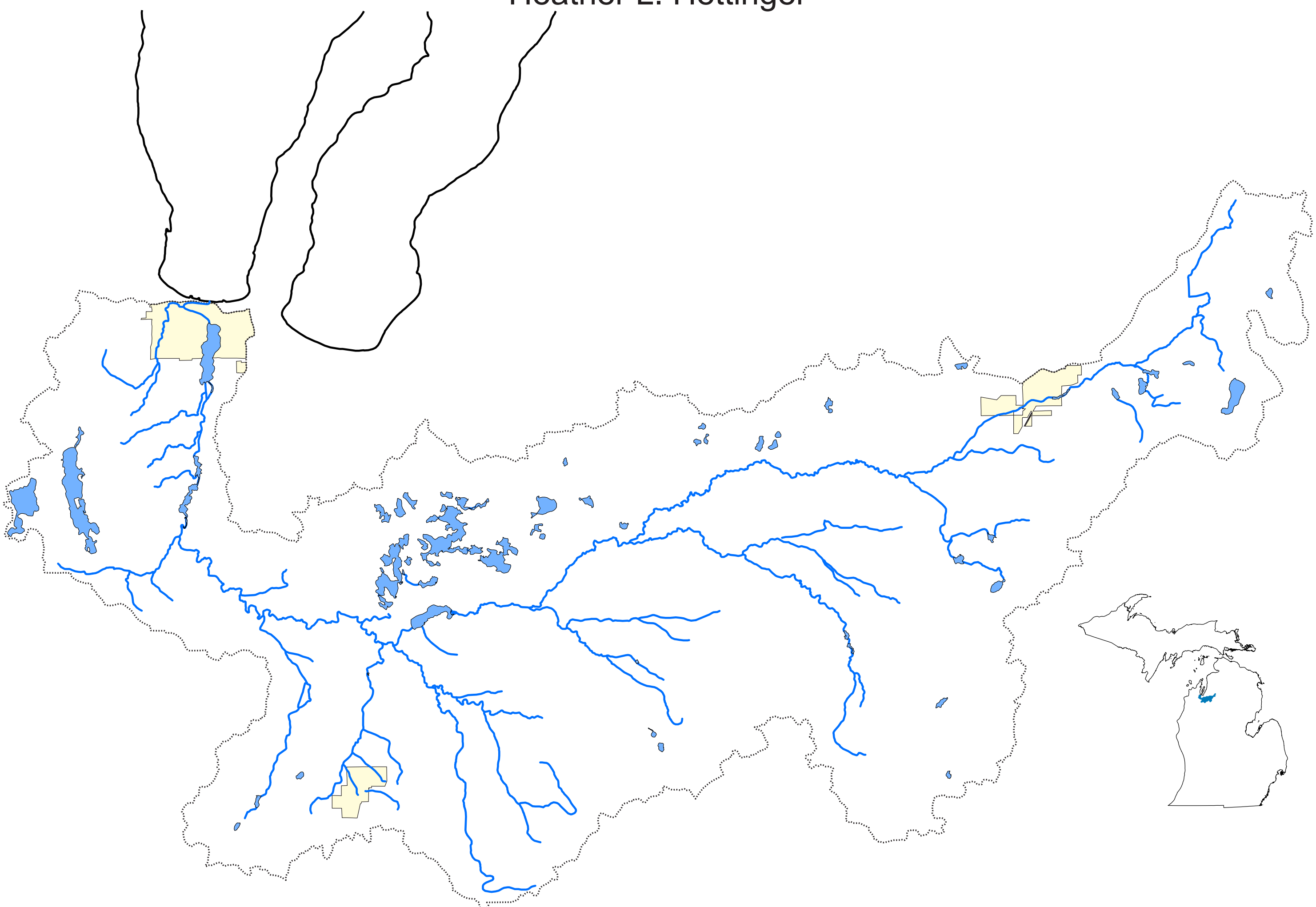
STATE OF MICHIGAN
DEPARTMENT OF NATURAL RESOURCES

FR31

August 2018

Boardman River Assessment

Todd G. Kalish, Mark A. Tonello,
and
Heather L. Hettinger



www.michigan.gov/dnr/

FISHERIES DIVISION
FISHERIES REPORT 31

Suggested Citation Format

Kalish, T.G., M.A. Tonello, and H.L. Hettinger. 2018. Boardman River assessment. Michigan Department of Natural Resources, Fisheries Report 31, Lansing.

For information or assistance on this publication, contact:

MICHIGAN DEPARTMENT OF NATURAL RESOURCES,
Fisheries Division
PO BOX 30446
LANSING, MI 48909
517-373-1280

TTY/TDD: 711 (Michigan Relay Center)

This information is available in alternative formats.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

ACKNOWLEDGEMENTS

We thank the many individuals who helped compile this document. In particular, we thank Todd Wills, Andy Nuhfer, and Tom Rozich, (MDNR) and Steve Largent (Grand Traverse Conservation District) for providing professional support and guidance. We also thank Tiffany Arp and Sarah Grannemann for participating in the Boardman River Assessment internship program during the summer of 2006. We also thank the editorial board and reviewers for this document (MDNR; David Clapp, Tom Rozich, Tim Cwalinski, and Brian Bury). Funding for this project was provided by the Federal Aid in Sport Fish Restoration grant, F-82, Study 232222.

EXECUTIVE SUMMARY

This assessment of the Boardman River watershed is one of a series being prepared by the Michigan Department of Natural Resources (MDNR), Fisheries Division for Michigan rivers. This report describes the Boardman River watershed and its biological communities.

River assessments are intended to provide a comprehensive reference for individuals who seek information about a river system. River assessments compile known information about the watershed and demonstrate how the river is influenced by the physical landscape and the rivers relationship to biological communities. River assessments are prepared to help identify problem areas and provide opportunities for solving these problems. They also identify areas where information is needed to better understand, manage, and protect the river. It is anticipated that this assessment will encourage citizens to become involved in the decision-making process that will benefit the river and its users.

This document consists of four principal sections: introduction, river assessment, management options, and public comments (with MDNR responses). The river assessment is the nucleus of the document. The characteristics of the Boardman River watershed are described under thirteen sections: geography, history, geology, hydrology, channel morphology, dams and barriers, soils and land use patterns, special jurisdictions, water quality, biological communities, fisheries management, recreational use, and citizen involvement.

The management options section identifies a variety of challenges and opportunities for protection, rehabilitation, or obtaining additional information to better understand the Boardman River. These management options are organized according to the main sections in the river assessment. The management options listed are not necessarily recommended by MDNR, Fisheries Division, but are intended to provide a foundation for public discussion and aid in planning for the future of the Boardman River watershed.

The Boardman River watershed drains 287 square miles of land in Grand Traverse and Kalkaska Counties. The watershed also contains 179 lineal miles of perennial streams and 97 natural lakes. For the purposes of this document, the Boardman River main stem is divided into three major sections based on a gradient of physical attributes that change over the course of the River. The sections are: the headwaters to the former Brown Bridge Dam (31.4 miles), the former Brown Bridge Dam to Boardman Dam (12.6 miles), and Boardman Dam to the mouth (6.4 miles).

The Boardman River has been important to humans for hundreds, if not thousands of years. Native Americans used the river for transportation and sustenance. The Boardman River was instrumental in the development of Traverse City and the Grand Traverse region. Early European settlers used the river for floating logs and power generation for sawmills and gristmills. By the late 1800s the recreational qualities of the Boardman River were realized, and since that time the river has been a draw for the tourism industry. Also in the late 1800s and early 1900s, the Boardman River was harnessed to provide industrial hydroelectric power. The Boardman River continues to be a tremendous recreational asset for Traverse City and the Grand Traverse region.

The morphological and hydrological characteristics of the Boardman River watershed are a result of glacial activity approximately 11,000 years ago. The ancestral Boardman River was formed as meltwater flowed from the stagnated glacial retreat. Fifty-one percent of the watershed is composed of glacial outwash sand and gravel, including the entire main stem from the headwaters to Jackson Creek. Most outwash deposits are in excess of 500 feet deep. The glacial outwash deposits in the Boardman River watershed generally have flat to rolling topography and typically do not support agriculture.

Expansive cedar swamps are also typical of the outwash plain. Glacial till (end moraines) and outwash make up 93% of the Boardman River watershed surficial geology.

The Boardman River watershed also contains numerous “pit or kettle” lakes such as Arbutus and Spider. These lakes are contained in outwash plains and were formed as glaciers retreated and left behind large, isolated blocks of ice. These ice blocks were covered in outwash as meltwater flowed from the glacier. Eventually, the outwash-covered ice melted and left basins, which have since been filled with water to form these lakes.

The hydrology of the Boardman River watershed encompasses the movement, distribution, and quality of subsurface, surface, and atmospheric water. The Boardman River is classified as one of the most stable rivers in the state because it has a standardized 5% exceedence (high) flow that is less than twice its median flow. Other rivers in the state that exhibit this level of stability include the Jordan, Manistee, and Au Sable rivers. The hydrologic stability of the Boardman River and its tributaries is environmentally and socially significant. The hydrologic stability buffers the watershed from flashy flood flows that are typical of watersheds with numerous dams, extensive development, or non-permeable soil profiles.

The Boardman River channel drops 495 feet and averages 11 feet/mile gradient from the headwaters to the confluence with Lake Michigan. Gradient remains relatively stable throughout the main stem except in the lower section (Boardman Dam to the mouth) where there is a significant increase in gradient resulting from channel aggradation through a glacial end moraine deposit laden with coarse-textured material. There are currently three dams within this section that impound the historic rapids. The historic rapids within this section are unique and rare in the lower peninsula of Michigan. The Keystone Rapids are indicative of the high quality aquatic habitat that is currently impounded by the three dams.

There are 20 dams in the Boardman River watershed that have at least six feet of head. The three largest dams are Union Street, Sabin, and Boardman, all located within six miles of the river mouth. There are currently no dams within the watershed that produce hydropower. Dams degrade aquatic species and habitat through fragmentation of habitat and intra-species interaction, disruption of natural flow regimes, disruption of natural transportation of sediment and organic material, genetic degradation, and introduction of invasive species. The Boardman River Dams Implementation Team is currently pursuing removal of Sabin and Boardman Dams and modification of Union Street Dam.

The relatively stable flow regime of the Boardman River and its tributaries is primarily due to soil constituency and land use practices within the watershed. Sandy glacial drift comprises approximately 62% of the watershed and is defined by sandy soil such as the Kalkaska, Grayling, and Rubicon soil series. The Fruit Belt comprises 38% of the watershed and is defined by poorly drained organic soils such as Tawas and Carbondale, which are generally dry and acidic in nature, with medium to low fertility depending upon the percent sand composition. The predominant sandy soil constituency of the watershed contributes to its stable flow regime. However, sandy soils are prone to erosion. There are 306 erosion sites and 84 road crossing sites that have been identified on the Boardman River.

The Boardman River watershed has a variety of special designations including 36 miles of Blue Ribbon Trout Stream, 13 designated trout streams, and a State Natural Rivers designation. These designations are a result of diverse aquatic, semi-aquatic, and terrestrial habitat within the watershed that supports significant wildlife populations. Currently the watershed supports three state threatened species (Bald eagle, common loon, and red-shouldered hawk), two state endangered species (king rail and Kirtland’s warbler), three state species of concern (Hill’s thistle, wood turtle, and ebony boghaunter), and five unique habitat types (Great blue heron rookery, dry-mesic northern forest, northern fen, oak-pine barrens, and rich conifer swamp).

The water quality of the Boardman River watershed is generally good, due primarily to the limited amount of development within the watershed. However, increasing developmental pressure within the watershed has the potential to negatively affect aquatic species and habitat. Sediment is the primary non-point source discharge in the watershed. Excessive sediment inflow into the Boardman River watershed adversely affects aquatic habitat and species by disrupting natural flow dynamics that create and maintain critical habitat features such as spawning riffles. The primary sediment inflow sites are road and trail crossings. There are also 11 NPDES permits currently issued within the Boardman River watershed.

A total of 56 species of fish presently inhabit or recently inhabited the Boardman River watershed. Thirty-nine species are native and presently exist within the watershed, one (Arctic Grayling) is native but extirpated, six are native but their current status is unknown, six were introduced and presently exist within the watershed (including the Sea Lamprey, which colonized the Boardman River watershed via the Welland Canal), and four were introduced but their current status is unknown.

The only documented native salmonid in the Boardman River watershed was the Arctic Grayling, although Lake Trout may have been present seasonally. However, in the mid- to late 1800s other salmonids were introduced, including Brook Trout, Brown Trout, and Rainbow Trout. By the turn of the Eighteenth century, Arctic Grayling were extirpated from the Boardman River. Today, the Boardman River supports a typical coldwater resident and migratory fishery consisting of self-sustaining Brook and Brown trouts, and stocked steelhead, Chinook, and Coho salmons (below Sabin Dam). Minimal natural reproduction of migratory salmonids including steelhead, Coho Salmon, and Chinook Salmon has been documented in the Boardman River below Sabin Dam and in several tributaries.

The Boardman River watershed hosts approximately two million recreational user days per year. The watershed offers a variety of public recreational opportunities. There are five state forest campgrounds and a comprehensive trail system that supports biking, hiking, horseback riding, and snowmobiling. State forest public land comprises thirty-two percent (58,292 acres) of the entire Boardman River watershed.

Public involvement in the management, protection, restoration, and enhancement of the Boardman River watershed is a crucial component of sustaining the long-term health of the watershed. There are numerous avenues available for public involvement in sustaining the health of the Boardman River watershed including participation in non-profit groups such as the Grand Traverse Conservation District, the Conservation Resource Alliance, the Grand Traverse Regional Land Conservancy, the Watershed Center Grand Traverse Bay, and the Boardman River Dams Implementation and Prosperity Teams.

This page was intentionally left blank.

Michigan Department of Natural Resources
Fisheries Report 31, 2018

BOARDMAN RIVER ASSESSMENT

Todd G. Kalish

Michigan Department of Natural Resources, Fisheries Division,
P.O. Box 30446, Lansing, Michigan 48909

Mark A. Tonello

Michigan Department of Natural Resources, Cadillac Customer Service Center,
8015 Mackinaw Trail, Cadillac, Michigan 49601

Heather L. Hettinger

Michigan Department of Natural Resources, Traverse City Customer Service Center,
2122 South M-37, Traverse City, Michigan 49685

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:

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 mainstem and tributaries.

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

Throughout this assessment we use data and shape files downloaded from the Michigan Geographic Data Library, maintained by the Michigan Center for Geographic Information (MDNR 2004). These data provide measures of watershed surface area for numerous categories (e.g., soil types, land use, surficial geology), measures of distance (e.g., stream lengths), and creation of associated figures. We used ArcView GIS 3.2a or ArcGIS (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 March 2014. A public meeting was held at the Grand Traverse County Nature Center, 1450 Cass Road, Traverse City, on Monday, April 14, 2014, with 22 people in attendance. Written comments were received through May 16, 2014, however, additional comments received through the end of the summer of 2014 were accepted. 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, Central Lake Michigan Management Unit
Traverse City Customer Service Center
2122 South M-37
Traverse City, Michigan 49685

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

RIVER ASSESSMENT

Geography

The Boardman River watershed is located in Grand Traverse and Kalkaska Counties in the Northern Lower Peninsula of Michigan (Figure 1). The Boardman River watershed encompasses 17 townships, two cities (Traverse City and Kalkaska), and three villages (Kingsley, Mayfield, and South Boardman). The river originates in the Mahan swamp (1,090 feet above sea level) in north central Kalkaska County, flows southwest for 44 miles, then turns north and flows 6.4 miles before entering West Grand Traverse Bay, Lake Michigan in Traverse City (577 feet above sea level). The Boardman River watershed drains a surface area of approximately 287 square miles and includes 179 lineal stream miles and 74 lakes (Figure 2).

The physical characteristics (channel morphology, gradient, flow, and valley form) of the Boardman River change from the headwaters to the mouth. Therefore, for the purposes of this document, the Boardman River main stem is divided into three sections based on a gradient of physical attributes that change over the course of the river. The sections are: the headwaters to the historic Brown Bridge Dam location (31.4 miles), the historic Brown Bridge Dam location to Boardman Dam (12.6 miles), and Boardman Dam to the mouth (6.4 miles). The sections were delineated based, in part, on the valley segment ecological classification system (Seelbach et al. 1997) which identifies 18 valley segments within the Boardman River watershed and nine within the main stem (Figure 3).

Headwaters to the historic Brown Bridge Dam

This section begins at 1,090 feet above sea level in Kalkaska County, and flows west for 31.4 miles to the historic Brown Bridge Dam location (768 feet above sea level). This section contains five major tributaries (Crofton, South Branch, Taylor, Carpenter, and Twenty-two creeks) and one major impoundment (Brown Bridge Pond). The South Branch is the most influential tributary within this section because it contributes the most flow volume.

Historic Brown Bridge Dam to Boardman Dam

This section begins at 768 feet above sea level at the historic Brown Bridge Dam location and flows southwest for 12.6 miles to Boardman Dam (614 feet above sea level). This section contains five major tributaries (East, Jackson, Swainston, Jaxon, and Beitner creeks) and one impoundment (Boardman Pond). East Creek is the most influential tributary within this section because it contributes the most flow volume.

Boardman Dam to the Mouth

This section begins at 614 feet above sea level at Boardman Dam and flows north for 6.4 miles to the mouth (577 feet above sea level). This section contains two major tributaries (Kids and Miller creeks), one major impoundment (Sabin Pond), and a natural lake (Boardman Lake).

History

The Boardman River watershed was formed near the end of the last glaciation period, the Wisconsin Period of the Pleistocene Epoch. After a number of glacial advances and retreats, the area became ice-free approximately 11,000 years ago (Farrand 1988). The glaciers are responsible for shaping much of Michigan's landscape, including the Boardman River watershed. The moraines (large hills), till (rock material), and outwash sand left behind by the glaciers are the reason the Boardman River is a stable, groundwater-fed trout stream today.

The Boardman River originated as a powerful river of glacial meltwater, much larger than it is today. It originated north of Elmira and flowed south through Antrim, Kalkaska, and Grand Traverse Counties, through Interlochen into Manistee County near Kaleva where it joined the Manistee River (Martin 1957). It likely flowed into the Manistee River through the channel that is now occupied by Bear Creek. The Mancelona gravel plain was likely built by the Boardman River (Martin 1957). The "modern" Great Lakes were fully formed about 3,000 years ago. It was likely around this time that the Boardman River flow was diverted to the north away from the Manistee River and into the west arm of Grand Traverse Bay (Martin 1957).

Paleo-Indians likely began to inhabit the Boardman River watershed soon after the glaciers receded. However, the earliest archaeological traces of humans in the region date back to the late Archaic period, approximately 4,000 years ago (B. Mead, Michigan Department of State, Archaeological Section, personal communication). Most Native American archaeological sites in the Boardman River watershed are less than 1,000 years old, from the Late Woodland period (B. Mead, Michigan Department of State, Archaeological Section, personal communication).

The Boardman River was originally named "the Ottawa" after the local band of Native Americans. The Boardman River watershed was very important to Native Americans before white settlers arrived. Native Americans camped at Squaw Point (near the Lake Michigan confluence), fished for Walleye *Sander vitreus* in Boardman Lake, and picked blueberries inland. Apparently they camped on Boardman Lake during the winter and the men of the tribe went on hunting trips inland (Rayle 1982). They used the Boardman River for transportation (Anonymous 1982b).

The "Ottawa" river was eventually changed to the Boardman, recognizing Captain Harry Boardman, from Napierville, Illinois, who was the first white settler in the Boardman River watershed. He arrived and settled in the spring of 1847 near the mouth of the Boardman River. He purchased the portion of land where Traverse City now lies, between Boardman Lake and West Grand Traverse Bay, including the river. Mr. Boardman came to the region seeking timber. Here are some descriptions of what Mr. Boardman would have seen at that time:

> "The Boardman River was a vast pinery with virgin Norway and White pine, hemlock and cedar; with hardwoods of maple, beech, elm, oak, ash, and birch along its sandy ridges. The Boardman flowed clear and pure." (Melkild 1982a).
>
> "The Boardman River, a glorious and beautiful stream at that time, was much larger in water volume than at present. The portion of the main river was described as 200 feet wide. It was teeming with speckled trout and grayling before the lumbering began" (Rennie and Swibold 1982).

Shortly after arriving in 1847, Mr. Boardman and his son constructed a saw mill on what is now Kid's Creek; this was the first dam constructed within the Boardman River watershed (Rayle 1982).

In the spring of 1851, Mr. Boardman sold his land, sawmill, and buildings to Hannah, Lay, and Co. for $4,500. Hannah, Lay, and Co. consisted of Perry Hannah, A. Tracy Lay, James Morgan, and later William Morgan. These men are commonly known as the founding fathers of Traverse City (Rayle 1982). They immediately set about to clear the upper Boardman River of fallen trees and debris so that logs could be floated. In 1853, they converted the saw mill on Kid's Creek into a grist mill after constructing a larger steam-powered saw mill on the narrow strip between the river and the bay (Hesselbart 1982; Rayle 1982).

The first permanent dam on the Boardman River was constructed in 1867 by Perry Hannah, between Cass and Union Streets in Traverse City. It was constructed to power a large grist mill which operated until 1926, when it burned down. The dam was renovated in the 1960s, and today is known as the Union Street Dam.

From 1851 through 1886, the Boardman River hosted major log drives consisting of millions of board-feet of timber each year. Timber mills were located in Traverse City on the Boardman River, and on Long Lake, several miles west of the city. Arbutus Lake was used as a staging area where logs were deposited into the lake and then transported three-quarters of a mile overland to the Boardman River via a short-haul gravity railway (Rennie and Swibold 1982).

> "The extensive logging damaged riverbanks, increased erosion, and increased sedimentation. The river was cleared to make it into a conduit for the transport of logs. Dams were built to facilitate log drives. Sawdust and other debris from the mills were dumped into the river and into Grand Traverse Bay. These changes devastated the river's ecosystem" (B. Mead, Michigan Department of State, Archaeological Section, personal communication).

The Boardman River watershed was essentially logged off by 1886, and the days of the river log drives came to an end. At the end of the logging era, numerous Michigan rivers were viewed as a potential source of power, and hydroelectric dams were constructed. The Boardman River was no exception. The first major hydroelectric dam built on the main stem of the Boardman River was Boardman Dam, which was completed in 1894. Sabin Dam was completed in 1907, and Keystone Dam in 1908. The last major hydroelectric dam constructed on the Boardman River was Brown Bridge Dam, constructed in 1921. All of the hydroelectric dams are still in place, except for Keystone Dam, which washed out in 1961 and was not rebuilt (Hesselbart 1982; Kellum 1982).

Although the early Traverse City economy was reliant on the timber industry, by the end of the lumbering era it had diversified enough to survive. Manufacturing, retail, tourism, and other businesses flourished and helped make Traverse City what it is today, the largest city in the Northern Lower Peninsula.

> "As forests were cleared, farmers moved in. Tree-related enterprises such as fruit orchards and maple syrup production thrived. However, in much of the Boardman drainage, the climate and soils did not prove to be conducive to agriculture, and by the early twentieth century, many farms were abandoned. Many of these farms and cut-over lands, abandoned by the lumbering companies, ended up in state ownership and were later managed as state forests" (B. Mead, Michigan Department of State, Archaeological Section, personal communication).

Tourism has always been a strong component of the economy of the Grand Traverse region. Much of the tourism was (and still is) supported by the Boardman River watershed. Early recreation guides describe the excellent fishing in the Boardman River and the lakes in the watershed:

> "This stream is believed by many to be the trout stream of Northern Michigan" (Anonymous 1876).

> "The Boardman River, its branches, and all the streams in the neighborhood of Traverse City contain Brook Trout" (Anonymous 1876).

> "There is splendid pickerel fishing in Boardman Lake within the village limits." (Bates and Buck 1891).

One recreation guide even mentions camping sites along the Boardman River:

> "Parties desiring can find good camping grounds at the "Forks" of the river, State Road Bridge, Railroad crossing near Mayfield town line, and Smith's Farm, all on the Boardman River" (Anonymous 1876).

A fly pattern that is still very popular today with fly-fishing anglers was developed on the Boardman River:

> "It was Leonard Halladay of Mayfield who first tied this fly pattern in 1922, then named it in honor of his good friend, C. F. Adams, an ardent angler who loved to fish the Boardman River nearby. A combination of brown and grizzly hackles, it is a dry fly that many fishermen claim is the best ever made. Some, in fact, say that if they had to use only one fly for all of their trout fishing, it would be the Adams, which imitates a variety of mayflies." (Charles 1982).

The Michigan Historical Center lists 83 archaeological sites within the Boardman River watershed (Table 1). However, professional archaeologists have inspected less than 1% of the land in the northwestern Lower Peninsula. Given the size of the Boardman River watershed, Mead (personal communication) expects that well over 500 archaeological sites exist in this area. Forty-nine of the known archaeological sites are of Native American origin, while the rest are of Nineteenth and Twentieth century origin. The majority of archaeological sites are Native American camps (19) and burial mounds (5), and Nineteenth and Twentieth century homestead (9) and farmstead sites (8).

Geology

The surficial geology of the Boardman River watershed is a direct result of glacial activity approximately 11,000 years ago. The Boardman River watershed present-day surficial configuration began to form as the ice retreated northward and formed the Port Huron moraine (Martin 1957). The Port Huron moraine creates the southern border of the watershed (Figure 4), and was created as the ice margin remained in one location, while internally the glacier transported sediment forward and deposited it at the current moraine as glacial till. Course-textured glacial till (sand, cobble, and rocks of various sizes) were deposited and formed irregular landforms and terraces observed today at the headwaters of Swainston, East, Carpenter, Bancroft, and Taylor creeks. Glacial till deposits in the Boardman River watershed form gently rolling hills that support a variety of agriculture (row crops and pasture) and typically support hardwood vegetation.

The northern border of the Boardman River watershed was formed by the Manistee moraine (Farrand 1988). After formation of the Port Huron moraine, the glacial retreat in the Grand Traverse region continued until it came to a standstill when the Manistee moraine was formed. The Manistee moraine forms portions of the northern and eastern borders of the Boardman River watershed, and is composed of glacial till similar to the Port Huron moraine. The Manistee and Port Huron moraines till comprise forty-two percent of the Boardman River watershed.

The ancestral Boardman River channel was formed as large quantities meltwater, flanked by the Port Huron and Manistee moraines, flowed from the stagnated glacial retreat. Large quantities of water flowed from the stagnated glacial retreat and carved the ancestral Boardman River channel. Water flowed south of its current path into the ancestral Manistee River and transported sediment (primarily sand and gravel) from the glacier and deposited it in the main stem valley (Martin 1957). Fifty-one percent of the watershed is composed of glacial outwash sand and gravel, including the entire main stem from the headwaters to Jackson Creek. Most outwash deposits are in excess of 500 feet deep (Boardman River Management Plan Committee 2002). These outwash deposits are composed primarily of Northern Michigan and Wisconsin sandy drift. This sandy soil is well drained, which contributes to the stable flow regime of the Boardman River and associated tributaries. The glacial outwash deposits in the Boardman River watershed generally have flat to rolling topography and typically do not support agriculture (see *Soils and Land Use*). Expansive cedar swamps are also typical of the outwash plain.

The Boardman River watershed also contains numerous “pit or kettle” lakes such as Arbutus and Spider. These lakes are contained in outwash plains and were formed as glaciers retreated and left behind large, isolated blocks of ice. These ice blocks were covered in outwash as meltwater flowed from the glacier. Eventually, the outwash-covered ice melted and left basins, which have since been filled with water to form these lakes.

Glacial till (end moraines) and outwash make up 93% of the Boardman River watershed surficial geology. The remaining watershed is composed of lacustrine sand and gravel and small sand dunes. The lacustrine sand and gravel deposits encompass the Boardman main stem from Boardman Pond to its confluence with Lake Michigan. This area was once inundated by the ancestral Lake Algonquin (precursor to the current Great Lakes). As the glaciers retreated, the ancestral lake bed uplifted and formed the current Boardman Lake.

Sand dunes make up a very small portion of the Boardman River watershed. Sand dunes are located at the headwaters of Carpenter, Taylor, and Crofton creeks. Sand dunes are composed of extremely dry sand transported primarily by wind action. Agriculture and vegetation growth is limited in these areas.

The other geologic component of the Boardman River watershed is bedrock geology. The bedrock geology of the watershed is important because it affects the flow regime and water quality of the Boardman River. In addition, the bedrock geology is economically significant in the watershed. Mississippian-aged bedrock is overlain by approximately 100–1,000 feet of glacial sediment throughout the watershed. The primary bedrock formations in the watershed are Coldwater, Ellsworth, and Antrim shales. Antrim shale is known for its oil and gas producing capabilities. There are 584 oil and/or gas related wells in the watershed (Figure 5). The continued oil and gas development within the Boardman River watershed may pose risks to water resources, and should be closely monitored. As stated by Zorn and Sendek (2001):

> “Efforts to minimize the adverse effects of oil and gas development have met with fair success. Improved techniques have been developed for drilling and laying subsurface pipelines. Replanting work areas has reduced sedimentation, but work is needed to ensure that disturbed soils are quickly re-vegetated. Problems with excess noise from facilities have been addressed with varying degrees of success. Density of future wells is limited to one well per 80 acres. Increased spacing of wells and use of angular drilling techniques would reduce the density of well pads and resulting sedimentation. Regulations have been passed that require on-site containment of accidental spills. Most spills from the past (20-40 years ago) have been, or are nearly, cleaned up. However, erosion damage resulting from illegal use of pipeline right-of-ways and access roads by off road vehicles is a concern. Concerns still exist regarding groundwater contamination due to improper containment of drilling fluids, disposal of cuttings from drilling activities, equipment lubricant spills, and leaks from deteriorating flow lines. Potential sedimentation from new roads, well pads, and flow and sales lines is also a cause for concern. Continued vigilance is needed to minimize the effects of oil and gas development on the [Boardman River’s] sensitive surface and groundwater resources. The need to protect groundwater resources from contamination is especially critical when exploiting oil-rich formations, such as the Niagara.” (R. Henderson, MDEQ, Geology Division, personal communication).

Hydrology

Hydrology describes the movement, distribution, and quality of subsurface, surface, and atmospheric water. This section is dedicated to describing how water moves throughout the Boardman River watershed. Water circulates throughout watersheds at different rates based on a variety of factors described elsewhere in this text (geography, geology, channel morphology, dams and barriers, and soils and land use). The rate at which water circulates throughout the watershed creates and maintains wildlife habitat, and therefore, affects the wildlife species compositions of the watershed. In addition, hydrologic aspects of the Boardman River watershed can be manipulated and degraded by anthropogenic practices, particularly land use practices, dams and barriers, and water withdrawals. Therefore, there are two primary purposes to documenting the hydrologic parameters of the Boardman River watershed: 1) provide a foundational data-set from which a continuous monitoring of anthropogenic effects to wildlife habitat and species can be accomplished and 2) provide a succinct description of the habitat components that appropriate management agencies can use to assure land-use practices are compatible with hydrologic capacities of the watershed.

Climate

The hydrology of the Boardman River watershed is determined primarily by climate. The Boardman River watershed is characterized by a short growing period (132 calendar days) compared to other areas of the Northern Lower Peninsula (Albert 1995; Cummings et al. 1990). The climate is strongly influenced by Lake Michigan. The Lake Michigan lake-effect increases annual precipitation (95 in annual average snowfall and 33 in of rainfall) and moderates spring and summer temperatures (45° F average annual) (Michigan Department of Agriculture 2000). Lake-effect precipitation is produced when large expanses of cool or cold dry air migrate easterly across the relatively warmer Lake Michigan. Water from Lake Michigan evaporates and is deposited in the “snow belt” areas of Michigan.

Daily, Seasonal, and Annual Streamflows

The United States Geological Survey (USGS) records daily discharge values for the Boardman River at Brown Bridge Road near Mayfield USGS gaging station, located near the Ranch Rudolf campground (Figure 1). The Boardman River is a relatively stable system as depicted by minimal variation in the average monthly flows (Figure 6) and standardized exceedence flow values (Figures 7 and 8). Relatively high flows are typical during spring runoff (March and April), and base flow persists from August through February. Flow stability is depicted by relatively high standardized discharge values during low flows (Figure 7) and low standardized values during high flow conditions (Figure 8).

The Boardman River can be classified as one of the most stable rivers in the state because it has a standardized 5% exceedence (high) flow that is less than twice its median flow. Other rivers in the state that exhibit this level of stability include the Jordan, Manistee, and Au Sable Rivers. The average annual discharge for the Boardman River (1997-2005 period of record, from the Brown Bridge Road USGS gage) is 111 cubic feet per second (cfs) and the average annual yield is 0.79 cfs/sq mile of watershed.

Another index of flow stability is the ratio of mean high to mean low flow. The highest and lowest mean monthly flows for the Boardman River were averaged over the USGS period of record (1997-2005). The ratio of the high and low flow averages was 1.96 (Table 2), which indicates stable flows dominated by groundwater (P. Seelbach, Michigan Department of Natural Resources (MDNR), Fisheries Division, personal communication).

Channel Morphology

River gradient is an important determinate of channel form and function. Therefore, river gradient is one of the most important factors in determining distribution and abundance of fish species (Hynes 1970; Knighton 1984). Aquatic species are typically most diverse and productive in river sections with gradient between 10 and 69.9 ft/mi (G. Whelan, MDNR, Fisheries Division, personal communication; Trautman 1942).

The Boardman River channel drops 495 feet and averages 11 ft/mi gradient from the headwaters to the confluence with Lake Michigan. The river has regular riffle-pool sequences with excellent hydraulic diversity (Figure 9). Gradient remains relatively stable throughout the main stem except in the lower section (Boardman Dam to the mouth) where there is a significant increase in gradient (Figure 10). This increase in gradient is a result of the river channel cutting through a glacial end moraine deposit laden with coarse-textured material such as sand and gravel. There were historically three hydroelectric dams constructed within this section due to the high gradient. The gradient from the Boardman impoundment downstream to the Sabin impoundment (one river mile) is one of the most significant gradients of any river (of comparable size to the Boardman River) in the lower peninsula of Michigan (D. Borgeson, Michigan Department of Natural Resources (MDNR), Fisheries Division, retired, personal communication.

Channel Cross Sections

Channel cross sections measure morphological diversity in a stream channel, and therefore may be used to show the quality of fish habitat in a stream (Schneider 2000). The Boardman River watershed does not have adequate channel cross section data to assess morphological diversity. However, the Boardman River Dams Committee (a collaborative of Boardman River watershed stakeholders) has contracted with an environmental consulting firm to conduct a variety of cross sections with the river to assess the potential effects of various dam disposition options. These data will be available in 2008 and incorporated into this document during the next revision.

Dams and Barriers

There are 20 dams in the Boardman River watershed that have at least six feet of head (Figure 11). Detailed information regarding impoundment size, owner, and dam height is lacking for most of the dams on the Boardman River tributaries. The four largest dams are located on the main stem.

The Union Street Dam was constructed in 1867 to supply power for a now defunct flourmill. It is owned by the City of Traverse City and its current purpose is to maintain the water level in Boardman Lake. The dam has nine feet of head and is composed of earthen materials and steel sheet pile. This is the only dam within the Boardman River watershed that is equipped with a fish ladder, constructed to allow migration of migratory salmon and trout while blocking upstream Sea Lamprey *Petromyzon marinus* migration.

The Union Street Dam impoundment, Boardman Lake, is a natural lake that was originally 259 acres in size and increased to 339 acres after the Union Street Dam was constructed. There are approximately 40 privately owned parcels and two parks, one with a boat ramp, on Boardman Lake.

Sabin Dam was constructed in 1906 and was rebuilt to its current configuration in 1930. It is an earthen and concrete dam with 20 feet of head and a powerhouse that was historically capable of generating 500 kilowatts (0.5 megawatt) per year. The dam's impoundment, Sabin Pond, is 40 acres in size and has a drainage area of 269 mi^2.

Sabin Dam is owned by Grand Traverse County and historically generated hydropower for Traverse City Light and Power Department (TCLPD), which is a community-owned, municipal utility. By agreement between Grand Traverse County and TCLPD, the Sabin Dam was retrofitted to produce hydropower and began generating again in 1986. Sabin Dam is operated as a run-of-river dam; a hydroelectric dam lacking a large reservoir and, therefore, with only a limited capacity for water storage. This means a run-of-river dam has limited control over its outflow and power generation. Sabin Dam was decommissioned as a hydropower-producing facility in 2006.

The Boardman Dam is owned by Grand Traverse County and historically generated hydropower for TCLPD. The Boardman Dam is operated as a run-of-river dam. Also locally referred to as Keystone Dam, it was constructed in 1894 and rebuilt to its current configuration in 1930. It is an earthen and concrete dam with 42 feet of head and a powerhouse that was historically capable of generating 1,000 kilowatts (1.0 megawatt) per year. Boardman Dam was decommissioned as a hydropower-producing facility in 2006.

The Boardman impoundment is known locally as both Boardman Pond and Keystone Pond. Boardman Pond is 102 acres in size and has a drainage area of 267 mi^2. Twenty-seven private parcels either border or have deeded access to Boardman Pond. The Michigan Department of Environmental Quality (MDEQ) required Boardman Pond to be lowered 14 feet from June-August, 2007 because the current spillway configuration is not capable of complying with the Michigan Dam Safety Statute. The MDEQ required the dam owner to assure compliance with the Michigan Dam Safety Statute by December 31, 2008.

The Brown Bridge Dam was constructed in 1921 and was removed in 2012. It had 33 feet of head and was an earthen and concrete dam with a powerhouse historically capable of generating 725 kilowatts (0.725 megawatt) per year. It was owned by Traverse City and historically generated hydropower for TCLPD. Brown Bridge Dam was operated as a run-of-river dam. The Brown Bridge Pond was 191 acres in size and had a drainage area of 151 mi^2. Brown Bridge Dam was decommissioned as a hydropower-producing facility in 2006.

The three former hydropower dams, Sabin, Boardman, and Brown Bridge, accounted for approximately 3.4% of the electricity needs for TCLPD's rate payers. On May 31, 2005 a settlement agreement was executed among nine governmental and non-profit entities to transfer regulatory jurisdiction of these three dams from Federal Energy Regulatory Commission (FERC) to the MDEQ and to facilitate an assessment of the environmental, economic, and social benefits and detriments of dam retention, modification, and removal (Appendix A). The Boardman River dams Committee (BRDC) was formed in 2005 to engage all interests in assessing and recommending the fate of the dams based upon a thorough analysis of options, including long- and short-term economic, social, environmental, aesthetic, transportation, and ecological impacts on the community, individuals, and riparian landowners. The BRDC provided a recommendation to gather specific additional information to clarify questions regarding the option to retain the dams from hydropower and electric utility companies statewide, and provided rationale for the option to remove the three largest dams and modify Union Street in 2008. In 2009, Grand Traverse County and Traverse City collected additional information and decided to pursue removal of Sabin, Boardman, and Brown Bridge dams and modification of Union Street dam to assure continued capacity to prohibit exotic invasive species migration such as Sea Lamprey. Additional information on the history and current activities of the Boardman River Dams Implementation Team can be found at theboardman.org.

The degrading effects of impoundments on fisheries habitat and populations are well-documented (Morita and Yamamoto 2001; Pejchar and Warner 2001; Taylor et al. 2001; Kanehl et al. 1997). The specific adverse effects of dams on trout populations and habitat in the Boardman River are: habitat fragmentation, habitat degradation, thermal disruptions, and introduction of invasive species.

The Union Street, Sabin, Boardman, and historic Brown Bridge dam affect the entire Boardman River watershed, including the tributaries. At the fish community level, overall aquatic productivity and diversity are degraded due to the loss of connectivity and degradation of habitat (Burroughs 2007b). At the stream morphology level, bedform and substrate compositions are affected (high occurrence of run bedforms and low percentage of sands) for 1.2 miles downstream of the historic Brown Bridge dam and 0.5 miles downstream of Sabin Dam (Burroughs 2007b). Aquatic habitat is further degraded by the restriction of woody material movement throughout the Boardman River. Woody material was less abundant downstream of the historic Brown Bridge Dam than upstream (Burroughs 2008). The degradation of the Boardman River watershed habitat is cumulative as long as the dams are in place. In addition, sediment continually accumulates within and upstream of the impoundments. There are large sediment plumes at the headwaters of all the impoundments on the Boardman River main stem. The continual accumulation of sediment upstream of the impoundments widens the stream channel, covers substrate, and aggrades the channel. The continual accumulation of sediment within the impoundments also degrades habitat, and will negatively affect the fish populations within these impoundments over time. The fish population within Sabin Pond is classified as poor due to low relative abundances of most game fish, and small average sizes of Northern Pike *Esox lucius.* The fish population within Boardman Pond is also classified as poor for all game fish except Smallmouth Bass *Micropterus dolomieu* (Burroughs 2008).

The Boardman River main stem dams all draw water from the top of the water column, raising water temperature and directly affecting coldwater fish species. The MDNR Fisheries Division collected water temperatures at hourly intervals two miles upstream of the historic Brown Bridge Pond inlet (Sheck's campground) and 0.20 miles downstream from the historic Brown Bridge Dam (canoe launch) throughout 2002. Water discharged out of the historic Brown Bridge Dam averaged 6°F warmer than water in the upstream channel from June-August 2002 (Figure 12). This discrepancy is counter to the requirements of the administrative rules associated with Part 31, Water Resources Standards, of the Natural Resources and Environmental Protection Act, 1994 PA 451. This rule states that rivers, streams and impoundments naturally capable of supporting coldwater fish shall not receive a heat load which would increase the temperature of the receiving waters at the edge of the mixing zone more than 2°F above existing natural water temperature.

The negative effects of warmwater discharge on coldwater fish species in the Boardman River were documented by Lessard and Hayes (2003). They sampled the Boardman River at six randomly selected 300-foot sample sites (three sites were located within a three mile stretch downstream of the historic Brown Bridge Dam and three sites were located within a three mile stretch upstream of the inlet to the historic Brown Bridge Pond). They documented significant upstream versus downstream differences in population abundances of Slimy Sculpin *Cottus cognatus*, Brook Trout *Salvelinus fontinalis*, and Brown Trout *Salmo trutta* (Lessard and Hayes 2003). They attribute the decreases in abundance to the adverse effect the Brown Bridge Dam warmwater discharge had on coldwater fish populations, since water temperature was the only habitat variable that was significantly different between the upstream and downstream sample sites.

Damming the Boardman River also allowed the exotic zebra mussel to inhabit the historic Brown Bridge and Boardman Ponds. Zebra mussels disrupt the food web of an ecosystem, negatively affecting native fish populations (Griffiths et al. 1989). If these dams were removed, zebra mussel colonization would likely be limited to Boardman Lake and other inland lakes since the Boardman River main stem does not provide optimal zebra mussel habitat (Griffiths et al. 1989).

In addition to the large dams on the Boardman River main stem, there are numerous small, private dams in the watershed. More thorough documentation of these dams and their social, environmental, and economic benefits and detriments is needed.

One of the oldest small dams in the watershed is the Swainston Creek Dam in the town of Mayfield. The Swainston Creek Dam creates an impoundment which is periodically stocked with Brook Trout by a local sportsmen's club, and supports a fair population. There is a bypass channel around the dam that carries a portion of the flow from Swainston Creek, but the channel is constructed of steeply-contoured smooth concrete and does not allow fish passage as it is currently configured. Another small dam is located on the North Branch of the Boardman River in the Village of Kalkaska (Kalkaska Mill Pond Dam). This dam creates an impoundment that supports a poor fishery due to the lack of water depth and sufficient habitat. Another small dam was constructed on Beitner Creek in 1875 to power a saw mill and a grist mill, and is still in place (Anonymous 1982a).

The Young's (upper dam) and Wellman (lower dam) dams were constructed in 1888 and 1889 as hydropower facilities. These dams are approximately ½ mile apart, in the South Branch of the Boardman River near the village of South Boardman. The Wellman impoundment was stocked by the MDNR Fisheries Division with 95 adult Brook Trout and 230 adult Rainbow Trout *Oncorhynchus mykiss* in 1989. The MDNR Fisheries Division recorded water temperatures over a three day period below Young's Dam and Wellman's Dam in August, 1970. Maximum water temperatures were 57° F below Young's Dam was and 67° F below Wellman's Dam.

Soils and Land Use Patterns

The relatively stable flow regime of the Boardman River and its tributaries is primarily due to soil constituency and land use practices within the watershed. There are two major Land Resource Areas (areas with similar soil constituency, climate, and geology) within this watershed: the Northern Michigan and the Wisconsin Sandy Drift, and Western Michigan and Northeastern Wisconsin Fruit Belt (Figure 13). The Sandy Drift area comprises 62% of the watershed and is defined by sandy soil such as Kalkaska, Grayling, and Rubicon series. These soils are, for the most part, dry sandy soils, acidic in nature, very pervious and low in fertility. The Fruit Belt (38% of the watershed) is defined by poorly drained organic soils such as Tawas and Carbondale, which are generally dry, acidic in nature with medium to low fertility, depending upon the amount of sand in the composition. Predominantly sandy soils within the watershed contribute to flow stability. However, sandy soils are also prone to erosion. Erosion and deposition are natural processes within watersheds, but anthropogenic activity can accelerate erosion, negatively affecting aquatic habitat and species. There are 306 anthropogenic erosion sites and 84 road-stream crossing sites that have been identified on the Boardman River (Largent 2006). Twenty-nine sites have been classified as severe, and twenty perched culvert sites have been identified (Figure 14).

Severe erosion sites negatively affect aquatic habitat and species through the continuous input of excessive sediment into the river. Continuous, unnatural sediment input disrupts the natural erosion-deposition process and can reshape the river channel by decreasing the ability of the river to scour its channel and expose substrate used by a variety of aquatic species for spawning, feeding, rearing, and refuge. The severe erosion sites within the Boardman River watershed are inadequately designed and maintained trail crossings, road-stream crossings, railroad right-of-ways, undersized culverts, road right-of-ways in close vicinity to the river, and high public-use areas.

Perched culverts also degrade aquatic habitat and species by limiting the movement of species within the watershed. Aquatic organisms including macroinvertebrates and fish need access to a variety of habitats for different requirements of their life cycles (e.g., feeding, reproduction, and survival). When the ability to move freely throughout the entire watershed is prevented by dams or perched culverts, aquatic organisms are forced to fill all habitat needs in smaller segments of the river system. Rarely, some species are able to achieve this, but more often the limited habitat available to them is deficient is some critical aspect, and the population is negatively impacted (Burroughs 2007a).

Land Use

Land use practices within the Boardman River watershed directly affect aquatic habitat and species. Fifty-five percent of the Boardman River watershed is forested, agriculture comprises 17%, wetlands 3%, open areas and water bodies account for 17%, and 8% of the land area is urban, primarily Traverse City (Largent 2006). Approximately 75% of the watershed is in private ownership (Figure 10), and the remaining 25% is in state ownership within the boundaries of state forests. Approximately 54% of the Boardman River frontage is commercially or privately owned, and the remaining 46% is state owned (Figure 15).

According to Comer (1996), approximately 17% of Grand Traverse County, or 32,000 acres, were originally wetland. Comer (1996) estimates that 28,409 acres of wetland remain in Grand Traverse County, meaning that approximately 10% of the original wetland acreage has been lost. The majority of the original 32,000 acres of wetlands were conifer-dominated swamps, including cedar and hemlock. However, nearly 94% of those conifer swamps were either drained or converted to other wetland types, including lowland hardwood swamps and shrub swamps. Only an estimated 7,400 acres of conifer swamp remain in Grand Traverse County. Kalkaska County has also lost a significant amount of wetland acreage, 40% or 14,000 acres out of an original 35,210 acres (Comer 1996). As with Grand Traverse County, lowland conifer swamp has suffered the most, with only 22% of the original conifer swamp land remaining in Kalkaska County.

Special Jurisdictions

Blue Ribbon Trout Stream Classification

The Blue Ribbon Trout Stream program is administered by the Michigan Department of Natural Resources. A Blue Ribbon Trout Stream designation distinguishes certain stream segments based on high quality biological, physical, and chemical attributes. In order to qualify for Blue Ribbon status, stream segments must be able to support excellent stocks of wild resident trout, have the physical characteristics to permit fly casting but be shallow enough to wade, produce diverse insect life and good fly hatches, have earned a reputation for providing an excellent (quality) trout fishing experience, and have excellent water quality. The MDNR has currently designated 868 stream miles as Blue Ribbon in Michigan, and 36 miles are in the Boardman River watershed (Figure 16).

Designated Michigan Trout Streams and Lakes

In addition to the Blue Ribbon Trout Stream Program, the MDNR designates streams and lakes based on their capacity to support coldwater fish populations through the Designated Trout Stream list. The Boardman River watershed has numerous stream segments and three lakes that exhibit these qualities (Table 3).

Dredge and Fill Activities and the Dam Safety Act

The State of Michigan has authority to regulate development activities affecting lakes, streams, or wetlands under the Michigan Natural Resources and Environmental Protection Act, 1994, Public Act 451, parts 301 and 303. Part 301, Inland Lakes and Streams, gives the state the authority to regulate certain activities including: dredge or fill of bottom lands; construction, enlargement or removal of structures on bottomlands; marina construction and operation; creation, enlargement or diminishment of an inland lake or stream; excavation or dredging within wetlands, or within 500 feet of the ordinary high-water mark of an existing inland lake or stream; and connecting any natural or artificial waterway with an existing body of water. Part 303, Wetland Protection, gives the state the authority to regulate certain activities within wetlands including: placement of fill material into a wetland; dredging or removal of soils from a wetland; construction within a wetland; or draining surface water form a wetland. Many of these activities are also subject to Natural River zoning ordinances and rules.

The Michigan Natural Resources and Environmental Protection Act, 1994, Public Act 451, gives the State of Michigan MDEQ the authority to regulate: dam construction, removal, and alteration; water quality associated with dams; and dam operation, including those dams regulated under the Federal Powers Act, chapter 41. federal dam safety regulations supersede state dam safety regulation on FERC licensed dams. Part 315 (Dam Safety) of Public Act 451 specifically regulates dams impounding five or more acres and having a dam height greater than six feet. There are 21 dams within the Boardman River watershed that are regulated by the MDEQ.

Natural Rivers Designation

The MDNR administers the Natural Rivers Program under the authority of Part 305, Natural Rivers, Natural Resources and Environmental Protection Act, 1994. The Natural Rivers program was developed to preserve, protect and enhance our state's finest river systems for the use and enjoyment of current and future generations by allowing property owners their right to reasonable development, while protecting Michigan's unique river resources. The majority of the Boardman River watershed is a state-designated Natural River (Figure 17). The Boardman River Natural River Management Plan (Boardman River Management Plan Committee 2002) and the Boardman River Natural River Zoning Rules that took effect in 1980, outline a variety of development and use restrictions within the Natural River district (400 feet wide on each side of, and parallel to, the river and its tributaries) to assure the high-quality values of the river are perpetuated through time.

Navigability

The terms “navigability” and “public waters” are typically considered to be synonymous. If a water body is determined to be navigable, then it is also public. Michigan riparian law describes navigable lakes and streams as the following:

> “The determination of navigability in Michigan inland lakes is any lake that is accessible to the public via publicly owned lands, waters, or highways contiguous thereto, or via the bed of a navigable stream, and which is reasonably capable of supporting a beneficial public interest, such as navigation, fishing, hunting, swimming or other lawful purposes inherently belonging to the people. A navigable Michigan inland stream is: 1) any stream declared navigable by the Michigan Supreme Court 2) any stream included within the navigable waters of the United States by the U.S. Army Engineers for administration of the laws enacted by Congress for the protection and preservation of the navigable waters of the United States 3) any stream which floated logs during the lumbering days, or a stream of sufficient capacity for the floating of logs in the condition which it generally appears by nature, notwithstanding there may be times when it becomes too dry or shallow for that purpose 4) any stream having an average flow of approximately 41 cubic feet per second, an average width of some 30 feet, an average depth of about one foot, capacity of floatage during spring seasonal periods of high water limited to loose logs, ties and similar products, used for fishing by the public for an extended period of time, and stocked with fish by the state 5) any stream which has been or is susceptible to navigation by boats for purposes of commerce or travel 6) all streams meandered by the General Land Office Survey in the mid 1800s.” (MDNR 1993).

Historical records indicate that portions of the Boardman River main stem and its tributaries were used to transport logs during the logging era. The stream segments used for this purpose are considered navigable.

Inland Lake Levels and Local Government

The Michigan Natural Resources and Environmental Protection Act, 1994, Public Act 451, Part 307 outlines the process involved in establishing a legal inland lake level. The local circuit court typically establishes a legal lake level with social, environmental, and economic considerations. Silver Lake is the only lake within the Boardman River watershed that has an established legal lake level.

Local units of government have authority to create and implement special ordinances and zoning restrictions that may affect the Boardman River watershed. There are two counties (Grand Traverse and Kalkaska) and ten townships that have governmental authority within the Boardman River watershed. The Grand Traverse and Kalkaska County Drain Commissioners are responsible for meeting the requirements of Part 91 of the Natural Resources and Environmental Protection Act (Act 451 of 1994, as amended) and the Michigan Drain Code (Act 40, Public Acts of 1956) to promote the safety, public health, and general welfare of the community through effectively sustaining the goal of storm water management and clean water in Grand Traverse and Kalkaska Counties and the State of Michigan. The Drain Commissioners had not identified any established County drains within the Boardman River watershed at the time this Assessment was drafted.

Sport Fishing Regulations

The Michigan Natural Resources and Environmental Protection Act, 1994, Public Act 451, Part 487, Sport Fishing, gives the State of Michigan the authority to regulate the take of fish, mollusks, amphibians, and reptiles. Along with this authority comes the right to establish harvest levels and sizes. MDNR, Fisheries Division is also responsible for the designation of trout streams. Trout streams are regulated as coldwater or warmwater streams under Michigan Surface Water Quality Standards. MDNR, Fisheries Division regulates trout streams and trout lakes under fishing regulations specified in the Michigan Inland Trout and Salmon Guide. Regulations for other species are specified in the Michigan Fishing Guide.

Tribal Jurisdiction

The tribal members of the Bay Mills Indian Community, Sault Ste. Marie Tribe of Chippewa Indians, Grand Traverse Band of Ottawa and Chippewa Indians, Little River Band of Ottawa Indians, and the Little Traverse Bay Bands of Odawa Indians retain their right to hunt, gather, and fish in the 1836 treaty area (which includes the Boardman River watershed) in accordance with the 2007 Inland Consent Decree (File No. 2: 73 CV 26). The 2007 Inland Consent Decree defines the extent of the Inland Article 13 treaty rights, and establishes parameters that define where, when, and how the Tribes may exercise those rights. The Decree provides mechanisms for necessary protection and management of natural resources, stability and predictability, and does not affect private land other than large tracts of commercial forest land already open to public hunting and fishing. The Decree also develops a framework for perpetual communication, consultation, and collaboration among the MDNR and the Tribes regarding natural resources management, protection, and use.

Water Quality

The water quality of the Boardman River watershed has been assessed by several agencies at a variety of sites. These assessments usually occur in conjunction with biological monitoring protocols. The continual monitoring of water quality is critical to assessing the effects of development and evaluating the long-term effectiveness of restoration and enhancement efforts.

The MDEQ conducted a biological survey of the Upper Boardman River and select tributaries in 1998. They surveyed 10 sites within the upper watershed and determined that all sites, except one, were in compliance with state-designated water quality standards that support a coldwater designation. Kids Creek (surveyed in Traverse City at the 11th Street crossing) did not meet state water quality standards for a coldwater designation. In addition, the MDEQ identified a section of the Boardman River (just upstream from Boardman Lake) that exceeded water-quality standards for PCBs.

Summer temperature increases in coldwater trout streams negatively effects aquatic organisms, and thus is considered thermal pollution. A variety of activities can cause temperature increases including activities which make the stream channel excessively wide or shallow, loss of riparian shading, storm water discharge from industries and municipalities, and the discharge of waters through dams. Temperature data has been collected throughout the Boardman River watershed (Appendix D), including sites in the upper watershed and below the current dams. While additional data should be collected in order to look at long term trends in water temperatures, it does appear that temperature increases may be occurring at locations below the current dams during some years.

Sediment is the primary non-point source discharge in the Boardman River watershed. Excessive anthropogenic sediment inflow into the Boardman River watershed adversely affects aquatic habitat and species by disrupting natural flow dynamics that create and maintain critical habitat features such as spawning riffles. The primary sediment inflow sites are road-stream and trail crossings (Largent 2006). A complete listing of degraded sites within the Boardman River watershed can be viewed at: http://www.northernmichiganstreams.org/boardmanws.asp.

In addition to non-point source pollution, there are currently 12 National Pollution Discharge Elimination System (NPDES) permits (point discharge) issued within the Boardman River watershed (Table 4). Point source discharges are regulated by the MDEQ.

Stream Classification

In 1967, the MDNR Fisheries Division classified streams throughout the state based on temperature, habitat quality, and riparian development. Streams in the Boardman River watershed are primarily classified as top-quality and second-quality cold water (Figure 18), with the majority of streams designated as top-quality. Top-quality trout water streams contain self-sustaining trout or salmon populations, while second-quality coldwater streams contain significant trout or salmon populations, but these populations are appreciably limited by such factors as inadequate natural reproduction, competition, siltation, or pollution (Anonymous 2000). The second-quality coldwater streams are located downstream of dams and in areas of low gradient or low-flow conditions.

Fish Consumption Advisories

Samples from fish population of the Boardman River watershed have been assessed by the MDEQ for contaminants at Boardman Lake in 1991 and 2003. The MDEQ analyzed edible samples from Walleyes, Northern Pike, and White Suckers *Catostomus commersonii*. The MDEQ assessed the samples for concentrations of mercury, PCBs, Chlordane, DDT, and other toxicants. The samples analyzed did not contain levels of toxicants or pollutants to warrant human consumption advisories above those documented in the Michigan Department of Community Health Fish Consumption Guide, which can be accessed at: http://www.michigan.gov/mdch.

Biological Communities

Original Fish Communities

Documentation of the presettlement fish community of the Boardman River is lacking. Most of the research and historical record of fish populations within the Boardman River watershed regards game fish sought by anglers, particularly trout. Prior to the installation of the first dam in 1868, migratory fish from Grand Traverse Bay would have been able to migrate throughout the majority of the watershed. According to Prokop Kyselka, an early Traverse City resident, here is what happened after the Union Street dam was installed:

> "Before the dam was built by the Hannah and Lay Co. in 1868, pickerel pike, herring, dogfish, and trout traveled up the Boardman River. In the fall of 1868 the fish were stopped by the dam. As there were no game wardens, people collected all the fish they wanted by dip nets or spearing." [Melkild 1982b].

In the mid-1800s when the first settlers arrived in the Boardman River valley, the Arctic Grayling was the only salmonid documented as present in the watershed, although Lake Trout *Salvelinus namaycush* may have been present seasonally. Brook Trout were likely not native to the Boardman River watershed. No one knows for certain whether Brook Trout were native to the lower peninsula of Michigan. Vincent (1962) discusses this topic in detail, and certainly by the 1850s Brook Trout were present in some northern Lower Peninsula streams, including the Boyne, Jordan, and Boardman Rivers. Whether they arrived in these rivers through natural colonization or human propagation is a matter of debate. According to Vincent (1962), Arctic Grayling were extirpated from the Boardman River by the late 1880s. Vincent (1962) also concludes that competition with Brook Trout was the primary mechanism by which the Arctic Grayling became extirpated from Michigan.

> "Of fishes, the usual lake species occur in the (Grand Traverse) bay but not in such numbers to render fishing a business of much importance. The speckled trout (Salmo fontinalis) occurs plentifully in all streams of the region, and in many of the small lakes." [Winchell 1866].
>
> "There are a few grayling in the Boardman, known by the local name of "garpin." [Anonymous 1876].
>
> "We have mentioned the passing of the grayling fishing from the river with the coming of the logging and lumbering, just as the passenger pigeons disappeared. The river had a swift current and was full of trout that my father told of catching with a fish pole cut from the willows. Standing in one place he could catch all of the speckled beauties he could carry home." [Rennie and Swibold 1982].

A tourist guide written in 1891 (Bates and Buck 1891) mentions that "There is splendid pickerel fishing in Boardman Lake within the village limits." They also refer to excellent "speckled trout" fishing in Grand Traverse area brooks. However, there is no reference to Arctic Grayling in the guide, which suggests that Arctic Grayling were extirpated from the Boardman River by then. However, in Henshall (1902) it is stated that in 1891 "the [Boardman] river was pretty well stocked with native grayling." Regardless, there is little doubt that Arctic Grayling were extirpated from the Boardman River watershed by the turn of the 19th century. Although Brook Trout were clearly present in the Boardman River system by at least the 1860s, the first recorded stocking did not occur until 1895.

According to MacCrimmon and Gots (1972), Rainbow Trout had been introduced into the Lake Michigan watershed by 1880. Stocking efforts made in 1880–81, 1896, and 1898–99 included the "Traverse Bay system," the Boardman River, and "Grand Traverse Creek." The first recorded Rainbow Trout in the Boardman River was caught by an angler in 1891 (Henshall 1902). Personal records from an anonymous angler around the turn of the century tell of catching rainbow and Brook Trout in the Boardman River from 1902–04. By 1909, major runs of steelhead were occurring in the Boardman River (Bower 1909). In Henshall (1902) there is much discussion and concern expressed about Rainbow Trout perhaps outcompeting or preying upon the Brook Trout in the Boardman River.

> Mr. Coulter: Then take the Boardman River: the facts are that wherever Rainbow Trout are put in different streams the speckled "brook" trout disappear and the Rainbow Trout predominate. You could not convince a native on those streams in a hundred years, or by all the books and the technical knowledge on earth, that the Rainbow Trout were not destroying the speckled "brook" trout in the Michigan waters.
>
> The President: Was the grayling driven out by another planting?
>
> Mr. Coulter: The theory of the average mortal along those streams who has lived all his life there and watched the disappearance of the native graylings, is that the speckled [brook] trout have destroyed the grayling, and in turn the rainbow is destroying the speckled [brook] trout, and you cannot convince him of anything else. I think at one time the Boardman River had some grayling in it; it was at first a native grayling stream, and the grayling was afterward replaced with the speckled trout, and today you will catch about half and half, but the speckled trout are disappearing every year. (Henshall 1902).

The concerns of these gentlemen did not come to fruition, as Brook Trout are still present in good numbers throughout much of the Boardman River watershed, whereas Rainbow Trout (steelhead) are, for the most part, only present in the lower watershed below Sabin Dam.

Despite the fact that Brown Trout were introduced into Michigan's Pere Marquette River in 1884 (MacCrimmon and Marshall 1968), all available evidence indicates that Brown Trout were not stocked into the Boardman River until 1895 (Appendix B). The personal records from an anonymous angler from 1902–04 refer to the catching of speckled (brook) trout and Rainbow Trout, but Brown Trout are not mentioned. The first reference of a Brown Trout being caught by an angler in the Boardman River is from 1919 (Charles 1982; Appendix B). Charles (1982) also makes reference to a 17 in. Brown Trout caught from the Boardman River in July of that year. Therefore, it is likely that Brown Trout had already been in the Boardman River watershed for at least several years by this time.

Modifying Factors

The Boardman River watershed has been significantly altered by human activities since the arrival of European settlers. These changes have had profound effects on both the physical characteristics and the fish community of the watershed. There are three human activities in particular that have caused major changes: the stocking of nonnative fish species, the construction of dams, and the intensive logging of the 19th and early 20th centuries.

Exotic species introductions, both intentional and unintentional, have affected the biological communities of the Boardman River in many ways. While intentionally-introduced species like Rainbow Trout, Brown Trout, Brook Trout, Chinook Salmon *Oncorhynchus tshawytscha*, and Coho Salmon *Oncorhynchus kisutch* have created valuable sport fisheries, other exotic species like Sea Lamprey and zebra mussels continue to cause problems (*see Pest Species* sub-section).

Dams were first constructed in the Boardman River watershed in the 1860s. The earliest dams were constructed to power sawmills and gristmills, but were later converted to generate hydroelectric power (see *Dams and Barriers*). Dams block upstream migrations of fish from West Grand Traverse Bay, including sport fish such as steelhead and salmon, and aquatic nuisance species like Sea Lamprey.

Although little formal documentation exists, it is likely that the Boardman River looked very different prior to European settlement, and in particular prior to the log drives of the 19th century. The Boardman River was likely narrower and deeper, with much more woody structure, in the form of large logjams. Prior to driving logs down a river, it was common practice to send crews of men down the river to clear the river of any existing jams. The actual log drives likely caused major streambank erosion, allowing large amounts of sand and sediment to enter the stream channel. While many of these erosion sites have either stabilized on their own or been repaired, the Boardman River is still lacking in large woody structure. One factor that may continue to contribute to this lack of structure is the in-stream cutting that occurs on an annual basis to facilitate the floating of canoes and other recreational watercraft down the river.

Other modifying factors, including urbanization, road construction, road/stream crossings, and oil and gas development, (see *Soils and Land Use, and Geology*) have also had negative effects on the Boardman River watershed. These factors can be detrimental if they serve as point sources for sediment input, block fish passage, or significantly alter the stream channel and flow regime. Development in the watershed increases the amount of impervious surface, causing more runoff to enter directly into the river instead of percolating into the soil and becoming groundwater. This runoff causes the Boardman River to become flashier and increases water temperatures. In addition, there are 135 anthropogenic erosion sites in the Boardman River watershed (Largent 2006). Unnatural amounts of sand entering a trout stream like the Boardman River can inundate high-quality gravel habitat, thereby reducing trout populations and insect productivity.

Current Fish Communities

Fifty-nine fish species have been documented in the Boardman River watershed (Appendix C). Several hybrids, including tiger trout (Brown Trout crossed with Brook Trout), tiger muskellunge (Northern Pike crossed with Muskellunge *Esox masquinongy*) and hybrid sunfish (a variety of possible crosses including Bluegill *Lepomis macrochirus*, Pumpkinseed *Lepomis gibbosus*, and Green Sunfish *Lepomis cyanellus*), have also been observed in the watershed. Nine nonnative species were intentionally introduced into the watershed, and one nonnative species (Sea Lamprey) has colonized the river from Lake Michigan. The Lake Sturgeon *Acipenser fulvescens* is a state-threatened species in Michigan, and several individuals have been observed below the Union Street Dam (the most recent sighting was by a MDNR Creel Clerk in 1996). The Arctic Grayling is the only aquatic species known to be extirpated from the Boardman River watershed.

The existing fish community in the Boardman River watershed has been shaped by the coldwater nature of the watershed and its connection to Grand Traverse Bay. There are three distinct groups of fish that inhabit the watershed (Appendix C). They are the resident fish species of the river, the migratory fish species that ascend the river from West Grand Traverse Bay, and the lake-dwelling species that inhabit the inland lakes in the watershed. Some of the species occupy more than one of those groups.

Inland lakes in the Boardman River watershed support fish communities typical to many inland lakes in Michigan. These communities include Largemouth Bass *Micropterus salmoides*, Smallmouth Bass, Bluegill, Pumpkinseed, Yellow Perch *Perca flavescens*, Rock Bass *Ambloplites rupestris*, Northern Pike, White Sucker, and bullhead. Various minnow and forage species are also present, often including Bluntnose Minnow *Pimephales notatus* and Golden Shiner *Notemigonus crysoleucas*. Walleyes have been documented in five lakes in the watershed (Boardman, Log, Rennie, Silver, and Spider).

Migratory species that seasonally inhabit the lower Boardman River include Rainbow Trout (steelhead), Coho Salmon, Chinook Salmon, Brown Trout, Lake Trout, Walleye, White Sucker, Sea Lamprey, and Lake Sturgeon. While the salmonids can typically migrate through the fish ladder at Union Street Dam, the other fish species cannot, and are thus restricted to that portion of the Boardman River below the dam. The salmonids can ascend as far upstream as Sabin Dam.

Mollusks

The mollusks (Phylum Mollusca) include a variety of familiar invertebrates including snails, clams, and mussels and are a critical component of the Boardman River watershed ecosystem. They are a significant food source for a variety of mammals including raccoons, otters, and muskrats; they are vectors for parasites including swimmers itch; and they are widely used as bioindicators of water quality. The Bivalvia (clams and mussels, including the zebra mussel) filter water, significantly affecting water quality where they are abundant.

The freshwater mollusks have the dubious honor of being the most imperiled members of the North American biota (Cushing and Allan 2001). The Endangered Species Act protects 111 Unites States species of freshwater invertebrates, and all but 25 are mollusks. The mollusks are used (and often over-harvested) for precious stones, they are extremely sensitive to degraded water and habitat quality, and they are typically localized. However, currently there are no endangered, threatened, or special-concern species documented within the Boardman River watershed (Table 5).

Arthropods

The Arthropods (Phylum Arthropoda) contain a diverse group of organisms including mayflies, spiders, crayfish, and mosquitoes. Arthropods are the largest phylum of animals (comprises more than 80% of all animals on earth). They are economically, environmentally, and socially significant for a variety of reasons including: they are a significant food source for numerous fish and wildlife species, they are the most widely used animal for determining water quality, they are vectors of various diseases including malaria, and they are a significant food source for humans. The Arthropods are the most abundant animal in the Boardman River watershed, and have been documented primarily by the MDEQ (Table 6). However, arthropod data is generally lacking for the Boardman River watershed, especially for the lower reaches (downstream of Boardman Dam) and the lakes. There are currently no endangered, threatened, or special concern species arthropods documented in the Boardman River watershed.

Amphibians and Reptiles

Amphibians and reptiles fulfill a critical niche within the Boardman River watershed. They are important prey items for a variety of mammals and fish, they are a human food source, and they are useful indicators of environmental quality. Approximately 1/3 of the world's amphibian species are currently threatened (Stuart et al. 2004). The reasons for global decline in amphibian species include habitat destruction, climate change, competition from introduced species, over-exploitation, habitat fragmentation, and pollution. Therefore, it is critical to document the extent of current amphibian and reptile populations within the Boardman River watershed (Table 7). However, in general this data is lacking. There are currently two reptiles (wood and Blanding's turtles) that have been documented in the watershed that are classified as special-concern species.

Birds

The Boardman River watershed provides abundant and diverse habitat for nesting, breeding, and migrating birds (Brewer et al. 1991) (Table 8). Birds are a critical component of the watershed because they provide forage for species of mammals and fish, they are vectors of various disease (including West-Nile virus and botulism), they transplant vegetation and fish species within and beyond the Boardman River watershed, and some are considered a human food item and are actively hunted (turkeys, upland game birds, and waterfowl). The Boardman River watershed provides habitat for a variety of federal and state endangered, threatened, and special-concern species. The following listed bird species have been identified in the Boardman River watershed: Kirtland's warbler (federal and state endangered), King rail (state endangered), Red-shouldered hawk (state threatened), Common loon (state threatened), and Bald eagle (federal and state threatened).

Mammals

The Boardman River watershed provides abundant and diverse habitat for a variety of mammals (Table 9). Mammals are a critical component of the watershed because they provide forage for numerous species of reptiles, birds, and other mammals. Some species, such as whitetail deer and black bear, are considered a human food item and are actively hunted. Mammals are also vectors of disease. The Boardman River watershed does not currently support any federal or state listed mammal species.

Other Natural Features of Concern

The Boardman River watershed contains diverse aquatic and upland habitat. The Michigan Natural Features Inventory (MNFI) currently recognizes 74 natural communities within Michigan. Four of these communities are documented within the Boardman River watershed; dry-mesic northern forest, northern fen, oak pine barrens, and rich conifer swamp. In addition, a state plant species of concern (Hill's thistle, *Cirsium hilli*) has been documented in the Boardman River watershed.

Pest Species

Coscarelli and Bankard (1999) define an aquatic nuisance species as a "waterborne, nonnative organism that threatens the diversity and abundance of native species, the ecological stability of impacted waters, or threatens a commercial, agricultural, aquaculture, or recreational activity." A MDNR-MDEQ report submitted to the Michigan Legislature indicates that about 160 nonindigenous aquatic species have been introduced into the Great Lakes Basin since the 1800s (Anonymous 2002). This River Assessment categorizes aquatic nuisance species into two divisions: animals and plants (Table 10). Currently there is no formal list of all documented exotic invasive species and their locations within the Boardman River watershed.

Aquatic Diseases, Parasites, and Anomalies

Aquatic diseases, parasites, and anomalies are a typical component of the Boardman River watershed biota. The susceptibility of aquatic animals to various disease and parasites is dependent upon the health and stress levels of the populations. Aquatic animals are more susceptible to disease and parasite infestation in degraded environments such as those with minimal oxygen availability, rapidly fluctuating or unnatural temperature or flow regimes, degraded or diminished habitat, excessive siltation, and pollution (Allison et al. 1977). The MDNR Fisheries Division monitors the prevalence of various diseases, parasites, and anomalies by three primary methods: 1) routine management surveys (discretionary and random) of lakes and rivers 2) targeted surveys for specific diseases, and 3) angler and general public reports. In 2007, the MDNR Fisheries Division collected representative samples of Bluntnose Minnows and Walleyes during a routine management survey of Silver Lake. The fish were tested for Viral Hemorrhagic Septicemia (VHS), and none had the disease.

The majority of aquatic diseases and parasites within the Boardman River watershed are species-specific, such as Lymphosarcoma in Northern Pike (Table 11). However, there are also aquatic parasites present that can affect humans, such as swimmer's itch (MDEQ 2005).

Fisheries Management

Historical and modern fisheries management in the Boardman River watershed has been shaped by the wide variety of habitat types in its rivers and lakes. The majority of fisheries management effort on the main stem of the Boardman River, as well as most of its tributaries, has been concerned with improving resident salmonid populations. Most of the Boardman River main stem (Boardman River Road crossing downstream to Boardman Pond) is rated as a "Blue Ribbon Trout Stream" by MDNR Fisheries

Division. Downstream of Sabin Dam, the primary focus has been on migratory salmonid populations. Most of the inland lakes in the Boardman River watershed are managed for warmwater and coolwater fish species, including Bluegill, Yellow Perch, Largemouth and Smallmouth bass, Walleye, and Northern Pike. There are currently only two lakes in the Boardman River watershed stocked with salmonids: Big Guernsey (annually stocked with Brown Trout), and Sand Lake #1 (annually stocked with Rainbow Trout).

In recent years, most of the habitat management activity within the Boardman River watershed has been conducted by the Grand Traverse Conservation District as part of the Boardman River Project (Largent 2006). Since the inception of the project in 1991, over 200 erosion sites on the Boardman River have been repaired. Most of those sites were human-caused streambank erosion sites; although some degraded road-stream crossings were also repaired.

The Boardman River Project currently maintains three sand traps in the watershed, in an attempt to remove some of the excess sand that is already present in the stream channel. The Boardman River Project has also completed a number of educational initiatives, and has worked with the Grand Traverse Regional Land Conservancy to protect nearly 3,000 acres of land and about 7.3 miles of waterfront in the Boardman River watershed from development (S. Largent, Grand Traverse Conservation District, personal communication).

Fishing Regulations

Currently, the Boardman River is regulated as a Type-1 trout stream for most of its length, upstream of Sabin Dam. The regulations for Type-1 trout streams allow fishing only during the "regular" trout season, from the last Saturday in April through September 30. The daily possession limit is five trout in any species combination, a minimum size of eight inches, with no more than three fish 15 inches in length or larger. All gear types are allowed in Type-1 waters. All trout stream tributaries of the Boardman River are also designated as Type-1 streams. From Sabin Dam downstream to West Grand Traverse Bay, the Boardman River is regulated as a Type-3 trout stream. Type-3 regulations allow for year-round angling, with a 15-inch minimum size limit on Brook Trout and Brown Trout. The minimum size limit for Chinook Salmon, Coho Salmon, Rainbow Trout, Atlantic Salmon *Salmo salar*, and Pink Salmon *Oncorhynchus gorbuscha* is 10 inches. The daily possession limit is five fish per day in any species combination, but no more than three may be 15 inches or larger. When the James T. Price Trap and Transfer facility (Boardman weir) is in place, fishing is not permitted 300 feet upstream or downstream of the weir.

In 1954, the Boardman River was selected, along with a number of other Michigan trout streams, to be studied for the effectiveness of flies-only regulations and more restrictive size and daily catch limits for improving resident Brown and Brook trout populations (Schultz 1955). The stream reach selected for the special regulations extended from the Forks campground 4.4 lineal miles downstream to Scheck's Bridge. The stream reaches used as controls in the experiment included the reach upstream from the Forks Campground to the bridge at the confluence of the North and South Branches of the Boardman River, and the reach downstream from Scheck's Bridge to the confluence with Brown Bridge Pond. The special regulations established included a flies-only restriction, a ten-inch minimum size limit, and a five fish per day catch limit (Schultz 1956). The standard regulations of that period included a seven-inch minimum size limit on brook and Brown Trout, and a ten fish per day catch limit.

According to Cooper et al. (1962), the special regulations imposed on the Boardman River did not result in any appreciable increase in either the numbers or size of Brown and Brook trout. Furthermore, according to Cooper et al. (1962), in 1960 and 1961 "population estimates for fish larger than 10 inches were more than twice as great in the control water as in the special water, but fall estimates of 7.0–9.9 inch trout were somewhat higher in the special water than in the control water." The researchers also noted that fishing pressure was two to three times higher in the control waters than in the special regulations area. Finally, due to budget cuts, investigations on the Boardman River were discontinued in 1962, and normal regulations resumed in 1965.

Headwaters to the Historic Brown Bridge Dam Location

North Branch Boardman River

The North Branch of the Boardman River originates at an outflow from Farrar Lake in northern Kalkaska County. It flows through dense wetlands for most of its length before entering the Kalkaska Millpond. Downstream of Kalkaska it gains size and volume, accumulating significant groundwater flows. The North Branch supports populations of Brown Trout and Brook Trout (Table 12). The North Branch is classified as a Blue Ribbon Trout Stream from the Crofton Creek confluence downstream to the Forks. There is one MDNR fisheries index station in this reach at Broomhead Road. There is abundant public access to the North Branch, as much of the riparian land is owned by the State of Michigan as part of the Pere Marquette State Forest. The largest North Branch tributaries are Failing Creek and Crofton Creek. The Grand Traverse Conservation District operates two sand traps on the North Branch of the Boardman River. The upstream sand trap is on private property in Section 24 of Kalkaska Township, Kalkaska County. The downstream sand trap is in Section 25 of Whitewater Township on state forest land in Grand Traverse County.

South Branch Boardman River

The South Branch of the Boardman River originates as a small spring creek in the Allbright Swamp, south of South Boardman in western Kalkaska County. Downstream of South Boardman (where it is dammed and impounded), the river gains size and volume by accumulating groundwater and supports populations of Brown Trout and Brook Trout (Table 12). From Boardman River Road downstream to the Forks, the South Branch of the Boardman River is rated as a Blue Ribbon Trout Stream by MDNR Fisheries Division. There is one MDNR fisheries index station in this reach at Broomhead Road. There is abundant public access to the South Branch, as much of the riparian land is owned by the State of Michigan as part of the Pere Marquette State Forest. One of the larger tributaries to the South Branch is Allbright Creek. The Grand Traverse Conservation District operates one sand trap on the South Branch of the Boardman River. It is located on state forest land in Section 7 of South Branch Township, Grand Traverse County.

"Forks" to Brown Bridge Pond

The North and South Branches of the Boardman River come together immediately upstream of Supply Road in eastern Grand Traverse County. This area is locally known as "The Forks." From the Forks downstream to Brown Bridge Pond, the Boardman River supports good populations of brook and Brown Trout (Table 12). This reach of the Boardman River is the coldest section of the entire main stem (Appendix D). There are three MDNR fisheries index stations in this reach, including the Forks Campground, Ranch Rudolf, and Scheck's Campground stations. There is abundant public access to the Boardman River in this reach, as much of the riparian land is owned by the State of Michigan as part of the Pere Marquette State Forest. There are two state forest campgrounds, including the Forks and Scheck's Place campgrounds. The larger tributaries in this reach are Carpenter and Twenty-two creeks.

Historic Brown Bridge Dam to Boardman Dam

Historic Brown Bridge Dam to Boardman Pond

The historic Brown Bridge Dam had a profound effect on the Boardman River, especially in terms of water temperature. While July average temperatures upstream of the historic Brown Bridge Pond were usually in the low 60s (Fahrenheit), downstream of the dam they were usually in the mid to upper 60s

°F (Appendix D). Maximum temperatures were also substantially higher downstream of the dam. Upstream of the historic Brown Bridge Pond, July maximum temperatures rarely reached 70° F. At sites downstream of the historic dam, July maximum temperatures routinely reached the mid-70°s F. Temperatures are similar throughout the reach from the historic Brown Bridge Dam to Boardman Pond. Despite the warmer water temperatures in this reach, good Brown Trout populations are still present (Table 12). However, Brook Trout abundance in this reach is substantially lower than in upstream reaches. This reach has more private riparian land than upstream reaches, although there are still some tracts of Pere Marquette State Forest land along the river. There are access points at Shumsky's canoe launch and Beitner Park (owned by the City of Traverse City). Downstream of Beitner Road, the 420 acre Grand Traverse Natural Education Reserve (owned by Grand Traverse County) provides access. The remnants of Keystone Dam are found in this area. The larger tributaries in this reach include East Creek, Swainston Creek, Jaxon Creek, and Beitner Creek.

Boardman Pond

Boardman Pond was drawn down 14 feet in 2007 in response to a MDEQ Dam Safety mandate and hasn't been surveyed since. However, historic surveys indicate that the pond supported Northern Pike, Smallmouth Bass, Rock Bass, Yellow Perch, Bluegill, and Brown Trout populations. It was surveyed by MDNR in 1986. According to Hay (1986a) Boardman Pond supports a "good population of perch, Rock Bass and pike," and he also mentions that angler reports indicate good success on Smallmouth Bass and Brown Trout.

The most recent fisheries survey of Boardman Pond was conducted in the spring of 2007 (prior to the drawdown) by the Grand Traverse Band of Ottawa and Chippewa Indians (B. Fessell, unpublished data). In the 2007 survey, fair numbers of Rock Bass and Smallmouth Bass were caught. Other species caught in relatively small numbers included Bluegill, Pumpkinseed, Largemouth Bass, Northern Pike, Yellow Perch, and White Sucker.

Boardman Dam has a warming effect on the Boardman River. MDNR water temperature data from 2005 and 2006 (Appendix D) show that July average water temperatures below Boardman Dam were 2° F warmer than Boardman River water temperatures just upstream of Boardman Pond, at Beitner Road.

Boardman Dam to West Grand Traverse Bay

Sabin Pond

Boardman and Sabin dams are less than one lineal stream mile apart. Boardman Dam essentially discharges immediately into Sabin Pond, as there is very little riverine habitat below Boardman Dam. Sabin Pond was draw down by approximately five feet in 2010 and hasn't been surveyed since. However, historic surveys indicate that the original pond was relatively shallow, with a maximum depth of 15 feet. It historically supported Northern Pike, Rock Bass, and Yellow Perch populations. It was last surveyed by MDNR in 1986. According to Hay (1986c), Sabin Pond had "poor fish populations" except for Northern Pike, although even the Northern Pike were stunted and growing very slowly. The most recent fisheries survey of Sabin Pond was conducted in the spring of 2007 by the Grand Traverse Band of Ottawa and Chippewa Indians (B. Fessell, unpublished data). In the 2007 survey, small numbers of Bluegill, Rock Bass, Smallmouth Bass, and Yellow Perch were caught. Northern Pike and White Sucker were the only two species in the survey that were represented by more than a dozen individuals. Most of the Northern Pike were small in size, averaging only nine inches in length.

Sabin Dam to Boardman Lake

The reach of the Boardman River from Sabin Dam to Boardman Lake is approximately 1.5 miles in length. Sabin Dam is the upstream limit for fish passage from Lake Michigan on the Boardman River.

This short stretch of river supports the largest, fastest growing Brown Trout in the Boardman River watershed (Table 13). This reach also supports an excellent hatch of Hexagenia mayflies during June and July, and receives considerable fishing pressure at that time. Since this reach is downstream of three dams, water temperatures are relatively warm (Appendix D). In 2006, the July average temperature in this reach was 69° F, with a July maximum temperature of 76° F. Due to the warmer water temperatures, this reach appears to be marginal for the survival of other salmonid species, and natural reproduction and survival only occur in cooler summers. Sampling in this reach in 2005 by MDNR Fisheries Division documented the presence of juvenile Rainbow Trout (steelhead), Coho Salmon, and Chinook Salmon, and Brown Trout. This reach also supports populations of Smallmouth Bass, White Sucker, Yellow Perch, and Northern Pike. The habitat of this reach of the Boardman River has been excessively manipulated over the years. In either the late 19th century or early 20th century, this reach was extensively dredged and straightened. No records exist of conditions prior to the dredging project. Much of the riparian land on the west side of this reach is publicly owned by Grand Traverse County as part of the Natural Education Reserve. Access can be obtained at Sabin Dam. Tributaries of note to this stretch include Jack's Creek and Miller Creek.

Boardman Lake

Boardman Lake is within the Traverse City limits, and is heavily developed with condominiums, industrial sites, and a wastewater treatment plant. Boardman Lake was most recently surveyed by MDNR Fisheries Division in 2003 (Kalish 2004). There was a good collection of Walleye in the 2003 survey, and in particular there were many young-of-the-year Walleye. Prior fisheries surveys of Boardman Lake documented a stunted Northern Pike population, but Northern Pike collected in the 2003 survey were growing well. Boardman Lake has no minimum size limit on Northern Pike, and a five fish daily catch limit. The goal of removing the minimum size limit on Northern Pike was to thin out the population through angler harvest of smaller pike, thereby reducing competition for food resources and improving growth for those fish that remain.

Union Street Dam to West Grand Traverse Bay

Below Union Street Dam, the Boardman River flows for about 1.5 miles before entering West Grand Traverse Bay. This reach of the Boardman River is accessible to all species of fish from Lake Michigan. The Boardman River weir is located within this reach. This reach receives seasonally heavy fishing pressure for salmon and steelhead. It also supports populations of Smallmouth Bass, Northern Pike, and Walleye. The one significant tributary to this reach is Kids Creek.

Inland Lakes

Most of the inland lakes (other than those already mentioned) in the Boardman River watershed are smaller than 100 acres. The exceptions are Crawford Lake in Kalkaska County, and Arbutus, Island, Rennie, Silver, Bass, and Spider Lakes in Grand Traverse County. Most inland lakes in the Boardman River watershed have healthy warm and coolwater fish populations, and do not require active management by MDNR Fisheries Division. Lakes that are currently managed by MDNR Fisheries Division include Big Guernsey Lake (annual Brown Trout stocking), Sand Lake #1 (annual Rainbow Trout stocking), and Silver Lake (Walleye stocking every three years). The MDNR Fisheries Division has current survey information for Silver Lake (general survey in 2006), Sand Lake #2 (general survey in 2006), Spider Lake (general survey in 2008), and Arbutus Lake (general survey in 2008).

The MDNR Fisheries Division discontinued the Brook Trout stocking program in Sand Lake #2 in 2009 since no Brook Trout were collected in the 2006 survey.

Sand Lake #1and Big Guernsey Lake are the only Designated Trout Lakes in the Boardman River watershed. They are located within the 2,800-acre Sand Lakes Quiet Area, a section of the Pere Marquette State Forest where motorized vehicles are prohibited. Sand Lake #1 and Big Guernsey Lake are regulated as Type-C trout lakes. Type-C regulations allow for year-round angling. The daily possession limit is five trout in any combination, with no more than three fish 15 inches or larger. Other inland lakes in the Boardman River watershed with special regulations include Boardman, Arbutus, and Spider Lakes. Boardman Lake has no minimum size limit on Northern Pike and a five fish per day possession limit. Standard state regulations impose a 24-inch minimum size limit and a two fish per day possession limit for Northern Pike. Arbutus and Spider Lakes have a 10 inch minimum size limit for bass, as opposed to the state standard minimum length of 14 inches.

Tributaries

Most of the tributaries to the Boardman River are designated trout streams that support Brown and Brook trout. The MDNR Fisheries Division has current (1990-2007) survey data for most of the tributaries within the watershed. A tributary that receives significant recreational and developmental pressure is Kids Creek.

Kids Creek is a tributary that flows into the Boardman River just upstream of the Boardman River Weir, about one mile from the mouth. The Kids Creek sub watershed has a long history of degradation from human activity, both agricultural and urban. At one time, the largest buffalo herd east of the Mississippi was pastured on the banks of Kids Creek. Since much of the watershed is within Traverse City or very close to it, Kids Creek suffers from high storm water runoff, industrial pollution, and poor land-use practices. There have been a number of fish kills in Kids Creek and its tributaries from industrial chemical releases. Despite all of the abuse Kids Creek has sustained, it is still a Designated Trout Stream with naturally reproducing populations of Brown Trout, Brook Trout, steelhead, Coho Salmon, and Chinook Salmon.

In recent years, there has been renewed interest in protecting and promoting Kids Creek. The Grand Traverse Conservation District has completed numerous habitat improvement projects on Kids Creek. In 2005, the Watershed Center Grand Traverse Bay completed a restoration project on Kids Creek to restore a severely degraded stretch of Kids Creek (just west of M-37 between Kohl's and the Great Wolf Lodge) and created hiking trails and an informational kiosk (The Watershed Center Grand Traverse Bay 2005). In 2006, the Watershed Center began the Kids Creek Storm water Project, which culminated in the drafting of a Kids Creek Action Plan, which outlines recommendations to help get the creek removed from the impaired waters list. Recommendations from that plan are already being implemented with the Watershed Centers Kids Creek Restoration Project

Resident Brown and Brook Trout

For many years, fisheries management of the Boardman River main stem and its coldwater tributaries included stocking resident Brown, Brook, and Rainbow trouts (Appendix B). However, in the late 1960s, stocking of resident trout into the main stem (upstream of Sabin Dam) was discontinued. Since that time, the resident brook and Brown Trout populations of the Boardman River have become self-sustaining. Upstream of the dams, Rainbow Trout have been documented only at the Ranch Rudolf station. These fish are likely escapees from privately stocked ponds at Ranch Rudolf. Other salmonid species, including Rainbow Trout (steelhead), Coho Salmon, and Chinook Salmon, have been collected in surveys of the Boardman River below Sabin Dam.

The first documented trout population estimates in the Boardman River watershed were conducted by Gowing and Alexander (1980). In that report, the authors indicated that the South Branch of the Boardman River was one of the more productive trout streams studied. They also studied the North Branch of the Boardman River and the main stem of the Boardman River at Ranch Rudolf. Gowing and Alexander (1980) also concluded that the South Branch of the Boardman River (among several of the other streams studied) showed signs of being enriched by human activities.

Since 1985, the trout populations of the Boardman River have been intensively studied. Mark-recapture electrofishing surveys have been used to obtain population estimates for trout populations at nine stations in the Boardman River watershed (Table 12). Ranch Rudolf is the only station where data was collected from before 1985. Sampling was conducted at this station in 1960, 1961, and 1976.

In recent years, Brown Trout numbers have ranged from 33–1,741 per acre, with biomass ranging from 14-138 lbs/acre (Table 12). The stations that consistently produce the most abundant populations are the South Branch of the Boardman River at Broomhead Road, and the Forks Campground. Although Brook Trout were present at all stations in all years (except for below Sabin Dam), Brook Trout density and biomass were, in most cases, substantially lower than those of Brown Trout. The stations with consistently abundant populations of Brook Trout included Ranch Rudolf, the North Branch at Broomhead Road, and the South Branch at Broomhead Road.

In recent surveys, Brown Trout at most Boardman River survey stations were growing at or above the State of Michigan average length at age (Table 13). The only surveys that indicated below average growth was Ranch Rudolf, with Brown Trout growing 0.2 inches slower than state average in 2002, 1.1 inches slower in 2003, and 0.6 inches slower in 2004. The station where Brown Trout exhibited the best growth was below Sabin Dam. In 2005, the Brown Trout collected at that station were growing 1.9 inches faster than the state average and in 2006 they were growing 2.0 inches faster than state average.

When compared with other northern Michigan trout streams like the Pere Marquette, Little Manistee, Upper Manistee, and Au Sable (Table 14), the Boardman River supports a smaller population of resident Brown Trout, particularly in terms of biomass. Age and growth analysis of Boardman River Brown Trout shows that there are few older Brown Trout in the Boardman River. Of 1,157 Boardman River Brown Trout that have been aged since 2002, only 37 have been older than age 3 (Table 13). Of those 37 older Brown Trout, 19 came from the station below Sabin Dam. Except for below Sabin Dam, it is very rare for Brown Trout in the Boardman River to survive past age 3 and exceed 15 inches in length.

The reasons for the lack of older, larger Brown Trout in the Boardman River are uncertain. Angler harvest is most likely not responsible, based on a 2005 MDNR creel census of the Boardman River (Appendix E). In that creel survey, it was estimated that 1,036 Brown Trout were caught and released and only 81 Brown Trout were harvested from the Boardman River for the entire season. According to these results, catch and release angling is very popular among Boardman River anglers. Survival to older age classes is not occurring in most stretches of the river. Data from the Ranch Rudolf station (Table 15) indicate that immigration into the station is taking place (i.e. increasing abundance of older age classes), but that very few Brown Trout are surviving past age 3.

Brook Trout at most Boardman River survey stations were growing near or above the State of Michigan average length-at-age (Table 16). The station where Brook Trout exhibited the best growth was Ranch Rudolf. In 2008, age-0, age-1, and age-2 Brook Trout at this station were growing 1.2 inches faster than the state average.

Although the habitat of the Boardman River has not been studied extensively, there appears to be a general lack of instream cover, either in the form of woody material or deeper holes. Much of the Boardman River is either run or riffle habitat. While gravel runs and riffles are conducive to producing large numbers of juvenile trout, they are not particularly effective at producing trophy size Brown Trout. A similar paucity of Brown Trout older than age 3 has been observed in other Michigan rivers (such as the North Branch Au Sable River) where run and riffle habitat predominate (A. Nuhfer, MDNR Fisheries Research Biologist, personal communication). While warmer water can inhibit Brown Trout reproduction and survival, it also promotes increased growth if warmer water temperatures are not extreme or prolonged, since trout growth rates are largely controlled by temperature and food rations (Elliot 1994). The high growth rates of Brown Trout below Sabin Dam are presumably attributable to a favorable combination of these factors. Hinz and Wiley (1997, 1998) reported that Michigan trout streams with higher water temperatures tended to produce higher densities of macroinvertebrates and higher growth rates for trout. Temperature analysis (Appendix D) shows that July average water temperatures are warmer below Sabin Dam than in most other stretches of the river. The only stretch with comparable water temperatures is just downstream of Brown Bridge Dam. Also, the stretch downstream of Sabin Dam is accessible to migratory fish. Migratory fish, including salmon and steelhead from Lake Michigan, diversify the forage base through input of eggs, carcasses, and juveniles not available in other reaches of the Boardman River.

Brook Trout abundance in the Boardman River is similar to that in other northern Michigan rivers, including the Upper Manistee and the Au Sable (Table 14). Although there are large numbers of Brook Trout in the Boardman River, very few of them reach eight inches in length. Age analysis of the Boardman River Brook Trout population showed that there are very few older Brook Trout present in the Boardman River. Of 455 Brook Trout aged from the Boardman River since 2002 (Table 16), only 15 were age 2, and none were older than age 2. The reason for the lack of older, larger Brook Trout in the Boardman River is unknown. Angler harvest is most likely not responsible, based on the 2005 MDNR creel census of the Boardman River (Appendix E). In that creel survey, it was estimated that only 49 Brook Trout were harvested from the Boardman River for the entire season. As with Brown Trout, lack of large Brook Trout may be related to a paucity of instream habitat. A similar lack of older, larger Brook Trout in other Michigan trout streams, including the Au Sable and Upper Manistee Rivers, has been observed in recent surveys (MDNR Fisheries Division, unpublished data).

Migratory Salmonids

Although significant steelhead runs were occurring in the Boardman River by 1909 (Bower 1909), it is likely that dam construction and Sea Lamprey predation greatly reduced those runs by the mid-1900s. In 1968, 1969, 1971, 1973, 1974, 1976, 1977, and 1978, domestic hatchery Rainbow Trout were stocked into West Grand Traverse Bay at various locations, including near the mouth of the Boardman River, in Bowers Harbor, and near Greilickville. In 1970, Little Manistee-strain steelhead were stocked into West Grand Traverse Bay, instead of the domestic Rainbow Trout. Steelhead were first stocked directly into the Boardman River in 1973. This was the start of the modern steelhead-stocking program on the Boardman River. Since that time, steelhead have been stocked into the Boardman River in all years except for 1979 (Appendix B). The Boardman River has been receiving an annual run of adult steelhead since the modern steelhead-stocking program began.

Pacific salmon were first stocked into the Great Lakes in 1966 (Coho Salmon) and 1967 (Chinook Salmon), and Coho Salmon were first stocked into the Boardman River watershed in 1967 (Appendix B), when fisheries managers stocked 3,111 adults upstream of the Boardman Dam. The goal of that stocking effort was to determine whether or not Coho Salmon could successfully reproduce in the Boardman River and its tributaries (Bullen 1969). From 1967–81, large numbers of Coho Salmon were stocked annually in Brewery Creek, which is a tributary to West Grand Traverse Bay located several miles northwest of the mouth of the Boardman River. In 1993, the Boardman River received 110,026 Coho Salmon yearlings. The Boardman River has since been stocked with Coho Salmon in 1996, 1997, 1999–2003, and 2004–2013.

Chinook Salmon were annually stocked into Brewery Creek from 1974-1980, and again in 1982. Chinook Salmon were first stocked into the Boardman River in 1985 (Appendix B). None were stocked in 1986, but in 1987 Chinook Salmon were stocked into Kids Creek. Since 1987, varying numbers of Chinook Salmon have been stocked in the Boardman River watershed. The stocking locations have varied between the Boardman River and Kids Creek several times. Starting in 2007, a portion of the

Chinook Salmon planted were held and fed in a net-pen prior to release into the Boardman River. Net pens have been shown to enhance the survival of stocked Chinook Salmon fingerlings (Dave Clapp, MDNR, unpublished data). The net pens are a cooperative venture between MDNR and the Grand Traverse Area Sport Fishing Association.

