Common Loon Habitat Enhancement*** **[Section included as to Bond Falls Development only]**
Contour maps shall be developed for Bond Falls Flowage and Victoria Reservoir to provide for the proper siting of the loon nesting structures and to provide information to support other aspects of the Settlement Agreement. Two common loon nesting structures shall be installed on Bond Falls Flowage and one loon nesting structure shall be installed on Victoria Reservoir.

3.5.6.3 ***Funding*** **[Section deleted]**

3.5.7 Osprey Protection and Management

3.5.7.1 ***Wildlife and Land Management Plan Consistency*** **[Section included as to Bond Falls Development only]**
UPPCO's Wildlife and Land Management Plan shall be consistent with USFS osprey management guidelines along with any future WDNR or MDNR osprey management guidelines.

3.5.7.2 ***Osprey Habitat Enhancement*** **[Section included as to Bond Falls Development only]**
One osprey nesting platform shall be constructed on each of Bond Falls Flowage, Lake Gogebic and Victoria Reservoir using Mitigation Enhancement Fund monies (Condition No. 15).

3.5.7.3 ***Funding*** **[Section deleted]**

3.6 Condition No. 10 – Erosion Control Measures Plan [Section deleted except the first sentence]
UPPCO shall be responsible for developing and implementing soil erosion control plans and measures for future construction activities related to project structures.

3.7 Condition No. 11 – Cultural Resources Protection

3.7.1 Responsibility [Section included as to Bond Falls Development only]
UPPCO shall be responsible for compliance with Section 106 of the National Historic Preservation Act , including all State Historic Preservation Officer requirements.

3.8 Condition No. 12 – Recreation Plan

3.8.1 Site Operation [Section deleted]

3.8.2 Accessibility Plan [Section deleted]

3.8.3 Recreation Site Enhancements

3.8.3.1 Victoria Impoundment and Tailwater

3.8.3.1.1 *Impoundment Boat Launch* [Section deleted]

3.8.3.1.2 *Shoreline Fishing Access* [Section deleted]

3.8.3.1.3 *Tailwater Fishing Access* [Section deleted]

3.8.3.1.4 *Canoe Portage* [Section deleted]

3.8.3.1.5 *Dispersed Camping* [Section deleted]

3.8.3.2 *Cisco Dam and Cisco Chain of Lakes* [Section deleted]

3.8.3.3 *Bergland Dam Tailwater* [Section deleted]

3.8.3.3.1 *Tailwater Fishing and Boating Access* [Section deleted]

3.8.3.4 *Bond Falls Flowage*

3.8.3.4.1 *Impoundment Boat Launches*
One accessible impoundment boat launching facility shall be developed at Bond Falls Flowage, including an 18-foot-wide concrete ramp, a skid pier, proper parking with designated sites, signage, hardened paths and a vault toilet or equivalent. Other gravel boat launching ramps will be maintained in good condition using the same or similar materials as currently exist at these sites.

3.8.3.4.2 *Campgrounds*
Current campgrounds shall continue to be operated, except as may be required for wildlife enhancement plans including threatened and endangered species.

3.8.3.4.3 *Dispersed Camping*
Designated dispersed camping sites shall be marked and developed on selected islands in Bond Falls Flowage. No restroom facilities, trash receptacles or other high-maintenance facilities shall be provided on the islands. Camping at Bond Falls Flowage shall be limited to formal campgrounds or designated dispersed sites only.

Project No. 1864-005

3.8.3.4.4 ***Canoe Portage***
A canoe portage route with take-out facility will be maintained.

3.8.4 Funding

3.8.4.1 ***Capital Funding*** **[Section deleted]**

3.8.4.2 ***Operation and Maintenance Funding*** **[Section included as to Bond Falls only]**
UPPCO shall fund the operation and maintenance of all required recreation sites at Bond Falls Flowage and tailwater, Victoria Reservoir and tailwater and Lake Gogebic tailwater. The Mitigation Enhancement Fund may not be used for this purpose.

3.9 Condition No. 13 – Storage Reservoir Operation Plan

3.9.1 Bond Falls Dam and Flowage

3.9.1.1. ***Bond Falls Flowage Target Elevations***
During normal project operation, UPPCO will make a good faith effort to meet or exceed the following end-of-month target elevations (local datum) at Bond Falls Flowage:

January	136.0 feet
February	134.0 feet
March	132.5 feet
April	136.0 feet
May	139.0 feet
June	137.5 feet
July	136.5 feet
August	135.0 feet
September	135.0 feet
October	138.0 feet
November	138.0 feet
December	137.0 feet

3.9.1.2 ***Bond Falls Flowage Minimum End-of-Month Headwater Elevations***
UPPCO shall maintain the following minimum end-of-month elevations at Bond Falls Flowage except during dry water years as defined in Condition No. 5 above:

January	135.0 feet
February	133.0 feet
March	132.0 feet
April	135.0 feet
May	138.0 feet
June	137.0 feet
July	136.0 feet
August	134.5 feet
September	134.5 feet
October	134.0 feet
November	134.0 feet
December	136.0 feet

The first three (3) years of the license term shall serve as a trial period to determine whether these target elevations can be attained without unduly affecting project operations. After the first three years, the USDA Forest Service as a part of the Team will assess the viability of these target elevations. Changes to the operating criteria may be made with the agreement of the Team.

3.9.1.3 *Winter Bond Falls Flowage Elevations*

UPPCO shall maintain the Bond Falls Flowage elevation between 132 and 140 feet local datum (1,467.9 to 1,475.9 feet mean sea level [MSL]) from February 1 through April 30.

3.9.1.4 *Open Water Season Bond Falls Flowage Elevations*

UPPCO shall maintain the Bond Falls Flowage elevation between 134 and 140 feet local datum (1,469.9 to 1,475.9 feet MSL) from May 1 through January 31.

3.9.2 Victoria Dam and Impoundment

3.9.2.1 *Impoundment Elevation Limits* [Section deleted]

3.9.2.2 *Spring Impoundment Elevation Limits* [Section deleted]

3.9.2.3 *Spring Powerplant Operation* [Section deleted]

3.9.2.4 *Powerplant Operation During Other Times of the Year* [Section deleted]

3.9.2.5 *Emergency Operation* [Section deleted]

3.9.3 Lake Gogebic and Bergland Dam

3.9.3.1 *Reservoir Elevation Limits* [Section deleted]

3.9.3.2 *Lake Gogebic Target Elevations* [Section deleted]

3.9.4 Cisco Dam and the Cisco Chain of Lakes

3.9.4.1 *Lake Elevation Limits* [Section deleted]

3.9.4.2 *Cisco Dam Operation* [Section deleted]

3.9.4.3 *Cisco Dam Ownership and Operation Under Any New Owner* [Section deleted]

3.9.5 Emergencies Beyond UPPCO's Control [Section deleted]

3.10 Condition No. 14 – Water Quality

3.10.1 Water Quality

3.10.1.2 *Water Temperature Limits-General* [Section deleted]

3.10.1.3 *Water Quality Measurement Locations* [Section deleted]

3.10.1.4 *Dissolved Oxygen Limits* [Section deleted]

3.10.1.5 *Deviation from Water Quality Limits* [Section deleted]

3.10.1.6 *Water Quality Mitigation* [Section deleted]

3.10.1.6.1 *Mitigation Responsibility* [Section deleted]

3.10.1.6.2 *Current Mitigation* [Section deleted]

3.10.1.6.3 *Water Quality Mitigative Solutions* [Section deleted]

3.10.1.6.4 *Water Quality Jurisdictional Statement* [Section deleted]

3.10.1.7 *Water Quality Monitoring Plan* [Section deleted]

3.11 Condition No. 15 – Mitigation and Enhancement Fund

3.11.1 General Concept [Section deleted]

3.11.2 Fund Administration [Section deleted]

3.11.3 Funding [Section deleted]

3.11.4 Mitigation Fund Items [Section deleted]

3.11.5 Items Outside of the Mitigation Enhancement Fund [Section deleted]

3.12 Condition No. 16 – Future Dam Responsibility

3.12.1 Scope of Responsibility [Section deleted]

3.12.2 Project Disposal [Section deleted]

3.12.2.1 *License Transfer* [Section deleted]

3.12.3 Application for Surrender [Section deleted]

3.12.4 Responsibility Fund [Section deleted]

3.12.5 Future Relicensing [Section deleted]

3.13 Condition No. 17 – Implementation and Oversight

3.13.1 Project Coordination

3.13.1.1 *Team Responsibility and Composition* [Section deleted]

3.13.1.2 *Ex officio Advisory Membership and Meeting Notification* [Section deleted]

3.13.1.3 *Annual Meetings* [Section deleted]

3.13.1.4 *Annual Meeting Notification* [Section deleted]

3.13.1.5 *Team Communications and Ad Hoc Teams* [Section deleted]

3.13.2 Review, Consultation and Concurrence of Settlement Submissions

3.13.2.1 *Communications and Correspondence* [Section deleted]

3.13.2.2 *Reviews* [Section deleted]

3.13.2.3 *Review Consultation* [Section deleted]

3.13.2.4 *Non-concurrence* [Section deleted]

3.13.2.5 *Concurrence* [Section deleted]

3.13.3 *Dispute Resolution* [Section deleted]

3.13.3.1 *Arbitration/Facilitation* [Section deleted]

3.13.3.2 *Final Resolution* [Section deleted]

Table 1. ***Mitigation and Enhancement Fund Schedule*** **[Table deleted]**

Appendix B

Distribution Maps of Fish Species

Known past and present fish distributions in the Ontonagon River system. Distribution of fishes were compiled from records located at the University of Michigan, Natural History Museum, Fisheries Library; Michigan Department of Natural Resources, Institute for Fisheries Research; and Michigan Department of Natural Resources, Baraga Operations Service Center. For species that are listed under Michigan's Endangered Species Act (Part 365, Endangered Species Protection, of the Natural Resource and Environmental Protection Act, Act 451 of the Public Acts of 1994), their status follows their scientific name. Categories are declining, rare, threatened, endangered, extinct, and locally extinct.

Habitat descriptions were compiled from the Fishes of Ohio (Trautman 1981), Freshwater Fishes of Canada (Scott and Crossman 1973), Fishes of Wisconsin (Becker 1983), Fishes of Missouri (Pflieger 1975), and Fishes of the Great Lakes Region (Hubbs and Lagler 1947).

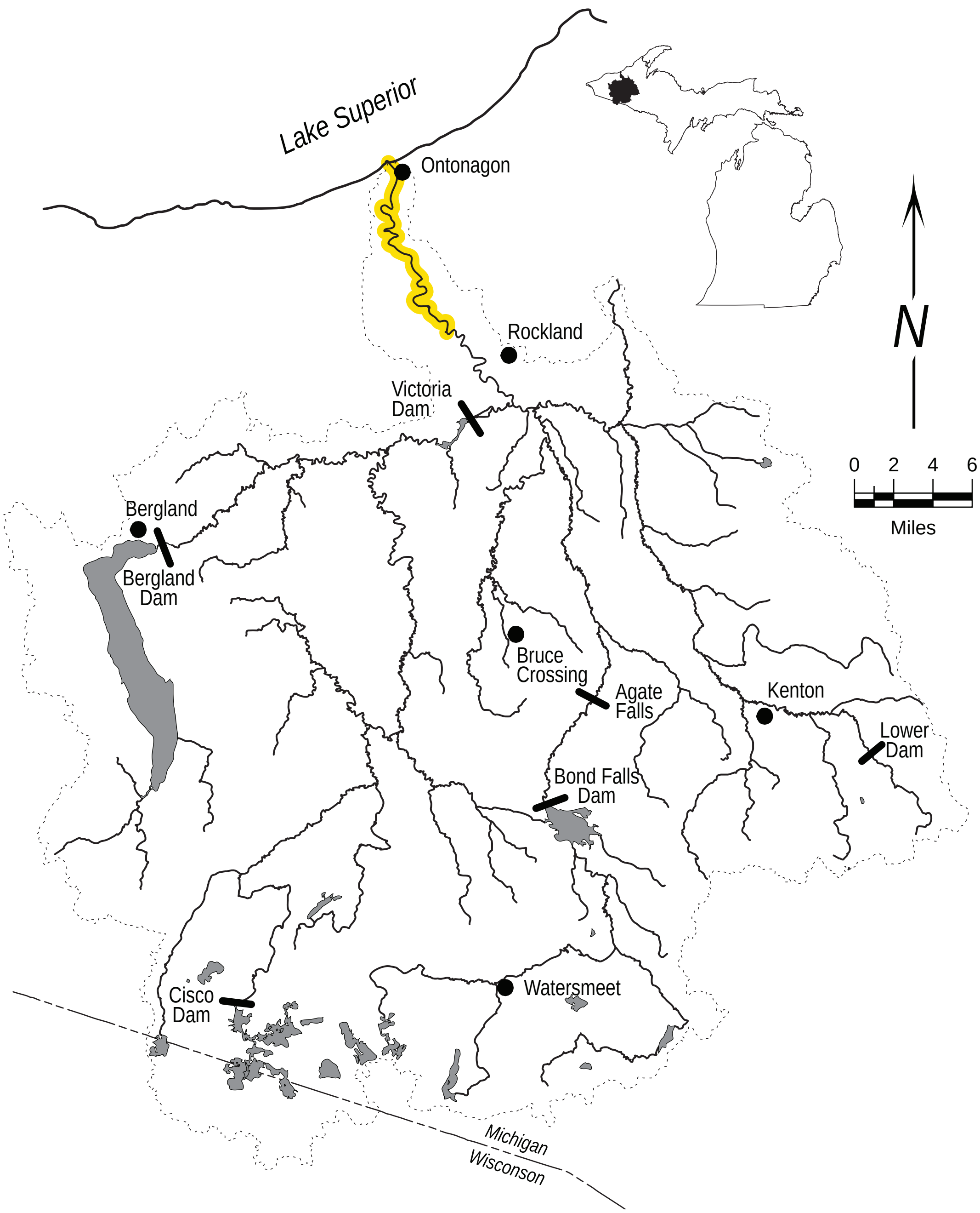
APPENDIX B INDEX

Northern brook lamprey *Ichthyomyzon fossor*

Habitat:

feeding - young: low gradient, substrate with bars and beds of mixed sand and organic debris
- moderately warm water

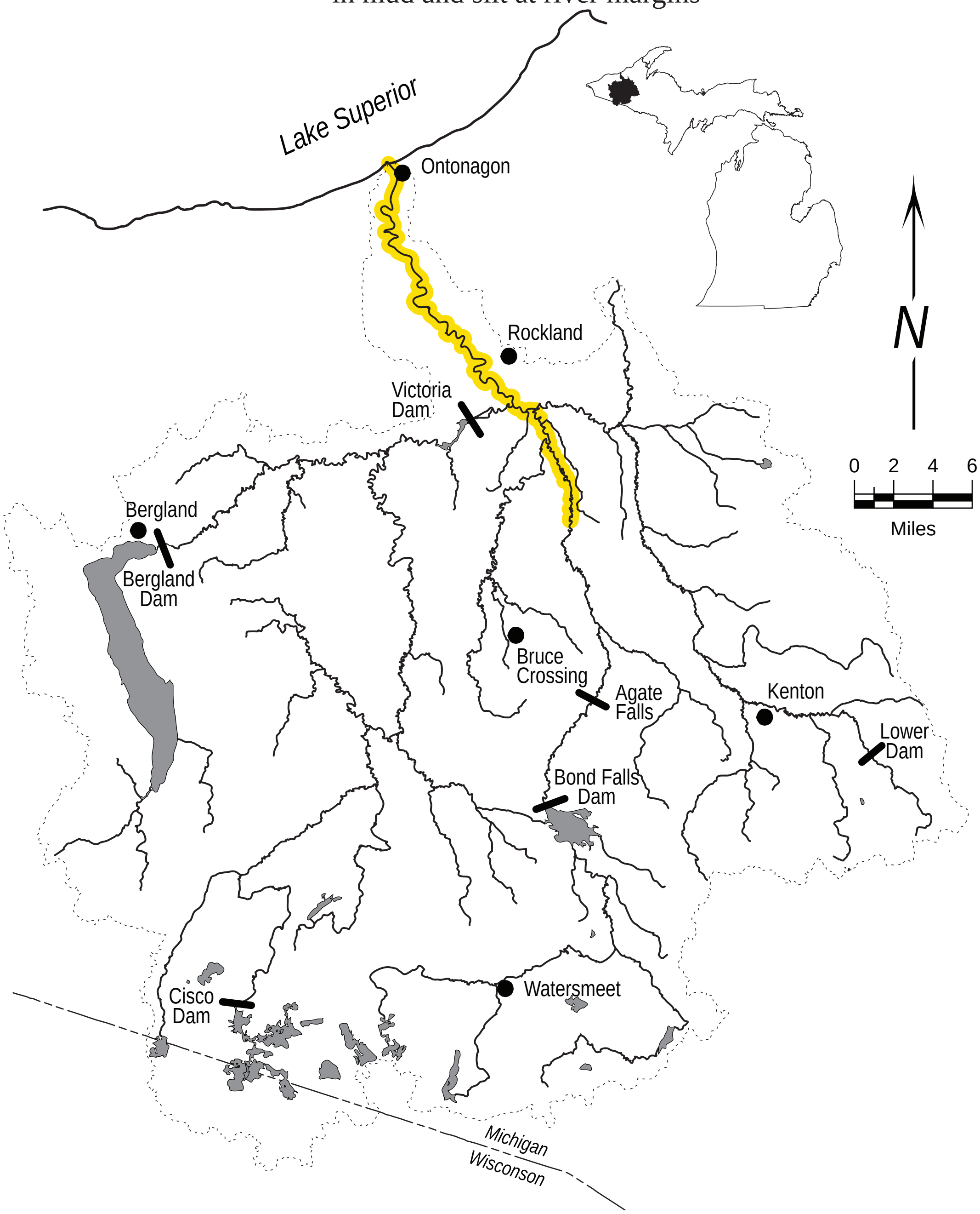
spawning - clear, high gradient streams (<15 feet wide)
- riffles with sand or gravel substrate



Silver lamprey *Ichthyomyzon unicuspis*

Habitat**:**

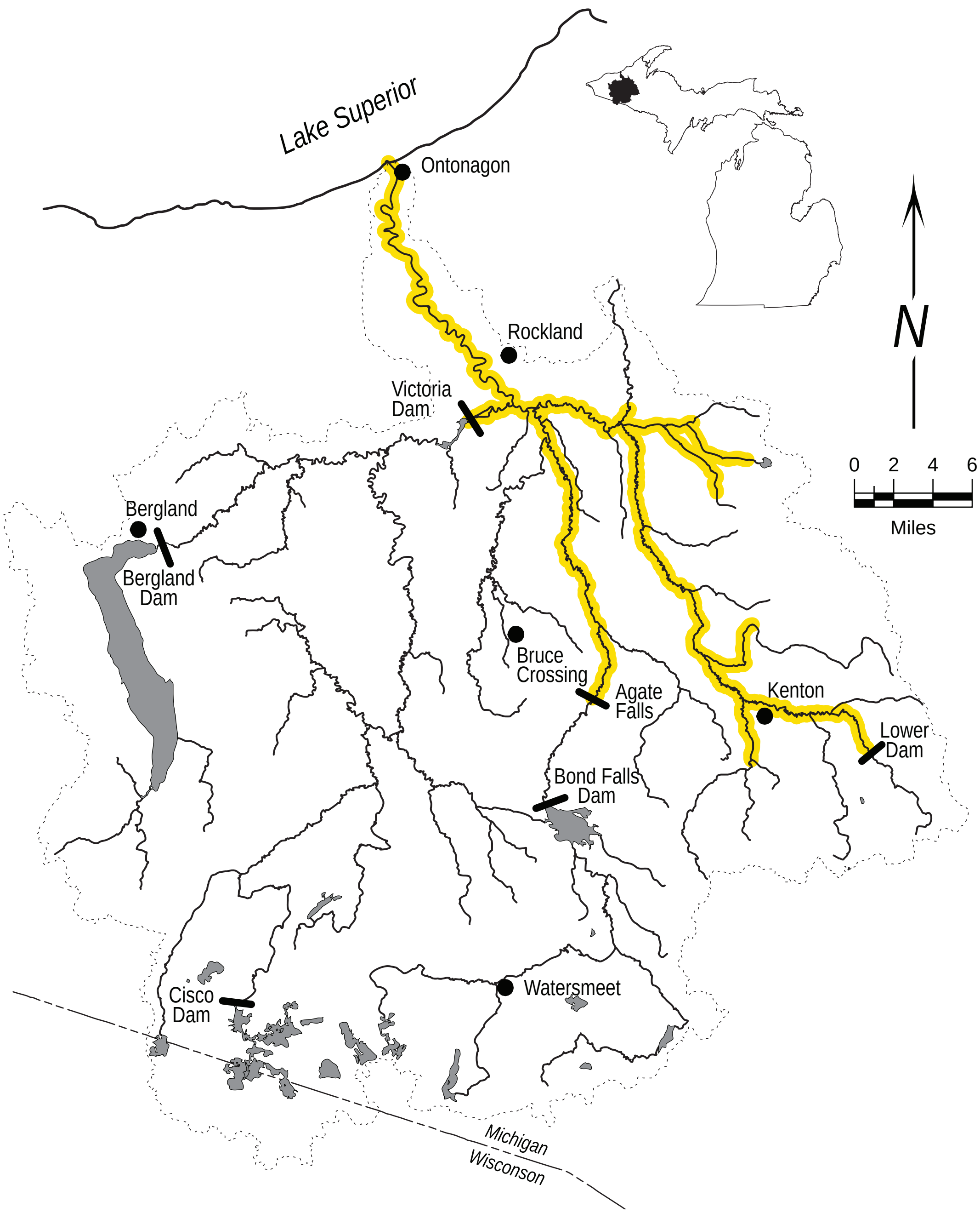
feeding	-	young: sand, muck, or organic debris substrate
	-	adults: clear river water with prey species
spawning	-	gravel and sand substrate
	-	moderate gradient
	-	moderate size stream
	-	cannot tolerate silt
	-	no dams
winter refuge	-	ammocetes burrow for 4 to 7 years in mud and silt at river margins



Sea lamprey *Petromyzon marinus*

Habitat**:**

feeding	-	young: substrate with beds of sand mixed with organic debris
	-	cannot tolerate silt
	-	adults: clear cool water of Lake Superior
spawning	-	no dams
	-	riffles with sand and gravel substrates

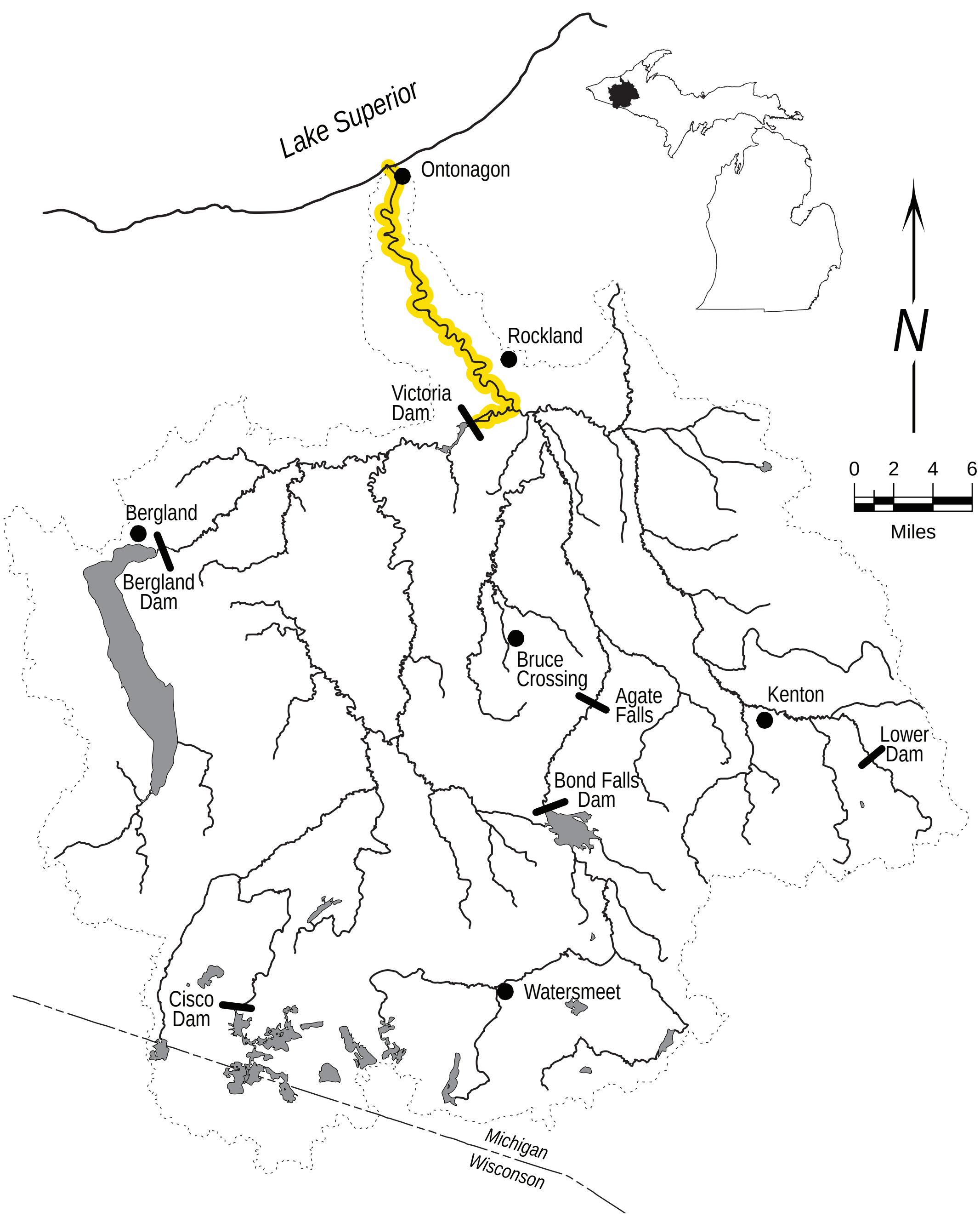


Lake sturgeon *Acipenser fulvescens* - threatened

Habitat:

feeding - shoal areas of large rivers, lakes, and impoundments
- gravel, sand, rock substrates

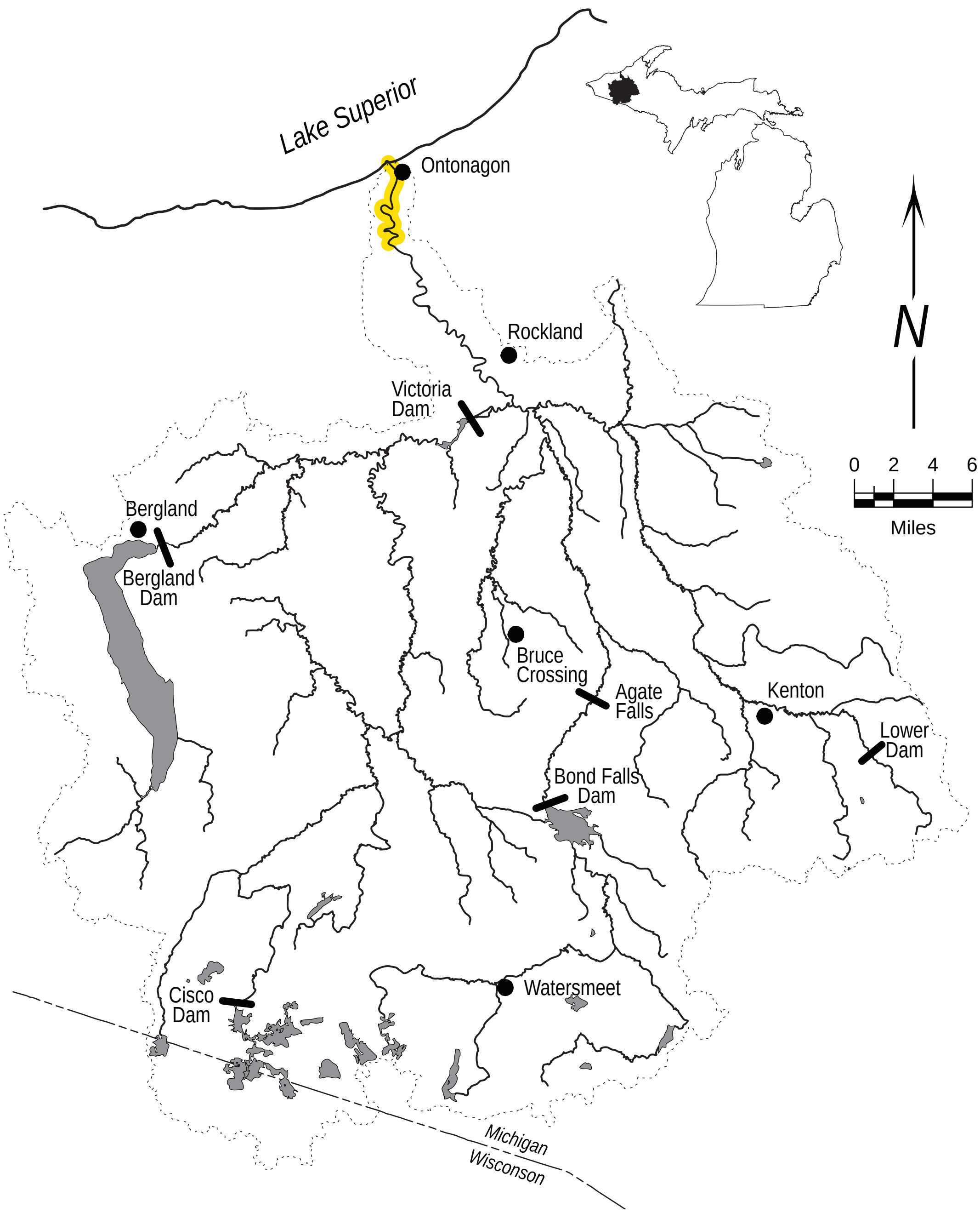
spawning - in or before rapids, at the base of dams in rivers
- in 2-15 feet of water
- swift current
- rocky ledges or around rocky islands in Great Lakes



Alewife *Alosa pseudoharengus*

Habitat**:**

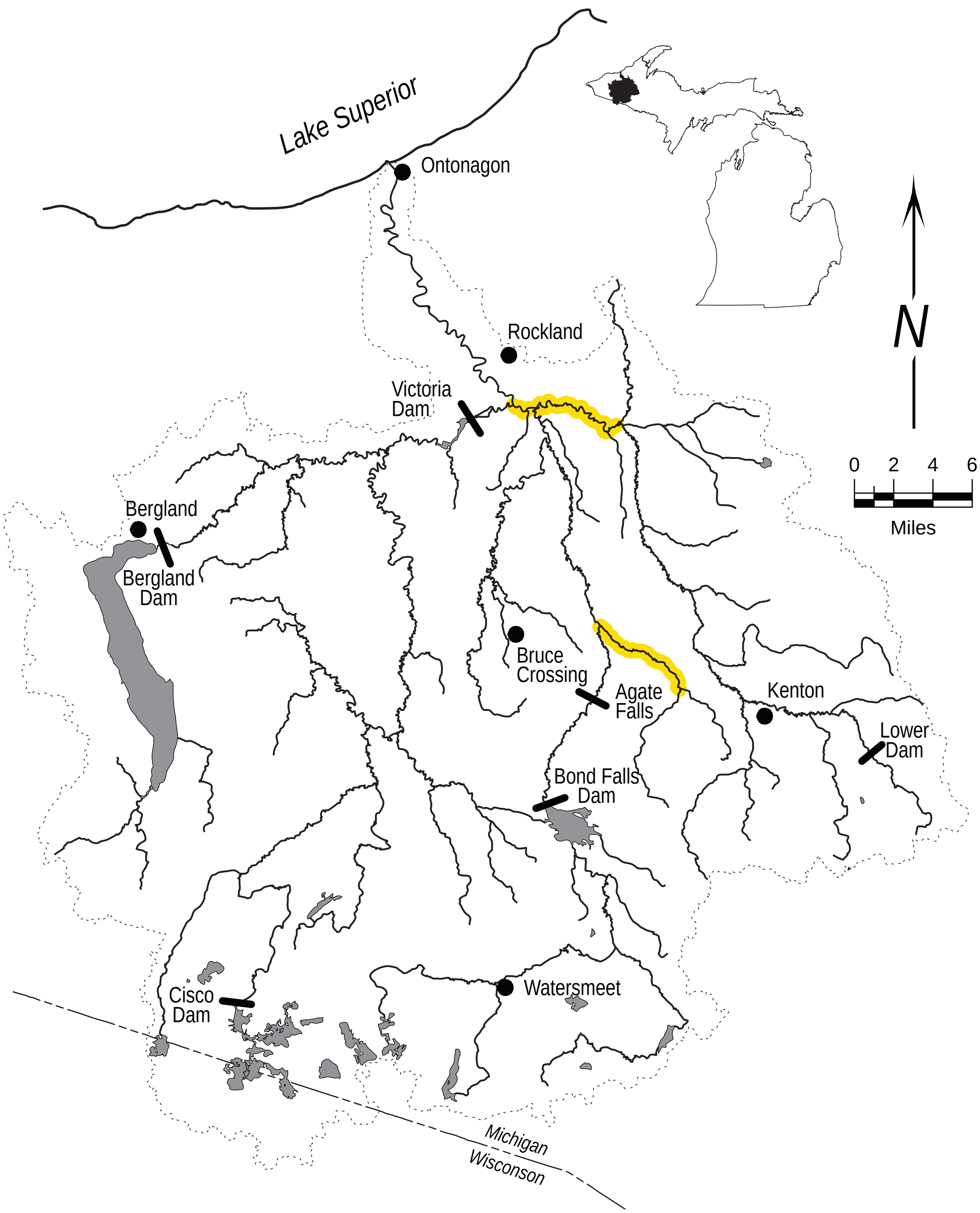
feeding	-	adults: deep water of Lake Superior
	-	young: shallow water of Lake Superior
	-	prefers warmer waters
spawning	-	streams or shallow beaches of lake
	-	sand or gravelly substrate
winter refuge	-	deep water



Lake chub *Couesius plumbeus*

Habitat:

feeding	-	large rivers and lakes
	-	over a variety of substrates
spawning	-	tributary streams
	-	rock substrate

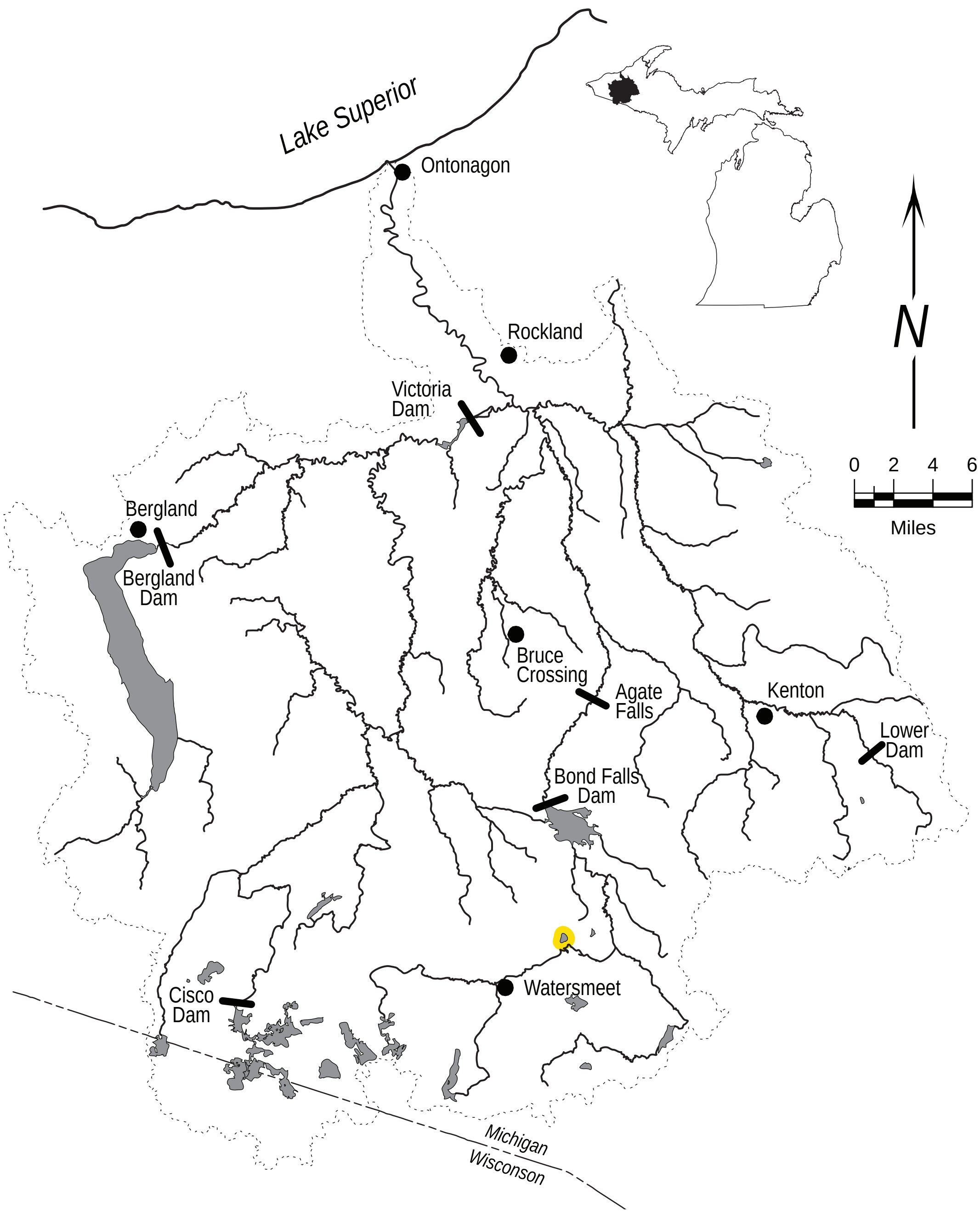


Spotfin shiner *Cyprinella spiloptera*

Habitat**:**

feeding - clear water tolerant of turbidity and siltation
- some current
- shallow depths
- medium sized streams, lakes, and impoundments
- clear sand or gravel substrate

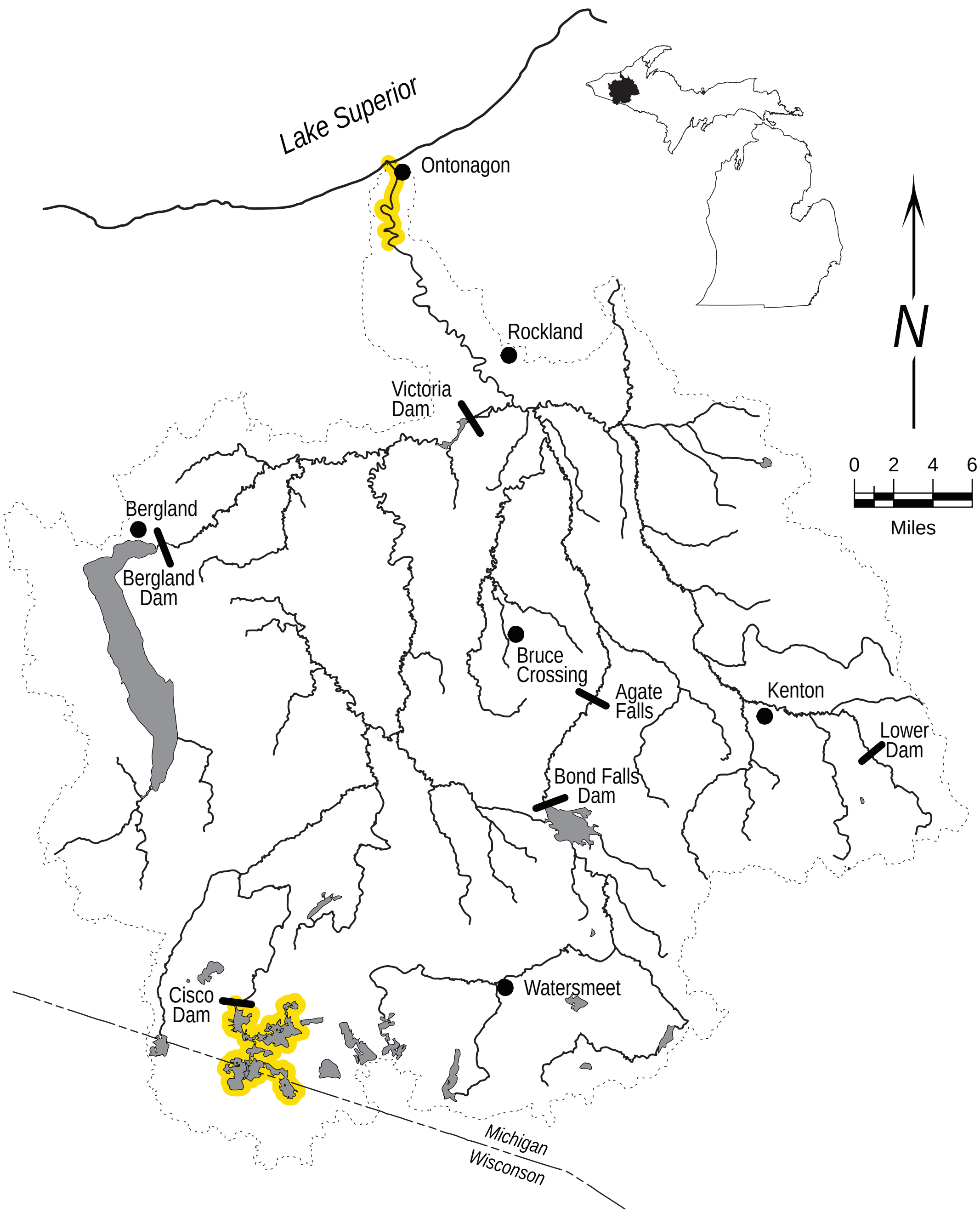
spawning - swift current
- crevice spawner or on underside of submerged logs and roots



Common carp *Cyprinus carpio*

Habitat:

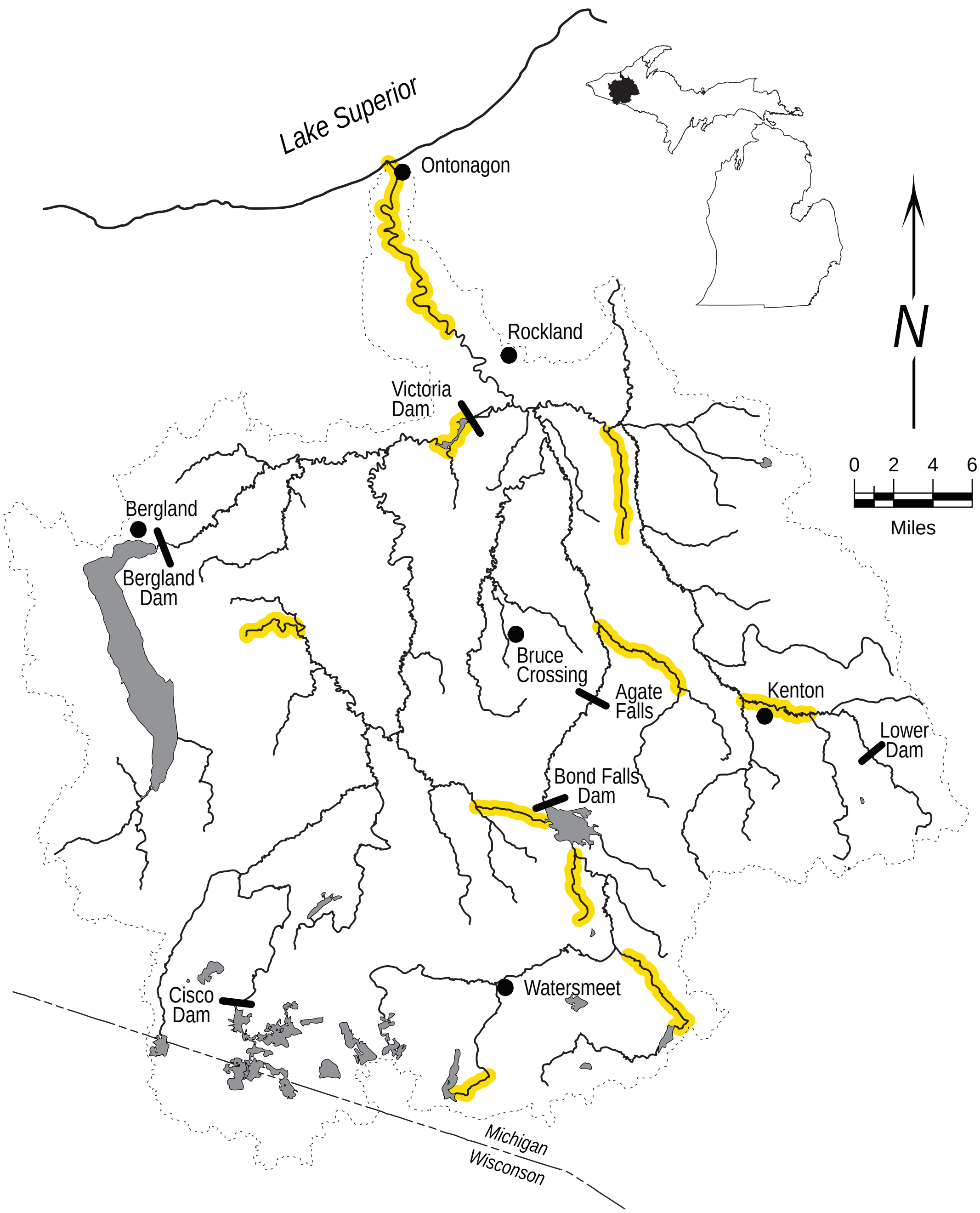
feeding	-	low gradient fertile streams, rivers, lakes, and impoundments
	-	abundance of aquatic vegetation or organic matter
	-	tolerant of all substrates and clear to turbid water
spawning	-	weedy or grassy shallows



