STATE OF MICHIGAN
DEPARTMENT OF NATURAL RESOURCES

Boardman River Assessment

2014 DRAFT

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and
Mark A. Tonello

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

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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 Pacific 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 extinct from the Boardman River. Today, the Boardman River supports a typical cold water resident and migratory fishery consisting of self-sustaining brook and brown trout, and stocked steelhead, Chinook, and coho salmon (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.

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INTRODUCTION

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

The comment period for this assessment is open until May 16, 2014. Anyone who reviews this draft is urged to comment, in writing, to:

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Comments received after May 16, 2014 will be considered during future revisions of this 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 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 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 (five), 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 one site 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) 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 MI (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 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 steam 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 and the fish population within Boardman Pond is also classified as poor for all game fish except smallmouth bass (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 warm water 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, brook trout, and brown trout (Lessard and Hayes 2003). They attribute the decreases in abundance to the adverse effect the Brown Bridge Dam warm water 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 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 cold water or warm water 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.

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.liaa.info/crabmp/.

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 cold water 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 cold-water 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 common white suckers. 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 MI 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 pre-settlement 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 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 extinct 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 extinct 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 non-native fish species, the construction of dams, and the intensive logging of the 19^{th} and early 20^{th} 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, and coho salmon 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 19^{th} 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*) 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 more flashy 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 northern muskellunge) and hybrid sunfish (a variety of possible crosses including bluegill, pumpkinseed sunfish, and green sunfish), have also been observed in the watershed. Nine non-native species were intentionally introduced into the watershed, and one non-native species (sea lamprey) has colonized the river from Lake Michigan. The lake sturgeon 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 niches.

Inland lakes in the Boardman River watershed support fish communities typical to many inland lakes in Michigan. These communities include largemouth bass, smallmouth bass, bluegill, pumpkinseed sunfish, yellow perch, rock bass, northern pike, white sucker, and bullhead. Various minnow and forage species are also present, often including bluntnose minnow and golden shiner. 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, coho, rainbow trout, Atlantic salmon, and pink salmon 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 sunfish, 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 2003, the Watershed Center Grand Traverse Bay began the Kids Creek Restoration Project (The Watershed Center Grand Traverse Bay 2005). The project restored 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. In 2006, the Watershed Center began the Kids Creek Stormwater Project. The goal of this project is to reduce the amount of storm water entering Kids Creek.

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 trout (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) and 1967 (Chinook), 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 Regional Sportfishing 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 salmon 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, common 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. 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, MI), 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; bluegills were 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, bluegills, 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 MI 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.

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

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

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FIGURES

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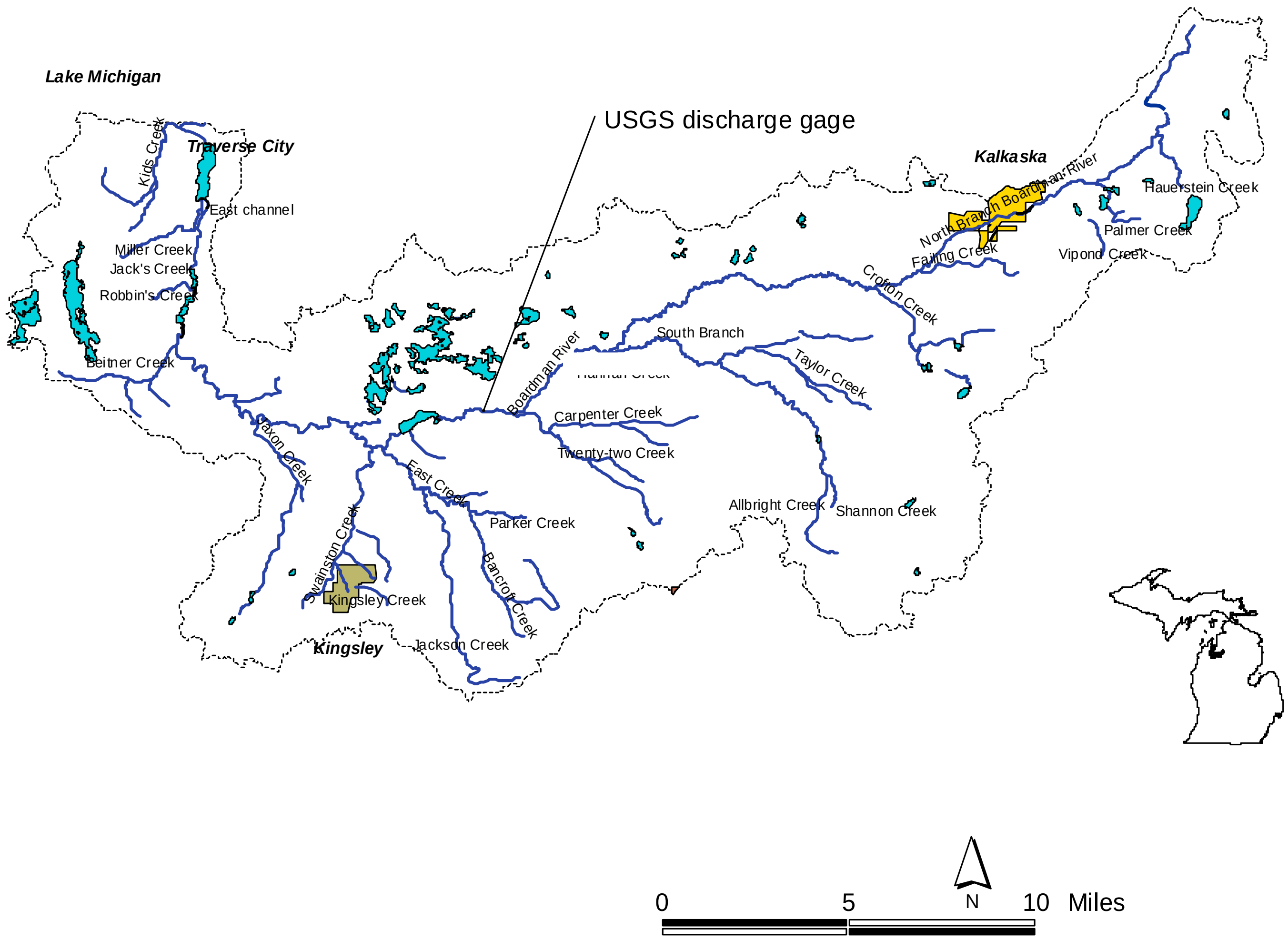

Figure 1.–The Boardman River watershed.

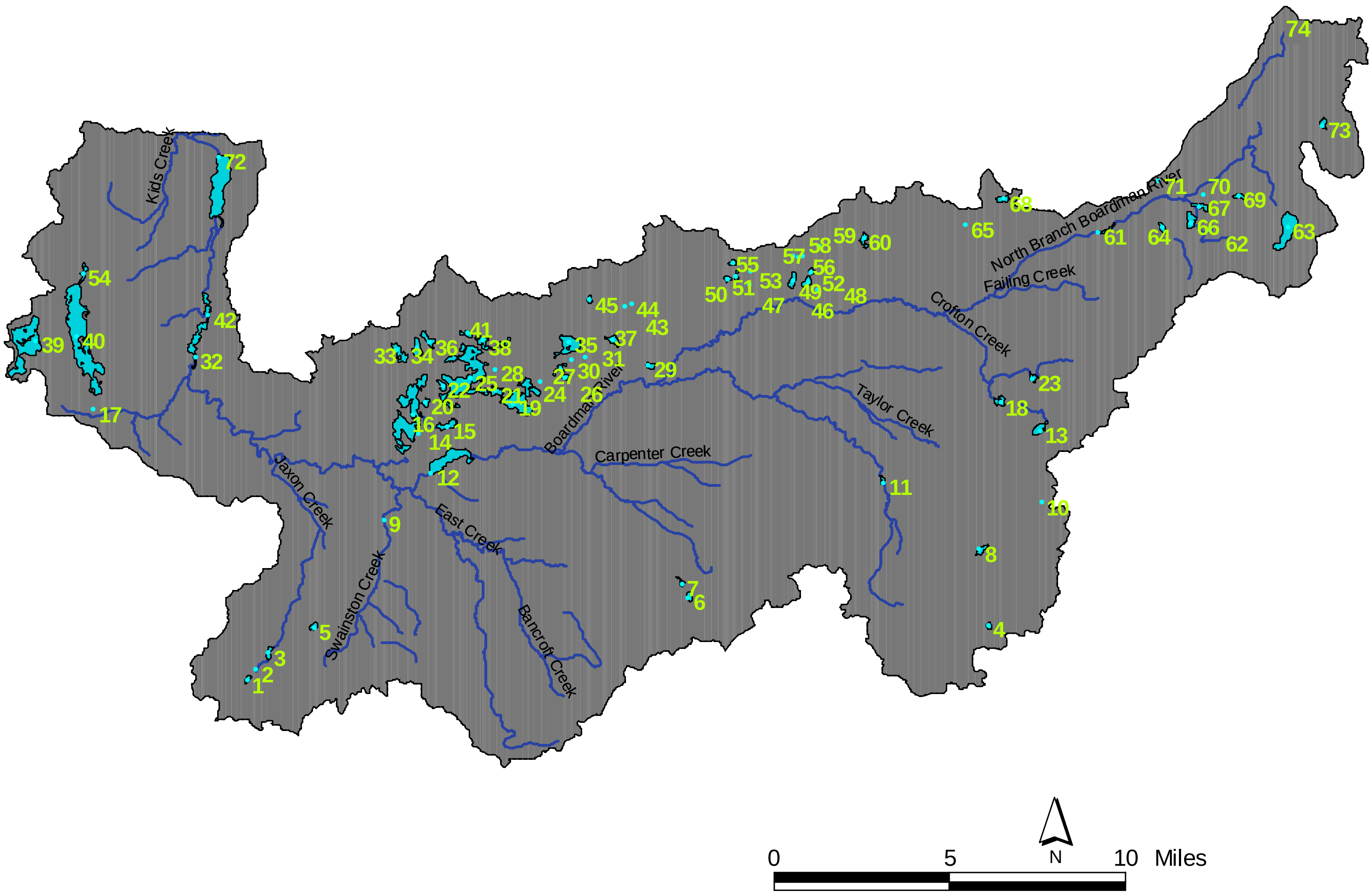

Figure 2.–Lake distribution (>10 acres) within the Boardman River watershed.