Since 1987, most Chinook and Coho salmon entering the Boardman River have been harvested at the James T. Price Trap and Transfer facility (Boardman weir) located off Hall Street, in downtown Traverse City (Table 17). The Boardman weir is a removable barrier that was constructed in 1987 by Traverse City Light and Power (TCLP) and is used to block runs of Chinook and Coho salmon. Salmon harvested at the weir are taken by a company under contract with the State of Michigan. Any steelhead or Brown Trout that enter the weir are passed upstream. Some Chinook and Coho salmon are able pass the weir each year. Typically the salmon that make it upstream are those small enough to pass through the weir grates or those that enter the river before and after the weir is operated (operation months are September and October). Natural reproduction for both Chinook and Coho salmons has been documented in the Boardman River downstream from Sabin Dam, and in Jack's and Kids creeks (Kalish, MDNR, unpublished data).

Union Street Dam is the first permanent barrier to upstream fish migration on the Boardman River. The dam blocks upstream migrations of coolwater species like Walleye, Yellow Perch, and Lake Sturgeon, which rarely ascend ladders that require jumping. However, strong jumping species, like Pacific salmon, steelhead, and Brown Trout ascend the ladder to move upstream into Boardman Lake and the stretch of the Boardman River below Sabin Dam. The Union Street Dam fish ladder was constructed by TCLP in 1987. The current upstream limit for all fish migration on the Boardman River is Sabin Dam. Boardman Dam is also a barrier to fish migration, and does not have a fish ladder.

Boardman River Dams Project

The Boardman River Implementation Team has facilitated the removal of Brown Bridge Dam and is currently pursuing removal of Sabin and Boardman Dams and modification of Union Street Dam. Complete dam removal or fish passage modification on the main stem dams could allow certain migratory species access to the entire Boardman River watershed. Many migratory species, salmonids in particular, would likely thrive throughout the Boardman River watershed if they could ascend to upstream areas that are currently inaccessible. In particular, Chinook Salmon, Coho Salmon, and steelhead would likely naturally reproduce and wild adult runs could contain thousands of fish. Other species such as Lake Trout, Brown Trout, White Sucker and possibly several species of redhorse would also likely use spawning habitat throughout the watershed if allowed to migrate upstream of the current dams. In addition, species such as Lake Sturgeon, Great Lakes Muskellunge, Northern Pike, Smallmouth Bass, Walleye, and Yellow Perch would benefit from additional habitat availability if allowed to migrate to Boardman Lake. However, there are also species that may have negative affects if additional habitat is made available such as Sea Lamprey and Round Goby *Neogobius melanostomus*. Therefore, the optimal situation is a barrier that permits controlled migration so current and future managers will have the ability to limit or pass species as deemed appropriate. The current passage barrier is the Union Street dam and seasonally the Boardman River Trap and Transfer facility.

There are pros and cons of allowing migratory salmonids further access to the watershed than they already have (Appendix F). Other area rivers with fish passage/access have excellent populations of both resident Brown Trout and migratory salmonids. The Little Manistee and Platte Rivers (Tonello 2005; Kalish unpublished data) are two examples of rivers that have large runs of steelhead, Coho Salmon, and Chinook Salmon, while also supporting excellent populations of resident Brown Trout. The Pine River is another example of a system where wild Brown and Rainbow trout coexist in relatively high numbers (Burroughs 2007a); although in the Pine River the Rainbow Trout are resident fish. The effects of migratory salmonids on Brook Trout are also unknown. There are Michigan streams that support excellent populations of resident Brook Trout, even though they have large wild runs of migratory salmonids. Bear Creek, a larger tributary to the Manistee River, is one example (Tonello, unpublished data). Some reaches of the Jordan River also support abundant populations of both Rainbow Trout and Brook Trout (MDNR file data).

Historically there have been relatively few studies in Michigan that focus on competition between migratory and resident salmonids. According to Taube (1975), Coho Salmon had little effect on Brown Trout populations in the Platte River (Benzie County, Michigan), except where the salmon spawners were highly concentrated. Even in those areas where a decrease in Brown Trout reproduction occurred, there was no reduction in numbers of older Brown Trout. The decrease in reproduction was compensated for by an increase in survival rates of Brown Trout to older ages. Taube (1975) also reported that the presence of Coho Salmon did not affect growth rates of Brown Trout in the Platte River. Wagner (1975) stated that although food habits of Brown Trout, Rainbow Trout, and Coho Salmon in the Platte River were similar at times, competition was not occurring to any significant degree between the three species, likely due to spatial segregation in the stream. By contrast, Stauffer (1977) suggested that juvenile Coho Salmon depressed abundance of brook and Brown Trout in three Lake Superior tributaries. Juvenile Chinook Salmon are not generally believed to be serious competitors with juveniles of resident trout species because most Chinook Salmon smolt and emigrate from the stream a few months after they emerge from the spawning gravel.

Fish passage of migratory salmonids has the potential to increase the productivity of the Boardman River. Nutrients would be added to the system through egg deposition and through the decomposition of the spawning fish after they die (Shuldt and Hershey 1995; Cederholm et al. 1999). One result of this increased productivity might be increased growth in resident Brown and Brook trout. This phenomenon may be responsible for the fact that the largest, fastest growing Brown Trout in the Boardman River watershed are currently found below Sabin Dam, where migratory fish are present. However, where migratory salmonids coexist with resident trout, studies have shown elevated levels of organic toxins such as PCBs in resident trout populations (Janetski et al. 2012 and Zorn and Sendek 2001). It is also possible that migratory fish passage could introduce fish pathogens to upstream areas.

Allowing migratory fish to access the entire Boardman River watershed also has the potential to create a positive economic effect for the surrounding community. For example, if salmon or steelhead were allowed access to the entire watershed, the Boardman River would likely become a very popular destination fishery for those species. Anglers might travel long distances for the sole purpose of fishing for salmon or steelhead throughout the watershed. This would cause a major increase in tourism at off-peak times, and particularly during spring and fall, when peak runs of salmon and steelhead occur. Businesses that cater to the needs of anglers, including restaurants, motels, sporting good shops, and guiding services, would directly benefit from migratory fish passage. According to the 2005 MDNR creel survey of the Boardman River (Appendix E), angling pressure is relatively light on most stretches of the Boardman River, particularly upstream of Union Street Dam. Allowing an upriver salmon or steelhead fishery to develop would likely create more fishing pressure at peak run times. While passing migratory salmon and steelhead to upstream reaches of the Boardman River could create a dynamic new fishery, it could also increase the potential for social conflict. The increased fishing pressure that might come with the new fishery could also be accompanied by an increase in conflicts with riparian landowners, fish law violations, and potential resource degradation from angler traffic. Chinook Salmon runs in particular on some Michigan streams have a history of creating a number of law enforcement and social problems.

There are many biologic, social, and economic issues that need to be considered when determining what fish species to pass and not to pass. The MDNR Fisheries Division is committed to working with stakeholders to identify and determine an appropriate fish passage strategy that incorporates the best current information and recommendations, but also allows us flexibility as information and recommendations change in the future.

Recreational Use

The Boardman River watershed offers a variety of public recreational opportunities. There are five state forest campgrounds and a comprehensive trail system that supports biking, hiking, horseback riding, and snowmobiling. State forest public land comprises thirty-two percent (58,292 acres) of the entire Boardman River watershed. Approximately 54% of the river frontage is commercially or privately owned. The remaining 46% is state owned (Steve Largent, Boardman River Project coordinator, personal communication). This public land includes numerous undeveloped and developed public access and recreational sites within the Boardman River watershed (Table 18).

The MDNR Fisheries Division conducted a creel survey of the Boardman River from April 26–September 30, 2005 (Appendix E). In addition MDNR conducted a variety of creel surveys in the Boardman River watershed from 1928-1965 (Appendix G). The 2005 survey area was delineated into two sites; the mouth to the historic Brown Bridge Pond (lower) and Brown Bridge Pond to the Forks (upper); confluence of the North and South Branches of the Boardman River. The survey estimated 18,868 angler hours in the lower sample sites; Yellow Perch was the most common species caught by boating anglers, and Smallmouth Bass was the most commonly caught species by anglers fishing from shore. The survey estimated 9,958 angler hours in the upper sample sites; Bluegill was the most common species caught by boating and shoreline anglers. The creel survey did not distinguish impoundment/lake (Sabin, Boardman, and historic Brown Bridge impoundments and Boardman Lake) from river anglers. Impoundment/lake anglers were likely encountered and interviewed more frequently than river anglers because river anglers are more mobile and dispersed. Therefore, the most abundant fish species documented were coolwater fish (Smallmouth Bass, Bluegill, and Yellow Perch) caught from the Boardman River impoundments and Boardman Lake.

The Boardman River watershed receives approximately two million recreational user days per year (Steve Largent, Boardman River Project coordinator, personal communication). Fishing, canoeing, hiking, and swimming all rank among the top five summer recreational activities undertaken by tourists in the Traverse City area (Traverse City Convention Bureau 2007). The Forks to the Boardman River mouth receives the greatest amount of canoeing, kayaking, and tubing activity due to the availability of public access sites and limited woody obstructions. There are two canoe liveries on the Boardman River (Ranch Rudolf and Mac's Landing) and numerous canoe launches (Table 18). The Boardman River has been classified as one of Michigan's finest paddling rivers, and features rare bursts of light whitewater (Abrams 2007).

Citizen Involvement

Public involvement in the management, protection, restoration, and enhancement of the Boardman River watershed is a crucial component of sustaining the long-term health of the watershed. There are numerous opportunities available for public involvement in the management of the Boardman River watershed (Table 19). Public involvement enhances the capacity of the community to respond to and proactively address a variety of natural resource issues and challenges. The capacity of the community in the watershed will determine the health of the watershed. The willingness of the watershed community to collaborate with and learn from each other will promote the long-term health of the watershed. A self-sustaining watershed community is proactive, collaborative, involved, and knowledgeable about all the stressors and challenges that could negatively affect the watershed. The Boardman River watershed community has all of the elements needed to become self-sustaining except a succinct organizational structure that will link and guide the self-sustaining effort. The Boardman River Prosperity Team (theboardman.org) is currently developing the foundation for a self-sustaining watershed community through active community engagement and collaboration among diverse stakeholders.

MANAGEMENT OPTIONS

The Boardman River watershed is unique because of the diverse aquatic habitat and species it supports. It also contains the largest metropolitan area (Traverse City) in the northern Lower Peninsula of Michigan. Therefore, it is subject to increasing developmental pressure which could adversely affect aquatic habitat and species.

The management options follow the recommendations of Dewberry (1992), who outlined measures needed to protect and preserve the health of a river ecosystem. Stressed are the protection and restoration of headwater streams, riparian corridors, and floodplains. We must view the river system as a whole, for many important elements are driven by whole-system processes.

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

Within each of the broader categories listed below, we convey four option types for correcting problems in the watershed. First, we present options to protect and preserve existing resources, second are options requiring additional surveys, and third are opportunities for rehabilitation of degraded resources. Opportunities to improve an area or its resources, given its present status, are listed last. These options are not intended for MDNR, Fisheries Division action only, but should also be initiated by citizen groups and other agencies.

Geology and Hydrology

The Boardman River has very stable flows. However, increasing urban development within the watershed has the potential to increase the flashiness of the river, specifically since the lower watershed contains the largest metropolitan area in the northern Lower Peninsula.

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

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

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

Option: Protect existing hydrologic conditions of lakes and remaining natural lake outlets by prohibiting construction of new lake-level control structures.

Option: Restore the natural hydrologic regime of the main stem Boardman River by removing, Boardman and Sabin dams.

Option: Restore the natural hydrologic regime of tributaries to the Boardman River by removing or modifying dams that negatively affect aquatic and semi-aquatic populations and habitat.

Option: Restore the connectivity of sub-watersheds by removing barriers among inland lakes, ponds, and tributaries.

Option: Restore the natural hydrologic regime of lakes and lake outlets by removing lake-level control structures where appropriate.

Channel Morphology

Adequate data on the channel morphology of the Boardman River is lacking. However, the limited data that does exist indicates relatively high gradient, especially in the lower reaches (Beitner Road downstream to Boardman Lake). The gradient in this section is likely higher than in any other large river in the Lower Peninsula, which explains why there were historically three hydroelectric dams in this reach. The main stem of the Boardman River generally lacks adequate aquatic habitat in the form of woody debris and pools. This may be a result of historic peaking operations of the dams which would homogenize channel morphology.

Option: Protect natural, unimpeded flow regimes in smaller tributaries by managing riparian areas in a way that preserves natural flow regimes.

Option: Protect diverse stream channel habitat by limiting removal of woody debris currently in the river.

Option: Restore extremely rare high-gradient habitat and rehabilitate inundated stream reaches on the Boardman River by removing Boardman, and Sabin dams.

Option: Restore sinuosity and channel diversity in stream reaches that were historically channelized.

Option: Improve habitat for coldwater fishes on the main stem of the Boardman River by narrowing and deepening the stream channel in appropriate areas and by adding woody instream overhead cover.

Option: Collect channel morphology and physical habitat data for the Boardman River in representative locations to develop a baseline dataset.

Dams and Barriers

The Boardman River watershed contains four major and numerous minor dams. The dams and barriers in the watershed disrupt the natural flow regime of lakes and rivers and degrade aquatic habitat and species.

Option: Protect biological communities of the river by providing select upstream and downstream fish passage at all dams to mitigate for habitat fragmentation.

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

Option: Remove Boardman and Sabin Dams to restore the natural flow regime of the Boardman River.

Option: Remove non-functioning or obsolete dams on tributaries in the watershed to restore natural flow regimes.

Option: Retrofit Union Street Dam to allow passage of select species, while preventing the migration of Sea Lamprey.

Option: Discourage the construction of any new dams or lake-level control structures in the watershed that will negatively affect aquatic species or habitat.

Option: Survey and document all the dams and barriers within the watershed to identify areas where environmental damage and the need for mitigation are the greatest.

Soils and Land Use Patterns

Soils in the Boardman River watershed are generally coarse-textured, providing high infiltration and groundwater recharge, but are also susceptible to significant erosion. In addition, the loss of wetlands within the watershed compounds the susceptibility and negative effects of erosion and sedimentation.

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

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

Option: Protect the river from excessive sedimentation by reducing the density of oil and gas well pads, and restore obsolete pads.

Option: Protect and maintain forested buffers along lakeshores and river corridors to retain critical habitats and to allow for natural wood deposition.

Option: Protect river channels from excessive sedimentation by applying BMPs at all road-stream crossings.

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

Option: Encourage the construction of bridges at road-stream crossings.

Option: Assess the effectiveness of sand traps and erosion/sedimentation control methods by conducting a watershed-based evaluation of natural versus anthropogenic (human-caused) sediment sources and transport.

Special Jurisdictions

The wildlife and fisheries resources within the Boardman River watershed are managed by the Department of Natural Resources and the Department of Environmental Quality. In addition, there are a variety of township, city, and county governmental entities that have authority over developmental practices that can affect aquatic natural resources.

Option: Protect the natural character and function of the Boardman River watershed by extending the Natural Rivers jurisdiction to include headwater areas of the North and South Branches of the Boardman River upstream of US 131.

Option: Protect coldwater tributaries by designating appropriate reaches as Designated Trout Streams to ensure proper management and environmental protection.

Option: Protect and restore the watershed by supporting collaborative planning and decision-making. Develop a Geographic Information System that could be used to facilitate these processes.

Option: Protect natural form and function of wetlands, streams, and lakes through rigorous enforcement of Public Act 451, parts 301 and 303.

Option: Rehabilitate lake-outlet streams by encouraging run-of-river management at lake-level control structures.

Option: Collaborate with local units of government, non-profit groups, state, and federal natural resources agencies, and Tribal agencies (in accordance with appropriate Decrees, ordinances, and laws) to protect, enhance, and restore aquatic resources.

Water Quality

Water Quality is generally good throughout the entire watershed with the exception of identified NPDES sites specifically on Boardman Lake, and non-point pollution sites such as poorly designed road-stream crossings. In addition, the water quality of the Boardman River is degraded downstream of dams due to increased water temperatures and decreased transportation of organic material.

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

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

Option: Protect aquatic resources by implementing best management practices for storm water and non-point source pollution.

Option: Protect major aquifers in the watershed by promoting hydrogeologic studies to characterize groundwater and programs to protect groundwater from contamination.

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

Option: Survey loading of nutrients and sediment to the river and develop strategies to reduce identified problems.

Option: Restore natural coldwater temperatures below dams by removing or physically modifying dams to reduce their thermal effects on downstream reaches.

Option: Rehabilitate water quality by encouraging communities to implement street cleaning practices that reduce contributions of refuse, sediment, and pollutants to the river.

Biological Communities

The Boardman River watershed supports a diverse biological community. This community has been historically degraded through inappropriate developmental practices such as extreme logging and the creation of unnatural structures such as dams. The present biological community is currently protected from large-scale degradation by a variety of local, state, and federal ordinances and oversight. However, the biological community is in danger of incremental, cumulative degradation that is less obvious than the effects of large-scale degradation.

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

Option: Protect unique biological habitat such as wetlands by discouraging development within these areas.

Option: Protect and rehabilitate upland habitats for native plant and wildlife diversity.

Option: Protect native mussels by removing dams so less lentic habitat is available for zebra mussels.

Option: Protect native and naturalized aquatic species from predation, competition, and habitat destruction from invasive species, by suppressing the spread and population expansion of invasives.

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

Option: Restore the potential for fishes to migrate through the watershed by removing dams whenever feasible.

Option: Survey and map biological community distributions in the watershed using advanced technology, including global positioning and geographic information systems.

Option: Survey and accumulate all data concerning the present distribution and status of fishes, aquatic invertebrates, mussels, amphibians, reptiles, aquatic plants, and pest species throughout the watershed.

Fisheries Management

The stable, groundwater-dominated flows of the Boardman River are a key factor in sustaining high-quality fisheries. Fishing is good throughout the watershed, but could be enhanced by removing obsolete dams, introducing woody debris, and restoring natural riparian corridors.

Option: Protect fish communities in Grand Traverse Bay and Lake Michigan from Sea Lamprey by perpetual maintenance of a lamprey barrier on the Boardman River.

Option: Protect fish communities by working with the general public to discourage the construction of additional dams.

Option: Initiate ecosystem-level monitoring of physical and biological characteristics of the main stem and tributaries throughout the watershed.

Option: Protect existing wetlands that provide spawning and rearing habitat.

Option: Restore aquatic connectivity of the Boardman River by removing Boardman and Sabin dams.

Option: Continue to operate and maintain the Boardman Weir between mid-September and mid-October, as appropriate.

Option: Enhance the fishery of the Boardman River by developing and operating a selective species passage barrier prior to the removal of Sabin and Boardman Dams.

Option: Assess the ten-inch minimum size limit on Largemouth and Smallmouth bass in Arbutus and Spider lakes

Option: Improve habitat for coldwater fishes on the main stem of the Boardman River by supporting projects that encourage the narrowing and deepening of the stream channel, and by adding woody instream cover.

Option: Continue to enhance the Boardman River, Grand Traverse Bays, and Lake Michigan fisheries by assessing and determining appropriate stocking initiatives.

Option: Enhance the fishery of the lower Boardman River, Boardman Lake, and Lake Michigan by allowing coolwater fish to access Boardman Lake such as Walleye, Smallmouth Bass, Great Lakes Muskellunge, Northern Pike, or Yellow Perch.

Option: Explore the potential for reintroducing Lake Sturgeon into the Boardman River when the major dams are removed.

Recreational Use

Recreational use in the watershed is substantial, primarily due to the abundance of public access and public land within Grand Traverse and Kalkaska Counties. The recreational use of resources in the watershed should be managed to assure an appropriate balance between use and abuse.

Option: Protect, encourage, and support existing parks, and promote responsible management for riparian areas in public ownership.

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

Option: Improve public access opportunity (where lacking) through MDNR, county, township, city, and other municipal recreation departments.

Option: Survey and quantify recreational user groups within the watershed, and identify programs to enhance compatible use of resources.

Citizen Involvement

The perpetual sustainability of wildlife and fisheries resources within the Boardman River watershed is reliant upon general public involvement in the protection, enhancement, and restoration of natural resources. Public involvement should occur from the very beginning of every environmental initiative. The ultimate goal of any environmental initiative is to create and perpetuate environmental stewardship. Environmental stewardship can only be accomplished by educating and empowering the general public to be actively engaged in environmental issues.

Option: Protect and expand Fisheries Division partnerships with diverse watershed stakeholders by initiating collaborative relationships and continuing to participating in watershed-based initiatives.

Option: Protect and rehabilitate the watershed by supporting efforts of interest groups seeking funding to protect, enhance, or restore wildlife and fisheries integrity.

Option: Protect and preserve the natural integrity of the watershed by actively participating on the Boardman Prosperity and Implementation Teams.

Option: Rehabilitate aquatic habitat by encouraging and supporting collaborative habitat improvement projects within the watershed.

PUBLIC COMMENT AND RESPONSE

The Boardman River Assessment draft was distributed during the spring of 2014. A press release was issued to solicit comments by directing interested parties and individuals to a web site where the draft assessment was posted online. Copies were distributed to a variety of stakeholder groups, including the Adam's Chapter of Trout Unlimited and were also available upon request at both the Traverse City Field office and the Cadillac Operations Service Center. The authors directly contacted all the groups associated with the Boardman River Implementation Team to solicit comments; those groups include Grand Traverse County, the City of Traverse City, Traverse City Light and Power, Michigan Hydro Relicensing Coalition, Grand Traverse Band of Odawa Indians, U.S. Fish and Wildlife Service, Michigan Department of Environmental Quality, Conservation Resource Alliance, Grand Traverse Conservation District, The Watershed Center, and the Rotary Club of Traverse City.

A public meeting was hosted by the authors to provide an overview of the assessment and to receive comments. This meeting was held at the Grand Traverse County Nature Center, 1450 Cass Road, Traverse City, on Monday, April 14, 2014 at 6 pm. Twenty-two members of the public attended this meeting. While this meeting was aimed at gathering comments for this assessment only, much of the public comment was directed towards issues remaining from the October 2012 Brown Bridge Dam breach and subsequent flooding.

The deadline for public comment was May 16, 2014; however, comments received through the end of the summer of 2014 were accepted. The comments were reviewed and incorporated into the final assessment or listed with the reason it was not incorporated.

Introduction

Comment: When was the last river assessment done?

Response: No assessment of the Boardman River has ever been completed in this format.

Comment: What is productivity in principle #1?

Response: Productivity refers to recognizing the limits of the river. Ecosystems have finite limits of what they are able to sustain or produce, known as a carrying capacity. For instance, the Boardman River can only support so many Brown Trout and Brook Trout at any given time based on what resources are available.

Comment: What is the intent of "recognize" in principal #4

Response: Recognizing if a species is well established, has recreational value, is unique or relevant. For example, Brown Trout, Rainbow Trout, Chinook Salmon, Coho Salmon, and Brook Trout are not native to the Boardman River, but are extremely valuable to the fishery.

Comment: What is the intent of "acknowledge" in principal #8?

Response: Recognizing that some Boardman River fisheries are currently sustained through stocking, such as Coho Salmon, Chinook Salmon, and steelhead. Fish stocking is a common option in fisheries management, and can be used temporarily to establish a new species or it can occur annually to sustain a desired level of a fishery.

Comment: Has the MDNR ever considered preserving some major trout river systems as refuges from Pacific salmonids that migrate from the Great Lakes?

Response: We have no specific policy that discusses this issue. We typically show strong support for dam removal and fish passage projects. However, we do look at each dam/barrier removal on a case by case basis and consider all factors.

Watershed Assessment

No comments were received under this section.

Geography

Comment: This section is missing the text regarding the National Education Reserve.

Response: We assume that you are referring to the Natural Education Reserve, which is administered by Grand Traverse County. We refer to it on pages 37 and 38.

Comment: On page 16, in the Headwaters to the Historic Brown Bridge Dam section, shouldn't the mention of the "one major impoundment" be deleted (now that there is no impoundment)?

Response: The draft of this document was completed in 2008; while some additional data up to 2012 was added, the decision was made to stop adding text to this document prior to the Brown Bridge Dam removal.

History

Comment: On page 18 in the middle of the page; "All of the hydroelectric dams are still in place, except for Keystone Dam, which washed out in 1961 and was not rebuilt". This statement also needs to be altered.

Response: The draft of this document was completed in 2008; while some additional data up to 2012 was added, the decision was made to stop adding text to this document prior to the Brown Bridge Dam removal.

Geology and Hydrology

Comment: Why did you move the river wherever you wanted at Brown Bridge Pond? Why was there not attempt to trap the sediment?

Response: Sand is more prone to erosion. Prior to the dam removal the watershed was mapped for such erosion sites. Sediment depth of refusal readings were used to determine the location of the historic river channel to reestablish its course. During the drawdown process sediments were trapped and removed to prevent them from moving downstream.

Comment: It's all sand upstream and there are buried contaminated soils up there. It's going to get back to the river.

> Response: Studies have documented elevated levels of chemicals and heavy metals in the three impoundments (barium, lead, selenium, and zinc in Brown Bridge Pond). The impoundments allow more contact with contaminated sediments. In the restored river channel there will be less contact with contaminated sediments by volume. Some of these sediments will also be removed during the river channel reconstruction process.

Comment: On page 20, doesn't the quotation belong in the Land Use subsection? The sentences on lines 9-14 express dangers from oil and gas operations merely as "concerns" and describes safeguards in vague terms. This exemplifies bureaucratic timidity. The river assessment should discuss the kinds and severities of damage to the Boardman River ecosystem that oil and gas development can cause. Catastrophic examples exist elsewhere, at least a couple of them in Michigan; namely, the oil spills into the Muskegon and Kalamazoo Rivers.

> Response: We believe that this quotation is in the appropriate section. Oil and gas development is regulated by the Department of Environmental Quality and is outside of the authority of the Department of Natural Resources. The current oil and gas wells within the watershed are documented in Figure 5, potential oil and gas risks are referred to on page 20, and specific concerns are referenced through Zorn and Sendek (2001).

Comment: This document should emphasize that the Boardman River and other streams of this region in Michigan owe the high quality of their water supply for coldwater fishes to a much more favorable geologic and climatic situation than exists in most other states or regions.

> Response: This topic is addressed within the Climate paragraph of the Geology and Hydrology section.

Comment: Each of the three paragraphs in this subsection emphasizes and explains the Boardman Rivers stable streamflow. Why is relatively stable flow important? How does the Boardman River compare with other streams in this respect? How does relatively stable flow affect trout and other organisms?

> Response: Stable stream flow results in consistent habitat availability to fish; low flows reduce the amount of habitat available and high flows alter how fish can use the available habitat and how the habitat functions. Stable flow allows for stable temperatures and consistent production within the system. A comparison of flow stability indices between the Boardman and other rivers throughout the state is included in Table 2.

Comment: Page 21, paragraph 4 average annual discharge reading should be noted that it is at the Ranch Rudolph USGS gage.

> Response: This comment has been incorporated into the draft, although it's important to note that the official name of the gage location is actually the "Boardman River above Brown Bridge Road near Mayfield, Michigan".

Comment: It's of little use to know the average annual flow without comparing it to that of other parts of this river or to other rivers. The information in Tables 7 and 8 about the variability or stability of flow serves well, but should be explained in the text. Data on annual summer and winter extreme low flows give much better indication of conditions for fish than average discharge does.

> Response: It is difficult to compare the Boardman to other rivers in this region when it comes to flow due to differences in geology and hydrology. However, a comparison of flow stability indices between the Boardman and other rivers throughout the state is included in Table 2. Temperature, which is often related to flow, was used instead to make comparisons.

Comment: Page 22, third paragraph states that the data will be available in 2008 and will be incorporated into this document during the next revision; where is this data?

> Response: The evaluation of this data was not completed at the time that this document was drafted.

Soils and Land Use Patterns

Comment: On page 25, paragraph 5 the paragraph on the problem of perched culverts blocking fish movement belongs in the section, Dams and Barriers.

> Response: We believe that this topic is appropriate in its current location.

Comment: Page 26, the first paragraph says that agriculture occupies 17% of the watershed. What kinds of agriculture? Which kind predominates and what are its known or likely effects on the river? Do significant legacy effects still exist from past, perhaps more extensive farming?

> Response: We do not believe that agriculture has a large impact on the watershed therefore it is not specifically addressed in this document. Other resources that provide greater detail regarding agriculture within the watershed include: include Largent (2006) and the Grand Traverse Bay Watershed Protection Plan: http://www.gtbay.org/resources/watershed-protection-plan/.

Comment: On page 26, the land use subsection- This topic deserves far more attention. The lead sentence sets the stage for a meaningful assessment. The 2 paragraph section however, simply lists the amounts of various kinds of land use, land cover, and land ownership. Nowhere does it assess how and to what extent the various kinds of land use affect or could affect aquatic habitat and species.

> Response: Potential impacts of various land use practices are described under this same section on page 25. Other resources that document and provide recommendations to address land management practices include Largent (2006) and the Grand Traverse Bay Watershed Protection Plan: http://www.gtbay.org/resources/watershed-protection-plan/.

Comment: Removal of trees and brush from the shore to allow river view (or facilitate boating?) is eluded to elsewhere in this draft but should be discussed in the land use section.

> Response: This topic is discussed in detail in the Boardman River Natural River Plan. http://www.michigan.gov/documents/Boardman_River_Plan_23122_7.pdf

Comment: The Land Use subsection should deal with the matter of oil and gas wells and the roads, pipelines, other infrastructure and the traffic, pollution, and other ecosystem disturbances involved.

Response: This activity is regulated by the Department of Environmental Quality and is outside of the authority of the Department of Natural Resources. The current oil and gas wells within the watershed are documented in Figure 5, potential oil and gas risks are referred to on page 20, and specific concerns are referenced through Zorn and Sendek (2001).

Channel Morphology

No comments were received under this section.

Dams and Barriers

No comments were received under this section.

Water Quality

Comment: The fish contaminant data should be updated as a result of the 2012 breach at Brown Bridge Dam.

Response: There is no indication that the dam breach would have resulted in an increase of contaminant levels in fish.

Comment: The negative impact of stormwater on the lower reaches of the Boardman River and Kids Creek should be mentioned here.

Response: Watershed protection issues, such as stormwater, are more adequately addressed in the Boardman River Prosperity Plan http://www.theboardman.org/prosperity-plan/ and the Grand Traverse Bay Watershed Protection Plan: http://www.gtbay.org/resources/watershed-protection-plan/.

Comment: This section lacks standard data on chemical parameters of the river's water- and interpretation of that information, especially in terms of its meaning for the biological community. Has no agency undertaken basic chemical analysis of the river's water?

Response: The MDEQ, The Watershed Center Grand Traverse Bay, and the Great Lakes Environmental Center (GLEC) have completed various chemical analyses of the Boardman River and its tributaries, and references to this work can be found in publications including these:

- Evans, E., M. Wilson, and W. Creal. 1990. Assessment of mercury contamination in selected Michigan lakes. In Michigan Department of Environmental Quality Sediment Contamination Survey, Boardman Lake. Report No. MI/DEQ/SWQ-01/073.
- http://www.gtbay.org/wp-content/uploads/2011/12/Final_Report_Full_smaller-size.pdf
- http://www.gtbay.org/wp-content/uploads/2010/10/KC-Action-Plan_draft.pdf

Comment: The Water Quality section should give much attention to thermal quality, especially to interpreting summer extremes of warm water and winter extremes of cold water and ice conditions in terms of their effects on the biota. At present, it mentions temperature only once and seeming in just passing, and it does not refer to Appendix D, which contains water temperature data for the river.

Response: The suggested change has been incorporated into the document.

Comment: On page 29, paragraph 1 reports exceedance of water-quality standards for PCB's in a river section just upstream from Boardman Lake- without pointing out that this section lies downstream of Sabin Dam, which fish migrating from Lake Michigan have not been able to pass. Drawing on the abundant scientific literature that exists, the authors should indicate the most likely process that put the PCB's in the contaminated section, discuss how those chemicals probably affect the biota, give reasonable explanations why similar PCB levels were not found upstream of that river section, and discuss the likelihood that migration of Lake Michigan fish into the river will bring contaminants that harm the ecosystem.

Response: Much of the historical and present-day industry along the Boardman River is located near or below Sabin Dam. We do not believe that transport of contaminates by migratory fish is a significant concern. Michigan has many river systems that include migratory fish species yet do not have any additional advisories for contaminates.

Comment: On page 29, paragraph 2 refers to http://www.liaa.info/crabmp/. Apparently that website no longer exists. It does not show up on my computer.

Response: That website has since changed. The appropriate site is:
http://www.northernmichiganstreams.org/boardmanws.asp

Special Jurisdictions

Comment: I like how you're suggesting that the Natural Rivers designation be extended upstream to the headwaters on both branches but would like to see that for the tributaries that are listed as well. Really the Natural Rivers Plan for the Boardman should be updated.

Response: Many of the tributaries to the Boardman River already fall under the Natural River Plan. Updating the Boardman River Natural River Plan is outside of the purview of this report.

Comment: Would like to see something that emphasizes that the two branches (especially the North Branch) be managed for the fishery and not for navigability.

Response: DNR Fisheries Division encourages recreational use of all types in the Boardman River. The diminutive size of the river that far up in the watershed already limits navigation.

Comment: Would like to see something about the use of existing transportation corridors to the greatest extent possible. What I am getting at here is no new expressways (US-131) through the heart of the Wild & Scenic portion of the watershed like what was proposed in the late 1990's.

Response: DNR Fisheries Division would advocate for less disruption.

Comment: Need to address motorized use in the upper part of the river system (jet skis, outboards, airboats, etc.).

> Response: Use restrictions are authorized through county ordinances and are not under the authority of the Michigan Department of Natural Resources.

Biological Communities

Comment: The concept of live vegetation occurs 37 times in the draft, including duplicate references, but is accompanied by no real description of its functions. State forest land is mentioned. How is that land managed, and how does this affect the river?

> Response: State forest land is managed by the DNR Forest Resources Division; this includes uses such as timber sales, state forest campgrounds, multiple trail systems, and fishing/ hunting access sites. These lands are managed following best management practices and a thorough public input process for parcels within the watershed.

Comment: The draft fails to deal with beaver, except to list the animal in Table 9. What legacy of their former abundance remains in the riparian corridor and small tributary creeks, and to what extent have their populations recovered in the Boardman River watershed?

> Response: We are not aware of any information, either past or present, on beaver populations for the Boardman River watershed. While the presence of beaver can be beneficial, they can also cause a variety of problems, and thus beaver populations should be maintained at a sustainable level without endangering or threatening other unique natural ecosystems. Should the beaver population in the Boardman River watershed begin to cause conflict, Fisheries Division would follow the protocol outlined in DNR Policy 39.21-20 - BEAVER MANAGEMENT to guide management decisions.

Comment: On page 31, paragraph 8 indicates that one should see the Soils and Land Use section for information about oil and gas development. It is however in the Geology section that oil and gas development are covered.

> Response: The suggested change has been incorporated into the document.

Comment: On page 32, paragraph 1 the last sentence reads “unnatural amounts of sand entering a trout stream like the Boardman River can inundate high-quality gravel, thereby reducing trout populations and insect productivity”. Too equivocal. Say whether or not you or other biologists believe this is a significant problem in the Boardman River system and present evidence for the opinion.

> Response: Excessive sediment erosion and deposition is a problem at various sites within the Boardman River, as it is in most rivers in the state. Our summary of these impacts is documented in the Soils and Land Use Patterns section on page 25.

Comment: Page 32, Current Fish Communities section- The text names 14 fish species or hybrids that live in the lakes of the watershed. The text also shows names of 9 river-migrant species but strangely no mention of any river-resident fish, not even Brook, Brown, or Rainbow trouts- except that Brook and Brown trouts appear in parentheses as parental for the tiger trout hybrid.

Response: The discussion of river resident fish occurs extensively under the Fisheries Management section on pages 39-44.

Comment: The river communities section typifies the drafts general flaw of presenting simple facts without discussing their interrelationships and other significance. Which species do humans use or otherwise especially value? Which important species require what special habitats at certain life stages? Which species prey on or compete with others?

Response: These questions are discussed in the Fisheries Management section on pages 39-44.

Comment: Information on predation on fish by birds, northern water snake, otter, raccoon, and possibly other species such as black bear is not included.

Response: Natural mortality is a component of all fish communities and is considered when managing populations. Although detailed predatory studies and information would be helpful, it is not required to make informed management decisions in all cases. Managers continually prioritize their data collection and analysis efforts to make the best use of their limited time and budgets.

Comment: On page 32, paragraph 3, line 6- “niches” is the wrong word. Change the sentence to: Some species occur in more than one of those groups.

Response: The suggested change has been incorporated into the document.

Fisheries Management

Comment: Is this document leading to a management plan for the river?

Response: Yes, a management plan will accompany the river assessment. The management plan will contain specific actions along with timelines for completion.

Comment: Have there been any studies or surveys of the fish community downstream of Brown Bridge after 2012?

Response: Yes, an index station just downstream of Brown Bridge Road that has historically been sampled has been surveyed annually since 2012 and will continue to be surveyed into the future.

Comment: There is an option listed to “evaluate the 10 inch size limit on large and Smallmouth Bass in Arbutus and Spider Lakes”. While I agree and have personally witnessed a high degree of stunting in Arbutus, Spider, and the worst- High Lake, it is an issue that is just simply outside interests of managing the Boardman River and I would therefore move to have that option stricken from the document.

Response: We respectfully disagree. This assessment is meant to be comprehensive of the entire watershed, and thus even inland lakes play a role in management. This objective was completed in 2015.

Comment: While most likely important to the DNR and the region, the enhancement of any fishery downstream from the mouth of the Boardman River, is not appropriate to include in this document. Certainly one might argue of the connectivity; however this document is a Boardman River Assessment, not a regional assessment. I therefore recommend removing any language pertaining to enhancing the fishery of any body of water that is not the Boardman River, including any portion of the Great Lakes, the Grand Traverse Bays, and inland lakes not directly connected to or without a natural inlet and outlet of the Boardman River.

Response: While the primary focus of this assessment is the Boardman River watershed, there are numerous species that migrate into the watershed for portions of their life cycle that need to be considered when developing and accessing management options.

Comment: In the Tributaries section you could also talk about how Kids Creek is on the state's Impaired Waters List and that The Watershed Center is working with the DEQ and the Grand Traverse Conservation District to restore the creek. The Kids Creek Action Plan was also recently completed. Corrections could read as follows; "In 2005, the Watershed Center Grand Traverse Bay completed a restoration project on Kids Creek to restore a severely degraded stretch of Kids Creek (just west of M-37 between Kohl's and the Great Wolf Lodge) and created hiking trails and an informational kiosk (The Watershed Center Grand Traverse Bay 2005). In 2006, the Watershed Center began the Kids Creek Storm water Project, which culminated in the drafting of a Kids Creek Action Plan, which outlines recommendations to help get the creek removed from the impaired waters list. Recommendations from that plan are already being implemented with the Watershed Centers Kids Creek Restoration Project."

Response: The suggested change has been incorporated into the document.

Comment: Page 36, Paragraph 1, line 6- "MDNR fisheries index station" – the term hasn't been defined, and doesn't exist in the glossary. What is it?

Response: An index station is a location at which we have previously conducted fisheries surveys at periodic intervals. This term has also been added to the Glossary.

Comment: Page 38, paragraph 1, lines 5-6- "Due to the warmer water temperatures, this reach (Sabin Dam to Boardman Lake) appears to be marginal for the survival of other salmonid species, and natural reproduction and survival only occur in cooler summers". Which of the salmonid species at issue reproduce in the summer?

Response: This statement discusses the survival of adults and smolts produced from natural reproduction; reproductive steps such as egg deposition do not occur in the summer.

Comment: The draft completely neglects the well-known problem of genetic harm to wild salmonid populations via interbreeding with hatchery-bred conspecifics, for instance, interbreeding of the wild, stream-resident Brown Trout population with hatchery-bred Brown Trout that migrate from Lake Michigan. I don't know whether MDNR stocks hatchery Brown Trout in Lake Michigan, but Wisconsin DNR does.

Response: As of 2016 we will be ceasing all Brown Trout stocking in West Grand Traverse Bay. Boardman River weir returns and creel census data have shown the Boardman River has never received a substantial run of migratory Brown Trout.

Comment: The draft fails to adequately discuss potential harm to the resident trout population from intrusion by Lake Michigan migrant salmonids as bearers of toxic contaminants and disease, as competitors, as predators, as spawning redd superimposers, etc.

> Response: We mention these potential issues in the document on page 43, but do not believe they warrant further discussion in the text. This topic is also discussed in Appendix F.

Comment: In paragraph 3, first two sentences; mark-recapture electrofishing surveys have been used to obtain population estimates for trout populations at nine stations in the Boardman River watershed. On what basis was each of the nine selected, how representative is each of the larger area in which it lies, and what are the channel characteristics of each?

> Response: Specific survey information summaries can be obtained by contacting the local Traverse City DNR fisheries biologist at 231-922-5280. The sites were selected using Stream Status and Trends Program protocol. The criteria for these sites can be found in the Fisheries Division Special Report cited below:
>
> Wills, Todd C., T. G. Zorn, and A. J. Nuhfer. 2006. Stream Status and Trends Program sampling protocols. Chapter 26 *in* J. C. Schneider, editor. 2000. Manual of fisheries survey methods II: with periodic updates. Michigan Department of Natural Resources, Fisheries Special Report 25, Ann Arbor.

Comment: The draft does not show the dates of the electrofishing.

> Response: The dates for the electrofishing surveys are shown in Tables 12–16.

Comment: Table 15 contains a major glitch: its shows 100% survival of Brown Trout from age 0 to age 1 in 2002 and 2003- that's an impossible situation.

> Response: True, it is not possible to have survival higher than 100%. However, these data are most likely reflecting trout immigrating into the station from other locations. Perhaps the habitat in this reach is more suitable for age-1 Brown Trout than age-0 Brown Trout.

Boardman River Dams Project

Comment: Paragraph 1, next to last sentence; "…the optimal situation is a barrier that permits controlled migration so current and future managers will have the ability to limit or pass species as deemed appropriate". Many kinds of such artificial barriers occasionally fail due to lapse of maintenance or other human error. And can MDNR install a barrier that will block upstream migration during the worst foreseeable floods?

> Response: There are presently two such structures in place, the Union Street Dam and the Boardman Weir. While both structures frequently require routine maintenance, neither one has failed.

Comment: Page 42, last paragraph, last two sentences; these statements are based on unpublished, non-peer-reviewed material, therefore to be regarded with a grain of salt.

Response: We respectfully disagree. Ample data exist showing the coexistence of Brook Trout and Rainbow Trout (steelhead parr) in these two systems. Please see the following report on Bear Creek, which was published in 2015:

Tonello, M. A. 2015. Bear Creek: Status of the Fishery Resource Report 2014-195. Michigan Department of Natural Resources, Lansing.

Comment: Regarding "organic toxins such as PCB's in resident trout populations", the draft merely refers to Janetski et al. (2012) and Zorn & Sendek (2001), but it should inform the public with a thorough discussion of the consequences to resident trout and the broader ecosystem, drawing on these two publications and other pertinent sources.

Response: We believe that, for the purpose of this document, we have adequately summarized this issue and provided appropriate resources for additional information if readers are interested. There are numerous rivers in Michigan that support annual migrations of salmon and steelhead but do not have known contamination issues or Fish Consumption Advisories related to migratory salmonids. Also, Fish Consumption Advisories are issued by the Michigan Department of Health and Human Services and are out of the purview of MDNR.

Recreational Use

Comment: The Assessment should address how canoes and other watercraft will be managed on the Boardman as the dams are removed. There are some areas that appear like they could be dangerous for the inexperienced and inebriated as well as problematic for those who live close to the river.

Response: MDNR does not have the legal authority or mandate to control watercraft use on the Boardman River.

Citizen Involvement

Comment: Have you ever looked at having a "River Keeper" for the Boardman River?

Response: Not at this time, but that is an option that could be addressed in the future management plan and through consultation with the National River Keeper Process.

Comment: The Boardman River Clean Sweep and the Traverse Area Paddle Club are not mentioned in the Citizen Involvement section or Table 19 in the listing or organizations involved in taking care of the river. I just thought these groups and their efforts should be mentioned in the assessment.

Response: While both of these groups are valuable stakeholders groups that provide services to the river, these groups do not aid the MDNR in making fisheries based management decisions.

Management Options

Comment: It would be key to mention specifically in the Management Options section something about the other existing management plans for the river, such as the Grand Traverse Bay Watershed Plan and the Boardman Prosperity Plan, and explain how the recommendations you put forth are consistent with recommendations in the other plans.

Response: At the time that this document was drafted, these plans were not yet completed. In fact, the Boardman Prosperity plan is still being drafted right now; however DNR Fisheries Division has been an active participant in the drafting of these additional management plans, and we have urged that the goals and objectives in both plans are well aligned.

Comment: You may want to add something in this section about protecting or encouraging vegetative buffers along the river and its tributaries in local ordinances.

Response: This topic is outside of the purview of this document, however is covered in the Boardman River Natural River Plan where vegetative protection already falls under local zoning ordinances.

Comment: We would like to see an option that addresses hydraulic fracturing.

Response: This topic is outside of the purview of this document. However, protecting groundwater from contamination is an option under the Water Quality section, protecting the natural hydrologic regimes of streams is an option under the Geology and Hydrology section, and protecting the river from excessive sedimentation by reducing the density of oil and gas well pads is an option in the Soil and Land Use Patterns section.

Comment: We would like to see an option that addresses the need for greater funding to support increased data collection.

Response: We are unsure what type of data this comment is referencing. Current long-term data collection on the river includes fish communities and macroinvertebrates, and herptafauna data collection is set to begin in the spring of 2016.

Comment: One option discusses Union Street Dam and speaks to allowing passage of "select species", need to identify "select species".

Response: The "select species" have not been determined at this time. MDNR Fisheries Division and Grand Traverse Band of Ottawa Indians will make the final decision about the passage and management of species. The decisions will be informed through a collaborative process that engages primary stakeholder groups and members of the public. Initial outreach efforts will begin in 2017.

Comment: Need an option that addresses trimming and or removal of fallen trees to maintain "safe navigation" for paddlers. How much should be trimmed? Who is responsible?

Response: We agree that such a discussion is warranted. However, MDNR does not have the legal authority or mandate to actively manage fallen trees on the Boardman River.

Comment: One of the Soils and Land Use Patterns options addresses undersized, perched, misaligned, or incorrectly placed culverts. Earlier in the assessment it's stressed that "we must view the river system as a whole, for many important elements are driven by whole-system processes". Therefore we would like to see an option that addresses that when these crossings are replaced consideration is given to the other wildlife species that utilize the riparian corridor and that the crossing provides for that use.

Response: Our concerns are inclusive of wildlife; on many of these types of projects we partner with wildlife staff and other groups to ensure that these structures are designed appropriately. A good example of this is the new Cass Road Bridge project, which has been designed with significant flood plain capacity under the bridge, including corridor space for wildlife.

Comment: The first option under Recreational Use should also include “properly maintain”.

Response: We feel that the existing verbiage is appropriate “promote responsible management” is very similar to “properly maintain.”

Comment: We would like to see an option that allows for the use of properly sized, located, and maintained sand traps as a tool to remove excessive sediment.

Response: It is no longer common practice by Fisheries Division to utilize sand traps as they are a questionable utility as a stand-alone restoration tool. Studies have shown that there is no significant upstream-downstream effect of traps on dominant substrate, thalweg depth, or bank stability. Most sand traps that were being utilized across the state were found to be undersized and inadequate, and not serving the purpose they were intended to.

Zorn, T. G., and T. C. Wills. 2012. A reconnaissance survey of the effects of sediment traps on Michigan streams. North American Journal of Fisheries Management 32:1005-1016.

Comment: We would like to see a management option that addresses “special regulations” on the Boardman River.

Response: With the ongoing dam removal process, the Boardman River is a system with too much fluctuation occurring in its watershed for special regulations to be considered at this time. At this time, the Boardman River does not meet the criteria outlined in Fisheries Order 213.10 for consideration as a gear restricted water; as the dam removal process progresses, these criteria will continue to be evaluated.

Comment: Need to be an option that addresses the potential nutrient loading and bio-contaminants introduced from nonnative Great Lakes fish.

Response: This issue was summarized on pages 42 and 43. The pros and cons of fish passage will be thoroughly discussed and addressed through a future initiative.

Comment: One option states “continue to operate and maintain the Boardman Weir between mid-September and mid-October, as appropriate”, what about nonnative Great Lakes fish that migrate outside that timeframe?

Response: Fish outside of this timeframe will be able to move freely.

Comment: The options barely address potential for discharge (i.e. from wells, pipelines, transportation) into the river itself or the aquifers that feed it. The Assessment ought to set out actions that can protect the watershed. The waters from the Boardman ultimately affect the Great Lakes.

Response: MDNR is not a regulatory agency. These issues would be addressed by MDEQ and the EPA. In addition, discharge issues are addressed through the options in the Geology and Hydrology section.

Comment: Several options propose to put at risk, if not destroy, the existing wild and self-sustaining population of Brook Trout and Brown Trout in the upper Boardman River by opening it to steelhead, salmon, and known and unknown invasive species and diseases. Where the Assessment claims that steelhead and salmon have “improved” brook and Brown Trout populations, it fails to mention the effects of repeated stocking efforts. Practically every river and creek flowing into Lake Michigan, except the Boardman and the upper Manistee, offer passage for steelhead and salmon so there is no need to decimate the wild brook and Brown Trout population in the Boardman River.

Response: Thank you for your comments. The River Assessment is not meant to define specific management actions. The Boardman River Management Plan will define specific management actions. The River Assessment identifies management options and defines some of their pros and cons. The pros and cons of potentially passing salmonids are summarized on pages 42 and 43.

Comment: Several of the areas where the public access the upper Boardman River become a mess as the recreation season unfolds. The state currently does nothing about this (toilet paper close to the river banks, camper’s trash, bait containers, bank erosion). These options do not address the current problem. The options do not address how the state will clean and repair the river and its banks from increased human pressure if it were opened to steelhead and salmon.

Response: Fisheries Division will work with Parks and Recreation Division to ensure that these sites are better maintained.

Comment: The assessment ought to include an option to at least test the effect of making part of the upper Boardman flies only with restricted limits, similar to the Au Sable and Manistee. The Assessment suggests the matter has been discussed periodically in the past. This might improve the trout population in the river.

Response: With the ongoing dam removal process, the Boardman River is a system with too much fluctuation occurring in its watershed for special regulations to be considered at this time. At this time, the Boardman River does not meet the criteria outlined in Fisheries Order 213.10 for consideration as a gear restricted water; as the dam removal process progresses, these criteria will continue to be evaluated. Creel data from as recent as 2015 indicated very light fishing pressure and essentially no harvest of fish on the Boardman compared to these other river systems.

Comment: Geology and Hydrology Subsection- Option 2 mentions “best management practices”, management of what?

Response: We are referring to Soil Erosion and Sedimentation Control techniques, which are commonly accepted practices that provide for the control of soil erosion and protects adjacent properties and the waters of the state from sedimentation.

Comment: Channel Morphology Subsection- The introductory paragraph says adequate data on channel morphology are lacking. Do they not exist in papers by Burroughs?

Response: These papers were not completed at the time that this document was completed. That information can be located in the following document:

Burroughs, B.A. 2008. Boardman River feasibility study: a report on the Boardman River fisheries habitat survey and data collection. Report of Environmental Consulting and Technology Inc. to the Boardman River Dams Committee, Traverse City, Michigan.

Comment: Channel Morphology Subsection- The introductory paragraph also says lack of adequate woody debris and pools may be the result of historic peaking operations of the dams which would homogenize channel morphology. What about the former log drives and the present riverside tree cutting, both mentioned elsewhere in the draft?

Response: While we acknowledge that these historic log drives and present day cutting of riparian cover have affected the amount of woody debris available to recruit to the river naturally, it is unknown to what extent this occurred/does occur. We do know that dams act as sinks for woody debris moving through a river system, and that peaking operations would have prevented wood from settling and creating the much needed pools.

Comment: Dams and Barriers Subsection- Add another option: Maintain the Union Street Dam to prevent the upstream passage of any fish. Add another option: Maintain the Sabin Dam to prevent the upstream passage of any fish.

Response: Various fish passage/blocking options will be thoroughly discussed and addressed through a future initiative.

Comment: Water Quality Subsection- None of the options deals with preventing contamination of the river system with toxic chemicals.

Response: The MDNR is not a regulatory agency; regulatory authority would fall under the purview of the MDEQ. However, the third and eighth options under the Water Quality section address protection of the river from pollutants.

Comment: Fisheries Management Subsection- this section lacks an explicitly stated option to maintain and enhance the Boardman River's fishery for wild, river resident trout.

Response: DNR Fisheries Division clearly wants to enhance and protect the resident fish populations; however it is not our only goal for the Boardman River.

Comment: A new management option should be added: Manage state-owned parts of the riparian corridor to maintain optimal plant communities for trout habitat in the river channel, and encourage such management among other riparian landowners.

Response: See Boardman River Natural River Plan
http://www.michigan.gov/documents/Boardman_River_Plan_23122_7.pdf

Comment: If anyone is interested in having a superb Brook Trout fishery in the Boardman River, add an option to eradicate Brown Trout from the river above Sabin Dam or some other barrier.

Response: We respectfully disagree. Eradication of Brown Trout from the river would be virtually impossible. Attempting such a project would be massively expensive and would result in killing all other fish in the Boardman River as well. Also, Brown Trout are a popular species in the Boardman River, so we do not believe that the public would be supportive of this option.

Appendices

Comment: In Appendix c- Its index (page 180) is labeled APPENDIX B INDEX and shows wrong page numbers for species. How did MDNR determine the distributions of river-resident fishes?

Response: Heading and page numbers are now correct. The distributions of fish species were compiled from records located at the University of Michigan, Museums Field Library; Michigan Department of Natural Resources, Institute for Fisheries Research; and Central Lake Michigan Management Unit offices in Traverse City and Cadillac.

Comment: The report in Appendix F gives no indication of having been peer-reviewed, so its material should not be considered to carry much weight until it has gone through the process and been revised accordingly.

Response: That is correct, the document in Appendix F was not peer reviewed. However, all of the data used in this document was later used in the following publication:

Nuhfer, A.J., T.C. Wills, and T.G. Zorn. 2014. Changes to a Brown Trout population after introducing steelhead in a Michigan stream. North American Journal of Fisheries Management 34:411-423.

Comment: The analysis deals only with some possible effects of steelhead that would migrate into and spawn in the Boardman River if allowed to do so, but effects of other "wild naturalized" and hatchery raised Pacific salmonids, Chinook, and Coho salmon are also at issue in some respects.

Response: Steelhead migration was discussed in greater detail because they present the strongest potential to affect other species based upon their life history.

Comment: Appendix F does not adequately consider effects on Brook Trout. The analysis focuses mainly on relationships of age-0 steelhead and age-0 Brown Trout, not on age-0 or other Brook Trout.

Response: The study cited was focused only on Brown Trout.

Comment: Appendix G, the term catch per effort appears in the introductory paragraph and in the table captions. The unit of effort, an hour of angling or whatever, should be stated.

Response: The unit of effort is defined as one (1) hour. Angling hours are referred to in each table.

GLOSSARY

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

base flow – groundwater discharge to the river

basin – a complete drainage including both land and water from which water flows to a central point

biomass – the amount of living matter (as in a unit area or volume of habitat)

biota – animal and plant life

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

Bottom lands – low-lying land along a watercourse

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

channelization – of a stream to a ditch; channelized streams are narrower, deeper, and straighter than natural channels; channelization may be done for navigation, flood control at that site, or to improve drainage for agricultural or other purposes

channel morphology – the structure and form of stream and river channels including width, depth, and bottom type (substrate)

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

confluence – the joining or convergence of two streams

coolwater fish species – usually used to refer to game fish in the perch or pike families; examples are; Walleye, Yellow Perch, Northern Pike, and Muskellunge; maximum growth potential for Walleye and pike occurs when temperatures are in the low to mid 70’s

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

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

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

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

extirpation – to make extinct, eliminate completely

FERC – Federal Energy Regulatory Commission

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

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

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

general survey – MDNR Fisheries Division survey that targets all fish species within a given water body by using a variety of fish collection gear which may include electroshocking gear, seines, gill nets, fyke, or trap nets

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

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

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

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

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

hydrology – the study of water

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

index station – a location where fisheries surveys have historically been conducted at periodic intervals using a specific format

indigenous – a species that is native to particular area

instream cover – large woody debris (e.g., trees, logs, logjams) in the channel, overhanging banks, boulders, and macrophytes

invertebrates – animals without a backbone

kettle lakes – lakes formed in the depression left when glacial chunks of ice melted

lacustrine – of, relating to, formed in, living in, or growing in lakes

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

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

lentic – non-flowing water; for example, lentic fishes typically inhabit non-flowing waters

LWMD – Land and Water Management Division

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

main stem – primary branch of a river or stream

MDEQ – Michigan Department of Environmental Quality

MDNR – Michigan Department of Natural Resources

MDOC – Michigan Department of Conservation (this organization was reorganized and renamed as the Michigan Department of Natural Resources circa 1965)

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

MNFI – Michigan Natural Features Inventory

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

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

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

nongame fish – term applied to fishes that sport-fishing anglers generally do not attempt to catch (e.g., minnows, darters, or common carp)

NPDES – National Pollution Discharge Elimination System

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

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

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

perennial – continuing without interruption

permeable – soils with coarse particles that allow passage of water

ppm – parts per million

recruitment – refers to natural reproduction of fishes in the context of this report

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

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

run habitat – fast, non-turbulent water

run-of-river – instantaneous inflow of water equals instantaneous outflow of water; on impounded systems, this flow regime mimics the natural flow regime of a river

salmonid – fishes in the family Salmonidae, or trouts; salmon, whitefish, and herring species are also in this family

sedimentation – the deposition or accumulation of sediment

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

sport fish – fish sought by anglers for sport and food (also "game fish")

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

surficial – referring to something on or at the surface

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

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

topography – the configuration of the earth's surface including its relief and the position of its natural features

USDA – Unites States Department of Agriculture

USFS – United States Forest Service

USGS – United States Geological Survey

warmwater fish species – species that grow and thrive best in waters that are warmer, at least seasonally; most game fish species in this classification are members of the sunfish family and maximum growth potential for these species generally occurs at temperatures higher than 82º F

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

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

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

young-of-year (YOY) – the offspring of fish that hatched in the current calendar year

This page was intentionally left blank.

FIGURES

This page was intentionally left blank.

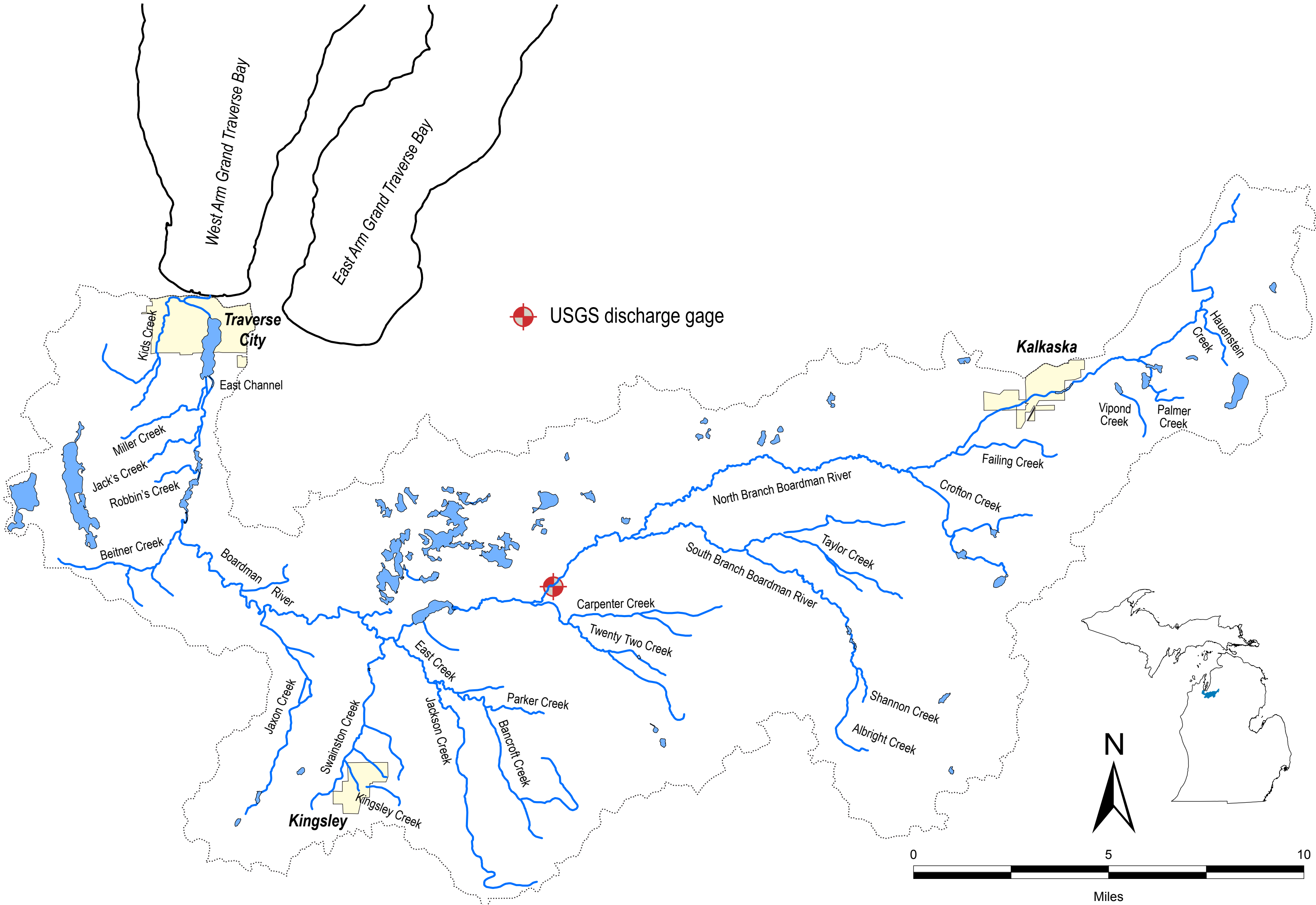


Figure 1.–The Boardman River watershed.

Figure 2 Legend

1 Abbott Lake
2 Arbutus Lake
3 Bass Lake
4 Bass Lake
5 Bass Lake
6 Blue Lake
7 Boardman Lake
8 Brewster Lake
9 Brown Bridge Pond
10 Bullhead Lake
11 Bumphrey Lake
12 Cedar Lake
13 Chandler Lake
14 Crawford Lake
15 Darby Lake
16 Deadhorse Lake
17 Denzer Lake
18 Dollar Lake
19 Downs Lake
20 Dyer Lake
21 Farrer Lake
22 George Lake
23 Guernsey Lake
24 High Lake
25 Indian Lake
26 Island Lake
27 Island Lake
28 Kalkaska Mill Pond
29 Kettle Lake
30 Keystone Pond
31 Knights Pond
32 Lake Five
33 Lake Placid
34 Little Guernsey Lakes
35 Log Lakes
36 Loon Lake
37 Mayfield Pond
38 Milk Lake
39 Mud Lake
40 Mud Lake
41 Muncie Lakes
42 North Selkirk Lake
43 Palmer Lake
44 Parsons Lake
45 Perch Lake
46 Perch Lake
47 Rennie Lake
48 Sabin Pond
49 Sand Lake #1
50 Sand Lake #2
51 Sand Lake #3
52 Sand Lake #4
53 Sand Lake #5
54 Silver Lake
55 Smith Lakes
56 South Selkirk Lake
57 Spider Lake
58 Spring Lake
59 Tibbets Lake
60 Twin Lakes
61 Twin Lakes
62 Vandervoight Lake
63 Wellman Pond
64 Wether Lake
65 Wistrand Lake
66 Youngs Pond

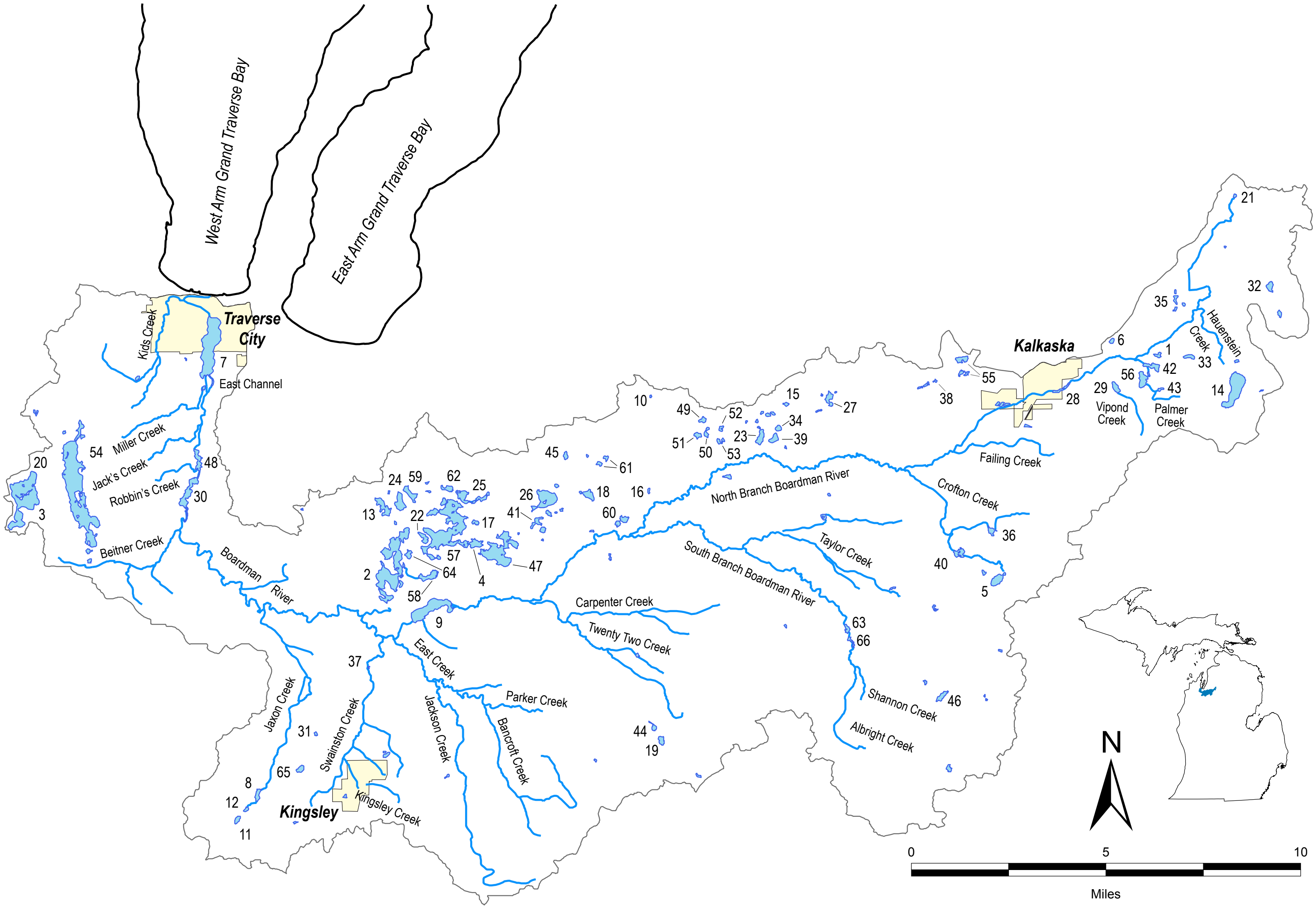


Figure 2.–Lake distribution (>10 acres) within the Boardman River watershed.

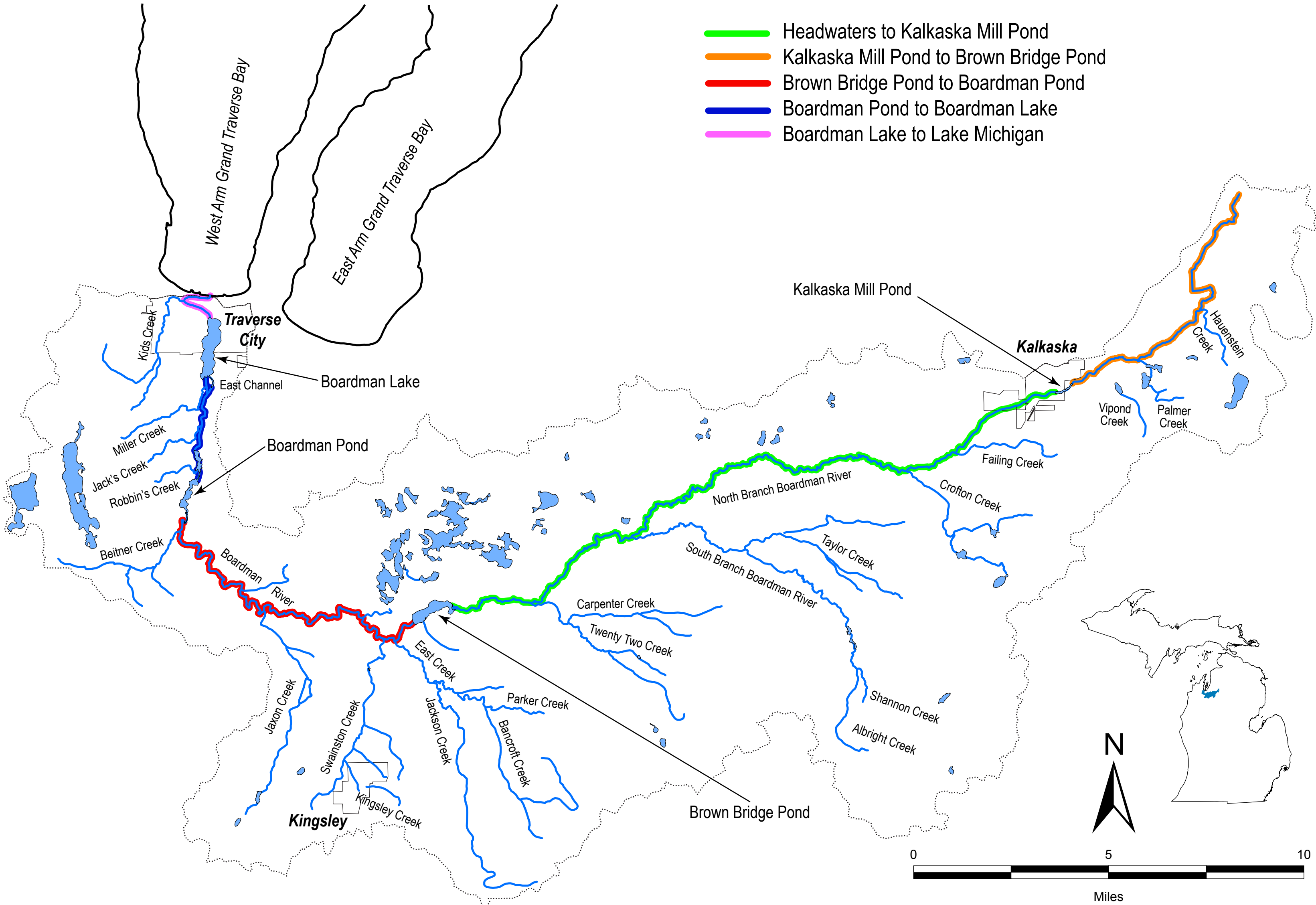


Figure 3.–Boardman River valley segments.

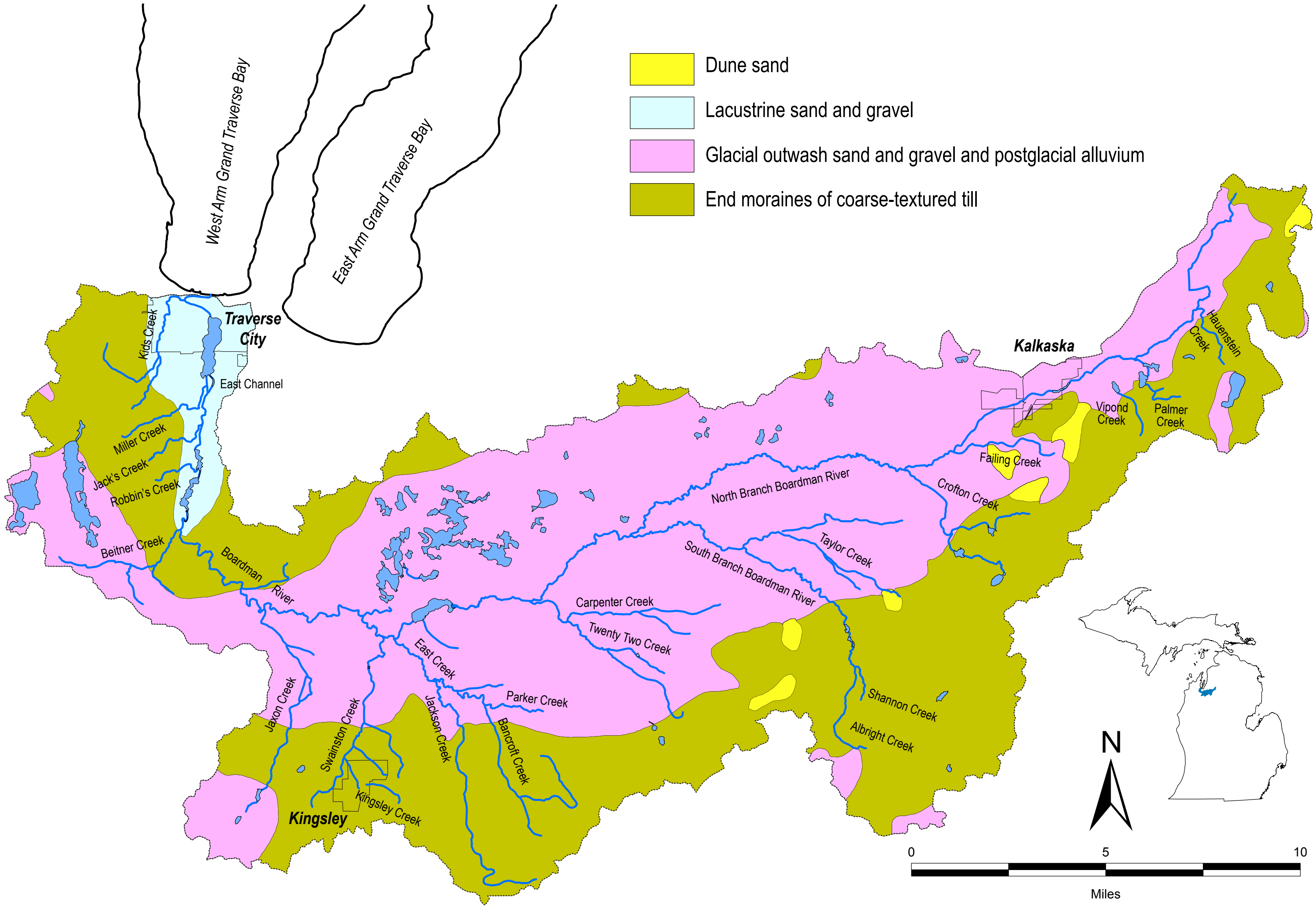


Figure 4.–Surficial geology of the Boardman River watershed.

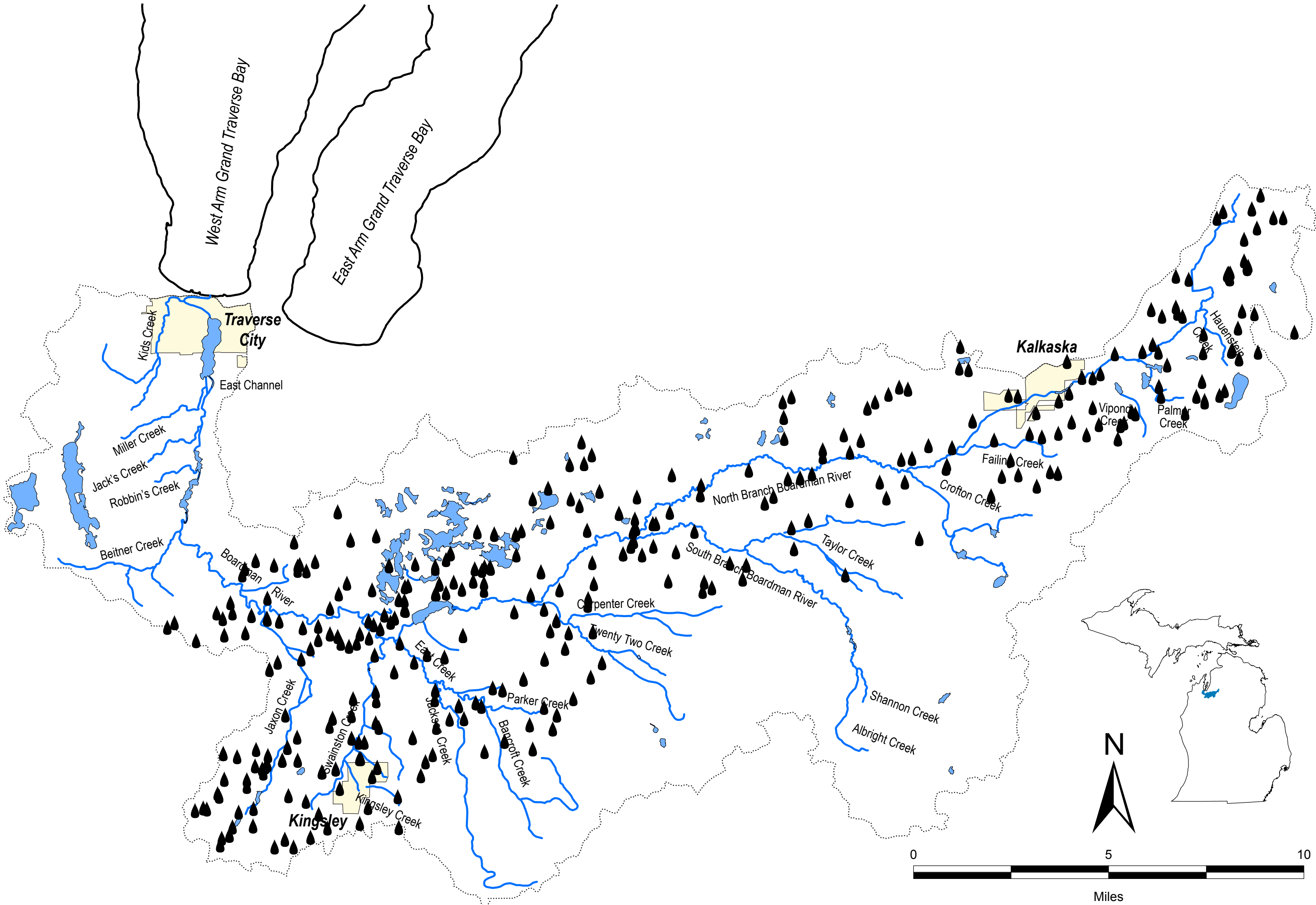


Figure 5.–Oil and gas wells in the Boardman River watershed.

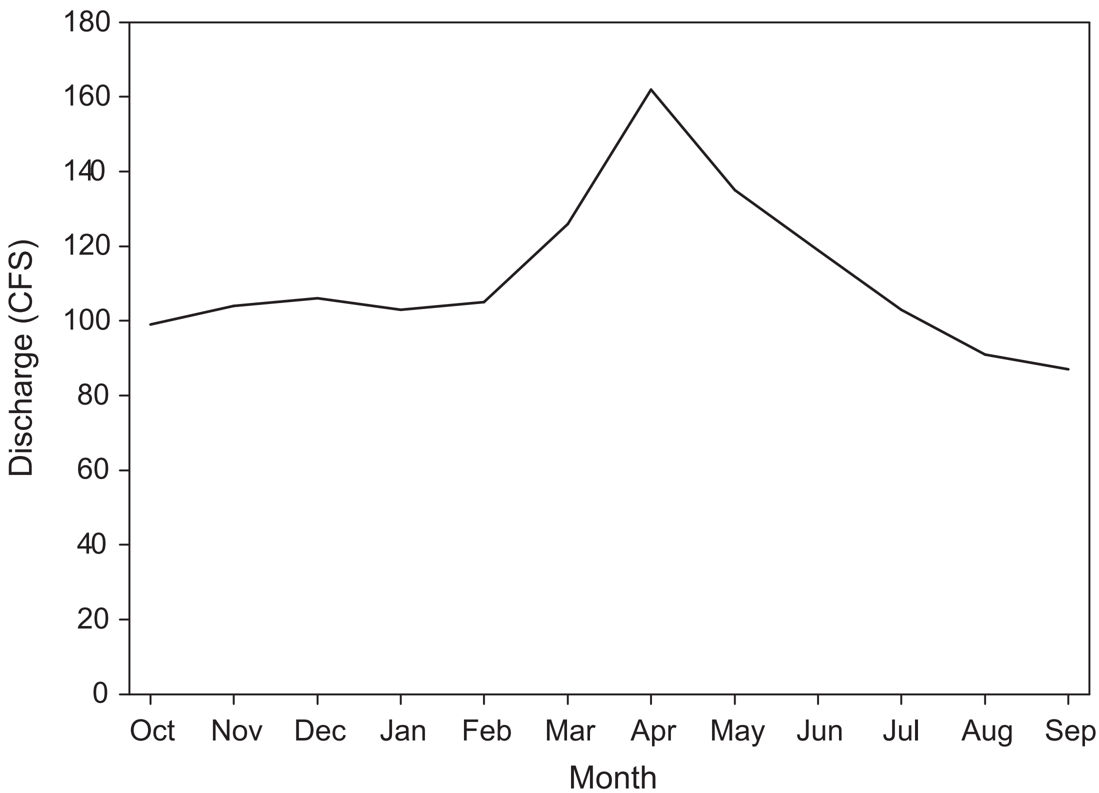


Figure 6.–Mean monthly discharge for the Boardman River for the period of record (1997–2005). Data are shown from October through September, a traditional water year. Source: United States Geological Survey, Ranch Rudolf gage station.

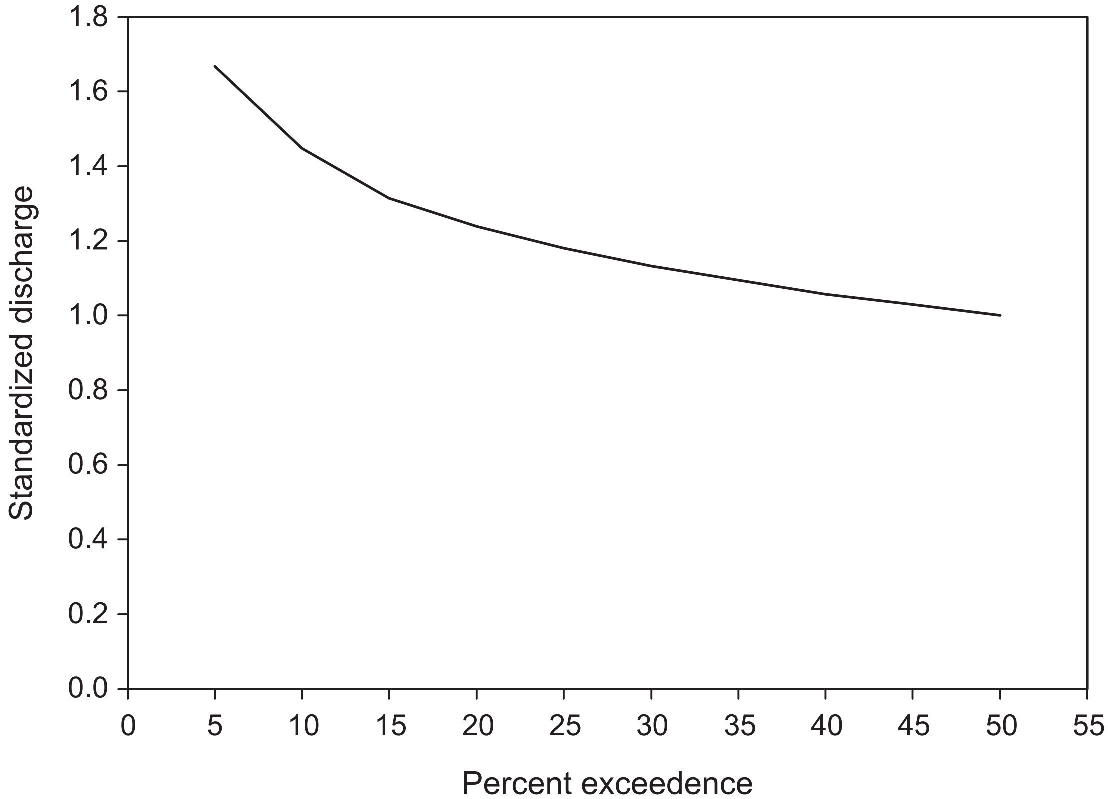


Figure 7.–Standardized high flow exceedence curves for the Boardman River (1997–2005). Standardized discharge is the discharge (Q)/ median (50% Q) discharge. Exceedence curves represent the probability of a discharge exceeding a given value. Source: United States Geological Survey, Ranch Rudolf gage station.

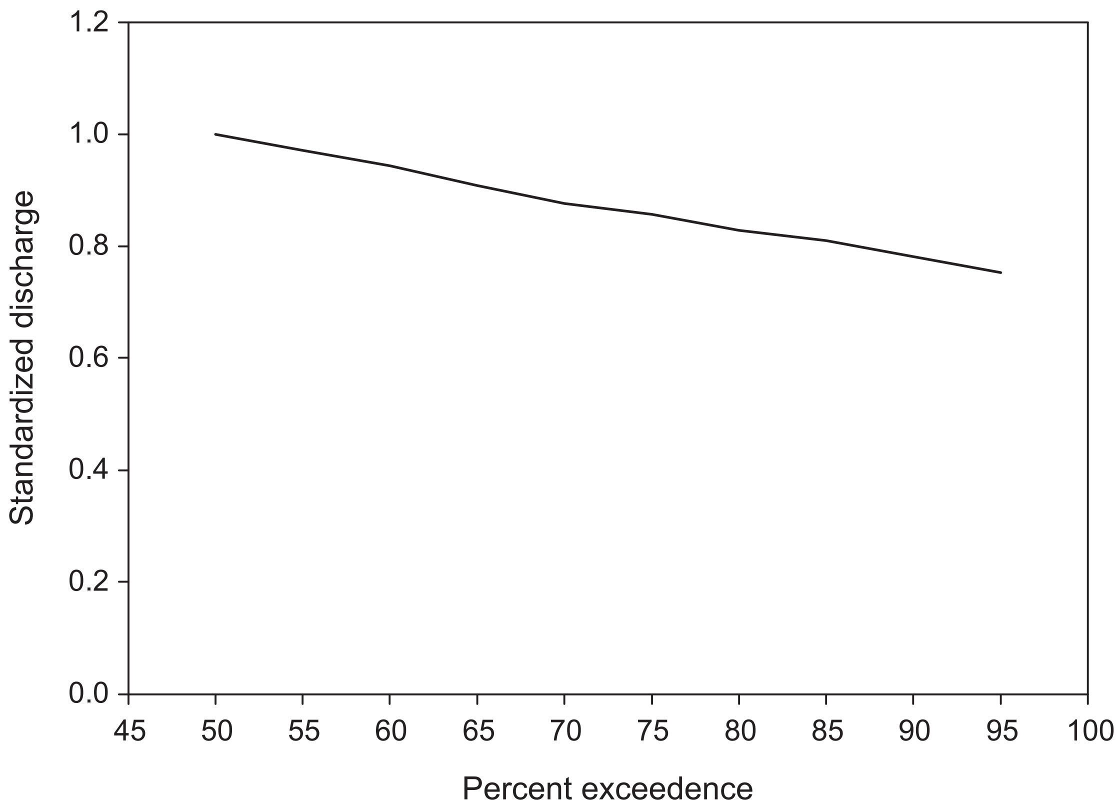


Figure 8.–Standardized low flow exceedence curves for the Boardman River (1997–2005). Standardized discharge is the discharge (Q)/ median (50% Q) discharge. Exceedence curves represent the probability of a discharge exceeding a given value. Source: United States Geological Survey Ranch Rudolf gage station.

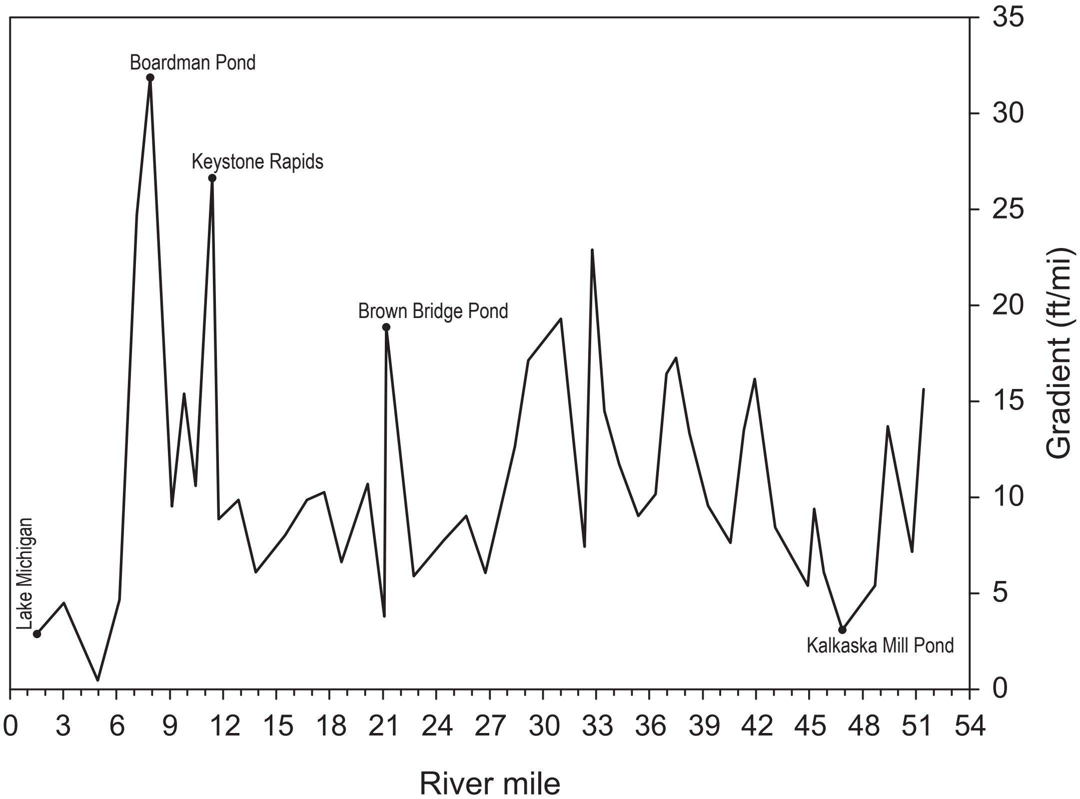


Figure 9.–Gradient (elevation change in feet per mile) of the Boardman River.

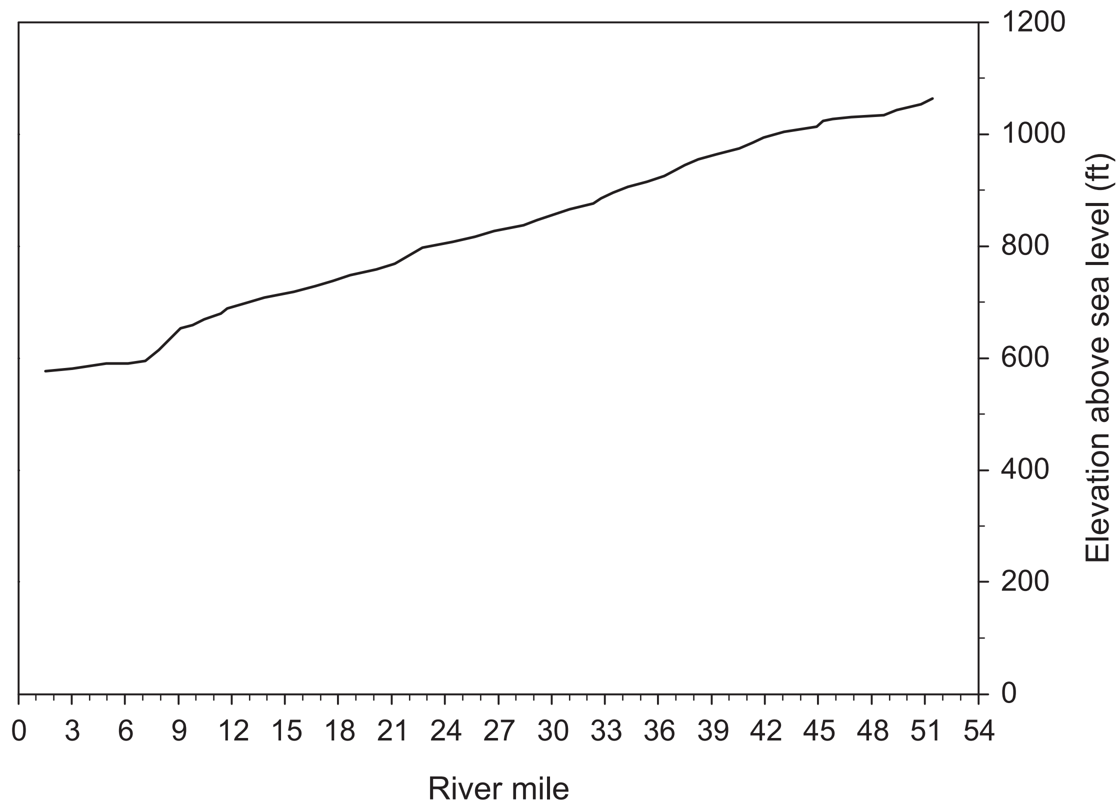


Figure 10.–Elevation changes, by river mile, from headwaters to the mouth of the Boardman River.

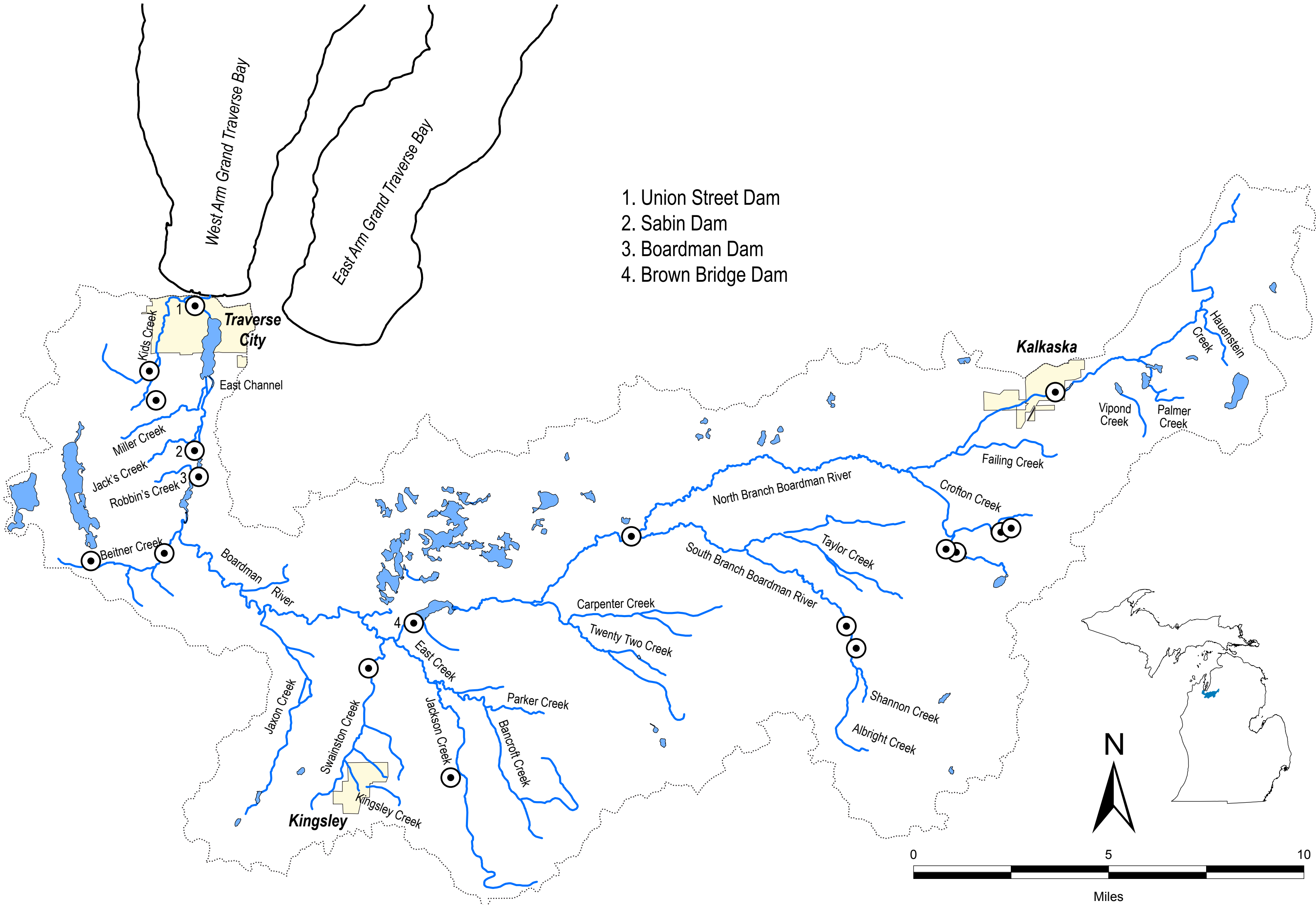


Figure 11.–Approximate location of dams (>6 ft of head) in the Boardman River watershed.