Brassy minnow *Hybognathus hankinsoni*

Habitat**:**

feeding - cool acidic streams
- slow to moderate current
- sand or gravel substrate

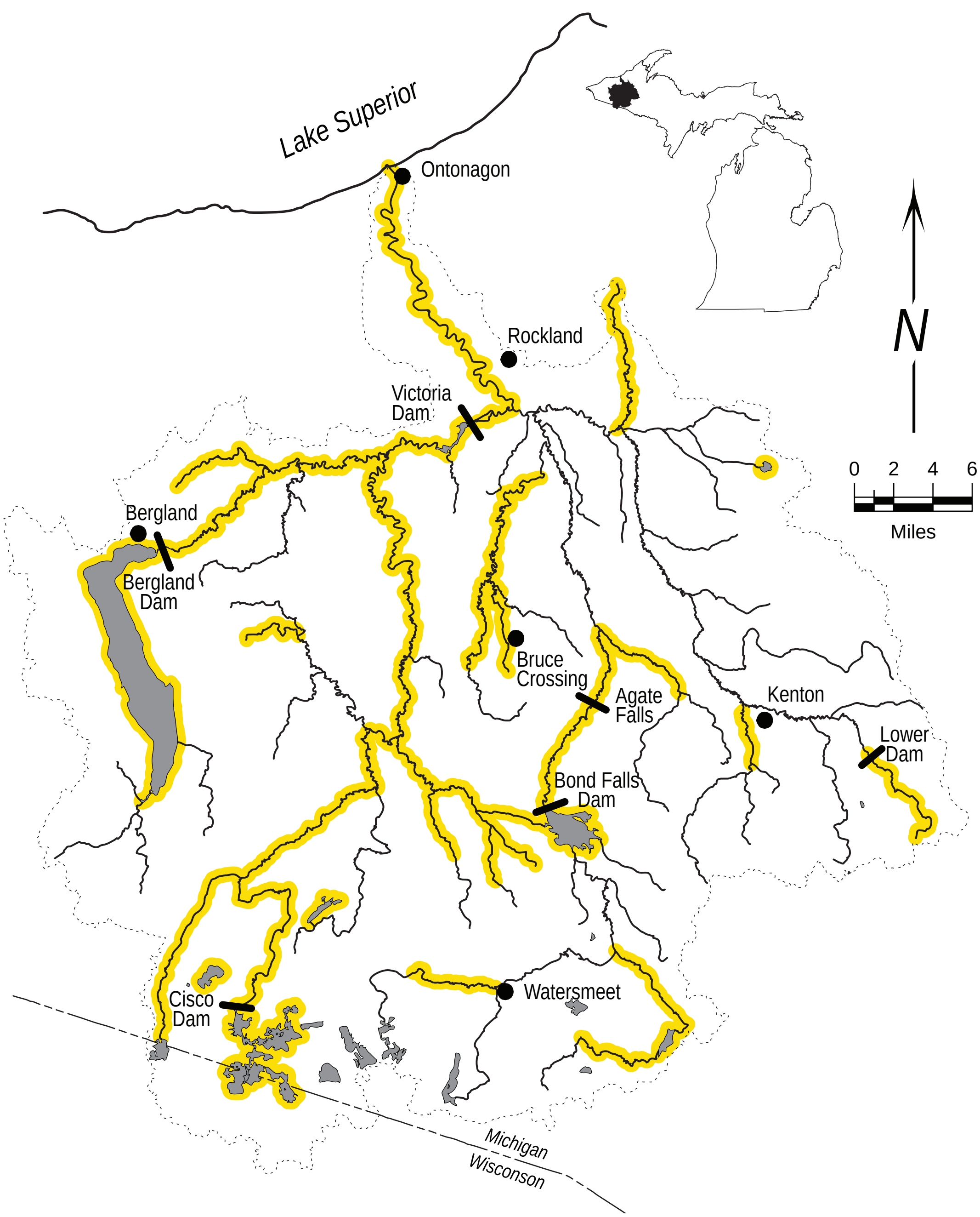


Common shiner *Luxilus cornutus*

Habitat**:**

feeding - small, clear, high-gradient streams and rivers, or shores of clear water lakes and impoundments
- gravel substrate
- can tolerate some submerged aquatic vegetation
- not very tolerant of turbidity or silted waters

spawning - gravel nests of other fish, especially those at the head of a riffle

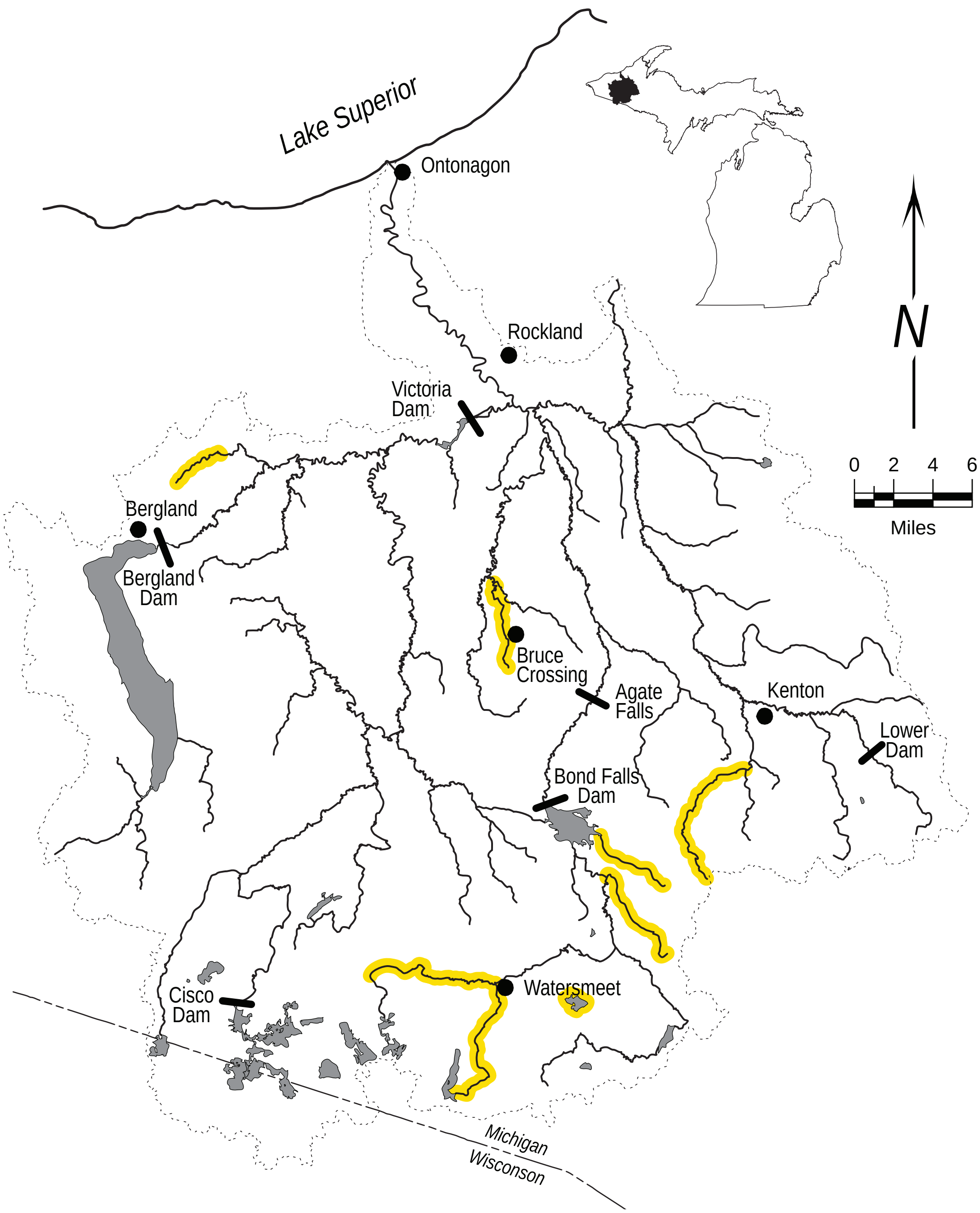


Northern pearl dace *Margariscus nachtriebi*

Habitat:

feeding - cool, neutral to acidic streams and lakes
- clear to slightly turbid water

spawning - males are territorial
- clear water, 18-24 inches deep
- sand or gravel substrate
- weak to moderate current

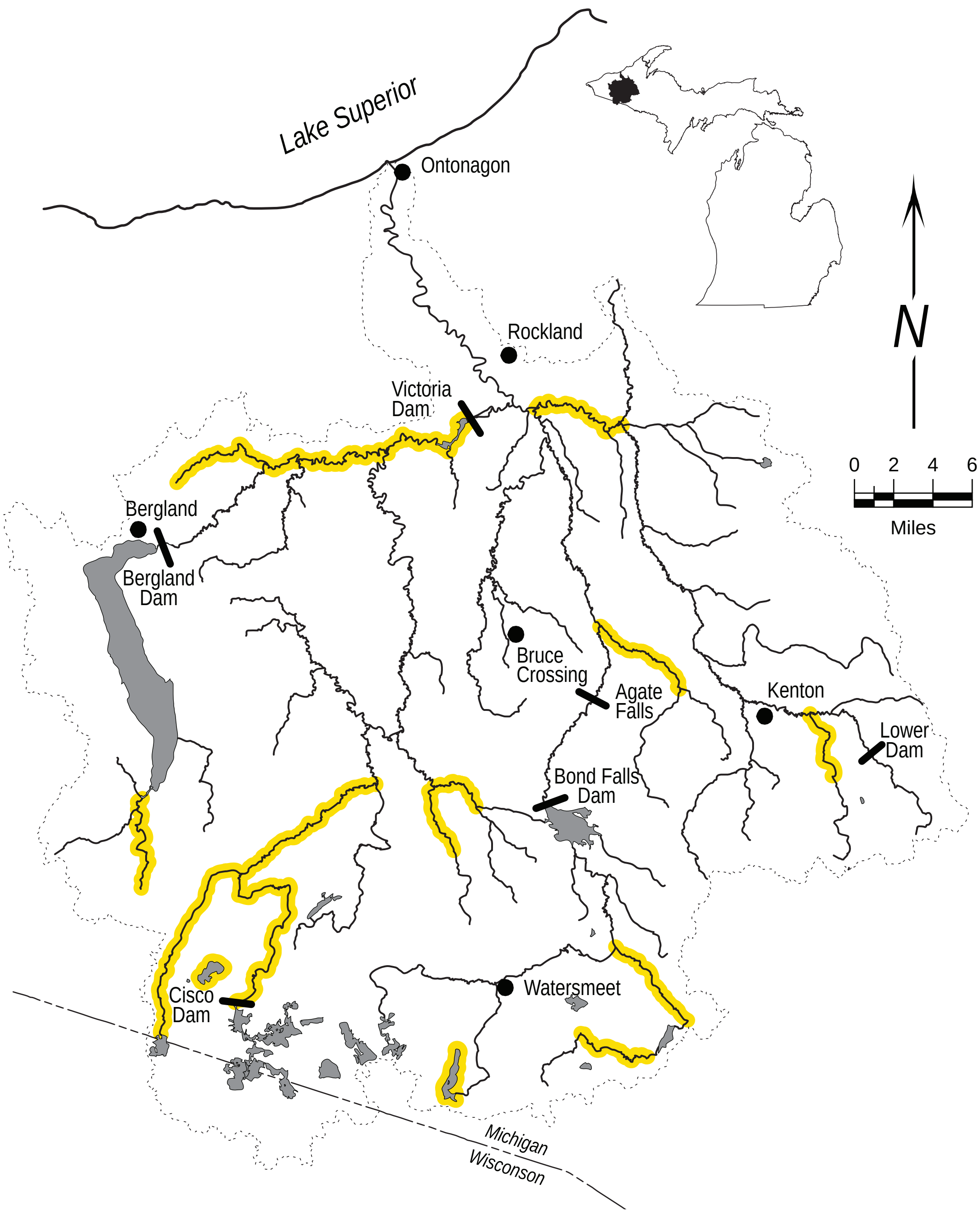


Hornyhead chub *Nocomis biguttatus*

Habitat:

feeding - adults: near riffles
- young: near vegetation
- clear water, does not tolerate turbidity
- gravel substrate
- low gradient streams that are tributaries to large streams

spawning - large stones and pebbles present
- often below a riffle in shallow water
- gravel substrate

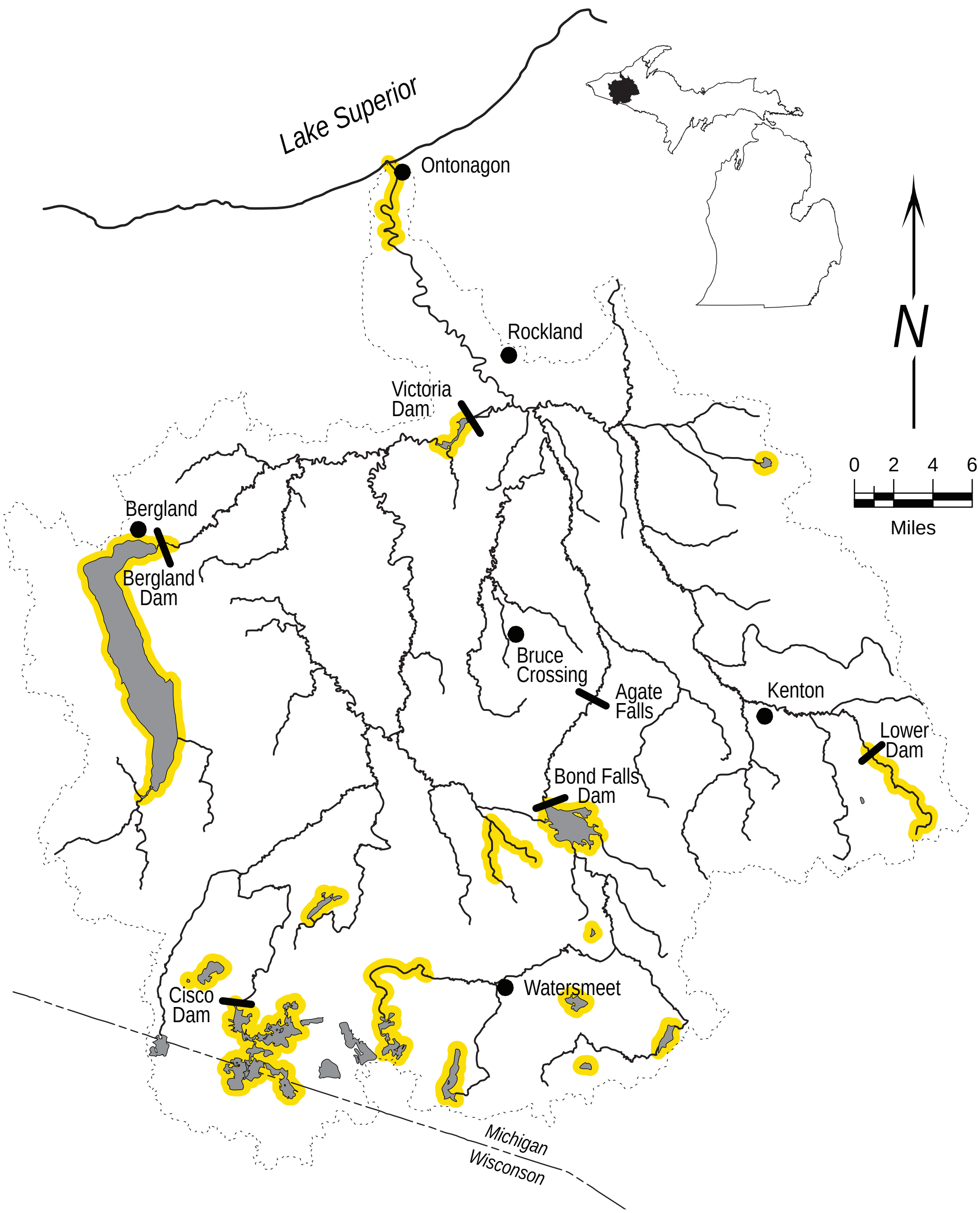


Golden shiner *Notemigonus crysoleucas*

Habitat**:**

feeding - lakes and impoundments and quiet pools of low gradient streams
- clear shallow water
- heavy vegetation

spawning - vegetation

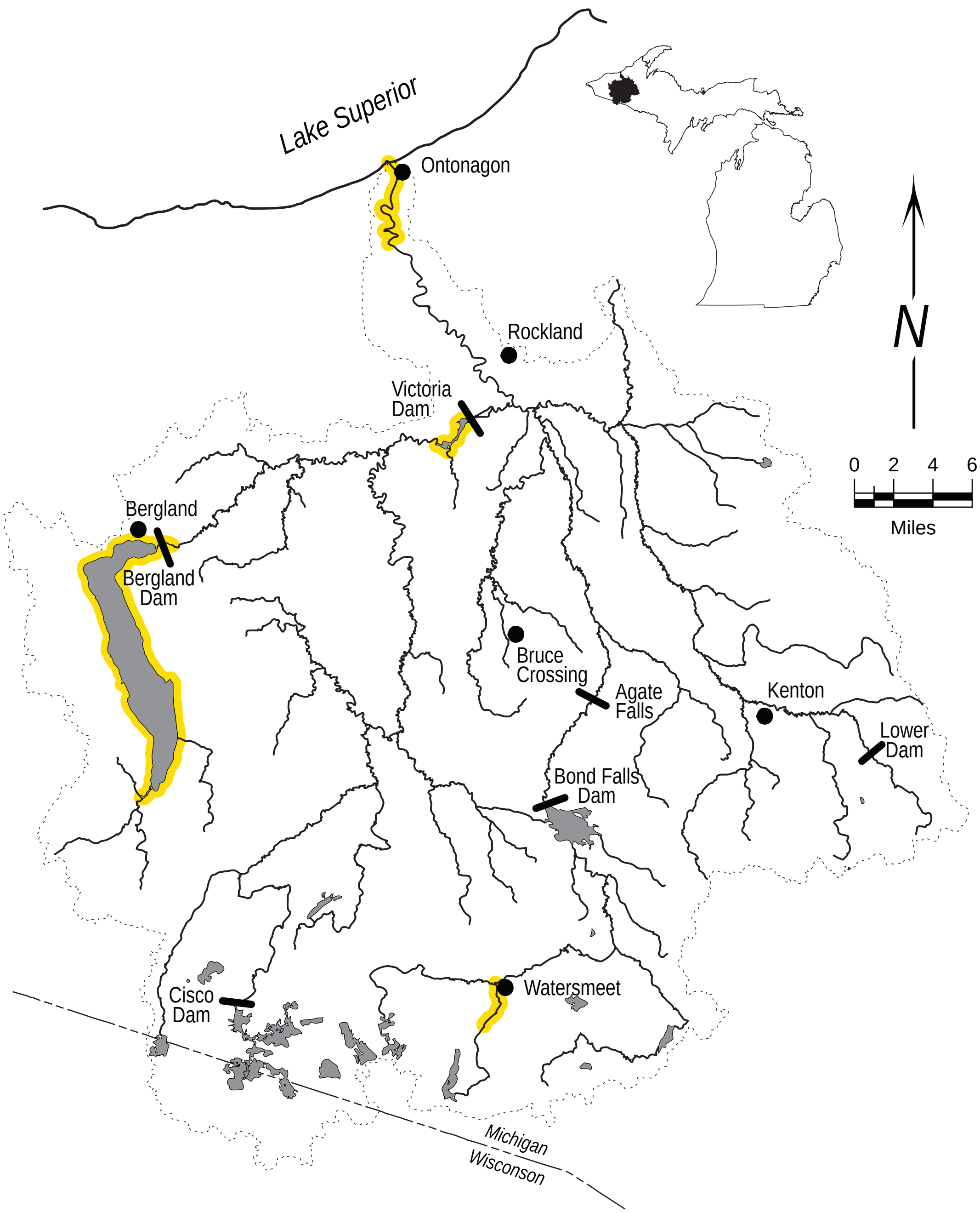


Emerald shiner *Notropis atherinoides*

Habitat:

feeding - open-large stream channels and lake
- low to moderate gradient
- range of turbidities and bottom types
- midwater or surface preferred, substrate of little importance
- avoids rooted vegetation

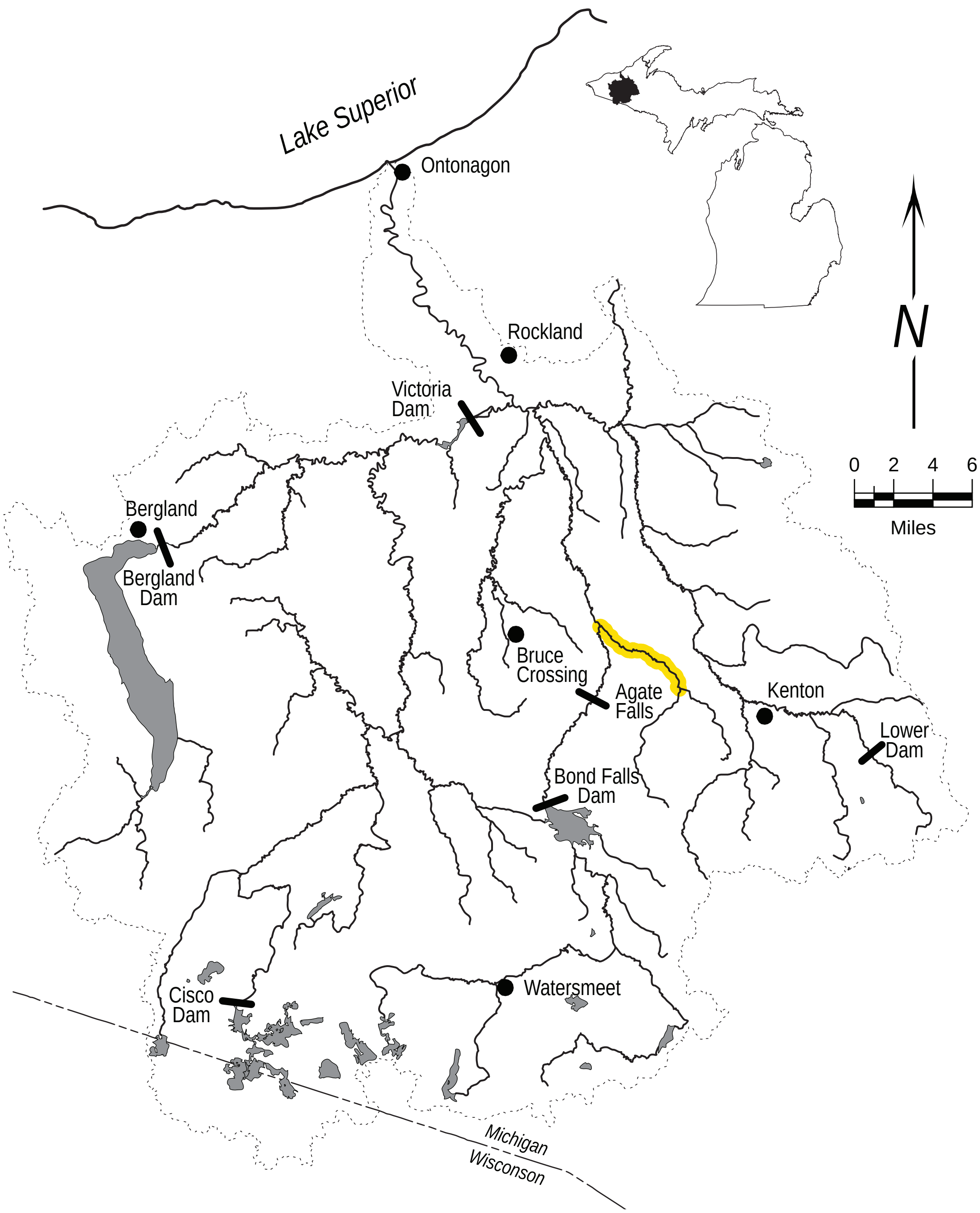
spawning - sand or firm mud substrate or gravel shoals



Bigmouth shiner *Notropis dorsalis*

Habitat:

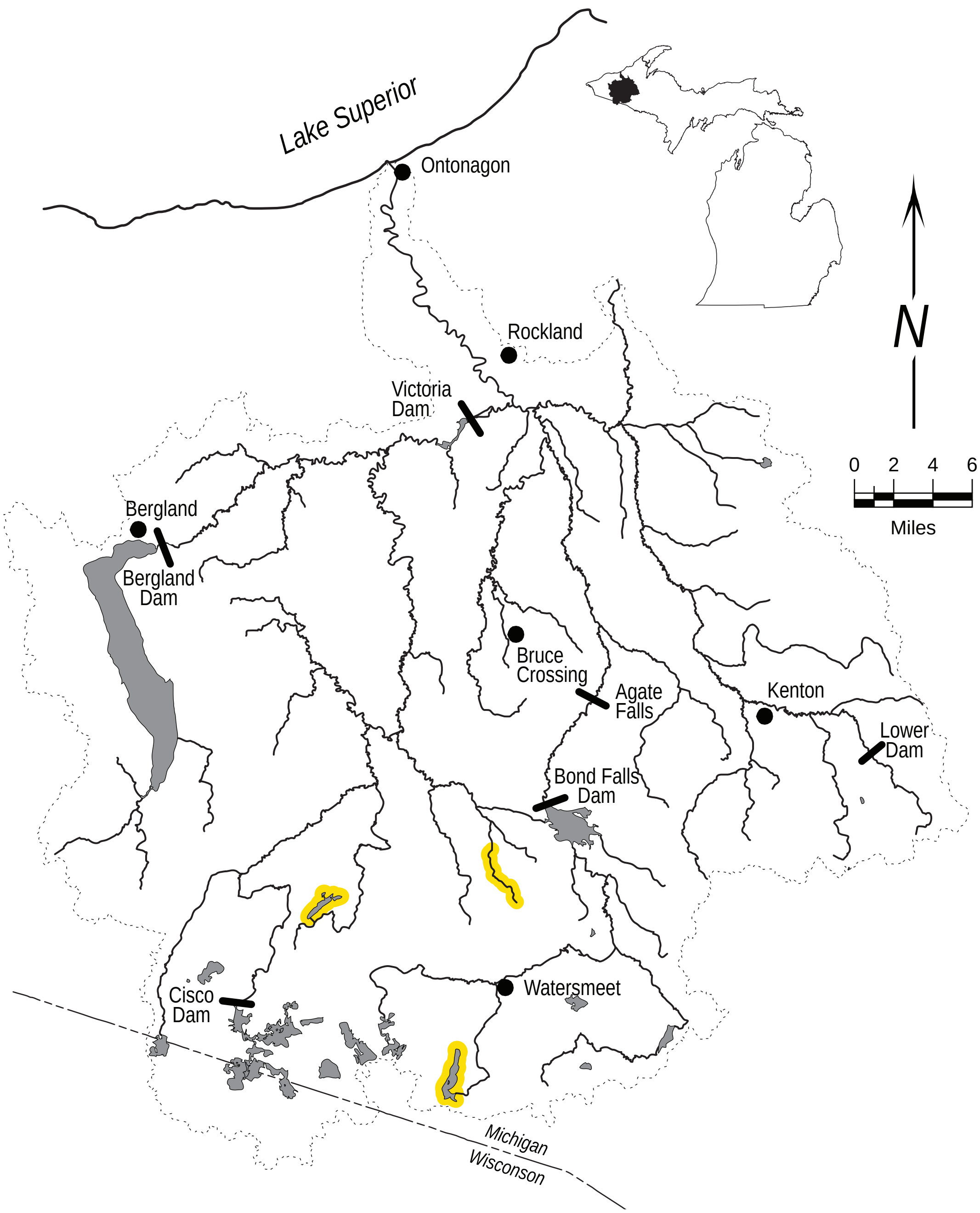
feeding - small clear streams
- good flows
- sand or gravel substrate
- open water, free from vegetation



Blackchin shiner *Notropis heterodon*

Habitat**:**

feeding - lakes, impoundments, and quiet pools in streams and rivers
- clear water
- clean sand, gravel, or organic debris substrate
- dense beds of submerged aquatic vegetation
- cannot tolerate turbidity, silt, or loss of aquatic vegetation

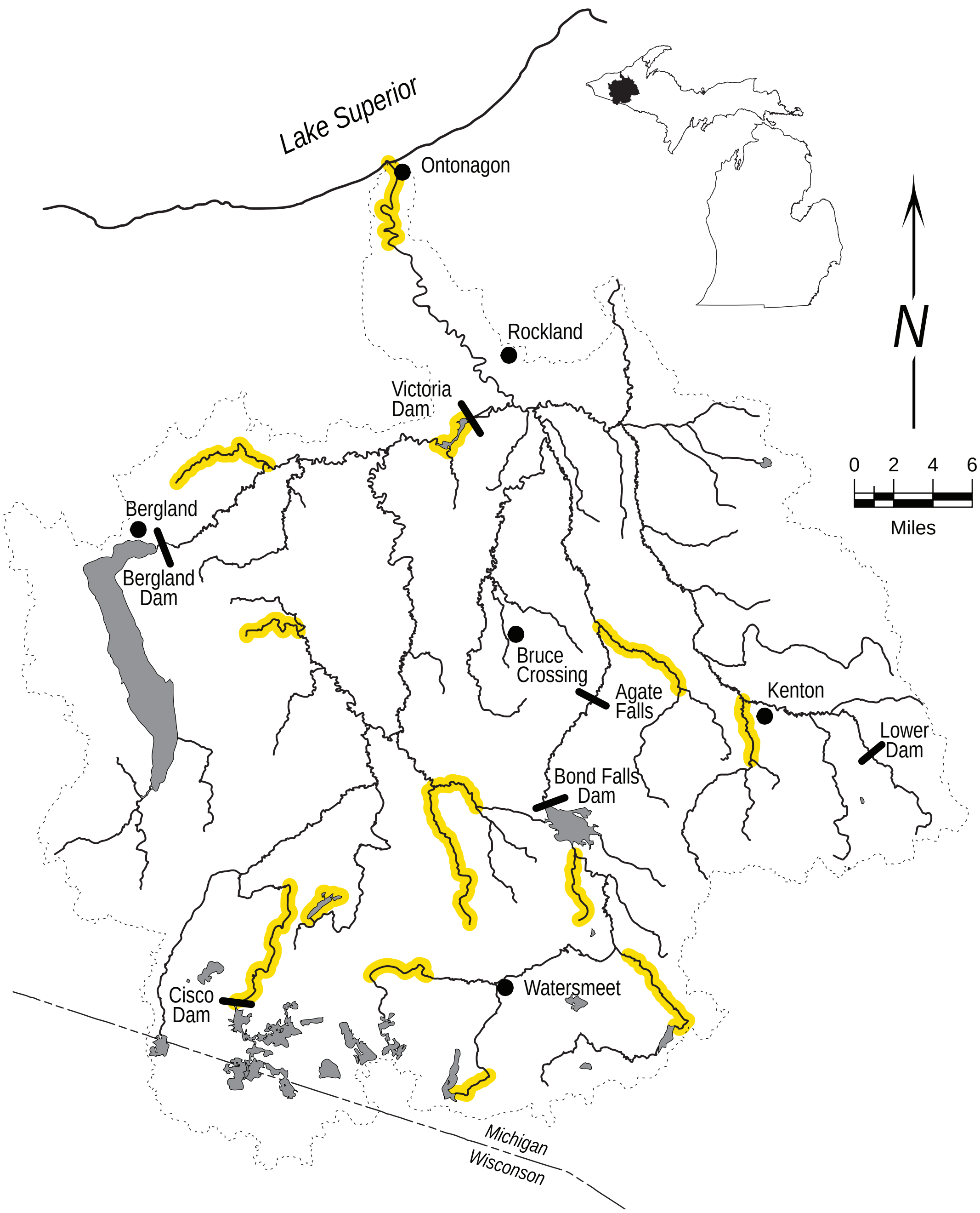


Blacknose shiner *Notropis heterolepis*

Habitat**:**

feeding - clear lakes, impoundments, and pools of small, clear, low-gradient streams
- aquatic vegetation
- clean sand, gravel, marl, muck, peat, or organic debris substrate
- cannot tolerate much turbidity, much siltation, or loss of aquatic vegetation

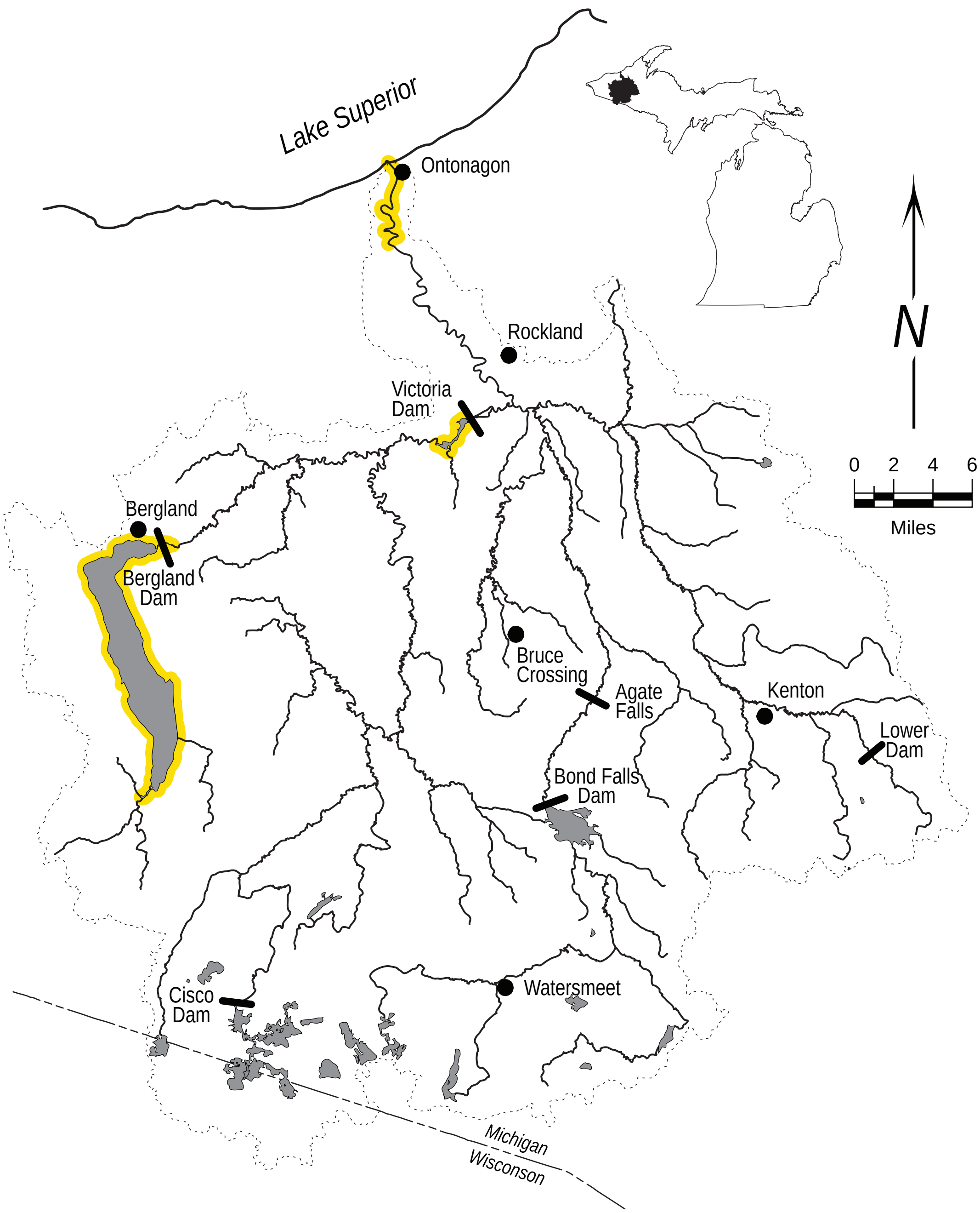
spawning - sandy substrate



Spottail shiner *Notropis hudsonius*

Habitat**:**

feeding	-	large rivers, lakes, and impoundments
	-	firm sand and gravel substrate
	-	low current
	-	sparse to moderate vegetation
	-	avoids turbidity
spawning	-	over sandy shoals or gravelly riffles
	-	near the mouths of small streams

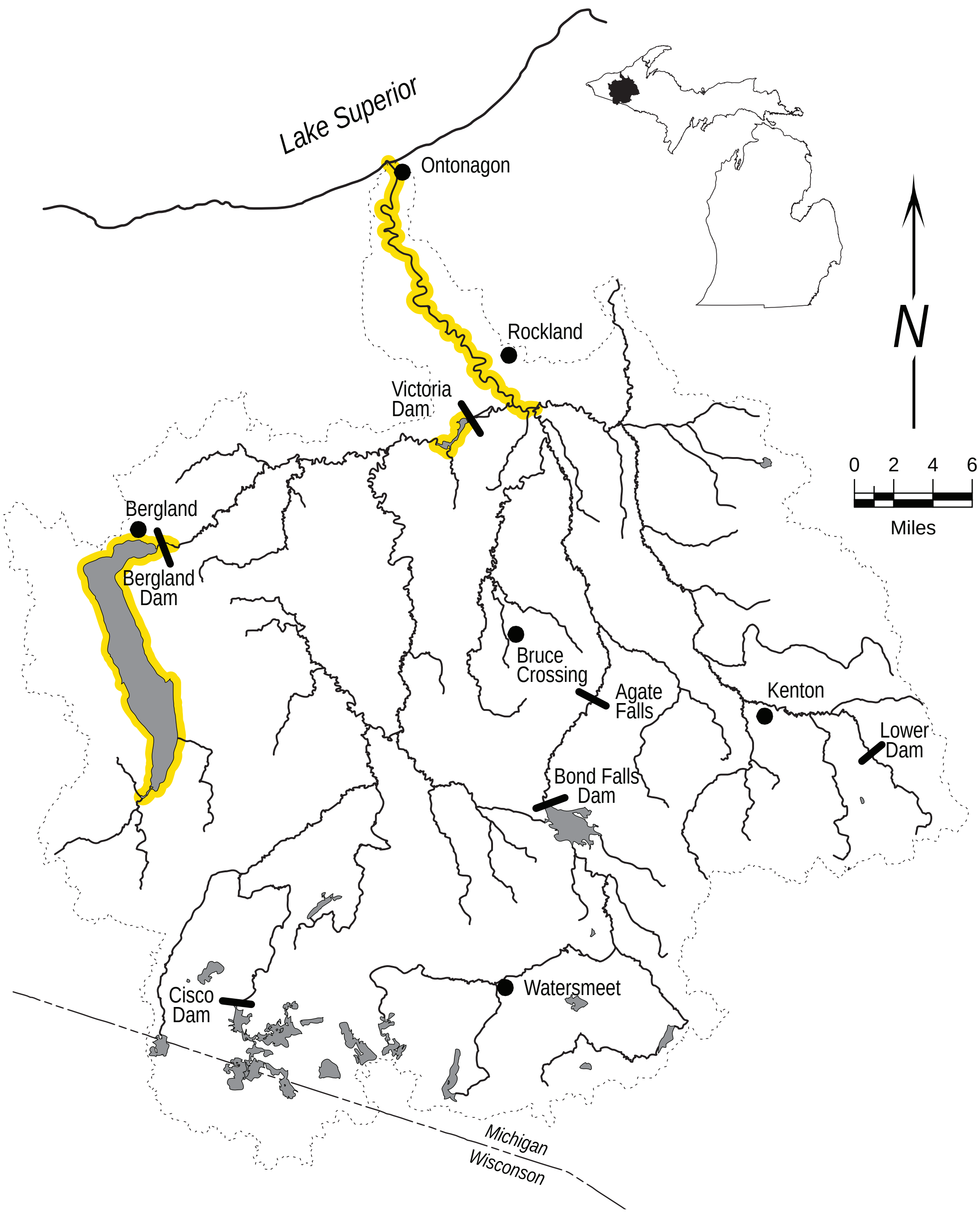


Sand shiner *Notropis stramineus*

Habitat**:**

feeding - sand and gravel substrate
- shallow pools in medium size streams, lakes, and impoundments
- clear water and low gradient
- rooted aquatic vegetation preferred
- tolerant of some inorganic pollutants provided substrate is not covered

spawning - clean gravel or sand substrate

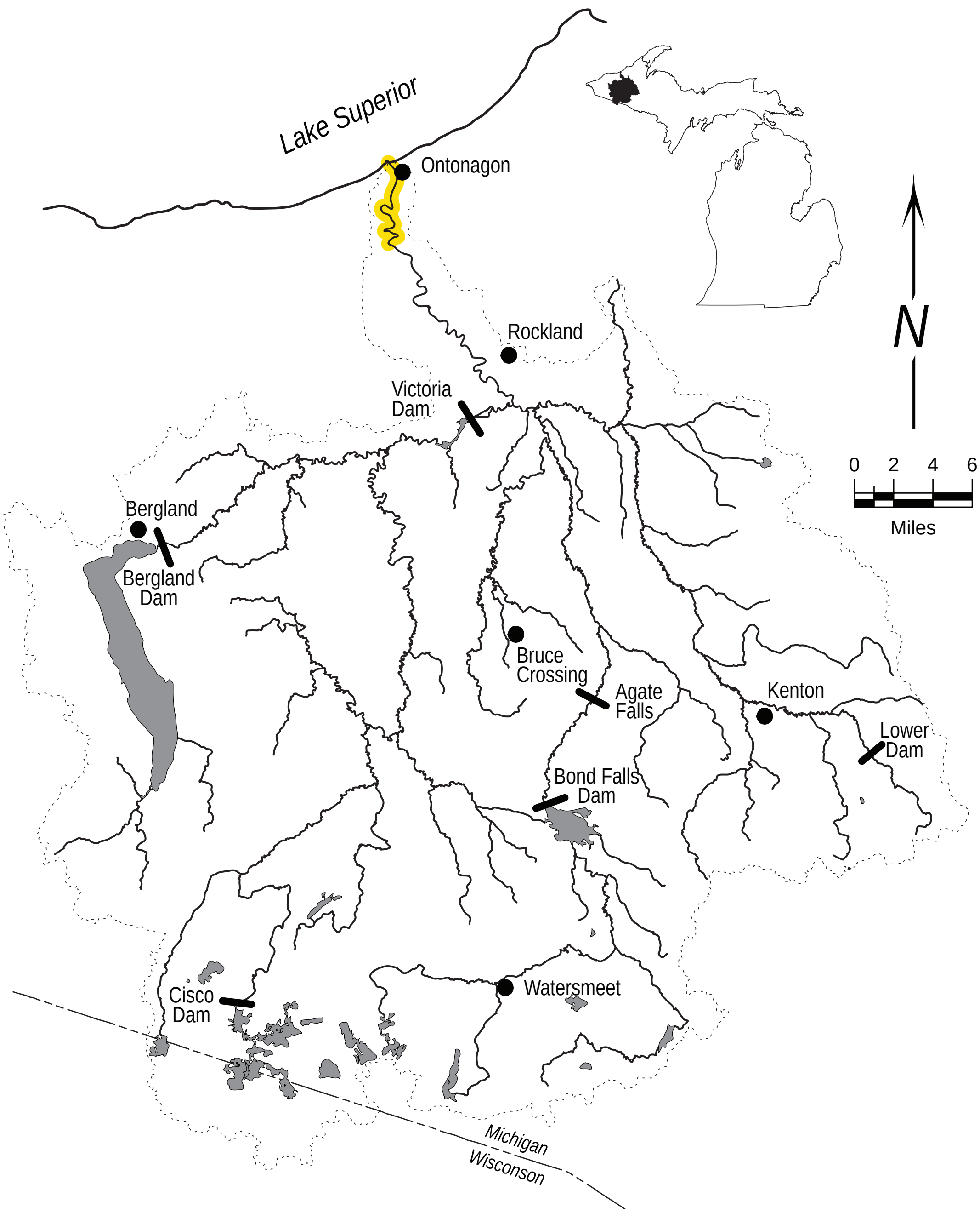


Mimic shiner *Notropis volucellu*

Habitat**:**

feeding - pools and backwater of streams, moderately weedy lakes and impoundments
- quiet or still water
- clear shallow water

spawning - aquatic vegetation necessary

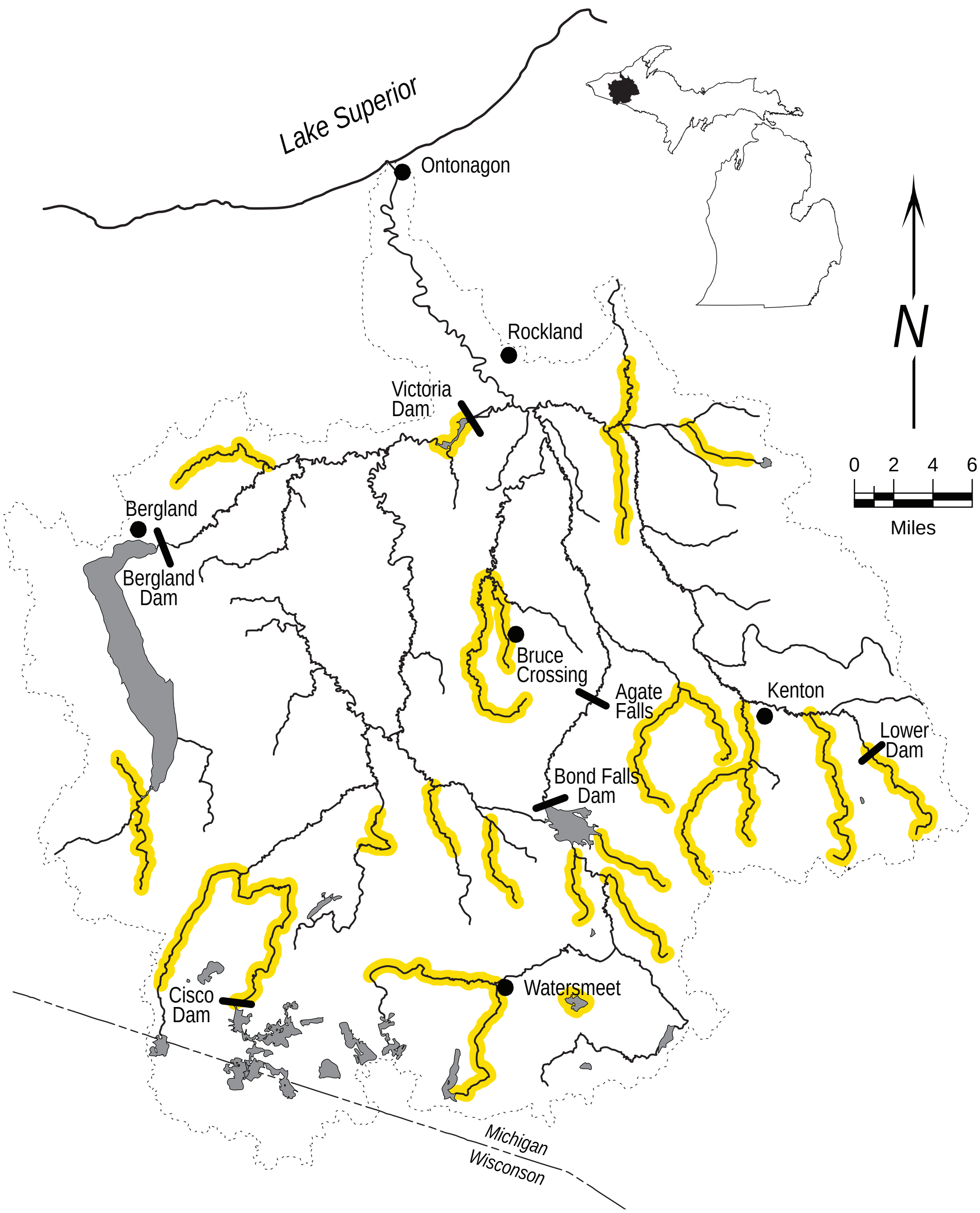


Northern redbelly dace *Phoxinus eos*

Habitat**:**

feeding - slow current
- in boggy lakes and streams
- detritus or silt substrate
- clear to slightly turbid water