Figure 2.–Legend

Number	Lake Name	Number	Lake Name	Number	Lake Name
1	Bumphrey Lake	26	Muncie Lake #4	51	Sand Lake (#2)
2	Cedar Lake	27	Muncie Lake #1	53	Sand Lake (#1)
3	Brewster Lake	28	Denzer Lake	54	Unnamed Lake
4	Breeds Lake	29	Twin Lake	55	Sand Lake (#4)
5	Wistrand Lake	30	Muncie Lake #2	56	Unnamed Lake
6	Downs Lake	31	Muncie Lake No.3	57	Unnamed Lake
7	Parsons Lake	32	Keystone Pond	58	Unnamed Lake
8	Perch Lake	33	Chandler Lake	59	Darby Lake
9	Mayfield Pond	34	High Lake	60	Island Lake
10	Butler Lake	35	Island Lake	61	Unnamed Lake
11	Young's Mill Pond	36	Tibbets Lake	62	Palmer Lake
12	Brown Bridge Pond	37	Dollar Lake	63	Crawford Lake
13	Bass Lake	38	Indian Lake	64	Kettle Lake
14	Perch Lake	39	Bass Lake	65	Milk Lake
15	Spring Lake	40	Silver Lake	66	South Selkirk Lake
16	Arbutus Lake	41	Vandervoight Lake	67	North Selkirk Lake
17	Cox Pond	42	Sabin Pond	68	Little Guernsey Lake
18	Mud Lake	43	Twin Lake (South)	68	Smith Lake
19	Rennie Lake	44	Twin Lake (North)	69	Lake Placid
20	Wethea Lake	45	Unnamed Lake	70	Abbot Lake
21	Bass Lake	46	Mud Lake	71	Little Log Lake
22	George Lake	47	Sand Lake (#5)	72	Boardman Lake
23	Loon Lake	48	Guernsey Lake	73	Lake Five
24	Grass Lake	49	Guernsey Lake	74	Farrar Lake
25	Spider Lake	50	Sand Lake (#3)		

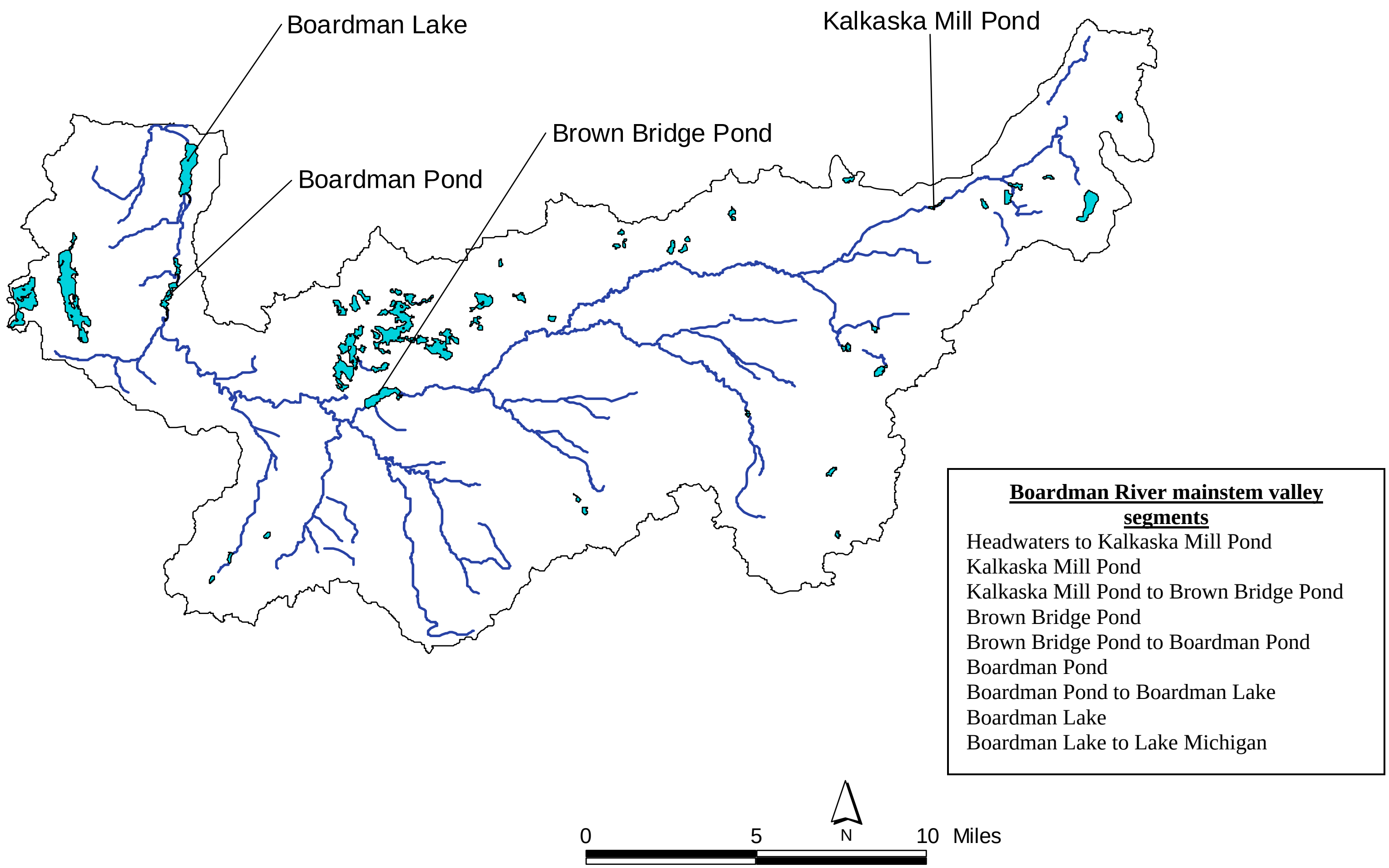

Figure 3.–Boardman River valley segments.