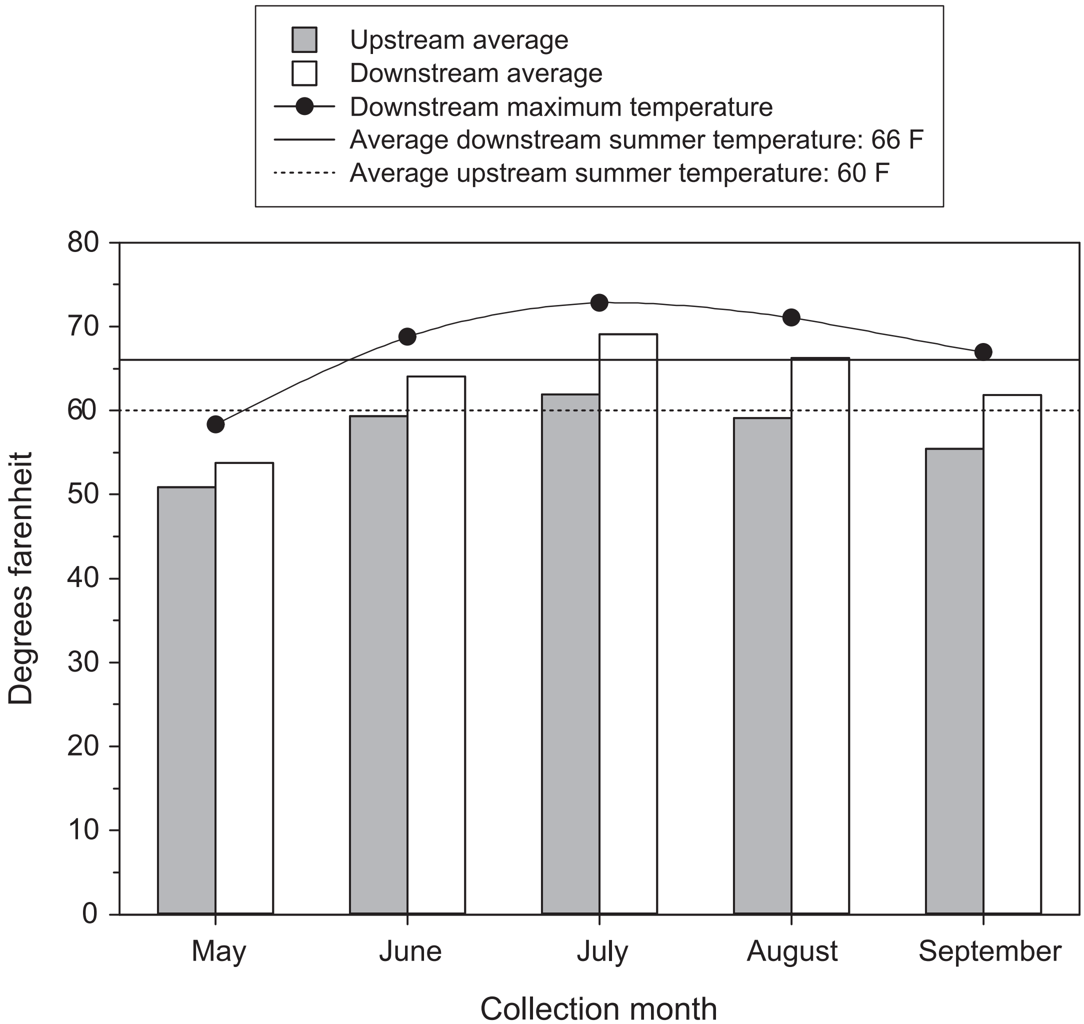


Figure 12.–Average and maximum water temperatures upstream and downstream of Brown Bridge Dam in 2002. Source: Michigan Department of Natural Resources, Fisheries Division.

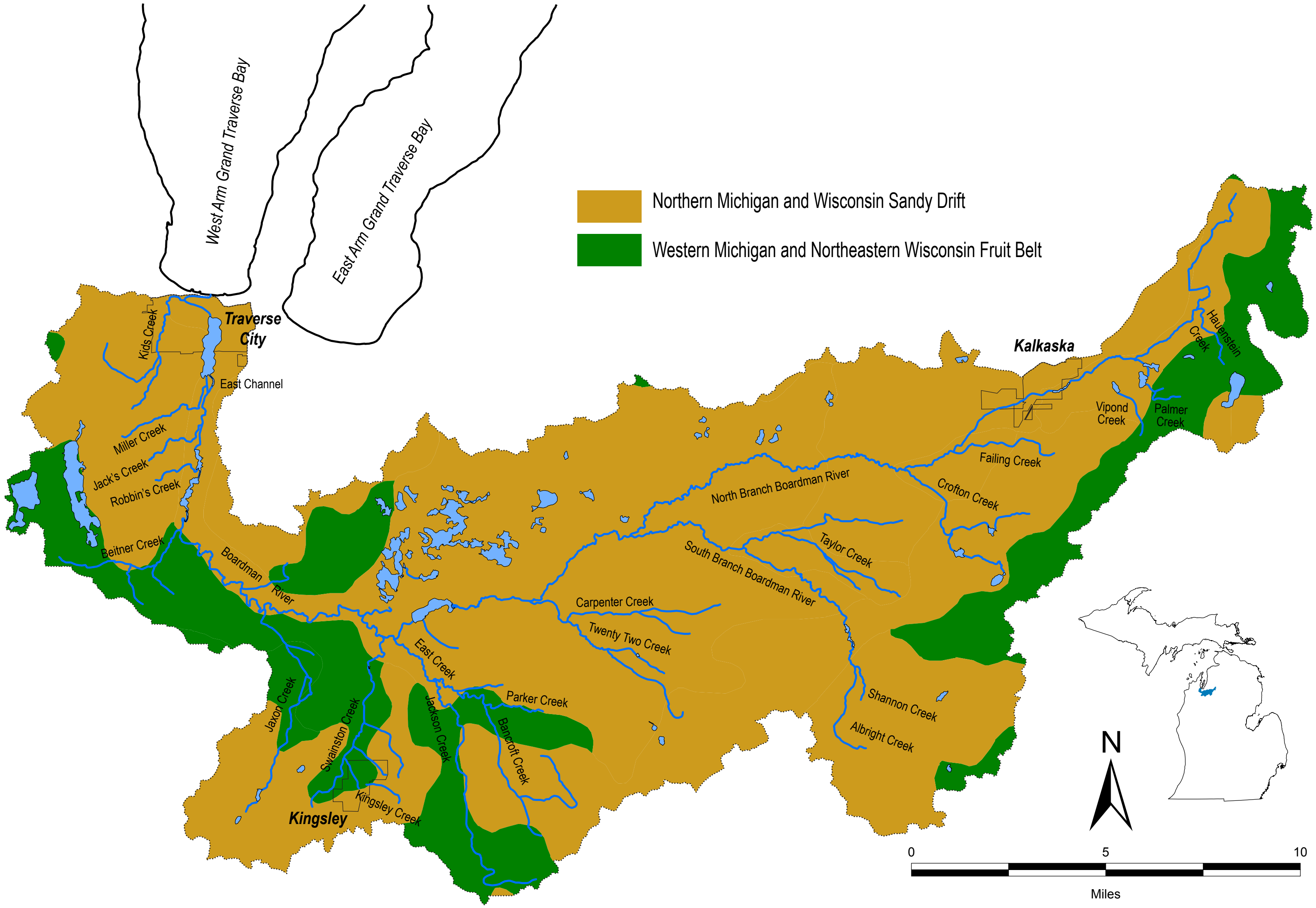


Figure 13.–Land Resource Areas within the Boardman River watershed.

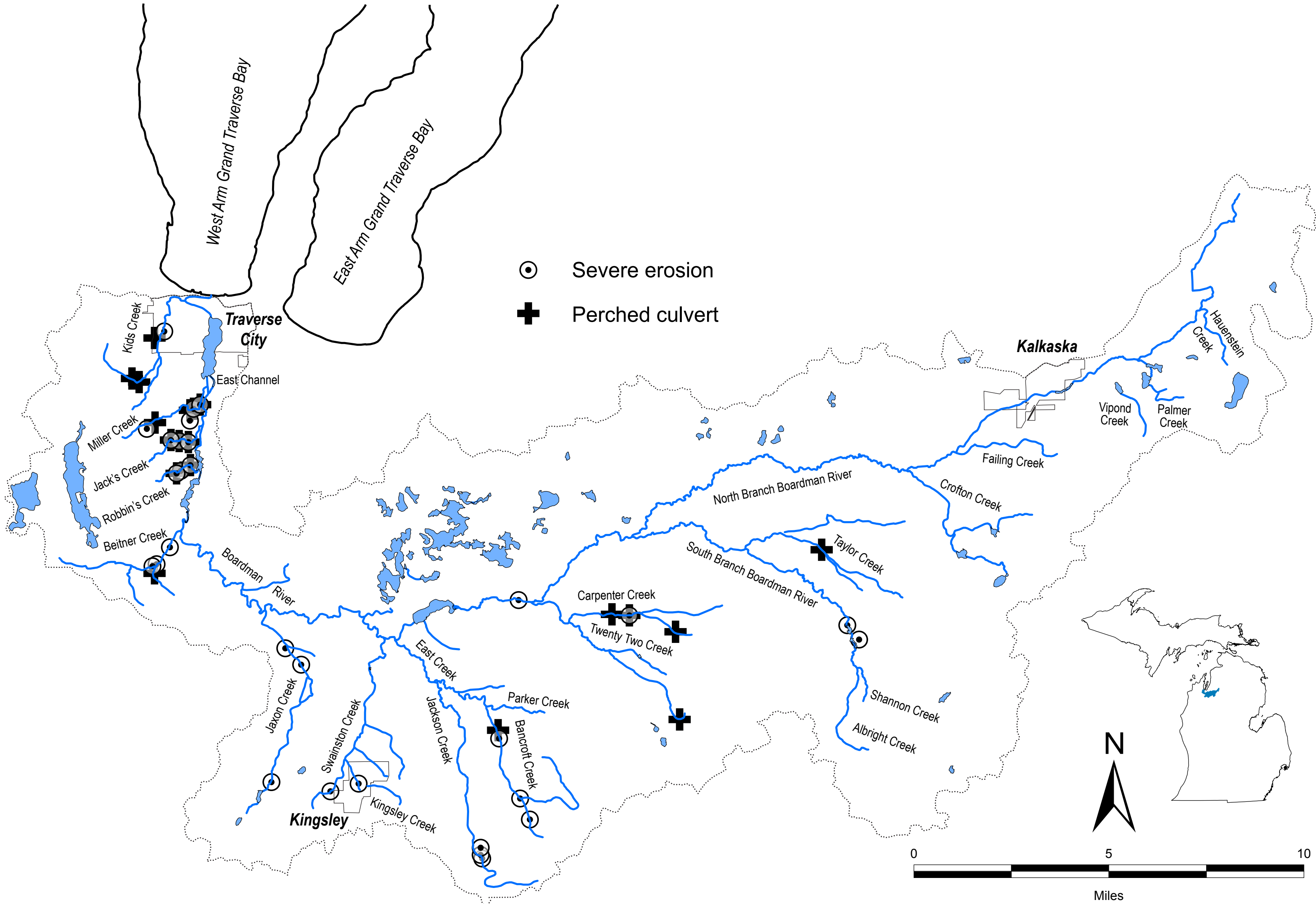


Figure 14.–Severe erosion and perched culvert sites within the Boardman River watershed.

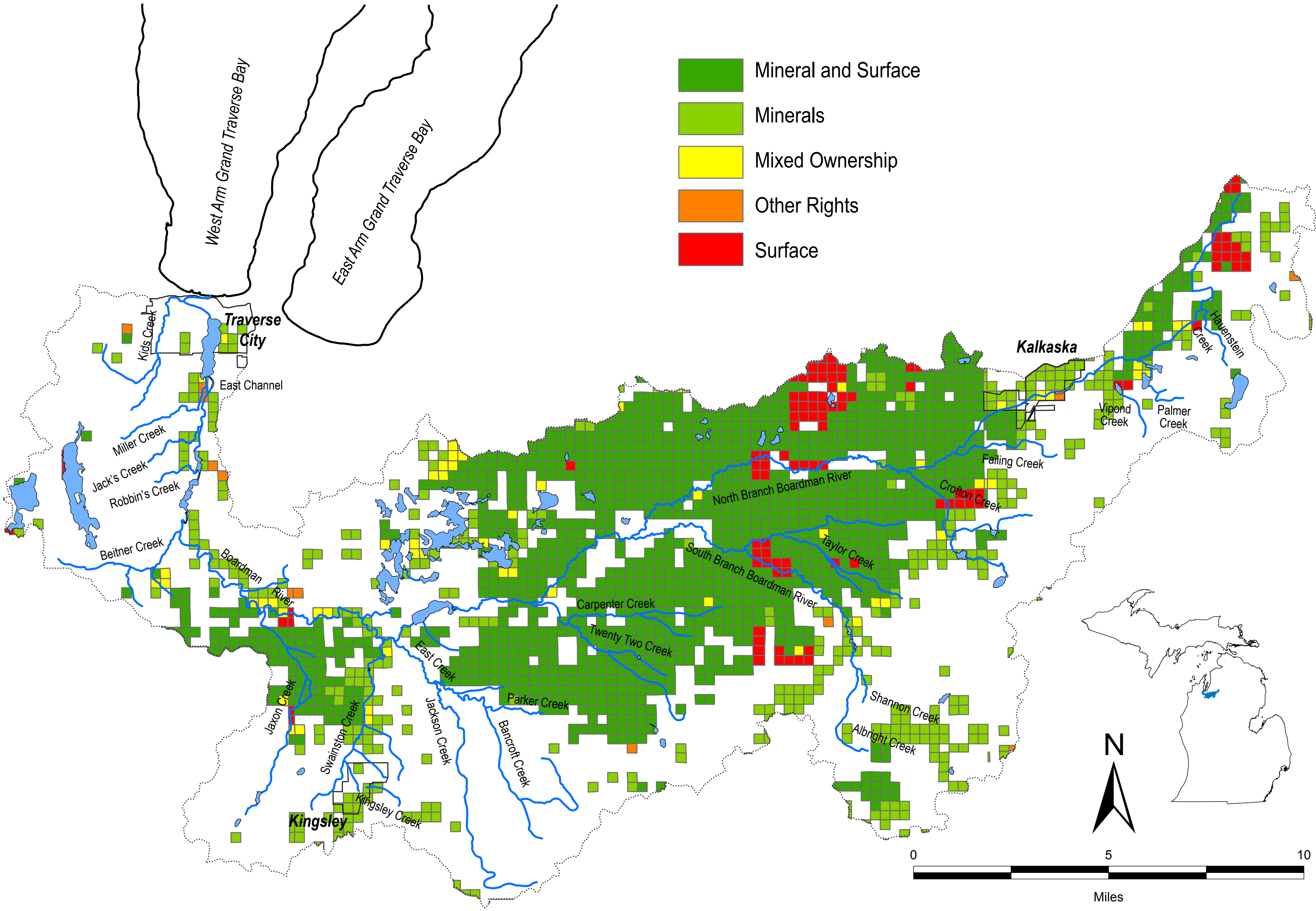


Figure 15.–State land ownership within the Boardman River watershed.

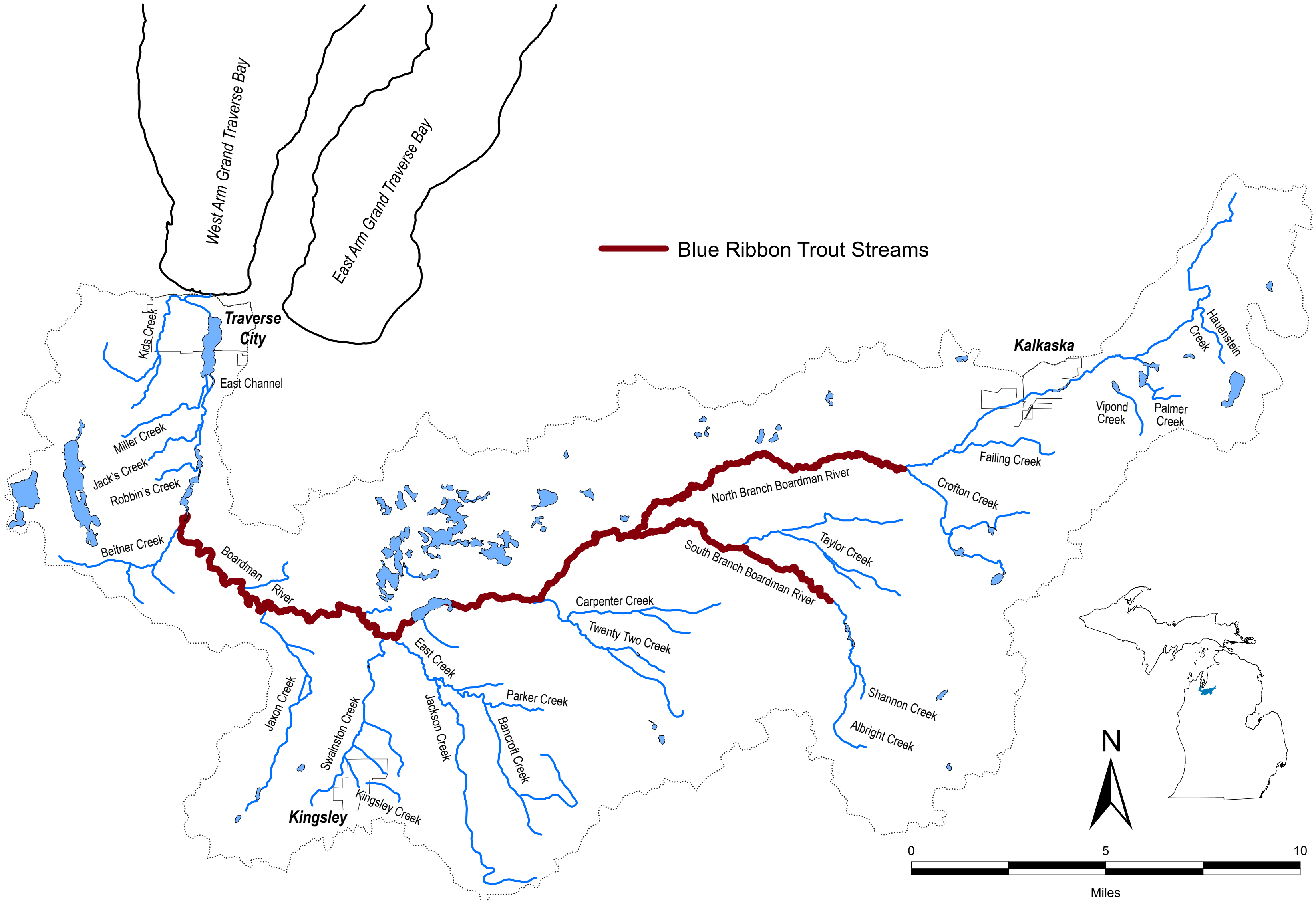


Figure 16.–Blue Ribbon Trout Stream designations within the Boardman River watershed.

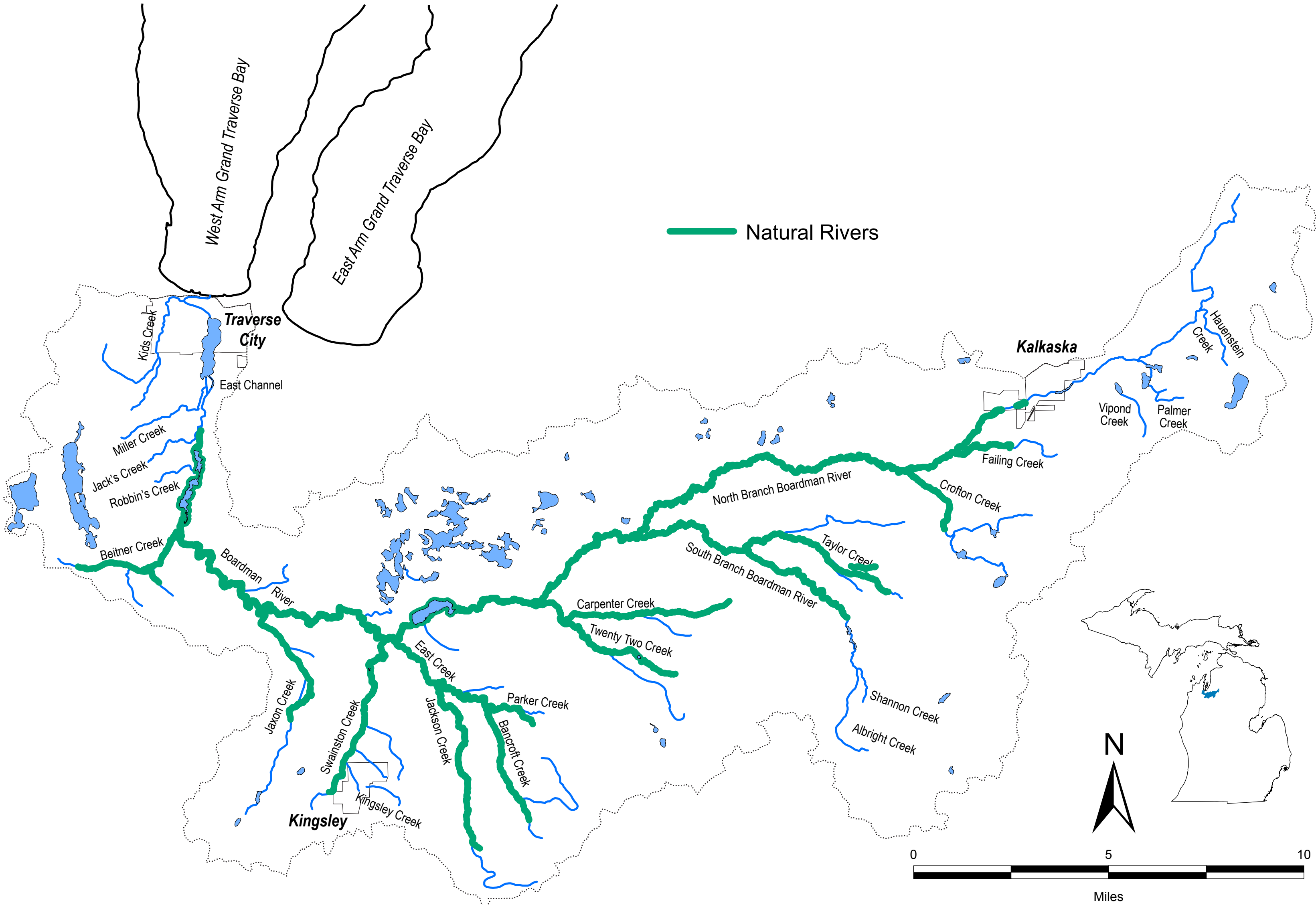


Figure 17.–Natural River designation within the Boardman River watershed.

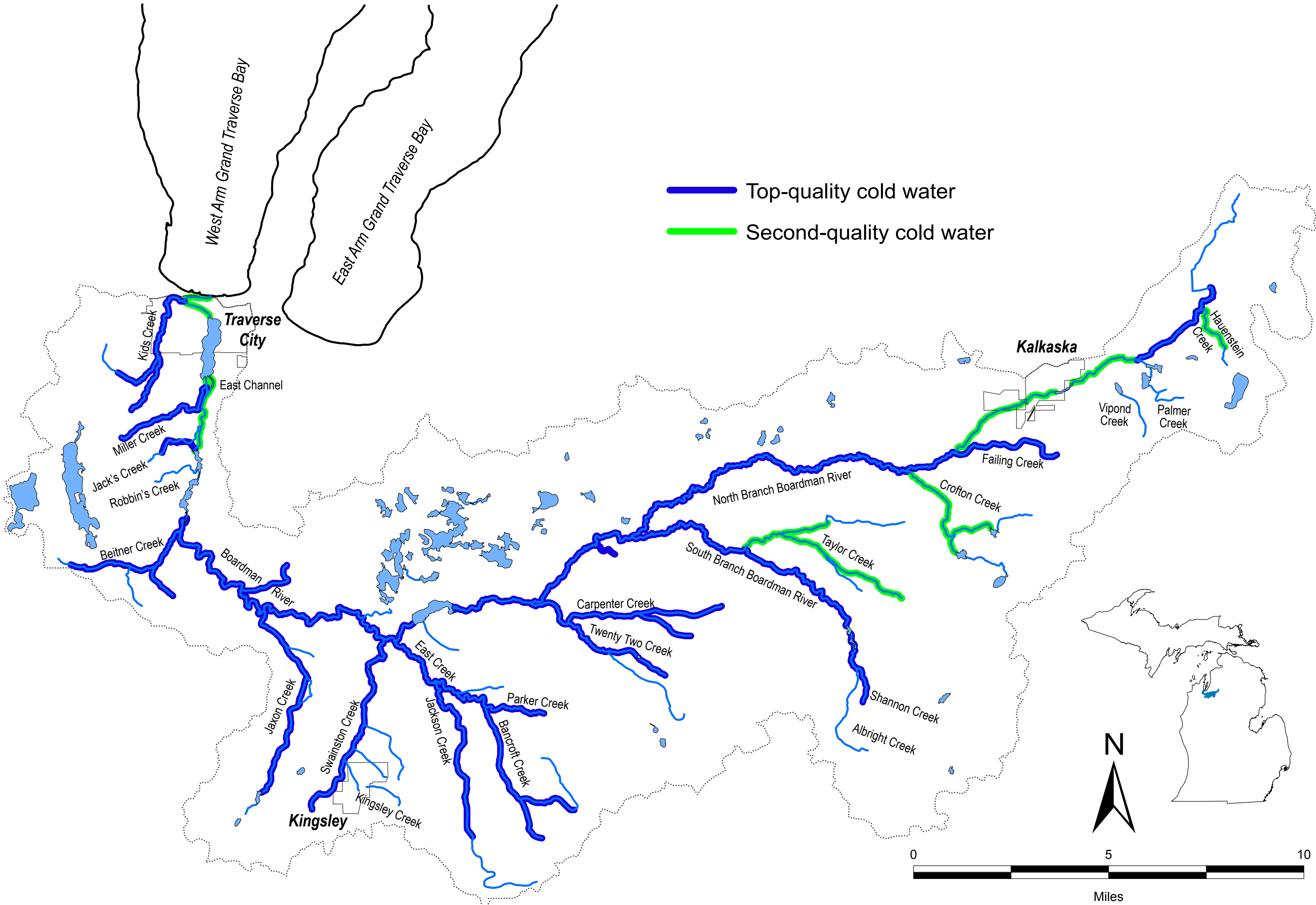


Figure 18.–Quality of water type in the Boardman River watershed.

This page was intentionally left blank.

TABLES

This page was intentionally left blank.

Table 1.–Number of recorded archaeological sites by township in the Boardman River watershed (B. Mead, Michigan Department of State, Archaeological Section, personal communication).

County	Township	Range	Number of sites
Grand Traverse	27N	11W	8
	26N	11W	2
	25N	11W	1
	27N	10W	1
	26N	10W	1
	25N	10W	0
	27N	09W	1
	26N	09W	12
	25N	09W	7
Kalkaska	27N	08W	13
	26N	08W	31
	28N	07W	2
	27N	07W	4
	26N	07W	0
	28N	06W	0
	27N	06W	0

Table 2.–Flow stability indices (ratio of mean high to mean low flow) for select river systems in Michigan, calculated from miscellaneous and short time frame USGS gage reports. Index values less than 2.1 indicate very good stability, values from 2.1–5.0 good stability, values from 5.1–10 fair stability, and values greater than 10 poor stability.

River	Location	Flow index	Classification
North Branch Kawkawlin	Kawkawlin	1,768.32	Poor
St. Joseph	Burlington	5.90	Fair
Kalamazoo	Allegan	3.70	Good
Paw Paw	Riverside	3.00	Good
White	Whitehall	2.81	Good
Boardman	Ranch Rudolf	1.96	Very Good
Au Sable	Grayling	1.94	Very Good

Table 3.–Designated trout streams and lakes within the Boardman River watershed (Michigan Department of Natural Resources, Fisheries Division).

Stream name	County	Location [a]
Boardman River	Grand Traverse	T27NR11W S2
Except: Boardman Lake		T27NR11W S10, S11, S14, S15
Sabin Hydro Pond		T27NR11W S27
Boardman Hydro Pond		T27NR11W S34, T26NR11W S3
Kids Creek	Grand Traverse	T27NR11W S3
Unnamed Creek	Grand Traverse	T27NR11W S22
Unnamed Creek	Grand Traverse	T27NR11W S27
Unnamed Creek	Grand Traverse	T26NR11W S3
Jaxon Creek	Grand Traverse	T26NR11W S13
Unnamed Creek	Grand Traverse	T26NR11W S14
Swainston Creek	Grand Traverse	T26NR10W S21
Fast Creek	Grand Traverse	T26NR10W S21
Twenty-two Creek	Grand Traverse	T26NR9W S18
Hannas Creek	Grand Traverse	T26NR9W S9
South Branch Boardman River	Grand Traverse and Kalkaska	T26NR9W S3
North Branch Boardman River	Grand Traverse and Kalkaska	T26NR9W S3
Except: Boardman Mill Pond from the dam upstream to Kettle Lake Road		T27NR7W S16

Lake name	County	Lake type/location
Sand Lake #1	Grand Traverse	Type C/T27NR9W S23
Big Guernsey Lake	Kalkaska	Type C/TT27NR8W S30

[a] Unless otherwise described, the location description listed after the stream name indicates the downstream limit of the trout designation. All of the stream and its tributaries, unless excepted, from that point upstream are designated trout waters.

Table 4.–National Pollution Discharge Elimination System (NPDES) permits issued in the Boardman River watershed (Michigan Department of Environmental Quality, Water Bureau).

Location	Permitee	Permit expiration date
Traverse City	Actron Steel Inc-Traverse City	04/01/2010
	Cone Drive Textron	10/01/2009
	Cone Drive Textron	04/01/2010
	Cornillie Concrete-Traverse	04/01/2010
	Northwestern Michigan College	04/01/2010
	Sara Lee Bakery	04/01/2010
	The Concrete Service-Traverse	04/01/2010
	Tower Automotive	04/01/2010
	Traverse City WFP	04/01/2010
	Traverse City WWTP	10/01/2009
	Waste Mgt of Northern MI-TC	04/01/2010
Kalkaska	Wayne Wire Kalkaska	04/01/2010

Table 5.–Mollusk documentation within the Boardman River watershed. MDEQ = Michigan Department of Environmental Quality; MDNR = Michigan Department of Natural Resources; SWQD = Surface Water Quality Division; UM = University of Michigan.

Scientific name	Location	Collector	Collection date	Number collected
Gastropoda (snails)				
Physidae	N. Branch of the Boardman R.	MDEQ-SWQD	09/31/1998	2
	S. Branch of the Boardman R.	MDEQ-SWQD	09/31/1998	3
	East Creek	MDEQ-SWQD	07/07/1998	1
	Bancroft Creek	MDEQ-SWQD	07/07/1998	4
	Beitner Creek	MDEQ-SWQD	07/09/1998	3
Lymnaeidae	Kids Creek	MDEQ-SWQD	07/08/1998	4
Bivalvia (mussels and clams)				
Unionoida				
Pisidiidae (clams)	Beitner Creek	MDEQ-SWQD	07/09/1998	2
	East Creek	MDEQ-SWQD	07/07/1998	3
Sphaeriidae (clams)	Parker Creek	MDEQ-SWQD	07/07/1998	3
Unionidae				
Pyganodon grandis (giant floater)	Arbutus Lake	Fenton and Carbine/UM[a]	1936	2
	Boardman Lake	M. Leach/UM	–	6
	Spider Lake	Van der Schalie/UM	08/31/1949	5
Strophitus undulates (creeper)	Silver Lake	M. Leach/UM	–	2
	Big Twin Lake	Carl Hubbs/UM	11/08/1930	2
	Big Guernsey Lake	DNR Fisheries/UM	1930	1
Lasmigona Costata (fluted-shell)	Boardman River	M. Leach/UM	–	2
Anodontoides ferussacianus (cylindrical papershell)	Boardman River	Frederick Stearns/UM	–	8
Lamsilis siliquoidea (mussel)	Boardman River	M. Leach/UM	–	2

[a] The University of Michigan records of mollusks within the Boardman River watershed were obtained from the University of Michigan Museum, Department of Zoology, 1109 Geddes Avenue, Ann Arbor, Michigan 48109, © University of Michigan, Museum of Zoology, 2006, http://www.ummz.lsa.umich.edu/mollusks/index.html.

Table 6.–Arthropod documentation within the Boardman River watershed. X = present; – = absent.

Scientific name (common name)	Collection location						
	N. Branch Boardman River County Road 612[a]	S. Branch Boardman River Boardman River Road crossing[a]	East Creek Mayfield Road crossing[b]	Parker Creek Knight Road crossing[b]	Bancroft Creek Sparling Road crossing[b]	Beitner Creek Beitner Road crossing[c]	Kids Creek 11th Street in Traverse City[d]
Annelida							
Hirudinea (leeches)	X	–	–	–	–	X	–
Oligochaeta (worms)	–	X	X	X	X	X	–
Crustacea							
Amphipoda (scuds)	X	X	X	X	X	X	X
Decapoda (crawfish)	X	–	–	–	–	X	–
Isopoda (sowbugs)	–	–	–	X	–	X	X
Arachnoidea (spiders)	–	–	–	–	–	–	–
Hydracarina	–	X	–	–	–	–	X
Insecta							
Ephemeroptera (mayflies)							
Baetidae	X	X	X	X	X	X	X
Ephemerellidae	X	–	X	X	–	X	–
Ephemeridae	X	X	X	X	–	–	–
Heptageniidae	X	–	X	X	–	X	–
Leptophlebiidae	X	X	–	X	X	–	–
Odonata							
Anisoptera (dragonflies)							
Aeshnidae	X	X	–	X	–	–	X
Cordulegastridae	X	–	X	X	–	–	–
Zygoptera (damselflies)							
Calopterygidae	–	X	–	–	–	–	–
Plecoptera (stoneflies)							
Leuctridae	–	–	X	–	–	–	–
Nemouridae	–	X	–	X	X	X	X
Perlidae	X	–	X	X	–	–	–
Perlodidae	X	–	–	–	–	–	–
Pteronarcyidae	–	–	X	–	–	–	–
Taeniopterygidae	–	–	–	–	X	–	–
Hemiptera (true bugs)							
Corixidae	–	X	–	X	–	–	–
Gerridae	X	X	X		X	–	X
Veliidae	X	X	–	–	–	–	–

Table 6.–Continued.

	Collection location						
Scientific name (common name)	N. Branch Boardman River County Road 612[a]	S. Branch Boardman River Boardman River Road crossing[a]	East Creek Mayfield Road crossing[b]	Parker Creek Knight Road crossing[b]	Bancroft Creek Sparling Road crossing[b]	Beitner Creek Beitner Road crossing[c]	Kids Creek 11th Street in Traverse City[d]
Megaloptera							
Corydalidae (dobson flies)	X	X	X	X	–	–	–
Sialidae (alder flies)	–	X	–	X	–	X	–
Trichoptera (caddisflies)							
Brachycentridae	X	X	X	X	X	X	X
Glossosomatidae	–	–	X	X	–	–	–
Hydropsychidae	X	X	X	X	X	X	X
Hydroptilidae	–	–	X	X	–	–	–
Lepidostomatidae	–	X	–	–	X	–	X
Limnephilidae	X	X	–	X	X	X	X
Molannidae	X	–	–	X	–	–	–
Philopotamidae	X	X	X	X	X	X	–
Phryganeidae	–	X	–	–	–	–	–
Polycentropodidae	–	X	–	X	–		–
Ryacophilidae	–	–	–	–	–	X	–
Coleoptera (beetles)							
Gyrinidae	–	–	–	X	X	–	–
Haliplidae	–	–	–	X	–	–	–
Hydrophilidae	–	–	X	–	X	–	–
Dryopidae	–	–	X	–	X	–	X
Dytiscidae	–	–	X		X	X	X
Elmidae	–	–	–	X	X	X	X
Diptera (flies)							
Athericidae	–	X	X	X	–	–	–
Chironomidae	X	X	X	X	X	X	X
Muscidae	–	X	–	–	–	–	–
Simuliidae	X	X	X	X	X	X	X
Tabanidae	–	–	X	–	–	–	–
Tipulidae	X	X	–	–	X	X	–
Stratiomyidae	–	–	–	–	X	–	–

[a] Collected by MDEQ on 09/03/1998.
[b] Collected by MDEQ on 07/07/1998.
[c] Collected by MDEQ on 07/09/1998.
[d] Collected by MDEQ on 07/08/1998.

Table 7.–Amphibian and reptile documentation within the Boardman River watershed. UM = University of Michigan. X = present; – = not observed in the survey.

Scientific (common) names	Documentation source		
	UM Museum of Zoology [a]	UM Press [b]	Audubon Society [c]
Salamanders			
Ambystoma laterale (blue-spotted salamander)	–	X	–
Ambystoma maculatum (spotted salamander)	–	X	–
Ambystoma tigrinum (eastern tiger salamander)	–	X	–
Hemidactylium scutatum (four-toed salamander)	–	X	–
Necturus maculosus (mudpuppy)	X	X	–
Notophthalmus viridescens (central newt)	–	X	–
Plethodon cinereus (red-backed salamander)	X	X	–
Frogs and toads			
Bufo americanus (American toad)	X	X	–
Bufo woodhousii (Fowler's toad)	–	X	–
Hyla versicolor and *Hyla chrysoscelis* (gray treefrog)	–	X	X
Pseudacris crucifer (northern spring peeper)	X	X	X
Pseudacris triseriata (western chorus frog)	–	X	–
Rana catesbeiana (bullfrog)	X	X	
Rana clamitans (green frog)	X	X	X
Rana palustris (pickerel frog)	X	X	–
Rana pipiens (northern leopard frog)	X	X	X
Rana sylvatica (wood frog)	X	X	–
Snakes			
Diadophis punctatus (northern ringneck snake)	–	X	–
Heterodon platyrhinos (eastern hognose snake)	–	X	–
Lampropeltis triangulum (eastern milk snake)	X	X	–
Nerodia sipedon (northern water snake)	X	X	–
Opheodrys vernalis (eastern smooth green snake)	–	X	–
Sistrurus catenatus (eastern massasauga rattlesnake)	–	X	–
Storeria dekayi (brown snake)	X	X	–
Storeria occipitomaculata (northern red-bellied snake)	X	X	–

Table 7.–Continued.

Scientific (common) names	Documentation source		
	UM, Museum of Zoology[a]	UM Press[b]	Audubon Society[c]
Thamnophis sauritus (northern ribbon snake)	X	X	–
Thamnophis sirtalis (eastern garter snake)	X	X	–
Lizards			
Eumeces fasciatus (five-lined skink)	X	X	–
Turtles			
Apalone spinifera (spiny softshell)	–	X	X
Chelydra serpentine (snapping turtle)	X	–	X
Clemmys guttata (spotted turtle)	–	X	–
Chrysemys picta (painted turtle)	X	X	X
Clemmys insculpta (wood turtle)	X	X	–
Emydoidea blandingii (Blanding's turtle)	X	X	–
Graptemys geographica (common map turtle)	–	X	–
Terrapene carolina (eastern box turtle)	–	X	–

[a] The University of Michigan, Museum of Zoology. 2006c. http://www.ummz.lsa.umich.edu/

[b] Harding, J.H. 1997. Amphibians and reptiles of the Great Lakes region. University of Michigan Press, Ann Arbor.

[c] The Audubon Society observed species; Bob Carstens Environmental Chair, GT Audubon Society, YMCA to Sabin Dam survey 1996–2002.

Table 8.–Bird documentation within the Boardman River watershed. An asterisk (*) indicates a state threatened species.

Scientific name	Common name[a]	Documentation source[a,b,c,d,e]
Anseriformes		
Anatidae		
Branta canadensis	Canada Goose	Atlas and Audubon 2
Cygnus olor	Mute Swan	Atlas and Audubon 2
Cygnus buccinator	Trumpeter Swan	Audubon 2
Aix sponsa	Wood Duck	Atlas and Audubon 2
Anas stepera	Gadwall	Audubon 2
Anas Americana	American Widgeon	Audubon 2
Anas rubripes	American Black Duck	Atlas
Anas rubripes	American Black Duck	Audubon 2
Anas platyrhynchos	Mallard	Atlas, Audubon 2, and Audubon 3
Anas discors	Blue-winged Teal	Atlas and Audubon 2
Anas acuta	Northern Pintail	Atlas
Anas crecca	Green-winged Teal	Atlas and Audubon 2
Aythya Americana	Redhead	Audubon 2
Aythya collaris	Ring-necked Duck	Atlas and Audubon 2
Aythya affinis	Lessor Scaup Species	Audubon 2
Bucephala albeola	Bufflehead (M)	Audubon 2
Lophodytes cucullatus	Hooded Merganser	Audubon 2
Mergus merganser	Common Merganser	Audubon 2
Oxyura jamaicensis	Ruddy Duck	Audubon 2
Galliformes		
Phasianidae		
Phasianus colchicus	Ring-necked Pheasant	Atlas
Bonasa umbellus	Ruffed Grouse	Atlas, Audubon 2, and Audubon 3
Meleagris gallopavo	Wild Turkey	Atlas and Audubon 2
Odontophoridae		
Colinus virginianus	Northern Bobwhite	Atlas
Gaviiformes		
Gaviidae		
Gavia immer	Common Loon*	Atlas and Audubon 2
Podicipediformes		
Podicipedidae		
Podilymbus podiceps	Pied-billed Grebe	Atlas and Audubon 2
Podiceps auritus	Horned Grebe	Audubon 1[b]
Pelecaniformes		
Phalacrocoracidae		
Phalacrocorax auritus	Double-crested Cormorant	Atlas and Audubon 2
Ciconiiformes		
Ardeidae		
Botaurus lentiginosus	American Bittern	Atlas
Butorides striatus	Green-backed Heron	Atlas and Audubon 3
Ardea herodias	Great Blue Heron	Atlas and Audubon 2

Table 8.–Continued.

Scientific name	Common name[a]	Documentation source
Falconiformes		
Cathartidae		
Cathartes aura	Turkey Vulture	Atlas and Audubon 2
Accipitridae		
Pandion haliaetus	Osprey	Atlas and Audubon 2
Haliaeetus leucocephalus	Bald Eagle*	Atlas and Audubon 2
Circus cyaneus	Northern Harrier	Atlas
Accipiter striatus	Sharp-shinned Hawk	Atlas and Audubon 2
Accipiter cooperii	Cooper’s Hawk	Atlas and Audubon 2
Accipiter gentilis	Northern Goshawk	Atlas and Audubon 2
Buteo lineatus	Red-shouldered Hawk	Atlas
Buteo platypterus	Broad-winged Hawk	Atlas and Audubon 2
Buteo jamaicensis	Red-tailed Hawk	Atlas and Audubon 2
Falconidae		
Falco sparverius	American Kestrel	Atlas
Gruiformes		
Rallidae		
Rallus elegans	King Rail	Atlas
Rallus limicola	Virginia Rail	Atlas
Porzana carolina	Sora	Atlas
Gallinula chloropus	Common Moorhen	Atlas
Fulica Americana	American Coot	Audubon 2
Charadriiformes		
Charadriidae		
Charadrius vociferus	Killdeer	Atlas and Audubon 2
Scolopacidae		
Actitis macularia	Spotted Sandpiper	Atlas, Audubon 2, and Audubon 3
Tringa solitaria	Solitary Sandpiper	Audubon 2
Calidris minutilla	Least Sandpiper	Audubon 2
Bartramia longicauda	Upland Sandpiper	Atlas
Tringa melanoleuca	Greater Yellow-legs	Audubon 2
Gallinago gallinago	Common Snipe	Atlas and Audubon 2
Scolopax minor	American Woodcock	Atlas and Audubon 2
Laridae		
Larus delawarensis	Ring-billed Gull	Audubon 2
Larus argentatus	Herring Gull	Audubon 2
Hydroprogne caspia	Caspian Tern	Audubon 2
Columbiformes		
Columbidae		
Columba livia	Rock Dove	Atlas
Zenaida macroura	Mourning Dove	Atlas, Audubon 2, and Audubon 3
Cuculiformes		
Cuculidae		
Coccyzus americanus	Yellow-billed Cuckoo	Atlas
Coccyzus erythropthalmus	Black-billed Cuckoo	Atlas and Audubon 2
Strigiformes		

Table 8.–Continued.

Scientific name	Common name[a]	Documentation source
Strigidae		
Megascops asio	Eastern Screech Owl	Atlas
Bubo virginianus	Great Horned Owl	Atlas and Audubon 2
Strix varia	Barred Owl	Atlas
Aegolius acadicus	Northern saw-whet Owl	Atlas
Caprimulgiformes		
Caprimulgidae		
Chordeiles minor	Common Nighthawk	Atlas and Audubon 2
Caprimulgus vociferus	Wip-poor-will	Atlas
Apodiformes		
Apodidae		
Chaetura pelagica	Chimney Swift	Atlas and Audubon 2
Trochilidae		
Archilochus colubris	Ruby-throated hummingbird	Atlas and Audubon 2
Coraciiformes		
Alcedinidae		
Megaceryle alcyon	Belted Kingfisher	Atlas, Audubon 2, and Audubon 3
Piciformes		
Picidae		
Melanerpes erythrocephalus	Red-headed Woodpecker	Atlas
Melanerpes carolinus	Red-bellied Woodpecker	Atlas
Sphyrapicus varius	Yellow-bellied Sapsucker	Atlas
Picoides pubescens	Downy Woodpecker	Atlas and Audubon 2
Picoides villosus	Hairy Woodpecker	Atlas and Audubon 2
Colaptes auratus	Northern Flicker	Atlas, Audubon 2, and Audubon 3
Dryocopus pileatus	Pileated Woodpecker	Atlas and Audubon 2
Passeriformes		
Tyrannidae		
Contopus virens	Eastern Wood-pewee	Atlas and Audubon 2
Empidonax alnorum	Alder Flycatcher	Atlas[c] and Audubon 2[d]
Empidonax traillii	Willow Flycatcher	Atlas
Empidonax minimus	Least Flycatcher	Atlas and Audubon 2
Sayornis phoebe	Eastern Phoebe	Atlas and Audubon 2
Myiarchus crinitus	Great Crested Flycatcher	Atlas, Audubon 2, and Audubon 3
Tyrannus tyrannus	Eastern Kingbird	Atlas, Audubon 2, and Audubon 3
Laniidae		
Lanius excubitor	Northern Shrike	Audubon 2
Vireonidae		
Vireo flavifrons	Yellow-throated Vireo	Atlas
Vireo gilvus	Warbling Vireo	Atlas, Audubon 2, and Audubon 3
Vireo solitarius	Solitary Vireo	Atlas and Audubon 2
Vireo olivaceus	Red-eyed Vireo	Atlas, Audubon 2, and Audubon 3
Corvidae		
Cyanocitta cristata	Blue Jay	Atlas, Audubon 2, and Audubon 3
Corvus brachyrhynchos	American Crow	Atlas, Audubon 2, and Audubon 3[e]
Corvus corax	Common Raven	Atlas and Audubon 2

Table 8.–Continued.

Scientific name	Common name[a]	Documentation source
Alaudidae		
Eremophila alpestirs	Horned Lark	Atlas, Audubon 2, and Audubon 3
Hirundinidae		
Progne subis	Purple Martin	Atlas and Audubon 2
Tachycineta bicolor	Tree Swallow	Atlas, Audubon 2, and Audubon 3
Stelgidopteryx serripennis	Northern Rough-winged Swallow	Atlas, Audubon 2, and Audubon 3
Riparia riparia	Bank Swallow	Atlas and Audubon 2
Petrochelidon pyrrhonota	Cliff Swallow	Atlas and Audubon 2
Hirundo rustica	Barn Swallow	Atlas and Audubon 2
Paridae		
Poecile atricapillus	Black-capped Chickadee	Atlas, Audubon 2, and Audubon 3
Baeolophus bicolor	Tufted Titmouse	Atlas and Audubon 2
Sittidae		
Sitta canadensis	Red-breasted Nuthatch	Atlas, and Audubon 3
Sitta carolinensis	White-breasted Nuthatch	Atlas and Audubon 2
Certhiidae		
Certhia americana	Brown Creeper	Atlas and Audubon 2
Troglodytidae		
Troglodytes aedon	House Wren	Atlas and Audubon 2
Troglodytes troglodytes	Winter Wren	Atlas, Audubon 2, and Audubon 3
Cistothorus platensis	Sedge Wren	Atlas
Cistothorus palustris	March Wren	Atlas
Regulidae		
Regulus satrapa	Golden-crowned Kinglet	Atlas
Regulus calendula	Ruby-crowned Kinglet	Audubon 2
Turdidae		
Sialia sialis	Eastern Bluebird	Atlas, Audubon 2, and Audubon 3
Catharus fuscescens	Veery	Atlas and Audubon 2
Catharus ustulatus	Swainson's Thrush	Atlas and Audubon 2
Catharus guttatus	Hermit Thrush	Atlas and Audubon 2
Hylocichla mustelina	Wood Thrush	Atlas and Audubon 2
Turdus migratorius	American Robin	Atlas, Audubon 2, and Audubon 3
Mimidae		
Dumetella carolinensis	Gray Catbird	Atlas, Audubon 2, and Audubon 3
Toxostoma rufum	Brown Thrasher	Atlas, Audubon 2, and Audubon 3
Sturnidae		
Sturnus vulgaris	European Starling	Atlas, Audubon 2, and Audubon 3
Bombycillidae		
Bombycilla cedrorum	Cedar Waxwing	Atlas, Audubon 2, and Audubon 3
Parulidae		
Vermivora chrysoptera	Golden-winged Warbler	Atlas and Audubon 2
Vermivora peregrine	Tennessee Warbler	Audubon 2
Vermivora ruficapilla	Nashville Warbler	Atlas and Audubon 2
Parula Americana	Northern Parula	Atlas
Dendroica petechia	Yellow Warbler	Atlas, Audubon 2, and Audubon 3
Dendroica pensylvanica	Chestnut-sided Warbler	Atlas and Audubon 2

Table 8.–Continued.

Scientific name	Common name[a]	Documentation source
Dendroica tigrina	Cape May Warbler	Atlas
Dendroica caerulescens	Black-throated Blue Warbler	Atlas
Dendroica coronata	Yellow-rumped Warbler	Atlas and Audubon 2
Dendroica virens	Black-throated Green Warbler	Atlas
Dendroica fusca	Blackburnian Warbler	Atlas
Dendroica pinus	Pine Warbler	Atlas
Dendroica kirtlandii	Kirtland's Warbler	Atlas
Dendroica palmarum	Palm Warbler	Audubon 2
Mniotilta varia	Black-and-white Warbler	Atlas
Setophaga ruticilla	American Redstart	Atlas and Audubon 2
Seiurus aurocapillus	Ovenbird	Atlas and Audubon 2
Seiurus noveboracensis	Northern Waterthrush	Atlas and Audubon 2
Oporornis Philadelphia	Mourning Warbler	Atlas, Audubon 2, and Audubon 3
Geothlypis trichas	Common Yellowthroat	Atlas, Audubon 2, and Audubon 3
Wilsonia pusilla	Wilson's Warbler	Audubon 2
Wilsonia Canadensis	Canada Warbler	Atlas and Audubon 2
Thraupidae		
Piranga olivacea	Scarlet Tanager	Atlas and Audubon 2
Emberizidae		
Pipilo erythrophthalmus	Eastern Towhee	Audubon 2
Spizella passerine	Chipping Sparrow	Atlas, Audubon 2, and Audubon 3
Spizella pusilla	Field Sparrow	Atlas and Audubon 2
Pooecetes gramineus	Vesper Sparrow	Atlas, Audubon 2, and Audubon 3
Passerculus sandwichensis	Savannah Sparrow	Atlas and Audubon 2
Ammodramus savannarum	Grasshopper Sparrow	Atlas
Ammodramus henslowii	Henslow's Sparrow	Atlas
Melospiza melodia	Song Sparrow	Atlas, Audubon 2, and Audubon 3
Melospiza lincolnii	Lincoln's Sparrow	Atlas
Melospiza Georgiana	Swamp Sparrow	Atlas and Audubon 2
Zonotrichia albicollis	White-throated Sparrow	Atlas, Audubon 2, and Audubon 3
Zonotrichia leucophrys	White-crowned Sparrow	Audubon 2
Junco hyemalis	Dark-eyed Junco	Atlas
Cardinalidae		
Cardinalis cardinalis	Northern Cardinal	Atlas, Audubon 2, and Audubon 3
Pheucticus ludovicianus	Rose-breasted Grosbeak	Atlas, Audubon 2, and Audubon 3
Passerina cyanea	Indigo Bunting	Atlas, Audubon 2, and Audubon 3
Spiza Americana	Dickcissel	Atlas
Icteridae		
Dolichonyx oryzivorus	Bobolink	Atlas
Agelaius phoeniceus	Red-winged Blackbird	Atlas, Audubon 2, and Audubon 3
Sturnella magna	Eastern Meadowlark	Atlas and Audubon 2
Sturnella neglecta	Western Meadowlark	Atlas
Euphagus cyanocephalus	Brewer's Blackbird	Atlas
Quiscalus quiscula	Common Grackle	Atlas, Audubon 2, and Audubon 3
Molothrus ater	Brown-headed Cowbird	Atlas and Audubon 2
Icterus galbula	Northern Oriole	Atlas and Audubon 2

Table 8.–Continued.

Scientific name	Common name[a]	Documentation source
Fringillidae		
Carpodacus purpureus	Purple Finch	Atlas
Carpodacus mexicanus	House Finch	Audubon 2
Carduelis pinus	Pine Siskin	Atlas
Carduelis tristis	American Goldfinch	Atlas, Audubon 2, and Audubon 3
Passeridae		
Passer domesticus	House Sparrow	Atlas

[a] Unless otherwise noted, all species are breeding. Migrating birds are distinguished by a (M).

[b] Audubon 1 references a breeding bird count done by Bob Carstens (Environmental Chair of the Grand Traverse Audubon Club) from 06/09/2003 to 07/22/2003

[c] Atlas refers to Brewer, R., G.G. McPeek, and R.J. Adams Jr. 1991. The Atlas of Breeding Birds of Michigan. Michigan State University Press, East Lansing.

[d] Audubon 2 references an environmental survey conducted by Grand Traverse Audubon Society, Northwestern Michigan College (Greg LaCrosse), and Ken Gregory from 1995–2000. The survey area extended from Beitner Bridge to approximately 300 yards north of Sabin Dam (T26NR11W S3, S27, and S34).

[e] Audubon 3 references an environmental survey (four field visits from 1996–99 at T27NR11W S27) by Joyce Ellsworth, Gary Ackert, Bob Carstens, Ruth Paterson, John Mesch, and Ken Gregory. The data was compiled by past Audubon president Bob Carstens.

Table 9.–Mammal documentation within the Boardman River watershed.

Scientific name	Common name	Documentation source [a,b,c]
Didelphimorphia		
Didelphidae		
Didelphis marsupialis	opossum	Burt
Insectivora		
Soricidae		
Sorex cinereus	masked shrew	Burt
Blarina brevicauda	shorttail shrew	Burt, Audubon 1
Talpidae		
Scalopus aquaticus	eastern mole	Burt, Audubon 1
Condylura cristata	starnose mole	Burt, Audubon 1
Chiroptera		
Vespertilionidae		
Myotis lucifugus	little brown myotis	Burt
Myotis keeni	keen myotis	Burt
Lasiurus cinereus	hoary bat	Burt
Lasionycteris noctivagans	silver-haired bat	Burt
Lasiurus borealis	red bat	Burt
Eptesicus fuscus	big brown bat	Burt
Lagomorpha		
Leporidae		
Sylvilagus floridanus	eastern cottontail rabbit	Burt, Audubon 1, Audubon 2
Lepus americanus	snowshoe hare	Burt
Rodentia		
Sciuridae		
Tamias striatus	eastern chipmunk	Burt, Audubon 1
Marmota monax	woodchuck	Burt, Audubon 1
Citellus tridecemlineatus	thirteen-lined ground squirrel	Burt, Audubon 1, Audubon 2
Sciurus carolinensis	eastern gray squirrel	Burt, Audubon 1, Audubon 2
Sciurus niger	eastern fox squirrel	Burt
Tamiasciurus hudsonicus	red squirrel	Burt, Audubon 1, Audubon 2
Glaucomys sabrinus	northern flying squirrel	Burt
Glaucomys volans	southern flying squirrel	Burt
Castoridae		
Castor canadensis	beaver	Burt, Audubon 1, Audubon 2
Muridae		
Peromyscus leucopus	white-footed mouse	Burt
Peromyscus maniculatus	deer mouse	Burt, Audubon 1
Microtus pennsylvanicus	meadow vole	Burt, Audubon 1
Clethrionomys gapperi	Boreal redback vole	Burt
Pitymys pinetorum	pine vole	Burt
Ondatra zibethica	muskrat	Burt, Audubon 1, Audubon 2

Table 9.–Continued.

Common name	Scientific name	Documentation source
Synaptomys cooperi	southern bog lemming	Burt
Mus musculus	house mouse	Burt
Napaeozapus insignis	woodland jumping mouse	Burt
Dipodidae		
Zapus hudsonius	meadow jumping mouse	Burt, Audubon 1
Erethizontidae		
Erethizon dorsatum	porcupine	Burt
Carivora		
Canidae		
Canis latrans	coyote	Burt
Vulpes fulva	red fox	Burt, Audubon 1
Urocyon cinereoargenteus	gray fox	Burt
Ursidae		
Ursus americanus	black bear	Burt
Procyonidae		
Procyon lotor	raccoon	Burt, Audubon 1
Mustelidae		
Mustela frenata	longtail weasel	Burt
Mustela rixosa	least weasel	Burt
Mustela erminea	shorttail weasel	Burt
Mustela vison	mink	Burt, Audubon 1
Taxidea taxus	badger	Burt
Mephitis mephitis	striped skunk	Burt, Audubon 2
Lutra Canadensis	river otter	Burt, Audubon 1
Felidae		
Lynx rufus	bobcat	Burt
Artiodactyla		
Cervidae		
Odocoileus virginianus	whitetail deer	Burt, Audubon 1, Audubon 2

[a] Audubon 1 references an environmental survey conducted by Grand Traverse Audubon Society, Northwestern Michigan College (Greg LaCrosse), and Ken Gregory from 1995 to 2000. The survey area extended from Beitner Bridge to approximately 300 yards north of Sabin Dam (T26NR11W S3, S27, and S34).

[b] Audubon 2 references an environmental survey (four field visits from 1996 to 1999 at T27NR11W S27) by Joyce Ellsworth, Gary Ackert, Bob Carstens, Ruth Paterson, John Mesch, and Ken Gregory. The data was compiled by past Audubon president Bob Carstens.

[c] Burt refers to: Burt, W.H. 1982. Mammals of the Great Lakes Region. University of Michigan Press.

Table 10.–Exotic and invasive species documented within the Boardman River watershed. (This list is not meant to be all inclusive and will be updated periodically to reflect new and additional information sources.) MDNR-FD = Michigan Department of Natural Resources, Fisheries Division; MISG = Michigan Sea Grant; USFWS = U.S. Fish and Wildlife Service; GTCD = Grand Traverse Conservation District; GTB = Grand Traverse Band of Ottawa and Chippewa Indians.

Common name Scientific name	Location	Location verification	Date
Animals			
Zebra mussel			
Dreissena polymorpha	Arbutus Lake	MDNR-FD	2000
	Silver Lake	MDNR-FD	2007
	Spider Lake	MISG	2004
	Boardman Lake	MDNR-FD	2003
	Brown Bridge Pond	MDNR-FD	2006
Rusty crawfish			
Orconectes rusticus	Silver Lake	MDNR-FD	2007
Sea Lamprey			
Petromyzon marinus	Boardman River—mainstem downstream of Union Street Dam	USFWS	2007
	Kids Creek—near the fire station in Traverse City	MDNR-FD	2007
Round Goby			
Neogobius melanostomus	Mouth of the Boardman River	MDNR-FD	2007
Plants			
Purple loosestrife			
Lythrum salicaria	Boardman Pond delta	GTCD	2007
	Kids Creek	GTCD	2007
	North Branch of Boardman River	GTCD	2007
Phragmites (Common reed)			
Phragmites australis	River Road (Ron’s Creek)	GTCD	2007
	Rennie Lake	GTCD	2007
	East Creek	GTCD	2007
	Spider Lake (Boy Scout Camp)	GTB	2007
Eurasion-water milfoil			
Myriophyllum spicatum	Silver Lake	MDNR-FD	2007
	Arbutus Lake	MISG	2007

Table 11.–Documentation of diseases, parasites, and anomalies in the Boardman River watershed. (Additional general information about these parasites and diseases can be found at: www.michigan.gov/dnr and www.michigan.gov/deq.)

Common name Scientific name	Classification	Species affected	Location	Location verification/date
Red sore *Lymphosarcoma*	Viral	Northern Pike (*Esox lucius*)	Boardman and Sabin Ponds	MDNR Fisheries Division, 06/2007
Lymphocystis *Lymphocystis*	Viral	Walleye (*Sander vitreus*)	Silver Lake	MDNR Fisheries Division, 06/2007
Black spot *Uvulifer ambloplitis*	Parasitic	Rock bass (*Ambloplites rupestris*)	Silver Lake	MDNR Fisheries Division, 06/2007
Swimmer's itch *Trichobilharzia* and *Gigantobilharzia*	Parasitic	Snails, waterfowl, and humans	Silver Lake	MDNR Fisheries Division, 06/2007

Table 12.–Chapman-Petersen population estimates for Brown Trout, Brook Trout, and Rainbow Trout (all ages combined) at survey stations on the Boardman River.

Station and survey area	Years sampled	Brown Trout no/acre	Brown Trout (lbs/acre)	Brook Trout no/acre	Brook Trout (lbs/acre)	Rainbow Trout no/acre	Rainbow Trout (lbs/acre)
North Branch Boardman							
River at Broomhead Rd.	1985	319	(58.0)	47	(2.4)		
0.76 acres (1985–94)	1986	98	(14.4)	14	(0.4)		
0.77 acres (2000–02)	1987	431	(54.9)	69	(2.5)		
	1994	146	(22.1)	593	(14.9)		
	2000	1,348	(37.6)	344	(10.5)		
	2001	407	(24.2)	369	(6.2)		
	2002	191	(34.9)	385	(13.1)		
South Branch Boardman							
River at Broomhead Road	1985	1,133	(118.2)	104	(3.3)		
0.71 acres (1985–94)	1986	1,140	(105.0)	30	(0.9)		
0.77 acres (2000–02)	1987	1,741	(137.6)	136	(3.1)		
	1994	946	(79.7)	357	(7.7)		
	2000	999	(98.1)	114	(3.2)		
	2001	939	(63.0)	123	(4.4)		
	2002	554	(62.7)	146	(4.6)		
Forks campground	1985	831	(89.5)	39	(0.9)		
1.04 acres (1985–1994)	1986	637	(50.8)	7	(0.3)		
	1987	693	(71.7)	5	(0.1)		
	1994	437	(50.1)	97	(3.3)		
Ranch Rudolf	1960	271	(36.2)	243	(11.9)		
0.96 acres (1960–76)	1961	514	(52.3)	401	(20.4)		
0.95 acres (1985–94)	1976	444	(75.7)	22	(0.8)		
1.06 acres (2002–04)	1985	540	(71.2)	47	(1.8)		
1.03 acres (2008–2010)	1986	360	(61.2)	21	(0.9)	1	(1)
	1987	355	(73.2)	44	(1.2)		
	1994	266	(42.7)	501	(11.9)		
	2002	205	(38.2)	463	(11.5)	2	(0.4)
	2003	200	(33.7)	496	(13.7)	1	(1)
	2004	201	(43.2)	346	(12.4)	1	(0.4)
	2008	177	(19.85)	213	(5.93)	6	(2.32)
	2009	206	(24.88)	249	(8.52)		
	2010	149	(24.06)	285	(7.06)	2	(1.67)
Scheck's Place campground	1985	609	(67.9)	52	(1.3)		
1.1 acres	1986	639	(27.7)	35	(1.4)		
	1987	534	(43.0)	59	(2.2)		
	1994	565	(47.6)	810	(10.8)		
	2005	510	(62.7)	271	(7.1)		
Brown Bridge road	1985	171	(59.8)	10	(1.1)		
1.24 acres	1986	71	(28.6)	6	(0.5)		
	1987	259	(37.9)	13	(1.2)		
	1994	232	(45.1)	14	(1.4)		
	2005	246	(30.3)	12	(0.2)		
	2010	344	(59.03)	6	(0.60)		

Table 12.–Continued.

Station and survey area	Years sampled	Brown Trout no/acre	Brown Trout (lbs/acre)	Brook Trout no/acre	Brook Trout (lbs/acre)	Rainbow Trout no/acre	Rainbow Trout (lbs/acre)
Shumsky's public access site	1985	188	(39.8)	3	(0.1)		
1.2 acres	1986	127	(22.9)	2	(0.4)		
	1987	208	(33.3)	2	(0.3)		
	1994	80	(19.5)	5	(0.1)		
	2005	128	(20.6)	2	(0.2)		
Beitner road	2005	379	(31.1)	328	(6.5)		
0.99 acres							
Below Sabin Dam	2006	33	(21.7)				
5.67 acres							

Table 13.–Average total length-at-age and growth (index relative to the state average, in inches) for Brown Trout from the Boardman River.

Survey station and year	Age	Number aged	Length range (in)	Weighted mean length (in)	Mean growth index[a] (in)
Ranch Rudolf	0	17	2.4–3.8	3.1	-0.2
2002	1	22	4.9–7.5	6.5	
	2	42	6.6–12.4	8.6	
	3	3	10.0–12.4	11.5	
2003	0	14	2.3–3.8	3.3	-1.1
	1	30	4.6–7.7	6.2	
	2	30	6.8–11.5	8.8	
	3	12	8.4–14.9	10.1	
	8	1	20.9–20.9	20.9	
2004	0	12	2.8–3.8	3.2	-0.6
	1	28	4.5–8.3	6.4	
	2	35	6.7–12.6	8.6	
	3	15	8.4–13.8	11.0	
	4	3	11.1–16.7	13.9	
2008	0	23	2.6–4.1	3.3	+0.5
	1	24	4.8–9.3	6.9	
	2	10	7.4–12.1	9.9	
	3	3	12.3–13.9	12.7	
	4	1	16.2	16.2	
2009	0	22	2.6–4.4	3.3	+0.2
	1	19	6.0–8.3	7.0	
	2	19	6.8–11.6	8.9	
	3	4	8.3–13.8	10.7	
	4	1	13.8	13.8	
	5	1	21.3	21.3	
	6	1	17.2	17.2	
2010	0	24	2.9–4.3	3.7	+0.7
	1	27	5.9–9.3	7.2	
	2	25	7.2–11.2	9.8	
	3	1	13.4	13.4	
	4	2	14.8–16.4	15.6	
	5	1	17.9	17.9	
Scheck's Place	0	27	2.0–2.5	3.1	+0.2
2005	1	29	5.1–8.3	6.5	
	2	32	7.8–11.1	9.4	
	3	15	11.0–13.1	12.4	
	4	3	14.0–16.1	14.8	

Table 13.–Continued.

Survey station and year	Age	Number aged	Length range (in)	Weighted mean length (in)	Mean growth index[a] (in)
Brown Bridge road	0	31	2.4–5.1	3.4	+1.0
2005	1	13	7.0–9.2	7.6	
	2	33	6.6–12.9	10.5	
	3	10	11.9–14.5	13.2	
2010	0	29	2.6–5.2	4.0	+.06
	1	18	6.1–9.2	7.6	
	2	34	8.1–11.9	9.4	
	3	16	9.8–14.8	12.0	
	4	4	14.7–16.2	15.5	
Shumsky's public access site	0	21	2.6–4.4	2.9	+0.2
2005	1	19	5.7–7.7	6.9	
	2	30	7.6–11.4	9.4	
	3	4	12.3–15.8	14.4	
Beitner road	0	23	2.2–4.1	3.2	+1.3
2005	1	33	5.4–9.4	7.5	
	2	23	9.1–12.1	10.5	
	3	2	13.3–13.5	13.4	
Below Sabin Dam	0	13	2.7–3.5	3.2	+1.9
2005	1	22	5.5–8.3	7.3	
	2	47	8.5–14.5	10.6	
	3	17	13.6–17.2	15.4	
	4	1	18.9–18.9	18.9	
	5	2	21.7–23.9	22.8	
2006	0	6	3.6–3.9	3.8	+2.0
	1	21	5.4–8.2	7.2	
	2	65	7.9–14.6	10.7	
	3	11	13.9–17.0	15.3	
	4	14	15.9–19.5	17.9	
	5	1	21.5–21.5	21.5	
	6	1	24.0–24.0	24.0	
Lone Pine Area (Historic headwaters of Boardman Pond)	0	9	4.0–5.0	4.37	+1.2
2008	1	2	6.5–9.2	7.9	
	2	4	9.8–10.8	10.5	

[a] Growth index is the deviation from the state average length; at least five individuals must be aged from an age group for inclusion in the state average index.

Table 14.–Population estimates for trout and juvenile salmon from select northern Michigan trout streams, 2008–10.

		Species					
		Brown Trout		Rainbow Trout	Brook Trout	Coho Salmon	Chinook Salmon
River (survey site)	Year	no/acre	lbs/acre	no/acre	no/acre	no/acre	no/acre
Little Manistee River							
(Johnson's Bridge)	2008	508	92.6	1,126	1.0	1,866	
	2009	826	83.3	2,382		625	28
	2010	988	95.8	1,879		409	13
Platte River							
(upper US-31 crossing)	2008	292	38.8	2,429		1,332	1
	2009	325	30.2	2,777		622	2
	2010	275	51.0	2,722		973	4
Pere Marquette River							
(mouth of the Baldwin River)	2008	259	112.2	1,373		170	33
	2009	293	122.3	910		412	30
	2010	318	106.8	1,112		96	43
Upper Manistee River							
(Cameron Bridge) [a]	2008	1,084	56.1		487		
	2009	883	50.2		485		
	2010	738	60.0		395		
Boardman River							
(Ranch Rudolf) [a]	2008	177	19.9	6	213		
	2009	206	24.9		249		
	2010	149	24.1	2	285		
Au Sable River							
(Stephan Bridge) [a]	2008	944	129.0	301	359		
	2009	1,444	119.4	480	491		
	2010	1,261	115.2	473	453		

[a] Stream reaches not accessible to Great Lakes migratory fish.

Table 15.–Brown Trout population estimates by age, percent by age, and annual survival at Ranch Rudolf, Boardman River, 2002–10.

	Population estimate by age (no/acre)						
Survey year	0	1	2	3	4	5	6
2002	27	61	96	3			
2003	46	72	53	17			
2004	18	75	67	21	6		
2008	123	29	12	3	1		
2009	124	37	37	6	2	1	1
2010	70	37	32	1	2	1	
	Percent of population by age						
Survey year	0	1	2	3	4	5	6
2002	14	33	51	2			
2003	25	37	29	9			
2004	10	40	36	11	3		
2008	73	17	7	2	1		
2009	60	17	17	3	1	1	1
2010	49	26	22	1	1	1	
	Percent survival by age						
Year class	0 to 1	1 to 2	2 to 3	3 to 4	4 to 5	5 to 6	
2002	100	87	17				
2003	100	94	40	33			
2008	30	93	67	50	67	100	
2009	30	87	33	4	33		

Table 16.–Average total length-at-age and growth index (relative to the state average, in inches) for Brook Trout from the Boardman River.

Station year	Age	Number aged	Length range (in)	Weighted mean length (in)	Mean growth index[a] (in)
Ranch Rudolf	0	28	2.6–4.5	3.4	+0.3
2002	1	30	4.9–8.2	5.9	
	2	1	8.9–8.9	8.9	
2003	0	30	2.5–4.6	3.2	+0.4
	1	30	4.3–8.2	6.1	
	2	7	5.6–9.0	7.1	
2004	0	25	2.5–4.1	3.3	+0.3
	1	41	4.4–7.8	5.9	
	2	4	7.3–9.1	7.9	
2008	0	30	2.3–4.6	3.5	+1.2
	1	11	6.2–8.7	7.4	
	2	2	8.8–9.4	9.1	
2009	0	21	2.9–4.7	3.7	+1.0
	1	23	5.4–8.7	6.9	
2010	0	30	2.8–4.5	3.5	+0.7
	1	20	5.2–8.2	6.4	
Scheck's Place	0	21	2.2–4.0	2.9	-0.1
2005	1	36	4.0–8.3	5.6	
	2	1	9.9–9.9	9.9	
Brown Bridge Road	0	12	2.0–3.5	2.8	-0.1
2005	1	1	5.6–5.6	5.6	
2010	0	4	3.1–4.1	3.5	–
	1	3	7.5–9.1	8.3	
Shumsky's public access site	1	2	5.9–7.7		–
2005					
Beitner Road	0	32	2.4–5.0	3.5	+0.6
2005	1	10	5.8–8.4	7.0	

[a] Growth index is the deviation from the state average length; at least five individuals must be aged from an age group for inclusion in the state average index.

Table 17.–The number of salmon and trout captured at the Boardman River weir, fall 1987–2012.

	Species			
Year	Chinook Salmon	Coho Salmon	Steelhead	Brown Trout
1987	4,902	306	17	12
1988	6,129	477	66	8
1989	5,809	288	36	21
1990	6,236	141	66	10
1991	5,556	64	38	9
1992	3,139	25	57	28
1993	2,299	182	30	14
1994	3,025	1,530	21	2
1995	4,546	146	15	10
1996	5,705	207	25	16
1997	3,040	3,804	11	2
1998	2,665	1,124	29	12
1999	6,008	97	6	18
2000	4,549	5,934	6	4
2001	5,231	596	14	1
2002	5,412	1,345	12	5
2003	6,165	162	7	1
2004	7,765	1,432	22	5
2005	7,783	61	13	3
2006	12,651	1,077	29	3
2007	5,018	1,764	20	0
2008	3,017	43	11	3
2009	2,636	58	11	2
2010	2,964	212	12	5
2011	7,257	11,168	46	14
2012	4,516	2,534	13	14
Total	134,023	34,777	633	222
Average	5,155	1,338	24	9

Table 18.–Public recreation areas in the Boardman River watershed.

Public recreation area name	Location	Description	Recreation area jurisdiction
Beitner Park	Boardman River mainstem, Keystone Road crossing	Boardman River access and canoe launch, day-use picnic area, and nonmotorized trail system	Grand Traverse County
Medalie Park	South end of Boardman Lake	Boardman Lake and River access, day-use picnic area, and nonmotorized trail system	Grand Traverse County
Nature Education Reserve	Boardman and Sabin Pond area, adjacent to Keystone Road	Boardman, Sabin Pond, and River access, day-use picnic area, and nonmotorized trail system	Grand Traverse County
VASA Pathway	Lower Boardman River watershed, Bartlett Road access	Nonmotorized trail system	Grand Traverse County
Brown Bridge Quite Area	Brown Bridge Pond area, Brown Bridge Road access	Boardman River and Brown Bridge Pond access and boat launch, day-use picnic area, and nonmotorized trail system	Traverse City
Boardman Lake Recreation area	North-east end of Boardman Lake	Boardman Lake boat launch and picnic day-use area	Traverse City
Union Street Dam	Union Street Dam, Sixth Street access	Day-use fishing access and picnic area	Traverse City
Arbutus 4 State Forest Campground	Arbutus Lake 4, North Arbutus Lake Road access	Arbutus Lake access and boat launch, rustic campground, and trail system	MDNR
Muncie Lake Pathway	Muncie Lake, Rennie Lake Road access	Muncie Lake access and nonmotorized trail system	MDNR
Scheck's Place State Forest Campground	Boardman River mainstem, Brown Bridge Road access	Boardman River access and canoe launch, rustic campground, and motorized trail system	MDNR
Scheck's Place Trail Camp	Boardman River mainstem, Brown Bridge Road access	Equestrian and rustic campground, and Boardman River access	MDNR
Forks Rustic Campground	Boardman River mainstem, Brown Bridge Road access	Boardman River access and canoe launch, and rustic campground	MDNR
Sand Lake Quite Area	Sand Lakes area, Broomhead Road access	Sand Lakes access and nonmotorized trail system	MDNR
Guernsey Lake State Forest Campground	Guernsey Lake area, Campground Road access	Guernsey Lake access and a boat launch, rustic campground, and motorized trail system	MDNR
Kids Creek Nature Area	Kids Creek, US Hwy. 31 access near Kohl's Dept Store and Great Wolf Lodge hotel	Kids Creek handicap access and nonmotorized trail system	Garfield Township

Table 19.–Citizen involvement organizations associated with the Boardman River watershed.

Organization/group	Primary function	Web page/e-mail address	Telephone
Conservation Resource Alliance	Restoration, enhancement, wise-use, and protection of natural resources	www.rivercare.org cra@rivercare.org	231-946-6817
Boardman River Project	Restoration, enhancement, wise-use, and protection of natural resources	www.boardmanriver.org slargent@gtcd.org	231-941-0960
Boardman River Dams Committee	Community recommendation of dam dispostion	www.theboardman.org jjay@message.nmc.edu	231-995-2617
Watershed Center Grand Traverse Bay	Restoration, enhancement, wise-use, and protection of natural resources	www.gtbay.org info@gtbay.org	231-935-1514
Grand Traverse Band of Ottawa and Chippewa Indians	Restoration, enhancement, wise-use, and protection of natural resources	www.gtb.nsn.us	231-534-7655
Michigan Department of Environmental Quality	Administer the Clean Water and Air Acts and other environmental laws within the watershed	www.michigan.gov/deq	231-775-3960
Michigan Department of Natural Resources	Conservation, protection, management, use and enjoyment of the State's natural resources for current and future generations	www.michigan.gov/dnr	231-922-5280
Grand Traverse County Drain Commissioner and Parks and Recreation	Administer the Soil Erosion and Sedimentation Control Act within Grand Traverse County and manage the Nature Reserve.	www.co.grand-traverse.mi.us/Home.htm information@co.grand-traverse.mi.us	231-922-4818
The City of Traverse City	Management of the Brown Bridge Quiet Area and City Parks within the City limits	www.ci.traverse-city.mi.us/ cityinfo@traversecitymi.gov	231-922-4440

This page was intentionally left blank.

REFERENCES

Abrams, E.S. 2007. Boardman River feasibility study: economic and social analysis of the Boardman River Dams. Report from Environmental Consulting and Technology, Inc. to the Boardman River Dams Committee, Traverse City, Michigan.

Albert, D.A. 1995. Regional landscape ecosystems of Michigan, Minnesota, and Wisconsin: a working map and classification. General Technical Report NC-178. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. Northern Prairie Wildlife Research Center Online. http://www.npwrc.usgs.gov/resource/1998/rlandscp/rlandscp.htm. (January 2006).

Allison, L.N., J.G. Hnath, and W.G. Yoder. 1977. Manual of common diseases, parasites, and anomalies of Michigan fishes. Michigan Department of Natural Resources. Fisheries Management Report 9, Lansing.

Anonymous. 1876. A guide to the haunts of the "little fishes": the "speckled Brook Trout" and the beautiful "American grayling", and many other kinds of the finny tribe in the land of northern Michigan. Grand Rapids and Indiana Railroad, Grand Rapids.

Anonymous. 1982a. People of the valley. Pages 38–64 *in* A.V. Williams, editor. Currents of the Boardman. Grand Traverse County Historical Society, Traverse City, Michigan.

Anonymous. 1982b. Rails in the valley, boats on the bay, and early trails. Pages 74–81 *in* A.V. Williams, editor. Currents of the Boardman. Grand Traverse County Historical Society, Traverse City, Michigan.

Anonymous. 2000. Michigan stream classification: 1967 system. Chapter 20 *in* Schneider, James C. (ed.). Manual of fisheries survey methods II: with periodic updates. Michigan Department of Natural Resources, Fisheries Division, Special Report 25, Ann Arbor.

Anonymous. 2002. Interdepartmental approach to harmful aquatic nuisance species, report to the Michigan Legislature, MDNR-MDEQ, October 2002, Lansing.

Bates, M.E.C., and M.K. Buck. 1891. Along Traverse Shores. Herald Office, Traverse City, Michigan.

Becker, G.C. 1983. Fishes of Wisconsin. The University of Wisconsin Press, Madison.

Boardman River Management Plan Committee. 2002. Boardman River natural river plan, Grand Traverse and Kalkaska counties, revised edition. Revised by Michigan Department of Natural Resources, Fisheries Division. Lansing.

Bower, S. 1909. The Rainbow Trout in Michigan. Transactions of the American Fisheries Society 39:130–142.

Brewer, R., G.G. McPeek, and R.J Adams, Jr. 1991. The breeding birds of Michigan. Michigan State University Press.

Bullen, W. 1969. Evaluation of 1967 adult coho transfers. Michigan Department of Natural Resources, Fisheries Division, Region II-District 6 Anadromous Fish Report, Cadillac.

Burroughs, B.A. 2007a. Boardman River feasibility study: a report on the Boardman River fisheries existing data. Report of Environmental Consulting and Technology Inc. to the Boardman River Dams Committee, Traverse City, Michigan.

Burroughs, B.A. 2007b. Effects of dam removal on fluvial geomorphology and fish. Doctoral dissertation. Michigan State University, East Lansing.

Burroughs, B.A. 2008. Boardman River feasibility study: a report on the Boardman River fisheries habitat survey and data collection. Report of Environmental Consulting and Technology Inc. to the Boardman River Dams Committee, Traverse City, Michigan.

Cederholm C.J., M.D. Kunze, T. Murota, and A. Sibatani. 1999. Pacific salmon carcasses: Essential contributions of nutrients and energy for aquatic and terrestrial ecosystems. Fisheries 24:6–15.

Charles, G. 1982. Those good old fishing days. Pages 82–88 *in* A.V. Williams, editor. Currents of the Boardman. Grand Traverse County Historical Society, Traverse City, Michigan.

Comer, P.J. 1996. Wetland trends in Michigan since 1800: a preliminary assessment. Report for USEPA and Michigan Department of Environmental Quality, Land and Water Management Division. Michigan Natural Features Inventory report number 1996-03. 76pp.

Cooper, G.P., D.S. Shetter, and G.R. Alexander. 1962. Progress report on recent data for trout streams with special regulations. Third supplement to Fisheries Research Report 1577. Michigan Department of Conservation, Institute for Fisheries Research, Ann Arbor.

Coscarelli, M., and E. Bankard. 1999. Aquatic nuisance species handbook for government officials. Michigan Department of Environmental Quality, Office of the Great Lakes, Lansing.

Cummings, T.R., J.L. Gillespie, and N.G. Grannemann. 1990. Hydrology and land use in Grand Traverse County, Michigan. U.S. Geological Survey Water-Resources Investigations Report 90-4122, 99 p. U. S. Geological Survey, Lansing, Michigan.

Cushing, C.E., and J.D. Allan. 2001. Streams: their ecology and life. Academic Press, San Diego. pp. 366.

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. pp. 424–432.

Elliott, J.M. 1994. Quantitative ecology and the Brown Trout. Oxford University Press, Oxford.

Farrand, W.R. 1988. The glacial lakes around Michigan. Michigan Department of Natural Resources, Geological Survey Division, Bulletin 4, Lansing.

Gowing, H., and G.R. Alexander. 1980. Population dynamics of trout in some streams of the northern lower peninsula. Michigan Department of Natural Resources, Fisheries Research Report 1877, Ann Arbor.

Griffiths, R.W., W.P. Kovalak, and D.W. Schloesser. 1991. The zebra mussel, *Dreissena polymorpha* (Pallas, 1771) in North America: impact on raw water users. Pages 11-26 *in* Symposium: Service water system problems affecting safety-related equipment. Charlotte, NC, November 6–8, 1989.

Hay, R.L. 1986a. Lake survey, Boardman Pond, 1986. Michigan Department of Natural Resources, Cadillac.

Hay, R.L. 1986b. Lake survey, Brown Bridge Pond, 1986. Michigan Department of Natural Resources, Cadillac.

Hay, R.L. 1986c. Lake survey, Sabin Pond, 1986. Michigan Department of Natural Resources, Cadillac.

Henshall, J.A. 1902. Food and game fishes of the rocky mountain region. Transactions of the American Fisheries Society 31:74–88.

Hesselbart, R.J. 1982. Hydroelectric days. Pages 28–37 *in* A.V. Williams, editor. Currents of the Boardman. Grand Traverse County Historical Society, Traverse City, Michigan.

Hinz, L.C. Jr., and M.J. Wiley. 1997. Growth and production of juvenile trout in Michigan streams: influence of temperature. Michigan Department of Natural Resources, Fisheries Research Report 2041, Ann Arbor.

Hinz, L.C. Jr., and M.J. Wiley. 1998. Growth and production of juvenile trout in Michigan streams: influence of potential ration and temperature. Michigan Department of Natural Resources, Fisheries Research Report 2042, Ann Arbor.

Hubbs, C.L., and K.F. Lagler. 1947. Fishes of the Great Lakes Region. The University of Michigan Press, Ann Arbor.

Hynes, H.B.N. 1970. The ecology of running waters. Liverpool University Press, Liverpool, Great Britain.

Janetski, D.J., D.T. Chaloner, A.H. Moerke, R.R. Rediske, J.P. O'Keefe, and G.A. Lamberti. 2012. Resident Fishes Display Elevated Organic Pollutants in Salmon Spawning Streams of the Great Lakes. Environmental Science Technology 46(15):8035–8043.

Kalish, T.G. 2004. Lake survey, Boardman Lake, 2003. Michigan Department of Natural Resources, Cadillac.

Kanehl, P.D., J. Lyons, and J.E. Nelson. 1997. Changes in the habitat and fish community of the Milwaukee River, Wisconsin, following removal of the Wollen Mills dam. North American Journal of Fisheries Management 17:387–400.

Kellum, F. 1982. Where flows the Boardman? Pages 5–11 *in* A.V. Williams, editor. Currents of the Boardman. Grand Traverse County Historical Society, Traverse City, Michigan.

Knighton, D. 1984. Fluvial forms and process. Edward Arnold Ltd., London, Great Britain.

Largent, S. 2006. Boardman River Watershed Report. Grand Traverse Conservation District. Traverse City, Michigan.

Lessard, J.L., and D.B. Hayes. 2003. Effects of elevated water temperature on fish and macroinvertebrate communities below small dams. River Research and Applications 19:721-732.

MacCrimmon, H.R., and T.L. Marshall. 1968. World distribution of Brown Trout, *Salmo trutta*. Journal of the Fisheries Research Board of Canada 25:2527–2598.

MacCrimmon, H.R., and B.L. Gots. 1972. Rainbow Trout in the Great Lakes. Ontario Ministry of Natural Resources, Toronto.

Martin, H.M. 1957. Outline of the Geologic History of the Grand Traverse Region. Michigan Department of Conservation, Geological Survey Division, Lansing.

Melkild, M. 1982a. Where Indian trails and river met. Pages 12–16 *in* A.V. Williams, editor. Currents of the Boardman. Grand Traverse County Historical Society, Traverse City, Michigan.

Melkild, M. 1982b. Article from notes from the journal of Prokop Kyselka and an interview with his granddaughter Evelyn Kyselka. Pages 142–147 *in* A.V. Williams, editor. Currents of the Boardman. Grand Traverse County Historical Society, Traverse City, Michigan.

Michigan Department of Agriculture. 2000. http://climate.geo.msu.edu/stations/8251/ (February 2006).

Michigan Department of Environmental Quality. 2005. Swimmer's itch in Michigan. Michigan Department of Environmental Quality, Water Bureau, Aquatic Nuisance Control and Remedial Action Unit. Report EQC 2791, Lansing.

Michigan Department of Natural Resources. 1993. A guide to the public rights on Michigan waters. Michigan Department of Natural Resources, Law Enforcement Division, Report 9, Lansing.

Morita, K., and S. Yamamoto. Effects of habitat fragmentation by damming on the persistence of stream-swelling charr populations. Conservation Biology 16:1318–1323.

Pejchar, L., and K. Warner. 2001. A river might run through it again: criteria for consideration of dam removal and interim lessons from California. Environmental Management 28:561–575.

Pflieger, W.L. 1975. The Fish of Missouri. Missouri Department of Conservation. Jefferson City.

Rayle, S.L. 1982. It all began on the Boardman. Pages 89–103 *in* A.V. Williams, editor. Currents of the Boardman. Grand Traverse County Historical Society, Traverse City, Michigan.

Rennie, A., and M. Swibold. 1982. Logging and lumbering days. Pages 17–27 *in* A.V. Williams, editor. Currents of the Boardman. Grand Traverse County Historical Society, Traverse City, Michigan.

Schneider, J.C., editor. 2000. Manual of fisheries survey methods II: with periodic updates. Michigan Department of Natural Resources, Fisheries Special Report 25, Ann Arbor.

Schultz, E.E. 1955. An investigation of the Boardman River, Grand Traverse County, to choose a section of the stream suitable for an experiment on restrictive fishing regulations. Michigan Department of Conservation, Institute for Fisheries Research Report 1459, Ann Arbor.

Schultz, E.E. 1956. Trout in the Boardman River during the first year of experimental restrictive regulations. Michigan Department of Conservation, Fisheries Research Report 1475, Ann Arbor.

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. 1997. A landscape-based ecological classification system for river valley segments in lower Michigan. Michigan Department of Natural Resources, Fisheries Research Report 2036, Ann Arbor.

Shuldt, J.A., and A.E. Hershey. 1995. Effect of salmon carcass decomposition on Lake Superior tributary streams. Journal of the North American Benthological Society 14:259–268.

Stuart, S.N., J.S. Chanson, N.A. Cox, B.E Young, A.S.L. Rodrigues, D.L. Fishman, and R.W. Waller. 2004. Status and trends of amphibian declines and extinctions worldwide. Science 306:1783–1786.

Stauffer, T.M. 1977. Numbers of juvenile salmonids produced in five Lake Superior tributaries and the effect of juvenile Coho Salmon on their number and growth, 1967–1974. Michigan Department of Natural Resources, Fisheries Research Report 1846, Ann Arbor.

Taube, C.M. 1975. Abundance, growth, biomass, and interrelationship of trout and Coho Salmon in the Platte River. Michigan Department of Natural Resources, Fisheries Research Report 1830, Ann Arbor.

Taylor, C.A., J.H. Knouft, and T.M. Hiland. 2001. Consequences of stream impoundment on fish communities in a small North American drainage. Regulated Rivers: Research and Management 17:687–698.

The Watershed Center Grand Traverse Bay. 2005. Kids Creek Restoration Project. Available: http://www.gtbay.org/kidscreek.asp. (December 2006).

Tonello, M.A. 2005. Status of the Fishery Report: Little Manistee River. Michigan Department of Natural Resources, Status of the Fishery Report 2005–08, Ann Arbor.

Trautman, M.B. 1981. The Fishes of Ohio, revised edition. Ohio State University Press, Columbus.

Trautman, M.B. 1942. Fish distribution and abundance correlated with stream gradient as a consideration in stocking programs. Pages 211–223 *in* Transactions of the Seventh North American Wildlife Conference, Washington, D.C.

Traverse City Convention and Visitors Bureau. 2007. Visitor statistics. Available: http://www.vistitraversecity.com (March 2008).

Vincent, R.E. 1962. Biogeographical and ecological factors contributing to the decline of the arctic grayling, *Thymallus arcticus* Pallas, in Michigan and Montana. Doctoral dissertation. University of Michigan, Ann Arbor.

Wagner, W.C. 1975. Food habits of coexisting juvenile Coho Salmon, Brown Trout, and Rainbow Trout in the Platte River, 1967 and 1972. Michigan Department of Natural Resources, Fisheries Research Report 1831, Ann Arbor.

Winchell, A. 1866. The Grand Traverse Region. Dr. Chase's Steam Printing House, Ann Arbor, Michigan.

Zorn, T.G., and S.P. Sendek. 2001. Au Sable River Assessment. Michigan Department of Natural Resources, Fisheries Special Report 26, Ann Arbor.

Thomas J. Rozich, Reviewer
Timothy A. Cwalinski, Reviewer
Brian J. Bury, Reviewer
David F. Clapp, Editor
Alan D. Sutton and Ellen S. Grove, Graphics
Ellen S. Grove, Desktop Publisher

Approved by Jay K. Wesley

This page was intentionally left blank.

APPENDICES

This page was intentionally left blank.

Appendix A.–Federal Energy Regulatory Commission settlement agreement among the Michigan Department of Natural Resources, Michigan Department of Environmental Quality, United States Department of Interior Fish and Wildlife Service, Michigan Hydro Relicensing Coalition, Grand Traverse County, City of Traverse City, Traverse City Light and Power Department, and the Grand Traverse Band of Ottawa and Chippewa Indians. (Available: http://www.theboardman.org/archived-documents/settlement-agreement.html)

Boardman River Dams Settlement Agreement

Originally drafted:
January 20, 2005
Revised:
May 16, 2005

Sabin, Boardman, and Brown Bridge Dam Settlement Agreement

Covering FERC Hydroelectric Projects Dams:

FERC Project Name:	**Project Number:**
Sabin	2980
Boardman	2979
Brown Bridge	2978

Executed by: Michigan Department of Natural Resources
Michigan Department of Environmental Quality
United States Department of Interior Fish and Wildlife Service
Michigan Hydro Relicensing Coalition
Grand Traverse County
City of Traverse City
Traverse City Light and Power Department
Grand Traverse Band of Ottawa and Chippewa Indians

May 16, 2005

IN WITNESS WHEREOF, each of the parties has caused this SETTLEMENT to be executed on its behalf by its officers thereunto duly authorized effective as of -----, 2005.

Traverse City Light and Power Department
Richard L. Smith, Executive Director

Linda Johnson
5-20-05
Linda Johnson, Chair — Date

Linda Smyka
City of Traverse City
Linda Smyka, Mayor

5-31-
Debbra A. Curtiss, City Clerk — Date

Grand Traverse County
Wayne Schmidt, Chair
Board of Commissioners

Linda Coburn 5/20/05
Linda Coburn, County Clerk — Date

5-19-05
Michigan Hydro Relicensing Coalition — Date

5-18-05
United States Department of the Interior
Fish and Wildlife Service — Date

5-17-05
Michigan Department of Environmental Quality — Date

5/17/05
Michigan Department of Natural Resources — Date

5.20.05
Grand Traverse Band of Ottawa and Chippewa Indians — Date

Approved
As To Form ____ W. Peter Doren - City Attorney
As to Substance ____ Richard I. Lewis - City Manager

Alan Schneider, Pros. Atty.
Dennis Aloia, County Admin.

TABLE OF CONTENTS 1

Appendices:

Appendix 1	Union Street, Sabin, Boardman, and Brown Bridge Dam locations
Appendix 2	Michigan Dam Safety Act MCL 324.31501
Appendix 3	Preliminary Restoration Plan for potential Removal of Union Street, Sabin, Boardman, and Brown Bridge Dams on the Boardman River, Grand Traverse County, Michigan
Appendix 4	Maintenance Agreement between Traverse City Light and Power Department and Grand Traverse County

Page 3 May 16, 2005

1. Background Information

1.1. The Applicant and the Projects

Traverse City Light and Power Department (TCLPD) operates the Sabin, Boardman, and Brown Bridge Projects. The Sabin and Boardman Dams are owned by Grand Traverse County, and Brown Bridge Dam is owned by the City of Traverse City. Therefore, this offer of settlement (Settlement), submitted pursuant to 18 CFR 385.602, concerns only the Sabin, Boardman, and Brown Bridge Projects (collectively referred to as the Boardman River Projects) Federal Energy Regulatory Commission (FERC) license surrender, project decommission, and potential dam removal. The Brown Bridge Project FERC license expires in 2014. The Sabin and Boardman Projects have FERC exempted licenses. TCLPD is the licensee for the Boardman River Projects and the applicant for the surrender applications which include FERC Project No. 2978 (Brown Bridge), 2979 (Boardman), and 2980 (Sabin). TCLPD has decided to surrender the licenses of the Boardman River Projects because they are no longer economic to operate (Appendix 1).

The City of Traverse City also owns and maintains the Union Street Dam. The Union Street Dam is not a FERC licensed project, but has been under MDEQ jurisdiction. The Union Street Dam is a lake level control structure and will be included in the engineering/feasibility study if the City of Traverse City decides it is appropriate.

The Boardman River Projects are located in Grand Traverse County in the Northern Lower Peninsula of Michigan. A map of the Boardman River Basin identifying the location of the project dams in this Settlement can be found in Appendix 1.

1.2. The Settlement

This Settlement was negotiated among the Parties (Michigan Department of Natural Resources, Michigan Department of Environmental Quality, United States Department of Interior Fish and Wildlife Service, Grand Traverse County, the City of Traverse City, TCLPD, the Michigan Hydro Relicensing Coalition, and the Grand Traverse Band of Ottawa and Chippewa Indians) to facilitate the surrender and decommissioning of the Boardman River Projects, and the disposition of the Boardman River Dams.

2. General Provisions

2.1. Abbreviations and Definitions

2.1.1. Abbreviations

CFR	- Code of Federal Regulations
CORPS	- United States Army Corps of Engineers
FERC	- Federal Energy Regulatory Commission
FPA	- Federal Power Act
FWS	- United States Department of Interior Fish and Wildlife Service
GTB	- Grand Traverse Band of Ottawa and Chippewa Indians
MDEQ	- Michigan Department of Environmental Quality
MDNR	- Michigan Department of Natural Resources
MHRC	- Michigan Hydro Relicensing Coalition
NGO	- Non-Governmental Organization
TCLPD	- Traverse City Light and Power Department
T/E/S	- Threatened/Endangered/Sensitive

2.1.2. Definitions

Boardman River Dams: the collective term for Sabin, Boardman, Brown Bridge, and Union Street Dams.
Boardman River Projects: Sabin, Boardman, and Brown Bridge hydroelectric facilities.
Day: a 24-hour period, midnight to midnight.
Ex officio advisory member: an organization or an individual that participates in the settlement implementation process but does not have voting rights.
Licensee: Traverse City Light and Power Department.
Michigan Hydro Relicensing Coalition: a coalition of Michigan conservation organizations that includes 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.
Parties: Signatories to the Settlement Agreement: Grand Traverse County, United States Department of the Interior Fish and Wildlife Service, Traverse City Light and Power Department, Michigan Department of Natural Resources, Michigan Department of Environmental Quality, the City of Traverse City, the Michigan Hydro Relicensing Coalition, and the Grand Traverse Band of Ottawa and Chippewa Indians.
Resource Agencies: the Michigan Department of Natural Resources, Michigan Department of Environmental Quality, and the United States Department of Interior Fish and Wildlife Service.
Riparian Lands: lands adjacent to a water course.
Settlement: the Boardman River Dams Settlement Agreement.

Team: Boardman River Dams Settlement Agreement Implementation Team as provided for in Section 6 of this document including representatives of Grand Traverse County, the City of Traverse City, TCLPD, the MDNR, GTB, MDEQ, FWS, MHRC, and ex officio advisory members. Ex officio advisory members are non-voting Team members.
Ad Hoc Committee: Any individual or organizational representative invited by the Team to participate in meetings and provide council or advice. Ad Hoc Committee members participate in an ex officio advisory capacity, in addition to the ex officio advisory members.