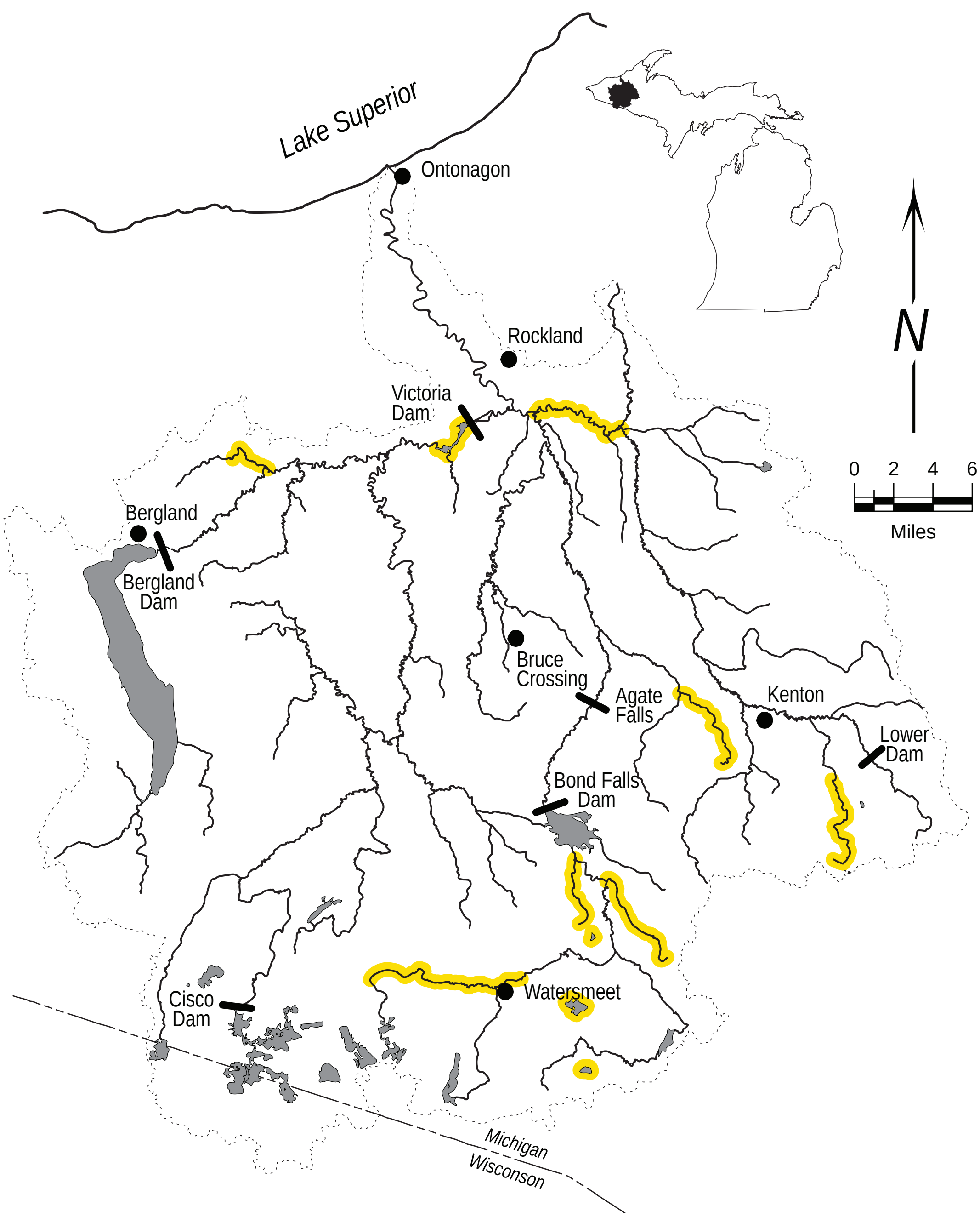
spawning - filamentous algae needed for egg deposition



Finescale dace *Phoxinus neogaeus*

Habitat:

feeding - cool bog lakes and streams
- neutral to slightly acidic waters
- various substrates

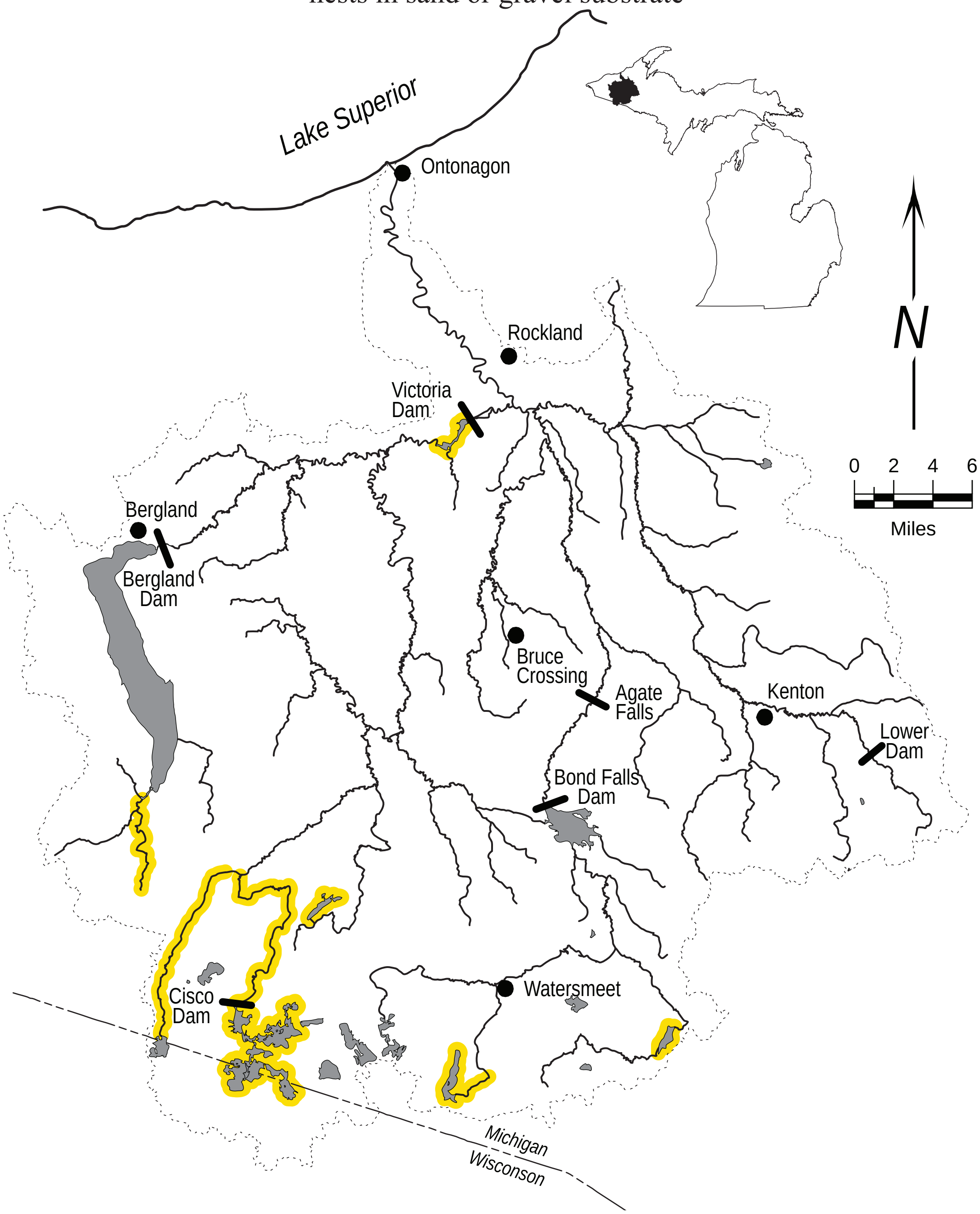


Bluntnose minnow *Pimephales notatus*

Habitat**:**

feeding - quiet pools and backwaters of medium to large streams, lakes, and impoundments
- clear warm water
- some aquatic vegetation
- firm substrates
- tolerates all gradients, turbidity, organic and inorganic pollutants

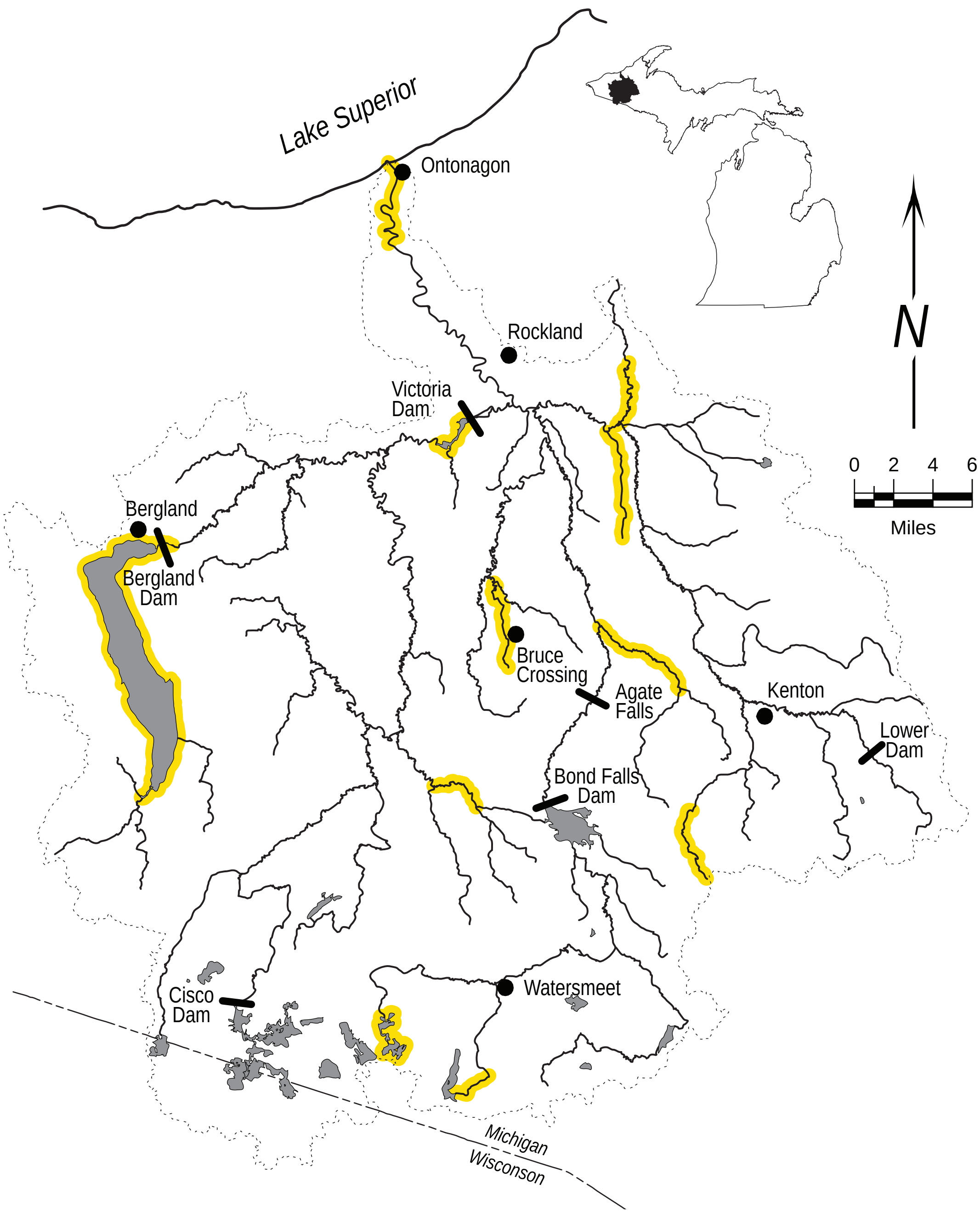
spawning - eggs deposited on the underside of flat stones or objects
- nests in sand or gravel substrate



Fathead minnow *Pimephales promelas*

Habitat**:**

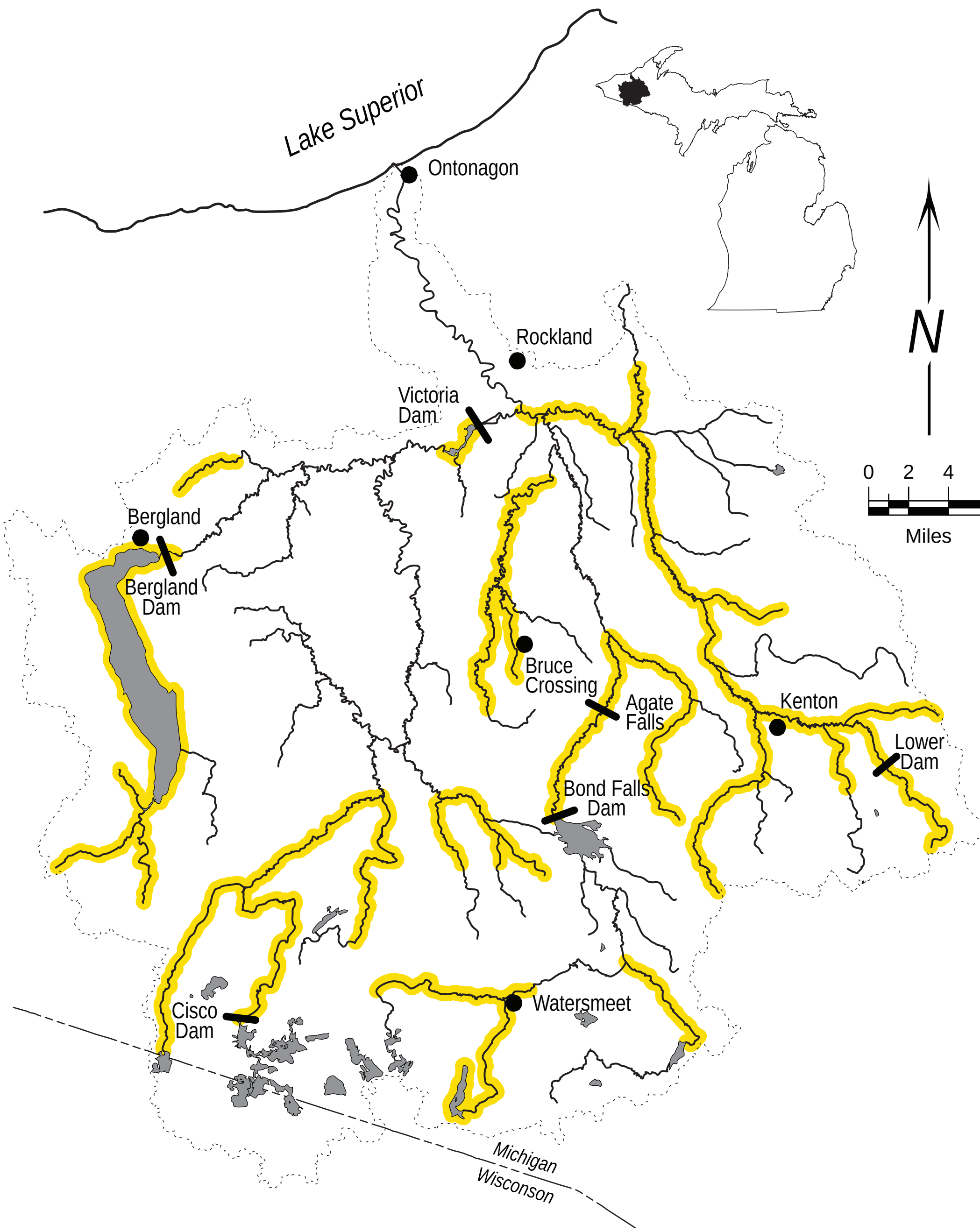
feeding	-	pools of small streams, lakes, and impoundments
	-	tolerant of turbidity, high temperatures, and low oxygen
spawning	-	on underside of objects in water 2 to 3 feet deep
	-	prefer sand, marl, or gravel substrate



Longnose dace *Rhinichthys cataractae*

Habitat**:**

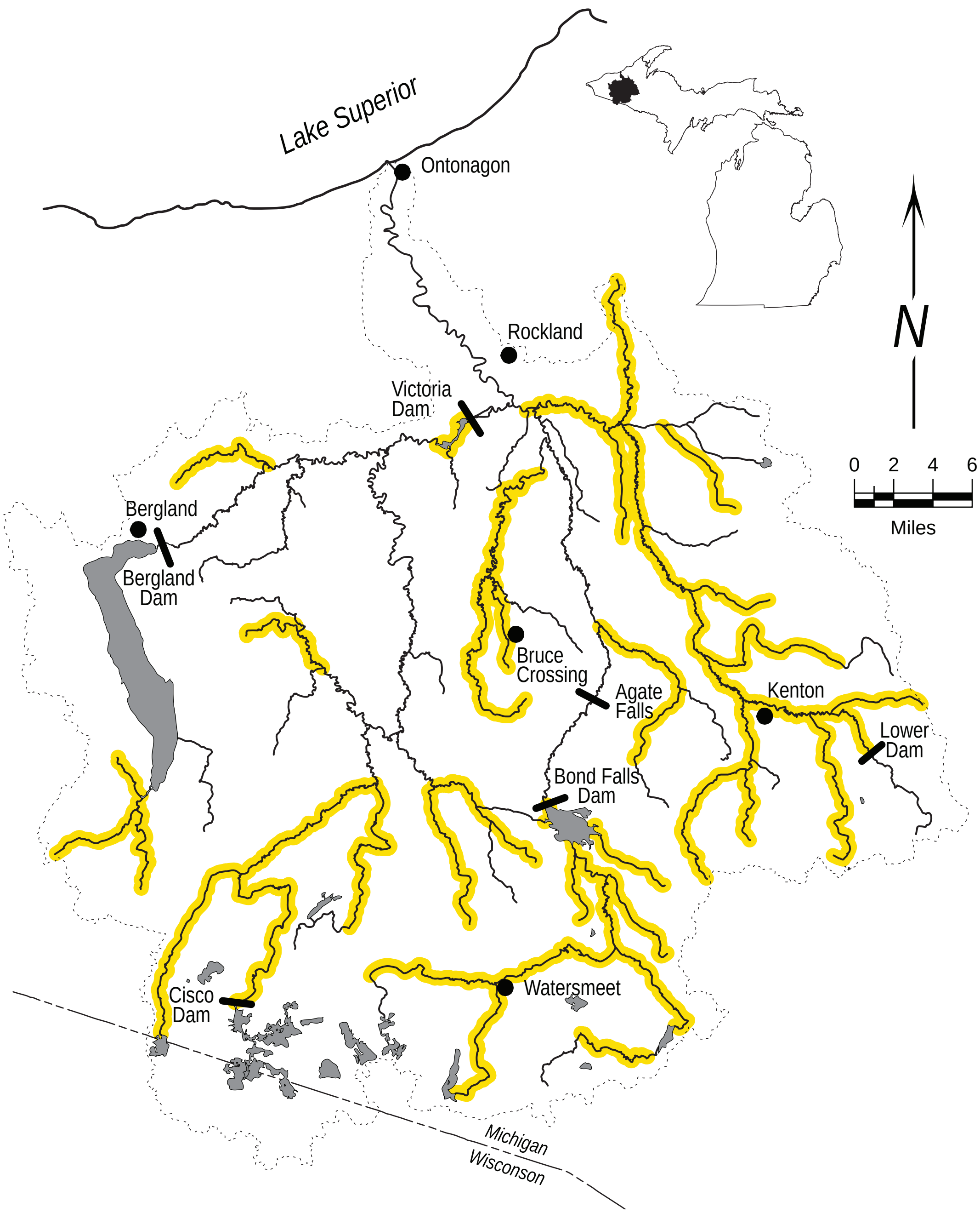
feeding - lakes and streams
- high gradient
- gravel or boulder substrate



Western blacknose dace *Rhinichthys obtusus*

Habitat**:**

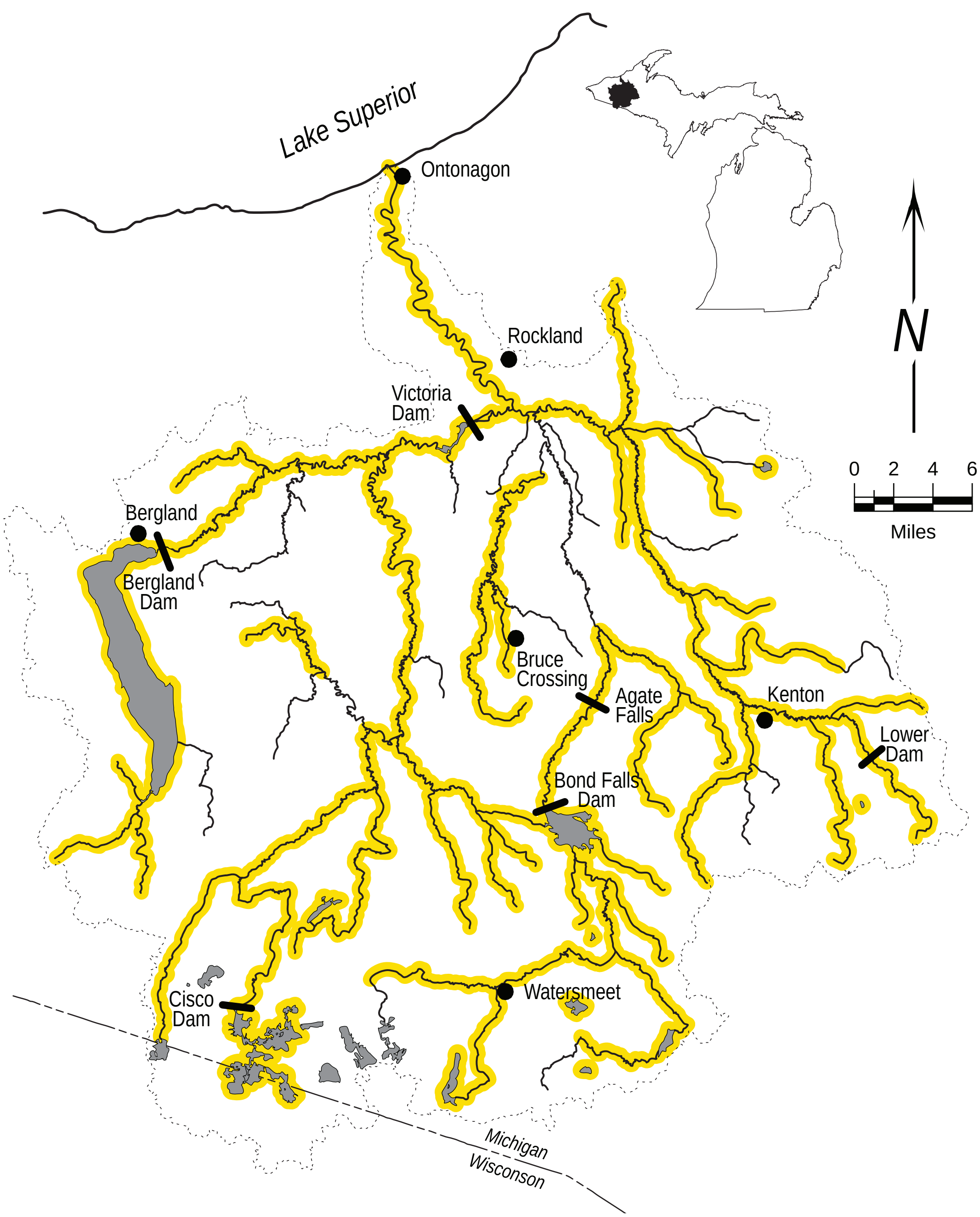
feeding	-	moderate to high gradient streams
	-	sand and gravel substrate
	-	clear cool water in pools with deep holes and undercut banks
	-	does not tolerate turbidity and silt well
spawning	-	riffles with gravel substrate and fast current
winter refuge	-	larger waters



Creek chub *Semotilus atromaculatus*

Habitat**:**

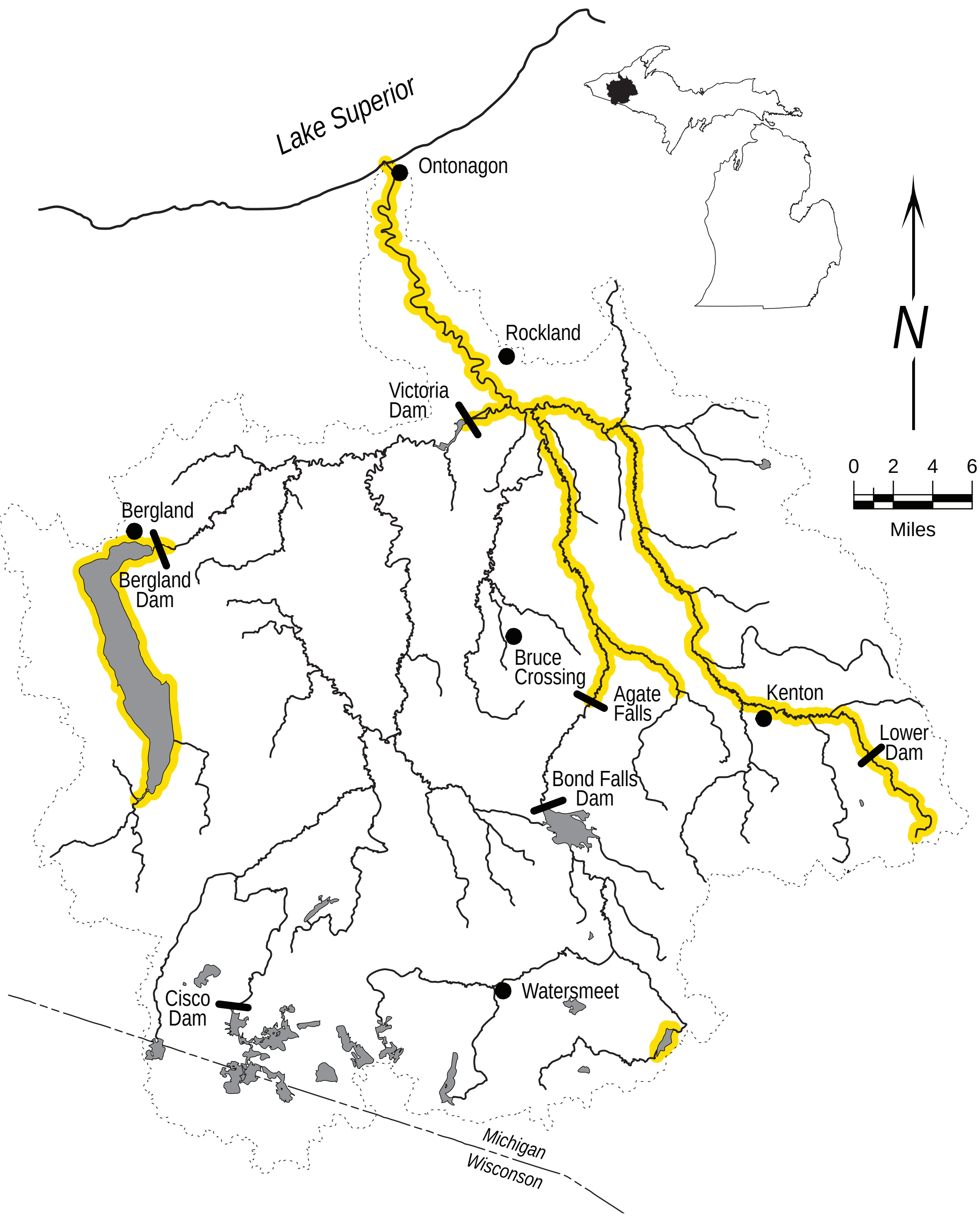
feeding	-	streams, rivers, or shore waters of lakes and impoundments
	-	can tolerate intermittent flows
	-	tolerates moderate turbidity
spawning	-	gravel nests
	-	low current
winter refuge	-	deeper pools and runs



Longnose sucker *Catostomus catostomus*

Habitat:

feeding	-	clear, cold rivers and lakes
spawning	-	in streams or lake shallows
	-	current
	-	gravel substrate

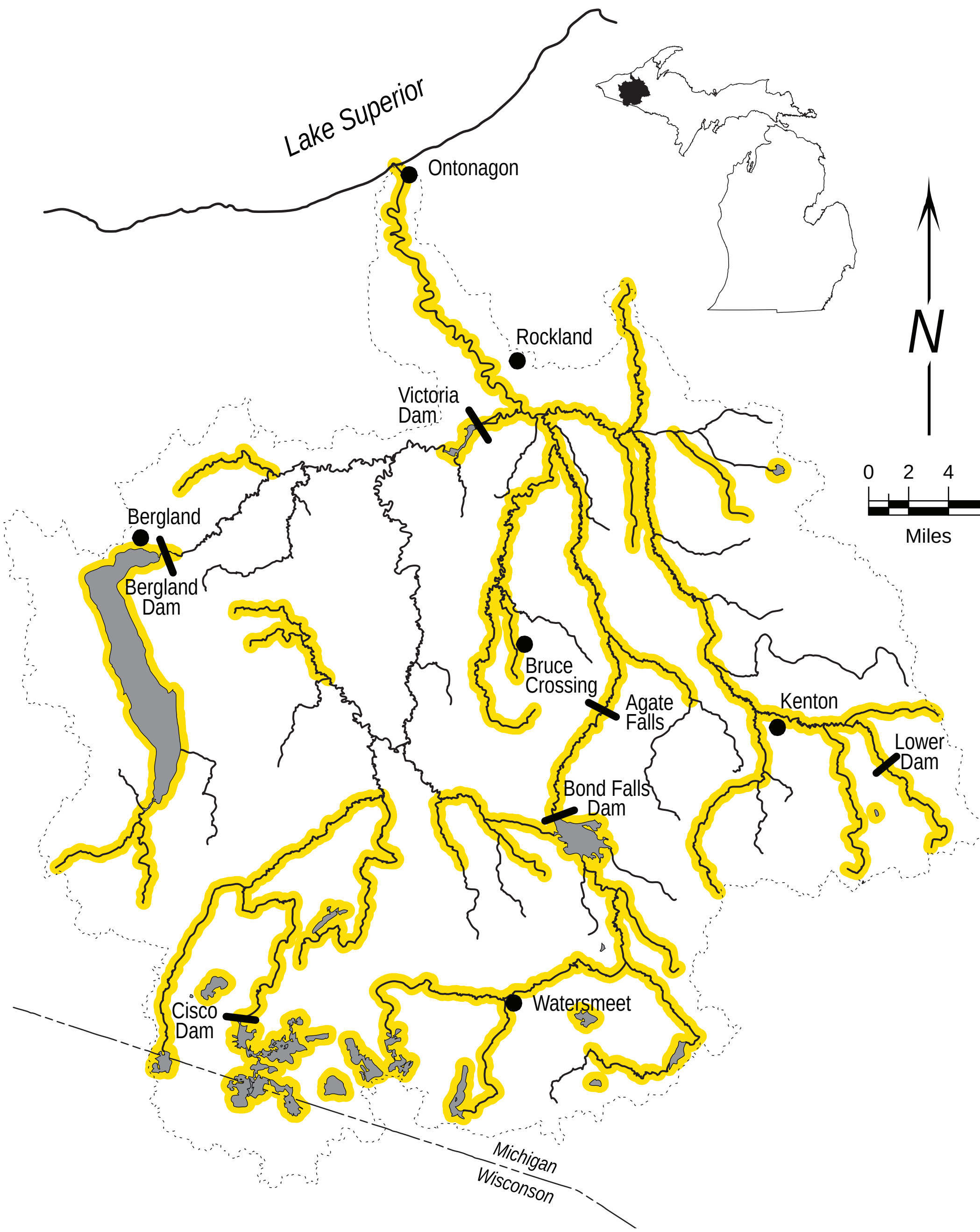


White sucker *Catostomus commersonii*

Habitat:

feeding - streams, rivers, lakes, and impoundments
- can inhabit highly turbid and polluted waters

spawning - quiet gravelly shallow areas of streams

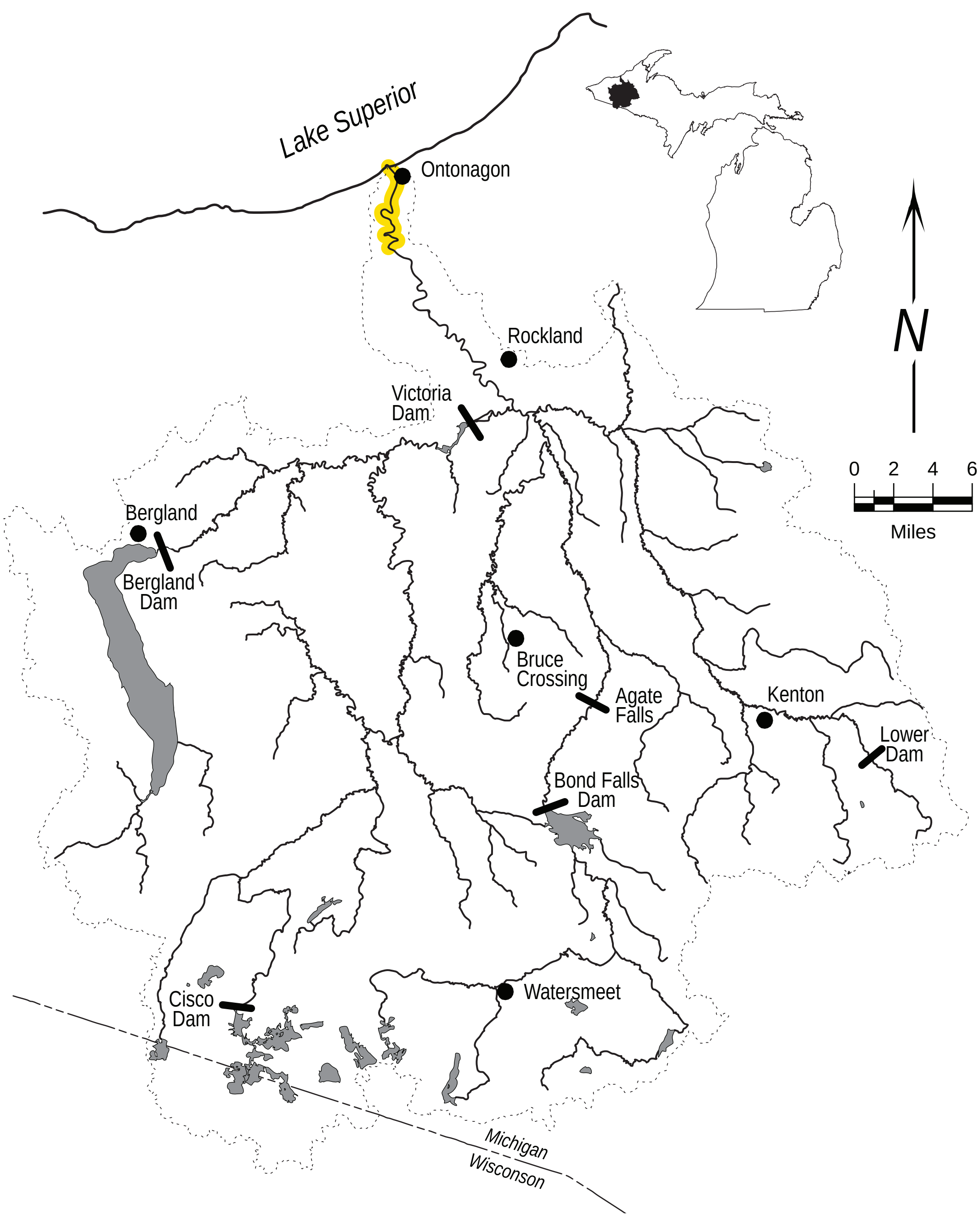


Silver redhorse *Moxostoma anisurum*

Habitat:

feeding - streams, rivers, lakes, and impoundments
- low current
- pollution and turbidity intolerant

spawning - swift current in rivers, do not spawn in tributaries
- males territorial
- gravel to rubble substrate

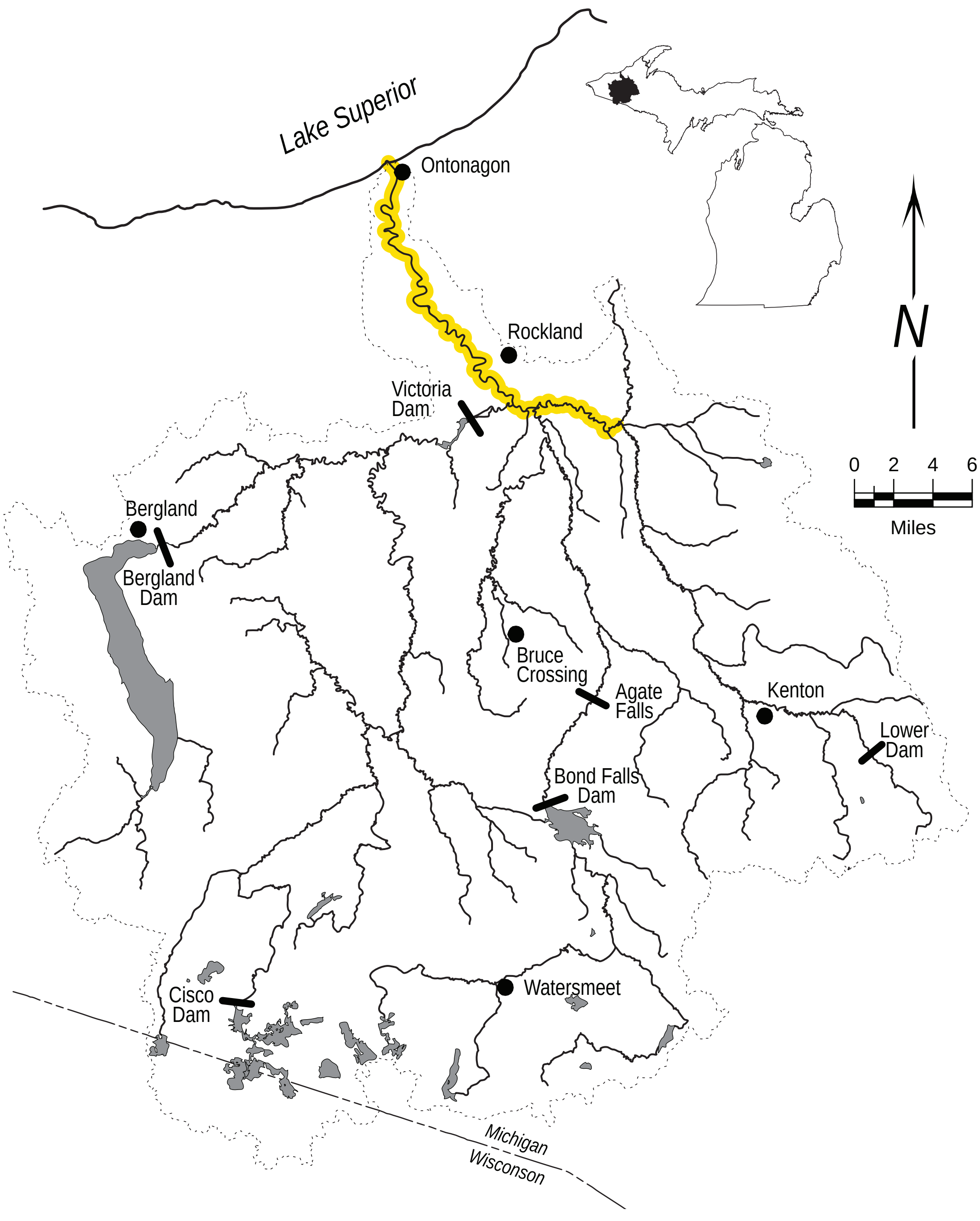


Shorthead redhorse *Moxostoma macrolepidotum*

Habitat**:**

feeding - downstream sections of large rivers, lakes, and impoundments
- rocky substrates
- swift water near riffles
- clear to slightly turbid water

spawning - gravelly riffles in smaller feeder streams

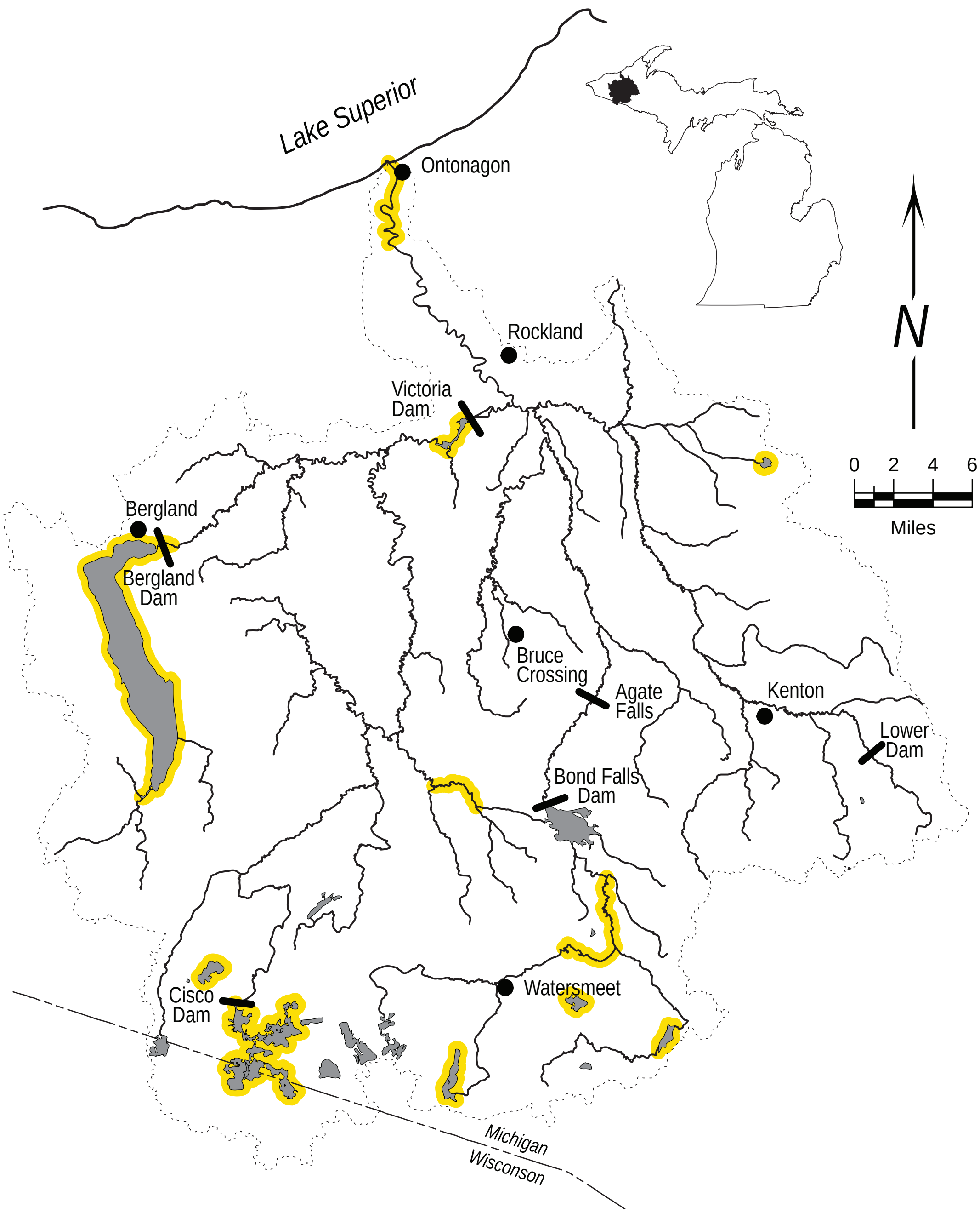


Black bullhead *Ameiurus melas*

Habitat:

feeding - turbid water
- silt bottom
- low gradient small to medium streams, pools, and headwaters of large rivers; also in lakes and impoundments
- can tolerate very warm water and very low dissolved oxygen