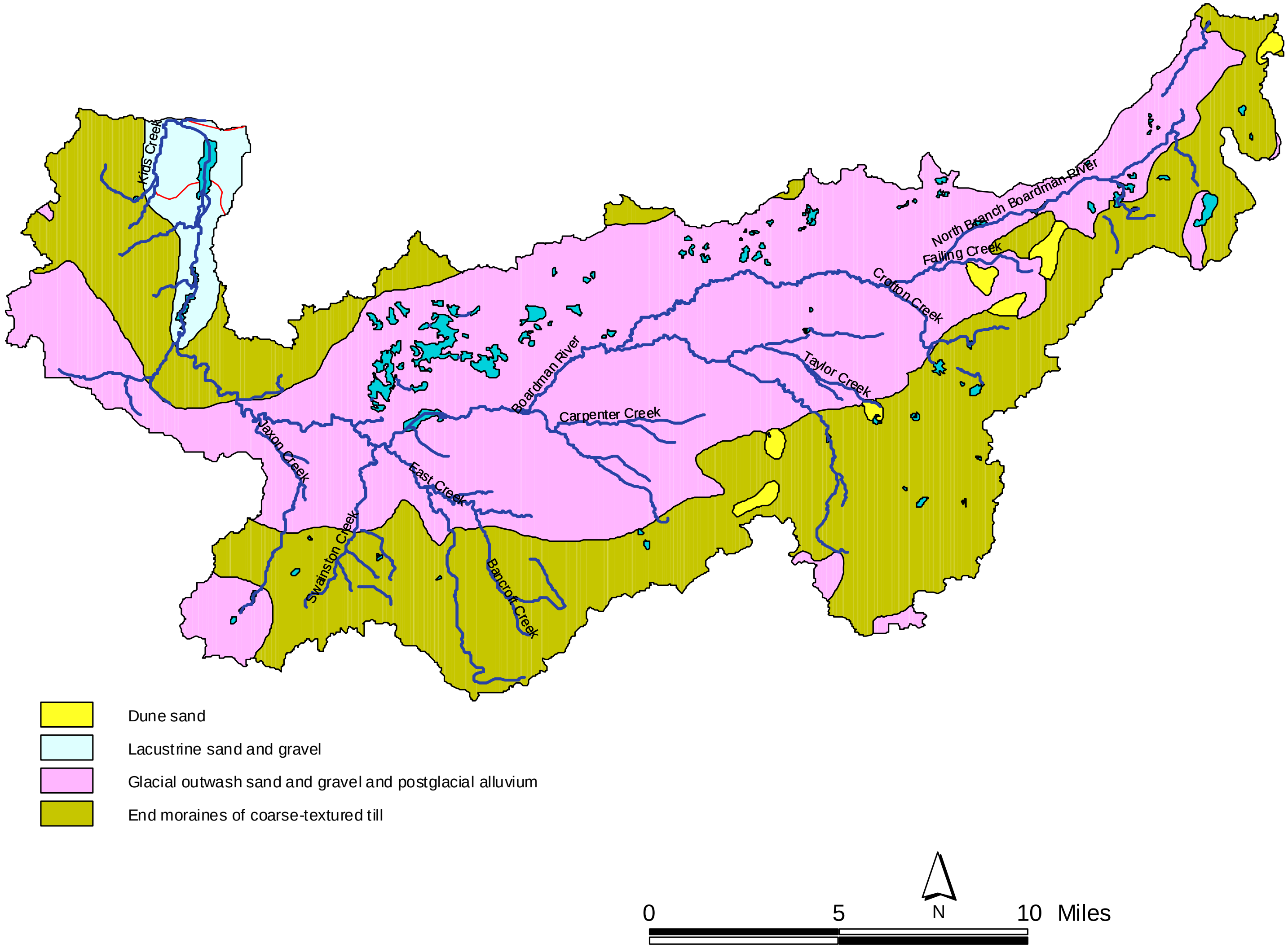

Figure 4.–Surficial geology of the Boardman River watershed.

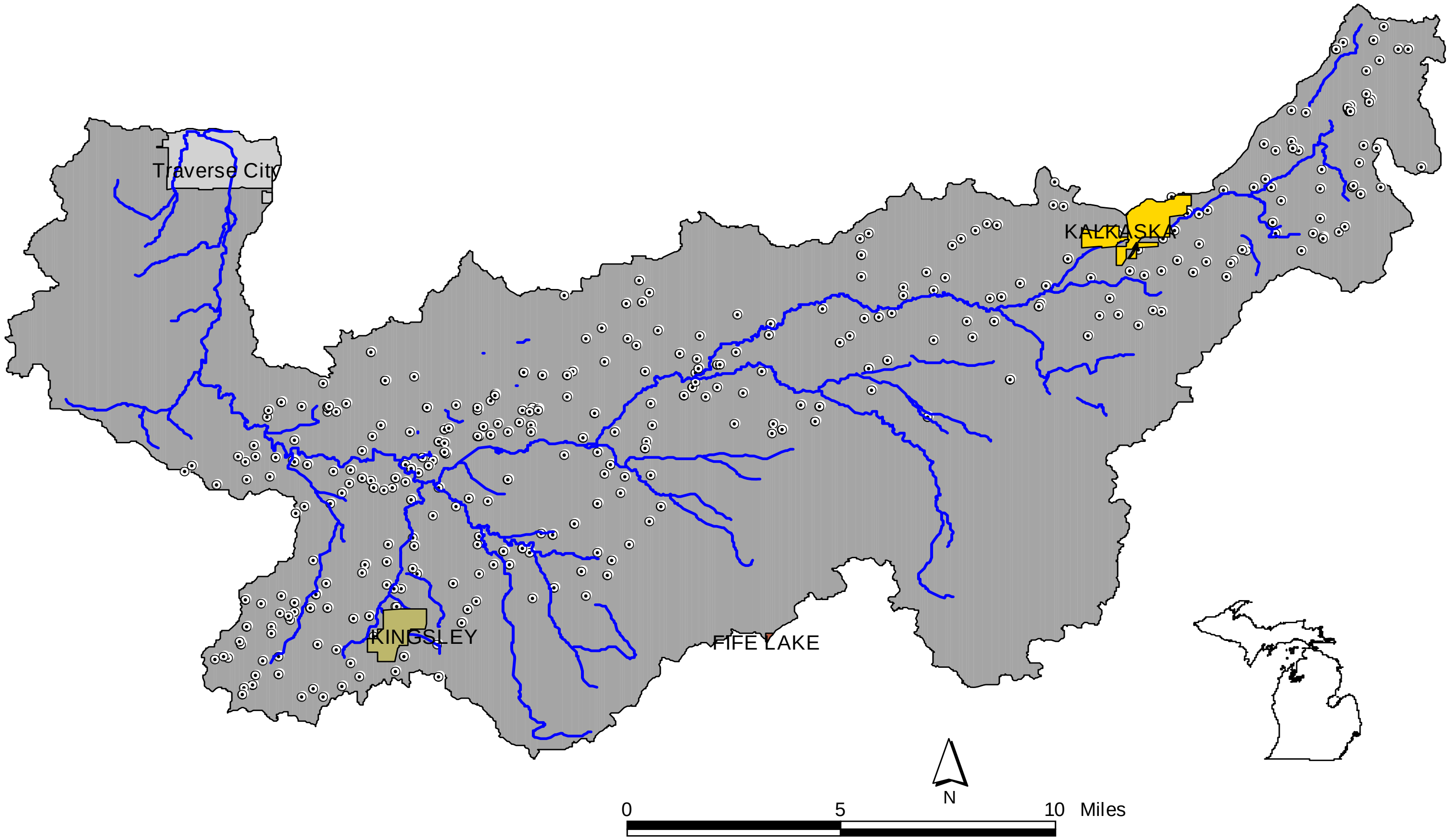

Figure 5.–Oil and gas wells in the Boardman River watershed.

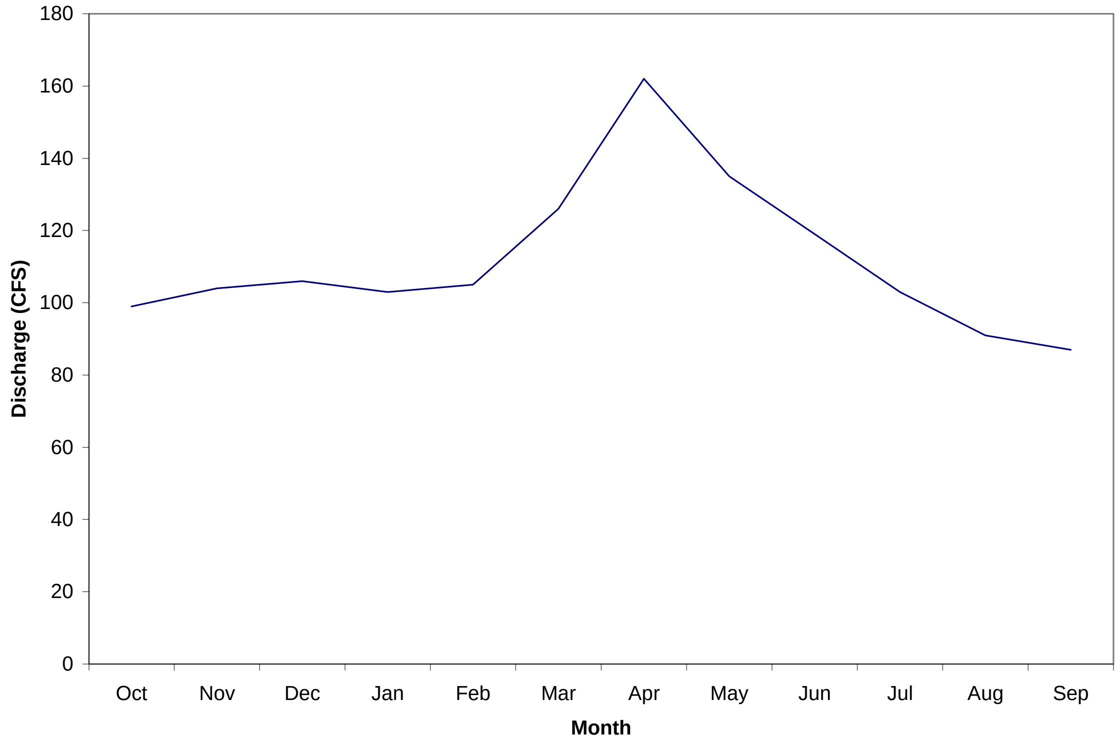

Figure 6.–Mean monthly discharge for the Boardman River for the period of record (1997-2005). Data are shown from October through September, a traditional water year. Source: United States Geological Survey, Ranch Rudolf gauge station.