2.2. Jurisdiction

2.2.1. The Offer of Settlement

This Settlement is entered into by the Parties for the Boardman River Projects pursuant to FERC rules, 18 CFR Section 385.602. This Settlement concerns the surrender, decommissioning, and disposition of the Boardman River Projects. The issues to be considered by the Parties in this Settlement Agreement, and through the implementation procedures set forth herein, will ultimately include: land management; water quality; wildlife management; threatened, endangered and sensitive species management; recreation, cultural resources, nuisance species, soil erosion, instream flows, future dam responsibility for the Boardman River Projects and other Settlement implementation matters.

2.3. Effect of Offer of Settlement

2.3.1. The Negotiated Settlement

This Settlement is made upon the express understanding that it constitutes a negotiated Settlement of issues in the above-captioned proceedings, and no Party to the Settlement shall be deemed to have approved, admitted, accepted, agreed to or otherwise consented to any operation, management, valuation or other principle underlying or supposed to underlie any of the matters herein, except as expressly provided herein. Further, the Parties agree that this Settlement shall not be used as a precedent or as an admission with regard to any issue dealt within the Settlement.

2.3.2. The Settlement and License Conditions

For those issues addressed in this Settlement, the Parties agree not to propose, mandate, support or otherwise communicate to FERC any license condition other than those provided for herein, or oppose FERC license articles which incorporate the provisions described in this Settlement, except as provided for in Section 18 of the Federal Power Act (FPA).

2.3.3. Settlement Effective Date

This Settlement shall become effective upon signature by all Parties. This Settlement may be modified pending the FERC's review. If the FERC issues final orders acknowledging the Settlement with modifications or conditions, this Settlement shall be considered modified to conform to the terms of those orders unless at least one Party indicates to the other Parties in writing within 30 days after the issuance of such orders its objection to the modification, change or condition. The Parties shall then commence negotiations for a period of up to 90 days to resolve the issue(s) and modify the Settlement as needed. If agreement cannot be reached at the end of the ninety (90) day period, the objecting Party may withdraw from the Settlement by notifying the other Parties in writing within 10 days. If any one of the Parties withdraws, this Settlement shall cease to have any force or effect. If this Settlement is modified to conform to the terms of the FERC orders, as discussed above, it shall be considered officially modified on the latest of the following events: the date when all of the rehearing requests on those orders have been denied; if rehearing is not applied for, the date on which the right to seek rehearing expires; the date upon which all of the Parties agree to the modification of the Settlement. The above shall not preclude a Party from seeking rehearing on the modifications or conditions pursuant to 18 C.F.R 385.713 within the prescribed time limits. However, a Party need not seek rehearing prior to withdrawing from this Settlement. The Request for rehearing shall be withdrawn if the Parties subsequently reach agreement on modifying the Settlement. The terms of this Settlement shall continue in effect, subject to the FERC's reserved authority under the license to require modifications until the effective date of any FERC order approving surrender of a project under 18 C.F.R. 6.1. For the purposes of this section, the phase that the FERC issues final orders accepting the Settlement with modifications or conditions includes, but is not limited to, the situation where the FERC issues final orders that do not include all of the conditions of this Settlement because the FERC has determined it lacks jurisdiction over those issues.

2.3.4. FERC Jurisdiction

In the event that the FERC issues final license orders that do not include all of the conditions of this Settlement because the FERC has determined it lacks jurisdiction over those issues, the Parties agree that they will be bound by the conditions of the entire Settlement. With respect to those conditions over which the FERC does not have jurisdiction or has relinquished its jurisdiction, the Parties agree that the Settlement shall be enforceable in a court of appropriate jurisdiction.

2.3.5. Environmental Resources

The Parties concur that this Settlement is an agreement that fairly and appropriately addresses, or provides a template for the future resolution of the environmental and natural resource issues associated with the license surrender and decommission of the Boardman River Projects by the FERC. The Parties will, if requested, support this Settlement as fairly and appropriately addressing environmental and natural resource issues before, but not limited to, the FERC.

2.3.6. Schedule of Implementation

The Parties shall prepare a draft schedule for implementing the studies, plans and actions called for in this Settlement. The schedule shall specify dates for initiation, progress reporting and completion for each study, plan, or action and shall include milestones for major activities. A draft schedule shall be submitted to the ex officio advisory members for review in accordance with Section 6 of this document not later than 120 days after execution of this Settlement by the Parties.

2.4. Parties Bound

This Settlement shall apply to, and be binding on, the Parties and their successors and assigns. However, no Party shall be bound by any part of this Settlement unless the Settlement is approved and made effective as provided for in Section 2.3.3. No change in the status of any Party shall in any way alter any other Party's responsibilities under this Settlement. Each signatory to this Settlement certifies that he or she is authorized to execute this Settlement and legally bind the Party he or she represents.

2.5. Anti-Deficiency Provision

Nothing herein shall be construed to make or authorize any expenditure or obligation of funds in excess of appropriations already made, nor create any cause of action by any party or non-party seeking implementation or funding of any activity described or referenced in this Agreement.

3. Project Surrender, Decommission, and Dam Removal

3.1. Project License Surrender

Upon signature of the Settlement by all Parties, and in accordance with 18 CFR 4.102, 6.1, 385.601, and 385.602:

3.1.1. The Parties will distribute the Settlement to the FERC.

3.1.2. TCLPD will initiate the process to surrender the licenses and decommission the Boardman River Projects.

3.1.3. Within 90 days of the Notices of Intent to Surrender, the TCLPD will file a schedule for submittal of a surrender application.

3.1.4. Appropriate Parties will prepare surrender applications for the Boardman River Projects according to the schedule.

3.1.5. Upon issuance of the Surrender Order by the FERC, regulatory responsibility over the Sabin, Boardman, and Brown Bridge Dams will be assumed by the appropriate authority under the Michigan Dam Safety Act MCL 324.31506 (Appendix 2), operation and maintenance of Sabin and Boardman Dams will revert to Grand Traverse County, and operation and maintenance of Brown Bridge Dam will revert to the City of Traverse City (Appendix 4).

3.2. Project Decommissioning

The Boardman River Projects shall be decommissioned upon issuance of the Surrender Order. TCLPD will cease to operate all equipment and remove the generators, related electrical equipment, turbines, and guide vanes (only remove guide vanes if they are not needed to regulate water flow) at the Boardman River Projects. The actual structure and such equipment required to regulate flows will remain intact until disposition of the Boardman River Dams is determined.

3.3. Disposition of the Boardman River Dams

A Draft Preliminary Restoration Plan has been prepared that documents the economic and ecologic consequences of the Boardman River Dam removals (Appendix 3). To facilitate decisions on the disposition of the Boardman River Dams, the following steps will be taken by appropriate Team members:

3.3.1. Collect community input on the Preliminary Restoration Plan once the Corps review of the Plan is complete.

3.3.2. Contract with a consultant to provide an engineering/feasibility study for potential dam removal. The study will evaluate the feasibility of removing Sabin, Boardman, and Brown Bridge Dams. It will also evaluate the feasibility of removing Union Street Dam if the City of Traverse City decides it is appropriate.

3.3.3. Prepare an Environmental Assessment and collect community input.

3.3.4. The Team will evaluate the engineering/feasibility study and the Environmental Assessment to determine whether or not dam removal is appropriate, and Grand Traverse County and the City of Traverse City will decide whether or not to pursue dam removal. If dam removal is pursued, then the Team will prepare a Removal Plan that includes (but is not limited to) sediment mitigation, erosion control, wildlife management, nuisance species mitigation, fish passage (Union Street Dam maintenance), cultural resources, appropriate permit acquisition, potential relocation of the river channel at the Boardman Pond, resolution of Boardman Pond bottomland ownership and disposition, and resolution of vehicular traffic at Cass Road.

3.3.5. Collect community input on the engineering/feasibility study results and decision on the disposition of the Boardman River Dams.

3.3.6. Implement the decision on the disposition of the Boardman River Dams.

4. Natural Resource Management Issues

4.1. State of Michigan Environmental Regulation

The TCLPD (until the Surrender Order is issued), Grand Traverse County, and the City of Traverse City shall operate the Boardman River Dams in such a manner to be in compliance with the Michigan Natural Resources and Environmental Protection Act, MCL 324.101 et. seq. FWS expresses no view whatsoever on the public safety implications associated with operation of the Boardman River Projects pursuant to this Settlement Agreement.

4.2. Recreation

Grand Traverse County and the City of Traverse City shall continue to provide and maintain appropriate existing recreational facilities associated with their respective Boardman River Dams.

4.3. Threatened, Endangered or Sensitive Species

The FWS has determined that presently there is a federally listed species (bald eagle) occurring within the vicinity of the Brown Bridge project area. In addition, Grand Traverse County and the City of Traverse City shall notify the resource agencies if any other federal or state listed threatened, endangered or sensitive species are found to occur within the former project boundaries and consult with the resource agencies on the development of a protection plan.

In working with the parties to develop terms and conditions to be proposed to the FERC, the FWS must fully comply with any and all federal statutory and regulatory requirements, including but not necessarily limited to the Endangered Species Act. Nothing herein shall be construed to affect or pre-determine the outcome of any Endangered Species Act, Section 7 Consultation between the FWS and the FERC, or any other federal agency.

4.4. Cultural Resources

The TCLPD (until the Surrender Order is issued), Grand Traverse County, and the City of Traverse City shall be responsible for compliance with Section 106 of the National Historic Preservation Act, including all State Historic Preservation Officer requirements.

5. Funding

5.1. General Concept

The Team will collaborate to secure necessary grants and funding for implementing the plans outlined in Section 3.3 of this document.

6. Implementation and Oversight

6.1. Project Coordination

6.1.1. Team Responsibility and Composition

The Team shall be established to provide for coordination and implementation of the Settlement. The Team shall consist of a single official representative or designate from MDNR, MDEQ, FWS, Grand Traverse County, the City of Traverse City, TCLPD, GTB, MHRC, and ex officio advisory members. The voting Team members shall designate a Chair. If any Party decides to change its Team member, the name, address and telephone number of the successor shall be provided, in writing, to the other Team Members and the FERC Director, Division of Project Compliance and Administration (DPCA) (if applicable), 7 days prior to the date the change becomes effective or as soon after as practical. The Team is subject to the Open Meetings Act and the Freedom of Information Act.

6.1.2. Ex officio Advisory Team Membership and Meeting Notification

The date, time, and location of Team meetings shall be public noticed and noticed to the ex officio advisory members. The Team may also invite other organizations or individuals to participate as ex officio advisory members. Ex officio advisory Team members do not have voting privileges.

6.1.3. Annual Meetings

The Team shall have one annual meeting to review activities for the preceding year and, in addition, may have other scheduled meetings throughout the year to provide for the ongoing coordination and implementation of the actions required by this Settlement. The Chair shall be responsible for: (1) setting the date, time and place of the annual meeting and such other meetings of the Team as may be required; (2) noticing the other Team members of any meeting at least 14 days in advance; (3) scheduling a meeting of the Team, if requested in writing by any two members; and (4) making all meeting arrangements, including the recording and dissemination of notes. All meeting items and arrangements shall be provided to the ex officio advisory members at the same time as the Team. A quorum to conduct business shall be defined as any four of the eight voting Team members, at a properly noticed meeting. All decisions will be made by consensus vote of the members of the Team in attendance at a meeting. For the purpose of this agreement, consensus means you do not need to have a unanimous approval of all voting Team members to make a decision. A voting Team member may disagree with but not oppose a decision for there to be a consensus. If one or more voting Team members oppose a proposed decision, there is no consensus.

6.1.4. Team Meeting Notification

The date, time and location of Team meetings to review the overall implementation of the Settlement shall also be noticed to the Team at least 14 days in advance and all ex officio advisory members. These individuals, or their designee, may attend Team meetings and participate in an ex officio advisory capacity. These individuals shall each receive a copy of the notes from the Team meetings, regardless of whether they or their designee attended. Provision of notice and notes to the representatives of ex officio advisory members is dependent on those members providing the Team with their respective representative's name and address in writing. The voting Team may, at its option, invite any individual or organizational representative to any of its meetings to serve in a similar ex officio advisory capacity.

6.1.5. Team Communications and Ad Hoc Committees

Communications among the Parties and all documents, reports, submissions and correspondence concerning activities performed pursuant to the terms and conditions of this Settlement shall be directed through the Team. The Team will meet as often as is necessary to provide for the implementation of the terms and conditions of this Settlement. The Team may, at its option, invite any individual or organizational representative to any of its meetings for advice and participation in an ex officio advisory capacity, in addition to the ex officio advisory members. The Team may also form ad hoc committees that include other employees, interested entities, contractors or consultants to pursue and/or monitor any actions required by or resulting from this Settlement. The Team shall periodically inform all interested entities, as may be identified, regarding their progress and actions taken to implement this Settlement. Nothing herein shall require FWS to take any action or engage in any process which will result in a violation of any federal statutory or regulatory requirement, including but not limited to the Federal Records Act, the Freedom of Information Act, and the Federal Advisory Committee Act.

This information may be provided in a written or meeting format. The frequency of these periodic reports will be determined at the Team meetings described in Section 6.1.4 of this document.

6.2. Dispute Resolution

6.2.1. Mediation/Facilitation

In the event that a dispute arises with the terms and conditions of this Settlement, the voting Team agrees to engage in good faith negotiations for a period of 90 days unless extended by written agreement of the voting Team members. The negotiations shall be initiated by either the Chair or the aggrieved voting Team member. In the event that resolution cannot be reached by the voting Team, it shall engage the services of a third party mediator/facilitator or other agreed upon entity. The voting Team and facilitator shall agree on the schedule for achieving a resolution under this process. All voting Team members shall share in the cost of the mediator/facilitator, with the total cost and distribution agreed upon by the voting Team prior to initiating the process, subject to available appropriated funds, with respect to any government agency that is a member of the voting Team.

7. Governing Law

7.1. This Settlement shall be governed by and interpreted in accordance with the laws of the State of Michigan and applicable federal law.

8. Waiver

8.1. No waiver of any of the provisions of this Settlement shall be deemed or shall constitute a waiver of any other provisions of this Settlement, nor shall such waiver constitute a continuing waiver unless otherwise expressly provided.

Page 14 May 16, 2005

9. Severability

9.1. If any term or other provision of this Settlement is invalid, illegal or incapable of being enforced under any rule of law, all other conditions and provisions of this Settlement shall nevertheless remain in full force and effect.

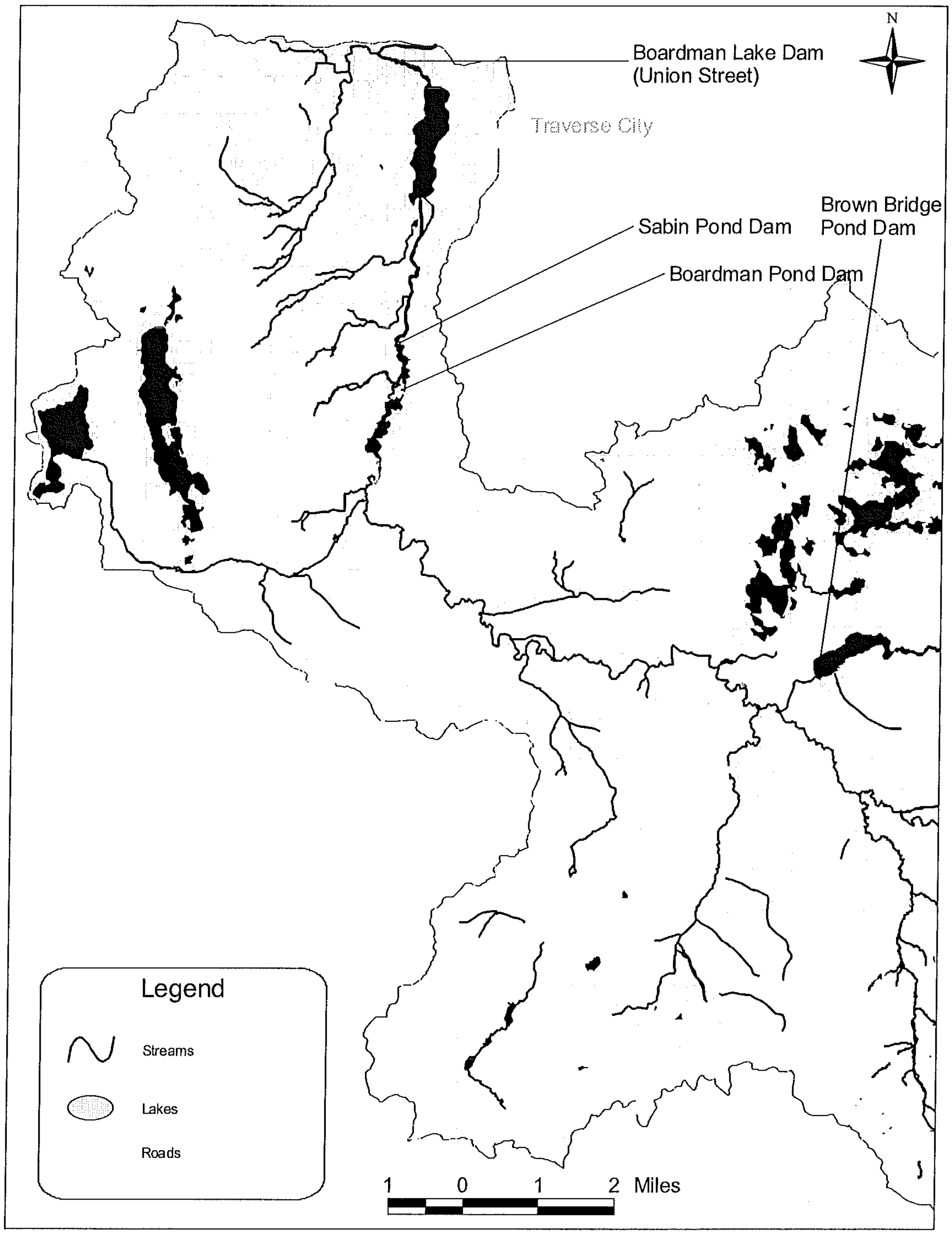
10. Hold Harmless

10.1. The Parties agree to use good faith and their best efforts to fulfill their obligations under this agreement. Grand Traverse County, the City of Traverse City, TCLPD, the GTB, and MHRC will indemnify and hold each other harmless against all losses, damages, costs, and expenses, including reasonable attorney fees, resulting from any breach of any warranty, representation, or covenant contained in this agreement. The DEQ and DNR shall be held harmless against all losses, damages, costs, and expenses, including reasonable attorney fees, resulting from any breach of any warranty, representation, or covenant contained in this agreement.

11. Termination of the Settlement Agreement

11.1. This Settlement Agreement shall be terminated at any time by agreement of all the Parties except that FWS may terminate its own involvement in this agreement by providing written notice to all other parties.

Appendix 1. Union Street, Sabin, Boardman, and Brown Bridge Dam Locations.
Source: Michigan Department of Natural Resources, unpublished data.



Appendix 2. Michigan Dam Safety Act MCL 324.31501. (Will be attached to the final draft that will be sent to FERC).

Appendix 3. Preliminary Restoration Plan for the Potential Removal of Union Street, Boardman, Sabin, and Brown Bridge Dams on the Boardman River, Grand Traverse County, Michigan. (Will be attached to the final draft that will be sent to FERC).

Appendix 4. Maintenance Agreement between Traverse City Light and Power Department and Grand Traverse County. (Will be attached to the final draft that will be sent to FERC).

Appendix B

Fish stocking records for the Boardman River watershed 1874–2006.

This appendix contains all the fish stocking records for the Boardman River watershed that the DNR Fisheries Division has on file. The data was collected from records documented at the Central Lake Michigan Management Unit DNR offices in Traverse City and Cadillac.

This page was intentionally left blank.

Table B.1.–Fish stocking records for the Boardman River watershed 1874–2006.

Year	Water body	County	Species	Number	Size or age	Strain
1874	Boardman River tributary	Grand Traverse	Atlantic salmon	40,000	fry	Penobscot
1876	Bass Lake	Kalkaska	Lake whitefish	12,500	fry	Detroit River
	Boardman River	Kalkaska	Chinook salmon	8,000	fry	McCloud River
	Island Lake	Kalkaska	Lake whitefish	10,000	fry	Detroit River
	Loon Lake	Kalkaska	Lake whitefish	12,500	fry	Detroit River
	Silver Lake	Grand Traverse	Lake whitefish	20,000	fry	Detroit River
1879	Spider Lake	Grand Traverse	Lake trout	3,000	fry	Lake Michigan
			Lake whitefish	80,000	fry	Detroit River
1883	Boardman River	Kalkaska	Brook trout	9,000	fry	
1884	Beitner Creek	Grand Traverse	Brook trout	10,000	fry	
1929	Chandler Lake	Grand Traverse	Largemouth bass	400	1 mo	
	High Lake	Grand Traverse	Largemouth bass	300	2 mo	
	Muncie Lake	Grand Traverse	Yellow perch	64,000	fry	
			Bluegill	2,500	4 mo	
	Rennie Lake	Grand Traverse	Largemouth bass	500	2 mo	
			Yellow perch	112,000	fry	
			Bluegill	3,000	4 mo	
	Silver Lake	Grand Traverse	Bluegill	8,700	4–5 mo	
	Spider Lake	Grand Traverse	Largemouth bass	1,500	2 mo	
			Yellow perch	144,000	fry	
			Bluegill	3,750	4 mo	
1930	Rennie Lake	Grand Traverse	Walleye	100,000	fry	
	Silver Lake	Grand Traverse	Smallmouth bass	750	5 mo	
		Grand Traverse	Bluegill	6,000	–	
	Spider Lake	Grand Traverse	Largemouth bass	180	adults	
1931	Silver Lake	Grand Traverse	Bluegill	3,000	5 mo	
	Spider Lake	Grand Traverse	Largemouth bass	600	–	
			Bluegill	6,600	5 mo	
1932	Spider Lake	Grand Traverse	Largemouth bass	500	–	
			Bluegill	1,000	–	
	Silver Lake	Grand Traverse	Largemouth bass	810	–	
			Bluegill	500	–	
1933	Abbott Creek	Kalkaska	Brook trout	200	6 mo	
	Arbutus Lake	Grand Traverse	Largemouth bass	2,000	6 mo	
			Bluegill	1,000	6 mo	
	Boardman River	Grand Traverse	Brown trout	45,300	5–7 mo	
	Boardman River Pond	Kalkaska	Brook trout	1,000	6 mo	
	Carpenter Creek	Grand Traverse	Brook trout	5,000	6 mo	
			Brown trout	1,000	7 mo	
	East Creek	Grand Traverse	Brook trout	7,000	6 mo	
			Brown trout	3,000	7 mo	

Table B.1.–Continued.

Year	Water body	County	Species	Number	Size or age	Strain
	Failing Creek	Kalkaska	Brook trout	900	6 mo	
	Grey Creek	Grand Traverse	Brook trout	2,000	7 mo	
	Island Lake	Kalkaska	Walleye	200,000	fry	
	N. Branch Boardman R.	Grand Traverse	Brook trout	5,000	6 mo	
		Kalkaska	Brook trout	20,000	6 mo	
	N. Selkirk Lake	Kalkaska	Brook trout	300	6 mo	
	Palmer Lake	Kalkaska	Brook trout	600	6 mo	
	Parker Creek	Grand Traverse	Brook trout	6,000	7–8 mo	
			Brown trout	500	7 mo	
	S. Branch Boardman R.	Grand Traverse	Brook trout	10,000	6 mo	
			Brown trout	3,000	7 mo	
		Kalkaska	Brook trout	11,000	6–8 mo	
	Sand Lake	Grand Traverse	Walleye	60,000	fry	
	Silver Lake	Grand Traverse	Walleye	100,000	fry	
			Bluegill	500	6 mo	
	Sparling Creek	Grand Traverse	Brook trout	5,500	7–8 mo	
	Spider Lake	Grand Traverse	Largemouth bass	2,000	6 mo	
			Bluegill	500	6 mo	
	Swainston Creek	Grand Traverse	Brook trout	10,500	6–8 mo	
	Twenty Two Creek	Grand Traverse	Brook trout	10,000	6–7 mo	
			Brown trout	1,000	7 mo	
	Wheeler Lake	Kalkaska	Bluegill	4,000	6 mo	
1934	Arbutus Lake	Grand Traverse	Largemouth bass	500	3 mo	
			Bluegill	5,000	3 mo	
	Beitner Creek	Grand Traverse	Brook trout	3,500	8 mo	
		Grand Traverse	Brown trout	5,000	7 mo	
	Boardman River	Grand Traverse	Brown trout	72,000	7–8 mo	
	Boardman Pond	Grand Traverse	Brown trout	12,500	8 mo	
	Carpenter Creek	Grand Traverse	Brook trout	3,000	8 mo	
	E. Br. Boardman River	Grand Traverse	Brown trout	4,000	8 mo	
	East Creek	Grand Traverse	Brook trout	2,500	8 mo	
			Brown trout	10,000	7 mo	
	Grey Creek	Grand Traverse	Brook trout	2,500	8 mo	
	High Lake	Grand Traverse	Largemouth bass	400	3 mo	
	Hospital (Asylum) Creek	Grand Traverse	Brook trout	3,000	8 mo	
	Island Lake	Kalkaska	Bluegill	7,000	3 mo	
	Jaxon Creek	Grand Traverse	Brook trout	3,500	8 mo	
	Kettle Lake	Kalkaska	Bluegill	7,000	3 mo	
	Log Lake	Kalkaska	Bluegill	7,000	3 mo	
	N. Br. Boardman River	Grand Traverse	Brook trout	11,500	8 mo	
		Kalkaska	Brook trout	18,000	8 mo	
	Parker Creek	Grand Traverse	Brook trout	3,000	8 mo	

Table B.1.–Continued.

Year	Water body	County	Species	Number	Size or age	Strain
	S. Br. Boardman River	Grand Traverse	Brook trout	11,500	8 mo	
		Kalkaska	Brook trout	8,000	8 mo	
	Silver Lake	Grand Traverse	Largemouth bass	1,000	3 mo	
			Yellow perch	5,000	7 mo	
			Bluegill	10,000	3 mo	
	Sparling Creek	Grand Traverse	Brook trout	2,000	8 mo	
	Spider Lake	Grand Traverse	Largemouth bass	1,000	3 mo	
			Bluegill	10,000	3 mo	
	Swainston Creek	Grand Traverse	Brook trout	3,500	8 mo	
	Twenty Two Creek	Grand Traverse	Brook trout	3,000	8 mo	
1935	Beitner Creek	Grand Traverse	Brook trout	4,000	7 mo	
	Blue Lake	Kalkaska	Walleye	68,000	fry	
			Bluegill	4,000	5 mo	
	Boardman River	Grand Traverse	Brown trout	40,000	7 mo	
	Carpenter Creek	Grand Traverse	Brook trout	3,000	7 mo	
			Brown trout	10,000	5 mo	
	East Creek	Grand Traverse	Brook trout	6,000	7 mo	
	Failing Creek	Kalkaska	Brook trout	500	7 mo	
	Grey Creek	Grand Traverse	Brook trout	6,000	7 mo	
			Brown trout	15,000	5 mo	
	Hospital (Asylum) Creek	Grand Traverse	Brook trout	3,000	7 mo	
	Jackson Creek	Grand Traverse	Brook trout	4,000	7 mo	
	Kettle Lake	Kalkaska	Walleye	85,000	fry	
	Log Lake	Kalkaska	Walleye	85,000	fry	
	N. Br. Boardman River	Grand Traverse	Brook trout	7,500	7 mo	
		Kalkaska	Brook trout	6,500	7 mo	
	Parker Creek	Grand Traverse	Brook trout	4,000	7 mo	
			Brown trout	15,000	5 mo	
	S. Br. Boardman River	Grand Traverse	Brook trout	7,500	7 mo	
		Kalkaska	Brook trout	5,000	7 mo	
	S. Selkirk Lake	Kalkaska	Walleye	85,000	fry	
	Silver Lake	Grand Traverse	Walleye	170,000	fry	
			Bluegill	10,000	4 mo	
	Sparling Creek	Grand Traverse	Brook trout	3,000	7 mo	
			Brown trout	10,000	5 mo	
	Spider Lake	Grand Traverse	Walleye	170,000	fry	
	Swainston Creek	Grand Traverse	Brook trout	7,000	7 mo	
	Taylor Creek	Kalkaska	Brook trout	1,000	7 mo	
	Twenty Two Creek	Grand Traverse	Brook trout	4,000	7 mo	
			Brown trout	10,000	5 mo	

Table B.1.–Continued.

Year	Water body	County	Species	Number	Size or age	Strain
1936	Arbutus Lake	Grand Traverse	Largemouth bass	200	yearlings	
			Bluegill	400	yearlings	
	Beitner Creek	Grand Traverse	Brook trout	2,000	8 mo	
		Grand Traverse	Brown trout	6,000	8 mo	
	Blue Lake	Kalkaska	Largemouth bass	200	5 mo	
			Bluegill	150	yearlings	
	Boardman River	Grand Traverse	Brown trout	80,000	8 mo	
	Carpenter Creek	Grand Traverse	Brook trout	3,000	8 mo	
	Cooks Creek	Grand Traverse	Brook trout	2,000	8 mo	
	East Creek	Grand Traverse	Brown trout	10,000	8 mo	
	Failing Creek	Kalkaska	Brook trout	2,000	8 mo	
	Grey Creek	Grand Traverse	Brook trout	7,000	8 mo	
	Hospital (Asylum) Creek	Grand Traverse	Brook trout	3,000	8 mo	
	Kettle Lake	Kalkaska	Walleye	90,000	fry	
			Largemouth bass	150	yearling	
			Largemouth bass	500	5 mo	
			Bluegill	200	yearlings	
	Log Lake	Kalkaska	Walleye	60,00	fry	
			Largemouth bass	200	5 mo	
			Bluegill	100	yearlings	
	Muncie Lake	Grand Traverse	Bluegill	400	yearlings	
	N. Br. Boardman River	Grand Traverse	Brook trout	8,000	8 mo	
		Kalkaska	Brook trout	8,000	8 mo	
		Kalkaska	Rainbow trout	15,000	3 mo	
	Parker Creek	Grand Traverse	Brook trout	3,000	8 mo	
	Rennie Lake	Grand Traverse	Walleye	150,000	fry	
			Largemouth bass	300	yearlings	
			Bluegill	400	yearlings	
	S. Br. Boardman River	Grand Traverse	Brook trout	7,000	8 mo	
		Kalkaska	Brook trout	7,000	8 mo	
		Kalkaska	Rainbow trout	3,000	4 mo	
	S. Selkirk Lake	Kalkaska	Walleye	90,000	fry	
	Silver Lake	Grand Traverse	Walleye	300,000	fry	
			Largemouth bass	150	yearlings	
			Largemouth bass	10,000	advanced fry	
			Yellow perch	3,250	8 mo	
			Bluegill	150	yearlings	
			Emerald shiner	27,000		
	Sparling Creek	Grand Traverse	Brook trout	7,000	8 mo	
	Spider Lake	Grand Traverse	Walleye	300,000	fry	
			Largemouth bass	200	yearlings	
			Bluegill	500	yearlings	

Table B.1.–Continued.

Year	Water body	County	Species	Number	Size or age	Strain
	Swainston Creek	Grand Traverse	Brook trout	4,000	8 mo	
	Taylor Creek	Kalkaska	Brook trout	3,000	8 mo	
	Twenty Two Creek	Grand Traverse	Brook trout	3,000	8 mo	
1937	Arbutus Lake	Grand Traverse	Largemouth bass	300	3 mo	
	Beitner Creek	Grand Traverse	Brown trout	2,000	9 mo	
	Big Guernsey Lake	Kalkaska	Bluegill	5,000	5 mo	
	Blue Lake	Kalkaska	Walleye	60,000	fry	
			Largemouth bass	200	3 mo	
			Smallmouth bass	200	3 mo	
			Bluegill	4,000	3 mo	
	Boardman River	Grand Traverse	Brown trout	40,000	9 mo	
	Carpenter Creek	Grand Traverse	Brook trout	5,000	8 mo	
	East Creek	Grand Traverse	Brown trout	16,000	9 mo	
	Failing Creek	Kalkaska	Brook trout	2,000	8 mo	
	Grey Creek	Grand Traverse	Brook trout	5,000	8 mo	
	Kettle Lake	Kalkaska	Walleye	75,000	fry	
			Largemouth bass	500	3 mo	
			Smallmouth bass	200	3 mo	
			Bluegill	5,000	5 mo	
	Log Lake	Kalkaska	Walleye	60,000	fry	
			Largemouth bass	200	3 mo	
			Smallmouth bass	200	3 mo	
			Bluegill	7,000	5 mo	
	N. Br. Boardman River	Grand Traverse	Brook trout	5,000	8 mo	
		Kalkaska	Rainbow trout	16,350	6 mo	
	Parker Creek	Grand Traverse	Brook trout	7,500	8 mo	
	Rennie Lake	Grand Traverse	Walleye	150,000	fry	
			Largemouth bass	300	3 mo	
			Bluegill	5,000	5 mo	
			Yellow perch	10,000	7 mo	
	S. Br. Boardman River	Grand Traverse	Brook trout	5,000	8 mo	
		Kalkaska	Brook trout	6,000	8 mo	
	S. Selkirk Lake	Kalkaska	Walleye	90,000	fry	
	Shannon Creek	Kalkaska	Brook trout	2,000	8 mo	
	Silver Lake	Grand Traverse	Walleye	240,000	fry	
			Smallmouth bass	100	adults	
			Smallmouth bass	7,000	5 mo	
			Smallmouth bass	1,000	3 mo	
			Largemouth bass	500	3 mo	
			Bluegill	20,000	5 mo	
			Yellow perch	10,000	7 mo	
	Sparling Creek	Grand Traverse	Brook trout	5,000	8 mo	
	Spider Lake	Grand Traverse	Walleye	240,000	fry	
		Grand Traverse	Largemouth bass	300	3 mo	
		Grand Traverse	Bluegill	5,000	5 mo	

Table B.1.–Continued.

Year	Water body	County	Species	Number	Size or age	Strain
	Swainston Creek	Grand Traverse	Brook trout	1,000	adults	
	Twenty Two Creek	Grand Traverse	Brook trout	5,000	8 mo	
1938	Arbutus Lake	Grand Traverse	Yellow perch	12,000	7 mo	
			Bluegill	5,000	4 mo	
	Bass Lake	Grand Traverse	Yellow perch	12,000	7 mo	
	Beitner Creek	Grand Traverse	Brook trout	2,000	9 mo	
			Brown trout	5,000	4 mo	
	Big Guernsey Lake	Kalkaska	Walleye	100,000	fry	
			Bluegill	10,000	4 mo	
	Blue Lake	Kalkaska	Largemouth bass	1,500	4 mo	
			Yellow perch	10,000	7 mo	
			Bluegill	5,000	4 mo	
	Boardman River	Grand Traverse	Brown trout	64,000	4–8 mo	
			Rainbow trout	110	adults	
			Rainbow trout	8,500	7 mo	
	Carpenter Creek	Grand Traverse	Brook trout	4,000	5 mo	
	East Creek	Grand Traverse	Brown trout	25,000	4 mo	
	Failing Creek	Kalkaska	Brook trout	2,000	9 mo	
	Grey Creek	Grand Traverse	Brook trout	4,000	9 mo	
	High Lake	Grand Traverse	Yellow perch	18,000	7 mo	
	Kettle Lake	Kalkaska	Walleye	40,000	fry	
			Largemouth bass	1,500	4 mo	
			Yellow perch	12,000	7 mo	
			Bluegill	5,000	4 mo	
	Little Guernsey Lake S.	Kalkaska	Walleye	100,000	fry	
			Bluegill	5,000	4 mo	
	Log Lake	Kalkaska	Largemouth bass	1,500	4 mo	
			Yellow perch	10,000	7 mo	
			Bluegill	5,000	4 mo	
	N. Br. Boardman River	Grand Traverse	Brook trout	5,000	9 mo	
			Rainbow trout	5,000	7 mo	
		Kalkaska	Brook trout	7,000	9 mo	
			Rainbow trout	10,000	7 mo	
	Parker Creek	Grand Traverse	Brook trout	4,000	9 mo	
	Rennie Lake	Grand Traverse	Walleye	100,000	fry	
			Largemouth bass	1,000	3 mo	
			Yellow perch	18,000	7 mo	
			Bluegill	10,000	4 mo	
	S. Br. Boardman River	Grand Traverse	Brook trout	5,000	9 mo	
			Rainbow trout	5,000	7 mo	
		Kalkaska	Rainbow trout	12,000	7 mo	
	S. Selkirk Lake	Kalkaska	Walleye	100,000	fry	
			Yellow perch	10,000	7 mo	

Table B.1.–Continued.

Year	Water body	County	Species	Number	Size or age	Strain
	Silver Lake	Grand Traverse	Walleye	180,000	fry	
			Smallmouth bass	3,500	5 mo	
			Bluegill	10,000	4 mo	
	Sparling Creek	Grand Traverse	Brook trout	2,000	9 mo	
	Spider Lake	Grand Traverse	Walleye	100,000	fry	
			Largemouth bass	2,000	3 mo	
			Yellow perch	24,000	7 mo	
			Bluegill	10,000	4 mo	
	Swainston Creek	Grand Traverse	Brook trout	4,000	9 mo	
	Twenty Two Creek	Grand Traverse	Brook trout	2,000	9 mo	
	Tibbets Lake	Grand Traverse	Yellow perch	12,000	7 mo	
	Wheeler Lake	Kalkaska	Largemouth bass	2,000	4 mo	
			Yellow perch	12,000	7 mo	
			Bluegill	10,000	4 mo	
1939	Albright Creek	Kalkaska	Rainbow trout	2,000	4 mo	
	Arbutus Lake	Grand Traverse	Smallmouth bass	800	4 mo	
			Yellow perch	8,000	7 mo	
			Bluegill	15,000	5 mo	
	Bass Lake	Grand Traverse	Smallmouth bass	400	4 mo	
			Bluegill	5,000	5 mo	
	Bass Lake	Kalkaska	Bluegill	5,000	5 mo	
	Beitner Creek	Grand Traverse	Brown trout	4,000	7–8 mo	
			Rainbow trout	2,000	4 mo	
	Big Guernsey Lake	Kalkaska	Smallmouth bass	300	4 mo	
			Bluegill	10,000	5 mo	
	Boardman Lake	Grand Traverse	Bluegill	35,000	4 mo	
	Boardman River	Grand Traverse	Brown trout	52,500	7–8 mo	
			Rainbow trout	7,000	7 mo	
	Carpenter Creek	Grand Traverse	Brook trout	2,000	10 mo	
			Rainbow trout	3,000	4 mo	
	Chandler Lake	Grand Traverse	Smallmouth bass	500	4 mo	
			Bluegill	10,000	5 mo	
	Crofton Creek	Kalkaska	Rainbow trout	2,000	4 mo	
	East Creek	Grand Traverse	Brown trout	3,000	8 mo	
			Rainbow trout	7,000	4–6 mo	
	Failing Creek	Kalkaska	Brook trout	2,000	9 mo	
			Rainbow trout	2,000	4 mo	
	Grey Creek	Grand Traverse	Brook trout	3,000	10 mo	
			Rainbow trout	2,000	4 mo	
	High Lake	Grand Traverse	Smallmouth bass	500	4 mo	
			Bluegill	10,000	5 mo	
	Indian Lake	Grand Traverse	Smallmouth bass	300	4 mo	
	Island Lake	Kalkaska	Smallmouth bass	300	4 mo	
			Bluegill	5,000	5 mo	
	Kettle Lake	Kalkaska	Walleye	60,000	fry	
			Smallmouth bass	100	5 mo	
			Bluegill	5,000	5 mo	

Table B.1.–Continued.

Year	Water body	County	Species	Number	Size or age	Strain
	Little Guernsey Lake	Kalkaska	Bluegill	5,000	5 mo	
	Little Guernsey Lake N.	Kalkaska	Smallmouth bass	100	4 mo	
	Little Guernsey Lake S.	Kalkaska	Smallmouth bass	100	4 mo	
	Log Lake	Kalkaska	Bluegill	5,000	5 mo	
	Muncie Lake	Grand Traverse	Walleye	60,000	fry	
			Smallmouth bass	300	4 mo	
			Bluegill	5,000	5 mo	
	N. Br. Boardman River	Grand Traverse	Brown trout	2,000	7 mo	
			Rainbow trout	8,000	6–7 mo	
		Kalkaska	Brook trout	4,000	9 mo	
			Brown trout	2,000	7 mo	
			Rainbow trout	14,000	6–7 mo	
	Parker Creek	Grand Traverse	Brook trout	2,000	10 mo	
			Rainbow trout	3,000	4 mo	
	Rennie Lake	Grand Traverse	Walleye	100,000	fry	
			Smallmouth bass	800	4 mo	
			Yellow perch	7,000	7 mo	
			Bluegill	15,000	5 mo	
	S. Br. Boardman River	Grand Traverse	Rainbow trout	7,000	6–7 mo	
		Kalkaska	Brown trout	2,000	7 mo	
			Rainbow trout	13,000	6–7 mo	
	S. Selkirk Lake	Kalkaska	Walleye	80,000	fry	
	Silver Lake	Grand Traverse	Walleye	100,000	fry	
			Smallmouth bass	2,333	4 mo	
			Yellow perch	8,000	7 mo	
			Bluegill	32,000	4–5 mo	
	Shannon Creek	Kalkaska	Brook trout	2,000	9 mo	
			Rainbow trout	2,000	4 mo	
	Spider Lake	Grand Traverse	Walleye	160,000	fry	
			Smallmouth bass	1,000	4 mo	
			Yellow perch	7,000	7 mo	
			Bluegill	25,000	5 mo	
	Sparling Creek	Grand Traverse	Brook trout	1,500	10 mo	
			Rainbow trout	2,000	4 mo	
	Spring Lake	Grand Traverse	Smallmouth bass	300	4 mo	
			Bluegill	5,000	5 mo	
	Swainston Creek	Grand Traverse	Brook trout	2,000	10 mo	
			Rainbow trout	2,000	4 mo	
	Taylor Creek	Kalkaska	Rainbow trout	2,000	4 mo	
	Tibbets Lake	Grand Traverse	Smallmouth bass	300	4 mo	
	Twenty Two Creek	Grand Traverse	Brook trout	1,500	10 mo	
			Rainbow trout	3,000	4 mo	
	Vipond Creek	Kalkaska	Rainbow trout	2,000	4 mo	

Table B.1.–Continued.

Year	Water body	County	Species	Number	Size or age	Strain
	Wheeler Lake	Kalkaska	Smallmouth bass	300	4 mo	
			Bluegill	10,000	5 mo	
1940	Albright Creek	Kalkaska	Rainbow trout	3,000	2 mo	
	Arbutus Lake	Grand Traverse	Smallmouth bass	2,200	4–7 mo	
			Bluegill	300	yearlings	
	Bass Lake	Grand Traverse	Smallmouth bass	200	4 mo	
	Bass Lake	Kalkaska	Smallmouth bass	200	4 mo	
	Beitner Creek	Grand Traverse	Brown trout	4,000	7 mo	
	Big Guernsey Lake	Kalkaska	Smallmouth bass	300	4 mo	
			Bluegill	100	yearlings	
	Boardman Lake	Grand Traverse	Bluegill	1,000	yearlings	
	Boardman River	Grand Traverse	Brown trout	50,650	8 mo, yearlings	
			Rainbow trout	10,500	8 mo	
			Rainbow trout	83	adults	
	Carpenter Creek	Grand Traverse	Brook trout	2,000	7 mo	
	Chandler Lake	Grand Traverse	Largemouth bass	500	4 mo	
	Denzer Lake	Grand Traverse	Largemouth bass	125	3 mo	
	East Creek	Grand Traverse	Brown trout	4,000	7 mo	
	Failing Creek	Kalkaska	Brook trout	2,000	8 mo	
		Kalkaska	Rainbow trout	3,000	2 mo	
	Grey Creek	Grand Traverse	Brook trout	2,000	7 mo	
	High Lake	Grand Traverse	Largemouth bass	375	3 mo	
	Indian Lake	Grand Traverse	Largemouth bass	250	3 mo	
	Island Lake	Kalkaska	Smallmouth bass	200	4 mo	
			Bluegill	100	yearlings	
	Kettle Lake	Kalkaska	Walleye	60,000	fry	
			Smallmouth bass	200	4 mo	
			Bluegill	100	yearlings	
	Little Guernsey Lake N.	Kalkaska	Smallmouth bass	100	4 mo	
			Bluegill	100	yearlings	
	Little Guernsey Lake S.	Kalkaska	Bluegill	100	4 mo	
	Little Log Lake	Kalkaska	Bluegill	100	yearlings	
	Log Lake	Kalkaska	Bluegill	100	yearlings	
	Muncie Lake	Grand Traverse	Walleye	40,000	fry	
			Smallmouth bass	200	4 mo	
			Bluegill	100	yearlings	
	N. Br. Boardman River	Grand Traverse	Brook trout	1,800	8 mo, yearlings	
			Rainbow trout	3,500	8 mo, yearlings	
		Kalkaska	Brook trout	11,200	8 mo, yearlings	
			Rainbow trout	7,000	8 mo, yearlings	
			Rainbow trout	500	adults	

Table B.1.–Continued.

Year	Water body	County	Species	Number	Size or age	Strain
	Parker Creek	Grand Traverse	Brook trout	2,000	7 mo	
	Rennie Lake	Grand Traverse	Walleye	80,000	fry	
			Largemouth bass	1,000	3 mo	
			Smallmouth bass	1,800	4–7 mo	
			Bluegill	400	yearlings	
	S. Br. Boardman River	Grand Traverse	Brook trout	4,000	8 mo, yearlings	
			Rainbow trout	2,000	8 mo, yearlings	
		Kalkaska	Brook trout	5,000	8 mo, yearlings	
			Rainbow trout	8,100	8 mo, yearlings	
	S. Selkirk Lake	Kalkaska	Walleye	60,000	fry	
	Shannon Creek	Kalkaska	Brook trout	2,000	8 mo	
			Rainbow trout	3,000	2 mo	
	Silver Lake	Grand Traverse	Walleye	140,000	fry	
			Smallmouth bass	2,267	3 mo	
			Bluegill	200	yearlings	
	Sparling Creek	Grand Traverse	Brook trout	2,000	7 mo	
	Spider Lake	Grand Traverse	Walleye	80,000	fry	
			Largemouth bass	1,000	3 mo	
			Smallmouth bass	2,100	4–7 mo	
			Bluegill	400	yearlings	
	Spring Lake	Grand Traverse	Largemouth bass	250	3 mo	
	Swainston Creek	Grand Traverse	Brook trout	2,000	7 mo	
	Taylor Creek	Kalkaska	Rainbow trout	3,000	2 mo	
	Tibbets Lake	Grand Traverse	Largemouth bass	250	3 mo	
	Twenty Two Creek	Grand Traverse	Brook trout	2,000	7 mo	
	Vipond Creek	Kalkaska	Rainbow trout	3,000	2 mo	
	Wheeler Lake	Kalkaska	Smallmouth bass	300	4 mo	
			Bluegill	100	yearlings	
1941	Albright Creek	Kalkaska	Brook trout	3,000	5 mo	
			Rainbow trout	6,000	3 mo	
	Arbutus Lake	Grand Traverse	Largemouth bass	1,400	4 mo	
			Bluegill	22,000	4 mo	
	Bass Lake	Grand Traverse	Largemouth bass	200	4 mo	
	Bass Lake	Kalkaska	Largemouth bass	200	4 mo	
			Bluegill	5,000	4 mo	
	Beitner Creek	Grand Traverse	Brown trout	12,000	5–8 mo	
			Rainbow trout	11,000	3 mo	
	Big Guernsey Lake	Kalkaska	Bluegill	5,000	4 mo	
	Bird Lake	Kalkaska	Largemouth bass	100	4 mo	
			Bluegill	1,000	4 mo	
	Blue Lake	Kalkaska	Largemouth bass	200	4 mo	
			Bluegill	2,000	4 mo	
	Boardman Creek	Kalkaska	Rainbow trout	3,000	3 mo	
	Boardman Lake	Grand Traverse	Bluegill	10,000	4 mo	

Table B.1.–Continued.

Year	Water body	County	Species	Number	Size or age	Strain
	Boardman River	Grand Traverse	Brown trout	23,000	8 mo	
			Rainbow trout	24,560	7–8 mo, yearlings	
			Rainbow trout	50	adults	
	Carpenter Creek	Grand Traverse	Brook trout	2,500	5 mo	
			Rainbow trout	7,500	3–8 mo	
	Chandler Lake	Grand Traverse	Largemouth bass	300	4 mo	
			Bluegill	7,000	4 mo	
	Crofton Creek	Kalkaska	Brook trout	2,000	5 mo	
			Rainbow trout	6,000	3 mo	
	East Creek	Grand Traverse	Brown trout	18,000	5–8 mo	
			Rainbow trout	8,000	3–8 mo	
	Failing Creek	Kalkaska	Brook trout	6,000	5 mo	
			Rainbow trout	8,000	3 mo	
	Grey Creek	Grand Traverse	Brook trout	3,000	5 mo	
			Rainbow trout	11,000	3–8 mo	
	Hannas Creek	Grand Traverse	Brook trout	1,000	5 mo	
			Rainbow trout	6,000	3 mo	
	High Lake	Grand Traverse	Largemouth bass	200	4 mo	
			Bluegill	3,000	4 mo	
	Hospital (Asylum) Creek	Grand Traverse	Brook trout	1,000	8 mo	
	Indian Lake	Grand Traverse	Largemouth bass	300	4 mo	
			Bluegill	5,000	4 mo	
	Island Lake	Kalkaska	Largemouth bass	200	4 mo	
			Bluegill	8,000	4 mo	
	Jaxon Creek	Grand Traverse	Brook trout	1,000	5 mo	
			Rainbow trout	10,000	3 mo	
	Kettle Lake	Kalkaska	Largemouth bass	300	4 mo	
			Bluegill	2,000	4 mo	
	Little Guernsey Lake N.	Kalkaska	Bluegill	2,000	4 mo	
	Little Guernsey Lake S.	Kalkaska	Bluegill	2,000	4 mo	
	Log Lake	Kalkaska	Largemouth bass	200	4 mo	
			Bluegill	2,000	4 mo	
	Loon Lake	Kalkaska	Largemouth bass	200	4 mo	
			Bluegill	3,000	4 mo	
	Muncie Lake	Grand Traverse	Largemouth bass	200	4 mo	
			Bluegill	4,000	4 mo	
	N. Br. Boardman River	Grand Traverse	Brook trout	9,500	5 & 8 mo, yearlings	
			Rainbow trout	2,600	8 mo, yearlings	
		Kalkaska	Brook trout	16,450	8 mo, yearlings	
			Rainbow trout	300	adults	
			Rainbow trout	15,000	3–8 mo	

Table B.1.–Continued.

Year	Water body	County	Species	Number	Size or age	Strain
	Parker Creek	Grand Traverse	Brook trout	2,000	5 mo	
			Rainbow trout	3,500	8 mo	
	Parker Creek, trib.	Grand Traverse	Brook trout	1,500	5 mo	
			Rainbow trout	5,000	3 mo	
	Rennie Lake	Grand Traverse	Largemouth bass	800	4 mo	
			Bluegill	12,000	4 mo	
	S. Br. Boardman River	Grand Traverse	Brook trout	3,000	8 mo, yearlings	
			Rainbow trout	1,500	8 mo	
		Kalkaska	Brook trout	13,000	8 mo, yearlings	
			Rainbow trout	12,500	3–8 mo	
	Shannon Creek	Kalkaska	Brook trout	3,000	5 mo	
			Rainbow trout	8,000	3 mo	
	Silver Lake	Grand Traverse	Smallmouth bass	1,776	4 mo	
			Bluegill	18,000	4 mo	
	Sparling Creek	Grand Traverse	Brook trout	3,500	5 mo	
			Rainbow trout	12,000	3–8 mo	
	Spider Lake	Grand Traverse	Largemouth bass	1,000	4 mo	
			Bluegill	15,000	4 mo	
	Spring Lake	Grand Traverse	Largemouth bass	200	4 mo	
			Bluegill	3,000	4 mo	
	Swainston Creek	Grand Traverse	Brook trout	2,000	5 mo	
			Rainbow trout	7,000	3–8 mo	
	Taylor Creek	Grand Traverse	Rainbow trout	5,000	3 mo	
	Tibbets Lake	Grand Traverse	Largemouth bass	200	4 mo	
			Bluegill	2,000	4 mo	
	Twenty Two Creek	Grand Traverse	Brook trout	4,000	5 mo	
			Rainbow trout	7,000	3–8 mo	
	Vipond Creek	Kalkaska	Brook trout	2,000	5 mo	
			Rainbow trout	5,000	3 mo	
	Wheeler Lake	Kalkaska	Largemouth bass	300	4 mo	
			Bluegill	3,000	4 mo	
1942	Albright Creek	Kalkaska	Rainbow trout	6,000	2–3 mo	
	Bass Lake	Kalkaska	Largemouth bass	200	4 mo	
			Bluegill	5,000	3 mo	
	Beitner Creek	Grand Traverse	Brown trout	2,000	7 mo	
			Rainbow trout	11,000	2–3 mo	
	Big Guernsey Lake	Kalkaska	Largemouth bass	100	4 mo	
			Bluegill	5,000	3 mo	
	Bird Lake	Kalkaska	Largemouth bass	50	4 mo	
			Bluegill	1,000	3 mo	
	Boardman Lake	Grand Traverse	Largemouth bass	500	4 mo	
	Boardman River	Grand Traverse	Brown trout	16,000	7 mo	
			Rainbow trout	1,380	adults	
			Rainbow trout	2,150	yearlings	

Table B.1.–Continued.

Year	Water body	County	Species	Number	Size or age	Strain
	Carpenter Creek	Grand Traverse	Brook trout	750	6 mo	
			Brook trout	100	yearlings	
			Rainbow trout	11,000	2–3 mo	
	Chandler Lake	Grand Traverse	Largemouth bass	200	4 mo	
			Bluegill	2,000	4 mo	
	Crofton Creek	Kalkaska	Rainbow trout	4,000	3 mo	
	East Creek	Grand Traverse	Brown trout	5,000	7 mo	
			Rainbow trout	14,000	2–3 mo	
	Failing Creek	Kalkaska	Brook trout	100	yearlings	
			Rainbow trout	4,000	3 mo	
	Grey Creek	Grand Traverse	Brook trout	1,000	6 mo	
			Rainbow trout	12,500	2–3 mo	
	Grey Creek, trib.	Grand Traverse	Rainbow trout	2,500	2 mo	
	Hannas Creek	Grand Traverse	Brook trout	500	6 mo	
			Rainbow trout	5,000	3 mo	
	High Lake	Grand Traverse	Largemouth bass	150	4 mo	
			Bluegill	2,000	4 mo	
	Hospital (Asylum) Creek	Grand Traverse	Brook trout	1,000	6 mo	
	Indian Lake	Grand Traverse	Largemouth bass	200	4 mo	
			Bluegill	2,000	4 mo	
	Island Lake	Kalkaska	Largemouth bass	150	4 mo	
			Bluegill	5,000	3 mo	
	Jaxon Creek	Grand Traverse	Brook trout	750	6 mo	
			Rainbow trout	6,000	3 mo	
	Kettle Lake	Kalkaska	Largemouth bass	200	4 mo	
	Little Guernsey Lake N.	Kalkaska	Largemouth bass	100	4 mo	
			Bluegill	2,000	3 mo	
	Little Guernsey Lake S.	Kalkaska	Largemouth bass	100	4 mo	
			Bluegill	2,000	3 mo	
	Log Lake	Kalkaska	Largemouth bass	100	4 mo	
	Loon Lake	Kalkaska	Largemouth bass	150	4 mo	
			Bluegill	3,000	3 mo	
	Muncie Lake	Grand Traverse	Largemouth bass	100	4 mo	
	N. Br. Boardman River	Grand Traverse	Brook trout	200	yearlings	
	N. Br. Boardman River	Kalkaska	Brook trout	200	yearlings	
			Brown trout	23,000	4 mo	
			Rainbow trout	20,000	2 mo	
			Rainbow trout	152	adults	
	Parker Creek	Grand Traverse	Brook trout	100	adults	
			Brook trout	1,000	6 mo	
			Rainbow trout	9,500	2–3 mo	
	Parker Creek, trib.	Grand Traverse	Brook trout	500	6 mo	
			Rainbow trout	2,500	2 mo	

Table B.1.–Continued.

Year	Water body	County	Species	Number	Size or age	Strain
	Rennie Lake	Grand Traverse	Walleye	160,000	fry	
			Largemouth bass	1,000	4 mo	
			Bluegill	10,000	4 mo	
	S. Br. Boardman River	Grand Traverse	Brook trout	225	yearlings	
	S. Br. Boardman River	Kalkaska	Brook trout	225	yearlings	
			Rainbow trout	20,000	2 mo	
	S. Selkirk Lake	Kalkaska	Walleye	60,000	fry	
	Shannon Creek	Kalkaska	Rainbow trout	12,000	2–3 mo	
	Silver Lake	Grand Traverse	Walleye	100,000	fry	
			Largemouth bass	1,280	5 mo	
			Bluegill	15,000	4 mo	
	Sparling Creek	Grand Traverse	Rainbow trout	5,000	2 mo	
	Spider Lake	Grand Traverse	Walleye	240,000	fry	
			Largemouth bass	1,000	4 mo	
			Bluegill	10,000	4 mo	
	Spring Lake	Grand Traverse	Largemouth bass	150	4 mo	
	Swainston Creek	Grand Traverse	Brook trout	750	6 mo	
			Rainbow trout	11,000	2–3 mo	
	Taylor Creek	Kalkaska	Rainbow trout	8,000	2–3 mo	
	Tibbets Lake	Grand Traverse	Largemouth bass	150	4 mo	
	Twenty Two Creek	Grand Traverse	Brook trout	100	adults	
			Brook trout	1,250	6 mo	
			Rainbow trout	11,000	2–3 mo	
	Vipond Creek	Kalkaska	Rainbow trout	9,000	2–3 mo	
	Wheeler Lake	Kalkaska	Largemouth bass	200	4 mo	
			Bluegill	5,000	3 mo	
	Young's Pond	Kalkaska	Brook trout	400	yearlings	
1943	Albright Creek	Kalkaska	Rainbow trout	7,000	1 mo	
	Arbutus Lake	Grand Traverse	Largemouth bass	1,000	4 mo	
	Bass Lake	Grand Traverse	Largemouth bass	800	4 mo	
			Bluegill	200	yearlings	
	Boardman River	Grand Traverse	Brook trout	4,575	yearlings	
	Beitner Creek	Grand Traverse	Rainbow trout	26,000	1–2 mo	
	Boardman Lake	Grand Traverse	Smallmouth bass	1,200	4 mo	
			Bluegill	400	adults	
			Bluegill	1,200	yearlings	
	Boardman River	Grand Traverse	Rainbow trout	2,500	yearlings	
	Carpenter Creek	Grand Traverse	Rainbow trout	19,000	1–2 mo	
	Chandler Lake	Grand Traverse	Largemouth bass	100	4 mo	
			Bluegill	100	yearlings	
	Crofton Creek	Kalkaska	Rainbow trout	26,000	3 mo	
	East Creek	Grand Traverse	Rainbow trout	14,000	1 mo	
	Failing Creek	Kalkaska	Rainbow trout	26,000	1–3 mo	
	Grey Creek	Grand Traverse	Rainbow trout	39,000	1–2 mo	
	Hannas Creek	Grand Traverse	Rainbow trout	13,000	1–2 mo	

Table B.1.–Continued.

Year	Water body	County	Species	Number	Size or age	Strain
	High Lake	Grand Traverse	Largemouth bass	100	4 mo	
			Bluegill	400	yearlings	
	Indian Lake	Grand Traverse	Smallmouth bass	300	4 mo	
			Largemouth bass	100	4 mo	
			Bluegill	100	yearlings	
	Island Lake	Kalkaska	Largemouth bass	200	4 mo	
			Bluegill	200	yearlings	
	Jaxon Creek	Grand Traverse	Rainbow trout	26,000	1–2 mo	
	Kettle Lake	Kalkaska	Largemouth bass	200	4 mo	
			Smallmouth bass	500	4 mo	
			Bluegill	750	yearlings	
	Little Log Lake	Kalkaska	Largemouth bass	450	4 mo	
	Muncie Lake	Grand Traverse	Largemouth bass	100	4 mo	
			Bluegill	100	yearlings	
	N. Br. Boardman River	Kalkaska	Brook trout	3,125	yearlings	
			Rainbow trout	454	adults	
			Rainbow trout	20,000	1–3 mo	
	Parker Creek	Grand Traverse	Rainbow trout	13,000	1–2 mo	
	Parker Creek, trib.	Grand Traverse	Rainbow trout	13,000	1–2 mo	
	Rennie Lake	Grand Traverse	Largemouth bass	700	4 mo	
			Bluegill	1,100	yearlings	
	S. Br. Boardman River	Kalkaska	Brook trout	2,500	yearlings	
			Rainbow trout	14,000	1 mo	
	Shannon Creek	Kalkaska	Rainbow trout	13,000	1–3 mo	
	Silver Lake	Grand Traverse	Smallmouth bass	2,200	4 mo	
	Sparling Creek	Grand Traverse	Rainbow trout	39,000	1–2 mo	
	Spider Lake	Grand Traverse	Largemouth bass	800	4 mo	
			Bluegill	1,400	yearlings	
	Spring Lake	Grand Traverse	Largemouth bass	100	4 mo	
			Bluegill	100	yearlings	
	Swainston Creek	Grand Traverse	Rainbow trout	26,000	1–2 mo	
	Taylor Creek	Kalkaska	Rainbow trout	13,000	1–3 mo	
	Taylor Creek, trib.	Kalkaska	Rainbow trout	19,000	1–3 mo	
	Tibbets Lake	Grand Traverse	Largemouth bass	100	4 mo	
			Bluegill	100	yearlings	
	Twenty Two Creek	Grand Traverse	Rainbow trout	26,000	1–2 mo	
	Vipond Creek	Kalkaska	Rainbow trout	13,000	1–3 mo	
1944	Albright Creek	Kalkaska	Rainbow trout	3,000	4 mo	
	Boardman Creek	Kalkaska	Rainbow trout	3,000	4 mo	
	Boardman Lake	Grand Traverse	Bluegill	20,000	4 mo	
	Boardman River	Grand Traverse	Brook trout	189	14 mo	
			Brown trout	7,500	adult	
			Rainbow trout	1,600	28 mo	
	Carpenter Creek	Grand Traverse	Brook trout	1,000	4 mo	
	Chandler Lake	Grand Traverse	Largemouth bass	200	3 mo	
			Bluegill	200	15 mo	

Table B.1.–Continued.

Year	Water body	County	Species	Number	Size or age	Strain
	Failing Creek	Kalkaska	Rainbow trout	3,000	4 mo	
	Grey Creek	Grand Traverse	Brook trout	1,000	4 mo	
	Hannas Creek	Grand Traverse	Brook trout	1,000	4 mo	
	High Lake	Grand Traverse	Largemouth bass	200	3 mo	
			Bluegill	200	15 mo	
	Hospital (Asylum) Creek	Grand Traverse	Brook trout	2,000	4 mo	
	Indian Lake	Grand Traverse	Largemouth bass	200	3 mo	
	Island Lake	Kalkaska	Largemouth bass	200	3 mo	
			Bluegill	200	4 mo	
	Jaxon Creek	Grand Traverse	Brook trout	1,000	4 mo	
	Kettle Lake	Kalkaska	Largemouth bass	500	3 mo	
			Bluegill	400	4 mo	
	Muncie Lake	Grand Traverse	Largemouth bass	200	3 mo	
			Bluegill	200	15 mo	
	N. Br. Boardman River	Grand Traverse	Brook trout	600	14 mo	
		Kalkaska	Brook trout	3,700	14 mo	
			Rainbow trout	500	2 yr	
	Parker Creek	Grand Traverse	Brook trout	1,000	4 mo	
	Parker Creek, trib.	Grand Traverse	Brook trout	1,000	4 mo	
	Rennie Lake	Grand Traverse	Largemouth bass	200	3 mo	
			Bluegill	1,000	15 mo	
	Shannon Creek	Kalkaska	Rainbow trout	3,000	4 mo	
	Silver Lake	Grand Traverse	Smallmouth bass	1,600	4 mo	
			Bluegill	500	15 mo	
	S. Br. Boardman River	Grand Traverse	Brook trout	375	14 mo	
		Kalkaska	Brook trout	1,048	14 mo	
	Sparling Creek	Grand Traverse	Brook trout	1,000	4 mo	
	Spider Lake	Grand Traverse	Largemouth bass	800	3 mo	
			Bluegill	1,000	15 mo	
	Spring Lake	Grand Traverse	Largemouth bass	200	3 mo	
	Swainston Creek	Grand Traverse	Brook trout	1,000	4 mo	
	Taylor Creek	Kalkaska	Rainbow trout	3,000	4 mo	
	Taylor Creek, trib.	Kalkaska	Rainbow trout	3,000	4 mo	
	Tibbets Lake	Grand Traverse	Largemouth bass	200	3 mo	
			Bluegill	200	15 mo	
	Twenty Two Creek	Grand Traverse	Brook trout	2,000	4 mo	
	Vipond Creek	Kalkaska	Rainbow trout	3,000	4 mo	
	Wheeler Lake	Kalkaska	Largemouth bass	400	3 mo	
1945	Albright Creek	Kalkaska	Brook trout	100	2 yr	
	Boardman River	Grand Traverse	Brook trout	1,100	2 yr	
			Brown trout	5,500	2 yr	
			Rainbow trout	5,000	18 mo	
	Hospital (Asylum) Creek	Grand Traverse	Brook trout	75	2 yr	

Table B.1.–Continued.

Year	Water body	County	Species	Number	Size or age	Strain
	N. Br. Boardman River	Grand Traverse	Brook trout	1,025	17 mo–2 yr	
			Brown trout	175	2 yr	
		Kalkaska	Brook trout	2,200	17 mo–2 yr	
			Brown trout	525	2 yr	
	S. Br. Boardman River	Grand Traverse	Brook trout	1,175	17 mo–2 yr	
			Brown trout	250	2 yr	
		Kalkaska	Brook trout	1,350	17 mo–2 yr	
			Brown trout	250	2 yr	
	Young's Pond	Kalkaska	Brook trout	100	2 yr	
1946	Albright Creek	Kalkaska	Rainbow trout	5,000	1 mo	
	Beitner Creek	Grand Traverse	Rainbow trout	10,000	1 mo	
	Boardman River	Grand Traverse	Brown trout	6,400	17–29 mo	
			Rainbow trout	3,600	17–28 mo	
	Carpenter Creek	Grand Traverse	Brook trout	100	25 mo	
			Rainbow trout	5,000	1 mo	
	Crofton Creek	Kalkaska	Rainbow trout	5,000	1 mo	
	Failing Creek	Kalkaska	Rainbow trout	5,000	1 mo	
	Grey Creek	Grand Traverse	Rainbow trout	10,000	1 mo	
	Grey Creek, trib.	Grand Traverse	Rainbow trout	5,000	1 mo	
	Hanna Creek	Grand Traverse	Rainbow trout	5,000	1 mo	
	Hospital (Asylum) Creek	Grand Traverse	Brook trout	150	25 mo	
	Jaxon Creek	Grand Traverse	Brook trout	100	25 mo	
			Rainbow trout	5,000	1 mo	
	N. Br. Boardman River	Grand Traverse	Brook trout	450	17–26 mo	
		Kalkaska	Brook trout	2,125	16–26 mo	
			Rainbow trout	75	adults	
	Parker Creek	Grand Traverse	Brook trout	100	25 mo	
			Rainbow trout	5,000	1 mo	
	Parker Creek, trib.	Grand Traverse	Rainbow trout	5,000	1 mo	
	S. Br. Boardman River	Grand Traverse	Brook trout	700	17–26 mo	
		Kalkaska	Brook trout	1,300	16–26 mo	
			Brown trout			
	Shannon Creek	Kalkaska	Rainbow trout	5,000	1 mo	
	Sparling Creek	Grand Traverse	Brook trout	100	25 mo	
			Rainbow trout	5,000	1 mo	
	Swainston Creek	Grand Traverse	Brook trout	100	25 mo	
			Rainbow trout	10,000	1 mo	
	Taylor Creek	Kalkaska	Rainbow trout	5,000	1 mo	
	Twenty Two Creek	Grand Traverse	Brook trout	100	25 mo	
			Rainbow trout	10,000	1 mo	
	Vipond Creek	Kalkaska	Rainbow trout	5,000	1 mo	
	Wellman Pond	Kalkaska	Brook trout	300	17 mo	
			Rainbow trout	250	17 mo	

Table B.1.–Continued.

Year	Water body	County	Species	Number	Size or age	Strain
	Young's Pond	Kalkaska	Brook trout	250	17 mo	
			Rainbow trout	150	17 mo	
1947	Boardman River	Grand Traverse	Brown trout	7,550	adults	
			Rainbow trout	2,000	adults	
	Hospital (Asylum) Creek	Grand Traverse	Brook trout	100	adults	
	Kalkaska Mill Pond	Kalkaska	Brook trout	600	yearlings	
			Rainbow trout	1,550	adults	
	Log Lake	Kalkaska	Rainbow trout	5,800	7 mo–adults	
	N. Br. Boardman River	Grand Traverse	Brown trout	450	adults	
			Rainbow trout	525	adults	
		Kalkaska	Brown trout	850	adults	
			Rainbow trout	275	yearlings	
	S. Br. Boardman River	Grand Traverse	Brown trout	475	adults	
			Rainbow trout	475	adults	
		Kalkaska	Brown trout	325	adults	
			Rainbow trout	225	adults	
	Wellman Pond	Kalkaska	Brown trout	500	adults	
			Rainbow trout	900	adults	
	Young's Pond	Kalkaska	Brook trout	150	yearlings	
1948	Boardman River	Grand Traverse	Brown trout	3,800	8.4–10.0 in	
			Rainbow trout	80,000	fry	
			Rainbow trout	2,900	7.9–8.6 in	
	Kalkaska Mill Pond	Kalkaska	Rainbow trout	400	8 in	
	Log Lake	Kalkaska	Rainbow trout	5,848	3–9.1 in	
	N. Br. Boardman River	Grand Traverse	Rainbow trout	2,350	7.9–8.4 in	
		Kalkaska	Rainbow trout	1,750	7.9–8.4 in	
	S. Br. Boardman River	Grand Traverse	Rainbow trout	3,400	7.7–8.4 in	
		Kalkaska	Rainbow trout	700	7.9–8.4 in	
	Wellman Pond	Kalkaska	Rainbow trout	600	7.9–8.4 in	
1949	Boardman River	Grand Traverse	Brown trout	5,700	7.2–8.9 in	
		Grand Traverse	Rainbow trout	2,000	7.5–8.4 in	
	Carpenter Creek	Grand Traverse	Brown trout	250	8.9 in	
	East Creek	Grand Traverse	Brown trout	250	8.9 in	
	Grey Creek	Grand Traverse	Brown trout	150	8.9 in	
	Hospital (Asylum) Creek	Grand Traverse	Brook trout	3,000	2.0 in	
	Jaxon Creek	Grand Traverse	Brown trout	150	8.9 in	
	Kalkaska Mill Pond	Kalkaska	Rainbow trout	400	9.2 in	
	Log Lake	Kalkaska	Rainbow trout	1,500	8.4 in	
	Mayfield Pond	Grand Traverse	Brown trout	100	8.9 in	

Table B.1.–Continued.

Year	Water body	County	Species	Number	Size or age	Strain
	N. Br. Boardman River	Grand Traverse	Brown trout	225	8.9 in	
		Grand Traverse	Rainbow trout	500	8.1–8.4 in	
		Kalkaska	Brook trout	6,000	2.0 in	
			Brook trout	200	8.4 in	
			Brown trout	375	8.9 in	
			Rainbow trout	2,000	8.1–8.4 in	
			Rainbow trout	5,000	2.0 in	
	Parker Creek	Grand Traverse	Brown trout	250	8.9 in	
	S. Br. Boardman River	Grand Traverse	Brown trout	250	8.9 in	
			Rainbow trout	650	8.1 in	
		Kalkaska	Brown trout	150	8.9 in	
			Rainbow trout	5,750	2.0 in	
			Rainbow trout	300	8.1 in	
	Smith Lake	Kalkaska	Brook trout	1,000	9.3 in	
			Brown trout	10,000	3.0 in	
	Sparling Creek	Grand Traverse	Brown trout	50	8.9 in	
	Swainston Creek	Grand Traverse	Brown trout	50	8.9 in	
	Twenty Two Creek	Grand Traverse	Brown trout	150	8.9 in	
	Wellman Pond	Kalkaska	Brown trout	200	8.9 in	
			Rainbow trout	500	8.1–8.4 in	
1950	Boardman River	Grand Traverse	Brown trout	5,025	7.2–9.1 in	
			Rainbow trout	3,300	7.2 in	
	Carpenter Creek	Grand Traverse	Brown trout	300	8.1 in	
	East Creek	Grand Traverse	Brown trout	500	7.8–8.1 in	
	Grey Creek	Grand Traverse	Brown trout	150	8.1 in	
	Jaxon Creek	Grand Traverse	Brown trout	150	8.1 in	
	Kalkaska Mill Pond	Kalkaska	Rainbow trout	400	7.8 in	
	Log Lake	Kalkaska	Rainbow trout	1,500	7.1 in	
	Mayfield Pond	Grand Traverse	Brown trout	150	8.1 in	
	N. Br. Boardman River	Grand Traverse	Rainbow trout	1,200	7.2–7.8 in	
		Kalkaska	Rainbow trout	3,200	7.2–7.8 in	
	Parker Creek	Grand Traverse	Brown trout	300	8.1 in	
	S. Br. Boardman River	Grand Traverse	Rainbow trout	2,150	7.2–7.8 in	
		Kalkaska	Rainbow trout	1,650	7.2–7.8 in	
	Smith Lake	Kalkaska	Brook trout	5,000	fry	
			Brown trout	5,000	fry	
	Sparling Creek	Grand Traverse	Brown trout	50	8.1 in	
	Swainston Creek	Grand Traverse	Brown trout	50	8.1 in	
	Twenty Two Creek	Grand Traverse	Brown trout	350	8.1 in	
	Wellman Pond	Kalkaska	Rainbow trout	1,200	7.2–7.8 in	
1951	Big Guernsey Lake	Kalkaska	Rainbow trout	15,000	3.0 in	
	Boardman River	Grand Traverse	Brown trout	5,200	7.8 in	
			Rainbow trout	2,600	7.2–7.8 in	

Table B.1.–Continued.

Year	Water body	County	Species	Number	Size or age	Strain
	East Creek	Grand Traverse	Brook trout	400	7.2 in	
	Grey Creek	Grand Traverse	Brook trout	300	7.2 in	
	Hospital (Asylum) Creek	Grand Traverse	Brook trout	450	7.4–7.8 in	
	Jaxon Creek	Grand Traverse	Brook trout	300	7.2 in	
	Kalkaska Mill Pond	Kalkaska	Rainbow trout	800	7.8–12.6 in	
	Log Lake	Kalkaska	Rainbow trout	1,500	7.2 in	
	N. Br. Boardman River	Grand Traverse	Brown trout	700	7.8 in	
			Rainbow trout	630	7.8 in	
		Kalkaska	Brown trout	1,800	7.8 in	
			Rainbow trout	960	7.8 in	
	Oleson Pond #1	Grand Traverse	Brook trout	5,112	fry	
	Oleson Pond #2	Grand Traverse	Brook trout	5,000	fry	
	Oleson Pond #3	Grand Traverse	Brook trout	5,000	fry	
	Oleson Pond #4	Grand Traverse	Brook trout	5,000	fry	
	Oleson Pond #5	Grand Traverse	Brook trout	5,000	fry	
	Parker Creek	Grand Traverse	Brook trout	300	7.2 in	
	S. Br. Boardman River	Grand Traverse	Brook trout	475	7.2 in	
			Brown trout	700	7.8 in	
			Rainbow trout	775	7.8 in	
		Kalkaska	Brook trout	525	7.2 in	
			Brown trout	800	7.8 in	
			Rainbow trout	825	7.8 in	
	Smith Lake	Kalkaska	Brook trout	5,000	fry	
			Brown trout	5,000	fry	
	Sparling Creek	Grand Traverse	Brook trout	200	7.2 in	
	Swainston Creek	Grand Traverse	Brook trout	300	7.2 in	
	Twenty Two Creek	Grand Traverse	Brook trout	300	7.2 in	
	Wellman Pond	Kalkaska	Brown trout	575	7.8 in	
			Rainbow trout	900	7.5–7.8 in	
1952	Big Guernsey Lake	Kalkaska	Rainbow trout	15,000	3.0 in	
	Boardman River	Grand Traverse	Brown trout	3,900	7.8 in	
			Brown trout	150	19.0 in	
			Rainbow trout	1,000	7.2 in	
	Carpenter Creek	Grand Traverse	Brown trout	200	7.8 in	
	East Creek	Grand Traverse	Brook trout	200	7.8 in	
	Grey Creek	Grand Traverse	Brook trout	250	7.8 in	
	Hospital (Asylum) Creek	Grand Traverse	Brook trout	550	7.2–7.4 in	
			Brown trout	15,000	fry	
	Jaxon Creek	Grand Traverse	Brook trout	250	7.8 in	
	Kalkaska Mill Pond	Kalkaska	Rainbow trout	1,000	7.4–7.8 in	
	Log Lake	Kalkaska	Rainbow trout	1,500	8.9 in	

Table B.1.–Continued.

Year	Water body	County	Species	Number	Size or age	Strain
	N. Br. Boardman River	Grand Traverse	Brown trout	1,100	7.2–7.7 in	
			Rainbow trout	300	7.2 in	
		Kalkaska	Brown trout	500	7.2 in	
			Rainbow trout	500	7.2 in	
	Parker Creek	Grand Traverse	Brook trout	250	7.8 in	
	S. Br. Boardman River	Grand Traverse	Brook trout	580	7.5 in	
			Brown trout	400	7.7 in	
			Rainbow trout	425	7.2 in	
		Kalkaska	Brook trout	600	7.5 in	
			Brown trout	725	7.7–8.4 in	
			Rainbow trout	75	7.2 in	
	Smith Lake	Kalkaska	Brook trout	20,000	fry	
	Sparling Creek	Grand Traverse	Brook trout	150	7.8 in	
	Swainston Creek	Grand Traverse	Brook trout	150	7.8 in	
	Twenty Two Creek	Grand Traverse	Brook trout	250	7.8 in	
	Wellman Pond	Kalkaska	Brown trout	800	7.7–8.4 in	
1953	Big Guernsey Lake	Kalkaska	Rainbow trout	15,000	3.5 in	
	Boardman River	Grand Traverse	Brook trout	2,200	8.1–8.5 in	
			Rainbow trout	2,200	7.2–14.7 in	
	East Creek	Grand Traverse	Brook trout	900	7.2–7.8 in	
			Rainbow trout	700	7.1–7.8 in	
	Hospital (Asylum) Creek	Grand Traverse	Brook trout	1,000	7.7–9.3 in	
	Log Lake	Kalkaska	Rainbow trout	1,500	8.6 in	
	Mayfield Pond	Grand Traverse	Brook trout	500	7.2–9.3 in	
	N. Br. Boardman River	Grand Traverse	Brook trout	900	7.2–8.5 in	
			Rainbow trout	600	7.5–7.8 in	
		Kalkaska	Brook trout	1,500	7.4–8.5 in	
			Rainbow trout	1,050	7.5–7.8 in	
	S. Br. Boardman River	Grand Traverse	Brook trout	200	7.8 in	
			Rainbow trout	200	7.5 in	
	Sand Lake #1	Grand Traverse	Rainbow trout	5,000	3.7 in	
			Rainbow trout	500	7.8 in	
	Smith Lake	Kalkaska	Brook trout	20,000	fry	
	Wellman Pond	Kalkaska	Brown trout	200	7.4–7.8 in	
			Rainbow trout	200	7.2–8.1 in	
1954	Big Guernsey Lake	Kalkaska	Rainbow trout	15,000	3.0 in	
	Boardman River	Grand Traverse	Brook trout	1,100	8.6 in	
			Rainbow trout	5,100	8.9–16.4 in	
	Hospital (Asylum) Creek	Grand Traverse	Brook trout	200	9.3 in	
			Rainbow trout	800	7.8–8.4 in	

Table B.1.–Continued.

Year	Water body	County	Species	Number	Size or age	Strain
	Log Lake	Kalkaska	Rainbow trout	1,500	8.9 in	
	Mayfield Pond	Grand Traverse	Brook trout	500	7.8–9.3 in	
	N. Br. Boardman River	Grand Traverse	Brook trout	600	7.7–8.6 in	
			Rainbow trout	900	7.8–8.4 in	
		Kalkaska	Brook trout	700	7.7–8.6 in	
			Rainbow trout	600	7.8–8.9 in	
	S. Br. Boardman River	Grand Traverse	Brook trout	200	7.7 in	
			Rainbow trout	200	7.8 in	
	Sand Lake #1	Grand Traverse	Rainbow trout	5,000	3.0 in	
	Smith Lake	Kalkaska	Brook trout	20,000	fry	
	Wellman Pond	Kalkaska	Rainbow trout	500	7.8–8.4 in	
1955	Big Guernsey Lake	Kalkaska	Rainbow trout	15,000	fry	
	Boardman River	Grand Traverse	Rainbow trout	7,000	legal	
	Hospital (Asylum) Creek	Grand Traverse	Rainbow trout	1,000	legal	
	Keystone Pond	Grand Traverse	Rainbow trout	200	legal	
	Log Lake	Kalkaska	Rainbow trout	1,500	legal	
	Mayfield Pond	Grand Traverse	Brook trout	500	sublegal	
	Sand Lake #1	Grand Traverse	Rainbow trout	10,000	fry	
	S. Selkirk Lake	Kalkaska	Rainbow trout	1,500	legal	
	Silver Lake	Grand Traverse	Rainbow trout	5,000	legal	
	Wellman Pond	Kalkaska	Rainbow trout	500	legal	
1956	Big Guernsey Lake	Kalkaska	Rainbow trout	7,500	fry	
				7,500	sublegal	
	Boardman River	Grand Traverse	Rainbow trout	24,792	legal	
	Hospital (Asylum) Creek	Grand Traverse	Rainbow trout	1,300	legal	
	Log Lake	Kalkaska	Rainbow trout	1,500	legal	
	S. Selkirk Lake	Kalkaska	Rainbow trout	1,500	legal	
	Silver Lake	Grand Traverse	Rainbow trout	20,000	fry	
				5,000	legal	
	Spider Lake	Grand Traverse	Muskellunge	2,364	fry	
	Wellman Pond	Kalkaska	Rainbow trout	600	legal	
1957	Blue Lake	Kalkaska	Walleye	1,000	fry	
	Boardman River	Grand Traverse	Rainbow trout	10,500	legal	
	Chandler Lake	Grand Traverse	Largemouth bass	3,000	fry	
			Bluegill	15,000	fry	
	Dollar Lake	Grand Traverse	Largemouth bass	4,000	fry	
			Bluegill	5,000	fry	
	Hospital (Asylum) Creek	Grand Traverse	Rainbow trout	1,000	legal	
	Log Lake	Kalkaska	Rainbow trout	1,500	legal	
	Rennie Lake	Grand Traverse	Walleye	5,000	fry	
	Sand Lake #1	Grand Traverse	Rainbow trout	200	legal	
	Sand Lake #3	Grand Traverse	Bluegill	2,370	sublegal	

Table B.1.–Continued.

Year	Water body	County	Species	Number	Size or age	Strain
	Sand Lake #4	Grand Traverse	Largemouth bass	513	fry	
			Bluegill	730	sublegal	
	Sand Lake #5	Grand Traverse	Largemouth bass	1,795	fry	
	S. Selkirk Lake	Kalkaska	Rainbow trout	1,500	legal	
	Silver Lake	Grand Traverse	Rainbow trout	5,000	legal	
	Spider Lake	Grand Traverse	Muskellunge	1,400	fry	
	Vandervoight Lake	Grand Traverse	Northern pike	25	legal	
	Wellman Pond	Kalkaska	Rainbow trout	600	legal	
1958	Boardman River	Grand Traverse	Brown trout	5,000	legal	
			Rainbow trout	7,500	legal	
	Hospital (Asylum) Creek	Grand Traverse	Rainbow trout	1,000	legal	
	Log Lake	Kalkaska	Rainbow trout	675	sublegal	
	N. Br. Boardman River	Kalkaska	Rainbow trout	400	legal	
	Sand Lake #1	Grand Traverse	Rainbow trout	300	legal	
				5,000	fry	
	Wellman Pond	Kalkaska	Rainbow trout	600	legal	
1959	Boardman Lake	Grand Traverse	Brown trout	2,000	legal	
	Boardman River	Grand Traverse	Rainbow trout	7,500	legal	
				1,200	sublegal	
			Rainbow trout (steelhead)	500	sublegal	
	Dollar Lake	Grand Traverse	Rainbow trout	4,000	fry	
	Hospital (Asylum) Creek	Grand Traverse	Rainbow trout	1,000	legal	
	Indian Lake	Grand Traverse	Largemouth bass	4,000	fry	
			Northern pike	15	legal	
	Log Lake	Kalkaska	Rainbow trout	1,500	legal	
	N. Br. Boardman River	Kalkaska	Rainbow trout	400	legal	
	Sand Lake #1	Grand Traverse	Rainbow trout	5,000	fry	
	Wellman Pond	Kalkaska	Rainbow trout	600	legal	
1960	Big Guernsey Lake	Kalkaska	Rainbow trout	15,000	fry	
	Boardman River	Grand Traverse	Rainbow trout	1,500	legal	
	Hospital (Asylum) Creek	Grand Traverse	Rainbow trout	1,000	legal	
	Island Lake	Kalkaska	Largemouth bass	1,175	fry	
	Log Lake	Kalkaska	Rainbow trout	1,500	legal	
	N. Br. Boardman River	Kalkaska	Brook trout	200	legal	
	S. Selkirk Lake	Kalkaska	Rainbow trout	1,500	legal	
	Sand Lake #1	Grand Traverse	Rainbow trout	5,000	fry	
	Sand Lake #2	Grand Traverse	Yellow perch	927	legal	
	Wellman Pond	Kalkaska	Rainbow trout	600	legal	

Table B.1.–Continued.

Year	Water body	County	Species	Number	Size or age	Strain
1961	Boardman River	Grand Traverse	Rainbow trout	3,000	legal	
	Hospital (Asylum) Creek	Grand Traverse	Rainbow trout	800	legal	
	Island Lake	Kalkaska	Bluegill	200	fingerlings	
	Log Lake	Kalkaska	Rainbow trout	1,500	legal	
	Mayfield Pond	Grand Traverse	Brook trout	300	legal	
	S. Selkirk Lake	Kalkaska	Rainbow trout	1,500	legal	
	Silver Lake	Grand Traverse	Rainbow trout	5,000	legal	
	Wellman Pond	Grand Traverse	Rainbow trout	400	legal	
1962	Boardman Pond	Grand Traverse	Brown trout	1,000	legal	
	Boardman River	Grand Traverse	Rainbow trout	7,250	legal	
	Hospital (Asylum) Creek	Grand Traverse	Rainbow trout	600	legal	
	Log Lake	Kalkaska	Rainbow trout	1,700	legal	
	Mayfield Pond	Grand Traverse	Brook trout	300	legal	
	Wellman Pond	Kalkaska	Rainbow trout	1,700	legal	
1963	Big Guernsey Lake	Kalkaska	Rainbow trout	7,500	legal	
	Boardman Lake	Grand Traverse	Brown trout	2,000	legal	
	Boardman Pond	Grand Traverse	Brown trout	1,000	legal	
	Boardman River	Grand Traverse	Rainbow trout	3,250	legal	
	Hospital (Asylum) Creek	Grand Traverse	Brook trout	200	legal	
			Rainbow trout	600	legal	
	Log Lake	Kalkaska	Rainbow trout	1,500	legal	
	Mayfield Pond	Grand Traverse	Brook trout	1,200	legal	
	Roots Lake	Grand Traverse	Smallmouth bass	3,000	fingerlings	
	Sand Lake #1	Grand Traverse	Rainbow trout	1,000	sublegal	
				500	legal	
	Silver Lake	Grand Traverse	Rainbow trout	1,000	legal	
	Wellman Pond	Kalkaska	Rainbow trout	600	legal	
1964	Big Guernsey Lake	Kalkaska	Rainbow trout	15,000	fingerlings	
	Boardman Lake	Grand Traverse	Brown trout	2,000	legal	
	Boardman Pond	Grand Traverse	Brown trout	1,000	legal	
	Boardman River	Grand Traverse	Rainbow trout	3,250	legal	
	Dollar Lake	Grand Traverse	Brook trout	3,000	legal	
			Smallmouth bass	3,000	fingerlings	
	Hospital (Asylum) Creek	Grand Traverse	Brown trout	600	legal	
	Log Lake	Kalkaska	Rainbow trout	1,500	legal	
	Mayfield Pond	Grand Traverse	Brook trout	300	legal	
	S. Selkirk Lake	Kalkaska	Rainbow trout	800	legal	
	Sand Lake #1	Grand Traverse	Rainbow trout	1,000	sublegal	
	Silver Lake	Grand Traverse	Rainbow trout	1,000	legal	
	Wellman Pond	Kalkaska	Rainbow trout	600	legal	

Table B.1.–Continued.

Year	Water body	County	Species	Number	Size or age	Strain
1965	Big Guernsey Lake	Kalkaska	Brook trout	5,200	legal	
	Boardman Lake	Grand Traverse	Brown trout	5,000	legal	
	Boardman Pond	Grand Traverse	Brown trout	2,500	legal	
	Boardman River	Grand Traverse	Rainbow trout	5,000	legal	
	Dollar Lake	Grand Traverse	Smallmouth bass	233	sublegal	
	Log Lake	Kalkaska	Rainbow trout	1,500	sublegal	
	Mayfield Pond	Grand Traverse	Rainbow trout	1,200	sublegal	
	S. Selkirk Lake	Kalkaska	Rainbow trout	500	sublegal	
	Sand Lake #1	Grand Traverse	Rainbow trout	1,000	sublegal	
	Silver Lake	Grand Traverse	Rainbow trout	1,000	sublegal	
1966	Log Lake	Kalkaska	Rainbow trout	2,600	fall fingerlings	
	Sand Lake #1	Grand Traverse	Rainbow trout	3,000	spring fingerlings	
	S. Selkirk Lake	Kalkaska	Rainbow trout	4,000	fall fingerlings	
1967	Big Guernsey Lake	Kalkaska	Rainbow trout	5,000	adults	
	Boardman River	Grand Traverse	Coho salmon	3,111	adults	Toutle R. (WA) and/or Cascade R. (OR)
	Dollar Lake	Grand Traverse	Rainbow trout	2,000	yearlings	
1968	Big Guernsey Lake	Kalkaska	Brown trout	1,100	yearlings	
			Largemouth bass	223	adults	
			Smallmouth bass	2,475	fingerlings	
	Log Lake	Kalkaska	Rainbow trout	1,300	yearlings	
	S. Selkirk Lake	Kalkaska	Rainbow trout	4,000	fall fingerlings	
	Sand Lake #1	Grand Traverse	Rainbow trout	2,000	yearlings	
	Wellman Pond	Kalkaska	Brown trout	300	yearlings	
1969	Dollar Lake	Grand Traverse	Rainbow trout	2,200	yearlings	
	Sand Lake #1	Grand Traverse	Rainbow trout	2,100	yearlings	
	Sand Lake #2	Grand Traverse	bluegill x green sunfish	8,650	fingerlings	
	Sand Lake #3	Grand Traverse	bluegill x green sunfish	7,450	fingerlings	
	Wellman Pond	Kalkaska	Brown trout	300	adults	
1970	Log Lake	Kalkaska	Rainbow trout	1,300	yearlings	
	S. Selkirk Lake	Kalkaska	Rainbow trout	1,400	yearlings	
	Silver Lake	Grand Traverse	Rainbow trout	925	adults	
	Wellman Pond	Kalkaska	Brown trout	150	adults	
1971	Dollar Lake	Grand Traverse	Rainbow trout	2,000	yearlings	
	Sand Lake #4	Grand Traverse	Rainbow trout	1,500	yearlings	

Table B.1.–Continued.

Year	Water body	County	Species	Number	Size or age	Strain
1972	Big Guernsey Lake	Kalkaska	Rainbow trout	2,500	yearlings	
	Dollar Lake	Grand Traverse	Rainbow trout	2,000	yearlings	
	Pothole Lake #1	Kalkaska	Rainbow trout	150	adults	
			bluegill x green sunfish	1,000	fingerlings	
	Pothole Lake #2	Kalkaska	Rainbow trout	200	adults	
				200	yearlings	
			bluegill x green sunfish	1,500	fingerlings	
	Pothole Lake #3	Kalkaska	Rainbow trout	100	adults	
			bluegill x green sunfish	1,500	fingerlings	
	Rennie Lake	Grand Traverse	Tiger muskellunge	1,000	fingerlings	
	Sand Lake #1	Grand Traverse	Rainbow trout	2,000	yearlings	
	Sand Lake #2	Grand Traverse	Largemouth bass	865	fingerlings	
			bluegill x green sunfish	8,650	fingerlings	
	Sand Lake #3	Grand Traverse	Largemouth bass	745	fingerlings	
			bluegill x green sunfish	7,450	fingerlings	
	Sand Lake #4	Grand Traverse	Rainbow trout	1,500	yearlings	
1973	Big Guernsey Lake	Grand Traverse	Rainbow trout	1,300	yearlings	
	Boardman River	Grand Traverse	Rainbow trout (steelhead)	10,000	yearlings	Little Manistee
	Dollar Lake	Grand Traverse	Rainbow trout	1,000	yearlings	
	Rennie Lake	Grand Traverse	Tiger muskellunge	1,500	fingerlings	
	Sand Lake #1	Grand Traverse	Rainbow trout	1,000	yearlings	
	Sand Lake #4	Grand Traverse	Rainbow trout	1,500	yearlings	
1974	Big Guernsey Lake	Kalkaska	Brown trout	500	yearlings	
			Rainbow trout	1,000	yearlings	
	Boardman River	Grand Traverse	Rainbow trout (steelhead)	10,062	yearlings	Little Manistee
	Dollar Lake	Grand Traverse	Rainbow trout	2,040	yearlings	
	Sand Lake #1	Grand Traverse	Rainbow trout	1,020	yearlings	
1975	Big Guernsey Lake	Kalkaska	Brown trout	1,000	yearlings	
			Rainbow trout (steelhead)	1,025	yearlings	Little Manistee
	Boardman River	Grand Traverse	Rainbow trout (steelhead)	5,094	yearlings	Little Manistee
	Dollar Lake	Grand Traverse	Rainbow trout (steelhead)	2,000	yearlings	Little Manistee
	Rennie Lake	Grand Traverse	Tiger muskellunge	1,026	fall fingerlings	
	Sand Lake #1	Grand Traverse	Rainbow trout (steelhead)	1,000	yearlings	Little Manistee

Table B.1.–Continued.

Year	Water body	County	Species	Number	Size or age	Strain
1976	Arbutus Lake	Grand Traverse	Northern pike	3,600	spring fingerlings	
	Big Guernsey Lake	Kalkaska	Brown trout	1,000	yearlings	
			Rainbow trout	1,000	yearlings	
	Boardman River	Grand Traverse	Rainbow trout (steelhead)	5,168	yearlings	Little Manistee
	Dollar Lake	Grand Traverse	Rainbow trout	2,000	yearlings	
	Rennie Lake	Grand Traverse	Tiger muskellunge	1,000	fall fingerlings	
	Sand Lake #1	Grand Traverse	Rainbow trout	1,000	yearlings	
1977	Big Guernsey Lake	Kalkaska	Brown trout	1,000	yearlings	
			Rainbow trout	2,200	yearlings	
	Boardman Lake	Grand Traverse	Walleye	525,000	fry	
	Boardman River	Grand Traverse	Brown trout	1,000	yearlings	
			Rainbow trout (steelhead)	14,910	yearlings	Little Manistee
	Dollar Lake	Grand Traverse	Rainbow trout	2,000	yearlings	
	Sand Lake #1	Grand Traverse	Rainbow trout	1,000	yearlings	
1978	Arbutus Lake	Grand Traverse	Northern pike	120,000	fry	
	Big Guernsey Lake	Kalkaska	Brown trout	1,000	yearlings	
			Rainbow trout	2,000	yearlings	
	Boardman Lake	Grand Traverse	Walleye	600,000	fry	
	Boardman River	Grand Traverse	Rainbow trout (steelhead)	5,000	yearlings	Little Manistee
	Dollar Lake	Grand Traverse	Rainbow trout	2,000	yearlings	
	Rennie Lake	Grand Traverse	Tiger muskellunge	1,000	fall fingerlings	
	Sand Lake #1	Grand Traverse	Rainbow trout	1,000	yearlings	
	Sand Lake #2	Grand Traverse	Brook trout	1,250	yearlings	
1979	Arbutus Lake	Grand Traverse	Northern pike	919	spring fingerlings	
	Big Guernsey Lake	Kalkaska	Brown trout	1,000	yearlings	
			Rainbow trout (steelhead)	2,000	yearlings	Little Manistee
	Boardman Lake	Grand Traverse	Walleye	750,000	fry	
	Dollar Lake	Grand Traverse	Rainbow trout (steelhead)	2,000	yearlings	Little Manistee
	Rennie Lake	Grand Traverse	Tiger muskellunge	1,000	fall fingerlings	
	Sand Lake #1	Grand Traverse	Rainbow trout	1,000	yearlings	
	Sand Lake #2	Grand Traverse	Brook trout	1,000	yearlings	
1980	Arbutus Lake	Grand Traverse	Northern pike	100	spring fingerlings	
	Big Guernsey Lake	Kalkaska	Brown trout	2,500	yearlings	
			Rainbow trout	2,000	yearlings	

Table B.1.–Continued.