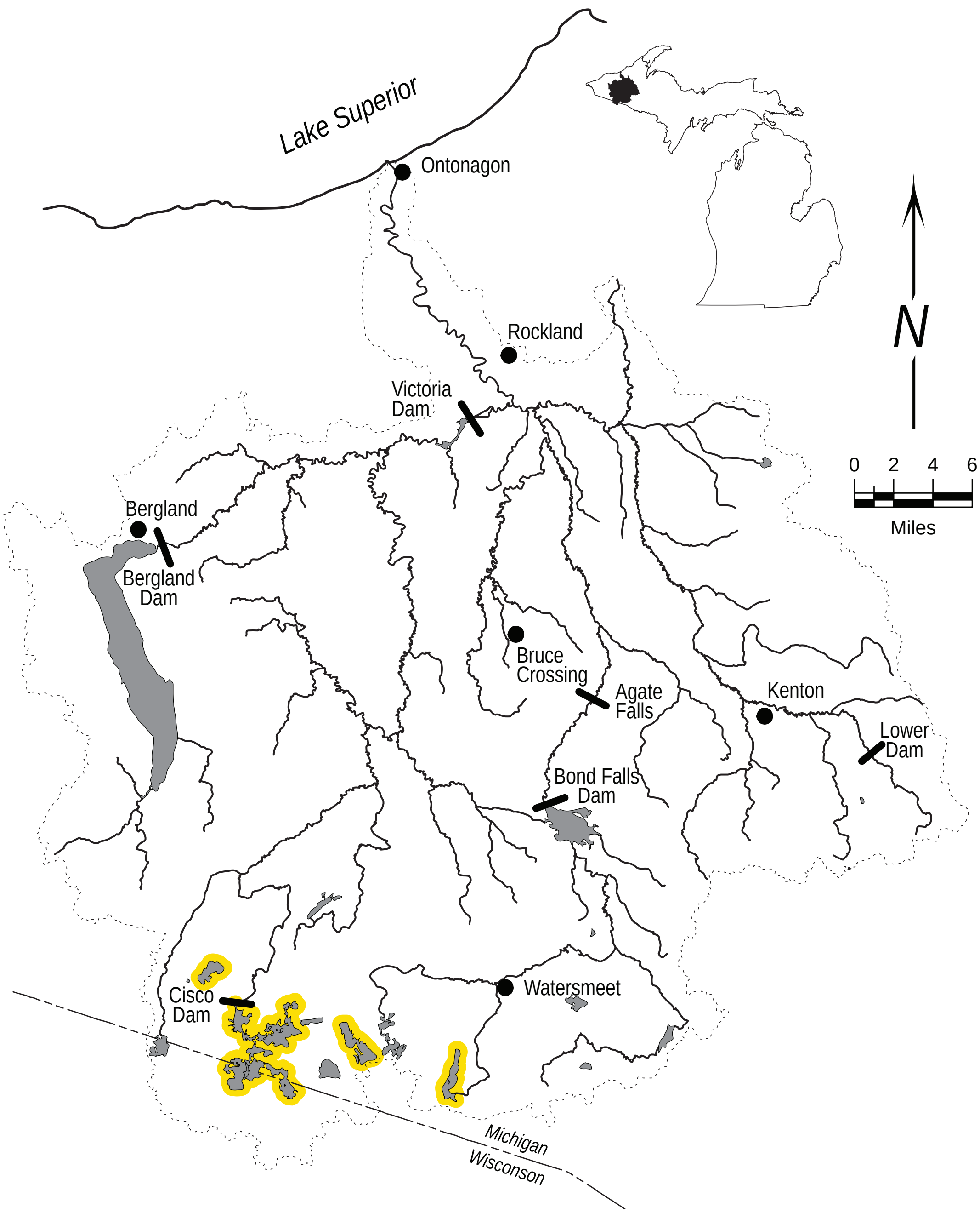
spawning - nest in moderate to heavy vegetation or woody debris and under overhanging banks



Yellow bullhead *Ameiurus natalis*

Habitat**:**

feeding	-	clear flowing water
	-	heavy vegetation
	-	low gradient streams, lakes, and impoundments
	-	tolerant of low oxygen
spawning	-	nest under a stream bank or near stones or stumps



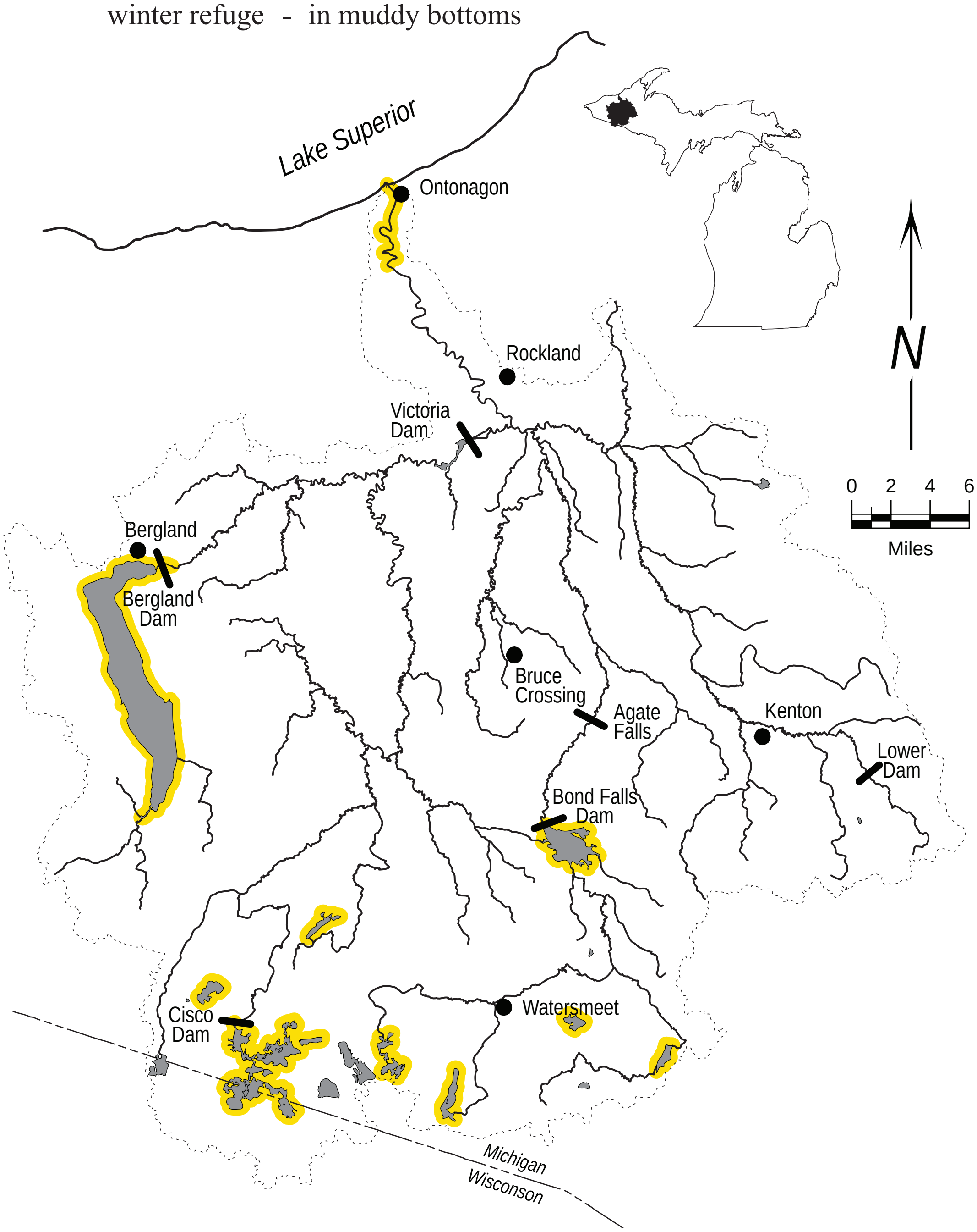
Brown bullhead *Ameiurus nebulosus*

Habitat**:**

feeding - larger streams and rivers, lakes and impoundments
- clear cool water with little clayey silt
- moderate amounts of aquatic vegetation
- sand, gravel, or muck substrate
- not tolerant of turbid water
- tolerant of warm water and low oxygen

spawning - nest in mud or sand substrate among rooted aquatic vegetation usually near a stump, tree, or rock

winter refuge - in muddy bottoms

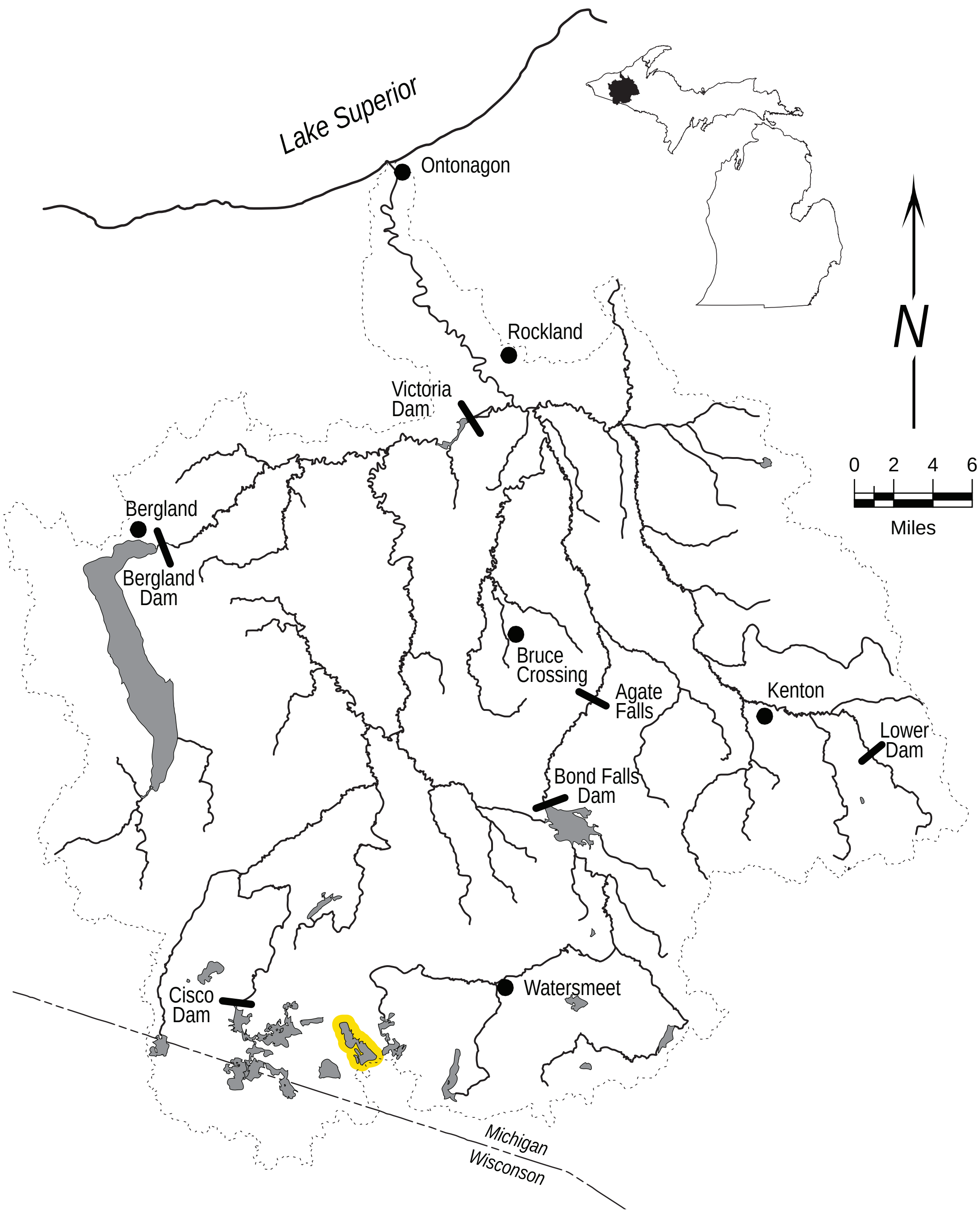


Stonecat *Noturus flavus*

Habitat**:**

feeding - consistent low to moderate gradient flowing water
- rocky riffles of larger streams and smaller rivers
- not tolerant of silt
- tolerant of low oxygen and pollution

spawning - eggs deposited beneath stones
- shallow rocky areas of streams or lakes

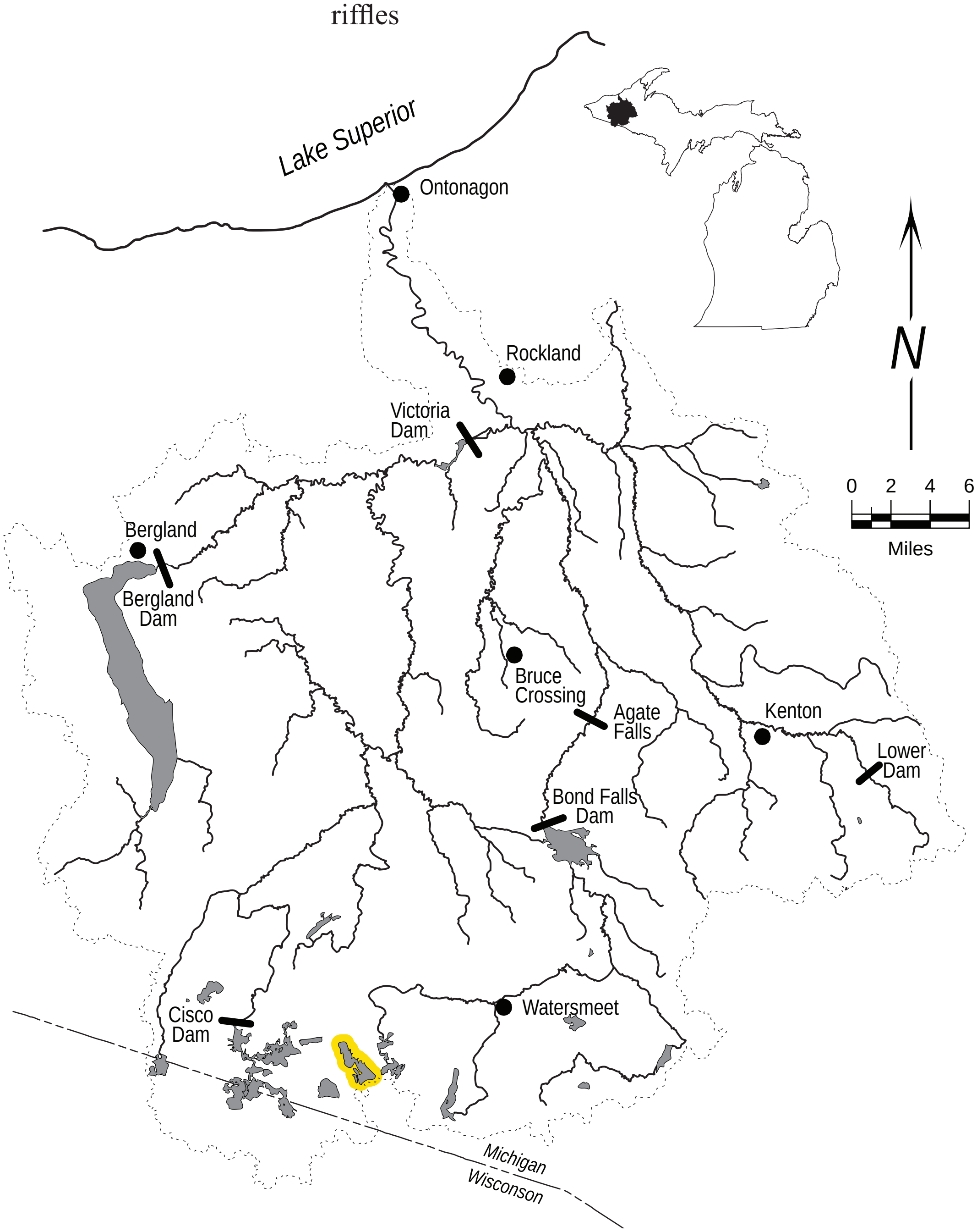


Margined madtom *Noturus gyrinus*

Habitat**:**

feeding - clear cool & warm water streams among rocks, boulders, and in gravel
- intolerant of silt
- low to moderate gradient in large creeks to large rivers
- occupies soft and hard bottoms of pools, runs, & riffles
- in daylight associated with substrate cover; at night in open areas

spawning - on flat rocks in gentle to moderate current above and below riffles

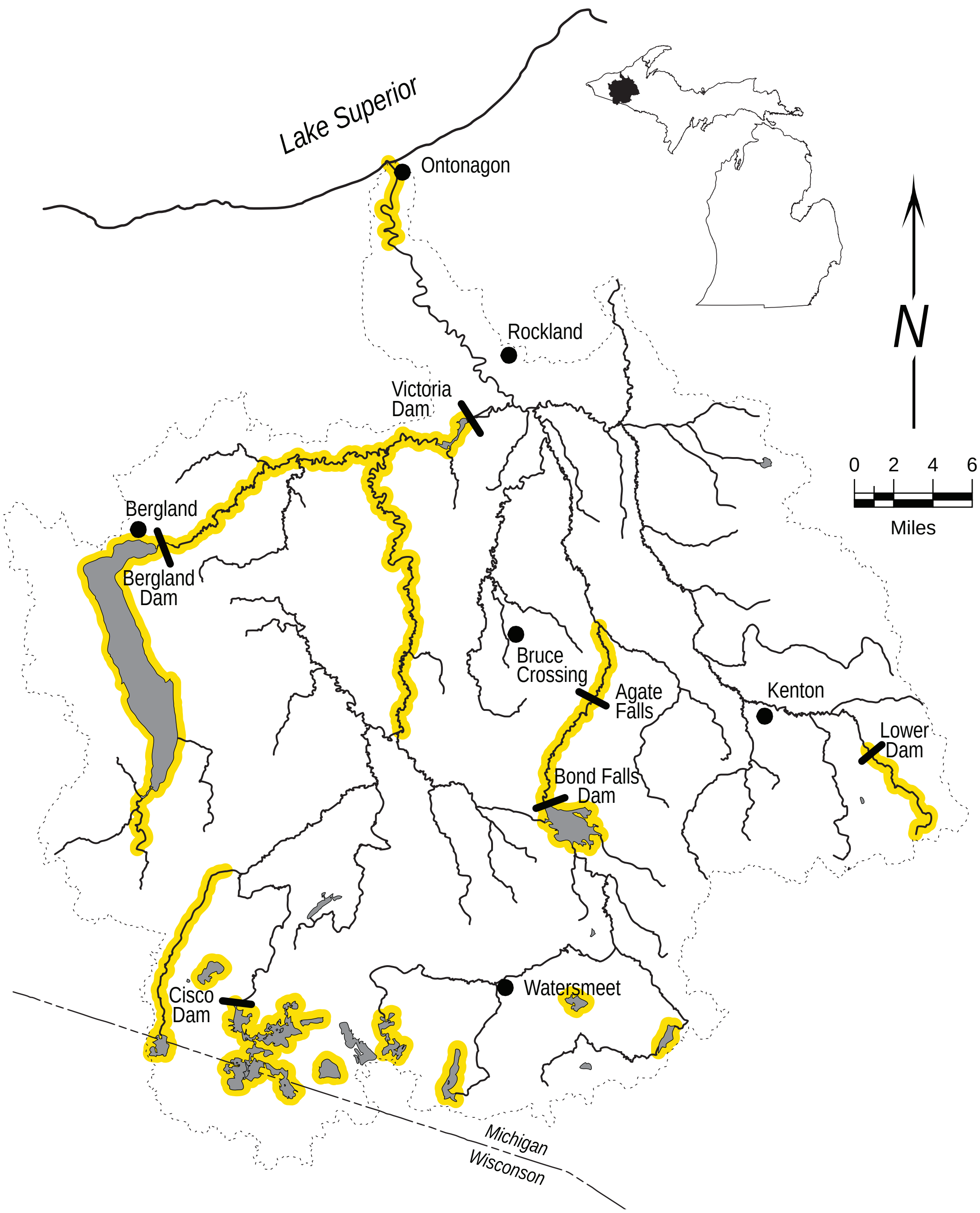


Northern pike *Esox lucius*

Habitat**:**

feeding - cool to moderately warm streams, rivers, lakes, and impoundments
- vegetation in slow to moderate current

spawning - submerged vegetation with slow current in shallow water

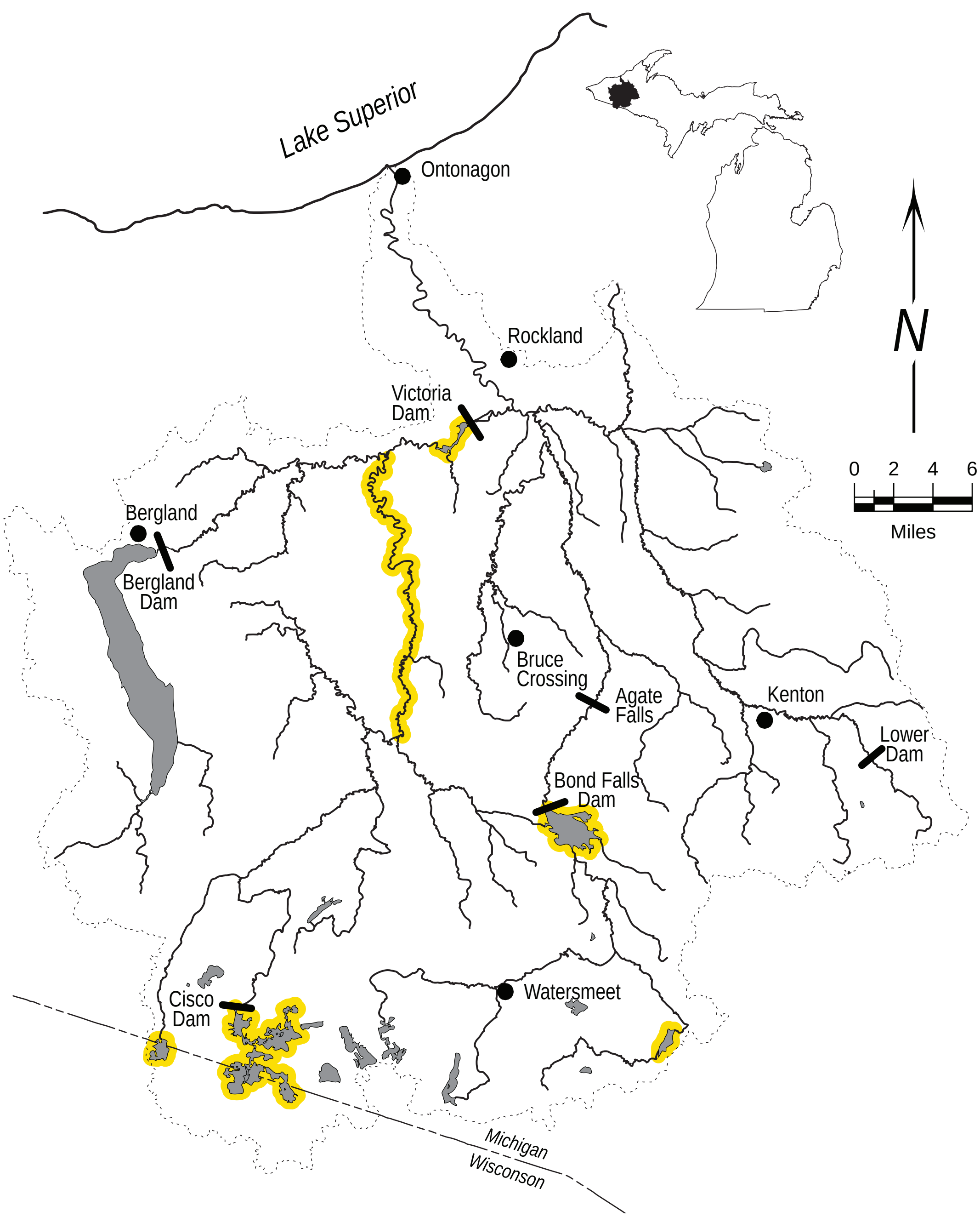


Muskellunge *Esox masquinongy*

Habitat:

feeding - warm, heavily vegetated lakes, stumpy weedy bays, and slow heavily vegetated medium to large rivers
- shallow cool water
- tolerant of low oxygen

spawning - clear shallow waters (15-20”) in heavily vegetated areas



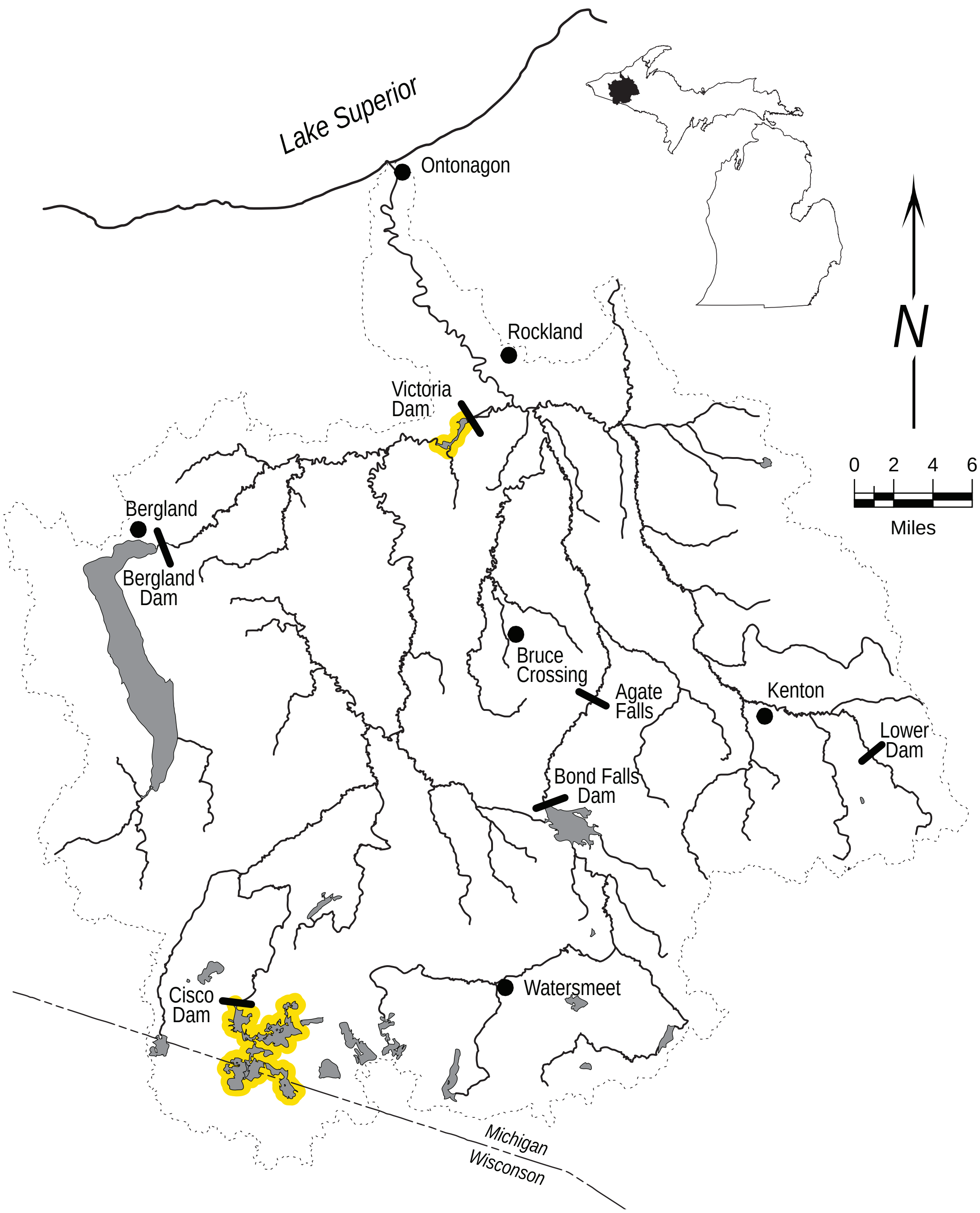
Tiger muskellunge *Esox masquinongy* x *E. lucius*

Habitat:

feeding - intermediate between muskellunge and northern pike

spawning - hybrid species; muskellunge x northern pike

- occasionally produced in wild, but most often from hatcheries
- males are sterile, females may be fertile

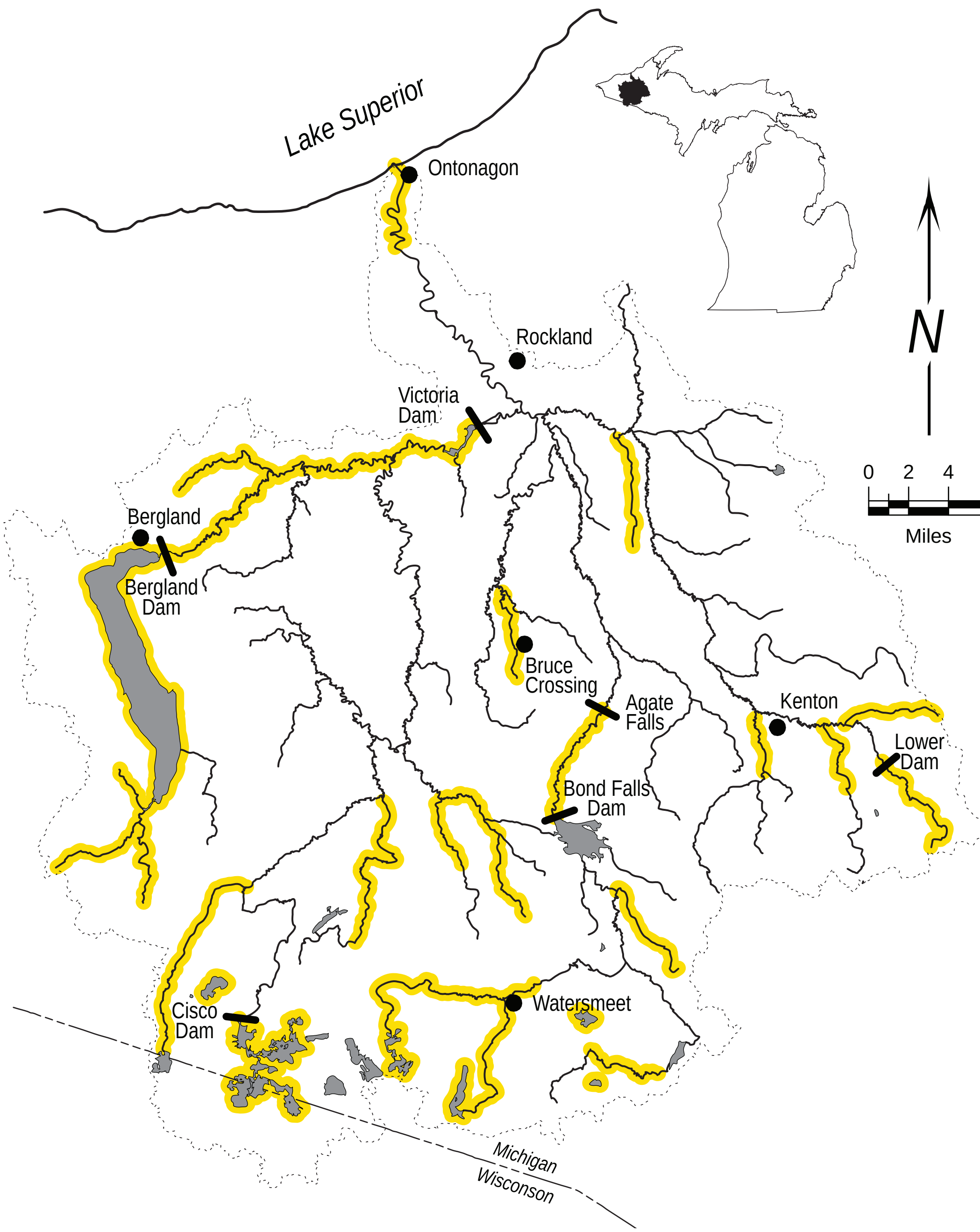


Central mudminnow *Umbra limi*

Habitat**:**

feeding - undisturbed clear, low-gradient streams or rivers and lakes and impoundments
- organic debris, muck, or peat substrates
- aquatic vegetation

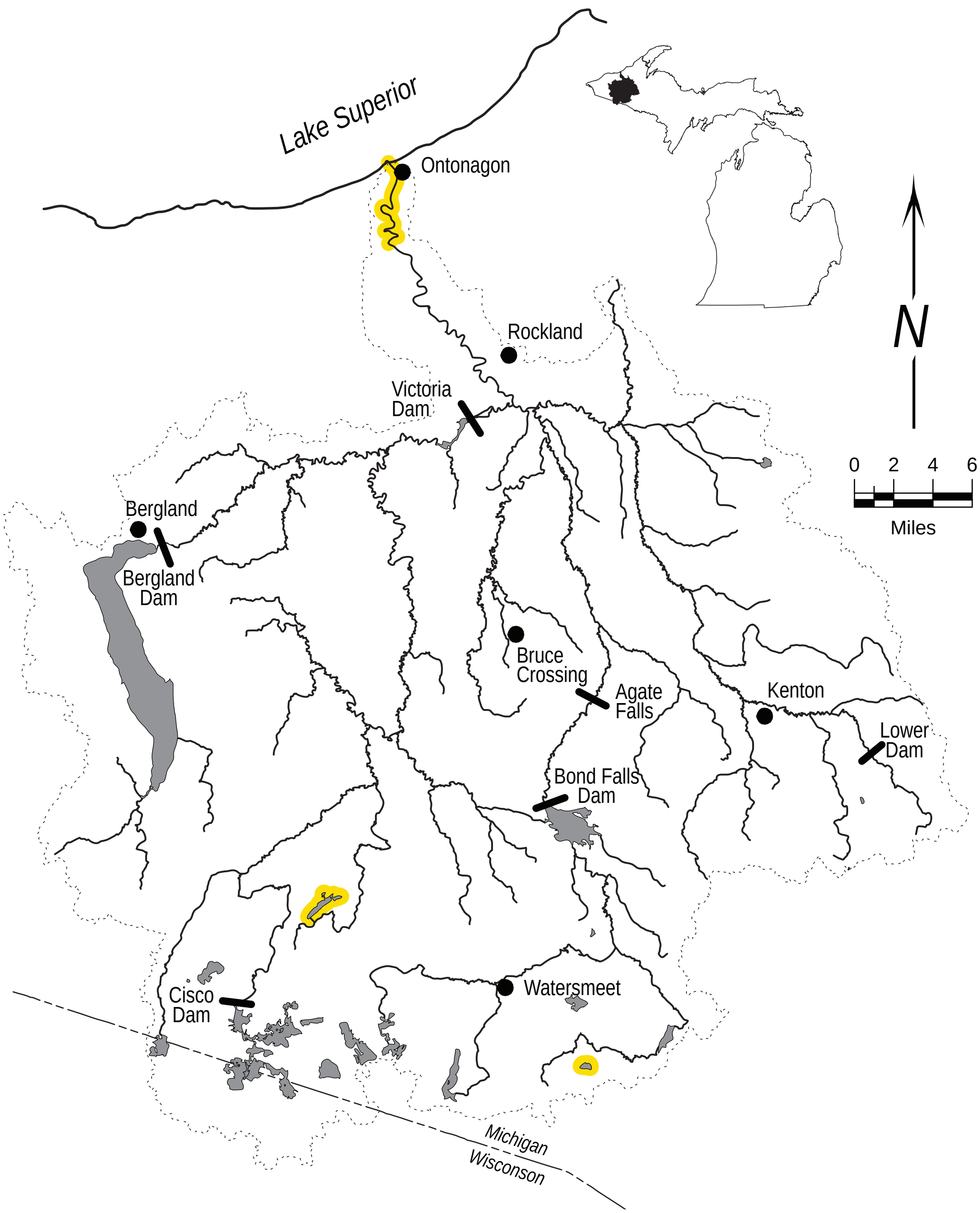
spawning - floodplain areas, on vegetation



Rainbow smelt *Osmerus mordax*

Habitat:

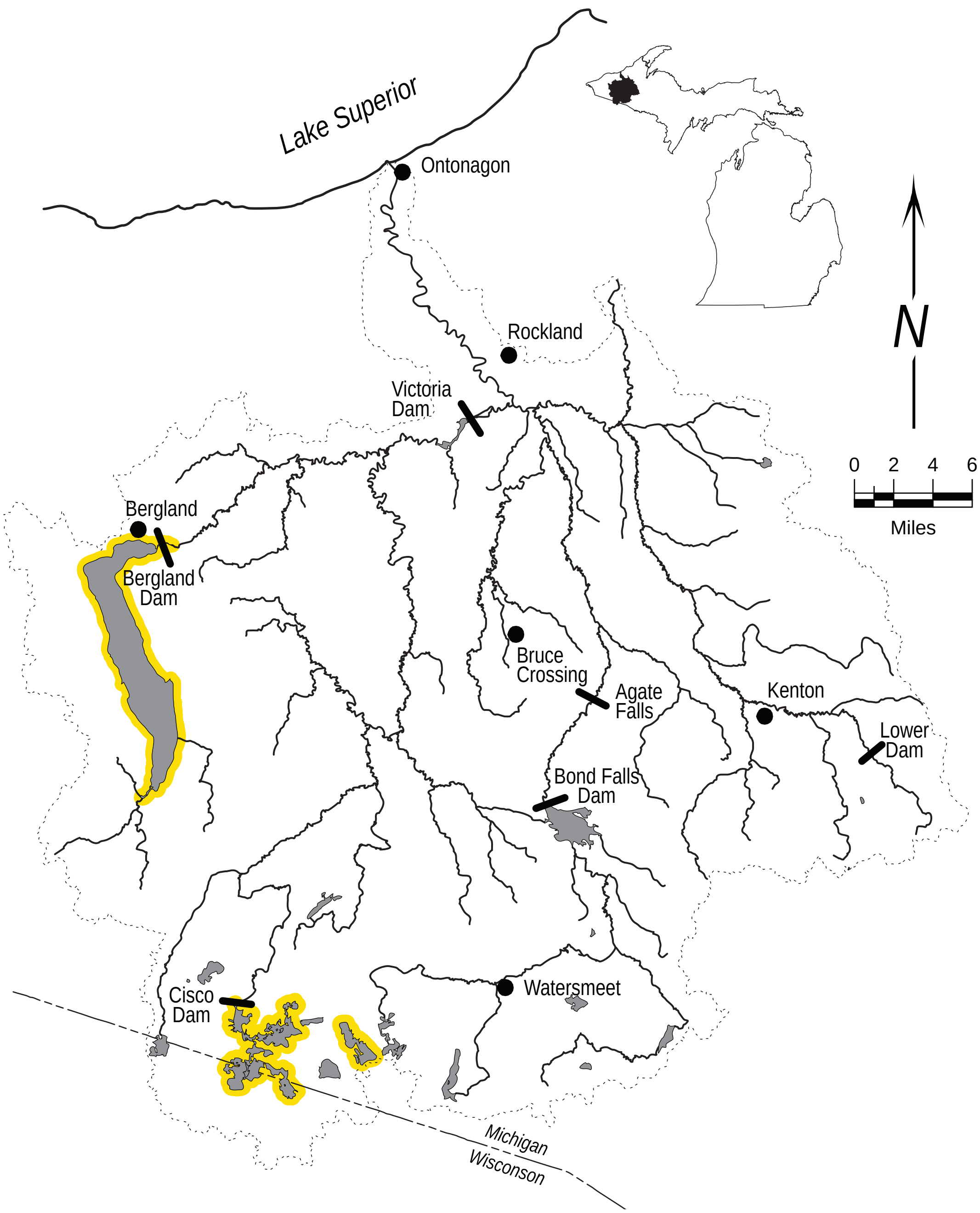
feeding	-	young: close inshore lake habitat along sand and gravel beaches\
	-	cold water
spawning	-	clear high-gradient streams or wave swept shoreline
	-	riffles with coarse sand or gravel substrate
winter refuge	-	midwaters of lakes or inshore coastal waters



Cisco {Lake herring} *Coregonus artedi* - **threatened**

Habitat:

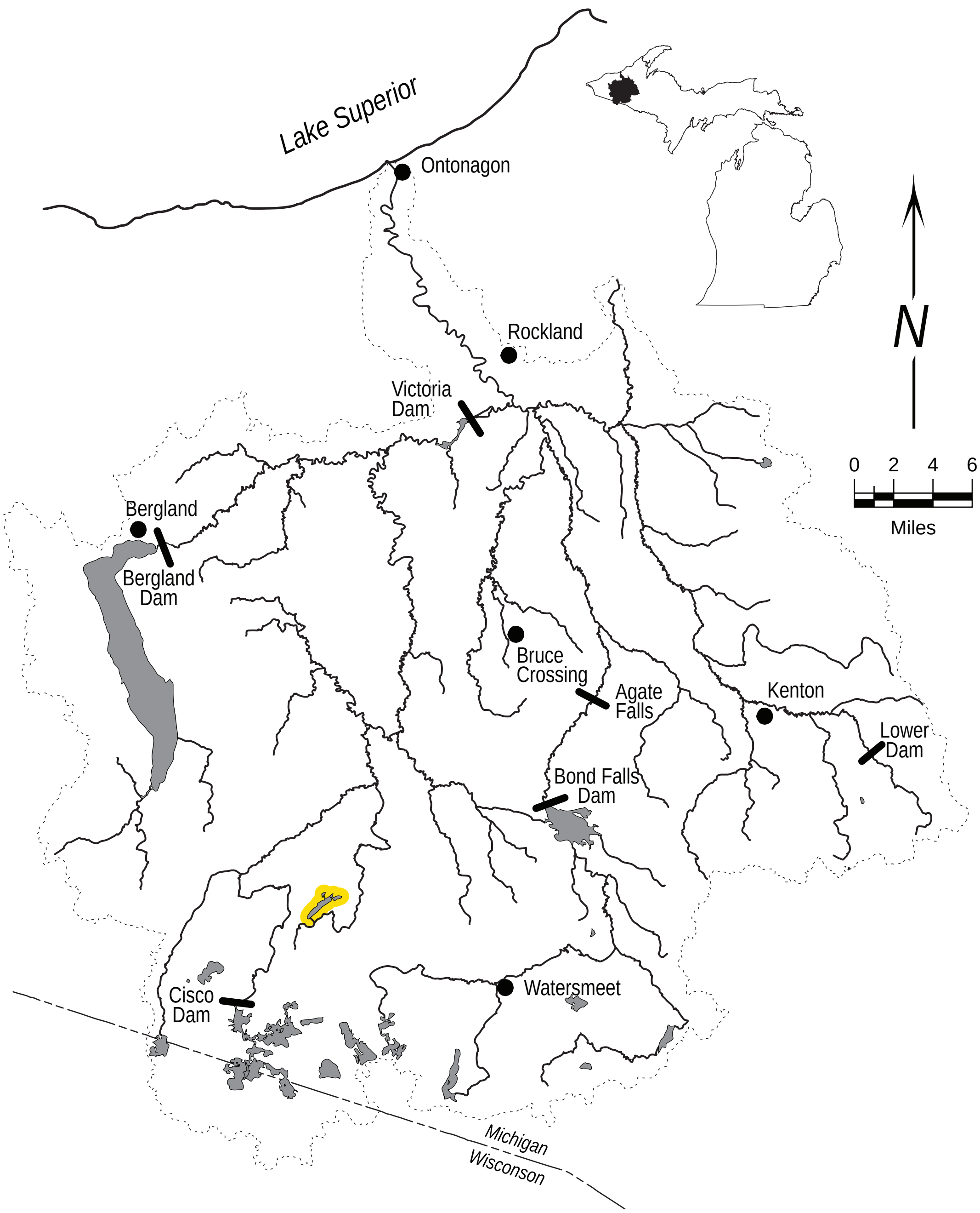
feeding - deep cool lakes, preferably oligotrophic
spawning - usually in lakes
- 3 to 6 feet of water with no vegetation
- often over gravel or stony substrate