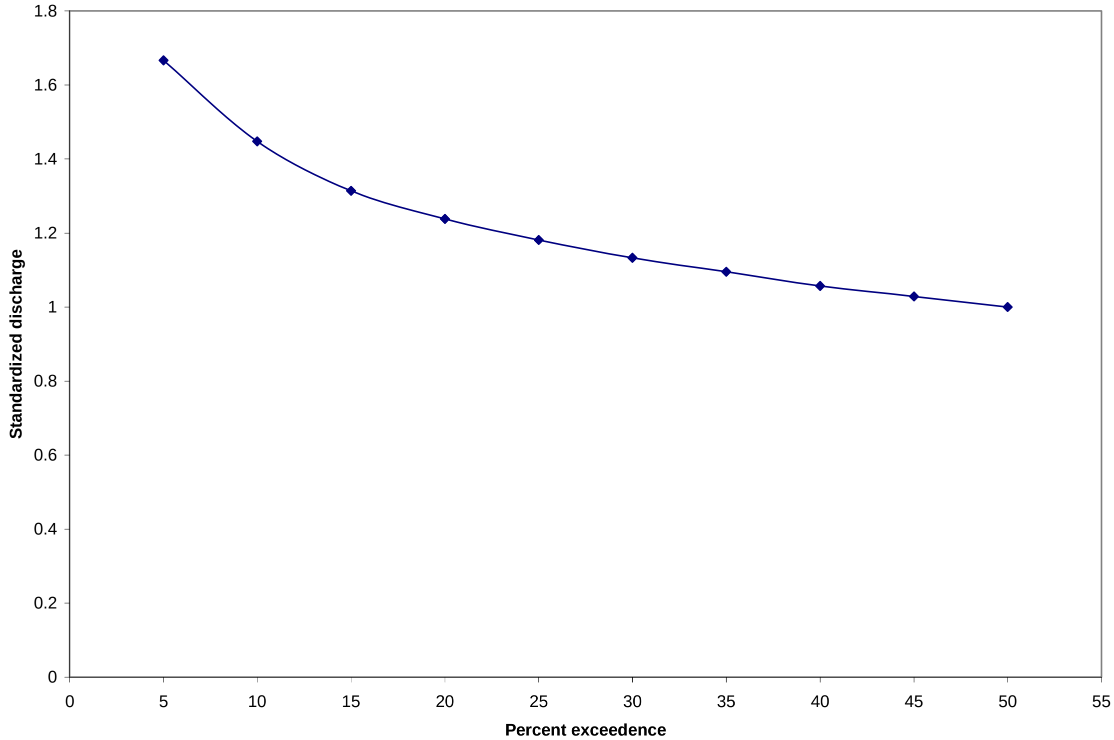

Figure 7.–Standardized low flow exceedence curves for the Boardman River (1997-2005). Standardized discharge is the discharge (Q)/ median (50% Q) discharge. Exceedence curves represent the probability of a discharge exceeding a given value. Source: United States Geological Survey, Ranch Rudolf gauge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

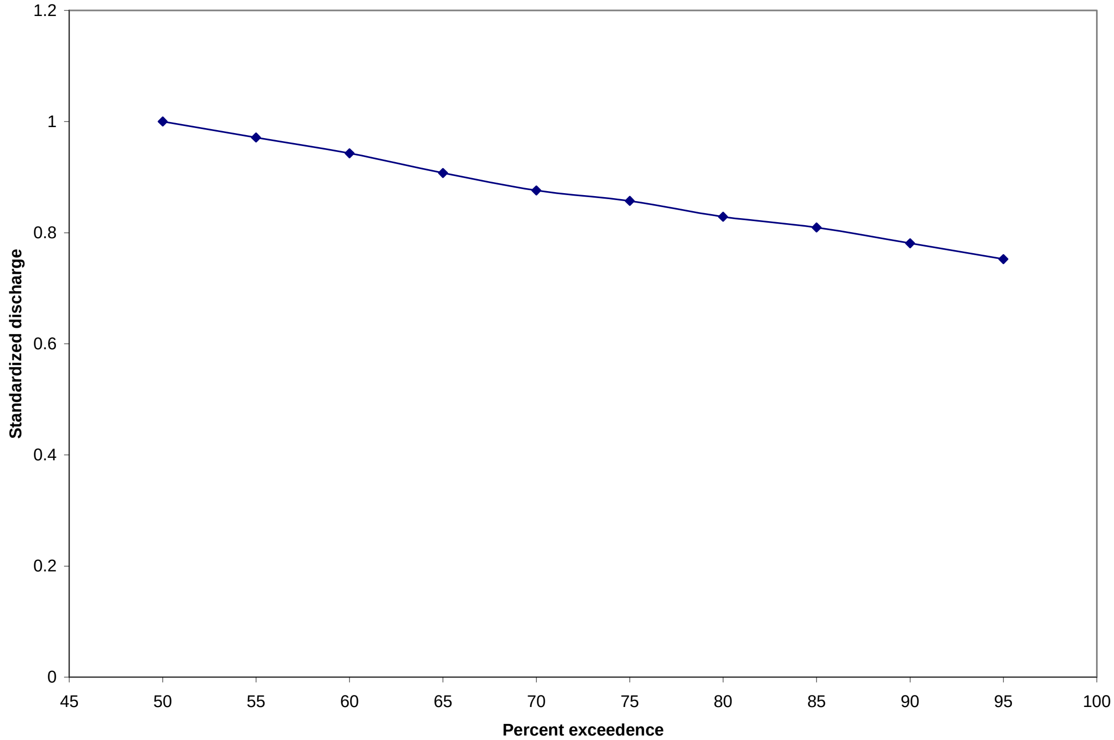

Figure. 8.–Standardized high flow exceedence curves for the Boardman River (1997-2005). Standardized discharge is the discharge (Q)/ median (50% Q) discharge. Exceedence curves represent the probability of a discharge exceeding a given value. Source: United States Geological Survey Ranch Rudolf gauge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

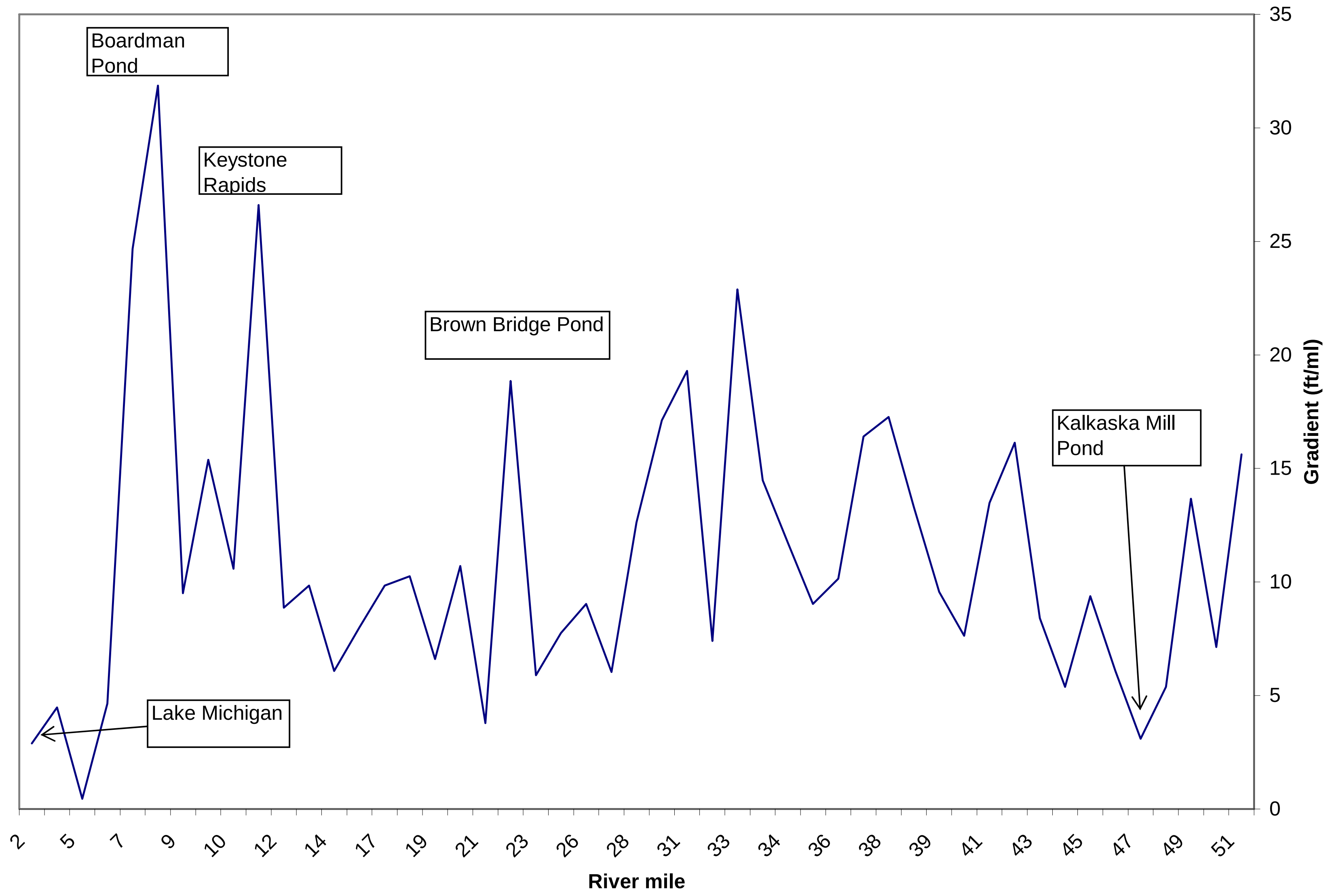

Figure 9.–Gradient (elevation change in feet per mile) of the Boardman River.