Year	Water body	County	Species	Number	Size or age	Strain
	Boardman Lake	Grand Traverse	Walleye	1,750,000	fry	
	Boardman River	Grand Traverse	Rainbow trout (steelhead)	19,989	yearlings	Little Manistee
	Rennie Lake	Grand Traverse	Tiger muskellunge	1,000	fall fingerlings	
	Sand Lake #1	Grand Traverse	Rainbow trout	1,000	yearlings	
	Sand Lake #2	Grand Traverse	Brook trout	1,000	yearlings	
1981	Big Guernsey Lake	Kalkaska	Brown trout	1,000	yearlings	
			Rainbow trout	2,000	yearlings	
	Boardman Lake	Grand Traverse	Walleye	1,750,000	fry	
	Boardman River	Grand Traverse	Rainbow trout (steelhead)	20,000	yearlings	Little Manistee
	Rennie Lake	Grand Traverse	Tiger muskellunge	1,000	fall fingerlings	
	Sand Lake #2	Grand Traverse	Brook trout hybrid	1,000	spring fingerlings	
1982	Big Guernsey Lake	Kalkaska	Rainbow trout	2,000	yearlings	
	Boardman Lake	Grand Traverse	Walleye	1,750,000	fry	New York
	Boardman River	Grand Traverse	Rainbow trout (steelhead)	15,000	yearlings	
	Rennie Lake	Grand Traverse	Tiger muskellunge	1,000	fall fingerlings	
	Sand Lake #2	Grand Traverse	Brook trout	1,000	spring fingerlings	Assinica
1983	Big Guernsey Lake	Kalkaska	Brown trout	1,000	yearlings	
			Rainbow trout	1,500	yearlings	
	Boardman Lake	Grand Traverse	Walleye	900,000	fry	
	Boardman River	Grand Traverse	Rainbow trout (steelhead)	15,000	yearlings	Little Manistee
	Dollar Lake	Grand Traverse	Hybrid sunfish	18,500	fall fingerlings	
	Rennie Lake	Grand Traverse	Tiger muskellunge	800	fall fingerlings	
	Sand Lake #1	Grand Traverse	Rainbow trout	1,000	yearlings	
	Sand Lake #2	Grand Traverse	Brook trout hybrid	2,000	spring fingerlings	
	Sand Lake #3	Grand Traverse	Hybrid sunfish	5,700	fall fingerlings	
1984	Big Guernsey Lake	Kalkaska	Brown trout	1,000	yearlings	
			Rainbow trout	1,500	yearlings	
	Boardman River	Grand Traverse	Rainbow trout (steelhead)	15,000	yearlings	Little Manistee
	Kids Creek	Grand Traverse	Rainbow trout	200	adults	
	Rennie Lake	Grand Traverse	Tiger muskellunge	880	fall fingerlings	

Table B.1.–Continued.

Year	Water body	County	Species	Number	Size or age	Strain
	Sand Lake #1	Grand Traverse	Rainbow trout	950	yearlings	
	Sand Lake #2	Grand Traverse	Brook trout hybrid	1,000	yearlings	
1985	Big Guernsey Lake	Kalkaska	Rainbow trout	2,000	yearlings	
	Boardman River	Grand Traverse	Chinook salmon	190,022	spring fingerlings	Michigan
			Rainbow trout (steelhead)	14,000	yearlings	Little Manistee
	Kids Creek	Grand Traverse	Rainbow trout	200	adults	
	Rennie Lake	Grand Traverse	Tiger muskellunge	800	fall fingerlings	
	Sand Lake #1	Grand Traverse	Rainbow trout	2,000	yearlings	
	Sand Lake #2	Grand Traverse	Brook trout hybrid	2,000	yearlings	
	Sand Lake #3	Grand Traverse	Hybrid sunfish	2,500	fall fingerlings	
1986	Big Guernsey Lake	Kalkaska	Brown trout	820	yearlings	
			Rainbow trout	2,000	yearlings	
	Boardman River	Grand Traverse	Chinook salmon	250,105	spring fingerlings	Michigan
			Rainbow trout (steelhead)	20,000	yearlings	Little Manistee
	Kids Creek	Grand Traverse	Rainbow trout	300	adults	
	Rennie Lake	Grand Traverse	Tiger muskellunge	1,000	fall fingerlings	
	Sand Lake #1	Grand Traverse	Rainbow trout	2,000	yearlings	
	Sand Lake #2	Grand Traverse	Brook trout hybrid	1,620	yearlings	
1987	Big Guernsey Lake	Kalkaska	Brown trout	850	yearlings	
			Rainbow trout	2,200	yearlings	
	Boardman Lake	Grand Traverse	Hybrid sunfish	16,000	spring fingerlings	
	Boardman River	Grand Traverse	Rainbow trout (steelhead)	17,547	yearlings	Little Manistee
	Kids Creek	Grand Traverse	Chinook salmon	238,500	spring fingerlings	Michigan
	Rennie Lake	Grand Traverse	Tiger muskellunge	850	fall fingerlings	
	Sand Lake #1	Grand Traverse	Rainbow trout	2,000	yearlings	
	Sand Lake #2	Grand Traverse	Arctic grayling	1,700	yearlings	Meadow Lk. (WY)
			Brook trout hybrid	2,000	yearlings	
	Sand Lake #3	Grand Traverse	Hybrid sunfish	11,250	fall fingerlings	

Table B.1.–Continued.

Year	Water body	County	Species	Number	Size or age	Strain
1988	Big Guernsey Lake	Kalkaska	Brown trout	1,000	yearlings	
			Rainbow trout	2,000	yearlings	
	Boardman River	Grand Traverse	Rainbow trout (steelhead)	15,000	yearlings	Little Manistee
	Kids Creek	Grand Traverse	Chinook salmon	277,000	spring fingerlings	Michigan
	Rennie Lake	Grand Traverse	Tiger muskellunge	800	fall fingerlings	
	Sand Lake #1	Grand Traverse	Rainbow trout	2,000	yearlings	
1989	Big Guernsey Lake	Kalkaska	Brown trout	1,000	yearlings	
			Rainbow trout	2,000	yearlings	
	Boardman River	Grand Traverse	Rainbow trout (steelhead)	15,000	yearlings	Little Manistee
	Dollar Lake	Grand Traverse	Hybrid sunfish	18,950	fall fingerlings	
	Kids Creek	Grand Traverse	Chinook salmon	300,093	spring fingerlings	Michigan
	Rennie Lake	Grand Traverse	Tiger muskellunge	1,000	fall fingerlings	
	Sand Lake #3	Grand Traverse	Hybrid sunfish	7,125	fall fingerlings	
	Wellman Pond	Kalkaska	Brook trout	95	adults	
			Rainbow trout	230	adults	
1990	Big Guernsey Lake	Kalkaska	Brown trout	900	yearlings	
			Rainbow trout	1,999	yearlings	
	Boardman River	Grand Traverse	Brown trout	200,000	spring fingerlings	
		Grand Traverse	Rainbow trout (steelhead)	10,000	yearlings	Little Manistee
			Rainbow trout (steelhead)	7,000	yearlings	Skamania
	Kids Creek	Grand Traverse	Chinook salmon	306,964	spring fingerlings	Michigan
	Rennie Lake	Grand Traverse	Tiger muskellunge	1,000	fall fingerlings	
	Sand Lake #1	Grand Traverse	Rainbow trout	1,500	yearlings	
	Sand Lake #2	Grand Traverse	Brook trout hybrid	2,000	yearlings	
	Silver Lake	Grand Traverse	Walleye	20,738	fall fingerlings	Bay de Noc
1991	Big Guernsey Lake	Kalkaska	Brown trout	1,000	yearlings	
			Rainbow trout	1,840	yearlings	
	Boardman River	Grand Traverse	Rainbow trout (steelhead)	13,222	yearlings	Little Manistee
			Rainbow trout (steelhead)	3,800	yearlings	Skamania

Table B.1.–Continued.

Year	Water body	County	Species	Number	Size or age	Strain
	Kids Creek	Grand Traverse	Chinook salmon	295,334	spring fingerlings	Michigan
	Rennie Lake	Grand Traverse	Tiger muskellunge	1,000	fall fingerlings	
	Sand Lake #1	Grand Traverse	Rainbow trout	1,700	yearlings	
	Silver Lake	Grand Traverse	Walleye	23,523	fall fingerlings	Muskegon
1992	Big Guernsey Lake	Kalkaska	Brown trout	980	yearlings	Wild Rose
			Rainbow trout	2,000	yearlings	Shasta
	Boardman River	Grand Traverse	Rainbow trout (steelhead)	30,001	yearlings	Little Manistee
	Kids Creek	Grand Traverse	Chinook salmon	300,634	spring fingerlings	Michigan
	Sand Lake #1	Grand Traverse	Rainbow trout	2,500	yearlings	Shasta
	Sand Lake #2	Grand Traverse	Arctic grayling	1,000	yearlings	
			Brook trout	1,000	yearlings	Owhi
	Silver Lake	Grand Traverse	Walleye	20,869	fall fingerlings	Bay de Noc
1993	Big Guernsey Lake	Kalkaska	Brown trout	990	yearlings	Wild Rose
			Rainbow trout	1,739	yearlings	Shasta
	Boardman River	Grand Traverse	Rainbow trout (steelhead)	13,500	yearlings	Little Manistee
	Kids Creek	Grand Traverse	Chinook salmon	253,162	spring fingerlings	Michigan
			Coho salmon	110,026	yearlings	Michigan
	Sand Lake #1	Grand Traverse	Rainbow trout	1,478	yearlings	Shasta
	Sand Lake #2	Grand Traverse	Brook trout	2,500	yearlings	Assinica
1994	Big Guernsey Lake	Kalkaska	Brown trout	3,000	yearlings	Wild Rose
	Boardman River	Grand Traverse	Rainbow trout (steelhead)	16,500	yearlings	Little Manistee
	Kids Creek	Grand Traverse	Chinook salmon	300,820	spring fingerlings	Michigan
	Sand Lake #1	Grand Traverse	Rainbow trout	2,449	yearlings	Shasta
	Sand Lake #2	Grand Traverse	Brook trout	2,500	yearlings	Assinica
1995	Big Guernsey Lake	Kalkaska	Brown trout	2,860	yearlings	Wild Rose
	Boardman River	Grand Traverse	Rainbow trout (steelhead)	16,500	yearlings	Little Manistee
	Kids Creek	Grand Traverse	Chinook salmon	292,789	spring fingerlings	Michigan
	Sand Lake #1	Grand Traverse	Rainbow trout	2,270	yearlings	Shasta
	Sand Lake #2	Grand Traverse	Brook trout	2,500	yearlings	Saint Croix
	Silver Lake	Grand Traverse	Walleye	2,764	spring fingerlings	Bay de Noc

Table B.1.–Continued.

Year	Water body	County	Species	Number	Size or age	Strain
1996	Big Guernsey Lake	Kalkaska	Brown trout	2,847	yearlings	Wild Rose
	Boardman River	Grand Traverse	Brown trout	145	yearlings	Wild Rose
			Chinook salmon	270,975	spring fingerlings	Michigan
			Coho salmon	100,016	yearlings	Michigan
			Rainbow trout (steelhead)	16,000	yearlings	Little Manistee
	Sand Lake #1	Grand Traverse	Rainbow trout	2,170	yearlings	Eagle Lake
	Sand Lake #2	Grand Traverse	Brook trout	2,100	yearlings	Assinica
1997	Big Guernsey Lake	Kalkaska	Brown trout	3,117	yearlings	Wild Rose
	Boardman River	Grand Traverse	Brown trout	150	yearlings	Wild Rose
			Chinook salmon	252,636	spring fingerlings	Michigan
			Coho salmon	100,035	yearlings	Michigan
			Rainbow trout (steelhead)	15,500	yearlings	Little Manistee
	Sand Lake #1	Grand Traverse	Rainbow trout	600	yearlings	Eagle Lake
				1,577	yearlings	Shasta
	Sand Lake #2	Grand Traverse	Brook trout	2,100	yearlings	Assinica
	Silver Lake	Grand Traverse	Walleye	20,394	spring fingerlings	Muskegon
1998	Big Guernsey Lake	Kalkaska	Brown trout	2,950	yearlings	Wild Rose
	Boardman River	Grand Traverse	Brown trout	145	yearlings	Wild Rose
			Chinook salmon	245,467	spring fingerlings	Michigan
			Rainbow trout (steelhead)	14,300	yearlings	Little Manistee
	Sand Lake #1	Grand Traverse	Rainbow trout	1,857	yearlings	Eagle Lake
	Sand Lake #2	Grand Traverse	Brook trout	2,500	yearlings	Temiscame
	Mayfield Pond	Grand Traverse	Rainbow trout	100	adults	Eagle Lake
1999	Big Guernsey Lake	Kalkaska	Brown trout	3,000	yearlings	Gilchrist Creek
	Boardman River	Grand Traverse	Chinook salmon	240,327	spring fingerlings	Michigan
			Coho salmon	120,034	yearlings	Michigan
			Rainbow trout (steelhead)	18,000	yearlings	Little Manistee
	Sand Lake #1	Grand Traverse	Rainbow trout	1,850	yearlings	Shasta
	Sand Lake #2	Grand Traverse	Brook trout	500	yearlings	Assinica
2000	Big Guernsey Lake	Kalkaska	Brown trout	3,200	yearlings	Wild Rose
	Boardman River	Grand Traverse	Chinook salmon	256,854	spring fingerlings	Michigan
			Coho salmon	132,127	yearlings	Michigan
			Rainbow trout (steelhead)	15,000	yearlings	Little Manistee

Table B.1.–Continued.

Year	Water body	County	Species	Number	Size or age	Strain
	Log Lake	Kalkaska	Rainbow trout	1,170	yearlings	Eagle Lake
	Sand Lake #1	Grand Traverse	Rainbow trout	2,000	yearlings	Eagle Lake
	Sand Lake #2	Grand Traverse	Brook trout	2,500	yearlings	Assinica
	Silver Lake	Grand Traverse	Walleye	24,277	spring fingerlings	Muskegon
2001	Big Guernsey Lake	Kalkaska	Brown trout	7,082	yearlings	Wild Rose
	Boardman River	Grand Traverse	Chinook salmon	234,520	spring fingerlings	Michigan
			Coho salmon	120,172	yearlings	Michigan
			Rainbow trout (steelhead)	16,000	yearlings	Little Manistee
	Log Lake	Kalkaska	Rainbow trout	1,010	yearlings	Eagle Lake
	Sand Lake #1	Grand Traverse	Rainbow trout	400	yearlings	Eagle Lake
			Rainbow trout	1,600	yearlings	Shasta
	Sand Lake #2	Grand Traverse	Brook trout	200	yearlings	Assinica
2002	Big Guernsey Lake	Kalkaska	Brown trout	3,030	yearlings	Wild Rose
			Rainbow trout	31	adults	Private Plant
	Boardman River	Grand Traverse	Coho salmon	99,234	yearlings	Michigan
			Rainbow trout (steelhead)	18,000	yearlings	Little Manistee
	Kids Creek	Grand Traverse	Chinook salmon	235,480	spring fingerlings	Michigan
	Log Lake	Kalkaska	Rainbow trout	1,500	yearlings	Eagle Lake
			Rainbow trout	31	adults	Private Plant
	Sand Lake #1	Grand Traverse	Rainbow trout	2,130	yearlings	Eagle Lake
	Sand Lake #2	Grand Traverse	Brook trout	2,500	yearlings	Assinica
	Spider Lake	Grand Traverse	Northern pike	400	yearlings	Private Plant
2003	Big Guernsey Lake	Kalkaska	Brown trout	3,020	yearlings	Wild Rose
	Boardman River	Grand Traverse	Coho salmon	93,000	yearlings	Michigan
			Rainbow trout (steelhead)	18,000	yearlings	Little Manistee
	Kids Creek	Grand Traverse	Chinook salmon	237,508	spring fingerlings	Michigan
	Log Lake	Kalkaska	Rainbow trout	1,440	yearlings	Eagle Lake
	Sand Lake #1	Grand Traverse	Rainbow trout	2,400	yearlings	Eagle Lake
	Sand Lake #2	Grand Traverse	Brook trout	2,500	yearlings	Assinica
	Silver Lake	Grand Traverse	Walleye	21,307	yearlings	Muskegon
2004	Big Guernsey Lake	Kalkaska	Brown trout	3,000	yearlings	Wild Rose
	Boardman River	Grand Traverse	Rainbow trout (steelhead)	17,310	yearlings	Little Manistee
	Kids Creek	Grand Traverse	Chinook salmon	238,983	spring fingerlings	Michigan
	Log Lake	Kalkaska	Rainbow trout	1,500	yearlings	Eagle Lake
	Sand Lake #1	Grand Traverse	Rainbow trout	2,250	yearlings	Eagle Lake
	Sand Lake #2	Grand Traverse	Brook trout	2,500	yearlings	Assinica

Table B.1.–Continued.

Year	Water body	County	Species	Number	Size or age	Strain
2005	Arbutus Lake	Grand Traverse	Northern pike	1,000	spring fingerlings	
	Big Guernsey Lake	Kalkaska	Brown trout	3,000	yearlings	Seeforellen
	Boardman River	Grand Traverse	Coho salmon	74,414	yearlings	Michigan
			Rainbow trout (steelhead)	15,200	yearlings	Little Manistee
	Kids Creek	Grand Traverse	Chinook salmon	237,434	spring fingerlings	Michigan
	Sand Lake #1	Grand Traverse	Rainbow trout	2,500	yearlings	Eagle Lake
	Sand Lake #2	Grand Traverse	Brook trout	2,500	yearlings	Assinica
	Spider Lake	Grand Traverse	Northern pike	1,000	spring fingerlings	
2006	Big Guernsey Lake	Kalkaska	Brown trout	3,000	yearlings	Wild Rose
	Boardman River	Grand Traverse	Coho salmon	100,002	yearlings	Michigan
			Rainbow trout (steelhead)	15,431	yearlings	Little Manistee
	Kids Creek	Grand Traverse	Chinook salmon	150,021	spring fingerlings	Michigan
	Sand Lake #1	Grand Traverse	Rainbow trout	2,000	yearlings	Eagle Lake
	Sand Lake #2	Grand Traverse	Brook trout	1,900	yearlings	Assinica
	Silver Lake	Grand Traverse	Walleye	26,876	spring fingerlings	Muskegon
2007	Big Guernsey Lake	Kalkaska	Brown trout	2,800	yearlings	Wild Rose
	Boardman River	Grand Traverse	Chinook salmon	49,519	spring fingerlings (net pen)	Michigan
			Rainbow trout (steelhead)	15,100	yearlings	Michigan
	Kids Creek	Grand Traverse	Chinook salmon	100,075	spring fingerlings	Michigan
	Sand Lake #1	Grand Traverse	Rainbow trout	2,400	yearlings	Eagle Lake
	Sand Lake #2	Grand Traverse	Brook trout	2,000	Yearlings	Assinica

Appendix C

Distribution maps of fish species within the Boardman River watershed

This appendix contains maps of known past and present fish distributions within the Boardman River watershed. The distributions of fish species were compiled from records located at the University of Michigan, Museums Fisheries Library; Michigan Department of Natural Resources, Institute for Fisheries Research; and Central Lake Michigan Mangaement Unit offices in Traverse City and Cadillac.

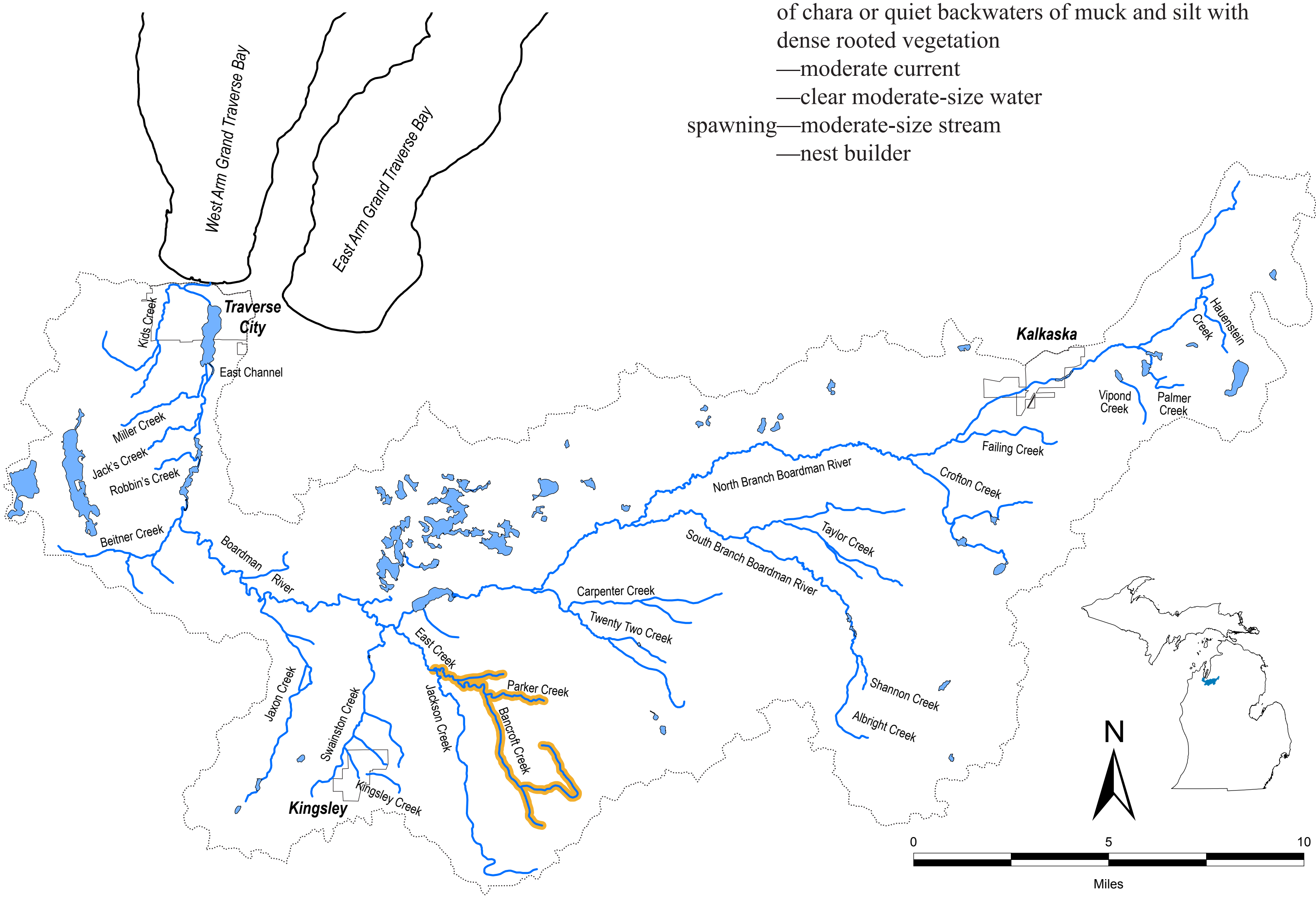
Habitat descriptions were compiled from Fishes of Ohio (Trautman 1981), Freshwater Fishes of Canada (Scott and Crossman 1973), Fishes of Wisconsin (Becker 1983), Fishes of Missouri (Pflieger 1975), and Fishes of the Great Lakes Region (Hubbs and Lagler 1947).

APPENDIX C INDEX

Chestnut Lamprey *Ichthyomyzon castaneus*

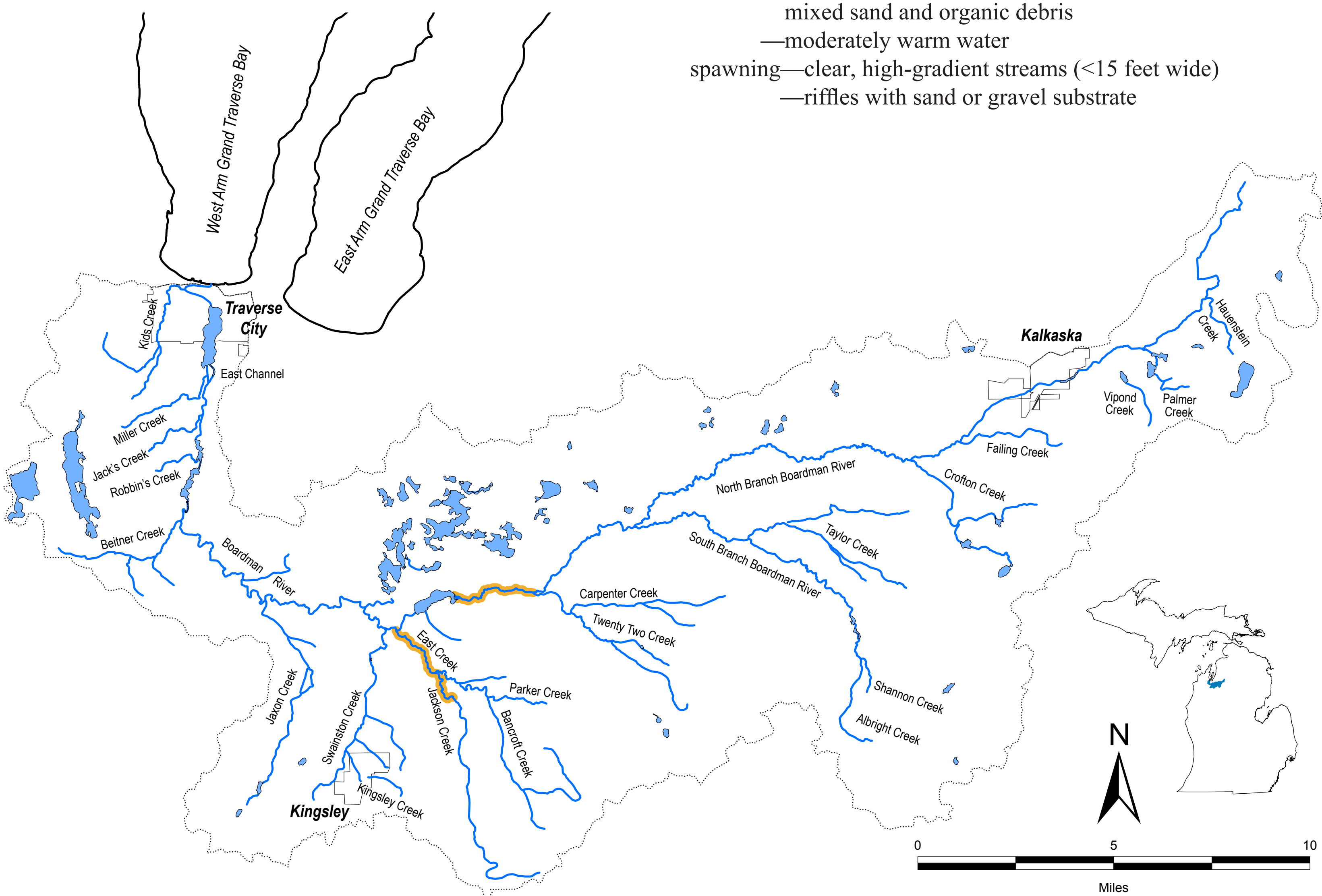
Habitat: feeding—stable substrate of sand and silt with light growth of chara or quiet backwaters of muck and silt with dense rooted vegetation
—moderate current
—clear moderate-size water

spawning—moderate-size stream
—nest builder



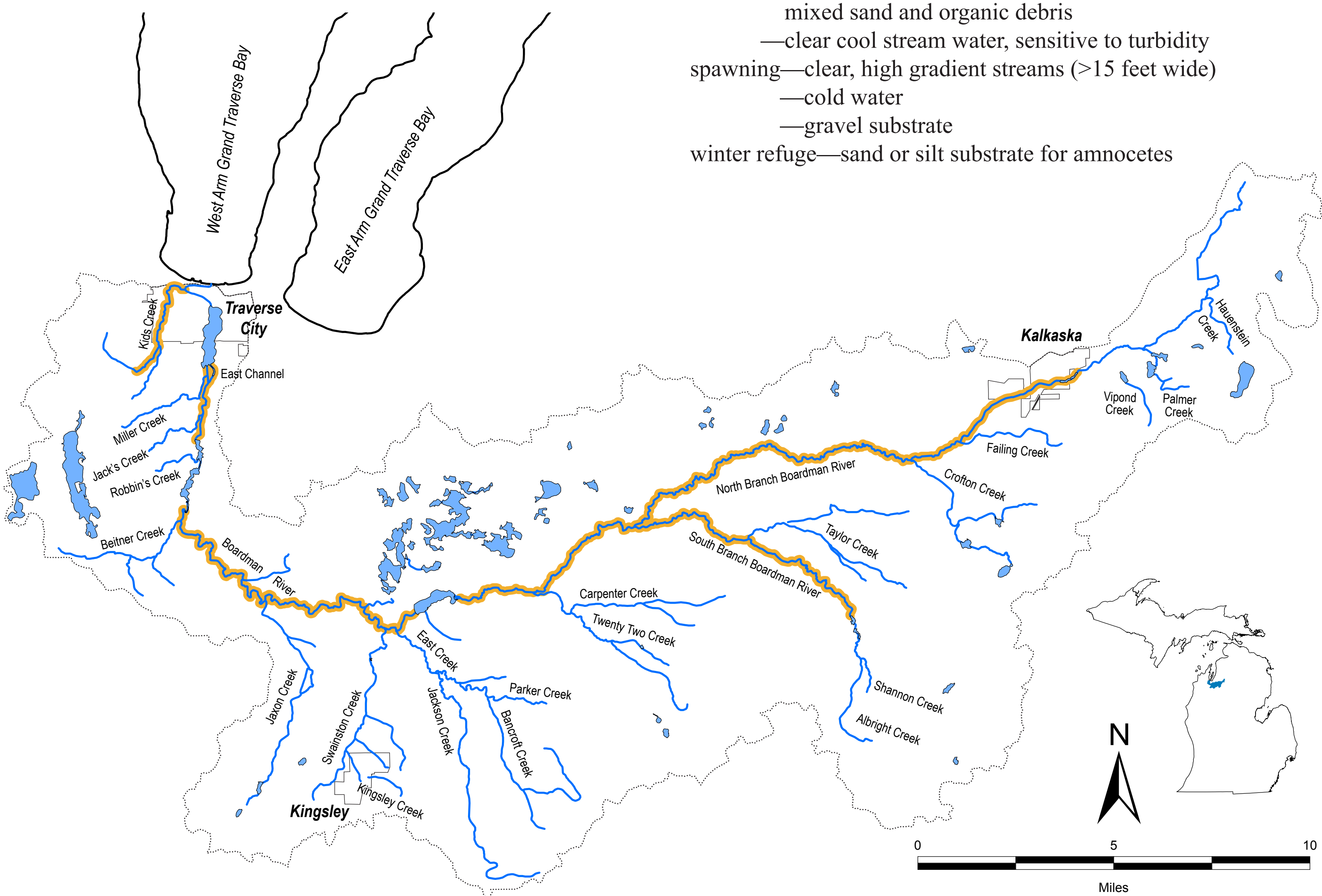
Northern Brook Lamprey *Ichthyomyzon fossor*

<u>Habitat</u>**:** 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



American Brook Lamprey *Lampetra appendix*

Habitat: feeding—young: low gradient, substrate with bars and beds of mixed sand and organic debris
—clear cool stream water, sensitive to turbidity
spawning—clear, high gradient streams (>15 feet wide)
—cold water
—gravel substrate
winter refuge—sand or silt substrate for amnocetes



Sea Lamprey *Petromyzon marinus*

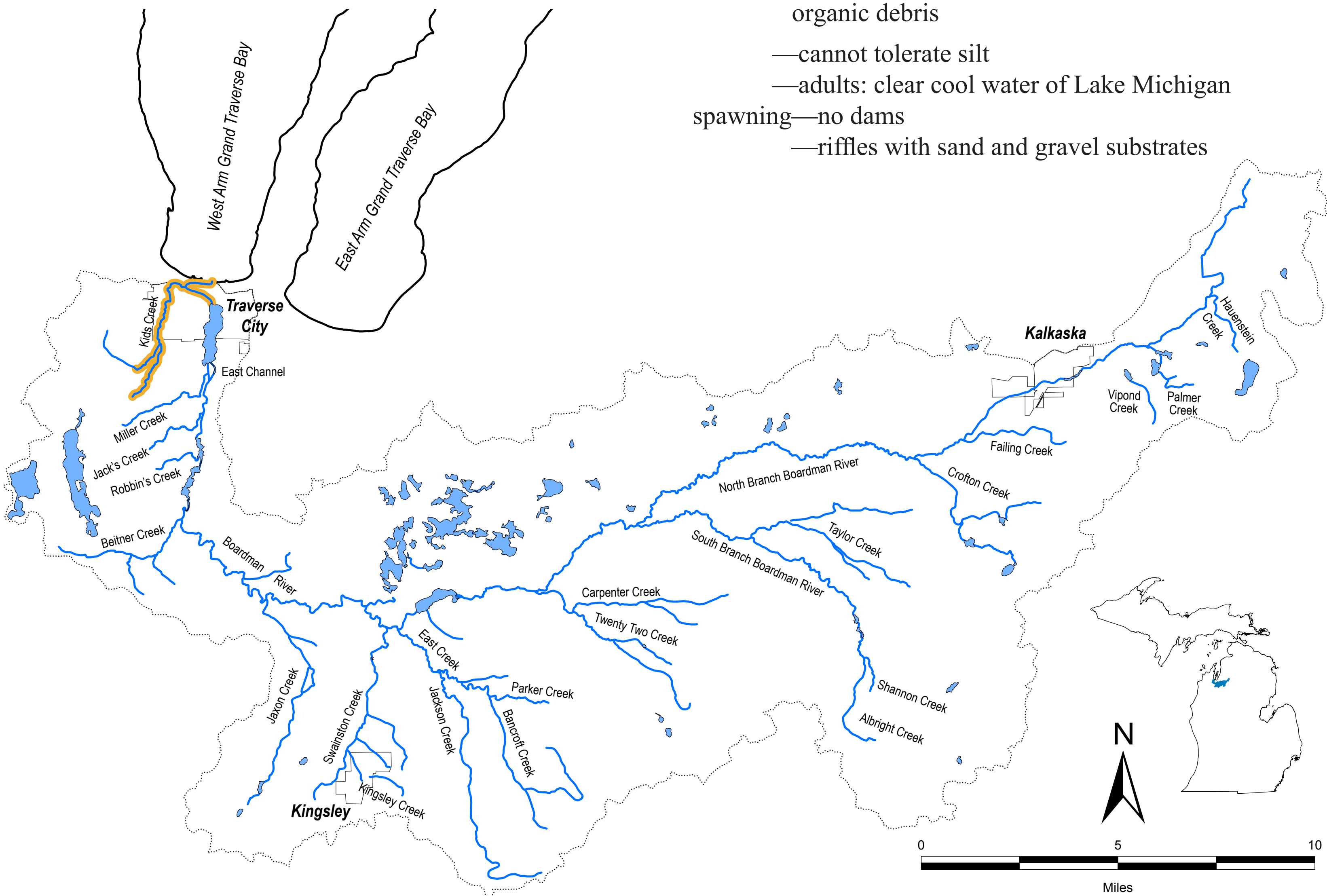
Habitat**:** feeding—young: substrate with beds of sand mixed with organic debris

—cannot tolerate silt

—adults: clear cool water of Lake Michigan

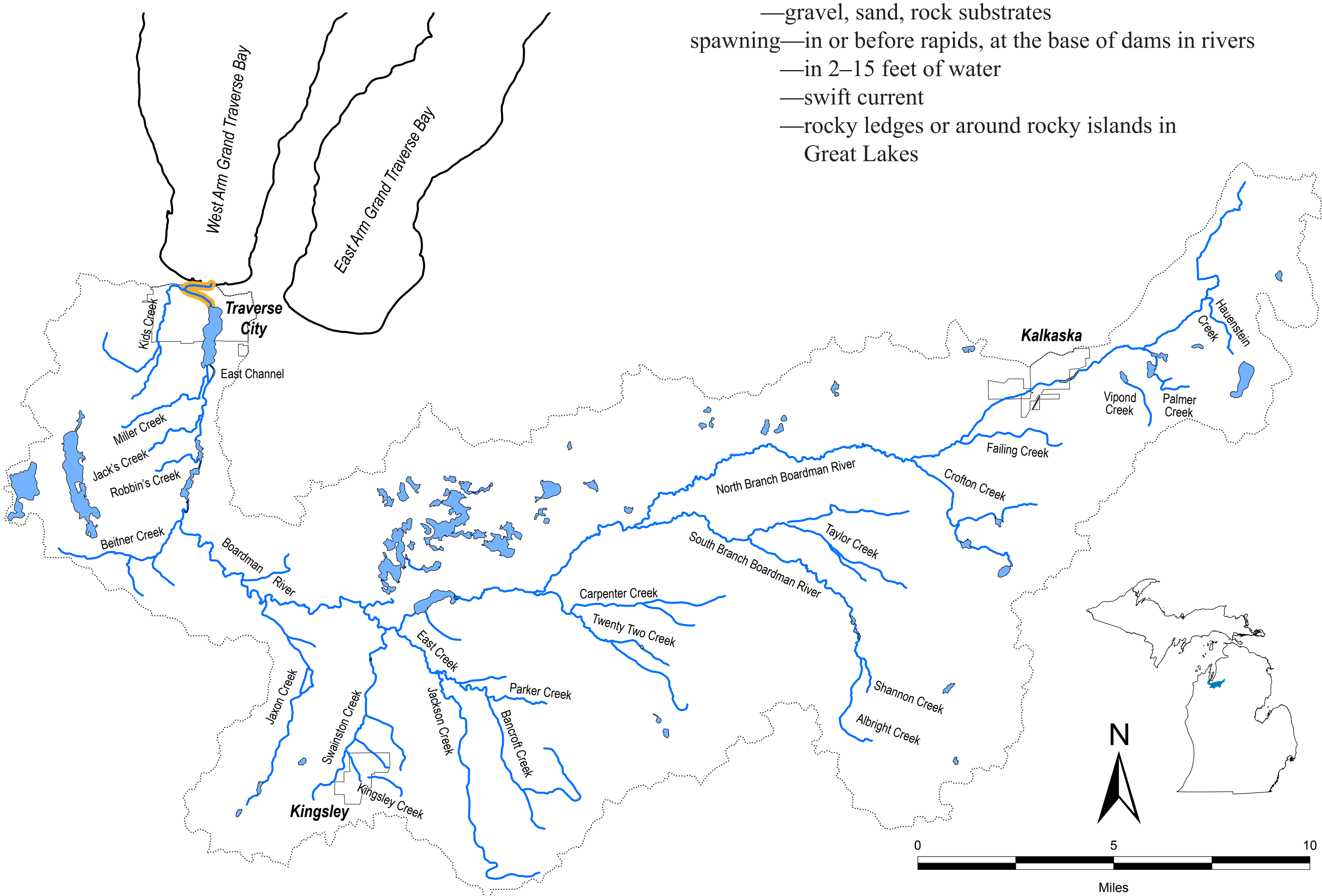
spawning—no dams

—riffles with sand and gravel substrates



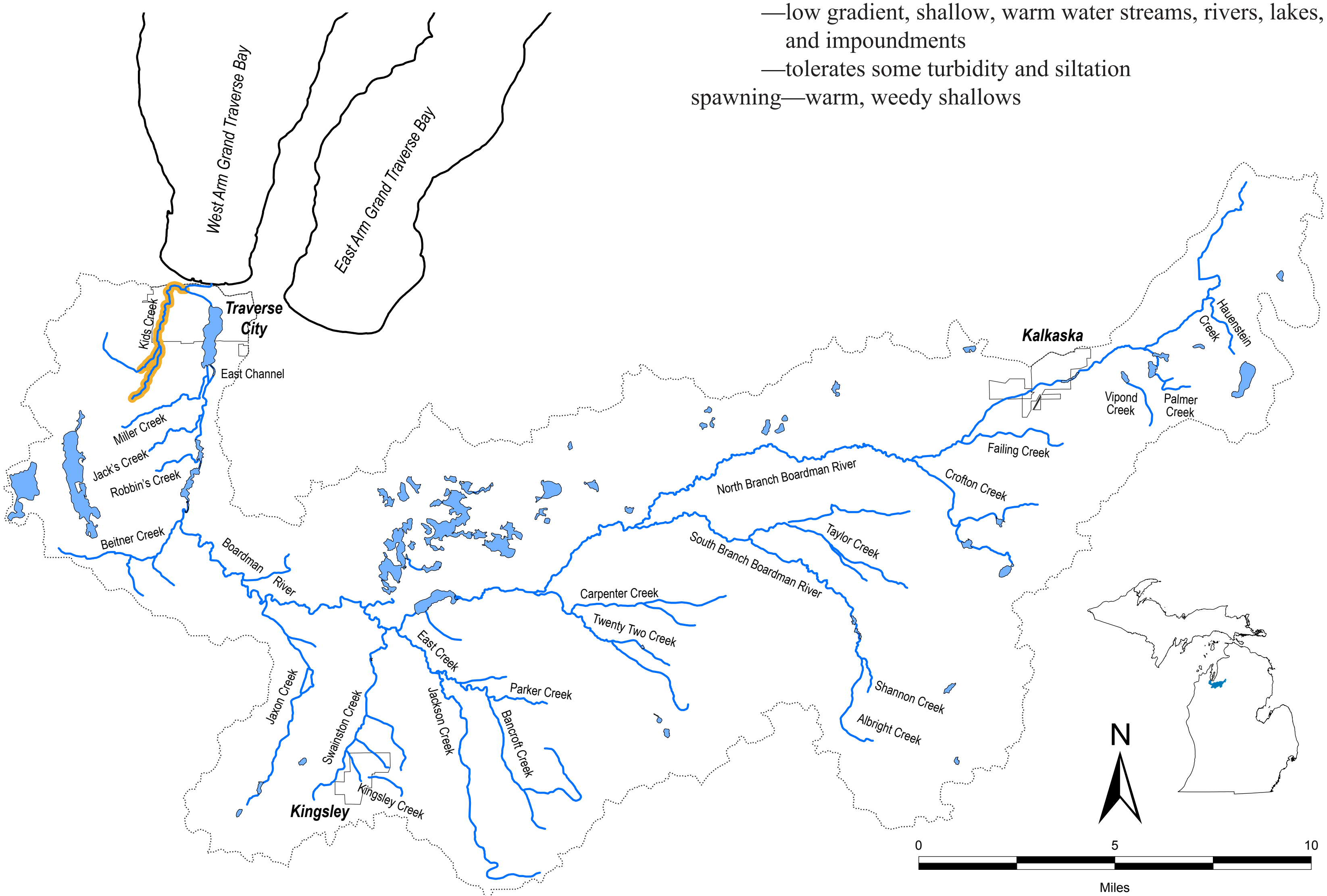
Lake Sturgeon *Acipenser fulvescens* – **threatened**

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



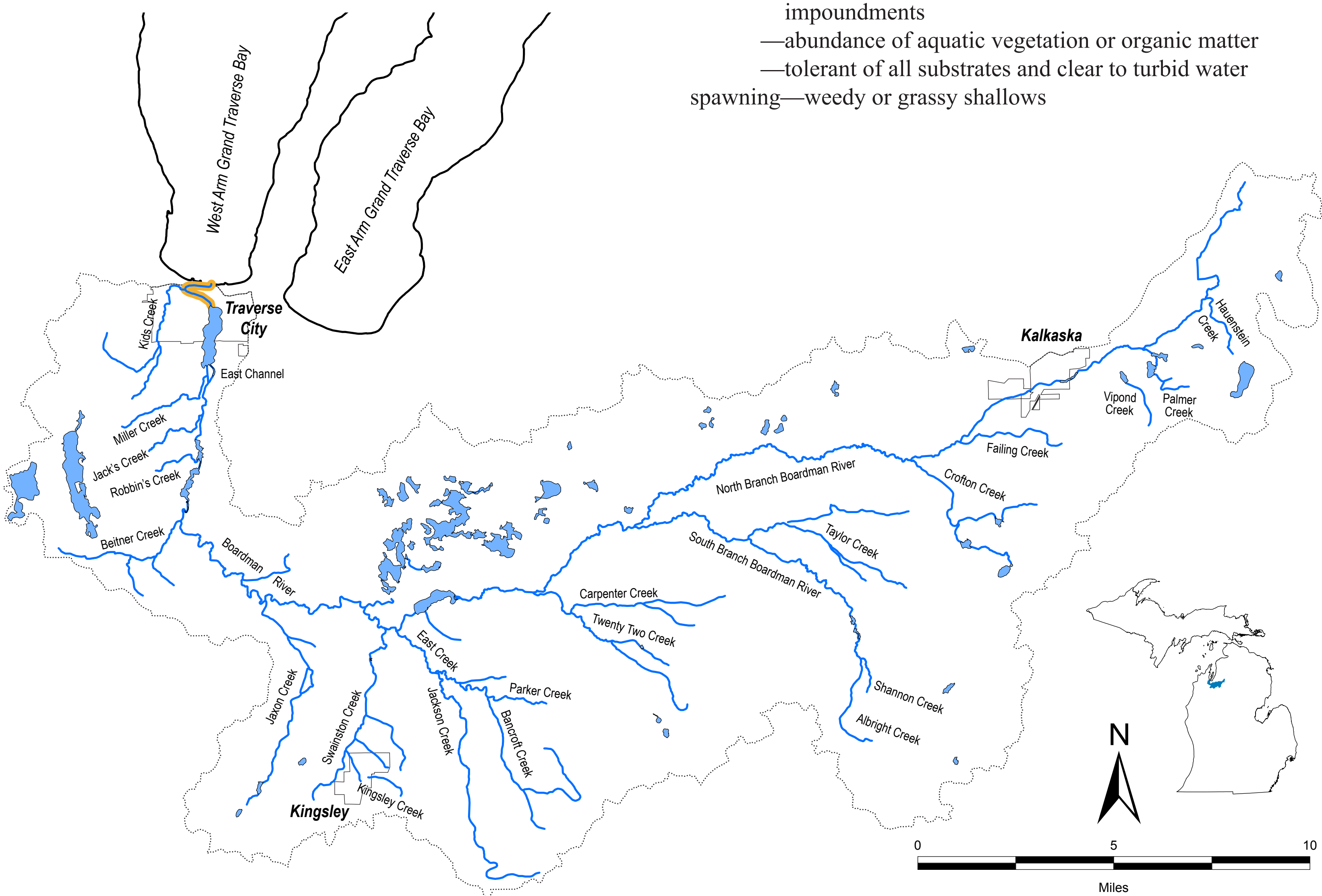
Goldfish *Carassius auratus*

Habitat: feeding—vegetation
—low gradient, shallow, warm water streams, rivers, lakes, and impoundments
—tolerates some turbidity and siltation
spawning—warm, weedy shallows



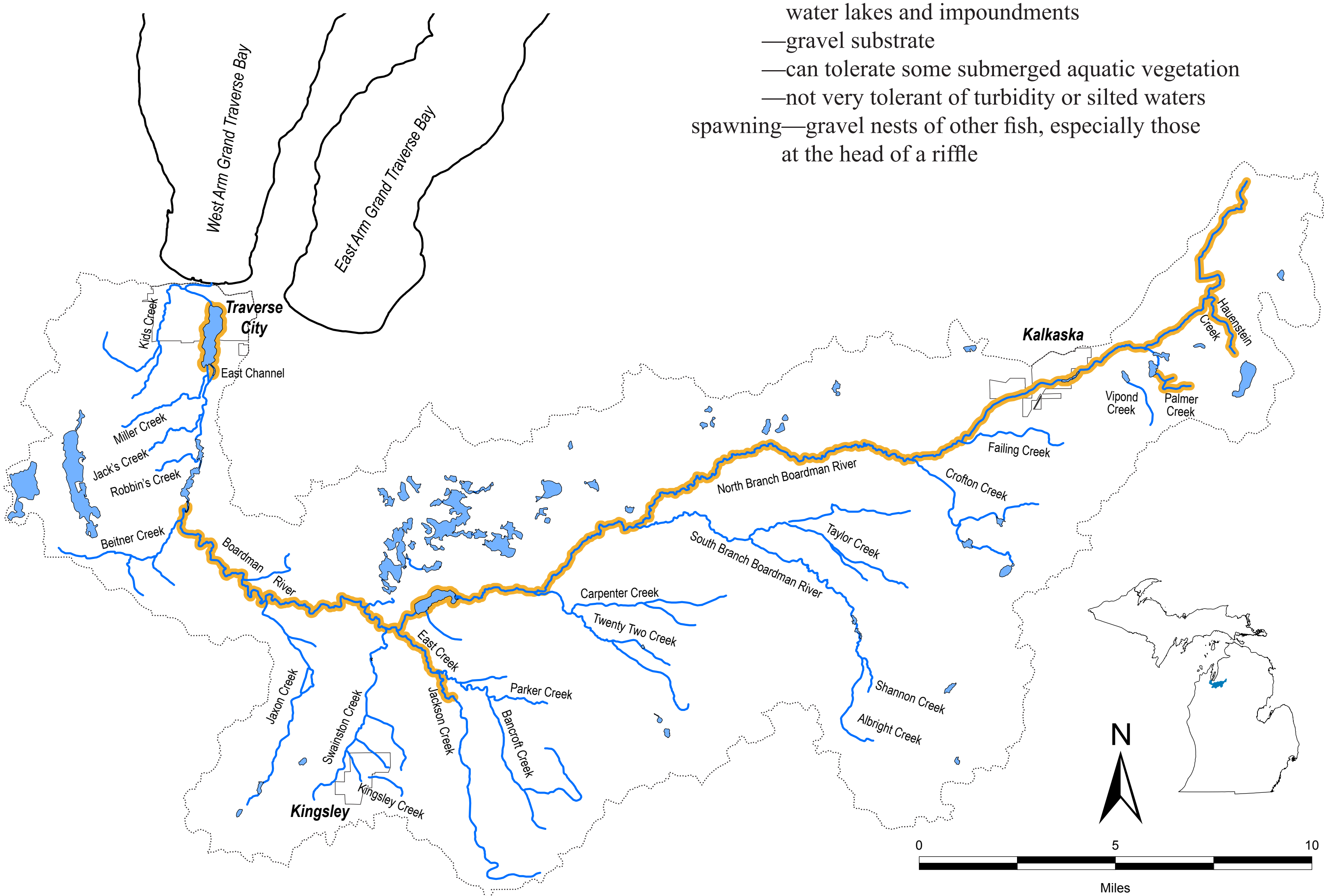
Common Carp *Cyprinus carpio*

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



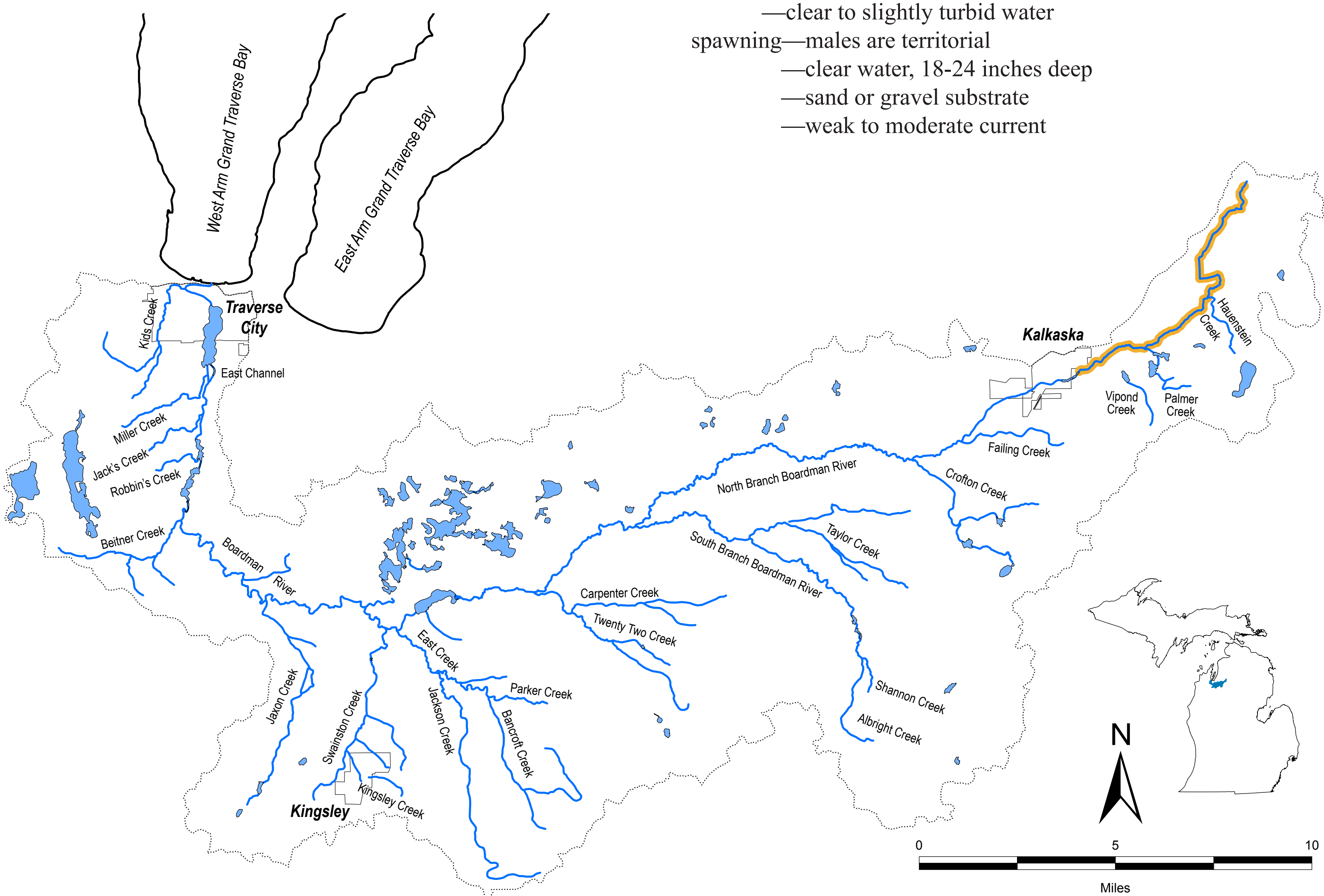
Common Shiner *Luxilus cornutus*

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



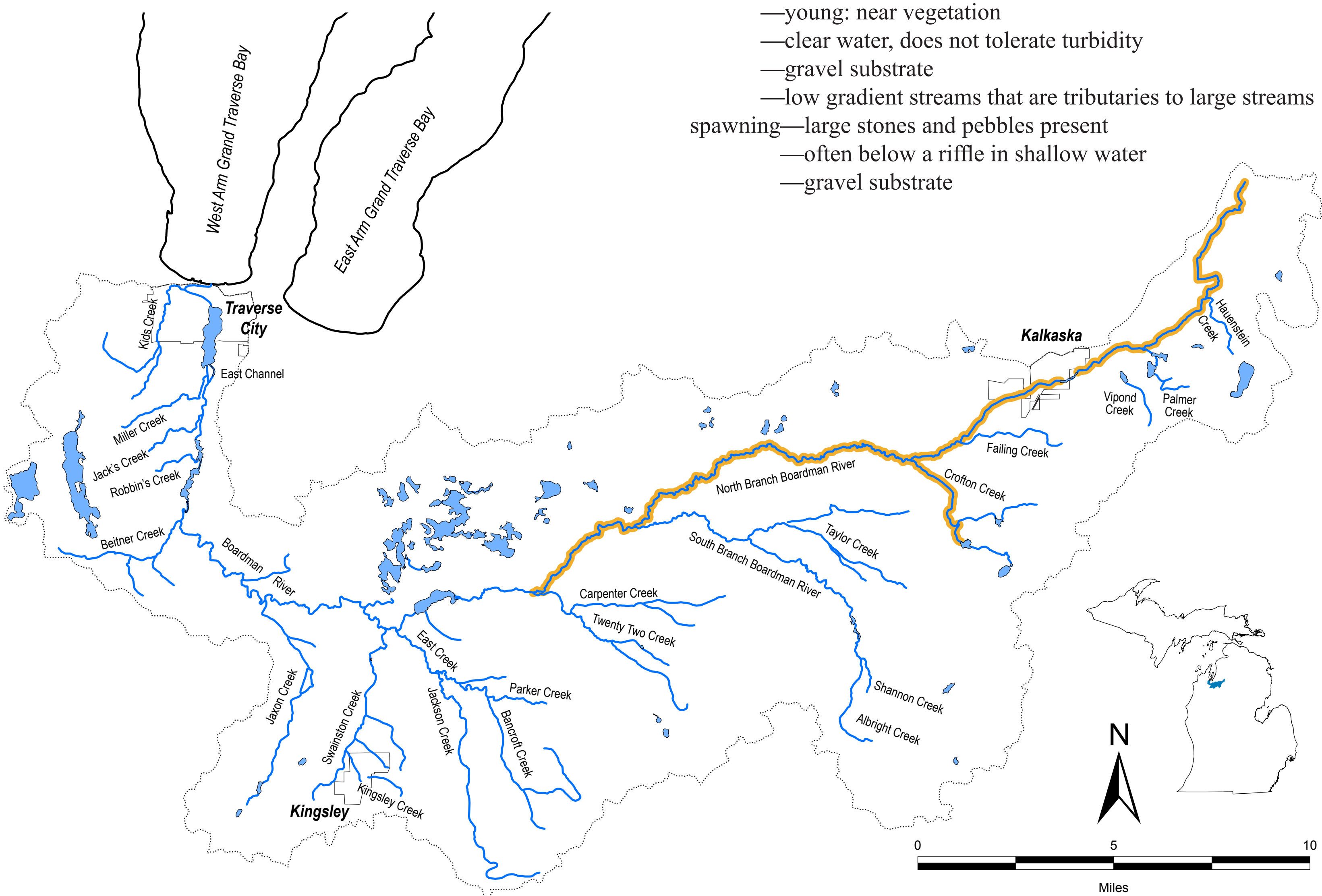
Northern Pearl Dace *Margariscus nachtriebi*

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



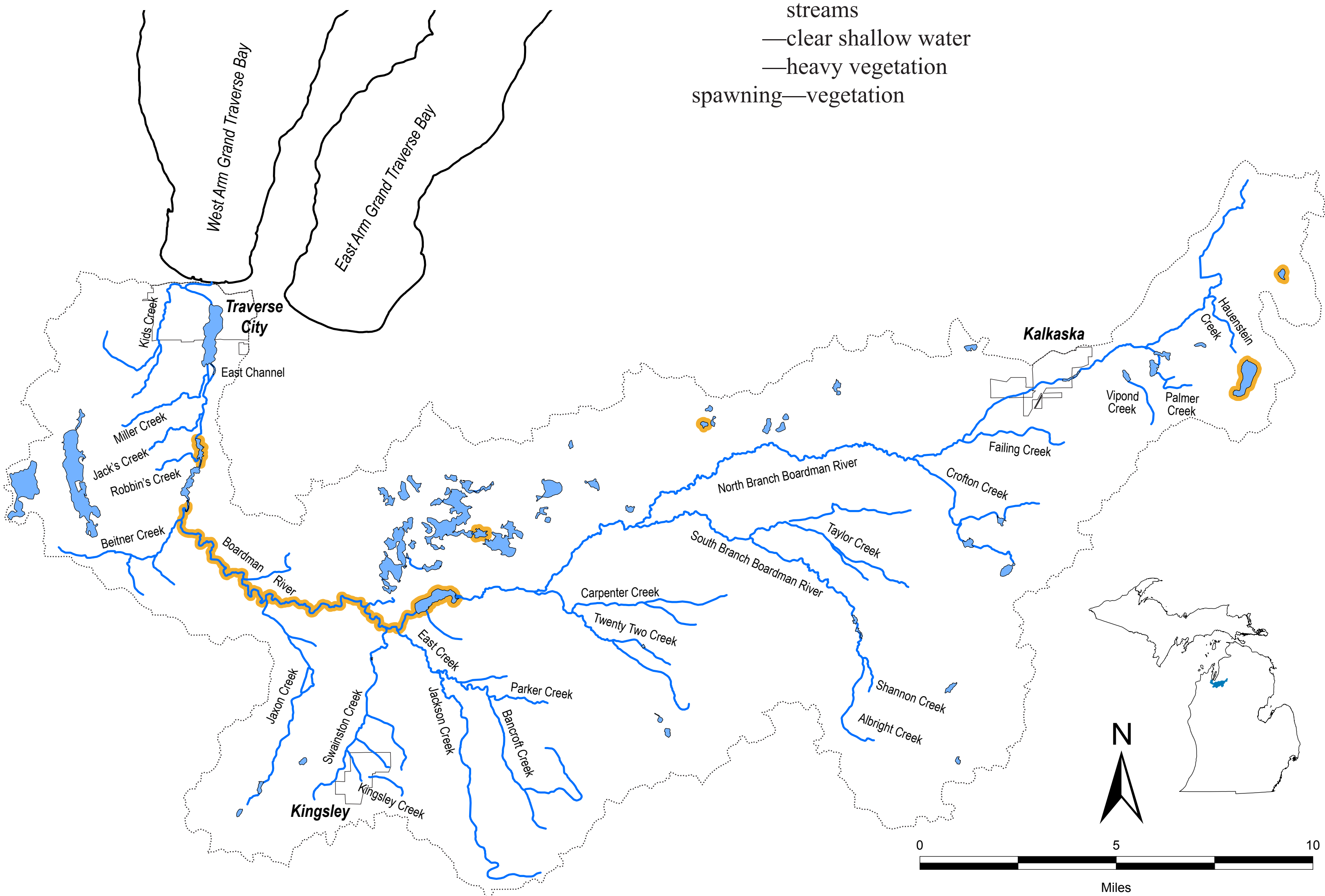
Hornyhead Chub *Nocomis biguttatus*

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



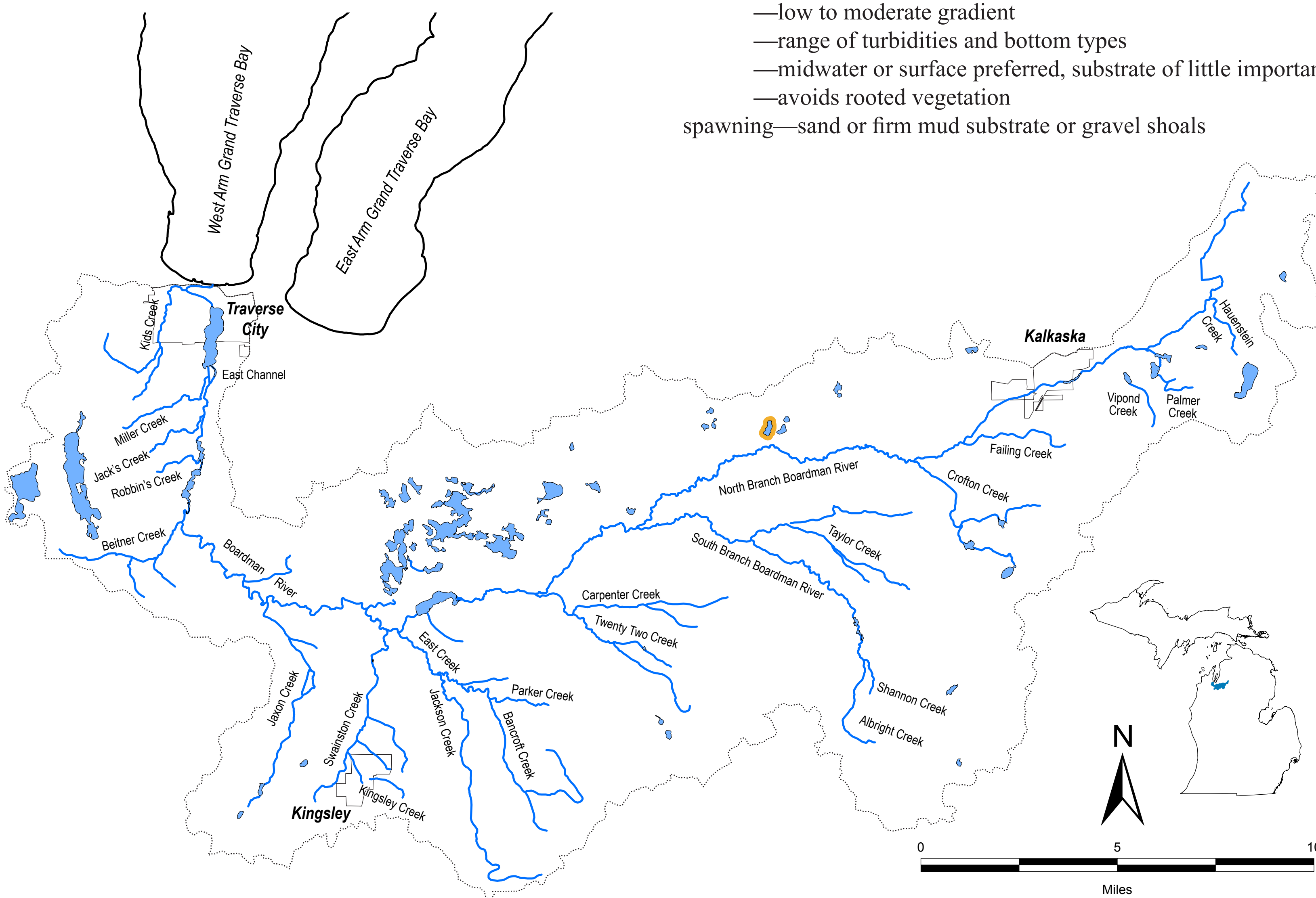
Golden Shiner *Notemigonus crysoleucas*

Habitat: feeding—lakes and impoundments and quiet pools of low-gradient streams
—clear shallow water
—heavy vegetation
spawning—vegetation



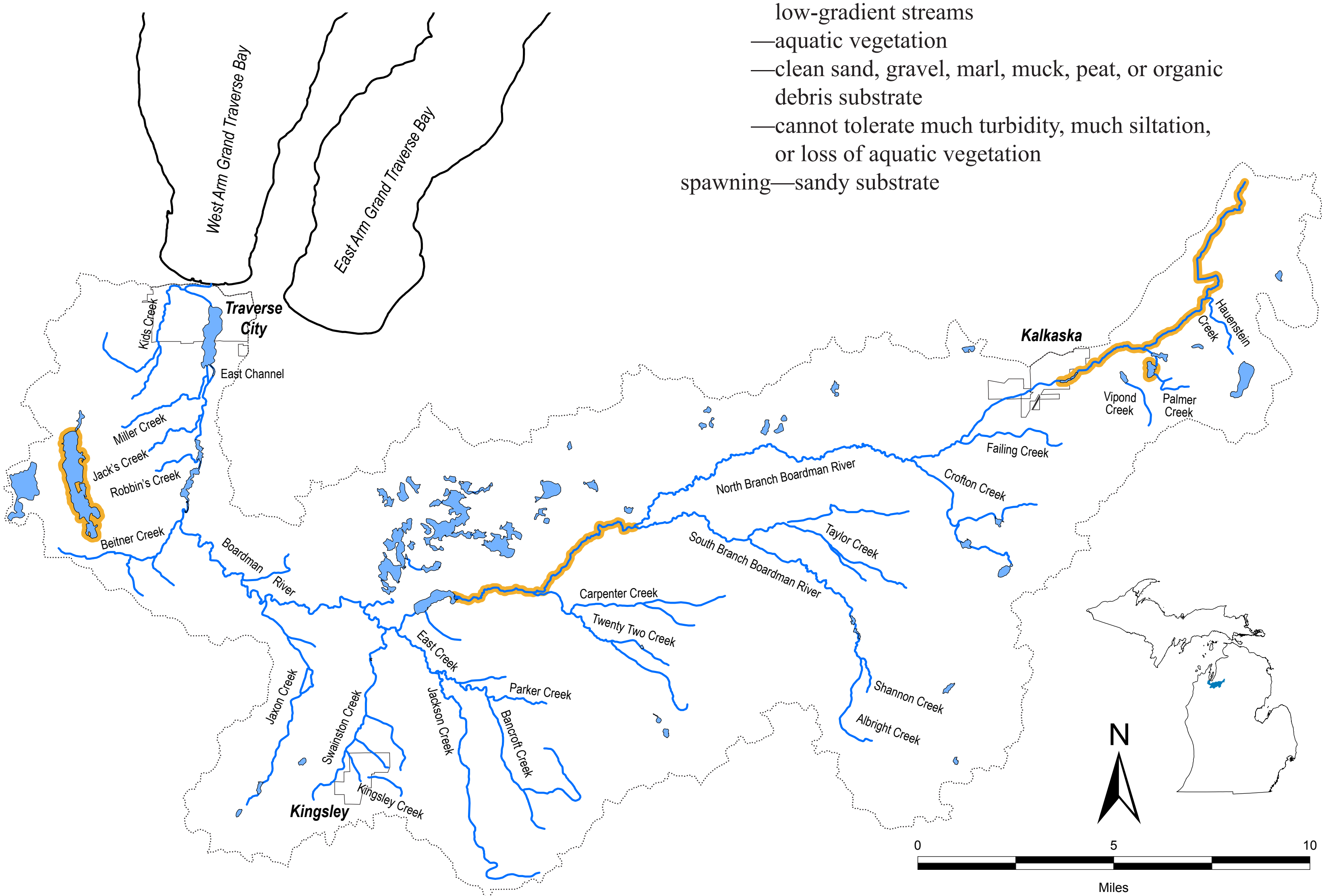
Emerald Shiner *Notropis atherinoides*

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



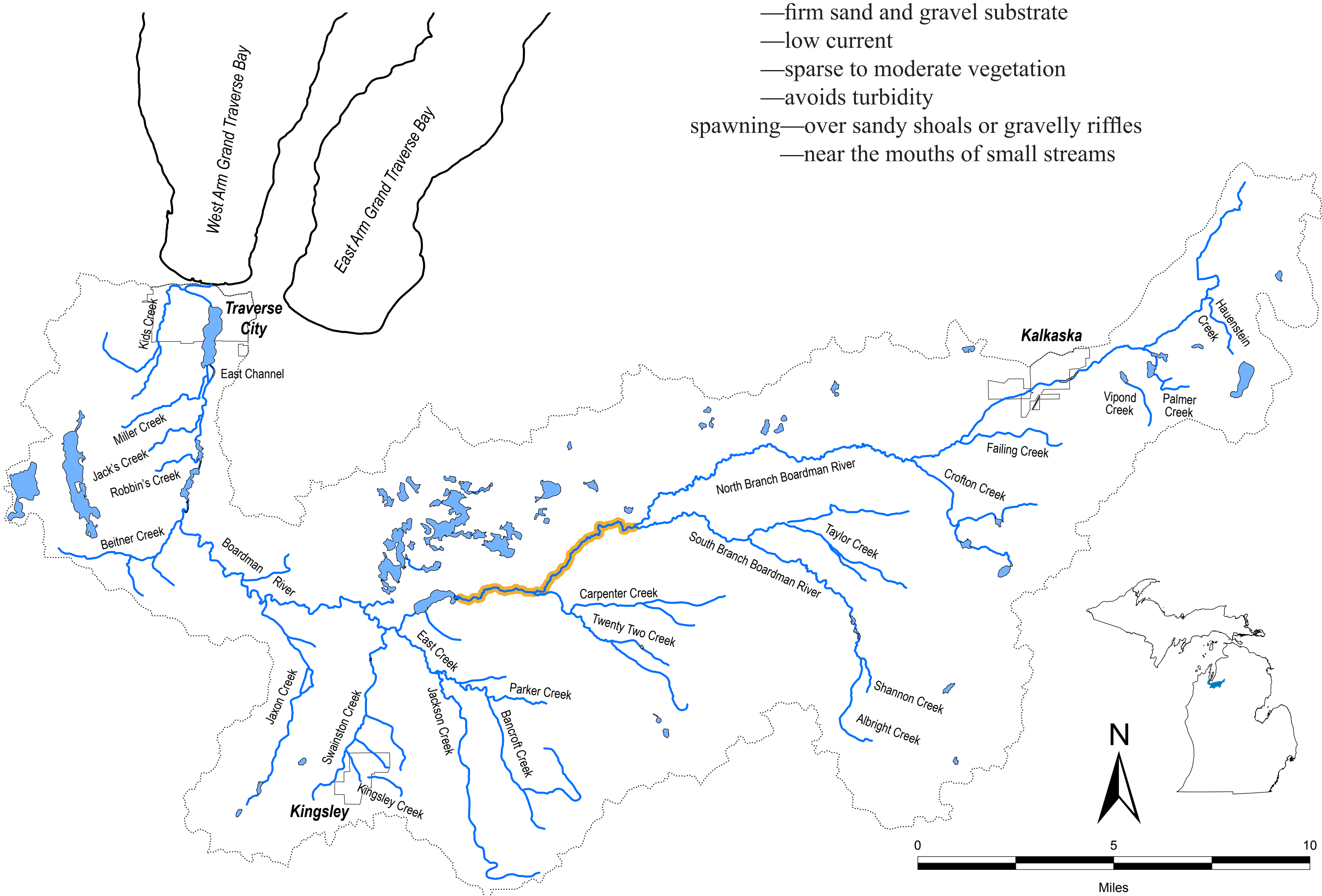
Blacknose Shiner *Notropis heterolepis*

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



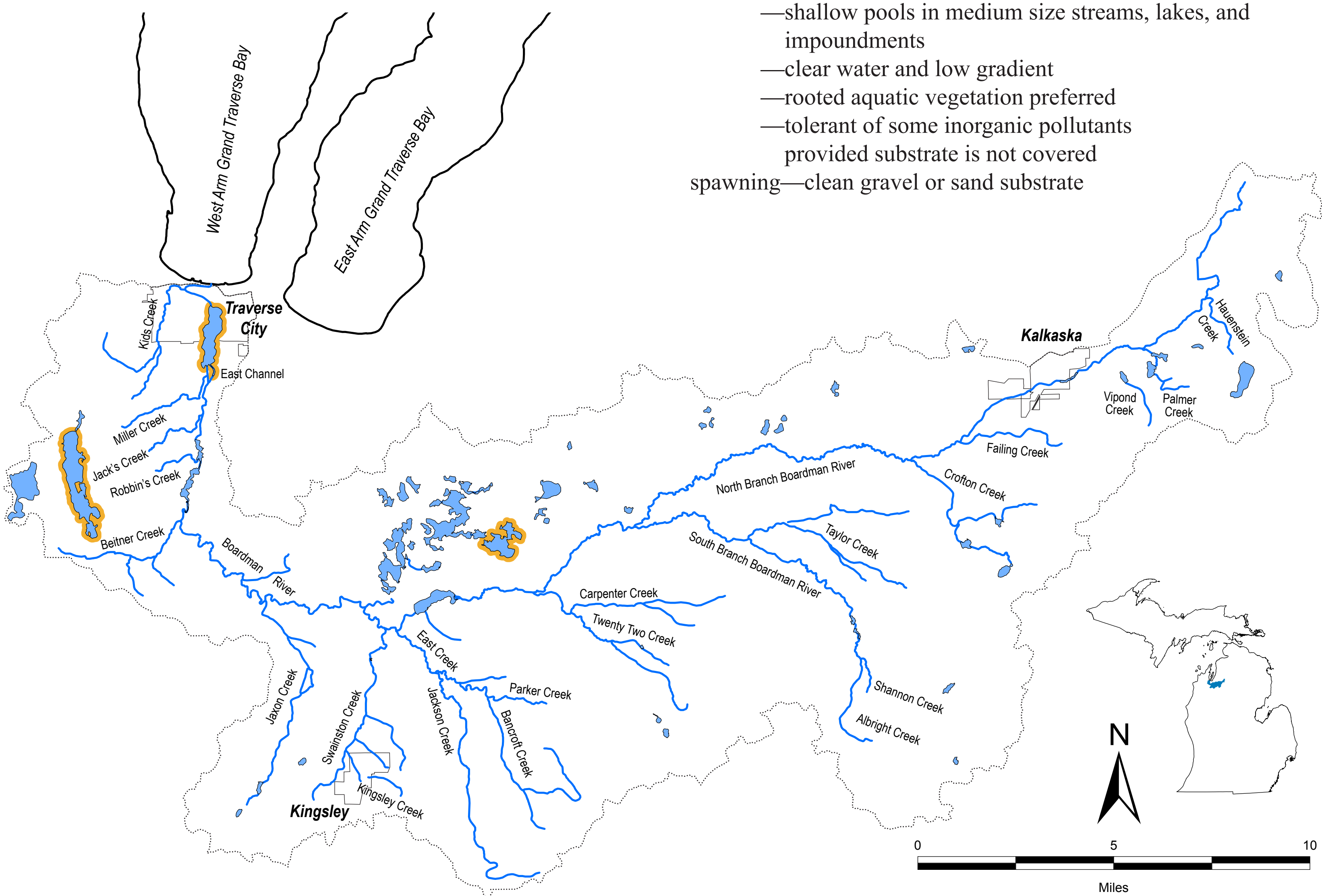
Spottail Shiner *Notropis hudsonius*

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



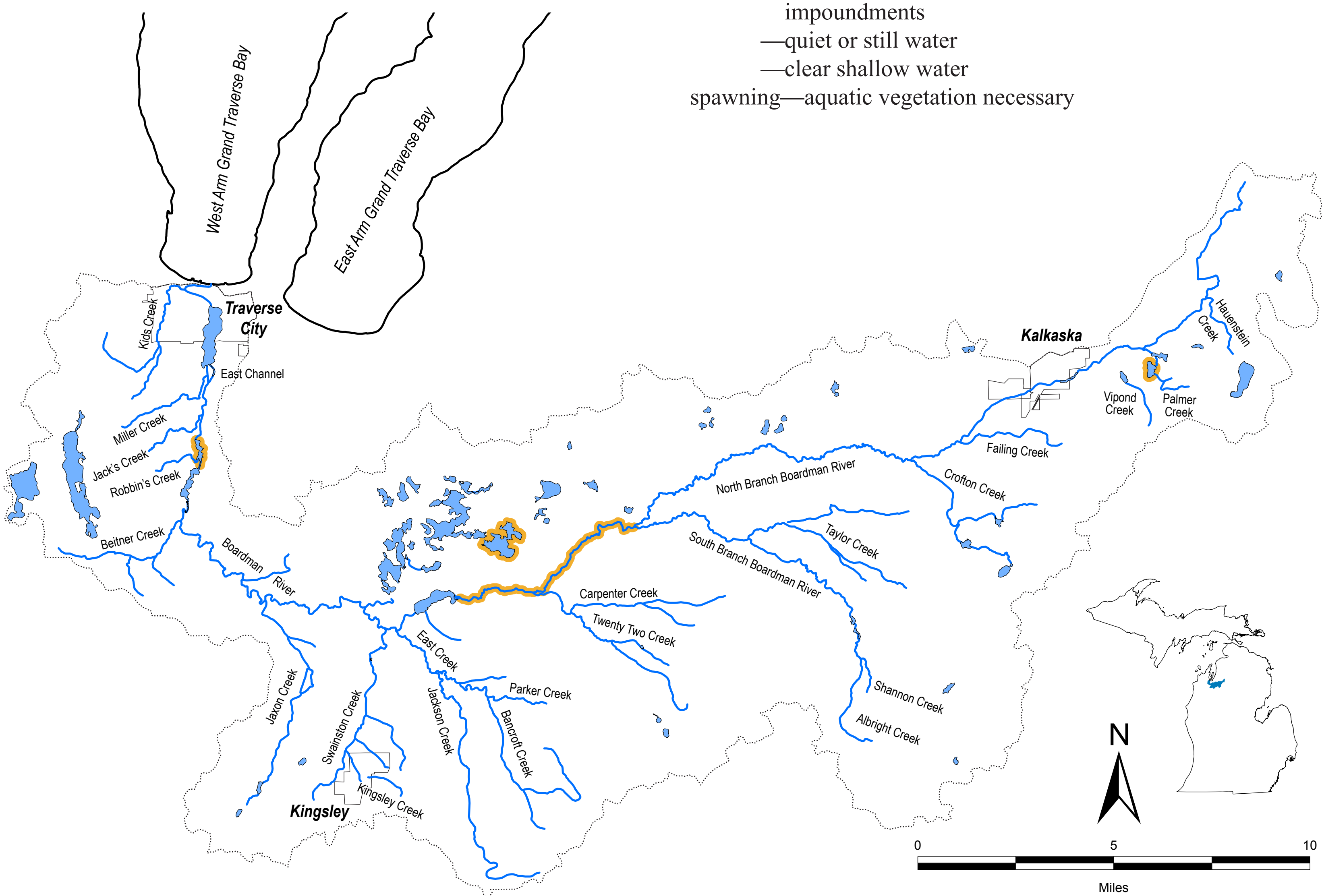
Sand Shiner *Notropis stramineus*

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



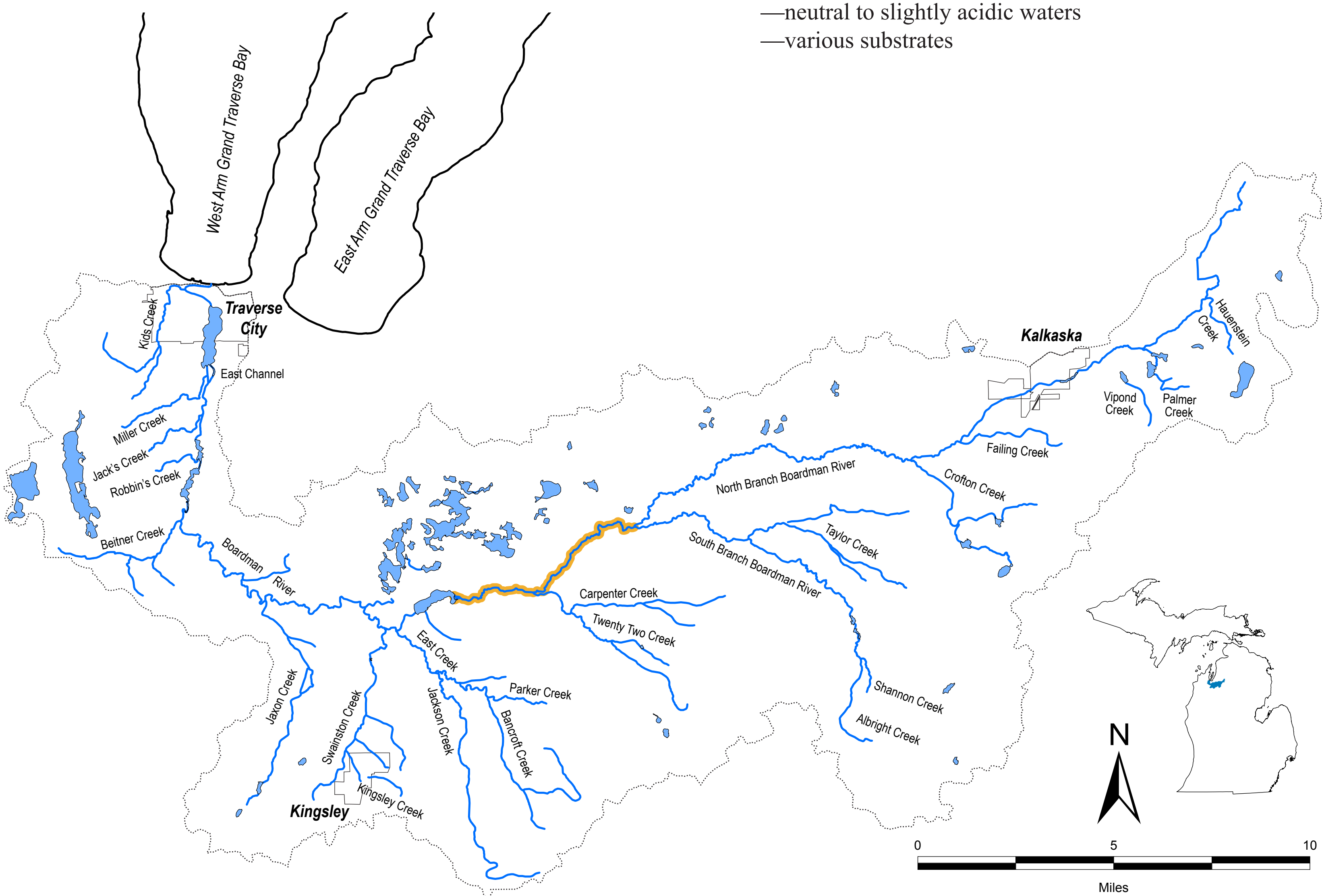
Mimic Shiner *Notropis volucellus*

Habitat: feeding—pools and backwater of streams, moderately weedy lakes and impoundments
—quiet or still water
—clear shallow water
spawning—aquatic vegetation necessary



Finescale Dace *Phoxinus neogaeus*

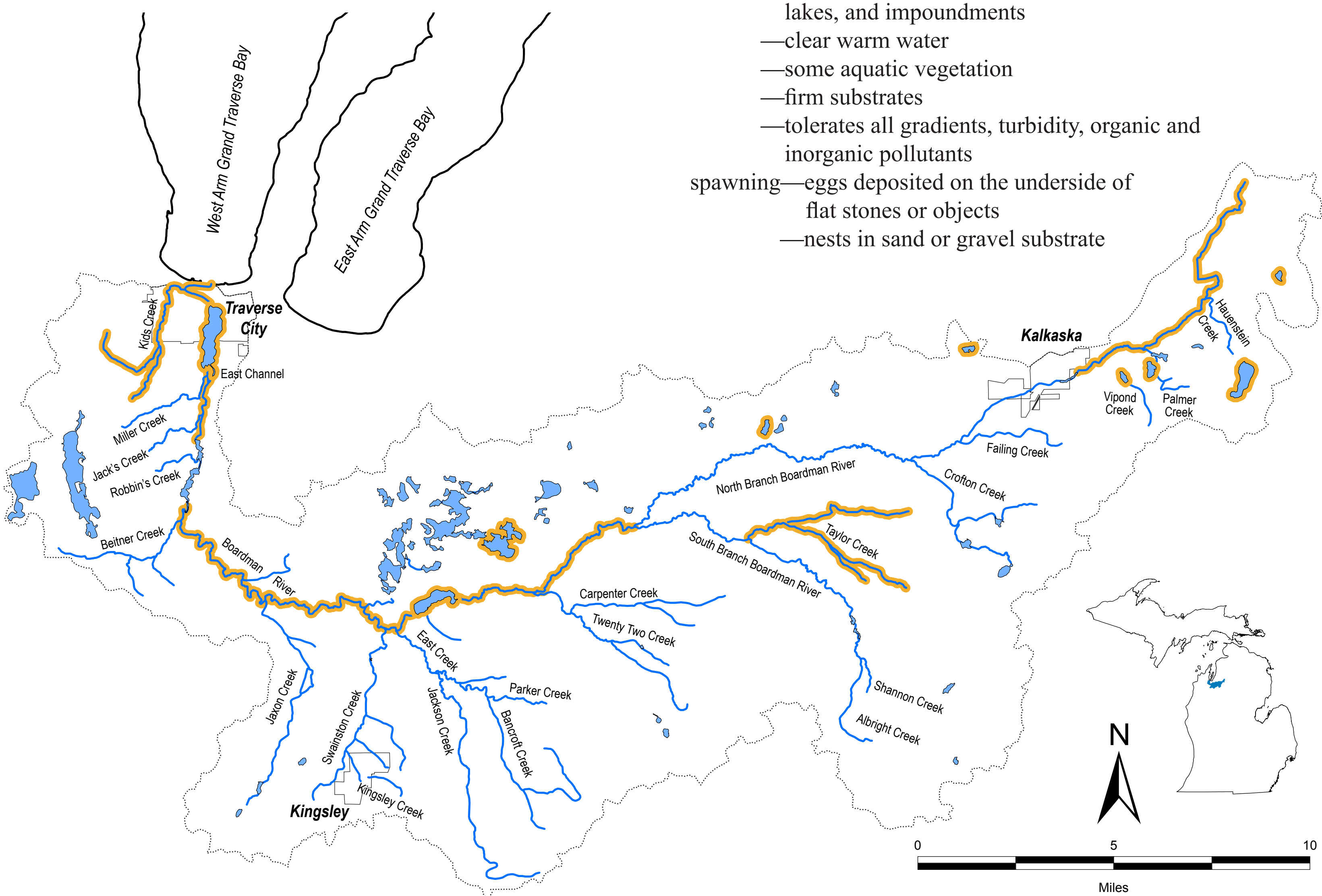
Habitat: feeding—cool bog lakes and streams
—neutral to slightly acidic waters
—various substrates



Bluntnose Minnow *Pimephales notatus*

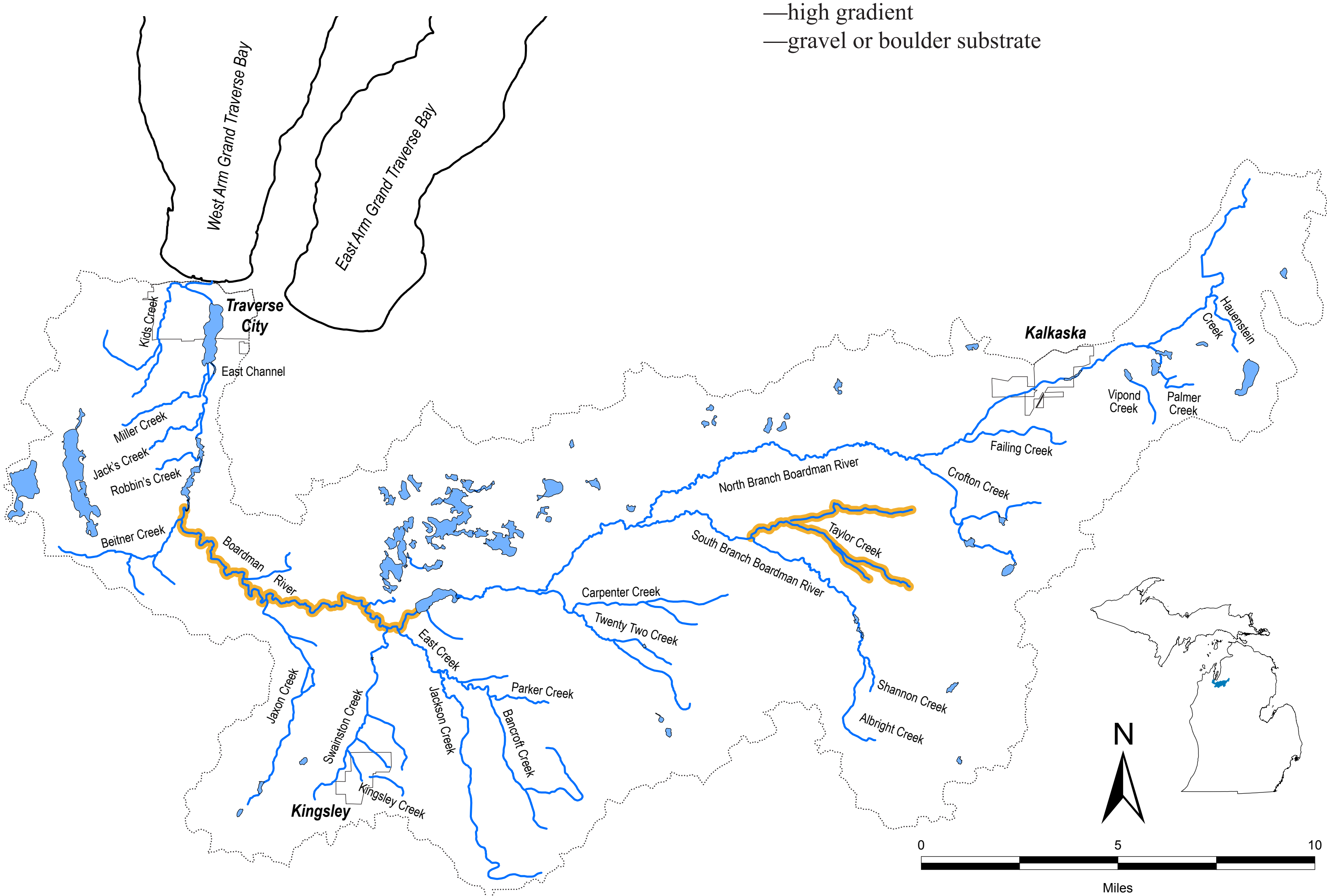
Habitat: feeding—quiet pools and backwaters of medium to large streams, lakes, and impoundments
—clear warm water
—some aquatic vegetation
—firm substrates
—tolerates all gradients, turbidity, organic and inorganic pollutants

spawning—eggs deposited on the underside of flat stones or objects
—nests in sand or gravel substrate



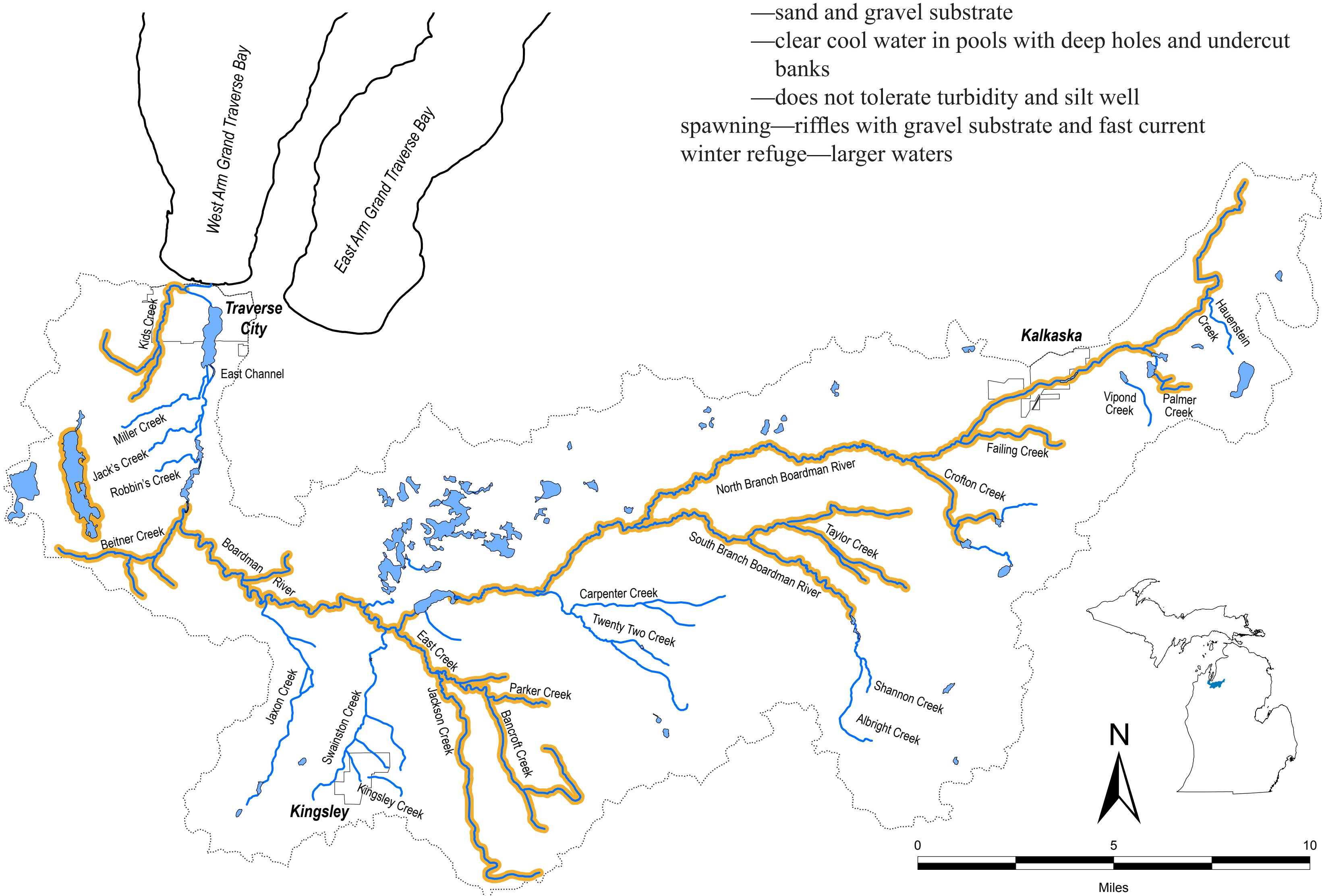
Longnose Dace *Rhinichthys cataractae*

Habitat: feeding—lakes and streams
—high gradient
—gravel or boulder substrate



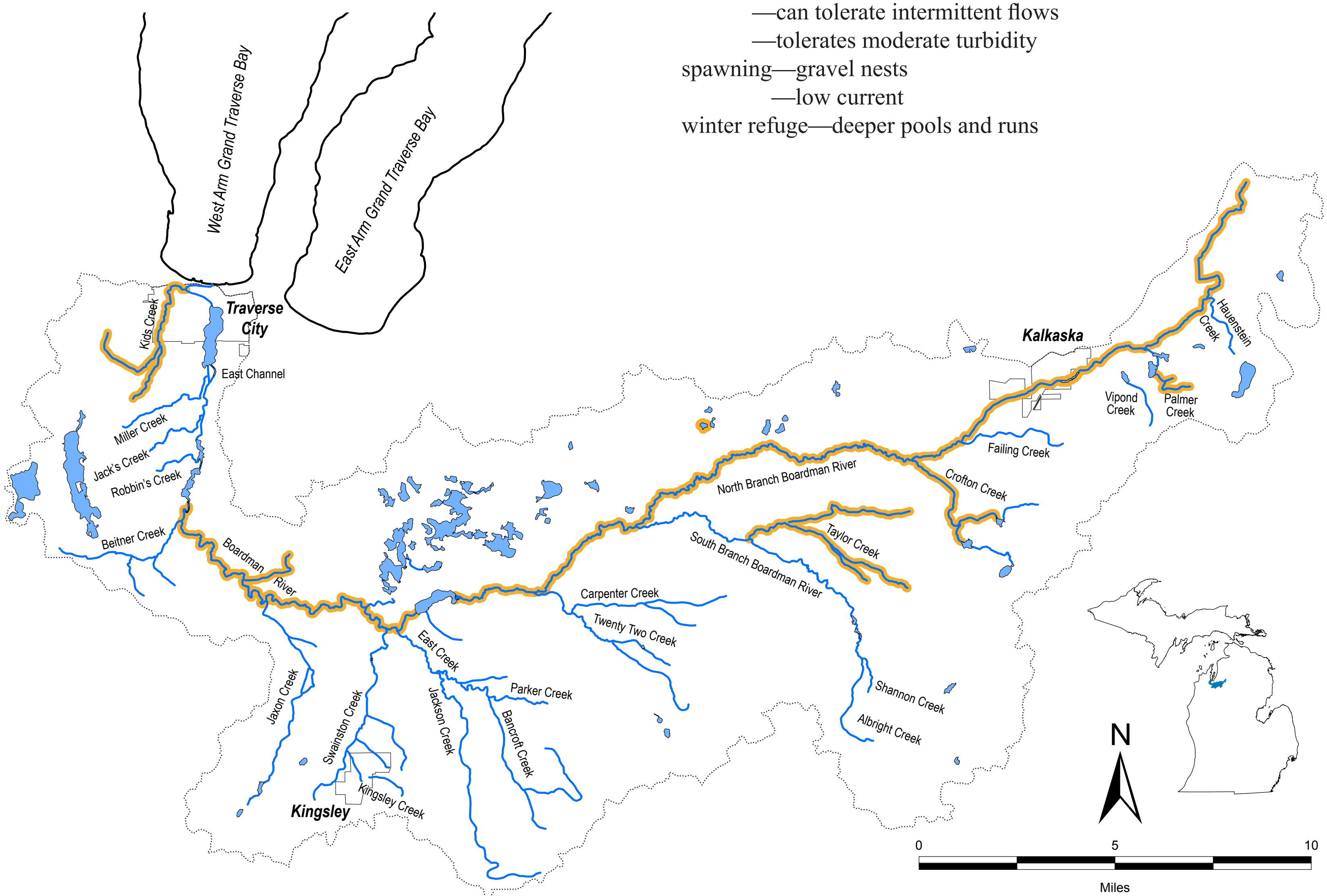
Western Blacknose Dace *Rhinichthys obtusus*