Lake whitefish *Coregonus clupeaformis*

Habitat:

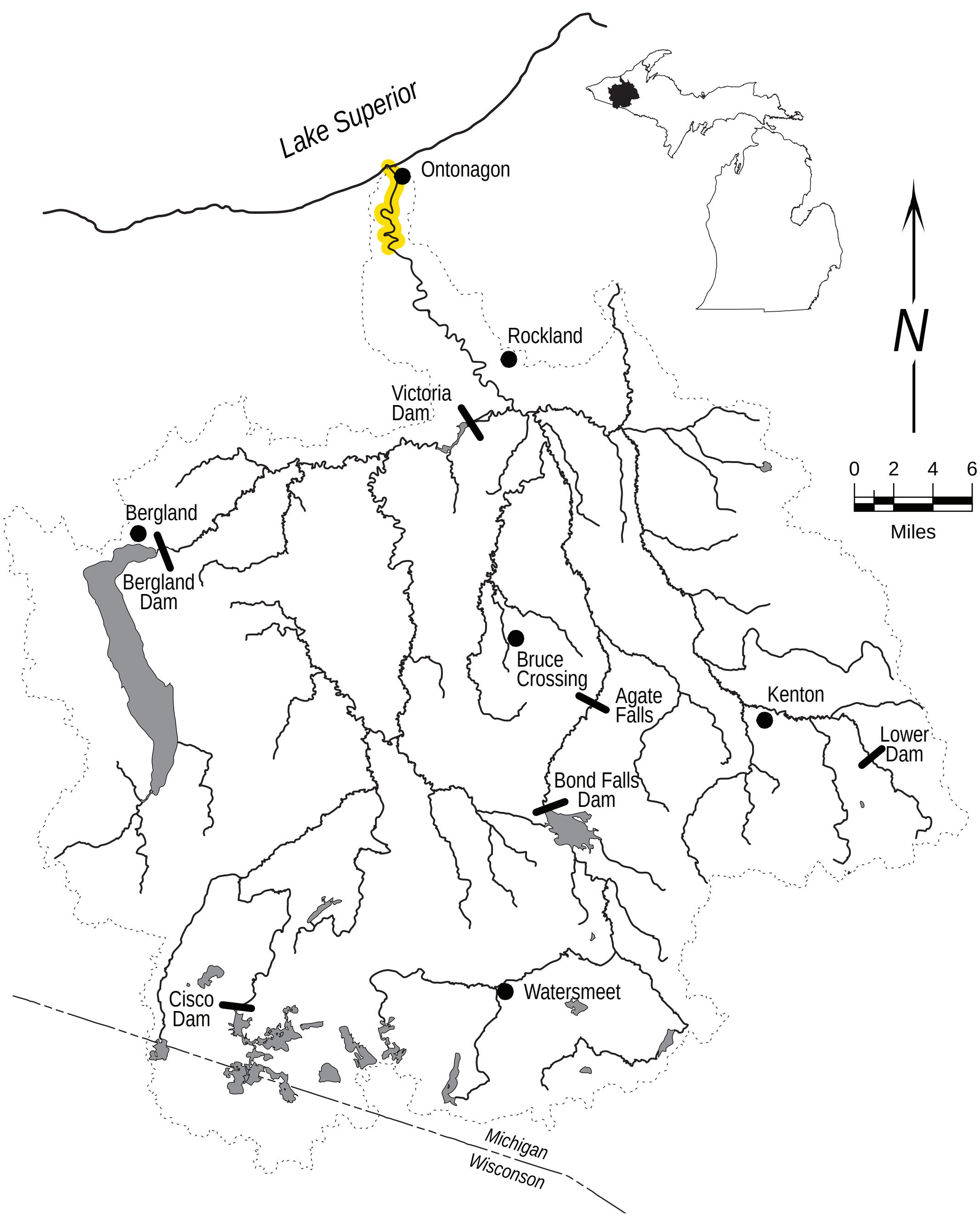
feeding - shallow water (for coregonids; 55-105 ft.)
spawning - cold shallow water (<25 ft.)
- hard, stony, or sand substrate



Pink salmon *Oncorhynchus gorbuscha*

Habitat:

feeding - large cold deep lakes - Lake Superior
spawning - gravel substrate in rivers
- female prepares and guards nest until death

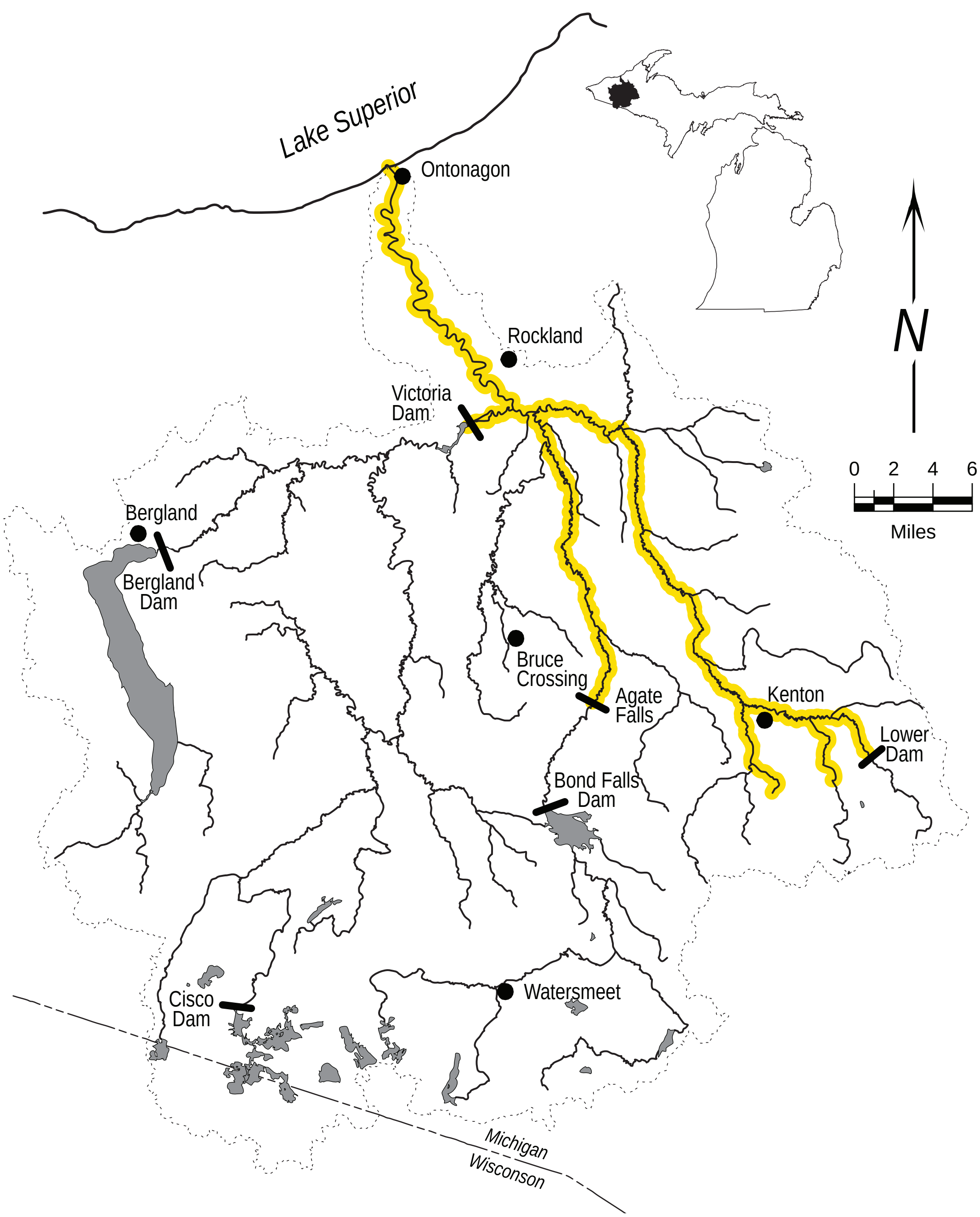


Coho salmon *Oncorhynchus kisutch*

Habitat**:**

feeding - adults: Lake Superior
- young: shallow gravel substrate in cold streams, later into pools

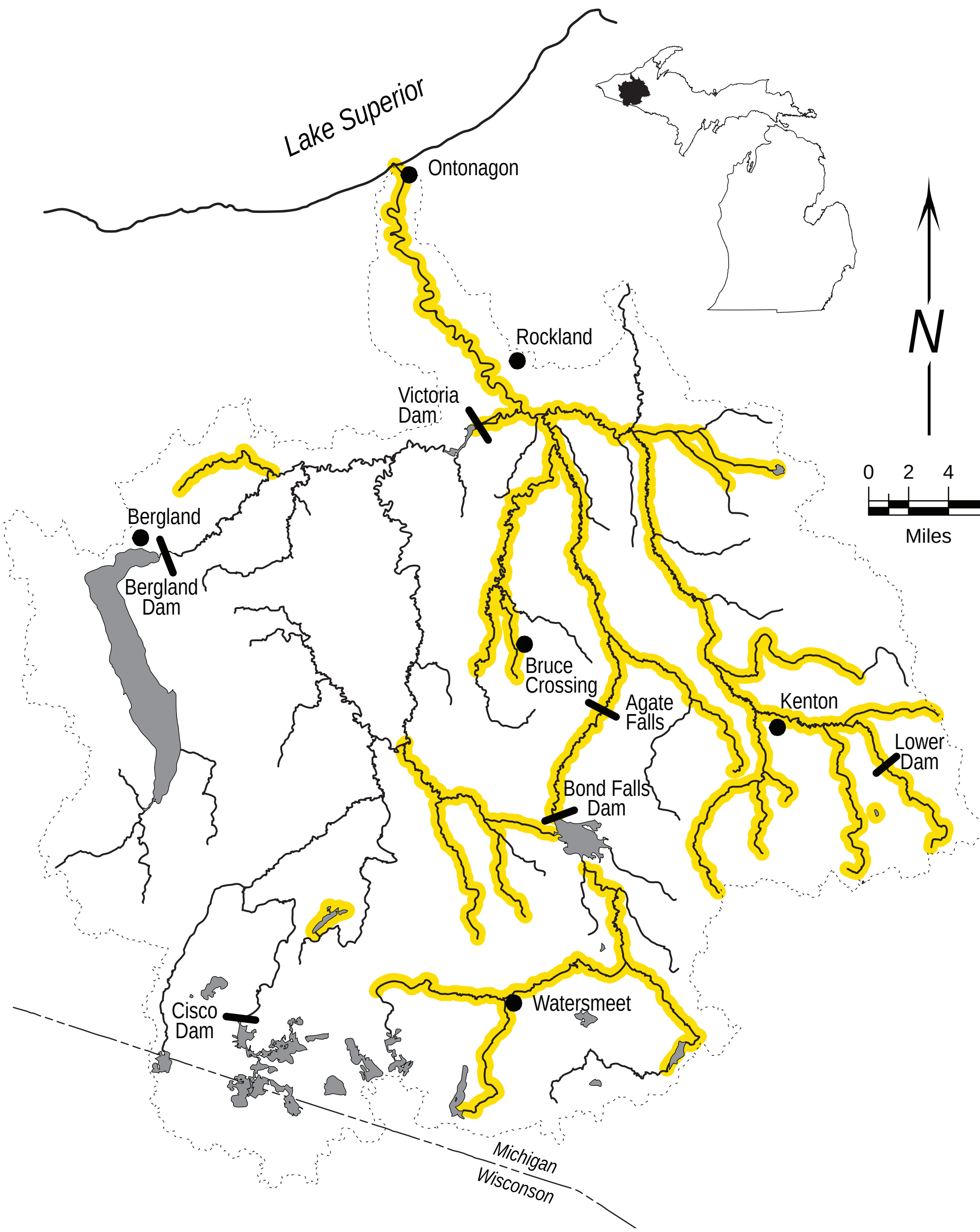
spawning - cold streams and rivers
- swifter water of shallow gravelly substrate



Rainbow trout *Oncorhynchus mykiss*

Habitat**:**

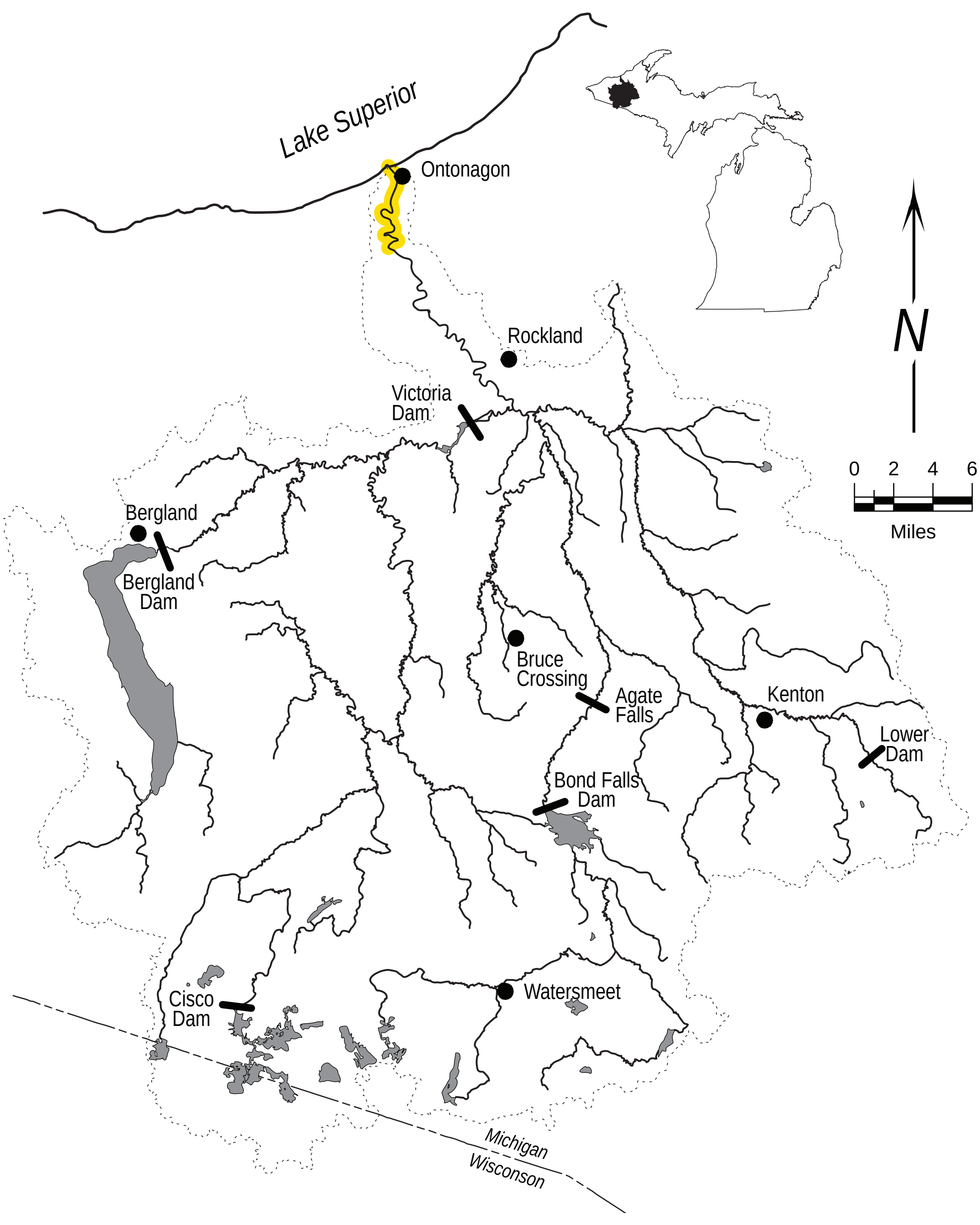
feeding	-	cold clear water of rivers and Lake Superior
	-	moderate current
spawning	-	gravelly riffles above a pool
	-	smaller tributaries



Chinook salmon *Oncorhynchus tshawytscha*

Habitat**:**

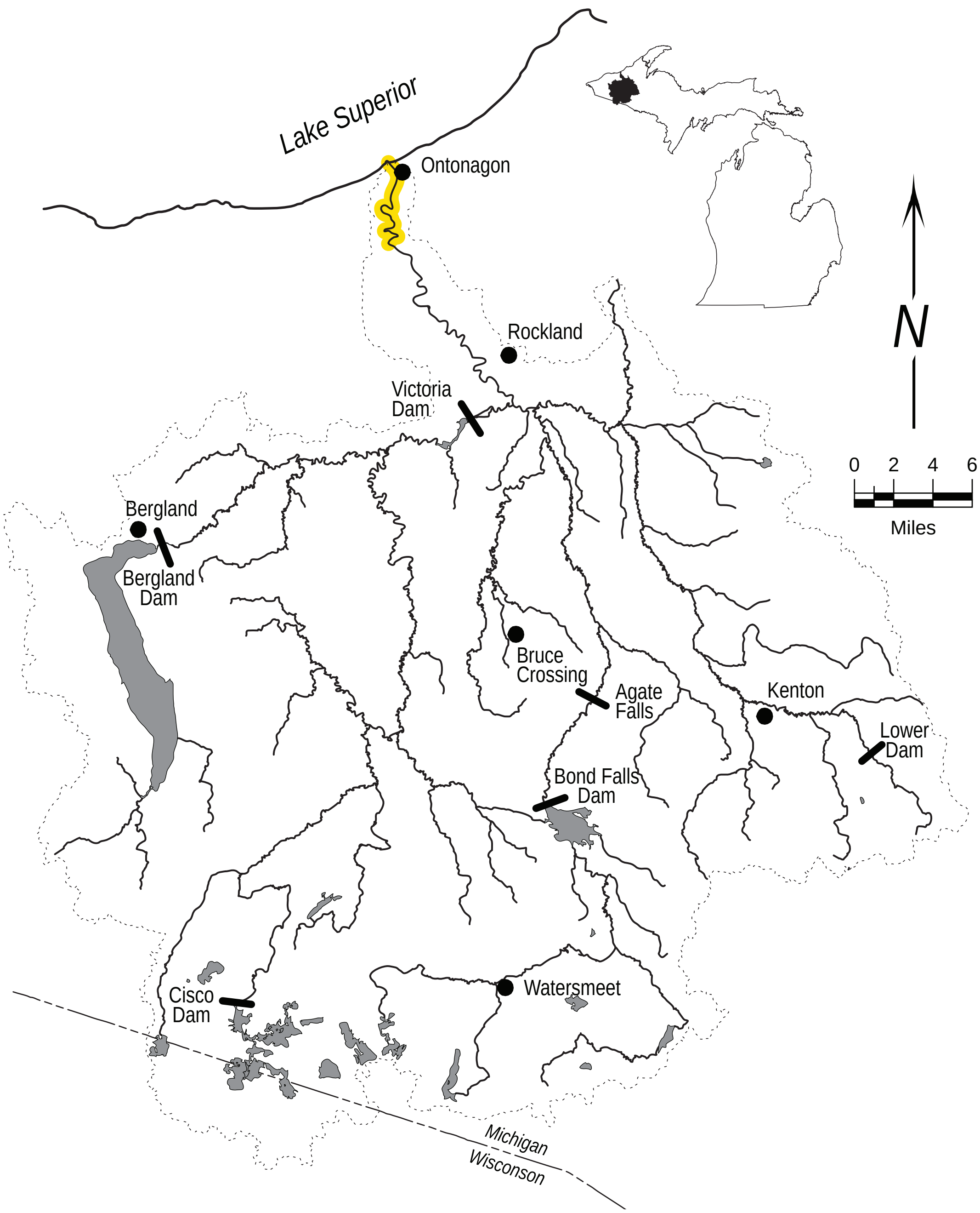
feeding	-	adults: Lake Superior
	-	young: shallow gravel substrate in cool streams, later into pools
spawning	-	gravelly substrate in cool streams



Round whitefish *Prosopium cylindraceum*

Habitat:

feeding - lakes, rivers, and streams
spawning - shallows of lakes and rivers
- gravel or rock substrate

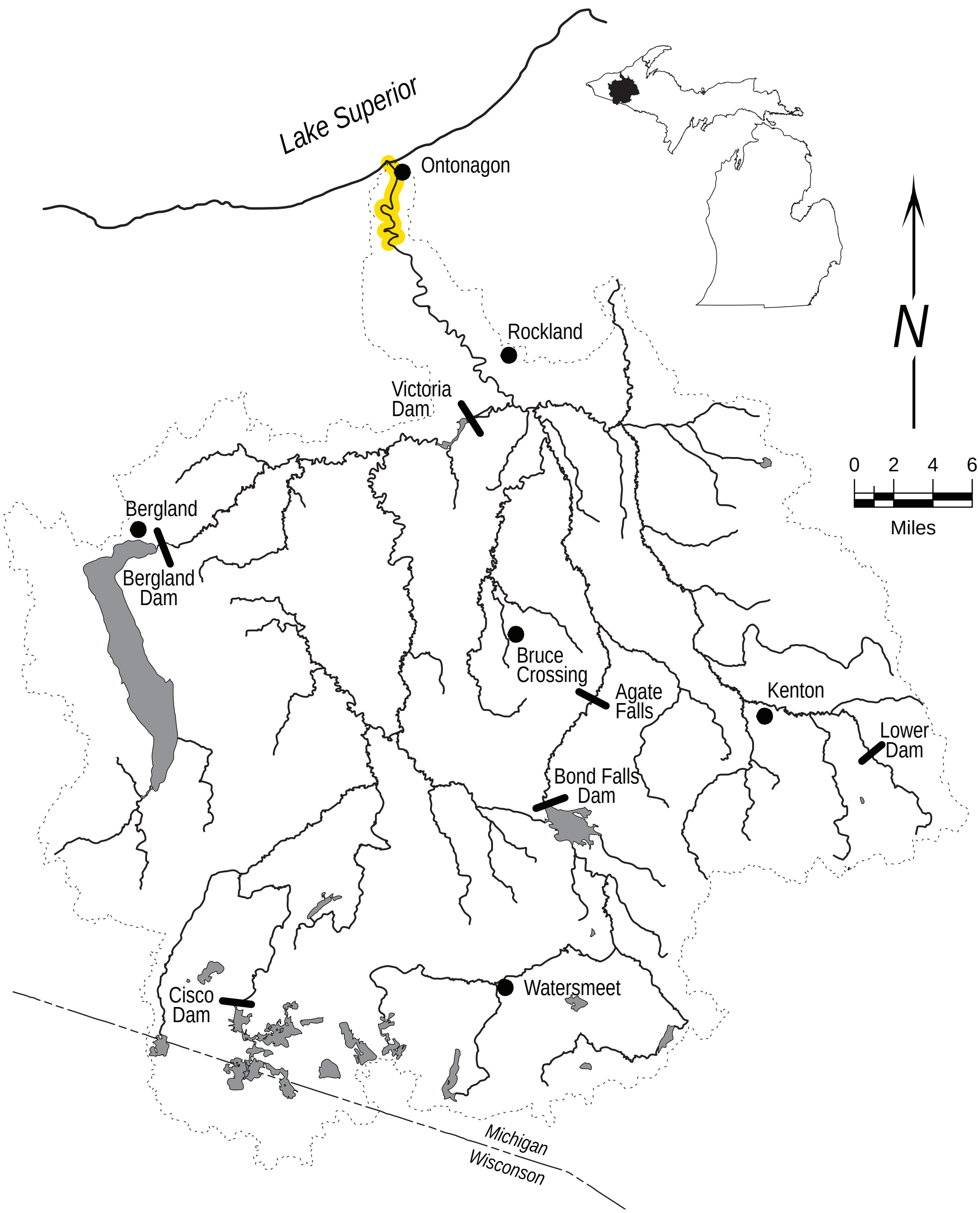


Atlantic salmon *Salmo salar*

Habitat:

feeding - young: gravel substrate streams
- adults: Lake Superior

spawning - streams and rivers
- nests in gravel substrate
- swift current

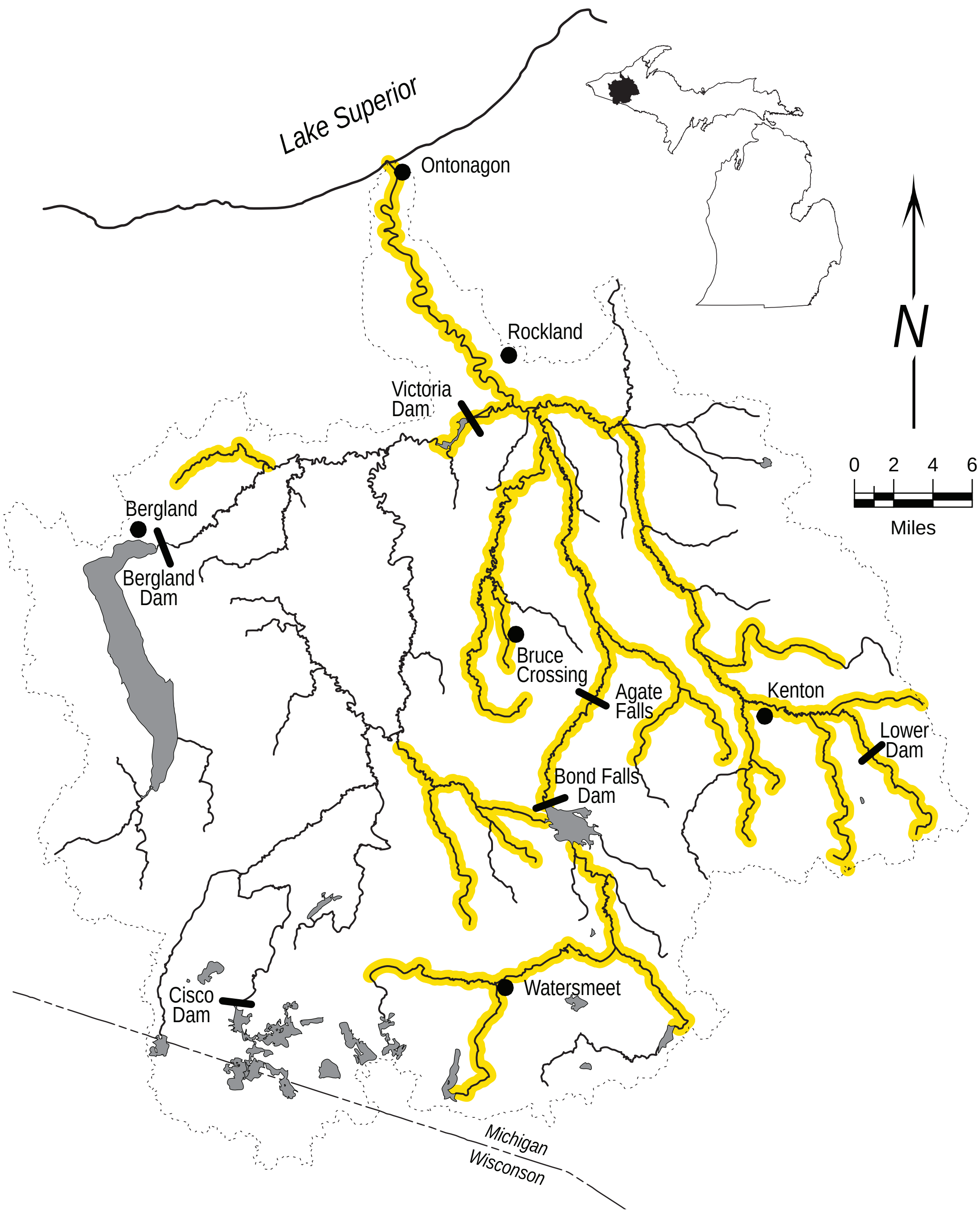


Brown trout *Salmo trutta*

Habitat**:**

feeding - cold, clear streams, rivers, and lakes (not >70°F)
- medium to swift current in streams
- does not tolerate silt well
- prefers few individuals and species around
- abundance of aquatic and land insects

spawning - gravelly riffles; shallow headwater areas

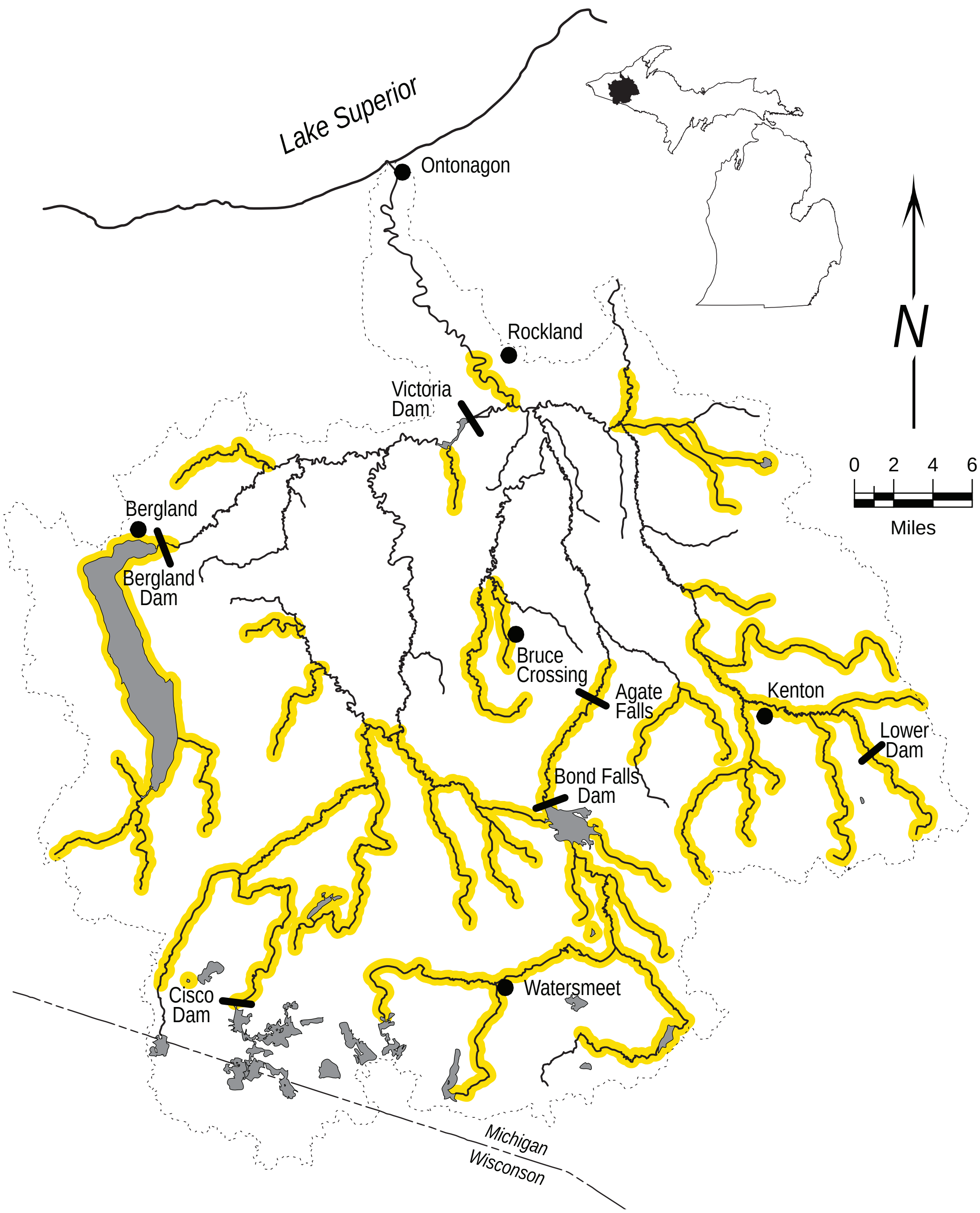


Brook trout *Salvelinus fontinalis*

Habitat**:**

feeding - cold, clear streams, rivers, and lakes (not >65°F)
- low current
- well oxygenated water

spawning - gravelly riffles; shallow or headwater streams

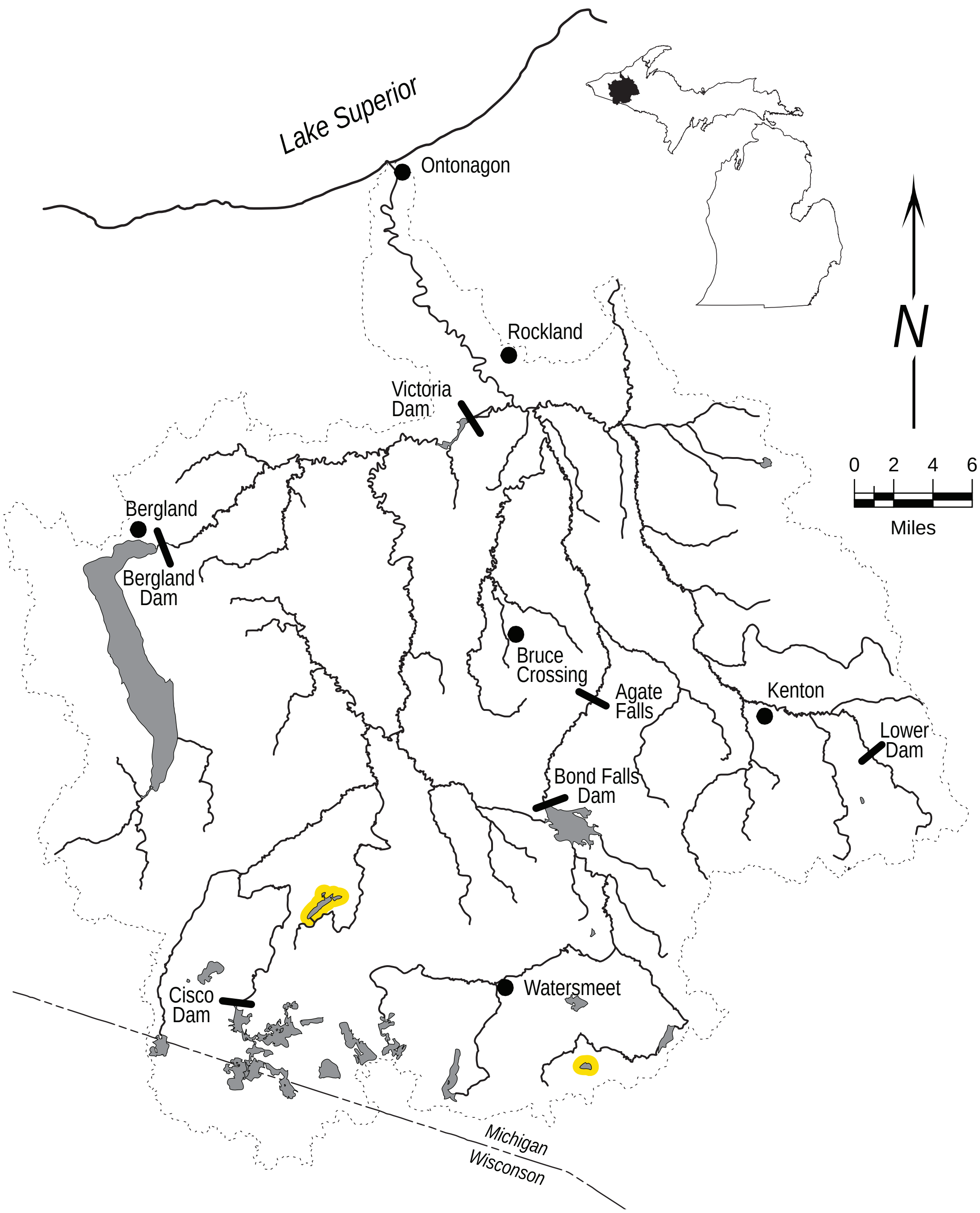


Splake *Salvelinus fontinalis x Salvelinus namaycush*

Habitat:

feeding - littoral habitat
- cool water lakes; also Lake Superior

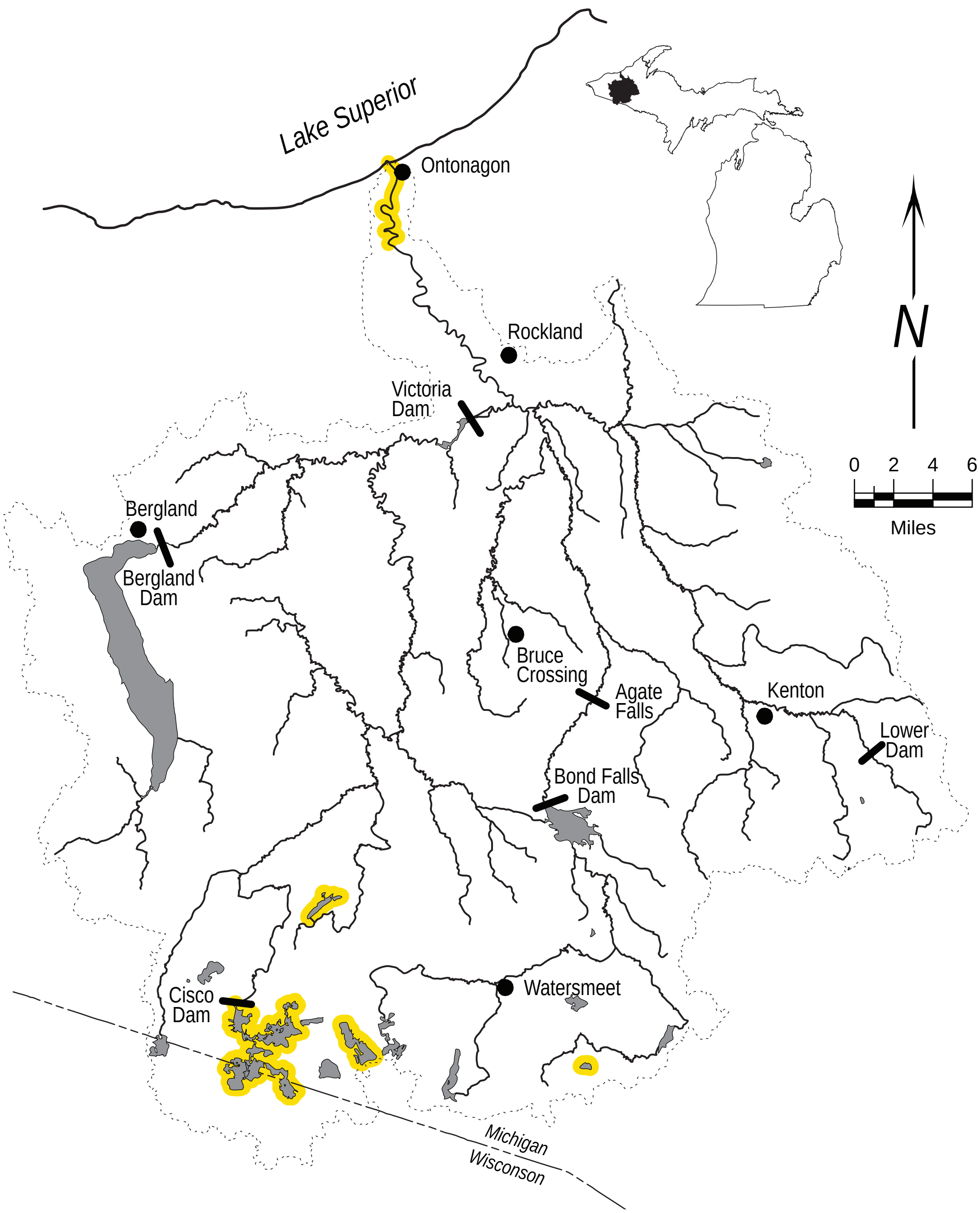
spawning - hatchery produced cross of brook and lake trout
- offspring usually fertile, but with lower fecundity than either parent species



Lake trout *Salvelinus namaycush*

Habitat:

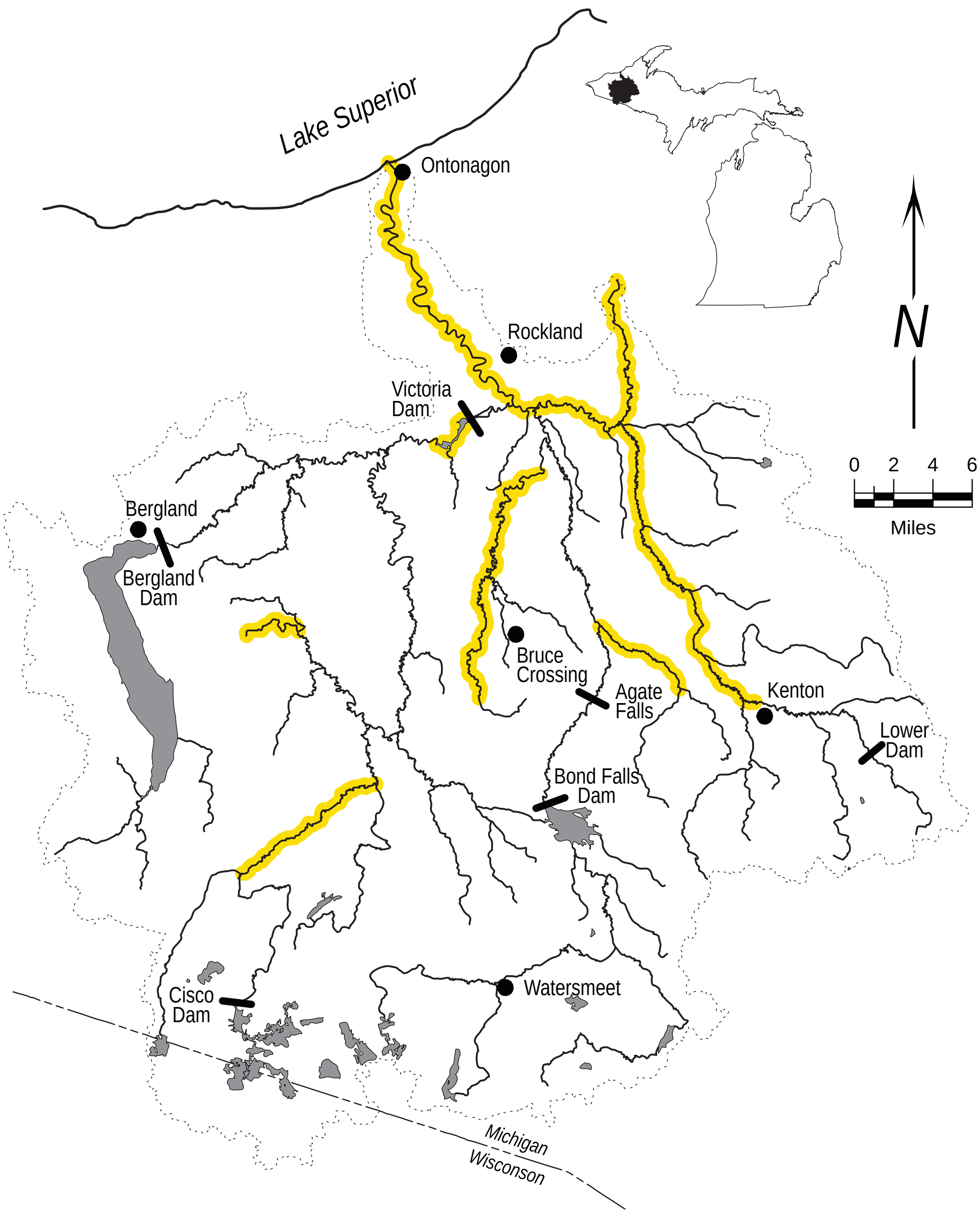
feeding - cold lakes and rivers
spawning - large boulder or rubble substrate
- shallow water of lakes and rivers



Trout-perch *Percopsis omiscomaycus*

Habitat**:**

feeding	-	clean sand or fine gravel substrate
	-	long deep pools in low gradient streams and Lake Superior
	-	highly intolerant of clayey silts
	-	avoids rooted aquatic vegetation
spawning	-	over rocks in shallows
	-	over sand and gravel substrates in Lake Superior