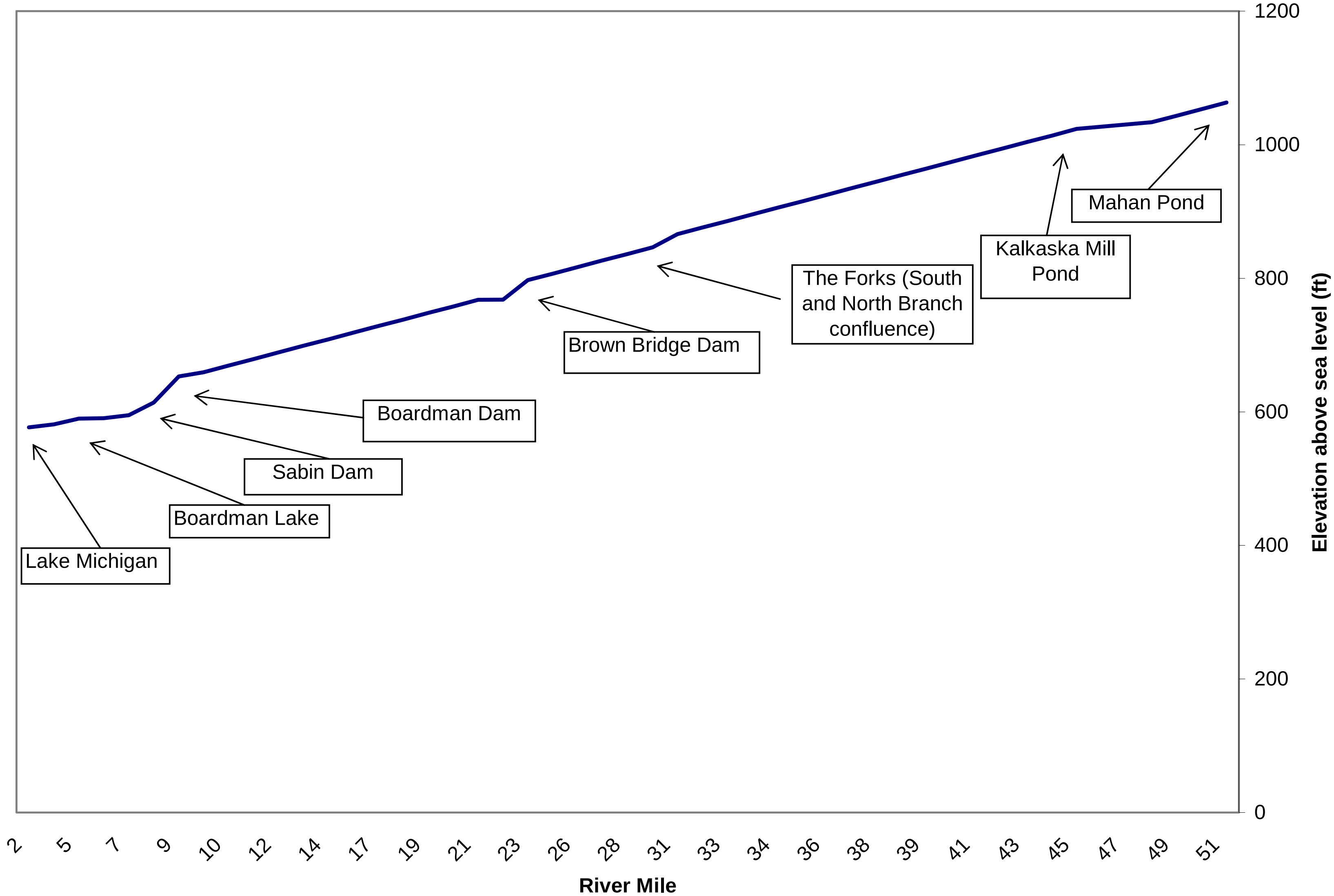

Figure 10.–Elevation changes, by river mile, from headwaters to the mouth of the Boardman River.

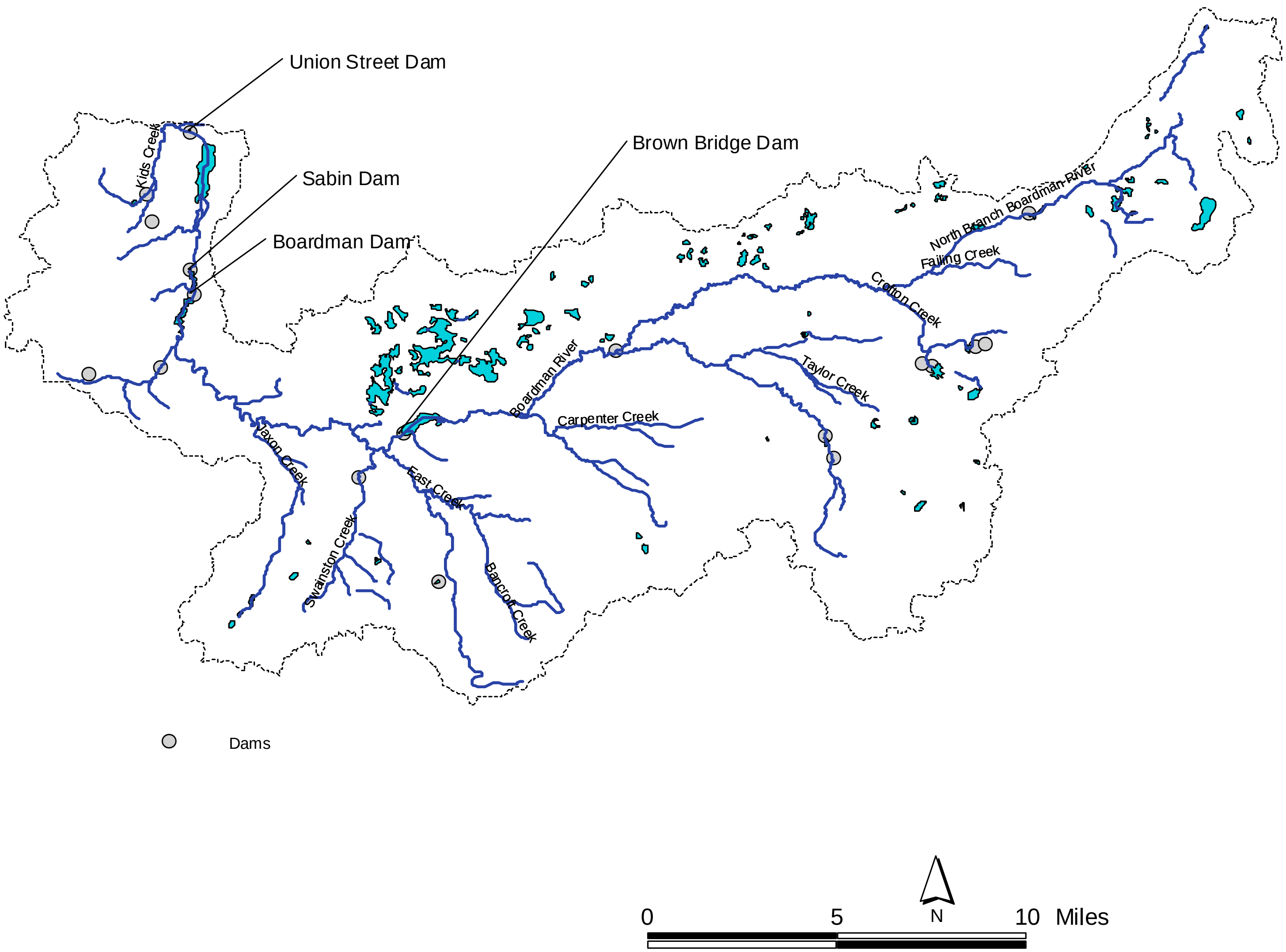

Figure 11.–Approximate location of dams (>6 ft of head) in the Boardman River watershed.