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



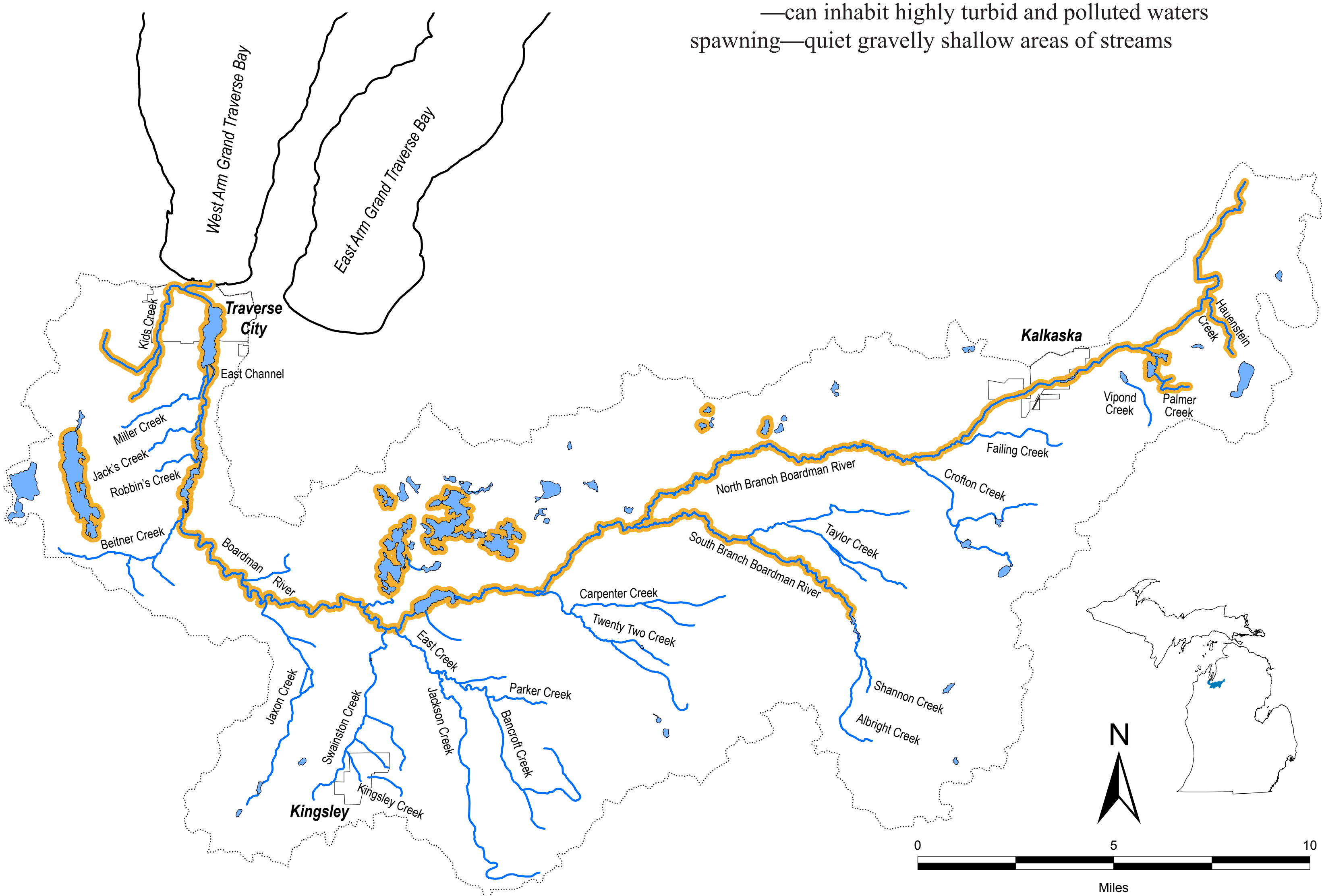
Creek Chub *Semotilus atromaculatus*

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



White Sucker *Catostomus commersonii*

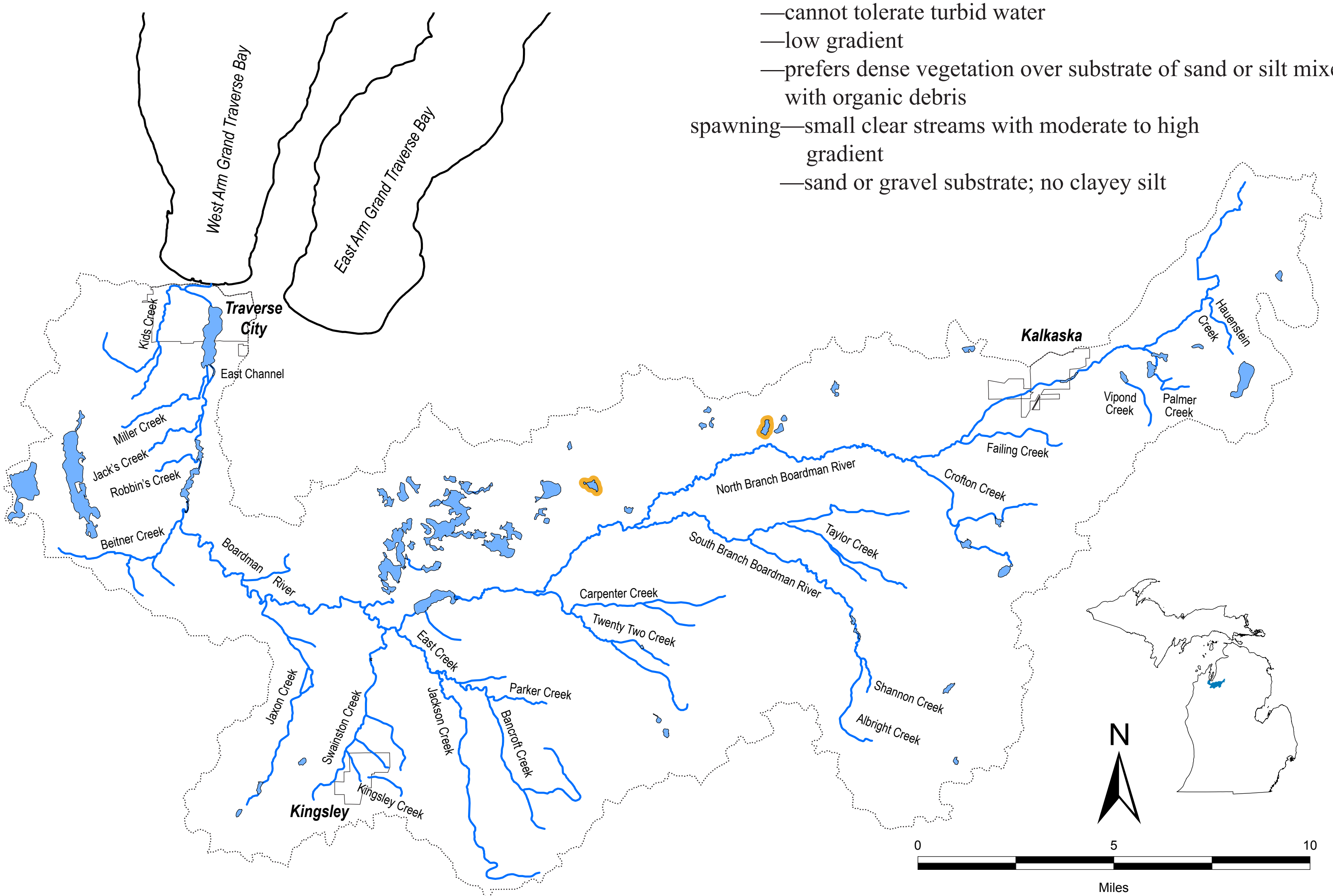
Habitat: feeding—streams, rivers, lakes, and impoundments
—can inhabit highly turbid and polluted waters
spawning—quiet gravelly shallow areas of streams



Lake Chubsucker *Erimyzon sucetta*

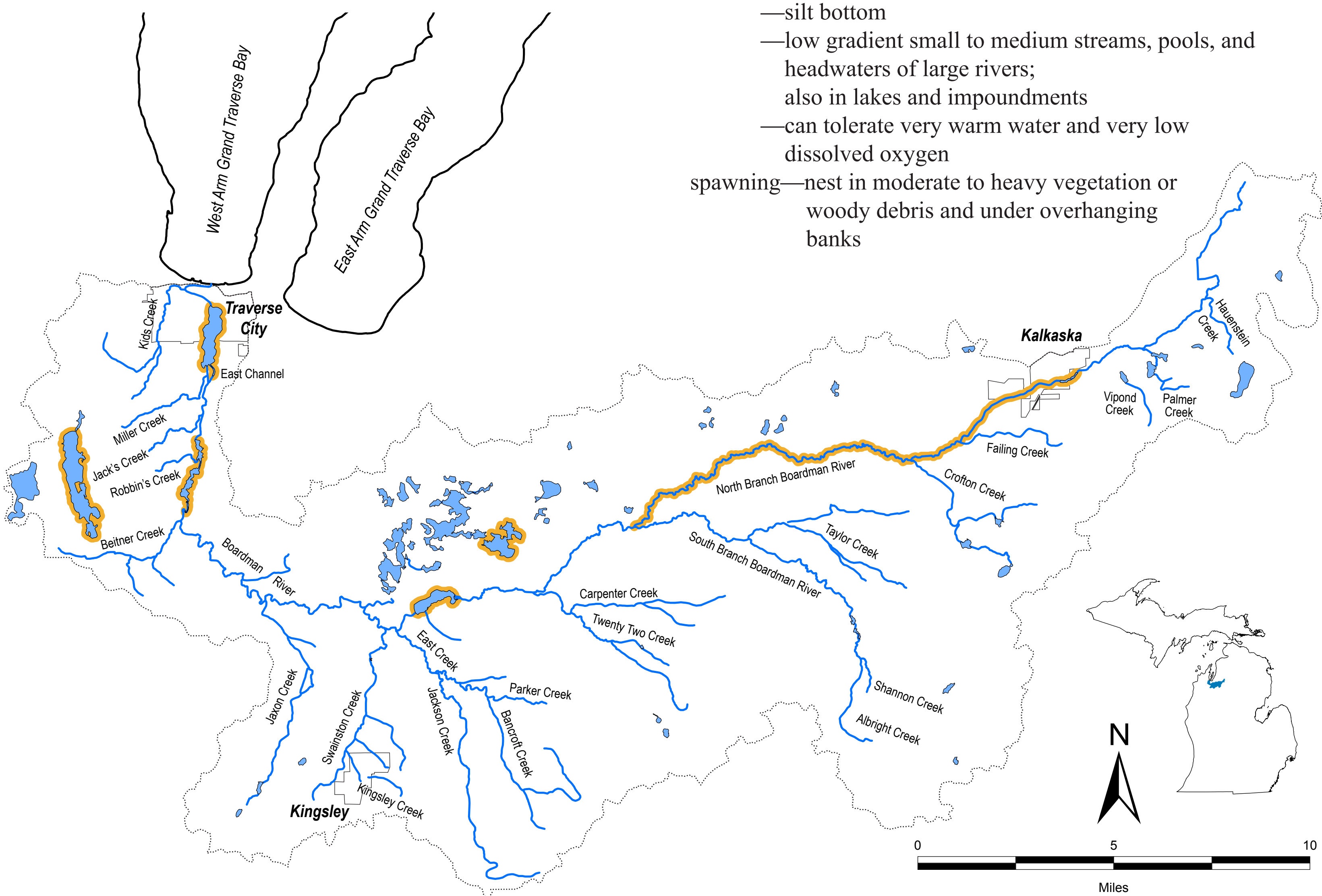
Habitat: feeding—larger clear streams, rivers, lakes, and impoundments
—cannot tolerate turbid water
—low gradient
—prefers dense vegetation over substrate of sand or silt mixed with organic debris

spawning—small clear streams with moderate to high gradient
—sand or gravel substrate; no clayey silt



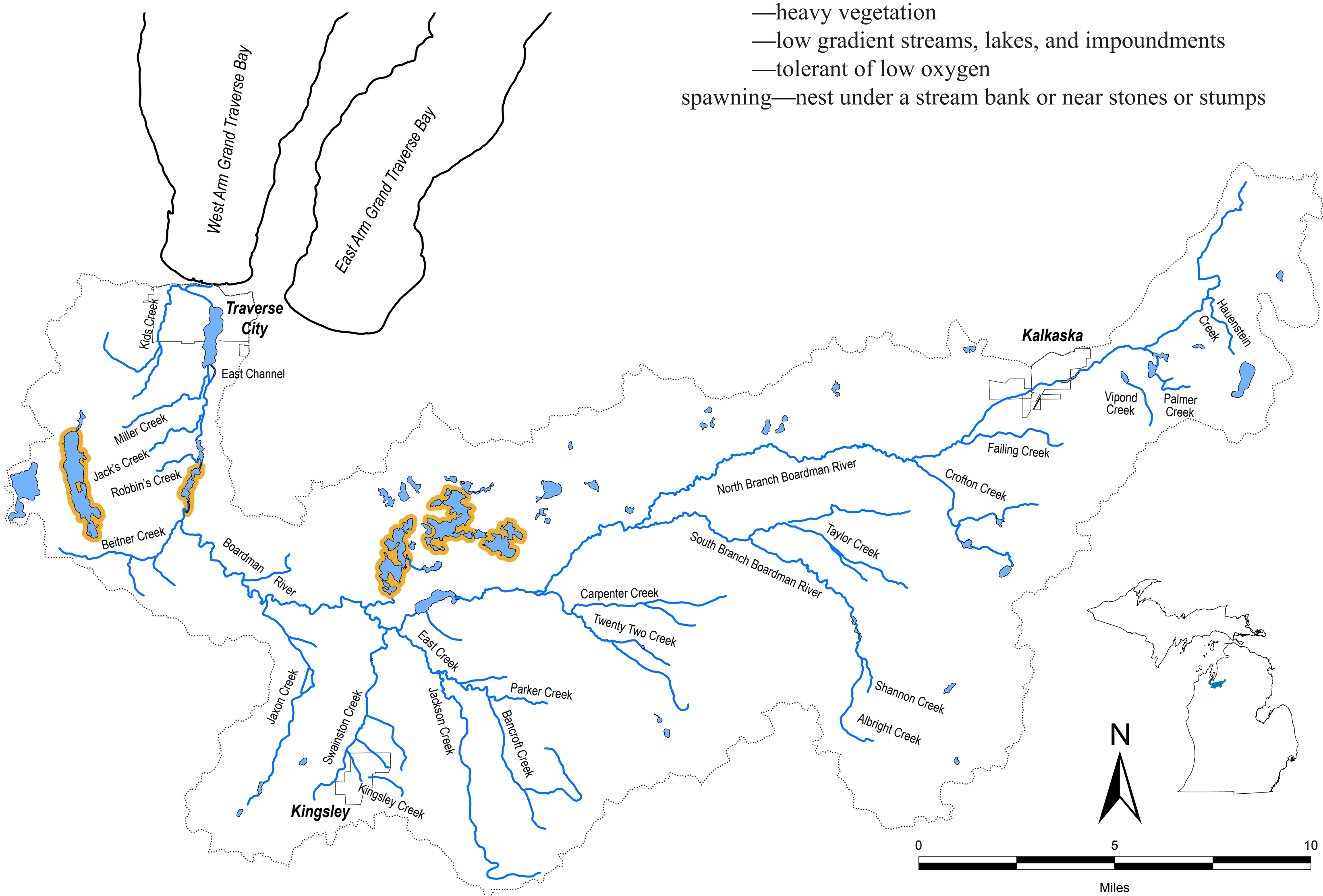
Black Bullhead *Ameiurus melas*

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



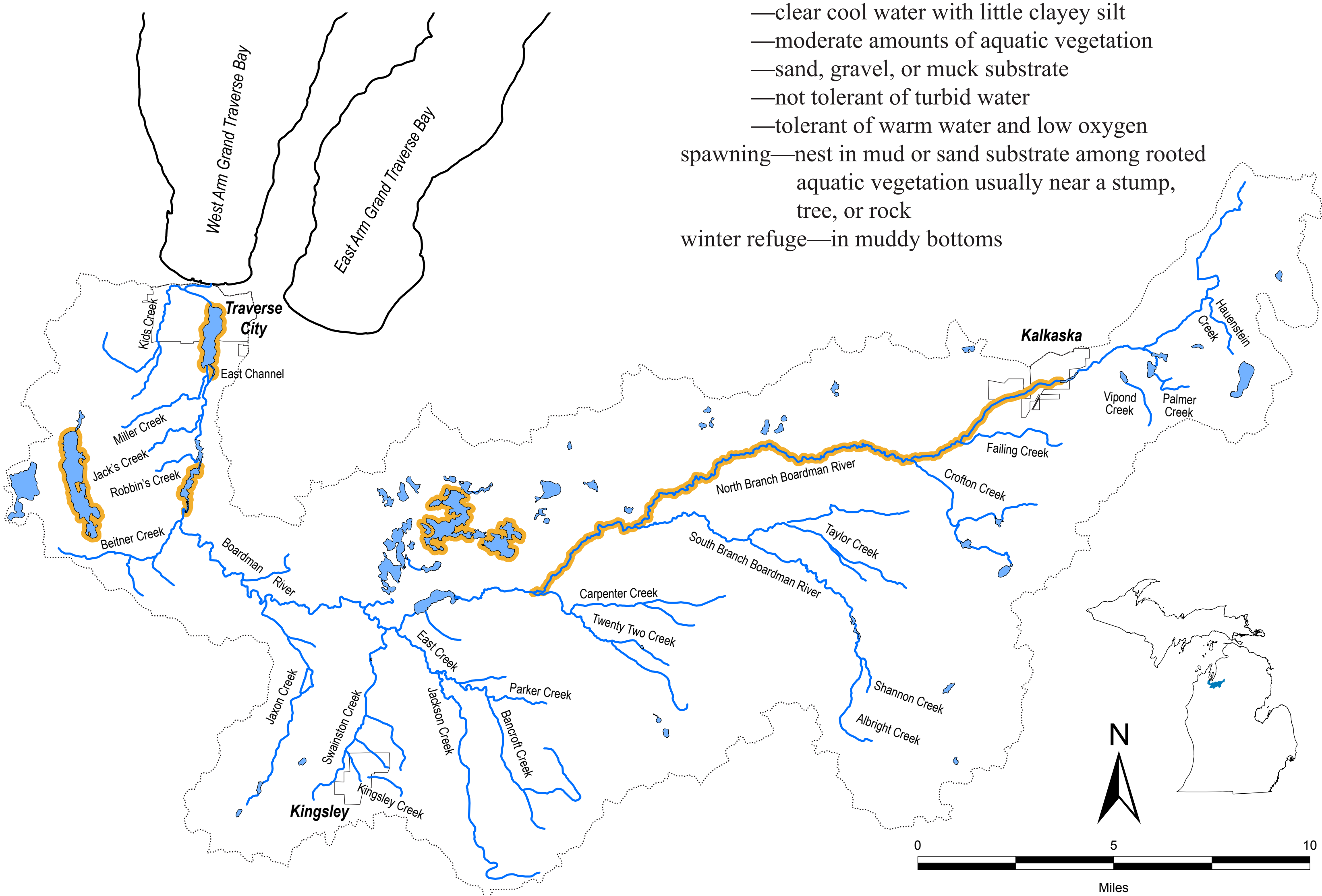
Yellow Bullhead *Ameiurus natalis*

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



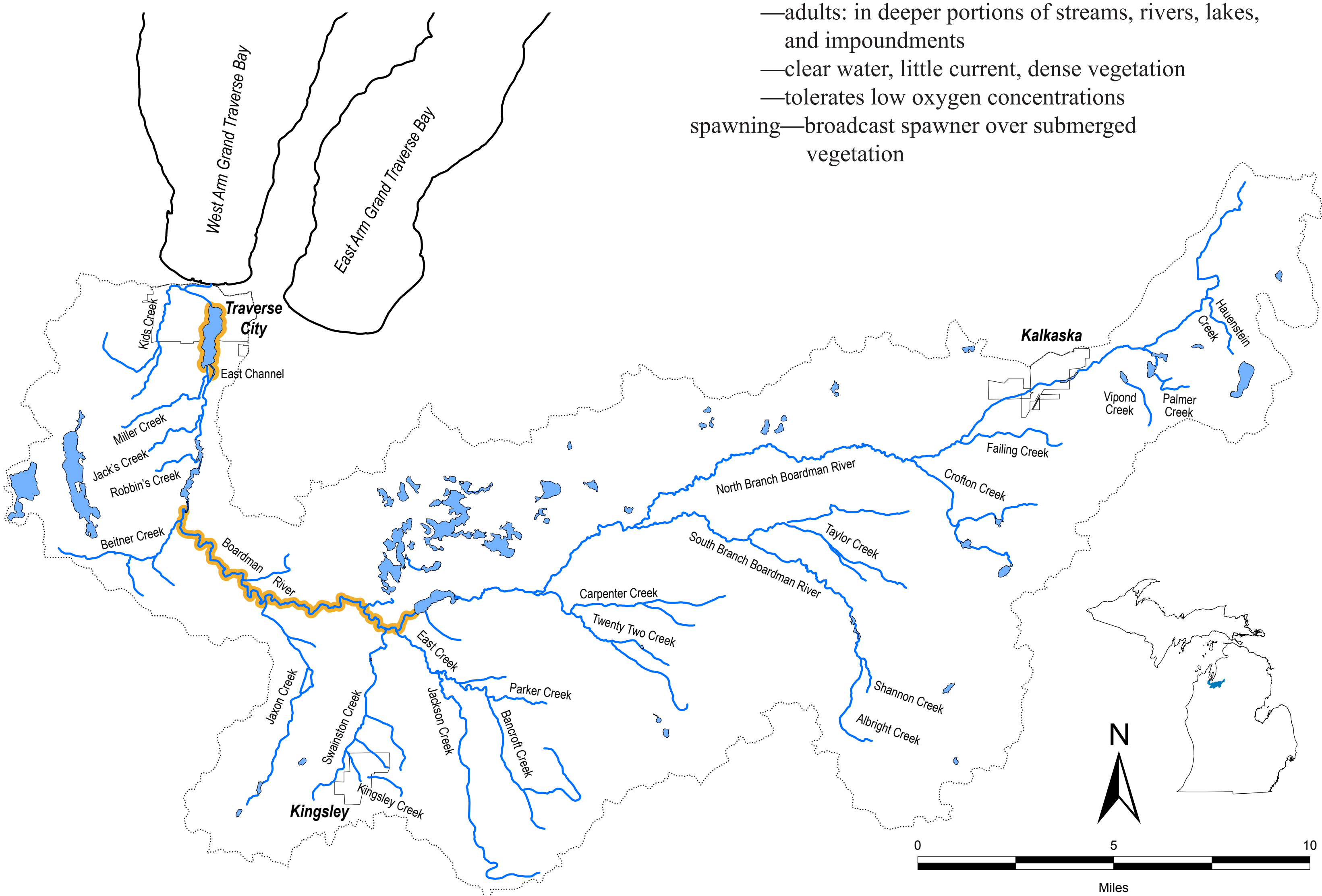
Brown Bullhead *Ameiurus nebulosus*

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



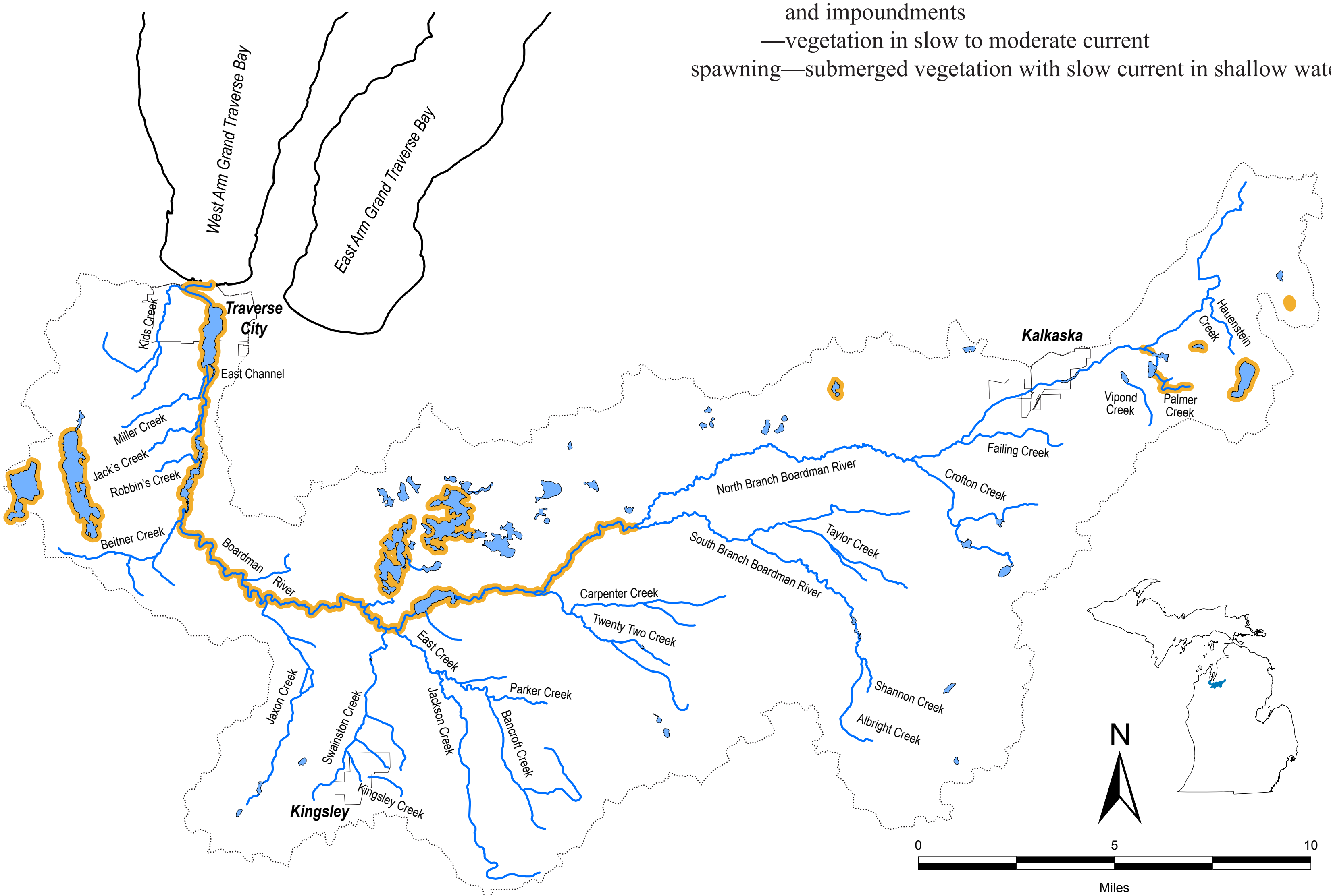
Grass Pickerel *Esox americanus vermiculatus*

Habitat**:** feeding—juveniles: along shore
—adults: in deeper portions of streams, rivers, lakes, and impoundments
—clear water, little current, dense vegetation
—tolerates low oxygen concentrations
spawning—broadcast spawner over submerged vegetation



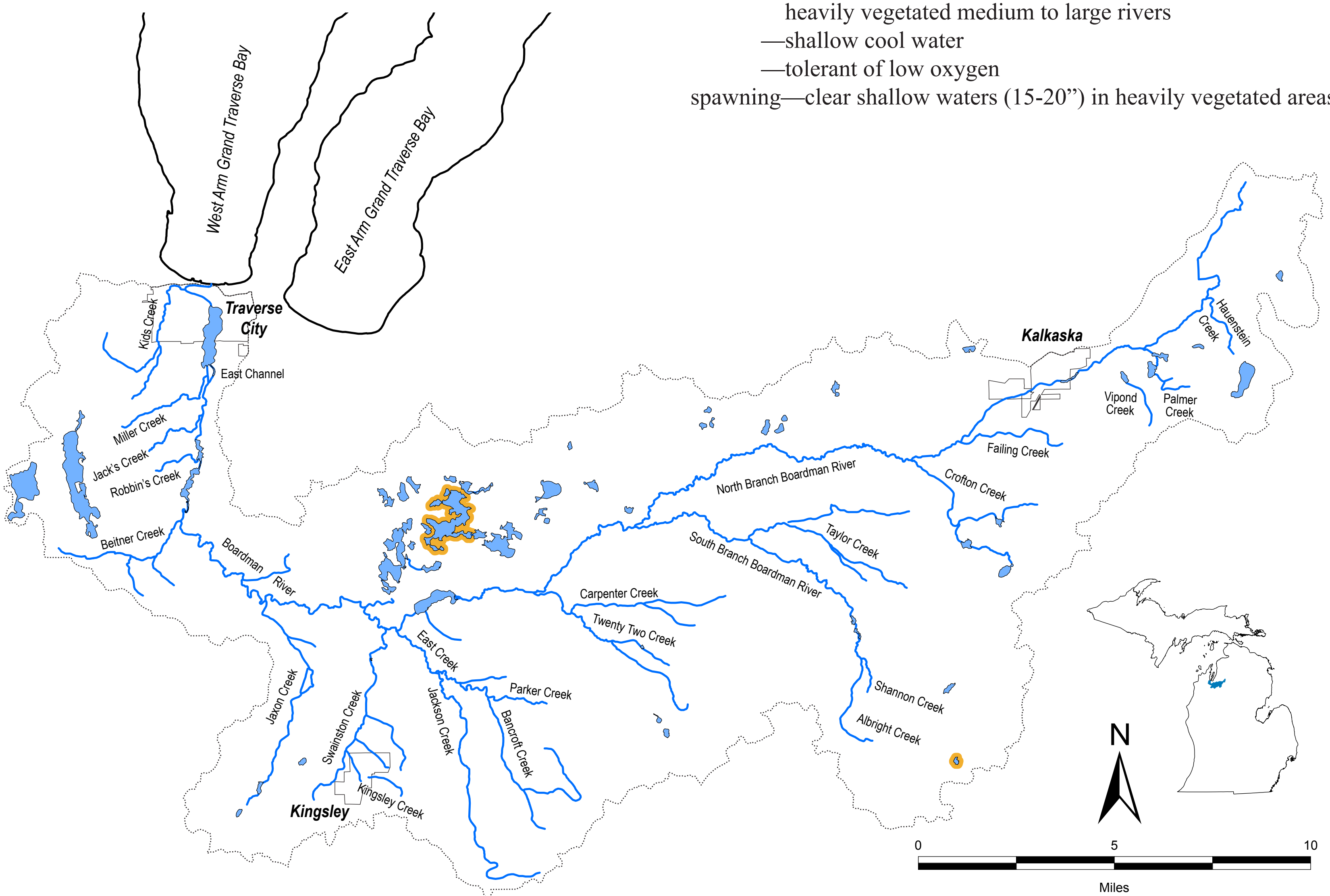
Northern Pike *Esox lucius*

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



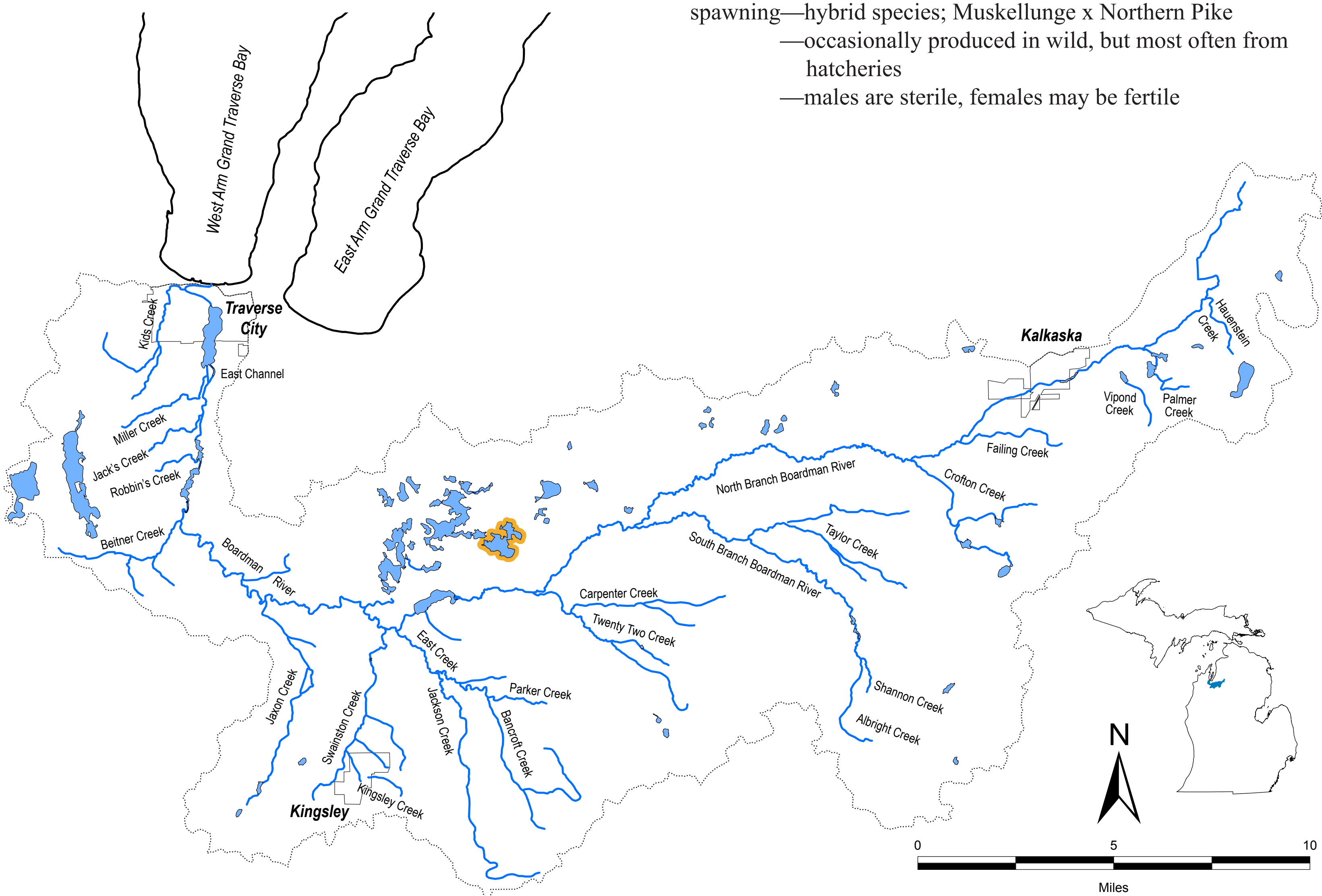
Muskellunge *Esox masquinongy*

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



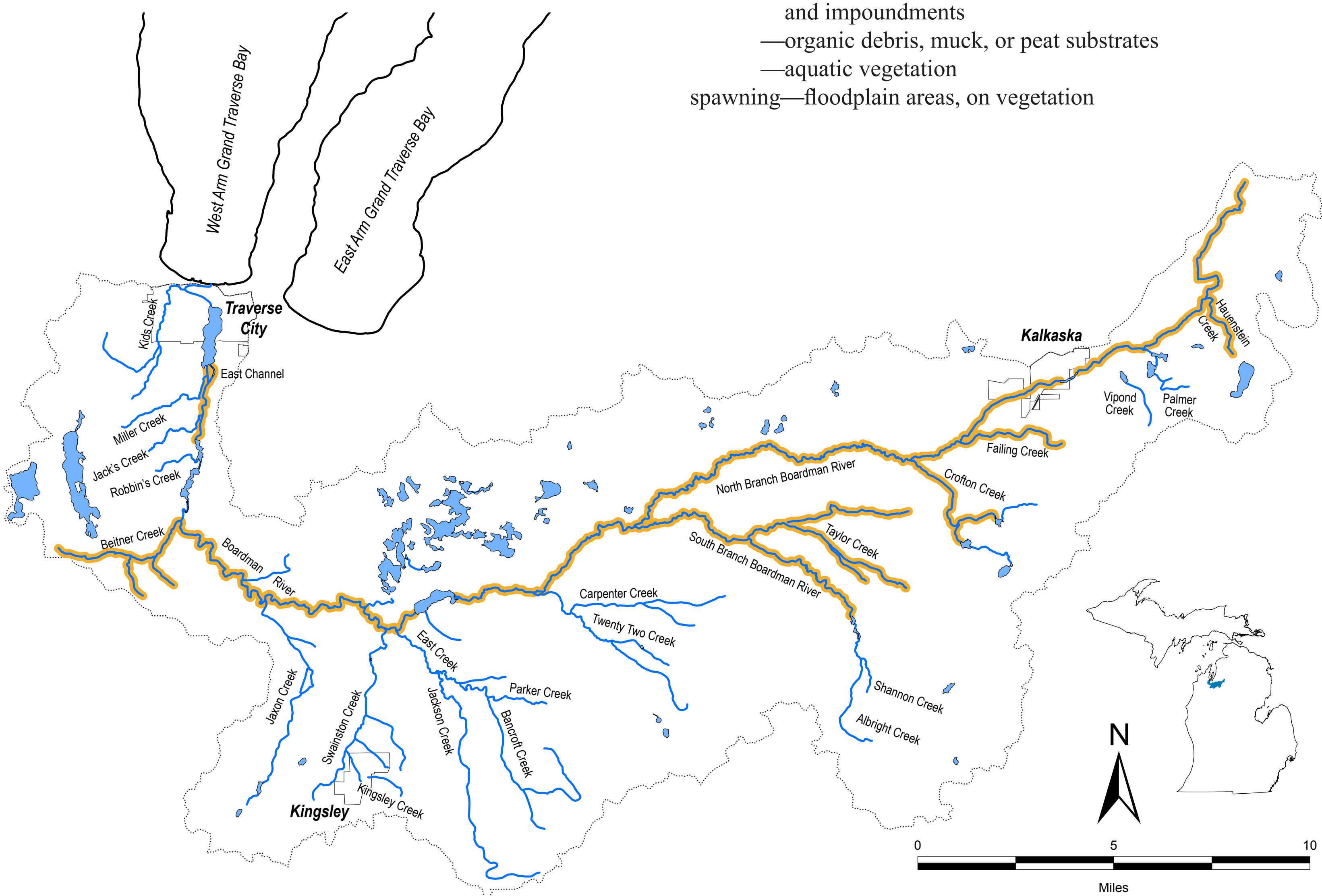
Tiger muskellunge *Esox masquinongy* x *E. lucius*

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



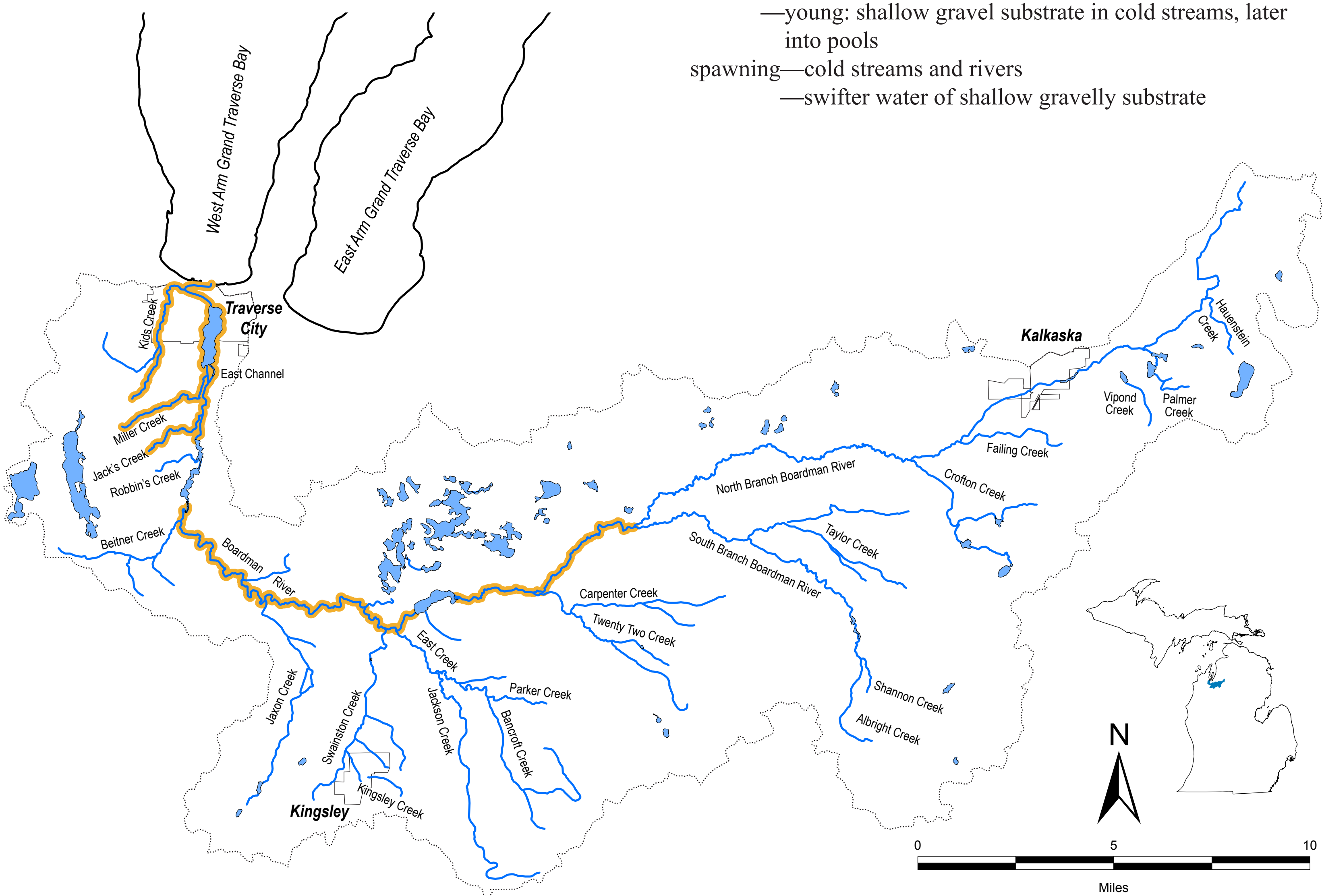
Central Mudminnow *Umbra limi*

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



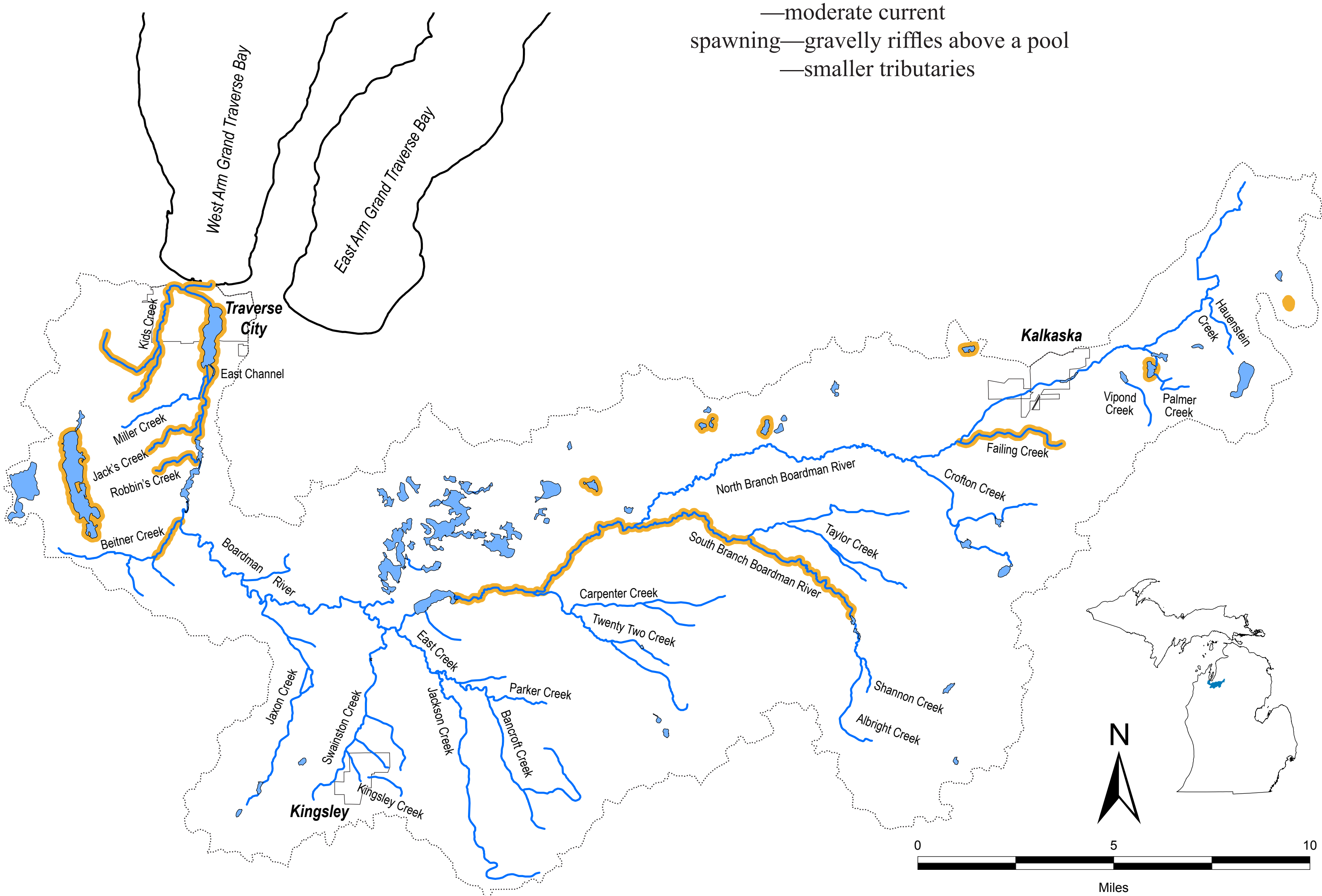
Coho Salmon *Oncorhynchus kisutch*

Habitat: feeding—adults: Lake Michigan
—young: shallow gravel substrate in cold streams, later into pools
spawning—cold streams and rivers
—swifter water of shallow gravelly substrate



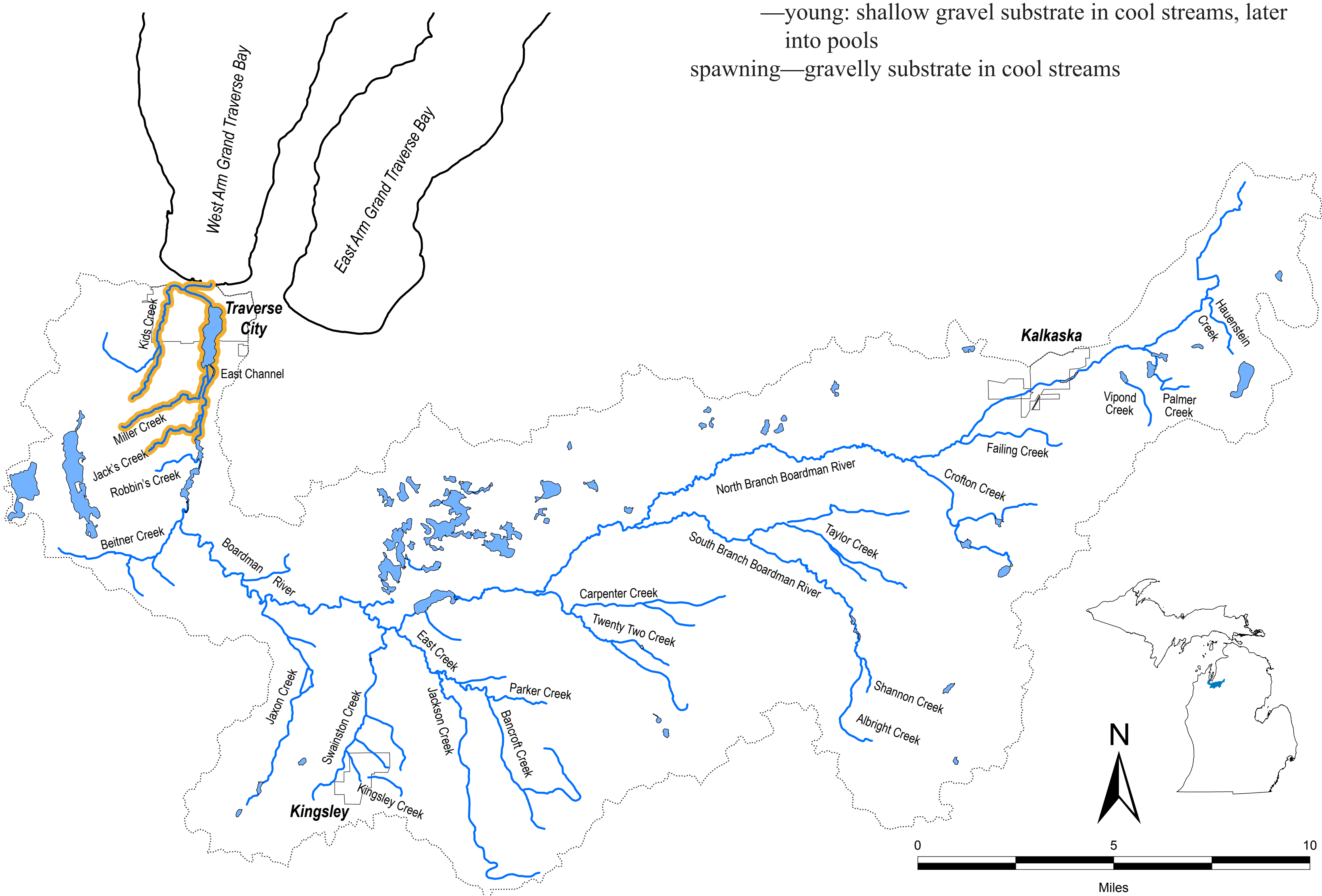
Rainbow Trout *Oncorhynchus mykiss*

Habitat: feeding—cold clear water of rivers and Lake Michigan
—moderate current
spawning—gravelly riffles above a pool
—smaller tributaries



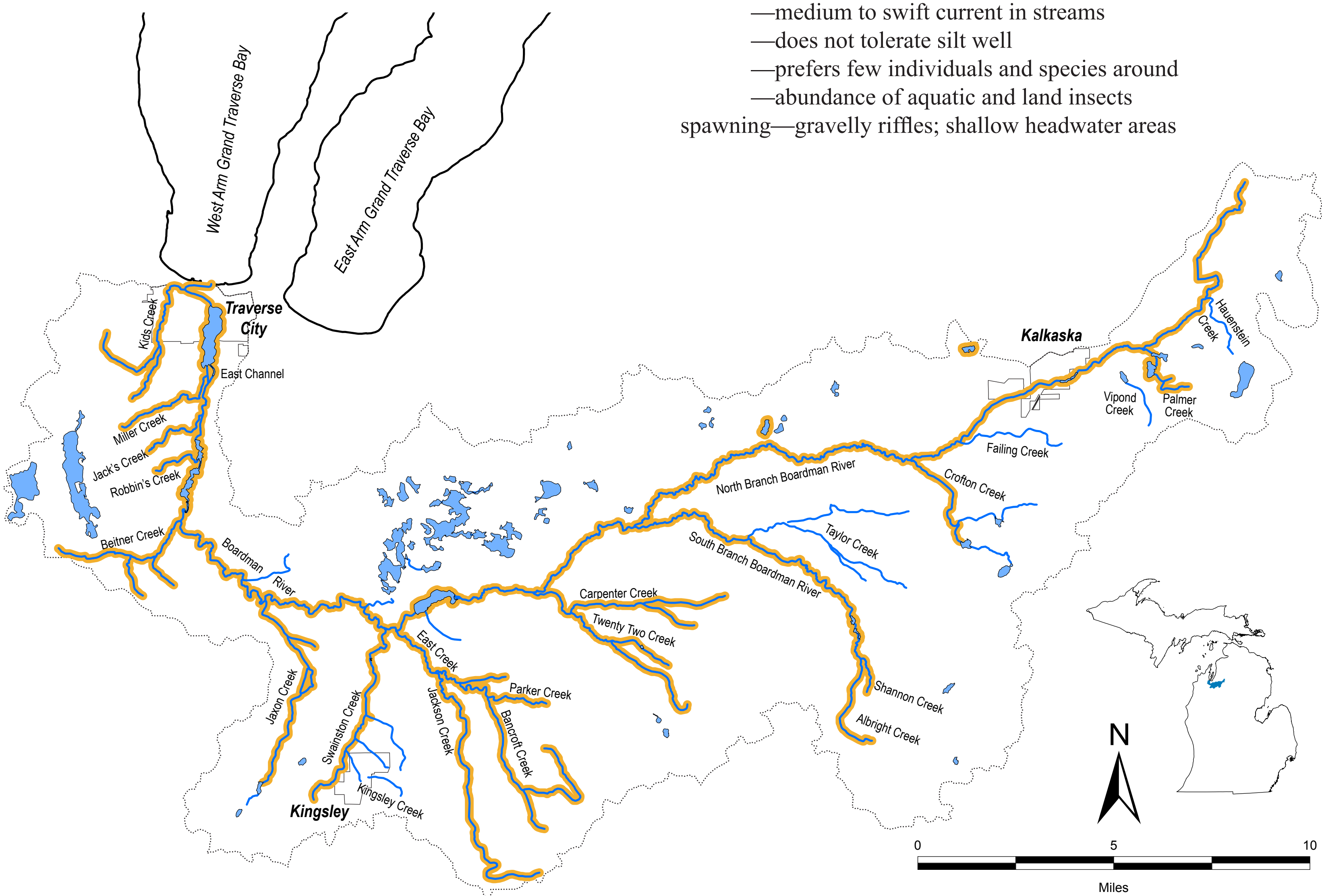
Chinook Salmon *Oncorhynchus tshawytscha*

Habitat: feeding—adults: Lake Michigan
—young: shallow gravel substrate in cool streams, later into pools
spawning—gravelly substrate in cool streams



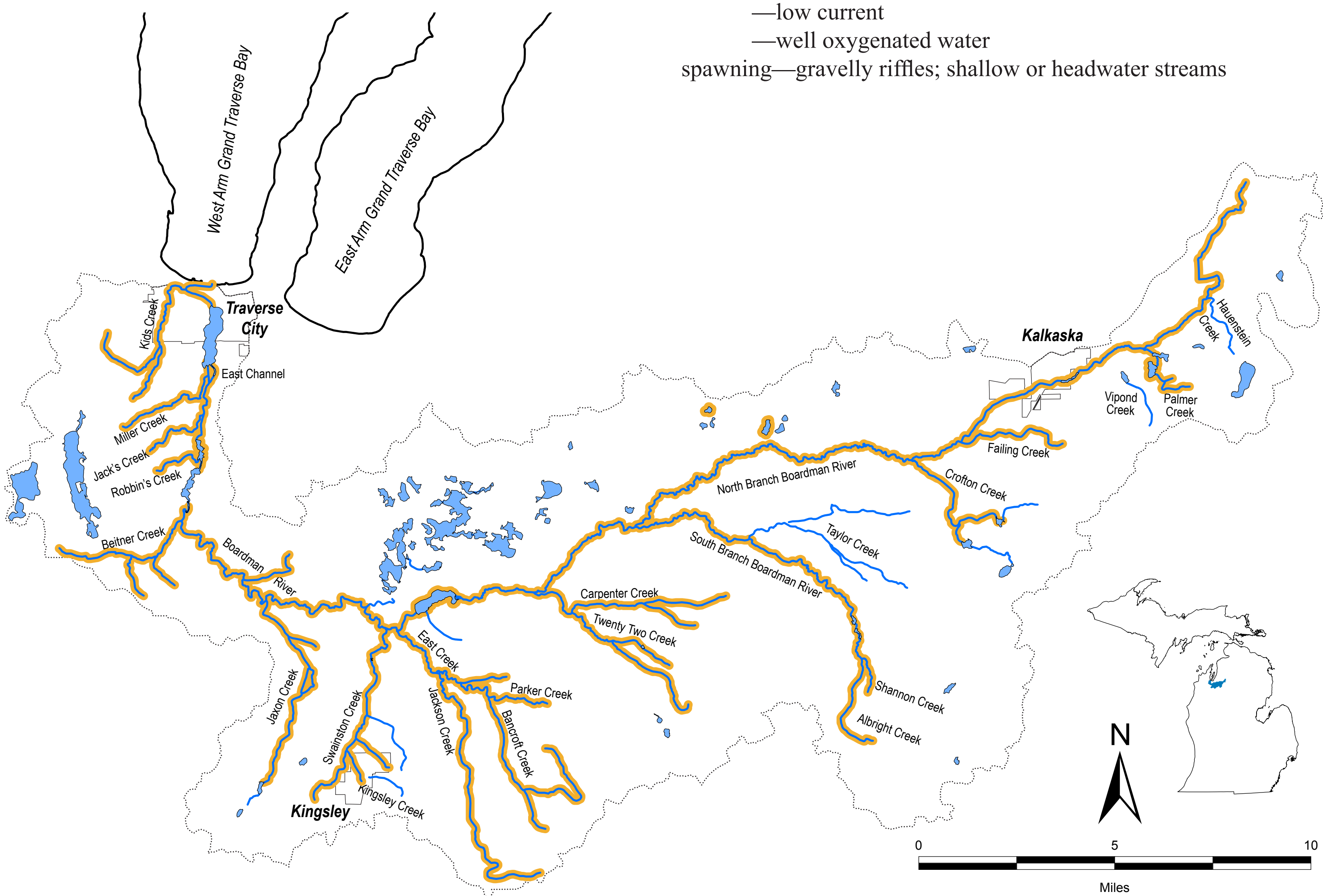
Brown Trout *Salmo trutta*

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



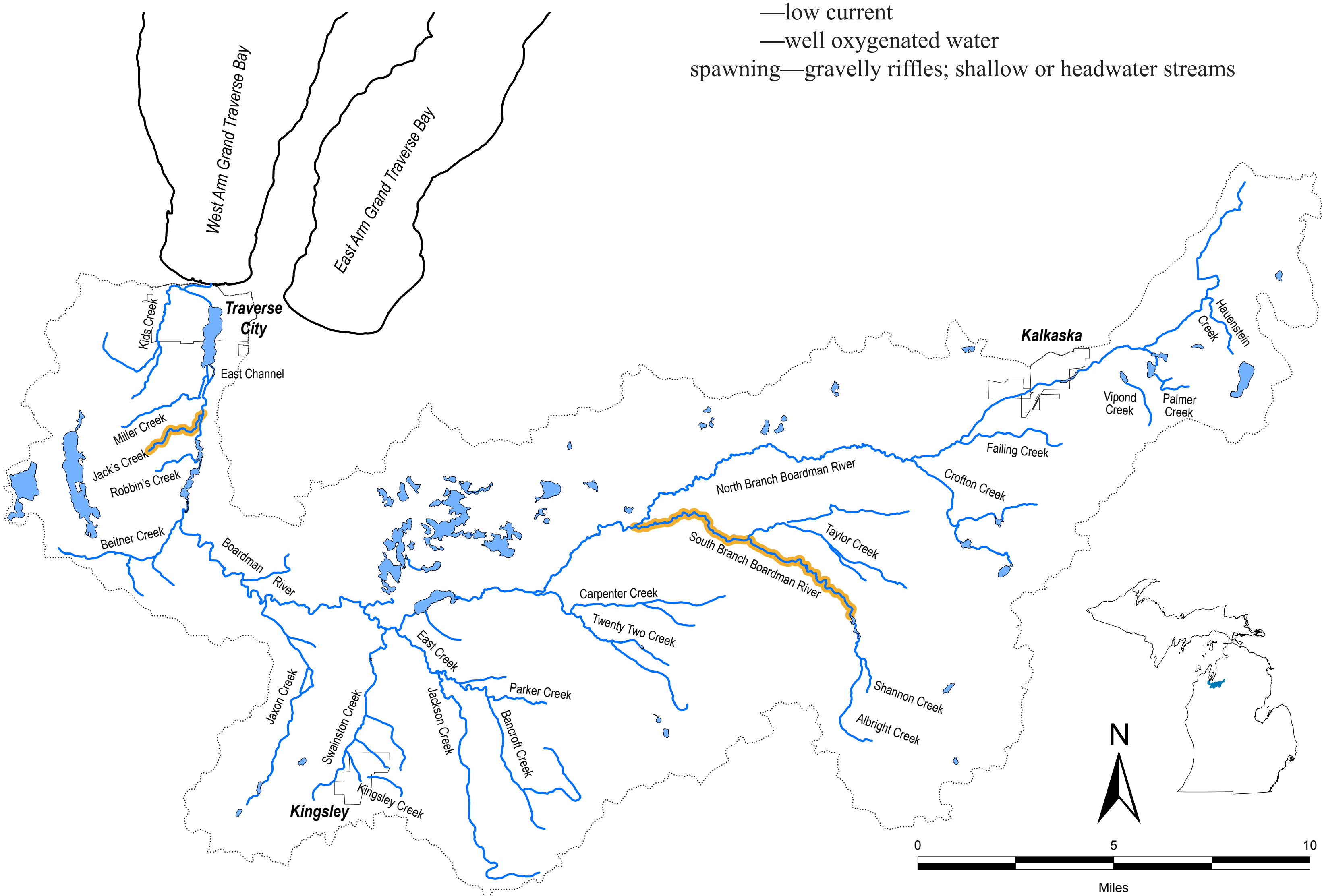
Brook Trout *Salvelinus fontinalis*

Habitat**:** feeding—cold, clear streams, rivers, and lakes (not >65°F)
—low current
—well oxygenated water
spawning—gravelly riffles; shallow or headwater streams



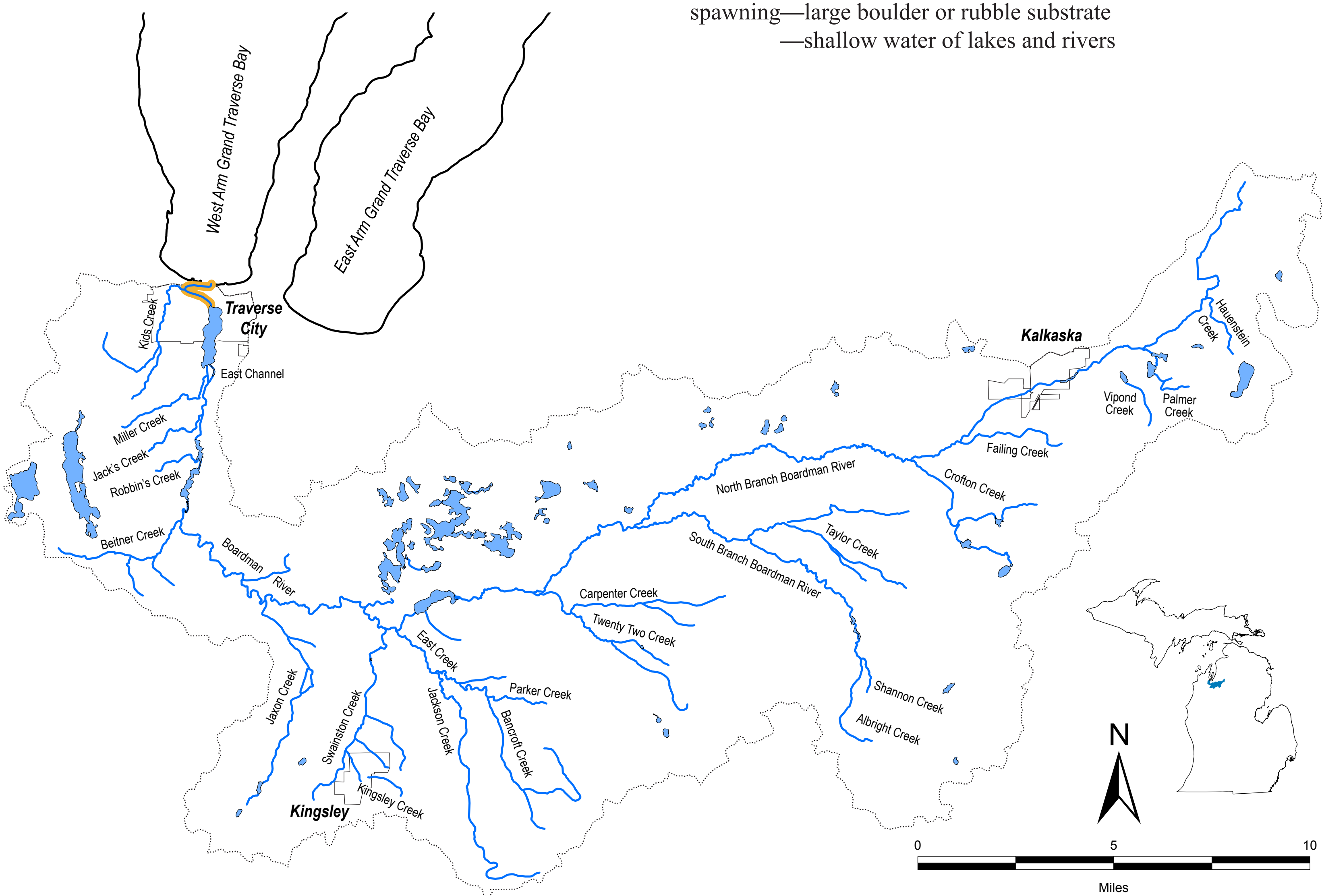
Tiger trout *Salmo trutta x. Salvelinus fontinalis*

Habitat**:** feeding—cold, clear streams, rivers, and lakes (not >65°F)
—low current
—well oxygenated water
spawning—gravelly riffles; shallow or headwater streams



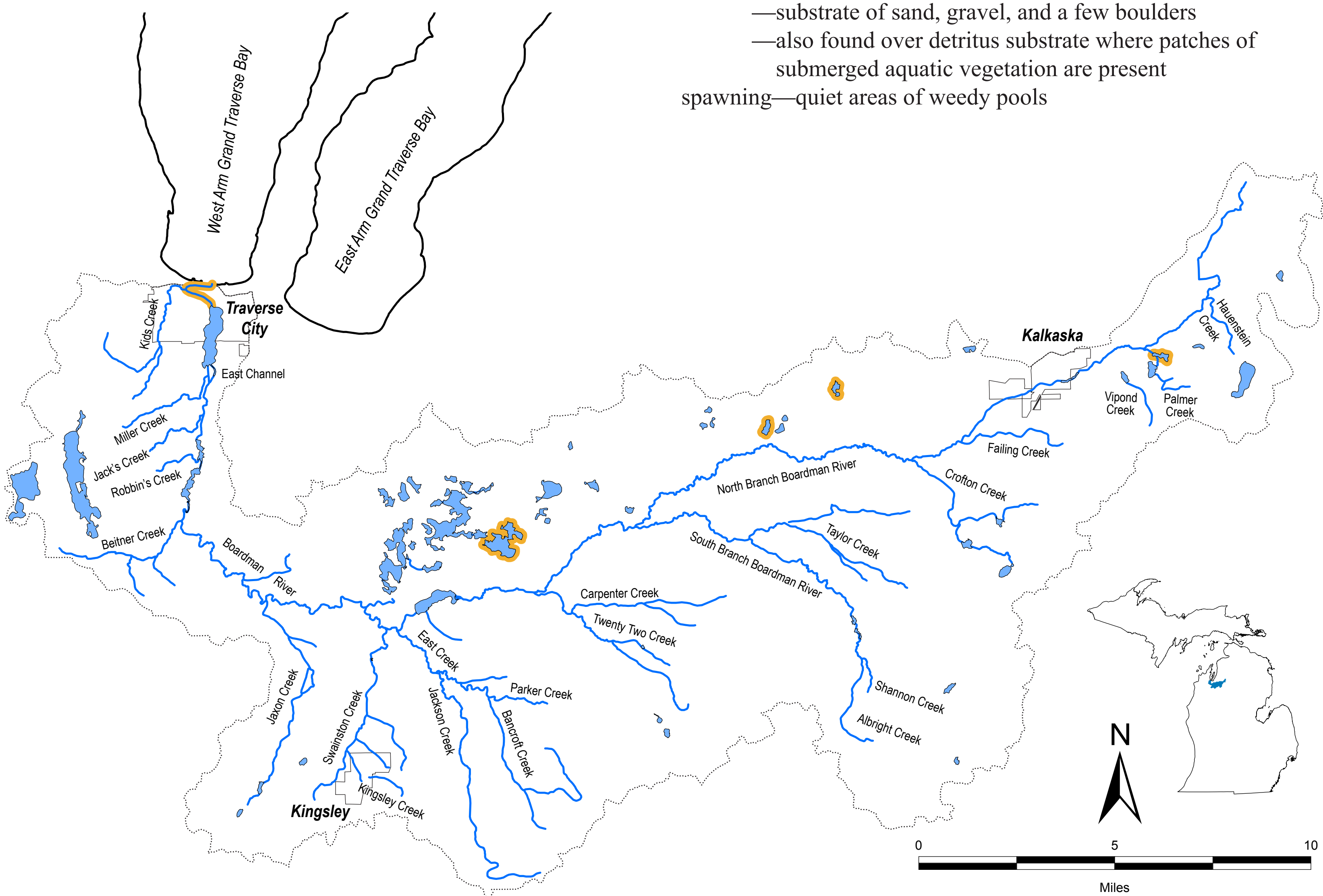
Lake Trout *Salvelinus namaycush*

Habitat: feeding—cold lakes and rivers
spawning—large boulder or rubble substrate
—shallow water of lakes and rivers



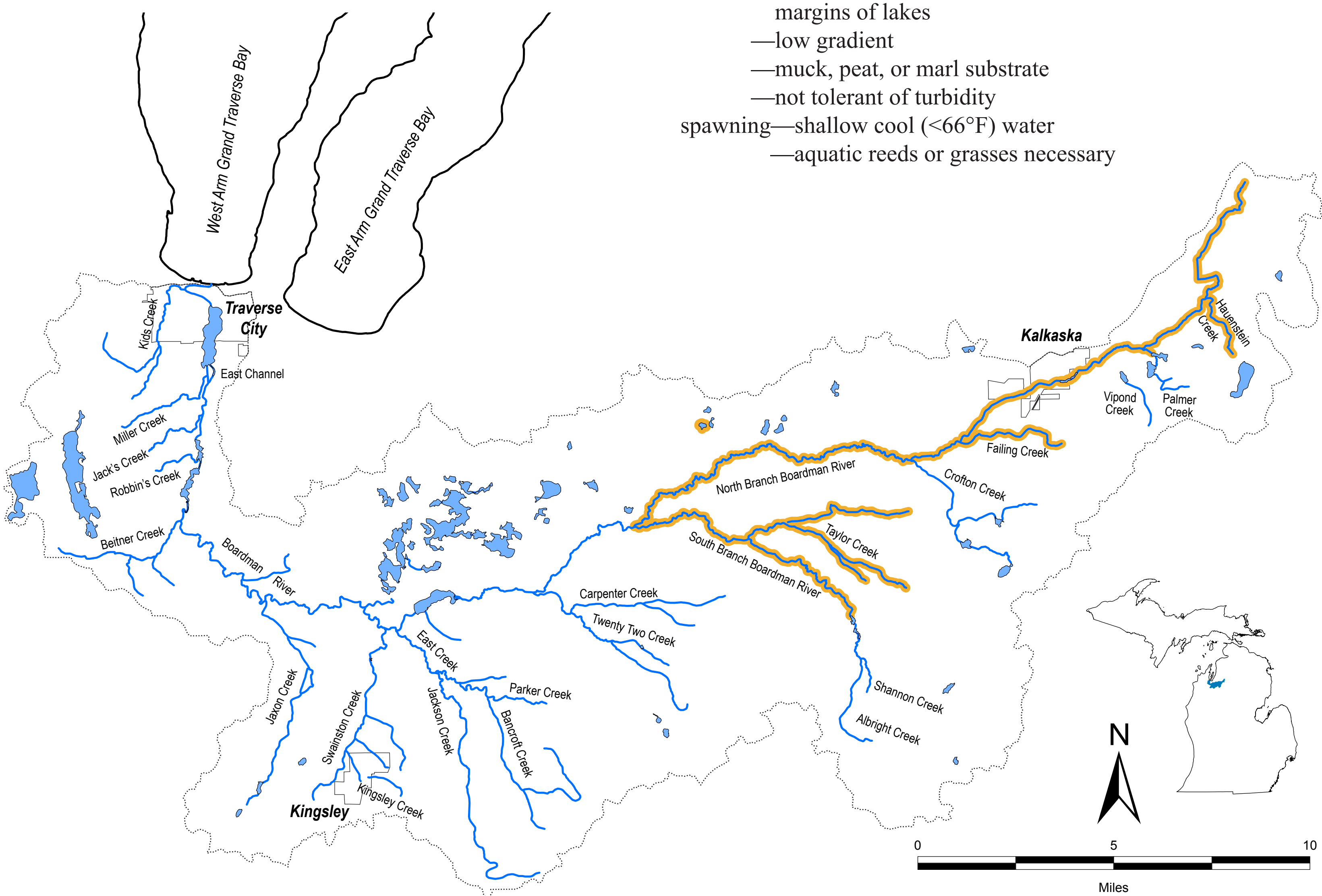
Western Banded Killifish *Fundulus diaphanus menona*

Habitat: feeding—quiet backwaters at the mouths of streams and lakes
—substrate of sand, gravel, and a few boulders
—also found over detritus substrate where patches of submerged aquatic vegetation are present
spawning—quiet areas of weedy pools



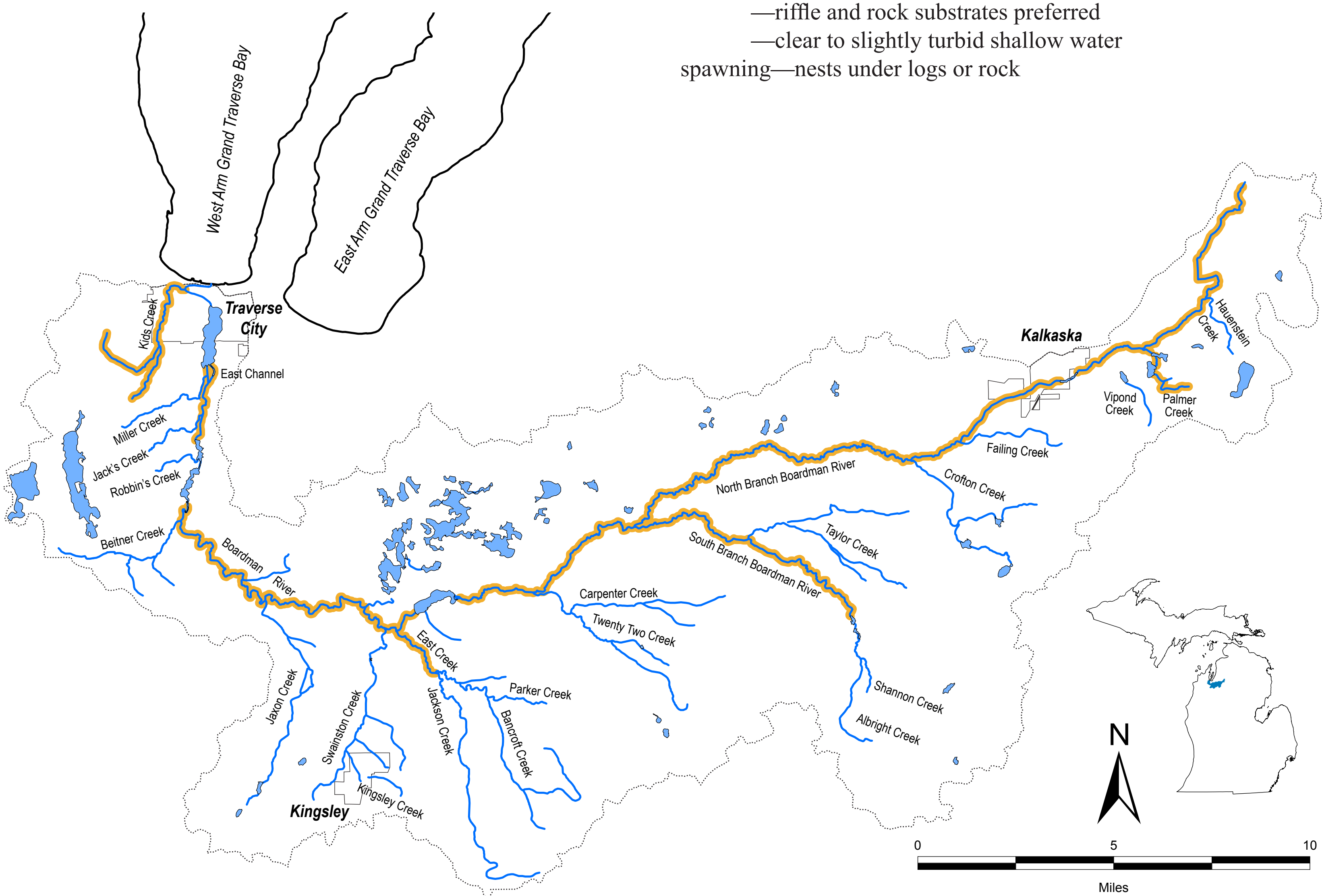
Brook Stickleback *Culaea inconstans*

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



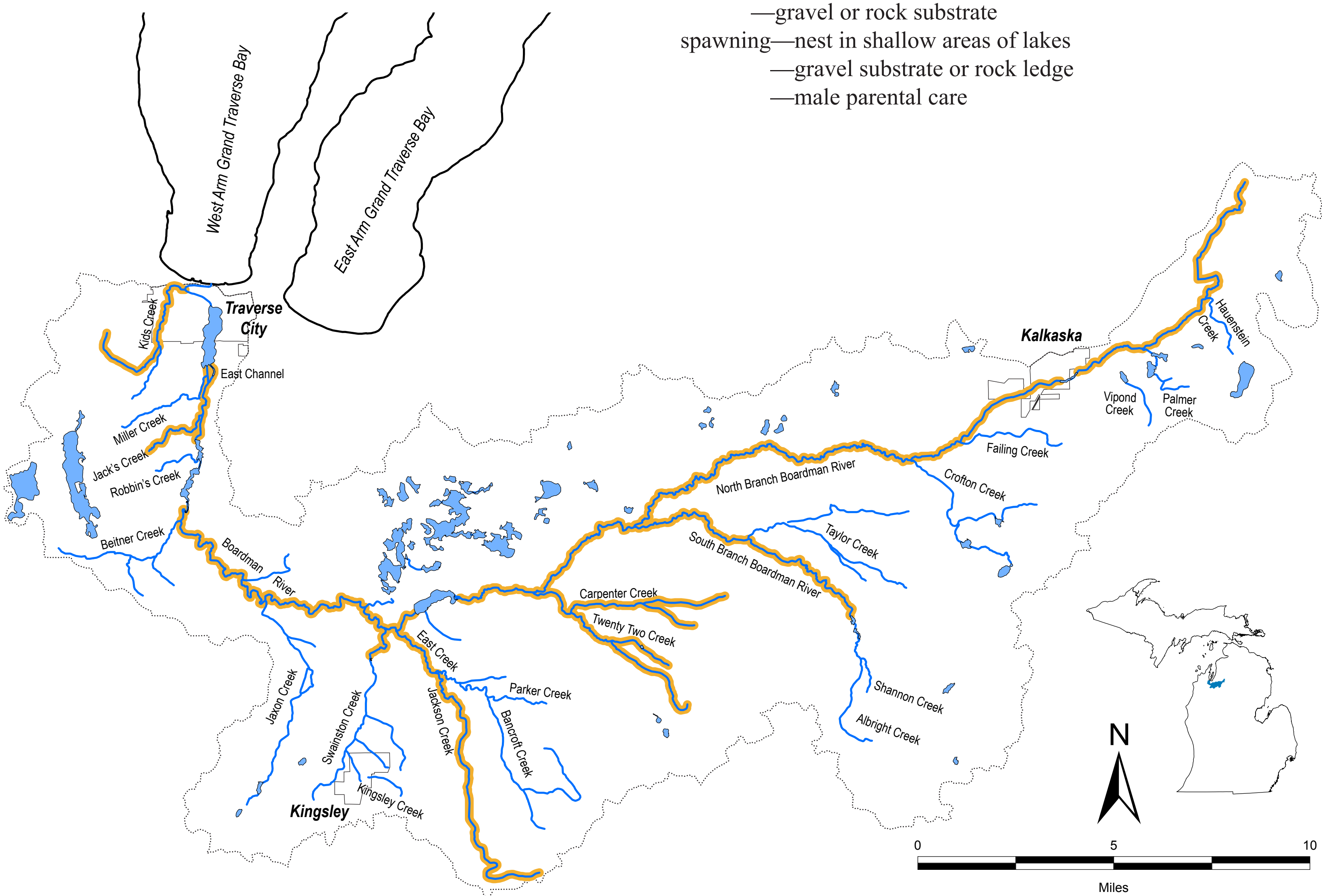
Mottled Sculpin *Cottus bairdii*

Habitat: feeding—cool to cold streams
—riffle and rock substrates preferred
—clear to slightly turbid shallow water
spawning—nests under logs or rock



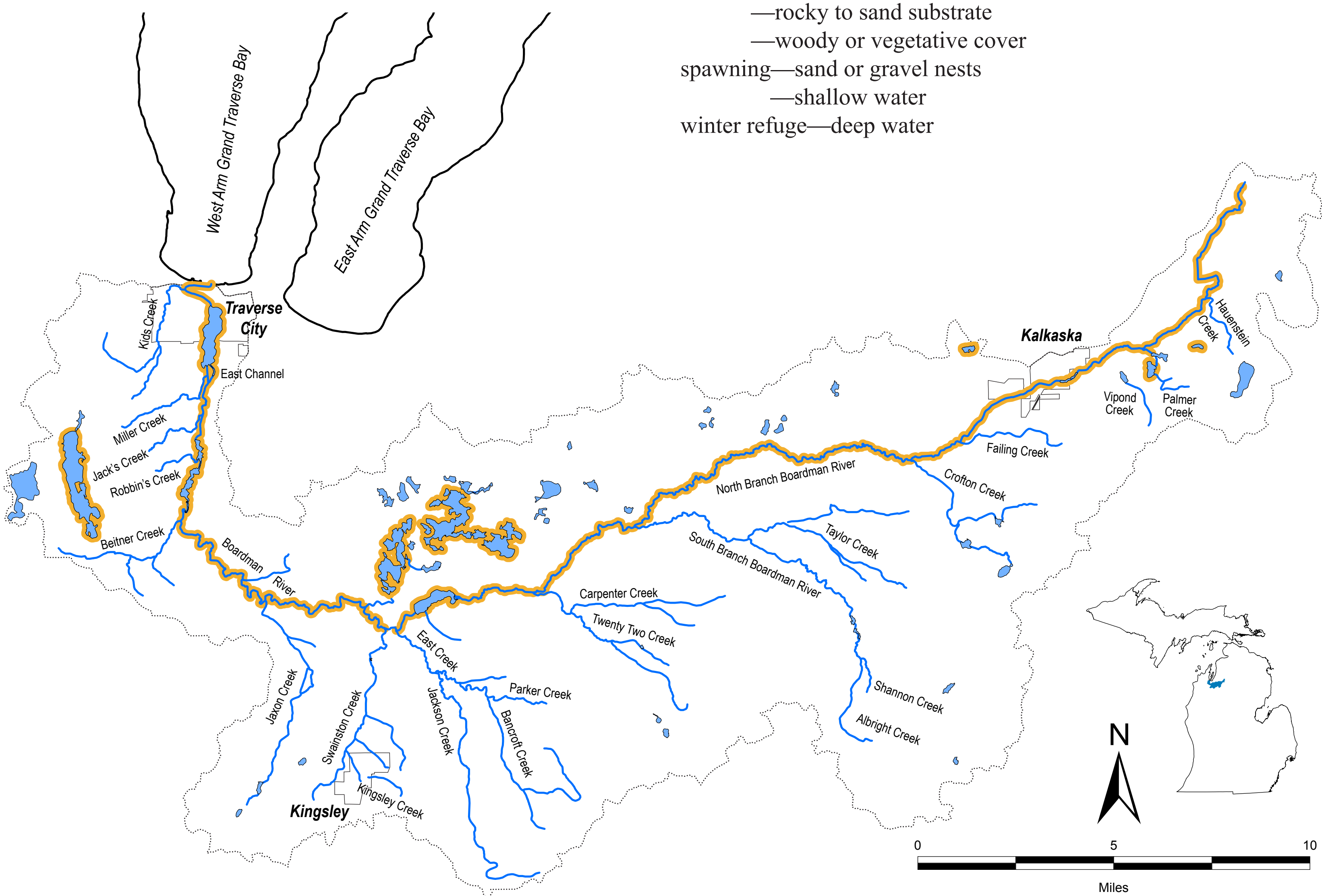
Slimy Sculpin *Cottus cognatus*

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



Rock Bass *Ambloplites rupestris*

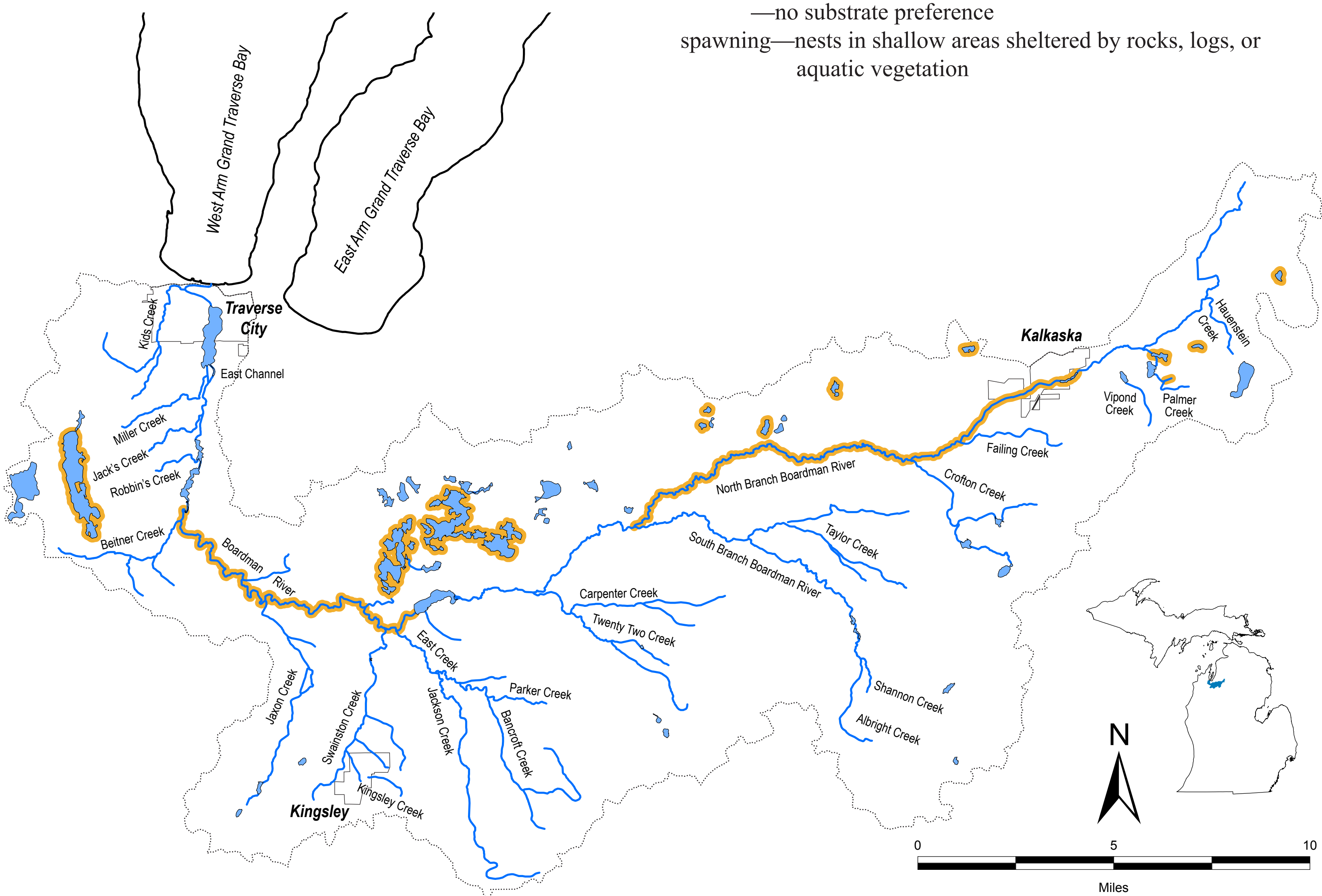
Habitat: feeding—clear, cool streams, rivers, and lakes
—rocky to sand substrate
—woody or vegetative cover
spawning—sand or gravel nests
—shallow water
winter refuge—deep water



Green Sunfish *Lepomis cyanellus*

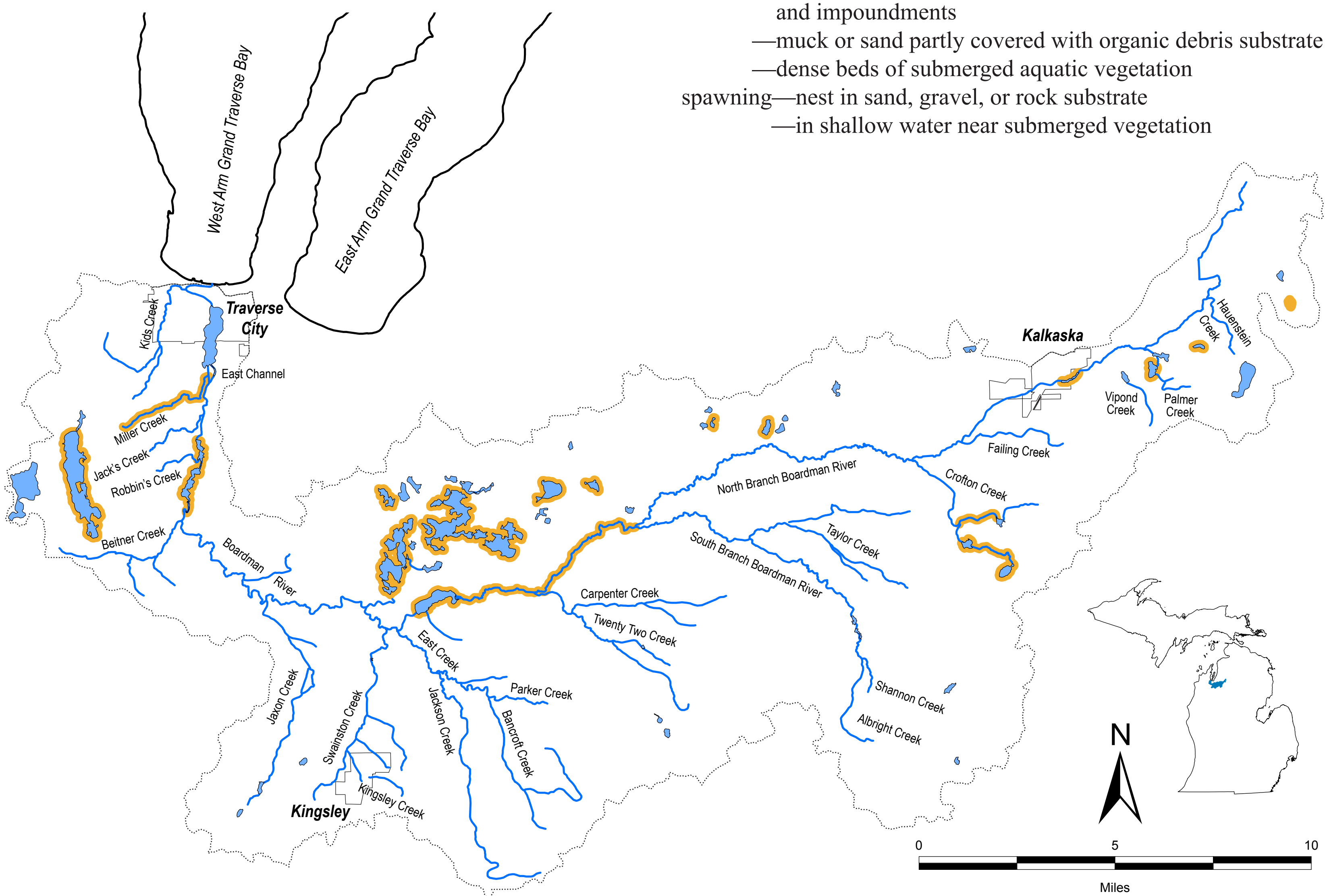
Habitat: feeding—impoundments and lakes, and low-current streams and rivers —no substrate preference