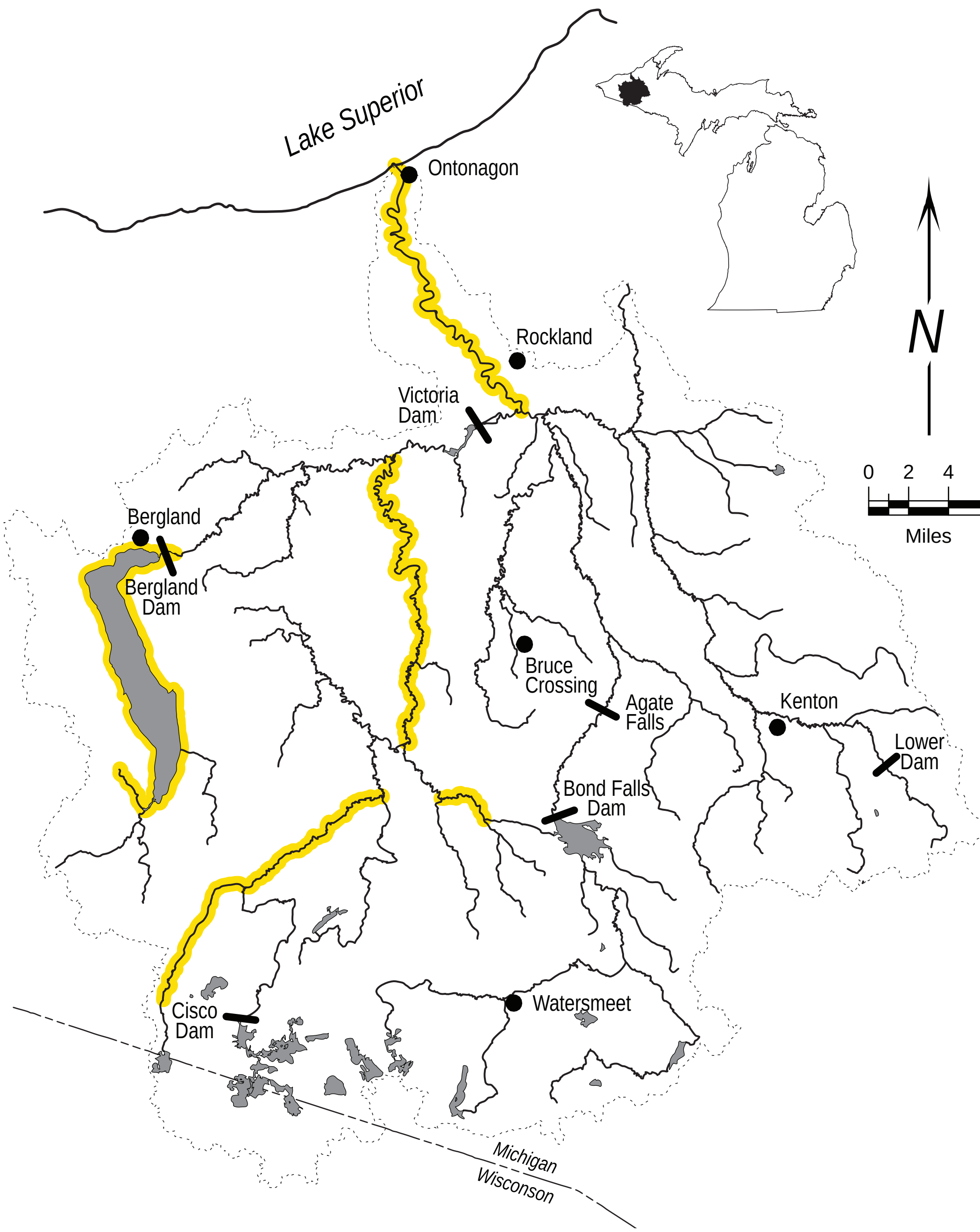


Burbot *Lota lota*

Habitat:

feeding - deep cold lakes and large cool rivers
- mud, sand, rubble, boulder, silt, and gravel substrates

spawning - in 1 to 4 feet of water in shallow bays or on shoals 5-10 feet deep usually in lakes, sometimes rivers
- over sand or gravel substrate
- under ice

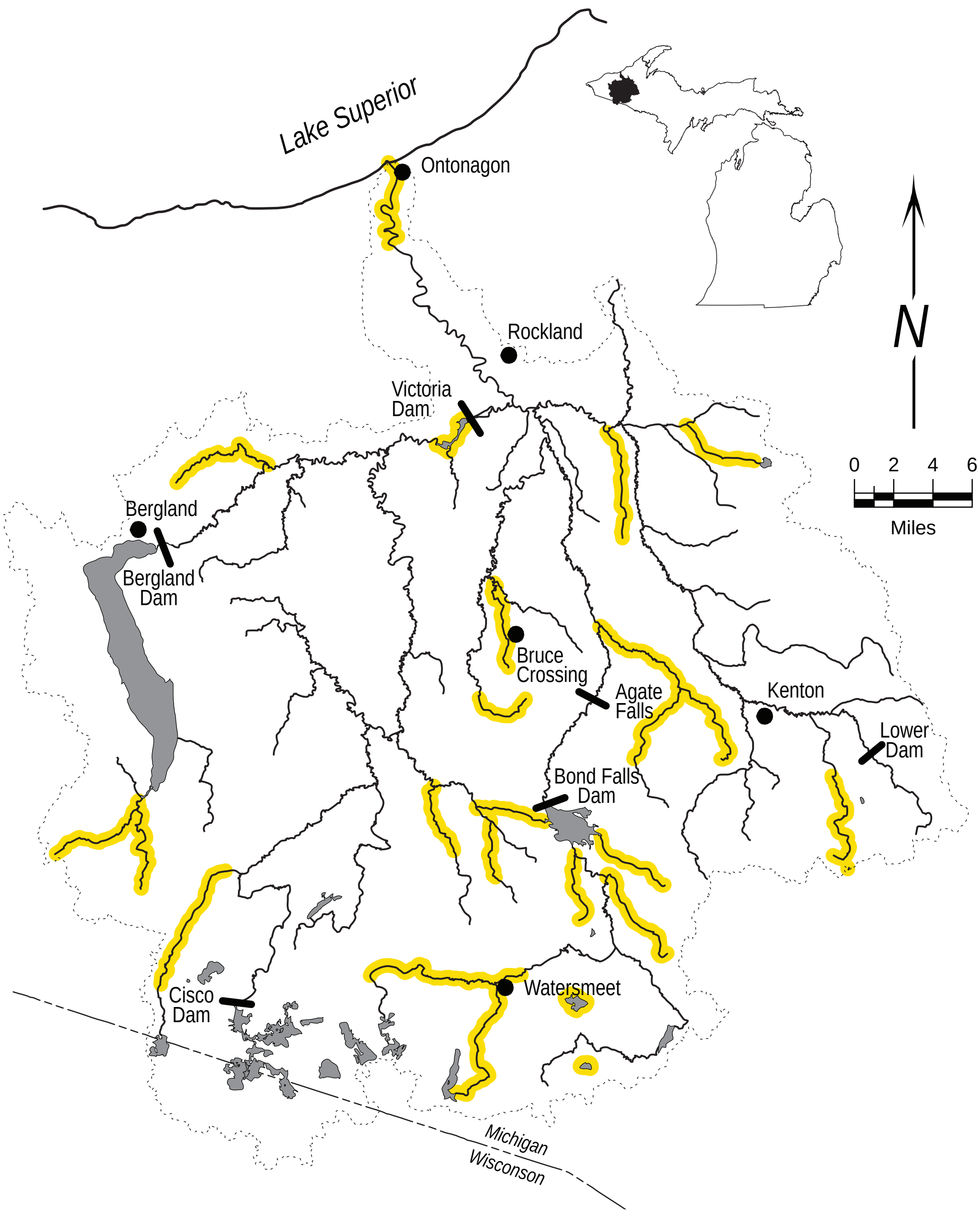


Brook stickleback *Culaea inconstans*

Habitat:

feeding
- clear, cold, densely vegetated streams, and swampy margins of lakes
- low gradient
- muck, peat, or marl substrate
- not tolerant of turbidity

spawning
- shallow cool (<66°F) water
- aquatic reeds or grasses necessary

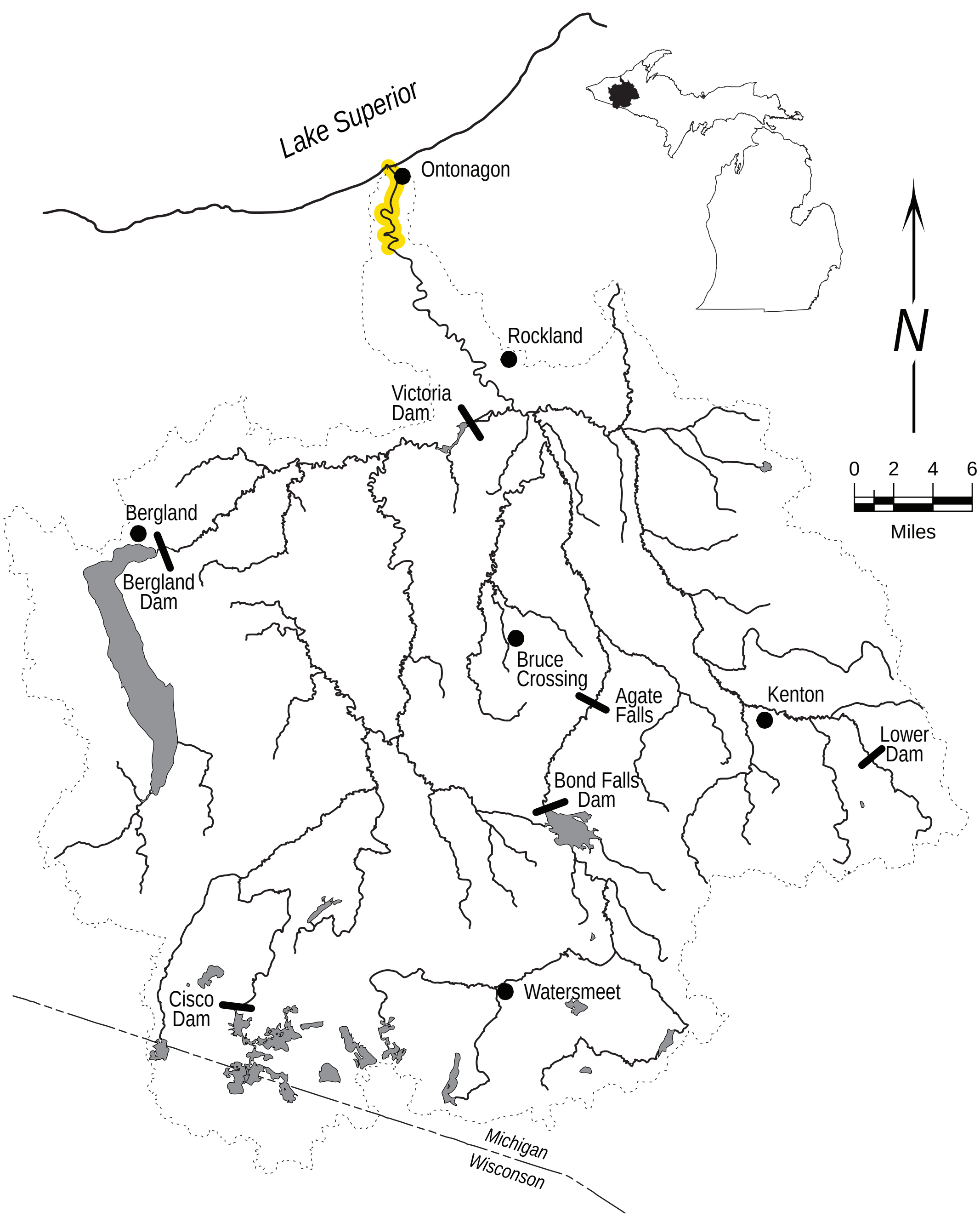


Ninespine stickleback *Pungitius pungitius*

Habitat:

feeding - open water of lakes; also Lake Superior
- cool quiet waters

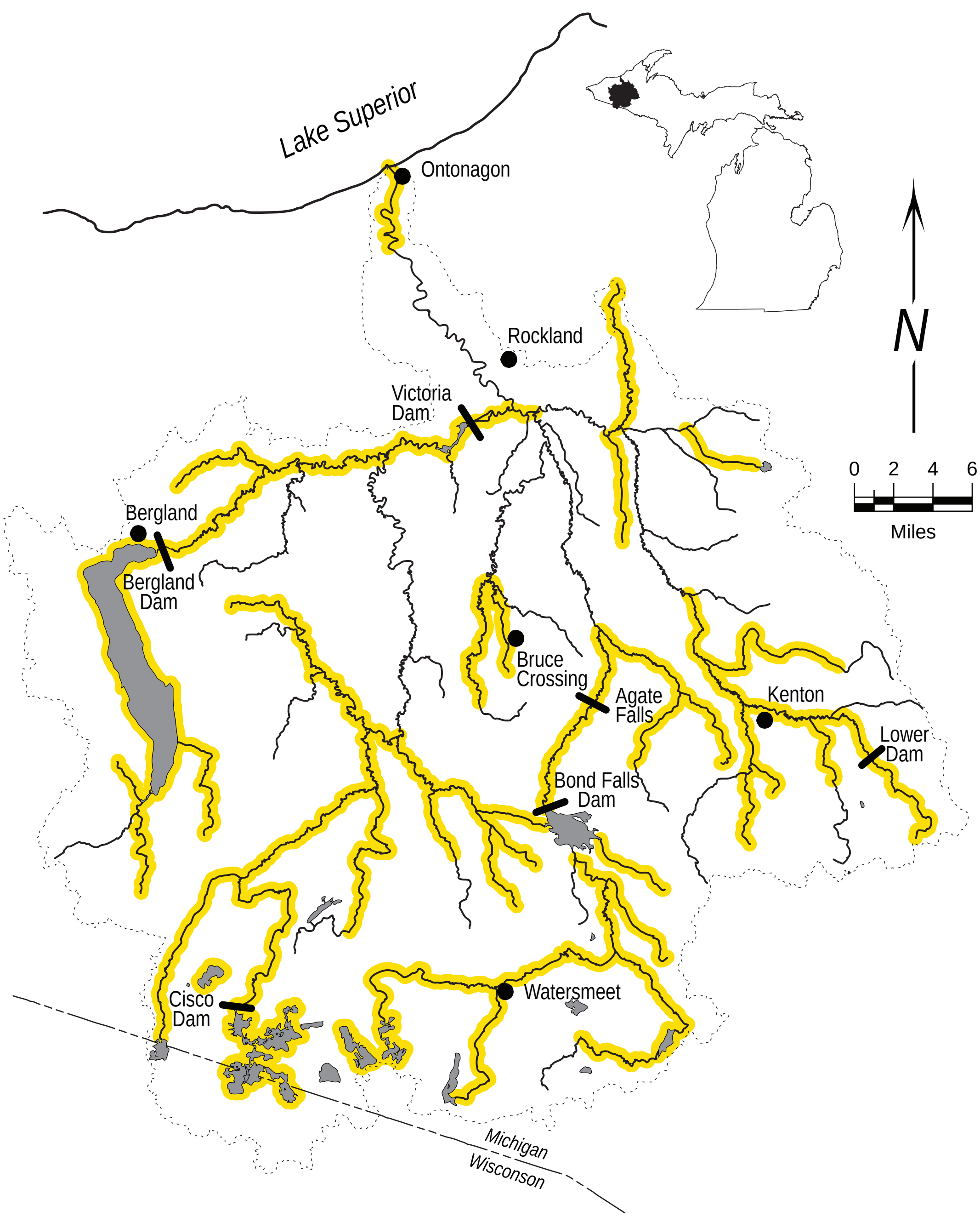
spawning - builds nests among aquatic vegetation in creeks and streams



Mottled sculpin *Cottus bairdii*

Habitat**:**

feeding	-	cool to cold streams
	-	riffle and rock substrates preferred
	-	clear to slightly turbid shallow water
spawning	-	nests under logs or rock

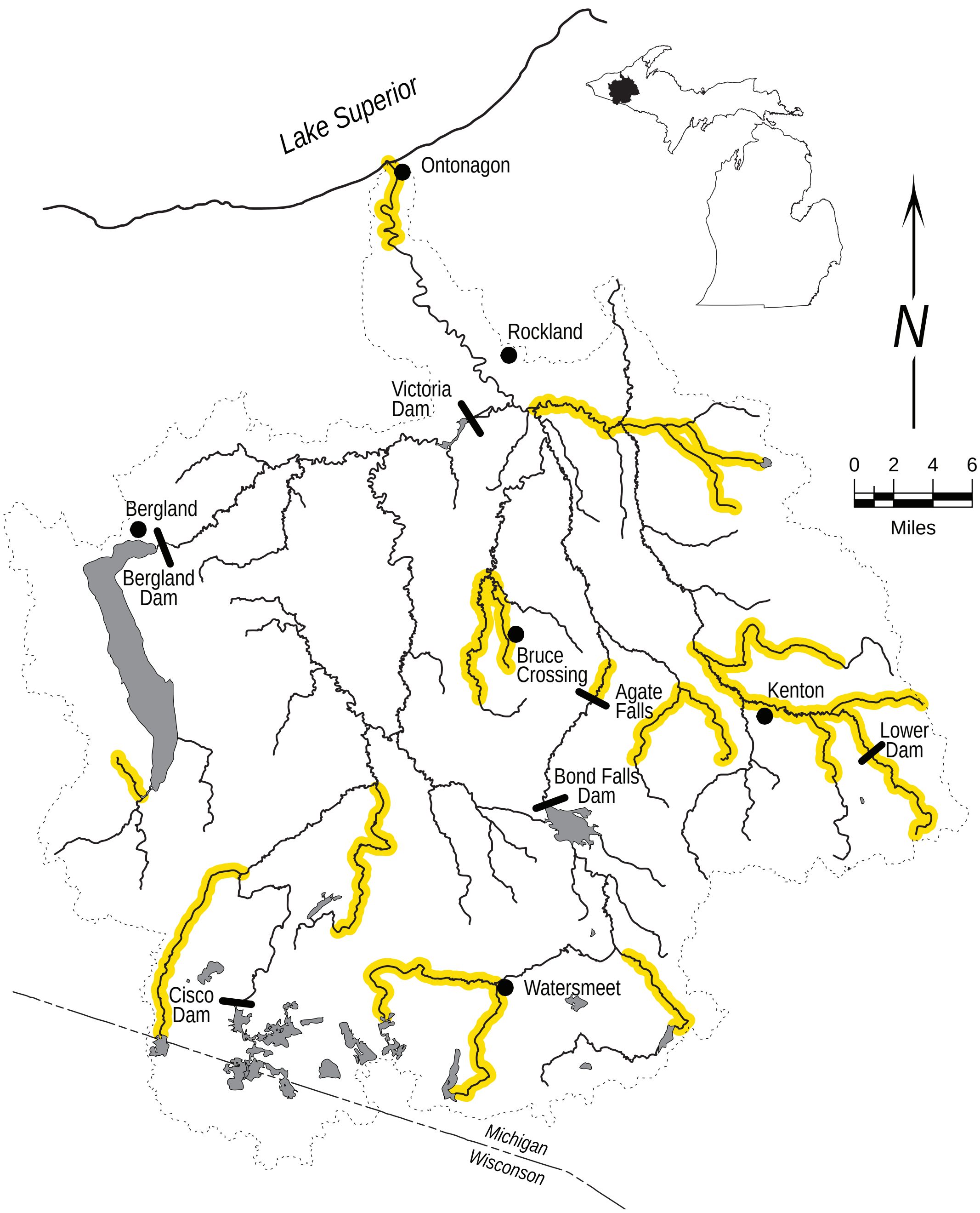


Slimy sculpin *Cottus cognatus*

Habitat:

feeding - cool lakes, impoundments, rivers, and streams
- gravel or rock substrate

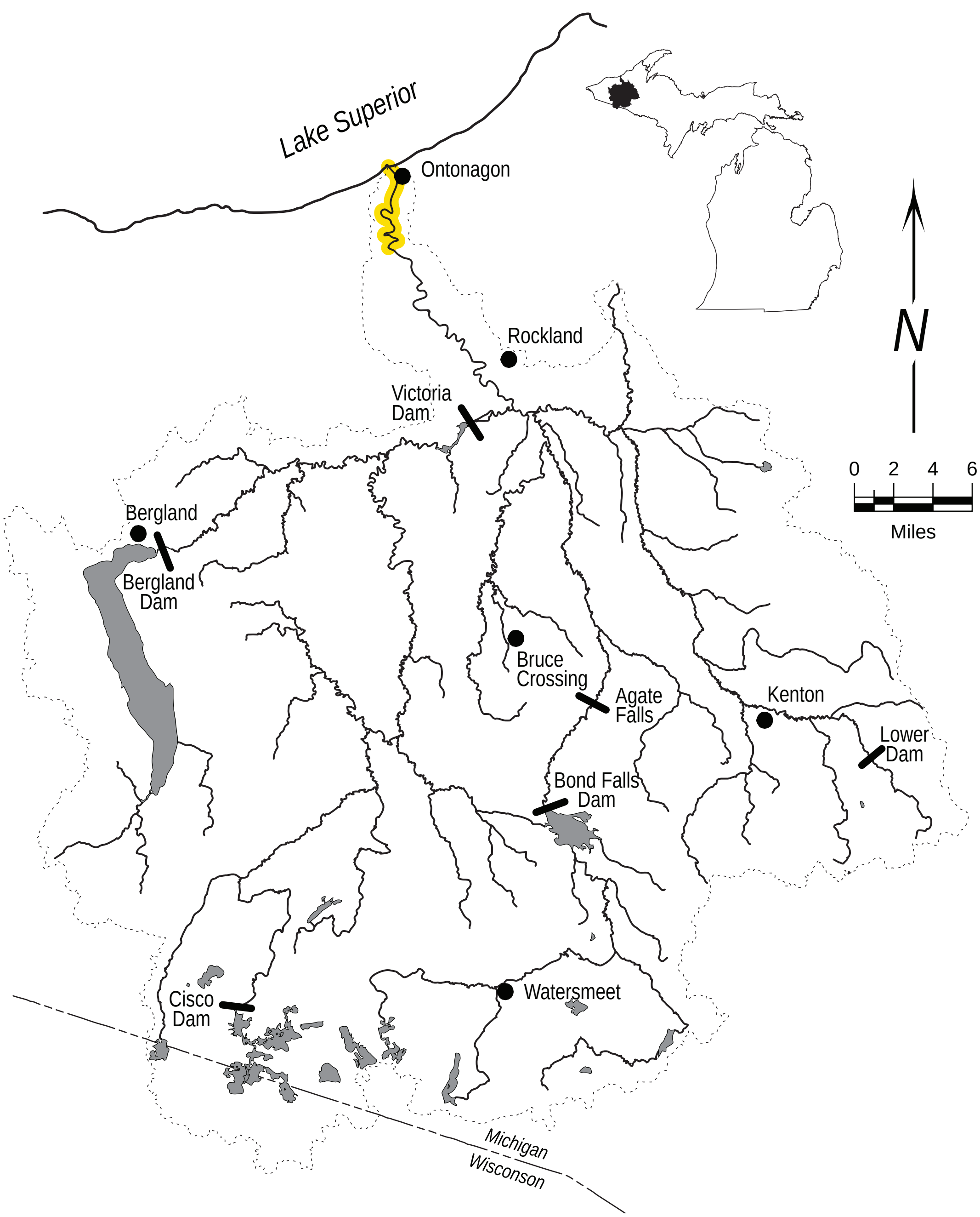
spawning - nest in shallow areas of lakes
- gravel substrate or rock ledge
- male parental care



Spoonhead sculpin *Cottus ricei* **– special concern**

Habitat:

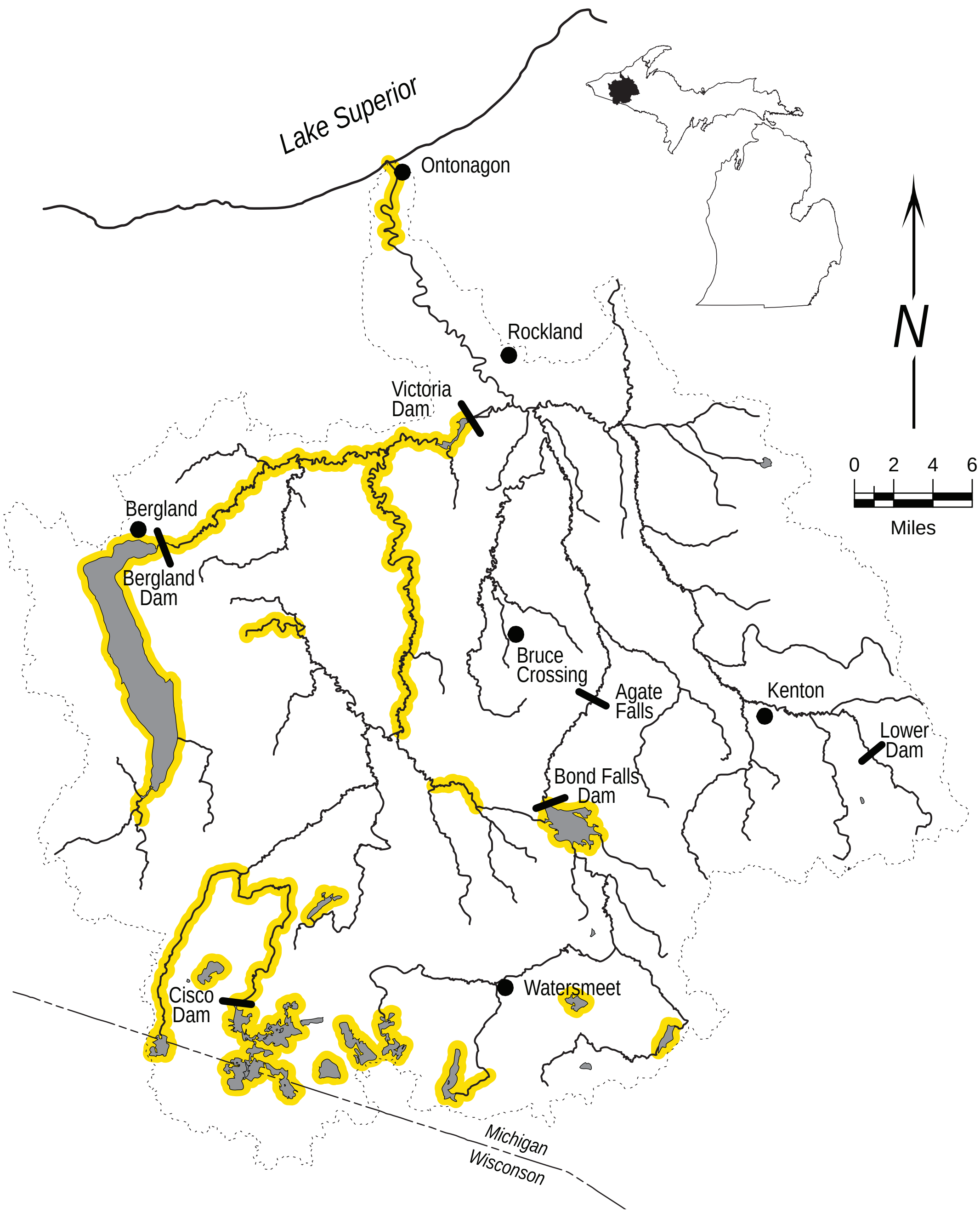
feeding - moderately deep water in Great Lakes;
- larger rivers and swift streams also in turbid water



Rock bass *Ambloplites rupestris*

Habitat**:**

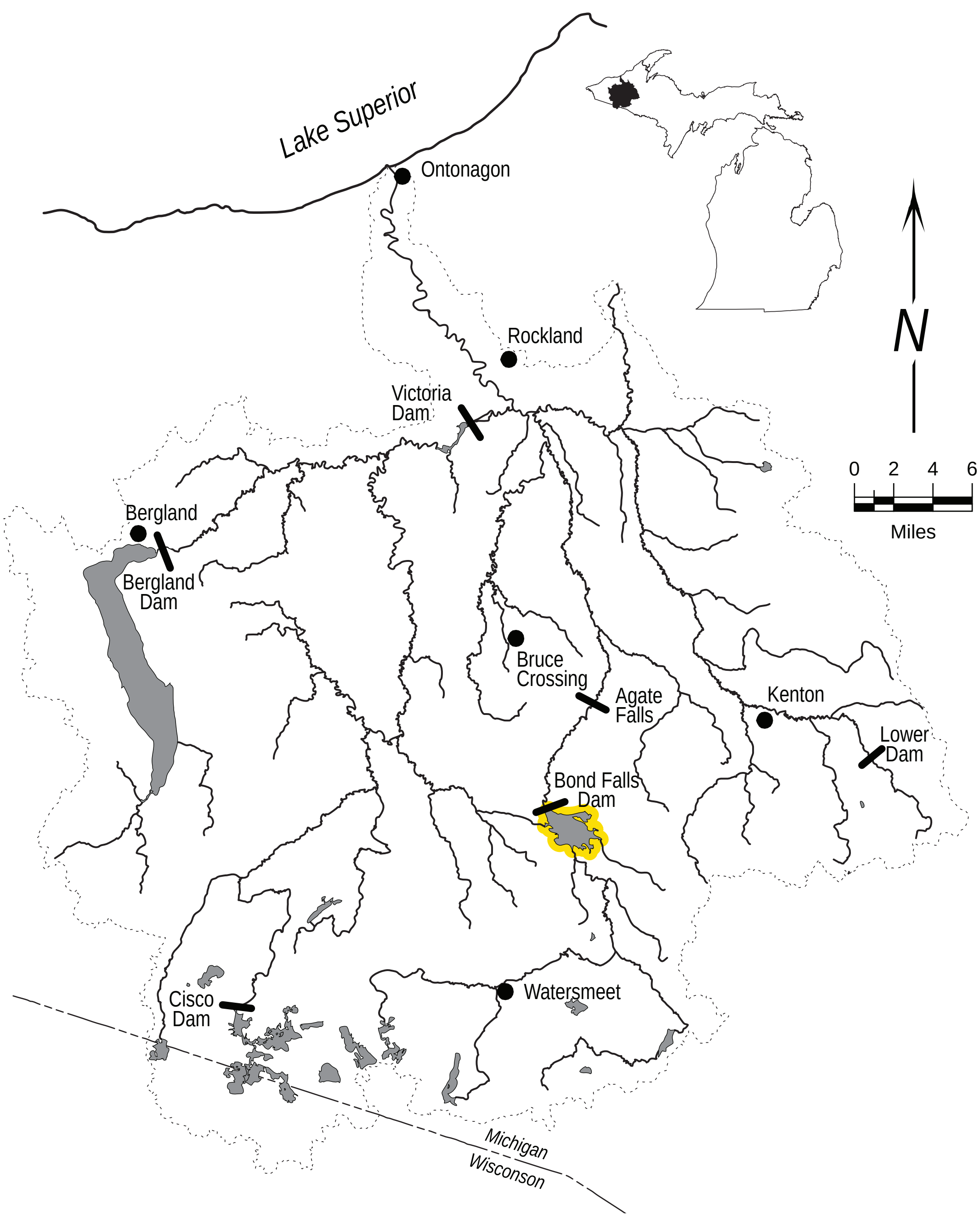
feeding	-	clear, cool streams, rivers, and lakes
	-	rocky to sand substrate
	-	woody or vegetative cover
spawning	-	sand or gravel nests
	-	shallow water
winter refuge	-	deep water



Green sunfish *Lepomis cyanellus*

Habitat**:**

feeding	-	impoundments and lakes, and low-current streams and rivers
	-	no substrate preference
spawning	-	nests in shallow areas sheltered by rocks, logs, or aquatic vegetation

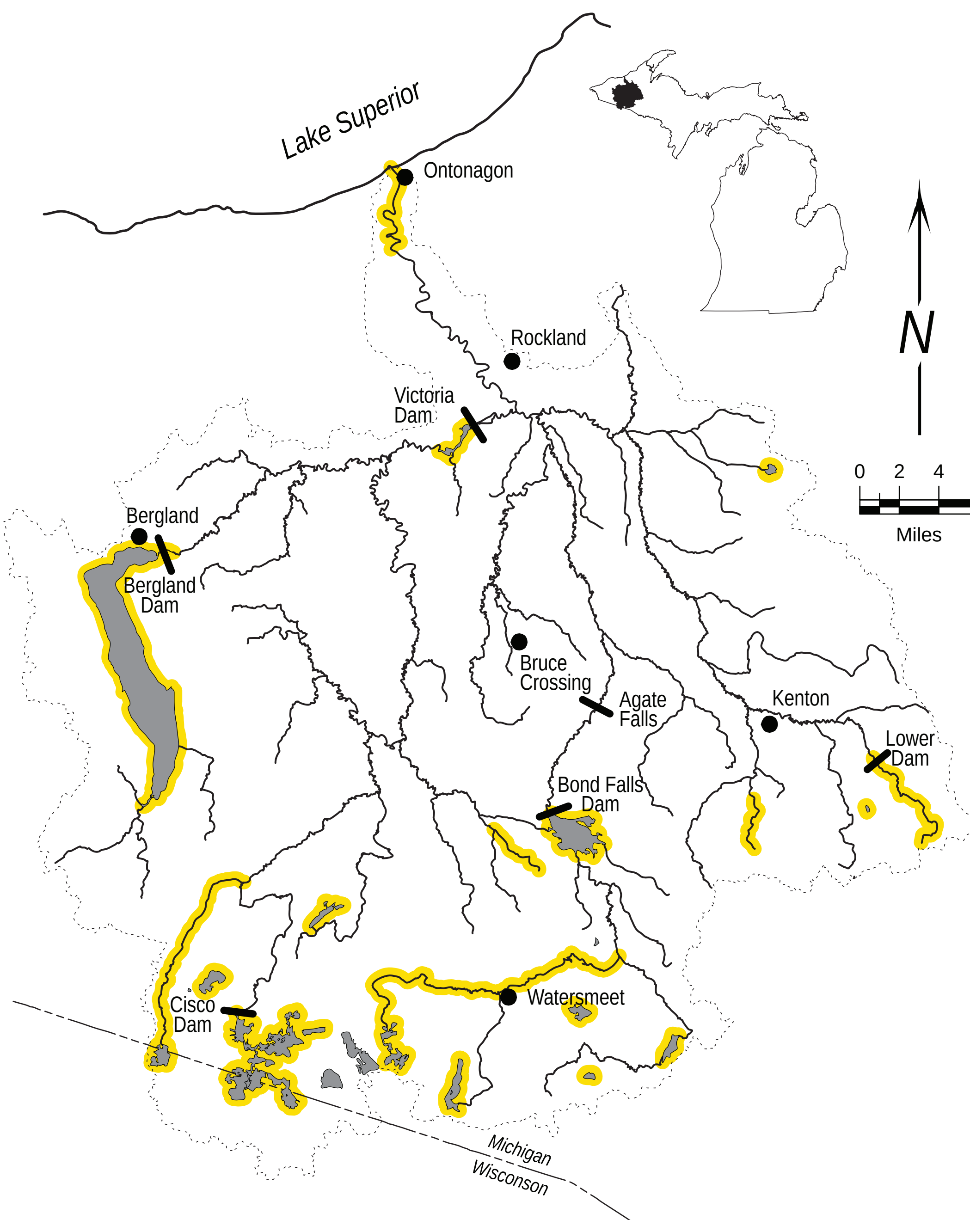


Pumpkinseed *Lepomis gibbosus*

Habitat**:**

feeding - non-flowing clear water in streams and rivers; also lakes and impoundments
- muck or sand partly covered with organic debris substrate
- dense beds of submerged aquatic vegetation

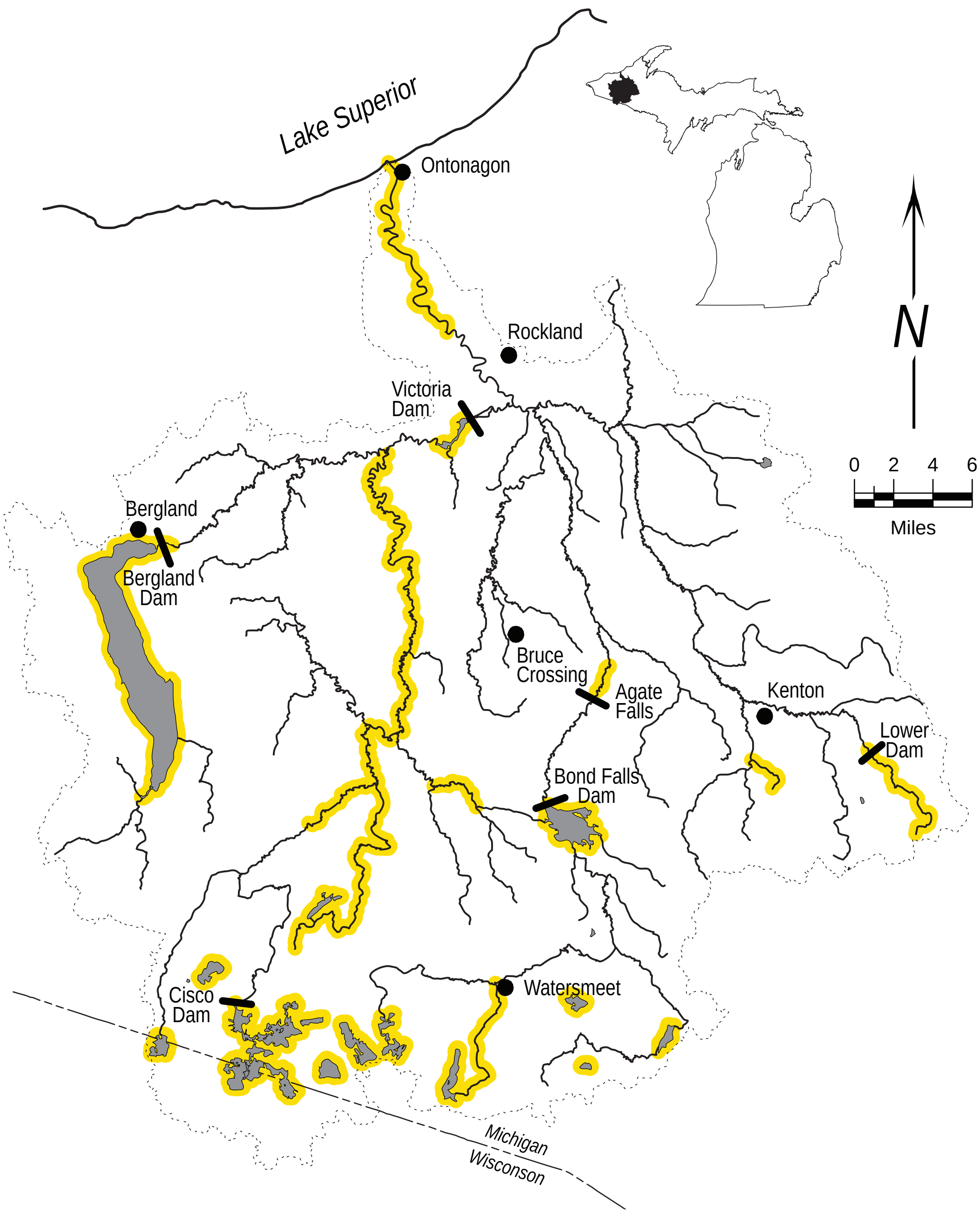
spawning - nest in sand, gravel, or rock substrate
- in shallow water near submerged vegetation



Bluegill *Lepomis macrochirus*

Habitat**:**

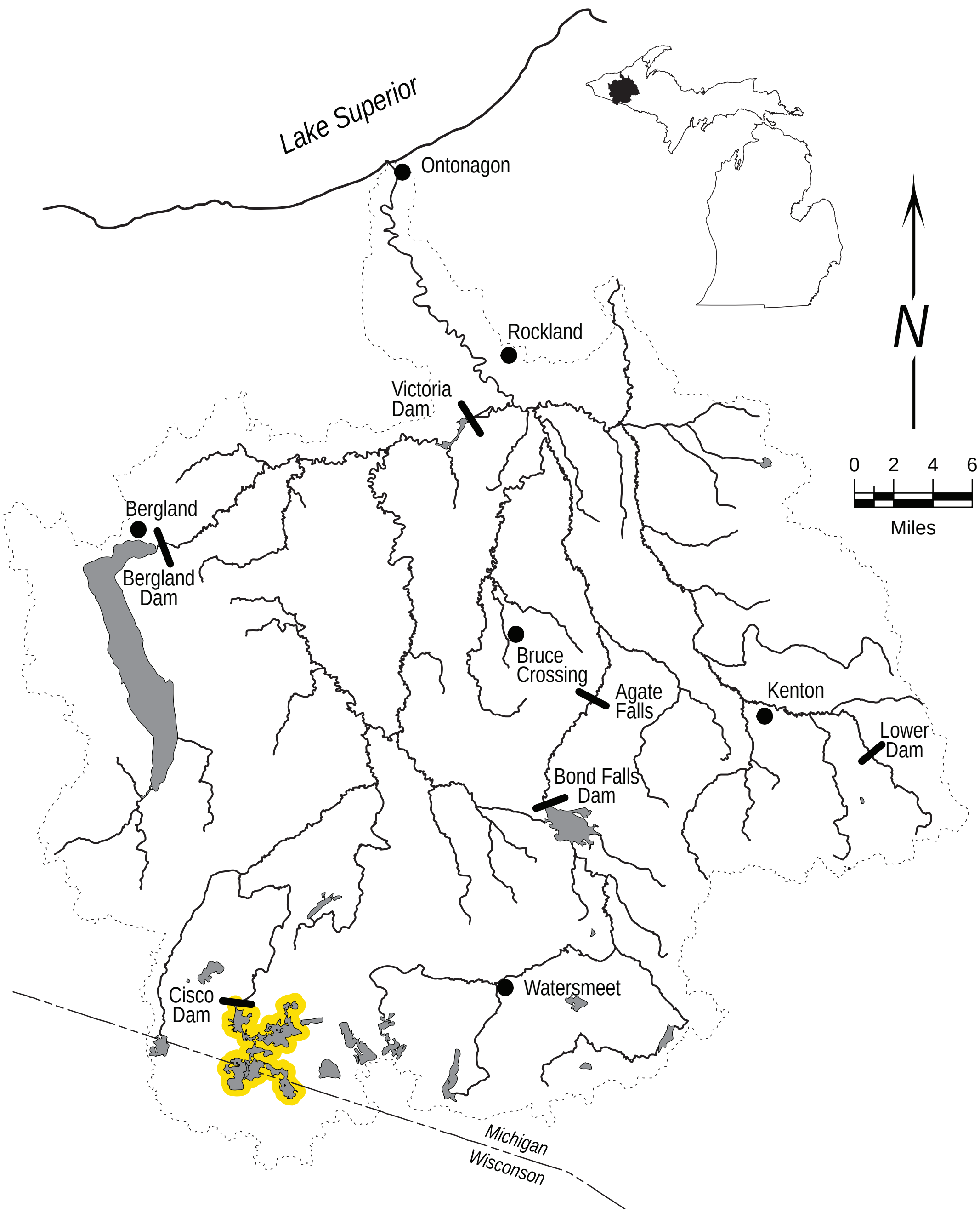
feeding	-	non-flowing clear streams and rivers; also lakes and impoundments
	-	sand, gravel, or muck containing organic debris substrate
	-	scattered beds of aquatic vegetation
	-	cannot tolerate low oxygen or continuous high turbidity and siltation
spawning	-	nests in firm substrate of gravel, sand, or mud
winter refuge	-	deep water



Northern longear sunfish *Lepomis peltastes*

Habitat**:**

feeding	-	clear moderate-sized shallow streams with moderate vegetation
	-	rocky substrates
	-	little to no current
spawning	-	nests in gravel, sand, or hard rock substrate