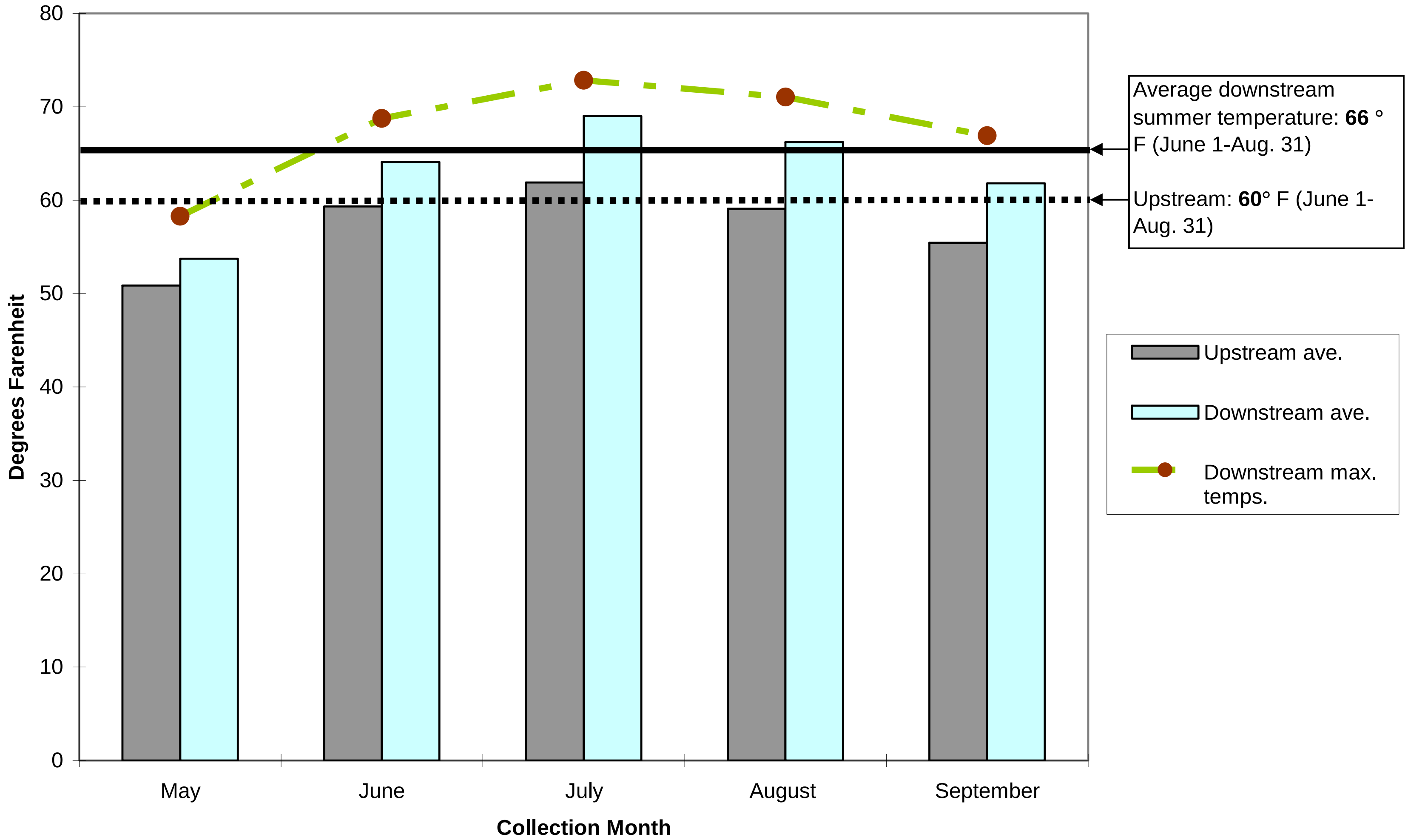

Figure 12.–2002 average and maximum water temperatures upstream and downstream of Brown Bridge Dam. Source: Michigan Department of Natural Resources, Fisheries Division.

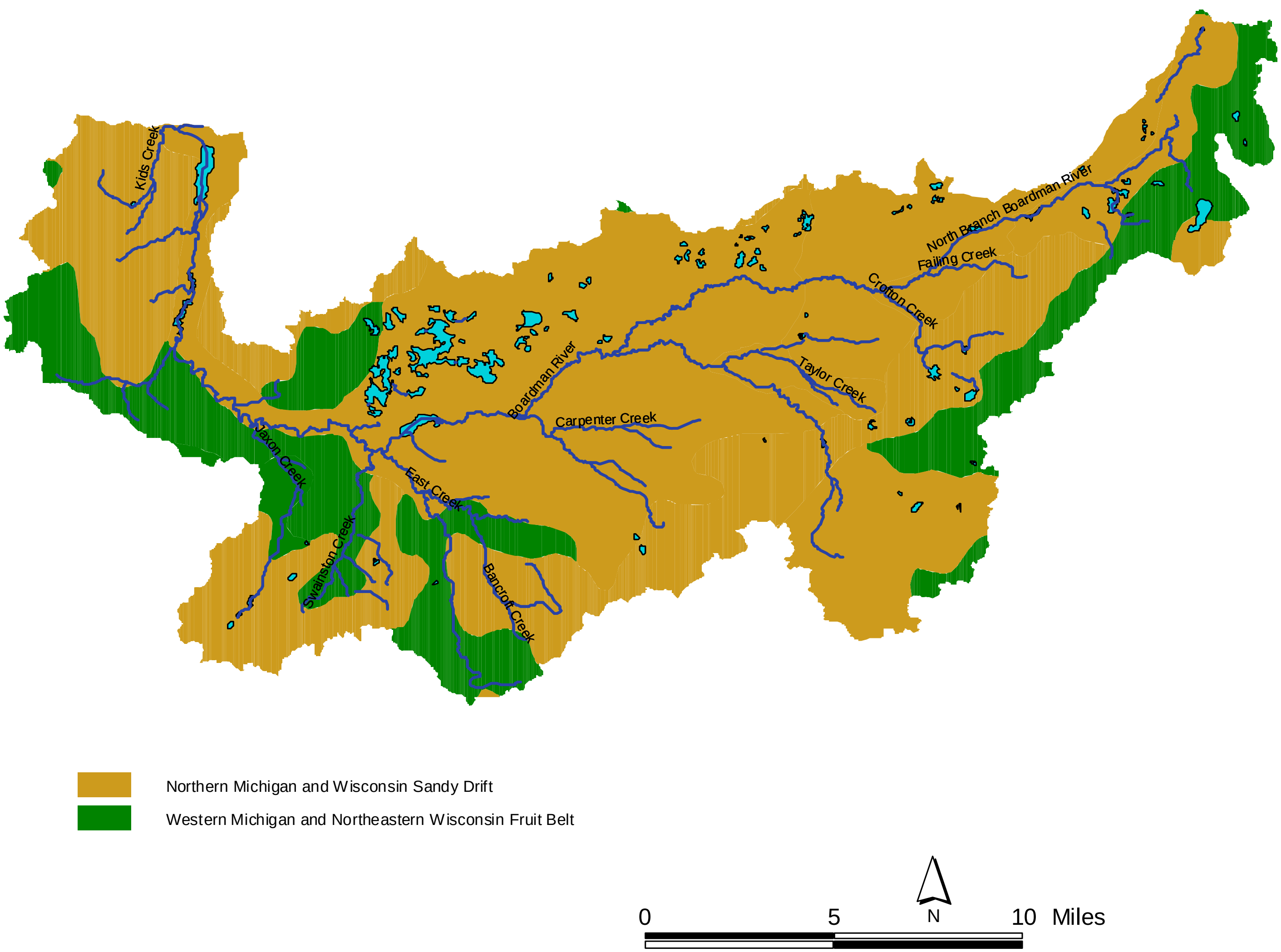

Figure 13.–Land Resource Areas within the Boardman River watershed.

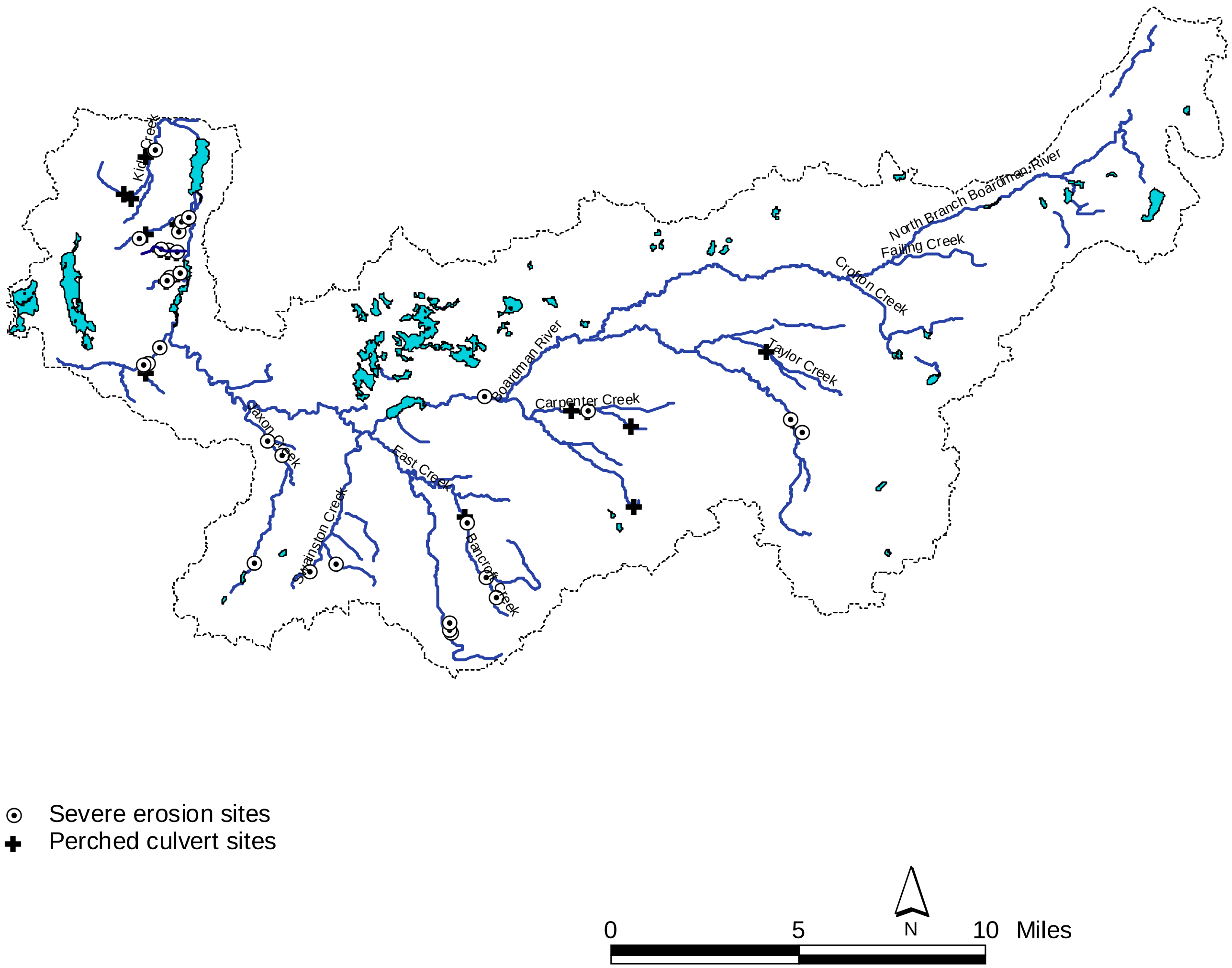

Figure 14.–Severe erosion and perched culvert sites within the Boardman River watershed