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

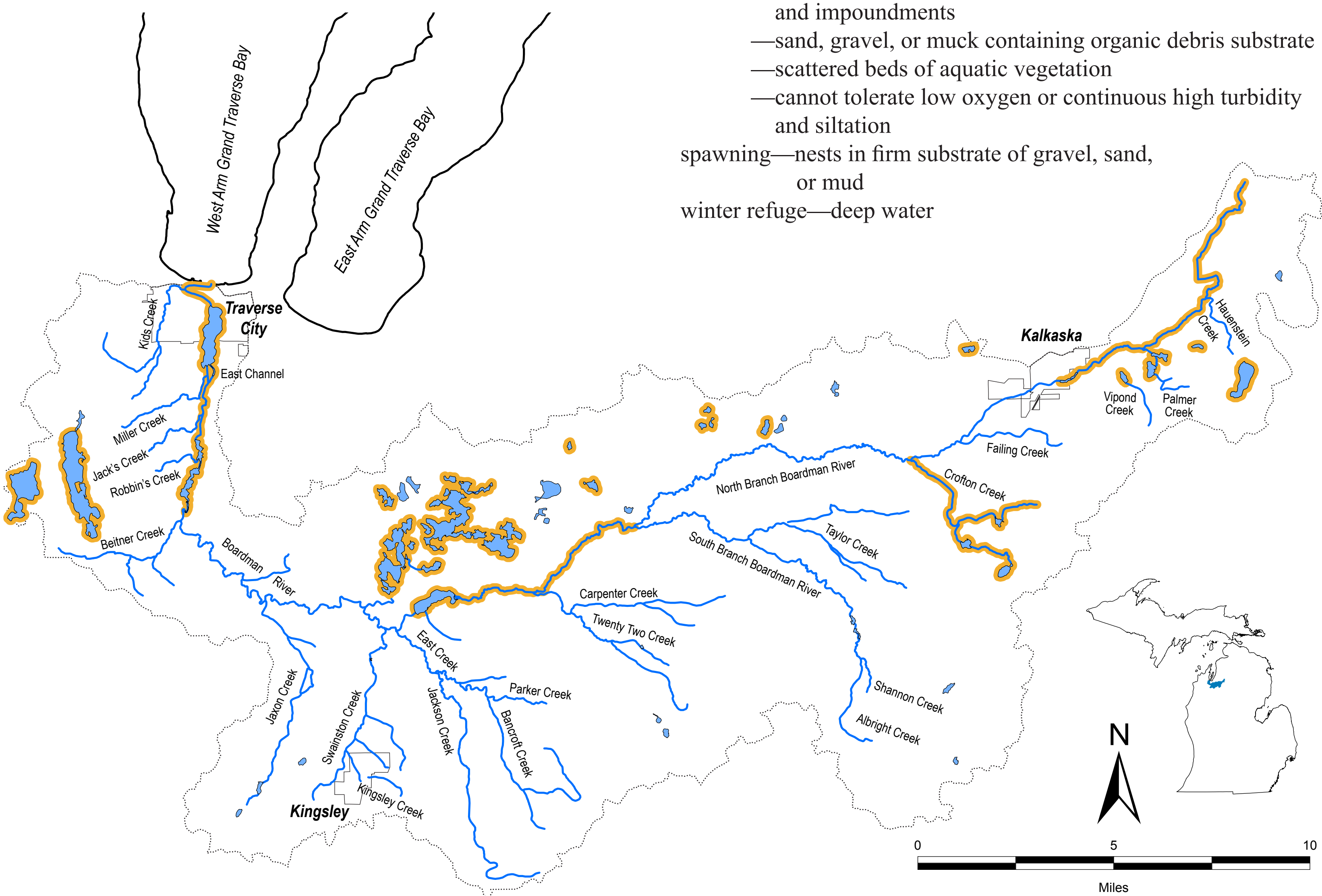


Bluegill *Lepomis macrochirus*

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

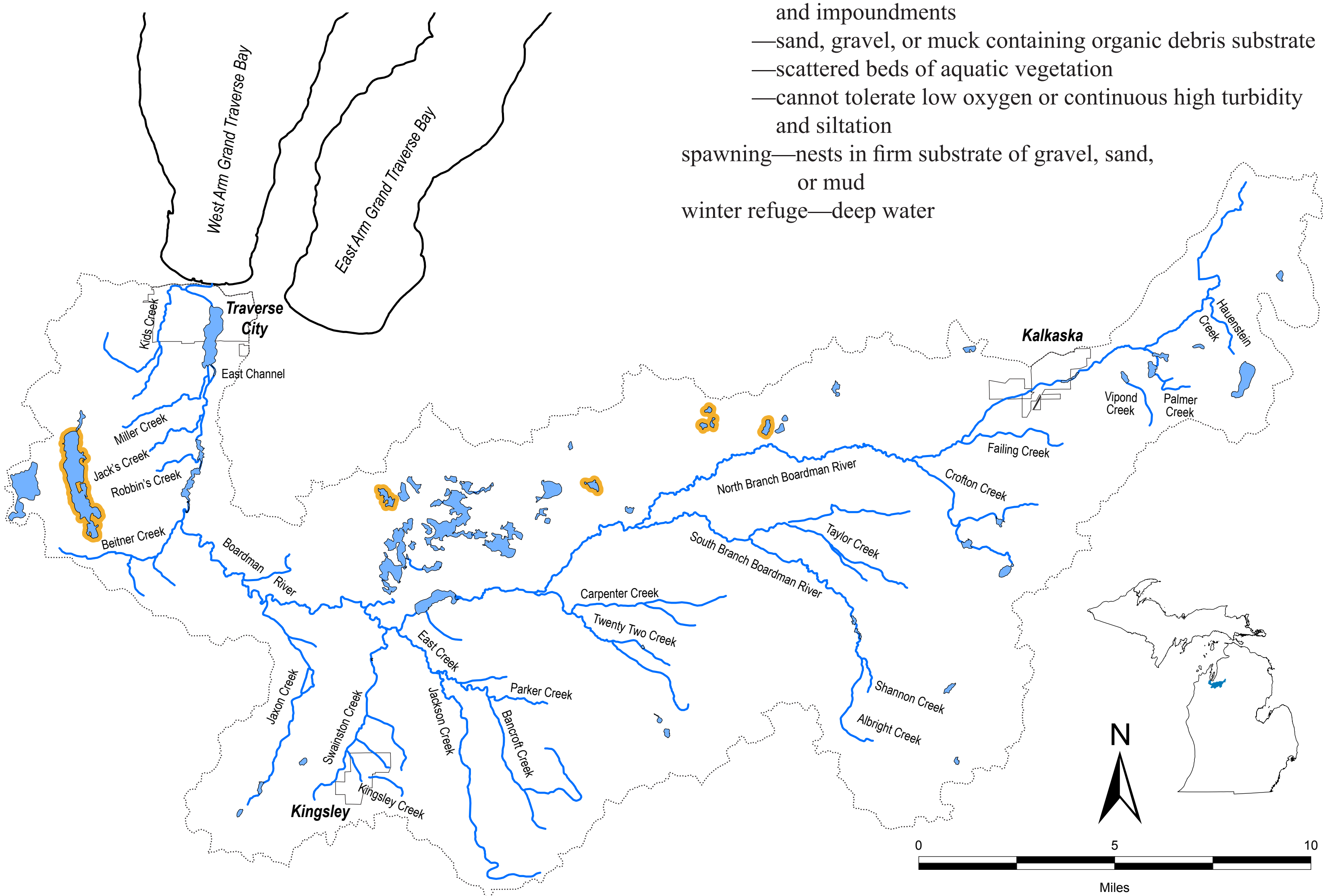


Hybrid sunfish *Lepomis macrochirus x. L. gibbosus*

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

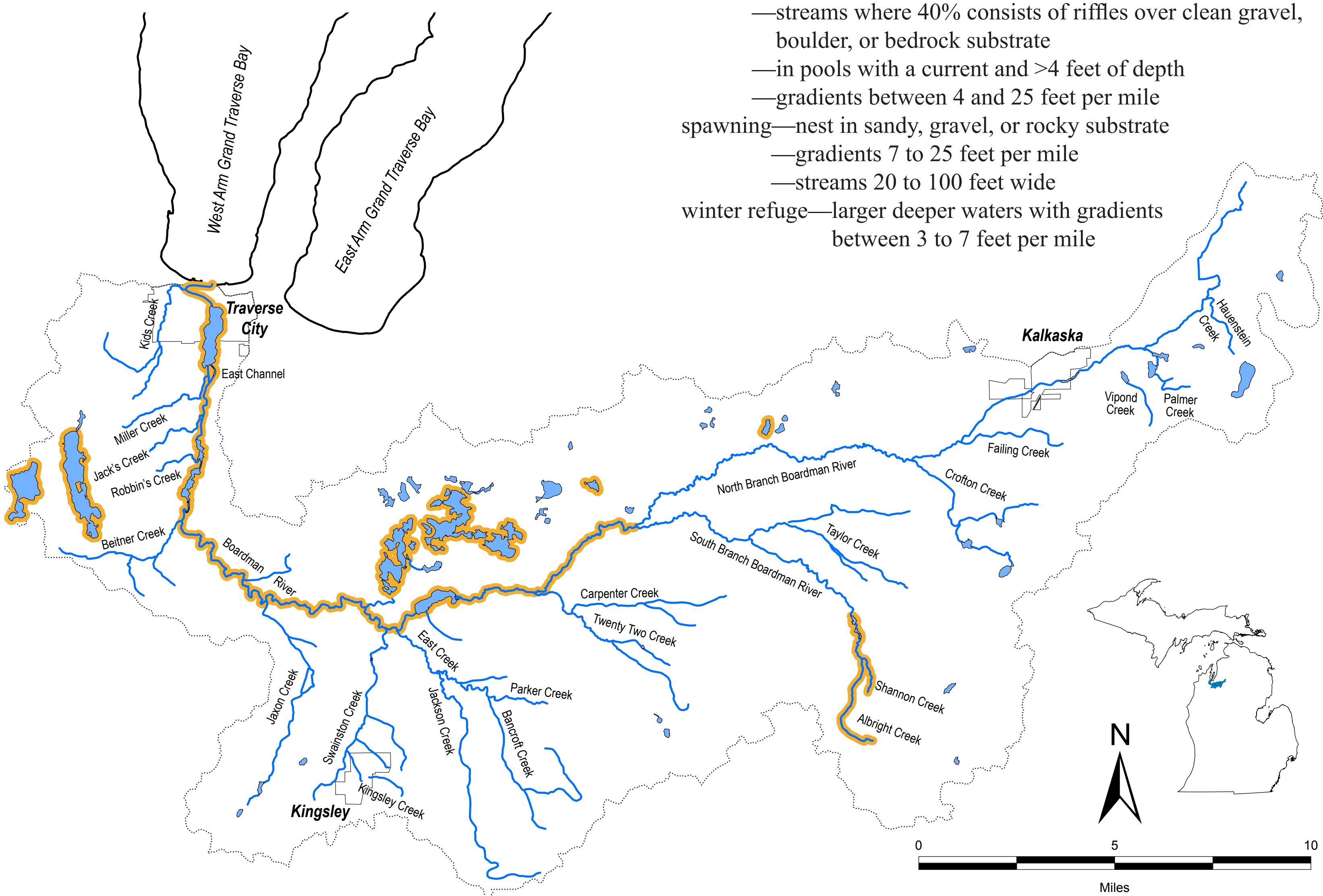
spawning—nests in firm substrate of gravel, sand, or mud

winter refuge—deep water



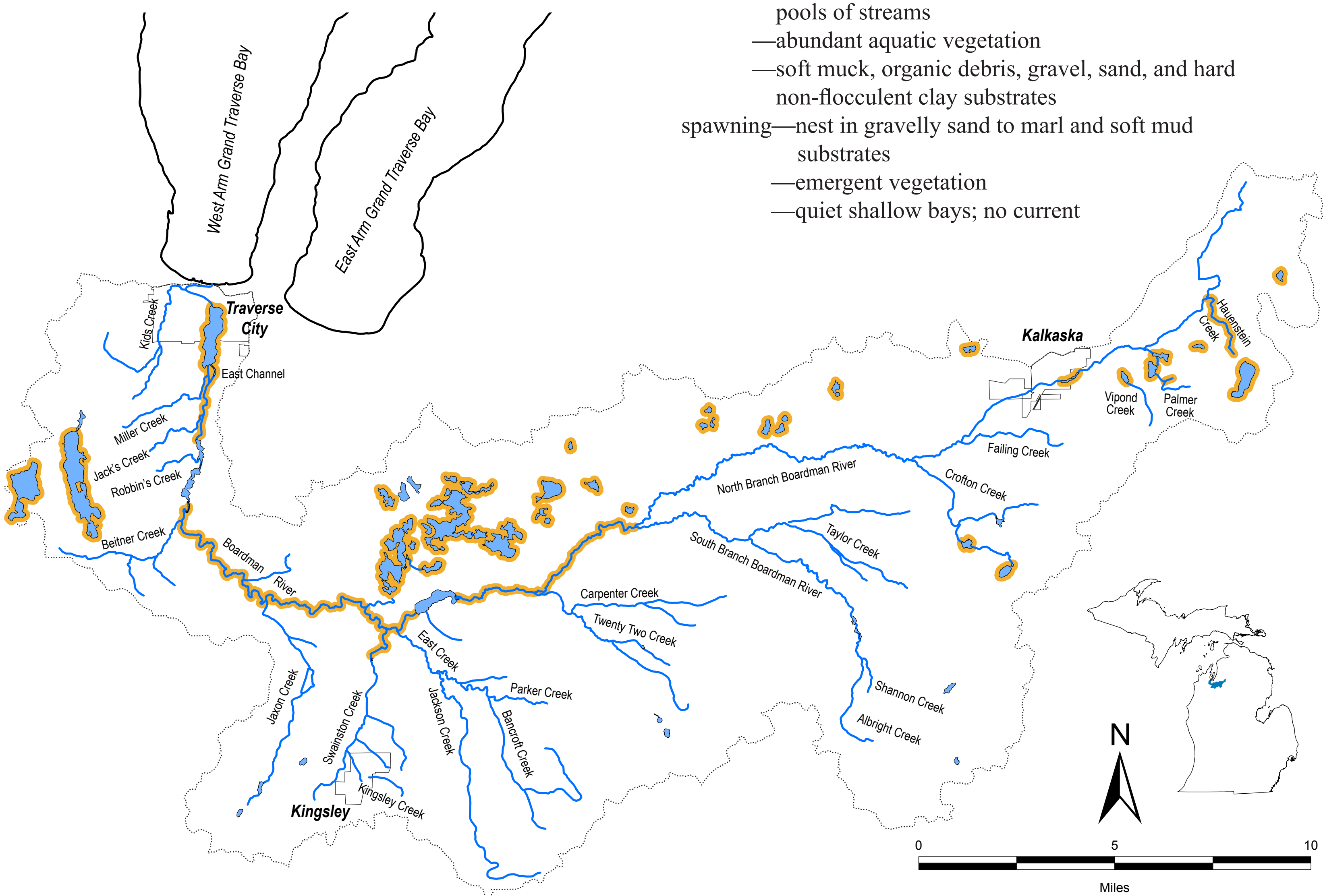
Smallmouth Bass *Micropterus dolomieu*

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



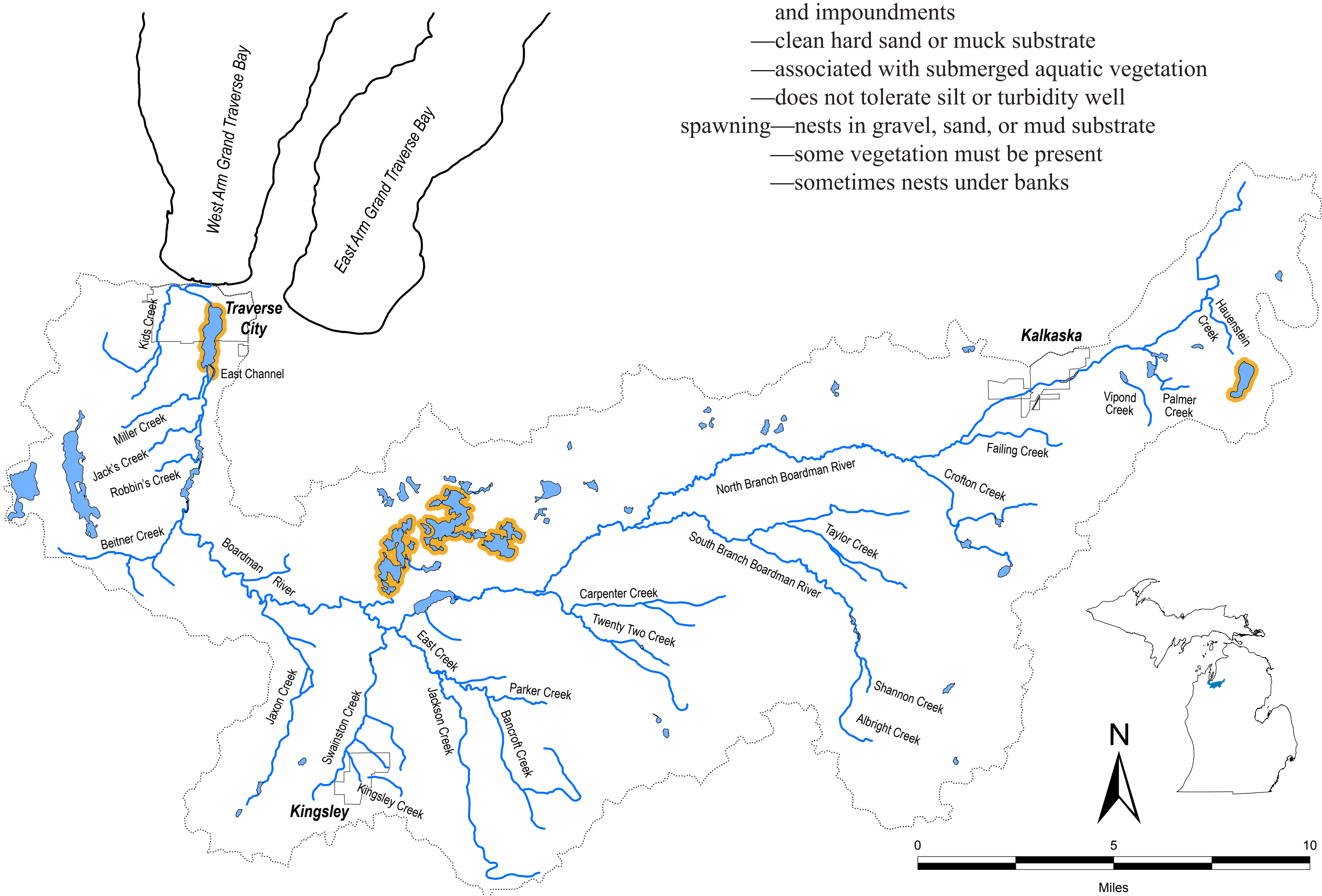
Largemouth Bass *Micropterus salmoides*

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



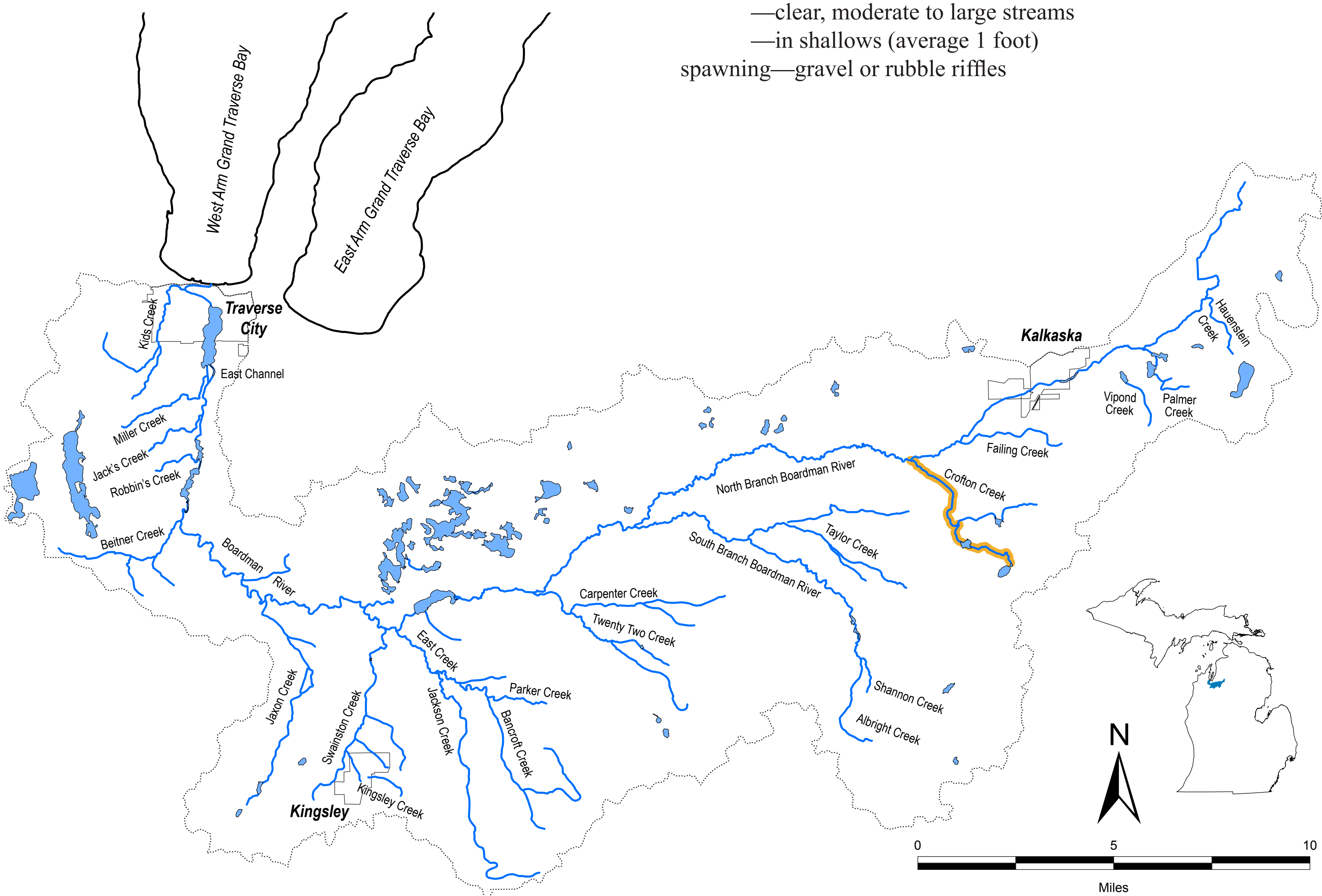
Black Crappie *Pomoxis nigromaculatus*

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



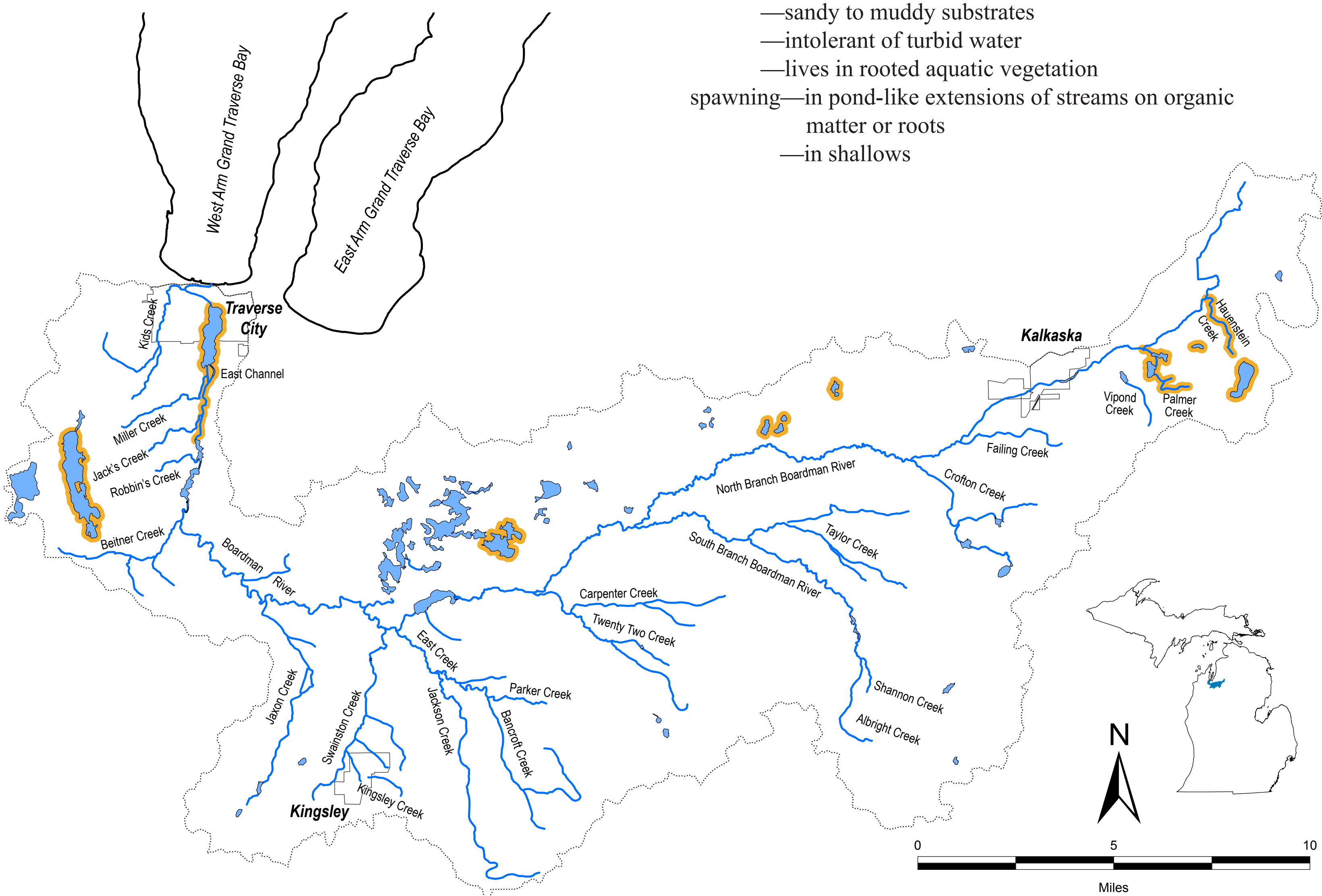
Rainbow Darter *Etheostoma caeruleum*

Habitat: feeding—gravelly high gradient riffles
—clear, moderate to large streams
—in shallows (average 1 foot)
spawning—gravel or rubble riffles



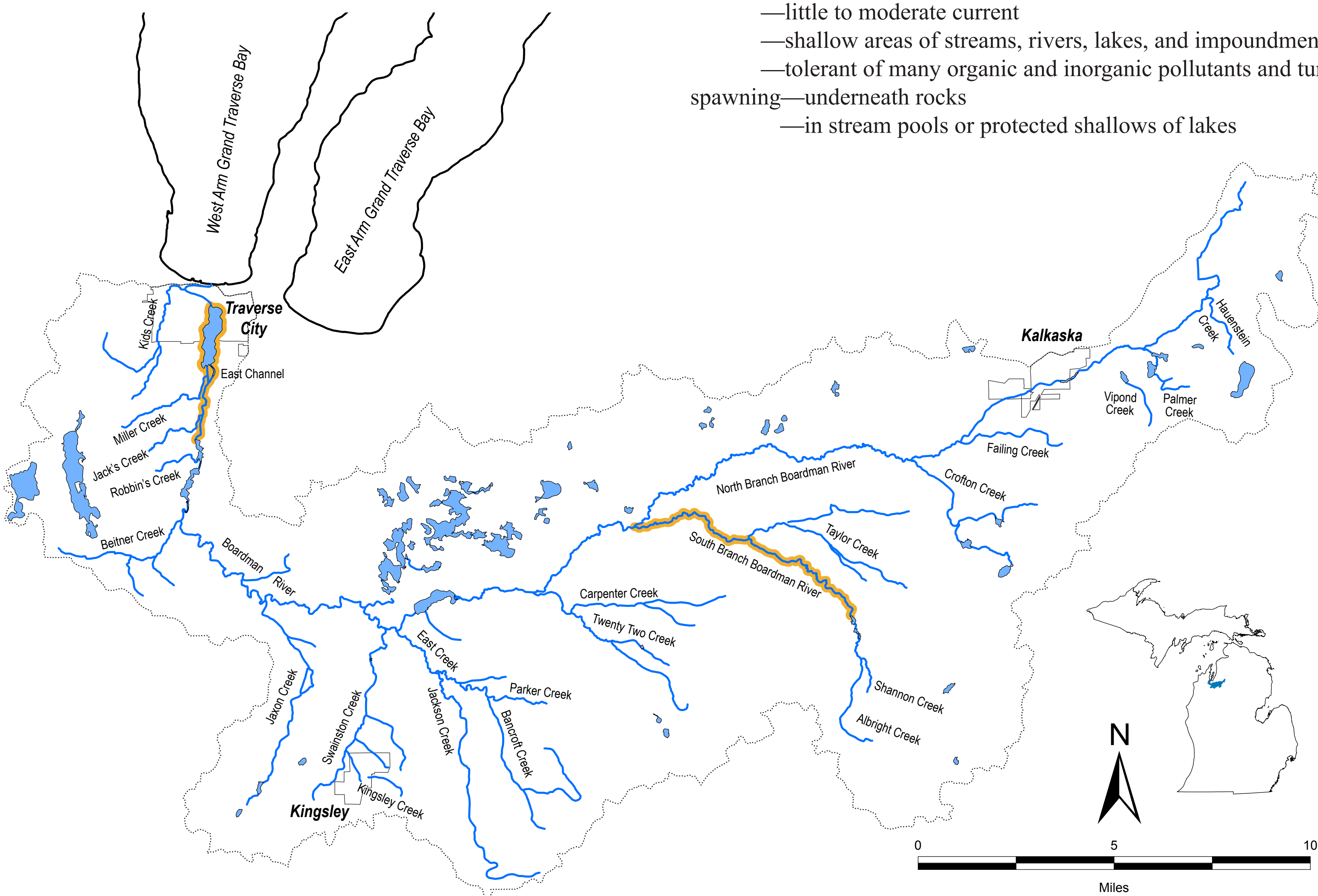
Iowa Darter *Etheostoma exile*

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



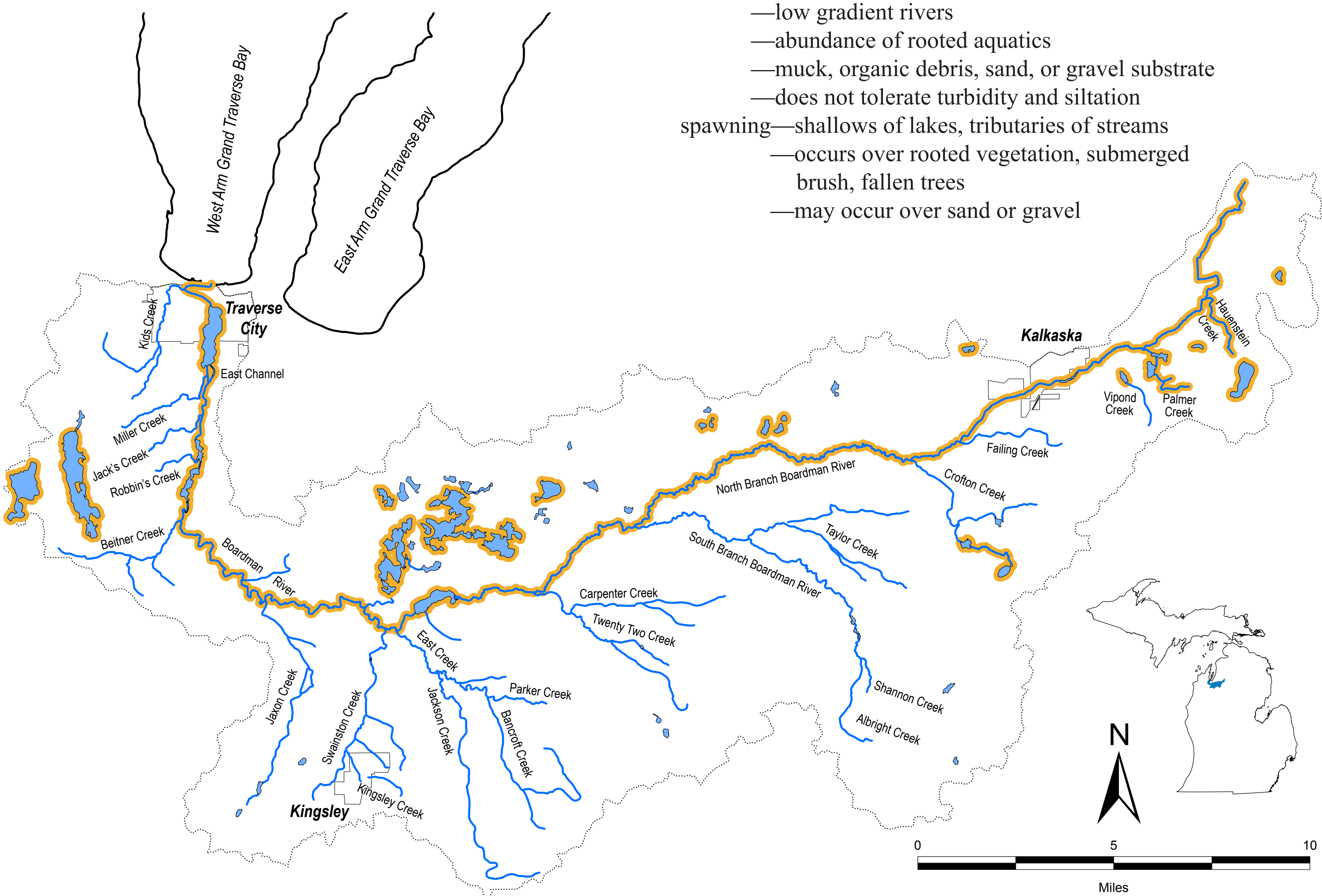
Johnny Darter *Etheostoma nigrum*

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



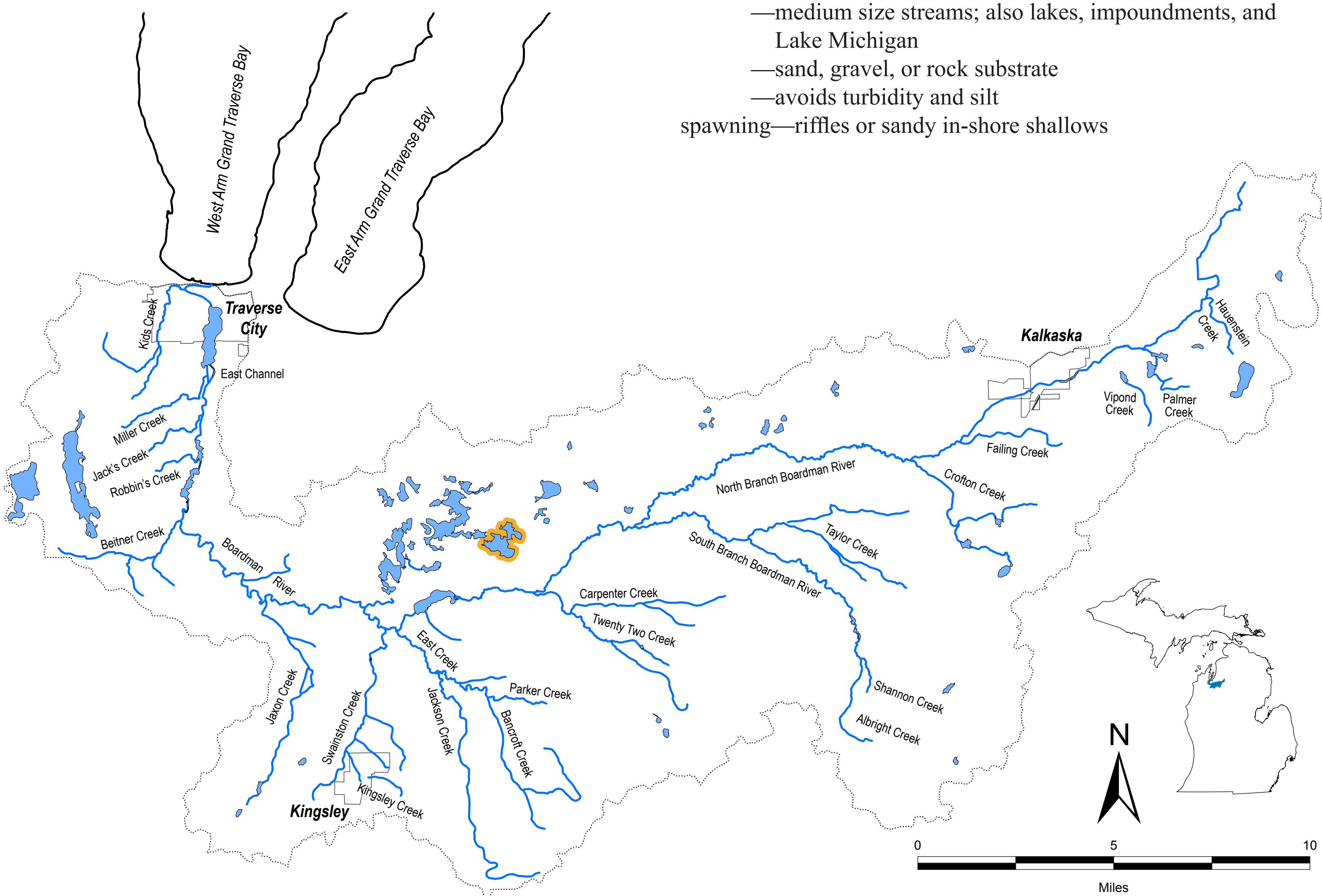
Yellow Perch *Perca flavescens*

Habitat**:** feeding—clear lakes and impoundments; also Lake Michigan
—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



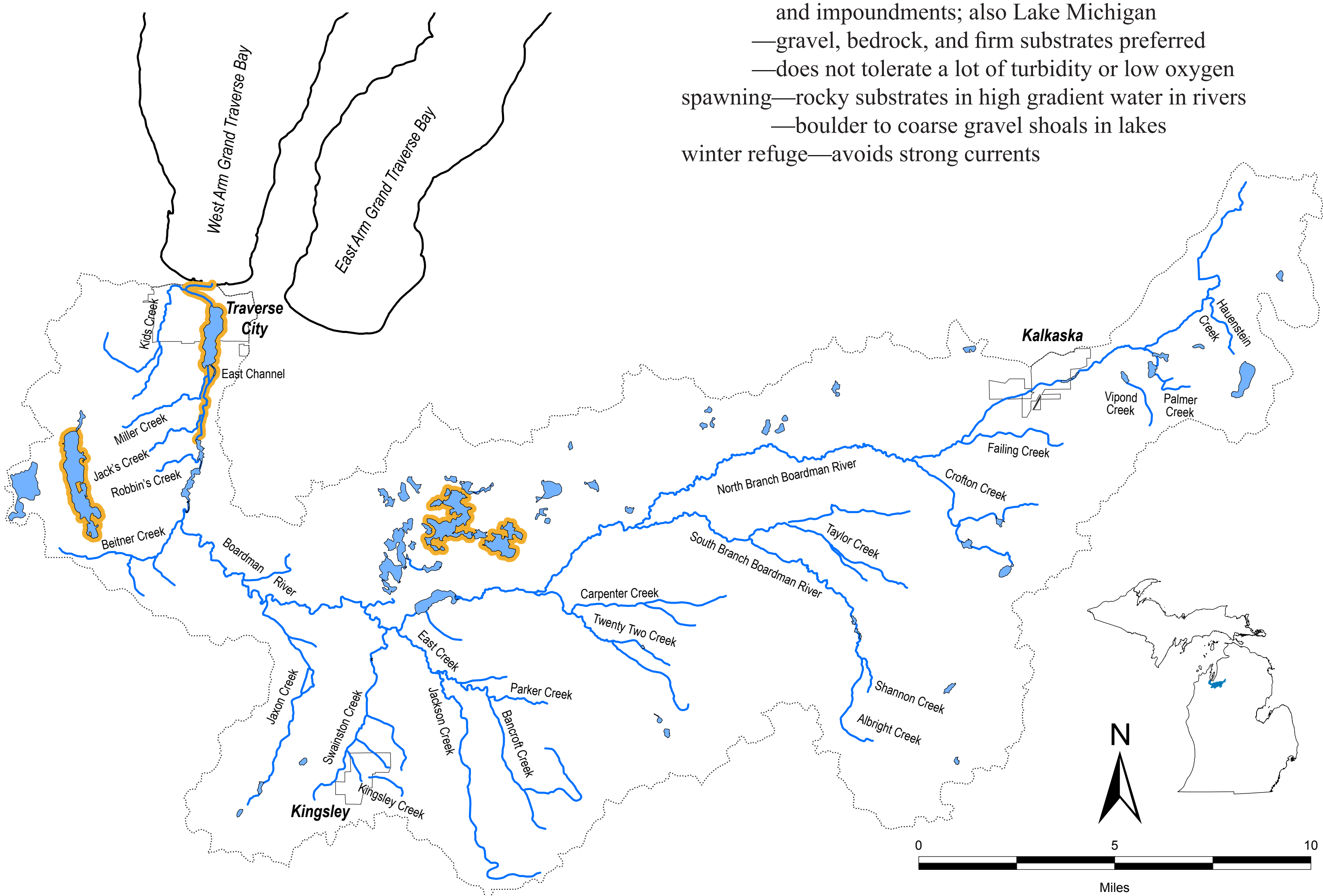
Northern Logperch *Percina caprodes semifasciata*

Habitat**:** feeding—gravel riffles, deeper slower sections of rivers
—medium size streams; also lakes, impoundments, and Lake Michigan
—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 Michigan
—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 D

Boardman River temperature data.

This appendix contains all the most recent water temperature data for the Boardman River main stem contained in records at the Central Lake Michigan Management Traverse City and Cadillac offices. All temperature documentation is in degrees Fahrenheit.

This page was intentionally left blank.

Table D.1.–Boardman River temperature data for Forks Campground, 27N 9W Sec. 4.

	2004			2005			2006		
Month	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min
January	–	–	–	–	–	–	–	–	–
February	–	–	–	–	–	–	–	–	–
June	–	–	–	60.8	70.2	51.4	58.4	68.0	50.0
July	–	–	–	60.6	68.4	51.5	60.8	69.4	53.4
August	–	–	–	59.2	68.6	50.8	58.6	71.8	50.8
December	–	–	–	–	–	–	–	–	–

Table D.2.–Boardman River temperature data for Ranch Rudolf, 26N 9W Section 7.

	2002 (upper) [a]			2002 (lower) [a]			2003 (upper)			2004 (lower)		
Month	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min
January	–	–	–	–	–	–	34.9	40.6	32.4	–	–	–
February	–	–	–	–	–	–	34.6	41.9	32.2	–	–	–
June	–	–	–	–	–	–	–	–	–	–	–	–
July	62.4	71.1	55.3	62.1	70.0	56.2	–	–	–	57.5	64.0	51.5
August	59.6	65.9	52.6	59.6	65.0	53.3	–	–	–	55.8	62.5	49.0
December	37.6	43.4	32.7	–	–	–	–	–	–	–	–	–

[a] Refers to the upper and lower ends of the electrofishing station.

Table D.3.–Boardman River temperature data for Scheck's Campground, 26N 9W Section 18.

	2003			2004			2005			2006		
Month	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min
January	–	–	–	34.3	41.3	31.9	35.5	40.3	32.0	–	–	–
February	–	–	–	–	–	–	37.6	42.0	32.3	–	–	–
June	57.1	69.9	46.1	–	–	–	60.9 [a]	69.4 [a]	52.0 [a]	–	–	–
July	59.5	66.4	52.0	–	–	–	60.4	67.9	51.2	–	–	–
August	59.5	67.0	51.4	56.5	64.2	49.0	59.0	68.2	51.7	–	–	–
December	37.6	42.2	33.7	37.0	41.7	32.0	37.4	41.4	33.8	–	–	–

[a] Includes data from June 4 through June 30, 2005.

Table D.4.–Boardman River temperature data for Below Brown Bridge Dam, 26N 10W, Section 15.

	2003			2004			2005			2006		
Month	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min
January	–	–	–	34.7	38.2	33.0	–	–	–	37.8	39.5	36.1
February	–	–	–	35.0	37.6	33.0	–	–	–	36.3	38.6	34.4
June	61.8	69.5	55.2	–	–	–	66.8 [a]	73.0 [a]	59.9 [a]	–	–	–
July	66.0	69.8	61.7	–	–	–	68.2	72.4	63.3	–	–	–
August	67.3	71.3	63.1	63.0	69.8	57.2	66.0	72.4	60.5	–	–	–
December	37.3	38.8	36.2	–	–	–	36.3	38.9	34.9	–	–	–

[a] Includes data from June 4 through June 30, 2005.

Table D.5.–Boardman River temperature data for Garfield Rd. (County Road 611), 26N, 10W, Section 21.

	2004			2005			2006		
Month	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min
January	–	–	–	–	–	–	37.7	39.3	35.9
February	–	–	–	–	–	–	36.2	38.5	34.2
June	–	–	–	–	–	–	63.8	67.8	59.7
July	–	–	–	–	–	–	67.1	72.0	61.4
August	62.9	69.5	57.5	–	–	–	66.2	73.2	61.2
December	–	–	–	36.1	38.7	34.8	–	–	–

Table D.6.–Boardman River temperature data for RR Trestle, 26N 10W Section 17.

	2004			2005			2006		
Month	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min
January	–	–	–	34.6	37.5	31.8	–	–	–
February	–	–	–	36.5	39.2	34.1	–	–	–
June	–	–	–	65.2	72.7	58.8	–	–	–
July	–	–	–	66.2	73.4	61.0	–	–	–
August	61.6	69.5	56.6	64.3	71.2	58.8	–	–	–
December	35.7	39.5	31.8	–	–	–	–	–	–

Table D.7.–Boardman River temperature data for Shumsky's Canoe Landing, 26N 11W Section 13.

	2004			2005			2006		
Month	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min
January	–	–	–	–	–	–	37.7	40.3	33.7
February	–	–	–	–	–	–	35.8	40.3	32.0
June	–	–	–	65.8 [a]	74.8 [a]	58.1 [a]	62.9	70.3	55.7
July	–	–	–	66.6	75.1	59.6	66.4	75.8	60.2
August	–	–	–	64.7	73.9	57.8	65.1	76.7	58.2
December	–	–	–	36.1	39.2	33.2	–	–	–

[a] Includes data from June 4 through June 30, 2005.

Table D.8.–Boardman River temperature data for Beitner Rd., 26N 11W Section 9.

	2004			2005			2006		
Month	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min
January	–	–	–	–	–	–	38.0	41.0	33.7
February	–	–	–	–	–	–	36.0	40.8	31.9
June	–	–	–	65.0	73.8	57.2	62.4	71.0	54.7
July	–	–	–	65.8	73.8	57.8	65.8	75.6	58.6
August	60.9	69.4	53.4	64.0	73.2	56.4	64.2	75.9	56.7
December	–	–	–	36.5	39.6	33.4	–	–	–

Table D.9.–Boardman River temperature data for Below Boardman Dam, 27N 11W Section 34

Month	2004			2005			2006		
	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min
January	–	–	–	34.8	37.7	32.5	37.7	39.7	36.3
February	–	–	–	36.9	38.8	34.8	36.3	39.1	33.7
June	–	–	–	66.7 [a]	73.3 [a]	61.0 [a]	64.1	69.1	59.9
July	–	–	–	67.9	73.3	64.2	67.7	73.0	64.5
August	62.8	66.8	59.0	65.9	72.7	61.6	66.6	74.2	61.9
December	36.0	39.4	32.5	36.4	38.9	34.6	–	–	–

[a] Includes data from June 4 through June 30, 2005.

Table D.10.–Boardman River temperature data for Below Sabin Dam, 27N 11W Section 27

Month	2004			2005			2006		
	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min
January	–	–	–	34.1	37.3	32.4	37.3	39.5	35.3
February	–	–	–	36.5	38.4	34.1	35.8	39.5	33.0
June	–	–	–	–	–	–	64.9	71.5	59.9
July	–	–	–	–	–	–	68.9	75.8	64.2
August	64.0	69.3	59.0	–	–	–	67.6	77.6	62.2
December	35.4	39.5	32.4	35.8	38.7	33.5	–	–	–

This page was intentionally left blank.

Appendix E

Angler creel survey report for Boardman River, summer, 2005

This appendix contains summary data from the DNR Fisheries Division creel census of the Boardman River April 26–September 30, 2005. Site 295 extended from the Boardman River mouth upstream to the Brown Bridge road crossing and site 296 extended from Brown Bridge Road to the Forks (confluence of the North and South branches of the Boardman River).

This page was intentionally left blank.

Table E.1.–Estimated harvest, catch per hour, and fishing pressure for 295, boat. Site 295 extended from the Boardman River mouth upstream to the Brown Bridge road crossing. Two standard errors are given in parentheses.

Species	C/H		Apr–May		Jun		Jul		Aug		Sep		Season	
			Number harvested											
Chinook salmon	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Rainbow trout	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Brown trout	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Brook trout	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Lake trout	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Smallmouth bass	0.0268	(<0.1)	0	(0)	0	(0)	99	(198)	0	(0)	0	(0)	99	(198)
Yellow perch	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Northern pike	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Bluegill	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Largemouth bass	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Rock bass	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Carp	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Common white sucker	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Other	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Total harvest	0.0268	(<0.1)	0	(0)	0	(0)	99	(198)	0	(0)	0	(0)	99	(198)
			Number released											
Coho salmon	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Chinook salmon	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Rainbow trout	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Brown trout	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Lake trout	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Smallmouth bass	0.0911	(<0.1)	0	(0)	0	(0)	298	(444)	40	(53)	0	(0)	338	(447)
Largemouth bass	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Walleye	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Northern pike	0.0268	(<0.1)	0	(0)	0	(0)	99	(198)	0	(0)	0	(0)	99	(198)
Common white sucker	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Rock bass	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Carp	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Bluegill	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Pumpkinseed	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Other	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Yellow perch	0.2141	(<0.1)	0	(0)	0	(0)	794	(1,587)	0	(0)	0	(0)	794	(1,587)
Total released	0.3319	(<0.1)	0	(0)	0	(0)	1,190	(1,660)	40	(53)	0	(0)	1,230	(1,661)
Total catch	0.3587	(<0.1)	0	(0)	0	(0)	1,290	(1,672)	40	(53)	0	(0)	1,330	(1,673)
Angler hours			2,035	(<0.1)	320	(640)	992	(887)	360	(416)	0	(0)	3,707	(<0.1)
Angler trips			1,357	(<0.1)	65	(133)	496	(444)	80	(92)	0	(0)	1,998	(<0.1)

Table E.2.–Estimated harvest, catch per hour, and fishing pressure for 295, shore. Site 295 extended from the Boardman River mouth upstream to the Brown Bridge road crossing. Two standard errors are given in parentheses.

Species	C/H		Apr–May		Jun		Jul		Aug		Sep		Season	
			Number harvested											
Chinook salmon	0.0101	(0.0104)	0	(0)	0	(0)	0	(0)	0	(0)	154	(152)	154	(152)
Rainbow trout	0.0096	(0.0088)	135	(127)	0	(0)	10	(21)	0	(0)	0	(0)	145	(129)
Brown trout	0.0013	(0.0025)	19	(38)	0	(0)	0	(0)	0	(0)	0	(0)	19	(38)
Brook trout	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Lake trout	0.0030	(0.0044)	46	(66)	0	(0)	0	(0)	0	(0)	0	(0)	46	(66)
Smallmouth bass	0.0081	(0.0113)	0	(0)	122	(168)	0	(0)	0	(0)	0	(0)	122	(168)
Yellow perch	0.0044	(0.0060)	0	(0)	0	(0)	58	(88)	9	(17)	0	(0)	67	(89)
Northern pike	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Bluegill	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Largemouth bass	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Rock bass	0.0278	(0.0414)	0	(0)	0	(0)	422	(618)	0	(0)	0	(0)	422	(618)
Carp	0.0030	(0.0049)	0	(0)	45	(74)	0	(0)	0	(0)	0	(0)	45	(74)
Common white sucker	0.0081	(0.0109)	124	(162)	0	(0)	0	(0)	0	(0)	0	(0)	124	(162)
Other	0.0012	(0.0025)	0	(0)	0	(0)	0	(0)	0	(0)	19	(38)	19	(38)
Total harvest	0.0766	(0.0503)	323	(220)	167	(183)	490	(625)	9	(17)	173	(157)	1,162	(705)
			Number released											
Coho salmon	0.0062	(0.0089)	94	(133)	0	(0)	0	(0)	0	(0)	0	(0)	94	(133)
Chinook salmon	0.0122	(0.0140)	0	(0)	0	(0)	0	(0)	0	(0)	185	(208)	185	(208)
Rainbow trout	0.1423	(0.0948)	1,294	(997)	92	(146)	746	(868)	6	(12)	19	(38)	2,157	(1,331)
Brown trout	0.0044	(0.0051)	43	(62)	0	(0)	0	(0)	3	(6)	21	(43)	67	(75)
Lake trout	0.0054	(0.0064)	81	(95)	0	(0)	0	(0)	0	(0)	0	(0)	81	(95)
Smallmouth bass	0.2470	(0.1164)	109	(132)	1,322	(947)	1,459	(960)	517	(507)	339	(369)	3,745	(1,493)
Largemouth bass	0.0020	(0.0041)	0	(0)	0	(0)	30	(62)	0	(0)	0	(0)	30	(62)
Walleye	0.0045	(0.0049)	0	(0)	23	(47)	25	(39)	20	(39)	0	(0)	68	(73)
Northern pike	0.0008	(0.0014)	0	(0)	0	(0)	0	(0)	12	(22)	0	(0)	12	(22)
Common white sucker	0.0246	(0.0172)	299	(219)	54	(100)	20	(40)	0	(0)	0	(0)	373	(244)
Rock bass	0.0958	(0.0685)	0	(0)	1,012	(933)	333	(237)	97	(136)	11	(21)	1,452	(972)
Carp	0.0159	(0.0239)	11	(21)	199	(354)	10	(20)	0	(0)	21	(43)	242	(358)
Bluegill	0.0032	(0.0052)	0	(0)	49	(77)	0	(0)	0	(0)	0	(0)	49	(77)
Pumpkinseed	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Other	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Yellow perch	0.0186	(0.0144)	0	(0)	68	(96)	152	(166)	20	(39)	43	(67)	282	(207)
Total released	0.5829	(0.2105)	1,931	(1,044)	2,819	(1,393)	2,776	(1,329)	673	(528)	639	(435)	8,838	(2,295)
Total catch	0.6596	(0.2291)	2,254	(1,067)	2,986	(1,405)	3,266	(1,469)	682	(528)	811	(463)	10,000	(2,401)
Angler hours			5,014	(1,698)	3,108	(2,258)	2,967	(1,438)	761	(672)	3,312	(1,997)	15,161	(3,806)
Angler trips			2,937	(1,123)	1,715	(1,404)	1,447	(771)	331	(284)	1,894	(1,287)	8,323	(2,359)

Table E.3.–Estimated harvest, catch per hour, and fishing pressure for 296, boat. Site 296 extended from Brown Bridge Road to the Forks (confluence of the North and South branches of the Boardman River). Two standard errors are given in parentheses.

Species	C/H	Apr–May	Jun	Jul	Aug	Sep	Season
		Number harvested					
Chinook salmon	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Rainbow trout	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Brown trout	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Brook trout	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Lake trout	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Smallmouth bass	0.0032 (<0.1)	13 (26)	0 (0)	0 (0)	0 (0)	0 (0)	13 (26)
Yellow perch	0.0248 (<0.1)	0 (0)	0 (0)	99 (199)	0 (0)	0 (0)	99 (199)
Northern pike	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Bluegill	0.0578 (<0.1)	231 (454)	0 (0)	0 (0)	0 (0)	0 (0)	231 (454)
Largemouth bass	0.0096 (<0.1)	38 (57)	0 (0)	0 (0)	0 (0)	0 (0)	38 (57)
Rock bass	0.0064 (<0.1)	26 (52)	0 (0)	0 (0)	0 (0)	0 (0)	26 (52)
Carp	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Common white sucker	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Other	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Total harvest	0.1018 (<0.1)	308 (461)	0 (0)	99 (199)	0 (0)	0 (0)	407 (502)
		Number released					
Coho salmon	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Chinook salmon	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Rainbow trout	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Brown trout	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Lake trout	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Smallmouth bass	0.0643 (<0.1)	0 (0)	77 (105)	40 (88)	0 (0)	140 (262)	257 (296)
Largemouth bass	0.0513 (<0.1)	180 (304)	26 (49)	0 (0)	0 (0)	0 (0)	205 (307)
Walleye	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Northern pike	0.0192 (<0.1)	0 (0)	77 (127)	0 (0)	0 (0)	0 (0)	77 (127)
Common white sucker	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Rock bass	0.0770 (<0.1)	282 (299)	26 (52)	0 (0)	0 (0)	0 (0)	308 (304)
Carp	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Bluegill	0.1048 (<0.1)	154 (303)	0 (0)	120 (184)	0 (0)	145 (263)	419 (441)
Pumpkinseed	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Other	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Yellow perch	0.0684 (<0.1)	0 (0)	26 (52)	238 (259)	0 (0)	10 (20)	273 (265)
Total released	0.3850 (<0.1)	616 (523)	230 (187)	398 (330)	0 (0)	295 (372)	1,540 (745)
Total catch	0.4868 (<0.1)	924 (697)	230 (187)	497 (385)	0 (0)	295 (372)	1,947 (899)
Angler hours		225 (134)	1,037 (1,116)	1,728 (919)	620 (<0.1)	390 (413)	3,999 (<0.1)
Angler trips		90 (61)	282 (308)	853 (494)	124 (<0.1)	220 (248)	1,569 (<0.1)

Table E.4.–Estimated harvest, catch per hour, and fishing pressure for 296, shore. Site 296 extended from Brown Bridge Road to the Forks (confluence of the North and South branches of the Boardman River). Two standard errors are given in parentheses.

Species	C/H		Apr–May		Jun		Jul		Aug		Sep		Season	
			Number harvested											
Chinook salmon	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Rainbow trout	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Brown trout	0.0104	(0.0119)	49	(66)	13	(20)	0	(0)	0	(0)	0	(0)	62	(69)
Brook trout	0.0083	(0.0109)	4	(9)	45	(63)	0	(0)	0	(0)	0	(0)	49	(64)
Lake trout	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Smallmouth bass	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Yellow perch	0.0127	(0.0182)	2	(5)	73	(107)	0	(0)	0	(0)	0	(0)	76	(107)
Northern pike	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Bluegill	0.0192	(0.0211)	14	(26)	73	(107)	27	(54)	0	(0)	0	(0)	114	(123)
Largemouth bass	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Rock bass	0.0078	(0.0100)	47	(59)	0	(0)	0	(0)	0	(0)	0	(0)	47	(59)
Carp	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Common white sucker	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Other	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Total harvest	0.0584	(0.0357)	116	(93)	205	(166)	27	(54)	0	(0)	0	(0)	348	(197)
			Number released											
Coho salmon	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Chinook salmon	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Rainbow trout	0.0060	(0.0074)	7	(14)	12	(24)	16	(33)	0	(0)	0	(0)	36	(43)
Brown trout	0.1625	(0.1260)	462	(598)	178	(223)	317	(327)	0	(0)	11	(21)	968	(717)
Lake trout	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Smallmouth bass	0.0226	(0.0195)	0	(0)	0	(0)	101	(100)	34	(51)	0	(0)	135	(112)
Largemouth bass	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Walleye	0.0023	(0.0046)	0	(0)	0	(0)	14	(27)	0	(0)	0	(0)	14	(27)
Northern pike	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Common white sucker	0.0046	(0.0066)	27	(39)	0	(0)	0	(0)	0	(0)	0	(0)	27	(39)
Rock bass	0.1795	(0.1208)	215	(272)	16	(33)	604	(578)	191	(212)	43	(63)	1,069	(677)
Carp	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Bluegill	0.1965	(0.1406)	133	(179)	230	(276)	521	(677)	251	(245)	35	(57)	1,171	(794)
Pumpkinseed	0.0023	(0.0047)	0	(0)	0	(0)	0	(0)	0	(0)	14	(28)	14	(28)
Other	0.0235	(0.0473)	0	(0)	0	(0)	0	(0)	0	(0)	140	(280)	140	(280)
Yellow perch	0.0216	(0.0167)	4	(9)	0	(0)	0	(0)	95	(76)	29	(56)	129	(95)
Total released	0.6214	(0.2613)	849	(682)	437	(357)	1,574	(955)	572	(337)	272	(300)	3,703	(1,307)
Total catch	0.6798	(0.2708)	965	(688)	641	(394)	1,601	(956)	572	(337)	272	(300)	4,051	(1,322)
Angler hours			1,834	(769)	952	(643)	1,881	(584)	902	(448)	390	(557)	5,958	(1,362)
Angler trips			696	(321)	404	(293)	1,030	(344)	391	(245)	270	(374)	2,791	(712)

Table E.5.–Estimated harvest, catch per hour, and fishing pressure for 295. Site 295 extended from the Boardman River mouth upstream to the Brown Bridge road crossing. Two standard errors are given in parentheses.

Species	C/H		Apr–May		Jun		Jul		Aug		Sep		Season	
			Number harvested											
Chinook salmon	0.0081	(<0.1)	0	(0)	0	(0)	0	(0)	0	(0)	154	(152)	154	(152)
Rainbow trout	0.0077	(<0.1)	135	(127)	0	(0)	10	(21)	0	(0)	0	(0)	145	(129)
Brown trout	0.0010	(<0.1)	19	(38)	0	(0)	0	(0)	0	(0)	0	(0)	19	(38)
Brook trout	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Lake trout	0.0024	(<0.1)	46	(66)	0	(0)	0	(0)	0	(0)	0	(0)	46	(66)
Smallmouth bass	0.0117	(<0.1)	0	(0)	122	(168)	99	(198)	0	(0)	0	(0)	221	(260)
Yellow perch	0.0035	(<0.1)	0	(0)	0	(0)	58	(88)	9	(17)	0	(0)	67	(89)
Northern pike	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Bluegill	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Largemouth bass	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Rock bass	0.0224	(<0.1)	0	(0)	0	(0)	422	(618)	0	(0)	0	(0)	422	(618)
Carp	0.0024	(<0.1)	0	(0)	45	(74)	0	(0)	0	(0)	0	(0)	45	(74)
Common white sucker	0.0065	(<0.1)	124	(162)	0	(0)	0	(0)	0	(0)	0	(0)	124	(162)
Other	0.0010	(<0.1)	0	(0)	0	(0)	0	(0)	0	(0)	19	(38)	19	(38)
Total harvest	0.0668	(<0.1)	323	(220)	167	(183)	589	(655)	9	(17)	173	(157)	1,261	(732)
			Number released											
Coho salmon	0.0050	(<0.1)	94	(133)	0	(0)	0	(0)	0	(0)	0	(0)	94	(133)
Chinook salmon	0.0098	(<0.1)	0	(0)	0	(0)	0	(0)	0	(0)	185	(208)	185	(208)
Rainbow trout	0.1143	(<0.1)	1,294	(997)	92	(146)	746	(868)	6	(12)	19	(38)	2,157	(1,331)
Brown trout	0.0036	(<0.1)	43	(62)	0	(0)	0	(0)	3	(6)	21	(43)	67	(75)
Lake trout	0.0043	(<0.1)	81	(95)	0	(0)	0	(0)	0	(0)	0	(0)	81	(95)
Smallmouth bass	0.2164	(<0.1)	109	(132)	1,322	(947)	1,756	(1,058)	557	(509)	339	(369)	4,083	(1,558)
Largemouth bass	0.0016	(<0.1)	0	(0)	0	(0)	30	(62)	0	(0)	0	(0)	30	(62)
Walleye	0.0036	(<0.1)	0	(0)	23	(47)	25	(39)	20	(39)	0	(0)	68	(73)
Northern pike	0.0059	(<0.1)	0	(0)	0	(0)	99	(198)	12	(22)	0	(0)	111	(200)
Common white sucker	0.0197	(<0.1)	299	(219)	54	(100)	20	(40)	0	(0)	0	(0)	373	(244)
Rock bass	0.0770	(<0.1)	0	(0)	1,012	(933)	333	(237)	97	(136)	11	(21)	1,452	(972)
Carp	0.0128	(<0.1)	11	(21)	199	(354)	10	(20)	0	(0)	21	(43)	242	(358)
Bluegill	0.0026	(<0.1)	0	(0)	49	(77)	0	(0)	0	(0)	0	(0)	49	(77)
Pumpkinseed	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Other	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Yellow perch	0.0570	(<0.1)	0	(0)	68	(96)	946	(1,596)	20	(39)	43	(67)	1,076	(1,601)
Total released	0.5336	(<0.1)	1,931	(1,044)	2,819	(1,393)	3,966	(2,127)	713	(531)	639	(435)	10,068	(2,833)
Total catch	0.6005	(<0.1)	2,254	(1,067)	2,986	(1,405)	4,556	(2,225)	722	(531)	811	(463)	11,329	(2,926)
Angler hours			7,049	(<0.1)	3,428	(2,347)	3,959	(1,689)	1,121	(790)	3,312	(1,997)	18,868	(<0.1)
Angler trips			4,293	(<0.1)	1,780	(1,410)	1,943	(889)	411	(299)	1,894	(1,287)	10,321	(<0.1)

Table E.6.–Estimated harvest, catch per hour, and fishing pressure for 296. Site 296 extended from Brown Bridge Road to the Forks (confluence of the North and South branches of the Boardman River). Two standard errors are given in parentheses.

Species	C/H		Apr–May		Jun		Jul		Aug		Sep		Season	
			Number harvested											
Chinook salmon	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Rainbow trout	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Brown trout	0.0063	(<0.1)	49	(66)	13	(20)	0	(0)	0	(0)	0	(0)	62	(69)
Brook trout	0.0049	(<0.1)	4	(9)	45	(63)	0	(0)	0	(0)	0	(0)	49	(64)
Lake trout	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Smallmouth bass	0.0013	(<0.1)	13	(26)	0	(0)	0	(0)	0	(0)	0	(0)	13	(26)
Yellow perch	0.0176	(<0.1)	2	(5)	73	(107)	99	(199)	0	(0)	0	(0)	175	(226)
Northern pike	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Bluegill	0.0347	(<0.1)	245	(455)	73	(107)	27	(54)	0	(0)	0	(0)	345	(470)
Largemouth bass	0.0039	(<0.1)	38	(57)	0	(0)	0	(0)	0	(0)	0	(0)	38	(57)
Rock bass	0.0073	(<0.1)	72	(78)	0	(0)	0	(0)	0	(0)	0	(0)	72	(78)
Carp	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Common white sucker	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Other	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Total harvest	0.0758	(<0.1)	424	(470)	205	(166)	126	(206)	0	(0)	0	(0)	755	(540)
			Number released											
Coho salmon	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Chinook salmon	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Rainbow trout	0.0036	(<0.1)	7	(14)	12	(24)	16	(33)	0	(0)	0	(0)	36	(43)
Brown trout	0.0972	(<0.1)	462	(598)	178	(223)	317	(327)	0	(0)	11	(21)	968	(717)
Lake trout	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Smallmouth bass	0.0394	(<0.1)	0	(0)	77	(105)	141	(133)	34	(51)	140	(262)	392	(316)
Largemouth bass	0.0206	(<0.1)	180	(304)	26	(49)	0	(0)	0	(0)	0	(0)	205	(307)
Walleye	0.0014	(<0.1)	0	(0)	0	(0)	14	(27)	0	(0)	0	(0)	14	(27)
Northern pike	0.0077	(<0.1)	0	(0)	77	(127)	0	(0)	0	(0)	0	(0)	77	(127)
Common white sucker	0.0027	(<0.1)	27	(39)	0	(0)	0	(0)	0	(0)	0	(0)	27	(39)
Rock bass	0.1383	(<0.1)	497	(405)	42	(61)	604	(578)	191	(212)	43	(63)	1,377	(742)
Carp	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Bluegill	0.1596	(<0.1)	287	(352)	230	(276)	641	(702)	251	(245)	181	(269)	1,590	(908)
Pumpkinseed	0.0014	(<0.1)	0	(0)	0	(0)	0	(0)	0	(0)	14	(28)	14	(28)
Other	0.0141	(<0.1)	0	(0)	0	(0)	0	(0)	0	(0)	140	(280)	140	(280)
Yellow perch	0.0404	(<0.1)	4	(9)	26	(52)	238	(259)	95	(76)	39	(59)	402	(282)
Total released	0.5264	(<0.1)	1,465	(859)	667	(403)	1,971	(1,010)	572	(337)	567	(478)	5,242	(1,504)
Total catch	0.6023	(<0.1)	1,889	(980)	872	(436)	2,098	(1,031)	572	(337)	567	(478)	5,997	(1,598)
Angler hours			2,058	(781)	1,989	(1,288)	3,608	(1,089)	1,522	(<0.1)	780	(693)	9,958	(<0.1)
Angler trips			786	(327)	686	(425)	1,883	(602)	515	(<0.1)	490	(449)	4,359	(<0.1)

Table E.7.–Estimated harvest, catch per hour, and fishing pressure for boat. Two standard errors are given in parentheses.

Species	C/H		Apr–May		Jun		Jul		Aug		Sep		Season	
			Number harvested											
Chinook salmon	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Rainbow trout	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Brown trout	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Brook trout	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Lake trout	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Smallmouth bass	0.0145	(<0.1)	13	(26)	0	(0)	99	(198)	0	(0)	0	(0)	112	(200)
Yellow perch	0.0129	(<0.1)	0	(0)	0	(0)	99	(199)	0	(0)	0	(0)	99	(199)
Northern pike	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Bluegill	0.0300	(<0.1)	231	(454)	0	(0)	0	(0)	0	(0)	0	(0)	231	(454)
Largemouth bass	0.0050	(<0.1)	38	(57)	0	(0)	0	(0)	0	(0)	0	(0)	38	(57)
Rock bass	0.0033	(<0.1)	26	(52)	0	(0)	0	(0)	0	(0)	0	(0)	26	(52)
Carp	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Common white sucker	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Other	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Total harvest	0.0657	(<0.1)	308	(461)	0	(0)	198	(281)	0	(0)	0	(0)	506	(540)
			Number released											
Coho salmon	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Chinook salmon	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Rainbow trout	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Brown trout	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Lake trout	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Smallmouth bass	0.0772	(<0.1)	0	(0)	77	(105)	338	(452)	40	(53)	140	(262)	595	(536)
Largemouth bass	0.0266	(<0.1)	180	(304)	26	(49)	0	(0)	0	(0)	0	(0)	205	(307)
Walleye	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Northern pike	0.0228	(<0.1)	0	(0)	77	(127)	99	(198)	0	(0)	0	(0)	176	(236)
Common white sucker	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Rock bass	0.0400	(<0.1)	282	(299)	26	(52)	0	(0)	0	(0)	0	(0)	308	(304)
Carp	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Bluegill	0.0544	(<0.1)	154	(303)	0	(0)	120	(184)	0	(0)	145	(263)	419	(441)
Pumpkinseed	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Other	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Yellow perch	0.1385	(<0.1)	0	(0)	26	(52)	1,032	(1,608)	0	(0)	10	(20)	1,067	(1,609)
Total released	0.3594		616	(523)	230	(187)	1,588	(1,692)	40	(53)	295	(372)	2,770	(1,820)
Total catch	0.4251	(<0.1)	924	(697)	230	(187)	1,786	(1,716)	40	(53)	295	(372)	3,276	(1,899)
Angler hours			2,260	(<0.1)	1,357	(1,287)	2,720	(1,277)	980	(<0.1)	390	(413)	7,706	(<0.1)
Angler trips			1,447	(<0.1)	347	(335)	1,349	(664)	204	(<0.1)	220	(248)	3,567	(<0.1)

Table E.8.–Estimated harvest, catch per hour, and fishing pressure for shore. Two standard errors are given in parentheses.

Species	C/H		Apr–May		Jun		Jul		Aug		Sep		Season	
			Number harvested											
Chinook salmon	0.0073	(0.0073)	0	(0)	0	(0)	0	(0)	0	(0)	154	(152)	154	(152)
Rainbow trout	0.0069	(0.0062)	135	(127)	0	(0)	10	(21)	0	(0)	0	(0)	145	(129)
Brown trout	0.0039	(0.0038)	68	(76)	13	(20)	0	(0)	0	(0)	0	(0)	81	(79)
Brook trout	0.0023	(0.0031)	4	(9)	45	(63)	0	(0)	0	(0)	0	(0)	49	(64)
Lake trout	0.0022	(0.0032)	46	(66)	0	(0)	0	(0)	0	(0)	0	(0)	46	(66)
Smallmouth bass	0.0058	(0.0080)	0	(0)	122	(168)	0	(0)	0	(0)	0	(0)	122	(168)
Yellow perch	0.0067	(0.0067)	2	(5)	73	(107)	58	(88)	9	(17)	0	(0)	142	(140)
Northern pike	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Bluegill	0.0054	(0.0059)	14	(26)	73	(107)	27	(54)	0	(0)	0	(0)	114	(123)
Largemouth bass	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Rock bass	0.0222	(0.0297)	47	(59)	0	(0)	422	(618)	0	(0)	0	(0)	468	(621)
Carp	0.0021	(0.0035)	0	(0)	45	(74)	0	(0)	0	(0)	0	(0)	45	(74)
Common white sucker	0.0058	(0.0078)	124	(162)	0	(0)	0	(0)	0	(0)	0	(0)	124	(162)
Other	0.0009	(0.0018)	0	(0)	0	(0)	0	(0)	0	(0)	19	(38)	19	(38)
Total harvest	0.0715	(0.0373)	440	(239)	372	(247)	517	(627)	9	(17)	173	(157)	1,510	(732)
			Number released											
Coho salmon	0.0045	(0.0064)	94	(133)	0	(0)	0	(0)	0	(0)	0	(0)	94	(133)
Chinook salmon	0.0088	(0.0100)	0	(0)	0	(0)	0	(0)	0	(0)	185	(208)	185	(208)
Rainbow trout	0.1038	(0.0661)	1,302	(997)	104	(148)	763	(869)	6	(12)	19	(38)	2,193	(1,331)
Brown trout	0.0490	(0.0354)	505	(601)	178	(223)	317	(327)	3	(6)	32	(48)	1,036	(721)
Lake trout	0.0039	(0.0045)	81	(95)	0	(0)	0	(0)	0	(0)	0	(0)	81	(95)
Smallmouth bass	0.1837	(0.0791)	109	(132)	1,322	(947)	1,559	(966)	551	(509)	339	(369)	3,880	(1,497)
Largemouth bass	0.0014	(0.0029)	0	(0)	0	(0)	30	(62)	0	(0)	0	(0)	30	(62)
Walleye	0.0039	(0.0037)	0	(0)	23	(47)	39	(48)	20	(39)	0	(0)	82	(78)
Northern pike	0.0006	(0.0010)	0	(0)	0	(0)	0	(0)	12	(22)	0	(0)	12	(22)
Common white sucker	0.0189	(0.0122)	326	(222)	54	(100)	20	(40)	0	(0)	0	(0)	400	(247)
Rock bass	0.1194	(0.0606)	215	(272)	1,028	(933)	938	(625)	288	(252)	53	(66)	2,522	(1,185)
Carp	0.0114	(0.0171)	11	(21)	199	(354)	10	(20)	0	(0)	21	(43)	242	(358)
Bluegill	0.0577	(0.0393)	133	(179)	279	(286)	521	(677)	251	(245)	35	(57)	1,219	(798)
Pumpkinseed	0.0007	(0.0013)	0	(0)	0	(0)	0	(0)	0	(0)	14	(28)	14	(28)
Other	0.0066	(0.0133)	0	(0)	0	(0)	0	(0)	0	(0)	140	(280)	140	(280)
Yellow perch	0.0195	(0.0114)	4	(9)	68	(96)	152	(166)	115	(86)	72	(87)	411	(228)
Total released	0.5938	(0.1690)	2,780	(1,247)	3,256	(1,438)	4,349	(1,637)	1,245	(626)	910	(528)	12,541	(2,641)
Total catch	0.6653	(0.1818)	3,220	(1,270)	3,628	(1,459)	4,867	(1,753)	1,254	(626)	1,083	(551)	14,050	(2,740)
Angler hours			6,848	(1,864)	4,060	(2,348)	4,847	(1,552)	1,663	(808)	3,702	(2,074)	21,119	(4,043)
Angler trips			3,632	(1,168)	2,120	(1,434)	2,477	(844)	722	(375)	2,164	(1,340)	11,114	(2,464)

Table E.9.–Estimated harvest, catch per hour, and fishing pressure for Boardman River. Two standard errors are given in parentheses.

Species	C/H		Apr–May		Jun		Jul		Aug		Sep		Season	
			Number harvested											
Chinook salmon	0.0053	(<0.1)	0	(0)	0	(0)	0	(0)	0	(0)	154	(152)	154	(152)
Rainbow trout	0.0050	(<0.1)	135	(127)	0	(0)	10	(21)	0	(0)	0	(0)	145	(129)
Brown trout	0.0028	(<0.1)	68	(76)	13	(20)	0	(0)	0	(0)	0	(0)	81	(79)
Brook trout	0.0017	(<0.1)	4	(9)	45	(63)	0	(0)	0	(0)	0	(0)	49	(64)
Lake trout	0.0016	(<0.1)	46	(66)	0	(0)	0	(0)	0	(0)	0	(0)	46	(66)
Smallmouth bass	0.0081	(<0.1)	13	(26)	122	(168)	99	(198)	0	(0)	0	(0)	234	(261)
Yellow perch	0.0084	(<0.1)	2	(5)	73	(107)	157	(217)	9	(17)	0	(0)	241	(243)
Northern pike	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Bluegill	0.0120	(<0.1)	245	(455)	73	(107)	27	(54)	0	(0)	0	(0)	345	(470)
Largemouth bass	0.0013	(<0.1)	38	(57)	0	(0)	0	(0)	0	(0)	0	(0)	38	(57)
Rock bass	0.0171	(<0.1)	72	(78)	0	(0)	422	(618)	0	(0)	0	(0)	494	(623)
Carp	0.0016	(<0.1)	0	(0)	45	(74)	0	(0)	0	(0)	0	(0)	45	(74)
Common white sucker	0.0043	(<0.1)	124	(162)	0	(0)	0	(0)	0	(0)	0	(0)	124	(162)
Other	0.0007	(<0.1)	0	(0)	0	(0)	0	(0)	0	(0)	19	(38)	19	(38)
Total harvest	0.0699	(<0.1)	748	(519)	372	(247)	716	(687)	9	(17)	173	(157)	2,016	(910)
			Number released											
Coho salmon	0.0033	(<0.1)	94	(133)	0	(0)	0	(0)	0	(0)	0	(0)	94	(133)
Chinook salmon	0.0064	(<0.1)	0	(0)	0	(0)	0	(0)	0	(0)	185	(208)	185	(208)
Rainbow trout	0.0761	(<0.1)	1,302	(997)	104	(148)	763	(869)	6	(12)	19	(38)	2,193	(1,331)
Brown trout	0.0359	(<0.1)	505	(601)	178	(223)	317	(327)	3	(6)	32	(48)	1,036	(721)
Lake trout	0.0028	(<0.1)	81	(95)	0	(0)	0	(0)	0	(0)	0	(0)	81	(95)
Smallmouth bass	0.1552	(<0.1)	109	(132)	1,399	(953)	1,897	(1,066)	591	(512)	479	(453)	4,475	(1,590)
Largemouth bass	0.0082	(<0.1)	180	(304)	26	(49)	30	(62)	0	(0)	0	(0)	235	(314)
Walleye	0.0028	(<0.1)	0	(0)	23	(47)	39	(48)	20	(39)	0	(0)	82	(78)
Northern pike	0.0065	(<0.1)	0	(0)	77	(127)	99	(198)	12	(22)	0	(0)	188	(237)
Common white sucker	0.0139	(<0.1)	326	(222)	54	(100)	20	(40)	0	(0)	0	(0)	400	(247)
Rock bass	0.0982	(<0.1)	497	(405)	1,054	(935)	938	(625)	288	(252)	53	(66)	2,829	(1,223)
Carp	0.0084	(<0.1)	11	(21)	199	(354)	10	(20)	0	(0)	21	(43)	242	(358)
Bluegill	0.0568	(<0.1)	287	(352)	279	(286)	641	(702)	251	(245)	181	(269)	1,639	(911)
Pumpkinseed	0.0005	(<0.1)	0	(0)	0	(0)	0	(0)	0	(0)	14	(28)	14	(28)
Other	0.0049	(<0.1)	0	(0)	0	(0)	0	(0)	0	(0)	140	(280)	140	(280)
Yellow perch	0.0513	(<0.1)	4	(9)	93	(109)	1,184	(1,617)	115	(86)	82	(89)	1,478	(1,625)
Total released	0.5311	(<0.1)	3,396	(1,353)	3,486	(1,450)	5,937	(2,354)	1,285	(628)	1,206	(646)	15,311	(3,207)
Total catch	0.6011	(<0.1)	4,144	(1,449)	3,858	(1,471)	6,653	(2,452)	1,294	(629)	1,378	(665)	17,327	(3,334)
Angler hours			9,107	(<0.1)	5,417	(2,677)	7,567	(2,010)	2,643	(<0.1)	4,092	(2,114)	28,826	(<0.1)
Angler trips			5,079	(<0.1)	2,467	(1,473)	3,826	(1,074)	926	(<0.1)	2,384	(1,363)	14,681	(<0.1)

This page was intentionally left blank.

Appendix F

An analysis of potential effects of upstream passage of steelhead on the Boardman River

This appendix contains an assessment of the biological effects that steelhead would have on resident trout in the Boardman River if they were allowed to migrate upstream of the four dams in the Boardman River mainstem. These data were compiled from records located at MDNR, Hunt Creek Fisheries Research Station.

This page was intentionally left blank.

An Analysis of Potential Effects of Upstream Passage of Steelhead on the Boardman River

Andy Nuhfer, Research Biologist, Hunt Creek Fisheries Research Station

March 28, 2007

Some anglers are concerned that upstream migration of potamodromous species such as steelhead and coho salmon might reduce the abundance of resident brown trout and brook trout in the Boardman River. In this analysis I present findings from a long-term evaluation of the effects of steelhead on brown trout in Hunt Creek and data from a large number of other Michigan streams where salmonid populations have been estimated during multiple years. Overall, my analysis suggests that significant adverse effects of steelhead on resident trout populations in the Boardman River are unlikely to occur, and if there are unwanted effects they could be mitigated by limiting the numbers of adult steelhead passed upstream.

The Hunt Creek Fisheries Research Station has been investigating effects of competition between brown trout and juvenile steelhead in Hunt Creek since 1995. A short summary of the results of that study, to date, are pasted below in italics.

Potential effects of competitive interactions between steelhead and resident brown trout Salmo trutta in Hunt Creek were evaluated by comparing population dynamics of resident trout in a 3.4 km treatment zone (TZ) before (1995-97) and after (1998-06) adult steelhead Oncorhynchus mykiss were stocked into the TZ. Adult steelhead trout were stocked each spring from 1998 through 2003. Resident brown and brook trout Salvelinus fontinalis populations were also estimated in reference zones (RZ's) without steelhead. Brown trout and brook trout abundance, growth, and survival in the TZ were compared between cohorts that interacted with juvenile steelhead and those that did not.

Density of cohorts of yearling-and-older brown trout in Hunt Creek that interacted with steelhead as young-of-the-year (YOY) was about half that of allopatric cohorts. This occurred primarily because mean annual survival of (YOY) brown trout declined from 38% to 23% when YOY steelhead were present. Similar temporal changes in survival and density of brown trout were not observed in the Gilchrist Creek RZ. ***Reduced survival of brown trout YOY probably occurred because mean fall density of YOY trout (brown trout and steelhead combined) was over three times higher than the pre-steelhead abundance of brown trout YOY****. Mean fall abundance of YOY brown trout in the TZ has not changed significantly, relative to the Gilchrist Creek RZ, indicating that steelhead did not impair brown trout reproductive success. Density of yearling brook trout cohorts that interacted with steelhead was lower than for allopatric cohorts. Few significant changes in growth rates of Hunt Creek brown trout or brook trout were detected following steelhead introductions.*

Streams vary in their capacity to support good survival of young-of-year (YOY) trout. In some streams there is no obvious relationship between fall density of YOY and their survival over the ensuing year. In these streams the apparent lack of density-dependent survival may occur because YOY are seldom abundant enough so that their habitat becomes limiting. In other streams with very high quality reproductive habitat YOY densities become high enough so that inverse density-dependent survival is evident. I will illustrate this using graphics derived from several long-term data sets including the Hunt Creek dataset collected when steelhead juveniles were present. Total density of salmonid YOY (steelhead + brown trout) were very high in Hunt Creek during years that adult steelhead spawned there (Figure 1) and average survival of brown trout to age 1 was clearly lower during those years (1998–

2003). Even when no other “competing” salmonid species are present, as is the case in Gilchrist Creek, smaller year classes of brown trout tend to survive better to age 1 although there is considerable variation (Figure 2).

I also searched for inverse density dependent survival relationships for brown trout by pooling population estimates from 17 Michigan Rivers and plotting annual survival of age-0 brown trout against total density of YOY trout in these streams, i.e. brook and brown trout combined (Figure 3). The distribution of data points suggests that high densities may limit survival or trigger emigration from the reach. Conversely, estimates of survival for some year classes, particularly those with densities less than 500 YOY per acre, were over 100% in some years, indicating immigration into the reach. I view the heavy diagonal line as an indicator of the “potential for survival” of brown trout YOY as a function of total brown and brook trout density. This line suggests to me that the “potential for survival” given appropriate habitat conditions is quite good for total brook trout and brown trout YOY densities up to about 1,000/acre. Note that the data plotted in Figure 3 were collected from Michigan rivers where long-term data sets were available, and only a few of these rivers contained significant populations of juvenile rainbow trout. There is considerable variation in brown trout survival rate estimates between years in these rivers that is not accounted for based solely on total YOY density.

Median density of YOY trout (brown trout + rainbow trout + brook trout) was 653 YOY/acre at 41 Michigan Stream Status and Trends Program (SSTP) fixed sites (Figure 4). However, the average total density of YOY was considerably higher (1,008/acre) due to the high numbers of juvenile steelhead present in some streams (Figure 4). Note that coho salmon were not considered in this analysis because they are abundant in only a few Michigan streams.

I examined the relation between total density of trout YOY and survival of brown trout YOY to age 1 at these SSTP sites to evaluate whether inverse density dependent survival was evident (i.e. Is survival of YOY brown trout usually lower when total density of all YOY salmonids is higher?). First I truncated survival rates higher than 100% down to 1. Estimates of survival exceeding 100% are found at sites where significant immigration of yearling trout into the sampling station occurs. This is most common at sampling stations where there are few YOY. In addition, I looked only at river sites where there were at least 50 YOY brown trout per acre since the focus of this analysis is on brown trout. With a few exceptions such as Bear Creek (Manistee County) rainbow trout were rarely abundant in the same streams where brook trout were found in significant numbers.

Survival of YOY brown trout to age 1 was often substantially higher than the median for brown trout streams even at SSTP fixed sites where total abundance of all trout YOY species exceeded 1,000 per acre (Figure 5). The Little Manistee River, Platte River, Sturgeon River and West Branch Sturgeon (Cheboygan River watershed), and Townsend Creek each had total densities of YOY trout over 1,000 per acre, higher-than-median survival rates for YOY brown trout, and also supported significant populations of juvenile steelhead.

Total density of YOY at 29 SSTP fixed sites accounted for virtually none of the variation in survival of brown trout YOY (Figure 6). I hypothesize that this occurred for several reasons. First, the streams with total YOY densities higher than the median were usually those where a majority of the YOY was rainbow trout. In these streams, density of YOY brown trout was usually substantially lower than the 460 YOY brown trout per acre found in Hunt Creek when YOY steelhead were not present. Thus my second hypothesis is that adverse effects of YOY steelhead on survival of YOY brown trout are less likely to occur when densities of brown trout YOY are lower than in Hunt Creek, as they are in most streams, including the Boardman River (Table 1). The apparent reduced potential for survival of YOY brown trout when densities of resident trout species exceeded 1,000 per acre (see Figures 2 and 3) presumably occurred because conspecifics are more likely to compete for the same habitat and are more likely to be about the same size. The average brown trout YOY can out-compete the average steelhead YOY for space on a one-to-one basis because they hatch earlier in the year and hence their average size is larger. However, by late summer there is substantial overlap in the length frequencies of YOY brown trout and steelhead as shown in Figure 7. I hypothesize that in Hunt Creek there were enough YOY steelhead as large as YOY brown trout so that competition intensity was high enough to reduce annual survival of YOY brown trout from 38% to 23%. Because Hunt Creek is relatively cold and unproductive it could not support a high survival rate for all these additional YOY. The SSTP data indicates that similar reductions in YOY brown trout survival did not occur in all Michigan streams (see Figures 5 and 6).

Some of the highest standing crops of resident trout in the state are found in streams receiving runs of potamodromous salmonids (Figure 8). Steelhead runs occur in 7 of the 12 streams with total trout standing stocks higher than the 75th percentile for the 46 streams depicted in Figure 8. Moreover, the average standing stocks of brown trout alone in these seven streams with steelhead runs was 104 pounds per acre. Clearly, steelhead runs are not incompatible with high standing stocks of resident trout species in many Michigan streams.

Upstream passage of steelhead in the Boardman River offers a tremendous opportunity to increase recruitment of steelhead smolts for Lake Michigan. Densities of YOY steelhead in Hunt Creek during years that adult steelhead were stocked averaged nearly 1,200 per acre. Yearling steelhead densities averaged 160 per acre. Most of these yearlings smolted at age 2 the following spring. Note also that the watershed-wide numbers of steelhead exported from Hunt Creek were far higher than the numbers shown above from the 2.1 mile stream reach that we sampled each year. Yearling steelhead were well distributed downstream from the primary area where adults spawned to the mouth of Hunt Creek, a distance of about 5 miles. It was easy to collect 60 yearling steelhead near the mouth of Hunt Creek during years when we collected them for disease testing. In addition, juvenile steelhead were caught in the Thunder Bay River and in Gilchrist Creek as far upstream as M-33. My main point is that although we could not estimate watershed-wide populations of pre-smolt steelhead the numbers had to be huge given their broad distribution and their high density throughout Hunt Creek.

Based on the forgoing analysis I recommend that steelhead be passed upstream into the Boardman River for the following reasons. Abundance of YOY brown trout in the Boardman River is lower than their abundance in Hunt Creek where interactions with juvenile steelhead resulted in lower survival of brown trout YOY. Survival of brown trout YOY at SSTP sites where large numbers of juvenile steelhead were found was often higher than the median for all sites and total YOY density (brown trout + brook trout + rainbow trout) did not explain variation in brown trout survival at SSTP sites (see Figures 4 through 6). Some of the highest standing crops of resident trout in the state were found in streams receiving runs of potamodromous salmonids (Figure 8). Finally, steelhead passage into the Boardman River offers a tremendous opportunity to increase recruitment of steelhead smolts for Lake Michigan.

Table F.1.–Abundance of brown trout and brook trout, total pounds per acre and numbers per acre by age at five population survey sites.

Year	Species	Site	Total pounds	Age 0	1	2	3	4
2005	BNT	Beitner Road	31.1	274	71	32	3	0
2005	BKT	Beitner Road	6.7	317	13	0	0	0
		Totals:	38	591	84	32	3	0
2005	BNT	Brown Bridge Rd.	30.3	188	13	31	13	0
2005	BKT	Brown Bridge Rd.	0.2	11	1	0	0	0
		Totals:	30	199	14	31	13	0
2004	BNT	Ranch Rudolf	43.2	20	80	73	23	6
2004	BKT	Ranch Rudolf	12.4	250	87	9	0	0
		Totals:	56	270	166	82	23	6
2005	BNT	Scheck's	63.4	331	74	82	18	5
2005	BKT	Scheck's	7.1	212	58	1	0	0
		Totals:	71	543	132	83	18	5
2005	BNT	Shumsky's	20.6	56	33	34	6	0
2005	BKT	Shumsky's	0.2	0	2	0	0	0
		Totals:	21	56	34	34	6	0

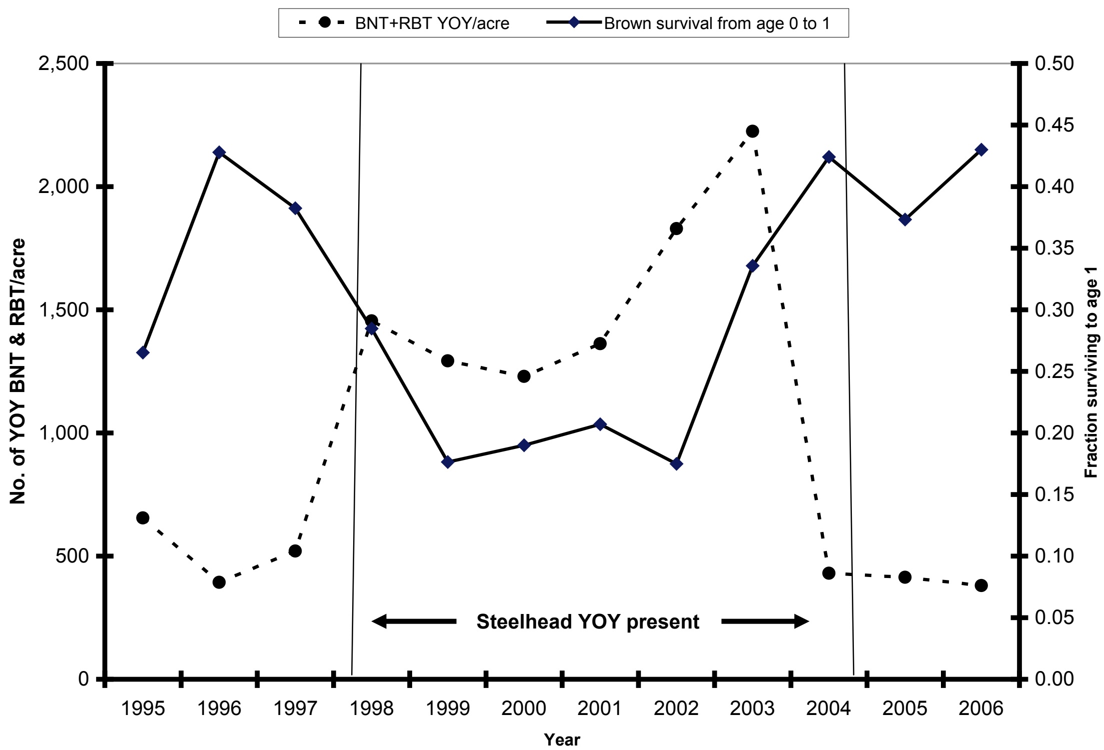


Figure 1.–Density of YOY brown trout and steelhead combined and survival of age-0 brown trout to age 1 in a 3.4 km reach of Hunt Creek. Average annual survival of age-0 brown trout was 37% when no steelhead were present but only 23% for year classes that interacted with YOY steelhead. Mean total YOY density (brown trout + steelhead) was 1,566/acre in years that adult steelhead spawned while mean density of brown trout YOY in years when adult steelhead were not present was only 463/acre.

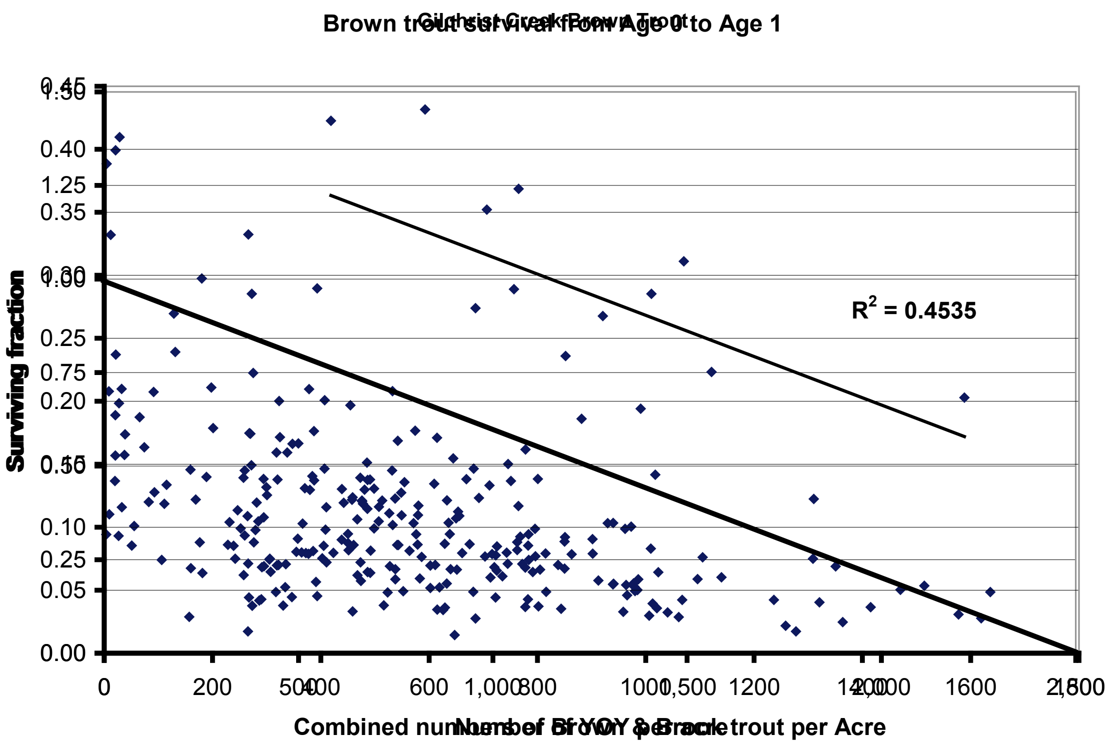


Figure F.2.–Survival of YOY brown trout to age 1 in a 2.3 km reach of Gilchrist Creek as a function of year class density. About 45% of the variation in survival was accounted for by density.

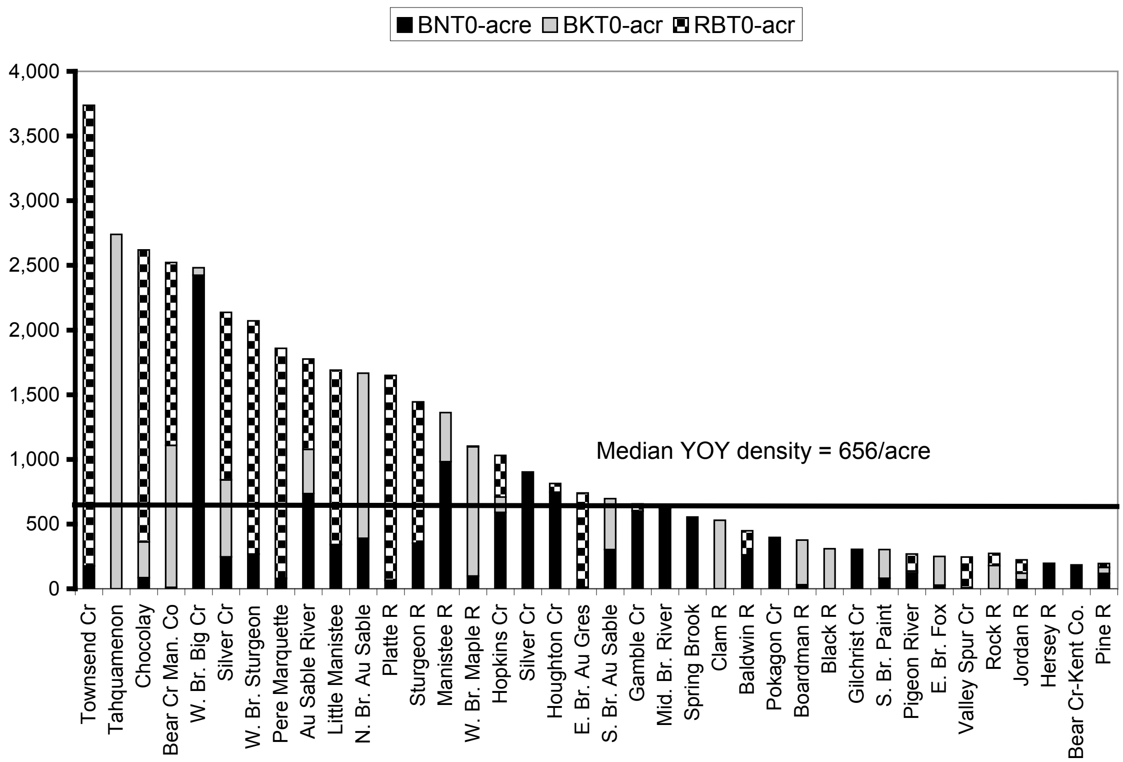


Figure F.3.–Relationship between fall age-0 density of brown trout and brook trout combined and the proportion of brown surviving to age-1 the following fall. A few proportion surviving values were above 1 indicating immigration into study reaches between years. Data are from 17 Michigan rivers: South Branch Paint River; mainstem, North Branch, and South Branch Au Sable River; Hunt Creek; Gilchrist Creek; Manistee River; North Branch and South Branch Boardman River; Baldwin River; Houghton Creek; Hersey River; Platte River; Spring Brook and Silver Creek (Kalamazoo River tributaries); and mainstem and Little South Branch Pere Marquette River.

Figure F.4.–Combined density of YOY brown trout, brook trout, and rainbow trout per acre at 41 Michigan SSTP fixed sampling sites. The heavy horizontal line is drawn at the median density level of 656 total YOY per acre. Three streams with very low YOY densities are not shown to improve clarity.

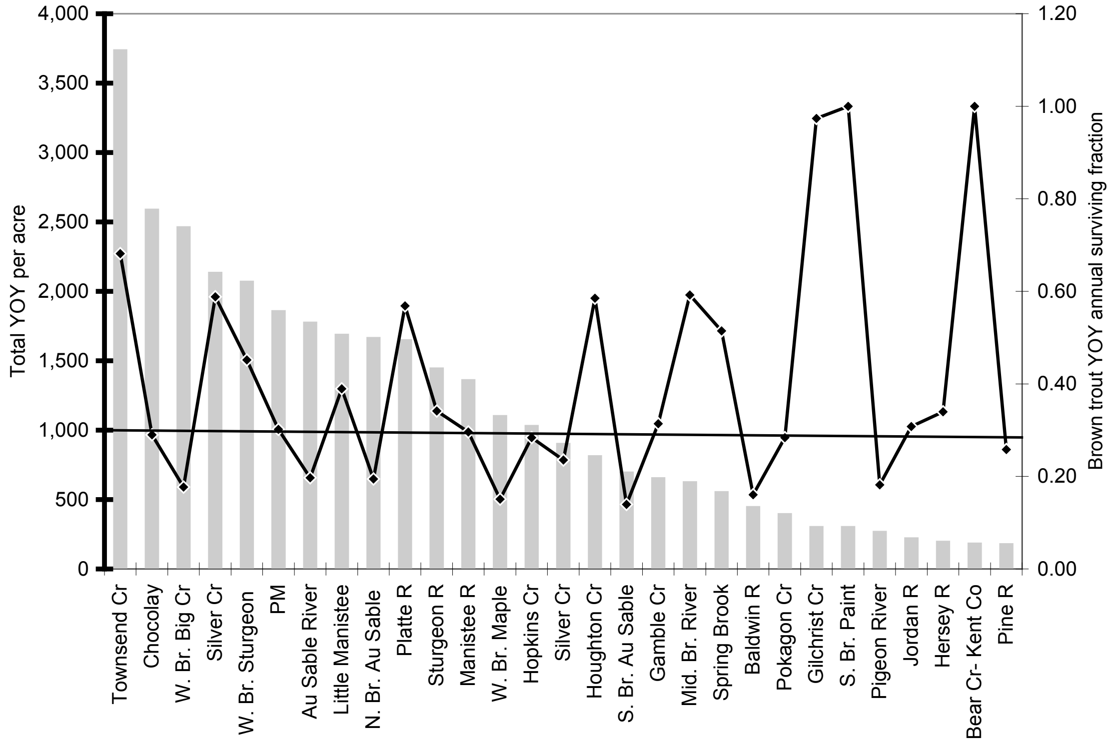


Figure F.5.–Total YOY density in 29 rivers at SSTP fixed sites (left-hand Y axis) and annual survival rate of brown trout YOY (right-hand Y axis). SSTP sites with less than 50 YOY brown trout per acre were not included in the graphic.