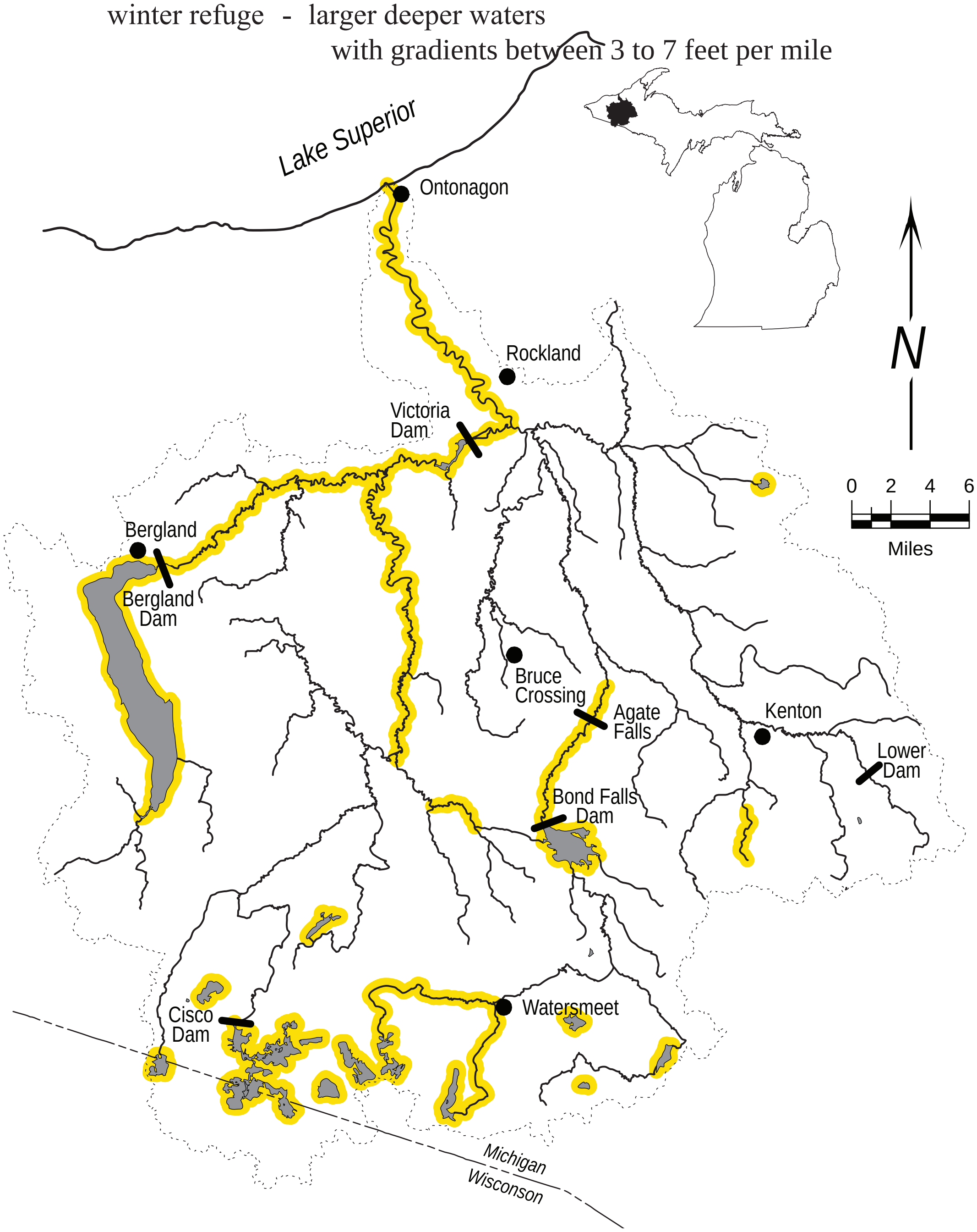
Smallmouth bass *Micropterus dolomieu*

Habitat**:**

feeding - clear, cool, deep lakes and rivers
- streams where 40% consists of riffles over clean gravel, boulder, or bedrock substrate
- in pools with a current and >4 feet of depth
- gradients between 4 and 25 feet per mile

spawning - nest in sandy, gravel, or rocky substrate
- gradients 7 to 25 feet per mile
- streams 20 to 100 feet wide

winter refuge - larger deeper waters with gradients between 3 to 7 feet per mile

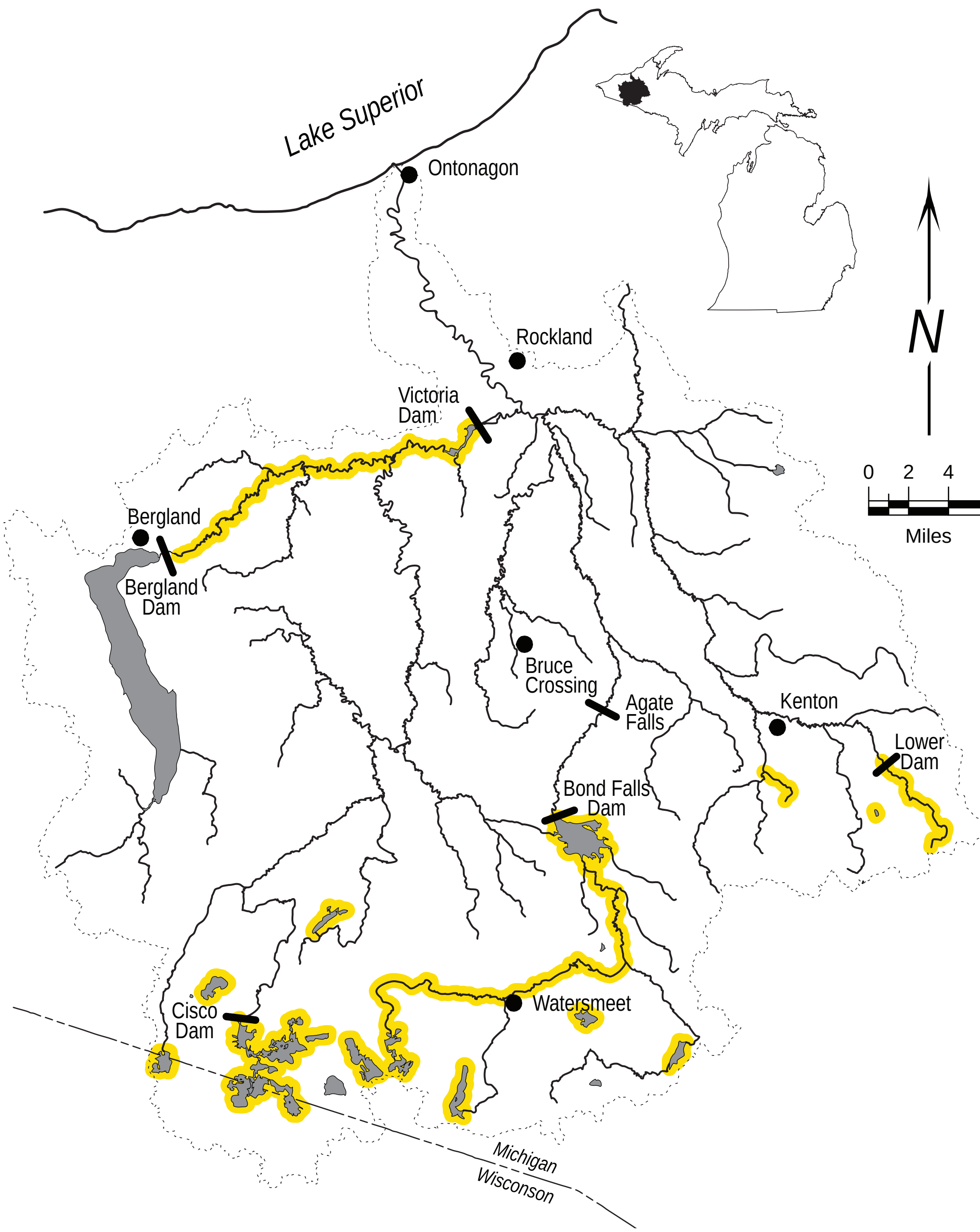


Largemouth bass *Micropterus salmoides*

Habitat**:**

feeding - non-flowing clear waters - lakes, impoundments, and pools of streams
- abundant aquatic vegetation
- soft muck, organic debris, gravel, sand, and hard non-flocculent clay substrates

spawning - nest in gravelly sand to marl and soft mud substrates
- emergent vegetation
- quiet shallow bays; no current

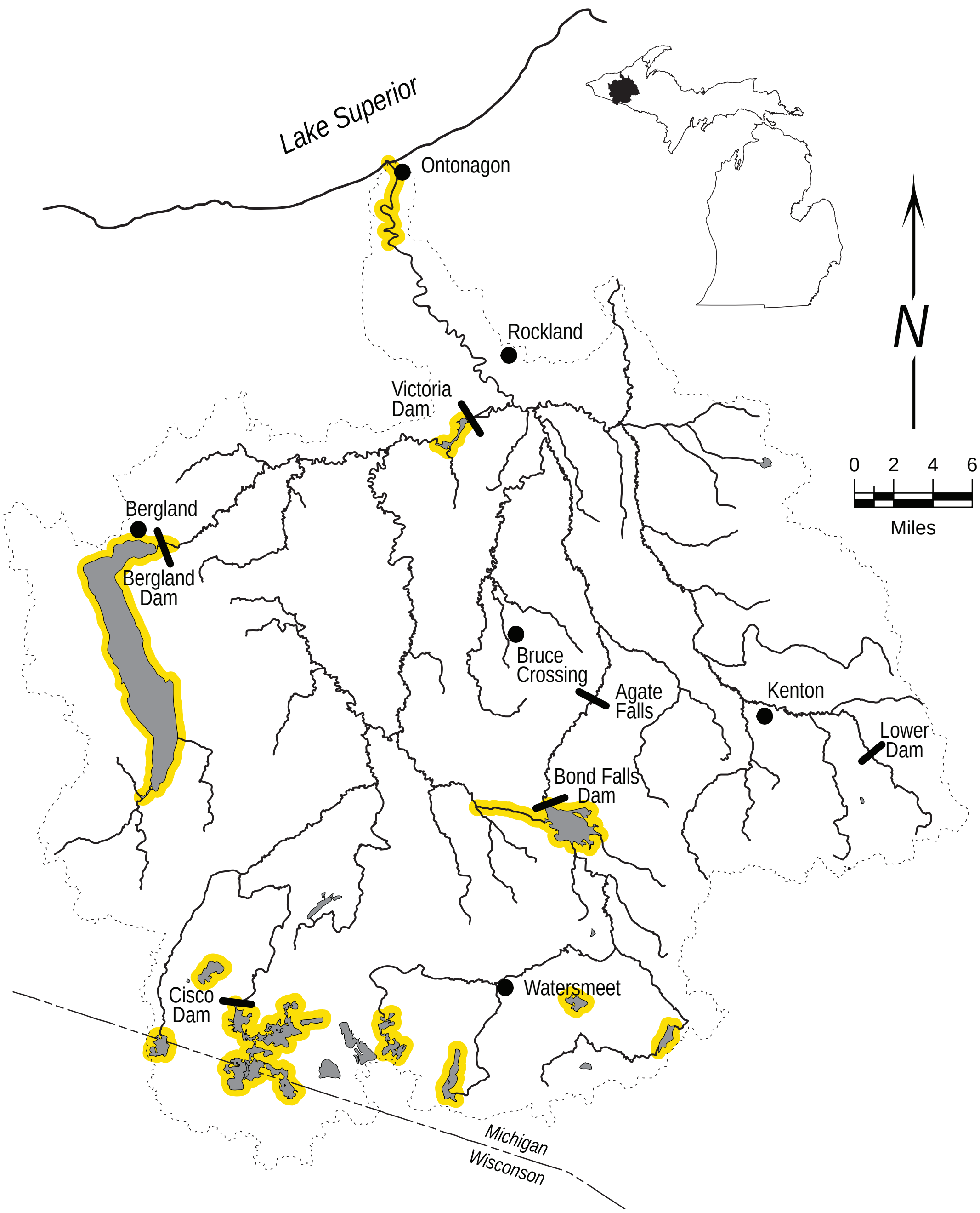


Black crappie *Pomoxis nigromaculatus*

Habitat**:**

feeding - larger clear non-silty low-gradient rivers; also in lakes and impoundments
- clean hard sand or muck substrate
- associated with submerged aquatic vegetation
- does not tolerate silt or turbidity well

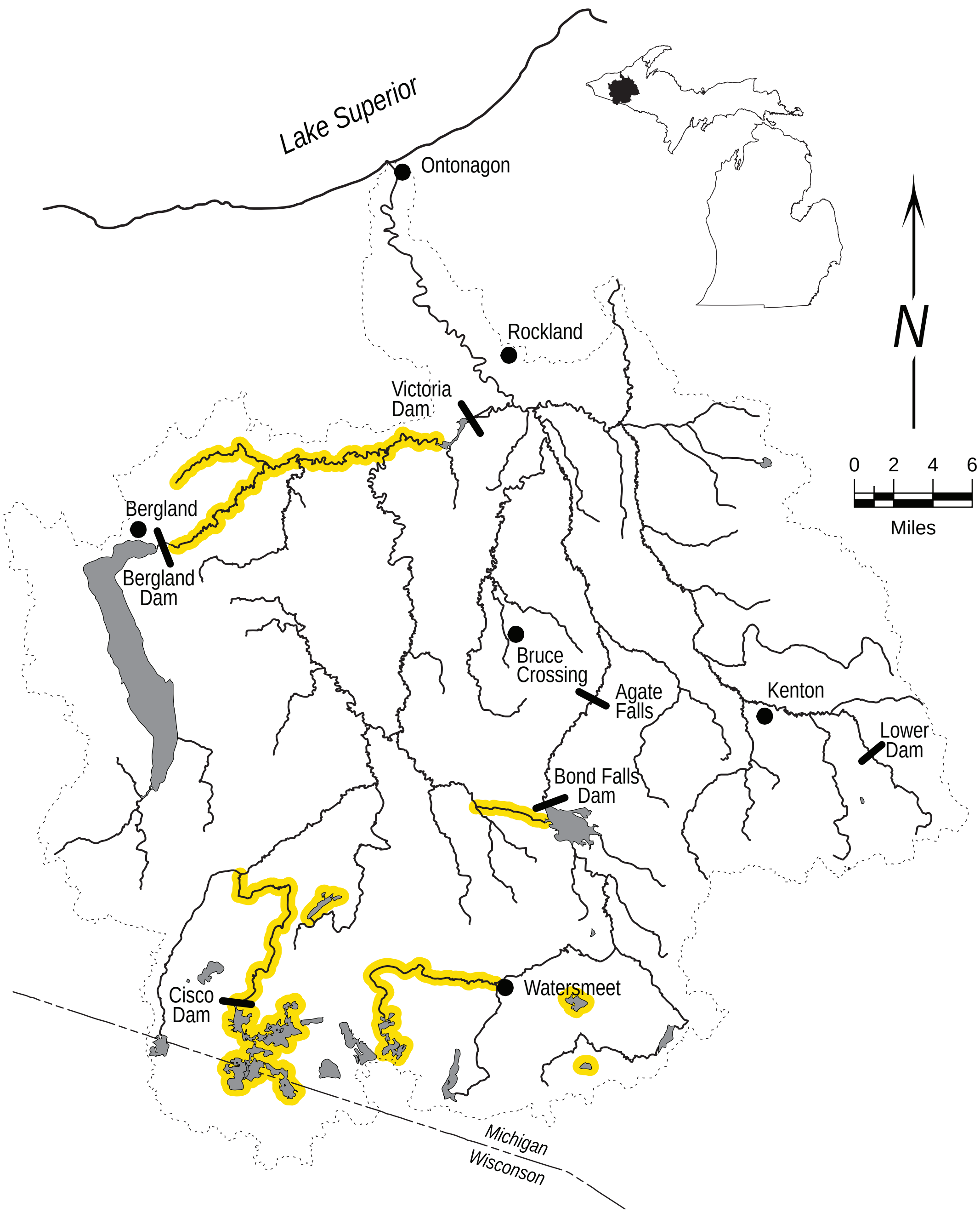
spawning - nests in gravel, sand, or mud substrate
- some vegetation must be present
- sometimes nests under banks



Iowa darter *Etheostoma exile*

Habitat**:**

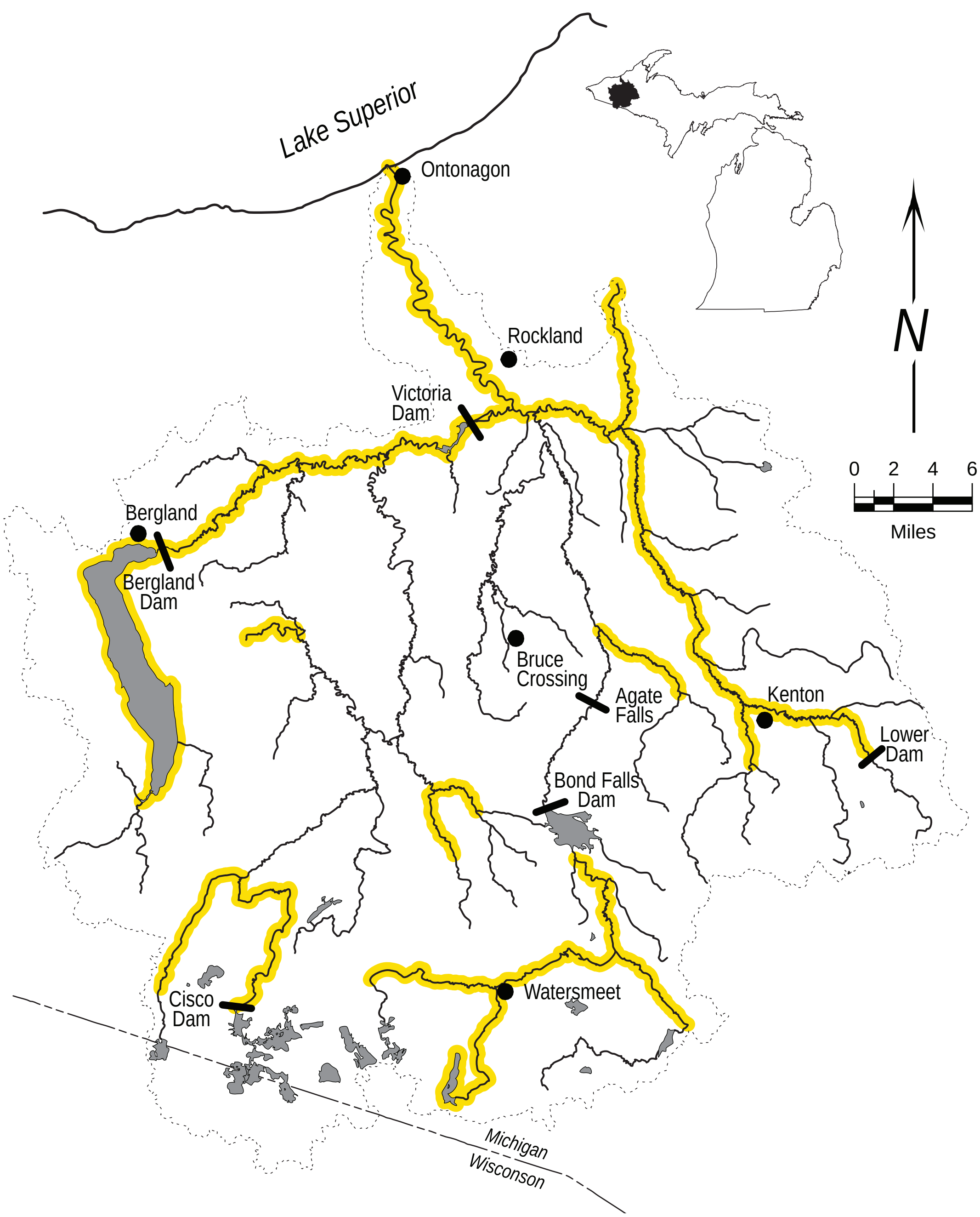
feeding	-	clear, slow moving streams and lakes
	-	sandy to muddy substrates
	-	intolerant of turbid water
	-	lives in rooted aquatic vegetation
spawning	-	in pond-like extensions of streams on organic matter or roots
	-	in shallows



Johnny darter *Etheostoma nigrum*

Habitat**:**

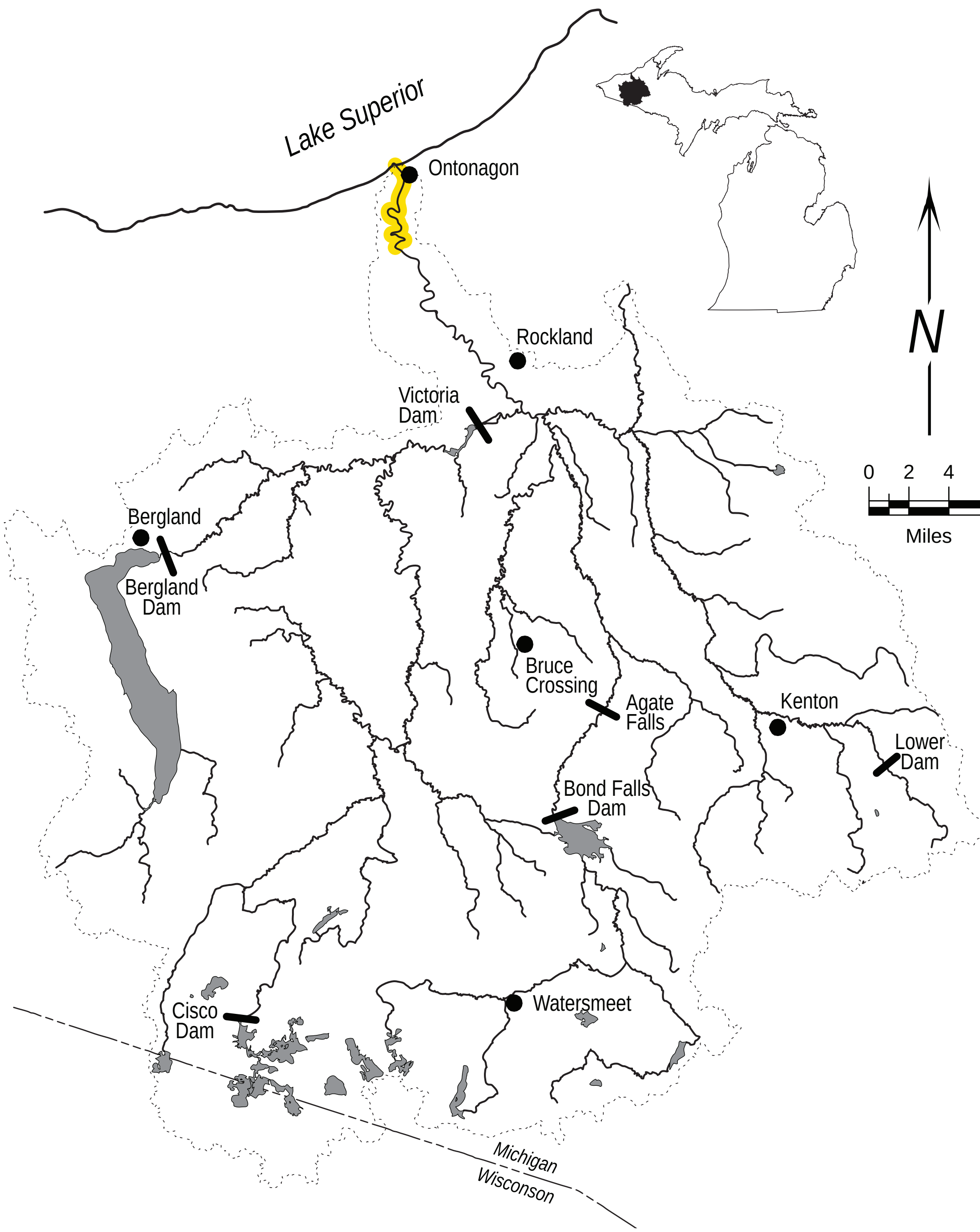
feeding	-	sand and silt substrate
	-	little to moderate current
	-	shallow areas of streams, rivers, lakes, and impoundments
	-	tolerant of many organic and inorganic pollutants and turbidity
spawning	-	underneath rocks
	-	in stream pools or protected shallows of lakes



Ruffe *Gymnocephalus cernuus*

Habitat:

feeding	-	shallow waters at night
	-	soft bottoms and no vegetation
spawning	-	warm shallows of turbid lakes with soft bottoms
	-	little or no vegetation present
	-	slow-moving water
winter refuge	-	deeper water

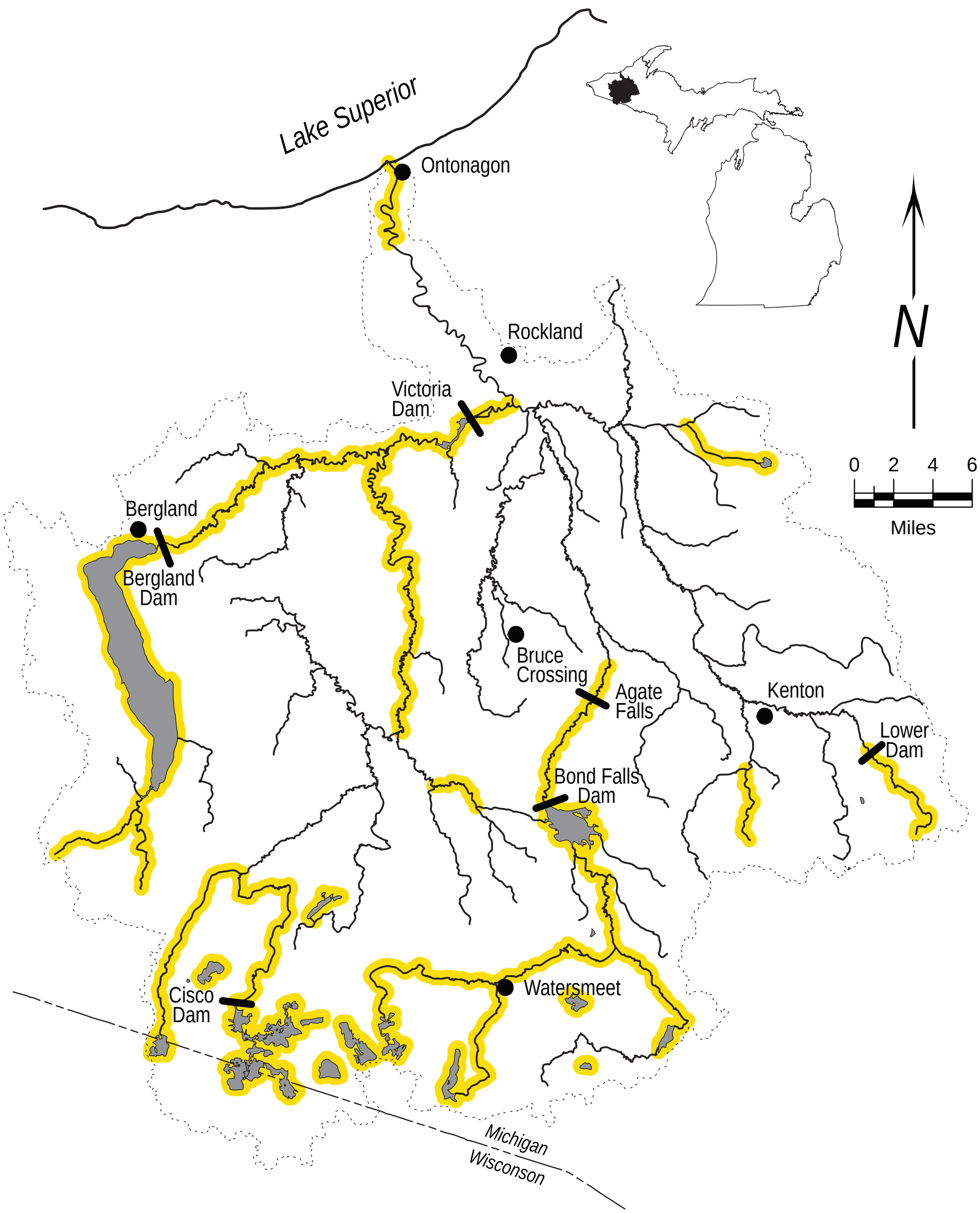


Yellow perch *Perca flavescens*

Habitat**:**

feeding
- clear lakes and impoundments; also Lake Superior
- low gradient rivers
- abundance of rooted aquatics
- muck, organic debris, sand, or gravel substrate
- does not tolerate turbidity and siltation

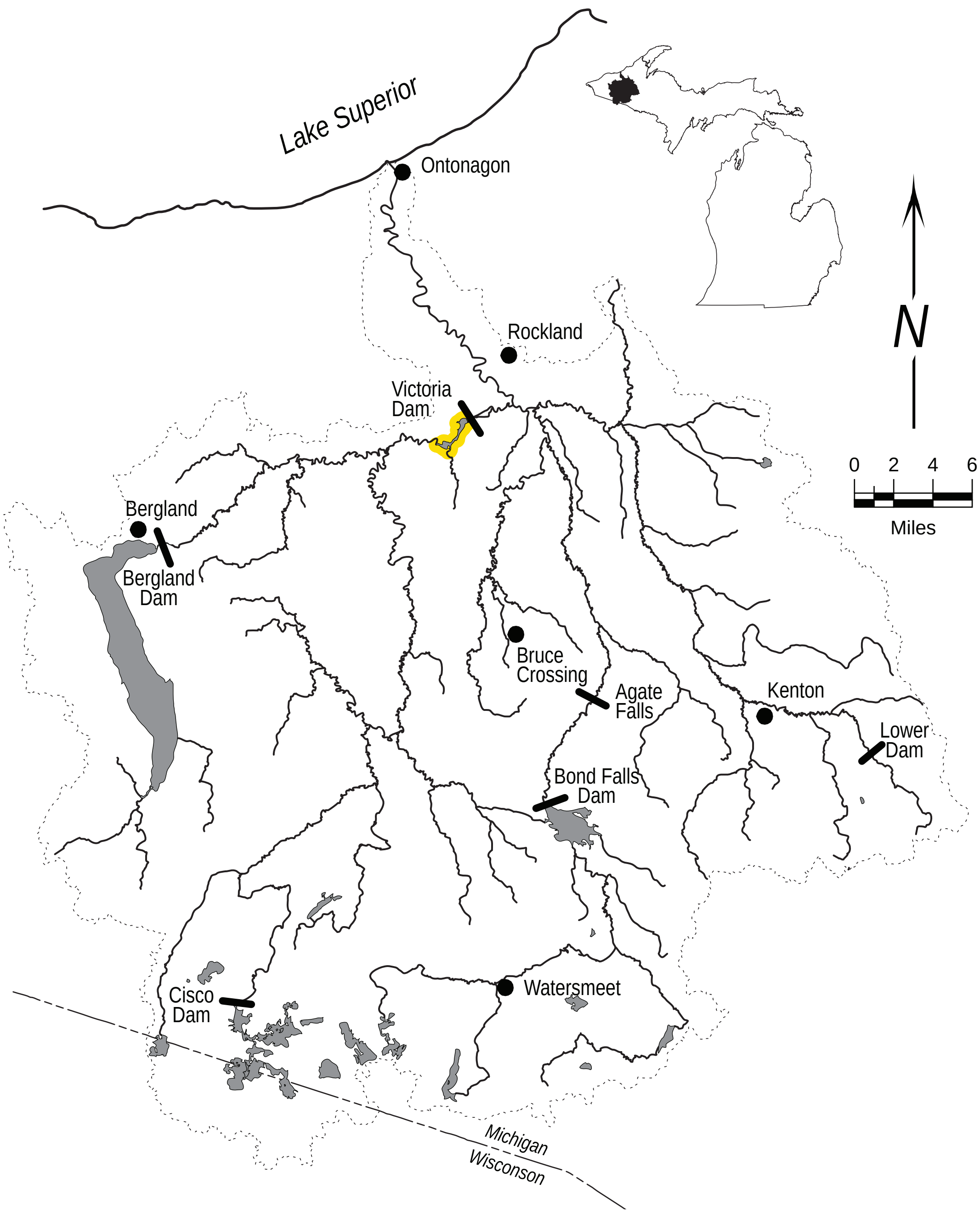
spawning
- shallows of lakes, tributaries of streams
- occurs over rooted vegetation, submerged brush, fallen trees
- may occur over sand or gravel



Northern logperch *Percina caprodes semifasciata*

Habitat**:**

feeding	-	gravel riffles, deeper slower sections of rivers
	-	medium size streams; also lakes, impoundments, and Lake Superior
	-	sand, gravel, or rock substrate
	-	avoids turbidity and silt
spawning	-	riffles or sandy in-shore shallows



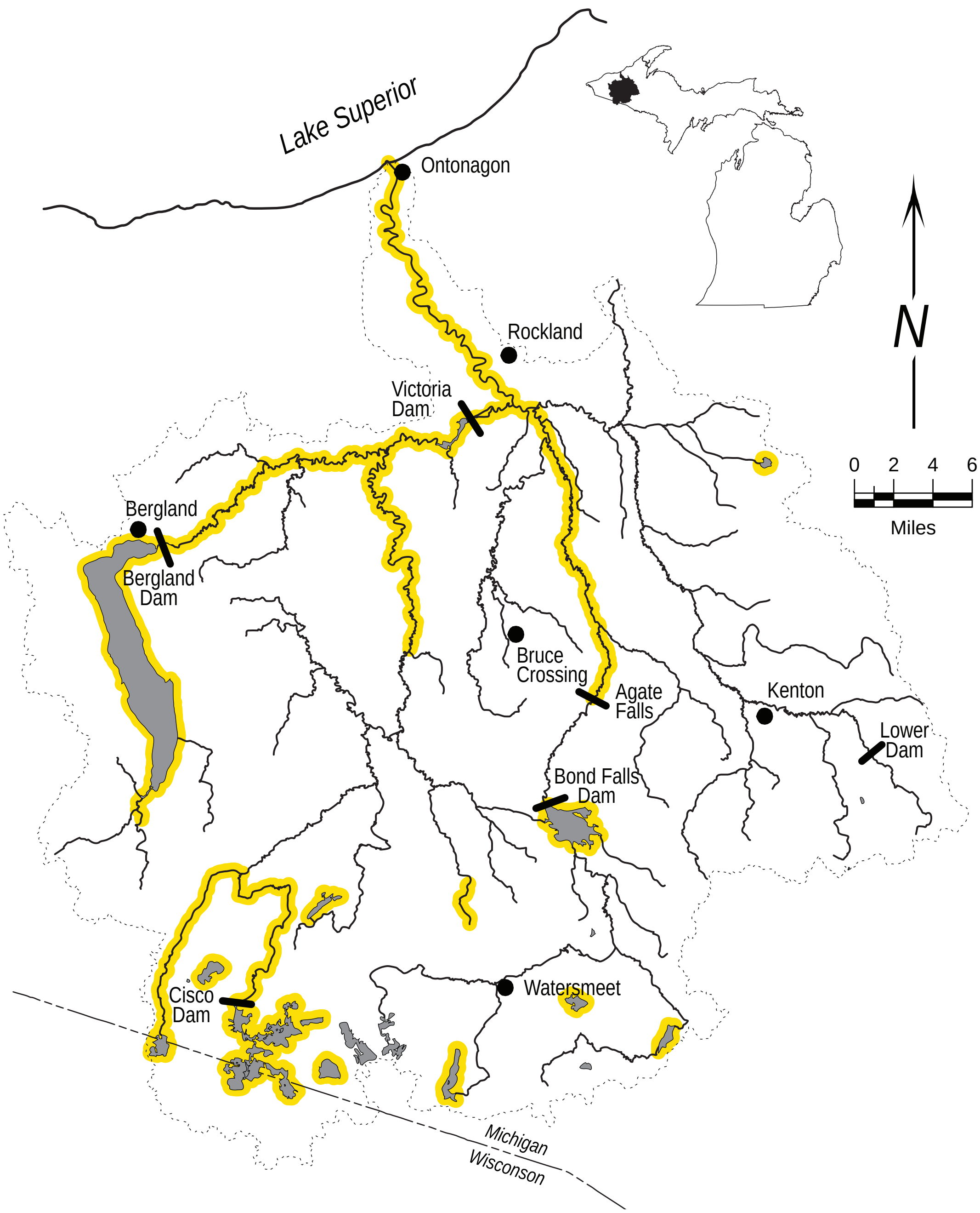
Walleye *Sander vitreus*

Habitat**:**

feeding - larger, deeper streams and in large, shallow, turbid lakes and impoundments; also Lake Superior
- gravel, bedrock, and firm substrates preferred
- does not tolerate a lot of turbidity or low oxygen

spawning - rocky substrates in high gradient water in rivers
- boulder to coarse gravel shoals in lakes

winter refuge - avoids strong currents



Appendix C

Summary of Michigan trout fishing regulations for April 1, 2008 through March 31, 2009. See Michigan Inland Trout and Salmon Guide (www.michigan.gov/dnr) for complete trout fishing regulations.

This page was intentionally left blank.

Table C.1.–Michigan trout stream fishing regulations for April 1, 2008 through March 31, 2009. (BKT = brook trout, BNT = brown trout, RBT = rainbow trout, SPL = splake, LAT = lake trout, COS = coho salmon, CHS = Chinook salmon, PKS = pink salmon, ATS = Atlantic salmon, L = Lower Peninsula, U = Upper Peninsula; * = 5 fish, with no more than 3 fish 15 in or larger, and no more than 1 Atlantic salmon, ** = Trout and salmon may not be possessed on type 7 streams regardless of where caught, EXCEPT: for children under the age of 12, the daily possession limit is one fish, the minimum size limit is 8 in, and the maximum size limit is 12 in. Fish less than 8 in or greater than 12 in must be released. + = 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.)

					Minimum size limit (inches)						
Type	Open season	Possession season	Tackle	Daily possession limit	BKT	BNT	RBT	SPL	LAT	COS, CHS, & PKS	ATS
1	Last Saturday in April – Sept. 30	Last Saturday in April–Sept. 30	All	5/3*	8(L) 7(U)	8(L) 7(U)	10	8	24	10	15
2	Last Saturday in April – Sept. 30	Last Saturday in April–Sept. 30	All	5/3*	10	12	12	10	24	10	15
3	All year	All year	All	5/3*	15	15	15	15	24	10	15
4	All year	BNT, BKT, ATS Last Saturday in April–Sept. 30 Other trout species all year	All	5/3*	8	10	10	10	24	10	15
5	All year	BNT, BKT, ATS Last Saturday in April–Sept. 30 Other trout species all year	Artificial flies only+	2	10	15	15	15	24	10	15
6	All year	BNT, BKT, ATS Last Saturday in April–Sept. 30 Other trout species all year	Artificial lures only+	2	10	12	12	10	24	10	15
7	All year	No-kill, catch and release only**	Artificial flies only+	0							

Table C.2.–Michigan trout lake fishing regulations for April 1, 2008 through March 31, 2009. (BKT = brook trout, BNT = brown trout, RBT = rainbow trout, SPL = splake, LAT = lake trout, COS = coho salmon, CHS = Chinook salmon, PKS = pink salmon, ATS = Atlantic salmon, * = 5 fish, with no more than 3 fish 15 in or larger, and no more than 1 Atlantic salmon, ** = 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. ^ = No more than 1 Atlantic salmon. + = 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.)

					Minimum size limit (inches)				
Type	Open season	Possession season	Tackle	Daily possession limit	BKT	BNT, RBT, & SPL	LAT	COS, CHS, & PKS	ATS
A	Last Saturday in April–Sept. 30	Last Saturday in April–Sept. 30	All except minnows	5/3*	10	12	15	10	15
B	All year	All year	All	5/3*	10	12	15	10	15
C	All year	All year	All	5/3*	8	8	8	10	15
D	Last Saturday in April–Sept. 30	Last Saturday in April–Sept. 30	Artificial lures only**	1	15	15	15	10	15
E	All year	All year	All	3^	15	15	15	10	15
F	All year	LAT: May 1–Labor Day Other trout species all year	All	5/3/2+	10	10	10	10	10

Appendix D

Miscellaneous creel data for streams and lakes within the Ontonagon River watershed. The data presented in Table D.1 was collected by conservation officers during the general creel census. Information included in Tables D.2 through D.4 was obtained through Michigan Department of Natural Resources, Large Lakes Survey Program (LLSP). The LLSP surveys followed a sampling design that incorporated counts of angling effort and interviews of anglers and angling parties. This design facilitated estimation of total angling effort for water bodies and total harvest for each fish species.

This page was intentionally left blank.

Table D.1.–Direct contact angler creel data for the Ontonagon River and its tributaries. Numbers are direct observations from conservation officers and are not subject to number expansion over time. CPH = catch-per-angler hour; ? = number of angler hours was not reported on original survey form, CPH could not be calculated.

Subwatershed stream	Year	Angler hours	Brook trout		Brown trout		Rainbow trout		Smallmouth bass		Largemouth bass		Bluegill		Pumpkinseed		Yellow perch		Walleye		Northern pike	
			Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH
Middle Branch—upper																						
Middle Branch Ontonagon River	1928	?	4																			
	1929	31	103	(3.32)																		
	1930	125	247	(1.98)			12	(0.10)														
	1931	215	435	(2.02)			3	(0.01)														
	1932	30	40	(1.33)																		
	1933	107	213	(2.00)			16	(0.15)														
	1934	47	67	(1.43)																		
	1935	76	167	(2.20)			16	(0.21)														
	1937	50	35	(0.71)	4	(0.08)																
	1938	49	60	(1.23)	1	(0.02)	4	(0.08)														
	1940	38	40	(1.05)			7	(0.18)														
	1941	439	363	(0.83)			10	(0.02)														
	1942	244	195	(0.80)	18	(0.07)	47	(0.19)									40	(0.16)				
	1944	360	363	(1.01)	13	(0.04)	9	(0.03)														
	1945	95	73	(0.77)	5	(0.05)	4	(0.04)														
	1946	296	309	(1.05)	18	(0.06)	14	(0.05)														
	1948	163	77	(0.47)	8	(0.05)	45	(0.28)														
	1949	627	237	(0.38)	44	(0.07)	81	(0.13)									1	(0.00)				
	1950	484	147	(0.30)	47	(0.10)	38	(0.08)					1	(0.00)								
	1951	217	61	(0.28)	12	(0.06)	41	(0.19)														
	1952	33	2	(0.06)			6	(0.18)					10	(0.30)	5	(0.15)						
	1953	138	34	(0.25)	7	(0.05)	13	(0.09)					4	(0.03)			25	(0.18)				
	1954	87	66	(0.76)	6	(0.07)	16	(0.18)														
	1955	136	126	(0.93)	6	(0.04)	19	(0.14)														
	1956	78	47	(0.60)	1	(0.01)	47	(0.60)									2	(0.03)				
	1957	176	168	(0.95)			46	(0.26)														
	1958	175	186	(1.06)			38	(0.22)														

Table D.1.–Continued.

Subwatershed stream	Year	Angler hours	Brook trout Catch	Brook trout CPH	Brown trout Catch	Brown trout CPH	Rainbow trout Catch	Rainbow trout CPH	Smallmouth bass Catch	Smallmouth bass CPH	Largemouth bass Catch	Largemouth bass CPH	Bluegill Catch	Bluegill CPH	Pumpkinseed Catch	Pumpkinseed CPH	Yellow perch Catch	Yellow perch CPH	Walleye Catch	Walleye CPH	Northern pike Catch	Northern pike CPH
Middle Branch—upper																						
Middle Branch Ontonagon River	1959	191	123	(0.64)	15	(0.08)	46	(0.24)	1	(0.01)							4	(0.02)				
	1960	62	21	(0.34)	6	(0.10)	8	(0.13)														
	1961	186	47	(0.25)	11	(0.06)	14	(0.08)														
	1962	108	53	(0.49)	9	(0.08)	37	(0.34)														
	1964	108	82	(0.76)	2	(0.02)	11	(0.10)														
Cedar Creek	1928	8	3	(0.38)			2	(0.25)														
	1938	6	1	(0.17)																		
	1941	13	19	(1.46)																		
	1944	10	10	(1.00)			1	(0.10)														
	1946	20	17	(0.85)	1	(0.05)																
	1948	3		(0.00)																		
	1950	4		(0.00)																		
	1954	7	11	(1.69)																		
	1955	1		(0.00)																		
	1956	8	7	(0.93)																		
	1957	19	23	(1.21)																		
	1958	9	18	(2.00)																		
	1959	18	20	(1.14)																		
Duck Creek	1929	32	47	(1.47)																		
	1932	16	15	(0.94)																		
	1933	4	3	(0.75)																		
	1934	19	39	(2.05)			2	(0.11)														
	1935	30	80	(2.67)																		
	1937	14	38	(2.71)																		
	1938	96	26	(0.27)																		
	1940	28	37	(1.32)																		
	1941	129	82	(0.64)																		
	1942	73	120	(1.64)																		
	1944	129	129	(1.00)			1	(0.01)														

Table D.1.–Continued.

Subwatershed stream	Year	Angler hours	Brook trout		Brown trout		Rainbow trout		Smallmouth bass		Largemouth bass		Bluegill		Pumpkinseed		Yellow perch		Walleye		Northern pike	
			Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH
Middle Branch—upper																						
Duck Creek	1945	32	40	(1.25)																		
	1946	82	117	(1.44)																		
	1948	30	18	(0.60)	5	(0.17)																
	1949	57	42	(0.74)	8	(0.14)																
	1950	24	8	(0.33)	1	(0.04)	1	(0.04)														
	1951	36	11	(0.31)																		
	1952	27	21	(0.78)			7	(0.26)														
	1953	13	16	(1.28)	1	(0.08)																
	1954	65	83	(1.28)																		
	1955	15	28	(1.87)																		
	1956	22	15	(0.68)																		
	1957	87	127	(1.47)			4	(0.05)														
	1958	69	103	(1.50)																		
	1959	47	54	(1.15)																		
	1960	5	5	(1.00)																		
	1961	8	1	(0.13)																		
	1962	29	34	(1.17)					1	(0.03)												
	1964	34	45	(1.32)																		
Imp Creek	1937	5	5	(1.11)																		
	1941	10	15	(1.58)																		
Interior Creek	1939	1																				
	1953	3	7	(2.80)																		
Johnson Creek	1940	15	9	(0.60)																		
Marion Creek	1955	2					3	(1.50)														
McGinty Creek	1931	16	13	(0.81)																		
	1939	1	4	(3.20)																		
	1940	2		(0.00)																		
	1941	20	1	(0.05)																		
	1944	6	6	(1.00)																		
	1947	7	3	(0.43)																		

Table D.1.–Continued.