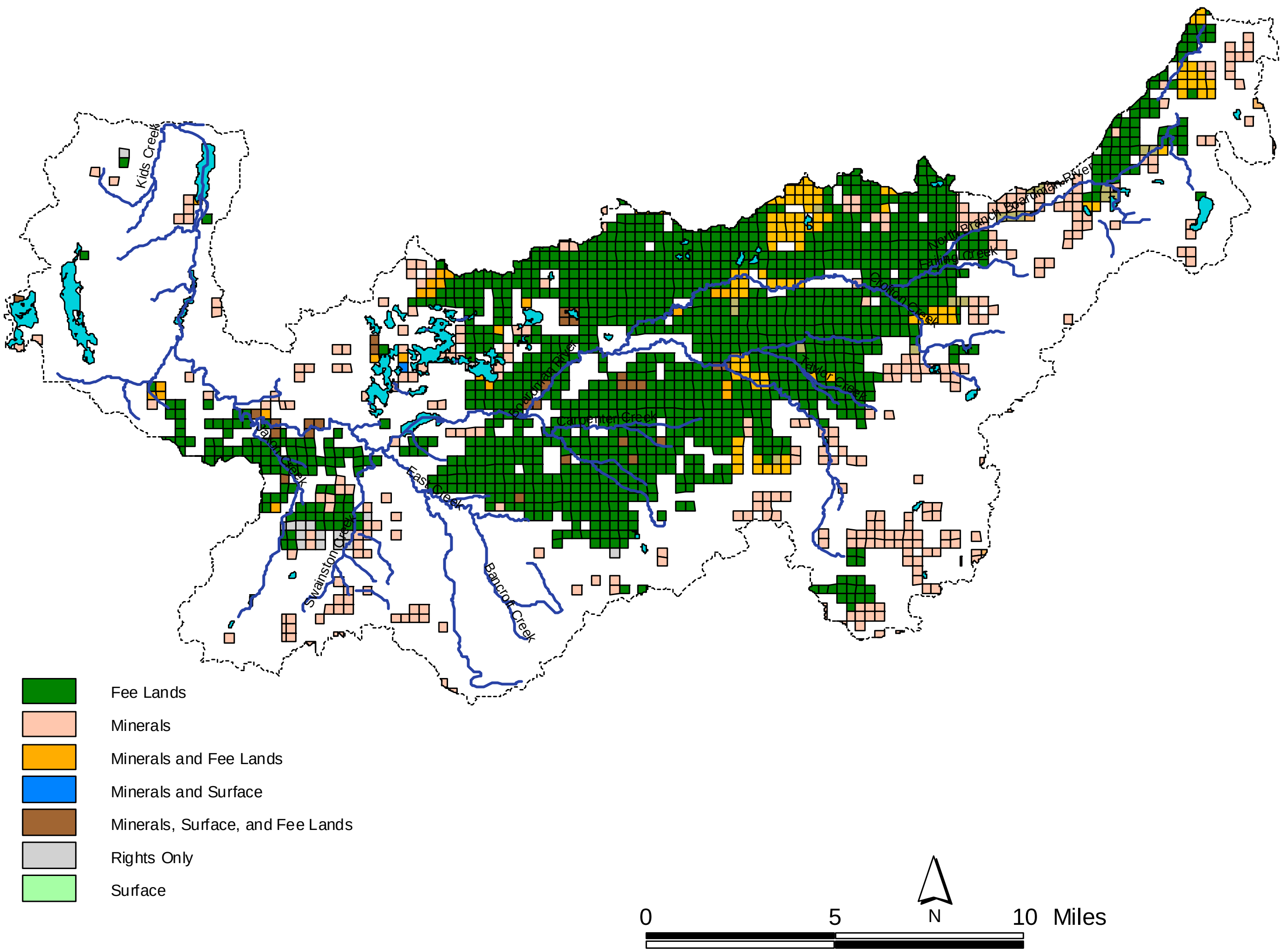

Figure 15.–State Land ownership within the Boardman River watershed.

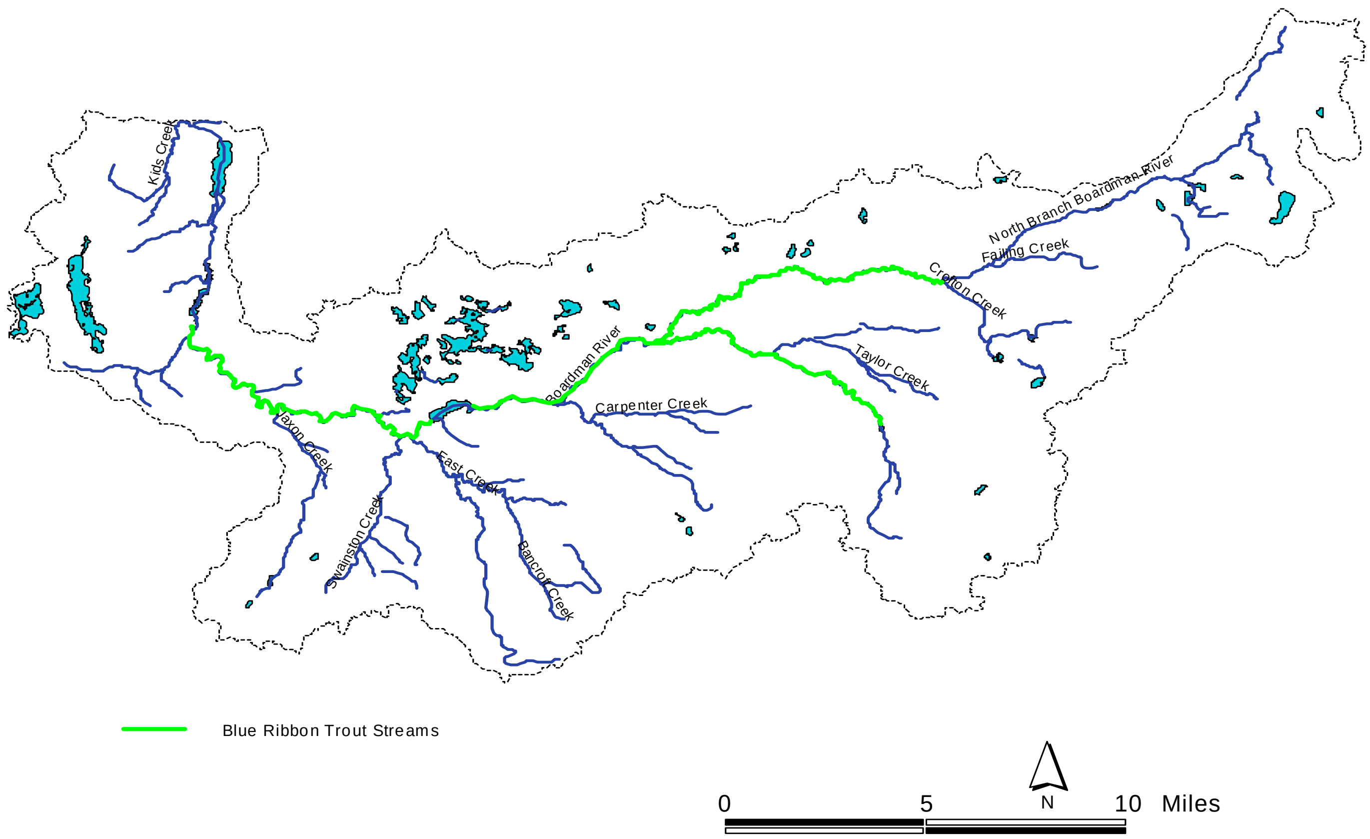

Figure 16.–Blue Ribbon Trout Stream designations within the Boardman River watershed.