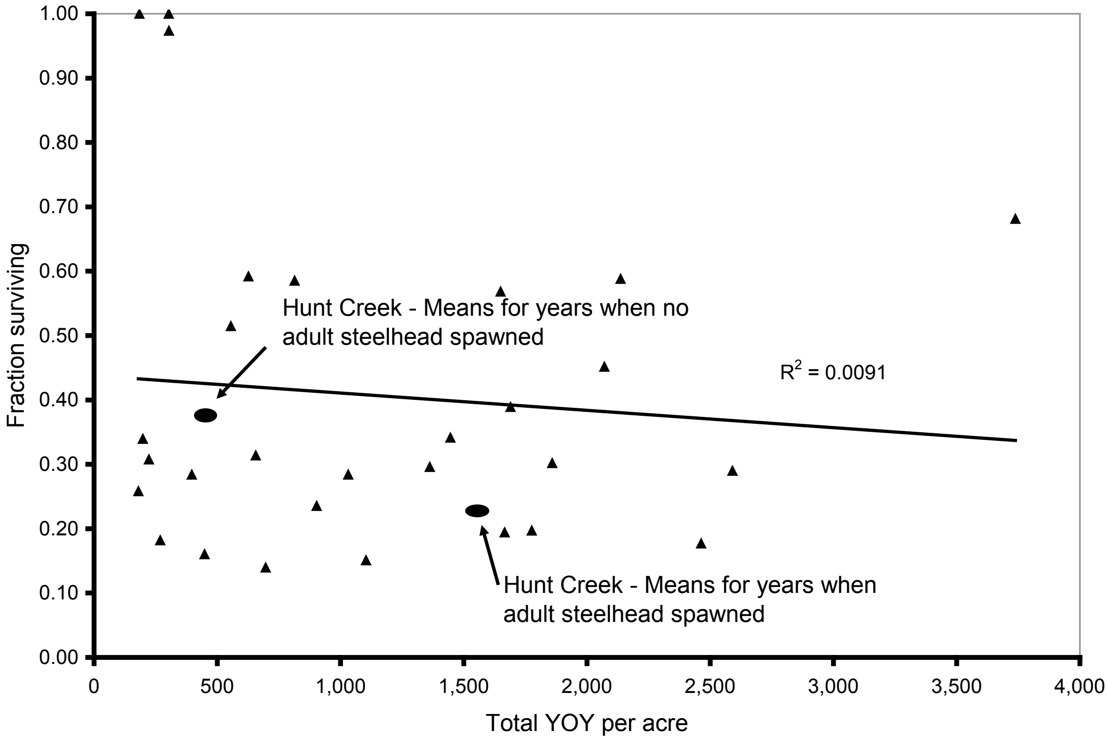


Figure F.6.–Survival of YOY brown trout versus total density of trout YOY (brown trout + brook trout + rainbow trout) at 29 Michigan SSTP fixed sites having at least 50 brown trout YOY per acre. Hunt Creek means were computed from a six-year period when adult steelhead spawned to produce large year classes of YOY rainbow trout and for seven years when no adult steelhead spawned.

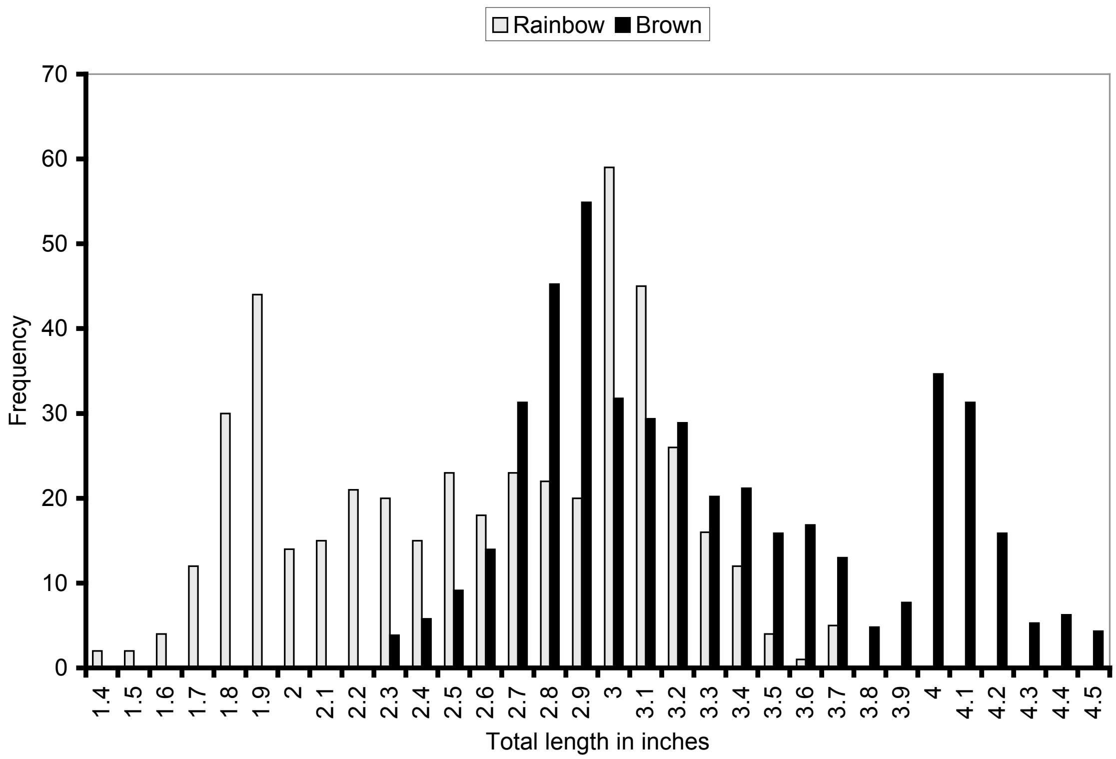


Figure F.7.–Length frequency of YOY rainbow trout (steelhead) and brown trout collected from Hunt Creek during August electrofishing surveys.

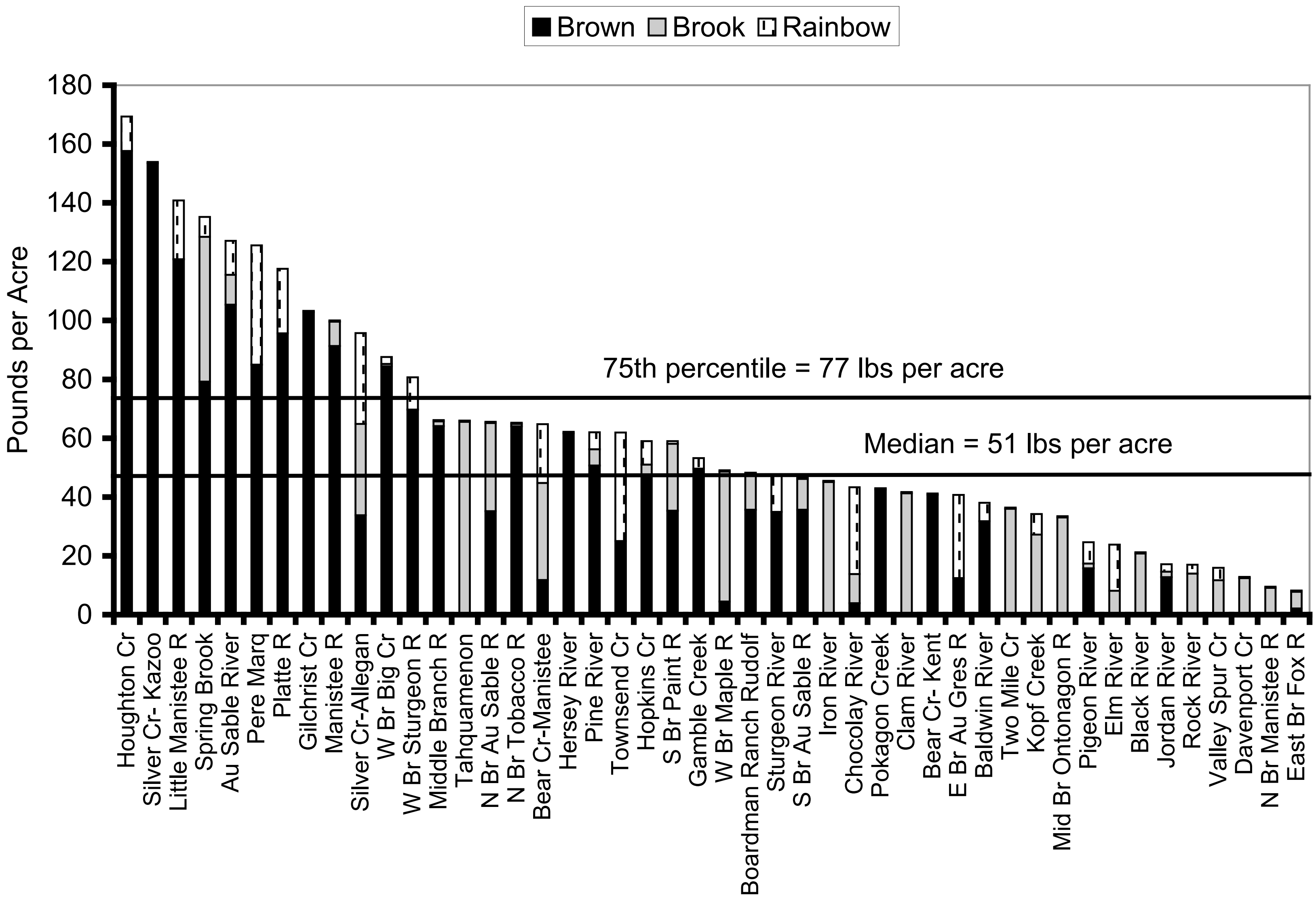


Figure F.8.–Pounds per acre of trout at 46 fixed SSTP sites.

Appendix G

Miscellaneous creel data from 1928–1965 for the Boardman River and tributaries.

This appendix contains miscellaneous creel data from 1928–1965 for the Boardman River and tributaries. These data were compiled from records located at MDNR, Institute for Fisheries Research. CPE = Catch Per Effort.

This page was intentionally left blank.

Table G.1.–Miscellaneous creel data from 1928–1965 for lakes within the Boardman River watershed. These data were compiled from records located at MDNR, Institute for Fisheries Research. CPE = Catch Per Effort.

Catch

Water body, county	Year	Angler hours	Brook trout	Borwn trout	Rainbow trout	Smallmouth bass	Largemouth bass	Bluegill	Pumpkinseed	Rock bass	Black crappie	Yellow perch	Grass pickerel	Walleye	Northern pike	Bullhead	Sucker	Lake trout	Total # fish
Arbutus Lake, Grand Traverse	1928	28	–	–	–	1	–	4	–	–	–	–	–	2	–	–	–	–	7
	1929	207	–	–	–	–	7	48	4	11	–	52	1	11	–	1	–	–	135
	1930	72	–	–	–	–	1	53	10	–	–	20	–	15	–	–	–	–	99
	1931	13	–	–	–	–	1	13	–	–	–	4	–	–	–	–	–	–	18
	1932	100	–	–	–	36	12	82	–	–	–	8	–	–	–	–	–	–	138
	1934	217	–	–	–	11	19	363	56	12	–	31	–	–	–	–	–	–	492
	1935	160	–	–	–	4	44	140	–	–	–	–	–	1	–	–	–	–	189
	1936	51	–	–	–	1	64	–	–	–	–	–	–	–	2	–	–	–	67
	1937	182	–	–	–	31	225	269	1	–	–	8	–	7	–	–	–	–	541
	1938	158	–	–	–	13	41	183	4	–	–	26	–	12	–	–	–	–	279
	1939	238	–	–	–	39	8	224	1	–	–	16	–	3	–	–	–	–	291
	1940	157	–	–	–	6	22	88	15	5	–	11	–	–	–	–	–	–	147
	1941	108	–	–	–	1	23	158	9	–	–	10	–	1	–	–	–	–	202
	1942	80	–	–	–	2	1	46	4	–	–	4	–	–	–	–	–	–	57
	1943	194	–	–	–	10	28	125	40	4	–	18	–	–	–	–	–	–	225
	1944	18	–	–	–	–	4	32	2	–	–	3	–	–	–	–	–	–	41
	1945	57	–	–	–	3	1	37	15	–	–	11	–	–	–	–	–	–	67
	1946	158	–	–	–	23	1	62	8	6	–	1	–	–	–	–	–	–	101
	1947	30	–	–	–	5	–	13	–	–	–	10	–	–	–	–	–	–	28
	1948	52	–	–	–	3	1	40	1	–	–	4	–	–	–	–	–	–	49
	1949	11	–	–	–	–	–	15	–	–	–	7	–	–	–	–	–	–	22
	1951	302	–	–	–	9	20	424	4	–	–	14	–	–	–	–	–	–	471
	1953	813	–	–	–	4	162	751	–	–	–	68	–	3	–	–	–	–	988
	1954	155	–	–	–	–	23	287	6	–	–	14	–	–	–	–	–	–	330
	1955	6	–	–	–	–	–	9	–	–	–	2	–	–	–	–	–	–	11
	1956	109	–	–	–	1	2	187	2	–	1	33	–	–	–	–	–	–	226
	1957	167	–	–	–	3	5	245	4	–	–	42	–	–	–	–	–	–	299
	1958	375	–	–	–	6	26	134	10	5	–	113	–	1	–	–	–	–	295
	1959	36	–	–	–	–	1	15	3	–	–	2	–	–	–	–	–	–	21
	1960	209	–	–	–	–	–	251	–	–	–	190	–	–	–	–	–	–	441

CPE

Water body, county	Year	Brook trout	Borwn trout	Rainbow trout	Smallmouth bass	Largemouth bass	Bluegill	Pumpkinseed	Rock bass	Black crappie	Yellow perch	Walleye	Northern pike	Bullhead	Sucker	Lake trout	Total CPE
Arbutus Lake, Grand Traverse	1928	–	–	–	0.0	–	0.1	–	–	–	–	–	0.1	–	–	–	0.3
	1929	–	–	–	–	0.0	0.2	0.0	0.1	–	0.3	0.0	0.1	–	0.0	–	0.7
	1930	–	–	–	–	0.0	0.7	0.1	–	–	0.3	–	0.2	–	–	–	1.4
	1931	–	–	–	–	0.1	1.0	–	–	–	0.3	–	–	–	–	–	1.4
	1932	–	–	–	0.4	0.1	0.8	–	–	–	0.1	–	–	–	–	–	1.4
	1934	–	–	–	0.1	0.1	1.7	0.3	0.1	–	0.1	–	–	–	–	–	2.3
	1935	–	–	–	0.0	0.3	0.9	–	–	–	–	–	0.0	–	–	–	1.2
	1936	–	–	–	0.0	1.3	–	–	–	–	–	–	–	0.0	–	–	1.3
	1937	–	–	–	0.2	1.2	1.5	0.0	–	–	0.0	–	0.0	–	–	–	3.0
	1938	–	–	–	0.1	0.3	1.2	0.0	–	–	0.2	–	0.1	–	–	–	1.8
	1939	–	–	–	0.2	0.0	0.9	0.0	–	–	0.1	–	0.0	–	–	–	1.2
	1940	–	–	–	0.0	0.1	0.6	0.1	0.0	–	0.1	–	–	–	–	–	0.9
	1941	–	–	–	0.0	0.2	1.5	0.1	–	–	0.1	–	0.0	–	–	–	1.9
	1942	–	–	–	0.0	0.0	0.6	0.1	–	–	0.1	–	–	–	–	–	0.7
	1943	–	–	–	0.1	0.1	0.6	0.2	0.0	–	0.1	–	–	–	–	–	1.2
	1944	–	–	–	–	0.2	1.8	0.1	–	–	0.2	–	–	–	–	–	2.3
	1945	–	–	–	0.1	0.0	0.7	0.3	–	–	0.2	–	–	–	–	–	1.2
	1946	–	–	–	0.1	0.0	0.4	0.1	0.0	–	0.0	–	–	–	–	–	0.6
	1947	–	–	–	0.2	–	0.4	–	–	–	0.3	–	–	–	–	–	0.9
	1948	–	–	–	0.1	0.0	0.8	0.0	–	–	0.1	–	–	–	–	–	0.9
	1949	–	–	–	–	–	1.4	–	–	–	0.6	–	–	–	–	–	2.0
	1951	–	–	–	0.0	0.1	1.4	0.0	–	–	0.0	–	–	–	–	–	1.6
	1953	–	–	–	0.0	0.2	0.9	–	–	–	0.1	–	0.0	–	–	–	1.2
	1954	–	–	–	–	0.1	1.9	0.0	–	–	0.1	–	–	–	–	–	2.1
	1955	–	–	–	–	–	1.5	–	–	–	0.3	–	–	–	–	–	1.8
	1956	–	–	–	0.0	0.0	1.7	0.0	–	0.0	0.3	–	–	–	–	–	2.1
	1957	–	–	–	0.0	0.0	1.5	0.0	–	–	0.3	–	–	–	–	–	1.8
	1958	–	–	–	0.0	0.1	0.4	0.0	0.0	–	0.3	–	0.0	–	–	–	0.8
	1959	–	–	–	–	0.0	0.4	0.1	–	–	0.1	–	–	–	–	–	0.6
	1960	–	–	–	–	–	1.2	–	–	–	0.9	–	–	–	–	–	2.1

Table G.1.–Continued.

			Catch																	CPE															
Water body, county	Year	Angler hours	Brook trout	Borwn trout	Rainbow trout	Smallmouth bass	Largemouth bass	Bluegill	Pumpkinseed	Rock bass	Black crappie	Yellow perch	Grass pickerel	Walleye	Northern pike	Bullhead	Sucker	Lake trout	Total # fish	Brook trout	Borwn trout	Rainbow trout	Smallmouth bass	Largemouth bass	Bluegill	Pumpkinseed	Rock bass	Black crappie	Yellow perch	Walleye	Northern pike	Bullhead	Sucker	Lake trout	Total CPE
	1961	106	–	–	–	–	–	178	–	–	–	49	–	–	–	–	–	–	227	–	–	–	–	–	1.7	–	–	–	0.5	–	–	–	–	–	2.1
	1962	11	–	–	–	–	4	9	–	–	–	–	–	–	–	–	–	–	13	–	–	–	–	0.4	0.8	–	–	–	–	–	–	–	–	–	1.2
	1964	242	–	–	–	–	27	269	49	5	–	72	–	–	–	–	–	–	422	–	–	–	–	0.1	1.1	0.2	0.0	–	0.3	–	–	–	–	–	1.7
Bass Lake, Grand Traverse	1928	38	–	–	–	–	14	36	–	–	–	11	–	–	–	–	–	–	61	–	–	–	–	0.4	0.9	–	–	–	0.3	–	–	–	–	–	1.6
	1929	46	–	–	–	–	17	29	–	15	–	31	–	–	–	–	–	–	92	–	–	–	–	0.4	0.6	–	0.3	–	0.7	–	–	–	–	–	2.0
	1930	46	–	–	–	4	8	20	2	–	–	14	–	–	–	–	–	–	48	–	–	–	0.1	0.2	0.4	0.0	–	–	0.3	–	–	–	–	–	1.0
	1931	2	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	0.5	–	–	–	–	0.5
	1932	4	–	–	–	–	–	22	–	–	–	–	–	–	–	–	–	–	22	–	–	–	–	–	5.5	–	–	–	–	–	–	–	–	–	5.5
	1933	6	–	–	–	6	–	14	–	2	–	2	–	–	–	–	–	–	24	–	–	–	1.0	–	2.3	–	0.3	–	0.3	–	–	–	–	–	4.0
	1934	23	–	–	–	–	–	34	–	1	–	1	–	–	–	–	–	–	36	–	–	–	–	–	1.5	–	0.0	–	0.0	–	–	–	–	–	1.6
	1935	25	–	–	–	1	2	5	2	3	–	3	–	–	–	–	–	–	16	–	–	–	0.0	0.1	0.2	0.1	0.1	–	0.1	–	–	–	–	–	0.7
	1939	46	–	–	–	5	6	109	–	–	–	11	–	–	–	–	–	–	131	–	–	–	0.1	0.1	2.4	–	–	–	0.2	–	–	–	–	–	2.8
	1941	9	–	–	–	1	–	–	2	–	–		–	–	1	–	–	–	4	–	–	–	0.1	–	–	0.2	–	–	–	–	–	0.1	–	–	0.4
	1942	31	–	–	–	–	5	15	–	–	–	6	–	–	–	–	–	–	26	–	–	–	–	0.2	0.5	–	–	–	0.2	–	–	–	–	–	0.8
	1945	46	–	–	–	–	4	64	–	–	–	13	–	–	–	–	–	–	81	–	–	–	–	0.1	1.4	–	–	–	0.3	–	–	–	–	–	1.8
	1946	23	–	–	–	2	–	114	–	5	–	–	–	–	2	–	–	–	123	–	–	–	0.1	–	5.0	–	0.2	–	–	–	–	0.1	–	–	5.3
	1947	116	–	–	–	4	–	32	–	–	–	18	–	–	10	–	–	–	64	–	–	–	0.0	–	0.3	–	–	–	0.2	–	–	0.1	–	–	0.6
	1948	153	–	–	–	1	11	193	–	3	–	18	–	–	3	–	–	–	229	–	–	–	0.0	0.1	1.3	–	0.0	–	0.1	–	–	0.0	–	–	1.5
	1949	24	–	–	–	–	–	16	–	–	–	14	–	–	2	–	–	–	32	–	–	–	–	–	0.7	–	–	–	0.6	–	–	0.1	–	–	1.3
	1950	40	–	–	–	4	–	10	–	–	–	3	–	–	–	–	–	–	–	–	–	–	0.1	–	0.3	–	–	–	0.1	–	–	–	–	–	–
	1951	39	–	–	–	–	1	18	–	–	–		–	–	5	–	–	–	24	–	–	–	–	0.0	0.5	–	–	–	–	–	–	0.1	–	–	0.6
	1952	39	–	–	–	–	–	79	3	–	–	18	–	–	–	–	–	–	–	–	–	–	–	–	2.0	0.1	–	–	0.5	–	–	–	–	–	–
	1953	44	–	–	–	–	–	85	–	–	–	32	–	–	1	–	–	–	118	–	–	–	–	–	1.9	–	–	–	0.7	–	–	0.0	–	–	2.7
	1954	65	4	–	17	–	1	136	8	–	–	27	–	–	1	–	–	–	194	0.1	–	0.3	–	0.0	2.1	0.1	–	–	0.4	–	–	0.0	–	–	3.0
	1955	18	–	–	–	–	–	16	–	–	–	5	–	–	–	–	–	–	21	–	–	–	–	–	0.9	–	–	–	0.3	–	–	–	–	–	1.2
	1956	6	–	–	4	–	–	13	–	4	–		–	–	–	–	–	–	21	–	–	0.7	–	–	2.2	–	0.7	–	–	–	–	–	–	–	3.5
	1957	127	–	–	–	–	15	270	–	–	–	36	–	–	–	–	–	–	321	–	–	–	–	0.1	2.1	–	–	–	0.3	–	–	–	–	–	2.5
	1958	221	–	–	–	–	11	352	4	–	–	22	–	–	2	–	–	–	391	–	–	–	–	0.0	1.6	0.0	–	–	0.1	–	–	0.0	–	–	1.8
	1959	15	–	–	–	–	–	14	–	–	–	3	–	–	–	–	–	–	17	–	–	–	–	–	0.9	–	–	–	0.2	–	–	–	–	–	1.1
	1960	4.5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1962	38	–	–	–	–	1	48	–	–	–	12	–	–	–	–	–	–	61	–	–	–	–	0.0	1.3	–	–	–	0.3	–	–	–	–	–	1.6

Table G.1.–Continued.

		Catch																	CPE															
Water body, county	Year	Angler hours	Brook trout	Borwn trout	Rainbow trout	Smallmouth bass	Largemouth bass	Bluegill	Pumpkinseed	Rock bass	Black crappie	Yellow perch	Grass pickerel	Walleye	Northern pike	Bullhead	Sucker	Lake trout	Total # fish	Brook trout	Borwn trout	Rainbow trout	Smallmouth bass	Largemouth bass	Bluegill	Pumpkinseed	Rock bass	Black crappie	Yellow perch	Walleye	Northern pike	Bullhead	Sucker	Lake trout	Total CPE
Boardman Lake, Grand Traverse	1931	31	–	–	–	–	–	–	–	–	–	–	8	–	–	–	–	–	8	–	–	–	–	–	–	–	–	–	–	0.3	–	–	–	–	0.3
	1934	42	–	–	–	–	–	–	–	–	–	–	19	–	–	–	–	–	19	–	–	–	–	–	–	–	–	–	–	0.4	–	–	–	–	0.4
	1935	122	35	2	–	–	–	–	–	–	–	–	45	–	–	–	2	1	85	0.3	0.0	–	–	–	–	–	–	–	–	0.4	–	–	–	0.0	0.7
	1937	4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1938	117	–	–	–	4	3	–	–	28	–	41	–	2	24	–	–	–	102	–	–	–	0.0	0.0	–	–	0.2	–	0.4	–	0.0	0.2	–	–	0.9
	1939	96	–	–	–	–	–	2	–	9	–	35	–	–	21	–	5	–	72	–	–	–	–	–	0.0	–	0.1	–	0.4	–	–	0.2	–	0.1	0.8
	1940	164	–	–	–	–	–	4	–	15	–	10	–	–	22	–	–	–	51	–	–	–	–	–	0.0	–	0.1	–	0.1	–	–	0.1	–	–	0.3
	1941	127	–	–	–	–	–	1	24	34	4	107	–	–	15	–	–	–	185	–	–	–	–	–	0.0	0.2	0.3	0.0	0.8	–	–	0.1	–	–	1.5
	1942	121	–	–	–	–	–	–	–	21	–	43	–	–	13	–	–	–	77	–	–	–	–	–	–	–	0.2	–	0.4	–	–	0.1	–	–	0.6
	1943	76	–	–	–	–	–	–	–	–	80	–	–	–	10	–	–	–	90	–	–	–	–	–	–	–	–	1.1	–	–	–	0.1	–	–	1.2
	1945	187	–	–	–	–	–	–	11	116	–	96	–	–	48	–	–	–	271	–	–	–	–	–	–	0.1	0.6	–	0.5	–	–	0.3	–	–	1.5
	1946	89	–	–	–	–	–	–	–	–	–	–	–	–	8	–	–	–	8	–	–	–	–	–	–	–	–	–	–	–	–	0.1	–	–	0.1
	1947	47	–	–	–	–	–	–	–	–	–	55	–	–	–	–	–	–	55	–	–	–	–	–	–	–	–	–	1.2	–	–	–	–	–	1.2
	1950	141	–	–	–	–	–	–	–	–	–	92	–	–	12	–	–	–	104	–	–	–	–	–	–	–	–	–	0.7	–	–	0.1	–	–	0.7
	1953	46	–	–	–	–	–	–	–	–	–	63	–	–	–	–	–	–	63	–	–	–	–	–	–	–	–	–	1.4	–	–	–	–	–	1.4
	1954	261	–	–	–	–	–	–	–	–	–	260	–	–	37	–	–	–	297	–	–	–	–	–	–	–	–	–	1.0	–	–	0.1	–	–	1.1
	1955	203	–	–	–	–	–	26	–	8	–	294	–	–	23	–	–	–	351	–	–	–	–	–	0.1	–	0.0	–	1.4	–	–	0.1	–	–	1.7
	1956	260	–	–	–	–	–	–	–	–	–	174	–	–	23	–	–	–	197	–	–	–	–	–	–	–	–	–	0.7	–	–	0.1	–	–	0.8
	1957	164	–	–	–	1	2	61	–	63	–	115	–	–	33	–	–	–	275	–	–	–	0.0	0.0	0.4	–	0.4	–	0.7	–	–	0.2	–	–	1.7
	1958	224	–	–	–	–	–	2	–	–	–	269	–	–	14	–	–	–	285	–	–	–	–	–	0.0	–	–	–	1.2	–	–	0.1	–	–	1.3
	1959	136	–	–	–	–	–	–	–	2	–	110	–	–	4	–	–	–	116	–	–	–	–	–	–	–	0.0	–	0.8	–	–	0.0	–	–	0.9
	1960	222	–	–	–	–	–	30		22	–	396	–	–	5	–	–	–	453	–	–	–	–	–	0.1	–	0.1	–	1.8	–	–	0.0	–	–	2.0
	1961	62	–	–	–	–	–	–	–	–	–	87	–	–	5	–	–	–	92	–	–	–	–	–	–	–	–	–	1.4	–	–	0.1	–	–	1.5
	1962	13	–	–	–	–	–	–	–	8	–	17	–	–	4	–	–	–	29	–	–	–	–	–	–	–	0.6	–	1.3	–	–	0.3	–	–	2.2
	1964	26	–	–	–	–	–	–	–	–	–	21	–	–	4	–	–	–	25	–	–	–	–	–	–	–	–	–	0.8	–	–	0.2	–	–	1.0
Boardman Pond, Grand Traverse	1937	12	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	0.1	–	–	–	–	–	–	–	–	–	–	–	–	0.1

Table G.1.–Continued.

			Catch																	CPE															
Water body, county	Year	Angler hours	Brook trout	Borwn trout	Rainbow trout	Smallmouth bass	Largemouth bass	Bluegill	Pumpkinseed	Rock bass	Black crappie	Yellow perch	Grass pickerel	Walleye	Northern pike	Bullhead	Sucker	Lake trout	Total # fish	Brook trout	Borwn trout	Rainbow trout	Smallmouth bass	Largemouth bass	Bluegill	Pumpkinseed	Rock bass	Black crappie	Yellow perch	Walleye	Northern pike	Bullhead	Sucker	Lake trout	Total CPE
Brewster Lake, Grand Traverse	1941	23	–	–	–	–	2	–	12	6	–	9	–	–	1	–	–	–	30	–	–	–	–	0.1	–	0.5	0.3	–	0.4	–	–	0.0	–	–	1.3
	1947	97	–	–	–	2	21	107	71	–	–	10	–	–	2	–	–	–	213	–	–	–	0.0	0.2	1.1	0.7	–	–	0.1	–	–	0.0	–	–	2.2
	1952	4	–	–	–	–	–	3	–	–	–		–	–	–	–	–	–	3	–	–	–	–	–	0.8	–	–	–		–	–	–	–	–	0.8
	1954	10	–	–	–	–	–	–	–	–	–	6	–	–	–	–	–	–	6	–	–	–	–	–	–	–	–	–	0.6	–	–	–	–	–	0.6
	1961	17	–	–	–	–	–	–	–	–	–	3	–	–	–	–	–	–	3	–	–	–	–	–	–	–	–	–	0.2	–	–	–	–	–	0.2
	1965	14	–	–	–	–	–	–	–	–	–		–	–	2	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	0.1	–	–	0.1
Brown Bridge Pond, Grand Traverse	1928	7	–	–	–	–	–	2	–	–	–	15	–	–	–	–	2	–	19	–	–	–	–	–	0.3	–	–	–	2.1	–	–	–	–	0.3	2.7
	1929	7	–	–	–	–	–	–	–	–	–	6	–	–	–	–	–	–	6	–	–	–	–	–	–	–	–	–	0.9	–	–	–	–	–	0.9
	1935	1	–	–	–	–	–	–	–	–	–		–	–	–	–	–	–		–	–	–	–	–	–	–	–	–		–	–	–	–	–	–
	1937	25	–	–	–	–	–	48	–	–	–	2	–	–	–	–	–	–	50	–	–	–	–	–	1.9	–	–	–	0.1	–	–	–	–	–	2.0
	1938	36	13	23	2	–	–	–	–	–	–	–	–	–	–	–	–	–	38	0.4	0.7	0.1	–	–	–	–	–	–	–	–	–	–	–	–	1.1
	1939	2	–	–	–	–	5	–	–	–	–	–	–	–	–	–	–	–	5	–	–	–	–	2.5	–	–	–	–	–	–	–	–	–	–	2.5
	1940	4	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	0.2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.3
	1941	6	–	–	–	–	–	–	1	9	–	9	1	–	–	–	–	–	20	–	–	–	–	–	–	0.2	1.5		1.5	0.2	–	–	–	–	3.3
	1944	26	–	–	–	1	–	14	11	–	–	1	–	–	–	–	–	–	27	–	–	–	0.0	–	0.5	0.4	–	–	0.0	–	–	–	–	–	1.0
	1945	8	–	–	–	1	3	9	–	–	–	2	–	–	–	–	–	–	15	–	–	–	0.1	0.4	1.1	–	–	–	0.3	–	–	–	–	–	1.9
	1946	8	–	–	–	–	–	–	–	–	–	10	–	–	–	–	–	–	10	–	–	–	–	–	–	–	–	–	1.3	–	–	–	–	–	1.3
	1948	279	–	–	–	1	–	1	–	–	–	96	–	–	13	–	–	–	111	–	–	–	0.0	–	0.0	–	–	–	0.3	–	–	0.0	–	–	0.4
	1953	157	–	1	–	19	–	34	2	–	–	7	–	–	16	–	–	–	79	–	0.0	–	0.1	–	0.2	0.0	–	–	0.0	–	–	0.1	–	–	0.5
	1954	18	–	–	–	–	2	–	–	–	–	20	–	–	–	–	–	–	22	–	–	–	–	0.1	–	–	–	–	1.1	–	–	–	–	–	1.2
	1955	16	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	0.1	–	–	0.1
	1957	56	–	–	–	–	–	–	–	–	–	152	–	–	3	–	–	–	155	–	–	–	–	–	–	–	–	–	2.7	–	–	0.1	–	–	2.8
	1958	22	–	–	–	–	–	–	–	–	–	101	–	–	–	–	–	–	101	–	–	–	–	–	–	–	–	–	4.6	–	–	–	–	–	4.6
	1959	27	–	–	–	–	–	–	–	–	–	55	–	–	1	–	–	–	56	–	–	–	–	–	–	–	–	–	2.0	–	–	0.0	–	–	2.1
Bumphrey Lake, Grand Traverse	1941	38	–	–	–	–	3	–	4	2	–	8	–	1	1	–	–	–	19	–	–	–	–	0.1	–	0.1	0.1	–	0.2	–	0.0	0.0	–	–	0.5
	1951	14	–	–	–	–	2	–	–	–	–	–	–	–	10	–	–	–	12	–	–	–	–	0.1	–	–	–	–	–	–	–	0.7	–	–	0.9
	1955	4	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	–	0.5	–	–	–	–	–	–	–	–	–	–	0.5

Table G.1.–Continued.

Water body, county	Year	Angler hours	Catch: Brook trout	Borwn trout	Rainbow trout	Smallmouth bass	Largemouth bass	Bluegill	Pumpkinseed	Rock bass	Black crappie	Yellow perch	Grass pickerel	Walleye	Northern pike	Bullhead	Sucker	Lake trout	Total # fish	CPE: Brook trout	Borwn trout	Rainbow trout	Smallmouth bass	Largemouth bass	Bluegill	Pumpkinseed	Rock bass	Black crappie	Yellow perch	Walleye	Northern pike	Bullhead	Sucker	Lake trout	Total CPE
	1958	16	–	–	–	–	2	4	–	–	–	–	–	–	2	–	–	–	8	–	–	–	–	0.1	0.3	–	–	–	–	–	–	0.1	–	–	0.5
	1965	8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Cedar Lake, Grand Traverse	1929	2	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	0.5	–	–	–	0.5
	1938	16	–	–	–	–	2	5	5	4	–	19	–	–	–	–	–	–	35	–	–	–	–	0.1	0.3	0.3	0.3	–	1.2	–	–	–	–	–	2.2
	1943	7	–	–	–	–	–	–	–	–	–	9	–	–	–	–	–	–	9	–	–	–	–	–	–	–	–	–	1.4	–	–	–	–	–	1.4
	1946	15	–	–	–	–	–	32	–	–	–	–	–	–	–	–	–	–	32	–	–	–	–	–	2.1	–	–	–	–	–	–	–	–	–	2.1
	1947	16	–	–	–	–	1	14	5	–	–	–	–	–	–	–	–	–	20	–	–	–	–	0.1	0.9	0.3	–	–	–	–	–	–	–	–	1.3
	1948	55	–	–	–	–	–	53	2	27	–	6	–	–	2	–	–	–	90	–	–	–	–	–	1.0	0.0	0.5	–	0.1	–	–	0.0	–	–	1.6
	1949	11	–	–	–	2	–	35	8	–	–	1	–	–	–	–	–	–	46	–	–	–	0.2	–	3.3	0.8	–	–	0.1	–	–		–	–	4.4
	1950	121	–	–	–	–	11	124	21	24	3	63	–	–	7	–	–	–	253	–	–	–	–	0.1	1.0	0.2	0.2	0.0	0.5	–	–	0.1	–	–	2.1
	1951	192	–	–	–	1	2	205	19	44	8	31	–	–	6	–	–	–	316	–	–	–	0.0	0.0	1.1	0.1	0.2	0.0	0.2	–	–	0.0	–	–	1.7
	1952	7	–	–	–	–	–	6	–	–	–	12	–	–		–	–	–	18	–	–	–	–	–	0.9	–	–	–	1.7	–	–		–	–	2.6
	1953	43	–	–	–	–	1	22	4	5	–	16	–	–	10	–	–	–	58	–	–	–	–	0.0	0.5	0.1	0.1	–	0.4	–	–	0.2	–	–	1.3
	1954	47	–	–	–	–	5	51	9	4	–	10	–	–	3	–	–	–	82	–	–	–	–	0.1	1.1	0.2	0.1	–	0.2	–	–	0.1	–	–	1.7
	1955	22	–	–	–	–	–	13	8	2	6	5	–	–	4	–	–	–	38	–	–	–	–	–	0.6	0.4	0.1	0.3	0.2	–	–	0.2	–	–	1.7
	1956	89	–	–	–	–	18	73	3	42	4	–	–	–	3	–	–	–	143	–	–	–	–	0.2	0.8	0.0	0.5	0.0	–	–	–	0.0	–	–	1.6
	1957	16	–	–	–	–	–	51	–	–	–	–	–	–	–	–	–	–	51	–	–	–	–	–	3.2	–	–	–	–	–	–	–	–	–	3.2
	1958	36	–	–	–	–	–	16	3	3	–	3	–	1	2	–	–	–	28	–	–	–	–	–	0.4	0.1	0.1	–	0.1	–	0.0	0.1	–	–	0.8
	1959	6	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	0.2	–	–	0.2
	1962	62	–	–	–	–	14	14	–	33	–	26	–	–	1	–	–	–	88	–	–	–	–	0.2	0.2	–	0.5	–	0.4	–	–	0.0	–	–	1.4
	1965	15	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Chandler Lake, Grand Traverse	1940	15	–	–	–	4	4	–	–	–	–	–	–	–	–	–	–	–	8	–	–	–	0.3	0.3	–	–	–	–	–	–	–	–	–	–	0.6
	1941	8	–	–	–	–	2	–	5	–	–	6	–	–	–	–	–	–	13	–	–	–	–	0.3	–	0.6	–	–	0.8	–	–	–	–	–	1.6
Darby Lake, Grand Traverse	1929	4	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	–	0.5	–	–	–	–	–	–	–	–	–	–	0.5
	1956	6	–	–	–	4	–	8	–	–	–	–	–	–	–	–	–	–	12	–	–	–	0.7	–	1.3	–	–	–	–	–	–	–	–	–	2.0
	1957	4	–	–	–	–	1	22	–	–	–	–	–	–	–	–	–	–	23	–	–	–	–	0.3	5.5	–	–	–	–	–	–	–	–	–	5.8
	1963	10	–	–	–	–	–	37	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table G.1.–Continued.

		Catch																		CPE															
Water body, county	Year	Angler hours	Brook trout	Borwn trout	Rainbow trout	Smallmouth bass	Largemouth bass	Bluegill	Pumpkinseed	Rock bass	Black crappie	Yellow perch	Grass pickerel	Walleye	Northern pike	Bullhead	Sucker	Lake trout	Total # fish	Brook trout	Borwn trout	Rainbow trout	Smallmouth bass	Largemouth bass	Bluegill	Pumpkinseed	Rock bass	Black crappie	Yellow perch	Walleye	Northern pike	Bullhead	Sucker	Lake trout	Total CPE
Dollar Lake,																																			
Grand Traverse	1950	2	–	–	–	–	–	3	–	–	–	2	–	–	–	–	–	–	5	–	–	–	–	–	1.5	–	–	–	1.0	–	–	–	–	–	2.5
	1956	8	–	–	–	–	–	–	–	–	–	34	–	–	–	–	–	–	34	–	–	–	–	–	–	–	–	–	4.3	–	–	–	–	–	4.3
	1959	4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1962	19	–	–	–	–	1	10	20	–	–	–	–	–	–	–	–	–	31	–	–	–	–	0.1	0.5	1.1	–	–	–	–	–	–	–	–	1.6
Downs (Dowen) Lake,																																			
Grand Traverse	1948	–	–	–	–	–	–	12	3	–	–	–	–	–	–	–	–	–	15	–	–	–	–	–	1.0	0.3	–	–	–	–	–	–	–	–	1.3
	1953	–	–	–	–	3	11	15	–	–	–	–	–	–	–	–	–	–	29	–	–	–	0.2	0.7	1.0	–	–	–	–	–	–	–	–	–	1.9
	1954	–	–	–	–	–	31	44	2	–	–	–	–	–	–	–	–	–	77	–	–	–	–	0.9	1.2	0.1	–	–	–	–	–	–	–	–	2.1
High Lake,																																			
Grand Traverse	1937	–	–	–	–	1	2	2	–	–	–	1	–	–	–	–	–	–	6	–	–	–	0.1	0.2	0.2	–	–	–	0.1	–	–	–	–	–	0.6
	1938	–	–	–	–	5	5	–	–	–	–	16	–	–	–	–	–	–	26	–	–	–	1.0	1.0	–	–	–	–	3.2	–	–	–	–	–	5.2
	1940	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	–	0.8	–	–	–	–	–	–	–	–	–	–	0.8
	1944	–	–	–	–	–	7	18	6	–	–	–	–	–	–	–	–	–	31	–	–	–	–	0.4	1.0	0.3	–	–	–	–	–	–	–	–	1.7
	1953	–	–	–	–	7	–	109	–	–	–	56	–	–	–	–	–	–	172	–	–	–	0.1	–	1.4	–	–	–	0.7	–	–	–	–	–	2.2
	1958	–	–	–	–	–	–	8	–	–	–	–	–	–	–	–	–	–	8	–	–	–	–	–	2.0	–	–	–	–	–	–	–	–	–	2.0
	1960	–	–	–	–	–	15	1	–	–	–	–	–	–	–	–	–	–	16	–	–	–	–	1.1	0.1	–	–	–	–	–	–	–	–	–	1.1
Indian Lake,																																			
Grand Traverse	1929	–	–	–	–	–	6	–	–	–	–	2	–	–	–	–	–	–	8	–	–	–	–	2.4	–	–	–	–	0.8	–	–	–	–	–	3.2
	1930	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1950	–	–	–	–	–	–	14	–	–	–	–	–	–	–	–	–	–	14	–	–	–	–	–	1.6	–	–	–	–	–	–	–	–	–	1.6
	1953	–	–	–	–	–	–	18	–	–	–	–	–	–	–	–	–	–	18	–	–	–	–	–	3.0	–	–	–	–	–	–	–	–	–	3.0
	1954	–	–	–	–	–	–	34	–	–	–	–	–	–	–	–	–	–	34	–	–	–	–	–	8.5	–	–	–	–	–	–	–	–	–	8.5
	1956	–	–	–	–	–	–	23	–	–	–	–	–	–	–	–	–	–	23	–	–	–	–		11.5		–	–	–	–	–	–	–		–
	1958	–	–	–	–	–	–	43	–	–	–	–	–	–	–	–	–	–	43	–	–	–	–	–	3.3	–	–	–	–	–	–	–	–	–	3.3
	1959	–	–	–	–	–	–	8	–	–	–	–	–	–	–	–	–	–	8	–	–	–	–	–	1.3	–	–	–	–	–	–	–	–	–	1.3
Island Lake,																																			
Kalkaska	1936	–	–	–	–	–	–	–	–	–	–	12	1	–	–	–	–	–	13	–	–	–	–	–	–	–	–	–	2.7	0.2	–	–	–	–	2.9
	1939	–	–	–	–	–	2	10	–	–	–	–	1	–	–	–	–	–	13	–	–	–	–	0.3	1.4	–	–	–	–	0.1	–	–	–	–	1.9
	1950	–	–	–	–	2	–	–	–	–	–	11	–	–	–	–	–	–	13	–	–	–	0.2	–	–	–	–	–	0.8		–	–	–	–	1.0
	1952	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1954	–	–	–		3		55	8			20	5						91				0.1		2.2	0.3			0.8	0.2	–	–	–	–	3.6

Table G.1.–Continued.

			Catch																	CPE															
Water body, county	Year	Angler hours	Brook trout	Borwn trout	Rainbow trout	Smallmouth bass	Largemouth bass	Bluegill	Pumpkinseed	Rock bass	Black crappie	Yellow perch	Grass pickerel	Walleye	Northern pike	Bullhead	Sucker	Lake trout	Total # fish	Brook trout	Borwn trout	Rainbow trout	Smallmouth bass	Largemouth bass	Bluegill	Pumpkinseed	Rock bass	Black crappie	Yellow perch	Walleye	Northern pike	Bullhead	Sucker	Lake trout	Total CPE
	1956	27	–	–	–	–	2	79	–	–	–	26	–	–	–	–	–	–	107	–	–	–	–	0.1	2.9	–	–	–	1.0	–	–	–	–	–	4.0
	1957	21	–	–	–	–	1	103	–	–	–	12	1	–	–	–	–	–	117	–	–	–	–	0.0	4.9	–	–	–	0.6	0.0	–	–	–	–	5.6
	1958	25	–	–	–	–	–	92	–	–	–	18	–	–	–	–	–	–	110	–	–	–	–	–	3.7	–	–	–	0.7	–	–	–	–	–	4.4
Kettle Lake, Kalkaska	1928	112	–	–	–	–	1	106	–	–	–	5	–	–	–	–	–	–	112	–	–	–	–	0.0	0.9	–	–	–	0.0	–	–	–	–	–	1.0
	1929	3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1930	4	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	0.3	–	–	–	–	–	–	–	–	–	–	–	0.3
	1936	2	–	–	–	–	2	31	–	–	–	–	–	–	–	–	–	–	33	–	–	–	–	0.9	13.8	–	–	–	–	–	–	–	–	–	14.7
	1939	3	–	–	–	–	–	6	3	–	–	1	–	–	–	–	–	–	10	–	–	–	–	–	2.0	1.0	–	–	0.3	–	–	–	–	–	3.3
	1942	35	–	–	–	–	–	23	–	–	–	–	–	–	–	–	–	–	23	–	–	–	–	–	0.7	–	–	–	–	–	–	–	–	–	0.7
	1945	10	–	–	–	–	–	20	–	–	–	–	–	–	–	–	–	–	20	–	–	–	–	–	2.0	–	–	–	–	–	–	–	–	–	2.0
	1949	8	–	–	–	–	–	22	–	–	–	–	–	–	–	–	–	–	22	–	–	–	–	–	2.8	–	–	–	–	–	–	–	–	–	2.8
	1954	21	–	–	–	1	–	73	–	–	–	4	–	–	–	–	–	–	78	–	–	–	0.0	–	3.5	–	–	–	0.2	–	–	–	–	–	3.7
	1956	8	–	–	–	–	–	20	–	–	–	–	–	–	–	–	–	–	20	–	–	–	–	–	2.5	–	–	–	–	–	–	–	–	–	2.5
	1957	21	–	–	–	–	–	71	–	–	–	7	–	–	–	–	–	–	78	–	–	–	–	–	3.4	–	–	–	0.3	–	–	–	–	–	3.7
	1958	15	–	–	–	–	–	52	–	–	–	–	–	–	–	–	–	–	52	–	–	–	–	–	3.5	–	–	–	–	–	–	–	–	–	3.5
	1959	43	–	–	–	–	–	13	5	9	–	51	–	–	–	–	–	–	78	–	–	–	–	–	0.3	0.1	0.2	–	1.2	–	–	–	–	–	1.8
	1960	4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1961	22	–	–	–	–	–	5	1	1	–	41	–	–	–	–	–	–	48	–	–	–	–	–	0.2	0.0	0.0	–	1.9	–	–	–	–	–	2.2
	1962	25	–	–	–	–	–	–	1	–	–	23	–	–	–	–	–	–	24	–	–	–	–	–	–	0.0	–	–	0.9	–	–	–	–	–	1.0
	1964	21	–	–	–	–	–	15	4	–	–	4	–	–	–	–	–	–	23	–	–	–	–	–	0.7	0.2	–	–	0.2	–	–	–	–	–	1.1
	1965	3	–	–	–	–	–	–		–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.3	–	–	–	–	–	–
Keystone (Boardman) Pond, Grand Traverse	1929	16	–	8	7	–	–	–	–	–	–	–	–	–	–	22	–	–	37	–	0.5	0.4	–	–	–	–	–	–	–	–	–	–	1.4	–	2.3
	1935	4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.6	0.6
	1938	30	9	–	5	–	–	–	–	–	–	–	–	–	–	–	–	–	14	0.3	–	0.2	–	–	–	–	–	–	–	–	–	–	–	–	0.5
	1939	3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1940	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1952	50	–	–	7	–	–	–	11	–	–	–	–	–	–	–	–	–	18	–	–	0.1	–	–	–	0.2	–	–	–	–	–	–	–	–	0.4
	1956	24	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1957	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table G.1.–Continued.

Water body, county	Year	Catch																		CPE															
		Angler hours	Brook trout	Borwn trout	Rainbow trout	Smallmouth bass	Largemouth bass	Bluegill	Pumpkinseed	Rock bass	Black crappie	Yellow perch	Grass pickerel	Walleye	Northern pike	Bullhead	Sucker	Lake trout	Total # fish	Brook trout	Borwn trout	Rainbow trout	Smallmouth bass	Largemouth bass	Bluegill	Pumpkinseed	Rock bass	Black crappie	Yellow perch	Walleye	Northern pike	Bullhead	Sucker	Lake trout	Total CPE
Lake Placid, Kalkaska	1942	6	–	–	–	2	–	5	–	–	–	–	–	–	–	–	–	–	7	–	–	–	0.3	–	0.8	–	–	–	–	–	–	–	–	–	1.2
Little Guernsey Lake, Kalkaska	1952	9	–	–	–	–	–	21	–	–	–	–	–	–	–	–	–	–	21	–	–	–	–	–	2.3	–	–	–	–	–	–	–	–	–	2.3
Loon Lake, Kalkaska	1939	8	–	–	–	–	5	11	–	–	–	–	–	–	–	–	–	–	16	–	–	–	–	0.6	1.4	–	–	–	–	–	–	–	–	–	2.0
Mayfield Pond, Grand Traverse	1941	11	7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	7	0.7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.7
Mud Lake, Kalkaska	1939	14	–	–	–	–	1	40	–	–	–	–	–	–	1	–	–	–	42	–	–	–	–	0.1	2.9	–	–	–	–	–	–	0.1	–	–	3.0
Muncie Lake, Grand Traverse	1938	7	–	–	–	–	5	15	–	–	–	–	–	–	–	–	–	–	20	–	–	–	–	0.7	2.1	–	–	–	–	–	–	–	–	–	2.9
	1951	60	–	–	–	2	1	245	–	–	–	–	–	–	–	–	–	–	248	–	–	–	0.0	0.0	4.1	–	–	–	–	–	–	–	–	–	4.1
	1956	6	–	–	–	–	–	–	8	–	–	–	–	–	–	–	–	–	8	–	–	–	–	–	–	1.3	–	–	–	–	–	–	–	–	1.3
	1957	46	–	–	–	–	–	29	–	–	–	22	–	–	–	–	–	–	51	–	–	–	–	–	0.6	–	–	–	0.5	–	–	–	–	–	1.1
	1958	57	–	–	–	–	6	117	–	–	–	–	–	–	–	–	–	–	123	–	–	–	–	0.1	2.1	–	–	–	–	–	–	–	–	–	2.2
	1960	35	–	–	–	–	3	75	–	–	–	–	–	–	–	–	–	–	78	–	–	–	–	0.1	2.1	–	–	–	–	–	–	–	–	–	2.2
	1962	14	–	–	–	–	3	24	–	–	–	–	–	–	–	–	–	–	27	–	–	–	–	0.2	1.7	–	–	–	–	–	–	–	–	–	1.9
Parsons Lake, Grand Traverse	1954	3	–	–	–	–	–	20	–	–	–	–	–	–	–	–	–	–	20	–	–	–	–	–	6.7	–	–	–	–	–	–	–	–	–	6.7
	1957	4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1963	6	–	–	–	–	–	5	–	7	–	9	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Perch Lake, Kalkaska	1930	20	–	–	–	–	1	22	–	–	–	12	–	–	–	–	–	–	35	–	–	–	–	0.1	1.1	–	–	–	0.6	–	–	–	–	–	1.8
	1939	10	–	–	–	–	1	7	–	–	–	3	–	–	–	–	–	–	11	–	–	–	–	0.1	0.7	–	–	–	0.3	–	–	–	–	–	1.1
	1942	10	–	–	–	–	1	16	–	–	–	–	–	–	–	–	–	–	17	–	–	–	–	0.1	1.6	–	–	–	–	–	–	–	–	–	1.7
	1945	36	–	–	–	2	6	67	–	–	–	5	–	–	–	–	–	–	80	–	–	–	0.1	0.2	1.9	–	–	–	0.1	–	–	–	–	–	2.2
	1948	11	–	–	–	–	1	37	–	–	–	–	–	–	–	–	–	–	38	–	–	–	–	0.1	3.4	–	–	–	–	–	–	–	–	–	3.5
	1950	7	–	–	–	–	1	14	–	–	–	3	–	–	–	–	–	–	18	–	–	–	–	0.1	2.0	–	–	–	0.4	–	–	–	–	–	2.6

Table G.1.–Continued.

Water body, county	Year	Angler hours	Catch: Brook trout	Catch: Borwn trout	Catch: Rainbow trout	Catch: Smallmouth bass	Catch: Largemouth bass	Catch: Bluegill	Catch: Pumpkinseed	Catch: Rock bass	Catch: Black crappie	Catch: Yellow perch	Catch: Grass pickerel	Catch: Walleye	Catch: Northern pike	Catch: Bullhead	Catch: Sucker	Catch: Lake trout	Catch: Total # fish	CPE: Brook trout	CPE: Borwn trout	CPE: Rainbow trout	CPE: Smallmouth bass	CPE: Largemouth bass	CPE: Bluegill	CPE: Pumpkinseed	CPE: Rock bass	CPE: Black crappie	CPE: Yellow perch	CPE: Walleye	CPE: Northern pike	CPE: Bullhead	CPE: Sucker	CPE: Lake trout	CPE: Total CPE
	1954	13	–	–	–	1	–	32	2	4	–	7	–	–	–	–	–	–	46	–	–	–	0.1	–	2.5	0.2	0.3	–	0.5	–	–	–	–	–	3.5
	1957	99	–	–	–	1	7	230	33	–	–	39	–	–	–	–	–	–	310	–	–	–	0.0	0.1	2.3	0.3	–	–	0.4	–	–	–	–	–	3.1
Rennie Lake, Grand Traverse	1928	2	–	–	–	–	–	–	–	–	–	–	2	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	1.0	–	–	–	–	1.0
	1929	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1930	23	–	–	–	–	–	–	–	–	–	1	–	5	–	–	–	–	6	–	–	–	–	–	–	–	–	–	0.0	–	0.2	–	–	–	0.3
	1934	3	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	–	0.7	–	–	–	–	–	–	–	–	–	–	0.7
	1938	12	–	–	–	–	–	3	1	–	–	–	–	–	–	–	–	–	4	–	–	–	–	–	0.2	0.1	–	–	–	–	–	–	–	–	0.3
	1939	3	–	–	–	–	1	3	–	–	–	1	–	–	–	–	–	–	5	–	–	–	–	0.3	1.0	–	–	–	0.3	–	–	–	–	–	1.7
	1940	8	–	–	–	1	–	20	4	–	–	1	–	–	–	–	–	–	26	–	–	–	0.1	–	2.4	0.5	–	–	0.1	–	–	–	–	–	3.2
	1942	33	–	–	–	–	2	23	18	–	–	6	–	–	–	–	–	–	49	–	–	–	–	0.1	0.7	0.5	–	–	0.2	–	–	–	–	–	1.5
	1943	19	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1946	3	–	–	–	3	–	–	–	–	–	–	–	–	–	–	–	–	3	–	–	–	1.0	–	–	–	–	–	–	–	–	–	–	–	1.0
	1953	44	–	–	–	–	14	15	–	–	–	–	–	–	–	–	–	–	29	–	–	–	–	0.3	0.3	–	–	–	–	–	–	–	–	–	0.7
	1957	54	–	–	–	–	3	25	–	–	–	22	–	–	–	–	–	–	50	–	–	–	–	0.1	0.5	–	–	–	0.4	–	–	–	–	–	0.9
	1958	22	–	–	–	–		29	–	–	–	12	–	–	–	–	–	–	41	–	–	–	–	–	1.3	–	–	–	0.5	–	–	–	–	–	1.9
	1959	115	–	–	–	–	9	106	–	–	–	61	–	2	–	–	–	–	178	–	–	–	–	0.1	0.9	–	–	–	0.5	–	0.0	–	–	–	1.5
	1960	32	–	–	–	–	–	74	–	–	–	37	–	–	–	–	–	–	111	–	–	–	–	–	2.3	–	–	–	1.2	–	–	–	–	–	3.5
	1961	22	–	–	–	–	–	19	–	–	–	36	–	–	–	–	–	–	55	–	–	–	–	–	0.9	–	–	–	1.6	–	–	–	–	–	2.5
Rennie Lake East End, Grand Traverse	1928	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Sand Lake, Grand Traverse	1928	4	–	–	–	–	–	–	–	–	–	25	–	–	–	–	–	–	25	–	–	–	–	–	–	–	–	–	6.3	–	–	–	–	–	6.3
	1947	50	–	–	–	–	25	–	–	–	–	–	–	–	–	–	–	–	25	–	–	–	–	0.5	–	–	–	–	–	–	–	–	–	–	0.5
	1961	25	–	–	–	–	15	–	–	–	–	–	–	–	–	–	–	–	15	–	–	–	–	0.6	–	–	–	–	–	–	–	–	–	–	0.6
	1962	18	–	–	–	–	3	29	–	–	–	–	–	–	–	–	–	–	32	–	–	–	–	0.2	1.6	–	–	–	–	–	–	–	–	–	1.8
Sand Lake No. 1 (Titus), Grand Traverse	1950	8	–	–	–	–	–	9	–	–	–	5	–	–	–	–	–	–	14	–	–	–	–	–	1.1	–	–	–	0.6	–	–	–	–	–	1.8
	1952	4	–	–	–	–	6	–	–	–	–	–	–	–	–	–	–	–	6	–	–	–	–	1.5	–	–	–	–	–	–	–	–	–	–	1.5
	1953	50	–	–	20	–	–	–	–	–	–	–	–	–	–	–	–	–	20	–	–	0.4	–	–	–	–	–	–	–	–	–	–	–	–	0.4
	1955	331	–	–	250	–	–	–	–	–	–	–	–	–	–	–	–	–	250	–	–	0.8	–	–	–	–	–	–	–	–	–	–	–	–	0.8

Table G.1.–Continued.

			Catch																	CPE															
Water body, county	Year	Angler hours	Brook trout	Borwn trout	Rainbow trout	Smallmouth bass	Largemouth bass	Bluegill	Pumpkinseed	Rock bass	Black crappie	Yellow perch	Grass pickerel	Walleye	Northern pike	Bullhead	Sucker	Lake trout	Total # fish	Brook trout	Borwn trout	Rainbow trout	Smallmouth bass	Largemouth bass	Bluegill	Pumpkinseed	Rock bass	Black crappie	Yellow perch	Walleye	Northern pike	Bullhead	Sucker	Lake trout	Total CPE
	1956	62	–	–	14	–	–	–	–	–	–	–	–	–	–	–	–	–	14	–	–	0.2	–	–	–	–	–	–	–	–	–	–	–	–	0.2
	1958	37	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1959	276	–	–	57	–	–	–	–	–	–	–	–	–	–	–	–	–	57	–	–	0.2	–	–	–	–	–	–	–	–	–	–	–	–	0.2
	1960	279	–	–	138	–	–	–	–	–	–	–	–	–	–	–	–	–	138	–	–	0.5	–	–	–	–	–	–	–	–	–	–	–	–	0.5
	1961	8	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	0.13		–	–	–	–	–	–	–	–	–	–	–	–
	1962	52	–	–	3	–	–	–	–	–	–	–	–	–	–	–	–	–	3	–	–	0.1	–	–	–	–	–	–	–	–	–	–	–	–	0.1
	1964	105	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Sand Lake No. 2, Grand Traverse	1954	3	–	–	–	–	–	12	–	–	–	–	–	–	–	–	–	–	12	–	–	–	–	–	4.0	–	–	–	–	–	–	–	–	–	4.0
Sand Lake No. 3, Grand Traverse	1954	37	–	–	–	–	–	36	–	–	–	44	–	–	–	–	–	–	80	–	–	–	–	–	1.0	–	–	–	1.2	–	–	–	–	–	2.2
	1955	14	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	2.9	–	–	–	–	–	–	–	–	–	2.9
Sand Lake No. 4, Grand Traverse	1960	12	–	–	–	–	6	10	–	–	–	–	–	–	–	–	–	–	16	–	–	–	–	0.5	0.8	–	–	–	–	–	–	–	–	–	1.3
Sand Lake No. 5, Grand Traverse	1954	102	–	–	34	–	–	38	–	–	–	–	–	–	–	–	–	–	72	–	–	0.3	–	–	0.4	–	–	–	–	–	–	–	–	–	0.7
	1960	14	–	–	–	–	15	1	–	–	–	–	–	–	–	–	–	–	16	–	–	–	–	1.1	0.1	–	–	–	–	–	–	–	–	–	1.1
Selkirk Lake, North, Kalkaska	1945	19	–	–	–	–	–	1	–	–	–	3	–	–	–	–	–	–	4	–	–	–	–	–	0.1	–	–	–	0.2	–	–	–	–	–	0.2
	1949	4	–	–	–	–	–	–	–	–	–	6	–	–	3	–	–	–	9	–	–	–	–	–	–	–	–	–	1.5	–	–	0.8	–	–	2.3
	1954	5	–	–	–	–	–	4	5	–	–	11	–	–	1	–	–	–	21	–	–	–	–	–	0.8	1.0	–	–	2.2	–	–	0.2	–	–	4.2
	1957	11	–	–	1	–	1	38	–	–	–	7	–	–	–	–	–	–	47	–	–	0.1	–	0.1	3.5	–	–	–	0.6	–	–	–	–	–	4.3
	1962	1	–	–	4	–	–	1	–	–	–	–	–	–	–	–	–	–	5	–	–	4.0	–	–	1.0	–	–	–	–	–	–	–	–	–	5.0
Selkirk Lake South, Kalkaska	1930	6.5	–	–	–	3	1	–	–	–	–	–	–	–	–	–	–	–	4	–	–	–	0.5	0.2	–	–	–	–	–	–	–	–	–	–	0.6
	1936	10	–	–	–	–	4	8	–	–	–	11	2	–	–	–	–	–	25	–	–	–	–	0.4	0.8	–	–	–	1.1	0.2	–	–	–	–	2.4
	1939	3	–	–	–	–	4	–	–	–	–	–	–	–	–	–	–	–	4	–	–	–	–	1.3	–	–	–	–	–	–	–	–	–	–	1.3
	1942	12	–	–	–	–	–	–	–	–	–	–	2	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	0.2	–	–	–	–	0.2
	1945	3	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	0.3	–	–	–	–	0.3
	1948	4	–	–	–	–	–	–	–	–	–	6	–	–	–	–	–	–	6	–	–	–	–	–	–	–	–	–	1.5	–	–	–	–	–	1.5
	1949	13	–	–				7	14			10	4						35						0.5	1.1			0.8	0.3					2.7

Table G.1.–Continued.

			Catch																	CPE															
Water body, county	Year	Angler hours	Brook trout	Borwn trout	Rainbow trout	Smallmouth bass	Largemouth bass	Bluegill	Pumpkinseed	Rock bass	Black crappie	Yellow perch	Grass pickerel	Walleye	Northern pike	Bullhead	Sucker	Lake trout	Total # fish	Brook trout	Borwn trout	Rainbow trout	Smallmouth bass	Largemouth bass	Bluegill	Pumpkinseed	Rock bass	Black crappie	Yellow perch	Walleye	Northern pike	Bullhead	Sucker	Lake trout	Total CPE
	1954	14	–	–	–	–	–	33	–	–	–	8	3	–	–	–	–	–	44	–	–	–	–	–	2.4	–	–	–	0.6	0.2	–	–	–	–	3.1
	1956	21	–	–	–	–	1	45	16	–	–	2	–	–	–	–	–	–	64	–	–	–	–	0.0	2.1	0.8	–	–	0.1	–	–	–	–	–	3.0
	1957	84	–	–	6	–	2	72	–	–	–	18	–	–	–	–	–	–	98	–	–	0.1	–	0.0	0.9	–	–	–	0.2	–	–	–	–	–	1.2
	1958	43	–	–	–	–	–	140	–	–	–	12	–	–	2	–	–	–	154	–	–	–	–	–	3.3	–	–	–	0.3	–	–	0.0	–	–	3.6
	1959	27	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	2	–	–		–	–	–	–	–	–	–	–	–	–	–	0.1	0.1
	1961	49	–	–	16	–	–	–	–	–	–	–	–	–	–	–	2	–	18	–	–	0.3	–	–	–	–	–	–	–	–	–	–	–	0.0	0.4
	1964	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Silver Lake, Grand Traverse	1928	109	–	–	–	12	–	1	1	7	–	–	2	8	–	–	–	–	31	–	–	–	0.1	–	0.0	0.0	0.1	–	–	0.0	0.1	–	–	–	0.3
	1929	62	–	–	–	1	3	6	1	1	–	2	4	–	–	–	–	–	18	–	–	–	0.0	0.0	0.1	0.0	0.0	–	0.0	0.1	–	–	–	–	0.3
	1930	93	–	–	–	4	2	–	1	2	–	4	10	5	–	–	1	–	29	–	–	–	0.0	0.0	–	0.0	0.0	–	0.0	0.1	0.1	–	–	0.0	0.3
	1931	40	–	–	–	1	4	38	–	–	–	–	–	2	–	–	–	–	45	–	–	–	0.0	0.1	1.0	–	–	–	–	–	0.1	–	–	–	1.1
	1934	53	–	–	–	7	4	138	19	2	–	11	1	5	–	–	–	–	187	–	–	–	0.1	0.1	2.6	0.4	0.0	–	0.2	0.0	0.1	–	–	–	3.6
	1935	21	–	–	–	–	–	4	–	–	–	5	8		–	–	–	–	17	–	–	–	–	–	0.2	–	–	–	0.2	0.4	–	–	–	–	0.8
	1937	12	–	–	–	–	–	6	–	–	–	–	–	6	–	–	–	–	12	–	–	–	–	–	0.5	–	–	–	–	–	0.5	–	–	–	1.0
	1938	54	–	–	–	10	4	30	–	–	–	13	1	5	–	–	1	–	64	–	–	–	0.2	0.1	0.6	–	–	–	0.2	0.0	0.1	–	–	0.0	1.2
	1939	12	–	–	–	4	–	–	–	–	–	1	2		–	–	–	–	7	–	–	–	0.3	–	–	–	–	–	0.1	0.2	–	–	–	–	0.6
	1940	19	–	–	–	–	–	–	18	10	–	7	1		–	–	–	–	36	–	–	–	–	–	–	0.9	0.5	–	0.4	0.1	–	–	–	–	1.9
	1941	98	–	–	–	–	4	88	6	4	–	29	–	1	–	–	–	–	132	–	–	–	–	0.0	0.9	0.1	0.0	–	0.3	–	0.0	–	–	–	1.3
	1942	108	–	–	–	6	1	93	7	4	–	20	–	–	–	–	–	–	131	–	–	–	0.1	0.0	0.9	0.1	0.0	–	0.2	–	–	–	–	–	1.2
	1943	224	–	–	–	5	3	86	16	4	–	8	–	12	18	–	–	–	152	–	–	–	0.0	0.0	0.4	0.1	0.0	–	0.0	–	0.1	0.1	–	–	0.7
	1945	74	–	–	–	3	–	47	22	–	–	12	–	3	3	–	–	–	90	–	–	–	0.0	–	0.6	0.3	–	–	0.2	–	0.0	0.0	–	–	1.2
	1946	18	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1947	114	–	–	–	6	1	–	–	–	–	–	–	30	8	–	–	–	45	–	–	–	0.1	0.0	–	–	–	–	–	–	0.3	0.1	–	–	0.4
	1950	252	–	–	–	1	–	216	–	–	–	–	–	–	20	–	–	–	237	–	–	–	0.0	–	0.9	–	–	–	–	–	–	0.1	–	–	0.9
	1951	24	–	–	–	–	–	20	–	–	–	–	–	–	–	–	–	–	20	–	–	–	–	–	0.8	–	–	–	–	–	–	–	–	–	0.8
	1952	86	–	–	–	–	–	161	14	–	–	4	–	–	4	–	–	–	183	–	–	–	–	–	1.9	0.2	–	–	0.0	–		0.0	–	–	2.1
	1953	380	–	–	–	–	14	284	6	–	–	13	–	2	8	–	–	–	327	–	–	–	–	0.0	0.7	0.0	–	–	0.0	–	0.0	0.0	–	–	0.9
	1954	307	–	–	–	–	–	463	14	–	–	3	–	1	10	–	–	–	491	–	–	–	–	–	1.5	0.0	–	–	0.0	–	0.0	0.0	–	–	1.6
	1955	86	–	–	–	–	1	113	13	–	–	2	–	–	2	–	–	–	131	–	–	–	–	0.0	1.3	0.2	–	–	0.0	–		0.0	–	–	1.5
	1956	161	–	–	–	–	5	78	–	–	–	–	–	8	8	–	–	–	99	–	–	–	–	0.0	0.5	–	–	–	–	–	0.0	0.0	–	–	0.6

Table G.1.–Continued.

		Catch																	CPE															
Water body, county	Year	Angler hours	Brook trout	Borwn trout	Rainbow trout	Smallmouth bass	Largemouth bass	Bluegill	Pumpkinseed	Rock bass	Black crappie	Yellow perch	Grass pickerel	Walleye	Northern pike	Bullhead	Sucker	Lake trout	Total # fish	Brook trout	Borwn trout	Rainbow trout	Smallmouth bass	Largemouth bass	Bluegill	Pumpkinseed	Rock bass	Black crappie	Yellow perch	Walleye	Northern pike	Bullhead	Sucker	Lake trout	Total CPE
	1957	1,182	–	–	58	2	13	367	25	26	–	48	–	10	12	–	1	–	562	–	–	0.1	0.0	0.0	0.3	0.0	0.0	–	0.0	–	0.0	0.0	–	0.0	0.5
	1958	240	–	–	–	5	–	158	12	–	–	5	–	–	10	–	–	–	190	–	–	–	0.0	–	0.7	0.1	–	–	0.0	–	–	0.0	–	–	0.8
	1959	116	–	–	3	3	13	37	7	31	–	15	–	–	–	–	–	–	109	–	–	0.0	0.0	0.1	0.3	0.1	0.3	–	0.1	–	–	–	–	–	0.9
	1962	73	–	–	1	–	5	32	–	8	–	2	–	–	–	–	–	–	48	–	–	0.0	–	0.1	0.4	–	0.1	–	0.0	–	–	–	–	–	0.7
	1964	125	–	–	–	–	5	38	17	4	–	29	–	3	2	–	–	–	98	–	–	–	–	0.0	0.3	0.1	0.0	–	0.2	–	0.0	0.0	–	–	0.8
Smith's Lake, Kalkaska	1950	23	82	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	82	3.6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3.6
	1952	6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1955	8	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	0.1	–	–	–	–	–	–	–	–	–	–	–	–	–	0.1
	1956	6	–	–	–	–	4	–	–	15	–	–	–	–	–	–	–	–	19	–	–	–	–	0.7	–	–	2.5	–	–	–	–	–	–	–	3.2
	1957	7	–	–	–	–	2	9	–	–	–	10	–	–	–	–	–	–	21	–	–	–	–	0.3	1.3	–	–	–	1.4	–	–	–	–	–	3.0
	1958	4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1960	4	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	0.3	–	–	–	–	–	0.3
	1961	21	–	–	9	–	–	–	–	23	–	–	–	–	–	–	–	–	32	–	–	0.4	–	–	–	–	1.1	–	–	–	–	–	–	–	1.5
	1962	6	–	–	–	–	–	–	–	–	–	19	–	–	–	–	–	–	19	–	–	–	–	–	–	–	–	–	3.2	–	–	–	–	–	3.2
	1964	4	–	–	–	–	–	–	–	–	–	17	–	–	–	–	–	–	17	–	–	–	–	–	–	–	–	–	4.3	–	–	–	–	–	4.3
	1965	25	–	2	–	–	–	–	–	–	–	45	–	–	–	–	–	–	–	–	0.1	–	–	–	–	–	–	–	1.8	–	–	–	–	–	1.9
Spider Lake, Grand Traverse	1928	166	–	–	–	7	118	118	–	–	–	10	–	–	–	–	–	–	253	–	–	–	0.0	0.7	0.7	–	–	–	0.1	–	–	–	–	–	1.5
	1929	23	–	–	–	–	12	–	–	–	–	–	–	–	–	–	–	–	12	–	–	–	–	0.5	–	–	–	–	–	–	–	–	–	–	0.5
	1930	5.5	–	–	–	3	–	–	–	–	–	–	1	–	–	–	–	–	4	–	–	–	0.5	–	–	–	–	–	–	0.2	–	–	–	–	0.7
	1934	119	–	–	–	11	36	265	8	46	–	21	–	–	–	–	–	–	387	–	–	–	0.1	0.3	2.2	0.1	0.4	–	0.2	–	–	–	–	–	3.3
	1935	126	–	–	–	–	16	369	1	6	–		–	–	–	–	–	–	392	–	–	–	–	0.1	2.9	0.0	0.0	–		–	–	–	–	–	3.1
	1937	64	–	–	–	3	10	213	4	3	–	3	–	–	–	–	–	–	236	–	–	–	0.0	0.2	3.3	0.1	0.0	–	0.0	–	–	–	–	–	3.7
	1938	53	–	–	–	1	14	59	7	5	–	2	–	–	–	–	–	–	88	–	–	–	0.0	0.3	1.1	0.1	0.1	–	0.0	–	–	–	–	–	1.7
	1939	158	–	–	–	2	12	274	1	6	–	3	–	–	–	–	–	–	298	–	–	–	0.0	0.1	1.7	0.0	0.0	–	0.0	–	–	–	–	–	1.9
	1940	61	–	–	–	1	14	53	6	51	–	2	–	–	–	–	–	–	127	–	–	–	0.0	0.2	0.9	0.1	0.8	–	0.0	–	–	–	–	–	2.1
	1941	221	–	–	–	4	26	268	40	22	–	36	–	–	–	–	–	–	396	–	–	–	0.0	0.1	1.2	0.2	0.1	–	0.2	–	–	–	–	–	1.8
	1942	55	–	–	–	–	4	35	5		–	12	–	–	–	–	–	–	56	–	–	–	–	0.1	0.6	0.1	–	–	0.2	–	–	–	–	–	1.0
	1943	39	–	–	–	1	3	23	5	2	–	–	–	–	–	–	–	–	34	–	–	–	0.0	0.1	0.6	0.1	0.1	–	–	–	–	–	–	–	0.9
	1945	83	–	–	–	1	13	108	51	–	–	44	–	–	–	–	–	–	217	–	–	–	0.0	0.2	1.3	0.6	–	–	0.5	–	–	–	–	–	2.6
	1946	92	–	–	–	–	–	108	–	–	–	–	–	–	–	–	–	–	108	–	–	–	–	–	1.2	–	–	–	–	–	–	–	–	–	1.2

Table G.1.–Continued.

Water body, county	Year	Angler hours	Catch																CPE															
			Brook trout	Borwn trout	Rainbow trout	Smallmouth bass	Largemouth bass	Bluegill	Pumpkinseed	Rock bass	Black crappie	Yellow perch	Grass pickerel	Walleye	Northern pike	Bullhead	Sucker	Lake trout	Total # fish	Brook trout	Borwn trout	Rainbow trout	Smallmouth bass	Largemouth bass	Bluegill	Pumpkinseed	Rock bass	Black crappie	Yellow perch	Walleye	Northern pike	Bullhead	Sucker	Lake trout	Total CPE
	1947	25	–	–	–	–	2	3	–	9	–	–	–	–	–	–	–	–	14	–	–	–	–	0.1	0.1		0.4			–	–	–	–	–	0.6
	1948	115	–	–	–	1	5	76	1	3	4	14	–	–	–	–	–	–	104	–	–	–	0.0	0.0	0.7	0.0	0.0	0.0	0.1	–	–	–	–	–	0.9
	1950	61	–	–	–	–	14	111	–	–	–	–	–	–	–	–	–	–	125	–	–	–	–	0.2	1.8	–	–	–	–	–	–	–	–	–	2.0
	1951	45	–	–	–	–	1	39	–	20	–	–	–	–	–	–	–	–	60	–	–	–	–	0.0	0.9	–	0.4	–	–	–	–	–	–	–	1.3
	1953	688	–	–	–	20	104	695	81	20	7	93	–	–	–	–	–	–	1,020	–	–	–	–	–	1.0	0.1	0.0	0.0	0.1		–	–	–	–	1.5
	1954	83	–	–	–	2	5	48	4	4	1	6	–	–	–	–	–	–	70	–	–	–	0.0	0.1	0.6	0.0	0.0	0.0	0.1	–	–	–	–	–	0.8
	1956	17	–	–	–	–	–	96	–	–	–	5	–	–	–	–	–	–	101	–	–	–	–	–	5.8	–	–	–	0.3	–	–	–	–	–	6.1
	1957	136	–	–	–	1	3	186	9	8	7	44	–	–	1	–	–	–	259	–	–	–	0.0	0.0	1.4	0.1	0.1	0.1	0.3	–	–	0.0	–	–	1.9
	1958	204	–	–	–	–	9	118	26	–	4	26	–	–	–	–	–	–	183	–	–	–	–	0.0	0.6	0.1	–	0.0	0.1	–	–	–	–	–	0.9
	1959	179	–	–	–	–	4	136	9	4	–	25	–	–	–	–	–	–	178	–	–	–	–	0.0	0.8	0.1	0.0	–	0.1	–	–	–	–	–	1.0
	1960	232	–	–	–	–	–	214	–	–	14	295	–	–	–	–	–	–	523	–	–	–	–	–	0.9	–	–	0.1	1.3	–	–	–	–	–	2.3
	1961	37	–	–	–	–	–	12	–	–	–	62	–	–	–	–	–	–	74	–	–	–	–	–	0.3	–	–	–	1.7	–	–	–	–	–	2.0
	1962	7	–	–	–	–	1	19	–	–	–	–	–	–	–	–	–	–	20	–	–	–	–	0.1	2.7	–	–	–	–	–	–	–	–	–	2.9
	1964	80	–	–	–	–	13	44	9	4	–	17	–	–	–	–	–	–	87	–	–	–	–	0.2	0.6	0.1	0.1	–	0.2	–	–	–	–	–	1.1
Spring Lake, Grand Traverse	1938	3	–	–	–	–	2	6	–	–	–	5	–	–	–	–	–	–	13	–	–	–	–	0.7	2.0	–	–	–	1.7	–	–	–	–	–	4.3
	1954	41	–	–	–	–	–	76	43	–	–	–	–	–	–	–	–	–	119	–	–	–	–	–	1.9	1.0	–	–	–	–	–	–	–	–	2.9
	1955	6	–	–	–	–	–	2	5	–	–	–	–	–	–	–	–	–	7	–	–	–	–	–	0.3	0.8	–	–	–	–	–	–	–	–	1.2
Twin Lakes, Grand Traverse	1957	6	–	–	–	–	–	2	3	–	–	–	–	–	–	–	–	–	5	–	–	–	–	–	0.3	0.5	–	–	–	–	–	–	–	–	0.8
	1960	14	–	–	–	–	–	7	–	–	–	3	–	–	3	–	–	–	13	–	–	–	–	–	0.5	–	–	–	0.2	–	–	0.2	–	–	0.9
	1961	9	–	–	–	–	2	–	–	–	–	–	–	–	1	–	–	–	3	–	–	–	–	0.2	–	–	–	–	–	–	–	0.1	–	–	0.3
Twin Lakes East, Grand Traverse	1942	4	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	0.3	–	–	–	–	–	–	–	–	–	–	0.3
	1959	4	–	–	–	–	–	8	–	–	–	–	–	–	–	–	–	–	8	–	–	–	–	–	2.0	–	–	–	–	–	–	–	–	–	2.0
Twin Lakes North, Grand Traverse	1955	6	–	–	3	–	–	–	–	–	–	–	–	–	–	–	–	–	3	–	–	0.5	–	–	–	–	–	–	–	–	–	–	–	–	0.5
	1957	21	–	–	12	–	–	–	–	–	–	–	–	–	–	–	–	–	12	–	–	0.6	–	–	–	–	–	–	–	–	–	–	–	–	0.6
	1958	71	2	1	38	–	1	–	–	–	–	–	–	–	–	–	–	–	42	0.0	0.0	0.5	–	0.0	–	–	–	–	–	–	–	–	–	–	0.6
	1961	12	–	–	–	–	–	–	–	–	–	14	–	–	–	–	–	–	14	–	–	–	–	–	–	–	–	–	1.2	–	–	–	–	–	1.2

Table G.1.–Continued.

			Catch																	CPE															
Water body, county	Year	Angler hours	Brook trout	Borwn trout	Rainbow trout	Smallmouth bass	Largemouth bass	Bluegill	Pumpkinseed	Rock bass	Black crappie	Yellow perch	Grass pickerel	Walleye	Northern pike	Bullhead	Sucker	Lake trout	Total # fish	Brook trout	Borwn trout	Rainbow trout	Smallmouth bass	Largemouth bass	Bluegill	Pumpkinseed	Rock bass	Black crappie	Yellow perch	Walleye	Northern pike	Bullhead	Sucker	Lake trout	Total CPE
Twin Lakes South, Grand Traverse	1937	7	–	–	–	–	–	4	–	–	–	–	–	–	–	–	–	–	4	–	–	–	–	–	0.6	–	–	–	–	–	–	–	–	–	0.6
	1938	2	–	–	–	–	–	11	–	–	–	2	–	–	–	–	–	–	13	–	–	–	–	–	5.5	–	–	–	1.0	–	–	–	–	–	6.5
	1947	2	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	0.5	–	–	–	–	0.5
	1950	30	–	–	–	–	–	–	–	–	–	–	–	–	9	–	–	–	9	–	–	–	–	–	–	–	–	–	–	–	–	0.3	–	–	0.3
	1952	12	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	0.1	–	–	0.1
	1953	26	–	–	–	–	–	–	–	–	–	–	–	–	7	–	–	–	7	–	–	–	–	–	–	–	–	–	–	–	–	0.3	–	–	0.3
	1954	10	–	–	–	–	–	8	–	–	–	–	–	–	1	–	–	–	9	–	–	–	–	–	0.8	–	–	–	–	–	–	0.1	–	–	0.9
	1955	11	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	0.1	–	–	0.1
	1956	31	–	–	–	–	–	–	–	–	–	–	1	–	1	–	–	–	2	–	–	–	–	–	–	–	–	–	–	0.0	–	0.0	–	–	0.1
	1957	53	–	–	–	–	–	–	–	–	–	3	–	–	6	–	–	–	9	–	–	–	–	–	–	–	–	–	0.1	–	–	0.1	–	–	0.2
	1958	38	–	–	–	–	–	30	–	–	–		–	–	3	–	–	–	33	–	–	–	–	–	0.8	–	–	–	–	–	–	0.1	–	–	0.9
	1960	52	–	–	52	–	–	–	–	–	–	–	–	–	–	–	–	–	52	–	–	1.0	–	–	–	–	–	–	–	–	–	–	–	–	1.0
	1962	53	–	–	17	–	–	–	–	–	–	–	–	–	–	–	–	–	17	–	–	0.3	–	–	–	–	–	–	–	–	–	–	–	–	0.3
Vandervoight Lake, Grand Traverse	1929	2	–	–	–	–	9	–	–	–	–	1	–	–	–	–	–	–	10	–	–	–	–	4.5	–	–	–	–	0.5	–	–	–	–	–	5.0
	1957	6	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	0.2	–	–	–	–	–	–	–	–	–	0.2

Table G.2.–Miscellaneous creel data from 1928–1965 for the Boardman River and tributaries. These data were compiled from records located at MDNR, Institute for Fisheries Research. CPE = Catch Per Effort.

			Catch																		CPE																	
Water body	Year	Angler hours	Brook trout	Brown trout	Rainbow trout	Smallmouth bass	Largemouth bass	Bluegill	Pumpkinseed	Rock bass	Yellow perch	Grass pickerel	Walleye	Northern pike	Bullhead	Carp	Sucker	Lake trout	Tiger trout	Total # fish	Brook trout	Borwn trout	Rainbow trout	Smallmouth bass	Largemouth bass	Bluegill	Pumpkinseed	Rock bass	Yellow perch	Grass pickerel	Walleye	Northern pike	Carp	Bullhead	Sucker	Lake Trout	Tiger trout	Total CPE
Bancroft Cr.	1953	10	1	3	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	6	0.1	0.3	0.2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.6
	1955	19	9	10	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	19	0.5	0.5		–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.0
Boardman R.	1928	229.5	32	76	20	–	–	–	–	10	2	8	–	–	4	–	1	–	–	153	0.1	0.3	0.1	–	–	–	–	0.0	0.0	0.0	–	–	0.0	0.0	0.0	–	–	0.7
	1929	110.5	30	20	24	–	–	–	–	–	11	–	–	–	–	–	–	–	–	85	0.3	0.2	0.2	–	–	–	–	–	0.1	–	–	–	–	–	–	–	–	0.8
	1930	72	69	14	24	7	–	–	–	–	–	8	–	–	46	–	–	–	–	168	1.0	0.2	0.3	0.1	–	–	–	–	–	0.1	–	–	0.6	0.6	–	–	–	3.0
	1931	76	27	6	10	–	–	–	–	–	–	–	–	–	–	–	–	–	–	43	0.4	0.1	0.1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.6
	1932	46	81	24	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	106	1.8	0.5	0.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2.3
	1933	8	17	1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	18	2.1	0.1		–	–	–	–	–	–	–	–	–	–	–	–	–	–	2.3
	1934	122.6	5	36	6	–	3	7		–	5	–	–	–	16	–	57	–	–	135	0.0	0.3	0.0	–	0.0	0.1	–	–	0.0	–	–	–	0.1	0.1	0.5	–	–	1.2
	1935	33.25	2	33	2	–	–	–	–	–		–	–	–	–	–	–	–	–	37	0.1	1.0	0.1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.1
	1937	264.8	8	206	29	–	–	–	–	90	21	–	–	–	–	–	–	–	–	354	0.0	0.8	0.1	–	–	–	–	0.3	0.1	–	–	–	–	–	–	–	–	1.3
	1938	77.25	–	33	28	1	2	–	–	–	1	–	–	–	–	–	–	–	–	65	–	0.4	0.4	0.0	0.0	–	–	–	0.0	–	–	–	–	–	–	–	–	0.8
	1939	179.5	6	88	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	96	0.0	0.5	0.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.5
	1940	154.5	1	57	22	87	–	–	–	22	9	–	–	1	–	–	–	–	–	199	0.0	0.4	0.1	0.6	–	–	–	0.1	0.1	–	–	0.0	–	–	–	–	–	1.3
	1941	219.3	1	42	3	–	–	–	22	–	119	–	2	9	–	–	–	–	–	198	0.0	0.2	0.0	–	–	–	0.1	–	0.5	–	0.0	0.0	–	–	–	–	–	0.9
	1942	22	–	50	14	–	–	–	–	–	–	–	–	–	–	–	–	–	–	64	–	2.3	0.6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2.9
	1943	52.5	2	17	31	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50	0.0	0.3	0.6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.0
	1944	129.8	1	59	30	–	–	–	–	–	–	–	–	–	–	–	–	–	–	90	0.0	0.5	0.2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.7
	1945	378	68	151	70	14	–	–	–	62	13	–	–	7	1	1	2	–	1	390	0.2	0.4	0.2	0.0	–	–	–	0.2	0.0	–	–	0.0	0.0	0.0	0.0	–	0.0	1.0
	1947	318	12	142	15	–	–	–	–	–	–	–	–	–	–	–	–	–	–	169	0.0	0.4	0.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.5
	1948	168	11	12	15	–	–	–	–	–	–	–	–	–	–	–	–	–	–	38	0.1	0.1	0.1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.2
	1949	180.5	6	36	33	–	–	–	–	–	–	–	–	–	–	–	–	–	–	75	0.0	0.2	0.2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.4
	1950	165	4	27	15	–	–	–	–	–	–	–	–	–	–	–	–	–	–	46	0.0	0.2	0.1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.3
	1951	133	1	50	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	52	0.0	0.4	–	–	0.0	–	–	–	–	–	–	–	–	–	–	–	–	0.4
	1952	321	10	162	9	–	–	–	–	–	–	–	–	–	–	–	–	–	–	181	0.0	0.5	0.0		–	–	–	–	–	–	–	–	–	–	–	–	–	0.6
	1953	520	45	96	69	4	–	–	–	–	–	–	–	4	–	–	–	–	–	218	0.1	0.2	0.1	0.0	–	–	–	–	–	–	–	0.0	–	–	–	–	–	0.4
	1954	345	1	35	11	–	–	–	–	–	–	–	–	–	–	–	–	–	–	47	0.0	0.1	0.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.1
	1955	126	–	18	9	–	–	–	–	–	–	–	–	–	–	–	–	–	–	27	–	0.1	0.1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.2
	1956	433	–	32	45	160	–	11	–	32	14	–	–	–	–	–	–	–	–	294	–	0.1	0.1	0.4	–	0.0	–	0.1	0.0	–	–	–	–	–	–	–	–	0.7
	1957	315	2	22	78	28	–	–	–	–	–	–	–	–	–	–	–	–	–	130	0.0	0.1	0.2	0.1	–	–	–	–	–	–	–	–	–	–	–	–	–	0.4
	1958	240	8	11	28	–	–	–	–	10	5	–	–	–	–	–	3	–	–	65	0.0	0.0	0.1	–	–	–	–	0.0	0.0	–	–	–	–	–	0.0	–	–	0.3
	1959	110	–	10	19	–	–	–	–	–	–	–	–	–	–	–	–	–	–	29	–	0.1	0.2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.3
	1960	103	7	26	5	–	–	–	–	–	–	–	–	–	–	1	–	–	–	39	0.1	0.3	0.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.4
	1962	71	1	22	8	–	–	–	–	–	–	–	–	4	–	–	–	–	–	35	0.0	0.3	0.1	–	–	–	–	–	–	–	–	0.1	–	–	–	–	–	0.5

Table G.2.–Continued.

Water body	Year	Angler hours	Catch: Brook trout	Brown trout	Rainbow trout	Smallmouth bass	Largemouth bass	Bluegill	Pumpkinseed	Rock bass	Yellow perch	Grass pickerel	Walleye	Northern pike	Bullhead	Carp	Sucker	Lake trout	Tiger trout	Total # fish	CPE: Brook trout	Borwn trout	Rainbow trout	Smallmouth bass	Largemouth bass	Bluegill	Pumpkinseed	Rock bass	Yellow perch	Grass pickerel	Walleye	Northern pike	Carp	Bullhead	Sucker	Lake Trout	Tiger trout	Total CPE
Boardman R., North Branch	1928	5	46	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	46	9.2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	9.2
	1929	74.5	96	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	96	1.3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.3
	1930	17.5	25	7	3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	35	1.4	0.4	0.2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2.0
	1931	12	34	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	34	2.8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2.8
	1935	1	5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	5	5.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	5.0
	1936	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1937	6	13	–	3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	16	2.2		0.5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2.7
	1945	31	19	2	6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	27	0.6	0.1	0.2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.9
	1948	43	16	11	14	–	–	–	–	–	–	–	–	–	–	–	–	–	–	41	0.4	0.3	0.3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.0
	1949	10	16	2	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	19	1.6	0.2	0.1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.9
	1951	99	11	9	7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	27	0.1	0.1	0.1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.3
	1954	68	48	8	23	–	–	–	–	–	–	–	–	–	–	–	–	–	–	79	0.7	0.1	0.3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.2
	1955	79	20	7	46	–	–	–	–	–	–	–	–	–	–	–	–	–	–	73	0.3	0.1	0.6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.9
	1956	93	55	20	110	–	–	–	–	–	–	–	–	–	–	–	–	–	–	185	0.6	0.2	1.2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2.0
	1957	38	10		45	–	–	–	–	–	–	–	–	–	–	–	–	–	–	55	0.3	–	1.2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.4
	1958	56	9	5	4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	18	0.2	0.1	0.1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.3
	1959	82	17	1	12	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30	0.2	0.0	0.1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.4
	1960	41	5	12	15	–	–	–	–	–	–	–	–	–	–	–	–	–	–	32	0.1	0.3	0.4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.8
	1962	57.5	29	13	6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	48	0.5	0.2	0.1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.8
Boardman R., South Branch	1928	6	20	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	20	3.3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3.3
	1929	38	51	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	51	1.3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.3
	1930	28	106	5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	111	3.8	0.2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4.0
	1931	23	32	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	33	1.4	–	0.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.4
	1933	3	10	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	10	3.3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3.3
	1937	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1939	11.5	2	2	3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	7	0.2	0.2	0.3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.6
	1945	7	3	3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	6	0.4	0.4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.9
	1948	12	11	7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	18	0.9	0.6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.5
	1950	3	1	3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4	0.3	1.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.3
	1954	21	32	4	4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	1.5	0.2	0.2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.9
	1956	20	17	9	18	–	–	–	–	–	–	–	–	–	–	–	–	–	–	44	0.9	0.5	0.9	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2.2
	1957	33	1	16	19	–	–	–	–	–	–	–	–	–	–	–	–	–	–	36	0.0	0.5	0.6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.1
	1958	25	–	11	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	11	–	0.4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.4
	1959	49	20	1	10	–	–	–	–	–	–	–	–	1	–	–	–	–	–	32	0.4	0.0	0.2	–	–	–	–	–	–	–	–	0.0	–	–	–	–	–	0.7
	1960	9.5	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	0.1	0.1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.2
	1961	6	–	–	3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3	–	–	0.5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.5

Table G.2.–Continued.

Water body	Year	Angler hours	Catch: Brook trout	Brown trout	Rainbow trout	Smallmouth bass	Largemouth bass	Bluegill	Pumpkinseed	Rock bass	Yellow perch	Grass pickerel	Walleye	Northern pike	Bullhead	Carp	Sucker	Lake trout	Tiger trout	Total # fish	CPE: Brook trout	Borwn trout	Rainbow trout	Smallmouth bass	Largemouth bass	Bluegill	Pumpkinseed	Rock bass	Yellow perch	Grass pickerel	Walleye	Northern pike	Carp	Bullhead	Sucker	Lake Trout	Tiger trout	Total CPE
Carpenter Cr.	1949	8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1957	8	7	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	8	0.9	–	0.1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.0
	1959	11	17	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	17	1.5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.5
Crofton Cr.	1948	11	15	–	3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	18	1.4	–	0.3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.6
	1955	2	6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	6	3.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3.0
	1956	5	17	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	17	3.4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3.4
	1959	20	14	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	14	0.7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.7
East Cr.	1930	12	17	2	–	–	–	–	–	–	–	–	–	–	–	–	–	9	–	28	1.4	0.2	–	–	–	–	–	–	–	–	–	–	–	–	–	0.8	–	2.3
	1934	4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1935	6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1937	4..5	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1939	17.75	1	18	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	19	0.1	1.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.1
	1940	3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1941	34.5	1	12	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	15	0.0	0.3	0.1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.4
	1944	18.75	4	–	14	–	–	–	–	–	–	–	–	–	–	–	–	–	–	18	0.2		0.7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.0
	1945	9.5	5	4	4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	13	0.5	0.4	0.4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.4
	1946	3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1949	31	41	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	41	1.3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.3
	1951	3	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	0.3	0.3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.7
	1952	11	3		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3	0.3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.3
	1955	2	–	3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3	–	1.5		–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.5
Failing Stream	1948	2	2		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	1.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.0
	1957	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Jaxon Cr.	1949	20	17	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	17	0.9	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.9
	1950	10	–	4	4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	8	–	0.4	0.4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.8
	1955	4	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	0.3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.3
Kids Cr.	1958	39	4	–	13	–	–	–	–	–	–	–	–	–	–	–	–	–	–	17	0.1	–	0.3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.4
Twenty-Two Cr.	1934	17	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1935	12	5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	5	0.4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.4
	1938	12	7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	7	0.6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.6
	1940	7.5	12	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	13	1.6	–	0.1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.7
	1945	11	14	3	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	19	1.3	0.3	0.2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.7
	1950	6	8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	8	1.3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.3
	1951	2	3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3	1.5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.5
	1957	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.0
	1959	19	7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	7	0.4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.4
	1960	10	9	2	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	12	0.9	0.2	0.1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.2