Subwatershed stream	Year	Angler hours	Brook trout		Brown trout		Rainbow trout		Smallmouth bass		Largemouth bass		Bluegill		Pumpkinseed		Yellow perch		Walleye		Northern pike	
			Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH
Middle Branch—upper																						
McGinty Creek	1948	12	7	(0.58)																		
	1949	31	26	(0.84)																		
	1950	3	11	(3.67)																		
	1953	4																				
	1954	10	2	(0.21)																		
	1955	1																				
	1956	6																				
	1959	16	5	(0.31)																		
Morrison Creek	1932	7	6	(0.86)																		
	1933	22	28	(1.30)			1	(0.05)											3	(0.14)		
	1935	3	4	(1.33)																		
	1940	12	37	(3.08)																		
	1941	43	62	(1.46)																		
	1942	44	40	(0.92)			1	(0.02)														
	1944	45	44	(0.99)																		
	1946	4	8	(2.00)	1	(0.25)																
	1948	18		(0.00)																		
	1949	267	100	(0.37)	1	(0.00)	8	(0.03)														
	1950	133	69	(0.52)			4	(0.03)														
	1953	5	9	(1.80)																		
	1954	7	12	(1.71)																		
	1955	2	6	(3.00)																		
	1956	24	14	(0.58)			2	(0.08)														
	1957	6																				
	1959	4																				
Sargents Creek	1951	1	7	(14.0)																		
	1954	4	20	(5.00)																		
	1955	2	10	(5.00)																		
	1956	4	7	(1.75)																		
	1959	13	11	(0.88)																		

Table D.1.–Continued.

Subwatershed stream	Year	Angler hours	Brook trout		Brown trout		Rainbow trout		Smallmouth bass		Largemouth bass		Bluegill		Pumpkinseed		Yellow perch		Walleye		Northern pike	
			Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH
Middle Branch—upper																						
Tamarack River	1928	14	6	(0.42)	1	(0.07)	6	(0.42)														
	1929	6	10	(1.67)																		
	1930	19	46	(2.49)																		
	1931	37	78	(2.11)																		
	1932	?	33														10					
	1933	28	31	(1.11)													22	(0.79)				
	1934	?	30														45					
	1935	80	84	(1.05)																		
	1936	61	47	(0.77)							3	(0.05)										
	1938	4	1	(0.25)	1	(0.25)																
	1940	2	5	(2.50)																		
	1941	6	4	(0.67)																		
	1942	166	185	(1.11)	2	(0.01)	25	(0.15)														
	1944	102	15	(0.15)			1	(0.01)														
	1945	43	10	(0.24)																		
	1946	9	12	(1.33)			1	(0.11)														
	1947	18	4	(0.22)			1	(0.06)														
	1948	30	15	(0.51)			4	(0.14)														
	1949	34	7	(0.21)	2	(0.06)																
	1950	119	54	(0.45)	16	(0.13)	7	(0.06)														
	1951	40	14	(0.35)			1	(0.03)														
	1952	5		(0.00)																		
	1953	25	17	(0.69)																		
	1954	24	49	(2.09)																		
	1955	6		(0.00)																		
	1956	51	52	(1.02)			13	(0.26)														
	1957	50	60	(1.20)			5	(0.10)														
	1958	134	166	(1.24)			16	(0.12)														
	1959	73	40	(0.55)																		
	1960	56	48	(0.86)			1	(0.02)														

Table D.1.–Continued.

Subwatershed stream	Year	Angler hours	Brook trout		Brown trout		Rainbow trout		Smallmouth bass		Largemouth bass		Bluegill		Pumpkinseed		Yellow perch		Walleye		Northern pike	
			Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH
Middle Branch—upper																						
Tamarack River	1961	18	18	(1.00)																		
	1962	79	46	(0.59)			1	(0.01)														
	1963	14	14	(1.00)																		
	1964	11	10	(0.91)																		
Middle Branch—lower																						
Middle Branch Ontonagon River	1947	44	15	(0.34)	1	(0.02)	4	(0.09)														
	1948	4	2	(0.50)	1	(0.25)	1	(0.25)														
	1949	13	1	(0.08)			4	(0.31)														
	1950	35	20	(0.57)			3	(0.09)														
	1951	86	3	(0.04)	3	(0.04)	15	(0.18)														
	1952	26											16	(0.62)								
	1953	19	2	(0.11)			14	(0.76)														
	1955	175	27	(0.15)	2	(0.01)	71	(0.41)														
	1956	38	2	(0.05)	4	(0.11)	10	(0.26)														
	1957	831					97	(0.12)														
	1960	523	33	(0.06)	15	(0.03)	76	(0.15)									4	(0.01)				
	1962	602	9	(0.01)	14	(0.02)	67	(0.11)														
	1964	131	38	(0.29)	6	(0.05)	20	(0.15)														
Baltimore River	1939	4	6	(1.50)																		
	1940	14	8	(0.59)																		
	1944	13	24	(1.85)																		
	1945	107	51	(0.48)	100	(0.94)	7	(0.07)														
	1946	27	3	(0.11)	24	(0.91)	7	(0.26)														
	1947	22	7	(0.33)	32	(1.49)																
	1948	3		(0.00)																		
	1950	49	19	(0.39)	43	(0.89)	2	(0.04)														
	1951	20	2	(0.10)	4	(0.20)	1	(0.05)														
	1953	60	12	(0.20)	31	(0.52)	6	(0.10)														
	1955	19	2	(0.11)	6	(0.32)	2	(0.11)														

Table D.1.–Continued.

Subwatershed stream	Year	Angler hours	Brook trout		Brown trout		Rainbow trout		Smallmouth bass		Largemouth bass		Bluegill		Pumpkinseed		Yellow perch		Walleye		Northern pike	
			Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH
Middle Branch—lower																						
Baltimore River	1956	15	9	(0.60)	5	(0.33)	2	(0.13)														
	1960	10	6	(0.63)	4	(0.42)																
	1962	28	29	(1.04)	13	(0.46)																
	1964	10	22	(2.20)																		
Clear Creek	1940	5																				
	1944	21	31	(1.51)	1	(0.05)																
	1945	7	12	(1.71)																		
	1950	66	117	(1.77)			2	(0.03)														
	1951	16	11	(0.69)			1	(0.06)														
	1953	35	36	(1.04)	1	(0.03)	2	(0.06)														
	1955	63	73	(1.16)			29	(0.46)														
	1956	18	16	(0.91)			9	(0.51)														
	1962	10	15	(1.58)																		
	1964	8	9	(1.13)																		
Dover Creek	1928	34	26	(0.76)																		
	1929	60	68	(1.13)																		
	1930	22	27	(1.23)																		
	1931	38	22	(0.58)																		
	1932	3	3	(1.00)																		
	1933	36	28	(0.78)																		
	1938	3																				
	1944	4																				
	1945	6	30	(5.00)																		
	1947	36	25	(0.69)	2	(0.06)																
	1951	11	11	(1.00)																		
	1953	2	4	(2.00)																		
	1956	8	6	(0.75)			4	(0.50)														
	1957	2	5	(2.50)																		
	1959	7	11	(1.52)																		
	1960	6					1	(0.18)														

Table D.1.–Continued.

Subwatershed stream	Year	Angler hours	Brook trout		Brown trout		Rainbow trout		Smallmouth bass		Largemouth bass		Bluegill		Pumpkinseed		Yellow perch		Walleye		Northern pike	
			Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH
Middle Branch—lower																						
Dover Creek	1961	1																				
	1963	3	3	(1.00)																		
	1964	2	1	(0.67)																		
East Branch Baltimore River	1960	5	3	(0.60)	1	(0.20)																
Trout Creek	1928	15	18	(1.20)																		
	1929	?	1																			
	1931	24	125	(5.21)																		
	1932	?	15																			
	1936	19	26	(1.37)																		
	1938	9	22	(2.59)																		
	1940	18	24	(1.33)																		
	1941	1	2	(2.00)																		
	1944	21	40	(1.95)																		
	1947	7	12	(1.71)																		
	1949	7																				
	1950	19	9	(0.47)																		
	1951	52	39	(0.75)																		
	1953	4	4	(1.00)																		
	1954	12																				
	1957	5	8	(1.78)																		
	1958	12	5	(0.42)																		
	1959	3			2	(0.67)																
	1961	6	3	(0.50)																		
	1962	1			1	(1.00)																
	1964	28	41	(1.46)			1	(0.04)														

Table D.1.–Continued.

Subwatershed stream	Year	Angler hours	Brook trout		Brown trout		Rainbow trout		Smallmouth bass		Largemouth bass		Bluegill		Pumpkinseed		Yellow perch		Walleye		Northern pike	
			Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH
Main Stem																						
Ontonagon River	1948	300	2	(0.01)															120	(0.40)	16	(0.05)
	1950	252			1	(0.00)	3	(0.01)											112	(0.44)	9	(0.04)
	1951	102			1	(0.01)											5	(0.05)	38	(0.37)	3	(0.03)
	1953	64			1	(0.02)	1	(0.02)											28	(0.44)	3	(0.05)
	1954	39					1	(0.03)											13	(0.33)	5	(0.13)
	1955	141																	44	(0.31)	3	(0.02)
	1956	173																	36	(0.21)	4	(0.02)
	1957	439					7	(0.02)									2	(0.00)	87	(0.20)	4	(0.01)
	1958	78																	16	(0.21)		
	1959	327							3	(0.01)									119	(0.36)	2	(0.01)
	1960	554											2	(0.00)					77	(0.14)	9	(0.02)
	1961	534																	85	(0.16)	11	(0.02)
	1962	369																	103	(0.28)	2	(0.01)
	1963	193																	39	(0.20)	3	(0.02)
	1964	155			1	(0.01)	5	(0.03)											15	(0.10)	1	(0.01)
Mill Creek	1939	6	1	(0.17)																		
East Branch																						
East Branch Ontonagon River	1928	96	151	(1.57)																		
	1929	43	23	(0.53)																		
	1930	44	60	(1.36)			8	(0.18)														
	1931	52	270	(5.19)																		
	1933	?	48														1					
	1934	?	17																			
	1935	115	171	(1.49)			1	(0.01)									24	(0.21)				
	1936	184	161	(0.88)			24	(0.13)														
	1937	32	46	(1.46)			5	(0.16)														
	1938	104	120	(1.16)			39	(0.38)														
	1939	63	71	(1.13)			1	(0.02)														
	1940	44	53	(1.22)			14	(0.32)														

Table D.1.–Continued.

Subwatershed stream	Year	Angler hours	Brook trout Catch	Brook trout CPH	Brown trout Catch	Brown trout CPH	Rainbow trout Catch	Rainbow trout CPH	Smallmouth bass Catch	Smallmouth bass CPH	Largemouth bass Catch	Largemouth bass CPH	Bluegill Catch	Bluegill CPH	Pumpkinseed Catch	Pumpkinseed CPH	Yellow perch Catch	Yellow perch CPH	Walleye Catch	Walleye CPH	Northern pike Catch	Northern pike CPH
East Branch																						
East Branch Ontonagon River	1941	48	25	(0.52)			18	(0.38)														
	1942	82	136	(1.66)	3	(0.04)	1	(0.01)														
	1943	27	36	(1.33)	1	(0.04)	1	(0.04)														
	1944	755	129	(0.17)	7	(0.01)	7	(0.01)														
	1945	35	59	(1.71)	1	(0.03)	3	(0.09)														
	1946	175	222	(1.27)	19	(0.11)	71	(0.41)														
	1947	89	93	(1.04)																		
	1948	23	20	(0.87)																		
	1949	410	97	(0.24)	16	(0.04)	80	(0.20)			12	(0.03)					6	(0.01)				
	1950	52	3	(0.06)	1	(0.02)	3	(0.06)														
	1951	114	41	(0.36)	9	(0.08)	3	(0.03)														
	1952	100	29	(0.29)	19	(0.19)	6	(0.06)														
	1953	161	94	(0.58)	3	(0.02)	16	(0.10)														
	1954	97	62	(0.64)	6	(0.06)	13	(0.13)														
	1955	55	14	(0.26)	5	(0.09)	49	(0.90)														
	1956	42	36	(0.87)	5	(0.12)	14	(0.34)														
	1957	107	123	(1.15)	2	(0.02)	46	(0.43)														
	1958	1	1	(2.00)																		
	1959	12	7	(0.58)																		
	1960	8																				
	1961	6	5	(0.83)																		
	1962	30	6	(0.20)	1	(0.03)	6	(0.20)														
	1963	37	23	(0.63)			1	(0.03)														
	1964	61	9	(0.15)	3	(0.05)	10	(0.17)														
Adventure Creek	1951	2	2	(1.00)																		
Beaver Creek	1929	36	79	(2.23)																		
	1930	101	81	(0.80)			14	(0.14)														
	1931	?	41																			
	1933	2																				

Table D.1.–Continued.

Subwatershed stream	Year	Angler hours	Brook trout		Brown trout		Rainbow trout		Smallmouth bass		Largemouth bass		Bluegill		Pumpkinseed		Yellow perch		Walleye		Northern pike	
			Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH
East Branch																						
Beaver Creek	1934	21	54	(2.57)																		
	1936	9	4	(0.44)																		
	1937	4	11	(2.75)																		
	1938	14	22	(1.57)																		
	1939	24	74	(3.08)																		
	1942	9	23	(2.56)																		
	1946	12	42	(3.50)																		
	1947	12																				
	1948	10	14	(1.40)																		
	1949	13	11	(0.85)																		
	1950	27	23	(0.85)																		
	1951	19	6	(0.32)			6	(0.32)														
	1952	14	5	(0.36)																		
	1953	8	3	(0.38)																		
	1954	7	9	(1.29)																		
	1955	35	18	(0.51)			32	(0.91)														
	1956	21	48	(2.34)			5	(0.24)														
	1957	57	109	(1.91)	4	(0.07)	10	(0.18)														
	1959	23	17	(0.74)	1	(0.04)	5	(0.22)														
	1960	58	63	(1.10)			7	(0.12)														
	1961	10	18	(1.80)																		
	1962	8	10	(1.25)																		
	1963	62	78	(1.26)																		
	1964	94	95	(1.01)	1	(0.01)																
Jumbo River	1929	20	59	(2.95)																		
	1930	15	25	(1.72)																		
	1931	74	135	(1.82)																		
	1932	15	37	(2.47)			1	(0.07)														
	1933	48	26	(0.54)					18	(0.38)					24	(0.50)	14	(0.29)			1	(0.02)
	1934	7	9	(1.29)											1	(0.14)						

Table D.1.–Continued.

Subwatershed stream	Year	Angler hours	Brook trout		Brown trout		Rainbow trout		Smallmouth bass		Largemouth bass		Bluegill		Pumpkinseed		Yellow perch		Walleye		Northern pike	
			Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH
East Branch																						
Jumbo River	1935	35	60	(1.71)																		
	1936	78	101	(1.29)			8	(0.10)														
	1937	10	4	(0.42)																		
	1938	19	26	(1.37)			1	(0.05)														
	1939	18	18	(1.00)																		
	1940	40	67	(1.68)																		
	1941	181	110	(0.61)			5	(0.03)														
	1942	130	151	(1.17)																		
	1944	263	70	(0.27)																		
	1945	8	3	(0.38)																		
	1946	74	49	(0.66)																		
	1947	122	57	(0.47)			1	(0.01)														
	1948	86	60	(0.70)			6	(0.07)														
	1949	245	180	(0.73)	5	(0.02)	35	(0.14)														
	1950	47	8	(0.17)	8	(0.17)	3	(0.06)														
	1951	83	53	(0.64)			7	(0.08)														
	1952	210	236	(1.13)	1	(0.00)	3	(0.01)														
	1953	46	57	(1.25)	1	(0.02)	15	(0.33)														
	1956	37	87	(2.35)	5	(0.14)	2	(0.05)														
	1957	25	47	(1.88)			1	(0.04)														
	1959	8	3	(0.40)																		
	1960	7	10	(1.43)																		
	1961	3																				
	1962	4	3	(0.75)																		
	1963	4																				
	1964	86	12	(0.14)			11	(0.13)														
Leveque Creek	1933	6	13	(2.17)																		
	1936	10	29	(2.90)																		
	1937	19	6	(0.32)																		
	1938	2	2	(1.00)																		

Table D.1.–Continued.

Subwatershed stream	Year	Angler hours	Brook trout		Brown trout		Rainbow trout		Smallmouth bass		Largemouth bass		Bluegill		Pumpkinseed		Yellow perch		Walleye		Northern pike	
			Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH
East Branch																						
Leveque Creek	1940	42	69	(1.64)																		
	1941	38	7	(0.18)																		
	1942	64	19	(0.30)																		
	1944	2	3	(1.50)																		
	1945	6	12	(2.00)																		
	1946	4	1	(0.25)																		
	1948	4	2	(0.50)																		
	1953	13	19	(1.46)			1	(0.08)														
	1954	4	10	(2.50)																		
	1955	13	42	(3.23)																		
	1956	10	9	(0.90)																		
	1958	2																				
	1960	22	10	(0.47)																		
	1961	22	20	(0.91)																		
	1962	22	39	(1.81)																		
	1963	21	24	(1.14)																		
	1964	6	3	(0.55)																		
Newholm Creek	1940	34	56	(1.65)			3	(0.09)														
	1941	26	8	(0.31)																		
	1942	8	9	(1.16)																		
	1944	19	10	(0.53)			4	(0.21)														
	1945	10	12	(1.20)																		
	1946	4																				
	1950	12																				
	1951	8	5	(0.63)			3	(0.38)														
	1954	5	2	(0.40)																		
	1957	2																				
	1958	5	6	(1.20)																		
	1960	7																				

Table D.1.–Continued.

Subwatershed stream	Year	Angler hours	Brook trout		Brown trout		Rainbow trout		Smallmouth bass		Largemouth bass		Bluegill		Pumpkinseed		Yellow perch		Walleye		Northern pike	
			Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH
East Branch																						
Newholm Creek	1962	3	6	(2.00)																		
	1963	7	14	(2.00)																		
Onion Creek	1936	26	34	(1.31)																		
	1952	6	3	(0.50)																		
	1957	23	4	(0.17)			17	(0.74)														
	1959	6	5	(0.83)																		
	1960	21	22	(1.05)																		
	1961	2	2	(1.00)																		
	1963	1	1	(2.00)																		
	1964	5	1	(0.20)																		
Passmore Creek	1944	16	2	(0.13)																		
	1946	12																				
	1949	2																				
Shane Creek	1939	3	10	(3.33)																		
Smith Creek	1928	27	34	(1.26)																		
	1929	86	65	(0.76)																		
	1930	1	1	(1.00)																		
	1938	10	4	(0.40)																		
	1939	2	3	(1.50)																		
	1940	18	18	(1.03)																		
	1941	18	28	(1.56)																		
	1943	5	15	(3.33)																		
	1944	3	9	(3.00)																		
	1945	23	8	(0.35)			2	(0.09)														
	1946	41	25	(0.61)	4	(0.10)	9	(0.22)														
	1947	41	8	(0.20)																		
	1948	3	5	(1.67)																		
	1950	16	19	(1.19)																		
	1951	12	6	(0.50)	6	(0.50)																
	1953	6	6	(1.00)																		

Table D.1.–Continued.

Subwatershed stream	Year	Angler hours	Brook trout		Brown trout		Rainbow trout		Smallmouth bass		Largemouth bass		Bluegill		Pumpkinseed		Yellow perch		Walleye		Northern pike	
			Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH
East Branch																						
Smith Creek	1954	9	11	(1.22)																		
	1958	4	9	(2.25)																		
	1961	6	1	(0.17)																		
Stony Creek	1933	49	50	(1.02)			5	(0.10)														
	1934	41	80	(1.95)																		
	1935	54	62	(1.16)																		
	1936	66	83	(1.27)																		
	1937	5	5	(1.00)																		
	1938	4	1	(0.25)																		
	1939	2	1	(0.50)																		
	1940	4																				
	1941	18	4	(0.22)																		
	1942	25	52	(2.12)																		
	1943	17	9	(0.53)																		
	1944	224	73	(0.33)																		
	1945	56	35	(0.63)			1	(0.02)														
	1946	26	39	(1.53)																		
	1947	47	8	(0.17)																		
	1948	10	2	(0.20)																		
	1951	4	5	(1.25)																		
	1952	15	22	(1.47)																		
	1954	25	24	(0.96)																		
	1960	8	1	(0.13)																		
	1961	2	4	(2.00)																		
	1963	10	5	(0.50)																		
West Branch Jumbo River	1931	9	18	(2.00)																		
	1936	23	14	(0.61)																		
	1937	8	8	(1.07)																		
	1938	11	5	(0.45)																		

Table D.1.–Continued.

Subwatershed stream	Year	Angler hours	Brook trout		Brown trout		Rainbow trout		Smallmouth bass		Largemouth bass		Bluegill		Pumpkinseed		Yellow perch		Walleye		Northern pike	
			Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH
East Branch																						
West Branch Jumbo River	1939	21	21	(1.01)																		
	1941	100	37	(0.37)																		
	1942	86	98	(1.14)																		
	1943	5	8	(1.60)																		
	1944	266	29	(0.11)																		
	1946	54	39	(0.72)																		
	1948	67	45	(0.67)																		
	1949	62	68	(1.10)																		
	1950	4	3	(0.75)			1	(0.25)														
	1951	18																				
	1952	72	163	(2.26)																		
	1957	17	25	(1.47)																		
	1960	10	3	(0.30)																		
	1961	33	28	(0.85)																		
	1964	7	11	(1.57)																		
Cisco Branch																						
Cisco Branch Ontonagon River	1941	12	21	(1.75)																		
	1942	2																				
	1953	4																				
	1962	3	1	(0.33)																		
Grosbeck Creek	1942	13	15	(1.15)																		
	1943	16	25	(1.56)																		
	1946	46	57	(1.24)																		
	1948	4																				
	1950	1																				
Tenderfoot Creek	1930	?	16																			
	1938	1																				
	1939	10	10	(1.00)																		

Table D.1.–Continued.

Subwatershed stream	Year	Angler hours	Brook trout		Brown trout		Rainbow trout		Smallmouth bass		Largemouth bass		Bluegill		Pumpkinseed		Yellow perch		Walleye		Northern pike	
			Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH
Cisco Branch																						
Tenderfoot Creek	1942	23	39	(1.70)																		
	1943	1	1	(1.00)																		
	1945	8	12	(1.50)																		
	1946	27																				
	1947	6																				
	1953	1																				
	1954	7	6	(0.86)																		
South Branch																						
South Branch Ontonagon River	1937	2																				
	1938	3																	3	(1.00)	2	(0.67)
	1948	1																				
Bluff Creek	1932	16	22	(1.38)																		
	1933	10	12	(1.20)																		
	1935	5																				
	1936	14	23	(1.70)																		
	1937	39	48	(1.25)																		
	1938	109	54	(0.50)																		
	1939	6	4	(0.67)																		
	1940	3	2	(0.62)																		
	1941	6	20	(3.33)																		
	1942	53	53	(1.00)																		
	1943	5		(0.00)																		
	1944	65	86	(1.32)																		
	1945	20	31	(1.55)																		
	1946	22	38	(1.73)	3	(0.14)																
	1947	17	27	(1.59)	2	(0.12)																
	1948	60	18	(0.30)			4	(0.07)	2	(0.03)												
	1950	93	109	(1.17)	2	(0.02)	4	(0.04)														
	1951	23		(0.00)																		

Table D.1.–Continued.

Subwatershed stream	Year	Angler hours	Brook trout		Brown trout		Rainbow trout		Smallmouth bass		Largemouth bass		Bluegill		Pumpkinseed		Yellow perch		Walleye		Northern pike	
			Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH
South Branch																						
Bluff Creek	1953	44	40	(0.92)			4	(0.09)														
	1954	13	38	(2.92)																		
	1955	128	85	(0.67)	3	(0.02)	77	(0.60)														
	1956	74	50	(0.68)			14	(0.19)														
	1957	29	38	(1.31)	1	(0.03)	8	(0.28)														
	1958	24	36	(1.53)																		
	1959	19	22	(1.16)			11	(0.58)														
	1960	16	4	(0.25)	2	(0.13)	2	(0.13)														
	1961	168	66	(0.39)	9	(0.05)	11	(0.07)														
	1962	44	14	(0.32)	4	(0.09)	7	(0.16)														
	1964	10	11	(1.10)			1	(0.10)														
Bond Falls Canal	1959	5	8	(1.60)			1	(0.20)														
	1960	7	2	(0.29)	3	(0.43)	1	(0.14)														
	1961	9	3	(0.33)			4	(0.44)														
	1962	2																				
Scott and Howe Creek	1948	2	8	(5.33)																		
	1949	4	9	(2.25)																		
	1950	5	27	(5.40)																		
	1951	3	3	(1.00)																		
	1953	2	4	(2.00)																		
	1954	12	22	(1.83)																		
	1955	2																				
	1962	3	6	(2.00)																		
	1964	7	13	(1.86)																		
Sisson-Lilley Creek	1945	10	19	(1.90)																		
Spring Creek (Tributary to Paulding Creek)	1950	14	28	(2.07)																		
Sucker Creek	1928	22																				
	1929	22																				

Table D.1.–Continued.

Subwatershed stream	Year	Angler hours	Brook trout		Brown trout		Rainbow trout		Smallmouth bass		Largemouth bass		Bluegill		Pumpkinseed		Yellow perch		Walleye		Northern pike	
			Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH
South Branch																						
Sucker Creek	1931	6																				
	1932	25	29	(1.16)																		
	1933	?	9																			
	1935	6	18	(3.00)																		
	1936	28	2	(0.07)															1	(0.04)		
	1937	3	4	(1.33)																		
	1938	25	18	(0.72)																		
	1939	3	4	(1.60)																		
	1941	6	22	(4.00)																		
	1942	16	16	(1.00)																		
	1944	18	47	(2.58)																		
	1945	24	32	(1.33)			20	(0.83)														
	1946	34	32	(0.94)	4	(0.12)																
	1947	8	15	(1.88)	3	(0.38)																
	1948	20	34	(1.70)	1	(0.05)	3	(0.15)														
	1950	69	102	(1.49)	1	(0.01)																
	1951	6																				
	1953	55	30	(0.55)	7	(0.13)	8	(0.15)														
	1954	3	3	(1.00)																		
	1955	89	58	(0.65)			14	(0.16)														
	1956	19	8	(0.42)	1	(0.05)	5	(0.26)														
	1957	2	11	(5.50)																		
	1958	36	59	(1.66)			10	(0.28)														
	1960	10	6	(0.60)	1	(0.10)																
	1961	24	27	(1.13)	3	(0.13)																
	1962	46	31	(0.68)			3	(0.07)														
	1964	40	67	(1.68)	4	(0.10)	4	(0.10)														
West Branch																						
West Branch Ontonagon River	1937	166																			65	(0.39)	4	(0.02)

Table D.1.–Continued.

Subwatershed stream	Year	Angler hours	Brook trout Catch	Brook trout CPH	Brown trout Catch	Brown trout CPH	Rainbow trout Catch	Rainbow trout CPH	Smallmouth bass Catch	Smallmouth bass CPH	Largemouth bass Catch	Largemouth bass CPH	Bluegill Catch	Bluegill CPH	Pumpkinseed Catch	Pumpkinseed CPH	Yellow perch Catch	Yellow perch CPH	Walleye Catch	Walleye CPH	Northern pike Catch	Northern pike CPH
South Branch																						
West Branch Ontonagon River	1938	9																	1	(0.11)		
	1939	14									1	(0.07)							8	(0.57)	4	(0.29)
	1941	90							6	(0.07)							8	(0.09)	35	(0.39)	4	(0.04)
	1942	15																	13	(0.87)		
	1944	124							9	(0.07)							13	(0.11)	85	(0.69)	3	(0.02)
	1945	26															1	(0.04)	13	(0.50)	4	(0.15)
	1946	67															14	(0.21)	13	(0.19)	14	(0.21)
	1947	52																	22	(0.42)	3	(0.06)
	1948	3																	3	(1.00)		
	1951	15															1	(0.07)				
	1953	7																	8	(1.14)	1	(0.14)
	1957	46			1	(0.02)											5	(0.11)	15	(0.33)	18	(0.39)
	1958	7																				
	1959	89							4	(0.05)							47	(0.53)	23	(0.26)	9	(0.10)
Cascade Creek	1930	6	75	(12.5)																		
	1931	10	34	(3.40)																		
	1936	12	13	(1.13)																		
	1937	20	64	(3.28)																		
	1938	52	128	(2.49)	1	(0.02)																
	1939	10	9	(0.90)																		
	1940	5	1	(0.20)																		
	1941	56	70	(1.25)																		
	1942	81	123	(1.52)			3	(0.04)														
	1944	52	44	(0.85)																		
	1945	57	72	(1.26)	1	(0.02)																
	1946	42	44	(1.06)																		
	1948	58	5	(0.09)																		
	1954	83	35	(0.42)			34	(0.41)														
	1955	107	53	(0.50)	3	(0.03)	8	(0.07)														

Table D.1.–Continued.

Subwatershed stream	Year	Angler hours	Brook trout		Brown trout		Rainbow trout		Smallmouth bass		Largemouth bass		Bluegill		Pumpkinseed		Yellow perch		Walleye		Northern pike	
			Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH
South Branch																						
Cascade Creek	1956	9	10	(1.11)																		
	1958	46	99	(2.18)			5	(0.11)														
	1959	45	24	(0.54)	10	(0.22)	3	(0.07)														
	1961	14	1	(0.07)	3	(0.21)																
Marshall Creek	1938	2																				
	1942	6	6	(1.00)																		
	1944	13	2	(0.15)																		
	1945	13	30	(2.31)																		
	1947	1																				
	1948	35	8	(0.23)			4	(0.11)														
Pelton Creek	1930	4	4	(1.00)																		
	1939	49	31	(0.63)																		
	1941	15	63	(4.20)																		
	1942	43	85	(1.98)																		
	1943	21	14	(0.67)																		
	1944	155	76	(0.49)																		
	1945	24	36	(1.50)																		
	1946	158	181	(1.15)																		
	1947	154	120	(0.78)																		
	1948	53	52	(0.98)																		
	1949	53	28	(0.53)																		
	1950	6																				
	1951	3	1	(0.33)																		
	1952	11	14	(1.27)																		
	1953	29	49	(1.69)																		
	1954	19	22	(1.16)																		
	1956	30	1	(0.03)																		
	1957	17	17	(1.00)																		
	1964	2	1	(0.50)																		

Table D.1.–Continued.

Subwatershed stream	Year	Angler hours	Brook trout		Brown trout		Rainbow trout		Smallmouth bass		Largemouth bass		Bluegill		Pumpkinseed		Yellow perch		Walleye		Northern pike	
			Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH
South Branch																						
Slate River	1930	?	76																			
	1931	55	34	(0.62)															6	(0.11)	1	(0.02)
	1932	4	8	(2.00)																		
	1933	16	41	(2.56)															14	(0.88)	1	(0.06)
	1934	?															6		3			
	1938	37	20	(0.54)																		
	1939	263	89	(0.34)													4	(0.02)	10	(0.04)	15	(0.06)
	1940	62	26	(0.42)															6	(0.10)	1	(0.02)
	1941	528	277	(0.52)			2	(0.00)											76	(0.14)	38	(0.07)
	1942	587	358	(0.61)													15	(0.03)	42	(0.07)	50	(0.09)
	1943	209	126	(0.60)															19	(0.09)	1	(0.00)
	1944	552	86	(0.16)													5	(0.01)	72	(0.13)	19	(0.03)
	1945	116	163	(1.41)													12	(0.10)	7	(0.06)		
	1946	251	248	(0.99)															4	(0.02)		
	1947	143	52	(0.36)															2	(0.01)	1	(0.01)
	1948	256	163	(0.64)	1	(0.00)											1	(0.00)	1	(0.00)		
	1949	186	109	(0.59)															16	(0.09)	1	(0.01)
	1950	5	1	(0.20)																		
	1951	3	7	(2.33)																		
	1953	18	4	(0.22)	17	(0.94)																
	1954	3	2	(0.67)																		
	1956	1																				
	1957	31	36	(1.16)																		
	1962	30															26	(0.87)				
	1964	7	6	(0.86)																		
Trout Brook	1939	5	6	(1.20)																		
	1940	11	16	(1.45)																		
	1941	9	14	(1.56)																		
	1942	25	52	(2.06)																		

Table D.1.–Continued.

Subwatershed stream	Year	Angler hours	Brook trout		Brown trout		Rainbow trout		Smallmouth bass		Largemouth bass		Bluegill		Pumpkinseed		Yellow perch		Walleye		Northern pike	
			Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH	Catch	CPH
South Branch																						
Trout Brook	1943	3																				
	1945	12	22	(1.83)																		
	1946	4	1	(0.25)																		
	1947	12	3	(0.25)																		
	1948	68	9	(0.13)																		
	1950	3																				
	1953	3	7	(2.33)																		
	1963	2																				

Table D.2.–Angler survey estimates for Bond Falls Flowage (Hanchin, in press). Survey period was May 8 through October 15, 2003. Two standard errors are given in parentheses.

Species	Catch/hour		May	June	July	August	Sept	Oct	Season
			Number harvested						
Smallmouth bass	0.0225	(0.0126)	21 (29)	267 (227)	48 (40)	77 (63)	59 (78)	0 (0)	472 (253)
Walleye	0.0453	(0.0154)	308 (194)	31 (34)	164 (94)	373 (174)	74 (63)	0 (0)	950 (287)
Yellow perch	0.0276	(0.0145	3 (5)	95 (119)	128 (100)	315 (235)	38 (76)	0 (0)	579 (292)
Northern pike	0.0053	(0.0034)	73 (62)	7 (10)	5 (8)	25 (28)	2 (4)	0 (0)	112 (70)
Muskellunge	0.0005	(0.0010)	0 (0)	0 (0)	0 (0)	0 (0)	10 (21)	0 (0)	10 (21)
Black crappie	0.0091	(0.0080)	0 (0)	25 (49)	157 (158)	5 (11)	4 (8)	0 (0)	191 (166)
Bluegill	0.0023	(0.0032)	0 (0)	0 (0)	17 (22)	31 (63)	0 (0)	0 (0)	48 (66)
Largemouth bass	0.0008	(0.0017)	0 (0)	18 (36)	0 (0)	0 (0)	0 (0)	0 (0)	18 (36)
Pumpkinseed	0.0003	(0.0007)	0 (0)	0 (0)	0 (0)	7 (14)	0 (0)	0 (0)	7 (14)
Rock bass	0.0383	(0.0249)	15 (30)	386 (344)	239 (299)	163 (221)	0 (0)	0 (0)	803 (507)
Green sunfish	0.0004	(0.0009)	0 (0)	9 (19)	0 (0)	0 (0)	0 (0)	0 (0)	9 (19)
Total harvested	0.1525	(0.0420)	420 (208)	838 (436)	758 (368)	997 (378)	187 (128)	0 (0)	3,200 (727)
			Number released						
Smallmouth bass	0.0564	(0.0284)	83 (91)	779 (536)	74 (52)	129 (113)	119 (104)	0 (0)	1,185 (568)
Walleye	0.1281	(0.1111)	393 (425)	145 (139)	293 (200)	445 (276)	1,414 (2,225)	0 (0)	2,690 (2,295)
Yellow perch	0.0189	(0.0181)	0 (0)	6 (12)	115 (153)	266 (340)	10 (21)	0 (0)	397 (374)
Northern pike	0.0766	(0.0283)	602 (379)	350 (252)	306 (198)	226 (176)	125 (112)	0 (0)	1,609 (538)
Muskellunge	0.0001	(0.0002)	0 (0)	0 (0)	2 (3)	0 (0)	0 (0)	0 (0)	2 (3)
Bluegill	0.0003	(0.0004)	0 (0)	0 (0)	4 (8)	0 (0)	2 (3)	0 (0)	6 (9)
Rock bass	0.0174	(0.0095)	41 (44)	162 (147)	62 (59)	48 (56)	52 (78)	0 (0)	365 (190)
Total released	0.2978	(0.1260)	1,119 (579)	1,441 (626)	856 (330)	1,113 (488)	1,721 (2,231)	0 (0)	6,252 (2,460)
Total (harvested & released)	0.4503	(0.1409)	1,539 (615)	2,280 (763)	1,615 (494)	2,110 (618)	1,908 (2,235)	0 (0)	9,452 (2,565)
			Fishing effort						
Angler hours			5,048 (2,104)	5,118 (1,318)	3,492 (1,185)	5,203 (1,511)	1,862 (785)	268 (443)	20,991 (3,266)
Angler trips			1,445 (660)	1,937 (658)	980 (349)	1,555 (559)	682 (308)	81 (135)	6,679 (1,190)

Table D.3.–Angler survey estimates for the Cisco Chain (Hanchin et al. 2008). Survey period was May 4 through October 31, 2002. Two standard errors are given in parentheses.

Species	Catch/hour	May	June	July	August	Sept	Oct	Season
					Number harvested			
Brook trout	0.0002 (0.0004)	0 (0)	0 (0)	34 (67)	0 (0)	0 (0)	0 (0)	34 (67)
Lake herring	0.0008 (0.0010)	0 (0)	0 (0)	38 (76)	97 (148)	10 (19)	0 (0)	145 (167)
Lake whitefish	<0.0001 (0.0001)	0 (0)	0 (0)	0 (0)	7 (10)	0 (0)	0 (0)	7 (10)
Smallmouth bass	0.0097 (0.0043)	11 (22)	283 (257)	644 (567)	469 (318)	253 (205)	0 (0)	1,660 (729)
Largemouth bass	0.0048 (0.0024)	0 (0)	167 (171)	579 (372)	62 (77)	13 (18)	0 (0)	821 (417)
Walleye	0.0160 (0.0042)	1,024 (480)	767 (350)	532 (329)	197 (150)	150 (95)	67 (44)	2,737 (704)
Yellow perch	0.3431 (0.0487)	11,358 (4,381)	11,270 (2,714)	12,674 (3,673)	9,496 (2,636)	11,189 (3,135)	2,781 (1,186)	58,769 (7,631)
Northern pike	0.0135 (0.0047)	213 (204)	746 (473)	507 (269)	115 (124)	692 (517)	46 (63)	2,318 (790)
Black crappie	0.0286 (0.0115)	560 (626)	2,297 (1,437)	1,523 (1,102)	104 (85)	413 (325)	5 (9)	4,901 (1,945)
Bluegill	0.2213 (0.0439)	124 (182)	5,493 (2,450)	16,898 (5,445)	8,711 (3,064)	6,070 (2,428)	609 (978)	37,906 (7,206)
Pumpkinseed	0.0103 (0.0056)	0 (0)	529 (686)	789 (595)	190 (144)	256 (243)	0 (0)	1,763 (951)
Rock bass	0.0117 (0.0060)	0 (0)	1,205 (817)	716 (592)	49 (65)	29 (59)	0 (0)	2,000 (1,013)
Round whitefish	0.0004 (0.0006)	0 (0)	0 (0)	0 (0)	62 (105)	0 (0)	0 (0)	62 (105)
Total harvested	0.6604 (0.0738)	13,290 (4,460)	22,756 (4,125)	34,933 (6,761)	19,573 (4,068)	19,075 (4,026)	3,507 (1,539)	113,135 (10,851)
					Number released			
Lake herring	<0.0001 (0.0001)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	7 (13)	7 (13)
Lake whitefish	0.0103 (0.0121)	0 (0)	0 (0)	1,771 (2,073)	0 (0)	0 (0)	0 (0)	1,771 (2,073)
Smallmouth bass	0.1036 (0.0202)	691 (652)	3,259 (1,087)	6,402 (2,247)	5,283 (1,981)	1,902 (792)	204 (172)	17,741 (3,307)
Largemouth bass	0.0320 (0.0077)	525 (348)	1,086 (546)	2,263 (870)	907 (540)	657 (399)	38 (65)	5,476 (1,278)
Walleye	0.0954 (0.0159)	4,335 (1,527)	3,675 (1,387)	2,842 (914)	2,217 (743)	2,271 (687)	1,006 (623)	16,346 (2,550)
Yellow perch	0.3772 (0.0715)	8,132 (6,113)	6,241 (2,089)	21,278 (7,913)	15,138 (4,269)	12,800 (3,659)	1,038 (530)	64,626 (11,672)
Northern pike	0.0697 (0.0150)	2,464 (1,460)	3,149 (1,073)	2,389 (1,110)	1,980 (858)	1,701 (920)	253 (192)	11,936 (2,477)
Bluegill	0.6090 (0.0998)	425 (445)	12,973 (4,766)	37,590 (9,230)	33,354 (9,706)	18,826 (6,994)	1,155 (2,238)	104,323 (16,007)
Pumpkinseed	0.0547 (0.0380)	63 (80)	665 (674)	6,501 (6,294)	1,686 (1,324)	461 (527)	0 (0)	9,376 (6,489)
Rock bass	0.0350 (0.0102)	534 (401)	1,801 (832)	3,080 (1,393)	462 (355)	87 (64)	25 (27)	5,990 (1,710)
Muskellunge	0.0018 (0.0009)	67 (105)	43 (46)	70 (59)	58 (45)	4 (6)	62 (72)	304 (155
Carp	0.0001 (0.0001)	0 (0)	0 (0)	11 (22)	0 (0)	0 (0)	0 (0)	11 (22)
Total released	1.3887 (0.1493)	17,236 (6,516)	32,891 (5,726)	84,196 (14,196)	61,085 (10,946)	38,709 (8,043)	3,789 (2,399)	237,905 (21,611)
Total harvested & released	2.0492 (0.1838)	30,527 (7,896)	55,647 (7,057)	119,129 (15,724)	80,658 (11,678)	57,783 (8,995)	7,296 (2,850)	351,040 (24,182)
					Fishing effort			
Angler hours		26,393 (4,534)	38,124 (4,375)	41,049 (4,891)	30,835 (3,456)	26,570 (4,080)	8,339 (2,155)	171,310 (9,841)
Angler trips		6,224 (1,773)	9,542 (3,334)	9,365 (2,910)	7,681 (2,049)	6,521 (1,716)	1,755 (596)	41,087 (5,498)

Table D.4.–Angler survey estimates for Lake Gogebic (Z. Su, MDNR Fisheries Division, unpublished). Survey period was May 15 through September 30, 2005. Two standard errors are given in parentheses.

Species	Catch/hour	May	June	July	August	Sept	Season
		Number harvested					
Smallmouth bass	0.0114 (0.0047)	87 (103)	466 (299)	104 (87)	318 (247)	178 (176)	1,152 (447)
Walleye	0.0479 (0.0129)	374 (241)	965 (444)	1,202 (443)	1,141 (475)	1,169 (764)	4,851 (1,123)
Yellow perch	0.0891 (0.0251)	987 (858)	849 (478)	3,139 (1,318)	3,131 (1,341)	930 (630)	9,035 (2,213)
Northern pike	0.0014 (0.0009)	25 (38)	41 (50)	48 (48)	6 (13)	25 (32)	145 (86)
Black crappie	0.0001 (0.0001)	6 (9)	0 (0)	0 (0)	0 (0)	0 (0)	6 (9)
Bluegill	0.0005 (0.0008)	0 (0)	0 (0)	0 (0)	0 (0)	47 (85)	47 (85)
Largemouth bass	0.0002 (0.0003)	17 (34)	0 (0)	0 (0)	0 (0)	0 (0)	17 (34)
Pumpkinseed	0.0022 (0.0018)	46 (72)	104 (141)	20 (40)	19 (37)	29 (50)	218 (175)
Rock bass	0.0020 (0.0021)	24 (37)	79 (128)	96 (158)	0 (0)	0 (0)	199 (206)
White sucker	0.0002 (0.0004)	0 (0)	18 (36)	0 (0)	0 (0)	0 (0)	18 (36)
Total harvested	0.1548 (0.0330)	1,565 (902)	2,523 (745)	4,609 (1,404)	4,614 (1,444)	2,378 (1,011)	15,689 (2,539)
		Number released					
Smallmouth bass	0.0679 (0.0295)	438 (475)	4,030 (2,634)	790 (397)	1,368 (804)	256 (231)	6,882 (2,832)
Walleye	0.1452 (0.0366)	2,778 (1,673)	3,532 (1,411)	3,057 (1,169)	3,409 (1,306)	1,947 (1,323)	14,723 (3,100)
Yellow perch	0.0451 (0.0166)	586 (662)	376 (286)	1,342 (752)	1,499 (831)	770 (806)	4,573 (1,558)
Northern pike	0.0339 (0.0105)	683 (478)	1,194 (571)	716 (406)	434 (281)	407 (322)	3,435 (949)
Bluegill	0.0011 (0.0017)	0 (0)	0 (0)	0 (0)	8 (16)	99 (166)	107 (167)
Pumpkinseed	0.0038 (0.0053)	0 (0)	0 (0)	0 (0)	0 (0)	390 (535)	390 (535)
Rock bass	0.0141 (0.0098)	20 (40)	307 (378)	445 (362)	424 (716)	235 (404)	1,431 (976)
White sucker	0.0001 (0.0002)	0 (0)	12 (24)	0 (0)	0 (0)	0 (0)	12 (24)
Total released	0.3113 (0.0635)	4,506 (1,921)	9,451 (3,079)	6,349 (1,545)	7,141 (1,906)	4,105 (1,742)	31,553 (4,714)
Total (harvested & released)	0.4660 (0.0835)	6,071 (2,123)	11,974 (3,168)	10,958 (2,087)	11,756 (2,391)	6,483 (2,014)	47,242 (5,355)
		Fishing effort					
Angler hours		15,430 (6,442)	26,438 (7,108)	21,496 (4,030)	21,765 (4,114)	16,243 (8,515)	101,372 (14,060)
Angler trips		4,649 (1,996)	7,012 (2,487)	7,173 (1,600)	4,757 (1,021)	4,552 (2,895)	28,143 (4,707)