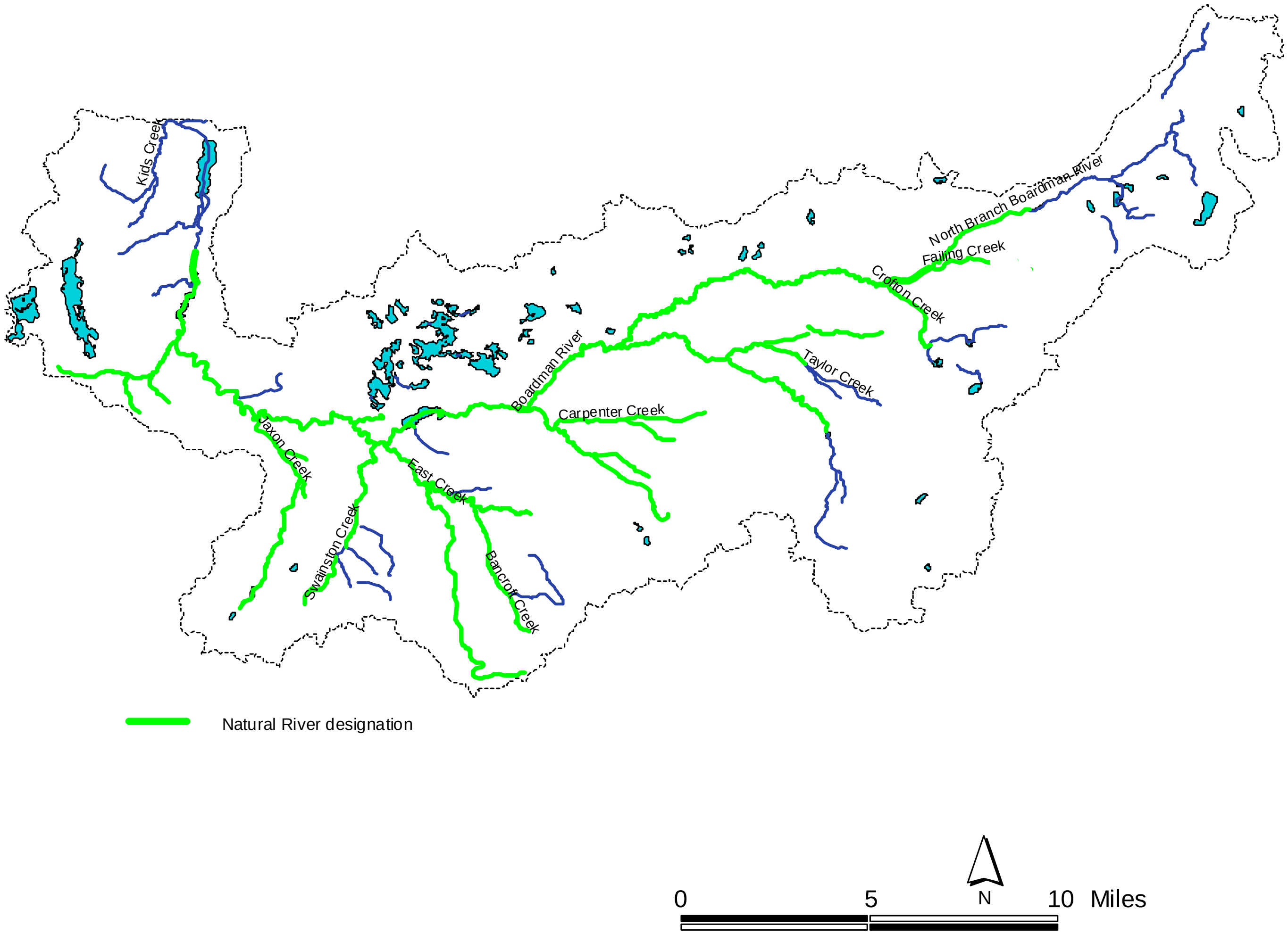

Figure 17.–Natural River designation within the Boardman River watershed.

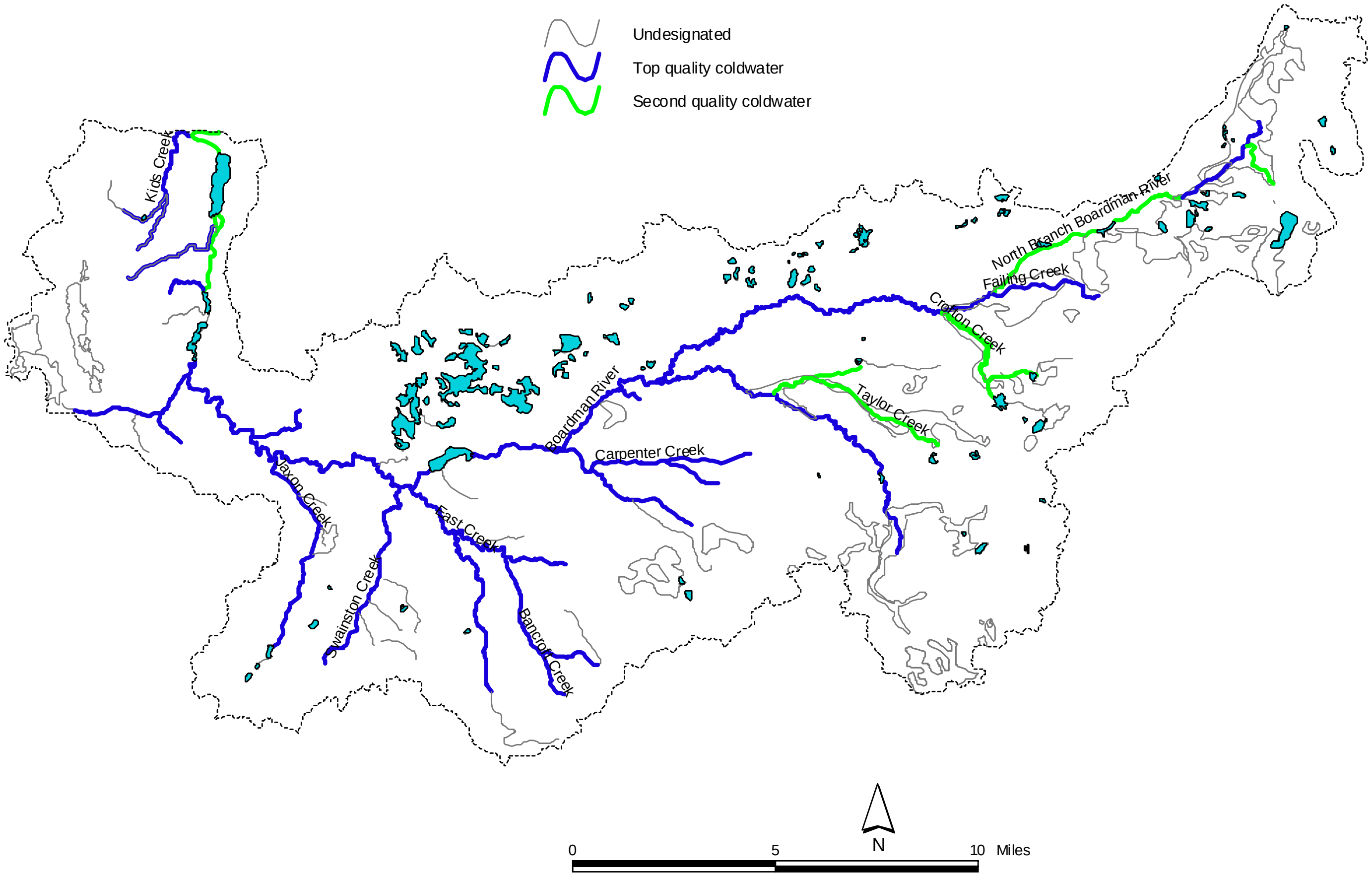

Figure 18.–Quality of water type in the Boardman River watershed.

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TABLES

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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 gauge 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	T27N, R11W, S2
Except: Boardman Lake		T27N, R11W, S10, 11, 14, 15
Sabin Hydro Pond		T27N, R11W, S27
Boardman Hydro Pond		T27N, R11W, S34;T26N, R11W, S3
Kids Creek	Grand Traverse	T27N, R11W, S3
Unnamed Creek	Grand Traverse	T27N, R11W, S22
Unnamed Creek	Grand Traverse	T27N, R11W, S27
Unnamed Creek	Grand Traverse	T26N, R11W, S3
Jaxon Creek	Grand Traverse	T26N, R11W, S13
Unnamed Creek	Grand Traverse	T26N, R11W, S14
Swainston Creek	Grand Traverse	T26N, R10W, S21
Fast Creek	Grand Traverse	T26N, R10W, S21
Twenty-two Creek	Grand Traverse	T26N, R9W, S18
Hannas Creek	Grand Traverse	T26N, R9W, S9
South Branch Boardman River	Grand Traverse and Kalkaska	T26N, R9W, S3
North Branch Boardman River	Grand Traverse and Kalkaska	T26N, R9W, S3
Except: Boardman Mill Pond from the dam upstream to Kettle Lake Road		T27N, R7W, S16

Lake name	County	Lake type/location
Sand Lake #1	Grand Traverse	Type C/T27N, R9W,S23
Big Guernsey Lake	Kalkaska	Type C/TT27N, R8W, 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 Ave., Ann Arbor, MI 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)	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]
	Collection location						
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.

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]
	Collection location						
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 06/09–07/22/2003
[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 MI College (Greg LaCrosse), and Ken Gregory from 1995–2000. The survey area extended from Beitner Bridge to approximately 300 yards north of Sabin Dam (T. 26N R.11W Secs. 3, 27, and 34).
[e] Audubon 3 references an environmental survey (four field visits from 1996–99 at T.27N R11W Sec. 27) 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 MI College (Greg LaCrosse), and Ken Gregory from 1995–2000. The survey area extended from Beitner Bridge to approximately 300 yards north of Sabin Dam (T. 26N R.11W Secs. 3, 27, and 34).

[b] Audubon 2 references an environmental survey (four field visits from 1996–99 at T.27N R11W Sec. 27) 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.

	Years	Brown trout		Brook trout		Rainbow trout	
Station and survey area	sampled	no/acre	(lbs/acre)	no/acre	(lbs/acre)	no/acre	(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 0.99 acres	2005	379	(31.1)	328	(6.5)		
Below Sabin Dam 5.67 acres	2006	33	(21.7)				

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

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